STELLAR ENVIRONMENTAL SOLUTIONS
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TRANSMITTAL MEMORANDUM

TO: ALAMEDA COUNTY HEALTH CARE SERVICES AGENCY – DEPT. OF ENVIRONMENTAL HEALTH – HAZARDOUS MATERIALS DIVISION
1131 HARBOR BAY PKWY, SUITE 250
ALAMEDA, CA 94502

DATE: 04/28/00

ATTENTION: SCOTT SEERY

FILE: SES-99012

SUBJECT: REDWOOD REGIONAL PARK FUEL LEAK SITE

WE ARE SENDING: (≤) HEREWITH ≤ UNDER SEPARATE COVER
≤ VIA MAIL ≤ VIA _____

THE FOLLOWING: SITE MONITORING REPORT – REDWOOD REGIONAL PARK SERVICE YARD (APRIL 2000)

≤ AS REQUESTED ≤ FOR YOUR APPROVAL
≤ FOR REVIEW (≤) FOR YOUR USE
≤ FOR SIGNATURE ≤ FOR YOUR FILES

COPIES TO: W. GEE (EBRPD)
M. RUGG (FISH & GAME)

BY: Bruce Rucker BNR

★ **Stellar Environmental Solutions**

2198 Sixth Street, Suite 201, Berkeley, CA 94710
Tel: (510) 644-3123 • Fax: (510) 644-3859
Geoscience & Engineering Consulting

April 21, 2000

Mr. Scott Seery
Alameda County Health Care Services Agency
Department of Environmental Health, Hazardous Materials Division
1131 Harbor Bay Parkway, Suite 250
Alameda, California 94502

Subject: Site Monitoring Report for Redwood Regional Park Service Yard Site, Oakland, California

Dear Mr. Seery:

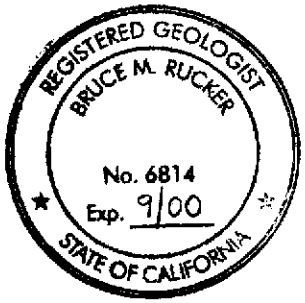
Enclosed is the Stellar Environmental Solutions (SES) Site Monitoring Report for the underground fuel storage tank (UFST) site located at the Redwood Regional Park Service Yard Site, 7867 Redwood Road, Oakland, California. This project is being conducted for the East Bay Regional Park District (District) and follows previous site investigation and remediation activities conducted since 1993 associated with former leaking underground fuel storage tanks. The key regulatory agencies for this investigation are Alameda County Health Care Services Agency (ACHCSA) and California Department of Fish and Game (CDFG).

This report summarizes activities conducted between December 1999 and January 2000 that we recommended in our June 1999 Residual Contamination Investigation and Remedial Action Assessment Report, and that were delineated in the SES workplan approved by your agency and CDFG. The scope of work included one stream bioassessment event (conducted by CDFG) and one groundwater and creek surface water monitoring event. If you have any questions regarding this report, please contact Mr. Ken Burger of the District or contact us directly at (510) 644-3123.

Sincerely,

Bruce M. Rucker

Bruce M. Rucker, R.G., R.E.A
Project Manager



cc: Michael Rugg, California Department of Fish and Game
Warren Gee and Ken Burger, East Bay Regional Park District

SITE MONITORING REPORT

REDWOOD REGIONAL PARK SERVICE YARD
OAKLAND, CALIFORNIA

Prepared For:

EAST BAY REGIONAL PARK DISTRICT
OAKLAND, CALIFORNIA

Prepared By:

STELLAR ENVIRONMENTAL SOLUTIONS
2198 SIXTH STREET
BERKELEY, CALIFORNIA 94710

April 21, 2000

Project No. 99012

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EXECUTIVE SUMMARY

Stellar Environmental Solutions (SES) was retained in 1998 by East Bay Regional Park District (District) to conduct continued site investigations at the Redwood Regional Park Service Yard fuel leak site at 7867 Redwood Road, Oakland, Alameda County. Tasks conducted since the previous SES report included an instream bioassessment event per California Department of Fish and Game protocols and one groundwater and surface water monitoring event. This scope was designed to provide continued data on groundwater and surface water contamination, and to evaluate impacts from the groundwater plume on aquatic organisms in Redwood Creek.

The site has undergone site investigations and remediation since 1993 to address the subsurface contamination caused by leakage from one or more of the two former underground fuel storage tanks (UFSTs) that contained gasoline and diesel fuel. The UFSTs and the majority of source area contaminated soil were removed in 1993. An estimated volume of 850 CY of petroleum-contaminated soil with concentrations above 1,000 mg/Kg is estimated to be left in place in the area of the original excavation and downgradient of it along the pathway of the plume. Most of the residual contaminated soil exists in the capillary fringe up to 150 feet downgradient of the former UFSTs, resulting from the sorption of fuel constituents from contaminated groundwater onto capillary fringe soils during periods of high groundwater elevation. This soil contamination will be a long-term source of groundwater contamination as it desorbs and contributes to the groundwater over time.

Groundwater sampling conducted on an approximately quarterly frequency since November 1994 (15 events) has shown an overall decreasing concentration trend in groundwater contaminants, which include gasoline, diesel and BTEX. MTBE was detected in both the source area and the downgradient monitoring wells when it was analyzed for the first time in September 1998.

Near-maximum historical groundwater contaminant concentrations were detected in February 1998, coinciding with unusually heavy rains and correspondingly high groundwater elevations, which likely desorbed capillary fringe soil contamination into groundwater. The recent (December 1999) groundwater analytical data showed results consistent with previous analyses, with maximum concentrations of most analytes detected in downgradient well MW-4, suggesting that **the center of mass of the contaminant groundwater plume has moved from the UFST source area and beyond well MW-2.**

The limits of the groundwater contaminant plume are well-defined by site groundwater monitoring wells and the April-May 1999 subsurface investigation, and extend from the source area to Redwood Creek, a distance of approximately 150 feet. The area of the plume with TPH concentrations greater than 10,000 µg/L is up to 60 feet wide by 100 feet long, and begins approximately 30 feet downgradient of the source area, suggesting that the plume is becoming "disconnected" from the former UFST source area. **The leading edge of the plume daylighting in the creek banks is at least 30 feet wide.** Site groundwater contaminants that have been historically (and recently) detected in excess of drinking water standards include benzene, ethylbenzene, total xylenes, and MTBE. TPH as gasoline has also been detected although there are no definative drinking water standards for TPH compounds. While it is unlikely that site groundwater would be used as a drinking water source, drinking water standards could be applied by regulators as cleanup standards.

Significantly greater groundwater contamination detected in the April 1999 subsurface investigation, relative to previous data suggest that MW-4 is not located directly in the center the plume's long axis. The recent data also suggest that there is a substantial mass of groundwater contamination upgradient of the parking lot's downgradient edge, which will continue to migrate toward Redwood Creek, and that future impacts to Redwood Creek from contaminated groundwater discharge may be worse than at present. There is no practical or cost-effective remedy for addressing that portion of capillary fringe soil and groundwater contamination in the approximately 20-foot wide zone between the downgradient edge of the site parking lot and the creek. Continued impacts to the creek from residual site contamination upgradient of that area could be mitigated by either hydraulic containment methods, or more cost-effectively by injection of oxygen-releasing compound into closely spaced boreholes within the zone of contamination, to stimulate biodegradation.

Redwood Creek is a hydraulic barrier preventing contaminated groundwater migration beyond the creek. The flowpath of groundwater in the immediate vicinity of the creek is likely to follow topgraphy, and would be expected to flow in the downstream direction (south) beneath the creek.

Natural attenuation is indicated to be occuring at the site, mainly at the plume margins and former source area. Natural attenuation is likely muted to negligable in the higher concentration portion along the centerline of the plume due to limited oxygen content, suggesting that natural attenuation has not and in the future will not be sufficient to mitigate against discharge of hydrocarbons to Redwood Creek.

Discharge of petroleum-contaminated groundwater into Redwood Creek is evidenced by: historical observation of petroleum-discolored soil in the bank of Redwood Creek downgradient of the former UFSTs; sporadic detection of fuel constituents in creek surface water samples collected at that location; and the growth of an algae on the surface water surface at that location suggesting that the petroleum is serving as a carbon source. **The December 1999 surface water sampling results showed concentrations near or above historical maxima for all site contaminants, supporting the** hypothesis

that groundwater contaminant concentrations immediately upgradient are on an increasing trend as the center of the contaminant plume mass moves downgradient toward the creek. Benzene, ethylbenzene and xylenes have been detected in creek surface water samples in excess of published water quality objectives (WQOs) for surface waters that are a potential drinking water source. Based on the absence of detectable contamination immediately downstream of the site, it is very unlikely that site contamination has the potential to impact the nearest municipal drinking water source (Upper San Leandro Reservoir).

The CDFG code stipulates a policy of zero discharge of petroleum to surface waters, unless it can be demonstrated that complete removal of the petroleum is infeasible and that instream biota are not affected. The results of the initial two stream bioassessment events (April 1999 and January 2000) indicate no impacts to the benthic macroinvertebrate community in Redwood Creek. Additional bioassessment events are warranted only if groundwater and/or surface water analytical results indicate a potential for significantly increased discharge of petroleum to the creek.

RECOMMENDATIONS

Based on the available data, SES recommends that the District implement the following actions to address regulatory concerns:

- Meet with ACHCSA and CDFG to discuss the results, conclusions and recommendations of this investigation, especially as regards the need to mitigate any unacceptable impacts associated with residual site contamination and/or the need to conduct future bioassessment events.
- If regulatory agencies deem mitigation is necessary, conduct a limited feasibility study to determine the most appropriate and cost-effective remedial strategy.
- Continue the established program of quarterly groundwater elevation monitoring (all six site wells) and sampling (wells MW-2 and MW-4 only).
- Continue the established program of quarterly surface water sampling at locations SW-2 and SW-3. The previous ACHCSA-approved recommendation to decrease the frequency of surface water sampling from quarterly to semi-annually is not technically appropriate at this time, given the documented impacts to Redwood Creek from discharge of contaminated groundwater, and the need to monitor the discharge closely.

1.0 INTRODUCTION

PROJECT BACKGROUND

The subject property is the East Bay Regional Park District (District) Redwood Regional Park Service Yard located at 7867 Redwood Road in Oakland, Alameda County, California. The site has undergone site investigations and remediation since 1993 to address the subsurface contamination caused by leakage from one or more of two former underground fuel storage tanks (UFSTs) containing gasoline and diesel fuel. The Alameda County Health Care Services Agency – Environmental Health Services – Environmental Protection (ACHCSA) has provided regulatory oversight of the investigation since its inception.

KEY OBJECTIVES AND SCOPE OF WORK

The principal program objectives of the current work were delineated in the SES April 1999 workplan (SES, 1999a) and June 1999 report (SES, 199b). These objectives were approved by ACHCSA in their October 1999 letter (ACHSA, 1999), and have been substantively met by the recent monitoring event program. The key objectives of this investigation and remedial action evaluation were to:

- Determine if benthic invertebrates in the creek, as indicators of the creek system ecological stability, have been impacted by the site contamination; and
- Continue to evaluate groundwater and surface water contamination over time.

The tasks that were conducted to meet these objectives include:

- Conduct one groundwater and surface monitoring, sampling and analysis event; and
- Conduct one instream bioassessment event.

The SES June 1999 report provided a full discussion of previous site remediation and investigations, site geology and hydrogeology, residual site contamination, a conceptual model for contaminant fate and transport, and an evaluation of hydrochemical trends and plume stability (SES, 1999b). This report specifically discusses the findings of the work conducted since that report, and summarizes previous findings where applicable.

SITE DESCRIPTION

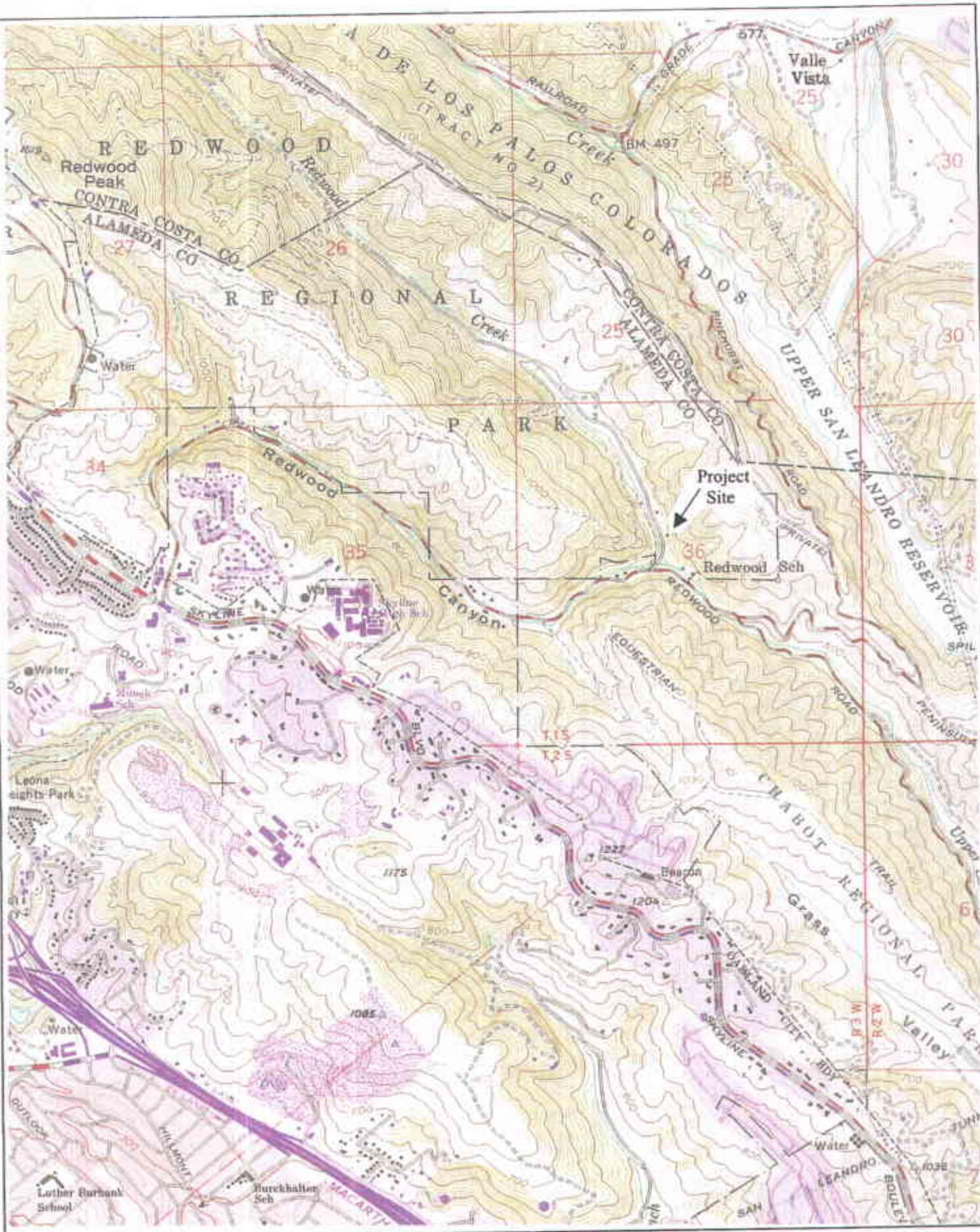
The project site is located at 7867 Redwood Road in Oakland, Alameda County, California. Figure 1 shows the location of the project site. The site slopes to the west, from an elevation of approximately 564 feet above mean sea level (MSL) at the eastern edge of the service yard to approximately 545 feet above MSL at Redwood Creek, which approximately defines the western edge of the project site as regards this investigation. Figure 2 is a site plan.

The project site is a service yard for Redwood Regional Park, which utilized two UFSTs (one 2,000-gallon diesel fuel and one 5,000-gallon unleaded gasoline) from the mid-1960s to 1993. Figure 2 shows the location of the former UFSTs. Both UFSTs were reportedly installed between 1965 and 1968 (Parsons, 1993a). The 5,000-gallon steel UFST contained unleaded gasoline, and was reportedly a converted channel buoy purchased from the Navy (Parsons, 1993a). The tanks and piping underwent integrity testing in 1984, 1986, 1988, and 1989. The unleaded gasoline UFST system failed the 1988 and 1989 tests (Parsons, 1993a).

SITE INVESTIGATION AND REMEDIATION HISTORY

Site remediation and characterization activities have been conducted since 1993, beginning with removal of the UFSTs. A more detailed discussion is provided in the SES June 1999 report. Appendix A contains tabular summaries of historical soil, groundwater and surface water analytical results, and site maps showing sample locations. A complete listing of previous site investigation and remediation reports is included in the References section (Section 9.0). The following phases of work have been conducted:

- The two UFSTs were removed in April 1993.
- Approximately 600 cubic yards of contaminated soil in the vicinity of the UFSTs were excavated for offsite disposal in April 1993, with a total excavation surface area of approximately 5,000 square feet and a maximum depth of approximately 25 feet (soil excavation activities were halted due to the potential for slope instability, the presence of significant facility constraints (roads and buildings), and the infiltration of spring water into the excavation).
- Excavation confirmation soil sampling was conducted in June 1993, and confirmed elevated levels of TPH-gasoline (TPHg), TPH-diesel (TPHd), and BTEX (lead was not detected and MTBE was not analyzed for).



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U.S.G.S. TOPOGRAPHIC MAP SHOWING SITE LOCATION

Redwood Regional Park Service Yard
Oakland, Alameda County, California

By: MJC | NOVEMBER 1997

Figure 1

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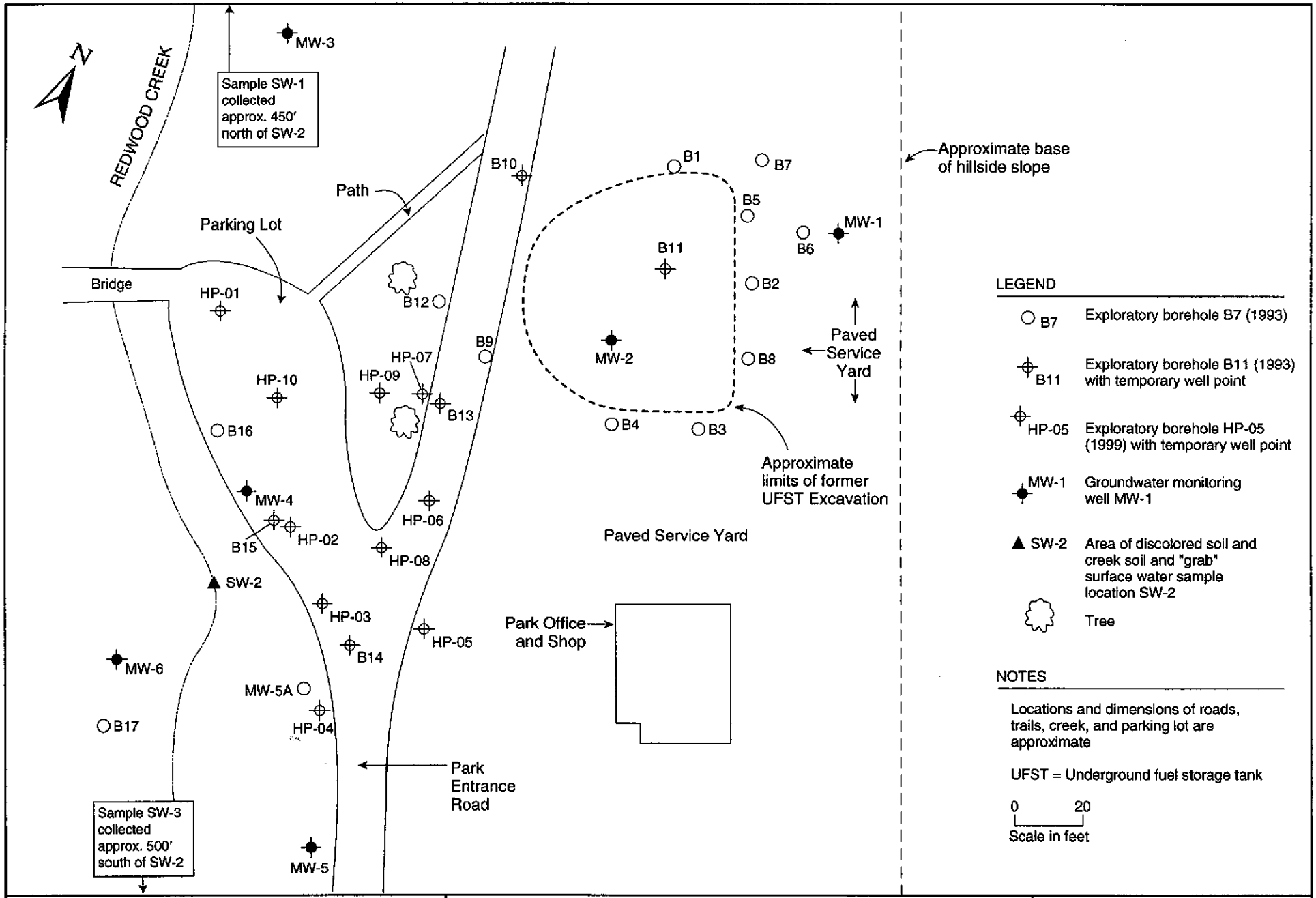


Stellar Environmental Solutions

Geoscience & Engineering Consulting

Site Plan and Historical Sampling Locations
Redwood Regional Park Service Yard, Oakland, CA

Figure 2

by: MJC | APRIL 2000

99012-11

- An initial site characterization was conducted in September and October 1993 in the vicinity of the former UFST excavation to evaluate the nature, magnitude and extent of soil and groundwater contamination, including 17 exploratory boreholes were drilled, five of which were converted to temporary well points. No significant soil contamination was detected in soil boreholes immediately north, south, or east of the former UFST remedial excavation. Fuels in soil were detected in soil boreholes up to 90 feet southwest of the former UFST excavation, and groundwater contamination was found to extend from the source area downgradient to just upgradient of Redwood Creek (Parsons, 1993c).

- A site characterization was conducted in April 1999 to fill data gaps about the extent of residual hydrocarbon contamination downgradient of the former tank area, to evaluate impacts from the groundwater plume on aquatic organisms in Redwood Creek and to provide a preliminary evaluation of the viability of monitored natural attenuation (MNA) as the sole remedial measure for addressing contamination impacts, or whether additional remedial measures might be required (SES 199a and 1999b). Eleven exploratory boreholes were drilled from which soil samples and grab-groundwater samples were collected for laboratory analysis. The data refined the lateral limits of the groundwater plume, which extends a distance of approximately 150 feet from the former tank area to the creek, with concentrations above 10,000 µg/L TPH occurring over a distance of 100 feet and a width of approximately 55 feet, beginning approximately 30 feet from the tank area, suggesting that the plume is becoming disconnected from the source area. **The data also indicated that natural attenuation is likely occurring on the margins of the plume, but is not sufficient to fully attenuate contamination within the axis of the plume prior to its discharge to the creek.**

- A total of 15 groundwater monitoring, sampling, and analysis events have been conducted on an approximately quarterly frequency since November 1994, which have defined the lateral extent of groundwater contamination.

- Thirteen surface water sampling events have been collected in Redwood Creek since 1994 to evaluate impacts of site contamination on that surface water body. Surface water sampling, creek bank soil sampling and visual observations have confirmed that contaminated groundwater discharges to the creek, that detected surface water contamination at the discharge area is diluted to non-detectable levels within several hundred feet downstream, and that naturally-occurring algae appear to be utilizing the petroleum as a carbon source.

- An initial instream bioassessment event was conducted in April 1999 to evaluate potential impacts to stream biota associated with the site contamination.

Historical ACHCSA-approved revisions to the groundwater sampling program have included: 1) discontinuing hydrochemical sampling and analysis in wells MW-1, MW-3, MW-5, and MW-6; 2) discontinuing creek surface water sampling at upstream location SW-1; and 3) reducing the frequency of creek surface water sampling from quarterly to semi-annually (ACHCSA, 1996). The latter recommendation has not yet been implemented due to continued concern over potential impacts to Redwood Creek.

