5-23

ROBERTS

DRAFT REPORT

26TH STREET PILOT REMEDIAL RECOVERY INVESTIGATION at the Atlantic Refining and Marketing Corporation Philadelphia, Pennsylvania

December 21, 1987

Prepared For:

Atlantic Refining and Marketing Corporation
Philadelphia, Pennsylvania

Prepared By:

Engineering Enterprises, Inc.
1215 West Baltimore Pike, Suite 5
Media, Pennsylvania 19063

EEI ENGINEERING ENTERPRISES, INC.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES

SECTION 1.0

INTRODUCTION

1.1 PROJECT SCOPE AND OBJECTIVES

Atlantic Refining and Marketing Co. (Atlantic) retained Engineering Enterprises, Inc. (EEI) to conduct a subsurface investigation and pilot remedial study at their Philadelphia Refinery. The purpose of the investigation was to determine the source(s) of petroleum hydrocarbon vapors within the city of Philadelphia's 26th Street sanitary sewer, and to implement a pilot remedial system. The 26th Street sewer is located adjacent to the Refinery's eastern property boundary.

Site work to date has consisted of the following:

- Installation of groundwater monitoring wells along the refinery's eastern boundary to determine the possible source(s) of petroleum hydrocarbon vapors in the 26th Street sewer.
- Evaluation of data from the installation and testing of the monitoring wells to define the extent of petroleum hydrocarbon contamination.
- Design and implement a pilot remedial system to evaluate the most effective means for remediation.

Well installation methods, data acquisition, and pilot remedial system installation and testing are discussed in Section 2.0 of this report. Results of the initial investigation and pilot remedial system testing are provided in Section 3.0, while conclusions and recommendations are presented in Section 4.0. Data regarding the field investigative process are in Appendices A through C.

SECTION 2.0

FIELD INVESTIGATION

2.1 MONITORING WELL INSTALLATION

EEI subcontracted Hardin and Huber, Inc. of Crofton, Maryland, for the drilling and installation of ten 2-inch diameter PVC monitoring wells (numbered 67-76). Monitoring wells were installed along the refinery's eastern property line adjacent to 26th street. Drilling, well installation, and development commenced on July 22 and was completed on August 3, 1987. The hollow stem auger drilling method was utilized for borehole advancement. To describe subsurface conditions and to detect the presence of petroleum hydrocarbon contamination, split spoon samples were collected. A well location map is presented in Figure 2.1.

Each monitoring well was constructed by the insertion of 2-inch schedule 40 PVC, threaded flush joint, 20-slot well screen and an appropriate length of 2-inch PVC threaded flush joint casing. The well screen was positioned approximately two to five feet above the static fluid level, and a graded sand pack was installed between the borehole wall and well screen from the total depth of the boring to a height of two to five feet above the top of the screen. A bentonite pellet seal was placed above the sand pack, and the remaining borehole was tremie pipe grouted with a cement/bentonite mix. A flush mount manhole was installed at wells located in high traffic areas. A monitoring well construction schematic is presented in Figure 2.2. Geologic and well construction logs are in Appendix A.

Upon completion of monitoring well installation, the wells were developed to remove any sand, silt or residual drilling fluid. Well

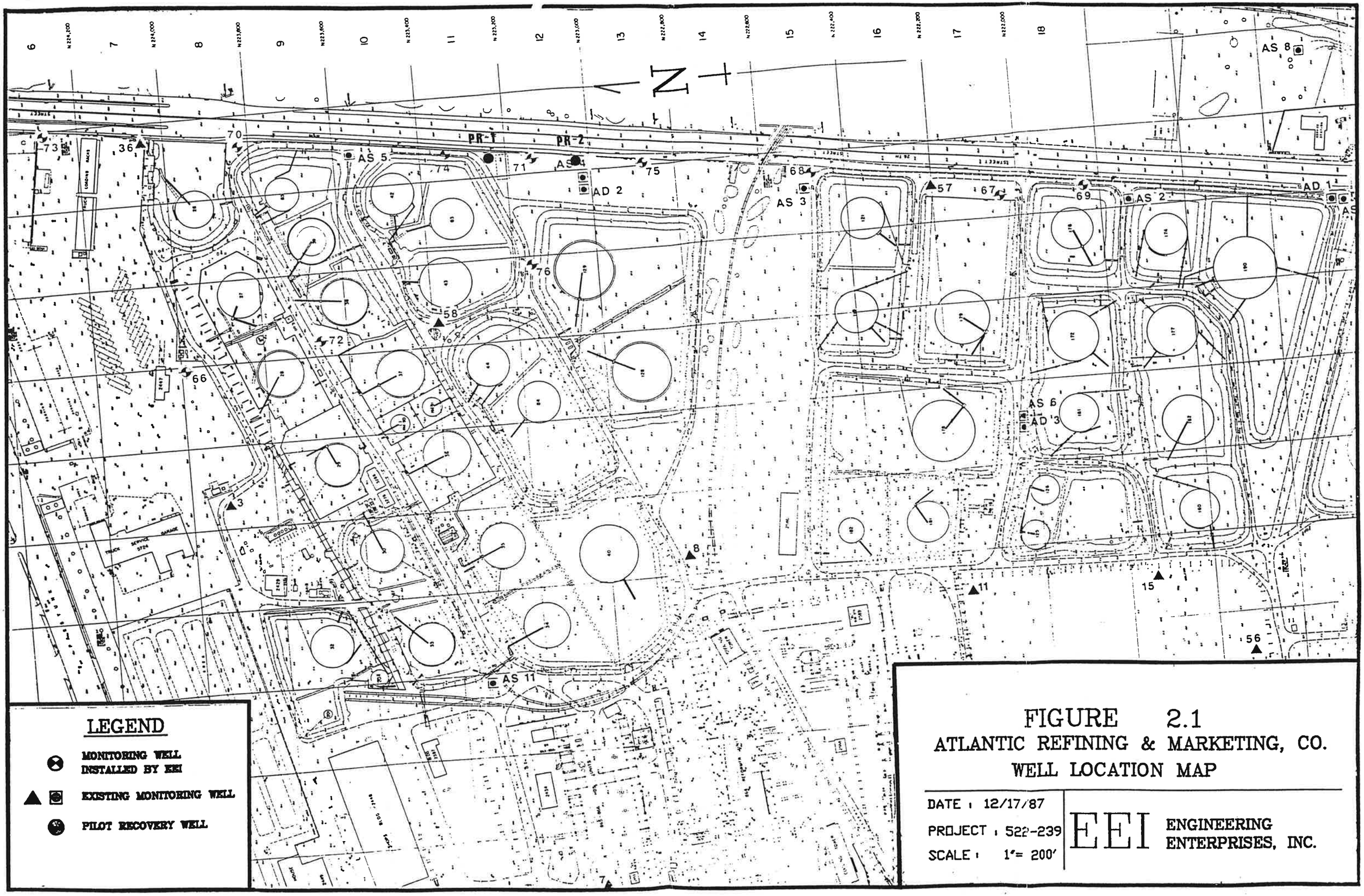


FIGURE 2.1

ATLANTIC REFINING & MARKETING, CO.

WELL LOCATION MAP

DATE : 12/17/87

PROJECT : 522-239

SCALE : 1"= 200'

EEI ENGINEERING ENTERPRISES, INC.

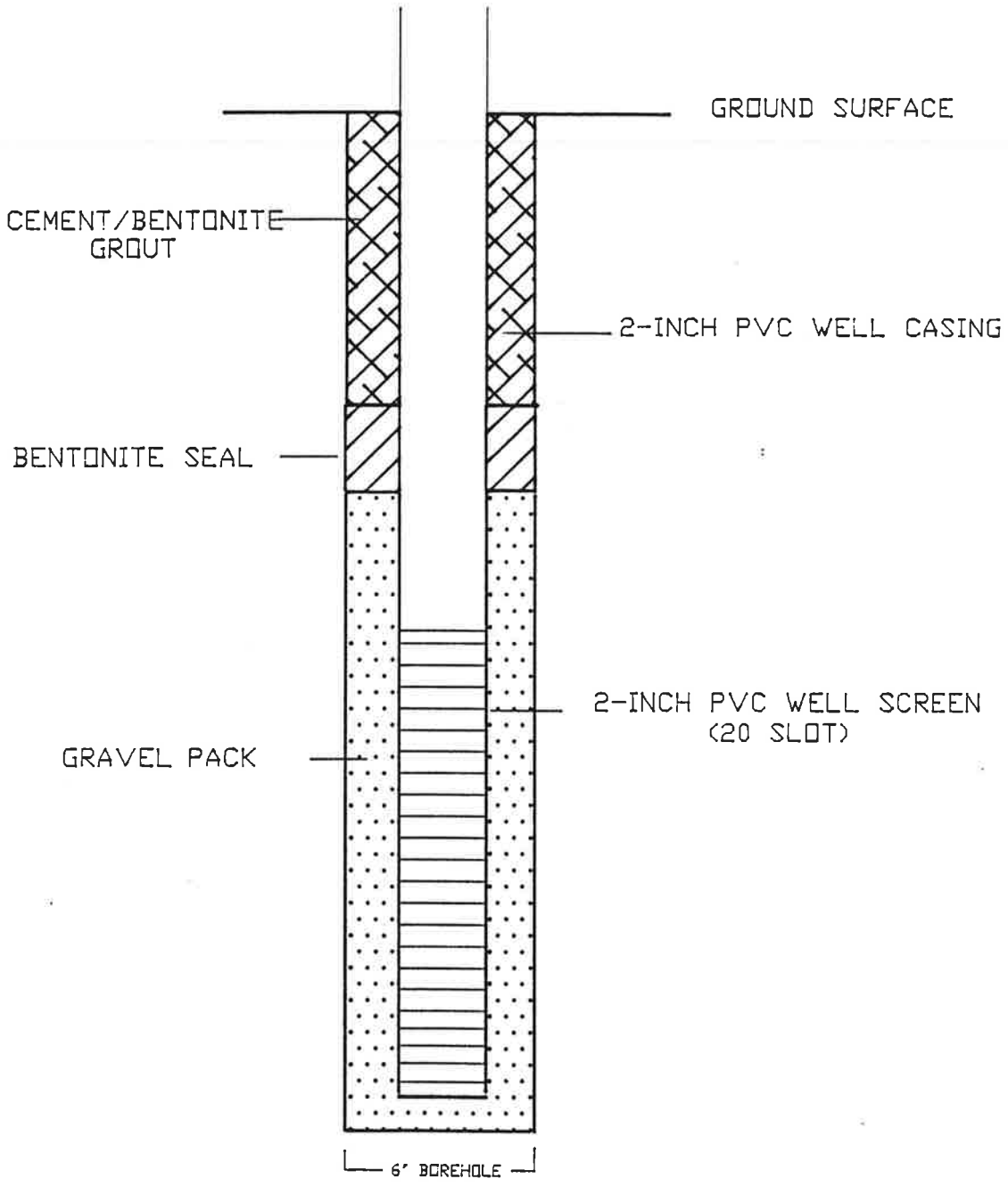


FIGURE 2.2
ATLANTIC REFINING & MARKETING,CO.
TYPICAL MONITORING WELL SCHEMATIC

DATE 12/15/87
PROJECT 522-239

EEI ENGINEERING ENTERPRISES,INC.

development was accomplished utilizing bailing and surging techniques. A dedicated 1 1/4 inch diameter bailer was inserted into the well to remove the fluid. When the fluid was relatively free of particulate matter, a 1 1/2 inch diameter surge tool was utilized to agitate and remove particulate matter that may have been lodged in the well screen and sand pack. The surging technique entails the up and down movement of the tool over the entire length of the well screen. Upon completion of surging, the well was again bailed to remove particulate matter that entered the well.

2.2 VERTICAL SURVEY AND LIQUID LEVEL ACQUISITION

Following the completion of the monitoring well installation program, the newly installed monitoring wells and selected existing wells were located via a vertical survey. The purpose of the vertical survey was to tie the wells into a common plant datum. Survey data was essential in the preparation of corrected water table contour maps.

Liquid levels were acquired from the newly installed monitoring wells and existing wells located in the study area on two separate occasions (August 4 and September 15, 1987). An oil/water interface probe was utilized to determine the thickness of petroleum hydrocarbon within the well and also to determine groundwater levels. This data was converted to an elevation base and utilized for the preparation of petroleum hydrocarbon thickness and corrected water table contour maps. Monitoring well gauging data is presented in Appendix B.

2.3 PETROLEUM HYDROCARBON BAIL TESTS

Petroleum hydrocarbon bail tests were conducted on the newly installed monitoring wells displaying significant accumulations of petroleum hydrocarbon. Bail tests were performed on wells 71, 74, and 75. Bail

testing was conducted in an effort to determine the most representative thickness of petroleum hydrocarbon in the subsurface and the rate of inflow of petroleum hydrocarbon into the well. The test consisted of measuring and recording the static thickness. The petroleum hydrocarbon was then bailed from the well, utilizing a dedicated 1 1/4 inch PVC bottom loading bailer, until the petroleum hydrocarbon was completely removed or until no further reduction in thickness could be achieved. The quantity of petroleum hydrocarbon that was bailed and the rate of recovery into the well was measured and recorded. Bail testing was considered complete when the petroleum hydrocarbon thickness in the well stabilized.

2.4 PILOT RECOVERY WELL INSTALLATION

Proceeding the monitoring well installation program and subsequent data evaluation, two pilot recovery wells (PR-1 and PR-2) were drilled, installed and developed from July 18 to July 20 , 1987. Hardin and Huber Inc. of Crofton, Maryland performed recovery well drilling. Pilot recovery well locations are presented in Figure 2.1.

The mud rotary drilling method was utilized for the advancement of an 8-inch borehole which would allow the insertion of 4-inch well screen and casing. Schedule 40 PVC, threaded flush joint, 20-slot well screen and an appropriate length of casing was inserted into the borehole. The annular space between the well screen and borehole was gravel packed with a graded sand pack. A bentonite seal was installed above the sand pack, and the remaining borehole was tremie pipe grouted with a cement/bentonite mix to ground surface. Presented in Figure 2.3 is a schematic of a typical recovery well. Geologic and well construction logs for the pilot recovery wells are in Appendix A.

