Report

Site Assessment
Tank STT61 - STT66
Tarawa Terrace

Marine Corps Base
Camp LeJeune
North Carolina
Contract N62470-90-R-7626

Naval Facilities Engineering Command
Norfolk, Virginia

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O'BRIEN & GERE

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REPORT

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

APRIL 1992

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TABLE OF CONTENTS

REFERENCES

TABLES

FIGURES

APPENDICES

TABLE OF CONTENTS (cont.)

APPENDICES (cont.)

EXHIBITS

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 a field investigation which included monitoring well installation, soil borings, penetrometer probes (hydropunches), soil and groundwater sampling, groundwater and free product monitoring, and in-situ permeability testing. This report presents a site assessment, risk assessment, and a remediation assessment.

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 Subsurface Field Investigation

In order to explore the site's geologic conditions and delineate the vertical and horizontal extent 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.

Initially, four shallow monitoring wells, (MW1,3,5,7) were installed in order to establish a groundwater flow direction. Secondly, ten hydropunches (H1 - H10) were completed in order to provide a preliminary delineation of the horizontal extent of contamination. Finally, the remaining monitoring wells (MW2,4,6,8 - 14), and four soil borings (B1 - B4) were completed in order to define the vertical and horizontal extent of contamination.

Hydropunch installation involved pushing the hydropunch apparatus to approximately 4 feet below the water table and then retrieving a groundwater sample. Groundwater collected from the hydropunch, and any subsurface sample recovered during field activities, was screened in the field for volatile organics using a photoionization detection device (Hnu).

Monitoring wells were installed in nested pairs, comprising one shallow well and one deep well. Each monitoring well was constructed of 2"I.D., 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, labelled, placed on wooden pallets and left at the site for management by Activity personnel.

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 Organics using the Hnu. Two soil samples from each deep well and soil boring were selected for laboratory analysis as discussed in section 2.02.3.

Following installation it was necessary to remove fine grained materials that may have entered the well during installation. This was accomplished by continuous low yield pumping in all of the monitoring wells. 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).

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.

2.01.3 Aquifer Testing

Hydraulic permeability (or conductivity) was estimated with the performance of in-situ permeability tests conducted on all the wells (MW1 - MW14). 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 groundwater re-enters the well is monitored until the well's static water level is approached. Groundwater 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.

2.01.4 Groundwater Flow

On two separate occasions groundwater elevations were gauged in all of the monitoring wells at the site. Using an electronic oil/water interface probe, groundwater 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 groundwater elevation in each well can be determined. Using the elevational data summarized on Table 1, groundwater contour maps were derived. Figure 3 depicts the groundwater flow across the study area as monitored by the shallow wells. Figure 4 illustrates the groundwater flow monitored by the deep wells. Groundwater appears to be flowing in an overall southerly direction at a very slow rate. With an estimated hydraulic gradient of 0.001 ft/ft and an effective porosity of 0.40, the flow velocity of the groundwater 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.

2.02.2 Air Characterization

During all field operations ambient air and sample head space was monitored for volatile organics using an Hnu. 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 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). All the liquid samples registered below 5 ppm on the Hnu.

2.02.3 Soil Characterization

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 (MW2,4,6,8, and MW14) were also analyzed for flash point (Pensky-Martin closed cup technique) and pH (EPA Method 1.50.1). Three water table samples (MW2,6,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.

2.02.4 Groundwater Characterization

Between January 7 and 11 1992 groundwater samples were collected from each monitoring well and hydropunch. Hydropunch sampling was accomplished by the methods previously described in Section 2.01.1 Groundwater samples from each monitoring well were obtained by using a stainless steel bailer and following the procedures dictated in Appendix F. Prior to sample collection, each monitoring well was purged of three times the well's volume. Groundwater 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 Groundwater Standards. Monitoring well MW14 and hydropunches H1,3 and 4 contained benzene concentrations ranging from 0.007 mg/l (H3 and H4) to 0.023 mg/l (MW14), compared to State standards 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.

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, pH meter and specific conductivity meter were calibrated on site. The Hnu 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.

SECTION 3 - RISK ASSESSMENT

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 tank, resulting from the past operation of the tank. 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 investigation for this project is 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

3.02.01 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, xylenes, styrene and 1,1,1-trichloroethane were detected as soil contaminants.

3.02.02 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.

3.02.03 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 investigation involved the installation, development and sampling of seven shallow monitoring wells and seven deep monitoring wells (as nested pairs; MW1 - MW14), four soil borings (B1 - B4), and ten hydropunches (H1 - H10). These are described in detail in Section 2.01 of this report.