2.0 PHYSICAL SETTING

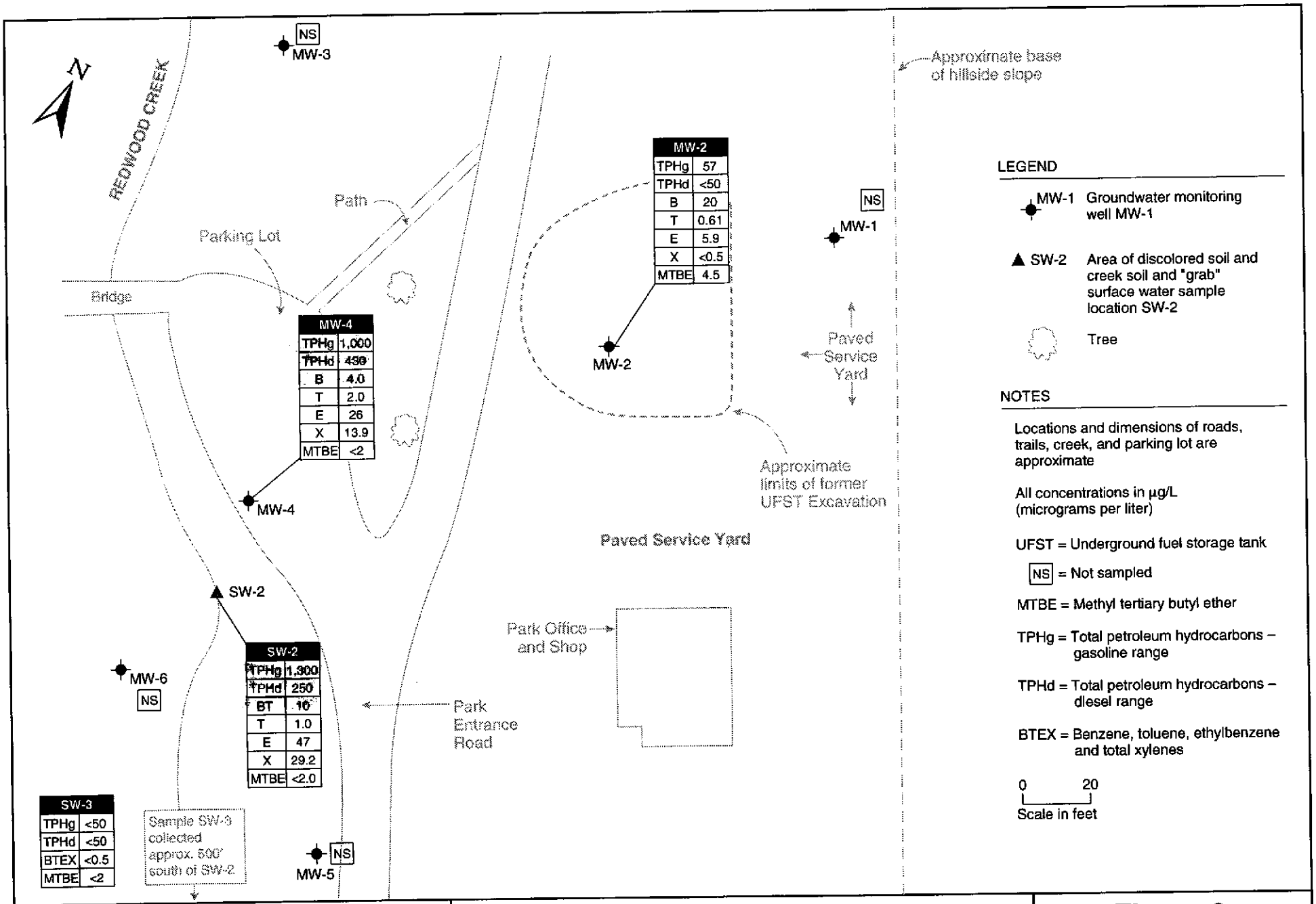
The following is a brief summary of the site hydrogeologic conditions based on geologic logging and water level measurements collected at the site since September 1993. A full discussion is presented in the SES June 1999 report.

Shallow soil stratigraphy consists of a surficial 3- to 10-foot thick clayey silt unit underlain by a 5- to 15-foot thick silty clay unit. In all monitoring well boreholes, a 5- to 10-foot thick clayey coarse-grained sand and clayey gravel unit was encountered that laterally grades to a clay or silty clay. This unit overlies a weathered siltstone at the base of the observed soil profile. Soils in the vicinity of MW-1 are inferred to be landslide debris.

Groundwater at the site occurs under unconfined and semi-confined conditions at a depth between 12.5 and 19 feet bgs, corresponding to the top of the clayey, silty sand-gravel zone. Local perched water zones have been observed well above the top of the capillary fringe. Local groundwater flow direction has been consistently measured as northeast to southwest. Figure 3 is a groundwater elevation map constructed from the December 1999 monitoring well static water levels. The groundwater gradient is relatively steep—approximately 2 feet per foot—between well MW-1 and the former UFST source area, resulting from the topography and the highly disturbed nature of sediments in the landslide debris. Downgradient from (west of) the UFST source area (between MW-2 and Redwood Creek), the groundwater gradient is approximately 0.1 feet per foot.

Site-specific empirical data (using the estimated time for UFST-sourced contamination to reach Redwood Creek) suggests a conservative estimate of groundwater velocity within the aquifer material to be between 7 to 10 feet per year, with the rate of movement within the clay rich zones being substantially less.

Redwood Creek borders the site to the west, and is a seasonal creek known for the occurrence of rainbow trout. Creek flow in the vicinity of the site shows significant seasonal variation with little to no flow during the summer and fall dry season, and vigorous flow with depths to 1 foot during the winter and spring wet season. The creek is a gaining stream (i.e., it is recharged by groundwater) in the vicinity of the site and discharges into Upper San Leandro Reservoir, located approximately 1 mile southeast of the site.



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Geoscience & Engineering Consulting

Groundwater Monitoring Well and Surface Water Analytical Results – December 30, 1999
Redwood Regional Park Service Yard, Oakland, CA

Figure 3

by: MJC | JANUARY 2000

99012-15

3.0 JANUARY 2000 STREAM BIOASSESSMENT

The CDFG requested in their October 26, 1998 letter that a "seasonal instream bioassessment program" be implemented to provide evidence of whether impacts to fish and/or aquatic life are occurring as a result of detected site contamination, and hence if further remediation is warranted (Rugg, 1998). The CDFG Water Pollution Control Laboratory (WPCL) is the CDFG group that established the bioassessment protocols; they have recommended that a minimum of two seasonal events be conducted: the first bioassessment event just after the rainy season (spring), and the second event prior to onset of heavy rains (winter). These two stages will best represent the variations in the macroinvertebrate life cycle and community development. Based on preliminary input from CDFG, we understand that if initial results suggest an impact to the creek, the bioassessment program could include several years of seasonal bioassessment events in order to evaluate both current conditions and the potential increase in contaminant concentrations at the creek/groundwater interface.

The initial (April 1999) and recent (January 2000) bioassessment events were conducted by the CDFG WPCL in accordance with their March 1996 protocols, entitled "California Stream Bioassessment Procedure (Habitat Assessment and Biological Sampling; Macroinvertebrate Laboratory and Data Analyses; and Field and Laboratory Quality Assurance/Control), and the monitoring strategy followed that recommended for point source pollution (CDFG, 1996). This method is a regional adaptation of the USEPA Rapid Bioassessment Protocols, and is recognized by the USEPA as California's standard bioassessment procedure. The method utilizes measures of the stream's benthic macroinvertebrate (BMI) community and its physical/habitat structure. BMIs can have a diverse community structure with individual species residing within the stream for a period of months to several years. The biological and physical assessment integrates the effects of water quality over time and provides a baseline assessment of a stream's ecological health. A copy of the assessment protocols is included in Appendix B. The protocols recommend that paired biostream asssessment events be conducted at the beginning and end of the macroinvertebrate life cycles, generally at the beginning and end of the rainy season. The protocols do not specify the number of paired assessments that should be conducted.

The second event was conducted on January 27, 2000, as soon as possible following onset of the winter rains and filling of the creek, as required by CDFG. The event consisted of a 2-person CDFG

team conducting an assessment/sampling of four "riffles" (sampling/assessment locations), including:

- Two upstream riffles (RC-U1 and RC-U2), approximately 300 meters and 200 meters upstream of the SW-2 location (area of contaminated groundwater discharge);
- One source area riffle (RC-GZ), approximately 3 meters downstream of the SW-2 location; and
- One downstream riffle (RC-D1), approximately 50 meters downstream of SW-2.

The CDFG report indicates that these locations were the best available representations of MBI habitat to evaluate potential impacts associated with site contamination. Three replicate samples were collected at each location to ensure statistical precision.

Field tasks completed include:

- Biological sampling (including completing a California Stream Bioassessment Procedure Field Worksheet at each riffle).
- Physical and habitat assessment.
- Taxonomic laboratory analyses and calculation of BMI metrics of five dominant taxa.
- Data compilation including statistical analysis.
- Qualitative assessment of impacts to the macroinvertebrate population assessed.

The full CDFG WPCL report summarizing the biostream assessment event (received by SES on April 20, 2000) is included in Appendix B. **The authors conclude that the benthic macrobiotic invertebrate communities at all sampled locations are indicative of normal conditions during the winter rainy season, and there is no evidence of adverse impacts associated with site contamination**

4.0 DECEMBER 1999 CREEK AND GROUNDWATER SAMPLING

This section presents the creek surface water and groundwater sampling and analytical methods. Subsequent Section 5.0 discusses the analytical results in the context of contaminant distribution, both current and historical, and presents a conceptual model of contaminant fate and transport. The analytical data and findings from the field activities are then presented in the following Section 5.0 of this report.

Monitoring and sampling protocols were in accordance with the ACHCSA-approved SES technical workplan (SES 1998a). Activities conducted include:

- Measuring static water levels and field analyzing groundwater samples for indicators of natural attenuation in all six site wells;
- Collecting groundwater analytical samples from the two site wells within the contaminant plume (MW-2 and MW-4); and
- Collecting creek surface water samples for laboratory analysis and field analyzing surface water samples for dissolved oxygen.

The current monitoring and sampling event was conducted on December 20, 1999. Groundwater level monitoring and creek sampling were conducted by SES. Groundwater monitoring well purging, sampling and field analyses were conducted by BlaineTech Services under direct supervision of SES personnel. The locations of all site monitoring wells and creek water sampling locations are shown on Figure 2. Well construction information is summarized in Table 1. Appendix C contains the groundwater monitoring field record. Appendix D contains the sample chain-of-custody records.

GROUNDWATER LEVEL MONITORING AND SAMPLING

Groundwater sampling of MW-2 and MW-4 was conducted on December 20, 1999 in accordance with state of California guidelines for sampling dissolved analytes in groundwater associated with leaking UFSTs (State Water Resources Control Board, 1989), and followed the methods and protocols approved by the ACHCSA in the SES 1998 workplan (SES 1998a).

Table 1
Groundwater Monitoring Well Construction Data

Well	Well Depth	Screened Interval	Depth to TOC	Ground Surface Elevation	TOC Elevation
MW-1	18	7-17	-2.3	563.6	565.9
MW-2	36	20-35	-2.4	564.1	566.5
MW-3	42	7-41	-2.8	558.1	560.9
MW-4	26	10-25	-2.1	546.0	548.1
MW-5	26	10-25	-2.3	545.2	547.5
MW-6	26	10-25	-2.3	543.3	545.6

Notes:

1) TOC = Top of Casing
2) All depths are feet below ground surface unless otherwise specified. Negative values for "Depth to TOC" indicate that the TOC is above ground surface.
3) All elevations are feet above USGS mean sea level (MSL). Elevations were surveyed by EBRPD relative to USGS Benchmark No. JHF-49. All wells are 4-inch inside diameter.

Static water levels were measured (Appendix C) in all six site wells on December 20, 1999. All water level measurements were made using an electric water level indicator. Pre-purge groundwater samples from all wells were field analyzed for indicators of natural attenuation including ferrous iron, dissolved oxygen, and oxygen reduction potential (ORP, or redox potential). The water sample collected from well MW-4 had a noticeable petroleum odor and sheen.

A total of approximately 53 gallons of purge water and decontamination rinsate from the current groundwater sampling event was containerized in the onsite plastic tank. The purge water will continue to be accumulated in the onsite tank until it is full, at which time it will be transported offsite for proper disposal.

CREEK SURFACE WATER SAMPLING

Surface water samples were collected on December 20, 1999 from Redwood Creek locations SW-2 (immediately downgradient of the former UFST source area and within the area of documented creek bank soil contamination) and SW-3 (approximately 500 feet downstream from SW-2) (see Figure 2 for locations). In accordance with a previous ACHCSA-approved SES recommendation, upstream sample location SW-1 was not sampled.

At the time of sampling, the creek flow was sluggish and depth of water at the sampling locations was approximately 6 to 12 inches. At the SW-2 location, where contaminated groundwater

discharge to the creek has historically been observed, petroleum odor was noted, as was orange algae growing on the saturated portion of the creek bank. It is inferred that this algae is utilizing the petroleum as a carbon source, and is therefore a good indicator of the presence of petroleum contamination.

5.0 FIELD AND LABORATORY ANALYTICAL RESULTS

This section presents the field and laboratory analytical results of the most recent (December 1999) investigation, including surface water and groundwater well sampling results. Section 6.0 presents a detailed discussion of the regulatory significance of the analytical results. Table 2 and Figure 4 summarize the analytical results of the current monitoring event samples.

GROUNDWATER SAMPLE RESULTS

As shown in Table 2, TPHg, benzene, ethylbenzene, toluene, ethylbenzene and MTBE were detected in MW-2. All site contaminants of concern except MTBE were detected in MW-4. With the exception of benzene and MTBE, detected concentrations in MW-4 were significantly greater than those in MW-2.

NATURAL ATTENUATION PARAMETERS MEASURED

Dissolved oxygen, ferrous iron and redox potential were field-measured in all six wells electronic meters. Nitrogen and sulfate from impacted wells MW-2 and MW-4 were analyzed in the laboratory. Table 3 shows the results that indicate a wide range of values. The implications of these natural attenuation parameters are discussed in Section 7.0.

CREEK SURFACE WATER SAMPLES

No compounds were detected above their respective method reporting limits in the downstream (SW-3) location. TPHd, TPHg, MTBE, and BTEX were detected at the SW-2 location (area of contaminated groundwater discharge).

QUALITY CONTROL SAMPLE ANALYTICAL RESULTS

Laboratory QC samples (e.g., method blanks, matrix spikes, surrogate spikes, etc.) were analyzed by the laboratory in accordance with requirements of each analytical method. All laboratory QC sample results and sample holding times were all within the acceptance limits of the methods (Appendix D), with one exception. **Surrogate recovery for the TPHg and BTEX analysis of creek water sample SW-2 was outside the QC limits due to matrix interference.** The laboratory case narrative indicated that no sample analytical problems were encountered.

Table 2
Groundwater and Surface Water Sample Analytical Results
December 20, 1999
Redwood Regional Park Corporation Yard - Oakland, California

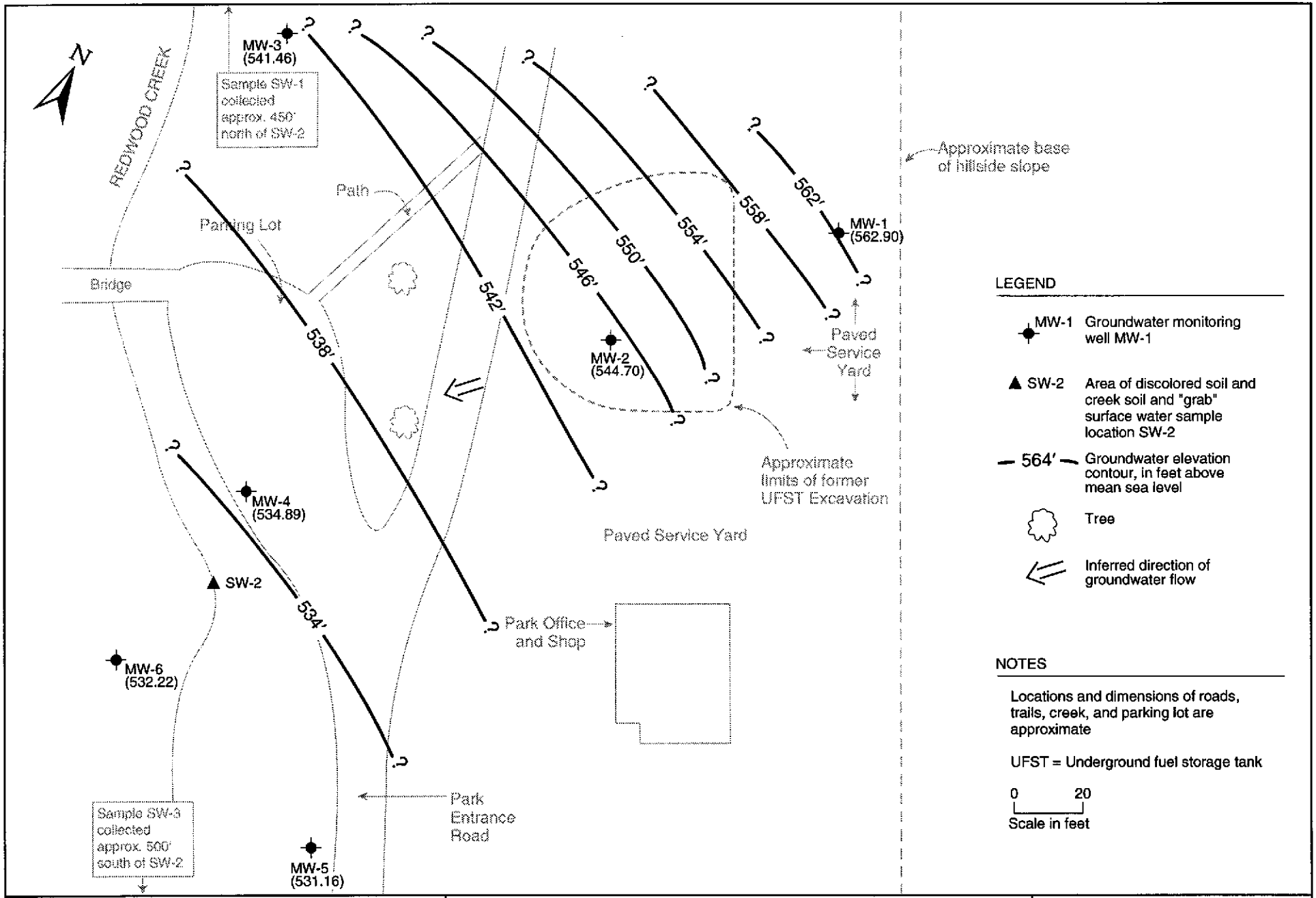
Compound	Concentrations in µg/L						
	TPHg	TPHd	Benzene	Toluene	Ethyl-benzene	Total Xylenes	MTBE
Groundwater Samples							
MW-2	57	< 50	20	0.61	5.9	< 0.5	4.5
MW-4	1,000	430	4.0	2.0	26	13.9	< 2.0
Redwood Creek Surface Water Samples							
SW-2	1,300	250	10	1.0	47	27	2.2
SW-3	< 50	< 50	< 0.5	< 0.5	< 0.5	< 0.5	< 2

Notes:
MTBE = Methyl tertiary butyl ether
TPHg = Total petroleum hydrocarbons - gasoline range (equivalent to total volatile hydrocarbons - gasoline range)
TPHd = Total petroleum hydrocarbons - diesel ranges (equivalent to total extractable hydrocarbons - diesel range)
µg/L = Micrograms per liter, equivalent to parts per billion (ppb)

Table 3
Groundwater Sample Analytical Results:
Natural Attenuation Indicators, December 20, 1999
Redwood Regional Park Corporation Yard - Oakland, California

Sample I.D.	Nitrogen (as Nitrate) (mg/L)	Sulfate (mg/L)	Dissolved Oxygen (mg/L)	Ferrous Iron (mg/L)	Redox Potential (milliVolts)
MW-1	NA	NA	1.8	ND	71
MW-2	< 0.05	**29**	4.2	ND	77
MW-3	NA	NA	1.6	**0.03**	67
MW-4	< 0.05	**110**	4.1	**2.4**	0
MW-5	NA	NA	1.5	**0.01**	7
MW-6	NA	NA	2.0	**0.06**	86

Notes: mg/L = Milligrams per liter, equivalent to parts per million (ppm); NA = Not Analyzed



Stellar Environmental Solutions
Geoscience & Engineering Consulting

GROUNDWATER ELEVATION MAP–DECEMBER 20, 1999
Redwood Regional Park Service Yard, Oakland, CA

Figure 4

by: MJC | JANUARY 2000

99012-20

6.0 REGULATORY CONSIDERATIONS

The following is a brief summary of Applicable Relevant and Appropriate Regulations (ARARs) for the site; a full discussion of site regulatory considerations was presented in the SES June 1999 report.

The lead regulatory agency for the site investigation since its inception has been ACHCSA, as the Local Oversight Program (LOP) to the RWQCB. The California Department of Fish and Game (CDFG) has communicated their concerns directly to ACHCSA as regards potential impacts to Redwood Creek. The RWQCB has ultimate decision-making authority as regards closure of contaminated groundwater sites.

Because site groundwater conditions meet the criteria for a potential drinking water source, regulatory agencies could apply drinking water standards for use as cleanup goals. There are no published numerical groundwater quality standards for TPH, which is specifically regulated under the RWQCB general "nondegradation of beneficial use" policy (RWQCB, 1992), which essentially is a zero-discharge policy. Table 4 summarizes the groundwater quality criteria, and recent maximum site concentrations. Contaminants historically detected in site groundwater in excess of published drinking water standards include BTEX and MTBE.

Because of the documented discharge of contaminated groundwater into Redwood Creek, the immediate concern of ACHCSA and CDFG is potential impacts to Redwood Creek – a protected trout steam - resulting from groundwater discharge. It is likely that these agencies will require, at a minimum, that groundwater contamination concentrations not exceed those that pose unacceptable impacts to Redwood Creek, and could utilize immediately upgradient groundwater concentrations as representative of worst-case surface water concentrations. As shown in Table 4, there are numerous numerical "action levels" and guidance criteria for surface water quality. Contaminants detected in historical Redwood Creek surface water samples in excess of these criteria include benzene and ethylbenzene. The CDFG has a "zero discharge" policy that prohibits petroleum discharge into waters of the state [Fish and Game Code Section 5650 (a) (1)]. As discussed previously, the current phase of work included CDFG-requested instream bioassessments to evaluate impacts to aquatic life.

Table 4
Surface and Ground Water Quality Criteria for Detected Contaminants

Analyte	Groundwater Regulatory Limit (µg/L)	Maximum Detected Groundwater Concentration & Date (a) (µg/L)	Surface Water Regulatory Limit (µg/L)	Maximum Historical Detected Surface Water Concentration (b) (µg/L) Number of Samples / Number of Exceedances
TPH-gasoline	No limit established	**54,000** – 2/99	No limit established	**1,300** (12/99)
TPH-diesel	No limit established	**270,000** – 2/99	No limit established	**250** (12/99)
Benzene	1 (Ca MCL-Prim) 71 (IRIS-H20)	**1,700** – 2/99	 0.34 (WQO-DW) 21 (WQO-Other) 21 (IRIS-H20+Org) 71 (IRIS-H20) 130 (EPA Tier II)	**13** (8/97) 5 / 14 0 / 14 0 / 14 0 / 14 0 /14
Toluene	40 (fed MCL-Sec-Prop) 1,000 (fed MCL-Prim-Prop) 200,000 (IRIS-H20)	**110** – 2/99	 9.8 (EPA Tier II) 6,800 (IRIS-H20+Org) 200,000 (IRIS-H20)	**1.0** (12/99) 0 / 14 0 / 14 0 / 14
Ethylbenzene	30 (fed MCL-Sec-Prop) 680 (Ca MCL-Prim) 29,000 (IRIS-H20)	**2,800** – 2/99	 7.3 (EPA Tier II) 3,100 (IRIS-H20+Org) 29,000 (IRIS-H20)	**47** (12/99) 2 / 14 0 / 14 0 / 14
Total Xylenes	20 (fed MCL-Sec-Prop) 1,750 (Ca MCL-Prim)	**11,000** – 2/99	 13 (EPA Tier II)	**27 (12/99)** **1** / 14
MTBE	5 (Ca MCL-Sec-Pro) 14 (Ca MCL-Prim-Pro)	**260** – 2/99	No limit established	**2.3** (4/99)

Notes:

(a) Concentrations detected since February 1999 in site monitoring wells or temporary well points

(b) Concentrations detected since 1993 in Redwood Creek

Ca MCL-Prim = State of California Primary Maximum Contaminant Level for drinking water

Ca MCL-Sec-Prop = State of California Secondary Maximum Contaminant Level (proposed) for drinking water

EPA Tier II = USEPA Tier II values from Proposed Water Quality Guidance for the Great Lakes System, 1993

Fed MCL-Prim-Prop = Federal Primary MCL (proposed); Fed MCL-Sec-Prop = Federal Secondary MCL (proposed)

WQO - DW= California State Water Resources Control Board (SWRCB) Water Quality Objective for inland surface waters that are potential drinking water sources

WQO – Other = SWRCB Water Quality Objective for inland surface waters that are not potential drinking water sources

IRIS-H20 = Environmental Protection Agency Integrated Risk Information System - concentration at which there is a human carcinogenicity risk of 10E-6 or less for consumption of water only.