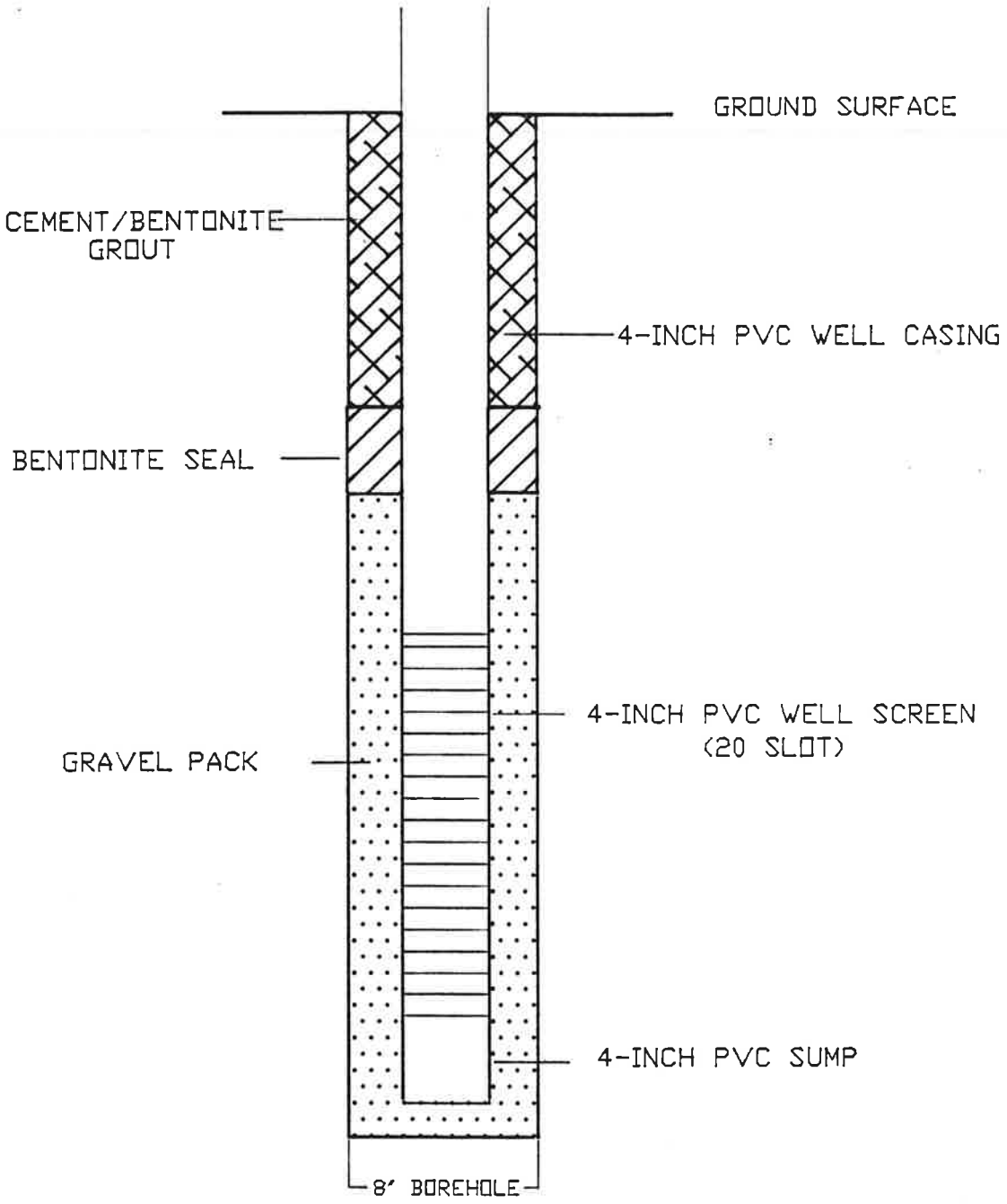


FIGURE 2.3
ATLANTIC REFINING & MARKETING, CO.
TYPICAL RECOVERY WELL SCHEMATIC

DATE 12/15/87
PROJECT 522-239

EEI ENGINEERING ENTERPRISES, INC.

Development of the recovery wells was accomplished immediately following installation, utilizing surge and pump development techniques. The development procedure employed was basically the same as monitoring well development, except that the bailing segment was replaced with pumping.

2.5 PILOT REMEDIAL SYSTEM INSTALLATION AND TESTING

Upon completion of recovery well drilling, a pilot remedial system was installed at PR-1 and PR-2. The system consisted of a diaphragm pump equipped with petroleum hydrocarbon resistant wetted parts and an EEI stainless steel air driven submersible pump. Total fluids (petroleum hydrocarbon and groundwater) were pumped from the wells to a petroleum hydrocarbon/water separator storage tank. The tank was equipped with a gravity drain system (water leg) that discharged the pumped groundwater to an on-site sewer and retained the recovered petroleum hydrocarbon.

The two separate pumping mechanisms were required due to different fluid levels observed within the recovery wells. Well PR-1, which displayed a static fluid level of 18.92 feet below top of casing, was equipped with the diaphragm pump. The diaphragm pump will only operate in areas were fluid levels are under suction lift conditions as in PR-1. The stainless steel submersible pump was installed in PR-2 due to its relatively deep static fluid level (26.98 feet below top of casing). This pump is capable of pumping fluid at depths greater than suction lift. Additionally, to enhance the flow of fluid into the well, the top of the well casings were sealed in order to create a vacuum. The fluid removed from the wells was discharged to the separator tank through 1-inch (ID) diameter above ground polypropylene pipe. A portable air compressor supplied air service to the pumps.

Following the completion of the pilot remedial system installation, a short-term pump test was conducted with both wells pumping simultaneously to determine groundwater withdrawal rates, the area of influence created by the system, and petroleum hydrocarbon production rates. Prior to the start of the test, static fluid levels were acquired from area monitoring wells. Following the start of the test, these monitoring wells were gauged daily, and groundwater, along with petroleum hydrocarbon withdrawal rates, were recorded. Testing commenced on October 27, 1987, and was completed on November 2, 1987. Atlantic has continued to operate the system and has collected data from area monitoring wells 71 and 74 for approximately three months.

SECTION 3.0

INVESTIGATION AND PILOT REMEDIAL SYSTEM RESULTS

3.1 GROUNDWATER CONDITIONS

Groundwater gauging data from the newly installed monitoring wells and selected existing wells currently indicate that water table conditions exists within the study area. Groundwater flow in this area is predominantly in a south/southeasterly direction. A corrected water table contour map, prepared from September 15, 1987 water level data, is presented in Figure 3.1. A 0.76 specific gravity value was utilized for water table/petroleum hydrocarbon corrections.

A review of the corrected water table map indicates that several factors may be controlling the groundwater flow system and the migration of petroleum hydrocarbon within the study area. A steep groundwater gradient exists between wells 74 and 71, located southeast of Tank 83. This steepening of contour lines could be the effect of localized lower permeabilities often seen in alluvial formations. Typically, when contour lines are positioned in a tight fashion, an area of lower permeability exists. The wide positioning of contour lines between wells 75 and 68, for example, usually indicates a relatively higher permeability. Another factor possibly contributing to the wide positioning of contour lines is the result of a man-made change in the subsurface, specifically a breach or break in the 26th Street sewer line which may act as a groundwater discharge or recharge point.

In the Belmont Terminal area, a slight groundwater depression exists between monitoring wells 73 and 70. Wells 36 and 66 displayed lower groundwater levels than other monitoring wells in the area. This lower

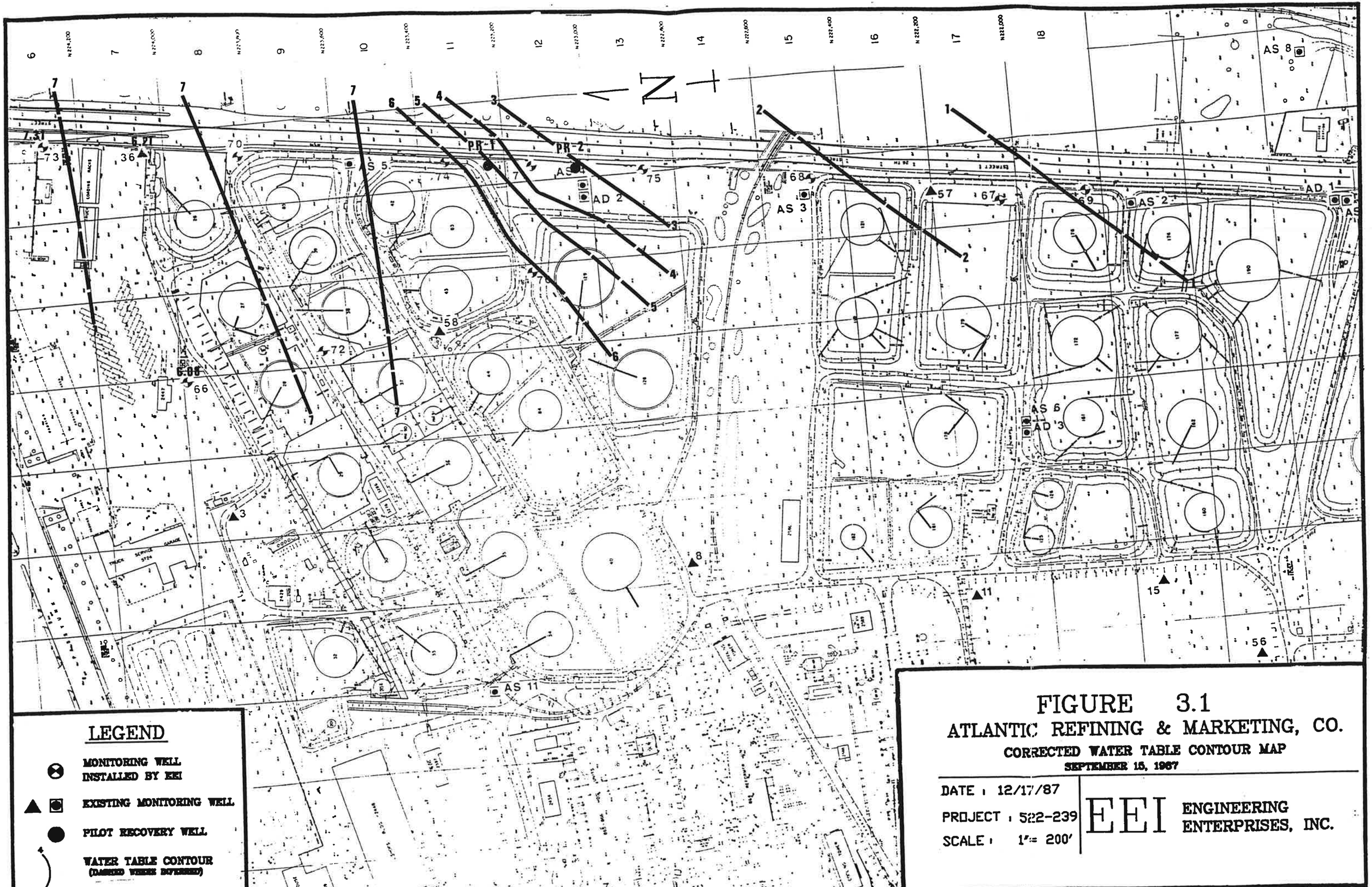


FIGURE 3.1

ATLANTIC REFINING & MARKETING, CO.

CORRECTED WATER TABLE CONTOUR MAP

SEPTEMBER 15, 1987

DATE : 12/17/87

PROJECT : 522-239

SCALE : 1"= 200'

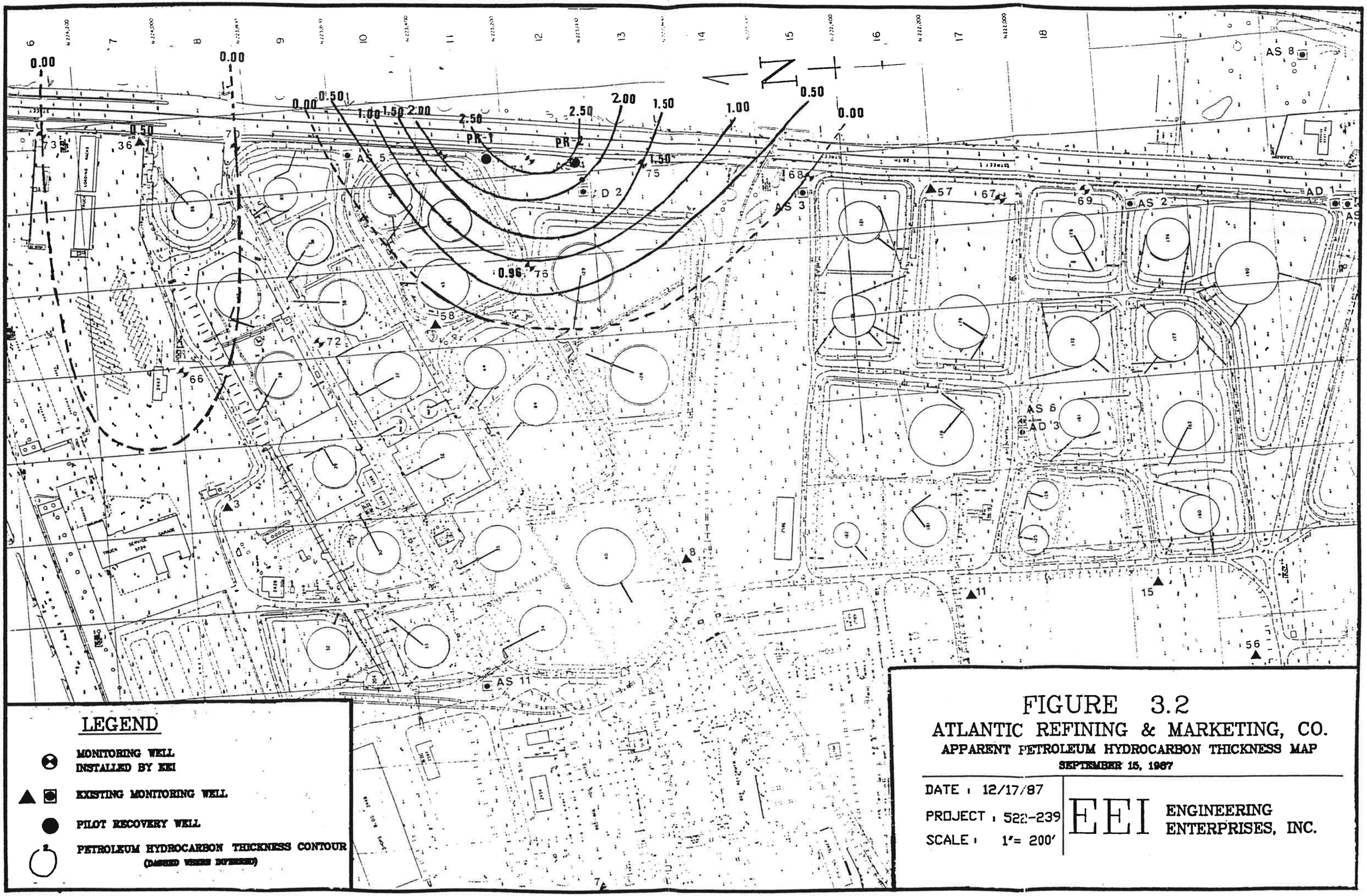
EEI ENGINEERING ENTERPRISES, INC.

groundwater level may be due to a high permeability channel existing in the area. Another explanation for this phenomenon could be the effect of man-made changes described above.

