PARSONS

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June 15, 2000

Ms. Susan Hugo
Alameda County Department of
Environmental Health
1131 Harbor Bay Parkway
Alameda County
Alameda, California 94502

RE: Greyhound Terminal
Location #8943/892540
Oakland, California
Closure Report for No Further Action Status

Dear Ms. Hugo:

On behalf of Greyhound Lines, Inc. (Greyhound), Parsons Engineering Science, Inc. (Parsons ES) is pleased to provide the Alameda County Department of Environmental Health (ACDEH) with this closure report requesting no further action (NFA) status for the Greyhound Terminal facility located at 2103 San Pablo Avenue in Oakland, California (see Attachment A; Figure 1 for site location). This report includes a brief discussion of the site history, existing conditions, and rationale for site closure with residual petroleum impacts remaining. This report also provides all additional information required for closure reports as specified in Appendix B of the RWQCB document entitled, "Tri-Regional Board Staff Recommendations for Preliminary Investigation and Evaluation of Underground Tank Sites, Requests for Closure, March 1, 1994." The following discussion addresses each requirement for closure reports as specified by the RWQCB.

Requirement #1: Site History and Existing Conditions

In 1990, Greyhound removed six diesel fuel underground storage tanks (USTs) and associated piping (Brown and Caldwall Consulting Engineers).

In November 1991, a preliminary site investigation was conducted. A total of five borings (ES-1 through ES-5) were advanced to evaluate the type, magnitude, and lateral and vertical extent of any soil impacts that might be present as a result of past fueling operations (see Attachment A; Figure 2 for the soil boring locations). A soil sample was collected from each boring and analyzed for total petroleum hydrocarbons as diesel TPHD and benzene, toluene, ethylbenzene, and xylenes (BTEX). The soil borings were subsequently converted to monitoring wells to characterize hydrogeologic condi-tions and groundwater quality. The wells were monitored for phase-separated hydrocarbon (PSH) accumulation and depth to groundwater, and groundwater samples were collected and analyzed for TPHD and BTEX.

Based on the results of the preliminary investigation, a groundwater monitoring program was initiated by Greyhound in June 1992 to further assess the impact of former UST operations on groundwater quality. The program included monthly groundwater level measurements, quarterly groundwater sampling, and reporting.

Based on the presence of measurable thicknesses of PSH discovered in four onsite monitoring wells, Greyhound subsequently proposed the installation of an automated PSH recovery system. Upon ACDEH approval in October 1992, Greyhound obtained the required permits and installed a onsite recovery system during the week of November 9, 1992. A report detailing recovery system installation was submitted to ACDEH on December 18, 1992. The recovery system was placed in cooperation during the week of January 4, 1993, after discharge permit conditions were finalized with the East Bay Municipal Utility District (EBMUD).

In a letter to Greyhound dated October 23, 1992, ACDEH requested that Greyhound provide documentation regarding the underground fuel storage tank system (UST) removal, including disposal documentation. Greyhound subsequently prepared a Tank Closure Documentation Report for the facility. The report was submitted to ACDEH on December 15, 1992.

In July 1993, Greyhound implemented a Supplemental Site Assessment at the facility to define the full extent of petroleum impacts both on and off site. Six monitoring wells ES-6 through ES-11 (see Attachment A; Figure 2) were installed and sampled during the investigation. Results of the Supplemental Site Assessment indicated that the residual soil and groundwater impacts were limited to the former onsite tank pit area. Greyhound presented these results to ACDEH in a meeting on September 1, 1993. At that time, ACDEH indicated that a risk assessment could be prepared to support "alternative points of compliance" or site-specific cleanup levels for this site. Greyhound submitted a Preliminary Risk Evaluation Report to ACDEH in October 1993. The Supplemental Site Assessment Report was submitted in November 1993.

During October 1995, after more than two years of remedial system operations and quarterly sampling, the scope of the quarterly groundwater sampling program was reduced to collecting and analyzing samples from three monitoring wells (ES-3, ES-4, and ES-6) with annual sampling of ES-7, ES-8, and ES-11. This reduction was discussed during an October 13, 1995, meeting between Greyhound and ACDEH, and confirmed in an October 31, 1995 letter from Greyhound to ACDEH.

Later, in February 1997, ACDEH authorized deactivation of the total fluid recovery system and modified the groundwater monitoring program. The modified groundwater program consisted of quarterly monitoring for the presence of PSHs, quarterly measurement of groundwater elevations, quarterly sampling of wells ES-1, ES-2, ES-3, ES-4, ES-5, ES-6, BC-1, BC-2, and BC-3; and annual sampling of wells ES-7, ES-8, and ES-11. Analysis of TPH-G, TPH-D, BTEX, methyl-tert-butyl-ether (MTBE), and PAHs (if TPH-D is detected) was specified.

In December 1997, the groundwater monitoring program was terminated with ACDEH and RWQCB's approval.

Requirement #2: Distance/Survey of Production Wells within 2,000 Feet of the Site

The City of Oakland obtains its municipal and industrial water from the East Bay Municipal Utility District (EBMUD). EBMUD imports this water primarily from the surface waters of the Sierra Nevada Mountain Range, located approximately 200 miles east of the site.

Groundwater in the area is utilized for limited irrigation and industrial purposes. The area is not considered a primary source of water supply because of the limited areal extent and thickness of the water-bearing unit (Alameda County Flood Control and Water Conservation District, 1988).

Approximately 384 wells are located within Section 26, Township 1S, Range 4W (ACPWA, 1991). The vast majority (99%) of these wells are used to monitor or extract contaminated groundwater at commercial/industrial sites. One of the wells is used to supply water for irrigation. None of the wells located in Section 26 are used for municipal water supply

Requirement #3: Site Maps

Refer to Attachment A for maps depicting site location, scaled site plan, soil boring and monitoring well locations, and site groundwater elevation contours.

Requirement #4: High and Low Groundwater Levels

The surface water body that is nearest to the Greyhound site is Lake Merritt, located approximately 1,700 feet east of the site (Figure 1). Lake Merritt is a brackish-water estuarine environment, connected to and influenced by the tidal fluctuations of San Francisco Bay. The Oakland Inner Harbor, the closest portion of the bay, is located approximately 2,700 feet south-southwest of the site.

The Greyhound facility lies within the Merritt Sand sub-area of the East Bay Plain Groundwater Basin. Locally, groundwater encountered at a depth of 18 to 22 feet below ground surface (bgs). Regional groundwater flow is to the west-southwest (Alameda County Flood Control and Water Conservation District, 1988). Based on groundwater elevation data collected during quarterly monitoring site visits, shallow groundwater flow direction appears to be toward the southeast. The groundwater elevation contour map from 1997 quarterly monitoring site visit is provided in Attachment A, and a summary task of all PSH thicknesses and water level collected to date is included in Attachment B.

Requirement #5: Tabulated Results of all Sampling and Analysis

Refer to Attachment C for summary table of sampling and analytical results conducted at the site to date.

Requirement #6: Vertical and Lateral Concentrations of Contaminants Found Initially, and Those Remaining in the Soil and Groundwater, Both On and Off Site.

Refer to Attachment D for vertical and lateral concentrations of petroleum impacts (graphically depicted) found initially, and those remaining in the soil and groundwater, both on and offsite.

Requirement #7: Maximum Calculation of the Substance Treated Versus that Remaining.

No soil remediation was required at the site.

Requirement #8: Technology Used to Clean the Site.

In October 1992, Greyhound proposed a total fluid recovery system to remove PSHs discovered in four onsite wells (ES-1, ES-2, ES-5, and BC-1). The remedial system was installed in November 1992 after receiving approval from ACDEH and was activated during the week of January 4, 1993. The system was deactivated in late 1997, as authorized by ACDEH in a February 19, 1997, letter.

Requirement #9: Zone of Influence Calculated for the Subsurface Remediation System and the Zone of Capture Attained for the Soil and Groundwater Remediation System.

The zone of capture attained for the groundwater remediation was a minimum of 30 feet. The distance was estimated based on water level measurements collected during monthly monitoring site visits for a period of five years.

Requirement #10: Reasons Why "Background" was/is Unattainable Using Best Available Technology.

The total fluid recovery system was operated for a total of five years. During this time period, PSH was completely removed and dissolved constituents were reduced to levels of diminishing returns. The risk assessment previously conducted indicated minimal threat to human health and the environment based on remaining levels of dissolved constituents. Dissolved constituents were never found to have migrated offsite from the source area.

Requirement #11: Rationale Why Conditions Remaining at the Site Will Not Adversely Impact Water Quality, Health, or Other Beneficial Uses.

Based on past historical analytical data, a Preliminary Risk Evaluation (PRE) completed in October 1993, and a Tier II Benzene Assessment for groundwater recently completed at the request of ACDEH, it is likely that the current conditions remaining at the site will not adversely impact human health and the environment under current land use. Factors limiting potential adverse impacts include the limited horizontal and vertical extent of the dissolved hydrocarbon plume and the removal of PSH from the vicinity of the former UST locations. The absence of potable drinking wells or reservoirs located within a one mile radius of the site (nearest potable water source is 200 miles away) is also an important factor. Conclusions from both the PRE and Tier II Benzene assessment (see Attachment E) indicated the lack of any significant health or environmental threats to current or future users of the site under current use conditions.

CONCLUSION AND RECOMMENDATIONS

Based on information obtained to date and summarized above, the residual petroleum impacts remaining beneath the site do not represent a significant threat to groundwater under current use conditions. However, a restriction should be applied so that conditions will be re-evaluated and proper steps taken to ensure human health and safety under potential future land use scenarios and groundwater beneath the site should be prohibited for potable uses. It is recommended that no further action status be granted for the site with a deed restriction and Risk Management Plan in place to ensure that any future changes in land use take into account the residual petroleum impacts present.

Greyhound looks forward to ACDEH's favorable review of this report. In the interim, if you have any questions or require additional information please contact us at (315) 451-9560.

Sincerely,

PARSONS ENGINEERING SCIENCE, INC.

Edward J. Ashton
Project Geologist

D. Alan Nickerson
Project Manager

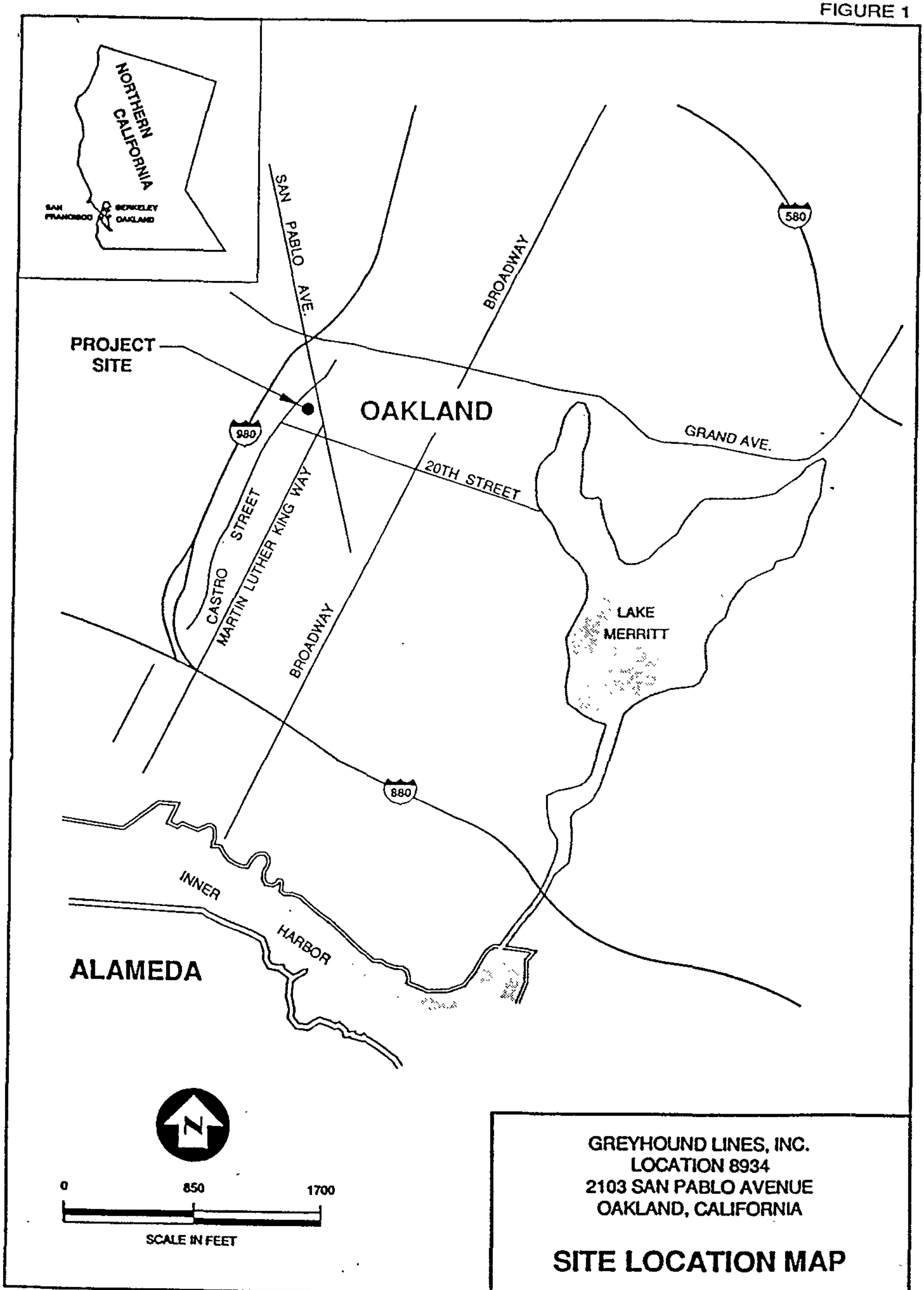
Attachments

cc: Ms. June Weirich, Greyhound, Dallas, TX
Project File: 728878.08943

ATTACHMENT A

SITE MAPS

FIGURE 1

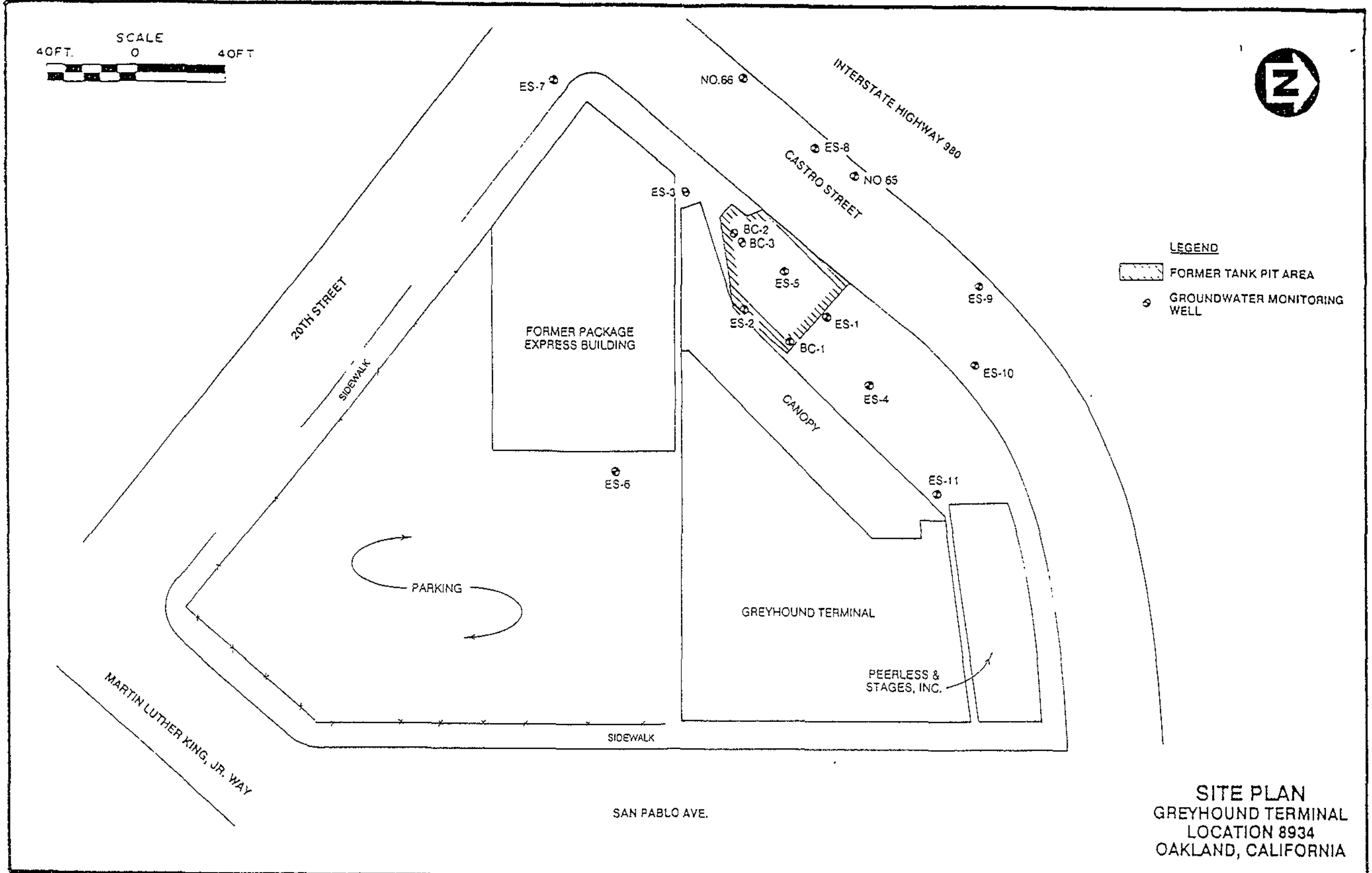


GREYHOUND LINES, INC.
LOCATION 8934
2103 SAN PABLO AVENUE
OAKLAND, CALIFORNIA

SITE LOCATION MAP

ENGINEERING-SCIENCE, INC.

FIGURE 2

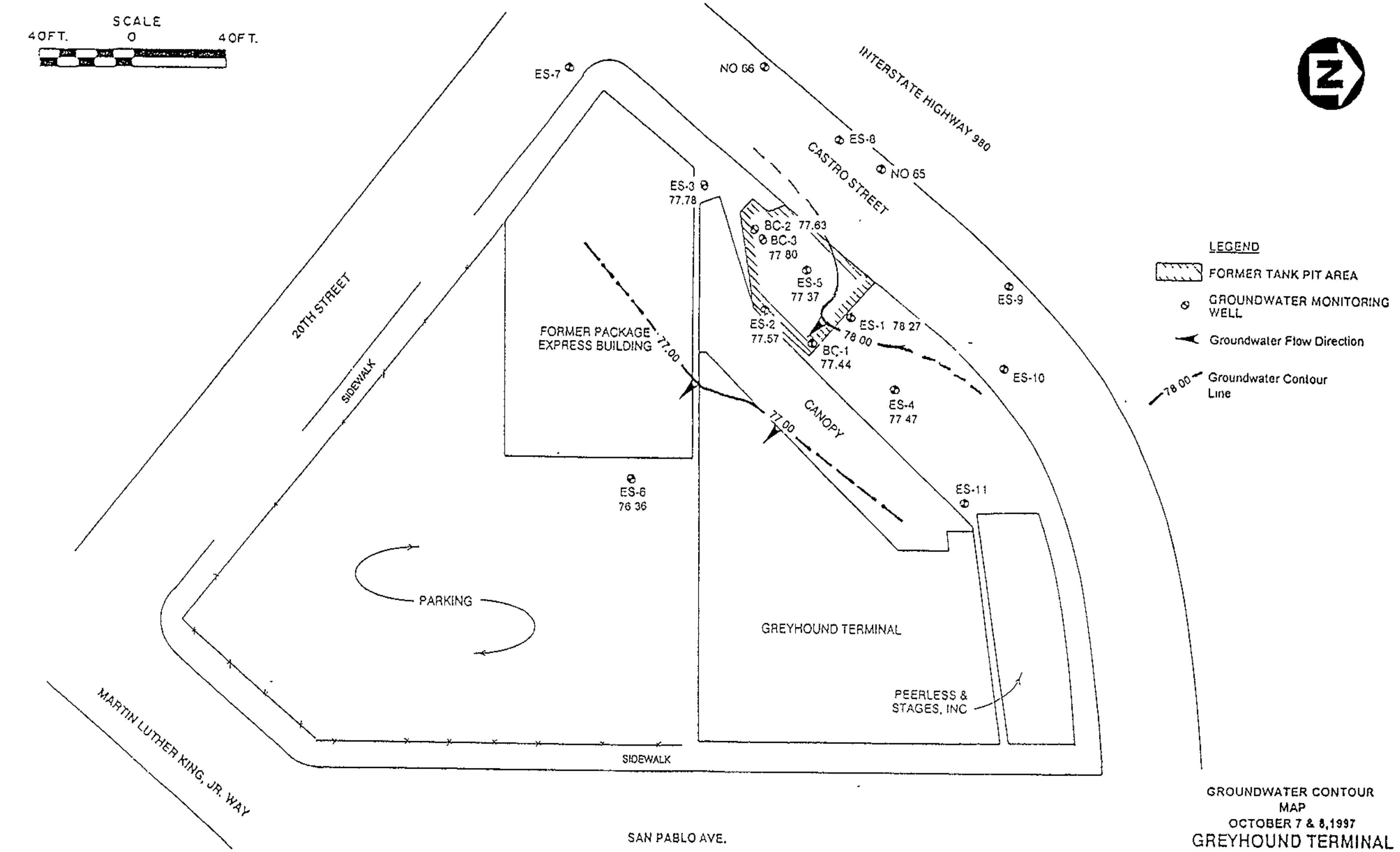


SITE PLAN
GREYHOUND TERMINAL
LOCATION 8934
OAKLAND, CALIFORNIA

SY356.06

PARSONS ENGINEERING SCIENCE, INC.