IRIS-H20+Org = Environmental Protection Agency Integrated Risk Information System - concentration at which there is a human carcinogenicity risk of 10E-6 or less for consumption of water only.

7.0 DISTRIBUTION AND TRANSPORT OF CONTAMINATION AND DISCUSSION OF FINDINGS

This section summarizes the current distribution of soil and groundwater contamination (and natural attenuation indicators) based on the April-May 1999 subsurface investigation and recent groundwater and surface monitoring, with an emphasis on the December 1999 sampling results as regards hydrochemical and surface water contaminant trends. A full discussion of the contaminant distribution and transport conceptual model was presented in the SES June 1999 report (SES 1999b). Appendix A contains historical soil, groundwater and surface water analytical data.

SOURCE AREA CONTAMINANT DISTRIBUTION

Previous (1993 and 1994) investigation data documented the extent and magnitude of contamination in the former UFST source area. While the 1993 remedial action resulted in the removal of approximately 600 cubic yards (CY) of TPH-contaminated soil, an estimated 20 to 100 CY of TPH-contaminated soil remains at the source area. This area is now completely paved and would be expected to act as a continued source to groundwater contamination only during seasonal periods of high groundwater elevations.

DOWNGRADIENT SOIL CONTAMINANT DISTRIBUTION

The magnitude and extent of soil contamination downgradient of the former UFST source area has been well defined by historical and recent (April-May 1999) borehole analytical results, and has shown that soil contamination beyond the source area is confined to the capillary fringe and does not extend downgradient across Redwood Creek. The zone of soil contaminated above 1,000 mg/kg TPH (TPHg + TPHd) is lenticular shaped, extends approximately 150 feet from the center of the former UFST source area to Redwood Creek, varies in width between approximately 20 and 40 feet (approximate average of 30 feet), and is widest approximately halfway between the source area and the creek. The thickness of this zone varies between 3 and 8 feet and averages approximately 4.5 feet over the length of the zone. This corresponds to an approximate volume of 850 cubic yards.

GROUNDWATER CONTAMINANT DISTRIBUTION

The magnitude and extent of groundwater contamination has been well defined by historical investigations, and shows the following:

- TPHg concentrations are significantly greater than TPHd concentrations and BTEX and MTBE constituents generally show the same distribution as for TPHg.
- Maximum total TPH (TPHg + TPHd) contamination in groundwater (approximately 300,000 µg/L) is located at the downgradient edge of the plume near MW-4, just upgradient of Redwood Creek, and total TPH concentrations decrease along the plume axis closer to the source area. Significant total TPH concentrations (approximately 47,000 µg/L to 70,000 µg/L) were detected in 1999 upgradient boreholes up to 60 feet upgradient of MW-4, suggesting a substantial mass of groundwater contamination that will continue to migrate downgradient toward the creek.
- Groundwater contamination above 10,000 µg/L TPH (TPHg + TPHd) comprises an elliptical plume that extends approximately 100 feet from the downgradient edge of the former UFST source area to Redwood Creek, and is approximately 60 feet wide (total of 6,000 square feet). The leading edge of the plume at the Redwood Creek interface appears to be about 30 feet wide. A smaller zone (approximately 200 square feet) with TPH contamination above 100,000 µg/L is located in the immediate vicinity of borehole HP-02 at the leading edge of the plume.

SURFACE WATER CONTAMINATION

As discussed previously, TPH and aromatic hydrocarbons have been historically detected at the SW-2 location where contaminated groundwater discharges to Redwood Creek. Contamination is generally detected only during periods of low creek flow when the contamination is not immediately swept away and diluted. It is also during periods of low creek flow when contaminated (discolored) soil is evident in the creek bank, providing empirical evidence of the capillary fringe zone of residual contaminated soil. Historical contaminant concentrations in creek surface water samples are several orders of magnitude below immediately upgradient groundwater samples.

December 1999 creek surface water samples at location SW-2 (at the groundwater discharge area) were near or above historical maxima for all site contaminants. This supports the hypothesis that a "slug" of groundwater contamination greater than that measured in site monitoring wells is moving toward the discharge area, and that contaminant discharge from groundwater to surface water could be on an increasing trend.

NATURAL ATTENUATION INDICATORS

As a result of the demonstrated degradability of petroleum hydrocarbons by naturally occurring mechanisms, monitored natural attenuation (MNA) has been found to be a viable option for addressing many hydrocarbon plumes, replacing the need for active remediation, when there are no

sensitive receptors that could be impacted before the MNA reduced the concentrations to acceptable levels. Specifically, biodegradation of petroleum hydrocarbons in groundwater has a significant role in creating a stable plume, minimizing groundwater plume configuration and concentrations over time (Lawrence Livermore National Laboratory, 1995). Hydrocarbon biodegradation and presence of a stable plume are the basis for application of risk-based methodologies in support of site closure (RWQCB, 1996).

A single round of biodegradation-indicator (bio-indicator) parameters was collected at the site in April 1999 in site wells and temporary well points, and additional natural attenuation analyses were conducted in the December 1999 groundwater monitoring event. The limited site data suggest that natural attenuation is occurring on the fringes of the plume, but that attenuation is muted to negligable in the centerline of the plume and is insufficient to prevent discharge of contaminated water to Redwood Creek.

TREND ANALYSIS AND PLUME STABILITY

Data from the 15 site groundwater monitoring events since November 1994 have been used to evaluate site hydrochemical trends for TPHg, TPHd and BTEX. A tabular summary of historical hydrochemical analyses is provided in Table A.2 (Appendix A) and hydrochemical trend plots for individual constituents are also included in Appendix A.

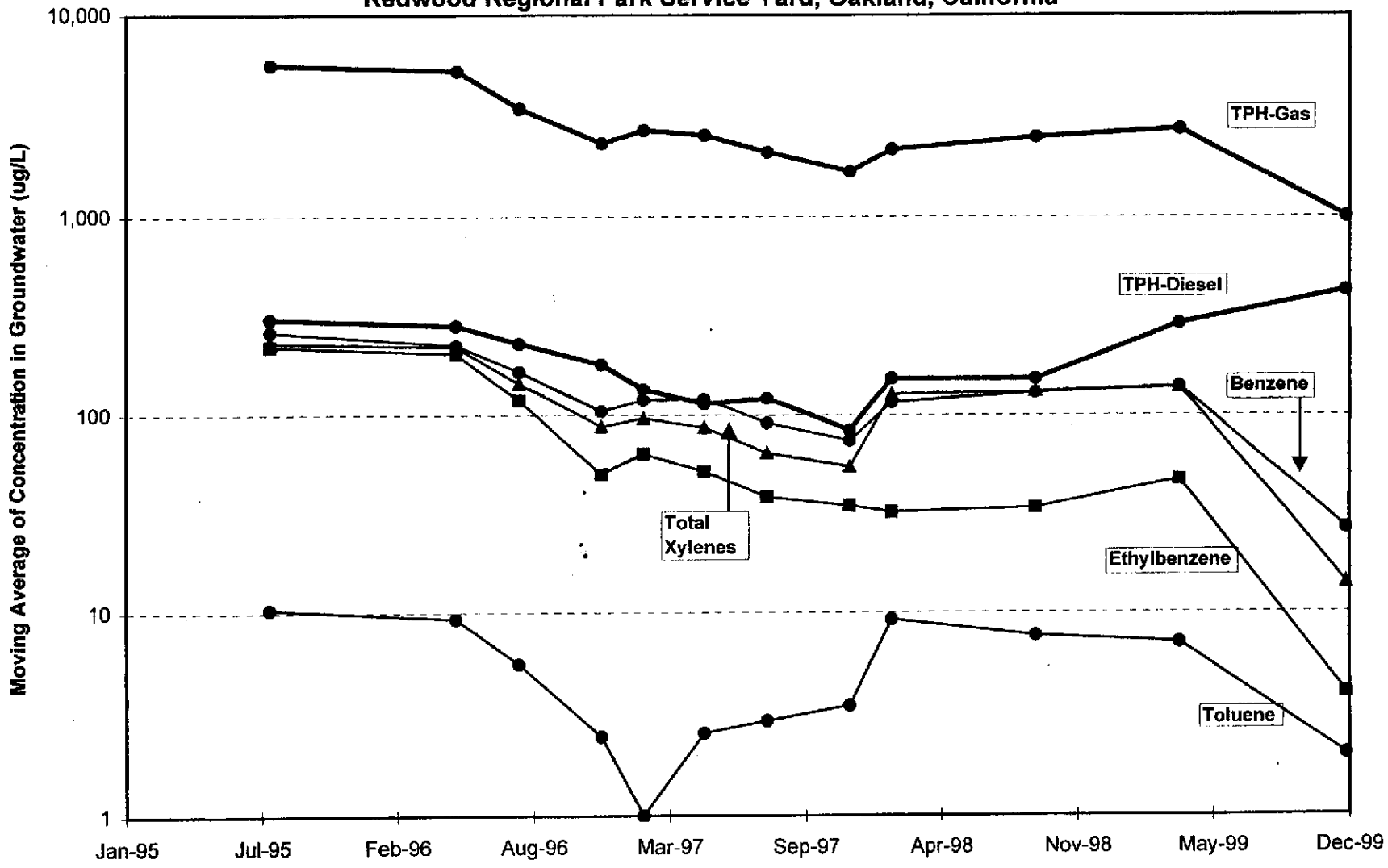
Figure 5 illustrates the hydrochemical trends in downgradient well MW-4, which has historically shown the highest and most persistent concentrations. The figure presents these data as a four quarter moving average on a logarithmic scale to enhance trend lines and allow for the comparison of all the chemicals of concern on one plot.

All constituents have shown a general decrease since groundwater monitoring began in 1994. Four-quarter moving average concentrations showed a general decrease through early 1998, when average concentrations began to increase, likely due to increasing groundwater elevations during the anomalously wet winters of 1998 and 1999, and subsequent desorption of contamination from the capillary fringe. With the exception of TPH-d, all site contaminants decreased substantially in the December 1999 monitoring event, likely due to the absence of significant precipitation (hence contaminant desorption) for the months prior to the sampling event.

PROJECTED FUTURE TRENDS AND REMEDIAL OPTIONS

As discussed previously, the majority of contaminated soil in the UFST source area was removed in 1993. Due to the location of the excavation being near the top of a landslide area, the excavation could not remove small pockets of relatively high concentration TPH-contaminated soil.

Figure 5
Historical (1995-2000) Ground Water Analytical Results: Well MW-4
Four Quarter Moving Average
Redwood Regional Park Service Yard, Oakland, California



GW&SW-Analytical Summary.XLS

Remediation by excavation at the site provided the residual TPH in the soil with more available oxygen through the layer of permeable backfill material overlying the original excavation. This should provide more oxygen transfer critical to aerobic degradation. The continued decrease in groundwater concentrations at source area well MW-2 confirms that the contaminant plume is in the process of "disconnecting" from the source area; however, long-term source area contributions will continue to some degree as long as groundwater is in contact with contaminated soil and is allowed to migrate downgradient.

The distribution of the residual TPH soil at depth along the length of the 150-foot long plume makes it practically and economically burdensome to remove. It is well documented in the literature natural attenuation of petroleum hydrocarbons is a viable mechanism for stabilization and ultimate reduction of plume size, and site data suggest that attenuation is indeed occurring on the fringes of the plume. However, the site data also suggest that attenuation is muted in the centerline of the plume due to the elevated contaminant concentrations and the short distance between the former source area and the creek. Attenuation in these conditions can be improved with supplemental oxygen, delivered via either venting, injection or introduction of oxygen-releasing compounds.

Current conditions include a 30- to 60-foot wide groundwater fuel plume in the approximately 20-foot long area between the downgradient edge of the parking area and Redwood Creek, a steep vegetated hillside slope with no vehicle access. There is no reasonably cost-effective method for remediating contamination within this zone. A substantial mass of groundwater and capillary fringe soil contamination is located upgradient of that zone, primarily under the parking lot. Based on the current plume configuration and hydraulic regime, we infer that groundwater contamination equaling or exceeding current site maxima could persist at the downgradient plume limits (adjacent to Redwood Creek) for at least several years.

Implementing a remedial action should be considered if current or future conditions result in unacceptable impacts to Redwood Creek. Current conditions, evidenced by the CDFG WPCL bioassessment findings and historical surface water sampling results, do not suggest current unacceptable impacts. Despite the elevated groundwater concentrations at immediately upgradient locations, the groundwater discharge-creek interface system suggests that only the vertically upper portion of the plume is contacting the creek, and the remaining contaminant mass is below the creek base. However, conditions could worsen as higher groundwater concentrations migrate downgradient and reach the creek. A significant site constraint is the relatively short distance between the current inferred center of contaminant mass and Redwood Creek, which precludes installation of an effective "trigger" monitoring well system between the plume and the creek.

Significant reduction of contaminant concentrations and duration of discharge could be achieved by a number of methods. The most effective mechanism for mitigating impacts to Redwood Creek would be a passive or relative hydraulic barrier, such as a cutoff wall, funnel-and-gate configuration, reactive wall or groundwater extraction trench across the plume's longitudinal axis at the most downgradient accessible location. However, this remedial strategy may not be viable based on high cost and disruption to the park operation.

Another potentially effective technique would be installation of an array of closely-spaced boreholes across the longitudinal axis of the plume that are screened over the saturated interval and contain an oxygen-releasing compound (ORC). This passive remedial technique creates a highly oxygenated zone in the areas where natural attenuation is limited by oxygen availability. The density of spacing is configured such that an "oxygen barrier" is created, effectively preventing significant plume migration beyond the array. The primary advantages of this technique are that it requires only a one-time program of borehole installation, minimizing impacts to park operations, and the relatively lower cost compared to other remedial strategies. The potential disadvantage of remediation by ORC is the limited area. Ideal conditions for this technique include a downgradient monitoring point(s) that can be used to evaluate the effectiveness of the technology. In this case, treatment boreholes would necessarily be installed at the most downgradient locations possible in order to achieve maximum control on the plume. If two or more longitudinal arrays were installed, a monitoring point could be placed between the arrays to provide for evaluation of at least the upgradient portion of the treatment area.

8.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

SUMMARY AND CONCLUSIONS

The conclusions and recommendations presented in this section are based on previous investigation and remediation reports, field investigation descriptions, analytical results, and interpretations delineated and developed in the body of this report. Interpretations are based on data collected by previous investigators between 1993 and February 1998, and on the results of the SES field investigations conducted between September 1998 and January 2000.

- The site utilized two UFSTs (diesel and gasoline) that were excavated and removed from the site in 1993, along with 600 CYof contaminated soil. An estimated volume of 850 CY of petroleum-contaminated soil with concentrations above 1,000 mg/Kg is estimated to be left in place in the area of the original excavation and downgradient of it along the pathway of the plume. Most of the residual contaminated soil exists in the capillary fringe up to 150 feet downgradient of the former UFSTs, resulting from the sorption of fuel constituents from contaminated groundwater onto capillary fringe soils during periods of high groundwater elevation. This soil contamination will be a long-term source of groundwater contamination.
- Groundwater sampling conducted on an approximately quarterly frequency since November 1994 (15 events) has shown an overall decreasing concentration trend in groundwater contaminants, which include gasoline, diesel and BTEX. MTBE was detected in both the source area and the downgradient monitoring wells when it was analyzed for the first time in September 1998.
- Near-maximum historical groundwater contaminant concentrations were detected in February 1998, coinciding with unusually heavy rains and correspondingly high groundwater elevations, which likely desorbed capillary fringe soil contamination into groundwater. The recent (December 1999) groundwater analytical data showed results consistent with previous analyses, with maximum concentrations of most analytes detected in downgradient well MW-4, suggesting that the center of mass of the contaminant groundwater plume has moved from the UFST source area and beyond well MW-2.
- The limits of the groundwater contaminant plume are well-defined by site groundwater monitoring wells and the April-May 1999 subsurface investigation, and extend from the

source area to Redwood Creek, a distance of approximately 150 feet. The area of the plume with TPH concentrations greater than 10,000 µg/L is up to 60 feet wide by 100 feet long, and begins approximately 30 feet downgradient of the source area, suggesting that the plume is becoming "disconnected" from the former UFST source area. The leading edge of the plume daylighting in the creek banks is approximately 30 feet wide. Site groundwater contaminants that have been historically (and recently) detected in excess of drinking water standards include benzene, ethylbenzene, total xylenes, and MTBE; there are no drinking water standards for TPH compounds. While it is unlikely that site groundwater would be used as a drinking water source, drinking water standards could be applied by regulators as cleanup standards.

- Significantly greater groundwater contamination detected in the April 1999 subsurface investigation relative to previous data suggest that MW-4 is not located directly along the plume's longitudinal axis. The recent data also suggest that there is a substantial mass of groundwater contamination upgradient of the parking lot's downgradient edge, which will continue to migrate toward Redwood Creek, and that future impacts to Redwood Creek from contaminated groundwater discharge may be worse than at present. There is no practical or cost-effective remedy for addressing that portion of capillary fringe soil and groundwater contamination in the approximately 20-foot wide zone between the downgradient edge of the site parking lot and the creek. Continued impacts to the creek from residual site contamination upgradient of that area could be mitigated by either hydraulic containment methods, or more cost-effectively by injection of oxygen-releasing compound into closely spaced boreholes within the zone of contamination, to stimulate biodegradation.

- Redwood Creek is a hydraulic barrier preventing contaminated groundwater migration beyond the creek. The flowpath of groundwater in the immediate vicinity of the creek is likely to follow topgraphy, and would be expected to flow in the downstream direction (south) beneath the creek.

- Natural attenuation is indicated to be occuring at the site, mainly at the plume margins and former source area. Natural attenuation is likely muted in the higher concentration portion along the centerline of the plume due to limited oxygen content, suggesting that natural attenuation has not and in the future will not be sufficient to mitigate impacts to the creek.

- Discharge of petroleum-contaminated groundwater into Redwood Creek is evidenced by: historical observation of petroleum-discolored soil in the bank of Redwood Creek downgradient of the former UFSTs; sporadic detection of fuel constituents in creek surface water samples collected at that location; and the growth of an algae on the surface water surface at that location suggesting that the petroleum is serving as a carbon source. The December 1999 surface water sampling results showed concentrations near or above

historical maxima for all site contaminants, supporting the hypothesis that groundwater contaminant concentrations immediately upgradient are on an increasing trend as the center of the contaminant plume mass moves downgradient toward the creek. Benzene, ethylbenzene and xylenes have been detected in creek surface water samples in excess of published water quality objectives (WQOs) for surface waters that are a potential drinking water source. Based on the absence of detectable contamination immediately downstream of the site, it is very unlikely that site contamination has the potential to impact the nearest municipal drinking water source (Upper San Leandro Reservoir).

- The CDFG code stipulates a policy of zero discharge of petroleum to surface waters, unless it can be demonstrated that complete removal of the petroleum is infeasible and that instream biota are not affected. The results of the initial two stream bioassessment events (April 1999 and January 2000) indicate no contaminant-sourced impacts to the benthic macroinvertebrate community in Redwood Creek. Additional bioassessment events are warranted only if groundwater and/or surface water analytical results indicate a potential for significantly discharge of petroleum to the creek.

RECOMMENDATIONS

Based on the available data, SES recommends that the District implement the following actions to address regulatory concerns:

- Meet with ACHCSA and CDFG to discuss the results, conclusions and recommendations of this investigation, especially as regards the need to mitigate any unacceptable impacts associated with residual site contamination and/or the need to conduct future bioassessment events.
- If regulatory agencies deem mitigation is necessary, conduct a limited feasibility study to determine the most appropriate and cost-effective remedial strategy.
- Continue the established program of quarterly groundwater elevation monitoring (all six site wells) and sampling (wells MW-2 and MW-4 only).
- Continue the established program of quarterly surface water sampling at locations SW-2 and SW-3. The previous ACHCSA-approved recommendation to decrease the frequency of surface water sampling from quarterly to semi-annually is not technically appropriate at this time, given the documented impacts to Redwood Creek from discharge of contaminated groundwater, and the need to monitor the discharge closely.

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10.0 LIMITATIONS

This report has been prepared for the exclusive use of East Bay Regional Park District and their authorized representatives and the Regulators. No reliance on this report shall be made by anyone other than the client and regulators for whom it was prepared.

The findings and conclusions presented in this report are based on the review of previous investigators' findings at the site as well as site activities conducted by SES since September 1998. This report provides neither a certification nor guarantee that the property is free of hazardous substance contamination. This report has been prepared in accordance with generally accepted methodologies and standards of practice of the area. The SES personnel who performed this limited remedial investigation are qualified to perform such investigations and have accurately reported the information available but cannot attest to the validity of that information. No warranty, expressed or implied, is made as to the findings, conclusions and recommendations included in the report.

The findings of this report are valid as of the present. Site conditions may change with the passage of time, natural processes or human intervention, which can invalidate the findings and conclusions presented in this report. As such, this report should be considered a reflection of the current site conditions as based on the investigation and remediation completed.

