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CONTAMINATION ASSESSMENT REPORT JET ENGINE TEST CELL NAS CECIL FIELD FL

3/1/1994

ABB ENVIRONMENTAL

CONTAMINATION ASSESSMENT REPORT

JET ENGINE TEST CELL
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

Unit Identification Code (UIC): N65928

Contract No. N62467-89-D-0317

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March 1994

FOREWORD

Subtitle I of the Hazardous and Solid Waste Amendments (HSWA) of 1984 to the Solid Waste Disposal Act (SWDA) of 1965 established a national regulatory program for managing underground storage tanks (USTs) containing hazardous materials, primarily petroleum products. Hazardous wastes stored in USTs were already regulated under the Resource Conservation and Recovery Act (RCRA) of 1976, which was also an amendment to SWDA. Subtitle I requires that the U.S. Environmental Protection Agency (USEPA) promulgate UST regulations. The program was designed to be administered by the individual States, who were allowed to develop more stringent standards, but not less stringent standards. Local governments were permitted to establish regulatory programs and standards that are more stringent, but not less stringent than either State or Federal regulations. The USEPA UST regulations are found in the Code of Federal Regulations, Title 40, Part 280 (Title 40 CFR 280), *Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks*, and Title 40 CFR 281, *Approval of State Underground Storage Tank Programs*. Title 40 CFR 280 was revised and published on September 23, 1988, and became effective December 22, 1988.

The Navy's UST program policy is to comply with all Federal, State, and local regulations pertaining to USTs. This report was prepared to satisfy the requirements of Chapter 17-770, Florida Administrative Code (FAC), *State Underground Petroleum Environmental Response*, regulations pertaining to petroleum contamination.

Questions regarding this report should be addressed to the Commanding Officer, Naval Air Station (NAS), Cecil Field, Jacksonville, Florida, or to Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM), Code 184 PDC, at 803-743-0307.

EXECUTIVE SUMMARY

The Jet Engine Test Cell site is located northeast of the Jet Road and Ninth Street intersection on the main base of Naval Air Station (NAS) Cecil Field. A JP-5 fuel tanks yard with two 20,000-gallon underground storage tanks and one 5,000-gallon aboveground storage tank is located at the site. Leakage from the tank manways and numerous spills from overfilling have occurred in the past. In January 1991, the U.S. Army Corps of Engineers performed a preliminary contamination assessment at the site. Results of the preliminary assessment indicated the presence of free product in soil and groundwater at the fuel tanks yard.

A preliminary contamination assessment was performed by ABB Environmental Services, Inc. (ABB-ES), in December 1990 and by the U.S. Army Corps of Engineers in January 1991. During this period, 23 soil borings were drilled and 7 temporary shallow monitoring wells were installed and sampled at the site. Based on the results of the preliminary assessment, a contamination assessment in accordance with Chapter 17-770, Florida Administrative Code (FAC), was recommended for the site. From June to December 1991, ABB-ES installed 12 shallow monitoring wells and 3 deep wells to assess the extent of groundwater contamination at the site. In December 1991, NAS Cecil Field began construction activities at Building 339, interrupting the monitoring well installation and sampling program. The field investigation was resumed in September 1993. From September 1993 to January 1994, 31 soil borings were drilled, and 9 shallow monitoring wells and 1 double-cased deep well were installed.

The objectives of this contamination assessment are to assess the degree and extent of petroleum contamination in soil and groundwater at the site and to recommend a feasible course of action, if necessary, to attain compliance with State regulations. Groundwater samples were collected and analyzed for petroleum constituents of the kerosene analytical group as defined in Chapter 17-770, FAC. The executive summary figure shows the location of the soil borings and monitoring wells and the approximate extent of groundwater and soil contamination. A contamination assessment report has been prepared and is attached herewith. The findings, conclusions, and recommendations of the contamination assessment report are summarized below.

FINDINGS

- Excessively contaminated soil was found at the fuel tanks yard, east of the yard, and southeast of the yard. Excessively contaminated soil was detected in the vicinity of Building 339 and north of Building 339. The vertical extent of excessively contaminated soil is approximately 7 feet below land surface (bls).

- There are two potable water wells on the base within a ¼-mile radius of the site. Neither well is expected to be affected by petroleum contamination from the site.

- Free product (JP-5) was observed in two shallow monitoring wells, CEF-811-09 and CEF-811-19, on November 4, 1993, and January 28, 1994. The free product thickness in the wells was 0.72 foot and 0.78 foot, respectively, on November 4, 1993, and 1.79 feet and 1.16 feet, respectively, on January 28, 1994.

- The greatest concentrations of contamination detected in groundwater samples from monitoring wells that did not contain free product are as follows: concentrations of total volatile organic aromatics (total VOA) were 440 micrograms per liter ($\mu g/\ell$) or parts per billion (ppb), benzene was 1.8 $\mu g/\ell$, and total naphthalenes were 241 $\mu g/\ell$. Total recoverable petroleum hydrocarbons (TRPH) were not detected in any of the monitoring wells. The Chapter 17-770, FAC, regulatory standards for total VOA, benzene, total naphthalenes, and TRPH are 50 $\mu g/\ell$, 1 $\mu g/\ell$, 100 $\mu g/\ell$, and 5 milligrams per liter (mg/ℓ) or parts per million (ppm), respectively.

CONCLUSIONS

- The source of the contamination is believed to be leaks and spills from the underground storage tanks at the fuel tanks yard.

- Groundwater and soil contamination at the Jet Engine Test Cell site exceeds Chapter 17-770, FAC, remedial target levels.

- The approximate extent of groundwater contamination, based on free product measurement and laboratory analytical results for total VOA and total naphthalenes, is shown on the executive summary figure. Analytical results from deep monitoring well CEF-811-22D indicate the vertical extent of groundwater contamination does not exceed 25 feet bls. The data indicate the contaminant plume is migrating from the fuel tanks yard northeast toward Building 811.

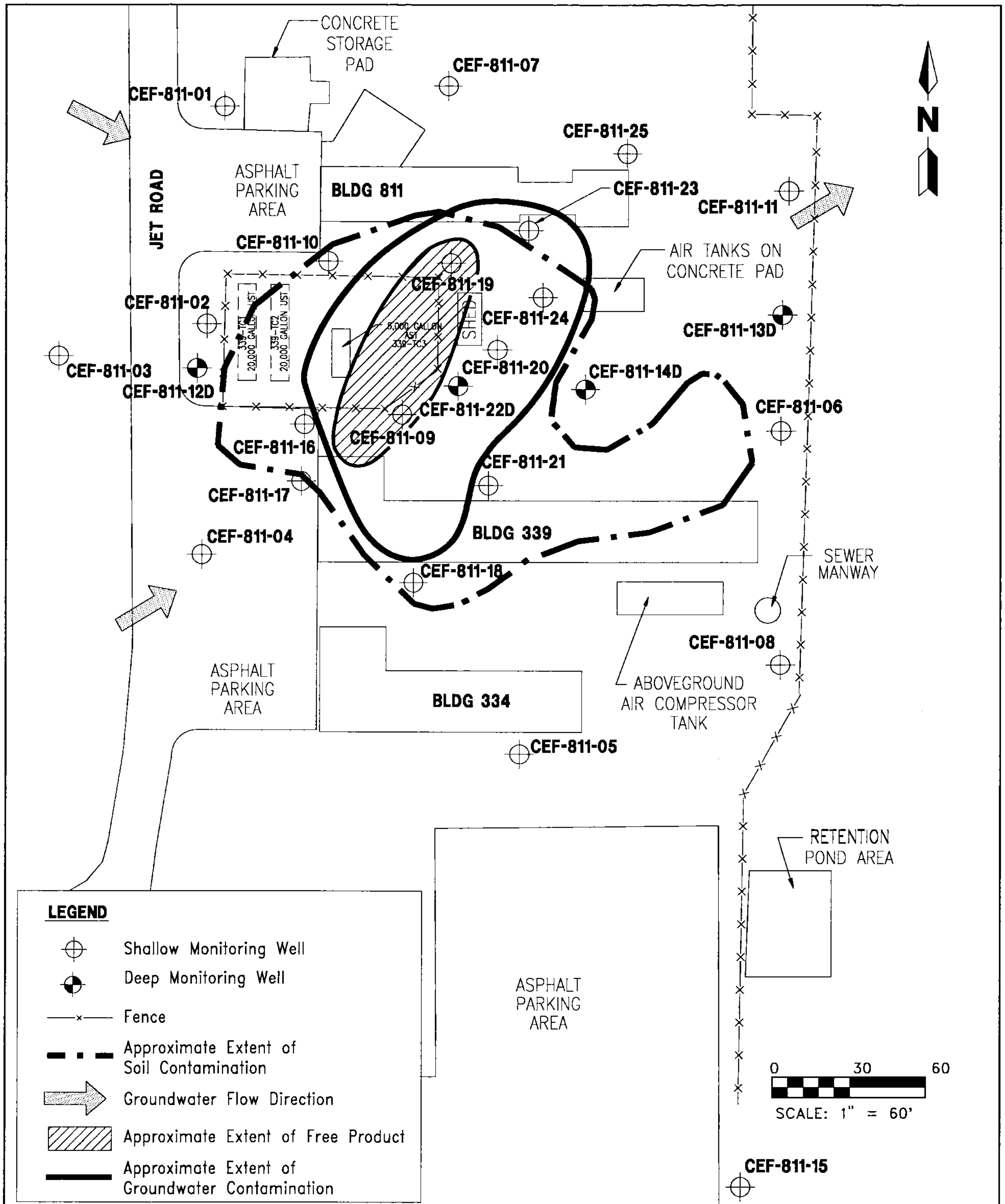
- A comparison of groundwater analytical results from 1991 and 1993 shows the extent of petroleum contamination has increased in the vicinity of the fenced area on the east side of the site. These analytical data are consistent with the groundwater flow direction, which is east-northeast.

RECOMMENDATIONS

Based on the findings and interpretations of this contamination assessment, ABB-ES recommends the following.

- Initial remedial action should be taken to remove free product from monitoring wells CEF-811-09 and CEF-811-19.

- A remedial action plan should be prepared to address the soil and groundwater petroleum contamination at the Jet Engine Test Cell site.



EXECUTIVE SUMMARY FIGURE

exec-sum/NP/3-11-94

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JET ENGINE TEST CELL
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

ACKNOWLEDGMENTS

In preparing this report, The Underground Storage Tank Section of the Comprehensive Long-Term Environmental Action, Navy Group at ABB Environmental Services, Inc., commends the support, assistance, and cooperation provided by the personnel at Naval Air Station Cecil Field, Jacksonville, Florida, and Southern Division, Naval Facilities Engineering Command.

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GLOSSARY

ABB-ES	ABB Environmental Services, Inc.
ASTM	American Society for Testing and Materials
BETX	benzene, ethyl benzene, toluene, and xylenes
bls	below land surface
CA	contamination assessment
CAP	contamination assessment plan
CAR	contamination assessment report
CFR	Code of Federal Regulations
CompQAP	Comprehensive Quality Assurance Plan
CTO	contract task order
°C	degrees Celsius
°F	degrees Fahrenheit
EDB	ethylene dibromide
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FDER	Florida Department of Environmental Regulation
FID	flame ionization detector
ft/day	feet per day
ft^2/day	feet squared per day
GC	gas chromatograph
gpm	gallons per minute
HSWA	Hazardous and Solid Waste Amendments of 1984
I	hydraulic gradient
JP	jet petroleum
K	hydraulic conductivity
mg/ℓ	milligrams per liter
msl	mean sea level
MTBE	methyl tert-butyl ether
n	porosity
NAS	Naval Air Station
NGVD	National Geodetic Vertical Datum
OVA	organic vapor analyzer

PAH	polynuclear aromatic hydrocarbons
Pb	lead
PCA	preliminary contamination assessment
POA	plan of action
ppb	parts per billion
ppm	parts per million
PVC	polyvinyl chloride
RAP	Remedial Action Plan
RCRA	Resource Conservation and Recovery Act
SOUTHNAV-FACENGCOM	Southern Division, Naval Facilities Engineering Command
SPT	standard penetration test
SWDA	Solid Waste Disposal Act of 1965
T	transmissivity
TRPH	total recoverable petroleum hydrocarbons
UIC	Unit Identification Code
USACOE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
UST	underground storage tank
V	velocity
VOA	volatile organic aromatics
VOCs	volatile organic compounds

1.0 INTRODUCTION

ABB Environmental Services, Inc. (ABB-ES), was authorized on September 21, 1990, by Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) to conduct a contamination assessment (CA) and develop a contamination assessment report (CAR) for the Jet Engine Test Cell site at Naval Air Station (NAS) Cecil Field in Jacksonville, Florida. NAS Cecil Field is situated in southwestern Duval County at the junction of Highway 228 (Normandy Boulevard) and 103rd Street (Figure 1-1). Due to construction activities at Building 339, the initial field investigative program was terminated before the CA was completed. The field investigation was resumed on September 14, 1993. The scope of services for the work is described in contract task order (CTO) No. 103, the plan of action (POA), and the contamination assessment plan (CAP) and includes the following:

- collecting soil samples from borings in the unsaturated zone for headspace analysis using an organic vapor analyzer (OVA) to assess the horizontal and vertical extent of petroleum contaminated soil,
- collecting saturated soil samples for field gas chromatograph (GC) screening to aid in placing monitoring wells to assess groundwater contamination at the site,
- installing and sampling groundwater monitoring wells to estimate the horizontal and vertical extent of groundwater contamination,
- collecting water level data to assess the groundwater flow direction and hydraulic gradient at the site,
- conducting a potable well inventory within a 0.25-mile radius of the site,
- conducting slug tests on selected wells to estimate aquifer characteristics, and
- reducing and analyzing data gathered during the CA to complete this CAR.

In January 1991, the U.S. Army Corps of Engineers (USACOE) conducted a preliminary contamination assessment (PCA) at the Jet Engine Test Cell site and submitted the PCA to SOUTHNAVFACENGCOM on March 6, 1991. A copy of the USACOE PCA report is attached as Appendix A.

The following sections of this report present the background information, data compilation, results, conclusions, and recommendations of the CAR. For convenience, the prefix "CEF-811-" has been replaced with "MW-" throughout the text of this report for monitoring well identification.

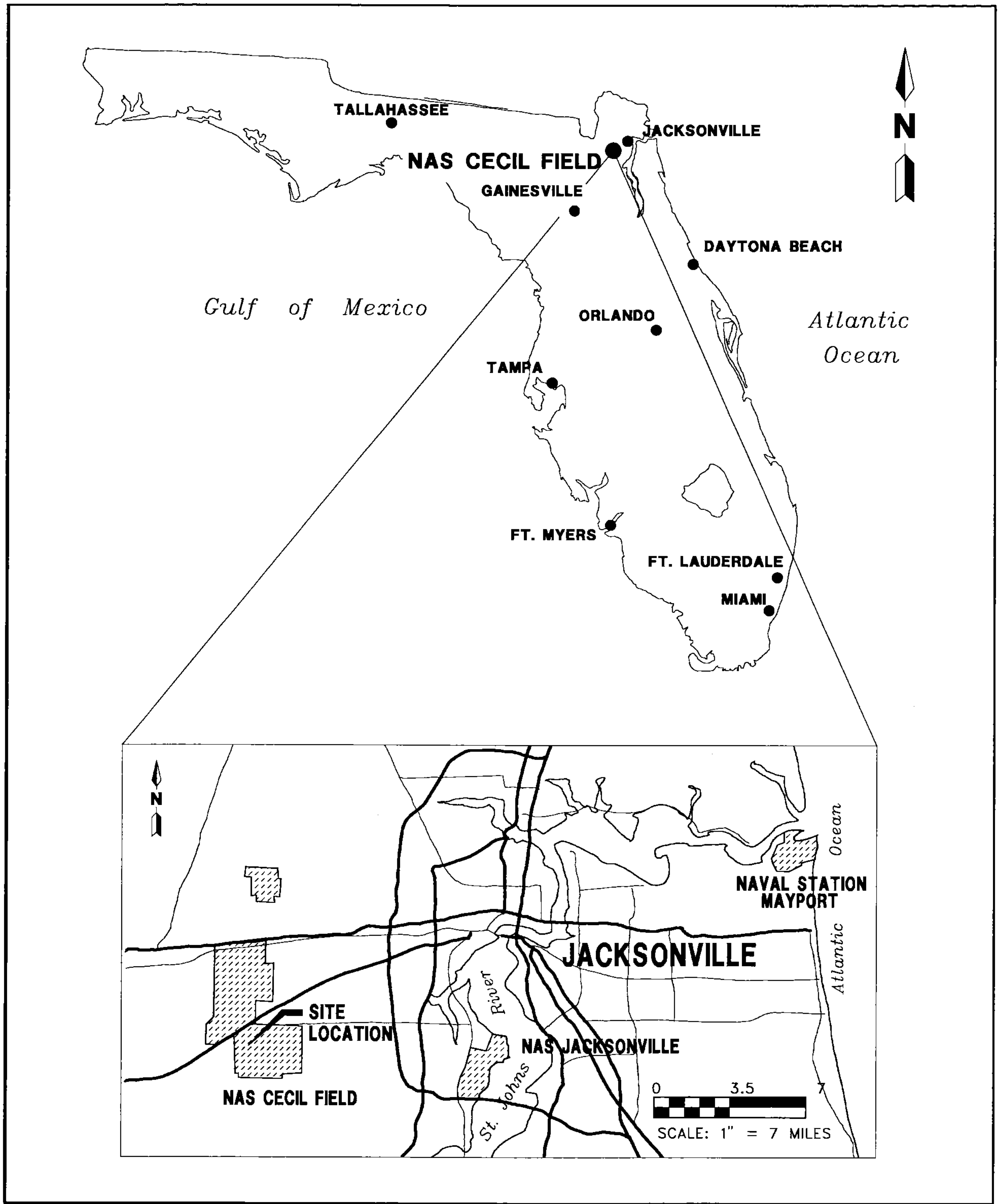

FIGURE 1-1
FACILITY LOCATION MAP

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JET ENGINE TEST CELL
NAS CECIL FIELD
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2.0 SITE BACKGROUND

The Jet Engine Test Cell is located at NAS Cecil Field, Jacksonville, Florida. The site is located on the main base, northeast of the Jet Road and Ninth Street intersection (Figure 2-1).

2.1 SITE DESCRIPTION. The Jet Engine Test Cell facilities consist of four buildings, each facing Jet Road. Building 811 is northernmost, Buildings 339 and 334 are central, and Building 328 is southernmost (Figure 2-2). Building 811 houses some of the maintenance facilities associated with the test cell, which include repair and maintenance of electrical systems and painting operations. Building 328 is an office and locker room area with a small garage attached for automotive repair and maintenance. The cells in which the jet engines are tested are Buildings 334 and 339.

The area between Jet Road and the buildings is covered with either asphalt or concrete. The remaining area is generally unpaved. Between Buildings 811 and 339 is a fuel tanks yard, approximately 800 square feet in area. In the western part of the yard are two 20,000-gallon, asphalt-coated steel, underground storage tanks (USTs) numbered 339-TC1 and 339-TC2 (Figure 2-3). These tanks, installed in 1953, contain JP-5 jet fuel. Tanks 339-TC1 and 339-TC2 have corrosion-resistant coated metal piping with cathodic protection.

In the eastern part of the yard is a third storage tank. Tank 339-TC3 is a 5,000-gallon aboveground storage tank constructed of stainless steel. Tank 339-TC3, installed in 1970, rests on a concrete base and is surrounded by a 3-foot high concrete block wall. The associated piping for tank 339-TC3 has no parts in contact with the soil. All tanks are reported to be gauged daily.

2.2 SITE HISTORY. In October 1989, as part of a release detection program for naval activities in Florida, precision fitness tests were attempted on Tanks 339-TC1 and 339-TC2. Due to inadequate seals between the manway covers and the tank walls, leaks occurred and the tests were precluded. The facility plans to repair the seals between the manway covers and the tank walls and test the tanks and pipelines for tightness. Several spills from these tanks have also occurred as a result of overfilling.

As an outcome of the release detection program, a PCA was initiated at the site by ABB-ES in December 1990. Six shallow soil borings were drilled and four soil samples were collected for OVA headspace analysis. In addition, five soil samples were sent to an approved analytical laboratory and analyzed for kerosene analytical group compounds. The results of the soil and OVA headspace analyses indicated the presence of excessively contaminated soil and, in accordance with Chapter 17-770, Florida Administrative Code (FAC), a CA was initiated.

In January 1991, the USACOE drilled and obtained OVA headspace readings for 17 soil borings and installed 7 temporary groundwater monitoring wells in a separate PCA. The PCA concluded that free product (JP-5) was present in soil and groundwater at the site (USACOE, 1991).

