DRAFT

Treatability Study in Support of Remediation by Natural Attenuation (RNA) for CCFTA-2 (FT-17)

Cape Canaveral Air Station
Florida

Prepared For

Air Force Center for Environmental Excellence
Technology Transfer Division
Brooks Air Force Base
San Antonio, Texas

and

45th CES/CEVR
Cape Canaveral Air Station
Florida

May 1997

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DRAFT

TREATABILITY STUDY IN SUPPORT OF REMEDIATION BY NATURAL ATTENUATION (RNA)

for

CCFTA-2 (FT-17)

CAPE CANAVERAL AIR STATION

FLORIDA

May 1997

Prepared for:

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE

TECHNOLOGY TRANSFER DIVISION

BROOKS AIR FORCE BASE

SAN ANTONIO, TEXAS

AND

45th CES/CEVR

CAPE CANAVERAL AIR STATION

FLORIDA

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EXECUTIVE SUMMARY

This report presents the results of a treatability study (TS) performed by Parsons Engineering Science, Inc. (Parsons ES) at CCFTA-2 (FT-17), Cape Canaveral Air Station, Florida to evaluate remediation by natural attenuation (RNA) of chlorinated aliphatic hydrocarbons (CAHs) dissolved in the site groundwater. The TS focused on the fate and transport of dissolved CAHs, particularly trichloroethene (TCE), dichloroethene (DCE), and vinyl chloride (VC); however, petroleum hydrocarbons [including benzene, toluene, ethylbenzene, and xylenes (BTEX)] are present in site groundwater. Residual and mobile light nonaqueous-phase liquid (LNAPL) present in the vadose zone and phreatic soils serves as a continuing source for the dissolved CAHs and BTEX. Site history and the results of previous investigations are summarized in this report. The use of RNA has been evaluated with consideration to additional remedial actions at CCFTA-2 (FT-17), including source remediation via excavation and soil washing, and a horizontal air sparging system (HASS) that has been installed to reduce CAH concentrations in groundwater that discharges to surface water.

Comparison of CAH, BTEX, electron acceptor, and biodegradation byproduct isopleth maps for CCFTA-2 (FT-17) provides strong qualitative evidence of biodegradation of dissolved CAHs. These geochemical data strongly suggest that reductive dehalogenation of dissolved CAHs is occurring at the site as microbes utilize natural organic carbon, BTEX, and other fuel hydrocarbons as substrates. Despite the presence of mobile LNAPL, BTEX concentrations in groundwater are low and will likely continue to drop as fuel compounds are consumed as substrates. Patterns observed in the distribution of

CAHs, daughter products of CAHs, electron acceptors, and biodegradation byproducts further indicate that biodegradation is reducing the concentration of CAHs dissolved in site groundwater. Field-scale first-order dehalogenation rates of 0.00007 day^{-1} to 0.0005 day^{-1} (equivalent to half-lives of 3.8 to 27 years) were calculated using site-specific CAH data.

An important component of this study was an assessment of the time required to attain groundwater and surface water standards. To perform this task, a numerical groundwater flow and solute transport model was developed for the site using the USGS groundwater flow modeling code MODFLOW and the transport modeling code MT3D. After calibration and sensitivity analyses, the combined model was used to evaluate the fate and transport of dissolved CAHs in the shallow groundwater under the influence of advection, dispersion, sorption, and biodegradation. Input parameters for the model were obtained from data collected by Parsons ES. Model parameters that were not measured at the site were estimated using reasonable literature values.

Model predictions were made for two scenarios. The first scenario was a baseline scenario constructed with the assumption that the contaminant source would not be removed, but that CAH dissolution from source area LNAPL and soils into groundwater would naturally decrease at a rate of 10 percent per year (each concentration was decreased by a factor equal to 10 percent of the previous year's concentration). The results of this model suggest that CAH concentrations that could migrate beyond the location of the HASS would drop below 50 µg/L after 46 to 53 years, although source area concentrations would exceed 50 µg/L for more than 70 years. The second predictive scenario incorporated the assumption that the source would be excavated just before the beginning of the model year corresponding to 1998. This would immediately reduce source loading by 90 percent, with the remaining source weathering at a rate of 10 percent per year. Results of this model suggest that CAH concentrations that could migrate beyond the

location of the HASS would drop below 50 µg/L after 26 to 32 years, and that source area concentrations would drop below 50 µg/L after about 60 years.

The results of the two model scenarios therefore suggest that RNA can best be used to reduce dissolved CAH concentrations to desired levels when the source area is remediated via engineered methods. At over 40 sites evaluated as part of the Air Force Center for Environmental Excellence's (AFCEE's) Natural Attenuation Demonstration Program (e.g., see Wiedemeier *et al.*, 1995 and 1996c), source removal or reduction commonly has been shown to speed up the remediation time frame when used in conjunction with RNA. Moreover, the results provide a time frame for HASS operation, suggesting that operation of the HASS for 26 to 32 years would be sufficient to protect receptors that may be impacted by the discharge of groundwater to surface water.

Long-term monitoring (LTM) of groundwater chemistry at CCFTA-2 (FT-17) is necessary to allow assessment of site conditions over time, to confirm the effectiveness of naturally occurring processes in reducing dissolved contaminant mass and minimizing dissolved contaminant migration, and to facilitate evaluation of the need for additional remediation, should conditions change. An LTM plan involving sampling of groundwater from a minimum of eight wells and/or monitoring points within or on the periphery of the CAH plume is recommended, along with sampling of surface water at five locations. In addition to analyses used to verify the effectiveness of RNA, the groundwater samples should be analyzed for CAH and BTEX compounds by US Environmental Protection Agency (USEPA) Method SW8260. If data collected under the LTM program indicate that the selected remedial actions are not sufficient to reduce CAH concentrations discharging to surface water to levels considered protective of human health and the environment, additional corrective actions may be required to remediate groundwater at the site.

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ACRONYMS AND ABBREVIATIONS

2D	two-dimensional
3D	three-dimensional
°C	degrees centigrade
°F	degrees Fahrenheit
$\Delta G°_r$	Gibbs free energy
µg/L	micrograms per liter
µg/kg	micrograms per kilogram
µmol/L	micromoles per liter
AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
ARA	Applied Reseach Associates
ARARs	applicable or relevant and appropriate requirements
AS	Air Station
ASCII	American Standard Code for Information Exchange
AST	aboveground storage tank
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
CAHs	chlorinated aliphatic hydrocarbons
$CaCO_3$	calcium carbonate
CPT	cone penetrometry testing
DCA	dichloroethane
DCE	dichloroethene
DO	dissolved oxygen
EE/CA	engineering evaluation/cost analysis
ESE	Environmental Science and Engineering, Inc.
ft/day	feet per day
ft/ft	foot per foot
ft/min	foot per minute
ft msl	feet above mean sea level
ft/yr	feet per year
g/cc	grams per cubic centimeter
GC	gas chromatograph

GWQS	groundwater quality standards
H_2	dissolved hydrogen
HASS	horizontal air sparging system
HDPE	high density polyethylene
ID	inside diameter
IM	interim measures
in/year	inches per year
IRP	Installation Restoration Program
K_{oc}	soil sorption coefficient
kg	kilogram
L/kg	liters per kilogram
LIF	laser-induced fluorometry
LLNL	Lawrence Livermore National Laboratories
LNAPL	light nonaqueous-phase liquid
LTM	long-term monitoring
mg	milligram
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MOC	method of characteristics
MS	mass spectrometer
msl	mean sea level
mV	millivolts
N	nitrogen
nM	nanomoles per liter
NRMRL	National Risk Management Research Laboratory
OBG	O'Brien and Gere Engineers, Inc.
OD	outside diameter
ORD	Office of Research and Development
ORP	oxidation-reduction potential
OSWER	Office of Solid Waste and Emergency Response
Parsons ES	Parsons Engineering Science, Inc.
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PID	photoionization detector

PNA	polynuclear aromatic hydrocarbons
POC	point of compliance
PVC	polyvinyl chloride
QC	quality control
RCRA	Resource Conservation and Recovery Act
redox	reduction/oxidation
RI/FS	remedial investigation/feasibility study
RMS	root mean squared
RNA	remediation by natural attenuation
SAP	sampling and analysis plan
TBC	to be considered criteria
TCA	trichloroethane
TCE	trichloroethene
TEAP	terminal electron-accepting process
TMB	trimethylbenzene
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TRM	test remedial measures
TS	treatability study
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	underground storage tank
VC	vinyl chloride
VFA	volatile fatty acid
VOC	volatile organic compound

SECTION 1

INTRODUCTION

This report was prepared by Parsons Engineering Science, Inc. (Parsons ES) and presents the results of a treatability study (TS) conducted to evaluate remediation by natural attenuation (RNA) of groundwater contaminated with petroleum hydrocarbons and chlorinated aliphatic hydrocarbons (CAHs) at Site CCFTA-2 (FT-17), located at Cape Canaveral Air Station (AS), Florida (the Base). As used in this report, RNA refers to a management strategy that relies on natural attenuation mechanisms to remediate contaminants dissolved in groundwater and to control receptor exposure risks associated with contaminants in the subsurface. The United States Environmental Protection Agency (USEPA) Offices of Research and Development (ORD) and Solid Waste and Emergency Response (OSWER) have proposed the following definition of natural attenuation (Wilson, 1996):

The biodegradation, dispersion, sorption, volatilization, and/or chemical and biochemical stabilization of contaminants to effectively reduce contaminant toxicity, mobility, or volume to levels that are protective of human health and the ecosystem.

As suggested by this definition, mechanisms for natural attenuation of petroleum hydrocarbons and CAHs include advection, dispersion, dilution from recharge, sorption, volatilization, abiotic chemical transformation, and biodegradation. Of these processes, biodegradation is the most common mechanism working to transform contaminants into innocuous byproducts. During biodegradation, indigenous microorganisms work to bring about a reduction in the total mass of contamination in the subsurface without artificial intervention (e.g., addition of nutrients). Patterns and

rates of natural attenuation can vary markedly from site to site depending on governing physical and chemical processes.

RNA is advantageous for the following reasons:

- Contaminants are transformed to innocuous byproducts (e.g., carbon dioxide, ethene, or water), not just transferred to another phase or location within the environment;
- Current pump-and-treat technologies are energy-intensive and no more effective in reducing residual contamination;
- The process is nonintrusive and allows continuing use of infrastructure during remediation;
- Engineered remedial technologies may pose a greater risk to potential receptors than RNA (e.g., contaminants may be transferred into another medium during remediation activities); and
- RNA is less costly than conventional, engineered remedial technologies.

The disadvantages of RNA include the following:

- Contaminants considered to be more mobile and toxic can be produced as byproducts of biodegradation [e.g., vinyl chloride (VC)];
- The effectiveness of RNA is generally limited by site geochemistry and the availability of substrates;
- RNA may require a larger groundwater remediation zone than other remedial alternatives; and

- RNA frequently takes longer to reach specified contaminant concentration limits than other remedial alternatives.

The main emphasis of the work described herein was to evaluate the potential for naturally occurring degradation mechanisms to reduce dissolved CAH concentrations in groundwater to levels that meet site remediation goals. As will be discussed in Section 4 of this report, dissolved fuel hydrocarbon concentrations [in the form of benzene, toluene, ethylbenzene, and xylenes (BTEX)] at the site are relatively low, and BTEX compounds are not discharging to a receptor exposure point in detectable concentrations, unlike CAHs. The fact that natural attenuation processes ubiquitously limit the size and concentrations of BTEX plumes is well documented (e.g., Rice *et al.*, 1995; Wiedemeier *et al.*, 1995; Kuehne and Buscheck, 1996; and Mace *et al.*, 1997). Moreover, the presence of BTEX is favorable for the biodegradation of CAHs.

1.1 SCOPE AND OBJECTIVES

Parsons ES, in conjunction with researchers of the USEPA National Risk Management Research Laboratory (NRMRL), was retained by the United States Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division to conduct site characterization and groundwater modeling to evaluate the scientific defensibility of RNA with long-term monitoring (LTM) as a remedial option for contaminated groundwater at CCFTA-2 (FT-17). This study is not intended to be a contamination assessment report or a remedial action plan; rather, it is provided for the use of the Base and its prime environmental contractor(s) as information to be used for future decision making regarding this site.

Performance of numerous tasks was required in order to fulfill the project objective. These tasks included:

- Reviewing existing hydrogeologic and soil and groundwater quality data for the site;

- Conducting supplemental site characterization activities to more thoroughly characterize the nature and extent of soil, surface water, and groundwater contamination;
- Collecting geochemical data in support of natural attenuation;
- Developing a conceptual hydrogeologic model of the shallow saturated zone, including the current distribution of contaminants;
- Evaluating site-specific data to determine whether naturally occurring processes of contaminant attenuation and destruction are occurring in groundwater at the site;
- Designing and executing a groundwater flow and contaminant fate and transport model for site hydrogeologic conditions;
- Simulating the fate and transport of CAHs in groundwater under the influence of advection, dispersion, adsorption, and biodegradation using the calibrated flow and transport models;
- Evaluating a range of model input parameters to determine the sensitivity of the model to those parameters and to consider several contaminant fate and transport scenarios;
- Determining if natural processes are minimizing dissolved CAH and aromatic hydrocarbon plume expansion so that acceptable groundwater and surface water quality can be maintained at a downgradient point of compliance (POC);
- Using the results of modeling to evaluate RNA in conjunction with other site remedial actions; and

- Providing a proposed LTM plan to monitor and evaluate the effectiveness of RNA for dissolved CAHs.

Site characterization activities in support of RNA included the collection of soil and groundwater samples with a Geoprobe®; cone penetrometer testing (CPT) in conjunction with laser-induced fluorometry (LIF); static groundwater level measurement; surface water sample collection and analysis; and groundwater sample collection and analysis from site monitoring wells, newly installed CPT points, and temporary Geoprobe® monitoring points.

Field work conducted under this program was oriented toward the collection of supplementary hydrogeologic and chemical data necessary to document and model the effectiveness of RNA with LTM for restoration of fuel-hydrocarbon- and CAH-contaminated groundwater. Site-specific data were used to develop a solute fate and transport model for the site and to conduct a preliminary receptor exposure pathways analysis. The modeling effort was used to predict the future extent and concentration of the dissolved CAH plume by modeling the combined effects of advection, dispersion, sorption, and biodegradation. Results of the model were used to predict future contaminant concentrations at selected points and to identify whether RNA with LTM is an appropriate and defensible remedial option for contaminated groundwater, possibly in conjunction with engineered remedial actions. The results are intended to provide technical support for the RNA with LTM option during regulatory negotiations, as appropriate.

This TS contains nine sections, including this introduction, and five appendices. Section 2 summarizes site characterization activities. Section 3 summarizes the physical characteristics of the study area. Section 4 describes the nature and extent of soil, groundwater, and surface water contamination, and the geochemistry of soil and groundwater at the site. Section 5 describes the fate and transport model and design of

the conceptual hydrogeologic model for the site; lists model assumptions and input parameters; and describes sensitivity analyses. Section 6 presents model results for an evaluation of RNA in conjunction with other remedial alternatives in place or planned for the site. Section 7 presents a proposed LTM plan for site groundwater. Section 8 presents the conclusions of this work and provides recommendations for further work at the site. Section 9 lists the references used to develop this document. Appendix A contains Geoprobe® borehole logs, CPT logs, monitoring point construction diagrams, monitoring point development and purging data sheets, and well/point sampling data sheets. Appendix B presents the soil, groundwater, and surface water analytical results that were used in the preparation of this report and collected as a part of this TS. Appendix C contains biodegradation rate calculations and other calculations related to model calibration. Appendix D contains model input and output in American Standard Code for Information Interchange (ASCII) format on a diskette. Appendix E contains graphical output of transport model results.

1.2 FACILITY BACKGROUND

Cape Canaveral AS is located on the east coast of Florida, on a barrier island in Brevard County. The main complex occupies about 25 square miles of assembly and launch facilities for missiles and space vehicles. The property is bounded by the Atlantic Ocean on the east and by the Banana River on the West. The southern boundary is a man-made shipping canal, and the John F. Kennedy Space Center adjoins Cape Canaveral AS to the north. Since 1950, Cape Canaveral AS has been a proving ground for the country's military missile programs, including the Bomarc, Matador, Redstone, Atlas, Titan, and the Navy Trident Programs.

Former fire training area CCFTA-2 (FT-17) is about 1,000 feet from the Banana River, on the western side of Cape Canaveral AS (Figure 1.1). The site was used for firefighter training between 1965 and 1985. During training exercises, waste fuels and waste oils (including halogenated and nonhalogenated solvents) were burned in an

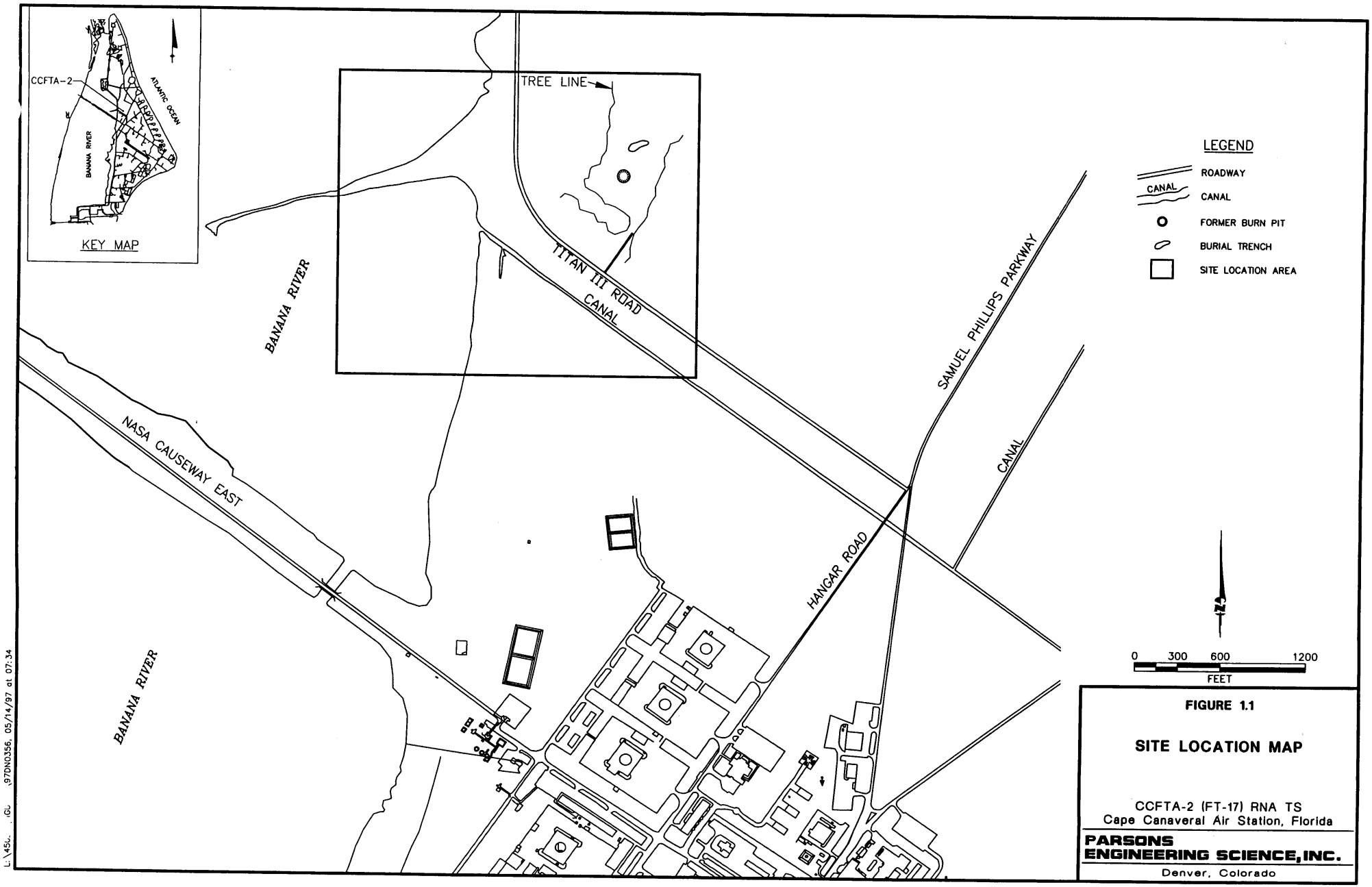

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FIGURE 1.1

SITE LOCATION MAP

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

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Denver, Colorado

unlined fire training pit. Fuel was stored onsite in aboveground storage tanks (ASTs) and was delivered to the burn pit via aboveground pipelines. Information regarding the amount of fuel and solvents burned during these exercises is not available. The burn area is a sparsely vegetated, circular, sandy pit approximately 75 feet in diameter and about 1 foot deep.

Containers of fuel and solvents were reportedly buried in disposal trenches at the site [O'Brien and Gere Engineers, Inc. (OBG), 1995b]. Empty drums were discovered buried in a trench approximately 200 feet north of the burn pit. Since 1985, the ASTs and the associated piping have been removed from the site. The site has no man-made structures other than supports for the former ASTs and a pilot-scale bioventing system. Major site surface features consist of the burn pit and some mounds of sandy marine soil with grass and shrub cover. The site is bordered on all sides by scrub oak and hardwood hammock. Figure 1.2 shows the site layout and its major features.

In 1984, an Installation Restoration Program (IRP) records search was conducted by Environmental Science and Engineering, Inc. (ESE, 1984). At that time, CCFTA-2 (FT-17) was identified as a site with potential environmental contamination. In 1985, a Resource Recovery and Conservation Act (RCRA) corrective action process commenced with a survey, site tour, and plan preparation for field activities. Phase II, Stage 1 sampling was completed in 1987, and the results were presented in a report in 1988 (ESE, 1988). A second stage of sampling (Phase II, Stage 2) was undertaken in order to more fully describe the extent of contamination, and the results of this work were presented in 1991 (ESE, 1991a). In 1992, O'Brien and Gere Engineers, Inc. (OBG, 1992) presented a conceptual TS report for CCFTA-2 (FT-17) as part of the Phase II, Stage 3, remedial investigation/feasibility study (RI/FS). In May 1995, OBG (1995a) presented an engineering evaluation/cost analysis (EE/CA) of test remedial measures (TRMs) for the site. In July, OBG (1995b) presented an RI/FS report for the site.

FIGURE 1.2

CCFTA-2 (FT-17)
SITE MAP

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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Results of groundwater sampling during the Phase II, Stage 1 and 2 investigations indicated the presence of dissolved petroleum hydrocarbons and CAHs exceeding Florida Class G-II Groundwater Quality Standards (GWQSs) (ESE, 1991a). Compounds of regulatory concern included benzene, trichloroethene (TCE), VC, 1,1-dichloroethene (1,1-DCE), and methylene chloride. In addition, 6 inches of mobile light nonaqueous-phase liquid (LNAPL, also known as free product) was detected in two wells at the site. Analysis of mobile LNAPL samples suggested the product in each well came from separate sources (ESE, 1991a). Soil sampling during these investigations detected elevated concentrations of individual petroleum compounds, total petroleum hydrocarbons (TPH), polychlorinated biphenyls (PCBs), pesticides, and chlorinated organic compounds.

Results of the Stage 3 RI/FS (OBG, 1995b) supported the results of the previous investigations and further defined the extent of contamination at the site. In addition, human health and ecological risk assessments were conducted, along with comparisons of site data to applicable or relevant and appropriate requirements (ARARs) and to-be-considered criteria (TBCs). The extent of the dissolved groundwater contaminant plume was more fully defined, along with the extents of the LNAPL bodies. The TBC and ARAR evaluation concluded that benzene, TCE, and VC exceed GWQSs. In conjunction with the results of the EE/CA (OBG, 1995a), the FS portion of the RI/FS (OBG, 1995b) recommended a remedial alternative consisting of deed restrictions, groundwater monitoring, soil excavation and washing, groundwater biosparging near the source area, and downgradient *in situ* air sparging of groundwater. In November 1995, OBG installed several additional wells at the site as part of the work directed toward implementing temporary remedial measures recommended in the EE/CA. These measures are discussed in Section 1.3.

1.3 REMEDIAL ACTIONS

In 1993, Engineering-Science, Inc. (ES, 1993) installed a pilot-scale bioventing system in the burn pit at Site CCFTA-2 (FT-17). Three air injection vent wells and three vapor monitoring points were installed, and tests were conducted to determine the radius of influence of each vent well and the rates of oxygen utilization and hydrocarbon degradation. Results of the tests indicated that air injection could increase available oxygen in the subsurface within a 30-foot radius of the vent wells, and that the system was capable of degrading 210 to 1,350 milligrams (mg) of fuel hydrocarbon per kilogram (kg) of soil per year (ES, 1993). Extended testing of the system is ongoing. There has been no evaluation of the effects of this system on CAHs in the vadose zone; however, the CAH source area appears to be the drum disposal area and thus is not likely to be affected by bioventing..

As one of the temporary measures recommended in the EE/CA, a horizontal air sparging system (HASS) was installed at the site in 1996 (OBG, 1997). Figure 1.3 shows the approximate location of the system. This system was installed to volatilize and remove CAHs (especially VC) from site groundwater before it discharges to the canal. The system is intended to decrease CAH concentrations in groundwater to less than 50 micrograms per liter (µg/L), theoretically resulting in VC concentrations of less than 5 µg/L in the downgradient canal located southeast of the burn pit (OBG, 1996b).

In addition to the HASS, the EE/CA also recommended excavation of shallow soil in the source areas (Figure 1.3), with onsite soil washing prior to the return of the treated soil to the excavation. This work is anticipated to take place in early to mid-1997.

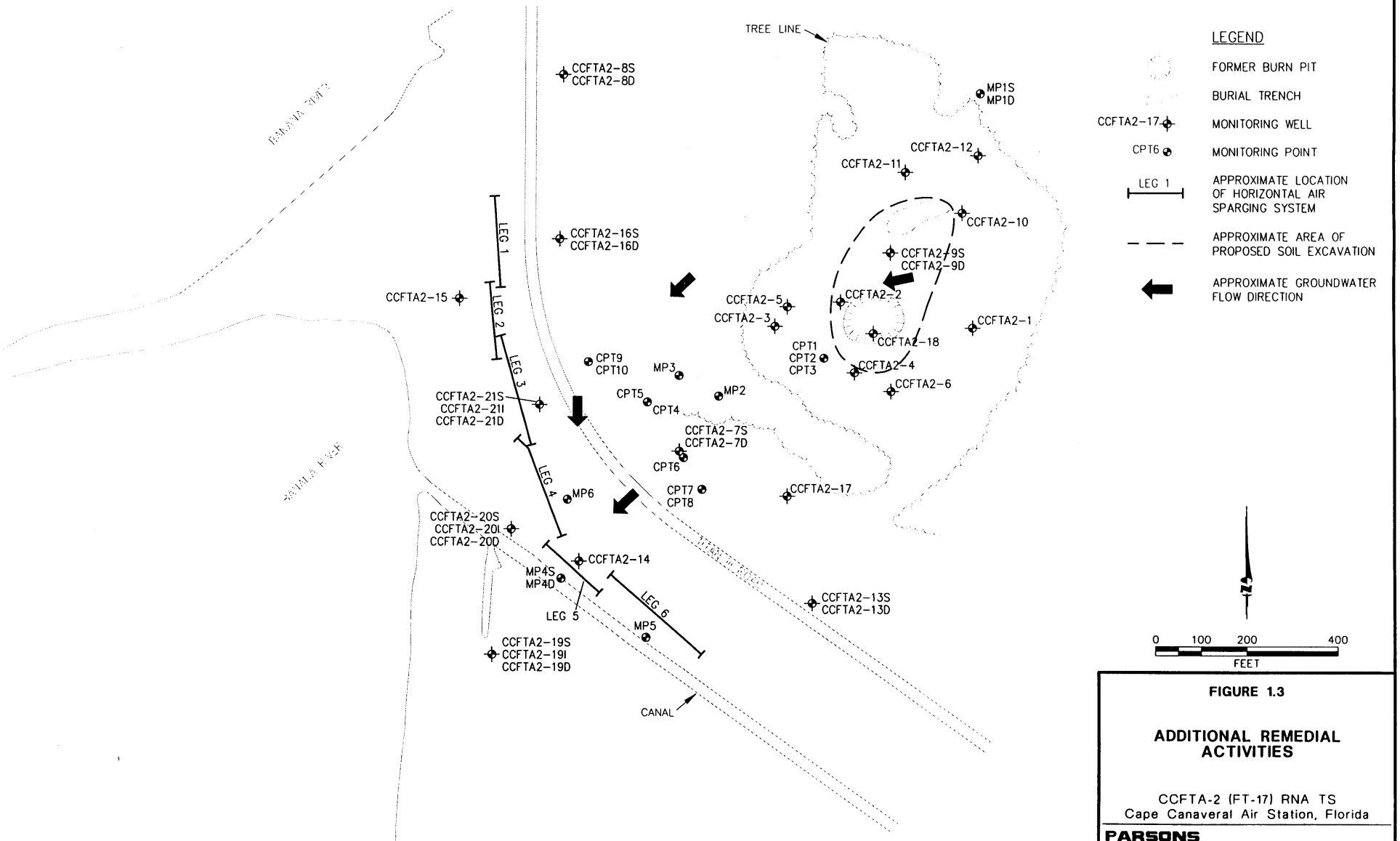

FIGURE 1.3

ADDITIONAL REMEDIAL ACTIVITIES

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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SECTION 2

SITE CHARACTERIZATION ACTIVITIES

To meet the requirements of the RNA demonstration, additional data were required to evaluate near-surface geology, aquifer properties, groundwater geochemistry, and the extent of soil, surface water, and groundwater contamination. Site characterization activities involved performing CPT with LIF and placing monitoring points using the CPT; using the Geoprobe® system for soil sampling and groundwater monitoring point placement; and groundwater and surface water sampling and analysis. The term "monitoring point" is used in this report to distinguish groundwater monitoring stations installed using the CPT or Geoprobe® from conventionally constructed monitoring wells. Groundwater sampling was accomplished during this investigation using both newly installed monitoring points and CPT points, and previously installed monitoring wells.

The physical and chemical data listed below were collected during the field work phase of the TS:

- Depth from measurement datum to the water table or potentiometric surface in monitoring wells and monitoring points;
- Stratigraphy of subsurface media;
- Groundwater geochemical data [pH; temperature, electrical conductivity; total alkalinity; oxidation/reduction potential (ORP); dissolved oxygen (DO); chloride; nitrate; nitrite; ammonia; ferrous iron; sulfate; sulfide; total organic carbon

(TOC); dissolved hydrogen; phenols and aromatic acids; and methane, ethene, and ethene];

- Groundwater concentrations of aromatic volatile organic compounds (VOCs), and CAHs
- Soil moisture content and TOC concentration in soil; and
- Concentrations of VOCs and CAHs in surface water.

Sampling locations for this evaluation are indicated on Figure 2.1, and a summary of the activity at each location is provided in Table 2.1. Due to differing sample nomenclature conventions used during two separate sampling events, the first column of Table 2.1 shows sample identifiers used during the 1996 event and the second column shows identifiers used during the 1994 event. For the remainder of this document, the 1996 identifiers are used. However, the 1994 identifiers may be encountered in the data presented in Appendices A and B.

CPT/LIF pushes were performed March 28 and 29, 1994. CPT pushes were performed at the locations labeled CPT-1 through CPT-10 (Figure 2.1) to install groundwater monitoring points. At locations CCAF-01 through CCAF-11, CPT pushes were performed to characterize subsurface stratigraphy. LIF was performed simultaneously at several of these locations to evaluate the presence of residual or free-phase hydrocarbons in the soils and groundwater. At CCAF-01, CCAF-06, and CCAF-07, soil samples from multiple depths also were collected. Groundwater samples were collected from the CPT-installed monitoring points and from several previously installed monitoring wells, and three surface water samples (SW-1, SW-2, and SW-3) were collected from the downgradient canal.

During the week of January 23 through January 30, 1996; a total of 5 soil samples were collected using the Geoprobe®, and 8 new temporary monitoring points were

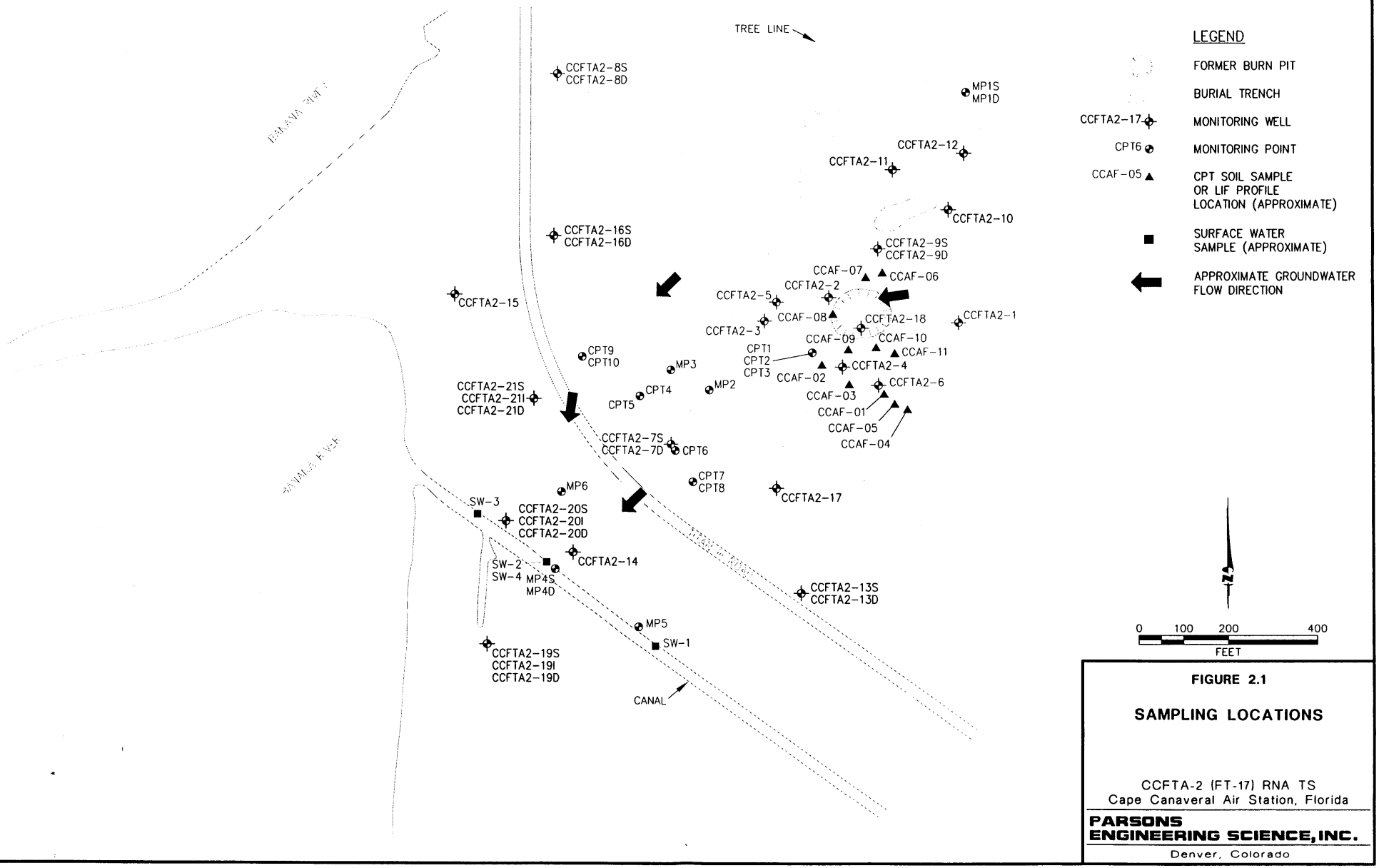

FIGURE 2.1

SAMPLING LOCATIONS

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

TABLE 2.1
SUMMARY OF FIELD INVESTIGATION
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

Identification	Previous Identification	Type of Sample Collected	Depth (feet bgs)[a/]	Description/ Drawing	Notes
Cone Penetrometer Pushes[b/]					
CCAF-01	CCAFB-01-LIF	none	14.3	CPT/LIF Log	Installed/collected in March 1994
CCAF-01	CCAFB-01-SS1	soil	5.5 - 6.5	none	
CCAF-01	CCAFB-01-SS1	soil	6.5 - 7.5	none	Same push as previous sample
CCAF-01	CCAFB-01-SS2	soil	7.5 - 8.5	none	
CCAF-01	CCAFB-01-SS2	soil	8.5 - 9.5	none	Same push as previous sample
CCAF-01B	CCAFB-01B-SS1	soil	5.5 - 6.5	none	Adjacent to CCAF-01
CCAF-01B	CCAFB-01B-SS1	soil	6.5 - 7.5	none	Same push as previous sample
CCAF-01B	CCAFB-01B-SS2	soil	7.5 - 8.5	none	Adjacent to CCAF-01
CCAF-01B	CCAFB-01B-SS2	soil	8.5 - 9.5	none	Same push as previous sample
CCAF-02	CCAFB-02-LIF	none	10.1	CPT/LIF Log	Installed/collected in March 1994
CCAF-03	CCAFB-03-LIF	none	15.3	CPT/LIF Log	Installed/collected in March 1994
CCAF-04	CCAFB-04-LIF	none	13.2	CPT/LIF Log	Installed/collected in March 1994
CCAF-05	CCAFB-05-LIF	none	15.0	CPT/LIF Log	Installed/collected in March 1994
CCAF-06	CCAFB-06-LIF	none	15.8	CPT/LIF Log	Installed/collected in March 1994
CCAF-06	CCAFB-06-SS1	soil	3.5 - 4.5	none	
CCAF-06	CCAFB-06-SS1	soil	4.5 - 5.5	none	Same push as previous sample
CCAF-06	CCAFB-06-SS2	soil	5.5 - 6.5	none	
CCAF-06	CCAFB-06-SS2	soil	6.5 - 7.5	none	Same push as previous sample
CCAF-07	CCAFB-07-LIF	none	14.5	CPT/LIF Log	Installed/collected in March 1994
CCAF-07	CCAFB-07-SS1	soil	5.5 - 6.5	none	
CCAF-07	CCAFB-07-SS1	soil	6.5 - 7.5	none	Same push as previous sample
CCAF-07	CCAFB-07-SS2	soil	7.5 - 8.5	none	
CCAF-07	CCAFB-07-SS2	soil	8.5 - 9.5	none	Same push as previous sample
CCAF-08	CCAFB-08-LIF	none	15.0	CPT/LIF Log	Installed/collected in March 1994
CCAF-09	CCAFB-09-LIF	none	19.0	CPT/LIF Log	Installed/collected in March 1994
CCAF-10	CCAFB-10-LIF	none	18.7	CPT/LIF Log	Installed/collected in March 1994
CCAF-11	CCAFB-11-LIF	none	19.0	CPT/LIF Log	Installed/collected in March 1994
Monitoring Point Installations [b/]					
CPT-1	CPT-87-MW1S	Groundwater	10.5	CPT/LIF Log	Installed using CPT in March 1994
CPT-2	CPT-87-MW1M	Groundwater	32.5	CPT/LIF Log	Installed using CPT in March 1994
CPT-3	CPT-87-MW1D	Groundwater	52.5	CPT/LIF Log	Installed using CPT in March 1994
CPT-4	CPT-87-MW3S	Groundwater	9.0	CPT/LIF Log	Installed using CPT in March 1994
CPT-5	CPT-87-MW3M	Groundwater	31.0	CPT/LIF Log	Installed using CPT in March 1994
CPT-6	CPT-87-7-MW1M	Groundwater	31.5	CPT/LIF Log	Installed using CPT in March 1994
CPT-7	CPT-87-MW2S	Groundwater	8.0	CPT/LIF Log	Installed using CPT in March 1994
CPT-8	CPT-87-MW2M	Groundwater	27.2	CPT/LIF Log	Installed using CPT in March 1994
CPT-9	CPT-87-MW4S	Groundwater	8.0	CPT/LIF Log	Installed using CPT in March 1994
CPT-10	CPT-87-MW4D	Groundwater	30.0	CPT/LIF Log	Installed using CPT in March 1994
MP-1S		Groundwater	12.0	MP Installation Record	Installed with Geoprobe in January 1996
MP-1D		Groundwater	30.0	MP Installation Record	Installed with Geoprobe in January 1996
MP-2		Groundwater	12.5	MP Installation Record	Installed with Geoprobe in January 1996
MP-3		Groundwater	12.0	MP Installation Record	Installed with Geoprobe in January 1996
MP-4S		Groundwater	10.0	MP Installation Record	Installed with Geoprobe in January 1996
MP-4D		Groundwater	30.0	MP Installation Record	Installed with Geoprobe in January 1996
MP-5		Groundwater	10.0	MP Installation Record	Installed with Geoprobe in January 1996
MP-6		Groundwater	12.0	MP Installation Record	Installed with Geoprobe in January 1996

TABLE 2.1 (concluded)
SUMMARY OF FIELD INVESTIGATION
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

Identification	Previous Identification	Type of Sample Collected	Depth (feet bgs)[a/]	Description/ Drawing	Notes
Monitoring Well Sampling					
CCFTA2-1		Groundwater	28.1	ESE	
CCFTA2-2		Groundwater	24.1	ESE	
CCFTA2-3		Groundwater	22.0	ESE	
CCFTA2-4		Groundwater	23.0	ESE	
CCFTA2-5		Groundwater	22.0	ESE	
CCFTA2-6		Groundwater	25.5	ESE	LNAPL sample collected in 1994
CCFTA2-7S		Groundwater	13.0	ESE	
CCFTA2-7D		Groundwater	60.0	ESE	
CCFTA2-8S		Groundwater	12.7	ESE	
CCFTA2-8D		Groundwater	56.0	ESE	
CCFTA2-9S		Groundwater	25.0	ESE	LNAPL sample collected in 1994
CCFTA2-9D		Groundwater	61.0	ESE	
CCFTA2-10		Groundwater	25.0	ESE	
CCFTA2-11		Groundwater	25.0	ESE	
CCFTA2-12		Groundwater	16.5	OBG	
CCFTA2-13S		Groundwater	14.5	OBG	
CCFTA2-13D		Groundwater	60.0	OBG	
CCFTA2-14		Groundwater	13.5	OBG	
CCFTA2-15		Groundwater	12.0	OBG	
CCFTA2-16S		Groundwater	11.5	OBG	
CCFTA2-16D		Groundwater	60.0	OBG	
CCFTA2-17		Groundwater	15.0	OBG	
CCFTA2-18		Groundwater	13.5	OBG	
CCFTA2-19S		Groundwater	11.0	OBG	
CCFTA2-19I		Groundwater	35.0	OBG	
CCFTA2-19D		Groundwater	65.5	OBG	
CCFTA2-20S		Groundwater	11.0	OBG	
CCFTA2-20I		Groundwater	40.0	OBG	
CCFTA2-20D		Groundwater	58.0	OBG	
CCFTA2-21S		Groundwater	12.0	OBG	
CCFTA2-21I		Groundwater	40.0	OBG	
CCFTA2-21D		Groundwater	57.0	OBG	
Surface Water Sampling					
SW-1	UPSTREAM	Surface Water	-	None	Collected in 1994; Location not certain
SW-2	DITCH	Surface Water	-	None	Collected in 1994; Location not certain
SW-3	DOWNSTREAM	Surface Water	-	None	Collected in 1994; Location not certain
SW-4	Grab - Lagoon	Surface Water	-	None	Collected in 1996

a/ Sample depth or total borehole depth in feet below ground surface (bgs); for wells/monitoring points, depth is total depth of well/point.

b/ Unless otherwise noted, each row represents a separate penetration of the ground.

installed (Figure 2.1). During that same week, groundwater samples were collected from 31 previously installed monitoring wells, 8 of 10 CPT points (2 points were not sampled because USEPA NRMRL personnel had to leave the site due to a possible government shutdown), and 8 newly installed temporary monitoring points. In addition to the 47 groundwater samples taken at CCFTA-2 (FT-17), 1 surface water sample was taken from the canal, adjacent to monitoring point MP4S.

Groundwater samples were analyzed by USEPA personnel in the field for pH, conductivity, temperature, DO, ORP, total alkalinity, free carbon dioxide, ferrous iron, and sulfide. Analyses for benzene, toluene, BTEX, trimethylbenzene (TMB) isomers, CAHs, nitrate/nitrite, ammonia, chloride, sulfate, methane, ethane, ethene, TOC and metals were performed at the NRMRL in Ada, Oklahoma.

The following sections describe the procedures that were followed when collecting site-specific data. Additional details regarding investigative activities are presented in the work plan (Parsons ES, 1996).

2.1 CONE PENETROMETRY

Subsurface conditions at the site were characterized using CPT coupled with LIF on March 28, and March 29, 1994. The purpose of the CPT/LIF sampling at the site was to determine subsurface stratigraphy and to help delineate the extent of petroleum hydrocarbon contamination. Boring logs for the CPT/LIF pushes and Geoprobe® sampling locations are included in Appendix A.

2.1.1 Determination of Stratigraphy

Cone penetrometry is an expeditious and effective means of analyzing the stratigraphy of a site by measuring the resistance against the conical probe of the penetrometer as it is pushed into the subsurface. Stratigraphy is determined from a correlation of the point stress at the probe tip and frictional stress on the side of the

cone. Stratigraphy as determined from the CPT is checked against previous soil data or against soil samples collected to correlate the CPT readings to the lithologies present at the site. Methodologies for the collection of soil samples are described in Section 2.1.3.

CPT was conducted using Applied Research Associates' (ARA's) cone penetrometer truck, which consists of an instrumented probe that is forced into the ground using a hydraulic load frame mounted on a truck, with the weight of the truck providing the necessary reaction mass. The penetrometer equipment is mounted inside an 18-foot van body attached to a 10-wheel truck chassis with a turbo-charged diesel engine. Ballast in the form of metal weights and a steel water tank, which can hold 5,000 pounds of water, is added to the truck to achieve an overall push capability of 45,000 pounds. Penetration force is supplied by a pair of large hydraulic cylinders bolted to the truck frame.

The penetrometer probe is of standard dimensions, having a 1.405-inch outside diameter (OD), 60-degree conical tip, and a 1.405-inch OD by 5.27-inch-long friction sleeve. Inside the probe, two load cells independently measure the vertical resistance against the conical tip and the side friction along the sleeve. Each load cell inside the probe is a cylinder of uniform cross section that is instrumented with four strain gauges in a full-bridge circuit. Forces are sensed by the load cells, and the data are transmitted to a computer in the penetrometry truck from the probe assembly via a cable running through the push tubes. The analog data are digitized, recorded, and plotted by the computer. The penetrometer is usually advanced vertically into the soil at a constant rate of 48 inches per minute, although this rate must sometimes be reduced (e.g., when hard layers are encountered). The magnitude of the penetration pore pressure is a function of compressibility and, most importantly, permeability. Penetration, dissipation, and resistivity data can be used to determine soil types as they are encountered in the field.

2.1.2 Investigation of Residual and Free-Phase Hydrocarbons

The known propensity of aromatic hydrocarbons to fluoresce under ultraviolet wavelengths has allowed the use of LIF technology, in conjunction with CPT technology, to detect soil characteristics and hydrocarbon contamination simultaneously. The LIF is not capable of detecting chlorinated solvents. The LIF system has a 0.25-inch sapphire window in the side of the cone that allows a laser to scan the soil for fluorescent compounds as the LIF penetrometer rod pushes through soil. Assuming that aromatic hydrocarbons are simultaneously solvenated with other fuel-hydrocarbon or CAH constituents, the magnitude of aromatic fluorescence is indicative of hydrocarbon contamination in a soil matrix. Fiber optic cables connected to the laser spectrometer and a 6-pair electrical conductor connected to the CPT data acquisition system, are routed through the interior of the push tubes to the CPT probe.

The basic components of the LIF instrument are a nitrogen laser, a fiber optic probe, a monochromator for wavelength resolution of the return fluorescence, a photomultiplier tube to convert photons into an electrical signal, a digital oscilloscope for waveform capture, and a control computer. The fiber optic probe for the cone penetrometer consists of delivery and collection optical fibers, a protective sheath, a fiber optic mount within the cone, and a 0.25-inch sapphire window (Figure 2.2). The wavelength used in the ARA CPT/LIF system gives the strongest fluorescence signal (attributable to the presence of contamination) for naphthalene and heavier long-chained hydrocarbons. Thus, while the LIF is not entirely appropriate for detecting the fluorescence of BTEX or CAHs, it is useful for defining soil contamination because the heavier long-chained hydrocarbons are more likely to sorb to the soil matrix.

Graphical results of each LIF/CPT push were plotted by ARA staff at the conclusion of each penetration and were available minutes after the completion of each hole. The graphs showed cone resistance, sleeve friction, soil classification, fluorescence intensity, and maximum fluoresced wavelength. The real-time availability of the CPT

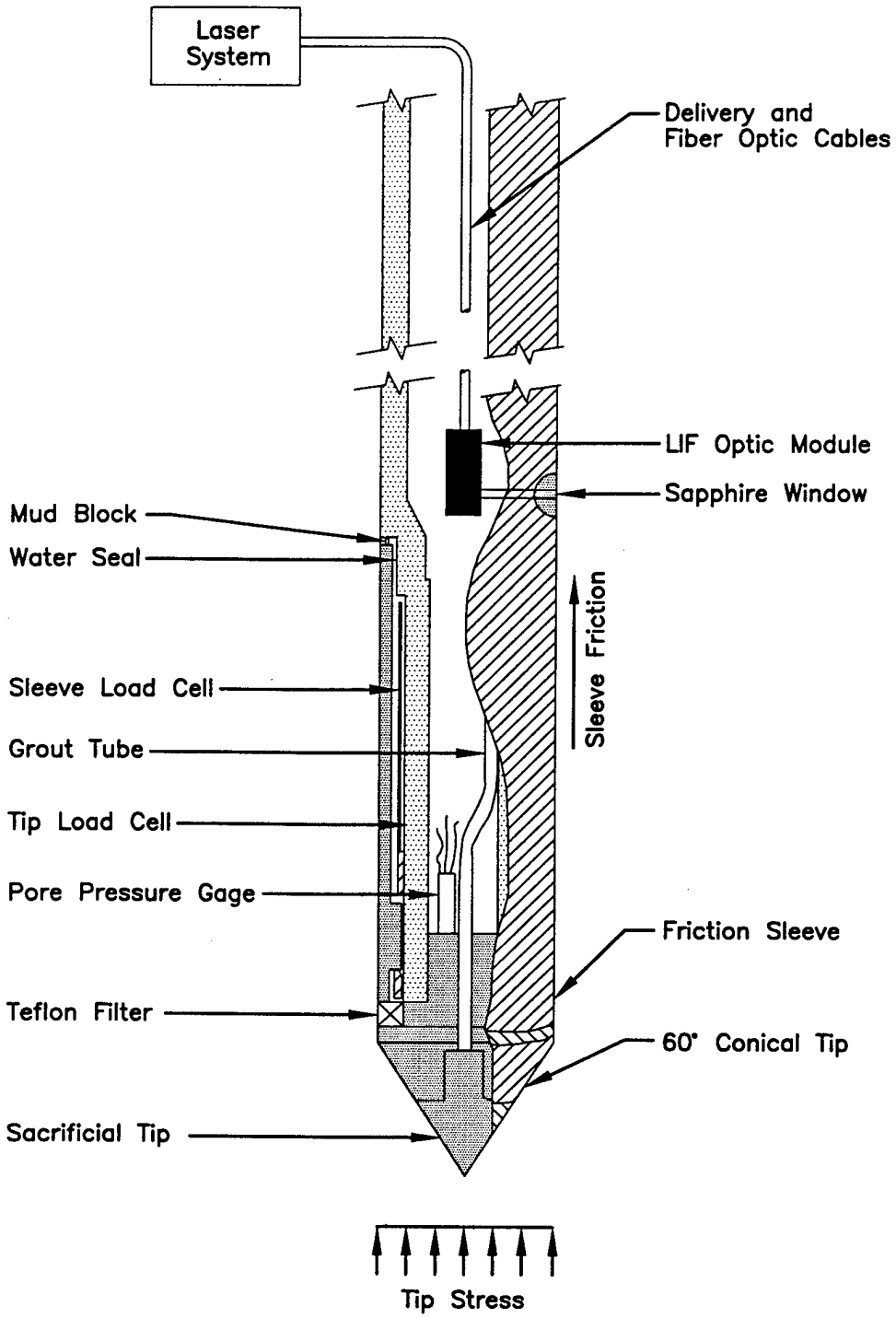

FIGURE 2.2

SCHEMATIC OF LASER-INDUCED FLUORESCENCE CONE PENETROMETER PROBE

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

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information allowed the Parsons ES field scientist to make investigative decisions based on the most current information. Final CPT logs are presented in Appendix A.

2.1.3 Soil Sample Collection

The CPT was used to collect several soil samples for analysis of TOC in March 1994. The samples were collected from multiple depths at CCAF-01, CCAF-06, and CCAF-07 (Figure 2.1).

The samples were collected using a Mostap-35® sampling device. The sampler is coupled to the penetrometer rod and pushed into the soil with the same equipment used for CPT/LIF. While the Mostap-35® cone is in position, soil is prevented from entering the sampling tube until the desired depth is achieved. After the sampler was pushed to the depth at which the soil sample was to be taken, the sampling unit was raised a few inches, and the Mostap-35® apparatus was unlocked. After unlocking the Mostap-35® attachment, a soil section was cut, and the sampling apparatus was pulled from the ground as quickly as possible.

The Mostap-35® sampling apparatus allowed collection of 2-foot-long, continuous samples. Recovery efficiencies for samples in saturated soils were occasionally reduced because of spillage from the device after extraction. To mitigate this problem, soil samples were compressed *in situ* with the penetrometer and Mostap assembly to expel the pore water before extraction. Compressed soil samples were then extracted and measured to give a description of the soil stratigraphy accurate for the length of soil core taken. Soil samples were placed in clean 8-ounce glass jars and delivered to the USEPA NRMRL field personnel for analysis.

2.1.4 CPT Hole Abandonment

The CPT/LIF probe is equipped with a grout tube and sacrificial tip; therefore, CPT/LIF holes were abandoned with a Portland® cement grout as the CPT pushrod

was withdrawn. Collection of samples with the Mostap-35® sampler did not allow for grouting during pushrod withdrawal; therefore, these holes were abandoned with Portland® cement from the ground surface after sample collection.

2.1.5 Equipment Decontamination

After sampling at each CPT location, CPT push rods were cleaned with the CPT steam-cleaning system (rod cleaner) as the rods were withdrawn from the ground. A vacuum system located beneath the CPT truck was used to recover cleaning water. Use of this system resulted in nearly 100-percent recovery of steam-cleaning rinseate from the rod cleaner. Rinseate was generated only as the rods moved past the cleaner, thereby minimizing liquid waste generation. Rinseate was collected in a 55-gallon drum, then released into the former burn pit.

2.1.6 Monitoring Point Installation

Using the CPT truck, the ARA staff installed 10 0.5-inch-ID monitoring points at 5 locations in the vicinity of CCFTA-2 (FT-17). Monitoring point locations are indicated on Figure 2.1. All monitoring points were initially assigned identifiers different than those shown on Figure 2.1. These identifiers were not all consistent; therefore, to avoid future confusion, the points were simply renamed CPT-1 through CPT-10 during the January 1996 sampling event. A summary of monitoring point construction details is provided in Table 2.2, and a list of the current and previous names for the points is provided in Table 2.1.

2.1.6.1 Materials

Monitoring points were constructed of flush-threaded, 0.5-inch-ID/0.75-inch-OD polyvinyl chloride (PVC) screens. Installed screens were 3.3 feet in length and factory-slotted with 0.010-inch openings. The sacrificial stainless steel CPT tip was screwed into the PVC screen and served as the bottom cap for the monitoring point when the push was finished. Some points were installed with PVC casings, and some

TABLE 2.2
WELL COMPLETION INFORMATION
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

Well Location	Installation Date	Northing (ft)	Easting (ft)	Well ID[a] (inches)	Datum[b] Elevation (ft msl)[c]	Ground Elevation (ft msl)	Screen Interval Top (ft bgs)[d]	Screen Interval Bottom (ft bgs)
MP-1S	1/24/96	1517400.2	790884.86	0.5	11.52	9.80	7.0	12.0
MP-1D	1/24/96	1517399.6	790884.38	tubing[e]	11.68	9.80	29.5	30.0
MP-2	1/24/96	1516733.5	790309.18	0.5	9.58	7.12	7.5	12.5
MP-3	1/24/96	1516779.0	790220.11	0.5	8.71	6.38	7.0	12.0
MP-4S	1/24/96	1516331.7	789959.45	0.5	4.44	3.07	5.0	10.0
MP-4D	1/24/96	1516332.4	789959.01	tubing	5.03	3.07	29.5	30.0
MP-5	1/24/96	1516202.8	790147.19	0.5	7.77	5.06	5.0	10.0
MP-6	1/24/96	1516505.0	789973.13	0.5	6.20	3.47	7.0	12.0
CPT-1	3/29/94	1516817.4	790542.19	0.5	5.14	4.15	7.2	10.5
CPT-2	3/29/94	1516817.8	790541.47	0.5	5.20	4.15	29.2	32.5
CPT-3	3/29/94	1516818.3	790540.52	0.5	5.22	4.15	49.2	52.5
CPT-4	3/30/94	1516720.1	790150.15	0.5	6.44	3.59	5.7	9.0
CPT-5	3/30/94	1516718.7	790149.49	tubing	6.04	3.59	30.5	31.0
CPT-6	3/30/94	1516597.4	790230.66	tubing	7.63	5.47	31.0	31.5
CPT-7	3/30/94	1516527.8	790271.89	0.5	6.94	5.78	4.7	8.0
CPT-8	3/30/94	1516527.2	790270.89	tubing	7.38	5.78	26.7	27.2
CPT-9	3/30/94	1516809.1	790019.55	0.5	6.25	4.85	4.7	8.0
CPT-10	3/30/94	1516809.0	790021.16	tubing	5.98	4.85	29.5	30.0
CCFTA2-1	1/13/87	1516886.1	790869.40	2	14.48	11.84	8.1	28.1
CCFTA2-2	1/16/87	1516942.6	790578.18	2	9.95	7.34	4.1	24.1
CCFTA2-3	1/19/87	1516889.6	790433.41	2	5.99	3.94	2.0	22.0
CCFTA2-4	1/13/87	1516785.7	790609.25	2	7.84	6.55	3.0	23.0
CCFTA2-5	1/19/87	1516932.6	790460.47	2	6.25	4.19	2.0	22.0
CCFTA2-6	1/20/87	1516743.6	790689.89	2	10.93	8.64	5.5	25.5
CCFTA2-7S	12/9/88	1516606.3	790226.93	2	8.40	5.74	3.0	13.0
CCFTA2-7D	12/8/88	1516611.7	790220.76	2	8.95	5.49	45.0	60.0
CCFTA2-8S	12/8/88	1517446.1	789961.52	2	7.53	4.83	2.4	12.7
CCFTA2-8D	12/8/88	1517441.4	789961.50	2	7.98	4.86	41.0	56.0
CCFTA2-9S	11/8/89	1517047.2	790681.89	2	10.29	6.63	5.0	25.0
CCFTA2-9D	12/6/88	1517051.4	790688.15	2	10.51	6.86	46.0	61.0
CCFTA2-10	11/9/89	1517138.3	790845.91	2	13.17	9.51	5.0	25.0
CCFTA2-11	11/8/89	1517227.3	790720.68	2	12.59	8.94	5.0	25.0
CCFTA2-12	5/24/93	1517264.4	790880.31	2	11.69	8.69	6.5	16.5
CCFTA2-13S	5/20/93	1516278.8	790515.81	2	10.39	7.34	4.5	14.5
CCFTA2-13D	6/3/93	1516284.4	790519.76	2	10.49	7.46	50.0	60.0
CCFTA2-14	5/20/93	1516369.9	789998.93	2	6.21	3.20	3.5	13.5
CCFTA2-15	6/3/93	1516950.0	789733.15	2	6.49	3.18	2.0	12.0
CCFTA2-16S	5/20/93	1517074.0	789955.23	2	6.86	4.15	1.5	11.5
CCFTA2-16D	6/17/93	1517087.6	789954.54	2	6.24	4.42	50.0	60.0
CCFTA2-17	5/24/93	1516513.0	790460.58	4	9.36	6.17	5.0	15.0
CCFTA2-18	3/8/94	1516873.7	790650.52	2	7.97	8.16	3.5	13.5
CCFTA2-19S	6/23/94	1516172.5	789803.14	2	5.48	1.88	1.0	11.0
CCFTA2-19I	10/22/95	1516165.5	789797.20	2	5.86	3.18	30.0	35.0
CCFTA2-19D	10/20/95	1516164.8	789806.62	2	5.66	3.00	60.5	65.5
CCFTA2-20S	10/22/95	1516441.3	789850.96	2	5.87	3.00	1.0	11.0
CCFTA2-20I	10/22/95	1516439.6	789845.93	2	5.95	2.99	35.0	40.0
CCFTA2-20D	10/23/95	1516435.9	789852.19	2	5.75	2.89	53.0	58.0
CCFTA2-21S	11/14/95	1516713.5	789915.30	2	4.90	5.25	2.0	12.0
CCFTA2-21I	11/14/95	1516714.6	789910.80	2	4.40	4.92	35.0	40.0
CCFTA2-21D	11/14/95	1516709.6	789913.31	2	4.28	4.96	52.0	57.0

[a] ID = inside diameter.
[b] Datum is top of inner PVC casing.
[c] ft msl = feet above mean sea level.
[d] ft bgs = feet below ground surface.
[e] Point constructed with a 0.5-foot-long stainless steel screen connected to 0.25-inch outside diameter HDPE tubing/riser.

were installed using a brass pipe fitting at the top of the screen, with 0.25-inch-ID Teflon® tubing leading to the surface. The purpose of using the Teflon® tubing was to field test this method of monitoring point construction.

Each PVC-cased monitoring point was fitted with a PVC top cap upon completion. Points completed with Teflon® tubing were fitted with 0.75-inch-OD surface casings that were in turn fitted with PVC top caps. Well materials were inspected for cleanliness prior to use. No glues or solvents were used with monitoring point materials.

2.1.6.2 Installation

Monitoring points were pressed into the ground through the inside of the CPT pushrods. This method protects the monitoring point screen and casing until the monitoring point has been pushed to the desired depth and the pushrods are removed. To accomplish this, the PVC screen was threaded through the bottom CPT pushrod. A sacrificial tip was screwed into the bottom of the screen and pressed into the bottom of the CPT pushrod. As the pushrod was pressed into the ground, CPT pushrods and new PVC casing (or Teflon® tubing) were continuously attached until the desired depth was reached. Upon removal of the pushrods, a fully-cased monitoring point remained. Data collection devices such as CPT and LIF could not be used during monitoring point placement; therefore, no additional data was collected where monitoring points were installed.

2.1.6.3 Development

Prior to sampling, newly installed monitoring points were developed. Typically, well development removes sediment from inside the well casing and flushes fines, cuttings, and drilling fluids from the sand pack and the portion of the formation adjacent to the well screen. Use of the CPT apparatus to place monitoring points minimizes the amount of fine sediment that might accumulate in the casing.

Monitoring point development was accomplished using a peristaltic pump with new (dedicated) or decontaminated high-density polyethylene (HDPE) tubing. The pump tubing was regularly lowered to the bottom of the point so that fines were agitated and removed from the well in the development water. Development was continued until a minimum of 10 casing volumes of water were removed from the monitoring point, and the temperature and DO concentrations of the groundwater had stabilized. All development water was contained in 5-gallon buckets and taken to the former burn pit, where it was released onto the ground surface.

2.2 GEOPROBE® FIELD ACTIVITIES

Geoprobe®-related field work occurred between January 23 and January 25, 1996, and consisted of soil characterization and sampling at monitoring points MP1S through MP6, and groundwater monitoring point installation for monitoring points MP1S through MP6. These activities were performed according to the procedures described in the work plan (Parsons ES, 1996) and reviewed in the following sections.

The Geoprobe® system is a hydraulically powered percussion/probing machine used to advance sampling tools through unconsolidated soils. This system provides for the rapid collection of soil, soil gas, and groundwater samples at shallow depths while minimizing the generation of investigation-derived waste materials. Figure 2.3 is a diagram of the system.

2.2.1 Groundwater Monitoring Point Locations and Completion Intervals

Eight new groundwater monitoring points were installed with the Geoprobe® at six locations to assist in the characterization of the contaminant distribution and the shallow and deep groundwater flow system at CCFTA-2. The new monitoring points were installed in the locations shown on Figure 2.1, and Table 2.2 presents completion details. Nested points (e.g., MP1S and MP1D) were installed adjacent to each other, with one point (designated by the suffix "S") screened just below, or across, the water

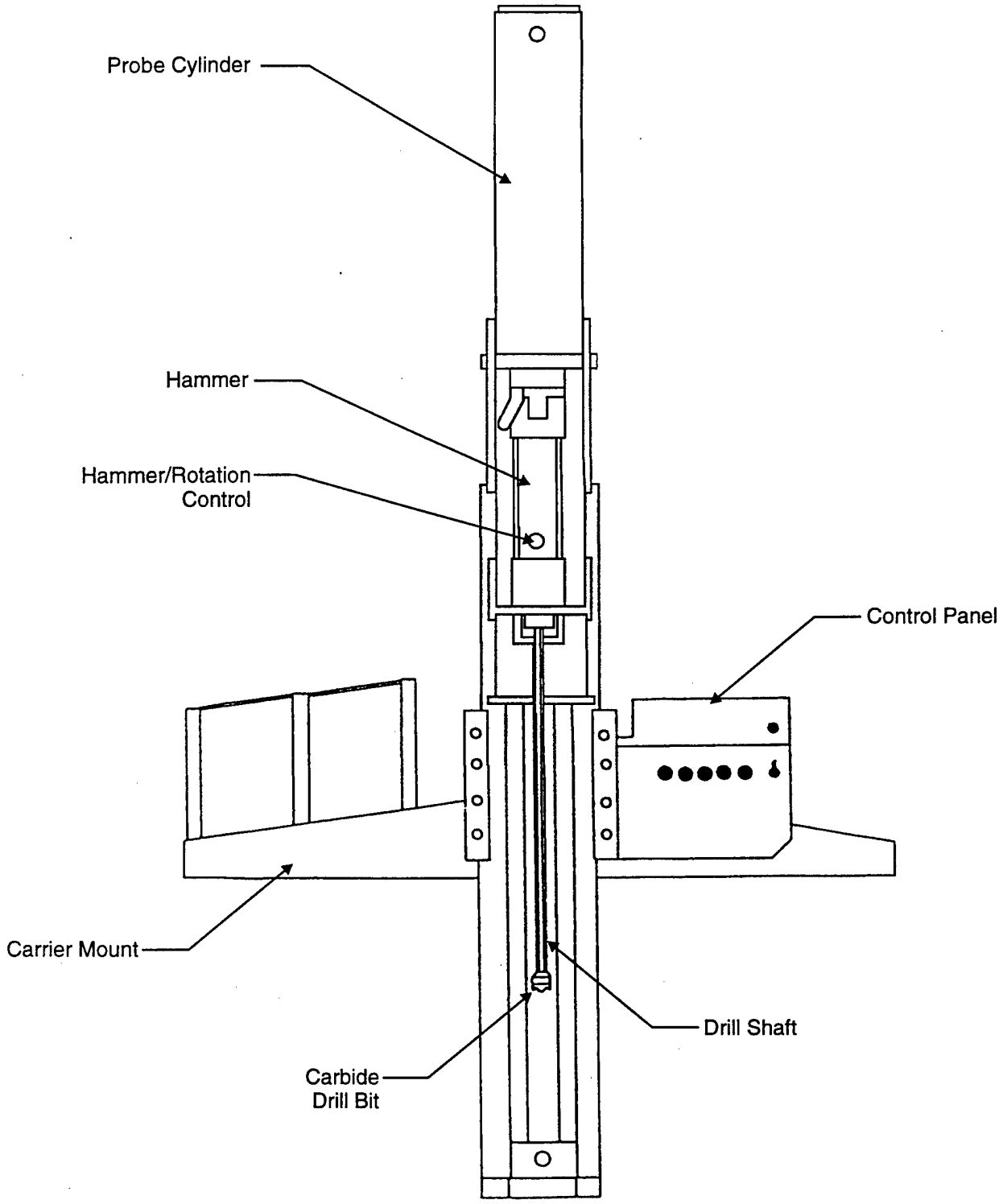

FIGURE 2.3

CROSS-SECTION OF GEOPROBE®

CCFTA-2 (FT-17) RNA TS
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table, and the other well (designated by the suffix "D") screened approximately 10 feet below the bottom of the shallow point. The monitoring point locations were selected to provide the hydrogeologic and chemical data necessary for successful implementation of the Bioplume II model and to support the RNA demonstration.

2.2.2 Groundwater Monitoring Point Installation and Soil Sampling Procedures

2.2.2.1 Borehole Advancement and Soil Sampling

The Geoprobe®-collected soil samples were obtained using a probe-drive sampler during installation of monitoring points MP1S through MP6. The probe-driven sampler serves as both the driving point and the sample collection device and is attached to the leading end of the probe rods. To collect a soil sample, the sampler was pushed or driven to the desired sampling depth, and the stop pin was removed, allowing the piston and drive point to retract as the sample barrel was pushed into undisturbed soil. The soil cores were retained within a clear acetate liner inside the sampling barrel. The probe rods were then retracted, bringing the sampling device to the surface. The soil sample was then extruded from the liners and transferred to analyte-appropriate jars supplied by USEPA NRMRL personnel. A portion of the sample was retained for visual logging, and another portion was placed in an unused, sealable plastic bag for headspace measurements of VOCs using a photoionization detector (PID).

The Parsons ES field hydrogeologist observed Geoprobe® sampling and monitoring point installation activities and maintained a descriptive log of subsurface materials recovered. Final geologic borehole logs are presented in Appendix A. Analyte-appropriate sample containers for the targeted analytes were provided by NRMRL. The containers were labeled as described in the work plan (Parsons ES, 1996).

The low volumes of waste soils generated during monitoring point installation and sampling operations were spread on the ground surface of the former burn pit at CCFTA-2 (FT-17).

2.2.2.2 Monitoring Point Installation

Groundwater monitoring points were installed in 8 boreholes under this program. Detailed monitoring point installation procedures are described in the following paragraphs. Monitoring point completion diagrams are included in Appendix A.

Monitoring point completion materials were inspected by the field hydrogeologist and determined to be clean and acceptable prior to use. All monitoring point completion materials were factory sealed in plastic wrap. Pre-packaged casing, sand, bentonite, and concrete mix were used in point construction, and the bags were inspected for possible external contamination before use. Materials that could not be cleaned to the satisfaction of the field hydrogeologist were not used.

Shallow monitoring points were constructed of Schedule 40 PVC riser pipe connected to factory-slotted PVC screens having an ID of 0.5 inch. Monitoring point screens constructed of PVC were 5 feet long and factory slotted with 0.010-inch openings. All shallow points were screened across the water table. All PVC casing and screen sections on the shallow monitoring points were flush threaded, and glued joints were not used. The riser pipe at each monitoring point was fitted with a PVC top cap, and a threaded PVC bottom cap was placed on the bottom of the screen. At the surface, each point was finished with a 2-inch-OD PVC surface casing with a slip-on cap.

Deep monitoring points were constructed with 0.25-inch-ID stainless steel mesh implants acting as monitoring point screens and 0.25-inch-ID Teflon®-lined HDPE tubing acting as risers connecting the mesh screen to the surface (HDPE tubing was threaded through the center of the Geoprobe® drive rods). Mesh monitoring point

screens were 0.5 foot in length with pore openings of 0.0057 inch. The riser tubing at deep monitoring points extended to the surface, into a 2-inch-OD PVC surface casing with a slip-on cap. Monitoring point construction details are summarized in Table 2.2.

The field hydrogeologist verified and recorded the borehole depth and the lengths of all casing sections and tubing. All lengths and depths were measured to the nearest 0.1 foot.

2.2.3 Monitoring Point Development

Before being sampled, newly installed monitoring points were developed. Use of the Geoprobe® system to place monitoring points eliminates cuttings and drilling fluids. Therefore, development of monitoring points was primarily intended to minimize the amount of fine sediment that might accumulate in the casing.

Development was accomplished using a peristaltic pump with dedicated silicon and HDPE tubing. The pump tubing was regularly lowered to the bottom of the shallow points so that fines were agitated and removed from the point in the development water. Development was continued until 10 casing volumes of water were removed, and the pH, temperature, and conductivity of the groundwater had stabilized. Development waters were discharged at the ground surface near the monitoring points being developed.

2.3 GROUNDWATER SAMPLING

This section describes the procedures used for collecting groundwater quality samples. In order to maintain a high degree of quality control (QC) during this sampling event, the procedures described in the site work plan (Parsons ES, 1996) and summarized in the following sections were followed. The primary groundwater sampling took place during January 1996, and consisted of collecting groundwater samples from new monitoring points and existing monitoring wells and CPT points. In

addition, several of the wells and CPT points also were sampled by Parsons ES and USEPA NRMRL personnel in March 1994.

2.3.1 Groundwater Sampling Locations

Groundwater samples were collected from 31 previously installed wells, 10 CPT monitoring points and 8 newly installed monitoring points. All sampling locations were purged and sampled using a peristaltic pump with dedicated HDPE and silicon tubing.

2.3.2 Preparation and Equipment Cleaning

All equipment used for sampling was assembled and properly cleaned and calibrated (if required) prior to use in the field. All portions of sampling and test equipment that contacted the sample were thoroughly cleaned before use. This equipment included the water level probe and cable, equipment for measuring onsite groundwater chemical parameters, and other equipment that contacted the samples. The following cleaning protocol was used:

- Clean with potable water and phosphate-free laboratory-grade detergent;
- Rinse with potable water;
- Rinse with isopropyl alcohol;
- Rinse with distilled or deionized water; and
- Air dry prior to use.

Any deviations from these procedures were documented in the field scientist's field notebook and on the groundwater sampling form. As required, field analytical equipment was calibrated according to the manufacturers' specifications prior to field use.

2.3.3 Groundwater Sampling Procedures

Special care was taken to prevent contamination of the groundwater and extracted samples through cross contamination from improperly cleaned equipment. Water level probes and cable used to determine static water levels and total well/point depths were thoroughly cleaned before and after field use and between uses at different sampling locations according to the procedures presented in the work plan (Parsons ES, 1996). In addition, a clean pair of new, disposable latex gloves was worn each time a different well or monitoring point was sampled. Dedicated HDPE and silicone tubing were used at each sampling location.

2.3.3.1 Preparation of Location

Prior to starting the sampling procedure, the area around the monitoring well or point was cleared of foreign materials, such as brush, rocks, and debris. These procedures prevented sampling equipment from inadvertently contacting debris around the monitoring well/point. The integrity of the monitoring well/point was also inspected, and any irregularities in the visible portions of the well/point, protective cover, or concrete pad were noted.

2.3.3.2 Water Level and Total Depth Measurements

Prior to removing any water from the well or shallow monitoring points, the static water level was measured. In the shallow, 0.5-inch-diameter PVC monitoring points, an electrical water level probe was used to measure the depth to groundwater below the well datum to the nearest 0.01 foot. An oil/water interface probe capable of measuring the depth to both mobile LNAPL (if present) and water was used in all the previously installed 2-inch diameter wells. Water levels in the newly installed points constructed of Teflon®-lined HDPE tubing were not obtained. After measurement of the static water level, the water level probe was lowered to the bottom of the well/point for measurement of total well/point depth (recorded to the nearest 0.1 foot). Based on

these measurements, the volume of water to be purged from the well/point was estimated.

2.3.3.3 Monitoring Well/Point Purging

Where possible, three times the calculated casing volume was removed from each monitoring well/point prior to sampling. Purging continued until the pH, DO concentration, ORP, conductivity, and temperature stabilized for a 1-minute period. A peristaltic pump with dedicated silicone and HDPE tubing was used for well evacuation. All purge water from areas believed to be contaminated based on field observations and historical groundwater quality data was discharged onto the ground surface inside the burn pit at CCFTA-2 (FT-17).

2.3.3.4 Sample Collection

A peristaltic pump with dedicated silicon and HDPE tubing was used to extract groundwater samples from each sampled well and monitoring point. In some instances, purging was performed up to 24 hours prior to sample collection. For shallow monitoring points constructed of 0.5-inch-ID PVC casing, the dedicated HDPE tubing was lowered down the casing to approximately the middle of the screened interval. Sampling from monitoring points constructed of tubing was accomplished by attaching the silicon tubing directly to the top of the monitoring point tubing. The samples were transferred directly into the appropriate sample containers. The water was carefully poured down the inner walls of each sample bottle to minimize aeration of the sample. Sample bottles for BTEX, TMBs, CAHs, and methane, ethane, and ethene were filled so that there was no headspace or air bubbles within the container.

2.3.4 Onsite Chemical Parameter Measurement

DO measurements were taken using an Orion® Model 840 DO meter in a flow-through cell at the outlet of the peristaltic pump. DO concentrations were recorded

after the readings stabilized, and in all cases represent the lowest DO concentration observed.

Because the electrical conductivity, pH, ORP, and temperature of the groundwater can change significantly within a short time following sample acquisition, these parameters were measured in the field, in the same flow-through cell used for DO measurements. Measured values were recorded on the groundwater sampling records (Appendix C).

2.3.5 Sample Handling

The fixed-base analytical laboratory (NRMRL) provided pre-preserved sample containers where appropriate. The sample containers were filled as described in Sections 2.2.3.4, and the container lids were tightly closed. The samples were labeled as described in the work plan.

After the samples were sealed and labeled, they were transported to the onsite NRMRL mobile laboratory. The following packaging and labeling procedures were followed:

- Samples were packaged to prevent leakage or vaporization from the containers;
- Samples were cushioned to avoid breakage.

Sample shipment to NRMRL and the associated chain-of-custody documentation was the responsibility of the USEPA/NRMRL field personnel.

2.4 SURFACE WATER SAMPLING

Surface water samples were collected from the canal adjacent to MP4 in March 1994 and January 1996 (Figure 2.1). These samples were collected in order to assess the impact of groundwater discharge on surface water quality. The surface water samples were analyzed for CAHs only.

Surface water samples were collected directly into the sample bottle by placing the sample bottle in the creek with the opening facing up and allowing the water to slowly fill the bottle. Sample handling proceeded as described for groundwater samples in Section 2.2.5.

2.5 SURVEYING

After completion of field work, the locations and elevations of all new monitoring points and pre-existing monitoring wells were surveyed by a licensed land surveyor. The horizontal locations and elevations of the measurement datum (top of PVC well casing) and the ground surface adjacent to the well casing were measured relative to existing control points referenced to the Florida state plane coordinate system. Horizontal locations were surveyed to the nearest 0.1 foot. Measurement datum and ground surface elevations were surveyed to the nearest 0.01 foot. Survey data are presented in Table 2.2 and Appendix A.

SECTION 3

PHYSICAL CHARACTERISTICS OF THE STUDY AREA

This section describes the physical characteristics of Site FT-17 as determined from data collected by Parsons ES in January 1996, in conjunction with data documented in previous reports on Cape Canaveral AS. Investigative techniques used by Parsons ES to further define the physical characteristics of the site are discussed in Section 2.

3.1 SURFACE FEATURES

3.1.1 Topography

Cape Canaveral AS is located on a barrier island between the Atlantic Ocean (to the east) and the Banana River. The CCFTA-2 (FT-17) site is located about 1,000 feet east of the Banana River, north of the Industrial Area on the west side of Cape Canaveral AS (Figures 1.1 and 1.2). Surficial topography at the site is characterized by little relief other than some sand mounds and berms. In the portion of the site north and east of Titan III Road, topography is variable, but south of the road the land surface generally slopes gently to the southwest toward the drainage canal south of the site. Ground surface elevations range from 3.2 to 11.8 feet above mean sea level (msl); the average elevation at the site is about 7.3 feet above msl.

3.1.2 Surface Water Hydrology

The CCFTA-2 (FT-17) site is about 800 feet northeast of a west-northwest-flowing drainage canal and is within 1,000 feet of the Banana River. Due to the relatively level land surface and the sandy surficial soils, nearly all precipitation at the site is likely to infiltrate rapidly, and overland runoff to the canal is likely to be negligible.

3.1.3 Manmade Features

FT-17 is located in a relatively undeveloped portion of the Base that is mostly vegetated. The site has no man-made surface structures except for the bioventing system and supports for the removed ASTs. Most of the site is covered with sparse vegetation, and the site area is bordered by dense vegetation such as scrub oak and hardwood hammock. The former burn pit is a depression in sandy soil about 500 feet north of Titan III Road (Figure 1.2). An earthen berm borders the southwestern margin of the burn pit area. South of the site are Titan III Road and the drainage canal.

3.2 REGIONAL GEOLOGY AND HYDROGEOLOGY

Cape Canaveral AS is situated on undifferentiated marine sands overlying the Pleistocene-age Anastasia Formation and Caloosahatchee Marl Formation; these three units comprise the surficial unconsolidated deposits in the area. The Anastasia Formation is a discontinuous layer of undifferentiated sands with silt and shells, and may not be present in this area. According to OBG (1995b), the Anastasia Formation was not observed at site CCFTA-2 (FT-17). The Caloosahatchee Marl Formation consists primarily of calcareous sand and shell deposits with interbedded calcareous sand, silt, and clay deposits.

Underlying the Caloosahatchee Formation is the Tamiami Formation, which consists of limestones, marls, silty sands, and clay. The Tamiami Formation forms a shallow bedrock aquifer. The marine sands, clays, and limestones of the Hawthorn Formation underlie the Tamiami Formation. Interspersed limestone layers form localized aquifers within the Hawthorn Formation. Beneath the Hawthorn Formation is the Floridan Aquifer, which consists of Ocala Formation limestone and extends to a depth of more than 1,500 feet below msl. Figure 3.1 shows the generalized stratigraphic sequence for the area.

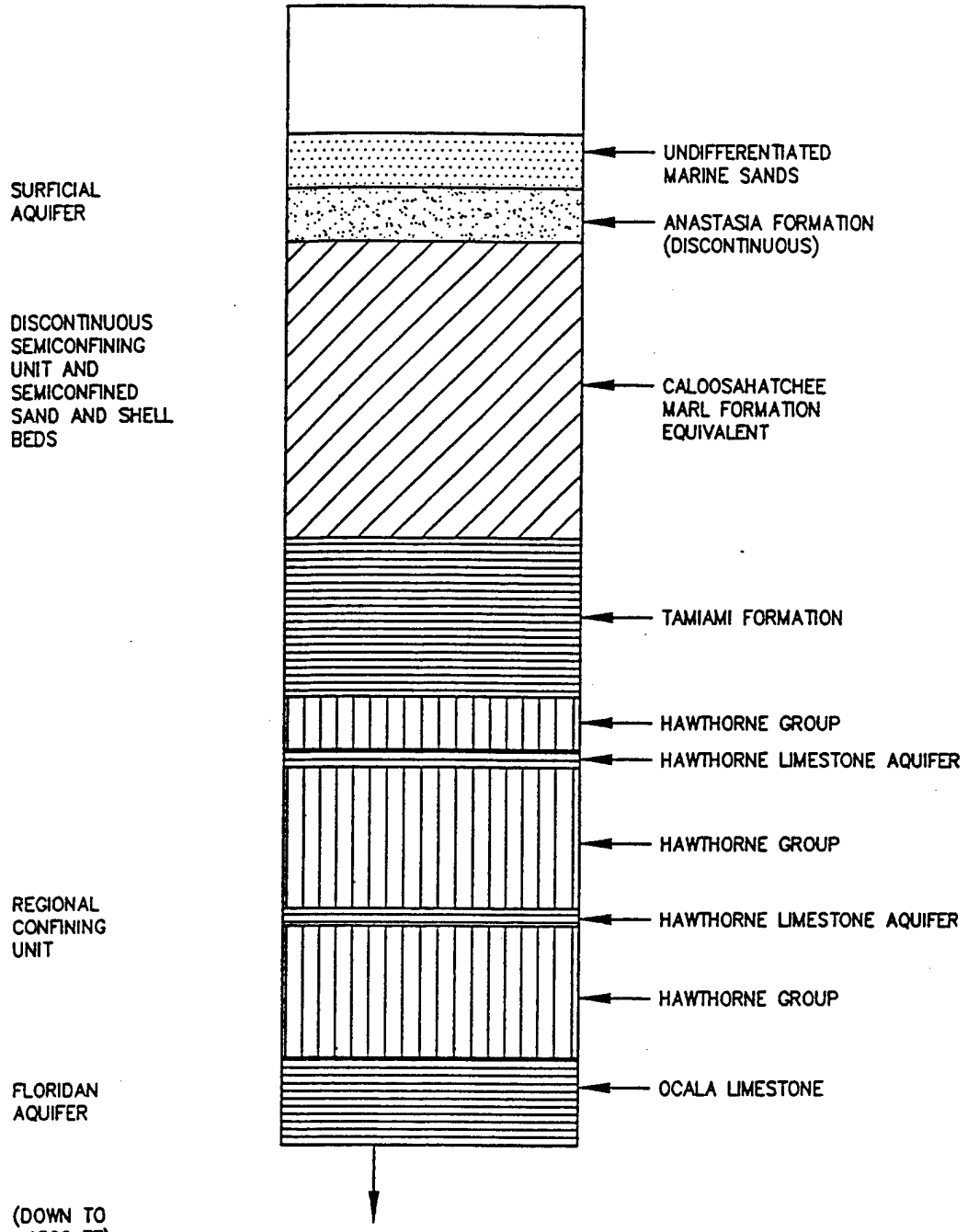

FIGURE 3.1

REGIONAL STRATIGRAPHIC SEQUENCE

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The surficial aquifer at Cape Canaveral AS includes the undifferentiated marine sands, the Anastasia Formation, the Caloosahatchee Marl, and the Tamiami Formation. The bottom of the surficial aquifer at Cape Canaveral is about 110 feet below msl, and is formed by clay units within the Hawthorn Formation (ESE, 1991a). This aquifer is typically unconfined, although local confined zones may exist due to the presence of fine-grained units.

The likelihood of contamination of the deep aquifers from sources in the shallow aquifer is thought to be minimal. This is because the deep aquifers in the region generally have sufficient pressure head to cause the potentiometric surface for the deep aquifers to be higher than the water table within the shallow unconfined aquifer, thus preventing downward vertical groundwater flow (and the associated migration of contaminants) from the shallow aquifer into the deeper units. Groundwater from beneath Cape Canaveral is not used for water supply purposes; the AS receives potable water from the city of Cocoa, Florida.

3.3 SITE GEOLOGY AND HYDROGEOLOGY

Characterization of the vadose zone and shallow aquifer system in the vicinity of Site CCFTA-2 (FT-17) has been the objective of several investigations. Multiple soil boreholes and monitoring wells (permanent and temporary) have been installed at the site since 1987. A total of 31 permanent groundwater monitoring wells have been installed at the site. Parsons ES and USEPA personnel installed 18 small-diameter temporary groundwater monitoring points during the 1994 and 1996 field events.

3.3.1 Lithology and Stratigraphic Relationships

Surface soil at the site consists of yellowish-brown and yellowish-gray, fine to coarse sand with some shell fragments. The soil is classified as Canaveral-Urban land complex according to the Soil Survey of Brevard County (US Department of Agriculture, 1974). This soil consists of Canaveral sand and Urban land that is a

mixture of sand and shells that have been dredged from the Indian and Banana Rivers and used as fill in tidal marshes. Beneath the surficial soil, an undifferentiated marine sand unit consisting of beach, eolian, estuarine, fluvial, and marsh sands extends to depths ranging from 5 to 12 feet bgs. From the land surface to a depth of about 5 feet, the sediments are pale yellowish-brown, loose, well-sorted, fine to coarse quartz sand. Below 5 feet bgs, the sands grade to a light-olive-gray to medium-gray color. The unit contains variable amounts of fine, medium, and coarse sand with up to 35-percent shells and shell fragments and occasional interspersed clay lenses.

The Anastasia Formation was not encountered at this site, and the Caloosahatchee Marl, deposited during the Pleistocene Epoch, directly underlies the undifferentiated marine sand unit. The Caloosahatchee Marl is a medium-gray to greenish-gray unit of fine-grained calcareous sand, unconsolidated shells and shell fragments, and interbedded calcareous sand, silt, and clay units. Shells and shell fragments, which locally comprise up to 70 percent of the sediment, generally are from mollusks, including gastropods and bivalves. Boring logs from deeper monitoring wells at the site (e.g., CCFTA2-08D, CCFTA2-13D, CCFTA2-16D, CCFTA2-19D, CCFTA2-20D, and CCFTA2-21D) indicate that a clay layer is present within the Marl at a depth of about 60 feet bgs, but a few logs (e.g., CCFTA2-07D and CCFTA2-09D) show the presence of silty sand at about 55 to 60 feet bgs. A few clay lenses were found at about 20 to 22 feet bgs in the boreholes for wells CCFTA2-07D and CCFTA2-09D, and CPT data from pushes in the vicinity of the former burn pit suggest that several small clay lenses up to 2 feet thick are present a depths between 11 and 19 feet bgs. Soil samples collected during installation of monitoring points in January 1996 were taken only from the ground surface to 12 feet bgs. Only sandy materials were observed in these samples.

Thin stringers of peat were observed in soil samples from about 20 to 26 feet bgs in wells CCFTA2-3, CCFTA2-5, CCFTA2-9D and CCFTA2-21D. Sediments deposited

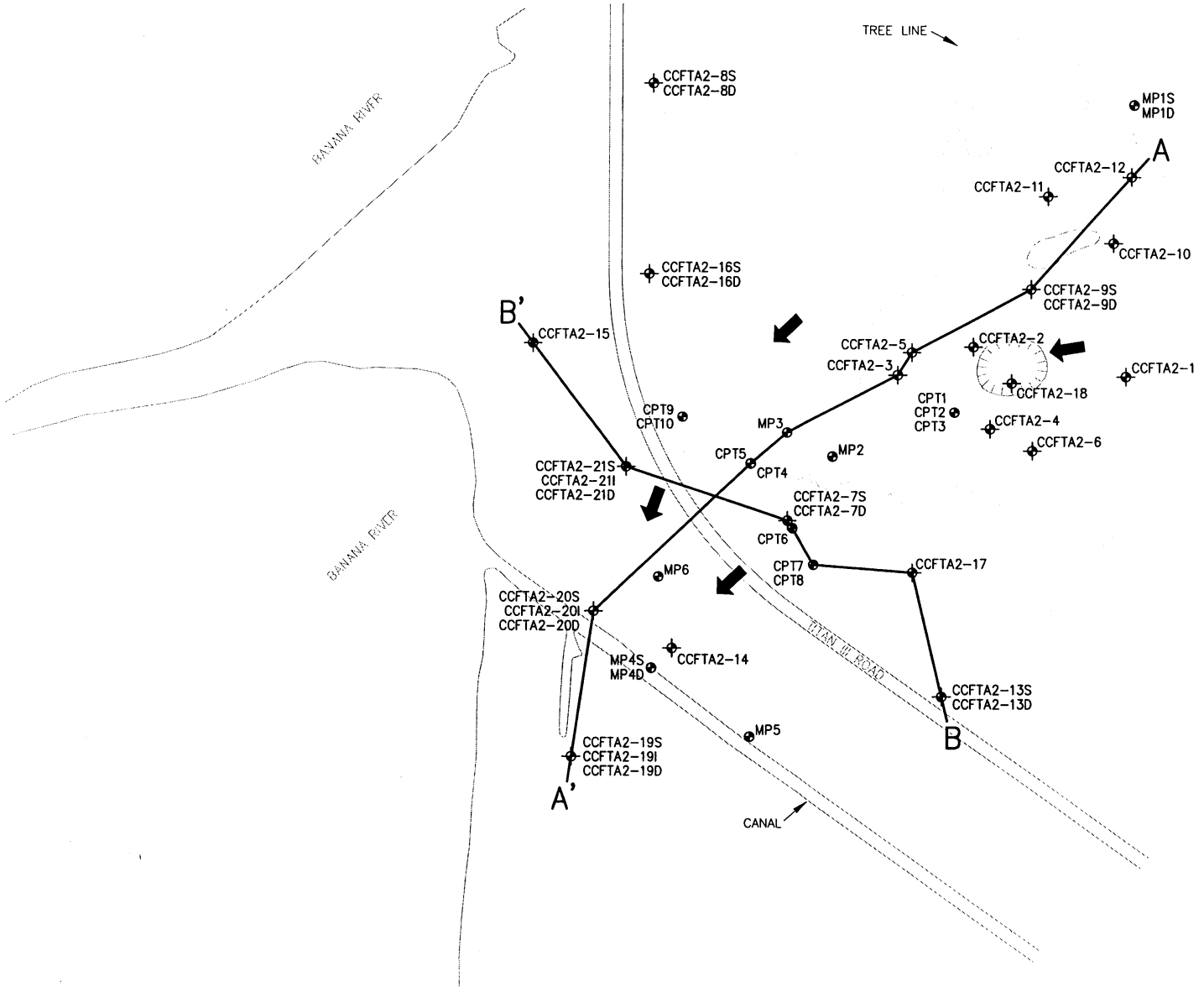
in a back-barrier environment often contain organic-rich intervals, as well as intervals with interspersed organic matter. This is important to consider when evaluating contaminant fate and transport. Soil organic matter content is discussed further in Section 4.1.3.

To illustrate these stratigraphic relationships, hydrogeologic sections have been developed from subsurface data derived from logs of previously installed monitoring wells and from the March 1994 CPT investigation and the January 1996 Geoprobe® investigation. Figure 3.2 shows the locations of these sections. Figure 3.3 presents hydrogeologic section A-A', which is approximately parallel to the direction of groundwater flow. Figure 3.4 presents hydrogeologic section B-B', which is approximately perpendicular to the direction of groundwater flow. In these sections, the contact between the undifferentiated marine sands and the Caloosahatchee Marl is not shown, because of the lithological similarity of the units.

3.3.2 Groundwater Hydraulics

3.3.2.1 Flow Direction and Gradient

The shallow unconfined aquifer at the site consists of the undifferentiated marine sands, the Caloosahatchee Marl, and the Tamiami Formation, with the bottom of the aquifer (as defined) at about 110 feet bgs. The clay layer observed at about 60 feet bgs appears to be present throughout the site and may serve as a lower confining unit for the shallow flow system at the site. Recharge to the aquifer occurs through the infiltration of precipitation through the thin and sandy vadose zone. Assuming negligible runoff, the amount of recharge is approximately equal to the amount of precipitation less the amount returned to the atmosphere through evapotranspiration. Data from Patrick Air Force Base (AFB) (ESE, 1991b) suggests that about 4.4 inches of precipitation may annually recharge the shallow aquifer near the site; however, because of the sandy soils and the relatively level ground surface at the site, recharge might be greater at CCFTA-2 (FT-17).