Historical Soil Analytical Results

Table A.1
Summary of Historical Soil Sample Analytical Results
Redwood Regional Park Service Yard
Oakland, California

Sample I.D.	Depth (ft bgs)	Concentrations in mg/kg					
		TPHg	TPHd/k	Benzene	Toluene	Ethyl-benzene	Total Xylenes
*UFST Excavation Confirmation Samples – May & June 1993 (*indicates soil at that location was removed)*							
DT-1*	10	NA	**4**	< 0.005	< 0.005	< 0.005	< 0.005
DT-2*	10	NA	**3**	< 0.005	< 0.005	< 0.005	< 0.005
GT-1*	12	**800**	NA	**6.3**	**43**	**18**	**94**
GT-2	12	**2,200**	NA	**19**	**120**	**45**	**250**
E1-17	17	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
E2-16	16	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
E3-16	16	**12,000**	NA	**80**	**390**	**230**	**1,100**
E4-13	13	**6**	NA	**0.37**	**0.006**	**0.1**	**0.1**
E5-7.5	7.5	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
Exploratory Borehole Samples – September and October 1994							
B1-11	11	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
B1-27	27	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
B2-11	11	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
B2-15	15	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
B3-12	12	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
B3-18	18	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
B4-18	18	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
B4-23	23	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
B5-11	11	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
B7-12	12	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
B8-4	4	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
B8-10	10	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
B9-11	11	**370**	NA	**1.7**	**7.9**	**6.9**	**34**
B9-21	21	< 1	NA	**0.1**	**0.011**	**0.017**	**0.069**
B9-28	28	< 1	NA	< 0.005	**0.033**	**0.035**	**0.14**

Sample I.D.	Depth (ft bgs)	Concentrations in mg/kg					
		TPHg	TPHd/k	Benzene	Toluene	Ethyl-benzene	Total Xylenes
15.5'							
HP-09-15'	15'	**610**	**630**	**1.5**	**1.5**	**3.8**	**11.2**
HP-10-14'	14'	**500**	**76**	**0.19**	**1.6**	**2.0**	**3.21**

Notes:

TPHg – Total petroleum hydrocarbons – gasoline range (equivalent to total volatile hydrocarbons)

TPHd/k – Total petroleum hydrocarbons – diesel/kerosene ranges (equivalent to total extractable hydrocarbons)

NA = Not Analyzed

mg/kg = milligrams per kilogram (equivalent to parts per million – ppm)

Sample I.D.	Depth (ft bgs)	Concentrations in mg/kg					
		TPHg	TPHd/k	Benzene	Toluene	Ethyl-benzene	Total Xylenes
B10-6	6	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
B10-21	21	< 1	7	< 0.005	< 0.005	< 0.005	< 0.005
B11-11.5	11.5	< 1	< 2	**0.021**	< 0.005	< 0.005	< 0.005
B12-14.5	14.5	**150**	NA	**0.24**	**0.44**	**1.7**	**4.6**
B12-15	15	**77**	NA	**0.15**	**0.24**	**0.9**	**2.7**
B12-21	21	**97**	NA	**0.46**	**1.2**	**2**	**5.4**
B13-12	12	**1,500**	NA	< 0.4	< 0.4	**13**	**78**
B13-15	15	**1,800**	**420**	**8.8**	**39**	**30**	**120**
B14-18	18	**210**	**50**	**0.017**	**0.1**	**0.34**	**0.63**
B15-17	17	**1,900**	**1,300**	**1.1**	**0.8**	**9.1**	**14**
B16-17.5	17.5	**50**	NA	< 0.1	< 0.1	**0.2**	**0.2**
B17-12.5	12.5	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
Monitoring Well Installation Borehole Samples – October 1994							
MW1-5	5	< 1	**3**	< 0.005	< 0.005	< 0.005	< 0.005
MW-21	21	**130**	**48**	**0.31**	**0.18**	**1.3**	**4.4**
MW3-10	10	< 1	**3**	< 0.005	< 0.005	< 0.005	< 0.005
MW3-25	25	< 1	**5**	< 0.005	< 0.005	< 0.005	< 0.005
MW4-15.5	15.5	**22**	**4**	< 0.005	**0.038**	< 0.005	**0.49**
MW4-16.5	16.5	**10**	**43**	< 0.005	**0.009**	**0.11**	**0.21**
MW5A-15	15	**570**	**200**	< 0.005	**1.1**	**1.9**	**2.9**
MW5-15	15	< 1	**2**	< 0.005	< 0.005	< 0.005	< 0.005
MW6-19	19	< 1	**2**	< 0.005	< 0.005	< 0.005	< 0.005
Exploratory Borehole Samples - April 1999							
HP-01-17.5'	17.5'	< 1.0	**3.8**	< 0.005	< 0.005	< 0.005	< 0.005
HP-02-14'	14'	**970**	**640**	**1.3**	**1.3**	**5.5**	**8.7**
HP-03-13'	13'	< 1.0	**5.8**	< 0.005	< 0.005	< 0.005	< 0.005
HP-04-15'	15'	< 1.0	**1.7**	< 0.005	< 0.005	< 0.005	< 0.005
HP-05-15'	15'	< 1.0	**4.3**	< 0.005	< 0.005	< 0.005	< 0.005
HP-06-11'	11'	**1,700**	**360**	**1.4**	**2.7**	**21**	**81**
HP-07-12'	12'	**2.9**	**340**	**0.028**	< 0.005	**0.13**	**0.347**
HP-08-	15.5'	**580**	**83**	< 0.1	**1.0**	**4.7**	**4.7**

Historical Groundwater Analytical Results

TABLE A.2

HISTORICAL GROUNDWATER MONITORING WELLS ANALYTICAL RESULTS

REDWOOD REGIONAL PARK SERVICE YARD, OAKLAND, CALIFORNIA

(wells MW-1,MW-3 and MW-6 not sampled after August 1995 based on absence of detected contamination)

(all concentrations in µg/L, equivalent to parts per billion [ppb])

Well MW-2									
Event	Date	TPH-G	TPH-D	Benzene	Toluene	Ethylbenzene	Total Xylenes	Total BTEX	MTBE
1	Nov-94	66	< 50	3.4	< 0.5	< 0.5	0.9	4.3	NA
2	Feb-95	89	< 50	18	2.4	1.7	7.5	29.6	NA
3	May-95	< 50	< 50	3.9	< 0.5	1.6	2.5	8	NA
4	Aug-95	< 50	< 50	5.7	< 0.5	< 0.5	< 0.5	5.7	NA
5	May-96	< 50	< 50	< 0.5	< 0.5	< 0.5	< 0.5	—	NA
6	Aug-96	< 50	< 50	< 0.5	< 0.5	< 0.5	< 0.5	—	NA
7	Dec-96	< 50	< 50	6.3	< 0.5	1.6	< 0.5	7.9	NA
8	Feb-97	< 50	< 50	0.69	< 0.5	0.55	< 0.5	1.24	NA
9	May-97	67	< 50	8.9	< 0.5	5.1	< 1.0	14	NA
10	Aug-97	< 50	< 50	4.5	< 0.5	1.1	< 0.5	5.6	NA
11	Dec-97	61	< 50	21	< 0.5	6.5	3.9	31.4	NA
12	Feb-98	2,000	200	270	92	150	600	1,112	NA
13	Sep-98	< 50	<50	< 0.5	< 0.5	< 0.5	< 0.5	—	7
14	Apr-99	82	710	4.2	< 0.5	3.4	4	11.6	7.5
15	Dec-99	57	<50	20	0.61	5.9	<0.5	26.5	4.5

NA = Not Analyzed for this constituent

TABLE A.2 (continued)

Well MW-4									
Event	**Date**	**TPH-G**	**TPH-D**	**Benzene**	**Toluene**	**Ethylbenzene**	**Total Xylenes**	**Total BTEX**	**MTBE**
1	Nov-94	**2,600**	**230**	**120**	**4.8**	**150**	**88**	**363**	*NA*
2	Feb-95	**11,000**	**330**	**420**	**17**	**440**	**460**	**1,337**	*NA*
3	May-95	**7,200**	**440**	**300**	**13**	**390**	**330**	**1,033**	*NA*
4	Aug-95	**1,800**	**240**	**65**	**6.8**	**89**	**66.5**	**227**	*NA*
5	May-96	**1,100**	**140**	**51**	*< 0.5*	*< 0.5*	**47**	**98**	*NA*
6	Aug-96	**3,700**	**120**	**63**	**2**	**200**	**144**	**409**	*NA*
7	Dec-96	**2,700**	**240**	**19**	*< 0.5*	**130**	**92.9**	**242**	*NA*
8	Feb-97	**3,300**	*< 50*	**120**	**1.0**	**150**	**102.5**	**374**	*NA*
9	May-97	**490**	*< 50*	**2.6**	**6.7**	**6.4**	**6.7**	**22**	*NA*
10	Aug-97	**1,900**	**150**	**8.6**	**3.5**	**78**	**52.6**	**143**	*NA*
11	Dec-97	**1,000**	**84**	**4.6**	**2.7**	**61**	**54.2**	**123**	*NA*
12	Feb-98	**5,300**	**340**	**110**	**24**	**320**	**402**	**856**	*NA*
13	Sep-98	**1,800**	*<50*	**8.9**	*< 0.5*	**68**	**26.9**	**104**	**23**
14	Apr-99	**2,900**	**710**	**61**	**1.2**	**120**	**80.4**	**263**	**32**
15	Dec-99	**1,000**	**430**	**4**	**2**	**26**	**13.9**	**45.9**	*<2.0*

NA = Not Analyzed for this constituent

TABLE A.2 (continued)

Well MW-5									
Event	**Date**	**TPH-G**	**TPH-D**	**Benzene**	**Toluene**	**Ethylbenzene**	**Total Xylenes**	**Total BTEX**	**MTBE**
1	Nov-94	**50**	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
2	Feb-95	**70**	*< 50*	**0.6**	*< 0.5*	*< 0.5*	*< 0.5*	**0.6**	*NA*
3	May-95	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
4	Aug-95	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
5	May-96	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
6	Aug-96	**80**	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
7	Dec-96	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
8	Feb-97	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
9	May-97	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
10	Aug-97	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
11	Dec-97	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
12	Feb-98	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
13	Sep-98	*< 50*	*<50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*< 2*
Groundwater monitoring in this well discontinued with Alameda County Health Care Services Agency approval									

NA = Not Analyzed for this constituent

TABLE A.3

HISTORICAL SURFACE WATER ANALYTICAL RESULTS

REDWOOD REGIONAL PARK SERVICE YARD, OAKLAND, CALIFORNIA

(all concentrations in µg/L, equivalent to parts per billion [ppb])

Sampling Location SW-1 (Upstream)									
Event	**Date**	**TPH-G**	**TPH-D**	**Benzene**	**Toluene**	**Ethylbenzene**	**Total Xylenes**	**Total BTEX**	**MTBE**
1	Feb-94	**50**	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
2	May-95	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
3	May-96	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
4	Aug-96	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
5	Dec-96	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
6	Feb-97	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
7	Aug-97	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
8	Dec-97	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
9	Feb-98	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
10	Sep-98	*< 50*	*<50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*< 2*
11	Apr-99	*< 50*	*<50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*< 2*
Samplingat this location discontinued after April 1999.									

NS = Not Sampled

NA = Not Analyzed for this constituent

TABLE A.3 (continued)

Sampling Location SW-2 (Area of Contaminated Groundwater Discharge)									
Event	**Date**	**TPH-G**	**TPH-D**	**Benzene**	**Toluene**	**Ethylbenzene**	**Total Xylenes**	**Total BTEX**	**MTBE**
1	Feb-94	**130**	*< 50*	**1.9**	*< 0.5*	**4.4**	**3.2**	**9.5**	*NA*
2	May-95	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
3	Aug-95	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
4	May-96	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
5	Aug-96	**200**	*< 50*	**7.5**	*< 0.5*	**5.4**	*< 0.5*	**12.9**	*NA*
6	Dec-96	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
7	Feb-97	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
8	Aug-97	**350**	**130**	**13**	**0.89**	**19**	**10.7**	**43.6**	*NA*
9	Dec-97	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
10	Feb-98	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
11	Sep-98	*< 50*	*<50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*< 2*
11	Apr-99	**81**	*<50*	**2.0**	*< 0.5*	**2.5**	**1.3**	**5.8**	**2.3**
13	Dec-99	**1,300**	**250**	**10.0**	**1.0**	**47**	**27**	**85.0**	**2.2**

NS = Not Sampled

NA = Not Analyzed for this constituent

TABLE A.3 (continued)

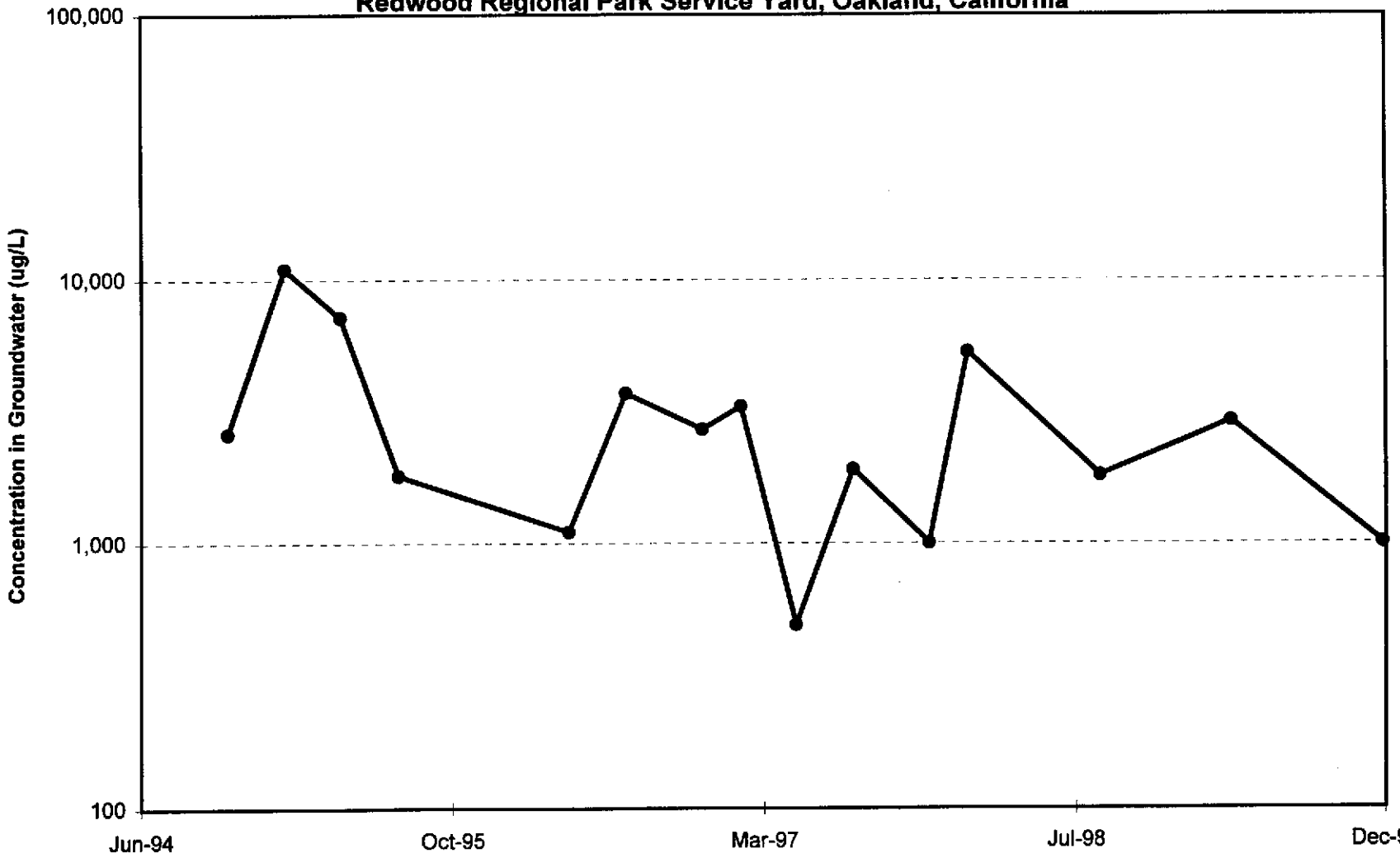
Sampling Location SW-3 (Downstream)									
Event	**Date**	**TPH-G**	**TPH-D**	**Benzene**	**Toluene**	**Ethylbenzene**	**Total Xylenes**	**Total BTEX**	**MTBE**
1	May-95	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
2	Aug-95	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
3	May-96	*< 50*	*74*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
4	Aug-96	**69**	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
5	Dec-96	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
6	Feb-97	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
7	Aug-97	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
8	Dec-97	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
9	Feb-98	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
10	Sep-98	*< 50*	*<50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*< 2*
11	Apr-99	*< 50*	*<50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*< 2*
12	Dec-99	*< 50*	*<50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*< 2*

NS = Not Sampled

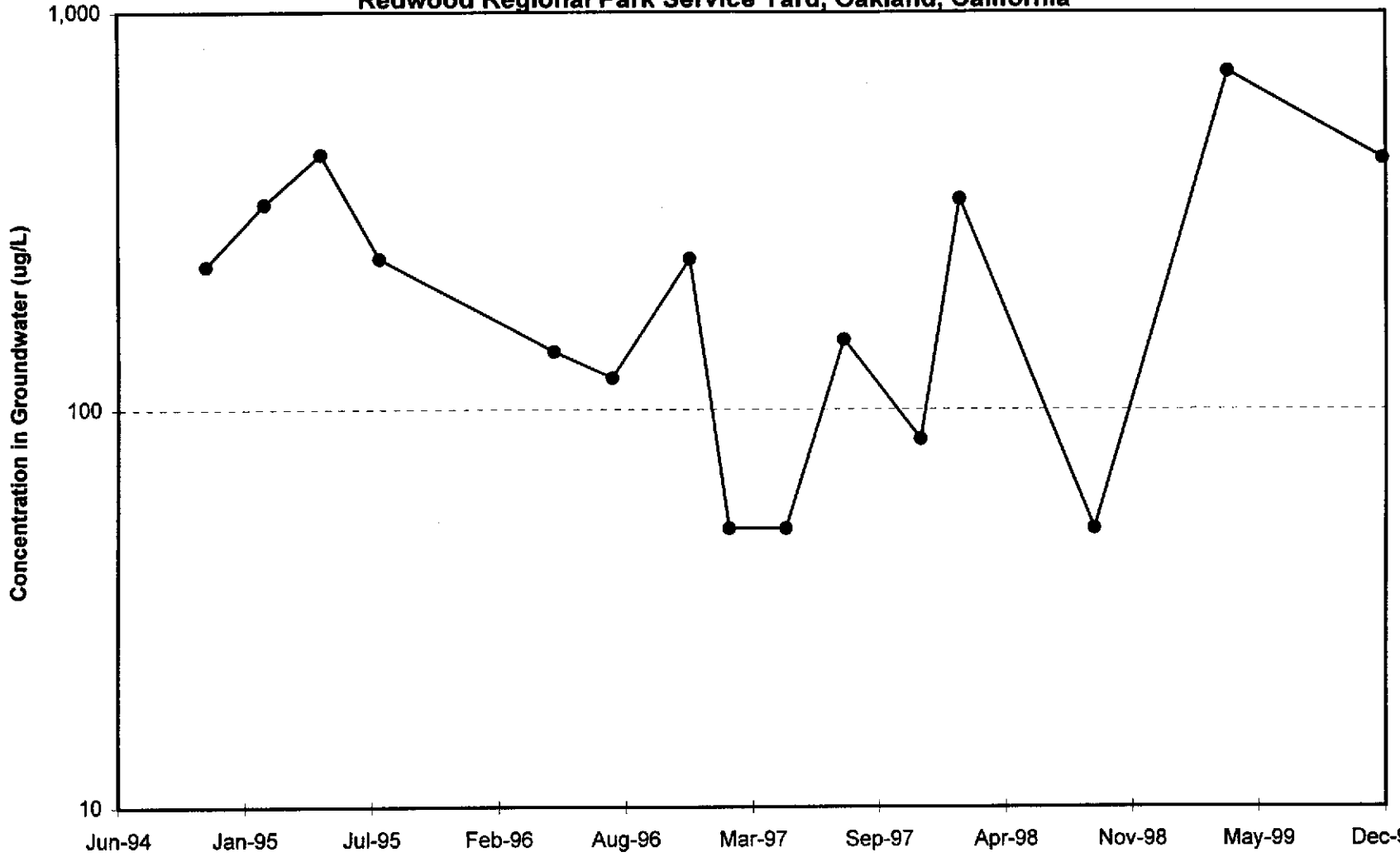
NA = Not Analyzed for this constituent

Hydrochemical Trend Analyses

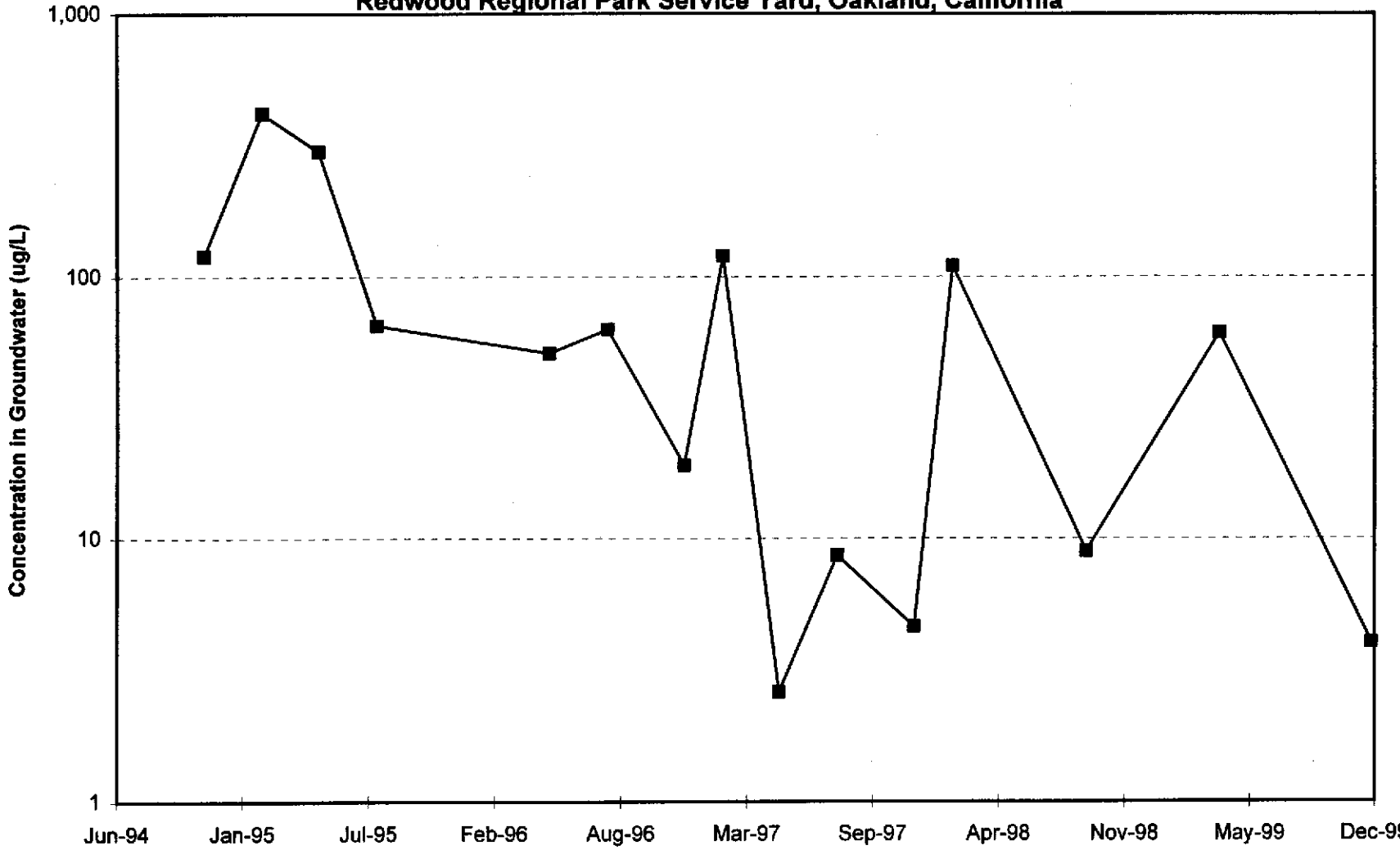
Historical Ground Water Analytical Results: Well MW-4
TPH-gasoline
Redwood Regional Park Service Yard, Oakland, California



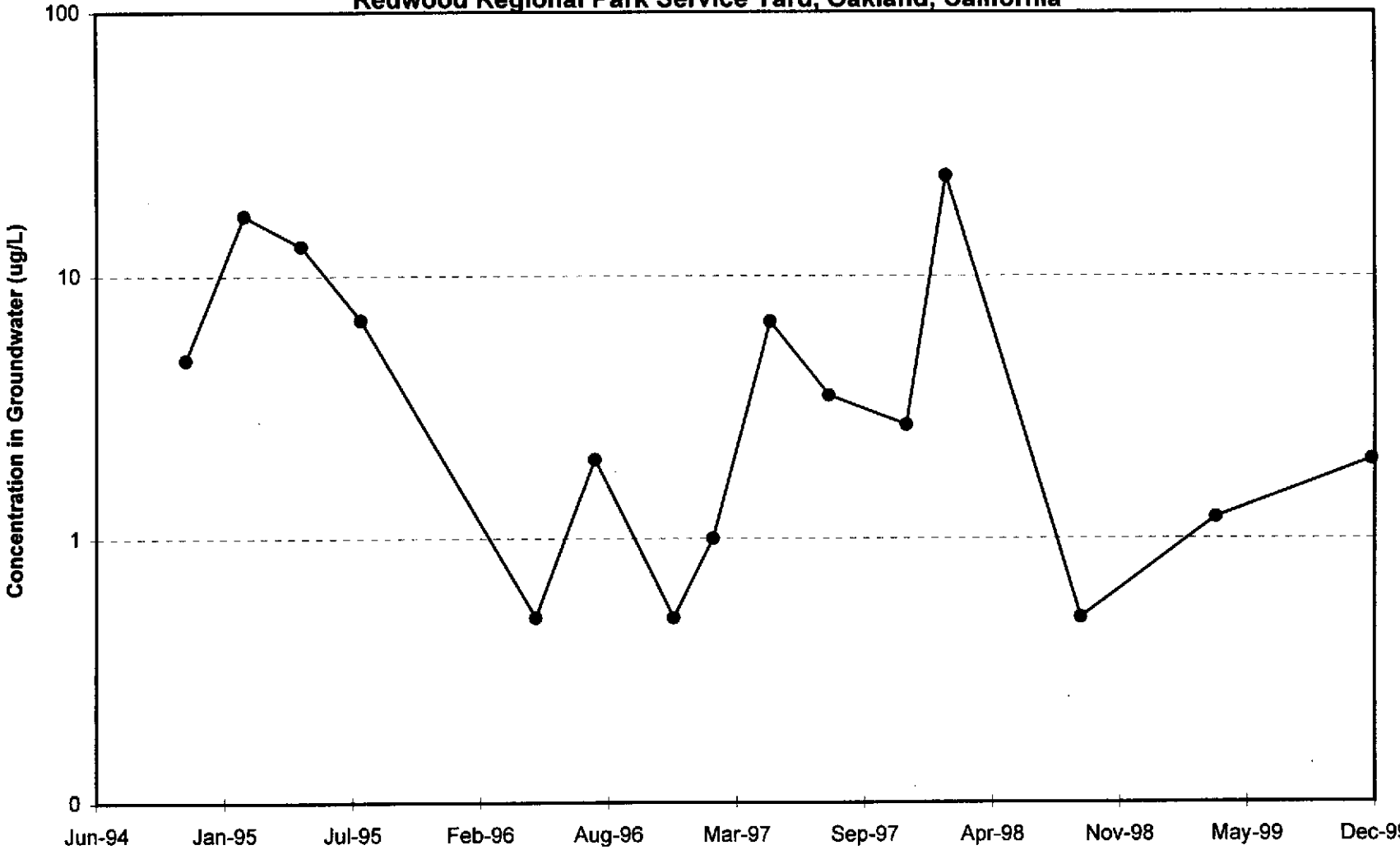
Historical Ground Water Analytical Results: Well MW-4
TPH-diesel
Redwood Regional Park Service Yard, Oakland, California