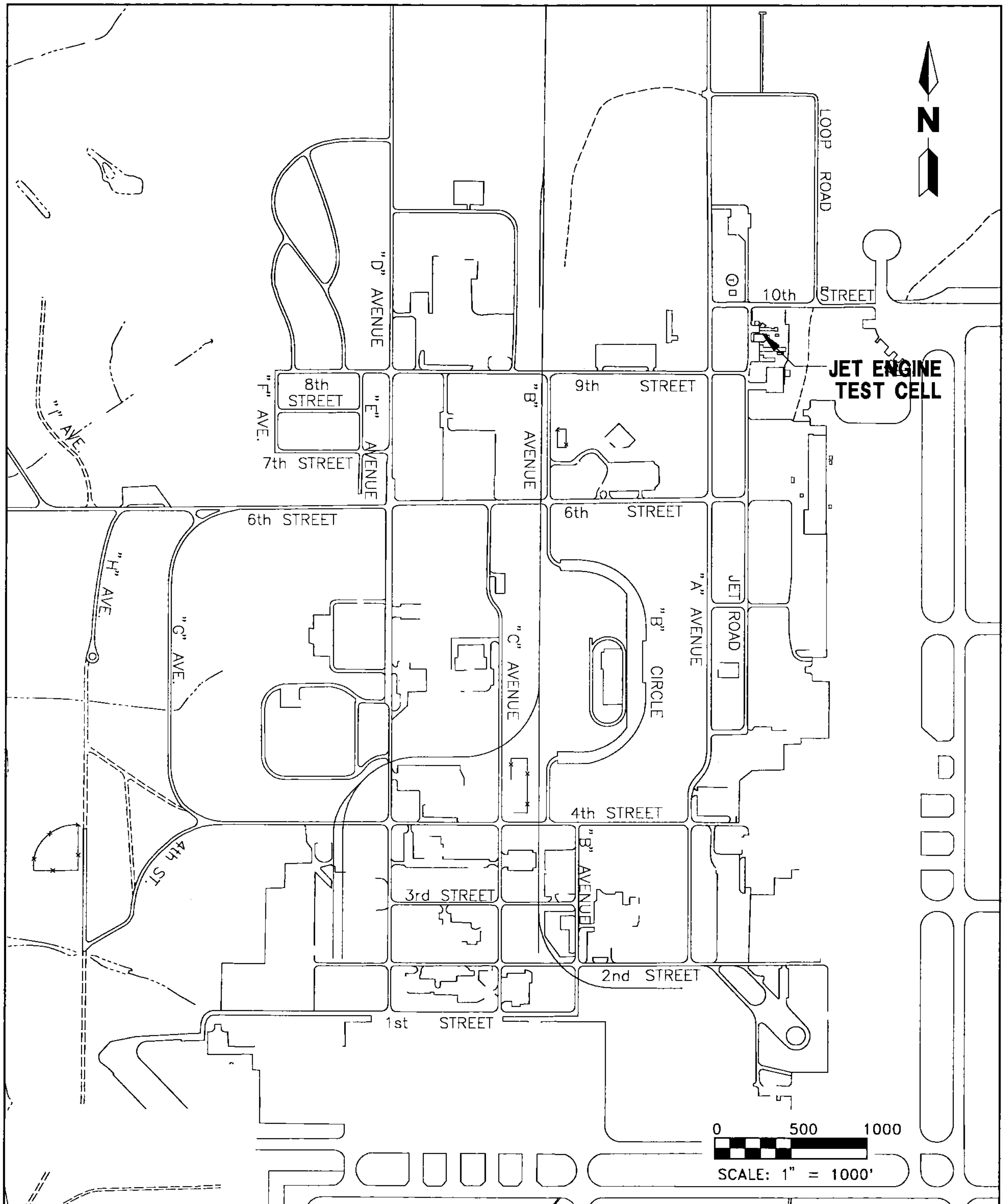

FIGURE 2-1
SITE LOCATION MAP

LOCATION/NP/3-11-94

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

CONTAMINATION ASSESSMENT REPORT

JET ENGINE TEST CELL
NAS CECIL FIELD
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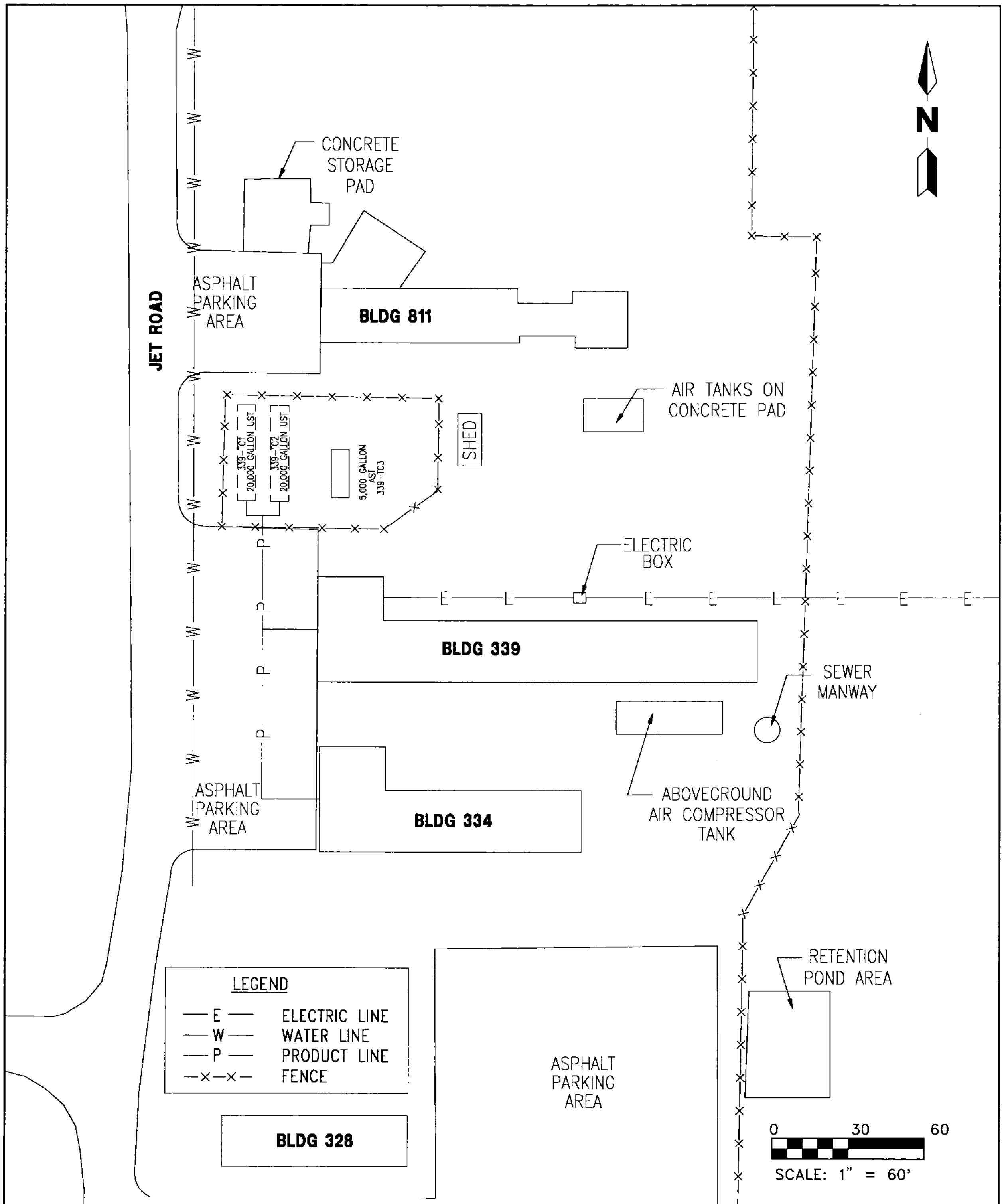

FIGURE 2-2
SITE PLAN

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SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

CONTAMINATION ASSESSMENT REPORT

JET ENGINE TEST CELL
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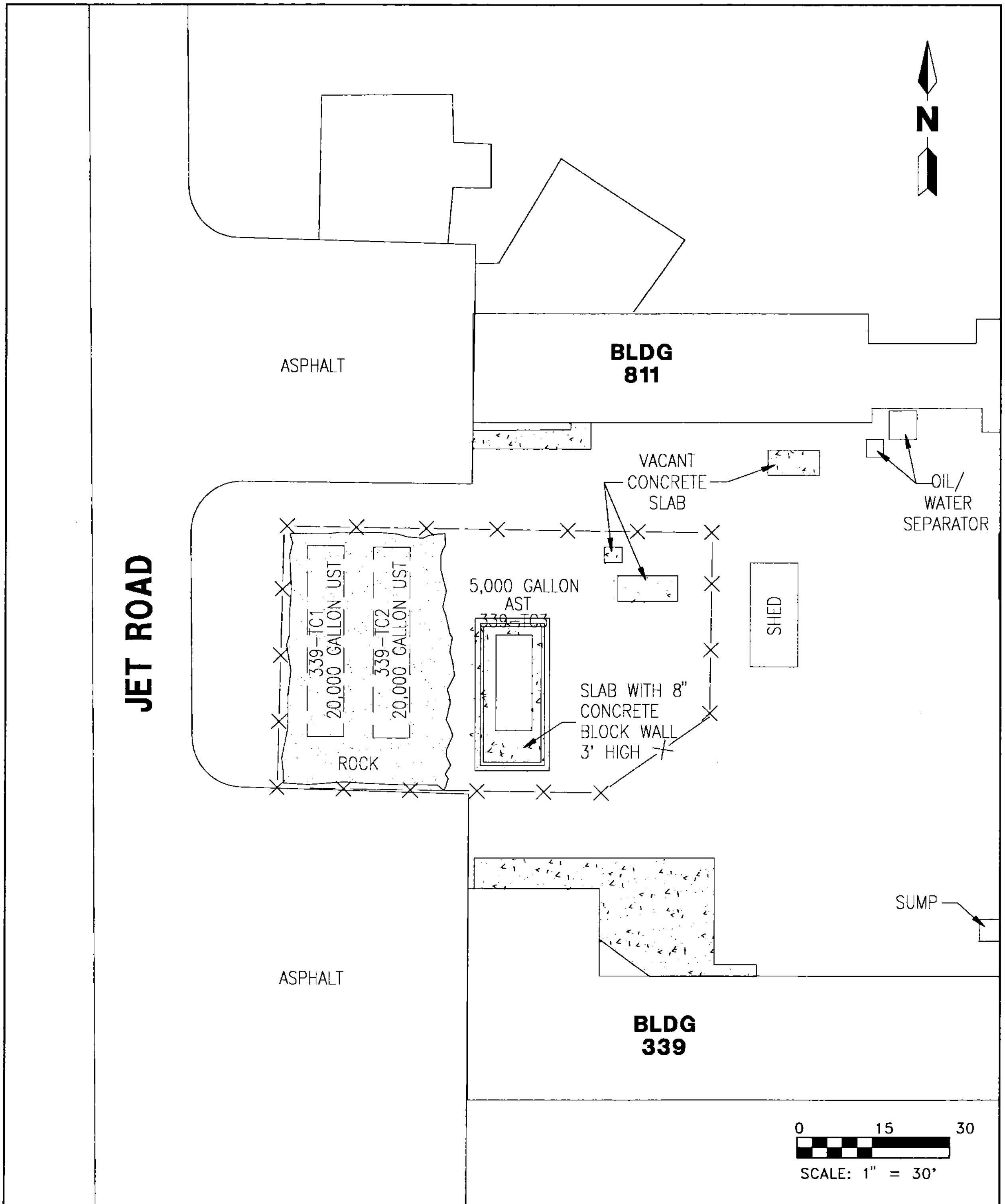

FIGURE 2-3
FUEL TANKS YARD

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From June to December 1991, as part of the CA, ABB-ES installed 12 shallow monitoring wells and 3 deep wells to assess the extent of groundwater contamination at the site. In December 1991, NAS Cecil Field began the demolition and reconstruction of Building 339, interrupting the monitoring well installation and sampling program. In December 1991, ABB-ES collected groundwater samples from all site monitoring wells that did not contain free product. The groundwater samples were shipped to ENSECO-Wadsworth/Alert Laboratories for analysis of kerosene analytical group compounds.

The analytical results of the soil and groundwater sampling were presented at a meeting with the Florida Department of Environmental Protection (FDEP) (formerly the Florida Department of Environmental Regulation [FDER]). At the meeting, it was agreed that additional soil borings and monitoring wells must be installed at the site to adequately assess the vertical and horizontal extent of soil and groundwater contamination and that free product should be removed from the monitoring wells in which it was observed. In September 1993, the field investigation at the Jet Engine Test Cell was resumed. Thirty-one soil borings were sampled for OVA headspace analysis and one additional two-stage deep monitoring well and six shallow monitoring wells were installed. Groundwater samples were collected and shipped to ENSECO-Wadsworth/Alert Laboratories for analysis of kerosene analytical group compounds. NAS Cecil Field is pursuing a subcontract to remove and dispose of free product from monitoring wells MW-09 and MW-19.

During the construction activities initiated at the site in 1991, it was necessary to lower the water level in the area excavated for the new building foundation. Shallow evacuation wells were installed along the north and south sides of the excavation. According to construction personnel, the wells were connected in series and water was pumped from them to an oil-water separator at a rate of 10 to 15 gallons per minute (gpm). Water from the oil-water separator was then discharged to the facility wastewater treatment plant via a nearby sewer drain. Any soil that was excavated was disposed by the construction contractor as non-hazardous petroleum contaminated soil. Manifests for disposal of free product and contaminated soil or groundwater recovered during construction activities at the site are not readily available but can be obtained from NAS Cecil Field, if necessary.

3.0 SITE CONDITIONS

3.1 PHYSIOGRAPHY.

3.1.1 Regional The general physiography of the Duval County area is discussed in Appendix B, Site Conditions.

3.1.2 Site Specific NAS Cecil Field lies within the Duval Uplands, an irregular flat plain with elevations ranging from 70 to 100 feet above mean sea level (msl). The land surface at the Jet Engine Test Cell site is nearly flat, sloping slightly south and east. Elevations range from approximately 80 feet msl north of Building 811 to 78 feet msl in the parking lot south of Building 328, a distance of approximately 500 feet. Sediments of the area consist typically of sand and clayey sand (Scott, 1978; Leve, 1966). General surface drainage in the surrounding area of the Jet Engine Test Cell site is southeast toward a detention pond adjacent to and east of the Building 328 parking lot.

3.2 HYDROGEOLOGY.

3.2.1 Regional The general hydrogeology in the Duval County area is discussed in Appendix B.

3.2.2 Site Specific The surficial aquifer at NAS Cecil Field is comprised of Holocene to Pliocene undifferentiated deposits. At the Jet Engine Test Cell site, these deposits were encountered in the deepest borehole, at a depth of 45 feet below land surface (bls). At the North Fuel Farm, approximately 2,000 feet north of the site, these sediments are at least 90 feet thick. Sediments at the site are generally characterized by a coarsening-upward sequence. From land surface to approximately 30 feet bls, sediments are typically very fine- and fine-grained sand with a small percentage of silt. From approximately 30 feet bls to at least 32 feet bls, the sediments have a substantially higher percentage of clay. From 32 feet bls to approximately 45 feet bls, sediments grade from sand to clayey sand to clay. A highly plastic clay lens approximately 4 feet thick was encountered in the borehole for MW-22D at a depth of 28 to 32 feet bls. Sediments beneath the clay layer are very fine-grained to medium-grained sand and clayey sand to a depth of 45 feet bls. Lithologic logs for all soil borings and monitoring wells are presented in Appendix C. A fence diagram illustrating the generalized lithology at the site encountered during drilling operations is shown in Figure 3-1.

Measured depth to water in the monitoring wells varied from about 4 to 7 feet bls across the site. Water level data from MW-22D, which is screened just below the clay layer, indicate a slight vertical downward gradient between the upper and lower water-bearing zones. It is likely that the clay acts as a semi-confining layer separating the surficial aquifer into upper and lower water-bearing zones.

Water table elevation data collected during this CA indicate the direction of groundwater flow is to the east and northeast. Water table elevations were measured on December 3, 1991, February 22, 1992, March 20, 1992, November 4, 1993, and January 28, 1994. Water level data for these dates are presented in

Figure 3-1 Fence Diagram

Table 3-1 and illustrated in Figures 3-2 through 3-6. In the PCA report submitted by the USACOE, groundwater was shown to flow toward the southwest. Water table elevations reported by the USACOE were approximately 5 feet below those recorded by ABB-ES.

Table 3-1
Water Table Elevation Data

Contamination Assessment Report
Jet Engine Test Cell
NAS Cecil Field
Jacksonville, Florida

Monitoring Well No.	Total Well Depth (feet)	TOC Elevation[1]	December 3, 1991		February 22, 1992		March 20, 1992		November 4, 1993		January 28, 1994	
			Depth to Water (feet)	Water Level Elevation[1] (feet)	Depth to Water (feet)	Water Level Elevation[1] (feet)	Depth to Water (feet)	Water Level Elevation[1] (feet)	Depth to Water (feet)	Water Level Elevation[1] (feet)	Depth to Water (feet)	Water Level Elevation[1] (feet)
CEF-811-01	14.78	80.46	6.37	74.09	6.08	74.38	5.94	74.52	4.95	75.51	5.09	75.37
CEF-811-02	14.83	80.23	6.20	74.03	5.90	74.33	5.78	74.45	4.84	75.39	4.95	75.28
CEF-811-03	14.00	80.25	6.13	74.12	5.82	74.43	5.72	74.53	4.77	75.48	4.86	75.39
CEF-811-04	14.08	79.94	6.07	73.87	5.79	74.15	5.65	74.29	4.76	75.18	4.86	75.08
CEF-811-05	12.68	79.63	6.20	73.43	5.90	73.73	5.75	73.88	5.04	74.59	5.19	74.44
CEF-811-06	12.92	80.14	7.00	73.14	6.72	73.42	6.60	73.54	5.87	74.27	5.99	74.15
CEF-811-07	13.92	80.03	6.58	73.45	6.30	73.73	6.19	73.84	5.27	74.76	5.46	74.57
CEF-811-08	14.00	79.89	6.66	73.23	6.35	73.54	6.23	73.66	5.57	74.32	5.66	74.23
CEF-811-09	14.00	80.02	FP	FP	FP	FP	FP	FP	FP	FP	FP	FP
CEF-811-10	14.11	80.02	6.21	73.81	5.90	74.12	5.77	74.25	4.83	75.19	5.00	75.02
CEF-811-11	13.68	80.27	7.42	72.85	7.15	73.12	7.06	73.21	6.37	73.90	6.45	73.82
CEF-811-12D	34.57	80.36	6.36	74.00	FP	--	6.03	74.33	5.55	74.81	5.17	75.19
CEF-811-13D	38.12	79.86	6.86	73.00	6.58	73.28	6.59	73.27	6.20	73.66	5.83	74.03
CEF-811-14D	40.51	79.76	6.68	73.08	5.78	73.98	5.46	74.30	5.64	74.12	4.91	74.85
CEF-811-15	12.51	78.04	4.52	73.52	4.18	73.86	4.09	73.95	3.77	74.27	3.77	74.27
CEF-811-16	15.00	80.01	--	--	--	--	--	--	4.95	75.06	5.10	74.91
CEF-811-17	15.00	79.97	--	--	--	--	--	--	4.97	75.00	5.09	74.88
CEF-811-18	15.00	80.15	--	--	--	--	--	--	5.41	74.74	5.54	74.61
CEF-811-19	15.00	79.40	--	--	--	--	--	--	FP	FP	FP	FP
CEF-811-20	15.00	79.63	--	--	--	--	--	--	6.03	73.60	5.52	74.11
CEF-811-21	15.00	79.79	--	--	--	--	--	--	5.51	74.28	5.33	74.46
CEF-811-22D	40.00	79.69	--	--	--	--	--	--	4.80	74.89	4.51	75.18
CEF-811-23	--	80.53	--	--	--	--	--	--	--	--	6.19	74.34
CEF-811-24	--	79.78	--	--	--	--	--	--	--	--	5.50	74.28
CEF-811-25	--	80.19	--	--	--	--	--	--	--	--	5.98	74.21

[1] Relative elevation datum is 80.00 feet located at southwest corner of Building 334.

Notes: TOC = top of casing.
FP = free product observed in well, no measurement recorded.
-- = well not installed when water levels recorded.

