Q3/Q4 2007 BIOVENTING STATUS AND ANNUAL SUMMARY REPORT

REDWOOD REGIONAL PARK
SERVICE YARD
OAKLAND, CALIFORNIA

Prepared for:

EAST BAY REGIONAL PARK DISTRICT
OAKLAND, CALIFORNIA

January 2008

STELLAR
ENVIRONMENTAL SOLUTIONS, INC.
GEOSCIENCE & ENGINEERING CONSULTING

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SERVICE YARD
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Prepared for:

EAST BAY REGIONAL PARK DISTRICT
P.O. BOX 5381
OAKLAND, CALIFORNIA 94605

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January 4, 2008

Project No. 2006-17

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January 4, 2008

Mr. Jerry Wickham, P.G.
Hazardous Materials Specialist
Alameda County Department of Environmental Health
1131 Harbor Bay Parkway, Suite 250
Alameda, California 94502

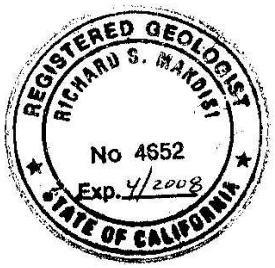
Subject: Third and Fourth Quarters 2007 Bioventing Status and Annual Summary Report, Redwood Regional Park Service Yard Site, Oakland, California – RO #0000246

Dear Mr. Wickham:

This report discusses activities conducted during the third and fourth quarters of 2007, and summarizes activities related to a bioventing corrective action system at the Redwood Regional Park Service Yard, located at 7867 Redwood Road, Oakland, California. A microbial respiration test was conducted during this period, from October 15 to October 17, 2007. A review and expansion of the remedial system followed by a Pilot Test Workplan has been requested by Alameda County Department of Environmental Health (ACDEH). This project is being conducted for the East Bay Regional Park District, and follows previous site investigation and remediation activities (conducted since 1993). The key regulatory agencies for this investigation are the ACDEH, the Regional Water Quality Control Board, and the California Department of Fish and Game. I declare, under penalty of perjury, that the information and/or recommendations contained in the attached document or report is true and correct to the best of my knowledge.

If you have any questions regarding this report, please contact Mr. Neal Fujita of the East Bay Regional Park District, or contact me directly at (510) 644-3123.

Sincerely,



Richard S. Makdisi, R.G., R.E.A.
Principal and Project Manager

cc: Carl Wilcox - California Department of Fish and Game
Neal Fujita - East Bay Regional Park District
State of California GeoTracker system (electronic upload)

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1.0 PROJECT DESCRIPTION AND SITE HISTORY

PROJECT DESCRIPTION

The subject property is the East Bay Regional Park District (EBRPD) 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 subsurface contamination caused by leakage from one or both of two former underground fuel storage tanks (UFSTs) that contained gasoline and diesel fuel. The Alameda County Health Care Services Agency, Department of Environmental Health (Alameda County Environmental Health) has provided regulatory oversight of the investigation since its inception. Other regulatory agencies with historical involvement in site review include the Regional Water Quality Control Board – San Francisco Bay Region (Water Board) and the California Department of Fish and Game (CDFG).

Bioventing was selected as an appropriate corrective action to mitigate residual petroleum contamination, based on site conditions, residual contaminant distribution, and results from a previously conducted bioventing pilot test in 2004 (SES, 2004b). The bioventing system was approved by Alameda County Environmental Health (Alameda County Environmental Health, 2005b), and was installed and started up in December 2005 and January 2006 (SES, 2006a). The First Quarter Bioventing Status Report was issued in April 2006 (SES, 2006b). Alameda County Environmental Health responded to that report (in its letter of March 15, 2006) approving the proposed approach of monthly bioventing operations and maintenance (O&M) and reporting.

This report documents the activities conducted in the Third and Fourth Quarter of 2007, and summarizes the soil bioventing system-related activities conducted at the site throughout 2007. A microbial respiration test was conducted during the Fourth Quarter, from October 15 to October 17, 2007.

SITE DESCRIPTION

Figure 1 shows the location of the project site. A site plan showing the full-scale bioventing system is presented on Figure 2.

N

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

Redwood Reg. Park Service Yard Oakland, CA	By: MJC	MARCH 2006
	Figure 1	

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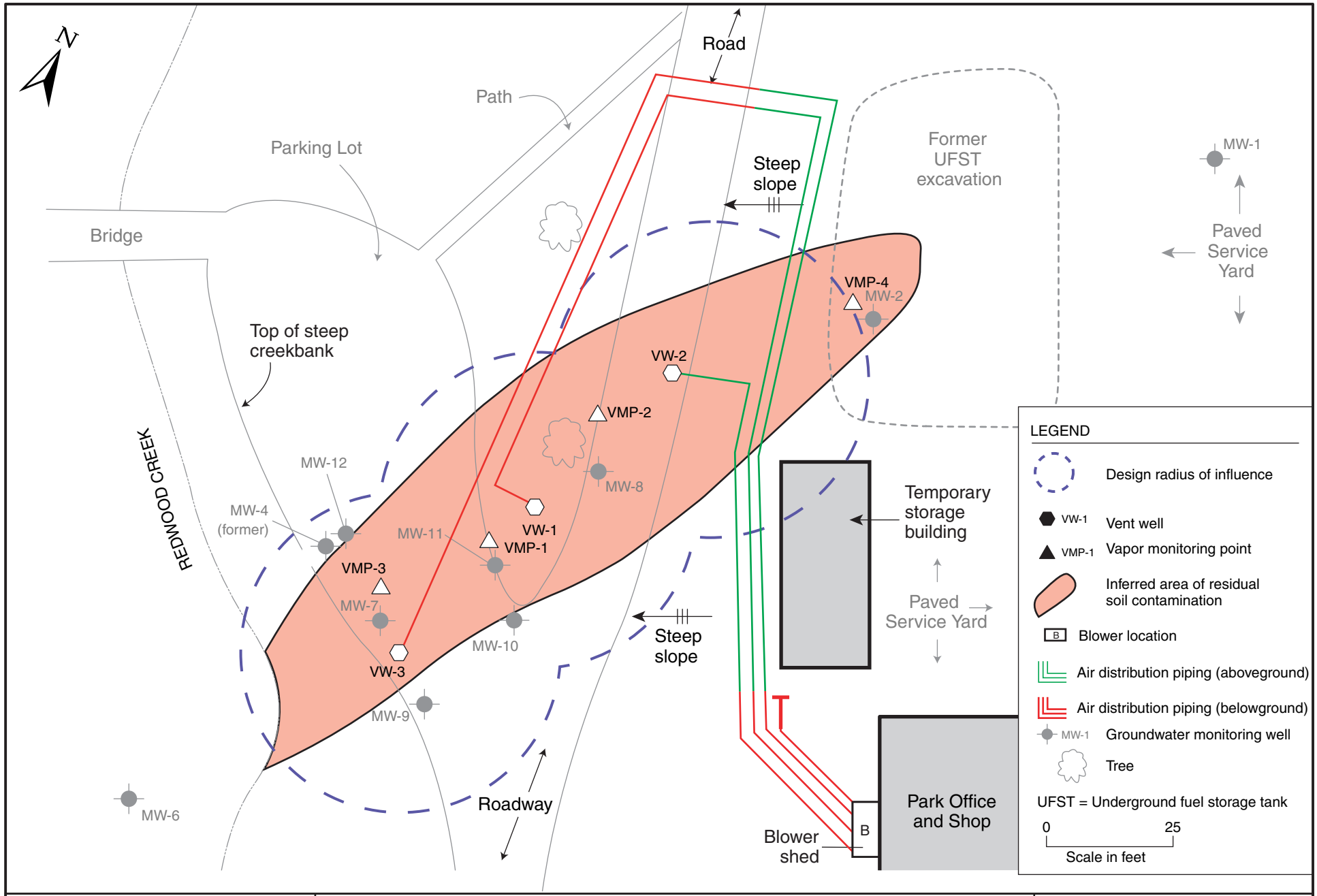
2006-17-01



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FULL-SCALE BIOVENTING SYSTEM

7867 Redwood Rd, Oakland, CA

Figure 2

by: MJC | **DECEMBER 2005**

2005-66--08

The site slopes to the west, from an elevation of approximately 564 feet above mean sea level (amsl) at the eastern edge of the service yard to approximately 530 feet amsl at Redwood Creek, which defines the approximate western edge of the project site with regard to this investigation.