FIGURE 3



GROUNDWATER CONTOUR MAP
OCTOBER 7 & 8,1997
GREYHOUND TERMINAL
LOCATION 8934
OAKLAND, CALIFORNIA

SY356.06

PARSONS ENGINEERING SCIENCE, INC.

ATTACHMENT B

GROUNDWATER SUMMARY OF HIGH AND LOW WATER LEVELS FROM JUNE 1992 THROUGH DECEMBER 1995

FACILITY NO.: 8934
FACILITY NAME:
STATE: CA
FACILITY TYPE:

Well ID	Date	DEPTH TO LIQUID (ft)	DEPTH TO WATER (ft)	PRODUCT THICKNESS (ft)
BC-001	7/07/92	19.55	20.66	1.11
BC-001	8/04/92	18.47	20.90	2.43
BC-001	8/31/92	18.68	21.02	2.34
BC-001	10/06/92	18.82	21.14	2.32
BC-001	11/06/92	18.24	20.69	2.45
BC-001	1/07/93	19.60	21.76	2.16
BC-001	4/06/93	18.26	18.26	0.00
BC-001	7/03/93	19.05	19.15	.10
BC-001	8/04/93	19.30	19.40	.10
BC-001	9/01/93	19.23	19.32	.09
BC-001	10/07/93	19.25	19.43	.18
BC-001	11/02/93	19.42	19.61	.19
BC-001	12/06/93	19.31	19.53	.22
BC-001	1/05/94	19.25	19.42	.17
BC-001	2/02/94	19.30	19.50	.20
BC-001	3/02/94	18.40	18.60	.20
BC-001	4/07/94	18.10	18.20	.10
BC-001	5/05/94	18.65	18.84	.19
BC-001	6/07/94	18.25	18.52	.27
BC-001	7/13/94	18.70	18.70	0.00
BC-001	8/03/94	18.40	18.40	0.00
BC-001	9/14/94	18.72	18.73	.01
BC-001	10/06/94	18.58	18.58	0.00
BC-001	11/02/94	18.81	18.82	.01
BC-001	12/07/94	17.93	17.94	.01
BC-001	1/13/95	18.58	18.58	0.00
BC-001	2/14/95	16.76	16.80	.04
BC-001	3/07/95	17.08	17.08	0.00
BC-001	4/11/95	16.55	16.55	0.00
BC-001	5/09/95	16.99	17.00	.01
BC-001	6/09/95	17.38	17.39	.01
BC-001	7/06/95	17.64	17.64	0.00
BC-001	8/10/95	17.89	17.89	0.00
BC-001	9/07/95	17.96	17.96	0.00
BC-001	10/03/95	18.23	18.23	0.00
BC-001	10/05/95	18.23	18.23	0.00
BC-001	11/02/95	18.02	18.02	0.00
BC-001	12/07/95	18.64	18.64	0.00
BC-001	1/03/96	18.36	18.36	0.00
BC-001	2/06/96	17.43	17.43	0.00
BC-001	3/12/96	16.85	16.85	0.00
BC-001	5/07/96	17.45	17.45	0.00
BC-001	6/05/96	17.46	17.46	0.00
BC-001	9/05/96	18.16	18.16	0.00
BC-001	10/08/96	18.40	18.40	0.00
BC-001	11/08/96	18.57	18.57	0.00
BC-001	12/13/96	18.24	18.24	0.00
BC-001	1/16/97	17.19	17.19	0.00
BC-001	2/14/97	16.88	16.88	0.00
BC-001	3/07/97	17.31	17.31	0.00

FACILITY NO.: 8934
FACILITY NAME:
STATE: CA
FACILITY TYPE:

Well ID	Date	DEPTH TO LIQUID (ft)	DEPTH TO WATER (ft)	PRODUCT THICKNESS (ft)
BC-001	4/17/97	17.92	17.92	0.00
BC-001	7/15/97	18.61	18.61	0.00
BC-001	10/07/97	18.72	18.72	0.00
BC-002	7/07/92	16.89	16.89	0.00
BC-002	8/04/92	18.46	18.46	0.00
BC-002	8/31/92	18.89	18.89	0.00
BC-002	10/06/92	18.50	18.50	0.00
BC-002	11/06/92	15.98	15.98	0.00
BC-002	1/07/93	13.50	13.50	0.00
BC-002	4/06/93	15.20	15.20	0.00
BC-002	7/03/93	17.75	17.75	0.00
BC-002	8/04/93	18.10	18.10	0.00
BC-002	9/01/93	18.48	18.48	0.00
BC-002	10/07/93	19.02	19.02	0.00
BC-002	11/02/93	18.76	18.76	0.00
BC-002	12/06/93	18.87	18.87	0.00
BC-002	1/05/94	16.76	16.76	0.00
BC-002	2/02/94	16.42	16.42	0.00
BC-002	5/05/94	17.30	17.30	0.00
BC-002	6/07/94	17.70	17.70	0.00
BC-002	7/13/94	17.10	17.10	0.00
BC-002	8/03/94	18.36	18.36	0.00
BC-002	9/14/94	17.04	17.04	0.00
BC-002	1/13/95	12.80	12.80	0.00
BC-002	2/14/95	15.11	15.11	0.00
BC-002	3/07/95	16.21	16.21	0.00
BC-002	4/11/95	15.56	15.56	0.00
BC-002	5/09/95	15.81	15.81	0.00
BC-002	6/09/95	16.88	16.88	0.00
BC-002	7/06/95	16.88	16.88	0.00
BC-002	8/10/95	17.55	17.55	0.00
BC-002	9/07/95	18.03	18.03	0.00
BC-002	10/03/95	18.24	18.24	0.00
BC-002	10/05/95	18.24	18.24	0.00
BC-002	11/02/95	18.36	18.36	0.00
BC-002	1/03/96	17.86	17.86	0.00
BC-002	2/06/96	16.31	16.31	0.00
BC-002	3/12/96	16.50	16.50	0.00
BC-002	4/09/96	16.90	16.90	0.00
BC-002	5/07/96	17.20	17.20	0.00
BC-002	6/05/96	17.10	17.10	0.00
BC-002	7/09/96	17.70	17.70	0.00
BC-002	10/08/96	18.40	18.40	0.00
BC-002	11/08/96	18.30	18.30	0.00
BC-002	12/13/96	16.80	16.80	0.00
BC-002	1/16/97	16.40	16.40	0.00
BC-002	2/14/97	16.30	16.30	0.00
BC-002	3/07/97	17.00	17.00	0.00
BC-002	4/17/97	17.70	17.70	0.00

FACILITY NO.: 8934
FACILITY NAME:
STATE: CA
FACILITY TYPE:

Well ID	Date	DEPTH TO LIQUID (ft)	DEPTH TO WATER (ft)	PRODUCT THICKNESS (ft)
BC-002	7/15/97	18.50	18.50	0.00
BC-002	10/07/97	18.69	18.69	0.00
BC-003	7/07/92	16.68	16.68	0.00
BC-003	8/04/92	19.24	19.24	0.00
BC-003	8/31/92	19.10	19.10	0.00
BC-003	10/06/92	18.93	18.93	0.00
BC-003	11/06/92	16.81	16.81	0.00
BC-003	1/07/93	16.55	16.55	0.00
BC-003	4/06/93	15.44	15.44	0.00
BC-003	7/03/93	16.81	16.81	0.00
BC-003	8/04/93	18.82	18.82	0.00
BC-003	9/01/93	18.40	18.40	0.00
BC-003	10/07/93	18.58	18.58	0.00
BC-003	11/02/93	18.53	18.53	0.00
BC-003	12/06/93	18.67	18.67	0.00
BC-003	1/05/94	17.51	17.51	0.00
BC-003	2/02/94	16.40	16.40	0.00
BC-003	3/02/94	15.00	15.00	0.00
BC-003	4/07/94	17.70	17.70	0.00
BC-003	5/05/94	17.90	17.90	0.00
BC-003	6/07/94	17.34	17.34	0.00
BC-003	7/13/94	18.10	18.10	0.00
BC-003	8/03/94	18.36	18.36	0.00
BC-003	9/14/94	18.31	18.31	0.00
BC-003	10/06/94	18.58	18.58	0.00
BC-003	11/02/94	18.61	18.61	0.00
BC-003	12/07/94	16.29	16.29	0.00
BC-003	1/13/95	15.40	15.40	0.00
BC-003	2/14/95	15.86	15.86	0.00
BC-003	3/07/95	16.21	16.21	0.00
BC-003	4/11/95	15.08	15.08	0.00
BC-003	5/09/95	16.92	16.92	0.00
BC-003	6/09/95	16.90	16.90	0.00
BC-003	7/06/95	16.87	16.87	0.00
BC-003	8/10/95	17.54	17.54	0.00
BC-003	9/07/95	17.80	17.80	0.00
BC-003	10/03/95	17.95	17.95	0.00
BC-003	10/05/95	17.95	17.95	0.00
BC-003	11/02/95	18.33	18.33	0.00
BC-003	1/03/96	17.55	17.55	0.00
BC-003	2/06/96	17.15	17.15	0.00
BC-003	3/12/96	16.50	16.50	0.00
BC-003	4/09/96	16.60	16.60	0.00
BC-003	5/07/96	16.90	16.90	0.00
BC-003	6/05/96	17.00	17.00	0.00
BC-003	7/09/96	17.40	17.40	0.00
BC-003	10/08/96	18.10	18.10	0.00
BC-003	11/08/96	18.20	18.20	0.00
BC-003	12/13/96	17.60	17.60	0.00

FACILITY NO.: 8934
FACILITY NAME:
STATE: CA
FACILITY TYPE:

Well ID	Date	DEPTH TO LIQUID (ft)	DEPTH TO WATER (ft)	PRODUCT THICKNESS (ft)
ES-001	1/16/97	16.79	16.79	0.00
ES-001	2/14/97	16.53	16.53	0.00
ES-001	3/07/97	17.01	17.01	0.00
ES-001	4/17/97	18.13	18.13	0.00
ES-001	7/15/97	18.44	18.44	0.00
ES-001	10/07/97	18.36	18.37	.01
ES-002	6/16/92	18.63	18.64	.01
ES-002	7/07/92	19.62	19.62	0.00
ES-002	8/04/92	19.17	19.76	.59
ES-002	8/31/92	19.29	19.90	.61
ES-002	10/06/92	19.41	20.00	.59
ES-002	11/06/92	18.84	19.44	.60
ES-002	1/07/93	20.05	20.40	.35
ES-002	4/06/93	18.20	18.31	.11
ES-002	7/03/93	19.31	19.32	.01
ES-002	8/04/93	19.15	19.18	.03
ES-002	9/01/93	19.50	19.59	.09
ES-002	10/07/93	19.57	19.60	.03
ES-002	11/02/93	19.60	19.61	.01
ES-002	12/06/93	19.71	19.74	.03
ES-002	1/05/94	19.57	19.61	.04
ES-002	2/02/94	19.20	19.25	.05
ES-002	3/02/94	19.00	19.50	.50
ES-002	4/07/94	19.10	19.19	.09
ES-002	5/05/94	18.77	18.79	.02
ES-002	6/07/94	18.61	18.61	0.00
ES-002	7/13/94	18.78	18.78	0.00
ES-002	8/03/94	18.72	18.72	0.00
ES-002	9/14/94	19.10	19.14	.04
ES-002	10/06/94	18.86	18.86	0.00
ES-002	11/02/94	18.97	19.91	.94
ES-002	12/07/94	18.14	18.14	0.00
ES-002	1/13/95	18.86	18.86	0.00
ES-002	2/14/95	16.92	16.92	0.00
ES-002	3/07/95	17.25	17.25	0.00
ES-002	4/11/95	16.71	16.71	0.00
ES-002	5/09/95	17.15	17.15	0.00
ES-002	6/09/95	17.60	17.61	.01
ES-002	7/06/95	17.78	17.79	.01
ES-002	8/10/95	18.09	18.10	.01
ES-002	9/07/95	18.29	18.29	0.00
ES-002	10/03/95	18.48	18.45	-.03
ES-002	10/05/95	18.45	18.48	.03
ES-002	11/02/95	18.62	18.65	.03
ES-002	12/07/95	18.85	18.90	.05
ES-002	1/03/96	18.55	18.54	-.01
ES-002	2/06/96	17.60	17.60	0.00
ES-002	3/12/96	17.08	17.08	0.00
ES-002	4/09/96	17.18	17.18	0.00

FACILITY NO.: 8934
FACILITY NAME:
STATE: CA
FACILITY TYPE:

Well ID	Date	DEPTH TO LIQUID (ft)	DEPTH TO WATER (ft)	PRODUCT THICKNESS (ft)
ES-002	5/07/96	17.66	17.66	0.00
ES-002	6/05/96	17.66	17.66	0.00
ES-002	7/09/96	18.02	18.02	0.00
ES-002	9/05/96	18.39	18.39	0.00
ES-002	10/08/96	18.61	18.61	0.00
ES-002	11/08/96	18.78	18.78	0.00
ES-002	12/13/96	18.43	18.43	0.00
ES-002	1/16/97	17.57	17.57	0.00
ES-002	2/14/97	17.08	17.08	0.00
ES-002	3/07/97	17.56	17.56	0.00
ES-002	4/17/97	18.11	18.11	0.00
ES-002	7/15/97	18.97	18.97	0.00
ES-002	10/07/97	18.87	18.87	0.00
ES-003	6/16/92	19.41	19.41	0.00
ES-003	7/07/92	19.52	19.52	0.00
ES-003	8/04/92	19.68	19.68	0.00
ES-003	8/31/92	19.80	19.80	0.00
ES-003	10/06/92	19.96	19.96	0.00
ES-003	11/06/92	18.84	19.84	1.00
ES-003	1/07/93	19.20	19.20	0.00
ES-003	4/06/93	15.92	15.92	0.00
ES-003	7/03/93	18.12	18.12	0.00
ES-003	8/04/93	19.18	19.18	0.00
ES-003	9/01/93	19.36	19.36	0.00
ES-003	10/07/93	19.62	19.62	0.00
ES-003	11/02/93	19.70	19.70	0.00
ES-003	12/06/93	19.68	19.68	0.00
ES-003	1/05/94	19.52	19.52	0.00
ES-003	2/02/94	19.30	19.30	0.00
ES-003	3/02/94	18.68	18.68	0.00
ES-003	4/07/94	19.00	19.00	0.00
ES-003	5/05/94	18.78	18.78	0.00
ES-003	6/07/94	18.90	18.90	0.00
ES-003	7/13/94	18.71	18.71	0.00
ES-003	8/03/94	19.03	19.03	0.00
ES-003	9/14/94	19.84	19.84	0.00
ES-003	10/06/94	19.24	19.24	0.00
ES-003	11/02/94	19.37	19.37	0.00
ES-003	12/07/94	18.44	18.44	0.00
ES-003	1/13/95	17.35	17.35	0.00
ES-003	2/14/95	17.22	17.22	0.00
ES-003	3/07/95	17.52	17.52	0.00
ES-003	4/11/95	16.95	16.95	0.00
ES-003	5/09/95	17.34	17.39	.05
ES-003	6/09/95	17.87	17.87	0.00
ES-003	7/06/95	18.07	18.07	0.00
ES-003	8/10/95	18.40	18.40	0.00
ES-003	9/07/95	18.59	18.59	0.00
ES-003	10/03/95	18.76	18.76	0.00

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Well ID	Date	DEPTH TO LIQUID (ft)	DEPTH TO WATER (ft)	PRODUCT THICKNESS (ft)
ES-003	10/05/95	18.76	18.76	0.00
ES-003	11/02/95	18.96	18.96	0.00
ES-003	12/07/95	19.19	19.19	0.00
ES-003	1/03/96	17.55	17.55	0.00
ES-003	2/06/96	17.86	17.86	0.00
ES-003	3/12/96	17.35	17.35	0.00
ES-003	4/09/96	17.65	17.65	0.00
ES-003	5/07/96	17.94	17.94	0.00
ES-003	6/05/96	17.94	17.94	0.00
ES-003	7/09/96	18.33	18.33	0.00
ES-003	9/05/96	18.63	18.63	0.00
ES-003	10/08/96	18.98	18.98	0.00
ES-003	11/08/96	19.16	19.16	0.00
ES-003	12/13/96	18.81	18.81	0.00
ES-003	1/16/97	17.72	17.72	0.00
ES-003	2/14/97	17.47	17.47	0.00
ES-003	3/07/97	17.90	17.90	0.00
ES-003	4/17/97	18.42	18.42	0.00
ES-003	7/15/97	19.01	19.01	0.00
ES-003	10/07/97	19.18	19.18	0.00
ES-004	6/16/92	18.63	18.98	.35
ES-004	7/07/92	18.51	18.51	0.00
ES-004	8/04/92	18.66	18.66	0.00
ES-004	8/31/92	18.79	18.79	0.00
ES-004	10/06/92	18.92	18.92	0.00
ES-004	11/06/92	18.94	18.94	0.00
ES-004	1/07/93	18.76	18.76	0.00
ES-004	4/06/93	17.26	17.26	0.00
ES-004	7/03/93	18.08	18.08	0.00
ES-004	8/04/93	18.16	18.16	0.00
ES-004	9/01/93	18.46	18.46	0.00
ES-004	10/07/93	18.62	18.62	0.00
ES-004	11/02/93	18.74	18.74	0.00
ES-004	12/06/93	18.72	18.72	0.00
ES-004	1/05/94	18.55	18.55	0.00
ES-004	2/02/94	18.42	18.42	0.00
ES-004	3/02/94	17.86	17.86	0.00
ES-004	4/07/94	18.80	18.80	0.00
ES-004	5/05/94	17.86	17.86	0.00
ES-004	6/07/94	17.94	17.94	0.00
ES-004	7/13/94	18.13	18.13	0.00
ES-004	8/03/94	17.94	17.94	0.00
ES-004	9/14/94	18.18	18.18	0.00
ES-004	10/06/94	18.25	18.25	0.00
ES-004	11/02/94	18.35	18.35	0.00
ES-004	12/07/94	17.56	17.56	0.00
ES-004	1/13/95	16.77	16.77	0.00
ES-004	2/14/95	16.37	16.37	0.00
ES-004	3/07/95	16.66	16.66	0.00

