5-Year Review

Lockheed Martin Corporation
Beaumont Site No. 1
Beaumont, California

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1.0 INTRODUCTION

Lockheed Martin Corporation (Lockheed Martin) has been conducting soil and groundwater remediation at the Lockheed Beaumont Test Site No. 1 (Site) since 1994. The Site is located in Beaumont, California (Figure 1). The primary purpose of the remediation program is to conduct source removal from the Burn Pit Area (BPA) and the Rocket Motor Production Area (RMPA) and reduce downgradient migration of VOCs from the RMPA. As part of the remediation program, a 5-year review is to be conducted to evaluate the performance of the remediation systems. A 5-year review was completed for the BPA in 1998 (Radian, 1998b). The previously submitted 5-year review for the BPA is intended to serve as a supplement to this 5-year review report. At the request of the California Environmental Protection Agency Department of Toxic Substances Control (DTSC), a summary of the performance of the soil vapor extraction (SVE) system is included in this report.

1.1 PURPOSE

The purpose of this 5-year review is to review and evaluate available analytical and operational data collected during remedial activities at the Site during the first 5 years of operation (from 1994 to 1999). The evaluation includes assessing the effectiveness of remedial action at the BPA and RMPA at the Site.

1.2 REGULATORY AGENCY

On June 14, 1989, Lockheed Martin and the DTSC signed a Consent Order (HSA-88-89-034) that required Lockheed to identify and remediate any soil, surface water, or groundwater contamination that occurred at the Site. On July 1, 1994, an Operation and Maintenance Agreement was made between Lockheed Martin and the DTSC to implement an operations and maintenance (O&M) plan for the remediation systems at the Site. As part of the O&M plan, Lockheed Martin is to conduct a 5-year review of the remediation systems.

1.3 REMEDIATION PROGRAM

The program consists of operating two remediation systems at the Site. One system is located in the BPA and the other is located in the RMPA (Figure 2), as described in the following sections.

1.3.1 Burn Pit Area

The remediation program at the BPA includes removing contaminant mass in the vadose zone. Remediation systems employed at the BPA include SVE and two-phase extraction (TPE). The remediation goals of the systems are to remediate impacted areas in the vadose zone, thereby removing the source and reducing the risk of further impacting groundwater (Radian, 1995).

Components of the BPA remediation systems include:

- SVE wells
- Two-phase, high vacuum extraction wells
- Groundwater injection wells (also used for the remediation system at the RMPA)
- Catalytic oxidizer to treat vapor prior to discharge to the atmosphere
- Liquid-phase carbon adsorption units to treat dissolved constituents in groundwater extracted from low permeability wells prior to groundwater injection.

A summary of the operation and effectiveness of the remediation program at the BPA is described in Sections 4.0 and 5.0, respectively.

1.3.2 Rocket Motor Production Area

The remediation program at the RMPA includes removing impacted groundwater via a pump-and-treat (P&T) system and injecting treated groundwater to upgradient and downgradient wells for hydraulic containment. Components of the RMPA remediation system include:

- Two groundwater extraction wells
- Five groundwater injection wells
- Air stripper system to remove halogenated volatile organic compounds (VOCs) from the impacted groundwater
- Two bag filters between groundwater feed tank and air stripper to remove suspended solids
- One 500-gallon treated water storage tank
- Vapor-phase carbon adsorbers (three 5,000-pound units) to treat vapor constituents prior to discharge to the atmosphere.

Operation and effectiveness of the remediation program at the RMPA is described in Sections 4.0 and 5.0, respectively.

2.0 SITE HISTORY

The Site consists of approximately 9,100 acres, located in the foothills of the San Jacinto Mountains. The Site was used for ranching until the 1950s, when it was purchased by the Grand Central Rocket Company. Lockheed Martin purchased the property in 1960 and acquired the Grand Central Rocket Company in 1961, which became a wholly owned subsidiary. Between 1961 and 1974, the Site was used for solid rocket propellant mixing and testing, ballistics testing, and open burning of waste propellant. In 1974, the facility was closed and operations ceased. Between 1975 and 1991, the Site was used by the International Union of Operating Engineers as a surveying and heavy equipment training area and portions of the Site were used for dryland farming (barley) and sheep grazing. In addition, Structural Composites used portions of the Site for vehicle roll-over tests through January 1983. General Dynamics also used portions of the Site between 1983 to 1984 on several occasions for testing activities (Radian, 1986).

Initial site investigation activities were conducted in 1983, which consisted of a hydrogeologic and water resource investigation. During the investigation, eight observation wells were installed to a depth of up to 70 feet below ground surface (bgs). Water level measurements were collected in these observation wells and existing "ranch wells" to characterize groundwater characteristics. Interim remedial measures were completed at the Site between 1984 and 1989. These remedial measures consisted of: soil cleanup from a polychlorinated biphenyl (PCB) spill that resulting from vandalism of a transformer; removal of three underground fuel storage tanks and associated soil cleanup; and an investigation and removal of low-level radioactive material at a one-time burial location at the Site.

Remedial site investigation activities were initiated in 1986 and continued through 1989. Preliminary remedial investigation activities included a geophysical investigation and a groundwater sampling program at existing monitoring and water supply wells. As a result of findings from the preliminary investigations, two detailed remedial investigations were conducted in late 1989. A remedial investigation at the BPA was conducted to identify waste materials and contaminant source areas. A hydrogeologic investigation was also conducted and consisted of installing 19 monitoring wells to determine the extent and magnitude of impact (Radian, 1990).

Soil investigations indicated no significant levels of soil impact at the Site. However, soil vapors (chlorinated VOCs) extended from the BPA northwest for approximately 1 mile. Chlorinated VOCs were also detected in the groundwater, occupying approximately an L-shaped area 1,000 feet long and 500 to 1,700 feet wide, flowing westerly from the BPA. Approximately 72 percent of the mass of VOCs were identified to be contained in the soil vapor and approximately 28 percent contained in the groundwater. A removal action plan for removing wastes remaining in the burn pits was submitted to the DTSC for approval in April 1991.

Remediation activities involving removal and disposal of burned debris from the former burn pits were initiated at the Site in 1992. Treatability studies were conducted in 1992 to evaluate alternatives for removing VOCs in the subsurface soil and groundwater. Selected alternatives include SVE at the BPA and groundwater pump-and-treat at the BPA and RMPA. Remediation systems at the BPA and RMPA were started up in June 1994 and began normal operations in August 1994.

In October 1999 an earthquake caused the loss of power to the Beaumont No. 1 site. Due to age and condition of the site power distribution equipment, the local power service provider would not continue to supply electricity to the site and requested the installation of new service equipment. The new equipment was installed and the system was brought back online on December 13, 1999.

A full chronology of Site events is contained in Table 1.

3.0 SUMMARY OF REMEDIAL ACTION

The SVE and P&T remediation systems implemented at the Site were designed to remove impacted soil vapor and groundwater and to reduce migration of the groundwater plume through extraction, injection, and treatment. Currently, 67 monitoring/observation wells are used to monitor the effectiveness of the remedial action. A well location map is included as Figure 3.

3.1 REMEDIAL OBJECTIVES

The remedial objectives outlined for the Site (Radian, 1992b and Radian, 1993) are to:

- Extract and treat contaminated soil vapors within the BPA to reduce potential health risks
- Extract and treat contaminated groundwater within the 1000 ppm isopleth in the RMPA
- Re-inject treated water to provide hydraulic control upgradient and downgradient of the RMPA thereby minimizing further migration of contaminants downgradient from the RMPA.

4.0 OPERATION OF THE REMEDIATION SYSTEM

Full-scale operation of the remediation systems at the BPA and the RMPA began in August 1994 and is described in the following sections.

4.1 BURN PIT AREA

The remediation system at the BPA was in full-scale operation between August 1994 and July 1998. In September 1998, an evaluation of the SVE system indicated that the VOCs in soil vapors had declined from more than 147,800 parts per billion by volume (ppbv) in April 1994 to approximately 1,370 ppbv in July 1998. The progress of remediation was also evaluated to determine if the SVE system could be turned off while still meeting the original goals of remediation (Radian, 1998b). The evaluation of the effectiveness of the BPA remediation system is described in Section 5.1.

4.2 ROCKET MOTOR PRODUCTION AREA

Prior to full-scale operation, several aquifer tests, groundwater modeling, and a system pilot test were conducted to design the P&T system. Since startup in 1994, continual operation and monitoring has been conducted on the system. Monitoring activities include system influent and effluent sampling, groundwater sampling, and groundwater level gauging. The sections below describe groundwater modeling, pilot test, system startup and operation, and groundwater quality.

4.2.1 Aquifer Testing

Twenty-seven aquifer tests were conducted between October 1990 and December 1991. The purpose of these tests was to better understand aquifer parameters and obtain data for modeling capture zones. Aquifer tests (constant rate, recovery, and slug tests) were conducted in both the Mount Eden Formation (beneath the BPA and down-gradient) and the alluvium unit (down-gradient of the BPA). The hydraulic conductivity of the alluvium ranged more than four orders of magnitude, with a logarithmic mean of 1.2×10^{-3} centimeters per second [cm/s]), indicating a heterogeneous unit. The hydraulic conductivity of the Mount Eden Formation ranged approximately two orders of magnitude with a logarithmic mean of 1.9×10^{-4} cm/s (Radian, 1992c).