From east to west, the study area consists of:

- Flat, paved EBRPD service yard with several permanent and temporary buildings/sheds (former UFST excavation area);
- Steep slope (approximately 45 degrees) between the western edge of the service yard and the park entrance road (immediately west of MW-2);
- Hummocky terrain with low vegetation (between MW-8 and MW-11), including a large EBRPD-designated sycamore tree (adjacent to MW-8 and VMP-2);
- Flat, unpaved parking lot (between MW-11 and MW-7); and
- Steep slope (approximately 45 degrees) to Redwood Creek (immediately west of MW-12, MW-7, and MW-9).

SITE HISTORY AND CONTAMINATION

Contaminant corrective actions and investigations have been conducted at the site since 1993. General phases of work previously conducted include:

- Removal of UFSTs and contaminated soil;
- Installation and quarterly monitoring of groundwater monitoring wells;
- Several phases of remedial investigation-oriented exploratory borehole drilling and sampling;
- A correction action feasibility study;
- Two phases of ORC™ injection;
- An evaluation of bioventing feasibility as a corrective action, which included a bioventing pilot test; and
- Installation and startup of the bioventing system in December 2005 and January 2006. After startup, four weekly monitoring/air flow optimization events were conducted.

As detailed in previous SES reports, the available data support the following conclusions:

- The saturated zone overlies laterally extensive bedrock, which limits downward migration of groundwater contamination.

- The unsaturated zone varies in thickness due to seasonal water level fluctuations of several feet.
- Site chemicals of concern include total petroleum hydrocarbons (TPH)—specifically as gasoline (TPHg) and diesel (TPHd); benzene, toluene, ethylbenzene, and xylenes (BTEX); and methyl *tertiary*-butyl ether (MTBE).
- Residual soil contaminant mass in the unsaturated zone is acting as a long-term source of groundwater contamination; the maximum thickness of the residual soil contamination (during lowest water level periods) is approximately 10 feet.
- Previous ORC™ injection programs resulted in apparent permanent reductions at the peripheral plume margins, but were followed by rebound to pre-injection conditions within the central portions of the plume, corroborating the conceptual model that remaining unsaturated zone soil contamination is continuing to impact groundwater.
- Site conditions appear favorable for bioventing as a corrective action to reduce unsaturated zone soil contamination, especially in the near-source area that is inaccessible to other methods due to the hilly topography.

REGULATORY STATUS AND DATA REPORTING

The lead regulatory agency for the site investigation and remediation is Alameda County Environmental Health, with oversight provided by the Water Board. The CDFG is also involved with regard to water quality impacts to Redwood Creek. The most recent regulatory agency input was Alameda County Environmental Health's request for a pilot test to evaluate one or more additional remedies to accelerate remediation at the site (Alameda County Environmental Health, 2007). SES is currently working with the EBRPD to develop a workplan for installing an additional vapor well. This workplan will be submitted to the ACEH by the requested date, February 11, 2008.

The site is in compliance with the State Water Resources Control Board's GeoTracker requirements for uploading of electronic data and reports. In addition, electronic copies of all bioventing-related reports have been uploaded to Alameda County Environmental Health's online file transfer protocol (ftp) system. Per Alameda County Environmental Health's October 31, 2005 "Miscellaneous Administrative Topics and Procedures" directive, effective January 31, 2006, paper copies of reports are no longer required to be provided to Alameda County Environmental Health.

2.0 BIOVENTING SYSTEM DESCRIPTION

The bioventing system consists of the following components:

- Three vent wells (VWs), screened across the unsaturated zone.
- Four vapor monitoring points (VMPs), each with two nested screened intervals at depths coincident with VW screened intervals.
- A regenerative-type air blower installed in a small shed on the west side of the service yard garage building. The blower is rated at 140 cubic feet per minute (cfm) and exerts a pressure of approximately 1 to 3 pounds per square inch (psi).
- Air distribution piping between the blower and the VW wellheads, including a manifold just downstream of the blower.
- Appurtenant air flow valves, pressure/vacuum gauges, and air sampling ports.

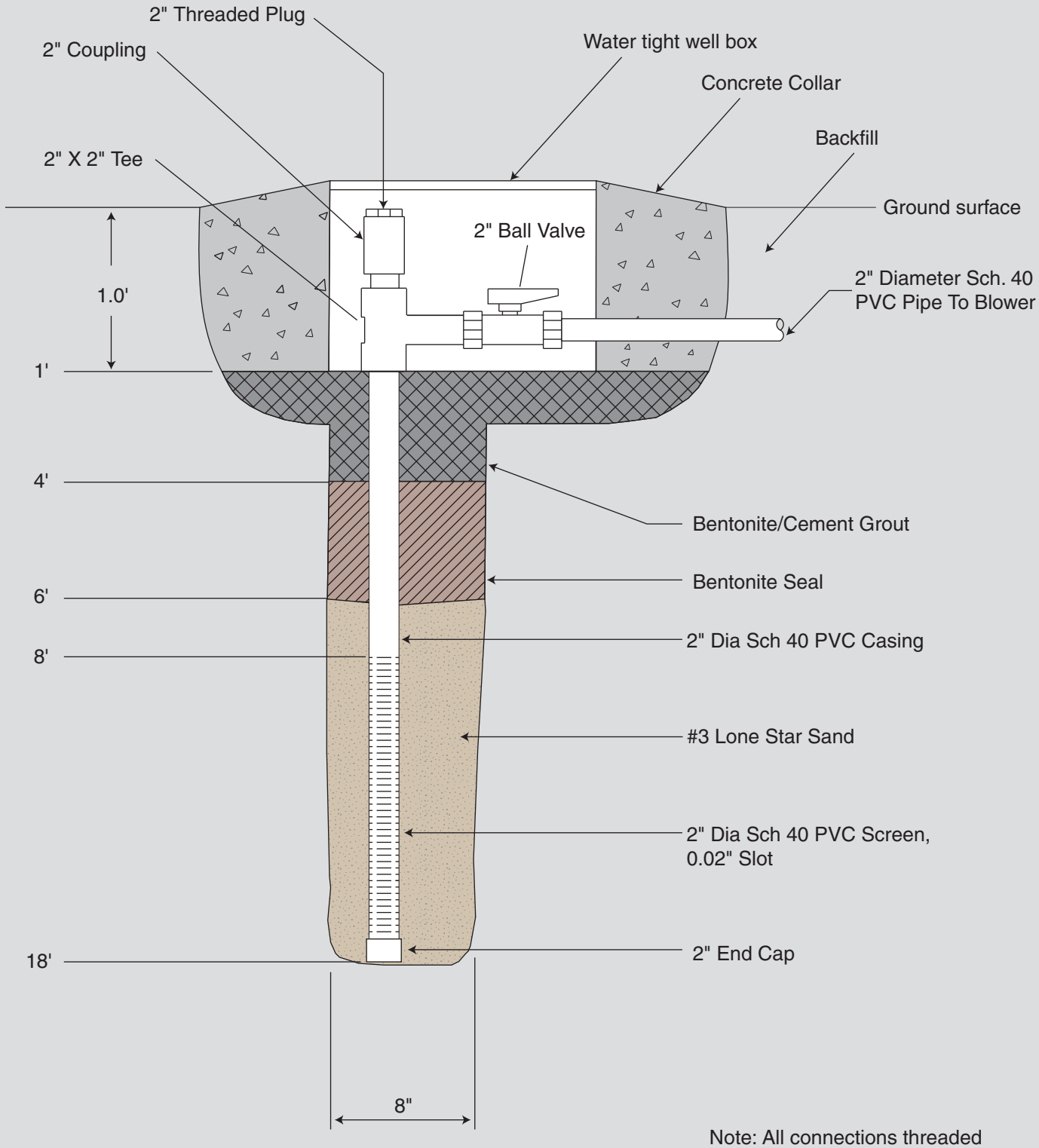
Table 1 summarizes bioventing well construction data. Figure 2 (in the previous chapter) is a site plan showing the layout of the bioventing system. Figures 3 and 4 are as-builts for typical site VMPs and VWs, respectively. Figure 5 is a flow instrumentation diagram for the blower and associated manifold. This blower system was designed and configured based on the pilot test design specifications—i.e., achieving a potential 30-foot radius of influence and a flow rate of 40 standard cubic foot per minute (scfm) to individual VWs under induced pressure conditions.