3.03.01 Soil Data

Two soil samples from each of the four soil borings, and two soil samples from each of the seven 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. Five deep soil samples (MW2, MW4, MW6, MW8, and MW14) were analyzed for flashpoint and pH. Four deep soil samples (MW2, MW6, MW8 and a composite) were selected for full-scan toxicity characteristic leaching procedure (TCLP) analyses.

The pH results ranged from 4.1 to 5.4; flashpoint 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

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.

3.03.01.1 Soil Data Evaluation

Nine of the 22 samples were non-detectable, while detected concentrations ranged from 1.16 mg/kg to a maximum of 13.2 mg/kg. Two 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 two samples, at concentrations up to 13.2 mg/kg will be addressed as a potential source.

3.03.02 Ground Water Data

No free product was detected in the fourteen ground water monitoring wells, nor was free product detected in the ten hydropunches.

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		
	H1	0.022		
	H3	0.007		
	H4	0.007		
toluene	MW10	0.003	1.0	2.0 *
	H1	0.190		
	H4	0.003		
ethyl benzene	MW10	0.004	0.029	0.7 *
	H1	0.017		
	H4	0.002		
xylenes (total)	MW10	0.017	0.4	10 *
	H1	0.062		
	H3	0.003		
	H4	0.012		
trichlorofluoromethane	MW10	0.005	n/a	n/a
	H1	0.001		
1,1-dichloroethane	H1	0.002	n/a	n/a

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.

3.03.02.2 Ground Water Data Evaluation

Benzene was detected in excess of both the North Carolina and Federal MCL criteria in two wells and three hydropunches. 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, 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 seven nested wells, is in a southerly direction; ground water flow velocity is calculated to be approximately 3 feet/year.

3.03.03 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

3.05.01 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.

3.05.02 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.

3.05.02.1 Potential Exposure to Fugitive Dust Emissions

Episodic releases of contaminated fugitive dusts to the general atmosphere would result if contaminated surface and/or subsurface 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.

3.05.02.2 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 groundwater (based on solubility), and readily volatilized from the groundwater (based on vapor pressures). However, volatilization of trace concentrations of benzene, 1,1-dichloroethane and/or trichlorofluoromethane from the groundwater, 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 groundwater 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.

3.05.02.3 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.

3.05.02.4 Conclusion on Air Exposure Pathway

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

3.05.03 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.

3.05.03.1 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.

3.05.03.2 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.

3.05.03.3 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.

3.05.04 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.

3.05.04.1 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.

3.05.04.2 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.

3.05.04.3 Conclusion on Ground Water Pathway

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

3.05.05 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.

3.05.05.1 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 and in insignificant quantities. Two locations, MW4 and MW6, exhibited soil TPH concentrations above the North Carolina action level of 10 mg/kg (13.2 ppm and 12.3 ppm, respectively). Based on the Site Sensitivity Evaluation (SSE) score of 41, found in "Guidelines for Remediation of Soil Contaminated by Petroleum", published by the North Carolina Dept. of Environment, Health and Natural Resources, the "Maximum Soils Cleanup Level" for this site is 35 ppm of TPH (Exhibit C). There are no soils present at the site exhibiting TPH concentrations above 35 ppm, therefore, remediation of contaminated soil is not warranted at this time.

Only one groundwater pollutant was discovered to exist above regulatory standards. Benzene was present in 5 of the 24 sample locations (H1, H3, H4, MW10 and MW14). 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 groundwater will readily provide transportation for benzene migration. While no risk has been established as a result of the benzene presence in the groundwater, the contaminant does exist above regulatory standards. Therefore, it is possible that remediation of the groundwater 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 Groundwater

Aerobic Biodegradation

This process involves stimulating microflora to decompose petroleum hydrocarbons in soils and groundwater. 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 groundwater. Due to the distances between contaminant occurrence at the site this technology is not recommended for remediation.

Groundwater 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 groundwater. The wells commonly screen the water table and extend several feet in the saturated zone. Groundwater 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 groundwater and the prevention of down gradient migration of the contaminants. This option could be considered as a remedial technology.

Groundwater Containment

Groundwater 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

In order to prevent a release that could be potentially harmful in the future, it is recommended that each tank undergo testing for leakage before subsequent usage. Since there is still waste oil present in tank STT66 it is suggested that it be emptied until such time that its integrity is established.

