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MCAS EL TORO PERIMETER INVESTIGATION INTERIM REPORT

APRIL 1989

INSTALLATION RESTORATION PROGRAM MARINE CORPS AIR STATIONS, TUSTIN AND EL TORO, CALIFORNIA

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SAN DIEGO BRANCH
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ENGINEERING COMMAND
SAN DIEGO, CALIFORNIA

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Consulting Engineers Inc.

INSTALLATION RESTORATION PROGRAM

MARINE CORPS AIR STATIONS

TUSTIN AND EL TORO, CALIFORNIA

MCAS EL TORO PERIMETER INVESTIGATION
INTERIM REPORT

San Diego Branch
Western Division
Naval Facilities Engineering Command
San Diego, California

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MCAS EL TORO PERIMETER INVESTIGATION
INTERIM REPORT

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EXECUTIVE SUMMARY

A multi-phase field investigation, called the Perimeter Investigation, was accomplished during a period from December 1987 through January 1989 at the Marine Corps Air Station (MCAS) El Toro, California. The objective of this investigation was to evaluate whether the trichloroethene (TCE) contamination observed at the three agricultural wells located on and off station is a result of past waste disposal practices at the station. This interim report is being provided by James M. Montgomery, Consulting Engineers, Inc. (JMM) in order to present results of investigations completed to date. A final report will be prepared following completion of all field and data interpretation efforts related to the Perimeter Investigation.

The components of the Perimeter Investigation included the installation and sampling of a cluster of wells designed to identify the physicochemical characteristics and the vertical extent of any volatile organic chemical (VOC) contamination near the agricultural well located on station. A total of 8 shallow monitoring wells were also installed and tested along the southwestern portion of the station in order to evaluate the presence and characteristics of any contamination leaving the station. These on-station investigations were conducted concurrently with the field investigations completed off station by the Orange County Water District (OCWD).

OCWD completed their investigations during February 1989 and issued a report that described their findings in March 1989. The OCWD report concluded that the TCE contamination detected in irrigation and monitoring wells located off station is continuous with the TCE contamination detected in irrigation and monitoring wells located on MCAS El Toro. The OCWD report further concluded that MCAS El Toro is the source of the TCE in the Irvine area.

The detailed interpretation and discussions presented in the Interim Report presented herein indicate that the conclusions presented in the OCWD report are unfounded. The data collected and presented by OCWD together with the findings of this study suggest that multiple VOC plumes exist in the Irvine area and that MCAS El Toro is a

contributor to this contamination and not the sole source of contamination. It is noted here that, for the purpose of this Interim Report, "plume" is defined as groundwater volumes and areas having VOC concentrations above detection limits imposed by the instruments the samples analyzed from.

Four areas of VOC contamination were identified. Three of these areas are located either totally or partially within the surface area of the MCAS El Toro. One of the VOC plumes located on station is surrounded by uncontaminated shallow and deep monitoring wells, installed and sampled by both OCWD and JMM, indicating that it is not contiguous with any of the off-station plumes. A second plume composed predominantly of TCE, is identified in the shallow aquifer near the southwest corner of the east-west runway. The continuity of this approximately 1500-foot long plume with the TCE plume located off station can not be established at this time. However, there is some likelihood that the historical pumping influence of an on-station agricultural well has drawn contaminated groundwater onto the station from a potential off-station source. A third plume composed predominantly of TCE and tetrachloroethene (PCE) is identified, also within the shallow aquifer, near the southwest corner of the north-south runway. Although the source of this plume has not yet been identified, it is believed that it is not contiguous with the off station TCE plume. The fourth plume, identified from the data provided by the OCWD, is located off station. The distribution, type, and relative concentrations of VOCs in this plume are substantially different than those found in the plumes located beneath MCAS El Toro. Furthermore, the contaminant transport time calculations using average and conservative estimates of aquifer parameters indicate that it would take an unrealistically long period of time for the TCE originating on station to reach the currently defined downgradient extent of this plume. These findings strongly suggest that other, perhaps multiple, sources of TCE may exist off station, throughout the Irvine area.

It is recommended that investigations should be initiated by the Navy and MCAS El Toro to define the off-station extent of VOC contamination related to the southern (third) plume believed to be originating from an on-station source. This work should include on- and off-station soil gas investigations as well as shallow monitoring wells

near MCAS El Toro to identify the horizontal extent of the third plume. A two level cluster well system should also be installed to delineate the vertical extent of VOC contamination. A similar investigation should be conducted around the second plume to identify the potential source location(s). Both of these investigations should also be directed towards gathering necessary data to design and implement a timely and cost-effective remediation system. The source(s) of the on-station plume should be identified during implementation of the Plan of Action for individual potential source locations throughout MCAS El Toro.

It is believed that the extent and chemical characteristic of the VOC plume located off station is fairly well defined. It is strongly recommended that the existing agricultural wells should not be utilized for the extraction and treatment of this plume. This is primarily because of the fact that the plume appears to be confined to a relatively small portion of the more than 400-foot thick aquifer, and that the continuously screened agricultural wells would likely cause cross-contamination of currently clean aquifer zones, thereby exacerbating the existing problem.

SECTION 1
INTRODUCTION

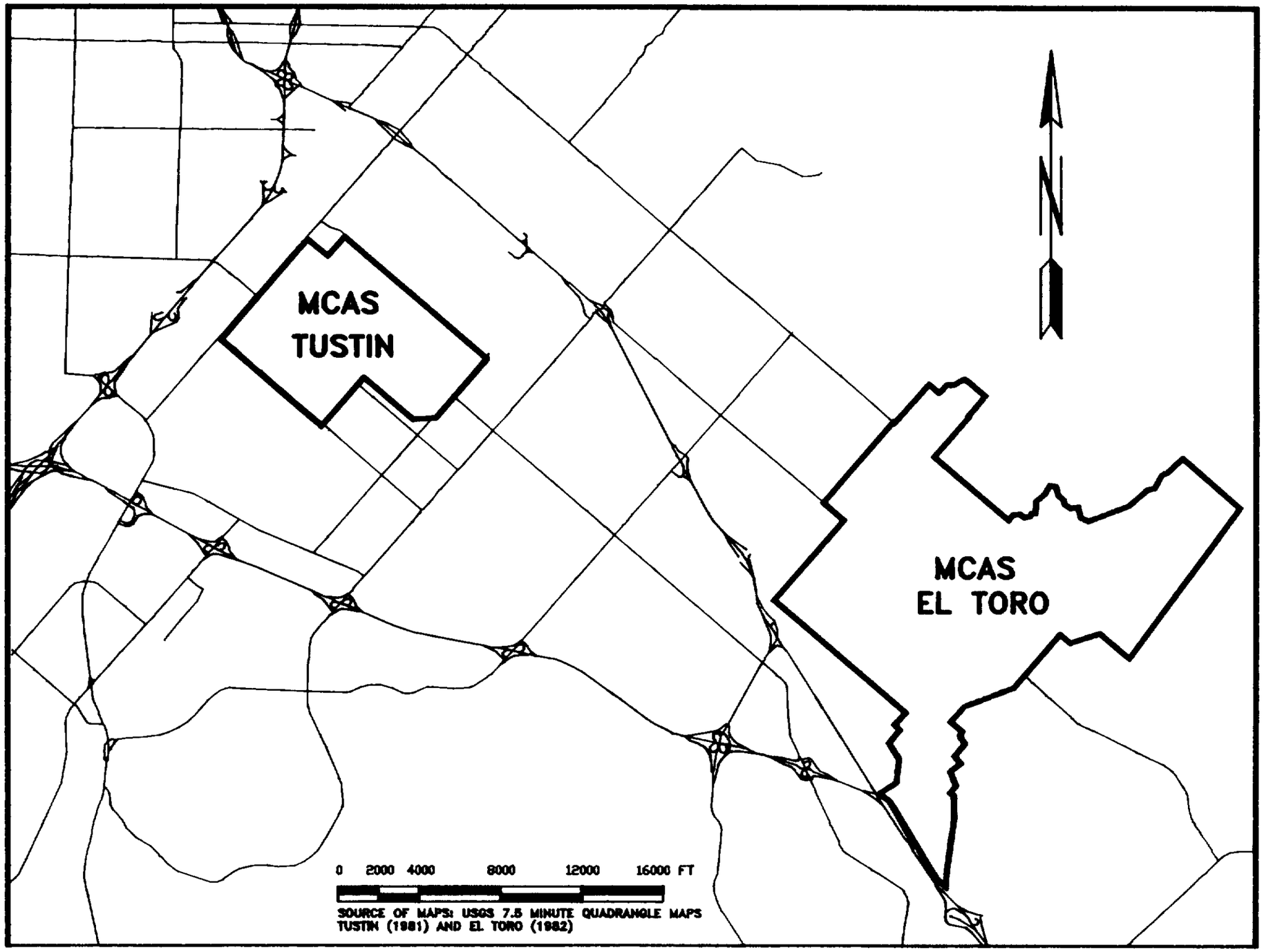
1.1 OBJECTIVE AND PURPOSE

The objective of this Interim Report for the Perimeter Investigation is to present results of field investigations conducted from December 1987 through January 1989, along the southwest perimeter of Marine Corps Air Station (MCAS) El Toro, California. This Interim Report is being submitted by James M. Montgomery, Consulting Engineers, Inc. (JMM) as part of Contract No. N62474-85-C-5592, Modification No. P00003, with the Western Division of the Naval Facilities Engineering Command (WESTDIVNAVFACENGCOM). The Perimeter Investigation is being performed under the auspices of the Navy Installation Restoration (IR) Program with technical direction provided by the Engineer-in-Charge (EIC) at the San Diego Branch of the West Division.

The purpose of the Perimeter Investigation is to identify whether trichloroethlene (TCE) contamination observed at agricultural production wells owned by The Irvine Company (TIC) on and near MCAS El Toro is a result of past waste generation and/or disposal activities on the air station. This report describes remedial investigations being done concurrently with the investigations conducted off station by the Orange County Water District (OCWD). In addition to these investigations, a Plan of Action (POA) has been submitted by JMM to conduct investigations at 22 sites in MCAS El Toro as part of the site inspection activities.

1.2 BACKGROUND

In June of 1985, (OCWD) sampled several agricultural production wells owned by TIC on and near MCAS El Toro. As shown in Figure 1.1, two of the off-station wells sampled, TIC-35 and TIC-47, had concentrations of TCE that exceeded the California



MCAS EL TORO, CALIFORNIA **PERIMETER INVESTIGATION** **INTERIM REPORT**	**GENERAL AREA OF** **MCAS TUSTIN AND EL TORO** **ORANGE COUNTY, CALIFORNIA**	FIGURE 1.1

Department of Health Services (DOHS) state action level (SAL) for TCE in drinking water (5 μg/L). TCE was also detected in a third well located on MCAS El Toro, TIC-55, at significantly lower levels.

After the initial discovery of TCE contamination in the three TIC wells, OCWD commissioned a study by Mills (1985). A summary of the results of that investigation is given in the following subsection (Section 1.2.1) OCWD is conducting a TCE investigation concurrently with the Perimeter Investigation. The findings from the Phase I report of that investigation (OCWD, 1989) are summarized in Section 1.2.2.

1.2.1 Mills Report (1985)

The TCE investigation conducted for OCWD (Mills, 1985) consisted of two components: (1) a literature review of land use, hydrogeology, and chlorinated hydrocarbon compounds; and (2) a soil gas survey in the vicinity of MCAS El Toro.

1.2.1.1 Land Use. The land use survey concluded that the primary land use in the area in 1985 was irrigated agriculture. The historical citrus and asparagus crops had high (relative to precipitated) rates of applied water: 2.9 and 3.3 ft per year (ft/yr), respectively. The primary non-agricultural land uses cited in the survey include the following:

ALSO SHOW ON MAP.

- MCAS El Toro (mid-1940s to present)
- Orange County International Raceway (1968 to 1984)
- Commercial area known as East Irvine, consisting of a grocery store, garage, gas station, RV trailer sales and an abandoned fruit packing facility.
- Southern California Edison substation

Mills (1985) also identified several drainage facilities which could potentially transport contaminants:

- Aqua Chiron wash
- Bee Canyon wash
- Rifle Range Ditch
- San Diego Creek

1.2.1.2 Hydrogeology. The thickness of the aquifer in the Irvine Basin ranges from a few hundred to 1500 ft in thickness. The sediments are generally fine-grained and consist of lenses of clay, silt and sand, although individual units are not areally contiguous. Groundwater flow velocities were estimated to range from 14 ft/yr to 1500 ft/yr (a hypothetical clean sand).

1.2.1.3 Chlorinated hydrocarbons. The primary end use of TCE was vapor degreasing, while PCE is used primarily in the dry-cleaning industry.

1.2.1.4 Soil Gas Survey. Mills (1985) used static soil vapor collectors in a grid pattern to the northwest and southweast of MCAS El Toro. The soil vapor collection device consisted of a glass container containing a ferro-magnetic wire coated with activated carbon which acted as a sorbent for volatilizing organic chemicals. Only PCE was detected in soil gas and was correlated in part with surface drainage washes. PCE was also detected sporadically in other areas. Mills (1985) found that the two areas with the greatest concentrations of PCE in soil gas were near the southwest boundary of MCAS El Toro and near the Southern California Edison Substation. Mills (1985) inferred that the soil gas PCE is unrelated to groundwater TCE contamination. Mills (1985) further concluded that the probable source of TCE contamination in TIC-35 and TIC-47 is MCAS El Toro, based solely on land use and groundwater flow, although other similar land uses (i.e., Orange County International Raceway) were identified as being upgradient of TIC-35 and TIC-47.

1.2.2 OCWD Report (1989)

OCWD conducted field investigations of off-base TCE contamination through February 1989 summarized in their Phase I report (OCWD, 1989). OCWD's field work included the following tasks:

- Installed four multipoint monitoring wells (MCAS-1, MCAS-2 MCAS -3 and MCAS-4)
- Performed temperature and flowmeter surveys in MCAS-1 and MCAS-3
- Performed aquifer pump tests in MCAS-1 and MCAS-3
- Measured piezometric levels in the multipoint monitoring wells
- Attempted to rehabilitate TIC-68, TIC-74, TIC-83 and TIC-127.
- Collected inorganic and volatile organic chemicals (VOC) samples from various wells in the vicinity of MCAS El Toro.

The interpretation of these data, coupled with the results of the Perimeter Investigation resulted in different conclusions than those drawn by JMM concerning the potential sources(s) of contamination, the continuity of the VOC plume(s) and the fate and transport of contaminants in the Irvine Basin.

1.3 SCOPE OF WORK

To evaluate whether MCAS El Toro is a source of TCE contamination in the TIC irrigation supply wells, an examination of potential sources, both on and off station, and the behavior of groundwater on MCAS El Toro and in the vicinity of the TIC wells was conducted along the perimeter of the station. The investigative approach included examination of potential source contaminants and potential transport mechanisms.

The original scope of work proposed a groundwater investigation and a stream recharge investigation. The specific purpose of the groundwater investigation was to determine

whether the aquifer is a medium through which contaminants such as TCE or PCE could be transported. Within the groundwater investigation, the approach included the following tasks:

- Packer testing of TIC-55
- Source and receptor characterization
- Areal groundwater flow modeling
- Solute transport modeling
- Cross sectional groundwater flow modeling
- Monitoring well installation along the MCAS El Toro boundary.

The scope of work proposed for a stream recharge investigation included field inspection of portions of drainage channels, construction of shallow monitoring wells, and water level monitoring of these streambed wells. The purpose of this investigation was to examine how recharge enters the groundwater and travels beyond the MCAS El Toro perimeter.

During the course of the groundwater investigation, it was determined necessary to include additional tasks to characterize the presence and location of contaminants in the groundwater. The following four tasks were added to the original scope of work:

- Installation and sampling of five cluster wells
- Specific capacity test of each cluster well
- Aquifer pump test of TIC-55
- Soil gas survey along the perimeter of the station.

This Interim Report will present and discuss the results of the groundwater and stream recharge investigation. A Final Report, to be prepared at the close of the Perimeter Investigation, will give a more detailed description of field procedures. Results of the groundwater and solute transport modeling will also be presented in the Final Report.

This section should show a graph indicating concentrations of all detected constituents per sampling point. It is difficult to "read" the data and see any relationship.

SECTION 2
REMEDIAL INVESTIGATION

The field program for the Perimeter Investigation was initiated in December 1987, and continued through January 1989. Work accomplished to date has included the following tasks:

- Depth-Specific sampling and packer testing of TIC-55
- Installation of streambed wells
- Installation of cluster wells
- Specific capacity testing of cluster wells
- Aquifer testing of TIC-55
- Soil gas sampling
- Installation of perimeter wells
- Groundwater quality sampling

2.1 STREAMBED WELLS

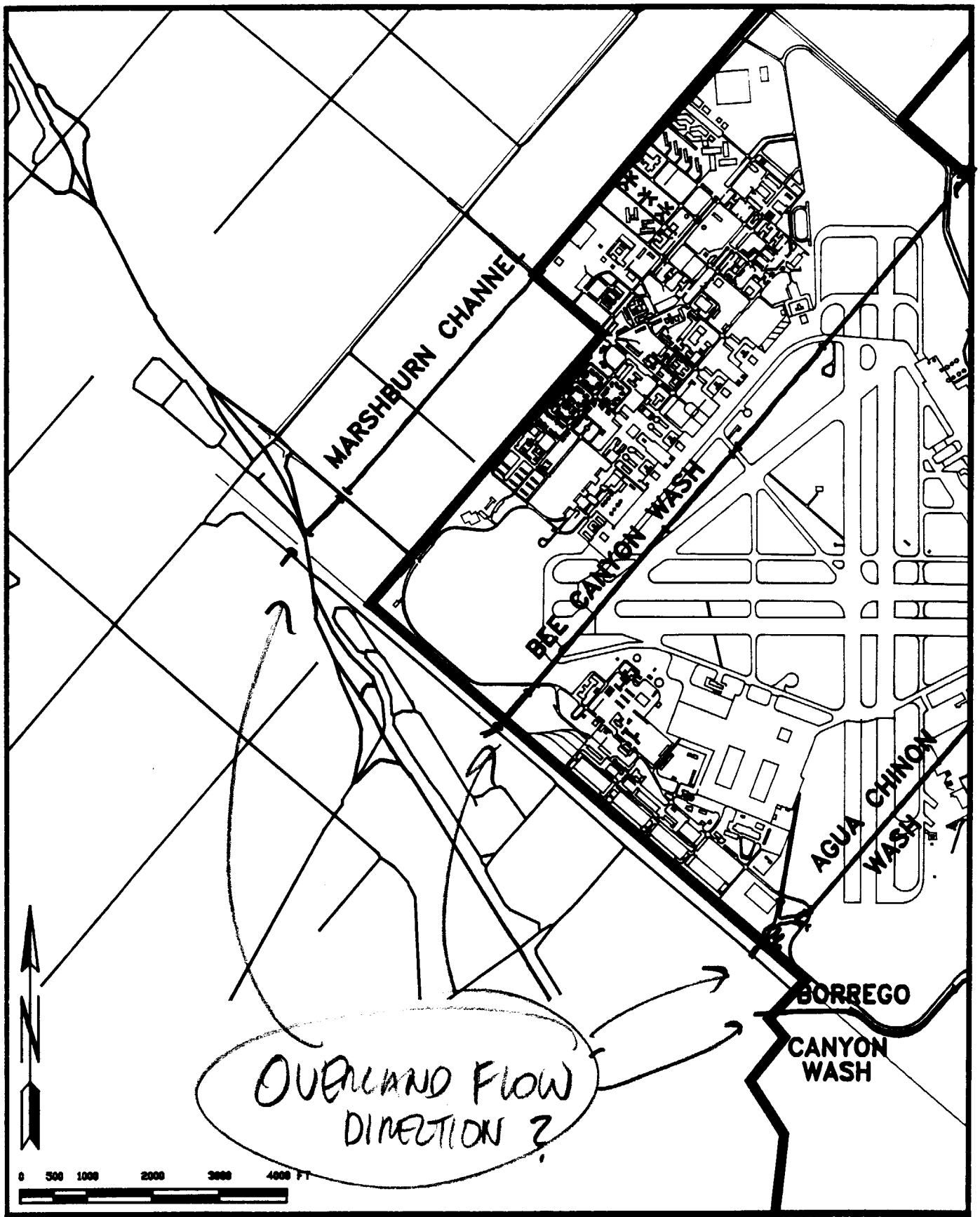
The purpose of installing the streambed wells was to determine if any significant recharge to the groundwater occur from the major drainage channels leaving the base (Figure 2.1). A total of seven shallow borings were completed and piezometers were installed in the borings. The locations were selected adjacent to the three washes that originate off station, collect runoff from the station, and exit along the southwestern boundary. Two wells were installed on either side of Borrego Canyon Wash, Aqua Chinon Wash and Bee Canyon Wash, to depths ranging from 30 to 45 ft. The seventh well was installed as an upgradient well adjacent to Bee Canyon Wash along the northwestern boundary of the base. Locations of these wells are show on Figure 2.2.

TABLE 2.1

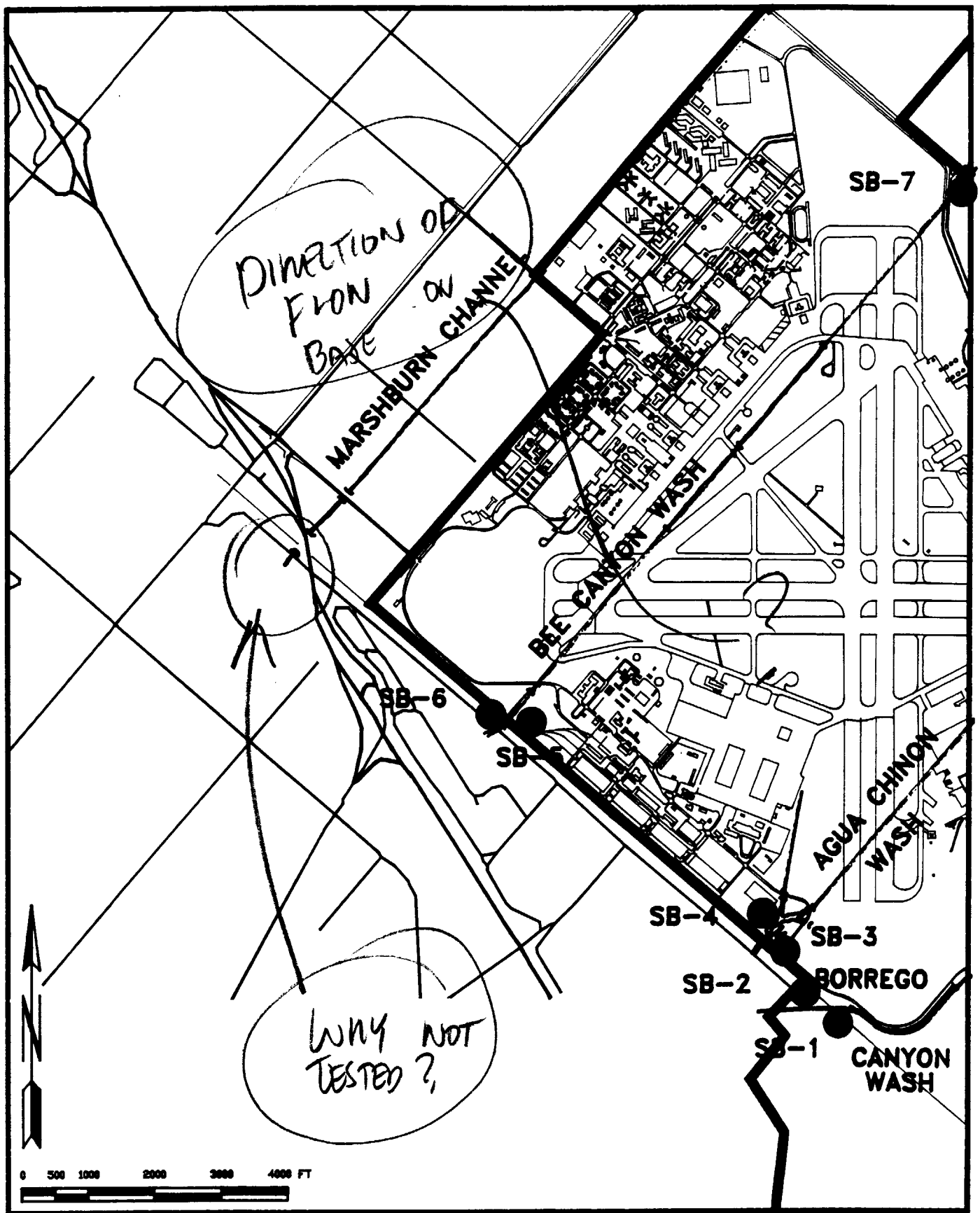
STREAMBED WELL CONSTRUCTION SUMMARY

Boring No.	Total Depth of Boring (ft)	Depth of Screen Interval (ft)	Depth of Filter Interval (ft)	Depth of Bentonite Material Interval (ft)	Depth of Grout Seal Interval (ft)
SB-1	46.0	21.0 - 41.0	18.8 - 41.0	16.9 - 18.0	0 - 16.4
SB-2	40.3	20.3 - 40.3	17.5 - 40.3	15.3 - 17.5	0 - 15.3
SB-3	45.2	25.2 - 45.2	18.3 - 45.2	16.4 - 18.3	0 - 16.4
SB-4	30.4	10.4 - 30.4	04.4 - 30.4	03.2 - 04.4	0 - 03.2
SB-5	35.0	15.0 - 35.0	10.0 - 35.0	08.0 - 10.0	0 - 08.0
SB-6	37.5	26.5 - 36.5	26.0 - 37.5	24.0 - 26.0	0 - 24.0
SB-7	45.5	25.5 - 45.5	22.8 - 45.5	20.9 - 22.8	0 - 20.9

Well diameter: 2 in.
Well riser: Schedule 40 PVC pipe
Well Screen: Schedule 40 PVC pipe, 0.02 in. slots
Filter Pack: Monterey #3 sand



MCAS EL TORO, CALIFORNIA PERIMETER INVESTIGATION INTERIM REPORT	LOCATIONS OF SURFACE DRAINAGE CHANNELS ON MCAS EL TORO	FIGURE 2.1



MCAS EL TORO, CALIFORNIA PERIMETER INVESTIGATION INTERIM REPORT	LOCATIONS OF STREAMBED WELLS	FIGURE 2.2

Soil samples were collected during drilling of each well for lithologic classifications, as well as geochemical and geotechnical analysis. Samples were analyzed for moisture content, porosity, grain size distribution and total organic content. Boring logs for the streambed wells are included in Appendix A.1.

No apparent soil contamination was observed during drilling of streambed wells. Perched groundwater was also not encountered during the drilling of any of the streambed wells. The wells have been monitored periodically throughout 1988, during both wet and dry seasons, and no water has collected in any of the wells.

2.2 TIC-55 DEPTH-SPECIFIC SAMPLING AND PACKER TESTING

The first task initiated for the Perimeter Investigation was the depth-specific sampling and packer testing of TIC-55, performed during December of 1987. The overall objective of the depth-specific sampling and testing of this well was to determine the vertical depth and extent of TCE contamination in order to assess potential target depths for the perimeter wells. The purpose of depth-specific sampling was to evaluate the change in concentration of TCE throughout the saturated depth of the TIC-55. The purpose of the packer test, on the other hand, was to isolate several aquifer zones in order to assess if a hydrologic connection existed between them.

Prior to initiation of any work on TIC-55, the submersible pump, along with the drop pipe and the electrical cable, were removed. A water sample was then collected at the static water level to check for presence of any floating oil. A minor amount of floating oil (less than a few inches) was pumped and the well was allowed to stabilize for two days to allow suspended solids to settle. The well was then surveyed with a color video camera lowered inside the casing to determine the condition of the casing and location of the perforations in the well. Due to the heavy crustation along the well casing and the screen, perforated intervals could not be determined. A wire brush assembly was lowered into the well and the casing was scoured. After allowing a day for solids to settle, the interior of the casing was viewed a second time to choose intervals for the

packer testing. The TV survey indicated that the perforated interval for the well was from 305 ft to 454 ft below ground surface. The well was also gamma-logged in an attempt to determine the characteristics of the aquifer material surrounding the well. The gamma-log was unsuccessful due to heavy crustation of the well casing and the screen. A groundwater temperature survey was also conducted inside the well casing to evaluate zones of preferential flow under non-pumping conditions. This survey indicated a steady increase in water temperature with depth (at approximately 0.7°F per 100 ft) with no apparent temperature spikes along the perforated interval of the casing.

To evaluate change in contaminant concentration with depth, under non-pumping conditions, a syringe sampler was used to collect groundwater samples at six discrete depth intervals. This type of sampling method allows collection of relatively undisturbed groundwater samples from specific depths without causing aeration losses of the volatile organic chemicals (VOCs). Samples were collected at depths of 312, 337, 362, 387, 412 and 437 ft below ground surface, and were analyzed for chloroform, PCE, toluene, TCE and acetone. Analytical results are summarized in Appendix B.1.

TCE was detected in each sample at concentrations ranging from 1.0 to 1.4 μg/L. Other compounds were measured at least once, at or near instrument detection limits. All concentrations detected, however, were below action levels set by DOHS for each compound.

Based on results of the TV survey, three zones were selected for the packer test from 298 to 344 ft, from 340 to 386 ft and from 388 to 434 ft. The packer test was performed by installing rubber packers above and below the pump suction, at intervals mentioned above, inflating the packers and then pumping the isolated aquifer zone at approximately 20 gallons per minute (gpm) for 180 minutes. Groundwater samples were collected at 30 minute intervals during the pumping of each isolated zone. The sample collected at the first 30 minute interval from each isolated zone was analyzed for 30 priority pollutant VOCs while all other samples were analyzed for five particular VOCs (namely, TCE, PCE, benzene, 1,1-DCE, and 1,1,1-TCA).

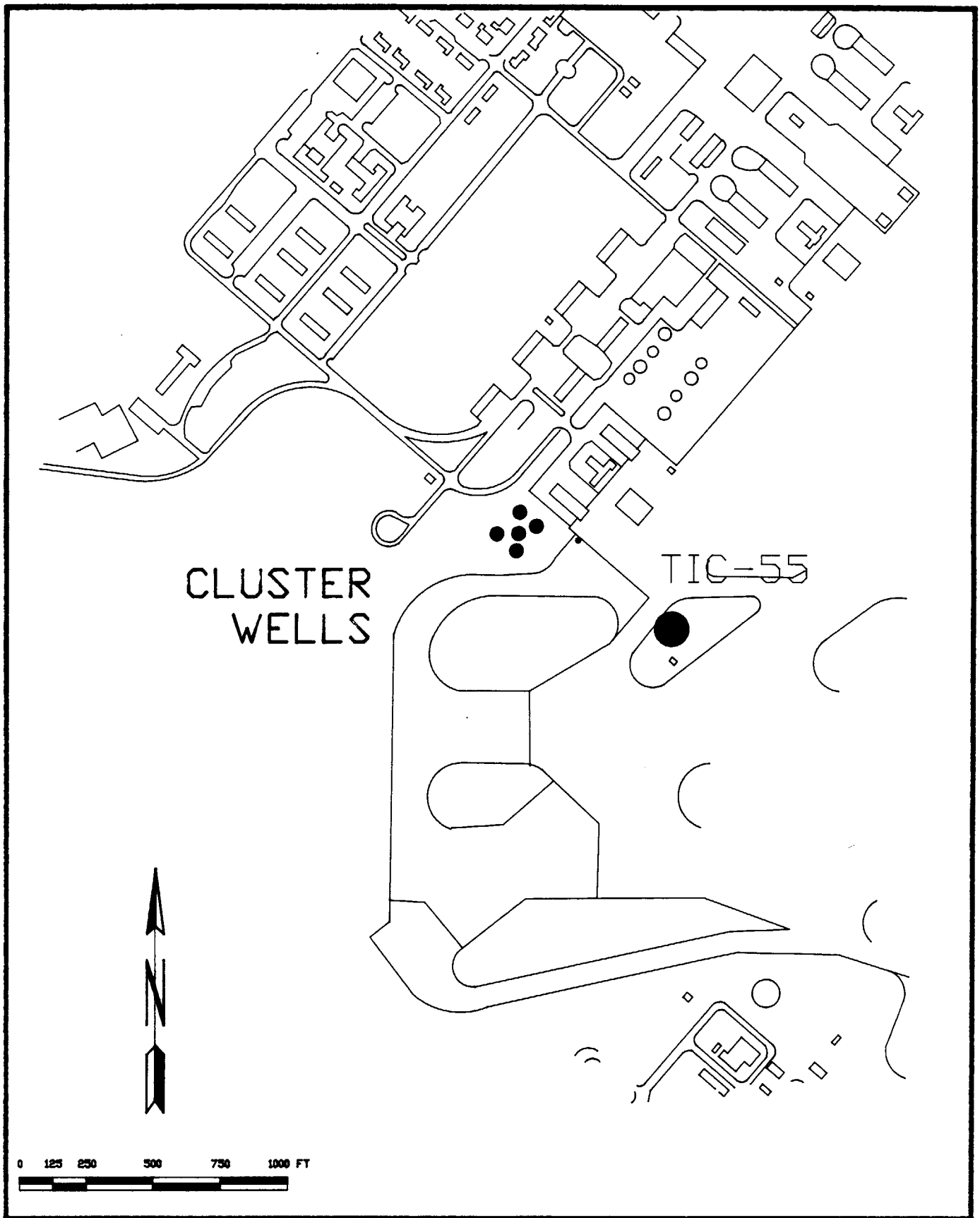
Results from samples taken during the packer tests in TIC-55 were similar to the depth specific samples collected from the syringe samples in that concentrations were measured at or close to the instrument detection limits and all detected concentrations were below state action levels. Results from each zone are tabulated in Appendix B.2. Concentrations TCE, PCE, and benzene were detected near the instrument detection limit in each isolated zone during the 180 minute test. Toluene was detected in all three zones at concentrations of 33, 36 and 17 μg/L, which are below the 100 μg/L state action level. It is believed that the benzene and toluene detected were due to the presence of minor floating oil in the well casing which could be completely removed. It is also possible that the toluene could have also leached into the groundwater samples from the electrical tape used on submersible pump wiring.

Change in hydrostatic pressure was monitored above and/or below, as well as between, the zones isolated by the packers to determine if the packer assembly effectively sealed the interval being tested. Substantial pressure changes above and/or below the packer isolated zones, combined with the relatively uniform distribution of contaminant concentrations, suggested that the zones were not successfully isolated. This is believed to be due primarily to the poor casing condition and the absence of any seals isolating aquifer zones along the screened interval of the well, as determined from the gamma-log.

2.3 CLUSTER WELL INSTALLATION

The results of depth-specific sampling and packer testing of the TIC-55 was less than satisfactory, in that no determination could be made as to the vertical distribution or extent of TCE contamination. A modification to the original contract was issued by the Navy, and JMM was authorized to install a well cluster to provide the needed information on the vertical zones of contamination in the groundwater.

Approximately 740 ft west-northwest of TIC-55, a pilot hole was first drilled to a depth of 884 ft below ground surface (Figure 2.3). This boring was drilled using direct rotary



MCAS EL TORO, CALIFORNIA PERIMETER INVESTIGATION INTERIM REPORT	**LOCATIONS OF TIC-55 AND CLUSTER WELLS**	FIGURE 2.3

equipment, with bentonite mud drilling fluid used to keep the borehole open. Grab soil samples were collected at 10 ft intervals to construct a lithologic log of the borehole. Upon completion of drilling, a suite of geophysical surveys were performed throughout the depth of the boring for additional lithologic definition. Geophysical surveys were done to measure changes in electrical resistivity, gamma-ray, and spontaneous potential of the soil stratum surrounding thes pilot borehole. Following approximately a day of equilibration after drilling, a temperature log of the fluid in the borehole was completed in order to evalate potential heat flow gradients throughout the saturated thickness of the aquifer. The purpose of collecting lithologic and geologic information was to identify possible zones of more permeable material consisting primarily of sands and gravels, isolated by less permeable material such as silts and silty clays.

Soils identified during drilling were alluvial sediments consisting mostly of sand, clay, silt, and gravel. Due to the presence of bentonite mud in the pilot borehole as the drilling fluid, and due to the selected interval of soil sampling, accurate depths of changes in lithology were difficult to identify. However, a noticeable change in soil material was observed at approximately 570 ft below ground surface, where a whitish-tan clay with trace sand was encountered. Another change in material occurred at 640 ft below ground surface, where a blue-grey clay was encountered. The sand and shale fragments in this clay increased with depth. A slight oily residue was observed on the returned drilling fluid at about 740 ft below ground surface. The oil sheen was attributed to the shale, which had small amounts of naturally-occurring oil and gas. This occurrence of shale is consistent with logs from other wells in the vicinity of the base. The boring log constructed from the pilot hole DPH-1 is included in Appendix A.2, which represents the cluster wells.

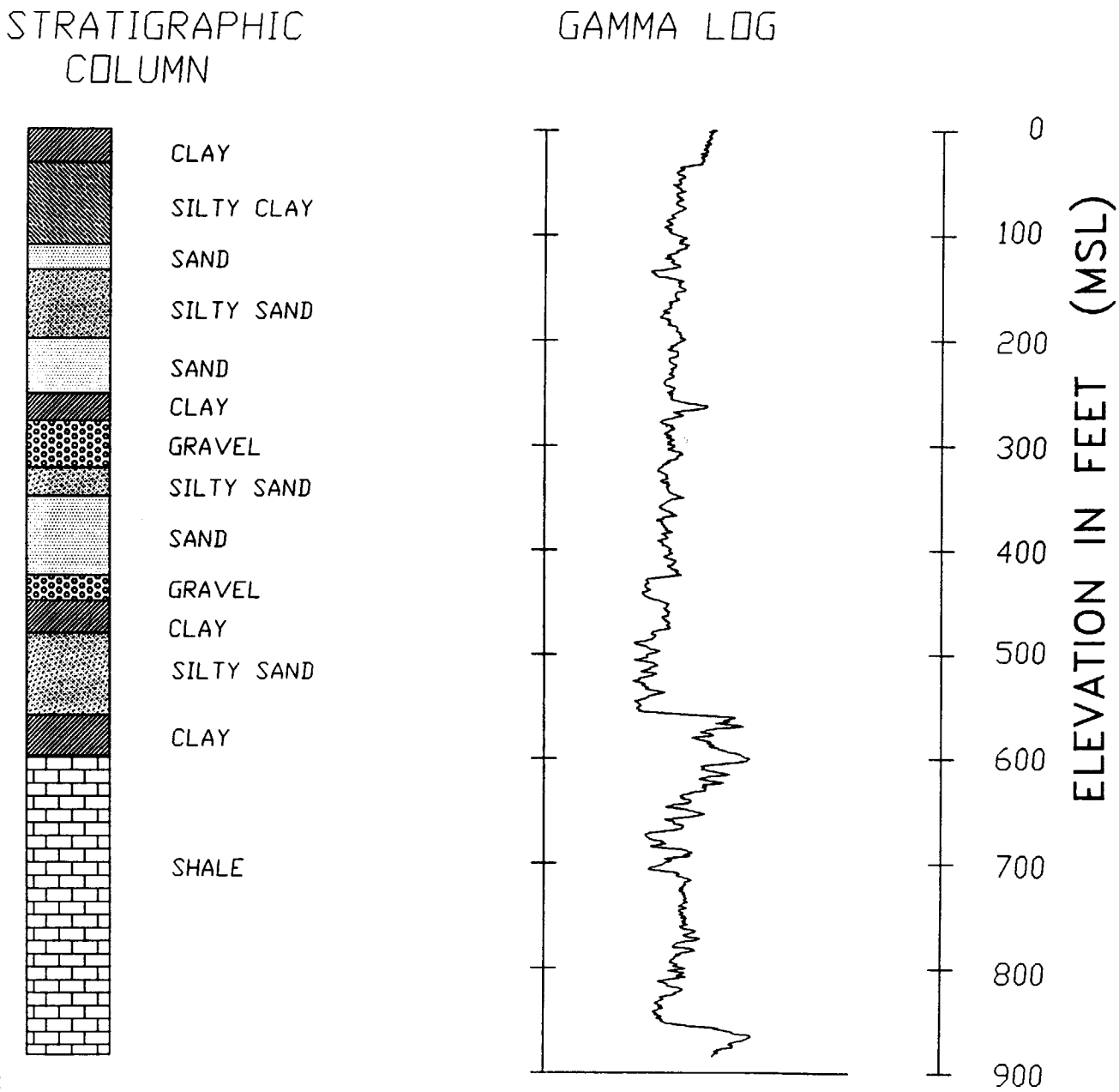
Results from the gamma-ray survey also indicated a stratigraphic change at a depth of approximately 550 ft, where there was an abrupt increase in the natural gamma radiation being measured. The gamma-ray survey measures naturally-occurring radiation coming from the silty and clayey formations. Clays and silts contain high concentrations of potassium that cause a higher response to gamma detection than sands, that are primarily

composed of silica, which is a relatively stable substance. Other noticeable increases in the gamma-ray survey occurred at 140, 260, 360 and 460 ft. Decreases in the gamma radiation occurred at 135, 425, and 480 ft in depth, denoting possible zones of more permeable, sandy material. These lithologic changes were also confirmed with other geophysical surveys. Figure 2.4 shows the interpreted lithologic log of the pilot borehole and the gamma ray survey results. Also shown in the figure are the selected intervals of cluster well completion depths.

Based on results from the geophysical surveys and from observations made during the drilling of the pilot borehole, five possible zones of more permeable material were identified at depths 135, 250, 350, 450 and 540 ft below ground surface. Five separate borings, each at 8-inches in diameter, were then drilled to these target depths and 4-inch diameter wells were constructed of PVC or steel casing and screen. All wells-in-cluster were located within approximately 20 ft of each other.

The hollow stem auger drilling method was used on the most shallow well drilled to 135 ft below ground surface. The remaining four wells were completed using the mud rotary drilling technique, due to the large depths involved and prior knowledge of the lithology from the pilot boring. Screened intervals of each well ranged from 20 to 50 ft in length placed at the bottom of the hole. The screen material installed in DW-135 consisted of PVC. Wells DW-250, 350 and 450 were constructed with stainless steel screen. Slotted steel pipe was used for the screen interval in DW-540. Filter pack material consisting of No. 3 Monterey sand was placed in the well annulus by a tremie pipe, from the bottom of the borehole to about 4 to 12 ft above the top of the screen. A 2 to 4 ft bentonite plug was then placed above the sand, and the remaining annulus to the ground surface was filled with cement grout. Table 2.2 summarizes depths, elevations, well construction materials, screened intervals, and measured water levels of the completed cluster wells.

Following drilling and installation, all wells in the cluster were bailed for a minimum of 2 hours to remove drilling fluids and solids from the well casing. Water was then



MCAS EL TORO, CALIFORNIA PERIMETER INVESTIGATION INTERIM REPORT	**PROFILE OF THE PILOT BORING**	FIGURE 2.4

TABLE 2.2

CLUSTER WELL CONSTRUCTION SUMMARY

Boring No.	Total Depth (ft)	Depth of Screen Interval (ft)	Depth of Filter Interval (ft)	Depth of Bentonite Material Interval (ft)	Depth of Grout Seal Interval (ft)
DW-135	135	115 - 135	111 - 135	109 - 111	0 - 109
DW-250	254	215 - 250	209 - 254	205 - 209	0 - 205
DW-350	350	310 - 350	305 - 353	302 - 305	0 - 302
DW-450	454	420 - 450	414 - 454	412 - 414	0 - 412
DW-540	541	490 - 540	479 - 541	479 - 475	0 - 475

airlifted out of each well at approximately 10 gpm, for 4 to 8 hours. All development water was processed through an on-site portable granular activated carbon (GAC) treatment plant before its discharge to the washes.

2.4 SPECIFIC CAPACITY TESTS

Upon completion of drilling, installation and development activities, specific capacity tests were conducted in each well-in-cluster. The purpose of these tests was to measure the response of the aquifer zones around the screened intervals to pumpage, in order to develop a better understanding of the hydrogeologic characteristics in the area. These tests were also used to evaluate the degree of hydraulic connection, if any, between the aquifer zones isolated by each well-in-cluster.

With the exception of monitoring well DW-135, each well-in-cluster was pumped over four continuous time steps where the flowrate was increased and the drawdowns in the pumped well, as well as in wells completed above and below the pumped well, were measured. Each of the first three steps in the four deeper wells-in-cluster was approximately 2 hours, and the fourth step was approximately 18 hours; for a total pump-out test duration of 24 hours. After the fourth step, the pump was turned off and water levels were allowed to recover. Water levels were also measured during the recovery period. Table 2.3 contains a summary of pump rates, time intervals, and observation wells used during each specific capacity test.

The most shallow well, DW-135, was pumped at a single rate significantly less than the other wells, because of limited recharge from the water table aquifer to the well. The test was only conducted over a 6 hour period. The test conducted in DW-450 was affected by pumping in nearby TIC-55, when it was turned on 110 minutes into the test, and turned off approximately 1140 minutes later.

Specific capacities were calculated for each aquifer zone represented by the screened intervals in the cluster wells. The specific capacity is a ratio of the pumping rate and

TABLE 2.3

CLUSTER WELL SPECIFIC CAPACITY TEST RESULTS

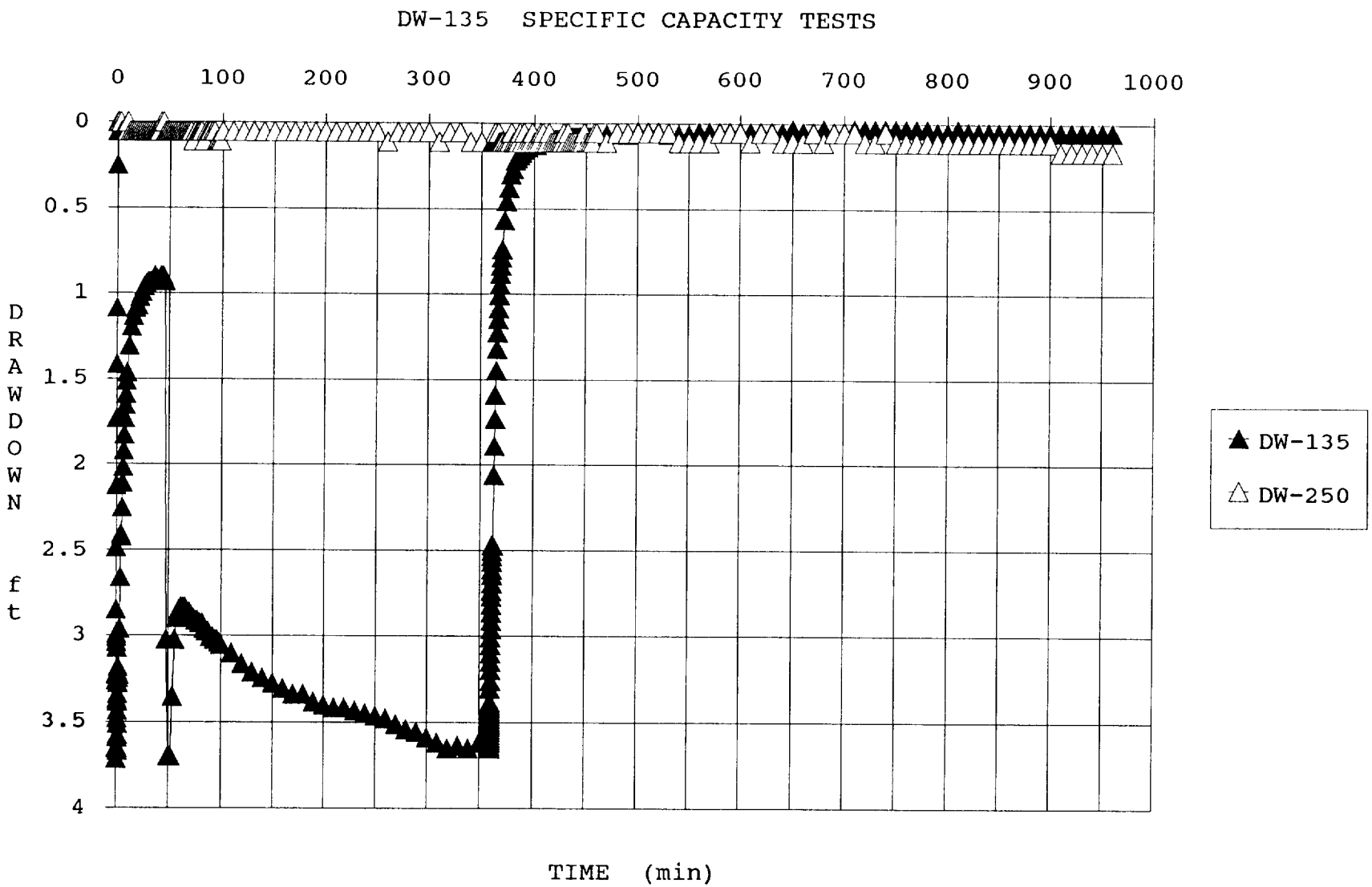
Pumping Well	Step #	Elapsed Time (minutes)	Observation Wells	Q (gpm)
DW-540	0	120	DW-540, DW-450	5.0
DW-540	1	120	DW-540, DW-450	9.2
DW-540	2	120	DW-540, DW-450	24.5
DW-540	3	1080	DW-540, DW-450	32.0
DW-540	4	230	DW-540, DW-450	recovery
DW-135	0	360	DW-135, DW-250	1.0
DW-135	1	600	DW-135, DW-250	recovery
DW-450	0	120	DW-540, DW-450, DW-250, DW-350	2.9
DW-450	1	110	DW-540, DW-450, DW-250, DW-350	7.5
DW-450	2	120	DW-540, DW-450, DW-250, DW-350	15.7
DW-450	3	1,080	DW-540, DW-450, DW-250, DW-350	31.8
DW-450	4	1,080	DW-540, DW-450, DW-250, DW-350	recovery
DW-250	0	130	DW-135, DW-450, DW-250, DW-350	5.0
DW-250	1	130	DW-135, DW-450, DW-250, DW-350	0.0
DW-250	2	110	DW-135, DW-450, DW-250, DW-350	14.6
DW-250	3	1,080	DW-135, DW-450, DW-250, DW-350	33.0
DW-250	4	240	DW-135, DW-450, DW-250, DW-350	recovery
DW-350	0	130	DW-135, DW-450, DW-250, DW-350	5.0
DW-350	1	100	DW-135, DW-450, DW-250, DW-350	10.0
DW-350	2	130	DW-135, DW-450, DW-250, DW-350	19.0
DW-350	3	1,030	DW-135, DW-450, DW-250, DW-350	25.4
DW-350	4	2,140	DW-135, DW-450, DW-250, DW-350	recovery

the measured drawdown in the pumped well. Specific capacity results from the final step of the test are of the most interest because equilibrium was reached by pumping the well at a constant rate for approximately 18 hours, stressing the aquifer at the particular screened interval. Time vs. drawdown plots of the specific capacity tests conducted in monitoring wells DW-135, DW-250, DW-350, DW-450, and DW-540 are included as Figures 2.5 through 2.9.

Although pumping rates for the final step in the four deeper wells varied only from 25.4 to 33.0 gpm, measured drawdowns ranged from 7.09 to 68.6 ft. Consequently, specific capacity values calculated also varied from 0.4 gpm/ft to 4.5 gpm/ft. Monitoring well DW-350 had the lowest calculated specific capacity (0.37 gpm/ft) while DW-450 had the largest calculated specific capacity (4.49 gpm/ft).

Specific capacity tests performed in wells DW-135, 250, and 350 did not appear to influence adjacent wells, because no drawdown was recorded in the other cluster wells throughout the duration of each test (Figures 2.5, 2.6, and 2.7). Drawdown measurements taken during the DW-450 test were affected by the unexpected pumping in TIC-55 (Figure 2.8) and provide only qualitative results regarding specific capacity and transmissivity. Affected water levels measured in DW-350, DW-540 and DW-450 during this specific capacity test were corrected by using drawdowns measured later during the aquifer testing of TIC-55. The resultant drawdown curves indicated that DW-350 and DW-540 were both influenced by the pumpage in DW-450. Results from the specific capacity test conducted in DW-540 (Figure 2.9) indicated 11 ft of drawdown in the pumped well. A total of 2 ft of drawdown was measured in DW-450, while only 0.13 ft of drawdown was measured in DW-350.

