FINAL
REMEDIAL DESIGN REPORT
PEMACO SUPERFUND SITE

5050 E. SLAUSON AVENUE
MAYWOOD, CALIFORNIA

August 2006

Volume I
Design Report, Tables, Figures, & Appendices B, C, D, E, & F

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Engineering and Science

317 E. Main Street
Ventura, CA 93001

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Acronyms and Abbreviations

°F	degree Fahrenheit
AC	alternating current
acfm	average cubic feet per minute
ARAR	Applicable or Relevant and Appropriate Requirements
AST	aboveground storage tank
ASTM	American Society for Testing and Materials
amu	Atomic mass unit
BACT	Best Available Control Technology
bgs	below ground surface
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
C	Celsius
CalEPA	California Environmental Protection Agency
CCS	California Coordinate System
CCRL	Concrete and Cement Reference Laboratory
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation and Liability Information System
CET	CET Environmental Services, Inc.
cfm	cubic foot per minute
CFR	Code of Federal Regulations
CO	Carbon monoxide
COC	Contaminants/chemicals of concern
COPC	Contaminants/chemicals of potential concern
CPT	Cone Penetrometer Technology
CPVC	chlorinated polyvinyl chloride
CQAP	Construction Quality Assurance Plan
CQC	Contractor Quality Control
DAF	Dilution Attenuation Factor
DCA	Dichloroethane

Acronyms and Abbreviations (Continued)

DCE	Dichloroethene
DPE	Dual-phase Extraction
DTSC	Department of Toxic Substances Control
E&E	Ecology & Environment
ERH	Electrical Resistance Heating
fps	foot per second
FS	Feasibility Study
ft	Foot or Feet
FTO	Flameless Thermal Oxidizer
GAC	Granular Activated Carbon
gpd	gallon per day
HDPE	high-density polyethylene
Hg	Mercury
hp	horsepower
HRS	Hazardous ranking system
HVDPE	High-vacuum dual-phase extraction
HVOC	Halogenated volatile organic compound
in	inch
in Hg	Inches of mercury
L	liter
LADWP	Los Angeles Department of Water and Power
LARWQCB	Los Angeles Regional Water Quality Control Board
lb	pound
lbs/day	pounds per day
MCL	Maximum Contaminant Level
mg/kg	milligram per kilogram
mg/L	milligram per liter
mg/m^3	milligram per cubic meter
min	minute
MIP	Membrane interface probe

Acronyms and Abbreviations (Continued)

NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NHVOC	Non-halogenated volatile organic compound
NOx	nitrous oxides
NPDES	National Pollution Discharge and Elimination System Permit
NPL	National Priorities List
O&M	operation and maintenance
od	outside diameter
OSHA	Occupational Safety and Health Administration
PAHs	polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene
P&ID	Piping and Instrumentation Diagram
PM10	particulates
ppb	Parts per billion
ppm	Parts per million
ppmv	Parts per million per volume
PRG	Preliminary remediation goal
psf	pounds per square foot
psi	pound per square inch
psig	pound per square inch gauge
PVC	polyvinyl chloride
RD/RA	Remedial Design/Remedial Action
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROC	Radius of Capture
ROD	Record of Decision

Acronyms and Abbreviations (Continued)

ROI	Radius of influence
RPM	Remedial Project Manager
RWQCB	Regional Water Quality Control Board
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act of 1986
SCAQMD	South Coast Air Quality Management District
scfm	standard cubic feet per minute
SD	submittal data
SDEF	Standard Data Exchange Format
SDR	standard dimension ratio
sec	second
Site	Pemaco Superfund Site
SOx	sulfur oxides
SRM	Standard Reference Materials
SS	stainless steel
SSHP	Site Safety and Health Plan
SSL	Soil screening level
SSPC	Society for Protective Coatings
SSU	Saybolt second universal
STI	Steel Tank Institute
SVE	Soil vapor extraction
SVOC	Semi-volatile organic compound
TCE	Trichloroethene
TDH	Total Dynamic Head
TN&A	T N & Associates, Inc.

Acronyms and Abbreviations (Continued)

TSH	Total Static Head
UBC	Uniform Building Code
UFC	Uniform Fire Code
UL	Underwriters Laboratory
USACE	United States Army Corps of Engineers
USCS	Unified Soil Classification System
USEPA	United State Environmental Protection Agency
UST	Underground storage tank
UV	ultraviolet
VE	Vapor Extraction
VOC	volatile organic compound
w.c.	water column
WOC	width of capture

1.0 INTRODUCTION

This Final *Design Report* has been prepared for the Pemaco Superfund Site (Pemaco Site) in Maywood, California. The report was prepared by TN & Associates (TN&A) in accordance with the following documents:

- *Record of Decision for the Pemaco Superfund Site* (ROD) (USEPA, 2005)
- Statement of Work (TN&A, 2000)
- Remedial Design/Remedial Action (RD/RA) Handbook (USEPA, 1995)

This work was conducted under the authority of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, also known as "Superfund") as amended by the Superfund Amendments and Reauthorization Act (SARA) and the CERCLA regulations published in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). TN&A conducted this work under contracts issued by the U.S. Army Corps of Engineers (USACE), Omaha District; for the USEPA, Region IX (USEPA).

1.1 PURPOSE AND SCOPE OF WORK

The purpose of this report is to present justification for design plans and specifications for the installation and implementation of soil and groundwater treatment systems at the Pemaco Superfund Site located in Maywood, California.

The Final Design includes:

- The Design Report (as Volume I, Tables, Figures, Appendices B – F)
- The Design Specifications (as Volume II, Appendix A)
- Final Design Drawings

Selected remedial actions for the Pemaco Site were presented in the ROD dated January 13, 2005. The State of California concurs with the selected remedy as documented by correspondence from the Department of Toxic Substances Control (DTSC) dated April 16, 2004.

1.2 PROJECT BACKGROUND

The Pemaco Site is comprised of 1.4 acres located in a mixed industrial and residential neighborhood in Maywood, Los Angeles County, California. Drawing G-1 is the Title Sheet of the design drawings package and shows the Site location and vicinity maps. The Facility formally operated as a custom chemical blender during the 1950s until 1991. A wide variety of chemicals were used and stored on site including chlorinated and aromatic solvents, flammable liquids, oils and specialty chemicals. These chemicals were stored in drums, aboveground storage tanks (ASTs) and underground storage tanks (USTs). In 1991 the facility was abandoned by its owner. Remaining stored chemicals in drums and storage tanks (USTs) were removed by the USEPA between 1992 and 1998.

Environmental assessments performed between 1990 and 1999 identified soil and groundwater contamination that originated from the blending and storage of chemicals at the Site. A soil vapor extraction (SVE) system was installed as an interim treatment measure in 1998 and operated until 1999, when it was shut down due to community concerns with emissions from the thermal oxidation unit used to treat the extracted vapors.

The USEPA enlisted the Pemaco Site into the Superfund program in 1999, and TN&A performed a full-scale Remedial Investigation (RI) between January 2001 and November 2001. TN&A conducted treatability tests including aquifer testing in December 2001 and a high vacuum dual phase extraction pilot test in December 2002. Additional “source” area evaluation was performed in September 2003 via membrane interface probe. The ROD for the soil vapor and groundwater systems was finalized in January 2005. Groundwater monitoring, “data gap” investigations, and pilot-scale activities for the evaluation of remedial technologies have been in progress for the Pemaco Site since May 2001.

The City of Maywood, in conjunction with the Trust for Public Land, is developing the Site and adjacent properties to build the Maywood Riverfront Park (“the Park”), a public recreational park. Future remedial activities at the Site and adjacent properties will be integrated with the existence of this park.

2.0 SITE DESCRIPTION

The Pemaco Site is adjacent to a residential neighborhood, a residential park and light industrial area immediately to the south. A heavy industrial area is located immediately to the north of the Site and an abandoned industrial property lies to the west of the Site. The concrete-lined Los Angeles River is on the eastern border of the Site.

The Site layout, location of the Los Angeles River, adjacent roads and properties, existing extraction and monitoring wells, and the contaminant plumes to be treated are shown on Drawing C-1. Grading activities for the Park have begun so the topography is currently in flux. The proposed grades and surface improvements for the Park are shown in Drawing C-2.

2.1 SURVEY DATUM

Site survey horizontal control is referenced to the California Coordinate System (CCS), North American Datum 1983 (NAD83). Benchmarks (vertical control) in the site vicinity are referenced to the North American Vertical Datum 1988 (NAVD88). Several control point locations have been established for the Park construction which will be adopted for the remedial action provided that vertical control is established to an accuracy of 0.01 feet and horizontal is established to an accuracy of 0.1 feet. Additional control points meeting the accuracy requirement are as follows:

The horizontal bench marker [DY9343, CCS Zone 5, NAD83], is located in the City of South Gate, California, approximately 0.3 miles west of the Los Angeles River and within the Union Pacific Railroad Right-of-Way. To reach the station from the intersection of the 710 Freeway with Firestone Boulevard, go westerly along Firestone Boulevard 0.4 miles. The monument is a stainless steel rod mark; the rim of the cover is stamped “CADT 07-CI HPGN-D 1992”. The vertical bench marker (CY 855, under the Los Angeles County Department Survey Section) is located on Slauson Avenue (on the Los Angeles River Bridge) within the City of Maywood, California.

2.2 EXISTING MONITORING WELL NETWORK

The existing groundwater monitoring well network in the vicinity of the Pemaco Site is shown on Drawing C-1. Well construction details are provided on Tables 2-1 and 2-2 for the Perched Zone wells and Exposition Aquifer wells, respectively.

2.3 GEOLOGICAL AND HYDROGEOLOGIC SETTINGS

2.3.1 Regional Geology/Hydrogeology

The Los Angeles–Orange County coastal plain is a structural basin formed by folding of the consolidated sedimentary, igneous and metamorphic rocks that underlie the basin at great depths. Primary geologic/hydrogeologic units in the area, from youngest to oldest include:

- Recent Alluvium – Primarily unconsolidated braided-river and floodplain deposits. These deposits comprise the uppermost 30 to 40 feet of soil/sediment in the immediate area.

- Pleistocene Lakewood Formation, including the Exposition and Gage/Gardena Aquifers – Consisting of braided river and floodplain deposits. In the Pemaco area, sediments of the Lakewood Formation generally comprise the stratigraphic interval between about 35 and 200 feet bgs. Saturated intervals of the Lakewood Formation within the study area that are stratigraphically equivalent to the Exposition Aquifer do not meet the strict definition of an aquifer because they are not capable of yielding economically significant quantities of water. The Gage/Gardena Aquifer is assumed to be located between 180 and 200 feet bgs in the site vicinity, but this has not been confirmed. The deepest borehole drilled during the RI activities went to 183 feet bgs.
- Lower Pleistocene San Pedro Formation, including the Hollydale, Jefferson, Lynwood and Silverado Aquifers – A variety of lithosomes deposited in both marine and non-marine environments. In the Pemaco area of the Central Groundwater Basin, the stratigraphic top of the San Pedro Formation is generally placed at the base of the Gage/Gardena Aquifer (basal Lakewood Formation), estimated to occur at approximately 200 feet bgs. The uppermost unit of the San Pedro Formation is a 50- to 75-foot thick fine-grained lithosome, generally regarded as an aquitard. The Hollydale and Jefferson aquifers are the upper aquifers in the San Pedro Formation and may be present below the Pemaco Site, with the top of the uppermost coarse-grained unit occurring somewhere between 250 and 325 feet bgs.

The aquifers mentioned above are all used for both municipal and industrial purposes in various parts of the Central Basin. In the Pemaco area, screened/perforated intervals in nearby production wells begin in the San Pedro Formation Aquifers, usually at depths of 350 feet bgs or deeper. The closest active well is approximately ½ mile south of the Site (screen interval begins at 610 feet bgs), one of the two wells owned and operated by Mutual Maywood Water Company No. 3. The shallowest production well within one mile of the Site is screened starting at 350 feet bgs within the uppermost aquifer of the San Pedro Formation (the Jefferson Aquifer). In general, the groundwater flow direction in the aquifers is southwest, towards the coast.

2.3.2 Geology/Hydrogeology of the Study Area

Geologic cross section A-A' (Figure 2-1) illustrates the Site's geology and hydrogeology as encountered in continuously-cored borings drilled during RI/FS activities (boring logs are provided as an attachment to Appendix A, Section 01115 – Site Description). To describe the stratigraphy and lithologic units underlying the site vicinity, the following nomenclature was adopted and will be used throughout the document as they relate to analytical results and remedial actions associated with the Site:

- Surface and Near-surface Soil;
- Upper Vadose Zone;
- Lower Vadose Zone;
- Perched Groundwater Zone; and
- Exposition Aquifer Zones 'A' through 'E'.

Site stratigraphy is summarized in Table 2-3 and may be used in conjunction with the discussion of each zone below.

2.3.2.1 Surface and Near-surface Soil

Surficial fill in the area varies in thickness from 2 to 6 feet and is typically comprised of dark yellowish brown silty sands and local gravelly sands or clayey gravels.

2.3.2.2 Upper Vadose Zone

For purposes of this report, the upper vadose zone includes the upper vadose zone sands and the perching clay. The saturated zone above the perching clay (perched groundwater zone) is discussed in Section 2.3.2.4.

Upper Vadose Zone Sands

Typical depth of the upper vadose zone is between 2 to 25 feet below ground surface (bgs). These native soils are predominately light olive gray to dark yellowish brown laminated to moderately bedded fine silty sands ranging from 1 to 20 feet in thickness interbedded with pale yellowish brown to light olive gray lenses of laminated to poorly bedded poorly graded sands and fine poorly graded sands with silt which are 2-inches to 6-feet thick. Local discontinuous lenses of olive gray sandy silt and lean clay lenses ranging from 3 inches to 4 feet thick are also present within the upper vadose zone sand.

Perching Clay

Typical depth of the perching clay is between 28 to 40 feet bgs. The top of this unit is comprised of silty lean and fat clays ranging from 1 to 15 feet in thickness, which are underlain and interbedded with olive gray to moderate yellowish brown clayey and sandy silts ranging from 1 to 8 feet in thickness. The perching clay and associated clayey silts comprise the fine-grained lithosome that ranges from 10 to 20 feet in total thickness. Local unsaturated silty sand and sands with silt lenses are found within the lithosome.

2.3.2.3 Lower Vadose Zone

Lower Vadose Zone Sand

The lower vadose zone sand is typically found between 40 to 50 feet bgs. It is predominately fine- to medium-grained, unsaturated, poorly graded sands and gravelly well-graded sands derived from granitic source rocks. The zone typically coarsens downward with poorly bedded gravelly basal units. The lower vadose zone sands are usually 1- to 14-foot thick with local intervals of silty sands and poorly graded sands with silt which are 6-inches to 3-foot thick. Local interbeds of silt lenses are 6-inches to 4-foot thick within this unit. The lower vadose zone sand appears to be continuous throughout the area as it was encountered in every boring completed in the site vicinity except in the area adjacent to MW 12 (Alamo and 60th Street) where it appears to pinch out locally. The thickest local sequences are found along District Blvd. and in the area underlying 60th Street between Walker Ave. and District Boulevard. Fine silty sands comprise the unit in locations where the interval is less than 3 feet thick.

Lower Vadose Zone Fine-Grained Unit

Typical depth of the lower vadose zone fine-grained unit is between 50 to 65 feet bgs. It is comprised of sandy and clayey silts ranging from 7 to 20 feet in thickness interbedded with lean and fat clays ranging from 6 inches to 5 feet in thickness. Local discontinuous lenses of unsaturated poorly graded sands and silty sands are 0.5- to 2-foot thick within this interval. The thickest areas of the unit are predominately silt. Localized abundant organic material can also be found throughout the interval.

2.3.2.4 Perched Zone

The perched groundwater zone is typically found between 25 and 40 feet bgs within the study area. Groundwater in the perched zone occurs in semi-continuous and discontinuous lenses of poorly graded sand, silty sand, and sandy silt. These lenses are located at different depths ranging from 20 and 40 feet bgs and 5 inches to 5 feet in thickness. The geometry of the perched zone is controlled by the highly irregular and undulating top surface of the underlying, laterally extensive perching clay (described above in Section 2.3.2.2). Measurements of depths to groundwater in the perched zone in the Pemaco site vicinity have ranged from 18.48 feet bgs (B-31, April 2001) to 39.31 feet bgs (B-17, May 2001) since measurements began in September 2000. Groundwater fluctuations of greater than 5 feet have been observed since routine gauging started. Forty-two monitoring wells are currently installed within the perched groundwater zone.

The complex hydrogeology of the perched zone causes highly variable groundwater gradients. The overall general component of apparent groundwater flow in the perched zone is towards the southwest, but there are many localized areas that indicate that the apparent groundwater flow is in multiple directions.

The perched zone can be characterized by low transmissivities and very limited yield. This is not a viable aquifer.

2.3.2.5 Exposition Aquifer Zones ‘A’ – ‘E’

Beneath the perched groundwater zone, there are five distinct saturated intervals present within the study area that are typically found between 65 and 175 feet bgs that are separated by silt/clay intervals. These saturated zones do not comprise a viable aquifer, as the groundwater yield does not produce economically significant quantities of water to local production wells. However, as these zones are stratigraphically equivalent with the more regional Exposition Aquifer, they have been have been informally named the Exposition ‘A’ through ‘E’ Zones. Thirty-six monitoring wells are currently installed within the five Exposition groundwater zones.

Exposition ‘A’ Zone

The first saturated zone encountered below the perched zone is the ‘A’ Zone, typically found between 65 and 75 feet bgs. It is comprised of fine silty and poorly graded sands locally interbedded with well-graded sands. The thickness of this zone is highly variable ranging from 3 inches to 10 feet in thickness. This interval can be characterized as a series of semi-discontinuous saturated sand lenses.

Potentiometric surface measurements in the semi-confined Exposition ‘A’ Zone have ranged from 52.52 feet bgs (MW-7-75, July 2003) to 64.27 feet bgs (MW-20-70, October 2003), and groundwater fluctuations of up to 7 feet have been observed in the ‘A’ Zone since measurements began in May 2001. Groundwater gradient of the Exposition ‘A’ Zone has typically ranged from 0.0035 to 0.011 feet per feet (feet/feet). Apparent groundwater flow directions have been consistently towards the southwest and south-southwest.

Exposition ‘B’ Zone

The ‘B’ Zone is the second saturated zone below the perching layer and is typically found between 80 and 90 feet bgs. It is comprised of fine silty sands, poorly graded sands and poorly graded sands with silt ranging from 1.5 to 10 feet in thickness. The fine-grained silty sands are typically light olive gray mottled with moderate yellowish brown or moderate olive brown. Some of the thicker portions of the unit have 4-foot-thick interbeds of silt/clay. The ‘B’ Zone is continuous throughout the site vicinity, except in the area along District Blvd., south of 60th Street, where it pinches out.

A secondary saturated silty sand lens located between 90 and 92 feet bgs was consistently observed during the coring of borings MW-16 through MW-18 and RW-01 located in the southernmost portion of the Pemaco Site. This secondary lens is isolated from the ‘B’ Zone described above by an overlying interval of fat clay ranging in thickness from 1 to 3 feet. Well MW-17-95 was screened solely in this zone for aquifer test purposes. This zone was informally named the ‘B2’ Zone. The ‘B2’ lens was not encountered in any of the offsite borings that were cored below 90 feet bgs.

Potentiometric surface measurements in the confined Exposition ‘B’ Zone have ranged from 57.71 feet bgs (MW-13-85, May 2001) to 72.40 feet bgs (MW-17-95, October 2002), and groundwater fluctuations of more than 4 feet have been observed in the ‘B’ Zone since measurements began in May 2001. Groundwater gradient of the Exposition ‘B’ Zone has typically ranged from 0.0057 to 0.0092 feet/feet. Apparent groundwater flow directions have been consistently towards the southwest.

The ‘B’ Zone is more uniform and laterally continuous than the ‘A’ Zone. These two zones are the predominant zones of concern and together are informally named the Upper Exposition Aquifer.

Exposition ‘C’ Zone

The ‘C’ Zone is typically found between 100 and 105 feet bgs. It is comprised of saturated dark greenish gray fine silty sands, poorly graded sands and poorly graded sands with silt ranging from 2 to 6 feet in thickness. It appears to be continuous throughout the site vicinity within the 95 to 110 feet depth interval.

Potentiometric surface measurements in the Exposition ‘C’ Zone have ranged from 87.31 feet bgs (MW-1-100, October 2003) to 97.56 feet bgs (MW-25-110, October 2003), and groundwater fluctuations of more then 4 feet have been observed in the ‘C’ Zone since measurements began. Groundwater gradients of the Exposition ‘C’ Zone have been calculated to be 0.0016 feet/feet. Inferred groundwater flow directions have generally been towards south.

Exposition 'D' Zone

The 'D' Zone is typically found between 125 and 145 feet bgs. It is comprised of interbedded fine silty sands, poorly graded sands and poorly graded sands with silt, well-graded sands and gravelly sands and local well-graded sandy gravel intervals. Total thickness ranges from 6 to 15 feet. This zone is the thickest and highest yielding of all the Exposition groundwater zones encountered in the Site vicinity. Potentiometric surface measurements in the Exposition 'D' Zone have ranged from 97.00 feet bgs (MW-07-130, January 2003) to 106.34 feet bgs (MW-10-170, October 2003), and groundwater fluctuations of more then 6 feet have been observed in the 'D' Zone since measurements began. Groundwater gradients of the Exposition 'D' Zone have been calculated to be 0.0023 feet/feet. Inferred groundwater flow directions have generally been towards southwest.

Exposition 'E' Zone

The 'E' Zone is typically found between 160 and 175 feet bgs and is comprised of alternating saturated intervals of 1-feet-thick fine silty sands and well-graded sands. Due to the limited number of monitoring wells screened within the Exposition 'E' Zone, no gradient data is available for this zone.

2.4 PREVIOUS INVESTIGATIONS

Numerous soil and groundwater investigations have been conducted at Pemaco and the adjacent properties to assess the nature and extent of contamination at the Pemaco Site and the surrounding area. The first soil assessment of the property was completed in 1990 by the Pemaco facility owner. The owner abandoned the Site sometime after 1991 and environmental activities at the Site became the responsibility of the State of California, and eventually the USEPA under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA).

2.4.1 Initial Removal Actions

Between 1991 and 1994, approximately four hundred 55-gallon drums and three above-ground storage tanks (ASTs) were removed from the Site by order of the Los Angeles District Attorney's office. A substantial fire in 1993 destroyed much of the main warehouse building. In 1994, USEPA Region IX Emergency Response conducted a removal assessment at Pemaco at the request of Los Angeles County. As a part of this assessment, USEPA removed six 55-gallon drums, installed fencing and secured underground storage tank (UST) fill pipes with locking well caps.

2.4.2 Preliminary Assessment/Site Inspection

In June of 1995, Bechtel completed a preliminary assessment/site inspection at Pemaco, which led to the listing of Pemaco into the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) under the identification number CAD980737092. Ecology & Environment's (E&E) Superfund Technical Assistance Response Team completed an expanded site investigation in 1997, which included an evaluation of Hazardous Ranking

System (HRS) factors. Based on these factors, Pemaco was recommended to the Superfund National Priorities List (NPL).

2.4.3 Additional Removal Activities

CET Environmental Services, Inc. (CET) completed additional removal activities at Pemaco between August 1997 and March 1998 under the direction of Region IX's Emergency Removal Office (E&E, 1998a, 1998b). Work included excavation and removal of over 30 USTs, building demolition, environmental sampling and the design, installation and operation of a soil vapor extraction (SVE) system. The SVE system operated between March 1998 and March 1999 (E&E, 1999). By the end of August 1998, the SVE system had operated for 3,230 hours (134.6 days) and had removed and treated approximately 90,000 pounds of hydrocarbons and solvents from vadose zone soils at the Site. The system was turned off on March 3, 1999 due to community concern regarding the possibility of dioxin releases from the thermal oxidation unit used to treat extracted soil vapor.

2.4.4 Remedial Investigation and Feasibility Study

The USEPA placed the Pemaco Site on the NPL in January 1999, making it eligible for cleanup action under Superfund. A full-scale RI was performed by USEPA between January 2001 and November 2001 to identify the nature and extent of soil and groundwater contamination present at the Site. USEPA also conducted treatability tests and additional "data gap" assessments between December 2001 and December 2002 to support the Remedial Investigation (RI) and Feasibility Study (FS) phase of the Superfund process, which was performed between January 2002 and August 2003. These activities included the collection of over 2,500 ambient air, soil, soil vapor, and groundwater samples.

2.4.5 Documentation of Activities to Date

The aforementioned environmental investigations, in particular the RI and FS, resulted in a large database of physical and chemical information associated with the various site media (i.e., surface and near-surface soil, upper vadose zone soil, perched groundwater, lower vadose zone soil and Exposition groundwater). A summary of each environmental investigation is provided in Table 2-4. The following documents may be referenced for a more detailed account of activities and results.

- Active Leak Testing, Inc. (12/26/90) Subject Site Assessment Investigation Report;
- Ecology and Environment, Inc. (2/25/94) Final Site Assessment Report;
- Ecology and Environment, Inc. (3/10/98) Pemaco Maywood Expanded Site Inspection;
- Ecology and Environment, Inc. (3/98) Subsurface Investigation;
- CET Environmental Services, Inc. (3/98) Design Report;
- CET Environmental Services, Inc. (4/4/98, 5/11/98, 6/8/98, 7/8/98, 8/5/98, 9/2/98, 10/29/98, 11/12/98, 1/4/99 and 2/4/99) Vapor Extraction Reports;

- CET Environmental Services, Inc. (5/6/98) Pemaco Stack Test;
- Ecology and Environmental, Inc. (5/99) Pemaco Removal Site Final Report;
- T N & Associates, Inc. (12/00) Preliminary Summary of Groundwater and SVE System Sampling Events;
- T N & Associates, Inc. (3/02) Final Technical Memorandum, Results of Aquifer Tests Performed on the Exposition 'A' and 'B' Groundwater Zones, December 2001;
- T N & Associates, Inc. (10/02) Final Technical Memorandum, Results of Groundwater Monitoring Activities, May 2001 through April 2002;
- T N & Associates, Inc. (3/03) Final Technical Memorandum, Results of High-Vacuum Dual-Phase Extraction Pilot Test Performed on the Perched Groundwater Zone and Exposition 'A' and 'B' Groundwater Zones, December 2002;
- T N & Associates, Inc. (8/03) Final Technical Memorandum, Baseline Risk Assessment;
- T N & Associates, Inc. (11/03) Final Remedial Investigation Report;
- T N & Associates, Inc. (2/04) Final Feasibility Study Report;
- T N & Associates, Inc. (2/04) Technical Memorandum: Groundwater Data Gap Assessment 2003, Exposition 'A', 'B', 'C', and 'D' Zones;
- T N & Associates, Inc. (3/04) Technical Memorandum: Results of the Source Area Investigation Using a Cone Penetration Testing Rig (CPT) Equipped with a Membrane Interface Probe (MIP); and
- T N & Associates, Inc. (11/04) Technical Memorandum: Pemaco Data Evaluation for Natural Attenuation and Biodegradation of Chlorinated Ethenes.

2.5 NATURE AND EXTENT OF CONTAMINATION

2.5.1 Chemicals of Concern

Analytical results of the environmental samples collected during the RI/FS confirmed that chemical concentrations originating from past industrial practices at the Pemaco property have impacted soil and groundwater at the Site, as well as offsite, below adjacent industrial and nearby residential properties. Based on the operational and land use history of Pemaco and the adjacent industrial properties, contamination sourced to Pemaco has been delineated from contamination sourced to the neighboring former industrial properties. In addition, contaminant plumes have been delineated to levels indicative of background [soil to levels below background data for California soils (Bradford et al., 1996) and groundwater to levels below USEPA and California Environmental Protection Agency (CalEPA) drinking water standards (e.g., maximum contaminant levels)].

Fifty-six chemicals of concern (COCs) have been identified at the Site based on the comparison of analytical results to USEPA Region IX Preliminary Remediation Goals (PRGs) and State of California and USEPA Maximum Contaminant Levels (MCLs). COCs include various species of metals, solvents/non-halogenated volatile organic compounds (NHVOCs), semi-volatile organic compounds (SVOCs) and volatile organic compounds (VOCs). COCs in each media zone are listed in Tables 2-5A through 2-5H.

The following sections describe the nature and extent of contamination based on analytical data for the following environmental media: surface and near-surface soil, upper vadose zone soil, lower vadose zone soil, perched groundwater, and Exposition Zone groundwater.

2.5.2 Surface and Near-Surface Soil

A total of 150 samples were obtained within a collection of discrete-sample grids (approximately 25 feet by 25 feet) and 5 composite-sample grids (approximately 50 feet by 100 feet) laid across the Pemaco Site and adjacent railroad right-of-way. Samples were analyzed for SVOCs and metals and indicated elevated concentrations of both within the two soil zones.

Four metals and seven SVOCs were detected above site cleanup criteria for surface and near-surface soils, or Region IX PRGs for residential soils. Additionally, iron was detected above the cleanup criteria, which is background [83,100 milligrams per kilogram (mg/kg)] (Bradford et al., 1996) (see Table 2-5C). Polyaromatic hydrocarbons (PAHs) were the most prevalent SVOCs detected above PRGs for Residential Soil in both surface and near-surface samples. Although there was no indication of historical use of PAHs at Pemaco or adjacent industrial properties, the compounds were detected throughout the Pemaco Site. A possible source of the PAH concentrations could be from creosote treated railroad ties located along the former Los Angeles Junction Railway property and the associated spurs branching off each property, or from the warehouse fire that occurred on the Pemaco Site in 1993. However, PAHs were also detected during previous environmental assessments of adjacent properties in areas distant from the railway and former warehouse. It is likely that PAHs can be found in shallow soil throughout the Maywood area due to vehicle exhaust, previous fires and paving activities that have occurred over the years. These concentrations appear to be only surficial phenomena.

Metals exceeding PRGs for residential soil in surface soils include iron, lead and manganese. Iron and arsenic concentrations exceed PRGs in near-surface soils. It is unlikely that the elevated metal concentrations are a result of previous activities on the Pemaco property. The elevated metal concentrations could be associated with the historical use of railcars and the presence of the train tracks. However, concentrations may also be contributed to high naturally-occurring background levels in the soil.

As concentrations of SVOC and metals in surface and near-surface soils indicate, the majority of surficial soil contamination appears to lie along the periphery of the Pemaco Site. This would be consistent with the fact that clean fill was placed over much of the Site during previous removal actions of the former warehouse foundation, UST excavation and soil removal within the central portion of the Site.

2.5.2.1 Upper Vadose Zone Soil

A total of 173 discrete soil samples were collected from upper vadose zone soils (approximately 2.5 feet to 35 feet bgs) from three depth intervals – approximately 5 feet bgs, near the capillary fringe (25 feet bgs) and at the top of the perching clay (approximately 35 feet bgs). Samples were analyzed for VOCs, SVOCs, NHVOCs and metals.

Analytical results were compared to site cleanup criteria for upper vadose zone soils, or USEPA Region IX Soil Screening Levels (SSLs), which are used to screen subsurface soil as a threat to groundwater (see Table 2-5D). The Dilution Attenuation Factor (DAF) 20 SSLs were selected for comparison because these soils are not directly adjacent to a drinking water source and dilution of the contaminant is occurring before it reaches the source. Principal analytical data are bulleted below:

- Arsenic and total chromium were the only target metals detected above DAF 20 SSLs. Samples with these concentrations were collected from borings located offsite. The distance of these samples from the Pemaco Site and the sporadic distribution of concentrations suggest that detected concentrations are likely background levels and not from a Pemaco release.
- Trace to low concentrations of NHVOCs were detected in the southwest portion of the Pemaco Site. Acetone was the only solvent that exceeded an SSL.
- The most prevalent SVOCs within the upper vadose zone soils were polyaromatic hydrocarbons (PAHs), the majority of which were located within 5 to 6 feet bgs adjacent to the central-west part of the Pemaco Site. As stated in the surface/near-surface soil section, there was no indication of historical use of PAHs at the Pemaco facility or the adjacent industrial properties.
- VOCs that exceeded Region IX DAF 20 PRGs included the following: 1,1-dichloroethene (DCE), acetone, benzene, cis-1,2-DCE, ethylbenzene, methylene chloride, tetrachloroethene (PCE), toluene, trichloroethene (TCE), vinyl chloride, and xylenes. The most prevalent and widespread concentrations consisted of chlorinated VOCs, although several “hot spots” of non-chlorinated VOCs (BTEX) are present within the upper vadose zone soils.

As discussed above, VOCs are the most prevalent and widespread contaminants within upper vadose zone soils at the Pemaco Site and surrounding area. The release of VOCs at Pemaco is likely a result of leaking USTs and spills associated with the loading area located in the southwest corner of the Site and leaking aboveground storage tanks and drum storage in the north-central portion of the Site. Five primary areas of VOC contamination have been identified in the upper vadose zone, these are:

1. Below the central part of Pemaco Site and extending approximately 80 feet offsite (to the west) between 25 and 35 feet bgs, primarily comprised of chlorinated VOCs;
2. A small area below the central part of the Pemaco around 15 feet bgs, primarily comprised of toluene, ethylbenzene and xylenes;
3. A small area below and adjacent to the central-west part of the Pemaco Site (below the rail tracks) around 5 feet bgs, primarily comprised of SVOCs;
4. Below the south part of Pemaco Site and extending approximately 200 feet offsite (to the west/southwest) between 25 and 35 feet bgs, primarily comprised of chlorinated VOCs; and

5. An offsite area resulting from releases at the adjacent former W.W. Henry-owned property, consisting primarily of benzene, toluene and hexane.

2.5.2.2 Lower Vadose Zone Soil

A total of 112 discrete soil samples were collected from vadose zone soils between approximately 35 and 65 feet bgs. Soil samples were collected at 10-foot intervals beginning at 35 feet bgs and continuing to approximately 65 feet bgs and analyzed for VOCs, SVOCs, NHVOCs and metals.

Analytical results were compared to site cleanup criteria for lower vadose zone soils, or USEPA Region IX DAF 20 SSLs for soils to 50 feet bgs and USEPA Region IX DAF 1 SSLs for soils 50 feet or greater (see Tables 2-5E and 2-5F). The DAF 1 SSLs assume that the contaminated soil source is directly adjacent to a drinking water source, such as a regional aquifer, and no dilution is occurring along the migration pathway between the source soil and the drinking water source. Due to the saturated zone present between approximately 55 and 65 feet bgs and the potential future use of the Exposition Aquifer as a viable water source, lower vadose zone soils present at 50 feet bgs or greater were also compared to DAF 1 SSLs. Primary analytical data are bulleted below by analyte group:

- All 24 metal target analytes were detected above method detection limits, although only total chromium was detected above DAF 20 SSLs. Upon comparison of lower vadose zone soils below 50 feet bgs with DAF 1 SSLs, the following metals were filtered: antimony, arsenic, barium, cadmium, total chromium, and nickel. Total chromium exceeded the DAF 1 SSL for chromium at every boring where samples were collected below 50 feet. With exception to antimony, all other metals were detected at concentrations exceeding their applicable SSLs at all borings sampled below 50 feet except for one to two locations. The widespread presence of metals within lower vadose zone soils suggests that these metals are likely background and not from a Pemaco release.
- Trace to low concentrations of SVOCs and NHVOCs were detected; however, no concentrations exceeded DAF 20 or DAF 1 SSLs.
- VOCs that exceeded Region IX DAF 20 SSLs include: benzene, cis-1, 2-DCE, 1,2-dichloroethane (DCA), methylene chloride, TCE, and vinyl chloride. Upon comparison of lower vadose zone VOC concentrations greater than 50 feet bgs with DAF 1 SSLs, all VOCs discussed above reported concentrations exceeding DAF 1 SSLs with exception of vinyl chloride. This comparison also revealed additional offsite contamination, although maximum exceedances remain concentrated within the southwest corner of the Pemaco Site between the depths of 55 and 60 feet bgs.

Like upper vadose zone soils, VOCs are the most prevalent and widespread contaminant within lower vadose zone soils. Two areas of contamination have been identified in the lower vadose zone (between 35 and 65 feet bgs). One area is located along the southern boundary of the Pemaco Site, which extends offsite to the south/southwest and is comprised of chlorinated VOCs. The other area is related to the W.W. Henry free product plume and was detected along

59th Place adjacent to the W.W. Henry property. The extent of this contamination was not fully evaluated, as it is not part of the Pemaco RI/FS scope.

2.5.2.3 Perched Groundwater

A total of 42 groundwater monitoring wells have been installed within the perched groundwater zone. Utilizing this network, eight quarterly groundwater sampling events (to date) have enabled the complete delineation of contaminant "plumes", which originate from the Pemaco property.

PCE, TCE and vinyl chloride are the most prevalent and widespread compounds detected within the perched groundwater zone. "Hot spot" areas within the plumes have had groundwater concentrations exceeding 1,000 microgram per liter (µg/L). The dissolved-phase portions of the plumes extend offsite and have migrated beneath adjacent properties extending up to 250 feet to the south and up to 200 feet southwest of the Pemaco property. Contaminant plumes originating from the Pemaco property have also co-mingled with other chlorinated and non-chlorinated contaminant plumes that have resulted from historical industrial uses of neighboring properties (former W.W. Henry and Lubricating Oil Services properties).

A more detailed description of the individual plumes is provided below:

- There appears to be three separate areas where PCE was released including the north-central portion of the Pemaco property, the northeast portion of the W.W. Henry property and in District Blvd (approximately half a block south of the Pemaco property). The highest concentrations (>500 µg/L) are found in the north-central portion of the Pemaco property in the vicinity of wells B-01 and SV-2. This area coincides with the former aboveground storage tanks and drum storage areas. The northern extent of this plume is approximately where the northern Pemaco property boundary lies. The western extent of this plume appears to co-mingle with another separate PCE plume that probably originated from the W.W. Henry property. This is indicated by the increase in concentrations going from northeast to southwest across the Pemaco and Railway properties onto the W.W. Henry property. This W.W. Henry hot spot also coincides with a documented release of PCE in soil adjacent to the former rail spur that ran along the northern boundary of the W.W. Henry property. The third identified perched zone PCE plume is located in a small area around well B-25. This small plume is likely to have originated from a release on the former Lubricating Oil Services property.
- TCE is the most prevalent VOC in the perched zone. The perched TCE plume extends throughout most of the Pemaco Site and adjacent areas. The highest concentrations (>100 µg/L) are found in the extreme southern portion of the Pemaco Site and to the south and southwest of the Pemaco Site. The "hot spot" of the perched TCE plume appears to be limited to an area between the 59th Place and Walker Avenue intersection, and the portion of District Blvd. north of B-25. This plume may have originated from the former loading dock located in the extreme southwest of the Pemaco property or from spills that could have occurred along the railway. In-situ groundwater samples were collected from selected residential lots in July 2001 to delineate the TCE plume in the residential area. The TCE plume is truncated to the west by the floating free product plume originating from the W.W. Henry property, as identified during RI activities

and confirmed by environmental investigations performed by W.W. Henry environmental contractors (Levine-Fricke, 2001). A second area of elevated concentrations (>50 µg/L) coincides with the north-central portion of the Pemaco Site in the SV-2 and B-01 areas. This TCE plume may be associated with the dechlorination of the PCE plume in that area.

- Vinyl chloride is one of the end daughter products in the degradation process of PCE and TCE. The vinyl chloride plume in the perched zone is probably due to the degradation of PCE and TCE (and subsequently DCE) and not from a release of vinyl chloride, which is a gas at room temperature and pressure. The “hot spot” (>100 µg/L) of the vinyl chloride plume appears to be in a small area near B-21. This well has elevated levels of toluene, which may be aiding in the degradation process of TCE and PCE causing the elevated vinyl chloride concentrations. The vinyl chloride plume terminates west of the Pemaco Site at the free product plume originating from the W.W. Henry property.

2.5.2.4 Exposition Groundwater Zones

A total of 36 groundwater monitoring wells have been installed in the five Exposition groundwater zones present in the vicinity of the Pemaco Site. Eight quarterly groundwater sampling events (to date) have been conducted using this well network. The most extensive contaminant plumes are found in the upper Exposition groundwater zones (‘A’ and ‘B’) are primarily comprised of TCE and its daughter products. The plume of largest lateral extent is approximately 1,300 feet long and 750 feet wide within the Exposition ‘B’ Zone. The dissolved-phase portion of this plume extends towards the southwest of the Pemaco property and underlies a two-block area that is used for residential housing. The “hot spot’ area of this plume is directly below the southernmost portion of the Pemaco property and contains TCE at concentrations exceeding 20,000 µg/L.

A more detailed summary of contamination within each Exposition groundwater zone is bulleted below by zone.

‘A’ Zone:

- The compounds PCE, TCE and their associated daughter products (1,1-DCE, cis-1,2-DCE, trans-1,2-DCE and vinyl chloride) are the only chlorinated compounds that are widespread and consistently detected in the ‘A’ Zone above regulatory levels. Detections of hexane and cyclohexane are the only non-chlorinated compounds that are consistently detected in the Exposition ‘A’ Zone, although concentrations are below regulatory levels. Chloroform has been consistently detected over the PRG of 0.16 µg/L, but it only appears in one well (MW-5-85).
- TCE is the prevalent compound in the ‘A’ Zone indicated by its high concentrations (21,000 µg/L) and large spatial area. PCE is consistently detected in the ‘A’ Zone, but the concentrations are relatively low (<10 µg/L) compared to the TCE concentrations (>20,000 µg/L). The “hot spot” concentrations (>10,000 µg/L) of the Exposition ‘A’ Zone TCE plume is limited to the southernmost portion of the Pemaco property and extends southward to the south side of 59th Place and westward to the 59th Place and Walker

Avenue intersection. This “hot spot” area is consistent with a release in the southernmost portion of the Pemaco Site possibly from the former loading dock, former drum storage area or one of the southernmost former USTs. The farthest that the dissolved-phase fringes of the plume extend offsite is southward where it terminates before 60th Place. The ‘A’ Zone TCE plume does not appear to extend in the southwest direction consistent with its gradient. This is likely due to the irregular geometry and discontinuous nature of the ‘A’ Zone sand lenses.