LEGEND

- FORMER BURN PIT
- BURIAL TRENCH
- CCFTA2-17 MONITORING WELL
- CPT6 MONITORING POINT
- A——A' LINE OF HYDROGEOLOGIC CROSS-SECTION
- APPROXIMATE GROUNDWATER FLOW DIRECTION

N

0 100 200 400
FEET

FIGURE 3.2

HYDROGEOLOGIC CROSS-SECTION LOCATION MAP

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

JL \96DN0246, 05/14/97 at 08:56

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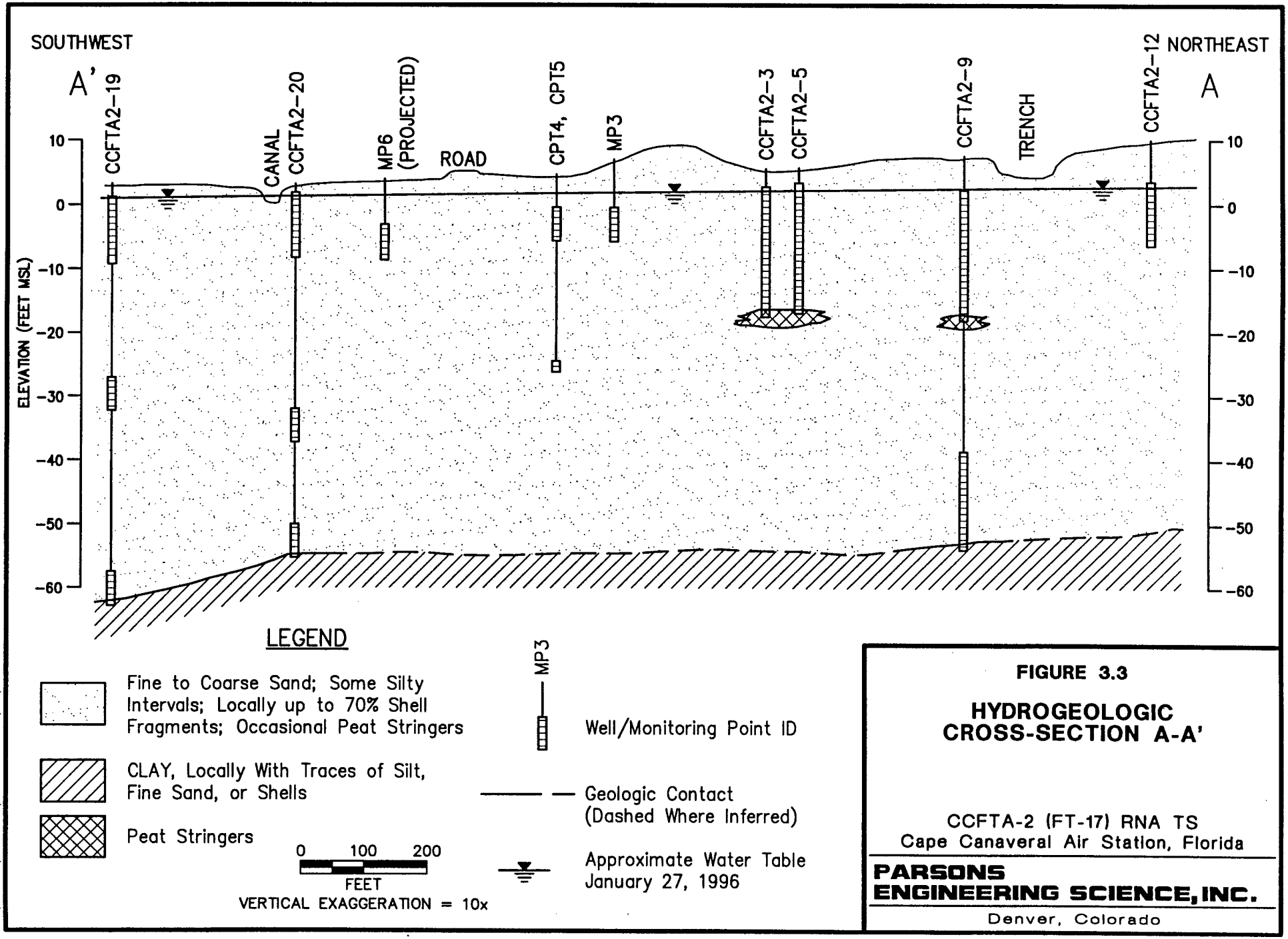


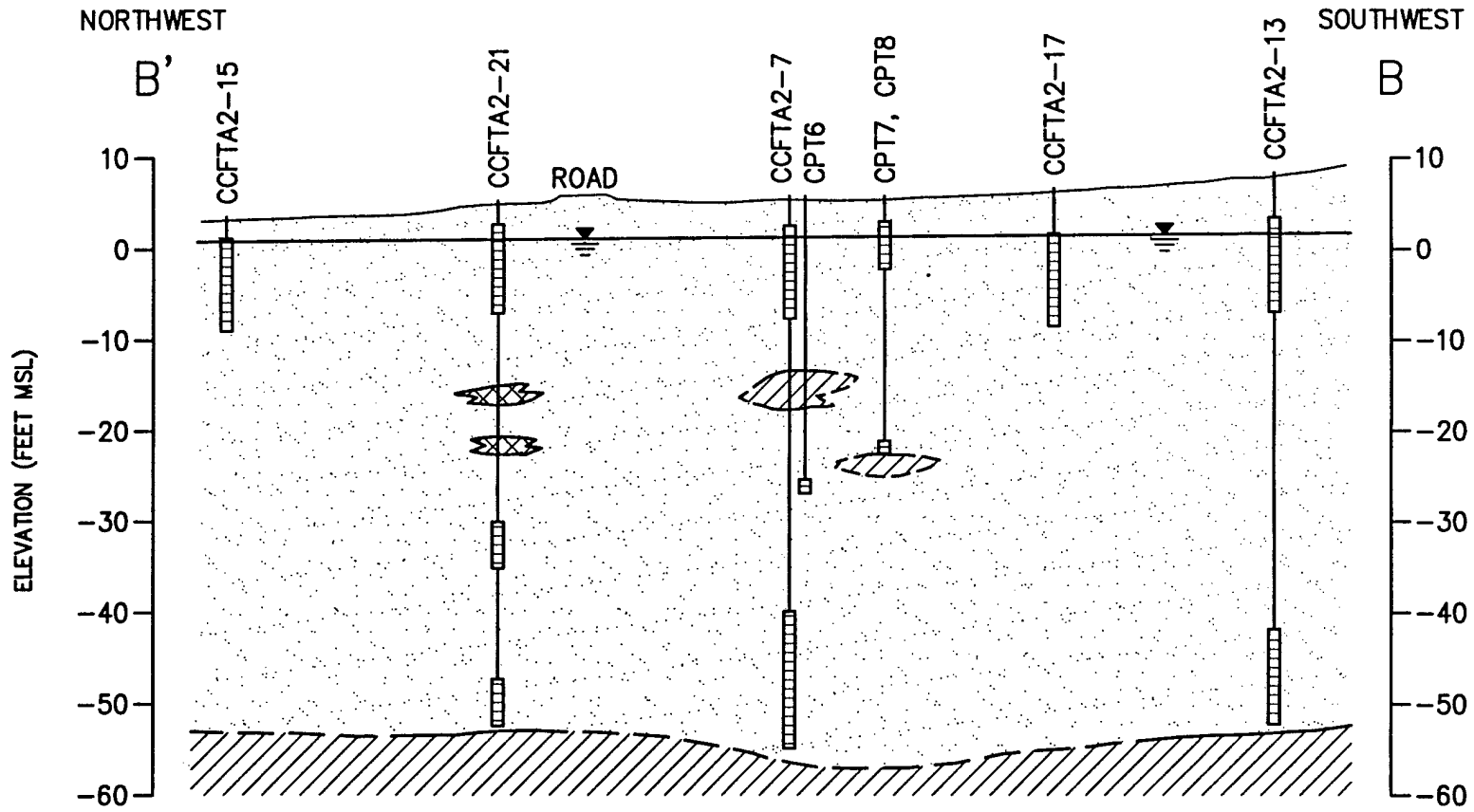
FIGURE 3.3

HYDROGEOLOGIC CROSS-SECTION A-A'

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

L:\45029\FIGURES\96DN0248, 05/14/97 at 07:08



LEGEND

Fine to Coarse Sand; Some Silty Intervals; Locally up to 70% Shell Fragments; Occasional Peat Stringers

CLAY, Locally With Traces of Silt, Fine Sand, or Shells

Peat

0 100 200
FEET
VERTICAL EXAGGERATION = 10x

CPT7 — Well/Monitoring Point ID

Geologic Contact (Dashed Where Inferred)

Approximate Water Table January 27, 1996

FIGURE 3.4

HYDROGEOLOGIC CROSS-SECTION B-B'

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

L:\45029\FIGURES\96DN0247, 05/14/97 at 07:15

The water table at CCFTA-2 (FT-17) is present from about 2.1 to 11.4 feet bgs (OBG, 1995b). Table 3.1 summarizes groundwater level measurements collected in January 1996. Groundwater flow at the site is to the southwest and west, toward the Banana River and the drainage canal. Figure 3.5 shows the water table elevations and flow conditions in the shallow portion of the aquifer on January 27, 1996. Flow in the deeper portion of the aquifer is also to the southwest and west. The horizontal hydraulic gradients measured on July 25, 1994 were 0.0004 foot per foot (ft/ft) in the shallow part of the aquifer and 0.0002 ft/ft in the deeper part of the aquifer (OBG, 1995b). On January 27 , 1996, horizontal gradients in the shallow part of the aquifer ranged from 0.00077 ft/ft to 0.0017 ft/ft, with an average of 0.0012 ft/ft; in the deeper part of the aquifer, the average horizontal gradient was about 0.0008 ft/ft.

Vertical gradients also were measured at well nests on the same dates. The July 1994 results indicated that the vertical component of groundwater flow within the shallow aquifer in the vicinity of the burn area and drum disposal trench was downward, while away from that area (toward the canal and the river) vertical gradients indicated that flow was upward (OBG, 1995b). In January 1996, gradients ranged from 0.0003 ft/ft to 0.011 ft/ft, and were mostly upward. Both sets of data suggest that flow from the shallow aquifer discharges to the canal and the Banana River. Figure 3.6 presents a vertical profile of heads in the shallow aquifer showing flow patterns indicated by the January 1996 data. The flow patterns shown on Figure 3.6 confirm that vertical flow at the site is generally upward, converging on the drainage canal.

3.3.2.2 Hydraulic Conductivity

During the RI field activities, OBG (1995b) performed *in situ* hydraulic conductivity tests at 19 monitoring wells. In the uppermost portion of the shallow aquifer, measured hydraulic conductivities ranged from 1.8×10^{-2} foot per minute (ft/min) to 8.1×10^{-2} ft/min. The geometric mean of these values is 3.6×10^{-2} ft/min (OBG,

TABLE 3.1
GROUNDWATER LEVEL MEASUREMENTS
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

Well Location	Date	Well ID (inches)	Datum Elevation (ft msl)[a/]	Ground Elevation (ft msl)	Total Depth to Water (ft btoc)[b/]	Elevation of Water Table (ft msl)
MP-1S	1/27/96	0.5	11.52	9.80	9.20	2.32
MP-2	1/27/96	0.5	9.58	7.12	8.32	1.26
MP-3	1/27/96	0.5	8.71	6.38	7.41	1.30
MP-4S	1/27/96	0.5	4.44	3.07	4.75	-0.31
MP-5	1/27/96	0.5	7.77	5.06	7.20	0.57
MP-6	1/27/96	0.5	6.20	3.47	5.32	0.88
CPT-1	1/27/96	0.5	5.14	4.15	3.60	1.54
CPT-2	1/27/96	0.5	5.20	4.15	3.67	1.53
CPT-3	1/27/96	0.5	5.22	4.15	3.45	1.77
CPT-4	1/27/96	0.5	6.44	3.59	5.61	0.83
CPT-7	1/27/96	0.5	6.94	5.78	5.95	0.99
CCFTA2-1	1/27/96	2	14.48	11.84	12.38	2.10
CCFTA2-2	1/27/96	2	9.95	7.34	8.29	1.66
CCFTA2-3	1/27/96	2	5.99	3.94	4.51	1.48
CCFTA2-4	1/27/96	2	7.84	6.55	6.17	1.67
CCFTA2-5	1/27/96	2	6.25	4.19	4.75	1.50
CCFTA2-6	1/27/96	2	10.93	8.64	9.19	1.74
CCFTA2-7S	1/27/96	2	8.40	5.74	7.37	1.03
CCFTA2-7D	1/27/96	2	8.95	5.49	7.38	1.57
CCFTA2-8S	1/27/96	2	7.53	4.83	6.13	1.40
CCFTA2-8D	1/27/96	2	7.98	4.86	6.39	1.59
CCFTA2-9S	1/27/96	2	10.29	6.63	8.41	1.88
CCFTA2-9D	1/27/96	2	10.51	6.86	8.46	2.05
CCFTA2-10	1/27/96	2	13.17	9.51	10.98	2.19
CCFTA2-11	1/27/96	2	12.59	8.94	10.59	2.00
CCFTA2-12	1/27/96	2	11.69	8.69	9.42	2.27
CCFTA2-13S	1/27/96	2	10.39	7.34	9.30	1.09
CCFTA2-13D	1/27/96	2	10.49	7.46	8.97	1.52
CCFTA2-14	1/27/96	2	6.21	3.20	5.47	0.74
CCFTA2-15	1/27/96	2	6.49	3.18	5.42	1.07
CCFTA2-16S	1/27/96	2	6.86	4.15	5.63	1.23
CCFTA2-16D	1/27/96	2	6.24	4.42	4.66	1.58
CCFTA2-17	1/27/96	4	9.36	6.17	8.20	1.16
CCFTA2-18	1/27/96	2	7.97	8.16	6.21	1.76
CCFTA2-19S	1/27/96	2	5.48	1.88	4.76	0.72
CCFTA2-19I	1/27/96	2	5.86	3.18	4.75	1.11
CCFTA2-19D	1/27/96	2	5.66	3.00	4.56	1.10
CCFTA2-20S	1/27/96	2	5.87	3.00	5.02	0.85
CCFTA2-20I	1/27/96	2	5.95	2.99	4.72	1.23
CCFTA2-20D	1/27/96	2	5.75	2.89	4.71	1.04
CCFTA2-21S	1/27/96	2	4.90	5.25	3.80	1.10
CCFTA2-21I	1/27/96	2	4.40	4.92	2.97	1.43
CCFTA2-21D	1/27/96	2	4.28	4.96	2.79	1.49

[a/] ft msl = feet above mean sea level.

[b/] ft btoc = feet below top of casing.

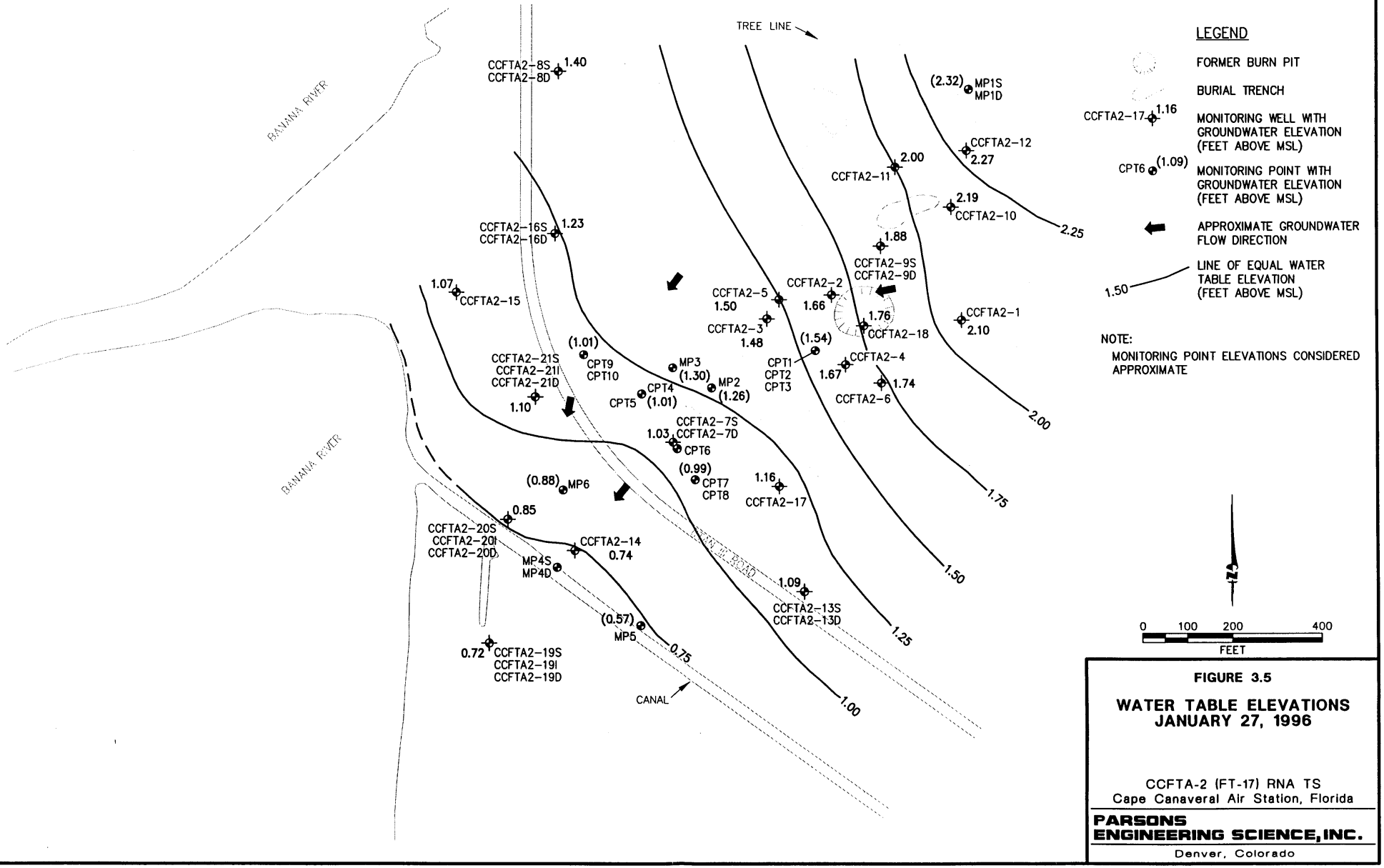


FIGURE 3.5

WATER TABLE ELEVATIONS JANUARY 27, 1996

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

L:\...\FIGU...96DN0245, 05/14/97 at 09:04

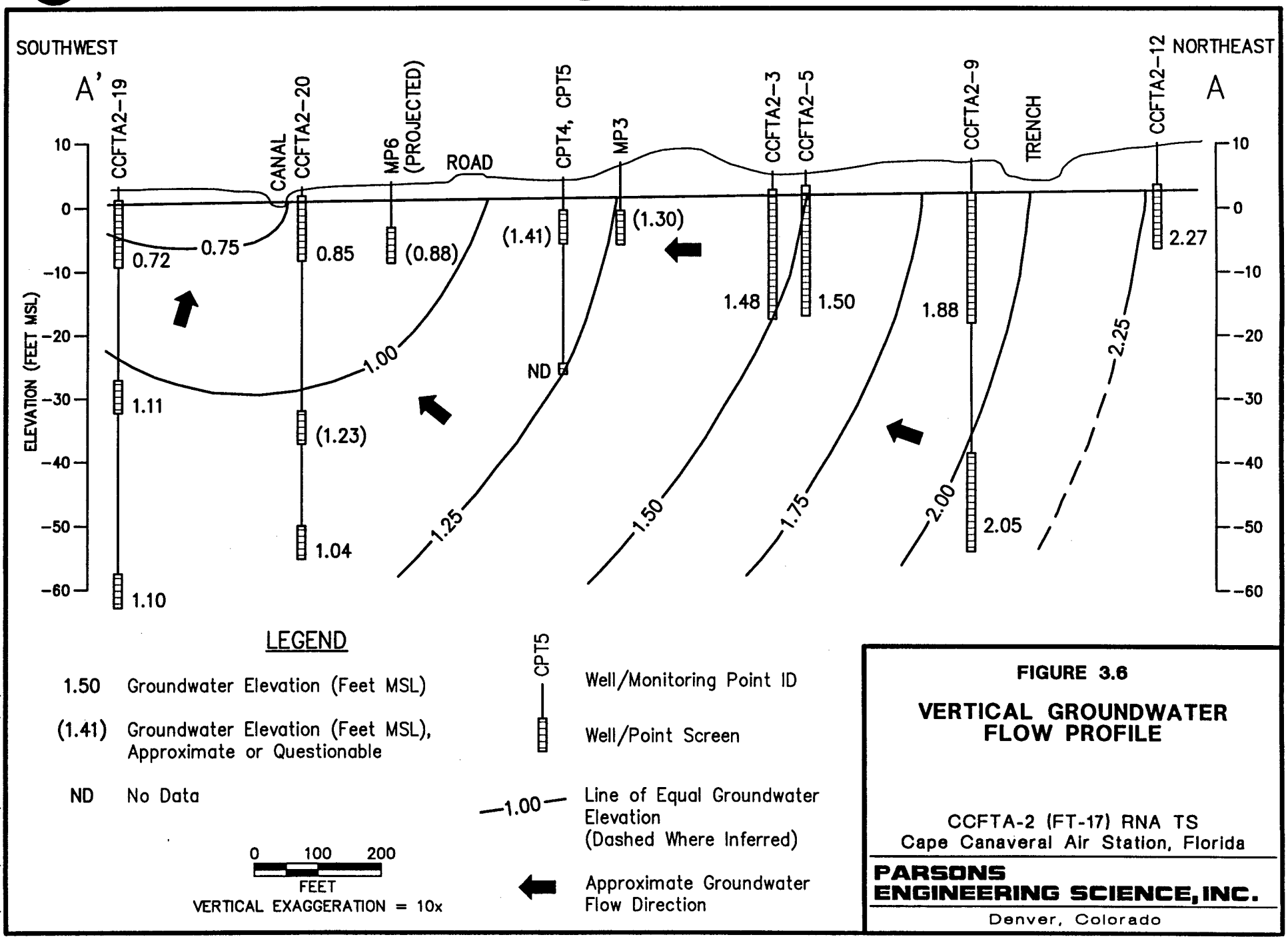


FIGURE 3.6

VERTICAL GROUNDWATER FLOW PROFILE

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

L:\45029\FIGURES\96DN0249, 05/14/97 at 07:23

1995b). In the deeper portion of the aquifer, measured hydraulic conductivities ranged from 1.7 x 10^{-2} ft/min to 4.9 x 10^{-2} ft/min, with a geometric mean of 2.9 x 10^{-2} ft/min. These results are summarized in Table 3.2, along with results from slug tests at wells CCFTA2-19 through CCFTA2-21. The latter results are from tests conducted by OBG (1996a) in December 1995. The mean of all the measured conductivity values is approximately 3.1 x 10^{-2} ft/min [44.6 feet per day (ft/day)]. Slug test data from 1995 also indicate that conductivities decrease slightly with depth in the shallow aquifer.

3.3.2.3 Effective Porosity

Because of the difficulty involved in accurately determining effective porosity, accepted literature values for the type of soil making up the shallow saturated zone were used. Walton (1988) gives ranges of effective porosity for fine to coarse sand of 0.1 to 0.35. An average effective porosity of 0.2 was assumed for this project.

3.3.2.4 Advective Groundwater Velocity

The advective velocity of shallow groundwater in the direction parallel to groundwater flow is given by:

$$\bar{v} = \frac{K}{n_e}\frac{dH}{dL}$$

Where: $\bar{v}$ = Average advective groundwater velocity (seepage velocity) [L/T]
K = Hydraulic conductivity [L/T] (3.6 x 10^{-2} ft/min, or 52 feet per day)
dH/dL = Gradient [L/L] (0.0012 ft/ft)
n_e = Effective porosity (0.2).

Using this relationship in conjunction with site-specific data, the average advective groundwater velocity at the site in January 1996 was 0.31 ft/day, or approximately 113 feet per year. The velocity in the shallow portion of the aquifer may be slightly greater than this average value, and in the lower portion of the aquifer, the velocity may be slightly slower. OBG (1995b) reported the groundwater flow velocities in the

TABLE 3.2
SUMMARY OF HYDRAULIC CONDUCTIVITY TESTING RESULTS
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

Well Name	Test Date	Well Diameter (inches)	Screen Length (feet)	Hydraulic Conductivity (ft/min)
CCFTA2-01	10/15/93	2	20	2.7E-02
CCFTA2-02	10/15/93	2	20	4.6E-02
CCFTA2-03	10/15/93	2	20	3.7E-02
CCFTA2-04	10/15/93	2	20	2.0E-02
CCFTA2-05	10/15/93	2	20	2.3E-02
CCFTA2-07D	10/18/93	2	15	3.4E-02
CCFTA2-07S	10/18/93	2	10	6.5E-02
CCFTA2-08D	10/18/93	2	15	1.7E-02
CCFTA2-08S	10/18/93	2	10	2.8E-02
CCFTA2-10	10/15/93	2	20	2.5E-02
CCFTA2-11	10/15/93	2	20	1.8E-02
CCFTA2-12	10/15/93	2	10	4.7E-02
CCFTA2-13D	10/18/93	2	10	4.9E-02
CCFTA2-13S	10/18/93	2	10	4.3E-02
CCFTA2-14	10/18/93	2	10	8.1E-02
CCFTA2-15	10/18/93	2	10	2.0E-02
CCFTA2-16D	10/18/93	2	10	2.4E-02
CCFTA2-16S	10/18/93	2	10	5.5E-02
CCFTA2-17	10/18/93	4	10	6.0E-02
CCFTA2-19S	12/13/95	2	10	2.5E-02
CCFTA2-19I	12/7/95	2	5	1.6E-02
CCFTA2-19D	12/7/95	2	5	1.1E-02
CCFTA2-20S	12/13/95	2	10	2.7E-02
CCFTA2-20I	12/7/95	2	5	5.2E-03
CCFTA2-20D	12/7/95	2	5	7.7E-03
CCFTA2-21S	12/13/95	2	10	2.9E-02
CCFTA2-21I	12/7/95	2	5	2.2E-02
CCFTA2-21D	12/7/95	2	5	1.6E-02
			AVERAGE:	3.1E-02

Sources: OBG, 1995b and 1996a.

shallow and deep portions of the aquifer as 0.08 ft/day and 0.03 ft/day, respectively, using data that indicated a shallower gradient and a slightly greater effective porosity.

3.3.2.5 Preferential Flow Paths

There is no obvious evidence of preferential groundwater flow paths at CCFTA-2 (FT-17). The sandy site soils are relatively permeable, and any utility trenches in the soils are not likely to have significantly greater permeability than the native soils. No zones of significantly higher hydraulic conductivity have been identified through soil sampling or aquifer testing. The groundwater flow map presented in Figure 3.5 further shows that flow patterns at the site do not indicate a preferred migration direction.

3.3.3 Groundwater Use

Groundwater from beneath Cape Canaveral AS is not used for water supply purposes; the Base receives potable water from the city of Cocoa, Florida. Potable water wells in the area are typically screened in the Floridan Aquifer. The deep aquifers in the region generally have sufficient pressure head to cause the potentiometric surface for the deep aquifers to be higher than the water table within the shallow unconfined aquifer, thus preventing downward vertical groundwater flow (and the associated migration of contaminants) from the shallow aquifer into the deeper units.

3.4 CLIMATE

The climate of the barrier island is humid subtropical. Monthly mean high temperatures range from 69 degrees Fahrenheit (°F) in January to 87°F in July and August. Extreme high and low temperatures for the period from 1950 to 1980 were 99°F and 27°F, respectively. Rainfall is unevenly distributed throughout the year, with the period from June through October having distinctly more precipitation than the rest of the year. A 30-year (1950 to 1980) mean of the annual precipitation recorded at

Patrick AFB, south of Cape Canaveral, is 44.7 inches, with a mean annual evapotranspiration of 40.3 inches (ESE, 1991b).

SECTION 4

CONTAMINANT DISTRIBUTION AND EVIDENCE FOR BIODEGRADATION

As noted in Section 1, contaminants at CCFTA-2 (FT-17) were introduced as a result of fire training activities and the storage of petroleum and solvents used for training exercises. Work during the RI/FS and the EE/CA focused on defining the nature and extent of contamination at the site. Results of those studies that are useful for the objectives of this TS are summarized in the following subsections, along with data collected during the field phase of this work. In particular, this section focuses on data useful for evaluating and modeling natural attenuation of CAHs.

4.1 CONTAMINANT SOURCES AND SOIL CHEMISTRY

4.1.1 Mobile LNAPL

Mobile LNAPL is defined as the LNAPL that is free to flow in the aquifer and that will flow from the aquifer matrix into a well under the influence of gravity. Mobile LNAPL was observed in two areas, centering around CCFTA2-9 (immediately south and west of the burial trench) and CCFTA2-6 (south of the former burn pit, near where the AST system was located). OBG (1995b) installed 55 temporary well point to more thoroughly delineate mobile and residual LNAPL. The well points were placed in the vicinity of the burial trench and the former burn pit. Several rounds of mobile LNAPL thickness data were collected from these well points. Table 4.1 presents LNAPL thickness data collected by Parsons ES in January 1996. Figure 4.1 shows the locations of the well points and summarizes LNAPL thickness data collected by OBG (1995b) in September 1994, along with the January 1996 data.

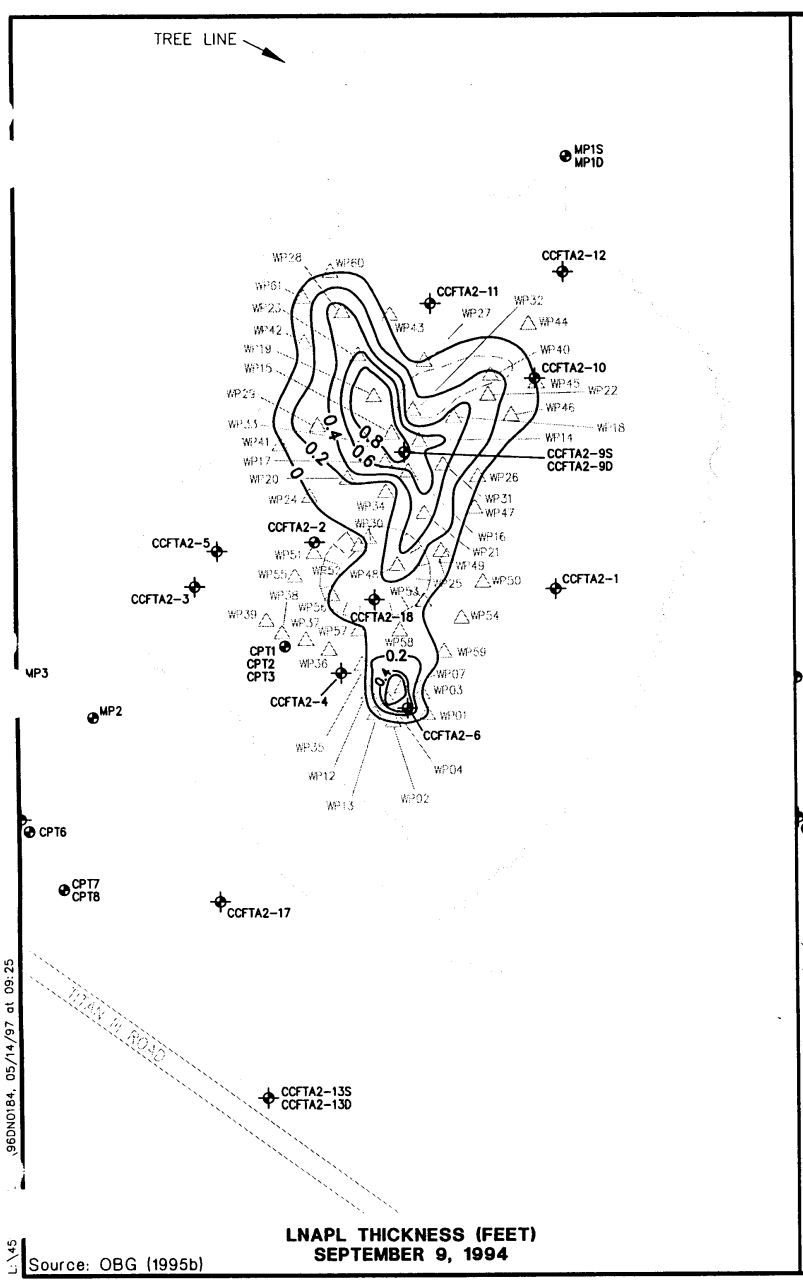
TABLE 4.1
LNAPL THICKNESS MEASUREMENTS
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

Well Location	Date	Total Depth to LNAPL (ft btoc)[a/]	Total Depth to Water (ft btoc)	LNAPL Thickness (feet)
WP01	1/22/96	--[b/]	7.96	0.00
WP02	1/22/96	--	7.62	0.00
WP03	1/22/96	--	7.77	0.00
WP04	1/22/96	--	7.65	0.00
WP12	1/22/96	6.72	6.72	trace[c/]
WP13	1/22/96	--	7.92	0.00
WP14	1/22/96	6.20	6.97	0.77
WP15	1/22/96	8.15	8.28	0.13
WP16	1/22/96	6.66	6.67	0.01
WP17	1/22/96	6.31	6.33	0.02
WP20	1/22/96	6.54	6.55	0.01
WP21	1/22/96	2.66	2.66	trace
WP22	1/22/96	7.32	7.32	trace
WP26	1/22/96	10.39	10.39	trace
WP27	1/22/96	--	7.70	0.00
WP29	1/22/96	6.77	7.21	0.44
WP30	1/22/96	--	9.71	0.00
WP31	1/22/96	8.99	9.06	0.07
WP33	1/22/96	6.71	7.30	0.59
WP34	1/22/96	--	7.17	0.00
WP35	1/22/96	7.88	7.88	trace
WP36	1/22/96	--	6.75	0.00
WP37	1/22/96	--	7.18	0.00
WP40	1/22/96	--	5.61	0.00
WP41	1/22/96	--	7.44	0.00
WP43	1/22/96	--	9.47	0.00
WP45	1/22/96	--	10.31	0.00
WP47	1/22/96	11.18	11.18	trace
WP48	1/22/96	10.27	10.29	0.02
WP49	1/22/96	--	11.05	0.00
WP50	1/22/96	9.96	9.96	trace
WP51	1/22/96	--	7.14	0.00
WP53	1/22/96	--	10.67	0.00
WP54	1/22/96	11.16	11.17	0.01
WP55	1/22/96	--	7.58	0.00
WP56	1/22/96	8.25	8.25	trace
WP57	1/22/96	--	10.13	0.00
WP59	1/22/96	--	10.44	0.00
CCFTA2-6	1/23/96	9.15	9.15	trace
CCFTA2-9	1/23/96	--	8.34	0.00
CCFTA2-18	1/23/96	--	6.23	0.00

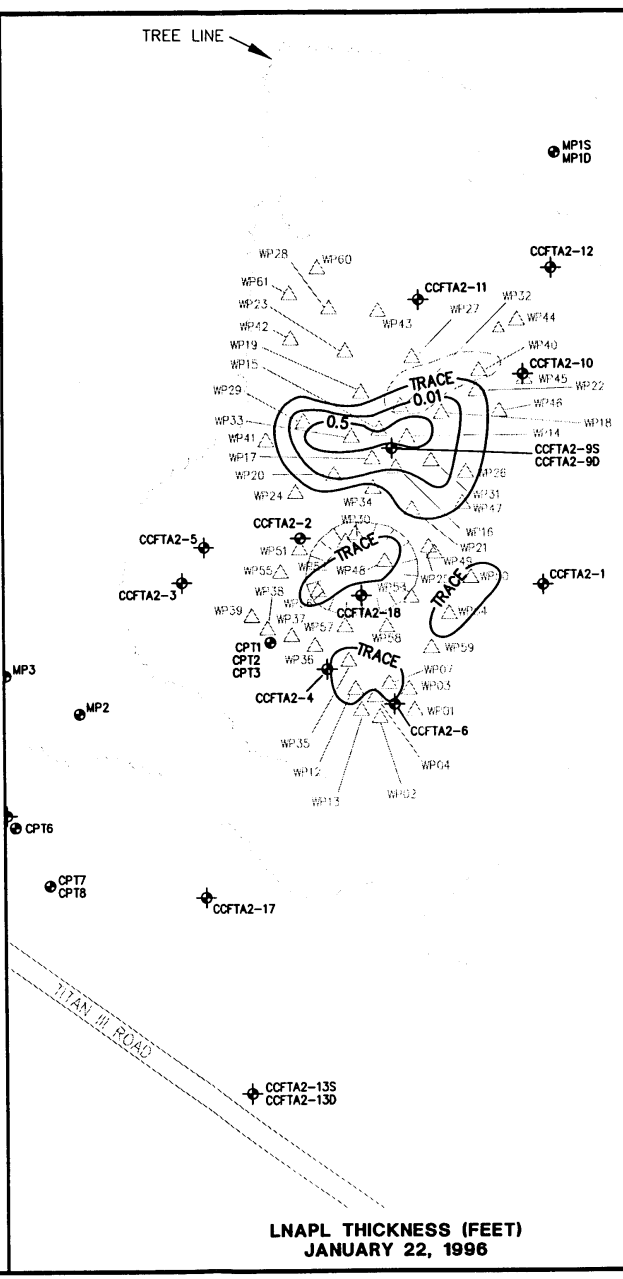
[a/] LNAPL = light nonaqueous-phase liquid; ft btoc = feet below top of casing.

[b/] -- = no LNAPL detected.

[c/] trace = probe indicated LNAPL present, but thickness was not measurable.



LNAPL THICKNESS (FEET)
SEPTEMBER 9, 1994



LNAPL THICKNESS (FEET)
JANUARY 22, 1996

Source: OBG (1995b)

L:\45\96DN0184, 05/14/97 at 09:25

LEGEND

- FORMER BURN PIT
- BURIAL TRENCH
- CCFTA2-17 — MONITORING WELL
- CPT6 — MONITORING POINT
- TEMPORARY LNAPL MONITORING POINT
- 0.4 — LINE OF EQUAL MOBILE LNAPL THICKNESS (FEET)

0 75 150 300
FEET

FIGURE 4.1

MOBILE LNAPL THICKNESS

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

In the vicinity of the burial trench, the maximum measured mobile LNAPL thickness was 1.48 feet in well point WP17, observed in February 1994 (OBG, 1995b). South of the burn pit, the maximum LNAPL thickness measured by OBG was 0.93 foot in well point WP07, also observed in February 1994. LIF data collected in March 1994 indicated the potential presence of mobile LNAPL at four locations: CCAF-01 (adjacent to monitoring well CCFTA2-06); CCAF-06 and CCAF-07 (between well CCFTA2-09 and the burn pit); and CCAF-08 (at the western edge of the burn pit). The LIF results are consistent with the 1994 mobile LNAPL data presented by OBG (1995b). In 1996, the maximum LNAPL thickness observed was 0.77 foot, at well point WP14 (in the vicinity of CCFTA2-9). In general, measurable thicknesses of mobile LNAPL were observed only in the vicinity of CCFTA2-9. Traces of LNAPL were detected in wells in the vicinity of CCFTA2-6 and the burn pit. While these data suggest that the mobile LNAPL bodies may be shrinking, they also may reflect changes due to water table fluctuations.

The relationship between the measured LNAPL thickness in a monitoring well and the total amount of mobile LNAPL in the subsurface at a site is extremely difficult to quantify. It is well documented that LNAPL thickness measurements taken in groundwater monitoring wells are not indicative of actual mobile LNAPL thicknesses in the formation (de Pastrovich *et al.*, 1979; Blake and Hall, 1984; Hall *et al.*, 1984; Hughes *et al.*, 1988; Abdul *et al.*, 1989; Testa and Paczkowski, 1989; Kemblowski and Chiang, 1990; Lehnard and Parker, 1990; Mercer and Cohen, 1990; Ballestero *et al.*, 1994). It has been noted by these authors that the thickness of LNAPL measured in a monitoring well is greater than the actual mobile LNAPL thickness present in the aquifer, and according to Mercer and Cohen (1990), measured LNAPL thickness in wells is typically 2 to 10 times greater than the actual mobile LNAPL thickness in the formation. Furthermore, only a fraction of the mobile LNAPL may be recoverable.

Samples of LNAPL were collected for analysis by OBG (1995b) in July and September 1993 and by USEPA personnel in March 1994. During both events, samples were collected from wells CCFTA2-6 and/or CCFTA2-9S. Results of these analyses are presented in Table 4.2. In the 1993 OBG sample from CCFTA2-6, the LNAPL almost entirely consisted of petroleum hydrocarbons, with the exception of low concentrations of the PCB Aroclor-1242. Interestingly, the TPH concentration for this sample was less than 300 milligrams per kilogram (mg/kg). The USEPA analysis of the 1994 sample from this well indicates that it largely consists of petroleum hydrocarbons, specifically paraffins, olefins, and polynuclear aromatic hydrocarbons (PNAs). Taken together, these data suggest that the mobile LNAPL in the vicinity of CCFTA2-6 is severely weathered and largely consists of heavier, long-chained hydrocarbons that may not have been detected by the OBG (1995b) TPH analytical method. OBG (1995b) reported that on the basis of a gas chromatograph (GC) fingerprint analysis, their sample from this well may not have been representative; which may also account for the apparent absence of TPH compounds.

Mobile LNAPL samples from CCFTA2-9S contained petroleum hydrocarbons, CAHs, and Aroclor-1242. OBG (1995b) reported that on the basis of GC fingerprint analysis, the mobile LNAPL is similar to kerosene or JP-7 jet fuel. It was not specified whether this represents the fingerprint for the weathered LNAPL or is an estimation of the fresh LNAPL composition. The TPH concentration in the 1993 sample was 830,000 mg/kg. The USEPA analysis of the 1994 sample from this well indicated that in addition to paraffins, olefins, and PNAs, the mobile LNAPL from CCFTA2-9S contained low concentrations of alkylbenzenes (Table 4.2). Moreover, both samples from this well contained significant concentrations of TCE. In the OBG sample, the TCE concentration was 22,000 mg/kg, while in the USEPA sample the TCE concentration was about 13,300 mg/kg. The USEPA analysis also revealed the presence of tetrachloroethene (PCE) and *cis*-1,2-DCE, at concentrations of 259 mg/kg

TABLE 4.2
COMPOUNDS DETECTED IN MOBILE LNAPL SAMPLES
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

Well CCFTA2-6

Compound	Date	Concentration (mg/kg)	Concentration (mg/L)[a]
o-dichlorobenzene	07/93	1.2	1.2
p-dichlorobenzene	07/93	0.15 J	0.15 J
ethylbenzene	07/93	3.9	3.9
2-methylnaphthalene	07/93	540	540
naphthalene	07/93	170 J	170 J
Aroclor-1242	07/93	340	340
phenanthrene	07/93	400 U	400 U
TPH[c]	10/93	<300	<300
TCE	07/93	0.25 U	0.25 U
xylenes (total)	07/93	5.9	5.9

Well CCFTA2-9S

Compound	Date	Concentration (mg/kg)	Concentration (mg/L)[b]
o-dichlorobenzene	07/93	11 U	10.1 U
p-dichlorobenzene	07/93	11 U	10.1 U
ethylbenzene	07/93	11 U	10.1 U
2-methylnaphthalene	07/93	1200	1104
naphthalene	07/93	390 J	359 J
Aroclor-1242	07/93	76	69.92
phenanthrene	07/93	200 J	184 J
TPH	10/93	830000	763600
TCE	07/93	22000	20240
xylenes (total)	07/93	11 U	10.1 U

Well CCFTA2-6

Compound	Date	Concentration (mg/kg)[d]	Concentration (mg/L)
paraffins	03/94	240964	180000
monocycloparaffins	03/94	282463	211000
dicycloparaffins	03/94	210174	157000
alkylbenzenes	03/94	ND[f]	ND
olefins	03/94	30924	23100
PNAs[g]	03/94	99598	74400
other	03/94	135207	101000

Well CCFTA2-9S

Compound	Date	Concentration (mg/kg)[e]	Concentration (mg/L)
paraffins	03/94	450667	338000
monocycloparaffins	03/94	198667	149000
dicycloparaffins	03/94	120000	90000
alkylbenzenes	03/94	2173	1630
olefins	03/94	25333	19000
PNAs	03/94	97200	72900
other	03/94	84533	63400
cis-1,2-DCE	03/94	2693	2020
TCE	03/94	13333	10000
PCE	03/94	259	194

[a] Calculated assuming a specific gravity of 1 (as reported by OBG, 1995b).

[b] Calculated assuming a specific gravity of 0.92 (as reported by OBG, 1995b).

[c] TPH = total petroleum hydrocarbons.

[d] Calculated assuming a specific gravity of 0.747 (from LNAPL data provided by USEPA NRMRL).

[e] Calculated assuming a specific gravity of 0.75 (from LNAPL data provided by USEPA NRMRL).

[f] ND = not detected.

[g] PNAs = polynuclear aromatic hydrocarbons.

and 2,693 mg/kg, respectively. This indicates that the mobile LNAPL in the vicinity of CCFTA2-9 is probably the most significant source of dissolved CAHs and petroleum hydrocarbons (especially BTEX) in site groundwater. The decrease in TCE concentrations from September 1993 to March 1994 may represent weathering and or mass loss due to dissolution, but may also be a partial result of heterogeneity of the LNAPL, other changes in site conditions, and differing sampling techniques and analytical methods.

4.1.2 Residual Contamination

Residual LNAPL is defined as the LNAPL that is trapped in the aquifer by the processes of cohesion and capillarity, and therefore will neither flow within the aquifer nor flow from the aquifer matrix into a well under the influence of gravity. At this site, residual LNAPL consists primarily of fuel hydrocarbons derived from waste fuels, along with cosolvenated CAHs. As part of the previous work at the site, several rounds of soil samples were collected. The following summary of the previous data serves to delineate the distribution of residual contamination. Soil samples collected during this investigation were not analyzed for contaminants because sampling locations were well away from the defined source areas.

Soil sampling data reported by OBG (1995b) indicate that VOCs detected at the site (and considered elevated compared to reference values) include PCE, TCE, and VC. PCE concentrations ranged from 0.0055 mg/kg to 0.47 mg/kg, while TCE concentrations ranged from 0.78 mg/kg to 8.5 mg/kg. Vinyl chloride was detected at a concentration of 0.15 mg/kg. VOCs were detected in four areas: at the northeastern end of the burial trench, near the southwestern end of the trench, in and west of the former burn pit, and near well CCFTA2-6 (in the vicinity of the former AST system). VOC concentrations in site soils were highest in the area immediately southwest of the drum burial trench. The data presented by OBG (1995b) suggest that soil VOC contamination has a relaively even vertical distribution, with slightly greater

concentrations present in deeper soils, near the water table. However, given the soil contaminant evidence presented by OBG (1995b) and considering groundwater contaminant data (presented in Section 4.3), LNAPL (mobile and residual) in the vicinity of the trench is likely the most significant source of groundwater contamination at CCFTA-2 (FT-17).

4.1.3 Total Organic Carbon in Soil

TOC concentrations are used to estimate the amount of organic matter sorbed to soil particles or trapped in the interstitial passages of a soil matrix. The TOC concentration in the saturated zone is an important parameter used to estimate the amount of contaminant that could potentially be sorbed to the aquifer matrix. Sorption results in retardation of the contaminant plume relative to the average advective groundwater velocity. In addition, TOC can be used as a gross indicator of organic compounds that are available as a source of carbon and electron donors (or substrate) for microbial activity.

Soil TOC concentrations were measured in 16 samples from 3 CPT locations in 1994, and in 5 samples from 5 Geoprobe® locations in 1996. These data are summarized in Table 4.3, and sampling locations are shown on Figure 2.1. Soil samples were collected from below the water table or in the capillary fringe. Soil TOC concentrations at CCFTA-2 (FT-17) ranged from 0.017 percent to 0.836 percent, with an average TOC content of 0.184 percent. Some of the CPT samples were taken in areas with soil contamination (which could possibly bias the results high), but the remainder were not.

The average TOC content of site soils is slightly higher than values reported for other sites with sandy soils (e.g., the TOC data compiled by Wiedemeier *et al.*, 1995). This is consistent with the depositional environment of site soils described in Section 3.3.1, in which organic matter (peat) may be deposited in discrete intervals or

TABLE 4.3
TOTAL ORGANIC CARBON IN SOIL
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

Sampling Location	Sampling Date	Sample Depth (feet bgs)	Total Organic Carbon (percent)
MP-1S	1/24/96	9 - 10	0.041
MP-3	1/24/96	9 - 10	0.114
MP-4S	1/24/96	7 - 8	0.019
MP-5	1/24/96	7 - 8	0.017
MP-6	1/24/96	7 - 8	0.021
CCAF-01[a/]	3/29/94	5.5 - 6.5	0.422
CCAF-01[a/]	3/29/94	6.5 - 7.5	0.467
CCAF-01[a/]	3/29/94	7.5 - 8.5	0.293
CCAF-01[a/]	3/29/94	8.5 - 9.5	0.04
CCAF-01B[a/]	3/29/94	5.5 - 6.5	0.044
CCAF-01B[a/]	3/29/94	6.5 - 7.5	0.075
CCAF-01B[a/]	3/29/94	7.5 - 8.5	0.041
CCAF-01B[a/]	3/29/94	8.5 - 9.5	0.018
CCAF-06[a/]	3/29/94	3.5 - 4.5	0.216
CCAF-06[a/]	3/29/94	4.5 - 5.5	0.148
CCAF-06[a/]	3/29/94	5.5 - 6.5	0.836
CCAF-06[a/]	3/29/94	6.5 - 7.5	0.361
CCAF-07[a/]	3/29/94	5.5 - 6.5	0.174
CCAF-07[a/]	3/29/94	6.5 - 7.5	0.424
CCAF-07[a/]	3/29/94	7.5 - 8.5	0.07
CCAF-07[a/]	3/29/94	8.5 - 9.5	0.023
		Range:	0.017 - 0.836
		Average:	0.184

[a/] Results may be biased due to the presence of soil contamination.

dispersed in the sandy units. As discussed in Section 3.3.1, stringers of peat were observed in several boreholes at CCFTA-2 (FT-17). Therefore, there may be localized areas in which mich higher concentrations of organic carbon are present. None of the samples collected for TOC analyses were collected from intervals containing peat, which provides a significant reservoir of organic carbon. In general, the soil TOC data for CCFTA-2 (FT-17) suggest that in addition to having sufficient organic carbon to retard organic contaminant migration, there may be enough organic matter to provide a suitable substrate for microbial activity.

4.2 OVERVIEW OF HYDROCARBON BIODEGRADATION

Mechanisms for natural attenuation of CAHs and BTEX include biodegradation, dispersion, dilution from recharge, sorption, and volatilization. Of these processes, biodegradation is the only mechanism working to transform contaminants into innocuous byproducts. Intrinsic bioremediation occurs when indigenous microorganisms work to bring about a reduction in the total mass of contamination in the subsurface without the addition of nutrients. In order to provide a foundation for interpreting site data, the following subsections review the major bioremediation processes that act upon CAHs and BTEX.

As discussed previously, the focus of this evaluation is on RNA of CAHs dissolved in groundwater. However, because BTEX compounds are present at CCFTA-2 (FT-17), and because such compounds may play a role in the biodegradation of CAHs, the following sections discuss the biodegradation of both BTEX and CAHs. Because the terminology describing biodegradation of both types of compounds is similar, a generalized review of the processes is presented first.

4.2.1 Review of Biodegradation Processes

Microorganisms obtain energy for cell production and maintenance by facilitating thermodynamically advantageous reduction/oxidation (redox) reactions involving the

transfer of electrons from electron donors to available electron acceptors. This results in the oxidation of the electron donor and the reduction of the electron acceptor. Electron donors may be natural organic carbon, fuel hydrocarbon compounds, and less-chlorinated solvents [e.g., VC, DCE, or dichloroethane (DCA)]. Fuel hydrocarbons or solvents are completely degraded or detoxified if they are utilized as the primary electron donor (i.e., as a primary substrate or carbon source) for microbial metabolism (Bouwer, 1992). Electron acceptors are elements or compounds that occur in relatively oxidized states, and include oxygen, nitrate, ferric iron, sulfate, manganese, carbon dioxide, and highly chlorinated solvents [e.g., PCE, TCE, trichloroethane (TCA), and polychlorinated benzenes].

The driving force of biodegradation is electron transfer, which is quantified by the Gibbs free energy of the reaction ($\Delta G°_r$) (Stumm and Morgan, 1981; Bouwer, 1994; Godsey, 1994). The value of $\Delta G°_r$ represents the quantity of free energy consumed ($\Delta G°_r > 0$) or yielded ($\Delta G°_r < 0$) to the system during the reaction. Although thermodynamically favorable, most of the reactions involved in biodegradation of fuel hydrocarbons or CAHs cannot proceed abiotically because of the lack of activation energy. Microorganisms are capable of providing the necessary activation energy; however, they will facilitate only those redox reactions that have a net yield of energy (i.e. $\Delta G°_r < 0$). Microorganisms preferentially utilize electron acceptors while metabolizing hydrocarbons (Bouwer, 1992). DO is utilized first as the prime electron acceptor. After the DO is consumed, anaerobic microorganisms use electron acceptors in the following order of preference: nitrate, manganese, ferric iron hydroxide, sulfate, and finally carbon dioxide. Chlorinated solvents are generally used as electron acceptors when aquifer conditions are such that sulfate or carbon dioxide is the preferred electron acceptor.

In addition to being controlled by the energy yield of the reaction, the expected sequence of redox processes is also a function of the oxidizing potential of the

groundwater. This potential is a measure of the relative tendency of a solution or chemical reaction to accept or transfer electrons. As each subsequent electron acceptor is utilized, the groundwater becomes more reducing, and the ORP of the water decreases. The main force driving this change in redox potential is microbially mediated redox reactions. ORP can be used as an indicator of which redox reactions may be operating at a site. Environmental conditions and microbial competition ultimately determine which processes will dominate.

Depending on the types and concentrations of electron acceptors present (e.g., nitrate, sulfate, carbon dioxide), pH conditions, and ORP, anaerobic biodegradation can occur by denitrification, manganese reduction, ferric iron reduction, sulfate reduction, or methanogenesis. Other, less common anaerobic degradation mechanisms such as manganese or nitrate reduction may dominate if the physical and chemical conditions in the subsurface favor use of these electron acceptors. Vroblesky and Chapelle (1994) show that the dominant terminal electron accepting process can vary both temporally and spatially in an aquifer with fuel hydrocarbon contamination.

4.2.2 Biodegradation of BTEX

Numerous laboratory and field studies have shown that hydrocarbon-degrading bacteria can participate in the degradation of many of the chemical components of fuel hydrocarbons, including the BTEX compounds (e.g., Jamison *et al.,* 1975; Atlas, 1981, 1984, 1988; Gibson and Subramanian, 1984; Reinhard *et al.,* 1984; Young, 1984; Bartha, 1986; Wilson *et al.,* 1986, 1987, and 1990; Barker *et al.,* 1987; Baedecker *et al.,* 1988; Lee, 1988; Chiang *et al.,* 1989; Grbic-Galic, 1989 and 1990; Cozzarelli *et al.,* 1990; Leahy and Colewell, 1990; Altenschmidt and Fuchs, 1991; Alvarez and Vogel, 1991; Baedecker and Cozzarelli, 1991; Ball *et al.,* 1991; Bauman, 1991; Borden, 1991; Brown *et al.*, 1991; Edwards *et al.,* 1991 and 1992; Evans *et al.,* 1991a and 1991b; Haag *et al.,* 1991; Hutchins and Wilson, 1991; Hutchins *et al.,* 1991a and 1991b; Beller *et al.,* 1992; Bouwer, 1992; Edwards and Grbic-Galic, 1992;

Thierrin *et al.*, 1992; Malone *et al.*, 1993; Davis *et al.*, 1994). Fuel hydrocarbons biodegrade naturally when an indigenous population of hydrocarbon-degrading microorganisms is present in the aquifer and sufficient concentrations of electron acceptors and nutrients are available to these organisms.

During biodegradation of fuel hydrocarbons, the fuel compounds are used as electron dononrs. They are the primary substrate ("food") for the microbes, while the electron acceptors provide the oxidant used to reduce (metabolize) the substrate and produce energy. In most subsurface environments, both aerobic and anaerobic degradation of fuel hydrocarbons can occur, often simultaneously in different parts of the plume. The nearly ubiquitous nature of these processes is well documeted (e.g., Rice *et al.*, 1995; Wiedemeier *et al.*, 1995; Kuehne and Busheck, 1996; and Mace *et al.*, 1997). Aerobic destruction of BTEX compounds dissolved in groundwater results in the consumption (reduction) of DO and the formation of carbon dioxide. Anaerobic destruction of the BTEX compounds is associated with the accumulation of fatty acids, production of methane, solubilization of iron, and reduction of nitrate and sulfate (Cozzarelli *et al.*, 1990; Wilson *et al.*, 1990).

4.2.3 Biodegradation of Chlorinated Solvents

Chlorinated solvents can be transformed, directly or indirectly, by biological processes (e.g., Bouwer *et al.*, 1981; Miller and Guengerich, 1982; Wilson and Wilson, 1985; Nelson *et al.*, 1986; Bouwer and Wright, 1988; Little *et al.*, 1988; Mayer *et al.*, 1988; Arciero *et al.*, 1989; Cline and Delfino, 1989; Freedman and Gossett, 1989; Folsom *et al.*, 1990; Harker and Kim, 1990; Alvarez-Cohen and McCarty, 1991a, 1991b; DeStefano *et al.*, 1991; Henry, 1991; McCarty *et al.*, 1992; Hartmans and de Bont, 1992; McCarty and Semprini, 1994; Vogel, 1994; Bradley and Chapelle, 1996; Klier *et al.*, 1996). Biodegradation of CAHs results from the same general processes that bring about biodegradation of fuel hydrocarbons. However, a

more complex series of processes often is involved, and CAHs may act as both a substrate (electron donor) and an electron acceptor.

Whereas BTEX are biodegraded in essentially one step by acting as an electron donor/carbon source, CAHs may undergo several types of biodegradation involving several steps. CAHs may undergo biodegradation through three different pathways: use as an electron acceptor, use as an electron donor, or cometabolism, which is degradation resulting from exposure to a catalytic enzyme fortuitously produced during an unrelated process. At a given site, one or all of these processes may be operating, although at many sites the use of CAHs as electron acceptors appears to be the most likely.

In a pristine aquifer, native organic carbon is utilized as an electron donor and DO is utilized first as the prime electron acceptor. Where anthropogenic carbon (e.g., fuel hydrocarbons or less-chlorinated CAHs) is present, it also will be utilized as an electron donor. After the DO is consumed, anaerobic microorganisms typically use native electron acceptors (as available) in the following order of preference: nitrate, ferric iron oxyhydroxide, sulfate, and finally carbon dioxide. Evaluation of the distribution of these electron acceptors can provide evidence of where and how CAH biodegradation is occurring. In addition, because CAHs may be used as electron acceptors or electron donors (in competition with other acceptors or donors), isopleth maps showing the distribution of these compounds will also provide evidence on the types of biodegradation processes acting at a site. A more complete description of the main types of biodegradation reactions affecting CAHs dissolved in groundwater is presented in the following subsections.

4.2.3.1 Electron Acceptor Reactions (Reductive Dehalogenation)

Under anaerobic conditions, biodegradation of chlorinated solvents usually proceeds through a process called reductive dehalogenation. During this process, the

halogenated hydrocarbon is used as an electron acceptor, not as a source of carbon, and a halogen atom is removed and replaced with a hydrogen atom. Figure 4.2 illustrates the transformation of chlorinated ethenes via reductive dehalogenation. In general, reductive dehalogenation of chlorinated ethenes occurs by sequential dehalogenation from PCE to TCE to DCE to VC to ethene. Depending upon environmental conditions, this sequence may be interrupted, with other processes then acting upon the products. During reductive dehalogenation, all three isomers of DCE can theoretically be produced; however, Bouwer (1994) reports that under the influence of biodegradation, *cis*-1,2-DCE is a more common intermediate than *trans*-1,2-DCE, and that 1,1-DCE is the least prevalent intermediate of the three DCE isomers. Reductive dehalogenation of chlorinated solvent compounds is associated with the accumulation of daughter products and an increase in chloride.

Reductive dehalogenation affects each of the chlorinated ethenes differently. Of these compounds, PCE is the most susceptible to reductive dehalogenation because it is the most oxidized. Conversely, VC is the least susceptible to reductive dehalogenation because it is the least oxidized of these compounds. The rate of reductive dehalogenation also has been observed to decrease as the degree of chlorination decreases (Vogel and McCarty, 1985; Bouwer, 1994). Murray and Richardson (1993) have postulated that this rate decrease may explain the accumulation of VC in PCE and TCE plumes that are undergoing reductive dehalogenation.

In addition to being affected by the degree of chlorination of the CAH, reductive dehalogenation can also be controlled by the redox conditions of the site groundwater system. In general, reductive dehalogenation has been demonstrated under anaerobic nitrate- and sulfate-reducing conditions, but the most rapid biodegradation rates, affecting the widest range of CAHs, occur under methanogenic conditions (Bouwer, 1994). Dehalogenation of PCE and TCE to DCE can proceed under mildly reducing conditions such as nitrate reduction or iron (III) reduction (Vogel *et al.*, 1987), while

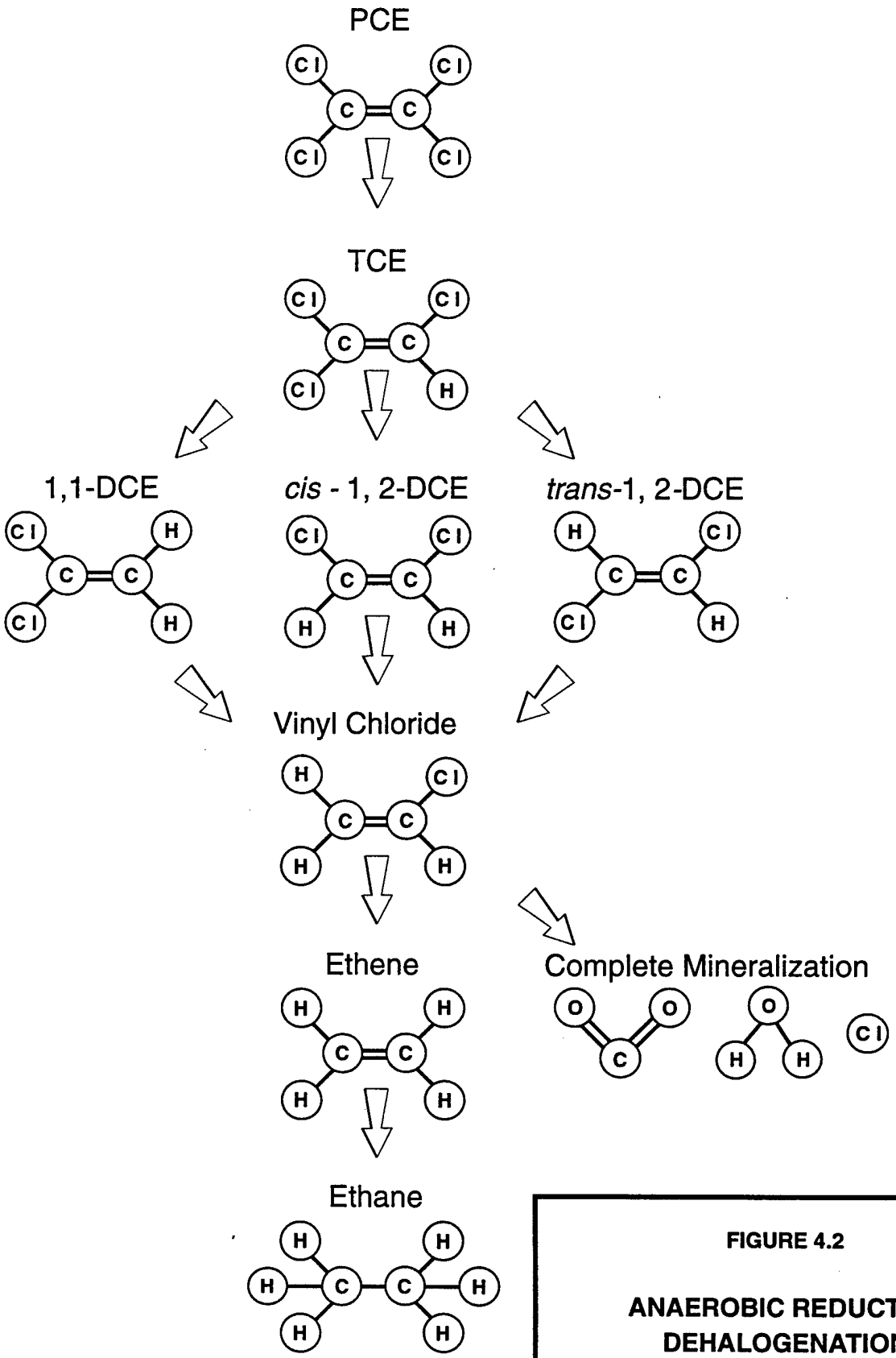


FIGURE 4.2

ANAEROBIC REDUCTIVE DEHALOGENATION

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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the transformation of DCE to VC, or the transformation from VC to ethene requires more strongly reducing conditions (Freedman and Gossett, 1989; DeStefano *et al.*, 1991; De Bruin *et al.*, 1992).

Because CAH compounds are used as electron acceptors, there must be an appropriate source of carbon for microbial growth in order for reductive dehalogenation to occur (Bouwer, 1994). Potential carbon sources can include low-molecular-weight compounds (e.g., lactate, acetate, methanol, or glucose) present in natural organic matter, fuel hydrocarbons, or less-chlorinated solvents (as discussed below).

4.2.3.2 Electron Donor Reactions

Under aerobic conditions some CAH compounds can be utilized as the primary substrate (i.e., electron donor) in biologically mediated redox reactions (McCarty and Semprini, 1994). In this type of reaction, the facilitating microorganism obtains energy and organic carbon from the degraded CAH. In contrast to reactions in which the CAH is used as an electron acceptor, only the least oxidized CAHs (e.g., VC, DCE, or chlorobenzene) may be utilized as electron donors in biologically mediated redox reactions.

For example, while Murray and Richardson (1993) write that microorganisms are generally believed to be incapable of growth using TCE and PCE, other less chlorinated CAHs have been shown to be used as substrates. Davis and Carpenter (1990) describe the aerobic oxidation of VC in groundwater. McCarty and Semprini (1994) describe investigations in which VC and 1,2-DCA were shown to serve as primary substrates. These authors also document that dichloromethane has the potential to function as a primary substrate under either aerobic or anaerobic environments. Klier *et al.* (1996) describe aerobic mineralization of all three isomers of DCE. In addition, Bradley and Chapelle (1996) show evidence of oxidation of VC

under iron-reducing conditions so long as there is sufficient bioavailable iron (III). Aerobic metabolism of VC may be characterized by a loss of VC mass, a decreasing molar ratio of VC to other CAH compounds, and rarely, the presence of chloromethane.

4.2.3.3 Cometabolism

When a CAH is biodegraded through cometabolism, it serves as neither an electron acceptor nor a primary substrate in a biologically mediated redox reaction. Instead, the degradation of the CAH is catalyzed by an enzyme or cofactor that is fortuitously produced by organisms for other purposes. The organism receives no known benefit from the degradation of the CAH; rather the cometabolic degradation of the CAH may in fact be harmful to the microorganism responsible for the production of the enzyme or cofactor (McCarty and Semprini, 1994).

Cometabolism is best documented in aerobic environments, although it potentially could occur under anaerobic conditions. Aerobic degradation pathways for chlorinated ethenes are illustrated in Figure 4.3. It has been reported that under aerobic conditions chlorinated ethenes, with the exception of PCE, are susceptible to cometabolic degradation (Murray and Richardson, 1993; Vogel, 1994; McCarty and Semprini, 1994). Vogel (1994) further elaborates that the cometabolism rate increases as the degree of dehalogenation decreases.

In the cometabolic process, TCE is indirectly transformed by bacteria as they use BTEX or another substrate to meet their energy requirements. Therefore, TCE does not enhance the degradation of BTEX or other carbon sources, nor will its cometabolism interfere with the use of electron acceptors involved in the oxidation of those carbon sources. Given this relationship, it would follow that depletion of suitable substrates (BTEX or other organic carbon sources) likely limits cometabolism of CAHs.

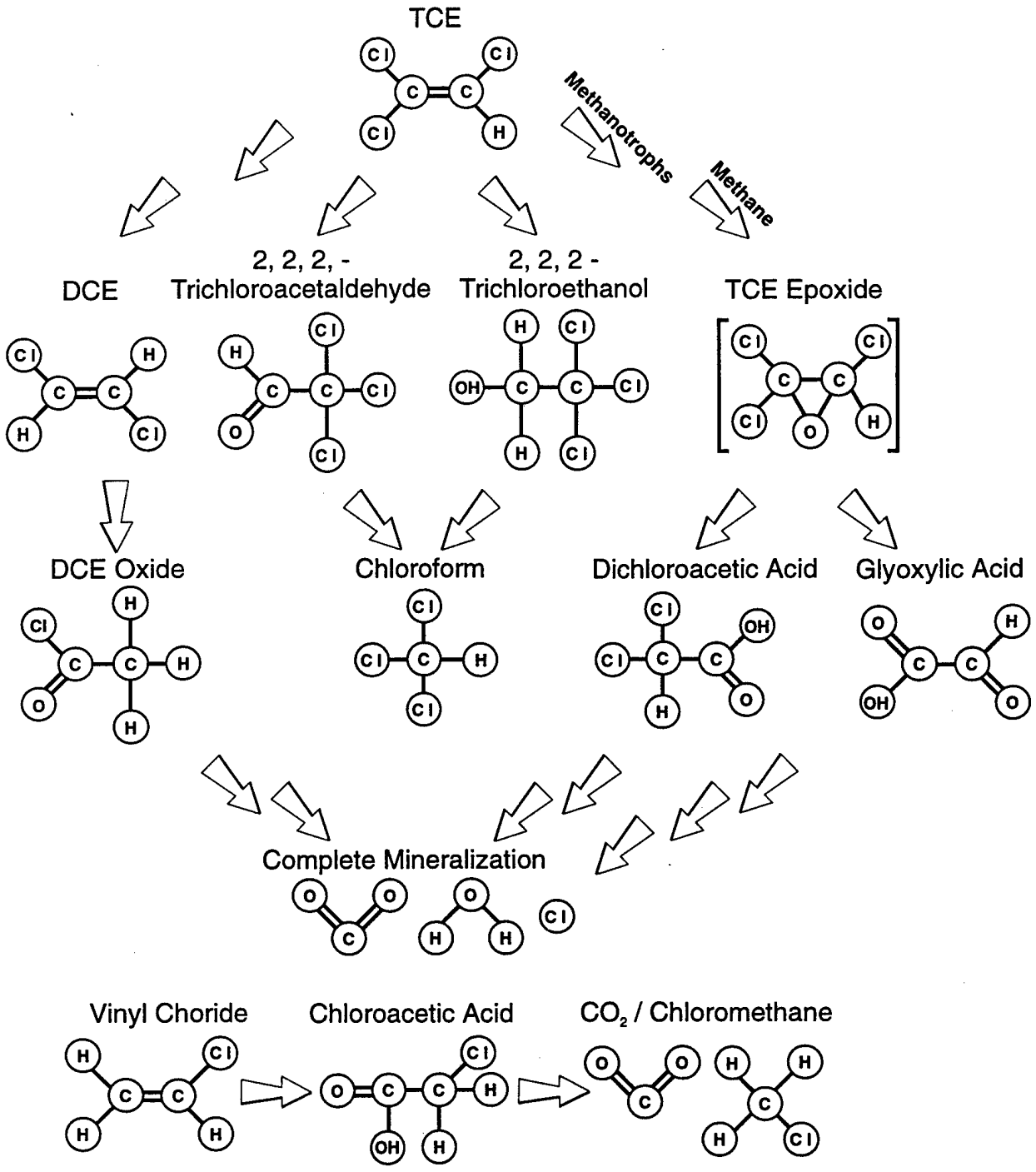

FIGURE 4.3

AEROBIC DEGRADATION

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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4.2.3.4 Behavior of Chlorinated Solvent Plumes

Chlorinated solvent plumes can exhibit three types of behavior depending on the amount of solvent, the amount of organic (native and/or anthropogenic) carbon in the aquifer, the distribution and concentration of natural electron acceptors, and the types of electron acceptors being utilized. Individual plumes may exhibit all three types of behavior in different portions of the plume. The different types of plume behavior are summarized below.

4.2.3.4.1 Type 1 Behavior

Type 1 behavior occurs where the primary substrate is anthropogenic carbon (e.g., BTEX or landfill leachate), and this anthropogenic carbon drives reductive dechlorination. When evaluating natural attenuation of a plume exhibiting type 1 behavior the following questions must be answered:

1. Is the electron donor supply adequate to allow microbial reduction of the chlorinated organic compounds? In other words, will the microorganisms "strangle" before they "starve" [i.e., will they run out of chlorinated aliphatic hydrocarbons (electron acceptors) before they run out of primary substrate (anthropogenic carbon)]?

2. What is the role of competing electron acceptors (e.g., dissolved oxygen, nitrate, iron (III) and sulfate)?

3. Is vinyl chloride being oxidized, or is it being reduced?

4. Type 1 behavior results in the rapid and extensive degradation of the highly chlorinated solvents such as PCE, TCE, or DCE.

4.2.3.4.2 Type 2 Behavior

Type 2 behavior dominates in areas that are characterized by relatively high concentrations of biologically available native organic carbon. This natural carbon source drives reductive dehalogenation (i.e., the primary substrate for microorganism growth is native organic carbon). When evaluating natural attenuation of a type 2 chlorinated solvent plume, the same questions as those posed in the description of type 1 behavior must be answered. Type 2 behavior generally results in slower biodegradation of the highly chlorinated solvents than Type 1 behavior, but under the right conditions (e.g., areas with high natural organic carbon contents), this type of behavior also can result in rapid degradation of these compounds.

4.2.3.4.3 Type 3 Behavior

Type 3 behavior dominates in areas that are characterized by low concentrations of native and/or anthropogenic carbon, and concentrations of DO that are greater than 1.0 mg/L. Under these aerobic conditions reductive dehalogenation will not occur. Thus there is little or no removal of PCE, TCE, and DCE. Biodegradation may proceed via the much slower process of cometabolism, but will be limited by the low concentrations of native or anthropogenic carbon. The most significant natural attenuation mechanisms for CAHs will be advection, dispersion, and sorption. However, VC can be rapidly oxidized under these conditions, DCE may be oxidized, and cometabolism may also occur.

4.2.3.4.4 Mixed Behavior

As mentioned above, a single chlorinated solvent plume can exhibit all three types of behavior in different portions of the plume. This can be beneficial for natural biodegradation of CAH plumes. For example, Wiedemeier *et al.* (1996a) describe a plume at Plattsburgh AFB, New York that exhibits Type 1 behavior in the source area and Type 3 behavior downgradient from the source. The best scenario involves a

plume in which PCE, TCE, and DCE are reductively dehalogenated (Type 1 or Type 2 behavior), then VC is oxidized (Type 3 behavior), either aerobically or via iron reduction. VC is oxidized to carbon dioxide in this type of plume and does not accumulate. The following sequence of reactions occurs in a plume that exhibits this type of mixed behavior:

$$PCE \rightarrow TCE \rightarrow DCE \rightarrow VC \rightarrow \text{Carbon Dioxide}$$

In general, the TCE, DCE, and VC may attenuate at approximately the same rate, and thus these reactions may be confused with simple dilution. Note that no ethene is produced during this reaction. VC is removed from the system much faster under these conditions than it is under VC-reducing conditions.

A less desirable scenario, but one in which all contaminants may be entirely biodegraded, involves a plume in which all CAHs are reductively dehalogenated via Type 1 or Type 2 behavior. VC is reduced to ethene, which may be further reduced to ethane or methane. The following sequence of reactions occur in this type of plume:

$$PCE \rightarrow TCE \rightarrow DCE \rightarrow VC \rightarrow \text{Ethene or Ethane}$$

This sequence has been investigated by Freedman and Gossett (1989). In this type of plume, VC degrades more slowly than TCE, and thus tends to accumulate.

4.3 DISTRIBUTION OF CAHS AND DAUGHTER PRODUCTS

One of the most straightforward methods for evaluating the occurrence and method of biodegradation of CAHs is to look at the distribution of target CAHs and the products of biodegradation of those compounds. At the same time, it is also useful to look at the distribution of other contaminants that may be acting as sources of electron donors (e.g., BTEX).

Because reductive dehalogenation is the most common biodegradation reaction, a typical pattern (e.g., as presented by Vogel, 1994) would have TCE (and/or PCE) concentrations highest in the source area, with elevated DCE concentrations (consisting mostly of *cis*-1,2-DCE) in and just downgradient from the source area. Vinyl chloride concentrations could be present along the entire plume length, with the highest VC concentrations likely to be found near the downgradient end of the CAH plume. If VC is also being reductively dehalogenated, dissolved ethene will also be present downgradient of the source area, in the vicinity of the highest concentrations of VC. A similar pattern is observed at CCFTA-2 (FT-17). The specific site data are discussed in the following subsections.

4.3.1 Trichloroethene and Tetrachloroethene

As measured in January 1996, TCE concentrations detected in groundwater at CCFTA-2 (FT-17) ranged from 15,800 micrograms per liter (µg/L) at CCFTA2-9S to less than 1 µg/L at several locations. Table 4.4 presents the results of CAH analyses for groundwater and surface water samples collected in 1994 and 1996. Figure 4.4 shows the configuration of the TCE plume as determined from January 1996 data (supplemented with March 1994 data) from shallow wells (wells screened across or just below the water table). As discussed in Section 4.1, the main source of TCE is the mobile LNAPL body in the vicinity of CCFTA2-9. From there, the plume extends to the west, then curves southwest toward the canal. This is consistent with the groundwater flow patterns shown on Figure 3.5.

PCE was detected in only nine shallow wells at the site, and in seven of those wells the concentration was less than 1 µg/L. At MP2, the PCE concentration was 2.3 µg/L, and at CCFTA2-9S, the concentration was 56 µg/L (Table 4.4).

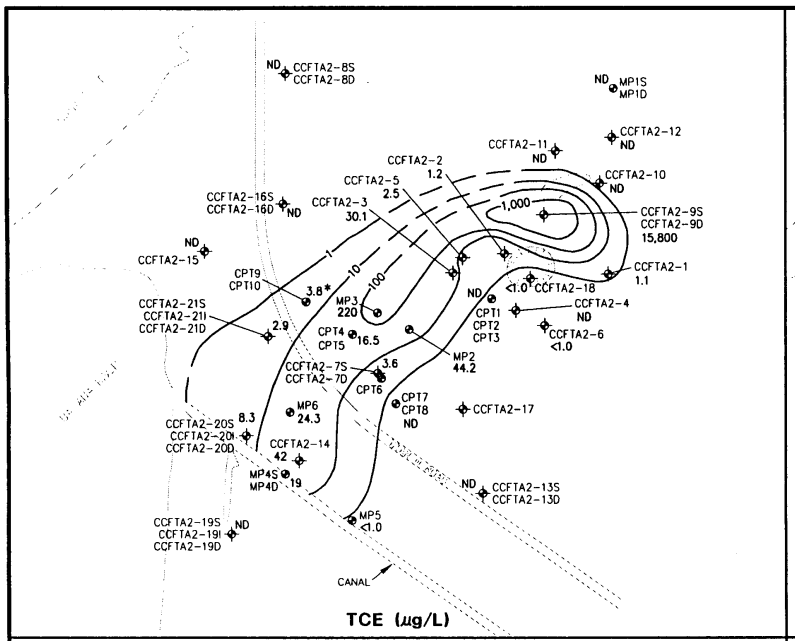
TABLE 4.4
ALIPHATIC HYDROCARBONS IN GROUNDWATER
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

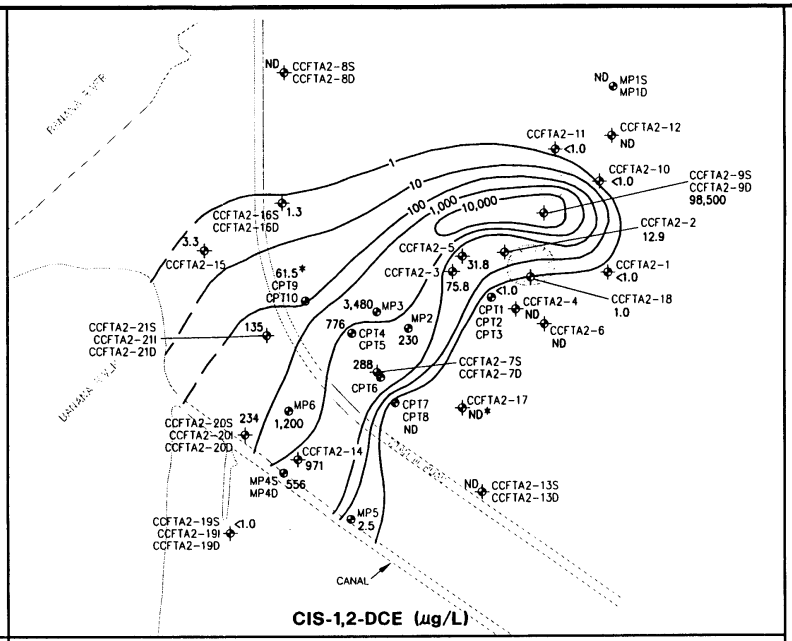
Sampling Location	Sampling Date	PCE (µg/L)	TCE (µg/L)	cis-1,2-DCE (µg/L)	trans-1,2-DCE (µg/L)	1,1-DCE (µg/L)	1,1-DCA (µg/L)	1,1,1-TCA (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)
MP-1S	1/25/96	ND[a]	ND	ND	ND	ND	ND	ND	ND	ND	ND
MP-1D	1/25/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.002
MP-2	1/26/96	2.3	44.2	230	11.2	2	14.2	ND	1080	57	9
MP-3	1/26/96	<1.0	220	3480	21.6	39	62.8	ND	3080	188	55
MP-4S	1/25/96	<1.0	19	556	18.5	11.2	55	ND	5024	150	3
MP-4D	1/25/96	ND	ND	16.3	ND	ND	ND	ND	10	<0.003	<0.002
MP-5	1/25/96	ND	<1.0	2.5	<1.0	ND	<1.0	ND	10.5	ND	ND
MP-6	1/25/96	<1.0	24.3	1200	15.7	16.6	46.7	ND	2520	107	13
CPT-1	1/24/96	ND	ND	<1.0	ND	ND	<1.0	ND	ND	ND	<0.002
CPT-1	3/29/94	<1.0	<1.0	<1.0	<1.0	<1.0	NA[a]	NA	<2.0	NA	NA
CPT-2	1/24/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CPT-2	3/29/94	<1.0	29.4	7.8	<1.0	<1.0	NA	NA	<2.0	NA	NA
CPT-3	1/24/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CPT-3	3/29/94	<1.0	10	2.5	<1.0	<1.0	NA	NA	<2.0	NA	NA
CPT-4	1/25/96	ND	16.5	776	5.9	8.5	23	ND	797	ND	ND
CPT-4	3/30/94	<1.0	11.7	490	5.2	5.4	NA	NA	742	NA	NA
CPT-5	1/25/96	ND	1.7	33.4	<1.0	ND	ND	ND	1.4	48	<2
CPT-5	3/30/94	<1.0	4	53.4	1.4	<1.0	NA	NA	2	NA	NA
CPT-6	1/25/96	ND	ND	ND	ND	ND	ND	ND	<1.0	44	<2
CPT-6	3/30/94	<1.0	<1.0	<1.0	<1.0	<1.0	NA	NA	<2.0	NA	NA
CPT-7	1/25/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CPT-7	3/30/94	<1.0	<1.0	<1.0	<1.0	<1.0	NA	NA	7.7	NA	NA
CPT-8	1/25/96	ND	ND	2.4	ND	ND	ND	ND	ND	ND	ND
CPT-8	3/30/94	<1.0	<1.0	6.3	<1.0	<1.0	NA	NA	3.2	NA	NA
CPT-9	3/30/94	<1.0	3.8	61.5	<1.0	<1.0	NA	NA	84.9	NA	NA
CPT-10	3/30/94	<1.0	3.6	448	8.1	<1.0	NA	NA	6.4	NA	NA
CCFTA2-1	1/26/96	ND	1.1	<1.0	ND	ND	ND	ND	ND	ND	ND
CCFTA2-1	3/28/94	<1.0	<1.0	<1.0	<1.0	<1.0	NA	NA	<2.0	NA	NA
CCFTA2-2	1/26/96	<1.0	1.2	12.9	2.8	ND	6.3	ND	7.2	<3	ND
CCFTA2-2	3/28/94	1.2	5.9	150	5.7	<1.0	NA	NA	122	NA	NA
CCFTA2-3	1/26/96	ND	30.1	75.8	1	<1.0	ND	<1.0	10	<3	ND
CCFTA2-3	3/28/94	<1.0	<1.0	13.6	<1.0	<1.0	NA	NA	3.4	NA	NA
CCFTA2-4	1/25/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CCFTA2-4	3/28/94	<1.0	<1.0	<1.0	<1.0	<1.0	NA	NA	<2.0	NA	NA
CCFTA2-5	1/26/96	<1.0	2.5	31.8	2	ND	2.3	ND	33.2	10	<2
CCFTA2-5	3/28/94	<1.0	1.7	50.4	1.5	<1.0	NA	NA	16.4	NA	NA
CCFTA2-6	1/25/96	ND	<1.0	ND	ND	ND	ND	ND	ND	ND	ND
CCFTA2-6	3/28/94	<1.0	<1.0	<1.0	<1.0	<1.0	NA	NA	<2.0	NA	NA
CCFTA2-7S	1/25/96	ND	3.6	288	4.3	1.9	6.5	ND	419	16	<2
CCFTA2-7S	3/27/94	1	35.5	209	14.3	13.8	NA	NA	1180	NA	NA
CCFTA2-7D	1/25/96	ND	ND	1.2	ND	ND	ND	ND	1.8	ND	ND
CCFTA2-7D	3/28/94	<1.0	<1.0	<1.0	<1.0	<1.0	NA	NA	<2.0	NA	NA

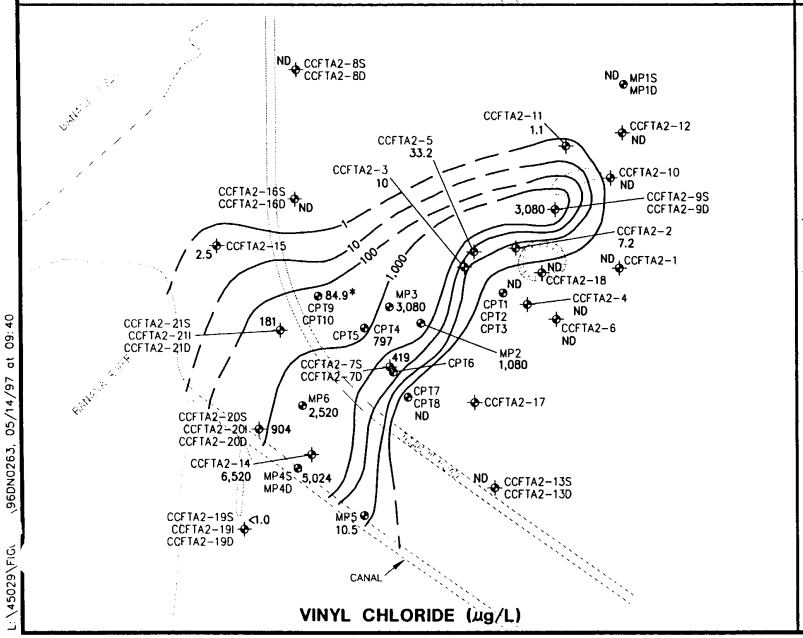
TABLE 4.4 (concluded)
ALIPHATIC HYDROCARBONS IN GROUNDWATER
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

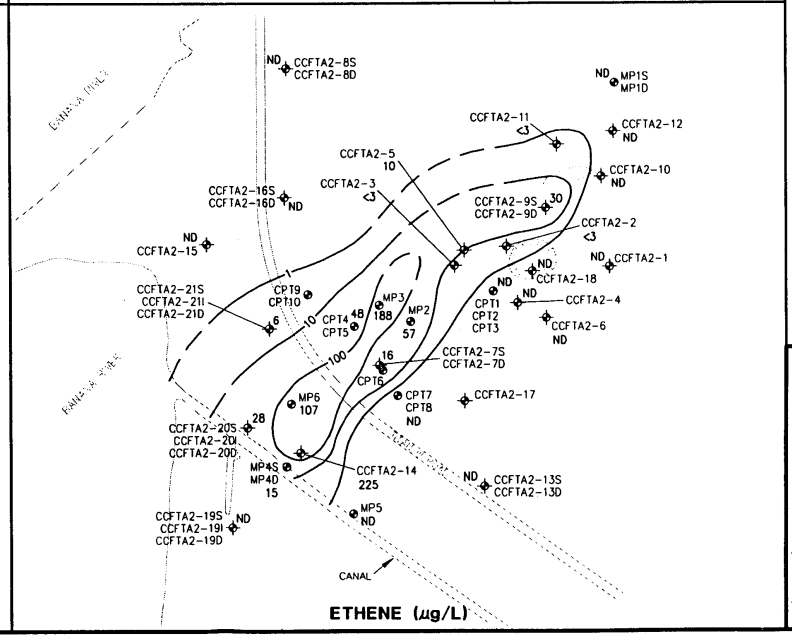
Sampling Location	Sampling Date	PCE (µg/L)	TCE (µg/L)	cis-1,2-DCE (µg/L)	trans-1,2-DCE (µg/L)	1,1-DCE (µg/L)	1,1-DCA (µg/L)	1,1,1-TCA (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)
CCFTA2-8S	1/25/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CCFTA2-8D	1/25/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CCFTA2-9S	1/25/96	56	15800	98500	389	200	443	258	3080	30	ND
CCFTA2-9S	3/28/94	46.1	5720	47000	140	112	NA	NA	1380	NA	NA
CCFTA2-9D	1/25/96	ND	6.7	37	ND	ND	ND	ND	ND	ND	ND
CCFTA2-9D	3/28/94	<1.0	<1.0	1	<1.0	<1.0	NA	NA	<2.0	NA	NA
CCFTA2-10	1/25/96	ND	ND	<1.0	ND	ND	ND	ND	ND	ND	ND
CCFTA2-11	1/25/96	ND	ND	<1.0	<1.0	ND	1.4	ND	1.1	<3	ND
CCFTA2-12	1/26/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CCFTA2-13S	1/24/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CCFTA2-13S	3/27/94	<1.0	<1.0	<1.0	<1.0	<1.0	NA	NA	2	NA	NA
CCFTA2-13D	1/24/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	<2
CCFTA2-13D	3/28/94	<1.0	<1.0	<1.0	<1.0	<1.0	NA	NA	<2.0	NA	NA
CCFTA2-14	1/25/96	<1.0	42	971	25	21	69.6	ND	6520	225	3
CCFTA2-14	3/27/94	<1.0	4.8	168	14.5	2.3	NA	NA	1660	NA	NA
CCFTA2-15	1/24/96	ND	ND	3.3	ND	ND	<1.0	ND	2.5	ND	ND
CCFTA2-15	3/28/94	<1.0	1.4	22.9	<1.0	<1.0	NA	NA	6.3	NA	NA
CCFTA2-16S	1/25/96	ND	ND	1.3	ND	ND	ND	ND	ND	ND	ND
CCFTA2-16S	3/28/94	<1.0	1.4	<1.0	<1.0	<1.0	NA	NA	<2.0	NA	NA
CCFTA2-16D	1/25/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	<2
CCFTA2-16D	3/28/94	<1.0	<1.0	<1.0	<1.0	<1.0	NA	NA	<2.0	NA	NA
CCFTA2-17	3/27/94	<1.0	<1.0	<1.0	<1.0	<1.0	NA	NA	<2.0	NA	NA
CCFTA2-18	1/26/96	<1.0	<1.0	1	ND	ND	1	ND	ND	ND	<2
CCFTA2-19S	1/26/96	ND	ND	<1.0	ND	ND	ND	ND	<1.0	ND	ND
CCFTA2-19I	1/26/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CCFTA2-19D	1/26/96	ND	ND	ND	ND	ND	ND	ND	ND	<3	<2
CCFTA2-20S	1/25/96	ND	8.3	234	5.8	2.7	12.4	ND	904	28	ND
CCFTA2-20I	1/25/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	<2
CCFTA2-20D	1/25/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	<2
CCFTA2-21S	1/24/96	ND	2.9	135	1.3	1.1	2.9	ND	181	6	ND
CCFTA2-21I	1/24/96	ND	ND	4.7	ND	ND	ND	ND	ND	ND	ND
CCFTA2-21D	1/24/96	ND	ND	ND	ND	ND	ND	ND	ND	<3	ND
SW-1	3/28/94	<1.0	<1.0	15.8	<1.0	<1.0	NA	NA	4.3	NA	NA
SW-2	3/28/94	<1.0	<1.0	16.7	1	<1.0	NA	NA	24.4	NA	NA
SW-3	3/28/94	<1.0	<1.0	14.8	<1.0	<1.0	NA	NA	125	NA	NA
SW-4	1/26/96	ND	<1.0	9.5	<1.0	ND	ND	ND	20.1	NA	NA

[a] ND = Compound not detected.
[b] NA = Compound not analyzed.









LEGEND

- FORMER BURN PIT
- BURIAL TRENCH
- CCFTA2-17 ⊕ MONITORING WELL
- CPT6 ⊕ MONITORING POINT
- 10 LINE OF EQUAL ANALYTE CONCENTRATION (µg/L) (DASHED WHERE INFERRED)
- * CONCENTRATION FROM 1994 DATA, USED TO AID IN PLUME DEFINITION
- ND NOT DETECTED

N

0 175 350 700
FEET

FIGURE 4.4

CAHs AND PRODUCTS OF REDUCTIVE DEHALOGENATION

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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4.3.2 Dichloroethene

As measured in January 1996, the *cis*-1,2-DCE concentrations detected in site groundwater ranged from 1.0 to 98,500 µg/L (Table 4.4). The *cis*-1,2-DCE plume shown on Figure 4.4 is similar in shape and distribution to that of the TCE plume, with the areas of highest *cis*-1,2-DCE concentrations roughly coinciding with the area of the highest TCE concentrations. This trend is what would be expected if TCE is being degraded to DCE via reductive dehalogenation. As noted before, under the influence of biodegradation, *cis*-1,2-DCE is a more common daughter product than the other DCE isomers. In general, *cis*-1,2-DCE concentrations at the site are about 5 to 400 times greater than the concentrations of *trans*-1,2-DCE and 1,1-DCE, and at only three locations are these ratios less than 20:1. Therefore, the distribution of *cis*-1,2-DCE at the site is a good indicator that the inital step of reductive dehalogenation of TCE is taking place in groundwater at CCFTA-2 (FT-17).

Some *cis*-1,2-DCE was detected in the mobile LNAPL sample collected from CCFTA2-9S in March 1994 (Table 4.2) and may be entering groundwater from the LNAPL body. However, comparison of the ratios of TCE to *cis*-1,2-DCE in the LNAPL to those observed in the groundwater is another means of assessing if the observed *cis*-1,2-DCE concentrations are largely a result of biodegradation. As observed in the LNAPL sample collected from CCFTA2-9S in March 1994, the ratio if TCE to *cis*-1,2-DCE was about 4.8:1. In nearly all of the groundwater samples, this ratio was below 0.4:1, with an average of 0.35:1. Thus, although *cis*-1,2-DCE is about three times more soluble than TCE and could be expected to produce a dissolved ratio of about 1.6:1 were it partitioning from the LNAPL, the lower observed ratio in groundwater is another indication that additional *cis*-1,2-DCE is being produced through reductive dehalogenation of TCE.

4.3.3 Vinyl Chloride

The distribution of VC in site groundwater is shown on Figure 4.4. VC concentrations detected at the site range from 1.1 to 6,520 µg/L (Table 4.4). The VC plume approximates the shape of the TCE and DCE plumes. However, the zone of the highest VC concentrations extends further downgradient than the zones of the highest TCE and DCE concentrations. In fact, the highest VC concentration detected in January 1996 was detected at well CCFTA2-14, near the canal into which shallow groundwater is discharging. This is consistent with the reductive dehalogenation of DCE. The highest VC concentrations are found downgradient from the source area because the transformation of DCE to VC occurs more slowly than the transformation of TCE to DCE, and because VC is less likely to sorb than DCE. As noted previously, the rate of reductive dechlorination decreases as the number of chlorine atoms in the molecules decreases.

4.3.4 Ethene

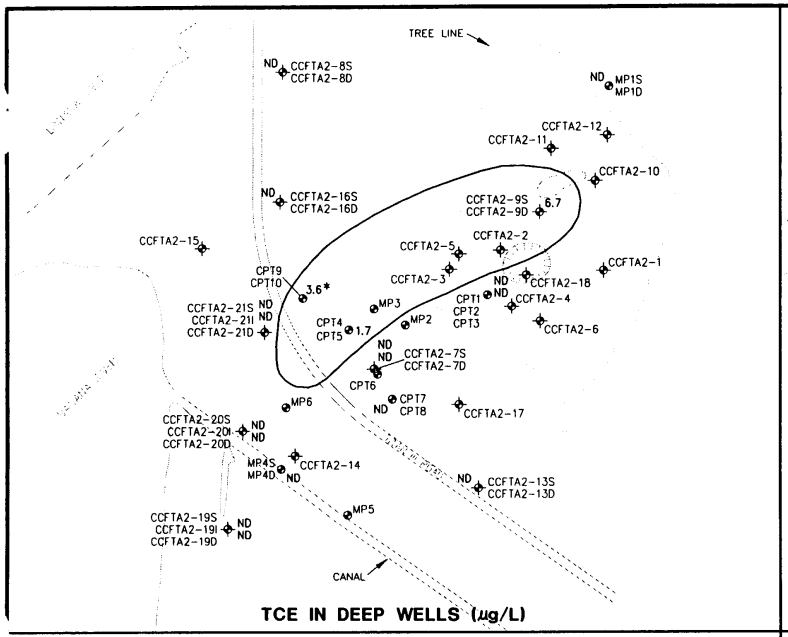
Ethene is the final product in the series of reductive dehalogenation reactions involving chlorinated ethenes. Ethene was detected in site groundwater at concentrations ranging from <3 µg/L to 225 µg/L (Table 4.4). Ethene was detected in a slightly smaller area than the CAHs (Figure 4.4), and like VC, the highest observed concentrations were present downgradient from the source area, at monitoring point MP2 and well CCFTA2-14. This implies that some of the VC dissolved in groundwater is undergoing reductive dehalogenation. The reaction that produces ethene from VC is the slowest of the series of reductive dehalogenation reactions involving chlorinated ethenes, accounting for the low concentrations of ethene relative to VC and the other CAHs.

4.3.5 Other CAHs

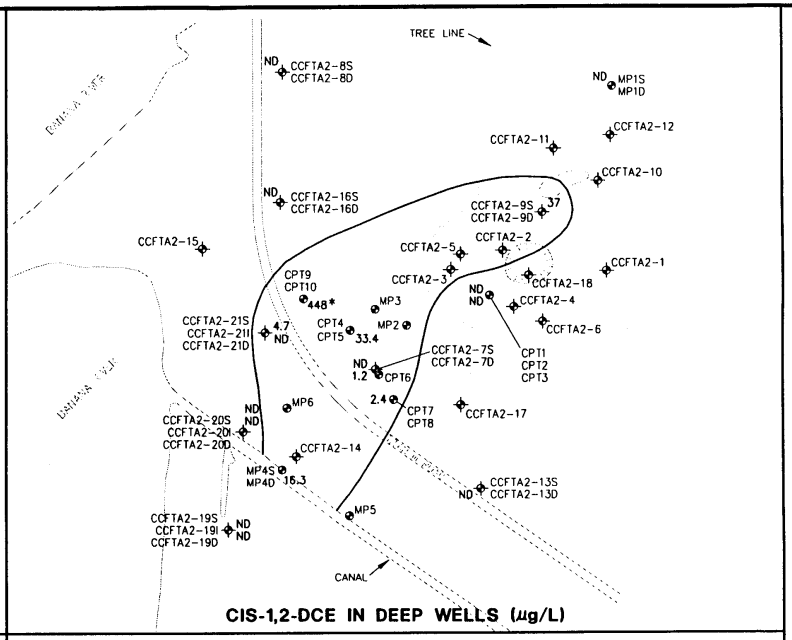
Other CAHs detected in the January 1996 shallow groundwater samples include 1,1-DCA and 1,1,1-TCA. TCA was detected in only two shallow wells (CCFTA2-9S and CCFTA2-3), while DCA was detected in 14 shallow wells. Concentrations of these compounds ranged from <1 µg/L to 443 µg/L (Table 4.4), with the highest concentrations observed in the source area at CCFTA2-9S, generally within the center of the area of the other CAH plumes. At this well, the DCA concentration was higher than the TCA concentration. These patterns suggest that TCA (which may have been an impurity in the source TCE) has undergone reductive dechlorination to DCA. DCA is an intermediate product of the reductive dehalogenation of TCA, with chloroethane and/or ethane the ultimate end products of this series of reactions (Bouwer, 1994).