4.2.1.1 Pilot Program

A pilot test was conducted in March 1991 to determine the feasibility of air stripping and carbon adsorption for groundwater treatment. The test was performed on 10.000 gallons of water containing approximately 0.13 pounds of VOCs as part of the treatability study conducted at the Site. Thirteen total optimization runs were conducted using low concentration influent extracted from monitoring wells MW-20, MW-23, and MW-30 (average total VOC concentration of 36.1 µg/L) for the first nine runs, and high concentration influent extracted from monitoring well MW-2 (average total VOC concentration of 427 µg/L) for the last four runs. The high concentration runs resulted in a 99.2 percent air stripper efficiency and a 99.9 percent carbon unit efficiency and indicated that the primary contaminants are easily stripped from the groundwater and are relatively insensitive to the air-to-water ratio. Therefore, the full-scale system was designed from the air-to-water ratios and corresponding mass transfer coefficients determined from the results of the Treatability Study (Radian, 1992a).

4.2.2 Groundwater Pump-and-Treat System

The groundwater P&T system was designed and implemented to capture groundwater impacted above 1,000 µg/L of VOCs. A mathematical model was used to determine the pumping rates and locations of the pumping centers needed to capture this zone. The well spacing and number of extraction wells installed were determined based upon modeling results and measured physical parameters (Radian, 1992b).

The alignment and spacing of the extraction wells were optimized with the minimum number of wells needed to minimize capture time of the most contaminated groundwater (Radian, 1993). Injection wells (IW-1 and IW-2) located to the south of the RMPA were used to narrow the groundwater plume and direct the flow towards extraction wells, EW-1 and EW-2. The injection wells located north of the RMPA (IW-3, IW-4, and IW-5) were used to reduce further contaminant migration towards the riparian area. The final remedial alternative also included groundwater extraction from two wells, EW-1 and EW-2. Extraction well EW-2 was installed to extend the capture zone to include extracting groundwater within the 1,000 µg/L isopleth in the area farther to the northwest (see figure 3).

System design parameters include:

- Process flow rate through the air stripper of 185 gallons per minute (gpm)
- Design flow rate for extraction well EW-1 of 50-80 gpm and 10-15 gpm for extraction well EW-2
- Design flow rate of gallery 1 injection wells (IW-1 and IW-2) of 30-60 gpm

- Design flow rate of gallery 2 injection wells (IW-3, IW-4, and IW-5) of 45-90 gpm
- Three skid-mounted 5,000-pound vapor-phase carbon units (2 operated in series at any one time).

4.2.2.1 System Startup

Startup and shakedown of the P&T system were conducted over a 2-month period in June and July 1994. The system was in operation 30 to 40 percent of this time primarily due to operational problems. The operational problems encountered during the startup period and the corresponding remedy are summarized below:

- Due to inadequate pumping rates, a larger transfer pump was installed to replace the designed transfer pump used for pumping water to wells IW-1 and IW-2
- Due to high suspended solids in the extracted groundwater, two 20,000-gallon tanks were added upstream of the bag filters to provide for additional settling time (the tanks were removed after one month)
- A crack in a 20-foot section of pump discharge pipe inside EW-1 was revealed and subsequently replaced.

A 48-hour pumping and injection test was conducted during the startup and shakedown period to determine optimum groundwater extraction and injection flow rates. Based upon pumping test results, extraction wells EW-1 and EW-2 were set at pumping rates of 55 gpm and 8 gpm, respectively. The groundwater extracted from these wells was injected into wells IW-1 through IW-5.

A total volume of 204,399 gallons of water was extracted, treated, and reinjected into the injection wells during the startup period. Effluent water samples analyzed during startup and shakedown were below the NPDES maximum daily concentration limits. Effluent data are contained in Appendix A.

Normal system operation began in August 1994 and consisted of continuous pumping from extraction wells EW-1 and EW-2 at 55 and 8 gpm, respectively, and injection into injection wells IW-1 through IW-5 at approximately 55 gpm.

4.2.2.2 Long-Term Operations

O&M has been conducted on the P&T system since August 1994. O&M activities included maintaining system operation, recording system data, conducting carbon change out, and performing National

Pollutant Discharge Elimination System (NPDES) discharge monitoring requirements. Effluent monitoring was conducted on a monthly basis between June 1994 and December 1997. The permit was later modified and effluent monitoring was conducted monthly and influent monitoring was conducted bimonthly beginning January 1998. Monthly reports summarizing effluent monitoring were submitted to the RWQCB per discharge requirements. In addition, quarterly and annual reports were prepared and issued to the DTSC summarizing O&M activities. A summary of discharge monitoring results and volume reinjected is included in Appendix A.

The P&T remediation system operated with approximately 87 percent uptime between August 1994 and June 1999. Average system uptime per year is presented in the table below. During this 5-year period (through December 1999), the system extracted, treated, and injected approximately 96,917,385 gallons of treated groundwater into injection wells IW-1 through IW-5. The system operated in compliance with the NPDES discharge permit (maximum discharge volume and concentrations) during the 5 years of operation.

During the startup period, wells EW-1 and EW-2 were extracting at a combined flow rate of 63 gpm (55 gpm from well EW-1 and 8 gpm from well EW-2). All extracted groundwater was injected into wells IW-1 through IW-5 during this startup period. The average injection flow rates were obtained from annual NPDES reports and average extraction flow rates were obtained from the semi-annual groundwater reports. Table A summarizes the average annual extraction and injection flow rates.

Table A: Extraction/Reinjection Rate Summary

Year	System Uptime (percent)	Average Extraction Flow Rates (gpm)	Average Injection Flow Rates (gpm)
Startup (June 1994)	NA	63	55
1994	81	63	36
1995	98	49	53
1996	89	40	43
1997	78	20	24
1998	89	24	29
1999	84	38	40

NA = Not Applicable

The annual extraction and injection flow rates varied with fluctuating groundwater levels, bacteriological growth and encrustation of well screens with fines and silts. Injection wells also encountered fines and silts, and bacteriological growth, which clogged the screened intervals, and therefore reduced the injection flow rates. Redevelopment of the extraction wells was conducted periodically in an attempt to increase their productivity. Furthermore, well casings and screens were replaced in the two extraction wells in June 1997 in an effort to increase the extraction rate. Finally, the use of a liquid carbon dioxide redevelopment method in 1998 significantly improved extraction rates. The injection wells were also redeveloped and swabbed biannually to remove fines and silts to maintain sufficient injection flow rates.

Presently, the P&T remediation system is currently operating at a combined flow rate of approximately 38 gpm (August 1999). O&M monitoring continues to be conducted in accordance with the O&M Agreement. NPDES monitoring continues to be conducted bimonthly for influent monitoring and monthly for effluent monitoring.

4.2.2.3 Summary and Analysis of Water-Level Information

The general direction of groundwater flow has been consistent during the 5 years of system operations. Groundwater flows in a west-northwest direction from the BPA towards Potrero Creek. Groundwater then flows in a southwest direction as groundwater gets closer to the creek bed. The direction of groundwater flow is illustrated in annual groundwater contour maps between 1994 and 1999. These maps are included in Appendix B.

Groundwater elevations at the Site have generally followed the same trends between August 1994 and October 1999. The water levels in wells upgradient of the BPA, OW-1 and MW-36, fluctuated between 2,150 to 2,184 feet above mean sea level (amsl) and 2,120 and 2,180 feet amsl, respectively, between 1994 and October 1999. The water level in wells downgradient of the P&T system, MW-29 and MW-42, generally followed the same trends, but only fluctuated between 2,092 to 2,101 feet amsl and 2,085 and 2,090 feet amsl, respectively. Groundwater elevations in the two extraction wells, EW-1 and EW-2, have decreased approximately 5 feet and 6 feet, respectively, between April 1994 to October 1999, to elevations of 2,120 and 2,114 feet amsl. EW-1 and EW-2 were turned off in advance of depth measurement. Hydrographs for the extraction wells, injection wells, and selected down-gradient and upgradient wells are included as Appendix C.

As illustrated in the contour maps, mounding and drawdown were observed in the vicinity of the injection and extraction wells. It appears that drawdown was most prevalent in July 1997 and January 1998, as depicted by the contour maps. The radii of influence in EW-1 and EW-2 were approximately 300 and 150 feet in July 1997 and 375 and 110 feet in January 1998, respectively. It appears that mounding was most prevalent in injection wells IW-1 and IW-2 in December 1994 during the initial start-up phase. The extent of mounding appeared to decrease after startup, and then in January 1998, following several well development activities, mounding appeared to increase.

4.2.2.4 Treatment Unit Water Quality Data

Effluent water quality from the air stripper was initially collected on a weekly basis and analyzed for 1,1-dichloroethene (1,1-DCE), 1,1,1-trichloroethane (1,1,1-TCA), and trichloroethene (TCE) as required by the original NDPES permit. In May 1997, the NDPES permit monitoring requirements were modified, and are presently being followed. The modified monitoring requirements include collecting effluent samples on a monthly basis and collecting air stripper influent water quality samples every two months. Air stripper influent concentrations have decreased from a total VOC concentration of 744 µg/L in June 1994 to 143 µg/L in October 1999. All effluent samples collected from the air stripper were below the NPDES discharge levels. Figure 4 represents the total VOC influent concentrations measured over the 5 years of operation. Effluent and influent concentrations presented in NPDES reports are also included in Appendix A.

4.2.3 Groundwater Quality Data

Total VOC concentrations in groundwater at the Site have generally decreased between 1994 and 1999. The areal extent of the 1,000 µg/L plume in the RMPA, detected in 1992, has diminished and is no longer apparent, as indicated in the April and October 1999 contour maps. The areal extent of the 400 µg/L plume, detected in 1992, has also been reduced and is no longer apparent in the RMPA in 1999. In general, the 50 µg/L plume area has remained fairly stable during the 5 years of operation. The total VOC isoconcentration contours for years 1992, 1996, 1997, 1998, 1999, contaminant concentration data figures for 1994, and specific contours for 1,1,1-TCA, 1,2-dichlroethane (1,2-DCA), 1,1-DCE, and TCE in 1995 are included as Appendix D.