- There were no SVOCs detected above California MCLs or PRGs in the Exposition ‘A’ Zone.
- There were only two NHVOCs detected in the ‘A’ Zone that exceeded PRG screening levels, these were acetone and acrylonitrile. These concentrations above PRGs were only detected during the first sampling event following the installation of wells and have been attributed to bentonite pellets (see note below) used during well installation (TN&A, 2002b). Furthermore, these two wells are the furthest down-gradient wells from the Pemaco property. The spatial distribution of the detected acetone concentrations supports the premise that these concentrations are anomalous.
- Metal concentrations in the Exposition ‘A’ Zone exceeded screening levels (MCLs and PRGs) for arsenic and hexavalent chromium. The spatial distributions of these concentrations appear to coincide with chlorinated VOC plume “hot spot” and could possibly be associated with a release or could be a byproduct of the chlorinated VOC release. Changing native state geochemical parameters could have caused acidic conditions that may cause metal concentrations to be leached from the soil and cause higher than native background metals in solution. These elevated metal concentrations could also be high natural background levels.

‘B’ Zone:

- The groundwater concentrations of VOCs are similar to the concentrations found in the ‘A’ Zone with TCE being the most prevalent and widespread compound. The dissolved-phase fringes of the TCE plume extend over a much greater area in the ‘B’ Zone than in the ‘A’ Zone. Less prevalent concentrations that are consistently detected in the ‘B” Zone include: hexane, cyclohexane, and benzene.
- The “hot spot” concentrations (>10,000 µg/L) of the Exposition ‘B’ Zone TCE plume mirrors the ‘A’ Zone “hot spot” area. The farthest that the dissolved-phase fringes of the ‘B’ Zone TCE plume extend offsite is southwestward where it terminates near the Alamo Avenue and 60th Place intersection. The total size of this elliptical plume is estimated to be 1,290 feet long and 750 feet wide in map view. The geometry of the ‘B’ Zone TCE plume appears to be consistent with the southwest groundwater gradient indicated by the groundwater measurements in the ‘B’ Zone wells. The estimated surface area of the ‘B’ Zone TCE plume is approximately 17.7 acres (771,004 square feet). This larger plume size is further indication that the ‘B’ Zone sand lenses are more uniform and continuous than the ‘A’ Zone sands.

- The consistent detections of elevated benzene, hexane and cyclohexane in samples from well MW-06-85 indicate that the non-chlorinated contamination, which is prevalent in the perched zone underlying the eastern portion of the W.W. Henry property (free product area), has migrated down to the Exposition groundwater zones. Further evidence of this migration is indicated by the benzene concentrations found in each of the soil samples collected from 25 to 65 feet bgs from the MW-06 boring.
- There were only two NHVOCs detected in the ‘B’ Zone that exceeded PRG screening levels, these were acetone and acrylonitrile. The same discussion applies for these two compounds as discussed in the Exposition ‘A’ Zone section above.
- There were no SVOCs detected above California MCLs or PRGs in the Exposition ‘B’ Zone during any of the quarterly groundwater sampling events.
- Metal concentrations in samples from the Exposition ‘B’ Zone exceeded screening levels (MCLs and/or PRGs) for aluminum, arsenic, hexavalent chromium, manganese, and thallium. The spatial distributions of the arsenic concentrations are not consistent with a release based on the fact that the highest concentrations are found in samples from wells outside of the Pemaco “hot spot” area. The hexavalent chromium concentrations appear to coincide with chlorinated VOC plume “hot spot” and could possibly be associated with a release or could be a byproduct of the chlorinated VOC release. The spatial distribution and limited occurrences of elevated aluminum, manganese and thallium concentrations indicate that these are likely high natural background levels.

‘C’ Zone:

- There are six wells screened in the Exposition ‘C’ Zone (MW-10-110 and MW-11-100 and MW-05-105, MW-23-110, MW-24-110 and MW-25-110, which were installed in July 2003 as part a data gap assessment). No VOCs exceeding California MCLs have been detected within the Exposition ‘C’ Zone wells. However, three VOCs (benzene, TCE and vinyl chloride) have been detected at concentrations which exceed the more stringent Region IX PRGs for tap water. In addition, 1,4-dioxane has been detected in a sample collected from monitoring well MW-23-110 at a concentration of 5.0 µg/L, exceeding the California Department of Health Services Action Level of 3.0 µg/L. There is currently no promulgated California MCL for 1,4-dioxane.

‘D’ and ‘E’ Zones:

- There are six wells screened in the Exposition ‘D’ Zone (MW-05-135, MW-07-130, MW-12-150 and MW-23-145, MW-24-140 and MW-25-130) that were installed in July 2003 as part a data gap assessment, and only one well screened in the Exposition ‘E’ Zone (MW-10-170). No wells within the ‘D’ Zone have reported VOCs in exceedance of California MCLs with exception to MW-24-140. This well has reported TCE at concentrations up to 120 µg/L. Although no other VOCs were detected above MCLs, three VOCs (bromodichloromethane, chloroform and vinyl chloride) have exceeded the more stringent Region IX PRGs for tap water.

2.5.3 Source Area Investigation

In September 2003, sixteen borings were completed by the USACE Site Characterization and Analysis Penetrometer System (SCAPS) rig to total depths ranging from 80 to 100 feet bgs. The screening tool used during the Pemaco source area investigation was a membrane interface probe (MIP) that was located approximately 2 feet above the probe tip and allowed for VOC concentration measurements in sub-surface soils as measured by the on-board Ion Trap/Mass Spectrometer (IT/MS) provided by Oak Ridge National Laboratories. The MIP heats the subsurface soils in-situ (MIP is heated to 105 to 110° Celsius), and transfers the off-gassed vapor concentrations to the on-board analytical instruments via a helium stream. A combination of both operational modes of the SCAPS rig was used for this investigation. This included continuous probing, which allows for rapid collection of concentration data that is very qualitative in nature, and discreet sampling where the probe is stopped at discreet intervals to collect data that can be quantified. The drill rig used was a conventional cone penetrometer technology (CPT) rig equipped with an MIP probe and an on-board IT/MS used to detect and speciate VOCs in soil, soil vapor and groundwater. Data from the continuous and discrete sampling program confirmed that the TCE soil plume, which is the source of the large groundwater plume in the Exposition 'A' and 'B' Zones underlying the area, is located in the extreme southern portion of the Pemaco site.

- The CPT/MIP source area data has delineated the highest TCE concentrations in soil and groundwater at an increased resolution as compared with interpretations from soil sampling and groundwater data from the borings and wells installed in the area.
- The CPT/MIP data has led to a better understanding of the depths, thicknesses and continuities of the hydrogeologic units in the source area as illustrated by the cross sections produced from the data.
- The majority of the TCE mass in soil is located between 35 and 90 feet bgs in the southern portion of the site. Three areas were identified where TCE concentrations were more continuously detected throughout the soil column. These areas generally coincide with the historic drum storage areas.
- The majority of the hydrocarbon mass is located between 25 and 60 feet bgs in the southern portion of the site. Two areas were identified where hydrocarbon concentrations were more continuously detected throughout the soil column. These areas generally coincide with the former UST locations.

2.6 ADDITIONAL INVESTIGATIONS AND PILOT STUDY

2.6.1 Radius of Capture for Capture for Exposition "A" and 'B' Zones

Aquifer tests were performed in the Exposition Aquifer 'A' and 'B' Zones in December 2001 for the Pemaco Site. A technical memorandum was prepared to document field activities, results, and data interpretations associated with the tests (TN&A, 2002e). The Exposition Aquifer within the study area is not a viable aquifer because the groundwater yield does not produce economically significant quantities of water to local production wells. However, there are five distinct saturated zones (Exposition ‘A’ through ‘E’ Zones) present between 65 and 180 feet beneath the site and surrounding area that are stratigraphically equivalent with the more regional Exposition Aquifer. The aquifer testing focused on the upper most saturated intervals (Exposition A and B Zones) of the stratigraphically equivalent Exposition Aquifer. Analytical results obtained during the RI indicated that these groundwater zones contain the highest concentrations of chemical of potential concern (COPCs) at the site. The aquifer test results, summarized in Table 2-6 and Table 2-7, helped facilitate the selection of the most appropriate remedial technologies for these groundwater zones during the FS phase of the project.

Four types of aquifer tests were performed to evaluate the hydrogeologic characteristics of the Exposition ‘A’ and ‘B’ groundwater zones. They included slug, step-drawdown, constant rate, and recovery tests. An additional “stress” pumping test was performed on the ‘B’ Zone to determine maximum sustainable pumping rates. These tests quantified parameters such as hydraulic conductivity, transmissivity, storage coefficient, well efficiency, and optimum pumping rates. These parameters were then used to calculate the effective radius of capture (ROC) for recovery wells that may be required for remediation purposes, establish the well design and configuration, and engineer the remediation equipment.

The following hydraulic conductivities were calculated from the data obtained during the aquifer test (refer to Table 2-7):

Zone	Hydraulic Conductivity (feet/minute)
A	8.3×10^{-4} to 2.3×10^{-3}.
B_1	1.1×10^{-3} to 1.1×10^{-1}
B_2	6.6×10^{-3}

The estimated radius of capture (stagnation point) [at a flow rate of 1.137 gallons per minute (gpm)] in the downgradient direction is:

Zone	Downgradient Radius of Capture* (feet)
Average A and B	123.90
B_1 and B_2 Average	139.90
B_1 Average	46.43
B_2 Average	730.03

*Downgradient radius of capture (stagnation point) per aquifer zone is averaged from individual pumping and recovery well radius of capture calculations. These calculations are based on the individual recovery and pumping well aquifer thicknesses and transmissivities calculated by AQTESOLV™ (refer to TN&A 2001, Tech Memo - Results of Aquifer Tests Performed on the Exposition 'A' and 'B' Groundwater Zones, December 2001). The individual well aquifer properties and calculated radius of capture are calculated by Grubb’s WELLCALC (1993) and shown in Table 2-6.

Based on this estimated radius of capture, the maximum crossgradient width of the capture zone was estimated using the following equation: $2\pi r$ = width of capture zone (feet). The crossgradient width of the capture zone for each zone is presented in the following table:

Zone	Crossgradient Width of Capture (feet)
Average A and B	778.49
B_1 and B_2 Average	879.02
B_1 Average	291.73
B_2 Average	4586.91

The following conclusions of the Aquifer Test pertain to expected flows from extraction wells installed for the Remedial Action:

- A series of groundwater slug, pumping, and recovery tests were performed at the Pemaco site between December 12th and 24th, 2001. Types of tests performed included: background/diurnal logging of “static” groundwater levels in the ‘A’ and ‘B’ Zones slug testing of five ‘A’ Zone wells, step-drawdown pump testing of the ‘B’ Zone while monitoring ‘A’ Zone and ‘B’ Zone well, constant-rate pump testing (72 hrs) of the ‘B’ Zone while monitoring ‘A’ and ‘B’ Zone wells, post-pumping recovery monitoring of all wells monitored during pumping test, “stress” pumping of the ‘B’ Zone to determine maximum sustainable pumping rates.
- Sustainable pumping rates from the ‘B’ Zone are approximately 1 gallon per minute (gpm) and approximately 0.5 gpm from the ‘A’ Zone. Theoretical maximum yield for the ‘B’ Zone is 1.4 gpm.

2.6.2 Radius of Capture for Exposition ‘C’ and ‘D’ Zones

No aquifer tests have been performed on the Exposition ‘C’ and ‘D’ Zones and thus no drawdown or recovery curves were available to estimate transmissivity. Therefore, capture zones were estimated by calculating hydraulic conductivity for each zone utilizing observed aquifer thicknesses and calculated hydraulic gradients. The estimated aquifer properties for ‘C’ and ‘D’ Zones are summarized in Table 2-8 and Table 2-9. Due to the similar aquifer properties and thickness, the average hydraulic conductivities for Exposition Well RW-1 (Table 2-6) was used as the estimated hydraulic conductivity for Exposition ‘C’ and ‘D’ Zone. Hydraulic conductivity values were then used to back-calculate transmissivity (T) using the following equation:

$$T = Kb$$

where:

K = hydraulic conductivity

b = average aquifer thickness, or saturated interval, beneath the Site.

Once transmissivity values were established, the radius of capture (stagnation point, X_L) in the downgradient direction was numerically estimated from the following equation:

$$X_L = Q/(2\pi Ti) \quad \text{(Todd, 1980)}$$

where:

X_L = radius of capture in the down gradient direction (stagnation point) (feet)

Q = pumping average discharge rate (ft^3/min.)

T = transmissivity of the water bearing unit (ft^2/min.)

i = average hydraulic gradient beneath the site (unitless)

π = mathematical constant representing the ratio of the circumference of a circle to its diameter (3.14159)

An estimated pumping rate of 1.1 gallons per minute (gpm) was used based on the section 3.6.2 Average Groundwater Extraction Rate performed on the Exposition 'D' Zone. The maximum width of the capture zone in the crossgradient direction (upgradient width) is equal to 2π times the downgradient radius of capture (TN&A, 2004a; Todd, 1980).

Using the above-described methodology, downgradient capture can be calculated using the following values:

Q = 0.147 ft^3/min (1.1 gpm)

i = 0.018 for 'C' Zone; 0.0017 for 'D' Zone (based on TN&A 2003, Remedial Investigation Report – Appendix 13: Groundwater Data Gap Assessment 2003, Exposition 'A', 'B', 'C', and 'D' Zones Figure 4 and 5).

Estimated average radius of capture (at a flow rate of 1.1 gpm) in the downgradient direction is: (refer to Table 2-9)

Zone	**Downgradient Radius of Capture* (feet/min)**
Average 'C' and 'D'	240.8
'C Average	80.2
'D' Average	401.4

*Downgradient radius of capture per aquifer zone is averaged from individual pumping and recovery well radius of capture calculations. These calculations are based on the individual recovery and pumping well aquifer thicknesses and transmissivities calculated by the above equations. The individual well aquifer properties and calculated radius of capture are shown in Table 2-8.

Based on this estimated radius of capture, the maximum crossgradient width of the capture zone is estimated using the following equation: $2\pi r$ = width of capture zone (feet). The crossgradient width of the capture zone for each zone is presented in the following table:

Zone	Crossgradient Width of Capture (feet/min)
Average ‘C’ and ‘D’	756.4
‘C Average	251.9
‘D’ Average	1261.0

2.6.2 HVDPE Pilot Test

A pilot test of high vacuum dual phase extraction (HVDPE) was performed at the Pemaco Site in December 2002. The tests were considered “remedy-selection tests” per USEPA guidelines for performing treatability studies under CERCLA, as HVDPE could potentially enhance contaminant recovery from soil and groundwater at the site (USEPA, 1992). This work was accomplished under contracts issued to TN&A by the U.S. Army Corps of Engineers, Omaha District. A technical memorandum was prepared to document the field activities, results, and data interpretations of the HVDPE Pilot Test (TN&A, 2003a).

The pilot tests were performed onsite and included the evaluation of HVDPE in the upper vadose soil and perched groundwater zone, as well as in the lower vadose soil and upper Exposition ‘A’ and ‘B’ groundwater zones. Calculations were performed to determine the radius of capture for individual SVE wells and contaminant mass recovery of the HVDPE system at various flow rates. The results were extrapolated to evaluate the technical and cost-effectiveness of a full-scale application of the technology as well as use of HVDPE to enhance the effectiveness of other remedial alternatives as a part of the FS.

The following conclusions and recommendations were identified based on the performance of the HVDPE system during the treatability study/pilot test.

Perched Groundwater Zone

- Conditions are very favorable in the upper vadose soil and perched zone for effective remediation using HVDPE using the drop-tube method.
- Effective vapor extraction radius of influence (ROI) for the upper vadose soil and perched zone sediments was 54 feet.
- Estimated groundwater ROI for the perched groundwater zone was 72 feet.
- Groundwater flow rates averaging 0.8 gpm were attained using HVDPE (typically <0.10 gpm with no vacuum applied)

Exposition A Zone

- Conditions are favorable for the lower vadose soil and Exposition ‘A’ Zone for effective remediation using HVDPE. The drop-tube method was found to be more effective than the down-hole pump method.
- Effective vapor extraction ROI for the lower vadose soil and Exposition ‘A’ Zone sediments is 37 feet (both methods).
- Groundwater ROI for Exposition ‘A’ groundwater zone is 175 feet (both methods).
- Groundwater flow rates of 1.1 gpm were attained using HVDPE with the drop tube method (typically <0.25 gpm with no vacuum applied).
- Maximum influent concentrations exceeded 900 part per million per volume (ppmv), average concentrations were higher during drop-tube method.

Exposition B Zone

- Conditions are not favorable for HVDPE to effectively remediate the ‘B’ Zone. However, HVDPE does increase sustainable groundwater extraction rates.
- Effective vapor extraction ROI for ‘B’ Zone sediments is 0 feet.
- Estimated groundwater ROI for ‘B’ Zone groundwater is 69 feet or greater.
- Estimated sustainable groundwater flow rates of 2.0 to 2.5 gpm were attained using HVDPE (typically 1.1 gpm with no vacuum applied).

3.0 SUMMARY OF RECORD OF DECISION

The Record of Decision for the Pemaco Maywood Superfund Site (ROD) dated January 13, 2005 is an official document that states the decision on a selected remedial action and provides information on other alternatives considered, the basis for the decision, the environmentally preferable alternative and the mitigating measures developed to avoid or minimize environmental harm. It also includes information of past removal action at the site, a responsiveness summary, and a bibliography of documents that were used to reach the remedial decision. The responsiveness summary includes all comments received from regulators and the general public.

The ROD was developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and to the extent practicable the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The USEPA issued this ROD pursuant to Section 104 of CERCLA and selected the remedial action in accordance with Section 121 of CERCLA. This was considered a final site ROD and the decision was based on the administrative record for the site.

The State of California concurred with the selected remedy as documented by correspondence from the Department of Toxic Substances Control (DTSC) dated April 16, 2004.

3.1 REMEDIAL DESIGN SUMMARY

The remedial action for Pemaco addresses removal of contaminants from soil and groundwater. Since the subsurface geologic and hydrogeologic environments and contamination levels found at Pemaco are highly irregular and variable, USEPA divided the site into three subsurface zones or “remediation zones” and assembled remedial alternatives by zone to develop an appropriate cleanup strategy for each individual zone. The remediation zones identified at the Pemaco site are:

- surface and near surface soil remediation zone (0-3 feet bgs)
- upper vadose zone soil and perched groundwater (3-35 feet bgs)
- lower vadose zone soil and Exposition groundwater (35-100+ feet bgs)

The selected remedy for the entire site is as follows:

- Surface and Near-Surface Soil: Soil Cover/Revegetation
- Upper Vadose Zone Soil and the Perched Groundwater: High-Vacuum Dual-Phase Extraction (HVDPE) with Granular-Activated Carbon (GAC) for treatment of extracted groundwater, and Flameless Thermal Oxidizer (FTO) and GAC for treatment of extracted vapors.
- Lower Vadose Zone Soil and Exposition Groundwater: Electrical Resistance Heating (ERH) with Vacuum Extraction (VE), Vacuum-Enhanced Groundwater Extraction, Groundwater Pump and Treat (P&T), and Monitored Natural Attenuation (MNA). GAC for treatment of extracted groundwater, and FTO and GAC for treatment of extracted vapors

The USEPA believes the selected remedy for Pemaco meets the threshold criteria and provides the best balance of tradeoffs among the alternatives considered. The USEPA expects the selected remedy to satisfy the statutory requirements of CERCLA Section 121(b): 1) protection of human health and the environment: 2) compliance with ARARs; 3) cost effectiveness; 4) use of permanent solutions and alternative treatment technologies to the maximum extent practicable; and 5) use of treatment as a principle component.

All remedies shall meet the Remedial Action Objectives (RAOs) for soil, groundwater and indoor air at the Pemaco Site. The USEPA has identified the following RAOs:

- Prevent human exposure (by direct contact) to contaminated soils having COCs in excess of the applicable, relevant and appropriate standards (ARARs) for soil and standards that are protective of human health and the environment.
- Prevent migration of COCs from soil to groundwater at levels that would exceed drinking water standards.
- Restore the groundwater quality in perched groundwater zone, and Exposition zones to drinking water standards (i.e., MCLs).
- Prevent vertical migration of COCs from the perched groundwater and deeper Exposition zones at rates that would cause groundwater to exceed drinking water standards.
- Prevent further off site migration of contaminated groundwater beneath additional adjacent properties.
- Prevent migration of contaminated groundwater to local production wells
- Remediate COCs in soil and groundwater to drinking water standards and other health based action levels to eliminate potential exposures to indoor air contaminants created by site contamination.
- Prevent further migration of soil vapor in excess of ARARs and standards that are protective of human health and the environment.

These RAOs for the Pemaco Site were developed by USEPA based on the following:

- Reasonable anticipated land use scenarios summarized in the human health risk assessment (HHRA) section of the ROD that include recreational land use, as the property is currently incorporated into redevelopment plans to be made into the Maywood Riverfront Park.
- The HHRA identified the appropriate exposure pathways, routes, and receptors as well as COCs which required that remedial action be performed at the site to protect human health and the environment.

3.2 SELECTED ACTION FOR SURFACE AND NEAR-SURFACE SOIL REMEDIATION ZONE

Soil Cover / Revegetation

The proposed future use of the Pemaco site is a recreational park. This alternative would place a 1-foot layer or approximately 4,550 cubic yards of clean soil on the site, with the addition of a non-woven geotextile layer between the soil cover and the native site soils. Implementation of this remedy will take one to two months. Implementation of this portion of the remedy will be conducted by the City of Maywood as part of the design and construction of the recreational park that includes the Pemaco property and the surrounding adjacent properties.

3.3 SELECTED ACTION FOR UPPER VADOSE SOILS AND THE PERCHED GROUNDWATER

HVDPE, FTO, and GAC

Twenty-seven (27) dual-phase extraction (DPE) wells will be installed into the upper vadose zone soil (approximately 80,000 to 95,000 cubic yards of soil affected) and the perched groundwater zone to remove contamination in both the liquid and gas phase. The perched groundwater plume has migrated approximately 250 feet to the south and up 200 feet southwest of the Pemaco property. Approximately 1.4 million gallons of contaminated groundwater is present within the impacted perched groundwater zone.

Extracted contaminated vapor will be pumped to the surface and treated onsite using a FTO unit. It is estimated that after one year, concentrations of poorly adsorbing chemicals (e.g., vinyl chloride) in the vapor phase will have decreased enough to safely change over to a GAC system for treatment of extracted vapors for the remainder of the cleanup.

Groundwater will be treated with a liquid-phase GAC system. Vinyl chloride is expected to pass through the GAC at trace level concentrations significantly below the effluent limitations. Based on a composite sample from the A&B source zone collected for the advanced oxidation water treatment bench test, the vinyl chloride concentrations were below 6 ppb. The discharge of treated groundwater is discussed in Section 4.6. It is estimated that the treatment system will operate for 5 years and require an additional 5 years of monitoring.

3.4 SELECTED ACTION FOR LOWER VADOSE SOILS AND EXPOSITION GROUNDWATER

ERH with VE, Vacuum-Enhanced Groundwater Extraction, Groundwater P&T, MNA, FTO, and GAC

Treatment in this zone targets the highest concentrations of contamination found on the site as well as the entire groundwater dissolved-phase plume. For the “core” or source area of contamination, an ERH system consisting of approximately 95 electrodes and 36 vapor extraction wells will be installed within the mapped isoconcentration contour line. This isoconcentration contour line collectively represents concentrations of TCE greater than 10,000 µg/L in groundwater, The CPT/MIP source area data which represents concentrations greater than 10,000 parts per billion (ppb) of vapors in soil and the CPT/MIP data that represents intervals greater than 10-feet thick with TCE response curves greater than 20,000 intensity counts. ERH treatment area and the combined plumes representative of the treatment “core” area are discussed in greater detail in Section 4.3.4 - ERH Design. The electrodes and monitoring wells will be installed to a depth of 100 feet bgs. The system will include a 2,000 cfm blower for vapor extraction.

The dissolved-phase Exposition ‘A’ and ‘B’ Zones groundwater plume extends southwest of the Pemaco property and lies beneath a two-block residential housing area. A vacuum-enhanced groundwater pump-and-treat network will address VOCs within the mapped isoconcentration contour line which represents 1,000 µg/L of TCE in groundwater. This treatment network will consist of approximately 12 vacuum enhanced groundwater extraction wells installed into the ‘A’ Zone (65 to 75 feet bgs) and the ‘B’ Zone (80 to 100 feet bgs).

Sampling conducted during late 2003 indicated that one well (MW-24) installed on the Pemaco property in the ‘C’ and ‘D’ Zones, contained low contaminant concentrations. The State of California requested that USEPA place an extraction well in this location. In response to this request, USEPA will install an extraction well into the ‘D’ Zone (approximately 120-140 feet bgs) and treat extracted groundwater from this zone.

Additional groundwater extraction wells will be installed to address groundwater contamination in the area between the mapped isoconcentration contour lines for 1,000 and 10 µg/L of TCE. MNA will be used outside the 10 µg/L TCE contour to demonstrate plume reduction and/or point of compliance.

FTO will be used to address the vapors extracted from the treatment systems with a change over to GAC when the vinyl chloride concentrations in the effluent have decreased to safe levels. USEPA estimates that this switch-out should occur within one year.

Groundwater will be treated with a liquid-phase GAC system as described in Section 3.3. The treated groundwater will be discharged to the sanitary sewer, or a portion reinjected back into the aquifer (to be determined based on the selected ERH Contractor design requirements). All appropriate water discharge permits and treatment requirements will be met.

Implementation of the ERH system for the Lower Vadose Soils and Exposition Groundwater will allow flexibility for possible future use of *in situ* oxidation and/or *in situ* bioremediation of portions of the source area of the plume, after the ERH system has been removed. This “life-cycle” remedial component will only be used if the USEPA determines, after completion of the ERH operation, that the additional implementation of *in situ* treatment is needed to augment or provide a “polishing step” for treatment of groundwater after the principal threat area has been treated.

It is estimated that ERH will require approximately one year for treatment of the source area. Vacuum-enhanced groundwater extraction and treatment, with the possibility of supplementary *in situ* chemical oxidation or enhanced bioremediation, is expected to continue for approximately 4 additional years. Groundwater monitoring is required for an additional 5 years for a total of 10 years.

4.0 BASIS OF DESIGN

4.1 SOIL COVER

The selected remedial action surface and near-surface soils will utilize a soil covering and surface revegetation. The soil cover will consist of a non-woven geotextile layer below a one-foot soil cover topped by a vegetation layer (or Park hardscape). Implementation of this portion of the overall remedy will be coordinated with the City of Maywood as part of the City's design of the recreational park that includes the Pemaco property and the surrounding adjacent properties.

The purposes of the soil closure cover, as stated in the ROD, are:

- To prevent human exposure to COCs in surface or near-surface soils;

Based on these requirements, the design objectives developed for the soil closure cover are:

- To minimize soil cover erosion through proper grading and vegetative cover;
- To maintain stability under static and dynamic loading, through proper grading;
- To minimize excavation into contaminated material; and
- To grade the site to conform to future park topography (to be performed by the Park Contractor).

The design criteria for the soil closure cover system are summarized in the table below.

Soil Closure Cover Cross Section	
Design Criteria	**Basis of Design**
The following cross section over the site can meet the design criteria (from bottom to top). • Non-woven geotextile layer • 1-foot soil fill layer • Vegetation layer	Using the Universal Soil Loss Equation, a one-foot vegetated layer can sufficiently protect the soil closure cover integrity (Section 4.1.1) See Section 4.1.2 for the basis for non-woven geotextile layer selection The vegetative cover shall be maintained year-round as a recreational park by the City of Maywood
Preclude ponding	The minimum slope for the cap surface is 1%. Grading design to be met by the City of Maywood's Park Contractor
Prevent erosion and size drainage for the 100-year predicted storm frequency	The Rational Method analysis is used to size the drainage structure for the peak run-off flow rate. Drainage design to be met by the City of Maywood's Park Contractor
Design soil closure cover to support	Terzaghi's equation is used to determine bearing

Soil Closure Cover Cross Section	
Design Criteria	**Basis of Design**
potential future vehicle loads for routine site maintenance and inspection and to support park activities and vegetative layer including trees	capacity. Typical structural point load is 2,000 pounds per square foot (psf). Bearing capacity requirements shall be met by the City of Maywood's Park Contractor

4.1.1 Universal Soil Loss Equation

The Universal Soil Loss Equation is a widely accepted method used to evaluate the erosion potential of various soil cover materials. The governing equation is:

$$A = R \times K \times L \times S \times C \times P$$

Where:

A = Average annual soil loss, in tons/acre

R = Rainfall and runoff erosivity index

K = Soil erodibility factor, tons/acre

L = Slope-length factor

S = Slope-steepness factor

C = Cover-management factor, and

P = Practice factor.

All of the variables can be determined from the tables and figures provided in Predicting Rainfall Erosion Losses (U.S. Department of Agriculture, 1978). Because the source of the cover material has yet to be determined, typical values for a local soil type capable of supporting vegetation are used. The soil variable values and additional details regarding the basis for these parameters and calculations are provided in Appendix B.

The potential for significant erosion of the closure cover is evaluated by dividing the annual soil loss by an acre's total mass of the site's vegetated soil layer. The total mass of an acre's vegetated soil layer is equal to 2,259 tons, based on a unit weight of 1.4 tons per cubic yard and a thickness of 1 foot. The number of years required to erode 10 percent of this mass, at the annual soil loss of 0.01026 tons per acre, calculated using the Universal Soil Loss Equation, is over 20,000 years. Therefore, the erosion potential does not present a significant hazard to closure cover integrity.

4.1.2 Non-Woven Geotextile Selection

The addition of a non-woven geotextile layer below the soil cover will act as an indicator of excessive erosion and provide an additional layer to ensure the effectiveness of the soil cover.

In selecting the type of non-woven geotextile to be used as part of the soil closure cover, the following qualities were identified.

- strength must support park activities and vegetation.
- must be permeable.
- must be textured and have traction to avoid creating a plane for slippage.
- must have a minimum useful lifetime of 30 years.
- must be able to be cut and replaced, for remediation system access and maintenance of Park utilities.
- cost.

U.S. Fabrics, Inc., Reed and Graham, Inc., and Amoco Fabrics and Fibers Co. were contacted and asked to provide a list of their recommended products that meet the above requirements. All companies were asked to submit specification sheets and cost data for their non-woven geotextile product lines so that they could be compared for the above quality criteria. Technical evaluation was performed separate from cost evaluation so that an overall “best value” product could be selected. U.S. Fabrics non-woven geotextile “115 NW” was selected as being the best value. The U.S. Fabrics specification sheet, which offers a comparison to the Amoco non-woven geotextile “4556” is included in Appendix B.

Sections of the non-woven geotextile will be sliced open in order to insert and install the irrigation system for the park. Outside of this, appropriate restrictions will be applied by the City of Maywood to minimize drilling, digging, or building over any part of the Pemaco Site.

4.1.3 Bearing Capacity

Future use of the site as Maywood Riverfront Park was considered in determining the loads for the cover structural analyses. The soil cover should be designed to support the load of general park activities and occasional light vehicle traffic for routine maintenance and inspection. Bearing capacity of a soil is dependent on the soils strength and the geometry of the loading condition. For the purpose of these analyses, the typical structural load on the soil cover was assumed to be 2,000 psf for light traffic loads. This load capacity can sustain trucks driving over the soil cover for routine operation and maintenance (O&M) tasks such as inspection or repairs. The proposed grading and compaction plan for the Maywood Riverfront Park construction demonstrates that the soil cover will be able to accommodate light vehicular traffic loads without damaging the covers integrity. For additional information, refer to the Construction Plans for Riverfront Park, City of Maywood, CA (City of Maywood, 2004).

4.1.4 Surface Water Management and Erosion Control Evaluation

The site will be graded to a minimum of 1 percent slope (overall) to promote drainage. The proposed stormwater collection system, vegetation plans, and grading plan for the Maywood Riverfront Park construction demonstrates that surface water and erosion will be properly managed. For additional information, refer to the Construction Plans for Riverfront Park, City of Maywood, CA (City of Maywood, 2004).

4.1.5 Inspections and Maintenance

Periodic inspections and maintenance will be necessary to assure the effectiveness of the soil cover. The inspection schedule and maintenance procedures for the soil cover area will be presented in more detail in the Operations and Maintenance (O&M) Plan for the Remedial Action. An abbreviated O&M schedule and maintenance procedure is outlined as follows:

For the first two years following construction of the soil cover, routine quarterly inspections will be performed by qualified professionals and reported as part of the long-term monitoring program. To evaluate the soil cover system, maintenance items including vegetation and the erosion control system will be inspected regularly. After the first two years, the closure cover inspections will likely be reduced to formal annual inspections in combination with routine surface maintenance performed by the City of Maywood.

Post-closure activities will include the completion of an annual inspection report which will be submitted to the appropriate regulatory agencies. An engineer will annually evaluate and document the condition of the cover. Items which shall be evaluated are indicated below:

- Condition of vegetation
- Erosion
- Seepage
- Slope stability
- Condition of erosion control systems

Post-remediation maintenance activities will be performed, if necessary, based on the results of post-remediation inspections or routine observations. Descriptions of the specific maintenance activities that will be completed, if necessary, are given below:

- The soil cover will be repaired. The cover will be regraded as necessary to maintain appropriate thicknesses to prevent contact with the underlying soil. Additional material will be added as necessary.
- Damage, washout, or erosion of the soil cover will be backfilled, compacted, and the grades will be reconstructed.
- The soil cover will be fertilized, seeded, and regraded, or otherwise protected from erosion in the absence of vegetation.
- Vegetation will be restored to any worn areas.
- Damaged fences will be repaired and/or replaced.

4.2 UPPER VADOSE SOIL AND PERCHED GROUNDWATER REMEDIATION

The selected remediation method for treating upper vadose zone soils/perched groundwater utilizes a high-vacuum dual phase extraction (HVDPE) system for extracting groundwater and soil vapor from the contaminated zone. Typical groundwater extraction wells screened through the contaminated soil and perched groundwater zones will be installed to remove contaminants in both the vapor and liquid phase. The HVDPE system will consist of twenty-seven dual phase extraction (DPE) wells to provide coverage over the contaminated upper soil and perched groundwater areas. The Extracted vapors shall be treated according to the methods prescribed in Section 4.5 – Vapor Treatment System Design. Extracted water will be treated according to Section 4.6 – Water Treatment System Design.

The objectives of the HVDPE system are to satisfy the technical requirements and intent of the ROD. Specifically, the ROD states the following design objectives:

- Reduce VOC mass in the upper vadose soil and perched groundwater remediation zone to a level that no longer threatens to contaminate groundwater at levels above MCLs.
- Restore the groundwater quality in perched groundwater zone to drinking water standards (i.e. maximum contaminant levels, MCLs).
- Prevent further off site migration of contaminated groundwater beneath additional adjacent properties.
- Prevent further migration of soil vapor in excess of ARARs and standards that are protective of human health and the environment.

HVDPE was determined to be the best technology to meet the ROD design objectives, as documented in the FS (TN&A, 2004a). The Upper Vadose Soil and Perched Groundwater Zone treatment area and criteria was based on sample locations that exceeded USEPA Region IX Soil SSLs DAF 20. This area was determined from the results of the RI/FS sampling activities and HVDPE Pilot Test (Refer to Section 2.6.3). The treatment area is shown as a plume map on Drawing C-1 and in this report in Figure 4-1.

4.2.1 Perched Zone Remediation System Layout

HVDPE well layout was based on the design Radius of Influence (ROI). The ROI is the maximum distance from a vapor extraction well at which sufficient air flow can be induced to sustain acceptable rates of remediation (as dictated by the desired or required remediation time). The ROI depends on many factors including the geometric configuration of extraction and vent wells, intrinsic permeability of the soil, soil moisture content, and desired remediation time. The best way to determine ROI is through a pilot test. Test data from the HVDPE pilot test performed in December 2002 (see Section 2.6.3) was analyzed to determine that an effective vapor extraction ROI for the upper vadose soil and perched zone sediments is 54 feet. Based on this data, the design spacing and layout of extraction wells was graphically determined, as shown in Figure 4-1.

The layout of the HVDPE wells provides maximum coverage to areas where VOC concentrations exceed the ARARs, as shown in Figure 4-1. The areas of overlapping coverage provide a factor of safety that will assure all plume areas will be targeted.

4.2.2 Well Design and Construction

The 27 HVDPE wells to be installed within the upper vadose soil and perched groundwater zone, PA-1 through PD-9, are designed as four-inch diameter wells with ten-foot screen intervals. The Perched Zone well installation schedule is shown on Drawing C-3. Adjustment to screen intervals and design depths will be made (in the field) according lithosome observations made by the installing geologist or engineer. Field adjustments will assure system optimization and prevent symptoms like short circuiting (not expected to be an issue because of depth and lithology).

Well installation shall follow the TN&A Standard Operating Practice for Well Installation (Appendix C) and Technical Specification Section 02525N - Extraction and Monitoring Wells. In general, Perched Zone well screens will have 0.020-inch slots and extend 0.5 feet into the perching clay layer. A filter pack comprised of #2/12 sand will be used to fill the annulus one foot above the top of the screen to the bottom of the borehole. The wells will be drilled with a 10.25 inch diameter hollow-stem auger. All perched HVDPE well casings and screens external to the heated ERH zone will be constructed using Schedule 40 PVC. Refer to Drawing C-6 for the Perched Zone well section and details.

As discussed in Section 4.3.4, portions of the perching clay within the ERH zone will be heated to approximately 212°F (100 degrees Celsius). All perched HVDPE well casings and screens within the heated ERH zone, are anticipated to be constructed using Schedule 40 CPVC or steel, based on final determination by the ERH Contactor.

The “drop tube” method for HVDPE shall be utilized in all Perched Zone wells, since it was successfully demonstrated in the HVDPE Pilot Test (TN&A, 2003a). A one-inch diameter PVC suction pipe (“stinger”) will be placed within the well casing and will terminate 0.5 feet before the bottom of the well casing. The suction pipe will have approximately twelve 1/8 inch drilled holes interspersed along the last two feet of the drop tube to facilitate entrainment of water. Suction pipes used in the Perched Zone wells within the ERH area will be made of Schedule 40 CPVC to withstand any excessive heat from the ERH system.

An important pneumatic factor that was considered to assure successful entrainment of water in the vapor extraction stream is the drop tube size. Entrainment of liquid droplets in a vapor stream and subsequent extraction from a well requires linear vapor velocities in excess of 15 feet/sec. A good design velocity should be significantly greater than the minimum, or approximately 27 feet/sec (USACE, 1999). The drop tube diameter will determine the velocity, since velocity equals flow divided by area ($V = Q/A$). Based on this formula, a 1-inch drop tube will require 8.95 cfm (approximately 9 cfm) of vapor flow to provide a good design linear velocity up the drop tube. Additional information pertaining to vapor flow and blower sizing is contained in Section 4.5.2.

Instructions from the City of Maywood Park Contractor require that the well vaults be installed flush to the existing grade. The Park Contractor will hydroseed around well vaults within the Park surface. All wells installed in roadways will also be finished flush to grade in accordance with details provided on Drawing C-4, trench cross section E, for excavations performed in roadways.

4.2.3 Perched Zone HVDPE System Mass Removal Estimates

Mass removal estimate calculations were determined from contaminant concentrations measured during the HVDPE Pilot Test. Refer to Table 4-1 for the measured VOC concentrations and the calculated mass removal rate.

According to Table 4-1, a mass removal rate of 0.016 lbs/day per Perched Zone well can be expected as shown from the table calculations. This rate was used as the basis for the calculation of total VOC mass removed per day, which is shown in the vapor extraction design worksheet on Table 4-2. Using a design flow of 10 scfm (explained in Section 4.5.2) the total removal rate for the HVDPE system is 4.32 lbs/day or 2,763 lbs after five years of operation. The basis for these calculations is explained in Table 4-2 comments and footnotes. It is recognized that these numbers may increase by 1 to 2 orders of magnitude depending on the final ERH design.

The second half of Table 4-2 shows the HVDPE mass removal over a five year period assuming exponential decay of contaminant concentration. The basis for the exponential decay model is based on company experience on similar projects. This table provides carbon corruption estimates for years two through five when the FTO is anticipated to be replaced by GAC treatment.

4.3 LOWER VADOSE SOIL AND EXPOSITION GROUNDWATER REMEDIATION

The selected remediation method for treating lower vadose zone soils and Exposition groundwater utilizes a vacuum enhanced groundwater extraction system for extracting groundwater and soil vapor from the contaminated zone. Removal of contaminants from lower vadose zone soils will be primarily addressed through the ERH system design. Refer to Section 4.3.4 for the discussion of the ERH system. Groundwater extraction wells screened through the Exposition groundwater zones will be installed to remove contaminants in both the vapor and liquid phase. The vacuum enhanced groundwater extraction system will consist of 33 extraction wells and will provide coverage over the Exposition groundwater plume areas. The wells are designated “DA,” “DB,” or “DAB,” according to the intended treatment zone targeted by the well as follows:

- Twelve vacuum enhanced groundwater extraction wells will be screened through the ‘A’ Zone (DA-1 to DA-12);
- Twelve vacuum enhanced groundwater extraction wells will be screened through the ‘B’ Zone (DB-1 to DB-12);
- Eight vacuum enhanced groundwater extraction wells will be screened through both the ‘A’ and ‘B’ Zones (DAB-1 to DAB-8); and
- Two existing groundwater wells (MW-24-140 and MW-24-110) that are screened through the ‘C’ and ‘D’ Zones may be used for extraction if monitoring data indicates contamination as discussed in Section 4.3.2).

The extracted vapors shall be treated according to the methods prescribed in Section 4.5 – Vapor Treatment System Design. Extracted water will be treated according to Section 4.6 – Water Treatment System Design.

