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Report

Addendum Site Assessment Tanks STT61-STT66

Contract N62470-90-R-7626

Tarawa Terrace
Marine Corps Base
Camp Lejeune, North Carolina

June 1993

O'BRIEN & GERE
ENGINEERS, INC.

01.06-6/1/93-00263

REPORT

ADDENDUM SITE ASSESSMENT
TANKS STT61 - STT66
TARAWA TERRACE
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA
CONTRACT # N62470-90-R-7626

June 1993

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SECTION 1 - INTRODUCTION

1.01 Purpose and Scope

O'Brien & Gere Engineers, Inc. (OBG) has been retained to provide the hydrogeologic services necessary to investigate the subsurface conditions in the vicinity of Tanks STT61 through STT66, at Tarawa Terrace, Marine Corps Base (MCB), Camp Lejeune, North Carolina.

OBG has completed two field investigations. The preliminary field investigation included monitoring well installation, soil borings, penetrometer probes (hydropunches), soil and ground water sampling and analysis, ground water and free product monitoring, and in-situ permeability testing. The site assessment developed from this field work recommended additional field investigations to better delineate the presence of a contaminant plume and determine the most appropriate remedial technology. A supplemental field study has been completed which included the installation of six, two inch inside diameter (ID), monitoring wells and a six inch ID test well, six penetrometer (hydropunch) probes, ground water and soil sampling and analysis, in-situ permeability testing and a pump test. This report presents the results of the addendum site study.

1.02 Site Description

Tanks STT61 through STT66 are situated within a fenced area between a railroad, approximately 75 feet to the south, and Highway 24, approximately 75 feet to the north. Entrance to the compound lies approximately 200 feet west of Tarawa Terrace, MCB Camp Lejeune (Figure 1).

Within the tank compound is a pump house, six above ground storage tanks (STT61 - STT66) and associated piping. An earthen berm surrounds the tanks extending beyond the fence to the south and west. Each storage tank has a 30,000 gallon capacity. Prior to waste oil storage the tanks were used for liquid petroleum. At present, all the tanks remain empty with the exception of STT66 which is still in service.

Previous soil investigations completed by Dewberry and Davis (Jan. 1991) demonstrated Total Petroleum Hydrocarbon (TPH) concentrations ranging from below detection limits to 5390 ppm. Laboratory results from this investigation are available in Exhibit B.

SECTION 2 - SITE ASSESSMENT

2.01 Hydrogeology

2.01.1 Preliminary Field Investigation

In order to explore the site's geologic conditions and identify the presence of a possible petroleum hydrocarbon plume, seven shallow monitoring wells, seven deep monitoring wells, four soil borings, and ten hydropunches were installed in the vicinity of Tanks STT61 - STT66 between 12 December 1991 and 11 January 1992.

Under the supervision of an OBG geologist, drilling operations were performed by ATEC Associates, Inc., of Raleigh, North Carolina, in accordance with the drilling procedures outlined in Appendix E. Figure 2 is an illustration of the various drill locations.

Monitoring wells were installed in nested pairs, comprising one shallow well and one deep well. Each monitoring well was constructed of 2" ID, schedule 40, PVC, with 10 feet of 0.01 slot screen. Shallow wells (odd numbered) were installed to a depth between 12 and 15 feet below grade. Within 3 feet of each shallow well a deep monitoring well (even numbered) was emplaced to a depth between 28 to 30 feet below grade. Appendix A contains well construction diagrams for each well. Soil borings were terminated at the water table which was encountered between 4 and 8 feet below grade. Cuttings generated from drilling activities were contained in 55 gallon drums and left at the site for future management.

Split spoon samples were collected during the drilling of the 7 deep wells and the 4 soil borings. Split spoon sampling occurred continuously from 0 to 6 feet below grade and in 5 foot intervals thereafter in accordance with ASTM D-1586. Detailed lithologic descriptions of each soil sample were recorded in the field on boring logs located in Appendix A. Each soil sample was screened for volatile organic compounds using an Hnu. Two soil samples from each deep well and soil boring were selected for laboratory analysis as discussed in section 2.02.3.

Each well's horizontal location and top of casing elevation was established to 0.01 ft. accuracy by a survey conducted by Robert H. Davis, RLS (Exhibit A).

Addendum Field Investigation

Resultant of the preliminary site assessment, additional field activities were warranted to better define subsurface contamination identified in the vicinity of MW13 and MW14. In December 1992, addendum field activities were completed which included the installation of 6 monitoring wells, a test well, six hydropunches, soil and ground water sampling and analysis and the completion of an eight hour pump test.

Drilling operations were completed by ATEC Associates under the supervision of an OBG geologist. Procedures for drilling activities are located in Appendix E. Figure 2 illustrates the location of all drilling activities.

Three monitoring wells (MW15, MW17 and MW19) were installed at a maximum depth of 15 feet and three monitoring wells (MW16, MW18 and MW20) were installed at a maximum depth of 30 feet below grade. The 6" ID test well was installed at a depth of 20 feet below grade. Well construction diagrams of each well are located in Appendix A. After installation each well was developed by continuous low yield pumping and sampled for volatile organics by method 601/602. Ground water analytical results are further discussed in Section 2.02.4. Aquifer characteristic testing, in the form of in-situ permeability testing and an eight hour pump test was conducted on each newly installed monitoring well and the test well, respectively. Aquifer characteristics are presented in Section 2.01.3.

Soil samples were collected during the installation of the three deep wells and the test well. Detailed lithological descriptions of each sample were recorded on bore logs presented as Appendix A. Two soil samples from each location were sent to ETS Laboratory for analysis of TPH, pH, and flash point. One sample, obtained from MW20, was also analyzed for TCLP to facilitate drill cutting disposal. Results of laboratory analyses are further discussed in Section 2.02.3.

Penetrometer probes were installed in 15 foot and 30 feet depths. Before completing the 30 foot deep hydropunches (H12, H14 and H16) site conditions necessitated initial augering to 20 feet below grade before attempting the hydropunch. An instrument survey was conducted by R.H.Davis (RLS) to determine the location and elevation of each hydropunch and well. Survey data is located in Exhibit A.

All fluids and soils generated by field activities were containerized and transported to a permitted disposal facility for subsequent disposal.

2.01.2 Geologic Conditions

MCB Camp Lejeune is situated in the Atlantic coastal Plain Physiographic Province which, in North Carolina, is characterized by a broad flat surface that slopes gently to the southeast (USGS, 1988). The MCB Camp Lejeune area overlies Cretaceous sediments of sands, silts and clays that thicken towards the east and reach a thickness of approximately 2500 feet. The investigation at Tarawa Terrace, Tanks STT61 - STT66, involved the upper 30 feet of sediments. Split spoon samples (Appendix A) revealed a subsurface geology characterized by sand, silt and clays in various hues of gray (bluish, greenish and pinkish) and light brown. Figures 5 and 6 present a geologic cross section of the study area along the downgradient direction. Split spoon samples from addendum drilling activities demonstrated findings consistent with the preliminary site investigation. A grain size analysis of soil obtained from the unconfined aquifer encountered during the installation of the test well (9 - 11 feet below grade) revealed sediments ranging from fine-to-medium, sandy-clay to fine-to-medium clayey-sand. Results of this grain size analysis, conducted by McCallum Testing Laboratories of Chesapeake, Va., by method ASTM D-422 are included in Appendix H. An Inclusive Graphic Standard Deviation (Folk) calculation determined the aquifer to be extremely poorly sorted.

2.01.3 Aquifer Testing

In-situ Permeability Testing

Hydraulic permeability (or conductivity) was estimated for each monitoring well with the performance of an in-situ permeability (slug) test. The test involves the removal of several gallons of water from each well, creating a potential for flow into the well from the surrounding aquifer. The rate at which the ground water re-enters the well is monitored until the well's static water level is approached. Ground water levels during the tests were measured with an electronic oil/water interface probe. Values of hydraulic conductivity were calculated based on the change in water level versus the change in time using Horselov's formula. Appendix D contains the test data and the results are summarized on Table 2. Using this method, the geometric mean for hydraulic conductivity was estimated to be 24 gpd/ft^2.

Pump Test

A six inch ID test well (TW) was installed at the site to determine the hydraulic characteristics of the aquifer including transmissivity, hydraulic conductivity and the pumping well's radius of influence. The test well was installed to a depth of 20 feet below grade with 15 feet of 0.01 slot screen. On December 17 1992, a pump test was performed with the constant discharge rate (Q) of 5.5 gallons per minute (gpm) for a duration of eight hours. The pumping rate was maintained by using a submersible pump with the pumping rate being calibrated every 30 minutes for the duration of the test. Water levels in the pumping well and two nearby well clusters (MW3&MW4 and MW9&MW10) were measured and recorded at various intervals during, and directly following the test. Following the pump test, ground water recovery of the test well was measured until the aquifer had recovered to within 95% of its static level.

Using a graphical well analysis computer program, data collected from the in-field testing was evaluated to determine the aquifer's hydraulic parameters by matching the drawdown data to Theis type curves. Aquifer coefficients were also calculated using a modification of the Theis type curve matching by the Cooper & Jacob (1946) straight line method, by plotting the drawdown of the ground water versus elapsed time and the drawdown versus distance from the pumping well on semi-logarithmic paper. By using these methods the values were determined for transmissivity, storage and hydraulic conductivity. Evaluation of data collected from MW9 and MW10 determined that the distance from MW9 and MW10 to the pumping test well may have been too great for the data to be utilized. MW10 did not demonstrate enough drawdown to be considered effective in the evaluation of aquifer characteristics, and was not used. The following values were determined for transmissivity, storage and hydraulic conductivity for the test well (TW), MW3, MW9 (shallow wells) and MW4 (deep well):

	Transmissivity (gpd/ft)	Hydraulic Conductivity (gpd/ft^2)	Storativity
TW-Theis	494	16	0.30
TW-Cooper/Jacob	449	15	0.06
MW3-Theis	2845	95	0.08
MW3-Cooper/Jacob	2850	95	0.06
MW4-Theis	10332	340	0.005
MW4-Cooper/Jacob	10103	340	0.004
MW9-Theis	2050	70	0.076
MW9-Cooper/Jacob	2604	90	0.035

The hydraulic conductivity determined by the pump test differs from that determined by the slug test by approximately one order of magnitude. Slug test results provide a more localized interpretation of conductivity whereas the 6" ID test well is more likely to provide a better estimate for a site-wide hydraulic conductivity.

Values in transmissivity and hydraulic conductivity appear to fluctuate with depth within the aquifer suggesting a heterogeneous formation. Differences in conductivity between shallow and deep wells are larger than those calculated for vertically equivalent depths at greater horizontal distances. This type of layered heterogeneity is common in unconsolidated marine deposits.

For the purpose of estimating the radius of influence, a geometric mean of transmissivity values (2000 gpd/ft) was used in the following equation:

$$YL = Q/2Ti$$ where:

YL = Radius of influence
i = Hydraulic gradient (0.001 ft/ft)
T = Estimated transmissivity (2000 gpd/ft)
Q = Pumping rate (7920 gpd)

From this equation, the radius of influence, using Theis type curves, is calculated to be approximately 2200 feet. Calculations utilizing values from the Cooper & Jacob straight line method approximate the radius of influence to be 2000 feet. These two values appear to be in agreement with one another. Data generated from the pump test can be reviewed in Appendix F.

2.01.4 Ground Water Flow

On December 17 1992, ground water elevations were gauged in all of the monitoring wells at the site. Using an electronic oil/water interface probe, ground water was measured to be between 4 and 8 feet below the top of the well casing. After installation, each well was surveyed to establish top of casing elevations relative to 100.00 feet. From these elevations, the ground water elevation in each well can be determined. Using the elevational data summarized on Table 1, ground water contour maps were derived. Figure 3 depicts the ground water flow across the study area as monitored by the shallow wells. Figure 4 illustrates the ground water flow monitored by the deep wells. Ground water appears to be flowing in an overall southerly direction. Variances in ground water elevations north of the railroad tracks suggest a possible re-charge boundary in the shallow ground water system, created by the railroad tracks and compacted path around the tank area. Differences in coarseness and compaction of shallow subsurface materials can produce a re-charge effect, especially during times of increased precipitation. The deeper monitoring wells do not appear to be affected by such shallow factors. With an estimated hydraulic gradient of 0.001 ft/ft and an effective porosity of 0.40, the flow velocity of the ground water can be approximated at 0.008 ft/day or 3 ft/yr.

2.02 Environmental Assessment

2.02.1 Free Product Characterization

With an electronic oil/water interface probe each well was monitored for the possible presence of free product on at least two occasions. Free product was not detected in any of the wells during preliminary or addendum field events.

2.02.2 Air Characterization

During all field operations ambient air and sample head space was monitored for volatile organics using an Hnu or PID (photoionization detector). At no time did the workers' breathing zone or the ambient air quality exceed 1 ppm. As each soil and liquid sample, was collected the Hnu/PID was used to detect volatile emissions. Only one soil sample (MW12) demonstrated volatile organic levels above 5 ppm (a reading of 9 ppm was recorded). Hnu/PID values for soil samples were recorded on the bore logs included in Appendix A. All the liquid samples registered below 5 ppm on the Hnu/PID.

2.02.3 Soil Characterization

Preliminary Field Investigation

Two soil samples from each soil boring and deep monitoring well were selected for laboratory analysis. At each location a sample from the water table and five feet above the water table was sent to Environmental Testing Services, Inc., in Norfolk, Virginia, for TPH analysis (California method). Five water table samples (MW2, MW4, MW6, MW8, and MW14) were also analyzed for flash point (Pensky-Martin closed cup technique) and pH. Three water table samples (MW2, MW6, and MW8) and a composite sample (obtained from directly beneath the tanks) were selected for Toxicity Characteristic Leaching Process (TCLP) analysis (EPA Manual SW-846 Method 1311). Laboratory results are presented in Appendix C.

Total Petroleum Hydrocarbons (TPH) for the 22 samples collected ranged from below method detection limits to 13.2 mg/kg. The geometric mean concentration was 2.31 mg/kg and only one water table sample (MW6) was above 10 mg/kg. Flash point testing on five soil samples was negative at the maximum temperature tested (110°C). Of the forty TCLP parameters, two constituents were found above method detection limits. Barium and Pentachlorophenol were present, however neither represented concentrations above regulatory levels.

Addendum Field Investigation

Two soil samples from each deep well and the test well were submitted to ETS Laboratory for analysis of TPH by methods 3550 and 5030, Flash Point by method 1010 and pH by method 9045. Only one soil sample exhibited TPH above laboratory detection limits. Soil obtained from 0-2 feet below grade from the test well contained 12 mg/kg TPH by method 3550. Analysis by method 5030 of the same interval did not demonstrate TPH values above laboratory detection limits. For the purpose of soil disposal, a TCLP analysis was conducted on soil collected from 10-12 feet below grade from MW20. Barium was the only parameter to be detected above laboratory detection limits. The detected concentration of Barium (0.641 mg/l) was below the regulatory level of 100 mg/l.

Flash point and pH analyses were conducted on three soil samples collected at the water table of each deep monitoring well. In each instance, flash point was less than 140°F. Measurements of pH ranged from 4.70 to 5.31. Laboratory results are presented in Appendix C.

2.02.4 Ground Water Characterization

Preliminary Field Investigation

Between January 7 and 11 1992 ground water samples were collected from each monitoring well and hydropunch. Hydropunch sampling was accomplished by the methods previously described in Section 2.01.1 Ground water samples from each monitoring well were obtained by using a stainless steel bailer and following the procedures dictated in Appendix G. Prior to sample collection, each monitoring well was purged of three times the well's volume. Ground water samples were sent to OBG Laboratories in Syracuse, N.Y. for analysis by EPA methods 8010, 8020, 8100 and TCLP. EPA methods 8010, 8020, and 8100 are derived from, and equivalent to, EPA methods 601, 602 and 610, respectively. They utilize the same technique and include the same parameters. Laboratory results are available for review in Appendix B.

Of all the parameters analyzed, only benzene was found to exist in concentrations over North Carolina Ground Water Standards. Monitoring well MW14 and hydropunches H1, H3 and H4 contained benzene concentrations ranging from 0.007 mg/l (H3 and H4) to 0.023 mg/l (MW14), compared to the State standard of 0.001 mg/l. Trichlorofluoromethane, and 1,1 dichloroethane were present in two sample locations (MW10 and H1), however, there are no regulatory standards listed for these analytes.

At the time of sampling specific conductivity and pH measurements were obtained from each of the monitoring wells. These measurements are summarized on Table 3.

Addendum Field Investigation

In December 1992, ground water from each newly installed monitoring well and hydropunch was collected and sent to OBG Laboratory for analysis by method 601/602 for volatile organics. Benzene, toluene, ethylbenzene, xylene (BTEX), trichlorofluoromethane, 1,1-dichloroethane, 1,1,1-trichloroethane, tetrachloroethene and chloroform was found to exist in the ground water in concentrations above laboratory detection limits. Six sample locations exhibited benzene in concentrations ranging from 0.001 mg/l (MW20) to 0.042 mg/l (H13). Monitoring well MW15, H12 and H13 were the only sample locations to demonstrate toluene, ethylbenzene and xylene above laboratory detection limits. MW15 contained toluene, ethylbenzene and xylene values of 0.009 mg/l, 0.010 mg/l and 0.019 mg/l, respectively. H12 demonstrated toluene, ethylbenzene, xylene concentrations of 0.10 mg/l, 0.03 mg/l and 0.17 mg/l, respectively. Toluene, ethylbenzene, xylene concentrations in H13 were 0.008 mg/l, 0.003 mg/l and 0.012, respectively. The toluene, ethylbenzene, xylene values were at or below the State Ground Water Standards. MW16 demonstrated a 0.002 mg/l concentration of chloroform. H12 and H13 were the only sample locations to exhibit the presence of trichlorofluoromethane. Concentrations were found to be 0.055 mg/l (H12) and 0.001 mg/l (H13). H12 was the only sample location to demonstrate 1,1-dichloroethane (0.002 mg/l), 1,1,1-trichloroethane (0.009 mg/l) and tetrachloroethene (0.002 mg/l) above laboratory detection limits. Ground water laboratory results are located in Appendix B.

Specific conductivity, measured at the time of sampling, ranged between 98 and 135 umhos/cm. Measurements of pH varied between 5.27 and 6.75 (standard units). Field measurements are included in Table 3.

2.03 Quality Assurance/Quality Control

Throughout field operations steps were taken to maintain quality assurance and quality control (QA/QC). Field instruments such as the Hnu/PID, pH meter and specific conductivity meter were calibrated on site. The Hnu/PID was calibrated to 100 ppm isobutylene. Specific conductivity and pH meters were calibrated with standardized solutions.

Sampling equipment was decontaminated by using a series of rinses involving distilled water, non-phosphate detergent, methanol and dilute nitric acid. A rinse blank (field blank) was included in the analysis to confirm the decontamination process effectiveness.

Standard laboratory QA/QC procedures were applied in accordance with the referenced EPA Methods. In addition, trip blanks and duplicate samples were used.

3.01 Introduction

This section presents an evaluation of the risk to human health associated with the former operation of aboveground waste oil storage tanks STT61 through STT66, located at Tarawa Terrace, MCB Camp Lejeune, North Carolina. This risk assessment specifically addresses the risk to human health related to identified environmental contamination in the immediate area of the tanks, resulting from the past operation of the tanks. The results of this risk assessment are used in developing a corrective action/remedial action strategy, as presented in Section 4 of this report.

The associated field investigations for this project are previously described in Sections 1 and 2 of this report.

This risk assessment has been prepared for the Naval Facilities Engineering Command, Atlantic Division and MCB Camp Lejeune. MCB Camp Lejeune will submit this document to the North Carolina Department of Environment, Health and Natural Resources (DEHNR). The DEHNR will then make a determination regarding potential corrective action requirements, as discussed in Section 4 of this report. Criteria discussed and/or used in this risk assessment are drawn from DEHNR and parallel U.S. Environmental Protection Agency (EPA) regulations and/or guidelines, where applicable. This document is consistent with typical goals of performing risk assessments related to environmental contamination. The primary guidance document applied is the EPA's "Risk Assessment

Guidance for Superfund, Volume I: Human Health Evaluation Manual". This manual details methodology for analysis of potential site-related acute and chronic health risks to on-site and off-site receptors, under both current and future use scenarios.

3.02 Site-Specific Descriptive Information

3.02.1 History

The six, 30,000 gallon, tanks were installed in 1942 for liquid petroleum storage. In approximately 1980, the tanks were changed over to waste oil storage. Currently, tanks STT61 through STT65 are empty; tank STT66 is still in service and contains variable amounts of waste oil.

The tanks are located just south (approximately 75 feet) of Highway 24 and north of railroad tracks running parallel to the highway. The tank area is enclosed by a locked fence. A berm surrounds the tanks, extending past the fence on the south and west sides. Within the fenced area is a small building with a boiler inside. Insulated piping lines run from the boiler to each of the six tanks.

Deliveries of petroleum were offloaded from rail cars to the tanks. Liquid petroleum was subsequently pumped from the tanks to waiting delivery trucks which serviced the Base.

According to Tom Morris, Environmental Management Dept. MCB Camp Lejeune, tank STT66 had a pipe freeze and break approximately five years ago. Mr. Morris stated that materials spilled during this incident were cleaned up.

Preliminary site investigations were conducted in November 1990 by Dewberry and Davis. This investigation included hand augering and soil boring sampling in the area of the tanks. Data from this investigation indicate some TPH contamination in soils, in excess of the North Carolina action level of 10 mg/kg. Also, benzene, toluene, ethylbenzene, xylene, styrene and 1,1,1-trichloroethane were detected as soil contaminants.

3.02.2 Site and Surrounding Area Description

The tanks are located approximately 200 feet west of Tarawa Terrace, MCB Camp Lejeune. The immediate area of the tanks is undeveloped, and covered by wooded and brush areas. The ground cover within the fence consists of grassy and coarse vegetative covers, with some gravel near the fence line. According to Environmental Management Dept. personnel the area is not serviced by underground utilities. An out of service fire hydrant was observed adjacent to the west side of the fenced-in area.

Residential family housing is located approximately 1600 feet away, toward the north.

Previous inspection notes, supplied by Mr. Morris, indicated that structure cracks were observed in the concrete cradles supporting the tanks.

No surface contamination, nor surface drainage pathways, were observed in the tank area. There are no water supply wells operating within 1500 feet of the study area.

A map of the site is presented as Figure 2.

3.02.3 Demographics

The population at MCB Camp Lejeune includes military personnel and their families, as well as civilian employees. The tank area itself is unoccupied; it is entered once per week for inspection.

3.03 Current Site Data

The site investigations involved the installation, development and sampling of ten shallow monitoring wells and ten deep monitoring wells, four soil borings (B1 - B4), and sixteen hydropunches (H1 - H16). These are described in detail in Section 2.01 of this report.

3.03.1 Soil Data

Two soil samples from each of the four soil borings, and two soil samples from each of the deep monitoring wells were selected for laboratory analyses for TPH by gas chromatograph/flame ionization detector (GC-FID). Deep samples were collected at the water table, and shallow samples were collected five feet above the water table. Eight deep soil samples (MW2, MW4, MW6, MW8, MW14, MW16, MW18 and MW20) were analyzed for flash point and pH. Four deep soil samples (MW2, MW6, MW8, MW20) and a composite (from underneath the tanks) were selected for full-scan toxicity characteristic leaching procedure (TCLP) analyses.

The pH results ranged from 4.1 to 5.4; flash point tests were negative; the TCLP results were below EPA regulatory criteria for this procedure. Barium and pentachlorophenol were detected above the analytical detection limits. The presence of pentachlorophenol

(PCP) in the TCLP leachate from MW6 indicates that PCP is present in the site subsurface soils.

Soil TPH results ranged from non-detectable to 13.2 mg/kg in MW4 (9 - 11 feet depth). Two soil samples exceeded 10 mg/kg TPH, as follows:

Sample #	Sample Location	TPH (mg/kg)
MW4	9′ - 11′	13.2
MW6	14′ - 16′	12.3
TW	0′ - 2′	12.0

All other soil samples analyzed, including samples from other depths at MW4 and MW6, and samples from borings (B1 and B2) which lie between MW4 and MW6, were less than 10 mg/kg.

3.03.1.1 Soil Data Evaluation

Sixteen of the 30 samples were non-detectable, while detected concentrations ranged from 1.16 mg/kg to a maximum of 13.2 mg/kg. Three samples yielded TPH results in excess of the North Carolina criterion. While these data do not indicate a "pocket" area of contamination, nor relatively high concentrations of TPH, as a conservative approach the presence of TPH in subsurface soils in three samples, at concentrations up to 13.2 mg/kg will be addressed as a potential source.

3.03.2 Ground Water Data

No free product was detected in the twenty ground water monitoring wells, nor was free product detected in the sixteen hydropunches or test well.

Ground water samples from each monitoring well and hydropunch were analyzed for volatile organic compounds by SW-846 methods 8010 and 8020. In addition, samples from MW1, MW3 and MW7 were analyzed by EPA SW-846 method 8100 (polynuclear aromatic hydrocarbons; PAHs). Ground water samples from MW3 were analyzed for full scan TCLP compounds. Section 2 of this report provides additional details on the analytical scheme.

TCLP results were less than detection limits; PAH results were less than the detection limits.

The 8010/8020 results were below method detection limits, with the exception of the following compounds:

Detected Compound	Sample	Results (mg/l)	NC Standard (mg/l)	MCL (mg/l)
benzene	MW10	0.014	0.001	0.005
	MW14	0.023		
	MW18	0.007		
	MW20	0.001		
	H1	0.022		
	H3	0.007		
	H4	0.007		
	H12	0.010		
	H13	0.042		
	H14	0.002		
	H16	0.002		
toluene	MW10	0.003	1.0	2.0 *
	MW15	0.009		
	H1	0.190		
	H4	0.003		
	H12	0.100		
	H13	0.008		
ethyl benzene	MW10	0.004	0.029	0.7 *
	MW15	0.010		
	H1	0.017		
	H4	0.002		
	H12	0.030		
	H13	0.003		

Detected Compound	Sample	Results (mg/l)	NC Standard (mg/l)	MCL (mg/l)
xylene (total)	MW10	0.017	0.4	10 *
	MW15	0.019		
	H1	0.062		
	H3	0.003		
	H4	0.012		
	H12	0.170		
	H13	0.012		
tri-chlorofluoromethane	MW10	0.005	n/a	n/a
	H1	0.001		
	H12	0.055		
	H13	0.001		
1,1-dichloroethane	H1	0.002	n/a	n/a
	H12	0.002		
111trichloroethane	H12	0.009	0.200	
Tetrachloroethene	H12	0.002	0.0007	

The NC standards are the water quality standards applicable to the ground waters of North Carolina, as dictated in Title 15, Subchapter 2L, Section 0.0200, of the North Carolina Administrative Code, dated 12/1/89. The standard applies to Class GA waters, which are considered to be drinkable in their natural state (i.e., potable water supplies).

MCL's are the Maximum Contaminant Level allowable for drinking water, under the National Primary Drinking Water Regulations. Those marked with the * indicate proposed limits; all others are final and current limits.

"n/a" indicates that North Carolina has not established a criterion for this chemical.

3.03.2.2 Ground Water Data Evaluation

Benzene was detected at or above North Carolina Standards in four wells and seven hydropunches. Benzene was in excess of Federal MCL criteria in three wells and five hydropunches. Tetrachloroethene was also present in the ground water above N.C. Standards. The other organic compounds detected in the ground water samples are within regulatory limits, as presented on the above table. The only exceptions are trichlorofluoromethane and 1,1-dichloroethane, for which no regulatory limits have been established to date.

As no criteria for trichlorofluoromethane and 1,1 dichloroethane exists, these compounds, along with benzene, tetrachloroethene and toluene will be considered in assessing the potential risk related to the presence of these organic compounds in the ground water.

Ground water flow, based on data collected from the twenty monitoring wells, is in a southerly direction; ground water flow velocity is calculated to be approximately 3 feet/year.

3.03.3 Ambient Air Data

Ambient air quality was monitored during field activities with a photoionizing organic vapor detector (PID) with a 10.2 eV lamp. PID readings were recorded from the breathing zone of the on-site workers and at the ground surface every 15 to 30 minutes. The PID readings did not exceed the detection limit of the PID (1 ppm) at any time during the ambient air monitoring.

3.04 Identification of Chemicals and Media of Concern

Based on the results of the site investigation, as described in the previous section, the environmental contaminants to be considered in the following exposure scenarios are benzene, trichlorofluoromethane and 1,1-dichloroethane in the ground water, and TPH in the subsurface soils.

3.05 Risk Assessment Approach

3.05.1 Introduction

This risk assessment addresses the potential for exposure to the ground water and TPH-contaminated subsurface soils in the area of tanks STT61 - STT66, under current and reasonably anticipated future conditions and site uses. Four potential exposure pathways are considered in assessing potential risk related to the identified contamination: 1) air, 2) surface water, 3) ground water, and 4) soil.

In the analysis of each exposure pathway, three key components are considered:

1. known source;
2. mechanisms for release and medium/vehicle for transport of contaminant(s);
3. potential receptor populations.

If an exposure pathway has these three components, it is considered as a complete exposure pathway. If an exposure pathway lacks one of these necessary components it is concluded that there is no potential for exposure via that incomplete pathway, and therefore no risk. Each pathway is analyzed separately in the following sections. Each analysis includes the following:

1. a description of the waste source;
2. mechanisms for release and transport of contamination in the environment;
3. the time frame of potential releases (i.e., continuous or episodic);
4. the existence of potential receptor populations;
5. potential exposure scenarios;
6. potential uptake routes (ingestion, inhalation, dermal absorption);

Should all of the above be present, it is determined that the exposure pathway is complete. Further quantitative analysis is then made. Exposure point concentrations are estimated, followed by exposure intakes.

Exposure scenarios may include current and future use conditions, children and adult exposures, and both carcinogenic and non-carcinogenic effects of chemicals involved in the exposure, as applicable. The calculated exposure intake is then compared to human-health based reference data. An assessment of the potential for adverse health effects is then made. Details of this quantitative analysis process are presented for the exposure pathway(s) to which it is applied.

3.05.2 Air Exposure Pathway

Three potential mechanisms for release of identified contamination to the air are considered in assessing potential risks related to the air exposure pathway:

1) episodic fugitive dust emissions of contaminated soil particulates;
2) continuous emissions of volatile components of soil contamination, through the soil, to the ambient air at the site; and
3) continuous emissions of volatile components of soil contamination, through soils, into subsurface structures at the site.

3.05.2.1 Potential Exposure to Fugitive Dust Emissions

Episodic releases of contaminated fugitive dusts to the general atmosphere would result if contaminated surface and/or sub-surface soils were exposed to surface scouring action (e.g., wind, vehicle traffic, foot traffic, heavy equipment operation). No surface contamination was visually observed. The area surrounding tanks STT61 through STT66 is covered by vegetation (grass and weeds). Traffic in the area of the tanks is limited to foot traffic, which is controlled by the locked gate, and occurs only once per week, likely for less than one-half hour per inspection. Therefore, there is limited potential for exposure to fugitive dust emissions.

Contamination was detected between 9 - 16 feet below grade. Based on the available analytical information, fugitive emissions would require scouring actions on subsurface contaminated soils at least nine feet below grade. However, there is at least nine feet of cover, with vegetative cover preventing erosion, over the detected soil contamination, thus eliminating the potential for regular site activities (limited foot traffic) to result in scouring actions on subsurface contaminated soils. Based on this information, the potential for fugitive dust emissions in the area is eliminated under current use conditions.

Based on information provided by Tom Morris, there are no plans to alter the study area; use of the area will not undergo substantial change with respect to land use, operations, or materials in the foreseeable future. Based on this, there is no potential for scouring actions to impact existing contaminated subsurface soils under future anticipated conditions.

3.05.2.2 Potential Exposure to Volatile Emissions in the General Atmosphere

Volatilization involves evaporation of volatile components from contaminated media. Vapors can then migrate up through the soils to release at the soil surface under certain conditions.

The identified ground water contaminants are benzene, 1,1-dichloroethane and trichlorofluoromethane. These compounds are volatile and soluble in water, as evidenced by the following data:

	Vapor Pressure (mm Hg)	Solubility in Water (mg/l)
Benzene	95.2	1791
1,1-dichloroethane	227	5060
trichlorofluoromethane	803	1080

As such, these compounds would be expected to be present in ground water (based on solubility), and readily volatilized from the ground water (based on vapor pressures). However, volatilization of trace concentrations of benzene, 1,1-dichloroethane and/or trichlorofluoromethane from the ground water, through approximately 15 feet of soil, would result in insignificant quantities entering the ambient atmosphere. Volatilized portions would then be subject to dilution and dispersion by the general atmosphere. As such, potential exposure to these organic vapors volatilized from site ground water through subsurface soils would be insignificant.

Additionally, volatilization from TPH contaminated subsurface soils is possible. Based on the available information on the nature of the waste oils (likely from diesel engines), such oils may contain trace amounts of volatile organic compounds. Such waste oils were formerly contained in tanks STT61 through STT66, and are currently contained in STT66. It is assumed that the low TPH concentrations detected in the soil samples from MW4 and MW6, near the tanks, indicate the presence of waste oils, and therefore may indicate the potential presence of trace amounts of volatile organic compounds. However, at least nine feet of soil cover would both inhibit and dilute such volatilization, to the extent that the release of such vapors into the general atmosphere would be insignificant. Soil interactions such as adsorption and degradation, as indicated by environmental degradation half-lives, as well as dilution and dispersion actions of ambient air movement, would result in minimal concentrations of such vapors with respect to concern for human exposure. Field monitoring supports this. The ambient air monitoring conducted throughout the field activities, which temporarily disturbed and exposed subsurface soils, indicated that no volatile organic compounds were detected, with a detection limit of 1 ppm in the breathing zone of the workers.

Based on the above discussions, no significant vapor emissions related to subsurface soil contamination are reasonably expected in the area of the tank. Thus, the risk potentially associated with volatile emissions from subsurface soils is negligible.

3.05.2.3 Potential Exposure to Volatile Emissions Released into Subsurface Structures

There are no subsurface structures located at the Tarawa Terrace tank site. The shed is a small, above-ground structure, apparently constructed and placed on the ground surface. In general, there are no subsurface structures at MCB Camp Lejeune, due to the high water table. Therefore, most buildings are constructed on slab.

Thus, no identified receptor populations exist to complete this exposure pathway. Based on this, the exposure pathway for volatile constituents of site contaminants that might migrate through soils into on-site subsurface structures is incomplete. As such, there is no risk of exposure via this mechanism.

3.05.2.4 Conclusion on Air Exposure Pathway

There is no significant risk of exposure via the air exposure pathway.

3.05.3 Surface Water Exposure Pathway

Two mechanisms for release of identified contamination to surface waters are considered in assessing risks related to the surface water exposure pathway:

1) contamination of surface water by contact with surface contamination; and
2) contamination of surface water by ground water discharge.

There are no identified surface water streams within the study area. The nearest surface water is Northeast Creek, located approximately 5,000 feet to the south.

3.05.3.1 Potential Exposure to Contaminated Surface Water in Contact with Surface Contamination

There was no observed surface contamination in the immediate area of the tank. As stated above, there are no permanent surface water bodies, including streams, within the study area. As there is no observable surface contamination, nor is there surface water at the study area to serve as either a source or a transport vehicle, this potential exposure pathway is incomplete; therefore, there is no risk associated with this pathway.

3.05.3.2 Potential Exposure to Contaminated Surface Water via Ground Water Discharge

Based on information obtained from this investigation, the following ground water discharge-to-surface water scenario is possible. The ground water flows southerly at a slow rate of approximately 3 feet/year; the nearest downgradient surface water body, Northeast Creek, is approximately 5,000 feet to the south. As such, ground water from the study area would likely flow via natural migration pathways and discharge to Northeast Creek over an extended period of time. The potential for exposures occurring in surface water contaminated by ground water flowing from the site to Northeast Creek far in the future (1700 years) is beyond both the current and reasonably anticipated future use/conditions scenarios. In addition, the trace concentrations of benzene would have decreased by natural mechanisms such as degradation and volatilization, such that prolonged migration of such a low concentration of benzene would lead to negligible concentrations over such a distance.

Therefore, the potential impact of site-related ground water on surface water is negligible.

3.05.3.3 Conclusion on Surface Water Exposure Pathway

There is no significant human health risk, based on current and reasonably anticipated future use scenarios, via the surface water pathway.

3.05.4 Ground Water Exposure Pathway

Two mechanisms for release of identified contamination to or through ground waters are considered in assessing risks related to the ground water exposure pathway:

1) Direct withdrawal and use/consumption of contaminated ground water (contamination, as detected, or contamination via leaching from subsurface soils); and

2) Exposure to ground water during subsurface disturbance.

3.05.4.1 Potential Exposure via Contaminated Ground Water Use/Consumption

There are no identified shallow ground water users within the study area. According to Tom Morris, the ground water of the shallow aquifer at MCB Camp Lejeune is not used for human consumption or other operations/purposes which might lead to potential human exposure. Potable ground water use in the area is limited to a deeper aquifer (known as the Castle Hayne aquifer) approximately 150′ below the ground surface. There are no known users/uses of the shallow aquifer (15′ below grade). Thus there is no receptor population.

Based on the lack of a receptor population, under both current and future use consideration, this exposure pathway is incomplete, and therefore there is no risk to human health related to use/consumption of the ground water at the tank area.

3.05.4.2 Potential Exposure via Disturbance/Contact with Ground Water

Based on information provided by Tom Morris, there are no current or anticipated plans to change the use of the study area;

i.e., there are no known or anticipated subsurface disturbance activities to take place in the study area. Therefore, there is no potential for exposure via contact with ground waters.

3.05.4.3 Conclusion on Ground Water Pathway

There is no potential for exposure, and therefore no significant risk related to the ground water exposure pathway.

3.05.5 Soil Exposure (Direct Contact) Pathway

One mechanism for exposure related to identified contamination is considered in assessing risks related to the soil exposure pathway:

1. Direct contact.

Subsurface soil contamination was detected at the site at depths ranging from 9 - 16 feet, to a maximum concentration of 13.2 mg/kg.

3.05.5.1 Potential Exposure via Direct Contact with Contaminated Subsurface Soils

There is no current or anticipated disturbance of contaminated subsurface soils (see also discussion in Sections 3.05.02.1 and 3.05.04.3). Thus there is no potential for direct contact with contaminated subsurface soils under current or anticipated future conditions.

In summary, under current and anticipated future conditions, there is no potential for exposure related to direct contact with the contaminated subsurface soils.

3.06 Conclusion

Based on the above assessment, there is no significant risk associated with the TPH-contaminated subsurface soils and ground water contamination in the area of tanks STT61 through STT66 at Tarawa Terrace, MCB Camp Lejeune, North Carolina.

SECTION 4 - REMEDIATION ASSESSMENT

4.01 Remedial Requirements

The Risk Assessment has indicated that there is no risk associated with the contamination found in the subsurface at tanks STT61 - STT66 at Tarawa Terrace. Laboratory results indicate that contamination present at tanks STT61 - STT66 is in a limited area. Three locations, MW4, MW6 and TW, exhibited soil TPH concentrations above the North Carolina action level of 10 mg/kg (13.2 ppm and 12.3 ppm, 12.0 ppm, respectively). Based on the Site Sensitivity Evaluation (SSE), found in "Groundwater Section Guidelines for the Investigation and Remediation of Soils and Groundwater", published by the North Carolina Department. of Environment, Health and Natural Resources, the "Maximum Soils Cleanup Level" for this site is 320 ppm of TPH (Exhibit C). There are no soils present at the site exhibiting TPH concentrations above 320 ppm, therefore, remediation of contaminated soil is not warranted at this time.

Only one ground water pollutant was discovered to exist above regulatory standards. Benzene was present in 11 of the 36 sample locations (H1, H3, H4, H12, H13, H14, H16, MW10, MW14, MW18 and MW20). Concentrations ranged from 0.001 ppm to 0.023 ppm compared to the North Carolina Standard of 0.001 ppm. Due to the extremely low hydraulic gradient (0.001 ft/ft), producing a very slow flow rate (3 ft/yr), it is not expected that ground water will readily provide transportation for benzene migration. While no risk has been established as a result of the benzene presence in the ground water, the contaminant does exist above regulatory standards.

Therefore, it is possible that remediation of the ground water may be necessary. Given the distance from the tanks and the depth of the benzene occurrences, the following remedial technologies have been considered if corrective action is deemed necessary.

4.02 Remedial Alternatives for Ground Water

Aerobic Biodegradation

This process involves stimulating microflora to decompose petroleum hydrocarbons in soils and ground water. This is a naturally occurring process which can be accelerated by the addition of nutrients, oxygen or specialized microbes. There are several factors that dictate the appropriateness of biodegradation. These include, but are not limited to the following: availability of oxygen and nutrients;type of hydrocarbon present and characteristics of the contaminated soils.

To implement in-situ biodegradation, wells and infiltration galleries are used to transport oxygen and nutrients to contaminated soils and ground water. Due to the distances between contaminant occurrence at the site this technology is not recommended for remediation.

Ground Water Extraction and Treatment

This system requires the installation of a treatment facility and a number of recovery wells within the contaminant plume to remediate dissolved hydrocarbons in the ground water. The wells commonly screen the water table and extend several feet in the saturated zone. Ground water that is removed generally contains dissolved petroleum hydrocarbons and may require treatment before being either injected back into the ground or discharged. The advantages of this system include the removal of contaminants from the ground water and the prevention of down gradient migration of the contaminants. This option could be considered as a remedial technology.

Ground Water Containment

Ground water containment is a process by which an area of concern is separated from the surrounding environment thereby minimizing the potential migration of hydrocarbon compounds. The separation may be accomplished by the installation of grout curtains, cut-off walls, and/or slurry walls. Recovery wells would then be installed to remove contaminants. Due to the distance between contaminant occurrence this technology is not recommended for this site

4.03 Recommendations

Concentrations of benzene, toluene, and tetrachloroethene detected in monitoring wells near the tank farm exceed North Carolina State Ground Water Standards. Laboratory results indicated that of these constituents, benzene is the most prevalent. As illustrated on Figure 7, benzene concentrations decrease with distance from the site. Ground water quality, 350 feet down gradient (MW20), meets North Carolina Standards. It is suspected that the natural processes of biodegradation, attenuation and dispersion account for the decrease in concentrations. Additionally, an identifiable source (e.g. free product or TPH laden soils) has not been detected in the ground water system.

Based on the fact that the risk assessment has determined that no risk has been identified as a result of benzene in the ground water, it appears that the most appropriate course of action would be to initiate a ground water sampling and monitoring program. A ground water monitoring and sampling program is suggested to verify the continuing affect of attenuation, dispersion and natural degradation of benzene and other parameters within the ground water system. A semi-annual frequency for a minimum duration of five years is recommended due to low hydraulic gradients and subsequent slow ground water flow velocities at the site.

If the results of this ground water sampling and monitoring program indicate that the aforementioned processes are not as effective as anticipated, or if site conditions change over the course of time, ground water remediation may be warranted. In that event, ground water extraction and treatment would appear to be the most appropriate technology for this site.

Tables

Table 1
Groundwater Elevations
Tanks STT61-66, Tarawa Terrace, MCB Camp Lejeune
December 17 1992

Well #	Top of Casing Elevation (relative)	Depth to Water (in feet)	Groundwater Elevation (relative)
MW1	100.88	5.75	95.13
MW2	100.81	6.36	94.45
MW3	101.09	6.14	94.95
MW4	100.99	6.62	94.37
MW5	101.53	6.24	95.29
MW6	101.61	7.06	94.55
MW7	101.74	6.56	95.18
MW8	101.70	7.22	94.48
MW9	101.08	5.66	95.42
MW10	100.98	6.62	94.36
MW11	101.63	6.14	95.49
MW12	101.54	7.22	94.32
MW13	100.20	4.96	95.24
MW14	100.18	5.93	94.25
MW15	100.29	5.30	94.99
MW16	99.65	5.45	94.20
MW17	98.70	3.38	95.32
MW18	99.74	5.53	94.21
MW19	100.36	5.91	94.45
MW20	100.47	6.36	94.11

TABLE 2

IN-SITU PERMEABILITY SUMMARY
TANKS STT61 - 66
Tarawa Terrace, MCB Camp Lejeune, North Carolina

WELL #	HYDRAULIC CONDUCTIVITY	
	FT/SEC	GPD/FT^2
MW1	1.9×10^{-5}	12.4
MW2	1.4×10^{-4}	88.9
MW3	1.4×10^{-5}	8.9
MW4	9.2×10^{-5}	59.8
MW5	4.7×10^{-5}	30.4
MW6	5.2×10^{-5}	33.7
MW7	3.9×10^{-5}	25.1
MW8	4.3×10^{-5}	27.6
MW9	1.1×10^{-5}	6.8
MW10	5.0×10^{-5}	32.1
MW11	3.0×10^{-5}	19.6
MW12	4.4×10^{-5}	28.3
MW13	1.5×10^{-5}	9.7
MW14	6.2×10^{-5}	39.9
MW15	1.3×10^{-5}	8.5
MW16	7.4×10^{-5}	47.7
MW17	1.1×10^{-5}	7.2
MW18	1.1×10^{-4}	71.8
MW19	2.2×10^{-5}	14.3
MW20	1.1×10^{-4}	69.5
Geometric Mean	3.7×10^{-5}	24.1

TABLE 3
SPECIFIC CONDUCTIVITY AND pH MEASUREMENTS
Tanks STT61 - 66
Tarawa Terrace, MCB Camp Lejeune, North Carolina

WELL #	pH (STANDARD UNITS)	SPECIFIC CONDUCTIVITY (uMHOS/CM)
MW1	7.50	200
MW2	7.00	700
MW3	8.00	200
MW4	7.50	100
MW5	7.50	100
MW6	7.50	100
MW7	7.50	100
MW8	8.50	300
MW9	7.50	100
MW10	7.00	300
MW11	6.50	100
MW12	7.50	100
MW13	*	100
MW14	*	400
MW15	6.65	135
MW16	6.75	122
MW17	5.27	122
MW18	6.04	111
MW19	5.68	142
MW20	6.20	98

* = not measured

TABLE 4
Hydropunch Analytical Results, in ppb
Tanks STT61-66
Tarawa Terrace, MCB Camp Lejeune, N.C.

COMPOUND	H1	H3	H4	H12	H13	H14	H16
Benzene	22	7	7	10	42	2	2
11Dichloroethane	2			2			
Ethylbenzene	17		2				
Toluene	190		3	100	8		
Trichlorofluoromethane	1			55	1		
Total Xylene	62	3	12	170	12		
111Trichloroethane				9			

NOTE: Hydropunch locations not on the table did not exhibit compounds above laboratory detection limits.

Compounds not represented on the table were not present in concentrations above laboratory detection limits.

TABLE 5
Monitoring Well Analytical Results, in PPB
STT61-66
Tarawa Terrace, MCB Camp Lejeune, N.C.

COMPOUND	MW10	MW14	MW15	MW16	MW18	MW20
Benzene		23			7	1
Ethylbenzene	4		10			
Toluene	3		9			
Trichlorofluoromethane	5					
Total Xylene	17		19			
Chloroform				2		

NOTE: Monitoring wells not identified on the table did not contain compounds above laboratory detection limits

Compounds not represented on the table were not demonstrated in the groundwater above laboratory detection limits.

TABLE 6
SOIL ANALYTICAL RESULTS in MG/KG
STT61-66
Tarawa Terrace, MCB Camp Lejeune, N.C.

Sample Location	Sample Depth in feet below grade	TPH in mg/kg	Barium in mg/l
MW2	9-11	9.76	
	14-16	9.58	0.933
MW4	9-11	13.2	
	14-16	9.69	
MW6	9-11	6.97	
	14-16	12.3	0.822
MW8	9-11		2.16
MW14	0-2	2.77	
	4-6	1.16	
MW20	10-12		0.641
TW	0-2	12	
	4-6	ND	
B1	0-2	1.85	
	4-6	ND	
B3	2-4	1.78	
	6-8	1.37	
B4	0-2	1.77	
	4-6	3.91	

NOTE: Drill locations not on the table did not exhibit constituent concentrations above laboratory detection limits.

Analytical parameters not represented on the table were not demonstrated above laboratory detection limits.