4.3.6 CAHs in Deep Wells

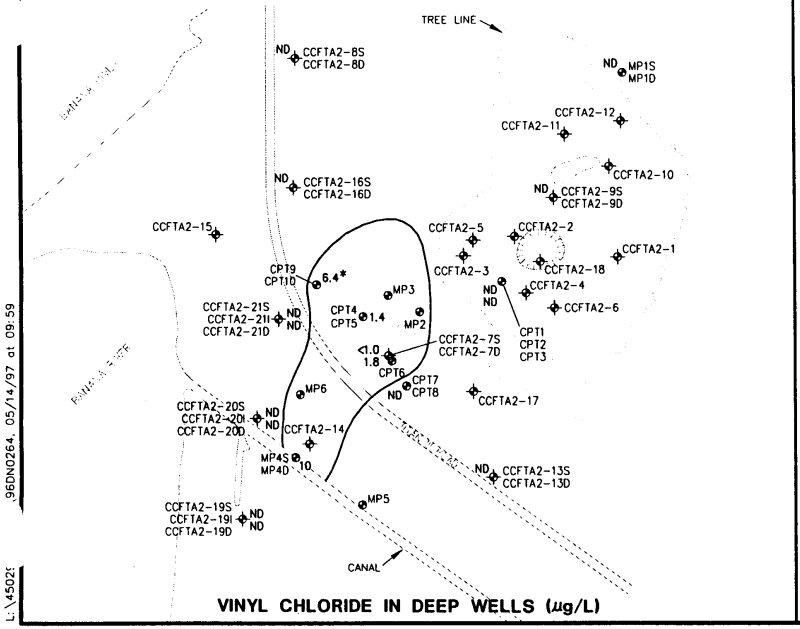
CAHs were also detected in deep wells at the site. For this discussion, the term "deep wells" refers to those wells where the top of the well screen is at least 20 feet below the water table. The distribution of TCE, *cis*-1,2-DCE, and VC in deep wells is shown on Figure 4.5. Consistent with the observed vertical flow patterns (i.e., upward gradients), CAH concentrations detected in deep wells were much lower than those detected in shallow wells at the same locations (Table 4.4). TCE was detected in two deep samples collected in 1996, and in one deep sample collected in 1994, with these sample locations roughly along the centerline of the shallow plume. Concentrations in these samples ranged from 1.7 µg/L to 6.7 µg/L. *cis*-1,2-DCE was detected in five samples collected in 1996 and in one sample collected in 1994, with concentrations ranging from 1.2 µg/L to 37 µg/L in the 1996 samples, and at a concentration of 448 µg/L in the 1994 sample. DCE was detected across a greater area of the site than the other compounds, including as far downgradient as MP-4D (adjacent to the canal). VC concentrations ranging from <1 µg/L to 10 µg/L were detected in four samples collected in 1996 and one sample collected in 1994. As in the shallow portion of the



TCE IN DEEP WELLS (µg/L)



CIS-1,2-DCE IN DEEP WELLS (µg/L)



VINYL CHLORIDE IN DEEP WELLS (µg/L)

LEGEND

- FORMER BURN PIT
- BURIAL TRENCH
- CCFTA2-17 — MONITORING WELL
- CPT6 — MONITORING POINT
- ESTIMATED EXTENT OF CONTAMINATION
- * — DATA FROM 1994
- ND — NOT DETECTED

NOTE:
WHERE TWO VALUES ARE LISTED, THE TOP VALUE REPRESENTS THE INTERMEDIATE-DEPTH WELL, AND THE BOTTOM VALUE REPRESENTS THE DEEPEST WELL.

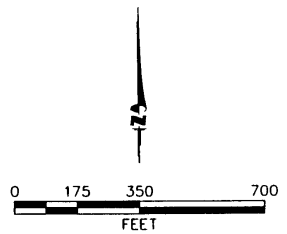


FIGURE 4.5

CAHs IN DEEP GROUNDWATER

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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aquifer, VC is present in the area downgradient from the site, with the highest concentration detected near the canal.

4.3.7 CAHs in Surface Water

One surface water sample was collected in January 1996, and three samples were collected in March 1994. Analytical results for these samples are included in Table 4.4. The 1996 sample (SW4) was collected from the canal immediately adjacent to monitoring point MP4, and analyzed for CAH concentrations. VC was detected at a concentration of 20.1 µg/L, and *cis*-DCE was detected at a concentration of 9.5 µg/L. Also detected were *trans*-1,2-DCE and TCE, but the concentrations were below the quantification limit of 1 µg/L. In 1994, three surface water water samples were collected. One (SW1) was slightly upstream from the site, one (SW2) was from the same vicinity as SW4, and one (SW3) was collected downstream from the site. Sample SW1 contained 4.3 µg/L of VC and 15.8 µg/L of *cis*-1,2-DCE. SW2 contained 24.4 µg/L of VC, 1 µg/L of *trans*-1,2-DCE, and 16.7 µg/L of *cis*-1,2-DCE. SW3 contained 12.5 µg/L of VC and 14.8 µg/L of *cis*-1,2-DCE (Table 4.4).

4.4 ADDITIONAL EVIDENCE OF CAH AND BTEX BIODEGRADATION

In addition to the distribution of TCE and its daughter products, other evidence can be used to support the interpretation that biodegradation of CAHs is ongoing at CCFTA-2 (FT-17). As noted in Section 4.2, comparing concentrations and distributions of electron donors, electron acceptors, and byproducts of microbially mediated reactions can help indicate what types of processes are operating at a site. In addition, other geochemical parameters, including ORP, alkalinity, and other changes in groundwater chemistry can also provide supporting evidence. Other data, such as volatile fatty acid concentrations, also can be useful for interpreting and confirming CAH biodegradation mechanisms.

4.4.1 Additional Indicators of Dehalogenation

4.4.1.1 Chloride

Chlorine is removed from CAHs during reductive dehalogenation and enters solution. Therefore, chloride concentrations in groundwater should increase above background levels in areas where reductive dehalogenation is taking place. Chloride concentrations are presented in Table 4.5, and Figure 4.6 shows the distribution of chloride in shallow groundwater at the site (chloride concentrations are naturally higher in deeper groundwater, which is slightly saline). Background chloride concentrations in shallow site groundwater range from about 5 milligrams per liter (mg/L) to about 25 mg/L, while chloride concentrations within the boundaries of the CAH plumes are elevated above background, with a maximum concentration of 373 mg/L.

In the vicinity of the CAH source area, chloride concentrations are 68.8 mg/L at CCFTA2-9S and 87.7 mg/L at CCFTA2-2. At CCFTA2-3 and CCFTA2-5, chloride concentrations are 373 and 213 mg/L, respectively; however, because these wells have 20-foot screens, it is possible some chloride is introduced from the deeper part of the shallow aquifer. Further downgradient, towards the canal, chloride concentrations range from 105 mg/L (at CCFTA2-14) to 185 mg/L (at MP4S). In the area of MP2, MP3, and CPT4, chloride concentrations are lower, but still elevated above background, ranging from 27.6 to 35.5 mg/L.

In conjunction with the distributions of CAHs and ethene shown on Figure 4.4, the elevated chloride concentrations observed at CCFTA-2 (FT-17) are a strong indication that CAHs are undergoing microbially mediated reductive dehalogenation. Additional geochemical data discussed in Sections 4.4.2 and 4.4.3 further support this evidence and more specifically indicate the processes operating at the site.

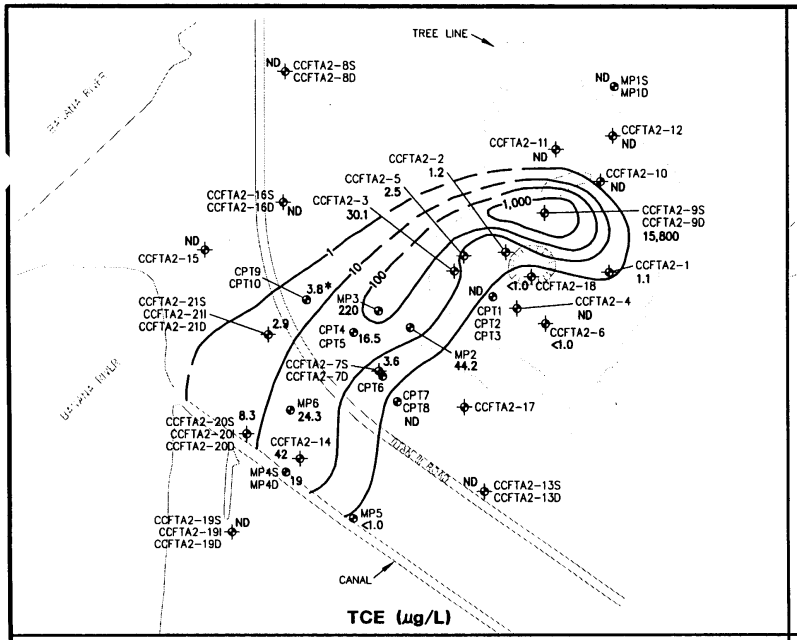
TABLE 4.5
GROUNDWATER GEOCHEMICAL DATA
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

Sampling Location	Sampling Date	Temp. (°C)	Redox (mV)	pH	Dissolved Oxygen (mg/L)	Conductivity (µs/cm)	Hydrogen Sulfide (mg/L)	Total Alkalinity (mg/L $CaCO_3$)	Ferrous Iron (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Nitrate + Nitrite (mg/L N)	Ammonia (mg/L N)	Methane (mg/L)
MP-1S	1/25/96	21.7	-30	7.2	1.16	588	NA[a/]	315	0.7	12	7.85	<0.05	<0.05	0.005
MP-1D	1/25/96	23.4	-140	6.9	0.72	2290	NA	485	0.2	185	514	<0.05	1.69	0.005
MP-2	1/26/96	21.6	-101	7	0.43	907	<0.1	341	1.6	27.6	92.5	<0.05	0.65	0.719
MP-3	1/26/96	21.8	-113	7	0.55	815	NA	328	1.5	35.5	35.2	<0.05	1.12	0.501
MP-4S	1/25/96	23.1	-140	7.3	0.61	1090	<0.1	360	1.2	84.9	65.8	<0.05	0.68	1.20
MP-4D	1/25/96	21.9	-118	7.3	0.5	6030	<0.1	415	3.6	1650	356	<0.05	1.96	0.039
MP-5	1/25/96	22.1	-130	7.2	0.71	890	<0.1	355	1.3	22.4	82.1	<0.05	0.31	0.744
MP-6	1/25/96	23	-190	7	0.3	1286	<0.1	360	3.6	120	96.7	<0.05	0.68	0.427
CPT-1	1/24/96	23	-230	6.9	0.52	1126	0.5	460	0.5	24	114	<0.05	1.78	4.57
CPT-1	3/29/94	22.8	-140	6.9	0.8	1131	0.1	513	0.1	20.3	76.4	0.11	NA	4.75
CPT-2	1/24/96	25.3	-80	7.2	1.66	3820	<0.1	405	1.3	871	180	<0.05	1.88	0.029
CPT-2	3/29/94	23.7	-60	7.3	1.2	4400	ND[b/]	416	1.1	1044	185	0.11	NA	0.017
CPT-3	1/24/96	25.2	-280	7.3	1.17	4010	5	436	<0.05	1110	45.7	<0.05	2.15	0.317
CPT-3	3/29/94	23.7	-280	7.6	4.3	3820	0.7	292	<0.05	1021	31.6	0.1	NA	0.087
CPT-4	1/25/96	22.4	-122	6.9	0.21	740	<0.1	319	3.2	30.1	15.6	<0.05	0.82	0.027
CPT-4	3/30/94	23.9	94	6.5	0.7	1118	ND	405	2.1	68.5	64.7	0.12	NA	0.002
CPT-5	1/25/96	23.8	-78	7.24	1.14	4120	NA	NA	NA	885	268	<0.05	1.7	5.49
CPT-5	3/30/94	24.3	51	7.5	1.1	4040	ND	396	0.2	906	223	0.11	NA	5.056
CPT-6	1/25/96	23.5	-85	7.2	0.7	3340	NA	446	1.1	739	192	<0.05	1.99	0.464
CPT-6	3/30/94	24.7	209	7.5	2.3	3780	ND	405	<0.05	843	185	0.1	NA	0.002
CPT-7	1/25/96	20.8	-60	7.3	2.6	570	NA	273	0.1	18.4	9.82	<0.05	<0.05	0.127
CPT-7	3/30/94	24.3	300	7.3	5.9	444	ND	188	<0.05	16.6	15.3	0.16	NA	0.003
CPT-8	1/25/96	23.2	-130	7.1	0.75	5230	<0.1	455	6.4	1220	533	<0.05	1.69	0.009
CPT-8	3/30/94	25.5	190	7.1	1.2	5260	ND	439	0.3	1130	461	0.13	NA	0.004
CPT-9	3/30/94	22.3	110	7	3.7	1150	ND	309	0.4	NA	NA	NA	NA	0.016
CPT-10	3/30/94	23.6	92	7.4	1.1	3170	ND	299	0.3	NA	NA	0.14	NA	0.039
CCFTA2-1	1/26/96	22.4	-60	7.1	1.06	919	<0.1	313	0.5	25.8	134	0.11	0.23	0.002
CCFTA2-1	3/28/94	24.3	-80	6.9	0.2	1723	ND	510	5.1	36.8	424	<0.05	NA	0.004
CCFTA2-2	1/26/96	23.2	-88	7	0.38	1540	<0.1	395	2.9	87.7	275	<0.05	1.94	0.605
CCFTA2-2	3/28/94	24	-92	6.9	0.1	1997	0.1	489	4.7	176	441	<0.05	NA	0.389
CCFTA2-3	1/26/96	21.6	-135	7	0.52	2690	<0.1	425	3.5	373	348	<0.05	1.26	1.10
CCFTA2-3	3/28/94	24.2	-97	7.1	0.2	2960	ND	368	3.9	559	281	<0.05	NA	0.014
CCFTA2-4	1/25/96	24	-100	7.1	2.37	785	NA	280	0.2	20.9	80.6	<0.05	0.56	1.25
CCFTA2-4	3/28/94	24.5	-52	7	0.2	1227	ND	394	1	59.7	171	<0.05	NA	1.254
CCFTA2-5	1/26/96	21.9	-128	7	0.59	2070	<0.1	452	10.3	213	316	<0.05	1.21	1.01
CCFTA2-5	3/28/94	24.4	-100	7	0.5	3120	ND	443	5.4	497	432	<0.05	NA	0.019
CCFTA2-6	1/25/96	23.1	-170	7	0.48	1090	NA	462	39	9.64	12.8	<0.05	8.31	4.90
CCFTA2-6	3/28/94	24.5	-322	7	0.1	1406	20	548	0.3	58.4	178	<0.05	NA	2.285

TABLE 4.5 (concluded)
GROUNDWATER GEOCHEMICAL DATA
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

Sampling Location	Sampling Date	Temp. (°C)	Redox (mV)	pH	Dissolved Oxygen (mg/L)	Conductivity (µs/cm)	Hydrogen Sulfide (mg/L)	Total Alkalinity (mg/L $CaCO_3$)	Ferrous Iron (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Nitrate + Nitrite (mg/L N)	Ammonia (mg/L N)	Methane (mg/L)
CCFTA2-7S	1/25/96	21.4	-40	7	0.4	503	NA	213	<0.05	16.5	18.9	<0.05	0.06	0.078
CCFTA2-7S	3/27/94	23.6	-94	7.1	0	800	ND	308	0.4	43.7	46.8	0.12	NA	0.29
CCFTA2-7D	1/25/96	23	-250	7.3	0.35	2050	NA	227	<0.05	457	24.3	<0.05	1.31	0.204
CCFTA2-7D	3/28/94	25.7	-338	7.6	0.1	2070	5	298	0.1	450	15.4	<0.05	NA	0.704
CCFTA2-8S	1/25/96	19.9	-174	7.4	0.29	488	<0.1	214	<0.05	20	14.8	0.15	0.58	0.813
CCFTA2-8D	1/25/96	22.3	-196	7.5	0.13	2090	0.1	176	<0.05	508	35.8	<0.05	1.02	0.062
CCFTA2-9S	1/25/96	22.5	-250	6.7	0.2	1100	NA	500	2	68.8	20.3	<0.05	3.62	0.348
CCFTA2-9S	3/28/94	23.3	-226	6.7	0.4	1355	1.2	480	3.5	62.6	127	<0.05	NA	0.761
CCFTA2-9D	1/25/96	23.7	-220	7.6	0.51	2820	NA	225	<0.05	735	42.1	<0.05	1.34	0.207
CCFTA2-9D	3/28/94	24.6	-285	7.4	0.2	2540	2	241	<0.05	640	36.7	<0.05	NA	0.214
CCFTA2-10	1/25/96	22.1	-250	7	0.39	1230	2.5	520	0.7	23.3	189	<0.05	0.28	0.461
CCFTA2-11	1/25/96	22.5	-160	7.4	0.76	438	NA	190	0.1	5.32	13.4	0.05	0.17	0.524
CCFTA2-12	1/26/96	22.5	-121	7.2	0.89	1070	NA	482	0.9	34.3	107	<0.05	0.11	0.002
CCFTA2-13S	1/24/96	21.9	-98	7.4	0.51	585	NA	263	0.1	15.1	25.8	<0.05	<0.05	0.042
CCFTA2-13S	3/27/94	23.9	-58	7.2	0.3	894	ND	302	0.8	24.6	129	0.14	NA	0.089
CCFTA2-13D	1/24/96	24.3	-290	7.3	0.32	2460	NA	289	<0.05	537	13.8	<0.05	2.14	1.24
CCFTA2-13D	3/28/94	26.4	-360	7.3	0.2	2080	3	402	0.1	405	3.79	<0.05	NA	1.719
CCFTA2-14	1/25/96	21.3	-160	7.1	0.69	1230	0.1	382	1.6	105	96	<0.05	1.14	1.66
CCFTA2-14	3/27/94	24	-90	6.9	0	1962	ND	413	1.9	282	165	0.09	NA	1.761
CCFTA2-15	1/24/96	21.1	-68	7	0.18	909	0.1	378	1	49	45.5	<0.05	0.57	0.629
CCFTA2-15	3/28/94	24	34	7.1	0.1	924	ND	308	0.2	54.3	90.6	<0.05	NA	0.178
CCFTA2-16S	1/25/96	20.6	101	7	0.95	1572	NA	379	<0.05	157	199	<0.05	0.27	0.125
CCFTA2-16D	1/25/96	22.4	-270	7.8	0.08	2220	10	257	<0.05	509	34.3	<0.056	1.41	0.121
CCFTA2-17	3/27/94	25.2	-80	7	0.1	1132	0.1	378	1.7	30.5	163	0.1	NA	NA
CCFTA2-18	1/26/96	24.9	-140	7.1	0.26	1160	NA	527	4	15	121	<0.05	4.64	6.97
CCFTA2-19S	1/26/96	21.9	-150	7.1	0.46	29200	NA	350	8.8	6970	842	<0.05	NA	0.036
CCFTA2-19I	1/26/96	23.5	-126	7.5	0.4	3660	NA	369	<0.05	904	9.13	0.72	2.03	0.409
CCFTA2-19D	1/26/96	23.5	-270	7.5	0.35	13800	NA	255	<0.05	9190	1100	<0.05	2.54	0.045
CCFTA2-20S	1/25/96	20.4	-200	7.1	0.32	1470	<0.1	417	1.4	169	89.8	<0.05	0.71	2.54
CCFTA2-20I	1/25/96	22.1	-330	7.5	0.54	7990	10	320	<0.05	2350	136	<0.05	3.25	0.136
CCFTA2-20D	1/25/96	22.3	-320	7.6	0.32	22500	10	285	<0.05	4230	238	<0.05	2.54	0.04
CCFTA2-21S	1/24/96	22.8	93	7	2.47	807	2	330	<0.05	41.1	38.5	0.14	1.86	1.34
CCFTA2-21I	1/24/96	25.1	-270	7.3	0.29	4420	NA	224	<0.05	1380	110	<0.05	1.21	0.038
CCFTA2-21D	1/24/96	25	60	7.6	0.14	4880	2	298	<0.05	1240	64	0.1	1.49	0.04

[a] NA = Compound not analyzed.
[b] ND = Compound not detected.



LEGEND

- FORMER BURN PIT
- BURIAL TRENCH
- CCFTA2-17 — MONITORING WELL
- CPT6 — MONITORING POINT
- 100 — LINE OF EQUAL ANALYTE CONCENTRATION (DASHED WHERE INFERRED)
- * — CONCENTRATION FROM 1994 DATA, USED TO AID IN PLUME DEFINITION
- ND — NOT DETECTED

0 175 350 700
FEET

FIGURE 4.6

INDICATORS OF DEHALOGENATION

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

L:\FIGU\96DN0265, 05/14/97 at 10:17

4.4.1.2 CAH Ratios

Another indicator of ongoing dehalogenation is provided by comparing the concentrations of *cis*-1,2-DCE and *trans*-1,2-DCE. Because *cis*-1,2-DCE is preferentially produced by microbial reductive dehalogenation, the ratio of *cis*-1,2-DCE to *trans*-1,2-DCE should be relatively high, especially in the areas where TCE is being transformed (e.g., near or just downgradient of the TCE source). As shown on Figure 4.6, this ratio is highest (about 250) in the vicinity of the source area at CCFTA-2 (FT-17). This is a strong indication that TCE is being reductively dehalogenated, because much more *cis*-1,2-DCE is present relative to *trans*-1,2-DCE.

When the ratio of *cis*-1,2-DCE to *trans*-1,2-DCE is plotted for all wells where both compounds were detected, the contours mimic those of the other CAHs, with a decrease in the ratio downgradient from the source. Because there already is evidence that VC is being produce by reductive dehalogenation of DCE, this trend suggests that in addition to being preferentially produced through microbially mediated reductive dehalogenation, *cis*-1,2-DCE also may be preferentially utilized as an electron acceptor relative to *trans*-1,2-DCE. This is consistent with evidence that different DCE isomers will biodegrade at different rates depending upon the molecular structure and the types of organisms or substrates that are involved (Janssen *et al.*, 1988; Semprini *et al.*, 1990; Hopkins *et al.*, 1993; Malachowsky *et al.*, 1994).

4.4.2 Electron Donors, Additional Electron Acceptors, and Byproducts

When investigating the biodegradation of CAHs, it is also necessary to look at the distribution of other compounds that are used in the microbially mediated reactions that facilitate CAH degradation. The distribution of potential electron donors, including BTEX compounds and dissolved native organic carbon, is useful for evaluating the feasibility of reductive dehalogenation or cometabolism (i.e., CAH degradation reactions involving another substrate). Moreover, electron acceptor and metabolic

byproduct data will further indicate what processes may be facilitating CAH degradation.

4.4.2.1 BTEX in Groundwater

BTEX compounds are typically considered solely as contaminants. However, for the purposes of this discussion, BTEX are viewed differently because the focus of this work is on natural attenuation of the CAHs. The presence of BTEX in the same area as the CAH plume creates favorable conditions for reductive dehalogenation, because the BTEX provide a source of electron donors and facilitate microbial reactions that drive down the local groundwater ORP. Given these conditions, BTEX in site groundwater is considered as a factor in the biodegradation of CAHs. In addition, BTEX concentrations are much lower than CAH concentrations, and the extent and concentrations of the BTEX plume are such that detectable concentrations of these compounds do not appear to have reached the canal.

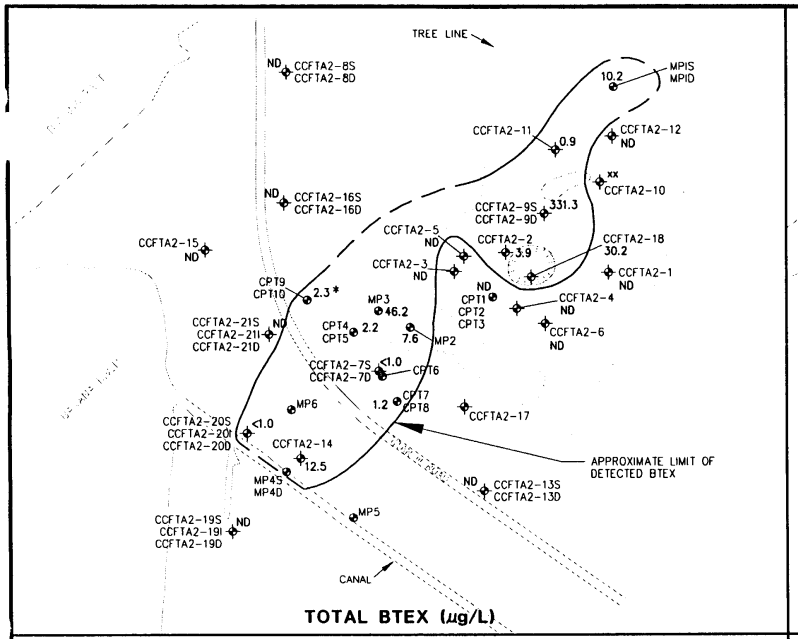
Experience implementing the AFCEE *Technical Protocol for Implementing Intrinsic Remediation with Long-Term Monitoring for Natural Attenuation of Fuel Contamination Dissolved in Groundwater* (Wiedemeier *et al.*, 1995) at nearly 40 locations at Air Force Bases nationwide suggests that biodegradation of fuel hydrocarbons is essentially ubiquitous for a wide range of hydrogeologic settings. Also, data presented by Lawrence Livermore National Laboratories (LLNL) indicates that for over 1,000 sites with fuel hydrocarbon releases, 33 percent of the plumes were shrinking, 59 percent were stable, and 8 percent were expanding, with most plumes less than 250 feet long (Rice *et al.*, 1995). Unpublished data provided by Kuehne and Buscheck (1996) indicate similar trends, with 52 percent of plumes contracting, 35 percent stable, and 92 percent of the plumes being less than 200 feet long. Mace *et al.* (1997) present similar evidence for more than 600 sites in Texas. Therefore, a thorough demonstration of BTEX biodegradation and attenuation is less important

relative to the need to demonstrate the use of RNA to address CAHs dissolved in groundwater at CCFTA-2 (FT-17).

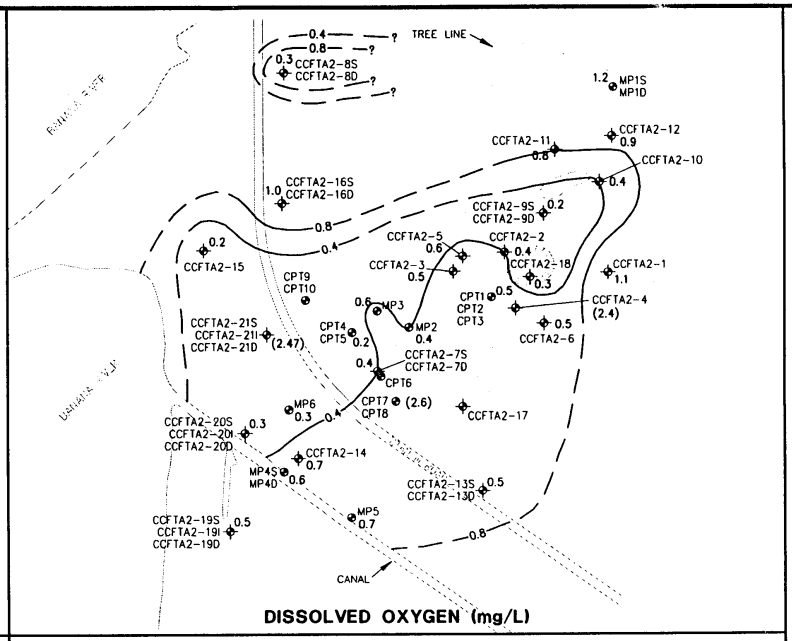
The distribution of BTEX measured in groundwater at CCFTA-2 (FT-17) in January 1996 is shown on Figure 4.7, and Table 4.6 summarizes detected petroleum hydrocarbon data from that sampling event. Where detected, total BTEX concentrations range from <1 µg/L to 331 µg/L. The highest concentration was detected in monitoring well CCFTA2-9S, in the immediate vicinity of the LNAPL body that is the source for the CAH plume. Groundwater beneath the LNAPL body in the vicinity of CCFTA2-6 contains no BTEX, except in the area of the burn pit. Groundwater in contact with fresh JP-4 fuel could contain up to 30 mg/L (30,000 µg/L) of total BTEX (Smith *et al.*, 1981), and groundwater in contact with fresh gasoline could contain up to 132 mg/L of BTEX (American Petroleum Institute, 1985; Cline *et al.*, 1991). These data imply that the mobile LNAPL in the subsurface at CCFTA-2 (FT-17) is severely weathered.

Weathering of the LNAPL includes dissolution into groundwater; however, the low dissolved BTEX concentrations indicate that a significant mass of BTEX (and other petroleum hydrocarbons) has been removed from groundwater. The relatively low BTEX concentrations present at the site, in conjunction with electron acceptor and biodegradation byproduct data (discussed in following subsections), indicate that biodegradation has contributed to removal of petroleum hydrocarbon mass. Although this discussion focuses on BTEX, other petroleum hydrocarbons (e.g., naphthalene) also will dissolve into groundwater and undergo biodegradation.

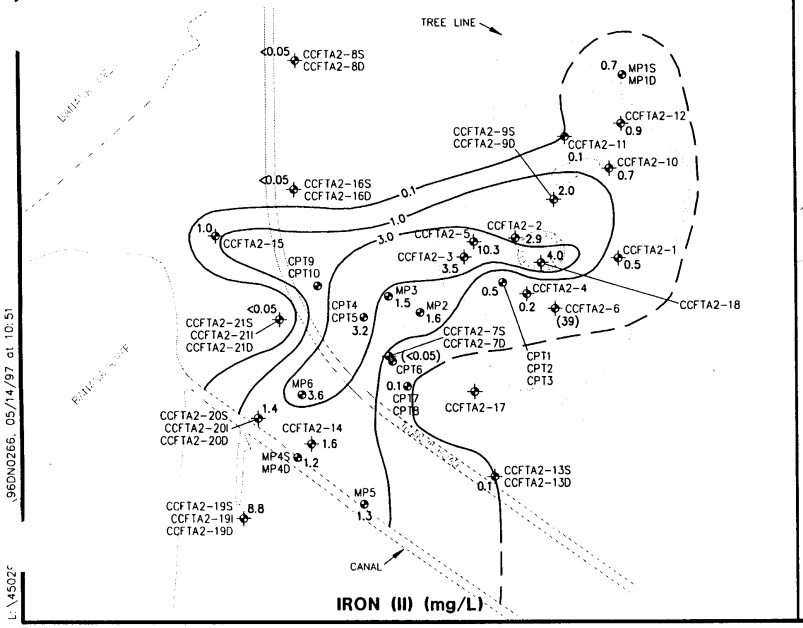
Neither BTEX nor petroleum hydrocarbons were detected in surface water in 1996. Nor did OBG (1995a, 1995b) report detections of these compounds in their 1994 surface water samples. BTEX therefore are attenuating (largely due to biodegradation) fast enough that groundwater concentrations remain low, and surface water is not



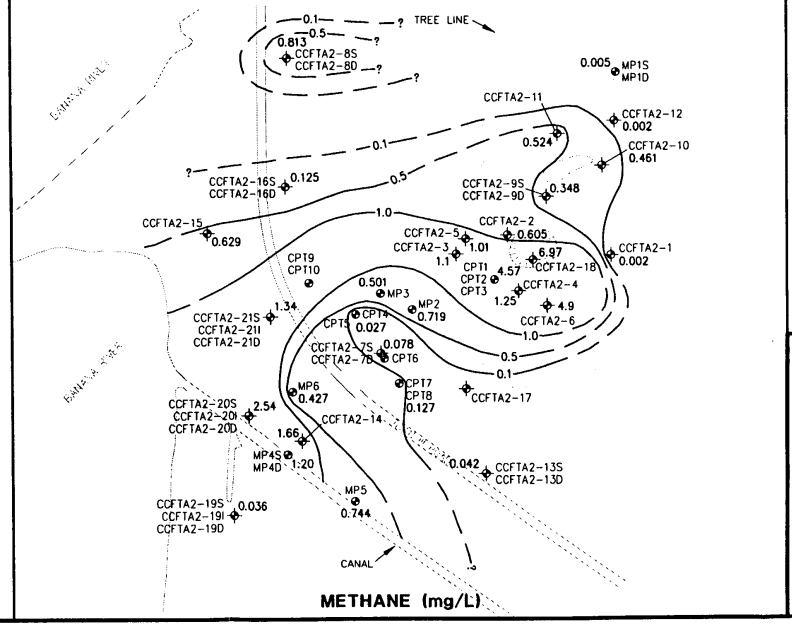
TOTAL BTEX (µg/L)



DISSOLVED OXYGEN (mg/L)



IRON (II) (mg/L)



METHANE (mg/L)

LEGEND

- FORMER BURN PIT
- BURIAL TRENCH
- CCFTA2-17 — MONITORING WELL
- CPT6 — MONITORING POINT
- 0.1 — LINE OF EQUAL ANALYTE CONCENTRATION (DASHED WHERE INFERRED)
- * — CONCENTRATION FROM 1994 DATA, USED TO AID IN PLUME DEFINITION
- ND — NOT DETECTED
- ( ) — DATUM NOT USED TO DRAW ISOPLETHS

0 175 350 700
FEET

FIGURE 4.7

ELECTRON DONORS, ADDITIONAL ELECTRON ACCEPTORS, AND BYPRODUCTS

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

TABLE 4.6
PETROLEUM HYDROCARBONS DETECTED IN GROUNDWATER
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

Sampling Location	Sampling Date	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	p-Xylene (µg/L)	m-Xylene (µg/L)	o-Xylene (µg/L)	Total BTEX (µg/L)	1,3,5-TMB (µg/L)	1,2,4-TMB (µg/L)	1,2,3-TMB (µg/L)	Fuel Carbon (µg/L)
MP-1S	1/25/96	ND[a]	10.2	ND	ND	ND	ND	10.2	ND	ND	ND	8.8
MP-2	1/26/96	0.9	5.6	ND	ND	ND	1.1	7.6	ND	ND	ND	26.9
MP-3	1/26/96	3.4	30.9	3.2	1.6	<1.0	7.1	46.2	1	ND	4.6	130
CPT-1	1/24/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CPT-1	3/29/96	8.3	1	1	ND	ND	ND	10.3	ND	ND	ND	NA[b]
CPT-2	1/24/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CPT-2	3/29/96	ND	6.7	ND	ND	ND	ND	6.7	ND	1.1	ND	NA
CPT-3	1/24/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CPT-3	3/29/96	ND	10.8	ND	ND	ND	ND	10.8	ND	1	ND	NA
CPT-4	3/30/94	1	1.2	ND	ND	ND	ND	2.2	ND	ND	ND	NA
CPT-5	3/30/96	ND	4.71	ND	ND	ND	ND	4.71	ND	ND	ND	NA
CPT-6	1/25/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CPT-6	3/30/94	ND	2.4	ND	ND	ND	ND	2.4	ND	ND	ND	NA
CPT-7	3/30/94	ND	1.2	ND	ND	ND	ND	1.2	ND	ND	ND	NA
CPT-8	3/30/94	ND	2.9	ND	ND	ND	ND	2.9	ND	ND	ND	NA
CPT-9	3/30/94	ND	2.3	ND	ND	ND	ND	2.3	ND	ND	ND	NA
CPT-10	3/30/94	ND	1.1	ND	ND	ND	ND	1.1	ND	ND	ND	NA
CCFTA2-6	1/25/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.7	96.8
CCFTA2-6	3/28/94	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
CCFTA2-7S	1/25/96	<1.0	ND	ND	ND	ND	ND	<1.0	ND	ND	ND	<1.0
CCFTA2-7S	3/27/96	2.5	1.3	1.4	1.9	1.1	3.6	11.8	1	ND	1.4	NA
CCFTA2-9S	1/25/96	20	181	21.6	18.3	45.8	44.6	331.3	16.5	40.6	48.7	1400
CCFTA2-9S	3/28/94	13.8	106	16	15.7	30.5	34.9	216.9	14.2	39.3	27.4	NA
CCFTA2-11	1/25/96	ND	0.9	ND	ND	ND	<1.0	0.9	ND	ND	ND	41.4
CCFTA2-14	1/25/96	3.8	1	ND	3	ND	4.7	12.5	ND	ND	0.9	37.8
CCFTA2-14	3/27/94	1	ND	ND	ND	ND	ND	1	ND	ND	ND	NA
CCFTA2-18	1/26/96	7.7	ND	20.4	2.1	ND	<1.0	30.2	<1.0	7.4	3.6	97.7
CCFTA2-20S	1/25/96	<1.0	ND	ND	ND	ND	<1.0	<1.0	ND	ND	ND	<1.0

[a] ND = Compound not detected.

[b] NA = Compound not analyzed.

impacted. This evidence, coupled with evidence of the weathering of the source, provided the basis for not addressing natural attenuation of BTEX in the same detail as CAHs.

The CAH and daughter product data presented in Sections 4.3 and 4.4.1 implied the occurrence of anaerobic reductive dehalogenation. The presence of petroleum hydrocarbons dissolved in groundwater is important because the biodegradation of those compounds helps create reducing conditions that favor dehalogenation. In addition, the petroleum compounds provide a source of electron donors and carbon (i.e., a substrate) for the microbial population, supplementing native organic carbon already present in the shallow aquifer.

4.4.2.2 Organic Carbon in Groundwater

Dissolved native organic carbon also can act as a source of electron donors during the reductive dehalogenation of CAHs. Dissolved TOC concentrations can be used as an indicator of the presence of such native carbon compounds in wells outside of the area containing dissolved contamination (anthropogenic organic compounds, such as CAHs or petroleum hydrocarbons, also are measured by the TOC analytical method).

TOC dissolved in groundwater was measured in samples collected in January 1996. These concentrations are presented in Table 4.7. Dissolved TOC concentrations in shallow groundwater at CCFTA-2 (FT-17) range from 1.1 mg/L to 90.3 mg/L. In general, dissolved TOC concentrations are elevated in wells in which BTEX and/or CAHs were detected. In the vicinity of CCFTA2-9 and the former burn pit (i.e., the contaminant source areas), dissolved TOC concentrations are 25 to 90 mg/L greater than background concentrations. Elsewhere, TOC concentrations are generally less than 15 mg/L. The significantly elevated dissolved TOC concentrations likely represent source contaminants (e.g., PCE, TCE, and BTEX), organic compounds that are intermediate byproducts of biodegradation, and non-BTEX petroleum hydrocarbons

TABLE 4.7
TOTAL ORGANIC CARBON IN GROUNDWATER
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

Sample Location	Sample Date	Total Organic Carbon (mg/L)
MP-1S	1/25/96	1.1
MP-1D	1/25/96	12.4
MP-2	1/26/96	14.4
MP-3	1/26/96	11.1
MP-4S	1/25/96	8.6
MP-4D	1/25/96	10.3
MP-5	1/25/96	9.4
MP-6	1/25/96	7.8
CPT-1	1/24/96	56.8
CPT-1	3/29/94	58.9
CPT-2	1/24/96	5.8
CPT-2	3/29/94	6.1
CPT-3	1/24/96	4.1
CPT-3	3/29/94	4
CPT-4	1/25/96	6.5
CPT-4	3/30/94	13.2
CPT-5	1/25/96	6
CPT-5	3/30/94	7.3
CPT-6	1/25/96	5.6
CPT-6	3/30/94	5.7
CPT-7	1/25/96	2.5
CPT-7	3/30/94	4.1
CPT-8	1/25/96	9.2
CPT-8	3/30/94	8.7
CPT-9	3/30/94	6.9
CPT-10	3/30/94	6.9
CCFTA2-1	1/26/96	3.4
CCFTA2-1	3/28/94	7.3
CCFTA2-2	1/26/96	30.6
CCFTA2-2	3/28/94	17.9
CCFTA2-3	1/26/96	12.8
CCFTA2-3	3/28/94	7.3
CCFTA2-4	1/25/96	7.1
CCFTA2-4	3/28/94	5.9
CCFTA2-5	1/26/96	12.2
CCFTA2-5	3/28/94	8.7

Sample Location	Sample Date	Total Organic Carbon (mg/L)
CCFTA2-6	1/25/96	96.6
CCFTA2-6	3/28/94	23.3
CCFTA2-7S	1/25/96	5.9
CCFTA2-7S	3/27/94	9.5
CCFTA2-7D	1/25/96	5
CCFTA2-7D	3/28/94	5.1
CCFTA2-8S	1/25/96	2.7
CCFTA2-8D	1/25/96	2.5
CCFTA2-9S	1/25/96	40.6
CCFTA2-9S	3/28/94	23.3
CCFTA2-9D	1/25/96	3.5
CCFTA2-9D	3/28/94	3.9
CCFTA2-10	1/25/96	6
CCFTA2-11	1/25/96	3.4
CCFTA2-12	1/26/96	4.8
CCFTA2-13S	1/24/96	55.8
CCFTA2-13S	3/27/94	3
CCFTA2-13D	1/24/96	4.2
CCFTA2-13D	3/28/94	5.2
CCFTA2-14	1/25/96	14.5
CCFTA2-14	3/27/94	9.3
CCFTA2-15	1/24/96	6.3
CCFTA2-15	3/28/94	4.5
CCFTA2-16S	1/25/96	19.9
CCFTA2-16D	1/25/96	4
CCFTA2-17	3/27/94	8.1
CCFTA2-18	1/26/96	90.3
CCFTA2-19S	1/26/96	18.2
CCFTA2-19I	1/26/96	4.1
CCFTA2-19D	1/26/96	5.6
CCFTA2-20S	1/25/96	11.8
CCFTA2-20I	1/25/96	4.8
CCFTA2-20D	1/25/96	7
CCFTA2-21S	1/24/96	4
CCFTA2-21I	1/24/96	3.2
CCFTA2-21D	1/24/96	5.1

that have entered groundwater from the mobile LNAPL bodies, as well as the native TOC.

Background concentations at upgradient and crossgradient wells ranged from 1.1 mg/L to 6.3 mg/L, with an anomalous value of 19.9 mg/L measured at CCFTA2-16S (Table 4.7). Dissolved TOC concentrations in deep wells (which contain only low contaminant concentrations) range from 2.5 mg/L to 12.4 mg/L. These background concentrations of dissolved TOC are noteworthy because they represent additional organic matter that is available for use as a substrate in biodegradation reactions. The background concentrations likely represent compounds dissolved from peat units and dispersed organic matter throughout the aquifer. In addition to the soil TOC (Table 4.3), this native carbon source should provide a continuing source of electron donors to be used in microbial redox reactions. As discussed in Section 4.4.2.3, other geochemical evidence indicates that microbial consumption of the native carbon is occuring within the CAH plume at CCFTA-2 (FT-17) as well as outside and upgradient from it.

4.4.2.3 Inorganic Chemistry

An interpretation of inorganic groundwater geochemistry, including isopleth maps for typical electron acceptors, can provide information regarding the relative importance of various biodegradation mechanisms and whether the conditions at the site are favorable for reductive dehalogenation of CAHs. Numerous geochemical parameters were evaluated in site groundwater samples. Results for geochemical parameters measured in site samples are presented in Table 4.5. The following paragraphs discuss those parameters that are most useful in the evaluation of site biodegradation processes.

4.4.2.3.1 Dissolved Oxygen

DO concentrations were measured at monitoring wells and points during the January 1996 sampling event. Concentrations ranged from 0.1 to 1.2 mg/L, except for concentrations of about 2.4 mg/L measured at CCFTA2-4 and CCFTA2-21S. Given the low DO concentrations measured across the site, the latter two measurements appear anomalous, but there is no evidence of meter malfunctions noted in the sampling records. Table 4.5 summarizes measured DO concentrations. Figure 4.7 illustrates DO concentrations at the site. The low concentrations of oxygen in the plume area relative to upgradient and crossgradient concentrations is a strong indication of biological activity in the plume area. DO concentrations in the deeper monitoring points ranged from 0.08 to 1.66 mg/L.

Because DO is recharged in the shallow groundwater through rainwater infiltration, it might be expected that DO concentrations in shallow groundwater upgradient of the CAH plume would contain DO concentrations near equilibrium with atmospheric oxygen. At groundwater temperatures between 19.9 degrees Celsius (°C) and 24.9°C (as observed at the site), DO concentrations would be expected to be in the range of about 8.2 mg/L to about 9.1 mg/L, or slightly lower, depending on the salinity of the water (Colt, 1984). The low upgradient and crossgradient DO concentrations observed at the site suggest that DO is naturally being consumed in this area, most likely as microbes use native organic carbon as a substrate. Further depletion of DO within the BTEX and CAH plumes at CCFTA-2 (FT-17) indicates that additional microbial activity stimulated by the presence of petroleum hydrocarbons is consuming additional DO.

4.4.2.3.2 Nitrate/Nitrite

Concentrations of nitrate/nitrite [as nitrogen (N)] were measured in groundwater samples collected in January 1996. Table 4.5 summarizes measured nitrate/nitrite (as N) concentrations. The maximum detected nitrate/nitrite (as N) concentration was

0.15 mg/L. The low observed nitrate concentrations indicate that insufficient nitrate is available for significant use as an electron acceptor during anaerobic biodegradation reactions.

4.4.2.3.3 Ferrous Iron

Ferrous iron [iron (II)] concentrations were measured in groundwater samples collected in January 1996. Table 4.5 summarizes ferrous iron concentrations. Measured ferrous iron concentrations range from 0.1 mg/L to 10.3 mg/L. Figure 4.7 shows the areal extent of ferrous iron in groundwater. Elevated ferrous iron concentrations coincide with the CAH and BTEX plumes. This suggests that ferric iron [iron (III)] hydroxide is being reduced to ferrous iron (Fe^{2+}) during biodegradation of native organic carbons and BTEX compounds. Background levels of ferrous iron appear to range from below detection limits (0.05 mg/L) to about 0.7 mg/L, as measured at upgradient and crossgradient wells. Despite the absence of BTEX, slightly elevated ferrous iron concentrations were detected northeast of the source area at monitoring wells CCFTA2-10, CCFTA2-11, and CCFTA2-12, as well as at monitoring point MP-1S. The presence of ferrous iron in these locations further suggests that native organic material is available for biodegradation through iron reduction.

Recent evidence suggests that the reduction of ferric iron to ferrous iron cannot proceed at all without microbial mediation (Lovley and Phillips, 1988; Lovley *et al.*, 1991; Chapelle, 1993). None of the common organic compounds found in low-temperature (i.e., non-hydrothermal), neutral, reducing groundwater could reduce ferric oxyhydroxides to ferrous iron under sterile laboratory conditions (Lovley *et al.*, 1991). This means that the reduction of ferric iron requires microbial mediation by microorganisms with the appropriate enzymatic capabilities. Because the reduction of ferric iron cannot proceed without microbial intervention, the elevated concentrations

of ferrous iron that were measured in the contaminated groundwater at the site are very strong indicators of microbial activity.

4.4.2.3.4 Sulfate

Sulfate concentrations were measured in groundwater samples collected in January 1996. Sulfate concentrations in shallow groundwater at the site ranged from 7.85 mg/L to 842 mg/L (Table 4.5). At the site, 20 of 30 shallow groundwater samples contained sulfate concentrations below 100 mg/L, with a concentration of 842 mg/L detected at CCFTA2-19S, near the Banana River (a saline water body). In groundwater samples from deep wells, sulfate concentrations ranged from 9.13 mg/L to 1,100 mg/L In deep groundwater, 12 of 18 samples contained sulfate concentrations below 200 mg/L, with a maximum concentration of 1100 mg/L detected at CCFTA2-19D (again, close to the Banana River). Table 4.5 summarizes measured sulfate concentrations.

Sulfate concentrations do not correlate well with CAH or BTEX concentrations. Given the amount of sulfate dissolved in site groundwater, it is likely that sulfate reduction is an ongoing anaerobic biodegradation process at CCFTA-2 (FT-17), but the data indicate no clear pattern. Dissolved hydrogen data (discussed in Section 4.4.2.4) indicate that sulfate reduction was operating in the vicinity of the dissolved CAH plume source area at the time of sampling.

4.4.2.3.5 Methane in Groundwater

Methane concentrations were measured in groundwater samples collected in January 1996. Table 4.5 lists methane concentrations, which ranged from 0.002 to 6.97 mg/L at the site. Figure 4.7 shows the distribution of methane in shallow site groundwater. Methane concentrations are greatest in the area between the burn pit and monitoring well CCFTA2-6, with the general trend of the dissolved methane plume similar to that of the CAH and BTEX plumes. The presence of methane in the plume

area indicates that conditions are sufficiently reducing that petroleum hydrocarbons and native organic matter are being used to support methanogenesis. Further, the fact that methanogenesis is ongoing indicates that conditions in the plume area are highly reducing and therefore favorable for reductive dehalogenation of CAHs.

As methanogenesis produces more carbon dioxide than it consumes (Table 4.7), an unlimited supply of carbon dioxide is theoretically available once the process of methanogenesis has been initiated. Therefore, methanogenesis is limited by the rate of reaction rather than the source of electron acceptors.

4.4.2.4 Dissolved Hydrogen

Dissolved hydrogen (H_2) concentrations can be used to determine the dominant terminal electron-accepting process (TEAP) in an aquifer. This method has been shown to provide a direct, independent measurement that identifies which redox reactions are taking place in anaerobic groundwater (Lovley and Goodwin, 1988; Lovley *et al.*, 1994; Vroblesky and Chapelle, 1994; Chapelle *et al.*, 1995). The efficiency of reductive dehalogenation increases as a system becomes more reducing (i.e., proceeds from denitifying conditions to ferric-iron-reducing, sulfate-reducing, and methanogenic conditions). Therefore, it is helpful to be able to define redox conditions more accurately than can be determined from conventional geochemical data when evaluating the potential for natural attenuation of CAHs in groundwater. When dissolved H_2 concentrations are measured using the methods presented by the aforementioned authors, the concentrations directly indicate which TEAP is dominant in a given location at a given time, as outlined in Table 4.8.

Groundwater samples for analysis of dissolved H_2 were collected from 17 wells at CCFTA-2 (FT-17) in January 1996. These results are summarized on Table 4.9. Measured H_2 concentrations range from <0.01 nanomoles per liter (nM) to 1.80 nM. The highest concentrations were measured in the vicinity of the northern mobile

LNAPL body. At CCFTA2-9S and CCFTA2-11, H_2 concentrations were 1.80 and 1.05 nM, respectively, indicating that sulfate reduction is the dominant TEAP in that area at that time. The remaining data indicate that ferric iron reduction was the dominant TEAP throughout the area of the CAH plume at the time of measurement.

TABLE 4.8

RANGE OF HYDROGEN CONCENTRATIONS FOR GIVEN TERMINAL ELECTRON-ACCEPTING PROCESSES

CCFTA-2 (FT-17) RNA TS

CAPE CANAVERAL AIR STATION, FLORIDA

Terminal Electron-Accepting Process	Hydrogen Concentration (nM)
Denitrification	<0.1
Iron (III) Reduction	0.2 to 0.8
Sulfate Reduction	1 to 4
Methanogenesis	>5

Source: Chapelle *et al.*, 1995.

While these data suggest that ferric iron reduction and sulfate reduction were the dominant TEAPs in January 1996, the presence of methane indicates that methanogenesis has also been an operating TEAP. Further, the presence of ethene in the downgradient portion of the CAH plume suggests that at some time, sulfate reduction and/or methanogenesis were active TEAPs in that area, even though the H_2 data show that ferric iron reduction was ongoing in January 1996. This is not unexpected; Vroblesky and Chapelle (1994) state that TEAPs can vary both spatially and temporally, with shifts taking place in as little as 10 days.

TABLE 4.9

DISSOLVED HYDROGEN CONCENTRATIONS IN GROUNDWATER, JANUARY 1996

CCFTA-2 (FT-17) RNA TS

CAPE CANAVERAL AIR STATION, FLORIDA

Well	Hydrogen Concentration (nM)
CPT1	0.21
CCFTA2-1	0.10
CCFTA2-2	<0.01
CCFTA2-3	0.22
CCFTA2-5	0.10
CCFTA2-6	0.21
CCFTA2-7S	0.16
CCFTA2-8S	0.16
CCFTA2-9S	1.80
CCFTA2-10	0.29
CCFTA2-11	1.05
CCFTA2-13S	0.17
CCFTA2-14	0.11
CCFTA2-15	<0.01
CCFTA2-16S	0.21
CCFTA2-20S	0.23
CCFTA2-21S	0.65

4.4.2.5 Volatile Fatty Acids and Phenols

During biodegradation of BTEX and other petroleum hydrocarbons, volatile fatty acids (VFAs) are produced as metabolic byproducts. Production of VFAs is a direct indication of biodegradation of organic matter, including petroleum hydrocarbons, natural organic matter, or chlorinated solvents. The standard method of VFA analysis performed by USEPA researchers is a GC/mass spectrometry (MS) method in which groundwater samples are compared to a standard mixture containing 58 phenols, aromatic acids, and aliphatic acids.

Samples for VFA analysis were collected from five wells at CCFTA-2 (FT-17). Wells CCFTA2-3, CCFTA2-5, CCFTA2-6, CCFTA2-9S, and CCFTA2-20S were sampled. Results are presented in Table 4.10. Collectively, 24 of the 58 compounds in the standard were detected in these samples. These data confirm the ongoing biodegradation of organic matter. In turn, the reducing conditions created by this biodegradation favor the reductive dehalogenation of CAHs.

4.4.3 Additional Geochemical Indicators

Other geochemical data collected for this evaluation can be used to further interpret and support the contaminant, electron donor, electron acceptor, and byproduct data previously discussed. These parameters provide additional qualitative indications of what processes may be operating at the site.

4.4.3.1 Oxidation/Reduction Potential

ORPs were measured at groundwater monitoring wells and points in January 1996. ORP is a measure of the relative tendency of a solution to accept or transfer electrons. The ORP of a groundwater system depends on which electron acceptors are being reduced by microbes during oxidation of organic compounds. ORPs for shallow groundwater at the site range from 101 millivolts (mV) to -250 mV. Table 4.5 summarizes available ORP data. The areal distribution of ORPs is illustrated

TABLE 4.10
PHENOLS, AROMATIC ACIDS, AND ALIPHATIC ACIDS IN GROUNDWATER
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

Compound	CCFTA2-9S	CCFTA2-3	CCFTA2-5	CCFTA2-6	CCFTA2-20S
	(concentrations in µg/L)				
propaoic acid	<5	<5	6	9	<5
2-methylpropanoic acid	10	<5	<5	6	<5
trimethyl acetic acid	6	<5	5	5	<5
butyric acid	16	8	16	18	8
2-methylbutyric acid	15	<5	<5	<5	<5
3-methylbutyric acid	40	<5	<5	<5	<5
3,3-dimethylbutyric acid	<5	<5	<5	22	ND[a/]
pentanoic acid	23	17	54	58	32
3,2-dimethylbutyric acid	<5	<5	<5	6	ND
4-methylpropanoic acid	8	ND	<5	<5	<5
hexanoic acid	32	22	56	66	39
o-cresol	5	ND	ND	<5	ND
2-ethylhexanoic acid	387	381	302	656	438
heptanoic acid	6	5	11	14	8
m-cresol	12	ND	ND	<5	ND
2,5-dimethylphenol	6	ND	ND	8	ND
cyclohexanecarboxylic acid	6	ND	<5	<5	<5
2,4-dimethylphenol	6	ND	ND	6	ND
3,5-dimethylphenol & m-ethylphenol	5	ND	ND	5	<5
octanoic acid	<5	<5	5	7	<5
p-ethylphenol	<5	ND	ND	5	ND
benzoic acid	14	12	24	18	12
m-methylbenzoic acid	21	ND	ND	ND	ND
decanoic acid	<5	<5	<5	8	<5

[a/] ND = Compound not detected.

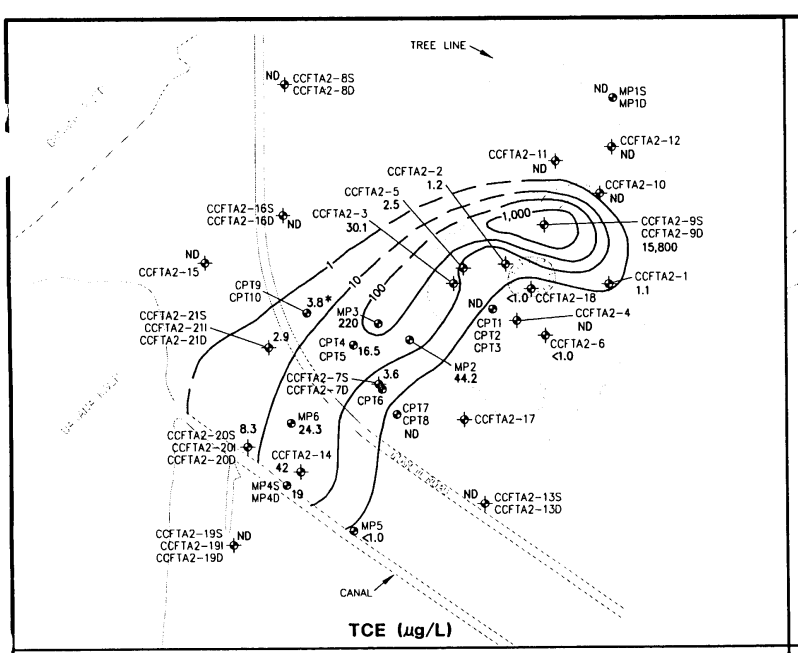
graphically on Figure 4.8. As expected, areas at the site with low ORPs appear to coincide with areas of elevated BTEX contamination, decreased DO, elevated ferrous iron, and elevated methane concentrations (see Figure 4.7). Also as expected, these areas coincide with areas where there is evidence of ongoing reductive dehalogenation.

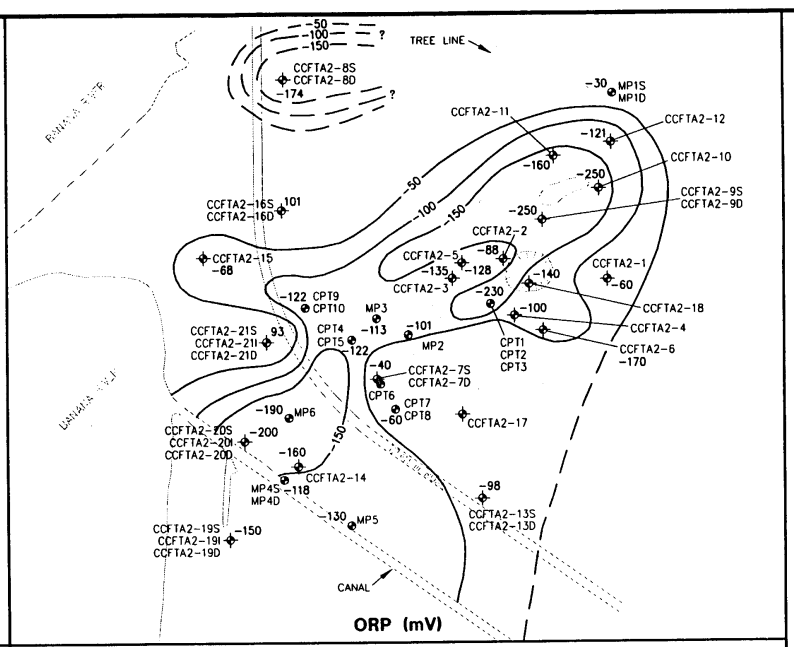
The observed ORPs also are relatively low outside of the plume area. Only at CCFTA2-16S and CCFTA2-21S are the redox potentials greater than -30 mV. In conjunction with the low observed DO concentrations, this further indicates that the local background groundwater conditions are already relatively reducing due to consumption of DO by microbes utilizing native organic carbon compounds as substrates.

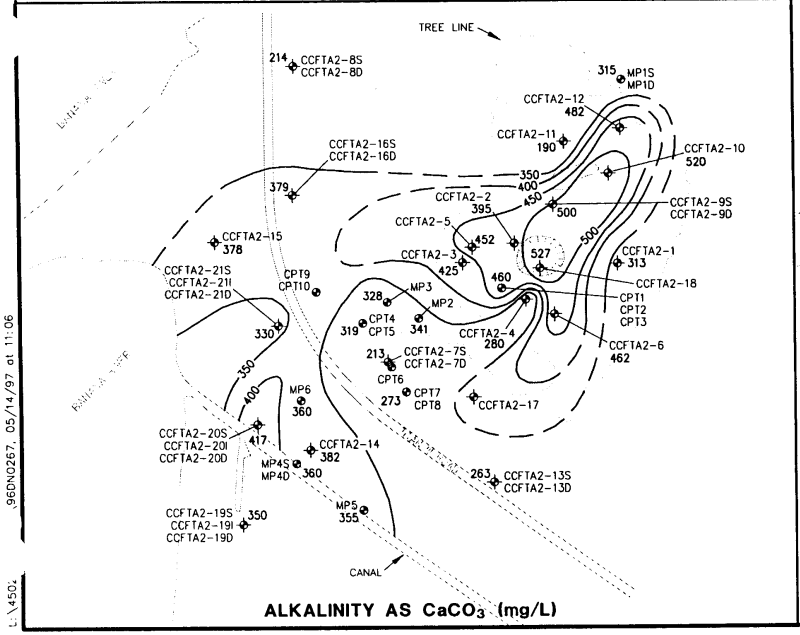
4.4.3.2 Alkalinity and Carbon Dioxide Evolution

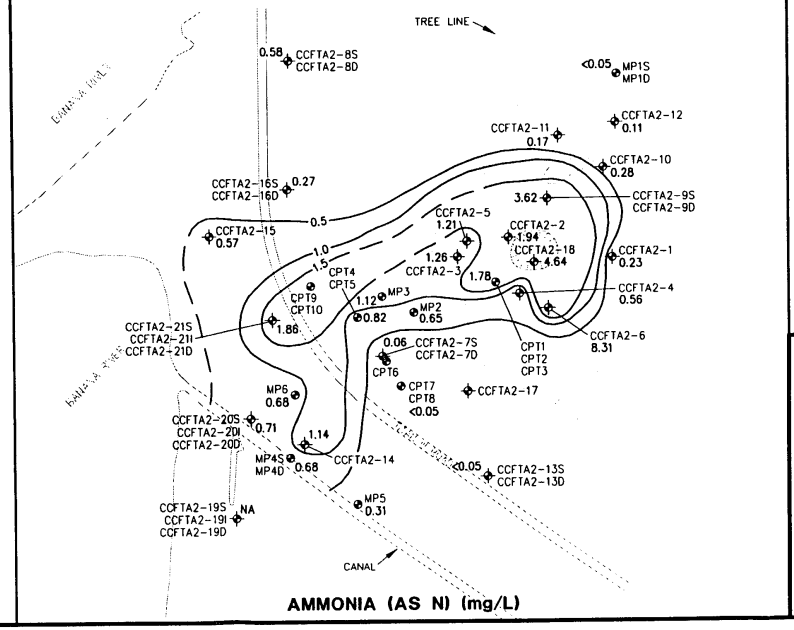
Carbon dioxide is produced during the biodegradation of petroleum hydrocarbons and native organic carbon compounds. In aquifers that have carbonate minerals as part of the matrix, carbon dioxide forms carbonic acid, which dissolves these minerals, increasing the alkalinity of the groundwater. An increase in alkalinity [measured as calcium carbonate ($CaCO_3$)] in an area with BTEX concentrations elevated above background conditions can be used to infer that petroleum hydrocarbons (or native organic carbon) has been destroyed through aerobic and anaerobic microbial respiration.

Total alkalinity (as $CaCO_3$) was measured in groundwater samples collected in January 1996. These measurements are summarized in Table 4.5 and illustrated on Figure 4.8. Alkalinity is a measure of the ability of groundwater to buffer changes in pH caused by the addition of biologically generated acids. Total alkalinity at the site varied from 213 mg/L to 527 mg/L. This range of alkalinity is sufficient to buffer potential changes in pH caused by biologically mediated reactions and suggests that aerobic and/or anaerobic biodegradation processes should not cause detrimental shifts









LEGEND

- FORMER BURN PIT
- BURIAL TRENCH
- CCFTA2-17 MONITORING WELL
- CPT6 MONITORING POINT
- 10 LINE OF EQUAL ANALYTE CONCENTRATION (DASHED WHERE INFERRED)
- * CONCENTRATION FROM 1994 DATA, USED TO AID IN PLUME DEFINITION

0 175 350 700
FEET

FIGURE 4.8

ADDITIONAL GEOCHEMICAL INDICATORS

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

.96DN0267, 05/14/97 at 11:06

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in groundwater pH (see Section 4.4.3.4). In addition, the areas with increased alkalinity generally coincide with the BTEX and CAH plumes. This is further evidence that biodegradation utilizing BTEX and native organic carbon compounds as substrates is ongoing at the site.

4.4.3.3 Ammonia

The presence of ammonia in groundwater can result from either nitrate reduction (facilitated by microbes) or fixing of atmospheric nitrogen (also a microbial process). Therefore, the presence of ammonia in groundwater is a strong indication of microbial activity. Figure 4.8 shows the distribution of ammonia (as N) concentrations measured in groundwater samples collected from CCFTA-2 (FT-17). Ammonia concentrations ranged from less than 0.05 mg/L to 4.64 mg/L (Table 4.5), with the area of highest ammonia concentrations coinciding with the BTEX and CAH plumes. Because very little nitrate is present in site groundwater, the source of nitrogen for this process must be atmospheric nitrogen gas. This implies that groundwater conditions within the BTEX and CAH plumes are reducing enough to support this process. Stumm and Morgan (1981) note that nitrogen fixation will occur when conditions are at least reducing enough to support iron reduction. This process can also occur when sulfate reduction or methanogenesis is favored. Therefore, this evidence of nitrogen fixation further confirms that conditions within the CAH and BTEX plumes are sufficiently reducing to allow reductive dehalogenation to proceed.

4.4.3.4 pH

pH was measured for groundwater samples collected from groundwater monitoring points and monitoring wells in January 1996. These measurements are summarized in Table 4.5. The pH of a solution is the negative logarithm of the hydrogen ion concentration [H^+]. Groundwater pH measured at the site ranges from 6.7 to 7.8 standard units. This range of pH is within the optimal range for BTEX-degrading microbes. The limited and relatively neutral range of pHs also indicates that microbial

reactions have a minimal effect on groundwater pH, likely due to the moderately high alkalinity of site groundwater (Section 4.4.3.2). In general, pHs were higher at depth, reflecting the higher salinity of the deeper groundwater.

4.4.3.5 Temperature

Groundwater temperature was measured at groundwater monitoring points and monitoring wells in January 1996. Table 4.5 summarizes groundwater temperature readings. Temperature affects the types and growth rates of bacteria that can be supported in the groundwater environment, with higher temperatures generally resulting in higher growth rates. Temperatures in the shallow part of the aquifer varied from 19.9°C) to 24°C, while temperatures in the deep part of the aquifer ranged from 21.9°C to 25.3°C. These are relatively warm temperatures for groundwater (but still within the optimal range), suggesting that bacterial growth rates should be high.

4.5 APPROXIMATION OF BIODEGRADATION RATES

Biodegradation rate constants are necessary to accurately simulate the fate and transport of contaminants dissolved in groundwater. In many cases, biodegradation of contaminants can be approximated using first-order kinetics. First-order biodegradation rate constants may be calculated on the basis of field-scale data, or by using a small sample of the aquifer material and groundwater for microcosm studies. For reductive dehalogenation of chlorinated compounds, first-order rates are not necessarily an accurate representation because the degradation of CAHs depends on both concentration of electron donors (e.g., fuel hydrocarbons or native organic material) and the concentrations of electron acceptors (including inorganic acceptors and CAHs) (Moutoux *et al.*, 1996). Second-order rates would therefore allow more accurate modeling, but at this time there are no readily available groundwater contaminant transport models that can utilize such rates. Therefore, first-order rates must be estimated for such an application.

Microcosm studies are used to show that the microorganisms necessary for biodegradation are present and to help quantify rates of biodegradation. Because microcosm studies are time consuming and expensive, they should be undertaken only at sites where there is considerable skepticism concerning the biodegradation of contaminants. The results of a microcosm study are strongly influenced by the nature of the geological material submitted for study, the physical properties of the microcosm, the sampling strategy, and the duration of the study. Biodegradation rate constants determined by microcosm studies often are much higher than those observed in the field. Microcosms are most appropriate as indicators of the potential for natural bioremediation, and to prove that losses are biological, but it may be inappropriate to use them to generate rate constants. The preferable method of contaminant biodegradation rate-constant determination is by use of field data.

In order to calculate first-order biodegradation rate constants on the field scale, the apparent degradation rate must be normalized for the effects of dilution, dispersion, and sorption. Two methods for determining first-order rate constants for BTEX compounds are described by Wiedemeier *et al.* (1996b). One method involves the use of a biologically recalcitrant compound found in the dissolved contaminant plume that can be used as a conservative tracer. The other method, proposed by Buscheck and Alcantar (1995), involves interpretation of a steady-state contaminant plume and is based on the one-dimensional, steady-state analytical solution to the advection-dispersion equation presented by Bear (1979). Both methods can be adapted to estimate rate constants for CAHs. Another method for estimating dehalogenation rates of CAHs is described by Moutoux *et al.* (1996). This method provides a total dechlorination rate for all dechlorination steps. All rates (including the rapid TCE to DCE rate and the slow VC to ethene) are averaged together using the Moutoux *et al.* (1996) method.

The methods of Buscheck and Alcantar (1995) and Moutoux *et al.* (1996) were used to estimate first-order biodegradation rate constants for CAHs at CCFTA-2 (FT-17). These methods and calculations are summarized in Appendix C. Rate constants were not calculated for BTEX compounds because of the relatively low remaining concentrations (Table 4.6) and the focus of this study on the CAHs. Decay rates computed using data from CCFTA-2 (FT-17) and the two methods referenced above included a total CAH dechlorination rate of 0.00007 day^{-1}, a total CAH dechlorination rate of 0.0003 day^{-1}, a TCE dechlorination rate of 0.0005 day^{-1}, and a DCE dechlorination rate of 0.0005 day^{-1}. The first rate was calculated using the method of Moutoux *et al.* (1996), while the latter three were calculated using the method of Buscheck and Alcantar (1995). The equivalent half-lives are 27 years, 6.3 years, 3.8 years, and 3.8 years, respectively. The 0.00007 day^{-1} calculated rate appears relatively slow because it includes the dechlorination step from VC to ethene, which is the slowest step. Because the anaerobically recalcitrant TMB compounds were not detected consistently at the site (Table 4.6), the tracer method (Wiedemeier *et al.*, 1996b) was not used.

4.6 DISCUSSION

Several lines of chemical and geochemical evidence indicate that dissolved CAHs at CCFTA-2 (FT-17) are undergoing biologically facilitated reductive dehalogenation. The presence of *cis*-1,2-DCE and VC in site groundwater and the accumulation of VC downgradient of the source area, accompanied by a decrease in TCE and DCE concentrations, are the primary lines of chemical evidence (Figure 4.4). This is further supported by the presence of ethene, which is a byproduct of reductive dehalogenation of VC, and by elevated chloride concentrations within the CAH plume. In addition, the ratios of *cis*-1,2-DCE to *trans*-1,2-DCE within the CAH plume (Figure 4.6) also are indicative of biologically mediated reductive dehalogenation.

Microbial consumption of both native and anthropogenic organic carbon compounds creates conditions favorable for reductive dehalogenation. Anthropogenic carbon compounds are present as petroleum hydrocarbons (including, but not limited to, BTEX) that are dissolved in groundwater, while native carbon compounds include solid organic matter in the aquifer matrix and whatever portion of that matter that has dissolved into site groundwater. These compounds are electron donors in redox reactions that are also consuming electron acceptors such as DO, ferric iron, carbon dioxide, and CAHs. Plots of these electron donors, electron acceptors, and byproducts of these reactions (Figures 4.4, 4.6, and 4.7) provide strong qualitative evidence of these processes. Additional indicators, such as ORP, alkalinity, ammonia concentrations, and VFAs, further confirm that biodegradation reactions are ongoing and have created reducing conditions that foster reductive dehalogenation.

The role of sulfate reduction is unclear because no clear relationship between the CAH plume and dissolved sulfate concentrations is apparent. However, dissolved H_2 data further confirm that conditions within the CAH plume in January 1996 were reducing (Tables 4.8 and 4.9), with iron reduction and sulfate reduction being the TEAPs operating within the plume. This further indicates conditions that favor reductive dehalogenation of TCE, DCE, and VC, and possibly some anaerobic oxidation of VC (under iron-reducing conditions). The presence of dissolved methane further indicates that conditions are sufficiently reducing for the dehalogenation processes to proceed.

The dissolved CAH plume at CCFTA-2 (FT-17) exhibits characteristics of both type 1 and type 2 behavior. Dissolved petroleum hydrocarbons are acting as a carbon source, and the geochemical data indicate some microbial consumption of native organic matter is taking place outside the plume (and and probably within the plume as well). It is likely that the introduction of petroleum hydrocarbons due to fire training activities stimulated additional microbial activity and made the groundwater system

reducing enough to allow reductive dehalogenation of CAHs, including VC. Ethene is being produced, but VC is also accumulating in the downgradient portion of the CAH plume. VC is likely to continue to accumulate as long conditions in that portion of the plume are at least oxidizing enough to favor ferric iron reduction.

As discussed in Section 4.5, rates of CAH degradation estimated from data collected for this investigation range from 0.00007 day^{-1} to 0.0005 day^{-1}. As petroleum hydrocarbons continue to be consumed, reductive dehalogenation will continue; however, once BTEX compounds are completely degraded, the rate at which CAHs are dehalogenated may slow slightly as the microbes utilize less easily degradable fuel hydrocarbons. However, these other fuel hydrocarbons and the native carbon compounds should be sufficient to sustain continuing biodegradation and maintain reducing conditions within the plume area. It also is conceivable that the plume may eventually come to display only type 2 behavior, but this will depend on the concentrations and degradability of the remaining (non-BTEX) fuel hydrocarbon compounds relative to the native organic matter.

As the type of organic matter used during biodegradation changes, the redox conditions may also change and alter which reactions are favored. This could also affect the rates at which CAHs are reductively dehalogenated, and could also cause dehalogenation of some compounds to cease. If and how this will happen is difficult to predict; the relative "degradability" of the native organic matter (or non-BTEX fuel hydrocarbons) and the effect of a changing electron donor source is not yet well-understood. It can be stated that if conditions become more oxidizing (but not aerobic), dehalogenation of VC may cease outright, and that the dehalogenation of DCE may also cease or slow. However, aerobic and/or anaerobic mineralization of VC and DCE may become more important.

SECTION 5

GROUNDWATER FLOW AND CONTAMINANT TRANSPORT MODEL

5.1 GENERAL OVERVIEW AND MODEL DESCRIPTION

In order to help predict the future migration and fate of CAHs dissolved in groundwater at CCFTA-2 (FT-17), Parsons ES simulated shallow groundwater flow and the fate and transport of the dissolved CAH plume. The modeling effort had three primary objectives: 1) predict the future extent and concentration of the dissolved contaminant plume by modeling the combined effects of advection, dispersion, sorption, and biodegradation; 2) assess the potential for downgradient receptors to be exposed to contaminants at concentrations above regulatory levels of concern; and 3) if applicable, provide technical support for the RNA with LTM option at regulatory negotiations. The model was developed using site-specific data and conservative assumptions about governing physical and chemical processes. The modeling effort did not include predictions to determine the future extent and concentration of the BTEX plume at CCFTA-2 (FT-17),due to the low BTEX concentrations, the role of BTEX as electron donors for CAH degradation, and the fact that detectable concentrations of BTEX are not present in surface water. This analysis is not intended to represent an assessment of potential risks posed by site contamination.

The model codes MODFLOW (McDonald and Harbaugh, 1988) and MT3D (Zheng, 1990) were used to estimate the potential for dissolved CAH migration and degradation by naturally occurring mechanisms operating at the site. The pre- and post-processors contained in Visual MODFLOW® (Waterloo Hydrogeologic, Inc., 1995) were used to

facilitate model development and analysis/presentation of model results. MODFLOW was used to generate a groundwater flow model for the site, and the flow field from this model was incorporated into the transport solution computed by MT3D. The MT3D code incorporates advection, dispersion, sorption, and biodegradation to simulate contaminant plume migration and degradation. MT3D uses solution routines based on the Method of Characteristics (MOC) solute transport model [e.g., as developed by Konikow and Bredehoeft (1978) for the US Geological Survey (USGS) two-dimensional (2D) MOC model code]. The model was modified by Zheng (1990) to allow three-dimensional (3D) solutions, and to allow use of a modified MOC method that reduces numerical dispersion. Biodegradation of dissolved and sorbed contaminants can be simulated through the use of a first-order decay constant.

These codes were selected over the Bioplume II code because MT3D is more stable (numerically) when the simulated solute plume reaches a boundary, because of the 3D nature of the local groundwater flow system (e.g., vertical flow and discharge to surface water in the vicinity of the canal and the Banana River), and because biodegradation of CAHs is not oxygen-limited. Ideally, a code for simulating degradation of CAHs would track parent compounds and daughter products and allow specification of varying decay rates for each compound. However, such a model is not yet available outside of research institutions.

5.2 CONCEPTUAL MODEL DESIGN AND ASSUMPTIONS

Prior to developing a groundwater model, it is important to determine if sufficient data are available to provide a reasonable estimate of aquifer conditions. In addition, it is important to ensure that any limiting assumptions can be justified. Important assumptions made when using the MT3D code are that dispersion, sorption, and biodegradation are major factors controlling contaminant fate and transport at the site. Data and information presented in Sections 3 and 4 suggest that biodegradation of CAHs is ongoing, although CAHs are reaching the canal. Data also indicate that

significant concentrations of organic carbon are present in the aquifer matrix, and that sorption is likely an important process. Biodegradation of CAHs can be simulated using a decay constant, sorption (assumed to be a linear process) can simulated using a coefficient of retardation, and dispersion can be estimated using literature values and accepted rules-of-thumb. Selection of values for these parameters is discussed in Section 5.4.2.

On the basis of the data presented in Section 3, the shallow saturated zone was conceptualized and modeled as an unconfined aquifer composed of fine- to coarse-grained sand (Figures 3.3 and 3.4). There are some slight heterogeneities in the shallow aquifer, such as the peat and clay lenses that were detected in some boreholes; however, the groundwater flow patterns and plume data do not clearly indicate any influence of these observed units on the system. As a result, the conceptual model does not incorporate significant heterogeneities (e.g., variation in hydraulic conductivity is limited to the range indicated by the slug test data). The aquifer is bounded on the bottom by the clay layer at about 60 feet bgs. Because there are significant vertical flow gradients at this site, and because the groundwater discharges to nearby surface water bodies, a 3D solution is most appropriate.

For the purposes of the model, it was assumed that contaminants were first introduced to the groundwater at this site when fire training operations began in 1965. LNAPL containing CAHs was likely concentrated in the vicinity of the drum disposal trench. Available evidence indicates that mobile LNAPL remains at the site (although the thickness may be decreasing), and that the remaining residual LNAPL is significantly weathered (especially with respect to petroleum hydrocarbon composition). The mobile and residual LNAPL acts as a continuing source of dissolved TCE, along with lesser concentrations of DCE and BTEX. Therefore, it was assumed that contaminants enter groundwater via dissolution from mobile LNAPL and residual LNAPL trapped below the water table, and by dissolution into recharge

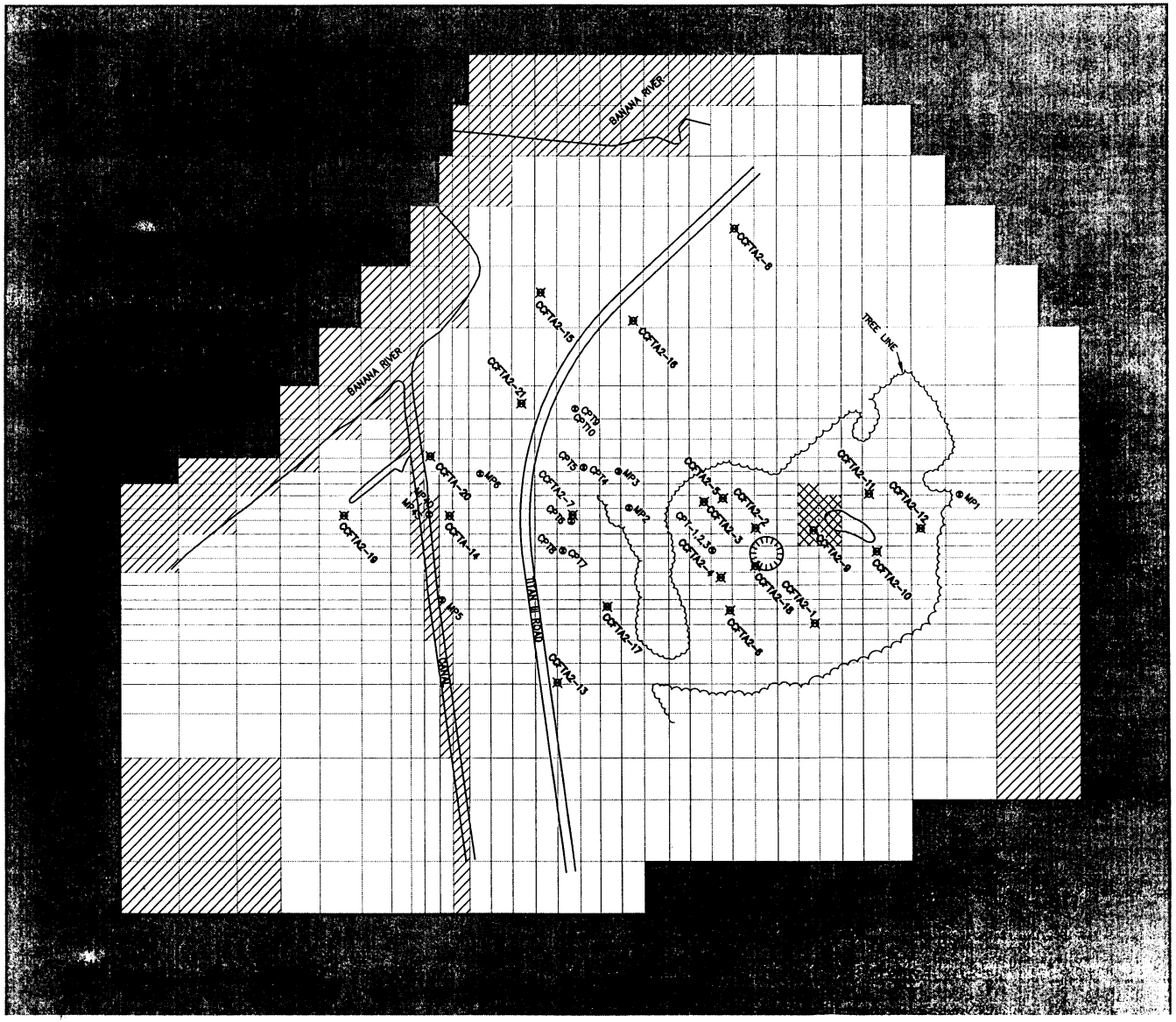
(infiltrating precipitation) as it passes around or through the LNAPL above the water table. Both these sources have likely diminished as the TCE and BTEX weathered out of the LNAPL, resulting in a decreasing source of dissolved contamination through time. It is likely that the source will continue to weather, and that the mass of contaminants entering groundwater will continue to decline.

5.3 INITIAL MODEL SETUP

Where possible, the initial setup for this model was based on site-specific data. Where site-specific data were not available (e.g., effective porosity and dispersivity), reasonable assumptions were made on the basis of widely accepted literature values for materials similar to those found in the shallow aquifer, or using calculations taken from the literature. The following sections describe the basic model setup. Those parameters that were varied during model calibration are discussed in Section 5.4.

5.3.1 Grid Design and Boundary Conditions

The model domain for CCFTA-2 (FT-17) was represented using 3 layers, each with a horizontal grid of 32 rows by 37 columns. Grid cell dimensions ranged from approximately 30 feet wide by 35 feet long to 130 feet by 310 feet, with most cells having lengths and widths less than 60 feet. The grid was oriented with the longest dimension parallel to the main direction of dissolved contaminant migration. The model grid covers an area of 8,250,000 square feet, or approximately 189 acres. The full extent of the model grid is indicated on Figure 5.1. The grid was extended a substantial distance southwest of the canal to allow simulation of potential contaminant underflow beneath the canal. The total thickness of the domain is 80 feet, divided into 3 equal layers. Part of the total model thickness includes an extra-thick unsaturated zone (which does not affect calculations, but allows for oscillation in the water table surface during early model iterations).



LEGEND

- FORMER BURN PIT
- BURIAL TRENCH
- CCFTA2-17 — MONITORING WELL
- CPT6 — MONITORING POINT
- CONSTANT-HEAD CELL (CANAL NOT REPRESENTED IN LOWER MODEL LAYERS)
- CAH CONCENTRATION SOURCE (RECHARGE BOUNDARY).

0 100 200 400
FEET

FIGURE 5.1

MODEL GRID AND BOUNDARY CONDITIONS

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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Boundary conditions are used to include the effects of the system outside the area being modeled on the system being modeled, while at the same time allowing the isolation of the desired model domain from the larger system. Boundary conditions describe the interaction between the system being modeled and its surroundings or, for transport models, the loading of contaminant mass into the system. In effect, the boundaries of the model tell the area immediately inside the boundaries what to expect from the outside world. The solution to any differential equation requires specification of the conditions at the periphery of the system. Model boundaries are thus mathematical statements that specify the dependent variable (head or contaminant concentration) or the flux (derivative of the head or contaminant concentration with respect to time) at the model grid boundaries.

Three types of boundary conditions generally are utilized to describe groundwater flow and solute transport. Boundary conditions are referred to as type one (Dirichlet), type two (Neumann), and type three (Cauchy). Table 5.1 summarizes boundary conditions for groundwater flow and solute transport.

TABLE 5.1

DEFINITION OF MODEL BOUNDARY CONDITIONS

CCFTA-2 (FT-17) RNA TS

CAPE CANAVERAL AIR STATION, FLORIDA

Boundary Condition	Boundary Type	Formal Name	General Mathematical Description	
			Groundwater Flow	Contaminant Transport
Specified-Head or Specified-Concentration	Type One	Dirichlet	$H = f(x,y,z,t)$	$C = f(x,y,z,t)$
Specified-Flux	Type Two	Neumann	$\frac{\partial H}{\partial n} = f(x,y,z,t)$	$\frac{\partial C}{\partial n} = f(x,y,z,t)$
Head-Dependent or Concentration-Dependent Flux	Type Three (mixed-boundary condition)	Cauchy	$\frac{\partial H}{\partial n} + cH = f(x,y,z,t)$	$\frac{\partial C}{\partial n} + cC = f(x,y,z,t)$

(Modified from Franke *et al.*, 1987)

In flow models, boundary conditions are ideally used to specify known hydrogeologic boundaries of the system, such as streams, lakes, confining units, groundwater divides, or any geologic feature that may bound a system. Also, the boundaries may be defined as areas where properties (e.g., flux) are known and can be defined. When using a numerical flow model, hydrologic boundaries such as constant-head features (e.g., lakes or streams) or constant-flux features (e.g., groundwater divides or confining units) should, when possible, be used to define the model area. In areas that lack obvious hydrologic boundaries, assumed or calculated constant-head or constant-flux boundaries can be specified at the numerical model perimeter as long as the perimeter is far enough removed from the contaminant plume that transport calculations will not be affected.

In transport models, boundary conditions are used to specify contaminant sources such as NAPL bodies, dissolved mass entering through recharge, injection wells, surface water bodies, and leaking structures. Sources such as NAPL bodies may be represented as specified-concentration boundaries (limited by solubility constraints or observed maximum concentrations) or as specified-flux boundaries (for which the chemical loading rate must be known or estimated). However, in most cases, only the effects of the source are measured, not the source characteristics (Spitz and Moreno, 1996). The source must therefore be represented as a "black box" that produces appropriate concentrations or fluxes at selected points in the model. The source may be misrepresented under such a scenario, but there is often little choice in the matter. Estimating contaminant flux into groundwater from NAPL is difficult and is dependent upon several parameters, most of which cannot be measured (Feenstra and Guiguer, 1996; Abriola, 1996).

Specified-head boundaries for the model were set at the upgradient model boundary, at the canal, along the western boundary to represent the Banana River, and on the southwestern perimeter of the model grid. These boundaries were selected to simulate

the southwesterly groundwater flow observed in the area north of the canal and the apparent northerly flow to the south of the canal. Use of the MODFLOW river package to simulate boundary conditions at the canal resulted in large numerical errors during model iterations, forcing the use of constant-head cells to simulate that feature.

By projecting heads from the groundwater flow maps, the hydraulic heads northeast of the burn pit were estimated to be 2.2, 2.85, and 3.6 feet above msl in layers 1, 2, and 3, respectively. Heads in the southeastern corner of the domain were assumed to be 1.5, 2.1, and 2.6 feet above msl in layers 1, 2, and 3, respectively. Heads were assumed to increase with depth because of the upward gradients observed at the site.

Heads at the Banana River were assumed to be a constant 0.4 foot above msl, and heads at the canal were assumed to be a constant 0.5 foot above msl. The canal boundary was assumed to be present only in model layer 1. In both surface water bodies, the heads likely will vary over time, but a steady-state flow field simplifies the contaminant transport modeling. Therefore, head values for the river and canal were estimated and adjusted slightly (no more than 0.1 foot) during calibration. Constant-head cells were placed far enough away from the CAH plume to avoid potential boundary interferences, with the exception of the river and canal cells into which the plume discharges.

Along the northeastern and southeastern boundaries of the model grid, a no-flow (specified-flux) boundary was assumed to be present. The flux through these boundaries is assumed to be zero because flow is generally interpreted to be parallel to these boundaries. The base or lower boundary of the model is also assumed to be no-flow, and was set at a depth of 65 feet below msl based on the apparent depth of the clay confining unit. The upper model boundary was defined by the simulated water table surface and therefore varied depending upon the results of the simulations.

5.3.2 Groundwater Elevation and Gradient

Groundwater elevation data collected in January 1996 and presented on Figures 3.5 and 3.6 were used as calibration targets for the flow model. These data were used because more measurements were collected at more points than in previous investigations, allowing greater definition of the groundwater head distribution. Hydraulic gradients and groundwater flow directions inferred from January 1996 data are generally similar to those inferred from 1995 data (OBG, 1996a), but smaller-scale variations are more apparent. The configuration of groundwater elevation isopleths on Figures 3.5 and 3.6 indicates that groundwater in the CCFTA-2 (FT-17) area primarily flows south-southwest to the canal, but away from the plume area, flow is more westerly toward the Banana River. Vertical flow profiles indicate that near the canal (and likely the Banana River), the vertical component of flow is upward.

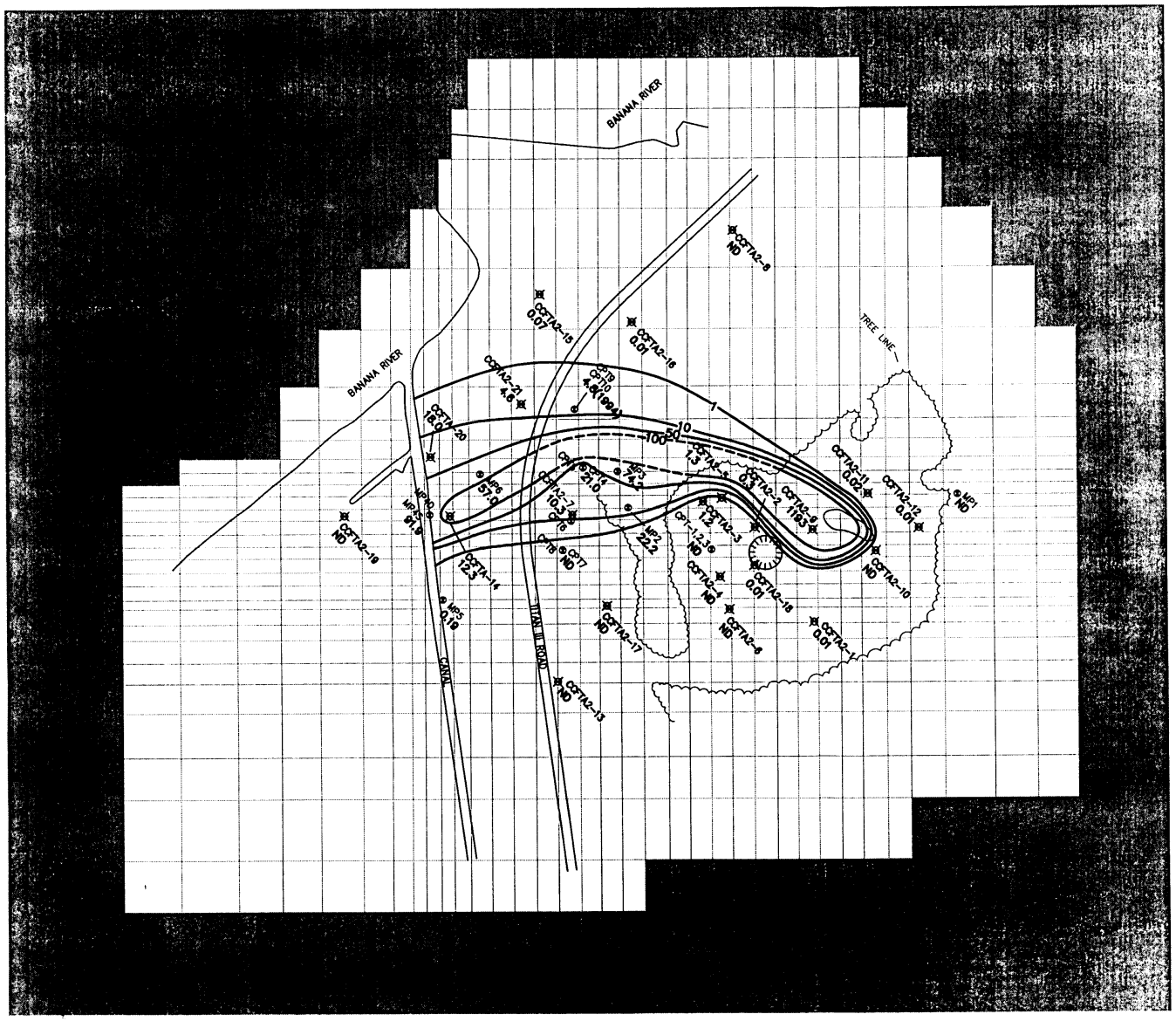
Additional groundwater flow direction and gradient data are presented by OBG (1995b). These data are generally consistent with the data collected by Parsons ES in March 1994 and January 1996. Therefore, it was assumed that the observed 1996 water levels were reasonably representative of steady-state conditions. As described further in Section 5.4.1, the model was calibrated to the observed January 1996 water table.

5.3.3 CAH Concentrations

Dissolved CAHs enter groundwater in the study area through two ongoing processes: 1) contact between groundwater and residual LNAPL at or below the water table, and 2) contact between groundwater and mobile LNAPL at the water table. Smaller amounts of contaminant mass may enter groundwater due to migration of recharge (precipitation) through soil containing mobile and residual LNAPL above the water table. Partitioning of CAHs from these sources into groundwater was simulated using recharge boundaries in the vicinity of the northern LNAPL body.

Rather than using various calculations to attempt to estimate CAH partitioning from LNAPL into groundwater, the "black box" source approach was used. Experience modeling fuel hydrocarbon sites as part of the AFCEE Natural Attenuation Initiative has suggested that this is the most direct method for reproducing observed plumes. For the CCFTA-2 (FT-17) model, CAH loading was assumed to begin in 1965, when fire training operations began. Loading was assumed remain constant until 1985, when fire training operations ceased. Loading after that period was assumed to decrease slightly due to natural weathering processes.

The total dissolved chlorinated ethene concentrations obtained from January 1996 laboratory analytical results for each monitoring well/point location were used as targets for model calibration. Table 4.4 presents dissolved CAH concentration data for January 1996, and Figure 4.4 shows the spatial distribution of dissolved CAHs in January 1996. For the purposes of this model, the concentrations of the individual compounds were converted from µg/L to micromoles per liter (µmol/L) before being summed. This was done because the primary reaction operating at CCFTA-2 (FT-17) is reductive dechlorination. As discussed in Section 4.2, reductive dechlorination is a mole-to-mole transformation from parent to daughter product, involving replacement of one chlorine atom with a hydrogen atom. The process results in decreased contaminant mass because the mass of the daughter compound is significantly lower; however, the molar concentration is unchanged. Because the biodegradation rates calculated from site data and used in the model represent rates of dechlorination only, and not rates of mass loss due to dechlorination, simulation of changes in molar concentrations is a more appropriate manner in which to simulate dechlorination of CAHs. The CAH plume in terms of total molar concentrations is presented on Figure 5.2. The concentrations and shapes of the plumes depicted in these figures are the result of transport under the influence of advection, dispersion, sorption, and biodegradation fate processes.



LEGEND

- FORMER BURN PIT
- BURIAL TRENCH
- CCFTA2-17 ND — MONITORING WELL WITH TOTAL CHLORINATED ETHENE CONCENTRATION (µmol/L)
- CPT6 10.3 — MONITORING POINT WITH TOTAL CHLORINATED ETHENE CONCENTRATION (µmol/L)
- 10 — LINE OF EQUAL TOTAL CHLORINATED ETHENE CONCENTRATION (µmol/L) CONTOUR INTERVAL = VARIABLE
- ND — NOT DETECTED

N

0 100 200 400
FEET

FIGURE 5.2

OBSERVED TOTAL CHLORINATED ETHENE CONCENTRATIONS (SHALLOW)

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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5.3.4 Degradation Rates

As discussed in Section 4.5, first-order biodegradation (dehalogenation) rates of 0.00007 day^{-1} to 0.0005 day^{-1} were estimated for CAHs using site-specific data. These rates were used to define an initial range of possible values for model input. Also as noted in Section 4.5, reductive dehalogenation of CAHs may be best represented using a second-order rate, but most common transport codes (including MT3D) can incorporate only a first-order rate. This impacts model calibration; however, at this time there is no feasible alternative for simulating CAH transport under the influence of biodegradation. So long as conservative values are used for other input parameters and a sensitivity analysis is performed, simulations incorporating a first-order rate constant are still useful and meaningful.

5.4 MODEL CALIBRATION

Model calibration is an important component in the development of any numerical groundwater model. Calibration of the flow model demonstrates that the model is capable of matching hydraulic conditions observed at the site; calibration of a contaminant transport model superimposed upon the calibrated flow model helps demonstrate that contaminant loading and transport conditions are being appropriately simulated. The numerical flow model presented herein was calibrated by altering transmissivity, recharge, and constant-head elevations in a trial-and-error fashion until simulated heads approximated observed field values within a prescribed accuracy. After calibration of the flow model, the numerical solute transport model was calibrated by altering contaminant transport parameters and contaminant source term concentrations in a trial-and-error fashion until the simulated CAH plume approximated observed field values. Model input and output are included in Appendix E.