The objectives of the vacuum enhanced groundwater extraction system are to satisfy the technical requirements and intent of the ROD. Specifically, the ROD states the following design objectives:

- Reduce VOC mass in the lower vadose soil and Exposition groundwater remediation zone to a level that no longer threatens to contaminate groundwater at levels above MCLs.
- Restore the groundwater quality in Exposition groundwater zone to drinking water standards (i.e. maximum contaminant levels, MCLs).
- Prevent further off site migration of contaminated groundwater.
- Prevent further migration of soil vapor in excess of ARARs and standards that are protective of human health and the environment.

Vacuum enhanced groundwater extraction was determined to be the best technology to meet the ROD design objectives, as documented in the FS (TN&A, 2004a). The lower vadose soil and Exposition Zone groundwater treatment area and criteria was based on vacuum enhanced groundwater extraction which will be used to remediate groundwater contamination within the area mapped by the 10 µg/L TCE isoconcentration lines shown on Drawing C-1. Monitored natural attenuation (MNA) will be used outside the 10 µg/L TCE contour line to demonstrate plume reduction and/or point of compliance. The plume was determined from the results of the RI/FS sampling activities.

4.3.1 Lower Vadose and Exposition Zone Remediation System Layout

The vacuum enhanced groundwater extraction well layout was based on the design capture zone which was determined from the observed radius of capture (ROC) and cross-gradient width of capture (WOC). The downgradient ROC and the cross-gradient WOC are considered the maximum reliable distance from a groundwater extraction well at which sufficient groundwater capture can be sustained over time. The ROC and WOC depend on many factors including the geometric configuration of extraction wells, hydraulic conductivity, porosity, hydraulic gradient and desired remediation time. The ROC and WOC were determined in the Aquifer Test referenced in Section 2.6.1.

The vacuum enhanced groundwater extraction well layout for the Exposition ‘A’ and ‘B’ Zones was determined using a graphic approach which consisted of situating scaled ROC shapes over the plume area until adequate coverage was provided. The layout of the vacuum enhanced groundwater extraction wells provides maximum coverage to areas where VOC concentrations exceed the ARARs, as shown in Figure 4-2. The areas of overlapping coverage provide a factor of safety that will assure all plume areas will be targeted. The estimated capture zones are intended to represent a finite distance in the down-gradient and cross-gradient direction. The upgradient capture zone is time dependent and will eventually include all contaminated zones upgradient of the extraction well.

Although the Aquifer Test indicated an average ROC of 124 feet and average cross-gradient WOC of 389 feet for the ‘A’ and ‘B’ Zones, the actual design was based on the more conservative minimum calculated downgradient ROC of 46 feet and minimum calculated cross-gradient WOC of 146 feet. The Exposition ‘A’ and ‘B’ Zone wells are designed to intercept groundwater flowing in a southwesterly direction, which is representative of the average hydraulic gradient of the composite ‘A’ and ‘B’ Zone plume map (Figure 4-2). Hydraulic gradients in the ‘A’ Zone have ranged from 0.0043 to 0.011 feet/feet from May 2001 to April 2002. Hydraulic gradients in the ‘B’ Zone ranged from 0.0063 to 0.0092 feet/feet from May 2001 to April 2002. Apparent groundwater flow directions have been consistently towards the southwest and south southwest.

The groundwater extraction well capture zone for the Exposition ‘D’ Zone was based on 59.2-foot downgradient ROC and 166.04-foot cross-gradient WOC as estimated by calculating the average hydraulic conductivity for each Exposition zone and using the observed aquifer thickness of the ‘D’ Zone. The Exposition ‘D’ Zone well is designed to intercept groundwater flowing in a southwesterly direction from the only area where VOC contamination has been detected, as shown in Figure 4-3. Refer to Section 2.5.2.4 for the information pertaining to detected contaminants in the ‘D’ Zone. The hydraulic gradient in the ‘D’ Zone is estimated at 0.0013 feet/feet in the south southwest direction.

4.3.2 Lower Vadose Soil and Exposition Aquifer Well Design and Construction

The 33 vacuum enhanced groundwater extraction wells to be installed within the Exposition Aquifer, (DA/DB-1 to DA/DB-12, DAB-1 to DAB-8 and MW-24-140), are designed as six-inch diameter wells. Well installation shall follow the Standard Operating Practice for Well Installation (Refer to Appendix C) and the Technical Specification Section 02525N - Extraction and Monitoring Wells. All vacuum enhanced groundwater extraction wells will be installed with ten-foot screen intervals with the exception of the “DAB” wells which will have 20-foot screen intervals. The Exposition Aquifer well installation schedule is shown on Drawing C-3.

Adjustment to screen intervals and design depths will be made (in the field) according to lithosome observations made by the installing geologist or engineer. Field adjustments will assure contaminated intervals are properly targeted and prevent cross-contamination between zones.

In general, Exposition Aquifer well screens will have 0.020-inch slots and extend one foot into the lower confining layer. A filter pack comprised of #2/12 sand will be used to fill the annulus three feet above the top of the screen to the bottom of the borehole. The wells will be drilled with a 12.25-inch diameter hollow-stem auger. Extraction well casings and screens within the ‘A’ Zone and external to the heated ERH Area will be constructed using Schedule 40 PVC. Extraction well casings and screens within the ‘B’ Zone that are external to the ERH Area will be constructed using Schedule 80 PVC which offers more rigidity for these deeper wells. Refer to Drawing C-8 for the Exposition Aquifer well section and details.

The lower vadose soil and Exposition groundwater within the ERH Area will be heated to approximately 212°F (100°C) by the ERH system. All vacuum enhanced groundwater extraction well casings and screens within the heated ERH Area are anticipated to be constructed using

Schedule 80 CPVC or steel, based on the final determination by the ERH Contactor. In addition, all groundwater pumps will be designed to tolerate the heat conditions.

Groundwater extraction is expected to be enhanced by vapor extraction as demonstrated by the HVDPE Pilot Test. The HVDPE Pilot Test showed that flows increased from 0.25 gpm (no vacuum applied) to 1.1 gpm (with vacuum applied) in the ‘A’ Zone and from 1.1 gpm (no vacuum applied) to 2.0 to 2.5 gpm (with vacuum applied) in the ‘B’ Zone. Average influent concentrations were also higher during vacuum enhanced groundwater extraction as influent concentrations reached a maximum of 900 ppmv. These results indicate that vacuum enhanced groundwater extraction is more efficient than groundwater extraction by itself for the lower vadose soil and Exposition groundwater zones. A 3.5 inch diameter pneumatic pump capable of delivering 2.8 gpm at 180 feet of water column (w.c.) will be used to extract groundwater for treatment.

Instructions from the City of Maywood Park Contractor require that the well vaults be installed flush to the existing grade. The Park Contractor will hydroseed around well vaults within the Park surface. All wells installed in roadways will also be finished flush to grade in accordance with details provided on Drawing C-4, trench cross section E, for excavations performed in roadways.

4.3.2.1 Liquid Phase Mass Removal (from Lower Vadose and Exposition Zone)

VOC mass removal estimates for groundwater extraction were determined from average contaminant concentrations measured from selected representative wells in both the “source area” and “containment area.” The representative wells are listed in Table 4-3. Generally, wells along 60th Street are considered “containment area” wells and wells within the park boundary are considered “source area” wells. Using the representative wells, average VOC concentrations for the Exposition Zones ‘A’, ‘B’, and combined ‘A’ and ‘B’ groundwater were determined. Refer to Table 4-3 for the basis of the calculation and refer to Drawing C-1 for the representative well locations.

The average VOC concentrations in groundwater were used in calculations shown in Table 4-4 in order to estimate the mass removal rate in pounds per day. The Exposition ‘D’ Zone concentration was determined from the one ‘D’ Zone data point (well MW-24-140) that contained concentrations of VOCs above the MCLs. Note that the D Zone data is anomalous and likely a result of cross-contamination between zones during well installation. Future data collection from the D Zone will be used to assess actual impact and the remedial design will be modified accordingly. Based on the Table 4-4 spreadsheet calculations and footnote clarifications, a total mass removal rate of 2.71 lbs/day can be expected from the groundwater extraction system. The Justification for the groundwater pumping rate used in Table 4-4 for the different Exposition zones is provided in Section 4.6.2. It is estimated that this mass removal rate may increase by one to two orders of magnitude depending on the final ERH design.

A VOC mass removal rate of 2.71 lbs/day was used as the basis for the average first year mass removal rate shown in Table 4-5. Using a design flow of approximately 47.1 gpm (explained in Section 4.6.2) the total removal rate for the extraction system after five years of operation is estimated to be 2,175 lbs. The basis for these calculations is explained in the Table 4-5 footnotes.

Table 4-5 also shows the groundwater mass removal rate and the estimated liquid phase carbon usage over a five year period assuming contaminant concentration decreases exponentially. The basis for the exponential decay model is company experience on similar projects. Furthermore, groundwater concentrations are likely to reach RAOs (MCLs) by year five as a result of ERH treatment or by exercising the option to inject oxidants. Table 4-5 also provides carbon usage estimates for the GAC treatment system.

4.3.2.2 Vapor Phase Mass Removal (from Lower Vadose and Exposition Zone)

VOC mass removal estimates from vapor extracted from the Exposition Zone wells were determined from the average vapor phase VOC concentration measured from one ‘A’ Zone and one ‘B’ Zone well during the HVDPE Pilot Test. Refer to Drawing C-1 to find the well locations. The representative wells are listed on Table 4-1 and represent “source area” conditions; i.e., higher than average VOC concentrations and mass loadings. An average of the mass loading rate (5.35 lbs/day), calculated in Table 4-1, was used in Table 4-6, to calculate an estimated 128.40 lbs/day of VOCs would be removed from the Exposition Zone via vapor extraction. Refer to the Table 4-6 footnotes for justification of this rate, which has been reduced by 25% to account for concentration spikes observed on the first day of the HVDPE operation. It is not anticipated that this rate would increase more than one order of magnitude as a result of ERH operation because significantly more ERH vapor extraction wells would be located closer to the source area.

A VOC mass removal rate of 128.4 lbs/day was used as the basis for the average first year mass removal rate shown on the Vapor Phase Mass Removal From Groundwater and Carbon Usage Worksheet (Table 4-6). Using a design flow of approximately 7 scfm (explained in Section 4.5.2) the total removal rate for the extraction system after five years of operation is estimated to be 87,016 lbs. The basis for these calculations is explained in the Table 4-6 comments and footnotes.

Table 4-6 indicates the estimated vapor mass removal rate over a five year period decreases exponentially. The basis for the exponential decay model is company experience on similar projects. Furthermore, vapor concentrations are decrease rapidly by year five as a result of ERH treatment or by exercising the option to inject oxidants. Table 4-6 also provides carbon consumption estimates that were useful in estimating carbon demand for post-FTO vapor treatment. The FTO will be taken offline following ERH treatment, when mass removal rates are anticipated to significantly decrease to the point where carbon is more economical. The criteria for the determination of this point will be discussed in the Remedial Action Work Plan.

4.3.3 Exposition Zone ERH System Design

Electrical Resistance Heating (ERH) utilizes electrodes that are inserted directly into contaminated soil. The electrodes heat the soil and groundwater to approximately 212°F (100°C). Contaminants are removed from the subsurface through multiple processes, including volatilization and in-situ steam stripping, and are collected at the surface via vapor extraction for treatment.

At Pemaco, ERH will be used to treat the Lower Vadose Zone soil and Exposition groundwater plume with highest concentrations of VOCs, per the RI and supplemental CPT/MIP investigation. The highest concentration area, which is referred to as the source area or “core”, is defined by mapped isoconcentration contour lines which represents >10,000 µg/L of TCE in groundwater and the CPT/MIP source area data which represents > 10,000 parts ppb (vapors in soil), and the CPT/MIP data representing intervals greater than 10-feet thick with TCE response curves greater than 20,000 intensity counts. The source area and the combined plumes representative of the “core” are shown on Figure 4-4. The source area “footprint” covers approximately 13,200 sq ft in the south portion of the former Pemaco property. The ERH system, consisting of approximately 95 electrodes, 36 vapor extraction wells, and 30 temperature monitoring/air monitoring wells will be installed within this area.

Currently there are three contractors in the United States that design, build and operate ERH systems. The USEPA and USACE worked to review proposals from all three of these companies and selected Thermal Remediation Services (TRS) to conduct the ERH remediation at the Pemaco Site. TRS has performed a supplemental Design Report for the ERH system at Pemaco in which the ERH design is detailed. The reader will be referred to that document for more detailed descriptions of the ERH implementation.

Application of ERH will affect several design criteria associated with the vacuum enhanced groundwater extraction system in the Lower Vadose and Exposition Aquifer within the ERH treatment area. Design criteria that have been adjusted to accommodate ERH treatment include:

- Well construction materials/details
- Well spacing
- Piping details
- Water and vapor flow rates
- Treatment system modifications

The high vacuum soil vapor and groundwater extraction wells are spaced on a significantly tighter grid and are screened in numerous discrete stratigraphic intervals within the ERH treatment area to ensure capture of all vapors/steam generated during the ERH process. The well screens and conveyance piping that will be affected by ERH heating are specified as Chlorinated Polyvinyl Chloride (CPVC) piping. The treatment compound design flow rates have been increased to accommodate ERH system effluent. In addition, some flexibility has been incorporated into this design package so that efficiency associated with “design/build” projects can be realized. Refer to the TRS Design Report for more detail.

4.4 PIPING AND TREATMENT COMPOUND DESIGN

4.4.1 Piping and Conveyance System Design

The complete piping system layout for both the perched HVDPE system and the vacuum enhanced groundwater extraction system (Exposition Aquifer) is presented in Drawing C-3. In general, the trench and pipe layout is divided into three separate trenches, which are referred to in the Drawings and Specifications as the east, west, and south trenches.

The criteria used to design the pipeline layout and three-trench system were to:

- Provide the most direct route to connect wells; i.e., minimize trench length
- Balance the number of wells per header and trench
- Minimize trench width to allow faster excavation runs
- Minimize piping cross-overs and -unders
- Avoid the proposed Park facilities, utility corridors, and obstructions
- Minimize disturbance to the proposed Park and vicinity.

The three trenches will be laid out in the field using the stationing and construction surveying methods shown in Drawing C-2. The trench and pipeline depth profile, shown in Drawing C-5, was designed using the following criteria:

- All pipelines are to be below Park irrigation (1.5 feet bgs) and electrical (2 feet bgs) systems
- Avoid subsurface obstructions such as: the foundation of District Boulevard, existing utilities, proposed drainage structures, and the proposed Park dry pond
- Maintain a slope of approximately 0.5% towards the treatment compound
- Minimize low points aside from the treatment compound
- Minimize depths greater than 5-feet and shoring requirements
- Allow for sufficient cover to protect pipelines.

4.4.2 Pipe Material Selection

Treatment system piping will convey extracted soil vapor to the treatment compound at service vacuums ranging from 13 to 27 inches of mercury (in Hg), depending on location in the network. Groundwater will be conveyed in piping that is under positive pressure, generally less than 5 pounds per square inch (psi). The most economical piping material suitable for this type of application includes Scheduled 40 or 80 Polyvinyl Chloride (PVC), or CPVC for high temperature applications. Of these, Schedule 40 PVC is suitable for most of the treatment system piping, including all conveyance piping in the south trench, beneath 60th Street. The following items were considered when selecting piping material type and are based on manufacturer's data:

- Working pressure and vacuum - Schedule 40 PVC piping is suitable for most vacuum applications; even if servicing a complete (hypothetical) vacuum, external atmospheric pressure would not collapse the piping.
- Working temperature - For temperature loading, the maximum service temperature of Schedule 40 PVC is 140°F, making it suitable for nearly all connection piping to the treatment compound aside from ERH piping areas (East Trench). It is anticipated that CPVC piping will be used for ERH impacted lines – depending on the Final ERH Design. For ERH areas, CPVC piping will be used. CPVC has a maximum service temperature of 210°F. As a factor of safety, and to compensate for any potential reactions from the heated contaminants, all pipes conveying water or vapor in excess of 100°F will be constructed of CPVC or materials recommended by the ERH Contractor.
- Vertical loading on buried pipe - Schedule 40 PVC has a compressive strength of 8,300 pounds per square inch (psi), or 1.2 x 106 pounds per square foot (psf). The table below summarizes H-20 and H-25 live loading pressures on buried pipe. Even at a minimum depth of 1-foot, H-20 and H-25 load pressures are significantly below the compressive strength of Schedule 40 PVC. Therefore, loads from activities around the park should not affect the selected pipe materials.

LIVE LOADS ON BURIED PIPING*

Depth of Cover (feet)	Load (psf)	
	H-20	H-25
1	1800	2280
2	800	1150
3	600	720
4	400	470
5	250	330
6	200	240
7	175	180
8	100	140
9	--	110

Source: Lane Enterprises *See ASTM A796

- Cost – Schedule 40 PVC is considered to be inexpensive piping and is commonly used for commercial, industrial, and environmental applications.

The design of the perched HVDPE piping system and the vacuum-enhanced groundwater extraction system is detailed in graphic format in Drawings M-2 and M-3, respectively. In addition, pipeline summary details are provided in Pipeline Summary Table 15400-1 located in Specification 15400 – PROCESS PIPING (Appendix A) contains all the design conditions and construction materials for every foot of pipe in the system.

Secondary containment or double walled pipe will be used to convey all groundwater to prevent any unintended discharges to the environment. Double walled pipe is not considered necessary to convey vapor and condensate in the vapor pipelines because it will be under vacuum, and is therefore, considered self containing. All pipelines will under go hydrostatic testing to test for leaks prior to being placed in service in accordance with Specification 15400 – PROCESS PIPING.

4.4.3 Pipe Diameter Selection

The design basis for the selection of pipe diameter as detailed in the Pipeline Summary Table 15400-1 located in Specification 15400 – PROCESS PIPING (Appendix A) falls into three criteria:

- Available pressure drop
- Velocity limitations
- Economic selection

All pipelines were initially designed using typical pressure drops referenced in literature as a guideline. This was followed by comparison to the system available pressure drop. The general design tenet of this method is to use the minimum size line that will use as much as the available pressure-drop as possible. This concept incorporates economic selection since pipe costs increase almost exponentially with diameter.

4.4.3.1 HVDPE and VE Pipe Diameter Selection

The HVDPE [used synonymously with dual phase extraction (DPE)] and VE conveyance pipeline diameters were generally selected to ensure the pressure drop (due to friction) was at or below the design criteria of 0.25 psi/100 feet (Parsons, 1976). This pressure drop value is associated with velocities ranging from 200 to 250 feet/sec. In DPE piping, where significant amounts of water are being carried with the vapor, high velocities can lead to slug flow of condensate within pipelines. In order to avoid slug flow, the design velocity was reduced (by increasing pipe diameters) to a range between 30 and 80 feet/sec, with exception to velocities in the drop tubes, which may be higher.

Calculations for friction loss (head loss) were performed using the Darcy-Weisbach equation and the calculations were confirmed with a computer model using general gas laws and formulas. The results of the head loss calculations are documented in Table D-1 DPE Head Loss Calculation and Table D-2 VE Head Loss Calculation spreadsheets attached in Appendix D. The computer model confirmation, literature, and equivalent pipe length literature are also included in Appendix D.

The friction loss calculations and pipe size selection assumed a design flow of 10 scfm per well for the DPE wells and 7 scfm for the VE (DA-, DB-, DAB-) wells. The pipe lengths and diameters that were selected are shown in Table 15400-1 (Specification 15400 in Appendix A).

4.4.3.2 Groundwater Extraction Pipe Diameter Selection

Groundwater conveyance pipeline diameters were generally selected to ensure the pressure drop (due to friction) was at or below the design criteria of 1 psi/100 ft (Parsons, 1976).

Calculations for head loss were performed using the Darcy-Weisbach equation and the calculations were confirmed with a computer model using general gas laws and formulas. The results of the head loss calculations are documented in Table D-3 - Groundwater Head Loss Calculation spreadsheet attached in Appendix D. The computer model confirmation, literature, and equivalent pipe length literature are also included in Appendix D.

Since the selected pneumatic well pumps discharge groundwater at rates nearly double the anticipated groundwater extraction rates (see Section 4.6.4), the friction loss calculations and pipe size selection were based on doubled averaged groundwater extraction flow rates as indicated in Table 4-13. The pipe lengths and diameters that were selected are shown in Table 15400-1 (Specification 15400 in Appendix A).

4.4.3.3 Compressed Air Pipe Diameter Selection

The compressed air conveyance pipeline diameters were generally selected to ensure the pressure drop (due to friction) was at or below 2 percent/100 feet.

Calculations for head loss were performed using the Darcy-Weisbach equation and the calculations were confirmed with a computer model using general gas laws and formulas. The results of the head loss calculations are documented in Table D-4 Groundwater Head Loss Calculation spreadsheet attached in Appendix D. The computer model confirmation, literature, and equivalent pipe length literature are also included in Appendix D.

Since the selected pneumatic well pumps discharge groundwater at rates nearly double the anticipated groundwater extraction rates (see Section 4.6.4), and therefore, consume nearly double the compressed air, the friction loss calculations and pipe size selection were based on doubled the anticipated compressed air flow rates as indicated in Table 4-13. The pipe lengths and diameters that were selected are shown in Table 15400-1 (Specification 15400 in Appendix).

4.4.4 ERH Area Connection Piping Design

In general, Schedule 40 CPVC piping will be used where extracted soil-vapor and groundwater temperatures are above 140°F. The CPVC piping is generally specified to temperatures up to 210°F. Schedule 40 PVC pipes will be used where extracted soil-vapor and groundwater temperatures are expected to be below 140°F.

All connection piping within the ERH area will be specified and designed by the ERH Contractor. There will be several service pipelines from the ERH area to the treatment compound that will be constructed according to the ERH Contractors specifications. A chiller/condenser unit, which will be provided by the ERH Contractor, will cool all extracted vapors and water condensate in the ERH area before they are transferred (via piping) to the treatment compound. Effluent from the ERH chiller/condenser unit will have an average temperature of 70°F. Therefore, vapors and water condensate transported from the ERH Area will generally meet the specifications for transport via Schedule 40 PVC. However, as a factor of safety, in the event of a malfunction in the chiller/condenser, CPVC ping has been specified for the ERH area conveyance piping. Drawing M-3 details the diameter and construction material for each section of connection piping. Lateral piping from the wells to the treatment system will be sloped toward the treatment system to allow entrained water and condensate to be collected in the knockout drum.

4.4.5 Treatment Compound

4.4.5.1 Pre-Engineered Steel Building

Selection of a pre-engineered steel building for housing the treatment compound was based on consideration of several factors, including:

- Ease of design and installation options
- Competitive cost per square foot of building
- Alterable design to meet floor plan requirements
- Exposed-column construction provides options for conveyance system bracing
- Exterior color and paneling schemes available to match Park architecture
- Building standards meet seismic and wind-loading requirements for Los Angeles

Refer to Drawing C-11 for the proposed treatment building design. The building will be engineered according to Section 13120 – Pre-engineered Steel Buildings. Steel fabrication will be performed according to Section 05055 – Metal Fabrication.

4.4.5.2 Treatment Compound Foundation

The treatment compound foundation was designed to support all of the treatment equipment (Drawing M-4) and also act as secondary containment in conjunction with the perimeter berm. The weights of each major piece of equipment, fully loaded with water or intended contents, is shown in Table 4-10.

The treatment compound was designed with a 10” thick concrete floor for the following reasons:

- An allowable bearing capacity of 2,000 psf was assumed considering that the location of the treatment compound was close to a major river and was within a very high seismic-activity area. After subgrade amendment and compaction, the allowable foundation and lateral pressure of 2,000 psf as stated in the Uniform Building Code, will be met.
- The treatment compound floor is planned as part of a mat foundation with a thickened section below the building columns.
- The building structure is to be supplied by a pre-engineered metal building supplier who, by specification requirement, will provide the engineering analysis of the building and foundation and has the final responsibility for sizing the building foundations.
- The floor loading consists of process equipment, storage tanks, and moving forklift wheel reactions which can be located anyplace within the floor area.
- The floor is designed per ACI 318, Building Code for Structural Concrete for a Minimum Coefficient for Shrinkage and Temperature Reinforcement of 0.0018.

- For a building 50 feet by 80 feet, reinforcement and control joints are provided to control concrete shrinkage and temperature effects that would otherwise cause unacceptable micro cracks in the floor slab and excessive leaking.
- Steel reinforcement is provided to minimize micro crack widths to less than 0.035-inches, so aggregate interlock occurs and shear forces will be transferred across the crack.
- The critical loading condition that controls the floor thickness occurs along the control joints and at the building columns from seismic loading.

A value engineering assessment examined the size, construction dimensions and slab thickness of the treatment compound in an effort to reduce the overall cost of the treatment compound installation. Cost savings were achieved by reducing the volume of liquid to be contained as a result of a spill or leak in the tank. This involved the following design changes:

- Reduction of the height of the concrete berm around the perimeter of the building from 12 inches to 4 inches,
- Elimination of the need for the walkway which reduced the building length by 4 feet,
- Reduction of the volume of concrete under the raised floor area by 50 percent,
- Reduction of the concrete volume of the ramp by 75 percent, and
- Elimination of the need for railings.

A reduction in floor thickness from ten inches to six inches was considered and would have reduced the construction cost by $4,000; however, the floor thickness will not be reduced as the cost of engineering required to review all of the loading conditions for the six inch floor would, in part, consume the construction cost savings.

A four-inch concrete containment berm will be constructed around the treatment compound to provide secondary containment in an overflow situation or similar failure scenario. The concrete will be finished with a water-sealant coating. The water-holding capacity of the containment berm is over 7,000 gallons. Water level indicators will be used for monitoring the containment sump. The water from the containment sump will be conveyed through filters and discharged to the holding tank by the sump pump. The sump pump is rated for a minimum of 30 gpm at 35 feet of total dynamic head. Reference calculations and specifications for the water holding tank and containment wall are provided in Appendix E. Additional sump pump specifications are provided in Table 4-11.

The level controls in the containment sump will perform the following functions:

- When water level drops below the low level set point, the low level switch will activate and the PLC will shutdown the sump pump.
- At the high water level set point, the high level witch will activate and the PLC will start the sump pump.
- In the event that the water level reaches the high/high set point, the level will activate and the PLC will shut down the entire system as a safety precaution.

4.5 VAPOR TREATMENT SYSTEM DESIGN

The vapor treatment system will consist of equipment, piping, and instrumentation as specified in the General Piping and Instrumentation Diagram (P&ID) Drawing M-1, Equipment and Instrumentation Specification Summary (Table 4-11), and Major Equipment Specifications (Table 4-12). The vapor treatment system will eliminate contaminants from extracted vapor using a Flameless Thermal Oxidizer (FTO) and granular activated carbon (GAC). The FTO will be purchased as a complete system including the acid-gas scrubber and necessary controls and instrumentation.

Vapors will be extracted from the subsurface using parallel blower units that are discussed in Section 4.5.2. The extracted vapors will be conveyed via subsurface piping to an eight-inch manifold in the treatment compound (Drawing M-4).

Effluent from the FTO and attached scrubber will be further treated to remove potential ultra-low concentrations of dioxin and furan contaminants in a polishing step consisting of GAC. Following the GAC, treated vapor will be discharged to the atmosphere at a minimum height above ground surface of 25 feet. The following subsections outline the design basis for the major vapor treatment system components:

- Influent Concentrations
- Vacuum Extraction Rate And Blower Sizing
- Moisture Separator
- Flameless Thermal Oxidizer System
- Vapor Conditioning Package
- Vapor-Phase Granular Activated Carbon
- FTO Emission Specifications
- Treatment Schedule

4.5.1 Influent Concentrations

Vapor sampling results from the HVDPE pilot test are provided in Table 4-1. This table indicates VOC concentrations (ppmv) that can be expected upon start up of the HVDPE system and the vacuum enhanced groundwater extraction system. The combined vapor phase VOC loading estimated from both systems is 132.7 pounds per day (Table 4-2 and Table 4-6). Refer to Sections 4.2.3 and 4.3.3 for the basis for the estimated vapor phase loading rate. This initial loading rate is well below the maximum loading rate specified by the FTO manufacturer (approximately 75 lbs/hour). It is recognized that operation of the ERH system may significantly increase this value; however, by the time ERH operation begins, initial concentration spikes from previously operating vapor extraction system will have dramatically decreased. Refer to the Remedial Action Schedule discussed in Section 5.10 for operational timeframe.

4.5.2 Vapor Extraction Flow Rate and Blower Sizing

Documented experience at many sites indicates a liquid ring pump is an economical and effective pump (blower) for achieving HVDPE goals. The primary factor for sizing the liquid ring blower for a full-scale HVDPE system is the volumetric flow rate of soil vapor necessary for the extraction of fluids from the wells via the drop tube.

From Section 4.2.2, design for entrainment of liquid droplets in a vapor stream and subsequent extraction from a well requires linear velocities in the drop tube of approximately 27 feet/sec (USACE, 1999). Based on a drop tube diameter of 1 inch, 9 cfm of vapor flow will provide more than the requisite linear velocity in the drop tube.

Sizing of the blower was performed with consideration of the Perched Zone HVDPE requirements as well as the less rigorous vacuum enhanced groundwater extraction requirement from the Exposition Zone wells. Refer to Table 4-7 for the blower sizing calculations. It was assumed that all 27 HVDPE wells in the Perched Zone require a flow of 10 scfm (includes factor of safety). It also assumes that on average, a flow of 7 scfm would be acceptable for the Exposition Zones wells, particularly since approximately 25% of them are outside the 100 ppb plume area; e.g., the wells along 60th Street. Contaminant removal may not be accelerated or made more economical by adding VE to these wells; however the option has been built into the design and will be assessed during system optimization. Flexible design elements will allow vacuum and flow to be conserved in some areas and directed to the wells that demonstrate the most economical and effective use of the remediation system's capabilities. Such optimization evaluations will be performed during the system optimization phase. Refer to the Remedial Action Schedule in Section 5.10 for the optimization phase time frame.

Vacuum levels measured from the HVDPE pilot study were used in Table 4-7 to size the blower; refer to the table footnotes for more information. Valves on the wells will allow vapor extraction rates to be varied, thereby optimizing the system to extract from wells producing measurable contaminants.

Based on the data contained in Table 4-7 and blower performance data presented in Table 4-9, twin 1100 acfm (nominal) 75 Horsepower (Hp) liquid (oil) sealed ring pumps (blowers) were specified to provide the required vacuum and vapor extraction flow rate. A twin blower design was selected to increase flexibility of the system and to allow for maintenance of one while the other operates. To ensure that vapor flow rate does not exceed the 1000 scfm maximum rating of the FTO, the blowers were sized for a maximum combined flow rate of 976 scfm at the lowest anticipated operating vacuum of 16 in. Hg.

The selected blower size (Hp) was also compared to empirical data compiled by Battelle from their long history of performing and sizing pumps for multiphase extraction projects (Battelle, 1998). The Battelle data is provided as Table 4-8. The Battelle data supports the selected Hp size for the blowers based on the flow rate and manifold pressures between 20 and 24 in Hg. The blowers and their specifications are shown on Drawing M-1. Additional blower specifications are provided in Table 4-12.

The manifold and piping system has been designed to minimize headloss and maintain steady vacuum levels throughout the system. A range of vacuums shall be established between 16 in Hg and 22 in Hg at the Perched Zone wellhead furthest from the pump based on the piping minimal head loss, blower curve and the desired ROI of 54 feet. The vapor conveyance piping was sized for minimal head loss less than 0.25 psi (0.51 in Hg) per 100 feet of pipe. System piping and headloss calculations are discussed in Section 4.4.

4.5.3 Moisture Separator

A 500-gallon moisture separator (equipment ID V-101) will separate vapor and water phases from the influent stream for phase-specific conveyance to the vapor or water treatment system. The moisture separator features a 250-micron demisting pad for removal of entrained water droplets. The moisture separator is sized according to manufacturer data based on vapor system treatment requirements (also see Appendix E, Miscellaneous Equipment Design). The moisture separator will include a water level switch, relief valves, and a manual drain valve.

The water phase from the moisture separator will be conveyed through a water filter and discharged to the holding tank (equipment ID V-106) by transfer pump P-201 as shown on Drawing M-1. Transfer pump P-201 is rated for a minimum discharge of 30 gpm at 75 feet of total dynamic head. A spare transfer pump for P-201 will be provided and stored on-site. The transfer pump will be valved and flanged to be quickly replaced with the spare pump in the event of pump failure. Level controls will be utilized to perform the following functions:

- At the high water level point, the level switch will activate and the PLC will start the transfer pump;
- When water level drops below the low set point point, the low level switch will be activated and the PLC will shut down the transfer pump; and
- In the event that the water level reaches the high-high set point, the level switch will activate and the PLC will shut down the vapor treatment system as a safety precaution.

Vapor phase from the moisture separator will move through a five micron vapor particulate filter prior to entering the parallel blowers. The vapor will then be processed through and discharged to the FTO and scrubber system for contaminant removal. Additional moisture separator and transfer pump specifications are provided in Table 4-12.

4.5.4 Flameless Thermal Oxidizer System

The FTO system is designed for the destruction of VOCs, including chlorinated solvents TCE, PCE, DCE, vinyl chloride, BTEX, and all other organic compounds. The FTO maximum flow sizing of 1,000 scfm is based on extracted air and water vapor flow volumes from all perched and exposition-zone extraction wells and will accommodate the two 1,100 (nominal) acfm blower units. The calculated inlet and outlet flow to the FTO system are provided on Table 4-9. The FTO system is capable of receiving a maximum VOC loading of 1,800 pounds per day and will remove all vapor phase VOCs at a destruction efficiency greater than 99.9% based on manufacturer-provided data. Refer to Specification Section 11378 - Flameless Thermal Oxidizer System, for details required for operation. The FTO system shall be equipped with supporting systems and equipment, including an acid gas scrubber system capable of removing 99% (minimum) of acid gas formed. Based on the range of influent concentrations, predicted 1,440 gallon 25% NaOH will be consumed each month. Therefore, a double contained 1,500 gallon caustic tank shall be installed and connected to the scrubber with a metering pump. Please see Table 4-13 for additional holding tank details.

The FTO system rapidly heats influent vapor to oxidation temperatures of 2,000°F to 2,200°F, and VOCs and chlorinated VOCs are broken down into combustion products. Together, high temperature and excess oxygen destroy the organic compounds by combustion, with the primary combustion products being carbon dioxide (CO2) and water (H2O). Some carbon monoxide (CO), minor unburned organics, nitrogen oxides, and (if any chlorides are present) hydrochloric acid (HCl) are generated along with nitrogen (N2).

Dilution air and supplemental fuel will be added to the influent stream prior to entering the FTO to promote combustion. A natural gas line located on 60th Street will be used as a supplemental fuel source.

Dioxins are formed as a result of incomplete combustion processes, i.e. insufficient heat. Standard thermal oxidizers operate at temperatures ranging from 1,400ºF to 1,800ºF while flameless thermal oxidizers operate at a much higher temperature as stated above. Higher operating temperatures will increase the destruction efficiency and ensure that little to no concentrations of dioxins will be formed. Ultra-low concentrations of dioxins potentially present in the FTO effluent will be treated in a polishing step consisting of activated carbon adsorption (Section 4.5.5).

The vapor will then be discharged to the vapor conditioning package for conditioning prior to the vapor-phase GAC system.

4.5.5 Vapor Conditioning Package

The vapor conditioning (VC) package will optimize the loading efficiency of the vapor-phase carbon polish system. The VC Package will be located between the FTO and the Vapor-Phase Carbon Adsorbers (carbon polishing) as shown on Drawings M-1 and M-4. Alternative arrangements may be considered based on result from requests for proposals for the VC package. The vapor conditioning package consists of the following:

- An air cooler (chiller/condenser) - represented on the P&ID Drawing M-1 as H-101A;
- one moisture separator (if separate from the chiller/condenser) - represented on the P&ID Drawing M-1 as V-103;
- one air warmer – represented on the P&ID Drawing M-1 as H-201; and
- one blower – represented on the P&ID Drawing M-1 as P-103.

The VC Package will used to handle effluent vapor from either the two blowers (P-101 & 102) or the FTO scrubber (H-301), depending on operating phase. This flexibility is required in the event the FTO/scrubber is taken off-line for maintenance. Also, after approximately 1-year, following ERH, it is estimated that the FTO will not be cost effective to operate and it will be permanently taken off-line and the system will be run using vapor phase carbon as the primary vapor phase treatment.

The VC package design will be governed by the effluent air from FTO scrubber. The scrubber effluent vapor will be 100% relative humidity (saturated) with a temperature of 180 °F. The scrubber effluent air shall pass through the VC Package and the air shall be conditioned to a temperature of less than 100°F and a relative humidity of less than 50%. A temperature monitoring indicator shall be installed after the VC package to ensure that the air effluent does not to exceed the GAC maximum operating temperature of 120°F.

The VC Package will be extremely corrosion resistant and capable of handling normal residual chloride (Cl- and HCl) concentrations of 3 ppm from the FTO scrubber and be capable of handling occasional excursions to 30 ppm from the FTO Scrubber. Excursions were reported by the FTO manufacturer as potentially occurring as a result of erroneous pH probe readings leading to insufficient buffering of the acid gas.

Effluent air from the VC Package must be run through a carbon polishing step as shown on Drawing M-1. The VC Package will be connected to the carbon vessels via 8-inch schedule 80 PVC. The carbon polishing step consists of two (3,000 cfm) carbon vessels in series and filled with 4,000 pounds of virgin coconut shell carbon as described in Table 4-11. Based on carbon vendor correspondence, the pressure drop will be a minimum of 7 inches of water column (" WC) and a maximum of 50" WC per vessel. The air will be pulled through the carbon and VC package using P-103 - regenerative blower.

The VC Package will be manufactured per NEMA 13 standards, be skid mounted, and moveable with conventional moving equipment. There is the option to mount the chiller/condenser outside on a concrete pad. If this is recommended by the manufacturer, then the controls shall be NEMA 4 for all outdoor portions.

The vapor conditioning package will be designed to function in synchronization with the FTO and interface with both the FTO PLC and treatment compound PLC. The VC package controls will include system on/off, individual piece of equipment on/off; i.e., one air chiller/condenser, one moisture separator (if needed), one air warmer, and one blower, system on light, alarm light/reset, emergency shutoffs, temperature monitoring and control, automatic system on-off, automatic remote dial-up in the event of a shut down, and air flow.

4.5.6 Vapor-Phase Granular Activated Carbon

The vapor-phase GAC system will remove potential ultra-low concentrations of dioxins from the FTO effluent. The GAC system design includes:

- Two vapor-phase GAC vessels, filled with 4,000 pounds of virgin coconut shell carbon, installed in series in a "down flow" system configuration for high-volume flows.

- A high-volume flow capacity (3000 cfm) in order to accommodate potentially varying flows while minimizing through-vessel pressure drop.
- The vapor phase carbon will remove potential ultra-low dioxin concentrations from the FTO effluent. The dioxin concentrations in the air stream will adsorb onto the carbon.

The removal efficiency of chemicals by vapor-phase carbon adsorption is dependent on the temperature, residence time, and relative humidity. Carbon adsorption is most effective in removing compounds with boiling points ranging from 77°F to 302°F and molecular weights between 50 and 200 atomic mass units (amu's). For optimal performance (because water vapor will compete for carbon adsorption sites), the influent stream should have a temperature below 104 degrees Fahrenheit and a low relative humidity between 40 and 50 percent. A vapor conditioning package has been incorporated in the design to meet the design requirements and increase loading efficiency (as described in Section 4.5.6).

The volume of carbon contained in the vapor-phase GAC vessels will meet the operation and efficiency requirements of the remediation system and be in conformance with existing treatment system design. The carbon in the vessels will be monitored and the vapor stream sampled regularly to determine usage and replacement schedule. The sampling schedule will be discussed further in the Sampling and Analysis Plan. Spent carbon will be removed from the Site and subsequently regenerated in high-temperature furnaces, and GAC vessels will be refilled with fresh carbon. Additional carbon vessels and activated carbon specifications are provided in Table 4-12.

4.5.7 FTO Emission Specifications

The South Coast Air Quality Management District (SCAQMD) is responsible for issuing air permits that typically govern all vapor treatment equipment emissions. The air permits are issued, and required monitoring levels are prescribed based on the overall human health risk posed by the combined emissions of all contaminants in the vapor stream. The procedures for determining human health risks from air emissions sources are outlined in the SCAQMD Risk Assessment Procedures for Rules 1401 and 212. In order to comply with Rules 1401 and 212, the human health risk from the emission source must be less than that rate which is calculated to cause cancer in 1 person in 100,000; or a cancer risk of 1×10^{-5}. Calculated Hazard Indices must also be less than 1.

USEPA's policy that CERLCA response actions are exempted by law from the requirement to obtain Federal, State or local permits related to any activities conducted on the CERCLA site (OSWER Directive 9355.7-03). It also is USEPA's policy to assure all activities conducted on sites are protective of human health and the environment. Therefore the USEPA will coordinate and consult with SCAQMD to assure compliance with the Risk Assessment Procedures for Rules 1401 and 212.

For a remediation project involving a FTO in the South Coast Basin, the applicable rules are those that fall under Regulation IV and Rules 1303 and 1304 under Regulation XIII. Rule 1166, which applies to all VOC-contaminated soil handing, is also relevant. Rule 1303 under Regulation XIII pertains to Best Available Control Technology (BACT). These guidelines indicate that FTOs (or “afterburners” as they are referred to in permit documents), which is the BACT for VOCs, are required to operate with a residence time greater than or equal to 0.3 seconds at a temperature greater than or equal to 1,400°F. The FTO far exceeds this requirement. The BACT for NOx, SOx, and PM10 is natural gas usage. For this particular project, NOx, SOx, carbon monoxide (CO), and PM10 emissions are exempted from offset requirements based on R134(c)(4). Only VOC emissions are subject to this Rule and, therefore, should not exceed the 4 tons/year threshold.

Emission standards and requirements for the vapor treatment system effluent will be based upon health risk analyses to be performed by the SCAQMD as part of the USEPA’s goal of meeting the substantive requirements of the air permitting process. Based on previous modeling efforts, the FTO system used for destruction of VOCs at the Pemaco Site will meet and exceed the SCAQMD effluent requirements.