The variation of drawdowns in response to pumping in each well suggest that different aquifers exist in the area. Although hydraulically connected, these aquifers are separated by soil formations of substantially less vertical hydraulic conductivity.
Aquifer transmissivities were also calculated from the specific capacity tests for each screened interval. Assuming an average 30 ft aquifer thickness represented by the



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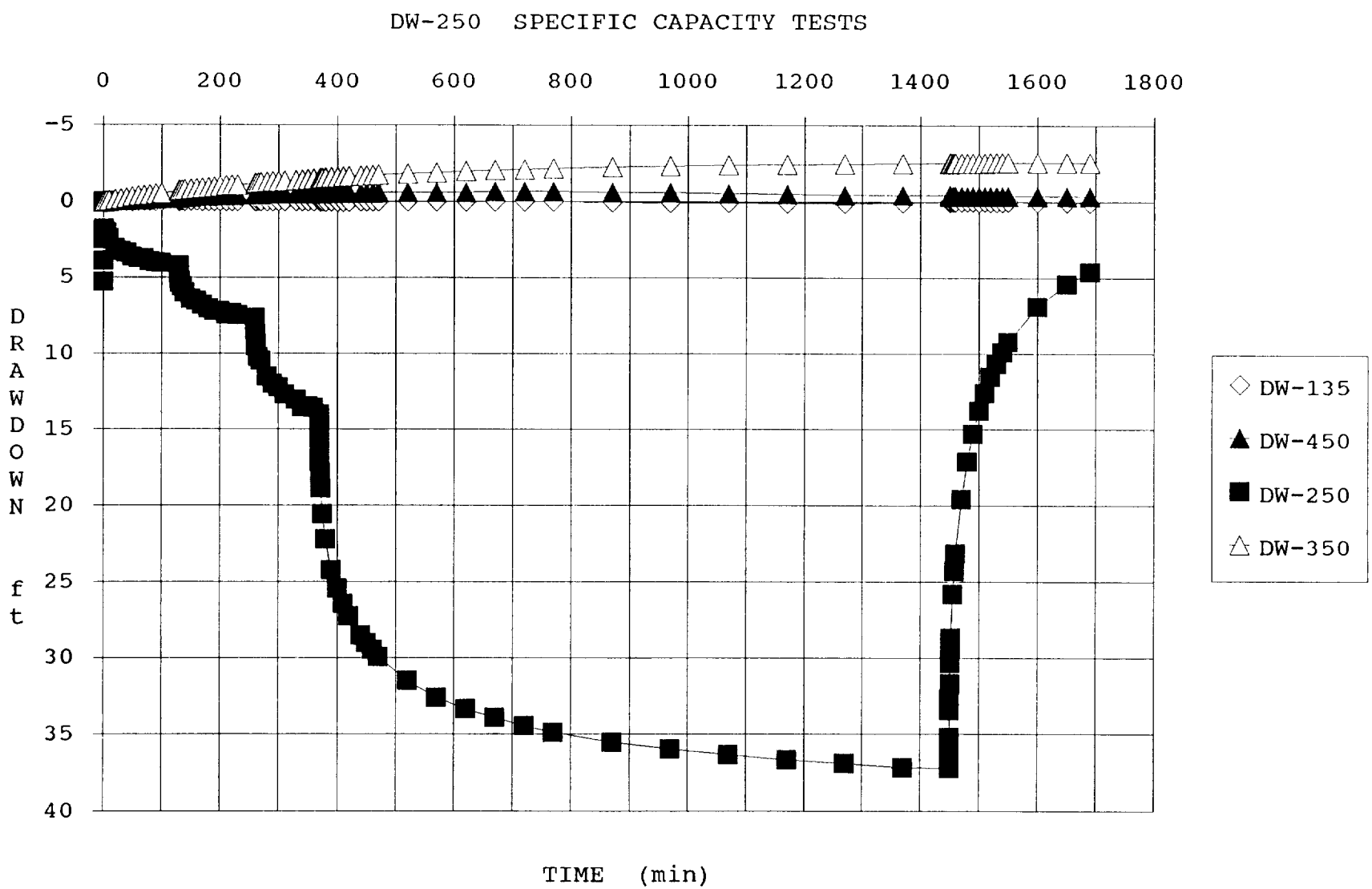
SPECIFIC CAPACITY TEST RESULTS
DW-135

FIGURE
2.5



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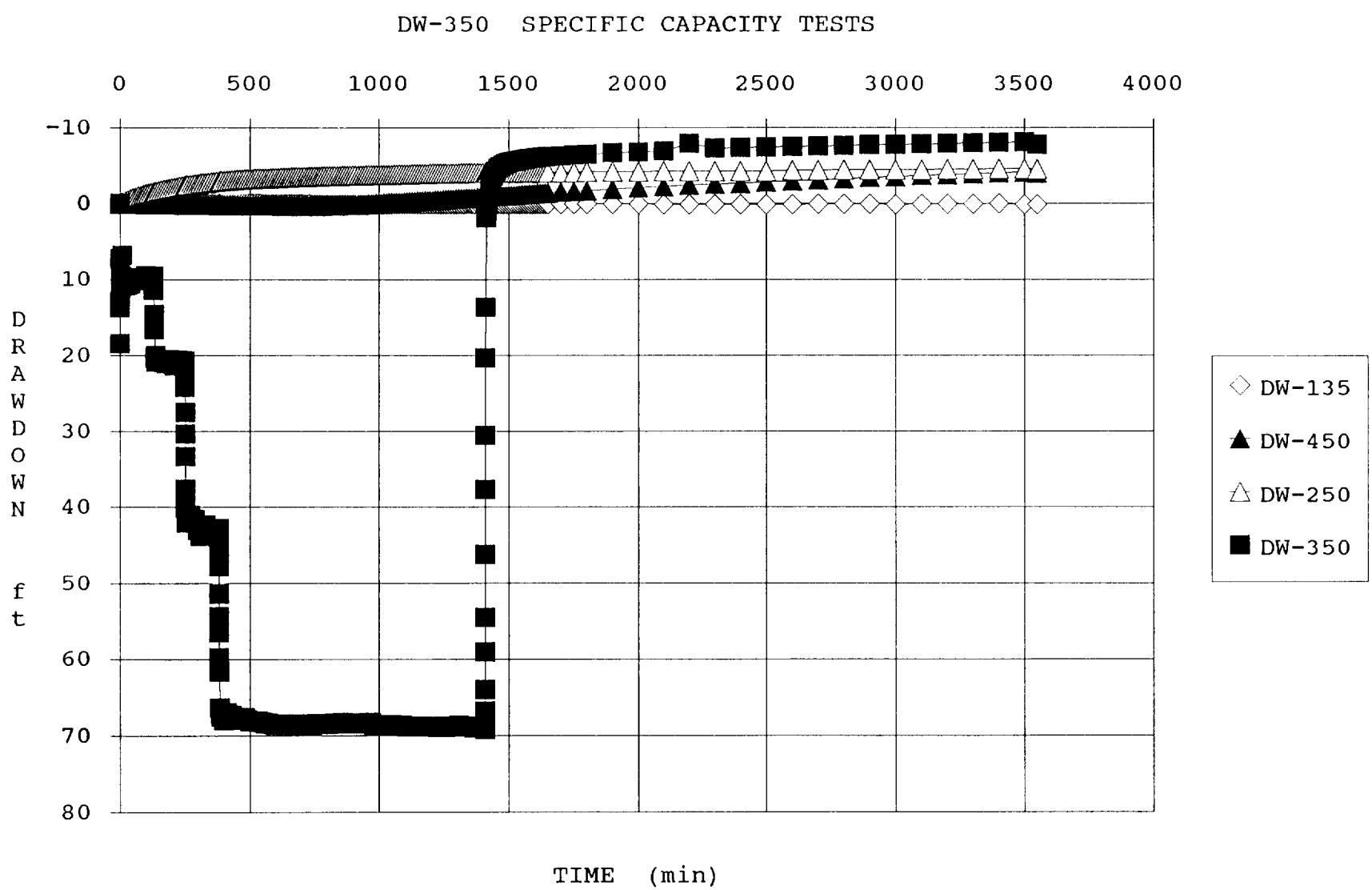
SPECIFIC CAPACITY TEST RESULTS
DW-250

FIGURE
2.6



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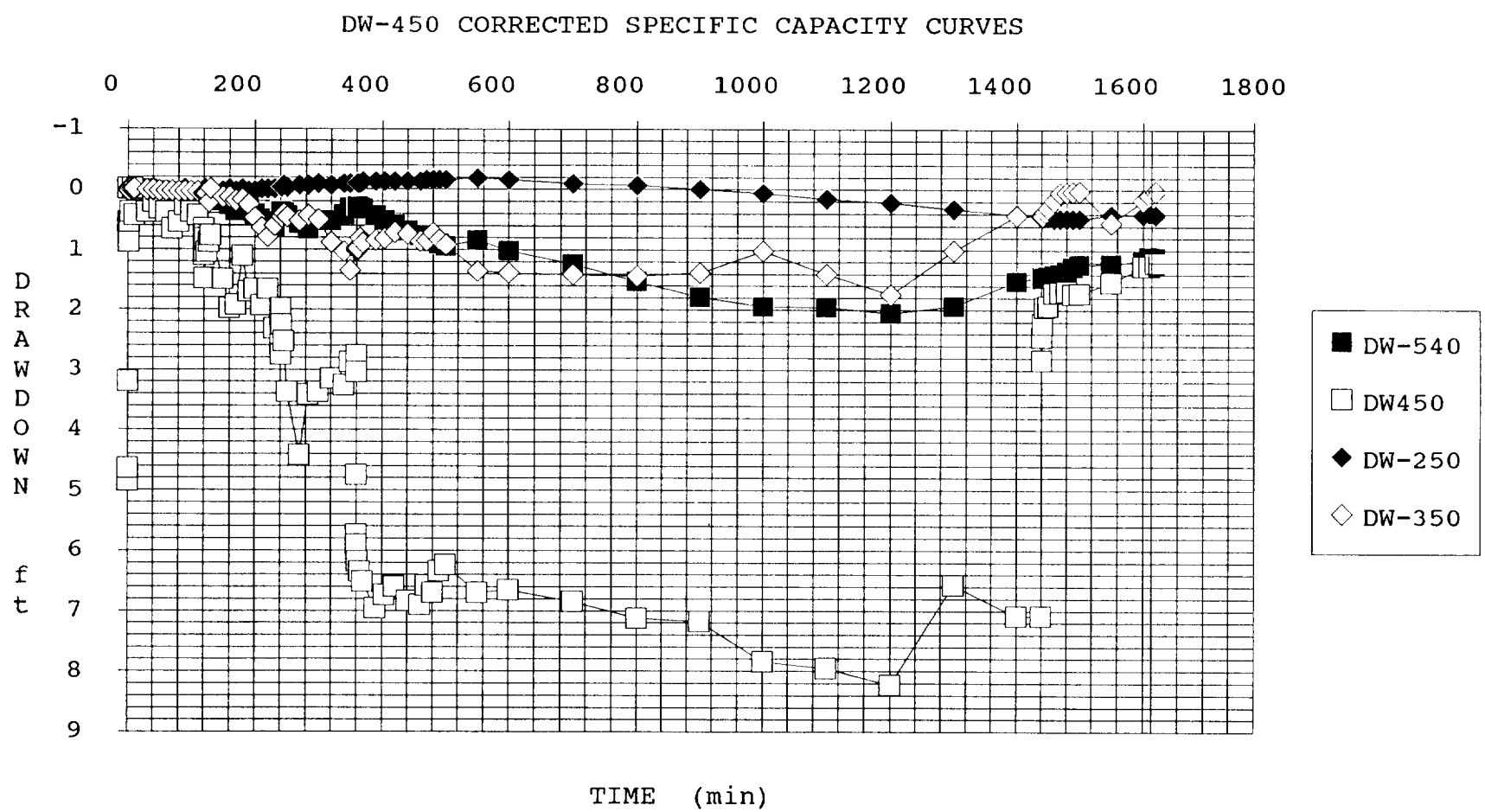
SPECIFIC CAPACITY TEST RESULTS
DW-350

FIGURE
2.7



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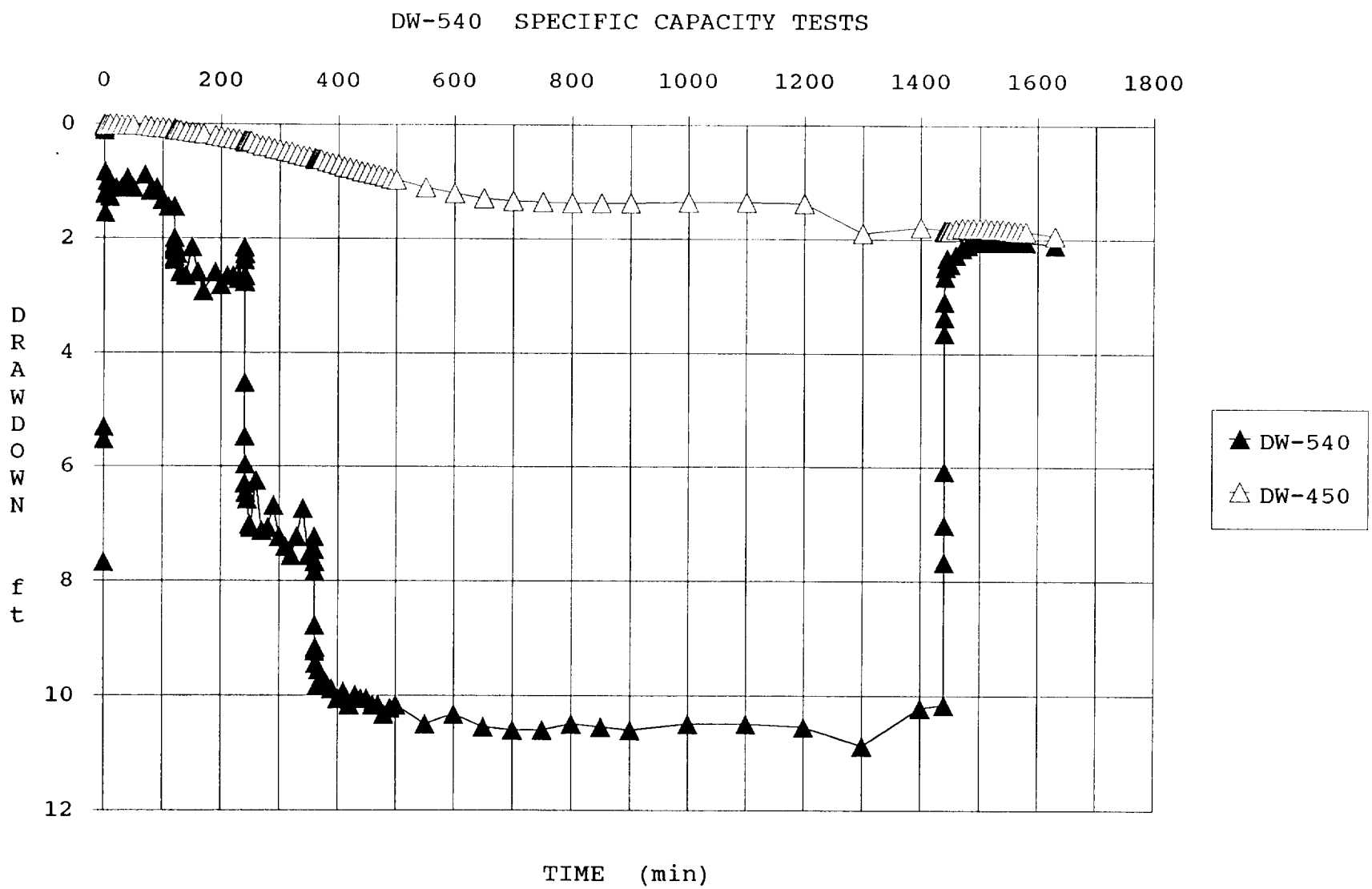
SPECIFIC CAPACITY TEST RESULTS
DW-450

FIGURE
2.8



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screened interval, transmissivity values calculated ranged from 67 to 1083 ft^2/day. Table 2.4 summarizes the calculated specific capacities and transmissivities calculated for the four deeper wells.

2.5 TIC-55 AQUIFER TEST

An aquifer test was conducted on TIC-55 to determine hydrogeologic characteristics relating to continuity or discontinuity of the subsurface formations. Aquifer transmissivities and storage coefficients were also estimated, based on the response of water levels measured in the cluster wells nearby to pumpage from TIC-55. Transmissivity (T) represents the capacity of an aquifer to transmit water, and is primarily dependent upon the size and arrangement of the water-transmitting openings within the aquifer, and the total thickness of that aquifer. The storage coefficient (S) is a non-dimensional parameter that represents the volume of water released from or stored into the aquifer per unit of storage area and change in head.

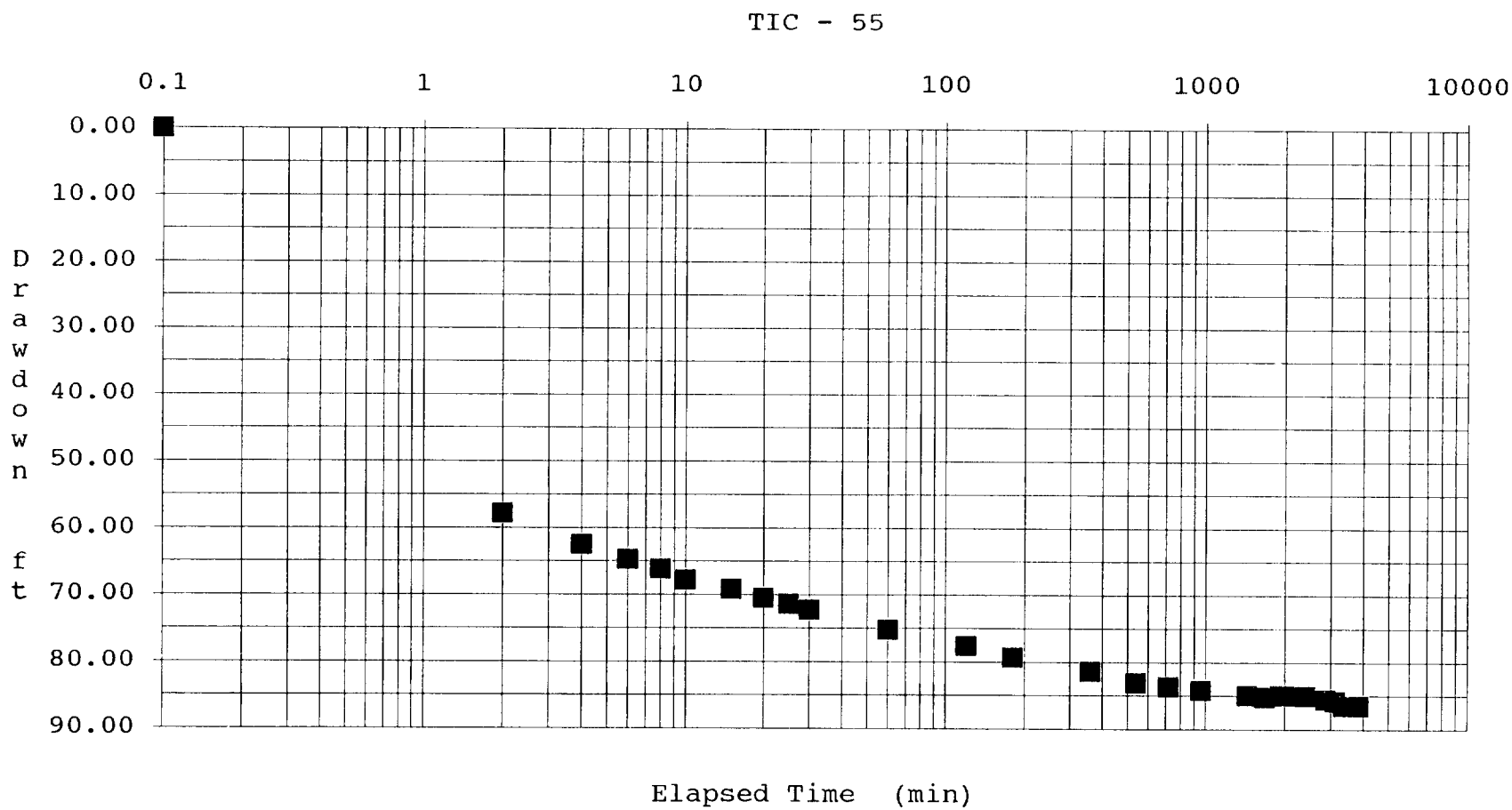
TIC-55 pump was turned off for 12 hours prior to the initiation of the test to allow for full recovery of water levels from routine pumping. TIC-55 was pumped at a rate of approximately 500 gpm over a 72 hour period. This procedure was followed by a 24 hour recovery period when the well was turned off and the water levels were allowed to recover. Water levels in TIC-55 were measured throughout the pump-out and the recovery period of the test. Drawdowns measured in TIC-55 during the pump test stabilized at approximately 86.5 ft 56 hours into the test (Figure 2.10). Roughly 95 percent of the drawdown measured in the well had occurred within the first nine hours of the test. When the pump was turned off, TIC-55 recovered almost instantaneously. During the total 24 hour recovery period, the water level rose to within 0.01 ft of the initial water level at the beginning of the test. These observations suggest that the majority of the water pumped came from storage in the aquifer penetrated by the TIC-55 rather than release from the drainage of the water table.

TABLE 2.4

SUMMARY OF CLUSTER WELL SPECIFIC CAPACITY TEST RESULTS

Property	Cluster Well Depth (ft)			
	250	350	450 [a]	550
Q (gpm)	33.0	25.4	31.8	32
s (ft)	37.24	68.6	7.09	10.16
Q/s (gpm/ft)	0.89	0.37	4.49	3.15
T (ft^2/day)	213	89	1,083	760

[a] Drawdown in DW-450 adjusted due to influence of TIC-55 pumping during aquifer test.
[b] Calculated for a 30-foot aquifer thickness around the well.



MCAS EL TORO, CALIFORNIA PERIMETER INVESTIGATION INTERIM REPORT	TIC-55 AQUIFER TEST DRAWDOWN CURVE FROM TIC-55	FIGURE 2.10

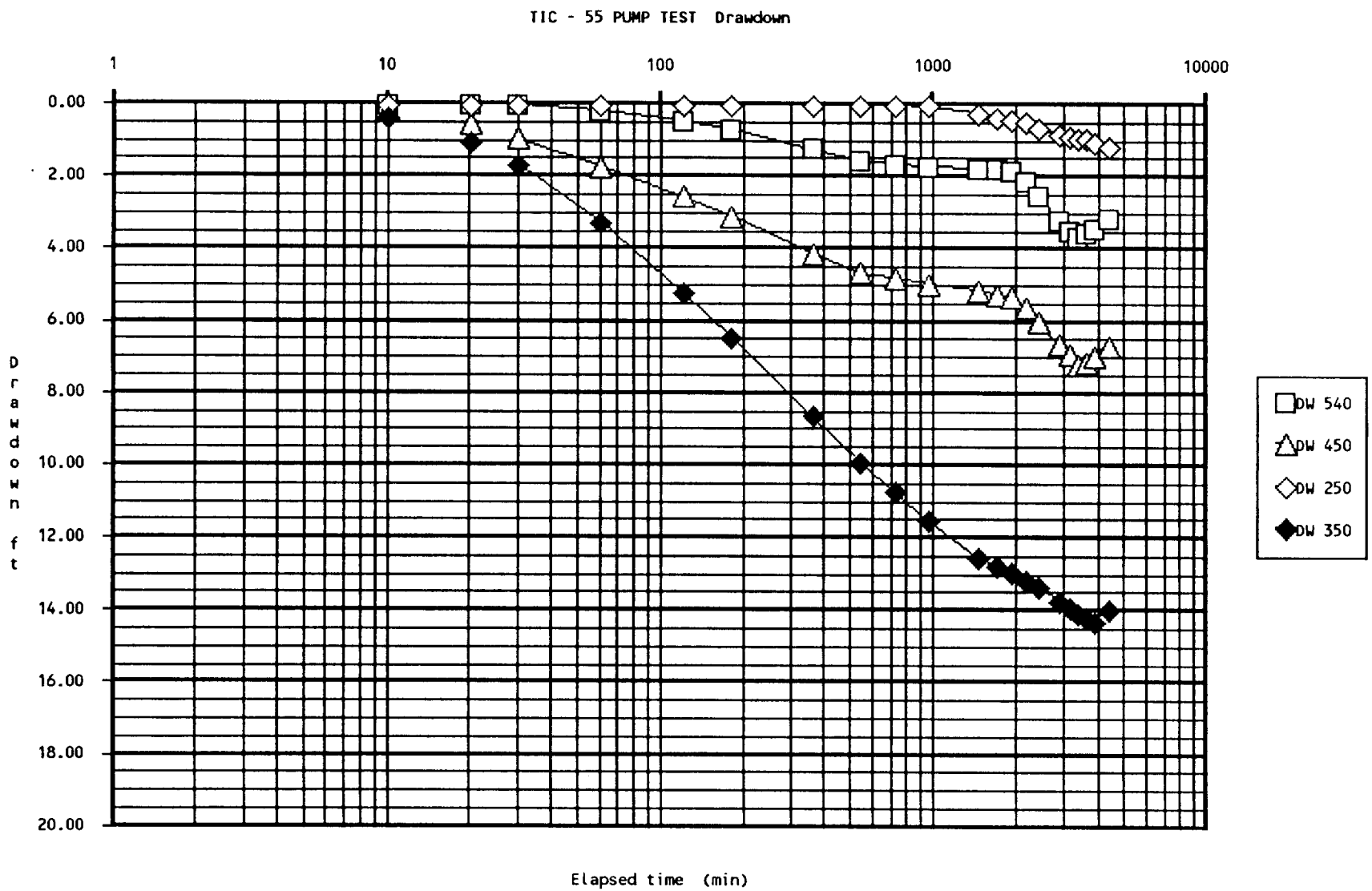
The cluster wells were used as observation wells during the aquifer test, to monitor pressure responses within the different screened zones during pumping of TIC-55. Drawdown measured in each cluster well is shown graphically in Figure 2.11. Well DW-350 was most affected by the pumping in TIC-55, with a maximum of 14.26 ft of drawdown measured at the end of the 72 hour pumping period. The water level in DW-450 was drawn down by 7.18 ft and in DW-540 by 3.67 ft. Drawdown in DW-250 was approximately 1 ft. Water levels in DW-135 were not affected by pumping in TIC-55.

Values for transmissivity and storativity from wells DW-250, 350, 450, and 540 were calculated using a variety of solutions that could possibly represent the aquifer system at TIC-55 and the cluster wells. Table 2.5 summarizes values of T and S calculated from the Theis method that assumes an unconfined aquifer, the Hantush method for confined aquifers, and the Hantush-Jacob method for non-steady flow also in confined aquifers.

2.6 CLUSTER WELL WATER QUALITY SAMPLING

Cluster wells were sampled twice during 1988 (July and September) and once during January 1989 as part of an ongoing program to monitor the presence and concentrations of VOCs in the groundwater on base at different depths. Prior to sample collection, three to five well volumes of water were removed from the well using a submersible pump, until pH and electrical conductivity values measured in the discharge water stabilized. Samples were taken via bladder pumps installed in each well to prevent sample aeration. Water removed from each well was treated through a portable GAC treatment unit that effectively removes any organic compounds prior to discharge to a drainage channel.

Tabulation of all groundwater sample results from cluster wells is included as Appendix B.3. Figures 2.12, 2.13, and 2.14 show the VOC concentrations detected in the wells. As shown in these figures, samples collected from the cluster wells during all three sampling rounds indicated low concentrations of select VOCs, primarily in wells DW-



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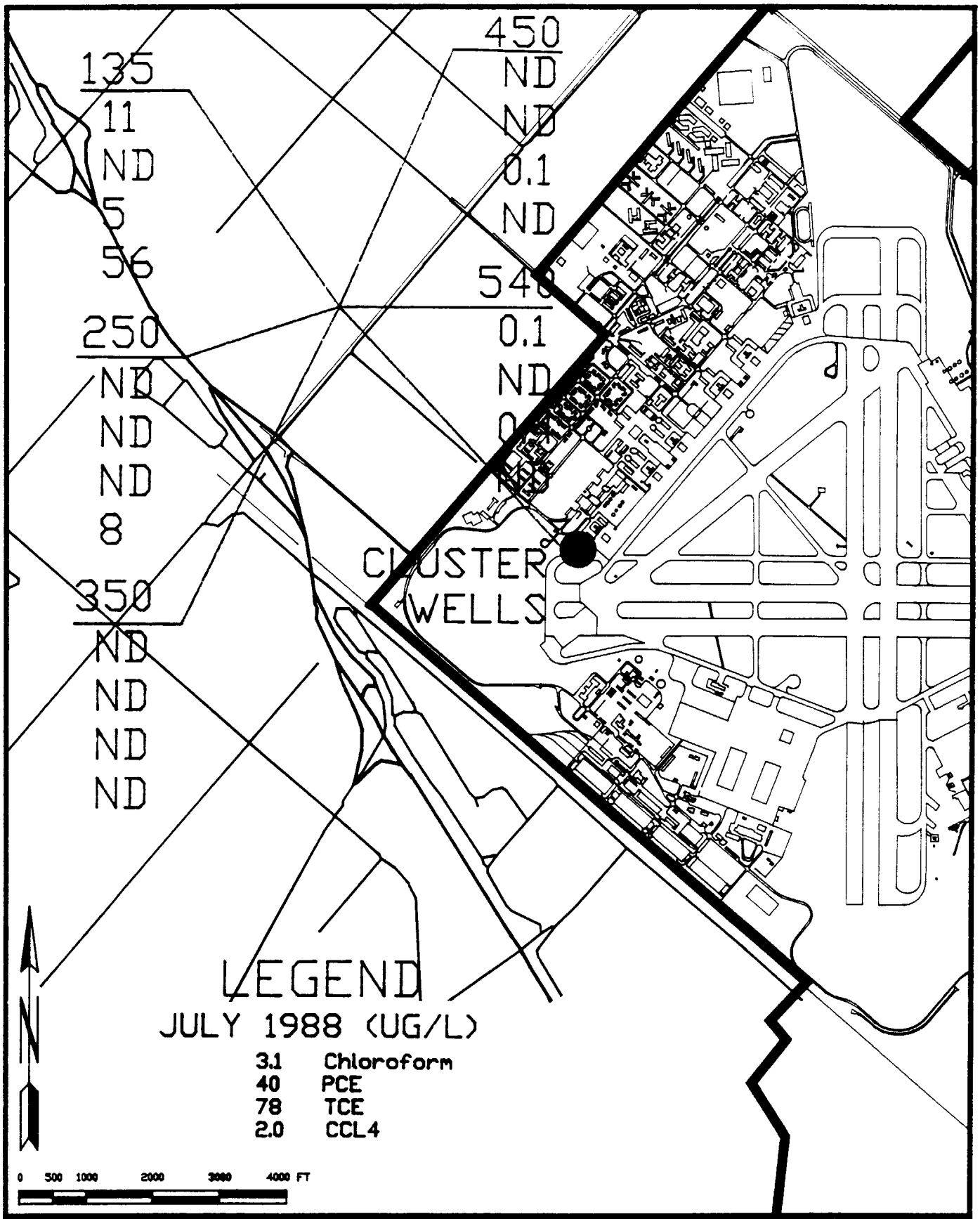
TIC-55 AQUIFER TEST
DRAWDOWN CURVES FROM
CLUSTER WELLS

FIGURE
2.11

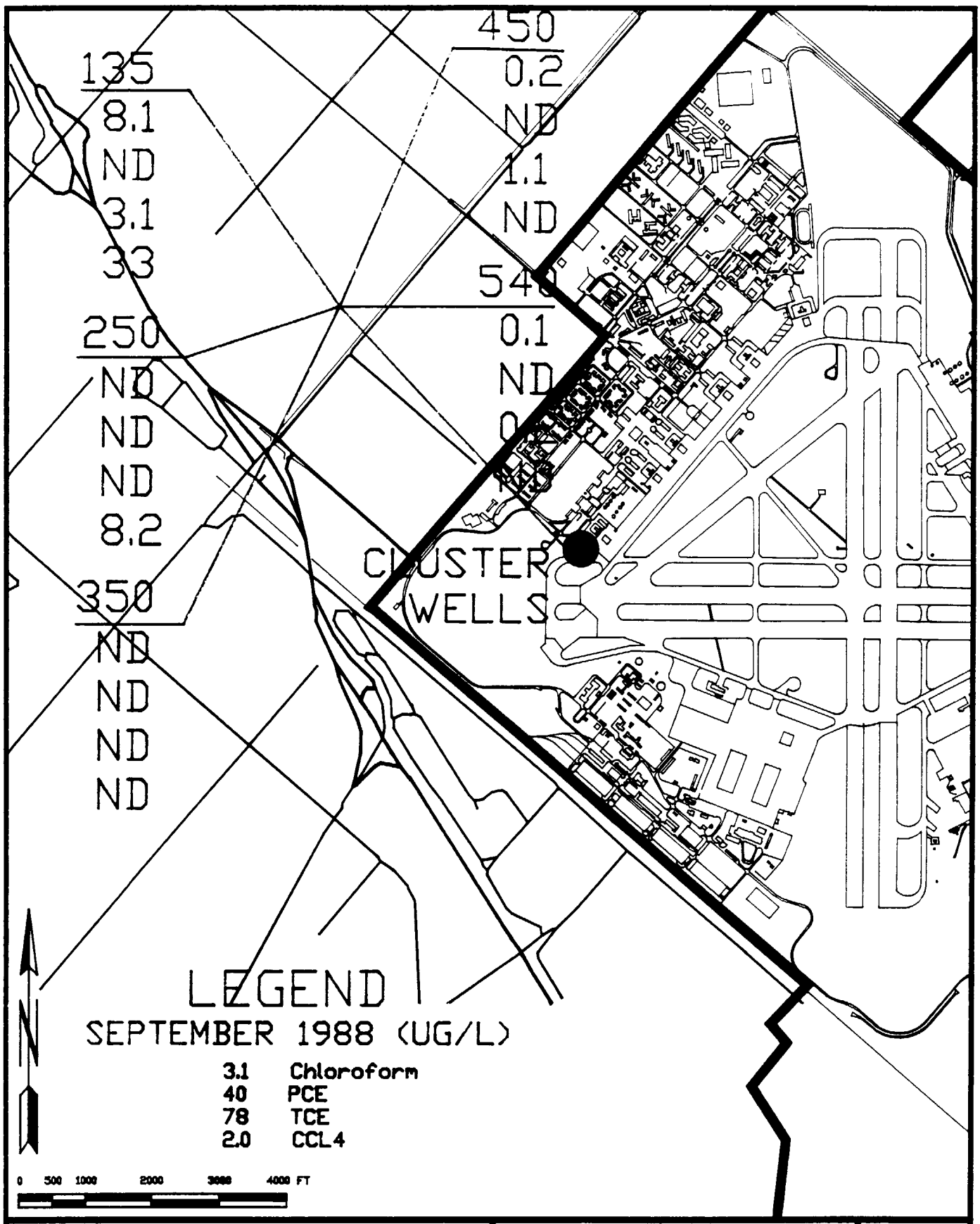
TABLE 2.5

SUMMARY OF SOLUTIONS FOR TRANSMISSIVITY AND STORATIVITY

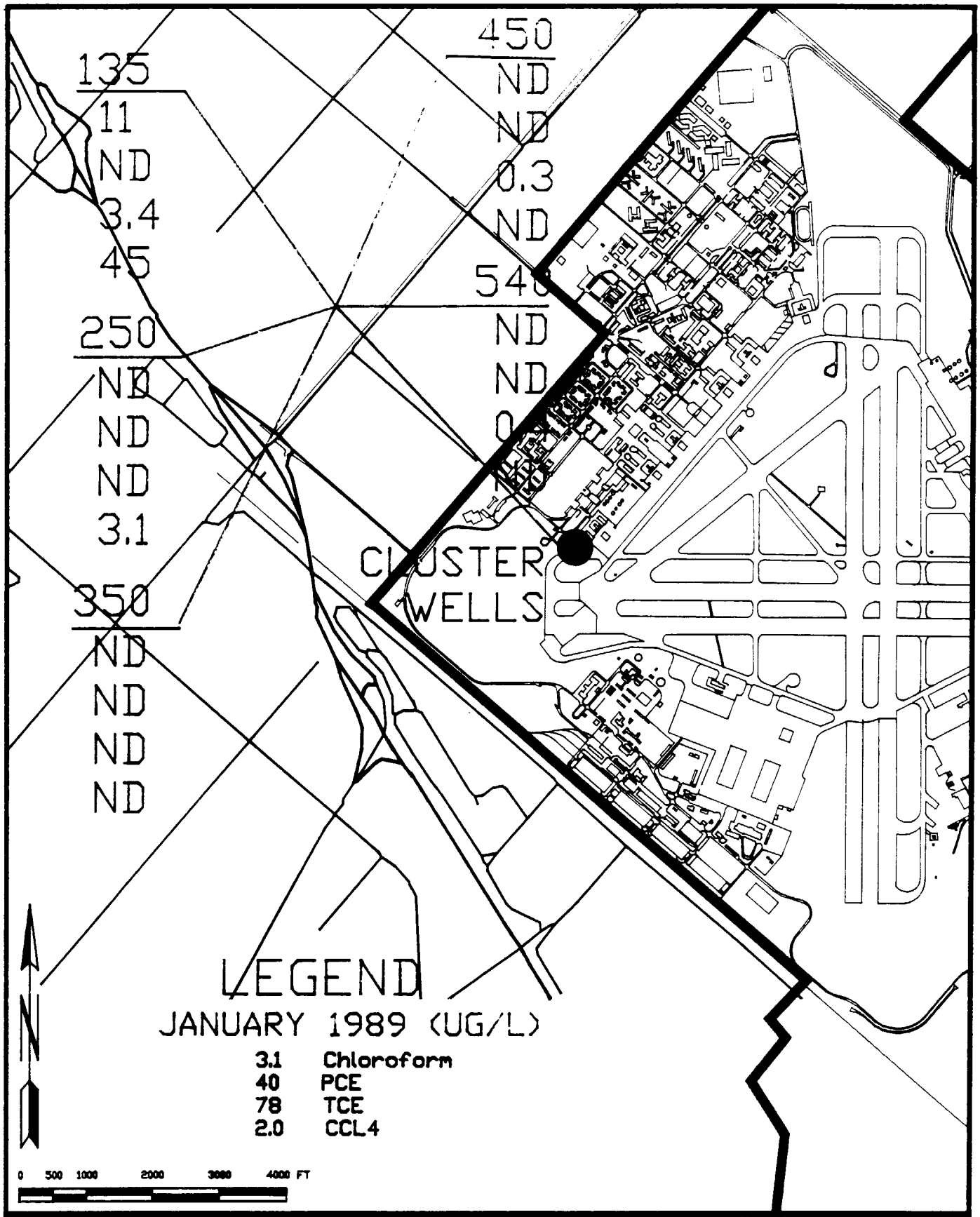
	Cluster Well Depth (ft)		
	350	450	550
Theis Type Curve (Unconfined Aquifer)			
T (ft^2/day)	2,837	4,787	7,660
S	2×10^{-4}	4×10^{-4}	3×10^{-3}
Hantush Type Curve (Confined Aquifer)			
T (ft^2/day)	451	3,830	4,255
S	2×10^{-2}	3×10^{-4}	2×10^{-3}
Hantush-Jacob Type Curve (Non-steady Flow-Confined Aquifer)			
T (ft^2/day)	2,128	4,506	4,255
S	9.4×10^{-4}	3.2×10^{-4}	2.2×10^{-3}



MCAS EL TORO, CALIFORNIA PERIMETER INVESTIGATION INTERIM REPORT	CLUSTER WELLS JULY 1988 VOC RESULTS	FIGURE 2.12



MCAS EL TORO, CALIFORNIA PERIMETER INVESTIGATION INTERIM REPORT	CLUSTER WELLS SEPTEMBER 1988 VOC RESULTS	FIGURE 2.13



MCAS EL TORO, CALIFORNIA PERIMETER INVESTIGATION INTERIM REPORT	CLUSTER WELLS JANUARY 1989 VOC RESULTS	FIGURE 2.14

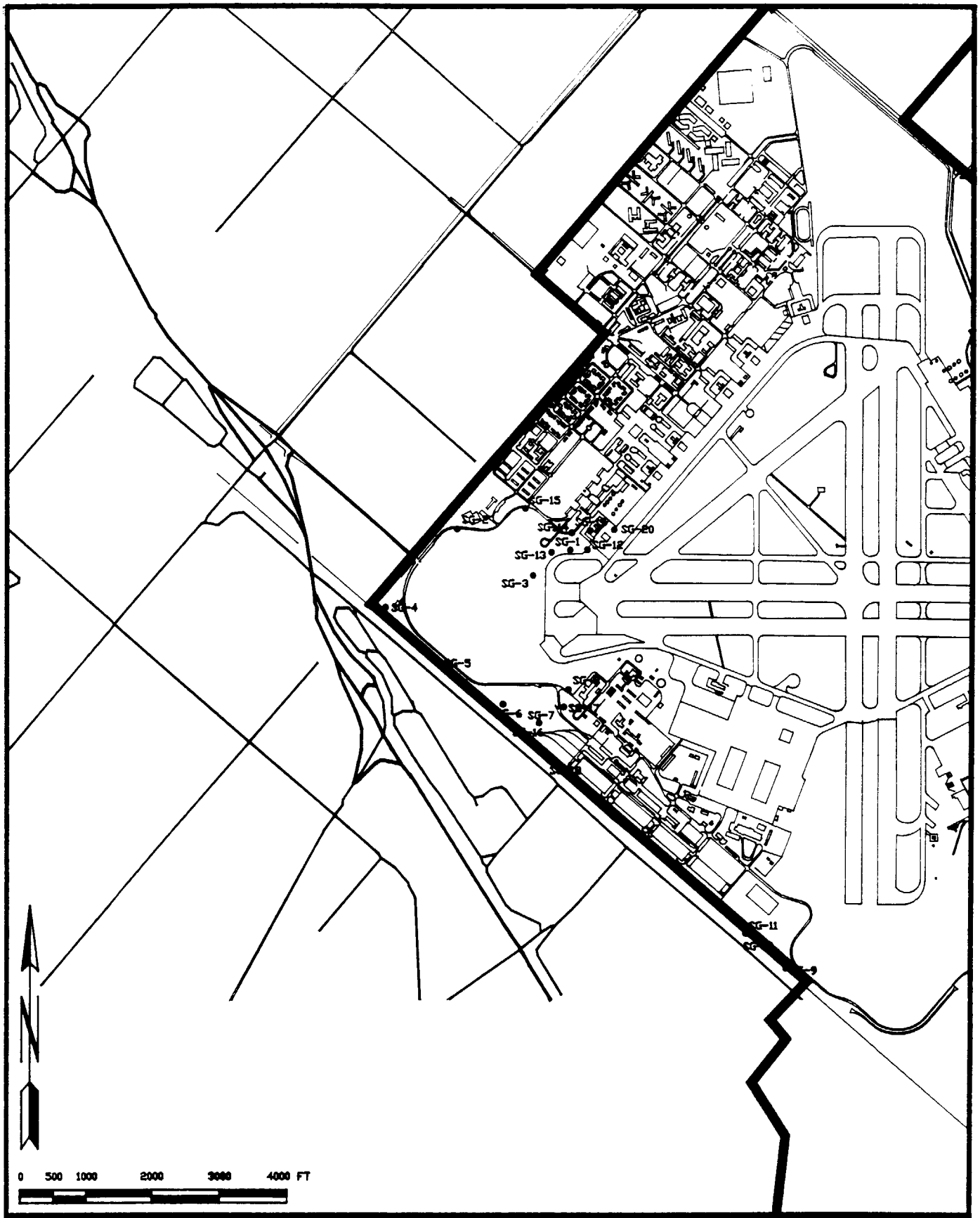
135 and DW-250. Concentrations of CCl4, chloroform, and TCE present in DW-135 remained consistent over this 7-month period, at maximum levels of 82 μg/L, 14 μg/L, and 7 μg/L, respectively. CCl4 was detected in DW-250 during all sampling rounds. No VOCs were detected in DW-350, and only low levels (below 1.1 μg/L) of TCE were detected in DW-450 and DW-540.

2.7 SOIL GAS SURVEY

A two-phase soil gas survey was conducted near the cluster wells, as well as along the southwestern boundary of the station to measure VOCs in the soil gas. This technique allows determination of potential contaminant source locations. In areas away from potential sources, and under relatively uniform soil conditions within the unsaturated zone, this technique also allows determination of the potential extent of groundwater contamination with VOCs. The latter is accomplished by measuring concentrations within the soil pore gas as the VOCs in groundwater volatilize and migrate upward through the soil column. The soil gas is a real-time survey of actual field conditions since the analyses are done in the field immediately following the sample collection.

A soil gas survey was conducted using a system in wide use. Soil gas is collected through a hollow steel rod that is hydraulically pushed or driven 5 to 7 ft into the soil. The rod is withdrawn a few inches to disconnect the embedded tip from the rod, and a small volume of soil gas is extracted from the tygon tube connected to the rod by means of a syringe. The gas sample is then injected into a gas chromatograph located on site for analysis. The soil gas samples were analyzed for 11 compounds, consisting of DCE, DCA, TCA, CCl4, TCE, PCE, benzene, toluene, xylenes, total hydrocarbons and CHC13. These compounds were selected based on their presence in cluster wells as well as on and off-station TIC wells.

A total of 49 soil gas samples were collected during the 2 sampling phases, over a period of 3 days. Twenty samples collected in the first phase (points SG-1 through SG-20 in Figure 2.15) were distributed around the southwest perimeter of the station from the



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PHASE I SOIL GAS
SAMPLING LOCATIONS

FIGURE
2.15

cluster wells to Borrego Canyon Wash to develop a general understanding of the possible VOC soil gas contamination. The remaining 29 samples (Figure 2.16) collected during the second phase focused on 3 particular areas where earlier results indicated detectable levels of VOCs.

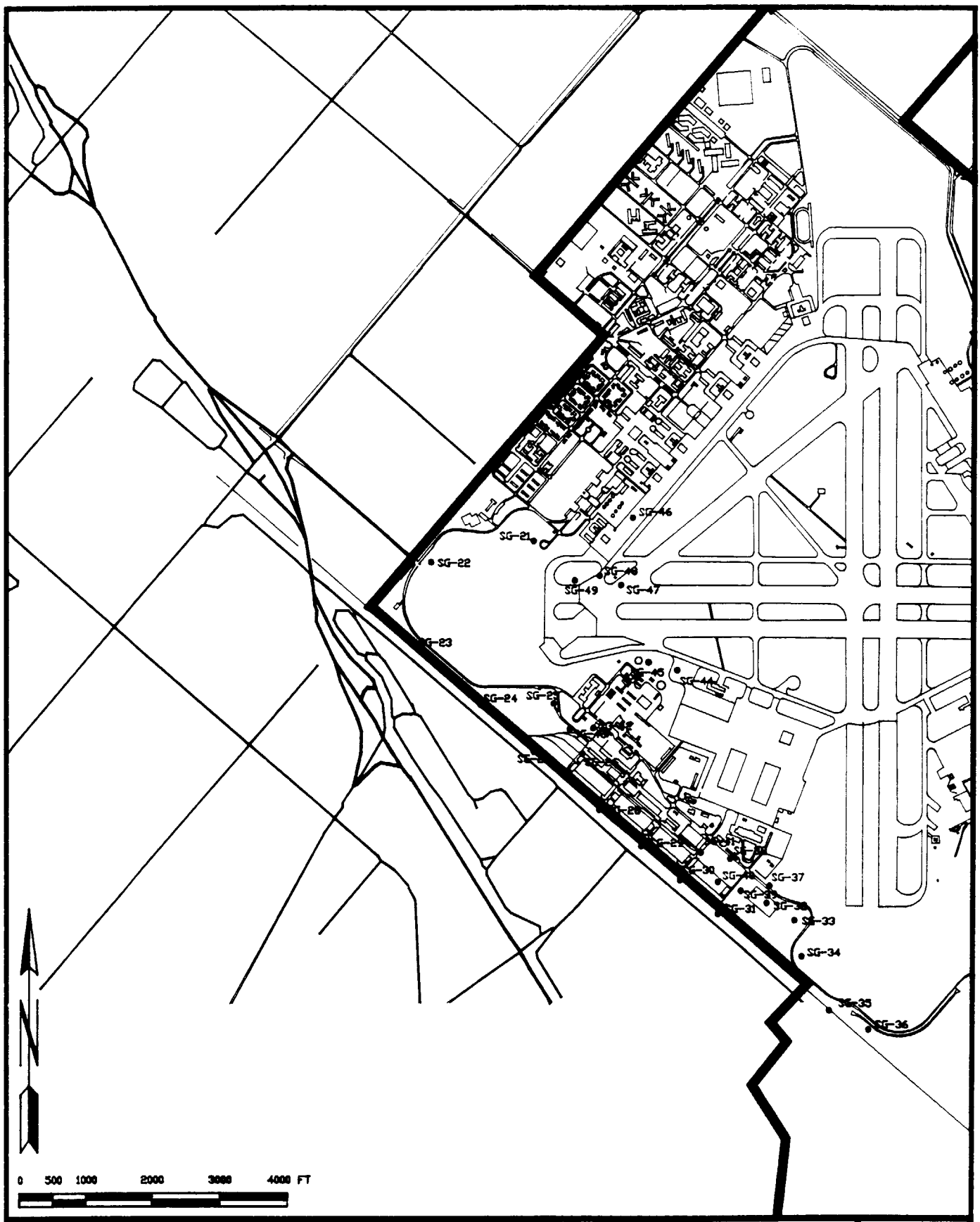
Results from the soil gas survey indicated that one or more of the TCE, PCE or CCl_4 were present in soil gas at three separate areas in the southwestern portion of the station. Figures 2.17 through 2.19 show the soil gas sample locations where TCE, PCE and CCl_4 were detected in soil gas above background.

Figure 2.20 shows the estimated extent of three discrete areas where the soil gas contamination above background levels was observed. Five soil gas samples collected from an area of approximately 1000 ft in diameter near the cluster wells indicated concentrations of CCl_4 ranging 0.4 to 10 μg/L. TCE was also measured in soil gas in this area, with PCE being detected near background levels. The relative magnitude of these soil gas VOC concentrations was similar to those observed from the cluster wells. This suggests that the soil gas survey was successful in determining the presence of these VOCs in groundwater.

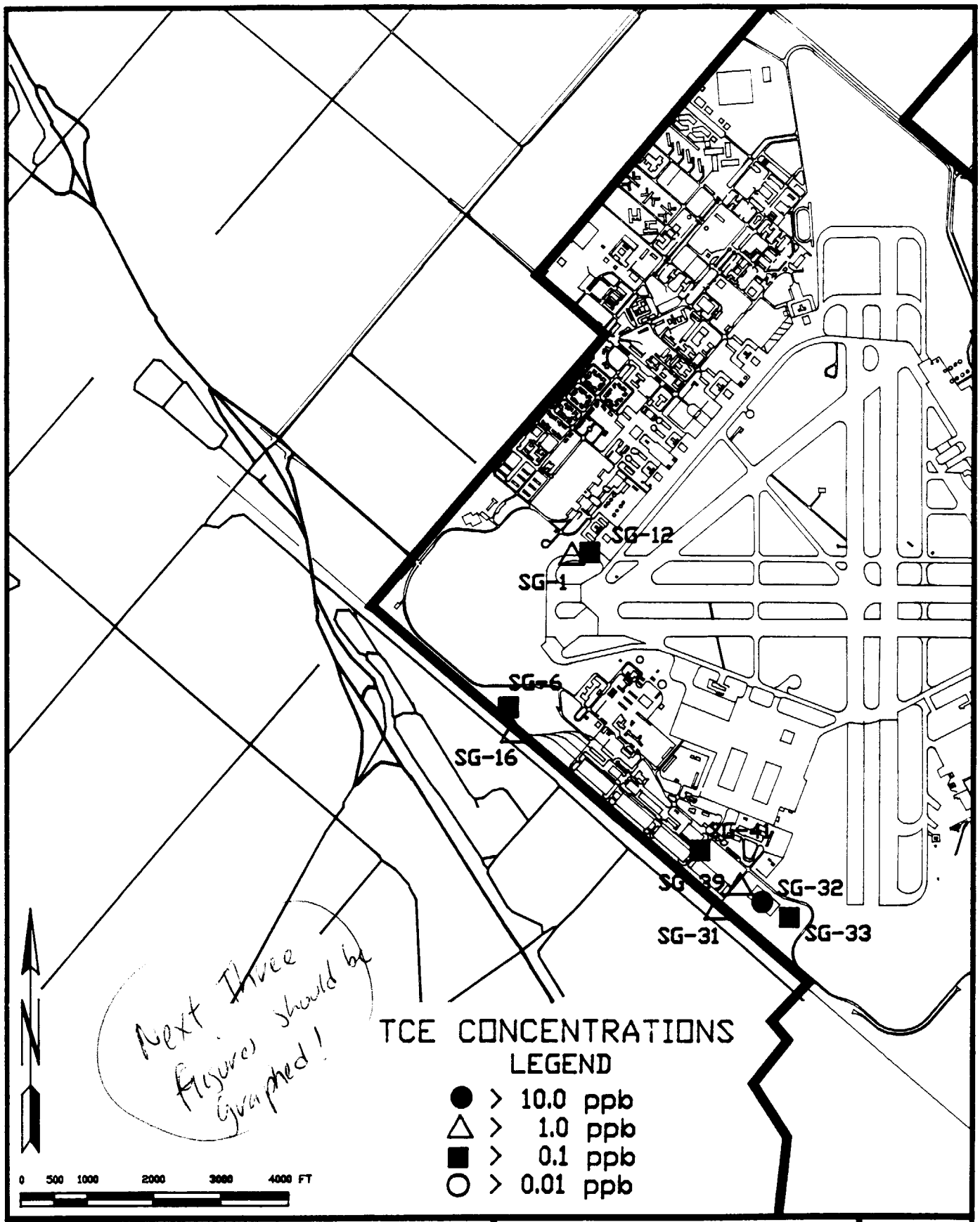
PCE was detected along the southern boundary, generally in two separate areas, at concentrations below 0.1 μg/L. An exception to this was the soil gas point SG-7, where PCE was measured at 56 μg/L. TCE was detected in 9 of the 49 soil gas samples at concentrations less than 0.1 ug/L to more than 10 ug/L. All three areas had TCE soil gas concentrations 1 ug/L or more.