Table 1
Bioventing Well Construction Data
Redwood Regional Park Service Yard, Oakland, California

Well	Screen Interval Depth (feet)	Filter Pack Sand Depth Interval (feet)
VW-1	6 – 16	4 – 16
VW-2	8 – 18	6 – 18
VW-3	8 – 18	6 – 18
VMP-1	10 – 11.5	9.5 – 12
	14 – 15.5	13.5 – 16
VMP-2	10 – 11.5	9.5 – 12
	14 – 15.5	13.5 – 16
VMP-3	10 – 11.5	9.5 – 12
	12.5 – 14	12 – 14.5
VMP-4	15.5 – 17	15 – 17.5
	20.5 – 22	20 – 20.5

Note:

All depths are in feet below top of well box (approximately ground surface).



NOT TO SCALE
(well casing is actually centered in borehole)

Note: All connections threaded with gasket or teflon tape. No glues used.

AS-BUILT VENT WELL CONSTRUCTION DETAILS FOR VW-2 & VW-3

Redwood Regional Park **Oakland, CA**	**By: MJC**	**DECEMBER 2005**
	Figure 3	

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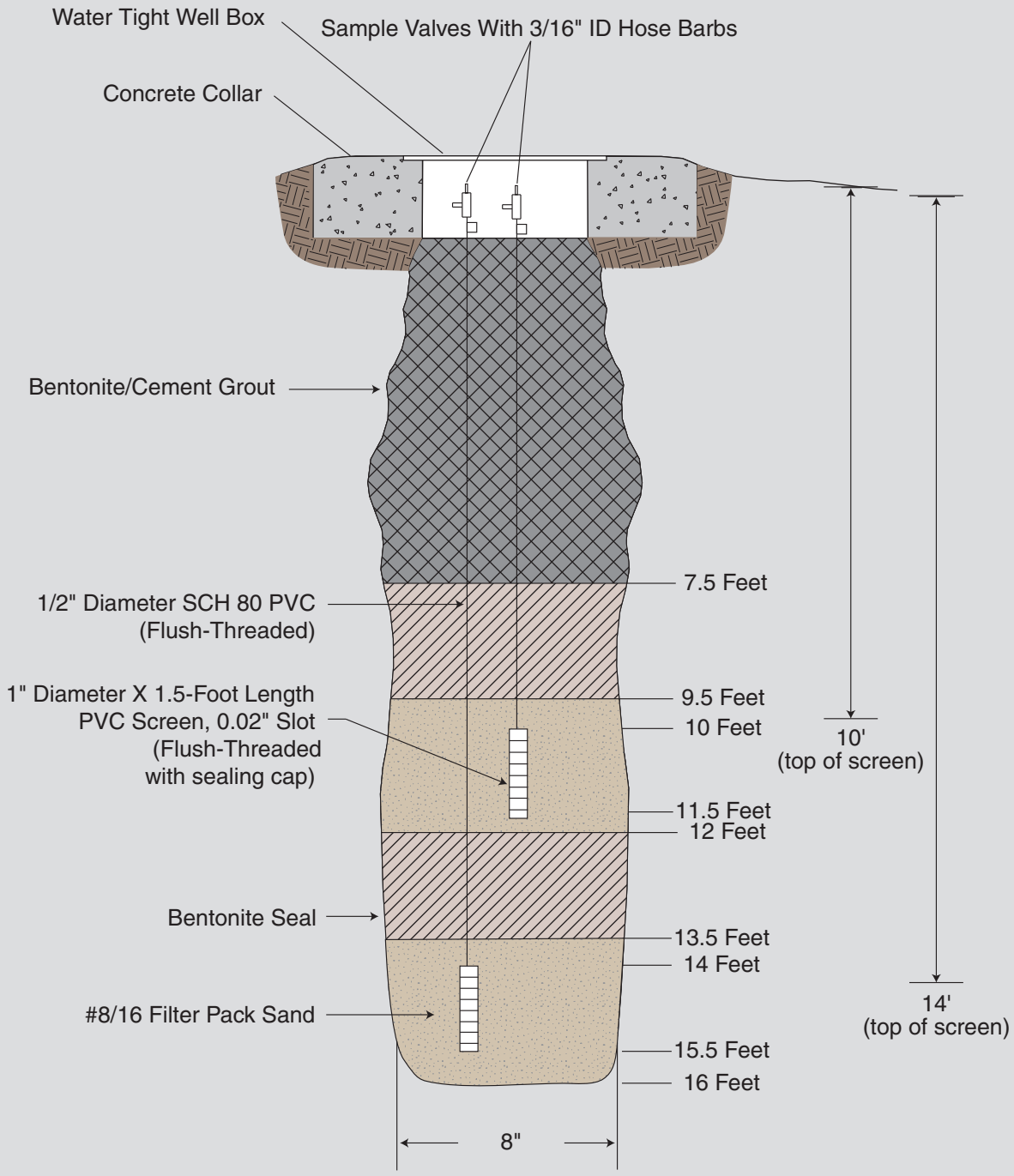
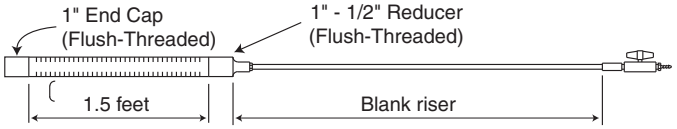
2005-66-09



Not To Scale

Note: Depts shown are applicable to VMP-1 and VMP-2. Deptsh in VMP-3 and VMP-4 vary.