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Well ID	Date	DEPTH TO LIQUID (ft)	DEPTH TO WATER (ft)	PRODUCT THICKNESS (ft)
ES-004	4/11/95	16.14	16.14	0.00
ES-004	5/09/95	16.57	16.57	0.00
ES-004	6/09/95	17.02	17.02	0.00
ES-004	7/06/95	17.19	17.19	0.00
ES-004	8/10/95	17.84	17.84	0.00
ES-004	9/07/95	17.68	17.68	0.00
ES-004	10/03/95	17.84	17.84	0.00
ES-004	10/05/95	17.84	17.84	0.00
ES-004	11/02/95	18.02	18.02	0.00
ES-004	12/07/95	18.23	18.23	0.00
ES-004	1/03/96	17.87	17.87	0.00
ES-004	2/06/96	17.02	17.02	0.00
ES-004	3/12/96	16.54	16.54	0.00
ES-004	4/09/96	16.76	16.76	0.00
ES-004	5/07/96	16.17	16.17	0.00
ES-004	6/05/96	17.05	17.05	0.00
ES-004	7/09/96	17.37	17.37	0.00
ES-004	9/05/96	17.74	17.74	0.00
ES-004	10/08/96	17.97	17.97	0.00
ES-004	11/08/96	18.13	18.13	0.00
ES-004	12/13/96	17.83	17.83	0.00
ES-004	1/16/97	16.92	16.92	0.00
ES-004	2/14/97	16.56	16.56	0.00
ES-004	3/07/97	16.95	16.95	0.00
ES-004	4/17/97	17.45	17.45	0.00
ES-004	7/15/97	18.05	18.05	0.00
ES-004	10/07/97	18.23	18.23	0.00
ES-005	6/16/92	18.40	20.40	2.00
ES-005	7/07/92	20.23	20.23	0.00
ES-005	8/04/92	18.16	20.43	2.27
ES-005	8/31/92	18.24	20.80	2.56
ES-005	10/06/92	18.24	21.37	3.13
ES-005	11/06/92	17.60	20.92	3.32
ES-005	1/05/93	18.42	19.75	1.33
ES-005	1/07/93	19.35	22.00	2.65
ES-005	4/06/93	17.28	17.28	0.00
ES-005	7/03/93	19.50	19.50	0.00
ES-005	8/04/93	18.61	18.61	0.00
ES-005	9/01/93	18.79	18.80	.01
ES-005	10/07/93	18.65	19.33	.68
ES-005	11/02/93	18.91	19.45	.54
ES-005	12/06/93	18.78	19.25	.47
ES-005	2/02/94	18.18	19.98	1.80
ES-005	3/02/94	18.07	18.30	.23
ES-005	4/07/94	18.37	18.38	.01
ES-005	5/05/94	18.24	18.26	.02
ES-005	6/07/94	18.26	18.27	.01
ES-005	7/13/94	18.30	18.30	0.00
ES-005	8/03/94	17.90	17.90	0.00

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ES-005	9/14/94	18.41	18.42	.01
ES-005	10/06/94	18.23	18.23	0.00
ES-005	11/02/94	18.47	18.47	0.00
ES-005	12/07/94	17.45	17.45	0.00
ES-005	1/13/95	18.23	18.23	0.00
ES-005	2/14/95	16.45	16.45	0.00
ES-005	3/07/95	16.53	16.53	0.00
ES-005	4/11/95	16.00	16.00	0.00
ES-005	5/09/95	16.45	16.45	0.00
ES-005	6/09/95	16.90	16.90	0.00
ES-005	7/06/95	17.09	17.09	0.00
ES-005	8/10/95	17.44	17.44	0.00
ES-005	9/07/95	17.61	17.61	0.00
ES-005	10/03/95	18.74	18.74	0.00
ES-005	10/05/95	18.74	18.74	0.00
ES-005	11/02/95	17.98	17.98	0.00
ES-005	12/07/95	18.21	18.22	.01
ES-005	1/03/96	17.89	17.89	0.00
ES-005	2/06/96	16.76	16.76	0.00
ES-005	3/12/96	16.36	16.36	0.00
ES-005	4/09/96	16.70	16.70	0.00
ES-005	5/07/96	16.95	16.95	0.00
ES-005	6/05/96	16.95	16.95	0.00
ES-005	7/09/96	17.34	17.34	0.00
ES-005	1/16/97	16.68	16.68	0.00
ES-005	2/14/97	16.43	16.43	0.00
ES-005	3/07/97	16.90	16.90	0.00
ES-005	4/17/97	17.41	17.41	0.00
ES-005	7/15/97	18.29	18.29	0.00
ES-005	10/07/97	18.48	18.48	0.00
ES-006	1/05/93	21.76	21.76	0.00
ES-006	9/01/93	21.94	21.94	0.00
ES-006	10/07/93	21.81	21.81	0.00
ES-006	11/02/93	21.91	21.91	0.00
ES-006	12/06/93	21.90	21.90	0.00
ES-006	2/02/94	21.74	21.74	0.00
ES-006	3/02/94	21.10	21.10	0.00
ES-006	4/07/94	21.30	21.30	0.00
ES-006	5/05/94	21.16	21.16	0.00
ES-006	6/07/94	21.02	21.02	0.00
ES-006	7/13/94	21.40	21.40	0.00
ES-006	8/03/94	21.58	21.58	0.00
ES-006	9/14/94	21.52	21.52	0.00
ES-006	10/06/94	21.58	21.58	0.00
ES-006	11/02/94	21.64	21.64	0.00
ES-006	12/07/94	20.94	20.94	0.00
ES-006	1/13/95	20.25	20.25	0.00
ES-006	2/14/95	19.82	19.82	0.00
ES-006	3/07/95	20.06	20.06	0.00

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Well ID	Date	DEPTH TO LIQUID (ft)	DEPTH TO WATER (ft)	PRODUCT THICKNESS (ft)
ES-006	4/11/95	19.56	19.56	0.00
ES-006	5/09/95	97.84	97.84	0.00
ES-006	6/09/95	20.37	20.37	0.00
ES-006	7/06/95	20.55	20.55	0.00
ES-006	8/10/95	20.81	20.81	0.00
ES-006	9/07/95	20.94	20.94	0.00
ES-006	10/03/95	21.14	21.14	0.00
ES-006	10/05/95	21.14	21.14	0.00
ES-006	11/02/95	21.31	21.31	0.00
ES-006	12/07/95	21.48	21.48	0.00
ES-006	1/03/96	21.24	21.24	0.00
ES-006	2/06/96	20.52	20.52	0.00
ES-006	3/12/96	19.85	19.85	0.00
ES-006	4/09/96	20.14	20.14	0.00
ES-006	5/07/96	20.42	20.42	0.00
ES-006	6/05/96	20.41	20.41	0.00
ES-006	7/09/96	20.74	20.74	0.00
ES-006	10/08/96	21.23	21.23	0.00
ES-006	11/08/96	21.44	21.44	0.00
ES-006	12/13/96	21.19	21.19	0.00
ES-006	1/16/97	20.15	20.15	0.00
ES-006	2/14/97	19.92	19.92	0.00
ES-006	3/07/97	20.31	20.31	0.00
ES-006	4/17/97	20.78	20.78	0.00
ES-006	7/15/97	21.32	21.32	0.00
ES-006	10/07/97	21.48	21.48	0.00
ES-007	1/05/93	19.90	19.90	0.00
ES-007	9/01/93	19.71	19.71	0.00
ES-007	10/07/93	19.99	19.99	0.00
ES-007	11/02/93	20.12	20.12	0.00
ES-007	12/06/93	20.15	20.15	0.00
ES-007	2/02/94	19.79	19.79	0.00
ES-007	3/02/94	19.14	19.14	0.00
ES-007	4/07/94	19.44	19.44	0.00
ES-007	5/05/94	19.30	19.30	0.00
ES-007	6/07/94	19.33	19.33	0.00
ES-007	7/13/94	19.11	19.11	0.00
ES-007	8/03/94	19.40	19.40	0.00
ES-007	9/14/94	19.64	19.64	0.00
ES-007	10/06/94	19.73	19.73	0.00
ES-007	11/02/94	19.79	19.79	0.00
ES-007	12/07/94	19.89	19.89	0.00
ES-007	1/13/95	18.11	18.11	0.00
ES-007	2/14/95	17.63	17.63	0.00
ES-007	3/07/95	17.92	17.92	0.00
ES-007	4/11/95	17.35	17.35	0.00
ES-007	5/09/95	17.79	17.79	0.00
ES-007	6/09/95	18.29	18.29	0.00
ES-007	7/06/95	18.46	18.46	0.00

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ES-007	8/10/95	18.77	18.77	0.00
ES-007	9/07/95	18.98	18.98	0.00
ES-007	10/03/95	19.15	19.15	0.00
ES-007	10/05/95	19.15	19.15	0.00
ES-007	11/02/95	19.36	19.36	0.00
ES-007	12/07/95	19.57	19.57	0.00
ES-007	1/03/96	19.29	19.29	0.00
ES-007	2/06/96	18.41	18.41	0.00
ES-007	3/12/96	17.76	17.76	0.00
ES-007	4/09/96	18.05	18.05	0.00
ES-007	5/07/96	18.36	18.36	0.00
ES-007	6/05/96	18.36	18.36	0.00
ES-007	7/09/96	18.72	18.72	0.00
ES-007	9/05/96	19.12	19.12	0.00
ES-007	10/08/96	19.37	19.37	0.00
ES-007	11/08/96	19.56	19.56	0.00
ES-007	12/13/96	19.28	19.28	0.00
ES-007	1/16/97	18.19	18.19	0.00
ES-007	2/14/97	17.88	17.88	0.00
ES-007	3/07/97	18.30	18.30	0.00
ES-007	4/17/97	18.81	18.81	0.00
ES-008	9/01/93	18.88	18.88	0.00
ES-008	10/07/93	19.13	19.13	0.00
ES-008	11/02/93	19.26	19.26	0.00
ES-008	12/06/93	19.24	19.24	0.00
ES-008	1/05/94	19.10	19.10	0.00
ES-008	2/02/94	19.08	19.08	0.00
ES-008	3/02/94	18.28	18.28	0.00
ES-008	4/07/94	18.44	18.44	0.00
ES-008	5/05/94	18.26	18.26	0.00
ES-008	6/07/94	18.32	18.32	0.00
ES-008	7/13/94	18.50	18.50	0.00
ES-008	8/03/94	18.42	18.42	0.00
ES-008	9/14/94	18.50	18.50	0.00
ES-008	10/06/94	18.76	18.76	0.00
ES-008	11/02/94	18.76	18.76	0.00
ES-008	12/07/94	18.00	18.00	0.00
ES-008	1/13/95	16.83	16.83	0.00
ES-008	2/14/95	16.67	16.67	0.00
ES-008	3/07/95	16.99	16.99	0.00
ES-008	4/11/95	16.41	16.41	0.00
ES-008	5/09/95	16.92	16.92	0.00
ES-008	6/09/95	17.35	17.35	0.00
ES-008	7/06/95	17.56	17.56	0.00
ES-008	8/10/95	17.89	17.89	0.00
ES-008	9/07/95	18.09	18.09	0.00
ES-008	10/03/95	18.27	18.27	0.00
ES-008	10/05/95	18.27	18.27	0.00
ES-008	11/02/95	18.51	18.51	0.00

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Well ID	Date	DEPTH TO LIQUID (ft)	DEPTH TO WATER (ft)	PRODUCT THICKNESS (ft)
ES-008	12/07/95	18.72	18.72	0.00
ES-008	1/03/96	18.36	18.36	0.00
ES-008	2/06/96	17.07	17.07	0.00
ES-008	3/12/96	16.79	16.79	0.00
ES-008	4/09/96	17.10	17.10	0.00
ES-008	5/07/96	17.34	17.34	0.00
ES-008	6/05/96	17.36	17.36	0.00
ES-008	7/09/96	17.71	17.71	0.00
ES-008	9/05/96	18.13	18.13	0.00
ES-008	10/08/96	18.44	18.44	0.00
ES-008	11/08/96	18.61	18.61	0.00
ES-008	12/13/96	18.32	18.32	0.00
ES-008	1/16/97	17.22	17.22	0.00
ES-008	2/14/97	16.94	16.94	0.00
ES-008	3/07/97	17.36	17.36	0.00
ES-008	4/17/97	17.90	17.90	0.00
ES-009	9/01/93	19.74	19.74	0.00
ES-009	10/07/93	17.90	17.90	0.00
ES-009	12/06/93	18.00	18.00	0.00
ES-009	1/05/94	17.80	17.80	0.00
ES-009	2/02/94	17.02	17.02	0.00
ES-009	3/02/94	17.12	17.12	0.00
ES-009	4/07/94	17.24	17.24	0.00
ES-009	5/05/94	17.04	17.04	0.00
ES-009	6/07/94	17.06	17.06	0.00
ES-009	7/13/94	17.40	17.40	0.00
ES-009	8/03/94	17.10	17.10	0.00
ES-009	9/14/94	17.09	17.09	0.00
ES-009	10/06/94	17.46	17.46	0.00
ES-009	11/02/94	17.55	17.55	0.00
ES-009	12/07/94	16.79	16.79	0.00
ES-009	1/13/95	15.80	15.80	0.00
ES-009	2/14/95	15.49	15.49	0.00
ES-009	3/07/95	15.79	15.79	0.00
ES-009	4/11/95	15.23	15.23	0.00
ES-009	5/09/95	15.72	15.72	0.00
ES-009	6/09/95	16.13	16.13	0.00
ES-009	7/06/95	16.34	16.34	0.00
ES-009	8/10/95	16.67	16.67	0.00
ES-009	9/07/95	16.87	16.87	0.00
ES-009	10/03/95	17.09	17.09	0.00
ES-009	10/05/95	17.09	17.09	0.00
ES-009	11/02/95	17.30	17.30	0.00
ES-009	12/07/95	17.48	17.48	0.00
ES-009	1/03/96	17.12	17.12	0.00
ES-009	2/06/96	16.00	16.00	0.00
ES-009	3/12/96	15.63	15.63	0.00
ES-009	4/09/96	15.92	15.92	0.00
ES-009	5/07/96	16.17	16.17	0.00

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Well ID	Date	DEPTH TO LIQUID (ft)	DEPTH TO WATER (ft)	PRODUCT THICKNESS (ft)
ES-009	6/05/96	16.19	16.19	0.00
ES-009	7/09/96	16.52	16.52	0.00
ES-009	9/05/96	16.92	16.92	0.00
ES-009	10/08/96	17.19	17.19	0.00
ES-009	11/08/96	17.37	17.37	0.00
ES-009	12/13/96	17.09	17.09	0.00
ES-009	1/16/97	15.99	15.99	0.00
ES-009	2/14/97	15.71	15.71	0.00
ES-009	3/07/97	16.12	16.12	0.00
ES-009	4/17/97	16.66	16.66	0.00
ES-010	9/01/93	18.04	18.04	0.00
ES-010	10/07/93	17.40	17.40	0.00
ES-010	11/02/93	17.46	17.46	0.00
ES-010	12/06/93	17.44	17.44	0.00
ES-010	1/05/94	17.27	17.27	0.00
ES-010	2/02/94	17.25	17.25	0.00
ES-010	3/02/94	16.61	16.61	0.00
ES-010	4/07/94	16.74	16.74	0.00
ES-010	5/05/94	16.55	16.55	0.00
ES-010	6/07/94	17.50	17.50	0.00
ES-010	7/13/94	16.10	16.10	0.00
ES-010	8/03/94	16.20	16.20	0.00
ES-010	9/14/94	16.48	16.48	0.00
ES-010	10/06/94	16.96	16.96	0.00
ES-010	11/02/94	17.05	17.05	0.00
ES-010	12/07/94	16.29	16.29	0.00
ES-010	1/13/95	15.42	15.42	0.00
ES-010	2/14/95	15.05	15.05	0.00
ES-010	3/07/95	15.34	15.34	0.00
ES-010	4/11/95	14.82	14.82	0.00
ES-010	5/09/95	15.26	15.26	0.00
ES-010	6/09/95	15.70	15.70	0.00
ES-010	7/06/95	15.89	15.89	0.00
ES-010	8/10/95	16.21	16.21	0.00
ES-010	9/07/95	16.42	16.42	0.00
ES-010	10/03/95	16.59	16.59	0.00
ES-010	10/05/95	16.59	16.59	0.00
ES-010	11/02/95	16.77	16.77	0.00
ES-010	12/07/95	16.97	16.97	0.00
ES-010	1/03/96	16.61	16.61	0.00
ES-010	2/06/96	15.71	15.71	0.00
ES-010	3/12/96	17.35	17.35	0.00
ES-010	4/09/96	15.44	15.44	0.00
ES-010	5/07/96	15.75	15.75	0.00
ES-010	6/05/96	17.75	17.75	0.00
ES-010	7/09/96	18.04	18.04	0.00
ES-010	9/05/96	16.45	16.45	0.00
ES-010	10/08/96	16.70	16.70	0.00
ES-010	11/08/96	16.87	16.87	0.00

FACILITY NO.: 8934
FACILITY NAME:
STATE: CA
FACILITY TYPE:

Well ID	Date	DEPTH TO LIQUID (ft)	DEPTH TO WATER (ft)	PRODUCT THICKNESS (ft)
ES-010	12/13/96	16.55	16.55	0.00
ES-010	1/16/97	15.49	15.49	0.00
ES-010	2/14/97	15.23	15.23	0.00
ES-010	3/07/97	15.67	15.67	0.00
ES-010	4/17/97	16.18	16.18	0.00
ES-011	9/01/93	18.74	18.74	0.00
ES-011	10/07/93	18.90	18.90	0.00
ES-011	11/02/93	19.00	19.00	0.00
ES-011	12/06/93	19.02	19.02	0.00
ES-011	1/05/94	18.86	18.86	0.00
ES-011	2/02/94	18.74	18.74	0.00
ES-011	3/02/94	18.14	18.14	0.00
ES-011	4/07/94	18.38	18.38	0.00
ES-011	5/05/94	18.15	18.15	0.00
ES-011	6/07/94	18.28	18.28	0.00
ES-011	7/13/94	18.60	18.60	0.00
ES-011	8/03/94	18.18	18.18	0.00
ES-011	9/14/94	18.47	18.47	0.00
ES-011	10/06/94	18.55	18.55	0.00
ES-011	11/02/94	18.64	18.64	0.00
ES-011	12/07/94	17.49	17.49	0.00
ES-011	1/13/95	17.16	17.16	0.00
ES-011	2/14/95	16.76	16.76	0.00
ES-011	3/07/95	17.04	17.04	0.00
ES-011	4/11/95	16.54	16.54	0.00
ES-011	5/09/95	16.95	16.95	0.00
ES-011	6/09/95	17.34	17.34	0.00
ES-011	7/06/95	17.54	17.54	0.00
ES-011	8/10/95	17.85	17.85	0.00
ES-011	9/07/95	18.03	18.03	0.00
ES-011	10/03/95	18.20	18.20	0.00
ES-011	10/05/95	18.20	18.20	0.00
ES-011	11/02/95	18.38	18.38	0.00
ES-011	12/07/95	18.59	18.59	0.00
ES-011	1/03/96	18.21	18.21	0.00
ES-011	2/06/96	17.45	17.45	0.00
ES-011	3/12/96	16.83	16.83	0.00
ES-011	4/09/96	17.13	17.13	0.00
ES-011	5/07/96	17.42	17.42	0.00
ES-011	6/05/96	17.42	17.42	0.00
ES-011	7/09/96	17.71	17.71	0.00
ES-011	9/05/96	18.07	18.07	0.00
ES-011	10/08/96	18.29	18.29	0.00
ES-011	11/08/96	18.45	18.45	0.00
ES-011	12/13/96	18.09	18.09	0.00
ES-011	1/16/97	17.10	17.10	0.00
ES-011	2/14/97	16.90	16.90	0.00
ES-011	3/07/97	17.30	17.30	0.00
ES-011	4/17/97	17.80	17.80	0.00

