FINAL

SITE-SPECIFIC WORK PLAN FOR THE PASSIVE DIFFUSION BAG SAMPLER DEMONSTRATION AT NORTON AFB, CALIFORNIA

June 2001

Prepared for:

Air Force Center for Environmental Excellence
Technology Transfer Division
and
Air Force Environmental Directorate

CONTRACT NO. F41624-00-8024
Task Order No. 0024

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFBCA	Air Force Base Conversion Agency
AFCEE/ERT	Air Force Center for Environmental Excellence, Technology Transfer Division
ANOVA	analysis of variance
bgs	below ground surface
CDM	Camp, Dresser, and McKee
DoD	Department of Defense
GIS	Geographical information system
GWMP	Groundwater Monitoring Program
HASP	Health and Safety Plan
IRP	Installation Restoration Program
MAW	Military Airlift Wing
MLW	multi-level well
MW	monitoring wells
Parsons	Parsons Engineering Science, Inc.
PDBS	passive diffusion bag sampler
RPD	relative percent difference
STL	Severn-Trent Laboratories
TCE	trichloroethene
TO	task order
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
WSCP	Water Supply Contingency Policy

1.0 INTRODUCTION

1.1 Project Description

On 27 February 2001, Parsons Engineering Science, Inc. (Parsons) was awarded a task order (TO) under Air Force Center for Environmental Excellence (AFCEE) contract F41624-00-D-8024 (TO24) to demonstrate the use of passive diffusion bag samplers (PDBSs) in existing groundwater monitoring programs at selected Air Force Base Conversion Agency (AFBCA) installations. The site of the PDBS demonstration outlined in this work plan is Norton Air Force Base (AFB), California. The Technology Transfer Division of AFCEE (AFCEE/ERT) has initiated the PDBS demonstration to introduce this technology to multiple Department of Defense (DoD) installations and to improve the cost effectiveness of groundwater monitoring programs for volatile organic compounds (VOCs).

Diffusion sampling is a relatively new technology designed to utilize passive sampling techniques that eliminate the need for well purging. Specifically, a diffusive-membrane capsule is filled with deionized/distilled water, sealed, suspended in a well-installation device, and lowered to a specified depth below the water level in a monitoring well. Over time (no less than 72 hours), the VOCs in the groundwater diffuse across the membrane, and the water inside the sampler reaches equilibrium with groundwater in the surrounding formation. The sampler is subsequently removed from the well, and the water in the diffusion sampler is transferred to a sample container and submitted for laboratory analysis of VOCs. Benefits of diffusion sampling include reduced sampling costs and reduced generation of investigation-derived waste.

1.2 Objective

The PDBS demonstration at Norton AFB has two primary objectives:

- Develop vertical profiles of VOC concentrations across the screened intervals of the sampled monitoring wells, and

- Assess the effectiveness of PDBS by statistically comparing groundwater analytical results for VOCs obtained using the current (conventional) sampling method (i.e., 3-casing-volume purge/sample) during the previously scheduled July 2001 Groundwater Monitoring Program (GWMP) event with results obtained using the PDBS method.

Vertical contaminant profiles will be developed by placing multiple PDBSs at discrete screened depths in each monitoring well included in the demonstration, and analyzing the resulting samples for VOCs. The resulting information will aid the Base in evaluating contaminant migration and fate in the saturated zone, and will allow optimization of the GWMP through collection of future groundwater samples from the depth interval of greatest contaminant concentrations. The statistical comparison of the conventional and diffusion sampling results will allow assessment of the appropriateness of implementing diffusion sampling for VOCs at each sampled well.

1.3 Scope

The Norton AFB PDBS sampling demonstration will require two mobilizations to the site: one to place the diffusion samplers in the selected monitoring wells, and a second to retrieve the samplers from the wells. The PDBSs will be installed during the second week of June 2001 to provide adequate equilibration time before the incumbent environmental contractor for Norton AFB, Earth Tech, begins the scheduled GWMP sampling event scheduled to begin on July 2, 2001. The PDBSs will be retrieved immediately prior to the conventional GWMP sampling event to ensure temporal comparability of the analytical results obtained using the two methods. The PDBSs will be in place for a minimum of 14 days, which fulfills the 14-day minimum equilibration time period specified in the AFBCA PDBS Project Work Plan (Parsons, 2001).

1.4 Document Organization

This work plan is organized into seven sections, including this introduction, and one appendix. The Norton AFB site description is presented in Section 2. Section 3 presents the scope of the PDBS investigation at Norton AFB. Project organization, schedule, and an overview of the PDBS site-specific results report are summarized in Sections 4, 5, and 6, respectively. References used in the preparation of this work plan are presented in Section 7. Appendix A provides a site-specific addendum to the Project Health and Safety Plan (HASP) (Parsons, 2001).