4.5.8 Treatment Schedule

The FTO system will operate beginning with HVDPE system start-up and continue through ERH operation, estimated to be one year. During this period, high loading of VOCs will be extracted. Due to the above-99.9 percent destruction efficiency of FTO, the production of combustion by-products (e.g., dioxin) above background concentrations will be removed during the carbon polishing step. It is estimated that the mass loading will be significantly reduced after the ERH treatment period, allowing continued remediation to be carried out via dedicated GAC vapor treatment. Refer to Section 5.11 for the Remedial Action Schedule.

4.6 WATER TREATMENT SYSTEM DESIGN

The water treatment system will consist of equipment, piping, and instrumentation as specified in the P&ID Drawing M-1, Table 4-11-Equipment and Instrumentation Specification Summary, and Table 4-12-Major Equipment Specifications. As noted in Section 3.3, the groundwater will be treated with a liquid-phase GAC system since the low-adsorptive compounds such as vinyl chloride are not present in the extracted groundwater at concentrations over the effluent limitations. Furthermore, vinyl chloride concentrations are estimated to reduce rapidly following the initiation of pumping and vapor extraction, as demonstrated by numerous site models where the vinyl chloride exists as a result of anaerobic degradation and not as a COC.

The following subsections outline the design basis for the groundwater treatment system and major system components:

- Influent Concentrations
- Groundwater Remedial Technologies
- Water Treatment System Design Flow
- Groundwater Booster Tank and Holding Tank
- Liquid-phase GAC
- Discharge Standards
- Treatment Schedule

4.6.1 Influent Concentrations

Influent concentrations of liquid phase VOCs will be received by the water treatment system after being extracted from the perched and Exposition treatment zones. The estimated VOC loading calculated for the Exposition groundwater is considered adequate for general treatment system specification. An explanation of the estimated VOC mass removal rates for Exposition groundwater is provided in Section 4.3.3. Additional VOC loading will be contributed by the extracted perched zone groundwater. An estimate for the perched zone contribution has not been included since preliminary estimates indicate the following:

- The perched zone is a finite groundwater source that will not withstand long-term pumping, and will not be a continued source for liquid phase VOC loading.
- Under a HVDPE scenario, extracted contaminants from the perched zone will tend to volatilize and be treated by the vapor treatment system.
- The volume of water treated (explained in Section 4.6.2) will be predominantly Exposition groundwater and reflect the mass loading rate calculated in Section 4.3.3.
- The uncertainty in the estimated mass loading that will result from operation of the ERH system makes further calculation for the perched zone moot.

From Section 4.3.3 and Table 4-5, the first year VOC mass loading to the water treatment system was estimated to be 2.71 lbs/day. The basis for this value is included in Table 4-5 footnotes. Operation of the ERH system may result in loading rates once to two orders of magnitude greater than this estimate.

4.6.2 Groundwater Remedial Technologies

Granular Activated Carbon (GAC) Groundwater Treatment

Groundwater will be treated with a liquid-phase GAC system. GAC remediation provides good control over contaminant concentrations for groundwater if low-adsorptive compounds are not present. Vinyl chloride is expected to pass through the GAC at trace level concentrations significantly below the effluent limitations. Based on a composite sample from the A&B source zone collected for the advanced oxidation water treatment bench test, the vinyl chloride concentrations were below 6 ppb. Sampling, replacement, and disposal of GAC will be addressed in the Remedial Action Work Plan and the Operation and Maintenance (O&M) plan.

4.6.3 Water Treatment System Design Flow

The design flow of extracted groundwater is based on the enhanced removal rates calculated during the HVDPE pilot test. The following table summarizes design flows by subsurface remediation zone.

Groundwater Flow Rates by Zone

Treatment Zone	Average Groundwater Extraction Rate (gpm)	No. of Extraction Wells	Zone Total[5] (gpm)	Average Daily Flow Rate (gpd)
A Zone[1]	0.7	12	8.4	12,096
B Zone[2]	1.6	12	19.2	27,648
A & B Containment[3]	2.3	8	18.4	26,496
D Zone[4]	1.1	1	1.1	1,584
Totals	-	33	47.1	67,824

Note:

1. Groundwater flow rates of 1.1 gpm were attained during the HVDPE pilot study (with the drop tube method). Groundwater pumping without vacuum yielded less then 0.25 gpm. The average of 1.1 gpm and 0.25 gpm is approximately 0.7 gpm. After the first year, the A Zone is anticipated to de-water, therefore, the average flow for the 5 year period is estimated to be 0.7 gpm.
2. Groundwater flow rates of approximately 2.0 gpm were attained during the HVDPE pilot study. Groundwater pumping without vacuum yielded 1.1 gpm. The average of 2.0 gpm and 1.1 gpm is approximately 1.6 gpm.
3. The extraction rate of 2.3 gpm for the A&B Containment Zone was based on the sum of the average extraction rate from the A and B Zones. The sum of 0.7 gpm and 1.6 gpm is 2.3 gpm.
4. The 1.1 gpm extraction is based on the estimated theoretical pumping rate for the D zone.
5. Zone Total is the cumulative groundwater flow rate from the extraction wells in each treatment zone.

Based on the result of HVDPE Extraction Pilot Test Performed, the low-yielding and heterogeneous nature of the saturated thickness found in the perched zone, it is plausible that the perched zone could result in a total de-watering of the zone after weeks or months of treatment system operation. Due to the finite groundwater volume localized in the perched zone, the groundwater extraction rate from perched-zone wells is expected to be neglected. The groundwater extraction rate from A and B-zone wells is also expected to decrease following two months of pumping, prior to ERH system startup. According to the hydrogeologic condition in this area, A zone can be characterized as a series of semi-discontinuous saturated sand lenses. It is estimated to be a de-watering zone after the first year of operation. The total extraction rate from all treatment zones is expected to be around 47.1 gpm following ERH startup and will likely decrease with continued system operations.

4.6.4 Groundwater Extraction Pumps

QED AutoPump AP-4B, 4-inch nominal, bottom loading, pneumatic pumps were selected for the groundwater recovery pumps for the Exposition Zone (A Zone, B Zone, and A&B Containment). These pumps have been proven to not only be the most cost-effective but also the most reliable. In addition, these pumps are chemical resistant, heat tolerant, and can handle sediment loading. The pumps will be bottom loading to allow for maximum pumping rates and water column depression in the recovery wells. At 70 psig air pressure supply, the pumps are capable of pumping nearly double the anticipated average groundwater flow rate from the Exposition Zone discussed in Section 4.6.3 (above). The QED AutoPump AP-4B capacity curve is provided in Appendix D.

The QED AutoPump AP-2B, 2-inch nominal, bottom loading pneumatic pump was selected for groundwater recovery from the Exposition C or D zone if future monitoring indicates contamination. The pump can be installed in existing extraction well MW-24-140' or MW-24-110'. Two-inch nominal pumps are required to be installed in wells MW-24-140' or MW-24-110' because the wells have been sleeved with 3-inch schedule 80 CPVC to protect them from ERH heating. The QED AutoPump AP-2B capacity curve is provided in Appendix D.

Approximately 3 spare groundwater pumps will be prepared on-site in the storage room for the event of pump failure.

4.6.5 Groundwater Booster Tank

Groundwater will be pumped from the Exposition Zone into the groundwater booster tank (V-110) via pneumatic submersible pumps. In addition, the condensate sump pumps will also discharge condensed water (from soil vapor) into the groundwater booster tank. The groundwater from the booster tank will be conveyed through water filters and discharged to the holding tank V-106 by booster pump P-203 as shown in Drawing M-1.

The booster tank was selected for the purpose of reducing the total dynamic head on the pneumatic groundwater pumps and to ensure efficient pump operations. Water filters prior to the 4,900 gallon holding tank (added to system design to avoid labor intensive tank cleaning), add approximately 60 feet of water head (maximum) to the pneumatic pumps and consequently, lower the flow rates and efficiencies of the pneumatic pumps. To reduce the additional head, the pneumatic pumps will discharge groundwater directly into the booster tank. The booster tank pump will transfer the groundwater and any sediment into the bag filters, prior to discharging the water into the 4,900 gallon holding tank.

The groundwater booster tank will consists of a 905-gallon crosslinked polyethylene tank installed in the treatment compound. Booster pump P-203 is rated for discharge of 110 gpm at 55 feet of total dynamic head. The booster pump will be rated to handle solids consisting of sands and silts. A spare transfer pump for P-201 will be provided and stored on-site. The transfer pump will be valved and flanged to be quickly replaced with the spare pump in the event of pump failure.

The booster tank will include level controls with low-low, low, high, and high-high level switches. The level controls will be used to control purging rates and treatment operations as well as trigger shutdowns in the event of a high-high or a low-low level conditions. The low-low level shutdown will prevent the transfer pump from becoming damaged from cavitation/running dry. The level controls will perform the following functions:

- In the event that the tank water level falls below the low-low set point, the level switch will activate and the PLC will shut down the groundwater treatment system as a safety precaution.
- At the high water level point, the level switch will activate, and the PLC will start the booster pump;
- When tank water level drops below the set low point, the low level switch will activate and the PLC will shutdown the booster pump; and
- In the event that the tank water level reaches the high-high set point, level switch will activate and the PLC will shut down the entire system as a safety precaution.

Additional specifications for the groundwater booster tank and the booster tank are provided in Table 4-12.

4.6.6 Groundwater Holding Tank

Groundwater from the booster tank and moisture separator will be pumped into the Holding Tank (V-106). The design of the groundwater holding tank specifications are based on the following:

- Designed groundwater extraction rates and holding time; and
- Tank dimensions and allotted space in treatment compound.

Based on the above criteria, a 4,900-gallon cylindrical holding tank is appropriate for groundwater treatment system design requirements. The tank will hold the average groundwater flow of 47.1 gpm for approximately 100 minutes. The tank will include level controls with low-low and high-high level switches along with a pressure transducer. The level controls will be used to trigger shutdowns in the event of a high-high or a low-low level condition. The low low condition will prevent the transfer pump from becoming damaged from running dry/cavitation. The pressure transducer will be used to maintain a constant water level in the holding tank. The water-level indicators will perform the following options:

- In the event that the tank water level reaches the low-low set point, the level indicator will go into alarm status and will shut down the groundwater treatment system as a safety precaution; and
- In the event that the tank water level reaches the high-high set point, the level indicator will go into alarm status and will shut the entire system down as a safety precaution.

A constant water level will be maintained in the holding tank by the pressure transducer (to ensure most efficient carbon performance).

Booster pump P-202 is rated for a minimum discharge of 100 gpm at 75 feet of total dynamic head. A spare transfer pump for P-202 will be provided and stored on-site. The transfer pump will be valved and flanged to be quickly replaced with the spare pump in the event of pump failure. Additional specifications for the groundwater holding tank and the associated transfer pumps are provided in Table 4-12.

4.6.7 Liquid –Phase Granular Activated Carbon

The liquid-phase GAC system will remove the majority of the known contaminants of concern to the 5 ppb level. Vinyl chloride is expected to pass through the GAC at trace level concentrations below the effluent limitations. The liquid-phase GAC system design includes:

- Two 3,000 pound liquid-phase GAC vessels in series filled with virgin coconut shell carbon; and
- Maximum flow capacity of 150 gpm.

The volume of carbon contained in liquid-phase GAC vessels will meet the operation and efficiency requirements of the remediation system and be in conformance with existing treatment system design. The carbon in the vessels will be monitored and the water stream sampled regularly to determine usage and replacement schedule. The sampling schedule will be discussed further in the Sampling and Analysis Plan. Spent carbon will be removed from the Site and subsequently regenerated in high-temperature furnaces, and GAC vessels will be refilled with fresh carbon. Additional specifications for carbon vessels and activated carbon are provided in Table 4-12

4.6.8 Discharge Standards

It is USEPA's policy to assure all activities conducted on sites are protective of human health and the environment. The USEPA will coordinate and consult with Sanitation Districts of LA County to assure treated water discharge complies with discharge permit requirements and limitations. According to LACSD Self-Monitoring Requirements for the Pemaco Superfund site issued on November 30, 2005, self-monitoring of industrial wastewater is required as a condition of discharge permit. Samples must be collected and preserved once per three (3) months in accordance with 40 CFR 136. Analysis of the samples must be performed for the parameters listed below by a laboratory that is certified by either the LACSD or the California State Department of Health Services.

Required Effluent Characterization Tests			
Test Parameter	**Unit**	**Limit**	**Type of Sample**
Total Wastewater Flow Rate	gpd	67,824*	Not Applicable
Peak Wastewater Flow Rate	gpm	40.0	Not Applicable
Temperature	°F	< 140	Not Applicable
Closed Cup Flash Point	°F	> 140	Not Applicable
Chemical Oxygen Demand (COD)	mg/l	--	24-hour Composite
Suspended Solids (SS)	mg/l	--	24-hour Composite
pH	pH units	> 6.0	Grab
Dissolved Sulfide	mg/l	0.1	Grab
Lead	mg/l	40	24-hour Composite
Oil & Grease	mg/l	--	Grab
Volatile Organics	ug/l	1,000	Not Applicable
Semi Volatile Organics	ug/l	1,000	Not Applicable

- See Section 4.6.2 Water Treatment System Design Flow for calculation details.

4.6.9 Treatment Schedule

A process flow diagram for the groundwater treatment system is provided on Drawing M-1. It is estimated that the treatment system will operate for 5 years and require an additional 5 years of monitoring. Refer to Section 5.10 for the Remedial Action Construction Schedule.

5.0 CONSTRUCTION AND IMPLEMENTATION

This section describes the various construction issues for building the treatment system that will be addressed in the Remedial Action Work Plan and associated documents. The following topics are discussed briefly in the Section:

- Identification of inter-agency coordination and communication
- Site preparation
- Property Access
- Staging Requirements
- Specifications
- Project Plans
- Construction Schedule
- Construction Cost Estimate

Each of these topics is discussed in the sections below.

5.1 INTER-AGENCY COORDINATION AND COMMUNICATION

Federal law provides that response actions performed under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA or "Superfund"), such as the Pemaco site are exempted from the requirement to obtain Federal, State or local permits related to any activities conducted on the CERCLA site (USEPA, 1992). It is USEPA policy to assure all activities conducted on CERCLA sites are protective of human health and the environment. The USEPA, which is the lead agency for this project, will coordinate and consult with the following state and local agencies to facilitate CERCLA actions at this site:

- **California Environmental Protection Agency (CALEPA), Department of Toxic Substances Control (DTSC).** This agency will be responsible for long-term operation and maintenance of the Pemaco remedial systems after five years. The DTSC provides review of all Design Documents and future project plans for CERCLA sites.
- **South Coast Air Quality Management District (SCAQMD).** The USEPA will coordinate and consult with the SCAQMD on anticipated and actual air emissions from vapor treatment system. SCAQMD will perform risk assessment modeling to assist the USEPA in determining the maximum permissible emissions from this site. The procedures for determining human health risks from air emissions sources are described is Section 4.5.7. The USEPA will provide vapor treatment system emissions data as part of the public information record for this project.
- **Los Angeles County Department of Health Services.** Los Angeles County adopted ordinances to protect groundwater quality by requiring a permit to be issued before a well can be drilled or modified. The Department of Health Services is responsible for well permitting. The USEPA will not seek permits for wells to be installed at the Pemaco site as part of this CERCLA action. However, the USEPA will construct all on-site wells to be

protective of human health and environment. Additionally, the USEPA will provide well construction information and well coordinates for all wells installed at the Pemaco site as part of the public information record for this project.

- **City of Los Angeles Department of Public Works Bureau of Engineers** would normally have jurisdiction over soil grading activities and building activities at the Site. The USEPA will consult with the Department of Public Works, Bureau of Engineers regarding planned grading and construction activities at that site. However, no permits will be sought prior to beginning the work.
- **Sanitation Districts of Los Angeles County.** The Pemaco Superfund site water treatment system will be designed to meet the substantive requirements for discharge of treated water to the Sanitation Districts of Los Angeles County sewer system. Connection to the LA Sewer District will be administered through the City of Maywood. The USEPA will provide design flow and waste stream monitoring information to the Sanitation Districts of Los Angeles County and City of Maywood as needed.
- **Los Angeles Regional Water Quality Control Board (LARWQCB).** The USEPA will provide groundwater data for all wells installed at the Pemaco site as part of the public information record for this project. The USEPA will notify the LARWQCB of any planned discharges to the storm water drain and will provide discharge monitoring data as part of The USEPA will consult and coordinate with other state and local agencies as necessary and upon their request.

In addition to coordination with state and local agencies, the USEPA response action at the Pemaco site will be consistent and compliant with all applicable federal, state and local laws and regulations protective of human health and the environment. Specific examples are discussed below:

- **The Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65)** of California requires that clear and reasonable warning be given to anyone who may be exposed to chemicals known to the State to cause cancer or reproductive toxicity. The Office of Environmental Health Hazard Assessment (OEHHA) of the California Environmental Protection Agency is the lead agency for the implementation of Proposition 65. To meet the substantive requirement of Proposition 65, the USEPA will provide information on possible chemical exposures to site workers in the Site Safety and Health Plan (SSHP) and to the public through the community involvement process as described in the Community Involvement Plan (CIP).
- **OSHA safety and health requirements.** The USEPA will comply with applicable worker safety and health laws and regulations during implementation of the response action at the Pemaco site. The SSHP for the Pemaco response action has been prepared in accordance with the Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1910.120, OSHA 29 CFR 1926; California Labor Code Section 6401.7 (where applicable), Title 8, California Code of Regulations, Section 5192; the TN&A Corporate Safety and Health Manual; and any other relevant Federal, State, and local regulations.

5.2 SITE PREPARATION

Site preparation will include locating subsurface utilities, setting up temporary office facilities for construction, erecting fencing where needed, and restoring access to existing wells. Specifications for some of this work are included in Specifications Section 01500 – Temporary Construction Facilities. Additional detail regarding site preparation procedures, such as disposal facilities and stockpiling, will be discussed in the Remedial Action Work Plan.

5.3 UTILITY REQUIREMENTS

Utility connections that shall be necessary during site remediation are electrical, natural gas, telephone, water, and sewer. Sewer and fresh water connections to the site trailer and the treatment plant will be coordinated through the City of Maywood and the Los Angeles Department of Water and Power (LADWP). TN&A has been coordinating electrical power connections through Southern California Edison (SCE). SCE has been provided electrical load schedules and drawings for the coordination of on-site power lines and power drops. The various connection locations will be shown on the Final Design Drawings.

5.4 PROPERTY ACCESS

Access to the Park areas and adjoining roadways will be required for the installation of the remedial treatment equipment. Property and road access will be coordinated through the City of Maywood and the Park Contractor. The remediation system construction is currently scheduled to dovetail into the Park construction plans. Truck traffic importing site materials will follow neighborhood restrictions be coordinated with on-going Park construction.

5.5 STAGING REQUIREMENTS

It is anticipated that the staging area for the remedial action will be located on the southern portion of the Pemaco property off of 60th Street. This area was selected because of its proximity to the entrance of the Site and the proposed treatment compound.

5.6 SPECIFICATIONS

Complete specifications for the remedial action are provided in Appendix A, Volume II. Volume II is intended to accompany the Drawings package for use in the field during construction.

5.7 PROJECT PLANS

The Remedial Action Work Plan identifies construction and implementation issues to be carried out by the remedial action contractor. The Remedial Action Work Plan will include the SSHP, Sampling and Analysis Plan (SAP), and the Construction Quality Control Plan (CQC Plan).

The CQC Plan establishes the project organization and includes requirements for independent evaluation of the construction conformance to the design specifications. The plan also defines the minimum testing and inspection protocols required to regulate this independent evaluation.

A construction completion report will be prepared that includes discussion of field design changes, as-built drawings, quality control results, and health and safety documentation. The report will be certified by the Quality Control Engineer specified in the CQC Plan.

The O&M Manual will be provided in conjunction with the Remedial Action under a separate cover. In accordance with the requirements set forth in the RD/RA Handbook, the O&M outline will include:

- A description of how the designer intends the facility to operate.
- A description of potential operating problems.
- A quality assurance plan for O&M, including recordkeeping requirements.
- A description of alternative procedures to prevent releases or threatened releases and the appropriate corrective actions.
- Specifications and maintenance schedules for all equipment.

These topics and others will be expanded upon by the RA Contractor prior to treatment plant start-up.

5.8 CONSTRUCTION SCHEDULE

Remedial Action activities will commence according to the Remedial Action Construction Schedule provided as Figure 5-1. The first construction task, "Park Well Installation and Demolition", will begin upon completion of the Park grading. Schedules have been coordinated with the City of Maywood and a tentative start date for Site Preparation has been set for July 6, 2005. It is anticipated that the field portion of the remedial construction can be completed by January 17, 2006.

In an effort to increase efficiency and reduce construction time, construction crews will work on different phases and tasks simultaneously whenever possible. These phases are shown in Figure 5-1 and include the following examples:

- The 60th Street wells, trench and pipelines will be installed at the same time as the construction of the treatment compound.
- Start-up and operation of the perched and Exposition groundwater and vapor extraction and treatment system will be performed prior to the completion of the ERH system installation in order to assure proper operation of the groundwater and vapor extraction and treatment system at ERH system start-up time.

5.9 CONSTRUCTION COST ESTIMATE

A remedial action cost estimate has been prepared based on the design presented herein and is provided in Appendix F. The cost estimate was prepared using actual subcontractor bids, cost estimating software (R.S. Means) and prior experience. In accordance with the RD/RA Handbook, the cost estimate provided is within plus 15 percent and minus 5 percent.

6.0 REFERENCES

ALT Leak Testing, Inc. (ALT) 1990, Subject Site Assessment Investigation Report, 5050 E. Slauson Ave., Maywood, California, 26 December 1990.

ALT. 1991. Report of Site Investigations, 5989 S. District Blvd.,Maywood, California, October.

Battelle. 1998. Application Guide for Bioslurping -TM-2301-ENV, Volume II - Principles and Practices of Bioslurping. October

Biren, Paul (Biren). 1992. Los Angeles County Fire Department, Hazardous Waste Control Program, Statement of Probable Cause, August 10.

Bradford, G.R., Chang, A.C., Page, A.L., Bakhtar, D., Frampton, J.A., and Wright, H.,(Bradford, et al). 1996. Kearney Foundation of Soil Science - University of California, Background Concentrations of Trace and Major Elements in California Soils, March.

California Department of Water Resources. 1961. Planned utilization of the ground water basins of the coastal plain of Los Angeles County: Bulletin 104, Appendix A, Ground Water Geology, p. 181.

California Department of Water Resources, Southern District. 2005. California Well Standards, http://wwwdpla.water.ca.gov/sd/groundwater/california_well_standards/well_standards.html

California Environmental Protection Agency, Department of Toxic Substances Control, Human and Ecological Risk Division (CalEPA). 1996. Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted, July 4.

Campanella, R.G. and Robertson, P.K. (Campanella and Robertson). 1988. “Current status of the piezocone test”, Penetration Testing 1988, Vol. 1 (Proc. ISOPT-1, Orlando), Balkema, Rotterdam, 93-116.

Cape Environmental Management, Inc. (Cape). 2001. Results of Additional Excavation and Confirmatory Sampling of Oil-Impacted Soil at the Lubricating Oil Services Site, 5989 South District Boulevard, Maywood, California, July.

City of Maywood. 2004. Construction Plans for Riverfront Park. December.

Cornerstone Technologies, Inc. (CTI). 1998. Remedial Action Report for Toluene- Impacted Soils, Former UST Area at WW Henry Property, 5920 Alamo Street, Maywood, California 90270. July.

CTI. 1998a. Phase I Environmental Site Assessment Including Preliminary Asbestos and Lead Based Paint Survey and Limited Phase II Subsurface Investigation Conducted at WW Henry Property, 5920 Alamo Street, Maywood, California 90270, March.

CTI. 2001. Report for 4th Quarter 2000 Groundwater Monitoring at Removed UST Area of Former WW Henry Facility, 5920 Alamo Avenue, Maywood, California, January.

Ecology & Environment (E&E). 1998a. Pemaco Maywood Expanded Site Investigation, March.

E&E. 1998b. Subsurface Investigation, Pemaco Site, Maywood, California, March 1998.

E&E. 1999. Pemaco Removal Site Final Report, May 1999.

Erler & Kalinowski, Inc. (EKI). 1998. Phase II Investigation Report, 5201 East 60th Street, Maywood, California, February.

EKI. 1999. Subsurface Investigation Report for the WW Henry Company Property Located at 5920 Alamo Avenue, Maywood, California, August.

EKI. 2001. Phase II Environmental Assessment Report, Lubricating Oil Services Property, 5989 South District Boulevard, Maywood, California, March.

Grosjean, E., Grosjean, D., Fraser, M.P. and Cass, G.R. (Grosjean, et al, 1996), Air quality model evaluation data for organics. 2. C1-C14 carbonyls in Los Angeles air. Environ. Sci. Technol. 30, 2687-2703.

Hocking, G., Wells, S.L. and R.I. Ospina. 2000. Deep Reactive Barriers for Remediation of VOCs and Heavy Metals. 2nd Int. Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey CA. May

International Conference of Building Officials. 1997. Uniform Building Code, Structural Engineering Design Provisions, Volume II, Whittier California, April.

Levine-Fricke. 2001. Soil, Soil Gas, and Groundwater Evaluation, Former W.W. Henry Property, 5920 Alamo Avenue, Maywood, California, 6 July.

Meridith, Boli & Associates, Inc. 1997. Tank Removal Report for Underground Storage Tanks, 5920 Alamo Avenue, Maywood, California, October 21, 1997.

Puls, R.W., R. Wilkin, C. Paul, F. Beck, P. Clark and M. McNeil (2002). Six Years of Intensive Monitoring of the 1st PRB to Treat a Mixed Waste Plume: USCG Site in Elizabeth City, NC, RTDF PRB Action Team Meeting, Washington D.C. Nov. 7-6.

Ralph M. Parsons Company (Parsons). 1976. Engineering Department Design Guide, May.

Todd. 1980. Aquifer Test News.

T N & Associates, Inc. (TN&A). 2000. Draft Summary of Groundwater and SVE System Sampling Events, October.

TN&A. 2002a. Results of In-situ Groundwater Sampling in the Perched Zone and Upper Exposition Groundwater Zones, February and November 2001, Pemaco Superfund Site, 5050 E. Slauson Avenue, Maywood, California.

TN&A. 2002b. Results of Groundwater Monitoring Activities, May 2001 through April 2002, Pemaco Superfund Site, 5050 E. Slauson Avenue, Maywood, California.

TN&A. 2002c. Results of the July 2001 Soil Gas, Indoor/Outdoor Air and Groundwater Sampling Completed in the Residential Neighborhood Adjacent to the Pemaco Superfund Site and Former WW Henry Properties, 5920 Alamo Avenue and 5050 E. Slauson Avenue, Maywood, California.

TN&A. 2002d. Health Risk Assessment, Maywood Riverfront Park, Maywood, California, July.

TN&A. 2002e. Technical Memorandum: Results of Aquifer Tests Performed in Exposition ‘A’ and ‘B’ Groundwater Zones, Pemaco Superfund Site, 5050 E. Slauson Avenue, Maywood, California. March.

TN&A. 2002f. Results of Soil Gas and Indoor/Outdoor Air Sampling, Pemaco Superfund Site, 5050 E. Slauson Avenue, Maywood, California.

TN&A. 2002g. Baseline Risk Assessment, Pemaco Superfund Site, 5050 E. Slauson Avenue, Maywood, California.

TN&A. 2002h. Environmental Site Assessment, Los Angeles Junction Railway Property, Maywood, California.

TN&A. 2003. Technical Memorandum: Results of Groundwater Monitoring Activities, May 2001 through April 2002, Pemaco Superfund Site, Maywood, California, November.

TN&A. 2003a. Technical Memorandum: HVDPE Pilot Test Performed in Perched and Exposition “A” and “B” Zones, Pemaco Superfund Site, Maywood, California. And Appendix D, Final Feasibility Study Report, TN&A 2004a.

TN&A. 2004. Final Remedial Investigation Report, Pemaco Superfund Site 5050 E. Slauson Avenue, Maywood, California. November.

TN&A, 2004a. Final Feasibility Study Report, Pemaco Superfund Site 5050 E. Slauson Avenue, Maywood, California. February.

United States Army Corps of Engineers, Omaha District (USACE). 1999. Engineering and Design of Multi-Phase Extraction System, Manual EM 1110-1-4010, June.

United States Environmental Protection Agency (USEPA) 1983. Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, February.

USEPA, Office of Solid Waste and Emergency Response (OSWER). 1992. Permits and Permit Equivalency Processes for CERCLA On-Site Response Actions, OSWER Directive 9355.7-03, February.

USEPA. 1994. USEPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, Interim final (USEPA QA/R-5), August.

USEPA. 2000. User's Guide for the Johnson and Ettinger (1991) Model for Subsurface Vapor Intrusion into Buildings (Revised).

USEPA. 2000a. Drinking Water Standards and Health Advisories, USEPA-822-B-00-001, Summer.

USEPA. 2004. EPA Region 9: Preliminary Remediation Goals (PRGs), http://www.epa.gov/region09/waste/sfnd/prg/

TABLES

TABLE 2-1
Existing Well Construction Data - Perched Zone Wells

Well I.D.	Associated Hydrogeologic Unit	Date Installed	Northing	Easting	Top of Casing Elevation	Casing Diameter (inches)	Well Material	Screening Interval	Screen Slot Size (inches)	Filter Pack Sand Size	Constructed Total Depth (bgs)
B-01	Perched Zone	07/19/90	1,817,183.99	6,509,516.29	147.84	2	Schedule 40 PVC	--	--	Pea Gravel	35
B-03	Perched Zone	07/18/90	1,817,172.57	6,509,452.98	146.06	2	Schedule 40 PVC	--	--	Pea Gravel	40
B-04	Perched Zone	07/18/90	1,817,121.53	6,509,468.70	145.92	2	Schedule 40 PVC	--	--	Pea Gravel	40
B-05	Perched Zone	07/18/90	1,817,139.90	6,509,458.37	145.91	2	Schedule 40 PVC	--	--	Pea Gravel	40
B-06	Perched Zone	07/19/90	1,817,097.47	6,509,526.68	146.36	2	Schedule 40 PVC	--	--	Pea Gravel	45
B-07	Perched Zone	07/18/90	1,817,093.69	6,509,563.42	146.64	2	Schedule 40 PVC	--	--	Pea Gravel	30
B-08	Perched Zone	07/19/90	1,817,067.20	6,509,578.20	146.32	2	Schedule 40 PVC	--	--	Pea Gravel	--
B-10	Perched Zone	07/19/90	1,817,036.93	6,509,591.80	145.50	2	Schedule 40 PVC	--	--	Pea Gravel	35
B-11	Perched Zone	07/20/90	1,817,004.23	6,509,607.57	144.57	2	Schedule 40 PVC	--	--	Pea Gravel	25
B-12	Perched Zone	07/18/90	1,816,927.58	6,509,632.80	142.36	2	Schedule 40 PVC	--	--	Pea Gravel	25
B-13	Perched Zone	07/20/90	1,816,951.73	6,509,574.91	140.26	2	Schedule 40 PVC	--	--	Pea Gravel	35
B-14	Perched Zone	07/20/90	1,817,022.70	6,509,500.08	141.55	2	Schedule 40 PVC	--	--	Pea Gravel	30
B-15	Perched Zone	07/20/90	1,817,051.94	6,509,471.83	141.05	2	Schedule 40 PVC	--	--	Pea Gravel	35
B-16	Perched Zone	07/20/90	1,817,074.26	6,509,454.45	141.39	2	Schedule 40 PVC	--	--	Pea Gravel	35
B-17	Perched Zone	04/16/01	1,817,351.66	6,509,406.34	150.30	1.5	Schedule 40 PVC	33 - 43	0.010	20/40	43
B-18	Perched Zone	04/16/01	1,817,270.76	6,509,340.33	147.05	1.5	Schedule 40 PVC	24 - 29	0.010	20/40	29
B-19	Perched Zone	04/18/01	1,817,152.21	6,509,374.68	143.58	1.5	Schedule 40 PVC	22-32	0.010	20/40	32
B-20	Perched Zone	04/19/01	1,817,047.53	6,509,461.88	141.40	1.5	Schedule 40 PVC	22-32	0.010	20/40	32
B-21	Perched Zone	04/16/01	1,816,938.69	6,509,530.86	140.20	1.5	Schedule 40 PVC	23-28	0.010	20/40	28
B-22	Perched Zone	04/18/01	1,816,895.62	6,509,507.69	138.12	1.5	Schedule 40 PVC	20-25	0.010	20/40	25
B-23	Perched Zone	04/18/01	1,816,710.69	6,509,489.14	137.43	1.5	Schedule 40 PVC	19-24	0.010	20/40	24
B-24	Perched Zone	04/16/01	1,816,717.14	6,509,625.76	138.20	1.5	Schedule 40 PVC	22-27	0.010	20/40	27
B-25	Perched Zone	04/17/01	1,816,742.47	6,509,714.16	137.84	1.5	Schedule 40 PVC	18-23	0.010	20/40	23
B-26	Perched Zone	04/17/01	1,816,837.46	6,509,677.06	139.66	1.5	Schedule 40 PVC	18-23	0.010	20/40	23
B-27	Perched Zone	04/17/01	1,816,917.90	6,509,407.22	138.67	1.5	Schedule 40 PVC	21-26	0.010	20/40	26
B-28	Perched Zone	04/17/01	1,816,929.59	6,509,294.01	138.67	1.5	Schedule 40 PVC	21-26	0.010	20/40	26
B-29	Perched Zone	04/17/01	1,816,945.89	6,509,165.33	138.85	1.5	Schedule 40 PVC	22-27	0.010	20/40	27
B-30	Perched Zone	04/16/01	1,817,032.22	6,509,245.82	143.60	1.5	Schedule 40 PVC	23-28	0.010	20/40	28
B-31	Perched Zone	04/16/01	1,817,100.48	6,509,311.30	140.38	1.5	Schedule 40 PVC	20-25	0.010	20/40	25
B-32	Perched Zone	04/17/01	1,817,153.03	6,509,321.45	141.45	1.5	Schedule 40 PVC	20-30	0.010	20/40	30
B-33	Perched Zone	11/07/01	1,816,649.98	6,509,752.83	137.59	1.5	Schedule 40 PVC	21-26	0.010	2/16	26
B-34	Perched Zone	11/08/01	1,816,558.24	6,509,788.03	137.21	1.5	Schedule 40 PVC	19-24	0.010	2/16	24
B-35	Perched Zone	11/07/01	1,816,629.32	6,509,670.08	138.03	1.5	Schedule 40 PVC	23-28	0.010	2/16	28
B-36	Perched Zone	11/07/01	1,816,855.43	6,509,622.68	139.78	1.5	Schedule 40 PVC	23-28	0.010	2/16	28
B-37	Perched Zone	11/08/01	1,817,369.54	6,509,379.23	153.78	1.5	Schedule 40 PVC	31-36	0.010	2/16	36
B-38	Perched Zone	01/10/02	1,817,428.13	6,509,346.80	153.33	2	Schedule 40 PVC	29-34	0.010	2/16	34
B-39	Perched Zone	11/08/01	1,817,104.79	6,509,217.90	140.08	1.5	Schedule 40 PVC	18-28	0.010	2/16	28
SV-1	Perched Zone	11/01/97	1,817,147.76	6,509,478.45	146.10	4	Schedule 40 PVC	10-35	0.010	2/16	35
SV-2	Perched Zone	12/01/97	1,817,247.09	6,509,445.60	148.36	4	Schedule 40 PVC	15-35	0.010	2/16	35
SV-3	Perched Zone	12/01/97	1,817,260.03	6,509,395.92	148.27	4	Schedule 40 PVC	15-35	0.010	2/16	35
SV-4	Perched Zone	12/01/97	1,817,086.72	6,509,543.45	146.19	4	Schedule 40 PVC	15-35	0.010	2/16	35
SV-5	Perched Zone	12/01/97	1,817,002.43	6,509,526.95	140.91	4	Schedule 40 PVC	15-35	0.010	2/16	35

TABLE 2-2
Existing Well Construction Data - Exposition Aquifer Wells

Well I.D.	Associated Hydrogeologic Unit	Date Installed	Northing	Easting	Top of Casing Elevation	Casing Diameter (inches)	Well Material	Screening Interval	Screen Slot Size (inches)	Filter Pack Sand Size	Constructed Total Depth (bgs)
MW-01-80	A and B Zones	05/17/97	1,817,283.00	6,509,290.20	146.04	2	Schedule 40 PVC	59 - 79	0.020	No. 3	79
MW-02-95	B Zone	05/13/97	1,817,006.10	6,509,548.80	144.61	2	Schedule 40 PVC	80 - 100	0.020	No. 3	100
MW-03-85	A and B Zones	05/15/97	18,168,741.40	6,509,615.50	139.50	2	Schedule 40 PVC	64 - 84	0.020	No. 3	84
MW-04-85	A and B Zones	05/14/97	1,816,867.00	6,509,692.90	140.42	2	Schedule 40 PVC	64 - 84	0.020	No. 3	84
MW-05-85	A and B Zones	03/23/01	1,816,734.27	6,509,491.42	137.30	4	Schedule 80 PVC	70 - 85	0.010	2/16	85
MW-05-105	C Zone	07/24/03	1,816,742.55	6,509,492.93	137.50	4	Schedule 80 PVC	95-105	0.010	2/16 and 0/30	105
MW-05-135	D Zone	04/02/01	1,816,726.81	6,509,490.50	137.57	4	Schedule 80 PVC	126 - 136	0.010	2/16	136
MW-06-85	B Zone	03/27/01	1,816,953.90	6,509,201.74	138.66	4	Schedule 80 PVC	79 - 84	0.010	2/16	84
MW-07-75	A Zone	03/26/01	1,816,531.15	6,509,817.14	137.19	4	Schedule 80 PVC	65 - 75	0.010	2/16	75
MW-07-130	D Zone	04/05/01	1,816,447.79	6,509,845.61	136.97	4	Schedule 80 PVC	120 - 130	0.010	2/16	130
MW-08-70	A Zone	03/28/01	1,816,346.91	6,509,419.25	136.90	2	Schedule 40 PVC	63 - 68	0.010	2/16	68
MW-08-85	B Zone	03/28/01	1,816,346.91	6,509,419.25	136.84	2	Schedule 40 PVC	79 - 84	0.010	2/16	84
MW-09-70	A Zone	03/30/01	1,816,611.11	6,509,258.06	137.44	2	Schedule 40 PVC	65 - 70	0.010	2/16	70
MW-09-85	B Zone	03/30/01	1,816,611.11	6,509,258.06	137.53	2	Schedule 40 PVC	80 - 85	0.010	2/16	85
MW-10-75	A Zone	04/02/01	1,816,416.06	6,508,720.43	138.53	2	Schedule 40 PVC	68 - 73	0.010	2/16	73
MW-10-90	B Zone	04/02/01	1,816,416.06	6,508,720.43	138.49	2	Schedule 40 PVC	87 - 92	0.010	2/16	92
MW-10-110	C Zone	04/06/01	1,816,426.52	6,508,721.65	138.52	4	Schedule 80 PVC	100 - 110	0.010	2/16	110
MW-10-170	E Zone	04/05/01	1,816,420.98	6,508,721.10	138.59	4	Schedule 80 PVC	163 - 173	0.010	2/16	173
MW-11-100	C Zone	03/29/01	1,816,185.04	6,509,927.41	136.08	4	Schedule 80 PVC	95 - 100	0.010	2/16	100
MW-12-70	A Zone	04/03/01	1,816,799.51	6,508,772.17	138.56	2	Schedule 40 PVC	65 - 70	0.010	2/16	70
MW-12-90	B Zone	04/03/01	1,816,799.51	6,508,772.17	138.58	2	Schedule 40 PVC	85 - 90	0.010	2/16	90
MW-12-150	D Zone	04/10/01	1,816,794.10	6,508,771.38	138.56	4	Schedule 80 PVC	138 - 148	0.010	2/16	148
MW-13-85	B Zone	04/04/01	1,816,563.36	6,509,621.22	137.72	4	Schedule 80 PVC	80 - 85	0.010	2/16	85
MW-14-80	A Zone	11/14/01	1,817,059.40	6,509,595.87	146.02	2	Schedule 40 PVC	76 - 81	0.010	2/16	81
MW-14-90	B Zone	11/14/01	1,817,059.40	6,509,595.87	145.93	2	Schedule 40 PVC	87 - 92	0.010	2/16	92
MW-15-70	A Zone	11/28/01	1,816,968.14	6,509,596.54	142.52	2	Schedule 40 PVC	63 - 68	0.010	2/16	68
MW-15-85	B Zone	11/19/01	1,816,965.16	6,509,598.63	141.94	2	Schedule 40 PVC	80 - 85	0.010	2/16	85
MW-16-70	A Zone	11/15/01	1,816,955.56	6,509,582.81	140.80	2	Schedule 40 PVC	63 - 68	0.010	2/16	68
MW-16-90	B Zone	11/15/01	1,816,955.56	6,509,582.81	140.77	2	Schedule 40 PVC	84 - 89	0.010	2/16	89
MW-17-70	A Zone	11/26/01	1,816,938.93	6,509,601.15	141.27	2	Schedule 40 PVC	63 - 68	0.010	2/16	68
MW-17-85	B Zone	11/26/01	1,816,935.67	6,509,602.56	141.28	2	Schedule 40 PVC	78 - 83	0.010	2/16	83
MW-17-95	B Zone	11/28/01	1,816,934.38	6,509,598.88	140.85	2	Schedule 40 PVC	90 - 92.5	0.010	2/16	92.5
MW-18-70	A Zone	11/16/01	1,816,939.40	6,509,578.16	139.49	2	Schedule 40 PVC	62 - 67	0.010	2/16	67
MW-18-85	B Zone	11/16/01	1,816,939.40	6,509,578.16	139.29	2	Schedule 40 PVC	81 - 86	0.010	2/16	86
MW-19-70	A Zone	11/27/01	1,816,925.51	6,509,569.71	139.25	2	Schedule 40 PVC	62 - 67	0.010	2/16	67
MW-19-90	B_2 Zone	11/27/01	1,816,925.51	6,509,569.71	139.59	2	Schedule 40 PVC	82 - 87	0.010	2/16	87
MW-20-70	A Zone	7/31/2003	1,817,059.43	6,509,264.63	145.48	2	Schedule 40 PVC	63-68	0.010	2/16	68
MW-20-85	B Zone	7/31/2003	1,817,059.43	6,509,264.63	145.53	2	Schedule 40 PVC	78-83	0.010	2/16	83
MW-21-80	A Zone	07/29/03	1,817,176.06	6,509,413.88	147.38	2	Schedule 40 PVC	68-78	0.010	2/16	78
MW-21-90	B Zone	07/29/03	1,817,176.06	6,509,413.88	147.44	2	Schedule 40 PVC	85-90	0.010	2/16	90
MW-22-75	A Zone	07/30/03	1,817,251.95	6,509,501.06	149.18	2	Schedule 40 PVC	69-74	0.010	2/16	74
MW-22-90	B Zone	07/30/03	1,817,251.95	6,509,501.06	147.96	2	Schedule 40 PVC	89-94	0.010	2/16	94
MW-23-110	C Zone	07/18/03	1,816,937.33	6,509,425.55	138.13	4	Schedule 80 PVC	99-109	0.010	2/16 and 0/30	109
MW-23-145	D Zone	07/17/03	1,816,936.68	6,509,431.04	137.93	4	Schedule 80 PVC	135-145	0.010	2/16 and 0/30	145
MW-24-110	C Zone	08/19/03	1,816,907.24	6,509,620.90	140.50	4	Schedule 80 PVC	100-110	0.010	2/16 and 0/30	110
MW-24-140	D Zone	08/18/03	1,816,908.46	6,509,606.73	139.90	4	Schedule 80 PVC	130-140	0.010	2/16 and 0/30	140
MW-25-110	C Zone	07/23/03	1,816,781.50	6,509,727.83	137.92	4	Schedule 80 PVC	102-107	0.010	2/16 and 0/30	107
MW-25-130	D Zone	07/22/03	1,816,776.71	6,509,729.69	138.03	4	Schedule 80 PVC	120-130	0.010	2/16 and 0/30	130