ATTACHMENT C

SUMMARY OF ALL ANALYTICAL RESULTS

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OAKLAND CA
TERMINAL

Date	Location	Matrix	MTBE	Benzene	Toulene	Ethyl-benzene	Total Xylenes	Total Btex	TPH diesel	TPH gasoline	Total PAHs
7/08/92	BC-02	WATER	NA	ND	ND	ND	8.4	8.4	2.1	NA	NA
7/08/92	BC-03	WATER	NA	ND	2.5	ND	6.1	8.6	3.9	NA	NA
7/08/92	ES-03	WATER	NA	54	21	48	34	157	1.3	NA	NA
7/08/92	ES-04	WATER	NA	31	5.6	ND	2.8	39.4	ND	NA	NA

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Date	Location	Matrix	MTBE	Benzene	Toulene	Ethyl-benzene	Total Xylenes	Total Btex	TPH diesel	TPH gasoline	Total PAHs
10/06/92	BC-02	WATER	NA	ND	1.1	0.9	7.2	9.2	ND	NA	NA
10/06/92	BC-03	WATER	NA	ND	1.9	0.5	1.8	4.2	0.8	NA	NA
10/06/92	ES-03	WATER	NA	93	18	ND	11	122	ND	NA	NA
10/06/92	ES-04	WATER	NA	100	8.2	ND	7.6	115.8	ND	NA	NA

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Date	Location	Matrix	MTBE	Benzene	Toulene	Ethyl-benzene	Total Xylenes	Total Btex	TPH diesel	TPH gasoline	Total PAHs
1/07/93	BC-02	WATER	NA	ND	1.1	1.5	9.5	12.1	ND	NA	NA
1/07/93	BC-03	WATER	NA	ND	ND	ND	ND	ND	ND	NA	NA
1/07/93	ES-03	WATER	NA	52	49	100	250	451	ND	NA	NA
1/07/93	ES-04	WATER	NA	30	6.7	7.7	16	60.4	ND	NA	NA

Date	Location	Matrix	MTBE	Benzene	Toulene	Ethyl-benzene	Total Xylenes	Total Btex	TPH diesel	TPH gasoline	Total PAHs
4/06/93	BC-02	WATER	NA	ND	ND	ND	ND	ND	0.13	ND	NA
4/06/93	BC-03	WATER	NA	ND	ND	ND	ND	ND	0.12	ND	NA
4/06/93	ES-03	WATER	NA	53	ND	67	78	198	0.51	4.5	NA
4/06/93	ES-04	WATER	NA	33	2.3	1.9	4.7	41.9	ND	0.36	NA

Date	Location	Matrix	MTBE	Benzene	Toulene	Ethyl-benzene	Total Xylenes	Total Btex	TPH diesel	TPH gasoline	Total PAHs
7/23/93	ES-03	WATER	NA	28	5.9	4.6	4.6	43.1	0.06	1500	NA
7/23/93	ES-04	WATER	NA	24	1.1	0.07	8.3	33.47	ND	ND	NA
7/23/93	ES-06	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
7/23/93	ES-07	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
7/23/93	ES-08	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
7/23/93	ES-09	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
7/23/93	ES-10	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
7/23/93	ES-11	WATER	NA	ND	0.7	ND	1.2	1.9	ND	ND	NA

Date	Location	Matrix	MTBE	Benzene	Toulene	Ethyl-benzene	Total Xylenes	Total Btex	TPH diesel	TPH gasoline	Total PAHs
10/07/93	BC-02	WATER	NA	ND	ND	ND	ND	ND	1.4	NA	NA
10/07/93	BC-03	WATER	NA	ND	ND	1.0	2.0	3.0	1.4	NA	NA
10/07/93	ES-03	WATER	NA	2.0	1.0	ND	2.0	5.0	ND	NA	NA
10/07/93	ES-04	WATER	NA	8.0	ND	ND	2.0	10.0	ND	NA	NA
10/07/93	ES-06	WATER	NA	1.0	ND	ND	ND	ND	ND	NA	NA
10/07/93	ES-07	WATER	NA	ND	ND	ND	ND	ND	ND	NA	NA
10/07/93	ES-08	WATER	NA	ND	ND	ND	ND	ND	ND	NA	NA
10/07/93	ES-09	WATER	NA	ND	ND	ND	ND	ND	ND	NA	NA
10/07/93	ES-10	WATER	NA	ND	ND	ND	ND	ND	ND	NA	NA
10/07/93	ES-11	WATER	NA	ND	ND	ND	ND	ND	ND	NA	NA

Date	Location	Matrix	MTBE	Benzene	Toulene	Ethyl-benzene	Total Xylenes	Total Btex	TPH diesel	TPH gasoline	Total PAHs
1/05/94	BC-02	WATER	NA	NA	NA	NA	NA	NA	NA	NA	NA
1/05/94	BC-03	WATER	NA	ND	ND	ND	1.6	1.6	1.8	ND	NA
1/05/94	ES-03	WATER	NA	13	2.0	7.0	5.0	27	NA	0.53	NA
1/05/94	ES-04	WATER	NA	15	0.6	0.4	3.0	19	ND	0.13	NA
1/05/94	ES-06	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
1/05/94	ES-07	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
1/05/94	ES-08	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
1/05/94	ES-09	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
1/05/94	ES-10	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
1/05/94	ES-11	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA

Date	Location	Matrix	MTBE	Benzene	Toulene	Ethyl-benzene	Total Xylenes	Total Btex	TPH diesel	TPH gasoline	Total PAHs
4/07/94	BC-02	WATER	NA	NA	NA	NA	NA	NA	NA	NA	NA
4/07/94	BC-03	WATER	NA	ND	ND	ND	ND	ND	0.85	ND	NA
4/07/94	ES-03	WATER	NA	10	9	26	34	79	0.91	0.85	NA
4/07/94	ES-04	WATER	NA	11	ND	ND	ND	11	ND	0.17	NA
4/07/94	ES-06	WATER	NA	ND	ND	ND	ND	ND	ND	0.16	NA
4/07/94	ES-07	WATER	NA	ND	ND	ND	ND	ND	0.10	0.11	NA
4/07/94	ES-08	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
4/07/94	ES-09	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
4/07/94	ES-10	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
4/07/94	ES-11	WATER	NA	ND	ND	ND	ND	ND	0.35	ND	NA

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Date	Location	Matrix	MTBE	Benzene	Toulene	Ethyl-benzene	Total Xylenes	Total Btex	TPH diesel	TPH gasoline	Total PAHs
7/13/94	BC-02	WATER	NA	NA	NA	NA	NA	NA	NA	NA	NA
7/13/94	BC-03	WATER	NA	ND	ND	ND	ND	ND	0.20	ND	NA
7/13/94	ES-03	WATER	NA	2.0	0.9	0.8	3.0	6.7	0.28	0.37	NA
7/13/94	ES-04	WATER	NA	9.0	ND	ND	0.7	9.7	ND	0.13	NA
7/13/94	ES-06	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
7/13/94	ES-07	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
7/13/94	ES-08	WATER	NA	ND	ND	ND	ND	ND	NA	ND	NA
7/13/94	ES-09	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
7/13/94	ES-10	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
7/13/94	ES-11	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA

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Date	Location	Matrix	MTBE	Benzene	Toulene	Ethyl-benzene	Total Xylenes	Total Btex	TPH diesel	TPH gasoline	Total PAHs
10/06/94	BC-02	WATER	NA	NA	NA	NA	NA	NA	NA	NA	NA
10/06/94	BC-03	WATER	NA	ND	ND	ND	ND	ND	0.82	ND	NA
10/06/94	ES-03	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
10/06/94	ES-04	WATER	NA	18.0	ND	2.0	3.0	23.0	ND	0.10	NA
10/06/94	ES-06	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
10/06/94	ES-07	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
10/06/94	ES-08	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
10/06/94	ES-09	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
10/06/94	ES-10	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
10/06/94	ES-11	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA

Date	Location	Matrix	MTBE	Benzene	Toulene	Ethyl-benzene	Total Xylenes	Total Btex	TPH diesel	TPH gasoline	Total PAHs
1/13/95	BC-02	WATER	NA	ND	ND	ND	ND	ND	1.1	ND	NA
1/13/95	BC-03	WATER	NA	ND	ND	ND	ND	ND	0.89	ND	NA
1/13/95	ES-03	WATER	NA	19	15	72	88	194	1.1	1.6	NA
1/13/95	ES-04	WATER	NA	12	ND	ND	2	14	ND	0.15	NA
1/13/95	ES-06	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
1/13/95	ES-07	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
1/13/95	ES-08	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
1/13/95	ES-09	WATER	NA	ND	ND	ND	ND	ND	1.1	ND	NA
1/13/95	ES-10	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
1/13/95	ES-11	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA

Date	Location	Matrix	MTBE	Benzene	Toulene	Ethyl-benzene	Total Xylenes	Total Btex	TPH diesel	TPH gasoline	Total PAHs
4/11/95	BC-02	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
4/11/95	BC-03	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
4/11/95	ES-03	WATER	NA	20	7	36	22	85	0.39	0.94	NA
4/11/95	ES-04	WATER	NA	39	4	12	24	79	ND	0.18	NA
4/11/95	ES-06	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
4/11/95	ES-07	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
4/11/95	ES-08	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
4/11/95	ES-09	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
4/11/95	ES-10	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
4/11/95	ES-11	WATER	NA	ND	ND	ND	ND	ND	ND	0.17	NA

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Date	Location	Matrix	MTBE	Benzene	Toulene	Ethyl-benzene	Total Xylenes	Total Btex	TPH diesel	TPH gasoline	Total PAHs
7/06/95	BC-02	WATER	NA	ND	ND	ND	ND	ND	0.29	ND	NA
7/06/95	BC-03	WATER	NA	ND	ND	ND	ND	ND	0.38	ND	NA
7/06/95	ES-03	WATER	NA	6	ND	7	ND	13	1.2	0.24	NA
7/06/95	ES-04	WATER	NA	100	10	26	61	197	0.16	0.60	NA
7/06/95	ES-06	WATER	NA	ND	ND	ND	2	2	ND	ND	NA
7/06/95	ES-07	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
7/06/95	ES-08	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
7/06/95	ES-09	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
7/06/95	ES-10	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
7/06/95	ES-11	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA

Date	Location	Matrix	MTBE	Benzene	Toulene	Ethyl-benzene	Total Xylenes	Total Btex	TPH diesel	TPH gasoline	Total PAHs
10/05/95	BC-02	WATER	NA	1	ND	ND	1	2	1.5	ND	NA
10/05/95	BC-03	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
10/05/95	ES-03	WATER	NA	2	2	ND	ND	4	0.11	ND	NA
10/05/95	ES-04	WATER	NA	210	16	71	84	381	0.17	1.2	NA
10/05/95	ES-06	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
10/05/95	ES-07	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
10/05/95	ES-08	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
10/05/95	ES-09	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
10/05/95	ES-10	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
10/05/95	ES-11	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA

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Date	Location	Matrix	MTBE	Benzene	Toulene	Ethyl-benzene	Total Xylenes	Total Btex	TPH diesel	TPH gasoline	Total PAHs
1/05/96	ES-03	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
1/05/96	ES-04	WATER	NA	34	ND	5	4	ND	ND	0.12	NA
1/05/96	ES-06	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA

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Date	Location	Matrix	MTBE	Benzene	Toulene	Ethyl-benzene	Total Xylenes	Total Btex	TPH diesel	TPH gasoline	Total PAHs
4/09/96	ES-03	WATER	NA	ND	ND	ND	ND	ND	0.12	NA	NA
4/09/96	ES-04	WATER	NA	57	3	17	19	96	ND	NA	NA
4/09/96	ES-06	WATER	NA	ND	ND	ND	ND	ND	0.22	NA	NA

Date	Location	Matrix	MTBE	Benzene	Toulene	Ethyl-benzene	Total Xylenes	Total Btex	TPH diesel	TPH gasoline	Total PAHs
7/09/96	ES-03	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
7/09/96	ES-04	WATER	NA	43	4.6	21	17	85.6	ND	0.22	NA
7/09/96	ES-06	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
7/09/96	ES-07	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
7/09/96	ES-08	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
7/09/96	ES-11	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA

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Date	Location	Matrix	MTBE	Benzene	Toulene	Ethyl-benzene	Total Xylenes	Total Btex	TPH diesel	TPH gasoline	Total PAHs
10/08/96	ES-03	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA
10/08/96	ES-04	WATER	NA	110	4.4	42	39	195.4	ND	0.86	NA
10/08/96	ES-06	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA

Date	Location	Matrix	MTBE	Benzene	Toulene	Ethyl-benzene	Total Xylenes	Total Btex	TPH diesel	TPH gasoline	Total PAHs
1/16/97	ES-3	WATER	NA	ND	ND	ND	ND	ND	ND	0.051	NA
1/16/97	ES-4	WATER	NA	4.6	ND	ND	0.56	ND	ND	0.059	NA
1/16/97	ES-6	WATER	NA	ND	ND	ND	ND	ND	ND	ND	NA

Date	Location	Matrix	MTBE	Benzene	Toulene	Ethyl-benzene	Total Xylenes	Total Btex	TPH diesel	TPH gasoline	Total PAHs
4/17/97	BC-1	WATER	ND	160	72	35	93	360	0.64	2000	NA
4/17/97	BC-2	WATER	ND	ND	ND	ND	ND	ND	0.05	ND	NA
4/17/97	BC-3	WATER	ND	ND	ND	ND	ND	ND	ND	ND	NA
4/17/97	ES-1	WATER	ND	110	18	7.3	45	180.3	ND	1000	NA
4/17/97	ES-11	WATER	ND	ND	ND	ND	ND	ND	ND	ND	NA
4/17/97	ES-2	WATER	ND	340	110	110	240	800	1.8	3800	NA
4/17/97	ES-3	WATER	ND	ND	ND	ND	ND	ND	0.12	ND	NA
4/17/97	ES-4	WATER	ND	87	11	49	24	171	0.10	ND	NA
4/17/97	ES-5	WATER	ND	590	1200	180	1000	2970	1.6	2400	NA
4/17/97	ES-6	WATER	ND	ND	ND	ND	ND	ND	0.12	ND	NA
4/17/97	ES-7	WATER	ND	ND	ND	ND	ND	ND	0.06	ND	NA
4/17/97	ES-8	WATER	ND	ND	ND	ND	ND	ND	ND	ND	NA

Date	Location	Matrix	MTBE	Benzene	Toulene	Ethyl-benzene	Total Xylenes	Total Btex	TPH diesel	TPH gasoline	Total PAHs
7/15/97	BC-1	WATER	100	520	130	170	290	1110	95	11000	203
7/15/97	BC-2	WATER	ND	ND	ND	ND	ND	ND	0.68	ND	ND
7/15/97	BC-3	WATER	ND	ND	ND	ND	ND	ND	0.49	ND	ND
7/15/97	ES-2	WATER	81	190	140	73	250	653	16	3700	194
7/15/97	ES-3	WATER	ND	ND	ND	ND	ND	ND	0.17	ND	ND
7/15/97	ES-4	WATER	ND	110	11	42	40	203	0.37	920	18.40
7/15/97	ES-6	WATER	ND	ND	ND	ND	ND	ND	0.06	ND	ND

8934
OAKLAND CA
TERMINAL

Date	Location	Matrix	MTBE	Benzene	Toulene	Ethyl-benzene	Total Xylenes	Total Btex	TPH diesel	TPH gasoline	Total PAHs
7/16/97	ES-1	WATER	ND	76	8.2	11	25	120.2	1.2	960	13.64
7/16/97	ES-5	WATER	350	810	1800	430	1800	9680	15	27000	215.6

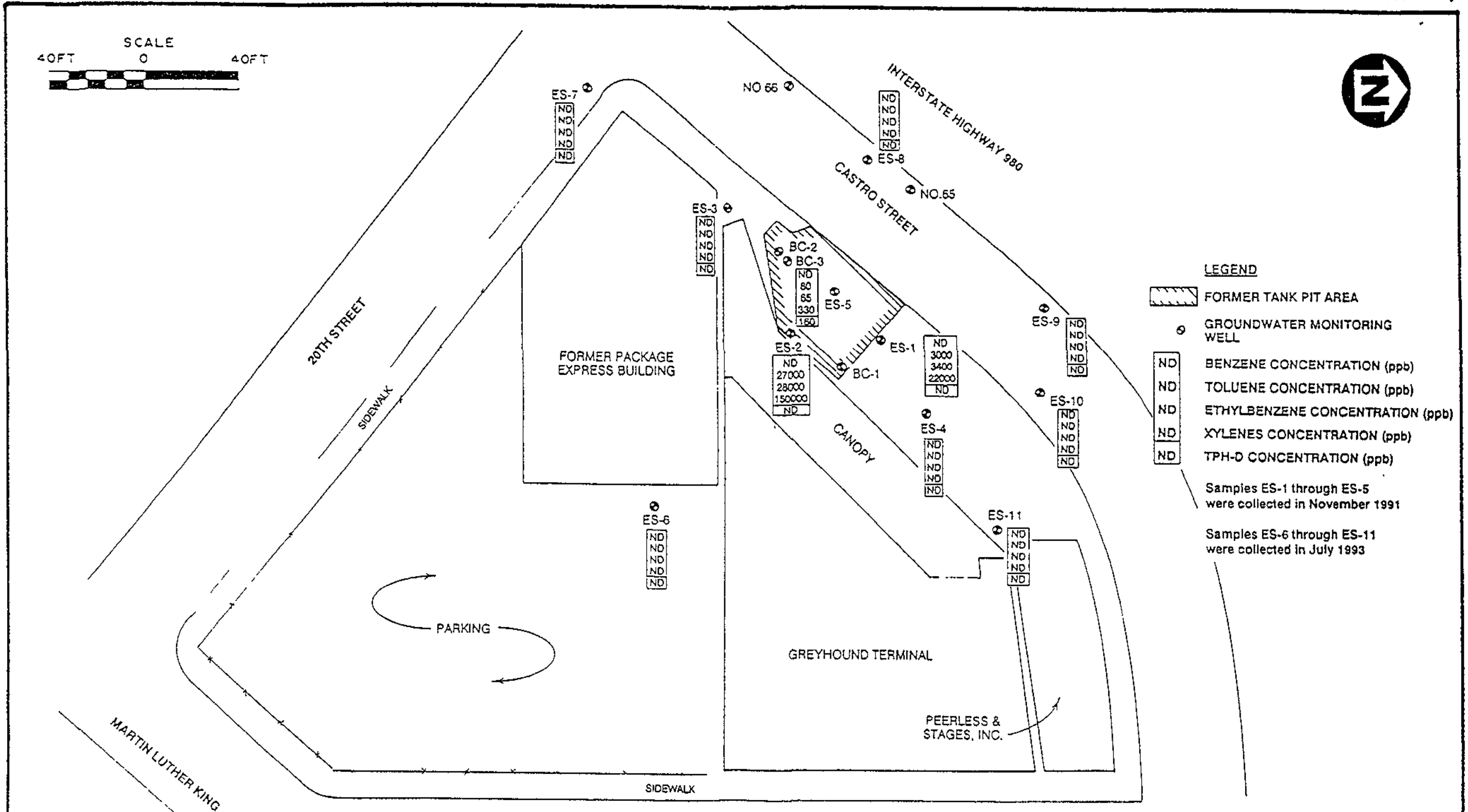
8934
OAKLAND CA
TERMINAL

Date	Location	Matrix	MTBE	Benzene	Toulene	Ethyl-benzene	Total Xylenes	Total Btex	TPH diesel	TPH gasoline	Total PAHs
10/07/97	BC-1	WATER	ND	310	600	370	1900	3180	484	31000	~~4215~~ 1343
10/07/97	BC-2	WATER	ND	ND	ND	ND	ND	ND	0.92	ND	ND
10/07/97	BC-3	WATER	ND	ND	ND	1.9	1.5	3.4	1.34	51	ND
10/07/97	ES-1	WATER	14	49	3.4	11	23	100.4	2.77	1700	9.92
10/07/97	ES-2	WATER	ND	190	46	46	70	352	8.04	7200	99.26
10/07/97	ES-3	WATER	ND	ND	ND	ND	ND	ND	0.205	ND	ND
10/07/97	ES-4	WATER	ND	11	ND	2.8	2.3	16.1	0.101	120	2.4
10/07/97	ES-5	WATER	ND	260	470	160	590	1480	6.51	15000	~~425.3~~ 123.6
10/07/97	ES-6	WATER	ND	ND	ND	ND	ND	ND	ND	ND	ND