Tarawa Terrace
Marine Corps Base
Camp LeJeune, North Carolina

SUMMARY OF RISK ASSESSMENT

EXPOSURE PATHWAY	RELEASE/TRANSPORT MECHANISM	IS PATHWAY COMPLETE?	RISK?	COMMENTS
AIR	fugitive dusts	no	none	subsurface (9'-16') contamination; soil and vegetative cover; minimal use
	volatile emissions to ambient air	yes	negligible	based on concentration, soil interactions, soil & vegetative cover, dilution/dispersion by ambient air
	volatile emissions to subsurface structures	no	none	no subsurface structures; therefore no receptor points
SURFACE WATER	contact with surface contamination	no	none	no surface water; no identified surface contamination
	ground water discharge to surface water	yes	negligible	due to distance, ground water flow rate, degradation, dilution, soil interactions
GROUND WATER	ground water use	no	none	no receptor points; shallow ground water not used/drawn for drinking or other purposes.
	exposure during subsurface disturbance	no	none	no plans for disturbance
SOIL	direct contact	no	none	contaminated soils are subsurface; soil and vegetative cover exists; no plans for disturbance

Figures

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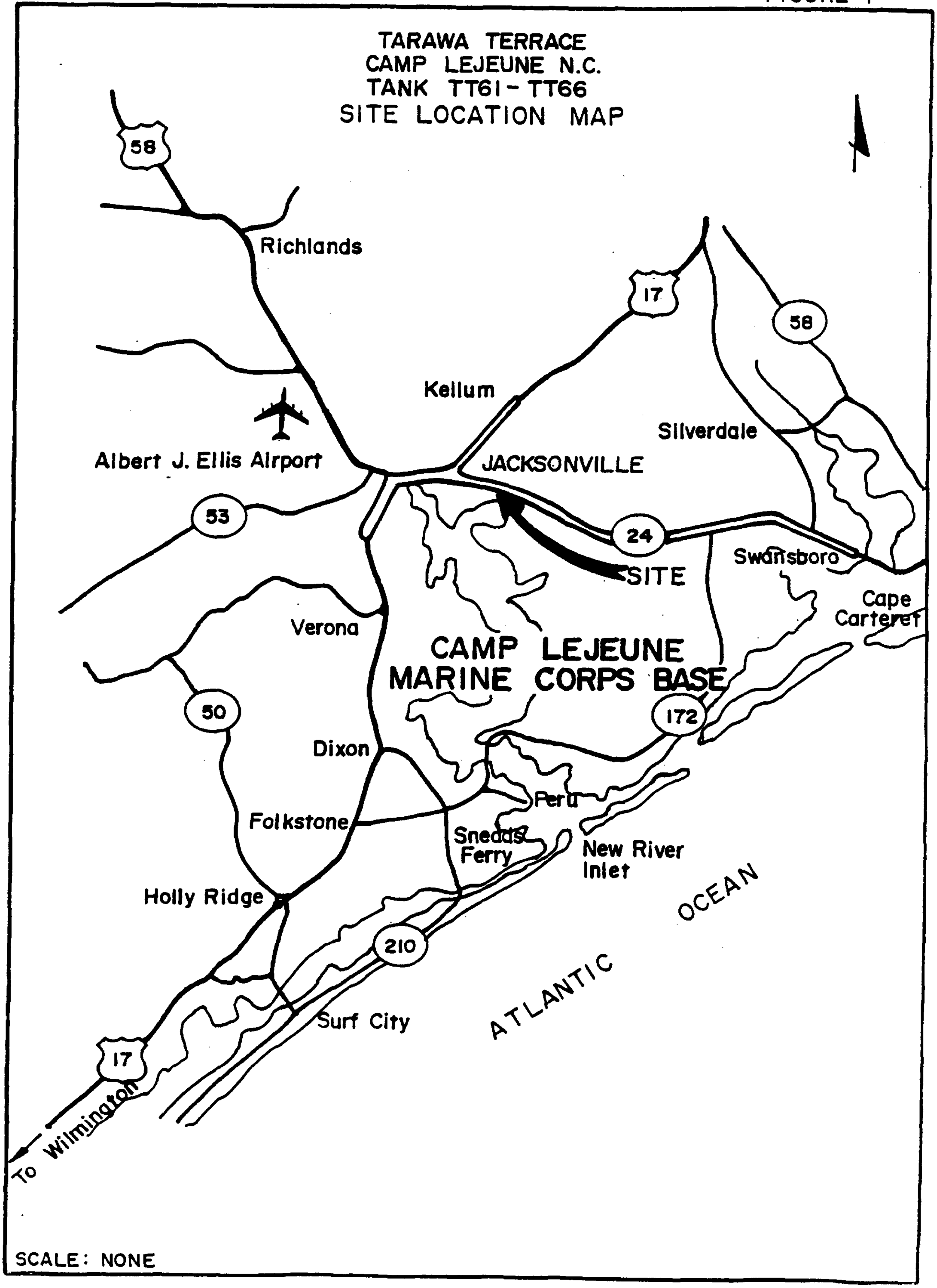
FIGURE 1



TARAWA TERRACE
CAMP LEJEUNE N.C.
TANK TT61 - TT66
SITE LOCATION MAP

SCALE: NONE

063397

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FIGURE 2

TARAWA TERRACE
CAMP LEJEUNE, NORTH CAROLINA
DRILLING LOCATIONS

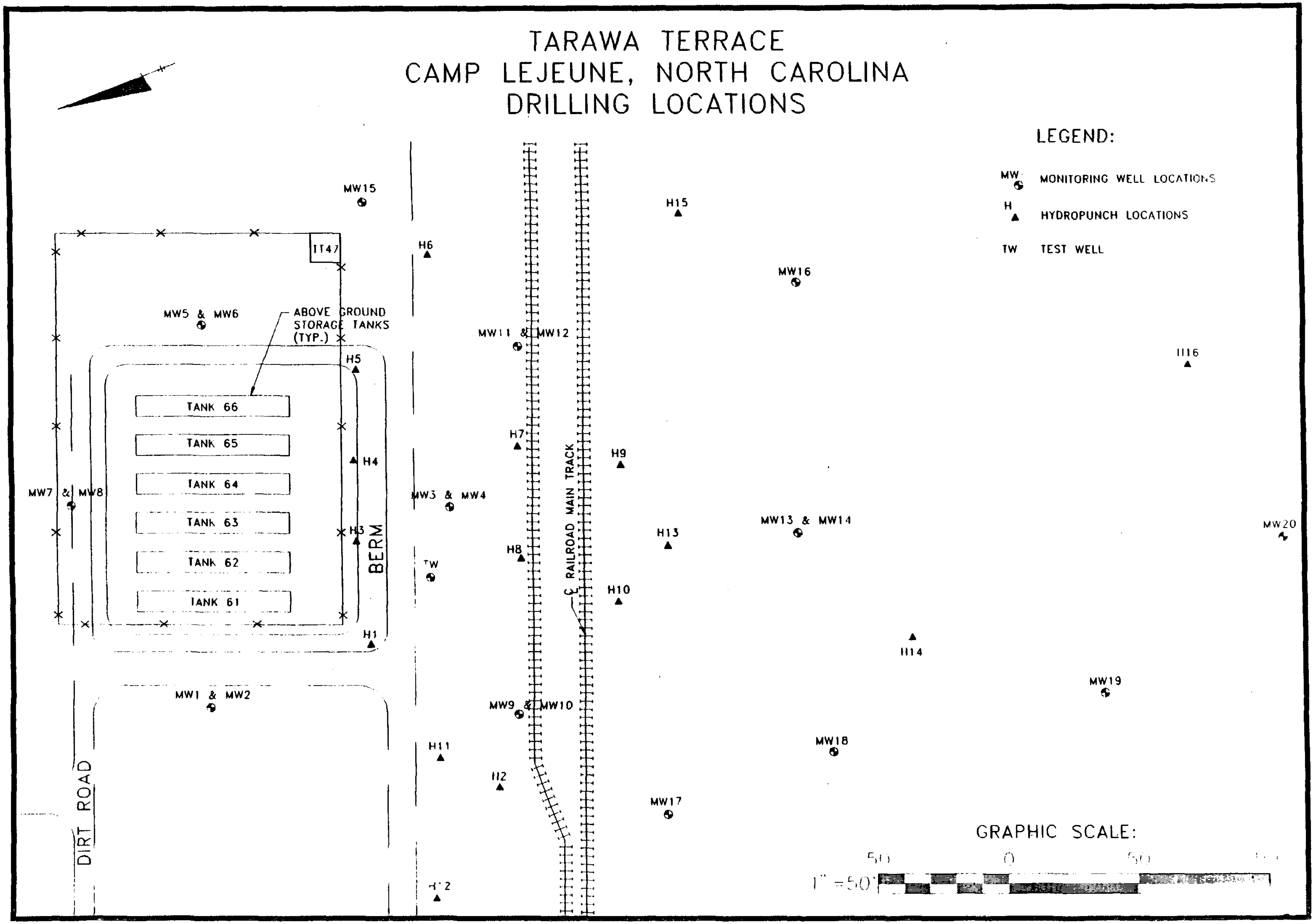

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FIGURE 3

TARAWA TERRACE
CAMP LEJEUNE, NORTH CAROLINA
GROUNDWATER CONTOUR MAP
DEEP WELLS-DECEMBER 1992

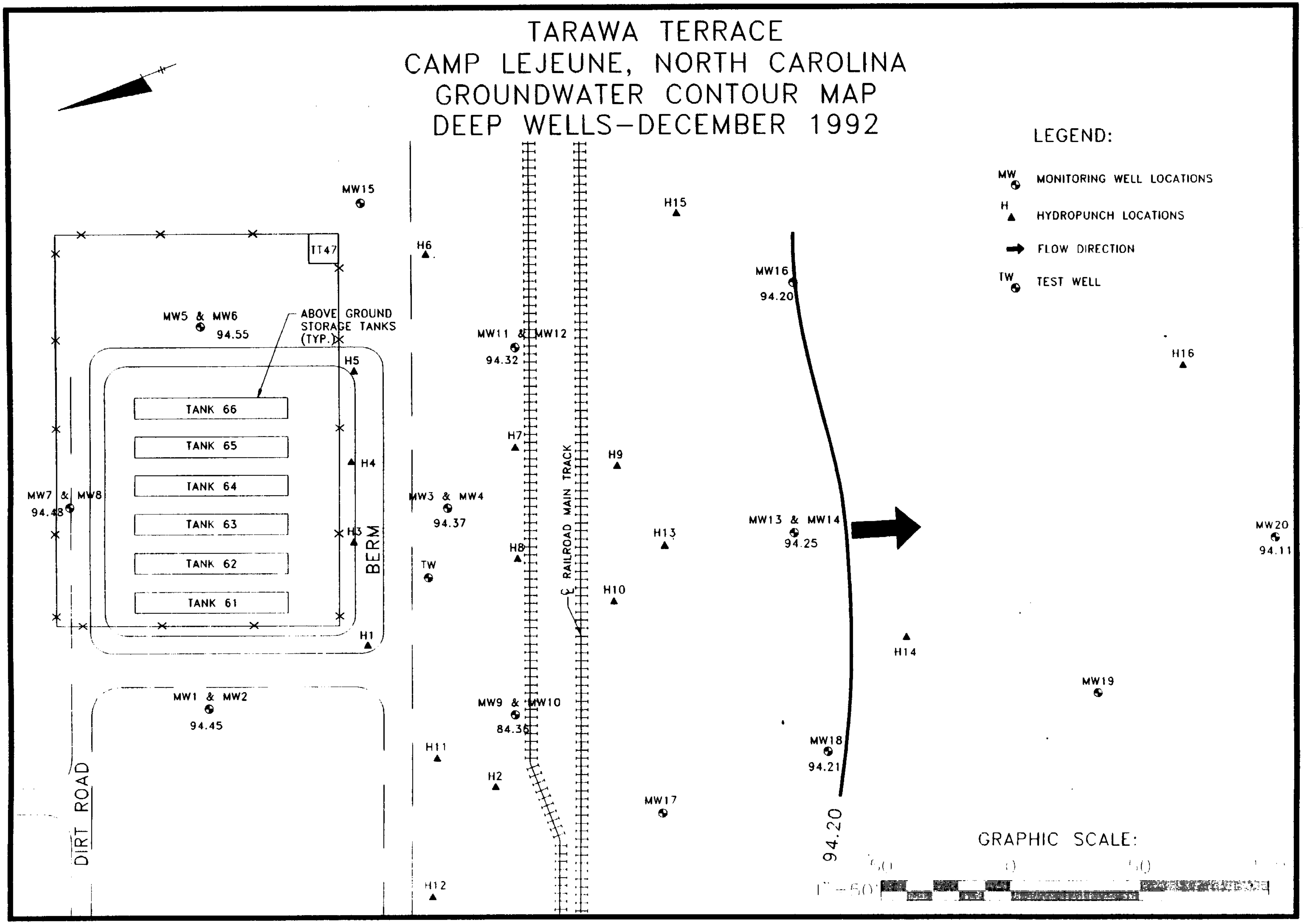

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FIGURE 4

TARAWA TERRACE
CAMP LEJEUNE, NORTH CAROLINA
GROUNDWATER CONTOUR MAP
DEEP WELLS–DECEMBER 1992

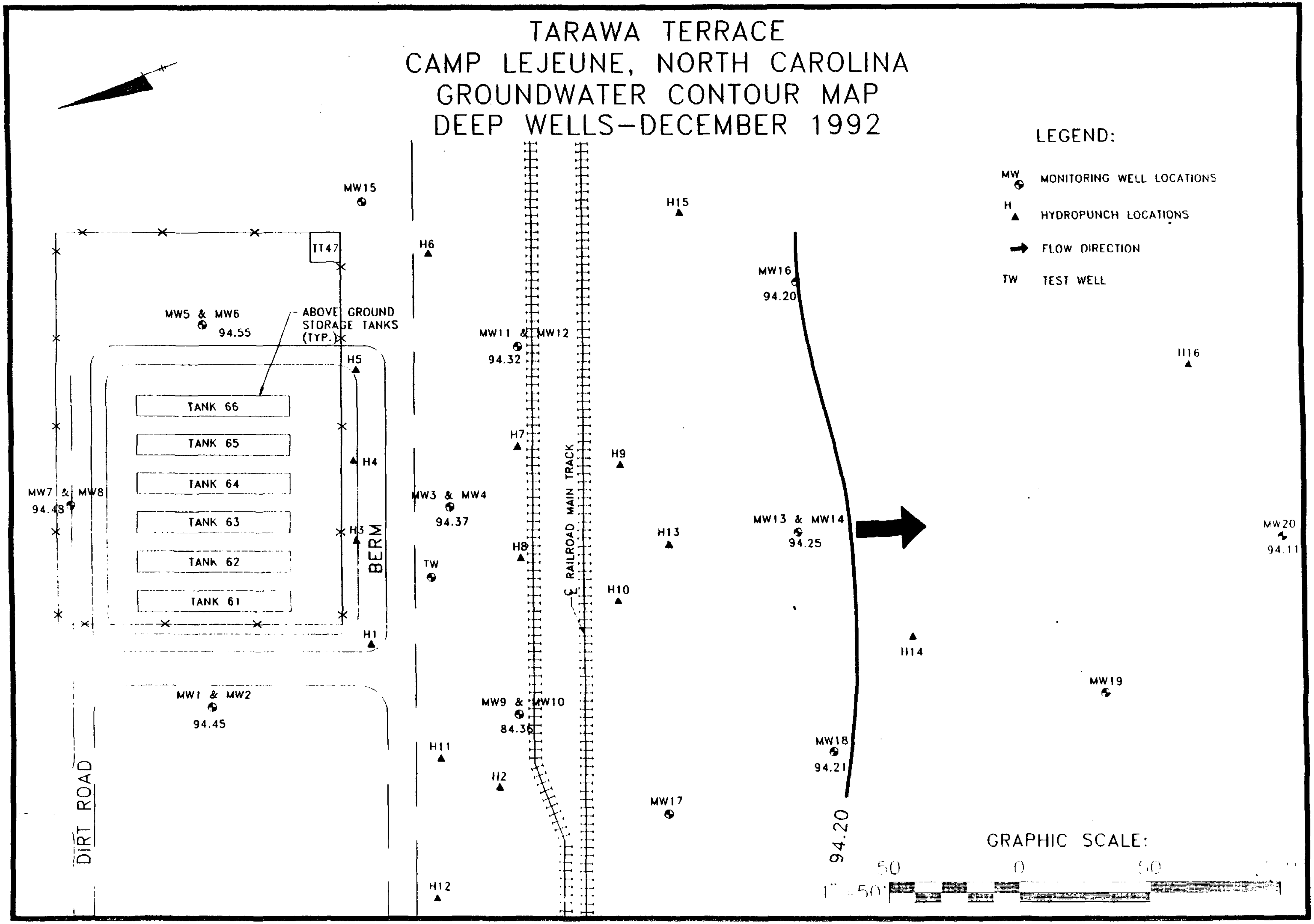

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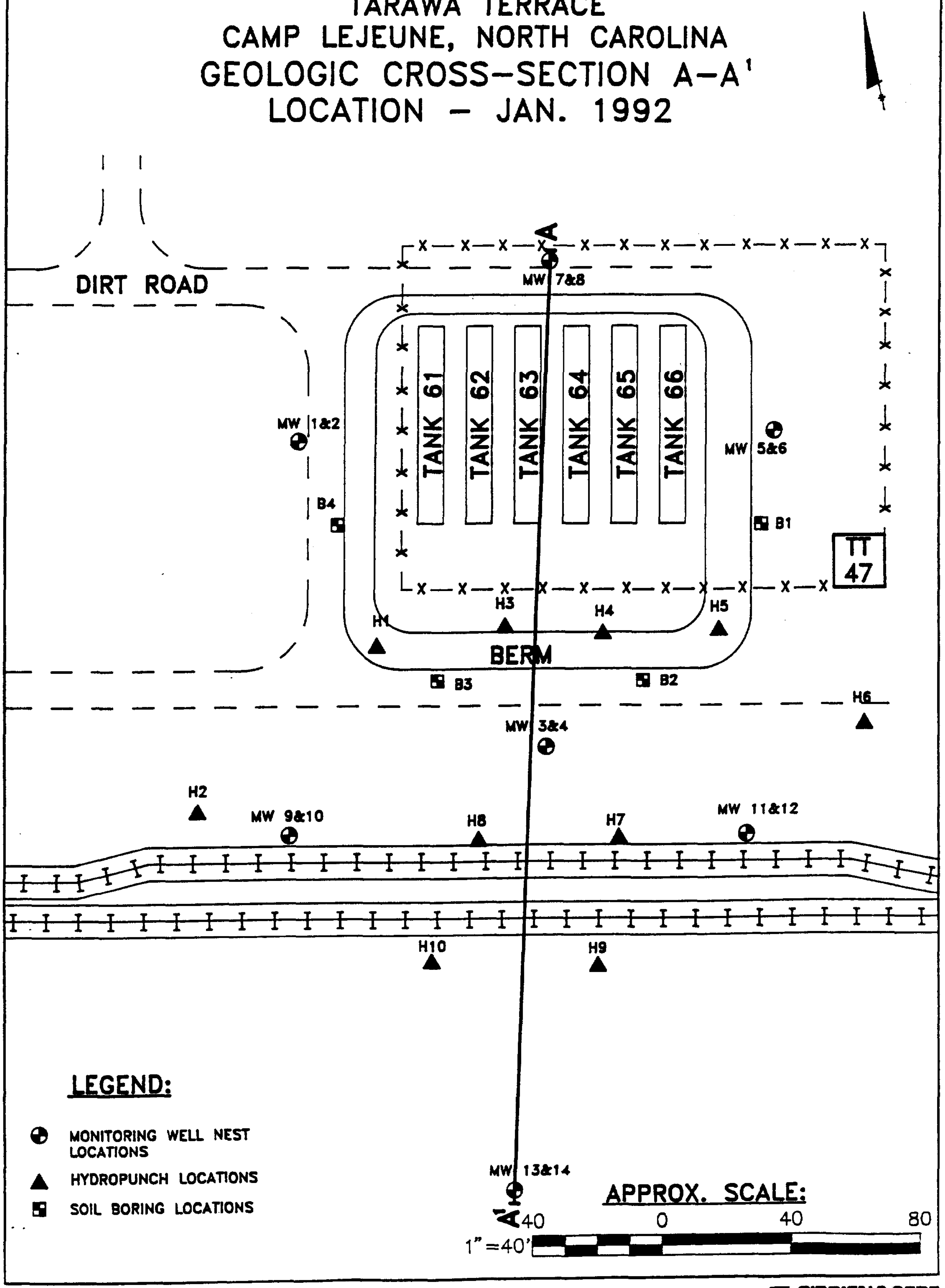
FIGURE 5

TARAWA TERRACE
CAMP LEJEUNE, NORTH CAROLINA
GEOLOGIC CROSS-SECTION A-A'
LOCATION - JAN. 1992



TARAWA TERRACE
CAMP LEJEUNE, NORTH CAROLINA
GEOLOGIC CROSS-SECTION A-A'
LOCATION - JAN. 1992

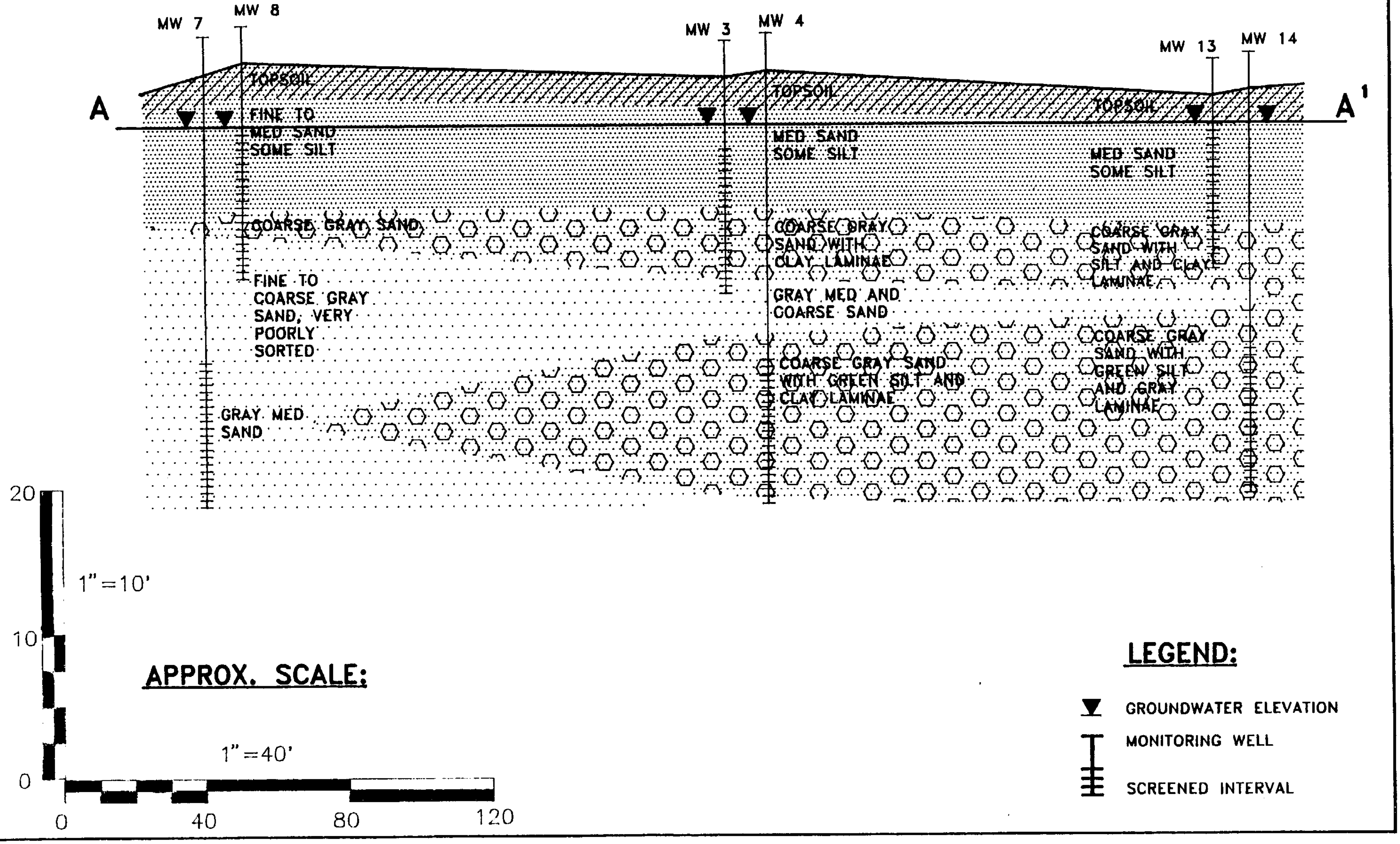


FIGURE 6

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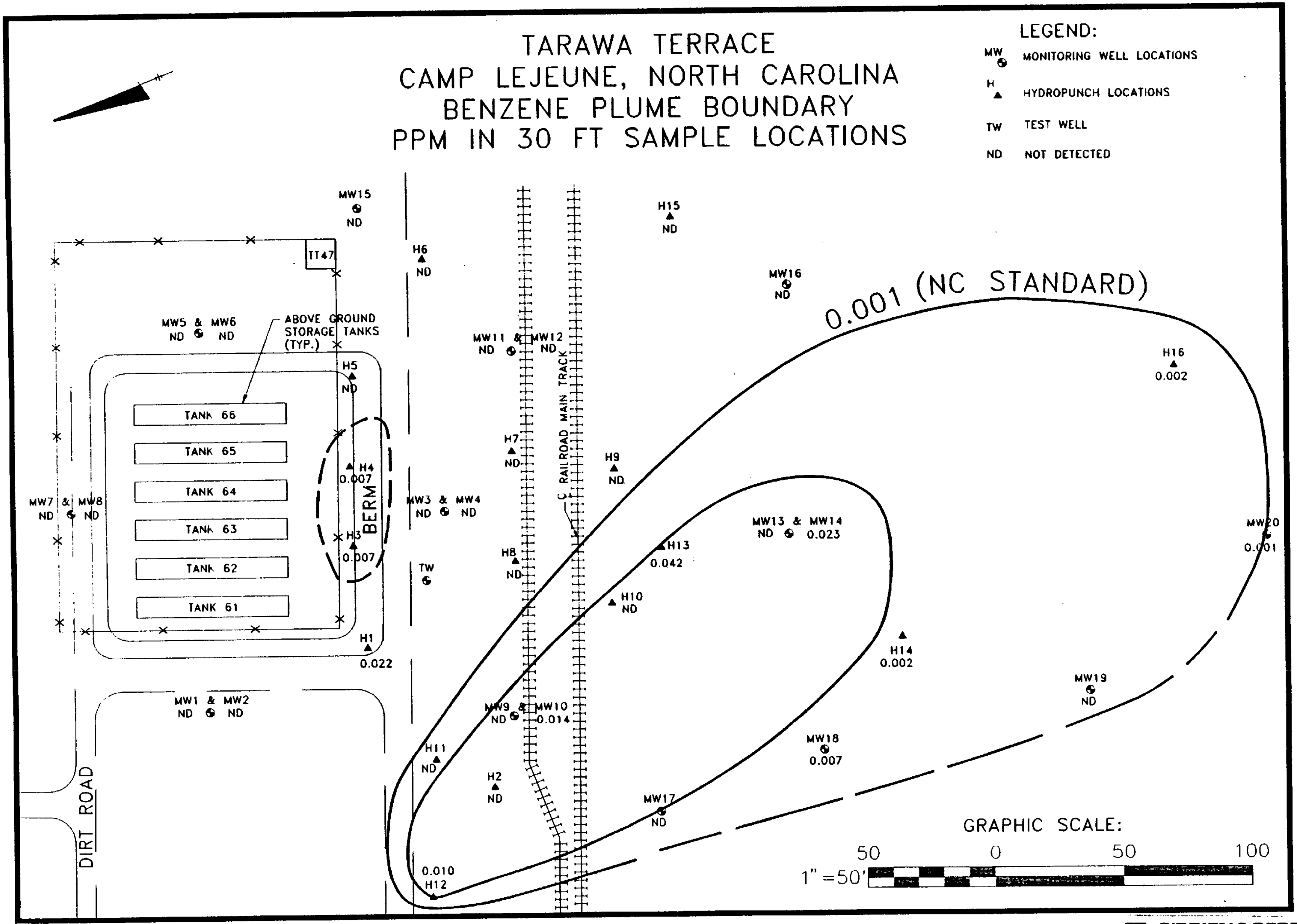
FIGURE 7



TARAWA TERRACE
CAMP LEJEUNE, NORTH CAROLINA
BENZENE PLUME BOUNDARY
PPM IN 30 FT SAMPLE LOCATIONS

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Appendices

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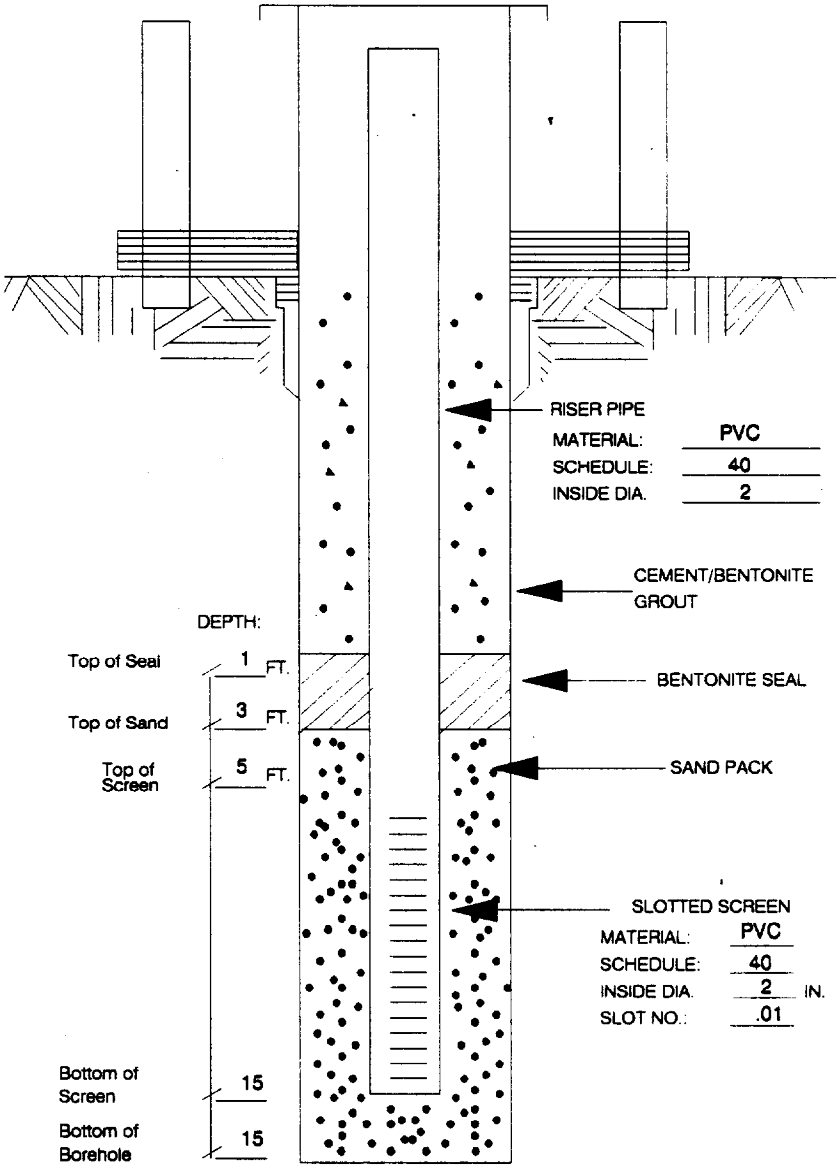
APPENDIX A

BORE LOGS AND WELL CONSTRUCTION DIAGRAMS



TYPICAL OVERBURDEN MONITORING WELL

N.T.S.

Tarawa Terrace

MW-1

12/12/91

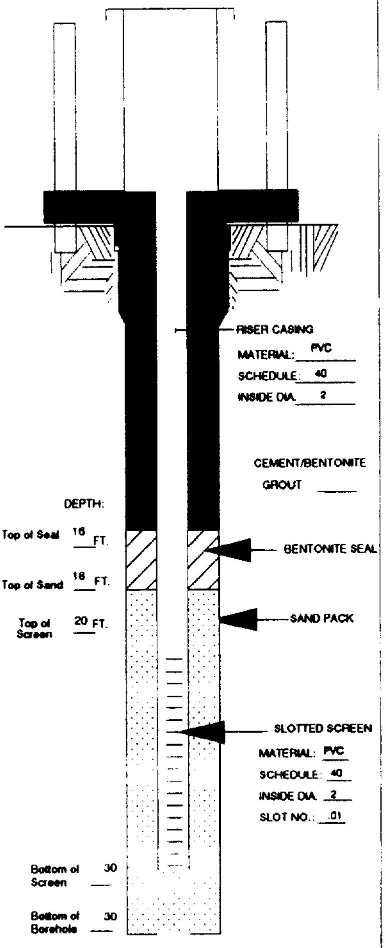
O'Brien & Gere Engineers, Inc.	Boring Log/Protective Casing Well	Report of Boring No. MW-2 Sheet 1 of 1
Location: TT61-66 Client: Navy Drilling Type: Hollow Stem	SAMPLER Type: 2" O.D. Split Spoon Hammer: 140# Fall: 30"	Ground Water Depth File No.

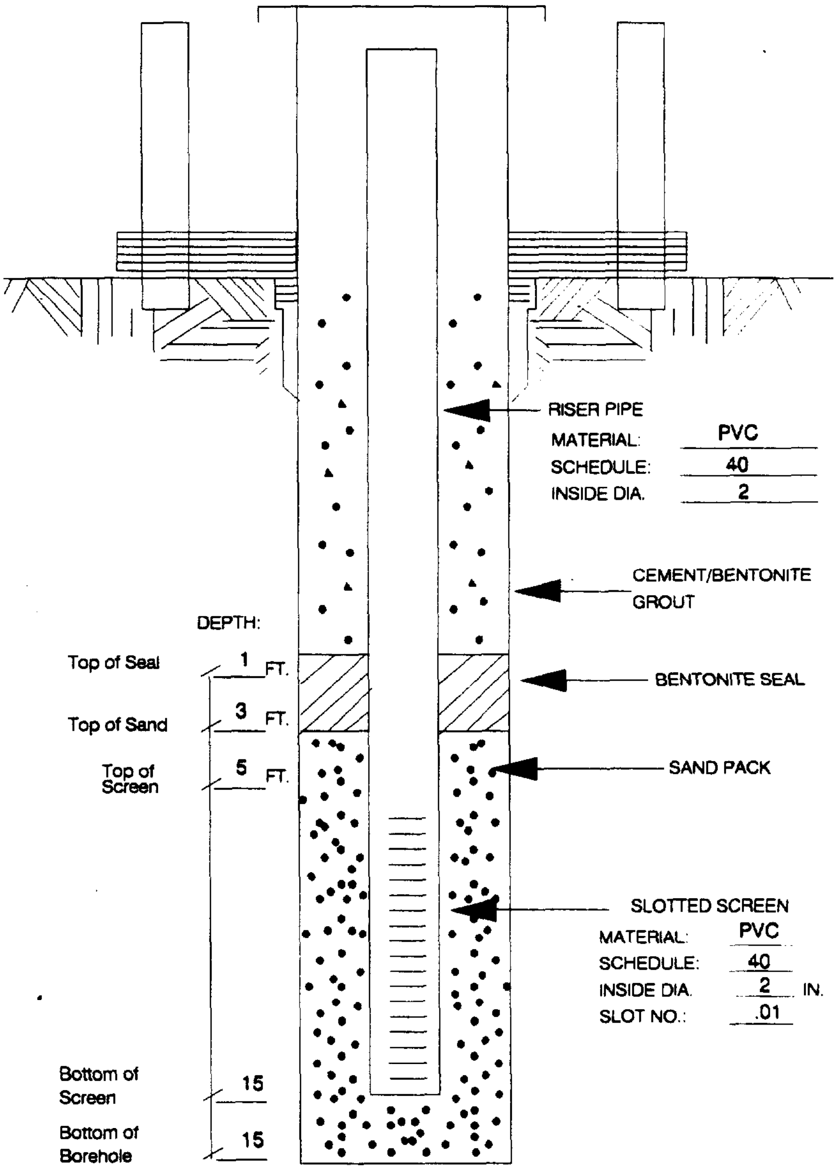
Boring Co.: ATEC
Foreman: Tim Williams
OBG Geologist T. Bickerstaff

Dates:
Started: 12/13/91 Ended: 12/13/91

Depth	Sample Depth	Sample Blows /6"	Sample Penetr/ Recovery	Sample PID Value	Sample Description
0	0-2	7/7/6/7	24/10		Black topsoil with sand. Roots.
2	2-4	4/3/5/4	24/24		Pinkish-gray silt with clay and sand, very moist.
4	4-6	3/3/3/4	24/24		Pinkish-gray silt with clay and sand. Very moist. Tip is wet.
9	9-11	3/3/3/4	24/24		Interbedded gray clay with course gray sands.
14	14-16	6/6/7/9	24/		Coarse gray sand with clay.
19	19-21	2/1/2/3	24/20		Greenish-gray, coarse sand with clay, fading to coarse, gray sand with clay, orange.
24	24-26	7/8/9/11	24/24		Gray, medium sand with streaks of greenish-gray.

Monitoring Well Specifications




RISER PIPE
MATERIAL: PVC
SCHEDULE: 40
INSIDE DIA. 2

CEMENT/BENTONITE GROUT

BENTONITE SEAL

SAND PACK

SLOTTED SCREEN
MATERIAL: PVC
SCHEDULE: 40
INSIDE DIA. 2 IN.
SLOT NO.: .01

DEPTH:
Top of Seal 1 FT.
Top of Sand 3 FT.
Top of Screen 5 FT.
Bottom of Screen 15
Bottom of Borehole 15

TYPICAL OVERBURDEN MONITORING WELL
N.T.S.

Tarawa Terrace
MW-3
12/12/91

O'Brien & Gere Engineers, Inc.

Boring Log/Protective Casing Well

Report of Boring No. MW-4
Sheet 1 of 1

Location: TT61-66
Client: Navy
Drilling Type: Hollow Stem

SAMPLER
Type: 2" O.D. Split Spoon
Hammer: 140# Fall: 30"

Ground Water Depth

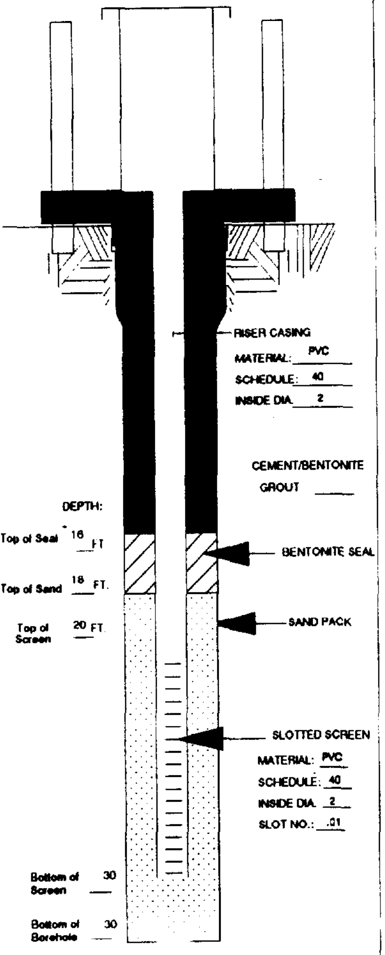
File No.

Boring Co.: ATEC
Foreman: Tom Sweeting
OBG Geologist T. Bickerstaff

Dates:
Started: 12/13/91 Ended: 12/13/91

Depth	Sample Depth	Blows /6"	Penetr/ Recovery	PID Value	Sample Description
0	0-2	2/2/2/4	24/10		Black topsoil.
2	2-4	4/5/5/7	24/10		Light brown, medium sand.
4	4-6	2/2/2/4	24/24		Black, tar-like at top, medium to fine sand with clay and silt. Moist.
9	9-11	2/3/4/5	24/24		Interbedded clay and coarse sand laminae with silt, gray. Wet.
14	14-16	2/3/3/5	24/24		Gray, coarse and medium sand.
19	19-21	1/1/4/6	24/24		Coarse, gray sand. Some silt and clay. A few greenish streaks.
24	24-26	3/6/8/9	24/24		Gray, medium sand. 2" laminae of greenish-gray silt in middle of spoon.
29	29-31		24/		Running sands.

Monitoring Well Specifications

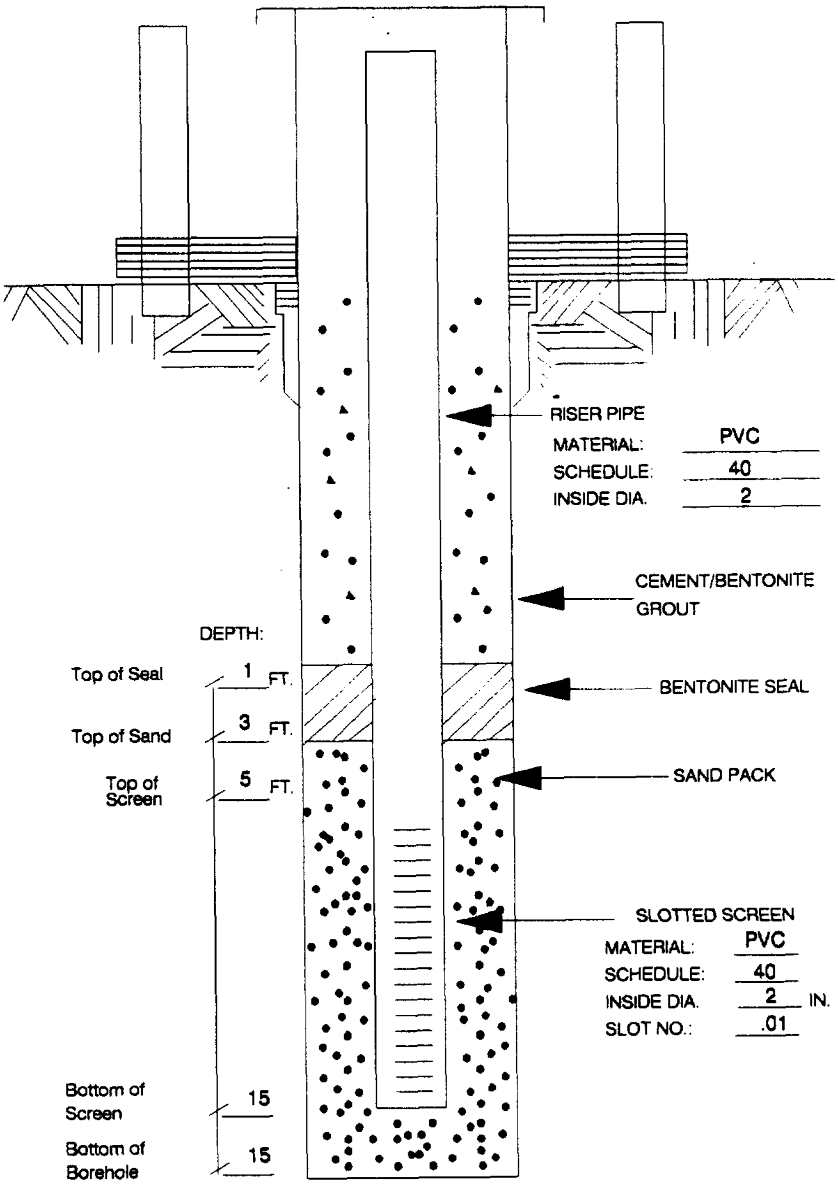


RISER CASING
MATERIAL: PVC
SCHEDULE: 40
INSIDE DIA. 2

CEMENT/BENTONITE GROUT

DEPTH:
Top of Seal 16 FT
Top of Sand 18 FT.
Top of Screen 20 FT.
Bottom of Screen 30
Bottom of Borehole 30

SLOTTED SCREEN
MATERIAL: PVC
SCHEDULE: 40
INSIDE DIA. 2
SLOT NO.: .01



TYPICAL OVERBURDEN MONITORING WELL
N.T.S.

Tarawa Terrace
MW-5
12/12/91

O'Brien & Gere Engineers, Inc.

Boring Log/Protective Casing Well

Report of Boring No. MW-6
Sheet 1 of 1

Location: TT61-66
Client: Navy
Drilling Type: Hollow Stem

SAMPLER
Type: 2" O.D. Split Spoon
Hammer: 140#
Fall: 30"

Ground Water Depth

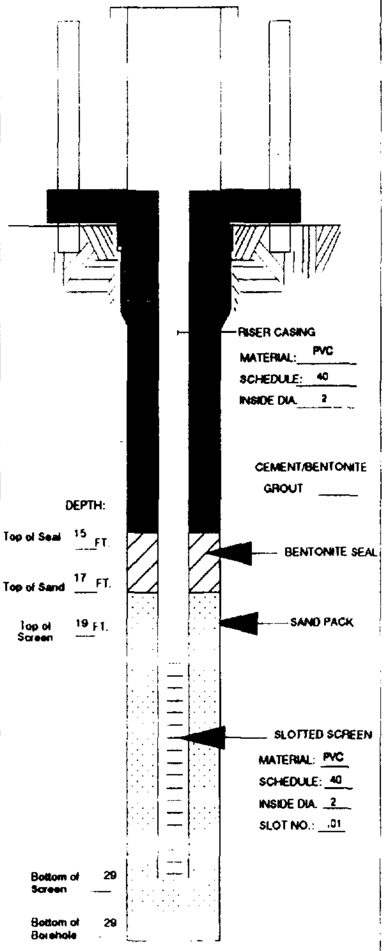
File No.

Boring Co.: ATEC
Foreman: Tom Sweeting
OBG Geologist T. Bickerstaff

Dates:
Started: 12/13/91
Ended: 12/13/91

Depth	Sample				Sample Description
	Depth	Blows /6"	Penetr/ Recovery	PID Value	
0	0-2	5/7/11/12	24/20		Dark brown topsoil, heavy clay content.
2	2-4	10/6/6/7	24/20		Dark brown, medium sand with clay mephatic.
4	4-6	1/1/1/2	24/24		Moist, black clay with sand mephatic.
9	9-11	3/5/4/5	24/24		Top 1/2 black clay. Bottom 1/2 wet, greenish-gray, coarse sand with clay.
14	14-16	5/2/3/4	24/21		Gray, coarse sand with clay. Silt at top of sppon mephatic.
19	19-21	9/9/9/11	24/24		MEdium and coarse gray sand.
24	24-26	WOH	24/		Light brown, coarse sand. Running sands.
29	29-31				Running sands.

Monitoring Well Specifications



RISER CASING
MATERIAL: PVC
SCHEDULE: 40
INSIDE DIA. 2

CEMENT/BENTONITE GROUT ____

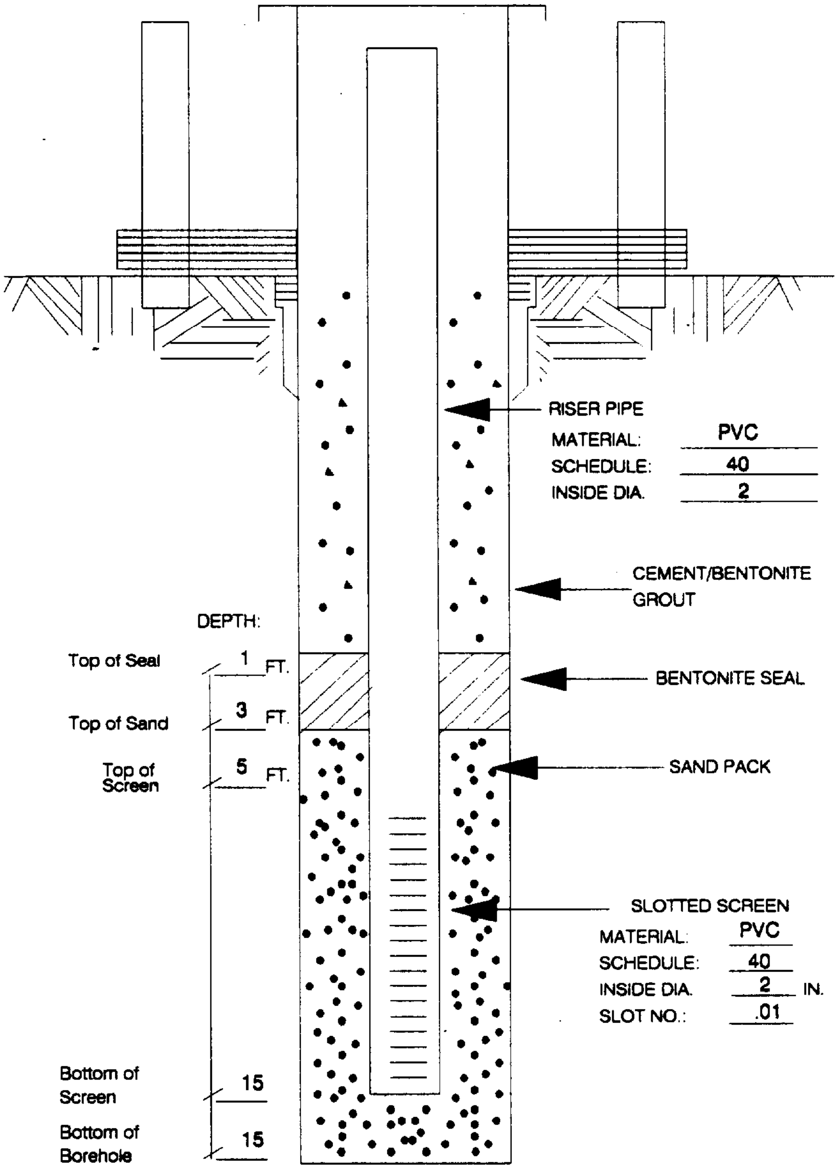
DEPTH:
Top of Seal 15 FT.
Top of Sand 17 FT.
Top of Screen 19 FT.

BENTONITE SEAL

SAND PACK

SLOTTED SCREEN
MATERIAL: PVC
SCHEDULE: 40
INSIDE DIA. 2
SLOT NO.: .01

Bottom of Screen 29
Bottom of Borehole 29



RISER PIPE
MATERIAL: PVC
SCHEDULE: 40
INSIDE DIA. 2

SLOTTED SCREEN
MATERIAL: PVC
SCHEDULE: 40
INSIDE DIA. 2 IN.
SLOT NO.: .01

DEPTH:
Top of Seal 1 FT.
Top of Sand 3 FT.
Top of Screen 5 FT.
Bottom of Screen 15
Bottom of Borehole 15

TYPICAL OVERBURDEN MONITORING WELL
N.T.S.

Tarawa Terrace
MW-7
1/7/92

O'Brien & Gere
Engineers, Inc.

Boring Log/Protective Casing Well

Report of Boring No. MW-8
Sheet 1 of 1

Location: TT61-66
Client: Navy
Drilling Type: Hollow Stem

SAMPLER
Type: 2" O.D. Split Spoon
Hammer: 140# Fall: 30"

Ground Water Depth

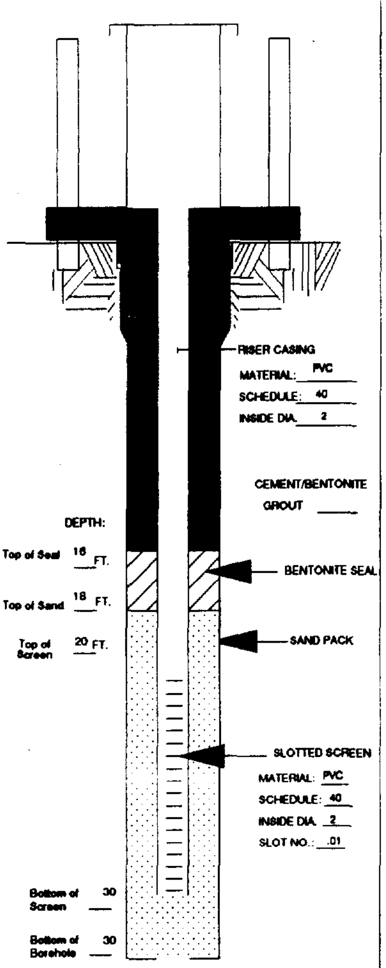
File No.

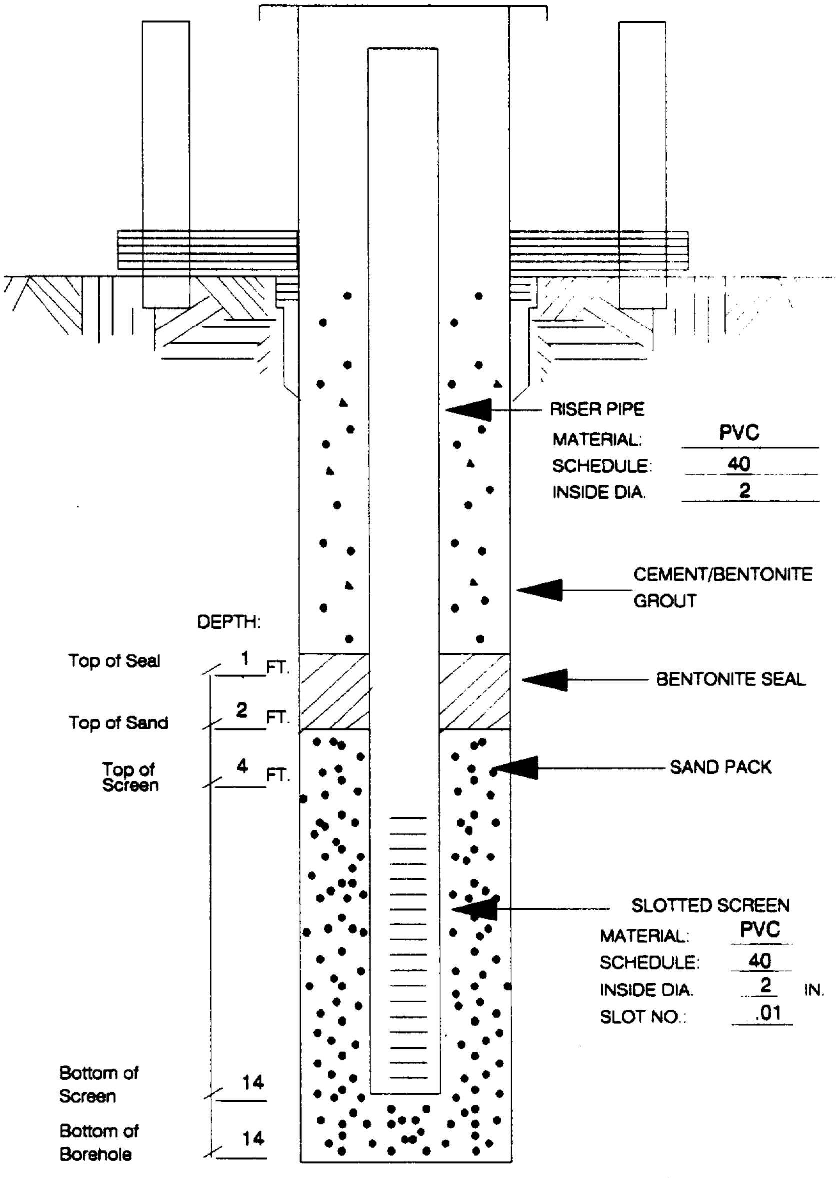
Boring Co.: ATEC
Foreman: Gary Copeland
OBG Geologist T. Bickerstaff

Dates:
Started: 1/8/92 Ended: 1/8/92

Depth	Sample				Sample Description
	Depth	Blows /6"	Penetr/ Recovery	PID Value	
2	2-4	6/5/9/3	24/20	.2	Medium brown sand mottled with black, medium sand.
4	4-6	4/1/1/1	24/24	0	Gray clay with silt and fine sand. Moist.
6	6-8	4/3/2/2	24/24	0	Gray, fine sand with clay. Moist.
9	9-11	3/3/4/5	24/24	0	Saturated, greenish-gray, medium sand with clay. 4" bed of coarse, gray sand toward bottom.
14	14-16	3/3/3/2	24/24	0	Fine, gray sand. Some silt toward top of spoon.
19	19-21	1/1/1/1	24/24	0	Gray, very poorly sorted saney-clay to coarse sand.
24	24-26	1/1/2/2	24/24	0	Gray, medium sand. .
29	29-31	2/6/7/9	24/24	0	Gray, medium sand.

Monitoring Well Specifications





TYPICAL OVERBURDEN MONITORING WELL
N.T.S.

Tarawa Terrace
MW-9
1/8/92

O'Brien & Gere Engineers, Inc.

Boring Log/Protective Casing Well

Report of Boring No. MW-10
Sheet 1 of 1

Location: TT61-66
Client: Navy
Drilling Type: Hollow Stem

SAMPLER
Type: 2" O.D. Split Spoon
Hammer: 140# Fall: 30"

Ground Water Depth

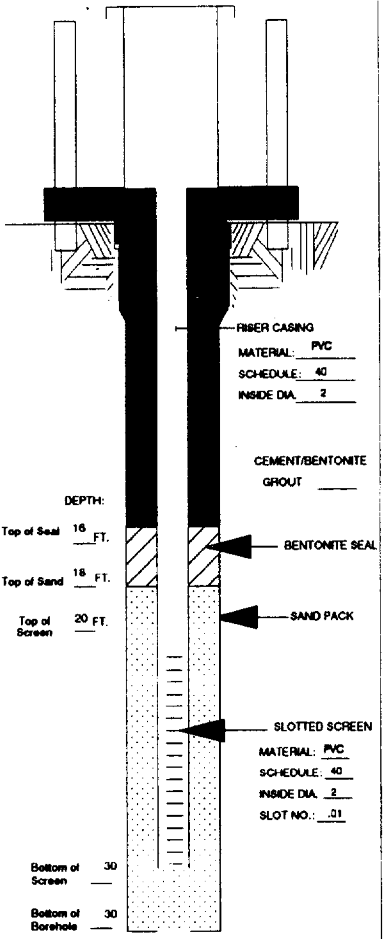
File No.

Boring Co.: ATEC
Foreman: Gary Copeland
OBG Geologist T. Bickerstaff

Dates:
Started: 1/8/92 Ended: 1/9/92

Depth	Sample Depth	Sample Blows /6"	Sample Penetr/ Recovery	Sample PID Value	Sample Description
0	0-2	3/6/7/9	24/10	0	Orange-red sand on top of black organic, medium sand.
2	2-4	6/8/9/13	24/24	0	Medium gray and light brown sand.
4	4-6	2/4/5/4	24/20	0	Gray, medium sand with clay. Wet.
9	9-11	3/1/2/1	24/10	0	Gray clay with coarse to fine sand.
14	14-16	2/2/2/2	24/24	4	Poorly sorted, medium gray sand with heavies.
19	19-21	5/8/6/9	24/24	0	Greenish-gray, medium sand. Odor.
24	24-26	6/9/10/6	24/24	.1	Gray, corase sand. gray clay stringers. Odor.
29	29-31				Running sands.