2.0 SITE DESCRIPTION

2.1 Location and Description of Norton Air Force Base

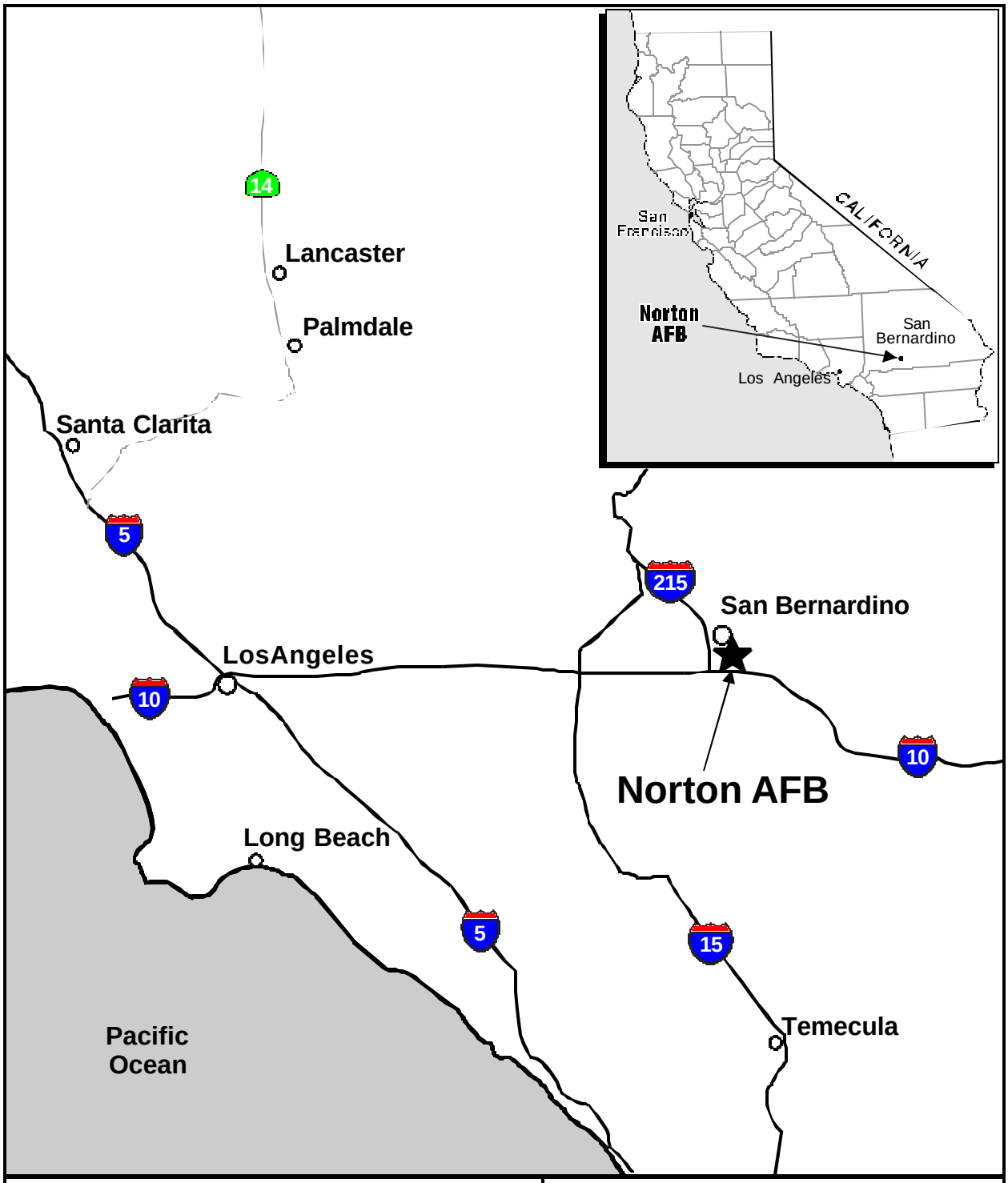
Norton AFB is located in San Bernardino County, approximately 65 miles east of Los Angeles, California (Figure 2.1). The Base was officially closed on March 31, 1994. The Base originally covered 2,288 acres including a 10,000-foot runway, offices, warehouses, and industrial structures (California Trade and Commerce Agency, 2000).

The Base began operations in 1942 and was used for aircraft maintenance and repair. After World War II, Norton had the responsibility for providing maintenance and logistics for liquid-fuel intercontinental ballistic missiles. Since 1966, the main operation was the 63rd Military Airlift Wing (MAW), which provided immediate airlift and sustenance capabilities for air and ground combat units worldwide.

Potential contamination has been investigated under the Installation Restoration Program (IRP) since 1982 (Earth Tech, 2001a). The previous studies identified trichloroethene (TCE) contamination in groundwater beneath the Central Base Area, extending southwest past the Base boundary.

2.2 Geology and Hydrogeology

Norton AFB lies on an alluvial terrace on the north bank of the Santa Ana River. The site is underlain by approximately 800 feet of alluvial and fluvial sediments consisting of clay, silt, gravel, and boulders in varying proportions. River channel deposits and



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0 10

ScaleinMiles

Figure 2.1

Norton AFB
Location Map

PassiveDiffusionBagSamplerDemonstration
Norton AFB,California

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Pasadena,CA

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younger alluvium characterize the surface geology. Deposits are laterally discontinuous and dip gently to the southwest (Camp, Dresser, and McKee [CDM] Federal, 1992).

The Base is located in the southeast portion of the Bunker Hill Groundwater Basin. Recharge to the basin is predominantly runoff from the San Bernardino Mountains (Duell and Schroeder, 1989). Regional groundwater flow is to the southeast with local variations near and along fault planes (Hardt and Freckleton, 1987). Depth to groundwater ranges from approximately 60 feet below ground surface (bgs) along the southern Base boundary to 130 feet bgs in the northeast Base area (CDM Federal, 1992). There is a 25 to 35 foot seasonal fluctuation to the ground water level in the basin. Historically some wells can change up to 15 feet between the monthly water level measurements.

2.3 Chemicals of Concern

Historically, contamination in groundwater has consisted primarily of TCE and its associated breakdown products. The TCE contamination is located primarily in the groundwater beneath the Central Base Area, extending southwest past the Base boundary (Figure 2.2).