5.4.1 Flow Model Calibration

The shallow water table across the study area was assumed to be influenced by continuous recharge and discharge at the constant-head cells established at the upgradient and downgradient model boundaries. In addition, it was assumed that precipitation recharge entered the subsurface across the site, which is almost completely unpaved. As stated in Section 3.4, the mean annual precipitation in the area is approximately 44 to 45 inches, with a mean evapotranspiration or about 40 inches. The recharge rate for the calibrated groundwater flow model was initially assumed to be a uniform 5 inches per year (in/year) across the entire model domain. During the calibration process, this value was reduced to 3 in/year.

Hydraulic conductivity is an important aquifer characteristic that represents the ability of the water-bearing strata to transmit groundwater. An accurate estimate of hydraulic conductivity is important to help quantify advective groundwater flow velocities and to define the flushing potential of the aquifer. As a result, models used to estimate contaminant transport are particularly sensitive to variations in hydraulic conductivity. Lower values of hydraulic conductivity result in a slower-moving plume with a relatively small areal extent. Higher values of hydraulic conductivity result in a faster-moving plume that is spread over a larger area.

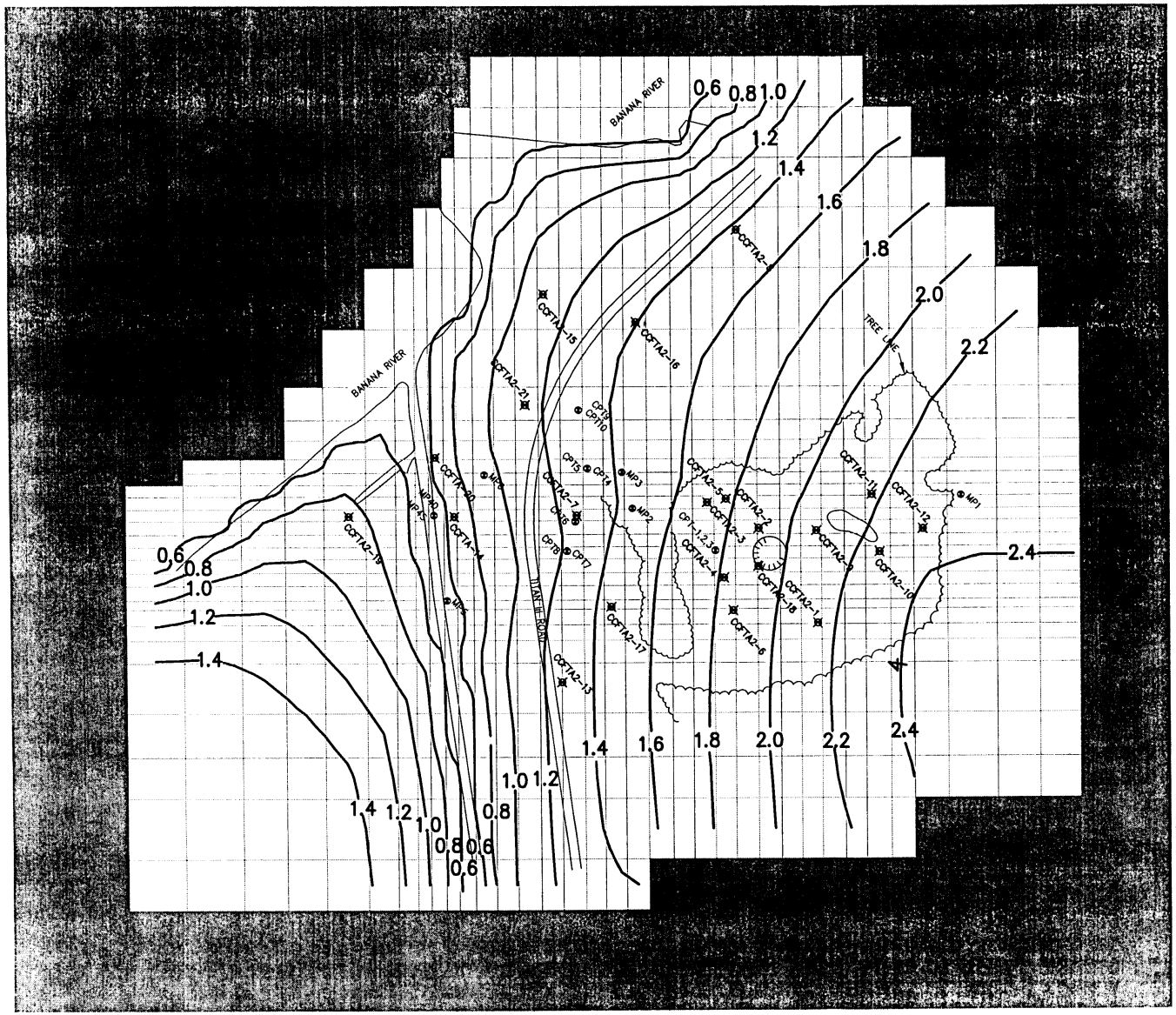
Geologic data and water level measurements were used in conjunction with the hydraulic conductivity values derived from slug tests to estimate an initial uniform hydraulic conductivity for the saturated zone across the entire model domain. As stated in Section 3.3.2.2, hydraulic conductivities derived from slug tests performed in the shallow sandy aquifer in the study area averaged about 45 ft/day. To better match heads in the model to observed values, initial hydraulic conductivity values were progressively varied in blocks and rows until the simulated water levels for cells corresponding to the selected well locations closely matched the observed water levels.

In addition to recharge and hydraulic conductivity values, the head values of constant-head cells were varied during the flow model calibration. In model layer 1 (the top layer), head values for the cells representing the Banana River and the canal were adjusted up and down by 0.1 foot, with resulting values of 0.4 foot above msl and 0.5 foot above msl for the river and the canal, respectively. In model layers 2 and 3, the values of the constant-head cells at the model margins also were adjusted to help simulate vertical gradients similar to those observed at the site.

Figure 5.3 shows the calibrated water table. Calibrated horizontal hydraulic conductivities ranged between 45 and 135 ft/day, with most cells having conductivities between 45 and 90 ft/day. In model layer 1, the vertical hydraulic conductivities that produced the best fit were equal to one-tenth of the horizontal conductivities. In model layers 2 and 3, the vertical conductivities producing the best results were equal to one-fiftieth of the corresponding horizontal hydraulic conductivities. As noted by Anderson and Woessner (1992), vertical hydraulic conductivities are often unknown and are estimated during calibration. Anderson and Woessner (1992) also note that ratios of vertical conductivities to hydraulic conductivities are commonly in the range of 1 to 0.001. The ratios used for the CCFTA-2 (FT-17) model are within that range.

Water level elevation data from 41 of 48 monitoring wells and monitoring points were used to compare measured and simulated heads for calibration. Data from the remaining 7 points at the site were excluded because the screens of some deep points were not deep enough to be below the bottom of model layer 1, because the data were anomalous, or because the points were in constant-head cells.

The root mean squared (RMS) error is commonly used to express the average difference between simulated and measured heads. RMS error is the average of the squared differences between measured and simulated heads, and can be expressed as:



LEGEND

- FORMER BURN PIT
- BURIAL TRENCH
- CCFTA2-17 — MONITORING WELL
- CPT6 — MONITORING POINT
- 2.2 — LINE OF EQUAL WATER TABLE ELEVATION (FEET MSL)

FIGURE 5.3

CALIBRATED WATER TABLE (MODFLOW)

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

L:\45025\FIG5_3, 5/14/97 at 11:54

$$RMS = \left[\frac{1}{n} \sum_{i=1}^{n} (h_m - h_s)_i^2 \right]^{0.5}$$

where: n = the number of points where heads are being compared,

h_m = measured head value, and

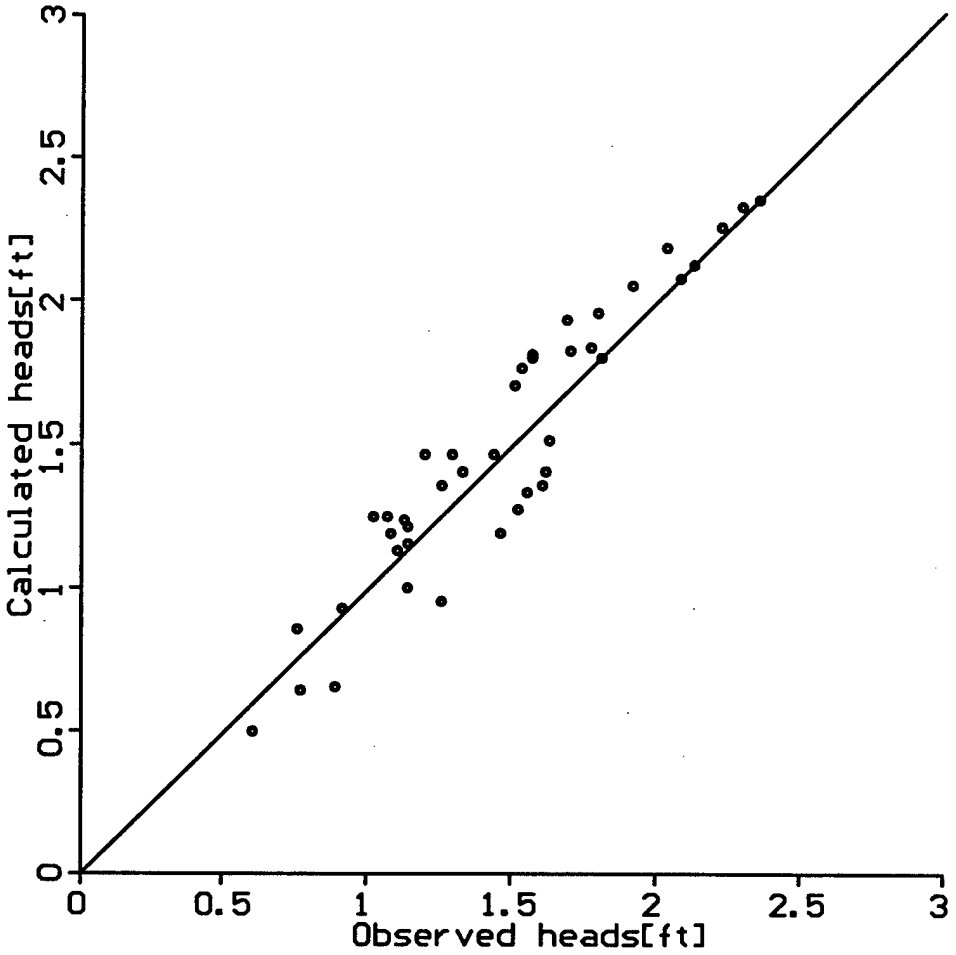
h_s = simulated head value.

The RMS error between observed and calibrated values at the 41 comparison points was 0.17 foot, which corresponds to a calibration error of 10 percent (the maximum difference in water levels measured at the site was about 1.7 feet). The RMS was calculated by commercial model post-processing software that also provides a comparison between measured and simulated heads. Figure 5.4 shows the relation between measured heads and simulated heads and the resulting RMS. This plot provides a qualitative method of checking the calibrated head distribution; the points should scatter randomly about the straight line (Anderson and Woessner, 1992).

To solve the groundwater flow equation, MODFLOW calculates an overall hydraulic balance that accounts for the numerical difference between flux into and out of the system. The hydraulic mass balance for the calibrated model was excellent, with 99.9 percent of the water flux into and out of the system being accounted for numerically (i.e., a 0.1-percent error). According to Anderson and Woessner (1992), a mass balance error of around 1 percent is acceptable, while Konikow (1978) indicates an error of less than 0.1 percent is ideal.

5.4.2 CAH Plume Calibration

Model input parameters affecting the distribution and concentration of the simulated CAH plume were modified so that model results for the time step corresponding to 1996 were similar to total dissolved CAH concentrations (expressed as µmol/L) measured in January 1996. To do this, model runs were made using the calibrated steady-state hydraulic parameters coupled with the introduction of contaminant mass in



Mean Error: 0.058 foot

Mean Absolute Error: 0.150 foot

RMS Error: 0.172 foot

FIGURE 5.4

CALCULATED HEADS VS. OBSERVED HEADS, GROUNDWATER FLOW MODEL

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.

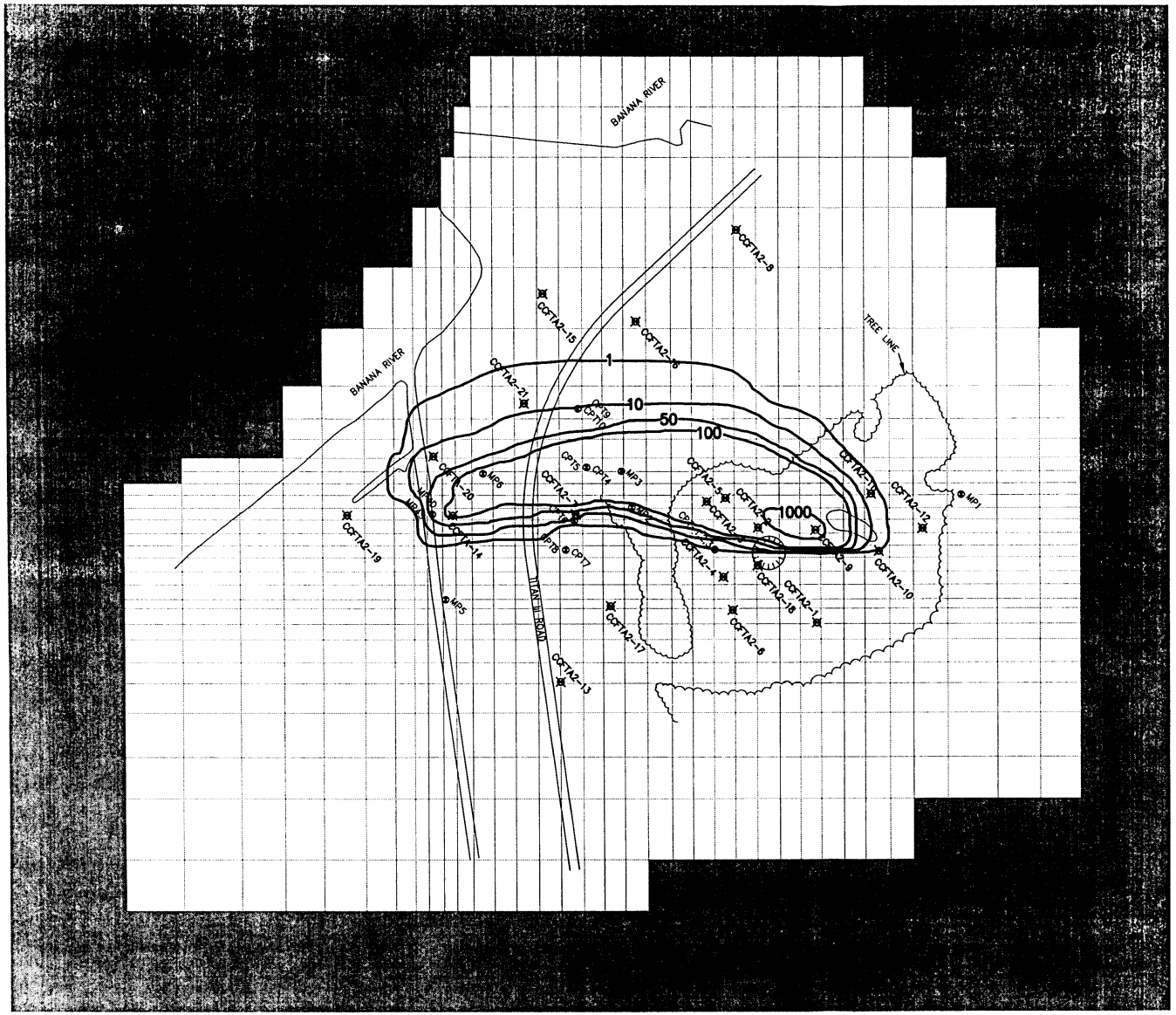
Denver, Colorado

L:\FIGURES\FIG5_4, 05/14/97 at 07:26

the area of the model corresponding to the mobile LNAPL containing chlorinated compounds. Transport model calibration was achieved by varying contaminant source term concentrations, rates of source concentration decreases, and contaminant transport parameters in the model in a trial and error fashion until simulated 1996 CAH concentrations were similar to observed concentrations. The calibrated plume is presented on Figure 5.5.

Observed January 1996 conditions and assumed 1965 conditions (prior to initiation of fire training activities) were used for model calibration. Groundwater was assumed to be clean in 1965, prior to initiation of fire training activities. After becoming operational, it was assumed that CCFTA-2 (FT-17) was used regularly until training activities ceased in 1985. For calibration purposes, a constant contaminant source term was approximated for the period from 1965 to 1985. Introduction of contaminants likely varied over time, but it is not possible to reconstruct these events. After 1985, it is reasonable to assume that the contamination source (residual and mobile LNAPL in the subsurface) began to decrease in strength due to the effects of leaching and weathering without the regular introduction of fresh product.

To simulate this history, the MT3D transport model was run for 20 years (1965 to 1985) with a "black box" source term introducing CAH mass into the model at a constant rate. Beginning in simulation year 21 and continuing to simulation year 31 (calendar years 1986 to 1996), the source term was reduced at geometric rates of 6 to 10 percent per year (i.e., injected CAH concentrations were decreased by 6 to 10 percent from the concentration used for the previous year to account for natural weathering of LNAPL and residuals). This reduction was used to simulate loss of CAH mass due to weathering (and without replenishment due to ongoing activity), and is consistent with weathering rates modeled at other sites within the AFCEE Intrinsic Remediation Demonstration program.



LEGEND

- FORMER BURN PIT
- BURIAL TRENCH
- CCFTA2-17 — MONITORING WELL
- CPT6 — MONITORING POINT
- 10 — LINE OF EQUAL TOTAL CAH CONCENTRATION (µmol/L) (SIMULATED)

CONTOUR INTERVAL = VARIABLE

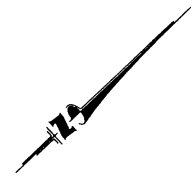


FIGURE 5.5

CALIBRATED TOTAL CAH PLUME (1996)

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

L:\4502\...\FIG5_5, 5/14/97 at 11:56

The partitioning of CAH compounds from residual and mobile LNAPL into the groundwater was simulated using the recharge boundary package of MT3D. This package assumes that mass is added to groundwater via recharge moving through the unsaturated zone. Locations of recharge source cells were first based on the historical distribution of mobile LNAPL at the site, but calibration of the plume required a slightly smaller modeled source area than indicated by the known extent of mobile LNAPL. However, the simulated source area roughly coincides with the areas of greatest LNAPL thickness and with the western end of the drum disposal trench. Locations of the source cells are shown on Figure 5.1. While the smaller source area appears to be inconsistent with observed LNAPL data, such an approach is reasonable given the "black box" approach discussed previously.

The primary differences between the simulated and measured plumes at Site CCFTA-2 (FT-17) are that concentrations along the plume axis are higher than those observed at the site, and that the southeastern portion of the plume is wider than indicated by field data. One reason for the concentration differences along the plume axis results from a lack of field data that clearly define the plume axis. These data could not be collected because of the inaccessibility of the area northwest of well CCFTA2-9, well CCFTA2-5, and monitoring point MP3. In addition, the groundwater flow field in the model is not identical to that of the natural system, given the calibration error and that a dynamic natural system is being represented as a steady-state system. This condition also explains why the southwestern edge of the plume extends further to the southwest than observed data indicate. Both differences result in a greater mass of contamination being present in the simulated plume than indicated by the field data. This makes the model conservative in that respect.

Slightly different concentrations calculated for model cells compared to corresponding wells or monitoring points result partially from the discretization of the system into cells as well as from the variations noted above. For example, the

calculated concentration for the cell containing CCFTA-20S is 12 µmol/L, but the measured concentration is 17 µmol/L. However, the well is near an edge of its corresponding model cell, and the adjoining cell has a simulated concentration of 22 µmol/L. Given this, the simulated concentrations for that area of the model was considered to be acceptable. Conversely, at MP2, the observed concentration was about 20 µmol/L, while the simulated concentration was 135 µmol/L. Again, the well is located very near a model cell edge and the adjoining cell had a simulated concentration of 10 µmol/L. The situation is somewhat the opposite of the first example, but the result also was considered to be acceptable. At monitoring point MP4, the corresponding model cell had a concentration of 68 µmol/L compared to the observed 87 µmol/L. The adjoining model cell nearest the well had a simulated concentration of 103 µmol/L, and so the simulated concentrations in that area were acceptable.

Site data on the vertical distribution of contaminants (Section 4.3.6 and Figure 4.5) suggested that most of the contaminant mass is in the upper portion of the aquifer, with CAHs detected in only a few of the deep wells and monitoring points. In the calibrated model, some contaminant mass is present in the second model layer, especially along the centerline of the plume beneath and downgradient of the source area. This is consistent with the observed data, and in general, the simulated concentrations in the second layer are higher than those observed in the field.

As noted previously, the main parameters varied during the calibration were dispersivity, the degradation rate constant, the coefficient of retardation, and the source concentrations. The following paragraphs briefly discuss how these parameters were varied and the rationale behind the calibration process.

5.4.2.1 Dispersivity

Much controversy surrounds the concepts of dispersion and dispersivity. Longitudinal dispersivity was originally estimated as 100 feet, using about one-tenth the distance between the source area and the canal. Results of initial model calibration runs indicated that this value was likely too high, and some values between 20 feet and 100 feet would cause the model calculations to oscillate and produce questionable results. The final dispersivity was set at 10 feet, which is consistent with a longitudinal dispersivity value of 13 feet calculated using the methods described by Xu and Eckstein (1995).

Transverse dispersivity values generally are estimated as one-tenth (0.1) of the longitudinal dispersivity values (Domenico and Schwartz, 1990). Vertical dispersivity values are typically lower than the transverse values, so it was assumed for this model that vertical dispersivity was 0.1 of the transverse dispersivity. During plume calibration, model output suggested that these values were appropriate, and that neither value (especially the vertical dispersivity) significantly affected results.

5.4.2.2 Biodegradation Rate Constant

As discussed in Section 4.5, the biodegradation rate constant was estimated to range from 0.00007 day^{-1} to 0.0005 day^{-1} on the basis of site data. This parameter was varied during plume calibration, and the calibrated model used a value of 0.0009 day^{-1}. Use of this value yielded a good match between simulated and measured CAH concentrations. The calibrated value is slightly greater than the maximum calculated rate. This higher rate may have been required because CAH degradation is in reality a multi-order process, dependent on several variables; however, the model code can only accommodate first-order degradation rates. CAH degradation rates are typically highest in a source area where fuel hydrocarbons are also present, but methods available for estimating first-order rates may underpredict source area degradation, and therefore require a higher overall rate to achieve calibration.

Another possible reason that a higher simulated biodegradation rate is required is that the calculated rates are for the process of reductive dechlorination only, while VC and DCE can be mineralized under aerobic conditions and VC can be mineralized under iron-reducing conditions. It is possible that these processes may be occurring in some portions of the plume. Geochemical data indicate that iron-reducing conditions are present, and it is likely that precipitation events introduce oxygenated groundwater to the system, and that oxygen facilitates short-term events of aerobic mineralization of VC and DCE. The simulated rate constant may therefore be appropriate because additional contaminant mass can be lost through these processes.

5.4.2.3 Coefficient of Retardation

Retardation of CAHs relative to the advective velocity of the groundwater occurs when CAH molecules are sorbed to organic carbon or clay in the aquifer matrix. Based on measured TOC concentrations near the water table, an assumed bulk density of 1.6 grams per cubic centimeter (g/cc) (typical for sediments of this type), and published values of the soil sorption coefficient (K_{oc}) for the CAH compounds (as summarized in Wiedemeier *et al.*, 1996c), the coefficients of retardation for the CAH compounds were calculated. The results of these calculations are summarized in Appendix C. The lower the assumed coefficient of retardation, the faster the contaminant will migrate downgradient. Although the retardation coefficients of the CAH compounds can vary significantly, the model allows only one coefficient to be entered because the model tracks only one solute. As a result, the average retardation coefficient for TCE (2.6) was used as the initial model input. During the plume calibration, this value was varied, and a value of 2.1 (similar to the average retardation coefficient calculated for DCE) was used in the calibrated model.

5.4.2.4 Source Concentrations

Nine model cells were used to simulate the source area in which CAHs partition from mobile and residual LNAPL. The locations and CAH concentrations of the source cells were varied until the calibrated plume matched measured conditions, as described previously. As noted previously, the cell configuration best used to reproduce the observed plume is shown on Figure 5.1. Also, the best results were obtained when the source was constant for the first 20 years of the calibration period, with concentrations thereafter decreasing by 6 percent per year to 10 percent per year. The rate at which the concentrations decreased was initially 6 percent, increasing to 10 percent over the last 11 years of the calibration period.

5.5 SENSITIVITY ANALYSIS

The purpose of a sensitivity analysis is to demonstrate model responses to variations in input parameters (Spitz and Moreno, 1996). Results of a sensitivity analysis can be used to identify sensitive parameters for which additional data collection (if feasible) would be most useful. For the CCFTA-2 (FT-17) model, the sensitivity analysis was conducted by varying dispersivity, the coefficient of retardation, the degradation/dechlorination rate constant, the effective porosity, recharge, and aquifer hydraulic conductivity. Each of these parameters was varied individually within ranges indicated by available site-specific data or relevant literature.

To perform the sensitivity analyses, the calibrated model was adjusted by systematically changing the aforementioned parameters individually, and then comparing the new simulations to the results of the original calibrated model. The models were run for a 31-year period, just as the original was, so that the independent effect of each variable could be assessed. Sixteen sensitivity runs of the calibrated model were performed, with the changes indicated in Table 5.2.

TABLE 5.2
MODEL SENSITIVITY ANALYSIS RESULTS
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

Parameter Change	Highest Concentration Entering Canal (µmol/L)	Concentration at MP4S (µmol/L)	Concentration at CCFTA2-14 (µmol/L)	Source Area Concentration[a] (µmol/L)	RMS Error (feet)	Width of 1 µmol/L isopleth[b] (feet)	Width of 10 µmol/L isopleth[b] (feet)	Width of 100 µmol/L isopleth[b] (feet)	Comments
NO CHANGES	103	68	113	1237	0.172	470	310	155	Calibrated model
α_L[c] = 20 feet	109	67	60	1155	--[d]	565	360	170	
α_L = 50 feet	88	49	46	991	--	760	450	155	
α_L = 5 feet	103	66	72	1206	--	385	260	175	
R[e] = 2.6	82	38	74	1190	--	430	300	145	
R = 1.0	115	109	96	1220	--	500	320	195	
R = 6.4	11	0.7	1.9	1260	--	290	155	--	
λ[f] = 0.00007	751	1621	1063	1516	--	670	470	295	
λ = 0.0005	246	218	212	1296	--	565	355	210	
λ = 0.0018	22	5.7	5.6	994	--	305	190	--	
recharge = 10 in/yr	70	31	35	1300	0.254	435	275	130	Recharge not changed in source area, so loading is consistent
recharge = 1 in/yr	118	111	88	1202	0.156	460	320	165	
uniform K[g]	43	1.6	1.3	1345	0.19	540	390	150	Plume veers to northwest
K x 2	99	99	176	669	0.16	475	315	165	
K / 2	34	11	11	2132	0.204	355	235	60	
n_e[h] = 0.1	57	19	33	1215	--	370	260	50	
n_e = 0.35	147	135	137	1407	--	510	330	190	

[a] For cell containing well CCFTA2-9S.
[b] Width measured along model column 16.
[c] α_L = longitudinal dispersivity.
[d] -- = not relevant or parameter not measurable.
[e] R = retardation coefficient.
[f] λ = biodegradation coefficient.
[g] K = hydraulic conductivity.
[h] n_e = effective porosity.

The results of the sensitivity analyses are summarized in Table 5.2. This table illustrates the effect of varying each transport parameter by showing changes in contaminant concentrations at several points within the model and by showing changes in isopleth widths. Contaminant concentrations were examined in the source area (in the cell containing well CCFTA2-9S) and at the downgradient end of the plume (at the cells containing well CCFTA2-14 and monitoring point MP-4, and by determining the highest concentration entering the canal). The isopleth widths were measured along model column 16, or roughly along a line from well CCFTA2-15 to well CCFTA2-13A. In addition, the effects of varying flow parameters were also assessed by showing changes in the RMS error.

In general, most of the changes resulted in a plume configuration that does not match or improve upon the calibrated plume, as suggested by the comparisons made in Table 5.2. One change in flow parameters appeared to have improved upon the calibration, but upon closer examination, it did not. When recharge was decreased to 1 in/year, the RMS error dropped and the plume widths and concentrations are similar to those at the comparison points the calibrated model. However, at other points throughout the plume, concentrations were not comparable with those in the calibrated model.

Results of the model runs for the sensitivity analysis show that the model is most sensitive to changes in the biodegradation rate constant. It is also sensitive to changes in the retardation coefficient and the effective porosity, both of which control contaminant velocity. In addition, the run made with uniform hydraulic conductivity shows that the hydraulic conductivity configuration used in the calibrated model is needed to reproduce the observed plume configuration. Overall, the results of the sensitivity analysis suggest that the parameters selected for the calibrated model are appropriate. The results do not make it clear if the solution is unique. Given the simplifying assumptions necessary for modeling total CAHs, the uniqueness of the

model is harder to determine because parameters such as the retardation coefficient and the degradation rate constant represent a compromise among the varying values for the different individual compounds.

5.6 MODEL PREDICTIONS

After calibration, the groundwater flow and contaminant transport model for CCFTA-2 (FT-17) was used to make predictions of future plume behavior. Two scenarios were simulated to estimate future groundwater CAH concentrations and extents. The first scenario does not assume source removal, in order to provide a baseline illustration of the effects of natural attenuation mechanisms. This scenario assumes that the source of CAHs diminishes by 10 percent per year (geometrically), consistent with the rate of source decrease used to produce the calibrated model. The second scenario assumed that just prior to the beginning of model year 1998, the source is instantly reduced to 10 percent of the final calibrated strength. After model year 1998, the remaining source strength is diminished by 10 percent per year (again, geometrically). This scenario was devised to illustrate the effects of source removal, assuming that a small amount of residual LNAPL will remain after excavation, resulting in a greatly diminished residual source that gradually weathers away.

To run these models, the calibrated model was used as a starting point and additional time steps were added. During those time steps, parameters affecting groundwater flow were not changed, and only the source terms of the contaminant transport portions of the models were changed, as described above. Both scenarios were run to predict conditions 70 years beyond the 1996 ending time of the calibrated model.

Results of these models are summarized in Section 6, and are interpreted in light of the interim remedial actions that have been implemented at or are planned for Site

CCFTA-2 (FT-17). The discussion in Section 6 is intended to illustrate the role natural attenuation may play as part of a site remediation strategy.

SECTION 6

EVALUATION OF RNA AS A COMPONENT OF SITE REMEDIATION

This section presents modeling results as they relate to the other remedial technologies to be implemented at Site CCFTA-2 (FT-17) at Cape Canaveral AS. Because two remedial actions are already in place or planned for the site, the intent of this evaluation is to present and interpret model results in a manner that will help assess whether RNA is appropriate for dissolved contamination in site groundwater.

6.1 SUMMARY OF PLANNED REMEDIAL ACTIONS

Typically in this section of the report, multiple remedial alternatives for the site would be developed and compared in terms of effectiveness, technical and administrative implementability, and cost. The comparison would include factors influencing alternatives development, such as the objectives of the AFCEE Intrinsic Remediation Demonstration program, contaminant properties, site geology and hydrogeology, contaminant properties, potential receptor exposure pathways, and remediation goals. However, these topics have been addressed in the FS that evaluates numerous remedial technologies for CCFTA-2 (FT-17) (OBG, 1995b), and in the EE/CA addressing the air sparging and excavation/soil washing IRAs (OBG, 1995a). On the basis of the work done for these documents, a set of interim measures (IMs) have been developed to reduce and attempt to reduce VOC concentrations in groundwater discharging to the drainage canal and the Banana River (OBG, 1996b).

The IM effort is a three-phased approach, consisting of: 1) a system to intercept and reduce VOC concentrations in the groundwater plume before discharge to surface water; 2) removal of soil and LNAPL sources of groundwater contamination; and 3)

treatment and remediation of remaining groundwater contamination within and downgradient from the site (OBG, 1996b). Specifically, the following actions have been implemented or are scheduled for implementation:

- A HASS has been installed parallel to Titan III Road (Figure 1.3) to intercept and volatilize the shallow VC plume. This system, which is designed to reduce VC concentrations in groundwater migrating above the sparge line to 50 μg/L, was installed in late 1996 (OBG, 1997).

- Soil and mobile LNAPL will be removed from the area of the burn pit and the drum disposal trench. This action is scheduled for mid-1997. Soil (including the LNAPL) will be excavated and treated on site via soil washing, then returned to the excavation.

- Treatment and remediation of remaining groundwater contamination: The use of RNA to address this issue will be evaluated in this section by presenting model results for dissolved contamination that consider RNA alone and in conjunction with effects of the other IMs.

Because the first two measures have already been implemented or planned, the primary focus of this section is to present the model predictions and how those results can be used to interpret the effects of RNA in conjunction with those measures.

Implementation of the engineered remedial actions described above will likely increase the rates at which contaminants are removed from groundwater in the vicinity of the canal. Installation of the HASS will aid in removal of VC before groundwater discharges to the canal. In addition to volatilizing and stripping VC from groundwater, the added oxygen could create conditions favorable for microbially mediated aerobic oxidation of VC and DCE (i.e., those compounds would be used as electron donors or substrates).

Overall, the HASS will likely prevent concentrations of the CAHs exceeding regulatory limits from reaching surface water and associated receptors. Source removal will decrease the mass of TCE entering site groundwater; however, it will also reduce the mass of petroleum hydrocarbons entering site groundwater. By decreasing the mass of available electron donors, reductive dehalogenation of CAHs may slow. Whether the loss of electron donors will be balanced by the decreased mass of CAHs entering groundwater is difficult to predict; such scenarios have not been studied or reported in the literature. It is also possible that excavation activities will temporarily oxygenate groundwater in the vicinity of the source, and this may affect CAH biodegradation. Nevertheless, once the source of TCE is eliminated, most of the remaining dissolved contaminant mass will be DCE and VC, which can be aerobically degraded or volatilized within the oxidized zone created by the HASS.

As discussed in the IM Work Plan for CCFTA-2 (FT-17) (OBG, 1996b), the goal of the IM (i.e., the HASS and the excavation/soil washing) is to reduce the concentration of VOCs in groundwater to 50 µg/L, in turn reducing concentrations of contaminants in surface water to acceptable levels. Therefore, evaluation of model results will primarily focus on the time needed to reach that goal (i.e., the time at which CAH concentrations greater than 50 µg/L no longer migrate beyond the HASS). Simulation of the HASS itself was not attempted because MT3D cannot readily approximate such a system.

6.2 MODEL RESULTS

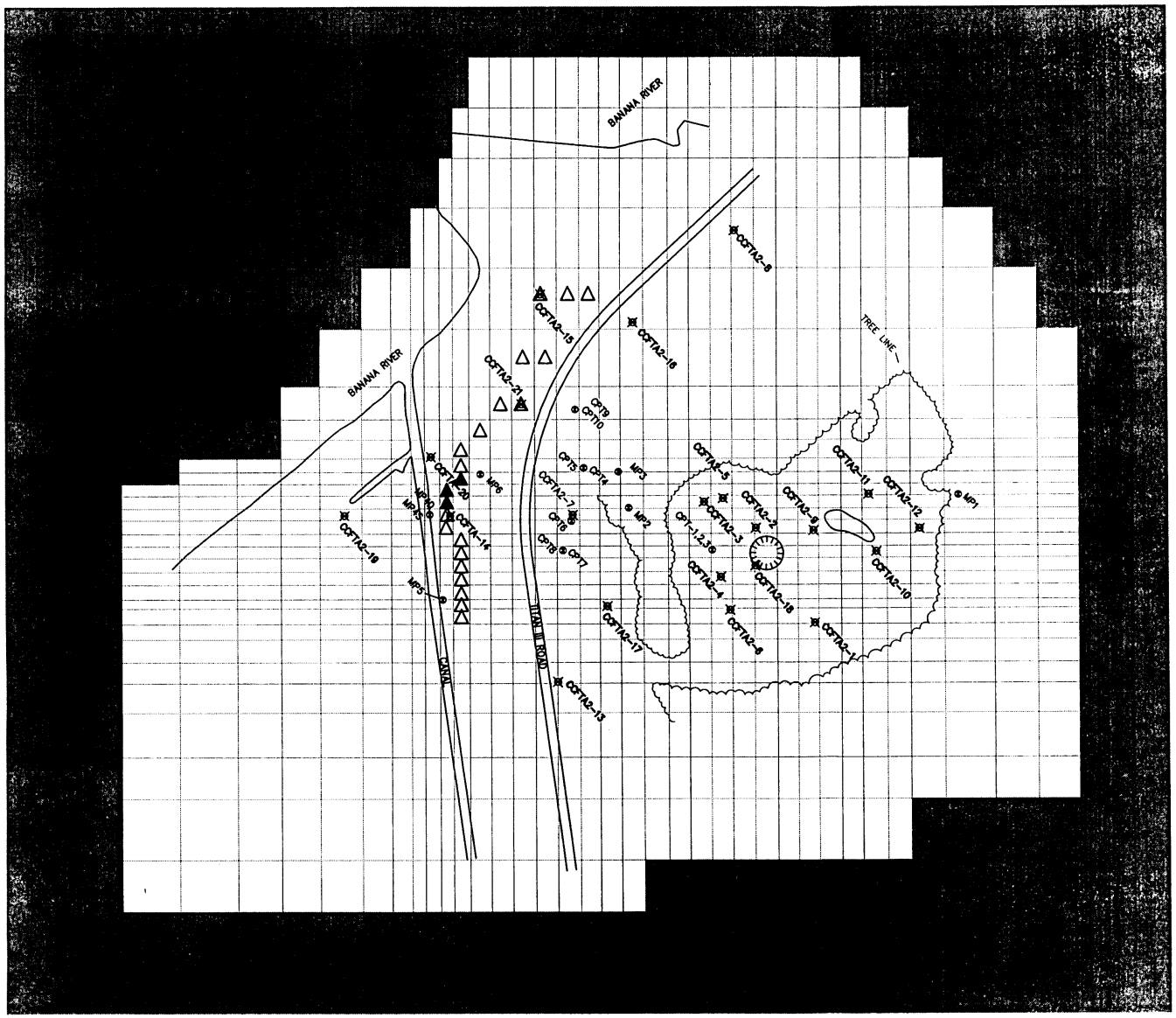
As noted in Section 5.6, two predictive model scenarios were set up and run using the calibrated model. The first scenario (model SR10) was designed with the assumption that the contaminant source would continue to weather at a rate of 10 percent per year (geometrically). This represents the case in which the CAH source area at CCFTA-2 (FT-17) is not excavated. This was done to provide a base case for illustrating the effects of natural attenuation alone (i.e., without any source removal). The second scenario (model SR90) was created with the assumption that excavation

would be completed just before the beginning of the model year 1998, and that this action would remove 90 percent of the remaining source. For the following time steps, it was assumed that the remaining source would weather at the rate of 10 percent per year. Both models assume that the first-order rate of reductive dehalogenation does not change with time, and that the supply of electron donors is sufficient to sustain reducing conditions for an indefinite period of time.

In place of maps showing CAH plumes predicted by the model, graphs of concentration trends will be used to illustrate model results in this section. The models were set up to track concentrations in cells corresponding to the HASS, using the simulated observation wells shown on Figure 6.1. At the end of each transport time step, the computed concentrations were written to a file, facilitating construction of graphs illustrating concentration changes over time in the cells containing the observation wells. This was done to more directly track the contaminant concentrations entering the HASS.

As noted on Figure 6.1, three cells consistently contained the highest CAH concentrations (i.e., they intersected the plume centerline). Concentration trends from these wells were used to interpret the time required for dissolved CAH concentrations to drop below thresholds of 0.8 μmoles/L and 0.4 μmoles/L. These values were selected because they correspond to 50 μg/L of VC and TCE, respectively [as noted in Section 6.1, the goal of the combined IM is to reduce VOC concentrations (consisting mostly of VC) below 50 μg/L]. VC has the lowest molecular weight of the CAHs at CCFTA-2 (FT-17), and TCE has the highest molecular weight. Therefore, using these two thresholds will bracket the range of time required to attain the remediation objectives.

Additional model results are presented in Appendix E. Specifically, predictive plume maps are presented to illustrate the simulated changes in the areal extent and concentration of the CAH plume over time for each scenario.



LEGEND

- FORMER BURN PIT
- BURIAL TRENCH
- CCFTA2-17 — MONITORING WELL
- CPT6 — MONITORING POINT
- △ OBSERVATION POINTS USED TO OBTAIN SIMULATED CONCENTRATION TRENDS FOR GROUNDWATER ENTERING HASS
- ▲ POINTS THROUGH WHICH HIGHEST CONCENTRATIONS PASS (PLUME CENTER)

0 100 200 400
FEET

FIGURE 6.1

LOCATION OF OBSERVATION WELLS FOR TRACKING SIMULATED CONCENTRATION TRENDS

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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6.2.1 Model SR10

As noted previously, model SR10 was run to simulate the effects of continued source weathering, assuming no source remediation. Simulated source concentrations were decreased by 10 percent per year (geometrically). Model concentration trends for the three centerline wells are presented on Figures 6.2 and 6.3, and maps of the CAH plume at selected times are presented in Appendix E. These trends are plotted as moving averages of 20 consecutive points of the model output. This was done because the MT3D code computes optimal time steps for the simulation such that certain criteria are met to ensure stability of the numerical approximation to the solution of the transport equation. As a result, for this model, there were nearly 1,800 individual time steps for which concentrations were recorded. Despite the number of time steps, there are still some significant fluctuations in the calculated concentrations, which is not unusual for a numerical transport model. Using the moving average makes the concentration histories much clearer and easier to view.

Figure 6.2 shows the trends for the full simulation, starting at a time of 0 days (corresponding to model year 1965), while Figure 6.3 shows a detail view of the same curves for the period between the model years 2035 to 2066. As shown on Figure 6.3, the highest simulated total CAH concentrations drop below 0.8 μmol/L at the model time step corresponding to the year 2043 (or about 46 years from 1997). Those concentrations drop below 0.4 μmol/L after about another 6 to 7 years, or about 52 to 53 years from 1997.

Concentrations in the source area also decrease over the duration of the 70-year predictive model, but they do not drop below the 0.4-μmol/L threshold. At the end of the simulation, the highest remaining CAH concentration is 0.77 μmol/L. This is equivalent to 48 μg/L of VC or 101 μg/L of TCE. While the model time frame was not long enough to determine when total CAH concentrations in the source area dropped below 0.4 μmol/L (or 50 μg/L of TCE), the concentrations will continue to decrease as the source weathers. The SR10 model was not run for more than 70 years

FIGURE 6.2
SIMULATED TOTAL CAH CONCENTRATIONS VS. TIME
AT SELECTED POINTS ALONG THE HASS (MODEL SR10)
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

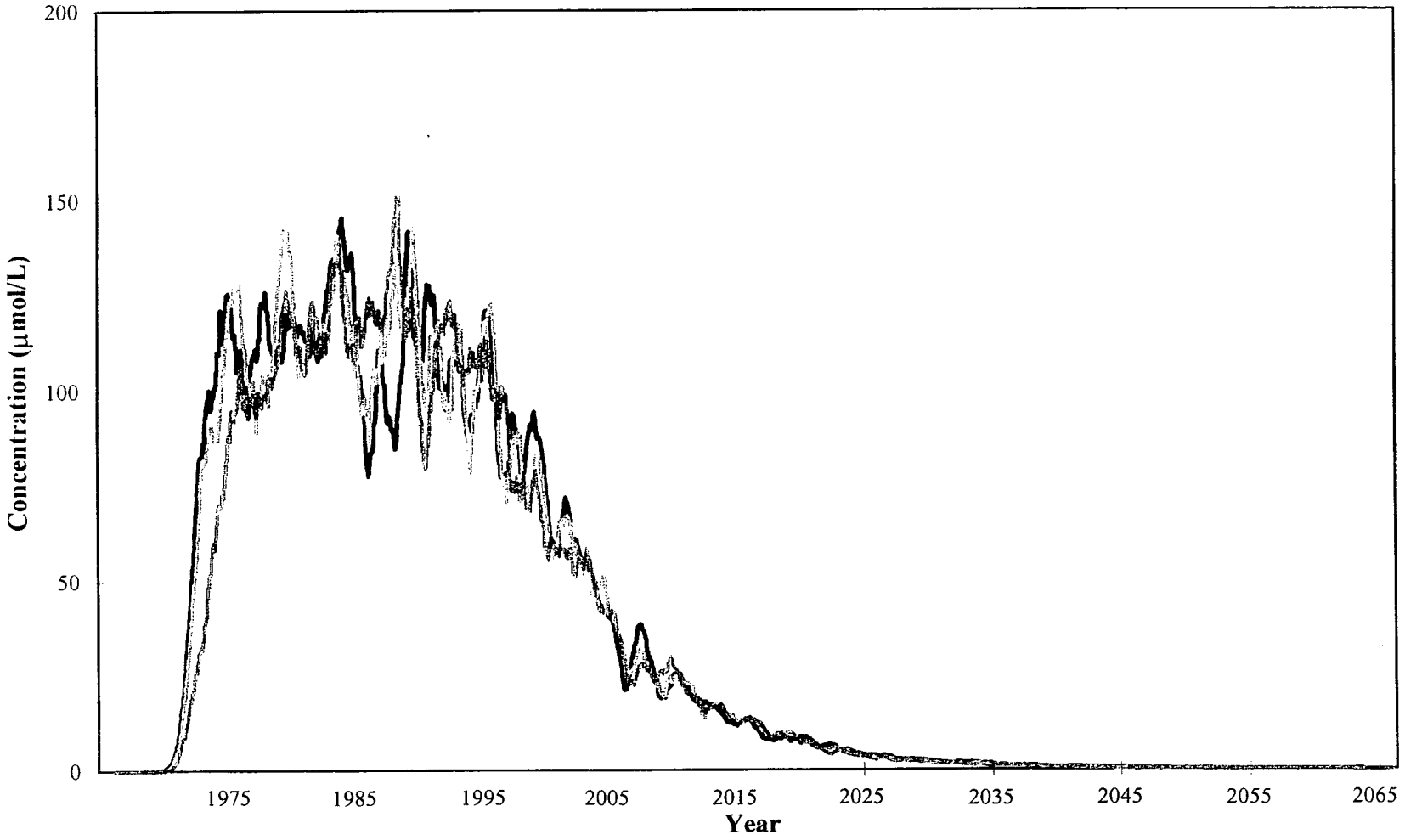
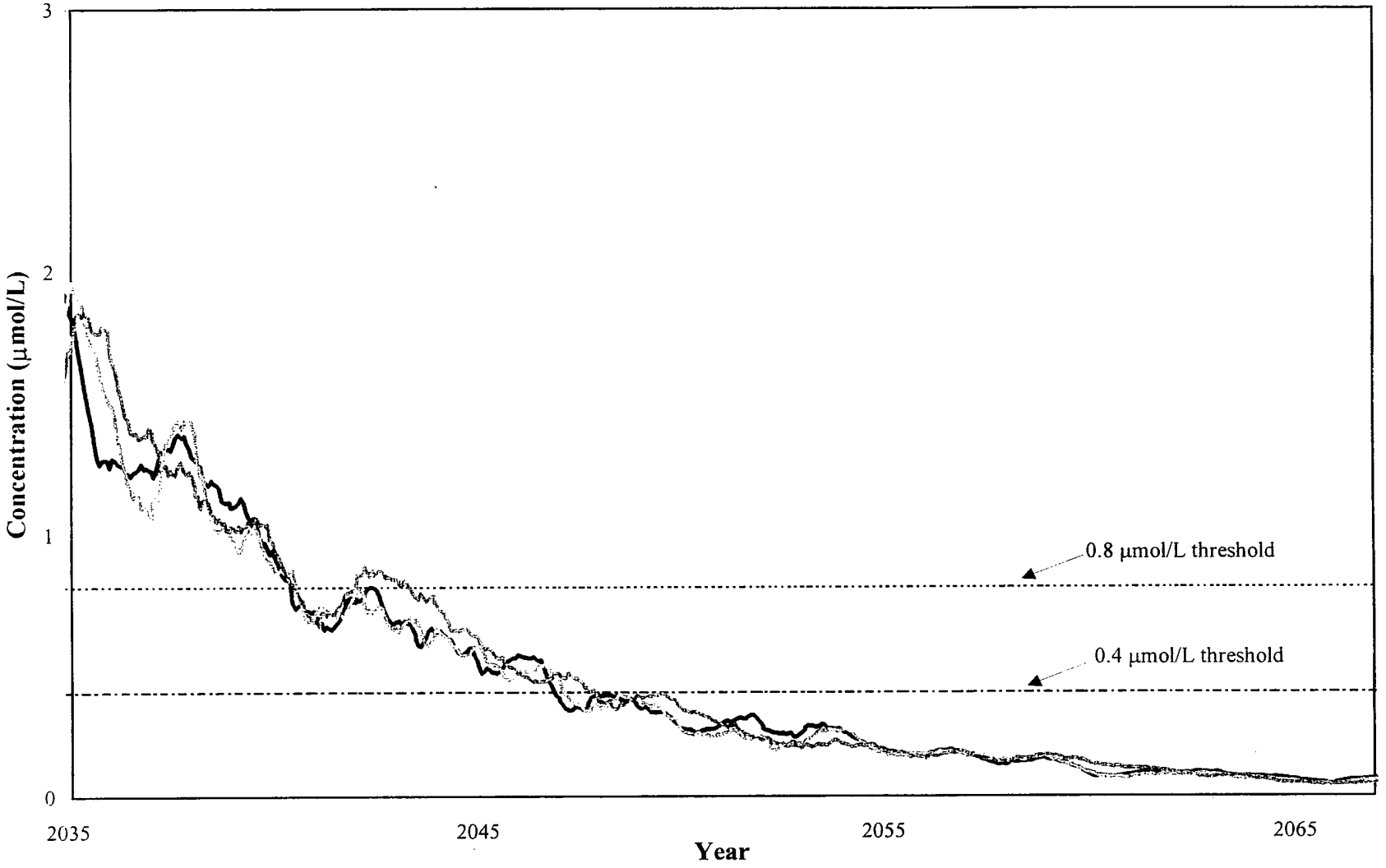


FIGURE 6.3

DETAIL OF SIMULATED TOTAL CAH CONCENTRATIONS VS. TIME AT SELECTED POINTS ALONG THE HASS (MODEL SR10)

CCFTA-2 (FT-17) RNA TS

CAPE CANAVERAL AIR STATION, FLORIDA



of predictive time because the source area will be excavated and there was no need to provide a comparison model with a longer time frame than model SR90 (which simulates the effects of source treatment).

6.2.2 Model SR90

Model SR90 was run to simulate the effects of source remediation via excavation and soil washing. To do so, the model was set up assuming that 90 percent of the source was instantly removed just prior to the simulation time step corresponding to 1998. Following the source removal, the remaining source is assumed to weather at the same rate as in model SR10, or 10 percent per year (geometrically). Model concentration histories for the three centerline wells are presented on Figures 6.4 and 6.5. Again, the moving average method was used to make the concentration histories more readable. Maps of the predicted plume at 10-year intervals are presented in Appendix E.

Figure 6.4 shows the trends for the full simulation, starting at a time of 0 days (corresponding to model year 1965), while Figure 6.5 shows a detail view of the same curves for the period corresponding to model years 2009 to 2035. Due to the source removal, concentrations drop more rapidly than in model SR10. As shown on Figure 6.5, the highest total simulated CAH concentrations passing through the HASS drop below 0.8 µmol/L in the time step corresponding to the year 2023 (or about 26 years from 1997). Those concentrations drop below 0.4 µmol/L after about another 5.5 to 6 years, or in the time step corresponding to the years 2028 to 2029. Total CAH concentrations in the source area drop below 0.4 µmol/L after about 60 years of simulation time and below 0.1 µmol/L (about 6.3 µg/L of VC or 13 µg/L of TCE) after about 65 years of simulation time for this scenario.

6.3 DISCUSSION

The model results suggest that natural attenuation of CAHs dissolved in groundwater at CCFTA-2 (FT-17), in conjunction with source removal and plume containment IMs,

FIGURE 6.4
SIMULATED TOTAL CAH CONCENTRATION VS. TIME
AT SELECTED POINTS ALONG THE HASS (MODEL SR90)
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

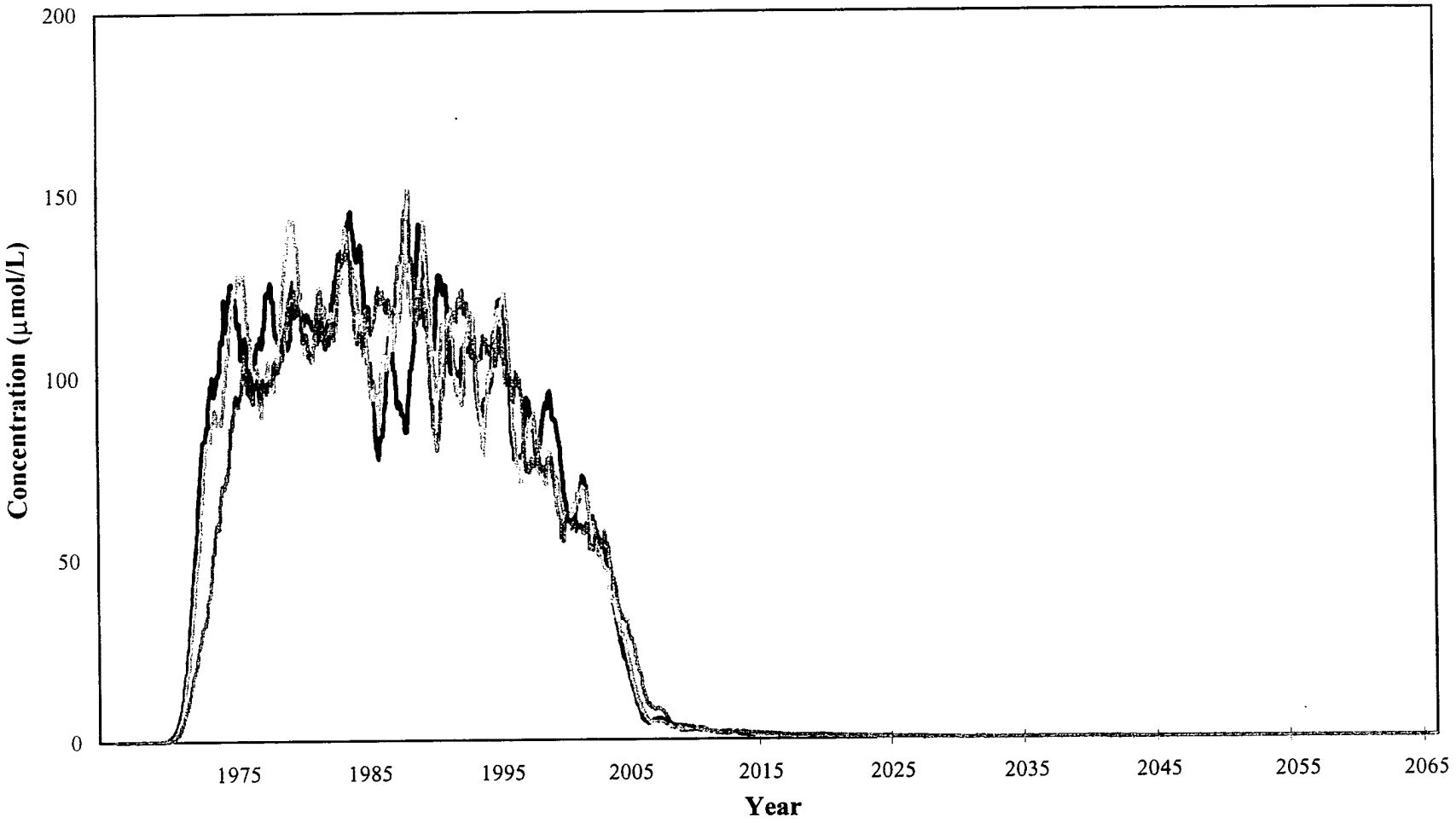
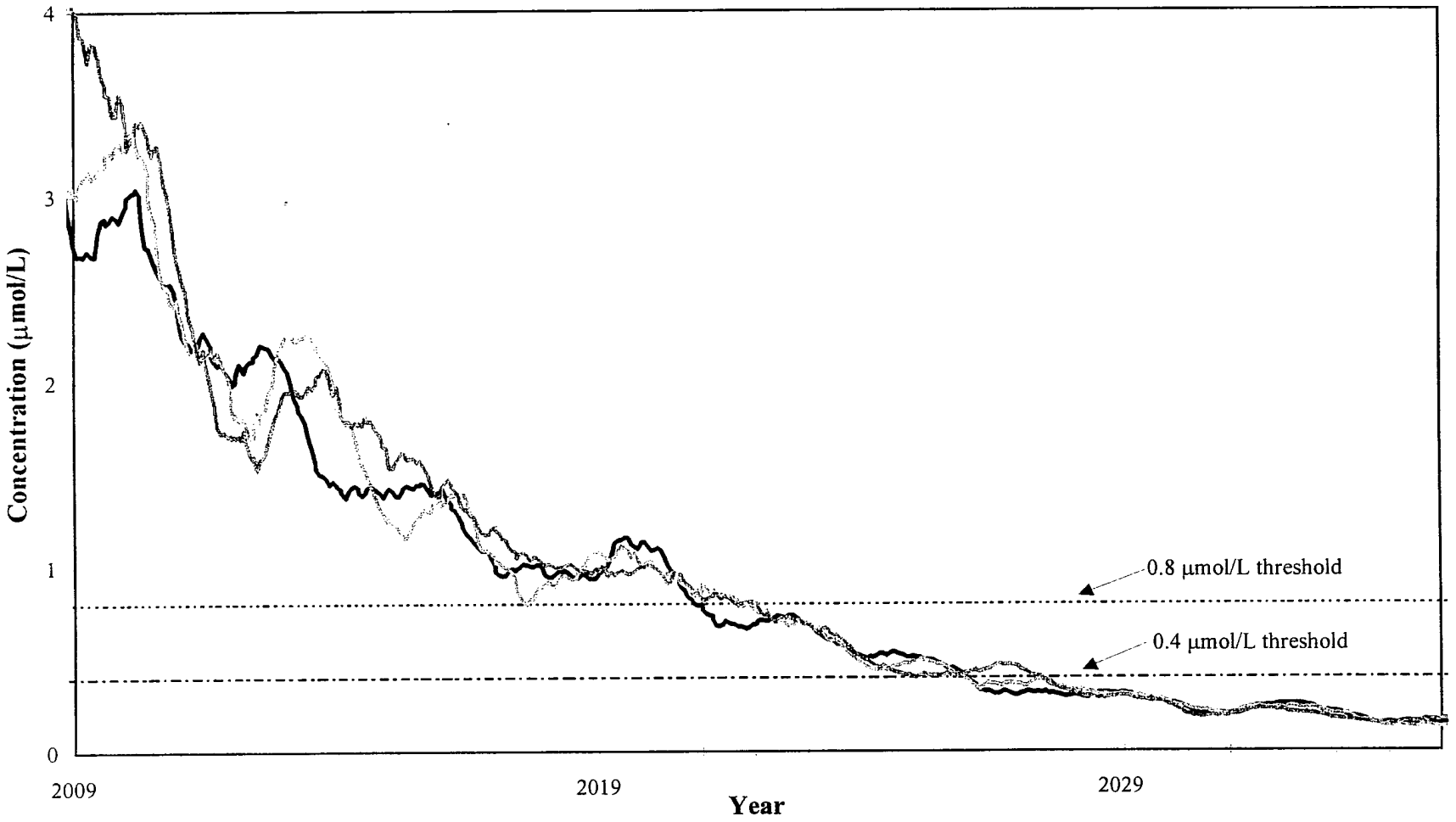


FIGURE 6.5
DETAIL OF SIMULATED TOTAL CAH CONCENTRATIONS VS. TIME AT SELECTED POINTS ALONG THE HASS (MODEL SR90)
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA



is capable of reducing dissolved contaminant concentrations to desired standards given sufficient time. As illustrated by model SR10, were the source area not to be remediated, the time needed to ensure that standards are met upgradient from the canal is on the order of 46 to 53 years from the present. When source remediation (i.e., excavation and soil washing) is factored into the model (model SR90), the necessary time drops to 26 to 32 years. Because the concentration trends were tracked at the approximate location of the HASS, these results suggest that if RNA is implemented for dissolved contamination in groundwater at CCFTA-2 (FT-17), the HASS will likely have to remain in operation for about 26 to 32 years in order to prevent VOC concentrations that exceed standards from reaching surface water. While unlikely, if source remediation is not implemented, the standards would not be met in the vicinity of the HASS for 46 to 53 years.

For concentrations in the source area to drop below standards will take longer, or just over 60 years if the source is removed and well over 70 years if the source is not remediated. These results point out the importance of source remediation for accelerating the time frame within which RNA can be used to meet site remediation goals. This is consistent with observations made at over 45 sites at which the AFCEE natural attenuation protocols (Wiedemeier *et al.*, 1995 and 1996c) have been implemented. Therefore, assuming the contaminant source at CCFTA-2 (FT-17) is remediated, that the HASS is left in operation, and that a 26- to 32-year time frame is acceptable, RNA is a viable option for remediation of dissolved contamination throughout the plume at CCFTA-2 (FT-17).

As noted previously, these modeled estimates assume that that the supply of electron donors is sufficient to maintain reductive dehalogenation and that biodegradation rates do not change with time. Neither the available analytical methods nor the current understanding of these processes are sufficient to provide data for resolving these issues. The validity of these assumptions can only be tested over time by monitoring concentrations of dissolved contaminants and other geochemical parameters. At

CCFTA-2 (FT-17), the concentrations of dissolved BTEX (which provides electron acceptors) in groundwater are low and will likely decrease further after soil excavation and soil washing is implemented. However, it appears that some native organic carbon in aquifer soil is being used as a source of electron donors. Whether the native organic matter or remaining residual fuel hydrocarbons will be sufficient to foster continuing reductive dehalogenation remains to be determined. Therefore, as at all sites, data from an LTM program are essential for ultimately verifying the viability and efficacy of RNA.

To account for these uncertainties, conservative (yet realistic) assumptions were used for the construction of the groundwater flow and contaminant transport models and for selection and calculation of site-specific model parameters. In addition, where site-specific data were not available, conservative estimates based on literature values were used. As a result, under the given assumptions the model results should be conservative (i.e., model results may overpredict contaminant concentrations and the time needed to meet site-specific criteria). If the assumptions do not hold true, then the conservative nature of the modeling results, in conjunction with an LTM plan, will allow sufficient time for the evaluation and implementation of additional remedial actions.

SECTION 7

LONG-TERM MONITORING

7.1 OVERVIEW

The following long-term groundwater monitoring plan proposed for CCFTA-2 (FT-17) was developed to allow assessment of site conditions over time, confirm the effectiveness of naturally occurring processes in reducing dissolved contaminant mass and minimizing dissolved contaminant migration, and facilitate evaluation of the need for additional remediation. This plan is designed on the basis of goals and strategies developed as part of the AFCEE Intrinsic Remediation Demonstration program and set forth in the AFCEE Technical Protocols (Wiedemeier *et al.*, 1995 and 1996c). As such, it may not account for all the site-specific monitoring requirements that may arise as a result of air sparging and source excavation activities. This plan has been prepared with the intent of recommending sampling locations and protocols for observing and evaluating changes in long-term dissolved contaminant concentrations and attenuation rates. It is assumed that this plan will be integrated with other monitoring plans that are part of the engineered remedial actions at the site.

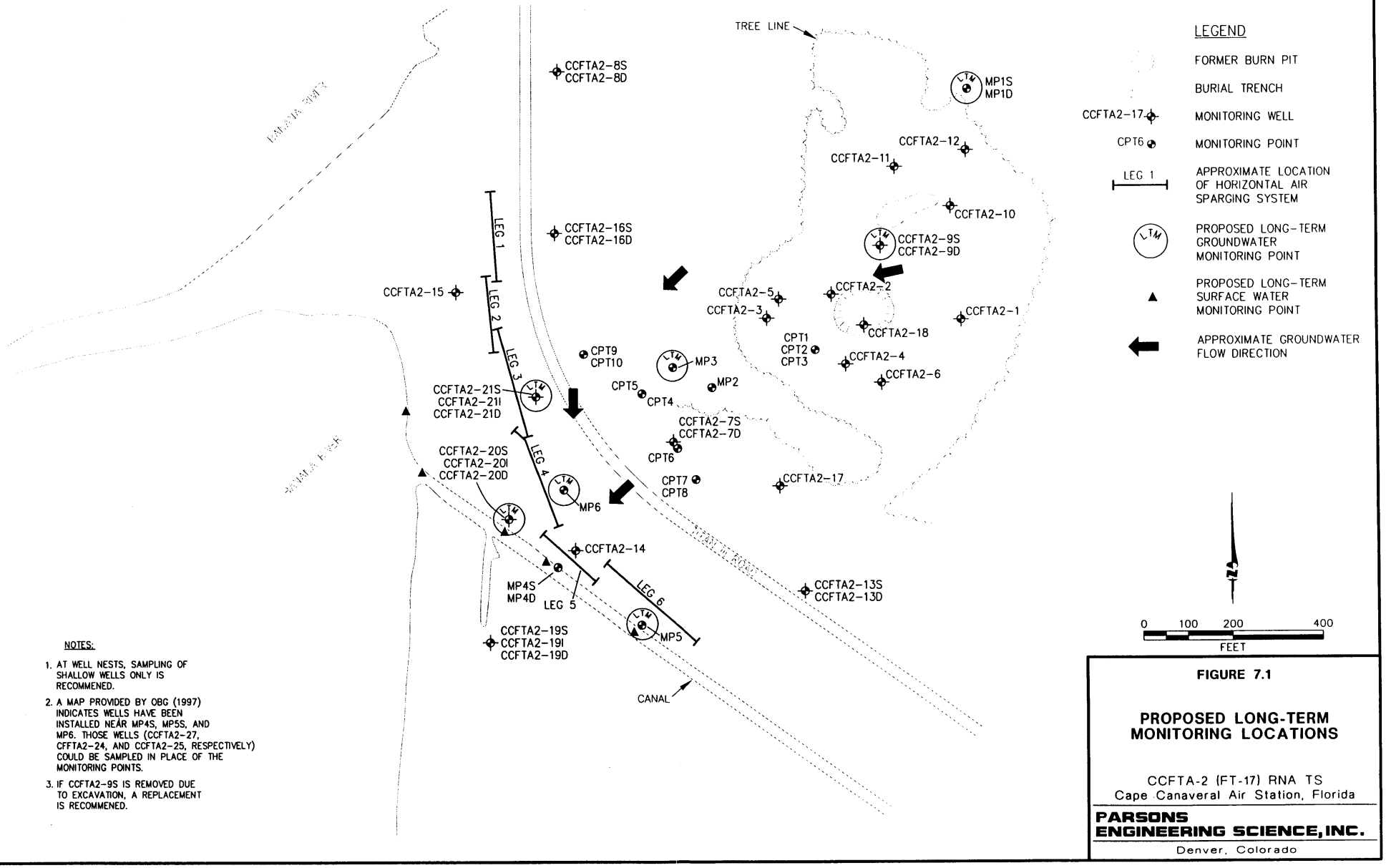
Long-term monitoring is an important element of RNA. The LTM plan consists of identifying the locations of LTM wells and developing a groundwater and surface water sampling and analysis strategy to demonstrate attainment of site-specific concentration goals (Section 6.1), to develop a historical database that conclusively demonstrates the continuing effectiveness of RNA, and to verify the predictions of the numerical contaminant fate and transport model. As with previous discussions in Sections 4, 5 and 6, this plan will focus on CAHs, owing to the low dissolved concentrations of

BTEX remaining in site groundwater. The strategy described in this section is designed to monitor plume behavior over time and to verify that natural processes (in conjunction with engineered actions) are adequately reducing contaminant concentrations and thus protecting potential receptors. In the event that data collected under this LTM program indicate that the planned combination of naturally occurring processes and engineered remedial actions is insufficient to protect human health and the environment, contingency controls to more aggressively remediate the dissolved CAH plume may be necessary.

7.2 GROUNDWATER MONITORING NETWORK

Long-term monitoring of groundwater from a minimum of 8 wells and/or monitoring points within or on the periphery of the CAH plume is recommended (Figure 7.1). These wells and points include MP1S, CCFTA2-9S, MP3, MP6, CCFTA2-21S, CCFTA2-20S, MP4S, and MP5. If CCFTA2-9S is removed during source area excavation, a replacement sampling point should be installed at or near the same location. Data on a map of the HASS provided by OBG (1997) indicate that several new monitoring wells have been installed since the field work for this evaluation was completed in January 1996. Some of these wells (e.g., CCFTA2-27, CCFTA2-24, and CCFTA2-25) appear to be near the locations of monitoring points MP4S, MP5, and MP6, respectively. These wells could be used for LTM in place of the monitoring points. MP1S is upgradient from the CAH plume, and CCFTA2-9S, MP3, and MP6 are along a flow path from the source area to the HASS. The remaining wells/points are at the plume margins or along the upgradient bank of the canal.

The wells/points suggested for LTM were chosen to provide a range of information on site groundwater conditions. MP1S was chosen to provide a location for collecting background geochemical data for comparison to conditions within the CAH plume, and to monitor any changes in background conditions. Data from wells/points along the flow path from the source area to the HASS will help monitor changes in contaminant



NOTES:

1. AT WELL NESTS, SAMPLING OF SHALLOW WELLS ONLY IS RECOMMENED.
2. A MAP PROVIDED BY OBG (1997) INDICATES WELLS HAVE BEEN INSTALLED NEAR MP4S, MP5S, AND MP6. THOSE WELLS (CCFTA2-27, CFFTA2-24, AND CCFTA2-25, RESPECTIVELY) COULD BE SAMPLED IN PLACE OF THE MONITORING POINTS.
3. IF CCFTA2-9S IS REMOVED DUE TO EXCAVATION, A REPLACEMENT IS RECOMMENED.

FIGURE 7.1

PROPOSED LONG-TERM MONITORING LOCATIONS

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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concentrations through time, as well as providing data that can be used to evaluate CAH degradation rates through time. Samples from CCFTA2-21S and MP6 will allow monitoring of contaminant concentrations entering the HASS, while samples from CCFTA2-20S, MP4S, and MP5 will allow monitoring of concentrations downgradient from the HASS and discharging to surface water.

Periodic sampling of these wells will allow continuing evaluation of the effectiveness of RNA (and the other remedial actions as well) at reducing CAH concentrations prior to groundwater discharge to surface water. In addition, the LTM results can be compared to model-predicted concentrations to assess whether the numerical model has accurately simulated plume migration over time.

7.3 SURFACE WATER MONITORING

Continued sampling of surface water in the canal is recommended at five locations (Figure 7.1), generally adjacent to or downgradient from monitoring wells that are concurrently sampled. Sampling at such locations will allow a more direct evaluation of changes in contaminant concentrations as groundwater discharges to surface water.

7.4 ANALYTICAL PROTOCOL

All LTM wells specified above should be sampled and analyzed to determine compliance with chemical-specific remediation goals and to verify the effectiveness of remediation at the site. Groundwater level measurements should be made during each sampling event. Groundwater samples from LTM wells should be analyzed for the parameters listed in Table 7.1. Surface water samples should be analyzed for VOCs using USEPA Method SW8260. A site-specific sampling and analysis plan (SAP) should be prepared as part of a remedial action plan (in compliance with site-specific goals and regulatory requirements) prior to initiating the LTM program.

TABLE 7.1
LONG-TERM GROUNDWATER MONITORING ANALYTICAL PROTOCOL
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

Analyte	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Ferrous Iron (Fe^{2+})	Colorimetric A3500-Fe D	Filter if turbid	May indicate an anaerobic degradation process due to the depletion of oxygen, nitrate, and manganese	Each sampling event	Collect 100 mL of water in a glass container; acidify with hydrochloric acid per method	Field
Ferrous Iron (Fe^{2+})	Colorimetric Hach 25140-25	Alternate method	Same as above.	Same as above	Collect 100 mL of water in a glass container	Field
Temperature	E170.1, direct-reading meter	Measure at well-head	Purging adequacy; metabolism rates for microorganisms depend on temperature	Each sampling event	Measure at well-head using a flow-through cell	Field
Dissolved Oxygen	Dissolved oxygen meter	Measure at well-head; refer to Method A4500 for a comparable laboratory procedure	Purging adequacy; concentrations less than 1 mg/L generally indicate an anaerobic pathway	Each sampling event	Measure at well-head using a flow-through cell	Field
pH	E150.1/SW9040, direct-reading meter	Measure at well-head	Purging adequacy; aerobic and anaerobic processes are pH-sensitive	Each sampling event	Measure at well-head using a flow-through cell	Field
Conductivity	E120.1/SW9050, direct-reading meter	Measure at well-head	General water quality parameter used as a marker to verify that site samples are obtained from the same groundwater system	Each sampling event	Collect 100–250 mL of water in a glass or plastic container	Field
Nitrate (NO_3^{-1})	IC method E300 or method SW9056; colorimetric, method E353.2	Method E300 is a Handbook[a/] method; method SW9056 is an equivalent procedure	Electron acceptor for microbial respiration if oxygen is depleted	Each sampling event	Collect up to 40 mL of water in a glass or plastic container; cool to 4°C; analyze within 48 hours	Fixed-base

TABLE 7.1 (concluded)
LONG-TERM GROUNDWATER MONITORING ANALYTICAL PROTOCOL
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

Analyte	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Sulfate (SO_4^{2-})	IC method E300 or method SW9056 or Hach SulfaVer 4 method	Method E300 is a Handbook method; method SW9056 is an equivalent procedure. Hach method is Photometric	Electron acceptor for anaerobic microbial respiration. Sulfate-reducing conditions are sufficient for reductive dehalogenation to begin.	Each sampling event	Collect up to 40 mL of water in a glass or plastic container; cool to 4°C	Fixed-base or field (for Hach method)
Oxidation-Reduction Potential (ORP)	A2580 B, direct-reading meter	Measurements are made with electrodes; results are displayed on a meter; samples should be protected from exposure to atmospheric oxygen	The redox potential of groundwater influences and is influenced by biologically mediated reactions; the redox potential of groundwater may range from more than 200 mV to less than -400 mV	Each sampling event	Measure at well-head using a flow-through cell	Field
Methane, Ethane, and Ethene	RSKSOP-114 modified to analyze water samples for methane by headspace sampling with dual thermal conductivity and flame ionization detection.	Method published and used by the USEPA Robert S. Kerr Laboratory	The presence of methane indicates the presence of optimal conditons for reductive dehalogenation to occur	Each sampling event	Collect water samples in 40 mL volatile organic analysis (VOA) vials with butyl gray/Teflon-lined caps (zero headspace); cool to 4°C	Fixed-base
Volatile Organics	GC/MS method SW8260	Handbook method	Measured for regulatory compliance	Each sampling event	Collect water samples in a 40 mL VOA vial; cool to 4°C; add hydrochloric acid to pH < 2	Fixed-base

a/ Handbook refers to "AFCEE Handbook to Support the Installation Restoration Program (IRP) Remedial Investigation / Feasibility Study (RI/FS).

7.5 SAMPLING FREQUENCY

Under the current remedial strategy (air sparging and source excavation/soil treatment), total dissolved CAH concentrations in excess of the 50-µg/L threshold concentration may be present far enough downgradient from the source area to discharge to surface water for up to 32 years. In the source area, total dissolved CAH concentrations exceeding 50 µg/L may be present for 50 to 60 years. Annual monitoring for the first 15 to 20 years should provide sufficient information to assess if RNA (and other remedial actions) are sufficiently reducing dissolved contaminant concentrations. After that time, or after groundwater contaminant concentrations adjacent to surface water and/or upgradient of the HASS drop below 50 µg/L (and potentially, the HASS is shut off), the sampling frequency could be reduced to once every 2 years.

Source area LTM may need to continue for 50 to 60 years, depending upon the ultimate remediation goals set for groundwater in that area. However, once LTM data indicate that CAH concentrations discharging to surface water are acceptable and continuing to decline, source-area monitoring intervals could be reduced even further (e.g., once every 3, 4, or 5 years).

The ultimate (comprehensive) LTM plan prepared for CCFTA-2 (FT-17) should be periodically reviewed and revised as appropriate on the basis of available groundwater and surface water quality data. For example, if LTM data indicate that the plume has stabilized or is receding, and that CAH concentrations are diminishing faster than predicted, then the sampling frequency could be reduced at that time. If the data collected at any time during the monitoring period indicate the need for additional remedial activities at the site, sampling frequency should be adjusted accordingly.

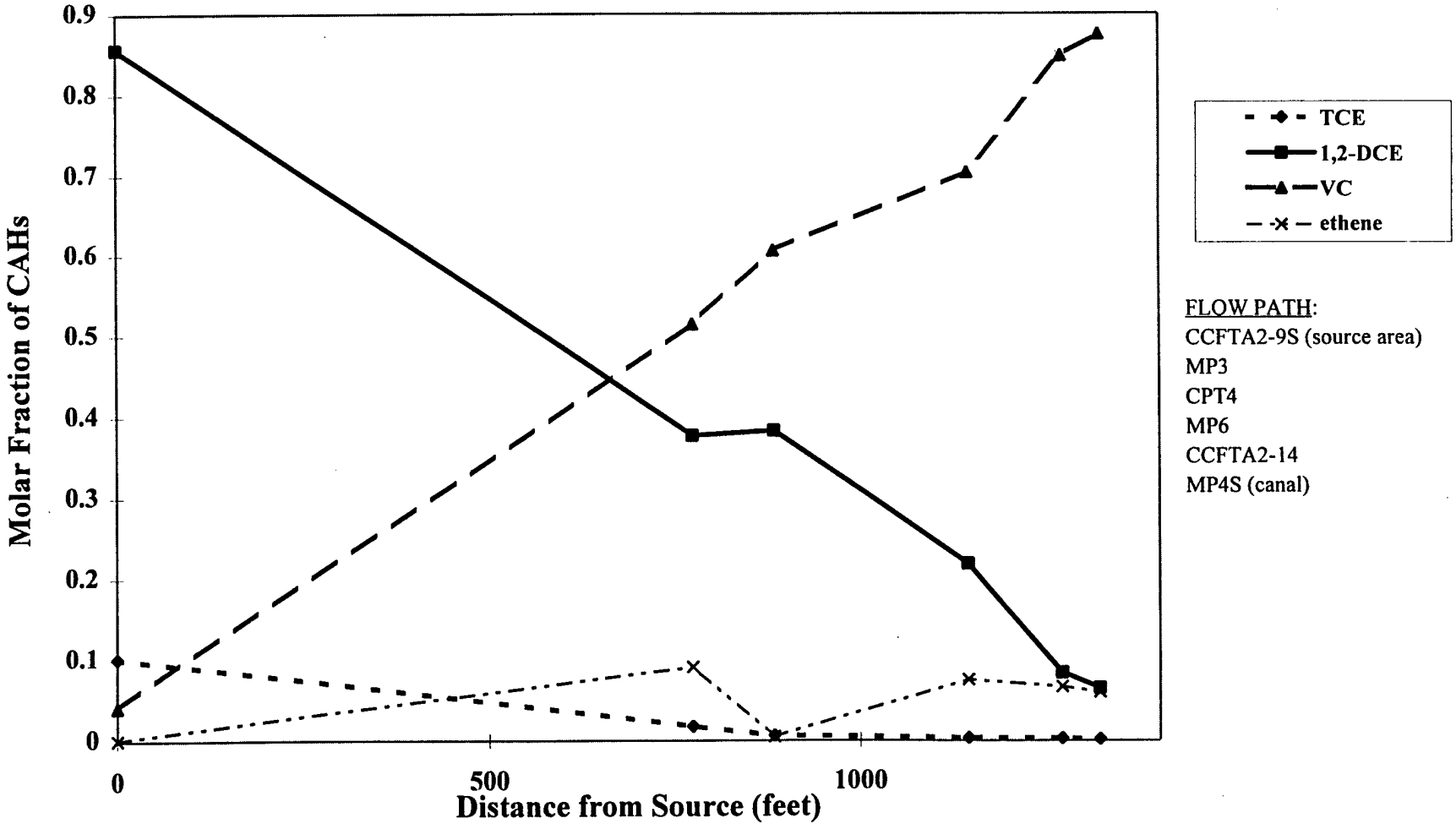
SECTION 8

CONCLUSIONS AND RECOMMENDATIONS

Results of this TS indicate that RNA is a viable alternative for treatment of fuel-hydrocarbon- and CAH-contaminated groundwater in the vicinity of site CCFTA-2 (FT-17) at Cape Canaveral Air Station, Florida. RNA will not be the sole remedy for site remediation; the HASS has been installed to reduce CAH concentrations that discharge to surface water, and source area excavation and soil washing is planned. Both of these actions will complement the effects of RNA by reducing the mass of contaminants entering groundwater and discharging to surface water.

Comparison of CAH, BTEX, electron acceptor, and byproduct data provides strong evidence that CAHs dissolved in groundwater at CCFTA-2 (FT-17) are being reductively dechlorinated (i.e., utilized as electron acceptors) as fuel hydrocarbons and native organic carbon are consumed as substrates for microbial life processes. Microbial consumption of fuel hydrocarbons (e.g., BTEX) is sufficient to keep BTEX concentrations in groundwater at or below 330 µg/L, despite the presence of mobile LNAPL. Consumption of fuel hydrocarbons also produces conditions that are sufficiently reducing for biodegradation of CAHs to proceed. Reductive dechlorination is occurring to the extent that TCE entering groundwater from the LNAPL is altered so rapidly that the molar concentration of DCE beneath the LNAPL is more than 8 times the TCE concentration (Figure 8.1). Downgradient from the source, DCE is dechlorinated to form VC at a relatively rapid pace, and the VC is more slowly dechlorinated to ethene. This is also shown on Figure 8.1, with VC concentrations steadily increasing downgradient from the source area, and with low concentrations of ethene produced as well. Figure 8.1 also illustrates that

FIGURE 8.1
MOLAR RATIOS OF CAHs ALONG THE PLUME CENTERLINE
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA



FLOW PATH:
CCFTA2-9S (source area)
MP3
CPT4
MP6
CCFTA2-14
MP4S (canal)

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dechlorination rates are greatest in the source area (where TCE is altered to DCE), and slowest downgradient (where VC accumulates and only low concentrations of ethene are produced).

Site-specific geologic, hydrologic, and laboratory analytical data were used to create a numerical groundwater flow and solute transport model (using the codes MODFLOW and MT3D) to simulate the effects of advection, dispersion, sorption, and biodegradation on the fate and transport of the dissolved CAH plume. Extensive site-specific data were used for model calibration. Model parameters that could not be obtained from existing site data were estimated using reasonable literature values for aquifer materials similar to those found at the site. After calibration, two predictive scenarios were run to assess the time frame within which total CAH concentrations crossing the HASS (and that could discharge to surface water) would drop below 50 µg/L

For one simulation (model SR10), it was assumed that CAH dissolution from source area LNAPL and soils into groundwater would naturally decrease at a rate of 10 percent per year (each concentration was decreased by a factor equal to 10 percent of the previous year's concentration). The results of this model suggest that CAH concentrations that could migrate beyond the location of the HASS would drop below 50 µg/L after 46 to 53 years, although source area concentrations would exceed 50 µg/L for more than 70 years. The second simulation (model SR90) assumes that source excavation and soil washing would immediately reduce source loading by 90 percent, with the remaining source weathering at a rate of 10 percent per year. Results of this model suggest that CAH concentrations that could migrate beyond the location of the HASS would drop below 50 µg/L after 26 to 32 years, and that source area concentrations would drop below 50 µg/L after about 60 years.

Model results are based on the assumption that CAH biodegradation rates will not change over time. This depends upon the amount of organic carbon that is available for use as a microbial substrate. Therefore, as BTEX and native carbon is consumed,

reductive dechlorination rates could decrease. However, it is possible that VC could be consumed as a substrate under reducing conditions, and should conditions become sufficiently oxidizing, both VC and DCE could be consumed as microbial substrates. Because most of the CAH mass dissolved in groundwater is VC and DCE (Figure 8.1), microbial utilization of DCE and VC as substrates may become a more important mechanism of CAH degradation over time, particularly because source area remediation will greatly reduce or eliminate the flux of TCE into site groundwater. Consumption of VC and DCE as substrates may also be fostered in the area of the HASS, where conditions will be relatively oxidizing due to the introduction of oxygen.

Predicting which mechanisms will ultimately dominate at the site is difficult, given the current understanding of CAH biodegradation at the field scale. As a result, LTM is a necessary component for the implementation of RNA. To verify that natural attenuation mechanisms will continue to reduce contaminant concentrations, LTM involving annual sampling of groundwater at eight locations and of surface water at five locations is recommended (Figure 7.1). The duration and intervals of the sampling may be changed in different areas of the site as dictated by the LTM results. Should LTM data suggest that RNA is not effective in reducing CAH concentrations, additional (engineered) remedial action may be necessary.

SECTION 9

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APPENDIX A

CPT LOGS, GEOPROBE® BOREHOLE LOGS, MONITORING POINT CONSTRUCTION DIAGRAMS, MONITORING POINT DEVELOPMENT AND PURGING DATA SHEETS, AND WELL/POINT SAMPLING DATA SHEETS

MONITORING POINT INSTALLATION RECORD

JOB NAME CAPE CANAVERAL, FL MONITORING POINT NUMBER MP-1S

JOB NUMBER 722450.29 INSTALLATION DATE 1/24/96 LOCATION upgradient

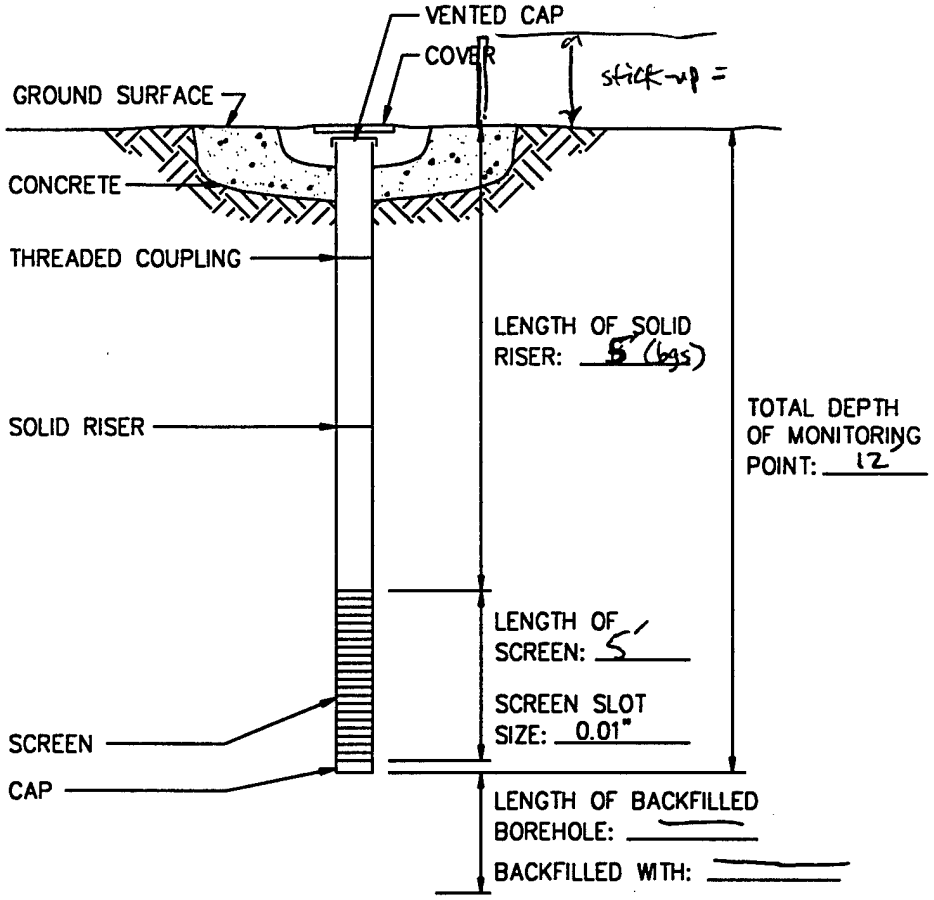
DATUM ELEVATION _____ GROUND SURFACE ELEVATION _____

DATUM FOR WATER LEVEL MEASUREMENT TOC

SCREEN DIAMETER & MATERIAL 0.5" ID Sch. 40 PVC SLOT SIZE 0.010"

RISER DIAMETER & MATERIAL 2" screen BOREHOLE DIAMETER 2"

GEOPROBE CONTRACTOR USEPA ES REPRESENTATIVE MS/MV



(NOT TO SCALE)

STABILIZED WATER LEVEL _____ FEET BELOW DATUM.

TOTAL MONITORING POINT DEPTH _____ FEET BELOW DATUM.

GROUND SURFACE _____ FEET

MONITORING POINT INSTALLATION RECORD

Intrinsic Remediation Demonstration
Cape Canaveral, FL

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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MONITORING POINT INSTALLATION RECORD

JOB NAME CAPE CANAVERAL, FL — MONITORING POINT NUMBER MP-1D

JOB NUMBER 722450.29 — INSTALLATION DATE 1/24/90 — LOCATION

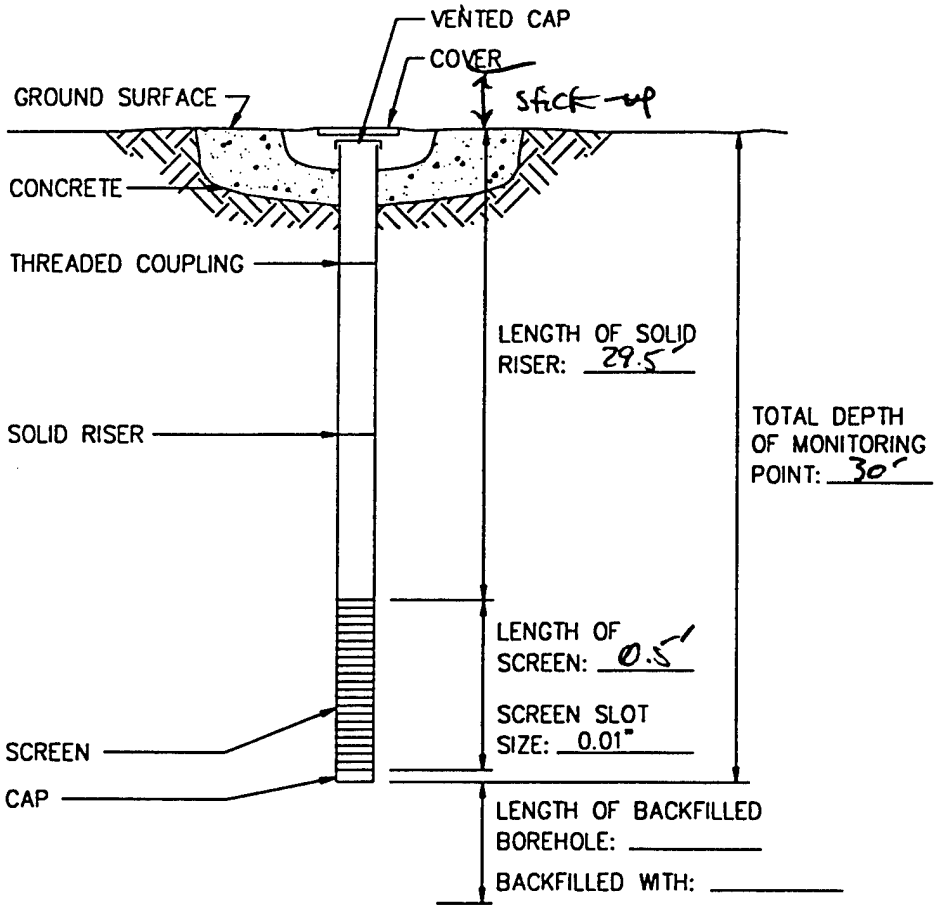
DATUM ELEVATION — GROUND SURFACE ELEVATION

DATUM FOR WATER LEVEL MEASUREMENT

SCREEN DIAMETER & MATERIAL Sch 40 PVC; 0.5" ID — SLOT SIZE 0.01"

RISER DIAMETER & MATERIAL 2" Screen — BOREHOLE DIAMETER 2"

GEOPROBE CONTRACTOR USEPA/ES — ES REPRESENTATIVE MS/MV



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STABILIZED WATER LEVEL _____ FEET BELOW DATUM.

TOTAL MONITORING POINT DEPTH _____ FEET BELOW DATUM.

GROUND SURFACE _____ FEET

MONITORING POINT INSTALLATION RECORD

Intrinsic Remediation Demonstration
Cape Canaveral, FL

PARSONS ENGINEERING SCIENCE,
Denver, Colorado

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GEOLOGIC BORING LOG

Sheet 1 of 1

BORING NO.: MP-1 CONTRACTOR: Parsons ES DATE SPUD: 1/24/96
CLIENT: AFCEE RIG TYPE: Geoprobe DATE CMPL.:
JOB NO.: 72450.29 DRLG METHOD: Geoprobe/Percussion ELEVATION: ≈ 12' above MSL
LOCATION: Cape Canaveral BORING DIA.: 2" TEMP: 70°
GEOLOGIST: MS/MV DRLG FLUID: none WEATHER: cloudy
COMENTS: PID Wkgrd = 0.1 - 0.5

Elev (ft)	Depth (ft)	Profile	US CS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
	1		SP	Yellow-tan SAND; f-VC; mostly f-m some shells upper 2.5'; becoming finer (mostly f-m) w/ depth					0.1			
	5		SP	tan f. sand to ≈ 6'; rust-colored 6-7'; tan-rust f-m sand, some coarse 7-8'; some stratification apparent; wet at tip					0.5			
	10		SP	grey-tan f-m sand w/ some coarse shell material; w/ depth, becoming more well-sorted; saturated					0.1			
	15			Built well to 12' bgs 5' screen 1 sample - 9-10' for TOC will push blind for MP-1D								
	20											
	25											
	30											
	35											

NOTES
bgs – Below Ground Surface
GS – Ground Surface
TOC – Top of Casing
NS – Not Sampled
SAA – Same As Above

SAMPLE TYPE
D – DRIVE
C – CORE
G – GRAB

▼ Water level drilled

GEOLOGIC BORING LOG

CCFTA-2(FT-17)
Intrinsic Remediation Demonstration
Cape Canaveral Air Station, Florida

ENGINEERING-SCIENCE, INC.
Denver, Colorado

MONITORING POINT INSTALLATION RECORD

JOB NAME CAPE CANAVERAL, FL MONITORING POINT NUMBER MP-25

JOB NUMBER 722450.29 INSTALLATION DATE 1/24/96 LOCATION _____

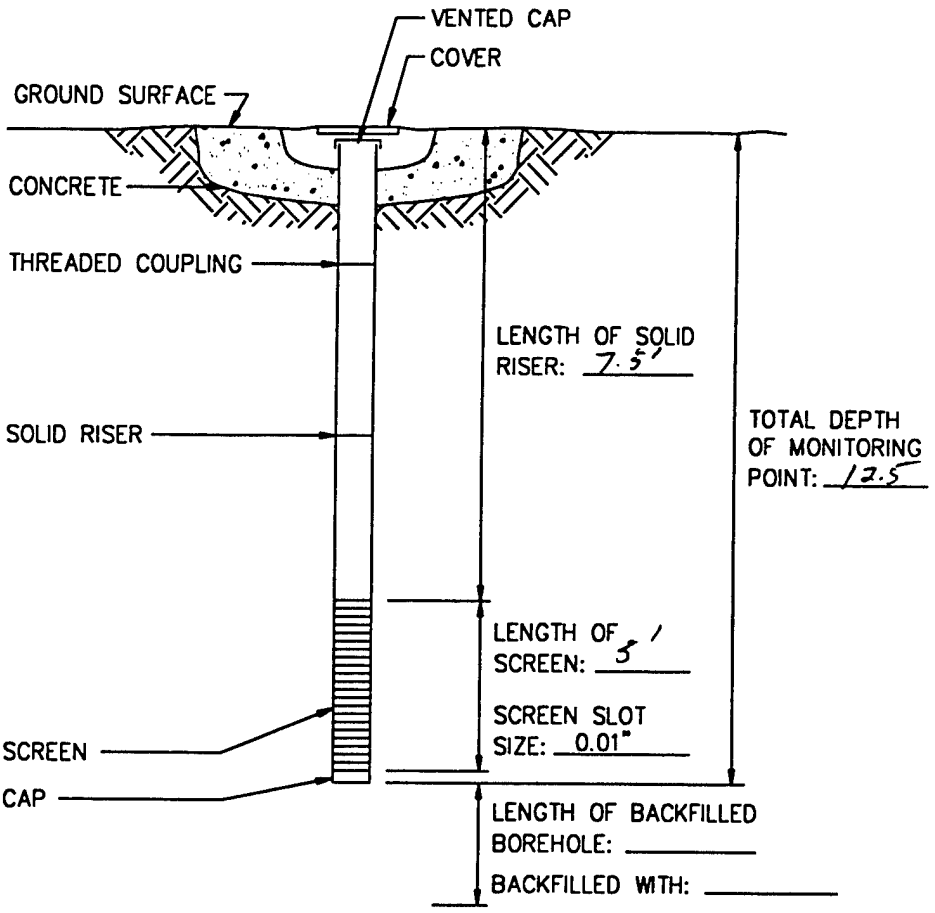
DATUM ELEVATION _____ GROUND SURFACE ELEVATION _____

DATUM FOR WATER LEVEL MEASUREMENT _____

SCREEN DIAMETER & MATERIAL _____ SLOT SIZE _____

RISER DIAMETER & MATERIAL _____ BOREHOLE DIAMETER _____

GEOPROBE CONTRACTOR _____ ES REPRESENTATIVE MS/MV



(NOT TO SCALE)

STABILIZED WATER LEVEL _____ FEET BELOW DATUM.

TOTAL MONITORING POINT DEPTH _____ FEET BELOW DATUM.