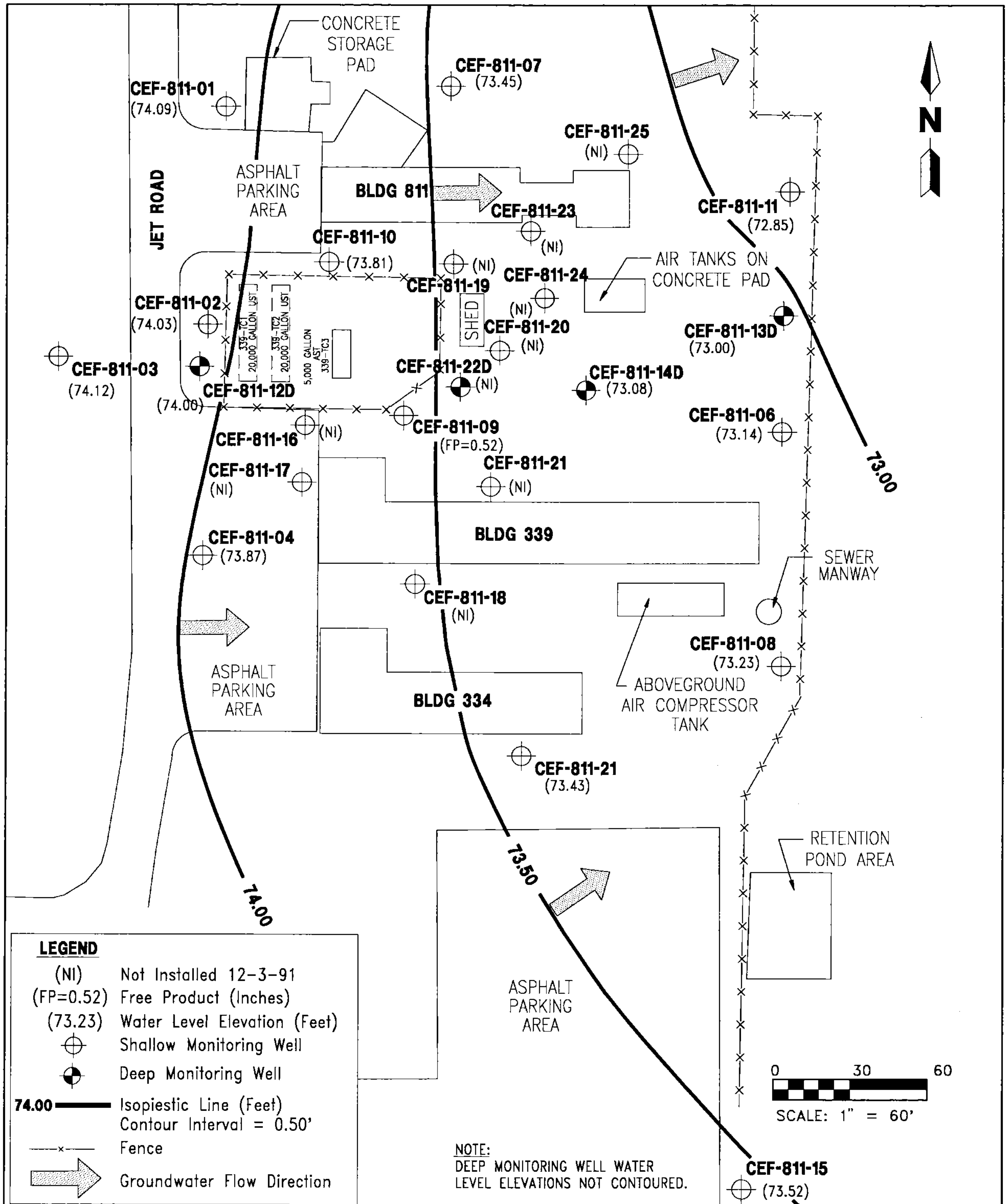

FIGURE 3-2
WATER TABLE ELEVATION MAP,
DECEMBER 3, 1991

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CAR/NP/3-11-94

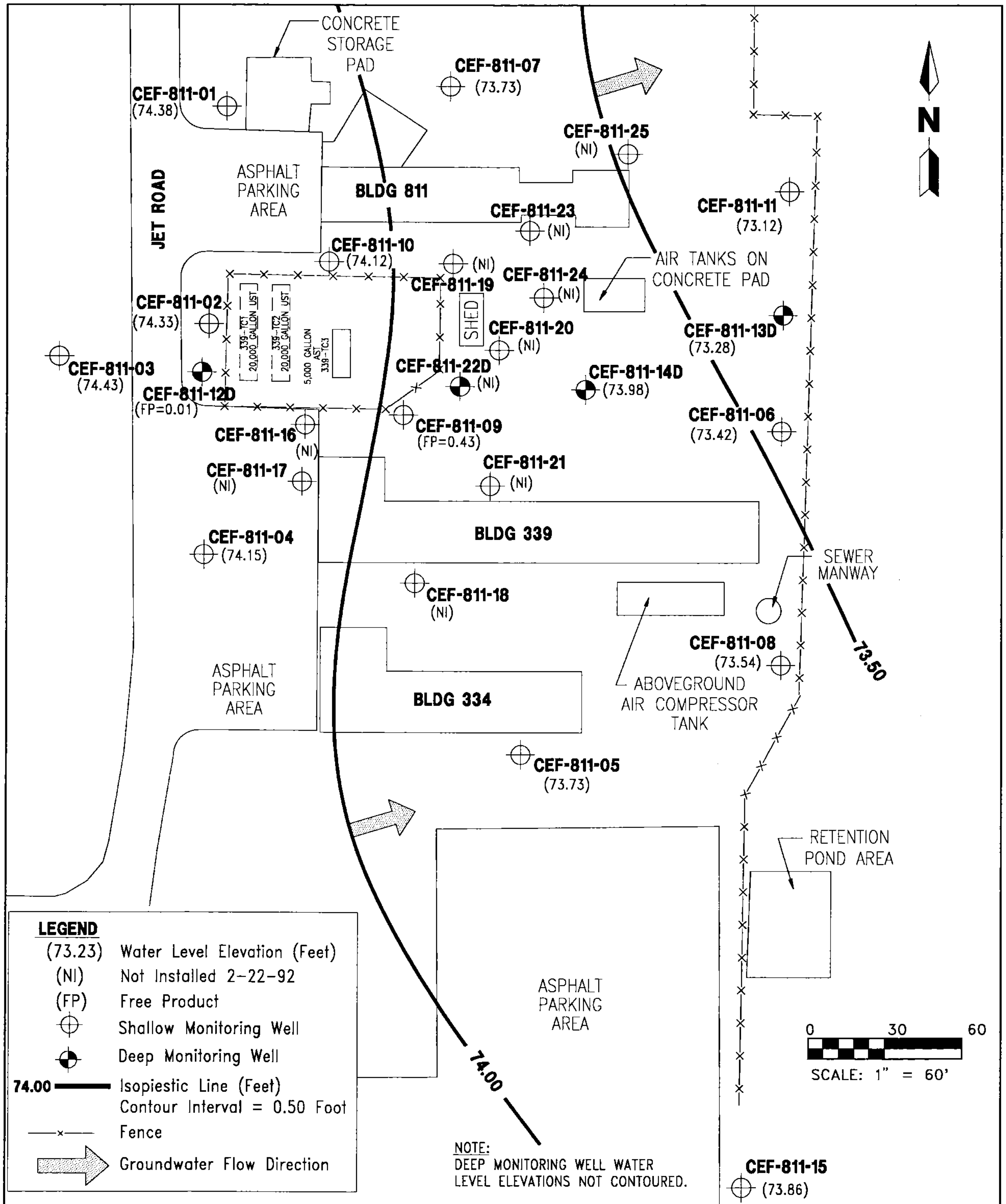

FIGURE 3-3
WATER TABLE ELEVATION MAP, FEBRUARY 22, 1992

CARPT.DWG/MAH/12-20-93

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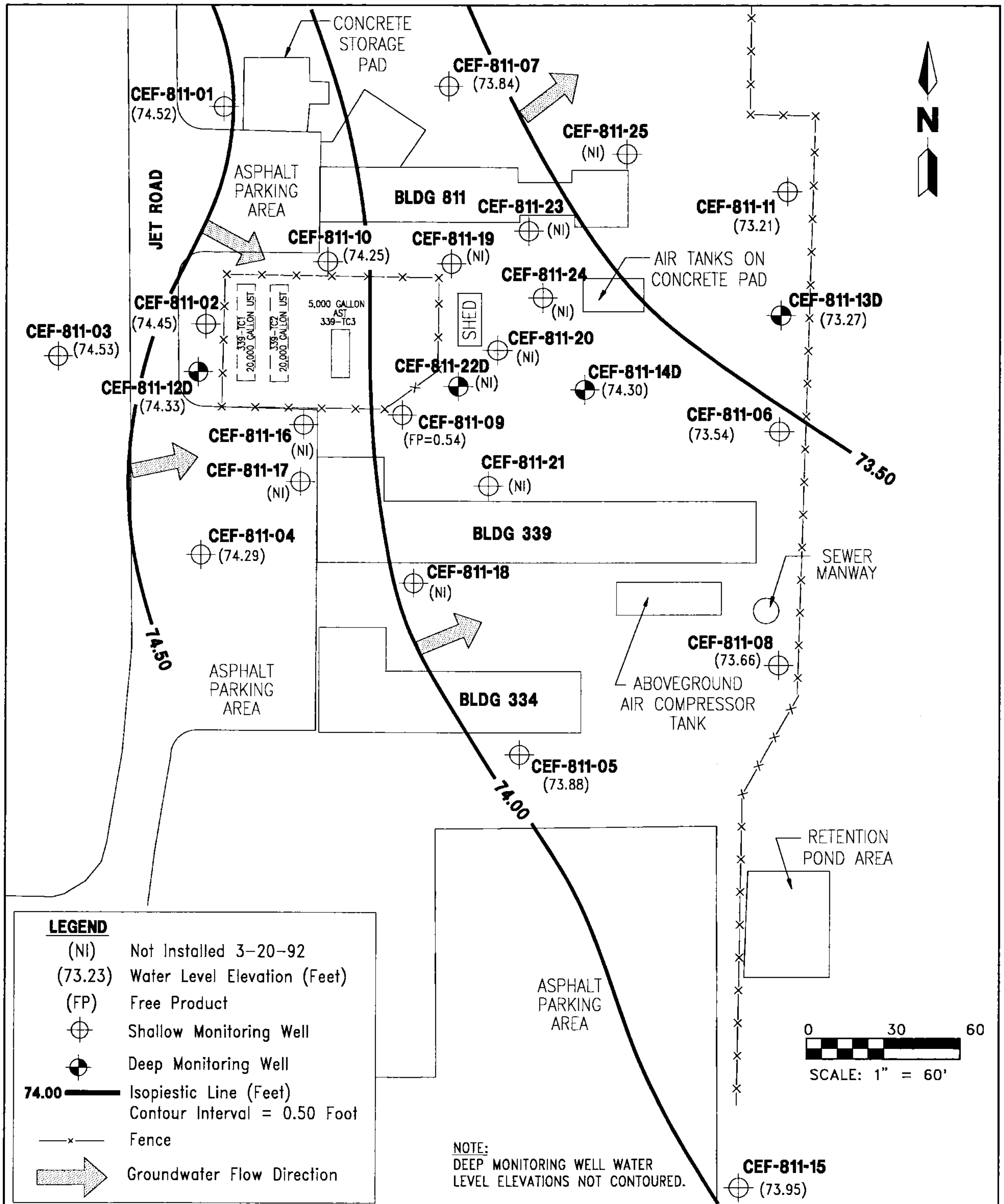

FIGURE 3-4
WATER TABLE ELEVATION MAP, MARCH 20, 1992

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JACKSONVILLE, FLORIDA

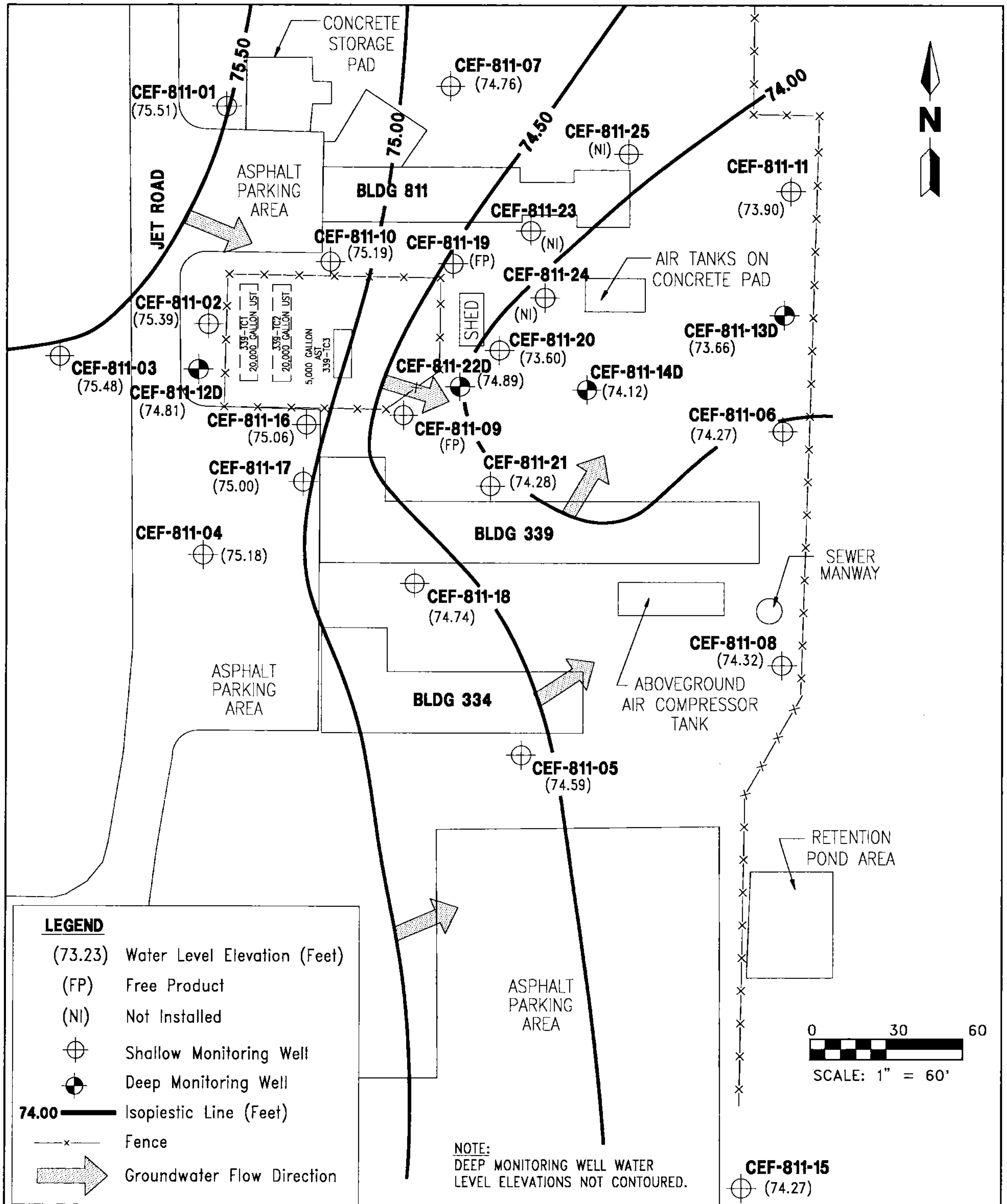

FIGURE 3-5
WATER TABLE ELEVATION MAP, NOVEMBER 4, 1993

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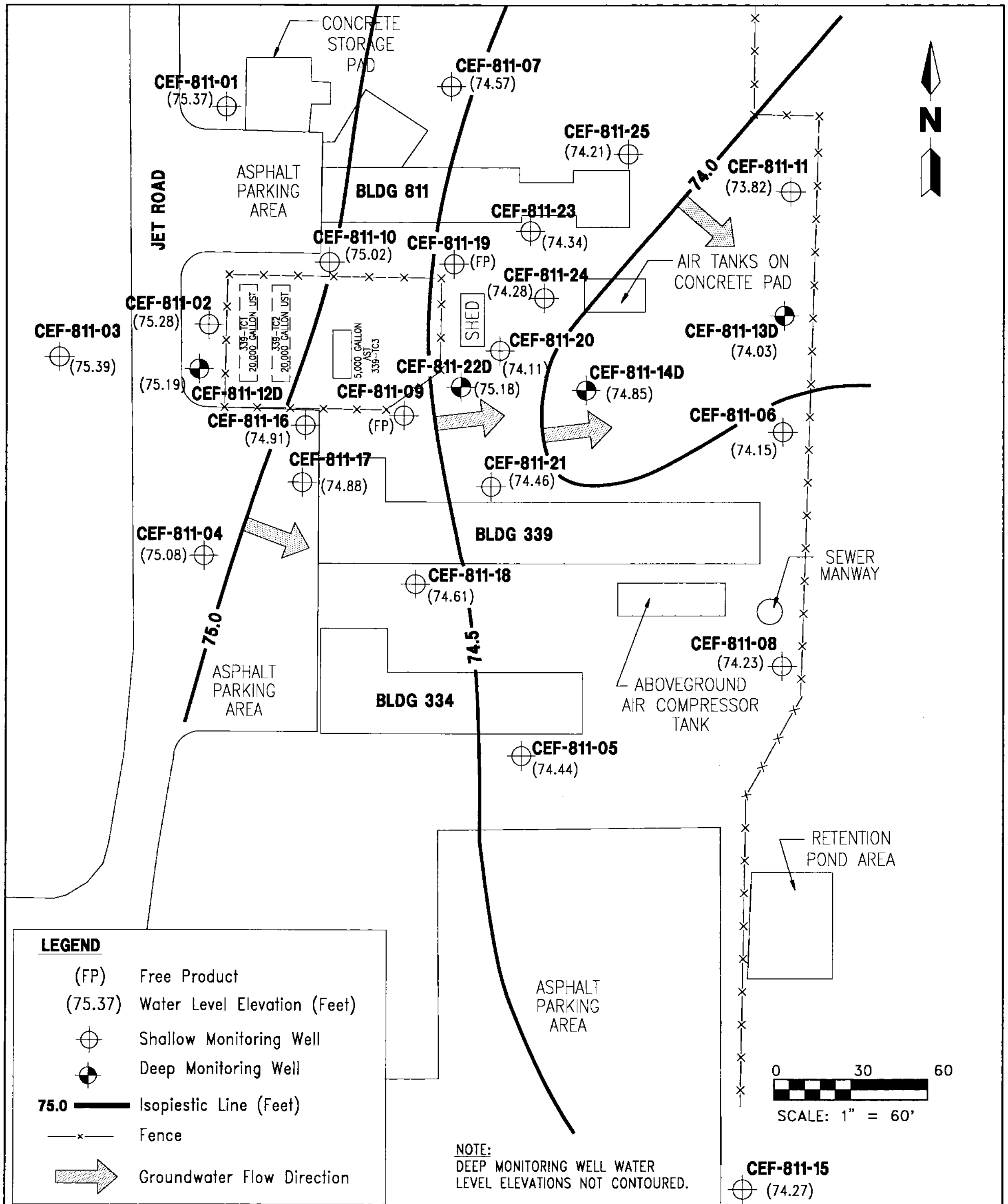

FIGURE 3-6
WATER TABLE ELEVATION MAP, JANUARY 28, 1994

CARPT3/NP/3-1-94

CONTAMINATION ASSESSMENT REPORT

JET ENGINE TEST CELL
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JACKSONVILLE, FLORIDA

4.0 FIELD METHODOLOGIES AND EQUIPMENT

All methodologies and equipment used during the course of this CA comply with the ABB-ES, FDEP-approved, Comprehensive Quality Assurance Plan (CompQAP). Appendix D, Investigative Methodologies and Procedures, describes all the investigative methodologies and equipment used during the CA.

4.1 SOIL BORING PROGRAM. In December 1990, as part of a PCA, ABB-ES hand augered six shallow soil borings (90SB-1 through 90SB-6) and collected soil samples for OVA headspace analysis. In January 1991, the USACOE drilled and sampled 17 soil borings (TC-1 through TC-17) in a separate PCA. In September 1993, ABB-ES drilled 31 additional shallow soil borings (93SB-1 through 93SB-31) in the vicinity of the fuel tanks yard, Building 339, and Building 811 to supplement the initial soil contamination investigation. Soil samples were collected from 1 foot bls and every 2 feet thereafter to the top of the water table. The water table was encountered at approximately 7.5 feet bls. Locations of soil borings drilled in 1990 and 1991 are shown in Figure 4-1. Locations of soil borings drilled in 1993 are shown in Figure 4-2. Soil headspace samples were analyzed for volatile organic compounds (VOCs) with an OVA equipped with a flame ionization detector (FID). The results of the soil boring and soil sampling program are discussed in Section 5.1.

4.2 MONITORING WELL INSTALLATION PROGRAM. In January 1991, the USACOE drilled and installed seven temporary monitoring wells in selected soil borings (TC-1, TC-3, TC-5, TC-6, TC-7, TC-10, and TC-15) during their PCA. In June through December 1991, ABB-ES supervised the drilling and installation of 12 shallow monitoring wells and 3 deep monitoring wells (MW-1 through MW-15) near the fuel tanks yard and Buildings 334, 339, and 811. In September 1993, ABB-ES drilled six additional shallow monitoring wells (MW-16 through MW-21) and one double-cased deep monitoring well (MW-22D). After reviewing the groundwater analytical data from the 1993 investigation, ABB-ES installed three additional monitoring wells (MW-23, MW-24, and MW-25) in January 1994 to better delineate the downgradient extent of free product and groundwater contamination at the site. Locations of all permanent site monitoring wells are shown in Figure 4-3.

The shallow monitoring wells were installed to depths ranging from 12.5 to 15.0 feet bls. Deep monitoring wells were installed to depths ranging from 34.5 to 40.5 feet. Installation details for shallow and deep monitoring wells are presented in Figures 4-4 and 4-5, respectively. Monitoring well construction details are included in Appendix C.

4.3 GROUNDWATER ELEVATION SURVEY. The top of the well casing elevation for each monitoring well was measured relative to a common datum using a surveyor's level and stadia rod. A National Geodetic Vertical Datum (NGVD) of 1929 benchmark could not be located in the immediate site vicinity; therefore, an arbitrary benchmark elevation of 80.00 feet was established at the ground surface at the southwest corner of Building 334 (Figure 3-2). The elevations and depth to water at all monitoring wells were measured on the north side of the well casing. Procedures for obtaining depth to groundwater measurements are described in Appendix D.