Concentrations from selected wells located upgradient of the RMPA, near the RMPA, and down-gradient of the RMPA are described in the following sections.

4.2.3.1 Wells Upgradient of the RMPA

Total VOC concentrations in selected wells, upgradient of the RMPA, have generally decreased between 1994 and 1999. VOC concentrations from three upgradient wells, MW-4, MW-50, and MW-63 (screened within the alluvial zone) have decreased since system startup in 1994. Wells MW-4, MW-50, and MW-63 are located approximately 1,160, 400, and 720 feet from well EW-1, respectively. TCE and 1,1-DCE were the primary VOCs detected in these three wells.

Total VOC concentrations from groundwater samples collected from well MW-4 decreased from 414 µg/L in 1994 to 184 µg/L in October 1999. Total VOC concentrations from groundwater samples collected from well MW-50 decreased from 2,250 µg/L in 1993 to 2 µg/L in October 1999. Total VOC concentrations from groundwater samples collected from well MW-63 decreased from 235.1 µg/L in 1997 to 25 µg /L in October 1999. A graph of historical total VOC concentrations for these upgradient wells is included in Appendix E.

4.2.3.2 Wells Near the RMPA

Total VOC concentrations in select wells at the RMPA have generally decreased between 1994 and 1999. Total VOC concentrations from groundwater samples collected from extraction well EW-1 (screened within the alluvial zone) decreased from 748 µg/L in 1993 to 120.7 µg/L in April 1999. The total VOC concentrations from groundwater samples collected from extraction well EW-2 (screened within the alluvial zone) decreased from 723 µg/L in 1993 to 243 µg/L in April 1999. Concentrations have remained relatively stable since June 1995. Primary constituents detected in groundwater samples collected from wells EW-1 and EW-2 are 1,1-DCE and TCE.

The total VOC concentrations in wells MW-5, MW-49, and MW-52 (screened within the alluvial zone), located approximately 400, 440, and 360 feet from EW-2, respectively, generally follow the same trend as the extraction wells. The total VOC concentrations from groundwater samples collected from well MW-5 decreased from 429 µg/L in 1991 to 283 µg/L in October 1999. The total VOC concentrations from groundwater samples collected from well MW-49 decreased from 226 µg/L in 1991 to 10.2 µg/L in October 1999. The total VOC concentrations from groundwater samples collected from well MW-52 decreased from 3,788 µg/L in 1993 to 151 µg/L in October 1999.

The vertical extent of contamination is monitored by one deep well, MW-56A (screened in the Mount Eden Formation), located in the RMPA area. Groundwater samples collected from this well increased from non-detectable levels in 1994 to 1.6 µg/L in October 1999. Historical total VOC concentration graphs for these wells are included in Appendix F.

4.2.3.3 Wells Down-gradient of the RMPA

Total VOC concentrations in selected wells down-gradient of the RMPA have both decreased and increased between 1994 and 1999. TCE and 1,1-DCE are the primary contaminants detected in down-gradient wells MW-19, MW-29, and MW-42 (screened in the alluvial zone), located approximately 760, 1,040, and 1,600 feet from EW-2, respectively.

Total VOC concentrations in groundwater samples collected from well MW-19 increased from 7 µg/L in 1991 to 29 µg/L in December 1995 and decreased to 25.6 µg/L by October 1999. Total VOC concentrations in groundwater samples collected from well MW-29 increased from 28 µg/L in 1991 to 87 µg/L in December 1995. The total VOC concentrations continued to increase in this well but only to 99 µg/L in October 1999. Total VOC concentrations in groundwater samples collected from well MW-42 decreased from 245 µg/L in 1991 to 185 µg/L in 1999. All three wells are screened at the same general depth, typically between 13.20 and 48.70 feet bgs. Historical VOC concentration graphs for these wells are included in Appendix G.

5.0 EFFECTIVENESS OF THE REMEDIATION PROGRAM

As previously stated, the purpose of this 5-year review is to evaluate the effectiveness of the remedial action in achieving the remedial objectives. The following sections describe the performance of the two remediation systems.

5.1 BURN PIT AREA

An evaluation of the effectiveness of the SVE remediation system at the BPA was previously conducted by Radian Corporation in September 1998 (Radian, 1998b). The Burn Pit Area Remediation System Evaluation is included as Appendix H. Results of the system evaluation indicated that VOC concentrations in soil vapor samples between April 1991 and August 1998 were reduced by an average of greater than 99 percent by the SVE system in the BPA. Near asymptotic levels were reached in mid-1995.

Pulsed operation of the SVE system was performed between September 1997 and July 1998. As a result, soil vapor concentrations did not rise significantly in all but two wells after the system was turned off in July 1998. This suggests that the source of soil vapors has been remediated almost completely (Radian, 1998b). As a result of the evaluation, the DTSC requested that quarterly vapor monitoring from key extraction wells be conducted. Soil vapor results from three key wells (VEW-6, VEW-10, and VEW-11) for 1994, 1996, 1997, 1998, and subsequent rounds of post-operation results, beginning in December 1998, are provided in the Table B below (Radian, 1996 and Radian, 1998a) and are presented graphically in Figure 5.

Table B: Soil Vapor Concentrations in the Burn Pit Area

Date	Total VOCs (ppmv)		
	VEW-6	VEW-10	VEW-11
4/94	NA	31.8	22.7
12/94	2.5	10.1	16.0
6/96	0.6	3.1	8.3
8/97	4.3	Not Detected	3.5
7/29/98	0.4	1.4	0.8
12/17/98	0.7	2.4	2.6
3/17/99	0.6	2.2	2.1
6/18/99	0.9	2.9	8.8
9/15/99	1.3	2.5	9.6
1/6/00	2.1	5.1	10.7

NA – Not Available

Soil vapor concentrations have increased somewhat since shut-down of the system in July 1998. Soil gas samples collected from well VEW-6 have increased from 0.4 parts per million per volume (ppmv) (July 1998) to 2.1 ppmv (January 2000). Soil gas samples collected from wells VEW-10 and VEW-11 have increased from 1.4 ppmv (July 1998) to 5.1 ppmv (January 2000), and from 0.8 ppmv (July 1998) to 10.7 ppmv (January 2000), respectively. This increase is suspected to be a result of offgassing of VOCs from contaminated groundwater below these three wells. The concentrations encountered in the vapor phase are less than can be expected during equilibrium between contaminants in the soil and groundwater according to Henry's Law. Offgassing occurs when dissolved VOCs in groundwater vaporize into the pour spaces in soil where VOCs concentrations have been reduced by SVE system. Concentrations in the vapor phase increase until equilibrium between VOCs in the liquid and vapor phases is reached. Equilibrium is also reached between vapor phase VOCs in the pore spaces and VOCs that adsorb to the soil particles.

The impacted groundwater at the BPA has not appeared to migrate further downgradient between 1992 and October/November 1999. The 1,000 μg/L total VOC isopleth area has diminished significantly between 1992 and October/November 1999, and is no longer present in the RMPA. However, the area containing 10,000 μg/L of total VOCs (in the BPA) has remained primarily unchanged between 1992 and 1999.

5.2 ROCKET MOTOR PRODUCTION AREA

The following sections describe the performance and evaluation of the P&T system in achieving groundwater remedial objectives at the Site.

5.2.1 Operation of the Treatment System and Achievement of Discharge Criteria

The P&T system has been effective at removing VOCs in the groundwater during the 5 years of operation. On average, the system has operated with an uptime of approximately 87 percent. Effluent groundwater samples collected after treatment with the air stripper has demonstrated that the constituent concentrations have been below the NPDES discharge levels. Extraction wells EW-1 and EW-2 have been shown to continuously extract impacted groundwater.

5.2.2 Impacts of the Treatment System Operations on Groundwater Flow Over Time

Overall, the extracted and injected groundwater flow rates have decreased since startup in 1994. As illustrated in table A (Section 4.2.2.2), the combined extraction flow rate from wells EW-1 and EW-2 decreased from an annual average of 63 gpm in 1994 to 20 gpm in 1997. The P&T system was shut down once due to plugging of the injection wells, and on other occasions for video logging, and power outages.

In an effort to increase the extraction flow rate, wells EW-1 and EW-2 were replaced with new well casings and screens in 1997. As a result, water production increased from 1997 levels to an average of 38 gpm through June 1999. A graph illustrating the monthly injected volumes for the period between June 1994 and June 1999 is included as Figure 6. Likewise, after decreasing from 55 gpm to a low of 24 gpm in 1997, the combined injection flow rate from the five injection wells increased to 40 gpm in 1999.

5.2.3 Achieving Groundwater Remedial Objectives

During the 5 years of operation (between June 1994 and June 1999), the P&T system has removed approximately 192 pounds of VOCs. On a yearly basis, mass removal has declined from approximately

60 pounds removed during 7 months of operation in 1994 to approximately 17 pounds removed during 1999. The mass removed was calculated using annual average influent concentrations and the volume of groundwater extracted for the respective year.

It is very unlikely that with existing technologies, continued pumping of VOC impacted groundwater at the site will reduce VOC concentrations to maximum contaminant levels (MCLs). There are no existing groundwater supply wells used for potable water sources at the site or nearby. Thus the original remedial action approach did not include MCLs as remediation goals.