2.8 PERIMETER WELL INSTALLATION

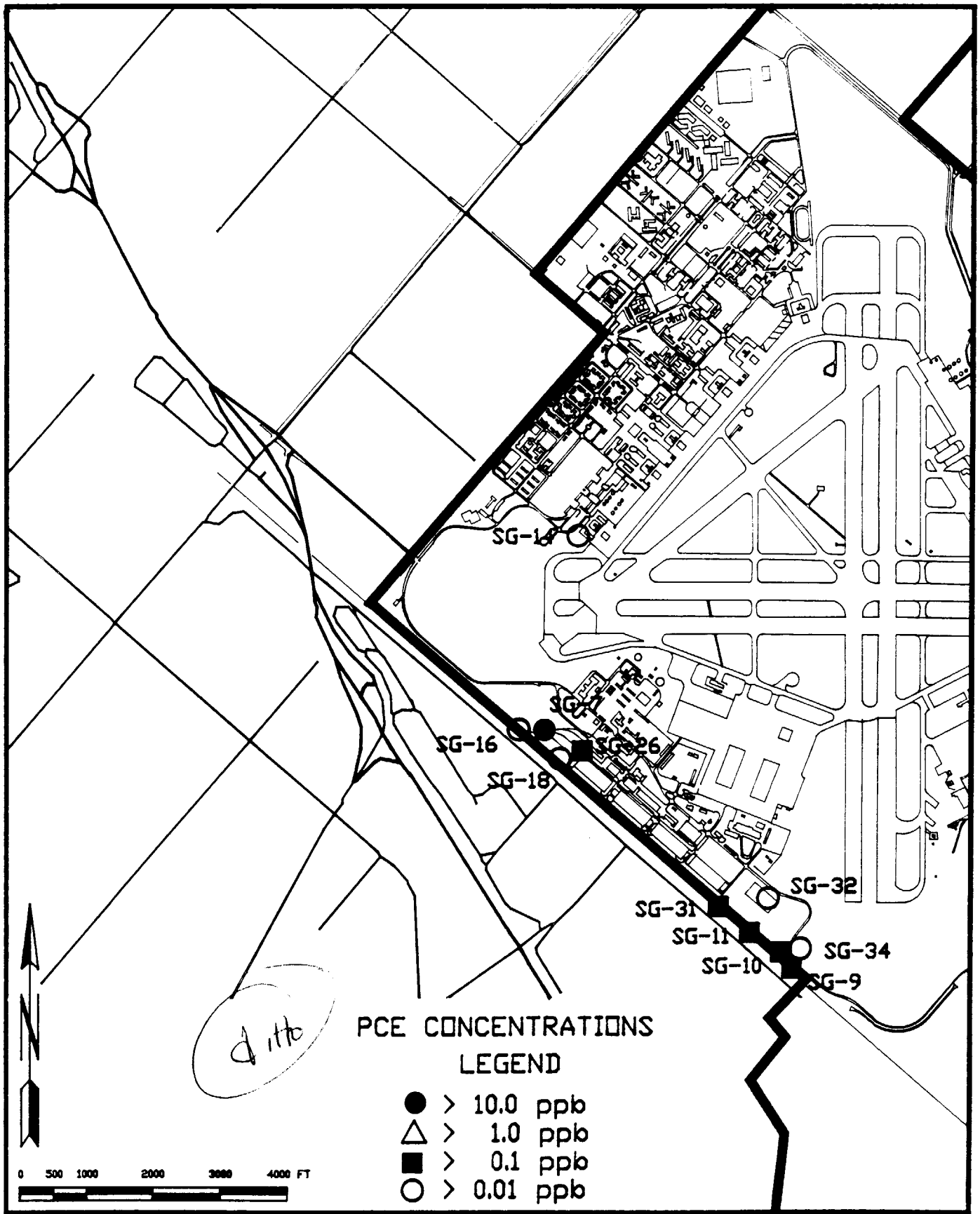
Based on the results of the soil gas survey, locations for three shallow perimeter wells (PS-1, PS-2, and PS-3) were selected along the southern portion of the base. The purpose of these perimeter wells was to determine if (Figure 2.21) that the VOCs existed



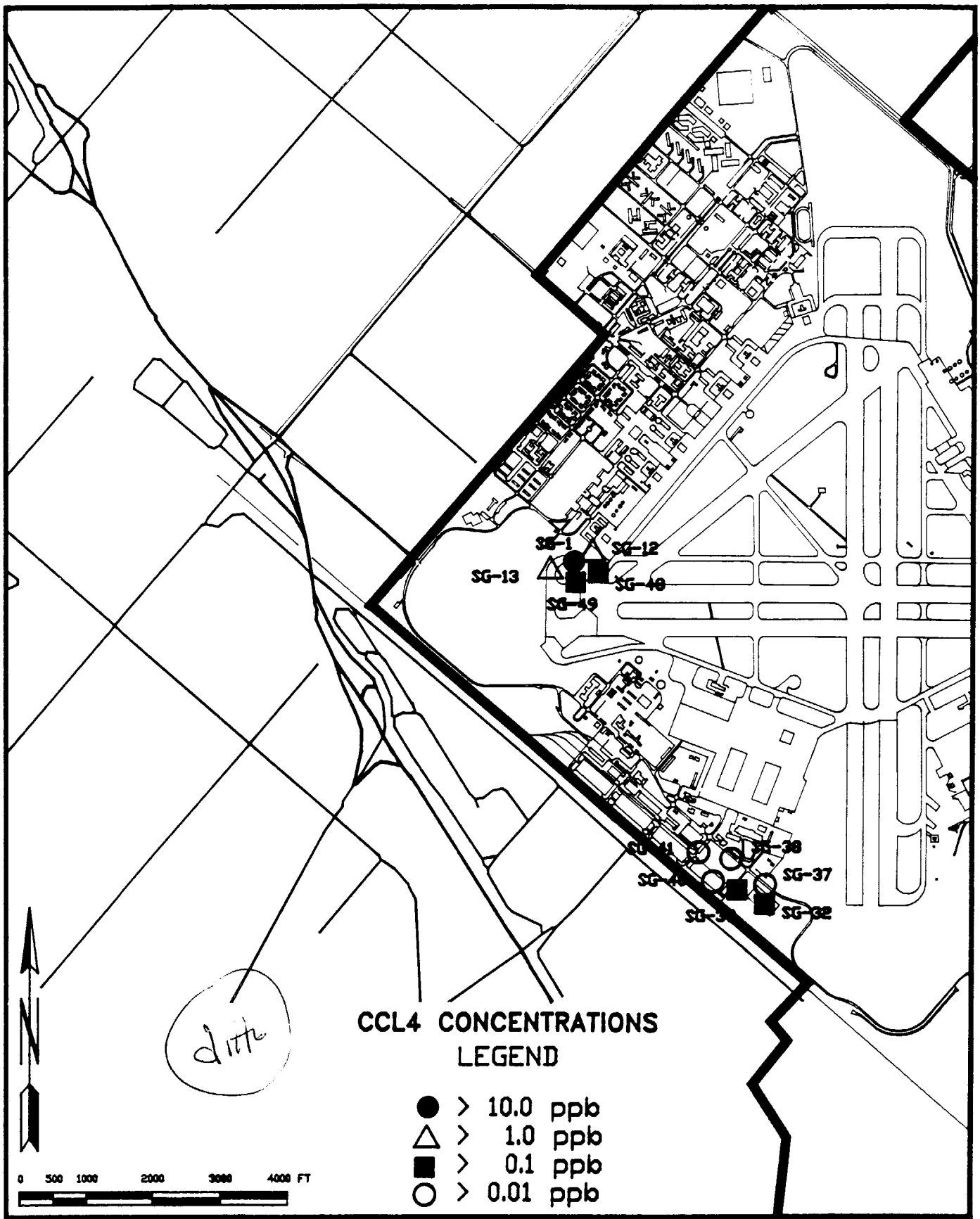
MCAS EL TORO, CALIFORNIA PERIMETER INVESTIGATION INTERIM REPORT	PHASE II SOIL GAS SAMPLING LOCATIONS	FIGURE 2.16



MCAS EL TORO, CALIFORNIA PERIMETER INVESTIGATION INTERIM REPORT	TCE SOIL GAS CONCENTRATIONS	FIGURE 2.17



MCAS EL TORO, CALIFORNIA PERIMETER INVESTIGATION INTERIM REPORT	PCE SOIL GAS CONCENTRATIONS	FIGURE 2.18



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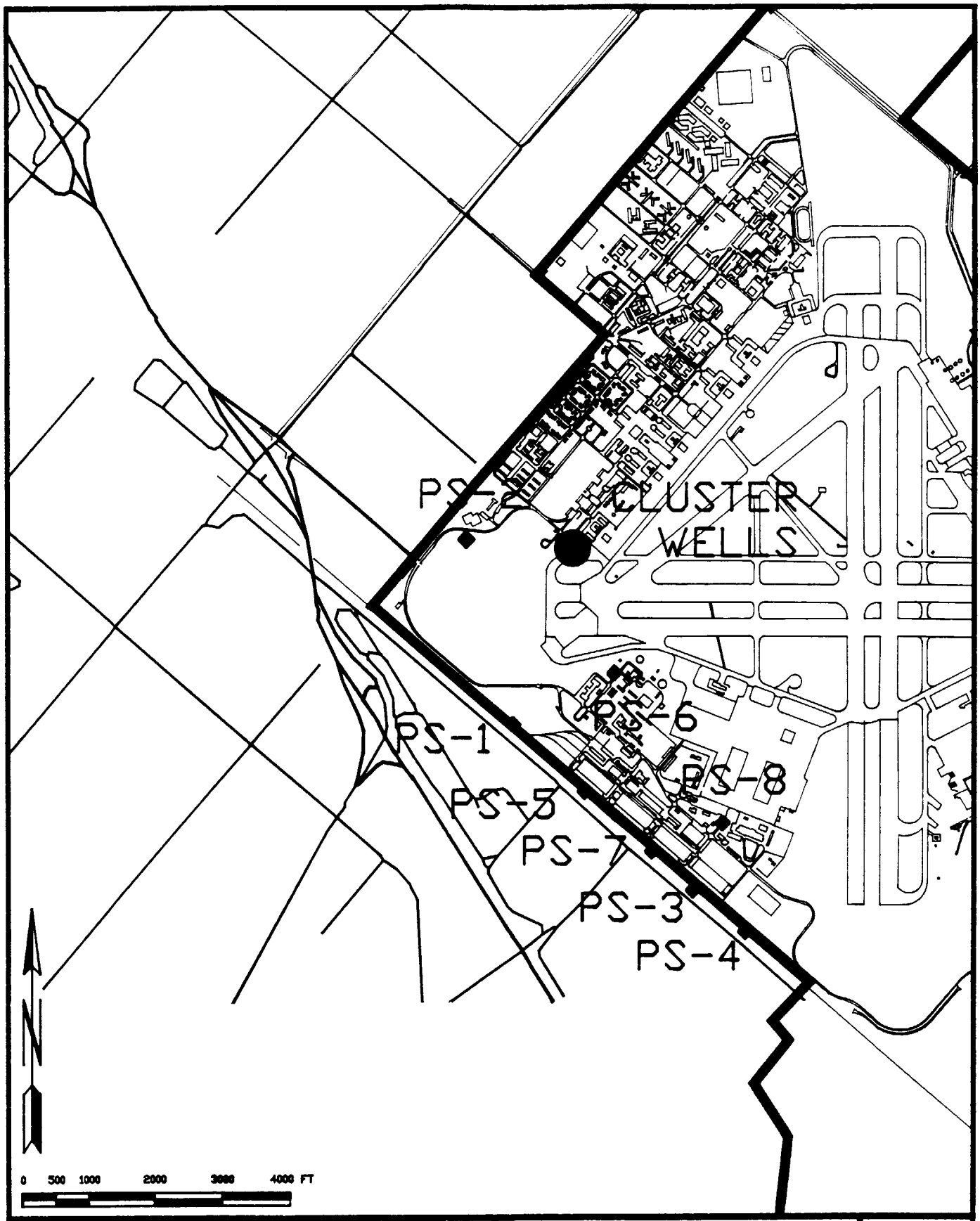
CCL4 SOIL GAS CONCENTRATIONS

FIGURE 2.19

MCAS EL TORO, CALIFORNIA PERIMETER INVESTIGATION INTERIM REPORT	**AREAS OF SOIL GAS CONCENTRATIONS**	FIGURE 2.20



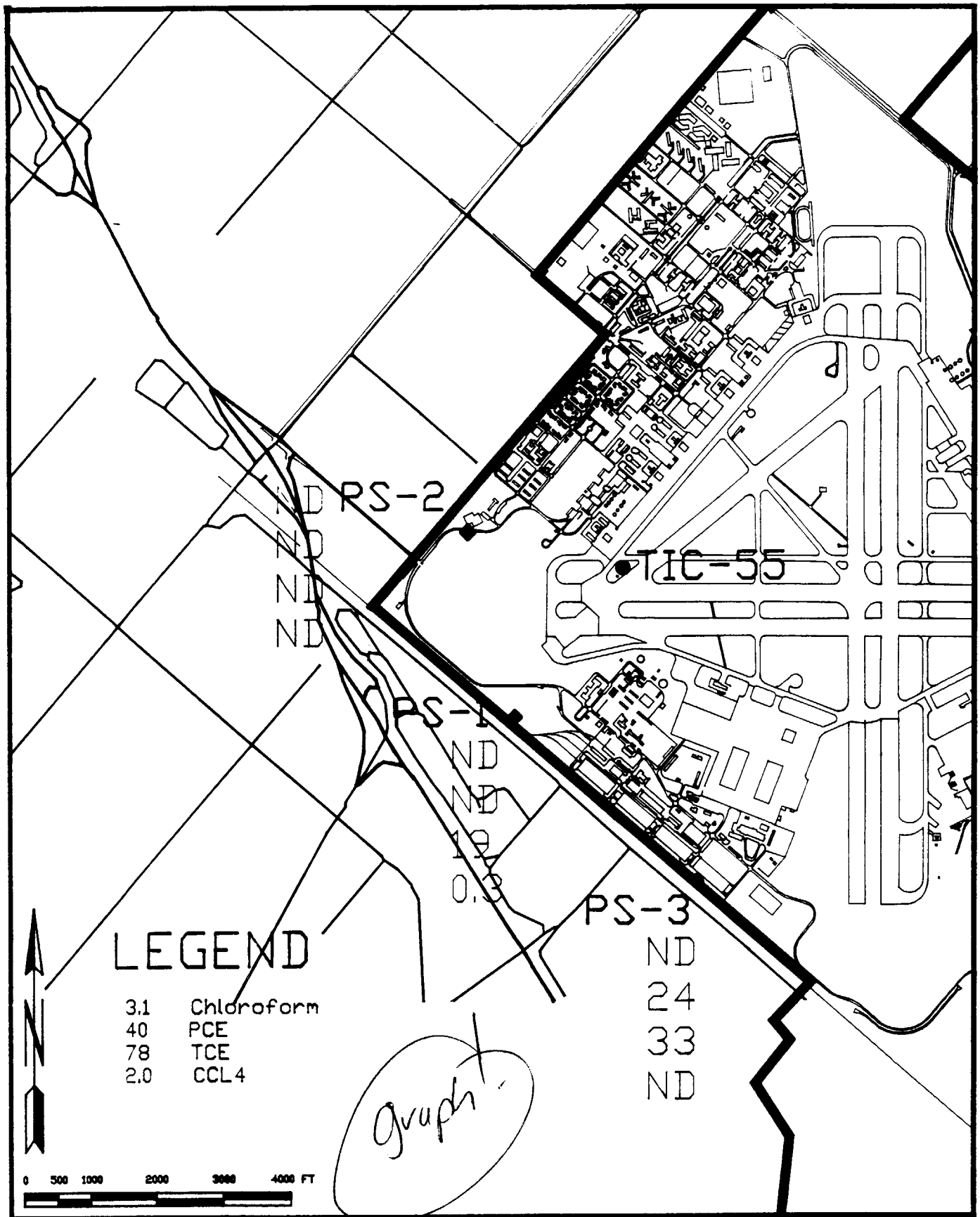
MCAS EL TORO, CALIFORNIA PERIMETER INVESTIGATION INTERIM REPORT	LOCATIONS OF PERIMETER WELLS	FIGURE 2.21

in the shallow groundwater in areas where soil gas samples indicated contamination. The investigation at this time was limited to the shallow groundwater at the perimeter of the base, because of the presence of carbon tetrachloride and TCE in DW-135, and the absence of VOCs in the deeper cluster wells at concentrations above state action levels. This decision was confirmed by results from MCAS-3, which indicated no detectable VOCs in the groundwater from several depth specific samples down to approximately 500 ft. The concentrations of CCl_4 in DW-250 were considered to be localized in the vicinity of the cluster wells, based on nondetectable VOC concentrations in TIC wells 55, 56 and 111.

Results from the December 1988 groundwater quality sampling of wells PS-1, PS-2, and PS-3 (Figure 2.22) were similar to results from the soil gas survey in that no VOCs were detected in PS-2. TCE and PCE were detected in PS-3 33 μg/L, and 24 μg/L, respectively. TCE and PCE were both detected by the soil gas survey in the vicinity of PS-3. Groundwater samples from PS-1 detected TCE at 19 μg/L. Chloroform and CCl_4 were also detected in PS-3, though at concentrations below 1.0 μg/L. Laboratory results are included in Appendix B.4.

Based on the water quality results from PS-1, PS-2, and PS-3, and the results of the soil gas survey, three of the remaining five wells, PS-3, PS-5, and PS-7, were positioned between PS-1 and PS-3, to determine if contamination detected in these wells is continuous along the entire southern boundary. Monitoring wells PS-6 and PS-8 were located away from the perimeter to identify the extent of contamination to the north of the base boundary, and to provide static water elevations to more accurately predict groundwater gradients in this area.

Each well was drilled using hollow stem augers that allowed for collection of relatively undisturbed soil samples. In the first three wells (PS-1, PS-2 and PS-3), soil was continuously sampled down to the static water level during drilling so that detailed lithologic logs could be compiled. Boring logs for all the shallow perimeter wells are included in Appendix A.3 Four-inch diameter PVC casing and riser were installed in



MCAS EL TORO, CALIFORNIA **PERIMETER INVESTIGATION** **INTERIM REPORT**	**PERIMETER WELLS** **DECEMBER 1988** **VOC RESULTS**	FIGURE 2.22

each well. All shallow perimeter wells were developed by bailing and pumping following installation.

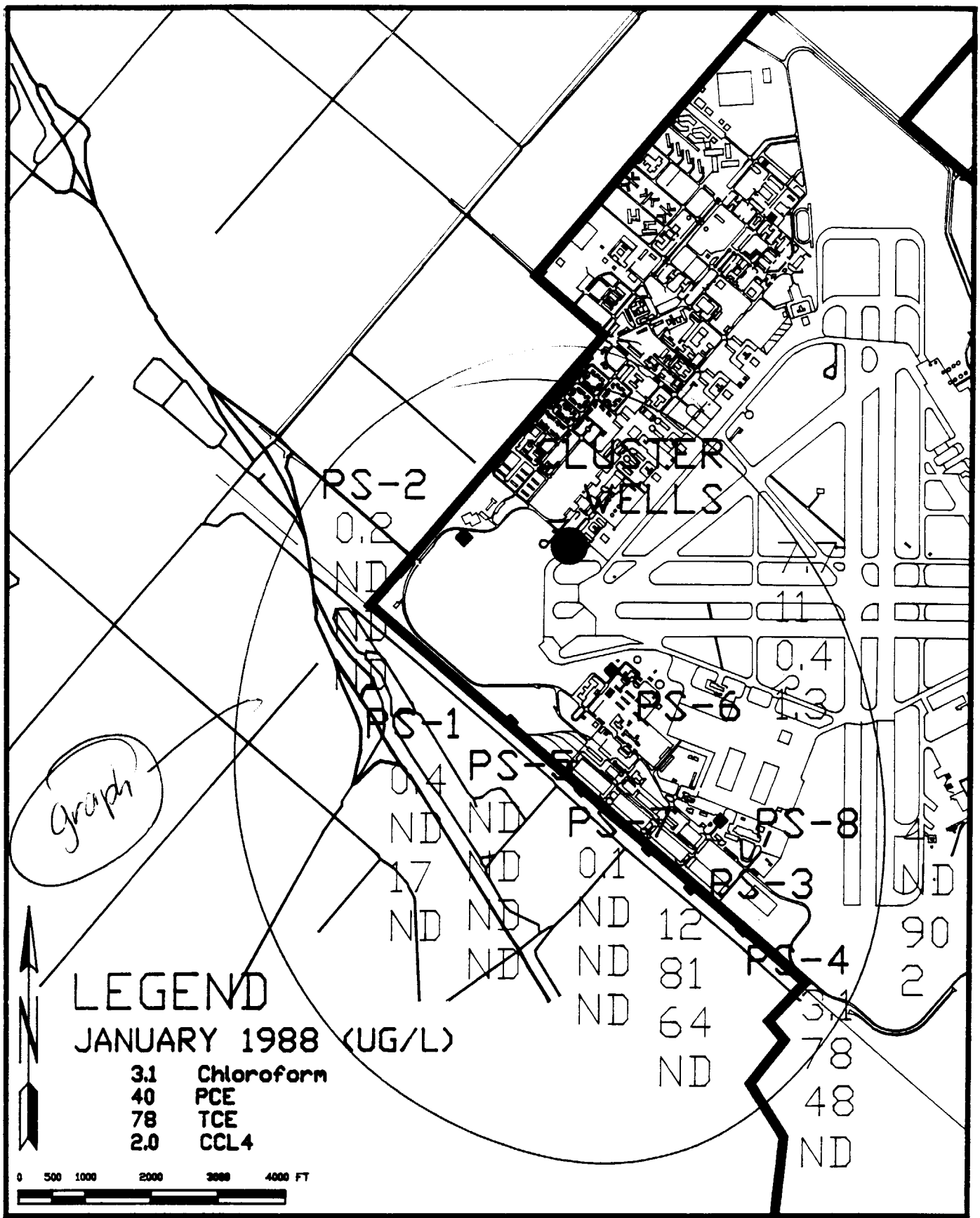
Soil samples were collected at various depths during drilling for geotechnical analysis of moisture content, grain size distribution, and porosity (Appendix C).

All perimeter and cluster wells were sampled in January 1989 and analyzed for priority pollutant VOCs (Figure 2.23). Results from samples collected in PS-5 and PS-7 showed no detectable VOCs, with the exception of chloroform detected in PS-7 at the limits of the analysis. These results confirmed results of the soil gas survey that two separate plumes exist in this area of the base. PS-4 water quality results were similar in composition and concentration to PS-3, with both TCE and PCE detected in the range of 64 to 78 μg/L and 48 to 81 μg/L, respectively. These results indicate the possibility of a localized plume extending off base. The extent, however, was not investigated or confirmed during this phase of the perimeter investigation.

In PS-8, TCE was detected at 90 μg/L, but no PCE was measured above the 1 μg/L detection limit.

Results from PS-6 showed TCE at 11 μg/L, and low levels of other VOCs detected at concentrations below their action levels.

All perimeter wells and cluster wells were surveyed and water levels were measured prior to sampling in January 1989 to estimate the groundwater gradient in the southwest corner of the base. The water levels indicate the direction of groundwater flow to be parallel to the base boundary, which is consistent with the regional direction of flow in this vicinity.



MCAS EL TORO, CALIFORNIA PERIMETER INVESTIGATION INTERIM REPORT	PERIMETER WELLS JANUARY 1989 VOC RESULTS	FIGURE 2.23

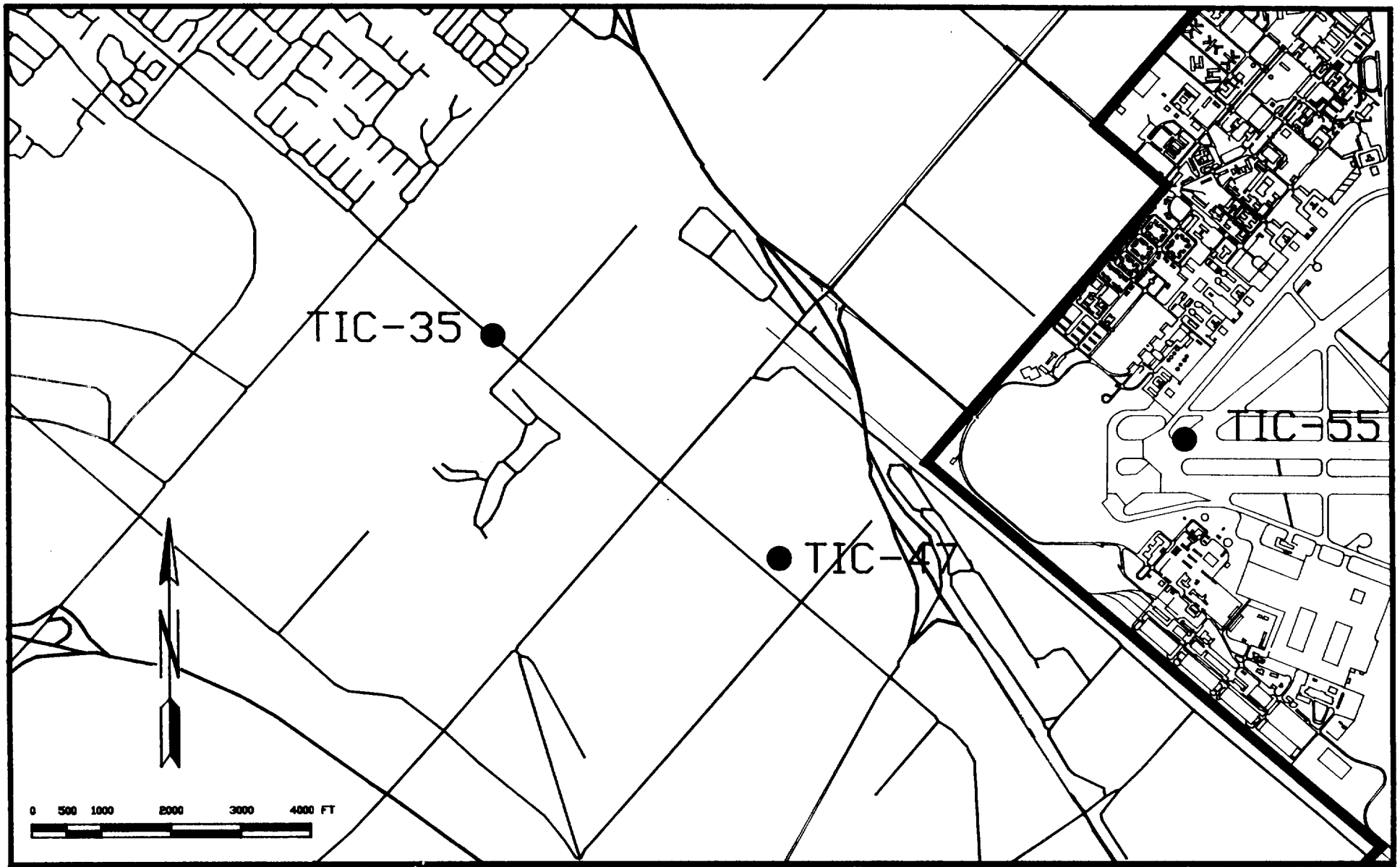
2.9 OCWD WORK ACCOMPLISHED TO DATE

OCWD's work accomplished to date had focused on extensive sampling and testing of TIC-35 and 47; installation of four multi-level monitoring wells (MCAS-1, MCAS-2, MCAS-3, and MCAS-7); rehabilitation of TIC 68, TIC 74, TIC 83, and TIC 127; and groundwater quality testing of wells for VOCs, general minerals and metals.

OCWD field work commenced in February 1988 by testing and sampling the existing wells TIC-35 and TIC-47 (Figure 2.24). Following a video survey, temperature, gamma, caliper, and flowmeter surveys were performed on both wells. Depth specific groundwater samples were also collected under nonpumping and pumping conditions in each well.

OCWD installed four multi-level monitoring wells (MCAS-1, MCAS-2, MCAS-3, and MCAS-7) at locations shown in Figure 2.25. Each well is equipped with a multiple-port sampling system that allows for depth discrete sampling. Results from organic analysis of samples have indicated the presence of TCE in wells MCAS-1, MCAS-2, and MCAS-7 at approximately 250 to 500 ft. below ground surface. Maximum concentrations in MCAS-1, MCAS-2, and MCAS-7 were 45.1, 40.7, and 24.8 μg/L, respectively. No VOCs were detected in samples collected from various depths in MCAS-3 during both the November and the December sampling rounds.

Four unused irrigation wells (TIC 68, TIC-74, TIC-83, and TIC-127) were also rehabilitated by OCWD (Figure 2.26). All wells were in poor condition due to corrosion. Sediment that had accumulated in the casing was removed and wells that remained open were logged for temperature, resistivity, and flow under pumping and nonpumping conditions. No logging was done in TIC-74 because the casing collapsed at 280 ft. below ground surface after development, and TIC-127 was not logged because it was too shallow. TIC wells 68, 74, and 83 were sampled at specific depths using the multiport sampling tool used in the MCAS wells.



MCAS EL TORO, CALIFORNIA
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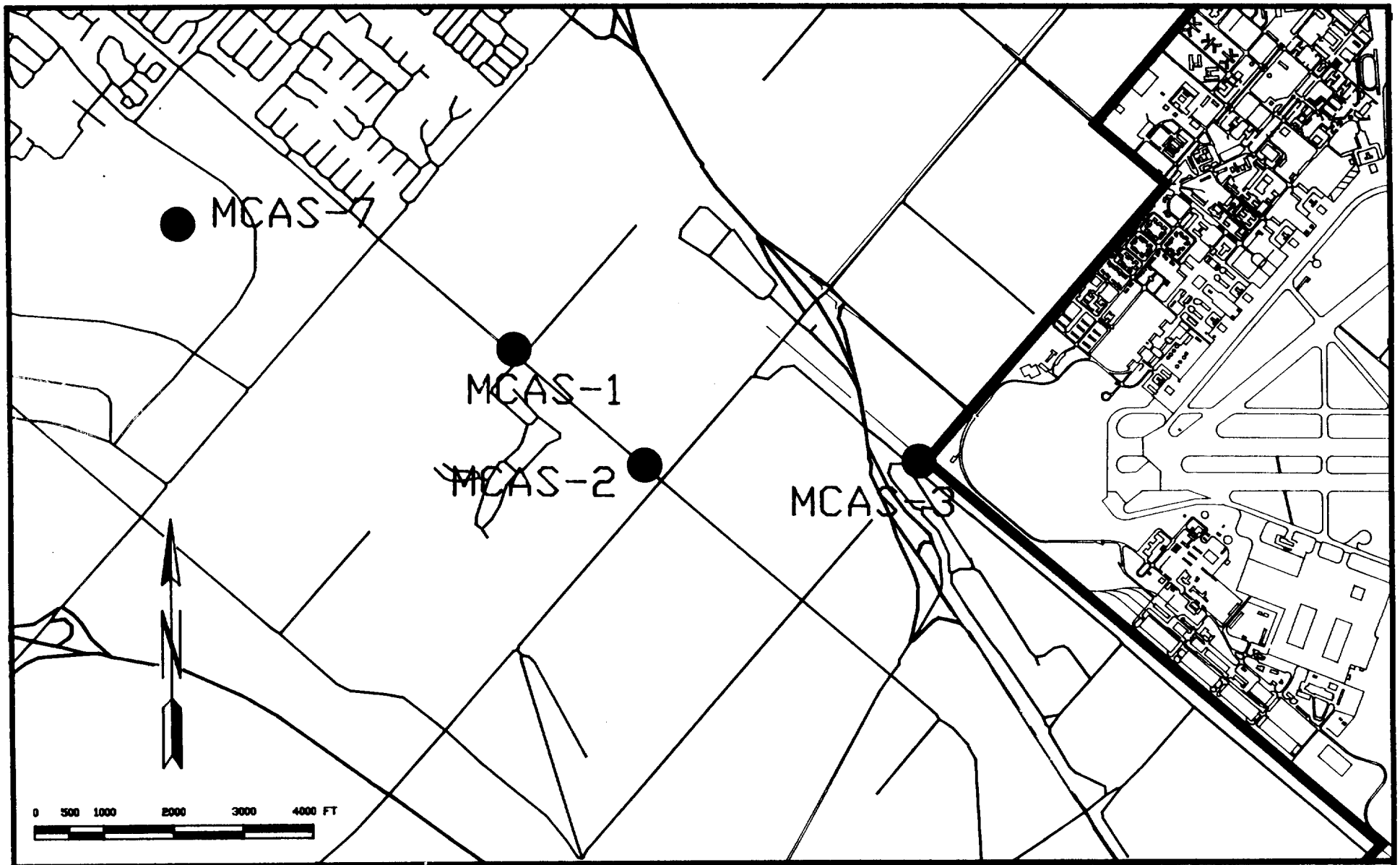
LOCATIONS OF TIC WELLS
35, 47, AND 55

FIGURE
2.24



MCAS EL TORO, CALIFORNIA
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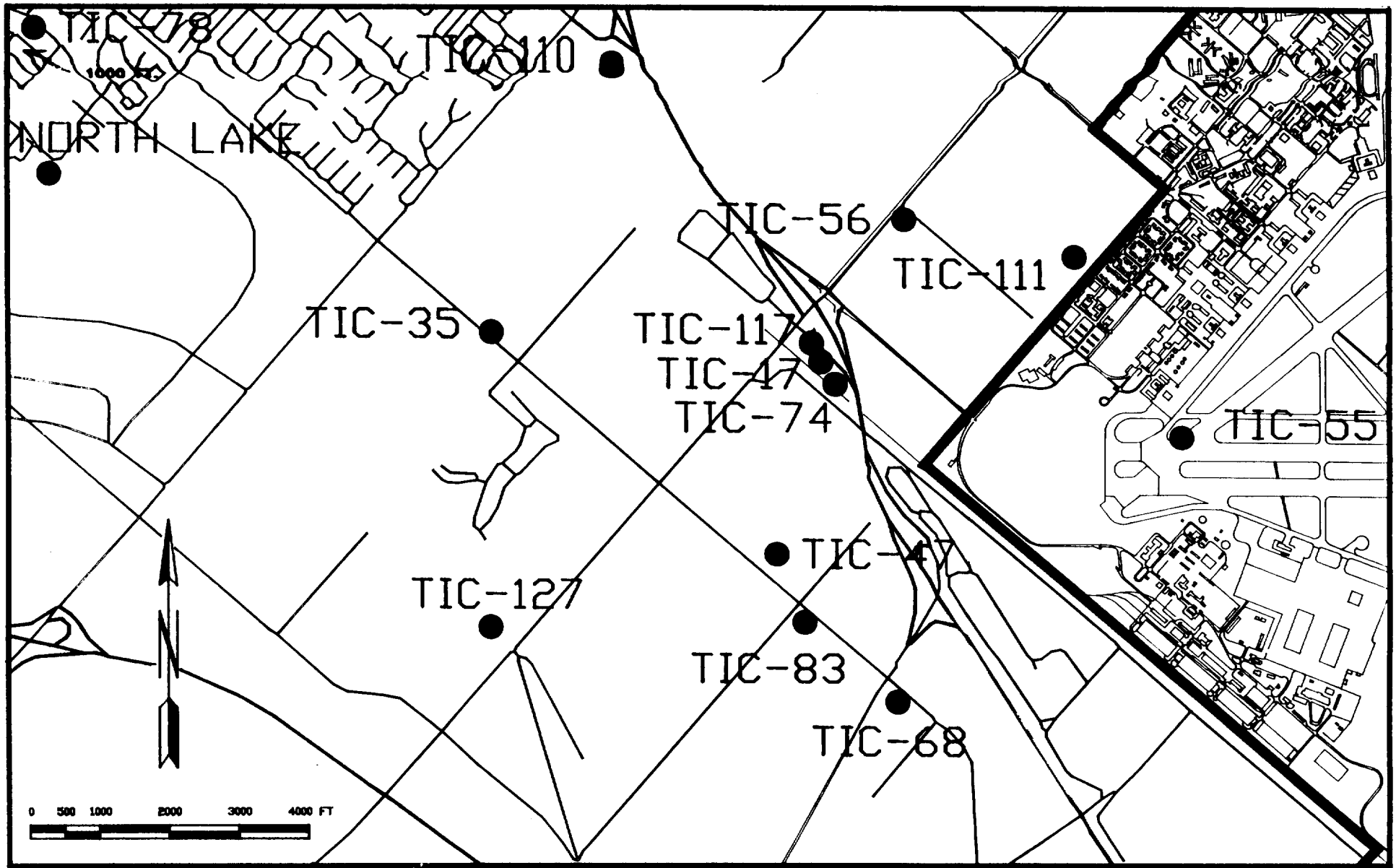
INTERIM REPORT

LOCATIONS OF MCAS WELLS

FIGURE
2.25



MCAS EL TORO, CALIFORNIA
PERIMETER INVESTIGATION
INTERIM REPORT

LOCATIONS OF OFF-BASE TIC WELLS

FIGURE 2.26

The results from the rehabilitated TIC wells indicated trace concentrations of TCE in TIC-68 and TIC-74. TCE was detected in TIC-83 at concentrations ranging from 7.4 to 9.1 μg/L. The results of groundwater analyses for TCE in samples collected from the MCAS and TIC wells are summarized in Appendix D.

SECTION 3.0
DISCUSSION OF FINDINGS

The findings of the Perimeter Investigation, along with all other available data are evaluated and interpreted in this section, which is divided into three principal subsections. The first two subsections examine the fundamental properties of the aquifer underlying the site with respect to groundwater flow, and the physico-chemical properties of the contaminants with respect to their potential environmental fate and transport. The third subsection discusses solute transport based on contaminant-aquifer interactions.

3.1 AQUIFER CHARACTERISTICS

Physical properties of the aquifer material underlying MCAS El Toro were determined or estimated using a series of aquifer tests, downhole geophysical logging, and geotechnical analyses. As discussed in Section 2, these tests included an aquifer test at TIC-55 and specific capacity tests at all of the five wells in the cluster. Resistivity (single, short normal and long normal), spontaneous potential, and natural gamma ray logs were conducted within the pilot borehole for the cluster well. Grain size distribution, porosity, aquifer bulk density, soil organic carbon fraction (f_{oc}), and soil moisture content in the unsaturated-zone were determined with laboratory geotechnical analyses.

3.1.1 Aquifer Physical Properties

The average aquifer physical properties as developed from field tests, geotechnical analyses, and preliminary calibration of the groundwater flow model are presented in Table 3.1.

TABLE 3.1

AQUIFER PROPERTIES

Property	Range of Values	Mean Value
Soil Organic Carbon Fraction, f_{oc}	0.0002 - 0.0032	0.001
Porosity, (percent)	0.25 - 0.36	0.3
Effective Porosity, (percent)		0.2
Hydraulic Conductivity, K, (ft/day)	30 - 54	—
Aquifer Bulk Density (g/cm^3)	1.68 - 1.97	1.81
Groundwater Gradient (ft/ft)	0.002 - 0.013	0.003 [a]

[a] Time weighted average value (1936-1987). See Table 3.2.

A number of soil organic carbon fraction, f_{oc}, tests were conducted on soil samples recovered from streambed, cluster, and perimeter monitoring wells. These samples included soils from both the saturated- and unsaturated-zones, as well as from fine and coarse-grained soil horizons. The measured f_{oc} values ranged over approximately one order of magnitude, from 0.0002 to 0.0032. The mean value was 0.001, which is fairly typical of aquifers in southern California groundwater basins. For the purposes of solute transport calculations, the mean and the lowest values for f_{oc} were used in estimating a typical and conservative range of retardation coefficients.

The range of values from porosity measurements conducted in the laboratory was from 0.25 to 0.36, with a mean value of 0.31. As with samples for f_{oc} analyses, these soil samples were also collected from fine- and coarse-grained materials located within both the saturated- and the unsaturated-zones. Assuming a specific retention value of about 10 percent, an estimate of 0.2 was used for effective porosity, e, in solute transport calculations.

The measured values of aquifer bulk density ranged from 1.68 to 1.97 g/cm3, with a mean value of 1.81 g/cm3, typical of soils encountered during this investigation. These values are calculated from laboratory measured soil densities and porosities. As with f_{oc}, the mean and low values of aquifer bulk density were used to develop a typical range of retardation coefficients.

The hydraulic conductivity values for the aquifers are calculated based on the results of the aquifer pump tests, specific capacity tests, and a weighted average of the hydraulic conductivities of typical soil material found in the vicinity of MCAS El Toro. Boyle Engineering (1981) estimated the hydraulic conductivities of the five major types of aquifer material in the Irvine Basin as follows:

Aquifer Material	Hydraulic Conductivity, (ft/day)
clay	0.13
clayey sand	4
sand	26.7
sand and gravel	53.5
gravel	106

Transmissivity values calculated from specific capacity tests for a 30 ft length of screen in each of the five monitoring wells in cluster ranged from 67 to 1083 ft^2/day. These values translate into hydraulic conductivities of 2.2 to 36 ft/day. The transmissivity values calculated from an aquifer test conducted at TIC-55, on the other hand, ranged from a low of about 1900 ft^2/day to a high of about 6400 ft^2/day. An average hydraulic conductivity of about 30 ft/day was then calculated for the most transmissive aquifer zone in the vicinity of TIC-55.

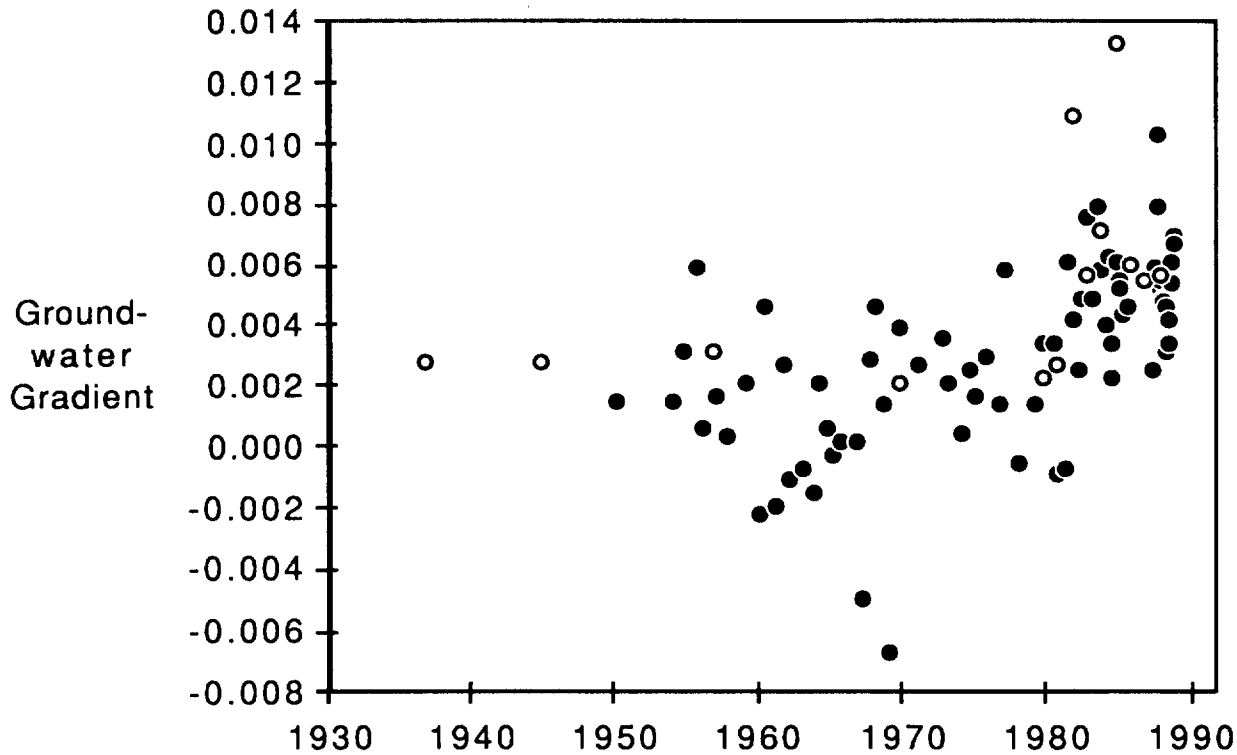
For the purposes of groundwater and solute transport velocity calculations, a value of 30 ft/day was chosen to be representative of the most transmissive aquifer as a whole (vertical average of hydraulic conductivities). In addition, a value of 54 ft/day was chosen to represent a maximum hydraulic conductivity for lenses and layers of coarse-grained material which can preferentially transmit groundwater containing contaminants. An examination of boring logs (Appendix A) on and near MCAS El Toro suggest that the values estimated by Boyle Engineering are appropriate, for the coarse-grained layer which exists typically at 250 to 450 ft below ground level. These soils consist primarily of fine to coarse sand mixtures that are neither well-sorted nor clean. Both of these conditions tend to reduce the actual hydraulic conductivity from that expected for a clean, well-sorted sand (approximately 100 to 130 ft/day).

3.1.2 Groundwater Gradients

Horizontal and vertical groundwater gradients were examined for the MCAS El Toro vicinity. When historical data were available, they were evaluated to determine a time-weighted average gradient. The horizontal gradients are then used in Section 3.1.3 to estimate a range of groundwater velocities.

3.1.2.1 Historical Horizontal Groundwater Gradients. Groundwater flow patterns and hydraulic gradients southwest of MCAS El Toro were examined for the period 1936 to 1988. Historical groundwater contour maps as prepared by OCWD (1989) are included in Appendix E for the years 1948, 1956, 1972 and 1988. These maps were constructed by OCWD using static water conditions measured in irrigation wells, and hence, are a composite of the various aquifer zones screened. The direction of groundwater flow near the southwest corner of the base, as determined from these maps, has historically been to the northwest or west, and was generally influenced by TIC-35 and TIC-47. In the 1940s and 1950s, a large pumping depression existed around TIC-35. There is some indication also of a component of flow that was northerly from off base towards TIC-55, caused by pumping of this well. It is estimated from the aquifer test that the radius-of-influence of TIC-55 is about 2000 ft or more. During the initial operational periods of this well, specific capacity, and hence the radius-of-influence, is expected to be significantly higher. Thus, operation of this well has probably caused an inflow of groundwater from off base to on base in a northeast direction.

As agricultural demands decreased and the use of reclaimed and imported supplies increased in the 1970s and 1980s, water levels have recovered between 50 to 100 ft in this portion of the Irvine Basin. The hydraulic gradient between the southwest corner of the base and TIC-35 has increased in the 1980s. This probably was caused by possible increases in water levels in the Irvine Spectrum 3 area, relative to the TIC-35 area, because of the more rapid urban development of that area. Therefore, the use of 1988 hydraulic gradients is not appropriate when examining the long-term-average or maximum potential transport of VOCs over the last few decades. Figure 3.1 represents monthly hydraulic gradients estimated from the water elevation differences between TIC-56 and TIC-35. The water levels were recorded under nonpumping conditions (IRWD, 1987). TIC-56 was used rather than TIC-55 because of the paucity of water level data at TIC-55 between 1950 and 1984. Although there is some variation in the hydraulic gradient on a monthly basis, the average gradient is approximately 0.003. Also shown in Figure 3.1 are hydraulic gradients estimated from contour maps obtained from OCWD (1989). These values follow approximately the same trend as that estimated from the water



MCAS EL TORO, CALIFORNIA PERIMETER INVESTIGATION INTERIM REPORT	GROUNDWATER GRADIENTS DURING THE PERIOD 1936 – 1988 IN THE VICINITY OF MCAS EL TORO	FIGURE 3.1

elevation differences between TIC-56 and TIC-35. These historical hydraulic gradients are given in Table 3.2. For calculation of groundwater and contaminant transport velocities, the time averaged hydraulic gradient of 0.003 estimated from data between 1936 and 1988 were used.

3.1.2.2 Vertical Groundwater Gradients. An examination of the piezometric level measurements performed by OCWD (1989) indicates that there are no significant vertical gradients in the aquifer in the immediate vicinity of MCAS El Toro. As shown in Figure 3.2, pressure transducer readings indicate a significant downward gradient of approximately 0.25 between the shallow zone (<200 ft below ground level) and the deeper zone (200 to 500 ft below ground level) in MCAS-1 and MCAS-7 (approximately 1.5 and 2.5 miles downgradient of MCAS El Toro). However, the vertical gradient is less significant at MCAS-2 (approximately 0.75 miles downgradient of MCAS El Toro) and essentially nonexistent at MCAS-3 (southwest corner of MCAS El Toro). Similarly to MCAS-3, the vertical groundwater gradient near cluster wells is practically non-existent under static groundwater conditions. These results suggest that no significant natural vertical gradients may exist east of the southwest corner of the base.

3.1.3 Groundwater Flow Velocities

The seepage velocity or average linear velocity was calculated from Darcy's Law:

$$V = \frac{K \cdot i}{e}$$

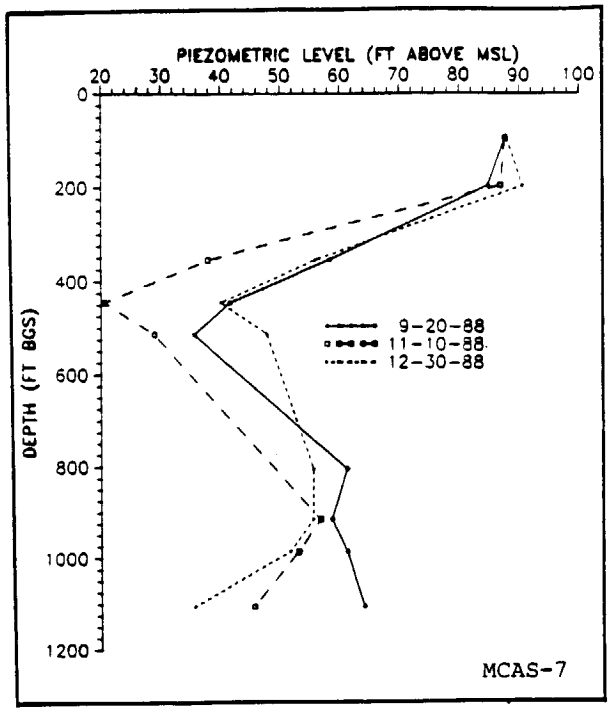
where
- V = seepage velocity of groundwater (ft/yr)
- K = hydraulic conductivity (ft/yr)
- i = hydraulic gradient (ft/ft)
- e = effective porosity (percent)

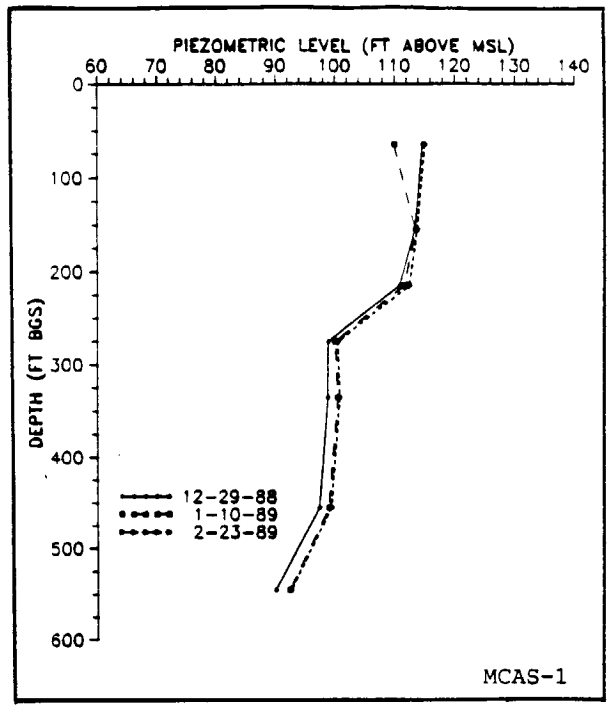
A range of possible groundwater flow velocities was estimated using the range of hydraulic conductivities described in Section 3.1.1. A value of 30 ft/day for hydraulic conductivity was chosen to be representative of the dominant main aquifer in the area

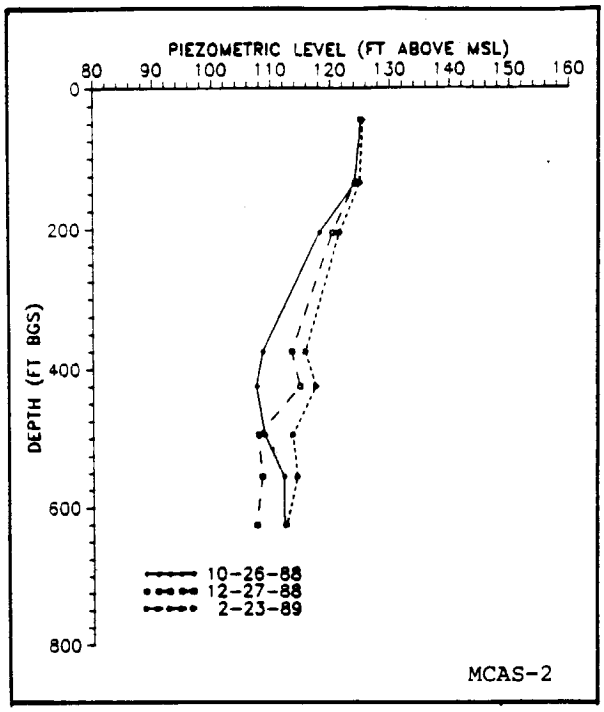
TABLE 3.2

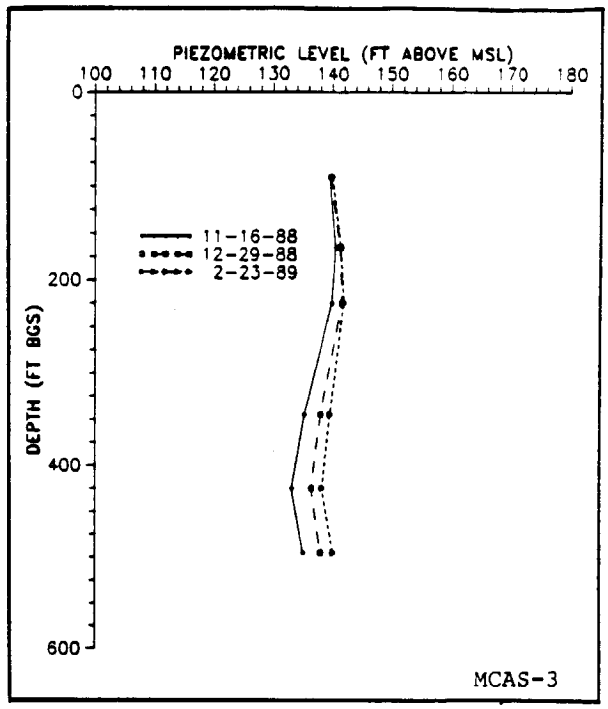
REGIONAL GROUNDWATER GRADIENT IN THE VICINITY OF MCAS - EL TORO

Year	Groundwater Gradient
1936	0.0028
1944	0.0028
1956	0.0032
1969	0.0021
1979	0.0022
1980	0.0027
1982	0.0057
1983	0.0072
1985	0.0060
1986	0.0055
1987	0.0057









MCAS EL TORO, CALIFORNIA PERIMETER INVESTIGATION INTERIM REPORT	**PIEZOMETRIC LEVELS AS A FUNCTION OF DEPTH IN MCAS WELLS**	FIGURE 3.2

(200 to 450 ft below ground level), and a value of 54 ft/day was chosen to represent lenses and layers of coarse-grained material which can preferentially transmit contaminants. Combined with a hydraulic gradient of 0.003 and an effective porosity of 0.2, this resulted in time-averaged (1936 to 1988) seepage velocities of 175 ft/yr for the main aquifer and 314 ft/yr for the coarse-grained soil lenses which are also dominant in the 250 to 400 ft below ground level-zone.

3.2 PHYSICO-CHEMICAL PROPERTIES

The four principal areas of groundwater contamination in the vicinity of MCAS El Toro have different suites of chemicals, suggesting that the sources of contamination are unrelated. A brief outline of chlorinated solvent use is given in the second subsection. The third subsection discusses the physico-chemical properties of the contaminants that affect their fate and transport in the groundwater environment.

3.2.1 Nature of Contamination

The contaminated areas within and near MCAS El Toro can be separated into four different areas based on the type of contaminants detected at the monitoring wells installed by JMM and the OCWD. The first area is located in an area immediately adjacent to the cluster wells where the predominant contaminant is CCl_4 (Figure 3.3). Other contaminants found in this area include chloroform and TCE at significantly less concentrations. Chloroform may be a degradation product of CCL_4. It should be noted here that the major contaminant CCl_4 does not exist in this area at elevations below 300 ft below ground level. This suggests that the TCE contamination measured near the instrument detection limit at elevations below 450 ft is likely not related to the near surface contamination in the area, and that it may be caused by cross contamination induced by pumping TIC-55. The zone between approximately 250 ft and 450 ft below ground level should have residual TCE contamination if the near surface and deep contamination are related.