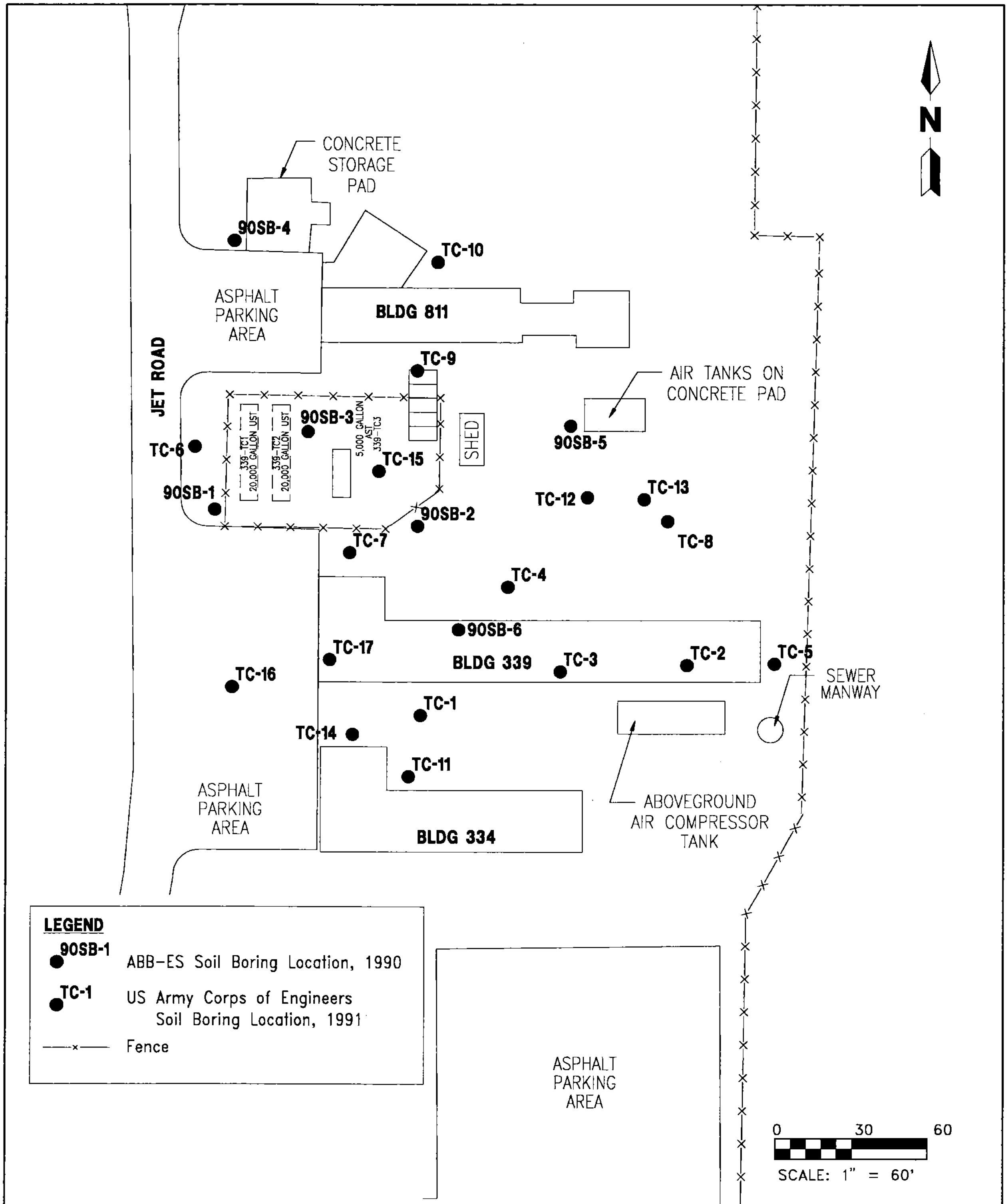

FIGURE 4-1
SOIL BORING LOCATION MAP, 1990 AND 1991

CARPT2.DWG/MAH/12-21-93

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

CONTAMINATION ASSESSMENT REPORT

JET ENGINE TEST CELL
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

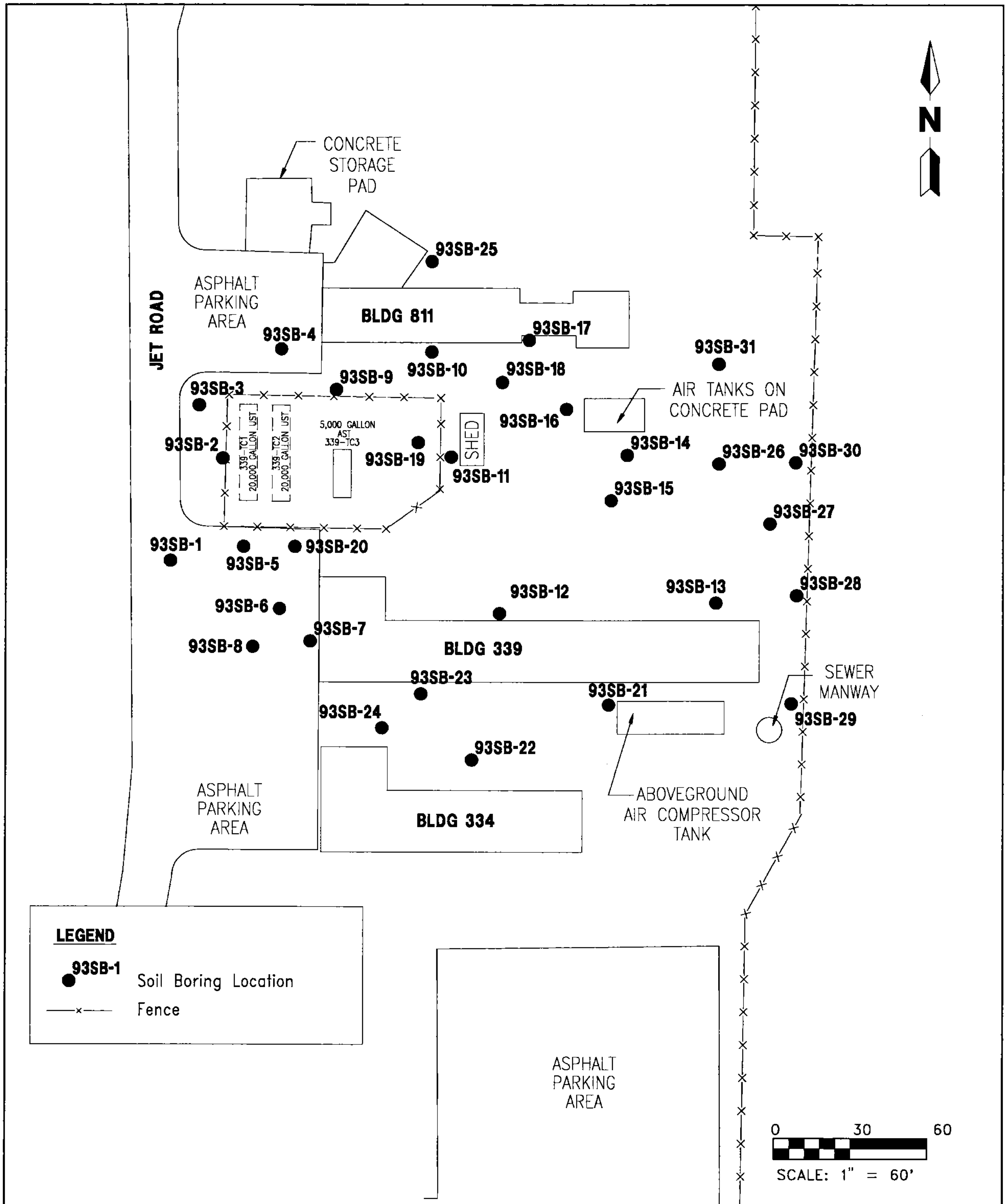

FIGURE 4-2
SOIL BORING LOCATION MAP,
OCTOBER 1993

CARPT.DWG/MAH/12-21-93

CONTAMINATION ASSESSMENT REPORT

JET ENGINE TEST CELL
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

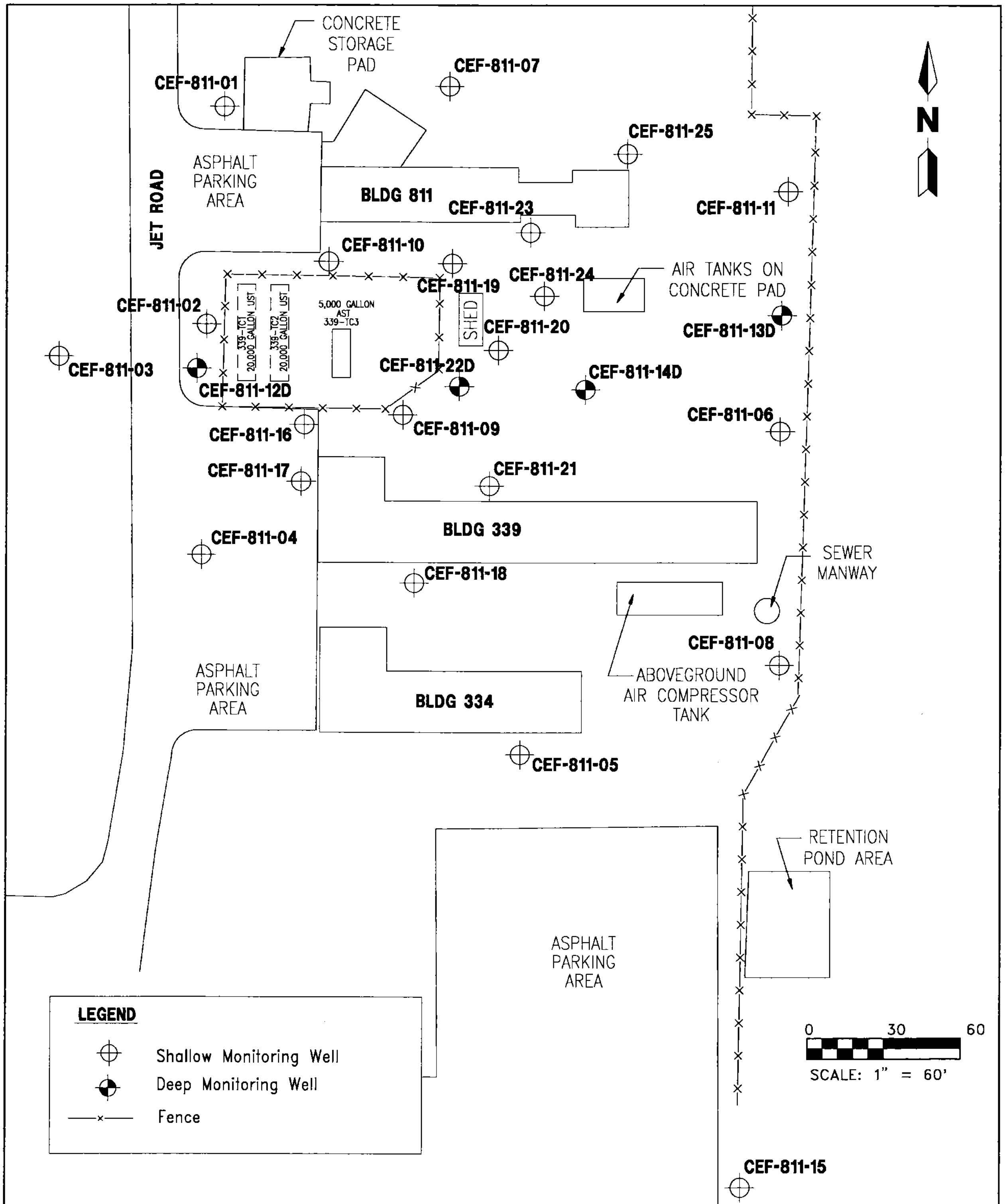

FIGURE 4-3
MONITORING WELL LOCATIONS

CARPT.DWG/MAH/12-20-93

CONTAMINATION ASSESSMENT REPORT

JET ENGINE TEST CELL
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

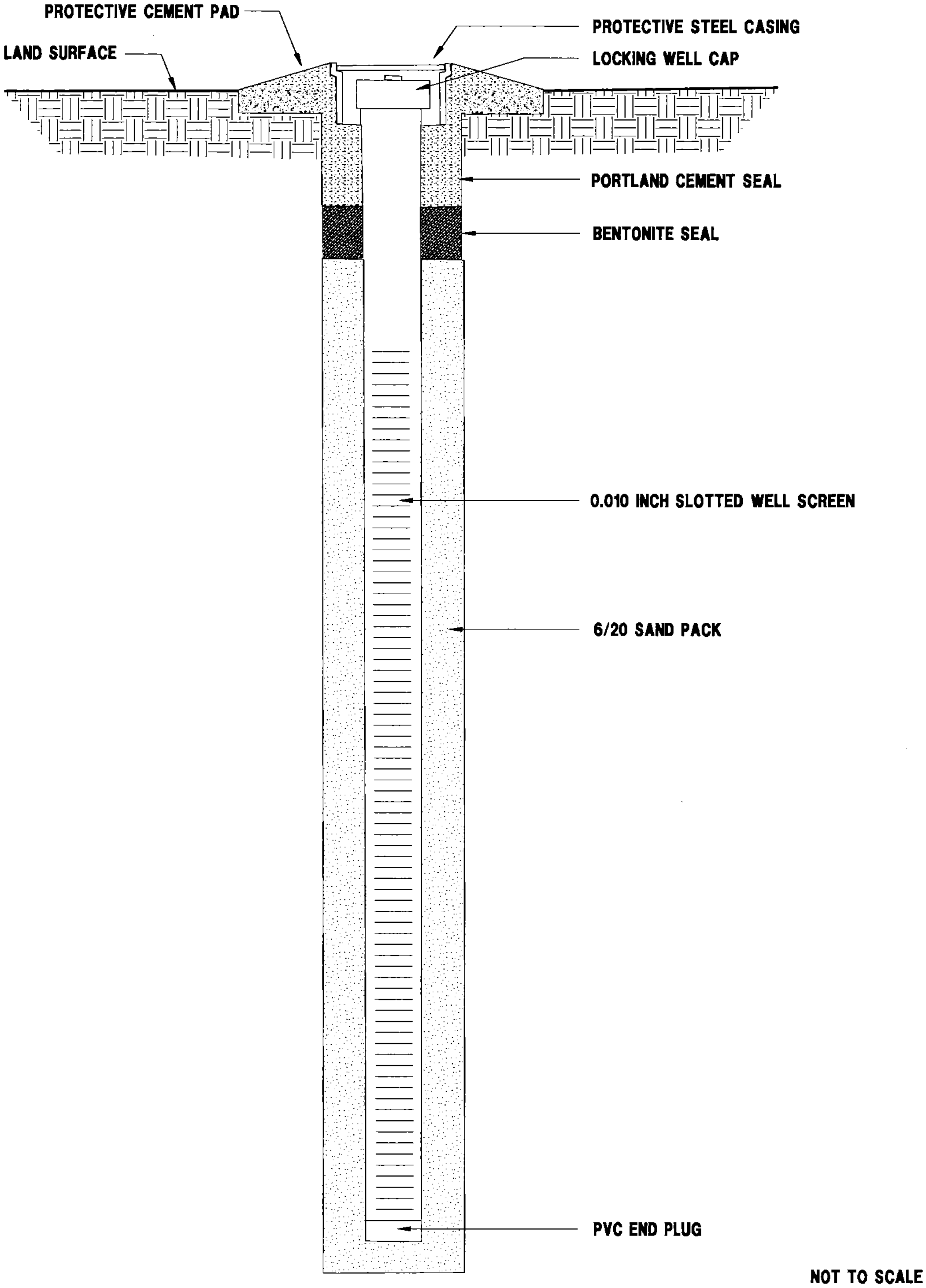

FIGURE 4-4
TYPICAL SHALLOW MONITORING WELL INSTALLATION DETAIL

CECWELL.DWG/MAH/12-30-93

CONTAMINATION ASSESSMENT REPORT

JET ENGINE TEST CELL
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

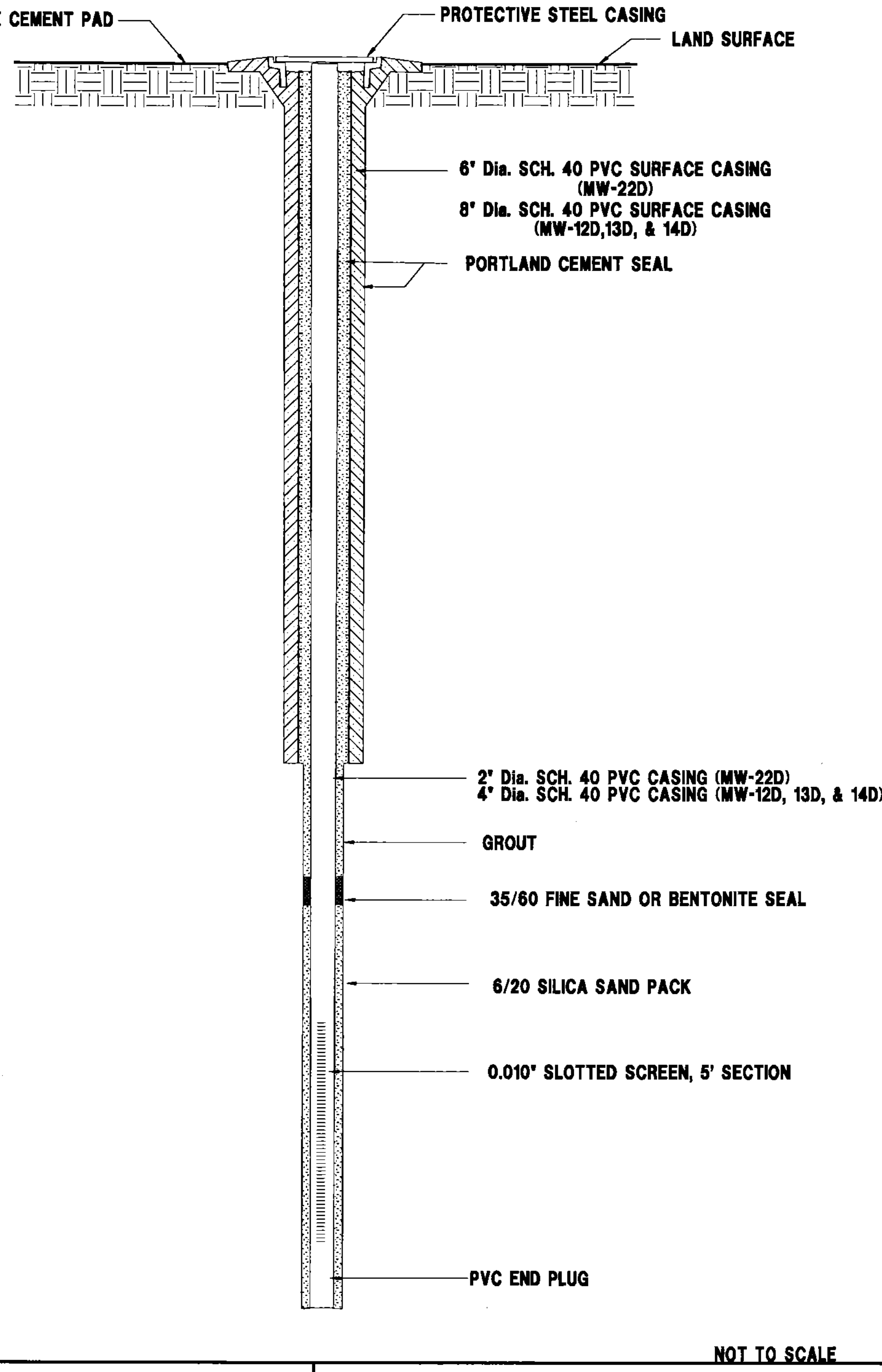

FIGURE 4-5
TYPICAL DEEP MONITORING WELL INSTALLATION DETAIL

CECWELL/NP/3-9-94

CONTAMINATION ASSESSMENT REPORT

JET ENGINE TEST CELL
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

4.4 SOIL AND GROUNDWATER SAMPLING PROGRAM.

4.4.1 Soil Samples In December 1990, five soil samples (SB-1/JE-1, SB-2/JE-2, SB-3/JE-3, SB-4/JE-4, and SB-5/JE-5) were collected and sent to Savannah Laboratories and Environmental Services for analyses of volatile organic aromatics (VOA) using U.S. Environmental Protection Agency (USEPA) Methods 503 and 8020, polynuclear aromatic hydrocarbons (PAH) using USEPA Method 610/8100, total recoverable petroleum hydrocarbons (TRPH) using USEPA Method 418.1, and lead (Pb) using USEPA Method 6010.

In September 1993, one soil sample was collected from a representative stratum (6 to approximately 16 feet bls) during installation of monitoring well MW-20 to facilitate the remedial design. The soil sample was analyzed for total Kjeldahl nitrogen (USEPA Method 351.3), ammonia-nitrogen (USEPA Method 350.2), nitrate/ nitrite (USEPA Method 353.2), total phosphorus (USEPA Method 365.1), total organic carbon (USEPA Method 415.2), total petroleum hydrocarbon (USEPA Method 418.1), uniformity coefficient, total bacteria, specific petroleum degraders (modified USEPA Method 907B), and fingerprint modified (USEPA Method 3550/8100), and American Society for Testing and Materials (ASTM) Methods 421 and 422 to determine grain size distribution. The sample was shipped to ENSECO-Wadsworth/ ALERT Laboratories, Inc., in Tampa, Florida, for analyses of the majority of remedial design parameters. Those remedial design parameters that could not be analyzed by ENSECO-Wadsworth/Alert Laboratories, Inc., were analyzed by ABB-ES, Inc., Bioremediation Group in Wakefield, Massachusetts. Results of all soil sample analyses are discussed in Section 5-1.

4.4.2 Groundwater Samples Unfiltered groundwater samples were collected on September 19 and 20, 1991; October 6, 7, 8, and 12, 1993; and January 14, 1994, from all monitoring wells except MW-09 and MW-19. Groundwater samples were not collected from wells MW-09 and MW-19 because they contained free product. The samples were analyzed for the Chapter 17-770, FAC, kerosene analytical group compounds, which include TRPH (USEPA Method 418.1), ethylene dibromide (EDB) (USEPA Method 504), halogenated hydrocarbons (USEPA Method 601), VOA (USEPA Method 602), PAHs (USEPA Method 625), and dissolved Pb (USEPA Method 239.1). In addition, one groundwater sample was collected to facilitate the remedial design. The remedial design groundwater sample was analyzed for iron (USEPA Method 236.1), manganese (USEPA Method 243.1), alkalinity (USEPA Method 310.1), chloride as Cl (USEPA Method 325.1), sulfate as SO_4 (USEPA Method 375.4), total sulfide (USEPA Method 376.1), oil and grease (USEPA Method 413.1), total organic carbon (USEPA Method 415.1), total solids (USEPA Method 160.3), total suspended solids (USEPA Method 160.2), total dissolved solids (USEPA Method 160.1), hardness (USEPA Method 130.2), color (USEPA Method 110.2), dissolved oxygen (USEPA Method 360.1), total Kjeldahl nitrogen (USEPA Method 351.3), ammonia-nitrogen (USEPA Method 350.2), nitrate-nitrite (USEPA Method 353.2), total phosphorus (USEPA Method 365.1), biological oxygen demand (USEPA Method 405.1), chemical oxygen demand (USEPA Method 410.4), total bacteria and specific petroleum degraders (USEPA Method 907B, Modified), and fingerprint (USEPA Method 8100). All samples were shipped to ENSECO-Wadsworth/ALERT Laboratories, Inc., in Tampa, Florida, for analyses of kerosene analytical group compounds and the majority of remedial design parameters. Those remedial design parameters that could not be analyzed by ENSECO-Wadsworth/Alert Laboratories, Inc., were analyzed by ABB-ES, Inc., Bioremediation Group in Wakefield, Massachusetts. Results of the groundwater quality analyses are discussed in Section 5-2.

4.5 AQUIFER SLUG TESTS. Two rising head slug tests were performed in monitoring wells MW-03, MW-04, MW-07, and MW-08 to estimate the hydraulic conductivity of the aquifer. Aquifer characteristics were calculated from slug test data using the computer program AQTESOLV™ (Geraghty & Miller, Inc., 1989). Procedures for conducting slug tests are included in Appendix D. Slug test graphical data and calculations are attached in Appendix E, Aquifer Parameter Calculations.

5.0 CONTAMINATION ASSESSMENT RESULTS

5.1 SOIL BORING PROGRAM AND ORGANIC VAPOR ANALYZER (OVA) RESULTS. JP-5 jet fuel is defined in Chapter 17-770-200(6), FAC, as part of the kerosene analytical group. Consequently, soil at the site is considered excessively contaminated if the OVA measures organic vapor concentrations in excess of 50 parts per million (ppm). According to FDEP regulations, excessively contaminated soil must be remediated (FDER, 1992). Soil having OVA concentrations between 10 ppm and 50 ppm may or may not require remediation.

As part of the PCA at the Jet Engine Test Cell site, 6 soil borings were advanced in December 1990 by ABB-ES and 17 soil borings were advanced in January 1991 by the USACOE (Figure 4-1). OVA measurements were recorded for most soil boring samples collected during the 1990 and 1991 PCAs. OVA readings were not measured for soil borings 90SB-1 and 90SB-2 because field personnel noted strong petroleum odors in the sample. During Building 339 demolition activities, construction personnel noted that the excavated soil also had a strong petroleum odor. As part of the CA, 31 soil borings were advanced at the Jet Engine Test Cell site during the week of September 13, 1993, by ABB-ES (Figure 4-2). Soil samples were collected from each borehole for OVA analyses as outlined in Chapter 17-770, FAC. The majority of borehole locations were located in the immediate vicinity of the fuel tanks yard, east of the yard, and near Building 339. Results of the ABB-ES 1990 and 1993 OVA headspace analyses are given in Table 5-1. ABB-ES 1990 and 1993 soil boring data are designated with the respective prefixes "90SB-" and "93SB-". USACOE soil boring OVA headspace data from 1991 are included in the PCA report attached in Appendix A.

Excessively contaminated soil was detected at the fuel tanks yard, northeast of the yard in the vicinity of Building 811, east of the yard near the air tanks, and southeast near Building 339 (Figures 5-1 and 5-2). Excessively contaminated soil was also detected at 1 foot bls in soil boring TC-11, near Building 334. The USACOE attributed this contamination to equipment cleaning activities associated with Building 334. Excessively contaminated soil was detected at depths ranging from 1 foot to approximately 7 feet bls.

Laboratory analyses from soil samples collected in December 1990, are summarized in Table 5-2 and illustrated in Figure 5-1. Laboratory analytical results indicated petroleum-related constituents were present in the fuel tanks yard soil. Total VOA concentrations detected were 22,900 parts per billion (ppb) for JE-3 and 12,200 ppb for JE-3 DUP. Total PAH concentrations detected in JE-3 and JE-3 DUP were 231 ppm and 133 ppm, respectively. TRPH concentrations detected in JE-3 and JE-3 DUP were 13,000 ppm and 8,300 ppm, respectively. Lead concentrations detected in samples JE-3 and JE-3DUP were 0.93 ppm and 0.81 ppm, respectively. To be defined as clean soil (Chapter 17-775.400, FAC), maximum concentrations must not exceed 100 ppb for total VOA, 1 ppm for total PAH, 10 ppm for TRPH, and 108 ppm for lead.

High total PAH concentrations were detected in the JE-4 soil sample (337 ppm) collected near a concrete slab where equipment associated with Building 811 is cleaned and stored. It appears that this contamination is associated with the cleaning operations.