The original goal of remediation in the RMPA was to provide capture of groundwater impacted above 1,000 µg/L of VOCs. Based on recent groundwater sampling conducted in April and October 1999, VOC concentrations within the RMPA have been reduced to less than 300 µg/L.

An additional objective of remediation in the RMPA was to maintain hydraulic control in the RMPA and minimize further migration of VOCs from the RMPA downgradient. VOC migration was reduced, as indicated by concentrations in downgradient wells MW-19, MW-29, and MW-42 that have remained stable.

As part of the remediation objective, treated groundwater is injected into upgradient wells (IW-1 and IW-2) and downgradient wells (IW-3, IW-4, and IW-5) to provide a hydraulic barrier to minimize migration to the north and to the south. Water injected into the upgradient wells also expedites groundwater remediation by flushing the groundwater towards the extraction wells (EW-1 and EW-2).

5.2.4 Effects of Further Groundwater Extraction

As mentioned above, the P&T system has been effective at meeting the remedial objectives of removing mass and providing hydraulic control, and thus, the original remedial action objectives in the RMPA have been achieved.

The downgradient and portions of the upgradient plume outside the RMPA have remained relatively stable during the last several rounds of groundwater sampling. VOC concentrations upgradient of the RMPA are the same or less than VOC concentrations downgradient. Now that the VOC concentrations in the RMPA have been reduced to less than 300 µg/L, downgradient VOC concentrations are not expected to increase. Continued groundwater extraction and treatment in the RMPA is not expected to provide additional positive effects on VOC concentrations downgradient of the RMPA. Thus, a reasonable course of action would be to turn off the treatment system in the RMPA and monitor the resulting downgradient VOC concentrations.

6.0 GEOCHEMICAL SAMPLING

Eight existing groundwater monitoring wells, MW-02, MW-26, MW-36, MW-40, MW-42, MW-52, MW-59B, and MW-63, were sampled and analyzed for a limited number of geochemical indicator parameters. The objective of the geochemical sampling and analyses was to perform a preliminary evaluation of the potential for natural attenuation to occur at the site. Based upon results from this preliminary evaluation, a recommendation could be made to conduct a more detailed evaluation of natural attenuation should the results indicate favorable conditions.

The eight monitoring wells were gauged prior to collecting groundwater samples to determine static water levels and total well depths. Each monitoring well was purged prior to sampling. Approximately three well casing volumes of groundwater were removed from each well using a purge pump at a low flow rate of about 1 gpm (to minimize disturbance of the groundwater in the wells).

Groundwater samples for field testing were collected using a disposable bailer using standard groundwater sampling procedures, with added care taken to lower the bailer gently to avoid disturbing the water column of the well All groundwater samples to be analyzed for dissolved analytes, including metals, were filtered in the field immediately following sample collection at each well location. The laboratory samples were collected with a disposable bailer and contained in laboratory-supplied sample containers. The samples were properly labeled and packaged in cooled ice chests at a temperature of approximately 4 degrees Centigrade (C) and delivered via a commercial carrier to the fixed-based laboratories on a daily basis under proper chain-of-custody protocol.

Wastewater generated from the sampling episode was placed in a mobile tank and transferred to a holding tank near the water treatment system at the site. The wastewater was treated using the treatment system and discharged under the NPDES permit.

The eight monitoring wells were sampled for VOCs using EPA Method 8260, alkalinity, dissolved organic carbon (DOC), ammonia, ortho-phosphate, nitrate/nitrite, total iron, total and dissolved manganese, sulfate, carbon dioxide, methane, chloride, ethane, and ethene. In addition, field samples were collected and analyzed/monitored for groundwater quality parameters, including: specific conductance, oxidation-reduction potential (ORP), pH, temperature, dissolved oxygen (DO), dissolved iron, and sulfide.

Microseeps and Columbia Analytical Services laboratories, located in Pittsburgh, Pennsylvania and Canoga Park, California analyzed groundwater samples from the eight monitoring wells. The results and methods of analyses are summarized in Table 2. Laboratory reports are included as Appendix I.

The laboratory and field monitoring parameters were selected to qualitatively assess natural attenuation at the site. Both abiotic and biotic processes were evaluated based on the limited extent of sampling and analysis. A full evaluation of natural attenuation would require extensive monitoring over a period of several quarters. Prior to undertaking such an extensive study, this limited study attempted to evaluate whether the more extensive study was warranted. If the monitoring parameters indicated that there is significant evidence of abiotic and/or biotic attenuation, further investigation would be warranted.

The evaluation of natural attenuation at a site primarily looks at trends in the data along a plume transect. Specific trends that are evaluated are dependent upon the target compounds. For chlorinated VOCs such as PCE and TCE, it is important for the environment to be anaerobic in order for biological degradation to occur. The lack of dissolved oxygen in groundwater throughout the plume transect is a key requirement for degradation to occur.

If the plume is found to be anaerobic, then the presence of daughter products such as cis-1,2 DCE and 1,1 DCE provide preliminary evidence that degradation may be occurring at the site. At many sites, it is difficult to establish that these compounds are daughter products and not from the original release. For this site, historical groundwater monitoring data was used to evaluate daughter product formation. The review of historical groundwater monitoring results proved inconclusive. While potential daughter products were identified, the groundwater throughout the area was primarily aerobic in nature. At best, this data indicates that, if natural biological attenuation is occurring, it is progressing at a slow rate.

The other monitoring parameters proved inconclusive in determining if significant rates of natural attenuation were occurring at the site. In reviewing the data, it is apparent that the reinjection of treated groundwater that is used to control plume migration is effecting the subsurface chemistry and creating aerobic zones throughout the aquifer. As a result, anaerobic degradation would be limited to areas near the leading edge of the plume. Accordingly, the leading edge of the plume is where most of the evidence for natural attenuation is found. Dissolved oxygen concentrations are much lower in this area, ORP is lower and within reducing condition ranges, daughter products are prevalent, and ethene and chloride were detected. While the evidence for natural attenuation is more favorable at the leading edge of the plume, the rate is still considered to be low.

Based upon the results of this initial natural attenuation evaluation, it was concluded that a more intensive evaluation of the site was not warranted. If natural attenuation is occurring at the site, it is at low rates and dispersion, diffusion, and phytoremediation (discussed in Section 7.0) are the primary mechanisms. A more detailed investigation of additional wells would have a low probability of changing this evaluation.

7.0 PHYTOREMEDIATION

A limited evaluation into the potential for phytoremediation to occur at the site was conducted in August 1999. The evaluation focused on the leading edge of the plume where the site is highly vegetated with several different species of trees and shrubs and groundwater is relatively shallow.

Phytoremediation is the use of plants, primarily trees, to degrade contaminants, create environments amenable to biological degradation of contaminants, and for pumping mechanisms to control groundwater flow. The initial phytoremediation evaluation was conducted at the downgradient leading edge of the plume by evaluating climatic conditions, hydrogeologic conditions, and vegetative distribution at the site.

Climatic conditions (precipitation and evapotranspiration [ET] rates) were researched to determine the water availability and competition for growth and rooting requirements of a phytoremediation system through the soil profile. A preliminary water balance for the site was prepared comparing water inputs (i.e., rainfall) to outputs (i.e., evapotranspiration) and evaluate potential vegetative species that can thrive at the site. Data from the Western Region Climate Center (mean precipitation data from 1948 to 1998) and California Irrigation Management Information Systems (normal year ET values) for Beaumont, California indicates that the majority of precipitation occurs in December, January, February, and March. Estimated ET rates exceed infiltration by 36.77 inches of water on a mean yearly basis. Net infiltration to the groundwater table is only likely to occur during the months of December, January, and February on a mean yearly basis. These data indicate that, unless the depth to groundwater is within the rooting zone (upper 30 feet bgs), irrigation is required to maintain vegetation. Table 3 illustrates the preliminary water balance data on a monthly mean basis.

Depth to groundwater at the downgradient leading edge of the plume ranged from 16.04 (MW-44) to the surface (MW-42 and OW-2) as measured during the April 1999 groundwater monitoring event (Earth Tech, 1999). These data indicate that the depth to groundwater at the leading edge of the plume is currently within the rooting zone.

The soils at the site consist of well-drained alluvial sand and gravel deposits that contain little organic material (Radian, 1992b).

The site evaluation of the vegetation was conducted on August 25 and 26, 1999 to collect and determine the following site-specific information:

- Approximate plan location and density based upon visual inspection of plants;
- Photographs near the leading edge of the groundwater plume; and
- Samples of plant species (i.e., branches, leaves, stem clippings) used to determine plant types existing at the site.

The downgradient portion of the leading edge of the plume extends towards the creek bed, where an abundant number of trees and plants currently exist. An estimated 4 to 6 trees per 1,000 square foot area were observed in the creek bed. The following are the common names of trees found at the site during the inspection of vegetation in order of most to least prevalent: 1) Willow; 2) Cottonwood; 3) Elderberry; 4) Mahogany/Hawthorne (Rose family); 5) Tamarisk; and 6) Arizona Sycamore.

The creek bed is densely populated with shrubs. At locations where the depth to groundwater is shallow, there is a greater density of ground cover. There was sparse vegetation at other areas of the site where the depth to groundwater is greater than 30 feet bgs.

Several types of trees known as "phreatophytes," such as cottonwood and willow trees, are known for their fast growth and large amounts of water consumption. This may assist in containing groundwater by removing groundwater through the root system to the atmosphere. Willow and Cottonwood trees have been successfully used to treat VOCs and to hydraulically control groundwater by pumping hundreds of gallons of water per day per tree.