3.2 PETROLEUM HYDROCARBON OCCURRENCE

Monitoring well liquid levels were measured within the study area on several occasions. A measurable petroleum hydrocarbon thickness was recorded for wells 71, 74, 75, 76 and pre-existing well AS-5. Petroleum hydrocarbon thicknesses ranged from 0.05 feet in AS-5 to 2.69 feet in well 71. Measurable thicknesses were also gauged in monitoring wells 36 and 66, located in the Belmont Terminal area. Well 36 displayed 0.50 feet of petroleum hydrocarbon and 0.52 feet was detected in well 66 on September 15, 1987. Monitoring well gauging data suggests that the major petroleum hydrocarbon plume, located south east of Tank 83, and the plume that exists in the Belmont area are not connected.

A petroleum hydrocarbon thickness map was prepared utilizing September 15, 1987, monitoring well data (Figure 3.2). This map indicates the area of greatest product accumulation is in the vicinity of wells 71, 74, and 75, located east and southeast of Tank 83. During the drilling and soil sampling of these wells, the split spoon samples indicated the occurrence of petroleum hydrocarbon. Well 76, which contained 0.96 feet of petroleum hydrocarbon during the September gauging, also displayed petroleum hydrocarbon contamination during soil sampling but to a lesser extent. Strong petroleum hydrocarbon odors were detected in soil samples acquired from wells 67, 69, 70, and 72. Slight odors were present in soil samples from well 68 and no petroleum hydrocarbon odors were detected in soil



LEGEND

- MONITORING WELL INSTALLED BY EEI
- EXISTING MONITORING WELL
- PILOT RECOVERY WELL
- PETROLEUM HYDROCARBON THICKNESS CONTOUR (DASHED WHERE INFERRED)

FIGURE 3.2

ATLANTIC REFINING & MARKETING, CO.

APPARENT PETROLEUM HYDROCARBON THICKNESS MAP

SEPTEMBER 15, 1987

DATE : 12/17/87
PROJECT : 522-239
SCALE : 1"= 200'

EEI ENGINEERING ENTERPRISES, INC.

samples collected from well 73. A review of drilling logs from existing wells 36 and 66 indicates that both monitoring wells displayed strong petroleum hydrocarbon odors during well installation.

3.3 BAIL TEST RESULTS

Petroleum hydrocarbon bail tests were conducted on wells displaying significant thickness accumulations of petroleum hydrocarbons. Wells 71 and 74 were tested on August 3, and well 75 was tested on August 17, 1987. Bail test graphs are presented in Appendix C.

A review of the graphs indicated that well 74, located east of Tank 83, displayed a good potential for recovery. This was based on the fact that petroleum hydrocarbon in well 74, after bailing, would recover to its static level within approximately 90 minutes. Bail test data from wells 71 and 75 indicated that petroleum hydrocarbon recharge into the wells was slow and neither of the wells reached its original static level during the test period. These results indicate a less than favorable area for recovery.

3.4 PILOT REMEDIAL SYSTEM TEST RESULTS

Following the monitoring well data evaluation, two locations were selected for the installation of pilot recovery wells (PR-1 and PR-2). The principal factor governing the selection of these well locations was the significant accumulation of petroleum hydrocarbon in the vicinity of wells 71, 74, and 75. The two recovery wells were located within this plume. PR-1 is located 100 feet south of monitoring well 74, and PR-2 is located approximately 100 feet north of well 75.

3.4.1 AQUIFER RESPONSE

An aquifer pumping test was conducted at the pilot remedial system for six days (8730 minutes). PR-1 was pumped at a rate of 7.5 gallons per minute (gpm) and PR-2 at 0.60 gpm. The varied pumping rates can be attributed to pumping equipment (i.e. PR-1) and well limitations (i.e. PR-2). The diaphragm pump installed at PR-1 has a maximum discharge rate of 7.5 to 8.0 gpm when pumping fluid from a depth of 25 feet and discharging through 1-inch pipe. The maximum discharge rate at PR-2, 0.60 gpm, can possibly be attributed to drilling and installation problems encountered during well construction. A black tar substance was evident from 1 to approximately 10 feet during borehole advancement. The overlying black tar substance hindered the placement of the graded sand pack around the well screen which may have contributed to poor well performance.

Monitoring wells AS-5, 71, 74, 75, and 76 were monitored during the test. Liquid levels in these wells were measured daily in order to determine the system's area of influence. Liquid levels were not acquired from the pumping wells due to the top of the well being sealed. Drawdown data was plotted to depict the area of influence of the remedial system and is presented in Figure 3.3.

Petroleum hydrocarbon production averages were also acquired from the two recovery wells during testing. PR-1 recovered, on the average, 6.9 barrels per day (bbls/day) at the start of testing and 24.9 bbls/day by the end of the extended test period. PR-2 produced minimal amounts of petroleum hydrocarbon on the order of less than 1 bbl/day. The average production figure was calculated by measuring the amount of petroleum hydrocarbon that accumulated in a grab sample. That measurement was

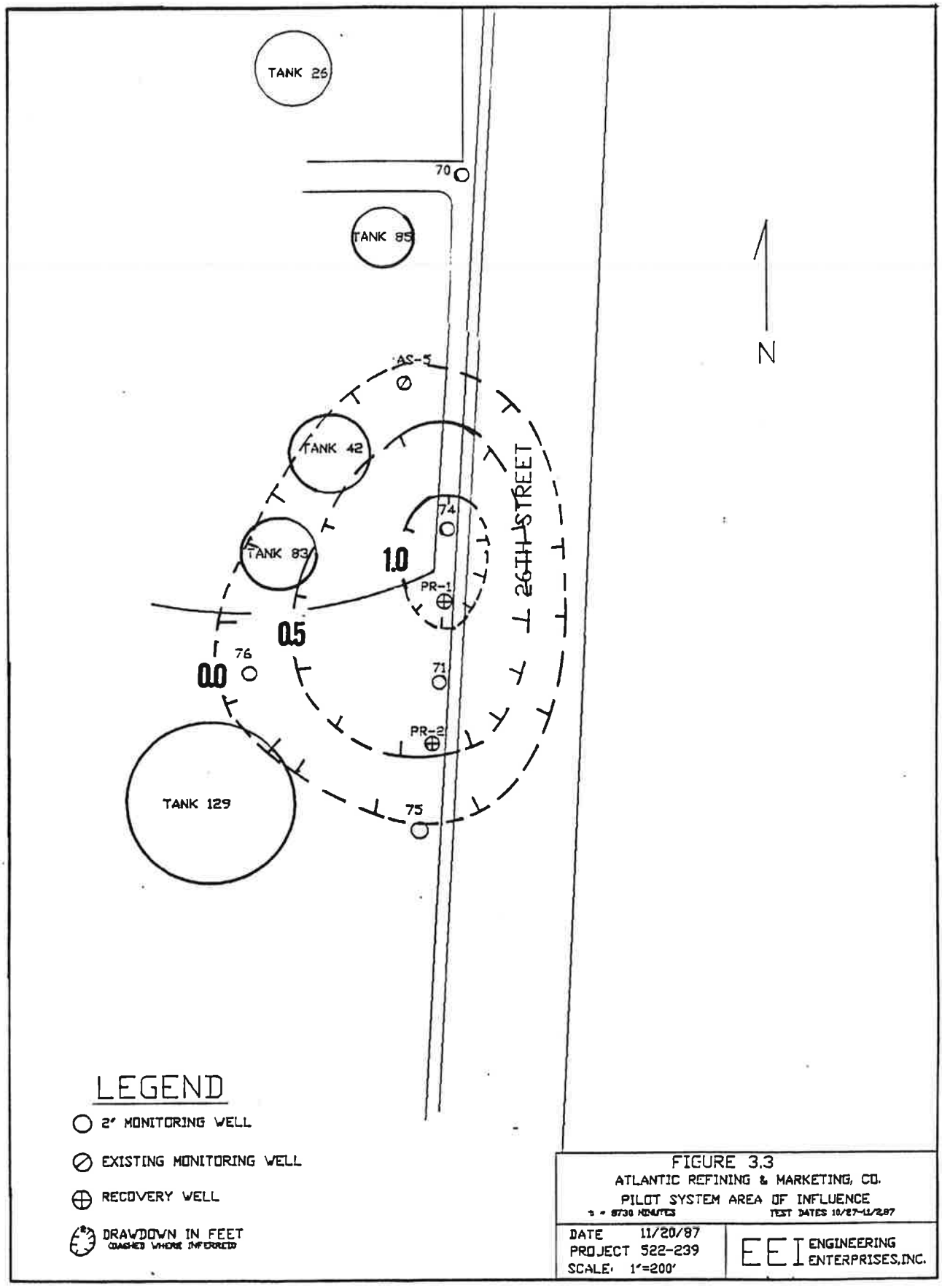


FIGURE 3.3
ATLANTIC REFINING & MARKETING, CO.
PILOT SYSTEM AREA OF INFLUENCE
t = 8730 MINUTES
TEST DATES 10/27-11/2/87

DATE 11/20/87
PROJECT 522-239
SCALE: 1"=200'

EEI ENGINEERING ENTERPRISES, INC.

divided by the total amount of fluid sampled to obtain a percent of petroleum hydrocarbon produced. The percent produced was then multiplied by the pumping rate and 1440 (minutes in one day) in order to determine daily production.

3.4.2 PETROLEUM HYDROCARBON THICKNESS CHANGES

During the testing, petroleum hydrocarbon thicknesses within area monitoring wells was recorded. Following the completion of the six day test, Atlantic continued to operate the system and additional liquid level data was collected. A review of the data reveals a general decline in petroleum hydrocarbon thicknesses in area monitoring wells. Table 3-1 presents petroleum hydrocarbon thickness changes from September to December of 1987.

The major factors affecting the increase or decrease of apparent petroleum hydrocarbon thickness within a monitoring well are fluctuations of the water table or the affects of pumping. Normally, if there is a rise in water levels, (i.e. increased recharge, tidal fluctuations, etc.) a decrease in petroleum hydrocarbon thickness can be expected. If the water table is lowered, an increase in petroleum hydrocarbon should be evident. When pumping a water table aquifer contaminated with petroleum hydrocarbon, a lowering of water levels and a decrease in petroleum hydrocarbon thickness is observed. The data acquired during this systems operation indicates the latter of these scenarios.

The September data was acquired prior to any long term testing and following bail testing. This data should be representative of static conditions within the study area. Petroleum hydrocarbon thicknesses acquired during December reflect the results of system operation.

TABLE 3-1

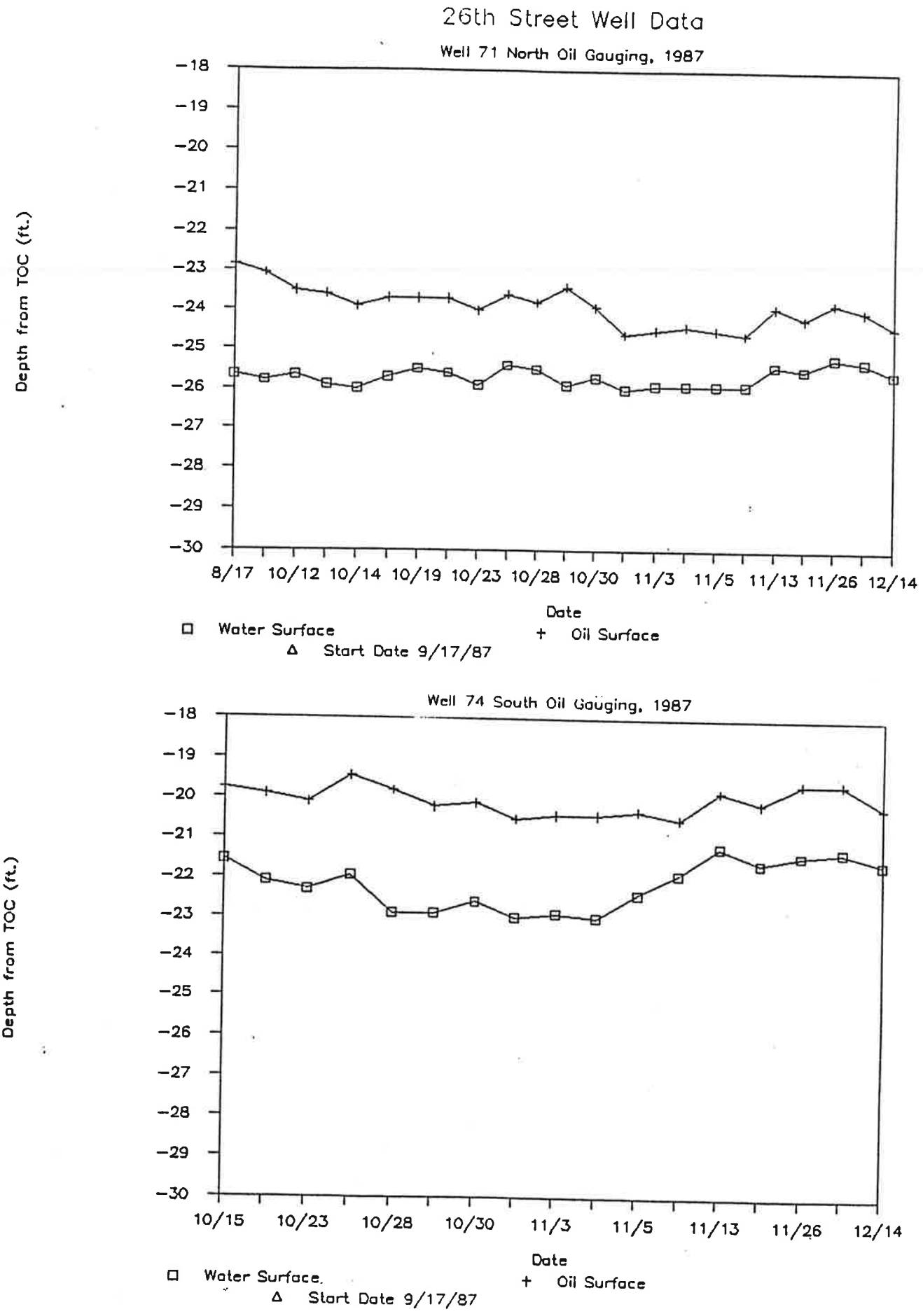
PETROLEUM HYDROCARBON THICKNESS CHANGES IN AREA MONITORING WELLS

WELL NO.	PETROLEUM HYDROCARBON THICKNESS (FEET) SEPTEMBER 1987	DECEMBER 1987	CHANGE IN FEET
71	2.69	1.19	(-) 1.50
74	2.00	1.68	(-) 0.32
75	1.50	1.12	(-) 0.38
76	0.96	1.17	(+) 0.21
AS-5	0.05	0.03	(-) 0.02