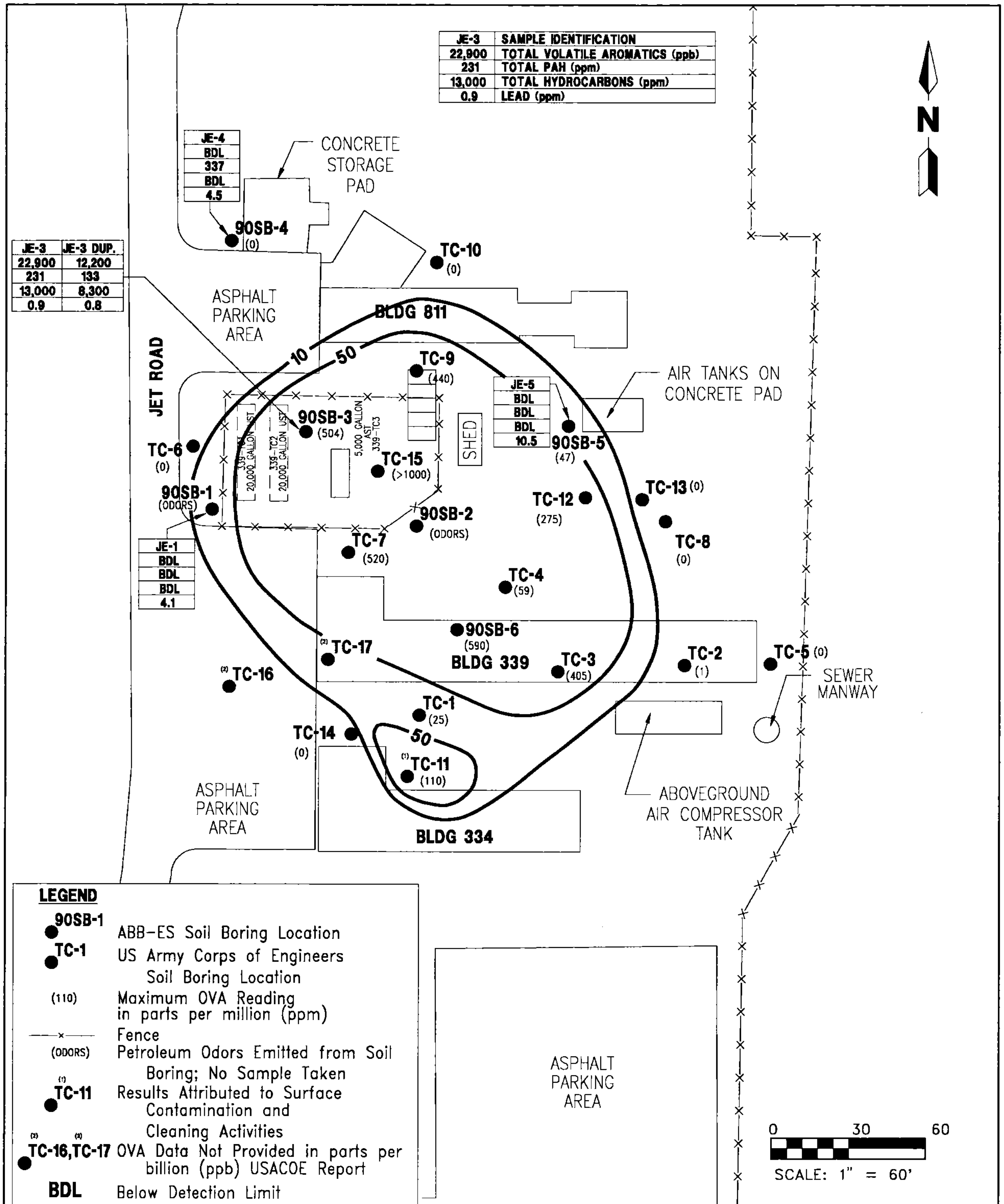

FIGURE 5-1
SOIL CONTAMINATION DISTRIBUTION MAP, DECEMBER 1990 AND JANUARY 1991

CARPT2/NP/3-1-94

CONTAMINATION ASSESSMENT REPORT

JET ENGINE TEST CELL
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

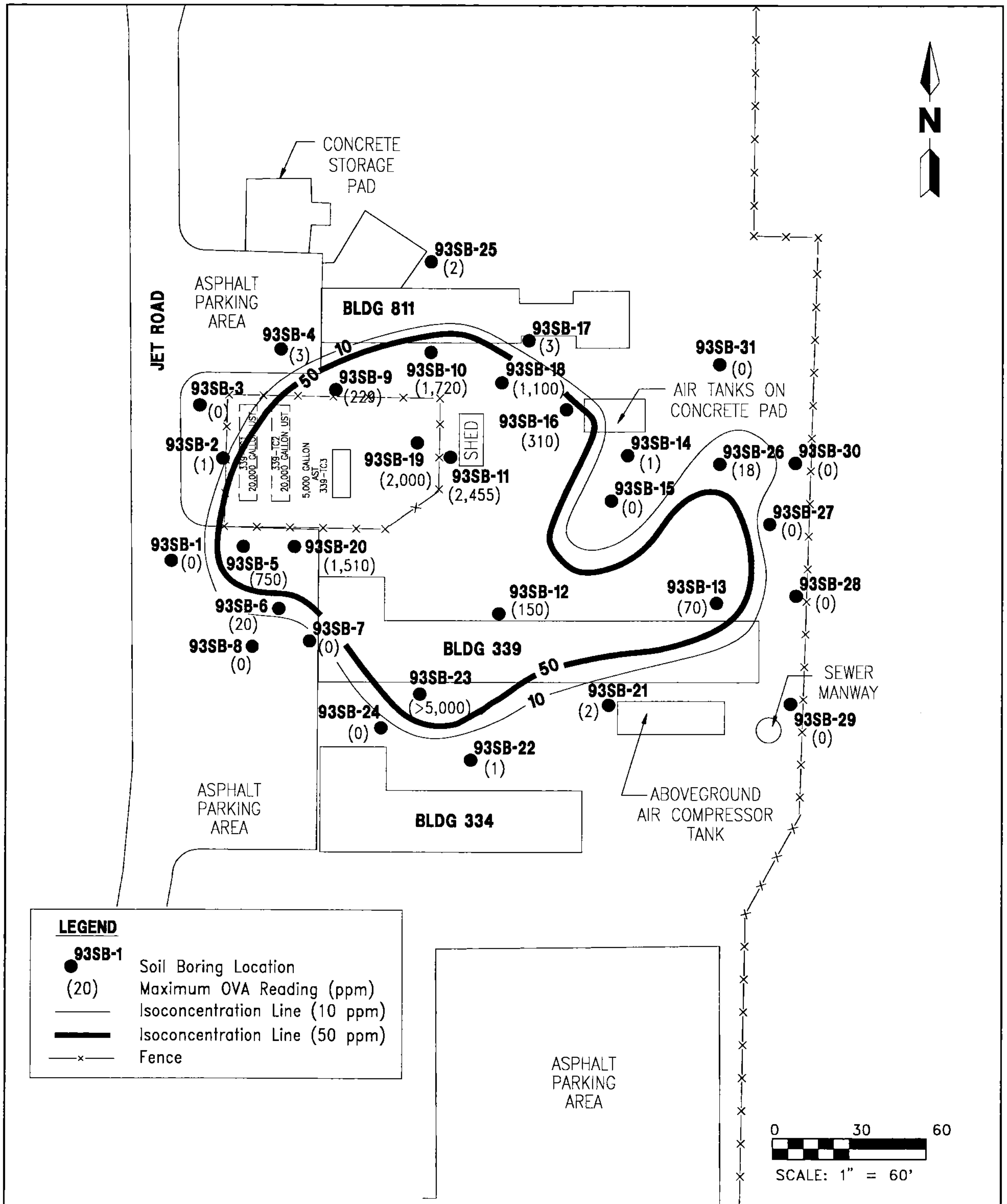

FIGURE 5-2
SOIL CONTAMINATION DISTRIBUTION MAP, OCTOBER 1993

CAR/NP/3-11-94

CONTAMINATION ASSESSMENT REPORT

JET ENGINE TEST CELL
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

Table 5-1
Summary of Soil Sample Organic Vapor Analyzer (OVA) Results

Jet Engine Test Cell
NAS Cecil Field
Jacksonville, Florida

Soil Boring Number	Depth (feet)	OVA Unfiltrated (ppm)	OVA Filtrated (ppm)	OVA Actual (ppm)
90SB-1	12.5		No sample taken, strong odor	
90SB-2			No sample taken, strong odor	
90SB-3	13.5	510	6	504
90SB-4	11.0	0	0	0
90SB-5	6.5	47	0	47
90SB-6	7.0	590	0	590
93SB-1	1	0	--	0
	3	0	--	0
	5	0	--	0
	7	0	--	0
93SB-2	1	0	--	0
	3	0	--	0
	5	1	0	1
	7	0	--	0
93SB-3	1	0	--	0
	3	0	--	0
	5	0	--	0
	7	0	--	0
93SB-4	1	0	--	0
	3	0	--	0
	5	0	--	0
	7	4	1	3
93SB-5	1	400	0	400
	3	600	0	600
	5	400	0	400
	7	750	0	750
93SB-6	1	0	--	0
	3	0	--	0
	5	2	0	2
	7	20	0	20
93SB-7	1	0	--	0
	3	0	--	0
	5	0	--	0
	7	0	--	0
93SB-8	1	0	--	0
	3	0	--	0
	5	0	--	0
	7	0	--	0
93SB-9	1	2	2	0
	3	96	0	96
	5	98	0	98
	7	250	21	229

See notes at end of table.

Table 5-1 (Continued)
Summary of Soil Sample Organic Vapor Analyzer (OVA) Results

Jet Engine Test Cell
NAS Cecil Field
Jacksonville, Florida

Soil Boring Number	Depth (feet)	OVA Unfiltrated (ppm)	OVA Filtrated (ppm)	OVA Actual (ppm)
93SB-10	1	0	0	0
	3	0	0	0
	5	51	11	40
	7	1,800	80	1,720
93SB-11	1	0	0	0
	3	2,500	45	2,455
	5	1,900	110	1,790
	7	1,900	70	1,830
93SB-12	1	0	0	0
	3	1	0	1
	5	150	0	150
	7	100	0	100
93SB-13	1	13	0	13
	3	70	0	70
	5	0	0	0
	7	6	0	6
93SB-14	1	1	0	1
	3	1	0	1
	5	0	0	0
	7	0	0	0
93SB-15	1	0	--	0
	3	0	--	0
	5	0	--	0
	7	0	--	0
93SB-16	1	0	--	0
	3	0	--	0
	5	0	--	0
	7	310	0	310
93SB-17	1	0	--	0
	3	0	--	0
	5	0	--	0
	7	3	0	3
93SB-18	1	0	--	0
	3	140	0	140
	5	850	0	850
	7	1,100	0	1,100
93SB-19	1	1,500	0	1,500
	3	1,700	0	1,700
	5	2,000	0	2,000
	7	1,300	0	1,300
93SB-20	1	600	70	530
	3	1,600	140	1,460
	5	1,400	140	1,260
	7	1,600	90	1,510

See notes at end of table.

Table 5-1 (Continued)
Summary of Soil Sample Organic Vapor Analyzer (OVA) Results

Jet Engine Test Cell
NAS Cecil Field
Jacksonville, Florida

Soil Boring Number	Depth (feet)	OVA Unfiltrated (ppm)	OVA Filtrated (ppm)	OVA Actual (ppm)
93SB-21	1	2	0	2
	3	0	--	0
	5	0	--	0
	7	0	--	0
93SB-22	1	0	--	0
	3	0	--	0
	5	0	--	0
	7	1	0	1
93SB-23	1	0	--	0
	3	2	0	2
	5	>5,000	0	>5,000
	7	150	0	150
93SB-24	1	0	--	0
	3	0	--	0
	5	0	--	0
	7	0	--	0
93SB-25	1	2	0	2
	3	0	--	0
	5	0	--	0
	7	2	0	0
93SB-26	0-1	0	--	0
	3	18	0	18
	5	0	--	0
	7	0	--	0
93SB-27	0-1	0	--	0
	3	0	--	0
	5	0	--	0
	7	0	--	0
93SB-28	0-1	0	--	0
	3	0	--	0
	5	0	--	0
	7	0	--	0
93SB-29	0-1	0	--	0
	3	0	--	0
	5	0	--	0
	7	0	--	0
93SB-30	0-1	0	--	0
	3	0	--	0
	5	0	--	0
	7	0	--	0
93SB-31	0-1	0	--	0
	3	0	--	0
	5	0	--	0
	7	0	--	0

Notes: OVA = organic vapor analyzer.
ppm = parts per million.
-- = not analyzed.

Table 5-2
Summary of Soil Sample Analytical Results,
December 21, 1990

Contamination Assessment Report
Jet Engine Test Cell
NAS Cecil Field
Jacksonville, Florida

Contaminant	Soil Boring Sample Number 90SB-1/JE-1 (12.5)[1]	90SB-3/JE3 (3.5)[1]	90SB-3/JE3DUP (3.5)[1]	90SB-4/JE-4 (12.5)[1]	90SB-5/JE-5 (6.5)[1]	Clean Soil[2] Maximum Concentration
Volatile Organic Aromatics (VOA) (USEPA Method 8020) (ppb)						
Benzene	ND	ND	ND	ND	ND	--
Ethyl benzene	ND	4,900	4,400	ND	ND	--
Toluene	ND	ND	ND	ND	ND	--
Xylenes	ND	18,000	7,800	ND	ND	--
Total VOA	ND	22,900	12,200	ND	ND	100
Polynuclear Aromatic Hydrocarbons (PAH) (ppm)						
Acenaphthylene	ND	24	19	29	ND	--
Total PAH	ND	231	133	337	ND	1.0
Naphthalene	ND	ND	ND	93	ND	--
1-Methylnaphthalene	ND	130	78	140	ND	--
2-Methylnaphthalene	ND	77	36	75	ND	--
Total naphthalenes	ND	207	114	308	ND	--
TRPH (USEPA Method 418.1) (ppm)						
TRPH	ND	13,000	8,300	ND	ND	[3]10 or 50
Lead (USEPA Method 6010 (ppm)						
Lead	4.1	0.93	0.81	4.5	10.5	108

[1] Depth in feet.
[2] Chapter 17-775.400, Florida Administrative Code.
[3] Provided total PAH does not exceed 1 part per million (ppm) and total volatile organic halocarbons do not exceed 50 parts per billion (ppb) (Chapter 17-775.400).

Notes: USEPA = U.S. Environmental Protection Agency.
ppb = parts per billion.
Total VOA = total volatile organic aromatics; the sum of benzene, ethyl benzene, toluene, and xylenes.
ppm = parts per million.
Total naphthalenes = the sum of naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene.
ND = not detected, below laboratory's practical quantitation limits.
-- no maximum concentration has been established.

Lead concentrations in soil samples JE-1, JE-4, and JE-5 were 4.1 ppm, 4.5 ppm, and 10.5 ppm, respectively.

5.2 AQUIFER CHARACTERISTICS AND HYDROGEOLOGIC PARAMETERS. Slug test data from wells MW-03, MW-04, MW-07, and MW-08 indicate horizontal hydraulic conductivity (K) values range between 0.51 and 0.97 foot per day (ft/day). The calculated hydraulic gradient in the northeast direction is 0.005 foot per foot. The calculated average pore water velocity (V) ranges from 0.011 to 0.019 ft/day in the northeast direction. The transmissivity (T) ranges from 4.13 to 7.86 square feet per day (ft^2/day). Slug test data, equations, and calculations used to derive these values are presented in Appendix E, Aquifer Parameter Calculations.

5.3 GROUNDWATER CONTAMINANT CHARACTERIZATION.

5.3.1 1991 Laboratory Analytical Results Results of laboratory analyses of samples collected September 19 and 20, 1991, indicated contaminant concentrations exceeded State target levels established for Class G-II waters (Chapter 17-770, FAC) for total naphthalenes in only the duplicate sample from well MW-10. Laboratory results indicate that petroleum-related contaminants were detected in groundwater samples from shallow monitoring wells MW-04, MW-08, MW-10, and MW-14; however, these concentrations were below FDEP target levels. Laboratory analytical results of groundwater samples collected in September 1991 are summarized in Table 5-3.

Methylene chloride was detected in the duplicate sample from wells MW-10 and MW-15 collected in September 1991. Methylene chloride is a common solvent used in the extraction process for laboratory analyses of groundwater samples and is suspected to result from laboratory contamination. Methylene chloride was not detected in MW-10 and MW-15 when the wells were resampled in October 1993. The distribution of contaminants detected in groundwater samples collected from site monitoring wells in September 1991 is shown in Figure 5-3.

5.3.2 1993 and 1994 Laboratory Analytical Results Laboratory analytical results of groundwater samples collected October 1993 and January 1994 show that petroleum-related constituents (dissolved hydrocarbons or lead) were detected in all of the 21 shallow monitoring wells. Results of laboratory analyses of samples collected in October 1993 indicate concentrations of contaminants exceed State target levels of 50 ppb for lead in MW-02, MW-03, MW-05, MW-08, MW-15, MW-16, MW-18, MW-23, MW-24, and MW-25. The State target level of 1 ppb for benzene was exceeded in groundwater samples from wells MW-16 and the duplicate sample from well MW-20. The State target levels of 50 ppb for total VOA and 100 ppm for total naphthalenes were exceeded in the sample and duplicate sample from wells MW-20 and MW-24. Laboratory analytical results for the groundwater samples collected during October 1993 and January 1994 are summarized in Table 5-4. The distribution of contaminants detected in groundwater samples collected from site monitoring wells in October 1993 and January 1994 is shown in Figure 5-4.

Laboratory analytical results indicate the dissolved hydrocarbon plume is oriented northeast to southwest from the fuel tanks yard toward Building 339. The analytical data indicate the dissolved hydrocarbon plume does not extend beyond Building 334. The horizontal extent of groundwater contamination at the

Table 5-3
Summary of Groundwater Sample Analytical Results, September 19-20, 1991

Contamination Assessment Report
Jet Engine Test Cell
NAS Cecil Field
Jacksonville, Florida

Contaminant	Monitoring Well, Number, CEF-811														Regulatory Standards for Class G-II Groundwater[2]
	01	02	03	04	05	06	07	08	[1]10/JTC DUP1	11	12D	13D	14D	15	
Volatile Organics (USEPA Method 601/602) (ppb)															
Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Ethyl benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Toluene	ND	ND	ND	2	ND	ND	ND	5	ND	ND	ND	ND	ND	ND	
Xylenes	ND	ND	ND	ND	ND	ND	ND	ND	3/2	ND	ND	ND	ND	ND	
Total VOA	ND	ND	ND	2	ND	ND	ND	5	3/2	ND	ND	ND	ND	ND	50
Methylene chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND/6	ND	ND	ND	ND	4	
Polynuclear Aromatic Hydrocarbons (USEPA Method 625) (ppb)															
1-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	15/35	ND	ND	ND	ND	ND	
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	14/39	ND	ND	ND	ND	ND	
Naphthalene	ND	ND	ND	ND	ND	ND	ND	ND	16/43	ND	ND	ND	ND	ND	
Total naphthalenes	ND	ND	ND	ND	ND	ND	ND	ND	45/117	ND	ND	ND	ND	ND	100
Total Recoverable Petroleum Hydrocarbons (TRPH) (ppm)															
TRPH	ND	ND	ND	ND	ND	ND	ND	ND	2/2	ND	ND	ND	ND	ND	5

[1] Duplicate sample.
[2] Chapter 17-770.730(5a), Florida Administrative Code (FAC).

Notes: Monitoring wells not listed above were not sampled due to the presence of free product.
Laboratory data sheets are included in Appendix F.
USEPA = U.S. Environmental Protection Agency.
ppb = parts per billion.
ND = not detected.
Total VOA = total volatile organic aromatics; the sum of benzene, ethyl benzene, toluene, and xylenes.
ppm = parts per million.

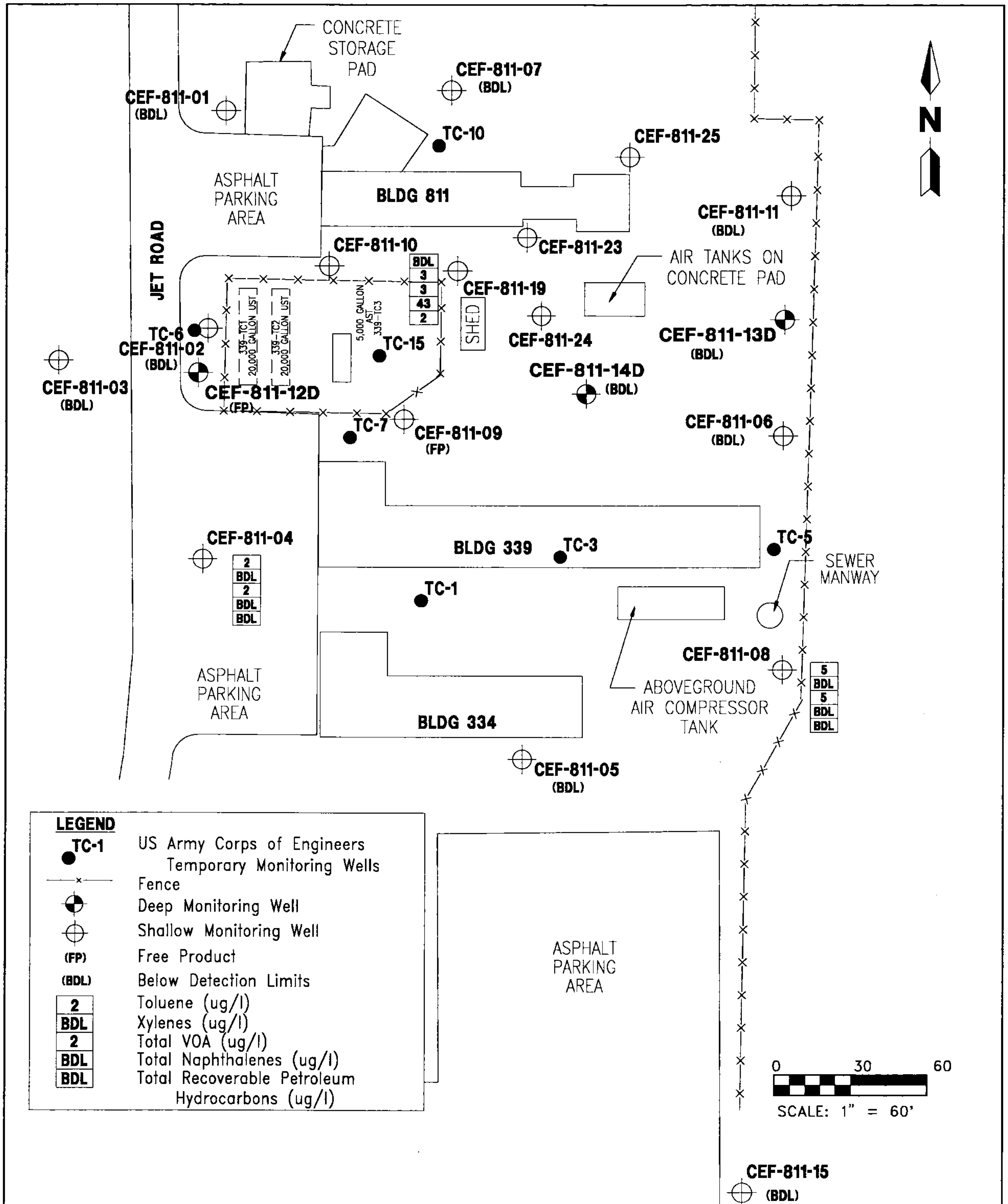

FIGURE 5-3
GROUNDWATER CONTAMINANT DISTRIBUTION MAP, SEPTEMBER 1991

CARPT2.DWG/MAH/1-10-94

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

CONTAMINATION ASSESSMENT REPORT

JET ENGINE TEST CELL
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

Table 5-4
Summary of Groundwater Sample Analytical Results, October and December 1993

Jet Engine Test Cell
NAS Cecil Field
Jacksonville, Florida

Contaminant	Monitoring Well Number CEF-811-													Regulatory Standards for Class G-II Groundwater
	01	02	03	04	05/05DS	06	07	08	09	10	11	12D	13D	
Volatile Organics (USEPA Method 601/602) (ppb)														
Benzene	ND	ND	ND	ND	ND/ND	ND	ND	ND	FP	ND	ND	ND	ND	1
Ethylbenzene	ND	ND	ND	ND	ND/ND	1.6	ND	ND	FP	16	ND	ND	ND	
Toluene	ND	ND	ND	ND	ND/ND	ND	ND	ND	FP	ND	ND	ND	ND	
Xylenes	ND	ND	ND	ND	ND/ND	ND	ND	1.0	FP	7.5	ND	ND	ND	
Total VOA	ND	ND	ND	ND	ND/ND	1.6	ND	1.0	FP	23.5	ND	ND	ND	50
Ethylene Dibromide	ND	ND	ND	ND	ND/ND	ND	ND	ND	FP	ND	ND	ND	ND	0.02
Polynuclear Aromatic Hydrocarbons (USEPA Method 675 (ppb)														
1-Methylnaphthalene	ND	ND	ND	ND	ND/ND	ND	ND	ND	FP	22	6.4	ND	ND	
2-Methylnaphthalene	ND	ND	ND	ND	ND/ND	ND	ND	ND	FP	26	5.7	ND	ND	
Naphthalene	ND	ND	ND	ND	ND/ND	13	ND	ND	FP	32	ND	ND	ND	
Total naphthalenes	ND	ND	ND	ND	ND/ND	13	ND	ND	FP	80	12.1	ND	ND	100
Total Recoverable Petroleum Hydrocarbons (TRPH) (ppm)														
TRPH	ND	ND	ND	ND	ND/ND	ND	ND	ND	FP	ND	ND	ND	ND	5
Lead (ppb)														
Lead	36	74	93	21	61/ND	10	16	70	FP	24	29	ND	ND	50
Methyl tert-butyl ether (MTBE) (ppb)														
MTBE	ND	ND	ND	ND	ND/ND	ND	ND	ND	FP	ND	ND	ND	ND	50

See notes at end of table.