Additional site assessment work will be useful to identify the lateral and vertical extent of contamination to the west and south of the site. Installation of additional monitoring wells and hydropunches would be necessary to delineate the extent of the benzene plume prior to recommending the most appropriate remedial technique.

REFERENCES

Dewberry & Davis, January 1991. Technical Memorandum No.2 Results of Field Investigation, Marine Corps Base, Camp Lejeune, North Carolina.

O'Brien & Gere Engineers Inc., July 1988. Contaminated Groundwater Study, Camp Lejeune, North Carolina.

Lloyd, O.Jr. and Daniel, C.III; U.S.Geological Survey, 1988. Water Resources Investigations Report 88-4034.

Tables

O'BRIEN & GERE

TABLE 1

GROUNDWATER ELEVATIONS
Tanks STT61 - 66
Tarawa Terrace, MCB Camp Lejeune, North Carolina

WELL #	TOP OF CASING ELEVATION (RELATIVE)	DEPTH TO WATER 1/11/92	GROUNDWATER ELEVATION 1/11/92	DEPTH TO WATER 1/29/92	GROUNDWATER ELEVATION 1/29/92
MW1	100.88	6.20	94.68	5.30	95.58
MW2	100.81	6.75	94.06	6.02	94.79
MW3	101.09	6.75	94.34	5.81	95.28
MW4	100.99	7.07	94.92	6.32	94.67
MW5	101.53	6.60	94.93	5.96	95.57
MW6	101.61	7.56	94.05	6.77	94.84
MW7	101.74	6.76	94.98	6.23	95.51
MW8	101.70	7.75	93.95	6.95	94.75
MW9	101.08	6.25	94.83	5.45	95.63
MW10	100.98	7.02	93.96	6.32	94.66
MW11	101.63	6.71	94.92	5.70	95.93
MW12	100.54	7.67	93.87	6.93	94.61
MW13	100.20	6.03	94.17	4.42	95.78
MW14	100.18	6.47	93.71	5.65	94.53

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
GEOMETRIC MEAN	3.7×10^{-5}	23.9

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	7.5	200
MW2	7.0	700
MW3	8.0	200
MW4	7.5	100
MW5	7.5	100
MW6	7.5	100
MW7	7.5	100
MW8	8.5	300
MW9	7.5	100
MW10	7.0	300
MW11	6.5	100
MW12	7.5	100
MW13	*	100
MW14	*	400

* = not measured

Figures

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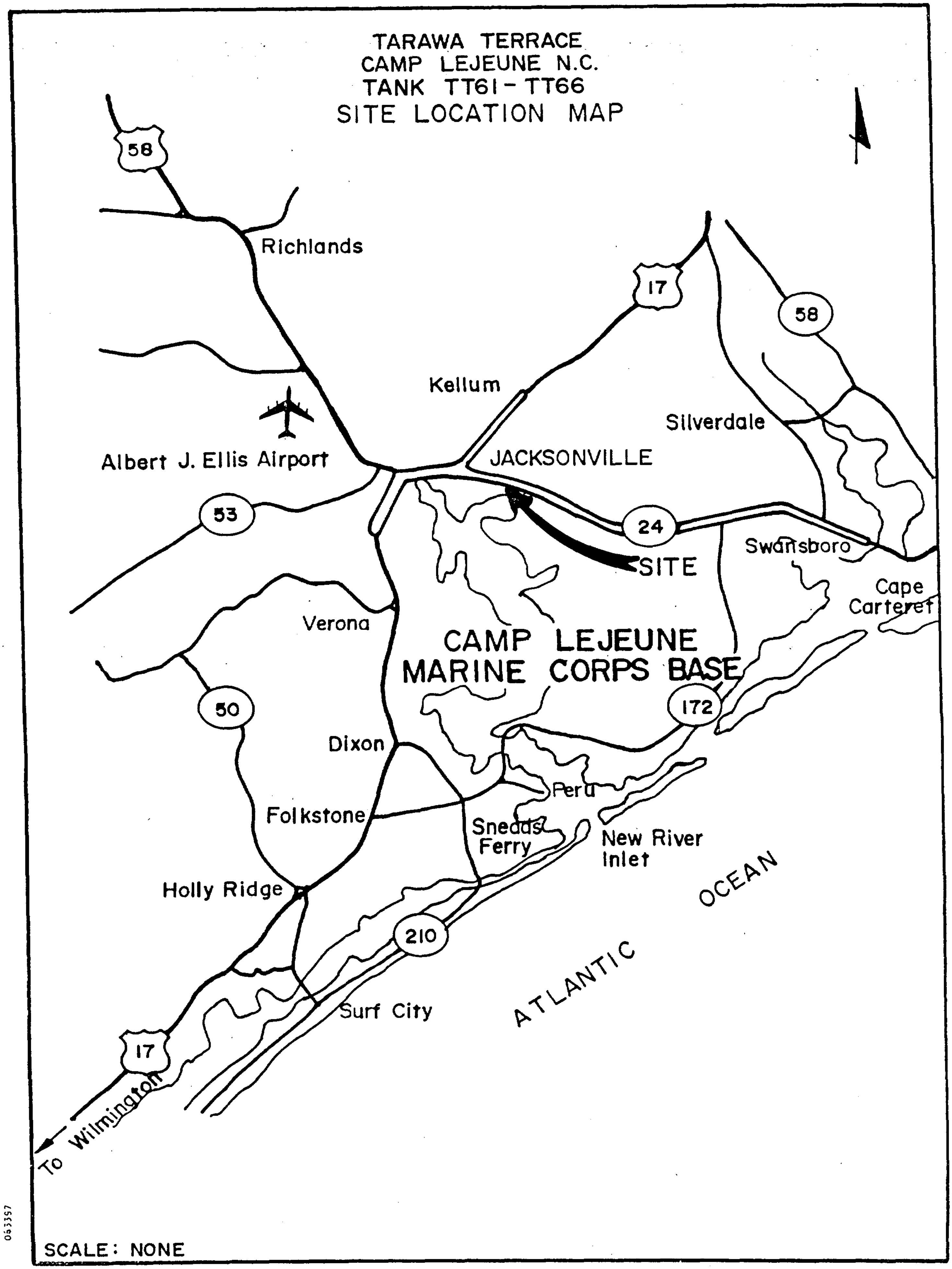
FIGURE 1