Monitoring well 71 displayed the largest decrease in petroleum hydrocarbon thickness (1.50 feet). Well 71 is located 50 feet south of PR-1. Wells AS-5, 74, and 75 declined 0.03, 0.32 and 0.38 feet, respectively. These decreases in thickness can be attributed primarily to pumping at the pilot remedial system. An increase in petroleum hydrocarbon thickness of 0.21 feet was observed in monitoring well 76. This increase is possibly due to the migration of petroleum hydrocarbon to the recovery wells. Corrected depth to water calculations were made during the evaluation of the system test data. These calculations revealed a decline in groundwater levels between the September and December gauging events.

A review of the data supplied to EEI by Atlantic also indicates monitoring well fluid level decreases. Fluid level graphs, prepared by Atlantic , for wells 71 and 74 are presented in Figure 3.4. Both wells 71 and 74 exhibit petroleum hydrocarbon thickness declines over the long term. However, an increase in fluid levels was detected in both wells during mid November. This increase may be due to precipitation or more likely the fact that the system was out of operation during this period.

FIGURE 3.4


26th Street Well Data
Well 71 North Oil Gauging, 1987
Depth from TOC (ft.)
-18
-19
-20
-21
-22
-23
-24
-25
-26
-27
-28
-29
-30
8/17 10/12 10/14 10/19 10/23 10/28 10/30 11/3 11/5 11/13 11/26 12/14
Date
□ Water Surface
+ Oil Surface
Δ Start Date 9/17/87
Well 74 South Oil Gauging, 1987
Depth from TOC (ft.)
-18
-19
-20
-21
-22
-23
-24
-25
-26
-27
-28
-29
-30
10/15 10/23 10/28 10/30 11/3 11/5 11/13 11/26 12/14
Date
□ Water Surface.
+ Oil Surface
Δ Start Date 9/17/87

SECTION 4.0

DISCUSSION

4.1 CONCLUSIONS

EEI has made the following conclusions based upon the results of the pilot recovery system program.

- The largest occurrence of petroleum hydrocarbon in the area of the 26th Street sewer is located in monitoring wells 71, 74, 75, and 76.

- Groundwater flow along the refinery's eastern property boundary is predominantly in a south/southeasterly direction. The corrected water table map indicates that two specific areas, the Belmont Terminal and southeast of Tank 83, are effected by permeability changes within the formation or changes in the subsurface due to manmade activities.

- A review of historical data, supplied by Atlantic, indicates a possible breach in the 26th Street sewer adjacent to Tanks 42 and 83.

- The pilot remedial system creates an area of influence approximately 640 feet north/south and 490 feet east/west when pumping is sustained for extended periods.

- Low flow rates of groundwater and petroleum hydrocarbon are evident in recovery well PR-2. The high viscosity petroleum hydrocarbon encountered during drilling hindered the placement of the gravel pack around the well screen which may have contributed to low discharge rates apparent at PR-2.

- A decrease in both groundwater levels and petroleum hydrocarbon thicknesses is apparent in area monitoring wells since the initiation of pilot remedial system pumping.

- Vapor levels, as reported verbally by Atlantic, within the 26th Street sewer manholes have been reduced. This lowering of levels may possibly be due to the effects of pumping at the pilot remedial system. At this time, sufficient data is not available to reaffirm this conclusion and the lowering of vapor levels may also be due to seasonal weather changes.

4.2 RECOMMENDATIONS

Based on a review of data acquired during the initial subsurface investigation and the results of pilot remedial system operation, the following recommendations are offered:

- Increase the rate of pumping at pilot remedial well PR-1 to create a larger area of influence and enhance petroleum hydrocarbon recovery.
- Redevelop pilot remedial well PR-2 to determine if the well's discharge rate and efficiency can be enhanced.
- Conduct a long term pump test at the pilot remedial system after improving system capacity. The purpose of this is to determine the new area of influence created by the system and to evaluate if any further recovery wells may be necessary to optimize petroleum hydrocarbon recovery.
- Install additional monitoring wells in the Belmont Terminal area to acquire further hydrogeologic data and to delineate the extent of petroleum hydrocarbon contamination in this area.

APPENDIX A

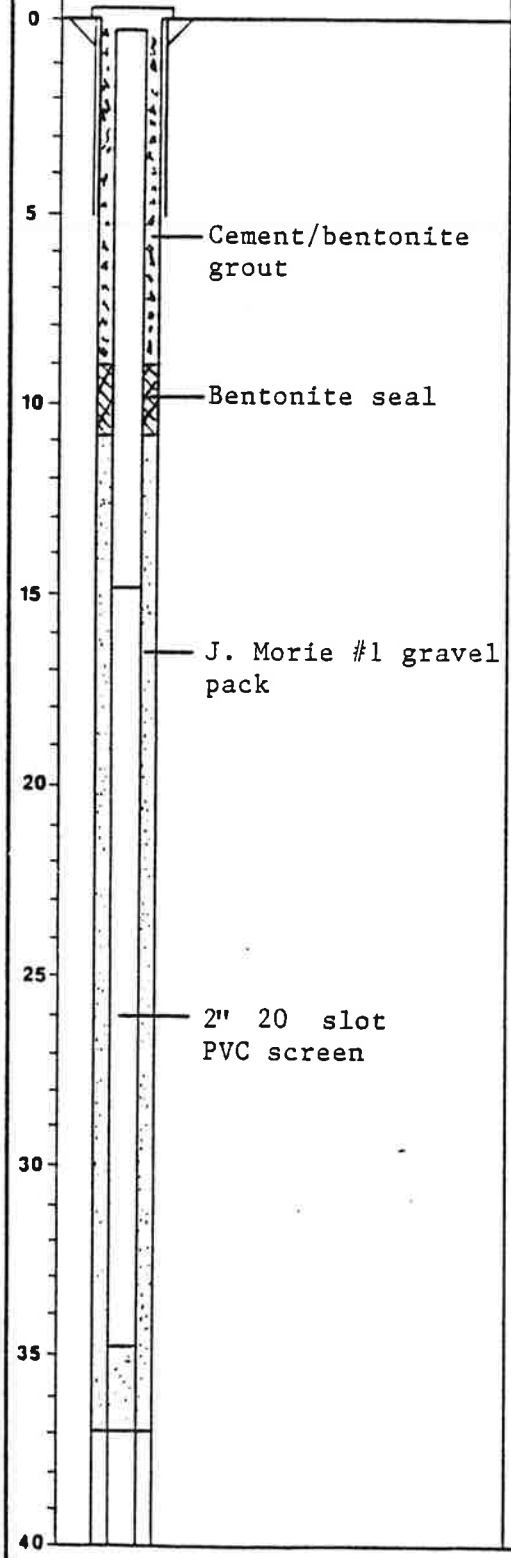
WELL COMPLETION LOGS

WELL #67

WELL ELEVATION:
WELL INSTALLED: 7-21-87
WELL DEVELOPED:
WELL DEPTH:

BORING

SURFACE ELEVATION:
DRILLING METHOD: Hollow Stem Auger
BORING DEPTH: 37.0



SOIL TYPE USCS	SOIL TYPE SYMBOLS	BORING	SAMPLE DATA BLOWS	SAMPLE DATA % RETAINED	SAMPLE DATA SAMPLE NO.	SAMPLE DATA SAMPLE DEPTH	SAMPLE DATA SAMPLE TYPE
		0.0 - 2.0 FILL: gravel, stone					
		2.0 - 7.0 FILL: dark brown silt, clay, gravel					
		7.0 - 8.5 SAND AND GRAVEL					
		8.5 - 13.0 CLAY: gray, silty, sandy, moist					
		13.0 - 15.0 SILT: clayey, trace sand, moist					
		15.0 - 18.0 SAND: variegated, clayey, some gravel			1		
		18.0 - 23.0 SAND AND GRAVEL: variegated, trace silt, strong odors			2		
		23.0 - 24.0 SAND AND GRAVEL: variegated, trace silt, strong odors					
		24. 0 - 30.0 SAND AND GRAVEL: variegated, with some silt, hydrocarbon present			3		
		30.0 - 32.0 SAND AND GRAVEL: variegated, with trace silt, wet, strong odors			4		
		32.0 - 36.5 SAND: clean, wet			5		
		TOTAL DEPTH 37.0					

Drilled By Hardin-Huber
Logged By Peter J. Dougherty
Client Atlantic
Job No. 522-239-00

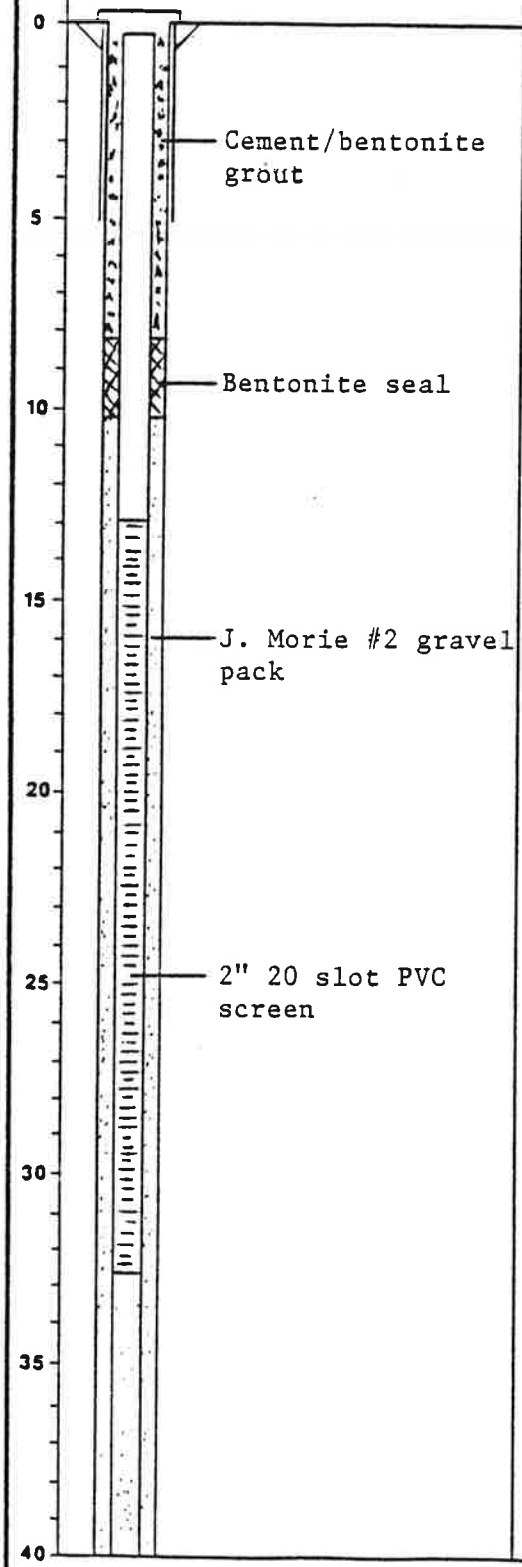
ENGINEERING ENTERPRISES, INC.