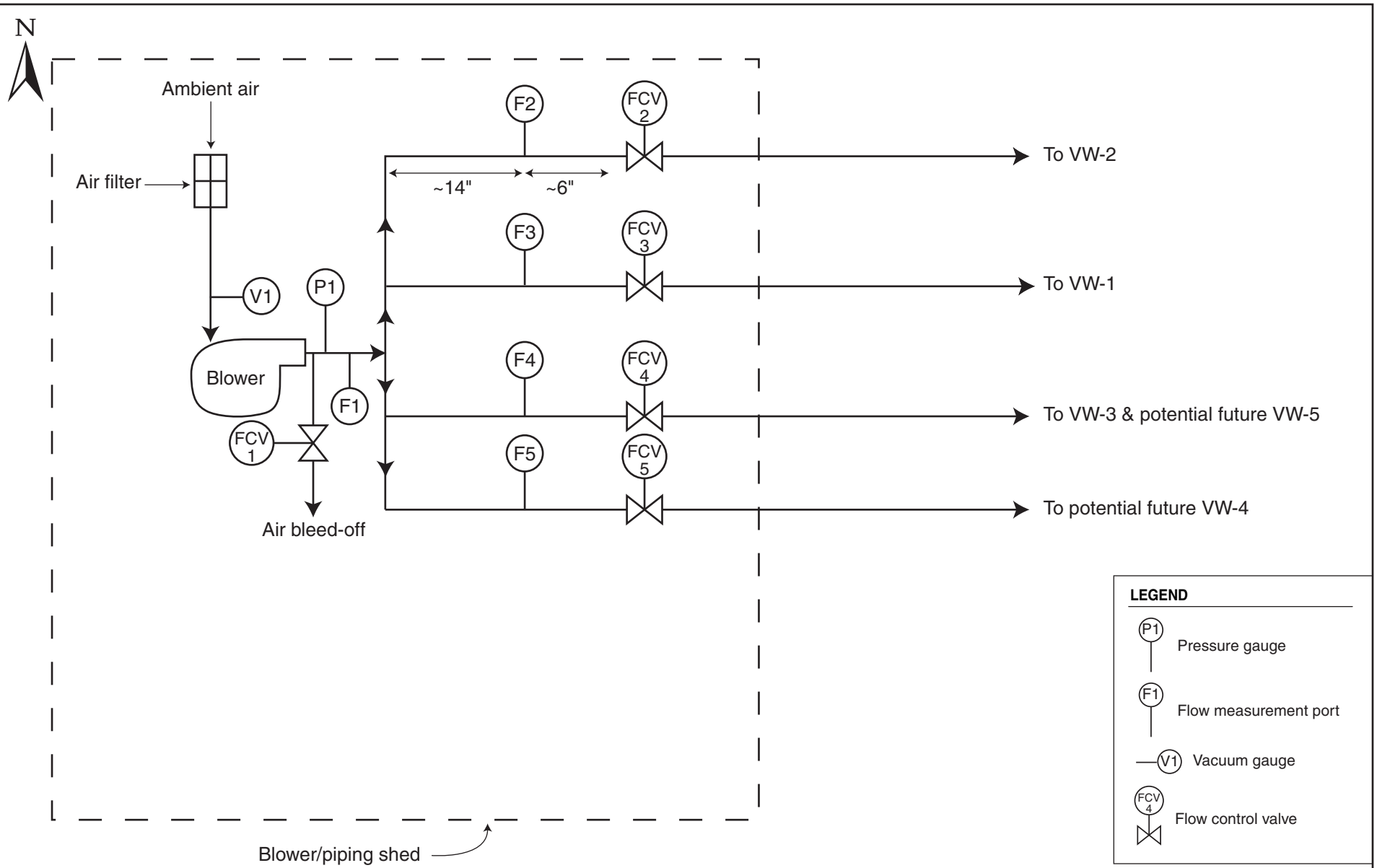


VMP SCREEN DETAIL
Not To Scale

AS-BUILT VAPOR MONITORING POINT CONSTRUCTION DETAILS

Redwood Regional Park **Oakland, CA**	**By: MJC**	**JUNE 2005**	STELLAR ENVIRONMENTAL SOLUTIONS, INC GEOSCIENCE & ENGINEERING CONSULTING
	Figure 4		

2005-66-10



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BIOVENTING PROCESS FLOW AND INSTRUMENTATION DIAGRAM

7867 Redwood Rd, Oakland, CA

Figure 5

by: MJC | **DECEMBER 2005**

2005-66-07

3.0 THIRD AND FOURTH QUARTERS ACTIVITIES AND FINDINGS

SYSTEM OPERATION

As discussed in the bioventing system installation and startup report (SES, 2006a), the system was started up in January 2006, and four weekly monitoring/air flow optimization events were conducted. During that time, manifold valves were open to all three VWs; however, no measurable air injection occurred in VW-2 (fully flooded well screen) or VW-3 (partially flooded well screen). Blower outlet pressure during that period was set at 50 inches of water.

Since May 2006, the system has operated continuously with VW-1, VW-2, and VW-3 fully open—except for temporary system shutdowns for monthly O&M activities, the in-situ respiration tests, and power outages that resulted in shutdowns for approximately 1 week in December 2006 and June 2007.

O&M ACTIVITIES

Monthly O&M events were conducted during the third and fourth quarters (on July 21, August 15, September 14, October 15, November 15, and December 6, 2007), with the following objectives:

- Confirm that the system was operating within design parameters, with no system problems (e.g., leaks, non-functioning components).
- Conduct preventive maintenance (i.e., clean blower air filter).
- Continue to evaluate air flow through the VW screened intervals.

Monthly O&M activities included:

- Measure water levels in all VMPs and VWs.
- Inspect aboveground portions of the system (i.e., blower, air distribution piping, and wellheads) for leaks or structural problems.
- Record blower outlet pressure and inlet vacuum.

- Qualitatively evaluate if air was flowing across the VW intervals. This was achieved by opening individual VW manifold wells while the blower was operating, and looking for a drop in blower pressure (a drop in outlet pressure when a valve is opened indicates that air flow is occurring).
- Inspect and clean the blower inlet filter.
- Complete an O&M checklist.

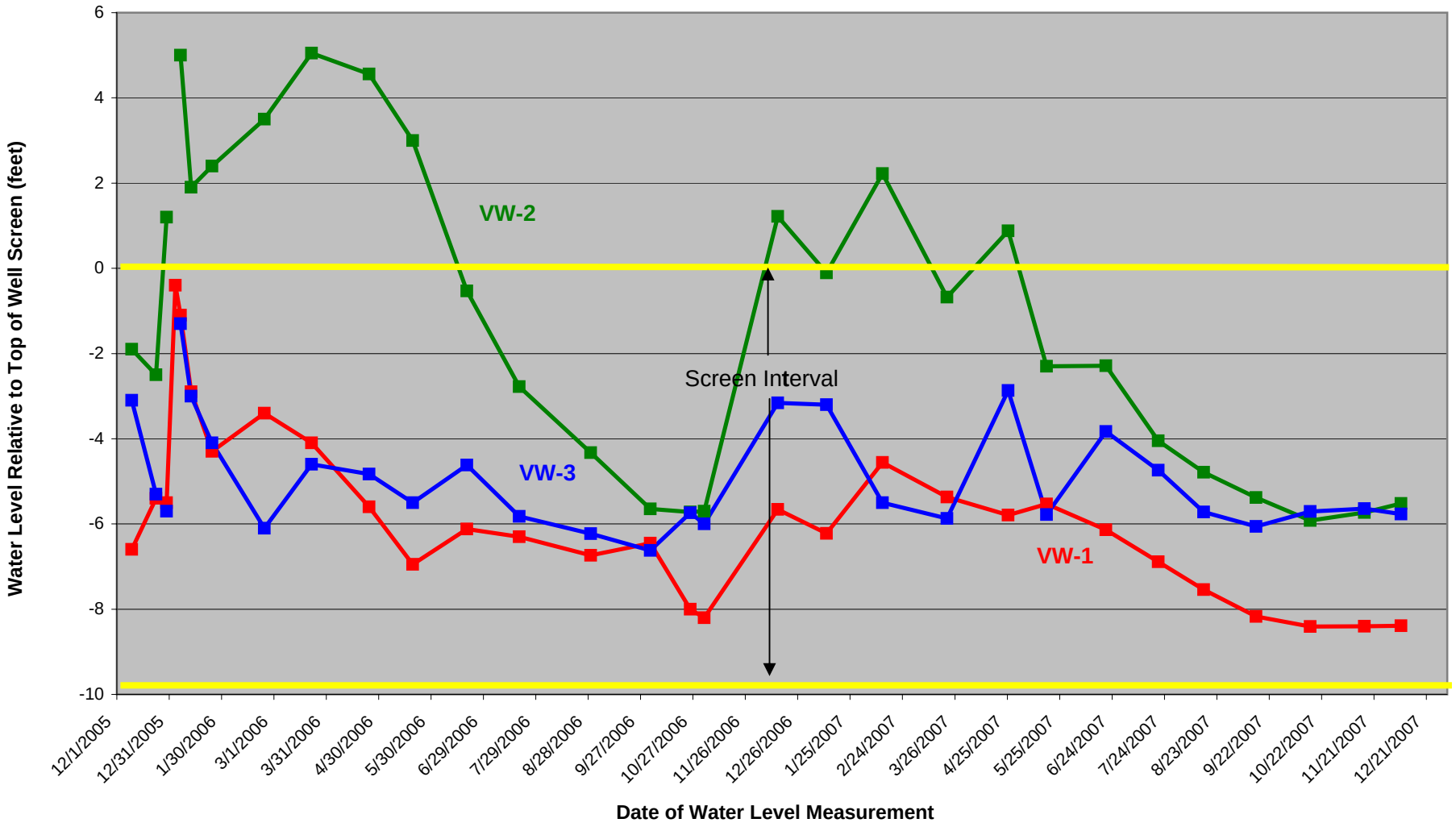
Appendix A contains the completed checklists for the third and fourth quarters.