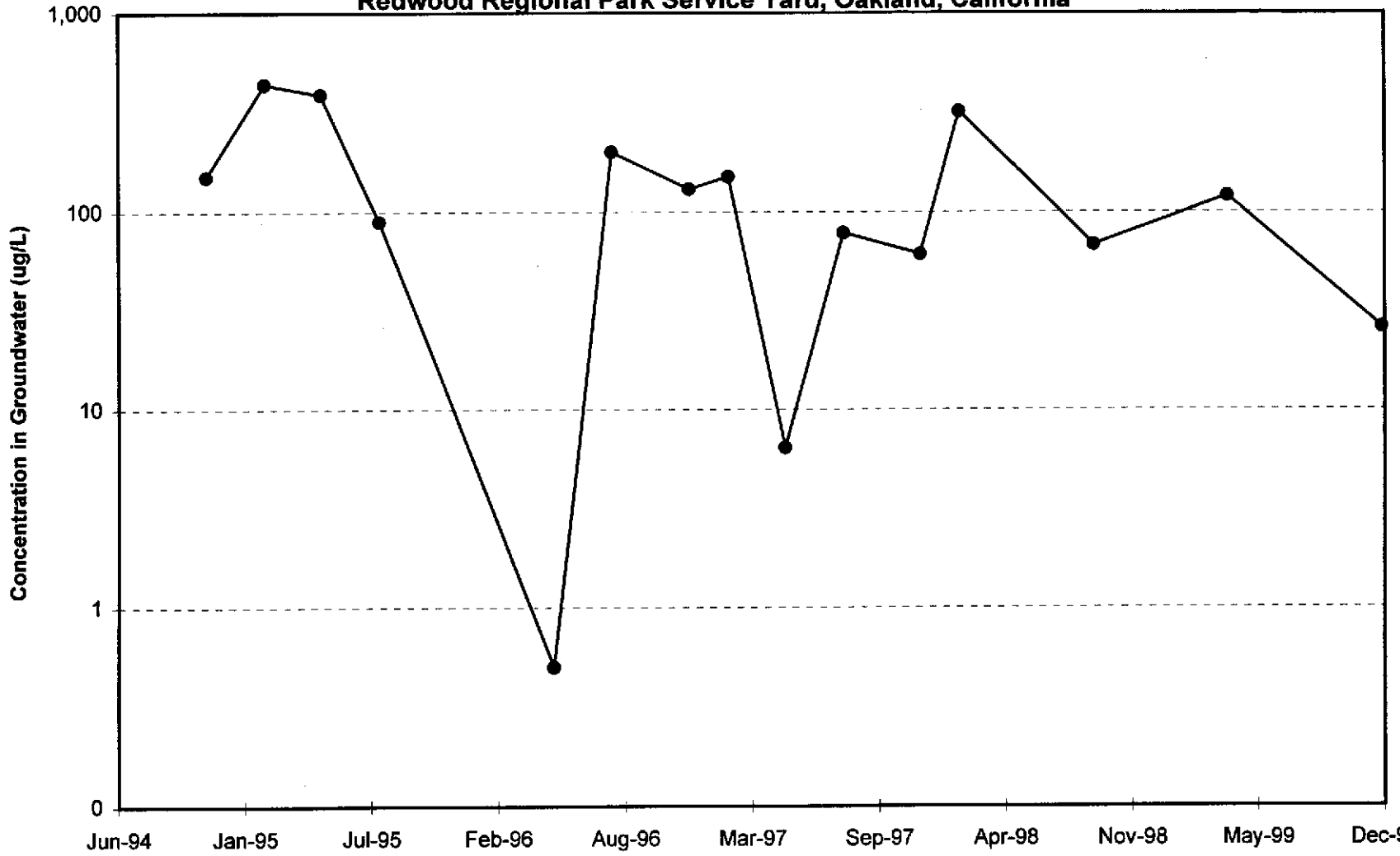
Historical Ground Water Analytical Results: Well MW-4
Benzene
Redwood Regional Park Service Yard, Oakland, California

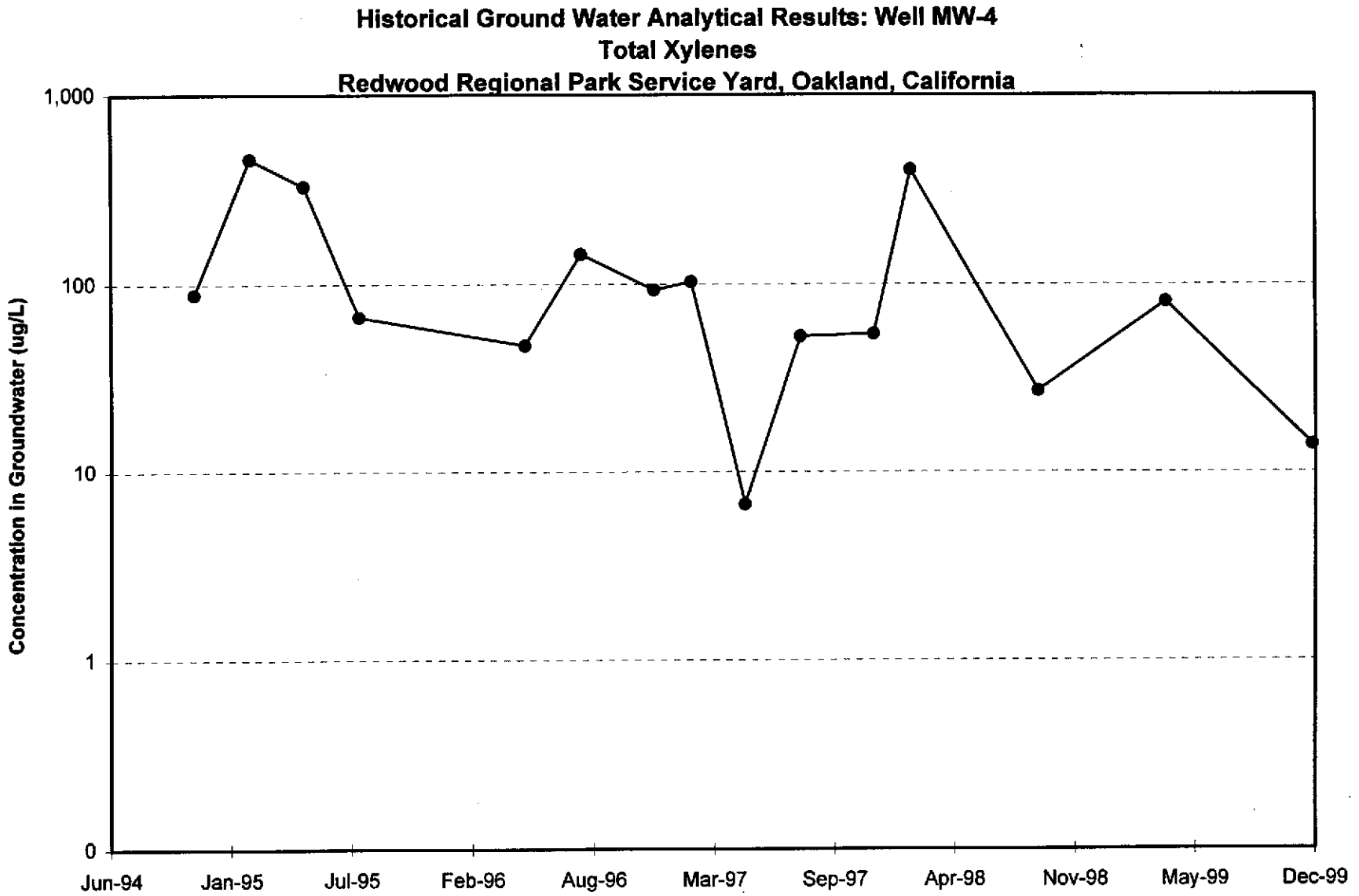


Historical Ground Water Analytical Results: Well MW-4
Toluene
Redwood Regional Park Service Yard, Oakland, California



Historical Ground Water Analytical Results: Well MW-4
Ethylbenzene
Redwood Regional Park Service Yard, Oakland, California




Historical Ground Water Analytical Results: Well MW-4
Total Xylenes
Redwood Regional Park Service Yard, Oakland, California
Concentration in Groundwater (ug/L)
1,000
100
10
1
0
Jun-94
Jan-95
Jul-95
Feb-96
Aug-96
Mar-97
Sep-97
Apr-98
Nov-98
May-99
Dec-99

CDFG Code

(2) A total allowable catch, reflecting the long-term yield each species is capable of sustaining, using the best available science and bearing in mind the ecological importance of the species and the variability of marine ecosystems.

(3) A permanent reduction in harvest.

(c) Funding to prepare the recovery and management plan and any planning and scoping meetings shall be derived from the fees collected for the abalone stamp.

(d) On or before January 1, 2008, and following the adoption of the recovery and management plan by the commission, the department may apply to the commission to reopen sport or commercial fishing in all or any portion of the waters described in Section 5521. If the commission makes a finding that the resource can support additional harvest activities and that these activities are consistent with the abalone recovery plan, all or a portion of the waters described in Section 5521 may be reopened and management measures prescribed and implemented, as appropriate. The commission may close or, where appropriate, may establish no-take marine refuges in any area opened pursuant to this section if it makes a finding that this action is necessary to comply with the abalone management plan.

(e) If the commission determines that commercial fishing is an appropriate management measure, priority for participation in the fishery shall be given to those persons who held a commercial abalone permit during the 1996-97 permit year.

(Added by Statutes 1997 Chap. 787)

CHAPTER 2. POLLUTION

Article 1. General

5650. Pollute Waters; Hazardous Substances List

(a) Except as provided in subdivision (b), it is unlawful to deposit in, permit to pass into, or place where it can pass into the waters of this state any of the following:

(1) Any petroleum, acid, coal or oil tar, lampblack, aniline, asphalt, bitumen, or residuary product of petroleum, or carbonaceous material or substance.

(2) Any refuse, liquid or solid, from any refinery, gas house, tannery, distillery, chemical works, mill, or factory of any kind.

(3) Any sawdust, shavings, slabs, or edgings.

(4) Any factory refuse, lime, or slag.

(5) Any cocculus indicus.

(6) Any substance or material deleterious to fish, plant life, or bird life.

(b) This section does not apply to a discharge or a release that is expressly authorized pursuant to ***, and in compliance with, the terms and conditions of a waste discharge requirement pursuant to Section 13263 of the Water Code or a waiver issued pursuant to subdivision (a) of Section 13269 of the Water Code issued by the State Water Resources Control Board or a regional water quality control board after a public hearing, or that is expressly authorized pursuant to, and in compliance with, the terms conditions of a federal permit *** for which the State Water Resources Control Board or a regional water quality control board has, after a public hearing, issued a water quality certification pursuant to Section 13160 of the Water Code. This section does not confer additional authority on the State Water Resources Control Board, a regional water quality control board, or any other entity.

(c) It shall be an affirmative defense to a violation of this section if the defendant proves, by a preponderance of the evidence, all of the following:

(1) The defendant complied with all applicable state and federal laws and regulations requiring that the discharge or release be reported to a government agency.

(2) The substance or material did not enter the waters of the state or a storm drain that discharges into the waters of the state.

(3) The defendant took reasonable and appropriate measures to effectively mitigate the discharge or release in a timely manner.

(d) The affirmative defense *** in subdivision (c) *** does not apply and may not be raised in an action for civil penalties or injunctive relief pursuant to Section 5650.1.

(e) The affirmative defense in subdivision (c) does not apply and may not be raised by any defendant who has on two prior occasions in the preceding five years, in any combination within the same county in which the case is prosecuted, either pleaded nolo contendere, been convicted of a violation of this section, or suffered a judgment for a violation of this section or Section 5650.1. This subdivision shall apply only to cases filed on or after January 1, 1997.

(f) The affirmative defense in subdivision (c) does not apply and may not be raised by the defendant in any case in which a district attorney, city attorney, or Attorney General alleges and the court finds, that the defendant acted willfully.

(Amended Statutes 1997 Chap. 766)

5650.1. Water Pollution - Civil Penalties

(a) Every person who violates Section 5650 is subject to a civil penalty of not more than twenty-five thousand dollars ($25,000) for each violation.

(b) The civil penalty imposed for each separate violation pursuant to this section is separate, and in addition to, any other civil penalty imposed for a separate violation pursuant to this section or any other provision of law.

(c) In determining the amount of any civil penalty imposed pursuant to this section, the court shall take into consideration all relevant circumstances, including, but not limited to the nature, circumstance, extent, and gravity of the violation. In making this determination the court shall consider the degree of toxicity and volume of the discharge, the extent of harm caused by the violation, whether the effects of the violation may be reversed or mitigated and with respect to the defendant, the ability to pay, the effect of any civil penalty on the ability to continue in business, any voluntary cleanup efforts undertaken, any prior history of violations, the gravity of the behavior, the economic benefit, if any, resulting from the violation, and any other matters the court determines justice may require.

(d) Every civil action brought under this section shall be brought by the Attorney General upon complaint by the department, or by the district attorney or city attorney in the name of the people of the State of California, and any actions relating to the same violation may be joined or consolidated.

(e) In any civil action brought pursuant to this chapter in which a temporary restraining order, preliminary injunction, or permanent injunction is sought, it is not necessary to allege or prove at any stage of the proceeding that irreparable damage will occur if the temporary restraining order, preliminary injunction, or permanent injunction is not issued, or that the remedy at law is

inadequate.

(f) After the party seeking the injunction has met its burden of proof, the court shall determine whether to issue a temporary restraining order, preliminary injunction, or permanent injunction without requiring the defendant to prove that it will suffer grave or irreparable harm. The court shall make the determination whether to issue a temporary restraining order, preliminary injunction, or permanent injunction by taking into consideration, among other things, the nature, circumstance, extent, and gravity of the violation, the quantity and characteristics of the substance or material involved, the extent of environmental harm caused by the violation, measures taken by the defendant to remedy the violation, the relative likelihood that the material or substance involved may pass into waters of the state, and the harm likely to be caused to the defendant.

(g) The court, to the maximum extent possible, shall tailor any temporary restraining order, preliminary injunction, or permanent injunction narrowly to address the violation in

Bioassessment Report of Findings

Aquatic Bioassessment Laboratory
California Department of Fish and Game
2005 Nimbus Road
Rancho Cordova, CA 95670

April 18, 2000

Bruce Rucker
Stellar Environmental Solutions
2198 6th Street, Suite 201
Berkeley, CA 94710

Dear Bruce:

I am enclosing a copy of our bioassessment report for our January 2000 sampling of macroinvertebrate communities in Redwood Creek, Alameda County. If you have any questions please contact me at (pode@ospr.dfg.ca.gov).

Sincerely,

Peter Ode

Peter Ode

A WATER QUALITY INVENTORY SERIES
BIOLOGICAL AND PHYSICAL/ HABITAT ASSESSMENT OF
CALIFORNIA WATER BODIES

Redwood Creek, Alameda County
January 2000 Bioassessment

California Department of Fish and Game
Office of Spill Prevention and Response
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INTRODUCTION

In February 1999, the California Department of Fish and Game's Aquatic Bioassessment Laboratory (ABL) was contracted by Stellar Environmental Solutions to assess the impact of groundwater flow from an underground petroleum storage tank on the invertebrate riffle community in Redwood Creek within Redwood Regional Park, Alameda County. Although the storage tank was removed several years ago, low concentration petrochemical groundwater discharge continues to enter Redwood Creek. DFG's Region III water quality biologist has requested that the stream invertebrate community be monitored to assess the impact of the discharge to Redwood Creek.

The California Stream Bioassessment Procedure (CSBP), developed by the California Department of Fish and Game (DFG), was used to evaluate the benthic macroinvertebrate communities in Redwood Creek (Harrington 1996). The CSBP is a regional adaptation of the U.S. Environmental Protection Agency (EPA) Rapid Bioassessment Protocols (Plafkin et al. 1989) and is recognized by the EPA as California's standardized bioassessment procedure (Davis et al. 1996).

The CSBP is a cost effective tool that utilizes measures of the stream's benthic macroinvertebrate (BMI) community and its physical/ habitat structure. BMIs can have a diverse community structure with individual species residing within the stream for a period of months to several years. They are also sensitive, in varying degrees, to temperature, dissolved oxygen, sedimentation, scouring, nutrient enrichment and chemical and organic pollution (Resh and Jackson 1993). Together, biological and physical assessments integrate the effects of water quality over time, are sensitive to multiple aspects of water and habitat quality, and provide the public with more familiar expressions of ecological health (Gibson 1996).

Samples were collected in April 1999 and January 2000. This report presents results from samples collected in January 2000; a prior report presents the results of the April 1999 sampling event.

MATERIALS AND METHODS

Monitoring Reach Descriptions

Monitoring reach descriptions are summarized in Table 1. The two uppermost riffles and the downstream riffle (RC-U1, RC-U2 and RC-D1) were similar in gradient and substrate types. The area sampled within the groundwater discharge zone had a steeper gradient and much less available habitat for macroinvertebrates than the other three sites. Despite the differences in habitat type, this was the best macroinvertebrate habitat present within the area of influence of the groundwater discharge.

Benthic Macroinvertebrate Sampling

BMIs were sampled on 27 January 2000 from four riffles in Redwood Creek within the boundaries of Redwood Regional Park.

Table 1. Benthic macroinvertebrate sampling location information for reaches sampled within Redwood Creek.

Stream Name	Location Description	Site ID	Latitude/ Longitude
Redwood Creek	300 Meters Upstream of Groundwater Discharge Zone	**RC-U1**	N37°48' 13.0", W122° 08' 39.0"
Redwood Creek	200 Meters Upstream of Groundwater Discharge Zone	**RC-U2**	N37°48' 13.0", W122° 08' 39.0"
Redwood Creek	3 Meters Downstream of Contaminated Groundwater Discharge Zone, Below Fish Ladder	**RC-GZ**	N37°48' 13.0", W122° 08' 39.0"
Redwood Creek	50 Meters Downstream of Groundwater Discharge Zone	**RC-D1**	N37°48' 13.0", W122° 08' 39.0"

Riffle length was determined for each riffle and a random number table was used to establish a point randomly along the upstream third of the riffle from which a transect was established perpendicular to the stream flow. Starting with the transect at the lowermost riffle, the benthos within a 2 ft^2 area was disturbed upstream of a 1 ft wide, 0.5 mm mesh D-frame kick-net.

Sampling of the benthos was performed manually by rubbing cobble and boulder substrates in front of the net followed by "kicking" the upper layers of substrate to dislodge any invertebrates remaining in the substrates. The duration of sampling ranged from 60-120 seconds, depending on the amount of boulder and cobble-sized substrates that required rubbing by hand; more and larger substrates required more time to process. Three locations representing the habitats along the transect were sampled and combined into a composite sample (representing a six ft^2 area). This composite sample was transferred into a 500 ml wide-mouth plastic jar containing approximately 200 ml of 95% ethanol. This technique was repeated for each of three riffles in each reach.

Physical Habitat Quality Assessment

Physical habitat quality was assessed for the monitoring reaches using U.S. Environmental Protection Agency (EPA) Rapid Bioassessment Protocols (RBPs) (Barbour *et al.* 1997). Habitat quality assessments were recorded for each monitoring reach during each sampling event. Photographs were taken within each of the monitoring reaches to document overall riffle condition at the time of sampling.

BMI Laboratory Analysis

At the laboratory, each sample was rinsed through a No. 35 standard testing sieve (0.5 mm brass mesh) and transferred into a tray marked with twenty, 25 cm^2 grids. All detritus was removed from one randomly selected grid at a time and placed in a petri dish for inspection under a stereomicroscope. All invertebrates from the grid were separated from the surrounding detritus and transferred to vials containing 70% ethanol and 5% glycerol. This process was continued until 300 organisms were removed from each sample. The material left from the processed grids was transferred into a jar with 70% ethanol and labeled as "remnant" material. Any remaining

unprocessed sample from the tray was transferred back to the original sample container with 70% ethanol and archived. Macroinvertebrates were then identified to a standard taxonomic level, typically genus level for insects and order or class for non-insects using standard taxonomic keys (Brown 1972, Edmunds et al. 1976, Klemm 1985, Merritt and Cummins 1995, Pennak 1989, Stewart and Stark 1993, Surdick 1985, Thorp and Covich 1991, Usinger 1963, Wiederholm 1983, 1986, Wiggins 1996, Wold 1974).

Data Analysis

A taxonomic list of benthic macroinvertebrates identified from the samples was entered into a Microsoft Excel® spreadsheet program. Excel® was used to calculate and summarize macroinvertebrate community based metric values. A description of the metric values used to describe the community is shown in Table 2.

Quality Assessment/ Quality Control

Standard laboratory quality assessment procedures were applied to the BMI samples. Ten percent of remnant samples were re-picked to assess complete sorting of material. A voucher collection of all taxa was verified by the ABL chief taxonomist.

RESULTS

Dominant BMI Taxa/ General Taxonomic Notes

The five dominant taxa observed in each of the monitoring reaches are presented in Table 3. A complete list of macroinvertebrates identified from the samples is presented in Appendix 1.

The BMI communities were very similar in the four riffles sampled. The capniid stonefly, *Boshecapnia/ Mesocapnia* (Plecoptera: Capniidae) was extremely abundant, contributing between 56 and 72 percent of the organisms at each site. Mayflies were uncommon in this sampling event and the minnow mayfly, *Baetis sp.* (Ephemeroptera: Baetidae), which was extremely abundant in the April 1999 samples was present at all sites, but uncommon. The shredding caddisfly, *Lepidostoma sp.* (Trichoptera: Lepidostomatidae) was common at all sites. There were very few non-insect taxa present at any site (except for undetermined worm taxa) and beetles were rare at all sites.

Benthic Macroinvertebrate Community Metrics

BMI metric values are presented by transect in Table 4 and summarized by reach mean and coefficient of variation in Table 5.

Richness

BMI richness metrics were comparable among the all riffles, averaging 16-23 taxa per replicate and 7-12 EPT taxa per replicate. Cumulative taxa richness and Cumulative EPT taxa richness were also comparable among the four sites although the upper sites had somewhat fewer taxa in the sensitive Ephemeroptera, Plecoptera and Trichoptera taxa (11 vs. 15 and 18).

Composition Measures

The Percent Dominant Taxa metric was very high at all sites due to the extreme abundance of the stonefly *Bolshecapnia/ Mesocapnia,* which made up 57 to 72 percent of the organisms in each sample. Due to the extreme abundance of this stonefly, Shannon Diversity values were low at all

Table 4. Macroinvertebrate community metric values calculated for samples collected January 27, 2000 from riffles in Redwood Creek, Alameda Co., California.

	Redwood Creek											
	100m Below Plume			At Plume			200m Above Plume			300m Above Plume		
	RC-D1			RC-GZ			RC-U2			RC-U1		
ABL Number:	3818	3819	3820	3821	3822	3823	3824	3825	3826	3827	3828	3829
Taxa Richness	22	16	25	23	23	16	17	16	17	16	20	24
Percent Dominant Taxon	55	66	49	70	69	76	51	65	56	79	61	56
Ephemeropteran Taxa	3	5	5	3	4	4	3	2	2	3	2	2
Plecopteran Taxa	2	2	7	4	4	2	3	2	4	1	3	4
Trichopteran Taxa	5	4	4	4	4	3	3	2	3	3	2	2
EPT Taxa	10	11	16	11	12	9	9	6	9	7	7	8
EPT Index (%)	68	85	74	87	86	88	74	79	72	88	77	76
Sensitive EPT Index	64	82	68	83	82	84	72	78	72	86	77	75
Dipteran Taxa	7	3	5	7	6	3	5	5	3	5	8	11
Percent Dipteran	8	3	7	10	9	8	16	6	7	7	14	12
Non-Insect Taxa	2	2	2	1	3	4	2	3	4	3	3	3
Percent Non-Insect	23	12	15	1	4	4	10	15	20	5	8	11
Percent Chironomidae	5	2	1	8	9	7	11	3	4	4	9	2
Shannon Diversity	1.5	1.3	2.0	1.4	1.4	1.1	1.7	1.3	1.6	1.0	1.6	1.8
Tolerance Value	3.1	2.1	2.7	1.7	1.8	1.7	2.3	2.2	2.6	1.6	2.1	2.1
Percent Intolerant (0-2)	62	79	63	82	83	84	72	78	71	85	77	75
Percent Tolerant (8-10)	23	11	11	1	3	2	9	14	16	4	6	10
Percent Collectors	31	16	20	11	14	12	22	17	20	9	13	14
Percent Filterers	0	0	0	3	1	2	0	0	0	1	3	1
Percent Grazers	1	2	4	3	4	2	4	3	6	3	6	8
Percent Predators	5	4	12	5	5	5	9	4	9	4	14	19
Percent Shredders	63	79	64	79	76	79	65	75	65	83	65	59
Abundance (#/ sample)	732	707	874	909	328	525	266	1012	447	508	492	374

Table 5. Means and coefficients of variation (CV) calculated from samples collected on 27 January 2000 from riffles in Redwood Creek, Alameda Co., California.