TABLE 2-3
Site Stratigraphy

STRATIGRAPHIC ZONE	AVERAGE DEPTH INTERVAL	GENERAL LITHOLOGY	GENERAL GEOTECHNICAL CHARACTERISTICS
Upper Vadose Zone	Surface to 25' bgs	Surficial fill from 2' to 6' deep. Underlying native soils are predominately fine SM sands from 1' to 20' thick interbedded with fine SP and SP-SM sands from 2" to 6' thick. Local discontinuous lenses of silt/clay ranging from 3" to 4' thick are also present within upper vadose zone interval.	▪ Total Porosity: 40% to 47% ▪ TOC: 1.15% to 2.12% ▪ Less than 200 Sieve: 14% to 33%
Perched Zone	25' to 30' bgs	Fine silty sand ranging from 6" to 4' thick. Locally, perched zone is comprised of sandy silts or silt with sand ranging from 1' to 3' thick.	▪ Total Porosity: 42% to 48% ▪ TOC: 0.92% to 1.14% ▪ Less than 200 Sieve: 21% to 25%
"Perching" Clay	Top of clay ranges from 25' to 35' bgs	Silty Lean and Fat clays ranging from 1' to 15' thick comprise top of perching unit and are underlain and interbedded with clayey and sandy silts ranging from 1' to 8' thick. Perching lithosome ranges from 10' to 20' total thickness.	▪ Total Porosity: 32% to 50% ▪ TOC: 0.48% to 3.71% ▪ Less than 200 Sieve: 77% to 90%
Lower Vadose Zone Sand	40' to 50' bgs	Predominately fine to medium SP sands and gravelly SW sands from 1' to 14' thick with local intervals of SM and SP-SM sands from 6" to 3' thick. Local interbeds of silt lenses from 6" to 4' thick are within this unit. Coarser units are derived from granitic source rocks.	▪ Total Porosity: 46% to 54% ▪ TOC: 0.2% to 5% ▪ Less than 200 Sieve: 1% to 4%
Lower Vadose Zone (Fine-Grained interval)	50' to 65' bgs	Lean and Fat Clays ranging from 6" to 5' thick interbedded with Sandy and Clayey Silts ranging from 2' to 20' thick. Local discontinuous lenses of unsaturated SP and SM sands are present from 6" to 2" thick within interval.	▪ Total Porosity: 47% to 68% ▪ TOC: 2.4% to 5.5% ▪ Less than 200 Sieve: 57% to 97%
Exposition "A"	65' to 75' bgs	Fine SM and SP sands locally interbedded with SW sands. Thickness is highly variable ranging from 3" to 10' thick. Interval is comprised of a series of discontinuous saturated sand lenses.	▪ Total Porosity: 44% to 69% ▪ TOC: 0.66% to 3% ▪ Less than 200 Sieve: 1.0% to 46% ▪ K range: 2.277E-03 to 8.281E-04
"A" – "B" Fine-Grained	75' to 80' bgs	Fat and Lean Clays with local interbeds of Clayey Silt with sand. Interval ranges from 5' to 10' thick and is continuous where both "A" and "B" aquifer zones are present.	▪ Total Porosity: 46% to 49% ▪ TOC: 2.63% ▪ Less than 200 Sieve: 88% to 94%
Exposition "B_1" **Exposition "B_2"**	80' to 90' bgs 90' to 92' bgs	Fine SM, SP and SM-SP sands ranging from 1.5' to 10' thick. Some of the thicker portions of the unit have interbeds of silt/clay to 1' thick. The "B" zone is continuous throughout site vicinity. Fine SM, SC and SP-SM sands ranging from 1.5' to 2' thick. This secondary unit has only been observed underlying the southernmost portion of the site where it is separated by the overlying B_1 unit by 1' to 3' of fat clay. This unit has not been observed offsite in any of the locations sampled below 90' bg.	▪ Total Porosity: 55% to 56% ▪ TOC: 0.6% to 0.64% ▪ Less than 200 Sieve: 4% ▪ K range: 1.046E-01 to 1.078E-03
"B" – "C" Fine-Grained	90' to 100' bgs	Predominately Fat and Lean Clays from from 8' to 10' thick with local interbeds Sandy Silts from 1' to 5' thick. Total thickness of unit ranges from 7' to 12'.	▪ Total Porosity: 40% to 47% ▪ TOC: 0.92% to 2.12% ▪ Less than 200 Sieve: 14% to 33%
Exposition "C"	100' to 105' bgs	Fine SM, SP and SP-SM sands ranging from 2' to 6' thick. Appears to be continuous throughout the site vicinity within the 95' to 110' depth interval.	▪ Total Porosity: 40% to 47% ▪ TOC: 0.92% to 2.12% ▪ Less than 200 Sieve: 14% to 33%

TABLE 2-3 (continued)
Site Stratigraphy

STRATIGRAPHIC ZONE	AVERAGE DEPTH INTERVAL	GENERAL LITHOLOGY	GENERAL GEOTECHNICAL CHARACTERISTICS
"C" – "D" Fine-Grained	105' to 125' bgs	Lean and Fat Clays form 3' to 6' thick interbedded with Sandy and Clayey Silts from 4' to 12' thick. Total unit thickness ranges from 18' to 30'.	▪ Total Porosity: 40% to 47% ▪ TOC: 0.92% to 2.12% ▪ Less than 200 Sieve: 14% to 33%
Exposition "D"	125' to 140' bgs	Interbedded fine SM, SP and SP-SM sands, SW sands and gravelly sands and local GW intervals. Total thickness rages from 6' to 15'.	▪ Total Porosity: 40% to 47% ▪ TOC: 0.92% to 2.12% ▪ Less than 200 Sieve: 14% to 33%
"D" – "E" Fine-Grained	140' to 160' bgs	Predominately Clayey Silt with local interbeds of Lean Clays. Thickness ranges from 12' to 18'. Local saturated SM sand lenses to 2' thick located within interval.	▪ Total Porosity: 40% to 47% ▪ TOC: 0.92% to 2.12% ▪ Less than 200 Sieve: 14% to 33%
Exposition "E"	160' to 175' bgs	Alternating intervals of 1' thick fine SM sands and SW sands.	▪ Total Porosity: 40% to 47% ▪ TOC: 0.92% to 2.12% ▪ Less than 200 Sieve: 14% to 33%
Lower Exposition Fine-Grained	175' to ???	Clay with Silt finely laminated with Silt. Local lenses of medium SP sand 6" thick.	▪ Total Porosity: 40% to 47% ▪ TOC: 0.92% to 2.12% ▪ Less than 200 Sieve: 14% to 33%

TABLE 2-4
Summary of Environmental Assessment Activities for the Pemaco Site
(Table only includes reports involving actual site activities)

Company	Report Date	Scope and Summary of Investigation
Active Leak Testing, Inc. (ALT)	12/26/90	*Subject Site Assessment Investigation Report* • 16 soil borings (B-1 through B-16) drilled from 30' to 40' below ground surface (bgs), sampled every 5'. • Locations of the borings were determined from a previous soil vapor survey performed by ALT. • Each soil sample analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX) and non-halogenated volatiles, 2 samples from each boring analyzed for volatile organic compounds (VOCs) as determined by photo ionization detector (PID) readings. • Contaminants detected in every boring, toluene and paraldehyde were the most prevalent, but benzene, tetrachloroethene (PCE), 1,1-Dichloroethene (1,1-DCE) and trichloroethene (TCE) were the only chemicals exceeding regulatory levels. • Each boring converted to shallow monitoring well (B-1 through B-16). • No indication in report of any water sampling performed.
Ecology and Environment, Inc. (E&E)	2/25/94	*Final Site Assessment Report* • Describes visual site characterization activities performed by E&E (contracted by the USEPA) to assess whether federal involvement was warranted. The site had been abandoned and the warehouse burnt down in December 1993, 31 underground storage tanks (USTs), 4 aboveground storage tanks (ASTs), 6 drums and one 15'-diameter open borehole remained onsite. • The borehole was grouted and a fence was placed around the site as an initial security measure. • The six remaining drums were sampled and removed and all the UST standpipes were locked.
Ecology and Environmental, Inc.	03/10/98	*Pemaco Maywood Expanded Site Inspection* • Details Expanded Site Assessment activities performed by the E&E's Emergency Response team over the time period between February – May 1997. • 118 shallow soil samples (5' bgs), 102 collected beneath concrete pad (former drum storage) and 19 others collected in UST and AST areas. All samples analyzed for VOCs. Majority of detects were BTEX, 1,1,1-Trichloroethane (1,1,1-TCA), PCE and acetone mainly found in northern portion of former drum storage pad. • 6 soil borings (SSB-1 through SSB-4, SMW-1 and SMW-2) completed to 90' bgs, samples collected

TABLE 2-4
Summary of Environmental Assessment Activities for the Pemaco Site
(Table only includes reports involving actual site activities)

Company	Report Date	Scope and Summary of Investigation
Ecology and Environment, Inc. (continued)		approx. every 10’ and analyzed for VOCs. • Acetone, 1,1- DCE, 1,1-Dichloroethane (1,1-DCA) and TCE were main detects. SSB-3 and SSB-4 had majority of hits [(TCE up to 1,200,0000 parts per billion (ppb) at 15’ (SSB-3)] and 990 ppb at 80’ (SSB-4). • Two of these borings converted to deep monitoring wells and 2 more deep (80’) monitoring wells (MW-3 and MW-4) installed downgradient with no soil sampling. • Groundwater samples collected from all perched wells (B-1 through B-16) and analyzed for VOCs, product found in 3 of the wells (B-2, B-6 and B-9). • Product wells sampled and analyzed and found to be 20% - 30% gasoline range hydrocarbons. • Chlorinated VOCs found in all perched wells sampled from <10 to 180 ppb. • TCE found in groundwater samples from MW-2 through MW-4 from 430 (MW-2) to 11,000 ppb (MW-4), MW-1 was non detect (ND).
Ecology and Environmental, Inc.	03/98	*Subsurface Investigation* • All USTs were removed in August through September 1997 except for one UST that was abandoned in place and all above ground structures were demolished and removed by the Emergency Response group. Horizontal screened piping was laid down in tank pits before backfilling to be hooked up to a future soil vapor extraction (SVE) system. • 44 surface (0.5’) and near surface samples (2.5’) were collected from 22 locations spread throughout the site in the UST, AST and warehouse areas in October 1997. • Also, 6 samples from 3 locations in former sump area (south of existing SVE manifolding). • All soil samples were analyzed for VOCs. • PCE and 1,1,1-TCA were most prevalent (up to 927 ppb). • 22 soil vapor locations (10’ – 15’ bgs) and 14 locations (18’ – 25’ bgs) were field screened using a flame ionization detector/photoionization detector (FID/PID), flame-out occurred due to lack of oxygen at 18 locations and 15 of the locations had reading >10,000 parts per million in volume (ppmv). • 15 soil vapor samples were collected from selected locations mentioned above and analyzed for VOCs. Toluene, 1,1,1-TCA, PCE, methylene chloride and xylenes were the most prevalent (up to 1,280 ppmv).

TABLE 2-4
Summary of Environmental Assessment Activities for the Pemaco Site
(Table only includes reports involving actual site activities)

Company	Report Date	Scope and Summary of Investigation
Ecology and Environment, Inc. (continued)		• 44 sub-surface soil samples from the 22 locations were collected (co-located with the soil vapor and near surface locations) from 12' and 22' bgs. • All 44 samples were analyzed for VOCs and a selected 10 samples were analyzed for semivolatile organic compounds (SVOCs). • 1,1-DCE, TCE, BTEX, 1,2,4-Trimethybenzene, 1,3,5-Trimethylbenzene, 4-Methyl-2-pentanone were the prevalent VOCs (up to 237 ppm). • Phenol and naphthalene were most prevalent SVOCs (up to 11 ppm). • Deep wells MW-1 through MW-4 were re-sampled and analyzed for VOCs in November 1997. • MW-2 through MW-4 had hits of TCE from 1,090 ppb (MW-2) to 8,590 ppb (MW-3), MW-1 was ND results lower than the May 1997 sampling. • Report concludes that in general the VOCs detected in all media consisted of: acetone, 4-methyl-2-pentanone, BTEX, methylene chloride, 2-butanone, TCE, PCE, 1,1-DCE, 1,1-DCA and 1,1,1-TCA. Some levels were above USEPA Region IX Residential Preliminary Remediation Goals (PRGs) and Soil Screening Levels (SSLs) (threat to groundwater); no SVOCs exceeded PRGs or SSLs. • Groundwater gradients calculated for the perched zone and Exposition groundwater zone(s) from data collected during the water sampling. • Perched zone characterized as discontinuous and sporadic with overall flow north towards the LA River with many localized mounds and sinks causing varying flow directions. • Exposition groundwater zone(s) flow calculated to be towards the south.
CET Environmental Services, Inc.	03/98	*Design Report* • Document is a design report for the SVE system with several schematics and discussion of design parameters for the SVE system.

TABLE 2-4
Summary of Environmental Assessment Activities for the Pemaco Site
(Table only includes reports involving actual site activities)

Company	Report Date	Scope and Summary of Investigation
CET Environmental Services, Inc.	2/4/99 1/4/99 11/12/98 10/29/98 9/2/98 8/5/98 7/8/98 6/8/98 5/11/98 4/4/98	*Vapor Extraction Reports* • Each of these documents is a monthly SVE system report with field PID measurements of influent and effluent concentrations, system parameter measurements and mass removal calculations. • Documents also give details of system adjustments and carbon usage • The February 1999 document (last report before system shut-down) reported that a total of 144,412 pounds (lbs) of hydrocarbons were removed from the site through vapor extraction and natural degrading.
CET Environmental Services, Inc.	5/6/98	*Pemaco Stack Test* • Stack test results for thermal oxidation unit.
Ecology and Environmental, Inc.	05/99	*Pemaco Removal Site Final Report* • Report summarizes work listed above by CET and also summarizes pilot testing (SVE, in-situ respiration and bio-slurping) of remedial techniques. • A soil vapor well (SV-1) was installed in the former UST area along with three vapor monitoring points (VMP-1 – VMP-3) to monitor the SVE system. • A 2-day in-situ respiration test concluded that a mass destruction of 300 lbs per month of VOCs was possible. • A 2-day bio-slurping test was conducted, it was concluded that this was not effective in removing free product in the perched zone. • The soil vapor extraction pilot test concluded that 33,000 lbs per month of VOCs could be removed from the site. • Ultimately the SVE system with 5 "SV" wells (SV-1 – SV-5), all the existing ALT wells, (B-1, B-3 – B-16)

TABLE 2-4
Summary of Environmental Assessment Activities for the Pemaco Site
(Table only includes reports involving actual site activities)

Company	Report Date	Scope and Summary of Investigation
Ecology and Environmental, Inc. (continued)		and the horizontal wells placed in the tank pit backfills were plumbed into a system with carbon canisters and a thermox unit, which were operated by CET as documented above. • SVE system operates from March 1998 to March 1999 when it was shut down due to community concerns. • From the weekly monitoring readings and measurements, it was calculated that the SVE system removed 67,610 lbs of contaminants. • An additional 82,294 lbs of hydrocarbons were destroyed by natural degradation during the 1 year SVE operation according to calculations.
T N & Associates, Inc.	12/00	*Preliminary Summary of Groundwater and SVE System Sampling Events* • **This is an internal draft document that was not formally submitted outlining sampling activities performed to assess current site conditions (current in 2000).** • Scope included testing of lo-flo sampling equipment, sampling of perched wells and Exposition groundwater zone(s) wells, and sampling of the dormant vapor extraction system by connecting a mobile blower to it, applying vacuum and collecting samples out of the sampling ports located on the manifold. • Perched wells B-1, B-3, B-4, B-5, B-10, B-13, SV-1 and SV-5 were lo-flo sampled (other wells were dry or obstructed) and analyzed for total petroleum hydrocarbons-gasoline range (TPH-g), VOCs, SVOCs and non-halogenated VOCs (NHVOCs). • Well B-15 was found to contain 6' of floating free product; the product was sampled and was characterized as kerosene range organics by the USEPA Region IX lab. • Every perched well sampled had detectable concentrations of TPH-g at 60 ppb (B-10) to 2,600 ppb (B-13). • VOCs in the perched wells were predominately acetone (up to 6,200 ppb) and BTEX (up to 100 ppb). The chlorinated compounds 1,1,1-TCA, 1,1-DCA, 1,1-DCE, PCE, TCE and vinyl chloride were semi-prevalent and ranged from 0.3 ppb to 750 ppb. • SVOCs were detected in the perched wells from 19 ppb (naphthalene) to 150 ppb (4-methyl phenol) and were not as prevalent as the VOCs.

TABLE 2-4
Summary of Environmental Assessment Activities for the Pemaco Site
(Table only includes reports involving actual site activities)

Company	Report Date	Scope and Summary of Investigation
TN & Associates, Inc. (continued)		• NHVOCs were detected in the perched wells from 0.16 ppm to 7.53 ppm (acetone, 1,4-dioxane, MEK and isopropanol). • The 4 Exposition groundwater zone(s) wells (MW-1 – MW-4) were lo-flo sampled and also analyzed for TPH-g, VOCs, SVOCs and non-halogenated volatile organic compounds (NHVOCs). • TPH-g ranged from 2,200 ppb (MW-2) to 10,000 ppb (MW-3) in MW-2 through MW-4, MW-1 was ND. • VOCs detected in the wells MW-1 through MW-4 were TCE, cis-1,2-DCE, TCE, methylene chloride and cyclohexane ranging from 0.2 ppb to 13,000 ppb. The predominant VOC in the Exposition wells is TCE. Well MW-1 had only trace hits of VOCs, none more than 2.1 ppb. • SVOCs above detection limits in the Exposition wells were 4-Methylphenol (12 ppb to 190 ppb) and naphthalene (19 ppb). • The only NHVOC detected in the Exposition wells was acetone on MW-2 at 200 ppb. • The gradient of the perched groundwater zone measured during this event indicated that no prevalent gradient direction existed and the potentiometric surface was highly irregular. • Based on the three data points (MW-2, MW-3 and MW-4), the groundwater gradient direction in the upper Exposition groundwater zones was toward the west. • It was concluded that the vertical and lateral extent of groundwater contamination in the perched zone, Exposition groundwater zones and deeper aquifers is not defined. • Summa sampling of the dormant vapor system indicated trace to low concentrations of BTEX, 1,1-DCE, cis-1,2-DCE, vinyl chloride, methylene chloride, 1,1-DCA, 1,1,1-TCA TCE; PCE; acetone; chloroethane; propylene; hexane; and cyclohexane ranged from <0.5 ppbv to 4,400 ppbv (cis-1,2-DCE in well B-3).

TABLE 2-4
Summary of Environmental Assessment Activities for the Pemaco Site
(Table only includes reports involving actual site activities)

Company	Report Date	Scope and Summary of Investigation
T N & Associates, Inc.	October 2002	*Draft Remedial Investigation Report, Pemaco Superfund Site* • **The following is a summary of Remedial Investigation (RI) Activities that were performed at the Pemaco site and adjacent areas from January 2001 through April 2002.** • 66 soil gas samples from 66 different locations were collected from 5' bgs and analyzed for VOCs. • Completion of soil borings including the following: - 14 borings to 90' bgs via Cone Penetrometer Test (CPT); - 46 borings to 25'-35' bgs via Geoprobe; - 9 borings to 90'-100' bgs and 1 boring to 130' bgs via hollow stem auger; and - 4 borings to 110'-175' bgs via mud-rotary rig. • Collection of soil samples from soil borings, including the following: - 152 upper vadose zone samples for VOCs, SVOCS, solvents, and metals; - 19 samples for total organic carbon (TOC) analysis; - 150 surface and near-surface samples via Geoprobe rig for SVOCs and metals; - 71 lower vadose zone samples for VOCs, SVOCs, solvents, and metals; - 25 lower vadose zone samples for TOC analysis; - 38 lower vadose zone samples for geotechnical parameters; and - 5 lower vadose zone samples for TOC and geotechnical parameters. • Conversion of 14 soil borings to 18 monitoring wells (4 were double-nested). Soil borings ranged in depth from approximately 68 feet to 174 feet bgs. • Installation of 16 perched zone monitoring wells via a Geoprobe rig. • Groundwater monitoring: - May 2001 (34 new wells, 23 existing wells) - Samples collected from 51 wells for VOCs, solvents, SVOCs, metals, cyanide, CrVI, CO_2, TOC,

TABLE 2-4
Summary of Environmental Assessment Activities for the Pemaco Site
(Table only includes reports involving actual site activities)

Company	Report Date	Scope and Summary of Investigation
TN & Associates, Inc. (continued)		methane, ethane, and ethene; - 3 wells (B-7, B-14, and B-16) were dry; - 3 wells (B-15, B-28, and B-29) had free product. - September 2001 (54 existing wells) - Samples collected from 37 wells for VOCs; - 8 additional samples collected for ferrous iron, sulfate, chloride, sulfide, and alkalinity; - 5 wells (B-7, B-11, B-12, B-14, and B-16) were dry; - 4 wells (B-08, B-15, B-28, and B-29) had free product. - January 2002 (21 new wells, 54 existing wells) - Samples collected from 43 wells for VOCs and NHVOCs; - 6 wells (B-07, B-08, B-11, B-14, B-16, and B-34) were dry; - 3 wells (B-15, B-28, and B-29) had free product. - April 2002 (75 existing wells) - Samples from 57 wells for VOCs and NHVOCs; - 7 wells (B-07, B-08, B-11, B-14, B-16, B-30, and B-34) were dry; - 3 wells (B-15, B-28, and B-29) had free product. • Collection of groundwater level measurements: - 35 perched zone wells in October 2000, June 2001, September 2001, January 2002 and April 2002 (quarterly gauging on-going since April 2002); - 22 Exposition groundwater zone(s) wells weekly for the month of May 2001, and monthly from June 2001 to present (measurements were used to evaluate the effects of the active Maywood production wells on the Exposition groundwater zones. • Quarterly monitoring has been on-going since April 2002. • Groundwater aquifer testing: - Conducted in December 2001 on Exposition 'A' and 'B' groundwater zones (slug, step-

TABLE 2-4
Summary of Environmental Assessment Activities for the Pemaco Site
(Table only includes reports involving actual site activities)

Company	Report Date	Scope and Summary of Investigation
		drawdown and 72-hour continuous test). • Soil vapor and Summa canister samples of indoor/outdoor air were collected from private residences adjacent to Pemaco in July 2001 and March 2002.
T N & Associates, Inc.		• **Analytical results of the above activities were not summarized due to the large amount of data produced, however, the RI activities have completely delineated the vertical and horizontal extent of soil and groundwater contamination sourced from the Pemaco property.** • **Results of the RI activities may be referenced in the *Final Remediation Investigation Report, Pemaco Superfund Site, Maywood, California* (TN&A, March 2004).**

TABLE 2-5A
Chemicals Exceeding USEPA Region IX PRGs for Ambient Air
Indoor/Outdoor Air

Chemical	USEPA PRG ($\mu g/m^3$)	Maximum Concentration Found in Indoor/Outdoor Air
Benzene	0.23	16 (SUMMA 5119)
Chloroform	3.1/0.35*	8.8 (SUMMA 5114)
Chloromethane	1.1	6.19 (5100 59th Place)
1,2-Dichloroethane	0.074	6.5 (SUMMA 1)
1,3-Dichlorobenzene	3.3	6.01 (5000/5130A 59th Place)
1,4-Dichlorobenzene	0.31	541.1 (SUMMA 5119)
Dichlorodifluoromethane	210	939.6 (SUMMA 5000)
Hexachlorobutadiene	0.086	8.4 (SUMMA 5014)
Methyl tert butyl ether	19/3.7*	72.1 (SUMMA 5119)
Tetrachloroethene	0.67	24.4 (SUMMA 7)
1,2,4-Trimethylbenzene	6.2	21.1 (SUMMA 7)

Notes:

(1.) '$\mu g/m^3$' - microgram per cubic meter.

(2.) Maximum ambient air concentrations obtained from July 2001 and March 2002 sampling events.

(3.) Maximum concentration followed in parentheses by the sample location.

(4.) USEPA Region IX Preliminary Remediation Goals (PRGs) are tools for evaluating and cleaning up contaminated sites. They are risk-based concentrations combining exposure information and EPA toxicity data for each environmental media; in this case, ambient air. PRGs should be viewed as Agency guidelines, not legally enforceable standards.

(5.) '*' - State of California modified PRG.

TABLE 2-5B
Chemicals Exceeding USEPA Region IX PRGs for Ambient Air (x100)
Soil Vapor, 5 feet and 15 feet bgs

Chemical	USEPA PRG X 100 (µg/m^3)	Maximum Concentration 5 feet bgs February 2001 (FASP Lab)	Maximum Concentration 5 feet bgs July 2001 & March 2002	Maximum Concentration 15 feet bgs July 2001 & March 2002
Benzene	23	--	92.7 (SV2002-4-5)	204.5 (SV2002-5-15)
Bromodichloromethane	11	--	--	107.2 (SV2002-5112-15)
Chloroform	8.4	1,000 (GP-SV-SO20, GP-SV-09)	73.3 (LFSG 19)	146.5 (SV2002-5112-15)
Chloromethane	310/35*	--	--	169.3 (SV2002-5002-15)
Dibromochloromethane	8.0	--	--	12.8 (SV2002-5112-15)
cis-1,2-Dichloroethene	3,700	26,000 (GP-SV-05)	--	--
1,1-Dichloroethane	52,000/120*	8,000 (GP-SV-04)	202.4 (SV2002-5002-5)	388.6 (SV2002-5002-15)
1,1-Dichloroethene	21,000.0	36,000 (GP-SV-SO11)	1,070.6 (SV2002-5002-5)	2,379.1 9 (SV2002-5002-15)
1,1,2,2-Tetrachloroethane	3.3	--	6.9 (SV2002-5100-5)	8.3 (SV2002-5021-15)
Tetrachloroethene	67	140,000 (GP-SV-09)	4,205.1 (SV2002-5-5)	1,288.7 (SV2002-5-15)
Trichloroethene	1.7	11,000 (GP-SV-05)	2,416.4 (SV2002-5-5)	10,739.5 (SV2002-4-15D)

Notes:

(1.) 'µg/m^3' - microgram per cubic meter.

(2.) "--" data not available

(3.) Maximum soil vapor concentrations obtained from February 2001, July 2001 , and March 2002 sampling events. Because the laboratory used during the February 2001 event was a field lab (Field Analytical Screening Program - FASP lab), which typically have higher method detection limits than fixed laboratories (as used during the July 2001 and March 2002 events), a separate column was included for soil vapor collected during the February 2001 sampling event.

(4.) Maximum concentration followed in parentheses by the sample location.

(5.) No soil vapor PRGs are available. USEPA Region IX Ambient Air Preliminary Remediation Goals (PRGs) were multiplied by an attenuation factor of 100 to allow for screening of soil vapor data and to evaluate whether further investigation of ambient air is warranted. PRGs are tools for evaluating and cleaning up contaminated sites. They are risk-based concentrations combining exposure information and EPA toxicity data for each environmental media; in this case, ambient air (multiplied by 100). PRGs should be viewed as Agency guidelines, not legally enforceable standards.

(6.) '*' - State of California modified PRG.

TABLE 2-5C
Chemicals Exceeding USEPA Region IX Residential Soil PRGs
Surface and Near Surface Soil (0 - 2.5 feet bgs)

Chemical	USEPA PRG (unit indicated below)	Maximum Concentration Found in Surface Soil	Maximum Concentration Found in Near Surface Soil
		SVOCs (µg/kg)	
Benzo (a) anthracene	620	22,000 (GP-SS-14)	950 (GP-SS-31)
Benzo (a) pyrene	62	33,000 (GP-SS-14)	1,100 (GP-SS-31)
Benzo (b) fluoranthene	620	38,000 (GP-SS-14)	1,000 (GP-SS-11, GP-SS-31)
Benzo (k) fluoranthene	6,200/380*	28,000 (GP-SS-14)	760 (GP-SS-11)
Chrysene	62,000/3,800*	24,000 (GP-SS-14)	--
Dibenzo (a,h) anthracene	62	5,300 (GP-SS-14)	130 (GP-SS-31)
Indeno (1,2,3-cd) pyrene	620	19,000 (GP-SS-14)	670 (GP-SS-30)
		Metals (mg/kg)	
Arsenic	22/0.39*	--	40.4 (GP-SS-45)
Iron	23,000	73,200 (GP-SS-75)	71,500 (GP-SS-61)
Lead	150	952 (GP-SS-87)	--
Manganese	1,800	1,940 (GP-SS-51)	--

Notes:

(1.) 'µg/kg' - microgram per kilogram.

(2.) 'mg/kg' - milligram per kilogram.

(3.) "--" data not available

(4.) Maximum concentration followed in parentheses by the sample location.

(5.) USEPA Region IX Preliminary Remediation Goals (PRGs) are tools for evaluating and cleaning up contaminated sites. They are risk-based concentrations combining exposure information and EPA toxicity data for each environmental media; in this case, residential soil. PRGs should be viewed as Agency guidelines, not legally enforceable standards.

(6.) '*' - State of California modified PRG.

TABLE 2-5D
Chemicals Exceeding USEPA Region IX DAF 20 PRGs
Upper Vadose Zone Soil (2.5 - 35 feet bgs)

Chemical	USEPA PRG (unit indicated below)	Maximum Concentration Found in Upper Vadose Zone Soil
VOCs (µg/kg)		
1,1-Dichloroethene	60	400 (WWH-2, 25-25.5')
Acetone	16,000	19,000 (MW-16, 25-25.5')
Benzene	30	4,100 (MW-06, 25-25.5')
cis-1,2-Dichloroethene	400	3,300 (MW-18, 25-25.5')
Ethylbenzene	13,000	61,000 (GP-VS-10, 16-16.5')
Methylene Chloride	20	530 (MW-06, 25.5-26')
Tetrachloroethene	60	2,000 (GP-VS-06, 29-29.5')
Toluene	12,000	98,000 (GP-VS-10, 16-16.5')
Trichloroethene	60	3,300 (GP-VS-18, 32-32.5')
Vinyl Chloride	10	280 (MW-15, 25-25.5')
Xylenes (total)	210,000	430,000 (GP-VS-10, 16-16.5')
SVOCs (µg/kg)		
Benzo (a) anthracene	2,000	32,000 (GP-VS-09, 5-5.5')
Benzo (a) pyrene	8,000	27,000 (GP-VS-09, 5-5.5')
Benzo (b) fluoranthene	5,000	40,000 (GP-VS-09, 5-5.5')
Carbazole	600	1,900 (GP-VS-09, 5-5.5')
Dibenzo (a,h) anthracene	2,000	5,200 (GP-VS-09, 5-5.5')
Indeno (1,2,3-cd) pyrene	14,000	15,000 (GP-VS-09, 5-5.5')
Isophorone	500	630 (GP-VS-09, 34.5-35')
NHVOCs (µg/kg)		
Acetone	16,000	22,000 (RW-01, 25-25.5')
Metals (mg/kg)		
Arsenic	29	29.2 (MW-13, 34.5-35')
Chromium (total)	38	48.4 (MW-13, 34.5-35')

Notes:

(1.) 'µg/kg' - microgram per kilogram.

(2.) 'mg/kg' - milligram per kilogram.

(3.) Maximum concentration followed in parentheses by the sample location and depth.

(4.) USEPA Region IX Preliminary Remediation Goals (PRGs) are tools for evaluating and cleaning up contaminated sites. They are risk-based concentrations combining exposure information and EPA toxicity data for each environmental media; in this case, subsurface soil. PRGs should be viewed as Agency guidelines, not legally enforceable standards. PRGs are used to screen subsurface soil as a threat to groundwater. Dilution Attentuation Factor (DAF) 20 PRGs are used when the contaminated soil is not directly adjacent to a drinking water source and dilution of the contaminant is occurring before it reaches the drinking water source.

TABLE 2-5E
Chemicals Exceeding USEPA Region IX DAF 20 PRGs
Lower Vadose Zone Soil (35 - 65 feet bgs)

Chemical	USEPA PRG (unit indicated below)	Maximum Concentration Found in Lower Vadose Soil Zone
VOCs (µg/kg)		
Benzene	30	520 (MW-06, 54.5-55')
1,2-Dichloroethane	20	400 (MW-17, 55-55.5')
cis-1,2-Dichloroethene	400	730 (RW-01, 55-55.5')
Methylene chloride	20	450 (MW-18, 55-55.5')
Trichloroethene	60	2,100 (MW-17, 45-45.5')
Vinyl Chloride	10	22 (GP-VS-32, 39.5-40')
Metals (mg/kg)		
Chromium (total)	38	39.3 (MW-19, 65-65.5')

Notes:

(1) 'µg/kg' - microgram per kilogram.

(2) 'mg/kg' - milligram per kilogram.

(3) Maximum concentration followed in parentheses by the sample location and depth.

(4) USEPA Region IX Preliminary Remediation Goals (PRGs) are tools for evaluating and cleaning up contaminated sites. They are risk-based concentrations combining exposure information and EPA toxicity data for each environmental media; in this case, subsurface soil. PRGs should be viewed as Agency guidelines, not legally enforceable standards. PRGs are used to screen subsurface soil as a threat to groundwater. Dilution Attenuation Factor (DAF) 20 PRGs are used when the contaminated soil is not directly adjacent to a drinking water source and dilution of the contaminant is occurring before it reaches the drinking water source.

TABLE 2-5F
Chemicals Exceeding USEPA Region IX DAF 1 PRGs
Lower Vadose Zone Soil (> 50 feet bgs)

Chemical	USEPA PRG (unit indicated below)	Maximum Concentration Found in Lower Vadose Zone Soils > 50 feet bgs
VOCs (µg/kg)		
Benzene	2.0	520 (MW-06, 54.5-55')
1,2-Dichloroethane	1.0	400 (MW-17, 55-55.5')
cis-1,2-Dichloroethene	20	730 (RW-01, 55-55.5')
Methylene chloride	1.0	450 (MW-18, 55-55.5')
Trichloroethene	0.7	1,400 (MW-17, 55-55.5')
Metals (mg/kg)		
Antimony	0.3	1.5 (MW-11, 64.5-65')
Arsenic	1.0	24.58 (MW-14, 55-55.5')
Barium	82	337 (MW-18, 55-55.5')
Cadmium	0.4	0.52 (MW-05, 59.5-60')
Chromium (total)	2.0	39.3 (MW-19, 65-65.5')
Nickel	7.0	35.3 (MW-11, 64.5-65')

Notes:

(1.) 'µg/kg' - microgram per kilogram.

(2.) 'mg/kg' - milligram per kilogram.

(3.) Maximum concentration followed in parentheses by the sample location and depth.

(4.) USEPA Region IX Preliminary Remediation Goals (PRGs) are tools for evaluating and cleaning up contaminated sites. They are risk-based concentrations combining exposure information and EPA toxicity data.for each environmental media; in this case, subsurface soil. PRGs should be viewed as Agency guidelines, not legally enforceable standards. PRGs are used to screen subsurface soil as a threat to groundwater. Dilution Attenuation Factor (DAF) 1 PRGs assume that the contaminated soil is directly adjacent to a drinking water source and no dilution of the contaminant is occurring along the pathway between the source soil and the drinking water source.

TABLE 2-5G
Chemicals Exceeding USEPA PRGs and/or California MCLs for Drinking Water
Perched Groundwater Zone

Chemical	Primary MCL (µg/L)	USEPA PRG (µg/L)	Maximum Concentration Found in Perched Groundwater (µg/L)
VOCs			
1,1-Dichloroethane	5.0	810/0.2*	410 (B-01)
1,1-Dichloroethene	6.0	340	2,000 (B-01)
1,2-Dibromo-3-chloropropane	0.2	0.048/0.0016*	2 (B-38)
1,2-Dichloroethane	0.5	0.12	18 (B-27)
1,1,2-Trichloroethane	5.0	0.2	9 (SV-04)
Acetone	--	610	1,500 (B-22)
Benzene	1.0	0.34	1,600 (B-30)
Chloroform	--	0.53	41 (B-23)
Chloroethane	--	4.6	50 (B-21)
cis-1,2-Dichloroethene	6.0	61	780 (B-21)
Dibromochloromethane	--	0.13	2.4 (B-17)
Ethylbenzene	700	2.9	1200 (B-08)
Methyl tert-butyl Ether	13	13/6.2*	30 (B-04)
Tetrachloroethene	5.0	0.66	1,100 (B-01)
Toluene	150	720	2,000 (B-13)
trans-1,2-Dichloroethene	10	120	59 (B-21)
Trichloroethene	5.0	0.028	680 (B-22)
Vinyl Chloride	0.5	0.02	240 (B-08, B-21)
NHVOCs			
Acetonitrile (Coelute w/MIBK)	--	100	223 (B-13)
Acrylonitrile	--	0.039	340 (B-21)
Methyl isobutyl ketone (MIBK)	--	160	223 (B-13)
SVOCs			
1,4-Dioxane	3.0*	6.1	920 (B-01)
bis(2-Ethylhexyl)phthalate	--	4.8	11 (B-10)
Naphthalene	--	6.2	25 (B-04)
Metals			
Aluminum	1,000	36,000	52,700 (B-10)
Arsenic	50	0.045	676 (B-10)
Chromium (total)	50	--	72 (B-10)
Iron	--	11,000	377,000 (B-10)
Lead	15*	--	115 (B-25)
Manganese	--	880	4,130 (B-20)
Selenium	50	180	279 (B-25)
Thallium	2.0	2.4	55.5 (B-10)

Notes:

(1.) ' µg/L' - microgram per liter.

(2.) "--" data not available

(3.) Maximum concentration followed in parentheses by the sample location.

(4.) USEPA Region IX Preliminary Remediation Goals (PRGs) are tools for evaluating and cleaning up contaminated sites. They are risk-based concentrations combining exposure information and EPA toxicity data for each environmental media; in this case, groundwater. PRGs should be viewed as Agency guidelines, not legally enforceable standards.

(5.) State of California Maximum Contaminant Levels (MCLs) are legally enforceable drinking water standards. These MCL levels are primarily risk-based levels similar to PRGs where it is assumed that a person will drink water with the specified chemical concentrations.

(6.) '*' - State of California Action Level, no available MCL.

TABLE 2-5H
Chemicals Exceeding USEPA PRGs and/or California MCLs for Drinking Water
Exposition Groundwater Zones

Chemical	Primary MCL (µg/L)	USEPA PRG (µg/L)	Maximum Concentration Found in Exposition Groundwater (µg/L)
VOCs			
1,1-Dichloroethene	6.0	340	30 (MW-17-85)
1,2-Dibromo-3-chloropropane	0.2	0.048/0.0016*	5 (MW-12-70, MW-12-90)
1,2-Dichloroethane	0.5	0.12	0.4 (MW-13-85)
Acetone	--	610	20,000 (MW-09-85)
Benzene	1.0	0.34	1,600 (MW-06-85)
Chloroform	--	6.2/0.53*	36 (MW-05-85)
cis-1,2-Dichloroethene	6.0	61	14,000 (MW-17-85)
Dibromochloromethane	--	0.13	16 (MW-03-85)
Methylene Chloride	5.0	4.3	6 (MW-10-175)
Methyl tert-butyl Ether	13	13/6.2*	30 (B-04)
Tetrachloroethene	5.0	0.66	8.1 (MW-03-85)
trans-1,2-Dichloroethene	10	120	53 (MW-17-70)
Trichloroethene	5.0	0.028	22,000 (MW-17-70)
Vinyl Chloride	0.5	0.02	780 (MW-18-85)
NHVOCs			
Acetone *(different analytical method)*	--	610	8,620 (MW-17-85)
Metals			
Aluminum	1,000	36,000	4,020 (MW-02-95)
Arsenic	50	0.045	52.7 (MW-10-110)
Manganese	--	880	1,410 (MW-09-85)
Thallium	2.0	2.4	7.4 (MW-03-85)
Anions			
Sulfide	--	110^{+}	9,500 (MW-09-85)

Notes:

(1.) ' µg/L' - microgram per liter.

(2.) "--" data not available

(3.) Maximum concentration followed in parentheses by the sample location.