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

O'BRIEN & GERE
ENGINEERS, INC

FIGURE 2

TARAWA TERRACE
CAMP LEJEUNE, NORTH CAROLINA
SUBSURFACE INVESTIGATION
LOCATION – JAN. 1992

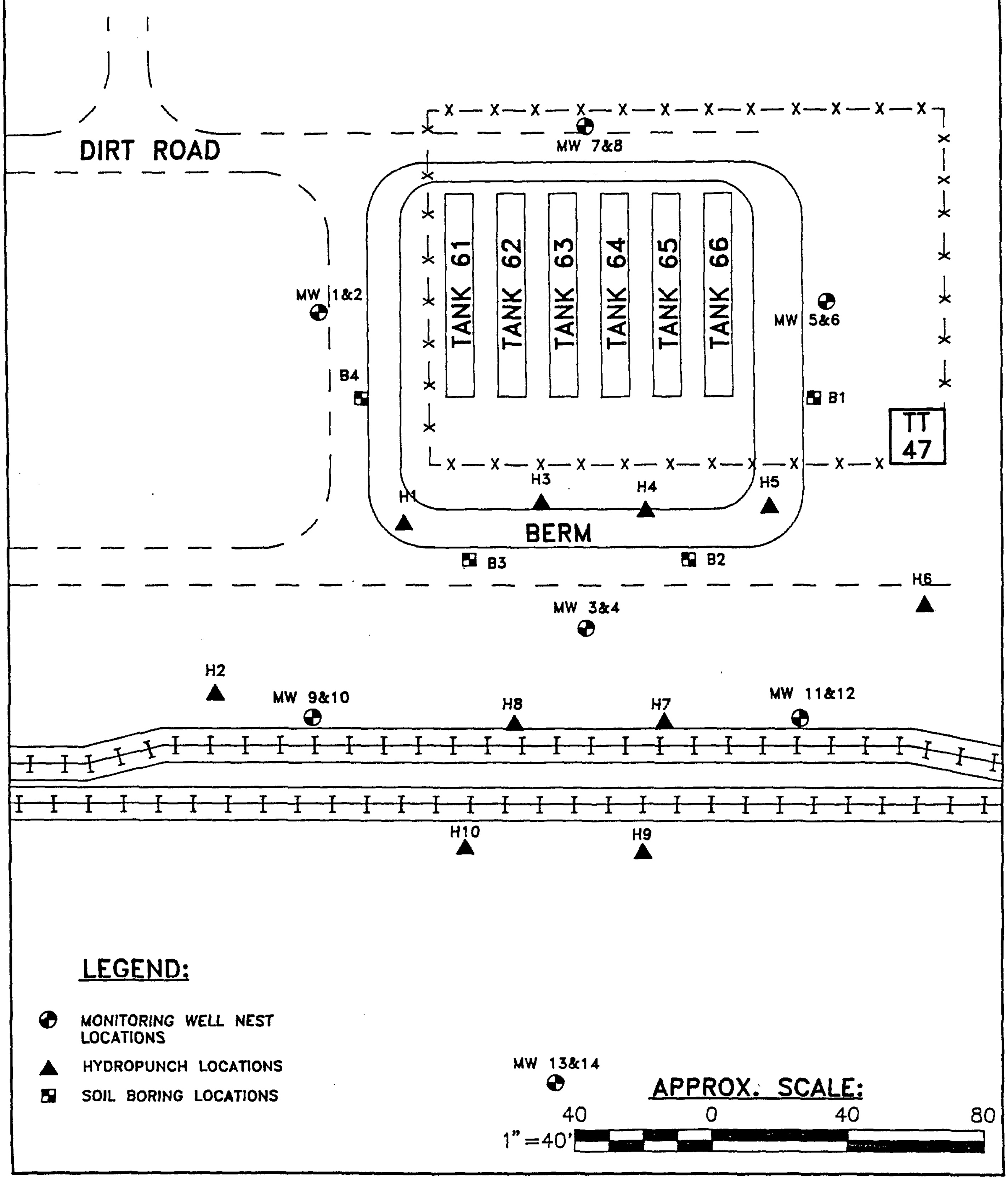
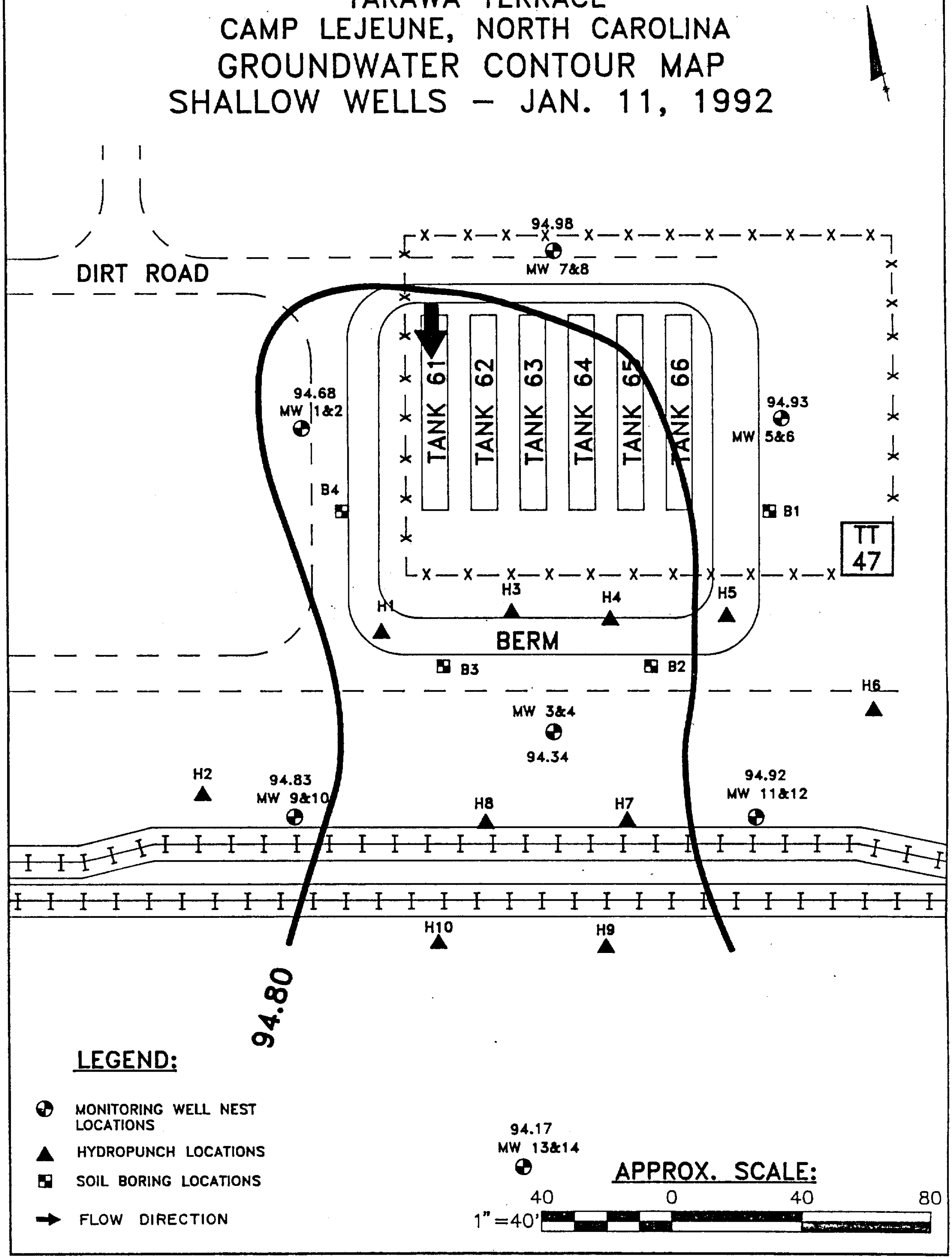