Table 5-4 (Continued)
Summary of Groundwater Sample Analytical Results, October and December, 1993

Jet Engine Test Cell
NAS Cecil Field
Jacksonville, Florida

Contaminant	Monitoring Well Number CEF-811-												Regulatory Standards for Class G-II Groundwater
	14D	15	16	17	18	19	20/20DS	21	22D	23	24/24DS	25	
Volatile Organics (USEPA Method 601/602) (ppb)													
Benzene	ND	ND	1.8	ND	ND	FP	ND/24	ND	ND	ND	ND/ND	ND	1
Ethylbenzene	ND	ND	12	ND	5.8	FP	120/130	ND	ND	21	48/47	ND	
Toluene	ND	ND	ND	ND	ND	FP	ND/ND	ND	ND	ND	4.5/4.8	ND	
Xylenes	ND	ND	7.2	18	9.0	FP	320/250	4.6	ND	43	110/110	ND	
Total VOA	ND	ND	21	18	14.8	FP	440/404	4.6	ND	64	162.5/161.8	ND	50
Ethylene Dibromide	ND	ND	ND	ND	ND	FP	ND/ND	ND	ND	0.028	ND/ND	ND	0.02
Polynuclear Aromatic Hydrocarbons (USEPA Method 675) (ppb)													
Methylnaphthalene	ND	ND	ND	11	27	FP	53/55	ND	ND	1,100	ND/ND	ND	
2-Methylnaphthalene	ND	ND	ND	ND	20	FP	48/43	ND	ND	1,200	ND/ND	ND	
Naphthalene	ND	ND	6.5	ND	38	FP	140/140	ND	ND	ND	ND/ND	ND	
Total naphthalene	ND	ND	6.5	11	85	FP	241/238	ND	ND	2,300	ND/ND	ND	100
Total Recoverable Petroleum Hydrocarbons (TRPH) (ppm)													
TRPH	ND	ND	ND	ND	ND	FP	ND/ND	ND	ND	284	37.2/27.2	ND	5
Lead ($\mu g/\ell$)													
Lead	ND	79	350	19	140	FP	28/7	ND	12	695	710/50.0	355	50
Methyl Tert-butyl Ether (MTBE) (ppb)													
MTBE	ND	ND	ND	ND	ND	FP	ND/ND	ND	ND	ND	ND/ND	ND	50

Notes: FP = free product.
ND = none detected.
DS = duplicate sample.
D = deep well.
USEPA = U.S. Environmental Protection Agency.
ppb = parts per billion.
ppm = parts per million.

Dates Sampled: October 6, 1993: CEF-811-06, CEF-811-08, and CEF-811-11.
October 7, 1993: CEF-811-01, CEF-811-02, CEF-811-03, CEF-811-05, CEF-811-07, and CEF-811-15.
October 8, 1993: CEF-811-04, CEF-811-10, CEF-811-16, CEF-811-17, CEF-811-18, CEF-811-20, and CEF-811-21.
October 12, 1993: CEF-811-12D, CEF-811-13D, CEF-811-14D, and CEF-811-22D.
January 14, 1993: CEF-811-23, CEF-811-24, and CEF-811-25.

Figure 5-4 Groundwater Contaminant Distribution Map, October 1993 and January 1994

Figure 5-5 Benzene Concentration Map, October 1993 and January 1994

Figure 5-6 Total Volatile Organic Aromatics Concentration Map, October 1993 and January 1994

Figure 5-7 Total Naphthalenes Concentration Map, October 1993 and January 1994

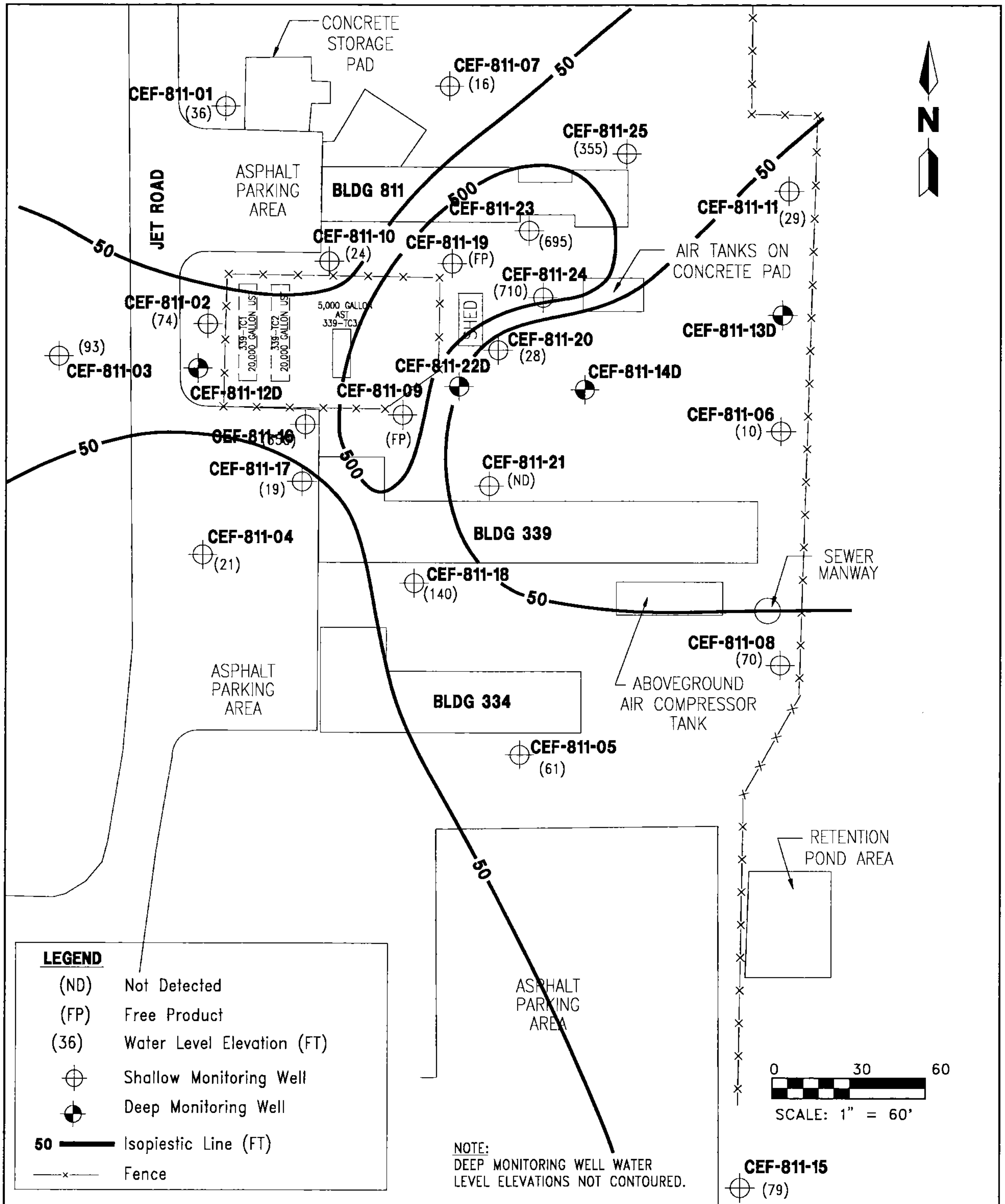

FIGURE 5-8
LEAD CONCENTRATION MAP, OCTOBER 1993 AND JANUARY 1994

CONTAMINATION ASSESSMENT REPORT

JET ENGINE TEST CELL
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

CARPT3/NP/3-1-94

Jet Engine Test Cell site is shown by the distribution of benzene, total VOA, total naphthalenes, and lead in Figures 5-5, 5-6, 5-7, and 5-8, respectively.

5.3.3 Extent of Free Product In February 1992, while measuring water levels at the site, an apparent petroleum sheen was observed in deep monitoring well MW-12D. Previously, free product had not been observed in well MW-12D during water level measurements taken in December 1991, or subsequently in March 1992, November 1993, or January 1994. Therefore, the isolated occurrence of the sheen in well MW-12D is believed to have been the result of an unknown source.

Groundwater samples were not collected from shallow monitoring wells MW-09 and MW-19 in September 1993 or January 1994. The observed JP-5 thickness in wells MW-09 and MW-19 was 0.72 and 0.78 foot, respectively, in September 1993. Free product was also observed in temporary well TC-15, installed by the USACOE in the fuel tanks yard. Free product was reported to be 0.58-foot thick in temporary well TC-15 (Attachment A). The locations of monitoring wells MW-09, MW-19, and TC-15 are predominantly around the fuel tanks. Based on the locations of the monitoring wells in which free product was observed or not observed, free product at the site extends northeast toward Building 811 and southeast beyond the perimeter of the fuel tanks yard. The estimated horizontal and vertical extent of free product at the site is shown in Figure 5-4. Laboratory analytical data indicate petroleum-related contaminants were not detected in the groundwater samples collected from MW-12. Thus, the vertical extent of groundwater contamination is less than 35 feet bls.

5.3.4 Extent of Groundwater Contamination Lead was detected in groundwater samples in which no other petroleum-related constituents were detected and may indicate undissolved lead in suspended sediments in the sample. Low concentrations of lead, however, were detected in groundwater samples from deep monitoring well MW-20D, which was relatively free of suspended sediments. Lead was not detected in deep monitoring wells MW-12D, MW-13D, and MW-14D.

Suspended sediments are the suspected source of high lead concentrations in the unfiltered groundwater samples. Past investigations have shown that lead concentrations significantly decreased, or were not detectable, in filtered groundwater samples collected from wells that had high lead concentrations in unfiltered samples. Upgradient lead concentrations were also significantly higher than normal background lead levels.

Groundwater quality field parameters were collected from all monitoring wells sampled in September 1991. The pH values ranged from 5.28 to 9.96 standard units, specific conductance values ranged from 70 to 430 micromhos per centimeter, and temperature values ranged from 62.7 to 74.6 degrees Fahrenheit (°F).

The dissolved hydrocarbon plume appears to be migrating toward the northeast with the groundwater flow direction. Laboratory analytical results of shallow monitoring well samples collected in 1993 indicate traces of dissolved hydrocarbons in the vicinity of the fenced area east and northeast of the site. Analytical data collected from shallow monitoring wells in 1991 reveal no detectable hydrocarbon concentrations near this fenced area.

Laboratory analytical data show that dissolved hydrocarbons were not detected in any of the deep monitoring wells in 1991, 1993, and 1994. Well MW-12D, the shallowest of the deep wells, is screened from 25 to 35 feet bls. The vertical extent of groundwater contamination, therefore, is less than 25 feet bls.

The groundwater flow direction at the site is toward the east and northeast. Data show the contaminant plume is generally oriented northeast to southwest parallel to the groundwater flow direction. The plume extends south of the fuel tanks area toward Building 339 and may have been influenced by either seasonal changes in groundwater flow directions, construction activities at Building 339, or a combination of the two.

__5.3.5 Effects of Construction Activities on Groundwater Flow__ During the construction activities initiated at the site in 1991, it was necessary to lower the water level in the area being excavated for the new building foundation. Shallow evacuation wells were installed along the north and south sides of the excavation. According to construction personnel, the wells were connected in series and water was pumped from them to an oil-water separator at a rate of 10 to 15 gpm. During the monitoring well installation program, the excavation site was pumped for at least 48 days. At rates of 10 to 15 gpm for a period of 48 days, 691,200 to 1,036,800 gallons of effluent would have been removed from the excavation site. Water table contour maps indicate the average water table gradient is approximately 0.005 foot per foot. The removal of water from the excavation area would create a potentiometric low at the excavation site and cause groundwater and contaminants to flow south and southeast, toward Building 339.

__5.4 POTABLE WELL SURVEY__. A potable well survey was conducted to show the proximity of potable water sources to contamination associated with activities at and beneath the site. There are five public water supply wells located at NAS Cecil Field (PS- 1, PS-2, PS-3, PS-4, and PS-5). Figure 5-9 shows the locations of these wells.

Well inventory data are presented in Table 5-5. The five public water supply wells are screened in the Floridan aquifer system at depths ranging from 887 to 1,350 feet bls. Potable water wells PS-4 and PS-5 are within a 0.25-mile radius of the site, but are upgradient of the Jet Engine Test Cell. The depth of contaminated groundwater at the Jet Engine Test Cell site is less than 25 feet bls. Water samples are collected from both wells and tested on a regular basis for petroleum constituents. Results of these tests indicate no groundwater contamination. Based on this information, groundwater from wells PS-4 and PS-5 does not appear to have been affected by contamination at the Jet Engine Test Cell site.

Surface water in the area is not used as a potable water source (Envirodyne Engineers, 1985).

No private potable wells are within 1 mile of this site (Geraghty & Miller, 1983).

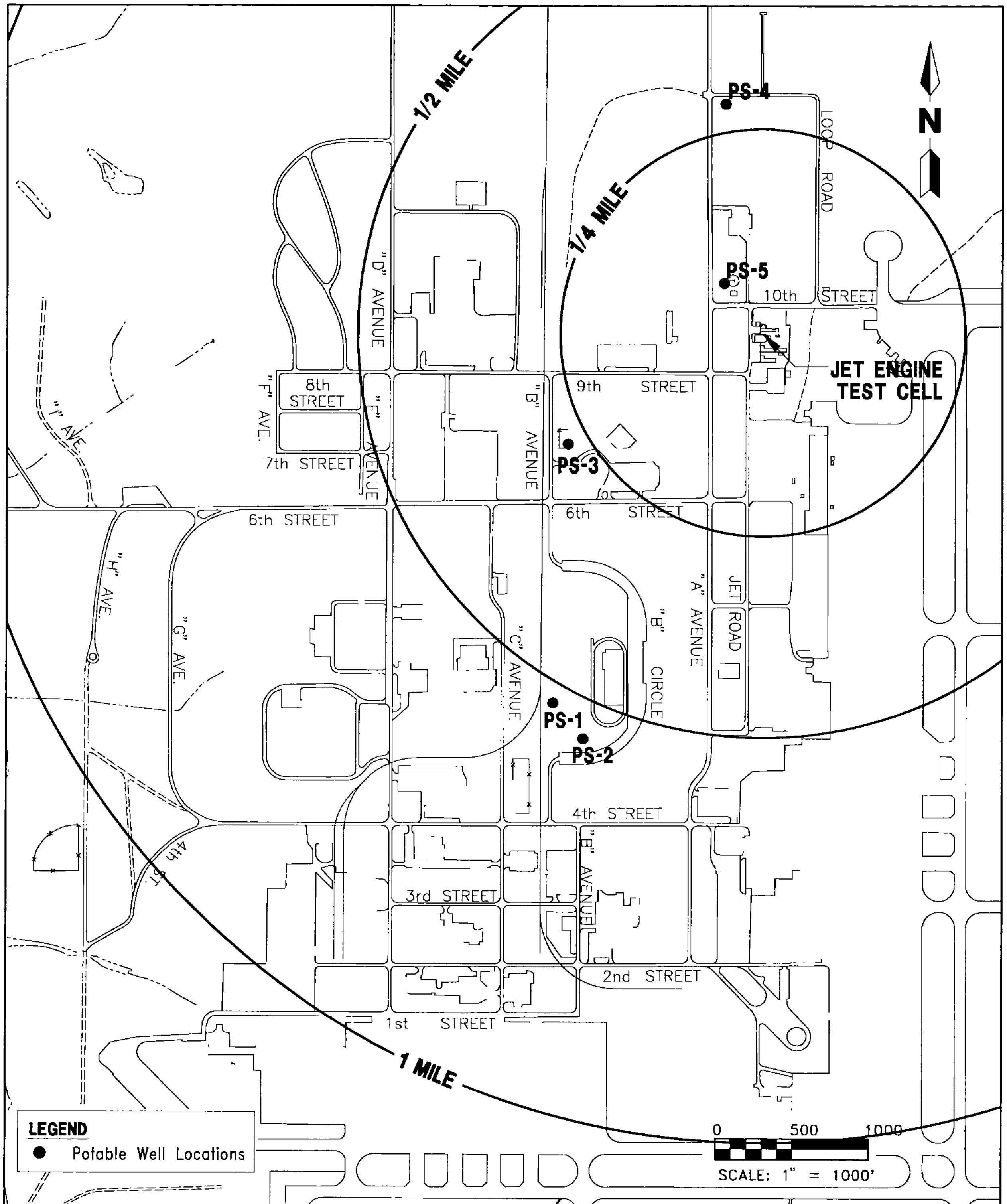

FIGURE 5-9
LOCATION OF POTABLE WELLS

LOCATION/NP/3-11-94

CONTAMINATION ASSESSMENT REPORT

JET ENGINE TEST CELL
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

Table 5-5
Potable Well Data

Contamination Assessment Report
Jet Engine Test Cell
NAS Cecil Field
Jacksonville, Florida

Well	Date Installed	Depth (feet)	Static Level (feet)	Drawdown (feet)	Yield (gpm)
PS-1	1941	887	30	8	450
PS-2	1945	907	33	13	525
PS-3	1950	950	33	11	500
PS-4	1956	1,303	34	15	1,000
PS-5	1956	1,350	35	15	1,000

Source: Geraghty & Miller, 1986.

Note: gpm = gallons per minute.

6.0 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

6.1 SUMMARY. Based on the findings of the CA field investigations and laboratory analytical results, the following is a summary of existing conditions at the site.

- Only the surficial, unconfined aquifer was encountered during drilling operations. The base of the surficial aquifer was not encountered during the CA, but is approximately 90 feet bls at the North Fuel Farm site, 2,000 feet north of the Jet Engine Test Cell Site.

- Generally, sediments encountered at the site were comprised predominantly of very fine- to fine-grained sand, clayey sand, and silty sand. Overall, the sediments exhibit a coarsening-upward sequence, having a higher clay content with depth.

- Groundwater at the site was encountered at depths ranging from approximately 4 to 7 feet bls.

- The overall direction of groundwater flow at the site is east and northeast but may be influenced by seasonal fluctuations.

- Free product thickness measured in wells MW-09 and MW-19 was 0.72 and 0.78 foot, respectively, in September 1993 and 1.79 and 1.16 feet, respectively, in January 1994.

- Contaminants detected in groundwater samples collected during the CA investigation include benzene, toluene, xylenes, naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene, TRPH, methylene chloride, and lead. Methylene chloride is a suspected laboratory contaminant and high lead concentrations are suspected to be the result of suspended sediments in groundwater samples.

- Concentrations of contaminants in groundwater samples exceeded State remedial target levels for benzene, total VOA, total naphthalenes, TRPH, and lead.

- Excessively contaminated soil was detected in the fuel tanks yard, in the area between the yard and the air tanks pad, and in the area between the yard and Building 339. Excessively contaminated soil was also detected in the soil beneath Building 339. The depth of excessively contaminated soil at the site is approximately 7 feet bls.

- Groundwater contamination at the site extends from the fuel tanks yard northeast toward Building 811 and south to southeast toward Building 339. Groundwater contamination does not extend deeper than 25 feet bls.

- There are two potable water wells on the base within a ¼-mile radius of the site. PS-4 and PS-5 both supply potable water to the site from a depth of 1,303 and 1,350 feet, respectively. Groundwater from wells PS-4 and PS-5 does not appear to have been affected by contamination at the Jet Engine Test Cell site.

- Hydraulic conductivity (K) values ranged from 0.51 to 0.97 ft/day. The hydraulic gradient (I) was calculated to be 0.005 foot per foot. Based on these values of K and I, the average linear pore water velocity (V) at the site ranges from 0.011 to 0.019 ft/day.

6.2 CONCLUSIONS.

- Benzene, total VOA, EDB, total naphthalenes, TRPH, and lead concentrations exceed State target levels for Class G-II groundwater.
- Class G-II groundwater in the surficial aquifer at the fuel tanks yard has been adversely impacted by the presence of free product.
- Groundwater contamination at the Jet Engine Test Cell site is generally restricted to the general vicinity of the fuel tanks yard and may be associated with past leaks and spills. The vertical extent of groundwater contamination does not exceed 25 feet bls.
- Soil at the Jet Engine Test Cell site is excessively contaminated as defined by Chapter 17-770, FAC, remediation target levels to a depth of approximately 7 feet bls.
- Nearby potable water wells have not been affected by contaminants at the site, and based on subsurface conditions, are not expected to be impacted.

6.3 RECOMMENDATIONS. ABB-ES recommends that (1) initial remedial action be implemented to recover free product at the site, (2) corrective measures be taken to abate the source(s) of contamination, and (3) a remedial action plan (RAP) be prepared to address the contamination and initiate an appropriate course of action.

7.0 PROFESSIONAL REVIEW CERTIFICATION

The CA contained in this report was prepared using sound hydrogeologic principles and judgment. This assessment is based on the geologic investigation and associated information detailed in the text and appended to this report. If conditions are determined to exist that differ from those described, the undersigned geologist should be notified to evaluate the effects of any additional information on the assessment described in this report. This CAR was developed for the Jet Engine Test Cell site at NAS Cecil Field, Jacksonville, Florida, and should not be construed to apply to any other site.

Michael J. Williams
Professional Geologist
P.G. No. 0000344

Date

8.0 REFERENCES

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APPENDIX A

U.S. ARMY CORPS OF ENGINEERS
PRELIMINARY CONTAMINATION ASSESSMENT REPORT
MARCH 1991

APPENDIX B

SITE CONDITIONS

Physiography

Duval County lies within the northern, or proximal zone, geomorphic province characterized by continuous high ground forming a broad upland that extends eastward to the Eastern Valley and westward continuously into the Western Highland of Florida (Scott, 1978). Naval Air Station (NAS) Cecil Field is situated on this broad upland, the Duval Upland. The Duval Upland is essentially a relict of a marine terrace. Elevations range from 20 to 30 feet above mean sea level (msl) at the toe to greater than 70 feet msl at the crest of the upland's scarp. Elevations continue to increase westward across the upland becoming greater than 100 feet msl at its western limit, the base of the Trail Ridge (White, 1970).

Regional Hydrogeology

NAS Cecil Field is underlain by two water-bearing units. These include the shallow aquifer and the Floridan aquifer system.

Geraghty & Miller (1983) indicate that the surficial aquifer extends to an approximate depth of 45 feet below land surface (bls). Fairchild (1972) considers all sediments younger than middle Miocene age sediments to be part of the shallow aquifer, thus increasing its thickness to greater than 100 feet. Fairchild (1972) divides the shallow aquifer into three, loosely defined sections, which are as follows.

- The upper section (Pleistocene to Holocene deposits) is comprised of unconsolidated deposits of sands, clayey sands, and clay with a hardpan layer of iron oxide. Typically, the sediments are 50 to 60 feet thick.

- The middle section, typically 55 to 90 feet bls (Upper Miocene or Pliocene deposits), consists of clayey sand to sandy clay and shell.

- The lower section, greater than 90 feet bls (Middle to Upper Miocene?), consists of interbedded sandy clays, clay, and soft, porous bioclastic limestones, which can be cavernous in places. Lithologic data indicate these deposits are part of the Coosawhatchie Formation of the Hawthorn Group (Scott, 1988). In the NAS Cecil Field area, a bioclastic limestone layer, approximately 20 to 25 feet thick, occurs at a depth of 60 to 120 feet bls (Geraghty & Miller, 1983). Most small domestic supplies are obtained from this part of the surficial aquifer.

The upper section of the surficial aquifer is recharged by local rainfall and discharges to area streams or percolates downward to the lower sections. The depth to the surficial aquifer water table at NAS Cecil Field typically is about 5 feet bls. Groundwater flow in the lower part of the surficial aquifer is to the east (Fairchild, 1972).

Water quality data (Fairchild, 1972) indicate that total dissolved solids in the shallow water table aquifer range from 200 to 400 milligrams per liter (mg/ℓ). As this aquifer is used as a potable water source and has total dissolved solids of less than 10,000 mg/ℓ, these waters are considered Class G-II waters as established by Chapter 17-3, FAC, *Water Quality Standards*.

The Floridan aquifer system is the principal source of freshwater in northeast Florida. It is comprised of, in ascending order, the Oldsmar, Lake City, and Avon Park Limestones, the Ocala Group, and a few discontinuous, thin, water-bearing zones in the lower part of the Hawthorn Group, some of which are not present in all areas.