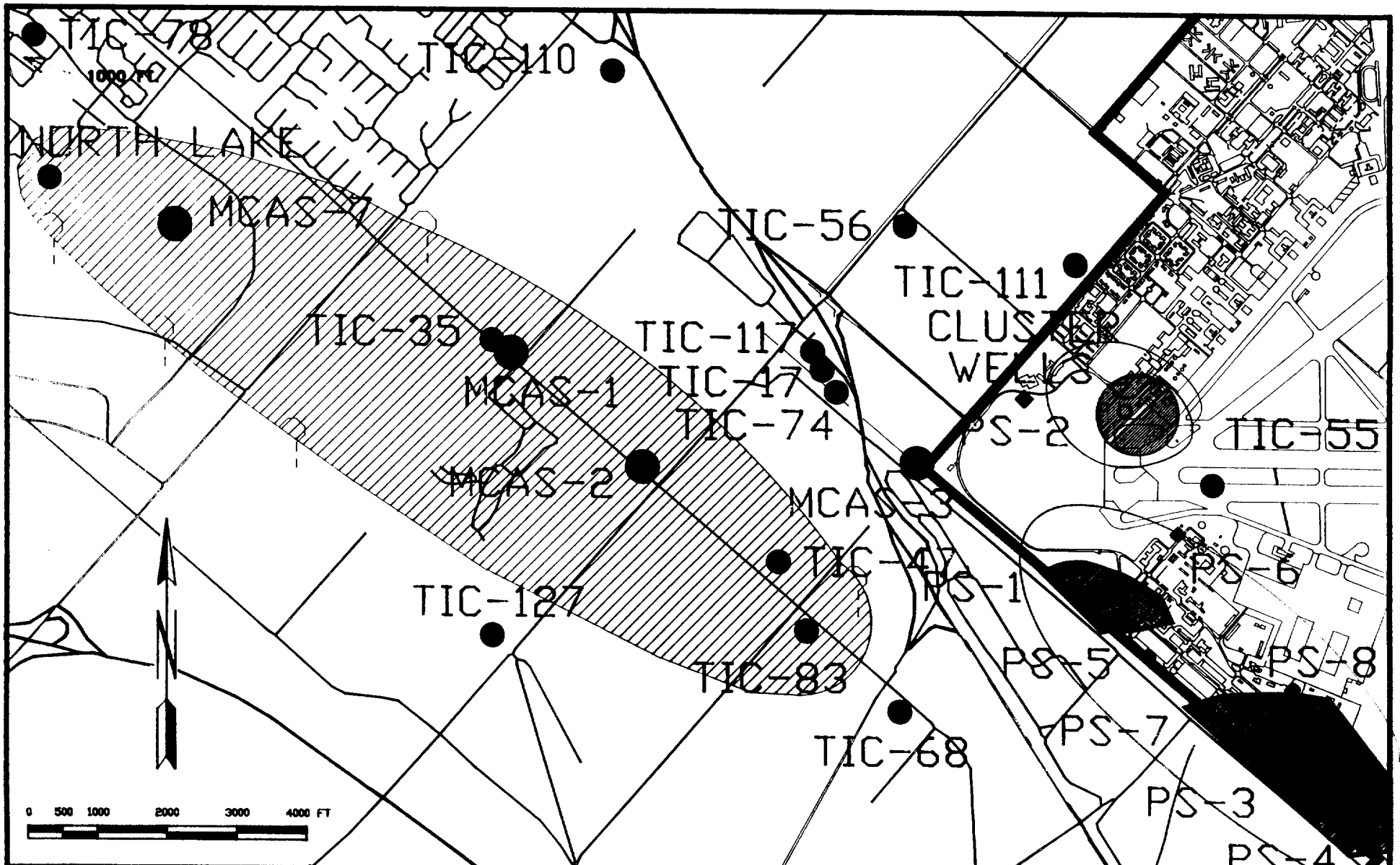
The second area of contamination is located near the perimeter wells PS-1 and PS-6 (Figure 3.3) PS-6 has significant contamination by several solvents including TCE, carbon tetrachloride and chloroform. There were trace (0.4 μg/L) concentrations of PCE, as well. This appears to be representative of mixed solvent usage at MCAS El Toro and is seen in the third area of groundwater contamination. PS-1, however, has significant TCE contamination, but no PCE or CCl_4. There is also trace concentration of cis-1,2-dichloroethene, a degradation product of TCE. TCE contamination in this well may be a result of the pumping influence of TIC-55 which would draw contamination from potential off-base source(s).

The third area of contamination encompasses PS-3, PS-4 and PS-8 (Figure 3-3). As with PS-6, this plume has a mixed suite of solvents including TCE, cis-1,2-dichloroethene, PCE, chloroform and CCl_4. Soil gas results from both the perimeter study and from Mills (1985), and the results of PS-5 and PS-7 indicate that this area of groundwater contamination is distinct from the second area of contamination.

The fourth area of contamination is located off base (Figure 3.3). This area is bounded by TIC-68 (below reportable detection limit) to the southeast, by TIC-127 (ND) to the south, by TIC-78 (ND) and the North Lake well (0.9 μg/L) to the Northwest, and by TIC-117 (ND), TIC-74 (below reportable detection limit), MCAS-3 (ND) and PS-2 (ND) to the northeast. The concentration of TCE increases from the southeast to the northwest to TIC-35 and then decreases toward the North Lake well. This plume appears to be virtually a single solvent plume, with only traces of trans-1,2-dichloroethene or 1,1,1-trichloroethane (1,1,1-TCA) in TIC-35, TIC-68, MCAS-1, MCAS-2. trans-1,2-Dichloroethene is a degradation product of TCE and 1,1,1-TCA is a solvent that has replaced TCE, and has not been detected in any on-base wells.

3.2.2 History of Solvent Usage

Large-scale commercialization of chlorinated solvents began in the early 1900s when a process for liquefying chlorine became viable. The demand for TCE increased in the



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ESTIMATED AREAL EXTENT
OF VOC CONTAMINATION

Change Marking

FIGURE
3.3

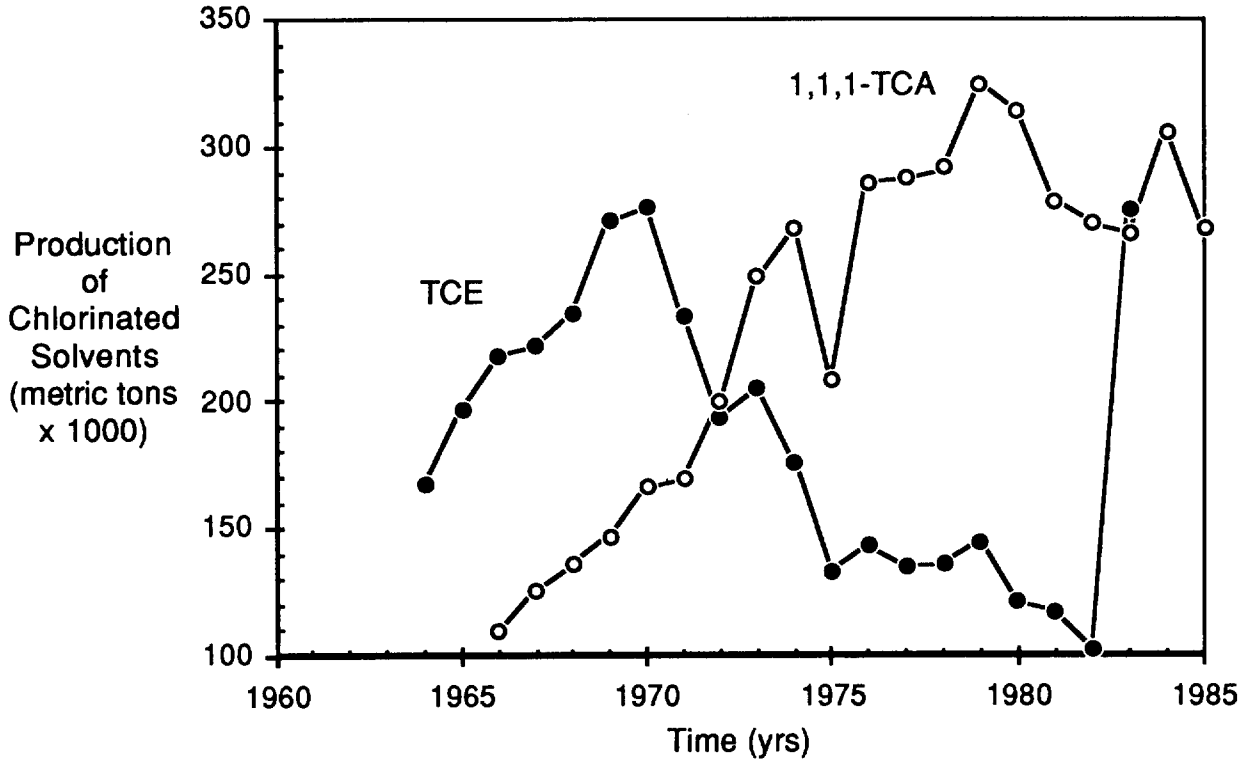
early to mid-1960s because of the growth in the automobile industry. The TCE market was further bolstered in the mid-1960s because of the aerospace and military demand for degreasing connected with the Vietnam War effort (Chestnutt, 1988). TCE use reached a peak around 1969 or 1970 and has declined since because of air pollution legislation (it was believed to contribute to photochemical smog) and growing concern over TCE's potential carcinogenicity. In the years following the conversion from TCE use, 1,1,1-TCA has replaced TCE in metal degreasing applications (Figure 3.4). Historically, approximately 80 percent of the end use of TCE was metal cleaning, 5 percent was chemical processing and intermediates, and 15 percent was miscellaneous uses. Ten percent of the PCE produced was used for metal cleaning, 53 percent for dry cleaning and textile processing, 28 percent for chemical processing and intermediates, and 9 percent was used for miscellaneous purposes (Chestnutt, 1988).

Metal cleaning consisted of either cold cleaning or vapor degreasing. In cold cleaning, the solvent is kept below its boiling point and the metal part is dipped into it, usually in a closed system. Vapor degreasing involves raising the solvent above its boiling point, passing the metal part through it and collecting the condensate (Wolf and Camm, 1987). In addition to virgin solvent uses, chlorinated solvents are often used in commercially available metal degreasing solutions such as carburetor cleaners.

It appears that the period with the highest potential for TCE use by MCAS El Toro and other users in the vicinity of the base was in the mid-1960s to the early 1970s. However, TCE was still produced as late as 1984 and may have been commercially available after that point in time.

3.2.3 Chemical Properties

The molecular weights, specific gravity, and solubilities of the trace organic chemicals are given in Table 3.3. The octanol-water partition coefficient is discussed in Section 3.3. The biodegradation half-life is discussed in Section 4.3.1. The specific gravities of benzene and the benzene derivatives are less than 1 g/cm^3 at 20°C, while the other



MCAS EL TORO, CALIFORNIA
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HISTORICAL PRODUCTION
OF TCE AND 1,1,1-TCA

FIGURE
3.4

TABLE 3.3

BENCHMARK CHEMICAL PARAMETERS

Contaminant	Molecular Weight (g/mol) a	Specific Gravity @ 20°C (g/cm3) a	Solubility in Water @ 20°C (mg/l) a	log Octanol-Water Partition Coefficient (log Kow) b	Biodegradation Half-life in Soil/ Groundwater (days) c
Benzene	78.11	0.8786	1,780	2.12	68 - 110
Carbon tetrachloride	153.82	1.59	800	2.64	14 e
Chloroform	119.38	1.489	8,000	1.97	36 e
1,2-Dichloroethane	99	1.25	8,690	1.48	"long" [e]
cis-1,2-Dichloroethene	96.95	1.28	800	0.7	140
trans-1,2-Dichloroethene	96.95	1.26	600	0.48	139
Ethylbenzene	106.17	0.867	152	3.15	37
Tetrachloroethene (PCE)	165.83	1.626	150 [d]	2.6	300
Toluene	92.1	0.867	515	2.73	37 - 39
Trichloroethene (TCE)	131.5	1.46	1.1	2.38	300

[a] Verschueren (1983)
[b] EPA (1986)
[c] @ 25°C
[d] @ 14°C

organics have specific gravities greater than 1 g/cm^3. If the organics were present as a separate immiscible phase, this would indicate the tendency of that phase to "float" on the top of the aquifer or "sink" to the bottom. However, the results of the groundwater quality analyses presented both in this Interim Report and the report presented by OCWD (1989), and the aqueous solubilities of the trace organic chemicals indicate that a separate phase does not exist and that the trace organics exist as dissolved species in groundwater. Hence, there is no tendency for the trace organics to migrate downward within the aquifer, based on density differences.

Vapor pressures and Henry's Law constants for the contaminants are given in Table 3.4. The Henry's Law constant is a relative measure of the tendency of the contaminant to volatilize out of aqueous solution.

3.3 TRANSPORT CHARACTERISTICS

The migration of chemicals in soil-water systems is governed by convection-dispersion processes, which can be divided into three distinct mechanisms: (1) mass flow, or passive movement of the contaminant with the mass of water in which it is dissolved; (2) liquid and gaseous diffusion, movement caused by molecular collisions; and (3) chemical potential gradients in both liquid and vapor phases. A wide variety of biogeochemical processes influence the actual rate of chemical movement through a dense web of complicated interactions. These processes are grouped generally into five categories:

- convection
- dispersion
- sorption/desorption
- volatilization
- transformation/(bio)degradation
- plant processes

TABLE 3.4

VOLATILITY OF CONTAMINANTS

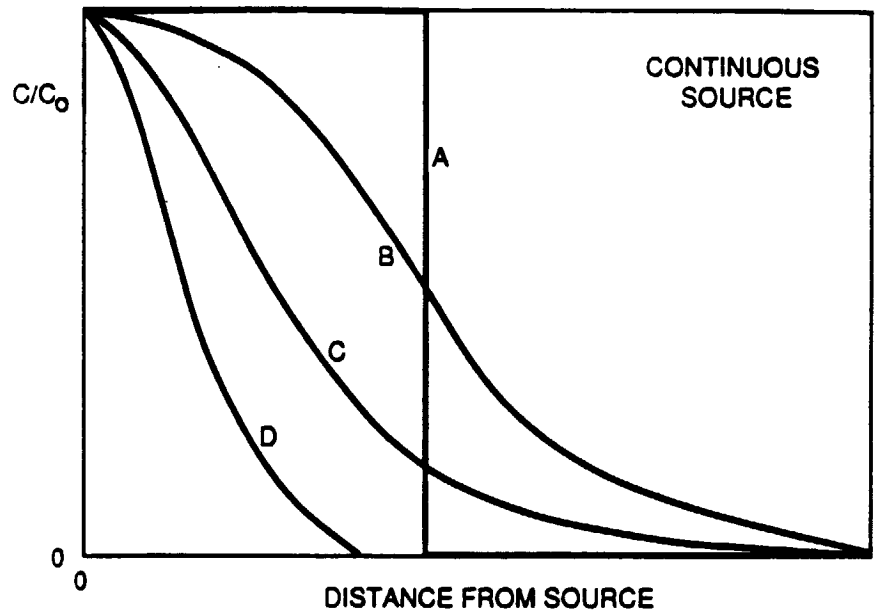
Contaminant	Vapor Pressure @ 20°C (mm Hg) [a]	Henry's Law Constant ($atm \cdot m^3/mol$) [b]
Benzene	76	5.59×10^{-3}
Carbon tetrachloride	90	2.41×10^{-2}
Chloroform	160	2.87×10^{-3}
1,2-Dichloroethane	61	9.78×10^{-4}
cis-1,2-Dichloroethene	200 [c]	7.58×10^{-3}
trans-1,2-Dichloroethene	200 [d]	6.56×10^{-3}
Ethylbenzene	7	6.43×10^{-3}
Tetrachloroethene (PCE)	14	2.59×10^{-2}
Toluene	22	6.37×10^{-3}
Trichloroethene (TCE)	60	9.1×10^{-3}

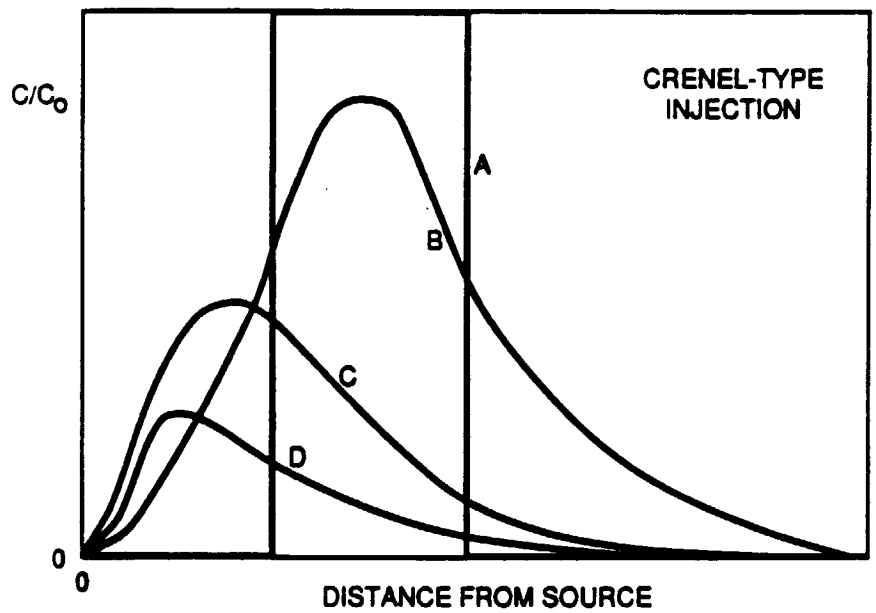
[a] Verschueren (1983)
[b] EPA (1986)
[c] @ 25°C
[d] @ 14°C

Convection is that component of solute transport that accounts for the hydraulic driving force of the solution that the solute is dissolved in (groundwater flow). Historical groundwater flow, including direction and hydraulic gradient, are discussed in Sections 3.1.2 and 3.1.3. Longitudinal and lateral dispersion has two components: dispersivity and a velocity term. Dispersivity is inherently a function of the grain size distribution of the aquifer material and dispersion increases as a function of increasing solute velocity. Hence, dispersion tends to decrease the travel time of the leading edge of the contaminant mass. Dispersion is not considered quantitatively in this Interim Report, although it is discussed in qualitative terms in Section 4.1.2. The dispersion of the contaminants will be addressed by the solute transport model in the Final Report. Sorption and desorption of the solute tends to slow the rate of solute movement in the aquifer, relative to the rate of groundwater flow. Volatilization is discussed in Section 4.1.1, in terms of soil gas measurements. The transformation of a chemical in the subsurface environment is more difficult to understand and predict from both a mechanistic and mathematical framework. It does, however, have implications concerning the source(s) of contaminants. The relative effects of dispersion, sorption and degradation on solute transport are illustrated in Figure 3.5.

Sorption/desorption is one of the most important processes influencing the movement or leaching of a chemical in groundwater and in the unsaturated-zone. It is generally thought of as a partitioning between a solid (sorbed) phase and the liquid phase (i.e., infiltrating water in the unsaturated-zone or groundwater) caused by hydrophobic and weak electrostatic interactions. This partition is described mathematically by the distribution coefficient, K_D (Jury 1986):

$$K_D = \frac{\mu g \text{ sorbed contaminant/g soil or aquifer material}}{\mu g \text{ contaminant/ml solution}}$$





A - ADVECTION ONLY
B - ADVECTION PLUS DISPERSION
C - ADVECTION, DISPERSION AND SORPTION
D - ADVECTION, DISPERSION, SORPTION AND DEGRADATION

MCAS EL TORO, CALIFORNIA PERIMETER INVESTIGATION INTERIM REPORT	COMPARISON OF SOLUTE TRANSPORT BEHAVIOR FOR CONTINUOUS AND DISCONTINUOUS SOURCES	FIGURE 3.5

Not only does sorption/desorption by the solid phase influence chemical movement, the residence time on the soil surface leads indirectly to increased potential for degradation. On the other hand, a more highly sorbed chemical would not volatilize as readily as a nonsorbing chemical (given the same Henry's Law Constant K_H) because of reduced concentrations in the liquid phase. The role of the distribution coefficient in mitigating chemical migration is given in an approximation of nonuniform flow by using average values for K_D, effective porosity, dispersion coefficient and groundwater flow velocity (seepage velocity). This gives the following form of the convection-dispersion equation:

$$K_D \frac{\partial C_L}{\partial t} = \frac{D \partial^2 C_L}{\partial x^2} - \frac{V \partial C_L}{\partial x} + r$$

where
K_D = distribution coefficient (µl/kg)
C_L = mass of contaminant per groundwater volume (µg/l)
D = dispersion coefficient (ft^2/day)
t = time (day)
x = distance (ft)
r = reaction rate (mass loss) (mg/day)

The distribution coefficient as defined above assumes that the adsorption isotherm is linear and that the reactions are reversible (without hysteresis, sorption and desorption can be described by the same isotherm) and fast (i.e., relative to the time-scale of groundwater movement). Although curves describing sorption of trace organics onto soils generally are best fit with the van Bemmelen-Freundlich isotherm equation, an approximation using a linear isotherm for low concentrations is a good approximation at low (μg/L) solution concentrations.

Because of the large variations in K_D, a parameter, K_{oc}, is introduced for organic compounds:

$$K_{oc} = K_D/f_{oc}$$

where f_{oc} = soil organic carbon fraction

K_{oc} is the organic carbon partition coefficient and is defined as the ratio of the concentration of contaminant associated with the organic fraction of the soil to the concentration of that contaminant in aqueous solution and is nearly independent of soil type and particle size. However, K_{oc} is not easily measured in the laboratory and is not usually reported in literature. The benchmark chemical parameter, octanol-water partition coefficient (K_{ow}) has been correlated statistically to K_{oc}. K_{ow} is the ratio of concentration in a selected organic phase (octanol) to that in water. K_{ow} has been used successfully to describe the sorption behavior of trace organic chemicals in aquifers. One empirical relation between K_{oc} and K_{ow} is given below (Lambert et al., 1982):

$$K_{oc} = 0.63 \cdot K_{ow}$$

Values of the logarithm of K_{ow} are given in Table 3.3 for the organic chemicals detected in groundwater during the Perimeter Investigation. The values of K_{ow} range three orders of magnitude. For instance, PCE is relatively less mobile than TCE.

If K_D is zero, then the chemical species of concern is unaffected by physico-chemical reactions and moves with the same velocity as groundwater. If KD is greater than zero, then the chemical movement is retarded as defined by the retardation coefficient, R:

$$R = 1 + \frac{\rho_b \cdot K_D}{e} = \frac{V}{V_E}$$

$$= 1 + \frac{\rho_b \cdot K_{oc} \cdot f_{oc}}{e} = 1 + \frac{\rho_b \cdot K_{ow} \cdot f_{oc} \cdot 0.63}{e}$$

where
- R = retardation factor
- ρ_b = aquifer bulk density (g/cm^3)
- K_D = soil distribution coefficient (µl/kg)
- e = effective porosity (percent)
- V = seepage velocity of groundwater (ft/yr)
- V_E = macroscopic average velocity of solute (ft/yr)
- K_{oc} = organic carbon partition coefficient
- K_{ow} = octanol-water partition coefficient
- f_{oc} = soil organic carbon fraction

The retardation of dissolved organic compounds is, therefore, dependent on the following parameters:

- o aquifer bulk density
- o effective porosity
- o soil organic carbon fraction
- o organic carbon partition coefficient

The first three parameters were determined through laboratory analyses during the Perimeter Investigation (results are given in Section 3.1.1), and the last parameter was estimated from literature values of K_{ow} using the empirical relation given by Lambert et al. (1982). The mean values and most conservative values for aquifer bulk density and soil organic carbon fraction were used to estimate a range of retardation coefficients. The results of this analysis are presented in Section 4.1.2.

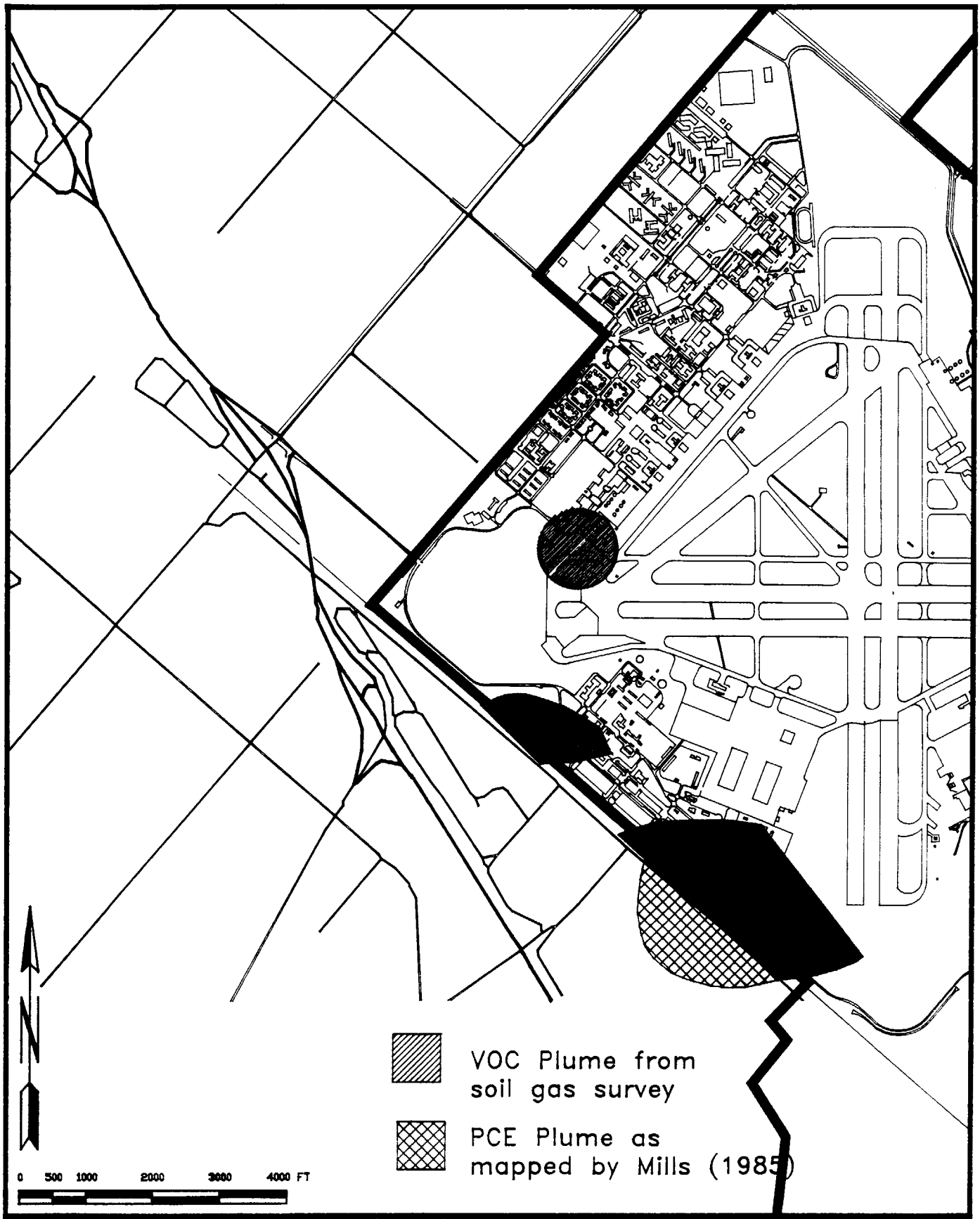
SECTION 4.0
FATE AND TRANSPORT OF CONTAMINANTS

4.1 AREAL EXTENT OF CONTAMINATION

4.1.1 Soil Gas

Soil gas measurements provide an indication of the concentrations of the vapor phase of VOCs by extracting a known volume of soil gas from shallow subsurface soils and determining the concentration by gas chromatography (GC). Because trace organic contaminants in groundwater volatilize and migrate vertically upward, soil gas has been used successfully at MCAS El Toro to delineate the approximate areas of the three small plumes within the base boundaries. As shown in Figure 4.1, the three soil gas plumes are distinctly separated and relatively small in areal extent. The soil gas measurements were confirmed with the groundwater sample results from subsequent shallow perimeter wells.

Mills (1985) used soil gas investigations in an attempt to determine the extent of VOC contamination in the vicinity of MCAS El Toro. Only PCE was detected, and Mills (1985) concluded that the PCE source was unconnected to the TCE source. However, because PCE has a much greater Henry's Law Constant (Table 3.4) a comparable concentration of PCE in groundwater is expected to have a higher concentration in soil gas than will TCE. In addition, because static soil gas samplers were used in the Mills study, TCE may not have been collected in the tubes because of its lower volatilization flux. It should be noted here that these findings are somewhat consistent with both the soil gas and groundwater results obtained within the southern general area of the base (e.g. consistently no TCE detected by Mills (1985) adjacent to station boundary and PCE detected near the area of PCE groundwater contamination). In fact, the soil gas PCE plume detected by Mills (1985) that was adjacent to MCAS El Toro matches in areal extent the soil gas PCE plume detected during the Perimeter Investigation (Figure 4.1). Hence, the soil gas results from Mills (1985) are more indicative of isolated PCE



MCAS EL TORO, CALIFORNIA PERIMETER INVESTIGATION INTERIM REPORT	**ESTIMATED AREAL EXTENT OF PCE CONTAMINATION FROM SOIL GAS RESULTS**	FIGURE 4.1

contamination and, combined with the results from this investigation, delineate a very distinct, relatively small, and continuous (on and off station) area of soil gas contamination along the southernmost portion of the station.

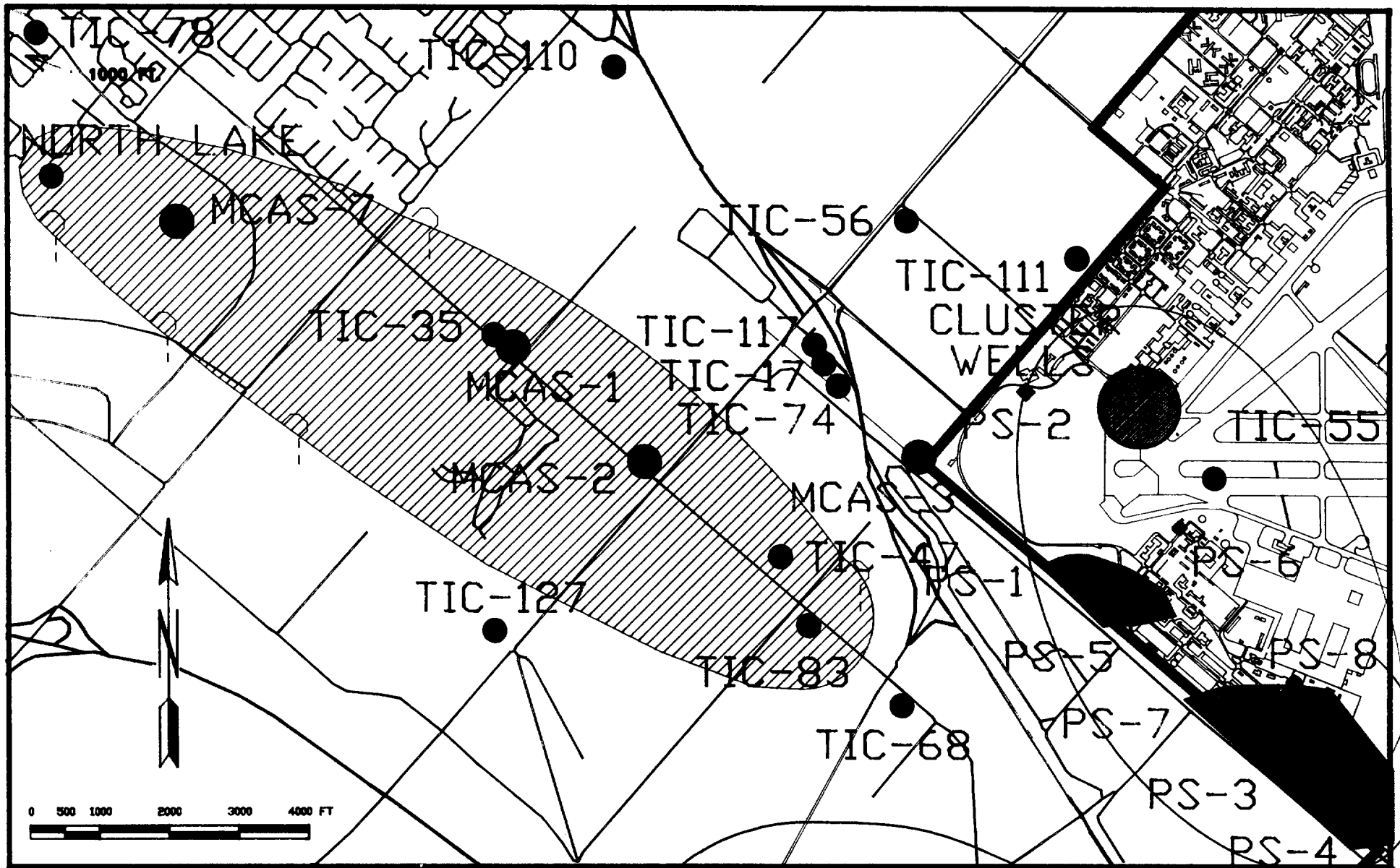
4.1.2 Groundwater

The contaminated area within and away from the MCAS El Toro can be separated into four different areas based on the type of contaminants detected at the monitoring wells installed by JMM and the OCWD. Figure 4.2 represents a best estimate of the areal extent of TCE contamination, based on the currently available data, and provides an interpretation of the location of other VOCs.

The first area is located immediately adjacent to the cluster wells where the predominant contaminant is CCl4. This area is delineated by the two contaminated shallow wells in the cluster, the shallow uncontaminated perimeter well PS-2, and off-station uncontaminated wells TIC-56 and TIC-111. Hence, it is believed that this plume is not contiguous with any of the off-station contamination.

The second area of contamination is located immediately south of the first plume where the predominant contaminant is TCE. This plume is identified by the soil gas investigations as well as groundwater results from shallow perimeter wells PS-1 and PS-6. The areal extent of this plume is defined by the uncontaminated downgradient wells PS-2 and MCAS-3, and by upgradient uncontaminated well PS-5. This plume is located close to the off-station plume discussed below. The continuity of these plumes can not currently be identified based on the lack of actual off-station groundwater data.

The third area of contamination is located southeast of the second plume where the predominant contaminants are TCE and PCE. The presence of this plume is confirmed by the groundwater sample results from shallow monitoring wells PS-3, PS-4, and PS-8. The downgradient extent of this plume is identified by the shallow perimeter wells PS-5 and PS-7. The upgradient extent of this plume could not currently be delineated based



MCAS EL TORO, CALIFORNIA
PERIMETER INVESTIGATION
INTERIM REPORT

ESTIMATED AREAL EXTENT OF VOC CONTAMINATION IN GROUNDWATER

is this title accurate?

FIGURE 4.2

lighten shading

on the lack of actual groundwater quality data. The relatively small on-station extent and low water transmitting capacity of the shallow aquifer suggest that this plume may not be contiguous with off-station contamination.

The fourth plume is located off station where the predominant contaminant is TCE. This plume is identified by the presence of contaminants at wells TIC-35, TIC-47, TIC-83, MCAS-1, MCAS-2, MCAS-7, and the North Lake well. The limits of this plume is identified by the uncontaminated wells TIC-68, TIC-74, TIC-117, TIC-127, TIC-110, and by TIC-78.

The four plumes identified above are not connected based on both soil gas (this investigation and Mills, 1985) and groundwater quality results from PS-5 and PS-7. MCAS-3, TIC-56, TIC-111, TIC-74, TIC-110 and PS-2 are all located to the west or northwest of the base and all are northwest of the two identified on-base TCE plumes. Each of these wells contained no detectable concentration of TCE, with the exception of trace quantities in TIC-74 (0.6 μg/L during March 1988). The off-station well TIC-68 is essentially uncontaminated (trace concentration (below reportable detection limit) during February 1989, 0.6 μg/L during May 1988) and is located upgradient of the off-station TCE plume and downgradient of eastern most plume located on station. Given the historical direction of groundwater flow (Section 3.1.2.1 and OCWD, 1989), an on-base source of TCE that is postulated to have reached the North Lake Well would likely have contaminated these wells as well. The fact that all these wells, especially MCAS-3 and TIC-117, contained no TCE, and trace levels at TIC-68, indicates that the potential source(s) lie to the south of the base boundary. There is some likelihood that the historical pumping influence of TIC-55 has drawn contaminated groundwater onto the base from a potential off-base source.

The approximate solute velocities of the contaminants of interest are given in Table 4.1. The range of solute velocities represents a range in retardation factors, representing the mean and the most conservative (least retarded) values. The solute velocity ranges also represent variations in groundwater velocity between an aquifer-averaged and higher

TABLE 4.1

ESTIMATED SOLUTE VELOCITIES IN THE VICINITY OF MCAS EL TORO

Contaminant	Groundwater Velocity [a] (ft/yr)	Retardation Factor [b]	Solute Velocity (ft/yr)
Benzene	175	1.75	100
	175	1.14	154
	314	1.75	179
	314	1.14	276
Carbon Tetrachloride	175	3.49	50
	175	1.46	120
	314	3.49	90
	314	1.46	215
Chloroform	175	1.53	114
	175	1.10	160
	314	1.53	205
	314	1.10	286
1,2-Dichloroethane	175	1.17	150
	175	1.03	170
	314	1.17	268
	314	1.03	304
cis-1,2-Dichloroethene	175	1.03	170
	175	1.01	174
	314	1.03	305
	314	1.01	312
trans-1,2-Dichloroethene	175	1.02	172
	175	1.00	175
	314	1.02	309
	314	1.00	313

TABLE 4.1 (CONTINUED)

ESTIMATED SOLUTE VELOCITIES IN THE VICINITY OF MCAS EL TORO

Contaminant	Groundwater Velocity [a] (ft/yr)	Retardation Factor [b]	Solute Velocity (ft/yr)
Ethylbenzene	175	9.05	19
	175	2.50	70
	314	9.05	35
	314	2.50	126
Tetrachloroethene (PCE)	175	3.27	54
	175	1.42	123
	314	3.27	96
	314	1.42	221
Toluene	175	4.06	43
	175	1.57	112
	314	4.06	77
	314	1.57	200
Trichloroethene (TCE)	175	2.37	74
	175	1.25	140
	314	2.37	133
	314	1.25	251

[a] Groundwater velocity range is based on a time-weighted average hydraulic gradient in the MCAS El Toro vicinity, an estimated value of effective porosity and a range of hydraulic conductivity values. The lower velocity is based on an approximate average value of hydraulic conductivity for the aquifer, while the higher value is based on the estimated hydraulic gradient of sand and gravel layers in the MCAS El Toro area.

[b] The retardation factor is based on the octanol-water partition coefficient, K_{ow}, of each contaminant, the estimated effective porosity and mean and extreme (conservative) values of soil bulk density and fraction of soil organic carbon, f_{oc}.

velocity associated with the coarse-grained sediments found at a depth of 250 to 400 ft below ground level. Carbon tetrachloride is highly retarded and is predicted to move at a rate of approximately 50 to 215 ft/yr. This is one explanation for the relatively contained CCl_4 plume around TIC-55 shown in Figure 4.2.

TCE is predicted to have a range of solute velocities between 74 and 251 ft/yr. Ignoring dispersion effects, it would take between 63 and 214 years for TCE to migrate from the edge of the base to the North Lake Well, approximately 3 miles away. There would be additional travel time (as much as 10 to 20 years) for the TCE to migrate from the soil surface to groundwater. MCAS El Toro was commissioned in 1947 and TCE solvent use reached its peak as a vapor degreasing agent in the mid-1960s to mid-1970s. Even with dispersion, it appears unlikely that TCE was transported from the soil surface at the base to the North Lake Well in groundwater.

PCE is a major component of two of the VOC plumes detected on base. PCE was confirmed by soil gas, the shallow perimeter wells, and by the soil gas study by Mills (1985). PCE is predicted to have a range of solute velocities between 54 and 221 ft/yr. If PCE were released at approximately the same time as TCE, one would expect to see the PCE transported 73 to 88 percent as far as TCE, based on their relative solute velocities. If the postulate that the North Lake TCE contamination originated from MCAS El Toro, than one would expect to see PCE in measurable concentrations between 2.2 and 2.6 miles from the base.

4.2 VERTICAL EXTENT OF CONTAMINATION

As discussed above, the contaminated area within and away from the MCAS El Toro can be separated into four different areas. The first area, located immediately adjacent to the cluster wells, shows, some contamination near the water table and very low contamination at depths. It should be noted here the major contaminant, CCl_4, does not exist in this area at depths greater than 300 ft below ground level. This suggests that the TCE contamination measured near detection limit at elevations below 450 ft is likely

not related to the near surface contamination in the area, and that it may be caused by cross contamination induced by the TIC-55. This is further substantiated with the fact that the TCE contamination is found (near State Action Levels) at the shallowest well in cluster and is not detected by the two wells completed at immediately lower elevations.

No vertically distributed on-station groundwater quality data exists near the second and third areas of contamination located south and southeast of the first plume.

As indicated above, depth-specific water quality sampling at the cluster well indicates that TCE concentration is minor (< 0.4 μg/L) at a depth of 450 to 540 ft below ground level. Furthermore, no contamination has been found at MCAS-3, which is located directly downgradient of the MCAS El Toro, at any of the depths during any of the three sampling events accomplished by OCWD (1989). However, TCE contamination at MCAS-1 and MCAS-2 is significant (maximum concentration over time of 52 and 38 μg/L, respectively) at a depth of approximately 250 to 400 ft below ground level. Because this depth zone at the cluster well and MCAS-3 had non-detected to trace concentrations of TCE, and because there are significant vertical gradients in the vicinity of TIC-35, there is a strong indication of another source of TCE which lies between MCAS El Toro and TIC-35.

4.3 ENVIRONMENTAL FATE OF CONTAMINANTS

The biodegradation rate of a dissolved organic chemical is dependent on the species and activity of soil and aquifer microbial population. The active biomass that could degrade the organic chemicals to potentially innocuous forms varies with depth, as a result of decreasing soil temperature, oxidation-reduction potential, and organic matter (substrate for microorganisms). Although significant biodegradation is usually limited to the upper few feet of soil, there are examples in which the activity of microorganisms in the aquifer is great enough to degrade trace organics. In addition, the groundwater temperature in the Irvine Basin increases with depth (Section 2 and OCWD, 1989). There exists also

a potential organic carbon substrate for microbial activity at depth as seen by visible hydrocarbon layers in boring logs (Section 2 and OCWD, 1989). Anaerobic bacteria found in groundwater have been shown to degrade carbon tetrachloride, PCE, TCE and 1,1,1-TCA into the following daughter compounds (Wood et al., 1986, Dragun, 1988):

Carbon tetrachloride → chloroform → methylene chloride

PCE → TCE → *cis*-1,2-dichloroethene / *trans*-1,2-dichloroethene / 1,1-dichloroethene → vinyl chloride

1,1,1-TCA → 1,1-dichloroethane / 1,1-dichloroethene → chloroethane

Biodegradation under anaerobic conditions has been demonstrated under laboratory and field conditions. In actual aquifer conditions, cis-1,2-dichloroethene is produced over trans-1,2-dichloroethene by a factor of about 25. The estimated biodegradation half-lives of the contaminants of interest are shown in Table 3.3. These are taken from field observations (Dragun, 1988). TCE and PCE are relatively more persistent than the other contaminants. Wood et al. (1986) found that in chlorinated solvent spills of greater than 15 years, a unique chemical profile developed in which the concentration of the parent compound (e.g., TCE or PCE) diminished with distance from the source, while the concentrations of the daughter compounds increased. Only trace concentrations of trans-1,2-dichloroethene were found in the off-base TCE plume (OCWD did not analyze for cis-1,2-dichlorothene). Because the concentrations of VOCs in the aquifer are probably not great enough to inhibit bacterial growth in the aquifer, the TCE spill was probably too recent for the establishment of a biodegradation profile in the aquifer. If the TCE spill was on base and migrated to the North Lake well, a period of several decades, one would expect a biodegradiation profile along the axis of the plume. Only traces of the daughter products were detected, however.

SECTION 5.0
CONCLUSIONS AND RECOMMENDATIONS

A Perimeter Investigation was conducted to determine whether TCE contamination observed in agricultural wells on and near MCAS El Toro is a result of past waste generation and handling and disposal practices at the base. Physical properties of the aquifer material underlying MCAS El Toro were determined or estimated using a series of aquifer tests, downhole geophysical logging, and geotechnical analyses. The aquifer tests included a pump test of TIC 55 and specific capacity tests of all five well depths in the cluster well. Resistivity (single, short normal and long normal), spontaneous potential, and natural gamma ray logs were conducted on the cluster well. Porosity, aquifer bulk density, soil organic carbon fraction (f_{oc}), and soil moisture content in the unsaturated-zone were determined with laboratory geotechnical analyses. Groundwater contour maps for the period of 1930-1988 were examined to determine the historical directions of flow and hydraulic gradient. These data, along with benchmark chemical parameters, were used to determine time-weighted average solute velocities for the contaminants of concern.

Trace organic water quality analyses conducted in the Perimeter Study and results of the OCWD study (1989) were incorporated to estimate the areal and vertical extent of VOC contamination in the vicinity of MCAS El Toro. The history of chlorinated solvent use was examined to determine the likelihood of large-scale use by MCAS El Toro at an early enough date that could plausibly account for TCE contamination in the North Lake well.

Based on the analyses of these results, the following conclusions can be drawn:

- The contaminated area on and near MCAS El Toro can be separated into four different areas based on the type of contaminants detected at the monitoring wells installed by JMM and the OCWD. Three of the areas exist within base boundaries. Rewrite

Oil soil gas tests!

- The first area is located immediately adjacent to the cluster wells where the predominant contaminant is CCl_4. This area is delineated by the two contaminated shallow wells in the cluster; the shallow, uncontaminated perimeter well PS-2; and the off-station, uncontaminated wells TIC-56 and TIC-111. Hence, it is believed that this plume is not contiguous with any of the off-station contamination.

  BROAD CONCLUSION CONSIDERING SHALLOW WELLS.

- The second area of contamination is located immediately south of the first plume where the predominant contaminant is TCE. This plume is identified by the soil gas investigations as well as groundwater results from shallow perimeter wells PS-1 and PS-6. The areal extent of this plume is defined by the uncontaminated downgradient wells PS-2 and MCAS-3, and by the upgradient uncontaminated well PS-5. This plume is located close to the off-station plume discussed below. The continuity of these plumes can not currently be identified based on the lack of actual off-station groundwater data.

- The third area of contamination is located southeast of the second plume where the predominant contaminants are TCE and PCE. Presence of this plume is confirmed by the groundwater sample results from shallow monitoring wells PS-3, PS-4, and PS-8. The downgradient extent of this plume is identified by the shallow perimeter wells PS-5 and PS-7. The upgradient extent of this plume could not currently be delineated based on the lack of actual groundwater data. The relatively small on-station extent and low water transmitting capacity of the shallow aquifer suggest that this plume may not be contiguous with off-station contamination.

- The fourth plume is located off-station where the predominant contaminant is TCE. This plume is identified by the presence of contaminants at wells TIC-35, TIC-47, TIC-83, MCAS-1, MCAS-2, MCAS-7, and the North Lake well. The limits of this plume are identified by the uncontaminated wells TIC-68, TIC-74, TIC-117, TIC-127, TIC-110, and by TIC-78.

WE USED "BELIEVED" AND "SUGGEST" ON PREVIOUS PAGE. HOW DID WE GET TO THIS CONCLUSION?

4 o The four plumes identified above are not connected based on both soil gas and groundwater quality results from PS-5 and PS-7. MCAS-3, TIC-56, TIC-111, TIC-74, TIC-110, and PS-2 are all located to the west or northwest of the base and all are northwest of the two identified on-base TCE plumes. Each of these wells contained no detectable concentration of TCE, with the exception of trace quantities in TIC-74 (0.6 μg/L during March 1988). The off-station well TIC-68 is essentially uncontaminated (trace concentration during February 1989, 0.6 μg/L during May 1988) and is located upgradient of the off-station TCE plume and downgradient of easternmost plume located on station. Given the historical direction of groundwater flow, an on-base source of TCE that is postulated to have reached the North Lake Well would likely have contaminated these wells as well. The fact that all these wells, especially MCAS-3 and TIC-117, contained no TCE and trace levels at TIC-68, indicates that the potential source(s) lie to the south of the base boundary. There is some likelihood that the historical pumping influence of TIC-55 has drawn contaminated groundwater onto the base from a potential off-base source.

HOW ABOUT OVERLAND FLOW

SPECULATION?

1 o Depth-specific water quality sampling at the cluster well indicates that TCE concentration is minor (< 0.4 μg/L) at a depth of 450 to 540 ft below ground level. Furthermore, no contamination has been found at MCAS-3, which is located directly downgradient of the MCAS El Toro, at any depth during any of the three sampling events. However, the TCE contamination at MCAS-1 and MCAS-2 is significant (maximum concentration over time of 52 and 38 μg/L, respectively) at a depth of approximately 250 to 400 ft below ground level. Because this depth zone at the cluster well and MCAS-3 had non-detected to trace concentrations of TCE, and because there are significant vertical gradients in the vicinity of TIC-35, there is a strong indication of another source of TCE which lies between MCAS El Toro and TIC-35.

GOOD! I THOUGHT THIS WAS THE POINT OF THIS REPORT

- A range of possible groundwater flow velocities was estimated using a range of hydraulic conductivities. A value of 30 ft/day for hydraulic conductivity was chosen to be representative of the dominant main aquifer in the area (200 to 450 ft below ground surface), and a value of 54 ft/day was chosen to represent lenses and layers of coarse-grained material which can preferentially transmit contaminants. Combined with a hydraulic gradient of 0.003 and an effective porosity of 0.2, this resulted in time-averaged (1936 to 1988) seepage velocities of 175 ft/yr for the main aquifer and 314 ft/yr for the coarse-grained soil lenses which are also dominant in the 250 to 400 ft. below ground level-zone.

- TCE is predicted to have a range of solute velocities between 74 and 251 ft/yr. Ignoring dispersion effects, it would take between 63 and 214 years for TCE to migrate from the edge of the base to the North Lake Well, approximately 3 miles away. There would be additional travel time (as much as 10 to 20 years) for the TCE to migrate from the soil surface to groundwater. MCAS El Toro was commissioned in 194~~7~~3 and TCE solvent use reached its peak as a vapor degreasing agent in the mid-1960s to mid-1970s. Even with dispersion, it appears unlikely that TCE was transported from the soil surface at the base to the North Lake Well in groundwater.

WHAT'S THE BASIS FOR THIS CONCLUSION?

- The suite of VOCs in the on-base wells has PCE as a predominant component. The off-base TCE plume has only traces of PCE. Although PCE is retarded to a greater extent than TCE, it should move approximately 73 to 88 percent as fast as TCE and would, therefore, be present in off-base wells, unless the on-base plumes were recent. Emphasize this fact as an indicator of a different source for the off-base site.

- IS TCE STILL USED?
- WHY DO WE INFER A RECENT SPILL

- There appears to be lack of expected degradation products in downgradient wells. Only trace concentrations of cis-1,2-dichloroethene in on-base wells and trans-1,2-dichloroethene in off-base wells were detected. In other TCE/PCE spills, a chemical profile of daughter compounds is established after 15 to 20 years. This indicates that the spill(s) maybe of relatively recent origin.

WHAT'S THE POINT?

and source and responsible parties

- o MCAS El Toro is not the only user of industrial and agricultural chemicals in the Irvine Basin.

GOOD - NAME COMMON USERS; INDUSTRIAL PROCESSES.

Based on the conclusions made above, it is recommended that:

- o Field investigations should be initiated by the Navy and MCAS El Toro to define the off-station extent of VOC contamination related to the southern (third) plume believed to be originating from an on-station source. This work should include on- and off-station soil gas investigations as well as shallow monitoring wells near MCAS El Toro to identify the horizontal extent of the third plume. A two level cluster well system should also be installed to delineate the vertical extent of VOC contamination.

DELETE

WHY NOT DEEP WELLS?

- o A similar investigation should be conducted around the second plume to identify the potential source location(s).

- o All field investigations should be directed towards gathering necessary data to design and implement a timely and cost-effective remediation system.

- o The source(s) of the on-station plume should be identified during implementation of the Plan of Action for individual potential source locations throughout MCAS El Toro.

- o It is believed that the extent and chemical characteristic of the VOC plume located off station is fairly well defined. It is strongly recommended that the existing agricultural wells should not be utilized for the extraction and treatment of this plume. This is primarily because of the fact that the plume appears to be confined to a relatively small portion of the more than 400-foot thick aquifer, and that the continuously screened agricultural wells would likely cause cross-contamination of currently clean aquifer zones, thereby exacerbating the existing problem.

APPENDIX A

BORING LOGS

A.1 STREAM BED WELLS

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.

501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER *SB-1* CLIENT *WESDIVNAVFACENGCOM*
DATE STARTED *1/25/88* COMPLETED *1/25/88* PROJECT *MCAS EL TORO*
ELEVATION *ft (ground level)* GEOLOGIST *P.N. CASEY*

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
	▨	1	4 5			SILTY SAND, lt brown, tr small gravel, damp, (fill?)	
2					SW	F-M SAND, clean, tr well rounded gravel clasts, lt tan, damp	
4							
6	▨	2	6 10		SM		
8						SILTY SAND, med. brown, damp/ most, tr F. gravel	
10	▨	3	10 24		ML	SILTY SAND, tan, damp/moist, tr crs. sand	
12	▨	4	8 18			SILT w/v.f. sand, lt brown, damp A.a., tan w/tr crse. sand. Fine sand w/silt, tan, damp	
14							
16	▨	5	10 12		ML		
18	▨	6	8 20			SILT w/v.f. sand, damp/moist. tr crse. sand, faint blocky structure, w/clean, crse sand lens <6 in. thick	
20	▨	7	10 20			V.F. SAND & SILT, damp-moist tan-lt. brown	
22	▨	8	10 20		SM	F-M SAND & SILT, damp-moist, lt. brown tr. c. sand.	
24					SM		
26	▨	9	10 20			SILT w/v.f. sand, moist, lt. brown v.f. sandy silt, tan to lt. brown, damp to most, tr. crse. sand	
28	▨	10	10 14			V.f. SAND/SILT w/some clay, lt. brown, damp/moist, tr fine caliche nodules, tr v.f. mica	

METHOD OF DRILLING *HOLLOW STEM AUGER* WELL COMPLETION DEPTH *41 feet*
HOLE DIAMETER *8 inches* WELL DIAMETER *2 inches*
TOTAL DEPTH *46 feet* WELL MATERIAL *SCHED 40 PVC*

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER SB-1 CLIENT WESDIVNAVFACENGCOM
DATE STARTED 1/25/88 COMPLETED 1/25/88 PROJECT MCAS EL TORO
ELEVATION ft (ground level) GEOLOGIST P.N. CASEY

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
	▨	11	9 20		SM	A.a., w/large (1-2 in) caliche nodules	
32							
34							
36	▨	12	9 18			SILTY v.f. SAND, tan, moist, tr small caliche nodules	
38							
40	▨	13	14 28		CL		
42						SILTY CLAY, med-dark brown, moist, med. dense	
44					SM	SILTY SAND w/1-4" thick clean F-M sand lenses, moist, lt. tan to lt. brown	
46	▨	14	19 28				
48							
50							
52							
54							
56							
58							

LOG OF WELL SB-1 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.