GROUND SURFACE _____ FEET

MONITORING POINT INSTALLATION RECORD

Intrinsic Remediation Demonstration
Cape Canaveral, FL

PARSONS ENGINEERING SCIENCE, I

Denver, Colorado

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GEOLOGIC BORING LOG

Sheet 1 of 1

BORING NO.: MP-2 CONTRACTOR: _____ DATE SPUD: _____
CLIENT: AFCEE RIG TYPE: _____ DATE CMPL.: _____
JOB NO.: 722450.29 DRLG METHOD: _____ ELEVATION: _____
LOCATION: CAPE CANAVERAL BORING DIA.: _____ TEMP: _____
GEOLOGIST: _____ DRLG FLUID: _____ WEATHER: _____
COMENTS: _____

Elev (ft)	Depth (ft)	Pro-file	US CS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
	1		SP	Yellow-tan, fine sand well sorted; no stratification; no structures; damp								
	5		SP	As above to 5'; 5-8' = f-m tan sand; some coarse shelly material; sat ≈ 7'								
	10		SP	as above; more coarse sand @ 10'; grey @ 10'; saturated								
				TD 12.5'								
	15											
	20											
	25											
	30											
	35											

NOTES

bgs – Below Ground Surface
GS – Ground Surface
TOC – Top of Casing
NS – Not Sampled
SAA – Same As Above

SAMPLE TYPE

D – DRIVE
C – CORE
G – GRAB

▼ Water level drilled

GEOLOGIC BORING LOG

Intrinsic Remediation Demonstration
Cape Canaveral Air Station, Florida

ENGINEERING-SCIENCE, INC.
Denver, Colorado

94DN0155, 02/28/94 at 10:52

MONITORING POINT INSTALLATION RECORD

JOB NAME CAPE CANAVERAL, FL — MONITORING POINT NUMBER MP-35

JOB NUMBER 722450.29 — INSTALLATION DATE _____ — LOCATION _____

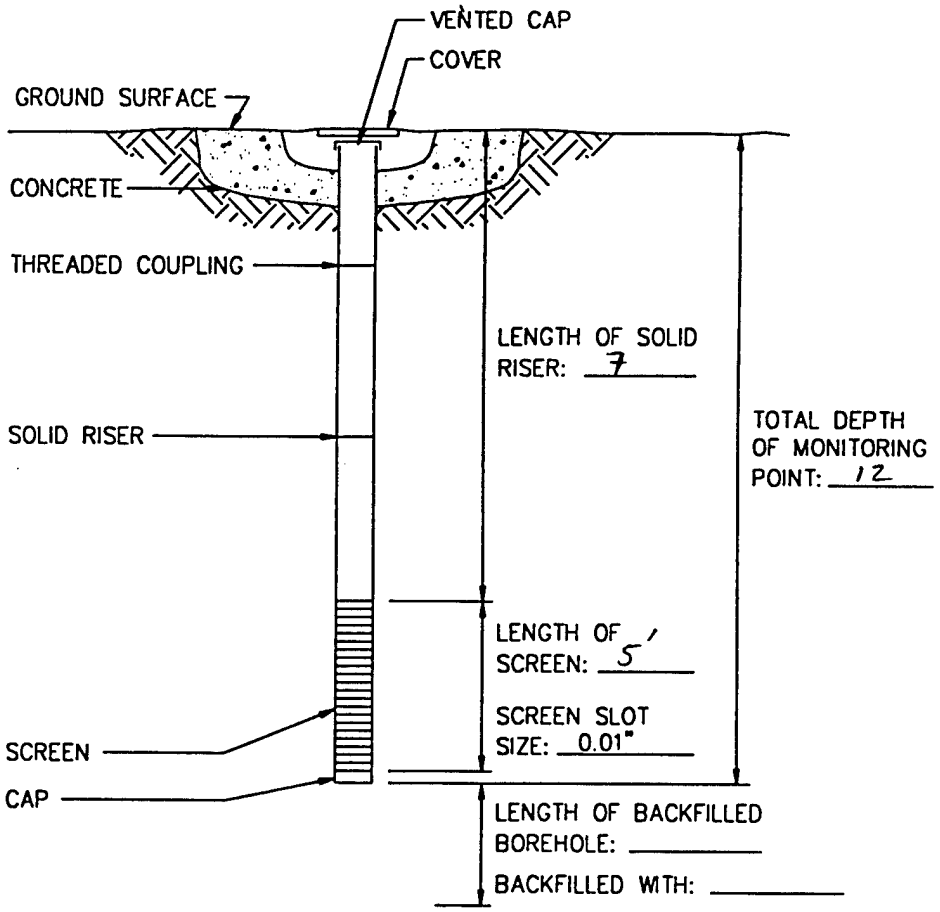
DATUM ELEVATION _____ — GROUND SURFACE ELEVATION _____

DATUM FOR WATER LEVEL MEASUREMENT _____

SCREEN DIAMETER & MATERIAL _____ — SLOT SIZE _____

RISER DIAMETER & MATERIAL _____ — BOREHOLE DIAMETER _____

GEOPROBE CONTRACTOR _____ — ES REPRESENTATIVE MS/MV



(NOT TO SCALE)

STABILIZED WATER LEVEL _____ FEET BELOW DATUM.

TOTAL MONITORING POINT DEPTH _____ FEET BELOW DATUM.

GROUND SURFACE _____ FEET

MONITORING POINT INSTALLATION RECORD

Intrinsic Remediation Demonstration
Cape Canaveral, FL

PARSONS ENGINEERING SCIENCE,
Denver, Colorado

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GEOLOGIC BORING LOG

Sheet 1 of 1

BORING NO.: MP-3 CONTRACTOR: _____ DATE SPUD: _____
CLIENT: AFCEE RIG TYPE: _____ DATE CMPL.: _____
JOB NO.: 72450.29 DRLG METHOD: _____ ELEVATION: _____
LOCATION: Cape Canaveral BORING DIA.: _____ TEMP: _____
GEOLOGIST: MS/MV DRLG FLUID: _____ WEATHER: _____
COMENTS: _____

Elev (ft)	Depth (ft)	Pro-file	US CS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
	1		SP	Yellow, Fine SAND, WELL SORTED to 5'					7.1			
	5			Fine to medium TAN SAND w/ several SHELL Fragments, WET @ 6'					31.6			
	10			SAME, GRAY					49.1			
	15											
	20											
	25											
	30											
	35											

NOTES
bgs – Below Ground Surface
GS – Ground Surface
TOC – Top of Casing
NS – Not Sampled
SAA – Same As Above

SAMPLE TYPE
D – DRIVE
C – CORE
G – GRAB

▼ Water level drilled

GEOLOGIC BORING LOG

CCFTA-2(FT-17)
Intrinsic Remediation Demonstration
Cape Canaveral Air Station, Florida

ENGINEERING-SCIENCE, INC.
Denver, Colorado

MONITORING POINT INSTALLATION RECORD

JOB NAME CAPE CANAVERAL, FL — MONITORING POINT NUMBER MP-45

JOB NUMBER 722450.29 — INSTALLATION DATE 1/24/96 — LOCATION

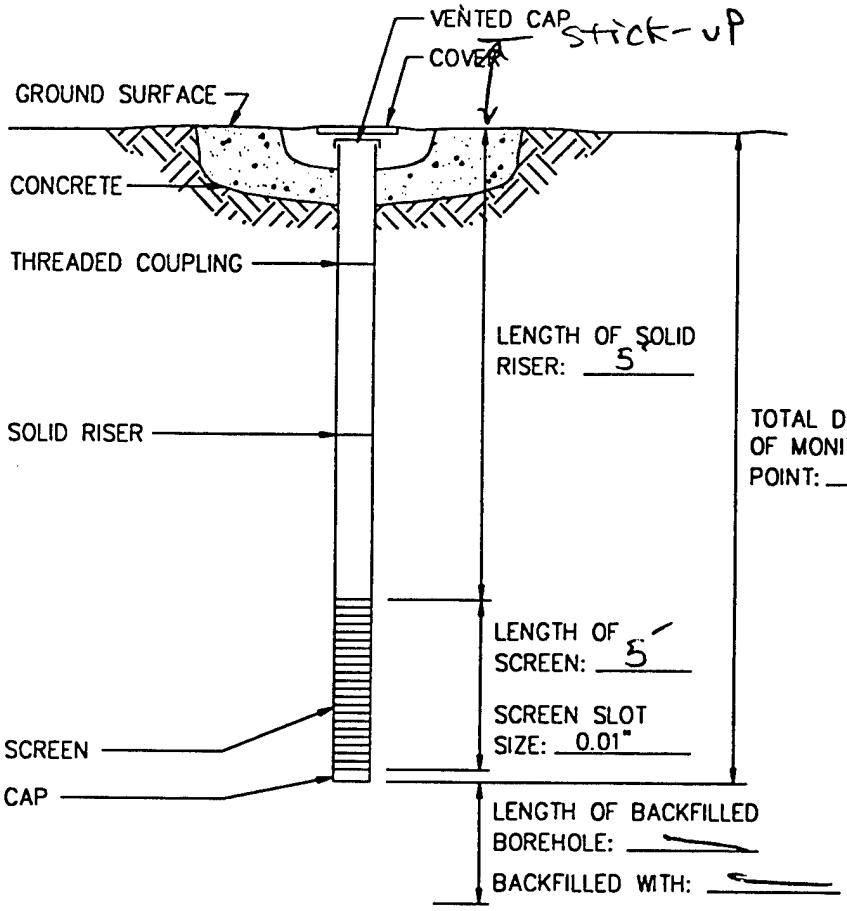
DATUM ELEVATION — GROUND SURFACE ELEVATION

DATUM FOR WATER LEVEL MEASUREMENT

SCREEN DIAMETER & MATERIAL Shc. 40 PVC 0.5" ID — SLOT SIZE 0.010"

RISER DIAMETER & MATERIAL 2" screen — BOREHOLE DIAMETER 2"

GEOPROBE CONTRACTOR USEPA/ES — ES REPRESENTATIVE MS/MV



(NOT TO SCALE)

STABILIZED WATER LEVEL _____ FEET BELOW DATUM.

TOTAL MONITORING POINT DEPTH _____ FEET BELOW DATUM.

GROUND SURFACE _____ FEET

MONITORING POINT INSTALLATION RECORD

Intrinsic Remediation Demonstration
Cape Canaveral, FL

PARSONS ENGINEERING SCIENCE,
Denver, Colorado

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MONITORING POINT INSTALLATION RECORD

JOB NAME CAPE CANAVERAL, FL — MONITORING POINT NUMBER MP-4D

JOB NUMBER 722450.29 — INSTALLATION DATE 1/24/96 — LOCATION

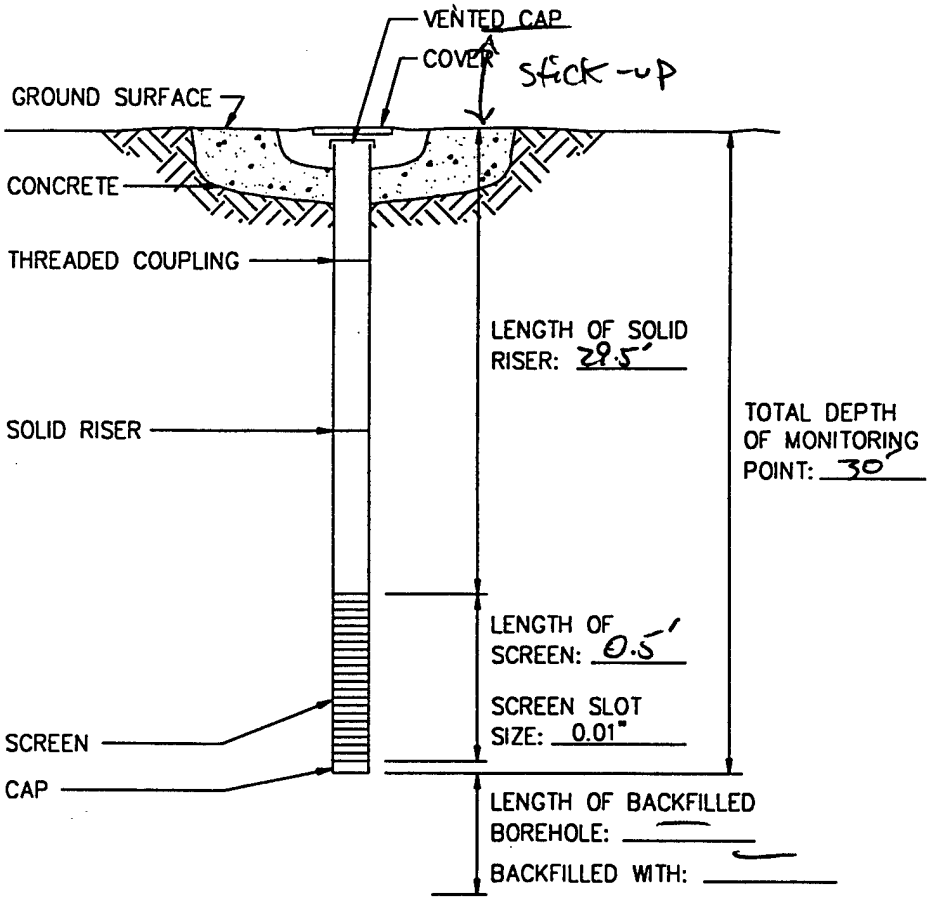
DATUM ELEVATION — GROUND SURFACE ELEVATION

DATUM FOR WATER LEVEL MEASUREMENT

SCREEN DIAMETER & MATERIAL sch 40 PVC, 0.5" ID — SLOT SIZE 0.01"

RISER DIAMETER & MATERIAL as screen — BOREHOLE DIAMETER

GEOPROBE CONTRACTOR USEPA/ES — ES REPRESENTATIVE MS/MV



(NOT TO SCALE)

STABILIZED WATER LEVEL _____ FEET BELOW DATUM.

TOTAL MONITORING POINT DEPTH _____ FEET BELOW DATUM.

GROUND SURFACE _____ FEET

MONITORING POINT INSTALLATION RECORD

Intrinsic Remediation Demonstration
Cape Canaveral, FL

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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GEOLOGIC BORING LOG

Sheet 1 of 1

BORING NO.: MP-4 CONTRACTOR: DATE SPUD: 1/24/96
CLIENT: AFCEE RIG TYPE: DATE CMPL.: 1/24/96
JOB NO.: 72450.29 DRLG METHOD: ELEVATION:
LOCATION: Cape Canaveral BORING DIA.: TEMP:
GEOLOGIST: MS/MV DRLG FLUID: WEATHER:
COMENTS: PID bkgrd = 1.7 - 2.3

Elev (ft)	Depth (ft)	Pro-file	US CS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
	1			0-2' vf-m brn sand, some shells; no strat					7.5			
				2-4 as above, gray, less m/sand; moist								
				4-5.5 → as above, wet @ 5'; no shells								
	5			5.5-8' brn, vf-f sand, some m sand; many shells; some org. matter					11			
				8-10 as above; amt. of shells varies					38			
	10			EOB								
				TD = 10'								
	15			Sample @ 7'								
				all soil has faint sulfur odor								
	20											
	25											
	30											
	35											

NOTES

bgs – Below Ground Surface
GS – Ground Surface
TOC – Top of Casing
NS – Not Sampled
SAA – Same As Above

SAMPLE TYPE

D – DRIVE
C – CORE
G – GRAB

▼ Water level drilled

GEOLOGIC BORING LOG

CCFTA-2(FT-17)
Intrinsic Remediation Demonstration
Cape Canaveral Air Station, Flori

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Denver, Colorado

MONITORING POINT INSTALLATION RECORD

JOB NAME CAPE CANAVERAL, FL — MONITORING POINT NUMBER MP-5

JOB NUMBER 722450.29 — INSTALLATION DATE 1/24/90 — LOCATION _____

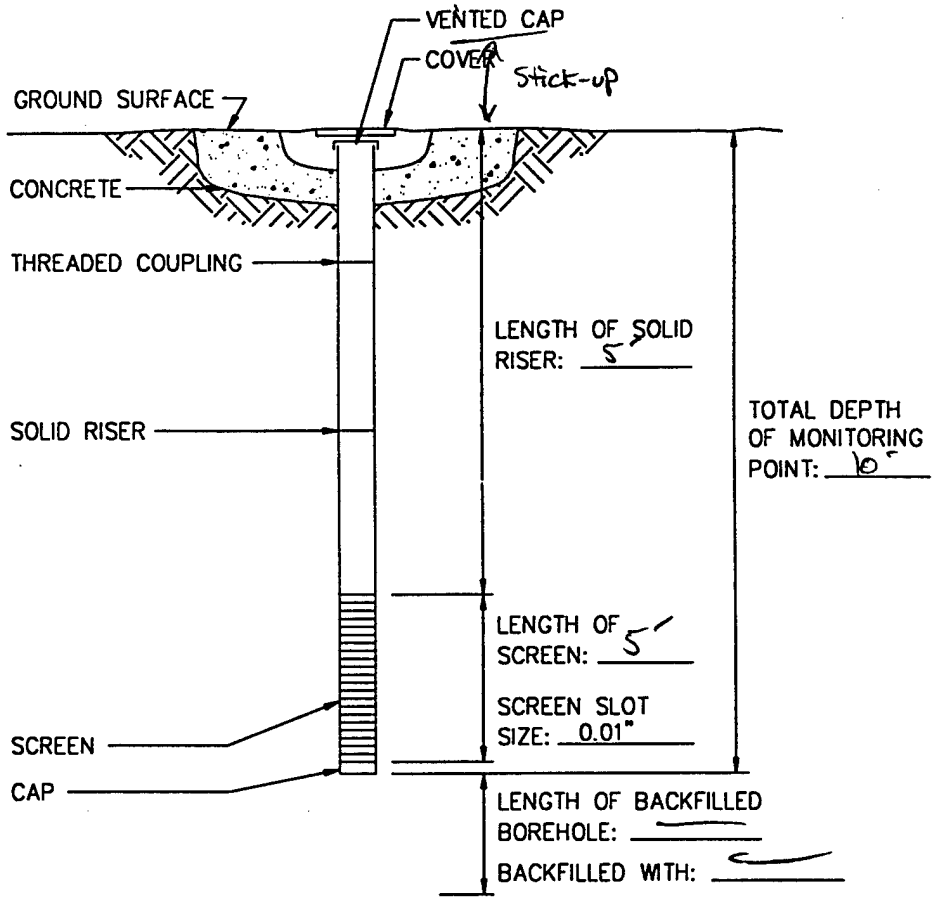
DATUM ELEVATION _____ — GROUND SURFACE ELEVATION _____

DATUM FOR WATER LEVEL MEASUREMENT _____

SCREEN DIAMETER & MATERIAL Sch 40 PVC; 0.5" ID — SLOT SIZE 0.01"

RISER DIAMETER & MATERIAL 2S screen — BOREHOLE DIAMETER 2"

GEOPROBE CONTRACTOR USEPA/ES — ES REPRESENTATIVE MS/MV



(NOT TO SCALE)

STABILIZED WATER LEVEL _____ FEET BELOW DATUM.

TOTAL MONITORING POINT DEPTH _____ FEET BELOW DATUM.

GROUND SURFACE _____ FEET

MONITORING POINT INSTALLATION RECORD

Intrinsic Remediation Demonstration
Cape Canaveral, FL

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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GEOLOGIC BORING LOG

Sheet 1 of 1

BORING NO.: MP-5 CONTRACTOR: EPA/ES DATE SPUD: 1/24/96
CLIENT: AFCEE RIG TYPE: DATE CMPL.: 1/24/96
JOB NO.: 72450.29 DRLG METHOD: Geoprobe ELEVATION:
LOCATION: Cape Canaveral BORING DIA.: 2" TEMP: 78°
GEOLOGIST: MS/MV DRLG FLUID: None WEATHER: Ptly Cldy
COMENTS: PID Bkgrd = 1.1 - 1.7

Elev (ft)	Depth (ft)	Pro-file	US CS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
	1		SP	Roots to 0.5'; 0.5-1' = tan f-m sand, well-sorted; 1-2' = gray f-m sand w/ plant matter; 2-4' = tan vf-m sand, some coarse shells								
	5		SP	4-7' = tan f sand, some shells; no stratification; very shelly 6-7'; gray at 7-8'; also some vf sand 7-8';					2.9			
				As above; very shelly ≈ 8'-9.5'					2.9			
	10								2.9			
	15											
	20											
	25											
	30											
	35											

NOTES
bgs – Below Ground Surface
GS – Ground Surface
TOC – Top of Casing
NS – Not Sampled
SAA – Same As Above

SAMPLE TYPE
D – DRIVE
C – CORE
G – GRAB

▼ Water level drilled

GEOLOGIC BORING LOG

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Intrinsic Remediation Demonstratio
Cape Canaveral Air Station, Flori

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Denver, Colorado

MONITORING POINT INSTALLATION RECORD

JOB NAME CAPE CANAVERAL, FL — MONITORING POINT NUMBER MP-6

JOB NUMBER 722450.29 — INSTALLATION DATE _____ — LOCATION _____

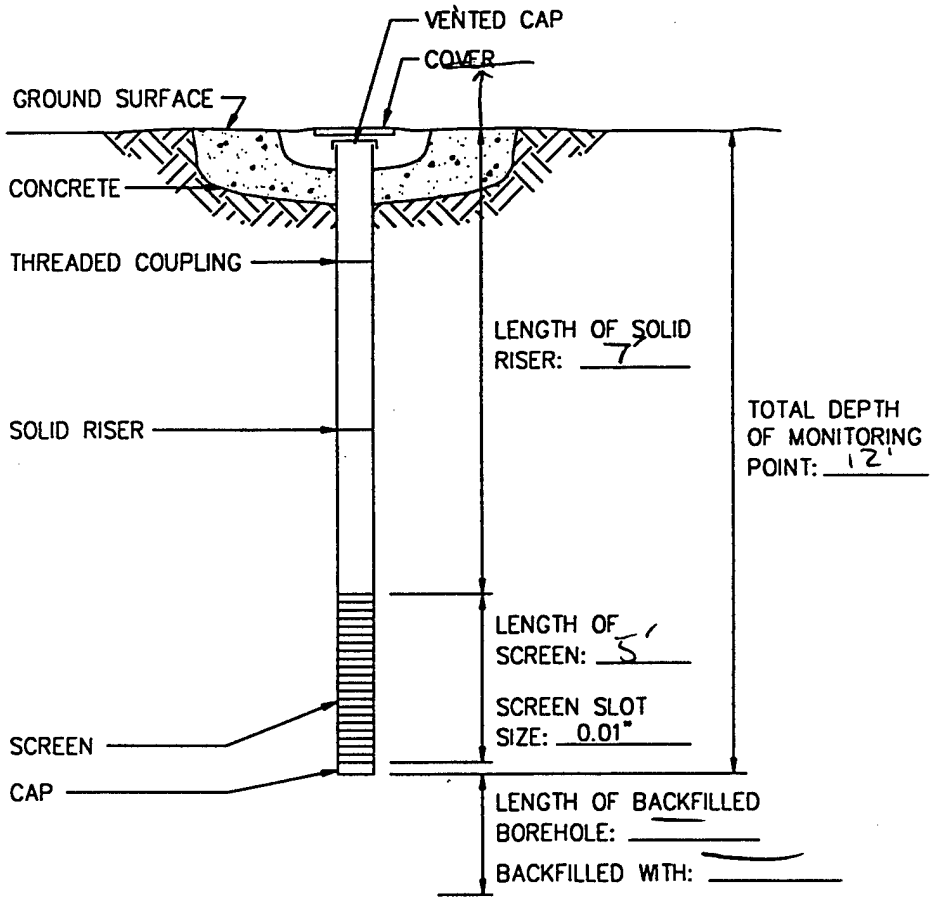
DATUM ELEVATION _____ — GROUND SURFACE ELEVATION _____

DATUM FOR WATER LEVEL MEASUREMENT _____

SCREEN DIAMETER & MATERIAL Sch. 40 PVC ; 0.5" ID — SLOT SIZE 0.01"

RISER DIAMETER & MATERIAL 2" screen — BOREHOLE DIAMETER 8 2"

GEOPROBE CONTRACTOR USEPA/ES — ES REPRESENTATIVE MS/MV



(NOT TO SCALE)

STABILIZED WATER LEVEL _____ FEET BELOW DATUM.

TOTAL MONITORING POINT DEPTH _____ FEET BELOW DATUM.

GROUND SURFACE _____ FEET

MONITORING POINT INSTALLATION RECORD

Intrinsic Remediation Demonstration
Cape Canaveral, FL

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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GEOLOGIC BORING LOG

Sheet 1 of 1

BORING NO.: MP-6 | CONTRACTOR: | DATE SPUD: 1/24/96
CLIENT: AFCEE | RIG TYPE: Geoprobe | DATE CMPL.: 1/24/96
JOB NO.: 72450.29 | DRLG METHOD: " | ELEVATION:
LOCATION: Cape Canaveral | BORING DIA.: 2" | TEMP: 78°
GEOLOGIST: MS/MV | DRLG FLUID: none | WEATHER: ptly cldy
COMENTS: PID bkgrd = 1.1

Elev (ft)	Depth (ft)	Pro-file	US CS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
	1		SP	roots (soil to 0.5'; 0.5-2' - brn vf-f sand, some med. sand; 2'-3' gray vf-f sand, well-sorted; 3-4' = brn, as above, w/ shells (c) roots at all depths; wet @ 3.5'					5.0			
▽	5		SP	as above; lt. tan; few shells					2.3			
	10		SP	as above; gray; occ. shelly layers					36			
	15			E.O.B. = 12' Sample @ 7'								
	20											
	25											
	30											
	35											

NOTES
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GS – Ground Surface
TOC – Top of Casing
NS – Not Sampled
SAA – Same As Above

SAMPLE TYPE
D – DRIVE
C – CORE
G – GRAB

▼ Water level drilled

GEOLOGIC BORING LOG

CCFTA-2(FT-17)
Intrinsic Remediation Demonstration
Cape Canaveral Air Station, Floric

ENGINEERING-SCIENCE, IN
Denver, Colorado

DEMONSTRATION OF THE AIR FORCE SITE CHARACTERIZATION AND ANALYSIS PENETROMETER SYSTEM (AFSCAPS) AT PATRICK AFB IN SUPPORT OF THE INTRINSIC REMEDIATION (NATURAL ATTENUATION) OPTION

Work performed under
Contract No. F08635-93-C-0080
SETA Subtask 8.01.1

March/April 1994

ARA Report No. 5868-322
May 4, 1994

by

Martin L. Gildea
Wesley L. Bratton, Ph.D.
James D. Shinn II, PE

of

Applied Research Associates, Inc.
120-A Waterman Road
South Royalton, Vermont 05068

and

Randy St. Germain
Greg D. Gillispie, Ph.D.

of

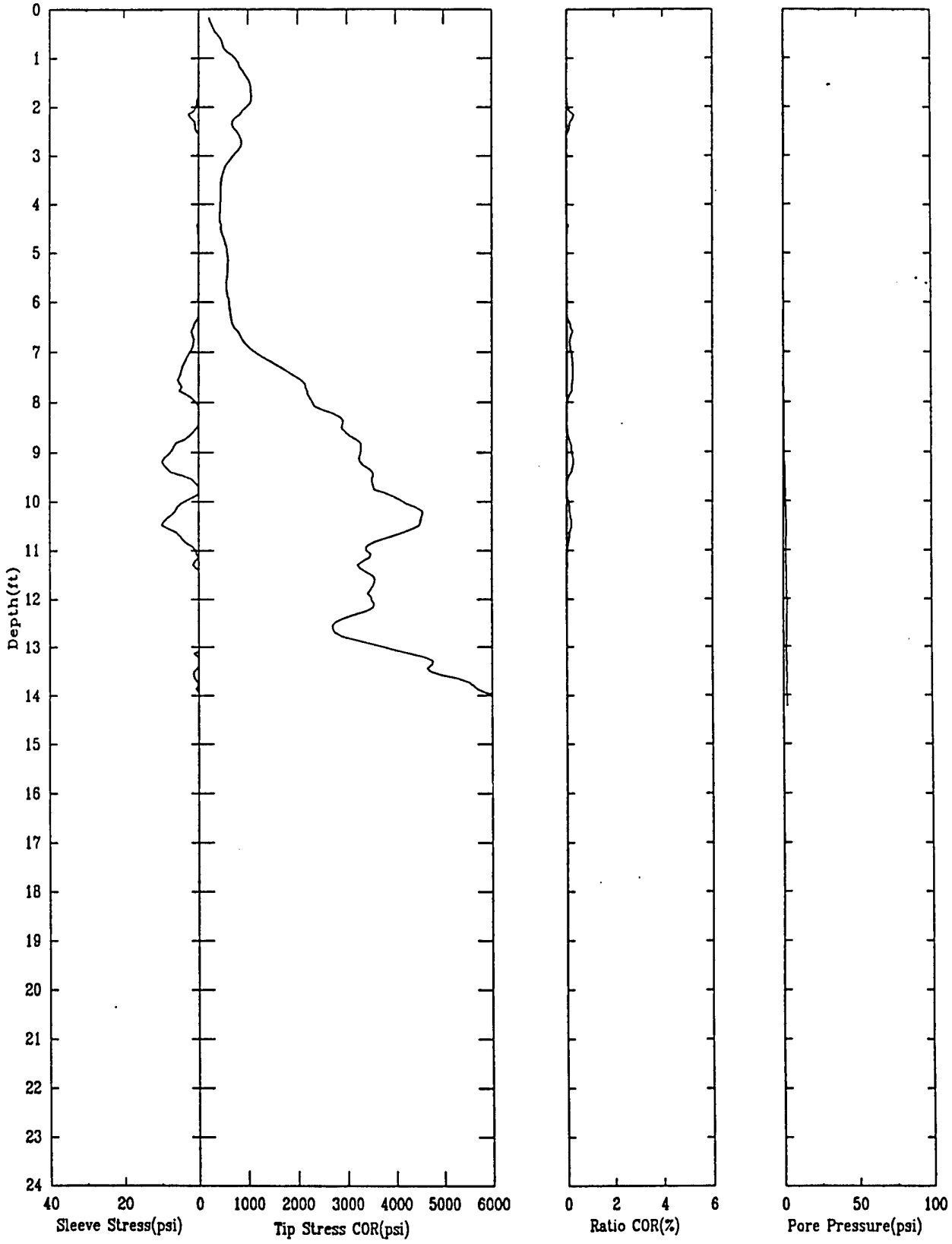
Dakota Technologies, Inc.
Fargo, North Dakota 58105

Table 2
Summary of CPT Soundings
Former Fire Training Area
Kennedy Space Center
Cape Canaveral, Florida

Test ID	Date	Type	MW type	Start Depth	Max Depth
CCAFB-01	29-Mar-98	CPT-LIF			14.31
CCAFB-01-SS01	30-Mar-98	SS		5.50	7.5
CCAFB-01-SS02	30-Mar-98	SS		7.50	9.5
CCAFB-01B-SS01	30-Mar-98	SS		5.50	7.5
CCAFB-01B-SS02	30-Mar-98	SS		7.50	9.5
CCAFB-02	29-Mar-98	CPT-LIF			10.12
CCAFB-03	29-Mar-98	CPT-LIF			15.30
CCAFB-04	29-Mar-98	CPT-LIF			13.23
CCAFB-05	29-Mar-98	CPT-LIF			15.01
CCAFB-06	29-Mar-98	CPT-LIF			15.81
CCAFB-06-SS01	30-Mar-98	SS		3.50	5.5
CCAFB-06-SS02	30-Mar-98	SS		5.50	7.5
CCAFB-07	29-Mar-98	CPT-LIF			14.51
CCAFB-07-SS01	30-Mar-98	SS		5.50	7.5
CCAFB-07-SS02	30-Mar-98	SS		7.50	9.5
CCAFB-08	29-Mar-98	CPT-LIF			15.03
CCAFB-09	29-Mar-98	CPT-LIF			19.01
CCAFB-10	29-Mar-98	CPT-LIF			18.74
CCAFB-11	29-Mar-98	CPT-LIF			19.00
CCFTA2-07-MW01M	31-Mar-98	MW	Tube		31.50
CCFTA2-CPT-MW01D	30-Mar-98	MW	Riser		52.50
CCFTA2-CPT-MW01M	30-Mar-98	MW	Riser		32.50
CCFTA2-CPT-MW01S	30-Mar-98	MW	Riser		10.00
CCFTA2-CPT-MW02S	31-Mar-98	MW	Riser		8.00
CPFTA2-CPT-MW02M	31-Mar-98	MW	Tube		27.20
CPFTA2-CPT-MW03D	31-Mar-98	MW	Tube		53.00
CPFTA2-CPT-MW03M	31-Mar-98	MW	Tube		31.00
CPFTA2-CPT-MW03S	31-Mar-98	MW	Riser		9.00
CPFTA2-CPT-MW04M	31-Mar-98	MW	Tube		30.00
CPFTA2-CPT-MW04S	31-Mar-98	MW	Riser		8.00

CCAFB-01 APPLIED RESEARCH ASSOCIATES, INC. 03/28/94

CCAFB



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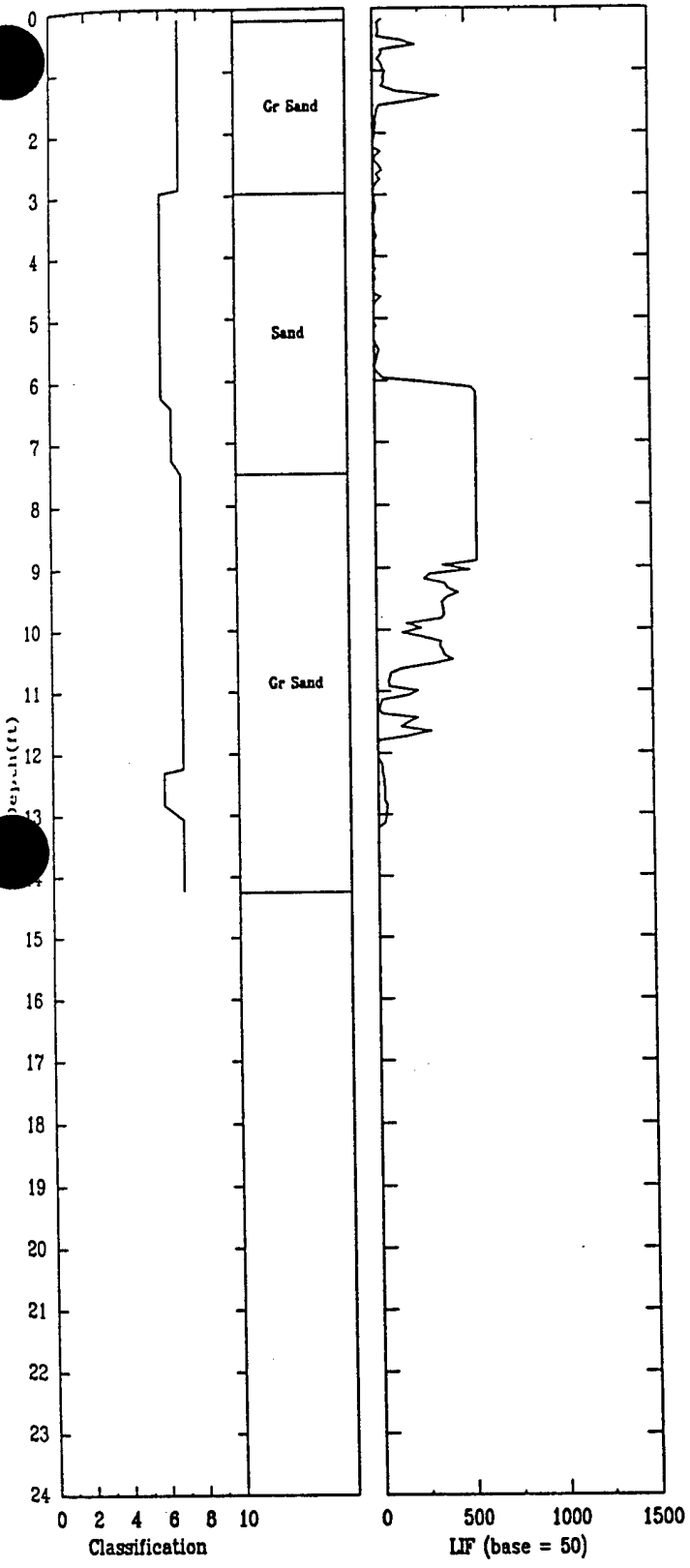

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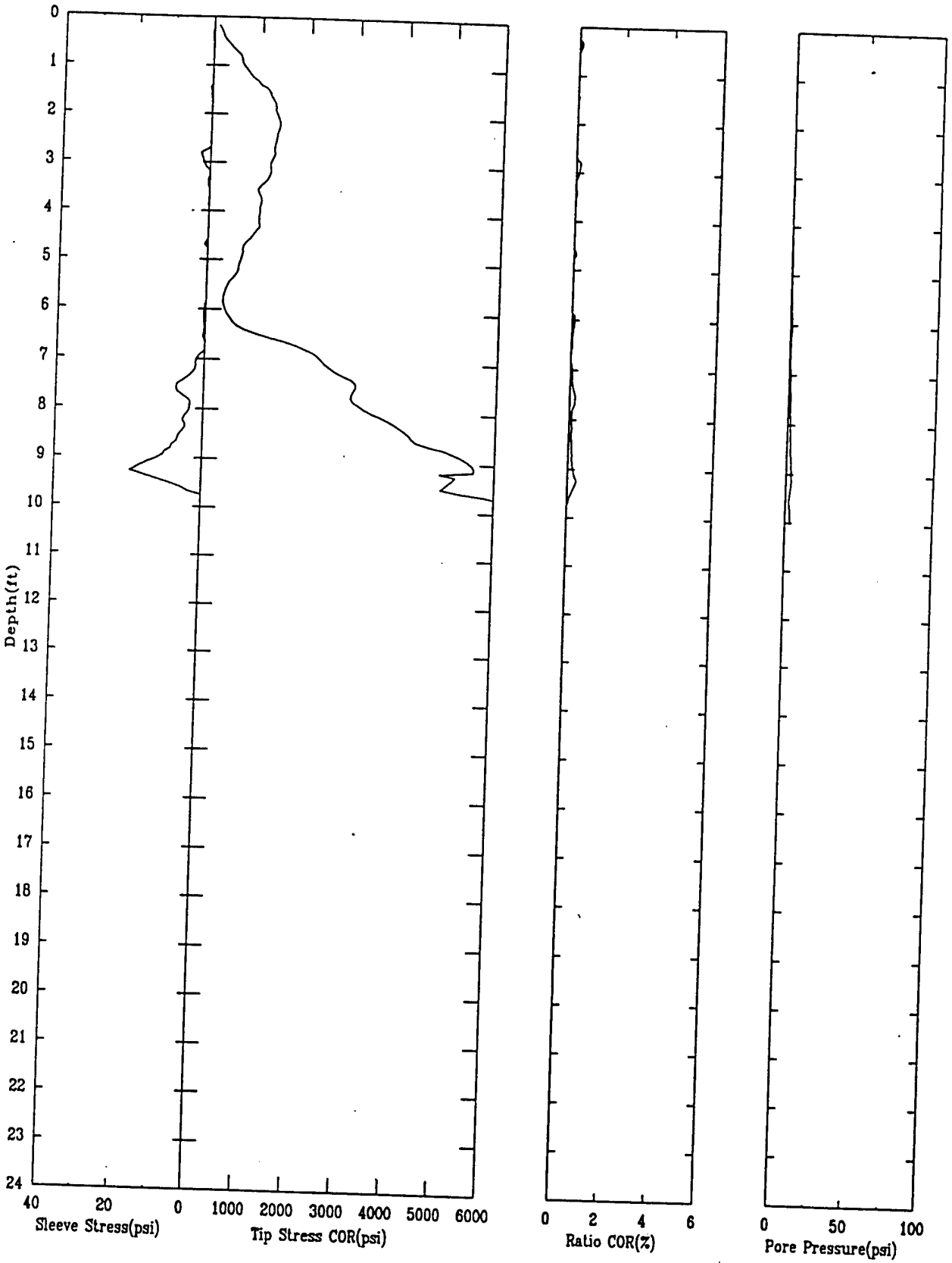

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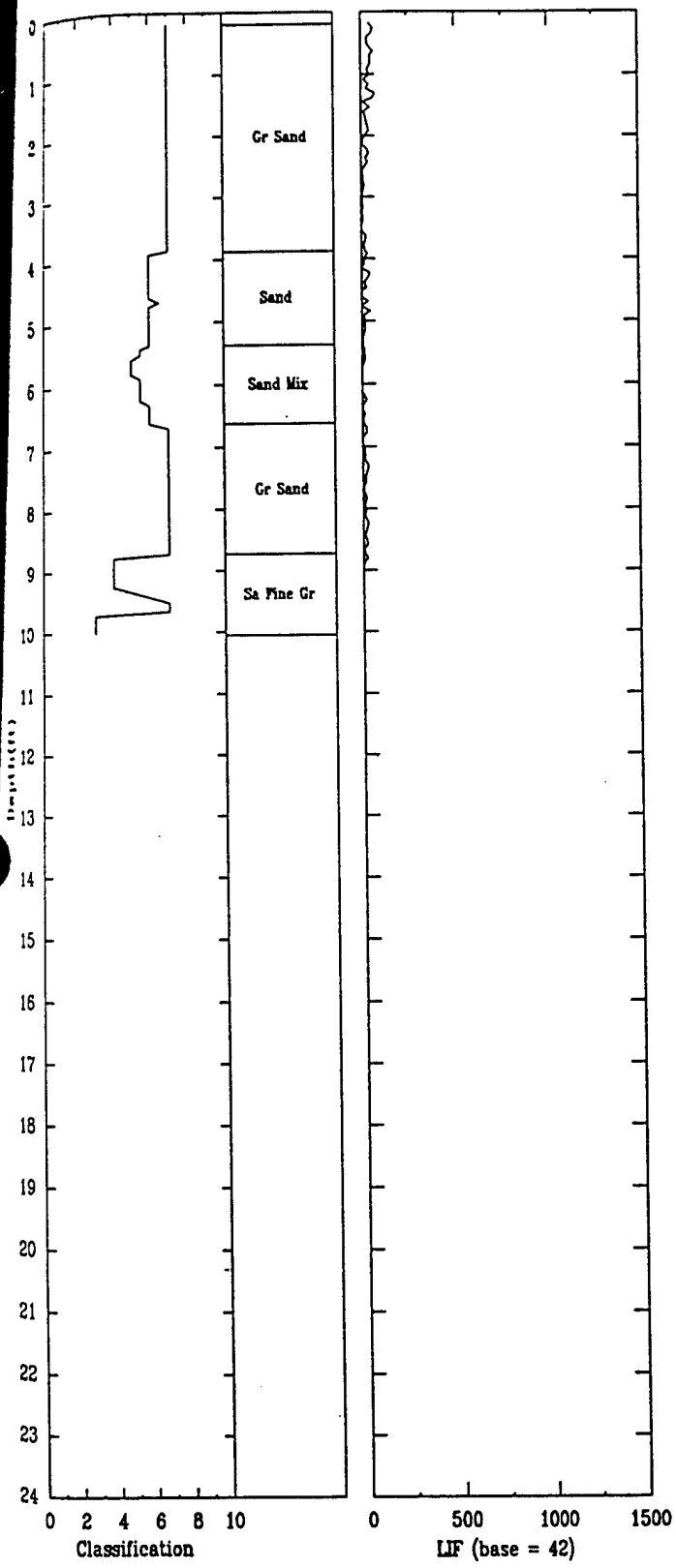

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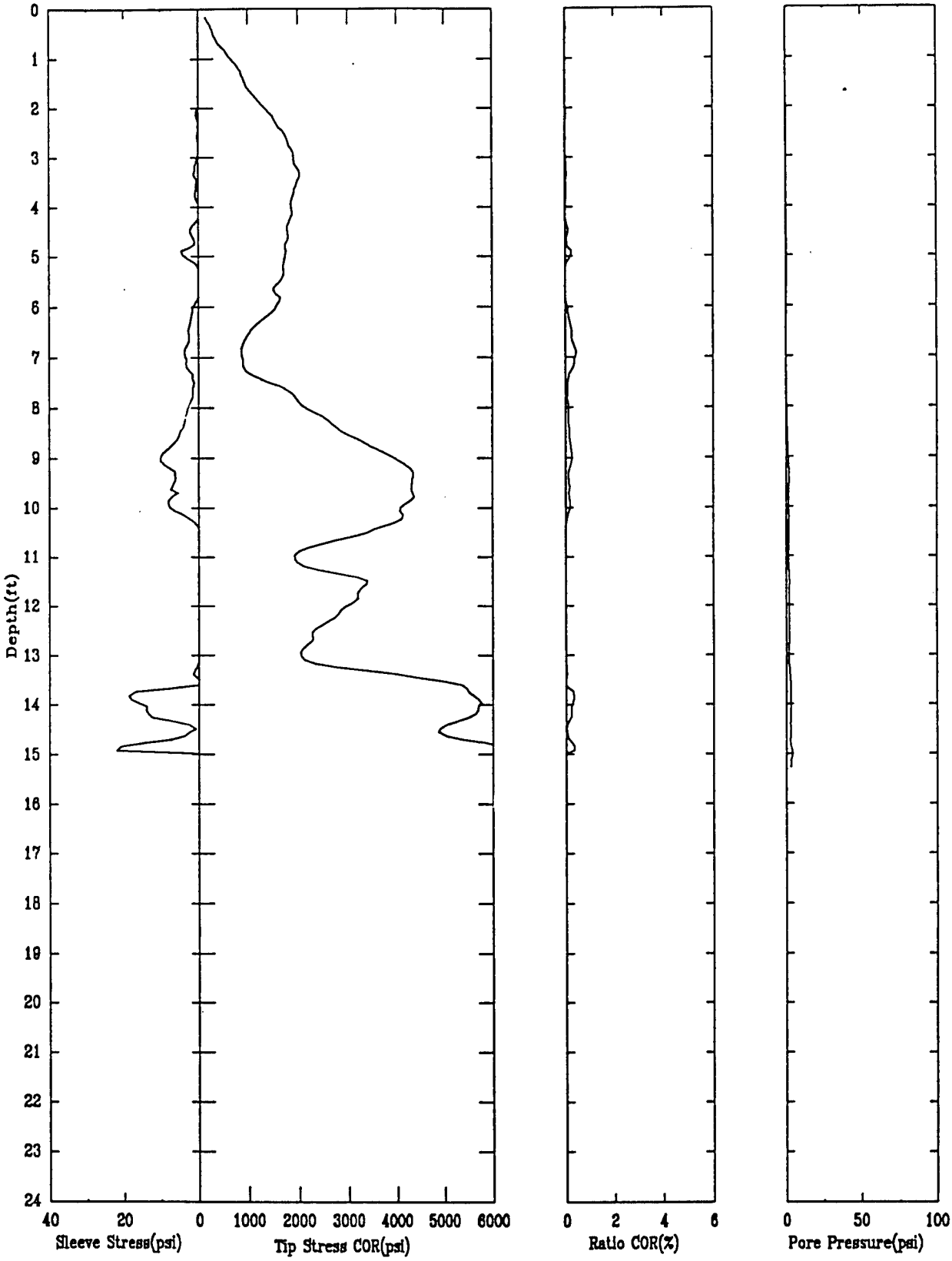

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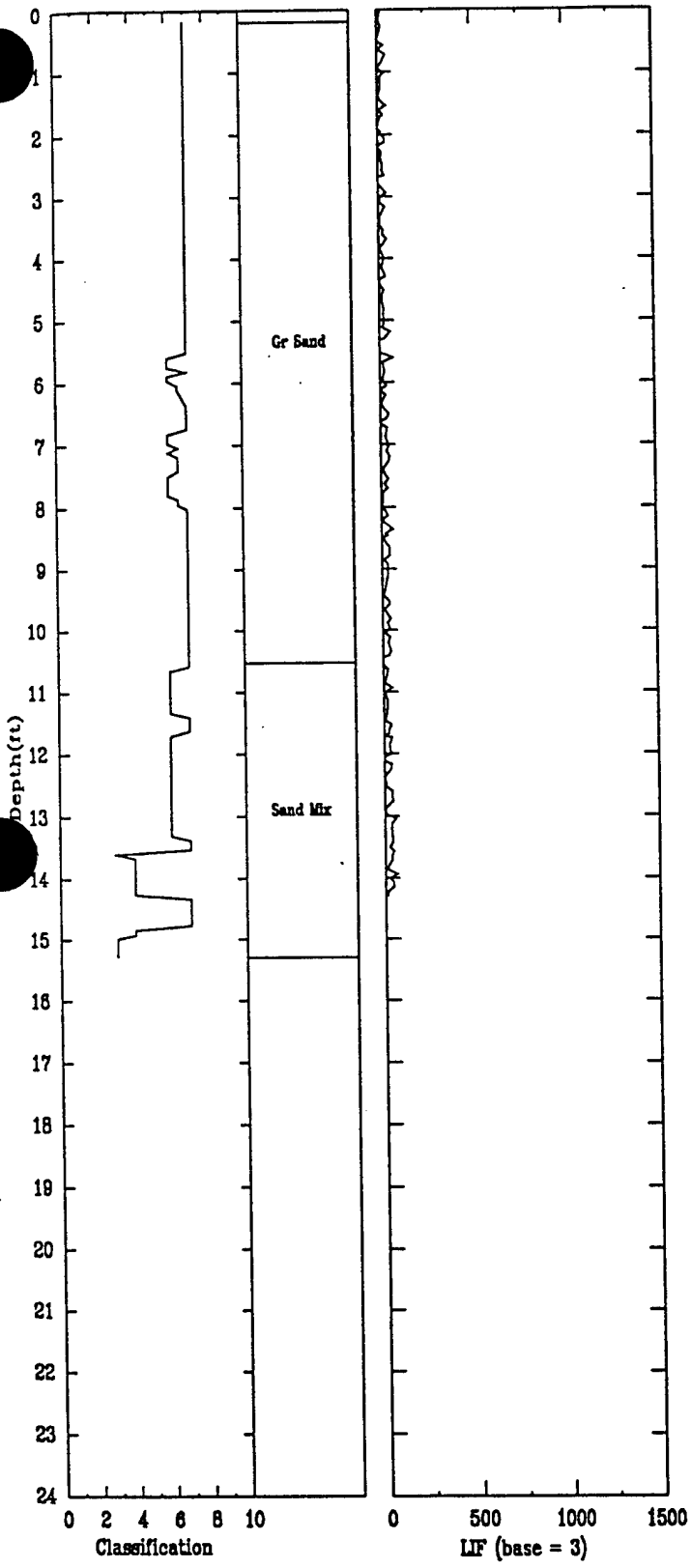

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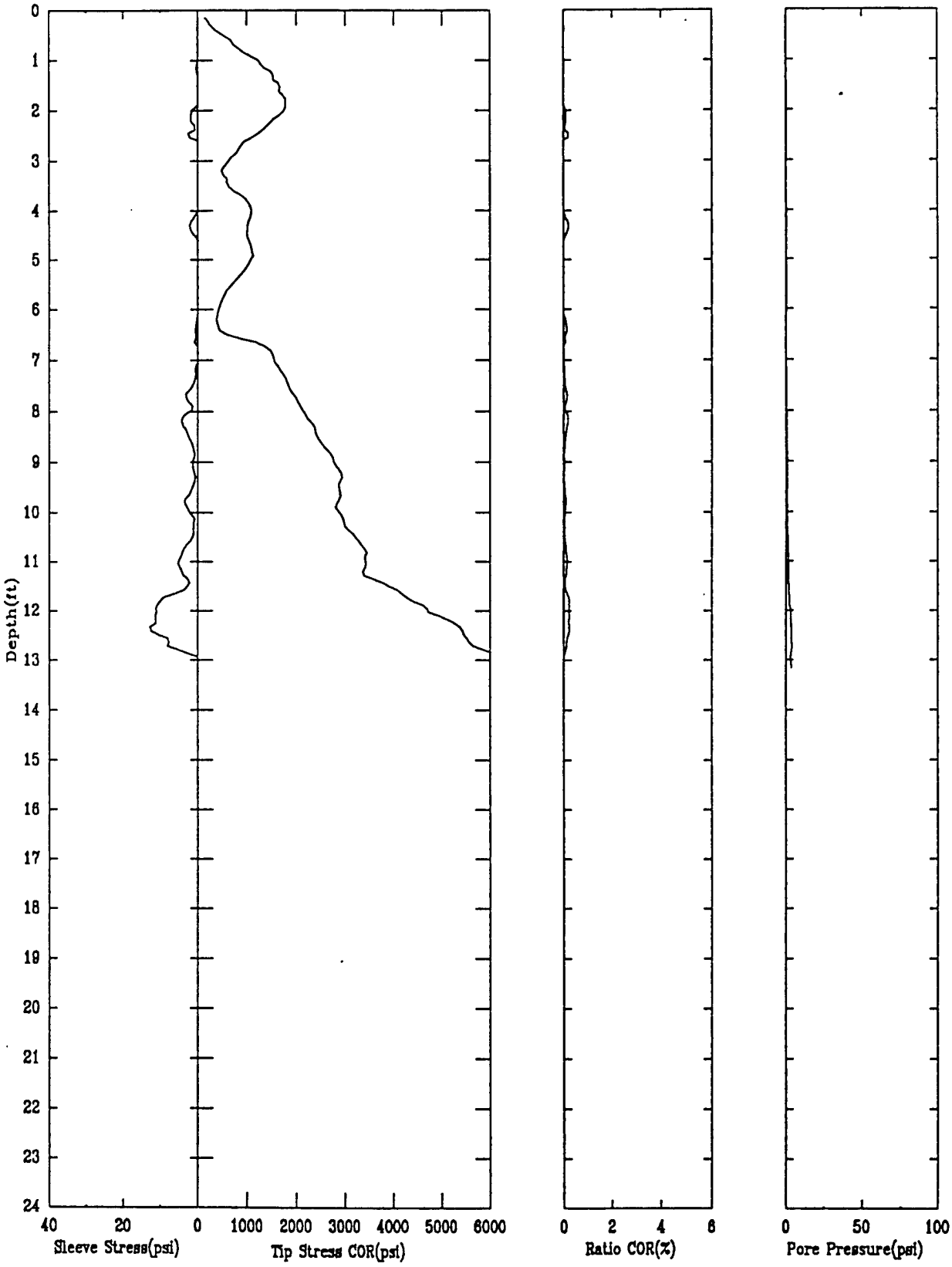

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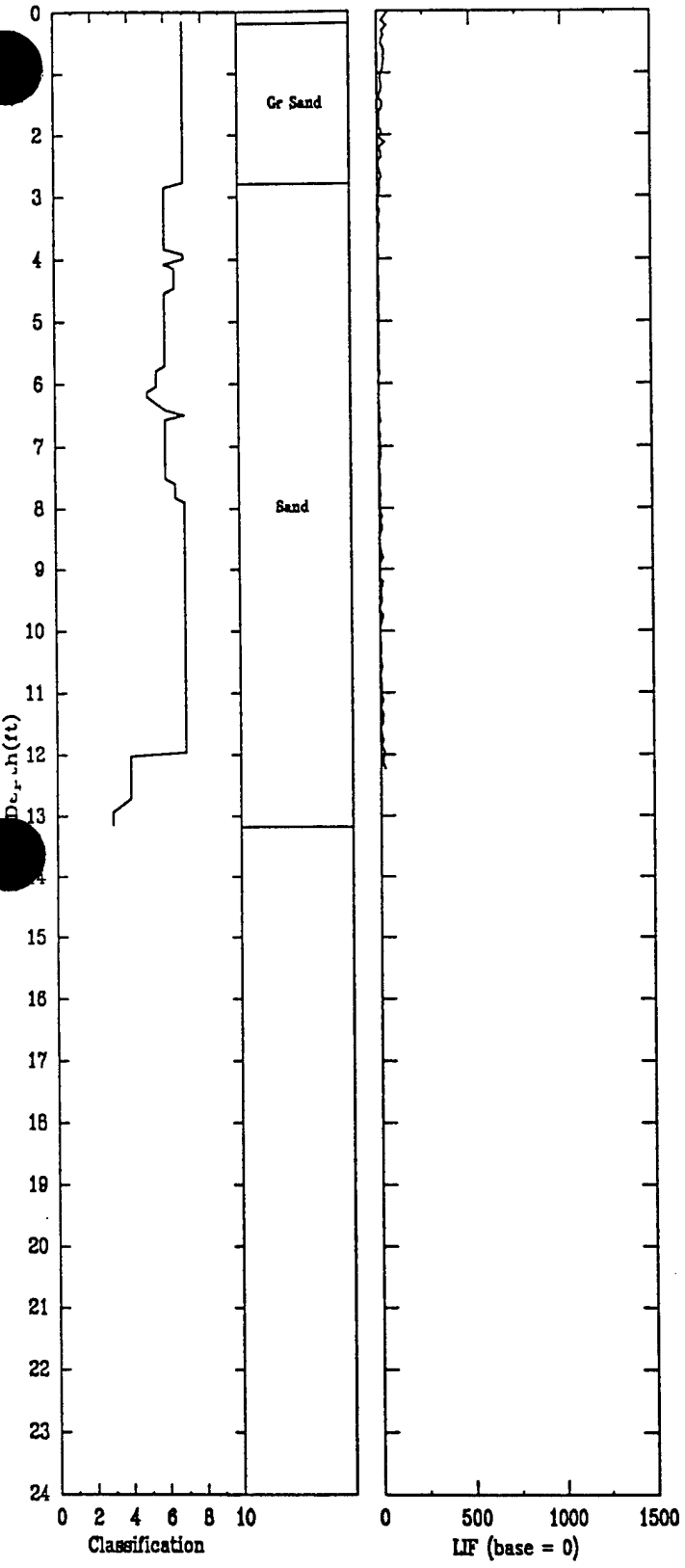

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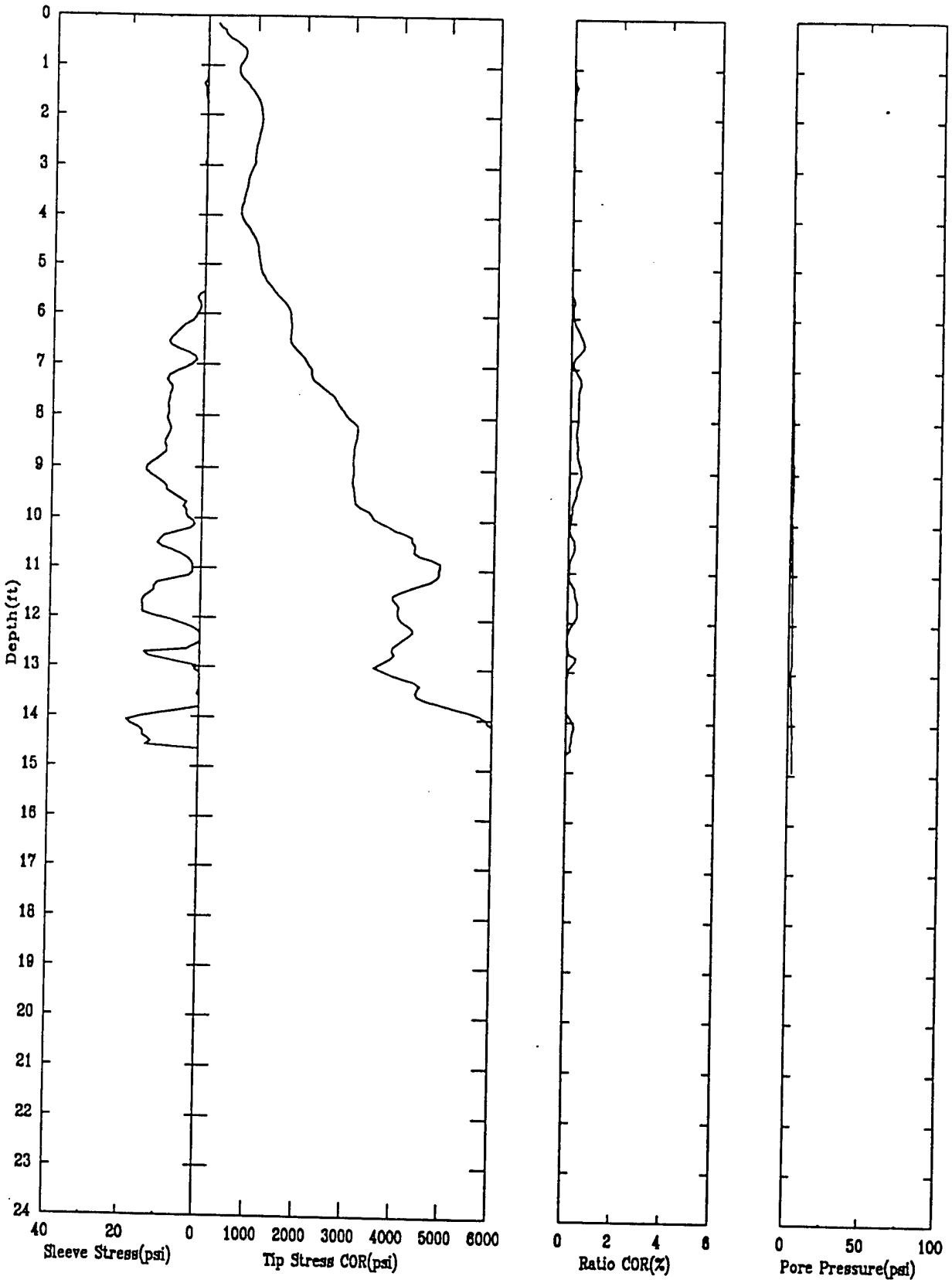

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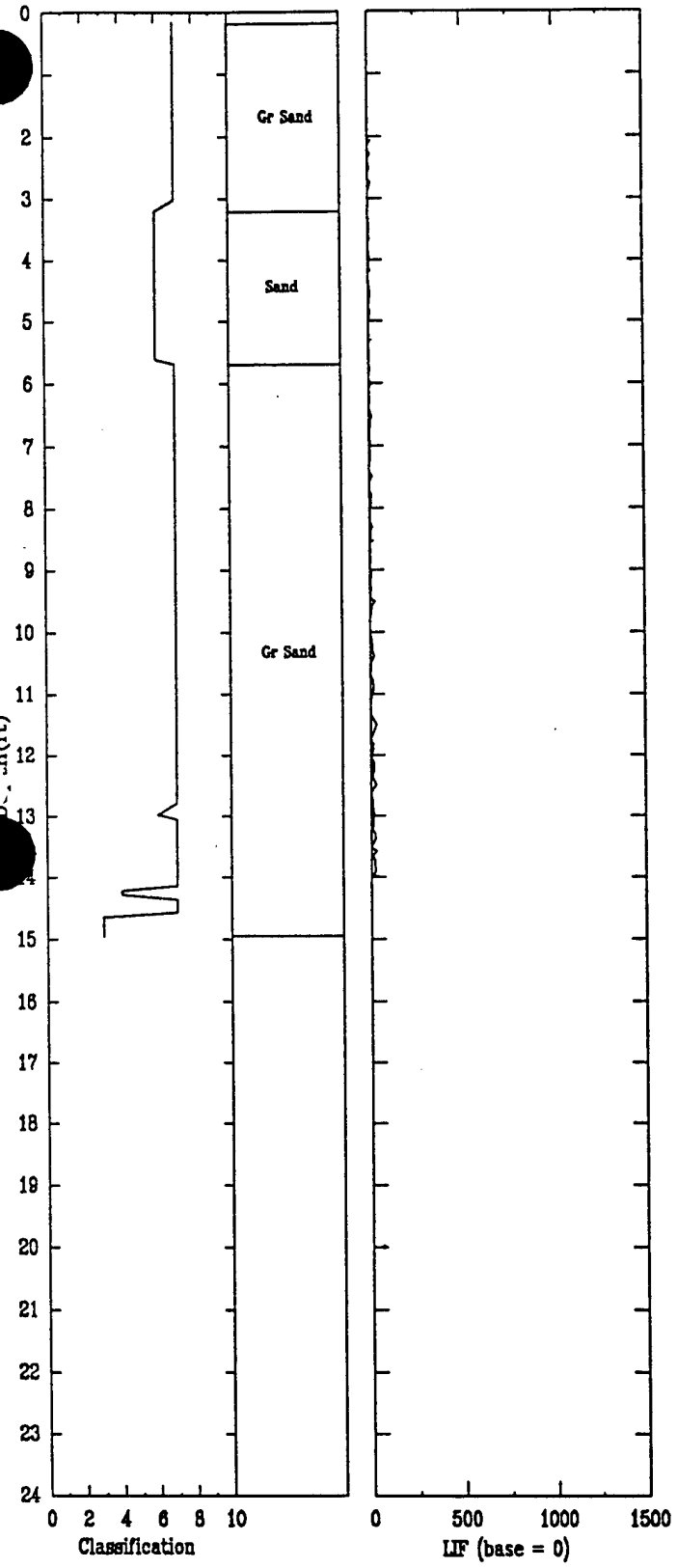

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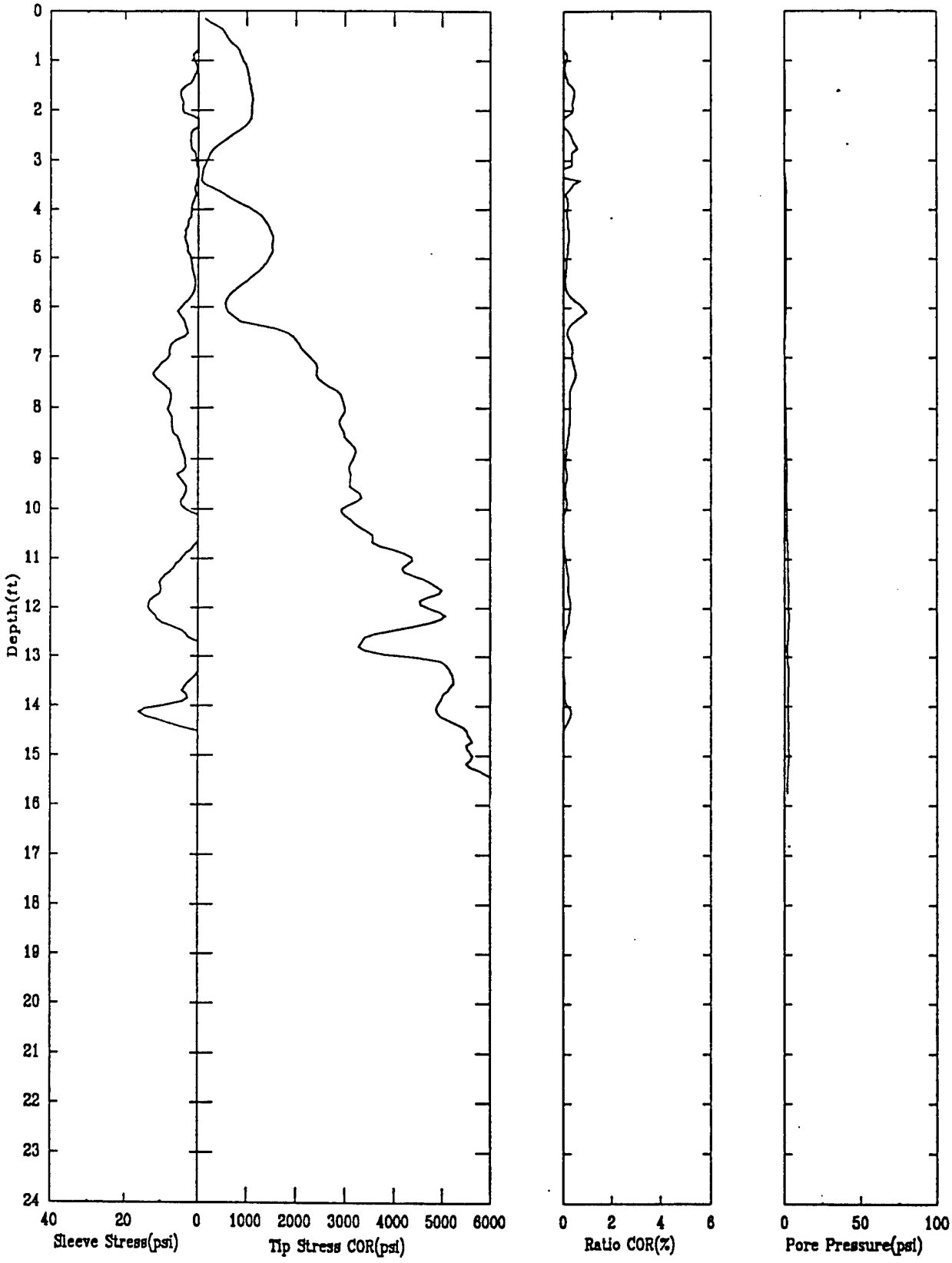

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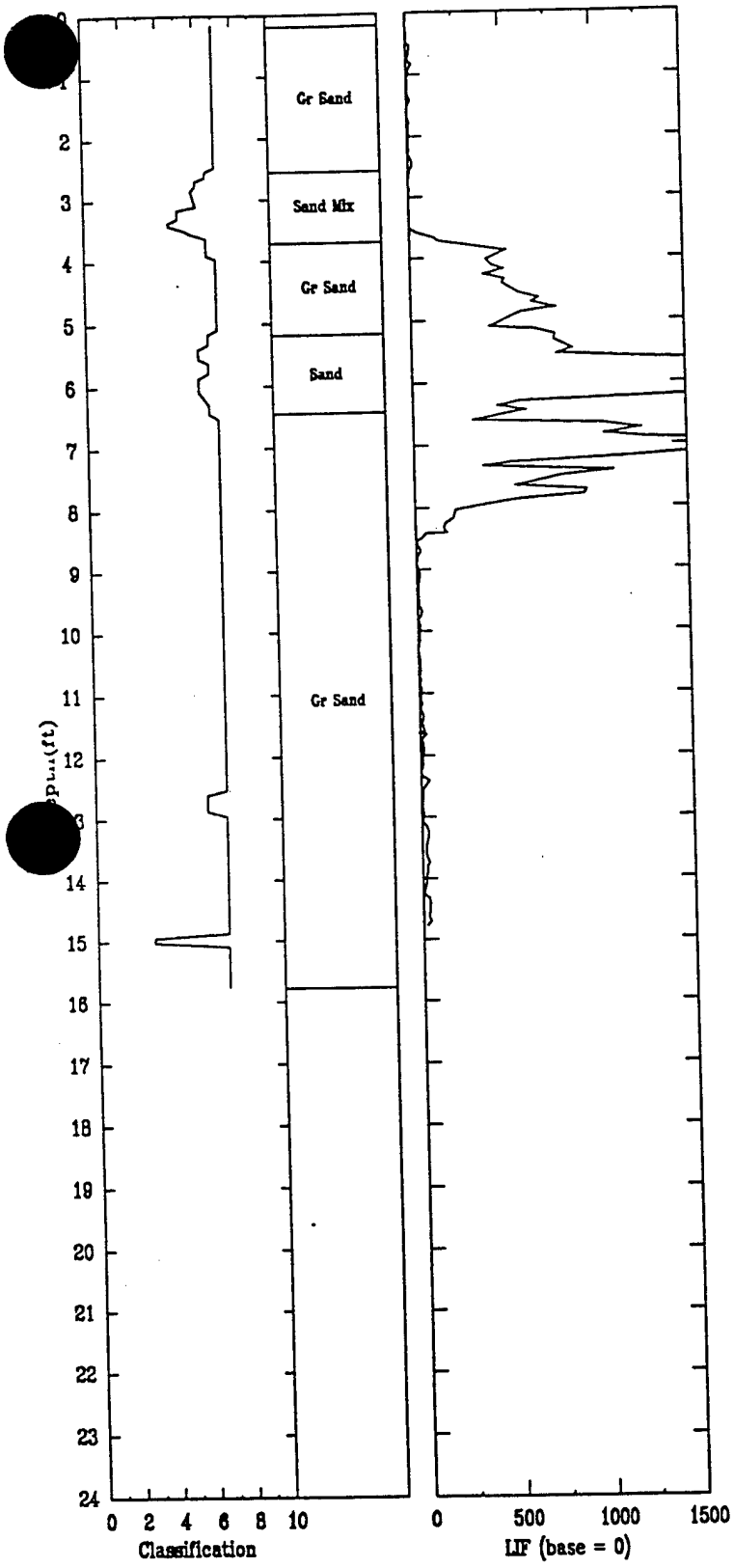

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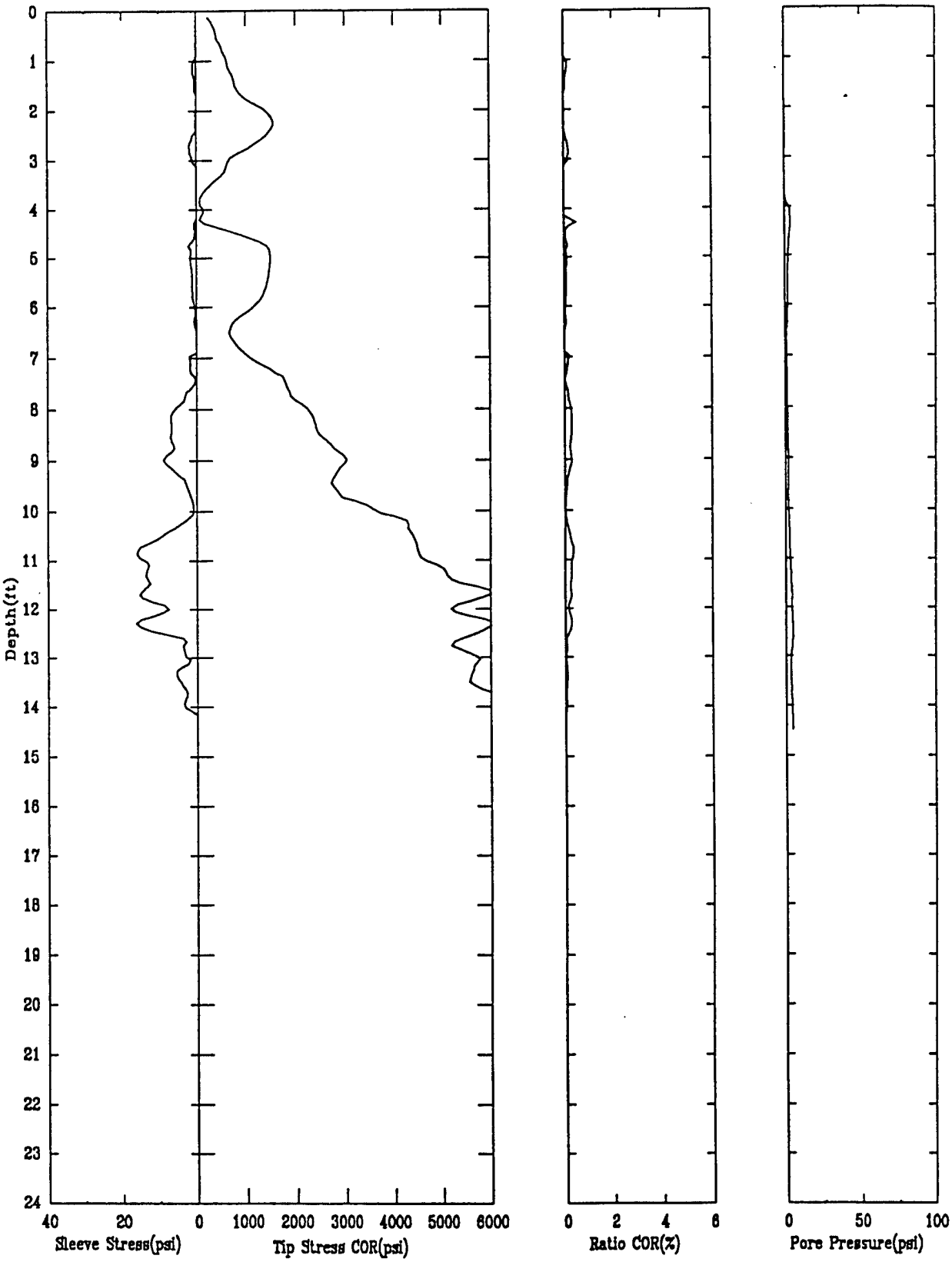

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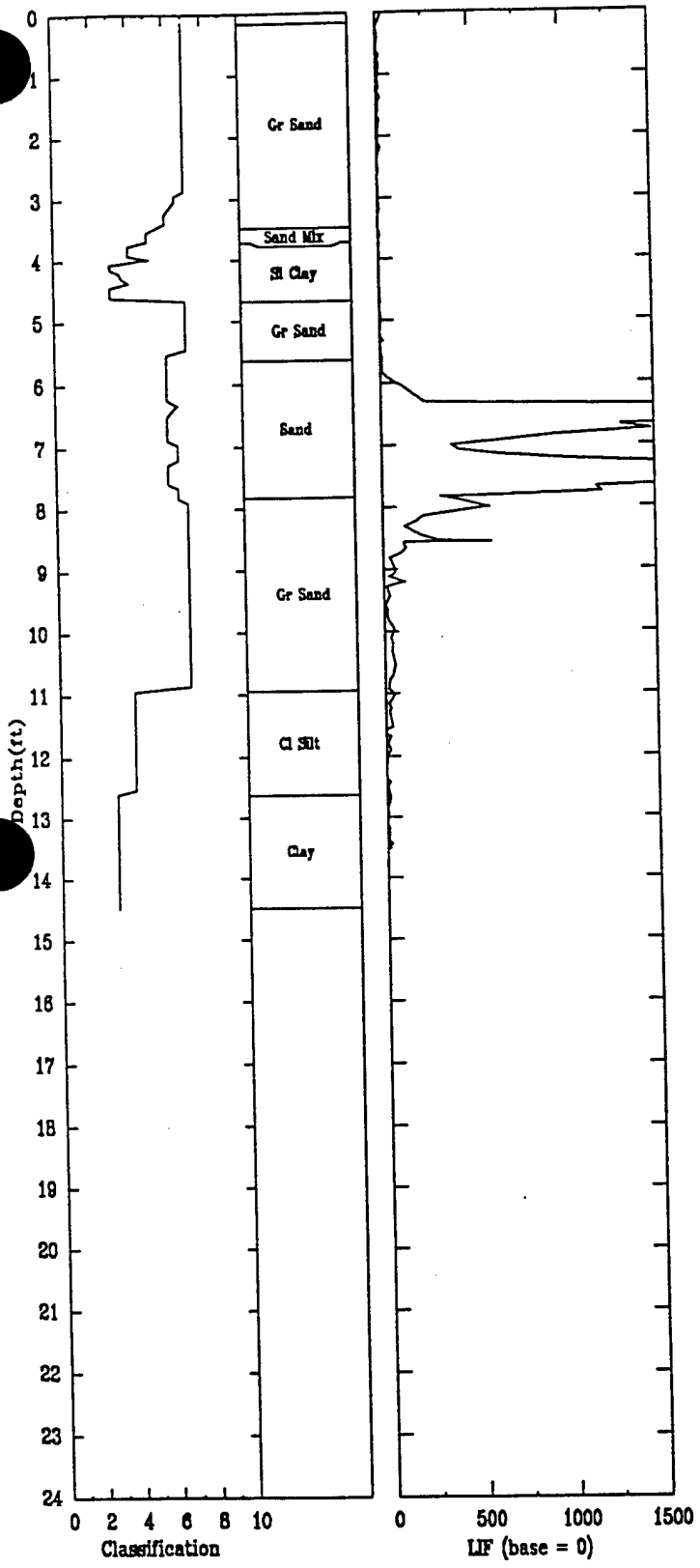

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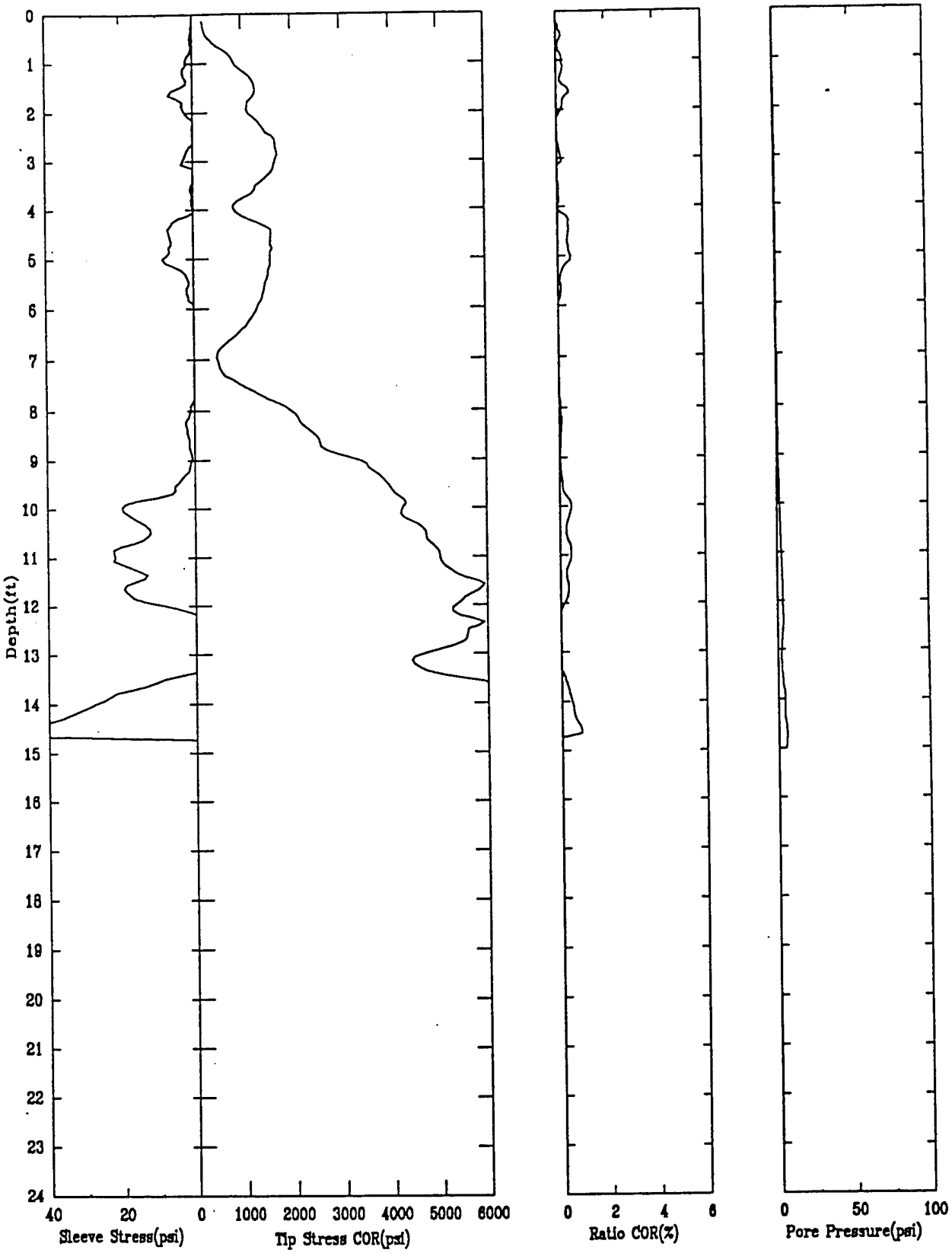

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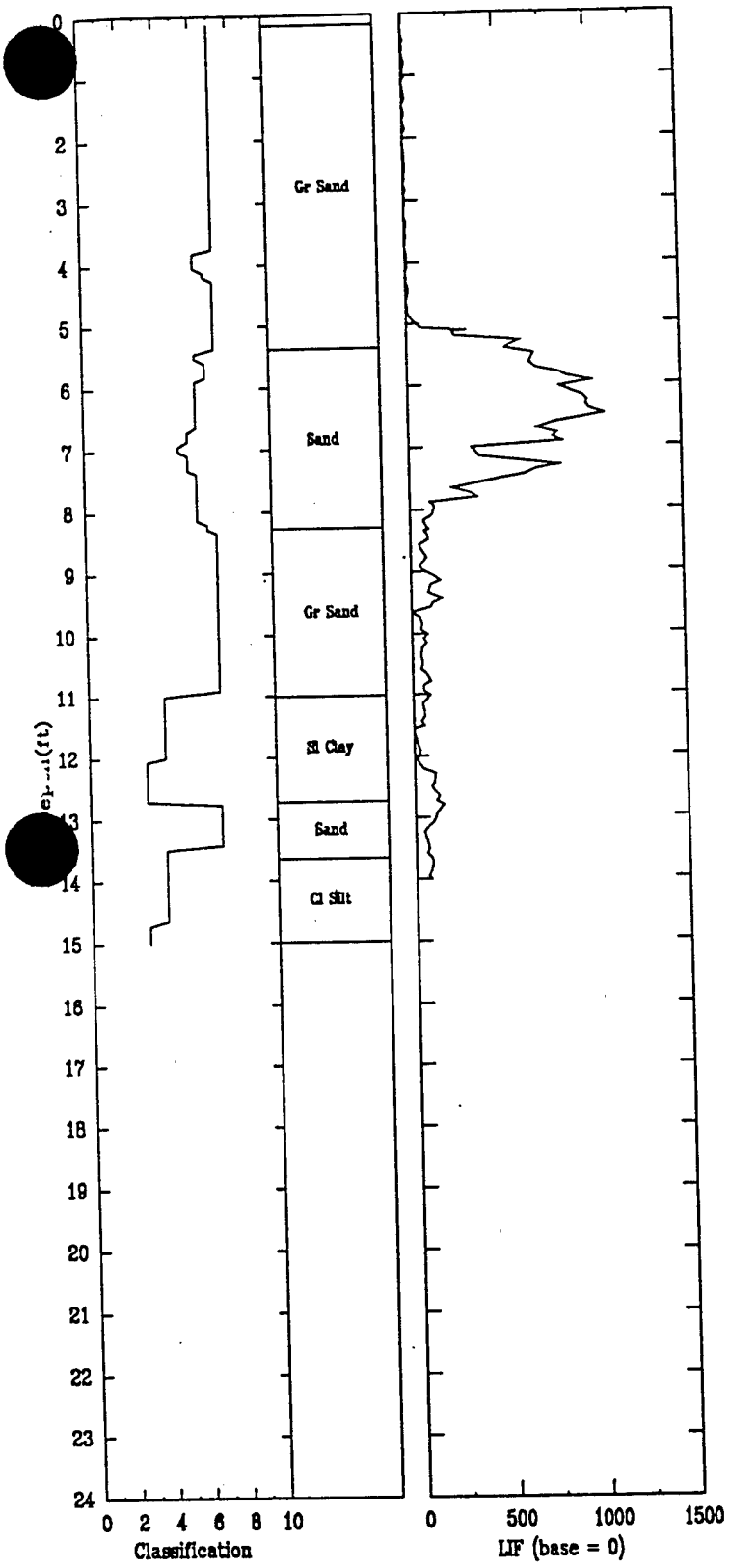

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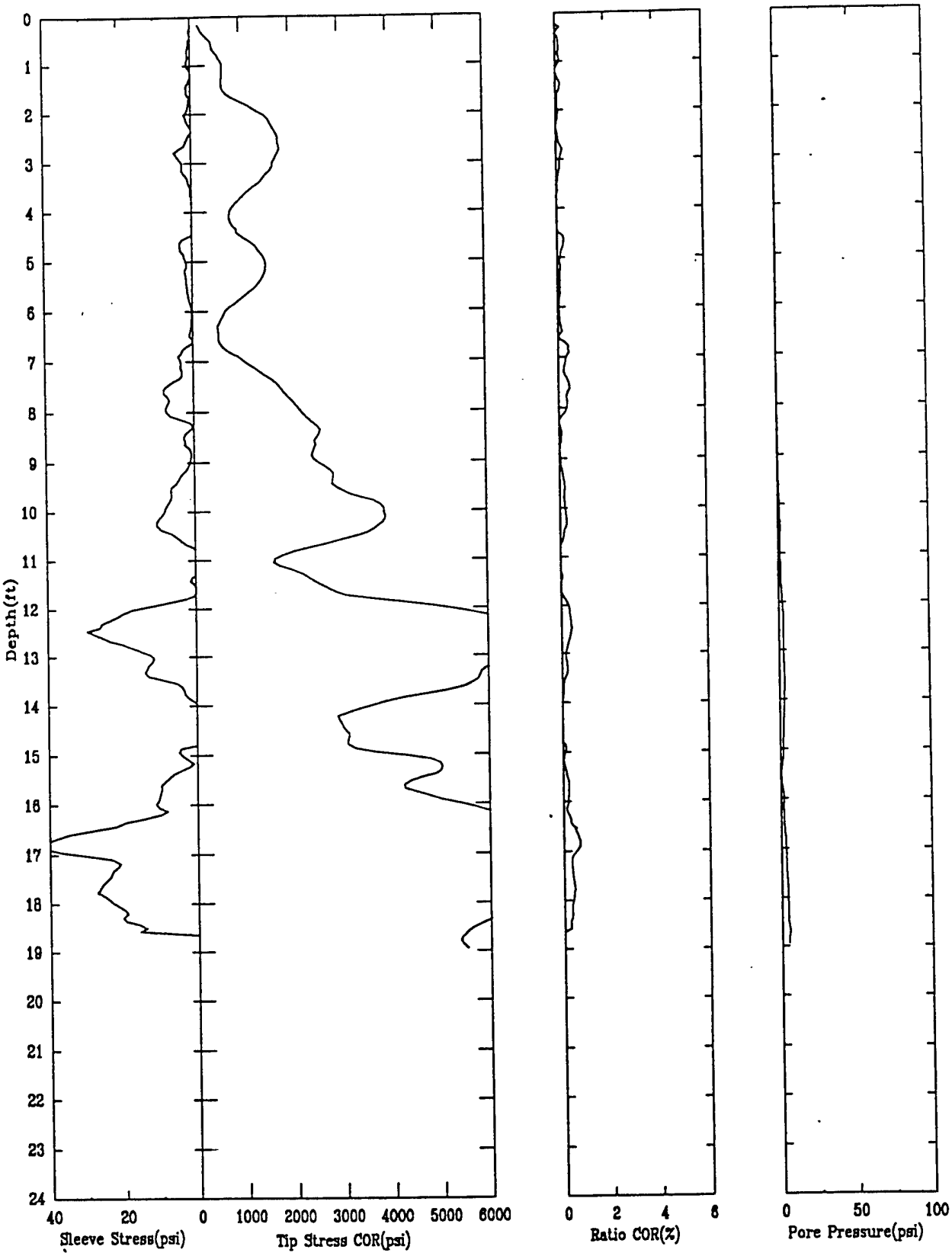

CCAFB-09 APPLIED RESEARCH ASSOCIATES, INC. 03/28/94

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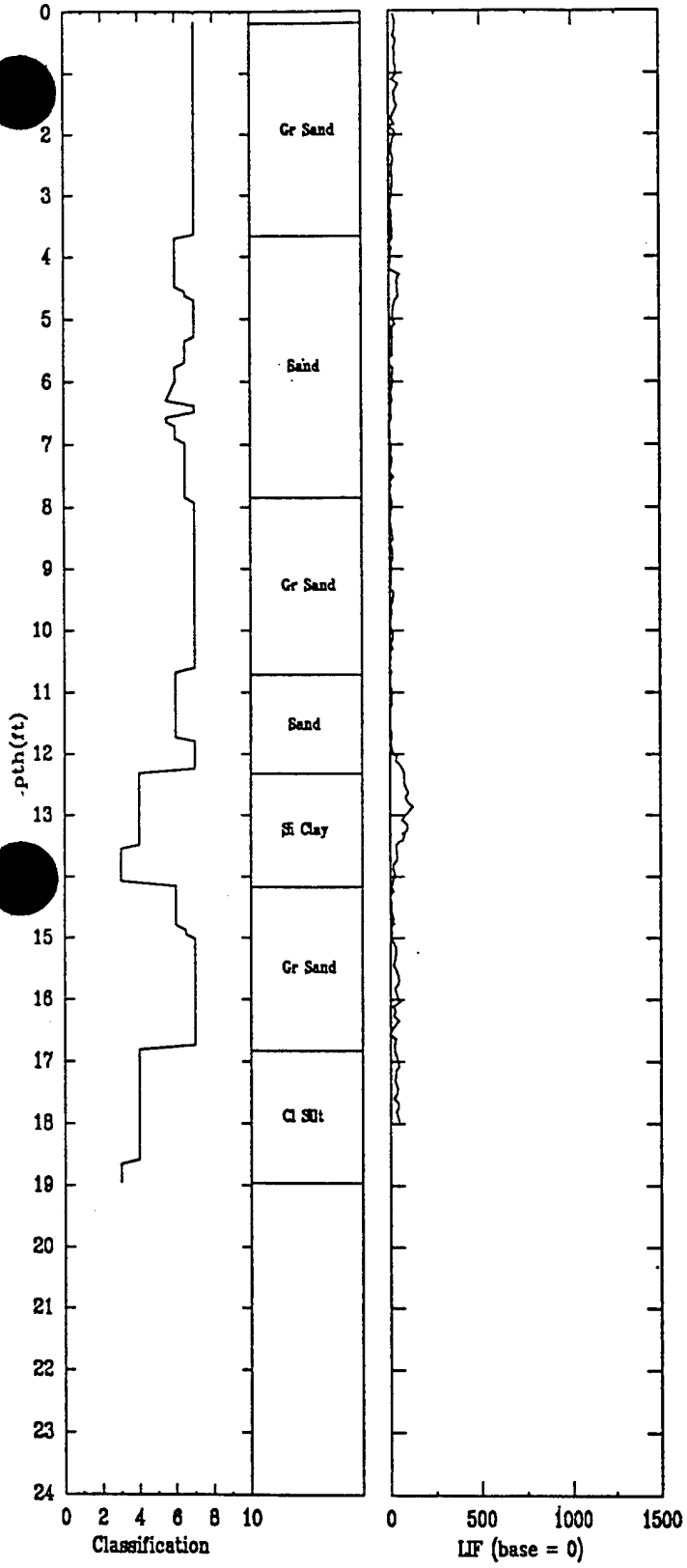

CCAFB-10 APPLIED RESEARCH ASSOCIATES, INC. 03/28/94

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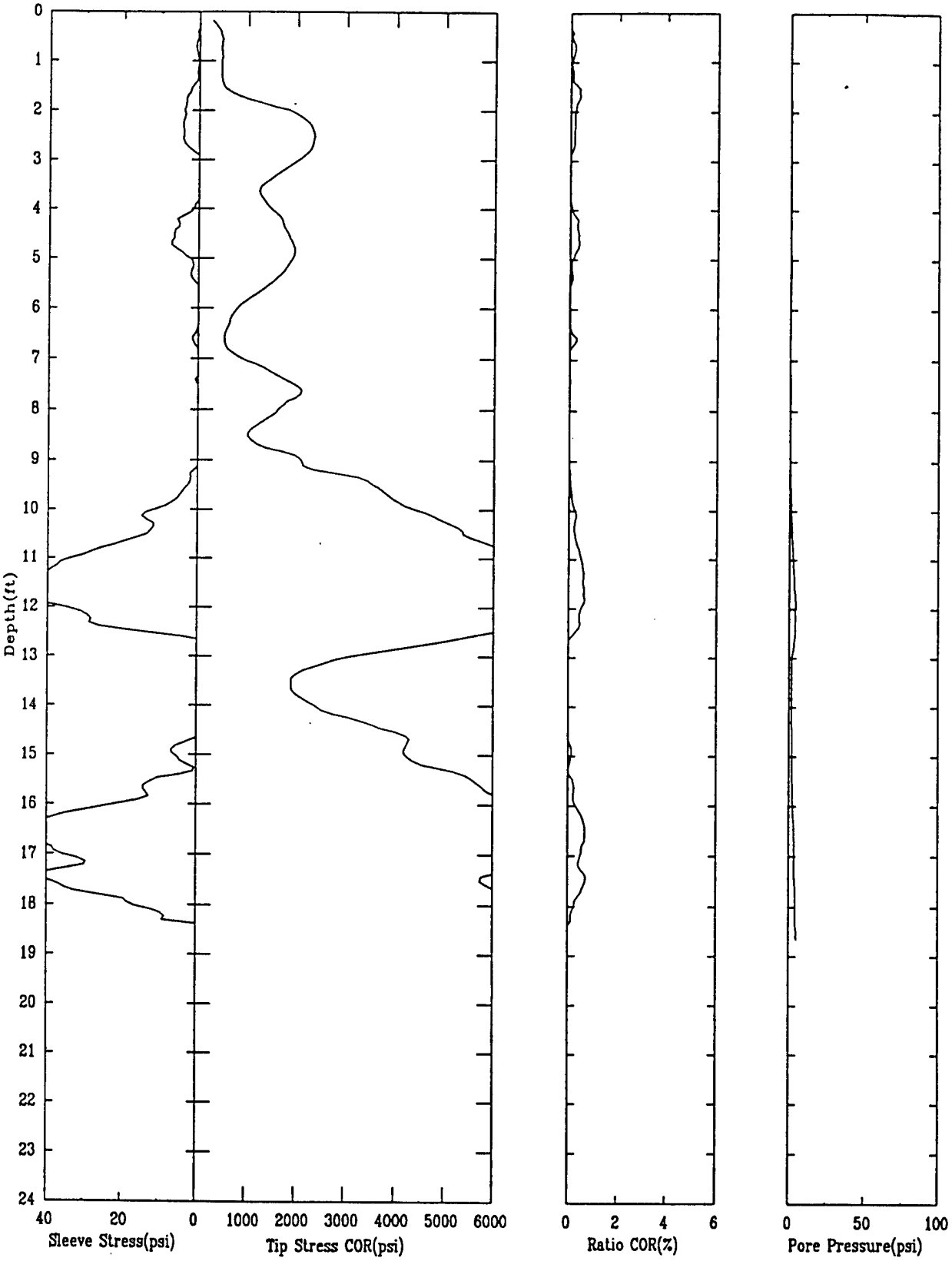