O&M FINDINGS

The results of the O&M activities are as follows:

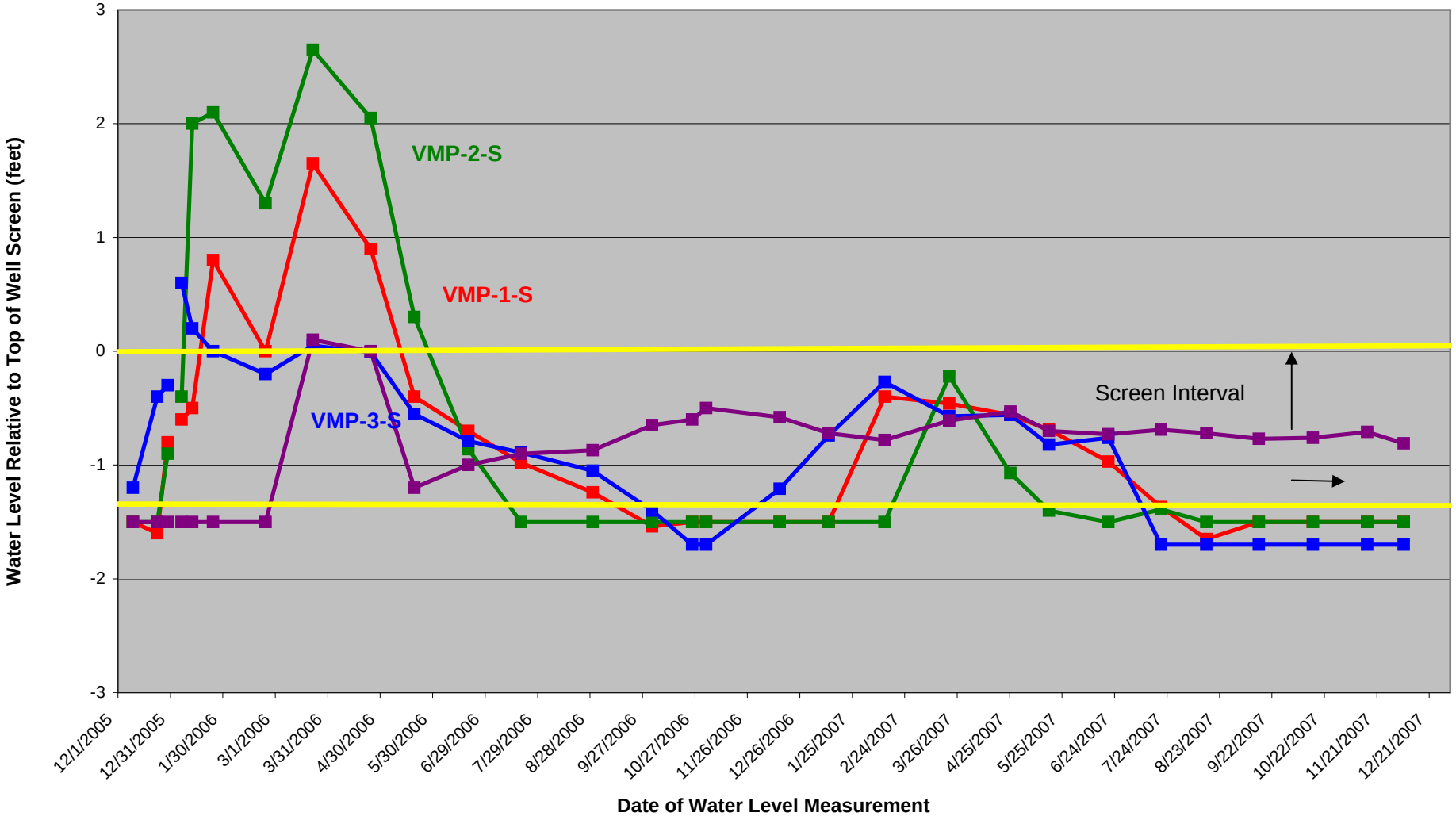
- The blower is functioning properly, there are no significant air leaks in the piping system, and the VMP and VW wellheads and air distribution piping are in good condition.
- Water levels are approximately the same in the shallow VMPs as in the deep VMPs (at each nested well location), suggesting that both the deep and shallow VMP well screens are under similar hydraulic conditions.
- Water levels in VWs showed a general increase after the wells were installed, resulting in partially or fully flooded well screens in all VWs. Water levels began to decrease after January of 2005. The water levels in VW-1 and VW-2 have fluctuated since then, but have always been below top of screen. Figure 6 shows groundwater levels in VWs relative to the top of the screened interval. The screen in VW-3 was fully to partially flooded from January 2007 to approximately April of 2007, at which point the water level began to lower. All three wells have had fully exposed screens since April of 2007. Water levels in all of the VWs have been decreasing since May of 2007.
- As shown on Figure 7, groundwater levels in the shallow VMPs have fluctuated slightly since March 2006. However, all of the VMPs have been below the top of the well screen since May 2006.
- As shown on Figure 8, groundwater levels in deep VMPs have been relatively stable since the VMPs were installed, with the exception of VMP-2-D, which has shown a general increase in groundwater level since March 2006. Since the deep VMPs were installed, water levels in three of the four deep VMPs have been above the top of the well screen. Water levels in VMP-2-D have historically been below the well screen; however, they have been above the well screen since September of 2007.

Figure 6 - Historical Groundwater Levels Relative to Top of VW Screened Intervals
Redwood Regional Park Service Yard - Oakland, California