2.4 Current Groundwater Monitoring Program

The GWMP is the basewide monitoring project and is part of the base closure process. The U.S. Air Force Off-Base Water Supply Contingency Policy (WSCP) is primarily an off-base monitoring program that was enacted to address the concerns about the possible impact of the Norton TCE plume on the drinking water wells supplying the city of Riverside.

Monitoring wells that are sampled currently at Norton AFB as part of the GWMP program are located (in the highest concentration) within the Central Base Area Operable Unit where contaminants have been historically detected. Sampling events are performed quarterly (80 wells), with some additional wells sampled semiannually (24 additional wells) and annually (13 additional wells). The WSCP wells are located off-base (to the southwest). WSCP wells are sampled monthly based on the past six month concentrations. The WSCP wells are included in the quarterly GWMP sampling events. The multi-level wells (MLWs) and the 300 series monitoring wells (MWs) are part of the WSCP. The GWMP and WSCP wells are sampled in accordance with the *Final Norton Sampling and Analysis Plan* (Earth Tech, 2001b).

3.0 SCOPE OF PDBS DEMONSTRATION

An estimated total of 101 passive diffusion samplers will be installed in 16 monitoring wells at Norton AFB as part of this project. An additional 6 alternate monitoring wells have been designated for sampling in the event that one or more of the primary monitoring wells cannot be sampled. Most of the wells are located in and around the main plume in the Central Base Area. Additional wells are located in the North Base Area and Sites 1 and 17 (located south of the runway). The monitoring wells that will be sampled during this PDBS demonstration are summarized on Table 3.1, and their locations are shown on Figures 3.1 through 3.4.

N

LEGEND

MW-180	Quarterly Groundwater Monitoring Well (No Dedicated Pump, included in Passive Diffusion Demonstration)
MW-195	Quarterly Groundwater Monitoring Well (Dedicated Pump, not included in Passive Diffusion Demonstration)
MLW1	Groundwater Monitoring Well (Multi-Level Bladder Dedicated Pump)
MW-281	Other Groundwater Monitoring Well (No Dedicated Pump, not sampled Quarterly)
MW-189	Other Groundwater Monitoring Well (Dedicated Pump, not sampled Quarterly)
	Approximate Location of TCE Plume (January 2001, from Earth Tech, 2001)

2000 0 2000

Scale in Feet

Figure 2.2

Approximate Extent of TCE Contamination

Passive Diffusion Bag Sampler Demonstration
Norton AFB, California

PARSONS ENGINEERING SCIENCE, INC.

Pasadena, CA

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TABLE 3.1
SAMPLING LOCATION SUMMARY
PASSIVE DIFFUSION BAG SAMPLER DEMONSTRATION
NORTON AFB, CALIFORNIA

Well Number	Primary/ Alternate (P/A)	Total Depth (ft)[a/]	Well Diameter (in)[a/]	Screened Interval (ft Below TOC)[b/]	Approximate Water Level Range (ft below TOC)	April '01 Water Level (ft below TOC) April 2001	Well Screen Level[c/]	Dedicated Pump (Y/N)	Estimated Number of PDBSs	Main COCs and Apr. 2001 Contaminant Concentration (µg/L)[b/]	Comments/Sampling Rationale
Central Base Area Wells											
MW-180	P	100.50	4" PVC	75-100	75.50 - 85.15	81.11	A	N	6	TCE: 22; cis-1,2-DCE: 2.1	Apr 2001 TCE exceeds regulatory limit
MW-183	P	105.00	4" PVC	79.5-104.5	84.59 - 94.38	90.61	A	N	4	TCE: 5.8; cis-1,2-DCE: 2.5	Apr 2001 TCE exceeds regulatory limit
MW-188	P	137.50	4" PVC	122-137	NM	NM	B	N	5	TCE: 3.9	Detectable TCE
MW-190	P	107.00	4" PVC	81.5-106.5	86.81 - 95.42	93.99	A	N	4	TCE: 18	Apr 2001 TCE exceeds regulatory limit
MW-209	P	142.00	4" PVC	126.5-141.5	72.67 - 84.45	78.23	B	N	5	TCE: 1.4	Detectable TCE
MW-224	P	111.80	4" PVC	86.5-111.5	82.82 - 92.23	90.27	A	N	7	TCE: 20; cis-1,2-DCE: 1.7	Apr 2001 TCE exceeds regulatory limit
MW-265	P	105.30	4" PVC	80-105	74.86 - 83.65	80.40	A	N	8	TCE: 5.8; cis-1,2-DCE: 2.5	Apr 2001 TCE exceeds regulatory limit
MW-266	P	88.30	4" PVC	63-88	59.59 - 70.63	61.99	A	N	8	TCE: 2	Detectable TCE
MW-268	P	110.50	4" PVC	85-110	82.86 - 90.75	89.19	A	N	7	TCE: 2.5	Detectable TCE
MW-304	P	99.00	4" PVC	73.6-98.6	57.59 - 68.29	58.86	A	N	8	TCE: 0.54J	Detectable TCE
MW-308	P	101.50	4" PVC	76-101	54.69 - 63.21	56.00	A	N	8	TCE: 1.6	Detectable TCE
MW-324	P	101.00	4" PVC	75.5-100.5	53.22 - 64.97	56.32	A	N	8	TCE: 2.8	Detectable TCE
MW-303	P	100.50	4" PVC	75-100	66.99 - 77.15	68.10	A	N	8	cis-1,2-DCE: 0.34J	Detectable TCE
MW-198	A	96.60	4" PVC	73-98	79.83 - 87.86	85.47	A	N	3	TCE: 2.6	Detectable TCE
MW-312	A	101.50	4" PVC	76.1-101.1	62.48 - 73.22	63.77	A	N	8	TCE: ND; PCE: ND [d/]	
MW-316	A	102.00	4" PVC	76.6-101.6	52.42 - 61.10	54.72	A	N	8	TCE: ND; PCE: ND	
MW-320	A	102.50	4" PVC	77.1-102.1	45.94 - 54.79	47.67	A	N	8	TCE: ND; PCE: ND	
North Base Area Wells											
MW-166	P	118.20	4" PVC	93.2-118.2	97.49 - 108.94	108.94	A	N	3	Dichlorobromoethane 0.71J; n-butylbenzene 0.60J	north area of Base, detectable VOCs
MW-252	P	164.30	4" PVC	139-164	115.69 - 135.81	135.59	A	N	8	DCFM 1.2J; TCFM 1.0J; 1,1-DCA 0.37J	north area of Base, detectable VOCs
Sites 1 and 17											
MW-1R	P	44.60	4" PVC	25-45	28.90 - 30.86	30.86	P	N	4	cis-1,2-DCE: 0.58J; 1,4-DCB 0.57J; 1,2-DCB 0.65J	south area of Base, detectable VOCs
MW-205	A	89.50	4" PVC	64-89	68.75 - 77.75	71.49	A	N	6	TCE: ND; PCE: ND	south area of Base; last sampled January-01
MW-299	A	100.00	4" PVC	75-100	68.27 - 77.35	71.00	A	N	8	TCE: ND; PCE: ND	south area of Base; last sampled January-01