CCAFB-10 APPLIED RESEARCH ASSOCIATES, INC. 03/28/94

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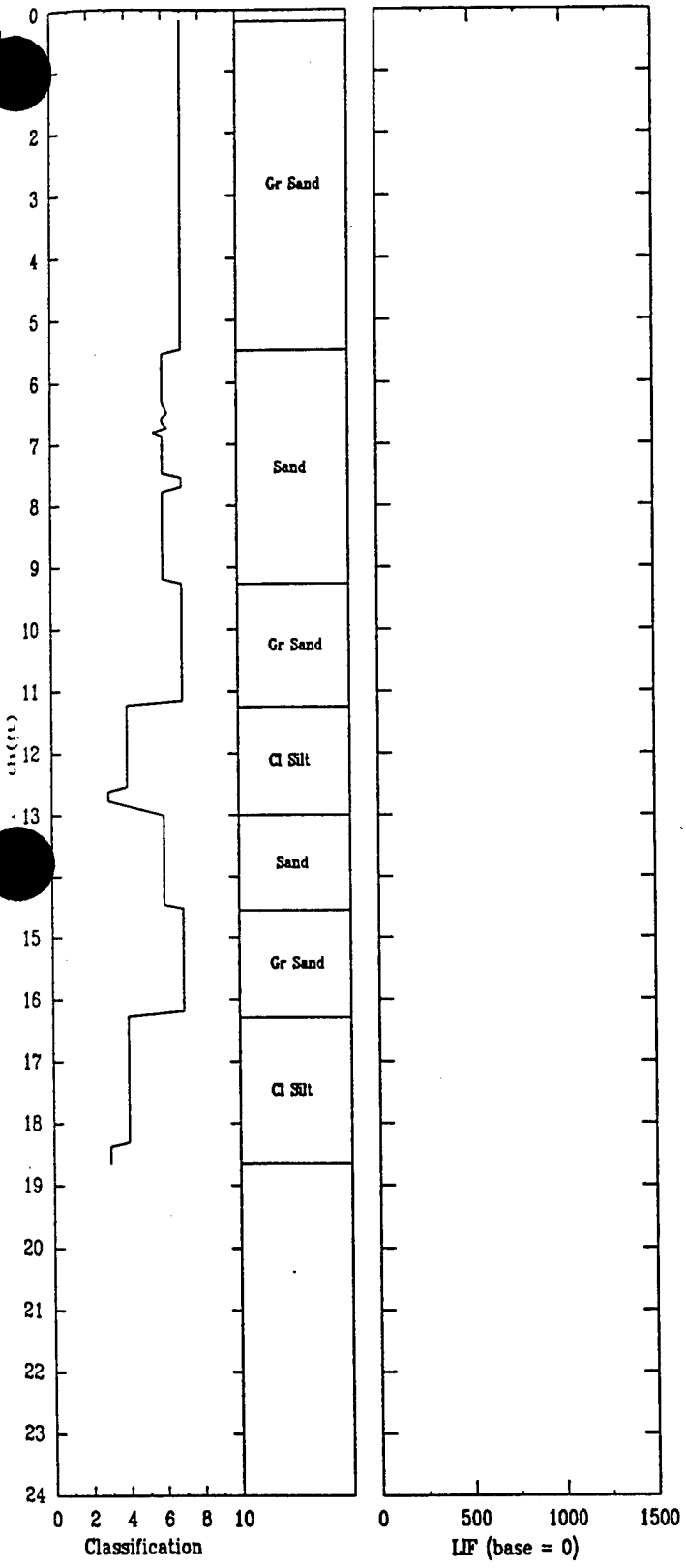

CCAFB-11 APPLIED RESEARCH ASSOCIATES, INC. 03/28/94

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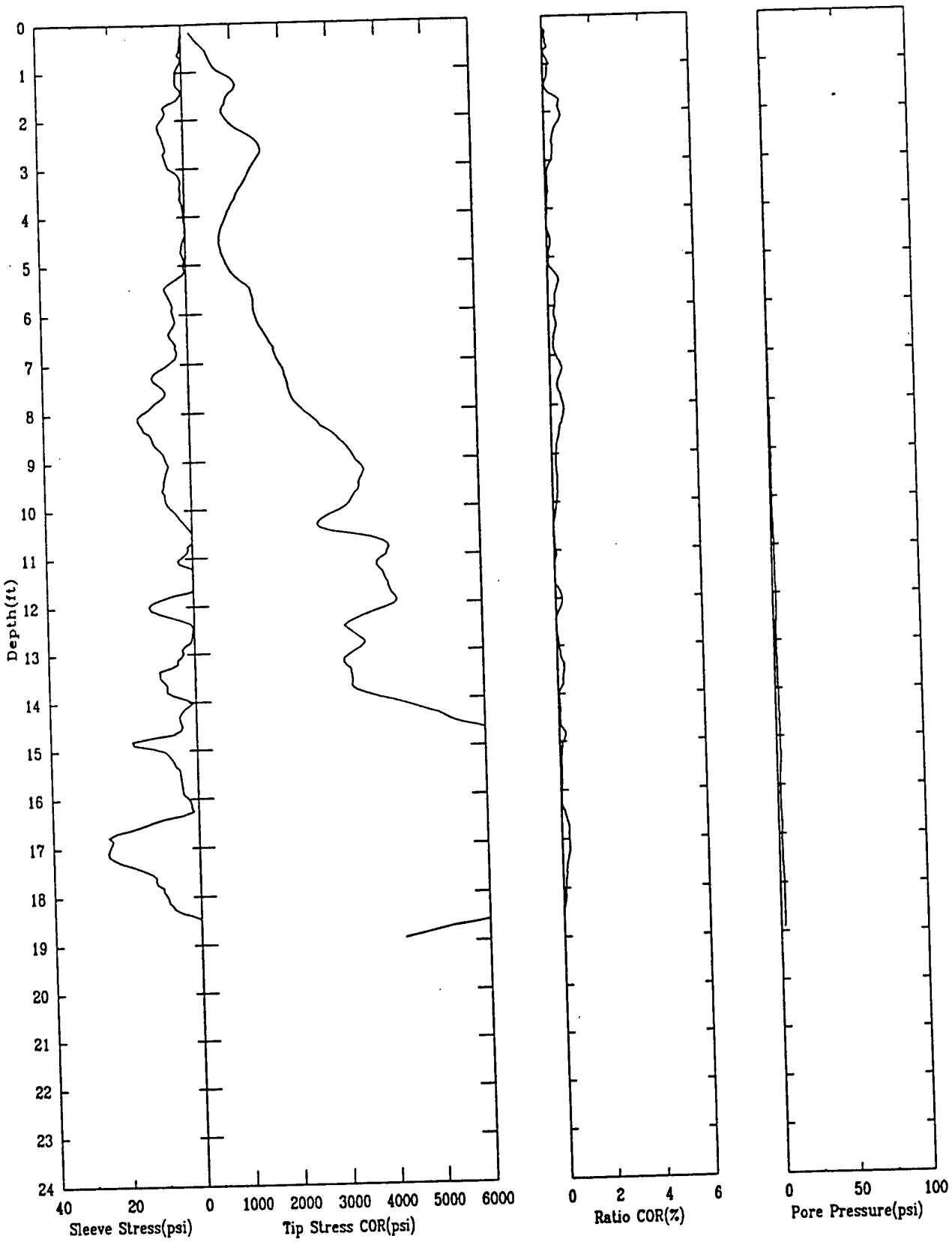

CCAFB-11 APPLIED RESEARCH ASSOCIATES, INC. 03/28/94

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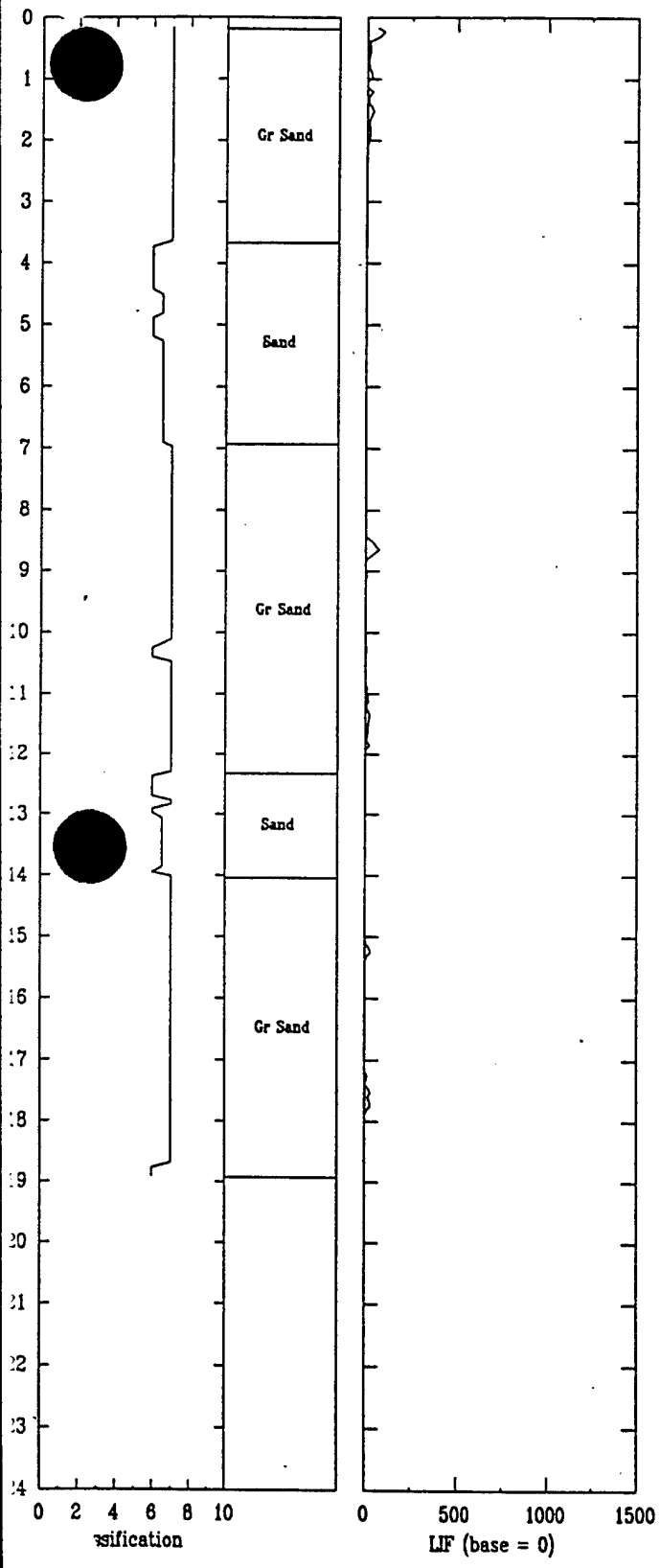


Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-1
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/26/96, 19__ ____ (a.m./p.m.)
SAMPLE COLLECTED BY: D. Kampbell of EPA
WEATHER: Sunny, 75°F, humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS / IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS / IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
2" PVC

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH 1so/H_2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH ____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 12.38' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: clear
1/26/96 Odor: weak hydrocarbon/sulfur
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
Volume Removed: 4 gallons
1/26/96 Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors:
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: _____
[✓] Pump, type: peristaltic
[ ] Other, describe: _____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp:	22.4 ° C	Measured with:	YSI 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	

See EPA Data

Other: _____

7 [✓] SAMPLE CONTAINERS (material, number, size):
2 vows w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
250 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

[✓] Preservatives added: H_3PO_4
H_2SO_4
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: _____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-2
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/26/96, 19__ ____ a.m./p.m.
SAMPLE COLLECTED BY: D. Kampbell of EPA
WEATHER: Sunny, 70°F, humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[Y] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
2" PVC

Check-off

1 [✓] EQUIPMENT CLEANED BEFORE USE WITH Iso/H2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH ____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 8.29' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: yellow/clear
1/25/96 Odor: mod/ hydrocarbon
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/25/96 Volume Removed: 10 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: mod. hydrocarbon
Other comments: yellow

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[✓] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp: 23.2 ° C — Measured with: YSI 55 D.O. Meter
pH: _____ — Measured with:_____
Conductivity: _____ — Measured with:_____
Dissolved Oxygen: _____ — Measured with:_____
Redox Potential: _____ — Measured with:_____
Salinity: _____ — Measured with:_____
Nitrate: _____ — Measured with:_____
Sulfate: _____ — Measured with:_____
Ferrous Iron: _____ — Measured with:_____
Other: H_2

See EPA Data

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 VOA w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-90 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[✓] Preservatives added: H_3PO_4
H_2SO_4
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-3
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/26/96, 19__ ____ a.m./p.m.
SAMPLE COLLECTED BY: D. Kamphell of EPA
WEATHER: Sunny, 75°F, humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
2" PVC

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH iso/H_2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH ____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 4.51' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: clear
1/26/96 Odor: weak hydrocarbon/sulfur
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/26/96 Volume Removed: 6 gallons
Observations: Water (~~slightly~~ - very) cloudy
Water level (rose - fell - no change)
Water odors: V. weak hydrocarbon/sulfur
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[✓] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp:	21.6 °C	Measured with:	YSI 55 D.O. Meters
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	
Other:	H_2		

see EPA Data

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 VOAs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[✓] Preservatives added: H_3PO_4
H_2SO_4
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-4
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19__ ____ a.m./p.m.
SAMPLE COLLECTED BY: D. Kampbell of EPA
WEATHER: Sunny, 65°F, humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
2" PVC

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH Iso/H_2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH ____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 6.17' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: yellow/clear
1/25/96 Odor: none
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/25/96 Volume Removed: 5 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: weak - mod. sulfur/hydrocarbon
Other comments: pale yellow

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[✓] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [ ] ONSITE MEASUREMENTS:

Temp:	24.0 ° C	Measured with:	YSI 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	
Other:	H_2		

See EPA Data

7 [✓] SAMPLE CONTAINERS (material, number, size):

4 VOAs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[✓] Preservatives added: H_2SO_4
H_3PO_4
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-5
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/26/96, 19__ ____ a.m./p.m.
SAMPLE COLLECTED BY: D. Kampbell of EPA
WEATHER: sunny, 70F, humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): 2" PVC

Check-off

1 [✓] EQUIPMENT CLEANED BEFORE USE WITH iso/h_2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH ____ FT. BELOW DATUM
Measured with: ____

1/27/96 WATER DEPTH 4.75' BTOC FT. BELOW DATUM
Measured with: ____

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: clear
1/25/96 Odor: weak / hydrocarbon?
Other Comments: ____

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/25/96 Volume Removed: 5 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: weak hydrocarbon
Other comments: ____

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: _____
[X] Pump, type: peristaltic
[ ] Other, describe: _____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp: 21.9 ° C	Measured with:	YSI 55 D.O Meter
pH: _____	Measured with:	_____
Conductivity: _____	Measured with:	_____
Dissolved Oxygen: _____	Measured with:	_____
Redox Potential: _____	Measured with:	_____
Salinity: _____	Measured with:	_____
Nitrate: _____	Measured with:	_____
Sulfate: _____	Measured with:	_____
Ferrous Iron: _____	Measured with:	_____
Other: H_2		

See EPA Data

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 VOAs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

[✓] Preservatives added: H_3PO_4
H_2SO_4
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: _____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-6
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19__ ____ a.m./p.m.
SAMPLE COLLECTED BY: D. Kimbrell of EPA
WEATHER: Dark, 60°F, humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[✓] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
2" PVC

Check-off

1 [✓] EQUIPMENT CLEANED BEFORE USE WITH 1SO/H2O
Items Cleaned (List): All meters

2 [✓] PRODUCT DEPTH ____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 9.19' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: yellow w/ orange flecks
1/25/96 Odor: weak hydrocarbon/Sulfers
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
Volume Removed: 5-6 gallons
1/25/96 Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: mod - strong hydrocarbon
Other comments: pl. yellow

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[✓] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [✓] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp:	23.1 ° C	Measured with:	YSI 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	
Other:	H_2		

See EPA Data

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 VOCs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[✓] Preservatives added: H_2SO_4
H_3PO_4
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-75
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19___ _____ a.m. (p.m.)
SAMPLE COLLECTED BY: D. Kimpbell of EPA
WEATHER: Sonny, 75°C, humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
2" PVC

Check-off

1 [✓] EQUIPMENT CLEANED BEFORE USE WITH iso/H_2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 7.37' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: clear
Odor: none
1/25/96 Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
Volume Removed: 5 gallons
1/25/96 Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: none
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[✓] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [✓] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp:	21.4 ° C	Measured with:	YSI 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	
Other:	H_2		

See EPA Data

7 [✓] SAMPLE CONTAINERS (material, number, size):

4 vocs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-50 ml ~~plastic~~ glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[✓] Preservatives added: H_3PO_4
H_2SO_4
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-7D
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19__ ____ a.m./(p.m.)
SAMPLE COLLECTED BY: ____ of ____
WEATHER: Sunny, 75°C humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): 2" PVC

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH Iso/h_2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH ____ FT. BELOW DATUM
Measured with: ____

1/27/96 WATER DEPTH 7.38' BTOC FT. BELOW DATUM
Measured with: ____

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: clear
1/25/96 Odor: mod. sulfur
Other Comments: ____

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/25/96 Volume Removed: 10 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: mod. sulfur
Other comments: ____

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: _____
[✓] Pump, type: peristaltic
[ ] Other, describe: _____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp:	23.0 ° C	Measured with:	YSI 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	

See EPA Data

Other: _____

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 vocs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4 1-250 ml plastic
2-500 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

[✓] Preservatives added: H_3PO_4
H_2SO_4
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: _____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-8S
(number)

REASON FOR SAMPLING: [ ] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19__ _____ a.m./p.m.
SAMPLE COLLECTED BY: D. Kimbell of EPA
WEATHER: Sunny - 65 F
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
2" PVC

Check-off

1 [✓] EQUIPMENT CLEANED BEFORE USE WITH iso/H2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 6.13' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: clear
1/24/96 Odor: weak sulfur
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/24/96 Volume Removed: 4 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: weak sulfur
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[✓] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

See EPA data

Temp: 19.9 ° C	Measured with:	YSI 55 D.O. Meter
pH: _____	Measured with:	
Conductivity: _____	Measured with:	
Dissolved Oxygen: _____	Measured with:	
Redox Potential: _____	Measured with:	
Salinity: _____	Measured with:	
Nitrate: _____	Measured with:	
Sulfate: _____	Measured with:	
Ferrous Iron: _____	Measured with:	
Other: H_2		

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 vocs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[✓] Preservatives added: H_2SO_4
H_3PO_4
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-8D
(number)

REASON FOR SAMPLING: [ ] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19__ ____ (a.m.) p.m.
SAMPLE COLLECTED BY: D. Kimphell of EPA
WEATHER: Sunny, 65°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS) IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS) IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
2" PVC

Check-off

1 [✓] EQUIPMENT CLEANED BEFORE USE WITH iso/H_2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH ____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 6.39' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: clear
1/25/96 Odor: none
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/25/96 Volume Removed: 12 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: weak sulfur
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: _____
[✓] Pump, type: peristaltic
[ ] Other, describe: _____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp: 22.3 ° C	Measured with:	YSI 55 DO Meter
pH: _____	Measured with:	_____
Conductivity: _____	Measured with:	_____
Dissolved Oxygen: _____	Measured with:	_____
Redox Potential: _____	Measured with:	_____
Salinity: _____	Measured with:	_____
Nitrate: _____	Measured with:	_____
Sulfate: _____	Measured with:	_____
Ferrous Iron: _____	Measured with:	_____

Other: _____

See EPA data

7 [✓] SAMPLE CONTAINERS (material, number, size): _____
4 VOAs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2- 60 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

[✓] Preservatives added: H_3PO_4
H_2SO_4
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: _____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-9S
(number)

REASON FOR SAMPLING: [✓] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19__ _____ a.m./p.m.
SAMPLE COLLECTED BY: D. Kampbell of EPA
WEATHER: Sunny, 70F, humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS / IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS / IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
2" PVC

Check-off

1 [✓] EQUIPMENT CLEANED BEFORE USE WITH iso/H2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 94' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: red/brown clear
1/25/96 Odor: mod. strong hydrocarbon
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/25/96 Volume Removed: 6 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: strong hydrocarbon
Other comments: gray/bleak color

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: _____
[✓] Pump, type: peristaltic
[ ] Other, describe: _____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

See EPA Data

Temp: 22.5 ° C	Measured with:	YSI 55 D.O. Meter
pH: _____	Measured with:	_____
Conductivity: _____	Measured with:	_____
Dissolved Oxygen: _____	Measured with:	_____
Redox Potential: _____	Measured with:	_____
Salinity: _____	Measured with:	_____
Nitrate: _____	Measured with:	_____
Sulfate: _____	Measured with:	_____
Ferrous Iron: _____	Measured with:	_____
Other: H_2		

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 vocs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

[✓] Preservatives added: H_3PO_4
H_2SO_4
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: _____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-9D
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19__ ____ a.m. (p.m.)
SAMPLE COLLECTED BY: D. Kampbell of EPA
WEATHER: Sunny, 85°, humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
2" PVC

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH 10% H_2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH ____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 8.46' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: brown / clear
1/25/96 Odor: weak hydrocarbon
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/25/96 Volume Removed: 9-10 gallons
Observations: Water (slightly / very) cloudy
Water level (rose - fell - no change)
Water odors: ~~no~~ weak hydrocarbon
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[✓] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp:	23.7 ° C	Measured with:	YSI 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	

See EPA Data

Other:_____

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 VOAs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[✓] Preservatives added: H_3PO_4 H_2SO_4
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-10
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19__ _____ a.m./p.m.
SAMPLE COLLECTED BY: Beth D. Kampbell of EPA
WEATHER: Sunny, 90° F, humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[Y] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
2" PVC

Check-off
1 [Y] EQUIPMENT CLEANED BEFORE USE WITH 1so/h2o
Items Cleaned (List): all meters

2 [Y] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 10.98' BTOC FT. BELOW DATUM
Measured with:

3 [Y] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: clear w/ black flakies
1/25/96 Odor: weak hydrocarbon / sulfur
Other Comments:

4 [Y] WELL EVACUATION:
Method: peristaltic pump
1/25/96 Volume Removed: 3 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: mod. hydrocarbon
Other comments: pl yellow

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: _____
[✓] Pump, type: peristaltic
[ ] Other, describe: _____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp:	22.1 ° C	Measured with:	YSI 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	
Other:	H_2		

See EPA Data

7 [✓] SAMPLE CONTAINERS (material, number, size): _____
4 VOAs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

[✓] Preservatives added: H_2SO_4
H_3PO_4
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: _____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-11
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19__ _____ a.m./p.m.
SAMPLE COLLECTED BY: D. Kimpbell of EDA
WEATHER: Sunny, 70°, humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[✓] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
2" PVC

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH iso/H2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 10.59' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: pl. yellow/clear
1/25/96 Odor: none
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/25/96 Volume Removed: 4 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: weak hydrocarbon/sulfur
Other comments: pl yellow

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[✓] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp:	22.5 ° C	Measured with:	YST 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	
Other:	H_2		

See EPA Data

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 VOAs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[✓] Preservatives added: H_3PO_4 H_2SO_4
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-12
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/26/96, 19__ ____ a.m./p.m.
SAMPLE COLLECTED BY: D. Kampbell of EPA
WEATHER: Sunny, 75°F, humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
2" PVC

Check-off

1 [✓] EQUIPMENT CLEANED BEFORE USE WITH iso/H2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH ____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 9.42' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: clear
1/26/96 Odor: weak hydrocarbon/sulfur
Other Comments: well was unlocked before we arrived @ site!!

4 [✓] WELL EVACUATION:
Method: peristaltic pump
Volume Removed: 6 gallons
1/26/96 Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: none
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[✓] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [✓] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp: 22.5 ° C	Measured with: YSI 55 D.O. Meter
pH: _____	Measured with: _____
Conductivity: _____	Measured with: _____
Dissolved Oxygen: _____	Measured with: _____
Redox Potential: _____	Measured with: _____
Salinity: _____	Measured with: _____
Nitrate: _____	Measured with: _____
Sulfate: _____	Measured with: _____
Ferrous Iron: _____	Measured with: _____

See EPA DATA

Other: _____

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 VOCs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[✓] Preservatives added: H_3PO_4
H_2SO_4
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-13S
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/24/96, 19__ ____ a.m./p.m.
SAMPLE COLLECTED BY: D. Kamphell of EPA
WEATHER: Sunny, Humid 75°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS / IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS / IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
2" PVC

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH Iso/H_2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH ____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 9.30' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: brown / clear
1/23/96 Odor: weak sulfur/hydrocarbon
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/23/96 Volume Removed: 4 gallons
Observations: Water (slightly / very) cloudy
Water level (rose - fell - no change)
Water odors: weak sulfur/hydrocarbon
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: _____
[✓] Pump, type: peristaltic
[ ] Other, describe: _____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

See EPA data

Temp: 21.9 ° C	Measured with:	YSI 55 D.O. Meter
pH: _____	Measured with:	_____
Conductivity: _____	Measured with:	_____
Dissolved Oxygen: _____	Measured with:	_____
Redox Potential: _____	Measured with:	_____
Salinity: _____	Measured with:	_____
Nitrate: _____	Measured with:	_____
Sulfate: _____	Measured with:	_____
Ferrous Iron: _____	Measured with:	_____
Other: H_2		

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 vocs w/ H_3PO_4
1-125ml plastic w/ H_2SO_4, 1-250ml plastic
2-amber glass 60ml bottles w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

[✓] Preservatives added: H_3PO_4, H_2SO_4
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: _____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-13D
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/24/96, 19__ _____ a.m./(p.m.)
SAMPLE COLLECTED BY: D. Kamphell of EPA
WEATHER: Sunny, Humid 75°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
2" PVC

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH iso/h2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 8.97' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: clear
1/23/96 Odor: weak Sulfur
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/23/96 Volume Removed: 12 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: weak Sulfur
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[✓] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [✓] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

See EPA data

Temp: 24.3 ° C		Measured with: YSI 55 D.O. Meter	
pH: _____		Measured with: _____	
Conductivity: _____		Measured with: _____	
Dissolved Oxygen: _____		Measured with: _____	
Redox Potential: _____		Measured with: _____	
Salinity: _____		Measured with: _____	
Nitrate: _____		Measured with: _____	
Sulfate: _____		Measured with: _____	
Ferrous Iron: _____		Measured with: _____	
Other: ft			

7 [✓] SAMPLE CONTAINERS (material, number, size):

4 vials w/ H_3PO_4
1-125ml plastic w/ H_2SO_4 1-250ml plastic
2-60ml amber glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[✓] Preservatives added: H_3PO_4
H_2SO_4
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-14
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19__ _____ a.m./p.m.
SAMPLE COLLECTED BY: D. Kampbell of EPA
WEATHER: Sunny, humid 75°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
2" PVC

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH Iso/H_2O
Items Cleaned (List):

2 [✓] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 5.47' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: clear
1/25/96 Odor: moderate hydrocarbon
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/25/96 Volume Removed: 9 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: strong hydrocarbon
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[✓] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

See EPA data

Temp:	21.3 ° C	Measured with:	YSI 55 D.O. meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	
Other:	H_2		

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 voas w/ H_3PO_4
1-125ml plastic w/ H_2SO_4, 1-250 ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[✓] Preservatives added: H_3PO_4
H_2SO_4
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-15S
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/24/96, 19__ _____ a.m./(p.m.)
SAMPLE COLLECTED BY: D. Kamphell of EPA
WEATHER: Sunny, humid 75° F
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
2" PVC

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH iso/h_2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 5.42' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: red/brown w/ fluffies
1/23/96 Odor: none
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/23/96 Volume Removed: 4 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: none
Other comments: -

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[✓] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

See EPA data

Temp:	21.0 ° C	Measured with:	YSI 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	
Other:	H_2		

7 [✓] SAMPLE CONTAINERS (material, number, size):

4 vocs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4 1-250 ml plastic
2-50 ml amber bottles w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[✓] Preservatives added: H_3PO_4
H_2SO_4
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-16S
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19__ ____ a.m./p.m.
SAMPLE COLLECTED BY: D. Kampbell of EPA
WEATHER: Sunny, 70°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): 2" PVC

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH iso/H_2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH ____ FT. BELOW DATUM
Measured with: ____

1/27/96 WATER DEPTH 5.63' BTOC FT. BELOW DATUM
Measured with: ____

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: pl. yellow/clear
1/24/96 Odor: none
Other Comments: ____

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/24/96 Volume Removed: 4 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: none
Other comments: ____

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[✓] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

See EPA data

Temp:	20.6 ° C	Measured with:	YST 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	
Other:	H_2		

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 vials w/ H_3PO_4
1-125 plastic w/ H_2SO_4, 1-250 plastic
2-40ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[✓] Preservatives added: H_3PO_4
H_2SO_4
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-16D
(number)

REASON FOR SAMPLING: [ ] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19__ _____ a.m./p.m.
SAMPLE COLLECTED BY: D. Kampbell of EPA
WEATHER: Sunny, 70°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
2" PVC

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH 150/H2O
Items Cleaned (List): all motors

2 [✓] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 4.66' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: clear
1/24/96 Odor: none
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/24/96 Volume Removed: 12 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: weak sulfur
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: _____
[✓] Pump, type: peristaltic
[ ] Other, describe: _____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [X] ONSITE MEASUREMENTS:

See EPA data

Temp:	22.4 ° C	Measured with:	YSI 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	
Other:			

7 [✓] SAMPLE CONTAINERS (material, number, size):

4 VOAs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml bottle plastic
2 - 50ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

[✓] Preservatives added: H_3PO_4, H_2SO_4
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: _____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-18
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/26/96, 19__ ____ (a.m.)/p.m.
SAMPLE COLLECTED BY: D. Kimpbell of EPA
WEATHER: Sunny, 75° F, humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS / IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS / IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
2" PVC flushmount

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH iso/H_2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH ____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 6.21' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: gray w/ black fluffies, slo cloudy
1/26/96 Odor: strong hydrocarbon
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/26/96 Volume Removed: 5 gallons
Observations: Water (slightly) - very) cloudy
Water level (rose - fell - no change)
Water odors: strong hydrocarbon
Other comments: pt. yellow

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[✓] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [✓] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp:	24.9 ° C	Measured with:	YSI 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	

See EPA Data

Other:_____

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 VOAs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[✓] Preservatives added: H_2SO_4
H_3PO_4
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-195
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/26/96, 19__ _____ a.m./p.m.
SAMPLE COLLECTED BY: D. Kampbell of EPA
WEATHER: Sunny, 75°F, humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): 2" PVC

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH Liq/H2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with: _____

1/27/96 WATER DEPTH 9.76' BTOC FT. BELOW DATUM
Measured with: _____

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Pl. yellow
1/26/96 Odor: moderate - sulfur
Other Comments: _____

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/26/96 Volume Removed: 4 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: weak sulfur
Other comments: Pl. yellow

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: _____
[✓] Pump, type: peristaltic
[ ] Other, describe: _____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp:	21.5 ° C	Measured with:	YSI 55 D.O Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	

See EPA Data

Other: _____

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 vocs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-60 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

[✓] Preservatives added: H_3PO_4
H_2SO_4
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: _____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-19I
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/26/96, 19__ ____ a.m./(p.m.)
SAMPLE COLLECTED BY: D. Kamphell of EPA
WEATHER: Sunny, 75°F, humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC.

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER ((IS) - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM ((IS) - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): 2" PVC

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH Iso/H_2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH ____ FT. BELOW DATUM
Measured with: ____

1/27/96 WATER DEPTH 4.75' BTOC FT. BELOW DATUM
Measured with: ____

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: V. pale yellow
Odor: weak sulfur
1/26/96 Other Comments: ____

4 [✓] WELL EVACUATION:
Method: peristaltic pump
Volume Removed: 7 gallons
1/26/96 Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: weak sulfur
Other comments: V pale yellow

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[✓] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [✓] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp:	23.5 °C	Measured with:	YSI 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	

See EPA Data

Other: _____

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 VOAs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[✓] Preservatives added: H_3PO_4
H_2SO_4
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-19D
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/26/96, 19__ _____ a.m. (p.m.)
SAMPLE COLLECTED BY: D Hamphell of EPA
WEATHER: Sunny, 75°F, humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
2" PVC

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH iso/h2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 4.56' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: clear
1/26/96 Odor: mod. sulfus/rot
Other Comments:

4 [✓] WELL EVACUATION:
Method: 12V peristaltic pump
1/26/96 Volume Removed: 12 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: weak - mod. sulfur
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[✓] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [✓] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp:	23.5 °C	Measured with:	YSI 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	

See EPA Data

Other: _____

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 VOAs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[✓] Preservatives added: H_2SO_4
H_3PO_4
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-205
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19__ ____ (a.m)/p.m.
SAMPLE COLLECTED BY: D. Kampbell of EPA
WEATHER: Sunny, 75°F, humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS) IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS) IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
2" PVC

Check-off

1 [✓] EQUIPMENT CLEANED BEFORE USE WITH Iso/H_2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH ____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 5.02' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: clear
1/25/96 Odor: mod-strong sulfur
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/25/96 Volume Removed: 4.5 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: none
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[✓] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp:	20.4 ° C	Measured with:	YSI 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	
Other:	H_2		

See EPA Data

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 VOAs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-glass 50 ml w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[✓] Preservatives added: H_3PO_4
H_2SO_4
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-20I
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19__ _____ (a.m./p.m.)
SAMPLE COLLECTED BY: D. Kimpbell of EPA
WEATHER: Sunny, 75°C humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[✓] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
2" PVC

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH iso/h2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 4.72' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: clear
1/25/96 Odor: none
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/25/96 Volume Removed: 6 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: mod. sulfur
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: _____
[✓] Pump, type: peristaltic
[ ] Other, describe: _____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp:	22.1 ° C	Measured with:	YSI 55 D.O. meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	

See EPA Data

Other: _____

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 VOAs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

[✓] Preservatives added: H_2SO_4
H_3PO_4
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: _____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-20D
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19__ _____ (a.m./p.m.)
SAMPLE COLLECTED BY: D. Kampbell of EPA
WEATHER: Sunny, humid, 75°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS / IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS / IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
2" PVC

Check-off

1 [✓] EQUIPMENT CLEANED BEFORE USE WITH 1so/h_2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 4.71' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: sl. cloudy
1/25/96 Odor: moderate sulfur
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/25/96 Volume Removed: 10 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: mod - strong sulfur
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: _____
[✓] Pump, type: peristaltic
[ ] Other, describe: _____

Sample obtained is [✓] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp:	22.3 ° C	Measured with:	YSI 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	

See EPA data

Other: _____

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 VOAs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-50 ml ~~plastic~~ glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

[✓] Preservatives added: H_2SO_4
H_3PO_4
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: _____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-215
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/24/96, 19__ _____ a.m./p.m.
SAMPLE COLLECTED BY: D. Kampbell of EPA
WEATHER: Sunny, humid 75°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC

MONITORING WELL CONDITION:
[✓] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS) IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS) IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
2" PVC - flushmount

Check-off

1 [✓] EQUIPMENT CLEANED BEFORE USE WITH Iso/H2O
Items Cleaned (List): all metals

2 [✓] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 3.80' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: White/clear
1/23/96 Odor: Weak Sulfur
Other Comments:

4 [✓] WELL EVACUATION:
Method: Peristaltic Pump
1/23/96 Volume Removed: 2 gallons
Observations: Water (slightly / very) cloudy
Water level (rose - fell - no change)
Water odors: weak Sulfur
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[✓] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

See EPA data

Temp: 22.8 ° C	Measured with: YSI 55 DO Meter
pH: _____	Measured with: _____
Conductivity: _____	Measured with: _____
Dissolved Oxygen: _____	Measured with: _____
Redox Potential: _____	Measured with: _____
Salinity: _____	Measured with: _____
Nitrate: _____	Measured with: _____
Sulfate: _____	Measured with: _____
Ferrous Iron: _____	Measured with: _____
Other: H_2	

7 [✓] SAMPLE CONTAINERS (material, number, size):

4 VOAs w/ H_3PO_4
5-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-40 ml amber glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[✓] Preservatives added: H_3PO_4
H_2SO_4
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-21I
(number)

REASON FOR SAMPLING: [✓] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/24/96, 19__ _____ a.m./p.m.
SAMPLE COLLECTED BY: D. Kampbell of EPA
WEATHER: Sunny, humid 75°C
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS / IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS / IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): 2" PVC - flush mount

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH iso/h_2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with: _____

1/27/96 WATER DEPTH 2.97' BTOC FT. BELOW DATUM
Measured with: _____

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: clear
1/23/96 Odor: none
Other Comments: _____

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/23/96 Volume Removed: 4 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: weak Sulfur?
Other comments: _____

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: _____
[✓] Pump, type: peristaltic
[ ] Other, describe: _____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

See EPA data

Temp:	25.1 ° C	Measured with:	YSI 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	

Other: _____

7 [✓] SAMPLE CONTAINERS (material, number, size):

4 VOAs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4 1-250 ml plastic
2-80 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

[✓] Preservatives added: H_2SO_4
H_3PO_4
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: _____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL FTA-21D
(number)

REASON FOR SAMPLING: [✓] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/24/96, 19__ _____ a.m./p.m.
SAMPLE COLLECTED BY: D. Kampbell of EPA
WEATHER: Sonny, humid 75°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[X] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
2" PVC - flushmount

Check-off

1 [✓] EQUIPMENT CLEANED BEFORE USE WITH Iso/H2O
Items Cleaned (List): all metals

2 [✓] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 2.79' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: clear
1/23/96 Odor: weak Sulfur
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
Volume Removed: 3 gallons
1/23/96 Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: weak - Sulfur
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: _____
[✓] Pump, type: peristaltic
[ ] Other, describe: _____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

See EPA data.

Temp:	25.0 ° C	Measured with:	YSI 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	

Other: _____

7 [✓] SAMPLE CONTAINERS (material, number, size):

9 vocs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

[✓] Preservatives added: H_3PO_4 H_2SO_4
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: _____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL CPT-1
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/24/96, 19__ _____ a.m./(p.m.)
SAMPLE COLLECTED BY: D. Kampbell of EPA
WEATHER: Sunny, Humid ~ 75° F
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
Black mark on TOC

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - (IS NOT) APPARENT
STEEL CASING CONDITION IS: NA
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - (IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
1/2" PVC

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH Iso/H_2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 3.60' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: gray/white cloudy
1/23/96 Odor: mod. sulfur
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/23/96 Volume Removed: 2 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: mod. sulfur
Other comments: v. cloudy

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[✓] Pump, type: Peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp:	23.0 ° C	Measured with:	YSI 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	
Other:	H_2		

See EPA data

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 VOAs - w/ H_3PO_4 preservative
2 plastic bottles 125 ml, 250 ml
2 amberglass 50 ml bottles (+ H_2SO_4)

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[✓] Preservatives added: H_3PO_4, H_2SO_4
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL CPT-2
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/24/96, 19__ _____ a.m./p.m.
SAMPLE COLLECTED BY: D. Kimbell of EPA
WEATHER: Sunny, Humid 75°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: NA
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
1/2" PVC

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH iso/H_2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 3.67' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: yellow/gray SL cloudy
1/23/96 Odor: weak sulfur
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/23/96 Volume Removed: 2 gallons
Observations: Water (slightly) - very) cloudy
Water level (rose - fell - no change)
Water odors: weak sulfur
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: _____
[✓] Pump, type: peristaltic
[ ] Other, describe: _____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp:	25.3 ° C	Measured with:	YSI 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	
Other:	H_2		

See EPA data

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 preserved vocs - H_3PO_4
2 plastic bottle - 125, 250 ml
2 amber 60 glass bottles, H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

[✓] Preservatives added: H_3PO_4
H_2SO_4
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: _____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL CPT-3
(number)

REASON FOR SAMPLING: [ ] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/24/96, 19__ _____ a.m./p.m.
SAMPLE COLLECTED BY: D. Kampbell of EPA
WEATHER: Sunny, Humid 75°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - ~~IS NOT~~) APPARENT
STEEL CASING CONDITION IS: NA
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - ~~IS NOT~~) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): 1/2" PVC

Check-off

1 [✓] EQUIPMENT CLEANED BEFORE USE WITH Iso/H2O
Items Cleaned (List):

2 [✓] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 3.45' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: gray/white sl. cloudy
1/23/96 Odor: mod. sulfur
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
Volume Removed: 2 gallons
Observations: Water (slightly very) cloudy
Water level (rose - fell - no change)
Water odors: mod. sulfur
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[✓] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp:	25.2 ° C.	Measured with:	YSI 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	
Other:	H_2		

See EPA data

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 VOAs w/ H_3PO_4
1-125ml plastic, 1-250 ml plastic
2-amber 40ml glass bottle w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[✓] Preservatives added: H_3PO_4
H_2SO_4
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL CPT-4
(number)

REASON FOR SAMPLING: [ ] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19__ ____ a.m./p.m.
SAMPLE COLLECTED BY: D. Kampbell of EPA
WEATHER: Sunny - 75°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[ ] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: NA
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
1/2" PVC

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH iso/H_2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH ____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 5.61' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: clear
1/24/96 Odor: weak hydrocarbon
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/24/96 Volume Removed: 2 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: weak - sulfur/hydrocarbon
Other comments:

Ground Water Sampling Record

5 [X] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: _____
[✓] Pump, type: peristaltic
[ ] Other, describe: _____

Sample obtained is [✓] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

See EPA data.

Temp:	22.4 ° C	Measured with:	YSI 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	

Other: _____

7 [✓] SAMPLE CONTAINERS (material, number, size):

4 VOAs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

[✓] Preservatives added: H_3PO_4, H_2SO_4
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: _____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL CPT-5
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19__ ____ (a.m./p.m.)
SAMPLE COLLECTED BY: D. Kamphell of EPA
WEATHER: Sunny, 75°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - (IS NOT) APPARENT
STEEL CASING CONDITION IS: OK
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - (IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
tubing

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH iso/h2o
Items Cleaned (List): all meters

2 [ ] PRODUCT DEPTH ____ FT. BELOW DATUM
Measured with:

WATER DEPTH ____ FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
1/24/96
Appearance: white/gray cloudy
Odor: weak hydrocarbon
Other Comments:

4 [✓] WELL EVACUATION:
1/24/96
Method: peristaltic pump
Volume Removed: 2 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: weak hydrocarbon
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: _____
[✓] Pump, type: peristaltic
[ ] Other, describe: _____

Sample obtained is [✓] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

See EPA data

Temp: 23.8 ° C	Measured with:	YSI 55 D.O. meter
pH: _____	Measured with:	_____
Conductivity: _____	Measured with:	_____
Dissolved Oxygen: _____	Measured with:	_____
Redox Potential: _____	Measured with:	_____
Salinity: _____	Measured with:	_____
Nitrate: _____	Measured with:	_____
Sulfate: _____	Measured with:	_____
Ferrous Iron: _____	Measured with:	_____
Other: _____		

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 vocs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4 1-250 ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration:
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

[✓] Preservatives added: H_3PO_4 H_2SO_4
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: _____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL CPT-6
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19___ _____ a.m./p.m.
SAMPLE COLLECTED BY: D. Campbell of EPA
WEATHER: sunny, 70°F humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe): tubing

MONITORING WELL CONDITION:
[ ] LOCKED: [✓] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: -> tubing
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): tubing

Check-off

1 [✓] EQUIPMENT CLEANED BEFORE USE WITH iso H_2O
Items Cleaned (List): all meters

2 [ ] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with: _____

WATER DEPTH _____ FT. BELOW DATUM
Measured with: _____

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: white/gray, v. cloudy
Odor: weak hydrocarbon
Other Comments: _____
1/25/96

4 [✓] WELL EVACUATION:
Method: peristaltic pump
Volume Removed: 2 gallons
1/25/96
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: none
Other comments: int./gray color

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: _____
[✓] Pump, type: peristaltic
[ ] Other, describe: _____

Sample obtained is [✓] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp:	23.5 ° C	Measured with:	YSI 55 DO. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	

See EPA data

Other: _____

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 vocs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

[✓] Preservatives added: H_3PO_4
H_2SO_4
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: _____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL CPT-7
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19__ _____ a.m./p.m.
SAMPLE COLLECTED BY: D Kampbell of EPA
WEATHER: Sunny, 70°F, Humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
1/2" PVC

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH iso/H_2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 5.95' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: brown/silty/cloudy
1/25/96 Odor: weak - sulfur/hydrocarbon
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/25/96 Volume Removed: 2 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: weak hydrocarbon
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: _____
[✓] Pump, type: peristaltic
[ ] Other, describe: _____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp:	20.8 ° C	Measured with:	YSI 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	
Other:			

See EPA Data

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 VOAs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

[✓] Preservatives added: H_3PO_4
H_2SO_4
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: _____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL CPT-8
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19___ _____ a.m./(p.m.)
SAMPLE COLLECTED BY: D. Kamphell of EPA
WEATHER: Sunny, 75°F, humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS (IS NOT) APPARENT
STEEL CASING CONDITION IS: NA
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS (IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): 1/2" PVC tubing

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH Iso/H_2O
Items Cleaned (List): all meters

2 [ ] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with: _____

WATER DEPTH _____ FT. BELOW DATUM
Measured with: _____

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: clear
Odor: weak - sulfur
Other Comments: _____
1/25/96

4 [✓] WELL EVACUATION:
Method: peristaltic pump
Volume Removed: 3 gallons
1/25/96
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: weak - sulfur?
Other comments: _____

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[✓] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp:	23.2 ° C	Measured with:	YSI 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	

See EPA data

Other: _____

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 VOCs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[✓] Preservatives added: H_3PO_4
H_2SO_4
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL MP-1D
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19___ _____ a.m./p.m.
SAMPLE COLLECTED BY: D. Kample of EPA
WEATHER: Sunny, 70°F, humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
~~TOC~~ NA - tubing

MONITORING WELL CONDITION:
[ ] LOCKED: [✓] UNLOCKED
WELL NUMBER (IS / IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS / IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [✓] EQUIPMENT CLEANED BEFORE USE WITH iso/H_2O
Items Cleaned (List): all meters

2 [ ] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with:

WATER DEPTH _____ FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: white/gray cloudy
Odor: none
Other Comments:
1/25/96

4 [✓] WELL EVACUATION:
Method: peristaltic pump
Volume Removed: 1.5 gallons
1/25/96
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: none
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: _____
[✓] Pump, type: peristaltic
[ ] Other, describe: _____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp:	23.9 ° C	Measured with:	YSI 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	
Other:			

See EPA Data

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 VOAs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

[✓] Preservatives added: H_3PO_4
H_2SO_4
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: _____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL MP-15
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19__ _____ a.m./p.m.
SAMPLE COLLECTED BY: D Kampbell of EPA
WEATHER: Sunny, 70°F, humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): 1/2" PVC

Check-off

1 [✓] EQUIPMENT CLEANED BEFORE USE WITH iso/H_2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with: _____

1/27/96 WATER DEPTH 9.20' BTOC FT. BELOW DATUM
Measured with: _____

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: gray/white - cloudy
1/25/96 Odor: none
Other Comments: _____

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/25/96 Volume Removed: 2 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: none
Other comments: 56 white

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: _____
[✓] Pump, type: peristaltic
[ ] Other, describe: _____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp:	21.7 ° C	Measured with:	YSI 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	

See EPA Data

Other: _____

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 vials w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

[✓] Preservatives added: H_2SO_4
H_3PO_4
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: _____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL MP-2
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/26/96, 19__ ____ (a.m./p.m.)
SAMPLE COLLECTED BY: D. Kumpbell of EPA
WEATHER: Sunny, 70°F, humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[ ] LOCKED: [✓] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
1/2" PVC

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH Iso/H2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH ____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 8.32' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: brown / cloudy
1/26/96 Odor: weak hydrocarbon / sulfur
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/26/96 Volume Removed: 2 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: weak - mod hydrocarbon
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[✓] Pump, type: Peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp:	21.6 ° C	Measured with:	YSI 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	

See EPA data

Other:_____

7 [✓] SAMPLE CONTAINERS (material, number, size):

4 VOAs w/ H_3PO_4
1-125ml plastic w/ H_2SO_4, 1-250 ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[✓] Preservatives added: H_3PO_4, H_2SO_4
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL MP-3
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/26/96, 19__ ____ a.m./p.m.
SAMPLE COLLECTED BY: D. Kimphell of EPA
WEATHER: Sunny, 75°F, humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[ ] LOCKED: [Y] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
1/2" PVC

Check-off
1 [Y] EQUIPMENT CLEANED BEFORE USE WITH iso/h2O
Items Cleaned (List): all meters

2 [Y] PRODUCT DEPTH ____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 7.41' BTOC FT. BELOW DATUM
Measured with:

3 [Y] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: brown (cloudy)
1/26/96 Odor: none
Other Comments:

4 [Y] WELL EVACUATION:
Method: peristaltic pump
1/26/96 Volume Removed: 2 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: weak - most hydrocarbon
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[✓] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp: 21.8 ° C	Measured with:	YSI 55 D.O. Meter
pH: _____	Measured with:	_____
Conductivity: _____	Measured with:	_____
Dissolved Oxygen: _____	Measured with:	_____
Redox Potential: _____	Measured with:	_____
Salinity: _____	Measured with:	_____
Nitrate: _____	Measured with:	_____
Sulfate: _____	Measured with:	_____
Ferrous Iron: _____	Measured with:	_____

See EPA Data

Other: _____

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 VOCs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[✓] Preservatives added: H_3PO_4
H_2SO_4
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL MP-4S
(number)

REASON FOR SAMPLING: [ ] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19__ ____ (a.m./p.m.)
SAMPLE COLLECTED BY: D. Kampbell of EPA
WEATHER: Sunny, 75°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: NA
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
1/2" PVC

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH iso/H_2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH ____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 4.75' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: brown/gray cloudy
1/25/96 Odor: hydrocarbon - 7ppm
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/25/96 Volume Removed: 4 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: hydrocarbon/moderate
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: _____
[✓] Pump, type: peristaltic
[ ] Other, describe: _____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

See EPA Data

Temp:	21.9 ° C	Measured with:	YSI 55 D.O. Meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	

Other: _____

7 [✓] SAMPLE CONTAINERS (material, number, size):

4 vocs w/ H_3PO_4
1-125 ml bottle w/ H_2SO_4, 1-250 ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

[✓] Preservatives added: H_2SO_4
H_3PO_4
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: _____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL MP-4D
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19__ ____ a.m./p.m.
SAMPLE COLLECTED BY: D. Kampbell of EPA
WEATHER: Sunny, 75°C
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: —
INNER PVC CASING CONDITION IS: tubing
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
tubing

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH iso/H_2O
Items Cleaned (List): all meters

2 [ ] PRODUCT DEPTH ____ FT. BELOW DATUM
Measured with:

WATER DEPTH ____ FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: brown/ muddy - cloudy
1/25/96 Odor: none
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/25/96 Volume Removed: 2 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: none
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[✓] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

See EPA data

Temp: 23.1 ° C	Measured with:	YSI 55 D.O. meter
pH: _____	Measured with:	_____
Conductivity: _____	Measured with:	_____
Dissolved Oxygen: _____	Measured with:	_____
Redox Potential: _____	Measured with:	_____
Salinity: _____	Measured with:	_____
Nitrate: _____	Measured with:	_____
Sulfate: _____	Measured with:	_____
Ferrous Iron: _____	Measured with:	_____

Other: _____

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 VOAs w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[✓] Preservatives added: H_2SO_4
H_3PO_4
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL MP-5
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19___ _____ a.m./p.m.
SAMPLE COLLECTED BY: D. Kampbell of EPA
WEATHER: Sunny, humid 75°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: -
INNER PVC CASING CONDITION IS:
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
1/2 PVC"

Check-off

1 [✓] EQUIPMENT CLEANED BEFORE USE WITH iso/H_2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 7.20' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: clear
1/25/96 Odor: none
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
Volume Removed: 4 gallons
1/25/96 Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: none
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[✓] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp:	22.1 ° C	Measured with:	YSI 55 DO. meter
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	

See EPA data

Other: _____

7 [✓] SAMPLE CONTAINERS (material, number, size):
4 vows w/ H_3PO_4
1-125 ml plastic w/ H_2SO_4, 1-250ml plastic
2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[✓] Preservatives added: H_2SO_4
H_3PO_4
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

Ground Water Sampling Record

SAMPLING LOCATION Cape Canaveral FTA
SAMPLING DATE(S) 1/22/96 - 1/27/96

GROUND WATER SAMPLING RECORD - MONITORING WELL MP-6
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 1/25/96, 19___ _____ a.m./p.m.
SAMPLE COLLECTED BY: D. Kimpbell of EPA
WEATHER: Sunny, 75°F, humid
DATUM FOR WATER DEPTH MEASUREMENT (Describe):
TOC

MONITORING WELL CONDITION:
[X] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):
1/2" PVC

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH Iso/H2O
Items Cleaned (List): all meters

2 [✓] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with:

1/27/96 WATER DEPTH 5.32' BTOC FT. BELOW DATUM
Measured with:

3 [✓] WATER CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: brown/ cloudy
1/25/96 Odor: weak hydrocarbon/ sulfur
Other Comments:

4 [✓] WELL EVACUATION:
Method: peristaltic pump
1/25/96 Volume Removed: 3 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: none
Other comments:

Ground Water Sampling Record

5 [✓] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: _____
[✓] Pump, type: peristaltic
[ ] Other, describe: _____

Sample obtained is [X] GRAB [ ] COMPOSITE SAMPLE

6 [✓] ONSITE MEASUREMENTS:

Temp:	23.0 ° C	Measured with:	
pH:		Measured with:	
Conductivity:		Measured with:	
Dissolved Oxygen:		Measured with:	
Redox Potential:		Measured with:	
Salinity:		Measured with:	
Nitrate:		Measured with:	
Sulfate:		Measured with:	
Ferrous Iron:		Measured with:	
Other:			

See EPA data

7 [✓] SAMPLE CONTAINERS (material, number, size): 4 vocs w/ H_3PO_4; 1-125 ml plastic w/ H_2SO_4, 1-250 ml plastic; 2-50 ml glass w/ H_2SO_4

8 [✓] ONSITE SAMPLE TREATMENT:

[ ] Filtration: Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

[✓] Preservatives added: H_3PO_4, H_2SO_4
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

9 [✓] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: _____

MONITORING POINT ~~DEVELOPMENT~~ PURGE RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/25/96
Well Number FTA-2 Measurement Datum

Pre-Development Information Time (Start): 13:40

Water Level: 8.29' BTOC Total Depth of Well:

Water Characteristics

Color yellow (Clear) Cloudy
Odor: None Weak ~~Moderate~~ Strong hydrocarbon
Any Films or Immiscible Material
pH 6.86 Temperature(°F (°C)) 24.2°C
Specific Conductance(µS/cm) 2340 us/cm
D.O. ~ 0.57 mg/L

Interim Water Characteristics

Gallons Removed 5 gallons
pH 6.80
Temperature (°F (°C)) 23.3°C
Specific Conductance(µS/cm) 1500 us/cm
D.O. ~ 0.66 mg/L

Post-Development Information Time (Finish): 14:15

Water Level: Total Depth of Well:

Approximate Volume Removed: 10 gallons

Water Characteristics

Color yellow (Clear) Cloudy
Odor: None Weak (Moderate) Strong hydrocarbon
Any Films or Immiscible Material
pH 6.86 Temperature(°F (°C)) 23.2°C
Specific Conductance(µS/cm) 1510 us/cm
D.O. ~ 0.38 mg/L

Comments:

MONITORING POINT ~~DEVELOPMENT~~ PURGE RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/26/98
Well Number FTA-3 Measurement Datum _____

Pre-Development Information Time (Start): 7:00

Water Level: 4.57' BTOC Total Depth of Well: 23.72'

Water Characteristics

Color – (Clear) Cloudy
Odor: None (Weak) Moderate Strong hydrocarbon/sulfur
Any Films or Immiscible Material _____
pH 6.89 Temperature(°F (°C) 22.2°C
Specific Conductance(µS/cm) 2910 us/cm
D.O. ~ 0.70 mg/L

Interim Water Characteristics

Gallons Removed 2.5 gallons
pH 6.97
Temperature (°F (°C) 21.8°C
Specific Conductance(µS/cm) 2900 us/cm
D.O. ~ 0.99 mg/L

Post-Development Information Time (Finish): 7:40

Water Level: _____ Total Depth of Well: –

Approximate Volume Removed: 6 gallons

Water Characteristics

Color – (Clear) Cloudy
Odor: ~~None~~ (Weak) Moderate Strong hydrocarbon/sulfur
Any Films or Immiscible Material –
pH 6.89 Temperature(°F °C) 21.6°C
Specific Conductance(µS/cm) 2580 us/cm
D.O. ~ 0.52 mg/L

Comments:

PURGE

MONITORING POINT ~~DEVELOPMENT~~ RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/25/96
Well Number FTA - 4 Measurement Datum

Pre-Development Information Time (Start): 13:40

Water Level: 6.19' BTOC Total Depth of Well:

Water Characteristics

Color yellow (Clear) Cloudy
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material —
pH 7.35 Temperature(°F (°C) 23.5°C
Specific Conductance(µS/cm) 460 us/cm
D.O. ~ 3.80 mg/L

Interim Water Characteristics

Gallons Removed 2.5 gallons

pH 7.11

Temperature (°F (°C) 23.8°C

Specific Conductance(µS/cm) 480 us/cm
D.O. ~ ~~2.37 mg/L~~ 3.20 mg/L

Post-Development Information Time (Finish): 14:10

Water Level: Total Depth of Well:

Approximate Volume Removed: 5 gallons

Water Characteristics

Color pl. yellow (Clear) Cloudy
Odor: None (Weak) Moderate Strong sulfur/hydrocarbon
Any Films or Immiscible Material —
pH 7.00 Temperature(°F (°C) 24.0°C
Specific Conductance(µS/cm) 780 us/cm
D.O. ~ 2.37 mg/L

Comments:

PURGE

MONITORING POINT ~~DEVELOPMENT~~ RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/25/96
Well Number FTA-5 Measurement Datum

Pre-Development Information Time (Start): 14:25

Water Level: 4.82' BTOC Total Depth of Well: 24.65'

Water Characteristics

Color — (Clear) Cloudy
Odor: None (Weak) Moderate Strong hydrocarbon?
Any Films or Immiscible Material —
pH 6.90 Temperature(°F (°C)) 22.0°C
Specific Conductance(µS/cm) 1880 us/cm
D.O. ~ 0.64 mg/L

Interim Water Characteristics

Gallons Removed 2.5 gallons
pH 6.90
Temperature (°F (°C)) 22.0°C
Specific Conductance(µS/cm) 1880 us/cm
D.O. ~ 0.36 mg/L

Post-Development Information Time (Finish): 14:50

Water Level: Total Depth of Well:

Approximate Volume Removed: 5 gallons

Water Characteristics

Color — (Clear) Cloudy
Odor: None (Weak) Moderate Strong hydrocarbon
Any Films or Immiscible Material —
pH 6.90 Temperature(°F °C) 21.9°C
Specific Conductance(µS/cm) 1920 us/cm
D.O ~ 0.59 mg/L

Comments:

PURGE

MONITORING POINT ~~DEVELOPMENT~~ RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/25/96
Well Number FTA-6 Measurement Datum

Pre-Development Information Time (Start): 14:20

Water Level: 9.15' BTOC Total Depth of Well:

Water Characteristics

Color yellow/ orange flufies (Clear) Cloudy
Odor: None (Weak) Moderate Strong hydrocarbon / sulfur
Any Films or Immiscible Material —
pH 6.54 Temperature(°F (°C) 23.2°C
Specific Conductance(µS/cm) 1210 us/cm
D.O. ~ 0.32 mg/L

Interim Water Characteristics

Gallons Removed 2.5 - 3 gallons
pH 6.53
Temperature (°F (°C) ~~0.48~~ 23.3°C
Specific Conductance(µS/cm) 1150 us/cm
D.O. ~ 0.70 mg/L

Post-Development Information Time (Finish): 14:40

Water Level: Total Depth of Well:

Approximate Volume Removed: 5-6 gallons

Water Characteristics

Color pl. yellow (Clear) Cloudy
Odor: None Weak (Moderate) Strong hydrocarbon
Any Films or Immiscible Material Sheen
pH 6.55 Temperature(°F (°C) 23.1°C
Specific Conductance(µS/cm) 1110 us/cm
D.O. ~ 0.48 mg/L

Comments:

MONITORING POINT ~~DEVELOPMENT~~ PURGE RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/25/96
Well Number FTA-75 Measurement Datum

Pre-Development Information Time (Start): 10:00

Water Level: 7.41' BTOC Total Depth of Well: 15.35

Water Characteristics

Color – (Clear) Cloudy
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material –
pH 7.10 Temperature(°F (°C)) 21.6°C
Specific Conductance(µS/cm) 630 us/cm
D.O. ~ 0.61 mg/L

Interim Water Characteristics

Gallons Removed 2.5 gallons
pH 7.09
Temperature (°F (°C)) 21.7°C
Specific Conductance(µS/cm) 690 us/cm
D.O. ~ 0.40 mg/L

Post-Development Information Time (Finish): 10:40

Water Level: Total Depth of Well:

Approximate Volume Removed: 3 gallons

Water Characteristics

Color – (Clear) Cloudy
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material –
pH 6.99 Temperature(°F (°C)) 21.4°C
Specific Conductance(µS/cm) 730 us/cm
D.O. ~ 0.40 mg/L

Comments:

PURGE

MONITORING POINT ~~DEVELOPMENT~~ RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/25/96
Well Number FTA-7D Measurement Datum

Pre-Development Information Time (Start): 10:00

Water Level: 7.49' BTOC Total Depth of Well: 64.45'

Water Characteristics

Color — (Clear) Cloudy
Odor: None (Weak) Moderate Strong Sulfur
Any Films or Immiscible Material —
pH 7.48 Temperature(°F (°C) 22.1°C
Specific Conductance(µS/cm) 2110 us/cm
D.O. ~ 0.21 mg/L

Interim Water Characteristics

Gallons Removed 4 gallons

pH 7.49

Temperature (°F (°C) 23.0°C

Specific Conductance(µS/cm) 2070 us/cm
D.O. ~ 0.38 mg/L

Post-Development Information Time (Finish): 10:40

Water Level: Total Depth of Well:

Approximate Volume Removed: 10 gallons

Water Characteristics

Color — (Clear) Cloudy
Odor: None (Weak) Moderate Strong Sulfur
Any Films or Immiscible Material —
pH 7.51 Temperature(°F (°C) 23.0°C
Specific Conductance(µS/cm) 2120 us/cm
D.O. ~ 0.35 mg/L

Comments:

PURGE

MONITORING POINT ~~DEVELOPMENT~~ RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/24/96
Well Number FTA-85 Measurement Datum _____

Pre-Development Information Time (Start): 7:15

Water Level: 6.17' BTOC Total Depth of Well: 15.3'

Water Characteristics

Color — (Clear) Cloudy
Odor: (None) Weak Moderate Strong Sulfur
Any Films or Immiscible Material —
pH 6.90 Temperature(°F °C) 19.7°C
Specific Conductance(µS/cm) 510 us/cm
D.O.~ 0.17 mg/L

Interim Water Characteristics

Gallons Removed 2 gallons
pH 7.16
Temperature (°F (°C) 19.9°C
Specific Conductance(µS/cm) 550 us/cm
D.O. ~ 0.25 mg/L

Post-Development Information Time (Finish): 8:00

Water Level: _____ Total Depth of Well: _____

Approximate Volume Removed: 4 gallons

Water Characteristics

Color — (Clear) Cloudy
Odor: None (Weak) Moderate Strong Sulfur
Any Films or Immiscible Material —
pH 6.98 Temperature(°F °C) 19.9°C
Specific Conductance(µS/cm) 560 us/cm
D.O. - 0.29 mg/L
Redox - 98 mV

Comments:

MONITORING POINT ~~DEVELOPMENT~~ PURGE RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/24/96
Well Number FTA-8D Measurement Datum

Pre-Development Information Time (Start): 7:30

Water Level: 7.53' BTOC Total Depth of Well: 60.35'

Water Characteristics

Color – (Clear) Cloudy
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material –
pH 7.13 Temperature(°F (°C) 21.6°C
Specific Conductance(µS/cm) 2150 us/cm
D.O. ~ 0.23 mg/L

Interim Water Characteristics

Gallons Removed 6 gallons
pH 7.50
Temperature (°F (°C) 22.2°C
Specific Conductance(µS/cm) 2160 us/cm
D.O. ~ 0.10 mg/L

Post-Development Information Time (Finish): 9:30

Water Level: Total Depth of Well:

Approximate Volume Removed: 12 gallons

Water Characteristics

Color – (Clear) Cloudy
Odor: (None) (Weak) Moderate Strong Sulfur
Any Films or Immiscible Material –
pH 7.51 Temperature(°F (°C) 22.3°C
Specific Conductance(µS/cm) 2160 us/cm
D.O. ~ 0.13 mg/L
Redox ~ -208 mV

Comments:

PURGE

MONITORING POINT ~~DEVELOPMENT~~ RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/25/96
Well Number FTA-95 Measurement Datum

Pre-Development Information Time (Start): 11:00

Water Level: 8.34' BTOC Total Depth of Well:

Water Characteristics

Color red/brown (Clear) Cloudy
Odor: None Weak (Moderate) Strong hydrocarbon
Any Films or Immiscible Material —
pH 6.55 Temperature(°F °C) 21.9°C
Specific Conductance(µS/cm) 1260 us/cm
D.O. ~ 0.09 mg/L

Interim Water Characteristics

Gallons Removed 3 gallons
pH 6.58
Temperature (°F (°C) 22.5°C
Specific Conductance(µS/cm) 1100 us/cm
D.O. ~ 0.26 mg/L

Post-Development Information Time (Finish): 11:40

Water Level: Total Depth of Well:

Approximate Volume Removed: 6 gallons

Water Characteristics

Color gray/black (Clear) Cloudy
Odor: None Weak Moderate (Strong) hydrocarbon
Any Films or Immiscible Material —
pH 6.58 Temperature(°F (°C) 22.5°C
Specific Conductance(µS/cm) 1100 us/cm
D.O. ~ 0.20 mg/L

Comments:

PURGE

MONITORING POINT ~~DEVELOPMENT~~ RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/25/96
Well Number FTA - 9D Measurement Datum

Pre-Development Information Time (Start): 11:00

Water Level: 8.34' BTOC Total Depth of Well:

Water Characteristics

Color brown (Clear) Cloudy
Odor: None (Weak) Moderate Strong hydrocarbon
Any Films or Immiscible Material —
pH 7.34 Temperature(°F (°C) 23.9°C
Specific Conductance(µS/cm) 2070 us/cm
D.O. ~ 3.45 mg/L

Interim Water Characteristics

Gallons Removed 5 gallons
pH 7.41
Temperature (°F (°C) 24.0°C
Specific Conductance(µS/cm) 2120 us/cm
D.O. ~ 0.77 mg/L

Post-Development Information Time (Finish): 11:45

Water Level: Total Depth of Well:

Approximate Volume Removed: 9 - 10 gallons

Water Characteristics

Color — (Clear) Cloudy
Odor: None (Weak) Moderate Strong hydrocarbon
Any Films or Immiscible Material —
pH 7.38 Temperature(°F (°C) 23.7°C
Specific Conductance(µS/cm) 2920 us/cm
D.O. ~ 0.51 mg/L

Comments:

MONITORING POINT ~~DEVELOPMENT~~ PURGE RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/25/96
Well Number FTA-10 Measurement Datum

Pre-Development Information Time (Start): 15:15

Water Level: 10.92' BTOC Total Depth of Well: 29.15'

Water Characteristics

Color clear w/ black fines (Clear) Cloudy
Odor: None (Weak) Moderate Strong hydrocarbon/sulfur
Any Films or Immiscible Material —
pH 6.98 Temperature(°F °C) 21.8°C
Specific Conductance(µS/cm) 1200 us/cm
D.O. ~ 0.76 mg/L

Interim Water Characteristics

Gallons Removed 2.5 gallons

pH 6.93

Temperature (°F (°C) 21.8°C

Specific Conductance(µS/cm) 1220 us/cm
D.O. ~ 0.40 mg/L

Post-Development Information Time (Finish): 15:40

Water Level: Total Depth of Well:

Approximate Volume Removed: 5 gallons

Water Characteristics

Color pl. yellow (Clear) Cloudy
Odor: None Weak (Moderate) Strong hydrocarbon
Any Films or Immiscible Material —
pH 6.95 Temperature(°F (°C) 22.1°C
Specific Conductance(µS/cm) 1230 us/cm
D.O. ~ 0.39 mg/L

Comments:

MONITORING POINT ~~DEVELOPMENT~~ PURGE RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/25/96
Well Number FTA-11 Measurement Datum

Pre-Development Information Time (Start): 15:20

Water Level: 10.54' BTOC Total Depth of Well: 29.07'

Water Characteristics

Color pl yellow (Clear) Cloudy
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material —
pH 7.36 Temperature(°F (°C) 21.2°C
Specific Conductance(µS/cm) 420 us/cm
D.O. ~ 1.37 mg/L

Interim Water Characteristics

Gallons Removed 2.5 gallons

pH 7.26

Temperature (°F (°C) 22.2°C

Specific Conductance(µS/cm) 440 us/cm
D.O. ~ 0.80 mg/L

Post-Development Information Time (Finish): 15:45

Water Level: Total Depth of Well:

Approximate Volume Removed: 9 gallons

Water Characteristics

Color pl yellow (Clear) Cloudy
Odor: None (Weak) Moderate Strong hydrocarbon/sulfur
Any Films or Immiscible Material —
pH 7.31 Temperature(°F (°C) 22.5°C
Specific Conductance(µS/cm) 460 us/cm
D.O. ~ 0.76 mg/L

Comments:

MONITORING POINT ~~DEVELOPMENT~~ PURGE RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/26/96
Well Number FTA-12 Measurement Datum

Pre-Development Information Time (Start): 13:30

Water Level: 9.32' BTOC Total Depth of Well: 20.30'

Water Characteristics

Color – (Clear) Cloudy
Odor: None (Weak) Moderate Strong hydrocarbon/sulfur
Any Films or Immiscible Material –
pH 6.76 Temperature(°F (°C)) 22.1°C
Specific Conductance(µS/cm) 1160 us/cm
D.O. ~ 0.61 mg/L

Interim Water Characteristics

Gallons Removed 3 gallons
pH 6.88
Temperature (°F (°C)) 22.2°C
Specific Conductance(µS/cm) 1120 us/cm
D.O. ~ 0.66 mg/L

Post-Development Information Time (Finish): 13:50

Water Level: Total Depth of Well:

Approximate Volume Removed: 6 gallons

Water Characteristics

Color – (Clear) Cloudy
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material –
pH 6.92 Temperature(°F (°C)) 22.5°C
Specific Conductance(µS/cm) 1120 us/cm
D.O. ~ 0.89 mg/L

Comments:

FTA-12 was unlocked and open prior to our arrival to the site.

PURGE

MONITORING POINT ~~DEVELOPMENT~~ RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/23/96
Well Number FTA-135 Measurement Datum _____

Pre-Development Information Time (Start): 15:40

Water Level: 9.28' BTOC Total Depth of Well: 18.41'

Water Characteristics

Color brown (Clear) Cloudy
Odor: None (Weak) Moderate Strong Sulfur/hydro
Any Films or Immiscible Material —
pH 7.12 Temperature(°F °C) 22.4°C
Specific Conductance(µS/cm) 640 us/cm
D.O ~ 0.61 mg/L

Interim Water Characteristics

Gallons Removed 2 gallons
pH 7.11
Temperature (°F (°C) 22.0°C
Specific Conductance(µS/cm) 610 us/cm
D.O. ~ 0.60 mg/L

Post-Development Information Time (Finish): 16:00

Water Level: _____ Total Depth of Well: _____

Approximate Volume Removed: 4 gallons

Water Characteristics

Color — (Clear) Cloudy
Odor: None (Weak) Moderate Strong Sulfur/hydro
Any Films or Immiscible Material —
pH 7.08 Temperature(°F (°C) 21.9
Specific Conductance(µS/cm) 650 us/cm
D.O. ~ 0.51 mg/L
Redox ~ -43 mV

Comments:

MONITORING POINT ~~DEVELOPMENT~~ PURGE RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/23/96
Well Number FTA - 13D Measurement Datum _____

Pre-Development Information Time (Start): 14:30

Water Level: 9.02' BTOC Total Depth of Well: 64.42'

Water Characteristics

Color – (Clear) Cloudy
Odor: None (Weak) Moderate Stro: g Sulfur
Any Films or Immiscible Material –
pH 7.44 Temperature(°F °C) 23.6°C
Specific Conductance(µS/cm) 1570 us/cm
D.O. ~3.34 mg/L

Interim Water Characteristics

Gallons Removed 6 gallons
pH 7.29
Temperature (°F (°C) 24.3°C
Specific Conductance(µS/cm) 1880 us/cm
D.O. ~ 0.47 mg/L

Post-Development Information Time (Finish): 15:30

Water Level: _____ Total Depth of Well: _____

Approximate Volume Removed: 12 gallons

Water Characteristics

Color – (Clear) Cloudy
Odor: None (Weak) Moderate Strong Sulfur
Any Films or Immiscible Material –
pH 7.29 Temperature(°F (°C) 24.3°C
Specific Conductance(µS/cm) 2680 us/cm
D.O. - 0.32 mg/L
Redox ~ -246 mV

Comments:

PURGE

MONITORING POINT ~~DEVELOPMENT~~ RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/25/96
Well Number FTA-14 Measurement Datum

Pre-Development Information Time (Start): 8:00

Water Level: 5.69' BTOC Total Depth of Well: 17.12'

Water Characteristics

Color – (Clear) Cloudy
Odor: None Weak (Moderate) Strong hydrocarbon
Any Films or Immiscible Material –
pH 6.67 Temperature(°F °C) 21.2°C
Specific Conductance(µS/cm) 1300 us/cm
D.O. ~ 0.50 mg/L

Interim Water Characteristics

Gallons Removed 2 gallons
pH 6.80
Temperature (°F °C) 21.3°C
Specific Conductance(µS/cm) 1260 us/cm
D.O. ~ 0.58 mg/L

Post-Development Information Time (Finish): 8:25

Water Level: Total Depth of Well:

Approximate Volume Removed: 4 gallons

Water Characteristics

Color – (Clear) Cloudy
Odor: None Weak (Moderate) Strong hydrocarbon
Any Films or Immiscible Material –
pH 6.82 Temperature(°F °C) 21.3°C
Specific Conductance(µS/cm) 1300 us/cm
D.O. ~ 0.69 mg/L

Comments:

MONITORING POINT ~~DEVELOPMENT~~ PURGE RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/23/96
Well Number FTA-155 Measurement Datum

Pre-Development Information Time (Start): 17:10

Water Level: 5.70' BTOC Total Depth of Well: 16.05'

Water Characteristics

Color red/brown fluffies (Clear) Cloudy
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material —
pH 6.92 Temperature(°F (°C) 20.5°C
Specific Conductance(µS/cm) 1000 us/cm
D.O. ~ 0.46 mg/L

Interim Water Characteristics

Gallons Removed 2 gallons
pH 6.94
Temperature (°F (°C) 21.0°C
Specific Conductance(µS/cm) 1000 us/cm
DO ~ 0.33 mg/L

Post-Development Information Time (Finish): 17:30

Water Level: Total Depth of Well:

Approximate Volume Removed: 4 gallons

Water Characteristics

Color — (Clear) Cloudy
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material —
pH 6.93 Temperature(°F °C) 21.1°C
Specific Conductance(µS/cm) 1000 us/cm
DO. ~ 0.18 mg/L
Redox ~ -46 mV

Comments:

PURGE

MONITORING POINT ~~DEVELOPMENT~~ RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/29/96
Well Number FTA-165 Measurement Datum

Pre-Development Information Time (Start): 9:05

Water Level: 5.81' BTOC Total Depth of Well: 14.85'

Water Characteristics

Color DI yellow/red fluffies (Clear) Cloudy
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material —
pH 6.96 Temperature(°F (°C) 19.7°C
Specific Conductance(µS/cm) 680 us/cm
D.O. ~ 360 mg/L

Interim Water Characteristics

Gallons Removed 2 gallons
pH 6.85
Temperature (°F (°C) 20.6°C
Specific Conductance(µS/cm) 1570 us/cm
D.O. ~ 0.91 mg/L

Post-Development Information Time (Finish): 9:40

Water Level: Total Depth of Well:

Approximate Volume Removed: 4 gallons

Water Characteristics

Color V. pale yellow (Clear) Cloudy
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material —
pH 6.84 Temperature(°F (°C) 20.6°C
Specific Conductance(µS/cm) 1590 us/cm
D.O. ~ 0.95 mg/L
Redox ~ +50.4 mV

Comments:

MONITORING POINT ~~DEVELOPMENT~~ PURGE RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/29/96
Well Number FTA-16D Measurement Datum

Pre-Development Information Time (Start): 9:05

Water Level: 4.81' BTOC Total Depth of Well: 78.85'

Water Characteristics

Color — (Clear) Cloudy
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material —
pH 7.24 Temperature(°F °C) 21.4°C
Specific Conductance(µS/cm) 2200 us/cm
D.O. ~ 0.24 mg/L

Interim Water Characteristics

Gallons Removed 6 gallons sl. sulfur odor
pH 7.52
Temperature (°F (°C) 22.0°C
Specific Conductance(µS/cm) 2220 us/cm
D.O. ~ 0.20 mg/L

Post-Development Information Time (Finish): 10:15

Water Level: Total Depth of Well:

Approximate Volume Removed: 12 gallons

Water Characteristics

Color — (Clear) Cloudy
Odor: None (Weak) Moderate Strong Sulfur
Any Films or Immiscible Material —
pH 7.46 Temperature(°F (°C) 22.4°C
Specific Conductance(µS/cm) 2310 us/cm
D.O. ~ 0.08 mg/L
Redox ~ -299 mV

Comments:

MONITORING POINT ~~DEVELOPMENT~~ PURGE RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/26/96
Well Number FTA-18 Measurement Datum

Pre-Development Information Time (Start): 11:20

Water Level: 6.23' BTOC Total Depth of Well:

Water Characteristics

Color grey/black fursies Clear (Cloudy) SL
Odor: None Weak Moderate (Strong) hydrocarbon
Any Films or Immiscible Material —
pH 6.90 Temperature(°F °C) 24.1°C
Specific Conductance(µS/cm) 1300 us/cm
D.O ~ 0.19 mg/L

Interim Water Characteristics

Gallons Removed 3 gallons
pH 6.81
Temperature (°F (C) 24.9°C
Specific Conductance(µS/cm) 1210 us/cm
D.O ~ 0.26 mg/L

Post-Development Information Time (Finish): 12:15

Water Level: Total Depth of Well:

Approximate Volume Removed: 5 gallons

Water Characteristics

Color pl. yellow (Clear) Cloudy
Odor: None Weak Moderate (Strong) hydrocarbon
Any Films or Immiscible Material —
pH 6.83 Temperature(°F (C) 24.9°C
Specific Conductance(µS/cm) 1200 us/cm
D.O ~ 0.26 mg/L

Comments:

—

MONITORING POINT ~~DEVELOPMENT~~ PURGE RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/26/96
Well Number FTA-19S Measurement Datum

Pre-Development Information Time (Start): 10:20

Water Level: 5.10' BTOC Total Depth of Well: 14.30

Water Characteristics

Color pl yellow (Clear) Cloudy
Odor: None Weak (Moderate) Strong sulfur/rotten
Any Films or Immiscible Material —
pH 6.90 Temperature(°F (°C) 21.7°C
Specific Conductance(µS/cm) >20,000 us/cm
D.O. ~ 0.47 mg/L

Interim Water Characteristics

Gallons Removed 2 gallons

pH 6.88

Temperature (°F (°C) 21.4°C

Specific Conductance(µS/cm) >20,000 us/cm
DO.~ 0.39 mg/L

Post-Development Information Time (Finish): 10:40

Water Level: Total Depth of Well:

Approximate Volume Removed: 4 gallons

Water Characteristics

Color pl yellow (Clear) Cloudy
Odor: None (Weak) Moderate Strong sulfur
Any Films or Immiscible Material —
pH 6.88 Temperature(°F (°C) 21.9°C
Specific Conductance(µS/cm) >20,000 us/cm
D.O.~ 0.46 mg/L

Comments:

PURGE

MONITORING POINT ~~DEVELOPMENT~~ RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/26/96
Well Number FTA-19I Measurement Datum

Pre-Development Information Time (Start): 10:25

Water Level: 5.91' BTOC Total Depth of Well: 37.95

Water Characteristics

Color v. pale yellow (Clear) Cloudy
Odor: (None) Weak Moderate Strong Sulfur
Any Films or Immiscible Material
pH 7.34 Temperature(°F (°C) 22.6°C
Specific Conductance(µS/cm) 3480 us/cm
D.O. ~ 0.81 mg/L

Interim Water Characteristics

Gallons Removed 3 gallons

pH 7.36

Temperature (°F (°C) 23.6°C

Specific Conductance(µS/cm) 3690 us/cm
D.O. ~ 0.38 mg/L

Post-Development Information Time (Finish): 10:55

Water Level: Total Depth of Well:

Approximate Volume Removed: 7 gallons

Water Characteristics

Color v. pale yellow (Clear) Cloudy
Odor: None (Weak) Moderate Strong Sulfur
Any Films or Immiscible Material
pH 7.40 Temperature(°F (°C) 23.5°C
Specific Conductance(µS/cm) 3770 us/cm
D.O. ~ 0.40 mg/L

Comments:

MONITORING POINT ~~DEVELOPMENT~~ PURGE RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/26/96
Well Number FTA-19D Measurement Datum

Pre-Development Information Time (Start): 10:25

Water Level: 4.54' BTOC Total Depth of Well: 69.0'

Water Characteristics

Color – (Clear) Cloudy
Odor: None Weak (Moderate) Strong sulfur/rot
Any Films or Immiscible Material –
pH 7.19 Temperature(°F (°C) 21.5°C
Specific Conductance(µS/cm) 11,720 us/cm
D.O. ~0.51 mg/L

Interim Water Characteristics

Gallons Removed 6 gallons

pH 7.45

Temperature (°F (°C) 23.1°C

Specific Conductance(µS/cm) 11,790 us/cm
D.O. ~~~0.35 mg/L~~ 0.53 mg/L

Post-Development Information Time (Finish): 11:00

Water Level: Total Depth of Well:

Approximate Volume Removed: 12 gallons

Water Characteristics

Color – (Clear) Cloudy
Odor: None (Weak) (Moderate) Strong Sulfur
Any Films or Immiscible Material –
pH 7.49 Temperature(°F (°C) @ 23.5°C
Specific Conductance(µS/cm) 11,990 us/cm
D.O. ~0.35 mg/L

Comments:

MONITORING POINT ~~DEVELOPMENT~~ PURGE RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/25/96
Well Number FTA-205 Measurement Datum

Pre-Development Information Time (Start): 9:05

Water Level: 5.31' BTOC Total Depth of Well: 13.15'

Water Characteristics

Color - (Clear) Cloudy
Odor: None Weak (Moderate) Strong Sulfur
Any Films or Immiscible Material -
pH 6.87 Temperature(°F °C) 20.4°C
Specific Conductance(µS/cm) 1520 us/cm
D.O. ~ 0.48 mg/L

Interim Water Characteristics

Gallons Removed 3 gallons
pH 6.91
Temperature (°F (°C) 20.3°C
Specific Conductance(µS/cm) 1510 us/cm
D.O. ~ 0.40 mg/L

Post-Development Information Time (Finish): 9:30

Water Level: Total Depth of Well:

Approximate Volume Removed: 4.5 gallons

Water Characteristics

Color - (Clear) Cloudy
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material -
pH 6.86 Temperature(°F (°C)) 20.4 °C
Specific Conductance(µS/cm) 1490 us/cm
D.O. ~ 0.32 mg/L

Comments:

PURGE
MONITORING POINT ~~DEVELOPMENT~~ RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/25/96
Well Number FTA-20I Measurement Datum _____

Pre-Development Information Time (Start): 8:30

Water Level: 4.89' BTOC Total Depth of Well: 42.23'

Water Characteristics

Color – (Clear) Cloudy
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material –
pH 7.16 Temperature(°F (°C) 20.1°C
Specific Conductance(µS/cm) 6470 us/cm
D.O. ~ 1.29 mg/L

Interim Water Characteristics

Gallons Removed 3 gallons
pH 7.33 mod. rotting odor
Temperature (°F °C) 22.0°C
Specific Conductance(µS/cm) 8480 us/cm
D.O. ~ 0.44 mg/L

Post-Development Information Time (Finish): 9:00

Water Level: _____ Total Depth of Well: _____

Approximate Volume Removed: 6 gallons

Water Characteristics

Color – (Clear) Cloudy
Odor: None Weak (Moderate) Strong Sulfur
Any Films or Immiscible Material –
pH 7.27 Temperature(°F (°C) 22.1°C
Specific Conductance(µS/cm) 8330 us/cm
D.O. ~ 0.54 mg/L

Comments:

MONITORING POINT ~~DEVELOPMENT~~ PURGE RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/25/96
Well Number FTA-20D Measurement Datum

Pre-Development Information Time (Start): 9:30

Water Level: 4.83' BTOC Total Depth of Well: 61.30'

Water Characteristics

Color sl silty (Clear Cloudy)
Odor: None Weak (Moderate) Strong Sulfur
Any Films or Immiscible Material —
pH 7.26 Temperature(°F °C) 21.7°C
Specific Conductance(µS/cm) 18,060 us/cm
D.O. ~ 0.57 mg/L

Interim Water Characteristics

Gallons Removed 6 gallons
pH 7.33
Temperature (°F (°C) 22.1°C
Specific Conductance(µS/cm) 18,090 us/cm
D.O - 0.37 mg/L

Post-Development Information Time (Finish): 9:20

Water Level: Total Depth of Well:

Approximate Volume Removed: 10 gallons

Water Characteristics

Color — (Clear) Cloudy
Odor: None Weak (Moderate) Strong Sulfur
Any Films or Immiscible Material —
pH 7.30 Temperature(°F (°C)) 22.3°C
Specific Conductance(µS/cm) 19,290 us/cm
D.O. ~ 0.32 mg/L

Comments:

MONITORING POINT ~~DEVELOPMENT~~ PURGE RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/23/96
Well Number FTA-215 Measurement Datum _____

Pre-Development Information Time (Start): 11:15

Water Level: 3.99' BTOC Total Depth of Well: 12.10'

Water Characteristics

Color clear/white (Clear) Cloudy
Odor: None (Weak) Moderate Strong Sulfur
Any Films or Immiscible Material —
pH 7.02 Temperature(°F °C) 23.0
Specific Conductance(µS/cm) 750 us/cm
D.O. - 3.19 mg/L

Interim Water Characteristics

Gallons Removed 1 gallon
pH 6.95
Temperature (°F (°C) 22.9°C
Specific Conductance(µS/cm) 760 us/cm
D.O. ~ 3.20 mg/L

Post-Development Information Time (Finish): 11:45

Water Level: _____ Total Depth of Well: _____

Approximate Volume Removed: 2 gallons

Water Characteristics

Color — (Clear) Cloudy
Odor: None (Weak) Moderate Strong Sulfur
Any Films or Immiscible Material —
pH 6.96 Temperature(°F (°C) 22.8°C
Specific Conductance(µS/cm) 790 us/cm
D.O. ~ 2.47 mg/L
Redox ~ + 121.0 mV

Comments:

PURGE

MONITORING POINT ~~DEVELOPMENT~~ RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/23/95
Well Number FTA-21I Measurement Datum

Pre-Development Information Time (Start): 11:50

Water Level: 2.91' BTOC Total Depth of Well: 58.32'

Water Characteristics

Color – (Clear) Cloudy
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material –
pH 7.53 Temperature(°F (°C) 23.8°C
Specific Conductance(µS/cm) 4660 us/cm
D.O. ~0.65 mg/L

Interim Water Characteristics

Gallons Removed 2 gallons

pH 7.48

Temperature (°F (°C) 25.0°C

Specific Conductance(µS/cm) 4720 us/cm
D.O. ~ 0.35 mg/L

Post-Development Information Time (Finish): 12:15

Water Level: Total Depth of Well:

Approximate Volume Removed: 4 gallons

Water Characteristics

Color – (Clear) Cloudy
Odor: (None) (Weak) Moderate Strong Sulfur?
Any Films or Immiscible Material –
pH 7.55 Temperature(°F (°C) 25.1 °C
Specific Conductance(µS/cm) 4740 us/cm
D.O. ~ 0.29 mg/L
Redox ~ -240 mV

Comments:

PURGE

MONITORING POINT ~~DEVELOPMENT~~ RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/23/96
Well Number FTA-21D Measurement Datum

Pre-Development Information Time (Start): 13:55

Water Level: 3.10' BTOC Total Depth of Well: 40.48'

Water Characteristics

Color – (Clear) Cloudy
Odor: None (Weak) Moderate Strong Sulfur
Any Films or Immiscible Material –
pH 8.25 Temperature(°F (°C) 24.3°C
Specific Conductance(µS/cm) 3800 us/cm
D.O. ~ 0.65 mg/L

Interim Water Characteristics

Gallons Removed 2 gallons

pH 7.83

Temperature (°F (°C) 24.9°C

Specific Conductance(µS/cm) 3880 us/cm
D.O. ~ 0.20 mg/L

Post-Development Information Time (Finish): 14:15

Water Level: Total Depth of Well:

Approximate Volume Removed: 9.5 gallons

Water Characteristics

Color – (Clear) Cloudy
Odor: None (Weak) Moderate Strong Sulfur
Any Films or Immiscible Material –
pH 7.62 Temperature(°F (°C) 25.0°C
Specific Conductance(µS/cm) 4640 us/cm
D.O. ~ 0.14 mg/L
Redox ~ -293.3 mV

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/23/96
Well Number CPT-1 Measurement Datum

Pre-Development Information Time (Start): 8:40

Water Level: 3.42' BTOC Total Depth of Well: 10.4'

Water Characteristics

Color grey/white Clear (Cloudy)
Odor: None Weak (Moderate) Strong Sulfur
Any Films or Immiscible Material —
pH 6.40 Temperature(°F (°C) 21.7°C
Specific Conductance(µS/cm) 1130 us/cm
D.O. ~ 0.79 mg/L

Interim Water Characteristics

Gallons Removed 2 liters

pH 6.76

Temperature (°F (°C) 23.1°C

Specific Conductance(µS/cm) 1130 us/cm
D.O. ~ 0.67 mg/L

Post-Development Information Time (Finish): 9:07

Water Level: Total Depth of Well:

Approximate Volume Removed: 2 gallons

Water Characteristics

Color lt. gray (Clear) Cloudy
Odor: None Weak (Moderate) Strong Sulfur
Any Films or Immiscible Material —
pH 6.73 Temperature(°F (°C) 23.0 °C
Specific Conductance(µS/cm) 1130 us/cm
D.O. ~ 0.52 mg/L
Redox ~ -237.6 mV

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/23/96
Well Number CPT-2 Measurement Datum

Pre-Development Information Time (Start): 9:20

Water Level: 3.38' BTOC Total Depth of Well: 33.05'

Water Characteristics

Color yellow - gray Clear (sl. Cloudy)
Odor: None (Weak) Moderate Strong Sulfur?
Any Films or Immiscible Material —
pH 6.97 Temperature(°F °C) 24.6°C
Specific Conductance(µS/cm) 1800 us/cm
D.O. ~ 1.50 mg/L

Interim Water Characteristics

Gallons Removed 2 liters

pH 7.20

Temperature (°F (°C) 25.5°C

Specific Conductance(µS/cm) 3120 us/cm
D.O. ~ 1.42 mg/L

Post-Development Information Time (Finish): 10:00

Water Level: Total Depth of Well:

Approximate Volume Removed: 2 gallons

Water Characteristics

Color gray Clear (Cloudy)
Odor: None Weak (Moderate) Strong Sulfur
Any Films or Immiscible Material —
pH 7.08 Temperature(°F (°C) 25.3 °C
Specific Conductance(µS/cm) 3410 us/cm
D.O. ~ 1.66 mg/L
Redox ~ -59.7 mV

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/23/96
Well Number CPT-3 Measurement Datum _____

Pre-Development Information Time (Start): 10:01

Water Level: 3.21' BTOC Total Depth of Well: 53.57'

Water Characteristics

Color gray/white Clear Sl. Cloudy
Odor: None ~~Weak~~ Moderate Strong Sulfur
Any Films or Immiscible Material _____
pH 7.35 Temperature(°F (°C) 25.2°C
Specific Conductance(µS/cm) 3730 us/cm
D.O. ~ 1.20 mg/L

Interim Water Characteristics

Gallons Removed 2 liters
pH 7.47
Temperature (°F (°C) 25.2°C
Specific Conductance(µS/cm) 3810 us/cm
D.O. ~ 1.51 mg/L

Post-Development Information Time (Finish): 10:30

Water Level: _____ Total Depth of Well: _____

Approximate Volume Removed: 2 gallons

Water Characteristics

Color gray-white Clear Cloudy
Odor: None Weak Moderate Strong Sulfur
Any Films or Immiscible Material _____
pH 7.46 Temperature(°F (°C) 25.2°C
Specific Conductance(µS/cm) 3810 us/cm
D.O. ~ 1.17 mg/L
Redox ~ -256 mV

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/24/96
Well Number CPT-4 (Shallow) Measurement Datum

Pre-Development Information Time (Start): 11:40

Water Level: Total Depth of Well:

Water Characteristics

Color – (Clear) Cloudy
Odor: (None) Weak Moderate Strong sulfur/hydrocarbon?
Any Films or Immiscible Material –
pH 6.53 Temperature(°F °C) 22.6°C
Specific Conductance(µS/cm) 810 us/cm
D.O. ~ 0.45 mg/L

Interim Water Characteristics

Gallons Removed 1 gallons
pH 6.60
Temperature (°F (°C) 22.5°C
Specific Conductance(µS/cm) 790 us/cm
D.O. ~ 0.32 mg/L

Post-Development Information Time (Finish): 12:00

Water Level: Total Depth of Well:

Approximate Volume Removed: 2 gallons

Water Characteristics

Color – (Clear) Cloudy
Odor: (None) Weak Moderate Strong sulfur/hydrocarbon?
Any Films or Immiscible Material –
pH 6.62 Temperature(°F (°C) 22.4°C
Specific Conductance(µS/cm) 790 us/cm
D.O. ~ 0.21 mg/L
Redox ~ -137 mV

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/24/96
Well Number CPT - 5 (Deep) Measurement Datum

Pre-Development Information Time (Start): 12:05

Water Level: NA (tubing) Total Depth of Well:

Water Characteristics

Color gray/white Clear (Cloudy)
Odor: None (Weak) Moderate Strong hydrocarbon
Any Films or Immiscible Material — (sand?)
pH 7.06 Temperature(°F (°C)) 24.4°C
Specific Conductance(µS/cm) 4020 us/cm
D.O. ~ 0.94 mg/L

Interim Water Characteristics

Gallons Removed 1 gallon

pH 7.15

Temperature (°F (°C)) 24.0°C

Specific Conductance(µS/cm) 4110 us/cm
D.O. ~ 1.03 mg/L

Post-Development Information Time (Finish): 12:30

Water Level: Total Depth of Well:

Approximate Volume Removed: 2 gallons

Water Characteristics

Color gray/white Clear (Cloudy)
Odor: None (Weak) Moderate Strong hydrocarbon
Any Films or Immiscible Material —
pH 7.24 Temperature(°F (°C)) 23.8°C
Specific Conductance(µS/cm) 4120 us/cm
D.O. ~ 1.14 mg/L
Redox ~ -78 mV

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/25/96
Well Number CPT-6 Measurement Datum _____

Pre-Development Information Time (Start): 10:40

Water Level: _____ Total Depth of Well: _____

Water Characteristics

Color White / gray Clear (Cloudy)
Odor: None (Weak) Moderate Strong hydrocarbon
Any Films or Immiscible Material —
pH 7.14 Temperature(°F °C) 23.3°C
Specific Conductance(µS/cm) 3200 us/cm
D.O. ~ 0.86 mg/L

Interim Water Characteristics

Gallons Removed 1 gallon

pH 7.14

Temperature (°F (°C) 23.3°C

Specific Conductance(µS/cm) 3210 us/cm
D.O. ~ 0.88 mg/L

Post-Development Information Time (Finish): 10:55

Water Level: _____ Total Depth of Well: _____

Approximate Volume Removed: 2 gallons

Water Characteristics

Color tan/gray Clear sl. (Cloudy)
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material —
pH 7.11 Temperature(°F (°C) 23.5°C
Specific Conductance(µS/cm) 3240 us/cm
D.O. ~ 0.70 mg/L

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/25/96
Well Number CPT-7 Measurement Datum _____

Pre-Development Information Time (Start): 10:20

Water Level: _____ Total Depth of Well: _____

Water Characteristics

Color brown/silty Clear (Cloudy)
Odor: None (Weak) Moderate Strong sulfur/hydrocarbon
Any Films or Immiscible Material —
pH 7.08 Temperature(°F (°C)) 21.0°C
Specific Conductance(µS/cm) 680 us/cm
D.O.~ 1.55 mg/L

Interim Water Characteristics

Gallons Removed 1 gallon
pH 7.12
Temperature (°F (°C)) 20.6°C
Specific Conductance(µS/cm) 620 us/cm
D.O.~ 1.18 mg/L

Post-Development Information Time (Finish): 10:40

Water Level: _____ Total Depth of Well: _____

Approximate Volume Removed: 2 gallons

Water Characteristics

Color — (Clear) Cloudy
Odor: None (Weak) Moderate Strong hydrocarbon
Any Films or Immiscible Material —
pH 7.12 Temperature(°F (°C)) 20.8°C
Specific Conductance(µS/cm) 620 us/cm
D.O.~ 2.60 mg/L

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/25/96
Well Number CPT-8 Measurement Datum _____

Pre-Development Information Time (Start): 10:00

Water Level: _____ Total Depth of Well: _____

Water Characteristics

Color – (Clear) Cloudy
Odor: (None) Weak Moderate Strong Sulfur
Any Films or Immiscible Material –
pH 6.91 Temperature(°F (°C)) 22.6°C
Specific Conductance(µS/cm) 4930 us/cm
D.O ~ 0.82 mg/L

Interim Water Characteristics

Gallons Removed 1.5 gallons
pH 6.85
Temperature (°F (°C)) 23.5°C
Specific Conductance(µS/cm) 5130 us/cm
D.O. 0.63 mg/L

Post-Development Information Time (Finish): 10:20

Water Level: _____ Total Depth of Well: _____

Approximate Volume Removed: 3 gallons

Water Characteristics

Color – (Clear) Cloudy
Odor: None (Weak) Moderate Strong Sulfur?
Any Films or Immiscible Material –
pH 6.93 Temperature(°F °C) 23.2°C
Specific Conductance(µS/cm) 5060 us/cm
D.O. ~ 0.75 mg/L

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/25/96
Well Number MP-15 Measurement Datum

Pre-Development Information Time (Start): 11:20

Water Level: Total Depth of Well:

Water Characteristics

Color grey/white Clear (Cloudy)
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material —
pH 7.04 Temperature(°F (°C) 21.7°C
Specific Conductance(µS/cm) 630 us/cm
D.O. ~ 1.53 mg/L

Interim Water Characteristics

Gallons Removed 1 gallon
pH 7.03
Temperature (°F (°C) 21.7°C
Specific Conductance(µS/cm) 620 us/cm
D.O. ~ 1.53 mg/L

Post-Development Information Time (Finish): 11:35

Water Level: Total Depth of Well:

Approximate Volume Removed: 2 gallons

Water Characteristics

Color sl white (Clear) Cloudy
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material —
pH 7.08 Temperature(°F (°C) 21.7°C
Specific Conductance(µS/cm) 630 us/cm
D.O. ~ 1.16 mg/L

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/25/96
Well Number MP-1D Measurement Datum _____

Pre-Development Information Time (Start): 11:10

Water Level: _____ Total Depth of Well: _____

Water Characteristics

Color White/Gray Clear (Cloudy)
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material —
pH 6.77 Temperature(°F (°C)) 23.0°C
Specific Conductance(µS/cm) 2240 us/cm
D.O. ~ 0.77 mg/L

Interim Water Characteristics

Gallons Removed _____
pH _____
Temperature (°F °C) _____
Specific Conductance(µS/cm) _____

Post-Development Information Time (Finish): 11:20

Water Level: _____ Total Depth of Well: _____

Approximate Volume Removed: 1.5 gallons

Water Characteristics

Color — (Clear) Cloudy
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material —
pH 6.81 Temperature(°F (°C)) 23.4°C
Specific Conductance(µS/cm) 8220 us/cm
D.O. ~ 0.72 mg/L

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/26/96
Well Number MP-2 Measurement Datum _____

Pre-Development Information Time (Start): 9:55

Water Level: _____ Total Depth of Well: _____

Water Characteristics

Color Drown Clear (Cloudy)
Odor: (None) Weak Moderate Strong hydrocarbon/sulfur
Any Films or Immiscible Material —
pH 6.83 Temperature(°F °C) 21.8°C
Specific Conductance(µS/cm) 850 us/cm
D.O. ~ 0.32 mg/L

Interim Water Characteristics

Gallons Removed _____
pH _____
Temperature (°F °C) _____
Specific Conductance(µS/cm) _____

Post-Development Information Time (Finish): 10:10

Water Level: _____ Total Depth of Well: _____

Approximate Volume Removed: 2 gallons

Water Characteristics

Color — (Clear) Cloudy
Odor: None Weak (Moderate) Strong hydrocarbon
Any Films or Immiscible Material —
pH 6.81 Temperature(°F (°C)) 21.6°C
Specific Conductance(µS/cm) 960 us/cm
D.O. ~ 0.43 mg/L

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/26/96
Well Number MP-3 Measurement Datum _____

Pre-Development Information Time (Start): 9:25

Water Level: _____ Total Depth of Well: _____

Water Characteristics

Color brown Clear (Cloudy)
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material —
pH 6.83 Temperature(°F (°C) 21.7°C
Specific Conductance(µS/cm) 750 us/cm
D.O. ~ 0.66 mg/L

Interim Water Characteristics

~~Gallons Removed _____~~
~~pH _____~~
~~Temperature (°F °C) _____~~
~~Specific Conductance(µS/cm) _____~~

Post-Development Information Time (Finish): 9:35

Water Level: _____ Total Depth of Well: _____

Approximate Volume Removed: 2 gallons

Water Characteristics

Color — (Clear) Cloudy
Odor: None (Weak) Moderate — Strong hydrocarbon
Any Films or Immiscible Material —
pH 6.83 Temperature(°F (°C) 21.8°C
Specific Conductance(µS/cm) 860 us/cm
D.O. ~ 0.55 mg/L

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/25/96
Well Number MP-45 Measurement Datum _____

Pre-Development Information Time (Start): 7:50

Water Level: 3.97' Total Depth of Well: _____

Water Characteristics

Color brown/gray Clear (Cloudy)
Odor: None Weak (Moderate) Strong hydrocarbon (7ppm)
Any Films or Immiscible Material —
pH 6.85 Temperature(°F °C) 21.2°C
Specific Conductance(µS/cm) 1120 us/cm
D.O. ~ 0.92 mg/L

Interim Water Characteristics

Gallons Removed 2 gallons

pH 6.85

Temperature (°F (°C) 21.9°C

Specific Conductance(µS/cm) 1120 us/cm
D.O. ~ 0.70 mg/L

Post-Development Information Time (Finish): 8:20

Water Level: _____ Total Depth of Well: _____

Approximate Volume Removed: 4 gallons

Water Characteristics

Color — (Clear) Cloudy
Odor: None Weak (Moderate) Strong hydrocarbon
Any Films or Immiscible Material —
pH 6.88 Temperature(°F (°C) 21.9°C
Specific Conductance(µS/cm) 1150 us/cm
D.O. ~ 0.50 mg/L

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/25/96
Well Number MP - 4D Measurement Datum _____

Pre-Development Information Time (Start): 7:50

Water Level: NA - tubing Total Depth of Well: _____

Water Characteristics

Color muddy - brown Clear (Cloudy)
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material —
pH 6.86 Temperature(°F °C) 22.6°C
Specific Conductance(µS/cm) 5800 us/cm
D.O. ~ 1.35 mg/L

Interim Water Characteristics

~~Gallons Removed~~ _____
~~pH~~ _____
~~Temperature (°F °C)~~ _____
~~Specific Conductance(µS/cm)~~ _____

Post-Development Information Time (Finish): 8:15

Water Level: _____ Total Depth of Well: _____

Approximate Volume Removed: 2 gallons

Water Characteristics

Color clear (Clear) Cloudy
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material —
pH 6.89 Temperature(°F °C) 23.1°C
Specific Conductance(µS/cm) 5710 us/cm
D.O. ~ 0.61 mg/L

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/25/96
Well Number MP-65 Measurement Datum _____

Pre-Development Information Time (Start): 8:45

Water Level: _____ Total Depth of Well: _____

Water Characteristics

Color — (Clear) Cloudy
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material —
pH 6.98 Temperature(°F (°C)) 21.9°C
Specific Conductance(µS/cm) 940 us/cm
D.O. ~ 0.33 mg/L

Interim Water Characteristics

Gallons Removed 2 gallons
pH 6.96
Temperature (°F (°C)) 20.8°C
Specific Conductance(µS/cm) 940 us/cm
D.O. ~ 0.46 mg/L

Post-Development Information Time (Finish): 9:15

Water Level: _____ Total Depth of Well: _____

Approximate Volume Removed: 4 gallons

Water Characteristics

Color — (Clear) Cloudy
Odor: (None) (Weak) Moderate Strong
Any Films or Immiscible Material —
pH 6.98 Temperature(°F (°C)) 22.1°C
Specific Conductance(µS/cm) 940 us/cm
D.O. ~ 0.71 mg/L

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 722450.29 Job Name: AFCEE Natural Attenuation
Location Cape Canaveral - CCFTA-2(FT-17) by MS/MV/SH/DK Date 1/25/96
Well Number MP-6 Measurement Datum _____

Pre-Development Information Time (Start): 9:20

Water Level: _____ Total Depth of Well: _____

Water Characteristics

Color brown Clear (Cloudy)
Odor: None ~~Weak~~ Moderate Strong hydrocarbon/sulfur
Any Films or Immiscible Material —
pH 6.98 Temperature(°F (°C) 22.9°C
Specific Conductance(µS/cm) 1240 us/cm
D.O ~ 0.04 mg/L

Interim Water Characteristics

Gallons Removed 2 gallons
pH 6.92
Temperature (°F (°C) 23.0°C
Specific Conductance(µS/cm) 1340 us/cm
D.O. ~ 0.16 mg/L

Post-Development Information Time (Finish): 9:35

Water Level: _____ Total Depth of Well: _____

Approximate Volume Removed: 3 gallons

Water Characteristics

Color — (Clear) Cloudy
Odor: (~~None~~) Weak Moderate Strong
Any Films or Immiscible Material —
pH 6.90 Temperature(°F (°C)
Specific Conductance(µS/cm) 1370 us/cm
D.O. ~ 0.30 mg/L

Comments:

APPENDIX B

SOIL, GROUNDWATER, AND SURFACE WATER ANALYTICAL RESULTS

NOTE REGARDING SAMPLE NAMES/NUMBERS AND LOCATIONS

For the 1994 sampling event USEPA and ARA personnel selected names and numbers for sampling locations. For the CPT pushes used to determine stratigraphy and collect soil samples, multiple pushes were performed at a single location (within a few feet of each other), and ARA gave each push a separate designation, which carried over to the EPA soil sampling data. For groundwater sampling, EPA gave each CPT-installed monitoring point a designation incorporating a project number they assigned (87) and a number such as MW1S (where the "S" is a desgnation for shallow). This scheme conflicts somewhat with the naming scheme of 2-inch monitoring wells at the site. When sampling 2-inch wells, EPA used the scheme "87-PXX", where "XX" is the last two digits of the well name as designated on the well and in this report. For example, the sample 87-P9S was collected from well CCFTA2-9S. Surface water samples were given descriptive names.