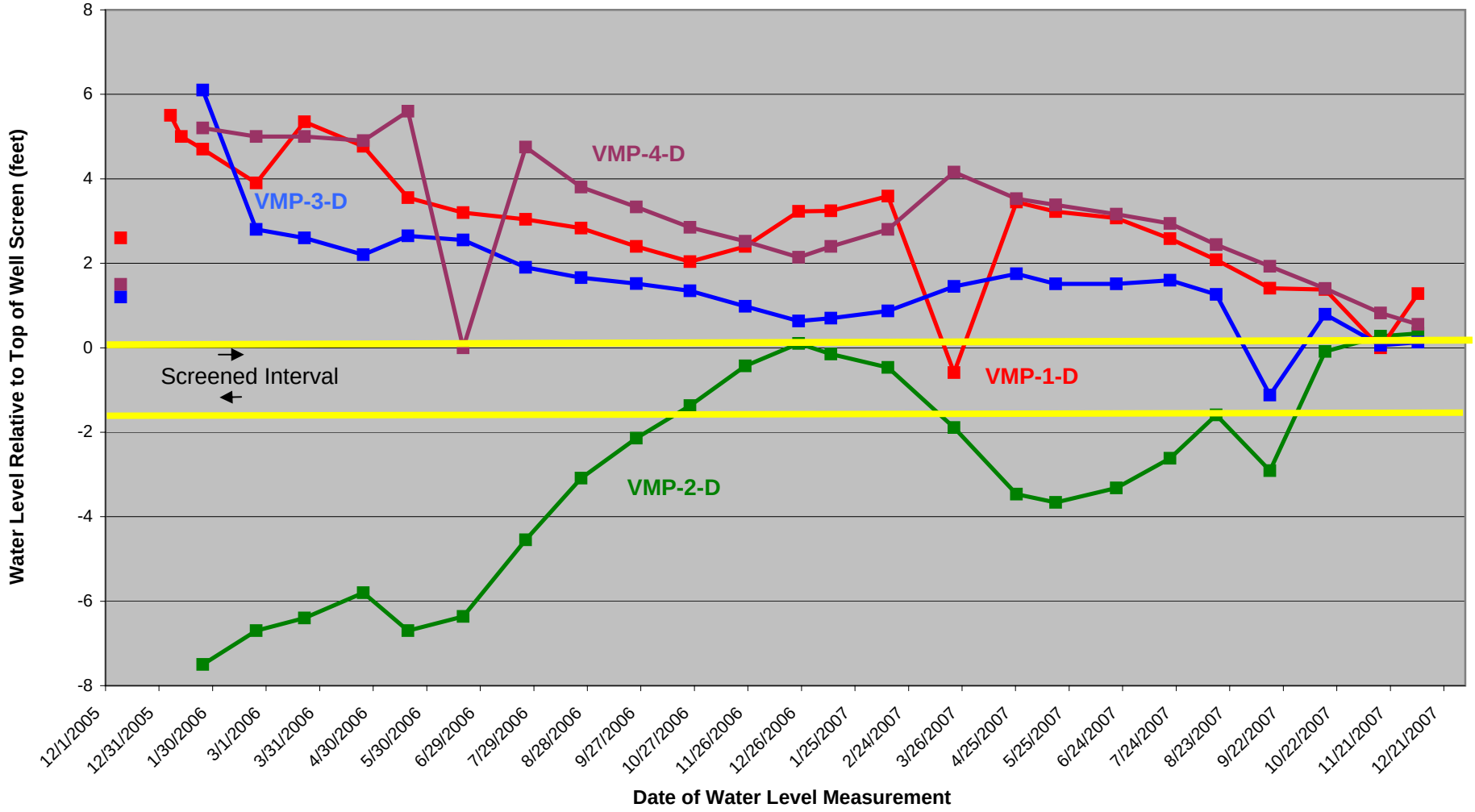
Note: "0" line represents the top of well screened interval;
water levels above that line represent fully flooded screen.

Figure 7 - Historical Groundwater Levels Relative to Top of Shallow VMP Screened Intervals
Redwood Regional Park Service Yard - Oakland, California



Note: "0" line represents the top of well screened interval;
water levels above that line represent fully flooded screen.

Figure 8 - Historical Groundwater Levels Relative to Top of Deep VMP Screened Intervals
Redwood Regional Park Service Yard - Oakland, California



Note: "0" line represents the top of well screened interval;
water levels above that line represent fully flooded screen.

- Air is being injected (and has been since system startup) in the non-flooded portion of the VW-1 screen, but at flow rates less than optimum due to the partially flooded screen. Optimum air flow was reached in October of 2007, but gradually began to lower as rainfall levels increased.
- No measurable air injection occurred in VW-2 December 2006 and March 2007, due to the fully flooded screen. Sporadic air flow occurred between March and June 2007. However, a significant increase was observed in July 2007 which remained steady until optimum flow was reached in October 2007. Partial flow was observed in November and December of 2007 as water levels begin to rise.
- No measurable air injection has occurred in VW-3 since system startup, although that well's screen has been at least partially exposed (not flooded) since installation. SES confirmed (by physical probing) that the screened interval of that well is properly installed (from 8 to 18 feet), and that water is infiltrating into the well (confirming that the annular filter pack was not inadvertently cemented in during well installation). The inability to inject air may be due to residual saturation in the well filter pack and/or surrounding soils, or because the native soils in the borehole annulus may have been smeared during installation. The well was redeveloped on August 15, 2007 to clean any smear that may have occurred in the borehole annulus. Although the screen was exposed, there remains no measurable air injection in VW-3.

IN-SITU RESPIRATION TEST

Groundwater elevations in the third and fourth quarters of 2007 lowered an average of 1.6 feet compared to the previous quarter, which reflects the dry season. The lowering of groundwater below the bioventing screened interval zone allowed for a microbial respiration test to be conducted.

RESPIRATION TEST

A respiration test was conducted at the site to access the degree of microbial biodegradation activity included: 1) three vapor monitoring points (VMP-1, VMP-2, and VMP-3) with both nested shallow and deep screen intervals; and 2) three vent wells (VW-1, VW-2, and VW-3) for a total of nine measuring points. The test consisted of measuring percent oxygen, percent carbon dioxide, and parts per million (ppm) by volume air of total volatile hydrocarbons (TVH) over a 2-day period.

VMP-2 and to a lesser extent VMP-1 showed a significant decrease in oxygen that would be indicative of microbial activity. The position of VMP-2 (nearly midway between the two vent

wells) and its relatively higher elevation likely resulted in increased aeration and microbial activity at this point.

While only VMP-2 showed response over the entire 48 hour period, this is the most important area, as it is the source area with the residual contamination that feeds the groundwater plume and thus this is the critical area where the bioventing must work. The respiration test completed at the site was a 48 hour test designed to evaluate oxygen utilization by indigenous microorganisms as an indicator of their ability to utilize the hydrocarbons in the soil as a food source. Oxygen utilization rates are determined from data obtained during the in-situ respiration test. The rates are calculated as the zero order relationship between percent oxygen and time, typically measuring the percent oxygen decrease within the first 24-hours to estimate a 24-hour utilization rate. Once oxygen concentrations drop below approximately 5 % there is considered to be no more utilization.

To calculate oxygen utilization rates, only the first 24-hour linear portion of the data is used because this represents oxygen utilization when the oxygen supply is not limited, as is the case during active bioventing. To estimate hydrocarbon biodegradation rates from the oxygen utilization rates, a stoichiometric relationship for the oxidation of the contaminant is used. For hydrocarbons, hexane is used as the representative hydrocarbon. The stoichiometric relationship used to determine petroleum degradation rates is:

$$C_6H_{14} + 9.5O_2 \rightarrow 6CO_2 + 7H_2O$$

Based on the utilization rates (% oxygen per day), the biodegradation rate in terms of milligrams of hexane-equivalent per kilogram of soil per day is estimated using the above equation. These terms may be derived through either direct measurement or estimation. The oxygen utilization rate, k_o is directly measured in the in-situ respiration test. The ratio of hydrocarbons to oxygen required for mineralization, C, can be calculated based on stoichiometry (see Equation for hexane) but generally will fall between 0.29 and 0.33. This neglects any conversion to biomass, which probably is small and difficult, if not impossible, to measure.

Figure 9 shows the respiration test results. The oxygen utilization within the first 24- hours is 5.8%. This value is essentially the same as the 6.1% oxygen utilization within the first 24-hours exhibited in the 2006 respiration test. Ideally, in the absence of additional hydrocarbon input form leaching residual hydrocarbons entrained in the soil of the original UFST source area, the oxygen utilization rate should decrease as a function of their being less and less mass to reduce over time.

The oxygen utilization are of the only respiration test derived value, the other terms of the equation used to estimate the Biodegradation rate, K_B, are literature derived, summarized by

Leeson and Hinchee (1996), such as the soil bulk density, density of oxygen, and mass of hydrocarbon to oxygen required for mineralization (1/3.5).