Based upon the results of this initial evaluation, it appears that significant vegetation occurs at the downgradient, leading edge of the plume. The species prevalent in the area have been identified as types that may be beneficial in controlling groundwater movement and removing VOCs from the subsurface.

8.0 CONCLUSIONS

Based on the review of remediation activities and operation and monitoring data at the Site, the following conclusions can be made:

- VOC-impacted groundwater in the BPA remains elevated at concentrations exceeding 10,000 µg/L total VOCs. Methods to reduce concentrations in this area are being evaluated
- The SVE system at the BPA has effectively remediated soil vapors at the BPA to asymptotic levels. Soil vapor samples collected following shut-down show a slight increase in concentrations, believed to be a result of VOCs offgassing from the groundwater into the soil
- The P&T remediation system at the RMPA has removed approximately 192 pounds of contaminant mass from the groundwater. As a result, the maximum isopleth concentration was reduced from 1,000 µg/L in 1994 to less than 300 µg/L in 1999, thus meeting remedial objectives
- Migration of VOCs from the RMPA to less contaminated areas downgradient has been minimized, thus meeting the original remedial objectives
- VOC concentrations downgradient of the RMPA have remained stable
- Based on geochemical data, it appears that although dechlorination may be occurring near the downgradient leading edge of the plume and within the BPA, it is occurring at a low rate
- The P&T system reinjects treated and oxygenated groundwater. The oxygenated groundwater may be helping to limit the rate of reductive dechlorination
- Vegetation in the form of trees, shrubs, and ground cover presently exist at the leading edge of the plume (creek bed area) where groundwater is available for vegetation to thrive. The location of the leading edge of the plume has been stable (not advancing) during the last 5 years.

9.0 RECOMMENDATIONS

Based on the 5-year review conclusions, the following recommendations can be made:

- Develop proposed maximum VOC concentration limits for soil vapor and a site-wide closure strategy
- The P&T system at the RMPA has been effectively removing mass and has reduced concentrations in this area from over 1,000 μg/L to less than 300 μg/L. It is recommended that the RMPA groundwater P & T system be evaluated to determine if discontinuing operations will negatively impact downgradient migration of VOCs
- It appears that reductive dechlorination may be occurring at two locations (creek bed and BPA). In addition, the current P&T system may be limiting the effectiveness of reductive dechlorination. Therefore, natural attenuation should be further evaluated without operation of the P&T system
- Four soil gas sampling events following SVE shut down in July 1998 have shown a gradual increase in concentrations in two of the wells tested. Because it is suspected that this increase may be a result of offgassing from the groundwater, permanent shut down of the SVE system should be considered
- In the event that the P&T system continues to operate, complete a cost analysis for the current groundwater treatment system at the RMPA. Since influent concentrations have decreased, it may be more cost effective to treat groundwater using liquid phase carbon only
- Because concentrations in excess of 10,000 μg/L still exist in the groundwater in the BPA, groundwater extraction for hot spot treatment should be considered in this area.

10.0 REFERENCES

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Radian, 1998b. Lockheed Martin Beaumont Burn Pit Area Remediation System Evaluation, September 24.

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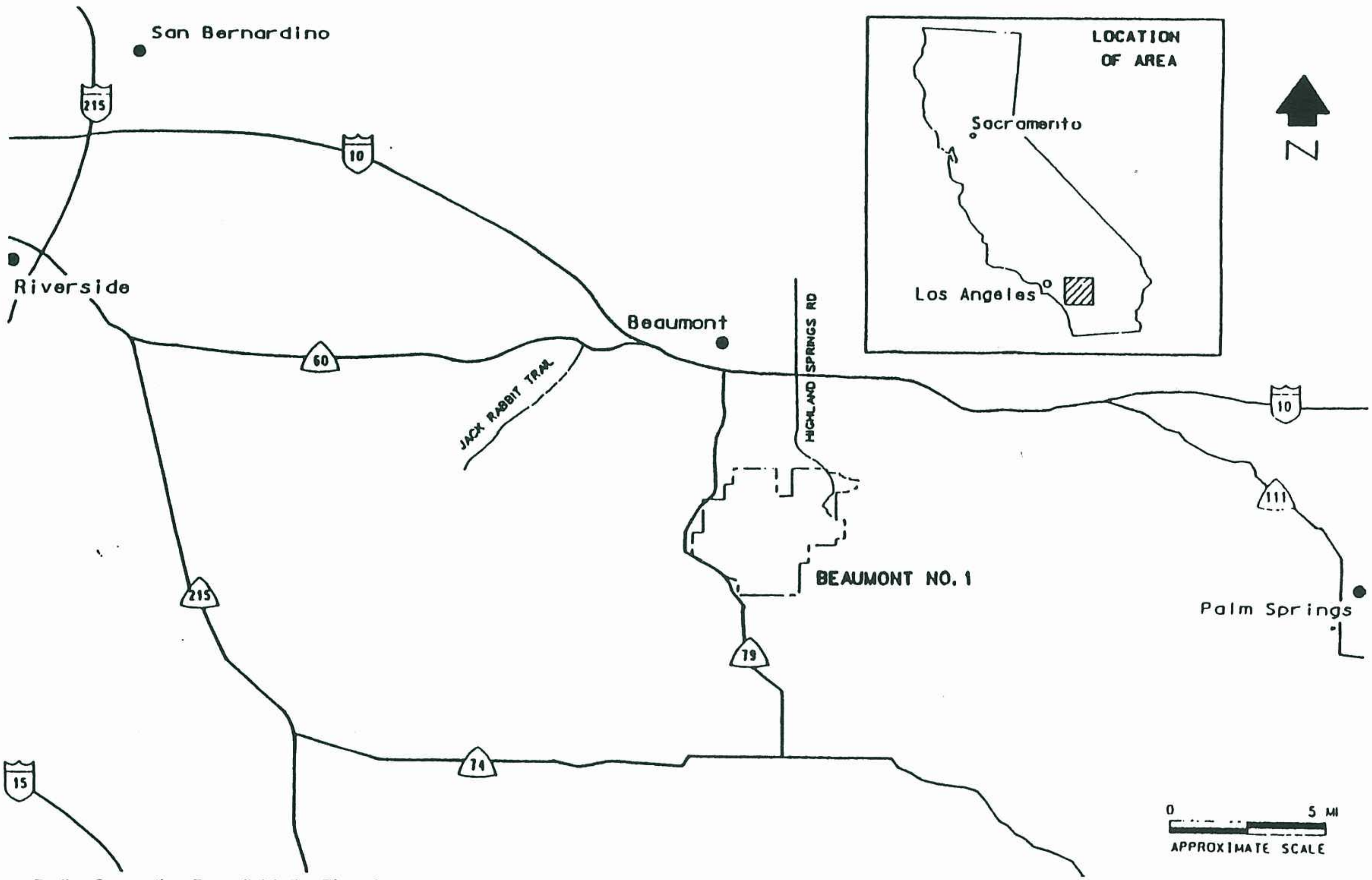
FIGURES

| DATE: Oc 999 | PRJCT #: CA000396.0001.0004 | DRAWING: G:\COMMON\LTULEY\LOCKHEED BEAUM ...E LOCATION MAP FIGURE1.XLS | CHECKED: L. Tuley | APPROVED: T. Wilson



Reference Source: Radian Corporation, Remedial Action Plan, August 1992.