Notes:

VC= Vinyl Chloride; TCE = Trichloroethene; cis-1,2-DCE = cis-1,2-Dichloroethene; PCE = Tetrachloroethene;
1,1-DCA = 1,1-Dichloroethane; 1,1-DCE = 1,1-Dichloroethene; 1,2,4-TMB = 1,2,4-Trimethylbenzene; 1,1,1-TCA = 1,1,1-Trichloroethane.
1,4-DCB = 1,4-Dichlorobenzene; 1,2-DCB = 1,2-Dichlorobenzene; MTBE = Methyl-t-butyl ether; DCFB = Dichlorodifluoromethane; TCFM = Trichlorofluoromethane.

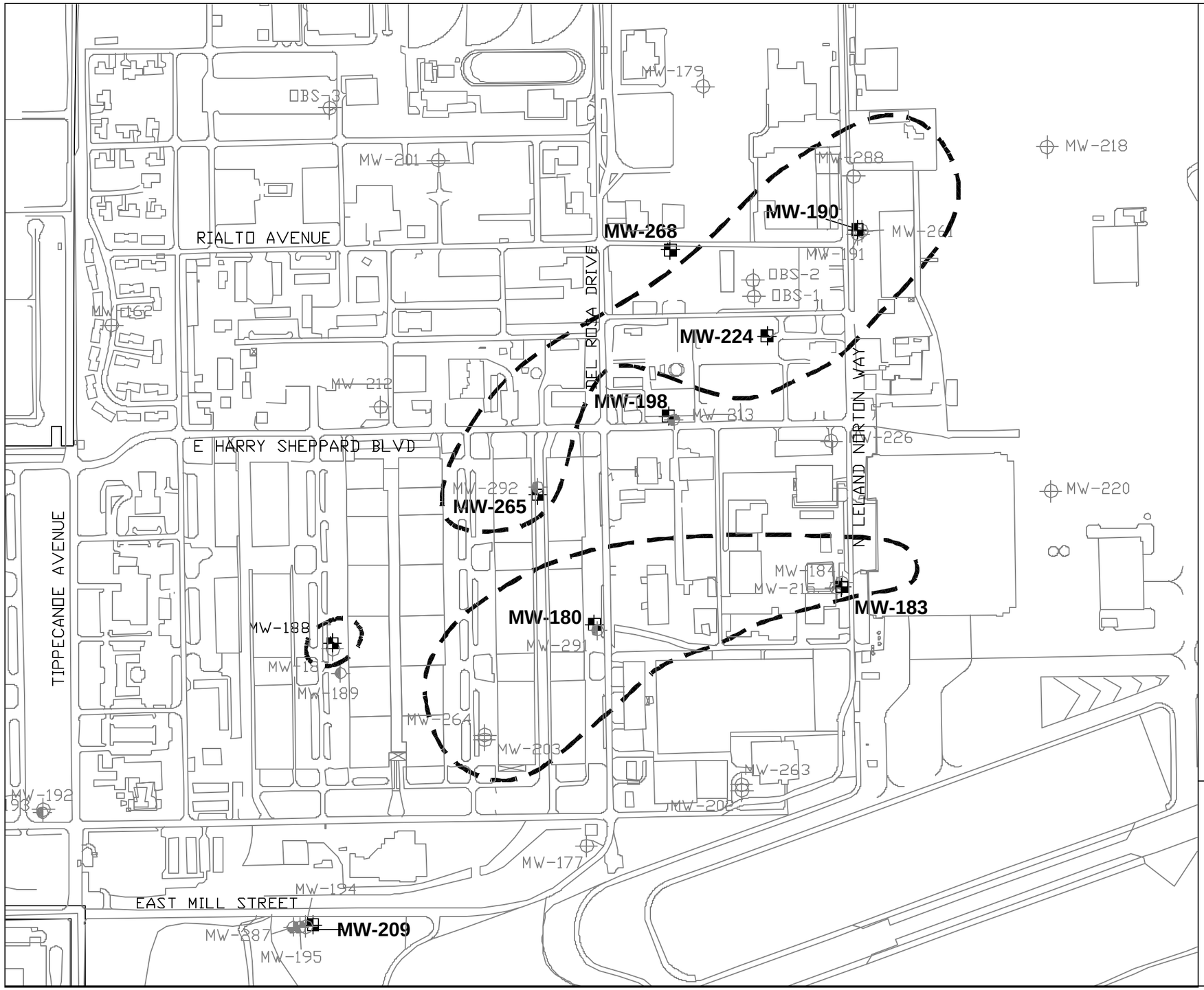
[a/] ft = feet; in = inches.