(4.) USEPA Region IX Preliminary Remediation Goals (PRGs) are tools for evaluating and cleaning up contaminated sites. They are risk-based concentrations combining exposure information and EPA toxicity data for each environmental media; in this case, groundwater. PRGs should be viewed as Agency guidelines, not legally enforceable standards.

(5.) State of California Maximum Contaminant Levels (MCLs) are legally enforceable drinking water standards. These MCL levels are risk-based levels similar to PRGs where it is assumed that a person will drink water with the specified chemical concentrations.

(6.) '*' - California modified PRG.

(7.) '+' 110 µg/L is the PRG for hydrogen sulfide.

TABLE 2-6
Summary of Zone 'A' and 'B' Aquifer Properties

Aquifer Zone	Well ID	Test Type	Slug Volume (gal)	Initial Displace-ment	Pumping Rate (Q) (gpm)	Aquifer Thickness (b) (feet)	Solution Method [Aqtesolv]	Trans-missivity (T) (ft2/min)	Storage Coefficient (S) (unitless)	Hydraulic Conductivity (K) (ft/min)	Downgradient Radius of Capture (feet)	Crossgradient Width of Capture (feet)	Seepage Velocity (ft/year)
A Zone	MW-14-80	Slug - Withdrawal	1.844	2.988	NA	1	Bouwer-Rice	1.303E-03	NA	1.303E-03	---	---	6.3
	MW-15-70	Slug - Withdrawal	1.396	0.615	NA	3	Bouwer-Rice	6.831E-03	NA	2.277E-03	---	---	11.0
	MW-16-70	Slug - Withdrawal	1.102	0.920	NA	1	Bouwer-Rice	8.281E-04	NA	8.281E-04	---	---	4.0
	MW-18-70	Slug - Withdrawal	1.094	1.237	NA	1	Bouwer-Rice	1.435E-03	NA	1.435E-03	---	---	6.9
A + B Zone	MW-3 A + B	Pumping	NA	NA	1.137	4.5	Hantush, 1960	1.466E-01	2.926E-04	3.258E-02	29.2	91.8	177.8
		Recovery	NA	NA	1.137	4.5	Hantush, 1960	1.104E-01	7.531E-04	2.453E-02	38.8	121.8	133.9
B_1 Zone	MW-2	Pumping	NA	NA	1.137	5	Hantush, 1960	9.690E-02	1.647E-05	1.938E-02	44.2	138.8	117.9
		Recovery	NA	NA	1.137	5	Hantush, 1960	1.053E-01	9.832E-04	2.106E-02	40.7	127.7	128.1
	MW-14-90	Slug - Withdrawal	1.847	2.480	NA	5	Bouwer-Rice	5.390E-03	NA	1.078E-03	---	---	6.6
		Pumping	NA	NA	1.137	5	Hantush, 1960	1.276E-01	4.393E-07	2.552E-02	37.9	119.1	155.2
		Recovery	NA	NA	1.137	5	Hantush, 1960	1.489E-01	3.606E-05	2.978E-02	32.5	102.1	181.1
	MW-15-85	Pumping	NA	NA	1.137	5	Hantush, 1960	8.090E-02	1.020E-10	1.618E-02	59.8	187.9	98.4
		Recovery	NA	NA	1.137	5	Hantush, 1960	6.820E-02	6.450E-06	1.364E-02	70.9	222.9	83.0
	MW-16-85	Pumping	NA	NA	1.137	5	Hantush, 1960	7.630E-02	2.672E-08	1.526E-02	63.4	199.2	92.8
		Recovery	NA	NA	1.137	5	Hantush, 1960	8.150E-02	2.890E-07	1.630E-02	59.4	186.5	99.1
	MW-17-85	Pumping	NA	NA	1.137	2.5	Hantush, 1960	1.938E-01	1.000E-10	7.752E-02	25.0	78.4	471.5
		Recovery	NA	NA	1.137	2.5	Hantush, 1960	1.570E-01	1.272E-10	6.280E-02	30.8	96.8	382.0
	MW-18-85	Pumping	NA	NA	1.137	1	Hantush, 1960	1.046E-01	1.767E-01	1.046E-01	46.3	145.3	636.2
		Recovery	NA	NA	1.137	1	Hantush, 1960	7.197E-02	1.322E-05	7.197E-02	67.2	211.2	437.8
	MW-19-85	Pumping	NA	NA	1.137	4.5	Hantush, 1960	1.884E-01	1.000E-10	4.187E-02	25.7	80.7	254.7
		Recovery	NA	NA	1.137	4.5	Hantush, 1960	1.050E-01	9.417E-11	2.333E-02	46.1	144.8	141.9
B_2 Zone	MW-17-95	Pumping	NA	NA	1.137	1	Hantush, 1960	6.691E-03	2.005E-01	6.691E-03	723.1	2271.7	40.7
		Recovery	NA	NA	1.137	1	Hantush, 1960	6.560E-03	1.703E-02	6.560E-03	737.5	2317.1	39.9
B_1 + B_2	RW-1	Recovery	NA	NA	1.137	9	Hantush-Jacob	2.766E-02	1.232E-03	3.073E-03	174.9	549.6	18.7

Notes:
1. Pumping rate is average for entire pumping duration.
2. Aquifer thickness assumed to be actual logged thickness adjacent to corresponding screened intervals.
3. Bouwer-Rice = Bouwer and Rice (1976) developed an empirical relationship for calculating hydraulic conductivity due to an instantaneous change in water level.
4. Hantush, 1960 = Analytical solution for pumping from a leaky aquifer system, assuming storage in the aquitard(s).
5. Transmissivity was calculated by AQTESOLV. The results can be obtained in TN&A 2002, Tech Memo: Results of Aquifer Tests Performed on the Exposition 'A' and 'B' Groundwater Zones.
6. Hydraulic conductivity K was calculated by the equation K=T/b, where 'T' is transmissivity and 'b' is aquifer thickness.
7. Downgradient radius of capture (stagnation point) and Crossgradient width of capture (upgradient width) were calculated by Grubb's WELLCALC.
8. NA = Not Applicable.

TABLE 2-7
Summary Ranges and Averages of Numeric Aquifer Properties for Zone 'A' and 'B'

		Aquifer Thickness (b) (feet)	Transmissivity (T) (ft2/min) (AQTESOLV)	Hydraulic Conductivity (K) (ft/min)	Downgradient Radius of Capture (ft)	Crossgradient Width of Capture (ft)	Seepage Velocity (ft/year)
A Zone	Minimum	1.0	8.281E-04	8.281E-04	---	---	4.00
	Maximum	3.0	6.831E-03	2.277E-03	---	---	11.00
	Average	**1.5**	**2.599E-03**	**1.461E-03**	**---**	**---**	**7.06**
B_1 Zone	Minimum	1.0	5.390E-03	1.078E-03	24.97	78.43	6.56
	Maximum	5.0	1.938E-01	1.046E-01	70.94	222.87	636.22
	Average	**4.1**	**1.155E-01**	**3.343E-02**	**46.43**	**145.86**	**203.35**
B_2 Zone	**Average**	**1.0**	**6.626E-03**	**6.626E-03**	**730.33**	**2294.39**	**40.30**
B Zone	Minimum	1.0	5.390E-03	1.078E-03	24.97	78.43	6.56
	Maximum	9.0	1.938E-01	1.046E-01	737.55	2317.07	636.22
	Average	**4.0**	**9.642E-02**	**2.818E-02**	**139.95**	**439.66**	**171.42**
A+B Zone	Minimum	---	8.281E-04	8.281E-04	---	---	---
	Maximum	---	1.938E-01	1.046E-01	---	---	---
	Average	**---**	**9.007E-02**	**2.504E-02**	**123.86**	**389.13**	**150.24**

Note:

1. The average calculations for B_1 Zone were performed without the "slug test" values and outliers.
2. The average calculation for A+B Zone were performed without outliers.
3. Downgradient radius of capture (stagnation point) per aquifer zone is averaged from individual pumping and recovery well radius of capture calculations. These calculations are based on the individual recovery and pumping well aquifer thicknesses and transmissivities calculated by AQTESOLV™ (refer to TN&A 2001, Tech Memo - Results of Aquifer Tests Performed on the Exposition 'A' and 'B' Groundwater Zones, December 2001). The individual well aquifer properties and calculated radius of capture are calculated by Grubb's WELLCALC and shown in Table 2-6.

4. Aquifer properties based on AQTESOLV™ modeling from well RW-1 data should be considered representative of the B zone since well RW-1 penetrates both the "B_1" and "B_2" Zones, is the greatest thickness (9-feet) compared to other test wells, and most closely matches the Remedial Design extraction/pumping wells (6 in diameter, fully penetrating). Note that all other test wells are 2 in, and not fully penetrating. Based on the aquifer properties calculated by AQTESOLV™, the calculated downgradient radius of capture and crossgradient width of capture (using Grubb's WELLCALC) is significantly greater in well RW-1 than the averaged downgradient width of capture and crossgradient width of capture in the B_1 zone by a factor of 3.77. Since the aquifer properties based on the recovery data from RW-1 were significantly greater than the averaged values in the B_1 zone, downgradient radius of capture and crossgradient width of capture at the site will likely be substantially greater than B_1 zone averaged values. Therefore, using the averaged downgradient radius of capture and crossgradient width of capture in B_1 zone is the most conservative value.

5. Attempt to model 'A' zone using Grubb's WELLCALC resulted in an unreasonable outcome (stagnation point 285 ft, upgradient width 894 ft). The occurrence of unreasonable results primarily due to aquifer dewatering.

TABLE 2-8
Summary of Zones 'C' and 'D' Aquifer Properties

Aquifer Zone	Well ID (screen)	Test Type	Slug Volume (gal)	Initial Displace-ment	Pumping Rate (Q)[1] (gpm)	Aquifer Thickness[2] (b) (feet)	Solution Method	Trans-missivity[3] (T) (ft2/min)	Hydraulic Conductivity[4] (K) (ft/min)	Downgradient Radius of Capture (feet)	Crossgradient Width of Capture (feet)
"C" Zone	MW-05-105	NA	NA	NA	1.1	4	Darcy's Law	1.229E-02	3.073E-03	105.8	332.30
"C" Zone	MW-10-110	NA	NA	NA	1.1	5.5	Darcy's Law	1.690E-02	3.073E-03	76.9	241.68
"C" Zone	MW-11-100	NA	NA	NA	1.1	5	Darcy's Law	1.537E-02	3.073E-03	84.6	265.84
"C" Zone	MW-23-110	NA	NA	NA	1.1	9.5	Darcy's Law	2.919E-02	3.073E-03	44.5	139.92
"C" Zone	MW-24-110	NA	NA	NA	1.1	5	Darcy's Law	1.537E-02	3.073E-03	84.6	265.84
"C" Zone	MW-25-110	NA	NA	NA	1.1	5	Darcy's Law	1.537E-02	3.073E-03	84.6	265.84
"D" Zone	MW-05-135	NA	NA	NA	1.1	11	Darcy's Law	3.380E-02	3.073E-03	407.3	1279.46
"D" Zone	MW-07-130	NA	NA	NA	1.1	12.5	Darcy's Law	3.841E-02	3.073E-03	358.4	1125.92
"D" Zone	MW-12-150	NA	NA	NA	1.1	12	Darcy's Law	3.688E-02	3.073E-03	373.3	1172.84
"D" Zone	MW-23-145	NA	NA	NA	1.1	12	Darcy's Law	3.688E-02	3.073E-03	373.3	1172.84
"D" Zone	MW-24-140	NA	NA	NA	1.1	10	Darcy's Law	3.073E-02	3.073E-03	448.0	1407.41
"D" Zone	MW-25-130	NA	NA	NA	1.1	10	Darcy's Law	3.073E-02	3.073E-03	448.0	1407.41

Notes:

1. A pumping rate of 1.1 gallons per minute (gpm) was used based on the section 3.6.2 Average Groundwater Extraction Rate performed on the Exposition ‘D’ Zone.
2. Aquifer thickness assumed to be actual logged thickness adjacent to corresponding screened intervals.
3. No aquifer tests have been performed on the Exposition ‘C’ and ‘D’ Zones and thus no drawdown or recovery curves were available to estimate transmissivity. Therefore, capture zones were estimated by estimated hydraulic conductivity for each zone utilizing observed aquifer thicknesses and calculated hydraulic gradients.
4. Use the hydraulic conductivity for Well RW-1 as the estimated hydraulic conductivity for the Exposition 'C' and ‘D’ Zone, due to their similar aquifer properties.
5. NA = Not Applicable.

TABLE 2-9
Summary Ranges and Averages of Numeric Aquifer Properties for Zone 'C' and 'D'

		Aquifer Thickness (b) (feet)	Transmissivity (T) (ft2/min)	Hydraulic Conductivity (K) (ft/min)	Downgradient Radius of Capture (ft)	Crossgradient Width of Capture (ft)
C Zone	Minimum	4.0	1.229E-02	NA	44.5	139.9
	Maximum	9.5	2.919E-02	NA	105.8	332.3
	Average	**5.7**	**1.700E-02**	**3.073E-03**	**80.2**	**251.9**
D Zone	Minimum	10.0	3.073E-02	NA	373.3	1125.9
	Maximum	12.5	3.841E-02	NA	448.0	1407.4
	Average	**11.3**	**3.500E-02**	**3.073E-03**	**401.4**	**1261.0**
C and D	**Average**	**8.5**	**2.600E-02**	**3.073E-03**	**240.8**	**756.4**

Note:

1. NA = Not Applicable
2. Downgradient radius of capture (stagnation point) and crossgradient width of capture (upgradient width) per aquifer zone is averaged from individual pumping and recovery well radius of capture calculations. These calculations are based on the individual recovery and pumping well aquifer thicknesses and transmissivities calculated by stagnation point and upgradient width equations (Todd, 1980).

TABLE 4-1
HVDPE Pilot Test Results - VOC Removal Rates

SVE Pilot Test Well & Date	Parameter	VOC Conc.[1] (ppmv)	Molecular Weight of Parameter (gram/ mole)	Ideal Gas Law[2] (L/mole)	Convert from L to c.f.	Convert from grams to lbs	Calculate (lbs/c.f.)	Flow Rate Per Well[1] (cfm)	Flow Rate (c.f./day)	Individual VOC Removal Rate (lbs/day)	Total Cumulative VOC Removed Per Well Per Day (lbs/day)
Sample # SV-01											
Perched GW	t-1, 2-Dichloroethene	0.0570	96.94	24.64	28.3	453.5	1.4E-08	68	97,920	0.001	0.001
Day 1	1,1-Dichloroethane	0.0400	98.96	24.64	28.3	453.5	1.003E-08	68	97,920	0.001	0.002
12/9/2002	c-1,2-Dichloroethene	0.0580	96.94	24.64	28.3	453.5	1.424E-08	68	97,920	0.001	0.004
	1,1,1-Trichloroethane	0.0230	133.40	24.64	28.3	453.5	7.773E-09	68	97,920	0.001	0.005
	Benzene	0.0130	78.11	24.64	28.3	453.5	2.573E-09	68	97,920	0.000	0.005
	Toluene	0.0100	92.13	24.64	28.3	453.5	2.334E-09	68	97,920	0.000	0.005
	Trichloroethene	0.0180	131.39	24.64	28.3	453.5	5.992E-09	68	97,920	0.001	0.006
	Tetrachloroethene	0.2000	165.83	24.64	28.3	453.5	8.402E-08	68	97,920	0.008	0.014
	Ethylbenzene	0.0370	106.17	24.64	28.3	453.5	9.952E-09	68	97,920	0.001	0.015
	p/m-Xylene	0.0210	106.17	24.64	28.3	453.5	5.648E-09	68	97,920	0.001	0.015
	o-Xylene	0.0066	106.17	24.64	28.3	453.5	1.775E-09	68	97,920	0.000	0.016
	1,2,4-Trimethylbenzene	0.0032	120.19	24.64	28.3	453.5	9.744E-10	68	97,920	0.000	0.016
	MTBE	0.0190	88.15	24.64	28.3	453.5	4.243E-09	68	97,920	0.000	**0.016**
Sample # SV-01											
Perched GW	Vinyl Chloride	0.0160	62.50	24.64	28.3	453.5	2.533E-09	68	97,920	0.00025	0.000
Day 2	Acetone	0.0120	161.00	24.64	28.3	453.5	4.895E-09	68	97,920	0.00048	0.001
12/11/2002	1,1-Dichloroethene	0.0057	96.94	24.64	28.3	453.5	1.4E-09	68	97,920	0.00014	0.001
	1,1-Dichloroethane	0.0160	98.96	24.64	28.3	453.5	4.011E-09	68	97,920	0.00039	0.001
	c-1,2-Dichloroethene	0.0230	96.94	24.64	28.3	453.5	5.649E-09	68	97,920	0.00055	0.002
	1,1,1-Trichloroethane	0.0170	133.40	24.64	28.3	453.5	5.746E-09	68	97,920	0.00056	0.002
	Benzene	0.0057	78.11	24.64	28.3	453.5	1.128E-09	68	97,920	0.00011	0.002
	Toluene	0.0170	92.13	24.64	28.3	453.5	3.968E-09	68	97,920	0.00039	0.003
	Trichloroethene	0.0088	131.39	24.64	28.3	453.5	2.929E-09	68	97,920	0.00029	0.003
	Tetrachloroethene	0.1000	165.83	24.64	28.3	453.5	4.201E-08	68	97,920	0.00411	0.007
	Ethylbenzene	0.1000	106.17	24.64	28.3	453.5	2.69E-08	68	97,920	0.00263	0.010
	p/m-Xylene	0.1400	106.17	24.64	28.3	453.5	3.766E-08	68	97,920	0.00369	0.014
	o-Xylene	0.0460	106.17	24.64	28.3	453.5	1.237E-08	68	97,920	0.00121	0.015
	1,2,4-Trimethylbenzene	0.0065	120.19	24.64	28.3	453.5	1.979E-09	68	97,920	0.00019	**0.015**
Sample # RW-01-70											
A Zone	Vinyl Chloride	29.0000	62.50	24.82	28.3	453.5	4.558E-06	82	118,080	0.538	0.538
1-Day Test	1,1-Dichloroethene	3.4000	96.94	24.82	28.3	453.5	8.289E-07	82	118,080	0.098	0.636
12/11/2002	Carbon Disulfide	0.9600	76.13	24.82	28.3	453.5	1.838E-07	82	118,080	0.022	0.658
	t-1,2-Dichloroethene	4.8000	96.94	24.82	28.3	453.5	1.17E-06	82	118,080	0.138	0.796
	c-1,2-Dichloroethene	83.0000	96.94	24.82	28.3	453.5	2.024E-05	82	118,080	2.389	3.186
	Toulene	0.8700	92.13	24.82	28.3	453.5	2.016E-07	82	118,080	0.024	3.209
	Trichloroethene	190.0000	131.39	24.82	28.3	453.5	6.279E-05	82	118,080	7.414	10.623
	Tetrachloroethene	0.9400	165.83	24.82	28.3	453.5	3.92E-07	82	118,080	0.046	10.669
	Hexachloro-1,3-Butadiene	0.2900	260.76	24.82	28.3	453.5	1.902E-07	82	118,080	0.022	**10.692**
Sample # RW-01-95											
B Zone	Acetone	0.0077	58.08	24.05	28.3	453.5	1.161E-09	15	21,600	0.000	0.000
1-Day Test	Carbon Disulfide	0.0022	76.13	24.05	28.3	453.5	4.348E-10	15	21,600	0.000	0.000
12/11/2002	c-1,2-Dichloroethene	0.014	96.94	24.05	28.3	453.5	3.523E-09	15	21,600	0.000	0.000
	Toluene	0.0034	92.13	24.05	28.3	453.5	8.131E-10	15	21,600	0.000	0.000
	Trichloroethene	0.089	131.39	24.05	28.3	453.5	3.035E-08	15	21,600	0.001	0.001
	Ethylbenzene	0.0045	106.17	24.05	28.3	453.5	1.24E-09	15	21,600	0.000	0.001
	p/m-Xylene	0.022	106.17	24.05	28.3	453.5	6.063E-09	15	21,600	0.000	0.001
	o-Xylene	0.0067	106.17	24.05	28.3	453.5	1.846E-09	15	21,600	0.000	**0.001**
Totals		**314**									
CALCULATED AVERAGE INFLUENT CONCENTRATIONS FROM 4 WELLS		163.00	107.32	24.05	28.3	453.5	4.541E-05	58	83,880	**3.81**	

Notes:

1 - VOC concentrations and air flow rates were measured during pilot study.

2 - Volume of one mole of inert gas at 81, 85, and 69 (degrees F) for the Perched, A, and B Zones, respectively, at atmospheric pressure.

TABLE 4-2
HVDPE System Design Summary For The Upper Vadose And Perched Groundwater Zone

VAPOR EXTRACTION DESIGN WORKSHEET

Application	Design No. of Wells in Perched Zone[1]	No. of Wells Simultaneously On-Line in Perched Zone[2]	Measured VOC Removed Per Well (lbs./Day)[3]	Measured Air Flow Per Well (acfm)[3]	Design Air Flow Per Well (scfm)[4]	Design Total Air Flow (scfm)[4]	Estimated Total VOC Removed Per Day (lbs./Day)[5]	Comments
Upper Vadose and Perched Zone	27	27	0.0160	68	10	270	0.43	Pilot test was performed on SVE-01 which was located in the perched zone outside the area of highest VOC concentration.
Totals						**270**	**4.32**	Total estimated VOC influent conc. = 5.1 ppmv.[5]

Notes:
1. Based on ROI of 54 feet, to provide overlapping coverage to the MCL throughout perched zone.
2. SVE system design can extract from all wells at 30 scfm; or extract from wells in cycles with 50% of the wells on-line (at 68 scfm) per extraction event, depending on influent concentrations.
3. Indicates data from the pilot study.
4. The Design Air Flow is based on information included in Section 4.2 of the Design Report.
5. Since pilot test was not performed in the area of highest concentration, the Estimated Total VOCs Removed Per Day and influent concentration was increased by 1 order of magnitude. Remediation of VOCs is in progress at the adjacent W.W. Henry Site. Wells in the vicinity of the W.W. Henry property may contribute significant amounts of additional VOCs depending on when the Pemaco remedial action is implemented.

VAPOR PHASE MASS REMOVAL AND CARBON USAGE WORKSHEET

Item	First Year Removal	Second Year Removal	Third Year Removal	Fourth Year Removal	Fifth Year Removal	Totals	Comments
Percent of Total Mass Removed	60%	25%	10%	4%	1%	100%	Percent removed distribution is based on T N & Associates experience with similar remediation projects.
VOC Removal Rate (lbs/day)	4.32	2.10	0.80	0.30	0.05	NA	The first year removal rate was determined from the above table.
Estimated VOC Mass Removed (lbs/yr)	1,577	767	292	110	18	**2,763**	Total mass considered for vapor phase carbon absorbtion from Upper Vadose/Perched Zone is based on 2,763 lbs.
Carbon Usage (lbs)	22,520*	7,665	2,920	1,095	183	34,383	Assumed vapor phase carbon retention factor = 10% for TCE.

Notes:
1. A five year project duration is estimated based on the conceptual design for HVDPE.
2. Under the electrical resistive heating scenario, significantly more mass would be removed depending on ERH Design, to be submitted under separate cover.
3. Remediation of VOCs is in progress at the adjacent W.W. Henry Site. Wells in the vicinity of the W.W. Henry property may contribute significant amounts of additional VOCs, resulting in additional carbon demand, depending on when the Pemaco remedial action is implemented.

* Based on the uncertainty discussed in Note 3, a contingency of 5,000 lbs of carbon has been added to the first year removal column.

TABLE 4-3
Calculation of Average "Source Area" and "Containment Area" Groundwater Concentrations

'A' ZONE SOURCE AREA REPRESENTATIVE WELLS

Well ID:		MW-17-70	MW-18-70	MW-19-70	AVG
Zone:		A	A	A	VOC CONC.
Collection Date:		12/5/2001	1/22/2002	12/6/2001	
Parameter	**Units**				**µg/L**
Benzene, Toluene, Ethylbenzene, and Total Xylenes (BTEX)	µg/L	4.32	0	0	1.44
1,1,1-Trichloroethane	µg/L	0	0	0	0
1,1-Dichloroethane	µg/L	1.3	0	0	0.43
1,1-Dichloroethene	µg/L	9.5	0	0	3.17
1,2-Dichloroethane	µg/L	0	0	0	0
Carbon Tetrachloride	µg/L	0	0	0	0
Chloroethane	µg/L	0	0	0	0
Chloroform	µg/L	5.1	0	0	1.70
cis-1,2-Dichloroethene	µg/L	330	1,600	85	671.67
Tetrachloroethene	µg/L	9.1	0	0	3.03
trans-1,2-Dichloroethene	µg/L	23	15	0	12.67
Trichloroethene	µg/L	27,000	3,400	5,000	11,800
Vinyl Chloride	µg/L	27	0	0	9
TOTAL & AVG VOCs	µg/L	**27,409.32**	**5,015**	**5,085**	**12,503.11**

'B' ZONE SOURCE AREA REPRESENTATIVE WELLS

Well ID:		MW-02-95	MW-13-85	MW-14-90	MW-17-85	MW-18-85	MW-19-90	AVG
Zone:		B	B	B	B	B	B	VOC CONC.
Collection Date:		1/15/2002	1/15/2002	11/28/2001	12/14/2001	1/22/2002	12/6/2001	
Parameter	**Units**							**µg/L**
Benzene, Toluene, Ethylbenzene, and Total Xylenes (BTEX)	µg/L	0	0.59	0	0	0	1.2	0.30
1,1,1-Trichloroethane	µg/L	0	0	0	0	0	0	0
1,1-Dichloroethane	µg/L	0	0	0.95	0	0	1.8	0.46
1,1-Dichloroethene	µg/L	2.9	0	3.6	0	12	2.3	3.47
1,2-Dichloroethane	µg/L	0	0	0	0	0	0	0
Carbon Tetrachloride	µg/L	0	0	0	0	0	0	0
Chloroethane	µg/L	0	0	0	0	0	0	0
Chloroform	µg/L	0	0	0.63	0	0	5.7	1.06
cis-1,2-Dichloroethene	µg/L	120	4.8	43	0	2,400	59	437.80
Methylene Chloride	µg/L	0	0	0	0	0	0	0
Tetrachloroethene	µg/L	0	0	2	0	0	1.8	0.63
trans-1,2-Dichloroethene	µg/L	4	0	3	0	0	1.8	1.47
Trichloroethene	µg/L	3,800.00	46	4,700	21,000	2,400	2,000	5,657.67
Vinyl Chloride	µg/L	5.4	0	0	0	780	3.6	131.50
TOTAL & AVG VOCs	µg/L	**3,932.30**	**51.39**	**4,753.18**	**21,000**	**5,592**	**2,077.20**	**6,234.35**

'A' and 'B' ZONE CONTAINMENT AREA REPRESENTATIVE WELLS

Well ID:		MW-07-75	MW-09-70	MW-09-85	MW-13-85	AVG
Zone:		A	A	B	B	VOC CONC.
Parameter	**Units**					**µg/L**
Benzene, Toluene, Ethylbenzene, and Total Xylenes (BTEX)	µg/L	0	0	0.1	0.5	0.15
Perchloroethene	µg/L	0	0	0.3	0.2	0.13
Trichloroethene	µg/L	2	0.25	52	60	28.56
cis-1,2-Dichloroethene	µg/L	0.9	0.25	8	9	4.54
trans-1,2-Dichloroethene	µg/L	0	0	0	0	0
1,1-Dichloroethene	µg/L	0	0	0	0	0
Vinyl chloride	µg/L	0.25	0.25	0.25	0.25	0.25
Ethane	µg/L	0	0	0	0	0
Ethene	µg/L	0	0	0	0	0
1,1,1-Trichloroethane	µg/L	0	0	0	0	0
1,1-Dichloroethane	µg/L	0	0	0.3	0.5	0.20
1,2-Dichloroethane	µg/L	0	0	0	0	0
Carbon Tetrachloride	µg/L	0	0	0	0	0
Chloroethane	µg/L	0	0	0	0	0
Chloroform	µg/L	0	0	7	0.3	1.83
TOTAL & AVG VOCs	µg/L	**3.15**	**0.75**	**67.95**	**70.75**	**35.65**

	AVERAGE CONC. (µg/L)	**AVERAGE DEPTH** (FEET BGS)
ZONE 'A'	12,503.11	70
ZONE 'B'	6,234.35	85
ZONE 'A' AND 'B'	35.65	77.5

TABLE 4-4

Summary of Groundwater Extraction Design and Mass Removal

Item	Source Area Wells				Containment Area Wells			All Wells
	A Zone[1]	B Zone[2]	D Zone[3]	Totals Source Area	A & B Zone[4]	D Zone[3]	Totals Containment Area	Totals of Source and Containment
Design No. of Wells[5]	12	12	1	25	8	0	8	33
Total avg. VOC Conc. (ug/L)	12,503	6,234	100	7,950	36	0	36	5,488
Avg. Pumping Rate Per Well[6] (gpm)	1.1	2.5	1.1	NA	2.5	0	2.5	NA
Total Avg. Flow (gpm)	13.2	30.0	1.1	44.3	20	0	20	64.3
Daily Flow (gpd)	19,008	43,200	1,584	63,792	28,800	0	28,800	92,592
Initial Daily VOC Removal (lbs/day)	1.98	2.25	0.001	4.23	0.01	0	0.009	4.24

1 - Average VOC concentration calculated from wells MW-18-70, MW-17-70, and MW 19-70.
2 - Average VOC concentration calculated from wells MW-02-95, MW-13-85, MW-14-90, MW-17-85, and MW-19-90.
3 - The Avg. VOC concentration in the D Zone was estimated based on plume concentration identified in Figure 4-3 of the Design Report
4 - Average VOC concentration calculated from wells MW-07-75, MW-09-70, MW-09-85, and MW-13-85.
Containment wells will be screened through A and B zones (not C zone), all other wells screened in respective zone, as indicated.
5 - No. of wells based on 45-foot width of capture along downgradient axis and 69-foot width of capture along the crossgradient axis; to provide hydraulic control of the plume area.
6 - Avg. pumping rate per well is a probable maximum flow rate based on pump tests and field observations.
7 - Mass removal is expected to increase by 1 to 2 orders of magnitude when ERH is started.

TABLE 4-5

Groundwater Mass Removal Rate and Liquid Phase Carbon Usage Worksheet

Item	First Year	Second Year	Third Year	Fourth Year	Fifth Year	Totals	Comments
Percent of Total Mass Removed - Yearly Basis	45%	22%	15%	11%	7%	100%	
VOC Removal Rate (lbs/day)	4.24	2.04	1.36	1.02	0.68	NA	Refer to Summary of Groundwater Extraction Design and Mass Removal Table that shows average groundwater conentrations measured in representative wells in 'A' and 'B' zones.
Estimated VOC Mass Removed (lbs/yr)	1,548	745	496	372	248	3,409	The total estimated mass considered for the ex-situ treatment alternatives is 3,409 lbs.
Carbon Usage (lbs)	112,964	54,350	36,234	27,175	18,117	248,839	Assumed liquid phase carbon adsorption capacity is 1.37% w/w for VOC compounds (excluding Vinyl Chloride).

Notes:

1. The assumed liquid-phase carbon usage of 1.37% (73 lb. of carbon per 1 lb of VOCs) is based carbon consumption calculations performed by Baker Filtration, Inc.
2. The 1.37% carbon adsorption capacity used to determine carbon usage in this table is a conservative value, based on the results of Remediation System Evaluation (April 18-19, 2001 Final Report), conducted at the Baird and McGuire Superfund Site, the average liquid-phase carbon adsorption capacity was 3.5%.
3. Vinyl chloride is expected to pass through carbon at trace level concentrations significantly below the 1,000 ppb total VOC LACSD sewer limit. Based on a composite sample from the A&B source zone collected for the advanced oxidation water treatment bench test, the vinyl chloride concentrations were below 6 ppb.
2. Concentrations 1 to 2 orders of magnitude greater may result from ERH operation.

TABLE 4-6

Vapor Extraction System Design Summary for Lower Vadose Soil and Exposition Groundwater Remediation Zone

VAPOR PHASE MASS REMOVAL FROM GROUNDWATER ESTIMATE

Application	Design Number of Vacuum Wells in Lower Vadose and Exposition Groundwater	Number of Wells Simultaneously On-Line	Average 'A' and 'B' Zone Measured VOC Removed Per Well, (lbs/day)	Average 'A' and 'B' Zone Measured Air Flow Per Well (cfm)	Design Air Flow Per Well (scfm)	Design Total Air Flow (scfm)	Estimated Total VOC Removed Per Day (lbs/day)	Comments
Lower Vadose and Exposition Groundwater	32	32	4.0	48.5	7	224	128.4	Pilot test was performed on source area wells RW-01-70 in the 'A' Zone and RW-01-95 in the 'B' Zone.

Notes:
1. Average per-well 'A' and 'B' zone air flow is based on HVDPE extraction rates from HVDPE Pilot Study (see Table 4.3)
2. Mass removal rate measured during the 1-day HVDPE Pilot Test (December 2002). Per-well VOC mass removal is an average adjusted by -25% for concentration spike observed on first day of operation.
3. Per-well mass removal estimate is based on average mass removed from 'A' and 'B' zones during the pilot test.

lbs - pounds
lbs/day - pounds per day
scfm - standard cubic feet per minute

VAPOR PHASE MASS REMOVAL FROM GROUNDWATER AND CARBON USAGE WORKSHEET

Item	First Year Removal	Second Year Removal	Third Year Removal	Fourth Year Removal	Fifth Year Removal	Totals	Comments
Percent of Total Mass Removed - Yearly Basis	54%	21%	11%	8%	6%	100%	Columns with multiple year periods were multiplied by the number of years in the period in order to equal 100%.
VOC Removal Rate (lbs/day)	128.4	50.0	25.0	20.0	15.0	NA	The first year removal rate was determined from the Mass Removal Estimate Worksheet (above).
Estimated VOC Mass Removed (lbs/yr)	46,866	18,250	9,125	7,300	5,475	87,016	Total mass considered for vapor phase carbon adsorbtion from 35 to 100 feet bgs is based on 87,016 lbs.
Carbon Usage (lbs)	468,660	182,500	91,250	73,000	54,750	870,160	Assumed vapor phase carbon retention factor equals 10% for TCE.

Notes:
1. Refer the Conceptual Designs for additional notes and assumptions.
2. Wells in the vicinity of the W.W. Henry property may contribute significant amounts of additional VOCs, resulting in additional carbon demand, depending on when the Pemaco remedial action is implemented

TABLE 4-7

Blower Sizing Calculations for Perched and Exposition Zone Vapor Extraction Systems (no ERH)

PERCHED ZONE BLOWER REQUIREMENT CALCULATION

	Perched Flow SCFM	No. of Wells	V1 Total Flow SCFM	P1/P2 Pressure Correction	T2/T1 Temperature Correction	V2 **Total Flow ACFM**
	9	27.00	243	3.35	1.05	854.30
Selected	10	27.00	270	3.35	1.05	949.22
	11	27.00	297	3.35	1.05	1044.15
	12	27.00	324	3.35	1.05	1139.07

REFERENCE DATA

	Perched Pilot Study Pressure Measurement	Absolute Pressure 0r Temp.
P2 = P at Blower Inlet (in Hg)	21	8.92
P1 = P atmos. (in Hg)	atmos	29.92
T2 = T at Blower Inlet (Deg. K)	85 Deg F	302.59
T1 = T at Well (Deg. K)	60 Deg. F.	288.7

EXPOSITION ZONE BLOWER REQUIREMENT CALCULATION

	Deep Flow SCFM	No. of Wells	V1 Total Flow SCFM	P1/P2 Pressure Correction	T2/T1 Temperature Correction	Total Flow ACFM	**SYSTEM DESIGN (Sum of Perched and Expo.)**
	4	32.00	128	4.32	1.05	553.43	**1502.66**
	5	32.00	160	4.32	1.05	691.79	**1641.01**
	6	32.00	192	4.32	1.05	830.15	**1779.37**
Selected	7	32.00	224	4.32	1.05	968.51	**1917.73**
	8	32.00	256	4.32	1.05	1106.87	**2056.09**

REFERENCE DATA

	Deep Pilot Study A Zone Pressure Measurement	Absolute Pressure 0r Temp.
P2 = P at Blower Inlet (in Hg)	23	6.92
P1 = P atmos. (in Hg)	atmos	29.92
T2 = T at Blower Inlet (Deg. K)	85 Deg F	302.59
T1 = T at Well (Deg. K)	58 Deg. F.	287.59

Notes:

Notes:

1. P1/P2 - from Boyles Law.
2. T2/T1 - from Charles Law.
3. 21 in. of Hg is the Avg. blower vacuum measurement from Perched Zone during the HVDPE Pilot Test.
3. 23 in. of Hg is the Avg. blower vacuum measurement from perched (21 in.), A Zone (23 in.), and B-Zone (26.5 in.) during the HVDPE Pilot Test.
4. Additional temperature correction for ERH should insignificant in blower sizing since ERH vented air will be mixed with perched and deep zone air to moderate temperature by the time the air reaches the blower inlet.
5. System design can be modified for the addition of ERH vapor wells by cycling extraction modes throughout the well field.

TABLE 4-8
Pump Power Results for Various Air Flowrates and Manifold Vacuum Levels

Air Flowrate (scfm)	Vacuum Pump Horse Power for Various Manifold Pressures			
	20” Hg	22” Hg	24” Hg	26” Hg
	4.89 psia	3.91 psia	2.93 psia	1.96 psia
5	0.56 hp	0.71 hp	0.9 hp	1.2 hp
10	1.1 hp	1.4 hp	1.8 hp	2.5 hp
50	5.6 hp	7.1 hp	9.1 hp	12.4 hp
100	11.3 hp	14.2 hp	18.3 hp	24.7 hp
200	22.6 hp	28.4 hp	36.5 hp	49.5 ho
500	56.6 hp	70.9 hp	91.3 hp	124 hp

Source: Battelle. October 1998. Application Guide For Bioslurping -TM-2301-ENV, Volume II - Principles and Practices of Bioslurping

TABLE 4-9
Vapor Treatment System Air Flow

Blower Operating Vacuum (in. Hg)	Blower Inlet Flow (ACFM)[1]	Blower Flow (SCFM)[2]	Maximum Flow Rate for Two Blowers (SCFM)	Notes
16	1050	488	976	Operating vacuum should not be less than 15 in. Hg to prevent oil blow-by
18	1080	430	860	
20	1100	364	728	
22	1120	296	592	
24	1100	217	434	

Notes
1. Blower flow rate is depicted from blower performance curve for Dekker Vacuum Technologies VMX1103 K (75 Hp)
2. Assumes a 68 degree (average) blower inlet temperature

Table 4-10

EQUIPMENT WEIGHTS AND SIZES

EQUIPMENT NAME	EQUIPMENT NUMBER	EQUIPMENT CAPACITY	CONTENTS WEIGHT [lb]	EQUIPMENT WEIGHT [lb]	TOTAL WEIGHT [lb]	SKID/EQUIPMENT DIMENSIONS LENGTH	WIDTH	HEIGHT	COMMENTS
VESSELS AND TANKS									
Moisture Separator	V-101	500 Gal/1000 SCFM	7,093	3,500	10,593	7'	7'	7'7"	Skid mounted
Caustic Soda Tank	V-102	1,500 Gallons	12,516	250	12,766	N/A	8' DIA.	6'10'"	With Secondary Containment
Vapor Granular Carbon Adsorber	V-104	4,000 lb	4,000	3,340	7,340	N/A	6' DIA.	7'10"	Circular base
Vapor Granular Carbon Adsorber	V-105	4,000 lb	4,000	3,340	7,340	N/A	6' DIA.	7'10"	Circular base
Holding Tank	V-106	4,900 Gallons	40,890	3,000	43,890	N/A	12' DIA.	8,1"	No skid
Liquid Granular Carbon Adsorber	V-107	3,000 lb	3,000	3,000	6,000	N/A	5' DIA.	8'	Circular base
Liquid Granular Carbon Adsorber	V-108	3,000 lb	3,000	3,000	6,000	N/A	5' DIA.	8'	Circular base
GW Booster Tank	V-110	905 Gallon	7,508	300	7,808	N/A	5'4" DIA.	6'7"	No skid
Flamless Thermal Oxidizer	H-301	1000 SCFM	2,500	13,000	15,500	30'	8'	7'	Stack to 25' high.
PUMPS AND VACUUM BLOWERS									
Vacuum Blower	P-101	1,000 SCFM	0	5,000	5,000	17'	8'	N/A	One skid for both vacuum blowers
Vacuum Blower	P-102	1,000 SCFM	0	5,000	5,000				
Vacuum Blower	P-103	1,500 SCFM	0	3,000	3,000	7'	7'	5'	Skid mounted
AIR COMPRESSORS									
Air Compressor	P-301	124 SCFM	0	1,375	1,375	3'9"	2'9"	N/A	Square base
FILTERS									
Water Filter	F-105	180 GPM	0	43	43	N/A	7.68" DIA.	N/A	Circular base
Water Filter	F-106	180 GPM	0	43	43	N/A	7.68" DIA.	N/A	Circular base
Water Filter	F-107	400 GPM	0	484	484	N/A	1'10" DIA.	5'8"	Circular base
Water Filter	F-108	180 GPM	0	43	43	N/A	7.68" DIA.	N/A	Circular base
Water Filter	F-109	180 GPM	0	43	43	N/A	7.68" DIA	N/A	Circular base
Water Filter	F-110	180 GPM	0	43	43	N/A	7.68" DIA	N/A	Circular base
Calcium Filter	F-112	20 GPM	700	810	1,510	4'2"	2'	6'8"	Circular base
VAPOR CONDITIONING PACKAGES									
Air Cooler	H-101	1,500 ACFM	0	200	200	2.5	6	4'	TBD by Anguik, Vapor Conditioning Package I
Moisture Separator	V-103	638 Gallons	5,524	2,627	8,151	N/A	4'6" DIA.	5'5"	TBD by Anguik, Vapor Conditioning Package I
Air Warmer	H-201	1,500 ACFM	0	200	200	2.5	6	4'	TBD by Anguik, Vapor Conditioning Package I
Heat Exchanger	H-202	20 GPM	0	600	600	5'7"	2'6"	3'1"	Water cooler. Possibly located outside.