Monitoring Well Specifications



RISER CASING
MATERIAL: PVC
SCHEDULE: 40
INSIDE DIA. 2

CEMENT/BENTONITE GROUT ____

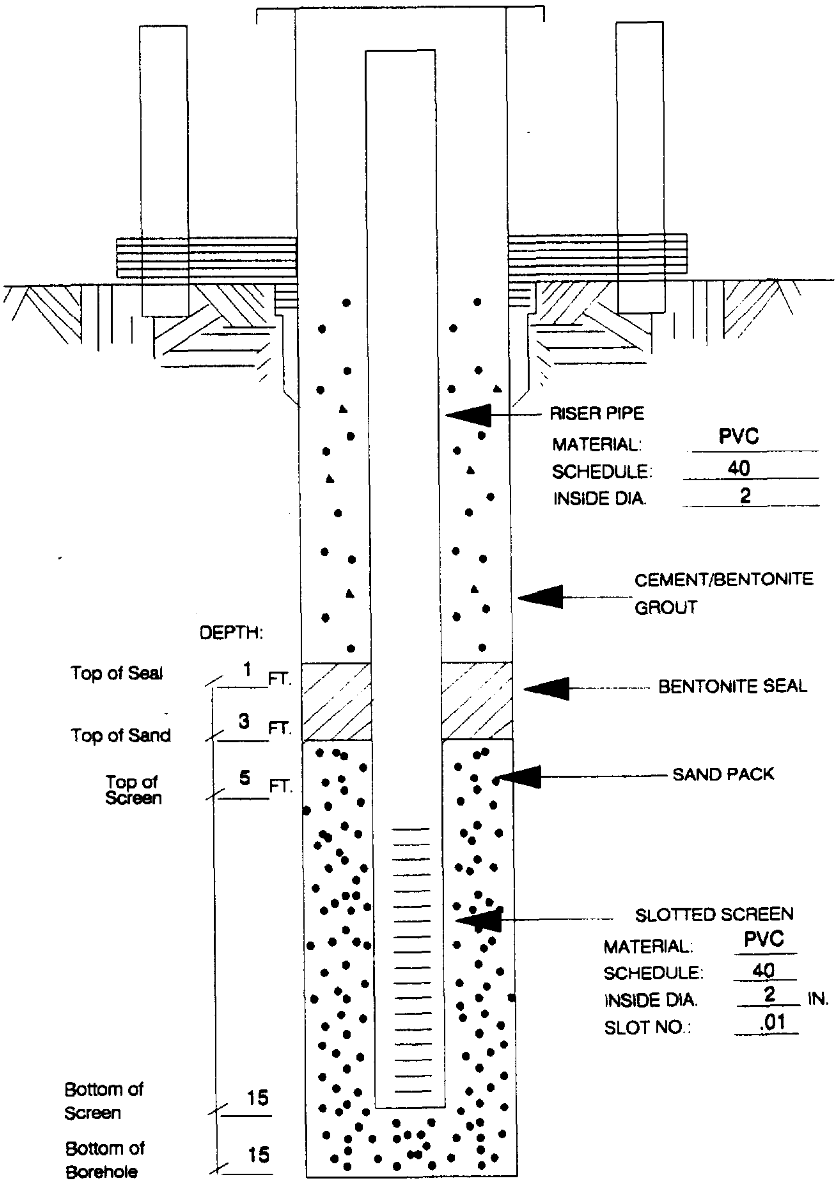
DEPTH:
Top of Seal 16 FT.
Top of Sand 18 FT.
Top of Screen 20 FT.

BENTONITE SEAL

SAND PACK

SLOTTED SCREEN
MATERIAL: PVC
SCHEDULE: 40
INSIDE DIA. 2
SLOT NO.: .01

Bottom of Screen 30
Bottom of Borehole 30



RISER PIPE
MATERIAL: PVC
SCHEDULE: 40
INSIDE DIA. 2

SLOTTED SCREEN
MATERIAL: PVC
SCHEDULE: 40
INSIDE DIA. 2 IN.
SLOT NO.: .01

DEPTH:
Top of Seal 1 FT.
Top of Sand 3 FT.
Top of Screen 5 FT.
Bottom of Screen 15
Bottom of Borehole 15

TYPICAL OVERBURDEN MONITORING WELL
N.T.S.

Tarawa Terrace
MW-11
1/8/92

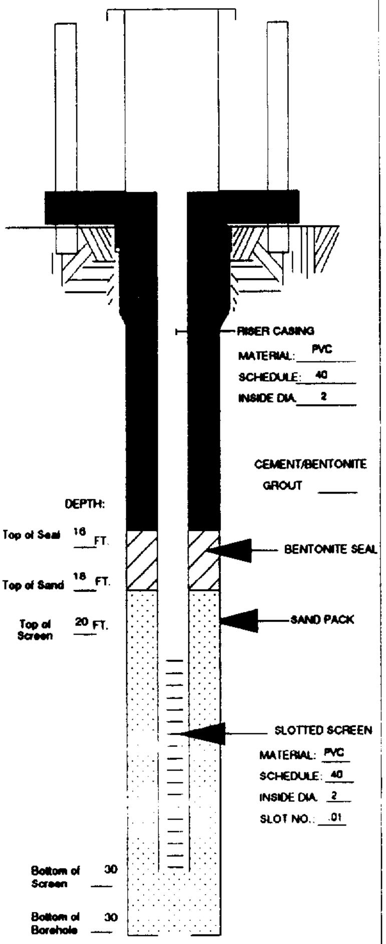
O'Brien & Gere Engineers, Inc.	Boring Log/Protective Casing Well	Report of Boring No. MW-12 Sheet 1 of 1
Location: TT61-66 Client: Navy Drilling Type: Hollow Stem	SAMPLER Type: 2" O.D. Split Spoon Hammer: 140# Fall: 30"	Ground Water Depth File No.

Boring Co.: ATEC
Foreman: Gary Copeland
OBG Geologist T. Bickerstaff

Dates:
Started: 1/9/92 Ended: 1/9/92

Depth	Sample Depth	Sample Blows /6"	Sample Penetr/ Recovery	Sample PID Value	Sample Description
0	0-2	2/2/3/4	24/24	9	Topsoil on top of light brown, medium sand.
2	2-4	2/4/7/8	24/24	.4	Black organic, medium sand on top of gray and orange mottled, medium sand.
4	4-6	2/2/3/4	24/24	0	Gray clay grading to bluish-gray, coarse sand with clay silt and fines. Tip is wet.
9	9-11	1/1/1/2	24/24	0	Interbedded strata of coarse, gray sand with silt and clay, greenish-gray.
14	14-16	1/1/2/2	24/24	0	Coarse, gray sand with clay stringers. Medium sand and gray clay at tip.
19	19-21	WOH	24/24	2	Coarse grained, greenish-gray sand. Odor.
24	24-26		24/24		Running sands.
29	29-31		24/		Running sands.

Monitoring Well Specifications

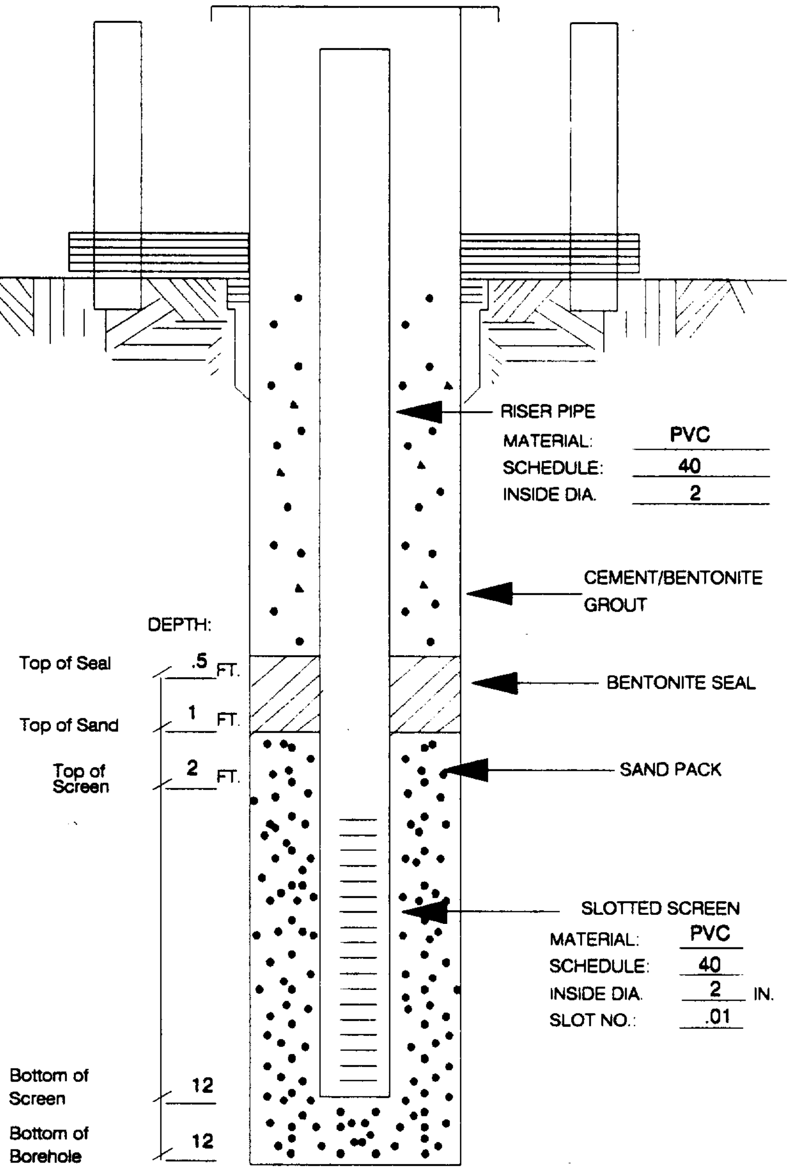


RISER CASING
MATERIAL: PVC
SCHEDULE: 40
INSIDE DIA. 2

CEMENT/BENTONITE GROUT

DEPTH:
Top of Seal 16 FT.
Top of Sand 18 FT.
Top of Screen 20 FT.
Bottom of Screen 30
Bottom of Borehole 30

SLOTTED SCREEN
MATERIAL: PVC
SCHEDULE: 40
INSIDE DIA. 2
SLOT NO.: .01



RISER PIPE
MATERIAL: PVC
SCHEDULE: 40
INSIDE DIA. 2

DEPTH:
Top of Seal .5 FT.
Top of Sand 1 FT.
Top of Screen 2 FT.
Bottom of Screen 12
Bottom of Borehole 12

SLOTTED SCREEN
MATERIAL: PVC
SCHEDULE: 40
INSIDE DIA. 2 IN.
SLOT NO.: .01

TYPICAL OVERBURDEN MONITORING WELL
N.T.S.

Tarawa Terrace
MW-13
1/9/92

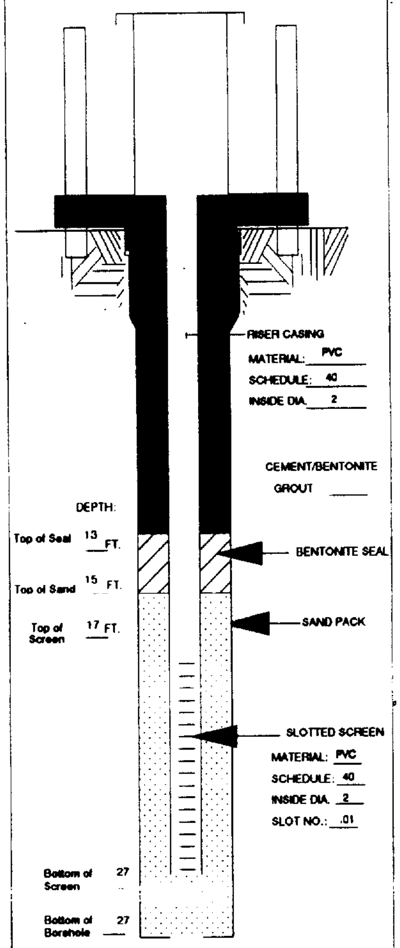
O'Brien & Gere Engineers, Inc.	Boring Log/Protective Casing Well	Report of Boring No. MW-14 Sheet 1 of 1
Location: TT61-66 Client: Navy Drilling Type: Hollow Stem	SAMPLER Type: 2" O.D. Split Spoon Hammer: 140# Fall: 30"	Ground Water Depth File No.

Boring Co.: ATEC
Foreman: Gary Copeland
OBG Geologist T. Bickerstaff

Dates:
Started: 1/9/92 Ended: 1/9/92

Depth	Sample				Sample Description
	Depth	Blows /6"	Penetr/ Recovery	PID Value	
0	0-2	8/16/6/8	24/10	1	Brown and black topsoil and medium sand.
2	2-4	7/8/5/6	24/24	2	Wet. Gray,medium sand with silt and clay.
4	4-6	2/3/4/5	24/16	1.2	Interbedded gray, coarse sand and silt and clay.
9	9-11	2/3/4/3	24/24	0	Gray, medium to coarse sand with silt and clay.
14	14-16	4/3/3/2	24/24	0	Coarse, greenish-gray sand. 4" strata of orangish-brown, medium sand in middle.
19	19-21	1/1/1/2	24/24	2	Gray, coarse sand with greenish-gray clay stringers. Odor.
24	24-26	9/18/18/19	24/24	0	Gray, coarse sand with greenish-gray clay stringers. Odor.
29	29-31		24/24	0	Gray, coarse sand with greenish-gray clay stringers. Odor.

Monitoring Well Specifications



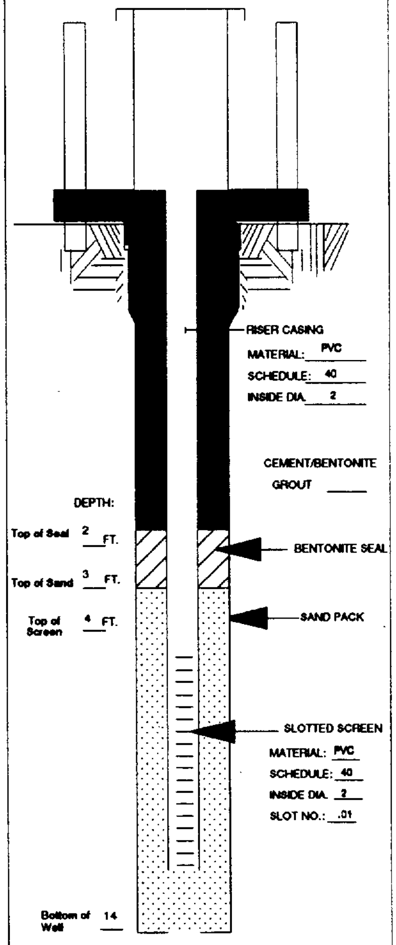
O'Brien & Gere Engineers, Inc.	Boring Log/Protective Casing Well•	Report of Boring No. MW15 Sheet 1 of 1
Location: Tarawa Terrace Client: Navy Drilling Type: Hollow Stem	SAMPLER Type: Off-flights Hammer: Fall:	Ground Water Depth File No.

Boring Co.: ATEC
Foreman: Sanford Sweeting
OBG Geologist T. Bickerstaff

Dates:
Started: 12/9/92 Ended: 12/9/92

Depth	Sample				Sample Description
	Depth	Blows /6"	Penetr/ Recovery	PID Value	
0	0-3	Off-flights			Dark brown, sandy clay.
3	3-4	Off-flights			Ground water encountered.
4	4-5	Off-flights			Gray, sandy clay.
5	5-10	Off-flights			Grayish-white, medium sand with silt. Small amount of clay.
10	10-14	Off-flights			Grayish-white, medium sand with silt. Small amount of clay.
14					Bottom of well.

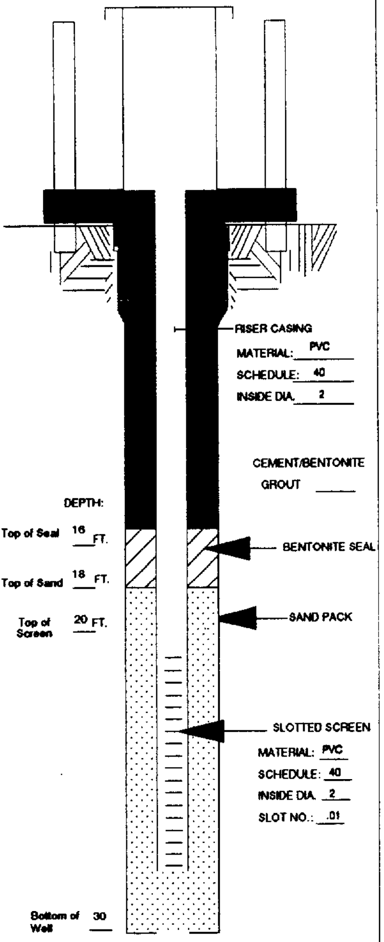
Monitoring Well Specifications



O'Brien & Gere Engineers, Inc.	Boring Log/Protective Casing Well	Report of Boring No. MW16 Sheet 1 of 1
Location: Tarawa Terrace Client: Navy Drilling Type: Hollow Stem	SAMPLER Type: 2" O.D. Split Spoon Hammer: 140# Fall: 30"	Ground Water Depth File No.
Boring Co.: ATEC Foreman: Chip Lefever OBG Geologist T. Bickerstaff		Dates: Started: 12/9/92 Ended: 12/9/92

Depth	Sample				Sample Description
	Depth	Blows /6"	Penetr/ Recovery	PID Value	
0	0-2	2/3/1/4	24/12	.8	Medium to fine sands with clay and silt.
4	4-6	3/3/3/6	24/20	1.3	Fine to medium sand, buff with clay. Bottom 3" medium, buff sand, no clay.
6	6-8	3/3/3/4	24/20	.4	Interbedded medium to coarse sand and gray clay. Sand is very moist, clay is not. Tip is wet.
9	9-11	5/3/6/10	24/24	-.2	Grayish-white, very fine to medium sand. Small amount of clay.
14	14-16	1/2/2/2	24/24	0	Grayish-white, very fine to medium sand. Small amount of clay. Some coarse grains and granules.
19	19-21	3/3/5/6	24/24	0	Gray and green, fine to coarse sand. Some coarse grains and granules.
24	24-26	6/6/5/8	24/24	0	Running sands. Fine to medium, gray sand with heavies. Ribboned green silt in middle of spoon, approx. 1/2" thick.
29	29-31				No sample. Running sands are too bad.
30					Bottom of well.

Monitoring Well Specifications



RISER CASING
MATERIAL: PVC
SCHEDULE: 40
INSIDE DIA. 2

CEMENT/BENTONITE GROUT ____

DEPTH:
Top of Seal 16 FT.
Top of Sand 18 FT.
Top of Screen 20 FT.
Bottom of Well 30

SLOTTED SCREEN
MATERIAL: PVC
SCHEDULE: 40
INSIDE DIA. 2
SLOT NO.: .01

O'Brien & Gere
Engineers, Inc.

Boring Log/Protective Casing Well

Report of Boring No. MW17
Sheet 1 of 1

Location: Tarawa Terrace
Client: Navy
Drilling Type: Hollow Stem

SAMPLER
Type: Off-flights
Hammer:
Fall:

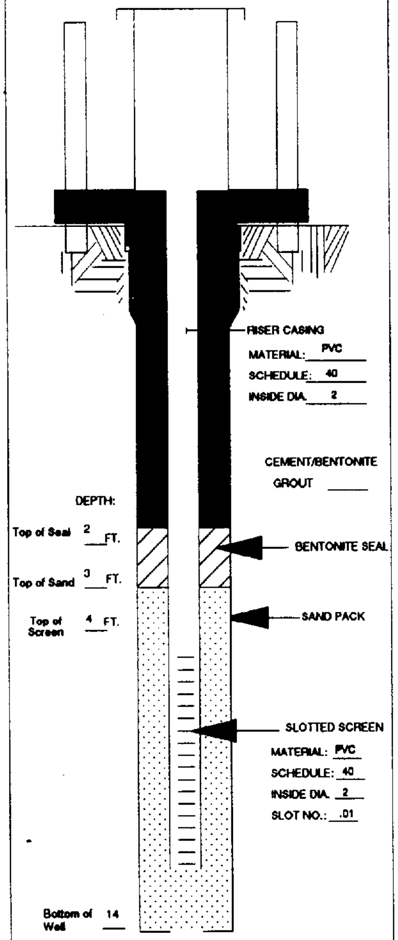
Ground Water Depth
File No.

Boring Co.: ATEC
Foreman: Chip Lefever
OBG Geologist T. Bickerstaff

Dates:
Started: 12/11/92 Ended: 12/11/92

Depth	Sample Depth	Sample Blows /6"	Sample Penetr/ Recovery	Sample PID Value	Sample Description
0	0-3	Off-flights			Topsoil and gray, sandy clay.
3	3-5	Off-flights			Gray, sandy silt and clay.
5	5-6	Off-flights			Ground water encountered.
6	6-10	Off-flights			Gray, clayey sand.
10	10-14	Off-flights			Gray, fine to medium sand with small amount of silt.
14		Off-flights			Bottom of well.

Monitoring Well Specifications



RISER CASING
MATERIAL: PVC
SCHEDULE: 40
INSIDE DIA. 2

CEMENT/BENTONITE GROUT ____

DEPTH:
Top of Seal 2 FT.
Top of Sand 3 FT.
Top of Screen 4 FT.

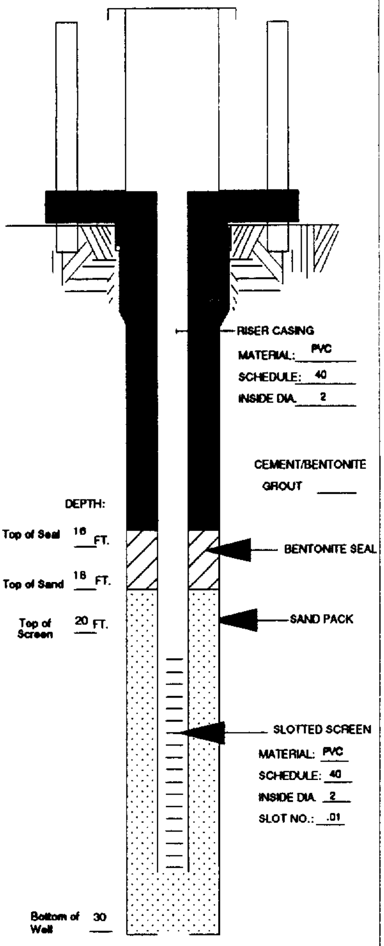
SLOTTED SCREEN
MATERIAL: PVC
SCHEDULE: 40
INSIDE DIA. 2
SLOT NO.: .01

Bottom of Well 14

O'Brien & Gere Engineers, Inc.	Boring Log/Protective Casing Well	Report of Boring No. MW18 Sheet 1 of 1
Location: Tarawa Terrace Client: Navy Drilling Type: Hollow Stem	SAMPLER Type: 2" O.D. Split Spoon Hammer: 140# Fall: 30"	Ground Water Depth File No.
Boring Co.: ATEC Foreman: Sanford Sweeting OBG Geologist T. Bickerstaff		Dates: Started: 12/9/92 Ended: 12/9/92

Depth	Sample				Sample Description
	Depth	Blows /6"	Penetr/ Recovery	PID Value	
0	0-4	Off-flights			Gray, sandy clay.
4	4-6	4/6/6/7	24/24	2	Orange and gray, sandy clay.
6	6-8	3/3/5/5	24/24	1.6	Gray clay on top of orange and gray, sandy, silty clay.
8	8-10	4/5/5/6	24/24	.8	Gray, silty clay with 1" medium sand lamina near tip.
10	10-12	2/1/3/5	24/24	0	Gray, fine sand on top of grayish-white, medium sand with silt. Tip is wet.
14	14-16	4/5/4/4	24/24	.3	Gray, sandy silt on top of grayish-white fine to coarse sand with silt.
19	19-21	2/2/4/5	24/24	0	Green-gray, fine to coarse sand.
24	24-26	5/15/23/25	24/24	.8	Grayish-white, fine to medium sand with thin 1/8" laminae of green silt.
29	29-31	2/2/4/5	24/24	0	Medium, gray sand with small amount of silt.
30					Bottom of well.

Monitoring Well Specifications



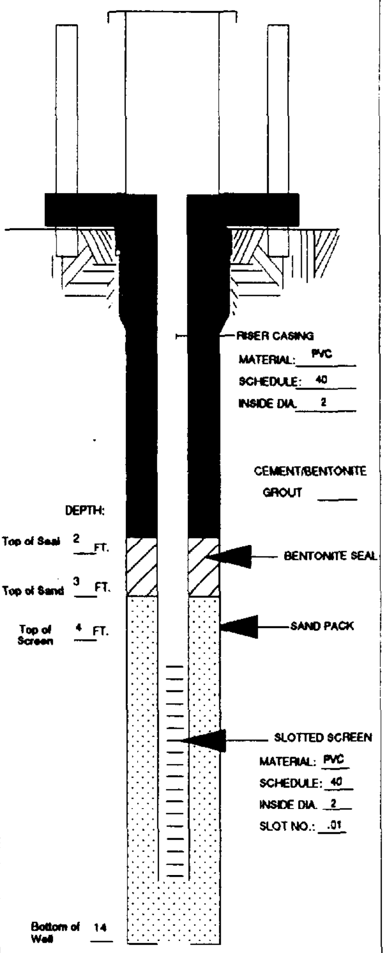
O'Brien & Gere Engineers, Inc.	Boring Log/Protective Casing Well	Report of Boring No. MW19 Sheet 1 of 1
Location: Tarawa Terrace Addendum Client: Navy Drilling Type: Hollow Stem	SAMPLER Type: Off-flights Hammer: Fall:	Ground Water Depth File No.

Boring Co.: ATEC
Foreman: Chip Lefever
OBG Geologist T. Bickerstaff

Dates:
Started: 12/15/92 Ended: 12/15/92

Depth	Sample				Sample Description
	Depth	Blows /6"	Penetr/ Recovery	PID Value	
0	0-1	Off-flights			Black topsoil.
1	1-5	Off-flights			Dark gray clay with silt.
5	5-9	Off-flights			Gray clayey, medium sand.
9		Off-flights			Wet.
10	10-14	Off-flights			Light gray, fine to medium sand with silt.
14		Off-flights			Bottom of well.

Monitoring Well Specifications



RISER CASING
MATERIAL: PVC
SCHEDULE: 40
INSIDE DIA. 2

CEMENT/BENTONITE GROUT ____

DEPTH:
Top of Seal 2 FT.
Top of Sand 3 FT.
Top of Screen 4 FT.
Bottom of Well 14

SLOTTED SCREEN
MATERIAL: PVC
SCHEDULE: 40
INSIDE DIA. 2
SLOT NO.: .01

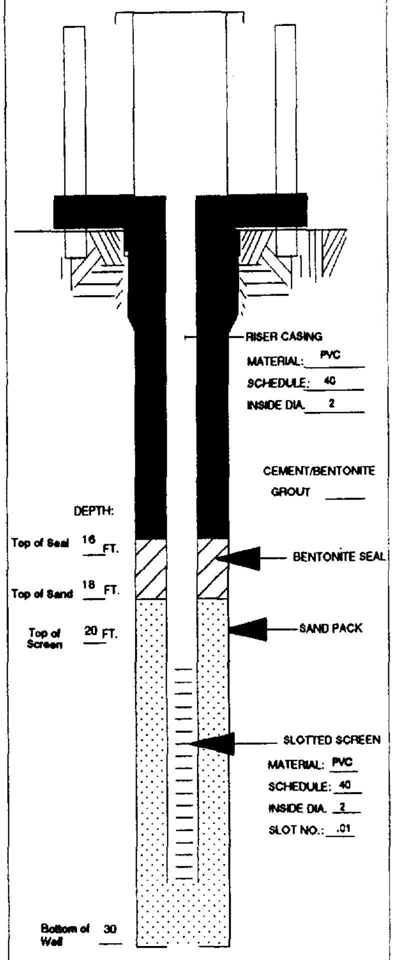
O'Brien & Gere Engineers, Inc.	Boring Log/Protective Casing Well	Report of Boring No. MW20 Sheet 1 of 1
Location: Tarawa Terrace Client: Navy Drilling Type: Hollow Stem	SAMPLER Type: 2" O.D. Split Spoon Hammer: 140# Fall: 30"	Ground Water Depth File No.

Boring Co.: ATEC
Foreman: Chip Lefever
OBG Geologist T. Bickerstaff

Dates:
Started: 12/9/92 Ended: 12/9/92

Depth	Sample Depth	Sample Blows /6"	Sample Penetr/ Recovery	Sample PID Value	Sample Description
0	0-4	Off-flights			Dark gray clay and silt.
4	4-6	3/2/2/3	24/12	0	Black silt on top of gray, sandy, silty clay.
6	6-8	3/3/3/5	24/12	.3	Grayish-white, silty clay.
8	8-10	4/4/5/11	24/24	1.2	Interbedded silt and medium sand, whitish-gray.
10	10-12	5/6/10/12	24/24	.4	Gray, fine to coarse sand, some silt. Wet.
14	14-16	1/1/2/5	24/12	0	Dark gray silt on top of whitish-gray medium sand with silt and clay.
19	19-21	3/4/5/8	24/24	.2	Gray, medium sand with clay on top of green-gray, medium sand. Tip is gray, medium to fine sand.
24	24-26	7/9/13/15	24/24	0	Gray, silty sand on top of gray, fine to medium sand.
29	29-31	6/4/5/5	24/24	0	Top 8" gray clay with silt. Bottom 6" tan to gray, medium sand with silt and clay.
30					Bottom of well.

Monitoring Well Specifications



RISER CASING
MATERIAL: PVC
SCHEDULE: 40
INSIDE DIA. 2

CEMENT/BENTONITE GROUT

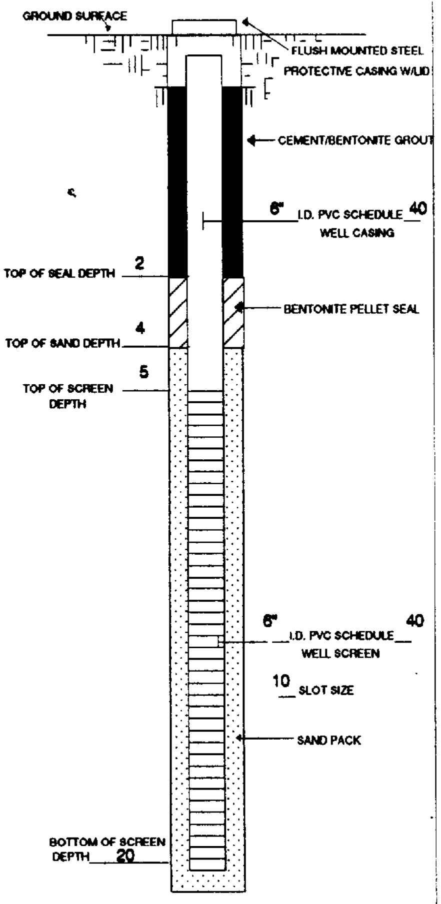
DEPTH:
Top of Seal 16 FT.
Top of Sand 18 FT.
Top of Screen 20 FT.
Bottom of Well 30

SLOTTED SCREEN
MATERIAL: PVC
SCHEDULE: 40
INSIDE DIA. 2
SLOT NO.: .01

O'Brien & Gere Engineers, Inc.	Boring Log/Flush Mount Well	Report of Boring No. TW Sheet 1 of 1
Location: Tarawa Terrace Client: Navy Drilling Type: Hollow Stem	SAMPLER Type: 2" O.D. Split Spoon Hammer: 140 # Fall: 30"	Ground Water Depth File No.
Boring Co.: ATEC Foreman: Sanford Sweeting OBG Geologist T. Bickerstaff		Dates: Started: 12/11/92 Ended: 12/11/92

Depth	Sample				Sample Description
	Depth	Blows /6"	Penetr/ Recovery	PID Value	
0	0-2	9/9/4/5	24/18	3.6	**Gravel on top of 12" black, sandy soil with pieces of wood.**
4	4-6	4/5/3/3	24/8	2	**Top is black, sandy soil. Bottom 2" gray, medium sand with silt. Wet.**
9	9-11	2/4/7/7	24/24	1.8	**Interbedded 4" beds of gray, silty clay and gray, silty, clayey, medium to coarse sand.**
11	11-15	off flights		0	**Gray, fine to medium sand with silt.**
15	15-20	off flights		0	**Gray, fine to medium sand with silt. Some coarse grains.**
20					**Bottom of well.**

Monitoring Well Specifications



O'Brien & Gere Engineers, Inc.	SOIL BORING LOG	Report of Boring No. B1 Sheet 1 of 1
Project Location: Tarawa Client: Navy Drill Type: Hollow Stem	SAMPLER Type: 2" O.D. Split Spoon Hammer: 140# Fall: 30"	Ground Water Depth File No.
Boring Co.: ATEC Foreman: Doug Young OBG Geologist T. Bickerstaff		Dates: Started: 1/10/92 Ended: 1/10/92

	Sample				Sample Description	Stratum Change General Description
Depth	Depth	Blows /6"	Penetr/ Recovery	PID Value		
0	0-2		24/10	1.2	Topsoil berm material, very coarse sand and gravel.	
2	2-4	4/4/4/2	24/24	.2	Gray, corase sand and berm material grading to black, medium sand.	
4	4-6	2/1/1/2	24/20	0	Wet. Dark brown to black, medium sand with clay. Tip is gray, fine to very fine sand.	

O'Brien & Gere Engineers, Inc.	SOIL BORING LOG	Report of Boring No. B2 Sheet 1 of 1
Project Location: Tarawa Client: Navy Drill Type: Hollow Stem	SAMPLER Type: 2" O.D. Split Spoon Hammer: 140# Fall: 30"	Ground Water Depth File No.
Boring Co.: ATEC Foreman: Doug Young OBG Geologist T. Bickerstaff		Dates: Started: 1/9/92 Ended: 1/9/92

Depth	Sample				Sample Description	Stratum Change General Description
	Depth	Blows /6"	Penetr/ Recovery	PID Value		
0	0-2	13/11/8/6	24/20	3	Black, organic, medium sand. Topsoil with roots and pieces of wood.	
2	2-4	3/3/4/5	24/24	1.2	Dark brown, medium sand.	
4	4-6	2/3/6/6	24/24	1	Dark fading to light brown, fine sand with silt.	
6	6-8		24/24	.4	Tip is wet. Greenish-gray, coarse sand with silt and clay. Odor.	

O'Brien & Gere Engineers, Inc.	SOIL BORING LOG	Report of Boring No. B3 Sheet 1 of 1
Project Location: Tarawa Client: Navy Drill Type: Hollow Stem	SAMPLER Type: 2" O.D. Split Spoon Hammer: 140# Fall: 30"	Ground Water Depth File No.
Boring Co.: ATEC Foreman: Doug Young OBG Geologist T. Bickerstaff		Dates: Started: 1/9/92 Ended: 1/9/92

Depth	Sample				Sample Description	Stratum Change General Description
	Depth	Blows /6"	Penetr/ Recovery	PID Value		
0	0-2	4/12/16/10	24/8	.2	Gravel and topsoil.	
2	2-4	6/5/5/5	24/20	2.0	Black and brown, medium sand.	
4	4-6	4/5/8/13	24/18	0	Gray, medium sand, with silt and clay. Very moist.	
6	6-8	2/5/5/5	24/	0	Saturated gray, coarse sand with silt and clay.	

O'Brien & Gere Engineers, Inc.	SOIL BORING LOG	Report of Boring No. B4 Sheet 1 of 1
Project Location: Tarawa Client: Navy Drill Type: Hollow Stem	SAMPLER Type: 2" O.D. Split Spoon Hammer: 140# Fall: 30"	Ground Water Depth File No.
Boring Co.: ATEC Foreman: Doug Young OBG Geologist T. Bickerstaff		Dates: Started: 1/10/92 Ended: 1/10/92

Depth	Sample				Sample Description	Stratum Change General Description
	Depth	Blows /6"	Penetr/ Recovery	PID Value		
0	0-2	21/19/17/12	24/18	1	Gravel and medium, brown sand.	
2	2-4	1/1/1/1	24/24	0	Dark brown, medium sand with 50% clay.	
4	4-6	1/WOH/1	24/24	0	Wet. Dark brown caly with sand and silt. Some gray, fine sand at tip.	

APPENDIX B

LABORATORY RESULTS LIQUID

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Volatile Organics
Method 8010/8020

CLIENT U.S. NAVY JOB NO. 3543.001.517

DESCRIPTION Tarawa Terrace-Camp Lejeune, NC

MATRIX: Water

DATE COLLECTED 1-10,11-92 DATE RECEIVED 1-15-92 DATE ANALYZED 1-23-92

DESCRIPTION:	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6
SAMPLE NO.:	P1014	P1015	P1016	P1017	P1018	P1019
Benzene	<1.	<1.	<1.	<1.	<1.	<1.
Benzyl chloride	<10.	<10.	<10.	<10.	<10.	<10.
Bis (2-chloroethoxy) methane	<500.	<500.	<500.	<500.	<500.	<500.
Bromobenzene	<5.	<5.	<5.	<5.	<5.	<5.
Bromodichloromethane	<1.	<1.	<1.	<1.	<1.	<1.
Bromoform	<10.	<10.	<10.	<10.	<10.	<10.
Bromomethane	<10.	<10.	<10.	<10.	<10.	<10.
Carbon tetrachloride	<1.	<1.	<1.	<1.	<1.	<1.
Chlorobenzene	↓	↓	↓	↓	↓	↓
Chloroethane	↓	↓	↓	↓	↓	↓
2-Chloroethylvinyl ether	<10.	<10.	<10.	<10.	<10.	<10.
Chloroform	<1.	<1.	<1.	<1.	<1.	<1.
1-Chlorohexane	<10.	<10.	<10.	<10.	<10.	<10.
Chloromethane	<10.	<10.	<10.	<10.	<10.	<10.
Chloromethylmethyl ether	<100.	<100.	<100.	<100.	<100.	<100.
2-Chlorotoluene	<5.	<5.	<5.	<5.	<5.	<5.
4-Chlorotoluene	<5.	<5.	<5.	<5.	<5.	<5.
Dibromochloromethane	<1.	<1.	<1.	<1.	<1.	<1.
Dibromomethane	<10.	<10.	<10.	<10.	<10.	<10.
1,2-Dichlorobenzene	<5.	<5.	<5.	<5.	<5.	<5.
1,3-Dichlorobenzene	↓	↓	↓	↓	↓	↓
1,4-Dichlorobenzene	↓	↓	↓	↓	↓	↓
Dichlorodifluoromethane	<10.	<10.	<10.	<10.	<10.	<10.

Authorized: Noriko Santucci

Date: February 24, 1992

LABORATORIES, INC.

Volatile Organics
Method 8010/8020

CLIENT U.S. NAVY **JOB NO.** 3543.001.517

DESCRIPTION Tarawa Terrace-Camp Lejeune, NC

MATRIX: Water

DATE COLLECTED 1-10,11-92 **DATE RECEIVED** 1-15-92 **DATE ANALYZED** 1-23-92

DESCRIPTION:	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6
SAMPLE NO.:	P1014	P1015	P1016	P1017	P1018	P1019
1,1-Dichloroethane	<1.	<1.	<1.	<1.	<1.	<1.
1,2-Dichloroethane	↓	↓	↓	↓	↓	↓
1,1-Dichloroethylene	↓	↓	↓	↓	↓	↓
1,2-Dichloroethylene (total)	↓	↓	↓	↓	↓	↓
Dichloromethane	↓	↓	↓	↓	↓	↓
1,2-Dichloropropane	↓	↓	↓	↓	↓	↓
cis-1,3-Dichloropropylene	↓	↓	↓	↓	↓	↓
trans-1,3-Dichloropropylene	↓	↓	↓	↓	↓	↓
Ethylbenzene	↓	↓	↓	↓	↓	↓
1,1,2,2-Tetrachloroethane	↓	↓	↓	↓	↓	↓
1,1,1,2-Tetrachloroethane	↓	↓	↓	↓	↓	↓
Tetrachloroethylene	↓	↓	↓	↓	↓	↓
Toluene	↓	↓	↓	↓	↓	↓
1,1,1-Trichloroethane	↓	↓	↓	↓	↓	↓
1,1,2-Trichloroethane	↓	↓	↓	↓	↓	↓
Trichloroethylene	↓	↓	↓	↓	↓	↓
Trichlorofluoromethane	↓	↓	↓	↓	↓	↓
1,2,3-Trichloropropane	↓	↓	↓	↓	↓	↓
Vinyl chloride	↓	↓	↓	↓	↓	↓
Xylene (total)	<3.	<3.	<3.	<3.	<3.	<3.

Comments:

Methodology: USEPA,SW-846, November 1986, 3rd Edition

Certification No.: 315

Units: µg/l

Page 2 of 2

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Date: February 24, 1992

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Volatile Organics
Method 8010/8020

CLIENT U.S. NAVY

JOB NO. 3543.001.517

DESCRIPTION Tarawa Terrace-Camp Lejeune, NC

MATRIX: Water

DATE COLLECTED 1-10,11-92 DATE RECEIVED 1-15-92 DATE ANALYZED 1-23,24-92

DESCRIPTION:	MW-7	MW-8	MW-9	MW-10	MW-11	MW-12
SAMPLE NO.:	P1020	P1021	P1022	P1023	P1024	P1025
Benzene	<1.	<1.	<1.	14.	<1.	<1.
Benzyl chloride	<10.	<10.	<10.	<10.	<10.	<10.
Bis (2-chloroethoxy) methane	<500.	<500.	<500.	<500.	<500.	<500.
Bromobenzene	<5.	<5.	<5.	<5.	<5.	<5.
Bromodichloromethane	<1.	<1.	<1.	<1.	<1.	<1.
Bromoform	<10.	<10.	<10.	<10.	<10.	<10.
Bromomethane	<10.	<10.	<10.	<10.	<10.	<10.
Carbon tetrachloride	<1.	<1.	<1.	<1.	<1.	<1.
Chlorobenzene	↓	↓	↓	↓	↓	↓
Chloroethane	↓	↓	↓	↓	↓	↓
2-Chloroethylvinyl ether	<10.	<10.	<10.	<10.	<10.	<10.
Chloroform	<1.	<1.	<1.	<1.	<1.	<1.
1-Chlorohexane	<10.	<10.	<10.	<10.	<10.	<10.
Chloromethane	<10.	<10.	<10.	<10.	<10.	<10.
Chloromethylmethyl ether	<100.	<100.	<100.	<100.	<100.	<100.
2-Chlorotoluene	<5.	<5.	<5.	<5.	<5.	<5.
4-Chlorotoluene	<5.	<5.	<5.	<5.	<5.	<5.
Dibromochloromethane	<1.	<1.	<1.	<1.	<1.	<1.
Dibromomethane	<10.	<10.	<10.	<10.	<10.	<10.
1,2-Dichlorobenzene	<5.	<5.	<5.	<5.	<5.	<5.
1,3-Dichlorobenzene	↓	↓	↓	↓	↓	↓
1,4-Dichlorobenzene	↓	↓	↓	↓	↓	↓
Dichlorodifluoromethane	<10.	<10.	<10.	<10.	<10.	<10.

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Date: February 24, 1992

LABORATORIES, INC.

Volatile Organics
Method 8010/8020

CLIENT	U.S. NAVY	**JOB NO.**	3543.001.517
DESCRIPTION	Tarawa Terrace-Camp Lejeune, NC		
		MATRIX:	Water

DATE COLLECTED 1-10,11-92 **DATE RECEIVED** 1-15-92 **DATE ANALYZED** 1-23,24-92

DESCRIPTION:	MW-7	MW-8	MW-9	MW-10	MW-11	MW-12
SAMPLE NO.:	P1020	P1021	P1022	P1023	P1024	P1025
1,1-Dichloroethane	<1.	<1.	<1.	<1.	<1.	<1.
1,2-Dichloroethane						
1,1-Dichloroethylene						
1,2-Dichloroethylene (total)						
Dichloromethane						
1,2-Dichloropropane						
cis-1,3-Dichloropropylene						
trans-1,3-Dichloropropylene				↓		
Ethylbenzene				4.		
1,1,2,2-Tetrachloroethane				<1.		
1,1,1,2-Tetrachloroethane						
Tetrachloroethylene				↓		
Toluene				3.		
1,1,1-Trichloroethane				<1.		
1,1,2-Trichloroethane						
Trichloroethylene				↓		
Trichlorofluoromethane				5.		
1,2,3-Trichloropropane				<1.		
Vinyl chloride	↓	↓	↓	↓	↓	↓
Xylene (total)	<3.	<3.	<3.	17.	<3.	<3.

Comments:

Methodology: USEPA,SW-846, November 1986, 3rd Edition

Certification No.: 315

Units: µg/l

Page 2 of 2

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Date: February 24, 1992

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Volatile Organics
Method 8010/8020

CLIENT U.S. NAVY **JOB NO.** 3543.001.517

DESCRIPTION Tarawa Terrace-Camp Lejeune, NC

MATRIX: Water

DATE COLLECTED 1-11-92 **DATE RECEIVED** 1-15-92 **DATE ANALYZED** 1-24-92

DESCRIPTION: **SAMPLE NO.:**	MW-13 P1026	MW-14 P1027	MW-14 Field Duplicate P1028	Field Blank P1029	QC Trip Blank P1030
Benzene	<1.	23.	23.	<1.	<1.
Benzyl chloride	<10.	<10.	<10.	<10.	<10.
Bis (2-chloroethoxy) methane	<500.	<500.	<500.	<500.	<500.
Bromobenzene	<5.	<5.	<5.	<5.	<5.
Bromodichloromethane	<1.	<1.	<1.	<1.	<1.
Bromoform	<10.	<10.	<10.	<10.	<10.
Bromomethane	<10.	<10.	<10.	<10.	<10.
Carbon tetrachloride	<1.	<1.	<1.	<1.	<1.
Chlorobenzene	↓	↓	↓	↓	↓
Chloroethane	↓	↓	↓	↓	↓
2-Chloroethylvinyl ether	<10.	<10.	<10.	<10.	<10.
Chloroform	<1.	<1.	<1.	<1.	<1.
1-Chlorohexane	<10.	<10.	<10.	<10.	<10.
Chloromethane	<10.	<10.	<10.	<10.	<10.
Chloromethylmethyl ether	<100.	<100.	<100.	<100.	<100.
2-Chlorotoluene	<5.	<5.	<5.	<5.	<5.
4-Chlorotoluene	<5.	<5.	<5.	<5.	<5.
Dibromochloromethane	<1.	<1.	<1.	<1.	<1.
Dibromomethane	<10.	<10.	<10.	<10.	<10.
1,2-Dichlorobenzene	<5.	<5.	<5.	<5.	<5.
1,3-Dichlorobenzene	<5.	<5.	<5.	<5.	<5.
1,4-Dichlorobenzene	<5.	<5.	<5.	<5.	<5.
Dichlorodifluoromethane	<10.	<10.	<10.	<10.	<10.

Authorized: Monika Santucci

Date: February 24, 1992

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Volatile Organics
Method 8010/8020

CLIENT U.S. NAVY **JOB NO.** 3543.001.517

DESCRIPTION Tarawa Terrace-Camp Lejeune, NC

MATRIX: Water

DATE COLLECTED 1-11-92 **DATE RECEIVED** 1-15-92 **DATE ANALYZED** 1-24-92

DESCRIPTION:	MW-13	MW-14	MW-14 Field Duplicate	Field Blank	QC Trip Blank
SAMPLE NO.:	P1026	P1027	P1028	P1029	P1030
1,1-Dichloroethane	<1.	<1.	<1.	<1.	<1.
1,2-Dichloroethane	↓	↓	↓	↓	↓
1,1-Dichloroethylene	↓	↓	↓	↓	↓
1,2-Dichloroethylene (total)	↓	↓	↓	↓	↓
Dichloromethane	↓	↓	↓	↓	↓
1,2-Dichloropropane	↓	↓	↓	↓	↓
cis-1,3-Dichloropropylene	↓	↓	↓	↓	↓
trans-1,3-Dichloropropylene	↓	↓	↓	↓	↓
Ethylbenzene	↓	↓	↓	↓	↓
1,1,2,2-Tetrachloroethane	↓	↓	↓	↓	↓
1,1,1,2-Tetrachloroethane	↓	↓	↓	↓	↓
Tetrachloroethylene	↓	↓	↓	↓	↓
Toluene	↓	↓	↓	↓	↓
1,1,1-Trichloroethane	↓	↓	↓	↓	↓
1,1,2-Trichloroethane	↓	↓	↓	↓	↓
Trichloroethylene	↓	↓	↓	↓	↓
Trichlorofluoromethane	↓	↓	↓	↓	↓
1,2,3-Trichloropropane	↓	↓	↓	↓	↓
Vinyl chloride	↓	↓	↓	↓	↓
Xylene (total)	<3.	<3.	<3.	<3.	<3.

Comments:

Methodology: USEPA,SW-846, November 1986, 3rd Edition

Certification No.: 315

Units: µg/l

Page 2 of 2

Authorized: Norika Santucci

Date: February 24, 1992

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Laboratory Report

CLIENT U.S. NAVY
JOB NO. 3543.001.517
DESCRIPTION Tarawa Terrace-Camp Lejeune, NC
MATRIX: Water
Date Analyzed 1-24-92
DATE COLLECTED 1-10,11-92
DATE RECEIVED 1-15-92

Description:	MW-3	MW-7	MW-1
Sample #	P1011	P1012	P1013
ACENAPHTHENE	<11.	<11.	<11.
ACENAPHTHYLENE	↓	↓	↓
ANTHRACENE	↓	↓	↓
BENZO(a)ANTHRACENE	↓	↓	↓
BENZO(a)PYRENE	↓	↓	↓
BENZO(b)FLUORANTHENE	↓	↓	↓
BENZO(k)FLUORANTHENE	↓	↓	↓
BENZO(g,h,i)PERYLENE	↓	↓	↓
CHRYSENE	↓	↓	↓
DIBENZO(a,h)ANTHRACENE	↓	↓	↓
FLUORANTHENE	↓	↓	↓
FLUORENE	↓	↓	↓
INDENO(1,2,3-cd)PYRENE	↓	↓	↓
NAPHTHALENE	↓	↓	↓
PHENANTHRENE	↓	↓	↓
PYRENE	↓	↓	↓

Comments:

Certification No.: 315
Units: µg/l

Authorized: Monika Santucci
Date: February 24, 1992

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OBG
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Laboratory Report

CLIENT U.S. NAVY
JOB NO. 3543.001.517
DESCRIPTION Tarawa Terrace-Camp Lejeune, NC
Toxicity Characteristic Leaching Procedure MATRIX: Water
DATE COLLECTED 1-11-92
DATE RECEIVED 1-15-92

Description:	MW-3				
Sample #	P1010				
TCLP Pesticides/Herbicides:					
CHLORDANE	<0.01				
ENDRIN	<0.005				
HEPTACHLOR	<0.005				
HEPTACHLOR EPOXIDE	<0.005				
LINDANE	<0.005				
METHOXYCHLOR	<0.01				
TOXAPHENE	<0.05				
2,4-D	<0.1				
2,4,5-TP (SILVEX)	<0.1				

Analytical Record:
Date Leachate Created 1-22-92
Date Herbicide Extracted 1-28-92
Date Pesticide Extracted 1-29-92
Date Herbicide Analyzed 2-3-92
Date Pesticide Analyzed 2-3-92

Comments:

Certification No.: 315
Units: mg/l

Authorized: Norita Santucci
Date: February 24, 1992

LABORATORIES, INC.

Laboratory Report

CLIENT U.S. NAVY

JOB NO. 3543.001.517

DESCRIPTION Tarawa Terrace-Camp Lejeune, NC

Toxicity Characteristic Leaching Procedure MATRIX: Water

DATE COLLECTED 1-11-92 **DATE RECEIVED** 1-15-92

Description:	MW-3				
Sample #	P1010				
TCLP Volatile Organics:					
BENZENE	<0.05				
CARBON TETRACHLORIDE	<0.05				
CHLOROBENZENE	<10.0				
CHLOROFORM	<0.60				
1,2-DICHLOROETHANE	<0.05				
1,1-DICHLOROETHYLENE	<0.07				
METHYL ETHYL KETONE	<20.0				
TETRACHLOROETHYLENE	<0.07				
TRICHLOROETHYLENE	<0.05				
VINYL CHLORIDE	<0.02				
Analytical Record:					
Date Leachate Created 2-3-92					
Date Analyzed 2-10-92					

Comments:

Certification No.: 315

Units: mg/l

Authorized: Monika Santucci

Date: February 24, 1992

OBG
LABORATORIES, INC.

Laboratory Report

CLIENT U.S. NAVY	**JOB NO.** 3543.001.517

DESCRIPTION Tarawa Terrace-Camp Lejeune, NC
Toxicity Characteristic Leaching Procedure MATRIX: Water

DATE COLLECTED 1-11-92 **DATE RECEIVED** 1-15-92

Description:	MW-3				
Sample #	P1010				
TCLP Semivolatile Organics:					
o-CRESOL	<0.1				
m-CRESOL	↓				
p-CRESOL					
TOTAL CRESOL					
1,4-DICHLOROBENZENE					
2,4-DINITROTOLUENE					
HEXACHLOROBENZENE					
HEXACHLOROBUTADIENE					
HEXACHLOROETHANE					
NITROBENZENE					
PENTACHLOROPHENOL	<0.5				
PYRIDINE	<1.0				
2,4,5-TRICHLOROPHENOL	<0.5				
2,4,6-TRICHLOROPHENOL	<0.1				

Analytical Record:
Date Leachate Created 1-22-92
Date Extracted 1-23-92
Date Analyzed 1-24-92

Comments:

Certification No.: 315
Units: mg/l

Authorized: Monika Santucci
Date: February 24, 1992

OBG
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Laboratory Report

CLIENT U.S. NAVY JOB NO. 3543.001.517

DESCRIPTION Tarawa Terrace-Camp Lejeune, NC

Toxicity Characteristic Leaching Procedure MATRIX: Water

DATE COLLECTED 1-11-92 DATE RECEIVED 1-15-92

Description:	MW-3				
Sample #	P1010				
Total Metals:					
ARSENIC	<0.5				
BARIUM	<10.				
CADMIUM	<0.1				
CHROMIUM	<0.5				
LEAD	<0.5				
MERCURY	<0.0005				
SELENIUM	<0.1				
SILVER	<0.5				

Comments:

Certification No.: 315

Units: mg/1

Authorized: Monika Santucci

Date: February 24, 1992

OBG
LABORATORIES, INC.