501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER SB-2 CLIENT WESTDIVNAVFACENGCOM
DATE STARTED 1/27/88 COMPLETED 1/27/88 PROJECT MCAS EL TORO
ELEVATION ft (ground level) GEOLOGIST P.N. CASEY

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
	X		6 7		GM	SILTY SAND & GRAVEL. Roots and organics, damp, med. brown	Background HNU: 0.2
2	X		7 10		SP	SAND, clean, tr. fines, lt. tan, damp	
4							
6	X		13 22		ML	A.a., w/fines 30%, med. brown, clasts of concrete.	
8	X	4	14 27			SILTY CLAY w/v.f. sand, hard, compact, damp, med-dk brown, blocky	
10						A.a, moist	
	X	5	14 16		SM	SILTY SAND, f-med grained, Lt. brown, damp tr. c. sand	
12	X	6	13 16			A.a. w/Mn stains	
14							
16	X	7	13 16		ML	SAND, tr. to some fines, tr. c. sand tan, damp.	
18						A.a	
20		8	18 25			SILTY CLAY w tr. to some F sand, damp, med-dk brown, tr c. sand, blocky	
22							
24							Softer drilling
26	X	9	10 16			A.a., w/1/2"stringer of f. sand, small (1/4"-3/4") caliche nodules, med. brown, fine laminae	
28							

METHOD OF DRILLING HOLLOW STEM AUGER WELL COMPLETION DEPTH 40.3 feet
HOLE DIAMETER 8 inches WELL DIAMETER 2 inches
TOTAL DEPTH 40.3 feet WELL MATERIAL Sched 40 PVC

JAMES M. MONTGOMERY
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501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER SB-2 CLIENT WESTDIVNAVFACENGCOM
DATE STARTED 1/27/88 COMPLETED 1/27/88 PROJECT MCAS EL TORO
ELEVATION ft (ground level) GEOLOGIST P.N. CASEY

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
	X	10	10 22		ML SW	SAND, tr. M-C sand, tan, damp,	
32							
						A.a., selected laminations are sl. cemented	
34					SM		
	X	11	18 20			SILTY SAND, lt. brown, damp, sand f.grained, tr. crse. sand	
36							
38						SILYT SAND	
40	X	12	18 18			SILTY CLAY, med-dk brown dense, moist	
42							
44							
46							
48							
50							
52							
54							
56							
58							

LOG OF WELL SB-2 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER SB-3
DATE STARTED 1/28/88 COMPLETED 1/28/88
ELEVATION ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT MCAS EL TORO
GEOLOGIST P.N. CASEY

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
	X	1	9 15			FILL, mix of gravel, silt and clay, damp, med. brown	Background HNU: 0.2
2	X	2	6 8		ML	CLAYEY SANDY SILT, damp, med-dk brown, tr f. gravel to c. sand, tr. mica.	
4							
6	X	3	11 22		CL	SILTY CLAY, med-dk brown, dry-damp, v. dense, caliche stringers	
8	X	4	8 11		ML	SANDY CLAY, w/stringers of silty sand, med-lt brown, damp	
10	X	5	8 10		SM	CLAYEY SAND, med brown, damp	
12							
14							
16	X	6	20 25			SILTY SAND, tr. clay, tr. gravel, tan, damp	
18							
20	X	7	12 12		ML	SAND w/tr to some silt/clay, tan, moist, 1-2" stringers of silty, sandy clay	
22							
24							
26	X	8	15 30			SILT w/F to C sand, med.-lt. brown, damp, med dense	
28							

METHOD OF DRILLING HOLLOW STEM AUGER
HOLE DIAMETER 8 inches
TOTAL DEPTH 46 feet

WELL COMPLETION DEPTH 45.2 feet
WELL DIAMETER 2 inches
WELL MATERIAL Sched. 40 PVC

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
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BORING/WELL NUMBER SB-3 CLIENT WESTDIVNAVFACENGCOM
DATE STARTED 1/28/88 COMPLETED 1/28/88 PROJECT MCAS EL TORO
ELEVATION ft (ground level) GEOLOGIST P.N. CASEY

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
	X	9	12 18		ML SM	SAND, tan, moist, tr fines	
32							
34							
36	X	10	10 22			SILTY SAND, tan-lt. brown, moist	
38							
40	X	11	16 30		SP	SANDY SILT, sand fn grained, med brown, moist, tr c. sand	
42							
44						SAND, poorly sorted, moist, tan, tr fines	
46	X	12	20 30		ML	SILTY CLAY, tr f. sand, med brown, moist/brown	
48							
50							
52							
54							
56							
58							

LOG OF WELL SB-3 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER SB-4
DATE STARTED 2/1/88 COMPLETED 2/1/88
ELEVATION ft (ground level)

CLIENT WEST DIV NAV FAC ENG COM
PROJECT EL TORO
GEOLOGIST C.SCHWYN/P.N.CASEY

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
	▨	1	25		SM	CLAYEY SILTY SAND, 10% clay, 20% silt, 55% fine sand, 15% med. sand-1cm gravel Subrounded-angular, dark brown, humic smell, moist fair sorting.	
2							
4							
6	▨	2	14 24			CLAYEY SILTY SAND, 10% clay, 15% silt, 5% lithic fragments, 70% dry, fine sand, subangular. Lt. brown, root tubes, damp.	
8	▨	3	22 25			A.a., no small, damp	
10	▨	4	15 18			A.a, light humis smell, damp-moist, tr. more lithic sands and gravels, tr. more med. grains	
12	▨	5	13 18			SILTY SAND, 15% silt, sand f-med grained, tr. coarse-fine gravel. Subangular-subrounded, dark buff color, light smell, moist, friable.	
14							
16	▨	6	12 16			A.a, 20% silt and clay. 25% coarse sand.	
18	▨	7	8 11			SILTY SAND, 25% silt, sand med-crs, sub-angular. Tr. very fine gravel, dark buff, wet	
20	▨	8	6 9		CL/ML	CLAYEY SILTY SAND, 45% silt and clay, sand v. fine, brown, 5% fine mica, wet, no smell, tr root tubes.	
22	▨	9	7 10			A.a., sand v. fine A.a, 45% clay and silt, blocky structure, brown, moist slightly plastic.	
24							
26	▨	10	8 10			A.a, 35-40% silt and clay moist	
28							

METHOD OF DRILLING HOLLOW STEM AUGER
HOLE DIAMETER 8 inches
TOTAL DEPTH 30.4 feet

WELL COMPLETION DEPTH 30.4 feet
WELL DIAMETER 2 inches
WELL MATERIAL SCH 40 PVC

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER SB-4 CLIENT WEST DIV NAV FAC ENG COM
DATE STARTED 2/1/88 COMPLETED 2/1/88 PROJECT EL TORO
ELEVATION ft (ground level) GEOLOGIST C.SCHWYN/P.N.CASEY

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
		11	10 20		CL ML	A.a, 45% silt and clay trace of vr. coarse sand damp.	
32							
34							
36							
38							
40							
42							
44							
46							
48							
50							
52							
54							
56							
58							

LOG OF WELL SB-4 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER SB-6
DATE STARTED 2/2/88 COMPLETED 2/2/88
ELEVATION ft (ground level)
CLIENT WESTDIVNAVFACENGCOM
PROJECT MCAS EL TORO
GEOLOGIST C. SCHWYN

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
	▨	1	3 5		SM	CLAYEY SILTY SAND, 10% clay, 25% silt, v. fine-gravel subrounded-angular, organic matter, black, moist, humic smell	
2							
4							
6	▨	2	6 5			CLAYEY SILTY SAND, 25% clay & silt, vr. fine grains-trace of coarse sand, subangular damp light smell, dark brown.	
8							
10	▨	3	4 5			SILTY SAND, v. fine sand, 15% silt, light brown, damp	
12							
14							
16	▨	4	5 6		SP/SM	SILTY SAND, 15% silt. V. fine-fine grained trace of med.-vr. coarse grs, damp light brown, friable	
18	▨	5	5 5		SW	SILTY SAND, well graded sand, 10% silt. Angular-fine grains, primarily quartz. Coarse lithic frags are subrounded, buff color, loose, friable	
20	▨	6	5 5		SM	SILTY CLAYEY SAND, 50% vry fine sand, 25% clay, moderate plasticity, moist, dark brown-black root tubes-abundant, moist	
22							
24	▨	7	5 5			A.a. with stringers of vr. fine sand 1/2-2" thick, moist	
26	▨	8	6 7		SM/SW	SILTY SAND, 20% silt, vr. fine-med. sand, tr. crs-fine gravel moist, loose, dark buff root tubes, trace lithic frags.	
28	▨	9	5 7			A.a, 5% clay, dense, subangular	

METHOD OF DRILLING HOLLOW STEM AUGER
HOLE DIAMETER 8 inches
TOTAL DEPTH 37.5 feet
WELL COMPLETION DEPTH 37.5 feet
WELL DIAMETER 2 inches
WELL MATERIAL SCH 40 PVC

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER SB-6 CLIENT WESTDIVNAVFACENGCOM
DATE STARTED 2/2/88 COMPLETED 2/2/88 PROJECT MCAS EL TORO
ELEVATION ft (ground level) GEOLOGIST C. SCHWYN

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
		10	3 3		SM	SILTY SAND, 25% silt, v. fine-fine sand, grades into a silty clayey sand, 35% silt and clay, root tubes, dark brn, damp, angular frgms.	
32							
		11	4 5			SILTY SAND, 10% silt angular-sub-angular, loose 5% crs-fine gravel, moist	
34							
						A.a, lithic gravel (2%). No sample taken, moist-wet	
36							
38		12	12 20		CL SC	CLAYEY SILTY SAND, 45% silt and clay, dns blocky sand is fine grained angular lithic frags., tr. pea gravel, moist	
40							
42							
44							
46							
48							
50							
52							
54							
56							
58							

LOG OF WELL SB-6 (continued)

JAMES M. MONTGOMERY
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501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER SB-7 CLIENT WESTDIVNAVFACENGCOM
DATE STARTED 2/2/88 COMPLETED 2/2/88 PROJECT MCAS EL TORO
ELEVATION ft (ground level) GEOLOGIST C.C.SCHWYN

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
	▨	1	2 2		SM	SILTY SAND. 30% silt, vr. fine-fine sand, trace medium to vr. coarse grains, subrounded organic rich, moist light black.	
2							
4							
6	▨	2	2 3			SILTY SAND, 15% silt, trace coarse grains, trace mica, buff, moist, contains layers of organics w/increased silt content and wood	
8							
10	▨	3	5 5			CLAYEY SILTY SAND, 30% clay and silt, moderate plasticity, fine grained trace of coarse grains, angular, subrunded trace mica, moist dark green brown.	
12							
14							
16	▨	4	5 7		CL	CLAYEY SILTY SAND. 20% clay 30% silt, trace med. grains moderate plasticity root tubes, dark black, damp.	
18							
20	▨	5	3 4		SM	A.a, (only 5% clay) Contacts a fine grained silty sand. 20% silt, buff color moist, blocky structure.	
22							
24							
26	▨	6	5 7			A.a, subrounded grains trace coarse grains	
28					CL/ML		

METHOD OF DRILLING HOLLOW STEM AUGER WELL COMPLETION DEPTH 45 feet
HOLE DIAMETER 8 inches WELL DIAMETER 2 inches
TOTAL DEPTH 45 feet WELL MATERIAL Sched. 40 PVC

JAMES M. MONTGOMERY
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501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER SB-7 CLIENT WESTDIVNAVFACENGCOM
DATE STARTED 2/2/88 COMPLETED 2/2/88 PROJECT MCAS EL TORO
ELEVATION ft (ground level) GEOLOGIST C.C.SCHWYN

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
		7	5 6		CL ML	CLAYEY SILTY SAND. 10% clay 35% silt, trace coarse to fine gravels, dark buff, damp, moderate plasticity	
32							
34							
36		8	5 6			CLAYEY SILTY SAND. 15% clay 35% silt. Trace clean fine sand stringers 1 cm thick, moist	
38					SP		
40		9	5 7			SAND, v. fine, subrounded and well sorted, light buff, damp, eolian, grades into silty sand trace medium grains.	
42							
44					SM		
46						SILTY SAND, 15% silt, poorly sorted vr. fine sand to gravels lithic frags plus quartz, damp, buff loose, ang-subrnded	
48							
50							
52							
54							
56							
58							

LOG OF WELL SB-7 (continued)

A.2 CLUSTER WELLS

JAMES M. MONTGOMERY
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501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER DPH-1
DATE STARTED 4/12/88 COMPLETED 4/14/88
ELEVATION 265 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT MCAS EL TORO
GEOLOGIST P.N.CASEY

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					SM		
10						SAND: med. brown, silty, coarse grained	
20					CL	CLAY: med. brown, silty, tr. sand and fine gravel	
30						A.a	
40						A.a	
50					ML	SILT: med. brown, some clay	
60					CL	CLAY: med. brown, silty, some sand and fine gravel	
70					SM	SAND and SILT: med. brown, clayey, fine to med. grained	
80					GM	GRAVEL: fine grained, silty, sandy	
90					SM	SAND: med.brown, fine to coarse grained with silt and clay, gravel	
100					CL	CLAY: med. brown, trace sand and fine gravel	
110						A.a	
120					SW	SAND: med. to coarse grained, trace silt/clay	
130					SP	SAND: fine grained, trace silt/clay	
140					SM	SILT: sandy (coarse grained), with some clay	

METHOD OF DRILLING DIRECT ROTORY
HOLE DIAMETER 7 7/8 inches
TOTAL DEPTH 884 feet

WELL COMPLETION DEPTH n/a feet
WELL DIAMETER n/a inches
WELL MATERIAL n/a

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER DPH-1 CLIENT WESTDIVNAVFACENGCOM
DATE STARTED 4/12/88 COMPLETED 4/14/88 PROJECT MCAS EL TORO
ELEVATION 265 ft (ground level) GEOLOGIST P.N.CASEY

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					SM	A.a, with trace coarse sand/fine gravel	
160						A.a	
					SP		
170						SAND: fine grained, trace silt/clay	
180						SAND: coarse grained, trace gravel and fine sand/silt, subrounded to angular	
					SM		
190						SAND: silty, coarse grained, trace fine sand	
200						SAND: coarse grained, trace gravel and silt/clay, subrounded to sub angular	
					SP		
210						SILT and coarse grained SAND	
					SM		
220						A.a	
230					SP	SAND: coarse grained, trace gravel and silt/clay	
240					SM	SILT and coarse grained SAND, trace gravel	
250						SILT: sandy (fine grained), trace coarse sand	
					GP		
260						COBBLES/GRAVEL	Drilling fluid/33 seconds/9.1
						COBBLES: with coarse sand, some fine to med sand, trace silt/clay	<1% sand
					CL		
270						CLAY: silty, trace coarse sand	
					GP		
280						GRAVEL/COBBLES: with fine to coarse sand, trace silt/clay	
290						A.a	

LOG OF WELL DPH-1 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER DPH-1 CLIENT WESTDIVNAVFACENGCOM
DATE STARTED 4/12/88 COMPLETED 4/14/88 PROJECT MCAS EL TORO
ELEVATION 265 ft (ground level) GEOLOGIST P.N.CASEY

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					GP	A.a	
					SM		
310						SILT: sandy (fine grained), trace clay and coarse sand	
320						SAND: silty, med. to coarse grained	
330						SAND: silty/clayey, med.to coarse grained, trace gravel	
340					CL	CLAY: silty, trace fine to med. grained sand	
350					SM	SAND: silty, med to coarse grained, trace gravel	
360					CL	SILT/CLAY: with fine to coarse grained sand, trace gravel	
370					ML	SILT: sandy (fine grained), with some med. to coarse gr. sand	
380					SM	SILT: sandy (med. to coarse grained)	
390					SP	SAND: coarse grained, trace to some gravel, subrounded to angular, 80% quartz	
400					SM	SAND: coarse grained, with fine sandy silt/clay	
410					SP	SAND: med.to coarse grained,trace gravel, subrounded to subangular	
420					SM	SAND: silty/clayey, med. to coarse grained	
					SP		
430						A.a	
440						SAND: med. to coarse grained, trace to some subrounded gravel	

LOG OF WELL DPH-1 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER DPH-1 CLIENT WESTDIVNAVFACENGCOM
DATE STARTED 4/12/88 COMPLETED 4/14/88 PROJECT MCAS EL TORO
ELEVATION 265 ft (ground level) GEOLOGIST P.N.CASEY

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					ML	SILT/CLAY: sandy	
460							
470						A.a	
480					SW		
490							
500						SAND: trace gravel, >80% quartz, subrounded	
510						A.a with trace to some silt/clay	
520						CLAY: sandy	
530					SC/CL	A.a with trace gravel	
540					SC	SAND: silty/clayey	
550					SM/SC	SAND: with some silt/clay	
560					SW	SAND: silty/clayey	
570					SM	SAND: yellow/tan, silty, med. to coarse grained	
580					CL	CLAY: white/tan, trace sand	
590						A.a	

LOG OF WELL DPH-1 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER DPH-1 CLIENT WESTDIVNAVFACENGCOM
DATE STARTED 4/12/88 COMPLETED 4/14/88 PROJECT MCAS EL TORO
ELEVATION 265 ft (ground level) GEOLOGIST P.N.CASEY

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					CL	CLAY: green/yellow	
610						CLAY: grey/white, with some fine to med. grained sand	
620					CL SC	SAND: grey/white, clayey	
630					SC	SAND: grey/white, with some silt/clay	
640					CL	CLAY: blue/green, trace sand	
650						A.a	
660						CLAY: blue/grey, with trace to some sand	
670						A.a	Drilling fluid/36 seconds/9.4 <1/4% sand
680						A.a	
690						CLAY: blue/grey, gravelly, sandy	
700						CLAY: blue/grey, trace sand	
710						A.a, med blue/green	
720						A.a, dark gray	Oil film on mud Black oil residue on mud
730						CLAY: dark blue/grey, trace sand and shale frags.	Nat. gas smell from bas bubbles in mud
740						A.a	

LOG OF WELL DPH-1 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER DPH-1 CLIENT WESTDIVNAVFACENGCOM
DATE STARTED 4/12/88 COMPLETED 4/14/88 PROJECT MCAS EL TORO
ELEVATION 265 ft (ground level) GEOLOGIST P.N.CASEY

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					CL	A.a	
760						A.a	
770						A.a	
780						A.a increasing shale frags	
790						A.a	
800						CLAY: blue/grey, silty, trace sand and shale frags	Slightly harder drilling HNU-PID: 10-15 in pit Slow drilling
810						A.a increasing sand and shale frags	
820						A.a	
830						A.a with increasing % of sand and shale frags, sand is 30% qtz, lt. grey/blue	Angular fragments
840						Shale/slate frags (H>7) with silty clay, 20% ang. quartz frags.	Hard drilling
850						CLAY: blue/grey, with shale frags	
860						A.a	Slow drilling
870						A.a	
880						A.a	
890							

LOG OF WELL DPH-1 (continued)

A.3 PERIMETER WELLS

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-1
DATE STARTED 12/5/88 COMPLETED 12/8/88
ELEVATION 241.7 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					SP	SAND: brown, fine, subangular sand w/5% silt and tr of subangular to subrounded med to cse sand, dry, loose 1.5 to 1.6: tan dry loose well graded SAND: fine to cse, subangular, v. clean, sharp top and base nonhorizontal.	
					SM	SILTY SAND: dark brown, 80% fine to cse sand, 20% brown silt matrix, dry to damp	
5						SILTY SAND: dk.brown, a.a., stiff, rootlets, cse sand decreases from 50% to tr. top to base.	
						SILTY SAND: a.a., no rootlets, med. sand, color change to pale red brown, dendritic white mottling appears at 6.8'.	
					unk		
					SP	SAND: dark brown and tan sand, laminated dark layers may be organic rich and are fine grained, lite layers are arkosic, coarse, subang to ang, and mica rich, sharp base	
					SM		
10						SILTY SAND: red brown, 35% brown silt w/60% fine to med sand, tr cse sand, white rootlets, tan dendritic mottling, dry to damp, sharp base	
					SP SW	SAND: tan, sli. compact, dry, v. fine to fine subang to subrnd, tr fines and med sand, abundant mica, damp	
					UNK		
15							
					SP SW	SAND: a.a., med sand w/less fine sand, loose, tr cse subang sand	

METHOD OF DRILLING HOLLOW STEM AUGER
HOLE DIAMETER 8 inches
TOTAL DEPTH 123 feet

WELL COMPLETION DEPTH 122 feet
WELL DIAMETER 4" inches
WELL MATERIAL SCH. 40 PVC

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-1 CLIENT WESTDIVNAVFACENGCOM
DATE STARTED 12/5/88 COMPLETED 12/8/88 PROJECT MCAS-EL TORO
ELEVATION 241.7 ft (ground level) GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					SP/SW		
					SP UNK	SAND: tan, dry, cse, subang, loose, tr pea gravel	
21							
					SM	SAND: tan, loose, a.a., w/sharp base above SILTY SAND: brown, 25% brown silt matrix containing med to cse subang to subrnd sand, abundant mica dry to damp	
26						SILTY SAND: a.a., w/up to 30% silt, 15% cse sand damp to dry, sharp base	
					SP/GP	SAND: tan, loose, damp, med to cse, subang to subrnd, arkosic sand, .1' of pea gravel at 27.4'	
					UNK		
					SP/SM	Interbedded sand (a.a.) and silty sand (a.a.), dry	
					SW	SAND: tan, loose, dry, fine to cse, subang to subrnd, arkosic, damp at base	
31						SILTY SAND: brown, 20% brown silt, 75% v fine to fine sand, tr csr sand, sli. cohesive	
					GW/SP	GRAVELLY SAND: dry, fine to cse, rnd gravel w/ fine to med, subang sand matrix, dry, compact	

LOG OF WELL PS-1 (continued)

JAMES M. MONTGOMERY
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501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-1 CLIENT WESTDIVNAVFACENGCOM
DATE STARTED 12/5/88 COMPLETED 12/8/88 PROJECT MCAS-EL TORO
ELEVATION 241.7 ft (ground level) GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					GW/SP		
					ML/SM	SANDY SILT: brown, dry to damp, 30% to 50% med sand in silt, loose	
					SC/SM	CLAYEY SAND: brown, stiff, 40% med to cse, subang to subrnd sand, bound in clayey matrix, v stiff, tr med gravel, subvert. dark brown rootlets, red brown mottling to 35', red brown color from 36' to 38'	
37							
					CL/SC	SANDY CLAY: a.a., dry, red brown, 25% cse sand, v. stiff w/blocky fracture from 38 to 41.5, fracture surfaces are shiny, fine sand increases to 70% below 41.5 and soil is less stiff, tr pea gravel appears at 42.5	
42					SC/SM	CLAYEY SAND/SANDY CLAY: a.a., dry, stiff, no blocky fracture	
					CL/SC	SANDY CLAY: a.a., dry, blocky fracture, brown, v. stiff, tr sand, black .5mm to 2mm organic debris	
47						CLAYEY SAND: a.a., loose, no blocky fracture, tan dendritic mottling effervesces in HCl	

LOG OF WELL PS-1 (continued)

JAMES M. MONTGOMERY
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501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-1 CLIENT WESTDIVNAVFACENGCOM
DATE STARTED 12/5/88 COMPLETED 12/8/88 PROJECT MCAS-EL TORO
ELEVATION 241.7 ft (ground level) GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					SC/SM	CLAYEY SAND: brown, dry to damp, 75% fine sand w/25% fines, loose	
					CL/ML	CLAY: dk brown w/tan dendritic mottling, v blocky fracture along tan mottled zones, tan zones effervesce in HCl, plastic, cse sand appears at base	
53					SC/SM	SAND: red brown, damp to dry, 60% v fine to fine sand and 40% fines, grades down to v stiff CLAYEY SAND at 52.5 which persits to 53: a.a., tan mottling not as abundant, sand increases sli to 56 (from 50% to 70%), with coincident decrease in stiffness	
						CLAYEY SAND: a.a., brown w/abundant tan to white mottling, which effervesces in HCl, sand is cse, ang, arkosic, tr granitic pebbles, stiff	
58						CLAYEY SAND: red brown, dry to damp, 90% fine to med sand w/red brown matrix of fines, crumbles easily, clay increases abruptly at 59.3 and soil is v stiff to 59.8, clay decreases to 15% and soil less stiff at 60	
			40		SM		
			53			SILTY SAND: lt brown, damp, v fine to cse sand, cse sand is subrnd to subang, loose	
			50		SC		
			68			CLAYEY SAND: a.a., brown, dry, stiff, olive green irreg mottling, 75% med, subrnd sand in brown clay matrix, tr pebbles	
			73		SM		
			105				
63			11			SILTY SAND: brown, dry, 90% subang to subrnd med sand w/brown matrix of fines, abundant white sand clasts (feld), olive green mottling	
			29				

LOG OF WELL PS-1 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-1
DATE STARTED 12/5/88 COMPLETED 12/8/88
ELEVATION 241.7 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT MCAS-EL TORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
			31 33 14 22 53 54		SM ML SP SM SP UNK	SILTY SAND: pale red brown, dry, v stiff, 65% v fine to med subang to subrnd sand bound in a silt matrix, sharp basal contact SAND: pale red brown, 90% med to cse subang to subrnd sand w/10% fines, abundant chalky white grains (feld), much qtz and black mica, loose	
69							
74						NO SAMPLES RECOVERED BETWEEN 68 AND 83 FEET	
79							

LOG OF WELL PS-1 (continued)

JAMES M. MONTGOMERY
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501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-1 CLIENT WESTDIVNAVFACENGCOM
DATE STARTED 12/5/88 COMPLETED 12/8/88 PROJECT MCAS-EL TORO
ELEVATION 241.7 ft (ground level) GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
			59		SP	SAND: tan, loose, dry to damp, cse subang to subrnd qtz (65%) feld (25%) and lithic frags (10%), clean	
			63				
			57				
			71				
85			63		SM	GRAVELLY SAND: tan, a.a. w/20% fine to cse pebbles sharp base	
			45			SILTY SAND: red brown, dry to damp, sand decreases from 80% to 50% (top to bottom), cse subang arkosic sand bound in silt matrix, tan dendritic mottling appears at 86, grades down to sand at 86.5	
			12				
			27		SP		
					SW		
			20		SM	SAND: tan, damp, loose, 90% med, subang to subrnd sand, 10% subang cse sand, grades down into silty sand, a.a. at 87,	
			14				
			10		SM	SANDY SILT: brown w/tan mottling which effervesces in HCl, 25% v fine sand, sand increases and csens to fine to med in SILTY SAND at 89: brown, 75% fine to medium sand, csens to med to cse arkosic sand at 90, damp at top to wet at bottom	
			17				
			24		SP		
			31				
90			16			SAND: brown, saturated, gravelly at top to fine to med at base, gravel is fine, sand is subang to ang, 1cm of clean cse sand at 90.5	
			29				
			10				
			16				
			30				
			17			SAND: lt brown, saturated, stratified cse gravelly sand, fine to med sand, silty sand, and silt from top to bottom, gradational contacts, center .2' is sandy silt immed above cse clean sand which overlies fine sand csening down to gravelly med sand	
			20				
			29				
			31				
95			28			GRAVELLY SAND: a.a., fines down to uniform fine sand at 95.5, sand is subang to subrnd, brown, abundant gold mica, saturated	
			30				

LOG OF WELL PS-1 (continued)

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501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-1 CLIENT WESTDIVNAVFACENGCOM
DATE STARTED 12/5/88 COMPLETED 12/8/88 PROJECT MCAS-EL TORO
ELEVATION 241.7 ft (ground level) GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
	X		6 17 19 21		SP ML SP	SAND: saturated, cse sand w/gravel fines from to fine sand above sandy silt at 97.1 to 97.3, silt is damp, below silt is stratified sand: cse and fine sand in subhorizontal layers (.5cm thick), wet to saturated	
					UNK		
101							
	X		10 13 16		SW	SAND: brown, saturated, fine to med w/tr of cse sand, mostly sand heave except for bottom, black selvage of organic material in bottom	
					UNK		
106							
	X				SP	SAND: brown, saturated, v fine to fine, well sorted, subang, sand heave	
					UNK		
111							

LOG OF WELL PS-1 (continued)

JAMES M. MONTGOMERY
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501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-1 CLIENT WESTDIVNAVFACENGCOM
DATE STARTED 12/5/88 COMPLETED 12/8/88 PROJECT MCAS-EL TORO
ELEVATION 241.7 ft (ground level) GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
			13 26 56 65		ML SM SP	Two stacked fining upward sequences, fine from basal med to cse arkosic saturated sands upward to sandy silt containing fine sand, silts are wet	
					UNK		
117							
			7 21 34 61		SW SM	SAND: tan, saturated, med to cse, subang to subrnd, 20% fine sand, sharp irregular base SILTY SAND: red brown, moist to wet, a.a., 30% fines, sli plastic, a tube of sand with tan border extends from 118.3 to 118.5	
					UNK		
122							
					SW	SAND HEAVE: sand is well graded fine to cse, subang to subrnd, arkosic, saturated, tr of cse sand mostly med sand	
127							

LOG OF WELL PS-1 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-2
DATE STARTED 12/9/88 COMPLETED 12/11/88
ELEVATION 244.6 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-ELTORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					ML	SILT: brown, dry, loose, sand increases from tr to 30% (top to bottom), gradational base	
					SM	SILTY SAND: brown, dry, loose, 70% fine to cse subang to subrnd sand, sand increases to base, rootlets, 15% voids, dendritic white mottling in lower 0.2' effervesces in HCl	
					ML	SILT: a.a., dry, up to 20% sand, tan mottling increases to base	
5							
					SM	SAND: tan, dry, loose, 70% med subang sand, 15% cse arkosic sand, sharp base	
					ML	SANDY SILT: brown, dry, stiff, 20% med subang sand, rootlets, subhorizontal white mottling	
						SANDY SILT: a.a., dry, fine to med sand increases to base which is gradational	
					SP	SAND: tan, dry, v fine at top to fine w/10% med sand at base, subang to subrnd, tr silt	
10							
					ML	SANDY SILT: a.a., laminated brown silt and redbrown sand, gradational base	
					SP/SM	SAND: a.a., dry, loose, 15% silt in laminae	
					UNK		
					SW/UNK	SAND: tan, dry, loose, 70% fine sand, 25% arkosic med to cse subang to subrnd sand, tr silt	
15							

METHOD OF DRILLING HOLLOW STEM AUGER
HOLE DIAMETER 8 inches
TOTAL DEPTH 135 feet

WELL COMPLETION DEPTH 133.1 feet
WELL DIAMETER 4" inches
WELL MATERIAL SCH. 40 PVC

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-2 CLIENT WESTDIVNAVFACENGCOM
DATE STARTED 12/9/88 COMPLETED 12/11/88 PROJECT PERIMETER INVESTIGATION MCAS-ELTORO
ELEVATION 244.6 ft (ground level) GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
					SW	SAND: tan, dry to damp, loose, well graded (fine to cse) subang to subrnd sand, cse sand is more abundant at top, contains laminated red brown sandy silt layer (a.a.) w/sharp boundaries	
21					UNK		
					ML	SILT: pale tan and dk brown laminae in upper .1', below 23.15 is brown sandy silt w/20% fine to cse sand, tr 2mm black mica flakes, tan subhz mottling tan areas effervesce in HCl	
26					UNK		
					ML	SILT: brown, dry to damp, sli plastic, tan mottling abundant voids, cse sand (qtz and lithic fragments) appears at 29 and increases to 15% at 30, sand is absent from 30 to 30.5 and gradually increases to 31 (fine to med, subang to subrnd)	
31					SP/SM	SAND: tan, loose, dry to damp, fine to med, subang to subrnd, arkosic, 15% granitic cse sand at base	

LOG OF WELL PS-2 (continued)

JAMES M. MONTGOMERY
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BORING/WELL NUMBER PS-2
DATE STARTED 12/9/88 COMPLETED 12/11/88
ELEVATION 244.6 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-ELTORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					SP/SM		
					ML	CLAYEY SILT: tan and brown laminae (brown are plastic), dry	
					SP/SM	SAND: tan, dry, loose, fine to med, subang to subrnd, variable silt up to 20%, v fine sand at base	
					ML	CLAYEY SILT: a.a., laminated	
					SP/SM	SAND: a.a., cross laminated	
					ML	CLAYEY SILT: a.a., laminae less sharp w/depth	
37						SANDY SILT: brown, dry, tan mottling, med to cse sand	
						SANDY SILT: brown, dry, mod stiff, abundant rootlets, subvert tubes, cross laminae of sand, sand is fine to cse, fine sand increases at base	
42							
					SM/SC	SILTY/CLAYEY SAND: brown, mod stiff, dry to damp, fine to med subang to subrnd arkosic sand, contains laminae of silt/clay w/sharp contacts	
					SP	SAND: tan, dry, clean, fine subang arkosic sand, hz layering, bottom .1' is cse subang arkosic sand	
					SW		
					UNK		
47							

LOG OF WELL PS-2 (continued)

JAMES M. MONTGOMERY
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501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-2
DATE STARTED 12/9/88 COMPLETED 12/11/88
ELEVATION 244.6 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-ELTORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					ML	SANDY SILT: brown, dry to damp, laminated to 48.2, 45% v fine sand, abundant mica, gradational base mod stiff	
					SM	SAND: tan, looser than silt, 60% v fine sand in silt matrix	
					ML/SM	SANDY SILT: a.a., contains clay layers and small lenses of v fine sand, abundant rootlets, some cross laminae of sand below 51.8, sli plastic	
53					SP	SAND: tan, loose, dry, v fine to fine, sharp base	
					ML/CL	SILTY SAND: red brown, dry to damp, sand is med to cse, subrnd to subang, increases from 25% to 45% (top to bottom)	
58						SANDY SILT: red brown, dry, subvert rootlet tubes, plastic, laminae of fine sand	
					SM	SILTY SAND: red brown, fine sand a.a., 25% silt, silt increases to base	
					ML/CL	SANDY SILT/CLAY: red brown, a.a., friable w/shiny fracture surfaces, 40% med to cse subang sand, some slate/shale chips, blocky fracture from 59.5 to 61.5	
						SILTY/CLAYEY SAND: red brown, dry, 15% fines, sand csens from fine at top to med at 65, cse gravel present at 65.5, gravel is rnd ss, aplite, basalt white mat'l coating gravel effervesces in HCl	
63					SM/SC		

LOG OF WELL PS-2 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-2
DATE STARTED 12/9/88 COMPLETED 12/11/88
ELEVATION 244.6 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-ELTORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					SM/SC		
					ML/CL	SEE BOTTOM OF PREVIOUS PAGE	
					GC/GM/UNK		
			12		ML	SANDY SILT: brown, dry to damp 30% med to cse subang to subrnd sand bound in silt matrix	
			25		SP	SAND: tan, dry to damp, loose, fine subang to subrnd sand, 20% fines, gradational base	
69			28		ML		
			32			SANDY SILT: a.a., dk brown w/subvert carbonate filled white tubes	
					UNK		
			15		ML	SANDY SILT: brown, stiff, dry, cross laminae of med subang sand, greenish mottling, subvert calcite tubes, sand increases to base	
			32				
74			59		SM	SILTY SAND: brown, dry, matrix bound, 70% fine sand 10% med to cse subrnd sand, remainder is fines, calcite filled white rootlet tubes	
			74				
					UNK		
			30		SM/SC	SILTY SAND: brown, dry, sli plastic, 75% fine to med subang to subrnd sand, 25% fines, white subvert zones are partially cemented by calcite	
			49				
79			80				
			68				

LOG OF WELL PS-2 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-2 CLIENT WESTDIVNAVFACENGCOM
DATE STARTED 12/9/88 COMPLETED 12/11/88 PROJECT PERIMETER INVESTIGATION MCAS-ELTORO
ELEVATION 244.6 ft (ground level) GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
			12		ML	SANDY SILT: brown, dry, stiff, 45% fine to cse sub-ang to subrnd sand, base is cross laminated sand and silt	
			32		SM		
			44			SILTY SAND: brown, dry to damp, loose, 75% fine ar-kosic sand, silt increases to 35% at 84.5 and soil is matrix bound to base, cse sand increases to base, tan dendritic zones and matrix effervesce in HCl	
			50				
85					UNK		
			19		ML	SILT: gray brown, dry, v stiff, contains cross lam-inae of tan sand and fines	
			50				
			61		SP	SAND: tan, dry to damp, loose, fine subang well sorted sand, sharp base	
			73		ML	SANDY SILT: pale red brown w/tan dendritic mottling and subvert tubes (effervesce in HCl), sand csens from v fine at top to fine to med at base, 65% silt	
90					UNK		
			34		CL	SAND: tan, damp, loose, bimodal: 80% fine to med subang sand and 15% cse subrnd sand, 5% fines	
			58		SP		
			55				
			77				
95					UNK		

LOG OF WELL PS-2 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-2
DATE STARTED 12/9/88 COMPLETED 12/11/88
ELEVATION 244.6 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-ELTORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
	X		16 42 52 53		SM SW	SILTY SAND: brown, damp to moist (at top), 40% silt 60% fine to cse sand, silt diminishes to 10% at 98.5 and pea gravel appears, soil is moist below 98.5, tr of silt below 100, sand is fine to cse subang to subrnd, arkosic	
					UNK		
101							
	X		10 15 31 39		SM ML SM UNK	SILTY SAND: lt brown, saturated, well graded, fine to cse subang to subrnd sand w/15% silt, silt increases to base SANDY SILT: brown, saturated, 45% v fine sand, tr subrnd cse sand, cser clasts are concentrated in laminae,	
106							
	X		8 19 26 60		SM UNK	SILTY SAND: brown, wet, sli plastic, mod stiff, 65% med subang to subrnd sand bound in silt matrix	
111							

LOG OF WELL PS-2 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-2
DATE STARTED 12/9/88 COMPLETED 12/11/88
ELEVATION 244.6 ft (ground level)
CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-ELTORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
	X		8 19 33 46		ML	SANDY SILT: brown, damp, stiff, 40% fine to cse sand bound in silt matrix, fines are sli plastic	
					SM UNK	SILTY SAND: brown, moist, matrix bound, 65% fine sand w/tr cse sand	
117							
	X		6 7 19		SP UNK	SAND: tan, saturated, med subang arkosic sand, tr cse sand, fine sand at base w/cse sand	
122							
	X				SW UNK	SAND HEAVE: brown, saturated, fine to cse subang to subrnd arkosic, 10% fines	
127							

LOG OF WELL PS-2 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-2
DATE STARTED 12/9/88 COMPLETED 12/11/88
ELEVATION 244.6 ft (ground level)
CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-ELTORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK	NO SAMPLE RECOVERED BETWEEN 125 AND 133	
133	X		7 36 57 66		SM	SILTY SAND: red brown, stiff, moist, 75% fine to med subang to subrnd arkosic sand, bound in matrix of red brown fines, tr black organic debris, olive green mottling	
138							
143							

LOG OF WELL PS-2 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-3
DATE STARTED 12/12/88 COMPLETED 12/14/88
ELEVATION 206.1 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					FILL	FILL: dk brown, compact sandy soil, sharp base	
					ML	SANDY SILT: brown, dry, mod stiff, 20% cse subrnd sand, matrix bound, many dendritic white rootlets in upper .1'	
					SP	SAND: tan, dry, 75% med to cse subrnd to subang sand, 25% fines, sharp top	
					ML	SANDY SILT: brown, dry, 30% fine to v fine sand in silt matrix	
					SW	SILTY SAND: brown, dry, fine to cse subang arkosic sand bound in 30% to 50% silt matrix, stiff to 7.2 where silt decreases to <15% and soil is loose	
5							
					SW/GP	GRAVELLY SAND: tan loose, dry, sand is well graded v fine to cse, subang to subrnd, and arkosic, 10% rnd gravel (granitic and volc), 10% fines	
10					UNK		
					ML	SILTY CLAY: brown, plastic, stiff, dry, tr med to cse sand, tan mottling, contains a laminae of clean cse arkosic sand at 13.8, gradational base	
15						SANDY SILT: brown, dry, 35% fine to cse subrnd to subang sand in matrix of fines, tan dendritic mottling, irreg rust orange and olive green mottling,	

METHOD OF DRILLING HOLLOW STEM AUGER
HOLE DIAMETER 8 inches
TOTAL DEPTH 123 feet

WELL COMPLETION DEPTH 122 feet
WELL DIAMETER 4" inches
WELL MATERIAL SCH. 40 PVC

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-3 CLIENT WESTDIVNAVFACENGCOM
DATE STARTED 12/12/88 COMPLETED 12/14/88 PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
ELEVATION 206.1 ft (ground level) GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					SM	SILTY SAND: brown, dry, sli cohesive, 75% fine sand 10% fine rnd gravel (a.a.) bound in silt matrix, mottling a.a., tan mottling effervesces in HCl	
						SILTY SAND: a.a., tan vert zone effervesces in HCl	
					GM	SILTY GRAVEL: tan, damp, fine to cse rnd gravel, metamorphic and lithic clasts, 20% silt, matrix is sli cohesive, sharp base	
21					SM	SILTY SAND: red brown, damp, sli cohesive, med to cse subang to subrnd sand, 15% silt abundant black mica, 21.2-21.8 soil darkens and sand is uniform cse subang w/much white feld, 10% subang to subrnd fine pebbles, sharp top and base	
					UNK		
			23		SM	SILTY SAND: brown, dry, 45% silt, 55% med to cse arkosic sand, gradational base	
			43				
			43				
			35		GP/GM	SANDY GRAVEL: brown, stratified, sli cohesive due to 10% fines, fine layers are damp/cse are dry, sand in matrix is fine to cse subang to subrnd, fine to cse gravel is rnd qtz and metamorphic clasts, layers have sharp boundaries	
26					GP/SW		
					SM/GM	SANDY GRAVEL: a.a., tr of silt	
					SM	SILTY SAND: greenish brown to red brown, dry to damp, stiff, blocky fracture w/shiny surfaces, cse to fine subang arkosic sand, 35% silt, tr fine gravel, sand increases to 75% at 32.8 and soil is loose	
31							

LOG OF WELL PS-3 (continued)

JAMES M. MONTGOMERY
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501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-3
DATE STARTED 12/12/88 COMPLETED 12/14/88
ELEVATION 206.1 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					SM	SILTY SAND: a.a., stiff, silt decreases at 35.7 and soil is loose, moist, 36.5 to 37 is dry to damp, w/silt rich layer w/sharp boundaries	
37					UNK		
					SW	SAND: tan, damp to moist, loose, well graded, tr fines, grades down to bimodal sand at 39.5: 90% fine to med, subang to subrnd sand, 10% subrnd cse sand, arkosic, much black mica in fines, a few hz laminae	
					SP		
					UNK		
42							
					SP	GRAVELLY SAND: lt brown, damp at top to moist at base, loose, 10% pebbles, 90% med to cse subrnd to subang sand, tr fines, sharp base	
					SM/ML	SILTY SAND: red brown, damp, mod stiff, 65% fine to med subang sand bound in silt matrix, tr cse sand, black dendritic organic matter, sharp base	
					SW/UNK	SAND: tan, dry, loose, cse arkosic sand	
47							

LOG OF WELL PS-3 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-3 CLIENT WESTDIVNAVFACENGCOM
DATE STARTED 12/12/88 COMPLETED 12/14/88 PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
ELEVATION 206.1 ft (ground level) GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					SM	SILTY SAND: lt brown, damp to moist, stiff, 65% med to cse sand bound in silt matrix, gradational base	
					SW	SAND: tan, dry to damp, loose, fine to cse subrnd arkosic sand, fines downward	
					SM	SILTY SAND: red brown, dry to damp, mod stiff, 75% med to cse subang arkosic sand	
					UNK		
53					SM	SILTY SAND: lt brown, damp, mod stiff, 30% silt, fine to med sand, tr cse subrnd sand, sharp base	
					SP	SAND: tan, damp, loose, med to cse subang to subrnd arkosic sand csens to pebbles at 55.5, sharp base above cross laminated v fine and fine sand which csens to hz-stratified med to cse arkosic sand at 55.8, finer soils contain more moisture	
					GP		
					SP		
					SM	SILTY SAND: brown, damp, 70% cse arkosic sand	
					UNK		
58					SM	SILTY SAND/SANDY SILT: brown, damp, non-plastic, v fine to fine sand, black organic debris	
					ML		
					SM	SILTY SAND: brown, damp, nearly loose, 75% med to cse subang to subrnd arkosic sand in silt matrix, gradational base	
					SP/GP	GRAVELLY SAND: lt brown, damp, loose, 10% fines, med to cse arkosic sand, gravel is mostly gray basalt, 1cm layers of redbrown silt-bound sand at 62.2	
					UNK		
63					SW	SAND: brown, damp to moist, loose, fine to cse subang to subrnd arkosic sand, tr fines, rnd to subang volc med gravel present at 64.5	

LOG OF WELL PS-3 (continued)

JAMES M. MONTGOMERY
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501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-3 CLIENT WESTDIVNAVFACENGCOM
DATE STARTED 12/12/88 COMPLETED 12/14/88 PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
ELEVATION 206.1 ft (ground level) GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					SW	SILTY SAND: brown, damp, silt bound, cse subang to subrnd arkosic sand, bottom .5'is cross laminated	
					SW/GP		
					SM		
					SP		
69						SAND: tan, damp, loose, grades from fine to cse (to 71.3), well sorted, tr fines, 65% qtz 20% white feld and lithic fragments, lower .2' are bimodal sand (fine and cse sand)	
					SP/SW		
					UNK		
					SP	GRAVELLY SAND: brown, dry, loose, med to cse subang sand w/10% fine pebbles, gradational base	
					SM/ML		
74						SILTY SAND/SANDY SILT: brown, dry, v stiff, 50%+ fines (sli plastic), tan dendritic mottling, olive green irregular mottling, gradational base	
					SM	SILTY SAND: brown, dry to damp, mod stiff, 70% fine to cse subang sand, silt increases to 50% below sharp contact at 77-coincident w/increase in stiffness	
					SM/ML		
					SM	SILTY SAND: brown, damp, loose, med to cse subang to subrnd arkosic sand, fine metamorphic pebbles appear at 79.5, sharp base	
79							

LOG OF WELL PS-3 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-3
DATE STARTED 12/12/88 COMPLETED 12/14/88
ELEVATION 206.1 ft (ground level)
CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					ML	SANDY SILT: brown, dry, vstiff, 50% silt, tr gravel	
					UNK	NO SAMPLE RECOVERED BETWEEN 82 AND 88	
85							
			32		CL	SANDY CLAY: green-gray, wet, plastic, 30% med to cse subang to subrnd sand, sharp base	
			42		SP	SAND: tan, wet to saturated, well sorted cse subrnd arkosic sand, 75% qtz 15% white feld, 10% black mica and lithic fragments, v clean	
			49				
			60				
90					UNK		
			16		SP	SILTY SAND: lt brown, saturated, similar to sand above w/10% silt, silt increases to 35% at 93.3 and sand is fine, sli plastic grades to fine to cse subang to subrnd arkosic sand w/tr gravel in silt matrix at 93.5, sharp base	
			32		SM		
			38		SM		
			47		ML	SANDY SILT: brown, damp to moist, sli plastic, 35% med to cse sand, sharp base	
95					SM		
					UNK	SILTY SAND: a.a., saturated, non-hz base above laminated brown and olive green silty sand (wet) at 94.9	

LOG OF WELL PS-3 (continued)

JAMES M. MONTGOMERY
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501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-3
DATE STARTED 12/12/88 COMPLETED 12/14/88
ELEVATION 206.1 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
	X		12 18		SW	SAND: brown, saturated, sli cohesive, 10% fines, fine to cse subang to subrnd sand, gradational base	
			25 25		SC CL	SANDY CLAY: dk brown, damp, plastic, 15% cse sand above 99.5, below is 45% fine to cse sand	
					UNK		
101							
						NO SAMPLES RECOVERED BELOW 100 DUE TO SAND HEAVE	
106							
111							

LOG OF WELL PS-3 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-3
DATE STARTED 12/12/88 COMPLETED 12/14/88
ELEVATION 206.1 ft (ground level)
CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
						NO SAMLES RECOVERED BELOW 100 DUE TO SAND HEAVE	
117							
122							
127							

LOG OF WELL PS-3 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-4
DATE STARTED 1/3/89 COMPLETED 1/6/89
ELEVATION 264.34 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					FIL	FILL: dk. brown silt/clay w/organic debris and sand	
					ML / SM / SW	SANDY SILT: red brown, damp, mod. stiff, sli, plastic, 40% fine to cse subang to subrnd sand in silt /clay matrix, rootlets, gradational base	
					SM	SILTY SAND: pale red brown, A.A.w/65% fine to med sand and tr. cse sand, sharp base	
					UNK	SAND: tan, dry, loose, fine to med sand is subang, cse sand is subrnd (35%), tr fines, sharp top and base, base is non-hz	
					SW	SILTY SAND: A.A., dry to damp, hz tan lenses appear at 2.5'	
					SM / ML	SAND: lt. brown, damp, loose, fine to cse subang to subrnd arkosic sand, sharp base, tr to 10% fines	
5					SM	SILTY SAND/SANDY SILT: red brown, A.A., contains laminae of clean med subang sand to 5', laminated to 4.4', rootlets, dend vert fractures s/shiny surfaces, brite red around fractures, some fractures filled w/tan matl, sand increases to base, tr ang pea gravel	
						SILTY SAND: red brown, damp, sli cohesive, 75% med to cse subang to subrnd arkosic sand, sharp base	
					CL	SANDY CLAY: dk brown, damp, plastic, v stiff, 10% subang sand, anastomozing fracture pattern w/shiny surfaces, tr fine pebbles, white vert zone at 9.5 effs in HCl, x-strata of silty sand present from 11' to 12', tr black organic debris, black layer at 12.5' has sharp base above red zone, grades down to laminated brown and black clay at 13'	
10						CLAYEY SAND & SANDY CLAY: stratified, sand is tan, dry to damp, loose, v fine to fine sand w/trace cse subrnd sand, clay is brown to gray brown, w/up to 35% sand; sharp contacts	
					SW	SAND: tan dry to damp, loose, x-laminated, v fine to cse subang sand, gradational base	
					CL	SANDY CLAY: A.A. w/more sand, gradational base	
15					SC	CLAYEY SAND: red brown, fine to cse ang to subrnd arkosic sand bound in brown matrix, up to 10% fine pebbles	

METHOD OF DRILLING HOLLOW STEM AUGER
HOLE DIAMETER 8 inches
TOTAL DEPTH 123 feet

WELL COMPLETION DEPTH 118.5 feet
WELL DIAMETER 4" inches
WELL MATERIAL SCH. 40 PVC

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-4 CLIENT WESTDIVNAVFACENGCOM
DATE STARTED 1/3/89 COMPLETED 1/6/89 PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
ELEVATION 264.34 ft (ground level) GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					SC	FOR DESCRIPTION OF SOIL BETWEEN 16' AND 18' SEE PREVIOUS PAGE	
					SM/SC	SILTY SAND: red brown, dry to damp, v stiff, 70% fine to cse, subang to subrnd sand bound in clay/silt matrix, gray green mottling, color darkens at 18.5' and shiny fractures appear, slate chips, gradational base	
21					SM/SP	SAND: tan, damp, loose and sli cohesive, fine to med subang sand, 15% fines, tr black organic debris, grades to clayey sand at 22.1' and soil is stratified A.A to 23'	
					UNK		
					ML	SANDY SILT: A.A., tr fine pebbles, tr black organic debris, sharp base	
					SM	SILTY SAND: A.A., sli cohesive, 90% v fine to fine subang sand, tr cse sand, 10% fines, silt increases to 30% at 24.5, sharp subhz base	
26					ML/CL	SANDY SILT/CLAY: A.A., v stiff, much black organic debris/rootlets, dk brown clay laminae at 26.2	
					UNK	NO RECOVERY 26.5' TO 27'	
					ML	SANDY SILT: red brown, v stiff, dry to damp, 50% v fine sand, tr med to cse sand, black rootlets	
					SM	SILTY SAND: red brown, stiff, dry to damp, 65% fine to med sand, tr cse sand, silt is <15% below 29.7	
					SP	SAND: tan dry, compact, 90% v fine subang sand, tr med to cse sand/fine pebbles, black organic debris is oriented parallel to hz laminations, sharp base	
31					CL/ML		
					UNK	SANDY CLAY/SILT: lt brown, v stiff, dry, laminated w/ sand a.a., abundant black organic debris	

LOG OF WELL PS-4 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-4
DATE STARTED 1/3/89 COMPLETED 1/6/89
ELEVATION 264.34 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK	NO RECOVERY 31' TO 33'	
					SP/SM	SAND: red brown to tan, damp, compact, 70% v fine to fine sand, 20%med to cse subang sand, 10% fines strata of silty sand at 35.6' (both hz and x), much black organic debris parallel to laminae, sand is cleanbet 34.8' and 35.2', gradational base	
					SM	SILTY SAND: brown, v stiff, dry, 50% med sand bound in brown silt matrix, hz lamination	
37					UNK	NO RECOVERY 37' TO 38'	
					SW	SAND: lt brown, dry to damp, loose, fine to med subang to subrnd arkosic sand, tr silt, tr cse subrnd sand, uniform, sharp base	
					SP/GP	GRAVELLY SAND: pale tan, dry, loose, 20% granules to fine gravel (volc & gr) in a med to cse subang sand matrix (70% qtz, 20% white feld, 10% lith frags), sharp base	
					SW/SM	SAND: A.A., damp	
42					UNK	NO RECOVERY 41' TO 43'	
					SW	SAND: tan dry to damp, v fine to med subang to subrnd arkosic sand, tr fines, cse sand above sharp base	
					ML/CL	SANDY SILT/CLAY: red brown, stiff, sli plastic dry to damp, 30% fine sand to fine pebbles, tr black organic debris, blocky fracture, gradational base	
					SM	SILTY SAND: red brown, dry to damp, sli plastic, 65% med to cse subang sand bound in silt matrix, gradational base	
					SP	SAND: brown, dry, loose, fine sand w/tr med to cse sand, uniform, sharp base	
47					SM	SILTY SAND: greenish brown, dry to damp, stiff, white lense shaped zones do not eff in HCl	