[b/] TOC = top of casing; µg/L = micrograms per liter; COCs = chemicals of concern.

[c/] Well screen level

A = Well screen at water table based on 1991 water table elevation.
B = Well screen approximately 50 feet below water table (1991).
C = Well screen approximately 100 feet below water table (1991).
D = Well screen approximately 150 feet below water table (1991).
P = Well screen in a Perched Zone

[d/] ND = not detected.



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	Approximate Location of TCE Plume (January 2001, from Earth Tech, 2001)

500 0 500

Scale in Feet

Figure 3.1

Proposed PDBS Wells
Central Base Area (North)

Passive Diffusion Bag Sampler Demonstration
Norton AFB, California

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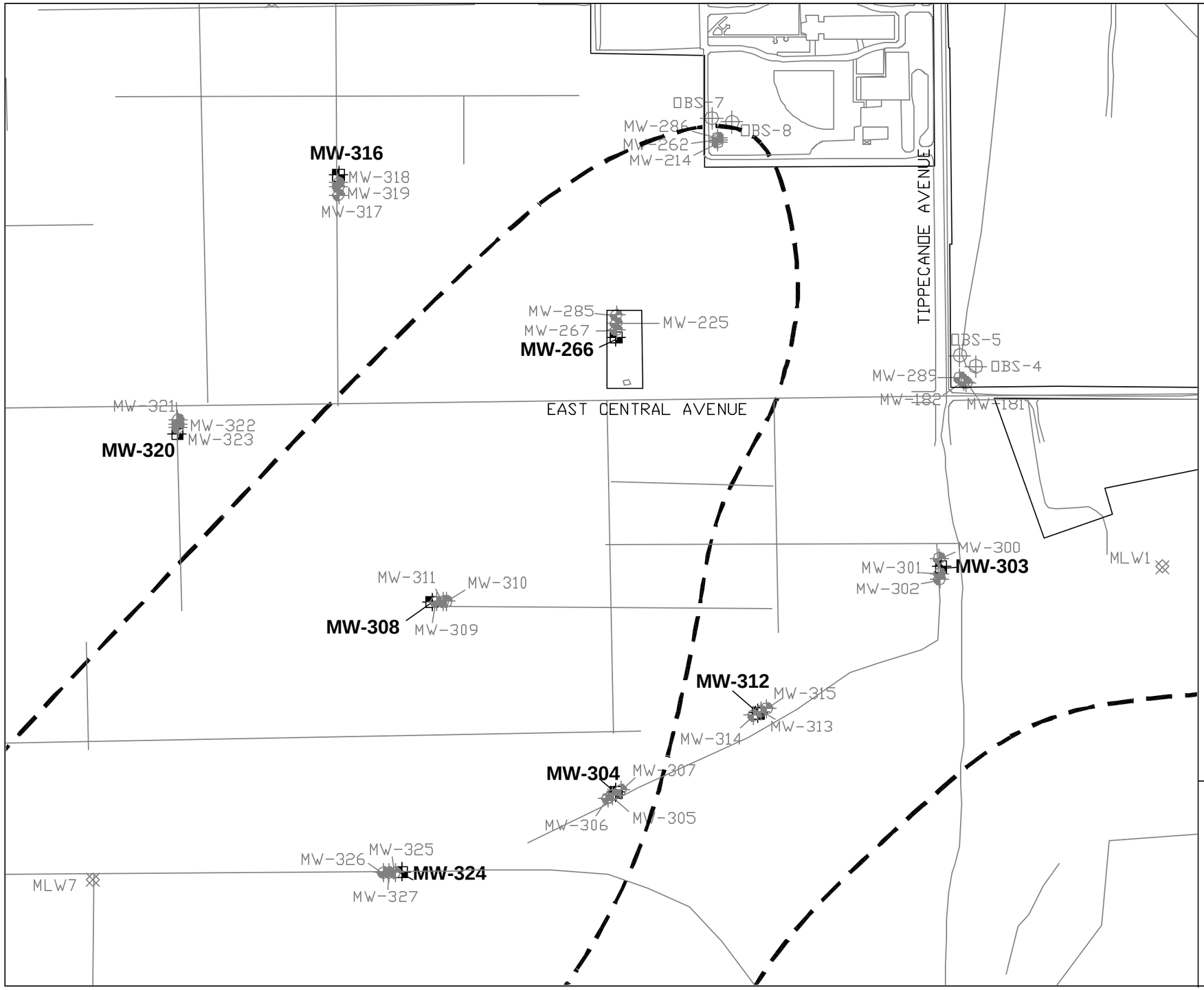

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	Approximate Location of TCE Plume (January 2001, from Earth Tech, 2001)

500 0 500

Scale in Feet

Figure 3.2

Proposed PDBS Wells
Central Base Area (Southwest Plume Area)

Passive Diffusion Bag Sampler Demonstration
Norton AFB, California

PARSONS ENGINEERING SCIENCE, INC.