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GERAGHTY & MILLER

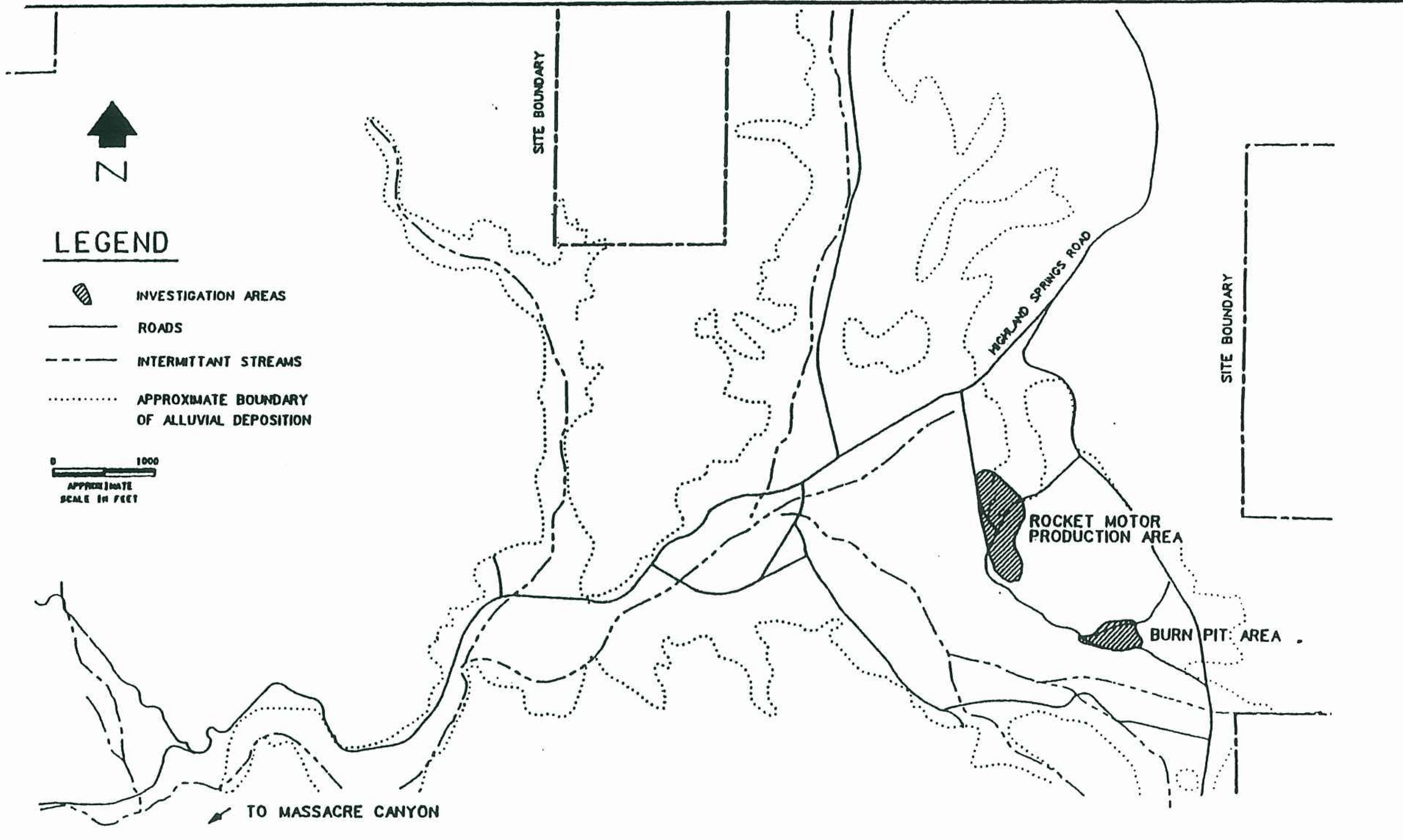
SITE LOCATION MAP

Lockheed Beaumont Test Site No. 1
Beaumont, California

FIGURE

1

| DATE: Oct 1999 | PRJCT #: CA000396.0001.0004 | DRAWING: G:\COMMON\LTULEY\LOCKHEED BEAUMC ... FIGURE2.XLS | CHECKED: L. Tuley | APPROVED: T. Wilson



Reference Source: Radian Corporation, Treatability Study, December 1992.

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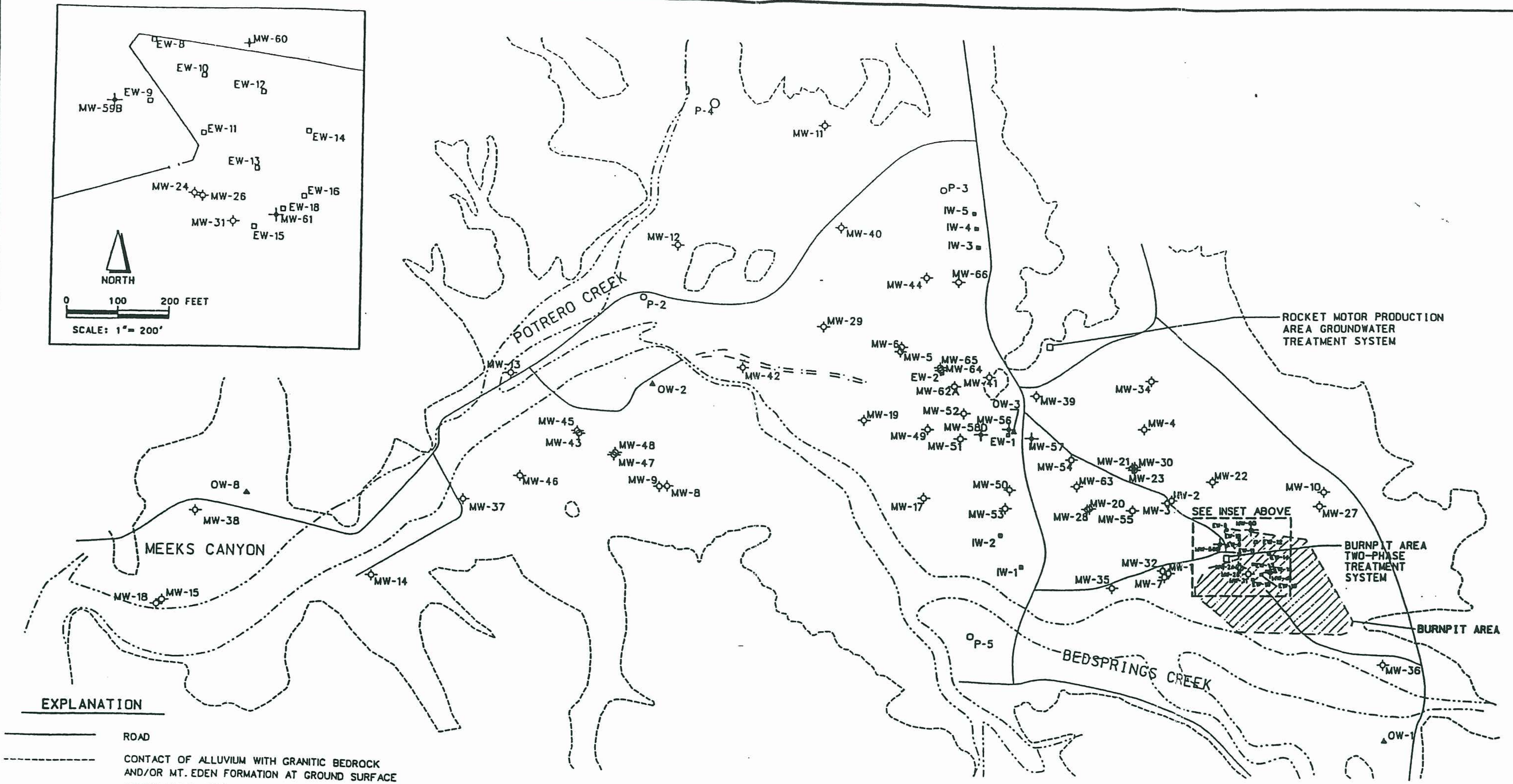
SITE PLAN

Lockheed Beaumont Test Site No. 1
Beaumont, California

FIGURE 2

ART: STILES | MAN: TULEY | CHK: TULEY | FILE: 99-575 | DWG: drawings\temp\TEMP | PRJ#: ? | DATE: 10/11/1999 11:58



EXPLANATION

———	ROAD
- - - - - -	CONTACT OF ALLUVIUM WITH GRANITIC BEDROCK AND/OR MT. EDEN FORMATION AT GROUND SURFACE
—··—··—	INTERMITTENT STREAM
— — — —	BURN PIT AREA PERIMETER ROAD
EW-18 □	EXTRACTION WELL (RADIAN CORPORATION)
MW-58	MULTIPLE WELL POINT CLUSTER (RADIAN CORPORATION)
MW-40	SINGLE POINT SHALLOW MONITORING WELL (RADIAN CORPORATION)
OW-1 ▲	OBSERVATION WELL (LEIGHTON & ASSOC.)
P-5 ○	PIEZOMETER (RADIAN CORPORATION)
IW-5 ▪	INJECTION WELL (RADIAN CORPORATION)

Reference Source: Earth Tech, 1999

NORTH

0 400 800 FEET

SCALE: 1" = 800'

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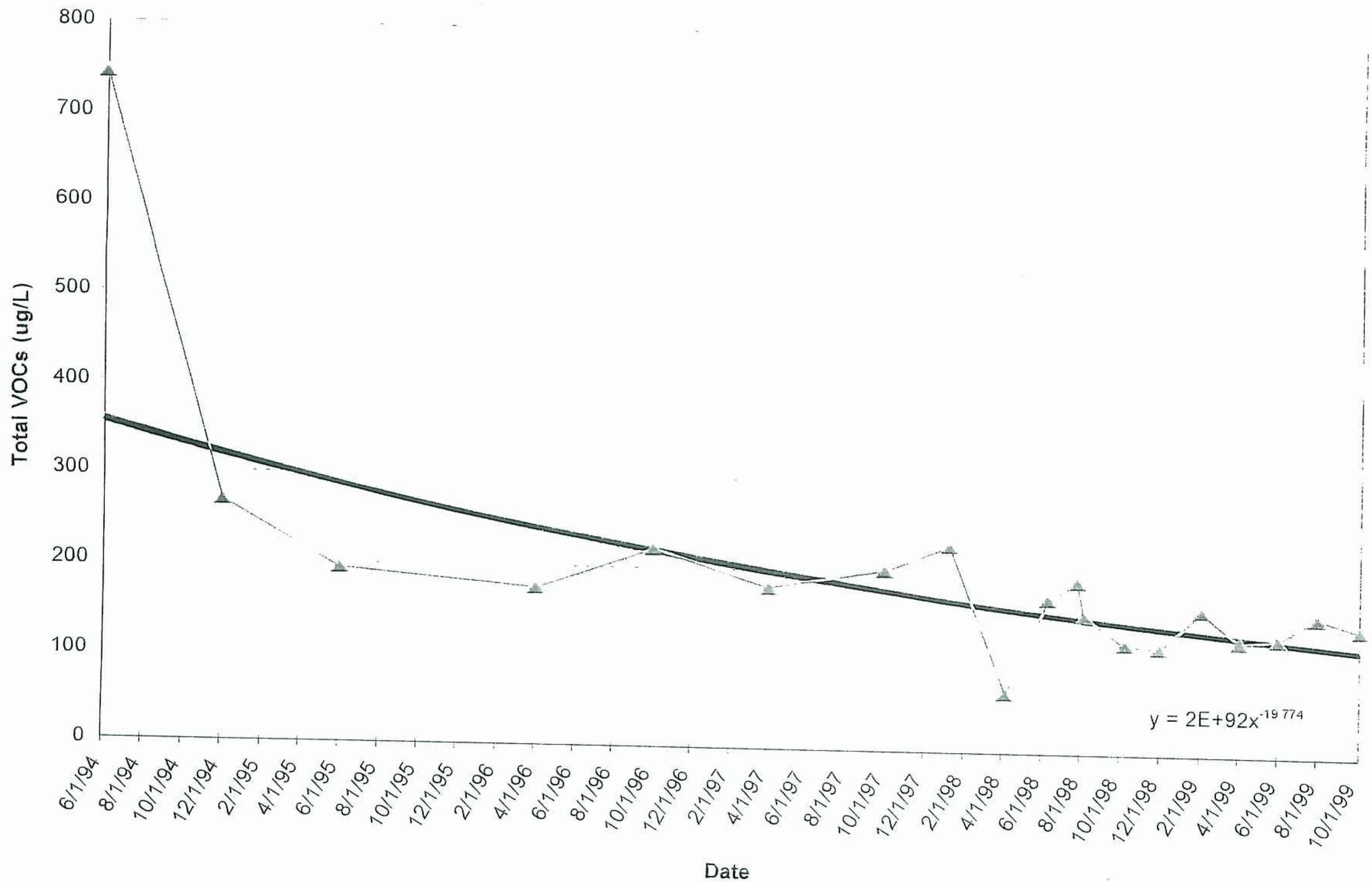
WELL LOCATION MAP