LOG OF WELL PS-4 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-4 CLIENT WESTDIVNAVFACENGCOM
DATE STARTED 1/3/89 COMPLETED 1/6/89 PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
ELEVATION 264.34 ft (ground level) GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					SP/SM	SAND: brown, damp, loose, fine to med subang arkosic sand, 15% silt, gradational base	
					SM	SILTY SAND: brown, dry to damp, mod stiff, 65% med to cse sand, ext friable w/blocky fracture, gradational base	
					SW	SAND: lt brown, damp, sli cohesive, 70% fine to med subang to subrnd sand, 15% cse subrnd qtz & feld sand, 15% fines, basal .2' is a clean arkosic sand sharp base	
					ML/CL	SILT/CLAY: dk brown, dry, sli plastic, stiff, gradational base	
					UNK	SANDY SILT/CLAY: stratified, brown, dry to damp stiff, 15% cse subang to subrnd sand in matrix of fines, and 20% fine to med sand in silt/clay matrix (a.a.)	
53							
					SM	SILTY SAND: lt brown, dry, loose, 85% sand-fine to med at top to fine to cse at base, fine pebble sized flat green slate chips appear at 55', gradational base	
					SW	SAND: tan, dry, loose, med to cse lithic sand (60% qtz, 25% lith frags, 15% feld), gradational base	
					GP/SP	GRAVELLY SAND: tan, dry, loose, rnd pea gravel in a cse sand matrix, gravel is volc w/ some gr and qtz pebbles, sharp base	
					SM	SILTY SAND: A.A., w/rnd pea gravel	
					UNK		
58							
					SW	SAND: lt brown, damp to dry, loose, med to cse, subrnd sand (70% qtz, 20% white feld, 10% lith frag) tr fines, csens downward	
					GP	GRAVEL: fine to cse, rnd pebbles in sand matrix (a.a.) sharp base	
					SM	SILTY SAND: lt brown, damp, loose, 85% vfine to fine sand, trcser sand, hz tan and brown laminae, gradational base	
					SW/SM	SAND: tan, dry to damp, loose to mod stiff, fine to med w/tr cse subang to subrnd sand, variable (tr to 15%) silt content, silt rich strata have sharp boundaries, sharp subhz base	
					SM		
					UNK	SILTY SAND: brown, stiff, dry to damp, 65% med sand to fine pebbles bound in silt matrix	
63							
					SW		

LOG OF WELL PS-4 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-4
DATE STARTED 1/3/89 COMPLETED 1/6/89
ELEVATION 264.34 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					SW	SAND: brown, dry to damp, loose, fine to cse subang to subrnd arkosic sand, tr rnd pebbles, gradational base	
					GP	GRAVEL: brown, dry to damp, loose, fine to cse rnd pebbles in med to cse sand matrix, gradational base	
					SP	SAND: A.A., cser, 15% white feld, x-laminae of cse sand/granules, sharp subhz base	
					SW	SAND: as at 64.1, a few x-strata fo cser sand a.a., sharp base	
					SM	SILTY SAND: dk brown, dry to damp, v stiff, 85% fine to cse sand bound in silt matrix, tr rnd pea gravel	
69					SP/GP	GRAVELLY SAND: lt brown, damp to dry, loose to sli cohesive, hz stratified cse arkosic sand, fine brown subrnd sand, well graded fine to cse sand, and granule/fine pebble layers, sand is generally arkosic, clean, some layers have tr silt, tr organic debris	
					UNK	NO RECOVERY 72' TO 73'	
74					SP/GP	SAND AND GRAVEL: tan, dry, loose, med to cse subang to subrnd sand, x-stratified w/cse rnd volc pebbles, some sand strata are 30% white subang feld	
					UNK	NO RECOVERY 75' TO 80'	
79							

LOG OF WELL PS-4 (continued)

JAMES M. MONTGOMERY
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501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-4
DATE STARTED 1/3/89 COMPLETED 1/6/89
ELEVATION 264.34 ft (ground level)
CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK	NO RECOVERY 80' TO 83'	
			8 22 28 29		SP SM CL/ML SM UNK	SAND: lt brown, saturated, loose, med to cse subang to subrnd arkosic sand (60% qtz, 20% white & pink feld, 20% lith frag), sharp base SILTY SAND: brown, sli cohesive, wet at top to moist at base, silt increases from 10% at top to 30% at base, sand is a.a., sharp subhz base CLAY/SILT: dk brown, damp, plastic, v stiff, much black organic debris at 84.55', laminated, tr sand sharp base SILTY SAND: brown, A.A., damp, stiff	
85							
			6 15 22 27		SW SW/ML UNK	SAND: lt brown, saturated, loose, cse subrnd arkosic sand, sharp subhz base STRATIFIED SOIL: cse sand (a.a.), brown silty sand, and silt/clay, fines are laminated, black organic debris abundant in fines, saadns are sat, fines are damp to wet	
90							
			8 16 18 28		CL/ML UNK	SANDY CLAY/SILT: brown, stiff, damp to dry, plastic, sand decreases from 50% in upper .5' (cse subrnd), to tr to 20% in lower 1.5' (fine to cse), clay varies from brown to olive greenish brown in sep laminae, black organic debris is abundant	
95							

LOG OF WELL PS-4 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-4
DATE STARTED 1/3/89 COMPLETED 1/6/89
ELEVATION 264.34 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
	X		8 16 16 21		SC CH SC	SANDY CLAY: gray brown, stiff, sticky, 50% cse sub-rnd sand in brown clay matrix, gradational base CLAY: red brown, stiff dry to damp, plastic, tr sand, laminated, green gray mottling, sand/silt increases to gradational base	
					UNK	SANDY CLAY: plastic, sticky, damp, as clay above w/v fine to fine sand, cse sand sized black organic debris	
101							
	X		11 45 71 86		SP SM ML UNK	SAND: tan, loose, wet, v clean, v well sorted, fine subang arkosic uniform sand, tr fines, 70% qtz, 15% white feld, 15% lith frag, cse sand at sharp base SILTY SAND: brown, stiff, moist, x-stratified w/ some sandier layers, lower .2' contains black organic chips	
106							
						NO RECOVERY 108' TO 118.5' DUE TO SAND HEAVE	
111							

LOG OF WELL PS-4 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-4
DATE STARTED 1/3/89 COMPLETED 1/6/89
ELEVATION 264.34 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
117							
122							
						NO RECOVERY 118.5' TO 125' DUE TO SAND HEAVE	
127							

LOG OF WELL PS-4 (continued)

JAMES M.MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-5
DATE STARTED 1/5/89 COMPLETED 1/7/89
ELEVATION 255.14 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER & JENNIFER GOODELL

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
5	X		13 9 10 11		ML SM	SANDY SILT/SILTY SAND: dk brown, damp to dry, mod stiff (crumbles easily), sub vert tubes, rootlets (esp at top), between 30 & 65%, fine to cse, sub-ang to subrnd sand, tr fine pebbles, vert crack filled w/arkosic med sand from 4.7' to 5.5'.	
					UNK		
10	X		6 5 7 6		ML CL SW ML CL	upper .2' MARL: tan, powdery, fines (silt & clay) tr sand, eff in hcl, dry. 9.7' to 9.8' SAND: tan, loose, dry, cse subang, arkosic sand, sharp base. 9.8' to 11.5' SANDY SILTY/CLAY: brown, dry to damp, mod stiff, sub hz, dend tan mott. eff in hcl (so does matrix), 30% med subrnd sand, sli plastic.	
					UNK		
15	X		2 6 7		SM SC	SANDY SILT/CLAY: 14.5' to 15', red-brown, a.a., damp grades down. SILTY/CLAYEY SAND: red-brown, cse basalt pebbles at top, sand increases down, 50% top to 70% bottom, fine to cse subrnd arkosic sand, matrix eff.in hcl	

METHOD OF DRILLING HOLLOW STEM AUGER
HOLE DIAMETER 10 inches
TOTAL DEPTH 123.8 feet

WELL COMPLETION DEPTH 126.5 feet
WELL DIAMETER 4" inches
WELL MATERIAL SCH. 40 PVC

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-5
DATE STARTED 1/5/89 COMPLETED 1/7/89
ELEVATION 255.14 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER & JENNIFER GOODELL

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
	X		7		SM/SC UNK		
21	X		3 4 4 4		SM/SC UNK	SILTY SAND: a.a., sand 75%, tr rnd qtz peagravel, many dk gray basalt sand clasts.	
26	X		7 16 31 22		SM/GM SM/SW UNK	SILTY/SAND: a.a., stiffer, 15% med to fine subang pebbles in upper.2', lite brn also, sli eff in hcl 75 to 80% med subrnd sand below gravel, sand fines to bottom (fine to med at base) abrupt color chng from red-brown to grayish at 26.3', grayish sand is better sorted.	
31	X		6 11 13 16		SM/SC UNK	SILTY/CLAYEY SAND: a.a., damp to moist, much tan irreg mottling, sharp base at 30' top of stratified silty sand a.a. & cleaner cse subrnd sands, x-strata at base of sample, strata have sharp contacts, clean layers are loose & moist, some siltier strata contain black organic mat'l (rootlets) sand in cse clean zones is subrnd & 88% qtz, color change from lt brown to red-brown at 30.7'.	

LOG OF WELL PS-5 (continued)

JAMES M. MONTGOMERY
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501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-5
DATE STARTED 1/5/89 COMPLETED 1/7/89
ELEVATION 255.14 ft (ground level)
CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER & JENNIFER GOODELL

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
	X		5 7 12 14		CL SC SM CL ML	SANDY CLAY: brown, wet, plastic, 35% fine sand in clay matrix, sharp base. SAND: brown, fine to med, subrnd to subang arkosic sand, 5% black mica, sharp.hz base, saturated. SANDY CLAY/SILT: top .5' is black from organic debris, remainder is red-brown, mica abundant in upper .3' 35% med to cse, subang sand in matrix of fines moist.	
					UNK		
37							
	X		7 16 20 21		CL	SANDY CLAY: red-brown, damp to dry, v. stiff plastic, blocky to hackly fracture w/ shiny surfaces much (3-5%) black organic debris. tr to 30% fines med sand, greenish tan irreg. mot.	
					UNK		
42							
	X		8 14 22 22		CL	SANDY CLAY: a.a., .5mm tan, trellis-like rootlets, sparse white patches/concretions do not eff in hcl top appears to be sand free to 44.8', dry.	
					UNK		
47							

LOG OF WELL PS-5 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-5
DATE STARTED 1/5/89 COMPLETED 1/7/89
ELEVATION 255.14 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER & JENNIFER GOODELL

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
	X		4 9 17 12		CL SC SW UNK	SANDY CLAY: a.a., sand gradually increases to 50.2' CLAYEY SAND: a.a., gradational base SAND: at 51.2': red-brown, loose, damp, fine to med subang sand, 5% black mica.	
53							
	X		10 17 26 28		SC UNK	SANDY CLAY: a.a., tan sub-vert zones (often coincide w/black rootlets) eff in hcl tr cse rnd qtz sand	
58							
	X		10 13 28 21		CL/ML SW UNK	SILT/CLAY: brown, tr sand, damp, plastic, sand increases towards base, green-gray mott, gradational base at 60' SANDY SILT/CLAY: brown, damp, plastic, sand is fine to med & increases to base, tan dendritic tubes eff in hcl (rootlet casts?) tan mott is in hz discontinuous lenses at 61' to 61.2', sharp base SAND: tan, dry, loose fine to med w/trace of cse, subang to subrnd, arkosic sand-uniform, laminated green caliche(?) at base.	
63							

LOG OF WELL PS-5 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-5
DATE STARTED 1/5/89 COMPLETED 1/7/89
ELEVATION 255.14 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER & JENNIFER GOODELL

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
	X		24 37 47 42		SM SC	SILTY SAND: orange-brown, damp, sli cohesive, 75 to 90% fine, subang to subrnd sand w/silt matrix, tan dendritic zones which eff in hcl appear at 66', tr of ang to subang cse qtz sand, poorly developed blocky fracture.	
					UNK		
69							
	X		13 22 24 30		SM SM SW	SILTY SAND: brown to 70', orange-brown to bottom, color change is & sharp coincides w/ decrease in silt from 25% to <10%, fine to cse subang to subrnd sand, finer at top and cse sand increases to base, uniform, damp, sli cohesive, upper 6" is mod stiff/sli plastic.	
					UNK		
74							
	X		13 21 22 21		SM	SILTY SAND: brown, damp, sli plastic, 85% fine to med subang sand in silt matrix, med rnd pebbles at 74.8', tr cse qtz sand, tr black organic debris.	
					UNK		
79							
	X		10		SM		

LOG OF WELL PS-5 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-5
DATE STARTED 1/5/89 COMPLETED 1/7/89
ELEVATION 255.14 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER & JENNIFER GOODELL

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
	X		21 23 31		SM UNK	SILTY SAND: dk brown, sli plastic, v. fine sand tr gravel, @ 80.0-80.5 coarse sand w/ pebbles (10-15%) less silt @ 80.5-81.5, lt brown/tan mottled, med fine/cse sand, med dense.	
85	X		14 23 33 33		ML SP SM UNK	SANDY SILT: lt brown w/ v.f. sand, sli plastic, damp. SILTY SAND: loose, tr silt (15%) sand cse, subang/subrnd, becoming less coarse @80.5, tan, reddish-brown, sand poorly graded 80.5'-81.5'.	
90	X		13 26 31 42		ML SM SP UNK	SANDY SILT: brown w/ v.f. sand, sli plastic, damp. SILTY SAND: @ 90.0', silt 10%, sand fine to coarse, well graded, subang/subrnd w/ zones of cse/fine sand saturated.	
95					SM UNK	SILTY SAND: tr silt (5%) sand med to cse. (sand heave)	

LOG OF WELL PS-5 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-5
DATE STARTED 1/5/89 COMPLETED 1/7/89
ELEVATION 255.14 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER & JENNIFER GOODELL

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
			11		CL	SILTY CLAY: dk brn, stiff, damp, plastic, gradational base	
			9		ML	SANDY SILT: dk brown, sli plastic, damp, sand 5-10%, med grained.	
			16				
101			23				
					UNK		
						not sampled - 17' of heaving sand in stem	
106							
			14		SP	SAND: brown, sat, loose to sli cohesive, med to cse, subrnd qtz sand (10% white feld, 10% lith frags)	
			16		SM		
			21			SILTY SAND: brown, moist, mod stiff, 50-80% sand w/brown silt matrix, tr black organic debris, sand is fine to cse w/10% cse subrnd qtz & tr pebbles qtz, tr pebbles.	
111			30				
					UNK		

LOG OF WELL PS-5 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-5
DATE STARTED 1/5/89 COMPLETED 1/7/89
ELEVATION 255.14 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER & JENNIFER GOODELL

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
	X		16 16 15 22		SP	SAND: lt brown, loose, sat, csens downward, fine to med at top, to med to cse at bottom, subrnd to subang sand, tr granules, subang to subrnd in lower 1.5, 70% qtz, 15% white feld, 15% lith frags sharp non-hz base	
					SW		
117					CL/CH UNK	CLAY: brown, plastic, sli sticky, tr fine to cse sand, laminated w/ nearly black organic rich layers.	
	X		4 12 19 26		SW	SAND: tan, sat, loose, fine, subang arkosic sand, csens to med subrnd sand at 120.3, med sand is brown, sat w/15% silt.	
					SM	SILTY SAND: brown, moist to wet, mod stiff, 30% brown silt, 70% fine to cse qtz sand, tr rnd med pebbles, sli plastic, sharp top.	
122					UNK		
	X		7 18 20 32		SP	SAND: tan, sat to wet, loose, v. fine subang sand, tr rnd peagravel, up to 5% silt.	
127							

LOG OF WELL PS-5 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-6
DATE STARTED 1/10/89 COMPLETED 1/14/89
ELEVATION 269.18 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
5	X		5 4 5 6		SM	SILTY SAND: brown in upper .1', pale red-brown in remainder, 65% fine sand w/silt matrix, tr med subang gravel top & bottom, dry, loose	
					UNK		
10	X		11 35 40 25		ML SW/SP	SANDY SILT: brown, 45% fine sand, dry, stiff to loose, tan dend mott eff in hcl, sharp base SAND: pale red-brown, dry, loose, v. fine to fine at top to fine to cse at base, arkosic, subang to subrnd sand, tr silt, sharp base of cse sand above sandy silt-a.a. in shoe	
					UNK		
15	X		5 5 7 5		SW SM	SAND: red-brown (pale), dry, loose, med to cse, subang arkosic sand tr silt, silt increases gradually to 15% at base	

METHOD OF DRILLING HOLLOW STEM AUGER
HOLE DIAMETER 10" inches
TOTAL DEPTH 155 feet

WELL COMPLETION DEPTH 151 feet
WELL DIAMETER 4" inches
WELL MATERIAL SCH. 40 PVC

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-6
DATE STARTED 1/10/89 COMPLETED 1/14/89
ELEVATION 269.18 ft (ground level)
CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
	X		5 4 4 4		SW ML	SAND: a.a. sli more fine sand, sharp base SILTY SAND: a.a., rootlets along dend zones, grades to sand a.a. at 19.8', silty sand a.a. in shoe	
21					UNK		
	X		5 5 8 5		ML SM ML	SANDY SILT: brown, dry to damp, mod stiff, 35% med to cse subrnd to subang sand bound in silt matrix, gradational base SILTY SAND: lt brown, dry, loose 85% fine to cse subrnd to subang arkosic sand, sharp base fines decrease to base.	
26					UNK	SANDY SILT: a.a., sli plastic.	
	X		4 7 10 12		ML	SANDY SILT: brown, damp to dry, mod stiff, tr to 20% v. fine to cse sand, mica, sub vert. tubes (rootlet molds?), sub hz to sub vert tan mott, zones - eff sli in hcl.	
31					UNK		

LOG OF WELL PS-6 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-6
DATE STARTED 1/10/89 COMPLETED 1/14/89
ELEVATION 269.18 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
			6 10 10 13		ML/CL SP	SILT/CLAY: dk brown, dry to damp, mod stiff, tr to 15% med sand, plastic, sharp base at 34.5'. SAND: tan, dry to damp, loose, fine to med subang arkosic sand (70% qtz, 15% white feld, 15% lith frags), uniform, tr cse subang sand, mica.	
					UNK		
37							
			5 9 18 20		ML/CL CH/MH	SILT/CLAY TO SANDY SILT/CLAY: red-brown, damp to dry, stiff, plastic, tr to 20% sand, sub vert dend tubes, lower .15' has blocky fractures coated w/black organic material & tr sand.	
					UNK		
42							
			7 14 20 22		ML/CL UNK	SANDY SILT/CLAY: red-brown, damp to dry, plastic, plasticity decreases to base, tr to 35% fine to cse subang to rnd sand, cser sand is better rndd, dend black rootlets, blocky fracture is poorly developed, sand increases in lower 9", tan mat'l replaces matrix in random patches	
47							

LOG OF WELL PS-6 (continued)

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-6
DATE STARTED 1/10/89 COMPLETED 1/14/89
ELEVATION 269.18 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
50	X		11 17 26 28		ML	SANDY SILT: a.a., not plastic to sli plastic, no tan patches, hz and vert blocky fracture fairly well developed	
					UNK		
55	X		5 11 14 20		ML	SANDY SILT: a.a., not v. much org. mat'l, mod stiff to nearly loose, dry, lower 1/2 contains dendritic network of eff mat'l	
					UNK		
60	X		20 70 65 69		ML SP/SM	SANDY SILT: a.a. w/40% med to cse sand, black sub vert rootlets w/greenish & rust-orange zones, sharp base SAND: tan, damp (wet at 60'), loose, cse, subrnd at base, sand clasts are diorite, much mica & silt at base, soil is silty sand.	
					UNK		

LOG OF WELL PS-6 (continued)

JAMES M.MONTGOMERY
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501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-6 CLIENT WESTDIVNAVFACENGCOM
DATE STARTED 1/10/89 COMPLETED 1/14/89 PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
ELEVATION 269.18 ft (ground level) GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
66			7 16 34 41		ML/CL UNK	SANDY SILT/CLAY: red-brown, dry to damp, stiff, tr to 40% fine to cse subrnd sand (qtz & volc), sand is variable & sample is stratified w/sand free & sand rich strata w/sharp bndrys, a tan to white coated fracture divides the sample vert is connected to a dendritic tan network, tan mat'l eff in hcl.	
71			13 19 24 25		CL/ML SP UNK	SANDY CLAY/SILT: brown, dry to damp, stiff, 35% med to cse subang to subrnd sand, sharp base. SAND: tan, dry to damp, loose, 95% fine subang arkosic sand (75% qtz, 15% white feld, 15% mica & lith frags), uniform, 5% med to cse, laminated gray sandy silt layer w/ sharp contacts at 69.5'.	
76			15 51 59 61		SM/GM GP/SW UNK	SILTY SAND: brown, dry, v. stiff, 45% granules & cse subrnd to rnd sand, matrix bound, eff tan patches, sharp base. SANDY GRAVEL: brown, fine to cse rnd pebbles (qtzite, gr, slate) in sand matrix, matrix is fine to cse, subrnd to rnd qtzose arkosic sand, orange mott in patches.	
			11 37		ML/CL SM	SANDY SILT/CLAY: brown, dry, stiff, tr to 35% med to cse sand to granules(rnd) bound in sli plastic matrix, sharp base.	

LOG OF WELL PS-6 (continued)

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BORING/WELL NUMBER PS-6 CLIENT WESTDIVNAVFACENGCOM
DATE STARTED 1/10/89 COMPLETED 1/14/89 PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
ELEVATION 269.18 ft (ground level) GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
	X		35 39		SM ML/CL UNK	SILTY SAND: brown, damp, loose to sli cohesive, 85% fine to cse subang to subrnd arkosic sand in silt matrix, sharp base above stratified sandy gray silt/clay w/white non eff top.	
82							
	X		6 18 26 41		ML/SM UNK	SANDY SILT/SILTY SAND: red-brown, dry, v. stiff, 30% v. fine to fine sand bound in silt matrix, dend black organic mat'l, sparse dend white non eff patches, sli plastic, greenish gray mott	
87							
	X		22 27 39 53		SM/ML UNK	SILTY SAND/SANDY SILT: red-brown, damp to dry, stiff, 35% red-brown fines, 65% fine to cse subang to subrnd sand, tr fine subrnd pebbles, one tubular pale green ash/met(?) frag, one cse subrnd pebble at 90', an irreg green gray tube extends from 89.8' to 90.4'	
92							
	X		12 25 27 30		SM/SC SP SP/SM	SAND: lt greenish-brown, damp, loose sli cohesive, silty-clayey at top to v. fine to fine at base, plastic at top, sharp base above brown silty cse sand in shoe	

LOG OF WELL PS-6 (continued)

JAMES M. MONTGOMERY
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501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-6
DATE STARTED 1/10/89 COMPLETED 1/14/89
ELEVATION 269.18 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
98							
	X		9 28 37 36		ML CL SP	SANDY SILT/CLAY: brown, dry, stiff, sli plastic, 40% fine to cse subang to subrnd sand, sharp base SAND: tan, dry to damp, loose, fine to med subang, arkosic at top to v. fine greenish-gray damp sand at base, tr black organic mat'l	
					UNK		
103							
	X		48 58 63 76		SP SP SM	SAND: lt brown, loose, dry to damp, fine to med subang arkosic sand, sharp base ASH(?): tan chalky mat'l w/some fine to med sand, as in other wells, sharp base SAND: tan, dry, loose, x-stratified, some silty laminae & strata of fine, cse & silty fine to med arkosic sand	
					UNK		
108							
	X		12 15 20 17		ML	SANDY SILT: brown, damp to moist, mod stiff, 35% fine sand, 10% cse subrnd qtz sand, cse sand forms a one clast thick, x-laminae at center of sample, vert fine sand filled tubes, in shoe are tan ripples in v. fine sand & silt.	
					UNK		

LOG OF WELL PS-6 (continued)

JAMES M. MONTGOMERY
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BORING/WELL NUMBER PS-6
DATE STARTED 1/10/89 COMPLETED 1/14/89
ELEVATION 269.18 ft (ground level)
CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
114	X		15 17 22 31		SP SM	SILTY SAND/SANDY SILT: red-brown, damp, stiff 50% med to cse subang to subrnd sand (mostly qtz w/ some feld & lith frags), irreg green-gray mott, tr med subrnd volc & gr pebbles.	
					UNK		
119	X		17 20 56 74		SP ML SW	SAND: brown, sat, cohesive, 95% fine sand, 5% cse subang sand, tr fines, grad base. SANDY SILT: brown, damp to moist, stiff, sli sli plastic, sharp base. SAND: tan, wet to sat, loose, csens down from med to cse subang to subrnd arkosic sand (70% qtz & 15% each feld & lith frags), tr. fine rnd pebbles, pebbles most abundant at base.	
					UNK		
124						N.R. 10' of sand heave	

LOG OF WELL PS-6 (continued)

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GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK	N.R. due to sand heave	
130							
			13 22		SW	SOUPY SAND (upper 1'): brown sat flowed out of sampler, fine to cse subrnd to subang sand, (sand heave)	
135			26 36		CL/ML	SANDY CLAY/SILT: greenish-brown, damp to moist, stiff sand increases from tr at top to 45% at base, fine to med, subrnd to subang sand	
					UNK		
						N.R. due to sand heave	
140							

LOG OF WELL PS-6 (continued)

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BORING/WELL NUMBER PS-6
DATE STARTED 1/10/89 COMPLETED 1/14/89
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CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG BELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
			17 26 27		SP	SAND, upper 1.5': lt brown, sat, loose med subang to subrnd arkosic sand, 75% qtz, 15% white feld, 10% lith frags, tr fines, sharp base	
146			30		CL UNK	CLAY: brown, damp to dry, plastic, tr cse subrnd qtz sand, black organic mat'l	
151			8 13 20 18		SP	SAND: brown, sat, loose, 10% cse subrnd qtz & lith sand, bimodal	
156							

LOG OF WELL PS-6 (continued)

JAMES M.MONTGOMERY
CONSULTING ENGINEERS, INC.
501 LENNON LANE, WALNUT CREEK, CALIFORNIA, 94598 / (415) 933-2250

BORING/WELL NUMBER PS-8
DATE STARTED 1/8/89 COMPLETED 1/12/89
ELEVATION 281.83 ft (ground level)

CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
	X		3 3 4 4		ML/SM	SANDY SILT/SILTY SAND: brown, 30 to 50% v. fine to fine sand in brown silt matrix, sli cohesive, plastic, damp, rootlets, poorly developed blocky fracture	
5					UNK		
	X		5 7 8 8		SM	SILTY SAND: pale red-brown, dry, crumbles easily, 80% fine to med, subang to subrnd arkosic sand, some clay chips, gold mica, white dend zones eff in hcl as does matrix, rootlets tr pebbles & rust-orange mott at top	
10					UNK		
	X		3 7 11 14		CL/ML	CLAY/SILT: dk brown, dry to damp, mod stiff, tr to 10% cse subrnd to subang sand, sli plastic, plasticity decreases w/depth, tan irreg zones eff in hcl	
15					UNK		

METHOD OF DRILLING HOLLOW STEM AUGER
HOLE DIAMETER 8 inches
TOTAL DEPTH 145 feet

WELL COMPLETION DEPTH 145.5 feet
WELL DIAMETER 4" inches
WELL MATERIAL SCH. 40 PVC

JAMES M. MONTGOMERY
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DATE STARTED 1/8/89 COMPLETED 1/12/89 PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
ELEVATION 281.83 ft (ground level) GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
	X		3 3 4 6		SM	SILTY SAND: pale red-brown, dry to damp, a.a., tan zones thinner than above & not as abundant, tr cse subrnd sand	
					UNK		
21							
	X		5 11 14 17		CL/ML	CLAY/SILT: brown at top to red-brown at 23.5' to base, dry to damp, stiff, poor blocky fracture surfaces w/greenish-gray coloration, tr black organic debris, tr subang cse sand, rootlets sparse tan zones eff in hcl	
					UNK		
26							
	X		5 9 15 21		CL/ML	CLAY/SILT: a.a., all brown, black organic debris more abundant, tr volc pebbles at top, no noticeable blocky fracture, tr fine tan sand lenses at 28.5'	
					UNK		
31							

LOG OF WELL PS-8 (continued)

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GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
	X		11 23 68 88		ML	SANDY SILT: pale red-brown, dry sli plastic v. stiff, sandy layer at 33.3' to 33.8' has 35% med to cse subrnd sand, blocky vert fracture zones, dendritic green-gray mott, much black organic mat'l, white chalky patches at top don't eff in hcl	
					UNK		
37							
	X		14 14 18 22		SM	SILTY SAND: lt brown, damp to dry, loose sli cohesive stratified layers of sand w/10-15% silt and layers w/25% silt, color darker in siltier layers, strata boundries are sharp, sand is fine to med (tr cse) subang to subrnd, tr black organic debris.	
					UNK		
42							
	X		5 16 36		CL	CLAY: brown, damp to dry, v. stiff, plastic tr sand at top, sand gradually increases to base sparse tan mott doesn't eff in hcl, tr med sand & pebbles (one is flat pale greenish-ash or meta)	
			25		SM	CLAYEY SAND: 85% fine subang sand w/20% fines dry to damp, loose, sli cohesive, pebble at top, red-brown	
					UNK		
47							

LOG OF WELL PS-8 (continued)

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BORING/WELL NUMBER PS-8
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CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
			8 12		ML	SANDY SILT: brown, dry, stiff, tr to 50% fine to med, subang to subrnd sand, gradational base	
			21 25		SM	SILTY SAND: red-brown, damp to dry, loose, sli cohesive, fine subang sand (90%) tr cser sand, tr black organic mat, tan irreg zones do not eff in hcl	
					UNK		
53			7 13		ML	SANDY SILT: brown, dry to damp, mod stiff, tr cse subrnd sand/granules, sharp base, 30% v. fine sand, sli plastic, sharp base	
			15 16		SM	SILTY SAND: pale red-brown, dry to damp, loose to sli cohesive, 85% v. fine to fine sand, black mica tubes encapsulated in white non-eff mat'l, tr fine to med subrnd pebbles at base.	
					UNK		
58			8 27		SM SC	SANDY SILT/CLAY: brown, dry, stiff, 40% med to cse subang sand (mostly qtz - some white feld), sharp base	
			48 80		SP	SAND: greenish-gray, damp to dry, mod stiff, 90% v. fine to fine sand, 10% cse subang sand (lith & qtz) white sub vert zones eff in hcl, hz cse sand laminae appear in lower 5".	
					UNK		
63			12		SP	SAND: as at 58' to 60', sharp base	
			48		CL SM	SANDY CLAY: gray-brown, damp to dry, v stiff, 30% v. fine to fine sand, gradational base	

LOG OF WELL PS-8 (continued)

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GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
			68 80		SM CL CH UNK	SILTY SAND: red-brown, dry to damp, sli cohesive, 90% med subang sand (80% qtz, 15% feld, lith & black mica, 10% silt), tr granules, gradational base SANDY CLAY: brown, dry to damp, v. stiff, dend white zones	
69			8 16 24 38		ML SM UNK	SANDY SILT/SILTY SAND: red-brown, dry to damp, silt is stiff, sand loose to sli cohesive, sand is fine to cse, arkosic, cse sand is mostly subang qtz w/lesser white feld, tan sub vert tube of white mat.-replaces silt matrix around sand clasts, eff in hcl.	
74			26 36 46 52		SP UNK	SAND: red-brown, damp, loose to sli cohesive, 95% v. fine, subang sand, abundant mica, 5% cse subrnd qtz & lith sand, tr silt, uniform.	
79			12 22 32 42		SM	SILTY SAND/SANDY SILT: brown, dry to damp, stiff, 50% fine to cse subang to subrnd sand bound in silt matrix, sli plastic abundant black rootlets-some encased by white non-eff min'l, poorly developed blocky fracture	

LOG OF WELL PS-8 (continued)

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GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
	X		11 27 42 46		SM SC SP	SANDY SILT/CLAY: brown, dry to damp, stiff, tr med to cse subrnd to subang sand, sharp base SAND: red-brown, damp, loose to sli cohesive, 90% fine subang sand, 10% cse subrnd sand (increases to base), tan mott, tr black organic mat'l	
85					UNK		
	X		30 48 56 75		SW	SAND: tan, dry to damp, loose, fine to cse, subang to subrnd qtzose sand (80% qtz, 10% feld, 10% lith frags) tr rnd med pebbles, top .25' is white powdery mat'l (ash?) similar to that described in other wells (sharp base).	
90					UNK		
	X		58 100			No recovery	
95							

LOG OF WELL PS-8 (continued)

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DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
	X		24 30 49 41		SC SM SP	SANDY CLAY: brown, v. stiff, dry, tr of sand at top to 35% sand at base, sand is cse subang to subrnd qtz & fled, gradational base SAND: tan, damp, loose, variable silt (tr to 10%), 85% fine subang sand, 15% cse subang sand uniform.	
					UNK		
101							
	X		7 30 45 34		ML CL SM	SANDY SILT/CLAY: greenish-brown, dry, stiff, 15% cse subrnd qtz sand, black mica, gradational base. SILTY SAND: brown, dry to damp, loose, 85% fine to cse subang sand (arkosic), black mica gradational base.	
					UNK		
106							
	X		20 31 59 74		CL SP UNK	SANDY CLAY/SILT: brown, sticky, wet, plastic, 30% med subang arkosic sand, sharp base SAND: brown, sat to wet, sli cohesive, fine to med subrnd arkosic sand, fine to med rnd pebbles in shoe, .5cm diam sub vert white tubes - no eff in HCl	
111							

LOG OF WELL PS-8 (continued)

JAMES M. MONTGOMERY
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BORING/WELL NUMBER PS-8 CLIENT WESTDIVNAVFACENGCOM
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ELEVATION 281.83 ft (ground level) GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
	X		14 20 32 43		SW CL SW	SAND: lt brown, sat, loose, fine to cse subrnd to subang arkosic sand, sharp base. SANDY CLAY: olive green, sticky (wet), dries to moist at base, stiff, plastic, tr to 20% fine to cse sand, cse sand is well rnd to rnd, mica, sparse white mott, black organic rootlets, sharp base above sand, a.a.	
					UNK		
117							
	X		13 28 41 37		SP SM ML CL	SAND: lt brown, sat, loose, med to cse subrnd to rnd qtz rich sand, tr to 10% fines, sharp base SANDY SILT/CLAY: brown, sticky wet to damp, laminated, some black organic laminae, tr to 40% fine to cse subang to subrnd sand, sand strata w/sharp boundaries are sat, black mica oriented parallel to laminae	
					UNK		
122							
	X		22 22 27 42		SW	SAND: brown, wet to sat, cohesive, v. fine to med, subang to subrnd arkosic sand (75% qtz, 15% white feld, 10% lith frags) tr to 5% silt, tr fine subrnd volc pebbles, uniform.	
					UNK		
127							

LOG OF WELL PS-8 (continued)

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BORING/WELL NUMBER PS-8 CLIENT WESTDIVNAVFACENGCOM
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ELEVATION 281.83 ft (ground level) GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK		
	X		11 22 47 56		CL	Heave in upper .5', fine to cse sat sand, a.a. CLAY: laminated greenish brown & red-brown clay, abundant black organic mat'l, a 1.5cm organic layer in shoe, plastic, tr cse subang to subrnd sand, abundant mica.	
					UNK		
133							
	X		15 33 34 37		CH	CLAY: a.a., 3-1cm black organic layers, red-brown areas are irreg patches	
					UNK		
138						No recovery - 28' of sand heave	
143						No recovery - 20' sand heave in stem	

LOG OF WELL PS-8 (continued)

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CLIENT WESTDIVNAVFACENGCOM
PROJECT PERIMETER INVESTIGATION MCAS-EL TORO
GEOLOGIST GREG RELLER

DEPTH feet	SAMPLE	SAMP. NO.	BLOWS/6 IN	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	COMMENTS
					UNK	NO RECOVERY DUE TO HEAVING SAND	
149							
154							
159							

LOG OF WELL PS-8 (continued)

APPENDIX B

LABORATORY RESULTS OF VOLATILE ORGANIC ANALYSIS

B.1 TIC-55 DEPTH-SPECIFIC SAMPLES

MCAS - EL TORO PERIMETER INVESTIGATION
SUMMARY OF SYRINGE SAMPLE RESULTS
TIC-55

COMPOUND	Detection Limit (ug/l)	DOHS Action Level (ug/l)	Concentration (ug/l) Sample Depths (ft) 312.0	337.0	362.0	387.0	412.0	437.0
Chloroform	0.1		0.1	ND	ND	0.1	ND	ND
PCE	0.1	4	0.3	ND	ND	ND	ND	0.2
Toluene	0.5	100	1.0	ND	2.0	3.0	ND	ND
TCE	0.1	5	1.2	1.1	1.0	1.0	1.1	1.4
Acetone	10.0		ND	ND	ND	10.0	ND	ND

B.2 TIC-55 PACKER TEST SAMPLES

TIC - 55 PACKER TEST
ZONE I 298 - 344 ft depth

COMPOUNDS	Detection Limit (mg/l)	MCL (ug/l)	DOHS DW Action Level (ug/l)	CONCENTRATION (micrograms/liter) Pumping time, in minutes 30	60	90	120	150	180
VOLATILE PRIORITY POLLUTANTS:									
Acrolein	1.00			ND	NA	NA	NA	ND	ND
Acrylonitrile	1.00			ND	NA	NA	NA	ND	ND
Benzene	0.10	5	0.7	0.5	0.4	0.4	0.4	0.3	0.3
Bromoform	0.10			ND	NA	NA	NA	NA	NA
Carbon Tetrachloride	0.10	5	5	ND	NA	NA	NA	NA	NA
Chlorobenzene	0.10			ND	NA	NA	NA	NA	NA
Dibromochloromethane	0.10			ND	NA	NA	NA	NA	NA
Chloroethane	1.00			ND	NA	NA	NA	NA	NA
2-Chloroethylvinylether	1.00			ND	NA	NA	NA	NA	NA
Chloroform	0.10			ND	NA	NA	NA	NA	NA
Dichlorobromomethane	0.10			ND	NA	NA	NA	NA	NA
1,1-Dichloroethane	0.10		20	ND	NA	NA	NA	NA	NA
1,2-Dichloroethane	0.10	5	1	ND	NA	NA	NA	NA	NA
1,1-Dichloroethene	0.10	7	6	ND	ND	ND	ND	ND	ND
1,1-Dichloropropane	0.10			ND	NA	NA	NA	NA	NA
Ethylbenzene	0.10		680	2	NA	NA	NA	NA	NA
Methyl Bromide	1.00			ND	NA	NA	NA	NA	NA
Methyl Chloride	1.00			ND	NA	NA	NA	NA	NA
Methylene Chloride	5.00		40	ND	NA	NA	NA	NA	NA
1,1,2,2-Tetrachloroethene	0.10		1	ND	NA	NA	NA	NA	NA
Tetrachloroethene (PCE)	0.10		4	ND	0.1	0.1	0.1	0.1	0.1
Toluene	0.50		100	33	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	0.10	200	200	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	0.10		100	ND	NA	NA	NA	NA	NA
Trichloroethene (TCE)	0.10	5	5	0.60	0.7	0.7	0.80	0.80	0.70
Vinyl Chloride	1.00	2	2	ND	NA	NA	NA	NA	NA
trans-1,3-Dichloropropene	0.10			ND	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	0.10			ND	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	0.10		16	ND	NA	NA	NA	NA	NA
Trichlorofluoromethane	1.00		3400	ND	NA	NA	NA	NA	NA
VOLATILE NON-PRIORITY POLLUTANTS:									
Acetone	10.00			ND	NA	NA	NA	NA	NA
Methylethylketone	1.00			ND	NA	NA	NA	NA	NA
Tetrahydrofuran	1.00			ND	NA	NA	NA	NA	NA
m,p-Xylenes	0.10		620	7	NA	NA	NA	NA	NA
o-xylene	0.10		620	2.2	NA	NA	NA	NA	NA
Styrene	0.50			ND	NA	NA	NA	NA	NA

COMPOUNDS	Detection Limit (mg/l)	MCL (ug/l)	DOHS DW Action Level (ug/l)	CONCENTRATION (micrograms/liter) Pumping time, in minutes 30	60	90	120	150	180
1,2-Dibromo-3-chloropropane	10.00			NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	0.10			ND	NA	NA	NA	NA	NA
Propylbenzene	1.00			NA	NA	NA	NA	NA	NA
NON-VOLATILE PRIORITY POLLUTANTS:									
1,2-Dichlorobenzene	0.50		130	ND	NA	NA	NA	NA	NA
1,3-Dichlorobenzene	0.50		130	ND	NA	NA	NA	NA	NA
1,4-Dichlorobenzene	0.50		0.5	ND	NA	NA	NA	NA	NA
Trichlorobenzene	1.00			NA	NA	NA	NA	NA	NA
Naphthalene	1.00			NA	NA	NA	NA	NA	NA

ND: Non-Detectable
NA: Not Analyzed

TIC - 55 PACKER TEST
ZONE II 340 - 386 ft. depth

COMPOUNDS	Detection Limit (mg/l)	MCL (ug/l)	DOHS DW Action Level (ug/l)	CONCENTRATION (micrograms/liter) Pumping time, in minutes 30	60	90	120	150	180
VOLATILE PRIORITY POLLUTANTS:									
Acrolein	1.00			ND	NA	NA	NA	ND	ND
Acrylonitrile	1.00			ND	NA	NA	NA	ND	ND
Benzene	0.10	5	0.7	ND	0.1	0.1	0.1	0.1	0.1
Bromoform	0.10			ND	NA	NA	NA	NA	NA
Carbon Tetrachloride	0.10	5	5	ND	NA	NA	NA	NA	NA
Chlorobenzene	0.10			ND	NA	NA	NA	NA	NA
Dibromochloromethane	0.10			ND	NA	NA	NA	NA	NA
Chloroethane	1.00			ND	NA	NA	NA	NA	NA
2-Chloroethylvinylether	1.00			ND	NA	NA	NA	NA	NA
Chloroform	0.10			0.1	NA	NA	NA	NA	NA
Dichlorobromomethane	0.10			ND	NA	NA	NA	NA	NA
1,1-Dichloroethane	0.10		20	ND	NA	NA	NA	NA	NA
1,2-Dichloroethane	0.10	5	1	ND	NA	NA	NA	NA	NA
1,1-Dichloroethene	0.10	7	6	ND	ND	ND	ND	ND	ND
1,1-Dichloropropane	0.10			ND	NA	NA	NA	NA	NA
Ethylbenzene	0.10		680	0.5	NA	NA	NA	NA	NA
Methyl Bromide	1.00			ND	NA	NA	NA	NA	NA
Methyl Chloride	1.00			ND	NA	NA	NA	NA	NA
Methylene Chloride	5.00		40	ND	NA	NA	NA	NA	NA
1,1,2,2-Tetrachloroethene	0.10		1	ND	NA	NA	NA	NA	NA
Tetrachloroethene (PCE)	0.10		4	ND	0.1	0.1	0.1	0.1	0.1
Toluene	0.50		100	36	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	0.10	200	200	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	0.10		100	ND	NA	NA	NA	NA	NA
Trichloroethene (TCE)	0.10	5	5	0.70	0.9	0.6	1.00	0.90	1.00
Vinyl Chloride	1.00	2	2	ND	NA	NA	1	NA	NA
trans-1,3-Dichloropropene	0.10			ND	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	0.10			ND	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	0.10		16	ND	NA	NA	NA	NA	NA
Trichlorofluoromethane	1.00		3400	ND	NA	NA	NA	NA	NA
VOLATILE NON-PRIORITY POLLUTANTS:									
Acetone	10.00			ND	NA	NA	NA	NA	NA
Methylethylketone	1.00			ND	NA	NA	NA	NA	NA
Tetrahydrofuran	1.00			ND	NA	NA	NA	NA	NA
m,p-Xylenes	0.10		620	1.8	NA	NA	NA	NA	NA
o-xylene	0.10		620	0.6	NA	NA	NA	NA	NA
Styrene	0.50			ND	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	0.10			ND	NA	NA	NA	NA	NA

COMPOUNDS	Detection Limit (mg/l)	MCL (ug/l)	DOHS DW Action Level (ug/l)	CONCENTRATION (micrograms/liter) Pumping time, in minutes 30	60	90	120	150	180
1,2-Dibromo-3-chloropropane	10.00			NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	0.10			ND	NA	NA	NA	NA	NA
Propylbenzene	1.00			NA	NA	NA	NA	NA	NA
NON-VOLATILE PRIORITY POLLUTANTS:									
1,2-Dichlorobenzene	0.50		130	ND	NA	NA	NA	NA	NA
1,3-Dichlorobenzene	0.50		130	ND	NA	NA	NA	NA	NA
1,4-Dichlorobenzene	0.50		0.5	ND	NA	NA	NA	NA	NA
Trichlorobenzene	1.00			NA	NA	NA	NA	NA	NA
Naphthalene	1.00			NA	NA	NA	NA	NA	NA

ND: Non-Detectable
NA: Not Analyzed

TIC - 55 PACKER TEST
ZONE III 390 - 450 ft depth

COMPOUNDS	Detection Limit (mg/l)	MCL (ug/l)	DOHS DW Action Level (ug/l)	CONCENTRATION (micrograms/liter) (Pumping time, in minutes) 30	30 DUP	60	90	120	150	180
VOLATILE PRIORITY POLLUTANTS:										
Acrolein	1.00			ND	ND	NA	NA	NA	ND	ND
Acrylonitrile	1.00			ND	ND	NA	NA	NA	ND	ND
Benzene	0.10	5	0.7	0.1	0.1	ND	0.1	0.1	0.1	0.1
Bromoform	0.10			ND	ND	NA	NA	NA	NA	NA
Carbon Tetrachloride	0.10	5	5	ND	ND	NA	NA	NA	NA	NA
Chlorobenzene	0.10			ND	ND	NA	NA	NA	NA	NA
Dibromochloromethane	0.10			ND	ND	NA	NA	NA	NA	NA
Chloroethane	1.00			ND	ND	NA	NA	NA	NA	NA
2-Chloroethylvinylether	1.00			ND	ND	NA	NA	NA	NA	NA
Chloroform	0.10			ND	ND	NA	NA	NA	NA	NA
Dichlorobromomethane	0.10			ND	ND	NA	NA	NA	NA	NA
1,1-Dichloroethane	0.10		20	ND	ND	NA	NA	NA	NA	NA
1,2-Dichloroethane	0.10	5	1	ND	ND	NA	NA	NA	NA	NA
1,1-Dichloroethene	0.10	7	6	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloropropane	0.10			ND	ND	NA	NA	NA	NA	NA
Ethylbenzene	0.10		680	0.2	0.2	NA	NA	NA	NA	NA
Methyl Bromide	1.00			ND	ND	NA	NA	NA	NA	NA
Methyl Chloride	1.00			ND	ND	NA	NA	NA	NA	NA
Methylene Chloride	5.00		40	ND	ND	NA	NA	NA	NA	NA
1,1,2,2-Tetrachloroethene	0.10		1	ND	ND	NA	NA	NA	NA	NA
Tetrachloroethene (PCE)	0.10		4	ND	ND	0.2	ND	ND	ND	ND
Toluene	0.50		100	17	15	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	0.10	200	200	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	0.10		100	ND	ND	NA	NA	NA	NA	NA
Trichloroethene (TCE)	0.10	5	5	1.2	1.3	1.1	1.2	1.2	1.2	1.2
Vinyl Chloride	1.00	2	2	ND	ND	NA	NA	NA	NA	NA
trans-1,3-Dichloropropene	0.10			ND	ND	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	0.10			ND	ND	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	0.10		16	ND	ND	NA	NA	NA	NA	NA
Trichlorofluoromethane	1.00		3400	ND	ND	NA	NA	NA	NA	NA
VOLATILE NON-PRIORITY POLLUTANTS:										
Acetone	10.00			ND	ND	NA	NA	NA	NA	NA
Methylethylketone	1.00			ND	ND	NA	NA	NA	NA	NA
Tetrahydrofuran	1.00			ND	ND	NA	NA	NA	NA	NA
m,p-Xylenes	0.10		620	1	1	NA	NA	NA	NA	NA
o-xylene	0.10		620	0.2	0.2	NA	NA	NA	NA	NA
Styrene	0.50			ND	ND	NA	NA	NA	NA	NA

COMPOUNDS	Detection Limit (mg/l)	MCL (ug/l)	DOHS DW Action Level (ug/l)	CONCENTRATION (micrograms/liter) (Pumping time, in minutes) 30	30 DUP	60	90	120	150	180
1,2-Dibromo-3-chloropropane	10.00			NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	0.10			ND	ND	NA	NA	NA	NA	NA
Propylbenzene	1.00			NA	NA	NA	NA	NA	NA	NA
NON-VOLATILE PRIORITY POLLUTANTS:										
1,2-Dichlorobenzene	0.50		130	ND	ND	NA	NA	NA	NA	NA
1,3-Dichlorobenzene	0.50		130	ND	ND	NA	NA	NA	NA	NA
1,4-Dichlorobenzene	0.50		0.5	ND	ND	NA	NA	NA	NA	NA
Trichlorobenzene	1.00			NA	NA	NA	NA	NA	NA	NA
Naphthalene	1.00			NA	NA	NA	NA	NA	NA	NA

ND: Non-Detectable
NA: Not Analyzed

B.3 CLUSTER WELL SPECIFIC CAPACITY TEST SAMPLES

MCAS - EL TORO PERIMETER INVESTIGATION

GROUNDWATER QUALITY RESULTS FROM SPECIFIC CAPACITY TESTS

COMPOUNDS	Detection Limit (ug/l)	MCL (ug/l)	DOHS DW Action Level (ug/l)	CONCENTRATIONS (ug/l) 6/16/88 0 hrs	6/16/88 6 hrs	6/16/88 12 hrs	6/16/88 18 hrs	6/16/88 24 hrs	DUP 6/16/88 24 hrs
DW-135									
Benzene	0.10	5	0.7	NA	ND	NA	NA	NA	NA
1,1-Dichloroethene (DCE)	0.10	7	6	NA	ND	NA	NA	NA	NA
Tetrachloroethene (PCE)	0.10		4	NA	ND	NA	NA	NA	NA
1,1,1-Trichloroethane (TCA)	0.10	200	200	NA	ND	NA	NA	NA	NA
Trichloroethene (TCE)	0.10	5	5	NA	3.9	NA	NA	NA	NA
DW-250									
Benzene	0.10	5	0.7	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	0.10	7	6	ND	ND	ND	ND	ND	ND
Tetrachloroethene (PCE)	0.10		4	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	0.10	200	200	ND	ND	0.40	ND	ND	ND
Trichloroethene (TCE)	0.10	5	5	ND	ND	ND	ND	ND	ND
DW-350									
Benzene	0.10	5	0.7	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	0.10	7	6	ND	ND	ND	ND	ND	ND
Tetrachloroethene (PCE)	0.10		4	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	0.10	200	200	1	ND	ND	ND	ND	ND
Trichloroethene (TCE)	0.10	5	5	ND	ND	ND	ND	ND	ND
DW-450									
Benzene	0.10	5	0.7	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	0.10	7	6	ND	ND	ND	ND	ND	ND
Tetrachloroethene (PCE)	0.10		4	ND	ND	0.10	0.10	0.10	0.10
1,1,1-Trichloroethane	0.10	200	200	ND	ND	ND	ND	ND	ND
Trichloroethene (TCE)	0.10	5	5	0.3	0.6	0.8	0.7	0.7	0.7

Notes:
ND: Non-Detectable
* Concentrations revised due to error in standard calibration

B.4 CLUSTER WELL SAMPLES

WELL DW-540

MCAS - EL TORO PERIMETER INVESTIGATION

GROUNDWATER QUALITY RESULTS FROM SPECIFIC CAPACITY TESTS

COMPOUNDS	Detection Limit (ug/l)	MCL (ug/l)	DOHS DW Action Level (ug/l)	Concentrations (ug/l) 6/16/88 Time 0	6/16/88 Time 6	6/16/88 Time 12	6/16/88 Time 18	6/16/88 Time 24	DUP 6/16/88 Time 24
VOLATILE PRIORITY POLLUTANTS:									
Acrolein	1.00			ND	ND	ND	ND	ND	ND
Acrylonitrile	1.00			ND	ND	ND	ND	ND	ND
Benzene	0.10	5	0.7	ND	ND	ND	ND	ND	ND
Bromoform	0.10			ND	ND	ND	ND	ND	ND
Carbon Tetrachloride	0.10	5	5	ND	ND	ND	ND	ND	ND
Chlorobenzene	0.10			ND	ND	ND	ND	ND	ND
Dibromochloromethane	0.10			ND	ND	ND	ND	ND	ND
Chloroethane	1.00			ND	ND	ND	ND	ND	ND
2-Chloroethylvinylether	1.00			ND	ND	ND	ND	ND	ND
Chloroform	0.10			ND	ND	ND	ND	ND	ND
Dichlorobromomethane	0.10			ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	0.10		20	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	0.10	5	1	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	0.10	7	6	ND	ND	ND	ND	ND	ND
1,1-Dichloropropane	0.10			ND	ND	ND	ND	ND	ND
Ethylbenzene	0.10		680	ND	ND	ND	ND	ND	ND
Methyl Bromide	1.00			ND	ND	ND	ND	ND	ND
Methyl Chloride	1.00			ND	ND	ND	ND	ND	ND
Methylene Chloride	5.00		40	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	0.10		1	ND	ND	ND	ND	ND	ND
Tetrachloroethene (PCE)	0.10		4	ND	0.20	0.20	0.20	0.20	ND
Toluene	0.50		100	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	0.10	5	200	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	0.10	2	100	ND	ND	ND	ND	ND	ND
Trichloroethene (TCE)	0.10		5	ND	ND	ND	ND	ND	ND
Vinyl Chloride	1.00		2	ND	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	0.10			ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	0.10			ND	ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	0.10		16	ND	ND	ND	ND	ND	ND
Trichlorofluoromethane	1.00		3400	ND	ND	ND	ND	2.10	ND
VOLATILE NON-PRIORITY POLLUTANTS:									
Acetone	10.00			ND	ND	ND	ND	ND	ND
Methylethylketone	1.00			ND	ND	ND	ND	ND	ND
Tetrahydrofuran	1.00			ND	ND	ND	ND	ND	ND
m,p-Xylenes	0.10		620	ND	ND	ND	ND	ND	ND
o-xylene	0.10		620	ND	ND	ND	ND	ND	ND
Styrene	0.50			ND	ND	ND	ND	ND	ND