Volatile Organics
Method 8010/8020

CLIENT U.S. NAVY

JOB NO. 3543.001.517

DESCRIPTION Tarawa Terrace - Camp Lejeune, NC

MATRIX: Water

DATE COLLECTED 1-7-92

DATE RECEIVED 1-9-92

DATE ANALYZED 1-17-92

DESCRIPTION:	H1	H2	H3	H4	H5	H6
SAMPLE NO.:	P0765	P0766	P0767	P0768	P0769	P0770
Benzene	22.	<1.	7.	7.	<1.	<1.
Benzyl chloride	<10.	<10.	<10.	<10.	<10.	<10.
Bis (2-chloroethoxy) methane	<500.	<500.	<500.	<500.	<500.	<500.
Bromobenzene	<5.	<5.	<5.	<5.	<5.	<5.
Bromodichloromethane	<1.	<1.	<1.	<1.	<1.	<1.
Bromoform	<10.	<10.	<10.	<10.	<10.	<10.
Bromomethane	<1.	<1.	<1.	<1.	<1.	<1.
Carbon tetrachloride	↓	↓	↓	↓	↓	↓
Chlorobenzene	↓	↓	↓	↓	↓	↓
Chloroethane	↓	↓	↓	↓	↓	↓
2-Chloroethylvinyl ether	<10.	<10.	<10.	<10.	<10.	<10.
Chloroform	<1.	<1.	<1.	<1.	<1.	<1.
1-Chlorohexane	<10.	<10.	<10.	<10.	<10.	<10.
Chloromethane	<1.	<1.	<1.	<1.	<1.	<1.
Chloromethylmethyl ether	<100.	<100.	<100.	<100.	<100.	<100.
2-Chlorotoluene	<5.	<5.	<5.	<5.	<5.	<5.
4-Chlorotoluene	<5.	<5.	<5.	<5.	<5.	<5.
Dibromochloromethane	<1.	<1.	<1.	<1.	<1.	<1.
Dibromomethane	<10.	<10.	<10.	<10.	<10.	<10.
1,2-Dichlorobenzene	<5.	<5.	<5.	<5.	<5.	<5.
1,3-Dichlorobenzene	↓	↓	↓	↓	↓	↓
1,4-Dichlorobenzene	↓	↓	↓	↓	↓	↓
Dichlorodifluoromethane	<10.	<10.	<10.	<10.	<10.	<10.

Authorized: Monika Santucci

Date: January 28, 1992

OBG
LABORATORIES, INC.

Volatile Organics
Method 8010/8020

CLIENT U.S. NAVY **JOB NO.** 3543.001.517

DESCRIPTION Tarawa Terrace - Camp Lejeune, NC

MATRIX: Water

DATE COLLECTED 1-7-92 **DATE RECEIVED** 1-9-92 **DATE ANALYZED** 1-17-92

DESCRIPTION:	H1	H2	H3	H4	H5	H6
SAMPLE NO.:	P0765	P0766	P0767	P0768	P0769	P0770
1,1-Dichloroethane	2.	<1.	<1.	<1.	<1.	<1.
1,2-Dichloroethane	<1.	↓	↓	↓	↓	↓
1,1-Dichloroethylene	↓	↓	↓	↓	↓	↓
1,2-Dichloroethylene (total)	↓	↓	↓	↓	↓	↓
Dichloromethane	↓	↓	↓	↓	↓	↓
1,2-Dichloropropane	↓	↓	↓	↓	↓	↓
cis-1,3-Dichloropropylene	↓	↓	↓	↓	↓	↓
trans-1,3-Dichloropropylene	↓	↓	↓	↓	↓	↓
Ethylbenzene	17.	↓	↓	2.	↓	↓
1,1,2,2-Tetrachloroethane	<1.	↓	↓	<1.	↓	↓
1,1,1,2-Tetrachloroethane	↓	↓	↓	↓	↓	↓
Tetrachloroethylene	↓	↓	↓	↓	↓	↓
Toluene	190.	↓	↓	3.	↓	↓
1,1,1-Trichloroethane	<1.	↓	↓	<1.	↓	↓
1,1,2-Trichloroethane	↓	↓	↓	↓	↓	↓
Trichloroethylene	↓	↓	↓	↓	↓	↓
Trichlorofluoromethane	1.	↓	↓	↓	↓	↓
1,2,3-Trichloropropane	<1.	↓	↓	↓	↓	↓
Vinyl chloride	<1.	↓	↓	↓	↓	↓
Xylene (total)	62.	<3.	3.	12.	<3.	<3.

Comments:

Methodology: USEPA,SW-846, November 1986, 3rd Edition

Certification No.: 315

Units: µg/l

Page 2 of 2

Authorized: Monika Santucci

Date: January 28, 1992

OBG Laboratories, Inc., *an O'Brien & Gere Limited Company*
5000 Brittonfield Parkway / Suite 300, Box 4942 / Syracuse, NY 13221 / (315) 437-0200

OBG LABORATORIES, INC.

Volatile Organics
Method 8010/8020

CLIENT U.S. NAVY

JOB NO. 3543.001.517

DESCRIPTION Tarawa Terrace - Camp Lejeune, NC

MATRIX: Water

DATE COLLECTED 1-7-92

DATE RECEIVED 1-9-92

DATE ANALYZED 1-17-92

DESCRIPTION:	H7	H8	H9	H10		
SAMPLE NO.:	P0771	P0772	P0773	P0774		
Benzene	<1.	<1.	<1.	<1.		
Benzyl chloride	<10.	<10.	<10.	<10.		
Bis (2-chloroethoxy) methane	<500.	<500.	<500.	<500.		
Bromobenzene	<5.	<5.	<5.	<5.		
Bromodichloromethane	<1.	<1.	<1.	<1.		
Bromoform	<10.	<10.	<10.	<10.		
Bromomethane	<1.	<1.	<1.	<1.		
Carbon tetrachloride	↓	↓	↓	↓		
Chlorobenzene	↓	↓	↓	↓		
Chloroethane	↓	↓	↓	↓		
2-Chloroethylvinyl ether	<10.	<10.	<10.	<10.		
Chloroform	<1.	<1.	<1.	<1.		
1-Chlorohexane	<10.	<10.	<10.	<10.		
Chloromethane	<1.	<1.	<1.	<1.		
Chloromethylmethyl ether	<100.	<100.	<100.	<100.		
2-Chlorotoluene	<5.	<5.	<5.	<5.		
4-Chlorotoluene	<5.	<5.	<5.	<5.		
Dibromochloromethane	<1.	<1.	<1.	<1.		
Dibromomethane	<10.	<10.	<10.	<10.		
1,2-Dichlorobenzene	<5.	<5.	<5.	<5.		
1,3-Dichlorobenzene	↓	↓	↓	↓		
1,4-Dichlorobenzene	↓	↓	↓	↓		
Dichlorodifluoromethane	<10.	<10.	<10.	<10.		

Page 1 of 2

Authorized: Monika Santucci

Date: January 28, 1992

OBG LABORATORIES, INC.

Volatile Organics
Method 8010/8020

CLIENT U.S. NAVY	**JOB NO.** 3543.001.517
DESCRIPTION Tarawa Terrace - Camp Lejeune, NC	
	MATRIX: Water

DATE COLLECTED 1-7-92 **DATE RECEIVED** 1-9-92 **DATE ANALYZED** 1-17-92

DESCRIPTION:	H7	H8	H9	H10		
SAMPLE NO.:	P0771	P0772	P0773	P0774		
1,1-Dichloroethane	<1.	<1.	<1.	<1.		
1,2-Dichloroethane	↓	↓	↓	↓		
1,1-Dichloroethylene						
1,2-Dichloroethylene (total)						
Dichloromethane						
1,2-Dichloropropane						
cis-1,3-Dichloropropylene						
trans-1,3-Dichloropropylene						
Ethylbenzene						
1,1,2,2-Tetrachloroethane						
1,1,1,2-Tetrachloroethane						
Tetrachloroethylene						
Toluene						
1,1,1-Trichloroethane						
1,1,2-Trichloroethane						
Trichloroethylene						
Trichlorofluoromethane						
1,2,3-Trichloropropane						
Vinyl chloride						
Xylene (total)	<3.	<3.	<3.	<3.		

Comments:

Methodology: USEPA,SW-846, November 1986, 3rd Edition

Certification No.: 315

Units: µg/1

Page 2 of 2

Authorized: Monika Santuca

Date: January 28, 1992

OBG
LABORATORIES, INC.

Purgeable Organics
Method 601 / 602

CLIENT U.S. NAVY **JOB NO.** 3543.001.517

DESCRIPTION Camp Lejeune-~~Bogue~~, NC

Tarawa Terrace **MATRIX:** Water

DATE COLLECTED 12-11-92 **DATE RECEIVED** 12-14-92 **DATE ANALYZED** 12-17,21,22-92

DESCRIPTION:	H-11	H-12	H-13
SAMPLE NO.:	R1318	R1319	R1320
Chloromethane	<10.	<10.	<10.
Bromomethane	↓	↓	↓
Dichlorodifluoromethane	↓	↓	↓
Vinyl chloride	<1.	<1.	<1.
Chloroethane	↓	↓	↓
Methylene chloride	↓	↓	↓
Trichlorofluoromethane	↓	55.	1.
1,1-Dichloroethene	↓	<1.	<1.
1,1-Dichloroethane	↓	2.	↓
1,2-Dichloroethene (total)	↓	<1.	↓
Chloroform	↓	↓	↓
1,2-Dichloroethane	↓	↓	↓
1,1,1-Trichloroethane	↓	9.	↓
Carbon tetrachloride	↓	<1.	↓
Bromodichloromethane	↓	↓	↓
1,2-Dichloropropane	↓	↓	↓
cis-1,3-Dichloropropene	↓	↓	↓
Trichloroethene	↓	↓	↓
Benzene	↓	10.	42.
Dibromochloromethane	↓	<1.	<1.
1,1,2-Trichloroethane	↓	↓	↓
trans-1,3-Dichloropropene	↓	↓	↓
2-Chloroethylvinyl ether	<10.	<10.	<10.

Authorized: Monika Santucci

Date: January 6, 1993

OBG
LABORATORIES, INC.

Purgeable Organics
Method 601/602

CLIENT U.S. NAVY **JOB NO.** 3543.001.517

DESCRIPTION Camp Lejeune-[redacted], NC
Tarawa Terrace **MATRIX:** Water

DATE COLLECTED 12-11-92 **DATE RECEIVED** 12-14-92 **DATE ANALYZED** 12-17,21,22-92

DESCRIPTION:	H-11	H-12	H-13			
SAMPLE NO.:	R1318	R1319	R1320			
Bromoform	<10.	<10.	<10.			
1,1,2,2-Tetrachloroethane	<1.	<1.	<1.			
Tetrachloroethene	↓	2.	<1.			
Toluene	↓	100.	8.			
Chlorobenzene	↓	<1.	<1.			
Ethylbenzene	↓	33.	3.			
Xylene (total)	<3.	170.	12.			
1,2-Dichlorobenzene	<5.	<5.	<5.			
1,3-Dichlorobenzene	↓	↓	↓			
1,4-Dichlorobenzene	↓	↓	↓			

Comments:

Methodology: Federal Register — 40 CFR, Part 136, October 26, 1984

Certification No.: 315

Units: µg/1

Page 2 of 2

Authorized: Monika Santucci

Date: January 6, 1993

OBG
LABORATORIES, INC.

Purgeable Organics
Method 601 / 602

CLIENT U.S. NAVY **JOB NO.** 3543.001.517

DESCRIPTION Tarawa Terrace, Camp Lejeune, NC

MATRIX: Water

DATE COLLECTED 12-14,17-92 **DATE RECEIVED** 12-21-92 **DATE ANALYZED** 12-29,30-92

DESCRIPTION:	H-14	H-15	H-16	MW-15	MW-16	MW-17
SAMPLE NO.:	R1651*	R1652	R1653	R1654	R1655	R1656
Chloromethane	<10.	<10.	<10.	<10.	<10.	<10.
Bromomethane	↓	↓	↓	↓	↓	↓
Dichlorodifluoromethane	↓	↓	↓	↓	↓	↓
Vinyl chloride	<1.	<1.	<1.	<1.	<1.	<1.
Chloroethane	↓	↓	↓	↓	↓	↓
Methylene chloride	↓	↓	↓	↓	↓	↓
Trichlorofluoromethane	↓	↓	↓	↓	↓	↓
1,1-Dichloroethene	↓	↓	↓	↓	↓	↓
1,1-Dichloroethane	↓	↓	↓	↓	↓	↓
1,2-Dichloroethene (total)	↓	↓	↓	↓	↓	↓
Chloroform	↓	↓	↓	↓	2.	↓
1,2-Dichloroethane	↓	↓	↓	↓	<1.	↓
1,1,1-Trichloroethane	↓	↓	↓	↓	↓	↓
Carbon tetrachloride	↓	↓	↓	↓	↓	↓
Bromodichloromethane	↓	↓	↓	↓	↓	↓
1,2-Dichloropropane	↓	↓	↓	↓	↓	↓
cis-1,3-Dichloropropene	↓	↓	↓	↓	↓	↓
Trichloroethene	↓	↓	↓	↓	↓	↓
Benzene	2.	↓	2.	↓	↓	↓
Dibromochloromethane	<1.	↓	<1.	↓	↓	↓
1,1,2-Trichloroethane	↓	↓	↓	↓	↓	↓
trans-1,3-Dichloropropene	↓	↓	↓	↓	↓	↓
2-Chloroethylvinyl ether	<10.	<10.	<10.	<10.	<10.	<10.

Authorized: Mirka Santucci

Date: January 19, 1993

OBG LABORATORIES, INC.

Purgeable Organics
Method 601/602

CLIENT U.S. NAVY **JOB NO.** 3543.001.517

DESCRIPTION Tarawa Terrace, Camp Lejeune, NC

MATRIX: Water

DATE COLLECTED 12-14,17-92 **DATE RECEIVED** 12-21-92 **DATE ANALYZED** 12-29,30-92

DESCRIPTION:	H-14	H-15	H-16	MW-15	MW-16	MW-17
SAMPLE NO.:	R1651*	R1652	R1653	R1654	R1655	R1656
Bromoform	<10.	<10.	<10.	<10.	<10.	<10.
1,1,2,2-Tetrachloroethane	<1.	<1.	<1.	<1.	<1.	<1.
Tetrachloroethene	↓	↓	↓	<1.	↓	↓
Toluene	↓	↓	↓	9.	↓	↓
Chlorobenzene	↓	↓	↓	<1.	↓	↓
Ethylbenzene	↓	↓	↓	10.	↓	↓
Xylene (total)	<3.	<3.	<3.	19.	<3.	<3.
1,2-Dichlorobenzene	<5.	<5.	<5.	<5.	<5.	<5.
1,3-Dichlorobenzene	↓	↓	↓	↓	↓	↓
1,4-Dichlorobenzene	↓	↓	↓	↓	↓	↓

Comments: *Analyzed 1 day beyond prescribed holding time.

Methodology: Federal Register — 40 CFR, Part 136, October 26, 1984

Certification No.: 315

Units: µg/1

Authorized:

Date: January 19, 1993

OBG Laboratories, Inc., *an O'Brien & Gere Limited Company*
5000 Brittonfield Parkway / Suite 300, Box 4942 / Syracuse, NY 13221 / (315) 437-0200

OBG
LABORATORIES, INC.

Purgeable Organics
Method 601/602

CLIENT U.S. NAVY JOB NO. 3543.001.517

DESCRIPTION Tarawa Terrace, Camp Lejeune, NC

MATRIX: Water

DATE COLLECTED 12-17-92 DATE RECEIVED 12-21-92 DATE ANALYZED 12-30,31-92

DESCRIPTION:	MW-18	MW-19	MW-20	MW-20 Duplicate	Field Blank	QC Trip Blank
SAMPLE NO.:	R1657	R1658	R1659	R1660	R1661	R1662
Chloromethane	<10.	<10.	<10.	<10.	<10.	<10.
Bromomethane	↓	↓	↓	↓	↓	↓
Dichlorodifluoromethane	↓	↓	↓	↓	↓	↓
Vinyl chloride	<1.	<1.	<1.	<1.	<1.	<1.
Chloroethane	↓	↓	↓	↓	↓	↓
Methylene chloride	↓	↓	↓	↓	↓	↓
Trichlorofluoromethane	↓	↓	↓	↓	↓	↓
1,1-Dichloroethene	↓	↓	↓	↓	↓	↓
1,1-Dichloroethane	↓	↓	↓	↓	↓	↓
1,2-Dichloroethene (total)	↓	↓	↓	↓	↓	↓
Chloroform	↓	↓	↓	↓	↓	↓
1,2-Dichloroethane	↓	↓	↓	↓	↓	↓
1,1,1-Trichloroethane	↓	↓	↓	↓	↓	↓
Carbon tetrachloride	↓	↓	↓	↓	↓	↓
Bromodichloromethane	↓	↓	↓	↓	↓	↓
1,2-Dichloropropane	↓	↓	↓	↓	↓	↓
cis-1,3-Dichloropropene	↓	↓	↓	↓	↓	↓
Trichloroethene	↓	↓	↓	↓	↓	↓
Benzene	7.	↓	1.	1.	↓	↓
Dibromochloromethane	<1.	↓	<1.	<1.	↓	↓
1,1,2-Trichloroethane	↓	↓	↓	↓	↓	↓
trans-1,3-Dichloropropene	↓	↓	↓	↓	↓	↓
2-Chloroethylvinyl ether	<10.	<10.	<10.	<10.	<10.	<10.

Authorized:

Date: January 19, 1993

OBG
LABORATORIES, INC.

Purgeable Organics
Method 601/602

CLIENT U.S. NAVY **JOB NO.** 3543.001.517

DESCRIPTION Tarawa Terrace, Camp Lejeune, NC

MATRIX: Water

DATE COLLECTED 12-17-92 **DATE RECEIVED** 12-21-92 **DATE ANALYZED** 12-30,31-92

DESCRIPTION:	MW-18	MW-19	MW-20	MW-20 Duplicate	Field Blank	QC Trip Blank
SAMPLE NO.:	R1657	R1658	R1659	R1660	R1661	R1662
Bromoform	<10.	<10.	<10.	<10.	<10.	<10.
1,1,2,2-Tetrachloroethane	<1.	<1.	<1.	<1.	<1.	<1.
Tetrachloroethene	↓	↓	↓	↓	↓	↓
Toluene						
Chlorobenzene						
Ethylbenzene						
Xylene (total)	<3.	<3.	<3.	<3.	<3.	<3.
1,2-Dichlorobenzene	<5.	<5.	<5.	<5.	<5.	<5.
1,3-Dichlorobenzene	↓	↓	↓	↓	↓	↓
1,4-Dichlorobenzene						

Comments:

Methodology: Federal Register — 40 CFR, Part 136, October 26, 1984

Certification No.: 315

Units: µg/l

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Authorized: Monika Santucci

Date: January 19, 1993

APPENDIX C

LABORATORY RESULTS
SOIL

ENVIRONMENTAL TESTING SERVICES, INC.
P.O. Box 12715 • 888 Norfolk Square • Norfolk, Virginia 23502 • (804) 461-ETSI (3874) • Fax (804) 461-0379

January 16, 1992
Page 1 of 6

ANALYTICAL SERVICES REPORT SHEET

Customer:
Ms. Tina Bickerstaff
O'Brien & Gere Engineers, Inc.
440 Viking Drive
Virginia Beach, Virginia 23452

Sample Description:
6 soil samples delivered on December 19, 1991 designated as Tarawa Terrace.

RESULTS

I. **Total Petroleum Hydrocarbons**: California Method, GC/FID.

Sample ID	TPH in mg/kg
MW2 14-16(TT)	9.58
MW2 9-11(TT)	9.76
MW4 14-16(TT)	9.69
MW4 9-11(TT)	13.2
MW6 14-16(TT)	12.3
MW6 9-11(TT)	6.97

Anne S Burnett
Anne S. Burnett
Quality Control Officer

II. pH Analysis: EPA Method 150.1.

Sample ID	pH
MW2 14-16(TT)	4.14
MW4 14-16(TT)	5.31
MW6 14-16(TT)	4.99

III. Flashpoint: EPA SW-846 Method 1010.

Sample ID	Results
MW2 14-16(TT)	Negative to 110°C
MW4 14-16(TT)	Negative to 110°C
MW6 14-16(TT)	Negative to 110°C

IV. Toxicity Characteristic Leaching Process (TCLP): EPA SW-846 Method 1311.

Sample ID	Results
MW2 14-16(TT)	See attached compound list
MW6 14-16(TT)	See attached compound list

Anne L Burnett
Anne S. Burnett
Quality Control Officer

The information presented in the report represents the laboratory analyses performed on the samples provided to Environmental Testing Services, Inc. in accordance with the test methods requested and described above. Environmental Testing Services, Inc. is not responsible for any use of this information by its clients and shall not reveal these results to any person or entity without written authorization from its client. Any liability on the part of Environmental Testing Services, Inc. shall not exceed the sum paid by the client to Environmental Testing Services, Inc for the work performed.

TOXICITY CHARACTERISTICS LEACHING PROCESS (TCLP) CONSTITUENT AND REGULATORY LEVELS

<u>Toxicity Characteristic Leaching Process (TCLP)</u>: EPA Manual SW-846 Method 1311.

Sample ID: MW2 14-16(TT)

Compound	Concentration (mg/l)	Regulatory Level (mg/l)
Arsenic	<0.050	5.0
Barium	0.933	100.0
Benzene	<0.009	0.5
Cadium	<0.010	1.0
Carbon tetrachloride	<0.005	0.5
Chlordane	<0.008	0.03
Chlorobenzene	<0.005	100.0
Chloroform	<0.005	6.0
Chromium	<0.050	5.0
o-Cresol	<0.020	200.0
m-Cresol	<0.040	200.0
p-Cresol	<0.040	200.0
Cresol	<0.005	200.0
2,4-D	<0.010	10.0
1,4-Dichlorobenzene	<0.005	7.5
1,2-Dichloroethane	<0.005	0.5
1,1-Dichloroethylene	<0.005	0.7
2,4-Dinitrotoluene	<0.008	0.13

Anne S. Burnett

Anne S. Burnett
Quality Control Officer

TOXICITY CHARACTERISTICS LEACHING PROCESS (TCLP) CONSTITUENT AND REGULATORY LEVELS CONTINUED

Sample ID: MW2 14-16(TT)

Compound	Concentration (mg/l)	Regulatory Level (mg/l)
Endrin	<0.005	0.02
Heptachlor (and its hydroxide)	<0.004	0.008
Hexachlorobenzene	<0.010	0.13
Hexachloro-1,3-butadiene	<0.010	0.5
Hexachloroethane	<0.010	3.0
Lead	<0.010	5.0
Lindane	<0.002	0.4
Mercury	<0.002	0.2
Methoxychlor	<0.010	10.0
Methyl ethyl ketone	<0.005	200.0
Nitrobenzene	<0.010	2.0
Pentachlorophenol	<0.020	100.0
Pyridine	<0.010	5.0
Selenium	<0.050	1.0
Silver	<0.010	5.0
Tetrachloroethylene	<0.005	0.7
Toxaphene	<0.010	0.5
Trichloroethylene	<0.005	0.5
2,4,5-Trichlorophenol	<0.010	400.0
2,4,6-Trichlorophenol	<0.010	2.0
2,4,5-TP (Silvex)	<0.005	1.0
Vinyl chloride	<0.010	0.2

Anne S. Burnett

Anne S. Burnett
Quality Control Officer

TOXICITY CHARACTERISTICS LEACHING PROCESS (TCLP) CONSTITUENT AND REGULATORY LEVELS

Toxicity Characteristic Leaching Process (TCLP): EPA Manual SW-846 Method 1311.

Sample ID: MW6 14-16(TT)

Compound	Concentration (mg/l)	Regulatory Level (mg/l)
Arsenic	<0.050	5.0
Barium	0.822	100.0
Benzene	<0.009	0.5
Cadium	<0.010	1.0
Carbon tetrachloride	<0.005	0.5
Chlordane	<0.008	0.03
Chlorobenzene	<0.005	100.0
Chloroform	<0.005	6.0
Chromium	<0.050	5.0
o-Cresol	<0.020	200.0
m-Cresol	<0.040	200.0
p-Cresol	<0.040	200.0
Cresol	<0.005	200.0
2,4-D	<0.010	10.0
1,4-Dichlorobenzene	<0.005	7.5
1,2-Dichloroethane	<0.005	0.5
1,1-Dichloroethylene	<0.005	0.7
2,4-Dinitrotoluene	<0.008	0.13

Anne S. Burnett

Anne S. Burnett
Quality Control Officer

The information presented in the report represents the laboratory analyses performed on the samples provided to Environmental Testing Services, Inc. in accordance with the test methods requested and described above. Environmental Testing Services, Inc. is not responsible for any use of this information by its clients and shall not reveal these results to any person or entity without written authorization from its client. Any liability on the part of Environmental Testing Services, Inc. shall not exceed the sum paid by the client to Environmental Testing Services, Inc.

TOXICITY CHARACTERISTICS LEACHING PROCESS (TCLP)
CONSTITUENT AND REGULATORY LEVELS
CONTINUED

Sample ID: MW6 14-16(TT)

Compound	Concentration (mg/l)	Regulatory Level (mg/l)
Endrin	<0.005	0.02
Heptachlor (and its hydroxide)	<0.004	0.008
Hexachlorobenzene	<0.010	0.13
Hexachloro-1,3-butadiene	<0.010	0.5
Hexachloroethane	<0.010	3.0
Lead	<0.010	5.0
Lindane	<0.002	0.4
Mercury	<0.002	0.2
Methoxychlor	<0.010	10.0
Methyl ethyl ketone	<0.005	200.0
Nitrobenzene	<0.010	2.0
Pentachlorophenol	0.179	100.0
Pyridine	<0.010	5.0
Selenium	<0.050	1.0
Silver	<0.010	5.0
Tetrachloroethylene	<0.005	0.7
Toxaphene	<0.010	0.5
Trichloroethylene	<0.005	0.5
2,4,5-Trichlorophenol	<0.010	400.0
2,4,6-Trichlorophenol	<0.010	2.0
2,4,5-TP (Silvex)	<0.005	1.0
Vinyl chloride	<0.010	0.2

Anne S. Burnett

Anne S. Burnett
Quality Control Officer

ENVIRONMENTAL TESTING SERVICES, INC.

P.O. Box 12715 • 888 Norfolk Square • Norfolk, Virginia 23502 • (804) 461-ETSI (3874) • Fax (804) 461-0379

January 28, 1992
Page 1 of 6

ANALYTICAL SERVICES REPORT SHEET

Customer:
Ms. Tina Bickerstaff
O'Brien & Gere Engineers, Inc.
440 Viking Drive
Virginia Beach, Virginia 23452

Sample Description:
17 soil samples delivered on January 14, 1992 designated as Tarawa Terrace Sampling Program.

RESULTS

I. **Total Petroleum Hydrocarbons**: California Method, GC/FID.

Sample ID	TPH in mg/kg
B1 0-2	1.85
B1 4-6	<1.00
B2 2-4	<1.00
B2 6-8	<1.00
B3 2-4	1.78
B3 6-8	1.37
B4 0-2	1.77
B4 4-6	3.91
MW8 4-6	<1.00
MW8 9-11	<1.00
MW10 0-2	<1.00
MW10 4-6	<1.00
MW12 0-2	<1.00
MW12 4-6	<1.00
MW14 0-2	2.77
MW14 4-6	1.16

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II. **pH Analysis**: EPA Method 150.1.

Sample ID	pH
MW14 4-6	4.80
MW8 9-11	5.41

III. **Flashpoint**: EPA SW-846 Method 1010.

Sample ID	Flashpoint
MW14 4-6	Negative to 110°C
MW8 9-11	Negative to 110°C

IV. **Toxicity Characteristic Leaching Process (TCLP)**: EPA SW-846 Method 1311.

Sample ID	Results
MW8 9-11	See attached compound list
Composite	See attached compound list

Anne S. Burnett

Anne S. Burnett
Quality Control Officer

The information presented in the report represents the laboratory analyses performed on the samples provided to Environmental Testing Services, Inc. in accordance with the test methods requested and described above. Environmental Testing Services, Inc. is not responsible for any use of this information by its clients and shall not reveal these results to any person or entity without written authorization from its client. Any liability on the part of Environmental Testing Services, Inc. shall not exceed the sum paid by the client to Environmental Testing Services, Inc for the work performed.

TOXICITY CHARACTERISTICS LEACHING PROCESS (TCLP)
CONSTITUENT AND REGULATORY LEVELS

Toxicity Characteristic Leaching Process (TCLP): EPA Manual SW-846 Method 1311.

Sample ID: MW8 9-11

Compound	Concentration (mg/l)	Regulatory Level (mg/l)
Arsenic	<0.050	5.0
Barium	2.16	100.0
Benzene	<0.009	0.5
Cadium	<0.010	1.0
Carbon tetrachloride	<0.005	0.5
Chlordane	<0.008	0.03
Chlorobenzene	<0.005	100.0
Chloroform	<0.005	6.0
Chromium	<0.050	5.0
o-Cresol	<0.020	200.0
m-Cresol	<0.040	200.0
p-Cresol	<0.040	200.0
Cresol	<0.005	200.0
2,4-D	<0.010	10.0
1,4-Dichlorobenzene	<0.005	7.5
1,2-Dichloroethane	<0.005	0.5
1,1-Dichloroethylene	<0.005	0.7
2,4-Dinitrotoluene	<0.008	0.13

Anne S. Burnett

Anne S. Burnett
Quality Control Officer

TOXICITY CHARACTERISTICS LEACHING PROCESS (TCLP)
CONSTITUENT AND REGULATORY LEVELS
CONTINUED

Sample ID: MW8 9-11

Compound	Concentration (mg/l)	Regulatory Level (mg/l)
Endrin	<0.005	0.02
Heptachlor (and its hydroxide)	<0.004	0.008
Hexachlorobenzene	<0.010	0.13
Hexachloro-1,3-butadiene	<0.010	0.5
Hexachloroethane	<0.010	3.0
Lead	<0.010	5.0
Lindane	<0.002	0.4
Mercury	<0.002	0.2
Methoxychlor	<0.010	10.0
Methyl ethyl ketone	<0.005	200.0
Nitrobenzene	<0.010	2.0
Pentachlorophenol	<0.020	100.0
Pyridine	<0.010	5.0
Selenium	<0.050	1.0
Silver	<0.010	5.0
Tetrachloroethylene	<0.005	0.7
Toxaphene	<0.010	0.5
Trichloroethylene	<0.005	0.5
2,4,5-Trichlorophenol	<0.010	400.0
2,4,6-Trichlorophenol	<0.010	2.0
2,4,5-TP (Silvex)	<0.005	1.0
Vinyl chloride	<0.010	0.2

Anne S Burnett

Anne S. Burnett
Quality Control Officer

TOXICITY CHARACTERISTICS LEACHING PROCESS (TCLP) CONSTITUENT AND REGULATORY LEVELS

Toxicity Characteristic Leaching Process (TCLP): EPA Manual SW-846 Method 1311.

Sample ID: Composite

Compound	Concentration (mg/l)	Regulatory Level (mg/l)
Arsenic	<0.050	5.0
Barium	1.12	100.0
Benzene	<0.009	0.5
Cadium	<0.010	1.0
Carbon tetrachloride	<0.005	0.5
Chlordane	<0.008	0.03
Chlorobenzene	<0.005	100.0
Chloroform	<0.005	6.0
Chromium	<0.050	5.0
o-Cresol	<0.020	200.0
m-Cresol	<0.040	200.0
p-Cresol	<0.040	200.0
Cresol	<0.005	200.0
2,4-D	<0.010	10.0
1,4-Dichlorobenzene	<0.005	7.5
1,2-Dichloroethane	<0.005	0.5
1,1-Dichloroethylene	<0.005	0.7
2,4-Dinitrotoluene	<0.008	0.13

Anne S. Burnett

Anne S. Burnett
Quality Control Officer

TOXICITY CHARACTERISTICS LEACHING PROCESS (TCLP)
CONSTITUENT AND REGULATORY LEVELS
CONTINUED

Sample ID: Composite

Compound	Concentration (mg/l)	Regulatory Level (mg/l)
Endrin	<0.005	0.02
Heptachlor (and its hydroxide)	<0.004	0.008
Hexachlorobenzene	<0.010	0.13
Hexachloro-1,3-butadiene	<0.010	0.5
Hexachloroethane	<0.010	3.0
Lead	<0.010	5.0
Lindane	<0.002	0.4
Mercury	<0.002	0.2
Methoxychlor	<0.010	10.0
Methyl ethyl ketone	<0.005	200.0
Nitrobenzene	<0.010	2.0
Pentachlorophenol	<0.020	100.0
Pyridine	<0.010	5.0
Selenium	<0.050	1.0
Silver	<0.010	5.0
Tetrachloroethylene	<0.005	0.7
Toxaphene	<0.010	0.5
Trichloroethylene	<0.005	0.5
2,4,5-Trichlorophenol	<0.010	400.0
2,4,6-Trichlorophenol	<0.010	2.0
2,4,5-TP (Silvex)	<0.005	1.0
Vinyl chloride	<0.010	0.2

Anne S Burnett

Anne S. Burnett
Quality Control Officer

ENVIRONMENTAL TESTING SERVICES, INC.

P.O. Box 12715 • 888 Norfolk Square • Norfolk, Virginia 23502 • (804) 461-ETSI (3874) • Fax (804) 461-0379

January 5, 1993
Page 1 of 2

Customer:
Ms. Tina Bickerstaff
O'Brien & Gere Engineers, Inc.
440 Viking Drive
Virginia Beach, Virginia 23452

Sample Description:
Designation: Tarawa Terrace
Sample site: MCB Lejeune
Sampled by: TB
Samples collected:
December 9 & 11, 1992
Matrix: Soil
No. of samples: 8

CERTIFICATE OF ANALYSIS

ETS ID#	Sample ID	Analysis	Method	Results	Det. Limit	Units	Date/ Time Analyzed	Analyst
25198	MW 16 4-6	TPH	5030/8020	U	1	mg/kg	12-18-92/15:37	PK
25198	MW 16 4-6	TPH	3550/8015 mod.	U	1	mg/kg	12-21-92/11:00	LX
25199	MW 16 6-8	TPH	5030/8020	U	1	mg/kg	12-18-92/17:00	PK
25199	MW 16 6-8	TPH	3550/8015 mod.	U	1	mg/kg	12-21-92/11:00	LX
25199	MW 16 6-8	Flash	1010	>140°	---	°F	12-15-92/12:30	DF
25199	MW 16 6-8	pH	9045	4.86	---	---	12-15-92/12:00	MS
25200	MW 18 6-8	TPH	5030/8020	U	1	mg/kg	12-18-92/ ---	PK
25200	MW 18 6-8	TPH	3550/8015 mod.	U	1	mg/kg	12-21-92/11:00	LX
25201	MW 18 10-12	TPH	5030/8020	U	1	mg/kg	12-18-92/19:48	PK
25201	MW 18 10-12	TPH	3550/8015 mod.	U	1	mg/kg	12-21-92/11:00	LX
25201	MW 18 10-12	Flash	1010	>140°	---	°F	12-15-92/12:30	DF
25201	MW 18 10-12	pH	9045	4.70	---	---	12-15-92/12:00	MS
25202	MW 20 6-8	TPH	5030/8020	U	1	mg/kg	12-18-92/21:13	PK
25202	MW 20 6-8	TPH	3550/8015 mod.	U	1	mg/kg	12-21-92/11:00	LX
25203	MW 20 10-12	TPH	5030/8020	U	1	mg/kg	12-18-92/22:37	PK
25203	MW 20 10-12	TPH	3550/8015 mod.	U	1	mg/kg	12-21-92/11:00	LX
25203	MW 20 10-12	Flash	1010	>140°	---	°F	12-15-92/12:30	DF
25203	MW 20 10-12	pH	9045	5.31	---	---	12-15-92/12:00	MS
25204	TW 0-2	TPH	5030/8020	U	1	mg/kg	12-19-92/00:01	PK
25204	TW 0-2	TPH	3550/8015 mod.	12	1	mg/kg	12-21-92/11:00	LX
25205	TW 4-6	TPH	5030/8020	U	1	mg/kg	12-19-92/01:24	PK
25205	TW 4-6	TPH	3550/8015 mod.	U	1	mg/kg	12-21-92/11:00	LX

U = Not detected above quantitation limit

Geoffrey C. Hinshelwood
Geoffrey C. Hinshelwood
Laboratory Manager

RECEIVED
JAN [illegible]
O'Brien & Gere Engineers, Inc.
Virginia Beach, VA.

ETS ID#	Sample ID	Analysis	Method	Results	Det. Limit	Regulatory Level	Units
25203	MW 20 10-12	Arsenic	1311	U	0.05	5.0	mg/l
25203	MW 20 10-12	Barium	1311	0.641	0.005	100.0	mg/l
25203	MW 20 10-12	Benzene	1311	U	0.009	0.5	mg/l
25203	MW 20 10-12	Cadmium	1311	U	0.01	1.0	mg/l
25203	MW 20 10-12	Carbon tetrachloride	1311	U	0.005	0.5	mg/l
25203	MW 20 10-12	Chlordane	1311	U	0.008	0.03	mg/l
25203	MW 20 10-12	Chlorobenzene	1311	U	0.005	100.0	mg/l
25203	MW 20 10-12	Chloroform	1311	U	0.005	6.0	mg/l
25203	MW 20 10-12	Chromium	1311	U	0.05	5.0	mg/l
25203	MW 20 10-12	o-Cresol	1311	U	0.02	200.0	mg/l
25203	MW 20 10-12	m-Cresol	1311	U	0.04	200.0	mg/l
25203	MW 20 10-12	p-Cresol	1311	U	0.04	200.0	mg/l
25203	MW 20 10-12	Cresol	1311	U	0.005	200.0	mg/l
25203	MW 20 10-12	2,4-D	1311	U	0.010	10.0	mg/l
25203	MW 20 10-12	1,4-Dichlorobenzene	1311	U	0.005	7.5	mg/l
25203	MW 20 10-12	1,2-Dichloroethane	1311	U	0.005	0.5	mg/l
25203	MW 20 10-12	1,1-Dichloroethylene	1311	U	0.005	0.7	mg/l
25203	MW 20 10-12	2,4-Dinitrotoluene	1311	U	0.008	0.13	mg/l
25203	MW 20 10-12	Endrin	1311	U	0.005	0.02	mg/l
25203	MW 20 10-12	Heptachlor	1311	U	0.004	0.008	mg/l
25203	MW 20 10-12	Hexachlorobenzene	1311	U	0.010	0.13	mg/l
25203	MW 20 10-12	Hexachloro-1,3-butadiene	1311	U	0.010	0.5	mg/l
25203	MW 20 10-12	Hexachloroethane	1311	U	0.010	3.0	mg/l
25203	MW 20 10-12	Lead	1311	U	0.01	5.0	mg/l
25203	MW 20 10-12	Lindane	1311	U	0.002	0.4	mg/l
25203	MW 20 10-12	Mercury	1311	U	0.002	0.2	mg/l
25203	MW 20 10-12	Methoxychlor	1311	U	0.010	10.0	mg/l
25203	MW 20 10-12	Methyl ethyl ketone	1311	U	0.005	200.0	mg/l
25203	MW 20 10-12	Nitrobenzene	1311	U	0.010	2.0	mg/l
25203	MW 20 10-12	Pentachlorophenol	1311	U	0.020	100.0	mg/l
25203	MW 20 10-12	Pyridine	1311	U	0.010	5.0	mg/l
25203	MW 20 10-12	Selenium	1311	U	0.05	1.0	mg/l
25203	MW 20 10-12	Silver	1311	U	0.01	5.0	mg/l
25203	MW 20 10-12	Tetrachloroethylene	1311	U	0.005	0.7	mg/l
25203	MW 20 10-12	Toxaphene	1311	U	0.010	0.5	mg/l
25203	MW 20 10-12	Trichloroethylene	1311	U	0.005	0.5	mg/l
25203	MW 20 10-12	2,4,5-Trichlorophenol	1311	U	0.010	400.0	mg/l
25203	MW 20 10-12	2,4,6-Trichlorophenol	1311	U	0.010	2.0	mg/l
25203	MW 20 10-12	2,4,5-TP (Silvex)	1311	U	0.005	1.0	mg/l
25203	MW 20 10-12	Vinyl chloride	1311	U	0.010	0.2	mg/l

U = Not detected above quantitation limit

Geoffrey C. Hinshelwood
Laboratory Manager

APPENDIX D

IN-SITU PERMEABILITY

IN-SITU HYDRAULIC CONDUCTIVITY TEST PROTOCOL

Introduction

The following presents the methods and procedures to be employed in completing in-situ hydraulic conductivity (K) tests. The purpose of the test is to obtain estimates of aquifer permeability which in turn will be used to estimate ground water flow velocity. A Quality Control/Quality Assurance (QA/QC) program for the K-tests has also been formulated and is presented herein.

Testing Methods and Procedures

Potential Hydraulic Difference Creation:

To complete an in-situ hydraulic conductivity (K) test, a potential hydraulic difference must be created between the well being monitored and the surrounding aquifer. This will be accomplished by rapidly inserting a solid piece of one-inch (1") diameter PVC into the well's water column, thereby displacing the water column upward and creating a potential for flow from the well to the surrounding aquifer. The rate of decline of the water level in the well will be monitored as it comes into equilibrium with the aquifer. Subsequent to the well water level approaching the hydraulic head static level, the displacing rod will be removed. This will result in a water level in the well that is lower than the surrounding aquifer and therefore will create a potential for flow from the aquifer into the well. This recovery will also be monitored until the static level is approached.

Revised
6/26/91

Ground Water Level Monitoring Equipment and Time Sequence:

Ground water levels during the tests will be monitored using an Enviro-Labs Data Logging System which employs a conventional analog signal generating pressure reducing that directly measures feet of hydraulic head to the one-hundredth (0.01) of a foot. During the tests, ground water level (hydraulic head) data will be collected for both the head decline and recovery periods according to the following time schedule:

Time After Potential Difference Induced	Time Between Water Level Readings
0 - 1 minutes	2 seconds
1 - 3 minutes	5 seconds
3 - 5 minutes	15 seconds
5 - 10 minutes	30 seconds
10 - 30 minutes	60 seconds

Note: It is anticipated that the well's water level will be near the pre-test measured static level after thirty (30) minutes.

Step by Step Testing Procedure:

1. Install pressure transducer and couple to data logging unit, noting depth installed.
2. Measure and record static ground water level in well to be tested.
3. Insert displacing rod.
4. Monitor water level declines to static level.
5. Remove displacing rod.
6. Monitor water level recovery.

Manual Methods

Under some field conditions, it may be appropriate to conduct in-situ conductivity testing manually without the aid of an electronic data logger. In these instances, the following procedures will be utilized:

1. The depth to ground water will be measured.
2. A potential hydraulic difference will be created by bailing or pumping ground water from the well to be measured.
3. Subsequent ground water recovery will be measured at appropriate intervals as determined by the field geologist.
4. Depth to ground water will be measured to the nearest 0.01 foot.
5. Measurements will be obtained until ground water has recovered to its static level or, if site conditions warrant, a minimum of 90% of the static level.

Equipment Decontamination

Following each respective test, equipment coming in contact with ground water will be decontaminated. This will be accomplished using a mild soap solution wash followed by a control source water rinse.

Quality Assurance/Quality Control Program

The objective of the Quality Assurance/Quality Control program is to ensure that the in-situ hydraulic conductivity (k) test data is of a known and acceptable quality. This will be accomplished by completing the following:

1. Daily manufacturer-specified pressure transducer and data logging instrument calibration,
2. Periodic physical ground water level measurements collected at five (5) minute intervals during the test to cross check pressure transducer readings.

Data Analysis

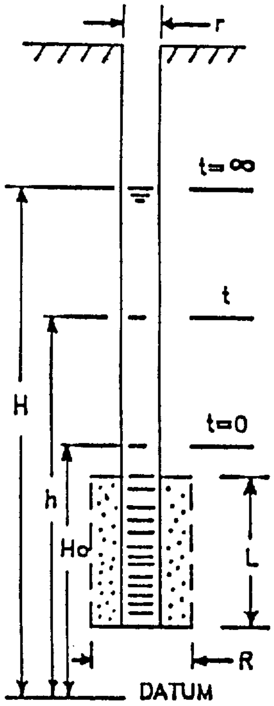
Values of hydraulic conductivity will be calculated from the change in head versus the change in time data using Hvorselv's formula.

Revised
6/26/91

IN–SITU PERMEABILITY TEST
FIELD LOG

PROJECT II61-66
WELL NUMBER mW1
DATE 1-8-92

LOCATION Tarawa Terrace
ELEVATION



STATIC HEAD (H) 6.27

PIPE RADIUS (r) .08

SCREEN RADIUS (R) .35

SCREEN LENGTH (L) 8.73

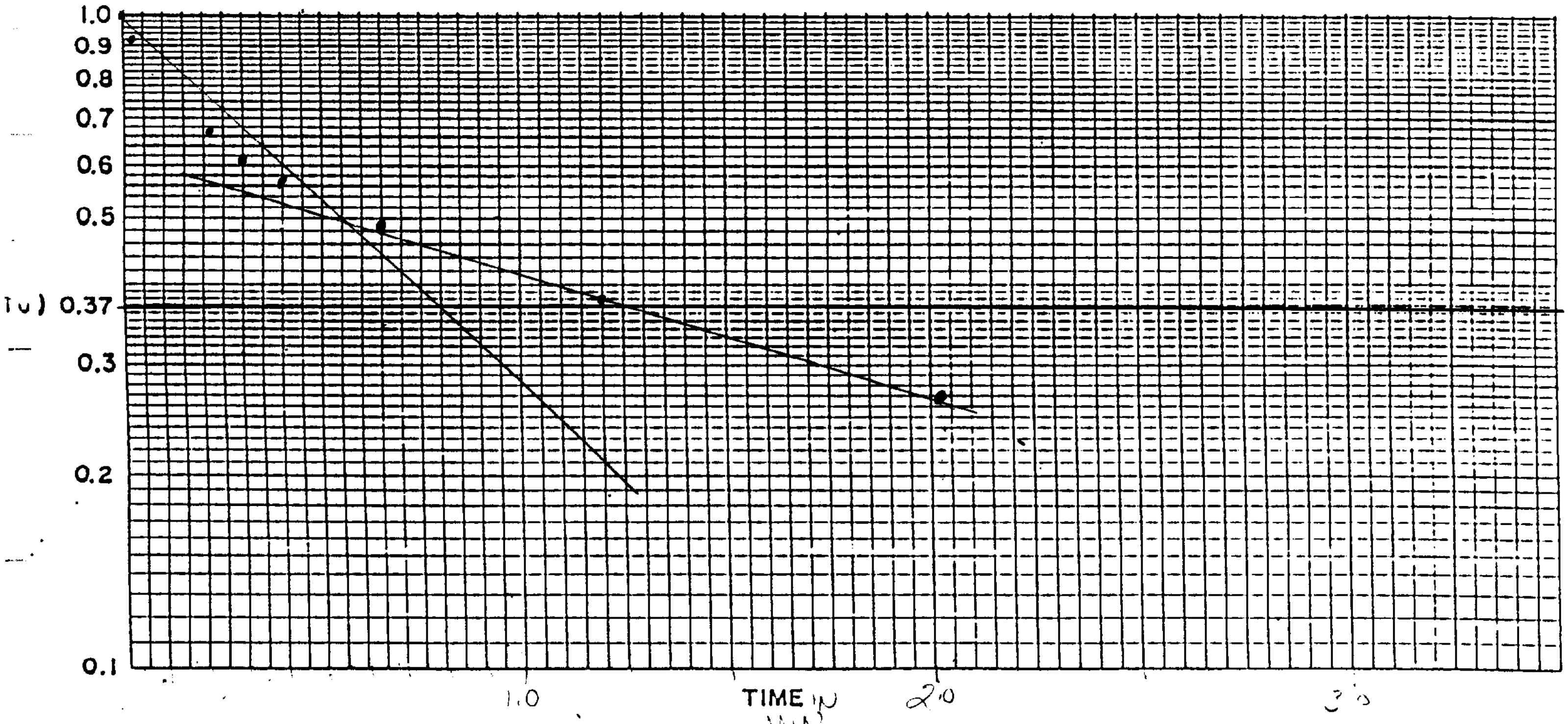
INITIAL HEAD (Ho) 16.0

HYDRAULIC CONDUCTIVITY :

$$K=\frac{r^2\ln(L/R)}{2LTo}$$

$$K=\frac{(.08^2)\ln\left(8.73/.35\right)=.02}{2(8.73\cdot 61.5)=1073.79}=1.9\times10^{-5}\text{ft/sec}\,(6.464\times10^{5})=12.4\text{ gpd/ft}^2$$

TIME sec	WATER DEPTH	t min	h	$\frac{H-h}{H-Ho}$ -9.73
0		0	16	1
2		.03	15.2	.92
13		.22	12.8	.67
18		.30	12.2	.61
24		.40	11.8	.57
39		.65	11.0	.49
72		1.20	10.0	.38
124		2.07	9.0	.28
216		3.60	8.0	.18
326		5.43	7.0	.07

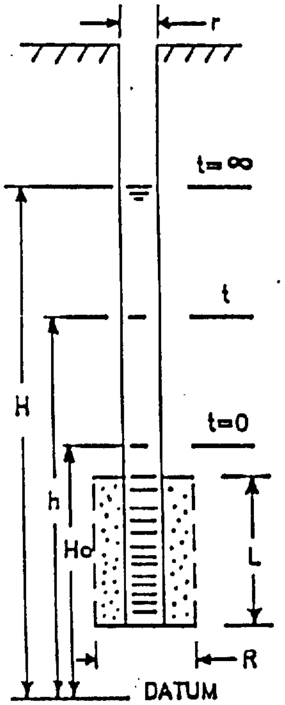


To=.80min=48sec To=1.25min=75sec x̄=61.5

IN–SITU PERMEABILITY TEST
FIELD LOG

PROJECT TT 61-66
WELL NUMBER mw2
DATE 1-8-92

LOCATION Tarawa Terrace
ELEVATION



STATIC HEAD (H) 6.57

PIPE RADIUS (r) .08

SCREEN RADIUS (R) .35

SCREEN LENGTH (L) 10

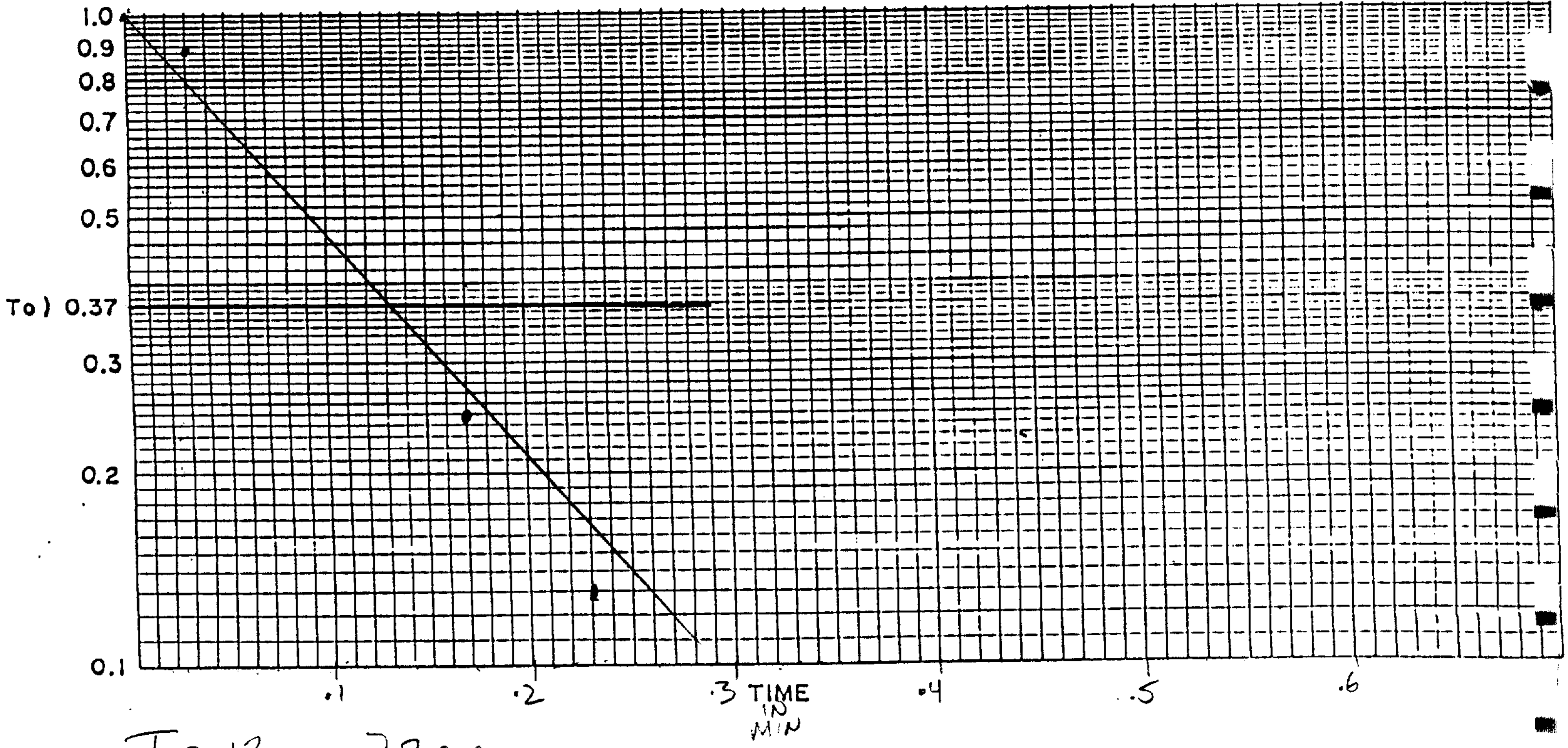
INITIAL HEAD (Ho) 11.5

HYDRAULIC CONDUCTIVITY :

$$K=\frac{r^2\ln(L/R)}{2LTo}$$

$$K=\frac{(.08)^2\ln(10/.35)=.02}{2(10\cdot7.8)=156} \quad 1.4\times10^{-4}\,ft/sec\,(6464\times10^{5})=88.9\,gpd/ft^2$$