Redwood Creek

	100m Below Plume		At Plume		200m Above Plume		300m Above Plume	
	Mean	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**
Taxa Richness	21	22	21	20	17	3	20	20
Cumulative Taxa	33		33		25		33	
Percent Dominant Taxon	57	15	72	5	57	13	65	19
Ephemeropteran Taxa	4	27	4	16	2	25	2	25
Plecopteran Taxa	4	79	3	35	3	33	3	57
Trichopteran Taxa	4	13	4	16	3	22	2	25
EPT Taxa	12	26	11	14	8	22	7	8
Cumulative EPT Taxa	18		15		11		11	
EPT Index (%)	76	12	87	1	75	4	80	8
Sensitive EPT Index	71	13	83	1	74	5	79	7
Dipteran Taxa	5	40	5	39	4	27	8	38
Percent Dipteran	6	45	9	14	10	58	11	33
Non-Insect Taxa	2	0	3	57	3	33	3	0
Percent Non-Insect	17	35	3	50	15	36	8	42
Percent Chironomidae	3	65	8	9	6	76	5	62
Shannon Diversity	1.6	22	1.3	12	1.5	14	1.5	27
Tolerance Value	2.6	21	1.7	2	2.4	8	2.0	14
Percent Intolerant (0-2)	68	14	83	1	74	5	79	7
Percent Tolerant (8-10)	15	46	2	41	13	26	7	50
Percent Collectors	22	36	12	12	20	13	12	23
Percent Filterers	0	3	2	48	0	7	1	85
Percent Grazers	2	64	3	31	4	32	5	39
Percent Predators	7	68	5	2	7	37	12	60
Percent Shredders	69	13	78	2	68	9	69	18
Abundance (#/ sample)	771	12	588	50	575	68	458	16

Table 2. Bioassessment metrics used to describe characteristics of the benthic macroinvertebrate(BMI) community at sampling reaches within Redwood Creek, Alameda Co., California.

BMI Metric	Description	Response to Impairment
Richness Measures		
Taxa Richness	Number of individual taxa collected from each replicate sampling transect	decrease
EPT Taxa	Number of taxa in the Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) insect orders collected from each replicate sample	decrease
Cumulative Taxa	Total number of individual taxa collected from each site	decrease
Cumulative EPT Taxa	Total number of taxa in the Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) insect orders collected at each site	decrease
Composition Measures		
EPT Index	Percent composition of mayfly, stonefly and caddisfly larvae	decrease
Sensitive EPT Index	Percent composition of mayfly, stonefly and caddisfly larvae with tolerance values between 0 and 3	decrease
Shannon Diversity Index	General measure of sample diversity that incorporates richness and evenness (Shannon and Weaver 1963)	decrease
Tolerance/Intolerance Measures		
Tolerance Value	Value between 0 and 10 weighted for abundance of individuals designated as pollution tolerant (higher values) or intolerant (lower values)	increase
Percent Dominant Taxon	Percent composition of the single most abundant taxon	increase
Percent Intolerant Organisms	Percent of organisms in sample that are highly intolerant to impairment as indicated by a tolerance value of 0, 1 or 2	decrease
Percent Tolerant Organisms	Percent of organisms in sample that are highly tolerant to impairment as indicated by a tolerance value of 8, 9 or 10	increase
Functional Feeding Groups (FFG)		
Percent Collectors (c)	Percent of macrobenthos that collect or gather fine particulate matter	increase
Percent Filterers (f)	Percent of macrobenthos that filter fine particulate matter	increase
Percent Grazers (g)	Percent of macrobenthos that graze upon periphyton	variable
Percent Predators (p)	Percent of macrobenthos that feed on other organisms	variable
Percent Shredders(s)	Percent of macrobenthos that shreds coarse particulate matter	decrease
Abundance		
Estimated Abundance	Estimated number of macroinvertebrates in sample calculated by extrapolating from the proportion of organisms counted in the subsample	variable

Table 3. Dominant macroinvertebrate taxa (and their percent contribution) by reach from samples collected from sites within Redwood Creek.

Sample Location	Dominant Taxa				
	1	2	3	4	5
300 Meters Upstream of Groundwater Discharge Zone (RC-U1)	*Bolshecapnia/ Mesocapnia* (56)	Oligochaeta (15)	*Lepidostoma* (3)	*Gumaga* (3)	*Paraleptophlebia* (3)
200 Meters Upstream of Groundwater Discharge Zone (RC-U2)	*Bolshecapnia/ Mesocapnia* (72)	Orthocladiinae (5)	*Lepidostoma* (5)	*Baetis* (3)	Oligochaeta (2)
Groundwater Discharge Zone (RC-GZ)	*Bolshecapnia/ Mesocapnia* (58)	Oligochaeta (13)	*Lepidostoma* (10)	*Orthocladiinae* (5)	*Rhyacophila* (2)
50 Meters Downstream of Groundwater Discharge Zone (RC-D1)	*Bolshecapnia/ Mesocapnia* (65)	Oligochaeta (7)	*Rhyacophila* (6)	Orthocladiinae (4)	*Lepidostoma* (3)

sites, ranging from 1.3 to 1.6. The majority of the diversity was comprised of the generally disturbance intolerant insect orders, Ephemeroptera, Plecoptera and Trichoptera, which were responsible for 21 of the 58 taxa found in Redwood Creek.

Tolerance Measures

Tolerance measures indicated communities that were only moderately tolerant to disturbance, but these metrics were driven largely by the abundance of the capniid stonefly *Bolshecapnia/ Mesocapnia* (tolerance value 1). Average tolerance values ranged between 4.2 to 4.5. When *Baetis* was removed from the analysis, the remaining communities were primarily composed of intolerant taxa; these intolerant taxa were responsible for two thirds of the remaining diversity.

Functional Feeding Groups

All of the FFGs were present within Redwood Creek, but filter-feeding organisms were encountered only rarely in a few sites (Table 5). The extreme abundance of the coarse particulate organic matter (CPOM) shredding stonefly *Bolshecapnia/ Mesocapnia* was the dominant feature of the community. The shredding caddisfly, *Lepidostoma sp.* (Trichoptera: Lepidostoma) was also common at all sites. The remainder of the community was dominated by fine particulate organic matter (FPOM) collectors.

Abundance
Mean abundance of organisms was moderate to low at all sites, ranging between 450 and 780 organisms per sample. Abundance did not vary substantially among the sites sampled.

Physical Habitat Assessment
Physical habitat quality scores are summarized in Table 6.

All riffles scored in the "good" range of the physical habitat measures, none of the sites had notable impaired physical habitat. The upstream riffles had very similar substrates to the downstream riffle, but had slightly lower gradient and were more affected by sediment than the downstream riffle. The sampling area within the influence of the groundwater discharge was considerably less suitable for macroinvertebrate diversity, primarily because the amount of appropriate substrate was much lower than it was in the other riffles. The distribution of suitable cobble and gravel was limited to small pockets in depositional areas behind large boulders.

Quality Assessment/ Quality Control
All quality assurance measures indicate that all laboratory analyses were performed within acceptable error limits. All QA/ QC data are available upon request from the ABL.

Conclusions/ Summary

These data provide no evidence of any influence of groundwater discharge from the excavated petroleum storage tank on the macroinvertebrate communities in the reaches of Redwood Creek that were sampled for this report. The BMI communities collected in January 2000 are indicative of normal conditions during the winter rain season.

The macroinvertebrate community we found in Redwood Creek is typical of ephemeral coastal range streams. The extreme abundance of the winter stonefly, *Bolshecapnia/ Mesocapnia,* had a strong impact on many of the bioassessment metrics, obscuring the otherwise well-balanced community. The dominant effect of *Bolshecapnia/ Mesocapnia* was most likely an artifact of the winter sampling season in which CPOM-shredding taxa like *Bolshecapnia/ Mesocapnia* and *Lepidostoma sp.* can dominate riffle communities.

These results taken with the results of the April 1999 sampling event indicate no adverse effect of the groundwater discharge on the macroinvertebrate communities in Redwood Creek.

Table 6. Physical habitat quality scores for sampling reaches within Redwood Creek. Scores for each habitat parameter range from 0 (poor) to 20 (excellent).

Habitat Parameter	Redwood Creek January 2000			
	RC-U1	RC-U2	RC-GZ	RC-D1
1. Instream Cover	12	8	13	14
2. Embeddedness	8	4	8	5
3. Velocity/ Depth Regimes	12	10	13	12
4. Sediment Deposition	8	6	14	13
5. Channel Flow	12	12	18	18
6. Channel Alteration	20	20	15	20
7. Riffle Frequency	13	14	12	16
8. Bank Vegetation	16	12	15	16
9. Bank Stability	15	12	16	15
10. Riparian Zone	16	15	14	17
TOTAL	**132**	**113**	**138**	**143**
Physical Condition	**good**	**good**	**good**	**good**

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APPENDIX 1

Taxonomic list of benthic macroinvertebrates identified from samples collected on 27 January 2000 from monitoring reaches within Redwood Creek

Redwood Creek

	TV	FFG	100m Below Plume RC-D1			At Plume RC-GZ			200m Above Plume RC-U2			300m Above Plume RC-U1		
			3818	3819	3820	3821	3822	3823	3824	3825	3826	3827	3828	3829
PHYLUM ARTHROPODA														
Class Insecta														
Coleoptera (Adults)														
Hydraenidae														
Hydraena sp.	5	g	-	-	-	-	-	-	1	1	-	-	-	-
Hydrophilidae														
Ametor sp.	5	c	-	-	-	1	-	-	-	-	-	-	-	-
Coleoptera (Larvae)														
Elmidae														
Narpus sp.	4	c	1	-	3	-	-	-	-	-	-	-	1	-
Optioservus sp.	4	g	-	-	6	1	1	-	-	1	-	2	-	-
Diptera														
Ceratopogonidae														
Atrichopogon sp.	6	c	-	-	1	-	-	-	-	-	-	-	-	-
Bezzia/ Palpomyia	6	p	6	2	16	3	-	1	3	4	8	2	8	8
Probezzia sp.	6	p	-	-	-	1	-	-	-	-	-	-	-	-
Stilobezzia sp.	6	p	-	-	-	-	-	-	-	-	-	-	-	2
Chironomidae														
Chironominae														
Chironomini	6	c	1	-	-	3	1	-	-	-	-	-	-	1
Tanytarsini	6	f	1	1	1	8	3	5	1	1	1	2	8	2
Orthocladiinae	5	c	11	5	3	11	18	16	28	7	11	10	16	4
Podonominae														
Parochlus sp.	6	c	-	-	-	-	1	-	-	-	-	-	-	-
Tanypodinae	6	p	1	-	-	1	1	-	-	-	-	-	1	-
Undetermined	6	c	-	-	1	-	-	-	-	-	-	-	-	-
Dolichopodidae	4	p	-	-	-	-	-	-	-	-	-	-	-	1
Empididae														
Chelifera sp.	6	p	1	-	-	-	1	-	-	-	-	-	-	-
Ephydridae	6	c	-	-	-	-	-	-	-	-	-	1	1	-
Scathophagidae		s	-	-	-	-	-	-	-	1	-	-	-	-
Tipulidae														
Hexatoma sp.	2	p	-	-	-	-	-	-	-	-	-	-	2	1
Holorusia sp.	5	s	-	-	-	-	-	-	-	-	-	-	-	1
Limonia sp.	6	s	1	-	-	-	-	-	-	-	-	-	-	-
Molophilus sp.	3	s	-	-	-	-	-	-	-	-	-	-	-	1
Rhabdomastix sp.	3	p	-	-	-	1	-	-	8	4	-	4	3	12
Tipula sp.	4	s	-	-	-	-	-	-	-	-	-	-	1	1
Undetermined Diptera	3	s	-	-	-	-	-	-	1	-	-	-	-	-
Megaloptera														
Corydalidae														
Neohermes sp.	0	p	1	-	-	-	1	-	-	-	-	-	-	-
Sialidae														
Sialis sp.	4	p	1	-	-	1	-	-	-	-	-	-	-	1
Lepidoptera														
Nepticulidae														
Stigmella sp.	5	s	-	-	-	1	-	-	-	-	1	-	2	1
Ephemeroptera														
Ameletidae														
Ameletus sp.	0	g	1	3	1	5	5	3	3	4	9	5	2	15
Baetidae														
Baetis sp.	5	c	-	2	7	10	8	11	5	2	2	4	2	-
Ephemerellidae														
Drunella sp.	0	g	-	-	1	-	1	-	1	-	-	-	-	-
Heptageniidae														
Cinygmula sp.	4	g	1	1	1	-	-	-	-	-	-	1	-	-
Ironodes sp.	4	g	-	1	-	-	-	1	-	-	-	-	-	-
Leptophlebidae														
Paraleptophlebia sp.	4	c	11	6	10	1	1	1	-	-	-	-	-	4
Plecoptera														
Capniidae														
Bolshecapnia/ Mesocapnia	1	s	160	185	145	197	193	220	131	188	166	215	174	161
Undetermined	1	s	-	-	5	-	-	-	-	-	-	-	-	-
Chloroperlidae														
Haploperla chilnualna	1	p	1	2	1	1	-	-	1	-	-	-	2	1
Sweltsa sp.	1	p	-	-	1	-	1	-	-	-	-	-	-	-

Redwood Creek

	TV	FFG	100m Below Plume RC-D1			At Plume RC-GZ			200m Above Plume RC-U2			300m Above Plume RC-U1		
			3818	3819	3820	3821	3822	3823	3824	3825	3826	3827	3828	3829
Leuctridae														
Despaxia augusta	0	s	-	-	1	-	-	-	-	-	-	-	-	-
Nemouridae														
Malenka sp.	2	s	-	-	-	1	1	-	-	-	-	-	-	-
Perlodidae														
Osobenus yakimae	2	p	-	-	-	-	-	-	-	-	1	-	-	3
Undetemined	1	s	-	-	2	-	-	-	-	-	2	-	-	-
Taeniopterygidae														
Taenionema sp.	2	g	-	-	2	2	5	3	5	3	5	-	13	7
Trichoptera														
Goeridae														
Goerita sp.	0	s	1	2	5	3	2	2	-	-	-	-	-	-
Lepidostomatidae														
Lepidostoma sp.	1	s	16	27	16	15	16	9	34	29	20	9	9	6
Polycentropodidae														
Polycentropus sp.	6	p	-	-	-	-	2	-	-	-	-	-	-	-
Rhyacophilidae														
Rhyacophila sp.	0	p	2	4	6	6	6	6	10	2	7	3	20	24
Sericostomatidae														
Gumaga sp.	3	s	5	7	16	3	-	-	1	-	1	1	-	-
Uenoidae														
Neophylax sp.	3	g	1	-	-	-	-	-	-	-	-	-	-	-
Subphylum Chelicerata														
Class Arachnoidea														
Acari														
Hygrobatidae	5	p	-	-	-	-	-	-	-	1	-	-	-	-
Subphylum Crustacea														
Class Copepoda														
Calanoida														
Cyclopoida														
Cyclopidae	8	c	-	-	-	-	1	1	-	-	-	-	-	-
Class Malacostraca														
Amphipoda														
Cragonyctidae														
Stygobromus sp.	4	c	-	-	-	-	-	-	-	-	-	-	-	1
Class Ostracoda														
Ostracoda														
Cyprididae	8	c	-	-	-	-	-	1	-	-	-	-	-	-
PHYLUM MOLLUSCA														
Class Gastropoda														
Subclass Pulmonata														
Lymnaeidae	6	g	-	-	-	-	-	-	-	-	3	-	1	-
Planorbidae														
Gyraulus sp.	8	g	-	-	-	-	-	-	-	-	-	1	-	-
PHYLUM NEMATODA	5	p	1	2	12	-	2	7	1	-	9	3	3	2
Class Turbellaria														
Tricladida														
Planariidae	4	p	-	-	-	-	-	-	-	1	1	-	-	-
PHYLUM ANNELIDA														
Class Oligochaeta	8	c	67	31	33	4	8	4	24	40	47	9	18	30

Total Bugs Recovered				292	281	296	280	279	291		258	289	294		272	287	290	
Total Extra Bugs				1	2	69	41	0	16		9	15	4		15	43	22	
Bugs Picked (includes extra bugs)				301	302	369	341	300	316		309	315	304		315	343	322	
Grids Processed				8	8	5	7	17	7		20	6	8		9	8	10	
Total Grids Possible				20	20	12	20	20	12		20	20	12		16	12	12	
Sorted				284	295	295	291	293	297		292	292	290		286	291	291	
Discards				6	13	0	4	2	2		2	1	0		3	0	3	
Abundance (#/ sample)				732	707	874	909	328	525		266	1012	447		508	492	374	

WELL GAUGING DATA

Project # 991220 R-1 Date 12-20-99 Client Stellar Environmental

Site Redwood Reg. Park Oakland, ca

Well ID	Well Size (in.)	Sheen / Odor	Depth to Immiscible Liquid (ft.)	Thickness of Immiscible Liquid (ft.)	Volume of Immiscibles Removed (ml)	Depth to water (ft.)	Depth to well bottom (ft.)	Survey Point: TOB or TOC	
MW-1	4					3.00	18.00		
MW-2	4					21.80	36.00		
MW-3	4					19.44	42.00		
MW-4	4	odor				13.21	26.00		
MW-5	4					16.34	26.00		
MW-6	4					13.38	26.00		

WELL MONITORING DATA SHEET

Project #: 991220R-1	Client: Stellar Environmental
Sampler: SR	Start Date: 12-20-99
Well I.D.: MW-1	Well Diameter: 2 3 (4) 6 8 ___
Total Well Depth: 18.00	Depth to Water: 3.00
Before: After:	Before: After:
Depth to Free Product:	Thickness of Free Product (feet):
Referenced to: (PVC) Grade	D.O. Meter (if req'd): (YSI) HACH

Purge Method: Bailer / Disposable Bailer / Middleburg / Electric Submersible / Extraction Pump / Other: ___

Sampling Method: Bailer / (Disposable Bailer) / Extraction Port / Other: ___

___ (Gals.) X ___ = ___ Gals.
1 Case Volume | Specified Volumes | Calculated Volume

Well Diameter	Multiplier	Well Diameter	Multiplier
2"	0.16	5"	1.02
3"	0.37	6"	1.47
4"	0.65	Other	radius² * 0.163

Time	Temp (°F)	pH	Cond.	Turbidity	Gals. Removed	Observations
10:05	54.1	6.6	877	7200	—	Pre-purge
						Ferrous Iron
	* No purge / Grab sample					0.0 mg.

Did well dewater? Yes (No) — Gallons actually evacuated: /

Sampling Time: ~~10:10~~ — Sampling Date: ~~12-20-99~~ Cancelled

Sample I.D.: MW-1 — Laboratory: ~~Curtis & Tompkins~~

Analyzed for: TPH-G (BTEX) MTBE (TPH-D) Other: ~~Nitrate & Sulfate~~, TVH

Equipment Blank I.D.: @ Time — Duplicate I.D.:

Analyzed for: TPH-G BTEX MTBE TPH-D Other:

D.O. (if req'd): (Pre-purge): ___ mg/L — Post-purge: ___ mg/L

ORP (if req'd): (Pre-purge): ___ mV — Post-purge: ___ mV

WELL MONITORING DATA SHEET

Project #: 99120 R-1	Client: Stellar Environmental
Sampler: JR	Start Date: 12-20-99
Well I.D.: MW-2	Well Diameter: 2 3 (4) 6 8 ___
Total Well Depth: 36.00	Depth to Water: 21.80
Before: After:	Before: After:
Depth to Free Product:	Thickness of Free Product (feet):
Referenced to: (PVC) Grade	D.O. Meter (if req'd): (YSI) HACH

Purge Method: Bailer / Disposable Bailer / Middleburg / (Electric Submersible) / Extraction Pump / Other: ___

Sampling Method: Bailer / (Disposable Bailer) / Extraction Port / Other: ___

9.2 (Gals.) X 3 = 27.6 Gals.
1 Case Volume | Specified Volumes | Calculated Volume

Well Diameter	Multiplier	Well Diameter	Multiplier
2"	0.16	5"	1.02
3"	0.37	6"	1.47
4"	0.65	Other	radius^2 * 0.163

Time	Temp (°F)	pH	Cond.	Turbidity	Gals. Removed	Observations
11:10	60.1	6.9	858	103.4	9.5	Pre purge
11:12	59.1	7.0	847	>200	19	ferrous Iron
11:14	59.2	7.0	831	>200	28	0.0 mg

Did well dewater? Yes (No) Gallons actually evacuated: 28

Sampling Time: 11:20 Sampling Date: 12-20-99

Sample I.D.: MW-2 Laboratory: Curtis Tompkins

Analyzed for: TPH-G (BTEX) MTBE (TPH-D) Other: Nitrate, Sulfate, TVH

Equipment Blank I.D.: @ Time Duplicate I.D.:

Analyzed for: TPH-G BTEX MTBE TPH-D Other:

D.O. (if req'd):	Pre-purge: 1.2 mg/L	Post-purge:	mg/L
ORP (if req'd):	Pre-purge: -77 mV	Post-purge:	mV

WELL MONITORING DATA SHEET

Project #: 991220 R-1	Client: Stellar Environmental
Sampler: JR	Start Date: 12-20-99
Well I.D.: MW-3	Well Diameter: 2 3 (4) 6 8 ___
Total Well Depth: 42.00	Depth to Water: 19.44
Before: After:	Before: After:
Depth to Free Product:	Thickness of Free Product (feet):
Referenced to: (PVC) Grade	D.O. Meter (if req'd): (YSI) HACH

Purge Method: Bailer / Disposable Bailer / Middleburg / Electric Submersible / Extraction Pump / Other: _____

Sampling Method: Bailer / (Disposable Bailer) / Extraction Port / Other: _____

_____ (Gals.) X _____ = _____ Gals.
1 Case Volume | Specified Volumes | Calculated Volume

Well Diameter	Multiplier	Well Diameter	Multiplier
2"	0.16	5"	1.02
3"	0.37	6"	1.47
4"	0.65	Other	radius² * 0.163

Time	Temp (°F)	pH	Cond.	Turbidity	Gals. Removed	Observations
10:30	57.1	6.8	638	>200	—	pre purge
						ferrous Iron
	* No purge / Grab Sample					0.03 mg.

Did well dewater? Yes (No) Gallons actually evacuated: —

Sampling Time: ~~10:35~~ Cancelled 12/21/99 Sampling Date: ~~12-20-99~~

Sample I.D.: MW-3 Laboratory: ~~Curtis Tompkins~~

Analyzed for: TPH-G ~~BTEX MTBE TPH-D~~ Other: Nitrate, Sulfate, TVH

Equipment Blank I.D.: @ Time Duplicate I.D.:

Analyzed for: TPH-G BTEX MTBE TPH-D Other:

D.O. (if req'd): (Pre-purge) 1.4 mg/L Post-purge: mg/L

ORP (if req'd): (Pre-purge) +67 mV Post-purge: mV

WELL MONITORING DATA SHEET

Project #: 99120 R-1	Client: Stellar Environmental
Sampler: SR	Start Date: 12-20-99
Well I.D.: MW-4	Well Diameter: 2 3 (4) 6 8 ___
Total Well Depth: 26.00	Depth to Water: 13.21
Before: After:	Before: After:
Depth to Free Product:	Thickness of Free Product (feet):
Referenced to: (PVC) Grade	D.O. Meter (if req'd): (YSI) HACH

Purge Method: Bailer / Disposable Bailer / Middleburg / (Electric Submersible) / Extraction Pump / Other: ___

Sampling Method: Bailer / (Disposable Bailer) / Extraction Port / Other: ___

8.3 (Gals.) X 3 = 24.9 Gals.
1 Case Volume | Specified Volumes | Calculated Volume

Well Diameter	Multiplier	Well Diameter	Multiplier
2"	0.16	5"	1.02
3"	0.37	6"	1.47
4"	0.65	Other	radius² * 0.163

Time	Temp (°F)	pH	Cond.	Turbidity	Gals. Removed	Observations
11:55	57.4	6.6	688	7200	8.5	Odor
11:57	57.8	6.5	710	7200	17	pre purge
11:59	57.3	6.6	723	7200	25	Ferrous Iron
						2.4 mg.