Pasadena, CA

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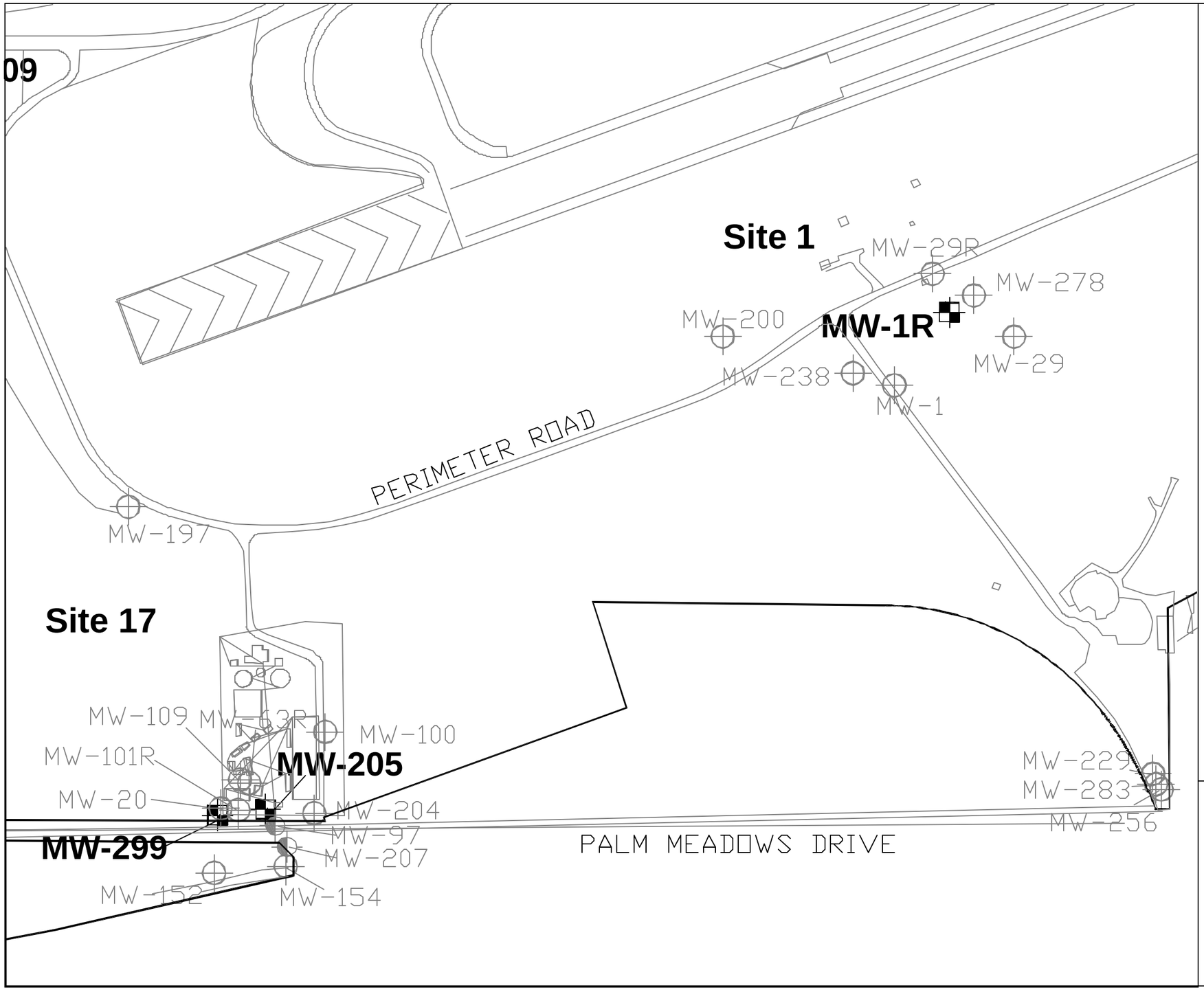

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	Approximate Location of TCE Plume (January 2001, from Earth Tech, 2001)

300 0 300

Scale in Feet

Figure 3.3

Proposed PDBS Wells
Sites 1 and 17

Passive Diffusion Bag Sampler Demonstration
Norton AFB, California

PARSONS ENGINEERING SCIENCE, INC.

Pasadena, CA

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1000 0 1000

Scale in Feet

DETAIL 1

DETAIL 2

MW-166 MW-249 MW-231 MW-233 MW-275 MW-274 MW-245 MW-218 MW-270 MW-113 MW-236 MW-110 MW-273 MW-298 MW-258 MW-246 MW-284 MW-252 MW-295 MW-294 MW-235 MW-157 MW-241 MW-259 MW-260 MW-244 MW-239 MW-242 MW-253