ATTACHMENT D

FIGURES SHOWING VERTICAL AND LATERAL CONCENTRATIONS IN SOIL AND GROUNDWATER

FIGURE 4

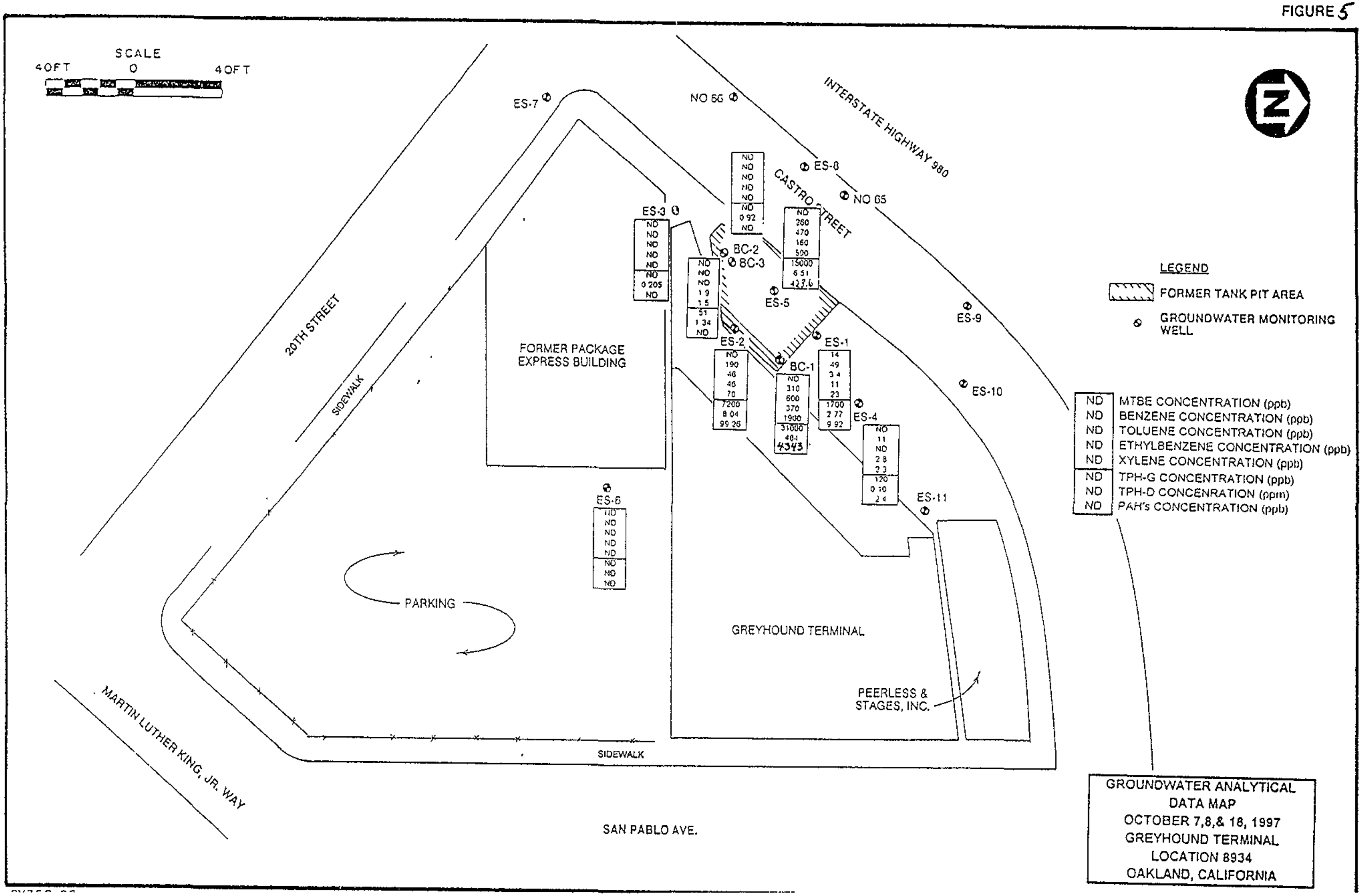


SOIL ANALYTICAL DATA MAP
GREYOUND TERMINAL
LOCATION 8934
OAKLAND, CALIFORNIA

SY356 06

PARSONS ENGINEERING SCIENCE, INC.

FIGURE 5



SCALE
40FT
0
40FT
ES-7
NO 66
INTERSTATE HIGHWAY 980
ES-8
CASTRO STREET
NO 65
ES-3
ND
ND
ND
ND
ND
ND
0 205
ND
ND
ND
ND
ND
ND
ND
0 92
ND
BC-2
BC-3
ND
ND
ND
1 9
1 5
51
1 34
ND
ND
260
470
160
500
15000
6 51
437.6
ES-5
ES-2
ND
190
46
46
70
7200
8 04
99 26
BC-1
ND
310
600
370
1900
31000
404
4343
ES-1
14
49
3 4
11
23
1700
2 77
9 92
ES-4
ND
11
ND
2 8
2 3
120
0 10
2 4
ES-9
ES-10
ES-11
ES-6
ND
ND
ND
ND
ND
ND
ND
ND
20TH STREET
SIDEWALK
FORMER PACKAGE EXPRESS BUILDING
PARKING
GREYHOUND TERMINAL
PEERLESS & STAGES, INC.
SIDEWALK
MARTIN LUTHER KING, JR. WAY
SAN PABLO AVE.
LEGEND
FORMER TANK PIT AREA
GROUNDWATER MONITORING WELL
ND MTBE CONCENTRATION (ppb)
ND BENZENE CONCENTRATION (ppb)
ND TOLUENE CONCENTRATION (ppb)
ND ETHYLBENZENE CONCENTRATION (ppb)
ND XYLENE CONCENTRATION (ppb)
ND TPH-G CONCENTRATION (ppb)
ND TPH-D CONCENRATION (ppm)
ND PAH's CONCENTRATION (ppb)
GROUNDWATER ANALYTICAL DATA MAP
OCTOBER 7,8,& 18, 1997
GREYHOUND TERMINAL
LOCATION 8934
OAKLAND, CALIFORNIA

PRELIMINARY RISK EVALAUTION
(OCTOBER 1993)

REPORT FOR

PRELIMINARY RISK EVALUATION
GREYHOUND TERMINAL
LOCATION 8934
Oakland, California

PREPARED FOR

PREPARED BY

OCTOBER 1993

D:\GREYHDCV\SY357.PM4

ENGINEERING-SCIENCE, INC.

290 Elwood Davis Road Suite 312 • Liverpool New York 13088 • (315) 451-9560 • Fax (315) 451-9570

November 5, 1993

Ms. Susan Hugo
Alameda County Department
of Environmental Health
80 Swan Way, Room 200
Oakland, California 94621

Re: Greyhound Terminal
Location 8934
Oakland, California
Preliminary Risk Evaluation

Dear Ms. Hugo:

On behalf of Greyhound Lines, Inc. (GLI), Engineering-Science, Inc. (ES) is pleased to provide the enclosed Preliminary Risk Evaluation report for the Greyhound Terminal in Oakland, California. This preliminary risk evaluation has been prepared in accordance with the discussions held in a meeting between GLI and the Alameda County Department of Environmental Health (ACDEH) on September 2, 1993. The risk assessment includes an evaluation of potential contaminant exposure pathways, existing contaminant levels and distribution, chemical characteristics, and site-specific factors such as soil permeability, and local land and water uses.

The results of this study indicate the lack of any significant health or environmental threat to current or future users of the site due to residual contaminants detected. Based on the results of this risk evaluation, alternative points of compliance, or site-specific cleanup criteria should be established. No soil remediation is recommended based on these results. Greyhound proposes to continue operation of the free product/groundwater treatment system on-site with monthly groundwater monitoring and system maintenance visits.

Greyhound looks forward to your favorable review of this report. In the interim, if you have any questions or require additional information, please contact us at (315) 451-9560.

Sincerely,

ENGINEERING-SCIENCE, INC.

Karen M. Scruton

Karen M. Scruton
Project Toxicologist

David A. Nickerson

David A. Nickerson
Project Manager

KMS/DAN/lml

cc: T. Portele, GLI, Dallas, TX
J.N. Baker, ES, Syracuse
Richard Hiatt, RWQCB
D. L. Chaffin, ES, Syracuse

PRELIMINARY RISK EVALUATION

GREYHOUND TERMINAL

OAKLAND, CALIFORNIA

Prepared for:

GREYHOUND LINES, INC.
DALLAS, TEXAS

Prepared by:

ENGINEERING-SCIENCE, INC
290 ELWOOD DAVIS ROAD
LIVERPOOL, NY 13088

OCTOBER, 1993

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PRELIMINARY RISK EVALUATION
GREYHOUND TERMINAL
OAKLAND, CALIFORNIA

EXECUTIVE SUMMARY

A preliminary risk evaluation was conducted for the Greyhound Terminal in Oakland, California. The purpose of the evaluation was to assess the potential risks to human health and the environment posed by contaminants detected at the facility and to determine the applicability of alternate site-specific cleanup levels. Site concentrations were compared to available or derived health and cleanup criteria.

For this preliminary risk assessment, the site was divided into two regions: the former Tank Pit area (source area) and the region surrounding the source area (perimeter). In the source area, concentrations of contaminants in groundwater exceeded criteria derived to protect both human health and the environment. A free-product/groundwater recovery system is currently in place in the source area. None of the chemicals detected in the groundwater in the perimeter were found to exceed the criteria used, indicating that the recovery system has been effective in preventing migration of contaminants from the source area.

Concentrations of BTEX in soils (benzene, toluene, ethylbenzene and xylenes) did not exceed calculated risk-based preliminary remediation goals (PRGs) in either the source area or the perimeter sample locations. Neither BTEX nor total petroleum hydrocarbons (TPH) were detected in the perimeter area, indicating that contamination has not migrated from the source area. Although TPH was detected in soils in the source area, risk-based PRGs could not be derived for these contaminants because USEPA-derived toxicity values are not available.

Currently, there are no individuals that may be exposed to either contaminated soil or groundwater, especially in the source area. The site is currently covered entirely by pavement and buildings, thereby eliminating contact with soils. The drinking water supply for the City of Oakland is currently municipally supplied with water originating in the Sierra Nevada Mountains, located 200 miles east of the site. Groundwater in the area is not considered a primary source of water supply because of the limited areal extent and thickness of the water-bearing unit. Consequently, it is highly unlikely that future users of the site will be exposed to groundwater. In the future, direct contact with soil is the only possible exposure pathway. Individuals may contact soil during future excavation and development of the site. As discussed above, however, neither BTEX in soil from the source area nor the perimeter were detected in concentrations above calculated risk-based cleanup levels. Given that the risks associated with TPH cannot be quantitated because USEPA-derived toxicity values are not available, it was concluded that a more detailed quantitative risk assessment is not appropriate.

INTRODUCTION

The preliminary risk evaluation provides an assessment of the potential risks to human health and the environment posed by any contaminants detected during the site characterization and subsequent analyses. The data used in this evaluation were those collected for the 1989 Phase I Investigation performed by Brown and Caldwell (Brown and Caldwell, 1989), the 1992 Preliminary Site Investigation Report (ES, 1992) and the 1993 Supplemental Site Investigation Report (ES, 1993). The objectives of the preliminary risk evaluation are:

- To provide qualitative information on the potential risks to human and environmental receptors due to the release or threat of release of hazardous substances; and
- To help determine whether or not further action is required and the applicability of alternate, site-specific cleanup levels. Further action might include the collection of additional data and the preparation of a quantitative risk assessment.

The results of the site investigations were used to identify 1) the affected environmental media, 2) the contaminants of concern, 3) the chemical concentrations present, and 4) the potentially-exposed human or environmental receptors.

The initial steps of the preliminary evaluation were to:

- Summarize the available chemical sampling data;
- Review the factors that affect migration of contaminants, and identify and evaluate potential migration pathways;
- Evaluate the potential toxicities associated with exposure to the selected chemicals by human or environmental receptors; and
- Identify potential hazards to human or environmental receptors that may be affected by the migration of contaminants along identified pathways.

The site characterization is the initial investigation of a site and its purpose is to confirm or deny the presence of contamination. In keeping with the preliminary nature of the investigation, detailed calculations to quantify risk to human health and the environment from the site were not performed. Instead a qualitative approach was taken in which all potential receptors and exposure pathways were evaluated as to the possibility of pathway completion. Completed pathways were further evaluated using various cleanup criteria. These criteria may be existing standards, calculated health-based criteria, or existing cleanup levels. This evaluation was based on existing site information concerning migration pathways, the location and types of contaminants present, and the location of current and possible future receptors. Conservative assumptions were employed to ensure that potential exposure pathways (current and future) were not excluded from consideration.

SITE DESCRIPTION

This section presents a description of the site, including surrounding land use, climate, geology, hydrology and surface and groundwater use.

Local Description and Surrounding Land Use and Climate

The triangular-shaped Greyhound site is located at the corner of San Pablo Avenue and Castro Street near the central business district of Oakland, California (Section 26, Township 1S, Range 4W, United States Geological Survey, 1980)(Figure 1 and 2). The site, which encompasses an area of approximately 61,250 square feet, is entirely paved with asphalt and concrete. Land use in the immediate vicinity of the terminal is mixed (commercial/residential). The terminal is bordered on the west by Castro Street, on the east by San Pablo Avenue and Martin Luther King Way, on the south by 20th Street and on the north by Castro Street/San Pablo Avenue.

The Oakland area has a climate characterized by mild wet winters and warm dry summers. Precipitation is seasonal, falling mostly between November and March. Average annual precipitation recorded over a ninety year period (1885-1975) for the Oakland area is 20 inches (Alameda County Flood Control and Water Conservation District, 1988).

Local Geology

The site is located in the San Francisco Bay Region of the Coast Ranges Geomorphic Province of California (Norris and Webb, 1990). The area, including the Greyhound facility, is underlain by a thick sequence of unconsolidated Pleistocene deposits that include the Merritt Sand and Older Alluvium. The Merritt Sand encountered directly below the site consists of loose, moderate-to well-sorted, fine- to medium-grained, clayey to silty sand and lenses of sandy clay and clay. It has a maximum thickness of 65 feet in the East Bay Plain Area. Underlying the Merritt Sand is 700 to 800 feet of Older Alluvium comprised of poorly consolidated to unconsolidated clay, silt, sand and gravel (Helley, Lajoie and Burke, 1972; Alameda County Flood Control and Water Conservation District, 1988).

Beneath the Greyhound facility, the subsurface materials encountered during previous investigations include sand, silt and clay. The predominant materials encountered during boring operations were silty, sandy clay with layers/lenses of fine-to medium-grained sand, silty sand and clayey sand interbedded within layers of clay and silty clay. Hydraulic conductivity values reported for silty, sandy clays range from 10^{-9} to 10^{-4} cm/sec (Freeze and Cherry, 1979; Domenico and Schwartz, 1990).

Hydrology

The nearest surface water body to the Greyhound site is Lake Merritt (Figure 1), located approximately 1,700 feet east of the site. Lake Merritt is a brackish-water estuarine environment, connected to and influenced by the tidal fluctuations of San Francisco Bay. The Oakland Inner Harbor, the closest portion of the bay, is located approximately 2,700 feet south-southwest of the site.

The Greyhound facility lies within the Merritt Sand subarea of the East Bay Plain groundwater basin. Locally, groundwater is encountered under water-table conditions at a depth of 18 to 22 feet below ground surface (bgs). Regional groundwater flow is to the west-southwest (Alameda County Flood Control and Water Conservation District, 1988). At the Greyhound site, shallow groundwater flow is to the southeast.

Local Surface Water and Groundwater Use

The City of Oakland obtains its municipal and industrial water from the East Bay Municipal Utility District (EBMUD). EBMUD imports this water primarily from the surface waters of the Sierra Nevada Mountain Range, located approximately 200 miles east of the site.

Groundwater in the area is utilized for limited irrigation and industrial purposes. The area is not considered a primary source of water supply because of the limited areal extent and thickness of the water-bearing unit (Alameda County Flood Control and Water Conservation District, 1988).

Approximately 384 wells are located within Section 26, Township 1S, Range 4W (ACPWA, 1991). The vast majority (99%) of these wells are used to monitor or extract contaminated groundwater at commercial/industrial sites. One of the wells is used to supply water for irrigation. None of the wells located in Section 26 are used for the municipal water supply.

CONTAMINANTS OF CONCERN

Five parameters were assessed in groundwater and soil samples from the site: benzene, ethylbenzene, toluene, and xylenes (BTEX), and total petroleum hydrocarbons (TPH). During this and previous site investigations, TPH was further characterized as TPH from diesel (TPHD) or from gasoline (TPHG) (ES, 1992; ES, 1993).

For this preliminary risk assessment, the site was divided into two distinct portions: the source area (Tank Pit area) and the area surrounding the source area (perimeter). The source area is defined as those groundwater and soil samples taken from within and immediately around the former Tank Pit area. These include the following monitoring well locations: BC-1 through BC-3 from the 1989 investigation (Brown and Caldwell, 1989), and ES-1 through ES-5 from the 1992 investigation (ES, 1992). The area surrounding the source area is characterized as those groundwater and soil samples around the perimeter of the site, which were taken during the 1993 investigation (ES-6 through ES-11) (ES, 1993).

The contaminants detected in the groundwater and soil samples in both of these areas, and their maximum concentrations are listed in Table 1. The maximum concentrations for each chemical provide an indication of the magnitude of chemical contamination in the analyzed samples. The maximum values are used in subsequent sections to estimate the potential for adverse health affects. This approach will greatly overestimate any risks.

Chemical and Physical Properties of the Chemicals of Concern

Physical and chemical properties of the chemicals of concern will affect fate and transport of those chemicals in the environment. Table 2 summarizes several important physical and chemical properties for the selected chemicals of concern.

The water solubility of a substance is a critical property affecting environmental fate. Highly-soluble chemicals can be rapidly leached from wastes and soils and are generally mobile in groundwater. Solubilities can range from less than 1 mg/L to totally miscible, with most common organic chemicals falling between 1 mg/L and 1,000,000 mg/L (Lyman et al., 1982). The water solubility of chemicals may become enhanced in the presence of organic solvents (e.g., toluene), which themselves are more soluble in water.

Volatilization of a compound will depend on its vapor pressure, water solubility, and air diffusion coefficient. Highly water-soluble compounds generally have lower volatilization rates from water unless they also have high vapor pressures. Vapor pressure, a relative measure of the volatility of chemicals in their pure state, ranges from roughly 0.001 to 760 millimeters of mercury (mm Hg) for liquids. The Henry's Law Constant, which combines vapor pressure with solubility, is more appropriate than vapor pressure alone for estimating releases from water to air for compounds having Henry's Law Constants. Compounds with Henry's Law Constants greater than 10^{-3} atmospheres - cubic meter per mole (atm-m^3/mole) may readily volatilize from water if not bound to organic matter; those with values ranging from 10^{-3} to 10^{-5} are associated with moderate volatilization, while compounds with values less than 10^{-5} will only volatilize from water to a limited extent (Lyman et al., 1982).

The organic carbon partition coefficient (K_{oc}) reflects the propensity of a compound to sorb to organic matter found in soil. The normal range of K_{oc} values is 1 to 10^7 milliliters per gram (mL/g), with higher values indicating greater sorption potential. Chemicals which have a strong tendency to sorb to organic matter (i.e., chemicals with high K_{oc} values) will move more slowly in the environment than chemicals with low K_{oc} values.