Did well dewater? Yes (No) Gallons actually evacuated: 25

Sampling Time: 12:05 Sampling Date: 12-20-99

Sample I.D.: MW-4 Laboratory: Curtis Tompkins

Analyzed for: TPH-G BTEX MTBE (TPH-D) @ Time Other: Nitrate, Sulfate, TVH

Equipment Blank I.D.: Duplicate I.D.:

Analyzed for: TPH-G BTEX MTBE TPH-D Other:

D.O. (if req'd): Pre-purge: ___ mg/L Post-purge: ___ mg/L

ORP (if req'd): Pre-purge: ___ mV Post-purge: ___ mV

WELL MONITORING DATA SHEET

Project #: 99120 R-1	Client: Stellar Environmental
Sampler: SR	Start Date: 12-20-99
Well I.D.: MW-5	Well Diameter: 2 3 (4) 6 8 ___
Total Well Depth: 26.00	Depth to Water: 16.34
Before: After:	Before: After:
Depth to Free Product:	Thickness of Free Product (feet):
Referenced to: (PVC) Grade	D.O. Meter (if req'd): (YSI) HACH

Purge Method: Bailer / Disposable Bailer / Middleburg / Electric Submersible / Extraction Pump / Other: ___

Sampling Method: Bailer / (Disposable Bailer) / Extraction Port / Other: ___

___/___(Gals.) X ___/___ = ___/___ Gals.
1 Case Volume | Specified Volumes | Calculated Volume

Well Diameter	Multiplier	Well Diameter	Multiplier
2"	0.16	5"	1.02
3"	0.37	6"	1.47
4"	0.65	Other	radius^2 * 0.163

Time	Temp (°F)	pH	Cond.	Turbidity	Gals. Removed	Observations
11:35	58.4	7.4	605	7200	—	Pre purge
						ferrous Iron
	* No purge / Grab sample					0.01 mg.

Did well dewater? Yes (No) Gallons actually evacuated: —

Sampling Time: ~~11:40~~ Cancelled 12/21 Sampling Date: ~~12-20-99~~

Sample I.D.: ~~MW-5~~ Laboratory: ~~Curtis & Tompkins~~

Analyzed for: ~~TPH-G~~ (~~BTEX~~ ~~MTBE~~ ~~TPH-D~~) Other: ~~Nitrate, Sulfate, TDH~~

Equipment Blank I.D.: @ Time Duplicate I.D.:

Analyzed for: TPH-G BTEX MTBE TPH-D Other:

D.O. (if req'd): (Pre-purge:) 1.5 mg/L Post-purge: mg/L

ORP (if req'd): (Pre-purge:) + 7 mV Post-purge: mV

WELL MONITORING DATA SHEET

Project #: 991220 R-1	Client: Stellar Environmental
Sampler: JR	Start Date: 12-20-99
Well I.D.: MW-6	Well Diameter: 2 3 (4) 6 8 ___
Total Well Depth: 26.00	Depth to Water: 13.38
Before: After:	Before: After:
Depth to Free Product:	Thickness of Free Product (feet):
Referenced to: (PVC) Grade	D.O. Meter (if req'd): (YSI) HACH

Purge Method: Bailer / Disposable Bailer / Middleburg / Electric Submersible / Extraction Pump / Other: ___

Sampling Method: Bailer / (Disposable Bailer) / Extraction Port / Other: ___

___ (Gals.) X ___ = ___ Gals.
1 Case Volume | Specified Volumes | Calculated Volume

Well Diameter	Multiplier	Well Diameter	Multiplier
2"	0.16	5"	1.02
3"	0.37	6"	1.47
4"	0.65	Other	radius² * 0.163

Time	Temp (°F)	pH	Cond.	Turbidity	Gals. Removed	Observations
10:50	55.9	6.6	620	>200	—	Pre purge
						ferrous iron
	* No purge / Grab Sample					0.06 mg.

Did well dewater? Yes (No) Gallons actually evacuated: /

Sampling Time: ~~10:55~~ Uncalibrated 12/21 Sampling Date: 12-20-99

Sample I.D.: MW-6 Laboratory: ~~Curtis Tompkins~~

Analyzed for: TPH-G ~~BTEX~~ MTBE ~~TPH-D~~ Other: ~~Nitrate~~, Sulfate, TDH

Equipment Blank I.D.: @ Time Duplicate I.D.:

Analyzed for: TPH-G BTEX MTBE TPH-D Other:

D.O. (if req'd): (Pre-purge:) 2.0 mg/L Post-purge: mg/L

ORP (if req'd): (Pre-purge:) 86 mV Post-purge: mV

Curtis & Tompkins, Ltd., Analytical Laboratories, Since 1878
2323 Fifth Street, Berkeley, CA 94710, Phone (510) 486-0900, Fax (510) 486-0532

ANALYTICAL REPORT

Prepared for:

Stellar Environmental Solutions
2198 6th Street
Suite 201
Berkeley, CA 94710

Date: 29-DEC-99
Lab Job Number: 143103
Project ID: N/A
Location: Redwood Reginal Park

Reviewed by: _____

Reviewed by: _____

1413103

STELLAR ENVIRONMENTAL SOLUTIONS

Chain of Custody Record

Lab job no.: _____
Date 12/20/99
Page 1 of 1

Laboratory Curtis + Tompkins
Address Berkeley, CA
Method of Shipment delivered
Shipment No. _____
Airbill No. _____
Cooler No. _____
Client EBRPD
Address _____
Project Manager Bm Rucker
Telephone No. 510 644 3123
Project Name Redwood Regional Park
Fax. No. 510 644 3859
Project Number _____
Samplers: (Signature) Hen Pietropaoli

Analysis Required

Field Sample Number	Location/ Depth	Date	Time	Sample Type	Type/Size of Container	Preservation: Temp.	Preservation: Chemical	Filtered Y/N	No. of Containers	TPH gas	TPH diesel	BTEX	MTBE	Sulfate	Nitrate	SES Stnd TAT	Remarks
SW-2	Surface water	12/20/99	0940	water	2-1l Amber	on ice	—			✓			✓	✓			
SW-2		12/20/99	0940	water	4-40ml VOA	on ice	HCl		✓		✓	✓					
SW-3		12/20/99	1020	water	2-1l Amber	on ice				✓			✓	✓			
SW-3	✓	12/20/99	1020	water	4-40ml VOA	on ice	HCl		✓		✓	✓				✓	

Relinquished by:	Date	Received by:	Date	Relinquished by:	Date	Received by:	Date
Signature Hen Pietropaoli	12/20/99	Signature [illegible]	12-20-99	Signature		Signature	
Printed H. Pietropaoli	Time 1125	Printed Bennetts	Time 11.25	Printed	Time	Printed	Time
Company SES		Company CAT		Company		Company	
Reason				Reason			

Comments: _____

Relinquished by:	Date	Received by:	Date
Signature		Signature	
Printed	Time	Printed	Time
Company		Company	
Reason			

SES-2110 Sixth Street, Berkeley, CA 95710

Curtis & Tompkins, Ltd.

Laboratory Number: **143103**
Client: **Stellar Environmental Solutions**
Project Name: **Redwood Regional Park**

Sample Date: **12/20/99**
Receipt Date: **12/20/99**

CASE NARRATIVE

This hardcopy data package contains sample results and batch QC results for two water samples received from the above referenced project. The samples were received cold and intact.

TVH/BTXE: High surrogate recovery was observed for bromofluorobenzene in sample SW-2 (CT# 143103-001) due to matrix interference. No analytical problems were encountered.

TEH: No analytical problems were encountered.

Curtis & Tompkins, Ltd.

Gasoline by GC/FID CA LUFT

Lab #:	143103	Location:	Redwood Reginal Park
Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8015M
Project#:	STANDARD	Prep Method:	EPA 5030
Matrix:	Water	Sampled:	20-DEC-1999
Units:	ug/L	Received:	20-DEC-1999
Diln Fac:	1.000	Analyzed:	21-DEC-1999
Batch#:	52747		

Field ID: SW-2 Lab ID: 143103-001
Type: SAMPLE

Analyte	Result	RL
Gasoline C7-C12	1,300	50

Surrogate	%REC	Limits
Trifluorotoluene	171 *	53-150
Bromofluorobenzene	118	53-149

Field ID: SW-3 Lab ID: 143103-002
Type: SAMPLE

Analyte	Result	RL
Gasoline C7-C12	ND	50

Surrogate	%REC	Limits
Trifluorotoluene	111	53-150
Bromofluorobenzene	114	53-149

Type: BLANK Lab ID: QC103995

Analyte	Result	RL
Gasoline C7-C12	ND	50

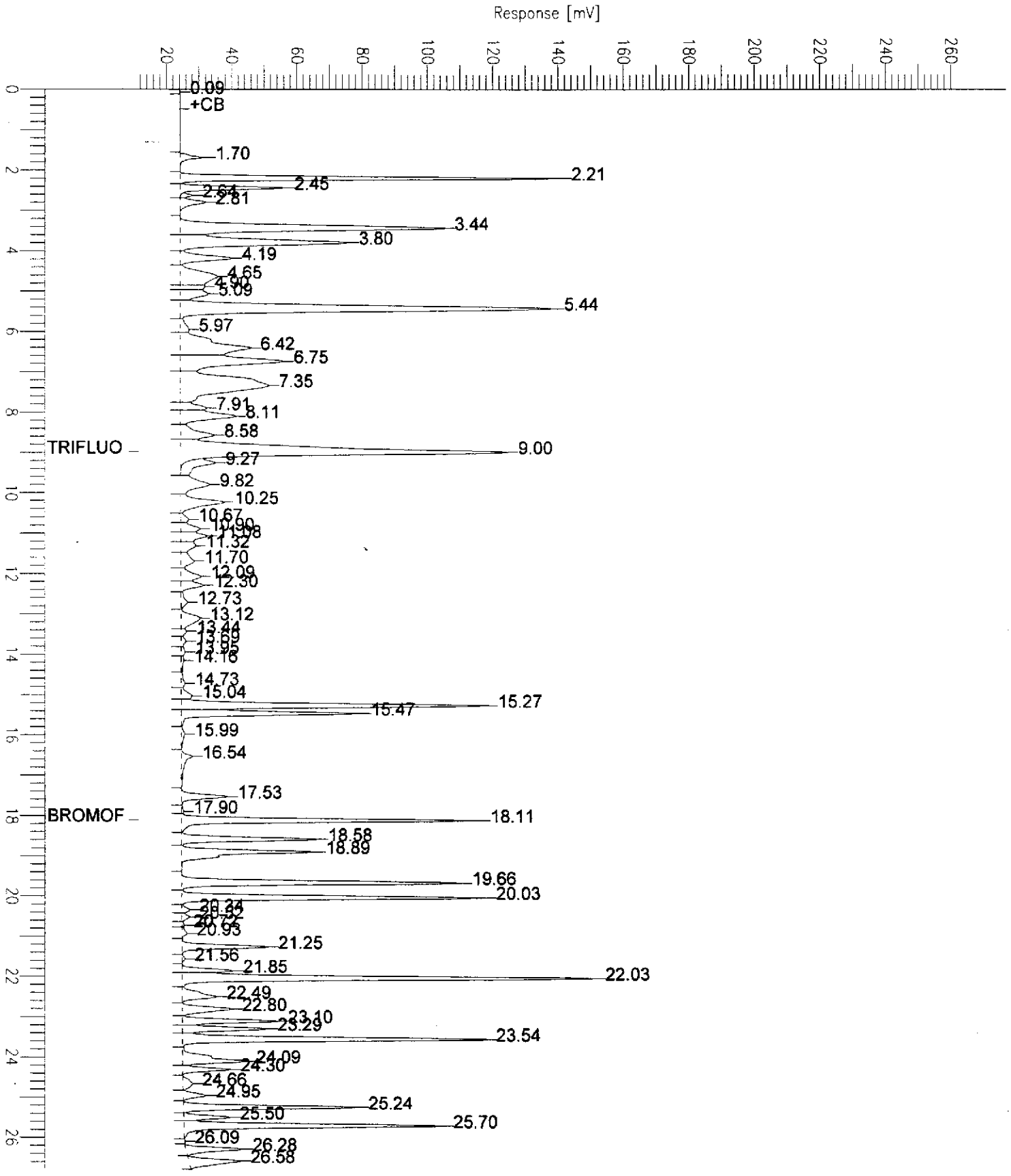
Surrogate	%REC	Limits
Trifluorotoluene	107	53-150
Bromofluorobenzene	108	53-149

* = Value outside QC limits
ND = Not Detected
RL = Reporting Limit

Chromatogram

Sample Name : 143103-001,52747
FileName : G:\GC05\DATA\355G012.raw
Method : TVHBTXE
Start Time : 0.00 min End Time : 26.80 min
Scale Factor: -1.0 Plot Offset: 12 mV

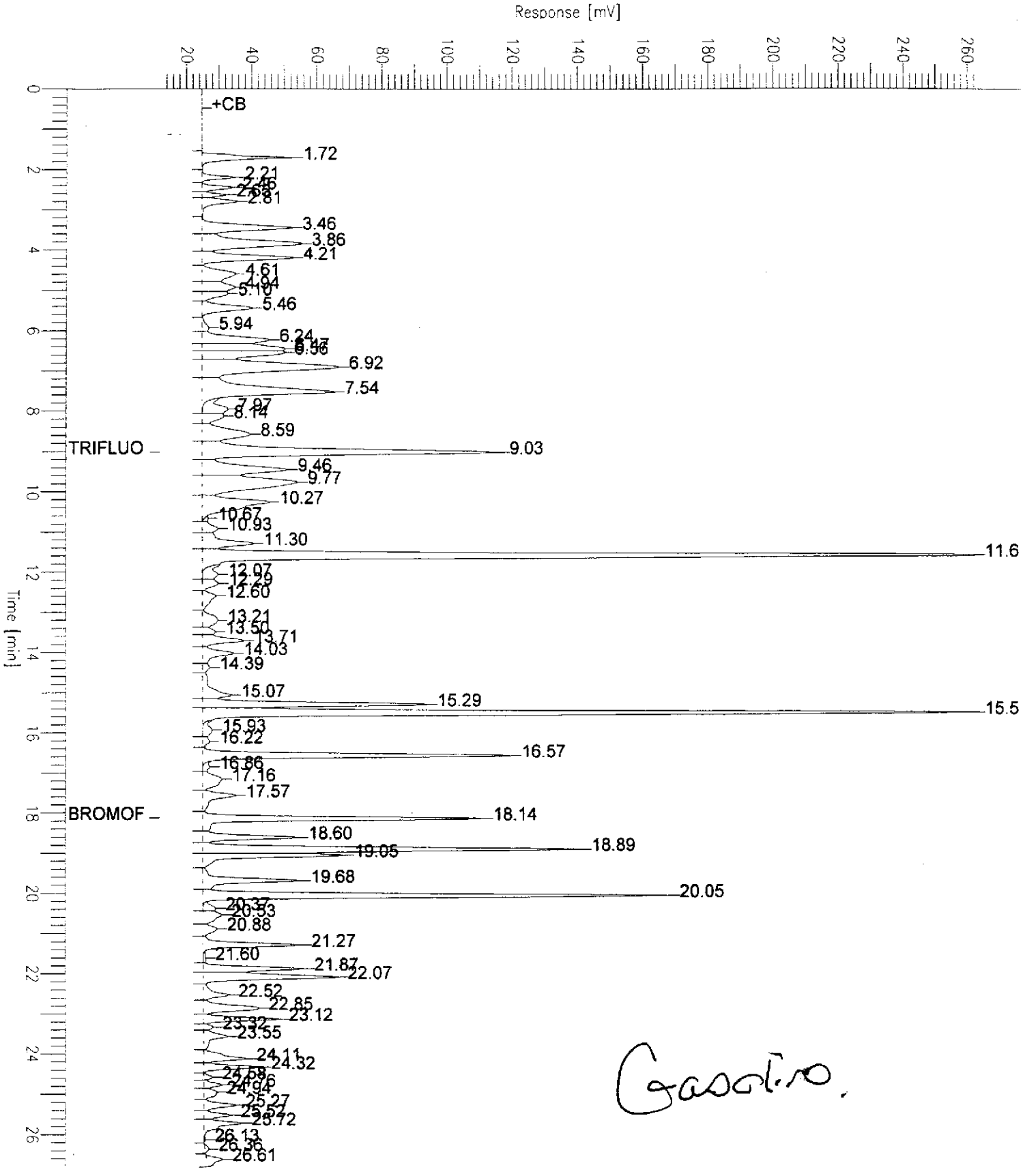
Sample #: Page 1 of 1
Date : 12/21/99 04:43 PM
Time of Injection: 12/21/99 04:16 PM
Low Point : 11.69 mV High Point : 261.69 mV
Plot Scale: 250.0 mV



Chromatogram

Sample Name : CCV/LCS,QC103994,99WS8283,52747
FileName : G:\GC05\DATA\355G001.raw
Method : TVHBTXE
Start Time : 0.00 min End Time : 26.80 min
Scale Factor: -1.0 Plot Offset: 12 mV

Sample #: GAS Page 1 of 1
Date : 12/21/99 09:04 AM
Time of Injection: 12/21/99 08:37 AM
Low Point : 12.08 mV High Point : 262.08 mV
Plot Scale: 250.0 mV



Gasoline.

Curtis & Tompkins, Ltd.

BTXE Compounds by GC/PID

Lab #:	143103	Location:	Redwood Reginal Park
Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8021B
Project#:	STANDARD	Prep Method:	EPA 5030
Matrix:	Water	Sampled:	20-DEC-1999
Units:	ug/L	Received:	20-DEC-1999
Diln Fac:	1.000	Analyzed:	21-DEC-1999
Batch#:	52747		

Field ID: SW-2 Lab ID: 143103-001
Type: SAMPLE

Analyte	Result	RL
MTBE	ND	2.0
Benzene	10	0.50
Toluene	1.0	0.50
Ethylbenzene	47	0.50
m,p-Xylenes	27	0.50
o-Xylene	2.2	0.50

Surrogate	%REC	Limits
Trifluorotoluene	144 *	51-143
Bromofluorobenzene	119	37-146

Field ID: SW-3 Lab ID: 143103-002
Type: SAMPLE

Analyte	Result	RL
MTBE	ND	2.0
Benzene	ND	0.50
Toluene	ND	0.50
Ethylbenzene	ND	0.50
m,p-Xylenes	ND	0.50
o-Xylene	ND	0.50

Surrogate	%REC	Limits
Trifluorotoluene	108	51-143
Bromofluorobenzene	116	37-146

Type: BLANK Lab ID: QC103995

Analyte	Result	RL
MTBE	ND	2.0
Benzene	ND	0.50
Toluene	ND	0.50
Ethylbenzene	ND	0.50
m,p-Xylenes	ND	0.50
o-Xylene	ND	0.50

Surrogate	%REC	Limits
Trifluorotoluene	107	51-143
Bromofluorobenzene	110	37-146

* = Value outside QC limits
ND = Not Detected
RL = Reporting Limit

Curtis & Tompkins, Ltd.

Gasoline by GC/FID CA LUFT

Lab #:	143103	Location:	Redwood Reginal Park
Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8015M
Project#:	STANDARD	Prep Method:	EPA 5030
Type:	LCS	Diln Fac:	1.000
Lab ID:	QC103994	Batch#:	52747
Matrix:	Water	Analyzed:	21-DEC-1999
Units:	ug/L		

Analyte	Spiked	Result	%REC	Limits
Gasoline C7-C12	2,000	2,052	103	77-117

Surrogate	%REC	Limits
Trifluorotoluene	127	53-150
Bromofluorobenzene	114	53-149

Curtis & Tompkins, Ltd.

BTXE Compounds by GC/PID

Lab #:	143103	Location:	Redwood Reginal Park
Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8021B
Project#:	STANDARD	Prep Method:	EPA 5030
Matrix:	Water	Batch#:	52747
Units:	ug/L	Analyzed:	21-DEC-1999
Diln Fac:	1.000		

Type: BS Lab ID: QC103996

Analyte	Spiked	Result	%REC	Limits
MTBE	20.00	17.06	85	66-126
Benzene	20.00	16.32	82	65-111
Toluene	20.00	16.53	83	76-117
Ethylbenzene	20.00	17.96	90	71-121
m,p-Xylenes	40.00	36.96	92	80-123
o-Xylene	20.00	18.02	90	75-127

Surrogate	%REC	Limits
Trifluorotoluene	109	51-143
Bromofluorobenzene	116	37-146

Type: BSD Lab ID: QC103997

Analyte	Spiked	Result	%REC	Limits	RPD	Lim
MTBE	20.00	16.57	83	66-126	3	12
Benzene	20.00	16.36	82	65-111	0	10
Toluene	20.00	16.63	83	76-117	1	10
Ethylbenzene	20.00	17.92	90	71-121	0	11
m,p-Xylenes	40.00	36.77	92	80-123	1	10
o-Xylene	20.00	17.96	90	75-127	0	11

Surrogate	%REC	Limits
Trifluorotoluene	110	51-143
Bromofluorobenzene	114	37-146

RPD= Relative Percent Difference

Curtis & Tompkins, Ltd.

Gasoline by GC/FID CA LUFT

Lab #:	143103	Location:	Redwood Reginal Park
Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8015M
Project#:	STANDARD	Prep Method:	EPA 5030
Field ID:	SW-3	Batch#:	52747
MSS Lab ID:	143103-002	Sampled:	20-DEC-1999
Matrix:	Water	Received:	20-DEC-1999
Units:	ug/L	Analyzed:	21-DEC-1999
Diln Fac:	1.000		

Type: MS Lab ID: QC103998

Analyte	MSS Result	Spiked	Result	%REC	Limits
Gasoline C7-C12	<50.00	2,000	2,059	103	69-131

Surrogate	%REC	Limits
Trifluorotoluene	131	53-150
Bromofluorobenzene	122	53-149

Type: MSD Lab ID: QC103999

Analyte	Spiked	Result	%REC	Limits	RPD	Lim
Gasoline C7-C12	2,000	2,103	105	69-131	2	13

Surrogate	%REC	Limits
Trifluorotoluene	131	53-150
Bromofluorobenzene	123	53-149

RPD= Relative Percent Difference

Curtis & Tompkins, Ltd.