LOCKHEED BEAUMONT TEST SITE NO.1
BEAUMONT, CALIFORNIA

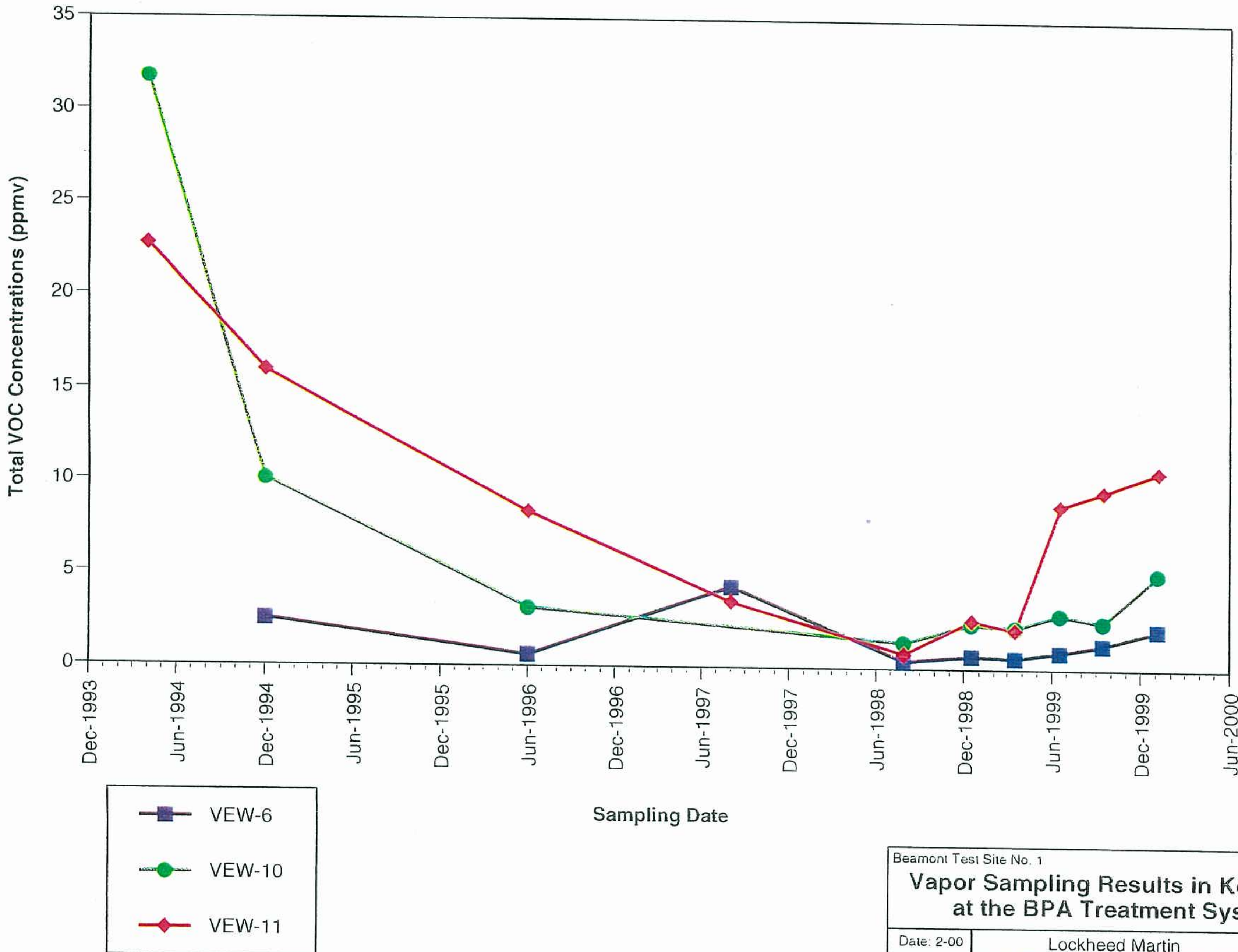
FIGURE 3



Beamont Test Site No. 1

Total VOC Concentrations in RMPA Treatment System Influent

Date: 3-00	Lockheed Martin	Figure
Project No		4

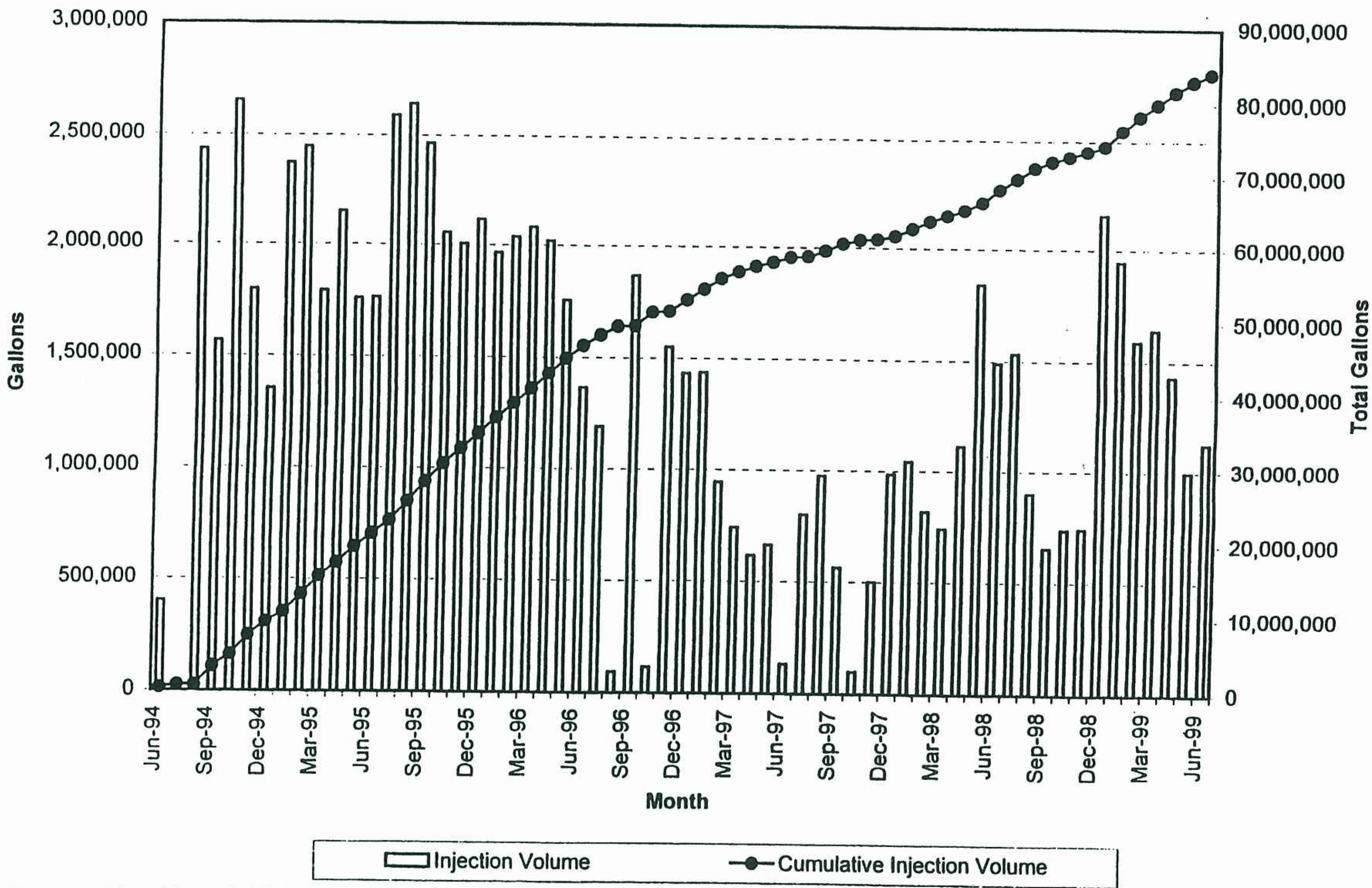


Beamont Test Site No. 1

Vapor Sampling Results in Key Wells at the BPA Treatment System

Date: 2-00	Lockheed Martin	Figure 5
Project No. 27590	EARTH TECH	

| DATE: October 19, | PRJCT #: CA000396.0001.0004 | DRAWING: G:\COMMON\LTULEY\LOCKHEED BEAUMONT\I... ON VOLUME FIG4.XLS | CHECKED: L. Tuley | APPROVED: T. Wilson



Note: Treated water was injected into wells IW-1 through IW-5.