WELL #68

WELL ELEVATION: 26.14
WELL INSTALLED: 7-22-87
WELL DEVELOPED:
WELL DEPTH:

BORING

SURFACE ELEVATION:
DRILLING METHOD: Hollow Stem Auger
BORING DEPTH: 40.0



SOIL TYPE USCS	SOIL TYPE SYMBOLS	BORING	SAMPLE DATA BLOWS	SAMPLE DATA % RETAINED	SAMPLE DATA SAMPLE NO.	SAMPLE DATA SAMPLE DEPTH	SAMPLE DATA SAMPLE TYPE
		0.0 - 1.5 FILL 1.5 - 4.5 SILT: brown, sandy					
		4.5 - 6.5 SILT: dark gray, some fine sand, moist, slight odor 6.5 - 12.0 SILT AND CLAY: dark gray					
		12.0 - 17.0 SAND AND GRAVEL: dark brown					
		17.0 - 20.0 SAND: dark brown, silty, gravel, moist, odor present					
		20.0 - 27.0 SAND: dark brown, silty, slightly finer gravel, wet, slight odors			1 2 3		
		27.0 - 32.0 SAND: variegated, some gravel, little silt, wet, strong odors			4		
		32.0 - 36.5 SAND: variegated, medium to coarse, some gravel			5		
		36.5 - 40.0 SAND: gray, medium to coarse, some silt and clay					
		TOTAL DEPTH 40.0					

Drilled By Hardin-Huber
Logged By Peter J. Dougherty
Client Atlantic
Job No. 522-239-00

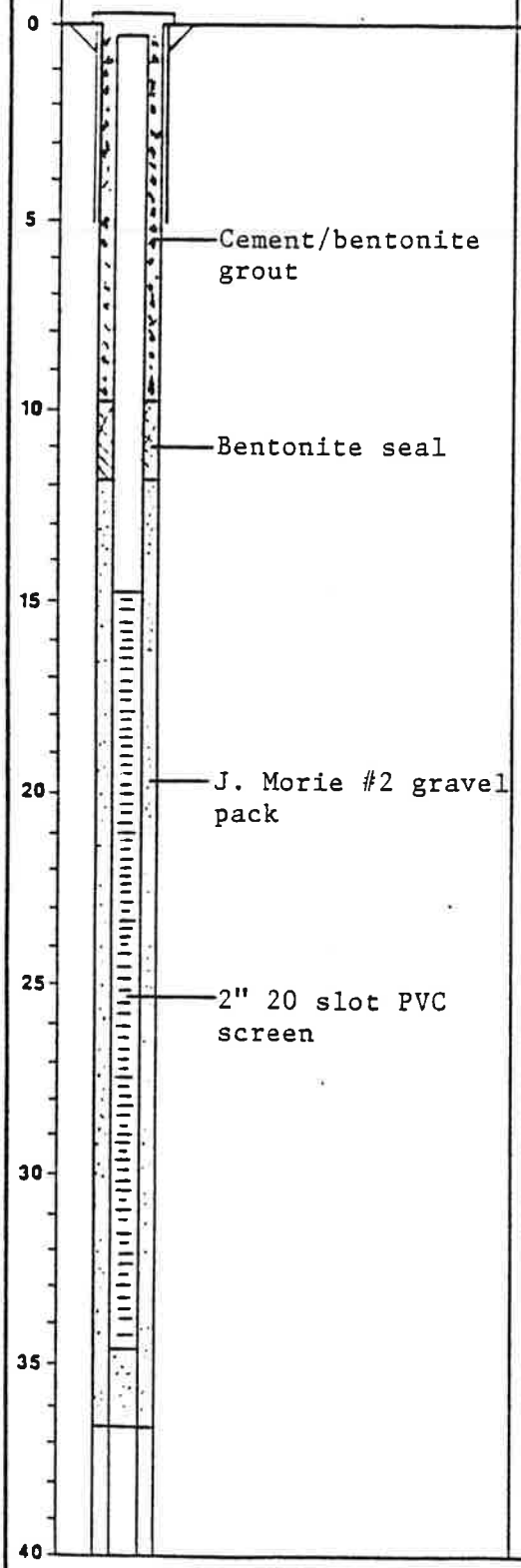
ENGINEERING ENTERPRISES, INC.

WELL #69

WELL ELEVATION: 24.73
WELL INSTALLED: 7-29-87
WELL DEVELOPED:
WELL DEPTH:

BORING

SURFACE ELEVATION:
DRILLING METHOD: Hollow Stem Auger
BORING DEPTH: 37.0



SOIL TYPE USCS	SOIL TYPE SYMBOLS	BORING
		0.0 - 0.5 BLACK TOP
		0.5 - 1.0 FILL
		1.0 - 4.0 SILT: brown and gray, some clay
		4.0 - 7.0 FILL: cinders, sand, silt
		7.0 - 20.0 SILT: brown, sandy, trace clay
		20.0 - 24.0 SAND: poorly sorted, cobbles, silt
		24.0 - 34.0 SAND: variegated, fine to coarse, wet, strong odor
		34.0 - 37.0 SILT: gray, sandy, clay, lens of gravel at 36.0 - 36.25, odors
		TOTAL DEPTH 37.0

SAMPLE DATA							
		BLOWS	% RETAINED	SAMPLE NO.	SAMPLE DEPTH	SAMPLE TYPE
				1		
				2		
				3		
				4		
				5		

Drilled By Hardin-Huber
Logged By Peter J. Dougherty
Client Atlantic
Job No. 522-239-00

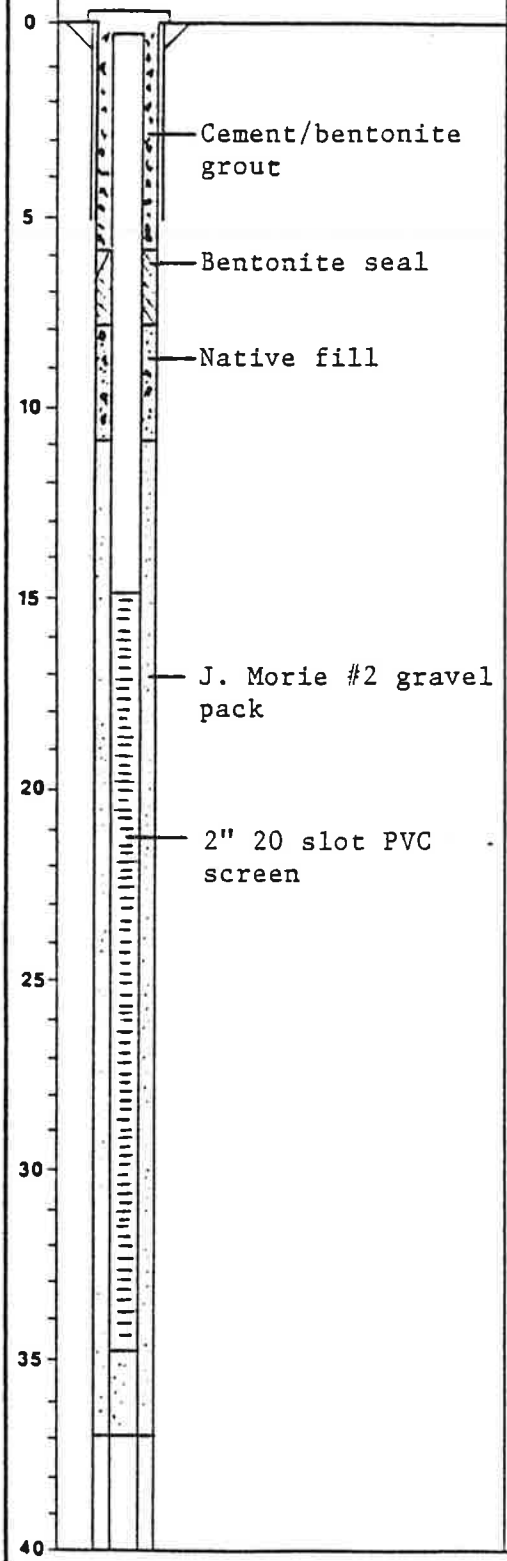
ENGINEERING ENTERPRISES, INC.

WELL #70

WELL ELEVATION: 38.85
WELL INSTALLED: 7-23-87
WELL DEVELOPED:
WELL DEPTH:

BORING

SURFACE ELEVATION: 28.97
DRILLING METHOD: Hollow Stem Auger
BORING DEPTH: 37.0



USCS	SYMBOLS	Description	BLOWS	% RETAINED	SAMPLE NO.	SAMPLE DEPTH	SAMPLE TYPE
		0.0 - 0.5 BLACK TOP					
		0.5 - 1.0 SILT: brown, sandy					
		1.0 - 4.5 CLAY: dark gray, silty, sandy, strong odor					
		4.5 - 7.0 FILL: brick and gravel					
		7.0 - 9.0 CLAY: black, silty, sandy, strong odor					
		9.0 - 12.0 CLAY: black, sandy					
		12.0 - 15.5 CLAY: gray, sandy, silt and gravel, wet, slight odor					
		15.5 - 20.0 SAND: variegated, gravel, dry, slight odor			1		
		20.0 - 33.0 SAND: variegated, fine to coarse, gravel with clay and trace silt			2 3 4		
		33.0 - 36.5 SAND: brown, fine to coarse, trace silt			5 6		
		36.5 - 37.0 SILT: light brown, sandy, clayey, micaceous					
		TOTAL DEPTH 37.0					

Drilled By Hardin-Huber
Logged By Peter J. Dougherty
Client Atlantic
Job No. 522-239-00

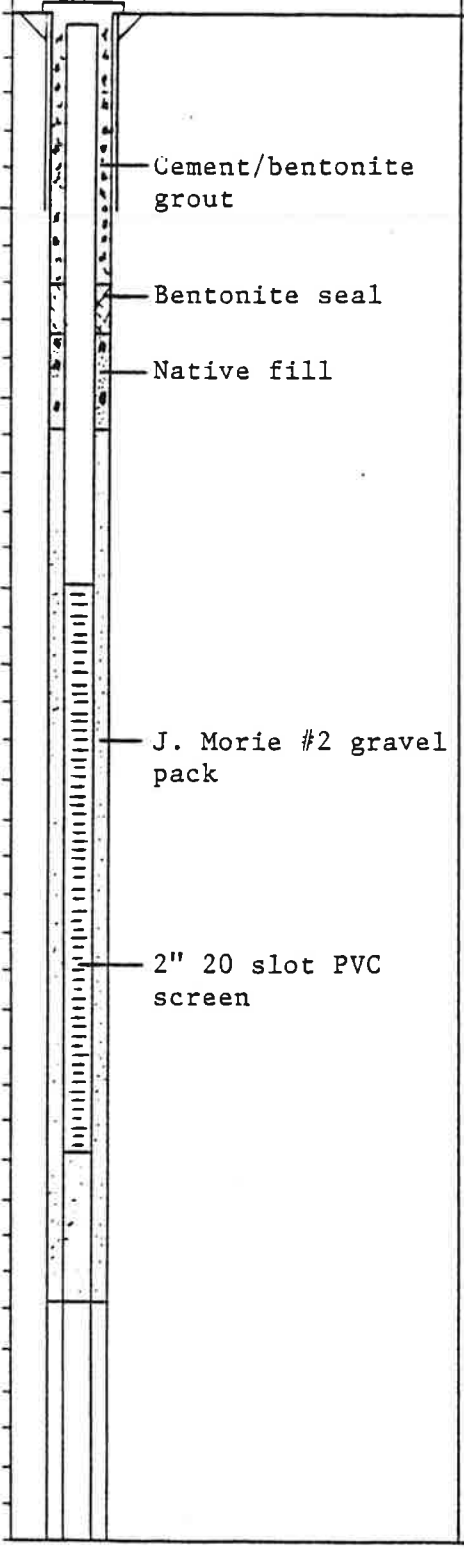
ENGINEERING ENTERPRISES, INC.

WELL #71

WELL ELEVATION: 27.64
WELL INSTALLED: 7-23-87
WELL DEVELOPED:
WELL DEPTH:

BORING

SURFACE ELEVATION:
DRILLING METHOD: Hollow Stem Auger
BORING DEPTH: 34.0



USCS	SYMBOLS		SAMPLE DATA: BLOWS	% RETAINED	SAMPLE NO.	SAMPLE DEPTH	SAMPLE TYPE
		0.0 - 2.0 FILL					
		2.0 - 9.0 SAND: black, silty some clay and fill material, oily					
		9.0 - 15.0 GRAVEL: black, clayey, silty					
		15.0 - 20.0 SAND: brown and gray, fine to medium, trace silt, saturated, strong odors					
		20.0 - 30.0 SAND: variegated, gravel, silt, saturated			1		
					2		
		24.0 FREE PRODUCT			3		
		30.0 34.0 SILT: brown, gray, sandy, clayey			4		
					5		
		TOTAL DEPTH 34.0					

Drilled By Hardin-Huber
Logged By Peter J. Dougherty
Client Atlantic
Job No. 522-239-00

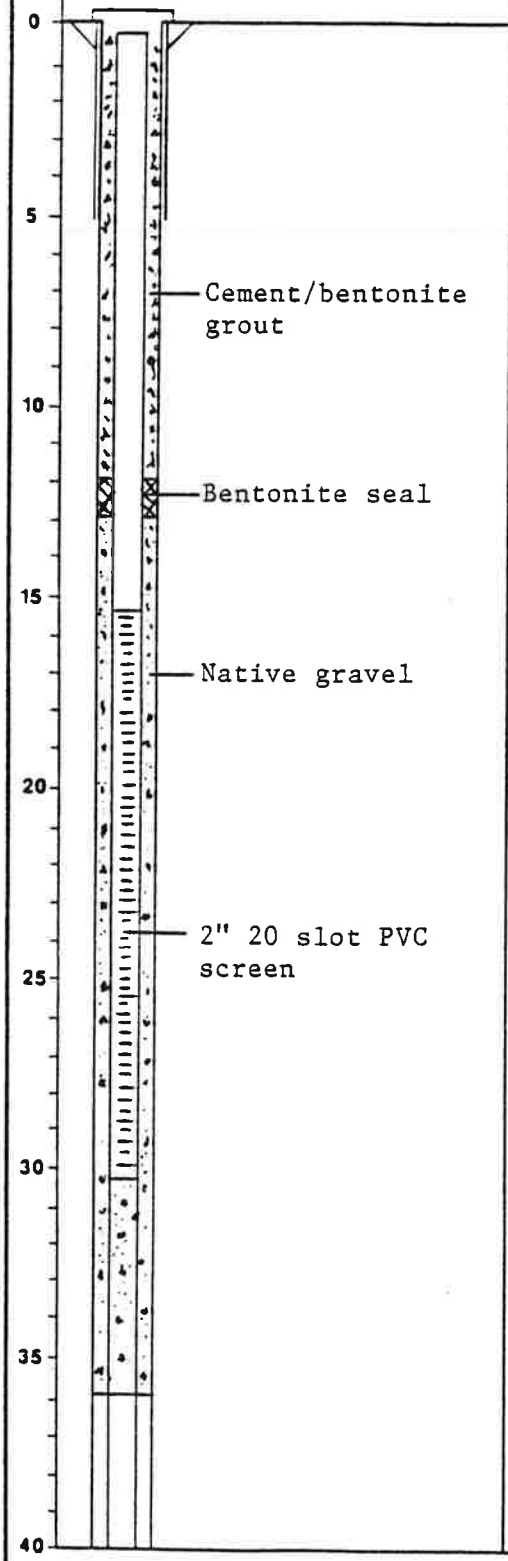
ENGINEERING ENTERPRISES, INC.