100TH STREET

Y STREET

U STREET

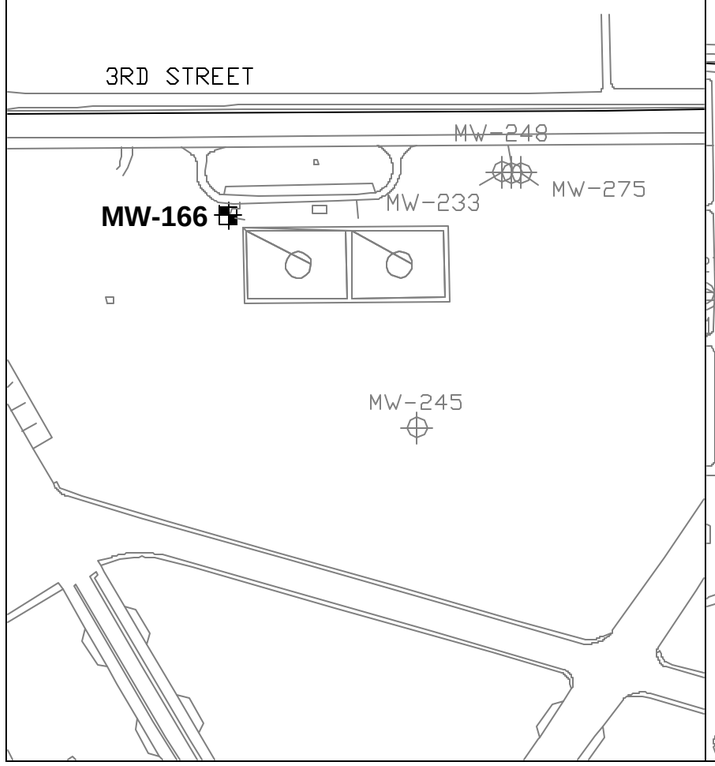
106TH STREET

3RD STREET

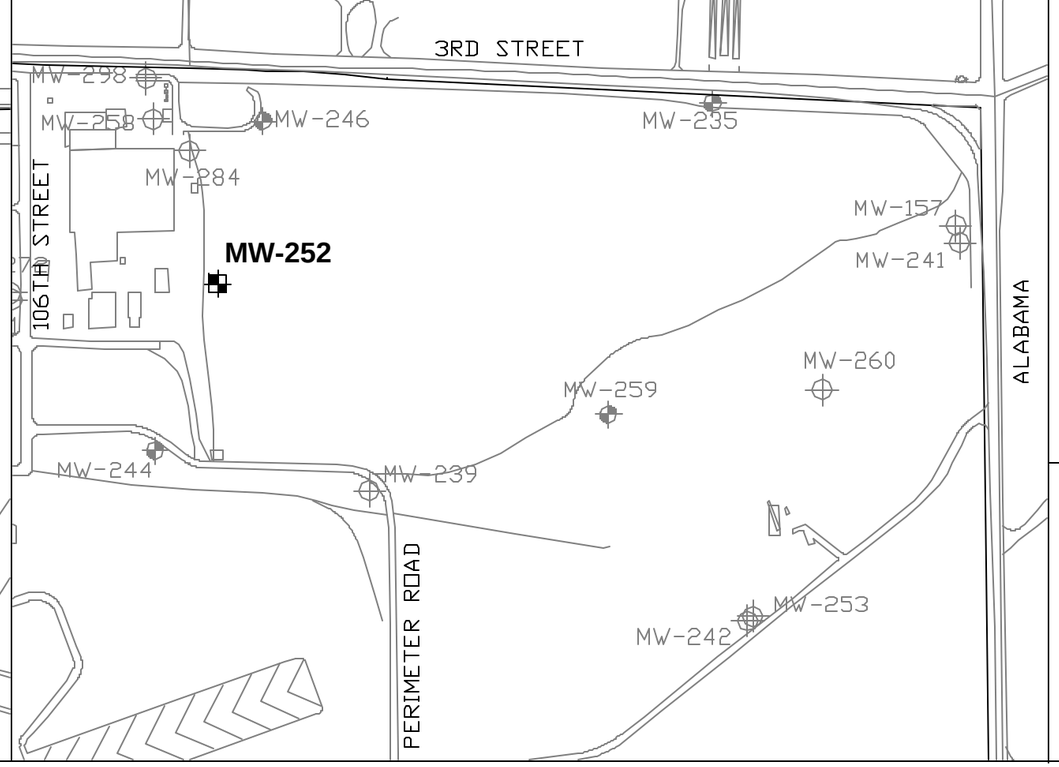
PERIMETER ROAD

ALABAMA

DETAIL 1



DETAIL 2



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	Approximate Location of TCE Plume (January 2001, from Earth Tech, 2001)

Detail Scale

500 0 500

Scale in Feet

Figure 3.4

Proposed PDBS Wells
North Base Area

Passive Diffusion Bag Sampler Demonstration
Norton AFB, California

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3.1 Diffusion Sampling

3.1.1 Field Activities

Monitoring wells selected for VOC sampling using the PDBS technique (Table 3.1) were chosen from the list of monitoring wells targeted for sampling by the Earth Tech GWMP scheduled to begin in July 2001. Monitoring wells were selected based primarily on VOC concentrations detected during previous sampling events and on the presence/absence of a dedicated pump. The selected wells are those that have had detectable concentrations of VOCs and do not contain dedicated pumps.

PDBSs deployed during this investigation will be installed and retrieved in general accordance with the diffusion sampler installation and recovery standard operating procedures presented in Appendix B of the AFILEV PDBS Project Work Plan (Parsons, 2001). PDBSs will be installed throughout the screened interval of each well (i.e., 1 PDBS per 3 feet of saturated screen) to obtain a vertical profile of contaminant concentrations. The PDBS samples will be collected prior to the July 2001 Earth Tech sampling event. Analysis of the vertical profiling samples is discussed in Section 3.1.2.