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TOTAL MONTHLY AND CUMULATIVE WATER INJECTED

Lockheed Beaumont Test Site No. 1
Beaumont, California

FIGURE 6

TABLES

Table 1. Chronology of Site Events, Lockheed Beaumont Test Site No. 1

SITE EVENTS	DATE
SITE USAGE	
Site used for ranching	pre-1950's
Site purchased by Grand Central Rocket Company	1950's
Site purchased by Lockheed Martin	1960
Grand Central Rocket Company aquired by Lockheed Martin	1961
Site used for solid rocket propellant mixing and testing, ballistics testing, open burning of wastes (burn pits)	1961-1974
Site used by the International Union of Operating Engineers and portions of theSite used for dry farming and sheep grazing	1975-1991
Sturctural Composites and General Dynamics used portions of the Site for testing activities	1983-1984
SITE INVESTIGATIONS/REPORTS	
Hydrologic Investigation for Water Resources Development	1983
PCB transformer vandalism/spill, investigation, and cleanup	April 1984 to August 1984
Historical Report	September 1986
Preliminary Remedial Investigation	December 1986
One-time burial (approximately in 1971) of low-level radioactive waste investigation and cleanup of area	1989
Consent Order signed by Lockheed Martin and DTSC	June 1989
Community Relations Plan	November 1989
Source and Hydrogeologic Investigation	February 1990
Burn Pit Removal Action Plan	April 1991
Burn Pit Excavation Management Plan	March 1991
Treatability Study	February 1992
Health Risk Assessment	March 1992
Feasibility Study	March 1992
Groundwater & Soil Vapor Well Installation Plan	July 1992
Remedial Action Plan	August 1992
Waste Discharge Requirements, Orner No. 91-63-0962	November 1992
Hydrogeologic Report	December 1992
Burn Pit Area Removal Action Report	June 1993
Hydrogeologic Investigation for Water Resources Development	October 1983
Review and Evaluation of Environmental Work	October 1993
Extraction System Installation Completion Report	December 1993
Operation and Maintenance Agreement signed by Lockheed Martin and DTSC	July 1994
RMPA remediation system startup	June 1994
BPA remediation system startup	June 1994
Normal operations of RMPA remediation system	August 1994 to present
Normal operations of BPA remediation system	August 1994 to July 1998
Water Level and Quality Report	December 1994
Remediation System 6-Month Evaluation	May 1995
Water Level and Quality Report	June 1995
Water Level and Quality Report	December 1995
Water Level and Quality Report	February 1996
Air Sparging Pilot Test Report	February 1996
December 1995 Water Quality Report	May 1996
April 1996 Water Quality Report	July 1996
Vapor Sampling Report, June 1996	October 1996
Semiannual Groundwater Monitoring Report, July and October 1996	March 1997
Semiannual Groundwater Monitoring Report, January and April 1997	July 1997
Semiannual Groundwater Monitoring Report, July and October 1997	March 1998
Shut-down BPA remediation system	July 1998
Semiannual Groundwater Monitoring Report, January and April 1998	August 1998
Vapor Sampling Report, August 1997	August 1998
Area Remediation System Evaluation, Lockheed Martin Beaumont Burn Pit	September 1998
Semiannual Groundwater Monitoring Report, April 1999	August 1999

BPA - Burn Pit Area
DTSC - California Environmental Protection Agency Department of Toxic Substances Control
PCB - polychlorinated biphenyl
RMPA - Rocket Motor Production Area

Table 2. Geochemistry in Groundwater, 5-Year Review Report, Lockheed Beaumont Test Site No. 1, Beaumont, California

Sample ID	Date Sampled	Groundwater Quality Parameters								Terminal Electron Acceptor Parameters													Degradation Products			Technical Quality Control Data		
		Alkalinity, Total (mg/L)	Ammonia as Nitrogen (mg/L)	Specific Conductivity [1] (µmhos/cm)	Dissolved Organic Carbon (mg/L)	Orthophosphate as Phosphate (mg/L)	Oxidation-Reduction Potential [1] (mV)	pH [1] (units)	Temperature [1] (° Centigrade)	Oxygen, Dissolved (mg/L)	Oxygen, Dissolved [1] (mg/L)	Oxygen, Dissolved [2] (mg/L)	Nitrate as Nitrate (mg/L)	Nitrite as Nitrite (mg/L)	Iron, Total (mg/L)	Iron, Dissolved [2] (mg/L)	Manganese, Total (mg/L)	Manganese, Dissolved (mg/L)	Sulfate (mg/L)	Sulfide [2] (mg/L)	Carbon Dioxide (mg/L)	Methane (µg/L)	Chloride (mg/L)	Ethane (ng/L)	Ethylene (ng/L)	Nitrogen (mg/L)	Propane (ng/L)	Propylene (ng/L)
EPA Method		SM2320B	350.30	Field Test	415.10	300	Field Test	Field Test	Field Test	*AM19GAX*	Field Test	Field Test	300	300	6010B	Field Test	6010B	6010B	300.00	Field Test	*AM19GAX*	*AM19GAX*	300	*AM19GAX*	*AM19GAX*	*AM19GAX*	*AM19GAX*	*AM19GAX*
Downgradient Wells (leading edge of plume)																												
MW-40	8/24/99	90	<0.1	0.316	8	<1.0	260.8	7.16	18.62	3.42	2.39	3	37	<0.01	0.11	<0.2	<0.01	<0.01	19	< 0.1	9.09	3.039	12	<5	<5	18.78	<10	<10
MW-42	8/25/99	70	<0.1	0.221	6.1	<1.0	-34.0	6.87	15.78	2.30	0.37	1	<1.0	<0.01	2.0	0.2	0.19	0.03	30	< 0.1	11.40	1.053	9	<5	34	27.01	<10	<10
MW-42D	8/25/99	68	<0.1	na	5.8	<1.0	na	na	na	1.79	na	na	<1.0	<0.01	2.3	na	0.18	0.03	30	na	10.78	0.513	9.1	<5	32	24.29	<10	<10
Wells Along Axis of the Plume																												
MW-02	8/26/99	54	<0.1	0.242	4.8	<1.0	228.8	6.94	17.67	7.42	10.24	9	19	<0.01	0.60	<0.2	<0.01	<0.01	7.1	< 0.1	5.70	0.544	9.3	34	<5	17.32	<10	<10
MW-52	8/25/99	65	<0.1	0.216	4.5	<1.0	211.8	6.72	18.11	7.46	9.28	6	40	<0.01	0.31	<0.2	<0.01	<0.01	9.2	< 0.1	12.18	0.356	7.6	<5	<5	19.11	<10	<10
MW-63	8/25/99	97	<0.1	0.178	6.9	<1.0	52.9	7.36	17.21	4.59	3.71	4	8.2	0.25	21	<0.2	0.14	0.02	5.1	< 0.1	2.91	1.25	8.5	218	64	18.86	205	<10
Wells Surrounding Burn Pit Area																												
MW-26	8/26/99	94	<0.1	0.349	4.4	<1.0	145.0	7.71	16.81	8.76	10.62	10	45	<0.01	2.0	<0.2	0.03	<0.01	14	< 0.1	<0.60	0.218	27	39	63	18.61	<10	<10
MW-36	8/26/99	61	<0.1	0.187	5.8	<1.0	207.3	6.61	15.47	5.68	7.43	7	11	<0.01	15	<0.2	0.20	<0.01	38	< 0.1	26.03	0.198	10	<5	<5	17.65	<10	<10
MW-59B	8/26/99	66	<0.1	0.359	5.9	<1.0	184.8	8.23	17.67	7.40	9.14	7	82	<0.01	3.5	<0.2	0.05	<0.01	15	< 0.1	1.44	0.406	11	72	<5	18.20	<10	<10

Note: The parameters with methods listed in *italics* were analyzed by Microseeps. All other parameters with EPA methods listed were analyzed by Columbia Analytical Services, Inc.

[1] Parameters measured in the field with YSI 6000 Water Quality Transmitter following purging (average value reported)

[2] Parameters measured in the field with Hach Field Test Kit

mg/L milligrams per liter

mV millivolts

ng/L nanogram per liter

na not applicable (no duplicate measuments were taken with field test kit or YSI 9000 Water Quality Transmitter)

µg/L microgram per liter

µmhos/cm micromhos per centimeter

Table 3. Preliminary Site Water Balance, Lockheed Beaumont Test Site No.1, Beaumont, California

Month of Year	Precipitation[1] (inches)	Evapotranspiration (ET)[2] (inches)	Δ
January	3.89	1.9	+1.99
February	3.45	2.3	+1.15
March	3.19	3.4	-0.21
April	1.31	4.4	-3.09
May	0.64	6.1	-5.46
June	0.16	7.1	-6.94
July	0.21	7.6	-7.39
August	0.22	7.9	-7.68
September	0.52	6	-5.48
October	0.61	3.9	-3.29
November	1.72	2.6	-0.88
December	2.21	1.7	+0.51
	18.13	54.9	-36.77

[1] = Precipitation - 1948 to 1998 mean data for Beaumont, California obtained from Western Regional Climate Center.

[2] = ET - Normal year values for Beaumont, California obtained from California Irrigation Management Informaion Systems.