WELL #72

WELL ELEVATION: 34.47
WELL INSTALLED: 7-27-87
WELL DEVELOPED:
WELL DEPTH:

BORING

SURFACE ELEVATION:
DRILLING METHOD: Hollow Stem Auger
BORING DEPTH: 36.0



SOIL TYPE USCS	SOIL TYPE SYMBOLS	BORING	SAMPLE DATA BLOWS	SAMPLE DATA % RETAINED	SAMPLE DATA SAMPLE NO.	SAMPLE DATA SAMPLE DEPTH	SAMPLE DATA SAMPLE TYPE
		0.0 - 2.0 FILL: sand, silt, gravel					
		2.0 - 4.0 CLAY: dark gray, silty, sandy, odors present					
		4.0 - 6.0 CLAY: light gray, silty, sandy					
		6.0 - 13.0 SILT: dark gray, clayey, sand and gravel, strong odors					
		13.0 - 17.5 SAND: black, silty, wet, strong odors					
		17.5 - 24.0 SAND: variegated, gravel, silt, dense, strong odor			1		
					2		
		24.0 - 27.0 SILT: dark brown, sandy, micaceous, highly saturated			3		
					4		
		27.0 - 30.0 SAND: brown, fine to coarse, gravel with silt					
		30.0 - 33.0 SAND: variegated, fine to coarse, gravel, some silt, wet, strong, odors			5		
		33.0 - 35.0 SAND: brown, fine to coarse, gravel, trace silt, wet, odors					
		TOTAL DEPTH 36.0			6		

Drilled By Hardin-Huber
Logged By Peter J. Dougherty
Client Atlantic
Job No. 522-239-00

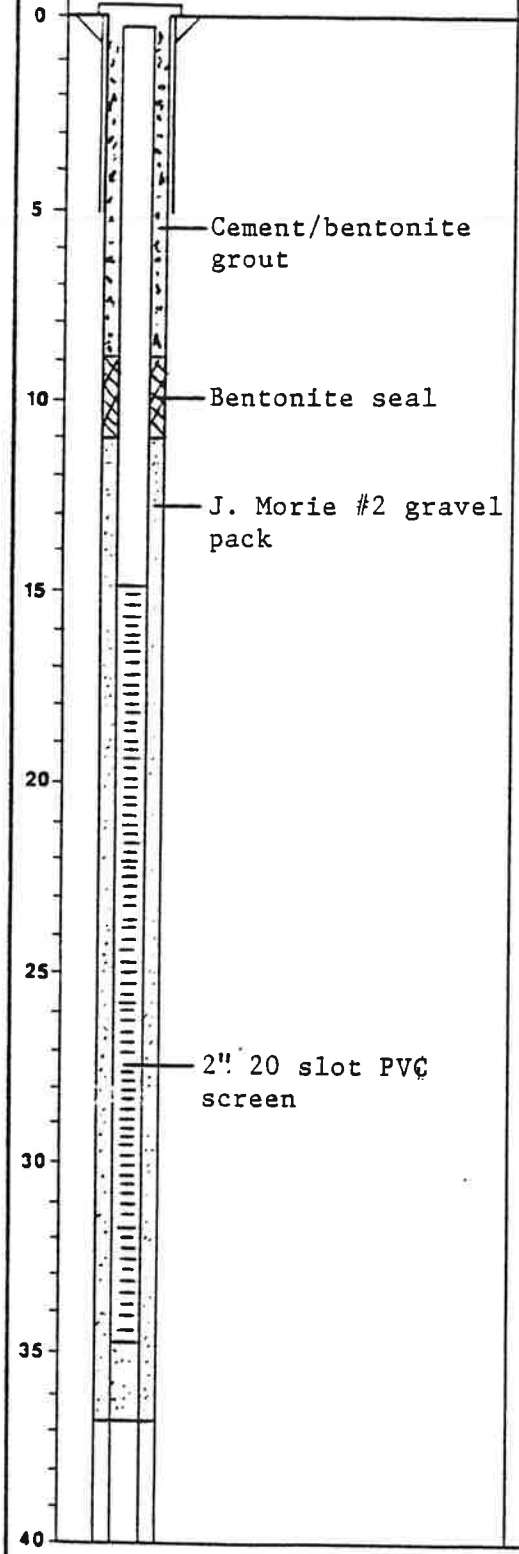
ENGINEERING ENTERPRISES, INC.

WELL #73

WELL ELEVATION: 33.14
WELL INSTALLED: 7-27-87
WELL DEVELOPED:
WELL DEPTH:

BORING

SURFACE ELEVATION:
DRILLING METHOD: Hollow Stem Auger
BORING DEPTH: 37.0



SOIL TYPE USCS	SOIL TYPE SYMBOLS	BORING
		0.0 - 1.0 BLACK TOP
		1.0 - 3.0 FILL
		3.0 - 3.5 SILT: brown, sandy,
		3.5 - 5.0 SILT: brown, sandy, clayey, wet, no ordor
		5.0 - 6.0 SILT: brown, sandy, moist, no odor
		6.0 - 10.0 SAND: light gray, silty, micaceous, wet, no odor
		10.0 - 12.0 CLAY: gray, moist, no odor
		12.0 - 17.0 SAND AND GRAVEL: brown, moist, no odor
		17.0 - 23.0 SAND: variegated, fine to coarse, trace silt, moist, no odor
		23.0 - 25.0 SILT: brown, sandy, micaceous, moist
		25.0 - 26.5 SILT: brown, sandy, trace gravel, wet, no odor
		26.5 - 37.0 SAND: variegated, fine to coarse, gravel and trace silt, wet, no odor
		TOTAL DEPTH 37.0

SAMPLE DATA						
		BLOWS	% RETAINED	SAMPLE NO.	SAMPLE DEPTH	SAMPLE TYPE
				1		
				2		
				3		
				4		
				5		

Drilled By Hardin-Huber
Logged By Peter J. Dougherty
Client Atlantic
Job No. 522-239-00

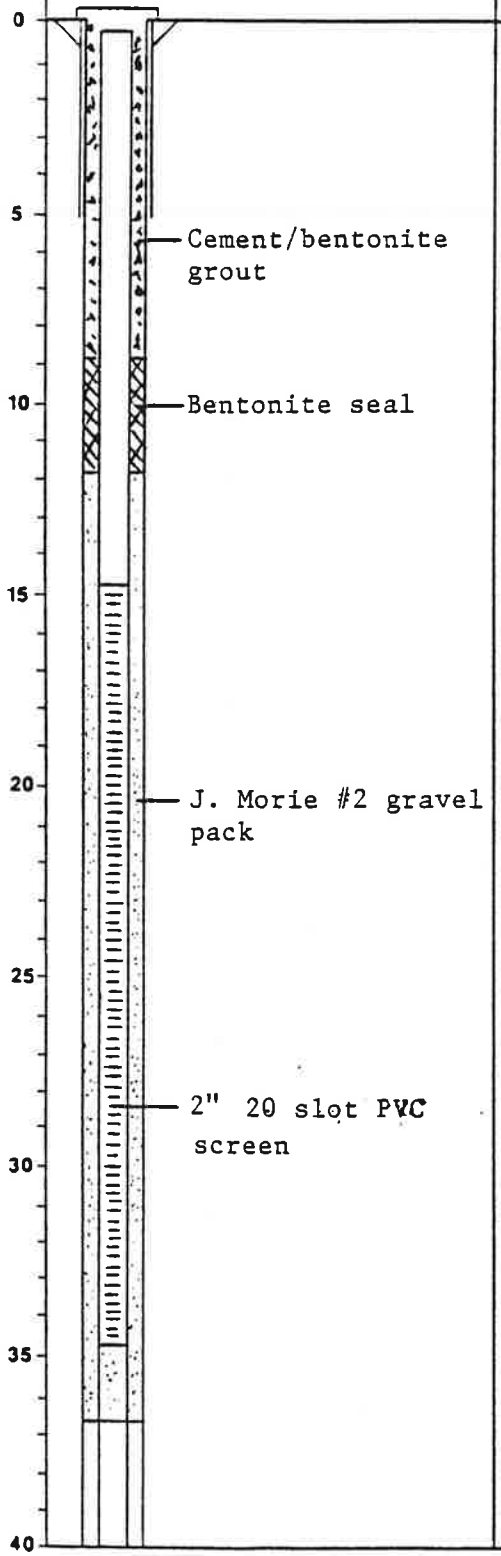
ENGINEERING ENTERPRISES, INC.

WELL #74

WELL ELEVATION: 26.40
WELL INSTALLED: 7-28-87
WELL DEVELOPED:
WELL DEPTH:

BORING

SURFACE ELEVATION:
DRILLING METHOD: Hollow Stem Auger
BORING DEPTH: 37.0



USCS	SYMBOLS	Description
		0.0 - 0.5 BLACK TOP
		0.5 - 2.0 FILL: silt, sand gravel
		2.0 - 4.0 SILT: dark brown, sandy, clayey, no odor
		4.0 - 5.5 SAND: black, silty no odor
		5.5 - 8.0 SAND: gray, fine, silty, fuel oil odor present
		8.0 - 12.0 SILT: brown and gray, clayey, some sand, no odor
		12.0 - 13.5 SAND: green, fine micaceous, no odor
		13.5 - 20.5 CLAY: brown, silty, no odor
		20.5 - 22.0 SAND: gray, fine to coarse, gravel with trace silt, saturated by hydro-carbons
		22.0 - 24.0 SAND: variegated, gravel, fine to coarse, silt, free product
		24.0 - 25.5 SILT, SAND, AND GRAVEL: stratified, variegated, free product
		25.5 - 30.0 SAND: variegated, fine to coarse, silty, free product
		30.0 - 33.5 SAND: gray, fine to coarse, gravel
		33.5 - 36.5 SILT: brown, clayey, some sand
		36.5 - 37.0 SAND: gray, silty, strong odors
		TOTAL DEPTH 37.0

SAMPLE DATA						
		BLOWS	% RETAINED	SAMPLE NO.	SAMPLE DEPTH	SAMPLE TYPE
				1		
				2		
				3		
				4		
				5		

Drilled By Hardin-Huber
Logged By Peter J. Dougherty
Client Atlantic
Job No. 522-239-00

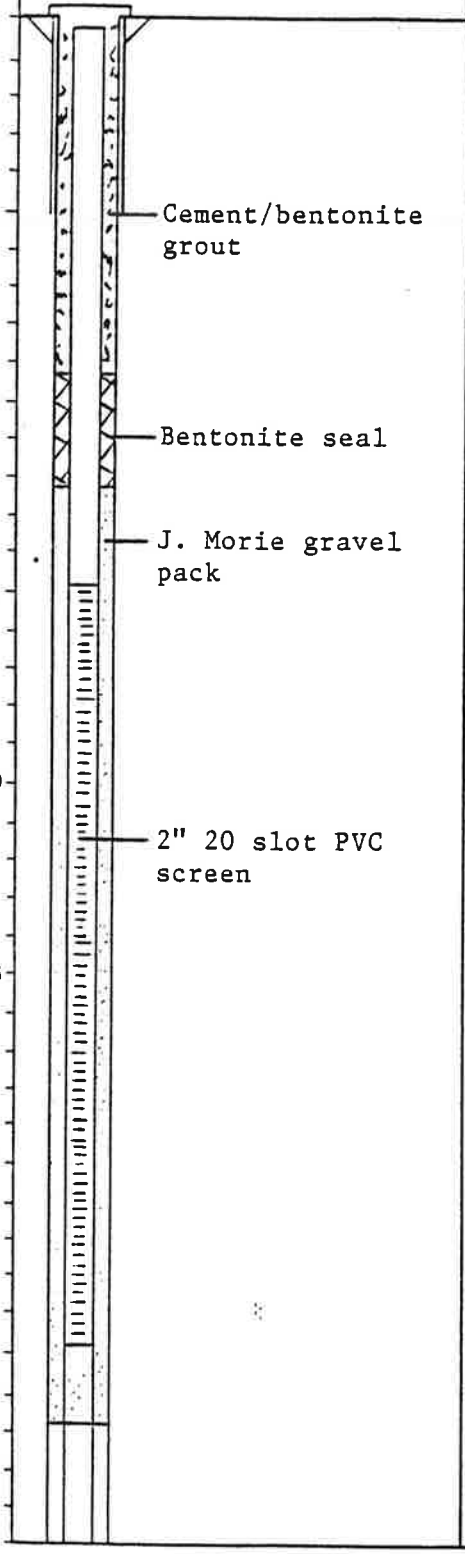
ENGINEERING ENTERPRISES, INC.

WELL #75

WELL ELEVATION: 28.99
WELL INSTALLED: 7-29-87
WELL DEVELOPED:
WELL DEPTH:

BORING

SURFACE ELEVATION:
DRILLING METHOD: Hollow Stem Auger
BORING DEPTH: 37.0



USCS	SYMBOLS	Description
		0.0 - 1.0 FILL: gravel 1.0 - 4.0 FILL: silt, sand, glass
		4.0 - 9.0 SILT: black, sandy, oily
		9.0 - 16.0 SILT: black, sandy, trace clay, oily
		16.0 - 22.0 SAND AND GRAVEL: variegated, trace silt, dry, no odor
		22.0 - 25.5 SAND: variegated, silty, fine to coarse, sand, gravel, cobbles
		25.5 - 26.0 SAND: gray, fine to coarse, silty, strong odors 26.0 - 30.0 SAND AND SILT: fine to coarse, sand, cobbles, fairly dry, odors present
		30.0 - 34.0 SAND: variegated, fine to coarse, trace silt, slight odor
		34.0 - 37.0 SAND: brown and gray, fine, silty, slightly clayey, wet, odor present
		TOTAL DEPTH 37.0

SAMPLE DATA						
		BLOWS	% RETAINED	SAMPLE NO.	SAMPLE DEPTH	SAMPLE TYPE
				1		
				2		
				3		
				4		
				5		
				6		

Drilled By Hardin-Huber
Logged By Peter J. Dougherty
Client Atlantic
Job No. 522-239-00

ENGINEERING ENTERPRISES, INC.