To avoid confusion and simplify these schemes, the location names and sample names/numbers reported in the main body of this report have been changed. The following table lists the previous (1994) names/numbers/locations and the corresponding names/numbers/locations used in this document.

1994 Designation	1996 Designation
CPT-87-MW1S	CPT-1
CPT-87-MW1M	CPT-2
CPT-87-MW1D	CPT-3
CPT-87-MW2S	CPT-7
CPT-87-MW2D	CPT-8
CPT-87-MW3S	CPT-4
CPT-87-MW3D	CPT-5
CPT-87-7-MW1M	CPT-6
CPT-87-MW4S	CPT-9
CPT-87-MW4D	CPT-10
CCAFB-01, -01-LIF, -01-SS1, -01-SS2	CCAF-01
CCAFB-02, -02-LIF	CCAF-02
CCAFB-03, -03-LIF	CCAF-03
CCAFB-04, -04-LIF	CCAF-04
CCAFB-05, -05-LIF	CCAF-05
CCAFB-06, -06-LIF, -06-SS1, -06-SS2	CCAF-06
CCAFB-07, -07-LIF, -07-SS1, -07-SS2	CCAF-07
CCAFB-08, -08-LIF	CCAF-08
CCAFB-09, -09-LIF	CCAF-09
CCAFB-10, -10-LIF	CCAF-10
CCAFB-11, -11-LIF	CCAF-11
CCAFB-01B, -01B-SS1, -01B-SS2	CCAF-01
87-P1	CCFTA2-1
87-P2	CCFTA2-2
87-P3	CCFTA2-3
87-P4	CCFTA2-4
87-P5	CCFTA2-5
87-P6	CCFTA2-6
87-P7S	CCFTA2-7S
87-P7D	CCFTA2-7D
87-P9S	CCFTA2-9S
87-P9D	CCFTA2-9D
87-P13S	CCFTA2-13S
87-P13D	CCFTA2-13D
87-P14	CCFTA2-14
87-P15	CCFTA2-15
87-P16S	CCFTA2-16S
87-P16D	CCFTA2-16D
87-P17	CCFTA2-17
UPSTREAM	SW-1
DITCH	SW-2
DOWNSTREAM	SW-3

NOTE:

In 1996, one surface water sample was collected. EPA called it "Grab - Lagoon." It is referred to as SW-4 in the report.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Robert S. Kerr Environmental Research Laboratory
P.O. Box 1198
Ada, Oklahoma 74820

April 29, 1994

R. Todd Herrington
Engineering-Science, Inc.
1700 Broadway, Suite 900
Denver, CO 80290

Dear Todd:

Enclosed is a copy of water sample analyses from Patrick AFB and Cape Canaveral Air Station. Analyses of the core samples will be completed the latter part of May. When analytical work is completed I will reorganize the data into condensed tabular form for distribution.

Sincerely,

Don Kampbell

Don H. Kampbell, Ph.D.
Research Chemist
Subsurface Processes Branch

Enclosure

Recycled/Recyclable
Printed with Soy/Canola Ink on paper that contains at least 75% recycled fiber

Table 1. Quantitation Report for S.R. # SF-0-52.

Concentration = ppb

Compound	87-P1	87-P2	87-P2 Field Dup	87-P3	87-P4	87-P5	87-P6	87-P6 Field Dup	87-P7S	87-P7S Field Dup 1/3 Dil
VINYL CHLORIDE	+++	122	55.3	3.4	+++	16.4	+++	+++	*****	1180
1,1-DICHLOROETHENE	---	---	---	---	---	---	---	---	12.0	13.8
T-1,2-DICHLOROETHENE	---	5.7	2.7	---	---	1.5	---	---	14.3	12.4
C-1,2-DICHLOROETHENE	---	150	77.7	13.6	---	50.4	---	---	207	209
TRICHLOROETHENE	---	5.9	2.6	---	---	1.7	---	---	35.5	33.0
TETRACHLOROETHENE	---	1.2	1.0	---	---	---	---	---	1.0	---

	87-P7D	87-P9S	87-P9S Lab Dup	87-P9S Field Dup 1/40 Dil	87-P9D	87-P13S	87-P13D	87-P14	87-P15	87-P16S
VINYL CHLORIDE	+++	1330	1270	1380	+++	2.0	+++	1660	6.3	+++
1,1-DICHLOROETHENE	---	100	92.6	112	---	---	---	2.3	---	---
T-1,2-DICHLOROETHENE	---	129	124	140	---	---	---	14.5	---	---
C-1,2-DICHLOROETHENE	---	*****	*****	47000	1.0	---	---	168	22.9	---
TRICHLOROETHENE	---	*****	*****	5720	---	---	---	4.8	1.4	1.4
TETRACHLOROETHENE	---	46.1	43.9	44.0	---	---	---	---	---	---

	87-P16D	87-P17	CPT87-MW1S	CPT87-MW1M	CPT87-MW1D	CPT87-MW2S	CPT87-MW2M	CPT87-MW3S	CPT87-MW3S Lab Dup	CPT87-MW3M
VINYL CHLORIDE	+++	+++	+++	+++	+++	7.7	3.2	719	742	2.0
1,1-DICHLOROETHENE	---	---	---	---	---	---	---	5.3	5.4	---
T-1,2-DICHLOROETHENE	---	---	---	---	---	---	---	5.2	5.1	1.4
C-1,2-DICHLOROETHENE	---	---	---	7.8	2.5	---	6.3	478	490	53.4
TRICHLOROETHENE	---	---	---	29.4	10.0	---	---	11.7	11.5	4.0
TETRACHLOROETHENE	---	---	---	---	---	---	---	---	---	---

Dup = Duplicate --- = Below Quantitation limit (1.0 ppb) +++ = Below Quantitation limit (2.0 ppb)
***** = Above Highest Calibration Std.(2000 ppb)

Table 2. Quantitation Report for S.R. # SF-0-52.

Concentration = ppb

Compound	CPT87-MW4S	CPT87-MW4M	CPT-87 MW7S	CPT87-MW7S Lab Dup 1/2 Dil	CPT87-MW7S Lab Dup 1/2 Dil	C87MW7M MW7M	87-TW39	87-TW39 Lab Dup	UP-STREAM	DITCH
VINYL CHLORIDE	84.9	6.4	*****	3610	3342	+++	+++	+++	4.3	24.4
1,1-DICHLOROETHENE	---	---	11.5	12.2	11.4	---	---	---	---	---
T-1,2-DICHLOROETHENE	---	8.1	13.3	13.2	12.8	---	---	---	---	1.0
C-1,2-DICHLOROETHENE	61.5	448	192	210	206	---	47.5	48.8	15.8	16.7
TRICHLOROETHENE	3.8	3.6	32.5	34.8	34.0	---	74.9	74.6	---	---
TETRACHLOROETHENE	---	---	1.0	---	---	---	---	---	---	---

	DOWN-STREAM	QC0405C 50 ppb	QC0405D 500 ppb	QC0405E 50 ppb	QC0405F 500 ppb	QC0405G 50 ppb	QC0406A 500 ppb	QC0406B 50ppb	QC0406C 500 ppb	QC0406D 50 ppb
VINYL CHLORIDE	12.5	50.1	488	45.4	469	47.8	471	50.2	475	54.2
1,1-DICHLOROETHENE	---	52.9	505	51.2	510	51.6	510	54.0	524	54.7
T-1,2-DICHLOROETHENE	---	54.5	507	51.7	499	52.2	488	54.7	506	52.3
C-1,2-DICHLOROETHENE	14.8	53.3	507	52.6	508	52.8	520	52.0	475	50.4
TRICHLOROETHENE	---	54.4	511	52.9	503	53.0	493	55.0	509	53.2
TETRACHLOROETHENE	---	51.8	502	49.7	515	49.6	506	52.3	512	51.3

	BL0405A	BL0405B	BL0405C	BL0406A	BL0406B
VINYL CHLORIDE	+++	+++	+++	+++	+++
1,1-DICHLOROETHENE	---	---	---	---	---
T-1,2-DICHLOROETHENE	---	---	---	---	---
C-1,2-DICHLOROETHENE	---	---	---	---	---
TRICHLOROETHENE	---	---	---	---	---
TETRACHLOROETHENE	---	---	---	---	---

Dup = Duplicate --- = Below Quantitation limit (2.0 ppb) +++ = Below Quantitation limit (2.0 ppb)

BL = Blank QC = Quality ** = Above High Quantitation Std.(2000 ppb)

Table 1. Quantitation Report for S.R. # SF-0-52.

Concentration = ppb

Compound	87-P1	87-P2	87-P2 Field Dup	87-P3	87-P4	87-P5	87-P6	87-P6 Field Dup	87-P7S	87-P7S Field Dup 1/3 Dil
VINYL CHLORIDE	+++	122	55.3	3.4	+++	16.4	+++	+++	*****	1180
1,1-DICHLOROETHENE	---	---	---	---	---	---	---	---	12.0	13.8
T-1,2-DICHLOROETHENE	---	5.7	2.7	---	---	1.5	---	---	14.3	12.4
C-1,2-DICHLOROETHENE	---	150	77.7	13.6	---	50.4	---	---	207	209
TRICHLOROETHENE	---	5.9	2.6	---	---	1.7	---	---	35.5	33.0
TETRACHLOROETHENE	---	1.2	1.0	---	---	---	---	---	1.0	---

	87-P7D	87-P9S	87-P9S Lab Dup	87-P9S Field Dup 1/40 Dil	87-P9D	87-P13S	87-P13D	87-P14	87-P15	87-P16S
VINYL CHLORIDE	+++	1330	1270	1380	+++	2.0	+++	1660	6.3	+++
1,1-DICHLOROETHENE	---	100	92.6	112	---	---	---	2.3	---	---
T-1,2-DICHLOROETHENE	---	129	124	140	---	---	---	14.5	---	---
C-1,2-DICHLOROETHENE	---	*****	*****	47000	1.0	---	---	168	22.9	---
TRICHLOROETHENE	---	*****	*****	5720	---	---	---	4.8	1.4	1.4
TETRACHLOROETHENE	---	46.1	43.9	44.0	---	---	---	---	---	---

	87-P16D	87-P17	CPT87-MW1S	CPT87-MW1M	CPT87-MW1D	CPT87-MW2S	CPT87-MW2M	CPT87-MW3S	CPT87-MW3S Lab Dup	CPT87-MW3M
VINYL CHLORIDE	+++	+++	+++	+++	+++	7.7	3.2	719	742	2.0
1,1-DICHLOROETHENE	---	---	---	---	---	---	---	5.3	5.4	---
T-1,2-DICHLOROETHENE	---	---	---	---	---	---	---	5.2	5.1	1.4
C-1,2-DICHLOROETHENE	---	---	---	7.8	2.5	---	6.3	478	490	53.4
TRICHLOROETHENE	---	---	---	29.4	10.0	---	---	11.7	11.5	4.0
TETRACHLOROETHENE	---	---	---	---	---	---	---	---	---	---

Dup = Duplicate --- = Below Quantitation limit (1.0 ppb) +++ = Below Quantitation limit (2.0 ppb)
***** = Above Highest Calibration Std.(2000 ppb)

Table 2. Quantitation Report for S.R. # SF-0-52.

Concentration = ppb

Compound	CPT87-MW4S	CPT87-MW4M	CPT-87 MW7S	CPT87-MW7S Lab Dup 1/2 Dil	CPT87-MW7S Lab Dup 1/2 Dil	C87MW7M MW7M	87-TW39	87-TW39 Lab Dup	UP-STREAM	DITCH
VINYL CHLORIDE	84.9	6.4	*****	3610	3342	+++	+++	+++	4.3	24.4
1,1-DICHLOROETHENE	---	---	11.5	12.2	11.4	---	---	---	---	---
T-1,2-DICHLOROETHENE	---	8.1	13.3	13.2	12.8	---	---	---	---	1.0
C-1,2-DICHLOROETHENE	61.5	448	192	210	206	---	47.5	48.8	15.8	16.7
TRICHLOROETHENE	3.8	3.6	32.5	34.8	34.0	---	74.9	74.6	---	---
TETRACHLOROETHENE	---	---	1.0	---	---	---	---	---	---	---

	DOWN-STREAM	QC0405C 50 ppb	QC0405D 500 ppb	QC0405E 50 ppb	QC0405F 500 ppb	QC0405G 50 ppb	QC0406A 500 ppb	QC0406B 50ppb	QC0406C 500 ppb	QC0406D 50 ppb
VINYL CHLORIDE	12.5	50.1	488	45.4	469	47.8	471	50.2	475	54.2
1,1-DICHLOROETHENE	---	52.9	505	51.2	510	51.6	510	54.0	524	54.7
T-1,2-DICHLOROETHENE	---	54.5	507	51.7	499	52.2	488	54.7	506	52.3
C-1,2-DICHLOROETHENE	14.8	53.3	507	52.6	508	52.8	520	52.0	475	50.4
TRICHLOROETHENE	---	54.4	511	52.9	503	53.0	493	55.0	509	53.2
TETRACHLOROETHENE	---	51.8	502	49.7	515	49.6	506	52.3	512	51.3

	BL0405A	BL0405B	BL0405C	BL0406A	BL0406B
VINYL CHLORIDE	+++	+++	+++	+++	+++
1,1-DICHLOROETHENE	---	---	---	---	---
T-1,2-DICHLOROETHENE	---	---	---	---	---
C-1,2-DICHLOROETHENE	---	---	---	---	---
TRICHLOROETHENE	---	---	---	---	---
TETRACHLOROETHENE	---	---	---	---	---

Dup = Duplicate --- = Below Quantitation limit (1.0 ppb) +++ = Below Quantitation limit (2.0 ppb)
BL = Blank QC = Quaity ** = Above High Quantitation Std.(2000 ppb)

Table 3. Quantitation Report for S.R. # SF-0-52.

Concentration = ppb

Compound	86-1	86-2MWS	86-2MWD	86-3MWS	86-3MWS Field Dup	86-3MWM	86-3MWD	86-4	86-4MWD	86-5MWS
Benzene	---	375	1.5	724	639	207	1.8	---	---	---
Toluene	2.42	18.9	1.7	737	585	15.6	1.1	6.0	3.7	1.2
Ethylbenzene	---	165	1.1	823	682	40.5	---	---	---	---
p-Xylene	---	166	1.4	1220	1070	42.2	---	---	---	---
m-Xylene	---	353	2.6	2410	2100	24.0	1.4	---	---	---
o-Xylene	---	119	1.4	1390	1130	7.5	---	---	---	---
1,3,5-Trimethylbenzene	---	71.2	---	347	305	2.8	---	---	---	---
1,2,4-Trimethylbenzene	---	270	2.5	1460	1286	25.1	1.5	---	---	1.1
1,2,3-Trimethylbenzene	---	86.3	1.3	403	319	16.0	---	---	---	---

	86-7	86-7 Lab Dup	86-8	86-9MWS	86-9MWD	86-12MWS	86-12MWD	86-16DD	86-18DD	86-18MWS
Benzene	---	---	---	2.0	427	---	93.5	---	---	---
Toluene	3.9	3.9	2.8	4.0	14.1	1.1	5.9	1.9	3.5	1.7
Ethylbenzene	---	---	---	---	2.9	---	---	---	---	2.3
p-Xylene	---	---	---	---	11.7	---	8.4	---	---	3.8
m-Xylene	1.0	1.0	---	---	12.1	1.2	7.0	---	---	6.6
o-Xylene	---	---	---	---	9.7	---	3.7	---	---	4.0
1,3,5-Trimethylbenzene	---	---	---	---	---	---	---	---	---	1.4
1,2,4-Trimethylbenzene	1.3	1.3	---	---	1.7	1.5	1.0	---	---	5.2
1,2,3-Trimethylbenzene	---	---	---	---	9.4	---	4.1	---	---	1.6

	86-18MWD	86-18MWD Lab Dup	86-19MWS	86-19MWD	86-20MWS	86-20MWS Field Dup	86-20MWD	86-23MWS	86-23MWD	86-100
Benzene	8.3	8.6	---	1.5	---	---	---	---	---	4.1
Toluene	2.1	2.2	---	---	2.1	1.9	---	---	---	---
Ethylbenzene	---	---	1.1	---	---	1.0	---	---	---	---
p-Xylene	---	---	1.5	---	1.5	1.5	---	---	---	1.1
m-Xylene	---	---	2.7	---	2.7	2.8	---	1.7	---	1.0
o-Xylene	---	---	---	---	1.8	1.8	---	---	---	---
1,3,5-Trimethylbenzene	---	---	---	---	---	---	---	---	---	---
1,2,4-Trimethylbenzene	---	---	3.1	---	2.8	2.9	---	2.0	---	---
1,2,3-Trimethylbenzene	---	---	---	---	1.0	---	---	---	---	---

Dup = Duplicate --- = Below Quantitation limit (1.0 ppb)

Table 4. Quantitation Report for S.R. # SF-0-52.

Concentration = ppb

Compound	86-PB5	86-PB5 Field Dup	86-6	86-PPOL6	86-10MWS	86-11	86-13	86-14MWD	86-14MWD Field Dup	86-PPOL15
Benzene	---	---	---	---	---	---	29.1	960	926	---
Toluene	---	---	11.1	---	3.1	1.0	8.4	16.6	16.0	---
Ethylbenzene	---	---	---	---	---	---	---	11.5	11.0	---
p-Xylene	---	---	1.3	---	---	---	10.4	39.2	37.4	---
m-Xylene	---	---	2.3	---	---	---	5.4	36.8	33.6	1.4
o-Xylene	---	---	---	---	---	---	3.1	44.2	42.8	---
1,3,5-Trimethylbenzene	---	---	---	---	---	---	---	15.3	14.4	---
1,2,4-Trimethylbenzene	---	---	2.6	---	---	---	1.5	13.6	12.9	---
1,2,3-Trimethylbenzene	---	---	---	---	---	---	6.7	23.0	22.3	---
						---				

	86-16	86-T19	86T-19 Lab Dup	86-T19 Field Dup	86-21MWS	86-21MWD	86-22MWS	86-22MWD	86-24MWS	86-24MWD
Benzene	1.0	---	---	---	---	---	---	1.5	---	---
Toluene	1.9	26.1	25.3	25.7	5.1	---	1.9	---	---	---
Ethylbenzene	---	---	---	---	---	---	---	---	---	---
p-Xylene	---	---	---	---	---	---	---	---	---	---
m-Xylene	---	---	---	---	---	---	---	---	---	---
o-Xylene	---	---	---	---	---	---	---	---	---	---
1,3,5-Trimethylbenzene	---	---	---	---	---	---	---	---	---	---
1,2,4-Trimethylbenzene	---	---	---	---	1.2	---	---	---	---	---
1,2,3-Trimethylbenzene	---	---	---	---	---	---	---	---	---	---

	86-25MWS	86-25MWD	86-26MWS	86-26MWD	86-26MWD Lab Dup	86-101	86-102	86-102 Lab Dup	86-103	86103C Field Dup
Benzene	---	---	---	---	---	---	---	---	---	---
Toluene	2.1	1.0	1.1	1.0	1.0	---	---	---	---	---
Ethylbenzene	2.3	---	---	---	---	---	---	---	---	---
p-Xylene	4.1	---	---	---	---	---	---	---	---	---
m-Xylene	6.9	1.4	---	---	---	---	---	---	---	---
o-Xylene	3.5	---	---	---	---	---	---	---	---	---
1,3,5-Trimethylbenzene	1.7	---	---	---	---	---	---	---	---	---
1,2,4-Trimethylbenzene	6.3	1.0	---	[redacted]	---	---	---	---	---	[redacted]
1,2,3-Trimethylbenzene	1.5	---	---		---	---	---	---	---	

Reporting Quantitation Limit (1.0 ppb)

Table 5. Quantitation Report for S.R. # SF-0-52.

Concentration = ppb

Compound	87-P1	87-P2	87-P3	87-P3 Lab Dup	87-P4	87-P5	87-P6	87-P7S	87-P7S Field Dup	87-P7D
Benzene	---	---	---	---	---	---	---	2.5	2.4	---
Toluene	---	---	---	---	---	---	---	1.3	1.2	---
Ethylbenzene	---	---	---	---	---	---	---	1.4	1.4	---
p-Xylene	---	---	---	---	---	---	---	1.9	1.8	---
m-Xylene	---	---	---	---	---	---	---	1.1	1.0	---
o-Xylene	---	---	---	---	---	---	---	3.6	3.5	---
1,3,5-Trimethylbenzene	---	---	---	---	---	---	---	1.0	1.0	---
1,2,4-Trimethylbenzene	---	---	---	---	---	---	---	---	---	---
1,2,3-Trimethylbenzene	---	---	---	---	---	---	---	1.4	1.4	---

Compound	87-P7D Lab Dup	87-P9S	87-P9S Field Dup	87-P9D	87-P13S	87-P13D	87-P14	87-P15	87-P16S	87-P16D
Benzene	---	13.7	13.8	---	---	---	1.0	---	---	---
Toluene	---	106	99.8	---	---	---	---	---	---	---
Ethylbenzene	---	15.1	16.0	---	---	---	---	---	---	---
p-Xylene	---	14.5	15.7	---	---	---	---	---	---	---
m-Xylene	---	27.4	30.5	---	---	---	---	---	---	---
o-Xylene	---	32.5	34.9	---	---	---	---	---	---	---
1,3,5-Trimethylbenzene	---	14.2	14.2	---	---	---	---	---	---	---
1,2,4-Trimethylbenzene	---	34.7	39.3	---	---	---	---	---	---	---
1,2,3-Trimethylbenzene	---	27.1	27.4	---	---	---	---	---	---	---

Compound	87-P17	87-MW1S	87-MW1M	87-MW1D	CPT87-MW2S	CPT87-MW2S Lab Dup	CPT87-MW2M	CPT87-MW3S	CPT87-MW3M	CPT87-MW4S
Benzene	---	8.3	---	---	---	---	---	1.0	---	---
Toluene	---	1.0	6.7	10.8	1.2	1.2	2.9	1.2	4.71	2.3
Ethylbenzene	---	1.0	---	---	---	---	---	---	---	---
p-Xylene	---	---	---	---	---	---	---	---	---	---
m-Xylene	---	---	---	---	---	---	---	---	---	---
o-Xylene	---	---	---	---	---	---	---	---	---	---
1,3,5-Trimethylbenzene	---	---	---	---	---	---	---	---	---	---
1,2,4-Trimethylbenzene	---	---	1.1	1.0	---	---	---	---	---	---
1,2,3-Trimethylbenzene	---	---	---	---	---	---	---	---	---	---

Dup = Duplicate --- = Below Quantitation Limit (1.0 ppb)

Table 6. Quantitation Report for S.R. # SF-0-52.

Concentration = ppb

Compound	CPT87-MW4M	CPT87-MW7M	87-TW39	87-TW39 Field Dup	QC0408A 50 ppb	QC0408B 500 ppb	QC0408C 50 ppb	QC0408D 500 ppb	QC0408E 50 ppb	QC0408F 500 ppb
Benzene	---	---	---	---	47.9	474	49.3	477	47.1	457
Toluene	1.1	2.4	---	---	48.5	473	49.4	486	49.3	450
Ethylbenzene	---	---	---	---	46.5	500	47.7	488	44.0	492
p-Xylene	---	---	---	---	47.4	506	48.5	486	48.6	483
m-Xylene	---	---	---	---	44.4	502	46.6	487	46.5	454
o-Xylene	---	---	---	---	48.2	503	48.5	492	48.7	475
1,3,5-Trimethylbenzene	---	---	---	---	44.3	488	46.2	473	47.7	480
1,2,4-Trimethylbenzene	---	---	1.0	1.0	50.2	533	49.8	523	50.3	519
1,2,3-Trimethylbenzene	---	---	---	---	49.4	522	50.9	491	49.7	483

	QC0408G 50 ppb	QC0411A 50 ppb	QC0411B 500 ppb	QC0411C 50 ppb	QC0411D 500 ppb	QC0411E 50 ppb	QC0412A 50 ppb	QC0412B 500 ppb	QC0412C 50 ppb	QC0412D 500 ppb
Benzene	49.1	50.8	493	50.0	473	49.1	50.5	489	51.2	457
Toluene	48.5	51.4	503	50.7	466	47.6	51.0	481	50.9	482
Ethylbenzene	46.6	47.3	518	48.8	505	46.6	50.1	520	47.7	499
p-Xylene	49.6	49.3	530	50.7	513	48.9	50.3	531	51.3	511
m-Xylene	45.9	45.2	517	51.0	503	46.3	48.3	506	49.9	502
o-Xylene	48.8	50.1	511	49.7	506	49.2	49.4	516	51.3	495
1,3,5-Trimethylbenzene	47.2	47.0	503	50.5	499	47.8	46.3	523	50.6	491
1,2,4-Trimethylbenzene	51.4	49.6	538	52.4	526	50.3	49.6	541	52.1	518
1,2,3-Trimethylbenzene	48.8	49.6	509	51.3	498	50.7	49.6	517	51.3	493

	QC0412E 50 ppb	QC0412F 500 ppb	QC0413A 50 ppb	QC0413B 500 ppb	BL0408A	BL0408B	BL0411A	BL0411B	BL0412A	BL0413A
Benzene	49.7	482	49.2	463	---	---	---	---	---	---
Toluene	50.6	489	49.9	447	---	---	---	---	---	---
Ethylbenzene	47.0	510	48.8	476	---	---	---	---	---	---
p-Xylene	50.4	513	50.0	497	---	---	---	---	---	---
m-Xylene	48.7	506	47.3	491	---	---	---	---	---	---
o-Xylene	50.1	499	49.4	494	---	---	---	---	---	---
1,3,5-Trimethylbenzene	48.7	482	45.9	460	---	---	---	---	---	---
[redacted]-Trimethylbenzene	50.9	511	49.5	503	---	---	---	---	---	---
[redacted]methylbenzene	50.8	501	49.[redacted]	196	---	---	---	---	[redacted]	---

[redacted] SF-0-52 Dr. Kampbell GC/MSD [redacted]atrick AFB MeCl2 extracts [redacted] Units = mg/kg

SAMPLE	BENZENE	TOLUENE	EB	p-XYLENE	m-XYLENE	o-XYLENE	1,3,5-TMB	1,2,4-TMB	1,2,3-TMB
B-1	BLQ	8.05E-03	ND	ND	BLQ	2.68E-02	7.54E-02	BLQ	BLQ
B-2	BLQ	BLQ	2.49E-01	ND	2.17E-01	3.13E-01	1.60E-01	1.35E-01	8.57E-01
B-3	ND	7.22E-03	2.96E-01	1.14E-02	2.99E-02	1.22E-01	5.70E-02	7.10E-02	3.76E-01
B-4	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ
B-5	BLQ	1.42E-02	4.52E-01	1.89E-01	6.70E-02	2.13E-01	5.62E-01	1.54E+00	5.22E-01
B-6	BLQ	1.83E-02	2.66E-01	1.06E-01	2.71E-02	2.57E-01	3.23E-01	1.05E+00	4.16E-01
B-7	BLQ	1.84E-02	BLQ	BLQ	BLQ	3.57E-02	7.07E-02	4.64E-02	6.72E-02
B-8	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ
B-9	BLQ	1.59E-02	9.61E-03	1.40E-02	1.68E-02	3.08E-02	3.09E-02	7.15E-02	4.91E-02
B-10	BLQ	9.36E-02	1.45E-01	1.32E-01	1.61E-01	2.71E-01	4.59E-01	1.04E+00	5.58E-01
B-11	8.08E-03	4.12E-01	5.23E-01	5.02E-01	7.35E-01	1.20E+00	1.63E+00	3.82E+00	1.67E+00
B-12	BLQ	3.14E-01	4.00E-01	3.85E-01	5.97E-01	8.55E-01	1.21E+00	2.82E+00	1.44E+00
B-13	BLQ	BLQ	BLQ	ND	BLQ	BLQ	BLQ	BLQ	BLQ
B-14	BLQ	ND	BLQ	BLQ	BLQ	BLQ	ND	BLQ	ND
B-15	BLQ	1.17E-02	1.16E-02	6.56E-02	ND	BLQ	BLQ	BLQ	BLQ
B-16	ND	ND	ND	ND	BLQ	ND	BLQ	ND	ND
86-2-A17	BLQ	BLQ	3.45E-02	2.49E-02	5.40E-02	2.96E-02	1.80E-02	5.14E-02	1.70E-02
86-2-A18	1.97E-01	6.05E-02	5.14E-01	1.44E+00	9.76E-01	7.03E-01	3.10E+00	3.28E+00	2.65E+00
86-2-A19	6.99E+00	8.08E+00	1.91E+02	2.57E+02	5.42E+02	2.31E+02	2.74E+02	7.86E+02	1.80E+02
86-2-A20	6.80E-01	3.45E-01	1.61E+01	2.03E+01	4.59E+01	1.79E+01	2.60E+01	7.74E+01	1.75E+01
86-2-A21	3.39E-01	1.06E-01	2.26E+00	2.91E+00	6.77E+00	2.74E+00	3.75E+00	1.17E+01	2.59E+00
86-2-A22	1.64E-01	1.42E-02	2.10E-01	2.53E-01	5.23E-01	2.43E-01	3.19E-01	8.44E-01	2.27E-01
86-3-A23	ND	BLQ	8.38E-03	1.02E-02	2.09E-02	1.07E-02	1.55E-02	4.61E-02	1.30E-02
86-3-A24	BLQ	4.62E-01	BLQ	3.98E+01	4.57E+01	8.58E+01	2.53E+02	3.32E+02	1.23E+02
86-3-A25	2.33E+00	2.95E+01	1.20E+02	1.86E+02	4.28E+02	2.09E+02	1.81E+02	6.75E+02	1.24E+02
86-3-A26	3.66E-01	5.32E-01	2.02E+00	3.48E+00	7.58E+00	4.40E+00	3.97E+00	1.27E+01	2.87E+00
86-5-A1	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ	7.46E-03	BLQ
86-5-A2	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ	1.17E-02	BLQ
86-5-A3	BLQ	BLQ	BLQ	7.25E-03	BLQ	BLQ	BLQ	8.79E-03	BLQ
86-5-A4	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ	1.49E-02	BLQ
86-9-A4	BLQ	BLQ	ND	BLQ	BLQ	BLQ	BLQ	ND	ND
86-9-A5	BLQ	BLQ	BLQ	BLQ	BLQ	ND	BLQ	BLQ	BLQ
86-9-A6	BLQ	3.40E-02	BLQ	3.11E-02	2.29E-02	1.09E-02	1.21E-02	BLQ	9.76E-03
86-9-A7	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ	8.18E-03	BLQ
86-13-SS1-A16	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ

Analyst: David A. Kovacs

BLQ < 0.02 µg/ml

Printed: 4/18/94

SR SF-0-52 Dr. Kampbell

GC/MSD of Patrick AFB MeCl2 extracts

Units = mg/kg

SAMPLE	BENZENE	TOLUENE	EB	p-XYLENE	m-XYLENE	o-XYLENE	1,3,5-TMB	1,2,4-TMB	1,2,3-TMB
86-15-A8	BLQ	BLQ	ND	BLQ	BLQ	BLQ	BLQ	1.60E-02	BLQ
86-15-A9	BLQ	BLQ	ND	BLQ	BLQ	BLQ	BLQ	1.28E-02	BLQ
86-15-A10	BLQ	1.20E-02	9.78E-03	BLQ	BLQ	2.26E-02	BLQ	1.14E-02	BLQ
86-15-A11	ND	ND	BLQ	BLQ	BLQ	BLQ	BLQ	1.79E-02	BLQ
86-16-A1	7.52E-03	7.61E-03	BLQ	BLQ	BLQ	BLQ	BLQ	6.58E-03	BLQ
86-16-A2	ND	BLQ	ND	BLQ	BLQ	BLQ	BLQ	1.04E-02	BLQ
86-17-A12	ND	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ	1.27E-02	BLQ
86-17-A13	ND	BLQ	ND	BLQ	BLQ	BLQ	BLQ	2.48E-02	BLQ
86-17-A14	ND	BLQ	BLQ	BLQ	7.79E-03	BLQ	BLQ	1.76E-02	BLQ
86-17-A15	ND	BLQ	ND	BLQ	BLQ	BLQ	BLQ	1.72E-02	BLQ
DK-1	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ
DK-2	7.40E+00	3.10E+00	5.76E+02	3.99E+02	1.04E+03	4.62E+02	3.70E+02	1.42E+03	2.58E+02
FIELD TRIP BLANK	ND	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ	BLQ
METHOD BLANK	ND	ND	BLQ	BLQ	BLQ	ND	ND	ND	BLQ

Note: Since some samples were rerun as dilutions and a new calibration curve was necessary during analysis, the check standard data is presented, sequentially, below.

0.1 µg/ml	9.73E-02	1.02E-01	1.05E-01	1.04E-01	1.05E-01	1.02E-01	1.01E-01	1.01E-01	9.81E-02
1 µg/ml	1.02E+00	1.04E+00	1.02E+00	1.02E+00	1.03E+00	1.03E+00	1.01E+00	1.03E+00	1.02E+00
10 µg/ml	1.03E+01	1.05E+01	1.05E+01	1.06E+01	1.06E+01	1.04E+01	1.05E+01	1.04E+01	1.04E+01
1 µg/ml	9.93E-01	9.83E-01	9.69E-01	9.48E-01	9.65E-01	9.69E-01	9.81E-01	9.80E-01	9.71E-01
0.1 µg/ml	1.02E-01	9.65E-02	9.51E-02	9.62E-02	9.51E-02	9.74E-02	9.89E-02	9.84E-02	1.02E-01
10 µg/ml	9.67E+00	9.46E+00	9.46E+00	9.46E+00	9.40E+00	9.56E+00	9.55E+00	9.58E+00	9.65E+00
100 µg/ml	1.07E+02	1.08E+02	1.09E+02	1.08E+02	1.09E+02	1.09E+02	1.11E+02	1.10E+02	1.11E+02
100 µg/ml QC	9.47E+01	9.11E+01	9.09E+01	9.14E+01	9.00E+01	9.10E+01	9.04E+01	9.01E+01	9.04E+01
1 µg/ml	9.70E-01	9.66E-01	9.75E-01	9.70E-01	9.88E-01	9.72E-01	9.75E-01	9.56E-01	9.80E-01
100 µg/ml	9.03E+01	9.49E+01	9.48E+01	9.47E+01	9.49E+01	9.45E+01	9.47E+01	9.61E+01	9.63E+01
100 µg/ml	1.04E+02	1.05E+02	1.06E+02	1.05E+02	1.06E+02	1.05E+02	1.06E+02	1.05E+02	1.06E+02
100 µg/ml	1.01E+02	1.02E+02	1.01E+02	1.01E+02	1.02E+02	1.02E+02	1.02E+02	1.02E+02	1.02E+02
[illegible] µg/ml QC	9.54E+01	9.28E+01	9.27E+01	9.31E+01	9.21E+01	9.27E+01	9.30E+01	[illegible]E+01	9.22E+01

BLQ = 0.02 µg/ml

Printed: 4/18/94

CAPE CANAVERAL AIR STATION, FLORIDA									
Sample	Date	Temp C°	Redox mV	Dissolved Oxygen mg/l	Conductivity μmhos/cm	pH	Hydrogen Sulfide mg/l	Total Alkalinity mg/lCaCO	Ferrous Iron mg/l
87-14P	3-27-94	24.0	-90	0.0	1962	6.9	0.0	413	1.9
87-13S	3-27-94	23.9	-58	0.3	894	7.2	0.0	302	.8
87-P17	3-27-94	25.2	-80	0.1	1132	7.0	0.1	378	1.7
87-P7S	3-27-94	23.6	-94	0.0	800	7.1	0.0	308	.4
87-13D	3-28-94	26.4	-360	0.2	2080	7.3	3.0	402	.1
87-15D	3-28-94	24.0	34	0.1	924	7.1	0.0	308	.2
87-7D	3-28-94	25.7	-338	0.1	2070	7.6	5.0	298	.1
87-P1	3-28-94	24.3	-80	0.2	1723	6.9	0.0	510	5.1
87-P2	3-28-94	24.0	-92	0.1	1997	6.9	0.1	489	4.7
87-P3	3-28-94	24.2	-97	0.2	2960	7.1	0.0	368	3.9
87-P5	3-28-94	24.4	-100	0.5	3120	7.0	0.0	443	5.4
87-P4	3-28-94	24.5	-52	0.2	1227	7.0	0.0	394	1.0
87-6	3-28-94	24.5	-322	0.1	1406	7.0	20.0	548	.3
87-P9S	3-28-94	23.3	-226	0.4	1355	6.7	1.2	480	3.5
87-P9D	3-28-94	24.6	-285	0.2	2540	7.4	2.0	241	< .05
87-MW1-S	3-28-94	22.8	-140	0.8	1131	6.9	0.1	513	.1
87-MW1-M	3-28-94	23.7	-60	1.2	4400	7.3	0.0	416	1.1

CAPE CANAVERAL AIR STATION, FLORIDA									
Sample	Date	Temp C°	Redox mV	Dissolved Oxygen mg/l	Conductivity µmhos/cm	pH	Hydrogen Sulfide mg/l	Total Alkalinity mg/lCaCO	Ferrous Iron mg/l
87-MW1-D	3-28-94	23.7	-280	4.3	3820	7.6	0.7	292	< .05
87-MW7-M	3-29-94	24.7	209	2.3	3780	7.5	0.0	405	< .05
87-MW2-S	3-29-94	24.3	300	5.9	444	7.3	0.0	188	< .05
87-MW2-M	3-29-94	25.5	190	1.2	5260	7.1	0.0	439	.3
87-MW3-S	3-29-94	23.9	94	0.7	1118	65	0.0	405	2.1
87-MW3-M	3-29-94	24.3	51	1.1	4040	7.5	0.0	396	.2
87-MW4-S	3-29-94	22.3	110	3.7	1150	7.0	0.0	309	.4
87-MW4-M	3-29-94	23.6	92	1.1	3170	7.4	0.0	299	.3

Sample	mg/l $NO^-_2+NO^-_3(N)$	mg/l Cl^-	mg/l $SO_4^=$
87-P1	<.05	36.8	424
87-P2	<.05	176	441
87-P3	<.05	559	281
87-P3 Dup		548	280
87-P4	<.05	59.7	171
87-P5	<.05	497	432
87-6	<.05	58.4	178
87-7D	<.05	450	15.4
87-7D Dup	<.05		
87-9D	<.05	640	36.7
87-9S	<.05	62.6	127
87-9S Dup		62.1	126
87-13D	<.05	405	3.79
87-15	<.05	54.3	90.6
86-3-MWS	<.05		
Blank	<.05	<.5	<.5
AQCWP031	.48	39.6	87.8
True Value	.52	40.6	92.0
Spike Recovery	100%	98%	103%

Sample	mg/l $NO^-_2+NO^-_3(N)$	mg/l Cl^-	mg/l $SO_4^=$
86-4-MWD	.09	12.4	1.47
86-5-MWS	.17	23.6	6.86
86-7	.12	30.2	2.52
86-8	.10	44.7	8.51
86-9-MWD	.11	34.7	15.3
86-9-MWD Dup	.11		
86-9-MWS	.10	14.3	6.64
86-12-MWD	.12	28.1	3.86
86-12-MWS	.10	15.2	8.38
86-12-MWS Dup		15.2	8.47
86-18-MWD	.11	15.0	1.85
86-18-MWS	.12	36.6	86.0
86-19-MWD	.10	33.7	1.51
86-19-MWS	.11	37.4	8.85
86-19-MWS Dup	.10		
86-20-MWD	.07	52.0	<.5
86-20-MWS	.10	9.83	25.5
86-23-MWD	.10	36.1	1.49
86-23-MWS	.12	23.4	<.5
86-23-MWS Dup		23.4	<.5
86-6	.13	47.8	7.03
86-10-MWS	.13	26.6	9.50
86-11	.15	12.7	15.9
86-13	.12	35.5	6.94
86-14-MWD	.11	34.6	3.68
86-16	.13	37.9	8.23
86-21-MWD	.14	29.8	13.3
86-21-MWS	.29	26.6	25.5
86-22-MWD	.12		
86-22-MWS	.07	66.6	128
86-22-MWS	.06		
86-24-MWD	.10	5.46	3.61
86-24-MWS	.12	6.63	<.5
86-25-MWD	.12	54.7	6.16
86-25-MWS	.12	28.0	51.9
86-26-MWD	.11	44.9	19.8
86-26-MWD Dup		43.6	19.5
86-26-MWS	.12	15.1	1.22
86-PPOL-15	<.05	44.0	3.20
86-PPOL-6	<.05	10200	1150
86-PPOL-6 Dup	<.05		
86-PB-5	.10	51.4	4.45
86-T19	2.04	35.1	29.6
87-13S	.14	24.6	129
87-14P	.07	282	165
87-14P Dup	.09		
87-P7S	.12	43.7	46.8
87-P17	.10	30.5	163
Blanks	<.05	<.05	<.05
AQCWP031	.51	39.3	88.5
		39.9	88.0
True Value	.52	41.2	92.0
Spike Recovery	103%	102%	101%
	103%	97%	95%

Sample	mg/l $NO^-_2+NO^-_3$	mg/l Cl^-	mg/l $SO_4^=$
87-MW1-D	.10	1,021	31.6
87-MW1-D Dup		1,021	28.2
87-MW1-M	.11	1,044	185
87-MW1-S	.11	20.3	76.7
CPT87-MW2-M	.13	1,130	461
CPT87-MW2-S	.16	16.6	15.3
CPT87-MW3-M	.11	906	223
CPT87-MW3-S	.12	68.5	64.0
CPT87-MW3-S Dup	.12	68.2	64.7
CPT87-MW7-M	.10	843	185
CPT87-MW4-S*	.23	203	114
CPT87-MW4-S*Dup	.16		
CPT87-MW4-M	.12		
CPT87-MW4-M Dup	.14		
CPT87-MW4-S*		81.4	120
Blanks	<.1	<.5	<.5
AQCWP031	.44	40.8	93.4
True Value	.52	41.2	92.0
Spike Recovery	105%	99%	100%

* - 2 unfixed samples were labeled the same, received 4-1-94

Set # 4
Samples received 03/30/94
Samples analyzed 03/30/94

Sample	mg/L TOC
87-P1	7.3
87-P2	17.9
87-P3	7.3
87-P4	5.9
87-P5	8.7
87-P6	23.3
87-7D	5.1
87-P9D	3.9
87-P9S	23.3
87-13D	5.2
87-13D Dup	5.2
87-15	4.5
RO H_2O	0.1
WP031 I	27.8
	28.0

Set # 5
Samples received 03/31/94
Samples analyzed 04/04/94

Sample	mg/L TOC
87-MW1-D	4.0
87-MW1-M	6.1
87-MW1-S	58.9
CPT87-MW2-M	8.7
CPT87-MW2-S	4.1
CPT87-MW2-S Dup	4.0
CPT87-MW3-M	7.3
CPT87-MW3-S	13.2
CPT87-MW7-M	5.7
CPT87-MW7-M Dup	5.7
RO H_2O	0.1
WP031 I	28.0
	28.2

Set # 6
Sample received 04/04/94
Sample analyzed 04/04/94

Sample	mg/L TOC
CPT87-MW4-S	6.9
CPT87-MW4-M	6.9
RO H_2O	0.1
WP031 I	27.6

True Value of WP031 I = 28.0 mg/L

Set # 3
Samples received 03/29/94
Samples analyzed 03/29/94

Sample	mg/L TOC
86-6	3.8
86-10 MWS	21.3
86-13	7.2
86-14 MWD	12.8
86-16	9.4
86-21 MWD	6.1
86-21 MWS	7.6
86-22 MWD	11.4
86-22 MWS	10.0
86-22 MWS Dup	10.0
86-24 MWD	2.8
86-24 MWS	5.6
86-25 MWD	15.7
86-25 MWS	15.7
86-26 MWD	8.3
86-26 MWS	5.0
87-P13S	3.0
87-14P	9.3
87-14P Dup	9.3
87-P7S	9.5
87-P17	8.1
RO H_2O	0.1
WP031 I	27.7
	28.0
	28.0
	28.3
	27.5
	27.8

DON KAMPBELL SOIL TOC RESULTS (SR# SF-0-52 1)

SAMPLE	SOIL FILT. % OC	SOLIDS % OC	TOTAL SOIL % TOC	SOIL % TOC (MEAN +/- 1 SD)		
B1-1	0.062	0.344	0.406			
B1-2	0.057	0.372	0.429	.422 +/- .014	CCAF-1	5.5-6.5'
B1-3	0.060	0.372	0.432			
B2-1	0.041	0.434	0.475			
B2-2	0.040	0.409	0.449	.467 +/- .016	"	6.5-7.5'
B2-3	0.039	0.439	0.478			
B3-1	0.039	0.177	0.216			
B3-2	0.041	0.448	0.489	.293 +/- .171	"	7.5-8.5'
B3-3	0.038	0.137	0.175			
B4-1	0.019	0.019	0.038			
B4-2	0.021	0.019	0.040	.040 +/- .003	"	8.5-9.5'
B4-3	0.020	0.023	0.043			
B5-1	0.014	0.142	0.156			
B5-2	0.015	0.212	0.227	.174 +/- .047	CCAF-7	5.5-6.5'
B5-3	0.017	0.122	0.139			
87-B6-1	0.081	0.335	0.416			
87-B6-2	0.075	0.326	0.401	.424 +/- .028	"	6.5-7.5'
87-B6-3	0.073	0.382	0.455			
B7-1	0.035	0.050	0.085			
B7-2	0.023	0.038	0.061	.070 +/- .013	"	7.5-8.5'
B7-3	0.029	0.036	0.065			
B8-1	0.015	0.010	0.025			
B8-2	0.013	0.008	0.021	.023 +/- .002	"	8.5-9.5'
B8-3	0.016	0.007	0.023			
B9-1	0.004	0.254	0.258			
B9-2	0.006	0.178	0.184	.216 +/- .038	CCAF-6	3.5-4.5'
B9-3	0.006	0.201	0.207			
B10-1	0.007	0.112	0.119			
B10-2	0.002	0.123	0.125	.148 +/- .045	"	4.5-5.5'
B10-3	0.002	0.198	0.200			
B11-1	0.093	0.783	0.876			
B11-2	0.093	0.701	0.794	.836 +/- .041	"	5.5-6.5'
B11-3	0.098	0.739	0.837			
B12-1	0.060	0.348	0.408			
B12-2	0.059	0.255	0.314	.361 +/- .047	"	6.5-7.5'
B12-3	0.062	0.300	0.362			

DON KAMPBELL SOIL TOC RESULTS (SR# SF-0-52 MOD. 1)

SAMPLE	SOIL FILT. % OC	SOLIDS % OC	TOTAL SOIL % TOC	SOIL % TOC (MEAN +/- 1 SD)
B13-1	0.020	0.030	0.050	
B13-2	0.018	0.024	0.042	.044 +/- .005
B13-3	0.019	0.022	0.041	
B14-1	0.022	0.044	0.066	
B14-2	0.023	0.048	0.071	.075 +/- .011
B14-3	0.023	0.064	0.087	
B15-1	0.018	0.023	0.041	
B15-2	0.020	0.021	0.041	.041 +/- 0
B15-3	0.019	0.022	0.041	
B16-1	0.011	0.007	0.018	
B16-2	0.013	0.006	0.019	.018 +/- .002
B16-3	0.011	0.005	0.016	
86-15-A8-1	0.015	0.015	0.030	
86-15-A8-2	0.015	0.015	0.030	.031 +/- .001
86-15-A8-3	0.013	0.019	0.032	
86-15-A9-1	0.017	0.034	0.051	
86-15-A9-2	0.023	0.034	0.057	.053 +/- .003
86-15-A9-3	0.016	0.035	0.051	
86-15-A10-1	0.038	1.062	1.100	
86-15-A10-2	0.039	1.089	1.128	1.13 +/- .030
86-15-A10-3	0.037	1.122	1.159	
86-15-A11-1	0.045	0.475	0.520	
86-15-A11-2	0.047	0.502	0.549	.558 +/- .044
86-15-A11-3	0.048	0.558	0.606	
86-9-A4-1	0.020	0.020	0.040	
86-9-A4-2	0.021	0.013	0.034	.036 +/- .003
86-9-A4-3	0.019	0.015	0.034	
86-9-A5-1	0.024	0.025	0.049	
86-9-A5-2	0.019	0.019	0.038	.042 +/- .006
86-9-A5-3	0.020	0.019	0.039	
86-9-A6-1	0.034	0.282	0.316	
86-9-A6-2	0.031	0.284	0.315	.307 +/- .015
86-9-A6-3	0.029	0.261	0.290	
86-9-A7-1	0.074	1.829	1.903	
86-9-A7-2	0.076	1.692	1.768	1.86 +/- .083
86-9-A7-3	0.071	1.848	1.919	

CCAF-1 (dup?) 5.5-6.5'

" 6.5-7.5'

" 7.5-8.5'

" 8.5-9.5'

Notebook No.

:CT CAPE CANAVERAL AIR station FL

Continued From Page

Core sample		Vial #	TLV Reading
CCAF-01-SS1	(5.5-6.5')	B7-B1	~~<10~~ <10
CCAF-01-SS1	(6.5-7.5)	B7-B2	20
CCAF-01-SS2	7.5-8.5	B7-B-3	80
CCAF01-SS2	8.5-9.5	B7-B-4	60
CCAF-02-SS1	5.5-6.5	B7-B5	350
	6.5-7.5	B7-B6	140
CCAF-07-SS2	7.5-8.5	B7-B7	100
	8.5-9.5	B7-B8	60
CCAF-06-SS1	3.5-4.5	B7-B9	90
	4.5-5.5	B7-B10	200
CCAF-06-SS2	5.5-6.5	B7-B11	130
	6.5-7.5	B7-B12	140
CCAF 01B-SS1	5.5-6.5	B7-B13	50
	6.5-7.5	B7-B14	30
CCAF 01B-SS2	7.5-8.5	B7-B15	50
	8.5-9.5	B7-B16	60

Continued on Page

Read and Understood By

PK

Signed

3/29/94

Date

MANTECH

Ref: 96-SH20/vg

March 13, 1996

Dr. Don Kampbell
National Risk Management Research Laboratory
Subsurface Protection & Remediation Division
U.S. Environmental Protection Agency
P.O. Box 1198
Ada, OK 74820

THRU: S.A. Vandegrift SV

Dear Don:

Attached are TOC results for 5 Cape Canaveral soils submitted January 24, 1996 under Service Request #SF-2-183. Sample analysis was begun February 27, 1996 and completed March 13, 1996 using RSKSOP-102 and RSKSOP-120.

Blanks, duplicates, and AQC samples were analyzed along with your samples, as appropriate, for quality control. If you have any questions concerning this data, please feel free to ask me.

Sincerely,

Sharon Hightower

Sharon Hightower

xc: R.L. Cosby
G.B. Smith
J.L. Seeley JS

AMPBELL CAPE CANAVERAL SOIL

SAMPLE	SOIL FILTRATE % O.C.	SOLIDS % O.C.	TOTAL SOIL % TOC	MEAN %TOC	STD. DEV.
MP1S 1-1	.016	.023	.039	.041	
1-2	.022	.021	.043		
MP-3 1-1	.023	.017	.040	.114	.146
1-2	.010	.273	.283		
1-3	.008	.012	.020		
MP5 1-1	.013	.006	.019	.017	
1-2	.013	.001	.014		
MP8-6 1-1	.015	.005	.020	.021	
1-2	.015	.006	.021		
MP 4S 1-1	.015	.005	.020	.019	
1-2	.014	.003	.017		
LECO STD.		1.04			
WPO34-II STD.	6.4				

Leco std. t.v.=1.00±.04
WPO34-II std. t.v.=6.3

Ref: 96-DF13

Feb. 27, 1996

Dr. Don Kampbell
National Risk Management Research Laboratory
Subsurface Protection and Remediation Division
U.S. Environmental Protection Agency
P.O. Box 1198
Ada, OK 74820

THRU: S.A. Vandegrift SV

Dear Don:

As requested in Service Request SF-2-183, GC/MS analysis for phenols and aliphatic/aromatic acids was done on water samples from well sites, FTA2-96, FTA2-03, FTA2-05, FTA2-06 and FTA2-205 at Cape Canaveral. Derivatization of the sample was done by Amy Zhao on Feb. 8, 1995. The extract was analyzed by GC/MS on Feb. 23, 1996. RSKERL SOP 177 was used for the extraction, derivatization and GC/MS analysis of the samples.

Table I provides the concentrations of the phenols and aliphatic/aromatic acids found in the Cape Canaveral samples. A derivative and extraction blank and a 50 ppb spiked extraction blank are also included. Please note that pentanoic acid, hexanoic acid, heptanoic acid and benzoic acid were present in extraction blanks at levels comparable to the samples. It is questionable whether these compounds are present in the samples due to their presence in the extraction banks. 2-Ethylhexanoic acid was found at much higher levels in the samples than in the blanks.

If you should have any questions, please feel free to contact me.

Sincerely,

Dennis D Fine

Dennis D. Fine

xc: J. Seeley gg
G. Smith
R. Cosby
D. Fine

Table I. Quantitative Report and QC Data for Phenols and Aliphatic and Aromatic Acids for Samples from Cape Canaveral (Service Request SF-2-183).

Concentration ppb

		FTA2-95	FTA2-03	FTA2-05	FTA2-06	FTA2-205	Standard Blank
1	PROPANOIC ACID - PFB	***	***	6	9	***	6
	2-METHYLPROPANOIC ACID - PFB	10	***	***	6	***	***
	TRIMETHYL ACETIC ACID - PFB	6	***	5	5	***	***
4	BUTYRIC ACID - PFB	16	8	16	18	8	20
5	2-METHYLBUTYRIC ACID - PFB	15	***	***	***	***	***
6	3-METHYLBUTYRIC ACID - PFB	40	***	***	***	***	***
7	3,3-DIMETHYLBUTYRIC ACID - PFB	***	***	***	22	N.F.	***
8	PENTANOIC ACID - PFB	23	17	54	58	32	70
9	2,3-DIMETHYLBUTYRIC ACID - PFB	***	***	***	6	N.F.	***
10	2-ETHYLBUTYRIC ACID - PFB	***	N.F.	N.F.	N.F.	N.F.	***
11	2-METHYLPENTANOIC ACID - PFB	***	N.F.	***	***	N.F.	***
12	3-METHYLPENTANOIC ACID - PFB	***	N.F.	***	***	***	***
13	4-METHYLPENTANOIC ACID - PFB	8	N.F.	***	***	***	***
14	HEXANOIC ACID - PFB	32	22	56	66	39	73
15	2-METHYLHEXANOIC ACID - PFB	***	N.F.	N.F.	***	***	N.F.
16	PHENOL - PFB	***	***	***	***	***	***
17	CYCLOPENTANECARBOXYLIC ACID - PFB	***	N.F.	N.F.	***	N.F.	***
18	5-METHYLHEXANOIC ACID - PFB	***	N.F.	N.F.	***	N.F.	N.F.
19	o-CRESOL - PFB	5	N.F.	N.F.	***	N.F.	N.F.
20	2-ETHYLHEXANOIC ACID - PFB	387	381	302	656	438	54
21	HEPTANOIC ACID - PFB	6	5	11	14	8	15
22	m-CRESOL - PFB	12	N.F.	N.F.	***	N.F.	N.F.
23	p-CRESOL - PFB	***	N.F.	N.F.	N.F.	N.F.	N.F.
24	1-CYCLOPENTENE-1-CARBOXYLIC ACID - PFB	N.F.	N.F.	N.F.	N.F.	N.F.	***
25	o-ETHYLPHENOL - PFB	***	N.F.	N.F.	***	N.F.	N.F.
26	CYCLOPENTANEACETIC ACID - PFB	***	N.F.	N.F.	N.F.	N.F.	N.F.
27	2,6-DIMETHYLPHENOL - PFB	***	N.F.	N.F.	***	N.F.	N.F.
28	2,5-DIMETHYLPHENOL - PFB	6	N.F.	N.F.	8	N.F.	N.F.
29	CYCLOHEXANECARBOXYLIC ACID - PFB	6	N.F.	***	***	***	***
	3-CYCLOHEXENE-1-CARBOXYLIC ACID - PFB	***	N.F.	N.F.	***	N.F.	N.F.
	2,4-DIMETHYLPHENOL - PFB	6	N.F.	N.F.	6	N.F.	N.F.
	3,5-DIMETHYLPHENOL & M-ETHYLPHENOL - PFB	5	N.F.	N.F.	5	***	N.F.
33	OCTANOIC ACID - PFB	***	***	5	7	***	6
34	2,3-DIMETHYLPHENOL - PFB	***	N.F.	N.F.	***	N.F.	N.F.
35	p-ETHYLPHENOL - PFB	***	N.F.	N.F.	5	N.F.	N.F.
36	BENZOIC ACID - PFB	14	12	24	18	12	6
37	3,4-DIMETHYLPHENOL - PFB	***	N.F.	N.F.	***	N.F.	N.F.
38	m-METHYLBENZOIC ACID - PFB	21	N.F.	N.F.	N.F.	N.F.	N.F.
39	1-CYCLOHEXENE-1-CARBOXYLIC ACID - PFB	***	N.F.	N.F.	N.F.	N.F.	N.F.
40	CYCLOHEXANEACETIC ACID - PFB	***	N.F.	N.F.	N.F.	N.F.	N.F.
41	2-PHENYLPROPANOIC ACID - PFB	***	N.F.	N.F.	***	N.F.	N.F.
42	o-METHYLBENZOIC ACID - PFB	***	N.F.	N.F.	***	N.F.	***
43	PHENYLACETIC ACID - PFB	***	***	***	***	***	***
44	m-TOLYLACETIC ACID - PFB	***	N.F.	N.F.	***	N.F.	N.F.
45	o-TOLYLACETIC ACID - PFB	***	N.F.	N.F.	***	N.F.	N.F.
46	2,6-DIMETHYLBENZOIC ACID - PFB	***	***	N.F.	***	N.F.	N.F.
47	p-TOLYLACETIC ACID - PFB	***	N.F.	N.F.	***	N.F.	N.F.
48	p-METHYLBENZOIC ACID - PFB	***	N.F.	***	***	N.F.	***
49	3-PHENYLPROPANOIC ACID - PFB	***	N.F.	N.F.	N.F.	N.F.	N.F.
50	2,5-DIMETHYLBENZOIC ACID - PFB	***	N.F.	N.F.	N.F.	N.F.	N.F.
51	DECANOIC ACID - PFB	***	***	***	8	***	***
52	2,4-DIMETHYLBENZOIC ACID - PFB	***	N.F.	N.F.	N.F.	N.F.	***
53	3,5-DIMETHYLBENZOIC ACID - PFB	***	N.F.	N.F.	N.F.	N.F.	N.F.
54	2,3-DIMETHYLBENZOIC ACID - PFB	***	N.F.	N.F.	N.F.	N.F.	N.F.
55	4-ETHYLBENZOIC ACID - PFB	N.F.	N.F.	N.F.	N.F.	N.F.	N.F.
56	2,4,6-TRIMETHYLBENZOIC ACID - PFB	***	N.F.	N.F.	***	***	N.F.
57	3,4-DIMETHYLBENZOIC ACID - PFB	***	N.F.	N.F.	N.F.	N.F.	N.F.
	2,4,5-TRIMETHYLBENZOIC ACID - PFB	***	N.F.	N.F.	N.F.	N.F.	N.F.

*** Indicates concentration of extract was below lowest calibration standard (5 ppb).
N.F. Indicates not found.

Table I. Quantitative Report and QC Data for Phenols and Aliphatic and Aromatic Acids for Samples from Cape Canaveral (Service Request SF-2-183).

		Concentration ppb					
		Standard Blank	Standard Blank	Extraction Blank	Extraction Blank	50ppb Extraction Recovery	50ppb Extraction Recovery
1	PROPANOIC ACID - PFB	46	6	6	81	***	10
2	2-METHYLPROPANOIC ACID - PFB	20	***	***	***	11	17
3	TRIMETHYL ACETIC ACID - PFB	12	***	***	***	40	43
4	BUTYRIC ACID - PFB	40	14	16	***	23	20
5	2-METHYLBUTYRIC ACID - PFB	***	***	***	***	34	35
6	3-METHYLBUTYRIC ACID - PFB	***	***	***	***	30	34
7	3,3-DIMETHYLBUTYRIC ACID - PFB	***	N.F.	***	N.F.	45	50
8	PENTANOIC ACID - PFB	15	47	64	9	64	47
9	2,3-DIMETHYLBUTYRIC ACID - PFB	***	N.F.	***	N.F.	45	50
10	2-ETHYLBUTYRIC ACID - PFB	N.F.	N.F.	***	N.F.	44	46
11	2-METHYLPENTANOIC ACID - PFB	N.F.	N.F.	***	***	45	48
12	3-METHYLPENTANOIC ACID - PFB	***	N.F.	***	N.F.	44	45
13	4-METHYLPENTANOIC ACID - PFB	N.F.	N.F.	***	N.F.	44	46
14	HEXANOIC ACID - PFB	18	29	75	25	92	61
15	2-METHYLHEXANOIC ACID - PFB	N.F.	N.F.	***	N.F.	46	51
16	PHENOL - PFB	N.F.	***	***	***	17	37
17	CYCLOPENTANECARBOXYLIC ACID - PFB	N.F.	N.F.	N.F.	N.F.	40	42
18	5-METHYLHEXANOIC ACID - PFB	N.F.	N.F.	N.F.	N.F.	47	38
19	o-CRESOL - PFB	N.F.	N.F.	N.F.	N.F.	32	49
20	2-ETHYLHEXANOIC ACID - PFB	70	24	47	5	75	50
21	HEPTANOIC ACID - PFB	12	5	19	9	68	54
22	m-CRESOL - PFB	N.F.	N.F.	N.F.	N.F.	27	47
23	p-CRESOL - PFB	N.F.	N.F.	N.F.	N.F.	31	45
24	1-CYCLOPENTENE-1-CARBOXYLIC ACID - PFB	N.F.	N.F.	***	N.F.	38	42
25	o-ETHYLPHENOL - PFB	N.F.	N.F.	N.F.	N.F.	35	50
26	CYCLOPENTANEACETIC ACID - PFB	N.F.	N.F.	N.F.	N.F.	45	48
27	2,6-DIMETHYLPHENOL - PFB	N.F.	N.F.	N.F.	N.F.	38	40
28	2,5-DIMETHYLPHENOL - PFB	N.F.	N.F.	N.F.	N.F.	37	45
29	CYCLOHEXANECARBOXYLIC ACID - PFB	N.F.	N.F.	N.F.	N.F.	45	49
30	3-CYCLOHEXENE-1-CARBOXYLIC ACID - PFB	N.F.	N.F.	N.F.	N.F.	45	48
31	2,4-DIMETHYLPHENOL - PFB	N.F.	N.F.	N.F.	N.F.	34	40
32	3,5-DIMETHYLPHENOL & M-ETHYLPHENOL - PFB	N.F.	N.F.	N.F.	N.F.	30	50
33	OCTANOIC ACID - PFB	7	***	10	5	53	60
34	2,3-DIMETHYLPHENOL - PFB	N.F.	N.F.	N.F.	N.F.	38	50
35	p-ETHYLPHENOL - PFB	N.F.	N.F.	N.F.	N.F.	33	55
36	BENZOIC ACID - PFB	5	5	7	8	55	52
37	3,4-DIMETHYLPHENOL - PFB	N.F.	N.F.	N.F.	N.F.	34	50
38	m-METHYLBENZOIC ACID - PFB	N.F.	N.F.	***	N.F.	36	42
39	1-CYCLOHEXENE-1-CARBOXYLIC ACID - PFB	N.F.	N.F.	N.F.	N.F.	48	51
40	CYCLOHEXANEACETIC ACID - PFB	N.F.	N.F.	N.F.	N.F.	48	50
41	2-PHENYLPROPANOIC ACID - PFB	N.F.	N.F.	N.F.	N.F.	47	50
42	o-METHYLBENZOIC ACID - PFB	N.F.	N.F.	N.F.	***	48	51
43	PHENYLACETIC ACID - PFB	***	***	***	***	48	52
44	m-TOLYLACETIC ACID - PFB	N.F.	N.F.	N.F.	N.F.	40	51
45	o-TOLYLACETIC ACID - PFB	N.F.	N.F.	N.F.	N.F.	42	48
46	2,6-DIMETHYLBENZOIC ACID - PFB	N.F.	N.F.	N.F.	N.F.	52	55
47	p-TOLYLACETIC ACID - PFB	N.F.	N.F.	N.F.	N.F.	43	50
48	p-METHYLBENZOIC ACID - PFB	N.F.	N.F.	N.F.	N.F.	48	53
49	3-PHENYLPROPANOIC ACID - PFB	N.F.	N.F.	N.F.	N.F.	48	49
50	2,5-DIMETHYLBENZOIC ACID - PFB	N.F.	N.F.	***	N.F.	49	48
51	DECANOIC ACID - PFB	10	***	5	***	49	49
52	2,4-DIMETHYLBENZOIC ACID - PFB	N.F.	N.F.	N.F.	N.F.	49	50
53	3,5-DIMETHYLBENZOIC ACID - PFB	N.F.	N.F.	N.F.	N.F.	48	49
54	2,3-DIMETHYLBENZOIC ACID - PFB	N.F.	N.F.	N.F.	N.F.	51	50
55	4-ETHYLBENZOIC ACID - PFB	N.F.	N.F.	N.F.	N.F.	49	53
56	2,4,6-TRIMETHYLBENZOIC ACID - PFB	N.F.	N.F.	N.F.	N.F.	49	51
57	3,4-DIMETHYLBENZOIC ACID - PFB	N.F.	N.F.	N.F.	N.F.	48	53
58	2,4,5-TRIMETHYLBENZOIC ACID - PFB	N.F.	N.F.	N.F.	N.F.	53	60

*** Indicates concentration of extract was below lowest calibration standard (5 ppb).
N.F. Indicates not found.

MANTECH

Ref: 96-SH7/vg

February 1, 1996

Dr. Don Kampbell
National Risk Management Research Laboratory
Subsurface Protection & Remediation Division
U.S. Environmental Protection Agency
P.O. Box 1198
Ada, OK 74820

THRU: S.A. Vandegrift SV

Dear Don:

Attached are TOC results for 52 liquids submitted January 30, 1996 under Service Request #SF-2-183. Sample analysis was begun and completed February 1, 1996 using RSKSOP-102.

Blanks, duplicates and AQC samples were analyzed along with your samples, as appropriate, for quality control. If you have any questions concerning this data, please feel free to ask me.

Sincerely,

Sharon Hightower

Sharon Hightower

xc: R.L. Cosby
G.B. Smith
J.L. Seeley JS

ManTech Environmental Research Services Corporation

R.S. Kerr Environmental Research Laboratory, P.O. Box 1198, 919 Research Drive
Ada, Oklahoma 74821-1189 405-436-8660 FAX 405-436-8501

KAMPBELL TOC CAPE CANAVERAL LIQUIDS SF-2-183

SAMPLE	Mg/L TOC
CPT-1	56.8
CPT-2	5.8
CPT-3	4.1
CPT-4 REP1	6.3
CPT-4 REP2	6.5
CPT-5 REP2	6.0
CPT-6 REP2	5.6
CPT-7 REP1	2.5
CPT-8 REP2	9.1
CPT-8 REP2 DUP	9.2
MP-2 REP2	14.4
MP-3 REP2	11.1
MP-5 REP2	9.4
MP-5 REP2 DUP	9.2
MP-6 REP1	7.8
MP-15 REP1	1.1
MP-4D	10.3
MP4S REP1	8.6
MP4S REP2	7.9
MP1D REP2	12.4
MW-1 REP1	3.4
MW-2 REP2	30.6
MW7S REP2	5.9
MW10 REP1	5.9
MW10 DUP	6.0
MW 19S	18.2
MW-70 REP2	5.0
CCFTA2-3 REP2	12.8
CCFTA2-9D REP2	3.5
CCFTA2-9S	40.6
CCFTA2-11	3.4
CCFTA-19D	5.6
FTA2-06 REP2	96.6
FTA-8S REP1	1.5
FTA-8S REP2	2.6
FTA-8S REP2 DUP	2.7
CCFTA2-19I REP2	4.1
FTA-8D REP2	2.5
FTA-13D REP2	4.2
FTA13-S REP 2	55.8
FTA-14 REP2	14.5
FTA-15S	6.3
FTA-20D REP2	7.0
FTA-20S REP1	11.8
FTA-21D	5.1
FTA-21I REP2	3.2
FTA-21S REP 2	4.0
FTA-160 REP2	4.0

KAMPBELL TOC CAPE CANAVERAL LIQUIDS SF-2-183

SAMPLE	MG/L TOC
FTA-16S REP2	19.9
FTA2-04 REP2	7.0
FTA2-04 REP 2 DUP	7.1
FTA2-05 REP2	12.2
FTA2-12 REP2	4.8
FTA-165 REP1	13.9
FTA2-18 REP2	90.3
FTA-20I REP2	4.8
WPO34-II	6.4

WPO34-II t.v.=6.30

MANTECH

Ref: 96\LB15

February 8, 1996

Dr. Don Kampbell
National Risk Management Research Laboratory
Subsurface Protection and Remediation Division
U.S. Environmental Protection Agency
P.O. Box 1198
Ada, OK 74820

THRU: S.A. Vandegrift SV

Dear Don:

Please find attached the analytical results for Service Request SF-2-183 requesting the analysis of groundwater samples to be analyzed by purge-and-trap/GC-FID:PID for Benzene, Toluene, Ethylbenzene, p-, m-, & o-Xylene, 1,3,5-, 1,2,4-, & 1,2,3-Trimethylbenzene, and Total Fuel Carbon. We obtained your 34 samples in duplicate, in capped, 40 mL VOA autosampler vials on January 29, 1996, and they were analyzed on February 6-7, 1996. Samples were stored at 4°C until analyzed. All samples were acquired and processed using the Millennium data system. A 5 place (1-500 ppb) external standard curve was used to quantitate the compounds.

RSKSOP-133, "Simultaneous Analysis of Aromatics and Total Fuel Carbon by Dual Column-Dual Detector for Ground Water Samples" was used for these analyses. Autosampling was performed using a Dynatech Precision autosampler system in line with a Tekmar LSC 2000 concentrator.

Sincerely,

Lisa R. Black

Lisa R. Black

xc: R. L. Cosby
G.B. Smith
J.T. Wilson
J.L. Seeley JB

ManTech Environmental Research Services Corporation

R.S. Kerr Environmental Research Laboratory, P.O. Box 1198, 919 Research Drive
Ada, Oklahoma 74821-1189 405-436-8660 FAX 405-436-8501

Printex 36 SF-2-183 DP-PT/GC-FID:PID /ses for Dr. Kampbell Units = ng/mL An .. Black

Samp[illegible]	BENZENE	TOLUENE	ETHYLBENZENE	p[illegible]NE	m-XYLENE	o-XYLENE	1,3,5-TMB	1,2,4-TMB	[illegible]MB	Fuel Carbon
10 PPB	11.1	11.2	10.8	11.5	11.1	11.1	11.3	11.6	11.6	N/A
QC, OBSERVED, PPB	54.9	53.9	58.4	55.0	55.3	55.8	55.0	56.7	57.3	N/A
QC, TRUE VALUE, PPB	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	N/A
GC LAB BLANK, PPB	ND	ND	ND	ND	ND	ND	ND	ND	ND	N/A
FTA-8D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FTA-8S	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FTA-13D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FTA-13S	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FTA-13S Duplicate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FTA-14	3.8	1.0	ND	3.0	ND	4.7	ND	ND	0.9	37.8
FTA-15S	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FTA-16D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FTA-16S	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
100 PPB	103	106	105	108	108	108	110	111	111	N/A
FTA-21D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FTA-21I	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FTA-21S	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FTA2-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FTA2-05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FTA2-06	ND	ND	ND	ND	ND	ND	ND	ND	2.7	96.8
FTA2-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FTA2-12 Duplicate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FTA2-18	7.7	ND	20.4	2.1	ND	BLQ	BLQ	7.4	3.6	97.7
FTA2-20I	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GC LAB BLANK	ND	ND	ND	ND	ND	ND	ND	ND	ND	N/A
1 PPB	1.0	0.9	1.0	1.2	1.0	1.0	0.9	0.9	1.1	N/A
FTA2-20S	BLQ	ND	ND	ND	ND	BLQ	ND	ND	ND	BLQ
CCFTA2-9D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CCFTA2-9S	20.0	181	21.6	18.3	45.8	44.6	16.5	40.6	48.7	1400
CCFTA2-11	ND	0.9	ND	ND	ND	BLQ	ND	ND	ND	41.4
CPT-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CPT-2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CPT-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CPT-3 Duplicate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CPT-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MP-1D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MP-1S	ND	10.2	ND	ND	ND	ND	ND	ND	ND	8.8
QC, OBSERVED, PPB	47.1	46.7	50.5	47.8	47.8	48.7	47.5	48.7	50.0	N/A
QC, TRUE VALUE, PPB	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	N/A
MP-2	0.9	5.6	ND	ND	ND	1.1	ND	ND	ND	26.9
MP-3	3.4	30.9	3.2	1.6	BLQ	7.1	1.0	ND	4.6	130
MW-1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-2	BLQ	BLQ	BLQ	0.9	ND	3.0	ND	ND	2.4	26.5
MW-3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7S	BLQ	ND	ND	ND	ND	ND	ND	ND	ND	BLQ
MW-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GC LAB BLANK, PPB	ND	ND	ND	ND	ND	ND	ND	ND	ND	N/A
1 PPB	1.0	1.0	1.0	1.0	0.9	1.0	0.9	0.9	1.0	N/A

ND = None Detected; BLQ = Below Limit of Quantitation, 1 ppb; N/A = Not Analyzed

MANTECH

Ref: 96-RWC6/vg

February 22, 1996

Dr. Don Kampbell
National Risk Management Research Laboratory
Subsurface Protection & Remediation Division
U.S. Environmental Protection Agency
P.O. Box 1198
Ada, OK 74820

THRU: S.A. Vandegrift SV

Dear Don:

Attached is a report of the data generated from the analyses of five (5) sample core extracts from Cape Canaveral AFB, FL which were submitted under Service Request #SF-2-183. The extracts were analyzed for total fuel hydrocarbons as JP-4 jet fuel. Data from the analyses of five calibration check standards, one solvent blank and one method blank are also included in the report.

Data quantification and component concentration calculations were performed with Millennium chromatography software. JP-4 data was quantified with a 7-point external standard calibration curve ranging from 50 to 50,000 ng/ul.

Sample core extracts were received February 20, 1996. Analyses were performed February 21 and 22, 1996, in accordance with RSKSOP-72, Rev. #1. Modifications to RSKSOP-72 are detailed in the attached outline.

Sincerely,

Randy Callaway

Randy Callaway

xc: R.L. Cosby
G.B. Smith
J.L. Seeley JS

ManTech Environmental Research Services Corporation

R.S. Kerr Environmental Research Laboratory, P.O. Box 1198, 919 Research Drive
Ada, Oklahoma 74821-1189 405-436-8660 FAX 405-436-8501

I. HP5880 GC - OPERATING CONDITIONS

A. Instrument Control
   1. Analyses: "HILL AFB"
   2. Program: "RWC-AS10"
   3. Calibration: "WOOD, SF-1-150"

B. Temperature Program
   1. Initial Temp & Time: 10C for 3.00 min
   2. Level 1: Rate = 4C/min to 70C, Final time = 0.00 min
   3. Level 2: Rate = 1.0C/min to 75C, Final time = 0.00 min
   4. Level 3: Rate = 10C/min to 290C, Final time = 15.50 min
   5. Run Time: 60.00 min
   6. Oven Equilibration Time: 1.00 min

C. Miscellaneous
   1. Peak Width: 0.02
   2. Attenuation: 2^5
   3. Chart Speed: 0.50
   4. Threshold: 0
   5. Offset: 10%

II. MILLENNIUM PROCESSING METHOD PARAMETERS

A. Integration Window
   1. Peak Width: 285.00
   2. Minimum Area: 1
   3. Threshold: 1.000
   4. Minimum Height: 100
   5. Timed Events:

	Start	Event Description	Value	Stop
a.	6.843	Allow Negative Peaks		9.697
b.	9.697	Forced Baseline by Time		13.723
c.	13.723	Forced Baseline by Time		24.777
d.	24.777	Forced Baseline by Time		26.727
e.	26.727	Forced Baseline by Time		31.977
f.	31.977	Forced Baseline by Time		36.457
g.	36.457	Forced Baseline by Time		39.237
h.	39.237	Forced Baseline by Time		40.713
i.	42.000	Set Minimum Height	800.00	

B. Component Table Window
   1. Component: JP-4
   2. Retention Time: 6.30 to 50.00 min
   3. Quantified by: area
   4. Calibration Curve
      a. Range: 50 - 50,000 ng/ul
      b. Curve Fit: quadratic
      c. Weighting: 1/X

C. QuickSet Parameters for Data Acquisition
   1. Data Start: 6.30 min
   2. Run Time: 50.00 min
   3. Acquisition Rate: 5 points/sec

MANTECH

Ref: 96-MB2
February 12, 1996

Dr. Don Kampbell
National Risk Management Research Laboratory
Subsurface Protection and Remediation Division
U.S. Environmental Protection Agency
P.O. Box 1198
Ada, Ok 74820

THRU: S.A. Vandegrift SV

Dear Don:

The fuel carbon extractions of the Cape Canaveral core, as requested by Service Request #SF-2-183, have been completed. The samples were prepared as follows: Using a 10cc plastic syringe with the tip cut off, a core sample was removed from the half pint sample jars and placed into a tared 40ml VOA vial that contained 5ml of methylene chloride and 5ml of DI water. The vial was reweighed to obtain a sample weight, this weight was recorded in a lab book. The vials were placed on a wrist action shaker for 30 minutes prior to the extraction procedure. The core samples arrived from Cape Canaveral AFS on February 5, 1996 and the extractions were complete on February 7, 1996. A total of 5 extracts and 1 method blank were distributed to Dave Kovacs for GC\MS analysis. The method used was "RSKSOP-72" (modification 1). Please find attached the % moisture determinations copied from my lab book.

If you have any questions concerning the preparation of these extracts, please see me at your convenience.

Sincerely,

Mark A. Blankenship

Mark A. Blankenship

xc: R.L. Cosby
J.L. Seeley
G.B. Smith

ManTech Environmental Research Services Corporation

R.S. Kerr Environmental Research Laboratory, P.O. Box 1198, 919 Research Drive
Ada, Oklahoma 74821-1189 405-436-8660 FAX 405-436-8501

36

K.E. 2-26-7
2-8-96

F-2-183
r. Kampbell
Cape Canaveral AFS
2-7-96

Fuel carbon extraction

Sample		sample wt. (g)
MP 15	9-10'	19.22
MP-3	10'	13.49
MP-45	7'	13.36
MP-5	7'	19.86
MP-6	7'	14.18
Method Blank		0.00

% moisture (dry wt. basis)

Sample	Tare	Tare+Wet	Tare+Dry	%moisture
MP-15	31.10	52.41	47.53	22.2%
MP-3	28.80	42.73	40.74	16.9%
MP-45	30.12	46.50	43.05	20.9%
* MP-5	28.28	44.94	40.17	31.2%
MP-6	30.30	43.64	41.53	16.1%

* Pint jar contained free standing water on the surface of the sample.

MANTECH

Ref: 96-DK8/vg
February 14, 1996

Dr. Don Kampbell
National Risk Management Research Laboratory
Subsurface Protection and Remediation Division
U.S. Environmental Protection Agency
P.O. Box 1198
Ada, OK 74820

THRU: S.A. Vandegrift SV

Dear Dr. Kampbell:

This report contains the results of my GC/MSD analysis of Cape Canaveral AFS core extracts for quantitation of benzene, toluene, trichloroethene (TCE), ethylbenzene (EB), p-Xylene, m-Xylene, o-Xylene, 1,3,5-trimethylbenzene (1,3,5-TMB), 1,2,4-trimethylbenzene (1,2,4-TMB) and 1,2,3-trimethylbenzene (1,2,3-TMB) (Service Request #SF-2-183).

The analytical method was a modification of RSKSOP-124. Cool on-column injection (0.5 µl) was used with electronic pressure control set for a constant flow of 0.9 ml/min. A 30m X 0.25mm Restek Stabilwax (Crossbonded Carbowax-PEG, 0.5µm film) capillary GC column with 9" X 0.53 mm ID uncoated capillary precolumn was used. The ions chosen were those listed in EPA method 524.2 Revision 3.0. Standards calibration ranged from 0.025 to 250 µg/ml. A complete report detailing the acquisition method and calibration curve has been recorded. The samples were extracted by Mark Blankenship on February 7, 1996, with GC/MSD data acquisition on February 9, 1996.

The follwing quantitation results were obtained (BLQ < 0.025 ug/ml):

Sample	
MP-1S 9-10'	No target compounds detected except toluene = BLQ
MP-3 10'	No target compounds detected
MP-4S 7'	No target compounds detected
MP-5 7'	No target compounds detected except toluene = BLQ
MP-6 7'	No target compounds detected

If I can be of further assistance, please feel free to contact me.

Sincerely,

David A. Kovacs

xc: R.L. Cosby
J.L. Seeley JS
G.B. Smith

SR#SF-2-183 / Kampbell / Cape Canaveral AFB, FL / Core Extracts

Sample I.D.	Dilution Factor	JP-4 in Extract (ng/ul)	JP-4 in Soil (ug/g)	Elemental Carbon in Soil (ug/g)
MP-1S (9-10')	1	1.04	blq	
MP-3 (10')	1	6.98	blq	
MP-4S (7')	1	7.95	blq	
MP-5 (7')	1	7.15	blq	
MP-6 (7')	1	nd	blq	
100 ng/ul JP-4		73.10		
1000 ng/ul JP-4		961.00		
10000 ng/ul JP-4		10400.00		
JPQC 6B5 (5000 ng/ul)		5010.00		
JPQC 6B6 (5000 ng/ul)		5070.00		
blank MeCl2		8.38		
Method Blank		nd		

NOTE: all reported values are corrected for dilution factors where applicable
nd = none detected
blq = below limit of quantitation (<50 ng/ul JP-4 determined in extract)
"Elemental Carbon in Soil" values are computed at 85% of "JP-4 in Soil" results

MANTECH ENVIRONMENTAL TECHNOLOGY

Ref: 96-JH13/vg

February 14, 1996

Dr. Don Kampbell
National Risk Management Research Laboratory
Subsurface Protection & Remediation Division
U.S. Environmental Protection Agency
P.O. Box 1198
Ada, OK 74820

THRU: S.A. Vandegrift SV

Dear Don:

Find attached results for methane, ethylene and ethane on 47 samples received January 26 and 29, 1996 under Service Request #SF-2-183. Samples were prepared and calculations done as per RSKSOP-175. Analyses were performed as per RSKSOP-147.

If you have any questions concerning this data, please contact me.

Sincerely,

Jeff Hickerson

Jeff Hickerson

xc: R.L. Cosby
G.B. Smith
J.L. Seeley JS

ManTech Environmental Research Services Corporation

R.S. Kerr Environmental Research Laboratory, P.O. Box 1198, 919 Research Drive
Ada, Oklahoma 74821-1189 405-436-8660 FAX 405-436-8501

SR# SF-2-183

ANALYSIS PERFORMED 1-30-96

SAMPLE	METHANE	ETHYLENE	ETHANE
LAB BLANK	BLQ	ND	ND
CPT-1	4.57	ND	BLQ
CPT-2	0.029	ND	ND
CPT-3	0.317	ND	ND
CPT-4	0.027	ND	ND
" FIELD DUP	0.027	ND	ND
CPT-5	5.49	0.048	BLQ
CPT-6	0.464	0.044	BLQ
CPT-7	0.127	ND	ND
CPT-8	0.009	ND	ND
MP-1D	0.005	ND	BLQ
" LAB DUP	0.004	ND	BLQ
MP-1S	0.005	ND	ND
MP-2	0.719	0.057	0.009
MP-3	0.501	0.188	0.055
MP-4D	1.20	0.150	0.003
MP-4S	0.039	BLQ	BLQ
" FIELD DUP	0.039	BLQ	BLQ
MP-5	0.744	ND	ND
MP-06	0.427	0.107	0.013
MW-1	0.002	ND	ND
MW-2	0.605	BLQ	ND
MW-10	0.461	ND	ND
" LAB DUP	0.423	ND	ND

ANALYSIS PERFORMED 2-1-96

SAMPLE	METHANE	ETHYLENE	ETHANE
LAB BLANK	BLQ	ND	ND
FTA-18	6.97	ND	BLQ
FTA2-19D	0.045	BLQ	BLQ
FTA2-19I	0.409	ND	ND
FTA-20D	0.040	ND	BLQ
" LAB DUP	0.036	ND	BLQ
FTA-20I	0.136	ND	BLQ
FTA-20S	2.54	0.028	ND
FTA-21D	0.040	BLQ	ND
FTA-21I	0.038	ND	ND
FTA-21S	1.34	0.006	ND
" LAB DUP	1.21	0.006	ND
10 PPM CH4	9.98	NA	NA
100 PPM CH4	100.08	NA	NA
1000 PPM CH4	998.91	NA	NA
1% CH4	1.00	NA	NA
10% CH4	10.00	NA	NA
10 PPM C2H4	NA	10.19	NA
100 PPM C2H4	NA	99.96	NA
1000 PPM C2H4	NA	999.62	NA
10 PPM C2H6	NA	NA	10.22
100 PPM C2H6	NA	NA	99.94

LIMITS OF QUANTITATION.

METHANE	ETHYLENE	ETHANE
0.001	0.003	0.002

SAMPLE UNITS ARE mg/L.
STANDARDS UNITS CORRESPOND
TO THE SAMPLE COLUMN.

BLQ DENOTES BELOW LIMIT OF QUANTITATION.
ND DENOTES NONE DETECTED.
NA DENOTES NOT ANALYZED.

ANALYSIS PERFORMED 1-31-96

SAMPLE	METHANE	ETHYLENE	ETHANE
LAB BLANK	BLQ	ND	ND
MW-7D	0.204	ND	ND
MW-7S	0.078	0.016	BLQ
MW-19S	0.036	ND	ND
FTA2-3	1.10	BLQ	ND
" LAB DUP	0.960	BLQ	ND
FTA2-04	1.25	ND	ND
FTA-05	1.01	0.010	BLQ
FTA2-06	4.90	ND	ND
FTA-8D	0.062	ND	ND
FTA-8S	0.813	ND	ND
" FIELD DUP	0.831	ND	ND
FTA2-9D	0.207	ND	ND
FTA2-9S	0.348	0.030	ND
FTA2-11	0.524	BLQ	ND
FTA2-12	0.002	ND	ND
FTA-13D	1.24	ND	BLQ
" LAB DUP	1.11	ND	ND
FTA-13S	0.042	ND	ND
FTA-14	1.66	0.225	0.003
FTA-15S	0.629	ND	ND
FTA-16D	0.121	ND	BLQ
FTA-16S	0.125	ND	ND
" FIELD DUP	0.124	ND	ND

MANTECH

Ref: 96/JAD10

March 12, 1996

Dr. Don Kampbell
National Risk Management Research Laboratory
Subsurface Protection and Remediation Division
U.S. Environmental Protection Agency
P.O. Box 1198
Ada, OK 74820

THRU: S.A. Vandegrift SV

Dear Don:

As requested in Service Request # SF-2-183, headspace GC/MS analysis of 48 Cape Canaveral water samples for volatile organics was completed. The samples were received on January 29, 1996 and analyzed on February 9, 1996. RSKSOP-148 (Determination of Volatile Organic Compounds in Water by Automated Headspace Gas Chromatography/Mass Spectrometry (Saturn II Ion Trap Detector) was used for this analysis.

An internal standard calibration method was established for the 11 compounds. The standard curves were prepared from 1.0 to 2000 ppb. The lower calibration limits were 1.0 ppb.

The following compounds were identified by mass spectra to be in the Cape Canaveral sample set. The highest levels being in sample FTA2-9S.

1,1,2-Trichloro-1,2,2-trifluoroethane
1,2-Dichloro-1,2,2-trifluoroethane
Trichlorofluoromethane
Dichlorofluoroethene
Chlorotrifluoroethene
Chloroethyne

A curve was developed for 1,1,2-trichloro-1,2,2-trifluoroethane. This compound is present in sample FTA2-9s at approximately 3000 ppb.

A dilution corrected quantitation report for the samples, lab duplicates, field duplicates, QC standards and lab blanks is presented in table 1-3.

If you should have any questions, please feel free to contact me.

Sincerely,

John Allen Daniel

xc: R.L. Cosby
G.B. Smith
D.D. Fine
J.L. Seeley
J.T. Wilson

Table 1. Quantitation Report for S.R. # SF-2-183 from Cape Canaveral.