Contaminant Fate and Transport

The previous subsection provided a description of the important physical and chemical properties of the contaminants detected at the site. This subsection describes how these properties affect the persistence and transport of these compounds in the environment.

Volatile Organic Compounds

Benzene, ethylbenzene, toluene, and xylenes are all volatile organic compounds. These compounds have high Henry's Law Constants, moderate to high solubilities and low K_{oc} values. This indicates that these compounds can be expected to be mobile in the environment.

All four of the volatile compounds have been detected in groundwater on site, and all, except benzene, have been detected in soil samples. The properties that enhance the mobilities of these compounds also make them more available for degradation. Because of their high vapor pressures these compounds would be expected to volatilize from uncovered surface soils. However, volatilization of these compounds from site subsurface soils would be inhibited by the overlying pavement and building foundations.

Petroleum Hydrocarbons

During the 1992 investigation (ES, 1992), an analysis of TPH as diesel was performed and, during the 1993 investigation (ES, 1993), TPH analyses for both diesel (TPHD) and gasoline (TPHG) were completed based on a requirement of the Alameda County Department of Environmental health (ACDEH).

TPHD and TPHG concentrations were measured in accordance with DHS/LUFT Method (EPA Method 3510/8015 for TPHD and EPA Method 8015M for TPHG).

The fate of petroleum hydrocarbons in soils is affected primarily by their distribution, volatility, and leaching potential. Low molecular weight aromatic hydrocarbons, such as BTEX, partially evaporate. The remaining hydrocarbons will migrate to different depths in the soil column and possibly to groundwater.

The aliphatic organics which represent the residual compounds have negligible water solubilities, low vapor pressures and high adsorption coefficients. The proportion of petroleum hydrocarbons that will adsorb to soil particles rather than continue migration depends on the type of soil, the particular petroleum product involved, the volume of the release, and the amount of rainfall. In general, leaching to groundwater is favored by high rainfall and permeable soils. Leaching potential also increases for petroleum compounds with high solubility and low adsorption coefficients.

Most compounds measured as petroleum hydrocarbons are relatively persistent in the environment. Biodegradation is the main elimination mechanism, but natural rates are somewhat slow, especially for cyclic or aromatic hydrocarbons. Complete natural biodegradation of petroleum hydrocarbons may require many years (API, 1986).

ARAR IDENTIFICATION

In evaluating the degree of contamination at a site, consideration must be given to applicable or relevant and appropriate requirements (ARARs) of Federal and State environmental laws. Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations that specifically address a hazardous substance, contaminant, remedial action, or other circumstance at a site. Relevant and appropriate requirements are those standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations that, while not "applicable", address problems or situations sufficiently similar to those encountered at the site that their use is well suited to the particular site.

Many local implementing agencies, such as ACDEH, use the LUFT Manual (1989) as guidance in the assessment and cleanup of UFST sites. Three site investigation categories are recognized by the LUFT manual: Category 1, no evidence of soil contamination; Category 2, known soil contamination; and Category 3, known or suspected groundwater contamination. Analytical results for soil and groundwater samples collected during the 1989 investigation (Brown and Caldwell Consulting Engineers, 1989), the preliminary site investigation (ES, 1992) and the supplemental site investigation (ES, 1993) indicate that the site falls under Category 3 (known or suspected groundwater contamination).

Groundwater ARARs

Potential ARARs for water quality at the site include the Safe Drinking Water Act, and the Clean Water Act. Standards and criteria promulgated under these programs are provided in Table 3 for potential contaminants of concern at the site. California Water Quality Standards for the compounds of concern are also provided on Table 3.

Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) mandates USEPA to establish regulations to protect human health from contaminants in drinking water. USEPA has promulgated drinking water standards which generally apply to community water systems. Primary drinking water standards include maximum contaminant levels (MCLs) and maximum contaminant level goals (MCLGs). MCLs are set at levels that are protective of human health, while taking into account available treatment technologies and the costs to large public water systems. MCLGs are strictly health-based and do not take cost or feasibility into account. Secondary drinking water regulations consist primarily of secondary maximum contaminant levels (SMCLs) for specific contaminants or water characteristics that may affect the aesthetic qualities of drinking water (i.e., color, odor, and taste).

USEPA MCLs and MCLGs for contaminants of concern at the site are provided in Table 3 (USEPA, 1993a). California MCLs are also identified (USEPA, 1992). The levels indicated are potential ARARs. Maximum site concentrations for the source area and the perimeter area are also presented in Table 3.

In the source area, the USEPA and/or California MCLs were exceeded for benzene, ethylbenzene, toluene and xylenes. MCLs are not available for TPHD (maximum concentration of 950 mg/L) or TPHG (maximum concentration of 1.5 mg/L). Given that it is highly unlikely that the groundwater at the site would ever be used as a source of drinking water, BTEX and TPHD/TPHG in the groundwater should not pose a hazard to either current or future receptors.

In the perimeter area, none of the USEPA and/or California MCLs were exceeded for benzene, ethylbenzene, toluene or xylenes. Neither TPHD nor TPHG were detected in any of the perimeter wells.

Clean Water Act

The Clean Water Act (CWA) requires the establishment of guidelines and standards to control the direct or indirect discharge of pollutants to waters of the

United States. The standards required by the CWA include water quality criteria for specific pollutants. USEPA has developed two kinds of water quality criteria: one for the protection of human health and another for the protection of aquatic life. These criteria are non-enforceable guidelines used by the states to set water quality standards for surface water. These non-enforceable standards are potential ARARs when the state has not promulgated water quality standards for the specific pollutants and water bodies of concern.

Table 3 provides the water quality criteria for the potential contaminants of concern at the site (USEPA, 1986a). Although these values are not applicable, they may be relevant and appropriate because groundwater at the site may eventually discharge to surface water (presumably Lake Merritt). Given that the surface water in the vicinity is brackish, water quality criteria for marine aquatic life are reported since these values are more conservative than those for freshwater aquatic life. Data, however, are insufficient to derive criteria for the marine life, therefore, the values presented in the table represent the Lowest-Observed-Effect-Level (LOEL). Given that the contaminants are expected to be diluted and degraded prior to reaching surface water in the area, it is highly unlikely that any of the site chemicals would ever reach any surface water body at concentrations above detection limits.

In the source area, acute and/or chronic ambient water quality criteria for marine aquatic life were exceeded for benzene and ethylbenzene. Criteria were not exceeded for toluene. Criteria were not available for xylenes and TPHs. It should be reiterated, however, that the values presented as criteria for these chemicals are LOEL values since data were insufficient for the development of criteria.

In the perimeter area, water quality criteria were not exceeded for benzene, ethylbenzene or toluene. Criteria are not available for xylenes and TPHs.

Soil ARARs

Exposure via soil is a possible pathway of concern for future site users if excavation is undertaken at the site. In California, soil cleanup levels at sites with underground storage tanks are evaluated on a case-by-case basis using guidance contained in the LUFT guidance (1989) and the Water Quality Control Plan of the San Francisco Bay Region (1992). The LUFT guidance focuses on the cleanup of soils to levels that will not adversely affect groundwater. The LUFT guidance evaluates three types of site-specific data in their general risk appraisal: precipitation, depth to groundwater and extent of soil contamination.

Given the conditions at the Greyhound site, the LUFT guidance indicates that soils should be cleaned up to non-detectable levels for the protection of groundwater. This is not appropriate for the Greyhound site, however, since the groundwater is currently being treated with a groundwater recovery system, which has been shown to be effective in preventing the migration of contamination from the source area. At this site, it is more appropriate to implement the guidance stated in the Water Quality Control Plan of the San Francisco Bay Region (1992). This guidance states that, if it is unreasonable to cleanup soils to background concentration levels, soil cleanup levels may be derived under the following conditions:

- allow residual pollutants to remain in soil at concentrations such that:

  (a) any leachate generated would not cause ground water to exceed applicable ground water quality objectives, and

  (b) health risks from surface and subsurface exposure are within acceptable guidelines.

- require follow-up groundwater monitoring to verify that groundwater is not polluted by chemicals remaining in the soil. Follow-up groundwater monitoring may not be required where residual soil pollutants are not expected to impact groundwater.
- require measures to ensure that soils with residual pollutants are covered and managed to minimize pollution of surface waters and/or exposure to the public.
- where significant amount of wastes remain onsite, implement institutional controls to the extent applicable. This may include, but is not limited to, subsurface barriers, pollutant immobilization, toxicity reduction, financial assurances.

Given that a groundwater recovery system is currently in place at the site, it is reasonable to derive soil cleanup levels that provide for the protection of human health following direct soil contact. USEPA (1991) provides guidance for the derivation of Preliminary Remediation Goals (PRGs) which represent initial cleanup goals. The risk-based PRGs were derived using a USEPA-defined conservative exposure scenario for soil ingestion and appropriate USEPA-derived toxicity values (discussed below under Toxicity Assessment; see Table 4 and Table 5). This scenario is based on a 30-year, time-weighted exposure of an individual ingesting soil. The exposure was time-weighted to account for differences in body weight and ingestion rate between children and adults (child: 6 year exposure of a 15 kg child to 200 mg soil/day; adult: 24 year exposure of a 70 kg adult to 100 mg soil/day). The exposure was assumed to occur 350 days/year and was averaged over 30 years for noncarcinogenic effects and 70 years for carcinogenic effects.

Maximum detected site concentrations of contaminants and the appropriate risk-based PRGs are presented in Table 6. Risk-based PRGs were not exceeded for BTEX in either the source area or in the perimeter area. Risk-based PRGs could not be calculated for TPHD, TPHG or TFH because USEPA has not derived toxicity values for these contaminants.

PRELIMINARY HUMAN HEALTH EVALUATION

The previous subsections have described the physical and chemical properties of contaminants found at the site and the effect these properties will have on environmental fate and transport mechanisms as well as identifying ARARs that can be used to evaluate the significance of the sampling results. This subsection provides the preliminary human health evaluation which includes an assessment of exposure routes, a description of contaminant toxicities and presents the initial human health risk screening.

Exposure Assessment

The presence of a contaminant in a particular environmental medium does not necessarily indicate that human exposure will occur. In order for human exposure to occur, a complete exposure pathway must exist. A complete exposure pathway consists of the following:

- A contaminant source and mechanism for release;
- An environmental transport medium;
- An exposure point; and
- A human receptor and a feasible route of exposure at the exposure point.

If any of the items listed above are missing then an exposure pathway is incomplete. The following paragraphs describe the transport mechanism and exposure pathways for the site.

Mechanisms of Migration

The media into which a contaminant migrates affects the types of human and environmental exposures which may occur. The previous subsections have described the physical and chemical properties of concern. This subsection discusses the mechanisms of contaminant migration and potential exposure routes for the site. Contaminants have been detected in groundwater and soil samples at the site. Several mechanisms exist through which contaminants may migrate.

Migration into Air. Contaminants may migrate into the air through three primary mechanisms: volatilization, soil gas migration, and suspension of soil particles (wind erosion or mechanical disturbances).

Volatilization is the mass transfer of a compound from a specific medium (such as soil) to the air. Environmental factors that affect volatilization include temperature, soil porosity, soil water content, soil organic carbon content, and depth of contamination (Jury et al., 1983). Volatilization may be an important migration pathway for contaminants having high vapor pressures (greater than 100 mm Hg) or high Henry's Law Constants (greater than 10^{-3} atm-m^3/mole). The contaminants detected at the site which are in this category are benzene, ethylbenzene, toluene and xylenes. Volatilization from soils, however, is unlikely to occur given that the site is completely covered by pavement and building foundations.

Fugitive dust emissions from wind or vehicle disturbances at the site are unlikely to occur now or in the future. The site is completely covered by pavement and building foundations.

Leaching into Groundwater. The percolation of rainwater through the soils at the site is unlikely, since the site is paved. Contamination of groundwater at the site by BTEX, TPHD and TPHG has been detected in the source area.

Once contaminants reach the groundwater, the individual chemicals will have different migration rates. Volatile organic compounds were detected in both the soil and groundwater in the source area. Given the nature of the soil at the site, (silty, sandy clay), soil permeability is expected to be low to moderate. The presence of pavement and the building foundations can be expected to slow contaminant migration off site. The fact that significant contamination was not found in the perimeter area indicates that contaminants are not migrating from the source area.

Migration in Surface Water. Contaminant migration into surface water may occur through groundwater discharge downgradient of the site. The regional flow pattern is southeast, towards Lake Merritt. Significant groundwater contamination has not been detected in the area immediately outside of the source area, indicating that contaminant migration is impeded by the low permeability soils and that the groundwater recovery system in place at the site is effective in containing the contaminants. Consequently, the amount of site contaminants reaching surface water should be below detection limits.

Pathways of Exposure

Potential pathways of exposure to chemicals of concern at the site have been summarized in Table 7. Demographic and land use information were used in developing exposure pathways. The USEPA requires that hypothetical future use of a site be considered as well as current use. Therefore, this table presents current-use and future-use pathways.

Current-use pathways include exposure to air, groundwater, surface water, and soils by local residents and on-site workers. Because the site is entirely covered by pavement and buildings, direct contact with soil and the generation of airborne volatiles from soil will be negligible. This indicates that the potential for completion of the soil and air pathways is very low.

The primary source of drinking water for the City of Oakland is surface waters of the Sierra Nevada Mountain Range, located approximately 200 miles east of the site. Groundwater in the area is utilized for limited irrigation and industrial purposes. The area is not considered a primary source of water supply because of the limited areal extent and thickness of the water-bearing unit (Alameda County Flood Control and Water Conservation District, 1988). Consequently, the groundwater pathway is incomplete for current nearby residents.

Exposure to contaminated surface water resulting from migration of chemicals off-site is highly unlikely since the amounts of contamination that would reach this water would be negligible. Groundwater in the perimeter of the source area did not contain significant contamination, indicating that the groundwater recovery system currently in place at the site is effective in containing contamination from the source area. The surface water pathway, therefore, is incomplete.

Future-use pathways include exposure to contaminated air, groundwater, surface water, and soils by hypothetical future residents and construction workers. The probability of future-use pathway completion is higher than that for current use, based primarily on the remote possibility of future development of the site for residential or commercial use. By the time development might occur on the site, contaminant concentrations in groundwater will have diminished significantly from current levels as a result of the installed groundwater recovery system, and concentrations in soil and water will have also diminished due to natural processes involving degradation and/or dispersion.

Similar to current-use pathways, exposure to contaminants through volatilization and fugitive dust generation is expected to be minimal. Exposure to contaminated groundwater through its development as a potable drinking water source is unlikely because future residents, if any, would be supplied with water by the City of Oakland. Exposure to contaminated surface water in the future is highly unlikely, as the amounts of contamination that would reach this water would be negligible. Exposure of hypothetical future residents and construction workers to contamination in soils is unlikely, but will be further assessed.

Toxicity Assessment

The objective of the toxicity assessment is to weigh available evidence regarding the potential for particular contaminants to cause adverse effects in exposed individuals and to provide, where possible, an estimate of the relationship between the extent of exposure to a contaminant and the increased likelihood and/or severity of adverse effects. The types of toxicity information applied in this assessment include the reference dose (RfD) used to evaluate noncarcinogenic effects and the slope factor used to evaluate carcinogenic potential.

Health Criteria for Noncarcinogenic Effects

For chemicals that exhibit noncarcinogenic effects, many authorities consider organisms to have repair and detoxication capabilities that must be exceeded by some critical concentration (threshold) before the health effect is manifested. For example, an organ can have a large number of cells performing the same or similar functions that must be significantly depleted before the effect on the organ is seen. This threshold view holds that a range of exposures from just above zero to some finite value can be tolerated by the organism without an appreciable risk of adverse effects.

Health Criteria for chemicals exhibiting noncarcinogenic effects for use in risk assessment are generally developed using USEPA RfDs (USEPA, 1993b,c). In general, the RfD is an estimate of route-specific average daily intake (dose) for individuals (including sensitive individuals) below which there will not be an appreciable risk of adverse health effects. The RfD is derived using conservative safety factors (e.g., to adjust from animals to humans and to protect sensitive subpopulations) to ensure that it is unlikely to underestimate the potential for adverse noncarcinogenic effects to occur. The purpose of the RfD is to provide a benchmark against which the sum of other doses (e.g., those projected from human exposure to various environmental conditions) might be compared. Doses that are significantly higher than the RfD may indicate an inadequate margin of safety could exist for exposure to that substance and that an adverse health effect could occur.

USEPA has developed oral and inhalation RfDs for most of the chemicals of concern selected for the site. In addition, the chemicals of concern may affect different target organs in the body. Some of the chemicals of concern that may have noncarcinogenic effects following long-term exposure, and the target organs that are most sensitive to these chemicals, are as follows:

- Ethylbenzene and xylenes may adversely affect the liver.
- Ethylbenzene may adversely affect the kidney.
- Toluene and xylenes may adversely affect the nervous system.
- Total xylenes may cause reproductive effects.

Potential noncarcinogenic effects with RfDs of chemicals of concern identified at the site are shown on Table 4.

No RfDs or slope factors are available for the dermal route of exposure. In some cases, however, noncarcinogenic or carcinogenic risks associated with dermal exposure can be evaluated using an oral RfD or an oral slope factor. Exposures via the dermal route generally are calculated and expressed as absorbed doses. These absorbed doses are compared to an oral toxicity value that is also expressed as an absorbed dose. This requires quantitative estimates of both oral and dermal exposure and is only appropriate for chemicals causing systemic toxicity. However, since the purpose of this evaluation is to provide only a gross estimate of site hazards, exposures via the dermal route will not be further considered.

Health Criteria for Carcinogenic Effects

For chemicals that exhibit carcinogenic effects, most authorities recognize that one or more molecular events can evoke changes in a single cell or a small number of cells that can lead to tumor formation. This is the nonthreshold theory of carcinogenesis which purports that any level of exposure to a carcinogen can result in some finite possibility of generating the disease. Generally, regulatory agencies assume the non-threshold hypothesis for carcinogens in the absence of information concerning the mechanisms of action for the chemical.

USEPA's Carcinogen Assessment Group (CAG) has developed slope factors (i.e., dose-response values) for estimating excess lifetime cancer risks associated with various levels of lifetime exposure to potential human carcinogens. The carcinogenic slope factors can be used to estimate the lifetime excess cancer risk associated with exposure to a potential carcinogen (USEPA, 1993b,c). Risks estimated using slope factors are considered unlikely to underestimate actual risks, but they may overestimate actual risks. Excess lifetime cancer risks are generally expressed in scientific notation and are probabilities. An excess lifetime cancer risk of $1x10^{-6}$ represents the probability that one individual out of one million will develop cancer as a result of exposure to a carcinogenic chemical over a 70-year lifetime under specified exposure conditions. USEPA has suggested developing remedial alternatives for cleanup of Superfund sites using total excess lifetime cancer risks ranging from 10^{-4} to 10^{-6}. Potential carcinogenic targets with associated slope factors for the chemicals of concern identified at the site are shown on Table 5.

In practice, slope factors are derived from the results of human epidemiology studies or chronic animal bioassays. The data from animal studies are generally fitted to the linearized multistage model and the dose-response curve is obtained. The 95th percentile upper confidence limit slope of the dose-response curve is subjected to various adjustments and an interspecies scaling factor is applied to conservatively derive the slope factor for humans. Thus, the actual risks associated with exposure to a potential carcinogen quantitatively evaluated based on animal data are not likely to exceed the risks estimated using these slope factors, but they may be much lower. Dose-response data derived from human epidemiological studies are fitted to dose-time-response curves on an ad hoc basis. These models provide rough but plausible estimates of the upper limits on lifetime risk. Slope factors based on human epidemiological data are also derived using very conservative assumptions and, as such, they too are considered unlikely to underestimate risks. In summary, while the actual risks associated with exposures to potential carcinogens are unlikely to be higher than the risks calculated using a slope factor, they could be considerably lower.