The Ocala Group is a homogeneous sequence of permeable, hydraulically connected, marine limestones containing a few hard, less transmissive dolomite or limestone beds that restrict the vertical movement of water. The Avon Park Limestone consists almost entirely of hard, relatively impermeable, dolomite confining beds and soft permeable limestone and dolomite water-bearing zones.

The top of the Floridan aquifer occurs at a depth of about 500 feet bls at NAS Cecil Field. Geraghty & Miller (1983) report that the transmissivity of the Floridan aquifer a few miles east of the base is 190,000 gallons per day per foot (gpd/ft).

Leve (1966) and Geraghty & Miller (1983) report that groundwater within the Floridan aquifer flows east-northeast in the vicinity of NAS Cecil Field. There is a net downward hydraulic gradient between the shallow rock aquifer and the Floridan aquifer in the area of NAS Cecil Field (Leve, 1966).

APPENDIX C

SOIL BORING AND MONITORING WELL LITHOLOGIC LOGS

APPENDIX D

INVESTIGATIVE METHODOLOGIES AND PROCEDURES

Soil Boring

The soil borings were advanced to the top of the water table by ABB Environmental Services, Inc. (ABB-ES), personnel, using a 3¼-inch (inside diameter [ID]) hand auger and by U.S. Army Corps of Engineers by using a 4-inch (ID) hand auger. A soil sample from each borehole, retrieved at the soil-water interface, was placed in a 16-ounce soil jar for headspace analysis using an organic vapor analyzer (OVA) following Florida Department Environmental Protection (FDEP) procedures as outlined in Chapter 17-770, Florida Administrative Code (FAC). The U.S. Army Corps of Engineers also collected soil samples at depth of 1 foot and 5 feet below land surface (bls).

Monitoring Well Construction

Most shallow monitoring wells were installed using a drill rig with hollow-stem augering capabilities. Two shallow monitoring wells were installed at the site with a 4-inch (ID) stainless-steel bucket auger and drilling mud (when needed). Deeper monitoring wells were installed using a drill rig with mud rotary capabilities. Soil quality samples were collected from each monitoring well borehole (except manually installed wells) prior to well installation using a Standard Penetration Test (SPT) split-spoon sampler. Initial soil quality samples were collected immediately above the water table. Subsequent soil quality samples were collected at 5-foot intervals to the bottom of the borehole. Samples were analyzed using a portable gas chromatograph (GC) calibrated to detect benzene, ethyl benzene, toluene, and xylene (BETX) to the part per billion (ppb) detection level. This screening procedure allowed for the judicious placement of monitoring wells during the investigation.

All monitoring wells installed during the investigation were constructed of schedule 40 polyvinyl chloride (PVC) casing with flush-threaded joints and 0.010-inch slotted screen. Each shallow well was constructed of 2-inch PVC with a 10-foot screen section placed at a depth that should encompass seasonal water table fluctuations. Deep monitoring wells are constructed of either 2-inch or 4-inch ID PVC with 5 feet of 0.010-inch slotted screen. The 2-inch ID deep monitoring wells have 6-inch ID surface casings which extend from land surface to approximately 20 feet bls. The well casings extend from the top of the screen to land surface. A 20/30 grade silica filter pack was placed in the annular space around each well to approximately 2 feet above the top of the screen. A 1- to 2-foot bentonite seal was then placed on top of the filter pack. The remaining annular space was grouted to the surface with a neat cement. A protective, flush-mounted, traffic-bearing, protective vault was installed to complete each well. Each monitoring well is equipped with a locking well cap and a padlock.

Subsequent to installation, the shallow wells were developed using a centrifugal pump. The deep wells were developed by air surging until the purged water was relatively sand free or as clear as the aquifer allowed after 10 well volumes had been removed.

Water Level Measurements

The groundwater levels were measured using an electric water level indicator and an engineering tape accurate to 0.01 foot. The wells were checked for the presence of free product by visual inspection of a groundwater sample taken from each well and the thickness of the free product was determined by the use of an oil-water interface probe. Water level elevations were calculated by subtracting the measured depth to groundwater from the surveyed elevation at the top of the well casing. This information was plotted on a scaled water table contour map where flow lines (depicting groundwater flow direction) can be drawn perpendicular to the groundwater elevation contours. The groundwater hydraulic gradient was calculated by subtracting the differences in groundwater elevation (in feet) between two wells or two points on the map and dividing the elevation difference by the distance between the two points to obtain a resulting hydraulic gradient in feet per foot.

Soil Sampling

Soil samples for organic vapor analysis were placed in 16-ounce glass jars using a stainless-steel spoon and set in a 20 degree Celsius (°C) water bath for 5 minutes. Samples were analyzed using an OVA with a flame ionization detector (FID) using the headspace technique described in Chapter 17-770, FAC.

Each soil sample for field GC analysis was collected from the center portion of a split-spoon sample. Approximately 30 grams of soil from the split-spoon sample were placed in a 40 milliliter glass vial. Organic-free water was added to the soil sample until the vial was approximately 80 percent full. The vial was then sealed with a Teflon™ septum and plastic cap, so as to preclude ambient air from entering the vial. The soil and water were shaken vigorously to mix the two phases and assist in the release of contaminants, if present, from the mixture into the remaining airspace (headspace) of the vial. A gaseous sample was then extracted from the headspace by an air-tight syringe and injected into the GC for analysis. Samples were analyzed using an H-Nu GC, model 311.

Groundwater Sampling

The groundwater samples were collected in accordance with the ABB-ES, FDEP-approved, Comprehensive Quality Assurance Program Plan (CompQAPP). The monitoring wells were purged with a Teflon™ bailer. Purging continued until water quality field parameters (specific conductance, temperature, and Ph) had stabilized. Groundwater samples were then collected using an extruded Teflon™ bailer. Each sample was placed into its appropriate container and preserved as specified by the required sample analysis and as outlined in the ABB-ES, FDEP-approved, CompQAPP. All samples were set in coolers and placed on ice. Samples were then shipped or delivered to Wadsworth/ALERT Laboratories, Inc., Tampa, Florida, within 24 hours after collection. All groundwater samples collected during the contamination assessment were analyzed for the kerosene analytical group outlined in Chapter 17-770, FAC.

Slug Tests

The slug was constructed of 1-inch outside diameter PVC pipe, 5 feet in length, filled with sand, and capped watertight at both ends. The water level changes in the monitoring wells were recorded on an In-Situ, Inc., Hermit 1000C data logger with a model PXD-260 pressure transducer.

The pressure transducer was suspended just above the bottom of the well and an initial water level was recorded prior to beginning the test. The slug was then lowered into the well until it was totally submerged beneath the water table.

Water levels were then observed until recovery to the original level. Following stabilization, the slug was quickly removed with water level measurements recorded over time until the water level returned to the original level. A minimum of two rising head tests were conducted for each well in order to obtain an average recovery response.

Aquifer characteristics were calculated from slug test data using the computer program AQTESOLV™ (Geraghty & Miller, Inc., 1989) based on the analytical method presented by Bouwer and Rice (1976) for partially penetrating wells screened in an unconfined aquifer. The program derives a hydraulic conductivity (K) value based on linear regression of the data gathered during the slug test. The slope of the resulting line represents the K value for each analytical run.

APPENDIX E

AQUIFER PARAMETER CALCULATIONS

Estimates of average pore water velocity were obtained using the following formula:

$$V = (K*I)/n$$

where

V = Seepage (velocity) (ft/day)
K = hydraulic conductivity (ft/day)
I = hydraulic gradient
n = estimated porosity

Assuming a high hydraulic conductivity of 0.97 ft/day and a low conductivity of 0.51 ft/day, an estimated porosity of 25 percent and a hydraulic gradient of 0.005 in the northeast direction, the calculated average linear pore water velocities would be as follows:

a: Northeast direction - gradient calculated from wells MW-03 to MW-11.

$$V = (0.97 * 0.005) / 0.25 \text{ and}$$
$$V = (0.51 * 0.005) / 0.25$$
$$V = 0.019 \text{ ft/day to } 0.011 \text{ ft/day}$$

In order to calculate a transmissivity value from the slug test results, the following formula was used:

$$T = K * b$$

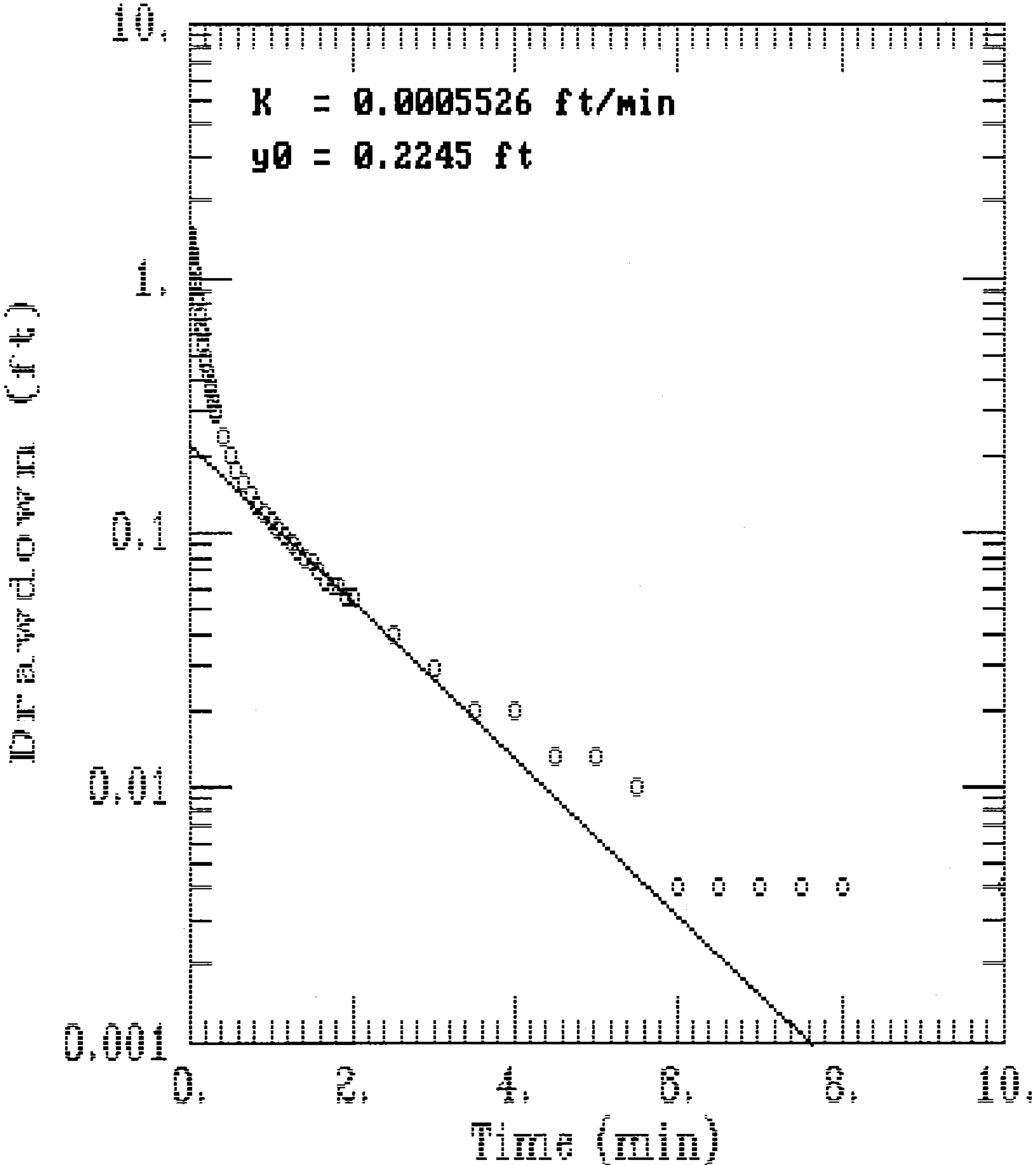
where

T = transmissivity (ft^2/day)
K = hydraulic conductivity (ft/day)
b = aquifer test interval (thickness) (ft)

based on the formula, the calculation for T would be as follows:

$$T = 0.97 * 8.1 \text{ (average aquifer thickness)}$$
$$T = 0.51 * 8.1 \text{ (average aquifer thickness)}$$
$$T = 7.86\ ft^2/\text{day to } 4.13\ ft^2/\text{day}$$

JETC CEF-811-03 RISING HEAD TEST RUN 1



AQTESOLV

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A Q T E S O L V   R E S U L T S
Version 1.10

12/21/93 13:25:38

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TEST DESCRIPTION

Data set........... A:3A.IP
Data set title..... JETC CEF-811-03 RISING HEAD TEST RUN 1

Knowns and Constants:
No. of data points.................. 61
Radius of well casing............... 0.08
Radius of well...................... 0.33
Aquifer saturated thickness......... 8
Well screen length.................. 10
Static height of water in well...... 8
Log(Re/Rw).......................... 2.437
A, B, C.............................. 0.000, 0.000, 1.979

==

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

==

RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

	Estimate
K =	5.4839E-004
y0 =	0.0000E+000

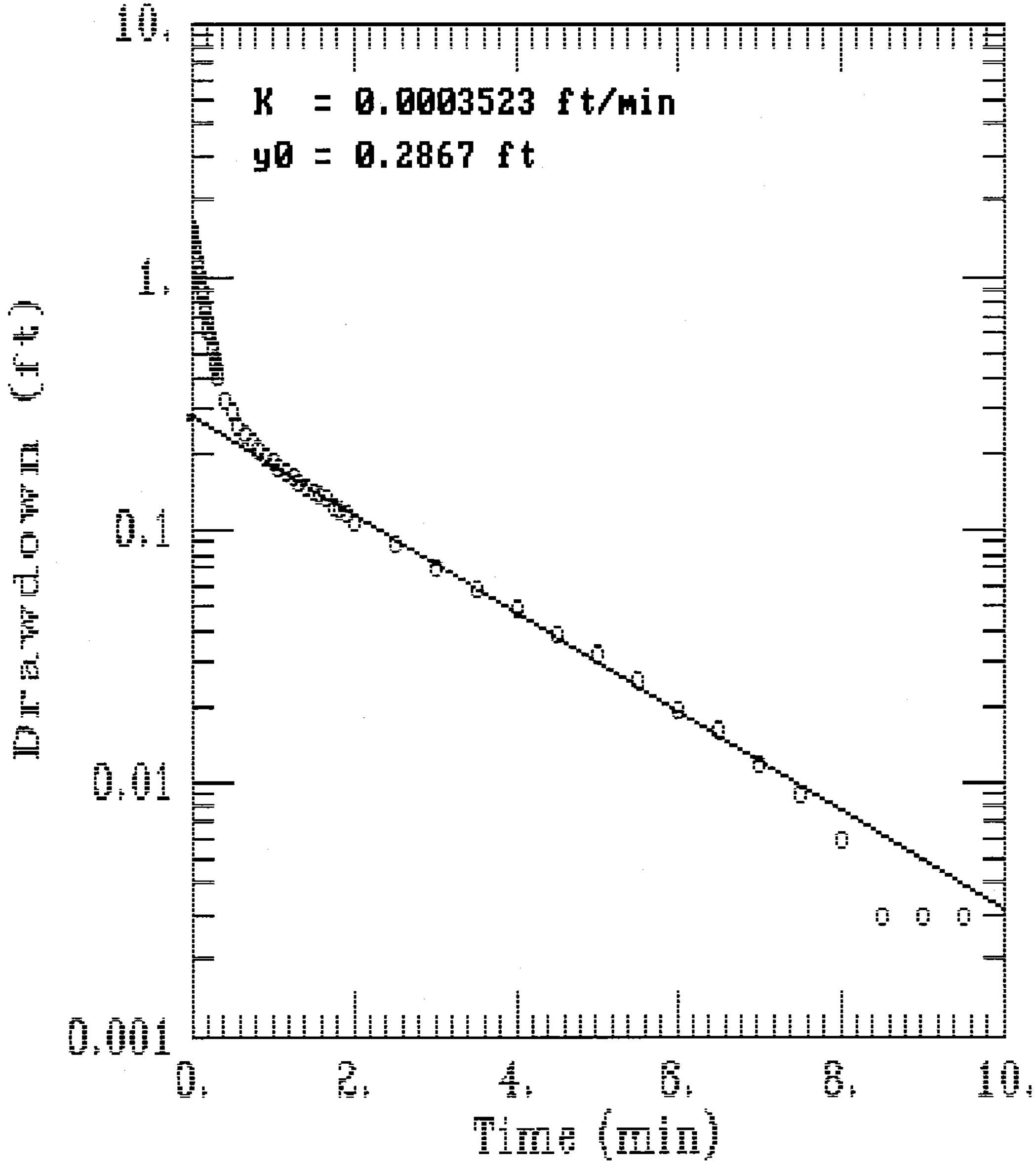
<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>

TYPE CURVE DATA

K = 3.69985E-003
y0 = 1.27350E+000

Time	Drawdown	Time	Drawdown	Time	Drawdown
0.000E+000	1.274E+000	1.000E+001	3.172E-021		

JETC CEF-811-03 RISING HEAD TEST RUN 2



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A Q T E S O L V   R E S U L T S

Version 1.10

12/21/93 13:50:40

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TEST DESCRIPTION

Data set........... A:3B.IP
Data set title..... JETC CEF-811-03 RISING HEAD TEST RUN 2

Knowns and Constants:
- No. of data points.................. 63
- Radius of well casing............... 0.08
- Radius of well...................... 0.33
- Aquifer saturated thickness......... 8
- Well screen length.................. 10
- Static height of water in well...... 8
- Log(Re/Rw).......................... 2.437
- A, B, C............................. 0.000, 0.000, 1.979

==

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

==

RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

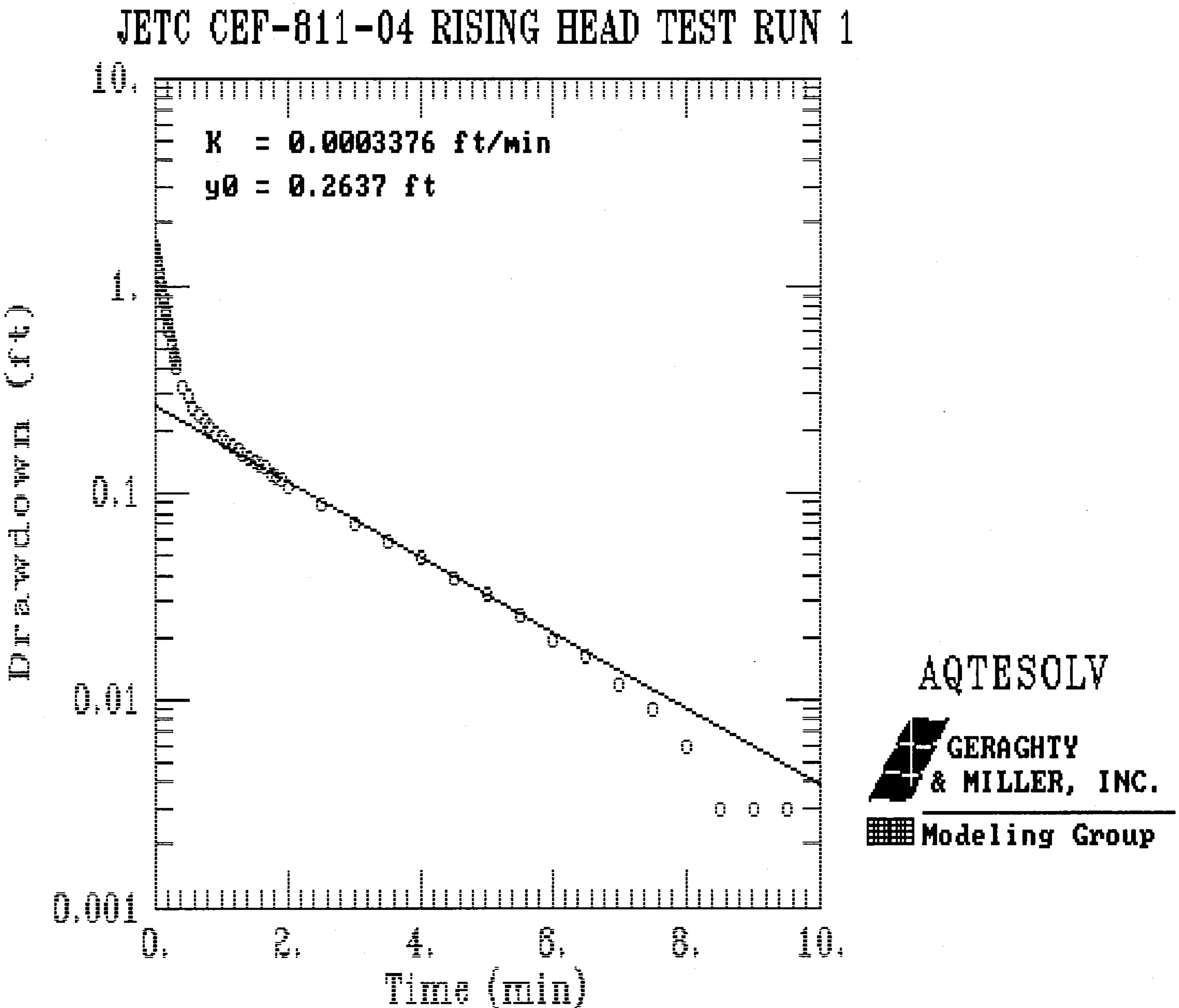
	Estimate
K =	3.3676E-004
y0 =	0.0000E+000

<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>

TYPE CURVE DATA

K = 3.52327E-004
y0 = 2.86651E-001

Time	Drawdown	Time	Drawdown	Time	Drawdown
0.000E+000	2.867E-001	1.000E+001	3.128E-003		



JETC CEF-811-04 RISING HEAD TEST RUN 1
K = 0.0003376 ft/min
y0 = 0.2637 ft
10.
1.
0.1
0.01
0.001
0.
2.
4.
6.
8.
10.
Drawdown (ft)
Time (min)
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A Q T E S O L V R E S U L T S

Version 1.10

12/21/93 14:23:01

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TEST DESCRIPTION

Data set........... A:4A.IP
Data set title..... JETC CEF-811-04 RISING HEAD TEST RUN 1

Knowns and Constants:

No. of data points.................. 63
Radius of well casing............... 0.08
Radius of well...................... 0.33
Aquifer saturated thickness......... 9
Well screen length.................. 10
Static height of water in well...... 9
Log(Re/Rw).......................... 2.512
A, B, C............................. 0.000, 0.000, 1.979