Total Extractable Hydrocarbons, GC/FID

Lab #:	143103	Location:	Redwood Reginal Park
Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8015M
Project#:	STANDARD	Prep Method:	EPA 3520
Matrix:	Water	Sampled:	20-DEC-1999
Units:	ug/L	Received:	20-DEC-1999
Diln Fac:	1.000	Prepared:	20-DEC-1999
Batch#:	52746		

Field ID: SW-2 Lab ID: 143103-001
Type: SAMPLE Analyzed: 23-DEC-1999

Analyte	Result	RL
Diesel C10-C24	250 H L Y	50

Surrogate	%REC	Limits
Hexacosane	96	58-128

Field ID: SW-3 Lab ID: 143103-002
Type: SAMPLE Analyzed: 23-DEC-1999

Analyte	Result	RL
Diesel C10-C24	ND	50

Surrogate	%REC	Limits
Hexacosane	92	58-128

Type: BLANK Analyzed: 22-DEC-1999
Lab ID: QC103991

Analyte	Result	RL
Diesel C10-C24	ND	50

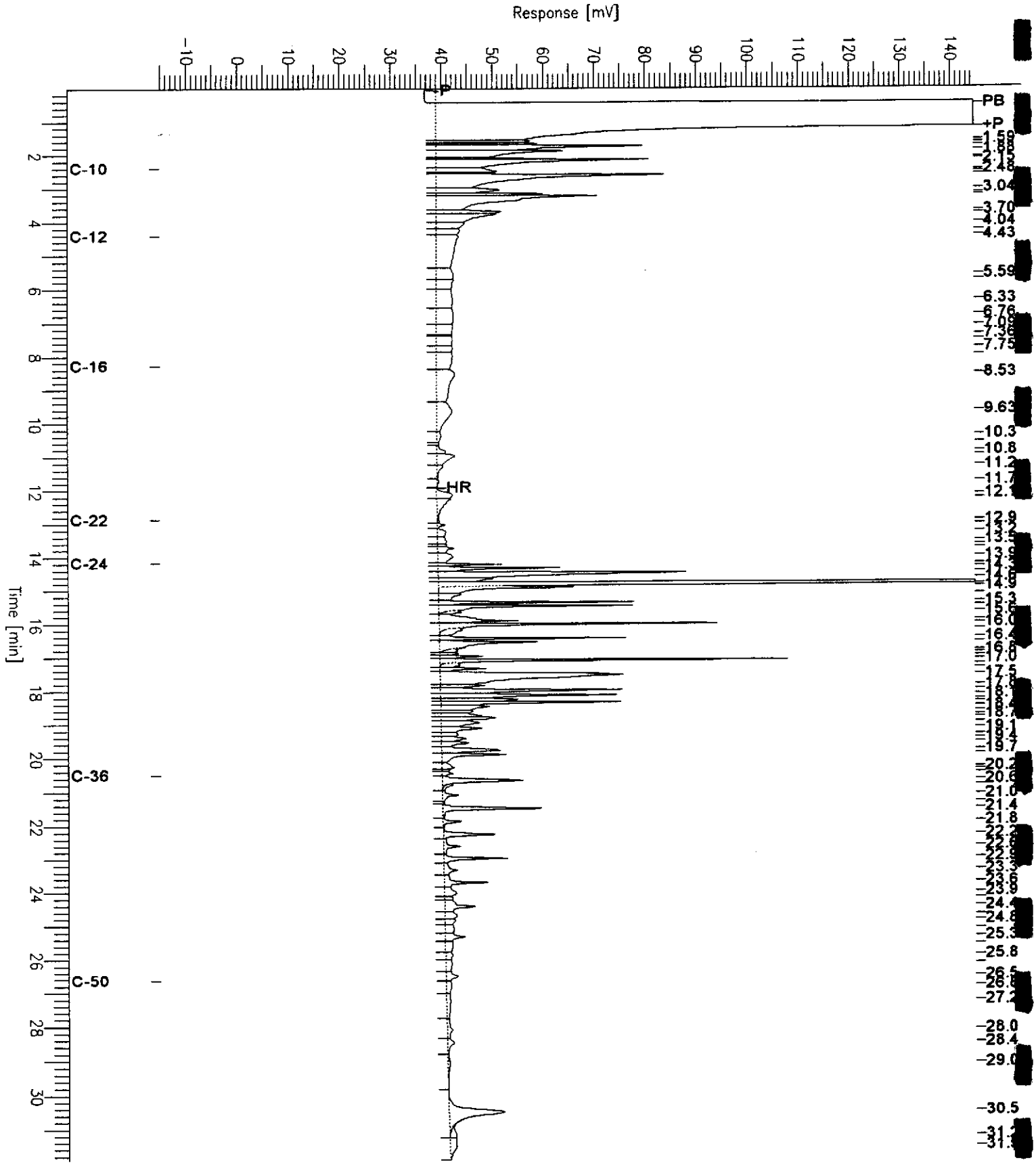
Surrogate	%REC	Limits
Hexacosane	89	58-128

H = Heavier hydrocarbons contributed to the quantitation
L = Lighter hydrocarbons contributed to the quantitation
Y = Sample exhibits fuel pattern which does not resemble standard
ND = Not Detected
RL = Reporting Limit

Chromatogram

Sample Name : 143103-001,52746
FileName : G:\GC15\CHB\355B047.RAW
Method : BTEH292.MTH
Start Time : 0.01 min End Time : 31.91 min
Scale Factor: 0.0 Plot Offset: -15 mV

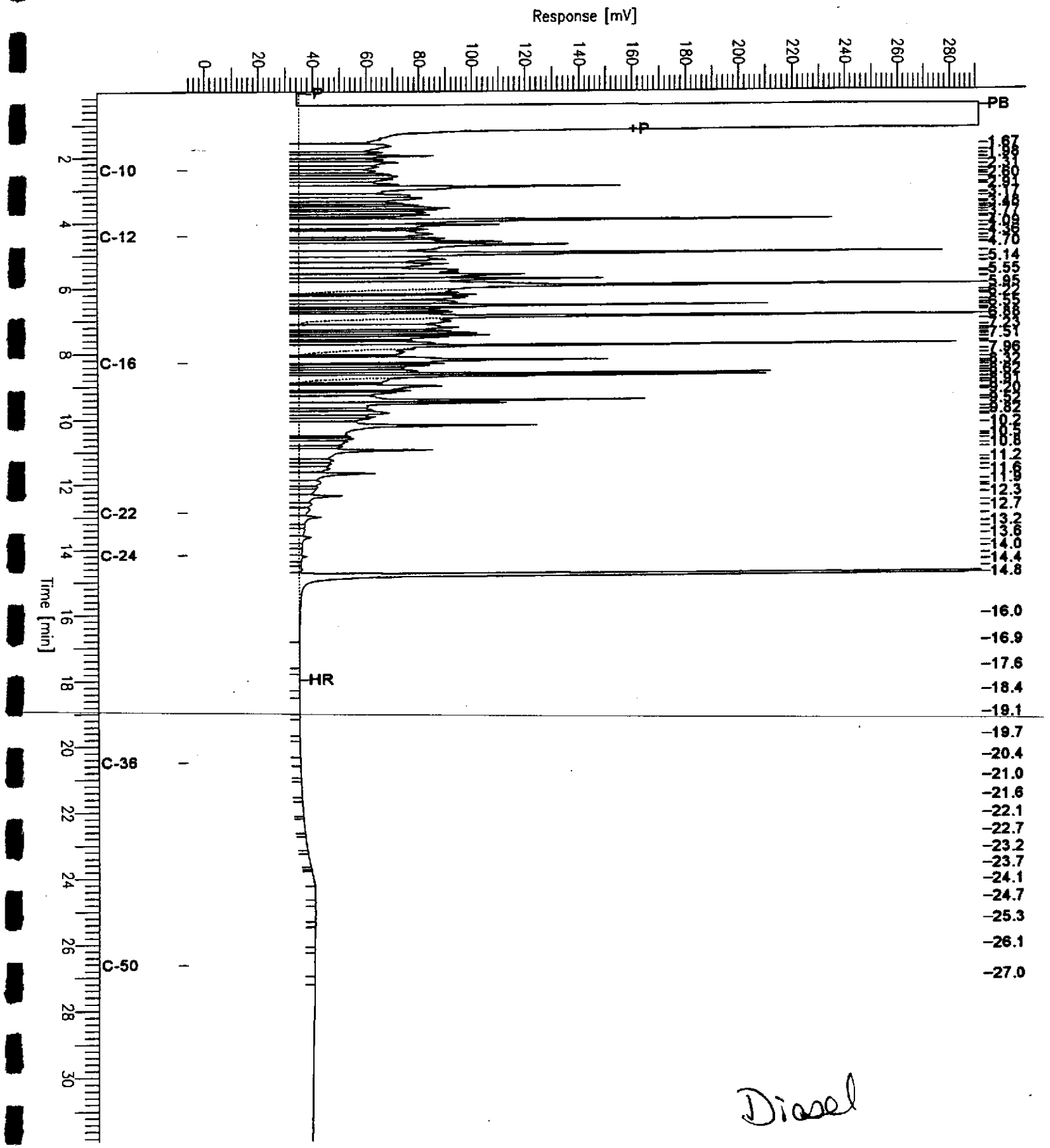
Sample #: 52746 Page 1 of 1
Date : 12/27/1999 11:02 AM
Time of Injection: 12/23/1999 01:34 AM
Low Point : -15.20 mV High Point : 144.62 mV
Plot Scale: 159.8 mV



Chromatogram

Sample Name : ccv,99ws8397,dsl
FileName : G:\GC15\CHB\355B002.RAW
Method : BTEH292.MTH
Start Time : 0.01 min End Time : 31.91 min
Scale Factor: 0.0 Plot Offset: -6 mV

Sample #: 500mg/l Page 1 of 1
Date : 12/22/1999 11:19 AM
Time of Injection: 12/21/1999 05:20 PM
Low Point : -6.45 mV High Point : 291.32 mV
Plot Scale: 297.8 mV



Diesel

Curtis & Tompkins, Ltd.

Total Extractable Hydrocarbons, GC/FID

Lab #:	143103	Location:	Redwood Reginal Park
Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8015M
Project#:	STANDARD	Prep Method:	EPA 3520
Matrix:	Water	Batch#:	52746
Units:	ug/L	Prepared:	20-DEC-1999
Diln Fac:	1.000	Analyzed:	22-DEC-1999

Type: BS Lab ID: QC103992

Analyte	Spiked	Result	%REC	Limits
Diesel C10-C24	2,475	1,852	75	50-114

Surrogate	%REC	Limits
Hexacosane	95	58-128

Type: BSD Lab ID: QC103993

Analyte	Spiked	Result	%REC	Limits	RPD	Lim
Diesel C10-C24	2,475	1,992	81	50-114	7	25

Surrogate	%REC	Limits
Hexacosane	98	58-128

RPD= Relative Percent Difference

Curtis & Tompkins, Ltd., Analytical Laboratories, Since 1878
2323 Fifth Street, Berkeley, CA 94710, Phone (510) 486-0900, Fax (510) 486-0532

A N A L Y T I C A L R E P O R T

Prepared for:

Stellar Environmental Solutions
2198 6th Street
Suite 201
Berkeley, CA 94710

Date: 13-JAN-00
Lab Job Number: 143120
Project ID: N/A
Location: Redwood Regional Park

Reviewed by: Tracy Bosy

Reviewed by:

M'SILW

STELLAR ENVIRONMENTAL SOLUTIONS
Chain of Custody Record

Lab job no.:
Date 12-20-99
Page 1 of 1

Laboratory: Curtis & Tompkins
Address:

Method of Shipment: LAB COURIER
Shipment No.:
Airbill No.:
Cooler No.:

Client: STELLAR
Address: 2110 SIXTH ST. BERKELEY, CA

Project Manager: BRUCE RUCKER
Telephone No.: (510) 644-3123
Fax. No.:

Project Name: DUTEL
Project Number: 99/220 R-1
Samplers: (Signature) [signature]

Analysis requested: TPHG, BTEX, MTBE, NITRATE, SO4, [illegible]

	Sample Number	Date	Time	No. of Containers	Sample Type	Type/Size of Container	Temp	Chemical	TPHG	BTEX	MTBE	NITRATE	SO4	[illegible]	Remarks
	~~MW-1~~	12/20	1010	6	W										
-1	MW-2	↓	11:20	↓	↓				X	X	X	X	X	X	CANCEL @ 12/21
	~~MW-3~~	↓	1033	↓	↓				↓	↓	↓	↓	↓	↓	
-2	MW-4	↓	12:05	↓	↓				↓	↓	↓	↓	↓	↓	CANCEL @ 12/21
	~~MW-5~~	↓	11:40	↓	↓				↓	↓	↓	↓	↓	↓	CANCEL @ 12/21
	~~MW-6~~	↓	10:55	↓	↓				↓	↓	↓	↓	↓	↓	CANCEL @ 12/21

Relinquished by:	Date	Received by:	Date	Relinquished by:	Date	Received by:	Date
Signature [signature]	12/21/99	Signature [signature]	12/21/99	Signature		Signature	
Printed Jim Rosa	Time	Printed G. P. Lumbia	Time	Printed	Time	Printed	Time
Company BTS	12:38	Company C&T	1238	Company		Company	
Reason				Reason			

Relinquished by:	Date	Received by:	Date
Signature		Signature	
Printed	Time	Printed	Time
Company		Company	
Reason			

Comments: CONFIRM NITRATE

* WATCH HOLD TIME

SES-2110 Sixth Street, Berkeley, CA 95710

Curtis & Tompkins, Ltd.

Gasoline by GC/FID CA LUFT

Lab #:	143120	Location:	Redwood Regional Park
Client:	Stellar Environmental Solutions	Prep:	EPA 5030
Project#:	STANDARD	Analysis:	EPA 8015M
Matrix:	Water	Sampled:	12/20/99
Units:	ug/L	Received:	12/21/99
Diln Fac:	1.000	Analyzed:	12/23/99
Batch#:	52810		

Field ID: MW-2 Lab ID: 143120-001
Type: SAMPLE

Analyte	Result	RL
Gasoline C7-C12	57	50

Surrogate	%REC	Limits
Trifluorotoluene	103	53-150
Bromofluorobenzene	102	53-149

Field ID: MW-4 Lab ID: 143120-002
Type: SAMPLE

Analyte	Result	RL
Gasoline C7-C12	1,000	50

Surrogate	%REC	Limits
Trifluorotoluene	107	53-150
Bromofluorobenzene	105	53-149

Type: BLANK Lab ID: QC104257

Analyte	Result	RL
Gasoline C7-C12	ND	50

Surrogate	%REC	Limits
Trifluorotoluene	97	53-150
Bromofluorobenzene	95	53-149

ND = Not Detected
RL = Reporting Limit

Curtis & Tompkins, Ltd.

BTXE Compounds by GC/PID

Lab #:	143120	Location:	Redwood Regional Park
Client:	Stellar Environmental Solutions	Prep:	EPA 5030
Project#:	STANDARD	Analysis:	EPA 8021B
Matrix:	Water	Sampled:	12/20/99
Units:	ug/L	Received:	12/21/99
Diln Fac:	1.000	Analyzed:	12/23/99
Batch#:	52810		

Field ID: MW-2 Lab ID: 143120-001
Type: SAMPLE

Analyte	Result	RL
MTBE	4.5	2.0
Benzene	20	0.50
Toluene	0.61	0.50
Ethylbenzene	5.9	0.50
m,p-Xylenes	ND	0.50
o-Xylene	ND	0.50

Surrogate	%REC	Limits
Trifluorotoluene	89	51-143
Bromofluorobenzene	86	37-146

Field ID: MW-4 Lab ID: 143120-002
Type: SAMPLE

Analyte	Result	RL
MTBE	ND	2.0
Benzene	4.0 C	0.50
Toluene	2.0	0.50
Ethylbenzene	26	0.50
m,p-Xylenes	12	0.50
o-Xylene	1.9	0.50

Surrogate	%REC	Limits
Trifluorotoluene	89	51-143
Bromofluorobenzene	88	37-146

Type: BLANK Lab ID: QC104257

Analyte	Result	RL
MTBE	ND	2.0
Benzene	ND	0.50
Toluene	ND	0.50
Ethylbenzene	ND	0.50
m,p-Xylenes	ND	0.50
o-Xylene	ND	0.50

Surrogate	%REC	Limits
Trifluorotoluene	85	51-143
Bromofluorobenzene	78	37-146

C = Presence confirmed, but confirmation concentration differed by more than a factor of two
ND = Not Detected
RL = Reporting Limit

Curtis & Tompkins, Ltd.

Gasoline by GC/FID CA LUFT

Lab #:	143120	Location:	Redwood Regional Park
Client:	Stellar Environmental Solutions	Prep:	EPA 5030
Project#:	STANDARD	Analysis:	EPA 8015M
Type:	LCS	Diln Fac:	1.000
Lab ID:	QC104258	Batch#:	52810
Matrix:	Water	Analyzed:	12/23/99
Units:	ug/L		

Analyte	Spiked	Result	%REC	Limits
Gasoline C7-C12	2,000	2,160	108	77-117

Surrogate	%REC	Limits
Trifluorotoluene	103	53-150
Bromofluorobenzene	111	53-149

Curtis & Tompkins, Ltd.

Gasoline by GC/FID CA LUFT

Lab #:	143120	Location:	Redwood Regional Park
Client:	Stellar Environmental Solutions	Prep:	EPA 5030
Project#:	STANDARD	Analysis:	EPA 8015M
Field ID:	ZZZZZZZZZZ	Batch#:	52810
MSS Lab ID:	143143-002	Sampled:	12/21/99
Matrix:	Water	Received:	12/22/99
Units:	ug/L	Analyzed:	12/23/99
Diln Fac:	1.000		

Type: MS Lab ID: QC104261

Analyte	MSS Result	Spiked	Result	%REC	Limits
Gasoline C7-C12	<50.00	2,000	2,041	102	69-131

Surrogate	%REC	Limits
Trifluorotoluene	105	53-150
Bromofluorobenzene	114	53-149

Type: MSD Lab ID: QC104262

Analyte	Spiked	Result	%REC	Limits	RPD	Lim
Gasoline C7-C12	2,000	1,987	99	69-131	3	13

Surrogate	%REC	Limits
Trifluorotoluene	104	53-150
Bromofluorobenzene	113	53-149

RPD= Relative Percent Difference

Curtis & Tompkins, Ltd.

BTXE Compounds by GC/PID

Lab #:	143120	Location:	Redwood Regional Park
Client:	Stellar Environmental Solutions	Prep:	EPA 5030
Project#:	STANDARD	Analysis:	EPA 8021B
Matrix:	Water	Batch#:	52810
Units:	ug/L	Analyzed:	12/23/99
Diln Fac:	--- 1.000		

Type: BS Lab ID: QC104259

Analyte	Spiked	Result	%REC	Limits
MTBE	20.00	18.50	93	66-126
Benzene	20.00	17.58	88	65-111
Toluene	20.00	17.85	89	76-117
Ethylbenzene	20.00	18.44	92	71-121
m,p-Xylenes	40.00	36.79	92	80-123
o-Xylene	20.00	18.63	93	75-127

Surrogate	%REC	Limits
Trifluorotoluene	87	51-143
Bromofluorobenzene	84	37-146

Type: BSD Lab ID: QC104260

Analyte	Spiked	Result	%REC	Limits	RPD	Lim
MTBE	20.00	18.10	91	66-126	2	12
Benzene	20.00	17.87	89	65-111	2	10
Toluene	20.00	17.80	89	76-117	0	10
Ethylbenzene	20.00	18.56	93	71-121	1	11
m,p-Xylenes	40.00	37.16	93	80-123	1	10
o-Xylene	20.00	18.55	93	75-127	0	11

Surrogate	%REC	Limits
Trifluorotoluene	86	51-143
Bromofluorobenzene	83	37-146

RPD= Relative Percent Difference

Curtis & Tompkins, Ltd.

Total Extractable Hydrocarbons, GC/FID

Lab #:	143120	Location:	Redwood Regional Park
Client:	Stellar Environmental Solutions	Prep:	EPA 3520
Project#:	STANDARD	Analysis:	EPA 8015M
Matrix:	Water	Sampled:	12/20/99
Units:	ug/L	Received:	12/21/99
Diln Fac:	1.000		

Field ID:	MW-2	Batch#:	52914
Type:	SAMPLE	Prepared:	12/30/99
Lab ID:	143120-001	Analyzed:	01/04/00

Analyte	Result	RL
Diesel C10-C24	ND	50

Surrogate	%REC	Limits
Hexacosane	90	58-128

Field ID:	MW-4	Batch#:	52776
Type:	SAMPLE	Prepared:	12/21/99
Lab ID:	143120-002	Analyzed:	12/23/99

Analyte	Result	RL
Diesel C10-C24	430 L Y	50

Surrogate	%REC	Limits
Hexacosane	103	58-128

Type:	BLANK	Prepared:	12/21/99
Lab ID:	QC104123	Analyzed:	12/23/99
Batch#:	52776		

Analyte	Result	RL
Diesel C10-C24	ND	50

Surrogate	%REC	Limits
Hexacosane	103	58-128

Type:	BLANK	Prepared:	12/30/99
Lab ID:	QC104672	Analyzed:	01/04/00
Batch#:	52914		

Analyte	Result	RL
Diesel C10-C24	ND	50

Surrogate	%REC	Limits
Hexacosane	84	58-128

L = Lighter hydrocarbons contributed to the quantitation
Y = Sample exhibits fuel pattern which does not resemble standard
ND = Not Detected
RL = Reporting Limit

Curtis & Tompkins, Ltd.

Total Extractable Hydrocarbons, GC/FID

Lab #:	143120	Location:	Redwood Regional Park
Client:	Stellar Environmental Solutions	Prep:	EPA 3520
Project#:	STANDARD	Analysis:	EPA 8015M
Matrix:	Water	Batch#:	52776
Units:	ug/L	Prepared:	12/21/99
Diln Fac:	1.000	Analyzed:	12/23/99

Type: BS Lab ID: QC104124

Analyte	Spiked	Result	%REC	Limits
Diesel C10-C24	2,475	2,131	86	50-114

Surrogate	%REC	Limits
Hexacosane	103	58-128

Type: BSD Lab ID: QC104125

Analyte	Spiked	Result	%REC	Limits	RPD	Lim
Diesel C10-C24	2,475	2,253	91	50-114	6	25

Surrogate	%REC	Limits
Hexacosane	108	58-128

RPD= Relative Percent Difference

Curtis & Tompkins, Ltd.

Total Extractable Hydrocarbons, GC/FID

Lab #:	143120	Location:	Redwood Regional Park
Client:	Stellar Environmental Solutions	Prep:	EPA 3520
Project#:	STANDARD	Analysis:	EPA 8015M
Matrix:	Water	Batch#:	52914
Units:	ug/L	Prepared:	12/30/99
Diln Fac:	1.000	Analyzed:	01/04/00

Type: BS Lab ID: QC104673

Analyte	Spiked	Result	%REC	Limits
Diesel C10-C24	2,475	1,660	67	50-114

Surrogate	%REC	Limits
Hexacosane	73	58-128

Type: BSD Lab ID: QC104674

Analyte	Spiked	Result	%REC	Limits	RPD	Lim
Diesel C10-C24	2,475	1,679	68	50-114	1	25

Surrogate	%REC	Limits
Hexacosane	73	58-128

RPD= Relative Percent Difference

Curtis & Tompkins, Ltd.

Nitrate Nitrogen

Lab #:	143120	Location:	Redwood Regional Park
Client:	Stellar Environmental Solutions	Prep:	METHOD
Project#:	STANDARD	Analysis:	EPA 300.0
Analyte:	Nitrogen, Nitrate	Batch#:	52780
Matrix:	Water	Sampled:	12/20/99
Units:	mg/L	Received:	12/21/99
Diln Fac:	1.000	Analyzed:	12/22/99

Field ID	Type	Lab ID	Result	RL
MW-2	SAMPLE	143120-001	ND	0.05
MW-4	SAMPLE	143120-002	ND	0.05
	BLANK	QC104138	ND	0.05

ND = Not Detected
RL = Reporting Limit

Nitrate Nitrogen

Lab #:	143120	Location:	Redwood Regional Park
Client:	Stellar Environmental Solutions	Prep:	METHOD
Project#:	STANDARD	Analysis:	EPA 300.0
Analyte:	Nitrogen, Nitrate	Batch#:	52780
Field ID:	ZZZZZZZZZZ	Sampled:	12/16/99
MSS Lab ID:	143117-003	Received:	12/18/99
Matrix:	Water	Analyzed:	12/22/99
Units:	mg/L		

Type	Lab ID	MSS Result	Spiked	Result	%REC	Limits	RPD	Lim	Dil'n Fac
BS	QC104139		3.000	2.830	94	80-120			1.000
BSD	QC104140		3.000	2.820	94	80-120	1	20	1.000
MS	QC104141	0.2862	7.500	7.600	98	75-125			5.000
MSD	QC104142		7.500	7.550	97	75-125	1	25	5.000

RPD= Relative Percent Difference

Curtis & Tompkins, Ltd.

Sulfate

Lab #:	143120	Location:	Redwood Regional Park
Client:	Stellar Environmental Solutions	Prep:	METHOD
Project#:	STANDARD	Analysis:	EPA 300.0
Analyte:	Sulfate	Sampled:	12/20/99
Matrix:	Water	Received:	12/21/99
Units:	mg/L	Analyzed:	12/22/99
Batch#:	52780		

Field ID	Type	Lab ID	Result	RL	Diln Fac
MW-2	SAMPLE	143120-001	29	5.0	10.00
MW-4	SAMPLE	143120-002	110	5.0	10.00
	BLANK	QC104138	ND	0.50	1.000

ND = Not Detected
RL = Reporting Limit

Sulfate

Lab #:	143120	Location:	Redwood Regional Park
Client:	Stellar Environmental Solutions	Prep:	METHOD
Project#:	STANDARD	Analysis:	EPA 300.0
Analyte:	Sulfate	Batch#:	52780
Field ID:	ZZZZZZZZZZ	Sampled:	12/16/99
MSS Lab ID:	143117-003	Received:	12/18/99
Matrix:	Water	Analyzed:	12/22/99
Units:	mg/L		

Type	Lab ID	MSS Result	Spiked	Result	%REC	Limits	RPD	Lim	Dlln Fac
BS	QC104139		10.00	9.450	95	80-120			1.000
BSD	QC104140		10.00	9.490	95	80-120	0	20	1.000
MS	QC104141	171.2	25.00	194.0	91	75-125			5.000
MSD	QC104142		25.00	195.7	98	75-125	1	25	5.000

RPD= Relative Percent Difference

Curtis & Tompkins, Ltd.