In addition, there are varying degrees of confidence in the weight of evidence for carcinogenicity of a given chemical. USEPA has proposed a system for characterizing the overall weight of evidence for a chemical's carcinogenicity based on the availability of animal, human, and other supportive data (USEPA, 1986b). The weight-of-evidence classification is an attempt to determine the likelihood that an agent is a human carcinogen and thus qualitatively affects the estimation of potential health risks. Three major factors are considered in characterizing the overall weight of evidence for carcinogenicity: (1) the quality of evidence from human studies, (2) the quality of evidence from animal studies, which are combined into a characterization of the overall weight of evidence for human carcinogenicity; and (3) other supportive information which is assessed to determine whether the overall weight of evidence should be modified. USEPA's final classification of the overall weight of evidence includes the following five categories:

- **Group A - - Human Carcinogen**

  This category indicates that there is sufficient evidence from epidemiological studies to support a causal association between an agent and cancer.

- **Group B - - Probable Human Carcinogen**

  This category generally indicates that there is at least limited evidence from epidemiological studies of carcinogenicity to humans (Group B1) or that, in the absence of adequate data on humans, there is sufficient evidence of carcinogenicity in animals (Group B2).

- **Group C - - Possible Human Carcinogen**

  This category indicates that there is limited evidence of carcinogenicity in animals in the absence of data on humans.

- **Group D - - Not Classified**

  This category indicates that the evidence for carcinogenicity in animals is inadequate.

- **Group E - - No Evidence of Carcinogenicity to Humans**

This category indicates that there is no evidence for carcinogenicity in at least two adequate animal tests in different species, or in both epidemiological and animal studies.

Slope factors are developed based on epidemiological or animal bioassay data for a specific route of exposure, either oral or inhalation. For some chemicals, sufficient data are available to develop route-specific slope factors for inhalation and ingestion. For chemicals with only one route-specific slope factor but for which carcinogenic effects may also occur via another route, USEPA has used the available value to evaluate risks associated with both potential routes of exposure. Slope factors, classifications, and potential carcinogenic effects for the chemicals of concern identified at the site are shown in Table 5.

Toxicity Profiles For the Chemicals of Concern

Environmental Fate and Toxicity information for both human and environmental receptors is included in the following paragraphs.

Benzene

Benzene is a colorless aromatic hydrocarbon with a characteristic odor. Benzene was widely used in the past as a solvent and as an octane-raising additive in gasoline. Presently, benzene is used primarily in the chemical industry where it is used as a starting or intermediate material for the synthesis of many other organic compounds (ATSDR, 1989a).

Benzene has been shown to be mobile in the soil/groundwater system. It is relatively soluble in groundwater and may be transported through sandy soils and soils of low organic content. The amount of benzene sorbed to the soil increases with increasing organic content. Benzene is highly volatile, and volatilization in surficial soils is probably an important transport mechanism, however, sorption of benzene vapors onto soil particles may slow the vapor-phase transport. Hydrolysis is not expected to be an important process for benzene degradation. In soils, benzene is biodegraded both aerobically and anaerobically by microorganisms. The specific organisms which biodegrade benzene, however, are found in small numbers in soil (ATSDR, 1989a).

Ambient water quality criteria for benzene were developed by USEPA for acute exposure of freshwater organisms and for both acute and chronic exposure of marine organisms (Table 3; USEPA, 1986a). No information is available on the toxicity of benzene to terrestrial wildlife, domestic animals, birds, or plants. Toxic effects in laboratory animals include central nervous system effects, hematological effects, and immune system depression (ATSDR, 1989a).

Benzene is readily absorbed following oral and inhalation exposure (ATSDR, 1989a). The toxic effects of benzene in humans following exposure by inhalation is the same as that for laboratory animals and includes central nervous system effects, hematological effects, and immune system depression. In humans, acute exposure to high concentrations of benzene vapors has been associated with dizziness, nausea, vomiting, headache, drowsiness, narcosis, coma, and death (Sittig, 1985). Chronic exposure to benzene vapors can produce reduced leukocyte, platelet, and red blood cell levels (ATSDR, 1989a).

Benzene is a human carcinogen (USEPA Group A). Chronic exposure to benzene is known to cause leukemia and bone marrow damage. In addition, the compound is a central nervous system depressant at high concentrations, and may cause acute narcotic reactions (Sittig, 1985).

Ethylbenzene

Ethylbenzene is a colorless aromatic liquid. It is used in industry as a resin solvent and in the conversion to styrene monomer (ATSDR, 1990a). No empirical studies on the bioaccumulation of ethylbenzene were found. No information on the toxicity of ethylbenzene to terrestrial wildlife or birds was available. The USEPA has developed ambient water quality criteria for ethylbenzene for acute exposure of freshwater and marine organisms (Table 3; USEPA, 1986a).

Ethylbenzene is moderately adsorbed to soils and will leach to groundwater, particularly in soils containing low levels of organic matter. Ethylbenzene will volatilize from surface soils and will be biodegraded by microbial populations (ATSDR, 1990a).

Ethylbenzene has been classified as a Group D carcinogen, indicating that there is no evidence that ethylbenzene causes cancer in humans or animals. In humans, short-term inhalation exposure to ethylbenzene can result in sleepiness, fatigue, headache, and mild eye and respiratory irritation. The liver, kidneys and developing fetus appear to be the primary targets following chronic oral exposure (ATSDR, 1990a).

Toluene

Toluene is a monocyclic, aromatic, colorless liquid used as a component of gasoline. It is used in manufacturing benzene, urethane foams and other organic compounds. Toluene functions as a solvent in products such as cleaning agents (ASTDR, 1989b).

From the available data, it appears that volatilization is the major route of removal from surface water and soils. Toluene is rapidly degraded in air, soil and water. Toluene will be adsorbed by sediments and suspended solids, especially those rich in organic matter (ATSDR, 1989b).

The USEPA has developed ambient water quality criteria for acute exposure of freshwater organisms and for both acute and chronic exposure of marine organisms (Table 3; USEPA, 1986a). Toluene is a volatile compound that has been found to readily move from water to the atmosphere. Toluene has a moderate tendency to bioaccumulate in the fatty tissues of aquatic species (ATSDR, 1989b).

Little information is available on the toxicity of toluene to terrestrial species. Information on the toxicity of toluene to plants or avian species is not available.

Toluene is absorbed in humans following all routes of exposure (ATSDR, 1989b). Toluene has been classified as a Group D carcinogen, indicating that there is no evidence that toluene causes cancer in humans or animals. In humans, the primary acute effects of toluene vapors are central nervous system depression and narcosis. Also seen at low levels of exposure are irritation of the skin and eyes and impairment of coordination and reaction time when inhaled. In humans, chronic exposure to toluene vapors has been associated with central and peripheral nervous system effects, hepatomegaly, and hepatic and renal function changes. Effects on the liver and central nervous system have also been observed in animals following oral exposure (ATSDR, 1989b).

Xylenes

Xylenes are mixtures of the ortho, meta, and para isomers, with the meta form usually the principal component. Xylenes may also contain impurities such as benzene, trimethylbenzene, toluene, phenol, thiophene and pyridene. The xylenes are widely used as fuel components and as solvents for paints and coatings. Xylenes are commonly used in the chemical industry as intermediates. Specifically, ortho-xylene is used in the manufacture of phthalic anhydride, which is a basic building block for plasticizers. Meta-xylene is an intermediate in the preparation of isophthalic acid, which is the base of unsaturated polyester resins. Commercially, para-xylene is the most important isomer, most of which converted to terephthalic acid or dimethylterephthalate and used to make ppolyester resins (ATSDR, 1990b).

Xylenes are relatively mobile in soil/water systems, especially in aqueous phase. Volatilization is the primary transport mechanism for xylenes. Xylenes will slowly biodegrade in subsurface soils (ATSDR, 1990b).

The xylenes have been classified as Group D carcinogens, indicating that there is no evidence that the xylenes cause cancer in humans or animals. The three xylene isomers have similar toxicological properties and are discussed together. Approximately 60 percent of an inhaled dose is absorbed, and absorption of orally-administered xylenes is nearly complete. Dermal absorption is reported to be minor following exposure to xylene vapor, but may be significant following contact with the liquid (ATSDR, 1990b)). Liquid xylenes and high vapor concentrations are irritating to the eyes and skin and may result in severe respiratory and central nervous system effects. Symptoms include dizziness, drowsiness, nausea, vomiting, abdominal pain, loss of appetite, pulmonary edema, and unconsciousness, as well as reversible effects on the liver and kidneys. The effects of chronic exposure resemble those from acute exposure, but are more severe (ATSDR, 1990b).

Petroleum Hydrocarbons

Petroleum hydrocarbons are a group of compounds that are thick, dark yellow to brown, or green-black liquids which consist of a mixture of hydrocarbons from C_2H_2 and up. They are used as a source of gasoline, petro ether, petrolatum, fuel and lubricating oils, butane, and isopropyl alcohol. The petroleum hydrocarbons found in diesel fuel are the ones of primary concern in this risk evaluation.

Hydrocarbon-containing petroleum residues are decomposed in soil systems. Hydrocarbons degrade to carbon dioxide and water via several intermediates (organic acids, ketones, aldehydes, alcohols, and other hydrocarbon derivatives). Nonvolatile components of oils tend to stay tightly bound in soil, while volatile fractions may escape into the atmosphere. No significant loss or movement of oil through surface runoff from rainfall or downward leaching occurs.

Fuel oil is a combustible liquid and a skin irritant. Breathing oil mists may irritate the nose and throat. Chronic exposure to oil mists may lead to the development of lipoid pneumonia. Similarly refined and processed petroleum residual materials have been shown to cause skin cancer and liver damage in laboratory animals through prolonged skin contact. There is no direct evidence that fuel oil causes skin cancer or liver damage in humans.

Risk Screening

Health and Environmental Criteria

In this section concentrations of chemicals of concern are compared with appropriate criteria to provide a rough estimation as to whether the contaminants pose a risk. The method is intended as a preliminary screening tool rather than a detailed evaluation of risks posed by contaminants at the site. Where ARARs are not developed, other information may be needed to determine what is protective of human health and the environment. Other criteria to be used for comparison purposes include health-based levels derived from toxicity data, and published target cleanup levels.

Current information on the health and environmental effects of various toxicants, including slope factors and RfDs were obtained from the Integrated Risk Information System (IRIS; USEPA, 1993b) and the Health Effects Assessment Summary Tables (HEAST; USEPA, 1993c). IRIS is a computerized library of current information that is updated on a continuous basis. It contains health risk assessment information on chemicals that have undergone a detailed review of toxicity data by work groups composed of USEPA scientists from several agency program offices, and represents an USEPA consensus. Information includes RfDs and slope factors for systemic toxicants. These values are used to calculate human health-based PRGs according to USEPA guidelines.

Site Screening

Exposure via soil is a possible pathway of concern for future site users if excavation is undertaken. A comparison of concentrations of chemicals detected in soil at the site with calculated PRGs is presented in Table 6. The contaminants in site subsurface soils did not exceed any of the calculated PRGs.

Exposure via inhalation of volatile organic contaminants or suspended particulates contaminated with volatile organic contaminants is unlikely due to low concentrations of these compounds in surface soils and the presence of overlying pavement and building foundations.

Uncertainties in Risk Screening

In quantifying risks for a given receptor who is exposed to multiple chemicals by a number of different pathways, USEPA generally assumes that the total risk incurred by the receptor is essentially a sum of the individual risks incurred by each chemical and pathway of exposure. This is reflected in the USEPA methodology used to quantify both noncarcinogenic and carcinogenic risks. Thus, the potential for adverse effects in a given receptor will increase with the number of chemicals detected at the site and the number of pathways by which the receptor could be exposed.

The preliminary risk assessment methodology employed here uses Health Criteria which were developed as though each chemical in question were present at the site by itself and as though exposure would occur through only one pathway (oral exposure to the medium of concern). Thus the risk screening process employed in this assessment considers only oral exposure pathways and does not apportion risks among the total number of chemicals detected at the site. Although in most cases, oral exposure will account for most contaminants, dermal exposure may also be of concern. If risks were apportioned among the total number of chemicals present and all possible pathways of exposure, Health Criteria values would be lower.

Negative findings in the screening process do not guarantee that there are no potential risks. If a baseline risk assessment were conducted in accordance with USEPA guidance documents (USEPA, 1989, 1990, 1991), the total risks for each receptor would be summed across all chemicals and pathways of exposure. Thus it is possible that unacceptable risks could be calculated in a baseline assessment even though the preliminary risk screening indicated that potential adverse health effects were not likely to occur. A negative risk screen thus should not be used as the sole basis for eliminating a site from further investigation or concern.

PRELIMINARY ECOLOGICAL EVALUATION

The area surrounding the site is typical of an urban area which has been significantly impacted by many anthropogenic sources over many years. There is little or no habitat of any significance within several miles of the site. The surrounding area consists of lands occupied by streets, parking lots, buildings, and other structures. The only wildlife expected to be in the immediate area includes that normally found in urban environments such as rodents (rats and mice) and birds (pigeons, starlings, and sparrows), and any wildlife present would not be exposed to site contaminants. Therefore, risks to nearby flora and fauna will not be further evaluated.

CONCLUSIONS

This preliminary risk evaluation does not indicate the presence of any significant health or environmental threat to current or future users of the site due to the contaminants detected at the Greyhound Oakland Terminal. The only potential exposure pathway identified was ingestion of soils by hypothetical future residents and workers. PRGs were derived for all chemicals of concern, except for TPHs because USEPA-derived toxicity values are not available for this group of compounds. Consequently, the potential toxicity of TPHs to future receptors could not be screened. Maximum site concentrations of BTEX were below the calculated PRG levels.

A groundwater recovery system and monitoring program are already in place. The recovery system appears to be effective in that contamination at the site is restricted to the source area: no significant contamination was reported in the perimeter area of the site. It is recommended that the recovery system and monitoring be continued in the near future and in the long-term, be replaced by groundwater monitoring. Additionally, no soil corrective action is recommended at this time. Site-specific cleanup levels which would allow existing residual soil contamination to be left in place are justified by the results of this risk assessment.

Given that toxicity values are not available for TPH, and that all other chemicals of concern were below calculated PRGs, a more detailed quantitative risk assessment is not appropriate.

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TABLE 1
MAXIMUM CONTAMINANT CONCENTRATIONS
GREYHOUND TERMINAL
OAKLAND, CALIFORNIA

Contaminant	Maximum Concentration (ppm) Source	Perimeter
GROUNDWATER		
Benzene	2.1	ND
Ethylbenzene	0.84	ND
Toluene	3.9	0.0007
Xylenes	6.0	0.0012
TPHD	950	ND
TPHG	1.5	ND
SOILS		
Benzene	ND	ND
Ethylbenzene	27	ND
Toluene	49.5	ND
Xylenes	150	ND
TPHD	160	ND
TPHG	NA	ND
TFH	4260	NA

ND = Parameter analyzed but not detected above the method detection limit.

NA = Parameter not analyzed.

TABLE 2
RELEVANT PHYSICAL AND CHEMICAL PROPERTIES (1)

CONTAMINANT	CAS NUMBER	WATER SOLUBILITY (mg/l) at 25°C	VAPOR PRESSURE (mm Hg) at 25°C	HENRY'S LAW CONSTANT (atm–m3/mole)	Koc (ml/g)
BENZENE	71–43–2	1,787.0	9.52E+01	5.50E–03	.3–100
ETHYLBENZENE	100–41–4	160.0	9.53E+00	7.90E–03	165
TOLUENE	108–88–3	515 (20°C)	22 (20°C)	6.60E–03	295
XYLENES (MIXED)	1330–20–7	130	6.72 (21°C)	5.2E–3 – 7.6E–3	47.7–260
TPH	–	–	–	–	–

(1) Source: ATSDR 1989a,b; 1990a,b

TABLE 3
GROUNDWATER ARARs
GREYHOUND TERMINAL
OAKLAND, CALIFORNIA

CONTAMINANT	MAXIMUM GROUNDWATER CONCENTRATIONS (mg/L) SOURCE	PERIMETER	CALIFORNIA MCLs (1) (mg/L)	SAFE DRINKING WATER ACT (mg/L) (2) MCL	MCLG	FEDERAL AMBIENT WATER QUALITY CRITERIA (mg/L) (3) Human Health Consumption: Water and Fish Ingestion	Fish Ingestion Only	Marine Aquatic Life (a): Acute Criteria	Chronic Criteria
Benzene	2.1	ND	0.001	0.005	0	0.00066 (b)	0.040 (b)	5.1 (c)	0.7 (c)
Ethylbenzene	0.84	ND	0.68	0.7	0.7	1.4	3.28	.43 (c)	–
Toluene	3.9	0.0007	–	1.0	1.0	14.3	424.0	6.3 (c)	5.0 (c)
Xylenes	6.0	0.0012	1.75	10.0	10.0	–	–	–	–
TPHD	950	ND	–	–	–	–	–	–	–
TPHG	1.5	ND	–	–	–	–	–	–	–

Footnotes:
(a) Given that most of the surface water in the vicinity of the site is brackish, values for marine life were used since they are more conservative than those for fresh water.
(b) Criteria based on carcinogenicity (10E–6 risk).
(c) Insufficient data were available to develop critieria, the values presented are LOELs (Lowest–Observed–Effect–Levels).

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(3) Quality Criteria for Water. USEPA: Office of Water Regulations and Standards. May, 1986 (USEPA, 1986a).

TABLE 4
TOXICITY VALUES FOR THE EVALUATION OF POTENTIAL NONCARCINOGENIC EFFECTS (1)

CONTAMINANT	CHRONIC INHALATION RfC (mg/cu. m)	CHRONIC ORAL RfD (mg/kg/day)	CRITICAL EFFECT	
			INHALATION	ORAL
BENZENE	ND	ND	ND	ND
ETHYLBENZENE	1.0E+00	1.0E−01	Developmental toxicity	Liver, kidney toxicity
TOLUENE	4.0E−01	2.0E−01	CNS effects	Liver, kidney weights
XYLENES(TOTAL)	ND	2.0E+00	ND	Body Weight, Mortality, Hyperactivity
TPH	ND	ND	ND	ND

(1) Source: USEPA Integrated Risk Information System. Online. September 1993.
CNS = Central Nervous System
ND = No Data

TABLE 5
TOXICITY VALUES FOR THE ASSESSMENT OF POTENTIAL CARCINOGENIC EFFECTS (1)

	SLOPE FACTOR 1/(mg/kg/day)		WEIGHT-OF-EVIDENCE CLASSIFICATION (2)		TUMOR SITE	
CONTAMINANT	INHALATION	ORAL	INHALATION	ORAL	INHALATION	ORAL
BENZENE	2.9E-02	2.9E-02	A	A	Blood Cells	Blood Cells
ETHYLBENZENE	NA	NA	D	D	NA	NA
TOLUENE	NA	NA	D	D	NA	NA
XYLENES (TOTAL)	NA	NA	D	D	NA	NA
TPH	NA	NA	NA	NA	NA	NA

(1) Source: USEPA Integrated Risk Information System (IRIS). Online. September, 1993.
(2) The Weight-of-Evidence Classification is defined in the text.
NA = Not Applicable.