WELL DW-540

MCAS - EL TORO PERIMETER INVESTIGATION

GROUNDWATER QUALITY RESULTS FROM SPECIFIC CAPACITY TESTS

DW-540 COMPOUNDS	Detection Limit (ug/l)	MCL (ug/l)	DOHS DW Action Level (ug/l)	Concentrations (ug/l) 6/16/88 Time 0	6/16/88 Time 6	6/16/88 Time 12	6/16/88 Time 18	6/16/88 Time 24	DUP 6/16/88 Time 24
1,2-Dibromo-3-chloropropane	NA			NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	0.10			ND	ND	ND	ND	ND	ND
Propylbenzene	NA			NA	NA	NA	NA	NA	NA
NON-VOLATILE PRIORITY POLLUTANTS:									
1,2-Dichlorobenzene	0.50		130	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	0.50		130	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	0.50		0.5	ND	ND	ND	ND	ND	ND
Trichlorobenzene	NA			NA	NA	NA	NA	NA	NA
Naphthalene	NA			NA	NA	NA	NA	NA	NA

ND: Non-Detectable
NA: Not Analyzed
* Concentrations revised due to error in standard calibration

WELL DW-135 **MCAS - EL TORO PERIMETER INVESTIGATION**

COMPOUNDS	Detection Limit (ug/l)	MCL (ug/l)	DOHS DW Action Level (ug/l)	CONCENTRATION (ug/l) 7/15/88	7/15/88 DUP	9/22/88	9/22/88 DUP	1/20/89
VOLATILE PRIORITY POLLUTANTS:								
Acrolein	10.00			ND	ND	ND	ND	ND
Acrylonitrile	10.00			ND	ND	ND	ND	ND
Benzene	1.00	5	0.7	ND	ND	ND	ND	ND
Bromoform	1.00			ND	ND	ND	ND	ND
Carbon Tetrachloride	1.00	5	5	56	82	33*	39*	45
Chlorobenzene	1.00			ND	ND	ND	ND	ND
Dibromochloromethane	1.00			ND	ND	ND	ND	ND
Chloroethane	10.00			ND	ND	ND	ND	ND
2-Chloroethylvinylether	10.00			ND	ND	ND	ND	ND
Chloroform	1.00			11	13	8.1*	6.4*	11
Dichlorobromomethane	1.00			ND	ND	ND	ND	ND
1,1-Dichloroethane	1.00		20	ND	ND	ND	ND	ND
1,2-Dichloroethane	1.00	5	1	ND	ND	ND	ND	ND
1,1-Dichloroethene (DCE)	1.00	7	6	ND	ND	ND	ND	ND
1,1-Dichloropropane	1.00			ND	ND	ND	ND	ND
Ethylbenzene	1.00		680	ND	ND	ND	ND	ND
Methyl Bromide	10.00			ND	ND	ND	ND	ND
Methyl Chloride	10.00			ND	ND	ND	ND	ND
Methylene Chloride	50.00		40	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	1.00		1	ND	ND	ND	ND	ND
Tetrachloroethene (PCE)	1.00		4	ND	ND	ND	ND	ND
Toluene	5.00		100	ND	ND	ND	ND	ND
1,1,1-Trichloroethane (TCA)	1.00	200	200	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	1.00		100	ND	ND	ND	ND	ND
Trichloroethene (TCE)	1.00	5	5	5	6	3.1*	2.6*	3.4
Vinyl Chloride	10.00	2	2	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	1.00			ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	1.00			ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	1.00		16	ND	ND	ND	ND	ND
Trichlorofluoromethane	10.00		3400	ND	ND	ND	ND	ND
VOLATILE NON-PRIORITY POLLUTANTS:								
Acetone	100.00			ND	ND	ND	ND	ND
Methylethylketone	10.00			ND	ND	ND	ND	ND
Tetrahydrofuran	10.00			ND	ND	ND	ND	ND
m,p-Xylenes	1.00		620	ND	ND	ND	ND	ND
o-xylene	1.00		620	ND	ND	ND	ND	ND
Styrene	5.00			ND	ND	ND	ND	ND

DW-135

MCAS - EL TORO PERIMETER INVESTIGATION

COMPOUNDS	Detection Limit (ug/l)	MCL (ug/l)	DOHS DW Action Level (ug/l)	CONCENTRATION (ug/l) 7/15/88	7/15/88 DUP	9/22/88	9/22/88 DUP	1/20/89
1,2-Dibromo-3-chloropropane	NA			NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	1.00			ND	ND	ND	ND	ND
Propylbenzene	NA			NA	NA	NA	NA	NA
NON-VOLATILE PRIORITY POLLUTANTS:								
1,2-Dichlorobenzene	5.00		130	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	5.00		130	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	5.00		0.5	ND	ND	ND	ND	ND
Trichlorobenzene	NA			NA	NA	NA	NA	NA

ND: Non-Detectable
NA: Not Analyzed
*Concentrations revised 12/88 due to laboratory error in standard calibration

WELL DW-250

MCAS - EL TORO PERIMETER INVESTIGATION

COMPOUNDS	Detection Limit (ug/l)	MCL (ug/l)	DOHS DW Action Level (ug/l)	CONCENTRATION (ug/l) 7/15/88	7/15/88 DUP	9/21/88	9/21/88 DUP	1/20/89
VOLATILE PRIORITY POLLUTANTS								
Acrolein	1.00			ND	ND	ND	ND	ND
Acrylonitrile	1.00			ND	ND	ND	ND	ND
Benzene	0.10	5	0.7	ND	ND	ND	ND	ND
Bromoform	0.10			ND	ND	ND	ND	ND
Carbon Tetrachloride	0.10	5	5	8.0	ND	8.2 *	ND	3.1
Chlorobenzene	0.10			ND	ND	ND	ND	ND
Dibromochloromethane	0.10			ND	ND	ND	ND	ND
Chloroethane	1.00			ND	ND	ND	ND	ND
2-Chloroethylvinylether	1.00			ND	ND	ND	ND	ND
Chloroform	0.10			ND	ND	ND	ND	ND
Dichlorobromomethane	0.10			ND	ND	ND	ND	ND
1,1-Dichloroethane	0.10		20	ND	ND	ND	ND	ND
1,2-Dichloroethane	0.10	5	1	ND	ND	ND	ND	ND
1,1-Dichloroethene	0.10	7	6	ND	ND	ND	ND	ND
1,1-Dichloropropane	0.10			ND	ND	ND	ND	ND
Ethylbenzene	0.10		680	ND	ND	ND	ND	ND
Methyl Bromide	1.00			ND	ND	ND	ND	ND
Methyl Chloride	1.00			ND	ND	ND	ND	ND
Methylene Chloride	5.00		40	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	0.10		1	ND	ND	ND	ND	ND
Tetrachloroethene (PCE)	0.10		4	ND	ND	ND	ND	ND
Toluene	0.50		100	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	0.10	200	200	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	0.10		100	ND	ND	ND	ND	ND
Trichloroethene (TCE)	0.10	5	5	ND	ND	ND	ND	ND
Vinyl Chloride	1.00	2	2	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	0.10			ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	0.10			ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	0.10		16	ND	ND	ND	ND	ND
Trichlorofluoromethane	1.00		3400	ND	ND	ND	ND	ND
VOLATILE NON-PRIORITY POLLUTANTS:								
Acetone	10.00			ND	ND	ND	ND	10.0
Methylethylketone	1.00			ND	ND	ND	ND	ND
Tetrahydrofuran	1.00			ND	ND	ND	ND	ND
m,p-Xylenes	0.10		620	ND	ND	ND	ND	ND
o-xylene	0.10		620	ND	ND	ND	ND	ND
Styrene	0.50			ND	ND	ND	ND	ND

WELL DW-250 **MCAS - EL TORO PERIMETER INVESTIGATION**

COMPOUNDS	Detection Limit (ug/l)	MCL (ug/l)	DOHS DW Action Level (ug/l)	CONCENTRATION (ug/l) 7/15/88	7/15/88 DUP	9/21/88	9/21/88 DUP	1/20/89
1,2-Dibromo-3-chloropropane	NA			NA	ND	NA	NA	NA
cis-1,2-Dichloroethene	0.10			ND	ND	ND	ND	ND
Propylbenzene	NA			NA	ND	NA	NA	NA
NON-VOLATILE PRIORITY POLLUTANTS:								
1,2-Dichlorobenzene	0.50		130	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	0.50		130	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	0.50		0.5	ND	ND	ND	ND	ND
Trichlorobenzene	1.00			NA	ND	NA	NA	NA
Naphthalene	1.00			NA		NA	NA	NA

ND: Non-Detectable
NA: Not Analyzed
* Concentrations revised due to error in standard calibration

WELL DW-350 **MCAS - EL TORO PERIMETER INVESTIGATION**

COMPOUNDS	Detection Limit (ug/l)	MCL (ug/l)	DOHS DW Action Level (mg/l)	CONCENTRATIONS (ug/l) 7/15/88	DUP 7/15/88	9/21/88	DUP 9/21/88	1/20/89
VOLATILE PRIORITY POLLUTANTS								
Acrolein	1.00			ND	ND	ND	ND	ND
Acrylonitrile	1.00			ND	ND	ND	ND	ND
Benzene	0.10	5	0.7	ND	ND	ND	ND	ND
Bromoform	0.10			ND	ND	ND	ND	ND
Carbon Tetrachloride	0.10	5	5	ND	ND	ND	ND	ND
Chlorobenzene	0.10			ND	ND	ND	ND	ND
Dibromochloromethane	0.10			ND	ND	ND	ND	ND
Chloroethane	1.00			ND	ND	ND	ND	ND
2-Chloroethylvinylether	1.00			ND	ND	ND	ND	ND
Chloroform	0.10			ND	ND	ND	ND	ND
Dichlorobromomethane	0.10			ND	ND	ND	ND	ND
1,1-Dichloroethane	0.10		20	ND	ND	ND	ND	ND
1,2-Dichloroethane	0.10	5	1	ND	ND	ND	ND	ND
1,1-Dichloroethene	0.10	7	6	ND	ND	ND	ND	ND
1,1-Dichloropropane	0.10			ND	ND	ND	ND	ND
Ethylbenzene	0.10		680	ND	ND	ND	ND	ND
Methyl Bromide	1.00			ND	ND	ND	ND	ND
Methyl Chloride	1.00			ND	ND	ND	ND	ND
Methylene Chloride	5.00		40	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	0.10		1	ND	ND	ND	ND	ND
Tetrachloroethene (PCE)	0.10		4	ND	ND	ND	ND	ND
Toluene	0.50		100	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	0.10	200	200	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	0.10		100	ND	ND	ND	ND	ND
Trichloroethene (TCE)	0.10	5	5	ND	ND	ND	ND	ND
Vinyl Chloride	1.00	2	2	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	0.10			ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	0.10			ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	0.10		16	ND	ND	ND	ND	ND
Trichlorofluoromethane	1.00		3400	ND	ND	ND	ND	ND
VOLATILE NON-PRIORITY POLLUTANTS:								
Acetone	10.00			ND	ND	ND	ND	ND
Methylethylketone	1.00			ND	ND	ND	ND	ND
Tetrahydrofuran	1.00			ND	ND	ND	ND	ND
m,p-Xylenes	0.10		620	ND	ND	ND	ND	ND
o-xylene	0.10		620	ND	ND	ND	ND	ND
Styrene	0.50			ND	ND	ND	ND	ND

WELL DW-350 **MCAS - EL TORO PERIMETER INVESTIGATION**

COMPOUNDS	Detection Limit (ug/l)	MCL (ug/l)	DOHS DW Action Level (mg/l)	CONCENTRATIONS (ug/l) 7/15/88	DUP 7/15/88	9/21/88	9/21/88	1/20/89
1,2-Dibromo-3-chloropropane	10.00			ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	0.10			ND	ND	ND	ND	ND
Propylbenzene	1.00			ND	ND	ND	ND	ND
NON-VOLATILE PRIORITY POLLUTANTS:								
1,2-Dichlorobenzene	0.50		130	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	0.50		130	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	0.50		0.5	ND	ND	ND	ND	ND
Trichlorobenzene	1.00			NA	ND	NA	NA	NA
Naphthalene	1.00			NA		NA	NA	NA

ND: Non-Detectable
NA: Not Analyzed

WELL DW-450 **MCAS - EL TORO PERIMETER INVESTIGATION**

COMPOUND	Detection Limit (ug/l)	MCL (ug/l)	DOHS DW Action Level (ug/l)	CONCENTRATION (ug/l) 7/14/88	DUP 7/14/88	9/21/88	1/20/89	DUP 1/20/89
VOLATILE PRIORITY POLLUTANTS								
Acrolein	1.00			ND	ND	ND	ND	ND
Acrylonitrile	1.00			ND	ND	ND	ND	ND
Benzene	0.10	5	0.7	ND	ND	ND	ND	ND
Bromoform	0.10			ND	ND	ND	ND	ND
Carbon Tetrachloride	0.10	5	5	ND	ND	ND	ND	ND
Chlorobenzene	0.10			ND	ND	ND	ND	ND
Dibromochloromethane	0.10			ND	ND	ND	ND	ND
Chloroethane	1.00			ND	ND	ND	ND	ND
2-Chloroethylvinylether	1.00			ND	ND	ND	ND	ND
Chloroform	0.10			ND	ND	0.2*	ND	ND
Dichlorobromomethane	0.10			ND	ND	ND	ND	ND
1,1-Dichloroethane	0.10		20	ND	ND	ND	ND	ND
1,2-Dichloroethane	0.10	5	1	ND	ND	ND	ND	ND
1,1-Dichloroethene	0.10	7	6	ND	ND	ND	ND	ND
1,1-Dichloropropane	0.10			ND	ND	ND	ND	ND
Ethylbenzene	0.10		680	ND	ND	ND	ND	ND
Methyl Bromide	1.00			ND	ND	ND	ND	ND
Methyl Chloride	1.00			ND	ND	ND	ND	ND
Methylene Chloride	5.00		40	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	0.10		1	ND	ND	ND	ND	ND
Tetrachloroethene (PCE)	0.10		4	ND	ND	ND	ND	ND
Toluene	0.50		100	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	0.10	5	200	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	0.10	2	100	ND	ND	ND	ND	ND
Trichloroethene (TCE)	0.10		5	0.1	ND	1.1*	0.20	0.30
Vinyl Chloride	1.00		2	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	0.10			ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	0.10			ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	0.10		16	ND	ND	ND	ND	ND
Trichlorofluoromethane	1.00		3400	ND	ND	ND	ND	ND
VOLATILE NON-PRIORITY POLLUTANTS:								
Acetone	10.00			ND	ND	ND	ND	ND
Methylethylketone	1.00			ND	ND	ND	ND	ND
Tetrahydrofuran	1.00			ND	ND	ND	ND	ND
m,p-Xylenes	0.10		620	ND	ND	ND	ND	ND
o-xylene	0.10		620	ND	ND	ND	ND	ND
Styrene	0.50			ND	ND	ND	ND	ND

WELL DW-450 **MCAS - EL TORO PERIMETER INVESTIGATION**

DW-450 COMPOUND	Detection Limit (ug/l)	MCL (ug/l)	DOHS DW Action Level (ug/l)	CONCENTRATION (ug/l) 7/14/88	DUP 7/14/88	9/21/88	1/20/89	DUP 1/20/89
1,2-Dibromo-3-chloropropane	10.00			ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	0.10			ND	ND	ND	ND	ND
Propylbenzene	1.00			NA	ND	NA	NA	NA
NON-VOLATILE PRIORITY POLLUTANTS:								
1,2-Dichlorobenzene	0.50		130	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	0.50		130	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	0.50		0.5	ND	ND	ND	ND	ND
Trichlorobenzene	1.00			NA	ND	NA	NA	NA
Naphthalene	1.00			NA		NA	NA	NA

ND: Non-Detectable
NA: Not Analyzed
* Concentrations revised due to error in standard calibration

WELL DW-540 **MCAS - EL TORO PERIMETER INVESTIGATION**

COMPOUNDS	Detection Limit (ug/l)	MCL (ug/l)	DOHS DW Action Level (ug/l)	CONCENTRATION (ug/l) 7/14/88	DUP 7/14/88	9/21/88	1/21/89
VOLATILE PRIORITY POLLUTANTS:							
Acrolein	1.00			ND	ND	ND	ND
Acrylonitrile	1.00			ND	ND	ND	ND
Benzene	0.10	5	0.7	ND	ND	ND	ND
Bromoform	0.10			ND	ND	ND	ND
Carbon Tetrachloride	0.10	5	5	ND	ND	ND	ND
Chlorobenzene	0.10			ND	ND	ND	ND
Dibromochloromethane	0.10			ND	ND	ND	ND
Chloroethane	1.00			ND	ND	ND	ND
2-Chloroethylvinylether	1.00			ND	ND	ND	ND
Chloroform	0.10			0.10	ND	ND	ND
Dichlorobromomethane	0.10			ND	ND	ND	ND
1,1-Dichloroethane	0.10		20	ND	ND	ND	ND
1,2-Dichloroethane	0.10	5	1	ND	ND	ND	ND
1,1-Dichloroethene	0.10	7	6	ND	ND	ND	ND
1,1-Dichloropropane	0.10			ND	ND	ND	ND
Ethylbenzene	0.10		680	ND	ND	ND	ND
Methyl Bromide	1.00			ND	ND	ND	ND
Methyl Chloride	1.00			ND	ND	ND	ND
Methylene Chloride	5.00		40	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	0.10		1	ND	ND	ND	ND
Tetrachloroethene (PCE)	0.10		4	ND	ND	ND	ND
Toluene	0.50		100	ND	ND	ND	ND
1,1,1-Trichloroethane	0.10	5	200	ND	ND	ND	ND
1,1,2-Trichloroethane	0.10	2	100	ND	ND	ND	ND
Trichloroethene (TCE)	0.10		5	0.40	ND	0.20*	0.40
Vinyl Chloride	1.00		2	ND	ND	ND	ND
trans-1,3-Dichloropropene	0.10			ND	ND	ND	ND
cis-1,3-Dichloropropene	0.10			ND	ND	ND	ND
trans-1,2-Dichloroethene	0.10		16	ND	ND	ND	ND
Trichlorofluoromethane	1.00		3400	ND	ND	ND	ND
VOLATILE NON-PRIORITY POLLUTANTS:							
Acetone	10.00			ND	ND	ND	ND
Methylethylketone	1.00			ND	ND	ND	ND
Tetrahydrofuran	1.00			ND	ND	ND	ND
m,p-Xylenes	0.10		620	ND	ND	ND	ND
o-xylene	0.10		620	ND	ND	ND	ND
Styrene	0.50			ND	ND	ND	ND

WELL DW-540 **MCAS - EL TORO PERIMETER INVESTIGATION**

COMPOUNDS	Detection Limit (ug/l)	MCL (ug/l)	DOHS DW Action Level (ug/l)	CONCENTRATION (ug/l) 7/14/88	DUP 7/14/88	9/21/88	1/21/89
1,2-Dibromo-3-chloropropane	NA			NA	NA	NA	NA
cis-1,2-Dichloroethene	0.10			ND	ND	ND	ND
Propylbenzene	NA			NA	NA	NA	NA
NON-VOLATILE PRIORITY POLLUTANTS:							
1,2-Dichlorobenzene	0.50		130	ND	ND	ND	ND
1,3-Dichlorobenzene	0.50		130	ND	ND	ND	ND
1,4-Dichlorobenzene	0.50		0.5	ND	ND	ND	ND
Trichlorobenzene	NA			NA	ND	NA	NA
Naphthalene	NA			NA		NA	NA

ND: Non-Detectable
NA: Not Analyzed
* Concentrations revised due to error in standard calibration

B.5 PERIMETER WELL SAMPLES

WELL PS-1 **MCAS - EL TORO PERIMETER INVESTIGATION**

COMPOUNDS	Detection Limit (ug/l)	MCL (ug/l)	DOHS DW Action Level (ug/l)	CONCENTRATION (ug/l) 12/15/88	1/22/89
VOLATILE PRIORITY POLLUTANTS:					
Acrolein	1.00			ND	ND
Acrylonitrile	1.00			ND	ND
Benzene	0.10	5	0.7	ND	ND
Bromoform	0.10			ND	ND
Carbon Tetrachloride	0.10	5	5	0.3	0.4
Chlorobenzene	0.10			0.3	ND
Dibromochloromethane	0.10			ND	ND
Chloroethane	1.00			ND	ND
2-Chloroethylvinylether	1.00			ND	ND
Chloroform	0.10			ND	ND
Dichlorobromomethane	0.10			ND	ND
1,1-Dichloroethane	0.10		20	ND	ND
1,2-Dichloroethane	0.10	5	1	ND	ND
1,1-Dichloroethene (DCE)	0.10	7	6	ND	ND
1,1-Dichloropropane	0.10			ND	ND
Ethylbenzene	0.10		680	ND	ND
Methyl Bromide	1.00			ND	ND
Methyl Chloride	1.00			ND	ND
Methylene Chloride	5.00		40	ND	ND
1,1,2,2-Tetrachloroethane	0.10		1	ND	ND
Tetrachloroethene (PCE)	0.10		4	ND	ND
Toluene	0.50		100	ND	ND
1,1,1-Trichloroethane (TCA)	0.10	200	200	ND	ND
1,1,2-Trichloroethane	0.10		100	ND	ND
Trichloroethene (TCE)	0.10	5	5	19	17
Vinyl Chloride	1.00	2	2	ND	ND
trans-1,3-Dichloropropene	0.10			ND	ND
cis-1,3-Dichloropropene	0.10			ND	ND
trans-1,2-Dichloroethene	0.10		16	ND	ND
Trichlorofluoromethane	1.00		3400	ND	ND
VOLATILE NON-PRIORITY POLLUTANTS:					
Acetone	10.00			ND	ND
Methylethylketone	1.00			ND	ND
Tetrahydrofuran	1.00			ND	ND
m,p-Xylenes	0.10		620	ND	ND
o-xylene	0.10		620	ND	ND
Styrene	0.50			ND	ND

WELL PS-1 **MCAS - EL TORO PERIMETER INVESTIGATION**

COMPOUNDS	Detection Limit (ug/l)	MCL (ug/l)	DOHS DW Action Level (ug/l)	CONCENTRATIONS (ug/l) 12/15/88	1/22/89
1,2-Dibromo-3-chloropropane	NA			NA	NA
cis-1,2-Dichloroethene	0.10			ND	0.4
Propylbenzene	NA			NA	NA
NON-VOLATILE PRIORITY POLLUTANTS:					
1,2-Dichlorobenzene	0.50		130	ND	ND
1,3-Dichlorobenzene	0.50		130	ND	ND
1,4-Dichlorobenzene	0.50		0.5	ND	ND
Trichlorobenzene	NA			NA	NA

ND: Non-Detectable
NA: Not Analyzed

WELL PS-2 **MCAS - EL TORO PERIMETER INVESTIGATION**

COMPOUNDS	Detection Limit (ug/l)	MCL (ug/l)	DOHS Action Level (ug/l)	CONCENTRATION (ug/l) 12/16/88	1/22/89
VOLATILE PRIORITY POLLUTANTS:					
Acrolein	1.00			ND	ND
Acrylonitrile	1.00			ND	ND
Benzene	0.10	5	0.7	ND	ND
Bromoform	0.10			ND	ND
Carbon Tetrachloride	0.10	5	5	ND	ND
Chlorobenzene	0.10			ND	ND
Dibromochloromethane	0.10			ND	ND
Chloroethane	1.00			ND	ND
2-Chloroethylvinylether	1.00			ND	ND
Chloroform	0.10			ND	0.2
Dichlorobromomethane	0.10			ND	0.2
1,1-Dichloroethane	0.10		20	ND	ND
1,2-Dichloroethane	0.10	5	1	ND	ND
1,1-Dichloroethene (DCE)	0.10	7	6	ND	ND
1,1-Dichloropropane	0.10			ND	ND
Ethylbenzene	0.10		680	ND	ND
Methyl Bromide	1.00			ND	ND
Methyl Chloride	1.00			ND	ND
Methylene Chloride	5.00		40	ND	ND
1,1,2,2-Tetrachloroethane	0.10		1	ND	ND
Tetrachloroethene (PCE)	0.10		4	ND	ND
Toluene	0.50		100	ND	ND
1,1,1-Trichloroethane (TCA)	0.10	200	200	ND	ND
1,1,2-Trichloroethane	0.10		100	ND	ND
Trichloroethene (TCE)	0.10	5	5	ND	ND
Vinyl Chloride	1.00	2	2	ND	ND
trans-1,3-Dichloropropene	0.10			ND	ND
cis-1,3-Dichloropropene	0.10			ND	ND
trans-1,2-Dichloroethene	0.10		16	ND	ND
Trichlorofluoromethane	1.00		3400	ND	ND
VOLATILE NON-PRIORITY POLLUTANTS:					
Acetone	10.00			ND	ND
Methylethylketone	1.00			ND	ND
Tetrahydrofuran	1.00			ND	ND
m,p-Xylenes	0.10		620	ND	ND
o-xylene	0.10		620	ND	ND
Styrene	0.50			ND	ND

WELL PS-2 **MCAS - EL TORO PERIMETER INVESTIGATION**

COMPOUNDS	Detection Limit (ug/l)	MCL (ug/l)	DOHS DW Action Level (ug/l)	CONCENTRATIONS (ug/l) 12/16/88	1/22/89
1,2-Dibromo-3-chloropropane	NA			NA	NA
cis-1,2-Dichloroethene	0.10			ND	ND
Propylbenzene	NA			NA	NA
NON-VOLATILE PRIORITY POLLUTANTS:					
1,2-Dichlorobenzene	0.50		130	ND	ND
1,3-Dichlorobenzene	0.50		130	ND	ND
1,4-Dichlorobenzene	0.50		0.5	ND	ND
Trichlorobenzene	NA				NA

ND: Non-Detectable
NA: Not Analyzed

WELL PS-3 **MCAS - EL TORO PERIMETER INVESTIGATION**

COMPOUNDS	Detection Limit (ug/l)	MCL (ug/l)	DOHS Action Level (ug/l)	CONCENTRATION (ug/l) 12/13/88	1/23/89
VOLATILE PRIORITY POLLUTANTS:					
Acrolein	10.0			ND	ND
Acrylonitrile	10.0			ND	ND
Benzene	1.0	5	0.7	ND	ND
Bromoform	1.0			ND	ND
Carbon Tetrachloride	1.0	5	5	ND	ND
Chlorobenzene	1.0			ND	ND
Dibromochloromethane	1.0			ND	ND
Chloroethane	10.0			ND	ND
2-Chloroethylvinylether	10.0			ND	ND
Chloroform	1.0			ND	12
Dichlorobromomethane	1.0			ND	ND
1,1-Dichloroethane	1.0		20	ND	ND
1,2-Dichloroethane	1.0	5	1	ND	ND
1,1-Dichloroethene (DCE)	1.0	7	6	ND	ND
1,1-Dichloropropane	1.0			ND	ND
Ethylbenzene	1.0		680	ND	ND
Methyl Bromide	10.0			ND	ND
Methyl Chloride	10.0			ND	ND
Methylene Chloride	50.0		40	ND	ND
1,1,2,2-Tetrachloroethane	1.0		1	ND	ND
Tetrachloroethene (PCE)	1.0		4	24	81
Toluene	5.0		100	ND	ND
1,1,1-Trichloroethane (TCA)	1.0	200	200	ND	ND
1,1,2-Trichloroethane	1.0		100	ND	ND
Trichloroethene (TCE)	1.0	5	5	33	64
Vinyl Chloride	10.0	2	2	ND	ND
trans-1,3-Dichloropropene	1.0			ND	ND
cis-1,3-Dichloropropene	1.0			ND	ND
trans-1,2-Dichloroethene	1.0		16	ND	ND
Trichlorofluoromethane	10.0		3400	ND	ND
VOLATILE NON-PRIORITY POLLUTANTS:					
Acetone	100.00			ND	ND
Methylethylketone	10.00			ND	ND
Tetrahydrofuran	10.00			ND	ND
m,p-Xylenes	1.00		620	ND	ND
o-xylene	1.00		620	ND	ND
Styrene	5.00			ND	ND

WELL PS-3 **MCAS - EL TORO PERIMETER INVESTIGATION**

COMPOUNDS	Detection Limit (ug/l)	MCL (ug/l)	DOHS DW Action Level (ug/l)	CONCENTRATION (ug/l) 12/13/88	1/23/89
1,2-Dibromo-3-chloropropane	NA			NA	NA
cis-1,2-Dichloroethene	1.0			ND	4.8
Propylbenzene	NA			NA	NA
NON-VOLATILE PRIORITY POLLUTANTS:					
1,2-Dichlorobenzene	5.0		130	ND	ND
1,3-Dichlorobenzene	5.0		130	ND	ND
1,4-Dichlorobenzene	5.0		0.5	ND	ND
Trichlorobenzene	NA			ND	NA

ND: Non-Detectable
NA: Not Analyzed

WELL PS-4 **MCAS - EL TORO PERIMETER INVESTIGATION**

COMPOUNDS	Detection Limit (ug/l)	MCL (ug/l)	DOHS Action Level (ug/l)	CONCENTRATION (ug/l) 1/23/89
VOLATILE PRIORITY POLLUTANTS:				
Acrolein	25.0			ND
Acrylonitrile	25.0			ND
Benzene	2.5	5	0.7	ND
Bromoform	2.5			ND
Carbon Tetrachloride	2.5	5	5	ND
Chlorobenzene	2.5			ND
Dibromochloromethane	2.5			ND
Chloroethane	25.0			ND
2-Chloroethylvinylether	25.0			ND
Chloroform	2.5			3.1
Dichlorobromomethane	2.5			ND
1,1-Dichloroethane	2.5		20	ND
1,2-Dichloroethane	2.5	5	1	ND
1,1-Dichloroethene (DCE)	2.5	7	6	ND
1,1-Dichloropropane	2.5			ND
Ethylbenzene	2.5		680	ND
Methyl Bromide	25.0			ND
Methyl Chloride	25.0			ND
Methylene Chloride	125.0		40	ND
1,1,2,2-Tetrachloroethane	2.5		1	ND
Tetrachloroethene (PCE)	2.5		4	48
Toluene	12.5		100	ND
1,1,1-Trichloroethane (TCA)	2.5	200	200	ND
1,1,2-Trichloroethane	2.5		100	ND
Trichloroethene (TCE)	2.5	5	5	78
Vinyl Chloride	25.0	2	2	ND
trans-1,3-Dichloropropene	2.5			ND
cis-1,3-Dichloropropene	2.5			ND
trans-1,2-Dichloroethene	2.5		16	ND
Trichlorofluoromethane	25.0		3400	ND
VOLATILE NON-PRIORITY POLLUTANTS:				
Acetone	250.0			ND
Methylethylketone	25.0			ND
Tetrahydrofuran	25.0			ND
m,p-Xylenes	2.5		620	ND
o-xylene	2.5		620	ND
Styrene	12.5			ND

WELL PS-4 **MCAS - EL TORO PERIMETER INVESTIGATION**

COMPOUNDS	Detection Limit (ug/l)	MCL (ug/l)	DOHS DW Action Level (ug/l)	CONCENTRATION (ug/l) 1/23/89
1,2-Dibromo-3-chloropropane	NA			NA
cis-1,2-Dichloroethene	2.5			10
Propylbenzene	NA			NA
NON-VOLATILE PRIORITY POLLUTANTS:				
1,2-Dichlorobenzene	12.5		130	ND
1,3-Dichlorobenzene	12.5		130	ND
1,4-Dichlorobenzene	12.5		0.5	ND
Trichlorobenzene	NA			NA

ND: Non-Detectable
NA: Not Analyzed

WELL PS-5 MCAS - EL TORO PERIMETER INVESTIGATION

COMPOUNDS	Detection Limit (ug/l)	MCL (ug/l)	DOHS Action Level (ug/l)	CONCENTRATION (ug/l) 1/23/89	DUP 1/23/89
VOLATILE PRIORITY POLLUTANTS:					
Acrolein	1.00			ND	ND
Acrylonitrile	1.00			ND	ND
Benzene	0.10	5	0.7	ND	ND
Bromoform	0.10			ND	ND
Carbon Tetrachloride	0.10	5	5	ND	ND
Chlorobenzene	0.10			ND	ND
Dibromochloromethane	0.10			ND	ND
Chloroethane	1.00			ND	ND
2-Chloroethylvinylether	1.00			ND	ND
Chloroform	0.10			ND	ND
Dichlorobromomethane	0.10			ND	ND
1,1-Dichloroethane	0.10		20	ND	ND
1,2-Dichloroethane	0.10	5	1	ND	ND
1,1-Dichloroethene (DCE)	0.10	7	6	ND	ND
1,1-Dichloropropane	0.10			ND	ND
Ethylbenzene	0.10		680	ND	ND
Methyl Bromide	1.00			ND	ND
Methyl Chloride	1.00			ND	ND
Methylene Chloride	5.00		40	ND	ND
1,1,2,2-Tetrachloroethane	0.10		1	ND	ND
Tetrachloroethene (PCE)	0.10		4	ND	ND
Toluene	0.50		100	ND	ND
1,1,1-Trichloroethane (TCA)	0.10	200	200	ND	ND
1,1,2-Trichloroethane	0.10		100	ND	ND
Trichloroethene (TCE)	0.10	5	5	ND	ND
Vinyl Chloride	1.00	2	2	ND	ND
trans-1,3-Dichloropropene	0.10			ND	ND
cis-1,3-Dichloropropene	0.10			ND	ND
trans-1,2-Dichloroethene	0.10		16	ND	ND
Trichlorofluoromethane	1.00		3400	ND	ND
VOLATILE NON-PRIORITY POLLUTANTS:					
Acetone	10.00			ND	ND
Methylethylketone	1.00			ND	ND
Tetrahydrofuran	1.00			ND	ND
m,p-Xylenes	0.10		620	ND	ND
o-xylene	0.10		620	ND	ND
Styrene	0.50			ND	ND

WELL PS-5 MCAS - EL TORO PERIMETER INVESTIGATION

COMPOUNDS	Detection Limit (ug/l)	MCL (ug/l)	DOHS DW Action Level (ug/l)	CONCENTRATION (ug/l) 1/22/89	DUP 1/22/89
1,2-Dibromo-3-chloropropane	NA			NA	NA
cis-1,2-Dichloroethene	0.10			ND	ND
Propylbenzene	NA			NA	NA
NON-VOLATILE PRIORITY POLLUTANTS:					
1,2-Dichlorobenzene	0.50		130	ND	ND
1,3-Dichlorobenzene	0.50		130	ND	ND
1,4-Dichlorobenzene	0.50		0.5	ND	ND
Trichlorobenzene	NA			NA	NA

ND: Non-Detectable
NA: Not Analyzed

WELL PS-6 **MCAS - EL TORO PERIMETER INVESTIGATION**

COMPOUNDS	Detection Limit (Ug/l)	MCL (ug/l)	DOHS Action Level (ug/l)	CONCENTRATION (ug/l) 1/22/89
VOLATILE PRIORITY POLLUTANTS:				
Acrolein	1.00			ND
Acrylonitrile	1.00			ND
Benzene	0.10	5	0.7	ND
Bromoform	0.10			ND
Carbon Tetrachloride	0.10	5	5	1.3
Chlorobenzene	0.10			ND
Dibromochloromethane	0.10			ND
Chloroethane	1.00			ND
2-Chloroethylvinylether	1.00			ND
Chloroform	0.10			7.7
Dichlorobromomethane	0.10			1
1,1-Dichloroethane	0.10		20	ND
1,2-Dichloroethane	0.10	5	1	ND
1,1-Dichloroethene (DCE)	0.10	7	6	ND
1,1-Dichloropropane	0.10			ND
Ethylbenzene	0.10		680	ND
Methyl Bromide	1.00			ND
Methyl Chloride	1.00			ND
Methylene Chloride	5.00		40	ND
1,1,2,2-Tetrachloroethane	0.10		1	ND
Tetrachloroethene (PCE)	0.10		4	0.4
Toluene	0.50		100	ND
1,1,1-Trichloroethane (TCA)	0.10	200	200	ND
1,1,2-Trichloroethane	0.10		100	ND
Trichloroethene (TCE)	0.10	5	5	11
Vinyl Chloride	1.00	2	2	ND
trans-1,3-Dichloropropene	0.10			ND
cis-1,3-Dichloropropene	0.10			ND
trans-1,2-Dichloroethene	0.10		16	ND
Trichlorofluoromethane	1.00		3400	ND
VOLATILE NON-PRIORITY POLLUTANTS:				
Acetone	100.00			ND
Methylethylketone	10.00			ND
Tetrahydrofuran	10.00			ND
m,p-Xylenes	1.00		620	ND
o-xylene	1.00		620	ND
Styrene	5.00			ND

WELL PS-6 **MCAS - EL TORO PERIMETER INVESTIGATION**

COMPOUNDS	Detection Limit (ug/l)	MCL (ug/l)	DOHS DW Action Level (ug/l)	1/22/89
1,2-Dibromo-3-chloropropane	NA			NA
cis-1,2-Dichloroethene	0.10			ND
Propylbenzene	NA			NA
NON-VOLATILE PRIORITY POLLUTANTS:				
1,2-Dichlorobenzene	0.50		130	ND
1,3-Dichlorobenzene	0.50		130	ND
1,4-Dichlorobenzene	0.50		0.5	ND
Trichlorobenzene	NA			NA

ND: Non-Detectable
NA: Not Analyzed

WELL PS-7 MCAS - EL TORO PERIMETER INVESTIGATION

COMPOUNDS	Detection Limit (ug/l)	MCL (ug/l)	DOHS Action Level (ug/l)	CONCENTRATION (ug/l) 1/23/89
VOLATILE PRIORITY POLLUTANTS:				
Acrolein	1.00			ND
Acrylonitrile	1.00			ND
Benzene	0.10	5	0.7	ND
Bromoform	0.10			ND
Carbon Tetrachloride	0.10	5	5	ND
Chlorobenzene	0.10			ND
Dibromochloromethane	0.10			ND
Chloroethane	1.00			ND
2-Chloroethylvinylether	1.00			ND
Chloroform	0.10			0.1
Dichlorobromomethane	0.10			ND
1,1-Dichloroethane	0.10		20	ND
1,2-Dichloroethane	0.10	5	1	ND
1,1-Dichloroethene (DCE)	0.10	7	6	ND
1,1-Dichloropropane	0.10			ND
Ethylbenzene	0.10		680	ND
Methyl Bromide	1.00			ND
Methyl Chloride	1.00			ND
Methylene Chloride	5.00		40	ND
1,1,2,2-Tetrachloroethane	0.10		1	ND
Tetrachloroethene (PCE)	0.10		4	ND
Toluene	0.50		100	ND
1,1,1-Trichloroethane (TCA)	0.10	200	200	ND
1,1,2-Trichloroethane	0.10		100	ND
Trichloroethene (TCE)	0.10	5	5	ND
Vinyl Chloride	1.00	2	2	ND
trans-1,3-Dichloropropene	0.10			ND
cis-1,3-Dichloropropene	0.10			ND
trans-1,2-Dichloroethene	0.10		16	ND
Trichlorofluoromethane	1.00		3400	ND
VOLATILE NON-PRIORITY POLLUTANTS:				
Acetone	100.00			ND
Methylethylketone	10.00			ND
Tetrahydrofuran	10.00			ND
m,p-Xylenes	1.00		620	ND
o-xylene	1.00		620	ND
Styrene	5.00			ND

WELL PS-7 MCAS - EL TORO PERIMETER INVESTIGATION

COMPOUNDS	Detection Limit (ug/l)	MCL (ug/l)	DOHS DW Action Level (ug/l)	CONCENTRATION (ug/l) 1/22/89
1,2-Dibromo-3-chloropropane	NA			NA
cis-1,2-Dichloroethene	0.10			ND
Propylbenzene	NA			NA
NON-VOLATILE PRIORITY POLLUTANTS:				
1,2-Dichlorobenzene	0.50		130	ND
1,3-Dichlorobenzene	0.50		130	ND
1,4-Dichlorobenzene	0.50		0.5	ND
Trichlorobenzene	NA			NA

ND: Non-Detectable
NA: Not Analyzed

WELL PS-8 **MCAS - EL TORO PERIMETER INVESTIGATION**

COMPOUNDS	Detection Limit (ug/l)	MCL (ug/l)	DOHS Action Level (ug/l)	CONCENTRATION (ug/l) 1/23/89
VOLATILE PRIORITY POLLUTANTS:				
Acrolein	10.0			ND
Acrylonitrile	10.0			ND
Benzene	1.0	5	0.7	ND
Bromoform	1.0			ND
Carbon Tetrachloride	1.0	5	5	2
Chlorobenzene	1.0			ND
Dibromochloromethane	1.0			ND
Chloroethane	10.0			ND
2-Chloroethylvinylether	10.0			ND
Chloroform	1.0			4
Dichlorobromomethane	1.0			ND
1,1-Dichloroethane	1.0		20	ND
1,2-Dichloroethane	1.0	5	1	ND
1,1-Dichloroethene (DCE)	1.0	7	6	ND
1,1-Dichloropropane	1.0			ND
Ethylbenzene	1.0		680	ND
Methyl Bromide	10.0			ND
Methyl Chloride	10.0			ND
Methylene Chloride	50.0		40	ND
1,1,2,2-Tetrachloroethane	1.0		1	ND
Tetrachloroethene (PCE)	1.0		4	ND
Toluene	5.0		100	ND
1,1,1-Trichloroethane (TCA)	1.0	200	200	ND
1,1,2-Trichloroethane	1.0		100	ND
Trichloroethene (TCE)	1.0	5	5	90
Vinyl Chloride	10.0	2	2	ND
trans-1,3-Dichloropropene	1.0			ND
cis-1,3-Dichloropropene	1.0			ND
trans-1,2-Dichloroethene	1.0		16	ND
Trichlorofluoromethane	10.0		3400	ND
VOLATILE NON-PRIORITY POLLUTANTS:				
Acetone	100.00			ND
Methylethylketone	10.00			ND
Tetrahydrofuran	10.00			ND
m,p-Xylenes	1.00		620	ND
o-xylene	1.00		620	ND
Styrene	5.00			ND

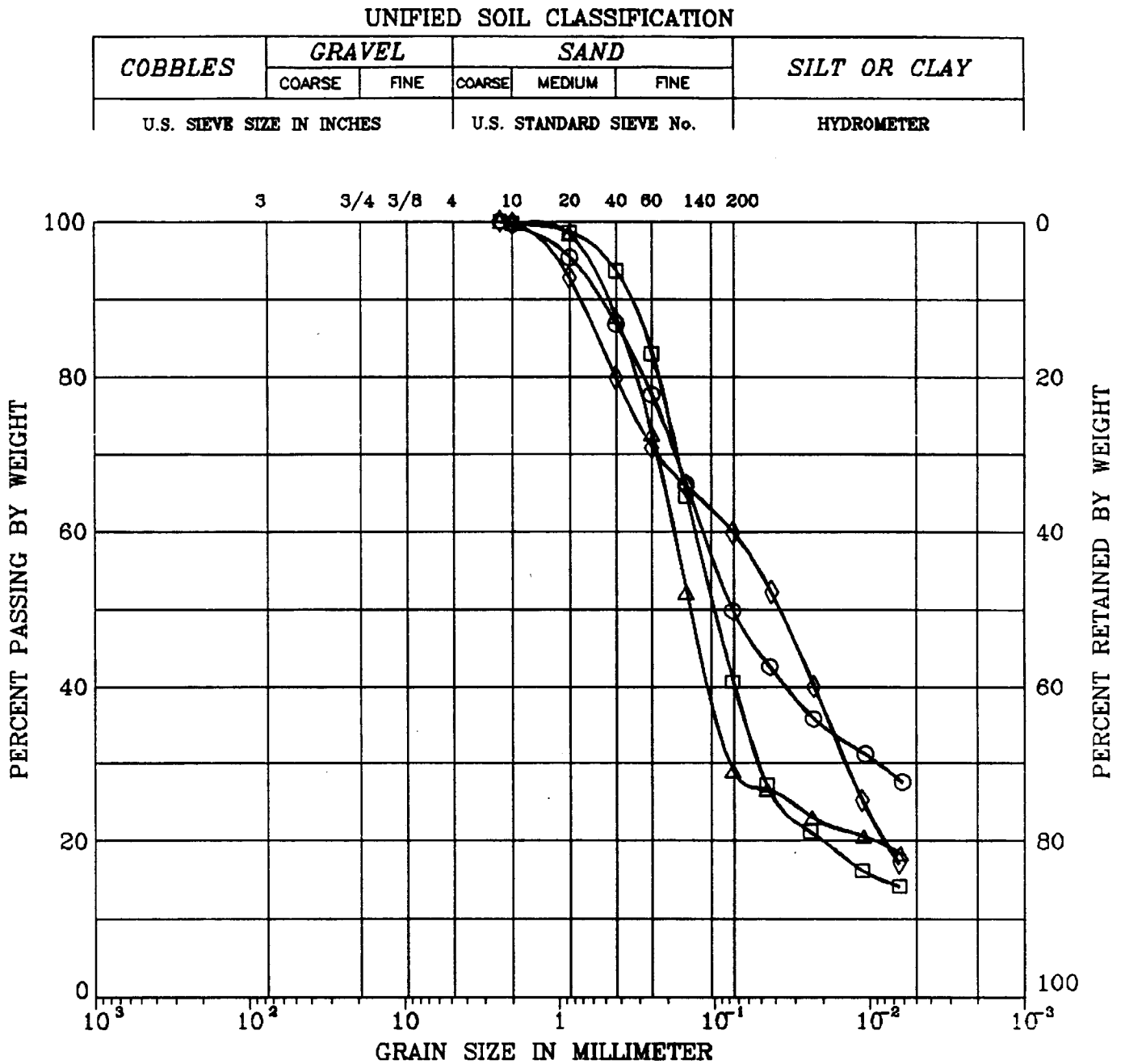
WELL PS-8 **MCAS - EL TORO PERIMETER INVESTIGATION**

COMPOUNDS	Detection Limit (ug/l)	MCL (ug/l)	DOHS DW Action Level (ug/l)	1/22/89
1,2-Dibromo-3-chloropropane	NA			NA
cis-1,2-Dichloroethene	1.0			ND
Propylbenzene	NA			NA
NON-VOLATILE PRIORITY POLLUTANTS:				
1,2-Dichlorobenzene	5.0		130	ND
1,3-Dichlorobenzene	5.0		130	ND
1,4-Dichlorobenzene	5.0		0.5	ND
Trichlorobenzene	NA			NA

ND: Non-Detectable
NA: Not Analyzed

APPENDIX C

LABORATORY RESULTS OF SOIL SAMPLES



SYMBOL	BORING	DEPTH (ft)	LL (%)	PI (%)	DESCRIPTION
○	SB-6/12				Clayey Sand (CL/SC)
□	SB-1/12				Silty Sand (SM)
△	SB-2/11				Silty Sand (SM)
◊	SB-3/9				Inorg. Silt and Clays (ML/CL)

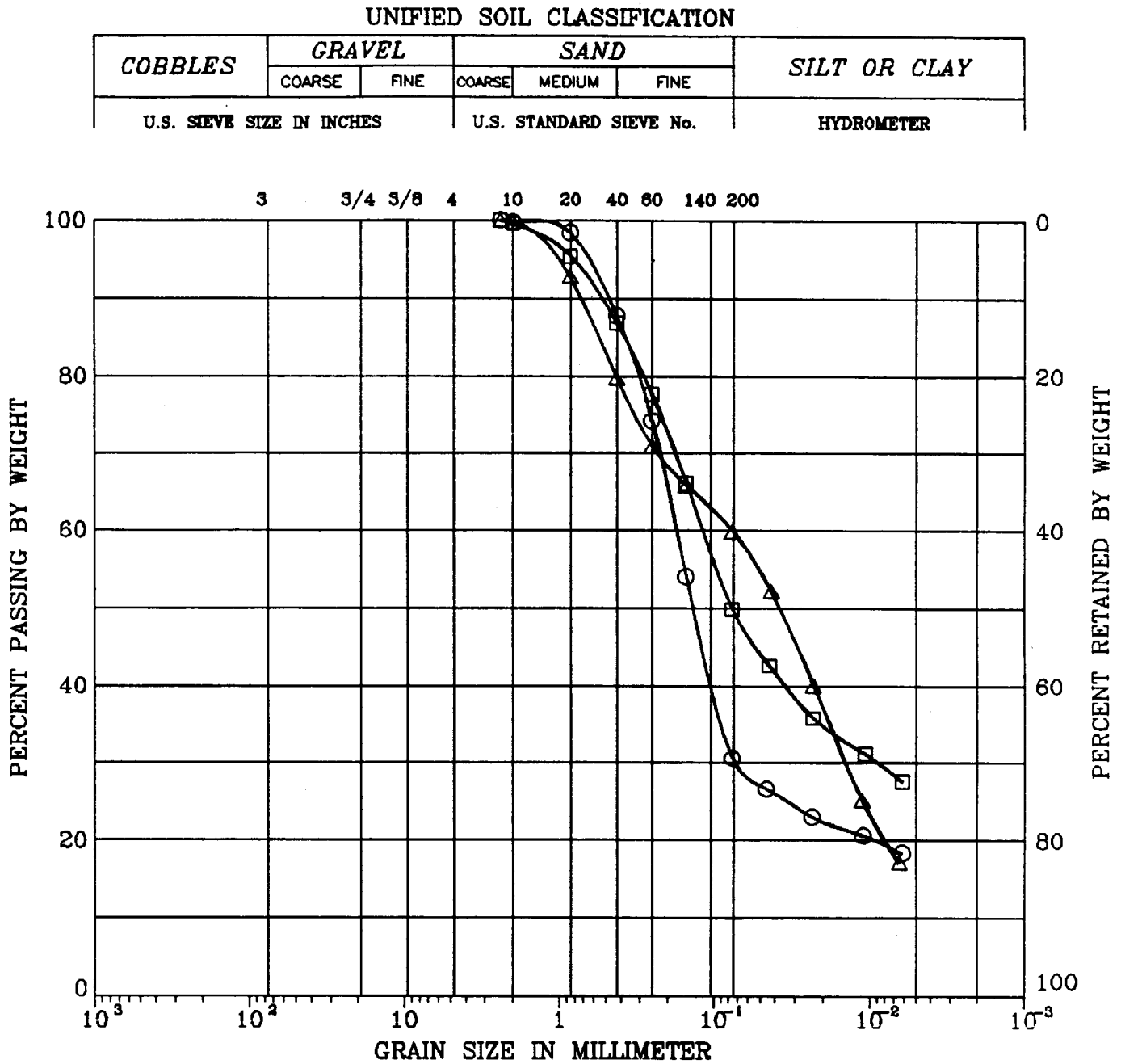
GRAIN SIZE DISTRIBUTION

J.M. MONTGOMERY
Laboratory Tests

Project No.
88-31-139-01

Converse Consultants Pasadena

Figure No.B-1



SYMBOL	BORING	DEPTH (ft)	LL (%)	PI (%)	DESCRIPTION
○	SB-2/11				Silty Sand (SM)
□	SB-6/12				SILTY SAND (SM)
△	SB-3/9				SILT (ML)

GRAIN SIZE DISTRIBUTION

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Laboratory Tests

Project No.
88-31-139-01

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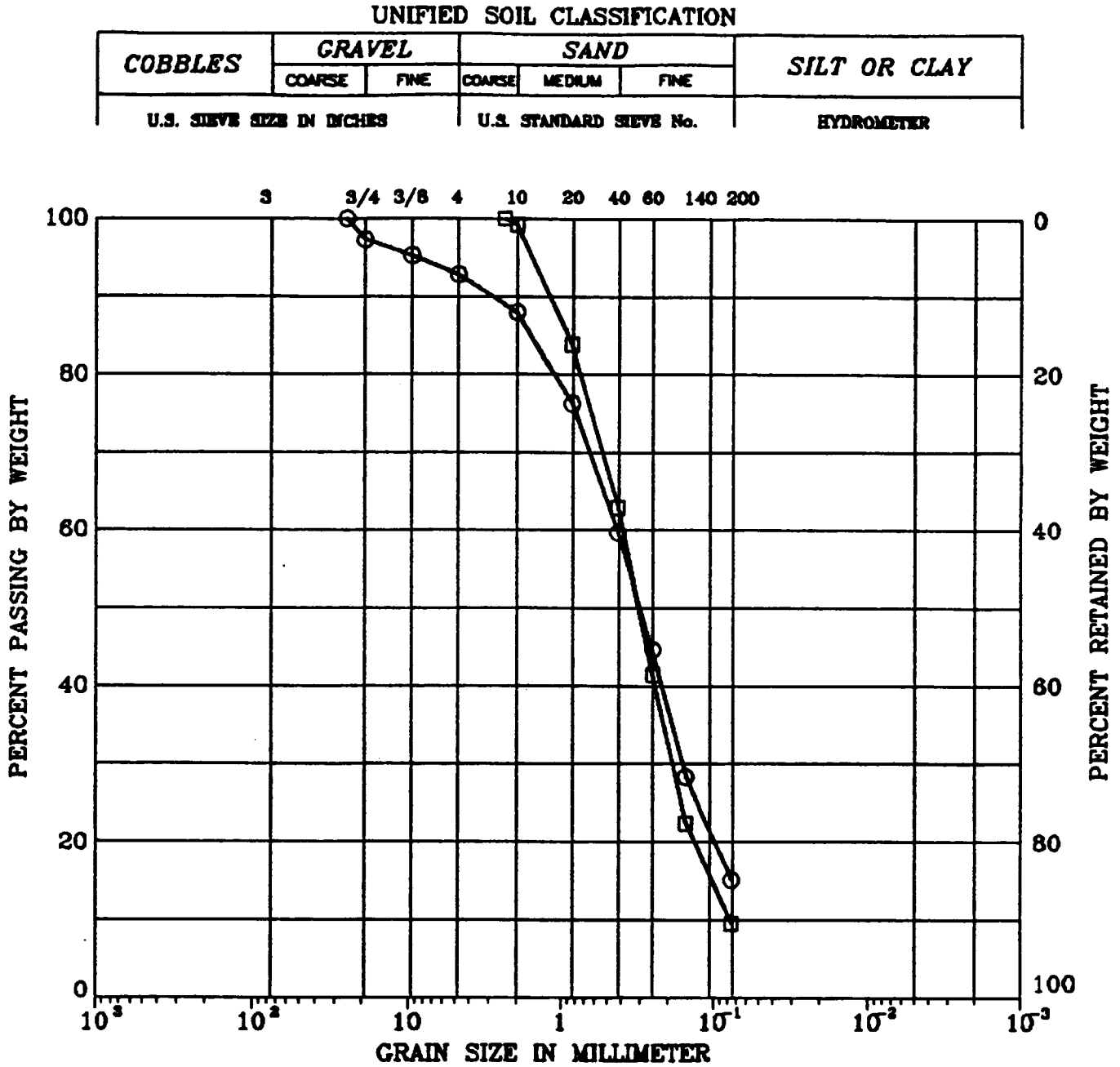
Figure No. B-2