TIME sec	WATER DEPTH	t min	h	$\frac{H-h}{H-Ho}$ 4.93
0		0	11.5	1
2		.03	11.0	.89
10		.17	7.8	.25
14		.23	7.2	.13
39		.65	6.9	.07
99		1.65	6.8	.05



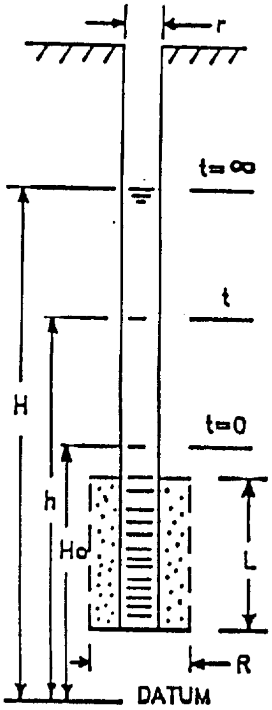
To = .13 min = 7.8 sec

O'BRIEN & GERE

IN-SITU PERMEABILITY TEST
FIELD LOG

PROJECT TT 61-66
WELL NUMBER MW3
DATE 1-9-92

LOCATION Tarawa Terrace
ELEVATION



STATIC HEAD (H) 6.67

PIPE RADIUS (r) .08

SCREEN RADIUS (R) .35

SCREEN LENGTH (L) 8.33

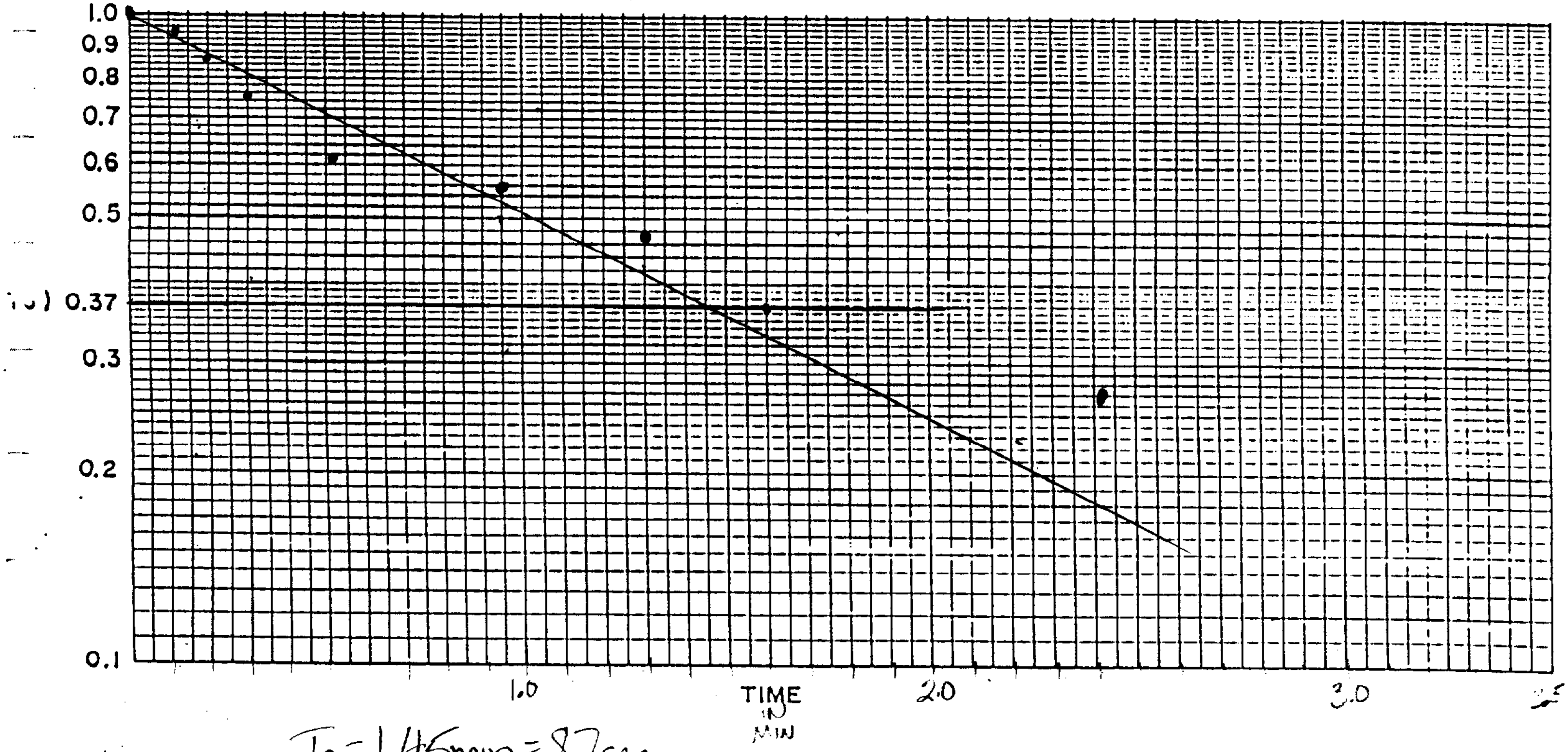
INITIAL HEAD (Ho) 17.0

HYDRAULIC CONDUCTIVITY :

$$K=\frac{r^2\ln(L/R)}{2LT_o}$$

$$K=\frac{(.08^2)\ln\left(8.33/.35\right)=.02}{2(8.33\cdot 87)\ 1449.42}=1.4\times10^{5}\,ft/sec\,(6.464\times10^{5})=8.9\,gpd/ft^2$$

TIME Sec	WATER DEPTH	t MIN	h	$\frac{H-h}{H-Ho}$ -10.33
0		0	17.0	1
7		.12	16.5	.95
12		.20	15.5	.85
18		.30	14.5	.75
32		.53	13.5	.66
57		.95	12.5	.56
78		1.3	11.5	.47
96		1.6	10.5	.37
145		2.42	9.5	.27
302		5.03	8.5	.18

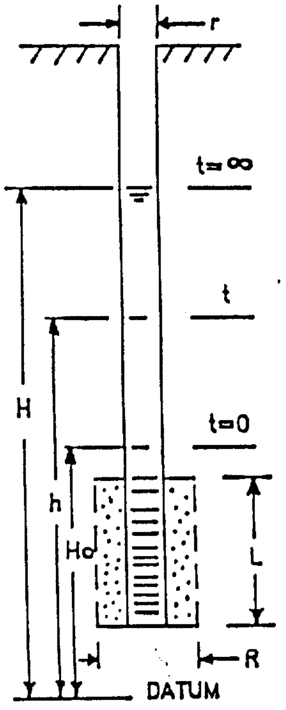


To=1.45min=87sec

IN-SITU PERMEABILITY TEST
FIELD LOG

PROJECT TT61-66
WELL NUMBER MW4
DATE 1-9-92

LOCATION Tarawa Terrace
ELEVATION

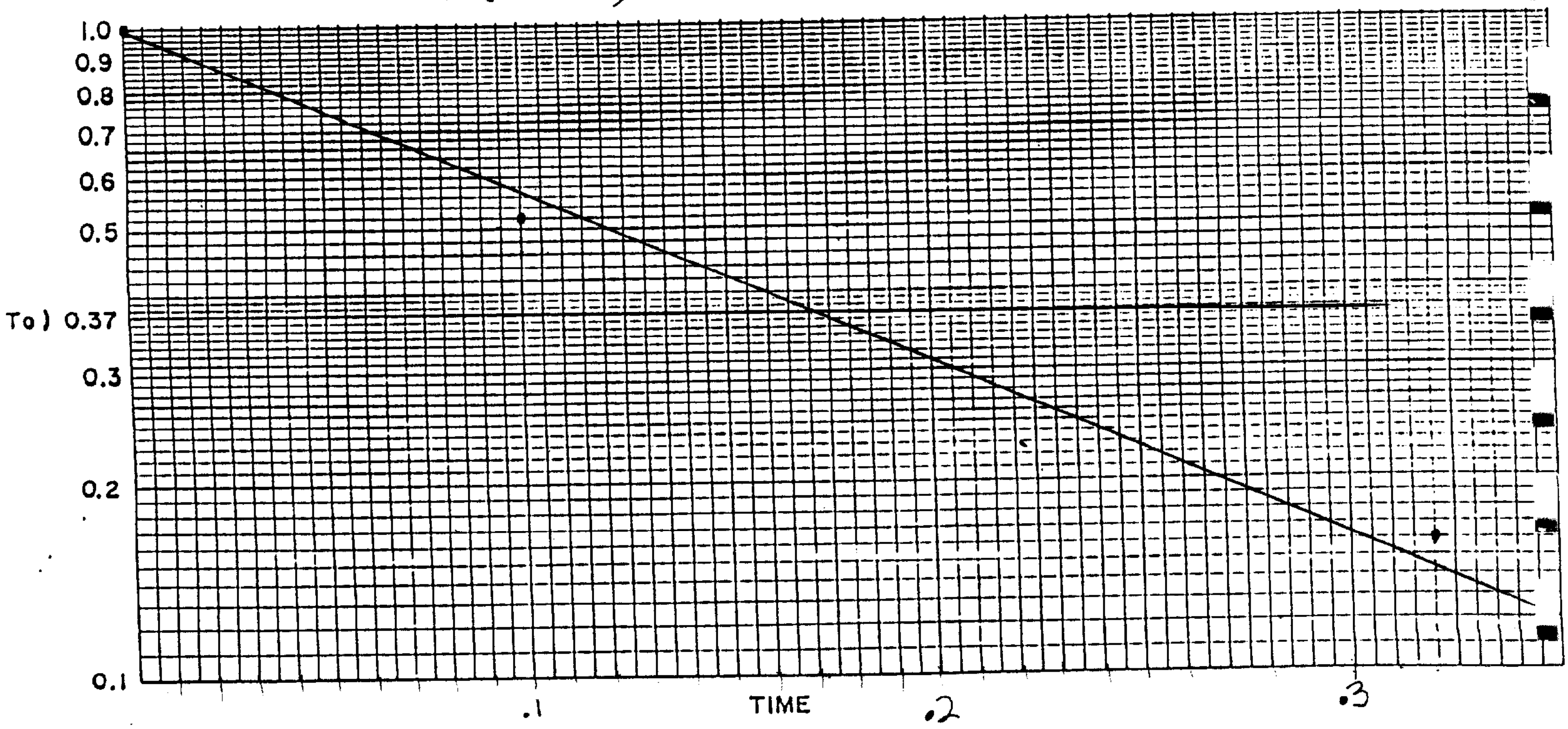


STATIC HEAD (H) 6.89
PIPE RADIUS (r) .08
SCREEN RADIUS (R) .35
SCREEN LENGTH (L) 10
INITIAL HEAD (Ho) 14.
HYDRAULIC CONDUCTIVITY :

$$K=\frac{r^2\ln(L/R)}{2LTo}$$

$$K=\frac{(.08^2)\ln(10/.35)=.02}{2(10\cdot 10.8)216}$$ 9.2×10⁻⁵ ft/sec (6464×10⁵) = 59.8 gpd/ft²

TIME Sec	WATER DEPTH	t Min	h	$\frac{H-h}{H-Ho}$ -7.11
0		0	14.0	1
6		.1	10.6	.52
19		.32	8.0	.16
31		.52	7.5	.02
136		2.27	7.0	.01

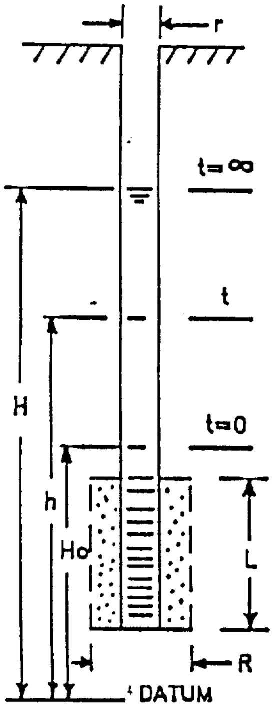


To = .18 min = 10.8 sec

IN-SITU PERMEABILITY TEST
FIELD LOG

PROJECT JT61-66
WELL NUMBER MW5
DATE 1-9-92

LOCATION Tarawa Terrace
ELEVATION

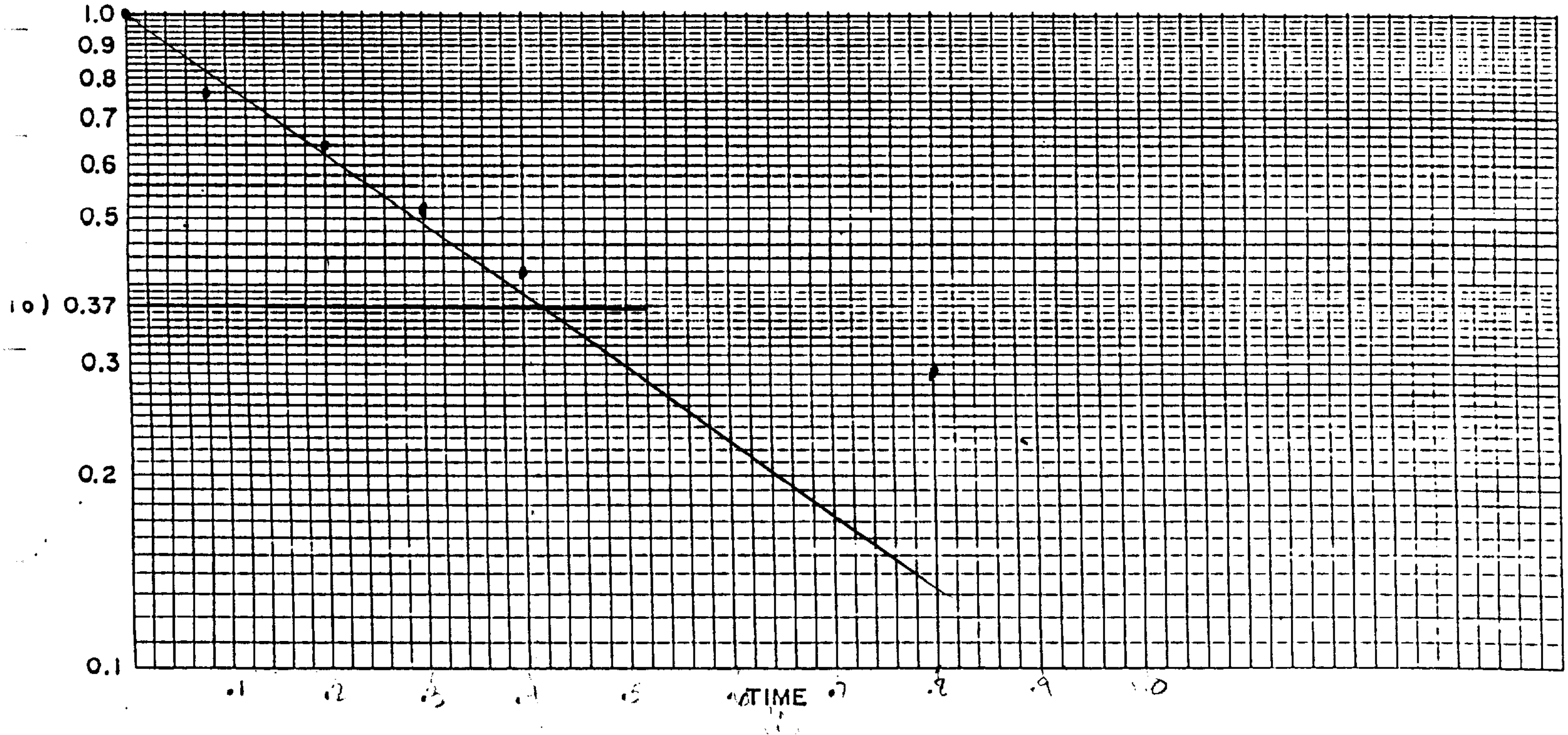


STATIC HEAD (H) 6.57
PIPE RADIUS (r) .08
SCREEN RADIUS (R) .35
SCREEN LENGTH (L) 8.43
INITIAL HEAD (Ho) 15.0
HYDRAULIC CONDUCTIVITY :

$$K=\frac{r^2\ln(L/R)}{2LT_o}$$

$$K=\frac{(.08^2)\ln(8.43/.35)=.02}{2(8.43\cdot 25.2)=424.87}$$ 4.7×10^{-5} ft/sec $(6.464\times10^{5})=30.4$ gpd/ft^2

TIME sec.	WATER DEPTH	t min	h	H−h / H−Ho −8.43
0		0	15.0	1
5		.08	13.0	.76
12		.20	12.0	.64
18		.30	11.0	.52
24		.40	10.0	.41
48		.80	9.0	.29
114		1.9	8.0	.17

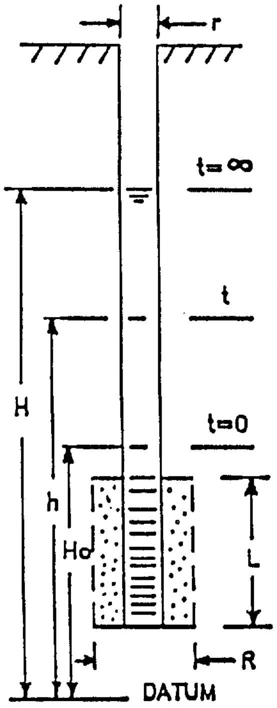


To= .42min=25.2sec

IN–SITU PERMEABILITY TEST
FIELD LOG

PROJECT TT61-66
WELL NUMBER MW6
DATE 1-9-92

LOCATION Tarawa Terrace
ELEVATION



STATIC HEAD (H) 7.18

PIPE RADIUS (r) .08

SCREEN RADIUS (R) .35

SCREEN LENGTH (L) 10

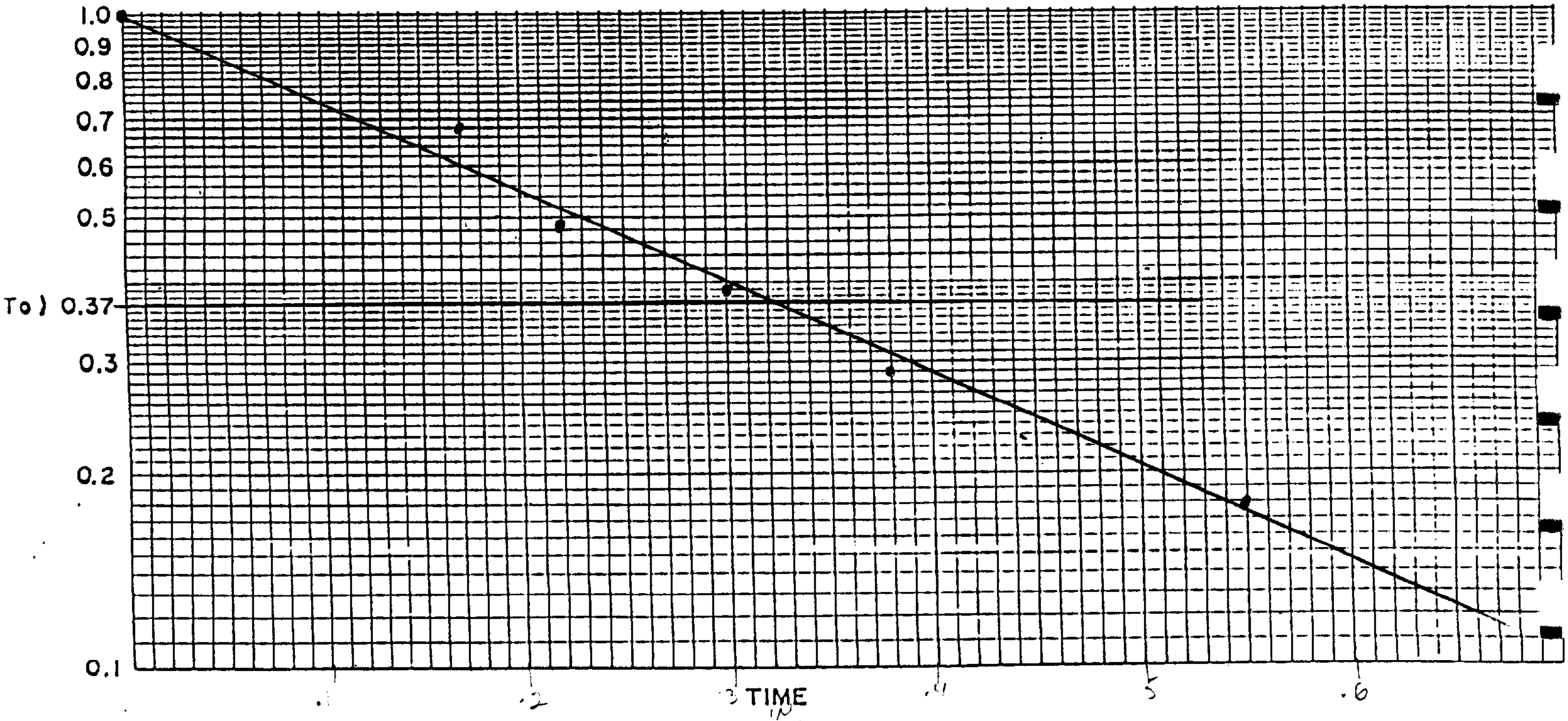
INITIAL HEAD (Ho) 17

HYDRAULIC CONDUCTIVITY :

$$K=\frac{r^2\ln(L/R)}{2LTo}$$

$$K=\frac{(.08^2)\ln(10/.35)=.02}{2(10\cdot19.2)\quad 384}=5.2\times10^{-5}\ ft/sec\,(6.464\times10^5)=33.7\ gpd/ft^2$$

TIME sec	WATER DEPTH	t min	h	$\frac{H-h}{H-Ho}$ -9.82
0		0	17	1
7		.17	13.9	.68
13		.22	12.0	.49
18		.30	11.0	.39
23		.38	10.0	.29
33		.55	9.0	.18
51		.85	8.0	.08
285		4.75	7.5	.03

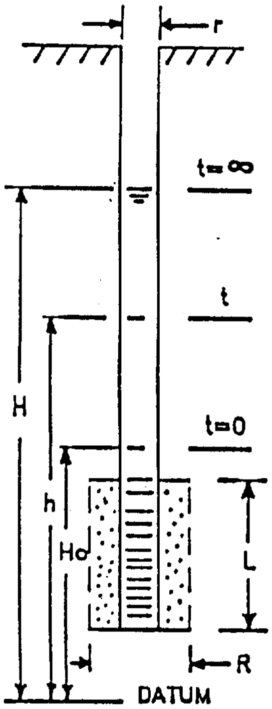


T_0 = .32 min = 19.2 sec

IN–SITU PERMEABILITY TEST
FIELD LOG

PROJECT TT 61-66
WELL NUMBER mw7
DATE 1-9-92

LOCATION Tarawa Terrace
ELEVATION



STATIC HEAD (H) 6.82

PIPE RADIUS (r) .08

SCREEN RADIUS (R) .35

SCREEN LENGTH (L) 8.18

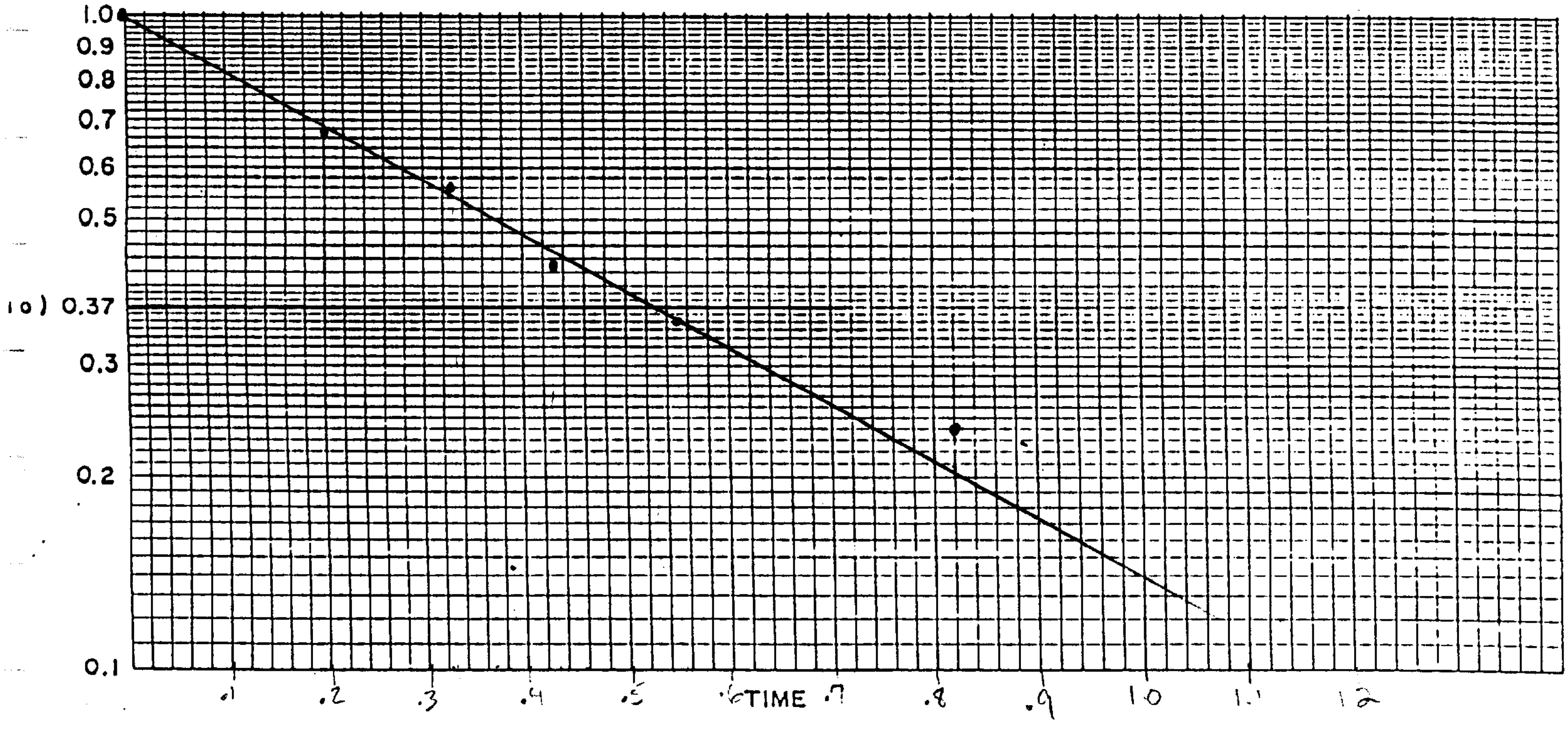
INITIAL HEAD (Ho) 16.0

HYDRAULIC CONDUCTIVITY :

$$K=\frac{r^2\ln(L/R)}{2LT_o}$$

$$K=\frac{(.08^2)\ln\left(8.18/.35\right)=.02}{2(8.18\cdot31.8)=520.25}=3.9\times10^{-5}\text{ ft/sec}\,(6.464\times10^5)=25.1\text{ gpd/ft}^2$$

TIME sec	WATER DEPTH	t min	h	$\frac{H-h}{H-H_o}$ − 9.18
0		0	16.00	1
12		.20	13.0	.67
20		.33	12.0	.56
26		.43	11.0	.45
33		.55	10.0	.35
49		.82	9.0	.24
96		1.6	8.0	.13



To = .53 min = 31.8 sec

IN-SITU PERMEABILITY TEST
FIELD LOG

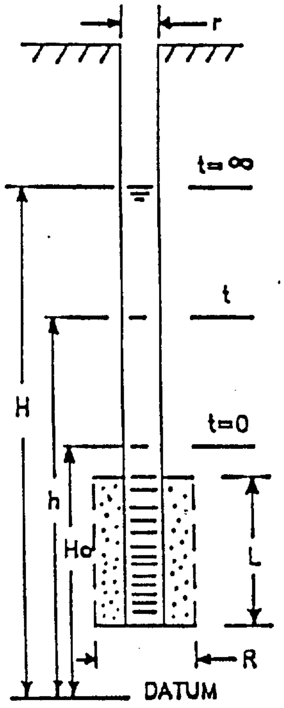
PROJECT TT 61-66

WELL NUMBER MW8

DATE 1-9-92

LOCATION Tarawa Terrace

ELEVATION



STATIC HEAD (H) 7.93

PIPE RADIUS (r) .08

SCREEN RADIUS (R) .35

SCREEN LENGTH (L) 10.0

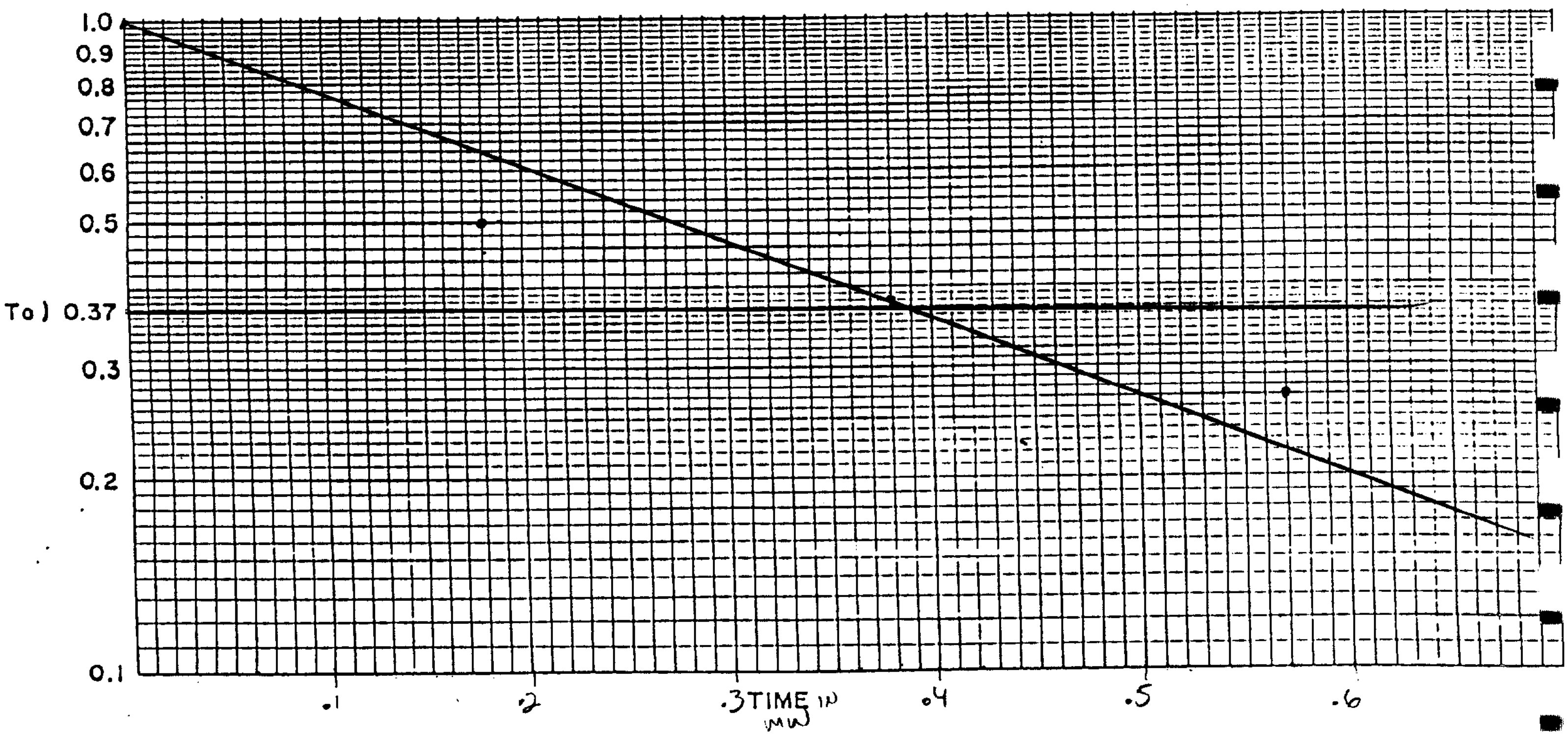
INITIAL HEAD (Ho) 16.0

HYDRAULIC CONDUCTIVITY :

$$K=\frac{r^2\ln(L/R)}{2LT_o}$$

$$K=\frac{(.08^2)\ln(10/.35)=.02}{2(10\cdot 23.4)=468}=4.3\times10^{-5}\ \text{ft/sec}\,(6.464\times10^{5})=27.6\ \text{gpd/ft}^2$$

TIME sec	WATER DEPTH	t min	h	$\frac{H-h}{H-Ho}$ -8.07
0		0	16.0	1
11		.18	12.0	.50
23		.38	11.0	.38
34		.57	10.0	.27
50		.83	9.0	.13
86		1.43	8.0	.01

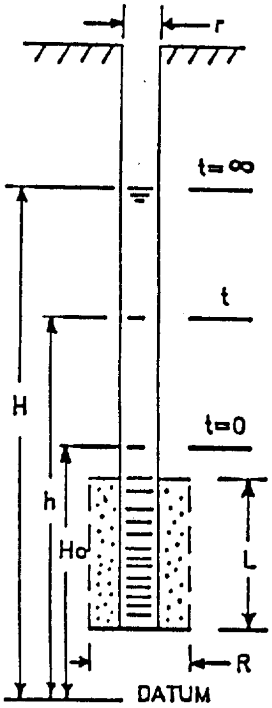


To = .39 MIN = 23.4 se

IN–SITU PERMEABILITY TEST
FIELD LOG

PROJECT TT61-66
WELL NUMBER MW9
DATE 1-9-92

LOCATION Tarawa Terrace
ELEVATION

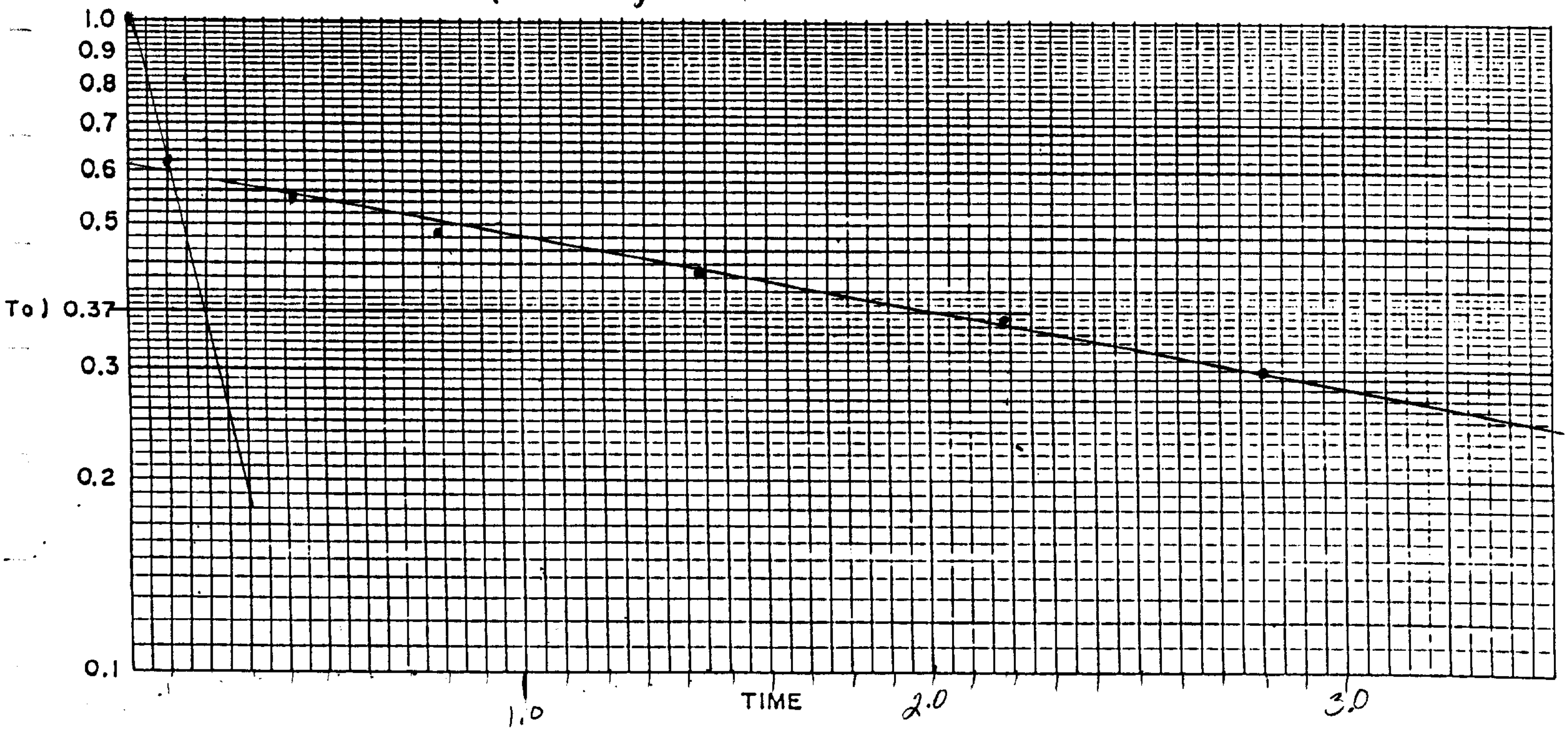


STATIC HEAD (H) 6.15
PIPE RADIUS (r) .08
SCREEN RADIUS (R) .35
SCREEN LENGTH (L) 7.85
INITIAL HEAD (Ho) 14.0
HYDRAULIC CONDUCTIVITY :

$$K=\frac{r^2\ln(L/R)}{2LTo}$$

$$K= \frac{(.08^2)\ln(7.85/.35)=.02}{2(7.85\cdot120)=1884} = 1.1\times10^{-5}\ ft/sec\,(6.464\times10^5) = 6.83\ gpd/ft^2$$

TIME sec	WATER DEPTH	t min	h	$\frac{H-h}{H-Ho}$ -7.85
0		0	14.0	1
6		.10	11.0	.62
25		.42	10.5	.55
47		.79	10.0	.49
86		1.43	9.5	.43
130		2.17	9.0	.36
179		2.98	8.5	.30

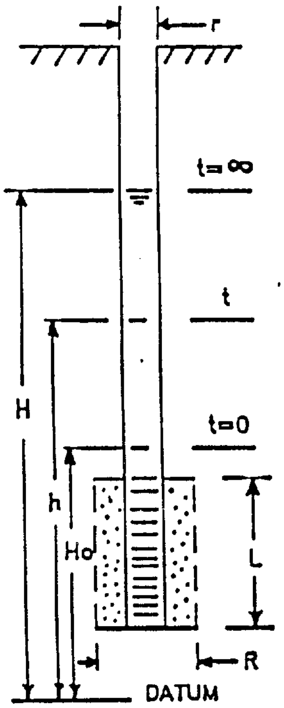


To=2.0min=120sec

IN-SITU PERMEABILITY TEST
FIELD LOG

PROJECT TT61-66
WELL NUMBER MW10
DATE 1-9-92

LOCATION Tarawa Terrace
ELEVATION

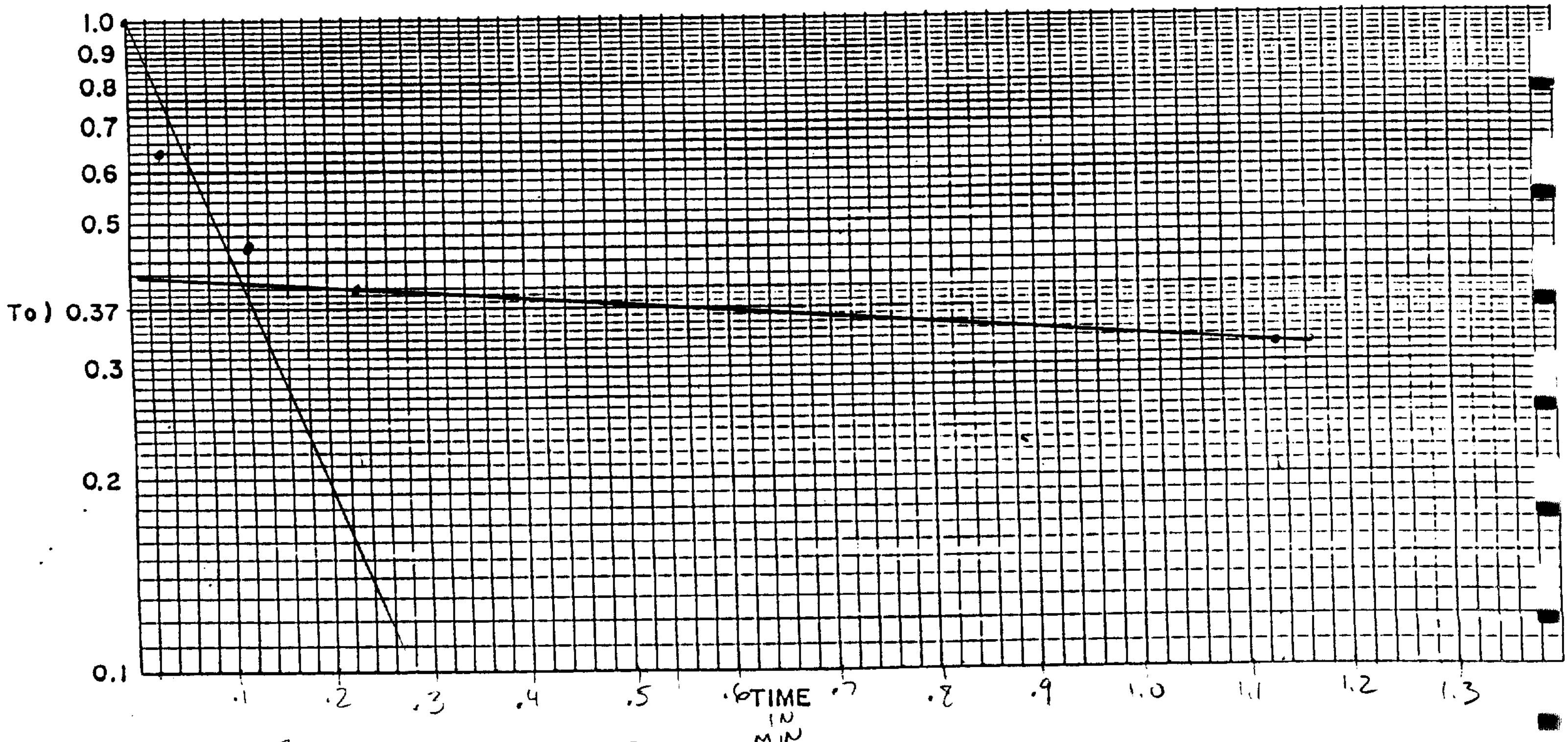


STATIC HEAD (H) 6.32
PIPE RADIUS (r) .08
SCREEN RADIUS (R) .35
SCREEN LENGTH (L) 10'
INITIAL HEAD (Ho) 8.0
HYDRAULIC CONDUCTIVITY :

$$K=\frac{r^2\ln(L/R)}{2LTo}$$

$$K=\frac{(.08^2)\ln(10/.35)=.02}{2(10\cdot20.1)\ 402}\ 5.0\times10^{-5}\text{ft/sec}(6464\times10^5)=32.1\text{ gpd/ft}^2$$

TIME sec	WATER DEPTH	t min	h	$\frac{H-h}{H-Ho}$ -1.68
0		0	8.0	1
2		.03	7.4	.64
7		.12	7.1	.46
14		.23	7.0	.40
68		1.13	6.9	.34

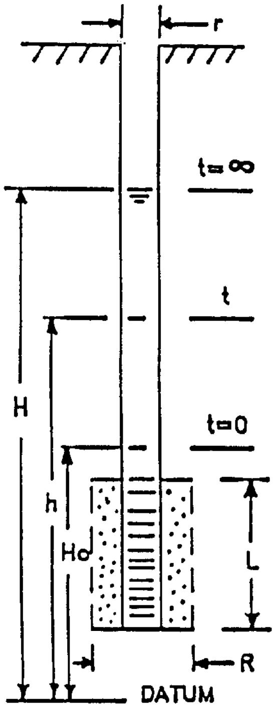


To= 13min-78sec and To= 5" =20.1 sec X̄ = 20.1

IN-SITU PERMEABILITY TEST
FIELD LOG

PROJECT TT61-66
WELL NUMBER MW11
DATE 1-10-92

LOCATION Tarawa Terrace
ELEVATION ____________

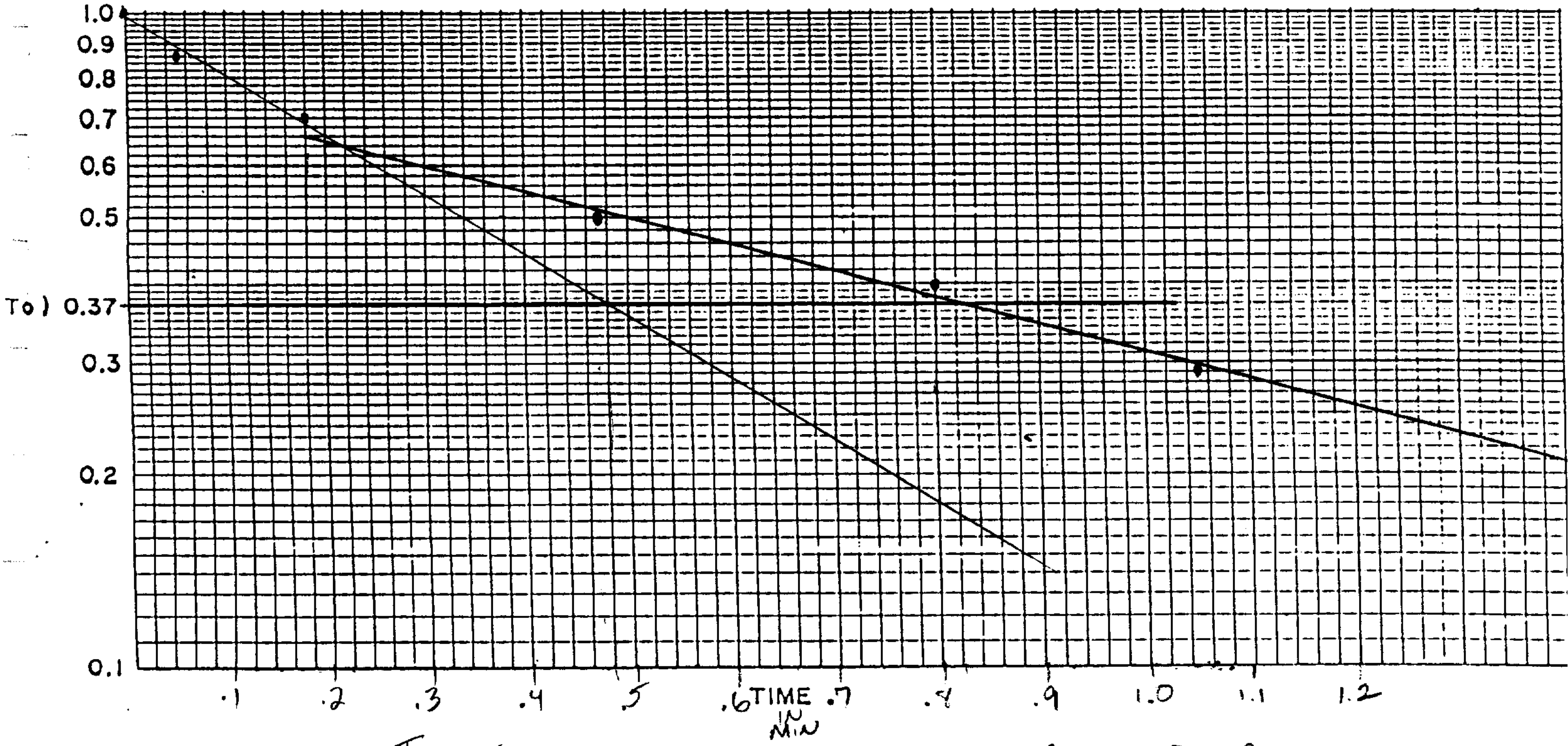


STATIC HEAD (H) 6.54
PIPE RADIUS (r) .08
SCREEN RADIUS (R) .35
SCREEN LENGTH (L) 8.46
INITIAL HEAD (Ho) 11.5
HYDRAULIC CONDUCTIVITY :

$$K = \frac{r^2 \ln(L/R)}{2LT_o}$$

$$K = \frac{(.08^2)\ln(8.46/.35) = .02}{2(8.46 \cdot 39) = 659.9}\ 3.0\times10^{-5}\ \text{ft/sec}\ (6.464\times10^5) = 19.6\ \text{gpd/ft}^2$$

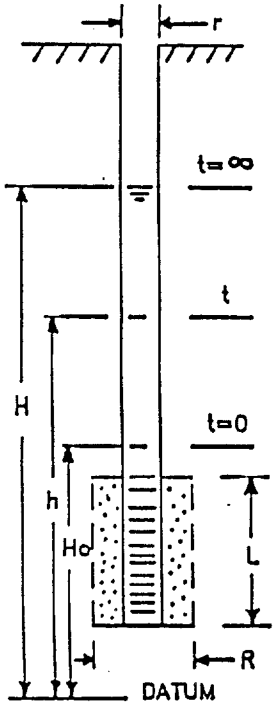
TIME sec	WATER DEPTH	t min	h	$\frac{H-h}{H-Ho}$ -4.96
0		0	11.5	1
3		.05	10.8	.86
11		.18	10.0	.70
28		.47	9.0	.50
48		.80	8.5	.40
63		1.05	8.0	.29
125		2.08	7.5	.19



IN–SITU PERMEABILITY TEST
FIELD LOG

PROJECT TT61-66
WELL NUMBER MW12
DATE 1-10-92

LOCATION Tarawa Terrace
ELEVATION



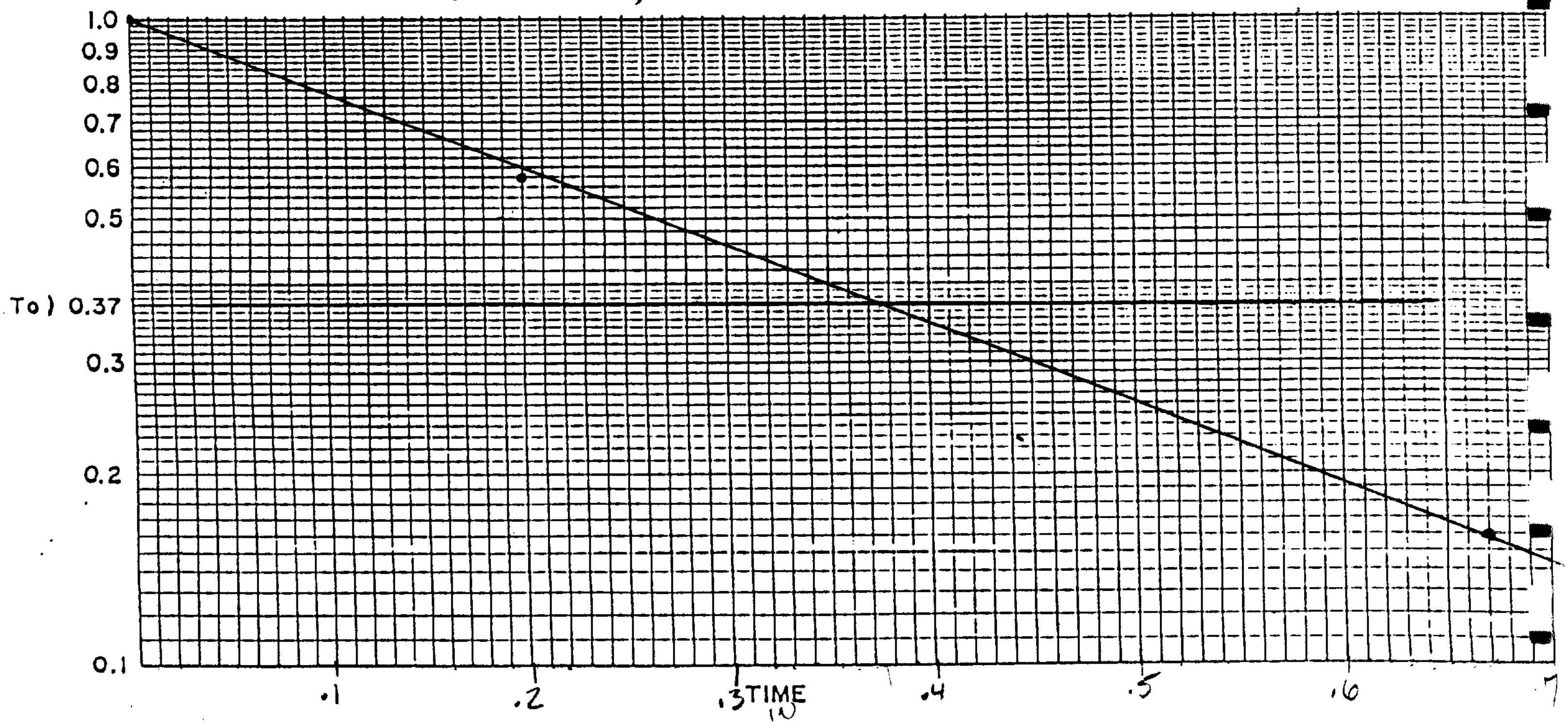
STATIC HEAD (H) 7.80
PIPE RADIUS (r) .08
SCREEN RADIUS (R) .35
SCREEN LENGTH (L) 10'
INITIAL HEAD (Ho) 9.0