TABLE 6
COMPARISON OF MAXIMUM SOIL CONTAMINANT
CONCENTRATIONS WITH RISK-BASED CLEANUP GOALS
GREYHOUND TERMINAL
OAKLAND, CALIFORNIA

CONTAMINANT	MAXIMUM CONCENTRATION (mg/kg) Source	Perimeter	RISK-BASED PRELIMINARY REMEDIATION GOALS (mg/kg) (1)	CONCENTRATION EXCEEDS CRITERION ?
BENZENE	ND	ND	22	NO
ETHYLBENZENE	27	ND	27,000	NO
TOLUENE	49.5	ND	54,000	NO
XYLENE (TOTAL)	150	ND	540,000	NO
TPHD	160	ND	–	–
TPHG	NA	ND	–	–
TFH	4260	ND	–	–

(1) Preliminary Remediation Goals (PRGs) derived using USEPA methodology (USEPA, 1991).
ND = Not Detected; NA = Not Analyzed; (–) = Not Applicable

TABLE 7

MATRIX OF POTENTIAL EXPOSURE PATHWAYS
GREYHOUND TERMINAL
OAKLAND, CALIFORNIA

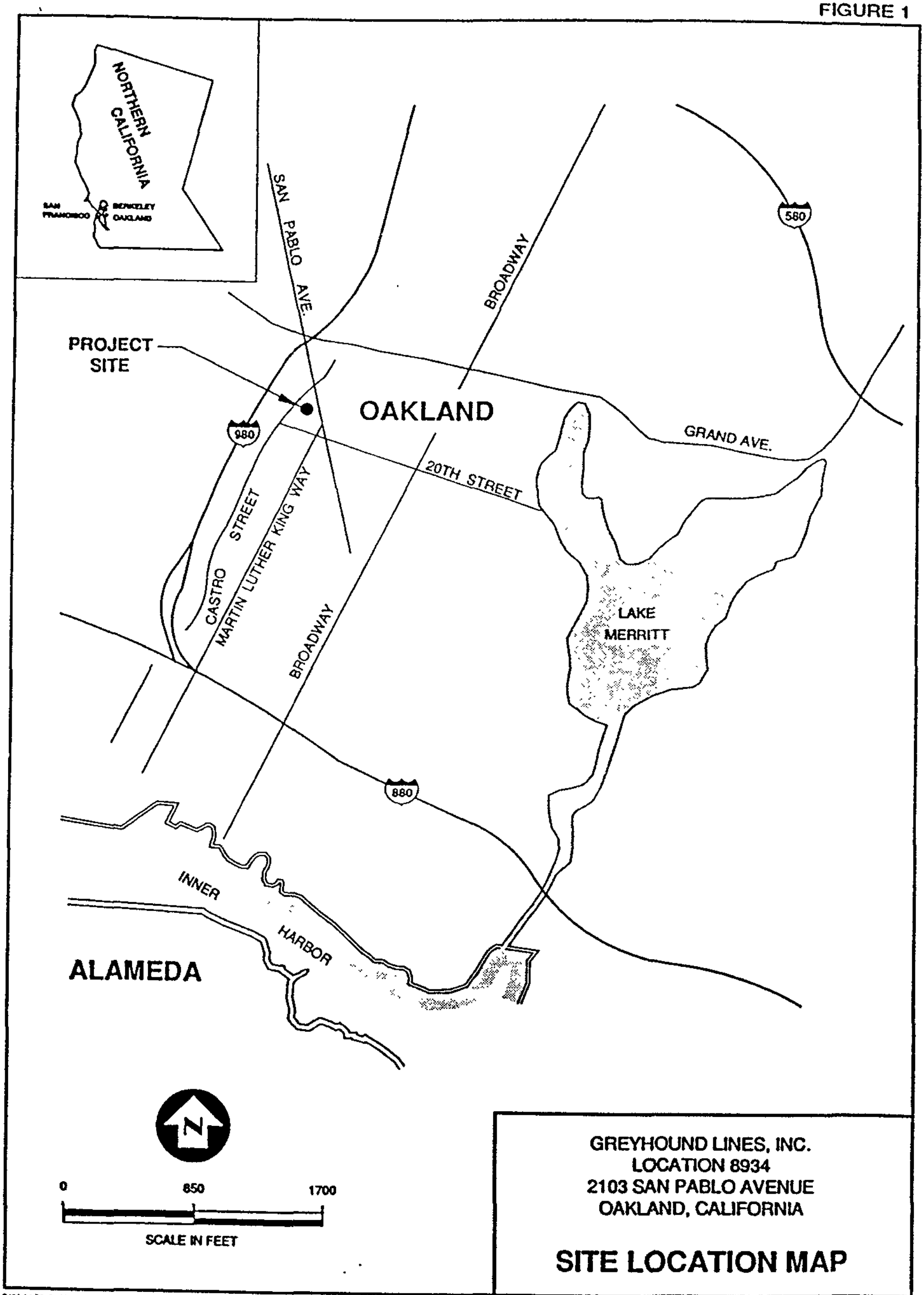
Potentially Exposed Population	Exposure Route, Medium and Exposure Point	Pathway Selected for Evaluation ?	Reason for Selection or Exclusion
		Current Land Use	
Local Residents	Ingestion of, dermal contact with, or inhalation of volatiles from downgradient groundwater	No	There are no known private or industrial water wells that are used for drinking water. The City of Oakland is served by municipal supplies originating 200 miles east of the site.
Local Residents and Workers	Inhalation of volatiles at the site	No	Contaminated soils are at depth and are covered by pavement and the building foundations.
Local Residents	Ingestion of or dermal contact with affected soils at the site	No	Contaminated soils are at depth and are covered by pavement and the building foundations.

TABLE 7 (continued)

MATRIX OF POTENTIAL EXPOSURE PATHWAYS
GREYHOUND TERMINAL
OAKLAND, CALIFORNIA

Potentially Exposed Population	Exposure Route, Medium and Exposure Point	Pathway Selected for Evaluation ?	Reason for Selection or Exclusion
		Future Land Use	
Hypothetical Future Residents	Ingestion of, dermal contact with, or inhalation of volatiles from shallow downgradient groundwater	No	It is highly unlikely that shallow groundwater from the vicinity of the site would ever be used as a drinking water source. Future drinking water needs would be met via the municipal supply.
Hypothetical Future Residents and Construction Workers	Ingestion of or dermal contact with affected soils at the site	Yes	If excavation is undertaken on site, it is possible that workers could be exposed. The area is zoned commercial/residential, so it is possible that future residents could live on-site.

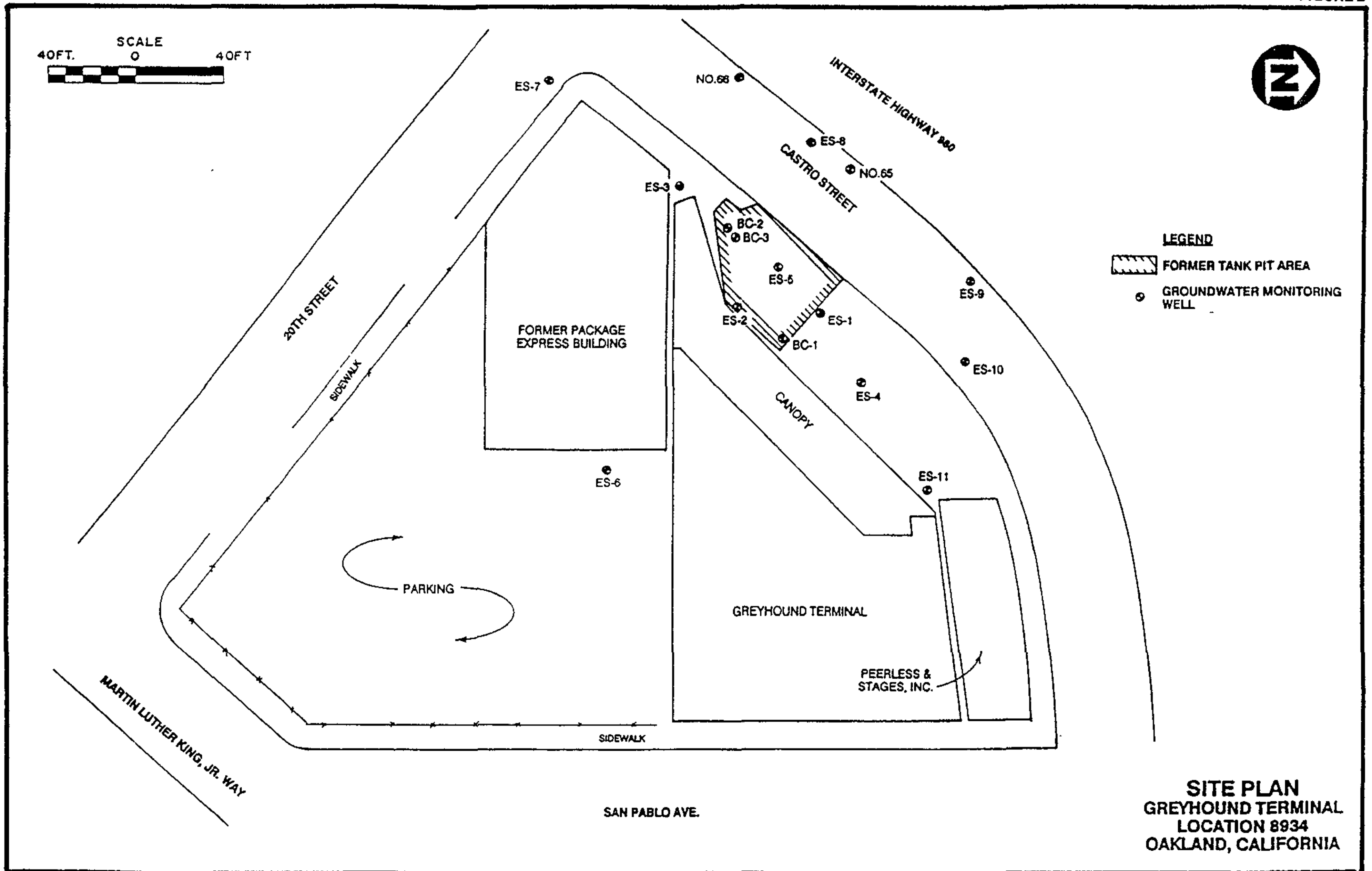
FIGURE 1



GREYHOUND LINES, INC.
LOCATION 8934
2103 SAN PABLO AVENUE
OAKLAND, CALIFORNIA

SITE LOCATION MAP

FIGURE 2



SITE PLAN
GREYHOUND TERMINAL
LOCATION 8934
OAKLAND, CALIFORNIA

SY356.06

ENGINEERING-SCIENCE

TIER II BENZENE ASSESSMENT

GREYHOUND - OAKLAND TERMINAL
EVALUATION OF POTENTIAL GROUNDWATER RISK

A Preliminary Risk Evaluation (PRE) was completed for the Greyhound Terminal (Location 8934) in Oakland, California in October 1993 (Engineering Science, 1993). The evaluation indicated that potential exposure of future on-site workers to soils was the only possible exposure pathway. BTEX was not detected in soils at concentrations greater than risk-based target values, indicating that potential exposure of future workers is not likely to result in adverse health effects. Potential exposure of receptors to groundwater was not considered to be complete given that the site and surrounding area are supplied via a municipal system.

Following completion on the PRE, groundwater sampling was completed at the facility, with the latest round of sampling being completed in October 1997. During this sampling round, benzene was detected at a maximum concentration of 310 µg/l (0.310 mg/l) in BC-1, which is located in the Tank Pit area. An evaluation of the potential impacts of this concentration of benzene was completed to ensure that no significant risk for on-sit workers would result from benzene in groundwater.

In the 1993 evaluation, no completed pathways were identified for groundwater. Subsequent to 1993, the American Society for Testing and materials (ASTM) has released the Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites (ASTM, 1995). This standard provides methodology for the quantitative evaluation of risk associated with indirect exposure to groundwater. Although direct exposure to groundwater (ingestion, dermal contact, inhalation of volatiles during showering) is not appropriate for this site because drinking water to the area is supplied by a municipal source, indirect exposure to contaminants in groundwater may occur. Indirect exposure includes inhalation of volatiles in indoor and outdoor air generated from volatilization of contaminants from groundwater through the soil column. For the Oakland terminal, inhalation of volatiles in outdoor air was evaluated for groundwater since the maximum detected concentrations of benzene was found in well BC-1, which is located in the Tank Pit area and not beneath a structure.

The methodology used to evaluate this pathway of exposure is described in the accompanying tables as follows:

- Table 1 provides a summary of the results of the comparison on the maximum detected value of benzene to the outdoor air screening value.
- Table 2 provides the equations used to derive the screening value.
- Table 3 provides the inputs to the model used to derive the screening value.
- Table 4 provides the chemical-specific factors used to derive the screening value.
- Table 5 provides the chemical-specific interim values used in the derivation of the screening value.

The screening value was derived using the State of California's inhalation slope factor of 0.1 (kg-day/mg) for benzene (Cal/EPA, 1999), which is much more conservative than the Federal

Benzene conc in GW in 1997 has ~~been~~ ranged ~~to~~

810 ppb in ES-5 in 7/97

520 " BC-1 in 7/97

590 " ES-5 in 4/97

inhalation slope factor of 0.029 (kg-day/mg). For noncarcinogenic effects, an inhalation reference dose of 0.02 (mg/kg-day) was used (Cal/EPA, 1999), which is less conservative than the Federal provisional inhalation reference dose of 0.002 (mg/kg-day). The screening value was based on the carcinogenic endpoint of risk. The screening value was derived using the conservative exposure assumptions for an industrial worker: exposure of 250 days/year over a period of 25 years.

As indicated on Table 1, the maximum detected value of 0.310 mg/l benzene is well below the outdoor air screening value of 60 mg/l for benzene. Therefore, potential exposure of on-site workers to benzene in outdoor air generated from groundwater should not result in adverse effects.

References:

ASTM, 1995. Standard for Risk-Based Corrective Action Applied at Petroleum Release Sites. ASTM Designation E 1739-95. November 1995.

Cal/EPA, 1999. State of California Environmental Protection Agency. Online. August 1999.

Engineering-Science. 1993. Preliminary Risk Evaluation, Greyhound Terminal, Location 8934, Oakland, California. Prepared for Greyhound Lines, Inc. by Engineering-Science. October 1993.

TABLE 1
COMPARISON OF MAXIMUM DETECTED CONCENTRATION OF CONSTITUENTS IN GROUNDWATER TO RISK-BASED SCREENING VALUES
Greyhound - Oakland Terminal

Constituent	Maximum Detected Concentration	Location of Maximum	SSTL - Inhalation of Outdoor Vapors(1) Industrial(2) Cancer(3)	Exceedence of Screening Value?
All units in mg/L				
Benzene	3.10E-01	BC-1 - 10/97	6E+01	No

ND = Not Detected; NA = Not Applicable

(1) The risk-based screening level represents a concentration in groundwater that will be protective for the following pathway of potential exposure: inhalation of vapors in outdoor air generated from groundwater beneath the ground surface in the Tank Pit area.

SSTL = Site-specific target level

The values were derived using the equations presented in the ASTM standard (E 1739-95 - November, 1995).

(2) Industrial exposure assumes exposure 250 days/year (5 days/week for 50 weeks) for 25 years.

(3) Based on a carcinogenic endpoint and a target cancer risk = 1×10^{-5}

Table 2
Derivation of Screening Value: Groundwater Vapors to Outdoor Air
Greyhound - Oakland Terminal

1. Derivation of D_{cap}^{eff}

D_{cap}^{eff} [cm^2/s]= $D_{air} \times (0_{acap}^{3.33}/0_T^2) + [D_{wat} \times (1/H) \times (0_{wcap}^{3.33}/0_T^2)]$

2. Derivation of D_s^{eff}

D_s^{eff} [cm^2/s]= $D_{air} \times (0_{as}^{3.33}/0_T^2) + [D_{wat} \times (1/H) \times (0_{ws}^{3.33}/0_T^2)]$

3. Derivation of D_{ws}^{eff}

D_{ws}^{eff} [cm^2/s]= $(h_{cap} + h_v) \times (h_{cap}/D_{cap}^{eff} + h_v/D_s^{eff})^{-1}$

4. Derivation of VF_{wamb}

VF_{wamb} [(mg/m^3-air)/(mg/L-H_2O)] = $$\frac{H}{1 + [(U_{air} \times S_{air} \times L_{gw})]/[W \times D^{eff}_{ws})]} \times 10^3 \text{ L/m}^3$$

5. Derivation of $RBSL_{air}$

<u>NONCANCER</u>

$RBSL_{air}$ [ug/m^3-air] = $$\frac{THQ \times RFDi \times BW \times ATn \times 365 \text{ days/year} \times 10^3 \text{ ug/mg}}{IR_{air} \times EF \times ED}$$

<u>CANCER</u>

$RBSL_{air}$ [ug/m^3-air] = $$\frac{TR \times BW \times ATc \times 365 \text{ days/year} \times 10^3 \text{ ug/mg}}{SFi \times IRair \times EF \times ED}$$

6. Derivation of $RBSL_w$

$RBSL_w$ [mg/L-H_2O] = $(RBSL_{air}[\text{ug/m}^3\text{-air}] / VF_{wamb}) \times 10^{-3}$ mg/ug

Table 3
Derivation of Screening Value: Groundwater Vapors to Indoor Air
Input Parameters
Greyhound - Oakland Terminal

Parameters:	description/units	Industrial
D^{air}	diffusion coefficent in air, cm^2/s	hemical-specific
D_{cap}^{eff}	effective diffusion coefficient through capillary fringe, cm^2/s	hemical-specific
D_s^{eff}	effective diffusion coefficient in soil based on vapor phase conc, cm^2/s	hemical-specific
Dw_s^{eff}	effective diffusion coefficient between groundwater and soil surface, cm^2/s	hemical-specific
O_{as}	volumetric air content in vadose soils, cm^3-air/cm^3-soil	0.26
O_T	total soil porosity, cm^3/cm^3-soil	0.38
D^{wat}	diffusion coefficent in water, cm2/s	hemical-specific
H	Henry's Law constant, cm^3-H_2O/cm^3-air	hemical-specific
VF_{wamb}	Volatilization factor - groundwater to ambient vapors, (mg/m^3-air)/(mg/L-H_2O)	hemical-specific
O_{ws}	volumetric water content in vadose soils, cm^3-H_2O/cm^3-soil	0.12
O_{acap}	volumetric air content in capillary fringe soil,cm^3-air/cm^3-soil	0.038
O_{wcap}	volumetric water content in capillary fringe soil,cm^3-H_2O/cm^3-soil	0.342
h_{cap}	thickness of capillary fringe, cm	5
h_v	thickness of vadose zone, cm	295
L_{gw}	depth to groundwater (hcap + hv), cm	300
THQ	total hazard quoitent for individual constituents, unitless	1
TR	target excess individual lifetime cancer risk, unitless	1.00E-05
RfDi	inhalation chronic reference dose, mg/kg-day	hemical-specific
SFi	inhalation cancer slope factor, $(mg/kg\text{-}day)^{-1}$	hemical-specific
BW	adult body weight, kg	70
ATn	averaging time for noncarcinogens, years	25
ATc	averaging time for carcinogens, years	70
IRair-outdoor	daily outdoor rate, m^3/day	20
EF	exposure frequency, day/year	250
ED	exposure duration, years	25
CF	conversion factor, L/m3	1000
CF	conversion factor, ug/mg	1000
CF	conversion factor, mg/ug	0.001
$RBSL_{air}$	Risk-Based Screening Level - air, ug/m^3-air	chemical-specific
$RBSL_w$	Risk-Based Screening Level - water, mg/L-H_2O	chemical-specific
U_{air}	wind speed above ground surface, cm/s	225
S_{air}	ambient air mixing zone height, cm	200
W	width of source area parallel to wind, cm	1500

TABLE 4

Factors Used in Derivation of $RBSL_w$[1]

Greyhound - Oakland Terminal

Constituent	D^{air} (cm^2/s)	D^{wat} (cm^2/s)	H (cm^3-H_2O/cm^3-air)	RfDi[2] (mg/kg-day)	SFi(2) $(mg/kg\text{-}day)^{-1}$	Solubility (mg/L)
Benzene	8.80E-02	9.80E-06	2.28E-01	2.00E-02	1.00E-01	1.75E+03

ND - Not available; ND - Not Determined since this constituent is not considered to be a carcinogen.

(1) The most recent literature values were used as the source of the factors.

(2) Toxicity values from State of California (on-line 8/99).

TABLE 5
DERIVATION OF RBSL VALUES - OUTDOOR AIR
Industrial Worker Exposure
Greyhound - Oakland Terminal

Constituent	D_s^{eff}	D_{cap}^{eff}	D_{ws}^{eff}	Vfwamb	$RBSL_{air}$		$RBSL_w$	
					Noncancer	Cancer	Noncancer	Cancer
Benzene	6.87E-03	1.97E-05	1.01E-03	2.56E-05	1.02E+02	1.43E+00	3.99E+03	5.58E+01