NOTES:

1. Items such as interior piping, liquid transfer pumps, vapor filters, miscellaneous gauges and equipment that cannot produce a significant point load have been omitted from this table.

TABLE 4-11 - EQUIPMENT AND INSTRUMENT SPECIFICATION SUMMARY

P&ID	Item Description	Dimension	Material/Schedule	Operating Spec.	Manufacturer Catalog	Other Specifications
CV-101	Compressed air FTO instrumentation solenoid control valve	3/4"	Brass	150 psig		PLC Controlled
CV-201	Compressed air supply 3-way solenoid valve	2"	Brass	150 psig		Controlled by PLC
CV-203	Actuated Valve	4"	PVC SCH 80	150 psig		Controlled by PLC
CV-401, 402	Bypass Control Valves	8"	CPVC SCH80	Rated for 15 psig, 200° F	Hayward Manual Butterfly Valve Engineer Approved Equivalent	Flanged Butterfly valve with Viton elastomer
CV-403	Actuated Valve	3/4"	CPVC SCH80	Rated for 15 psig, 200° F		Controlled by PLC
dPIT-101	Differential Pressure Indicating Transmitter		Stainless Steel	0-10" WC	Dwyer Instrument Model# 605-6	Electrical accuracy ±0.5%, mechanical accuracy ±2%, 4-20 mA, 2 wire, 10-35 VDC, 0-10" WC, stainless steel connection tubing
F-101 & 102	Inlet Vacuum Particulate Filter	Skid: 4'x3'-2"	Stainless Steel	5 Microns/2000 ACFM	Solberg CSL Series	99%+ removal efficiency, Inlet air enters canister above element, SS Housing cartridge filter, Positive sealing O-ring seal system, 0.5 bar pressure for vacuum tightness, Vacuum level: 1x10^{-3} mmHg. Two filters installed in parallel with valving as shown in Drawing M-4.
F-103 & 104	Oil Mist Exhaust Filter	Skid 4'-4"x3'-8"	Stainless Steel	5 Microns/1000 ACFM	Solberg HDL Series	0-5 PSIG operating, 10 PSIG proof pressure, Minimum 99.97% D.O.P. on 0.3 um diameter particles, Positive sealing O-ring seal system, SS Housing cartridge filter. Two filters installed in parallel with valving as shown in Drawing M-4.
F-105, F-106, F-109, F-110	Water Filter, size two bag filter housing	7.68" Diameter	316 Stainless Steel	180 GPM	Hayward/Eaton Filtration, LLC. Flowline™ VMBF SE # VMBF-0402-AB10-040A-UT-11SE	Single 316 SS bag filter with size two bag filter housing, 2" flanged inlet/outlets. Skid mounted. Shut-off valves as shown in Drawing M-4.
F-107	Water Filter, Four (4) size two bag filter housings in one vessel	22" Diameter x 68" Height	316 Stainless Steel	400 GPM	Hayward/Eaton Filtration, LLC. Qic-Lock™ Maxiline™ VMBF SE # VMBF-0402-AB10-040A-UT-11SE	Multiple 316 SS bag filter with (4) size two bag filter housings inside one vessel, spring assisted cover, 4" flanged inlet/outlets, low profile for quick filter replacement. Mounted on skid with single bag filter F-108. Inlet/outlet shut-off valves as shown in Drawing M-4.
F-108	Water Filter, One (1), size two bag filter housing	7.68" Diameter	316 Stainless Steel	180 GPM	Hayward/Eaton Filtration, LLC. Flowline™ VMBF SE # VMBF-0402-AB10-020A	Single 316 SS bag filter with (1) size two bag filter housing, 2" flanged inlet/outlets, low profile for quick filter replacement. Mounted on skid with multiple bag filter housing F-107. Shut-off valves as shown in Drawing M-4.
F-111	Air Filter-compressed air particulate filter with automatic drain	1 1/2" NPTF		250 cfm @ 150 psig	Kaeser KPF-250	
F-112	Calcium Filter	50"x24"x80"/1.5" inlet		20 GPM min/<3ppm Calcium	U.S. Filter KF Series KFZSDO21FPZVBX	US Filter KF Series Duplex Alternating Softener w/ brine tank, Feed Temp 45-100°F, Feed pressure 30-100 psig, <3ppm Calcium
F-113	Regenerative Desiccant Dryer	23" x 7" x31" (L x W x H)		5 SCFM, 90 PSIG, -90°F Dew Point	KAESER KADW-10	To provide continuous 5 scfm, 90 psig, and -90°F dew point purge air to FTO, Regenerative desiccant type
FE-101	Vapor Flow Element-Averaging Pitot Tube		Stainless Steel	0-3040 SCFM	Dywer DS-300-8"	Averaging pitot tube to be used with differential pressure transmitter (dPIT-101)
FI-101	Vapor Flow Indicator	1/4" NPT	Brass		Swagelock Borethrough B-500-1-4BT with Plug (B-500-P)	1/4" NPT borethrough fitting for insertion of averaging pitot tube.
FQI-201	Flow Totalizer & Indicator	Inlet: 3"/Outlet: 3"	PVDF Rotor, PVC SCH80 TEE	22-450 GPM	Signet Series 515 Rotor X, Signet Series 8550 ProcessPro Flow Transmitter, Signet Installation Fitting 3" Tee	Self-powered flow sensor, housing material PVDF, rotor material nat. PVDF, pipe size 1/2" to 4" <Harrington Plastics Part# PS1530-V0>, Field mount with dual input/output <Harrington Plastics Part# 3-8550-3>, 4-20mA, 24 VDC power, <Harrington Plastics Part# PV8T030>
FQI-202	Flow Totalizer & Indicator	Inlet: 2"/Outlet: 2"	PVDF Rotor, PVC SCH80 TEE	20-200 GPM	Signet Series 515 Rotor X, Signet Series 8550 ProcessPro Flow Transmitter, Signet Installation Fitting 2" Tee	Self-powered flow sensor, housing material PVDF, rotor material nat. PVDF, pipe size 1/2" to 4" <Harrington Plastics Part# PS1530-V0>, Field mount with dual input/output <Harrington Plastics Part# 3-8550-3>, 4-20mA, 24 VDC power, <Harrington Plastics Part# PV8T020>
FQI-203	Flow Totalizer & Indicator	Inlet: 2"/Outlet: 2"	Brass	2.5-160 GPM	McMaster-Carr 3786k96	Corrosion-Resistant totalizer with Impeller, NPT male connection
H-101	Air Chiller/Condenser	To be Determined Via Design/Build				The VC Package must be capable of interfacing with both the FTO PLC and treatment compound PLC.

TABLE 4-11 - EQUIPMENT AND INSTRUMENT SPECIFICATION SUMMARY

P&ID	Item Description	Dimension	Material/Schedule	Operating Spec.	Manufacturer Catalog	Other Specifications
H-201	Air Warmer	To be Determined Via Design/Build				The VC Package must be capable of interfacing with both the FTO PLC and treatment compound PLC.
H-202	Heat Exchanger	Inlet: 2"/Outlet: 2"	Stainless Steel/Copper coils	20 GPM	Xchanger, Inc. LC series or equivalent	See Table 4-12 2 - Major Equipment Specifications for more details.
H-301	Flameless Thermal Oxidizer and Scrubber	Skid: 8'x30'		1000 SCFM Max.		To be provided by Anguil and procured by USACE
LI-101	Level Indicator					Level indicator for moisture separator to consist of clear pipe with valves and flanges/unions to allow for replacement/cleaning of indicator
LI-102	Level Indicator					Level indicator for Holding Tank to consist of clear pipe with valves and flanges/unions to allow for replacement/cleaning of indicator
LI-103	Level Indicator					Level indicator for caustic tank. Mechanical gauge mounted onto the top of the double contained caustic tank.
LI-201	Level Indicator					Level indicator for booster tank to consist of clear pipe with valves and unions to allow for replacement/cleaning of indicator
LSH-101	Level Switch High		Stainless Steel		W.E. Anderson Flotect® Series L6 with stainless steel float	Plumbing and electrical configured for quick removal for cleaning/replacement
LSH-201	Level Switch High		Stainless Steel		W.E. Anderson Flotect® Series L6 with stainless steel float	Plumbing and electrical configured for quick removal for cleaning/replacement
LSH-202	Level Switch High		Stainless Steel		Dwyer F7-MQ Series Multi-Station Level Switch or Engineer approved equivalent.	Plumbing and electrical configured for quick removal for cleaning/replacement
LSHH-101	Level Switch High-High		Stainless Steel		W.E. Anderson Flotect® Series L6 with stainless steel float	Plumbing and electrical configured for quick removal for cleaning/replacement
LSHH-102	Level Switch High-High		Stainless Steel		W.E. Anderson Flotect® Series L6 with stainless steel float	Plumbing and electrical configured for quick removal for cleaning/replacement
LSHH-201	Level Switch High-High		Stainless Steel		W.E. Anderson Flotect® Series L6 with stainless steel float	Plumbing and electrical configured for quick removal for cleaning/replacement
LSHH-202	Level Switch High-High		Stainless Steel		Dwyer F7-MQ Series Multi-Station Level Switch or Engineer approved equivalent.	Plumbing and electrical configured for quick removal for cleaning/replacement
LSL-101	Level Switch Low		Stainless Steel		W.E. Anderson Flotect® Series L6 with stainless steel float	Plumbing and electrical configured for quick removal for cleaning/replacement
LSL-103	Level Switch Low		316 Stainless Steel		Dwyer/W. E. Anderson Series F7 Vertical Level Switch	Vertical Level Switch installed from the top of the double contained tank. Float material must be chemically compatible with 25% NaOH solution.
LSL-201	Level Switch Low		Stainless Steel		W.E. Anderson Flotect® Series L6 with stainless steel float	Plumbing and electrical configured for quick removal for cleaning/replacement
LSL-202	Level Switch Low		Stainless Steel		Dwyer F7-MQ Series Multi-Station Level Switch or Engineer approved equivalent.	Plumbing and electrical configured for quick removal for cleaning/replacement
LSLL-102	Level Switch Low-Low		Stainless Steel		W.E. Anderson Flotect® Series L6 with stainless steel float	Plumbing and electrical configured for quick removal for cleaning/replacement
LSLL-201	Level Switch Low-Low		Stainless Steel		W.E. Anderson Flotect® Series L6 with stainless steel float	Plumbing and electrical configured for quick removal for cleaning/replacement
P-101 & 102	Liquid-Ring Vacuum Pump	Skid: 17'x8'/Inlet: 8"/Outlet: 8"	TYP	75 HP/1000 SCFM	Oil-Sealed 75 hp Dekker Vacuum Technologies, Inc. Model VMX1103K	Equipped with oil liquid ring, system interlock/failsafe, alarms, and hour meters. See Table 4-12 - Major Equipment Specifications for more details.
P-103	Regen. blower with sound enclosure	Skid" 7'x7', Inlet: 8"/Outlet: 8"		Approx 1,500 CFM, 20 HP		To be provided by Anguil part of the vapor conditioning package

TABLE 4-11 - EQUIPMENT AND INSTRUMENT SPECIFICATION SUMMARY

P&ID	Item Description	Dimension	Material/Schedule	Operating Spec.	Manufacturer Catalog	Other Specifications
P-201	Transfer Pump	Skid: combined with V-101 moisture separator	316 Stainless Steel	30 GPM/75' TDH/3 Phase, 460 V		Self priming centrifugal see Major Equipment Specifications for more details.
P-202	Holding Tank Pump	Skid: 4'x4'	316 Stainless Steel	100 GPM/75' TDH/3 Phase, 460 V		Centrifugal pump see Major Equipment Specifications for more details.
P-203	Booster Tank Pump	TYP	316 Stainless Steel	110 GPM/55' TDH/3 Phase, 460 V		Centrifugal pump see Major Equipment Specifications for more details.
P-204	Pump for Secondary Containment Sump	TYP	316 Stainless Steel	30 GPM/35' water/3 Phase, 460 V		Submersible sump pump, solid handeling, self priming. Equipped with LSL, LSH, LSHH, system interlock, and alarms.
P-205	Metering Pump	TYP				Provided by Anguil and installed by the contractor.
P-206	Transfer Pump					To be provided by Anguil part of the vapor conditioning package
P-301	Rotary Screw Air Compressor and receiver tank	45" x 33" - compressor, 30" Dia receiver	TYP	125 PSI, 124 SCFM, 30 Hp, 240 Gallon receiver	Kaeser Compressor AS-30	See Table 4-12 - Major Equipment Specifications for more details.
PI-101	Air Pressure Indicator	TYP	304 Stainless Steel	0-15 PSI		2-1/2" Dial Glycerin-Filled, Grade A, Back or Bottom NPT male connection
PI-102	Air Pressure Indicator		304 Stainless Steel	0-200		2-1/2" Dial Glycerin-Filled, Grade A, Back or Bottom NPT male connection
PI-103	Air Pressure Indicator		304 Stainless Steel	0-120		2-1/2" Dial Glycerin-Filled, Grade A, Back or Bottom NPT male connection
PI-201	Water Pressure Indicator	TYP	316 Stainless Steel	0-60 PSI		2-1/2" Dial Glycerin-Filled, Grade A, Back or Bottom NPT male connection
PI-202	Water Pressure Indicator	TYP	316 Stainless Steel	0-30 PSI		2-1/2" Dial Glycerin-Filled, Grade A, Back or Bottom NPT male connection
PS-101	Pressure Switch	TYP	Stainless Steel	22.5-125 PSI	McMaster# 46995K17	Compact cylindrical pressure switch, Nema 1, 1/2" NPT male, 5A @ 125/250 VAC, Buna - N diaphragm - sealed piston, set point range 22.5-125 psi, SPDT
PT-101	Air Pressure Transmitter	TYP	Stainless Steel	0-15 PSI	Dwyer Instrument Model# 673-3C	±0.25% full span accuracy, 17-4 PH SS, 4 to 212°F, 4-20 mA, 2 wire, 0-15 psi
PT-102	Water Pressure Transmitter	TYP	Stainless Steel	0-5 PSI	Dwyer Instrument Model# 673-3C	±0.25% full span accuracy, 17-4 PH SS, 4 to 212°F, 4-20 mA, 2 wire, 0-5 psi
PT-201	Water Pressure Transmitter	TYP	316 Stainless Steel	0-60 PSI	McMaster# 3196K1	Economy transducer, 1/4" NPT male, 316 SS, -40 to 212°F,≤ 0.5% accuracy, 10-30 VDC, 2 wire, 4-20 mA
PT-202	Water Pressure Transmitter	TYP	316 Stainless Steel	0-60 PSI	McMaster# 3196K1	Economy transducer, 1/4" NPT male, 316 SS, -40 to 212°F,≤ 0.5% accuracy, 10-30 VDC, 2 wire, 4-20 mA
PT-203	Water Pressure Transmitter	TYP	316 Stainless Steel	0-60 PSI	McMaster# 3196K1	Economy transducer, 1/4" NPT male, 316 SS, -40 to 212°F,≤ 0.5% accuracy, 10-30 VDC, 2 wire, 4-20 mA
PT-204	Water Pressure Transmitter	TYP	316 Stainless Steel	0-60 PSI	McMaster# 3196K1	Economy transducer, 1/4" NPT male, 316 SS, -40 to 212°F,≤ 0.5% accuracy, 10-30 VDC, 2 wire, 4-20 mA
R-101	Air Regulator	1 1/2" NPTF		5-125 psi	McMaster# 4959K57	
R-102	Air Regulator	3/4" NPTF		5-150 psi	McMaster# 4959K54	
R-103	Air Regulator	1" NPTF		5-125 psi	McMaster# 4959K55	

TABLE 4-11 - EQUIPMENT AND INSTRUMENT SPECIFICATION SUMMARY

P&ID	Item Description	Dimension	Material/Schedule	Operating Spec.	Manufacturer Catalog	Other Specifications
TI-101	Temperature Indicator	TYP	Stainless Steel	30-240°F		3" Dial Bimetal Stem Thermometer, 30 to 240°F, 316 SS, Back or Bottom NPT male connection with thermowell
TIT-101	Temperature Indicating Transmitter	TYP	Stainless Steel	0-200°F	Transmitter - Omega # PRTXD-200F-4-SL Thermowell - McMaster# 3957K667	Temperature Transmitter with Display and RTD sensor, straight thermowell, 1/2" NPT, 4" bore depth, 316 SS
TIT-102	Temperature Indicating Transmitter	TYP	Stainless Steel	0-200°F	Transmitter - Omega # PRTXD-200F-4-SL Thermowell - McMaster# 3957K667	Temperature Transmitter with Display and RTD sensor, straight thermowell, 1/2" NPT, 4" bore depth, 316 SS
TIT-103	Temperature Indicating Transmitter	TYP	Stainless Steel	0-200°F	Transmitter - Omega # PRTXD-200F-4-SL Thermowell - McMaster# 3957K667	Temperature Transmitter with Display and RTD sensor, straight thermowell, 1/2" NPT, 4" bore depth, 316 SS
TIT-201	Temperature Indicating Transmitter	TYP	Stainless Steel	0-200°F	Transmitter - Omega # PRTXD-200F-4-SL Thermowell - McMaster# 3957K667	Temperature Transmitter with Display and RTD sensor, straight thermowell, 1/2" NPT, 4" bore depth, 316 SS
TIT-202	Temperature Indicating Transmitter	TYP	Stainless Steel	0-200°F	Transmitter - Omega # PRTXD-200F-4-SL Thermowell - McMaster# 3957K667	Temperature Transmitter with Display and RTD sensor, straight thermowell, 1/2" NPT, 4" bore depth, 316 SS
V-101	Moisture Separator	Approximate skid dimensions to be 7' x 7'	1/4" minimum hot rolled steel	Remove 95% of all liquid droplet/30" Hg Max. Vacuum	Rated at 500 Gal. working capacity and 1000 SCFM at 22 in. Hg	See Table 4-12 - Major Equipment Specifications for more details.
V-102	Caustic Soda Tank	8' Dia x 6'-10" High	Crosslinked Polyethylene Double wall	1,500 Gal	Poly Processing Company SAFE-TANK® Stock Number 42001550	See Table 4-12 - Major Equipment Specifications for more details.
V-103	Moisture Separator	To be Determined Via Design/Build				The VC Package must be capable of interfacing with both the FTO PLC and treatment compound PLC.
V-104 & 105	Carbon Adsorber	6' Dia.x 94" High/Inlet: 10"/Outlet: 10"	Double layered Epoxy Coated Carbon Steel, Vacuum Rated	4,000 lb, 3000 cfm, 15 psig, 4 in. Hg Vac.	Baker Filtrations Kleen.Air 4,000S-F	Operating fill: 4,000 lb virgin coconut shell carbon. See Table 4-12 - Major Equipment Specifications for more details.
V-106	Water Holding Tank	12' Dia, 8' 1" High	cross linked HDPE	4,900 Gallon	Poly Processing Company Stock Number 11004900.	See Table 4-12 - Major Equipment Specifications for more details.
V-107 & 108	Liquid-Phase Carbon Adsorber	5' Dia x 96" High/Inlet: 4", Outlet: 4"	Double layered Epoxy Coated Carbon Steel	3,000 lb/150 GPM/75 psig	Baker Filtration Kleen. Water 3000HPV	Operating fill: 3,000 lb virgin coconut shell carbon. See Table 4-12 - Major Equipment Specifications for more details.
V-104 & 105	Vapor-Phase Carbon Vessel	2" Inlet/outlets	Epoxy Coated Steel	55-Gallon Drum/200 pound capacity		55-Gallon carbon drum filled with virgin coconut shell carbon.
V-110	Groundwater Booster Tank	5' 4" Dia x 6' 7" Tall	cross linked HDPE	905 Gallon	Poly Processing Company Stock Number 41100905	See Table 4-12 - Major Equipment Specifications for more details.
V-111	Air Receiver Tank	240 Gallon 30" Diameter	Painted Carbon Steel	240 Gallon		See Table 4-12 - Major Equipment Specifications for more details.
V-106	Water Holding Tank	12' Dia, 8' 1" High	cross linked HDPE	4,900 Gallon	Poly Processing Company Stock Number 11004900.	See Table 4-12 - Major Equipment Specifications for more details.
VI-101	Vacuum Indicator	TYP	Stainless Steel	0 to -30" Hg		2-1/2" Dial Glycerin-Filled, Grade A, Back or Bottom connection, 5" Figure Interval, 0.5" Grad. Mark, 1/2" NPT male, 316 SS
VT-101	Pressure Transmitter	TYP	Stainless Steel	0 to -30" Hg	McMaster# 3200K1	High accuracy transducer, 1/2" male NPT, 316 SS, -40 to 212°F, < 0.25% accuracy, 10-30 VDC, 2 wire, 4-20 mA
	Flame Arrestor	Size to match pipe				Flame arrestor to serve as a backflash prevention device (from vapor phase carbon vessels).
	Clean-out Wye	Inlet: 2"/Outlet: 2"				Flanged
	Vacuum Breaker (Anti-Siphon)	Inlet: 3"/Outlet: 3"	PVC or Brass	125 PSI Max		Installed at the highest point of the treatment train (as shown in Drawing M-4). Must meet ASSE Standard
	Sampling Box for LACSD					Insalled above grade by the building contractor. Refer to LACSD std. drawing I-12 for details.

TABLE 4-11 - EQUIPMENT AND INSTRUMENT SPECIFICATION SUMMARY

P&ID	Item Description	Dimension	Material/Schedule	Operating Spec.	Manufacturer Catalog	Other Specifications
	Water Ball Valves	Size to match pipe	PVC		Spears True Union 2000 Industrial Ball Valve or Engineer Approved Equivalent	True union ball valve with viton liner/seals.
	Water Butterfly Valves	Size to match pipe	PVC		Hayward Manual Butterfly Valve Engineer Approved Equivalent	Flanged Butterfly valve with viton seats/seals
	Water Check Valves	Size to match pipe	PVC		Spears Industrial Ball Check Valve Engineer Approved Equivalent	True union with viton elastomer.
	Vapor Diaphragm Valves	6"	PVC		Asahi Flanged Diaphragm Valves Type G	Flange, Teflon with EPDM backing, bubble-tight closure, position indicator
	Vapor Butterfly Valves	Size to match pipe	Match Pipe Material		Hayward Manual Butterfly Valve Engineer Approved Equivalent	Flanged Butterfly valve with Viton elastomer
	Vapor Check Valves	Size to match pipe	CPVC or Stainless Steel		Technocheck seatless check valve or Engineer Approved Equivalent	Flanged, viton elastomer

TABLE 4-12 - MAJOR EQUIPMENT SPECIFICATIONS

Moisture Separator V-101 and Transfer Pump P-201

<u>Moisture Separator</u>

- Skid mounted
- 500 gallon minimum working capacity (volume between LSL and LSH).
- Air flow capacity of 1000 scfm at 22 in. Hg.
- Vacuum rated (30" Hg vacuum).
- 316 Stainless Steel Construction
- Tangential inlet and demister element.
- Water droplets reduced to 250 micron.
- The moisture separator must remove 95% of all liquid droplets.
- Sight tube/level indicator with unions and isolation valves for quick disassembly/replacement and clean-out.
- 8-inch flanged inlet, 8-inch flanged vapor outlet.
- One 2” manual drain at the bottom of tank.
- Two access points shall be provided for knockout tank clean-out.
  - A clean-out access plate shall be installed on top to allow demister element servicing.
  - A minimum eight-inch-diameter access plate at the bottom of the knockout tank to allow for cleaning sediment and any debris from the tank bottom.
- 316 stainless steel LSL, LSH, and LSHH level switches.
- Level switches must be installed to allow for quick disassembly and clean-out.
- The moisture separator must include a vacuum and pressure relief valve.
- Maximum skid dimension (including transfer Pump P-201 below) to be 7’ by 7’.
- Skid to include anchor bolt holes and must be bolted to concrete.

<u>Transfer Pump</u>

- Mounted on V-101 moisture separator skid.
- 316 Stainless Steel, <u>self priming</u>, centrifugal pump (480 VAC, 60 Hz, three phase) equipped with ODP or TEFC motor.
- Rated for a minimum of 30 gallons per minute rated at 75 feet of total dynamic head.
- Rated for high level of solids processing including silts and sands.
- Materials of construction rated for chlorinated and petroleum hydrocarbons.
- Flanged inlet/outlet with appropriate expansion fittings
- LSL and LSH controlled from PLC.
- Pump inlet to be positioned at the bottom of the tank for solids removal.
- A clean-out wye to be installed between transfer pump and knockout tank.
- The outlet of the transfer pump to include a 0-30 psig pressure gauge, a throttling valve, and a bubble tight PVC spring loaded check valve with viton seals as shown in P&ID.
- Piping and instrumentation specifications per drawing M-1.
- The transfer pump must be installed for quick removal/replacement.
- Provide one replacement transfer pump with flanges. The pump must be configured with electrical/plumbing that will allow for quick replacement of the originally installed pump.

High Vacuum Blower P-101 and P-102

Two High Vacuum Blowers

- Skid Mounted.
- Power supply for blower skid should be 480 VAC, three-phase, 60 Hz.
- Two (2) Oil-Sealed 75 hp Dekker Vacuum Technologies, Inc. Model VMX1103K assembly.
- Seal fluid separators/reservoirs to be equipped with high and low oil level shutdown switches.
- High oil temperature shutdown switches to be installed between outlet of liquid ring vacuum pumps and inlet to seal fluid separator/reservoir.
- Piping between seal fluid outlet of separator/reservoir and liquid ring vacuum pump inlet to be equipped with temperature control valves.
- 8” flange inlet and outlet to skid.
- Liquid ring vacuum pumps must be able to operate independently or combined.
- Piping must include expansion fittings.
- Low friction loss check valves at the discharge side of each blower.
- Blowers must be constructed with lip seals and/or other provisions to allow for quick removal.
- Motors must be installed/configured for quick removal.
- Vacuum relief valves.
- Piping and Instrumentation as shown in Figure M-1.
- Skid to be constructed with top steel plate and include a 6” high steel berm at the perimeter for the purpose of containing any spilled liquid-ring pump coolant/oil.
- Skid to include anchor bolt holes and must be bolted to concrete.

Control Panel

- UL-listed electrical assembly with a main disconnect in an oversized NEMA 13 enclosure.
- Overcurrent protection for main, branches, and controls. Thermal overload protection for motor starters/contactors.
- Two (2) Hour Meters, one per blower.
- High and low oil level alarms in oil/seal fluid separator/reservoir.
- High temperature oil/seal fluid alarm.
- Two spare alarms.
- Input/Output communication to the PLC (per PLC specifications).
- Alarms above and PLC will shutdown the blowers.
- Hand/Off/Auto switch for each blower. Each blower must be able to operate independently. Hand mode will bypass the PLC.
- All control wires to be numbered.
- Green LED indicator lights: “Blower 1 Run 1,” “Blower 2 Run, and red LED alarm lights: "B 1 High Oil Level", "B 2 High Oil Level", "B 1 Low Oil Level", "B 2 Low Oil Level", “ B 1 High Oil Temperature", leave the spare alarm lights unlabeled . All lights to have push to test feature.
- Red, clearly placarded, emergency stop (E-Stop) push button mounted on panel. The E-stop will shutdown blowers when activated.

Groundwater Booster Vessel V-110 and Groundwater Booster Pump P-203

Groundwater Booster Vessel V-110

- 905 gallon (5’ 4” Dia x 6’ 7” Tall) vertical high density crosslinked polyethylene tank with integrally molded flanged outlet
- Tank to consist of Poly Processing Company Stock Number 41100905
- Tank Pad to consist of Poly Processing Company Pad Stock Number 78000054
- Vapor tight, bolted, polyethylene man way with viton gaskets with 19” opening.
- Tank fittings to be PVC. Gaskets to be Viton.
- Tank penetration to be vapor tight.
- Inlet and outlet connections to be flexible to allow from tank expansion/contraction and to reduce piping vibration stress on the tank.
- Tank must include vacuum and pressure relief valves.
- 316 stainless steel LSLL, LSL, LSH, and LSHH level switches.
- Level switches must be installed to allow for quick disassembly and clean-out.
- Sight tube/level indicator with unions and isolation valves for quick disassembly/replacement and clean-out.
- Tank fill piping to consist of a 4” PVC bulkhead fitting and 4” schedule 80 PVC interior drop pipe (installed to the bottom of the tank).
- Indoor seismic zone IV restraint system installed per manufacturer’s requirements.
- Tank to include ladder

Booster Pump

- Goulds NPE series (or engineer approved equivalent), 316 stainless steel, centrifugal pump (480 VAC, 60 Hz, three phase) equipped with ODP or TEFC motor.
- Rated for a minimum of 110 gallons per minute rated at 55 feet of total dynamic head.
- Rated for high levels of solids processing including silts and sands.
- Materials of construction rated for chlorinated and petroleum hydrocarbons.
- Flanged inlet/outlet with appropriate expansion fittings.
- LSL and LSH controlled from PLC.
- A clean-out wye to be installed between transfer pump and tank.
- The outlet of the transfer pump to include a 0-30 psig pressure gauge, a throttling valve, and a bubble tight PVC check valve with viton seals as shown in P&ID.
- Bolted to concrete pad.
- Piping and instrumentation specifications per drawing M-1.
- The transfer pump must be installed for quick removal/replacement.
- Provide one replacement transfer pump with flanges. The pump must be configured with electrical/plumbing that will allow for quick replacement of the originally installed pump.

TABLE 4-12 - MAJOR EQUIPMENT SPECIFICATIONS

Holding Tank V-106 and Transfer Pump P-202

Holding Tank V-106

- 4,900 gallon (12' Dia x 8' 1" Tall) vertical high density crosslinked polyethylene tank
- Tank to consist of Poly Processing Company Stock Number 11004900.
- Tank outlet to consist of a bottom flanged siphon drain located at the lowest possible location of the tank (outlet with 45 deg elbow to bottom of tank).
- Tank fill piping to consist of 3" PVC bulkhead fitting with 3" schedule 80 PVC interior downpipe (installed to the bottom of the tank).
- Vapor tight, bolted, polyethylene man way with viton gaskets with 19" opening. (Available from Poly Processing Company).
- Tank fittings to be PVC. Gaskets to be Viton.
- All tank penetration to be vapor tight.
- Inlet and outlet connections to be flexible to allow from tank expansion/contraction and to reduce piping vibration stress on the tank.
- Tank must include vacuum and pressure relief valves.
- 316 stainless steel LSLL and LSHH level switches.
- Level switches must be installed to allow for quick disassembly and clean-out.
- Sight tube/level indicator with unions and isolation valves for quick disassembly/replacement and clean-out.
- Indoor seismic zone IV restraint system installed per manufacturer's requirements.
- Tank to include ladder

Transfer Pump

- Goulds NPE series (or engineer approved equivalent), 316 stainless steel, centrifugal pump (480 VAC, 60 Hz, three phase) equipped with ODP or TEFC motor.
- Rated for a minimum of 100 gallons per minute rated at 75 feet of total dynamic head.
- Rated for solids processing including silts and sands.
- Materials of construction rated for chlorinated and petroleum hydrocarbons.
- Flanged inlet/outlet with appropriate expansion fittings.
- Controlled by variable frequency drive and set water level from pressure transducer (see PLC specifications).
- A clean-out wye to be installed between transfer pump and tank.
- The outlet of the transfer pump to include a 0-30 psig pressure gauge, a throttling valve, and a bubble tight PVC check valve with viton seals as shown in P&ID.
- Bolted to concrete pad.
- Piping and instrumentation specifications per drawing M-1.
- The transfer pump must be installed for quick removal/replacement.
- Provide one replacement transfer pump with flanges. The pump must be configured with electrical/plumbing that will allow for quick replacement of the originally installed pump.

Air Compressor P-201

- 480 VAC, 60 Hz, three phase electrical service
- Kaeser rotary screw Model AS 30 compressor.
- Configured to operate at 125 psig with 124 cfm air flow.
- 240 Gallon ASME certified air receiver tank.
- The air compressor and receiver tank must be installed and configured as shown in the P&ID.
- Receiver tank to include a pressure gauge, pressure relief valve, automatic drain, manual drain, and galvanized steel plumbing.
- The receiver tank must be painted white.
- The discharge side of the receiver must include a Kaeser compressed air filter KPF-250 air particulate filter with automatic drain and a 5-125 psig pressure regulator with pressure gauge.
- Air compressor and 240 gallon receiver to be anchored to concrete per manufactures requirements.

Heat Exchanger H-202

- 480 VAC, 60 Hz, three phase electrical service.
- TEFC motor.
- Rated for outdoor use
- Xchanger, Inc. LC series or equivalent.
- Tube material to be copper.
- Sized for 20 gpm water flow with inlet temperature of 165° F and outlet temperature of 130° F.
- Two-inch flanged inlets and outlets
- Vertical air flow configuration

Vapor-phase Carbon Vessels V-104 and V-105

- Baker Filtrations Kleen.Air 4000 S-F. Calgon Protect VS-6 vessels can be used as an alternative, however, the contractor must ensure these vessels can fit inside the door of the building.
- 6' diameter, 94" height, 10" inlet/outlets.
- 3000 cfm maximum flow rate.
- Vacuum and pressure relief valves.
- The vessels must be bolted to the concrete pad.
- Lead/Lag manifold mounted on pipe rack with valves and instrumentation as shown in Drawing M-1. The pipe rack must be bolted to the concrete pad.
- Filled with 4,000 pounds of <u>virgin</u> coconut shell carbon with the following specifications:
    - Minimum Butane Activity (ASTM D5742) of 23.5
    - Minimum carbon tetrachloride activity (ASTM D3467) of 60%
    - 1100-1250 surface area (B.E.T) m^2/g

Liquid-phase Carbon Vessels V-107 and V-108

- Baker Filtration Kleen Water 3000 HPV vessels.
- 60" diameter, 96" height, 4" inlet/outlet
- 150 gpm maximum flow.
- Pressure relief valves.
- Automatic air vents with drains installed to the bottom of the vessels.
- The vessels must be bolted to the concrete pad.
- Lead/Lag manifold mounted on pipe rack with valves and instrumentation as shown in Drawing M-1.
- Filled with 3,000 pounds <u>virgin</u> coconut shell carbon with the following specifications:
  - Acid washed, contact pH 6.5 – 8
  - Minimum Iodine of 1100 mgI_2/g (ASTD D 4607)
  - Minimum carbon tetrachloride activity (ASTM D3467) of 60%

Caustic Tank V-102

- Poly Processing Company SAFE-TANK® Stock Number 42001550.
- Inlet to include 2" PVC bulkhead with 2" PVC downpipe (installed to the bottom of the tank) and support.
- Outlet to include 2" SAFE-TANK® bellows style secondary transition fittings with PVC nipple Poly Processing Company Part # 7604 installed at bottom of tank.
- Indoor seismic zone IV restraint system installed per manufacturer's requirements.
- Tank to include pressure and vacuum relief valves.
- Inlet and outlet connections to be flexible to allow from tank expansion/contraction and to reduce piping vibration stress on the tank.
- Tank to include 316 stainless steel magnetic type level switch installed from the top of the tank.
- Tank level indicator to consist of a mechanical gauge installed through the roof of the tank.
- Tank to include ladder.

Skids

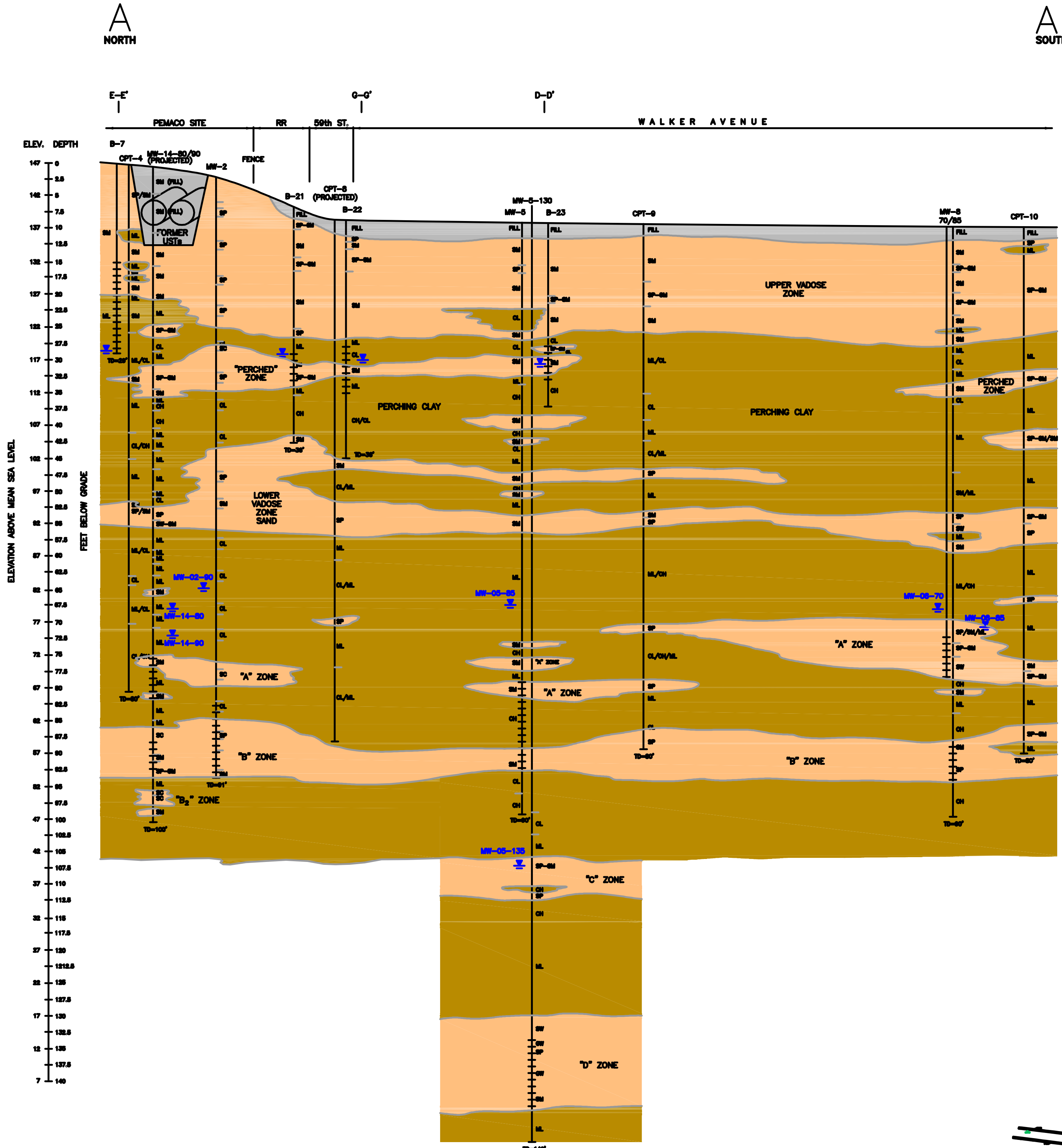
- All components to be removable without lifting skid (i.e., bottom nuts or connecting bolts for each component to be welded to skid).
- Equipped with appropriate anchor bolt holes and secured to concrete.
- Painted with rust resistant enamel coating.

Table 4-13
Pump Air and Groundwater Flow Rates for Friction Loss Calculations

Pumping Zone	Depth to Pump (ft) [1]	Anticipated Average Flow (gpm) [2]	Pump Air Supply Pressure (psig)	Air Flow (scfm) [3]	Doubled Groundwater Flow (gpm)	Doubled Air Flow (scfm)
A Zone	80	0.7	70	0.518	1.4	1.036
B Zone	100	1.6	70	1.296	3.2	2.592
A and B Exposition Zones	90	2.3	70	1.771	4.6	3.542
D Zone	140	1.1 (1.0)[4]	100	1.125	2.0	2.250

Note:
1. Pumps in the A Zone, B Zone, and A & B Exposition Zones are QED Long AP-4/BL.
   The pump in the D Zone is the QED Long AP-2/BL.
2. Refer to QED Long AP-4/BL Performance Curve: 3/4-inch I.D. Discharge with 2 ft of submergence and
   QED Long AP-2/BL Performance Curve: 1/2-inch I.D. Discharge with 10 ft of submergence.
3. Air flow is based on the Long AP-4/BL and AP-2/BL Performance Curve.
4. The pump average flow of 1.0 gpm obtained from the performance curve is slightly less then the
   1.1 gpm anticipated flow rate from the formation.

FIGURES



LEGEND

- WELL SCREEN INTERVAL
- COARSE-GRAINED LITHOSOMES
- FINE-GRAINED LITHOSOMES
- FILL MATERIAL
- MW-05-85 POTENTIOMETRIC SURFACE LEVEL JANUARY 2002

NOTES:

1.) PERCHED ZONE GROUNDWATER DATA FROM WELLS GAUGED 6/5/01 AND FROM DEPTH OF FIRST WET SEDIMENTS ENCOUNTERED IN BORING MW-8 DURING DRILLING ON 3/28/01.

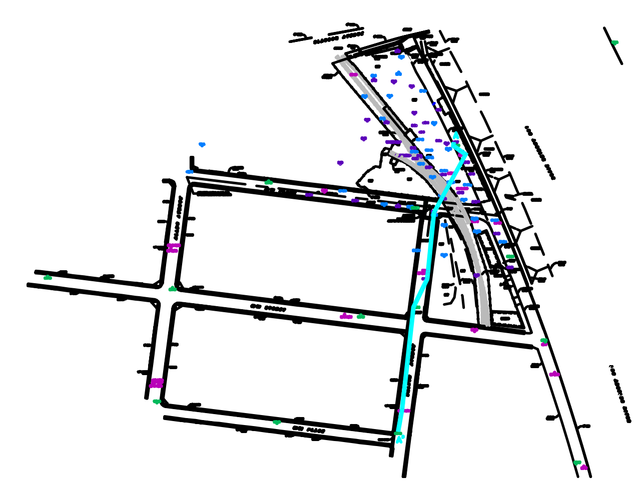
2.) EXPOSITION 'A', 'B', 'C' AND 'D' ZONE GROUNDWATER DATA FROM WELLS GAUGED 5/21/01. ALL OF THESE LEVELS ARE PRESSURE LEVELS AND REPRESENT THE PEIZOMETRIC SURFACE.