==

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

==

RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

	Estimate
K =	5.0154E-004
y0 =	6.9315E+234

<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>

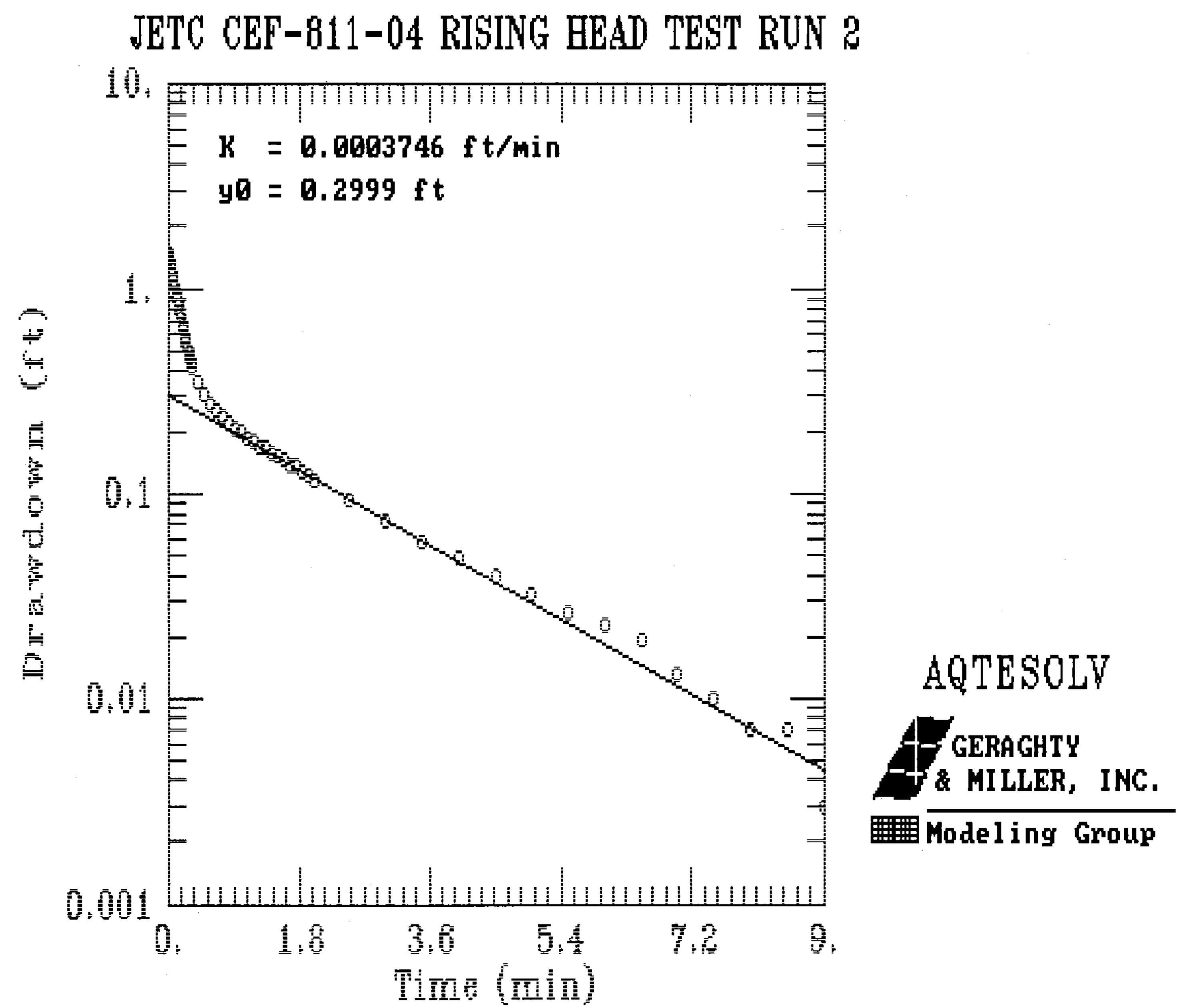
TYPE CURVE DATA

K = 3.45334E-004
y0 = 2.64467E-001

Time	Drawdown	Time	Drawdown	Time	Drawdown
0.000E+000	2.645E-001	1.000E+001	3.605E-003		

TYPE CURVE DATA

K = 3.45334E-004
y0 = 2.64467E-001



JETC CEF-811-04 RISING HEAD TEST RUN 2
K = 0.0003746 ft/min
y0 = 0.2999 ft
10.
1.
0.1
0.01
0.001
Drawdown (ft)
0.
1.8
3.6
5.4
7.2
9.
Time (min)
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A Q T E S O L V   R E S U L T S
Version 1.10

12/21/93 14:38:22

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TEST DESCRIPTION

Data set........... A:4B.IP
Data set title..... JETC CEF-811-04 RISING HEAD TEST RUN 2

Knowns and Constants:
No. of data points.................. 62
Radius of well casing............... 0.08
Radius of well...................... 0.33
Aquifer saturated thickness......... 9
Well screen length.................. 10
Static height of water in well...... 9
Log(Re/Rw).......................... 2.512
A, B, C............................. 0.000, 0.000, 1.979

==

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

==

RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

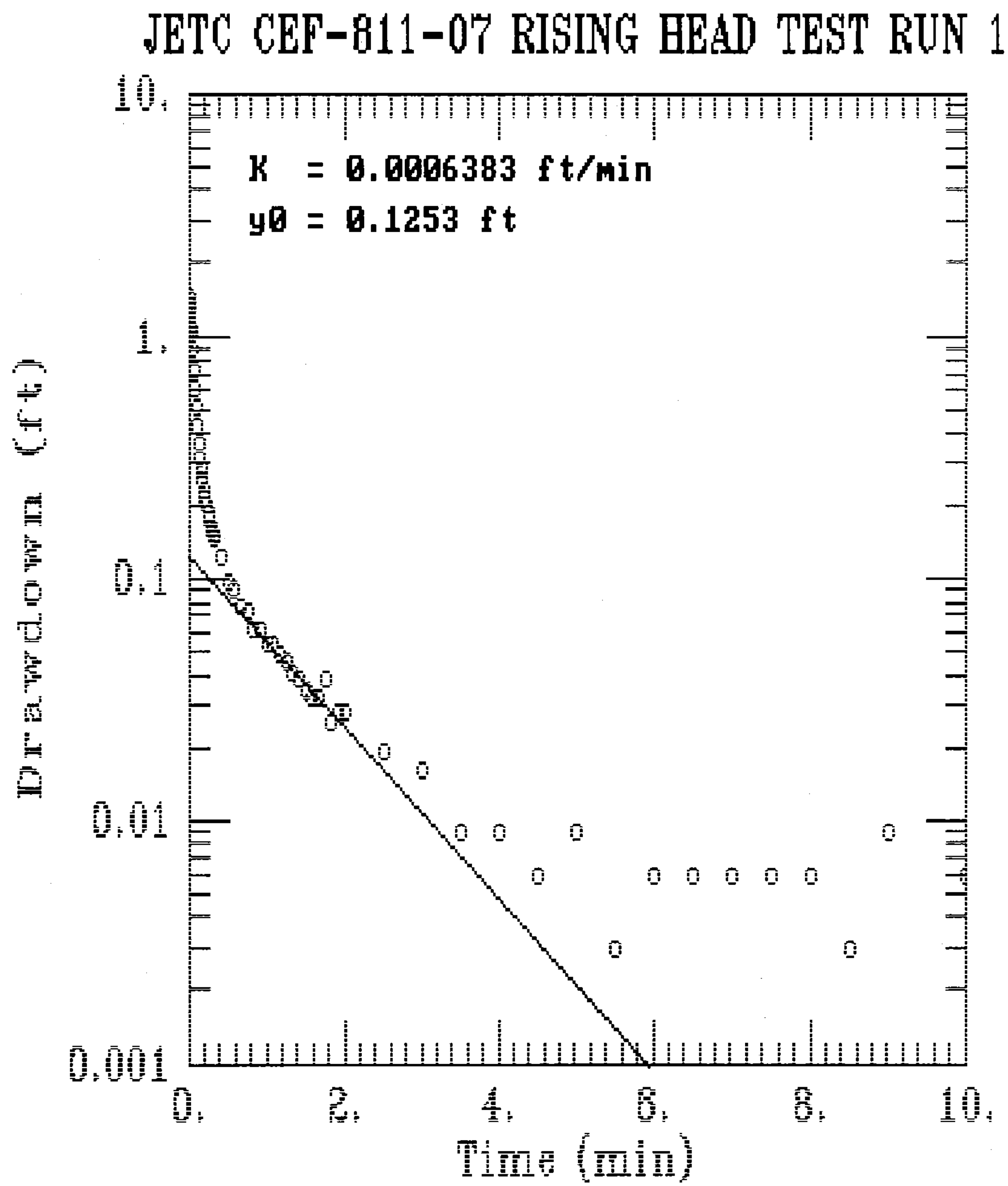
	Estimate
K =	4.9020E-004
y0 =	6.9315E+234

<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>

TYPE CURVE DATA

K = 3.63889E-004
y0 = 2.90402E-001

Time	Drawdown	Time	Drawdown	Time	Drawdown
0.000E+000	2.904E-001	9.000E+000	4.941E-003		



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A Q T E S O L V   R E S U L T S

Version 1.10

12/21/93 15:03:30

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TEST DESCRIPTION

Data set........... A:7A.IP
Data set title..... JETC CEF-811-07 RISING HEAD TEST RUN 1

Knowns and Constants:
- No. of data points.................. 126
- Radius of well casing............... 0.08
- Radius of well...................... 0.33
- Aquifer saturated thickness......... 8.3
- Well screen length.................. 10
- Static height of water in well...... 8.3
- Log(Re/Rw).......................... 2.461
- A, B, C............................. 0.000, 0.000, 1.979

==

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

==

RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

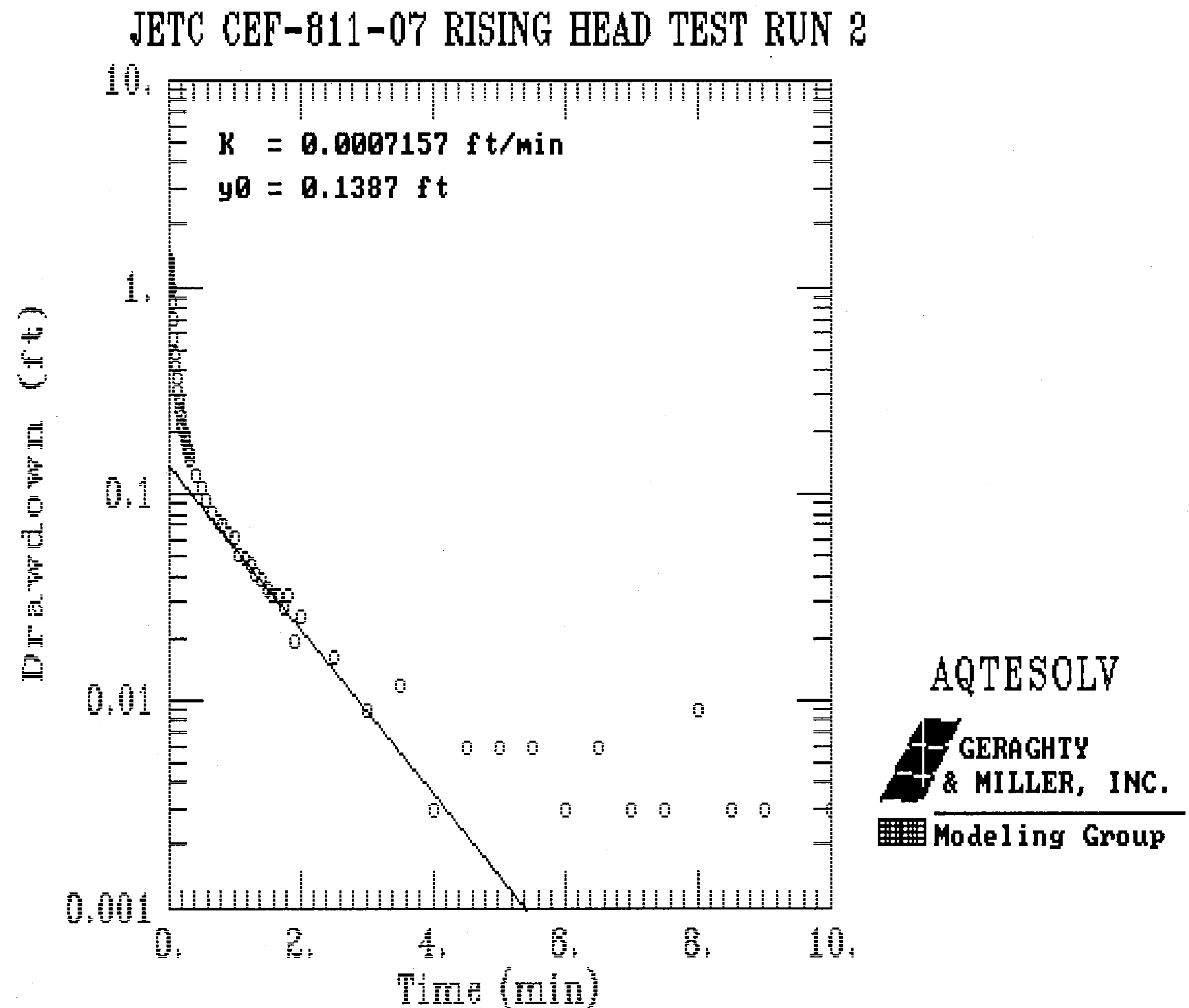
	Estimate
K =	4.5272E-004
y0 =	6.9315E+234

<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>

TYPE CURVE DATA

K = 6.38335E-004
y0 = 1.25314E-001

Time	Drawdown	Time	Drawdown	Time	Drawdown
0.000E+000	1.253E-001	1.000E+001	3.779E-005		


JETC CEF-811-07 RISING HEAD TEST RUN 2
K = 0.0007157 ft/min
y0 = 0.1387 ft
10.
1.
0.1
0.01
0.001
Drawdown (ft)
0.
2.
4.
6.
8.
10.
Time (min)
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A Q T E S O L V   R E S U L T S

Version 1.10

12/21/93 15:24:38

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TEST DESCRIPTION

Data set........... A:7B.IP
Data set title..... JETC CEF-811-07 RISING HEAD TEST RUN 2

Knowns and Constants:
No. of data points.................. 63
Radius of well casing............... 0.08
Radius of well...................... 0.33
Aquifer saturated thickness......... 8.3
Well screen length.................. 10
Static height of water in well...... 8.3
Log(Re/Rw).......................... 2.461
A, B, C............................. 0.000, 0.000, 1.979

==

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

==

RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

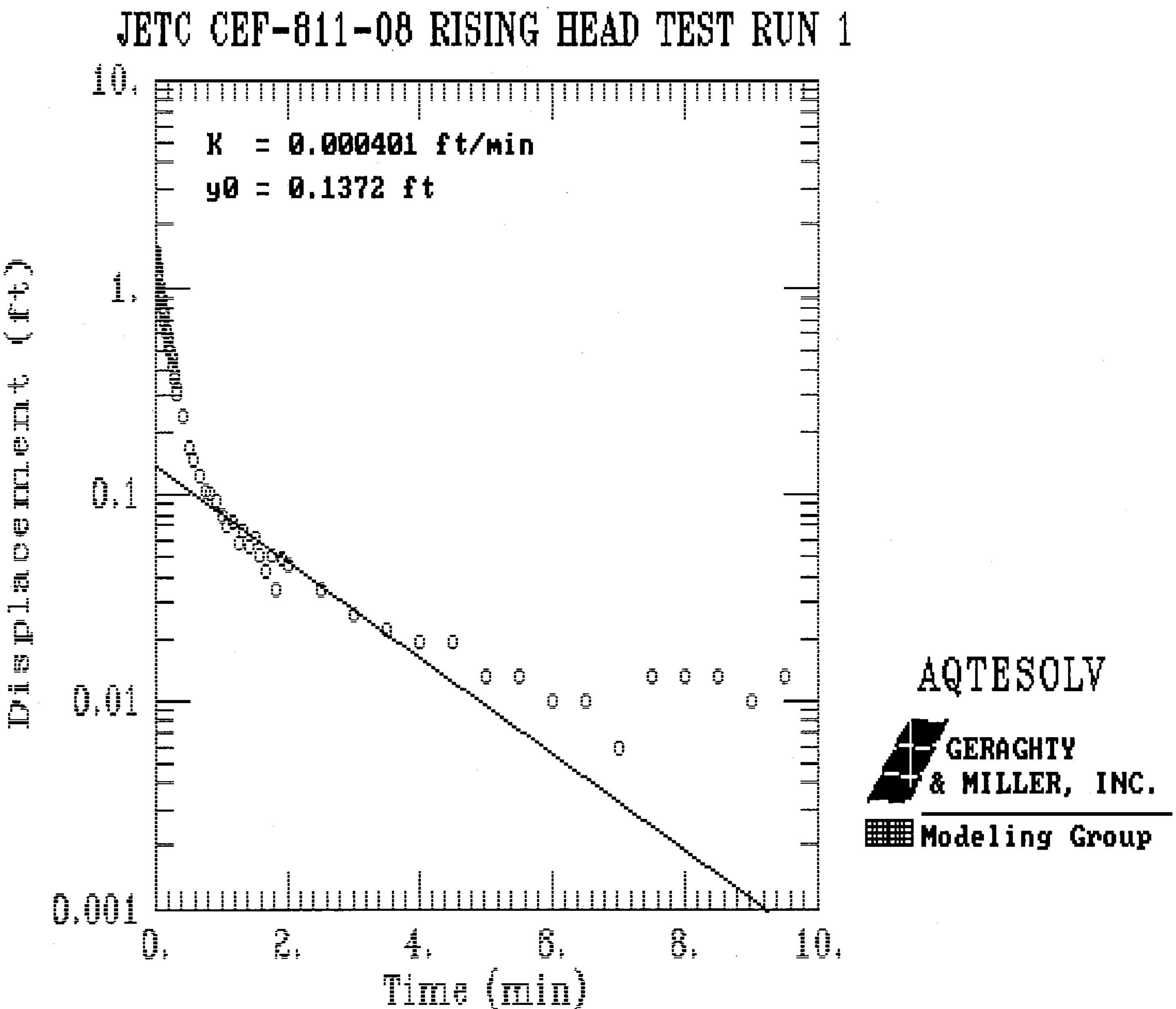
	Estimate
K =	4.9228E-004
y0 =	6.9315E+234

<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>

TYPE CURVE DATA

K = 7.15709E-004
y0 = 1.38676E-001

Time	Drawdown	Time	Drawdown	Time	Drawdown
0.000E+000	1.387E-001	1.000E+001	1.565E-005		



JETC CEF-811-08 RISING HEAD TEST RUN 1
K = 0.000401 ft/min
y0 = 0.1372 ft
Displacement (ft)
10.
1.
0.1
0.01
0.001
0.
2.
4.
6.
8.
10.
Time (min)
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A Q T E S O L V   R E S U L T S

Version 1.10

12/21/93 15:35:56

TEST DESCRIPTION

Data set........... A:8A.IP
Data set title..... JETC CEF-811-08 RISING HEAD TEST RUN 1

Knowns and Constants:
No. of data points.................. 63
Radius of well casing............... 0.08
Radius of well...................... 0.33
Aquifer saturated thickness......... 7.12
Well screen length.................. 10
Static height of water in well...... 7.12
Log(Re/Rw).......................... 2.362
A, B, C............................. 0.000, 0.000, 1.979

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

	Estimate
K =	4.1500E-004
y0 =	6.9315E+234

<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>

TYPE CURVE DATA

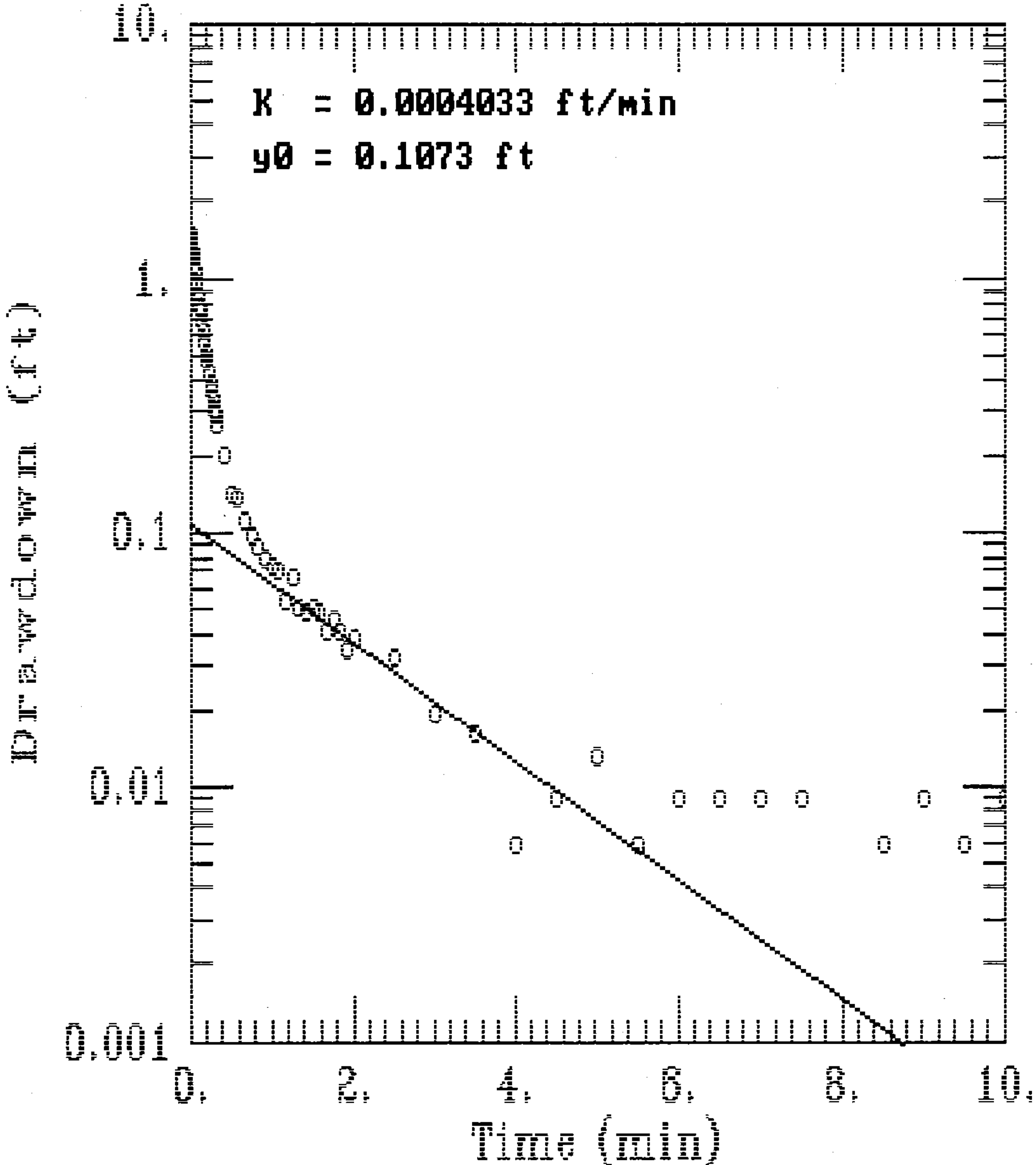
K = 4.01015E-004
y0 = 1.37151E-001

Time	Drawdown	Time	Drawdown	Time	Drawdown
0.000E+000	1.372E-001	1.000E+001	6.804E-004		

TYPE CURVE DATA

K = 4.01015E-004
y0 = 1.37151E-001

JETC CEF-811-08 RISING HEAD TEST RUN 2



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A Q T E S O L V   R E S U L T S
Version 1.10

12/21/93 15:43:25

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TEST DESCRIPTION

Data set........... A:8B.IP
Data set title..... JETC CEF-811-08 RISING HEAD TEST RUN 2

Knowns and Constants:
No. of data points.................. 63
Radius of well casing............... 0.08
Radius of well...................... 0.33
Aquifer saturated thickness......... 7.12
Well screen length.................. 10
Static height of water in well...... 7.12
Log(Re/Rw).......................... 2.362
A, B, C............................. 0.000, 0.000, 1.979

==

ANALYTICAL METHOD

Bouwer-Rice (Unconfined Aquifer Slug Test)

==

RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

	Estimate
K =	4.3020E-004
y0 =	6.9315E+234

<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>

TYPE CURVE DATA

K = 4.03320E-004
y0 = 1.07322E-001

Time	Drawdown	Time	Drawdown	Time	Drawdown
0.000E+000	1.073E-001	1.000E+001	5.165E-004		