POROSITY TEST RESULTS
87-31-107-01
J.M. Montgomery

SAMPLE	MOISTURE CONTENT, %	DRY DENSITY, pcf	SPECIFIC GRAVITY	POROSITY
DP-1	13.9	115	2.62	0.30
DP-2	15.7	117	2.62	0.28
DP-3	16.9	110	2.62	0.33
SP-4	16.7	111	2.63	0.32
PS-5	14.7	114	2.62	0.30
PS-6	16.3	115	2.63	0.30
PS-7	11.8	123	2.63	0.25
PS-8	26.0	105	2.63	0.36



SYMBOL	BORING	DEPTH (ft)	LL (%)	PI (%)	DESCRIPTION
○	DP-1	95-95.5			
□	DP-2	119-119.5			

GRAIN SIZE DISTRIBUTION

JAMES M MONTGOMERY/MCAS EL TORO
226-0320

Project No.
88-31-107-01

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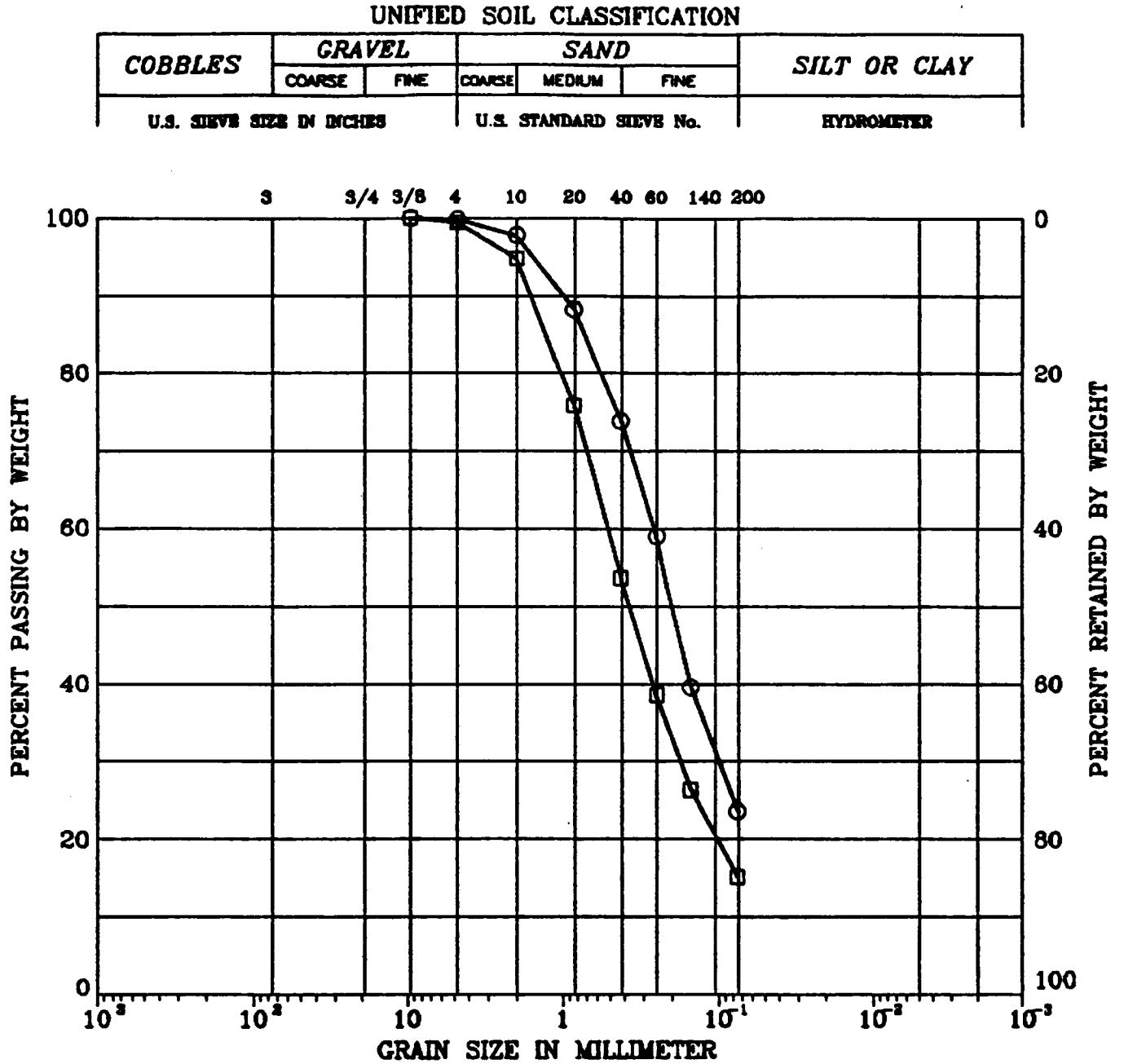
Drawing No. 1



SYMBOL	BORING	DEPTH (ft)	LL (%)	PI (%)	DESCRIPTION
○	DP-3	93.5-94			
□	SP-4	83-83.5			

GRAIN SIZE DISTRIBUTION

JAMES M. MONTGOMERY/MCAS EL TORO
226-0320

Project No.
88-31-107-01

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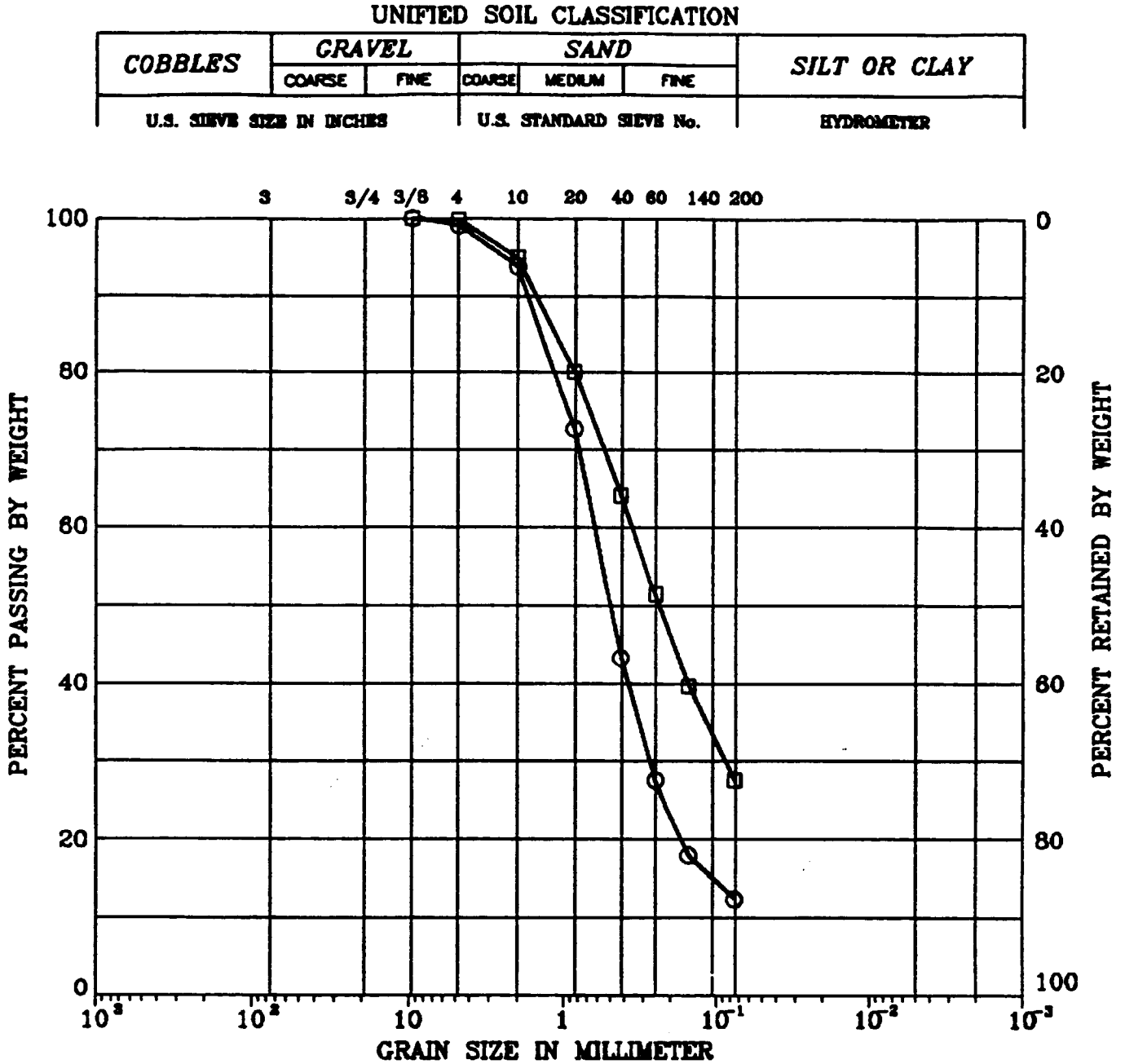
Drawing No. 2



SYMBOL	BORING	DEPTH (ft)	LL (%)	PI (%)	DESCRIPTION
○	PS-7	95.25-95.75			
□	PS-8	119-119.5			

GRAIN SIZE DISTRIBUTION

JAMES M. MONTGOMERY/MCAS EL TORO
226-0320

Project No.
88-31-107-01

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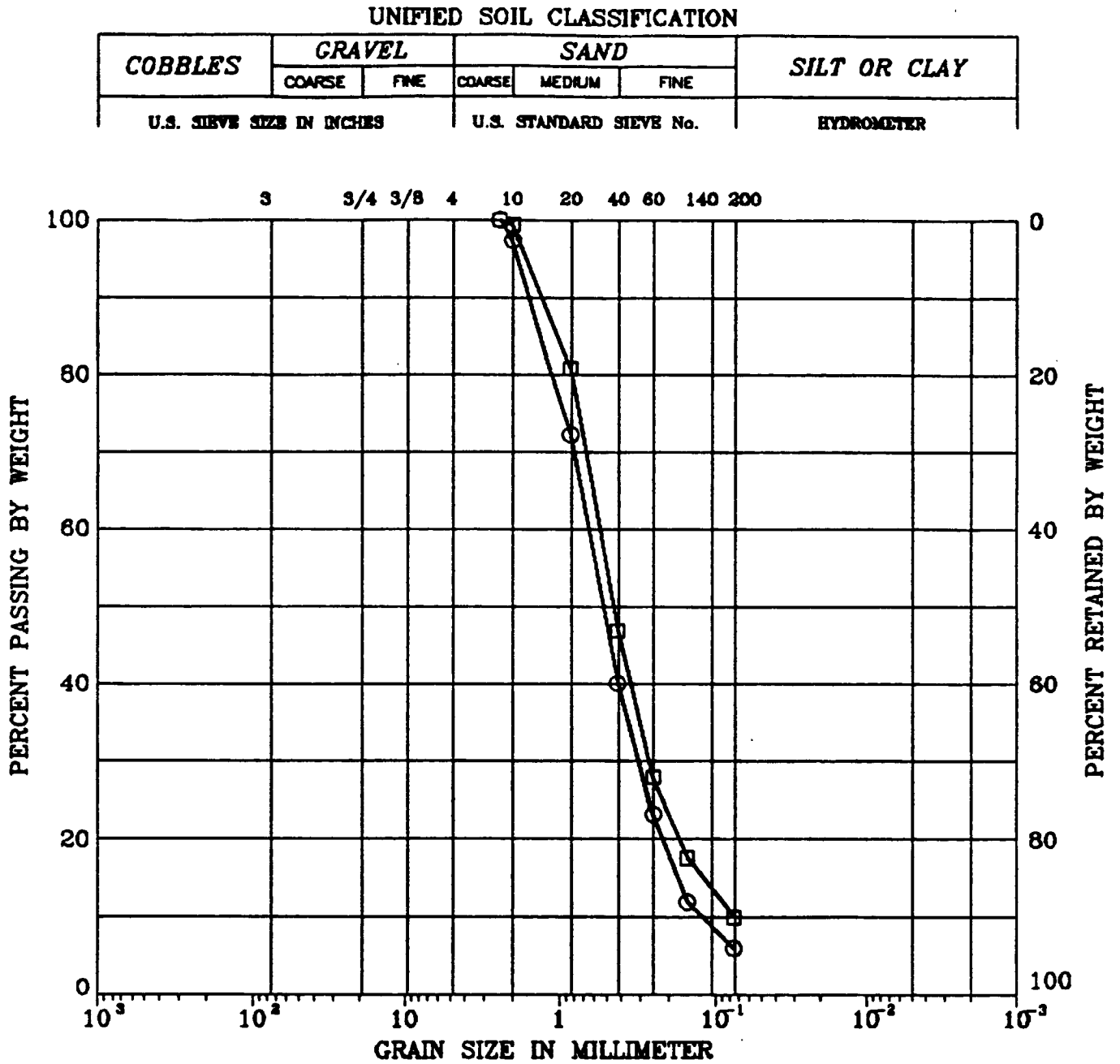
Drawing No. 4



SYMBOL	BORING	DEPTH (ft)	LL (%)	PI (%)	DESCRIPTION
○	PS-5	115.5-116			
□	PS-6	145-145.5			

GRAIN SIZE DISTRIBUTION

JAMES M. MONTGOMERY/MCAS EL TORO
226-0320

Project No.
88-31-107-01

Converse Consultants Pasadena

Drawing No. 3

11/19/36

Global Geochemistry Corporation
Work Order 4249
Montgomery Labs
Gregory Reller

SAMPLE	GGC ID	TOC (weight %)	TOC duplicate	TOC triplicate
PS1-35.1-SC	4249-1	0.05	0.06	0.04
PS2-60.85-CL/ML	4249-2	0.06	0.06	0.05
PS2-103.5-SM	4249-3	0.02	0.03	0.02
PS3-94-SP/SM	4249-4	0.02	0.03	0.02
PS4-12.25-CL	4249-5	0.29	0.29	0.28
PS4-89.5-SM/SW	4249-6	0.04	0.04	0.02
PS5-116.5-CL/CH	4249-7	0.18	0.19	0.13
PS8-130.5-CL	4249-8	0.33	0.33	0.31

APPENDIX D

LABORATORY RESULTS FROM OCWD INVESTIGATION

Water Sample Analyses Showing Those VOCs Found Above Reportable Limits

Well No.	Date Sampled	Electrical Conductivity (umhos/cm)	TCE (ug/l)	PCE (ug/l)	t-1,2 DCE (ug/l)	Chloroform (ug/l)	cis-1,2-DCE (ug/l)	1,1,1 TCA (ug/l)	Carbon Tetrachloride (ug/l)	Chloro-benzene (ug/l)	Dichloro-bromomethane (ug/l)
TIC 35	7-22-85	1294	11.4	TR	ND	ND	NT	ND	ND	ND	ND
	6-18-86	1725	15.9	ND	ND	ND	NT	ND	ND	ND	ND
	9-16-86	1385	27.8	ND	TR	ND	NT	ND	ND	ND	ND
	5-15-87	1392	31.8	ND	0.6	ND	NT	ND	ND	ND	ND
	5-27-88	1511	31.3	ND	0.5	ND	NT	0.8	ND	ND	ND
TIC 47	6-17-85	NT	10.1	TR	ND	ND	NT	ND	ND	ND	ND
	6-24-85	NT	9.8	ND	ND	ND	NT	ND	ND	ND	ND
	9-17-85	1461	8.4	ND	ND	ND	NT	ND	ND	ND	ND
	9-30-85	1499	7.9	ND	ND	ND	NT	ND	ND	ND	ND
	10-01-85	1499	8.7	ND	ND	ND	NT	ND	ND	ND	ND
	10-24-85	1601	9.0	ND	ND	ND	NT	ND	ND	ND	ND
	6-18-86	1468	9.5	ND	ND	ND	NT	ND	ND	ND	ND
	9-16-86	1463	6.7	ND	ND	ND	NT	ND	ND	ND	ND
	4-13-87	1687	3.8	ND	ND	ND	NT	ND	ND	ND	ND
	5-10-88	1376	6.6	ND	ND	ND	NT	ND	ND	ND	ND
	8-31-88	1355	5.6	ND	ND	ND	NT	ND	ND	ND	ND
	9-09-88	1365	7.6	ND	ND	ND	NT	ND	ND	ND	ND
TIC 55	7-22-85	1004	TR	TR	ND	ND	NT	ND	ND	ND	ND
	9-17-85	999	TR	ND	ND	ND	NT	ND	ND	ND	ND
	10-24-85	1028	TR	ND	ND	ND	NT	ND	ND	ND	ND
	4-13-87	1002	0.7	ND	ND	ND	NT	ND	ND	ND	ND
	5-28-87	1020	0.9	ND	ND	ND	NT	ND	ND	ND	ND
	8-08-88	1114	TR	ND	ND	ND	NT	ND	ND	ND	ND

Notes : umhos/cm = micromhos/centimeter; ug/l = micrograms/liter
TR = constituent detected below reportable limit
ND = Not Detected; NT = Not Tested

Water Sample Analyses Showing Those VOCs Found Above Reportable Limits

Well No.	Date Sampled	Electrical Conductivity (umhos/cm)	TCE (ug/l)	PCE (ug/l)	t-1,2 DCE (ug/l)	Chloroform (ug/l)	cis-1,2-DCE (ug/l)	1,1,1 TCA (ug/l)	Carbon Tetrachloride (ug/l)	Chloro-benzene (ug/l)	Dichloro-bromomethane (ug/l)
TIC 56	7-22-85	2019	ND	ND	ND	ND	NT	ND	ND	ND	ND
TIC 68	5-06-88	612	0.6	ND	ND	ND	NT	ND	ND	TR	ND
	2-07-89 (at 80 ft)	1262	TR	ND	ND	ND	NT	ND	ND	ND	ND
TIC 74	11-20-86	1170	ND	ND	ND	ND	NT	ND	ND	TR	ND
	12-14-87	1691	TR	ND	ND	ND	NT	ND	ND	ND	ND
	3-29-88	1197	0.6	ND	ND	ND	NT	ND	ND	ND	ND
	1-31-89 (at 280 ft)	1176	TR	ND	ND	ND	NT	ND	ND	ND	ND
TIC 78	7-08-85	NT	ND	ND	ND	ND	NT	ND	ND	ND	ND
	3-04-87	831	ND	ND	ND	ND	NT	ND	ND	ND	ND
	8-07-87	810	ND	ND	ND	ND	NT	ND	ND	ND	ND
	7-26-88	775	ND	ND	ND	ND	NT	ND	ND	ND	ND
	11-03-88	768	ND	ND	ND	ND	NT	ND	ND	ND	ND
TIC 83	2-14-89 (at 210 ft)	1230	9.1	TR	ND	ND	NT	ND	ND	ND	ND
TIC 106	7-09-86	668	ND	ND	ND	ND	NT	ND	ND	ND	ND
	12-30-86	4076	ND	ND	ND	ND	NT	ND	ND	ND	ND
	6-20-88	556	ND	ND	ND	ND	NT	0.9	ND	ND	ND
TIC 107	7-22-86	1135	ND	ND	ND	ND	NT	ND	ND	ND	ND
	5-10-88	1087	ND	ND	ND	ND	NT	ND	ND	ND	ND

Notes : umhos/cm = micromhos/centimeter; ug/l = micrograms/liter
TR = constituent detected below reportable limit
ND = Not Detected; NT = Not Tested

Water Sample Analyses Showing Those VOCs Found Above Reportable Limits

Well No.	Date Sampled	Electrical Conductivity (umhos/cm)	TCE (ug/l)	PCE (ug/l)	t-1,2 DCE (ug/l)	Chloroform (ug/l)	cis-1,2-DCE (ug/l)	1,1,1 TCA (ug/l)	Carbon Tetrachloride (ug/l)	Chloro-benzene (ug/l)	Dichloro-bromomethane (ug/l)
TIC 108	7-22-86	982	ND	ND	ND	ND	NT	ND	ND	ND	ND
	4-13-87	1070	ND	ND	ND	ND	NT	ND	ND	ND	ND
	6-20-88	1076	ND	ND	ND	ND	NT	TR	ND	ND	ND
TIC 110	7-08-85	NT	ND	ND	ND	ND	NT	ND	ND	ND	ND
	9-16-86	1640	ND	ND	ND	ND	NT	ND	ND	ND	ND
	8-07-87	1245	ND	ND	ND	ND	NT	ND	ND	ND	ND
	8-31-88	2323	ND	ND	ND	ND	NT	ND	ND	ND	ND
	11-04-88	NT	ND	ND	ND	ND	NT	ND	ND	ND	ND
TIC 111	7-22-85	1187	ND	ND	ND	ND	NT	ND	ND	ND	ND
	9-16-86	1286	ND	ND	ND	ND	NT	ND	ND	ND	ND
	8-07-87	1902	ND	ND	ND	ND	NT	ND	ND	ND	ND
	7-26-88	1244	ND	ND	ND	ND	NT	ND	ND	ND	ND
TIC 113	8-11-86	1192	ND	ND	ND	ND	NT	ND	ND	ND	ND
	4-13-87	1028	ND	ND	ND	ND	NT	ND	ND	ND	ND
	5-28-87	1113	ND	ND	ND	ND	NT	ND	ND	ND	ND
TIC 117	2-07-86	1027	ND	ND	ND	ND	NT	ND	ND	ND	ND
	10-13-87	1997	ND	ND	ND	ND	NT	ND	ND	ND	ND
TIC 127	3-07-89 (Pumping)	1268	ND	ND	ND	ND	NT	ND	ND	ND	ND
	3-07-89 (Bailed)	1234	ND	ND	ND	ND	NT	ND	ND	ND	ND

Notes : umhos/cm = micromhos/centimeter; ug/l = micrograms/liter
TR = constituent detected below reportable limit
ND = Not Detected; NT = Not Tested

Water Sample Analyses Showing Those VOCs Found Above Reportable Limits

Well No.	Date Sampled	Electrical Conductivity (umhos/cm)	TCE (ug/l)	PCE (ug/l)	t-1,2 DCE (ug/l)	Chloroform (ug/l)	cis-1,2-DCE (ug/l)	1,1,1 TCA (ug/l)	Carbon Tetrachloride (ug/l)	Chloro-benzene (ug/l)	Dichloro-bromomethane (ug/l)
North Lake (Woodbridge)	7-08-85	NT	ND	ND	ND	ND	NT	ND	ND	ND	ND
	9-16-86	1662	ND	ND	ND	ND	NT	ND	ND	ND	ND
	10-08-87	1581	ND	ND	ND	ND	NT	ND	ND	ND	ND
	11-02-88	1020	0.9	ND	ND	ND	NT	ND	ND	ND	ND
PS-1	12-15-88	NT	19	ND	ND	ND	ND	ND	0.3	0.3	ND
	1-22-89	NT	17	ND	ND	ND	0.4	ND	0.4	ND	ND
PS-2	12-16-88	NT	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1-22-89	NT	ND	ND	ND	0.2	ND	ND	ND	ND	0.2
PS-3	12-13-88	NT	33	24	ND	ND	ND	ND	ND	ND	ND
	1-23-89	NT	64	81	ND	12	4.8	ND	ND	ND	ND
PS-4	1-22-89	NT	78	48	ND	3.1	10	ND	ND	ND	ND
PS-5	1-23-89	NT	ND	ND	ND	ND	ND	ND	ND	ND	ND
PS-6	1-23-89	NT	11	0.4	ND	7.7	ND	ND	1.3	ND	ND
PS-7	1-23-89	NT	ND	ND	ND	0.1	ND	ND	ND	ND	ND
PS-8	1-23-89	NT	90	ND	ND	4.0	ND	ND	2.0	ND	ND

Notes : umhos/cm = micromhos/centimeter; ug/l = micrograms/liter
TR = constituent detected below reportable limit
ND = Not Detected; NT = Not Tested

Depth-Specific Water Sample Analyses Showing Those VOCs Found Above Reportable Limits

Well No.	Date Sampled	Sampling Depth (ft)	Electrical Conductivity (umhos/cm)	TCE (ug/l)	PCE (ug/l)	Chloroform (ug/l)	t-1,2 DCE (ug/l)	1,1,1 TCA (ug/l)	Carbon Tetrachloride (ug/l)	Acetone (ug/l)	Benzene (ug/l)	Chloro-benzene (ug/l)	Ethyl-benzene (ug/l)	Toluene (ug/l)
TIC 35														
Non-	3-2-88	50	NT	15.3	ND	ND	1.7	ND	ND	NT	ND	ND	ND	ND
Pumping		200	NT	14.7	ND	ND	1.5	ND	ND	NT	ND	ND	ND	ND
(Syringe)		265	NT	5.5	ND	ND	TR	ND	ND	NT	ND	ND	ND	ND
		278	NT	9.2	ND	ND	0.9	ND	ND	NT	ND	ND	ND	ND
		325	NT	5.6	ND	ND	TR	ND	ND	NT	ND	ND	ND	ND
		325	NT	5.8	ND	ND	TR	ND	ND	NT	ND	ND	ND	ND
		350	NT	3.7	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		370	NT	6.3	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		400	NT	6.0	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
Pumping	3-1-88	400	NT	2.5	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
(Welenco)		485	NT	0.5	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		550	NT	TR	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		650	NT	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		750	NT	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		1000	NT	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		1400	NT	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
Pumping	3-10-88	47 G	1870	10.0	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
(Welenco)		48 G	1870	12.4	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		50 G	1870	6.4	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		265	1890	26.4	ND	ND	TR	ND	ND	NT	ND	ND	ND	ND
		278	1870	31.9	ND	ND	TR	ND	ND	NT	ND	ND	ND	ND
		325	1770	46.1	ND	ND	0.7	ND	ND	NT	ND	ND	ND	ND
		350	1770	45.6	ND	ND	0.7	ND	ND	NT	ND	ND	ND	ND
		370	1920	34.1	ND	ND	0.7	ND	ND	NT	ND	ND	ND	ND
		400-I	1920	17.2	ND	ND	TR	ND	ND	NT	ND	ND	ND	ND
		400-II	1940	31.8	ND	ND	0.7	ND	ND	NT	ND	ND	ND	ND
		485	2400	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		550	2280	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND

Notes : Samples from MCAS wells were obtained through MP sampling port.
umhos/cm = micromhos/centimeter; ug/l = micrograms/liter
TR = constituent detected below reportable limit; ND = Not Detected; NT = Not Tested
G Grab sample obtained from bailer

Depth-Specific Water Sample Analyses Showing Those VOCs Found Above Reportable Limits

Well No.	Date Sampled	Sampling Depth (ft)	Electrical Conductivity (umhos/cm)	TCE (ug/l)	PCE (ug/l)	Chloroform (ug/l)	t-1,2 DCE (ug/l)	1,1,1 TCA (ug/l)	Carbon Tetrachloride (ug/l)	Acetone (ug/l)	Benzene (ug/l)	Chloro-benzene (ug/l)	Ethyl-benzene (ug/l)	Toluene (ug/l)
TIC 68	2-7-89	80	1262	TR	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
Pumping		120	1272	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
(Welenco)		170	1262	TR	ND	ND	ND	0.5	ND	NT	ND	ND	ND	ND
		220	1262	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		270	1272	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		380	1272	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
TIC 74	1-31-89	220	1354	TR	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
Pumping		255	1186	TR	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
(Welenco)		280	1176	TR	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
TIC 83	2-14-89	160	1235	8.5	TR	ND	ND	ND	ND	NT	ND	ND	NT	ND
Pumping		210	1230	9.1	TR	ND	ND	ND	ND	NT	ND	ND	NT	ND
(Welenco)		300	1226	7.4	ND	ND	ND	ND	ND	NT	ND	ND	NT	ND
		360	1226	8.1	ND	ND	ND	ND	ND	NT	ND	ND	NT	ND
MCAS-1														
After	1-4-89	65	2191	ND	ND	2.0	ND	TR*	ND	NT	ND	ND	ND	TR*
Purging		155	2905	ND	ND	ND	ND	TR*	ND	NT	ND	ND	ND	TR*
		215	1871	1.8	ND	ND	ND	TR*	ND	NT	ND	ND	ND	TR*
		275	1713	4.8	ND	TR	ND	TR*	ND	NT	ND	ND	ND	TR*
		335	NT	34.6	ND	TR	TR	ND	ND	NT	ND	ND	ND	ND
		455	1477	45.1	ND	TR	1.4	ND	ND	NT	ND	ND	ND	ND
		545	2550	TR	ND	0.7	ND	ND	ND	NT	ND	TR	ND	ND
	2-6-89	65	2329	ND	ND	2.0	ND	ND	ND	NT	ND	ND	ND	ND
		155	3050	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		215	1973	1.5	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
	2-7-89	275	1178	5.2	ND	TR	ND	ND	ND	NT	ND	ND	ND	ND
		335	NT	39.1	ND	0.5	TR	ND	ND	NT	ND	ND	ND	ND
	2-6-89	455	1189	51.9	ND	TR	1.8	ND	ND	NT	ND	ND	ND	ND
		545	2534	ND	ND	0.5	ND	ND	ND	NT	ND	TR	ND	ND

Notes : Samples from MCAS wells were obtained through MP sampling port.
umhos/cm = micromhos/centimeter; ug/l = micrograms/liter
TR = constituent detected below reportable limit; ND = Not Deter NT = Not Tested
* Due to lab contamination

Depth-Specific Water Sample Analyses Showing Those VOCs Found Above Reportable Limits.

Well No.	Date Sampled	Sampling Depth (ft)	Electrical Conductivity (umhos/cm)	TCE (ug/l)	PCE (ug/l)	Chloroform (ug/l)	t-1,2 DCE (ug/l)	1,1,1 TCA (ug/l)	Carbon Tetrachloride (ug/l)	Acetone (ug/l)	Benzene (ug/l)	Chloro-benzene (ug/l)	Ethyl-benzene (ug/l)	Toluene (ug/l)
MCAS-2														
Before	11-9-88	45	2777	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
Purging		135	4009	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		205	2748	ND	ND	0.7	ND	ND	ND	NT	ND	ND	ND	ND
		375	2787	ND	ND	0.7	ND	ND	ND	NT	ND	ND	ND	ND
		425	2831	ND	ND	0.7	ND	ND	ND	NT	ND	ND	ND	ND
		495	2982	ND	ND	0.6	ND	ND	ND	NT	ND	ND	ND	ND
		555	3667	ND	ND	ND	ND	ND	ND	NT	ND	TR	ND	ND
		625	3618	ND	ND	ND	ND	ND	ND	NT	TR	TR	ND	ND
After	12-27-88	45	2732	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
Purging		135	3939	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		205	1699	1.4	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		375	1280	34.6	ND	TR	ND	ND	ND	NT	ND	ND	ND	ND
		425	1172	38.9	ND	ND	0.6	ND	ND	NT	ND	ND	ND	ND
		495	2437	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		555	3033	ND	ND	ND	ND	ND	ND	NT	TR	ND	ND	0.5
		625	2609	ND	ND	ND	ND	ND	ND	NT	0.6	TR	ND	0.9
	2-7-89	45	2900	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		135	3943	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		205	1810	1.8	TR	ND	ND	ND	ND	NT	ND	ND	ND	ND
	2-16-89	375	1376	28.5	ND	TR	ND	ND	ND	NT	ND	ND	ND	ND
	2-08-89	425	1256	37.0	ND	ND	0.5	ND	ND	NT	ND	ND	ND	ND
		495	2807	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		555	3371	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		625	2918	ND	ND	ND	ND	ND	ND	NT	TR	0.6	0.9	0.6

Notes : Samples from MCAS wells were obtained through MP sampling port.
umhos/cm = micromhos/centimeter; ug/l = micrograms/liter
TR = constituent detected below reportable limit; ND = Not Detected; NT = Not Tested

Depth-Specific Water Sample Analyses Showing Those VOCs Found Above Reportable Limits

Well No.	Date Sampled	Sampling Depth (ft)	Electrical Conductivity (umhos/cm)	TCE (ug/l)	PCE (ug/l)	Chloroform (ug/l)	t-1,2 DCE (ug/l)	1,1,1 TCA (ug/l)	Carbon Tetrachloride (ug/l)	Acetone (ug/l)	Benzene (ug/l)	Chloro-benzene (ug/l)	Ethyl-benzene (ug/l)	Toluene (ug/l)
MCAS-3														
Before Purging	11-21-88	90	2599	ND	ND	1.9	ND	ND	ND	NT	ND	ND	ND	ND
		165	1743	ND	ND	0.6	ND	TR	ND	NT	ND	ND	ND	ND
		225	1221	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		345	1025	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		425	1465	ND	ND	TR	ND	ND	ND	NT	ND	ND	ND	ND
		495	1191	ND	ND	ND	ND	TR	ND	NT	ND	ND	ND	ND
After Purging	12-6-88	90	2606	ND	ND	2.8	ND	ND	ND	NT	ND	ND	ND	ND
		165	1929	ND	ND	0.7	ND	ND	ND	NT	ND	ND	ND	ND
		225	1260	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		345	1041	ND	ND	ND	ND	TR	ND	NT	ND	ND	ND	ND
		425	1203	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		495	1203	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
	1-30-89	90	2750	ND	ND	2.1	ND	ND	ND	NT	ND	ND	ND	ND
		165	2036	ND	ND	TR	ND	ND	ND	NT	ND	ND	ND	ND
		225	1240	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		345	1013	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		425	1013	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		495	1215	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND

Notes : Samples from MCAS wells were obtained through MP sampling port.
umhos/cm = micromhos/centimeter; ug/l = micrograms/liter
TR = constituent detected below reportable limit; ND = Not Detected; NT = Not Tested

Depth-Specific Water Sample Analyses Showing Those VOCs Found Above Reportable Limits

Well No.	Date Sampled	Sampling Depth (ft)	Electrical Conductivity (umhos/cm)	TCE (ug/l)	PCE (ug/l)	Chloroform (ug/l)	t-1,2 DCE (ug/l)	1,1,1 TCA (ug/l)	Carbon Tetrachloride (ug/l)	Acetone (ug/l)	Benzene (ug/l)	Chloro-benzene (ug/l)	Ethyl-benzene (ug/l)	Toluene (ug/l)
MCAS-7														
After	10-17-88	94	3210	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
Purging		194	NT	3.0	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		354	1195	20.0	ND	ND	TR	ND	ND	NT	ND	ND	ND	ND
		444	1050	19.4	ND	ND	4.1	ND	ND	NT	ND	ND	ND	ND
		514	3000	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		804	3242	ND	0.6	ND	ND	ND	ND	NT	ND	0.6	ND	0.8
		914	2468	ND	0.8	ND	ND	ND	ND	NT	ND	ND	TR	TR
		984	3194	ND	0.7	ND	ND	ND	ND	NT	ND	ND	TR	0.9
		1104	3049	ND	0.7	ND	ND	ND	ND	NT	TR	ND	0.8	1.0
	11-30-88	94	3294	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		194	1203	2.6	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		354	1076	24.8	ND	ND	0.5	ND	ND	NT	ND	ND	ND	ND
		444	1036	19.7	ND	ND	4.2	ND	ND	NT	ND	ND	ND	ND
		514	2797	ND	ND	ND	ND	TR	ND	NT	ND	ND	ND	TR
		804	3112	ND	0.7	ND	ND	0.6	ND	NT	TR	ND	TR	0.7
		914	2244	ND	0.8	ND	ND	TR	ND	NT	TR	ND	TR	0.6
		984	3093	ND	0.6	ND	ND	TR	ND	NT	ND	TR	TR	0.8
		1104	2892	ND	0.5	ND	ND	TR	ND	NT	TR	TR	0.9	0.7
	1-20-89	94	3211	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		194	1141	3.2	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
		354	1003	19.8	ND	ND	TR	ND	ND	NT	ND	ND	ND	ND
	1-19-89	444	1005	23.6	ND	ND	4.1	ND	ND	NT	ND	ND	ND	ND
	1-18-89	514	2500	ND	ND	ND	ND	ND	ND	NT	ND	ND	ND	ND
	1-19-89	804	2964	ND	TR	ND	ND	ND	ND	NT	ND	0.7	ND	ND
		914	2305	ND	TR	ND	ND	ND	ND	NT	ND	ND	ND	ND
		984	2974	ND	0.5	ND	ND	TR	ND	NT	ND	TR	ND	TR
	1-18-89	1104	2866	ND	TR	ND	ND	ND	ND	NT	ND	TR	0.7	TR

Notes : Samples from MCAS wells were obtained through MP sampling port.
umhos/cm = micromhos/centimeter; ug/l = micrograms/liter
TR = constituent detected below reportable limit; ND = Not Detected; NT = Not Tested

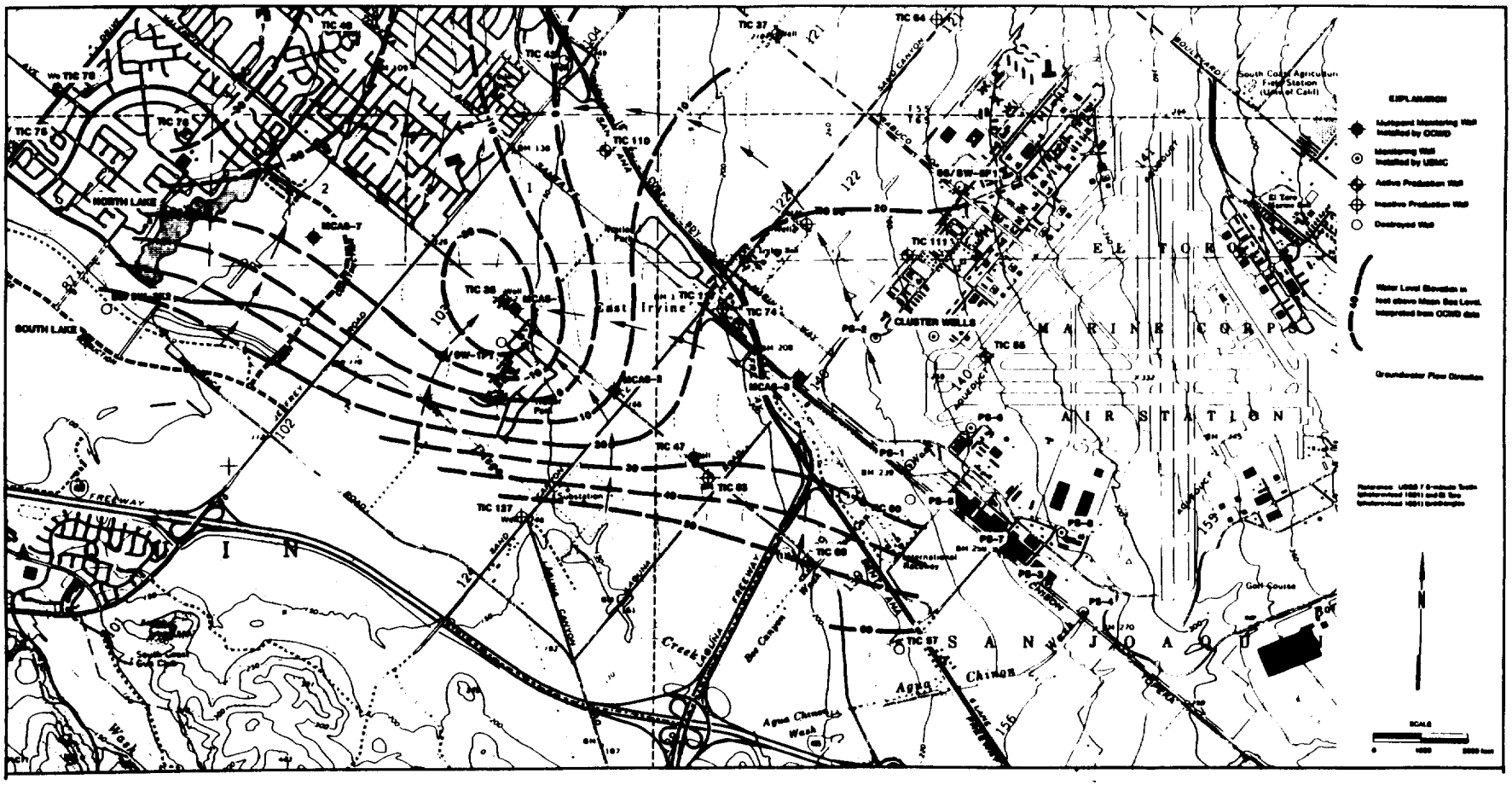
Depth-Specific Water Sample Analyses Showing Those VOCs Found Above Reportable Limits

Well No.	Date Sampled	Sampling Depth (ft)	Electrical Conductivity (umhos/cm)	TCE (ug/l)	PCE (ug/l)	Chloroform (ug/l)	t-1,2 DCE (ug/l)	1,1,1 TCA (ug/l)	Carbon Tetrachloride (ug/l)	Acetone (ug/l)	Benzene (ug/l)	Chloro-benzene (ug/l)	Ethyl-benzene (ug/l)	Toluene (ug/l)
Cluster Wells														
DW-135	7-15-88	135	NT	5.0	ND	11	ND	ND	56	ND	ND	ND	ND	ND
DW-250		250	NT	ND	ND	ND	ND	ND	8.0	ND	ND	ND	ND	ND
DW-350		350	NT	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DW-450		450	NT	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DW-540		540	NT	0.4	ND	0.1	ND	ND	ND	ND	ND	ND	ND	ND
DW-135	9-22-88	135	NT	7.0	ND	14	ND	ND	61	ND	ND	ND	ND	ND
DW-250		250	NT	ND	ND	ND	ND	ND	15	ND	ND	ND	ND	ND
DW-350		350	NT	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DW-450		450	NT	2.5	ND	0.3	ND	ND	ND	ND	ND	ND	ND	ND
DW-540		540	NT	0.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DW-135	1-20-89	135	NT	3.4	ND	11	ND	ND	45	ND	ND	ND	ND	ND
DW-250		250	NT	ND	ND	ND	ND	ND	3.1	10.0	ND	ND	ND	ND
DW-350		350	NT	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DW-450		450	NT	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DW-540	1-21-89	540	NT	0.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

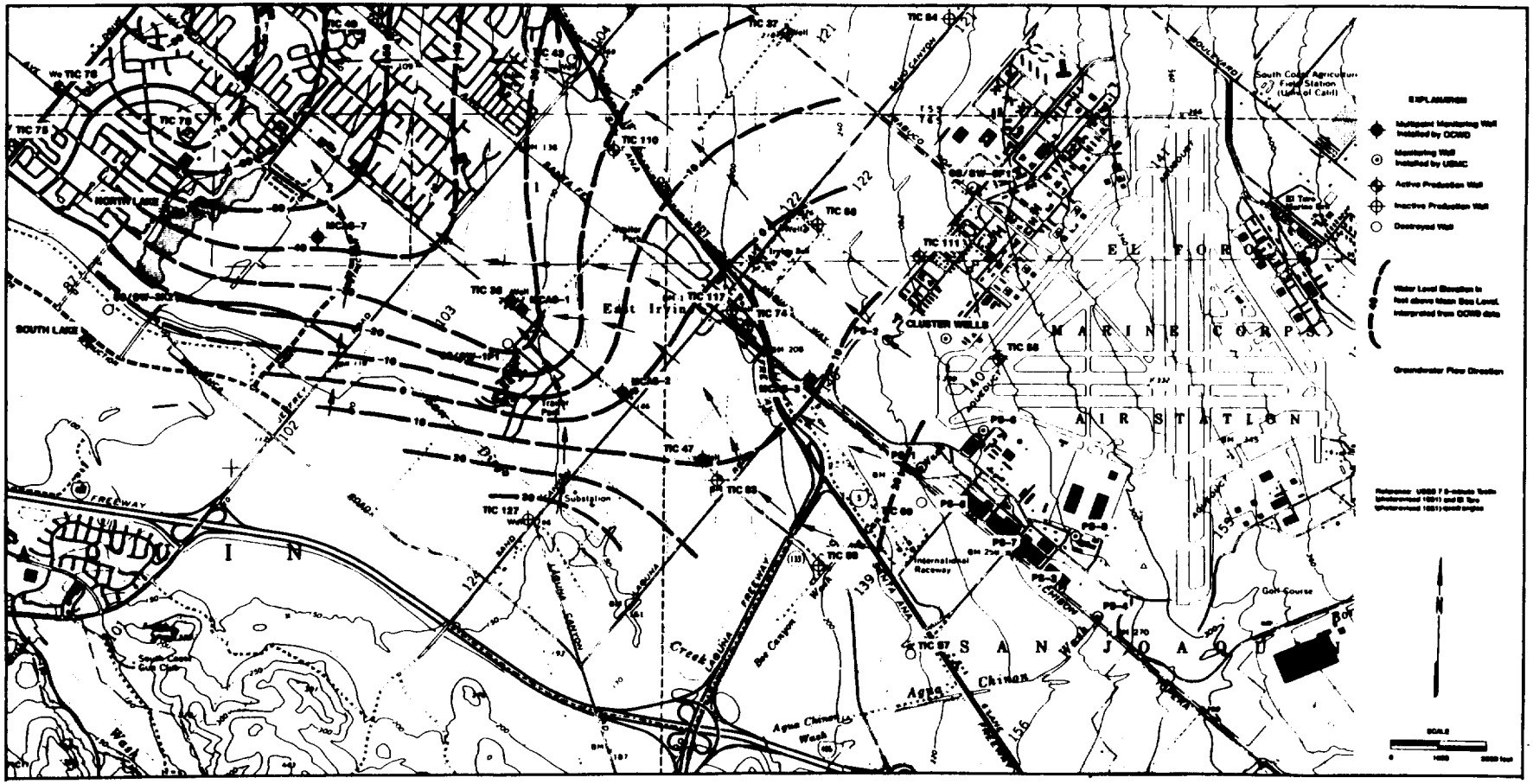
Notes : Samples from MCAS wells were obtained through MP sampling port.
umhos/cm : micromhos/centimeter; ug/l = micrograms/liter
TR = constituent detected below reportable limit; ND = Not Detected; NT = Not Tested

APPENDIX E

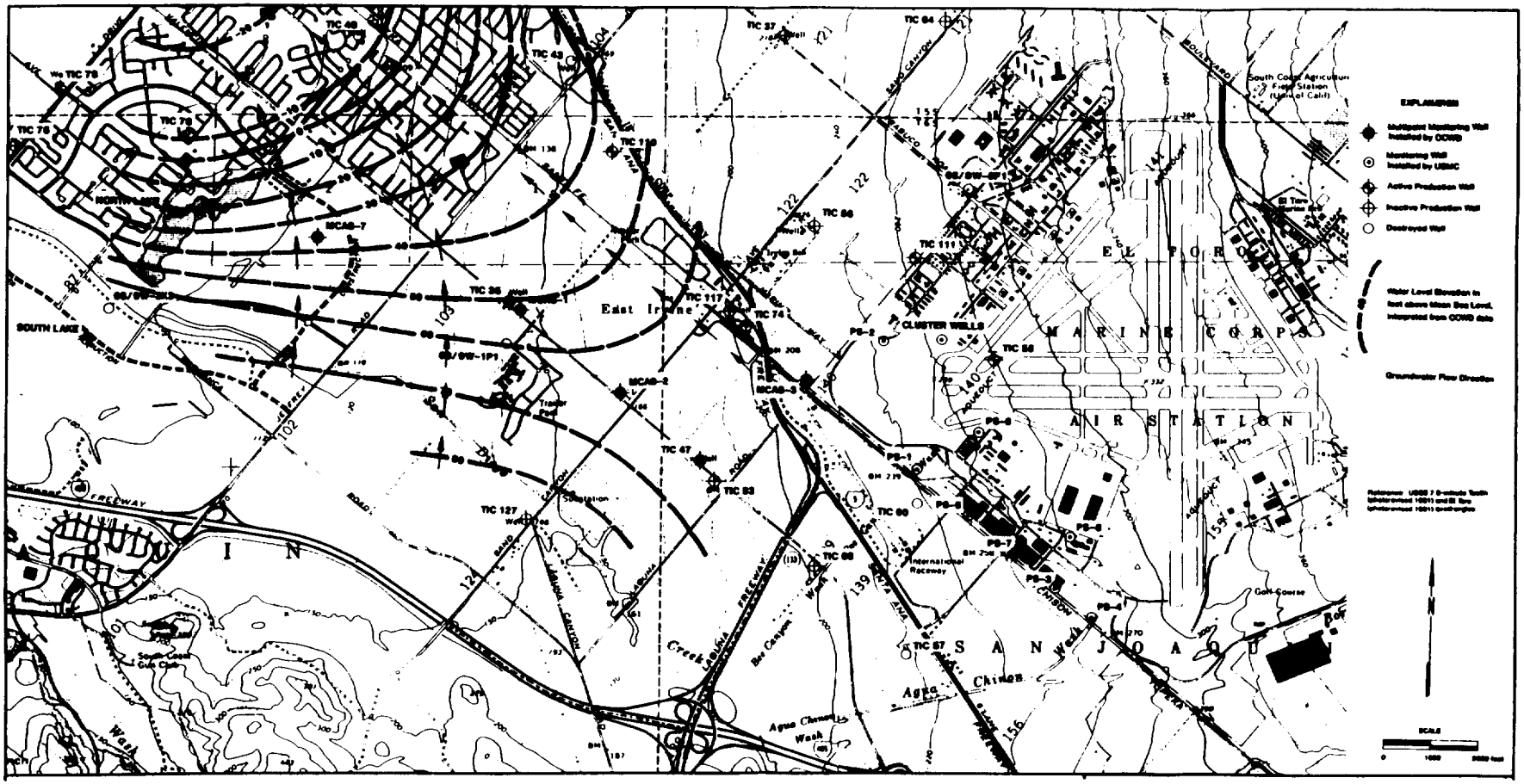
HISTORICAL GROUNDWATER CONTOUR MAPS



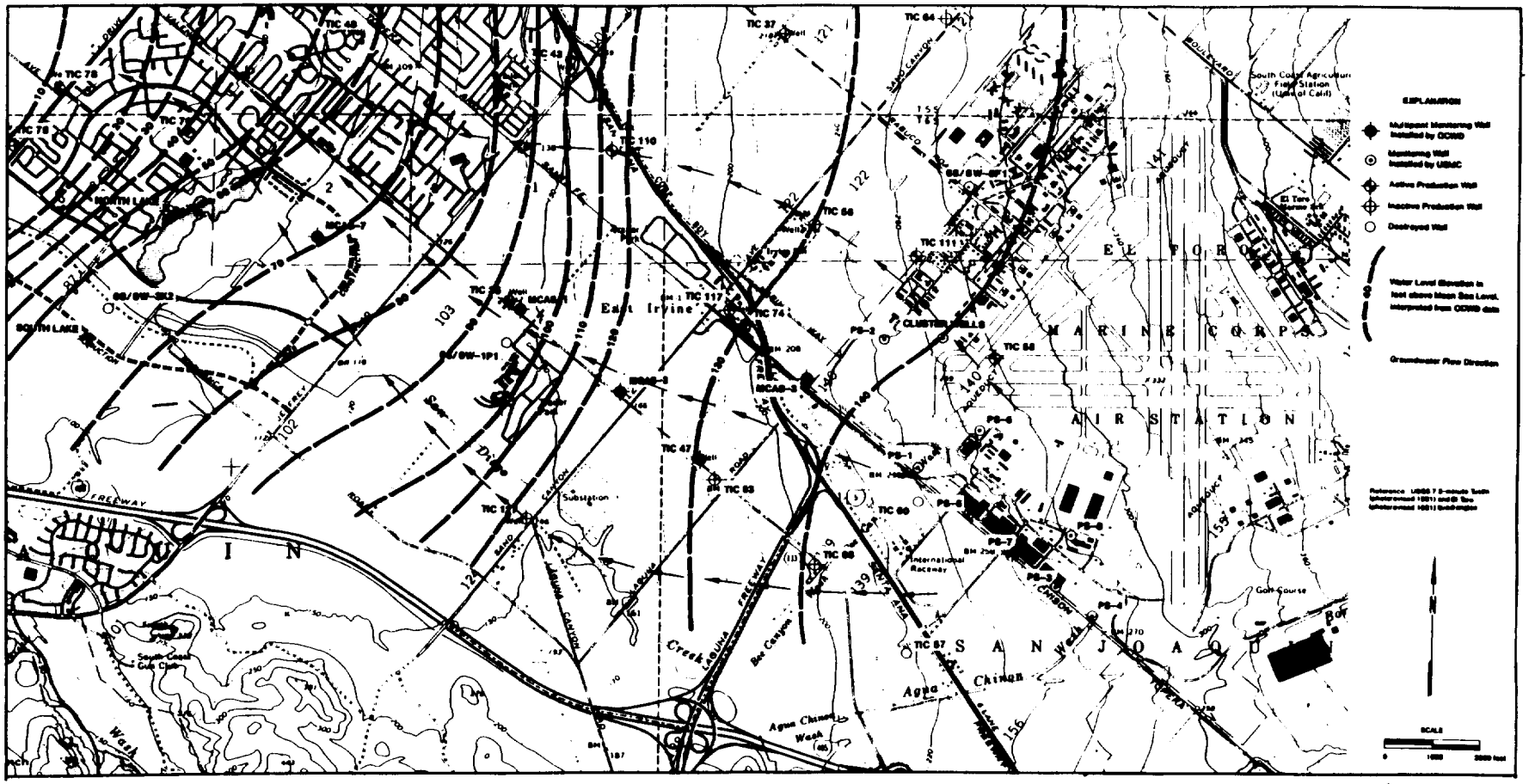
MCAS EL TORO, CALIFORNIA PERIMETER INVESTIGATION INTERIM REPORT	GROUNDWATER CONTOUR MAP NOVEMBER, 1948 From OCWD (1989)	APPENDIX E



MCAS EL TORO, CALIFORNIA **PERIMETER INVESTIGATION** **INTERIM REPORT**	**GROUNDWATER CONTOUR MAP** **NOVEMBER, 1956** **From OCWD (1989)**	APPENDIX E



MCAS EL TORO, CALIFORNIA **PERIMETER INVESTIGATION** **INTERIM REPORT**	**GROUNDWATER CONTOUR MAP** **SEPTEMBER, 1972** **From OCWD (1989)**	APPENDIX E



MCAS EL TORO, CALIFORNIA **PERIMETER INVESTIGATION** **INTERIM REPORT**	**GROUNDWATER CONTOUR MAP** **NOVEMBER, 1988** **From OCWD (1989)**	APPENDIX E

APPENDIX F

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REFERENCES

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