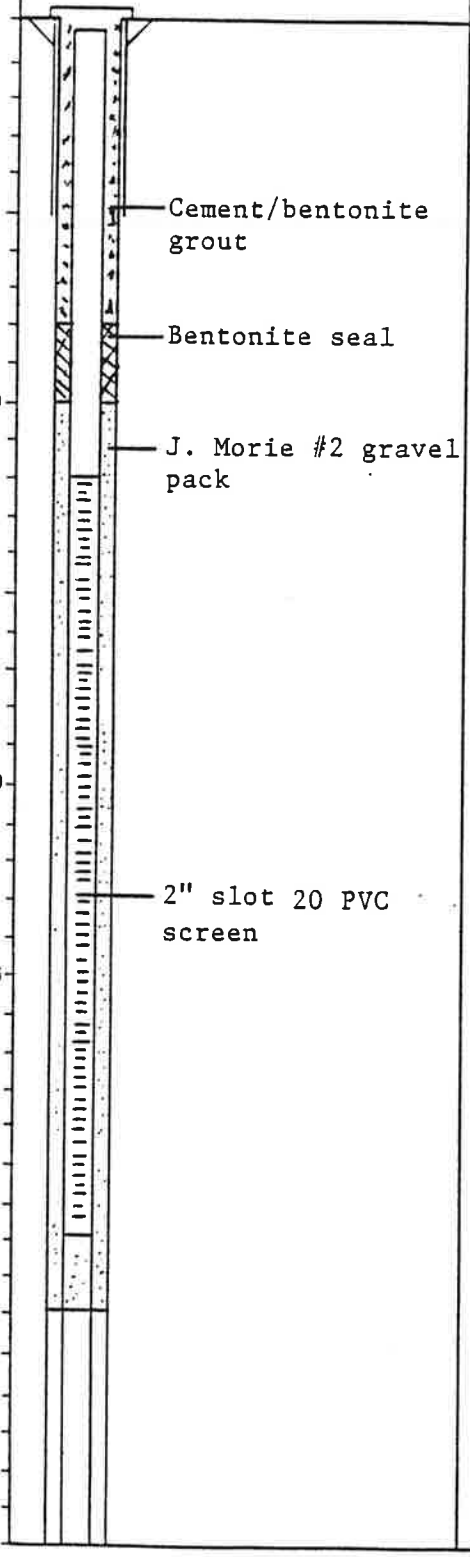
WELL #76

WELL ELEVATION:
WELL INSTALLED: 7-29-87
WELL DEVELOPED:
WELL DEPTH:

BORING

SURFACE ELEVATION:
DRILLING METHOD: Hollow Stem Auger
BORING DEPTH: 34.0

DEPTH IN FEET	USCS	SYMBOLS	SAMPLE DATA: BLOWS	% RETAINED	SAMPLE NO.	SAMPLE DEPTH	SAMPLE TYPE
0							
5							
10							
15							
20							
25							
30							
35							
40							



0.0 - 0.5 BLACK TOP
0.5 - 3.0 FILL: black, silty sand, gravel
3.0 - 12.0 SAND: gray, fine to coarse, silty, gravel, clay, odors present

12.0 - 14.0 SAND: brown, , trace clay, moist, no odor
14.0 - 16.0 SILT: brown, sandy, trace clay, moist, no odor
16.0 - 21.0 CLAY: gray, fine silty sand, no odor

21.0 - 31.0 SAND: gray, fine to coarse, clayey, gravel, dry, odors present

31.0 - 34.0 CLAY: gray and brown, sandy, trace silt

TOTAL DEPTH 34.0

SAMPLE NO.	SAMPLE DEPTH	SAMPLE TYPE
1		
2		
3		
4		
5		

Drilled By Hardin-Huber
Logged By Peter J. Dougherty
Client Atlantic
Job No. 522-239-00

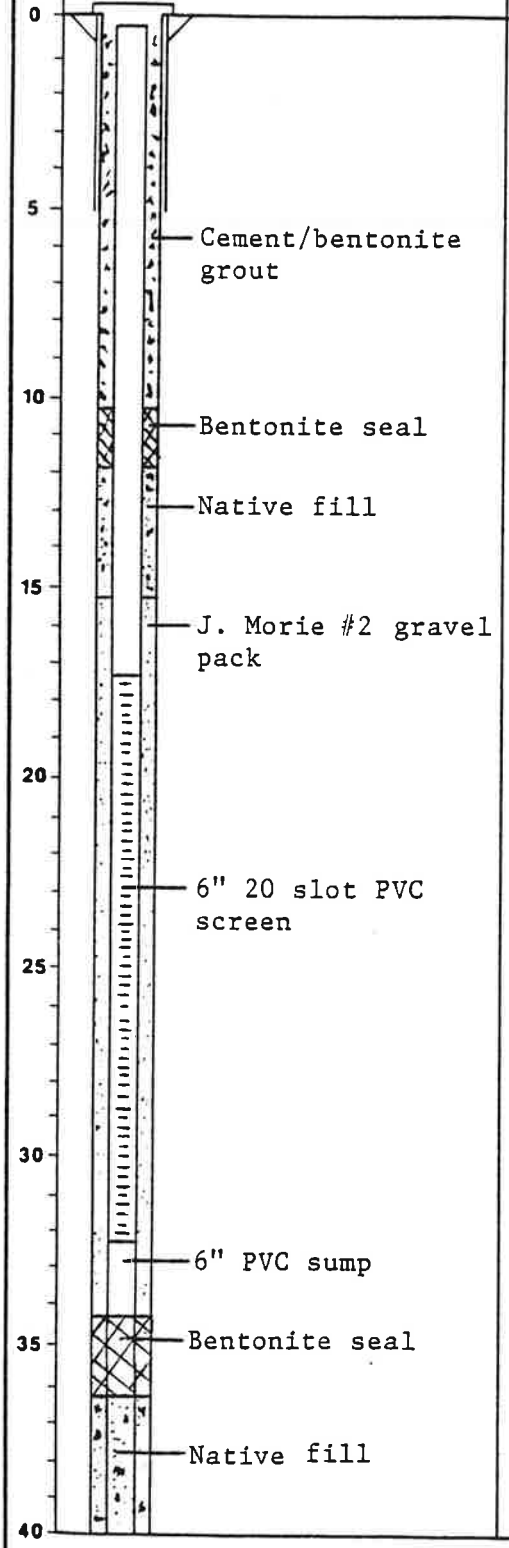
ENGINEERING ENTERPRISES, INC.

WELL PR-1

WELL ELEVATION:
WELL INSTALLED: 8/18/87
WELL DEVELOPED: 8/19/87
WELL DEPTH: 34.5

BORING

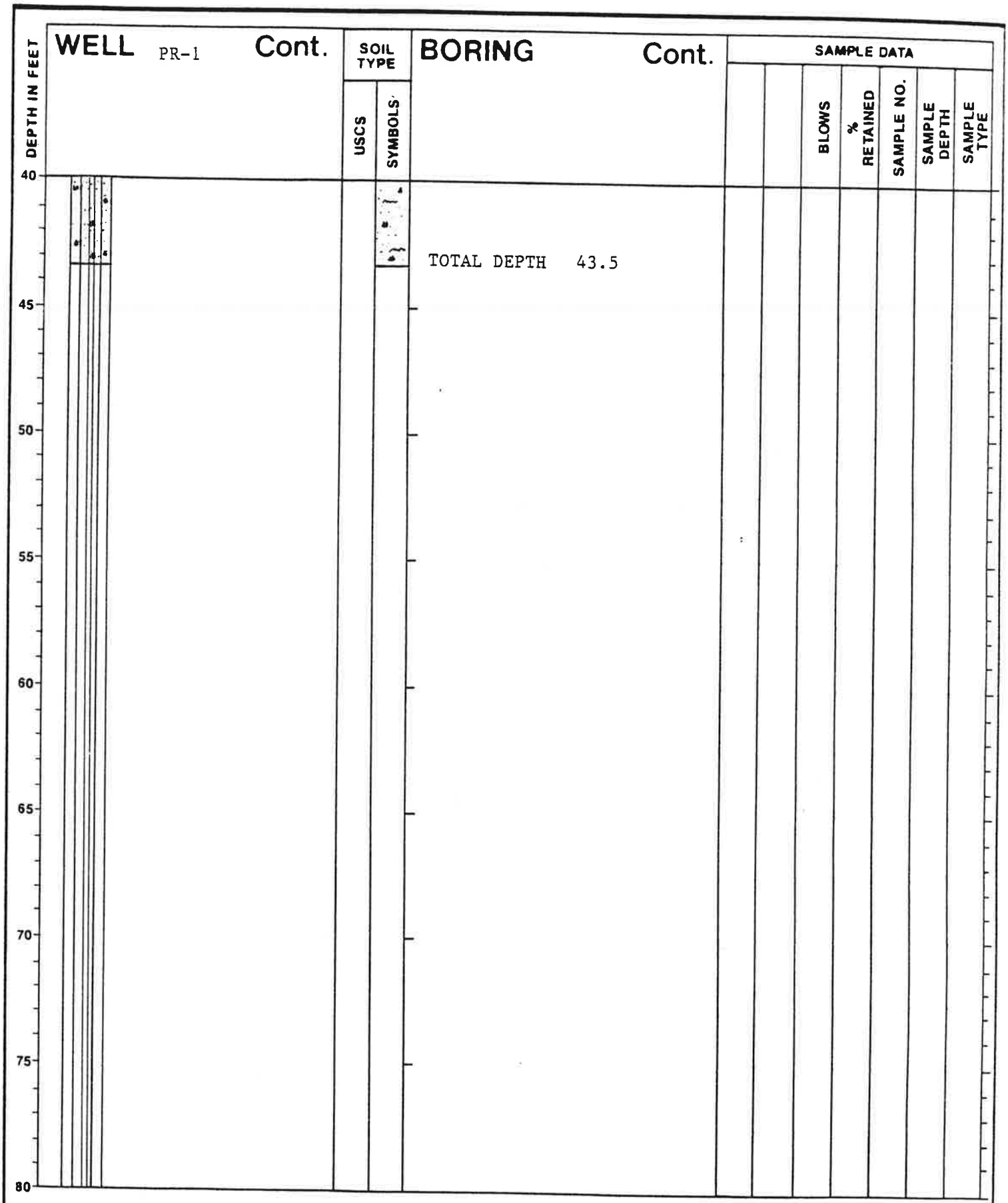
SURFACE ELEVATION:
DRILLING METHOD: Mud Rotary
BORING DEPTH: 43.5



SOIL TYPE		SAMPLE DATA						
USCS	SYMBOLS			BLOWS	% RETAINED	SAMPLE NO.	SAMPLE DEPTH	SAMPLE TYPE
		0.0 - 6.5 FILL: silt, sand, gravel, brick						
		6.5 - 19.0 SAND: fine, silty						
		19.0 - 23.0 SAND: silty, some gravel						
		23.0 - 32.5 SAND: slightly silty, some gravel						
		32.5 - 36.5 SILT: sandy, clayey						
		36.5 - 43.5 SAND: silty, some gravel						

Drilled By Hardin-Huber
Logged By Peter J. Dougherty
Client Atlantic
Job No. 522-239-00

ENGINEERING ENTERPRISES, INC.



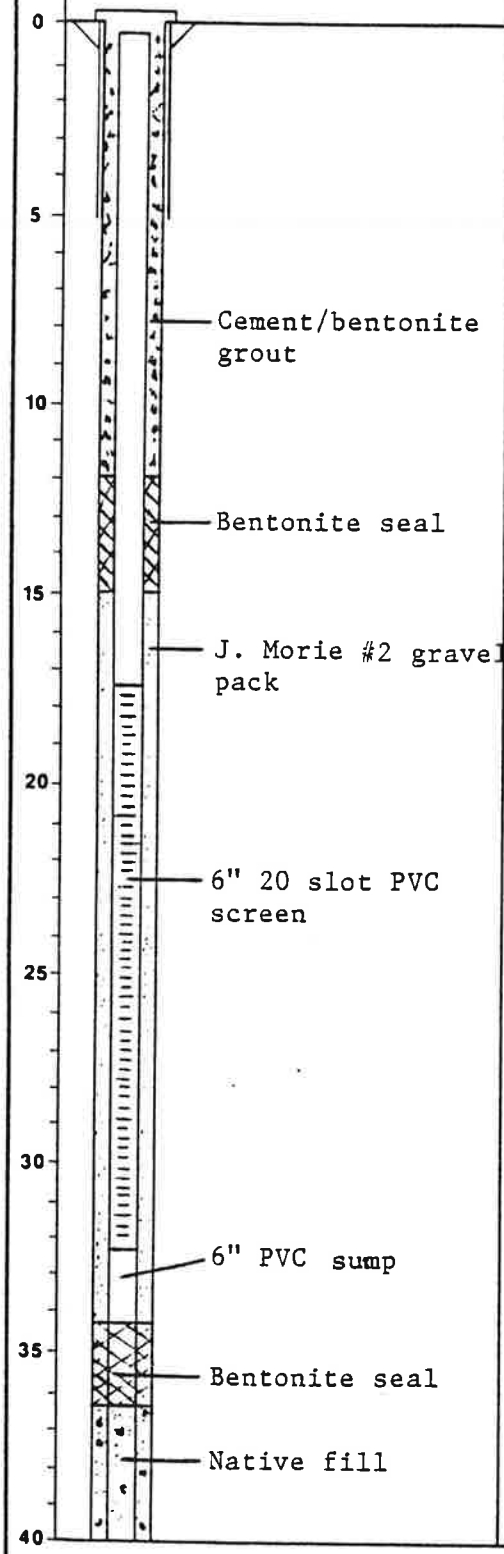
ENGINEERING ENTERPRISES, INC.

WELL PR-2

WELL ELEVATION:
WELL INSTALLED: 8/19/87
WELL DEVELOPED: 8/20/87
WELL DEPTH: 34.5

BORING

SURFACE ELEVATION:
DRILLING METHOD: Mud Rotary
BORING DEPTH: 44.0



SOIL TYPE			SAMPLE DATA						
USCS	SYMBOLS				BLOWS	% RETAINED	SAMPLE NO.	SAMPLE DEPTH	SAMPLE TYPE
		0.0 - 15.0 FILL: black, sand, silty, clay, wood, oily							
		(5.0 - 7.0 thick oily waste)							
		15.0 - 18.0 SAND: gray, fine, silty							
		18.0 - 27.0 SAND: clayey, gravel, some silt							
		27.0 - 31.5 COBBLES							
		31.5 - 38.5 SAND: fine, silty, some clay							
		38.5 - 40.5 SAND: some cobbles							

Drilled By Hardin-Huber
Logged By Peter J. Dougherty
Client Atlantic
Job No. 522-239-00

ENGINEERING ENTERPRISES, INC.

WELL PR-2 Cont.

BORING Cont.