FIGURE 3

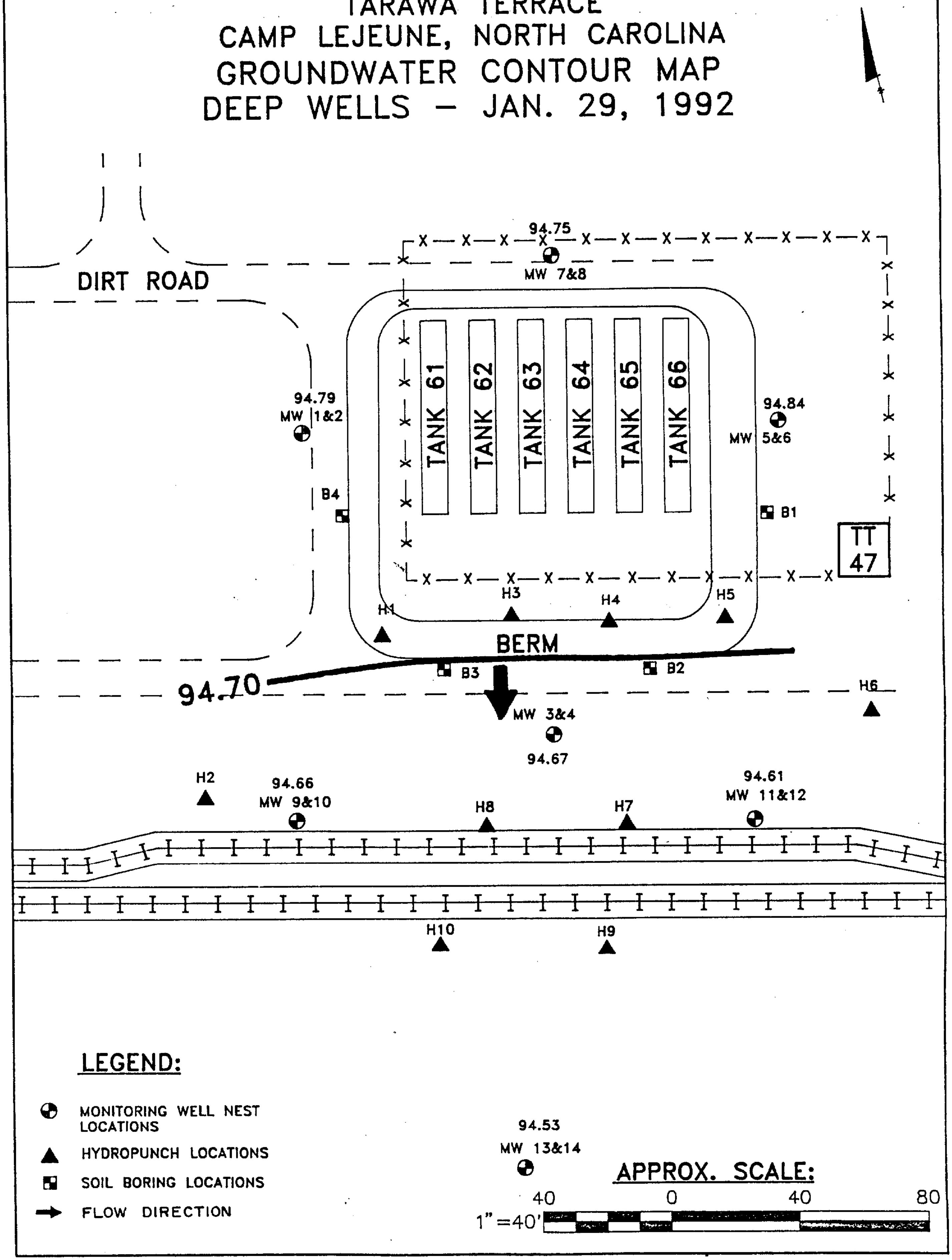
TARAWA TERRACE
CAMP LEJEUNE, NORTH CAROLINA
GROUNDWATER CONTOUR MAP
SHALLOW WELLS – JAN. 11, 1992



O'BRIEN & GERE
ENGINEERS, INC.