HYDRAULIC CONDUCTIVITY :

$$K = \frac{r^2 \ln(L/R)}{2LT_o}$$

$$K = \frac{(.08^2)\ln(10/.35) = .02}{2(10 \cdot 22.8) = 456} = 4.4\times10^{-5}\ \text{ft/sec}\,(6.464\times10^{5}) = 28.3\ \text{gpd/ft}^2$$

TIME sec	WATER DEPTH	t MIN	h	$\frac{H-h}{H-Ho-1.2}$
0		0	9.0	1
12		.20	8.5	.58
40		.67	8.0	.16
62		1.03	7.9	.08

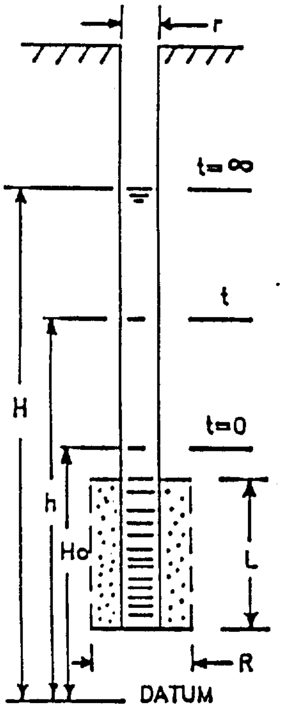


To = .38 min = 22.8 sec

IN-SITU PERMEABILITY TEST
FIELD LOG

PROJECT TT61-66
WELL NUMBER MW13
DATE 1-11-92

LOCATION Tarawa Terrace
ELEVATION

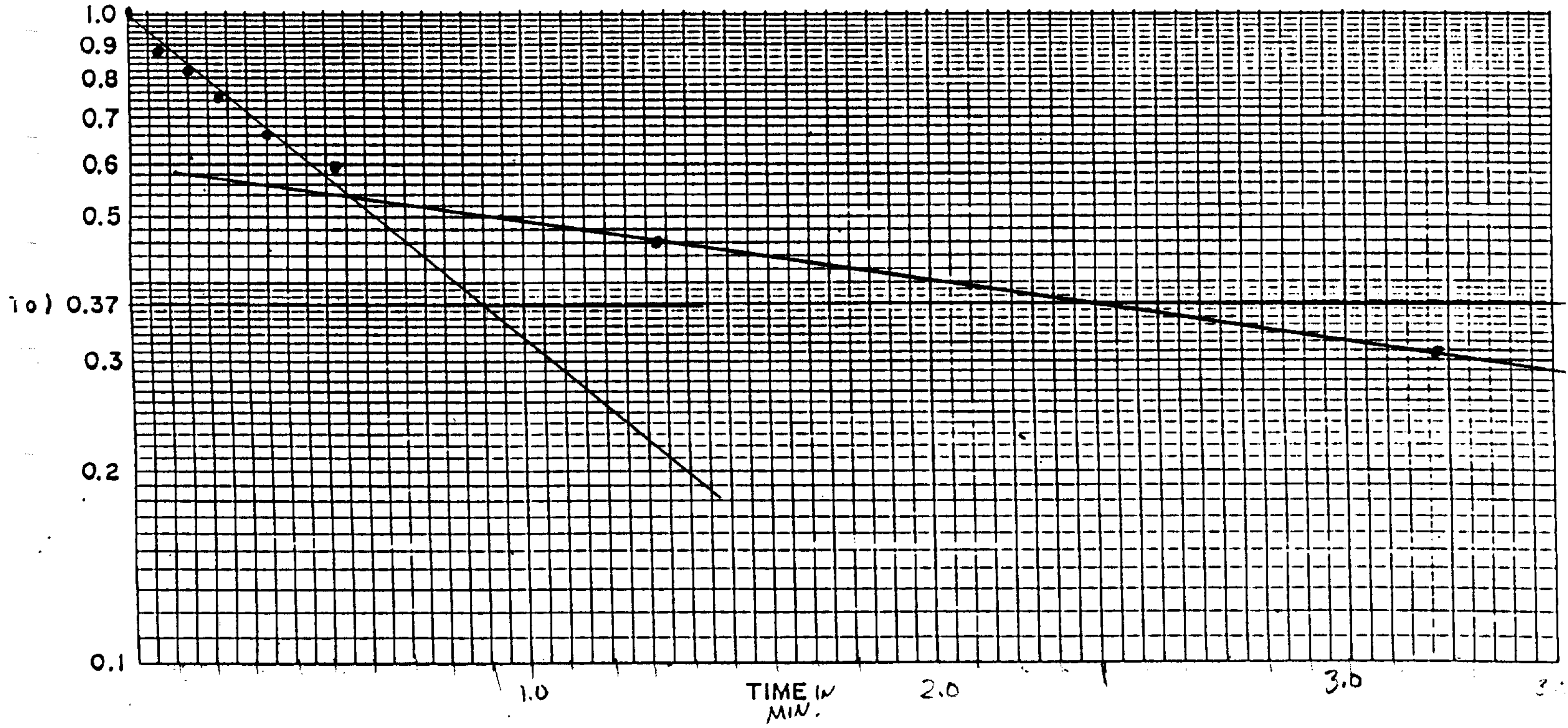


STATIC HEAD (H) 5.85
PIPE RADIUS (r) .08
SCREEN RADIUS (R) .35
SCREEN LENGTH (L) 6.15
INITIAL HEAD (Ho) 12.7
HYDRAULIC CONDUCTIVITY :

$$K=\frac{r^2\ln(L/R)}{2LT_o}$$

$$K=\frac{(.08^2)\ln(6.15/.35)=.02}{2(6.15\cdot 99)=1217.7}=1.5\times10^{-5}\text{ ft/sec}(6.464\times10^5)=9.7\text{ gpd/ft}^2$$

TIME sec	WATER DEPTH	t min	h	$\frac{H-h}{H-Ho}$ -6.85
0		0	12.7	1
4		.07	11.9	.88
9		.15	11.5	.82
13		.22	11.0	.75
21		.35	10.4	.66
32		.53	10.0	.60
80		1.33	9.0	.46
194		3.23	8.0	.31



To = .90min = 54sec and To = 2.4min = 141sec X̄ = 99sec

IN–SITU PERMEABILITY TEST
FIELD LOG

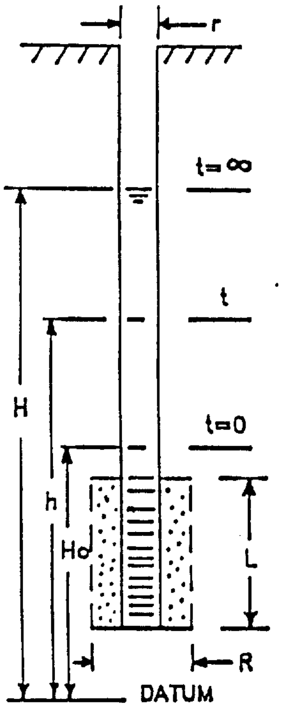
PROJECT TT61-66

WELL NUMBER MW14

DATE 1-11-92

LOCATION Tarawa Terrace

ELEVATION ______



STATIC HEAD (H) 6.41

PIPE RADIUS (r) .08

SCREEN RADIUS (R) .35

SCREEN LENGTH (L) 10'

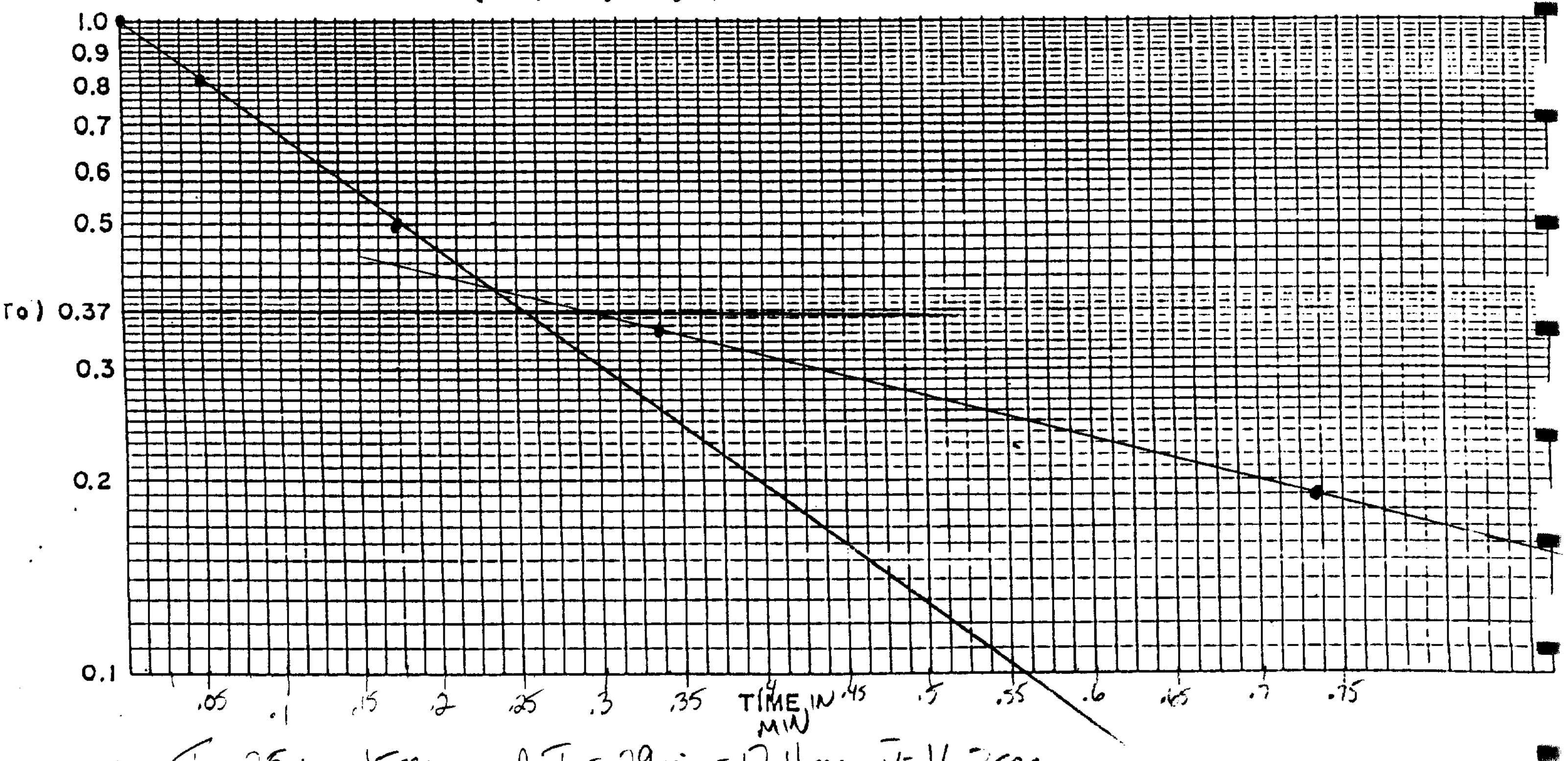
INITIAL HEAD (Ho) 9.0

HYDRAULIC CONDUCTIVITY :

$$K=\frac{r^2\ln(L/R)}{2LTo}$$

$$K=\frac{(.08^2)\ln(10/.35)=.02}{2(10\cdot16.2)=324}=6.2\times10^{5}\ \text{ft/sec}\,(6.464\times10^{5})=39.9\ \text{gpd/ft}^2$$

TIME Sec	WATER DEPTH	t min	h	$\frac{H-h}{H-Ho}$ -2.59
0		0	9.0	1
3		.05	8.5	.81
10		.17	7.7	.50
20		.33	7.3	.34
44		.73	6.9	.19
109		1.82	6.6	.07

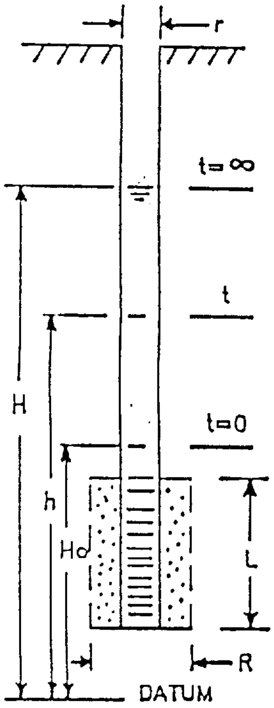


To=.25min=15sec and To=.29min=17.4sec $\bar{x}$=16.2sec

IN–SITU PERMEABILITY TEST
FIELD LOG

PROJECT TT 61-66
WELL NUMBER MW 15
DATE 12-17-92

LOCATION Tarawa Terrace
ELEVATION

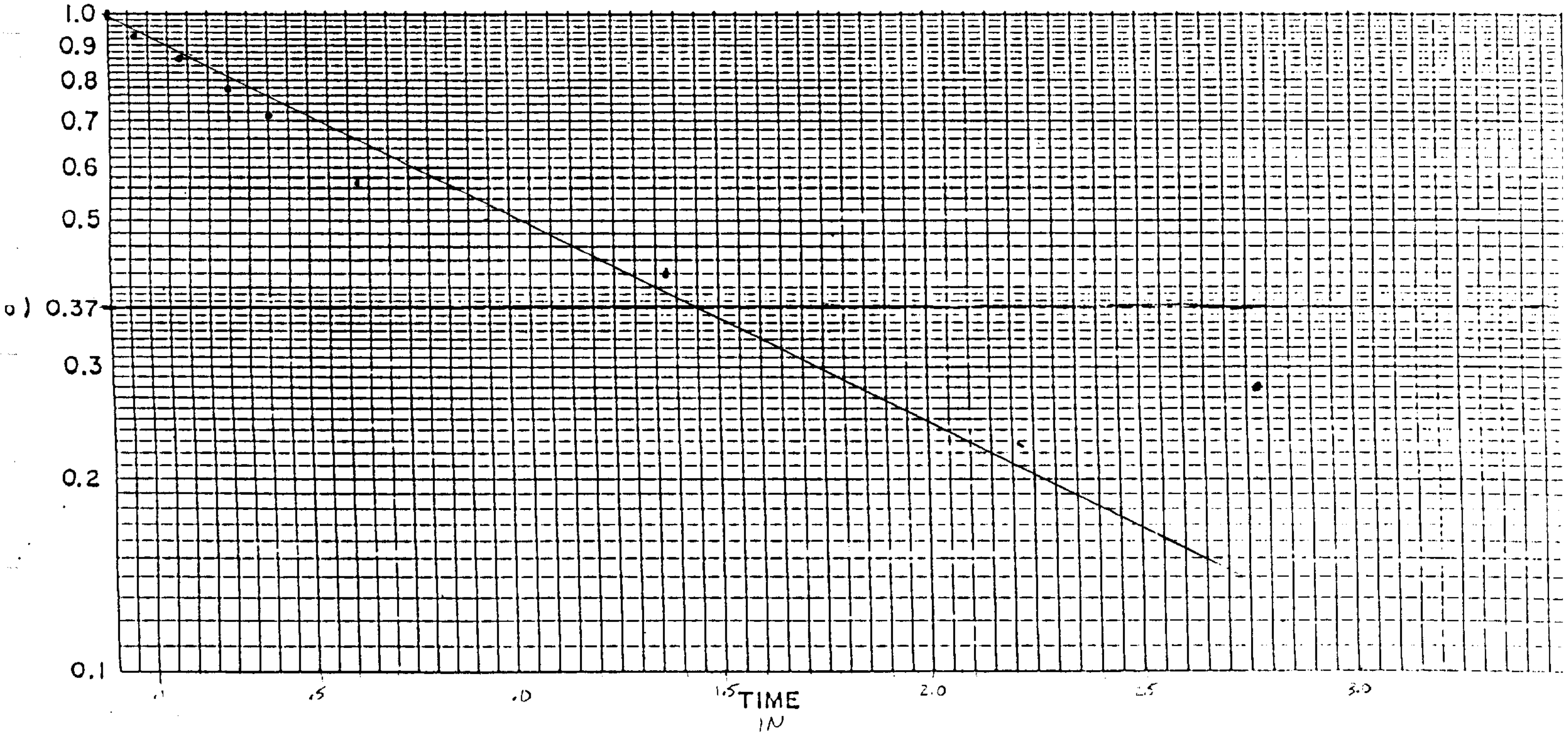


STATIC HEAD (H) 5.05
PIPE RADIUS (r) .08
SCREEN RADIUS (R) .36
SCREEN LENGTH (L) 8.95
INITIAL HEAD (Ho) 12.0
HYDRAULIC CONDUCTIVITY :

$$K=\frac{r^2 \ln(L/R)}{2LT_o}$$

$$K= \frac{(.08)^2 \ln\left(8.95/.36\right) = .02}{2(8.95 \cdot 87) = 1557.3} = 1.32\times10^{-5}\ \text{ft/sec}\ \cdot 6.464\times10^{5} = 8.5\ \text{gp}\ldots$$

TIME/sec	WATER DEPTH	t/min	h	$\frac{H-h}{H-H_o}$ −6.95
0		0	12	1
4		.07	11.5	.93
10		.17	11.0	.86
18		.30	10.5	.78
24		.40	10.0	.71
37		.62	9.0	.57
83		1.38	8.0	.42
167		2.78	7.0	.28
338		5.63	6.0	.14

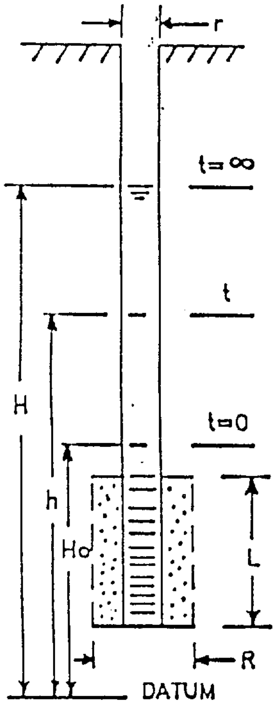


To=1.45=min=87

IN-SITU PERMEABILITY TEST
FIELD LOG

PROJECT T761-66
WELL NUMBER MW 17
DATE 12-17-92

LOCATION Tarawa Terrace
ELEVATION

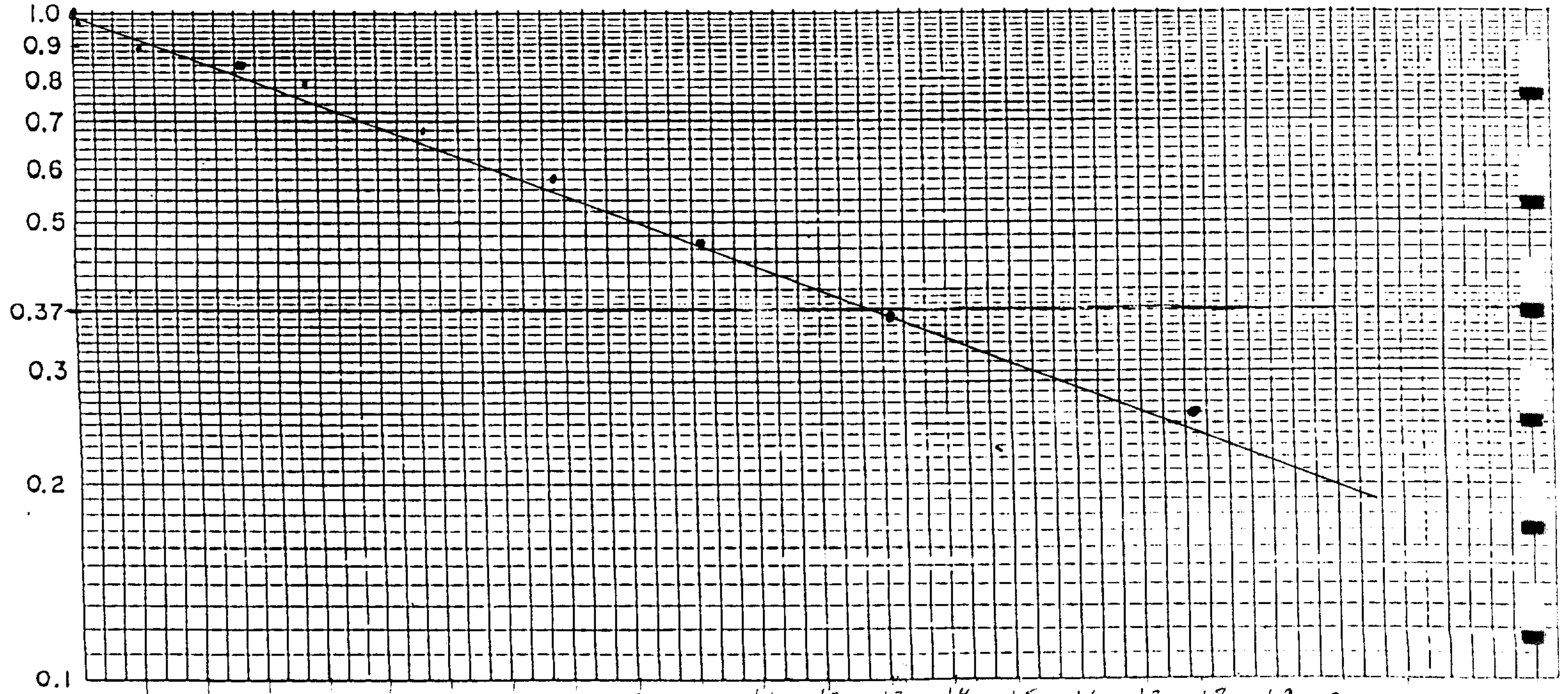


STATIC HEAD (H) 3.56
PIPE RADIUS (r) .08
SCREEN RADIUS (R) .36
SCREEN LENGTH (L) 10'
INITIAL HEAD (Ho) 13.0
HYDRAULIC CONDUCTIVITY :

$$K=\frac{r^2\ln(L/R)}{2LT_o}$$

$$K=\frac{(.08)^2\ln(10/.36)=.02}{2(10\cdot 90)=1800}=1.1\times10^{-5}\text{ ft/sec}\cdot 6.464\times10^{5}=7.18\text{ gpd/ft}^2$$

TIME/sec	WATER DEPTH	time	h	$\frac{H-h}{H-Ho}$ -9.44
0		0	13.0	1
5		.08	12.7	.97
10		.17	12.0	.89
16		.27	11.5	.84
22		.37	11.0	.79
34		.57	10.0	.68
47		.78	9.0	.57
62		1.03	8.0	.47
79		1.32	7.0	.36
106		1.77	6.0	.26
164		2.73	5.0	.15
345		5.75	4.0	.05

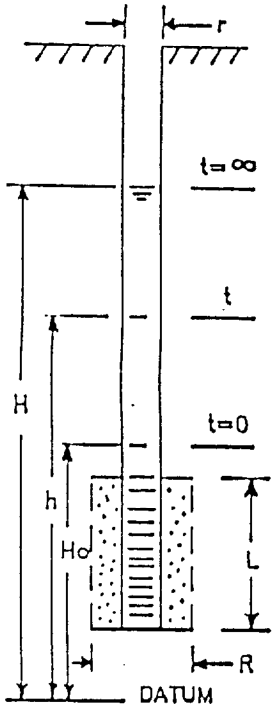


To = 1.5 min = 90 sec

IN-SITU PERMEABILITY TEST
FIELD LOG

PROJECT TT 61-66
WELL NUMBER MW20
DATE

LOCATION Tarawa Terrace
ELEVATION

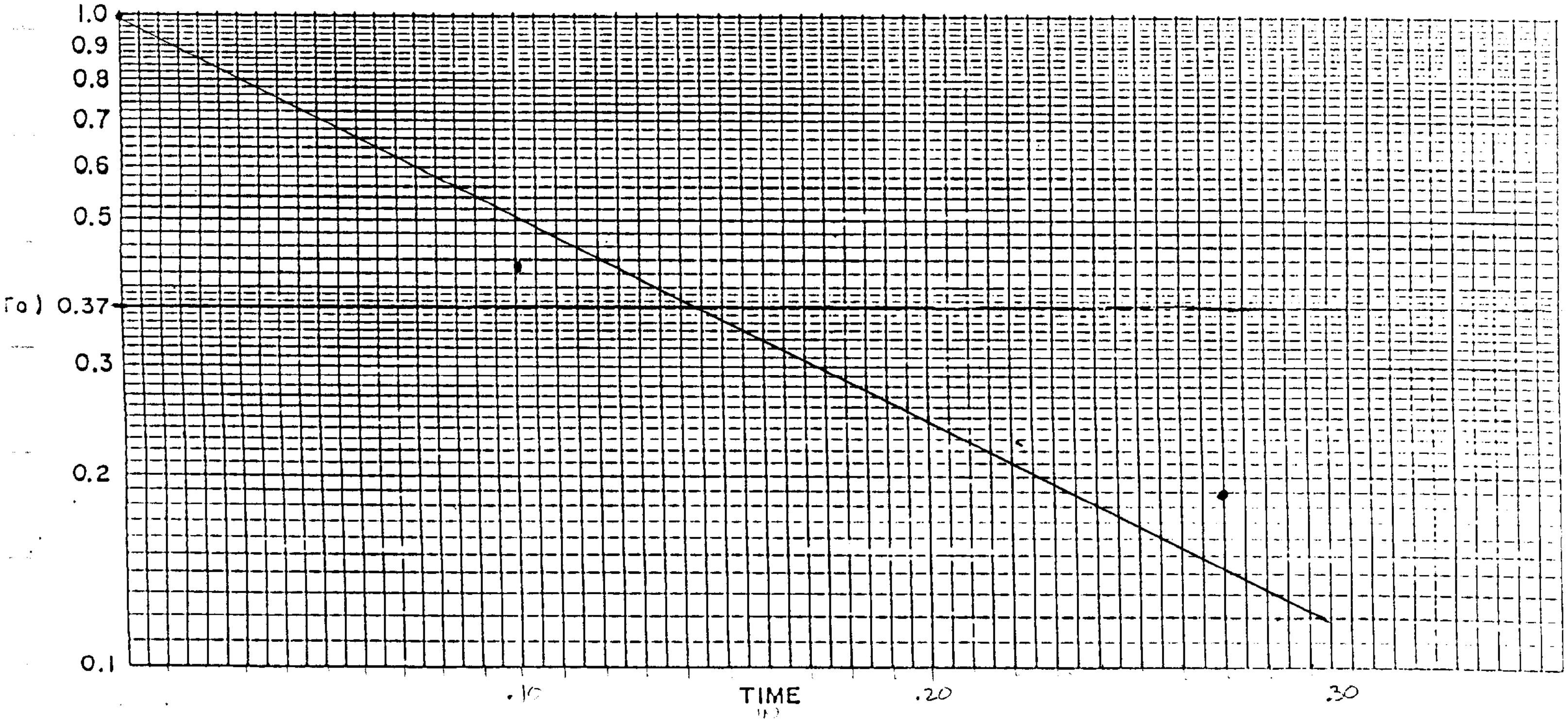


STATIC HEAD (H) 6.15
PIPE RADIUS (r) .08
SCREEN RADIUS (R) .36
SCREEN LENGTH (L) 10
INITIAL HEAD (Ho) 10.7
HYDRAULIC CONDUCTIVITY :

$$K = \frac{r^2 \ln(L/R)}{2LT_o}$$

$$K = \frac{(.08)^2 \ln(10/.36) = .02}{2(10 \cdot 9.3) = 186} = 1.07 \times 10^{-4}\ \text{ft/sec} \cdot 6.46 \times 10^5 = 69.5\ \text{gpd/ft}^2$$

TIME/sec	WATER DEPTH	t/Min	h	$\frac{H-h}{H-Ho}$ -4.55
0		0	10.7	1
6		.10	8.1	.43
13		.27	7.0	.19
32		.53	6.5	.08
85		1.42	6.3	.03

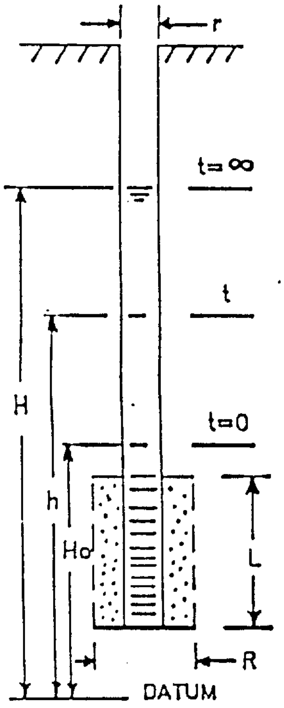


To = .155 = 9.3 sec

IN–SITU PERMEABILITY TEST
FIELD LOG

PROJECT TT61-66
WELL NUMBER MW 18
DATE 12-17-92

LOCATION Tarawa Terrace
ELEVATION



STATIC HEAD (H) 5.38

PIPE RADIUS (r) .08

SCREEN RADIUS (R) .36

SCREEN LENGTH (L) 10'

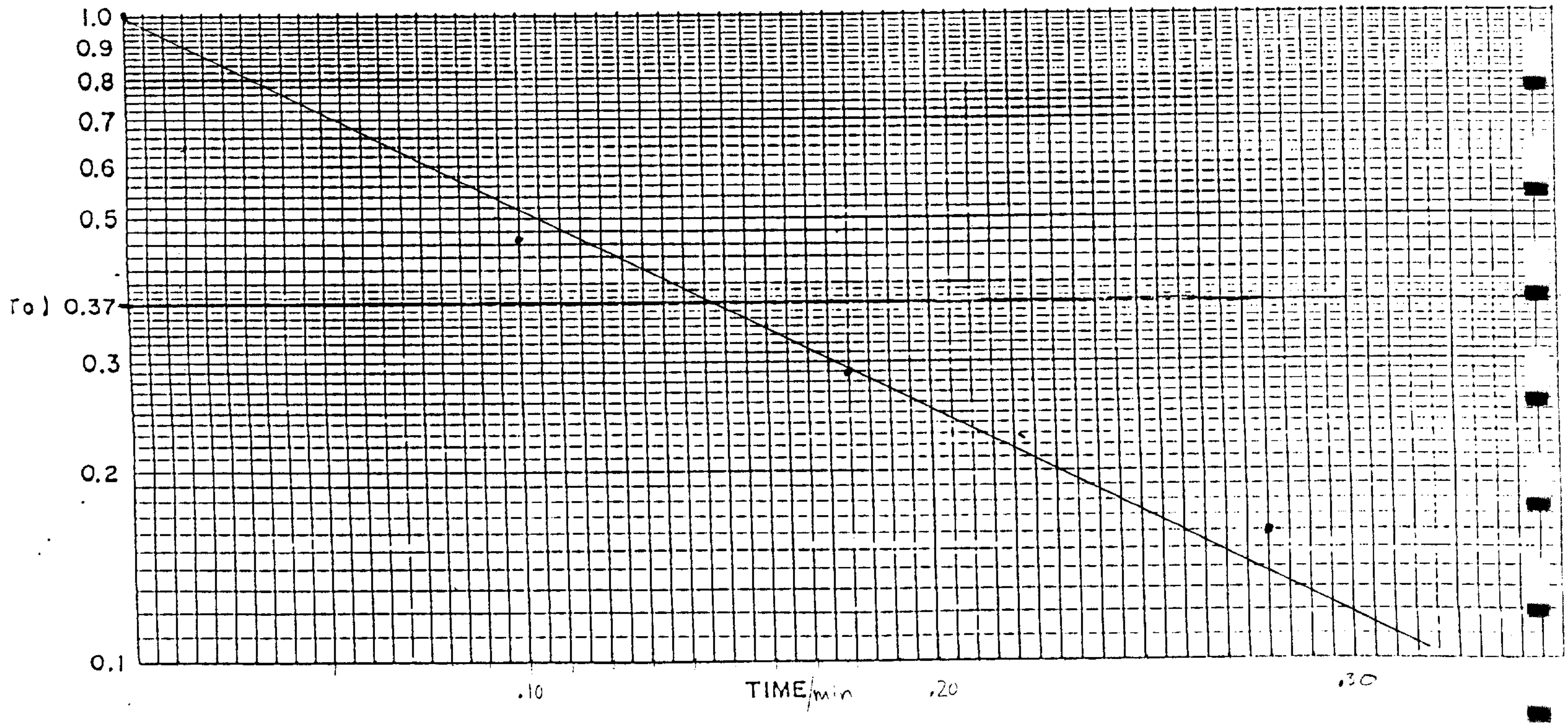
INITIAL HEAD (Ho) 11.0

HYDRAULIC CONDUCTIVITY :

$$K=\frac{r^2 \ln(L/R)}{2LTo}$$

$$K= \frac{(.08)^2 \ln(10/.36) = .02}{2(10\cdot 9) = \quad 180} = 1.1\times10^{-4}\ \text{ft/sec}\cdot 6.464\times10^{5} = 71.8\ \text{gpd/ft}^2$$

TIME/sec	WATER DEPTH	t/min	h	$\frac{H-h}{H-Ho}$ =5.62
0		0	11.0	1.0
6		.10	9.0	.47
11		.18	7.0	.29
17		.28	6.2	.16
23		.38	6.0	.11
37		.62	5.5	.06
106		1.77	5.45	.01

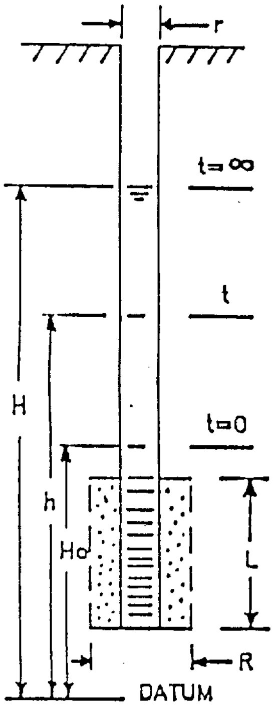


To = .15 min = 9 sec

IN–SITU PERMEABILITY TEST
FIELD LOG

PROJECT JT 61-66
WELL NUMBER MW 19
DATE 12-17-92

LOCATION Tarawa Terrace
ELEVATION



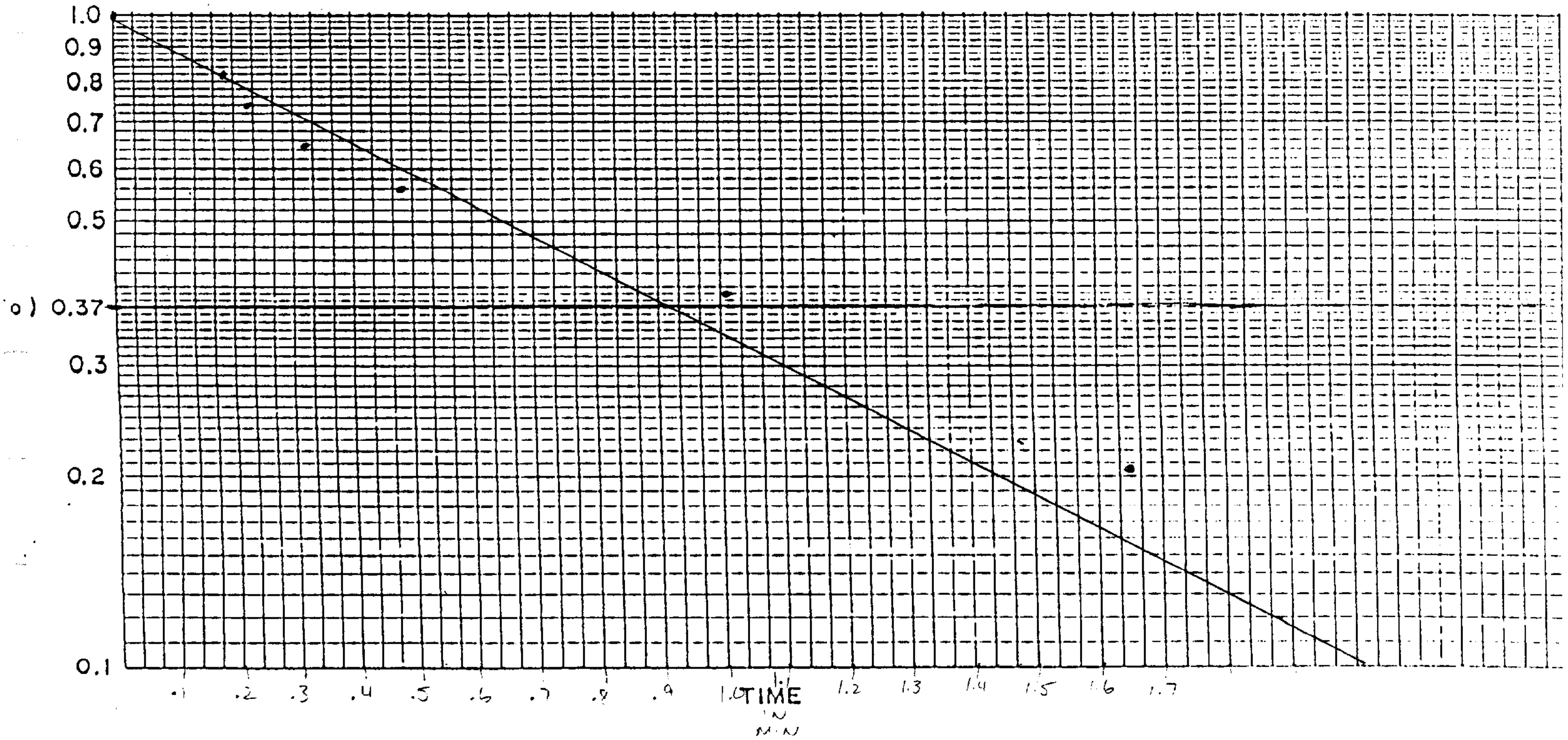
STATIC HEAD (H)	5.77
PIPE RADIUS (r)	.08
SCREEN RADIUS (R)	.36
SCREEN LENGTH (L)	8.23
INITIAL HEAD (Ho)	11.5

HYDRAULIC CONDUCTIVITY :

$$K = \frac{r^2 \ln(L/R)}{2LTo}$$

$$K = \frac{(.08)^2 \ln\left(8.23/.36\right) = .02}{2(8.23 \cdot 55.2) = 908.59} = 2.2 \times 10^{-5}\ \text{ft/sec} \cdot 6.464 \times 10^{5} = 14.25\ \text{ft/day}$$

TIME/sec	WATER DEPTH	t min	h	H−h / H−Ho−5.73
0		0	11.5	1
7		.17	10.5	.82
13		.22	10.0	.74
19		.32	9.5	.65
29		.48	9.0	.56
63		1.05	8.0	.39
98		1.63	7.0	.21
294		4.90	6.3	.07

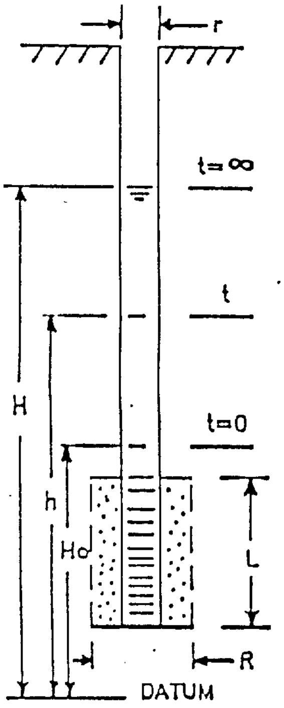


To=.92m=55.2sec

IN–SITU PERMEABILITY TEST
FIELD LOG

PROJECT TT 61-66
WELL NUMBER MW 16
DATE 12-17-92

LOCATION Tarawa Terrace
ELEVATION

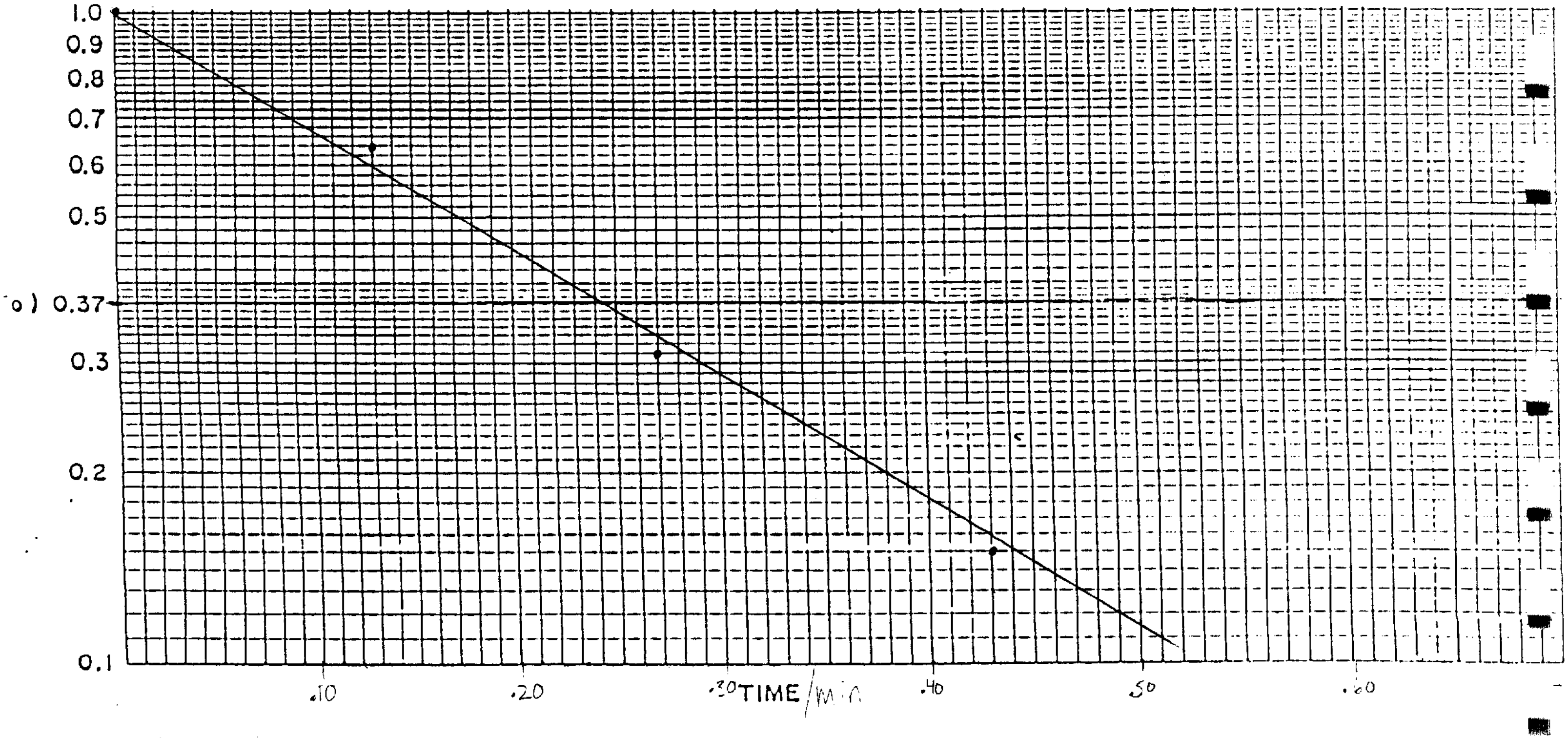


STATIC HEAD (H) 5.30
PIPE RADIUS (r) .08'
SCREEN RADIUS (R) .36'
SCREEN LENGTH (L) 10'
INITIAL HEAD (Ho) 13.0
HYDRAULIC CONDUCTIVITY :

$$K=\frac{r^2\ln(L/R)}{2LT_o}$$

$$K=\frac{(.08)^2\ln(10/.36)=.02}{2(10\cdot14.4)\quad =288}=7.39\times10^{-5}\ \text{ft/sec}\cdot6.464\times10^{5}=47.75\ \text{gpd ft}^{-2}$$

TIME sec.	WATER DEPTH	t/min	h	$\frac{H-h}{H-Ho}$ -7.7
0		2	13.0	1
8		.13	10.2	.64
16		.27	7.7	.31
26		.43	6.5	.15
37		.62	5.9	.08
63		1.05	5.5	.02



To = .24 min = 14.4 sec

APPENDIX E

DRILLING PROCEDURES

UST MONITORING WELL CONSTRUCTION

AND

FIELD OPERATIONS

REQUIREMENTS

Well permits required by state agencies are the responsibility of the contractor. All monitoring wells will be installed in accordance with the following Navy UST monitoring well specifications.

DRILLING

During the drilling program, boreholes will be advanced using conventional hollow stem auger drilling methods. If it is the opinion of the contractor that air or mud rotary drill methods are necessary, approval must be obtained from the EIC. Presentation of justification for a boring method change shall be presented prior to drilling.

The wells will be constructed of flush joint threaded PVC well screen and riser casing depending on conditions encountered during borehole completion.

Well construction details are shown in Figures A-1 and A-2. A drill mounted on an All-Terrain-Vehicle (ATV) may be required for access to remote areas. Each rig will use necessary tools, supplies and equipment supplied by the contractor to drill each site. Drill crews should consist of an experienced driller and a driller assistant for work on each rig. A geologist, experienced in hazardous waste site investigations, shall be on site to monitor the drillers efforts and for air monitoring/safety control. Additional contractor personnel may be needed to transport water to the rigs, clean tools, assist in the installation of the security and marker pipes, construct the concrete aprons/collars and develop the wells. A potable water source on base will be designated by the Government.

Standard penetration tests will be performed in accordance with ASTM D-1586. Standard penetration tests will be performed at the following depths: 0.0-foot to 1.5-foot; 1.5-foot to 3.0-foot; 3.0-foot to 4.5-foot; and 5-foot centers thereafter. A boring log of the soil type, stratification, consistency and groundwater level will be prepared.

Groundwater sampling using a Hydropunch penetrometer (or similar penetrometer probe) and the corresponding laboratory analysis will be used to help define the lateral and horizontal extent of the contamination. The Hydropunch sample shall be obtained from either the upper or lower portion of the aquifer as needed. The use of augering to provide a pilot hole shall not be used. The Hydropunch operation shall not produce soil debris or excess groundwater. The proposed location of Hydropunch penetrometer sampling shall be detailed in the preliminary well location plan.

Attachment (b)

SAMPLING

Two soil samples will be obtained from each boring/well in accordance with ASTM Method D-1586 for split barrel sampling. The first sample will be obtained from 2 to 5 feet below ground surface. The second soil sample will be from the water table to 5 feet above the water table. Each soil sample will be screened in the field using an HNu photoionizer, organic vapor detector or similar type direct readout instrument to identify the presence of petroleum product within the soils. This field screening will provide a preliminary indication of the vertical and horizontal extent of petroleum contamination in order to select the optimum locations of other monitoring wells during the drilling program. Based on the field screening, monitoring wells will be installed at the locations where the most significant accumulation of fuel is encountered. Groundwater sample shall be obtained from each well and penetrometer probe after development is completed per the instructions below.

DEVELOPMENT

After completion of the soil sampling and drilling to the specified depth, 2-inch or 4-inch (as required by the EIC) I.D. flush-threaded Schedule 40 PVC (Schedule 80 in traffic areas) monitoring wells with slotted screens and well casings will be installed in the borehole. A 5 to 15-foot section of 0.01 inch slotted PVC well screen should be used in each well. Deep/shallow well pairs are to be used to obtain samples from both the upper and lower portions of the surficial aquifer. A sand pack will be placed around each slotted well screen extending to 2 feet above the top of the screen. A bentonite seal (minimum thickness - 1 ft.) will be placed on top of the sand pack. Finally, a ground mixture of two parts sand and one part cement, thoroughly mixed with the specified amount of potable water, will be placed in the borehole and rodded to insure a proper seal.

All wells will be developed following their installation to remove fine ground materials that may have entered the well during construction. This will be accomplished by either bailing or continuous low yield pumping. Equipment used for well installation, that may have come in contact with potentially contaminated material will be decontaminated with a high pressure steam clean wash followed by a potable supply water rinse. For the purpose of this scope of work, it is assumed that all fluid generated from well development and equipment decontamination can be disposed of on the ground at each respective well site.

After development, a standard slug permeability test will be done at each 2" monitoring well that does not contain product.

Soil removed from the borehole will containerized in DOT approved barrels and properly identified. It is expected that sampling required for this effort will suffice for determining if the material is hazardous. The drill equipment and tools will be cleaned prior to drilling each well using a portable decontamination system/operation supplied by the contractor. Wash water at the sites will not be contained, unless otherwise directed by the Government, and may seep into the ground locally.

Supplies and equipment will be transported to the lay-down area designated on the station by the Government. Any office space, trailers, etc., required for drilling, subsequent sampling and shipping shall be arranged and provided by the contractor.

WELL HEAD COMPLETION

A 4-inch diameter security pipe with a hinged locking cap will be installed on the well casing top having an embedment depth of 2.5 feet into the grout.

There are two acceptable methods of completing the wellheads.

In non-traffic areas the acceptable method of finishing a wellhead is shown in figure A-1. Each well will be marked with three Schedule 40 steel pipes, 3-inch I.D., imbedded in a minimum of 2.5-foot of 3,000 psi concrete. (The concrete used to secure the three pipes will be poured at the same time and be an integral part of the 5-foot by 5-foot by 0.5-foot concrete apron described above.). The security pipes will extend a minimum 2.5 feet and maximum 4.0 feet above the ground surface. The steel marker pipes will be filled with concrete and painted day-glo yellow or an equivalent.

In traffic areas (and non-traffic areas where required), a "flush" manhole type cover shall be built into a concrete pad as shown in figure A-2. If the well as installed through a paved or concrete surface, the annular space between the casing and the bore hole shall be grouted to a depth of at least 2.5 feet and finished with a concrete collar. If the well was not installed through a concrete or paved medium and still finished as a high traffic area well, a concrete apron measuring 5-foot by 5-foot by 0.5 foot will be constructed around each well. This apron/collar will be constructed of 3,000 psi ready-mixed concrete. The concrete will be crowned to provide and to meet the finished grade of surrounding pavement as required. The concrete pads can be constructed within five days after all of the wells have been installed.

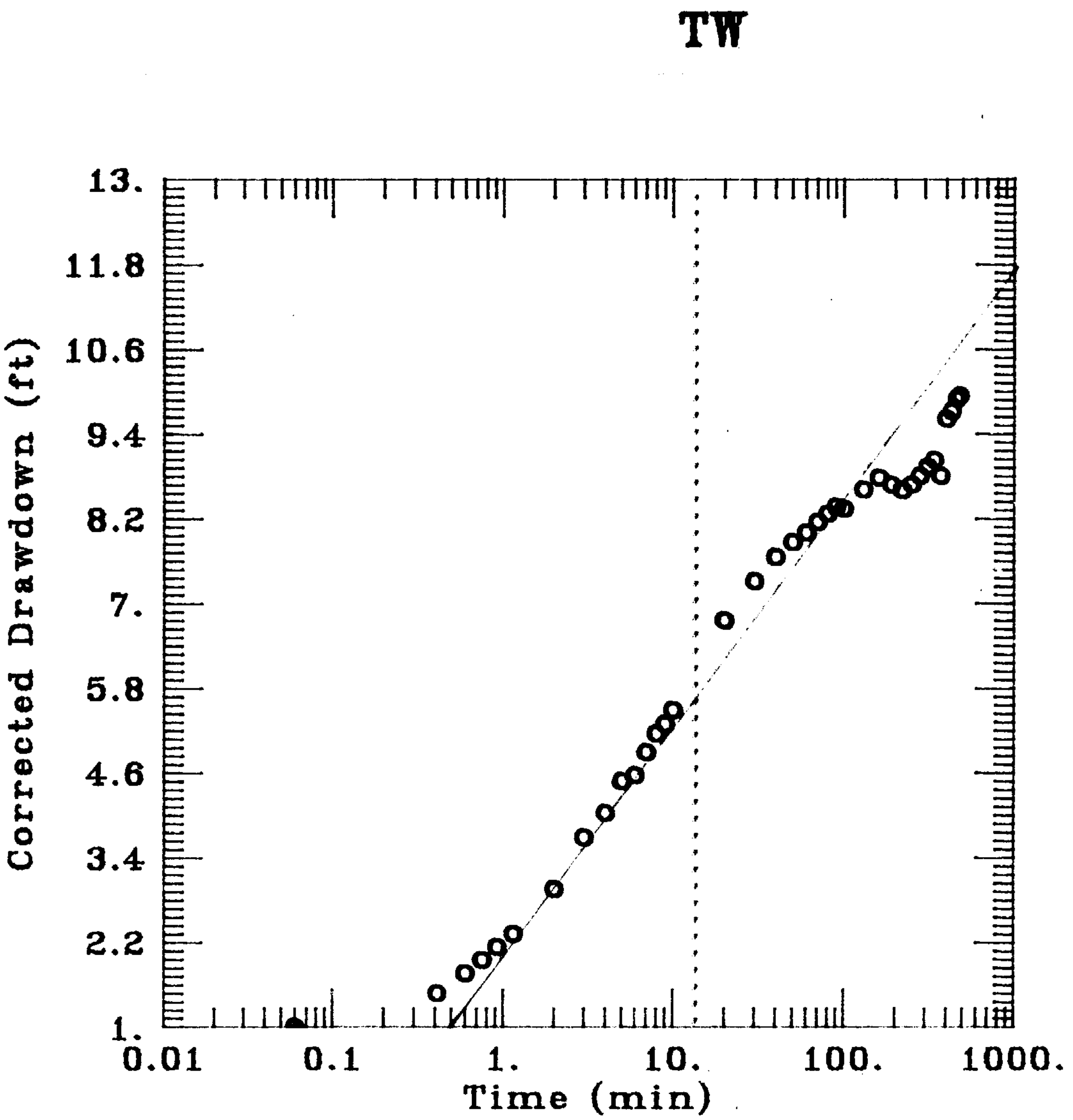
In all finishing methods, the well covers will be properly labeled by metal stamping on the exterior of the security pipe locking cap and by labeling vertically on the exterior of the security pipe or manhole cover as appropriate. The labeling shall consist of the letters UGW (UST Groundwater) (to describe the medium and the reason for the well) and a number specific to each well.