DEPTH IN FEET	SOIL TYPE USCS	SOIL TYPE SYMBOLS	BORING Cont.	SAMPLE DATA BLOWS	SAMPLE DATA % RETAINED	SAMPLE DATA SAMPLE NO.	SAMPLE DATA SAMPLE DEPTH	SAMPLE DATA SAMPLE TYPE
40			40.5 - 44.0 SAND: silty, some clay					
			TOTAL DEPTH 44.0					
45								
50								
55								
60								
65								
70								
75								
80								

Native fill

ENGINEERING ENTERPRISES, INC.

APPENDIX B

MONITORING WELL GAUGING DATA

Atlantic Refining & Marketing Co.
data for 8/ 4/87

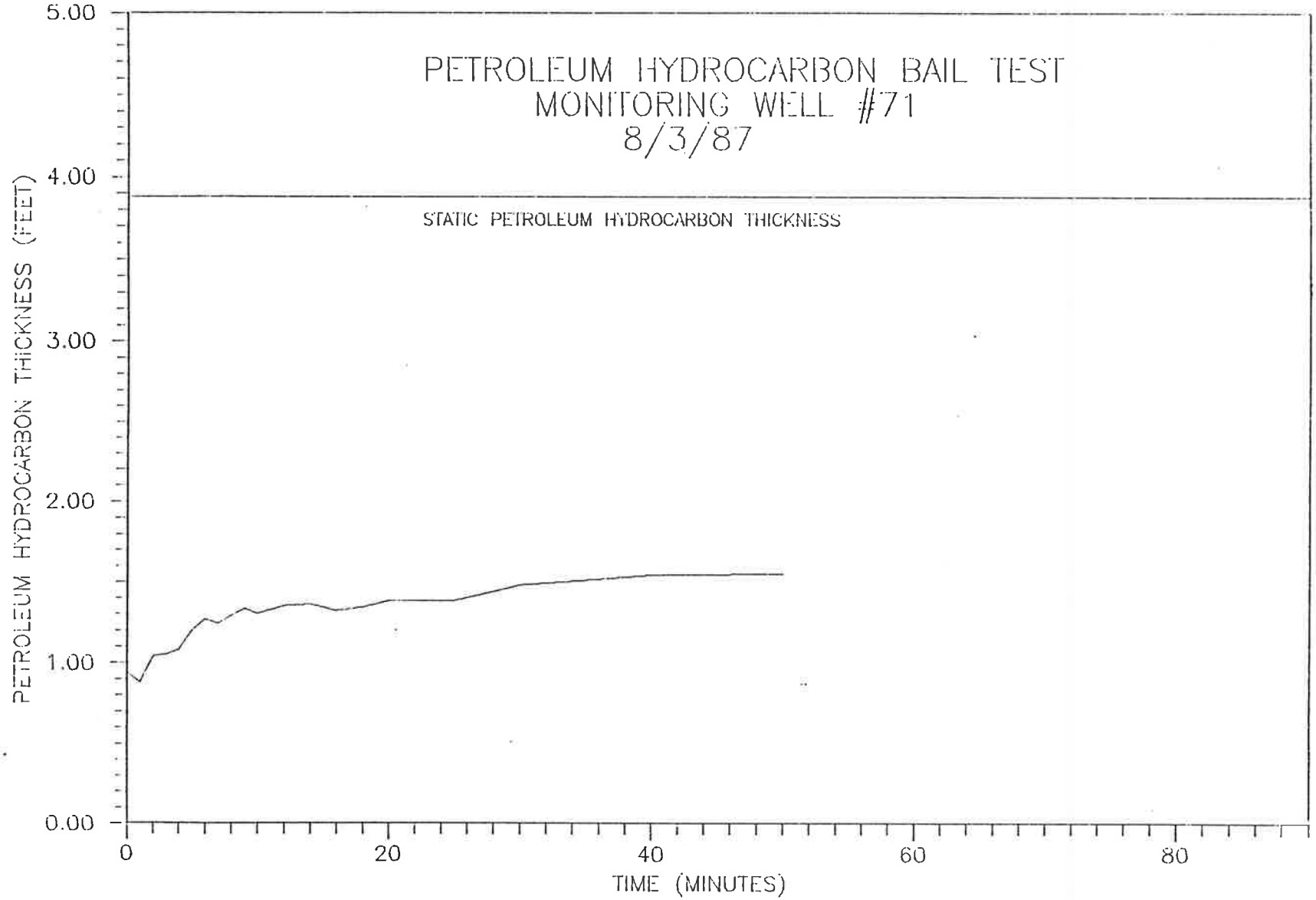
Well ID	DTO	DTW	Oil Thk	Cor Piezo Elevation
36	ND	ND	ND	ND
57	24.75	24.75	0.00	1.86
58	23.98	23.98	0.00	9.32
66	26.53	26.73	0.20	6.36
67	24.45	24.45	0.00	1.53
68	23.65	23.65	0.00	2.49
69	23.65	23.65	0.00	1.13
70	23.55	23.55	0.00	7.30
71	22.83	26.25	3.42	3.99
72	27.05	27.05	0.00	7.42
73	25.46	25.46	0.00	7.68
74	19.21	21.15	1.94	6.72
75	26.63	26.65	0.02	2.36
76	20.69	20.69	0.00	6.68
AD1	26.18	26.18	0.00	2.67
AD2	25.78	25.82	0.04	3.23
AS 1	26.92	26.92	0.00	1.97
AS 2	26.23	26.25	0.02	0.16
AS 3	25.10	25.10	0.00	2.84
AS 4	26.87	26.87	0.00	3.34
AS 5	23.30	23.32	0.02	7.22

Atlantic Refining & Marketing Co.
data for 9/15/87

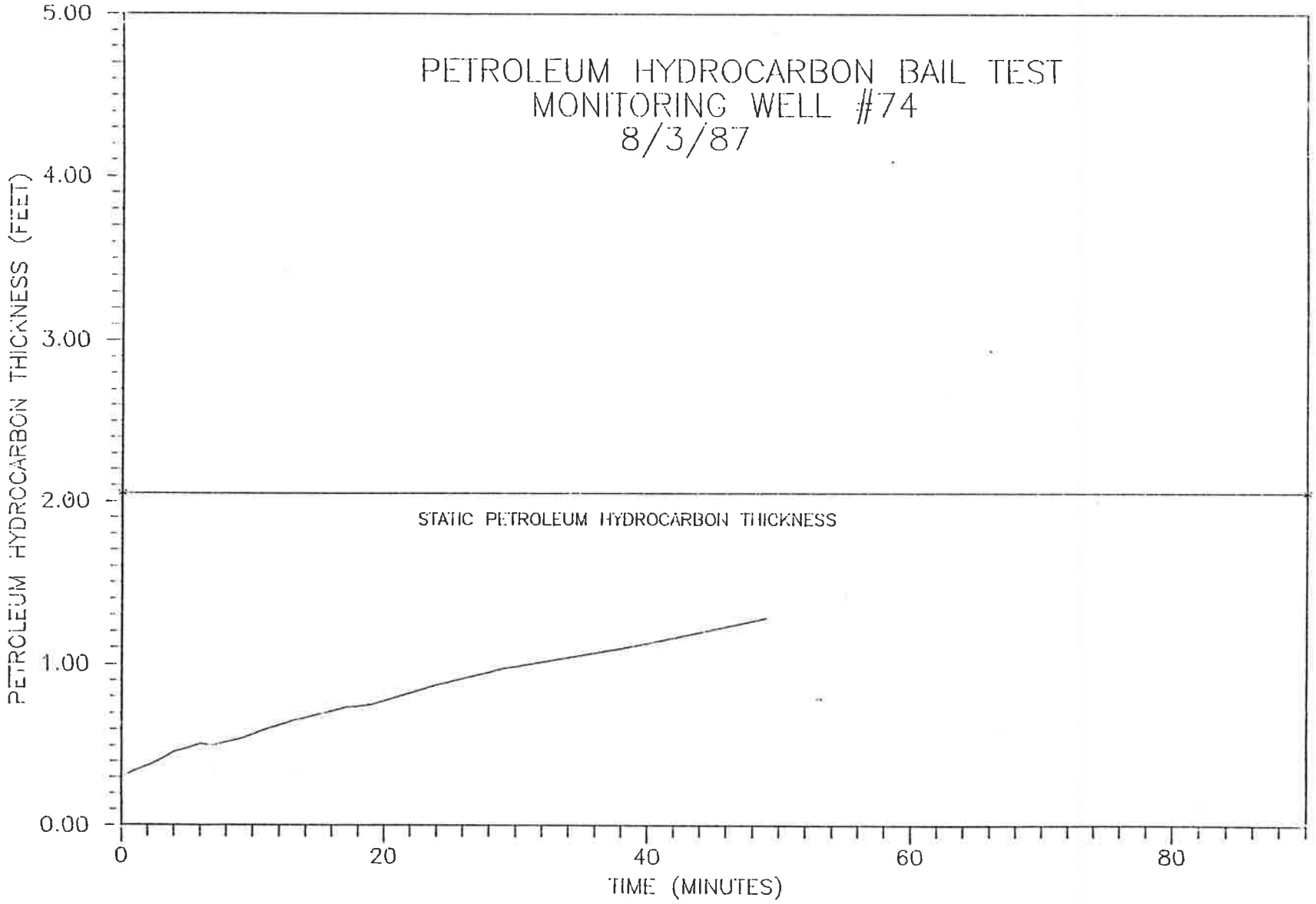
Well ID	DTO	DTW	Oil Thk	Cor Piezo Elevation
36	27.50	28.00	0.50	6.21
57	25.05	25.05	0.00	1.56
58	24.05	24.05	0.00	9.25
66	26.75	27.27	0.52	6.08
67	24.75	24.75	0.00	1.23
68	23.87	23.87	0.00	2.27
69	23.87	23.87	0.00	0.91
70	23.56	23.56	0.00	7.29
71	23.18	25.87	2.69	3.81
72	27.18	27.18	0.00	7.29
73	25.83	25.83	0.00	7.31
74	19.50	21.50	2.00	6.42
75	26.62	28.12	1.50	2.01
76	20.79	21.75	0.96	6.35
AD1	26.75	26.75	0.00	2.10
AD2	26.13	26.13	0.00	2.89
AS 1	27.50	27.50	0.00	1.39
AS 2	26.41	26.41	0.00	-0.02
AS 3	ND	ND	ND	ND
AS 4	27.08	27.08	0.00	-0.36
AS 5	23.41	23.46	0.05	7.10

APPENDIX C

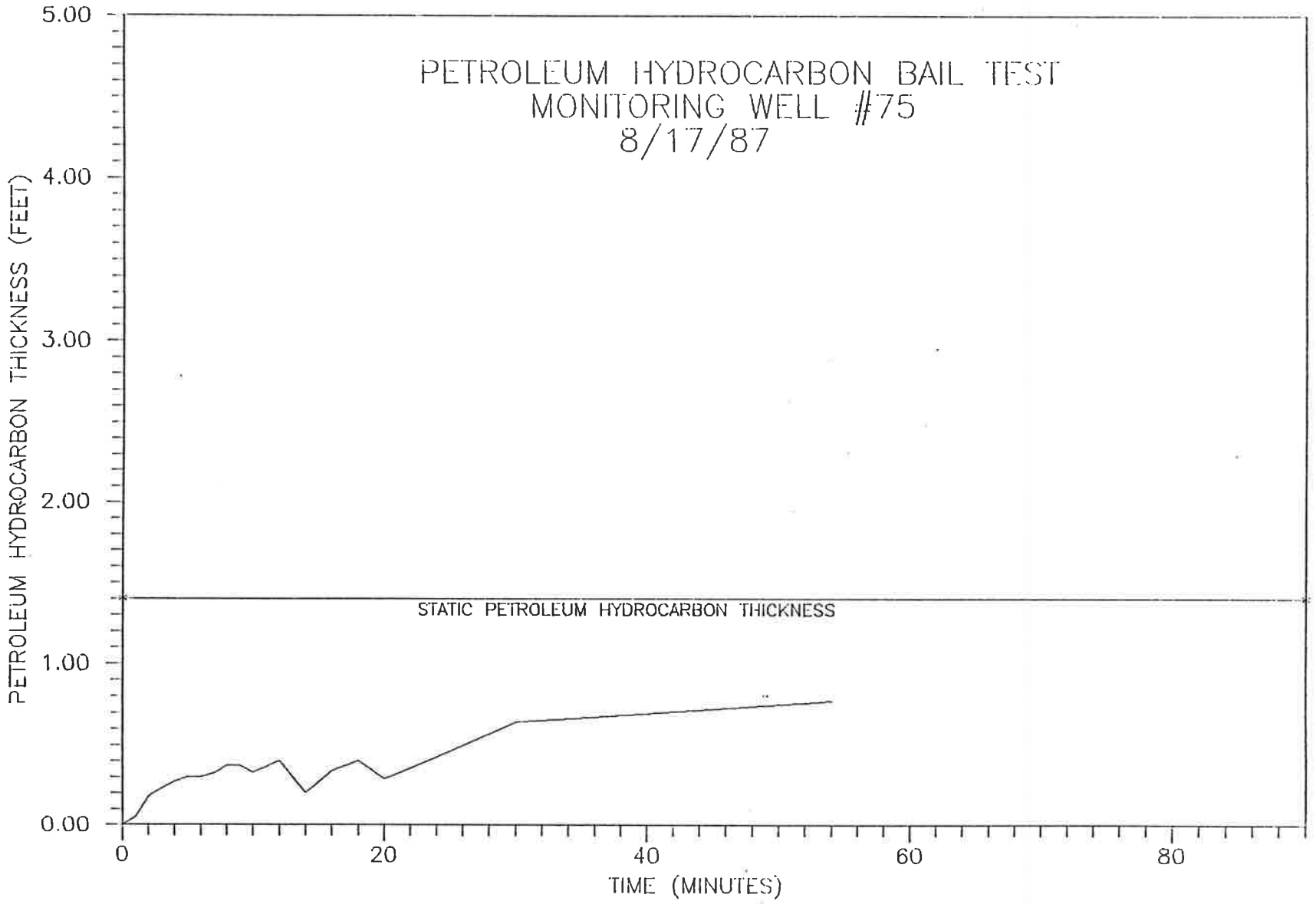
PETROLEUM HYDROCARBON BAIL TEST GRAPHS



ENGINEERING ENTERPRISES, INC.



ENGINEERING ENTERPRISES, INC.



EEI ENGINEERING ENTERPRISES, INC.