FIGURE 4

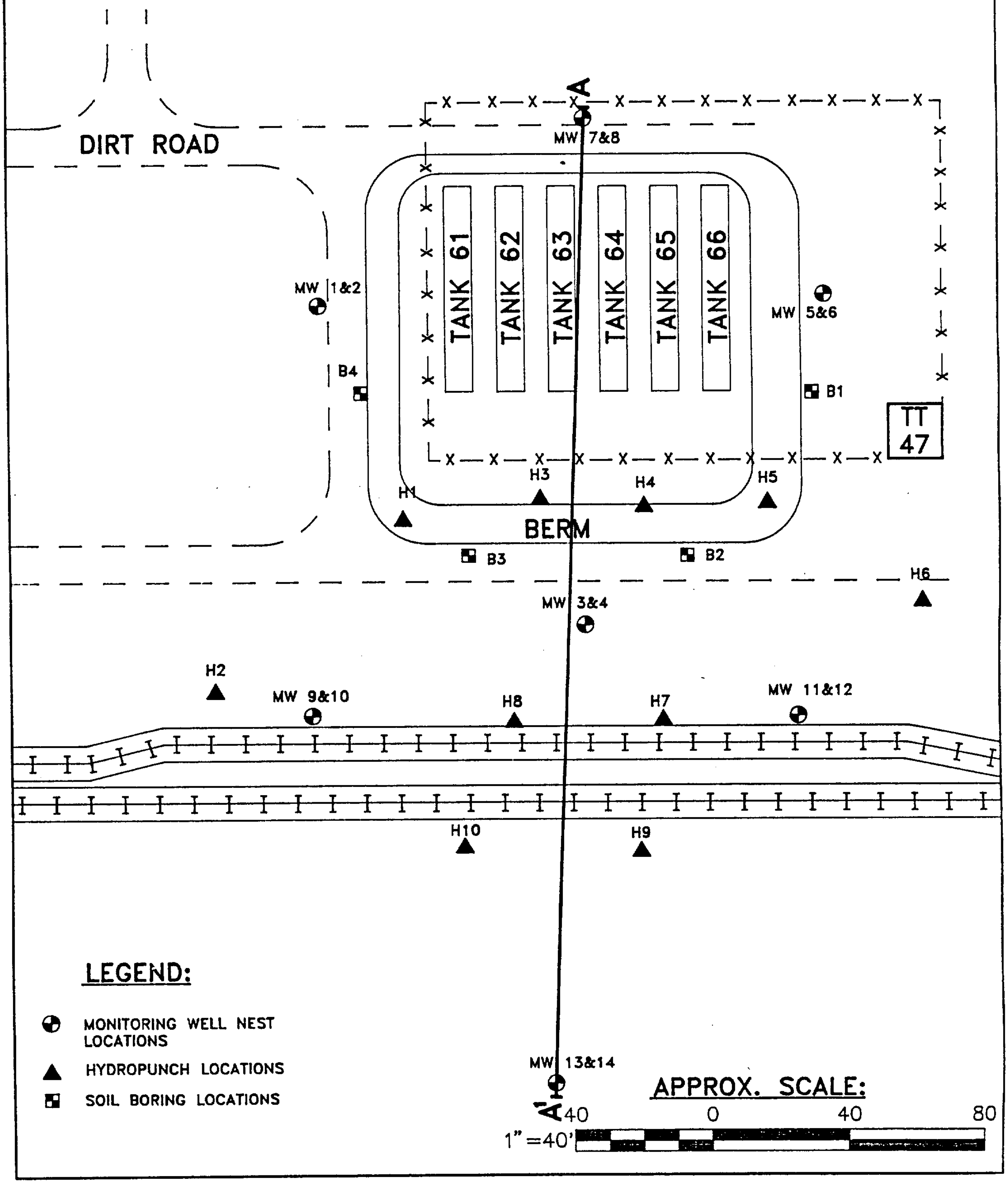
TARAWA TERRACE
CAMP LEJEUNE, NORTH CAROLINA
GROUNDWATER CONTOUR MAP
DEEP WELLS – JAN. 29, 1992



O'BRIEN & GERE ENGINEERS INC

FIGURE 5

TARAWA TERRACE
CAMP LEJEUNE, NORTH CAROLINA
GEOLOGIC CROSS-SECTION A-A^1
LOCATION - JAN. 1992



O'BRIEN & GERE
ENGINEERS, INC.