3.) MW-2 SAMPLED APPROXIMATELY EVERY FIVE FEET. ALL OTHER BORINGS WERE CONTINUOUSLY CORED.

4.) 'PROJECTED' = ACTUAL WELL LOCATION IS OFFSET FROM CROSS SECTION LINE. THE LITHOLOGY IS 'PROJECTED' ONTO THE CROSS SECTION.

5.) LITHOLOGIC ACRONYMS:

SP = POORLY GRADED SANDS
SW = WELL GRADED SANDS
SM = SILTY SANDS
SP-SM = POORLY GRADED SANDS WITH SILT
SW-SP = WELL GRADED SANDS WITH SILT
ML = SILT
CH = FAT CLAY (HIGHLY PLASTIC CLAY)
CL = LEAN CLAY (LOW PLASTICITY CLAY)



CROSS SECTION INDEX MAP

10 / 0 / 60
APPROX. SCALE IN FEET
6x VERTICAL EXAGGERATION

CROSS SECTION A-A'

PEMACO SUPERFUND SITE
5050 EAST SLAUSON AVENUE
MAYWOOD, CALIFORNIA

PREPARED FOR:
U.S. Environmental Protection Agency
Region IX
San Francisco, California

PREPARED BY:
T N & Associates, Inc.
Engineering and Science

SCALE: AS SHOWN
APPROVED
DRAFT
DATE: 1/13/2003
DESIGNED: MB & JW
DRAWN: CRG
CHECKED: JW
FIGURE 2-1
REV 0

FILE NAME: Figure2-1_xsection.DWG

LEGEND

PERCHED GW PLUME EXCEEDING VOC ARARS

PROPOSED PERCHED ZONE HVDPE WELL (54 FT RADIUS OF INFLUENCE, 27 WELLS)

WATER LINE

SEWER LINE

GAS LINE

PERCHED ZONE PIPING:

LIGHT BLUE	DPE–A	6 WELLS (P1–A TO P6–A)
DARK BLUE	DPE–B	7 WELLS (P7–B TO P13–B)
BROWN	DPE–C	7 WELLS (P14–C TO P20–C)
PURPLE	DPE–D	7 WELLS (P21–D TO P27–D)

NOTES:

1. A 54' RADIUS OF INFLUENCE (ROI) WAS USED AS THE BASIS FOR WELL SPACING, IN ACCORDANCE WITH THE ROI MEASURED DURING THE HVDPE PILOT TEST (HVDPE TECH MEMO, TN&A, MARCH 2003).
2. ROIs HAVE THE POTENTIAL TO EXCEED 54' AS A RESULT OF THE EFFECT OF OVERLAPPING ROIs. SHADED AREAS NOT INCLUDED IN THE ROI CIRCLES WILL BENEFIT FROM THIS EFFECT.
3. WELL PLACEMENT CLOSER TO THE L.A. RIVER IS RESTRICTED BY THE STEEP GRADES PROPOSED BY THE MAYWOOD RIVERFRONT PARK GRADING PLANS.
4. COMPOSITE PERCHED PLUME BASED ON SAMPLES COLLECTED IN JANUARY 2002.

0 40 80

APPROXIMATE SCALE IN FEET

BASIS FOR DESIGN OF PERCHED ZONE HVDPE WELL FIELD

PEMACO SUPERFUND SITE
5050 EAST SLAUSON AVENUE
MAYWOOD, CALIFORNIA

PREPARED FOR:
U.S. Environmental Protection Agency
Region IX
San Francisco, California

PREPARED BY:
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Engineering and Science

SCALE: AS SHOWN

APPROVED
DRAFT

DATE: 4/29/2005

DESIGNED: MB & JW
DRAWN: CBG
CHECKED: JW

FIGURE 4–1

REV 6

FILE NAME: Figure4–1_Basis–PerchedR6.DWG

LEGEND:

- >10,000 ug/L TCE
- 1,000–10,000 ug/L TCE
- 100–1,000 ug/L TCE
- 10–100 ug/L TCE
- DAB–1 — PROPOSED EXTRACTION WELL SCREENED THROUGH BOTH 'A' AND 'B' ZONES
- DA–1 DB–1 — PROPOSED NESTED EXTRACTION WELL WITH INDIVIDUAL SCREENS FOR THE 'A' AND 'B' ZONES
- DD–1 — PROPOSED EXTRACTION WELL SCREENED THROUGH 'D' ZONE
- ESTIMATED WELL CAPTURE ZONE FOR 'A' ZONES.
- WATER LINE
- SEWER LINE
- GAS LINE

EXPOSITION ZONE PIPING:

GREEN 1	GW–1	7 WELLS (DAB–1 TO DAB–7) SOUTH TRENCH
GREEN 2	GW–2	15 WELLS (DAB–8, DA/DB–1 TO DA/DB–7) WEST TRENCH
GREEN 3	GW–3	11 WELLS (DA/DB–8 TO DA/DB–12, MW–24–140) E. TRENCH
RED 1	VE–1	7 WELLS (DAB–1 TO DAB–7) SOUTH TRENCH
RED 2	VE–2	15 WELLS (DAB–8, DA/DB–1 TO DA/DB–7) WEST TRENCH

NOTES:

1. THE BASIS FOR DESIGN OF EXPOSITION ZONE WELL SPACING IS 46' DOWNGRADIENT RADIUS OF CAPTURE (ROC) AND 146' CROSS–GRADIENT WIDTH OF CAPTURE AS MEASURED DURING THE AQUIFER PILOT TEST (AQUIFER TECH MEMO, TN&A, MARCH 2002).
2. THE ESTIMATED CAPTURE ZONES ARE INTENDED TO REPRESENT A FINITE DISTANCE IN THE DOWNGRADIENT AND CROSS–GRADIENT DIRECTION. THE UPGRADIENT CAPTURE ZONE IS TIME DEPENDENT AND WILL EVENTUALLY INCLUDE ALL CONTAMINATED ZONED IDENTIFIED IN THE LEGEND.
3. PLUME BASED ON SAMPLES COLLECTED IN JANUARY 2002.
4. THE EXPOSITION ZONE 'A' WELL FIELD HAS BEEN DESIGNED TO INTERCEPT GROUNDWATER FLOWING IN A SOUTHLY DIRECTION BASED ON PLUME SHAPE. THE AVERAGE HYDRAULIC GRADIENT IN THE 'A' ZONE HAVE RANGED FROM 0.0043 TO 0.011 FEET PER FOOT (FT/FT) FROM MAY 2001 TO APRIL 2002.
5. ADDITIONAL GROUNDWATER OR VAPOR EXTRACTION WELLS MAY BE PLACED IN THE >10,000 ug/L PLUME AREA IN ACCORDANCE WITH THE ERH CONTRACTOR'S DESIGN.
6. WELLS ARE SCREENED THROUGH THE 'A' AND 'B' ZONE OUT SIZE THE 100 PPB CONTOUR.

0 60 120
APPROXIMATE SCALE IN FEET

BASIS FOR DESIGN OF EXPOSITION 'A' ZONE WELL FIELD

PEMACO SUPERFUND SITE
5050 EAST SLAUSON AVENUE
MAYWOOD, CALIFORNIA

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Region IX
San Francisco, California

PREPARED BY:
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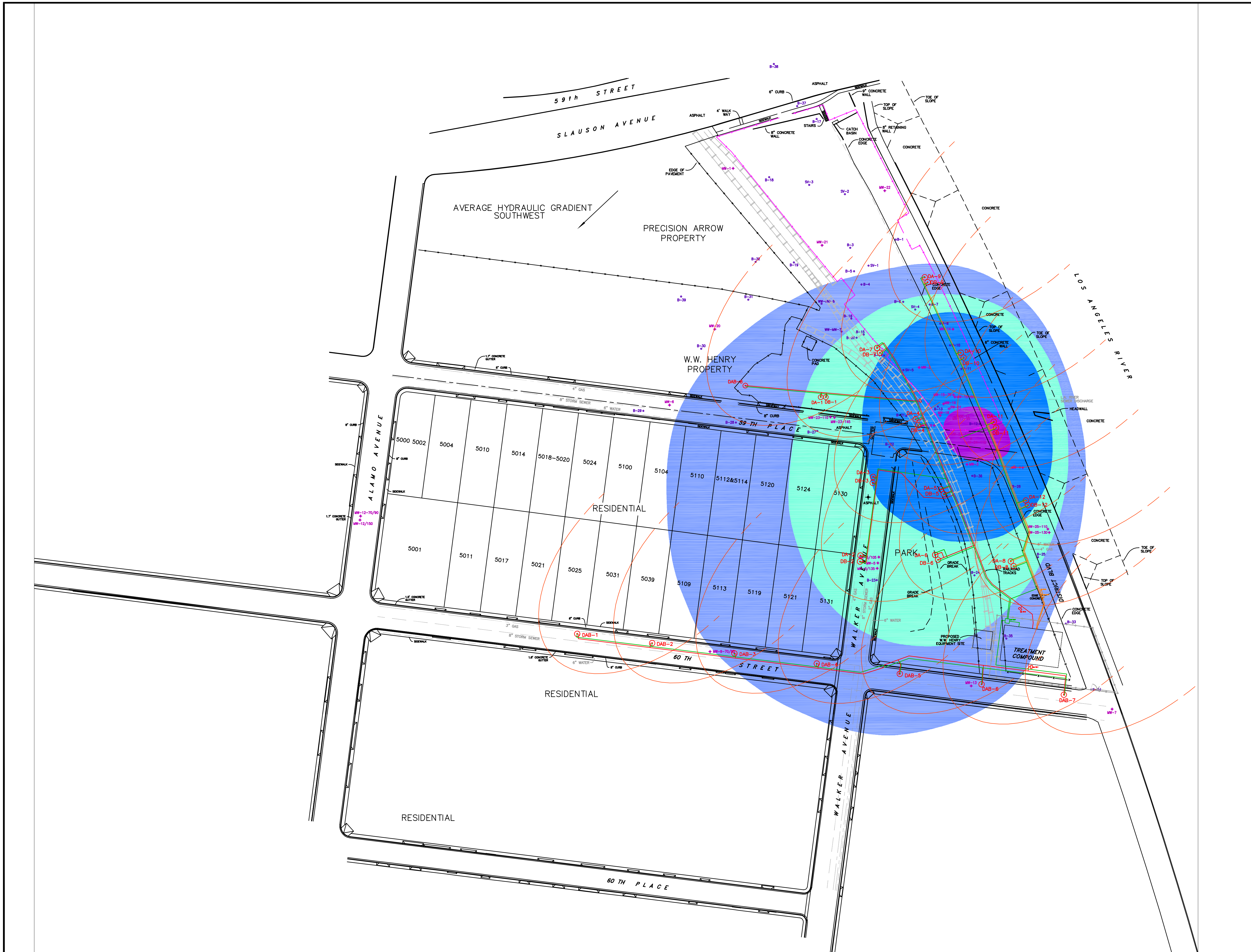
Engineering and Science

SCALE: AS SHOWN
DESIGNED: MB & JW
DRAWN: CBG
CHECKED: JW
APPROVED
DRAFT
DATE: 3/10/2006
FIGURE 4–2
REV 1

FILE NAME: Figure4–2_Basis–ExpoR8.DWG



LEGEND:

- >10,000 ug/L TCE
- 1,000–10,000 ug/L TCE
- 100–1,000 ug/L TCE
- 10–100 ug/L TCE
- DAB–1 — PROPOSED EXTRACTION WELL SCREENED THROUGH BOTH 'A' AND 'B' ZONES
- DA–1 DB–1 — PROPOSED NESTED EXTRACTION WELL WITH INDIVIDUAL SCREENS FOR THE 'A' AND 'B' ZONES
- DD–1 — PROPOSED EXTRACTION WELL SCREENED THROUGH 'D' ZONE
- ESTIMATED WELL CAPTURE ZONE FOR 'B' ZONES.
- WATER LINE
- SEWER LINE
- GAS LINE

EXPOSITION ZONE PIPING:

GREEN 1	GW–1	7 WELLS (DAB–1 TO DAB–7) SOUTH TRENCH
GREEN 2	GW–2	15 WELLS (DAB–8, DA/DB–1 TO DA/DB–7) WEST TRENCH
GREEN 3	GW–3	11 WELLS (DA/DB–8 TO DA/DB–12, MW–24–140) E. TRENCH
RED 1	VE–1	7 WELLS (DAB–1 TO DAB–7) SOUTH TRENCH
RED 2	VE–2	15 WELLS (DAB–8, DA/DB–1 TO DA/DB–7) WEST TRENCH

NOTES:

1. THE BASIS FOR DESIGN OF EXPOSITION ZONE WELL SPACING IS 46' DOWNGRADIENT RADIUS OF CAPTURE (ROC) AND 146' CROSS–GRADIENT WIDTH OF CAPTURE AS MEASURED DURING THE AQUIFER PILOT TEST (AQUIFER TECH MEMO, TN&A, MARCH 2002).
2. THE ESTIMATED CAPTURE ZONES ARE INTENDED TO REPRESENT A FINITE DISTANCE IN THE DOWNGRADIENT AND CROSS–GRADIENT DIRECTION. THE UPGRADIENT CAPTURE ZONE IS TIME DEPENDENT AND WILL EVENTUALLY INCLUDE ALL CONTAMINATED ZONED IDENTIFIED IN THE LEGEND.
3. PLUME BASED ON SAMPLES COLLECTED IN JANUARY 2002.
4. THE EXPOSITION ZONE 'B' WELL FIELD HAS BEEN DESIGNED TO INTERCEPT GROUNDWATER FLOWING IN A SOUTHWESTERLY DIRECTION BASED ON PLUME SHAPE. APPARENT GROUNDWATER FLOW DIRECTIONS HAVE BEEN CONSISTENTLY TOWARD THE SOUTHWEST HYDRAULIC GRADIENTS IN THE 'B' ZONE RANGED FROM 0.0063 TO 0.0092 FT/FT APPARENT GROUNDWATER FLOW DIRECTIONS FROM MAY 2001 TO APRIL 2002.
5. ADDITIONAL GROUNDWATER OR VAPOR EXTRACTION WELLS MAY BE PLACED IN THE >10,000 ug/L PLUME AREA IN ACCORDANCE WITH THE ERH CONTRACTOR'S DESIGN.
6. WELLS ARE SCREENED THROUGH THE 'A' AND 'B' ZONE OUT SIZE THE 100 PPB CONTOUR.

0 60 120
APPROXIMATE SCALE IN FEET

BASIS FOR DESIGN OF EXPOSITION 'B' ZONE WELL FIELD

PEMACO SUPERFUND SITE
5050 EAST SLAUSON AVENUE
MAYWOOD, CALIFORNIA

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PREPARED BY:
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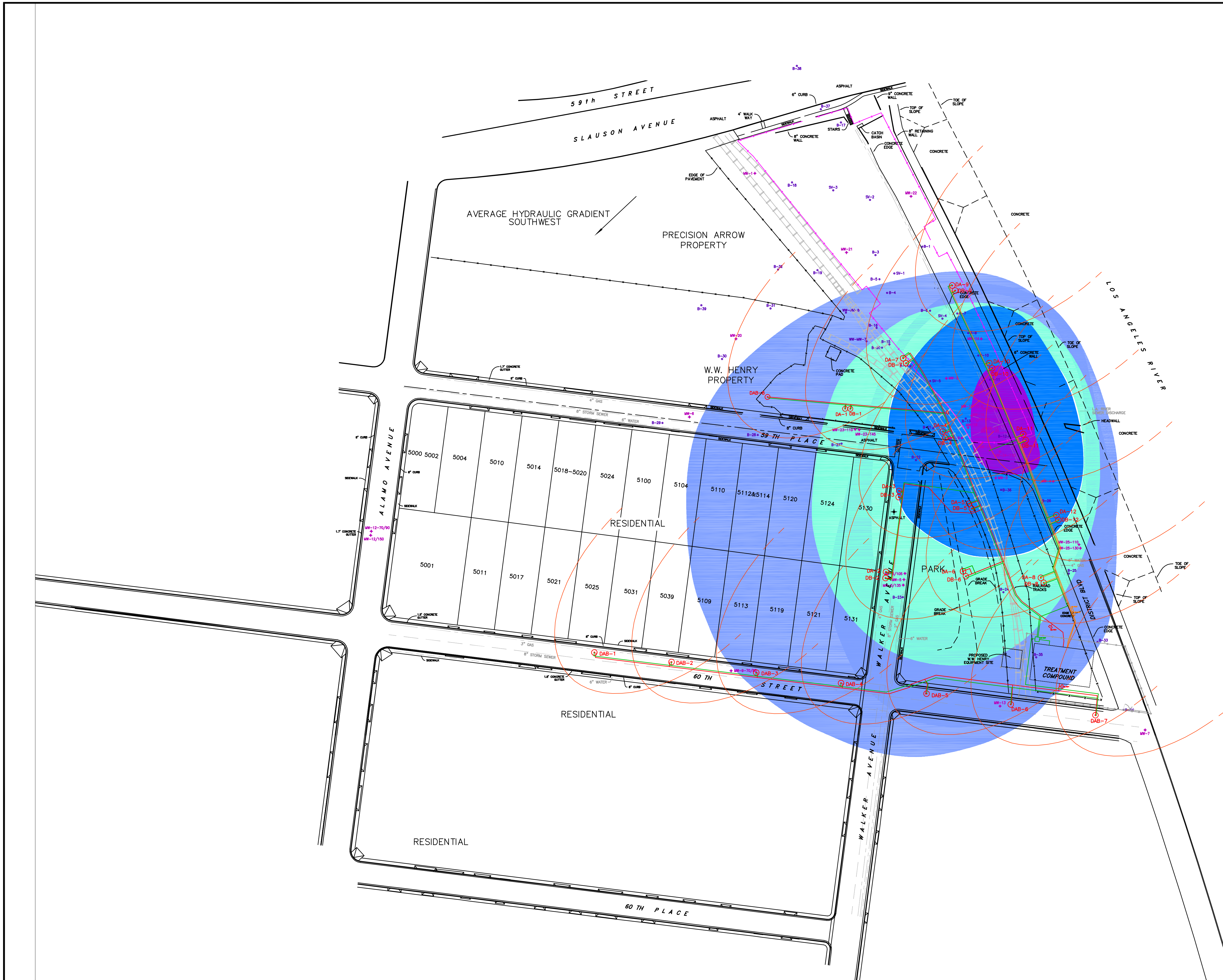
FIGURE 4–3
REV 1

FILE NAME: Figure4–2_Basis–ExpoR8.DWG



LEGEND:

- >10,000 ug/L TCE
- 1,000–10,000 ug/L TCE
- 100–1,000 ug/L TCE
- 10–100 ug/L TCE
- DAB–1: PROPOSED EXTRACTION WELL SCREENED THROUGH BOTH 'A' AND 'B' ZONES
- DA–1 DB–1: PROPOSED NESTED EXTRACTION WELL WITH INDIVIDUAL SCREENS FOR THE 'A' AND 'B' ZONES
- DD–1: PROPOSED EXTRACTION WELL SCREENED THROUGH 'D' ZONE
- ESTIMATED WELL CAPTURE ZONE FOR 'A' AND 'B' ZONES.
- WATER LINE
- SEWER LINE
- GAS LINE

EXPOSITION ZONE PIPING:

GREEN 1	GW–1	7 WELLS (DAB–1 TO DAB–7) SOUTH TRENCH
GREEN 2	GW–2	15 WELLS (DAB–8, DA/DB–1 TO DA/DB–7) WEST TRENCH
GREEN 3	GW–3	11 WELLS (DA/DB–8 TO DA/DB–12, MW–24–140) E. TRENCH
RED 1	VE–1	7 WELLS (DAB–1 TO DAB–7) SOUTH TRENCH
RED 2	VE–2	15 WELLS (DAB–8, DA/DB–1 TO DA/DB–7) WEST TRENCH

NOTES:

1. THE BASIS FOR DESIGN OF EXPOSITION ZONE WELL SPACING IS 46' DOWNGRADIENT RADIUS OF CAPTURE (ROC) AND 146' CROSS–GRADIENT WIDTH OF CAPTURE AS MEASURED DURING THE AQUIFER PILOT TEST (AQUIFER TECH MEMO, TN&A, MARCH 2002).
2. THE ESTIMATED CAPTURE ZONES ARE INTENDED TO REPRESENT A FINITE DISTANCE IN THE DOWNGRADIENT AND CROSS–GRADIENT DIRECTION. THE UPGRADIENT CAPTURE ZONE IS TIME DEPENDENT AND WILL EVENTUALLY INCLUDE ALL CONTAMINATED ZONED IDENTIFIED IN THE LEGEND.
3. PLUME BASED ON SAMPLES COLLECTED IN JANUARY 2002.
4. THE EXPOSITION ZONE 'A' AND 'B' WELL FIELD HAS BEEN DESIGNED TO INTERCEPT GROUNDWATER FLOWING IN A SOUTHWESTERLY DIRECTION BASED ON PLUME SHAPE.
   HYDRAULIC GRADIENTS IN THE 'A' ZONE HAVE RANGED FROM 0.0043 TO 0.011 FEET PER FOOT (FT/FT) FROM MAY 2001 TO APRIL 2002. HYDRAULIC GRADIENTS IN THE 'B' ZONE RANGED FROM 0.0063 TO 0.0092 FT/FT APPARENT GROUNDWATER FLOW DIRECTIONS FROM MAY 2001 TO APRIL 2002.
5. ADDITIONAL GROUNDWATER OR VAPOR EXTRACTION WELLS MAY BE PLACED IN THE >10,000 ug/L PLUME AREA IN ACCORDANCE WITH THE ERH CONTRACTOR'S DESIGN.
6. WELLS ARE SCREENED THROUGH THE 'A' AND 'B' ZONE OUT SIZE THE 100 PPB CONTOUR.

0 60 120
APPROXIMATE SCALE IN FEET

BASIS FOR DESIGN OF EXPOSITION 'A' AND 'B' ZONE WELL FIELD

PEMACO SUPERFUND SITE
5050 EAST SLAUSON AVENUE
MAYWOOD, CALIFORNIA

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Region IX
San Francisco, California

PREPARED BY:
T N & Associates, Inc.
Engineering and Science

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DATE: 3/10/2006
FIGURE 4–4
REV 1

FILE NAME: Figure4–2_Basis–ExpoR8.DWG

LEGEND:

- >100 ug/L TCE
- DD-1 PROPOSED EXTRACTION WELL SCREENED THROUGH 'D' ZONE
- ESTIMATED WELL CAPTURE ZONE FOR 'D' ZONE.
- WATER LINE
- SEWER LINE
- GAS LINE

EXPOSITION ZONE PIPING:

GREEN 3 GW-3 EAST TRENCH
13 WELLS (DA/DB-9 TO DA/DB-12, DD-1)
ONLY DD-1 SHOWN.

NOTES:

1. THE BASIS FOR DESIGN OF EXPOSITION ZONE WELL SPACING IS 59.2' DOWNGRADIENT RADIUS OF CAPTURE (ROC) AND 166.04' CROSS-GRADIENT WIDTH OF CAPTURE WERE ESTIMATED BY CALCULATING HYDRAULIC CONDUCTIVITY FOR EACH ZONE UTILIZING OBSERVED AQUIFER THICKNESSES (AS LOGGED BY A FIELD GEOLOGIST DURING WELL INSTALLATION ACTIVITIES IN MARCH 2005).
2. THE ESTIMATED CAPTURE ZONES ARE INTENDED TO REPRESENT A FINITE DISTANCE IN THE DOWNGRADIENT AND CROSS-GRADIENT DIRECTION. THE UPGRADIENT CAPTURE ZONE IS TIME DEPENDENT AND WILL EVENTUALLY INCLUDE ALL CONTAMINATED ZONED IDENTIFIED IN THE LEGEND.
3. THE EXPOSITION ZONE 'D' WELL FIELD HAS BEEN DESIGNED TO INTERCEPT GROUNDWATER FLOWING IN A SOUTHWESTERLY DIRECTION, WHICH IS REPRESENTATIVE OF THE AVERAGE HYDRAULIC GRADIENT OF THE 'D' ZONE PLUME MAP. THE HYDRAULIC GRADIENT IN THE 'D' ZONE IS ESTIMATED AT 0.0013 FT/FT IN THE SOUTH SOUTHWEST DIRECTION.

0 60 120
APPROXIMATE SCALE IN FEET

BASIS FOR DESIGN OF EXPOSITION 'D' ZONE WELL FIELD

PEMACO SUPERFUND SITE
5050 EAST SLAUSON AVENUE
MAYWOOD, CALIFORNIA

PREPARED FOR:
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Region IX
San Francisco, California

PREPARED BY:
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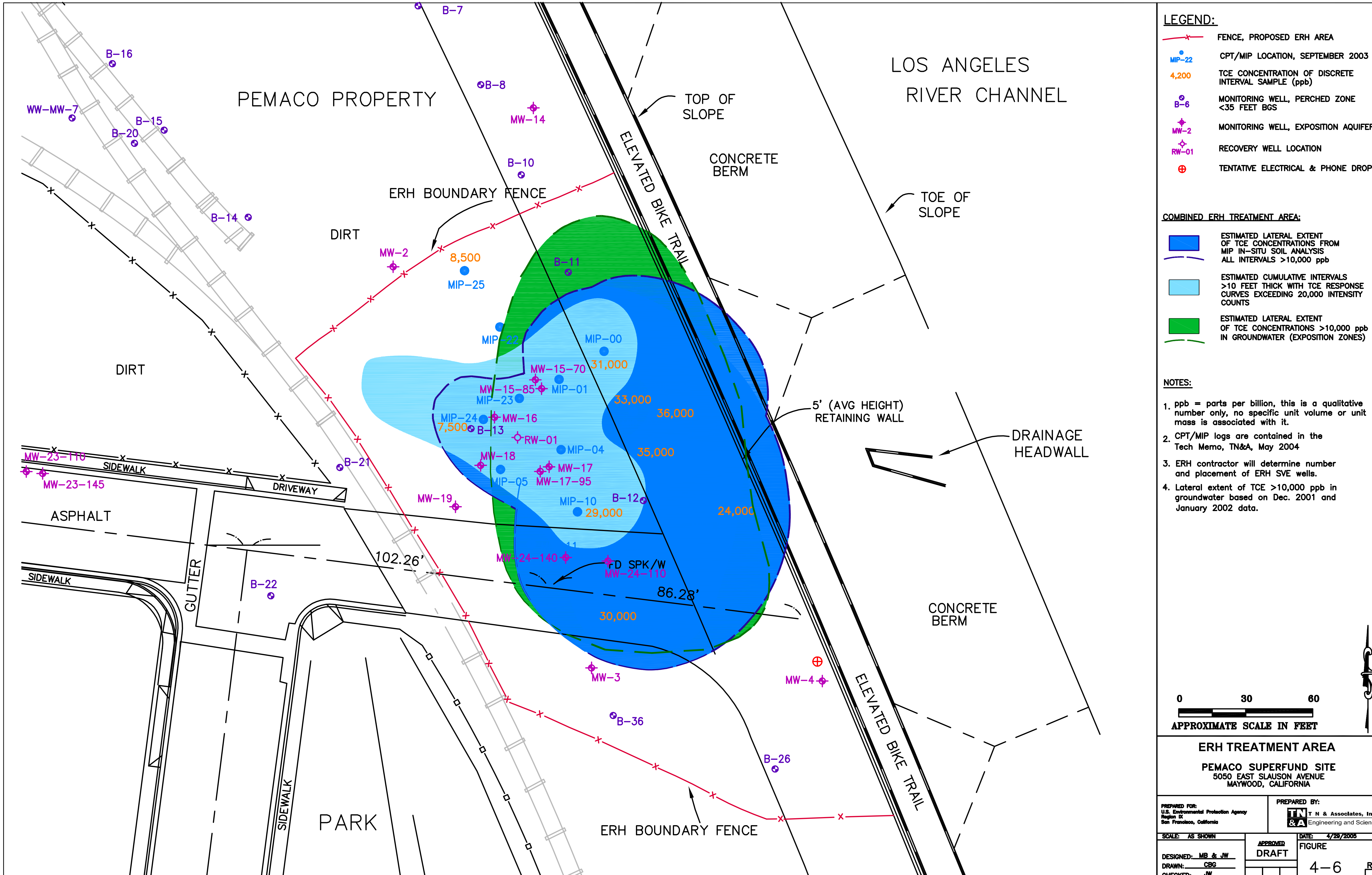
Engineering and Science

SCALE: AS SHOWN	APPROVED	DATE: 4/29/2005
DESIGNED: MB & JW DRAWN: CBG CHECKED: JW	DRAFT	FIGURE 4-5 REV 0

FILE NAME: Figure4-3_Basis-ExpoDZoneR0.DWG



LEGEND:
FENCE, PROPOSED ERH AREA
MIP-22
CPT/MIP LOCATION, SEPTEMBER 2003
4,200
TCE CONCENTRATION OF DISCRETE INTERVAL SAMPLE (ppb)
B-6
MONITORING WELL, PERCHED ZONE <35 FEET BGS
MW-2
MONITORING WELL, EXPOSITION AQUIFER
RW-01
RECOVERY WELL LOCATION
TENTATIVE ELECTRICAL & PHONE DROP
COMBINED ERH TREATMENT AREA:
ESTIMATED LATERAL EXTENT OF TCE CONCENTRATIONS FROM MIP IN-SITU SOIL ANALYSIS ALL INTERVALS >10,000 ppb
ESTIMATED CUMULATIVE INTERVALS >10 FEET THICK WITH TCE RESPONSE CURVES EXCEEDING 20,000 INTENSITY COUNTS
ESTIMATED LATERAL EXTENT OF TCE CONCENTRATIONS >10,000 ppb IN GROUNDWATER (EXPOSITION ZONES)
NOTES:
1. ppb = parts per billion, this is a qualitative number only, no specific unit volume or unit mass is associated with it.
2. CPT/MIP logs are contained in the Tech Memo, TN&A, May 2004
3. ERH contractor will determine number and placement of ERH SVE wells.
4. Lateral extent of TCE >10,000 ppb in groundwater based on Dec. 2001 and January 2002 data.
0
30
60
APPROXIMATE SCALE IN FEET
PEMACO PROPERTY
LOS ANGELES RIVER CHANNEL
TOP OF SLOPE
TOE OF SLOPE
CONCRETE BERM
ELEVATED BIKE TRAIL
ERH BOUNDARY FENCE
DIRT
DIRT
ASPHALT
SIDEWALK
DRIVEWAY
GUTTER
SIDEWALK
SIDEWALK
PARK
5' (AVG HEIGHT) RETAINING WALL
DRAINAGE HEADWALL
CONCRETE BERM
ELEVATED BIKE TRAIL
ERH BOUNDARY FENCE
FD SPK/W
102.26'
86.28'
B-7
B-8
B-16
WW-MW-7
B-15
B-20
B-14
MW-14
B-10
MW-2
8,500
MIP-25
B-11
MIP-22
MIP-00
31,000
MW-15-70
MW-15-85
MIP-01
MIP-23
33,000
36,000
MIP-24
7,500
B-13
MW-16
RW-01
MIP-04
35,000
MW-18
MW-17
MW-17-95
MIP-05
MW-23-110
MW-23-145
B-21
MW-19
MIP-10
29,000
B-12
24,000
MW-24-140
MW-24-110
B-22
30,000
MW-3
MW-4
B-36
B-26
ERH TREATMENT AREA
PEMACO SUPERFUND SITE
5050 EAST SLAUSON AVENUE
MAYWOOD, CALIFORNIA
PREPARED FOR:
U.S. Environmental Protection Agency
Region IX
San Francisco, California
PREPARED BY:
TN & A
T N & Associates, Inc.
Engineering and Science
SCALE: AS SHOWN
DATE: 4/29/2005
DESIGNED: MB & JW
DRAWN: CBG
CHECKED: JW
APPROVED
DRAFT
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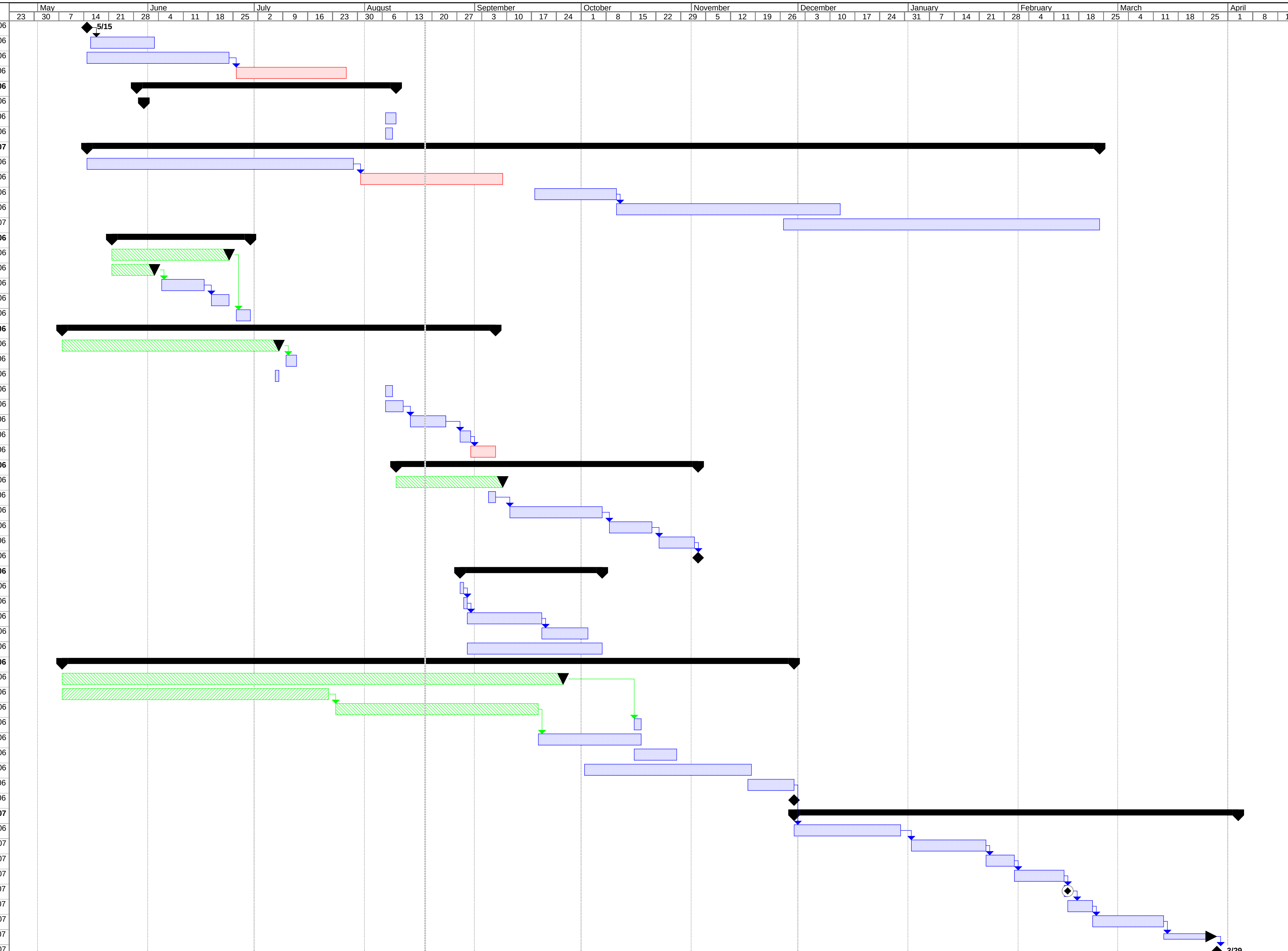
REMEDIAL ACTION CONSTRUCTION SCHEDULE - PHASE II
(Revised 8/1/06)
PEMACO SUPERFUND SITE
MAYWOOD, CA

ID	Task Name	Duration	Start	Finish
1	USACE Approval of Construction Plan	1 day	Mon 5/15/06	Mon 5/15/06
2	Notification of Subs., Labor, & Suppliers	14 days	Tue 5/16/06	Fri 6/2/06
3	RA Design Plans, Work Plans, & HASP	30 days	Mon 5/15/06	Fri 6/23/06
4	DTSC Approval of Plans	23 days	Mon 6/26/06	Wed 7/26/06
5	**Mobilization / Preparation**	**53 days**	**Mon 5/29/06**	**Wed 8/9/06**
6	Install ERH fence for park opening	2 days	Mon 5/29/06	Tue 5/30/06
7	Move Construction Office, estab. utilities	3 days	Mon 8/7/06	Wed 8/9/06
8	Move tools and parts to site	2 days	Mon 8/7/06	Tue 8/8/06
9	**ERH SUBCONTRACTOR WORK**	**205 days**	**Mon 5/15/06**	**Fri 2/23/07**
10	Design Plans, Work Plans, Permits	55 days	Mon 5/15/06	Fri 7/28/06
11	DTSC Approval of Plans	30 days	Mon 7/31/06	Fri 9/8/06
12	Install/Sample Thermocouples Wells	17 days	Mon 9/18/06	Tue 10/10/06
13	Drilling and Electrode Install	45 days	Wed 10/11/06	Tue 12/12/06
14	Surface Installation and Start-Up tests	65 days	Mon 11/27/06	Fri 2/23/07
15	**ERH Electrical Installation**	**29 days**	**Mon 5/22/06**	**Thu 6/29/06**
16	Lead Time For SCE Equip.	25 days	Mon 5/22/06	Fri 6/23/06
17	Lead Time for Sub. Vault Equip.	10 days	Mon 5/22/06	Fri 6/2/06
18	Earthwork - trenchs, vault excavation	10 days	Mon 6/5/06	Fri 6/16/06
19	Install vaults and conduit	5 days	Mon 6/19/06	Fri 6/23/06
20	SCE install meter, trans. pull wire	4 days	Mon 6/26/06	Thu 6/29/06
21	**Treatment Cmpd. Earthwork & Concrete**	**88 days**	**Mon 5/8/06**	**Wed 9/6/06**
22	Lead Time - Structural Stamp & Plan Approval	45 days	Mon 5/8/06	Fri 7/7/06
23	Plan Approval	3 days	Mon 7/10/06	Wed 7/12/06
24	Construction/geophysical survey & staking	1 day	Fri 7/7/06	Fri 7/7/06
25	Subgrade material test	2 days	Mon 8/7/06	Tue 8/8/06
26	Mob., excavate, compact, test subgrade	5 days	Mon 8/7/06	Fri 8/11/06
27	Forms, steel reinforcement, subslab conduit	8 days	Mon 8/14/06	Wed 8/23/06
28	Pour Concrete & finish surface	3 days	Mon 8/28/06	Wed 8/30/06
29	Concrete cure	5 days	Thu 8/31/06	Wed 9/6/06
30	**Metal Building Erection**	**61 days**	**Thu 8/10/06**	**Thu 11/2/06**
31	Lead Time For Metal Febrication	22 days	Thu 8/10/06	Fri 9/8/06
32	Mob. parts, equip., labor	2 days	Tue 9/5/06	Wed 9/6/06
33	Building erection	20 days	Mon 9/11/06	Fri 10/6/06
34	Interior walls, vents, partition	10 days	Mon 10/9/06	Fri 10/20/06
35	Misc. hardware, punchlist, and correction	8 days	Mon 10/23/06	Wed 11/1/06
36	City/seismic inspections	1 day	Thu 11/2/06	Thu 11/2/06
37	**Groundwater and Condensate Sump Install**	**30 days**	**Mon 8/28/06**	**Fri 10/6/06**
38	Construction Measure and staking.	1 day	Mon 8/28/06	Mon 8/28/06
39	GW & Cond. sump earthwork	1 day	Tue 8/29/06	Tue 8/29/06
40	GW & Cond. sump build/install	15 days	Wed 8/30/06	Tue 9/19/06
41	Surface vault completions	9 days	Wed 9/20/06	Mon 10/2/06
42	Install GW pumps and complete wellheads	28 days	Wed 8/30/06	Fri 10/6/06
43	**Facilities & Treatment Equipment Installation**	**148 days**	**Mon 5/8/06**	**Wed 11/29/06**
44	FTO Purchase Lead Time	101 days	Mon 5/8/06	Mon 9/25/06
45	Subcontractor Bid Package/contracting	55 days	Mon 5/8/06	Fri 7/21/06
46	Work Plans and Equipment Procurement	41 days	Mon 7/24/06	Mon 9/18/06
47	Deliver & Install FTO	2 days	Mon 10/16/06	Tue 10/17/06
48	Deliver/Install Treatment Equipment	21 days	Tue 9/19/06	Tue 10/17/06
49	Internal & external electrical, lighting, PLC	10 days	Mon 10/16/06	Fri 10/27/06
50	Connect/Plumb treatment equip.	35 days	Mon 10/2/06	Fri 11/17/06
51	Punchlist, QC, corrections	9 days	Fri 11/17/06	Wed 11/29/06
52	City/seismic inspections	1 day	Wed 11/29/06	Wed 11/29/06
53	**Start-up Operation and Testing**	**89 days**	**Thu 11/30/06**	**Tue 4/3/07**
54	MPE and GW System start-up, line balancing	22 days	Thu 11/30/06	Fri 12/29/06
55	Effluent sampling and analysis, rapid TAT	15 days	Tue 1/2/07	Mon 1/22/07
56	Begin baseline O&M & troubleshoot	6 days	Tue 1/23/07	Tue 1/30/07
57	Optimization and improvement	10 days	Wed 1/31/07	Tue 2/13/07
58	RPM demonstration	1 day	Wed 2/14/07	Wed 2/14/07
59	Upgrades and improvements	5 days	Thu 2/15/07	Wed 2/21/07
60	ERH start-up and effluent testing	14 days	Thu 2/22/07	Tue 3/13/07
61	Begin continuous full scale O&M	11 days	Wed 3/14/07	Wed 3/28/07
62	City Facility Tour and Demonstration	4 days	Thu 3/29/07	Tue 4/3/07



Pemaco Superfund Site
Remedial Action
Draft Schedule: 5-04-06

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

Note:
1. The latest schedule was updated on August 1, 2006.