Thus is we assume an average oxygen utilization rate of 5.8% O_2/day and an initial average soil concentration of 6,000 mg TPH/kg soil (based on the average of the soil samples from the source area), the oxygen utilization is related to hydrocarbon degradation by the following equations:

$C_6H_{14} + 9.5\ O_2 \rightarrow\ 6\ CO_2 + 7\ H_2O$

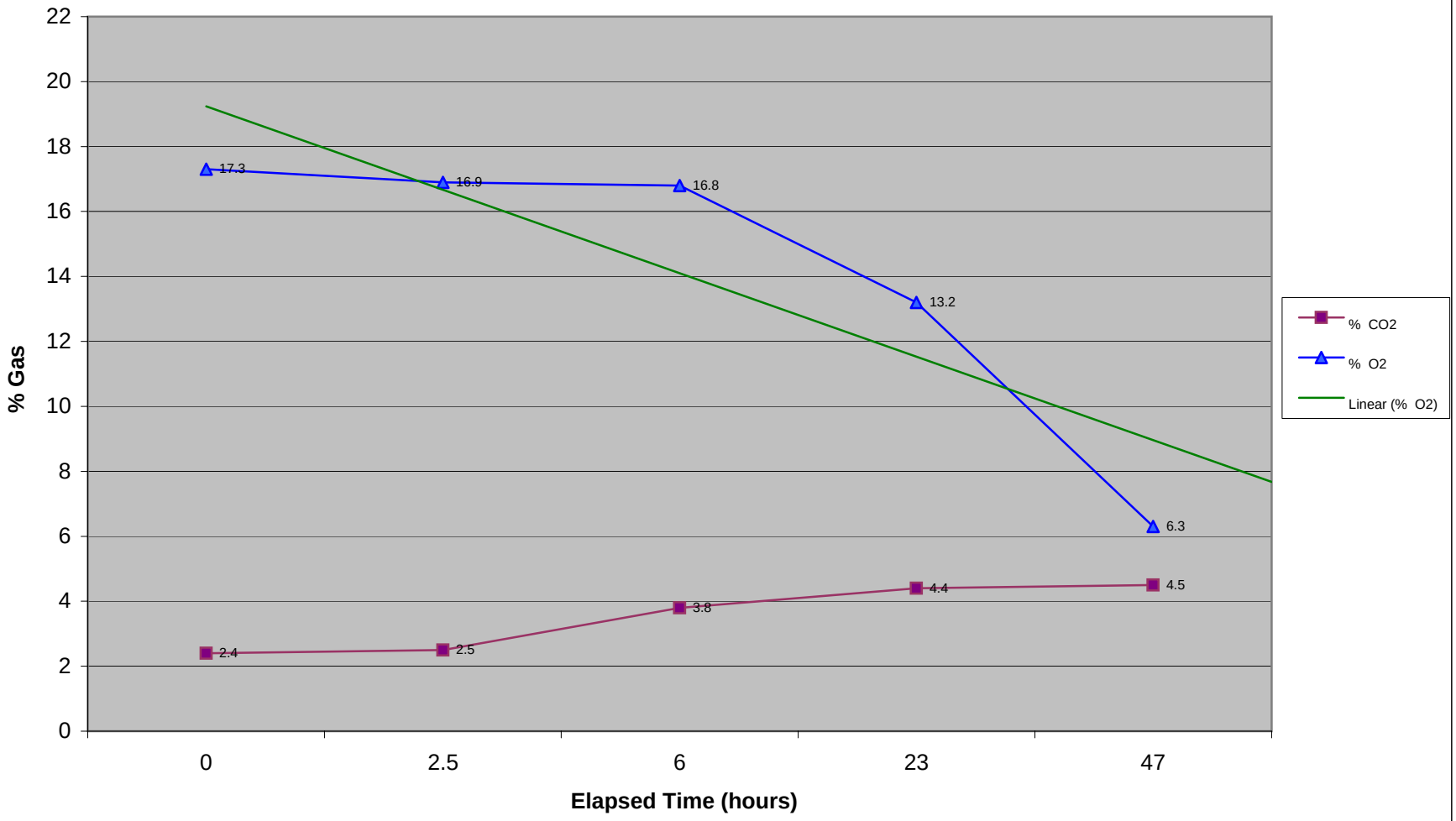
Using the above assumptions, an oxygen utilization rate of 5.8% O_2/day would correspond to a biodegradation rate of approximately 3.4 mg/kg-day. Given that the initial soil concentration is 6,000 mg/kg, an estimate of cleanup time is calculated as follows:

6,000 mg/kg = 1,764 days = 4.8 years at 3.4 mg/kg-day

This calculation provides a reasonable estimate of the amount of time necessary to remediate the site, but only in so much as the initial soil concentration of 6,000 mg/kg is accurate and empirical data associated with the groundwater concentrations, particularly recently at monitoring well MW-2, suggest more hydrocarbon contaminant mass is likely associated with the upgradient source area that originally indicated. The calculation method generally tends to underestimate treatment time because k_B decreases over time. At the same time, this calculation overestimates treatment time because it does not consider treatment in the expanded bioreactor. Therefore, the calculation must be coupled with process monitoring to provide field-based evidence—such as reduction in the dissolved hydrocarbon fraction in the Redwood monitoring wells—to gauge whether the site actually is remediated within this time period. Due to widely variable contaminant concentrations in the soil (from a few 100 mg/kg to 8,000 mg/kg), the average biodegradation rate does not reflect actual biodegradation rates throughout the site. Biodegradation rates also may fluctuate with season and as contaminant concentrations decrease. Therefore, process monitoring is an important parameter in determining treatment time.

In-situ respiration testing should be used as the primary indicator for site closure. A good indication that the site is remediated and that final soil sampling can be conducted is when the in-situ respiration rate in the contaminated area is similar to that in the uncontaminated area. In-situ respiration testing to determine remediation success is preferable economically to relying on soil sampling as the sole indicator of site remediation, because it eliminates the high cost of intermediate soil sampling. A 2008 respiration test will be performed to evaluate changes in the apparent oxygen utilization rate.

Figure 9: Respiration Test VMP-2 O_2-CO_2 Trend Plot
October 15-17, 2007
Redwood Regional Park Service Yard, Oakland, CA



4.0 SUMMARY, CONCLUSIONS, AND PROPOSED ACTIONS

This section presents the conclusions and proposed actions with regard to continued operation of the bioventing corrective action system at the Redwood Regional Park Service Yard.

SUMMARY AND CONCLUSIONS

- The blower is operating within design parameters, and there are no physical problems with the blower or air distribution piping.
- Air flow is occurring through a significant portion of the VW-1 screened interval, but at times at less-than-optimum rate due to high water level conditions.
- Air flow continues to flow through the VW-2 screened interval as water levels have been significantly lower than previous years. Historically, this screen on this well becomes saturated in November or December.
- No air flow has occurred through the VW-3 screened interval; even though the screen has been fully exposed since May. Redeveloping the well to clear any clay particles which would impede air flow did not clear the screen; and therefore, there most be some other obstruction which is impeding air flow.
- An estimate of biodegradation of approximately 1,280 ppm per year is estimated from the respiration test at VMP-2 based on the oxygen utilization.
- Continued monthly O&M (including water level measurements) will determine whether air injection rates at the VWs will improve.

PROPOSED ACTIONS

EBRPD proposes to implement the following actions with regard to the bioventing program:

- Augment the existing bioventing system in the area of the upgradient original UFST source area. A design review and expansion of the remedial system and development of a workplan has been requested by ACDEH. The workplan is to be submitted to the Water Board by the requested date of February 11, 2008.
- Continue to conduct monthly system O&M events, including air flow optimization when water level changes and/or air injection rates warrant.