Concentration = ppb

Compound	MP-1D	MP-1S	MP-2	MP-3	MP-3 Field Dup 1/4 Dil	MP-4D	MP-4D Field Dup 1/10 Dil	MP-4S	MP-5	MP-6
VINYL CHLORIDE	ND	ND	1080	*****	3080	*****	5024	10.0	10.5	*****
1,1-DICHLOROETHENE	ND	ND	2.0	39.0	32.4	11.2	11.0	ND	ND	16.6
T-1,2-DICHLOROETHENE	ND	ND	11.2	21.6	21.2	17.4	18.5	ND	---	15.7
1,1-DICHLOROETHANE	ND	ND	14.2	62.8	60.8	55.0	53.9	ND	---	46.7
C-1,2-DICHLOROETHENE	ND	ND	230	*****	3480	556	541	16.3	2.5	1200
1,1,1-TRICHLOROETHANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CARBON TETRACHLORIDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-DICHLOROETHANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRICHLOROETHENE	ND	ND	44.2	220	206	15.3	19.0	ND	---	24.3
TETRACHLOROETHENE	ND	ND	2.3	---	ND	---	ND	ND	ND	---
CHLOROBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Compound	MP-6 Field Dup 1/4 Dil	MW-1	MW-2	MW-3	MW-7S	MW-10	MW-19S	CPT-1	CPT-2	CPT-3
VINYL CHLORIDE	2520	ND	7.2	10.0	419	ND	---	ND	ND	ND
1,1-DICHLOROETHENE	11.5	ND	ND	---	1.9	ND	ND	ND	ND	ND
T-1,2-DICHLOROETHENE	12.1	ND	2.8	1.0	4.3	ND	ND	ND	ND	ND
1,1-DICHLOROETHANE	37.8	ND	6.3	ND	6.5	ND	ND	---	ND	ND
C-1,2-DICHLOROETHENE	1070	---	12.9	75.8	288	---	---	---	ND	ND
1,1,1-TRICHLOROETHANE	ND	ND	ND	---	ND	ND	ND	ND	ND	ND
CARBON TETRACHLORIDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-DICHLOROETHANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRICHLOROETHENE	16.0	1.1	1.2	30.1	3.6	ND	ND	ND	ND	ND
TETRACHLOROETHENE	ND	ND	---	ND	ND	ND	ND	ND	ND	ND
CHLOROBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Compound	CPT-4	CPT-5	CPT-6	CPT-6 Lab Dup	CPT-7	CPT-8	FTA-7D	FTA-8D	FTA-8S	FTA-13D
VINYL CHLORIDE	797	1.4	---	ND	ND	ND	1.8	ND	ND	ND
1,1-DICHLOROETHENE	8.5	ND	ND	ND	ND	ND	ND	ND	ND	ND
T-1,2-DICHLOROETHENE	5.9	---	ND	ND	ND	ND	ND	ND	ND	ND
1,1-DICHLOROETHANE	23.0	ND	ND	ND	ND	ND	ND	ND	ND	ND
C-1,2-DICHLOROETHENE	776	33.4	ND	ND	ND	2.4	1.2	ND	ND	ND
1,1,1-TRICHLOROETHANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CARBON TETRACHLORIDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-DICHLOROETHANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRICHLOROETHENE	16.5	1.7	ND	ND	ND	ND	ND	ND	ND	ND
TETRACHLOROETHENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHLOROBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 2. Quantitation Report for S.R. # SF-2-183 from Cape Canaveral.

Concentration = ppb

Compound	FTA-13S	FTA-14	FTA-14 Lab Dup 1/10 DII	FTA-15S	FTA-16D	FTA-16S	FTA-20D	FTA-20I	FTA-20S	FTA-21
VINYL CHLORIDE	ND	*****	6520	2.5	ND	ND	ND	ND	904	181
1,1-DICHLOROETHENE	ND	19.2	21.0	ND	ND	ND	ND	ND	2.7	1.1
T-1,2-DICHLOROETHENE	ND	25.0	24.2	ND	ND	ND	ND	ND	5.8	1.3
1,1-DICHLOROETHANE	ND	69.6	68.3	---	ND	ND	ND	ND	12.4	2.9
C-1,2-DICHLOROETHENE	ND	944	971	3.3	ND	1.3	ND	ND	234	135
1,1,1-TRICHLOROETHANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CARBON TETRACHLORIDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-DICHLOROETHANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRICHLOROETHENE	ND	41.7	42.0	ND	ND	ND	ND	ND	8.3	2.9
TETRACHLOROETHENE	ND	---	ND	ND	ND	ND	ND	ND	ND	ND
CHLOROBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Compound	FTA-21 Lab Dup	FTA-21D	FTA-21I	FTA2-04	FTA2-05	FTA2-06	CCFTA2-9D	CCFTA2-9S	CCFTA2-9S Field Dup 1/40 DII	CCFTA2-9S Field Dup 1/100 DII
VINYL CHLORIDE	172	ND	ND	ND	33.2	ND	ND	*****	2703	3080
1,1-DICHLOROETHENE	1.1	ND	ND	ND	ND	ND	ND	225	280	200
T-1,2-DICHLOROETHENE	1.3	ND	ND	ND	2.0	ND	ND	384	388	389
1,1-DICHLOROETHANE	3.0	ND	ND	ND	2.3	ND	ND	393	348	443
C-1,2-DICHLOROETHENE	135	ND	4.7	ND	31.8	ND	37.0	*****	*****	98500
1,1,1-TRICHLOROETHANE	ND	ND	ND	ND	ND	ND	ND	236	250	258
CARBON TETRACHLORIDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-DICHLOROETHANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRICHLOROETHENE	2.9	ND	ND	ND	2.5	---	6.7	*****	14600	15800
TETRACHLOROETHENE	ND	ND	ND	ND	---	ND	ND	51.3	56.0	---
CHLOROBENZENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Compound	CCFTA2-11	FTA2-12	FTA2-18	FTA2-18 Lab Dup	CCFTA2 -19D	CCFTA2 -19I	CCFTA2 -19I Lab Dup	Grab Lagoon	QC0209A 20 ppb	QC0209B 200 ppb
VINYL CHLORIDE	1.1	ND	ND	ND	ND	ND	ND	20.1	19.9	208
1,1-DICHLOROETHENE	ND	ND	ND	ND	ND	ND	ND	ND	18.7	197
T-1,2-DICHLOROETHENE	---	ND	ND	ND	ND	ND	ND	---	19.7	193
1,1-DICHLOROETHANE	1.4	ND	---	1.0	ND	ND	ND	ND	NI	NI
C-1,2-DICHLOROETHENE	---	ND	1.1	1.0	ND	ND	ND	9.5	18.8	195
1,1,1-TRICHLOROETHANE	ND	ND	ND	ND	ND	ND	ND	ND	20.3	201
CARBON TETRACHLORIDE	ND	ND	ND	ND	ND	ND	ND	ND	20.2	202
1,2-DICHLOROETHANE	ND	ND	ND	ND	ND	ND	ND	ND	17.3	195
TRICHL[redacted]ETHENE	ND	ND	---	[redacted]	ND	ND	ND	---	21.0	210
TETRA[redacted]IENE	ND	ND	---	[redacted]	ND	ND	ND	ND	20.5	208
CHLOROBENZ[redacted]	ND	ND	ND	[redacted]	ND	ND	ND	ND	19.7	19[redacted]

Table 3. Quantitation Report for S.R. # SF-2-183 from Cape Canaveral.

Concentration = ppb

Compound	QC0209C 20 ppb	QC0209D 200 ppb	QC0209E 20 ppb	QC0209F 200 ppb	QC0209G 20 ppb	QC0209H 200 ppb	QC0209I 20 ppb	QC0209J 200 ppb	QC0209K 20 ppb	QC0209L 200 ppb
VINYL CHLORIDE	19.7	196	19.4	201	20.4	194	20.4	187	19.8	197
1,1-DICHLOROETHENE	17.6	185	17.8	190	17.7	182	18.0	179	17.1	182
T-1,2-DICHLOROETHENE	18.4	182	18.3	189	17.8	187	17.3	184	17.9	181
1,1-DICHLOROETHANE	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
C-1,2-DICHLOROETHENE	19.0	192	19.1	193	18.4	201	18.9	200	18.4	197
1,1,1-TRICHLOROETHANE	20.3	197	20.6	203	20.2	198	20.0	197	20.0	191
CARBON TETRACHLORIDE	19.6	197	18.8	196	18.6	191	18.8	185	18.2	190
1,2-DICHLOROETHANE	17.6	193	19.5	200	18.2	210	17.8	207	18.6	198
TRICHLOROETHENE	21.0	207	20.0	205	19.5	201	19.7	201	20.2	195
TETRACHLOROETHENE	18.9	181	17.8	188	17.2	183	17.6	174	16.8	178
CHLOROBENZENE	20.1	192	19.7	198	19.5	191	19.9	198	19.8	194

	QC0215A 50 ppb	BL0209A	BL0209B
VINYL CHLORIDE	NI	ND	ND
1,1-DICHLOROETHENE	55.0	ND	ND
T-1,2-DICHLOROETHENE	50.8	ND	ND
1,1-DICHLOROETHANE	44.6	ND	ND
C-1,2-DICHLOROETHENE	49.2	ND	ND
1,1,1-TRICHLOROETHANE	NI	ND	ND
CARBON TETRACHLORIDE	50.8	ND	ND
1,2-DICHLOROETHANE	48.2	ND	ND
TRICHLOROETHENE	52.7	ND	ND
TETRACHLOROETHENE	48.3	ND	ND
CHLOROBENZENE	48.4	ND	ND

ND = None Detected QC = Quality Control Std. BL = Blank NI = Not In QC

FIELD DATA

CAPE CANAVERAL AIR STATION

Sample	Date	Redox mv	pH	Cond.	Hydrogen Sulfide mg/l	Total Alkativity mg/l CaCo3	Ferrous Iron mg/l
CPT-1	1-24-96	-230	6.9	1126	.5	460	.5
CPT-2	1-24-96	-80	7.2	3820	<.1	405	1.3
CPT-3	1-24-96	-280	7.3	4010	5.0	436	<.05
FTA-21 I	1-24-96	-270	7.3	4420	------	224	<.05
FTA-21 D	1-24-96	60	7.6	4880	2.0	298	<.05
FTA-21 S	1-24-96	93	7.0	807	2.0	330	<.05
FTA-13 D	1-24-96	-290	7.3	2460	------	289	<.05
FTA-13 S	1-24-96	-98	7.4	585	------	263	.1
FTA-15 S	1-24-96	-68	7.0	909	.1	378	1.0
FTA-8D	1-25-96	-196	7.5	2090	.1	176	<.05
FTA-8S	1-25-96	-174	7.4	488	<.1	214	<.05
FTA-16 S	1-25-96	101	7.0	1572	------	379	<.05
FTA-16 D	1-25-96	-270	7.8	2220	10	257	<.05
FTA-14	1-25-96	-160	7.1	1230	.1	382	1.6
MP-4 S	1-25-96	-118	7.3	6030	<.1	415	3.6
MP-4D	1-25-96	-140	7.3	1090	<.1	360	1.2
MP-5	1-25-96	-130	7.2	890	<.1	355	1.3
FTA-20 I	1-25-96	-330	7.5	7990	10	320	<.05
FTA-20 D	1-25-96	-320	7.6	22500	10	285	<.05
FTA-20 S	1-25-96	-200	7.1	1470	<.1	417	1.4
MP-6	1-25-96	-190	7.0	1286	<.1	360	3.6
CPT-8	1-25-96	-130	7.1	5230	<.1	455	6.4

FIELD DATA

CAPE CANAVERAL AIR STATION

Sample	Date	Redox mv	pH	Cond.	Hydrogen Sulfide mg/l	Total Alkativity mg/l CaCo3	Ferous Iron mg/l
MW-10	1-25-96	-250	7.0	1230	2.5	520	.7
FTA-7 S	1-25-96	-40	7.0	503	——	213	<.05
FTA-7 D	1-25-96	-250	7.3	2050	——	227	<.05
FTA-2-11	1-25-96	-160	7.4	438	——	190	.1
CPT-6	1-25-96	-85	7.2	3340	——	446	1.1
CPT-7	1-25-96	-60	7.3	570	——	273	.1
MP-1S	1-25-96	-30	7.2	588	——	315	.2
MP-1 D	1-25-96	-140	6.9	2290	——	485	5.5
FTA-2-04	1-25-96	-100	7.1	785	——	280	.2
FTA-2-06	1-25-96	-170	7.0	1090	——	462	39
FTA-2-9 D	1-25-96	-220	7.6	2820	——	225	<.05
FTA-2-95	1-25-96	-250	6.7	1100	——	500	2.0
MW-2	1-26-96	-88	7.0	1540	<.1	395	2.9
FTA-2-3	1-26-96	-135	7.0	2690	<.1	425	3.5
FTA-2-5	1-26-96	-128	7.0	2070	<.1	452	10.3
MW-1	1-26-96	-60	7.1	919	<.1	313	.5
MP-3	1-26-96	-113	7.0	815	——	328	1.5
CPT-4	1-26-96	-122	6.9	740	<.1	319	3.2
MP-2	1-26-96	-101	7.0	907	<.1	341	1.6
CPT-2	1-26-96	-118	7.2	4050	<.1	367	1.4
FTA-19S	1-26-96	-150	7.1	29,200	——	350	8.8
FTA-19 I	1-26-96	-126	7.5	3660	——	369	<.05
FTA-19D	1-26-96	-270	7.5	13,800	——	255	<.05
FTA-12	1-26-96	-121	7.2	1070	——	482	.9
FTA-18	1-26-96	-140	7.1	1160	——	527	4.0

MANTECH

Ref: 96-TH1/vg
96-JRD1/vg
96-LP8/vg

February 1, 1996

Dr. Don Kampbell
National Risk Management Research Laboratory
Subsurface Protection & Remediation Division
U.S. Environmental Protection Agency
P.O. Box 1198
Ada, OK 74820

THRU: S.A. Vandegrift SV

Dear Don:

Attached are the results of 52 Cape Canaveral, FL field samples submitted to MERSC as part of Service Request #SF-2-183. The samples were received January 26 and 29, 1996 and analyzed January 29 and 30, 1996. The methods used for analysis were EPA Methods 353.1 for NO_2 and NO_3, 350.1 for NH_3 and Waters capillary electrophoresis Method N-601 for Cl and SO_4. Quality assurance measures performed on this set of samples included spikes, duplicates, known AQC samples and blanks.

If you have any questions concerning these results, please feel free to contact us.

Sincerely,

Tim Hensley
Tim Hensley

Justin Daniel
Justin Daniel

Lynda Pennington
Lynda Pennington

xc: R.L. Cosby
G.B. Smith
J.L. Seeley

ManTech Environmental Research Services Corporation

R.S. Kerr Environmental Research Laboratory, P.O. Box 1198, 919 Research Drive
Ada, Oklahoma 74821-1189 405-436-8660 FAX 405-436-8501

Sample	mg/l Cl^-	mg/l SO_4^{-2}	mg/l NO^-_2+NO^-_3 (N)	mg/l NH_3 (N)
CPT-1	24.0	114	<.05	1.78
CPT-2	871	180	<.05	1.88
CPT-3	1110	45.7	<.05	2.15
FTA-21I	1380	108	<.05	1.21
FTA-21I Dup	1380	110	----	----
FTA-21D	1240	64.0	.10	1.49
FTA-21S	41.1	38.5	.14	1.86
FTA-13D	537	13.8	<.05	2.14
FTA-13S	15.1	25.8	<.05	<.05
FTA-15S	49.0	45.5	<.05	.57
FTA-8D	508	35.8	<.05	1.02
FTA-8D Dup	----	----	<.05	1.02
FTA-8S	20.0	14.8	.15	.58
FTA-16S	157	199	<.05	.27
FTA-16D	509	34.3	<.05	1.41
FTA-14	105	96.0	<.05	1.14
MP-4S	1650	356	<.05	1.96
MP-4D	84.9	65.8	<.05	.68
MP-5	22.4	80.3	<.05	.31
MP-5 Dup	21.4	82.1	----	----
FTA-20I	2350	136	<.05	3.25
FTA-20D	4230	238	<.05	2.54
FTA-20S	169	89.8	<.05	.71
MW-10	23.3	189	<.05	.28
CPT-8	1220	533	<.05	1.69
FTA-7D	457	24.3	<.05	1.31
FTA-7D Dup	----	----	<.05	1.30
FTA-2-11	5.32	13.4	.05	.17
CPT-6	739	191	<.05	1.99
CPT-6 Dup	710	192	----	----
CPT-7	18.4	9.82	<.05	<.05
MP-1S	12.0	7.85	<.05	<.05
MP-1D	185	514	<.05	1.69
FTA-2-04	20.9	80.6	<.05	.56
FTA-2-06	9.64	12.8	<.05	8.31
FTA-2-9D	735	42.0	<.05	1.34
FTA-2-9D Dup	729	42.1	<.05	1.33
FTA-2-9S	68.8	20.3	<.05	3.62
MW-2	87.7	275	<.05	1.94
FTA-2-3	373	348	<.05	1.26

Sample	mg/l Cl^-	mg/l SO_4^{-2}	mg/l $NO^-_2+NO^-_3$ (N)	mg/l NH_3 (N)
FTA-2-5	213	316	<.05	1.21
MW-1	25.8	134	.11	.23
MP-3	35.3	35.2	<.05	1.12
CPT-4	30.1	15.6	<.05	.82
MP-2	27.6	92.4	<.05	.65
MP-2 Dup	27.5	92.5	<.05	.64
FTA-19I	904	9.13	.72	2.03
FTA-12	34.3	107	<.05	.11
FTA-18	15.0	121	<.05	4.64
CPT-5	885	268	<.05	1.70
MW-7S	16.5	18.9	<.05	.06
FTA-19D	9190	1100	<.05	2.54
MP-6	120	96.7	<.05	.68
MW-19S	6970	842	<.05	
Blank	<.5	<.5	<.05	<.05
WP034	56.0	52.3	6.01	8.79
	----	----	6.06	8.80
WP034 T.V.	55.9	52.0	6.00	8.80
Spike Rec.	99%	100%	99%	101%

APPENDIX C

BIODEGRADATION RATE CALCULATIONS AND OTHER CALCULATIONS

BIODEGRADATION RATE CONSTANT CALCULATIONS

FIRST-ORDER DECAY RATE ESTIMATION

The change in a solute's concentration in groundwater over time often can be estimated using the linear form of the first-order kinetic model:

$$C = C_o e^{-kt} \quad (4)$$

where C = concentration at time t [µg/L], C_o = source concentration [µg/L], k = overall attenuation rate (first-order rate constant) [day^{-1}]

Using this relationship, a total first-order attenuation rate could be estimated for a site by producing a log-linear plot of total contaminant concentration versus travel time for a series of points along the flowpath of a contaminant plume. If the data plot along a straight line, the relationship is first-order, and an exponential regression analysis can be performed, with the slope of the resulting equation equivalent to the total attenuation rate. This overall attenuation rate groups all processes acting to reduce contaminant concentrations and includes advection, dispersion, dilution from recharge, sorption, volatilization, and biodegradation. This approach is very sensitive to hydrogeologic variability, as well as to the proximity of the sampled points to the dominant flow path of the plume, both laterally and vertically. This can contribute to the generation of less than desirable correlation coefficients (R^2). Because site conditions at CCFTA-2 (FT-17) preclude obtaining data from the true centerline of the plume, this method was not used.

ESTIMATING FIRST-ORDER BIODEGRADATION FOR A STEADY-STATE PLUME

In order to ensure that some portion of observed decreases in contaminant concentrations can be attributed to biodegradation, measured contaminant concentrations must be corrected for the effects of dispersion, dilution, and sorption. Buscheck and Alcantar (1995) derive a relationship that allows calculation of first-order biodegradation rate constants for steady-state plumes. This method involves coupling the regression of contaminant concentration (plotted on a logarithmic scale) versus distance downgradient (plotted on a linear scale) to an analytical solution for one-dimensional, steady-state, contaminant transport that includes advection, dispersion, sorption, and biodegradation.

The relationship developed by Buscheck and Alcantar (1995) was applied to the data from CCFTA-2 (FT-17). As expected, the rates attributed to biodegradation are less than the total attenuation rates, with estimated rates ranging from one-half to three-quarters of the total attenuation rate. Data and results for are presented in Tables C.1 through C.5. Because this technique uses the same concentration data as the total attenuation technique, it is also sensitive to sampling locations and hydrogeologic variability.

ESTIMATING FIRST-ORDER REDUCTIVE DECHLORINATION: THE CARBON CORE AS A TRACER

A convenient way to isolate the rate of biodegradation from other attenuation processes is to use as tracers compounds or elements associated with the contaminant plume that are relatively unaffected or predictably affected by biological processes occurring within the aquifer. When present, the trimethylbenzene isomers associated with fuels can serve as useful tracers under certain geochemical conditions (Wiedemeier *et al.*, 1995 and 1996c). Likewise, chloride, a degradation product of chlorinated solvent biodegradation has the potential to serve as a useful tracer (Wiedemeier *et al.*, 1996b). This section describes a tracer method that can be used with reductively dehalogenated solvent plumes, and involves tracking the "carbon" core of the chlorinated compounds in relation to the remaining chlorine mass. This method was first presented by Moutoux *et al.* (1996).

Measured tracer and contaminant concentrations from a minimum of two points along a flow path can be used to estimate the amount of contaminant remaining at each point if biodegradation had been the only attenuation process operating to reduce contaminant concentrations. To accomplish this, it is assumed that the fraction of contaminant remaining as a result of all attenuation processes is equivalent to the fraction of contaminant remaining as a result of non-destructive attenuation mechanisms only, multiplied by the fraction of contaminant remaining as a result of biodegradation. The fraction of contaminant remaining as a result of all attenuation processes can be computed from the measured contaminant concentrations at two points along a flow path. The fraction of contaminant remaining as a result of non-destructive attenuation mechanisms only can be estimated from the tracer concentrations at the same two points, because an ideal tracer is affected by non-destructive attenuation mechanisms to the same degree as the contaminant of interest and is not affected by biologic processes. The following equation uses these assumptions to solve for the estimated downgradient contaminant concentration if biodegradation had been the only attenuation process operating between two points (*i* and *i-1*) along the flow path:

$$C_{i,corr} = C_{i-1,corr}\left(\frac{C_i}{C_{i-1}}\right)\left(\frac{T_{i-1}}{T_i}\right) \qquad (5)$$

where $C_{i,corr}$= corrected contaminant concentration at point i; $C_{i-1,corr}$= corrected contaminant concentration at point i-1 (Note that if point i-1 is the first or most upgradient point, $C_{i-1,corr}$ is equivalent to the observed contaminant concentration.); C_i = observed contaminant concentration at point i; C_{i-1}= observed contaminant concentration at point i-1; T_i= observed tracer concentration at point i; and T_{i-1}= observed tracer concentration at point i-1.

This equation can be used to estimate the theoretical contaminant concentration resulting from biodegradation alone for every point along a flow path on the basis of the measured contaminant concentration at the point of plume origin and the contaminant/tracer ratios between consecutive points along the flow path. This series of points can then be used to estimate a first-order rate of biodegradation as described for estimating total attenuation rates.

During reductive dechlorination, the source chlorinated solvent undergoes successive transformations involving the replacement of a chlorine atom by a hydrogen atom; however, the carbon core of both the parent and daughter compounds remains unchanged (i.e., no carbon bonds are broken). The carbon core is subject to the same non-destructive attenuation mechanisms that act on the larger chlorinated molecule, but it is unaffected by biologically mediated reductive dechlorination. For this reason, tracking the carbon core of dissolved

chlorinated solvents can serve as a theoretically perfect "tracer" for biodegradation via reductive dechlorination. This assumes that the only operating biodegradation mechanism is reductive dechlorination.

In order to use the carbon core of the chlorinated parent and daughter compounds as a "tracer" for reductive dechlorination, "equivalents" for the dissolved mass of carbon and chlorine must be calculated for each point along a flow path. The "equivalents" are calculated by first converting contaminant concentrations into molar concentrations. For chlorinated ethenes, the carbon equivalent is calculated by multiplying the number of carbon atoms per molecule of chlorinated ethene (2) by the sum of the molar concentrations for PCE, TCE, DCE, VC, and ethene:

$$Ceq_i = 2\,(M_{PCE,i} + M_{TCE,i} + M_{DCE,i} + M_{VC,i} + M_{Ethene,i}) \quad (6)$$

where Ceq_i = carbon equivalent at point i; $M_{PCE,i}$ = molar concentration of PCE at point i; $M_{TCE,i}$ = molar concentration of TCE at point i; $M_{DCE,i}$ = molar concentration of DCE at point i; $M_{VC,i}$ = molar concentration of VC at point i; and $M_{Ethene,i}$ = molar concentration of ethene at point i.

The chlorine "equivalent" is defined as the sum of the products of molar concentration and chlorine atoms per molecule for each parent and daughter compound. For the chlorinated ethenes, the numbers of chlorine atoms per molecule are 4 for PCE, 3 for TCE, 2 for DCE, 1 for VC, and 0 for ethene:

$$Cleq_i = (M_{PCE,i}*4) + (M_{TCE,i}*3) + (M_{DCE,i}*2) + M_{VC,i} \quad (7)$$

where $Cleq_i$ = chlorine equivalent at point i.

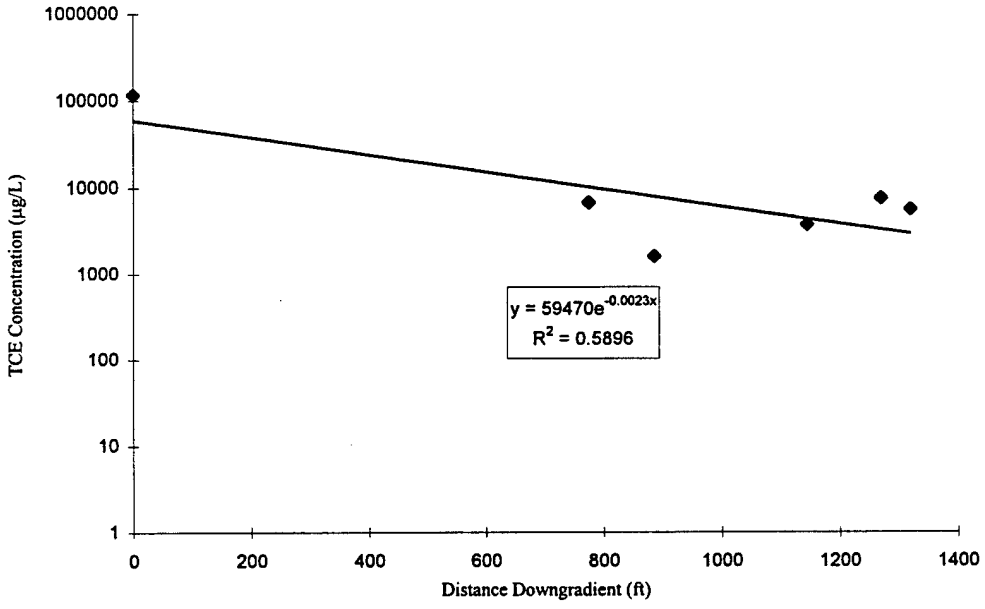
Using equation 5, and substituting Ceq for tracer concentrations and Cleq for observed contaminant concentrations, yields the theoretical total CAH concentrations at downgradient locations if reductive dechlorination had been the only natural attenuation process operating along the flow path. The same process can be used to determine the theoretical chlorine equivalents. Chlorine equivalents, carbon equivalents, the corrected total CAH concentrations, and the corrected chlorine equivalents for CCFTA-2 (FT-17) are presented in Table C.6. The corrected CAH concentrations are useful for comparison to other techniques; the corrected chlorine equivalents simplify visualization of the reductive dechlorination rate. Either the corrected total CAH concentrations or corrected chlorine equivalents can be used to calculate identical first-order rates for dechlorination. A log-linear plot is provided in Figure C.1 for the 1996 CCFTA-2 (FT-17) data.

There are two important aspects of this technique to remember. First, the calculated first-order rate is for reductive dechlorination only. Secondly, the rate estimate does not adequately assess the total biodegradation rate if biodegradation mechanisms other than reductive dechlorination are operant. Alternate biodegradation avenues are available for lower molecular weight solvents such as DCE and VC as groundwater conditions become less reducing. However, conditions at CCFTA-2 (FT-17) appear to be sufficiently reducing that this issue should not be a concern.

TABLE C.1
FIRST-ORDER RATE CONSTANT CALCULATION
USING THE METHOD OF BUSCHECK AND ALCANTAR (1995)
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

Point	Distance Downgradient(ft)	Total CAHs (µg/L) Jan-96
CCFTA2-9S	0	117825
MP3	775	6802
CPT4	885	1595
MP6	1145	3760
CCFTA2-14	1270	7558
MP4S	1320	5618

PLOT OF TOTAL CAH CONCENTRATION VERSUS DISTANCE



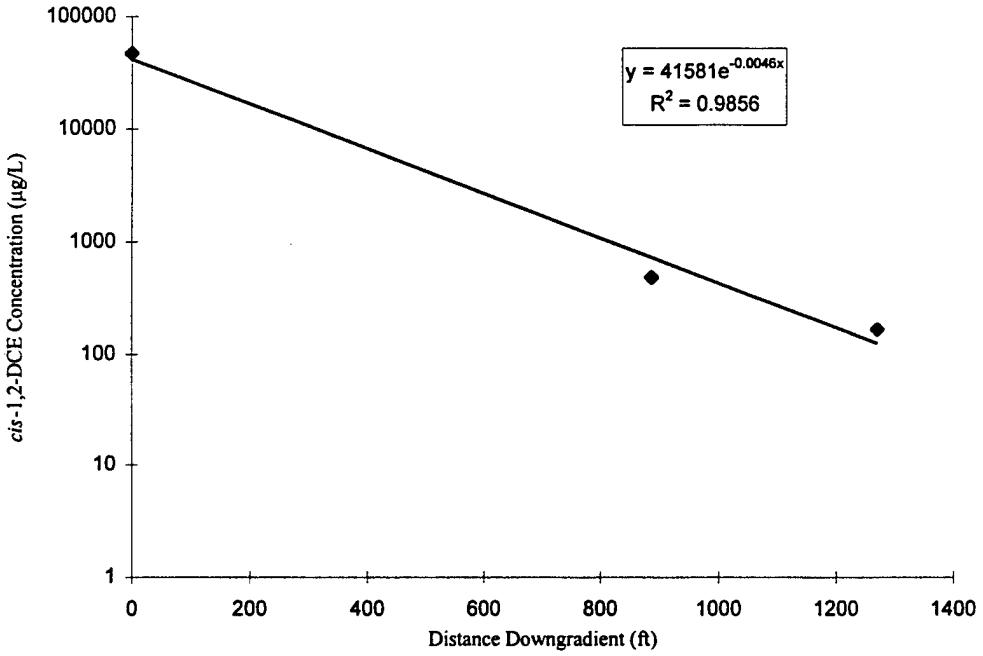
$$\lambda = v_c/4\alpha_x([1+2\alpha_x(k/v_x)]^2-1)$$

where $v_c = 0.14$
$\alpha_x = 50$
$k/v = -0.0023$
therefore $\lambda = -0.0003$

TABLE C.2
FIRST-ORDER RATE CONSTANT CALCULATION
USING THE METHOD OF BUSCHECK AND ALCANTAR (1995)
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

Point	Distance Downgradient(ft)	*cis*-1,2-DCE (µg/L) Mar-94
CCFTA2-9	0	47000
CPT4	885	490
CCFTA2-1	1270	168

PLOT OF *cis*-1,2-DCE CONCENTRATION VERSUS DISTANCE



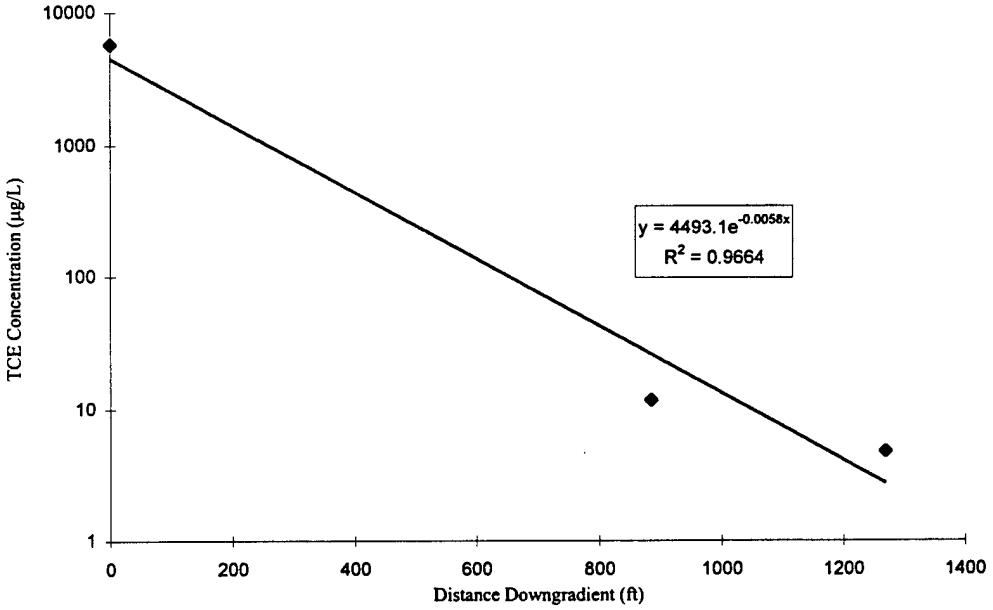
$$\lambda = v_c/4\alpha_x([1+2\alpha_x(k/v_x)]^2-1)$$

where $v_c = 0.14$
$\alpha_x = 50$
$k/v = -0.0046$
therefore $\lambda = -0.0005$

TABLE C.3
FIRST-ORDER RATE CONSTANT CALCULATION
USING THE METHOD OF BUSCHECK AND ALCANTAR (1995)
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

Point	Distance Downgradient(ft)	TCE (µg/L) Mar-94
CCFTA2-9S	0	5720
CPT4	885	11.7
CCFTA2-14	1270	4.8

PLOT OF TCE CONCENTRATION VERSUS DISTANCE



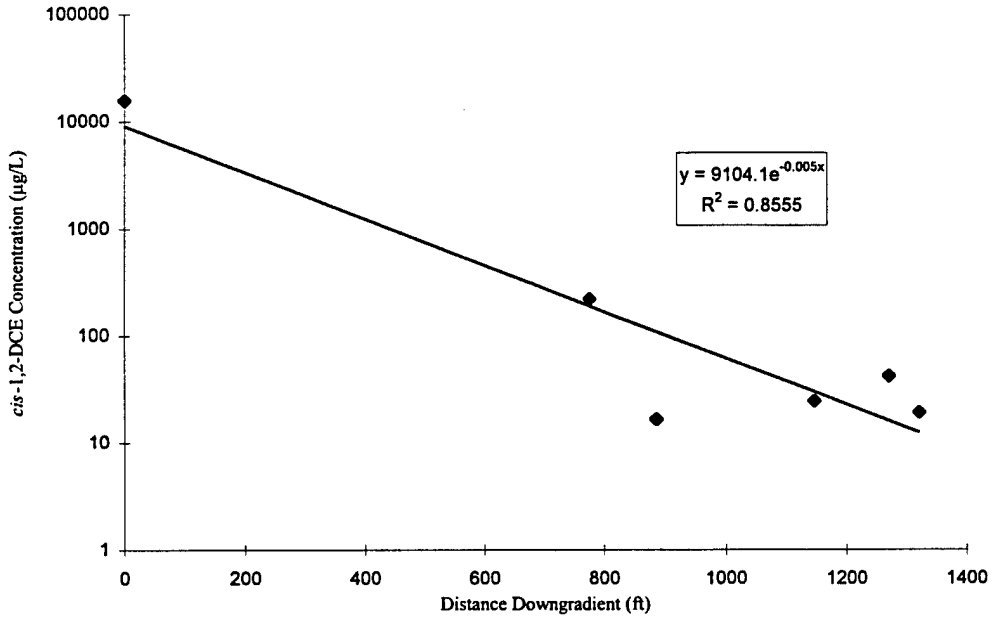
$$\lambda = v_c/4\alpha_x([1+2\alpha_x(k/v_x)]^2-1)$$

where $v_c = 0.12$
$\alpha_x = 50$
$k/v = -0.0058$
therefore $\lambda = -0.0005$

TABLE C.4
FIRST-ORDER RATE CONSTANT CALCULATION
USING THE METHOD OF BUSCHECK AND ALCANTAR (1995)
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

Point	Distance Downgradient(ft)	*cis*-1,2-DCE (µg/L) Jan-96
CCFTA2-9S	0	15800
MP3	775	220
CPT4	885	16.5
MP6	1145	24.3
CCFTA2-14	1270	42
MP4S	1320	19

PLOT OF *cis*-1,2-DCE CONCENTRATION VERSUS DISTANCE



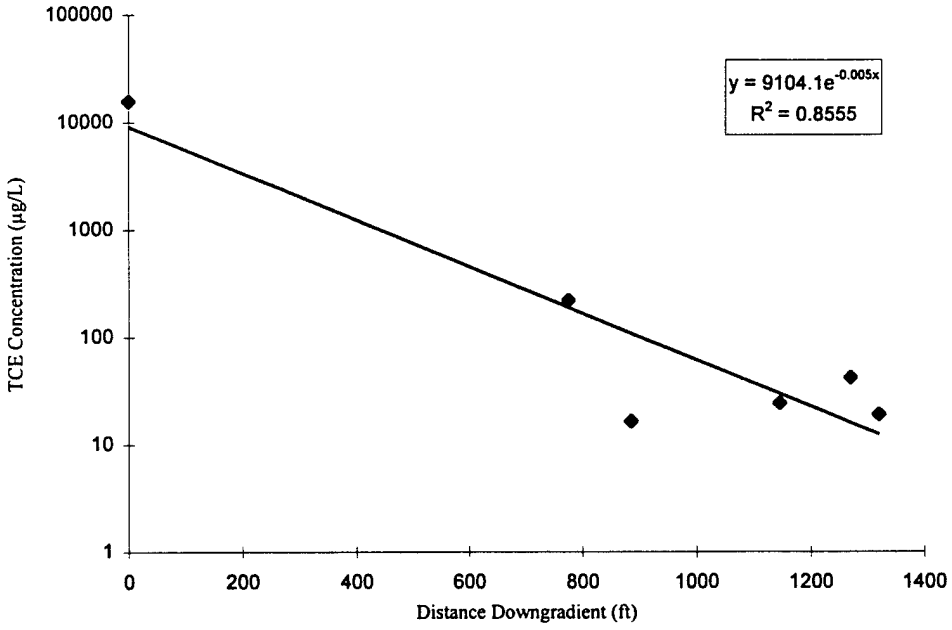
$$\lambda = v_c/4\alpha_x([1+2\alpha_x(k/v_x)]^2-1)$$

where $v_c = 0.14$
$\alpha_x = 50$
$k/v = -0.005$
therefore $\lambda = -0.0005$

TABLE C.5
FIRST-ORDER RATE CONSTANT CALCULATION
USING THE METHOD OF BUSCHECK AND ALCANTAR (1995)
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

Point	Distance Downgradient(ft)	TCE (µg/L) Jan-96
CCFTA2-9S	0	15800
MP3	775	220
CPT4	885	16.5
MP6	1145	24.3
CCFTA2-14	1270	42
MP4S	1320	19

PLOT OF TCE CONCENTRATION VERSUS DISTANCE



$$\lambda = v_c/4\alpha_x([1+2\alpha_x(k/v_x)]^2-1)$$

where $v_c = 0.14$
$\alpha_x = 50$
$k/v = -0.005$
therefore $\lambda = -0.0005$

TABLE C.6
CALCULATION OF DECHLORINATION RATES
USING THE METHOD OF MOUTOUX ET AL. (1996)
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

Step 1: Enter Observed Contaminant Concentration (µg/L)

Well	PCE	TCE	DCE	VC	Ethene	Total CAHs
CCFTA2-9S	0	15800	98500.0	3080	30	117410.0
MP3	0.0	220	3480.0	3080	188	6968.0
CPT4	0	16.5	776.00	797.00	48	1637.50
MP6	0	24	1200.0	2520	107	3851.3
CCFTA2-14		42	971.0	6520	225	7758.0
MP4S	0	19.0	556.0	5024	15	5614.0

Step 2: Compute Molar Concentrations (micromoles/Liter)

Well	M_{PCE}	M_{TCE}	M_{DCE}	M_{VC}	M_{Ethene}	Total M_{CAHs}
CCFTA2-9S	0.00	120.26	1016.09	49.28	1.07	1186.70
MP3	0.00	1.67	35.90	49.28	6.70	93.55
CPT4	0.00	0.13	8.00	12.75	1.71	22.59
MP6	0.00	0.18	12.38	40.32	3.81	56.70
CCFTA2-14	0.00	0.32	10.02	104.32	8.02	122.67
MP4S	0.00	0.14	5.74	80.38	0.53	86.80

Step 3: Compute Carbon Equivalents

Well	Total M_{CAHs}	x 2	= Ceqi
CCFTA2-9S	1186.70		2373.41
MP3	93.55		187.11
CPT4	22.59		45.19
MP6	56.70		113.39
CCFTA2-14	122.67		245.35
MP4S	86.80		173.60

Step 4: Compute Chlorine Equivalents

Well	M_{PCE} x 4	M_{TCE} x 3	M_{DCE} x 2	M_{VC}	$\Sigma = Cleq_i$
CCFTA2-9S	0.00	360.79	2032.18	49.28	2442.25
MP3	0.00	5.02	71.80	49.28	126.10
CPT4	0.00	0.38	16.01	12.75	29.14
MP6	0.00	0.55	24.76	40.32	65.63
CCFTA2-14	0.00	0.96	20.03	104.32	125.31
MP4S	0.00	0.43	11.47	80.38	92.29

TABLE C.6 (concluded)
CALCULATION OF DECHLORINATION RATES
USING THE METHOD OF MOUTOUX ET AL. (1996)
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

Step 5: Compute Corrected CAH Concentrations

$$C_{i,corr} = C_{i-1,corr} \times (Cleq_i / Cleq_{i-1}) \times (Ceq_{i-1} / Ceq_i)$$

Well	$C_{i-1,corr}$	$Cleq_i / Cleq_{i-1}$	Ceq_{i-1} / Ceq_i	$C_{i,corr}$
CCFTA2-9S	117410.00			117410.00
MP3	117410.00	0.05	12.68	76898.29
CPT4	76898.29	0.23	4.14	73578.32
MP6	73578.32	2.25	0.40	66041.30
CCFTA2-14	66041.30	1.91	0.46	58276.69
MP4S	58276.69	0.74	1.41	60658.72

Step 6: Average Contaminant Velocity

v_c (ft/day)
0.140

Step 7: Plot Exponential Trendline of Contaminant Concentration vs. Time

Well	Distance From Source (ft)	CAH velocity (ft/day)	CAH Travel Time (day)	$C_{i,corr}$
CCFTA2-9S	0	0.140	0	117410.00
MP3	775	0.140	5536	76898.29
CPT4	885	0.140	6321	73578.32
MP6	1145	0.140	8179	66041.30
CCFTA2-14	1270	0.140	9071	58276.69
MP4S	1320	0.140	9429	60658.72

Reductive Dechlorination Rate

$C = C_0 e^{-kt}$ where:

C = Corrected Contaminant Concentration (µg/L) at time t (days)
C_0 = Initial Contaminant Concentration (µg/L)
k = Reductive Dechlorination Rate (day^{-1})

from Figure C.1: $y = 116677e^{-7E-05x}$ $k = 0.00007\ day^{-1}$

Figure C.1
Reductive Dechlorination Rate
CCFTA-2 (FT-17)
Cape Canaveral Air Station, Florida

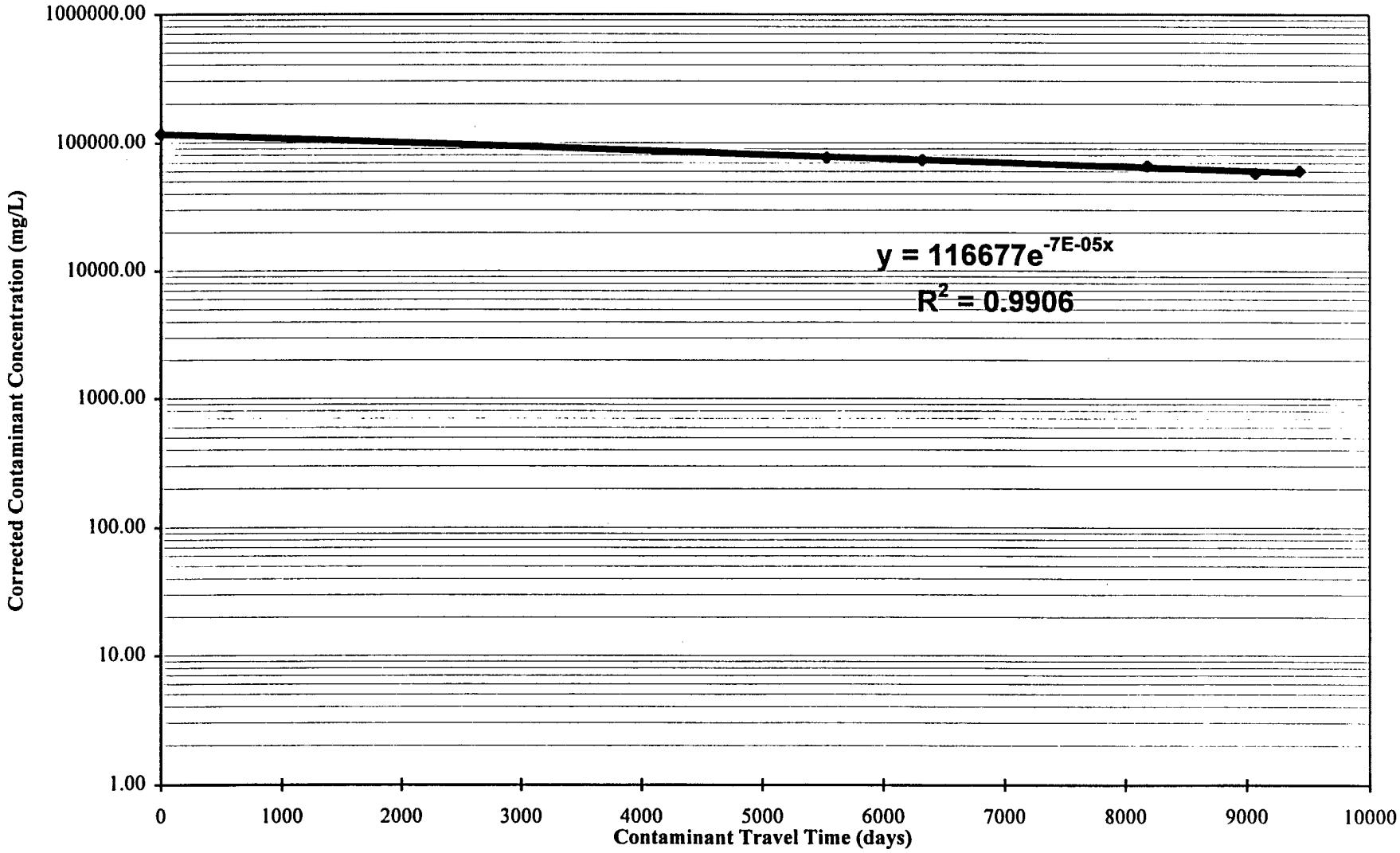


TABLE C.7
CALCULATION OF RETARDATION COEFFICIENTS
CCFTA-2 (FT-17) RNA TS
CAPE CANAVERAL AIR STATION, FLORIDA

Compound	K_{oc} (L/kg [a/])	Maximum Fraction Organic Carbon [b/]	Minimum Fraction Organic Carbon [b/]	Average Fraction Organic Carbon [b/]	Distribution Coefficient K_d (L/kg) Maximum [c1/]	Minimum [c2/]	Average [c3/]	Bulk Density (kg/L) [d/]	Effective Porosity	Coefficient of Retardation Maximum	Minimum	Average
TCE	107	0.00836	0.00017	0.00184	0.895	0.018	0.197	1.60	0.20	8.16	1.15	2.58
cis-1,2-DCE	80.2	0.00836	0.00017	0.00184	0.670	0.014	0.148	1.60	0.20	6.36	1.11	2.18
VC	2.45	0.00836	0.00017	0.00184	0.020	0.000	0.005	1.60	0.20	1.16	1.00	1.04
Benzene	79	0.00836	0.00017	0.00184	0.660	0.013	0.145	1.60	0.20	6.28	1.11	2.16
Toluene	190	0.00836	0.00017	0.00184	1.588	0.032	0.350	1.60	0.20	13.71	1.26	3.80
Ethylbenzene	468	0.00836	0.00017	0.00184	3.912	0.080	0.861	1.60	0.20	32.30	1.64	7.89
m-xylene	405	0.00836	0.00017	0.00184	3.386	0.069	0.745	1.60	0.20	28.09	1.55	6.96
o-xylene	422	0.00836	0.00017	0.00184	3.528	0.072	0.776	1.60	0.20	29.22	1.57	7.21
p-xylene	357	0.00836	0.00017	0.00184	2.178	0.357	0.857	1.60	0.20	12.61	2.90	5.57

NOTES:

[a/] From Technical Protocol (Wiedemeier *et al*., 1996) or Montgomery and Welkom, 1990.

[b/] From site data

[c1/] K_d = Maximum Fraction Organic Carbon x K_{oc}

[c2/] K_d = Minimum Fraction Organic Carbon x K_{oc}

[c3/] K_d = Average Fraction Organic Carbon x K_{oc}

[d/] Literature values

APPENDIX D

MODEL INPUT AND OUTPUT (ELECTRONIC)

MODFLOW AND MT3D INPUT/OUTPUT

The enclosed 3.5-inch diskette contains input files and basic output files for the models SR10 and SR90. Using the shareware program PKZIP, these ASCII text files are compressed into the following files:

sr10in.zip

sr10out.zip

sr90in.zip

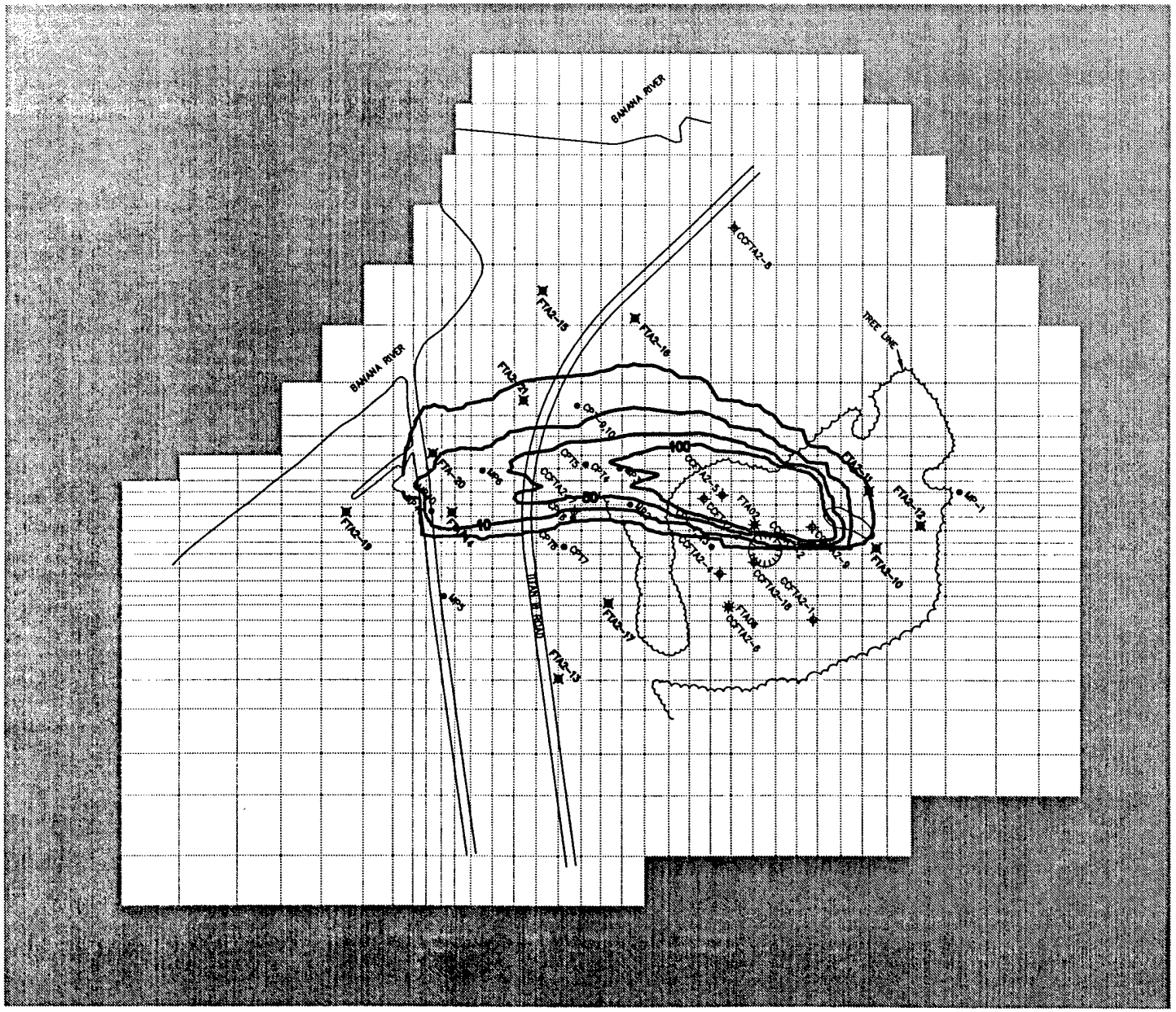
sr90out.zip

The files "sr10in.zip" and "sr90in.zip" contain input files that are read by the MODFLOW and MT3D codes. The files "sr10out.zip" and "sr90out.zip" include simple output files containing listing information and messages from MODFLOW and MT3D, as well as mass balance data. To get the actual output data (e.g., heads or concentrations), the model must be run using the input files. The files containing this information are quite large and not suitable for distribution on diskette.

To restore the files, use PKUNZIP.EXE (included on the disk) or any other similar program such as WinZip®. To use PKUNZIP, copy the four files listed above and PKUNZIP.EXE to a directory on your computer (e.g., C:\MODEL). Then, at the DOS prompt (or using "Start" and then "Run" in Windows 95), type "pkunzip *filename*.zip", where *filename* is the name of the file to be uncompressed.

APPENDIX E

GRAPHICAL OUTPUT OF TRANSPORT MODEL RESULTS



100 LINE OF EQUAL TOTAL CAH CONCENTRATION (µmol/L) (SIMULATED)

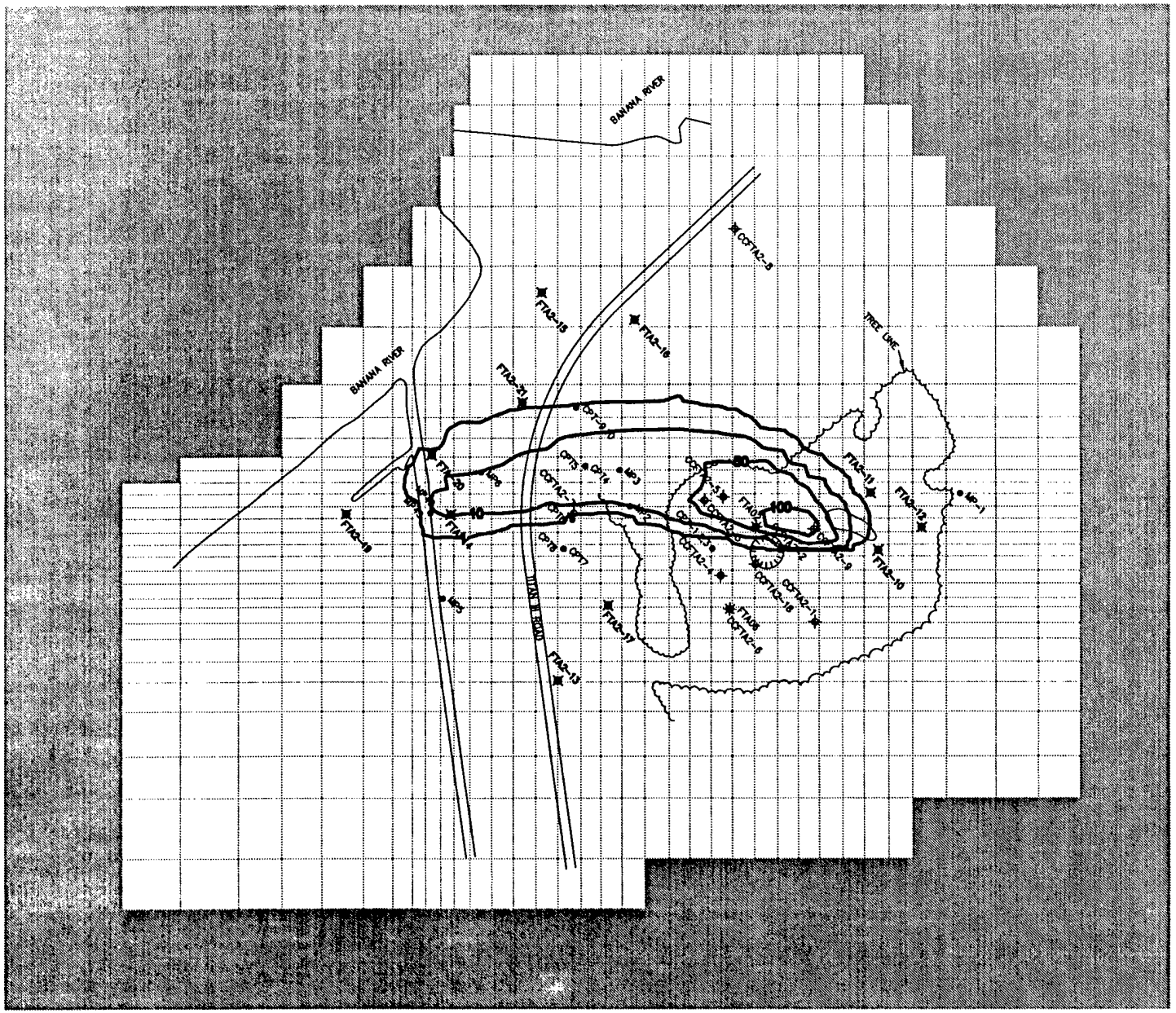
FIGURE E.1

PREDICTED PLUME FOR 2006 MODEL SR10 (10 PERCENT ANNUAL SOURCE WEATHERING)

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

L:\45029\FIGURES\SR10_10, 04/21/97 at 13:09



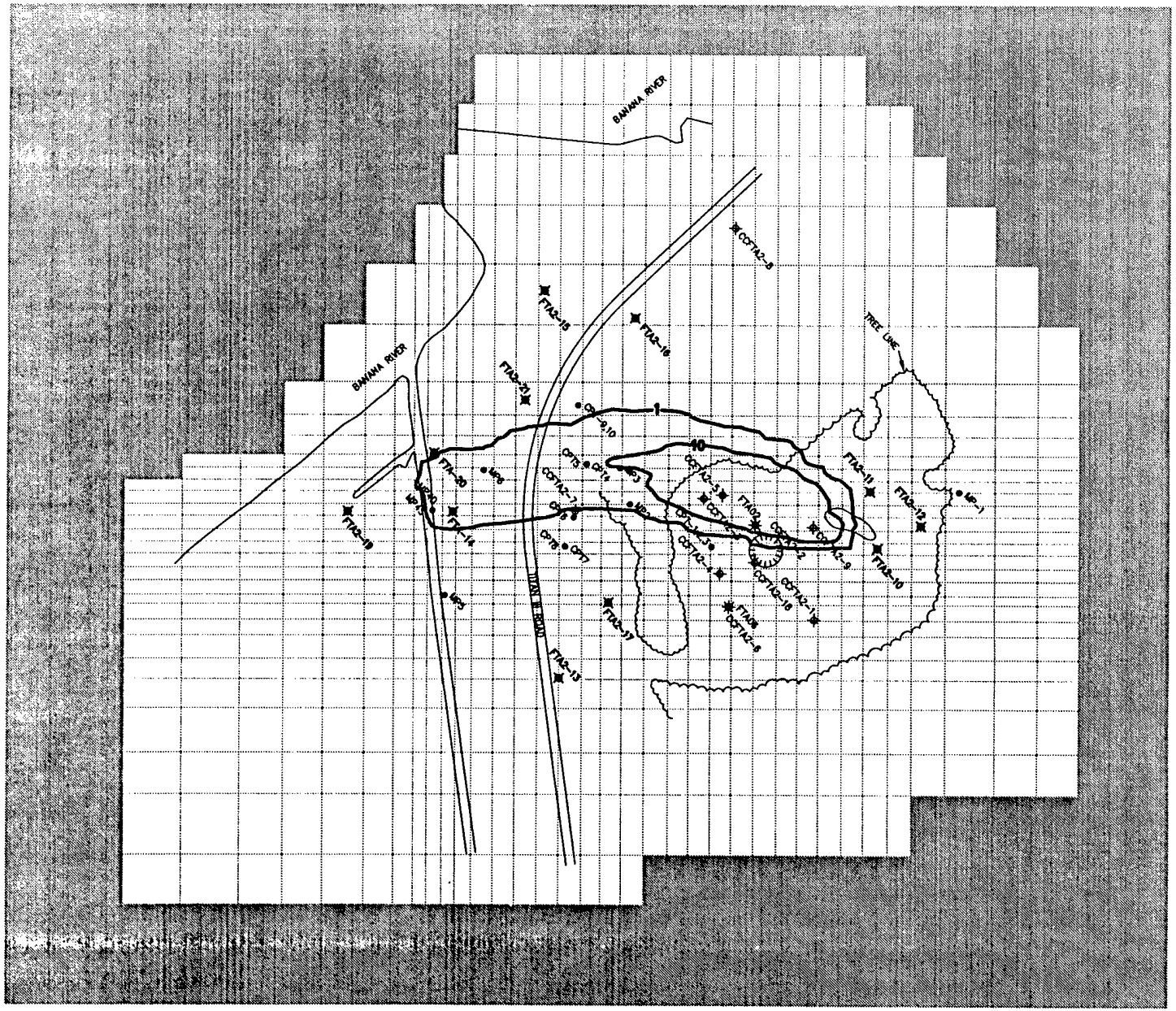
L:\45529\FIGURES\SR10-20, 04/21/97 at 1:30

FIGURE E.2

PREDICTED PLUME FOR 2018 MODEL SR10 (10 PERCENT ANNUAL SOURCE WEATHERING)

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado



10 — LINE OF EQUAL TOTAL CAH CONCENTRATION (µmol/L) (SIMULATED)

0 100 200 400
FEET

FIGURE E.3

PREDICTED PLUME FOR 2026 MODEL SR10 (10 PERCENT ANNUAL SOURCE WEATHERING)

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

L:\45029\FIGURES\SR10-30, 04/21/97 at 1:43

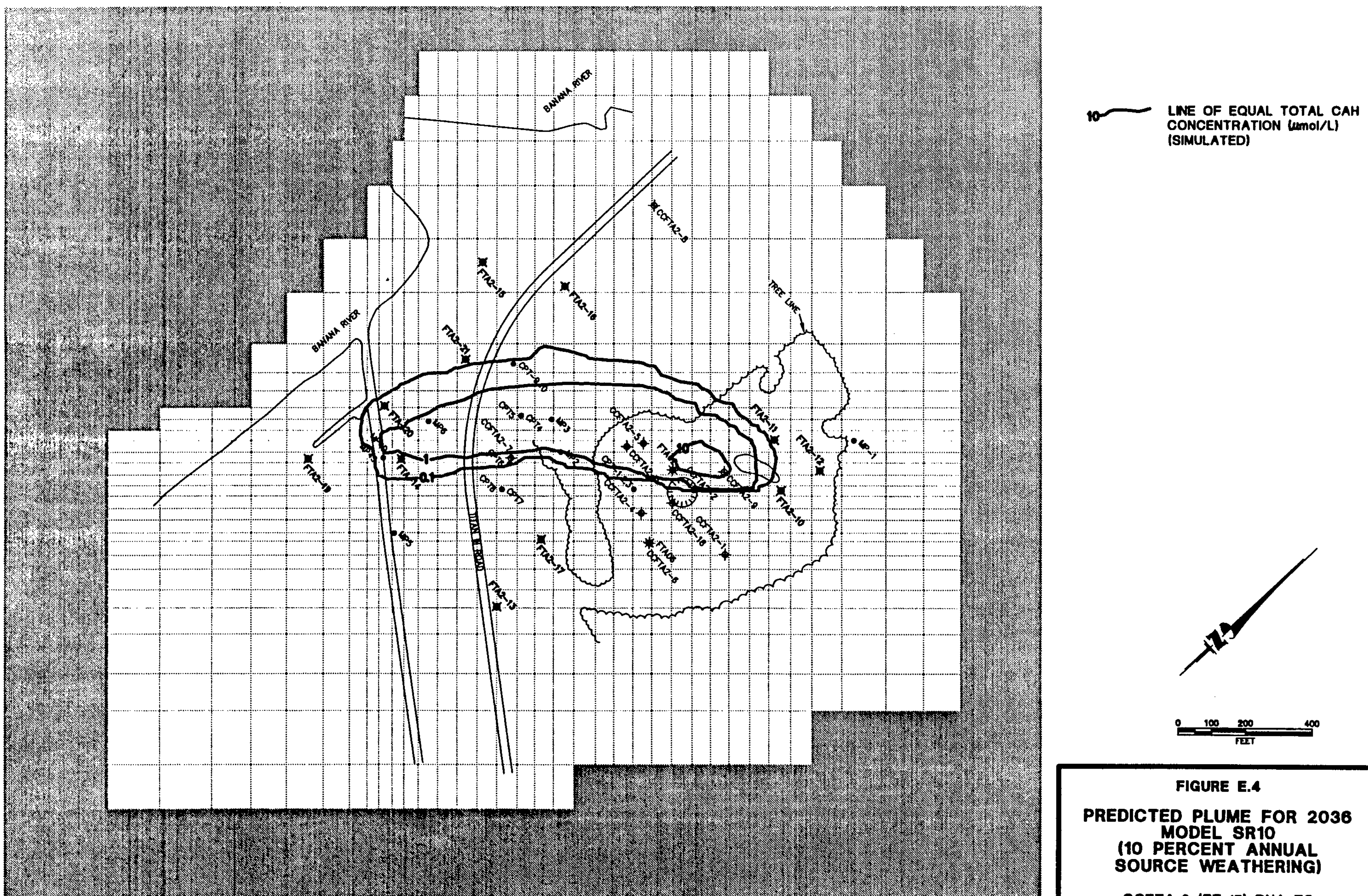


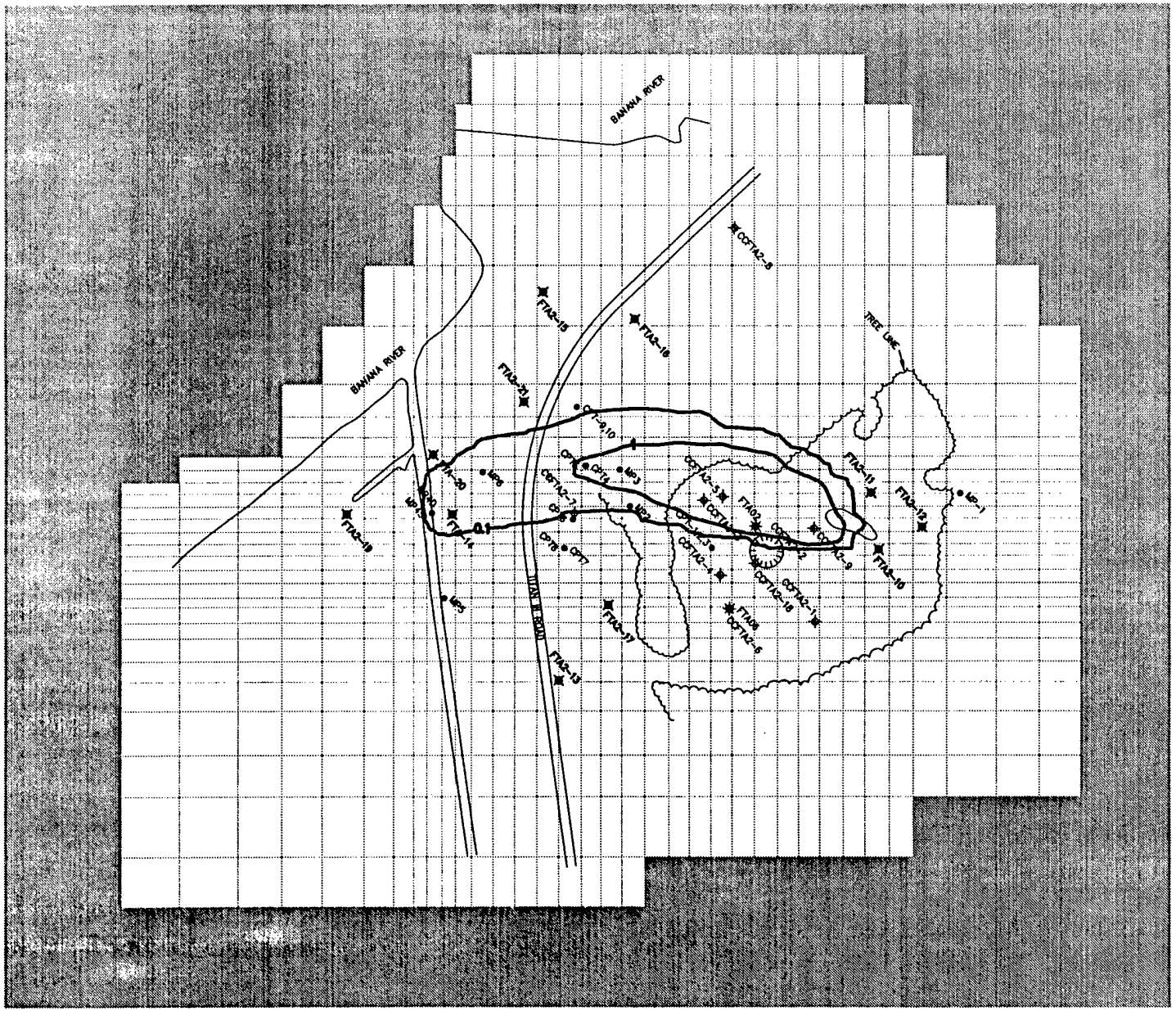
FIGURE E.4

PREDICTED PLUME FOR 2036
MODEL SR10
(10 PERCENT ANNUAL
SOURCE WEATHERING)

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS
ENGINEERING SCIENCE, INC.
Denver, Colorado

L:\45029\FIGURES\SR10-40, 04/21/97 at 1:55



10 LINE OF EQUAL TOTAL CAH CONCENTRATION (µmol/L) (SIMULATED)

0 100 200 400
FEET

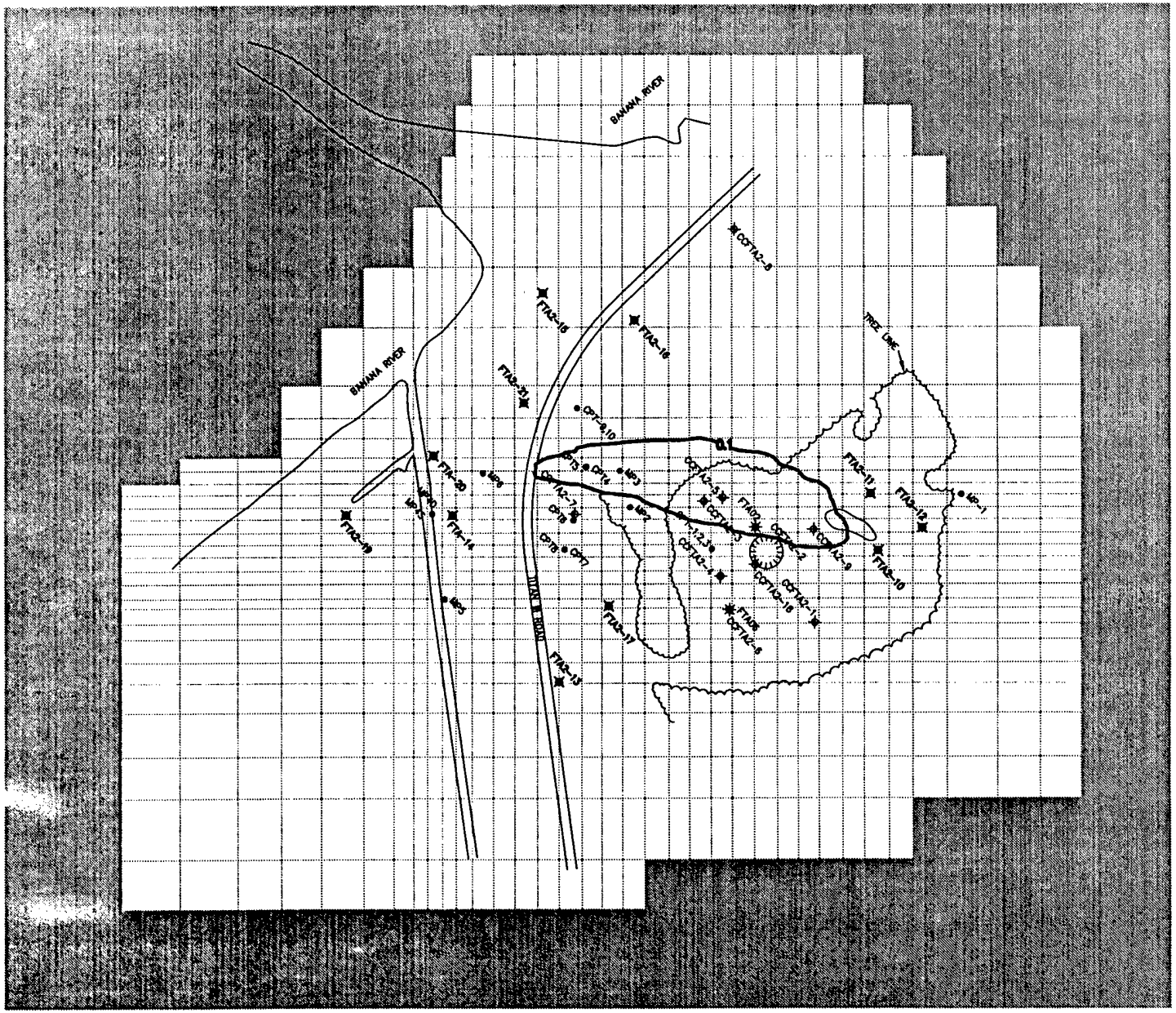
FIGURE E.5

PREDICTED PLUME FOR 2046 MODEL SR10 (10 PERCENT ANNUAL SOURCE WEATHERING)

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

L:\45029\FIGURES\SR10_70, 04/21/97 at 2:15



10 LINE OF EQUAL TOTAL CAH CONCENTRATION (µmol/L) (SIMULATED)

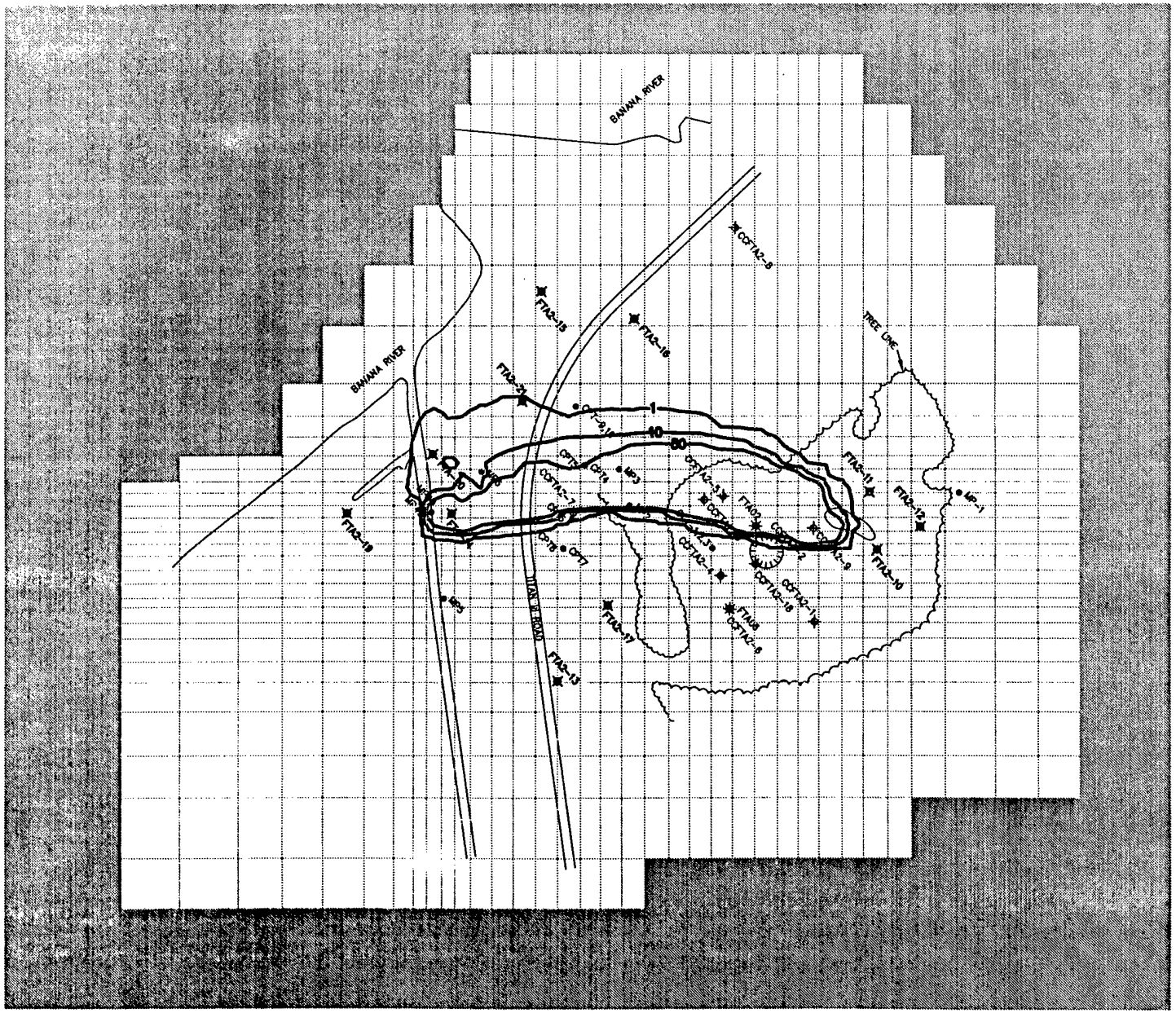
FIGURE E.6

PREDICTED PLUME FOR 2066 MODEL SR10 (10 PERCENT ANNUAL SOURCE WEATHERING)

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

L:\45029\FIGURES\SR10_70, 04/29/97 at 2:11



10 LINE OF EQUAL TOTAL CAH CONCENTRATION (µmol/L) (SIMULATED)

0 100 200 400
FEET

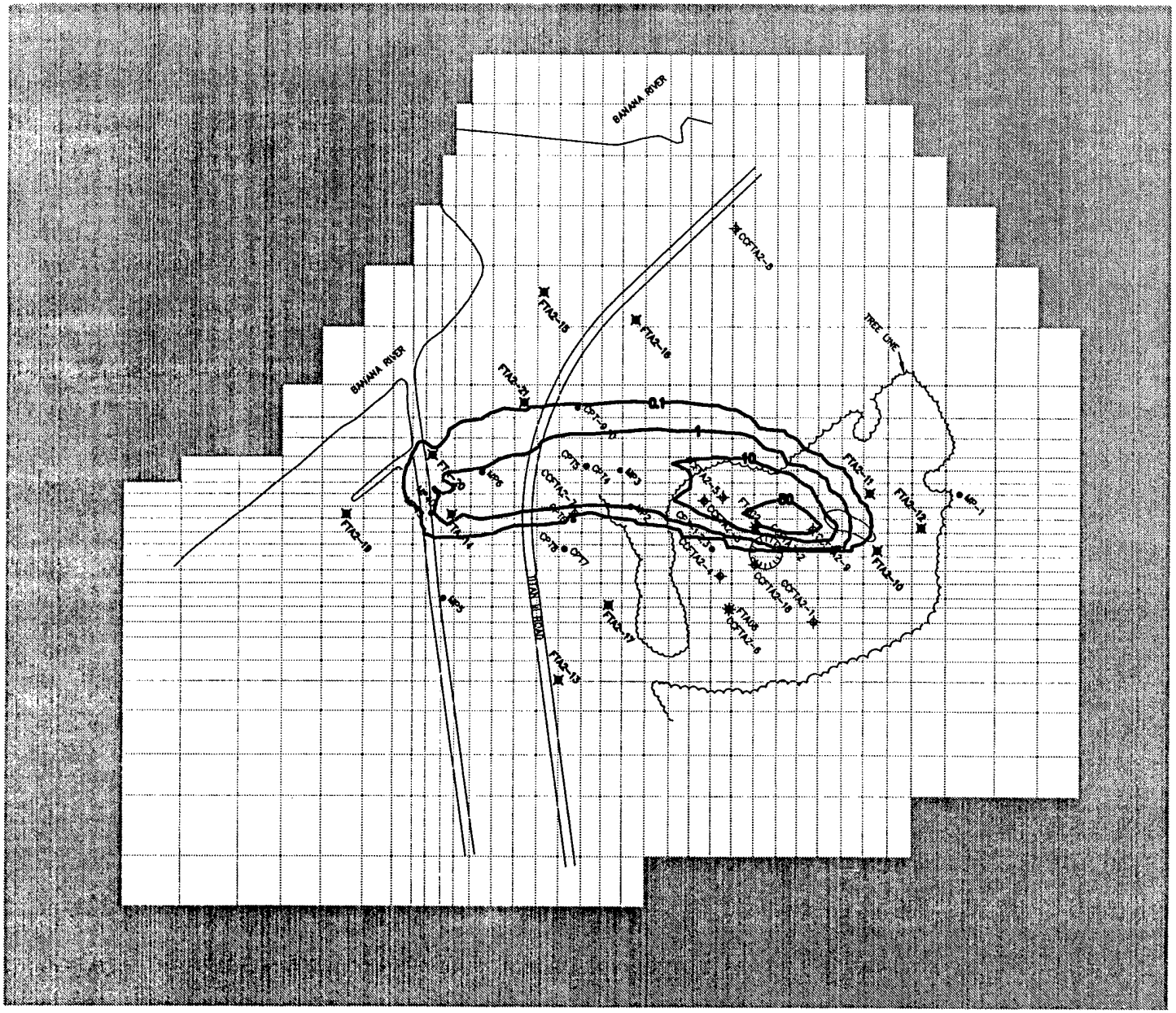
FIGURE E.7

PREDICTED PLUME FOR 2006 MODEL SR90 (90 PERCENT SOURCE REMOVAL, FOLLOWED BY WEATHERING)

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

L:\45029\FIGURES\SR90_10, 04/21/97 at 2:58



10 LINE OF EQUAL TOTAL CAH CONCENTRATION (µmol/L) (SIMULATED)

0 100 200 400
FEET

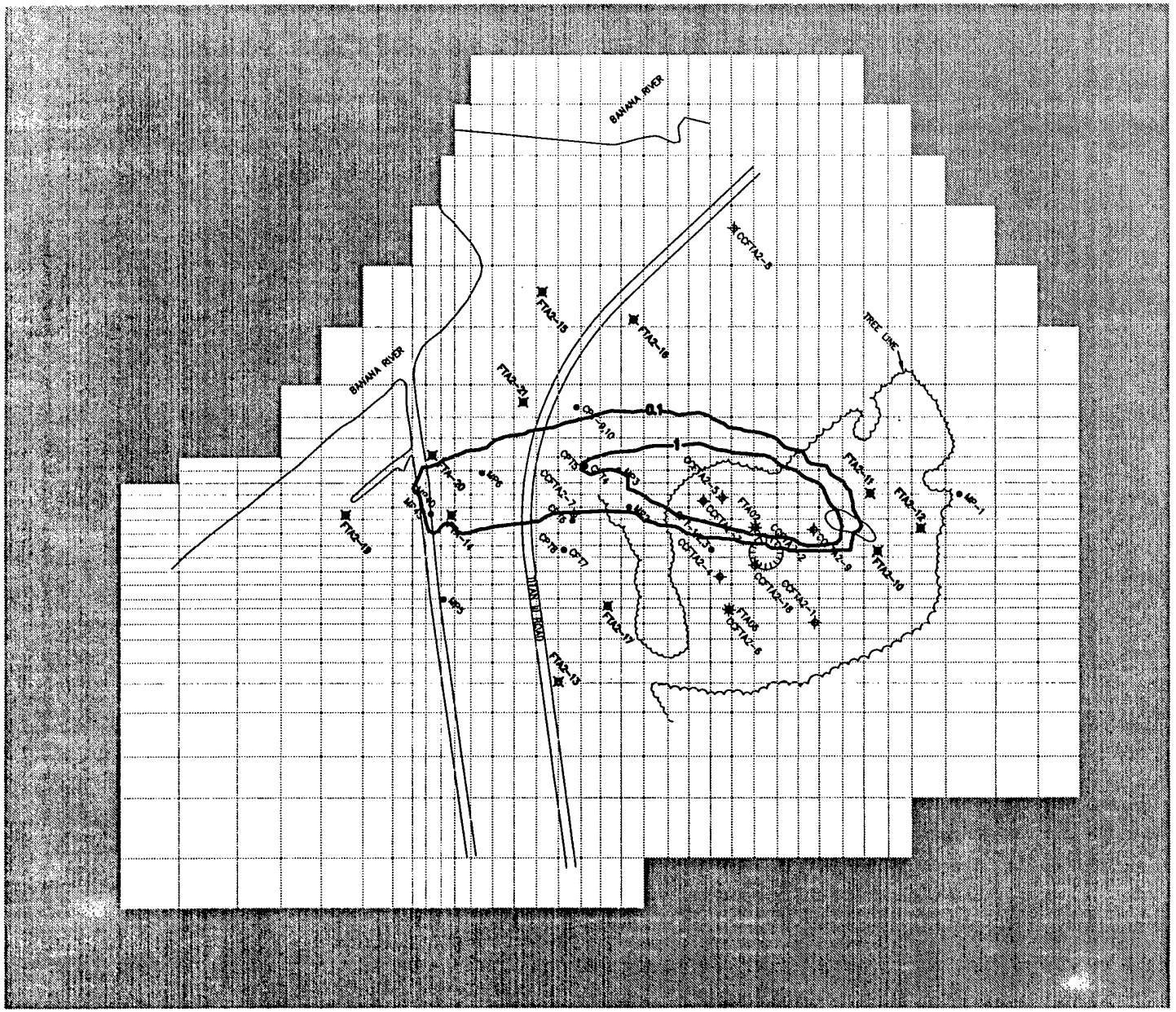
FIGURE E.8

PREDICTED PLUME FOR 2016 MODEL SR90 (90 PERCENT SOURCE REMOVAL, FOLLOWED BY WEATHERING)

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

L:\45029\FIGURES\SR90_20, 04/21/97 at 2:29



10 LINE OF EQUAL TOTAL CAH CONCENTRATION (µmol/L) (SIMULATED)

N

0 100 200 400
FEET

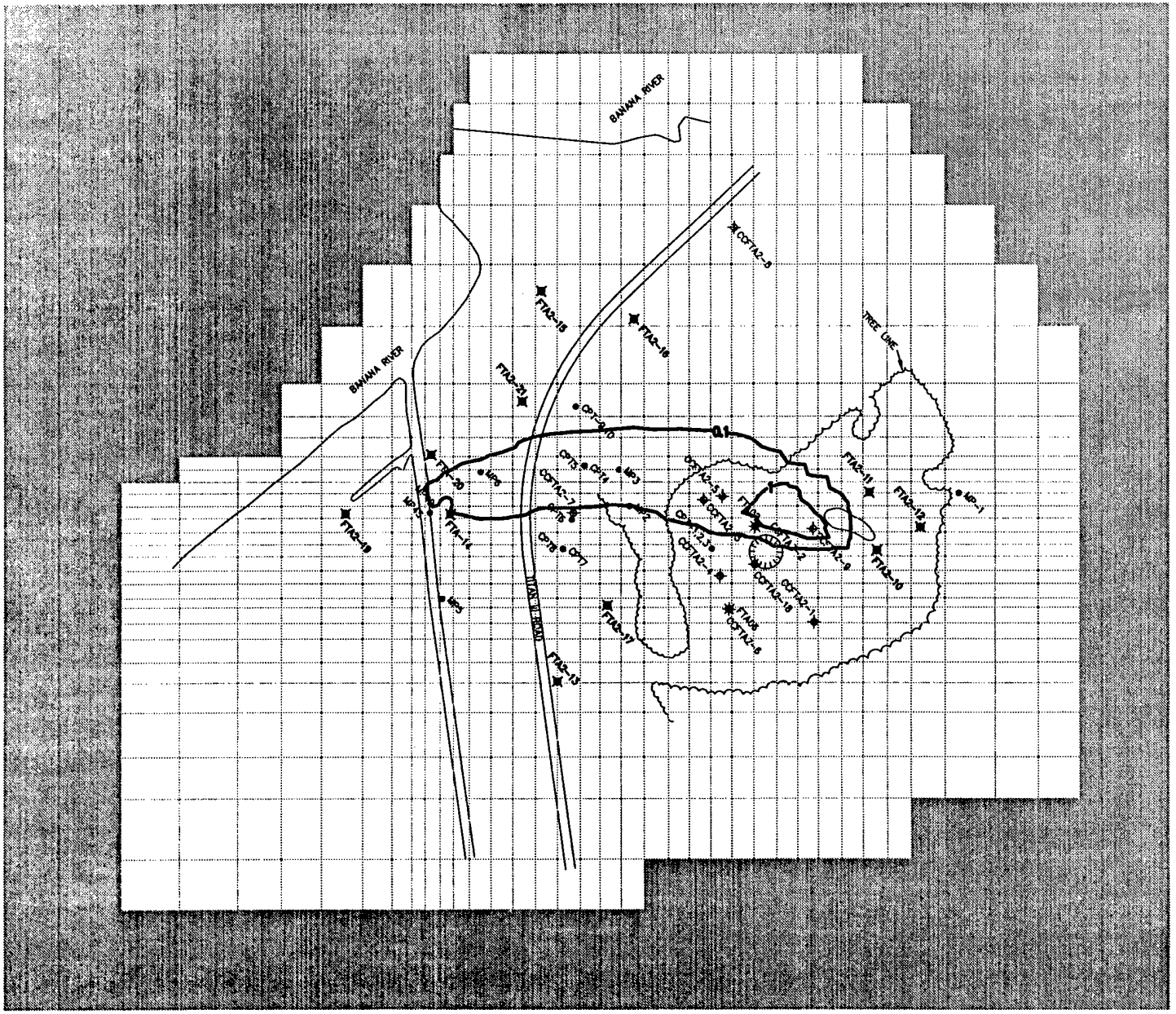
FIGURE E.9

PREDICTED PLUME FOR 2026 MODEL SR90 (90 PERCENT SOURCE REMOVAL FOLLOWED BY WEATHERING)

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

I:\45029\FIGURES\SR90_30, 04/21/97 at 2:32



10 LINE OF EQUAL TOTAL CAH CONCENTRATION (µmol/L) (SIMULATED)

0 100 200 400
FEET

FIGURE E.10

PREDICTED PLUME FOR 2036 MODEL SR90 (90 PERCENT SOURCE REMOVAL FOLLOWED BY WEATHERING)

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

L:\45029\FIGURES\SR90_40, 04/21/97 at 2:36

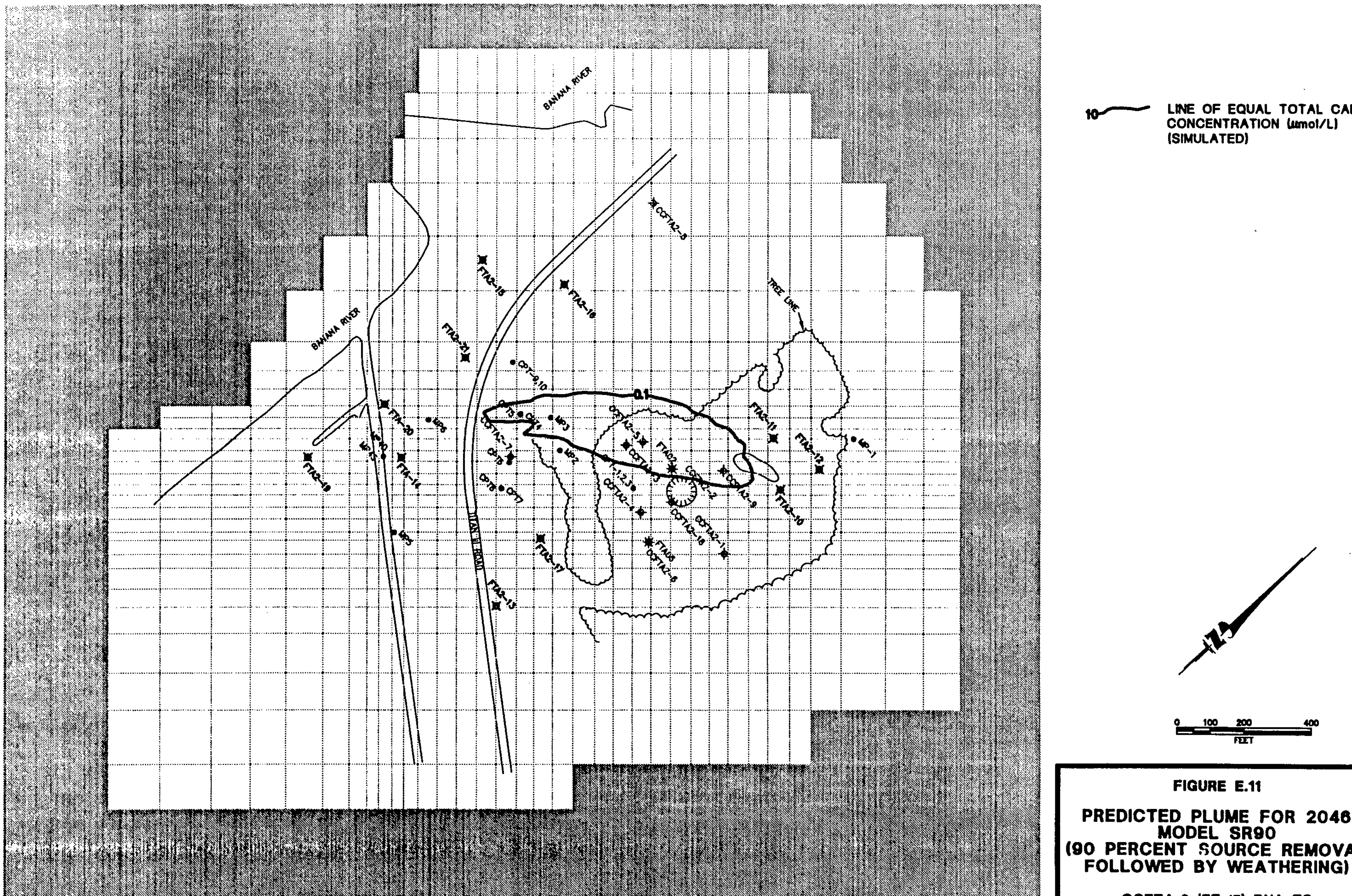


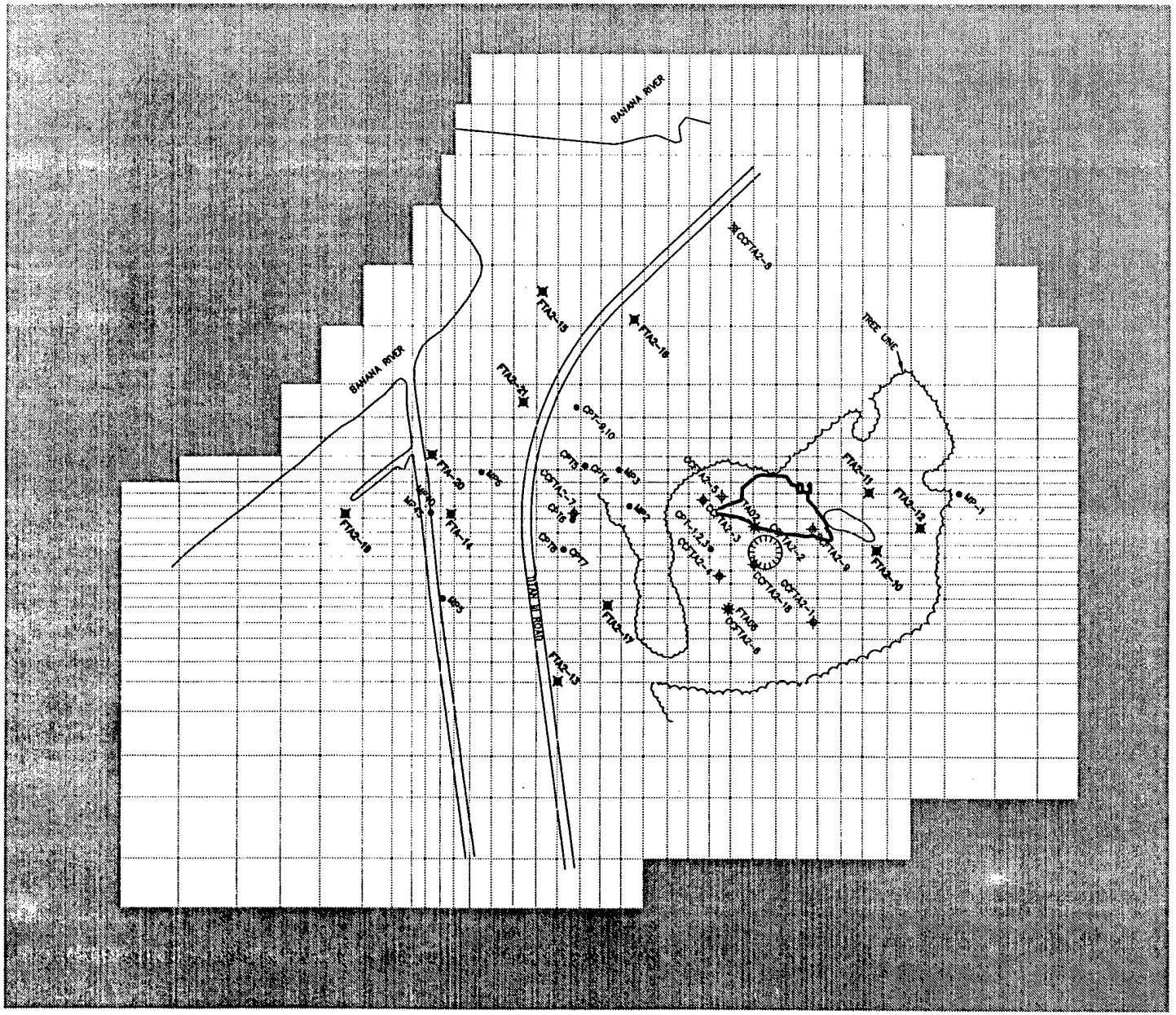
FIGURE E.11

PREDICTED PLUME FOR 2046
MODEL SR90
(90 PERCENT SOURCE REMOVAL
FOLLOWED BY WEATHERING)

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS
ENGINEERING SCIENCE, INC.
Denver, Colorado

L:\45029\FIGURES\SR90_50, 04/21/97 at 2:39



10 LINE OF EQUAL TOTAL CAH CONCENTRATION (µmol/L) (SIMULATED)

0 100 200 400
FEET

FIGURE E.12

PREDICTED PLUME FOR 2056 MODEL SR90 (90 PERCENT SOURCE REMOVAL FOLLOWED BY WEATHERING)

CCFTA-2 (FT-17) RNA TS
Cape Canaveral Air Station, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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