A sign reading "NOT FOR POTABLE USE OR DISPOSAL" SHALL BE FIRMLY ATTACHED TO EACH WELL.

* The contractor or project team may supplement these requirements, but may not modify or delete them, in total or in part, without prior approval of the Contracting Officer.

APPENDIX F

PUMP TEST DATA



DATA SET:
a:tw.dat
12/30/92

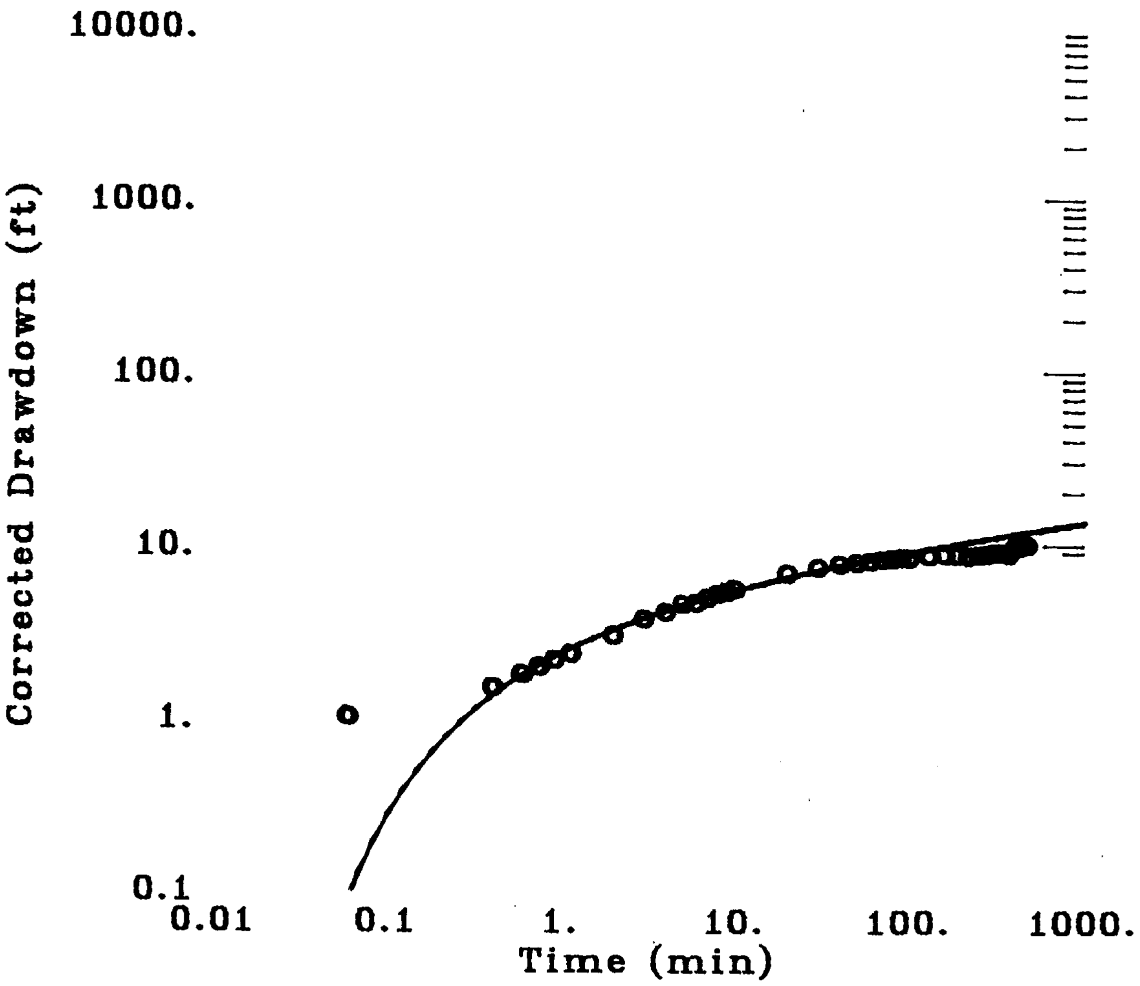
AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Cooper-Jacob

ESTIMATED PARAMETERS:
T = 0.04166 ft^2/min
S = 0.3446

TEST DATA:
Q = 0.286 ft^3/min
r = 0.25 ft
b = 50. ft

TW



DATA SET:

a: tw.dat
12/30/92

AQUIFER TYPE:

Unconfined

SOLUTION METHOD:

Theis

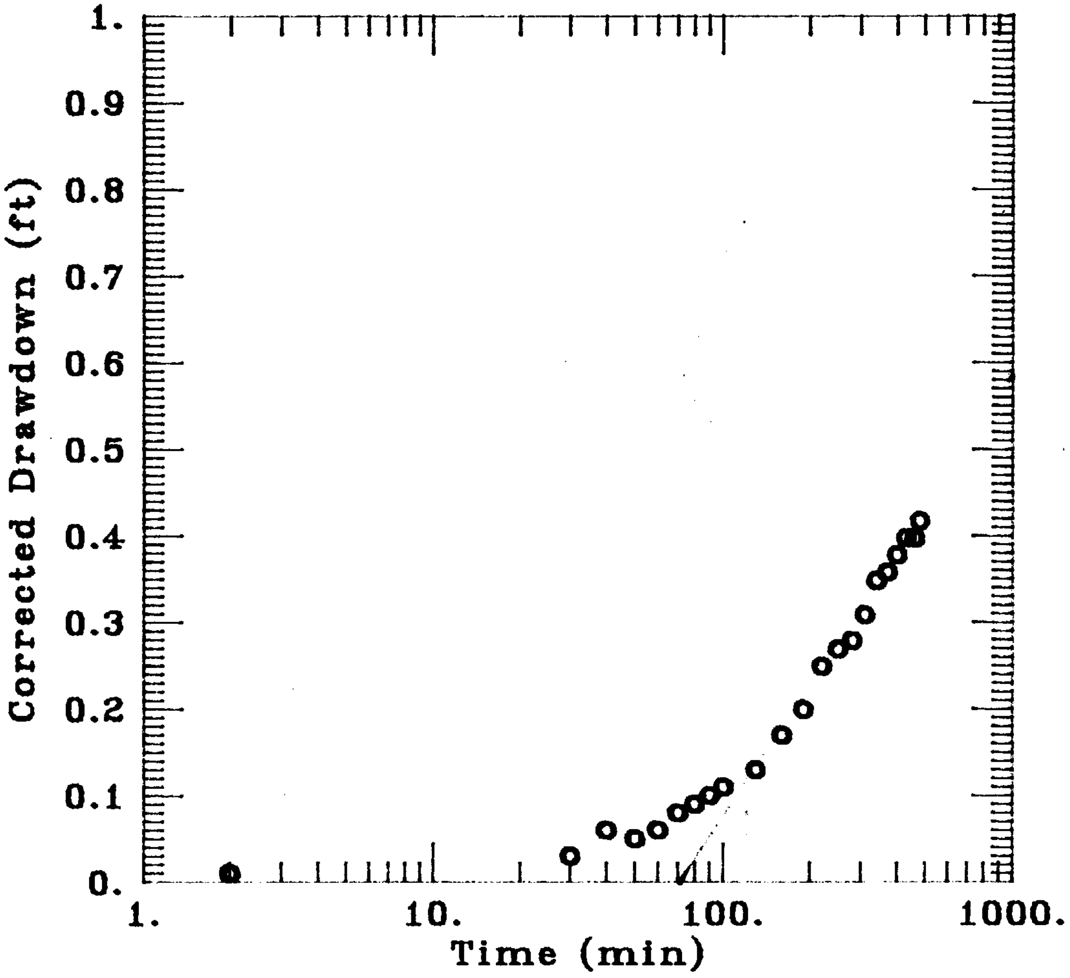
ESTIMATED PARAMETERS:

T = 0.04584 ft^2/min
S = 0.2964

TEST DATA:

Q = 0.735 ft^3/min
r = 0.25 ft
b = 30. ft

MW3



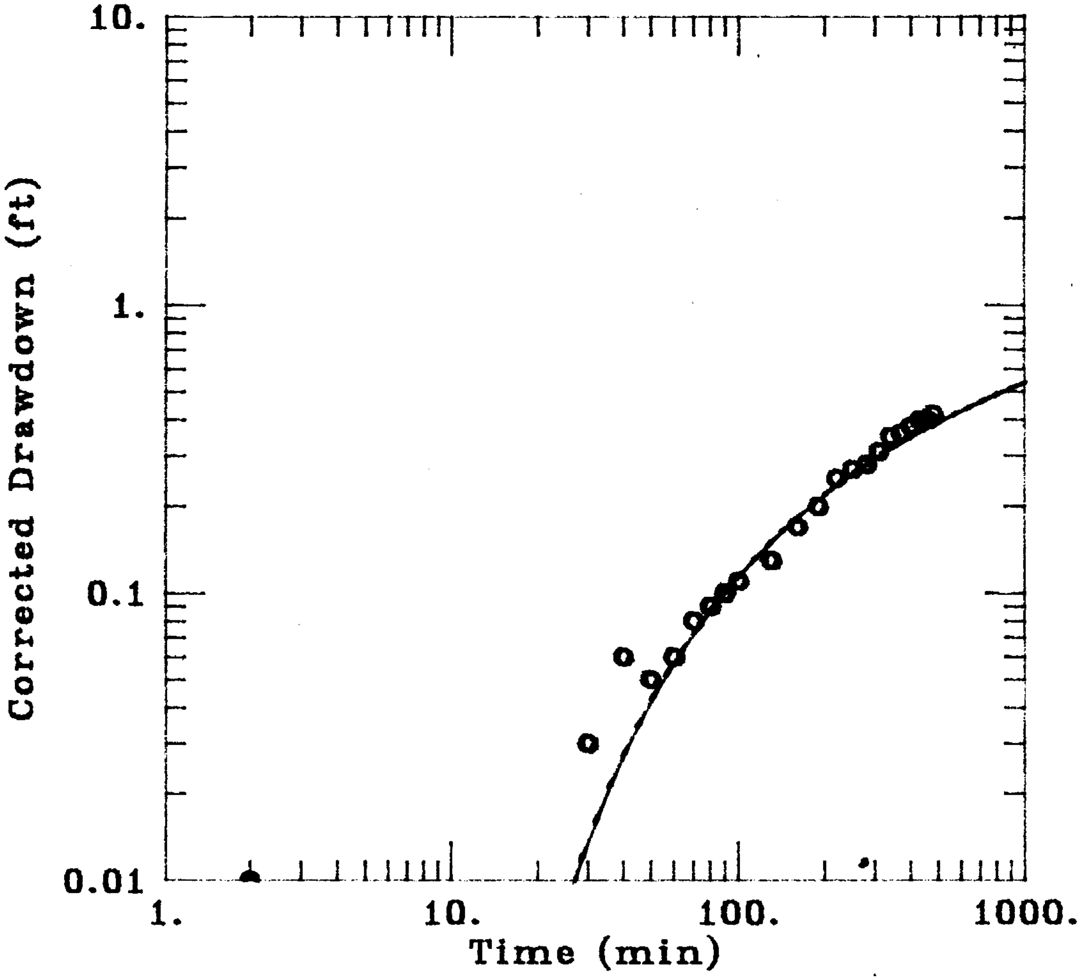
DATA SET:
a:mw3.dat
01/05/95

AQUIFER TYPE:
Unconfined
SOLUTION METHOD:
Cooper-Jacob

ESTIMATED PARAMETERS:
T = 0.2646 ft^2/min
S = 0.06199

TEST DATA:
Q = 0.755 ft^3/min
r = 26. ft
b = 30. ft

MW3



DATA SET:

a: mw3.dat

01/03/93

AQUIFER TYPE:

Unconfined

SOLUTION METHOD:

Theis

ESTIMATED PARAMETERS:

T = 0.2642 ft^2/min

S = 0.08019

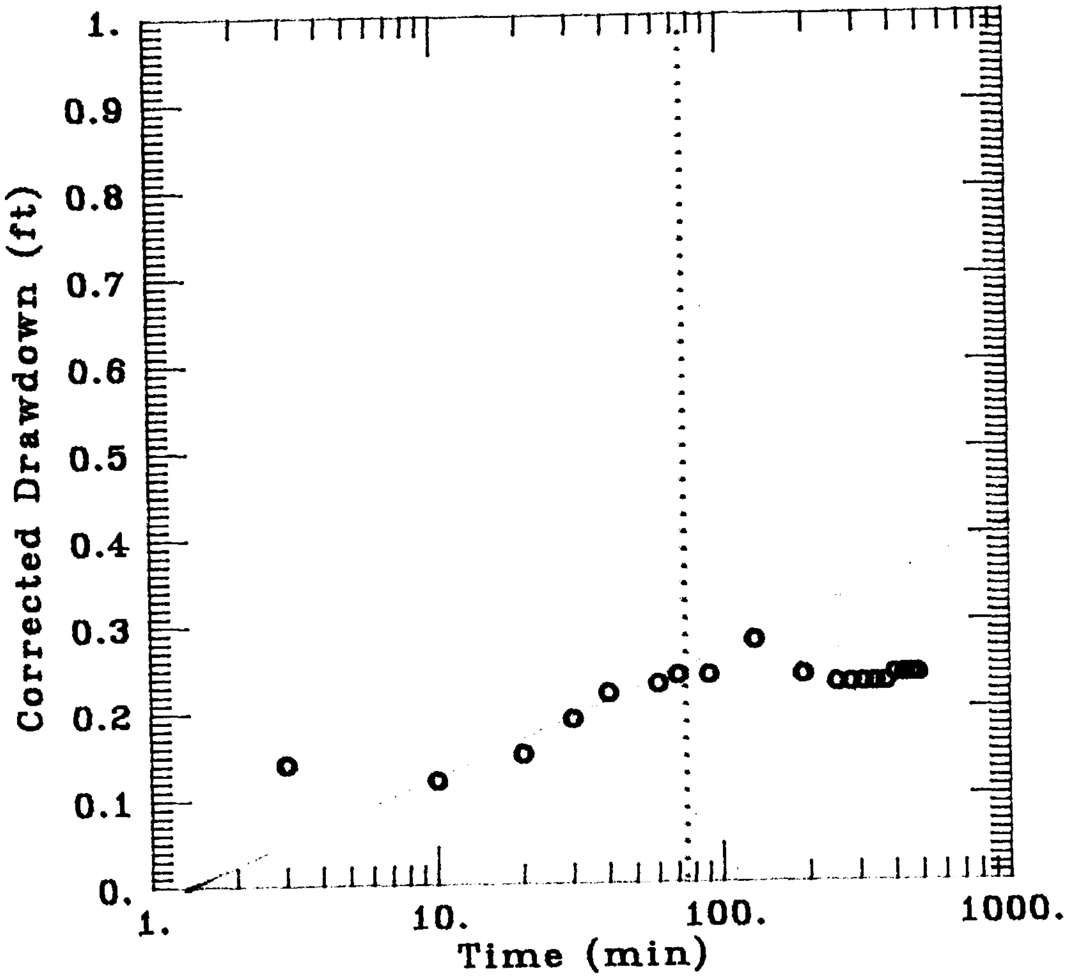
TEST DATA:

Q = 0.735 ft^3/min

r = 26. ft

b = 30. ft

MW4



DATA SET:
a: mw4.dat
01/03/93

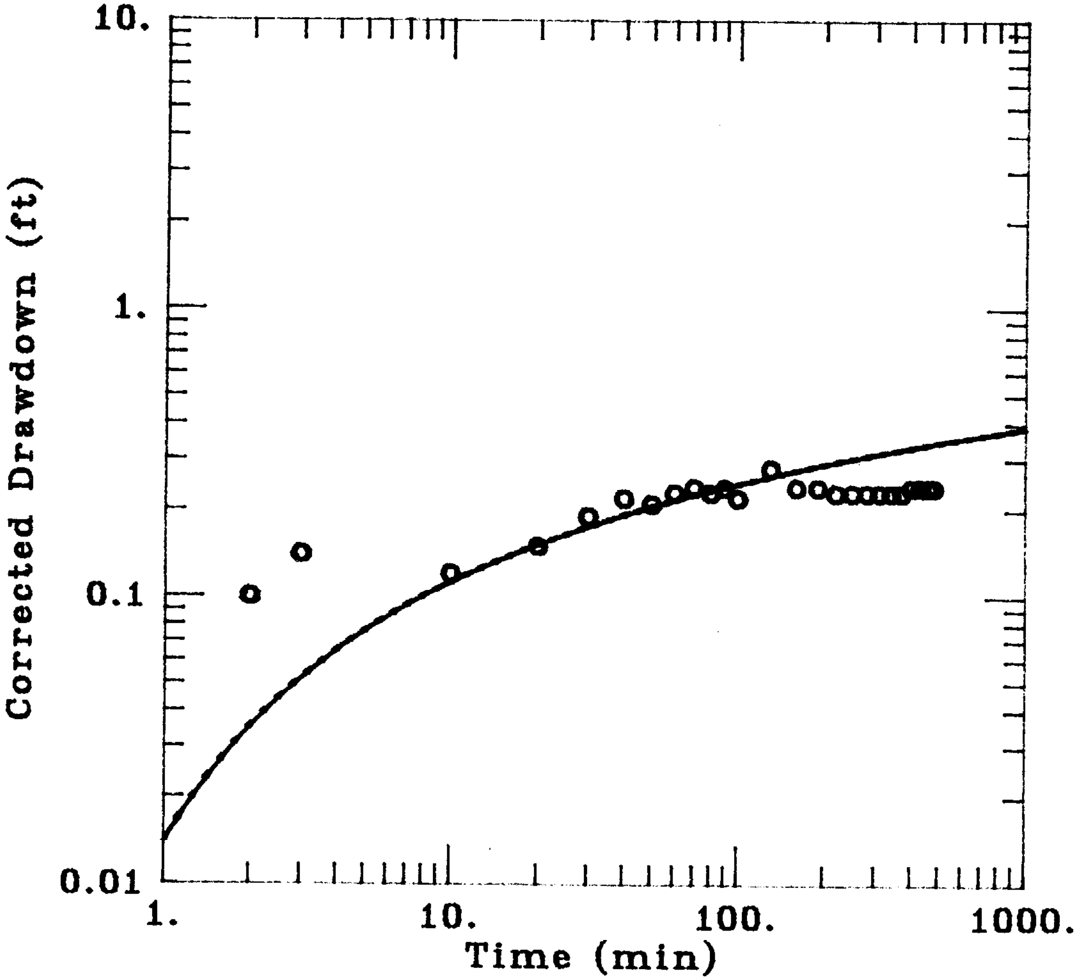
AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Cooper-Jacob

ESTIMATED PARAMETERS:
T = 0.9381 ft^2/min
S = 0.004102

TEST DATA:
Q = 0.735 ft^3/min
r = 26. ft
b = 30. ft

MW4



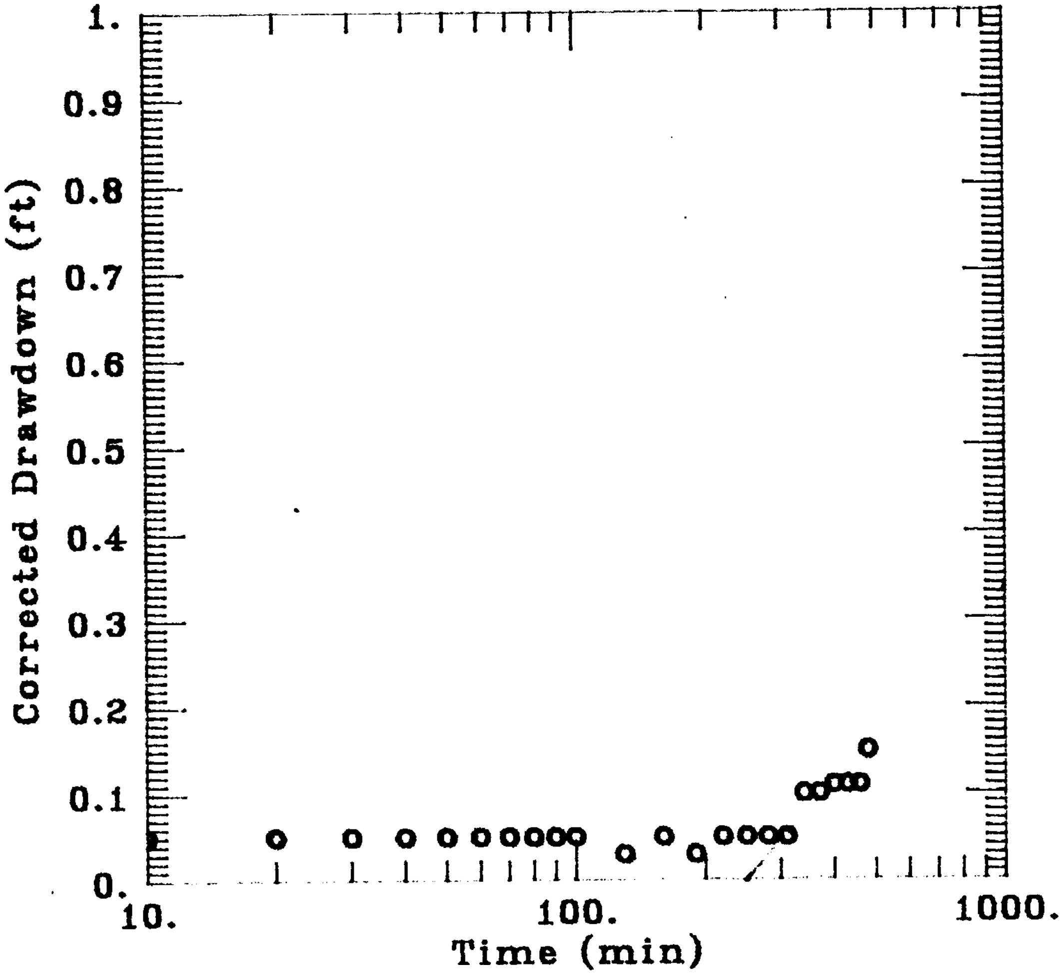
DATA SET:
a: mw4.dat
01/03/93

AQUIFER TYPE:
Unconfined
SOLUTION METHOD:
Theis

ESTIMATED PARAMETERS:
T = 0.9593 ft^2/min
S = 0.005081

TEST DATA:
Q = 0.735 ft^3/min
r = 26. ft
b = 30. ft

MW9



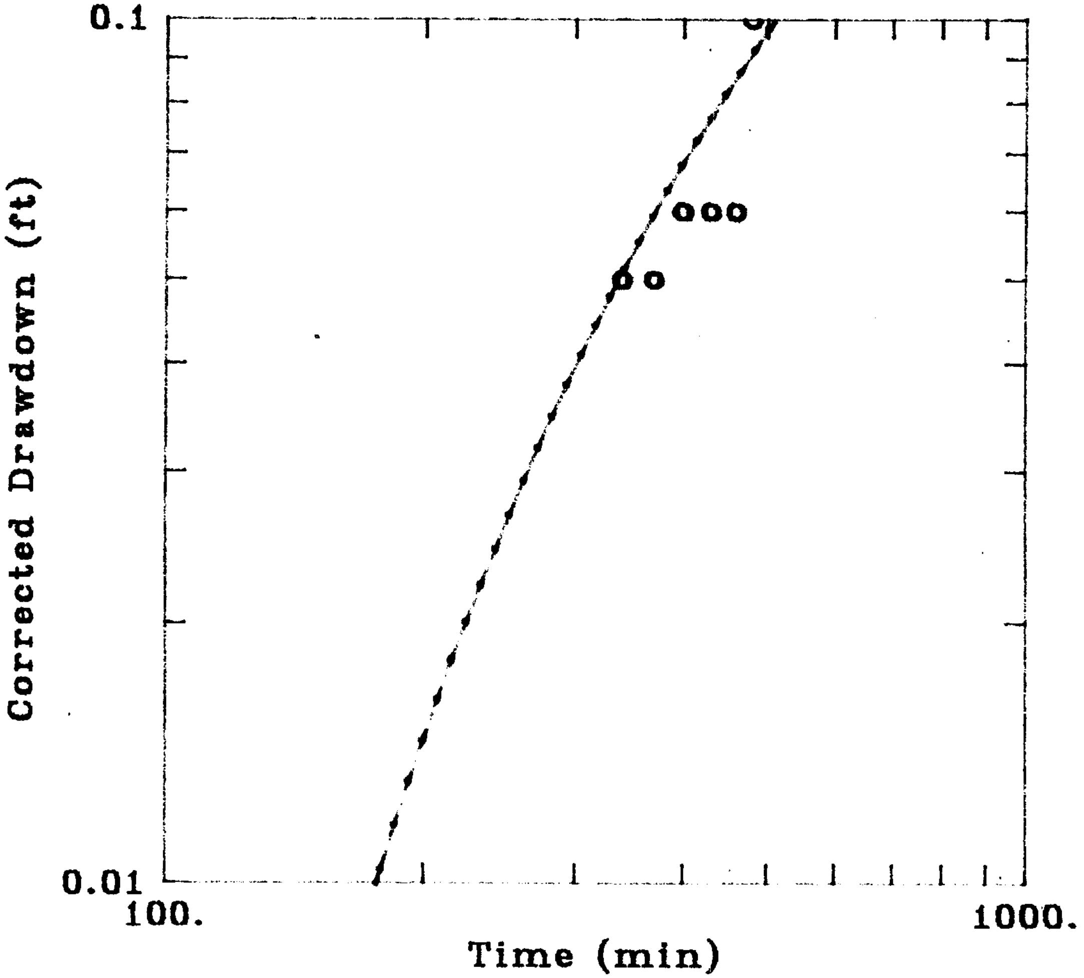
DATA SET:
a: mw9.dat
01/06/93

AQUIFER TYPE:
Unconfined
SOLUTION METHOD:
Cooper-Jacob

ESTIMATED PARAMETERS:
T = 0.2418 ft^2/min
S = 0.035

TEST DATA:
Q = 0.735 ft^3/min
r = 62. ft
b = 30. ft

MW9



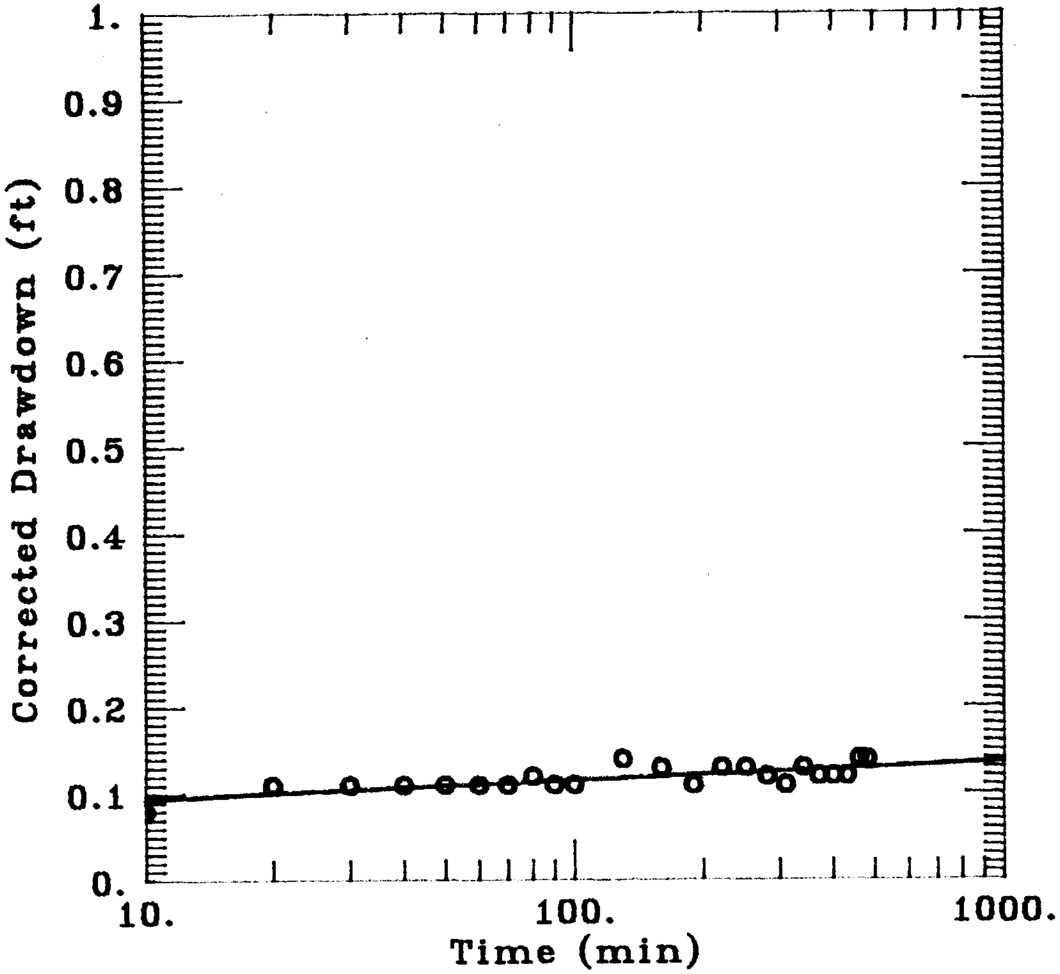
DATA SET:
a:mw9.dat
01/08/93

AQUIFER TYPE:
Unconfined
SOLUTION METHOD:
Theis

ESTIMATED PARAMETERS:
T = 0.1903 ft^2/min
S = 0.07624

TEST DATA:
Q = 0.735 ft^3/min
r = 62. ft
b = 30. ft

MW10



DATA SET:
a:mw10.dat
01/03/93

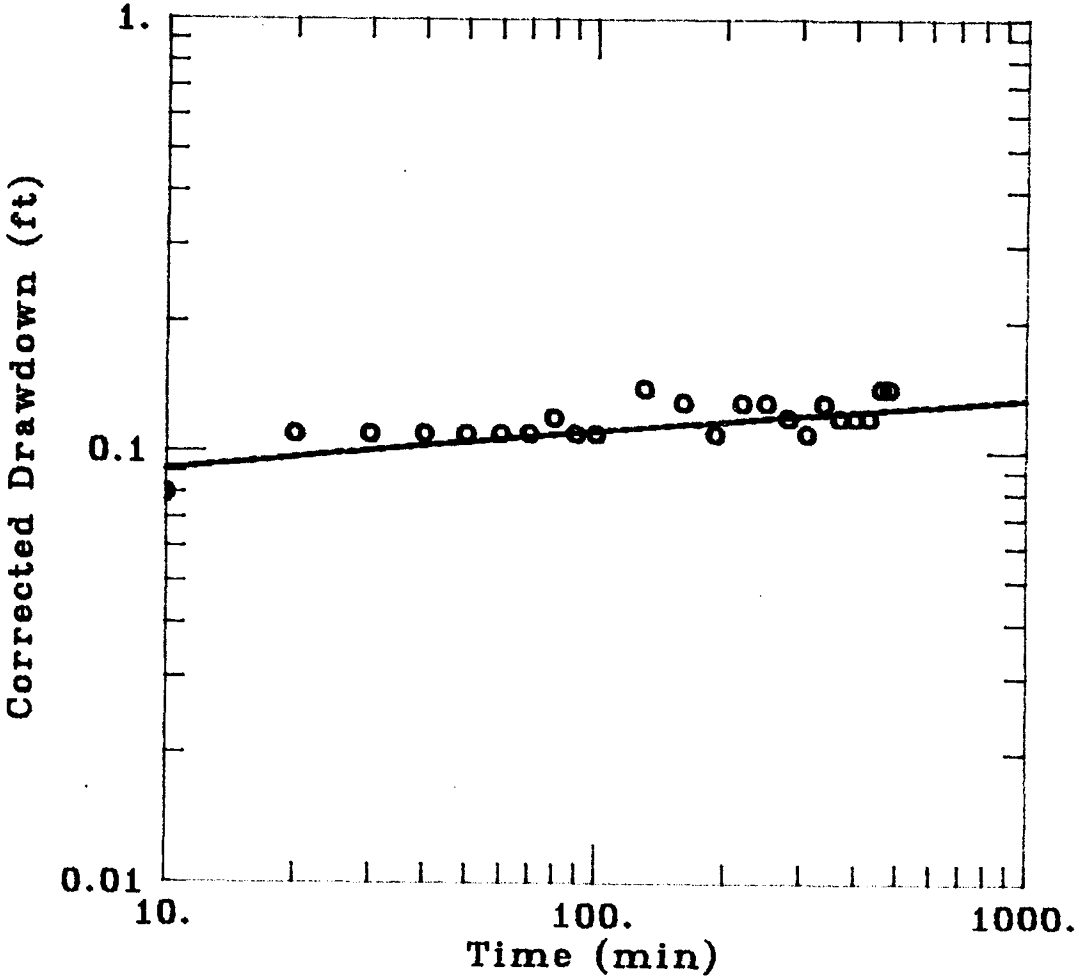
AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Cooper-Jacob

ESTIMATED PARAMETERS:
$T = 6.392\ ft^2/min$
$S = 1.1573E-06$

TEST DATA:
$Q = 0.735\ ft^3/min$
$r = 62.\ ft$
$b = 30.\ ft$

MW10



DATA SET:
a: mw10.dat
01/03/93

AQUIFER TYPE:
Unconfined
SOLUTION METHOD:
Theis

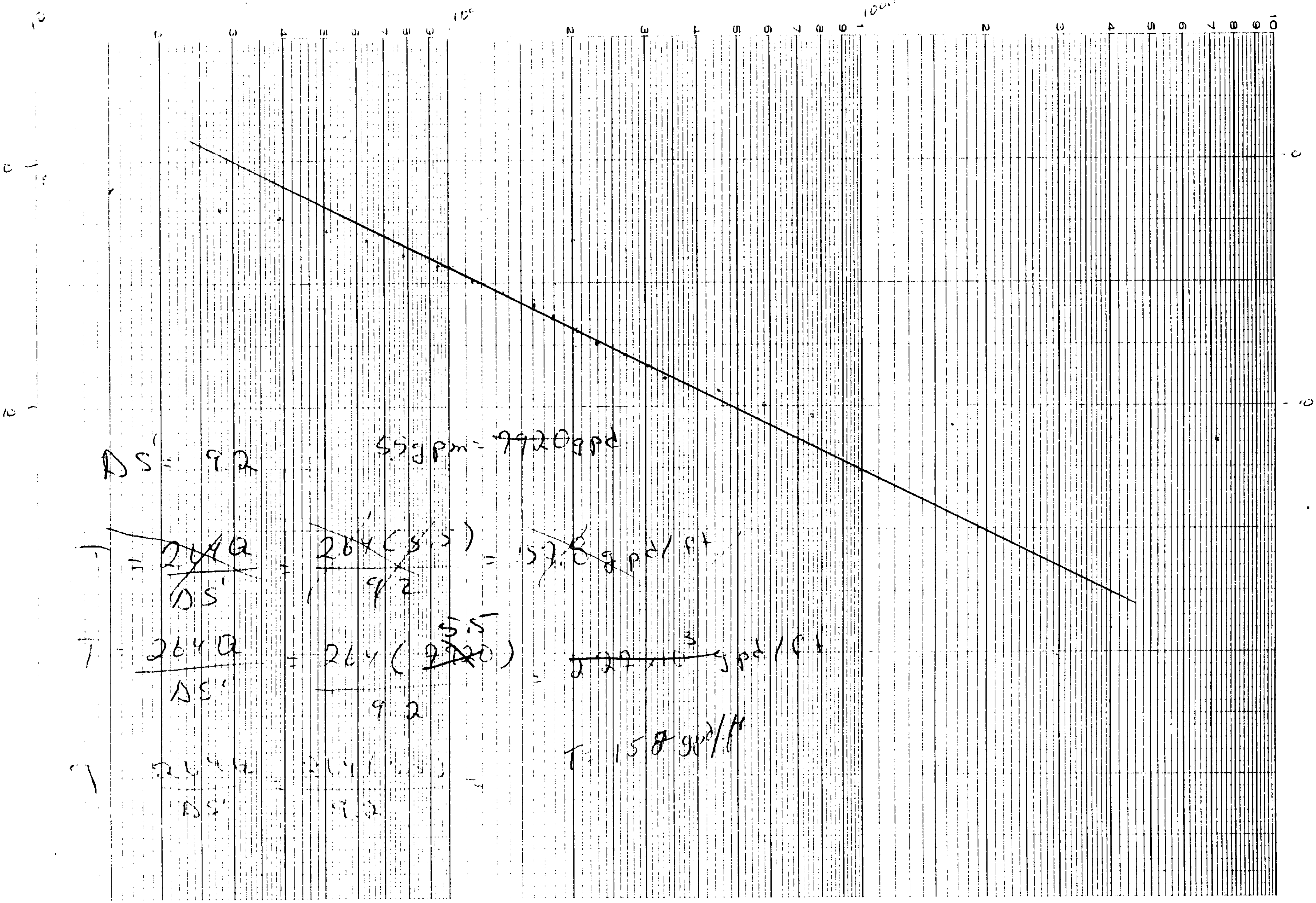
ESTIMATED PARAMETERS:
T = 6.424 ft^2/min
S = 1.1322E-06

TEST DATA:
Q = 0.735 ft^3/min
r = 62. ft
b = 30. ft

t'	t	t/t'	s'
0	480		11.91
0.28	480.28	1715.285	11.41
0.45	480.45	1067.666	10.91
0.63	480.63	762.9047	10.41
0.83	480.83	579.3132	9.91
1.07	481.07	449.5981	9.41
1.28	481.28	376	8.91
1.57	481.57	306.7324	8.41
1.78	481.78	270.6629	7.91
2.07	482.07	232.8840	7.41
2.33	482.33	207.0085	6.91
2.63	482.63	183.5095	6.41
3	483	161	5.91
3.52	483.52	137.3636	5.41
4.27	484.27	113.4121	4.91
5.1	485.1	95.11764	4.41
6.17	486.17	78.79578	3.91
7.55	487.55	64.57615	3.41
9.53	489.53	51.36726	2.91
12.47	492.47	39.49238	2.41
17.75	497.75	28.04225	1.91
32.98	512.98	15.55427	1.41
49.12	529.12	10.77198	1.21

[illegible] DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
3 CYCLES X 10 DIVISIONS PER INCH

DIETZGEN CORPORATION
MADE IN U.S.A.



$\Delta S' = 9.2$

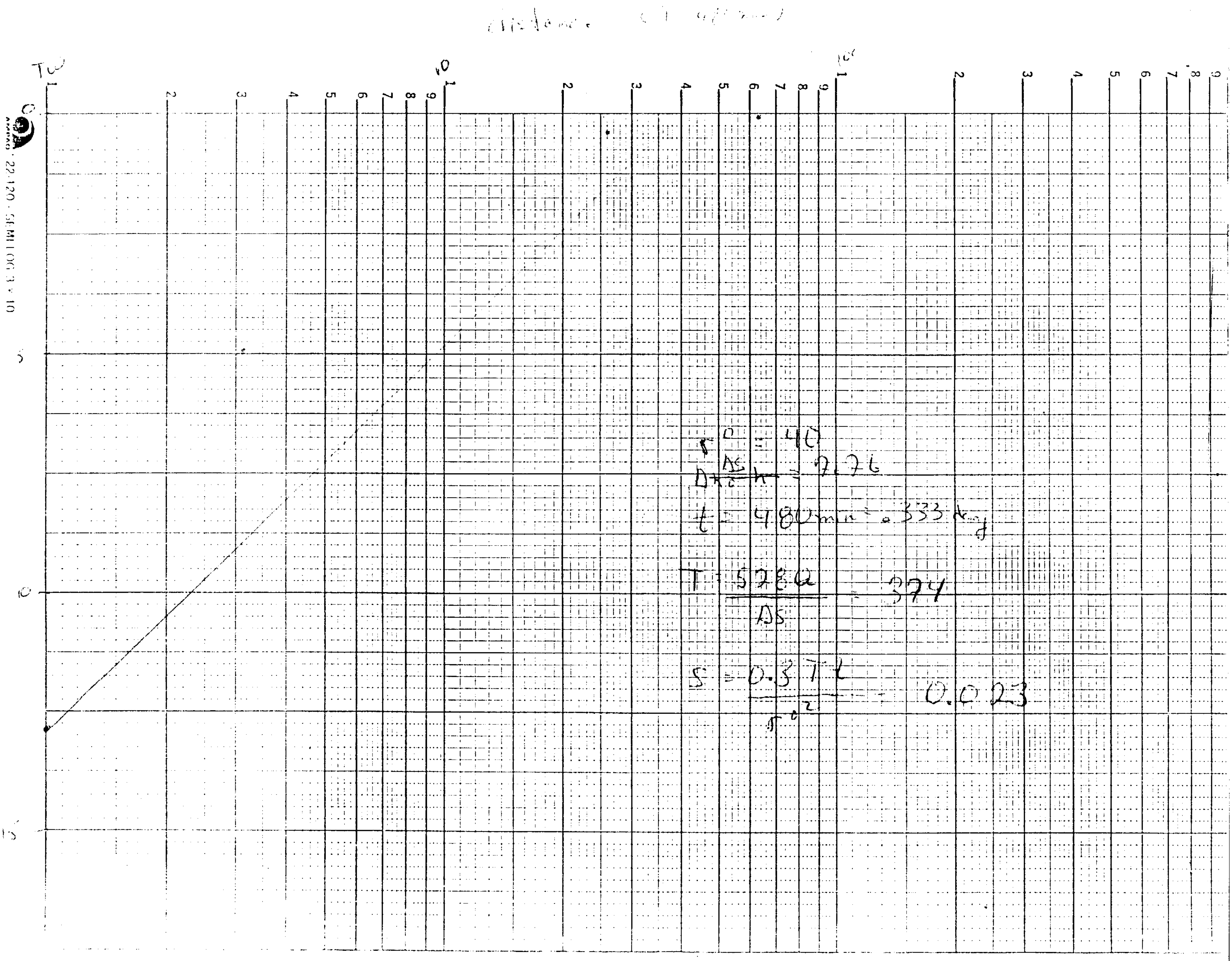
5.5 gpm = ~~7920 gpd~~

~~$T = \frac{264Q}{\Delta S'} = \frac{264(5.5)}{9.2} = 157.8$ gpd/ft~~

$T = \frac{264Q}{\Delta S'} = \frac{264(\cancel{7920}\ 5.5)}{9.2} =$ ~~0.227×10^3~~ gpd/ft

$T = \frac{264Q}{\Delta S'} = \frac{264(5.5)}{9.2} =$

T = 158 gpd/ft



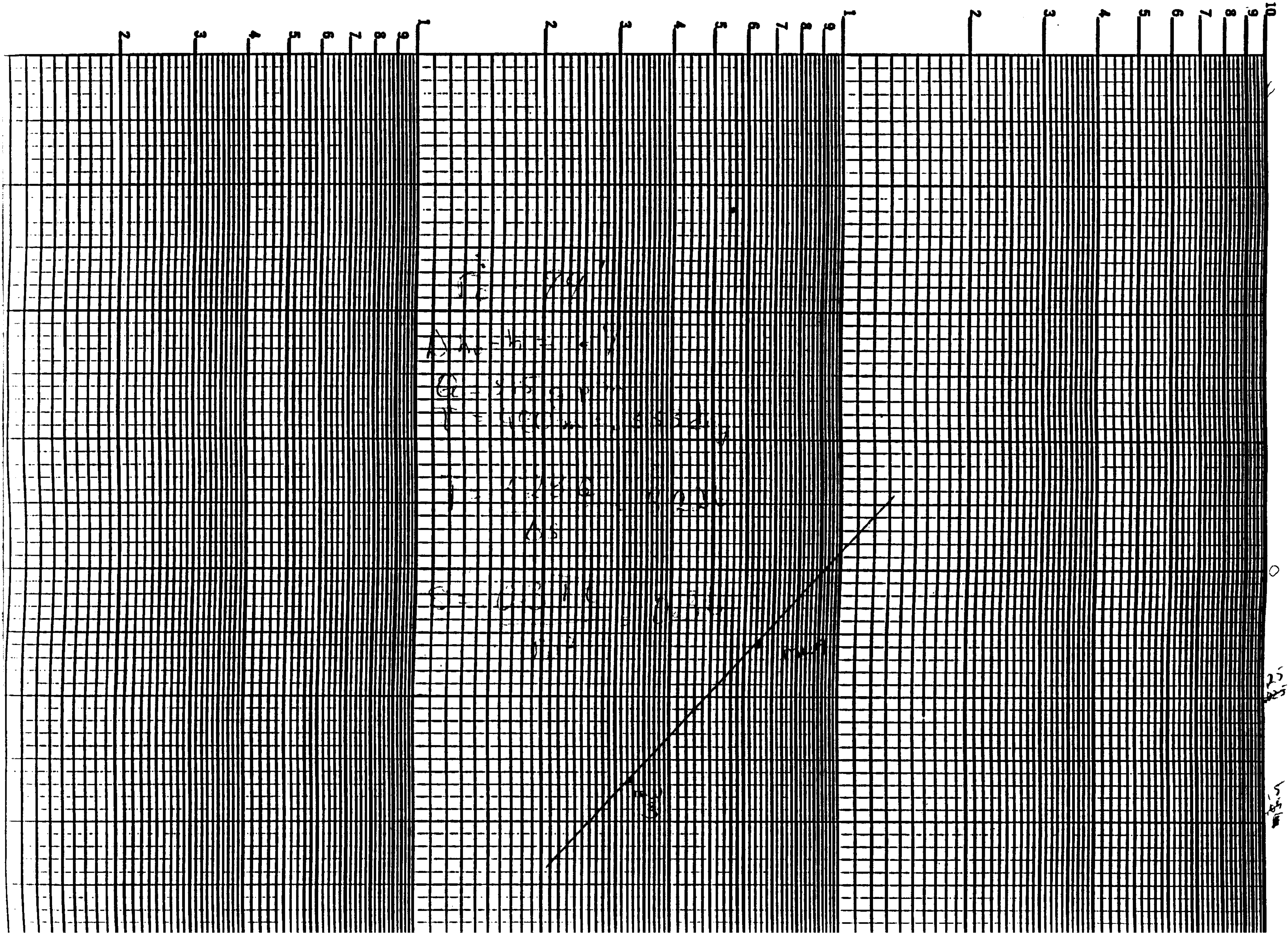
$r_0 = 40$

$\Delta s = 7.76$

$t = 480 \text{ min} = .333 \text{ day}$

$$T = \frac{528Q}{\Delta s} = 374$$

$$S = \frac{0.3Tt}{r_0^2} = 0.023$$


1
2
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6
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3
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6
7
8
9
1
2
3
4
5
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9
10
0
25
15

APPENDIX G

SAMPLING PROCEDURES

GROUNDWATER SAMPLING PROTOCOL

Use of the following procedures for sampling of ground water observation wells is dependent upon the size and depth of the well to be sampled and the presence of immiscible petroleum product in the well. To obtain representative ground water samples from wells containing only a few gallons of ground water and no product present, the bailing procedures is preferred. To obtain representative ground water samples from wells containing more than a few gallons if an immiscible product layer is apparent, the pumping procedure generally facilitates more representative sampling. Each of these procedures is explained in detail below.

1. Identify the well and record the location on the Ground Water Sampling Field Log, Attachment A.
2. Put on a new pair of disposable gloves.
3. Cut a slit in the center of the plastic sheet, and slip it over the well creating clean surface onto which the sampling equipment can be positioned.
4. Clean all meters, tools, equipment, etc., before placing on the plastic sheet.
5. Using an electric well probe, measure the depth of the water tube and the bottom of the well. Record this information in the Ground Water Sampling Field Log.
6. Clean the well depth probe with an acetone soaked towel and rinse it with distilled water after use.
7. Compute the volume of water in the well, and record this volume on the Ground Water Sampling Field Log.
8. Attach enough polypropylene rope to a bailer to reach the bottom of the well, and lower the bailer slowly into the well making certain to submerge it only far enough to fill one-half full. The purpose of this is to recover any oil film, if one is present on the water table.

9. Pull the bailer out of the well keeping the polypropylene rope on the plastic sheet. Empty the ground water from the bailer into a glass quart container and observe its appearance. NOTE: This sample will not undergo laboratory analysis, and is collected to observe the physical appearance of the ground water only.

10. Record the physical appearance of the ground water on the Ground Water Sampling Field Log.

11. Lower the bailer to the bottom of the well and agitate the bailer up and down to resuspend any material settled in the well.

12. Initiate bailing the well from the well bottom. All groundwater should be dumped from the bailer into a graduated pail to measure the quantity of water removed from the well.

13. Continue bailing the well throughout the water column and from the bottom until three times the volume of groundwater in the well has been removed, or until the well is bailed dry. If the well is bailed dry, allow sufficient time (several hours to overnight) for the well to recover before proceeding with Step 13. Record this information on the Groundwater Sampling Field Log.

14. Remove the sampling bottles from their transport containers and prepare the bottles for receiving samples. Inspect all labels to insure proper sample identification. Sample bottles should be kept cool with their caps on until they are ready to receive samples. Arrange the sampling containers to allow for convenient filling.

15. To minimize agitation of the water in the well, initiate sampling by lowering the bailer slowly into the well making certain to submerged it only far enough to fill it completely. Fill each sample container following the instructions listed in the Sample Containerization Procedures, Attachment B. Return each sample bottle to its proper transport container.

16. If the sample bottle cannot be filled quickly, keep them cool with the caps on until they are filled. The vials (3) labeled purgeable priority pollutant analysis should be filled from one bailer than securely capped. NOTE: Samples must not be allowed to freeze

17. Record the physical appearance of the groundwater observed during sampling on the Groundwater Sampling Field Log.

18. After the last sample has been collected, record the data and time, and, and if required, empty one bailer of water from the surface of the water in the well into the 200 ml beaker and measure and record the pH , conductivity and temperature of the ground water following the procedures outlined in the equipment operation manuals. Record this information on the Ground Water Sampling Field Log. The 200 ml beaker must then be rinsed with distilled water prior to reuse.

19. Begin the Chain of Custody Record.

20. Replace the well cap, and lock the well protection assembly before leaving the well location.

21. Place the polypropylene rope, gloves, rags and plastic sheeting into a plastic bag for disposal.

22. Clean the bailer by rinsing with control water and then distilled water. Store the clean bailer in a fresh plastic bag.

Sampling Procedures (PUMP)

1. Identify the well and record the location on the Ground Water Sampling Field Log.

2. Put on a new pair of disposable gloves.

3. Cut a slit in the center of the plastic sheet, and slip it over the well creating a clean surface onto which the sampling equipment can be positioned.

4. Clean all meters, tools, equipment, etc., before placing on the plastic sheet.

5. Using an electric well probe, measure the depth of the water tube and the bottom of the well. Record this information in the Ground Water Sampling Field Log.

6. Clean the well depth probe with an acetone soaked towel and rinse it with distilled water after use.

7. Compute the volume of water in the well, and record this volume on the Ground Water Sampling Field Log.

8. Attach enough polypropylene rope to a bailer to reach the bottom of the well, and lower the bailer slowly into the well making certain to submerge it only far enough to fill one-half full. The purpose of this is to recover any oil film, if one is present on the water table.

9. Pull the bailer out of the well keeping the polypropylene rope on the plastic sheet. Empty the ground water from the bailer into a glass quart container and observe its appearance. NOTE: This sample will not undergo laboratory analysis, and is collected to observe the physical appearance of the ground water only.

10. Record the physical appearance of the ground water on the Ground Water Sampling Field Log.

11. Prepare the submersible pump for operation. A pump with a packer inflated above the screened interval is preferred.

12. Lower the bailer to just below the top of the water column and pump the ground water into a graduated pail. Pumping should continue until sufficient well volumes have been removed or the well is pumped dry. If the well is pumped dry, allow sufficient time for the well to recover before proceeding with Step 16. Record this information on the Ground Water Sampling Field Log.

13. Remove the sampling bottles from their transport containers and prepare the bottles for receiving samples. Inspect all labels to insure proper sample identification. Sample bottles should be kept cool with their caps on until they are ready to receive samples. Arrange the sampling containers to allow for convenient filling.

14. With submersible pump raised to a level just below the surface of the water in the well, fill each sample container following the instructions listed in the Sample Containerization Procedures. Return each sampling bottle to its proper transport container. NOTE: A clean bottom loading stainless steel or Teflon bailer should be used to collect the sample used to fill the sample vials labeled purgeable priority pollutant analysis. Gently lower the bailer into the water to minimize agitation of the water. The vials (2) should be filled from one bailer.

15. If the sample bottle cannot be filled quickly, keep them cool with the caps on until they are filled. The vials (3) labeled purgeable priority pollutant analysis should be filled from one bailer than securely capped. NOTE: Samples must not be allowed to freeze.

16. Record the physical appearance of the groundwater observed during sampling on the Groundwater Sampling Field Log.

17. After the last sample has been collected, record the data and time, and, and if required, empty one bailer of water from the surface of the water in the well into the 200 ml beaker and measure and record the pH, conductivity and temperature of the ground water following the procedures outlined in the equipment operation manuals. Record this information on the Ground Water Sampling Field Log. The 200 ml beaker must then be rinsed with distilled water prior to reuse.