Sample aliquots from PDBSs installed in the 44 existing wells targeted for sampling will be shipped to Severn-Trent Laboratories (STL) in Santa Ana, California for VOC analysis using US Environmental Protection Agency (USEPA) Method 8260B. This is the same laboratory that will be used by Earth Tech during their conventional sampling of the same wells under the same procedures. Field quality control samples will be collected at the following frequencies:

- 10 percent field duplicates;
- 5 percent matrix spikes and matrix spike duplicates;
- 1 pre-installation equipment blank; and
- 1 trip blank per cooler of samples.

3.1.2 Contaminant Profiling

Per the project work plan (Parsons, 2001), contaminant profiling within the screened intervals of the GWMP wells was intended to be conducted using field-screening methods, with only the sample exhibiting the greatest VOC concentrations based on the field analysis method being submitted for laboratory analysis. However, the field-screening test kits specified in the AFILEV PDBS Project Work Plan (Parsons, 2001) are not appropriate for use at Norton AFB because recently reported VOC concentrations in most of the monitoring wells are below the minimum quantitation limits of the field test kits.

Therefore, the field test kits will not be used to screen groundwater samples at Norton AFB. Rather, sample aliquots will be collected from all PDBSs to be installed in the 16 monitoring wells and shipped to STL Laboratories for VOC analysis. Thus, vertical profiling of VOC concentrations within each well will be completed using fixed-based laboratory analyses rather than field-screening methods.

3.1.3 Analytical Results Comparison/Evaluation

Analytical results for groundwater samples collected using the PDBSs and using conventional techniques will be compared, and the results will be evaluated. Typically, if maximum concentrations from the PDBSs are higher than concentrations in samples collected using the conventional method, it is probable that the concentrations from the PDBSs are more representative of ambient groundwater chemistry conditions than are the conventional-sampling data (Vroblesky, 2001). If, however, the conventional method produces VOC results that are higher by a predetermined amount than the concentrations reported for the PDBS, then the PDBS may not adequately represent local ambient groundwater conditions. In this case, the difference may be due to a variety of factors, including hydraulic and chemical heterogeneity within the saturated screened interval of the well, vertical flow of groundwater within the well, and/or the relative permeability of the well screen with respect to the surrounding aquifer matrix (Vroblesky, 2001).

Considering the above guidance, if the maximum analytical result obtained using the PDBS is greater than or equal to the conventional sampling result, it will indicate that the PDBS method is appropriate for use in that particular well and no further comparison of results will be performed. However, if the maximum PDBS result is less than the conventional sampling result, further comparison of the two sets of results will be undertaken. In this instance, analytical results for samples collected using the diffusion samplers will be compared to results from the conventional sampling using relative-percent-difference (RPD), as defined by the following equation:

$$RPD = 100*[abs(D-C)]/[(D+C)/2]$$

Where:

abs = absolute value

D = diffusion sampler result

C = conventional sample result.

For this investigation, an RPD of less than 15 (McClellan AFB, 2000) will be considered to demonstrate good correlation between sample results. Calculated RPDs in excess of 15 will be reviewed individually in an attempt to determine the reason for the variance.

3.2 Monitoring Network Optimization Evaluation

A portion of the groundwater monitoring network at this installation will be evaluated using both qualitative assessments and a geographical information system (GIS)-based algorithm that performs statistically based temporal and spatial analyses of monitoring-well information. Locations and completion intervals of individual monitoring wells and sampling points will be examined, and the informational contribution of each well or sampling point to the network will be weighed against the cost of monitoring at that point. Monitoring protocols and analytical methods also will be evaluated. Where warranted, recommendations will be developed for optimization of the portion of the monitoring network that is evaluated. Methods to be used in the evaluation will include,

but are not limited to, qualitative hydrogeologic and hydrochemical analyses, application of statistical optimization techniques, and application of decision-logic structures.

A maximum of 45 monitoring wells at this installation will be evaluated as part of this task. Parsons will coordinate with Norton AFB to determine which wells to include in the evaluation. The results of the evaluation will be included in the Site-Specific Diffusion Sampler Demonstration Report for Norton AFB.

4.0 PROJECT ORGANIZATION

Addresses and telephone numbers of the Norton AFB PDBS management team are as follows:

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Mr. Doug Downey	Parsons ES Technical Director for PDBS	1700 Broadway, Suite 900 Denver, Colorado 80290	(303) 764-1915 email: doug.downey@parsons.com	(303) 831-8208
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Name	Title	Address	Phone/Email	Fax
		80290		
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5.0 SCHEDULE

Work performed as part of this demonstration at Norton AFB will be completed according to the schedule summarized below.

- Submittal of the Draft Norton AFB PDBS Work Plan to commenting parties: June 7, 2001
- Receipt of Draft Norton AFB PDBS Work Plan Comments: June 12, 2001
- Submittal of the Final Norton AFB PDBS Work Plan to commenting parties: June 26, 2001
- Install PDBS samplers in 44 monitoring wells at Norton AFB: June 14-15, 2001
- Remove PDBS samplers from 44 monitoring wells at Norton AFB: July 2-5, 2001
- Preparation of the Draft Norton AFB PDBS Report: August 13 – October 14, 2001.

6.0 REPORTING

The site-specific results report will provide a map and accompanying table identifying the location and depth for each PDBS sample collected. Analytical results collected as

part of this study will be compared to conventional-sampling analytical results collected by Earth Tech in a scientifically defensible manner using statistical analyses. The results of the statistical comparisons will be presented in a clear and logical manner in the results report. Statistical methods will include calculation of RPDs between PDBS and conventional sampling results, and possibly parametric or non-parametric analysis of variance (ANOVA) tests.

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APPENDIX A

HEALTH AND SAFETY PLAN ADDENDUM