- Continue to evaluate water levels in VWs and VMPs.
- Conduct an in-situ respiration test in 2008, at such time as water levels drop sufficiently to evaluate response in at least the shallow VMP screens, which should occur in late summer to early fall.
- Continue to report on bioventing system progress/activities in quarterly progress reports, and prepare an annual summary report.

5.0 REFERENCES

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Alameda County Health Care Services Agency, Department of Environmental Health (Alameda County Environmental Health), 2006. Letter approving monthly bioventing O&M and reporting and in-situ respiration test. March 15.

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APPENDIX A

Monthly System O&M Checklists

Redwood Regional Park Service Yard
Bioventing Operations & Maintenance Checklist
Vapor Monitoring Points

Date: **10/15/2007**

	Depth to Top of Screen (ft below TOC)	Water Level (ft below TOC)	Well Head in Good Condition?
VMP-1-Shallow	9.3	Dry	Yes
VMP-1-Deep	13.4	12.02	Yes
VMP-2-Shallow	9.5	Dry	Yes
VMP-2-Deep	13.9	14.24	Yes
VMP-3-Shallow	9.8	Dry	Yes
VMP-3-Deep	12.0	11.87	Yes
VMP-4-Shallow	15.1	15.86	Yes
VMP-4-Deep	20.8	20.25	Yes

TOC= Top of well Casing

Redwood Regional Park Service Yard
Bioventing Operation & Maintenance Checklist
Blower and Vent Wells

Date: **10/15/2007**

	Air Flow (scfm)		Blower Inlet Vaccum (inches H_20)		Blower Outlet Pressure (inches H_20)		Depth to Top of Screen	Water Level	Well Head in
	Before adjustment	After adjustment	Before adjustment	After adjustment	Before adjustment	After adjustment	(ft below TOC)	(ft below TOC)	Good Condition?
Blower [(a)]	NM	NM	22	22	20	20			
VW-1 [(b)]	NM	NM					5.6	14.01	yes
VW-2 [(b)]	NM	NM					8.4	14.32	yes
VW-3 [(b)]	NM	NM					8.8	14.51	replaced

Wells on-line (valve open) at arrival **1,2,3** Wells on-line at departure **1,2,3**

Notes:
[(a)] Air flow measured at sampling port between blower discharge and manifold.
[(b)] Air flow measured at blower manifold sampling port
TOC - Top of Casing of well NM = Not Measured

Checklist Items

Is any airflow evident through VW-1? **40** inches H_2O drop
(Close all VW valves, set outlet pressure at 40 inches H_20, then open VW-1 valve only)

Is any airflow evident through VW-2? **45** inches H_2O drop
(Close all VW valves, set outlet pressure at 40 inches H_20, then open VW-2 valve only)

Is any airflow evident through VW-3? **0** inches H_2O drop
(Close all VW valves, set outlet pressure at 40 inches H_20, then open VW-3 valve only)

Any audible air leaks in air distribution piping or VW wellheads? **No**

Blower filter removed and brushed off? **Yes** Blower filter replaced? **No**

Redwood Regional Park Service Yard
Bioventing Operations & Maintenance Checklist
Vapor Monitoring Points

Date: **11/15/2006**

	Depth to Top of Screen (ft below TOC)	Water Level (ft below TOC)	Well Head in Good Condition?
VMP-1-Shallow	9.3	Dry	Yes
VMP-1-Deep	13.4	No Meas	Broken
VMP-2-Shallow	9.5	Dry	Yes
VMP-2-Deep	13.9	15.03	Yes
VMP-3-Shallow	9.8	Dry	Head needs rep.
VMP-3-Deep	12.0	11.99	Yes
VMP-4-Shallow	15.1	15.81	Head needs rep.
VMP-4-Deep	20.8	19.94	Yes

TOC= Top of well Casing

Redwood Regional Park Service Yard
Bioventing Operation & Maintenance Checklist
Blower and Vent Wells

Date: **11/15/2007**

	Air Flow (scfm)		Blower Inlet Vaccum (inches H_20)		Blower Outlet Pressure (inches H_20)		Depth to Top of Screen (ft below TOC)	Water Level (ft below TOC)	Well Head in Good Condition?
	Before adjustment	After adjustment	Before adjustment	After adjustment	Before adjustment	After adjustment			
Blower [a]	NM	NM	22	22	20	20			
VW-1 [b]	NM	NM					5.6	14.00	Yes
VW-2 [b]	NM	NM					8.4	14.13	Yes
VW-3 [b]	NM	NM					8.8	14.44	Yes

Wells on-line (valve open) at arrival **1,2,3** Wells on-line at departure **pending - system turned off because VM turned back on 11/20/07 after sampling p**

Notes:

[a] Air flow measured at sampling port between blower discharge and manifold.

[b] Air flow measured at blower manifold sampling port

TOC - Top of Casing of well NM = Not Measured

Checklist Items

Is any airflow evident through VW-1? **20** inches H_2O drop
(Close all VW valves, set outlet pressure at 40 inches H_20, then open VW-1 valve only)

Is any airflow evident through VW-2? **21** inches H_2O drop
(Close all VW valves, set outlet pressure at 40 inches H_20, then open VW-2 valve only)

Is any airflow evident through VW-3? **0** inches H_2O drop
(Close all VW valves, set outlet pressure at 40 inches H_20, then open VW-3 valve only)

Any audible air leaks in air distribution piping or VW wellheads? **No**

Blower filter removed and brushed off? **Yes** Blower filter replaced? **No**

Redwood Regional Park Service Yard
Bioventing Operations & Maintenance Checklist
Vapor Monitoring Points

Date: **12/6/2007**

	Depth to Top of Screen (ft below TOC)	Water Level (ft below TOC)	Well Head in Good Condition?
VMP-1-Shallow	9.3	Dry	Yes
VMP-1-Deep	13.4	12.12	Yes
VMP-2-Shallow	9.5	Dry	Yes
VMP-2-Deep	13.9	15.16	Yes
VMP-3-Shallow	9.8	Dry	Yes
VMP-3-Deep	12.0	12.03	Yes
VMP-4-Shallow	15.1	15.91	Yes
VMP-4-Deep	20.8	19.92	Yes

TOC= Top of well Casing

Redwood Regional Park Service Yard
Bioventing Operation & Maintenance Checklist
Blower and Vent Wells

Date: **12/6/2007**

	Air Flow (scfm)		Blower Inlet Vaccum (inches H_20)		Blower Outlet Pressure (inches H_20)		Depth to Top of Screen	Water Level	Well Head in
	Before adjustment	After adjustment	Before adjustment	After adjustment	Before adjustment	After adjustment	(ft below TOC)	(ft below TOC)	Good Condition?
Blower [(a)]	NM	NM	22	22	20	20			
VW-1 [(b)]	NM	NM					5.6	13.99	Yes
VW-2 [(b)]	NM	NM					8.4	13.92	Yes
VW-3 [(b)]	NM	NM					8.8	14.57	Yes

Wells on-line (valve open) at arrival **1,2,3** Wells on-line at departure **1,2,3**

Notes:
[(a)] Air flow measured at sampling port between blower discharge and manifold.
[(b)] Air flow measured at blower manifold sampling port
TOC - Top of Casing of well NM = Not Measured

Checklist Items

Is any airflow evident through VW-1? **20** inches H_2O drop
(Close all VW valves, set outlet pressure at 40 inches H_20, then open VW-1 valve only)

Is any airflow evident through VW-2? **22** inches H_2O drop
(Close all VW valves, set outlet pressure at 40 inches H_20, then open VW-2 valve only)

Is any airflow evident through VW-3? **0** inches H_2O drop
(Close all VW valves, set outlet pressure at 40 inches H_20, then open VW-3 valve only)

Any audible air leaks in air distribution piping or VW wellheads? **No**

Blower filter removed and brushed off? **Yes** Blower filter replaced? **No**