18. Begin the Chain of Custody Record. A separate form is required for each well with the required analysis listed individually.

19. Remove the submersible pump from the well and clean the pump and necessary tubing both internally and externally. Cleaning is comprised of rinses with a source water and acetone or methanol mixture, and distilled water using disposable towers and separate wash basins. The pump should then be returned to its covered storage box.

20. Replace the well cap, and lock the well protection assembly before leaving the well location.

21. Place the gloves, towels, disposable shoe covers and plastic sheet into a plastic bag for disposal.

APPENDIX H

GRAIN SIZE ANALYSIS

McCALLUM
TESTING LABORATORIES INC.
Subsurface Exploration • Geotechnical Engineering

January 6, 1993

O'Brien and Gere
440 Viking Drive
Suite 250
VA Beach, VA 23452

Attention: Ms. Tina Brickerstaff

Subject: Laboratory Test Results - 12/23/92
Tarawa Terrace
Camp Lajune, NC
MTL Project 93-103

Dear Ms. Brickerstaff:

Attached are the results of Hydrometer-Grain Size Analysis Tests (ASTM D 422) performed on soil samples received on 12/23/92 for the above referenced project.

Should you have any questions concerning this report, please contact this office at your convenience.

Very truly yours,

McCALLUM TESTING LABORATORIES INC.

Kenneth K. Esswein
Laboratory Manager

No. 5855

Douglas S. Kinloch, P.E.

1808 HAYWARD AVENUE P.O. BOX 13337 CHESAPEAKE, VIRGINIA 23325-0337
TELEPHONE (804) 420-2520 • FAX (804) 424-2874

McCallum Testing Laboratories, Inc.
1808 HAYWARD AVENUE
P.O. Box 13337
CHESAPEAKE, VIRGINIA 23325-0266
(804) 420-2520

Our File Number 93-103
Client's Order No.
Client's Req'n No.
Date 1/6/93

REPORT ON SOIL

Lab. No. 37-1
Chesapeake, Va.
Sample of TW
Proposed Use
Sample No. #1
From Tarawa Terrace, Camp Lejune, NC
Depth Taken
Depth From 9' to 11'
Depth of Cut
Height of Fill
Represents
Submitted by O'Brien & Gere
Sampled
Received 12/23/92

MECHANICAL ANALYSIS (ASTM D 422)

COARSE AGGREGATE

SIEVE ANALYSIS		TOTAL % PASSING	
3"-2"	%	3"	%
2"-1½"	%	2"	%
1½"-1"	%	1½"	%
1"-¾"	%	1"	%
¾"-½"	%	¾"	%
½"-3/8"	%	½"	%
3/8"-#4	%	3/8"	%
Passing #4	%	#4	%

SOIL MORTAR

SIEVE ANALYSIS		TOTAL % PASSING	
Coarse Sand #4-#10	0.1 %	# 4	100.0 %
Medium Sand #10-#40	11.8 %	# 10	99.9 %
Fine Sand #40-#200	35.4 %	# 40	88.1 %
Silt #200—0.005 mm	19.0 %	#100	56.9 %
Clay-Smaller than 0.005 mm	33.7 %	#200	52.7 %
Colloids-Smaller than 0.001 mm	%		

OTHER TEST DATA

Liquid Limit
Water Content as Received %
Plastic Limit
Plasticity Index
Loss on Ignition (corrected) %
Specific Gravity
Coefficient of permeability Ft. per day
Classification
H.R.B.

Remarks: Sample Contained

Lab. No.

FORM L-111

McCallum Testing Laboratories, Inc.
1808 HAYWARD AVENUE
P.O. Box 13337
CHESAPEAKE, VIRGINIA 23325-0266
(804) 420-2520

Our File Number 93-103
Client's Order No.
Client's Req'n No.
Date 1/6/93

REPORT ON SOIL

Lab. No. 37-2
Chesapeake, Va.
Sample of TW
Proposed Use
Sample No. #2
From Tarawa Terrace, Camp Lejune, NC
Depth Taken
Depth From 9' to 11'
Depth of Cut
Height of Fill
Represents
Submitted by O'Brien & Gere , ,
Sampled
Received 12/23/92

MECHANICAL ANALYSIS (ASTM D 422)

COARSE AGGREGATE

SIEVE ANALYSIS		TOTAL % PASSING	
3"-2"	%	3"	%
2"-1½"	%	2"	%
1½"-1"	%	1½"	%
1"-¾"	%	1"	%
¾"-½"	%	¾"	%
½"-3/8"	%	½"	%
3/8"-#4	%	3/8"	%
Passing #4	%	#4	%

SOIL MORTAR

SIEVE ANALYSIS		TOTAL % PASSING	
Coarse Sand #4-#10	0.1 %	# 4	100.0 %
Medium Sand #10-#40	30.7 %	# 10	99.9 %
Fine Sand #40-#200	37.8 %	# 40	69.2 %
Silt #200—0.005 mm	7.8 %	#100	33.9 %
Clay-Smaller than 0.005 mm	23.6 %	#200	31.4 %
Colloids-Smaller than 0.001 mm	%		

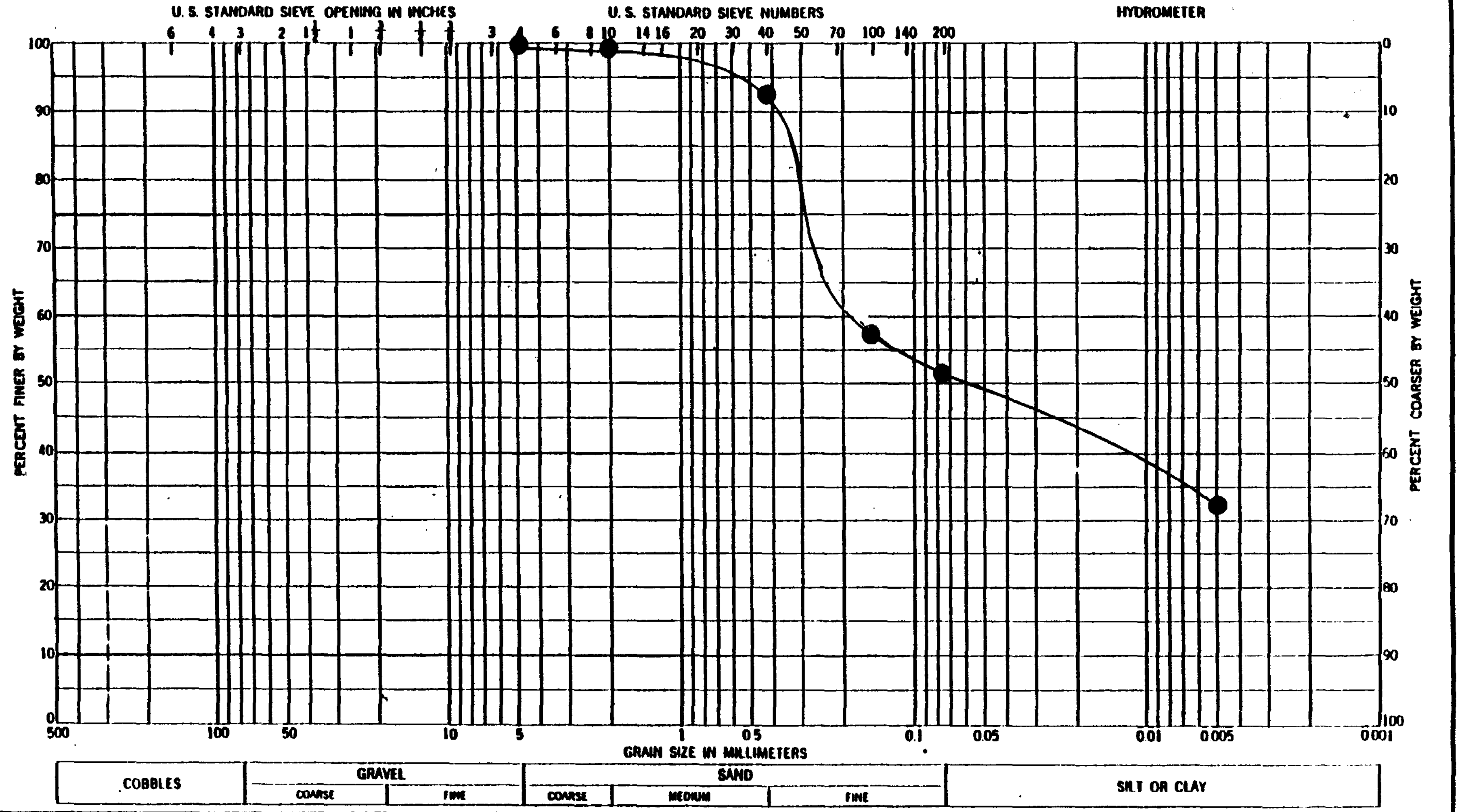
OTHER TEST DATA

Liquid Limit
Water Content as Received %
Plastic Limit
Plasticity Index
Loss on Ignition (corrected) %
Specific Gravity
Coefficient of permeability Ft. per day
Classification
H.R.B.

Remarks: Sample Contained

Lab. No.

FORM L-111



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
37-1	9' to 11'	Yellowish brown silty fine to medium sandy clay	N/A	N/A	N/A	N/A

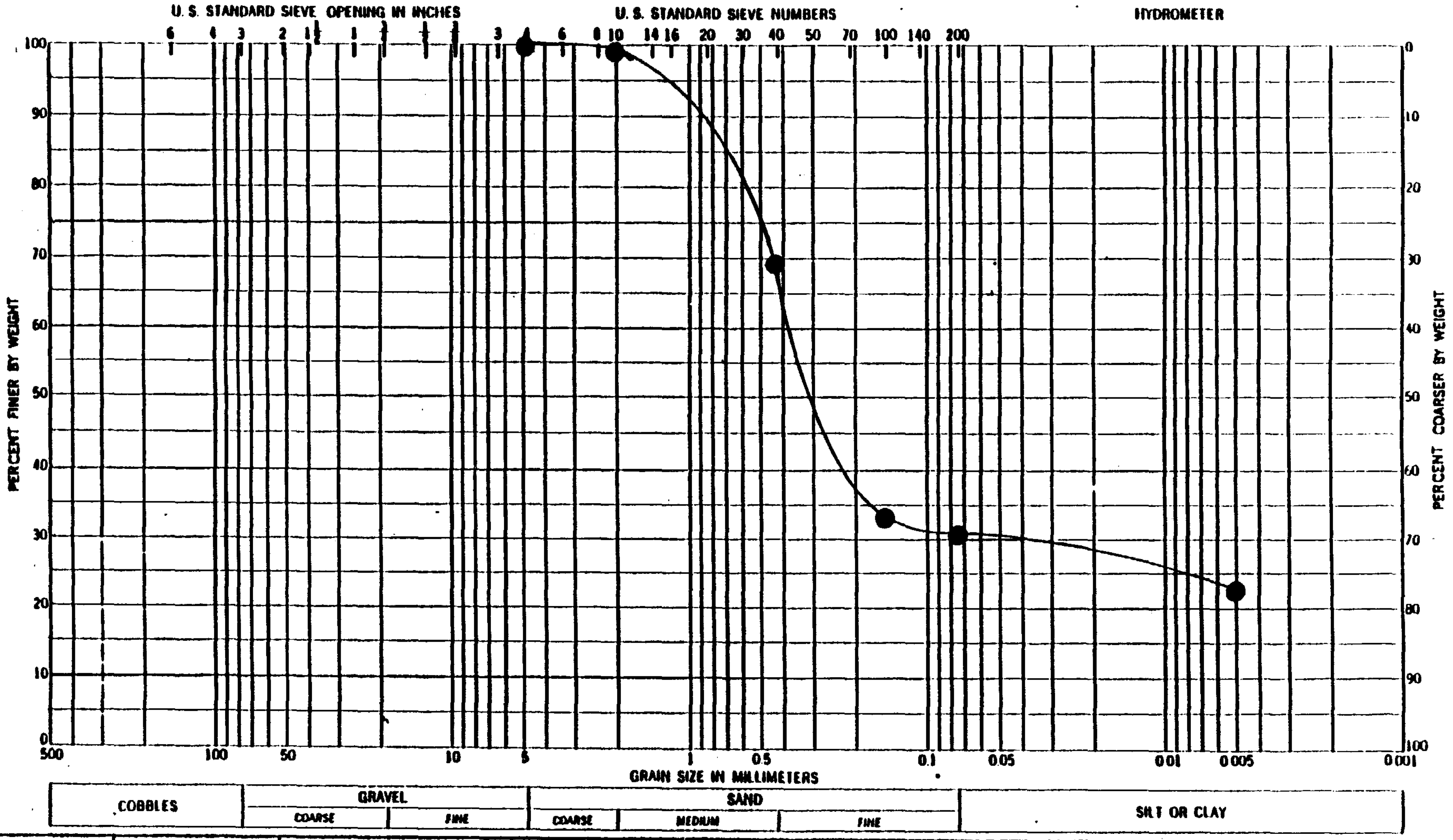
Project O'Brien & Gere
Tarawa Terrace

Area Camp Lejune, NC

Boring No. TW

Date 1/6/93

GRADATION CURVES



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
37-2	9' to 11'	Yellowish brown silty clayey fine to medium sand	N/A	N/A	N/A	N/A

Project O'Brien & Gere
Tarawa Terrace

Area Camp Lejune, NC

Boring No. TW

Date 1/6/93

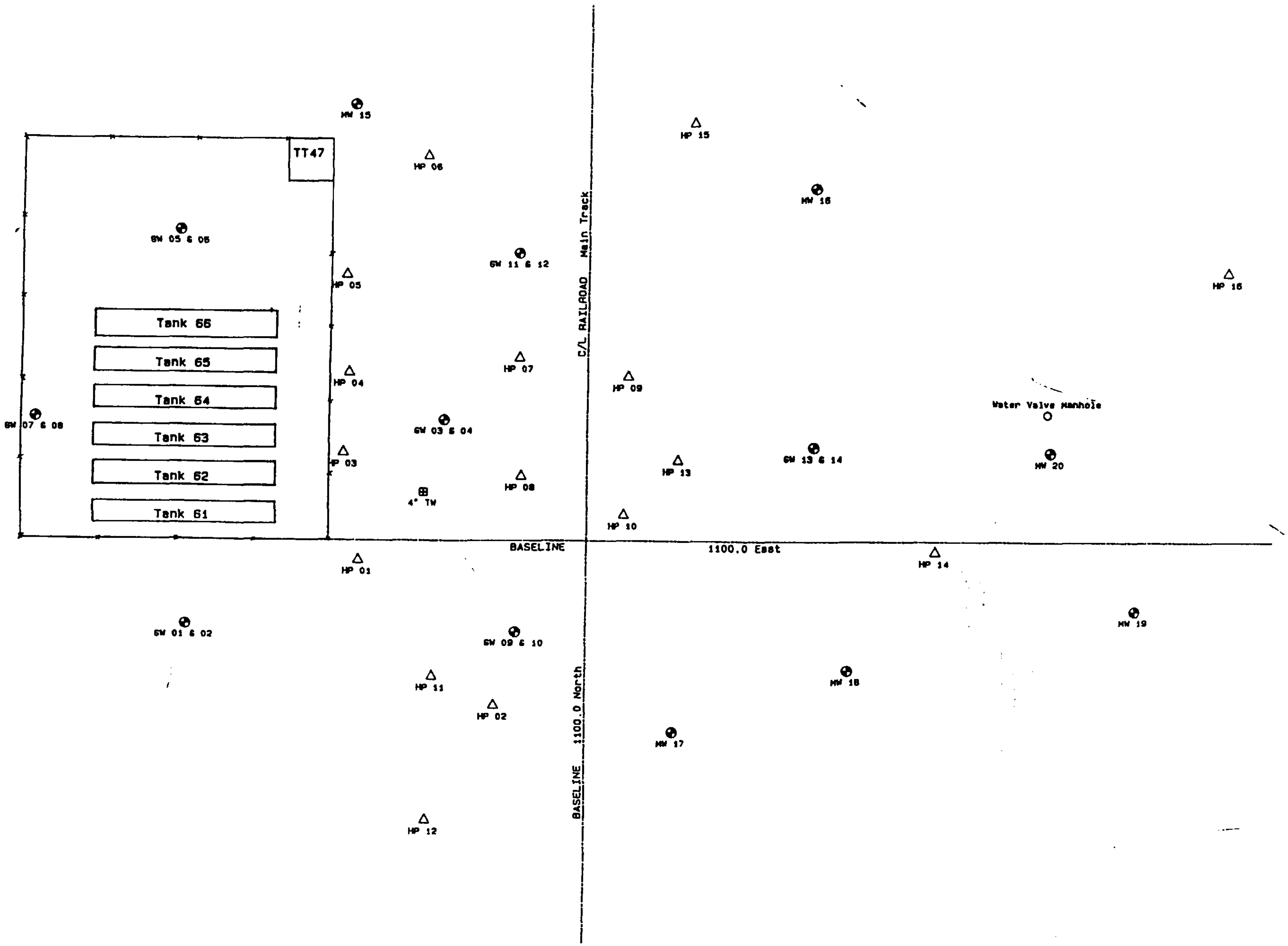
GRADATION CURVES

Exhibits

O'BRIEN & GERE
ENGINEERS, INC.

EXHIBIT A

SITE SURVEY DATA



ROBERT H. DAVIS, RLS
SURVEYORS AND PLANNERS
7175 HIGHWAY 70 EAST
NEW BERN, NORTH CAROLINA 28562
919-636-2109

L-2432

-07-93

ROBERT H. DAVIS, RLS
SURVEYORS AND PLANNERS
7175 HIGHWAY 70 EAST
NEW BERN, NORTH CAROLINA 28562
919-636-2109

JOB 91130 06 1 O'Brien & Gere
~~SHEET NO.~~ Attn Tina Bickerstaff OF
CALCULATED BY RHD DATE 01-07-93
CHECKED BY RHD DATE 01-07-93
SCALE None

POINT	NORTHING	EASTING	ELEVATION	POINT	NORTHING	EASTING	ELEVATION
GW 01	1245.1	1068.3	100.88	HP 01	1182.7	1092.5	100.00
GW 02	1245.1	1068.3	100.81	HP 02	1132.8	1038.1	97.65
GW 03	1152.0	1145.0	101.09	HP 03	1188.4	1132.7	100.15
GW 04	1152.0	1145.0	100.99	HP 04	1186.5	1162.6	100.00
GW 05	1248.1	1215.5	101.53	HP 05	1187.8	1198.9	100.48
GW 06	1248.1	1215.5	101.61	HP 06	1158.9	1243.6	97.88
GW 07	1299.7	1145.6	101.74	HP 07	1124.7	1168.1	99.16
GW 08	1299.7	1145.6	101.70	HP 08	1123.9	1124.1	99.39
GW 09	1125.5	1065.7	101.08	HP 09	1085.3	1161.2	99.30
GW 10	1125.5	1065.7	100.98	HP 10	1086.6	1109.7	98.95
GW 11	1125.4	1207.2	101.63	HP 11	1155.6	1048.9	98.2
GW 12	1125.4	1207.2	101.54	HP 12	1157.8	995.5	97.4
GW 13	1017.1	1135.2	100.20	HP 13	1067.1	1130.1	97.0
GW 14	1017.1	1135.2	100.18	HP 14	972.8	1095.9	98.1
MW 15	1185.3	1262.8	100.29	HP 15	1062.2	1256.2	96.9
MW 16	1017.3	1231.8	99.65	HP 16	866.6	1200.2	97.8
MW 17	1068.2	1028.1	98.70				
MW 18	1004.3	1051.5	99.74				
MW 19	899.9	1074.1	100.36				
MW 20	931.0	1133.3	100.47				
4" TW	1159.5	1118.3	98.64				

DATA FROM FIELD SURVEY PERFORMED JANUARY 15, 1992 & DECEMBER 18, 1992

ELEVATIONS BASED ON TBM AT SITE MARKED 100.00' ASSUMED
ACTUAL TBM ELEVATION WOULD BE APPROXIMATELY 30' MSL

Robert H Davis
01-07-93

SEAL
L-2432
ROBERT H. DAVIS

EXHIBIT B

TECHNICAL MEMORANDUM NO. 2 EXCERPTS

TECHNICAL MEMORANDUM NO. 2
RESULTS OF FIELD INVESTIGATION

Prepared for:

Public Works Division
Marine Corps Base, Camp Lejeune

Contract N62470-C090-6796

D&D Project No: LZ682-000001-93160-D086

Prepared by:

Dewberry & Davis
5238 Valleypointe Parkway
Suite One-B
Roanoke, Virginia 24019

(703) 362-7725

January 1991

8.0 TARAWA TERRACE

8.1 Tank Contents. The results for the laboratory testing on the sample from the Tarawa Terrace tank are presented in Table 10. The tank sampled was designated STT-66. At the time of sampling (11/26/90), there was approximately 3 inches of product in the tank, for an approximate volume of 450 gallons. The other tanks (STT-61, 62, 63, 64 and 65) each had approximately 1 to 3 inches of product. The tank was sampled utilizing a clean sample bag lowered on a rope. The leachate extraction procedure was not applicable to the waste oil sample, therefore, the TCLP parameters are total concentrations and many of the detection limits are above the regulatory levels.

The VOC's that were detected in the sample above their detection levels included 1,1-Dichloroethane,Tetrachloroethene,1,1,1-TrichloroethaneTrichlorofluoromethane,Benzene, Toluene, Ethylbenzene and Total Xylenes. For those detected VOCs with established maximum contaminant levels (MCL) or maximum contaminant level goals (MCLG), the concentrations in the waste oil exceed those MCL/MCLG's on the order of 3 to 600 times, All of the detected VOCs are commonly associated with petroleum and chlorinated solvents.

The TCLP constituents detected in the sample above their detection limits included Benzene, Methyl Ethyl Ketone, Tetrachloroethylene, Arsenic, Barium, Cadmium, Chromium, Lead and Mercury. Those that exceeded their regulatory levels included Benzene (3.15 ppm vs. 0.50 ppm), Tetrachloroethylene (5.12 ppm vs. 0.70 ppm), Cadmium (1.74 ppm vs 1.0 ppm), Chromium (95.0 ppm vs. 5.0 ppm), and Lead (25.0 ppm vs. 5.0 ppm). Mercury was detected at its regulatory level of 0.2 ppm.

The sample did not contain PCBs above the detection limit of 5.0 ppm and it was not hazardous by reactivity, ignitability or corrosivity indicators.

8.2 Site Geology. The site was investigated by six hand augers and nine soil borings advanced to a depths of 0.5 to 5 feet. The test locations are shown on the Tarawa Terrace Site sheet in the sleeve at the back of this report. The general locations are as follows:

- Soil borings TTSB-1, 2 and 3 are along the piping from the boiler house to the tanks
- Soil boring TTSB-4 is near the piping between tanks STT-65 and 66
- Soil borings TTSB 5, 6, 7, 8 and 9 are along the underground piping from the pump house to the railroad loading station and the piping along the railroad loading station

TABLE 10

CAMP LEJEUNE HAZARDOUS WASTE OIL TANKS LABORATORY RESULTS OF TANK CONTENTS

SITE	HOLCOMB	MIDWAY	NEW RIVER	TARAWA	
DATE SAMPLED	11/27/90	11/26/90	11/27/90	11/26/90	
TANK DESIGNATION	891	S-781	AS421	STT-66	
ESTIMATED VOLUME	24600 GAL	5100 GAL	330 GAL	450 GAL	
VOC'S					MCL
CHLOROBENZENE	0.607	0.597	ND	ND	0.06
CHLOROFORM	ND	0.914	5.27	ND	0.1
CHLOROMETHANE	ND	0.547	ND	ND	—
1,1-DICHLOROETHANE	ND	0.294/1.9	ND	1.45	—
1,1-DICHLOROETHENE	3.69	ND	ND	ND	—
METHYLENE CHLORIDE	ND	0.562	0.542	ND	—
TETRACHLOROETHENE	ND	0.709	ND	5.12	—
1,1,1-TRICHLOROETHANE	11.1	2.00/13.0	ND	4.43	0.2
TRICHLOROETHENE	2.23	314.0	1.08	ND	—
TRICHLOROFLUOROMETHANE	2.06	1.18	1.39	2.94	—
1,1,2-TRICHLOROTRI-FLUOROETHANE	ND	10.5	0.513	ND	—
BENZENE	7.31	2.78/11.0	ND	3.15	0.005
1,2-DICHLOROBENZENE	ND	0.213	ND	ND	0.62
ETHLYBENZENE	19.7	6.97/39.0	0.571	22.6	0.68
TOLUENE	6.20	20.5/96.0	2.80	7.12	2.0
TOTAL XYLENES	73.7	23.2/260.0	3.97	87.9	0.44
TCLP					REG. LEVEL
ARSENIC	0.100	0.002	0.151	0.100	5.0
BARIUM	15	1.8	ND	40	100.0
BENZENE	7.31	ND	ND	3.15	0.50
CADMIUM	2.24	0.138	1.01	1.74	1.0
CHLOROFORM	ND	ND	5.27	ND	6.0
CHROMIUM	80	0.14	55	95	5.0
1,1-DICHLOROETHYLENE	3.69	ND	ND	ND	0.70
LEAD	20	0.4	15	25	5.0
MERCURY	ND	ND	2.40	0.200	0.2
METHYL ETHYL KETONE	11.2	ND	7.19	20.4	200.0
TRICHLOROETHYLENE	2.23	6.13	1.08	ND	0.5
TETRACHLOROETHYLENE	ND	ND	ND	5.12	0.7

TABLE 10

(CONTINUED)

CAMP LEJEUNE HAZARDOUS WASTE OIL TANKS LABORATORY RESULTS OF TANK CONTENTS

SITE	HOLCOMB	MIDWAY	NEW RIVER	TARAWA
DATE SAMPLED	11/27/90	11/26/90	11/27/90	11/26/90
TANK DESIGNATION	891	S-781	AS421	STT-66
OTHER				
PCB	<5.0	<0.200	<5.0	<5.0
REACTIVITY				
TOTAL HYDROGEN CYANIDE	<5	<5	<5	<5
TOTAL HYDROGEN SULFIDE	<10	<10	<10	<10
IGNITABILITY				
FLASHPOINT	>212 F	>212 F	>212.2 F	208.4 F
CORROSIVITY				
pH	9.0 S.U.	5.88 S.U.	5.31 S.U.	7.25 S.U.

NOTES:

1) ALL RESULTS ARE PRESENTED IN PARTS PER MILLION (PPM), WHICH IS ANALOGOUS TO MILLIGRAMS PER KILOGRAM FOR THE VOC'S, PCB'S, REACTIVITY AND THE TCLP FOR HOLCOMB, NEW RIVER AND TARAWA. PPM IS ANALOGOUS TO MILLIGRAMS PER LITER FOR THE TCLP FOR MIDWAY. FLASHPOINT IS IN DEGREES FAHRENHEIT (F) AND pH IS IN STANDARD UNITS.
2) VOLATILE ORGANIC COMPOUNDS (VOC) IS A PARTIAL LIST CONSISTING OF 34 CHEMICALS. THOSE NOT INCLUDED IN THE TABLE WERE BELOW THEIR DETECTION LIMITS. THE DETECTION LIMIT FOR VOC'S WERE 0.125 PPM AT MIDWAY AND 0.500 PPM AT THE OTHER SITES.
3) TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) WAS WAS ONLY APPLICABLE TO THE MIDWAY SITE; THE OTHER SITES CONSISTED OF OIL SAMPLES FOR WHICH THE EXTRACTION WAS NOT APPLICABLE. THEREFORE, THE RESULTS FOR THOSE THREE SITES ARE FOR TOTAL CONCENTRATIONS IN THE WASTE OIL, WHILE THE RESULTS FOR MIDWAY ARE FOR THE LEACHATE FROM THE SLUDGE SAMPLED.
4) ND – NOT DETECTED; "<" – LESS THAN THE DETECTION LIMIT.
5) "O.294/1.9" FOR MIDWAY INDICATE RESULTS FROM FIRST AND SECOND LABORATORIES.
6) S.U. – STANDARD UNITS
7) F – DEGREES FAHRENHEIT
8) MCL – MAXIMUM CONTAMINANT LEVEL

- Hand auger TTHA-2 is near a valve which is dripping into a 55 gallon drum
- Hand auger TTHA-3 is next to a pump
- Hand auger TTHA-4 is next to piping between tanks STT-62 and 63
- Hand auger TTHA-5 is under overhead piping between tanks STT-62 and 63
- Hand auger TTHA-6 is in a low spot adjacent to two pipes with valves next to the pump house.

The soils encountered at each of the test locations are described in Table 11. A generalized subsurface is presented in Figure 2. The soils conditions encountered consisted primarily of 1 to 3 feet of fine to coarse sand with varying amounts of silt, which is underlain by up to 1.5 feet of soft, black organic silt and peat with varying amounts of sand, except at the railroad loading station where the organic silt/peat is absent. Below the organic silt/peat or the silty sand where the organic layer is absent is either a very silty sand to sandy silt on the north and east sides of the site or a fine sand with little silt to the south side of the site. Groundwater was not encountered within the depth investigated. Decaying odors were prevalent in much of the sand above and below the organic layer. These odors may be due to the decomposing organics.

8.3 Laboratory Results. The laboratory test results for the soil samples obtained at the Tarawa Terrace site are presented in Table 12. TPH levels were recorded above the detection limit of 10 ppm for the following samples:

- TTHA-1: 56 ppm by GC as diesel
- TTHA-2: 308 ppm by GC as diesel and 5390 ppm by IR at the second laboratory
- TTHA-3: 21 ppm by GC as diesel

The samples from the other soil borings indicated TPH levels below the detection limit of 10 ppm.

TABLE 11

SOIL DESCRIPTIONS
TARAWA TERRACE WASTE OIL TANKS

LOCATION	DEPTH	DESCRIPTIONS	DEPTH/ TPH	BLOW COUNT
TTHA-1	0'-1.5	TAN TO GREY FINE SAND, LITTLE SILT, SLIGHT DECAYING ODOR, MOIST.	0'-4' 56 PPM DIESEL	N/A
	1.5'-2'	GRADING GREYISH TAN, TRACE DECAYING ODOR.		
	2'-2.3'	BLACK ORGANIC SILT AND SAND, WOOD, MOIST.		
	2.3'-4'	DARK BROWN TO GREY FINE SAND AND SILT, SLIGHT DECAYING ODOR, MOIST.		
TTHA-2	0'-2'	TAN TO GREY FINE SAND, LITTLE SILT, SLIGHT DECAYING ODOR, MOIST.	0'-4' 308 PPM DIESEL 5390 PPM TOTAL	N/A
	2'-2.5'	BLACK ORGANIC SILT AND PEAT, MOIST.		
	2.5'-3'	DARK BROWN TO GREY FINE SAND AND SILT, MOIST.		
	3'-4'	GREY FINE SAND, SOME SILT, DECAYING ODOR.		
TTHA-3	0'-0.3'	WHITE FINE TO COARSE SAND.	0'-4' 21 PPM DIESEL	N/A
	0.3'-1.7'	TAN TO GREY FINE SAND, LITTLE SILT, SLIGHT DECAYING ODOR, MOIST.		
	1.7'-2'	BROWNISH GREY FINE SAND, SOME SILT, MOIST.		
	2'-4'	TAN TO GREY FINE SAND, LITTLE SILT, NO ODOR, MOIST.		
TTHA-4	0'-0.5'	TAN TO GREY FINE SAND, LITTLE SILT, NO ODOR, MOIST.	0'-0.5' <10 PPM	N/A
	0.5'	REFUSAL ON CONCRETE (TANK FOUNDATION).		
TTHA-5	0'-0.5'	BROWNISH GREY FINE TO COARSE SAND AND CRUSHED GRAVEL.	0'-4' <10 PPM	N/A
	0.5'-2.5'	TAN TO GREY FINE SAND, LITTLE SILT, SLIGHT DECAYING ODOR, MOIST.		
	2.5'-3'	BROWN FINE SAND, SOME SILT, NO ODOR, MOIST.		
	3'-3.5'	DARK BROWN FINE SAND AND ORGANIC SILT, SOME ROOTS.		
	3.5'-4'	BROWNISH GREY FINE SAND, SOME SILT, LITTLE ORGANICS, MOIST.		
TTHA-6	0'-1.5'	TAN TO GREY FINE SAND, LITTLE SILT, NO ODOR, MOIST.	0'-4' <10 PPM	N/A
	1.5'-2.5'	DARK BROWN FINE SAND, SOME SILT, NO ODOR, MOIST.		
	2.5'-3.3'	BLACK ORGANIC SILT, PEAT AND FINE SAND, MOIST.		
	3.3'-3.7'	DARK BROWN FINE SAND, SOME ORGANIC SILT, MOIST.		
	3.7'-4'	GREY FINE SAND, SOME SILT, DECAYING ODOR.		

TABLE 11

(CONTINUED)

SOIL DESCRIPTIONS
TARAWA TERRACE WASTE OIL TANKS

LOCATION	DEPTH	DESCRIPTIONS	DEPTH/ TPH	BLOW COUNT
TTSB-1	0'-0.3'	GREY FINE TO COARSE SAND AND CRUSHED GRAVEL.	0'-5' <10 PPM	0'-2' 3-5-4-4
	0.3'-2'	BROWN TO GREY FINE SAND, LITTLE SILT, NO ODOR, MOIST.		
	2'-2.3'	BLACK ORGANIC SILT, SOME FINE SAND, MOIST.		
	3'-3.4'	DARK BROWN FINE SAND, SOME SILT, NO ODOR, SOFT, MOIST.		3'-5' 1-2-1-2
	3.4'-4'	GREY FINE SAND AND SILT, NO ODOR, MOIST.		
	4'-5'	DARK GREY SILT AND FINE SAND, NO ODOR, MOIST.		
TTSB-2	0'-0.3'	GREY FINE TO COARSE SAND AND CRUSHED GRAVEL.		
	0.3'-1.2'	TAN TO GREY FINE SAND, LITTLE SILT, NO ODOR, MOIST.	0.5'-4' <10 PPM	0'-2' 4-5-7-8
	1.2'-2'	BLACK ORGANIC SILT AND FINE SAND, SOME PEAT, MOIST.		
	3'-3.7'	BLACK SILT AND FINE SAND, MOIST.		3'-5' 3-4-4-6
	4'-5'	GREY FINE SAND, SOME SILT, NO ODOR, MOIST.		
TTSB-3	0'-0.3'	GREY FINE TO COARSE SAND AND CRUSHED GRAVEL.	0'-2' <10 PPM	0'-2' 2-5-6-7
	0.3'-2'	TAN TO GREY FINE SAND, LITTLE SILT, NO ODOR, MOIST.		
	3'-4'	BROWN TO BLACK ORGANIC SILT AND PEAT, MOIST.		
	4'-5'	GREY FINE SAND AND SILTY CLAY, NO ODOR, SOFT, MOIST.		3'-5' 2-1-2-2
TTSB-4	0'-0.2'	GREY FINE TO COARSE SAND AND CRUSHED GRAVEL.	0'-2' <10 PPM	0'-2' 3-5-5-6
	0.2'-1'	TAN TO GREY FINE SAND, LITTLE SILT, NO ODOR, MOIST.		
	1'-2'	DARK BROWN AND GREY FINE SAND, SOME SILT, NO ODOR, MOIST.		3'-5' 1-1-3-3
	3'-3.2'	WOOD.		
	3.2'-3.5'	BLACK ORGANIC SILT, SOME FINE SAND, MOIST.		
	3.5'-5'	GREY SILT, SOME FINE SAND, NO ODOR, MOIST.		
TTSB-5	0'-1'	GREY FINE TO COARSE SAND AND CRUSHED GRAVEL.		0'-2' 10-8-8-6
	1'-2'	TAN TO GREY FINE SAND, LITTLE SILT, NO ODOR, MOIST.		
	3'-3.7'	DARK GREY FINE SAND, SOME SILT, SLIGHT DECAYING ODOR, MOIST.	3'-5' <10 PPM	3'-5' 1-2-3-3
	3.7'-5'	LIGHT GREY FINE SAND, LITTLE SILT, SLIGHT DECAYING ODOR, MOIST.		
TSB-6	0'-1.2'	GREY FINE TO COARSE SAND AND CRUSHED GRAVEL.		
	1.2'-1.5'	GREY FINE SAND, LITTLE SILT, MOIST.		1'-3' 11-6-7-7
	1.5'-3'	DARK BROWN FINE SAND AND ORGANIC SILT, LITTLE PEAT, MOIST.		
	3'-5'	BROWNISH GREY FINE SAND, LITTLE SILT, SLIGHT DECAYING ODOR, MOIST.	3'-5' <10 PPM	3'-5' 2-3-3-3

TABLE 11

(CONTINUED)

SOIL DESCRIPTIONS
TARAWA TERRACE WASTE OIL TANKS

LOCATION	DEPTH	DESCRIPTIONS	DEPTH/ TPH	BLOW COUNT
TTSB-7	0'-0.5'	GREY FINE TO COARSE SAND AND CRUSHED GRAVEL.		0'-2'
	0.5'-2'	DARK BROWN FINE SAND, SOME ORGANIC SILT, MOIST.	1'-4'	1-2-3-5
	3'-3.7'	BROWN AND GREY FINE SAND, SOME SILT, NO ODOR, MOIST.	<10 PPM	3'-5' 2-3-2-3
	3.7'-5'	LIGHT GREY FINE SAND, LITTLE SILT, SLIGHT DECAYING ODOR, MOIST.		
TTSB-8	0'-0.2'	GREY FINE TO COARSE SAND AND CRUSHED GRAVEL.	0'-2'	0'-2'
	0.2'-1'	DARK BROWN FINE SAND, SOME SILT, MOIST.	<10 PPM	2-2-4-6
	1'-2'	BROWN AND GREY FINE SAND, LITTLE SILT, NO ODOR, MOIST.		
	3'-5'	LIGHT GREY FINE SAND, LITTLE SILT, SLIGHT DECAYING ODOR, MOIST.		3'-5' 3-4-4-3
TTSB-9	0'-0.2'	GREY FINE TO COARSE SAND AND CRUSHED GRAVEL.	0'-2'	0'-2'
	0.2'-2'	BROWN AND GREY FINE SAND, LITTLE SILT, NO ODOR, MOIST.	<10 PPM	2-2-5-6
	3'-5'	LIGHT GREY FINE SAND, LITTLE SILT, TRACE DECAYING ODOR, MOIST.	3'-5' <10 PPM	3'-5' 2-3-4-4

NOTES:
1) DEPTHS ARE APPROXIMATE.
2) TPH - TOTAL PETROLEUM HYDROCARBONS.
3) PPM- CONCENTRATION IN PARTS PER MILLION, WHICH IS ANALOGOUS TO MILLIGRAMS PER KILOGRAM.
4) BLOW COUNTS ARE THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT SPOON 2 FEET IN 6 INCH INCRIMENTS.

TABLE 12

TARAWA TERRACE WASTE OIL TANKS
LABORATORY RESULTS OF SOIL SAMPLES

SAMPLE	DEPTH	TPH	BENZENE	TOLUENE	ETHYL BENZENE	TOTAL XYLENES	V17	V19	V20	V23	V25	V32
TTHA-1	0'-4	56 D	--	--	--	--	--	--	--	--	--	--
TTHA-2	0'-4	308 D 5390 IR*	0.011 --	0.088 --	0.149 --	0.475 --	0.063 --	0.022 --	0.044 --	0.034 --	0.346 --	0.304 --
TTHA-3	0'-4	21 D	--	--	--	--	--	--	--	--	--	--
TTHA-4	0'-0.5'	ND	--	--	--	--	--	--	--	--	--	--
TTHA-5	0'-4	ND	--	--	--	--	--	--	--	--	--	--
TTHA-6	0'-4	ND	--	--	--	--	--	--	--	--	--	--
TTSB-1	0'-5'	ND	--	--	--	--	--	--	--	--	--	--
TTSB-2	0.5'-4'	ND	--	--	--	--	--	--	--	--	--	--
TTSB-3	0'-2'	ND	--	--	--	--	--	--	--	--	--	--
TTSB-4	0'-2'	ND	--	--	--	--	--	--	--	--	--	--
TTSB-5	3'-5'	ND	--	--	--	--	--	--	--	--	--	--
TTSB-6	3'-5'	ND	--	--	--	--	--	--	--	--	--	--
TTSB-7	1'-4'	ND	--	--	--	--	--	--	--	--	--	--
TTSB-8	0'-2	ND	--	--	--	--	--	--	--	--	--	--
TTSB-9A	0'-2'	ND	--	--	--	--	--	--	--	--	--	--
TTSB-9B	3'-5'	ND	--	--	--	--	--	--	--	--	--	--

NOTES:

1) ALL RESULTS ARE PRESENTED IN PARTS PER MILLION (PPM), WHICH IS ANALOGOUS TO MILLIGRAMS PER KILOGRAMS.

2) TPH - TOTAL PETROLEUM HYDROCARBONS. TEST METHOD IS BY GAS CHROMATOGRAPH (GC); "D" INDICATES DIESEL, "IR" - INDICATES INFRARRED SPECTROPHOTOMETRY METHOD IN LIEU OF OR IN ADDITION TO GC METHOD. "*" - INDICATES TEST RESULTS FROM SECOND LABORATORY.

3) VOLATILE ORGANIC COMPOUNDS (VOC) ARE 34 COMMON PRIORITY POLLUTANTS. V17 MEHYLENE CHLORIDE, V19 - TETRACHLOROETHENE, V20 - 1,1,1 TRICHLOROETHANE, V23 - TRICHLOROFLUOROMETHANE, V25 - 1,1,2 TRICHLOROTRIFLUOROETHANE (FREON), V32- STYRENE. INCLUDES BENZENE, TOLUENE, ETHYLBENZENE, TOTAL XYLENE (BTEX). ALL OTHER COMPOUNDS WERE BELOW THEIR DETECTION LIMITS.

4) "ND" - NOT DETECTED. DETECTION LIMITS: TPH IN SOIL = 10 PPM, VOC AND BTEX IN SOIL = 0.005 PPM.

Sample TTHA-2 was tested for VOC,s and indicated detectable limits of Methylene Chloride, Tetrachloroethene, 1,1,1-Trichloroethane, Trichlorofluoromethane, 1,1,2-Trichlorotrifluoroethane (Freon), Styrene, Benzene, Toluene, Ethylbenzene and Total Xylenes. For those VOCs for which maximum contaminant levels (MCL) or maximum contaminant level goals (MCLG) have been established some compounds exceed them and some do not. These were:

- 1,1,1-Trichloroethane: 0.044 ppm vs. 0.20 ppm.
- Benzene: 0.011 ppm vs. 0.005 ppm.
- Toluene: 0.088 ppm vs. 2.0 ppm.
- Ethylbenzene: 0.149 ppm vs. 0.68 ppm.
- Total Xylenes: 0.475 ppm vs. 0.440 ppm.
- Styrene: 0.304 ppm vs. 0.140 ppm.

It should be noted that these MCL/MCLG apply to contaminants in water. Methylene Chloride commonly contaminates samples via diffusion through the sample container septum during shipment and storage. Furthermore, in lieu of an established MCL, a calculated health based level (Representative Regulatory Equivalent Number) for Methylene Chloride in potable water is 0.046 ppm, which is less than the soil sample concentration of 0.063 ppm. No such calculated number exists for the other detected VOCs.

8.4 Asbestos. A total of twelve samples were collected, with nine testing positive by PLM for ACM.

Sample No.	Location	Material	ACM Content
TW07	Bldg. TT47	Boiler Cover	5% Chrysotile 40% Amosite
TW08	Bldg. TT47	Boiler Cover	5% Chrysotile 40% Amosite
TW09	Bldg. TT47	Boiler Cover	5% Chrysotile 45% Amosite
TW10	Pipes	Insulation	5% Chrysotile 45% Amosite
TW11	Pipes	Insulation	10% Chrysotile 40% Amosite
TW12	Pipes	Insulation	20% Chrysotile 30% Amosite
TW13	Pipes	Mudded Joints	25% Chrysotile 25% Amosite

TW14	Pipes	Mudded Joints	60% Chrysotile
TW15	Pipes	Mudded Joints	5% Chrysotile 30% Amosite
TW18	Pipes	Mudded Joints	75% Chrysotile

Based on the foregoing, the following quantities of asbestos removal are projected:

Boiler Cover	175 square feet
Pipe Insulation	280 linear feet
Mudded Joints	25 each

Due to the nature of the boiler cover and potential for building contamination, the entire building will have to be contained and closed as a part of the boiler cover removal. Piping and mudded joints may be abated with a glove bag with negative air pressure.

8.5 Lead Based Paint. Three paint samples for percentage of lead testing were taken. The results are:

Sample Identification	Percent Lead
STT-64	19.38
STT-66	22.23
STT-62	11.29

The above results were a test performed on the coatings only. The current guidelines are a percentage of lead by weight. Including the base metal in this test procedure will dramatically decrease the percentage of lead by weight. Based upon this criteria, it appears that the levels of lead in the tank coating are below trigger levels. The Contractor should be made aware that lead is a part of the existing coating system, and that caution should be exercised to minimize release of lead powders, particularly in cutting operations.

EXHIBIT C

and greater than 250 ppm oil & grease, as detected by EPA method 9071. Remedial activities will generally **not** be required on soil exhibiting TPFH levels of less than or equal to (≤) 10 ppm TPFH (EPA Method 5030), levels of ≤ 40 ppm TPFH (EPA method 3550), or O&G levels of ≤ 250 ppm (EPA Method 9071). However, in cases where groundwater has been contaminated or other special site conditions exist, a lower cleanup level and/or additional investigation may be required by the DEM.

In any case, whenever soil remediation is necessary, the treatment/disposal technologies that are used should be cost effective and provide adequate protection of human health and the environment.

6.1 SITE SENSITIVITY EVALUATION (SSE)

STEP 1: Site Characteristics Evaluation (See Table 1)

The sensitivity of groundwater to contamination from petroleum contaminated soils is evaluated by assessing five specific site characteristics. These characteristics are rated in accordance with their potential for contributing to the contamination of groundwater; the greater the potential contribution, the higher the score. The overall sensitivity of a site is determined by a numerical value representing the sum of values for each site characteristic.

Complete the SSE score sheet (Table 1) and proceed to step 2.

EXPLANATION OF SITE CHARACTERISTICS

Grain Size - The main objective of this analysis is to estimate soil permeability, potential for contaminant attenuation, and the presence of zones which restrict contaminant migration.

> Sample Collection and Location: The sample collected for determination of grain size should be **representative** of the **predominant** soil type found in the area of the deepest contaminated soils located beneath the source, or in proximity to the source (in the apparent downgradient direction). Retaining this soil sample for future reference is advisable.
>
> Sample Classification: The soil sample collected as described above should be classified according to the Unified Soil Classification System (ASTM designation D-2487) or the U.S. Department of Agriculture's method of soil classification. (A visual and textural field inspection will suffice.)

NOTE: *SSE's and sample collection and classification should be performed by a qualified person, who through a combination of training and experience is competent to evaluate the conditions existing at the contamination site, including the physical and chemical conditions of the subsurface. A geologist, soil scientist, or engineer experienced and active in the environmental field will be considered qualified.*

Relict structures, sedimentary structures, and/or textures present in the zone of contamination and underlying "soils"- These include structures in soils that may significantly increase the permeability such as quartz veins, fractures, or textures with coarse grained sandy beds in clays and silts, weathered coarse grained igneous intrusions, etc.

Distance from location of deepest contaminated soil to seasonal high water table - The determination may be based upon water levels in shallow water table wells in the immediate vicinity, mottling of the soil, an auger hole in the area of contamination or immediate vicinity, or specific knowledge of an area. If an auger hole penetrating the water table is made, it shall immediately be grouted with neat cement. Compaction of soil located on the ground surface is acceptable for borings that do not penetrate the water table as long as the compaction of the borehole soils has the same (or lower) permeability as the original soil.

Location of the water table relative to bedrock or transmissive indurated sediments - Is the top of bedrock or top of transmissive indurated sediments (shell limestone, fractured shale or sandstone, etc.) located closer to the surface than the water table?

Artificial conduits present within the zone of contamination - Are there water lines, sewer lines, telephone cables, product dispensing piping, etc., in the area of contamination?

STEP 2: Initial Cleanup Level (See Table 2)

Once the SSE score has been obtained, select the corresponding initial cleanup level based on the test method(s) (i.e. 5030, 3550 or 9071) for determining the type of fuel product (low or high boiling point, or heavy fuels) released on site. Proceed to step 3.

STEP 3: Final Cleanup Level (See Table 2, Table 3 [SSE Site Category Descriptions])

Determine and document the site category (A, B, C, D, or E) based on field evaluations. Use Tables 2 and 3 (SSE Site Category Descriptions), to select the final cleanup level. Based on the final cleanup level, determine the quantity of soil that requires remediation. Evaluate several treatment/disposal technologies and their associated costs.*

Submit data and other evidence used in the determination of the final cleanup level to the appropriate regional office. They will verify the site's final cleanup level upon review of the information provided. However, the responsible party should begin soil remediation without waiting for regional office verification. Upon completion of the SSE, the responsible party should immediately begin remediation of soils containing TPFH or O&G concentrations in excess of the final proposed cleanup level, utilizing cost effective treatment/disposal technologies that will provide protection of human health and the environment. **The responsible party should maintain accurate records of the remediation process and be prepared to justify all remediation activities and costs.**

*NOTE:*See Section 8 "Limiting Quantities and Costs of Soil Treatment/Disposal."*

Table 1

Site Sensitivity Evaluation (SSE)

Site Characteristics Evaluation (Step 1)

Characteristic	**Condition**	**Rating**	
Grain Size*	Gravel Sand Silt Clay	150 100 50 0	100
Are relict structures, sedimentary structures, and/or textures present in the zone of contamination and underlying "soils"?	Present and intersecting the water table. Present but <u>not</u> intersecting the water table. None present.	10 5 0	0
Distance from location of deepest contaminated soil** to water table.	0 -5 feet (C, D & E sites only) 5 - 10 feet >10 - 40 feet > 40 feet	20 20 10 0	20
Is the top of bedrock or transmissive indurated sediments located above the water table?	Yes No	20 0	0
Artificial conduits present within the zone of contamination.	Present and intersecting the water table. Present but <u>not</u> intersecting the water table. Not present.	10 5 0	0

Total Site Characteristics Score: 120

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* **Predominant** grain size based on Unified Soil Classification System or U.S. Dept. of Agriculture's Soil Classification Method.

** (>10 ppm TPFH by Method 5030; >40 ppm TPFH by Method 3550; >250 ppm O&G by Method 9071)

Site Sensitivity Evaluation (SSE)

Initial Cleanup Level (Step 2)

Final Cleanup Level (Step 3)

EPA Method 5030 for Low Boiling Point Hydrocarbons such as Gasoline, Aviation Fuels, Gasohol

Total Site Characteristics Score	**Initial** Cleanup Level TPFH (ppm)
>150	≤10
121-150	20
91-120	40
61-90	60
31-60	80
0-30	100

Select Site Category* →

Final Cleanup Level

Category A & B (Multiply initial cleanup level by 1) 1 x ____ = ______ ppm

Category C & D (Multiply initial cleanup level by 2) 2 x ____ = ______ ppm

Category E (Multiply initial cleanup level by 3) 3 x ____ = ______ ppm

EPA Method 3550 for High Boiling Point Hydrocarbons such as Kerosene, Diesel, Varsol, Mineral Spirits, Naphtha

Total Site Characteristics Score	**Initial** Cleanup Level TPFH (ppm)
>150	≤40
121-150	80
91-120	160
61-90	240
31-60	320
0-30	400

Select Site Category* →

Final Cleanup Level

Category A & B (Multiply initial cleanup level by 1) 1 x ____ = ______ ppm

Category [✓ C] & D (Multiply initial cleanup level by 2) 2 x 160 = 320 ppm

Category E (Multiply initial cleanup level by 3) 3 x ____ = ______ ppm

EPA Method 9071 for Heavy Fuels - Oil & Grease (O&G) such as Fuel Oil #4, #5, #6, Motor Oil, Hydraulic Fluid

Total Site Characteristics Score	**Initial** Cleanup Level O&G (ppm)
>150	≤250
121-150	400
91-120	550
61-90	700
31-60	850
0-30	1000

Select Site Category* →

Final Cleanup Level

Category A & B (Multiply initial cleanup level by 1) 1 x ____ = ______ ppm

Category C & D (Multiply initial cleanup level by 2) 2 x ____ = ______ ppm

Category E (Multiply initial cleanup level by 3) 3 x ____ = ______ ppm

* See Site Category Descriptions, Table 3

TABLE 3

SSE SITE CATEGORY DESCRIPTIONS

CATEGORY A (*Site meets any one of the criteria*)

1. Water supply well(s) contaminated and not served by accessible public water supply.
2. Vapors present in confined areas at explosive or health concern levels.
3. Treated surface water supply in violation of the safe drinking water standards.

CATEGORY B (*Site meets any one of the criteria*)

1. Water supply well(s) contaminated, but served by accessible public water supply.
2. Water supply well(s) within 1500 feet of site, but not contaminated and not served by accessible public water supply.
3. Vapors present in confined areas but not at explosive or health concern levels.

CATEGORY C (*Site meets both of the criteria*)

1. No known water supply well(s) contaminated.
2. Water supply well(s) greater than 1500 feet from site but not served by accessible public water supply.

CATEGORY D (*Site meets both of the criteria*)

1. No known water supply well(s) contaminated.
2. Water supply well(s) within 1500 feet of site but served by accessible public water supply.

CATEGORY E (*Site meets both of the criteria*)

1. No known water supply well(s) contaminated or within 1500 feet of site.
2. Area served by accessible public water supply.