TARAWA TERRACE
CAMP LEJEUNE, NORTH CAROLINA
GEOLOGIC CROSS-SECTION A-A^1
LOCATION - JAN. 1992

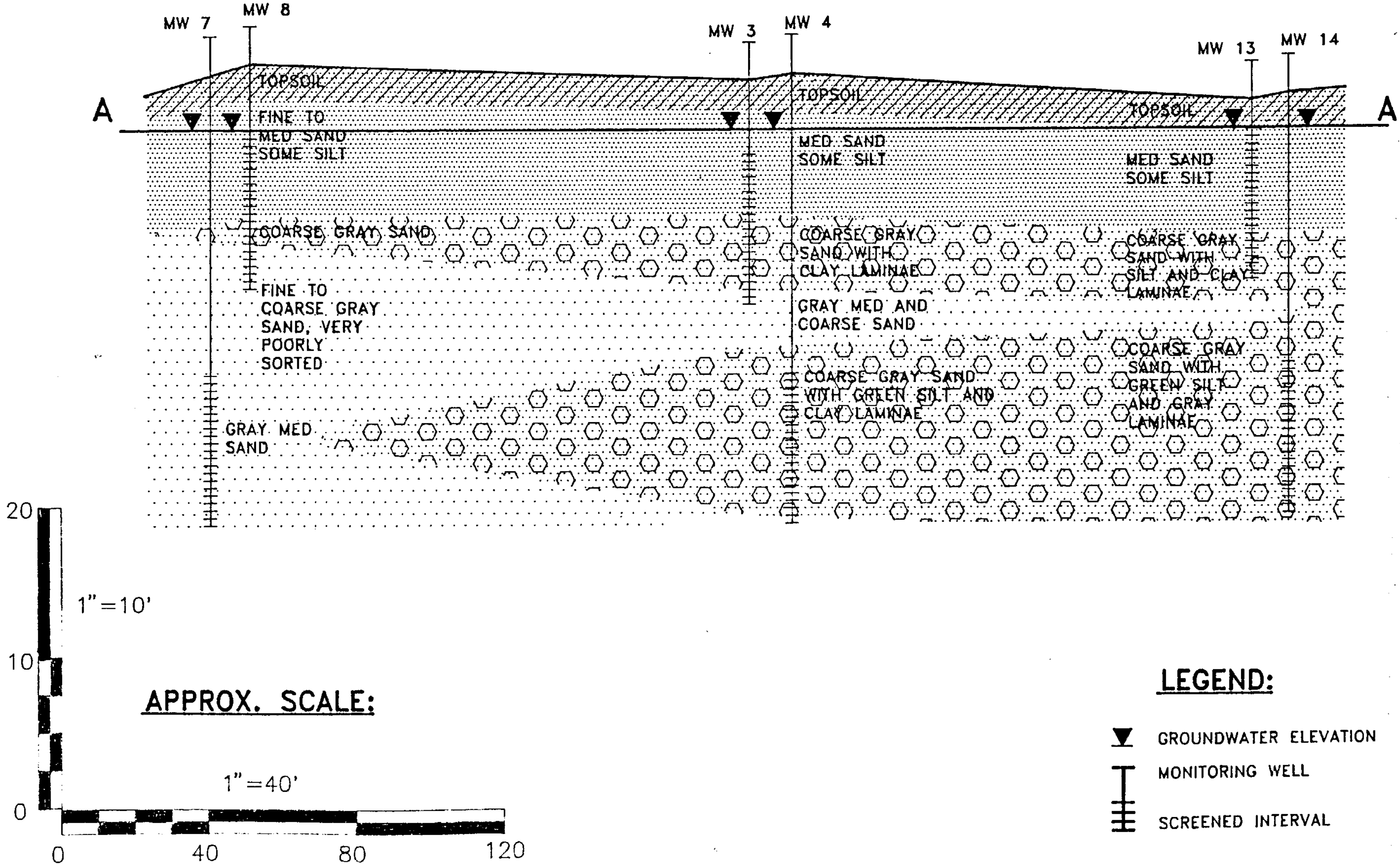
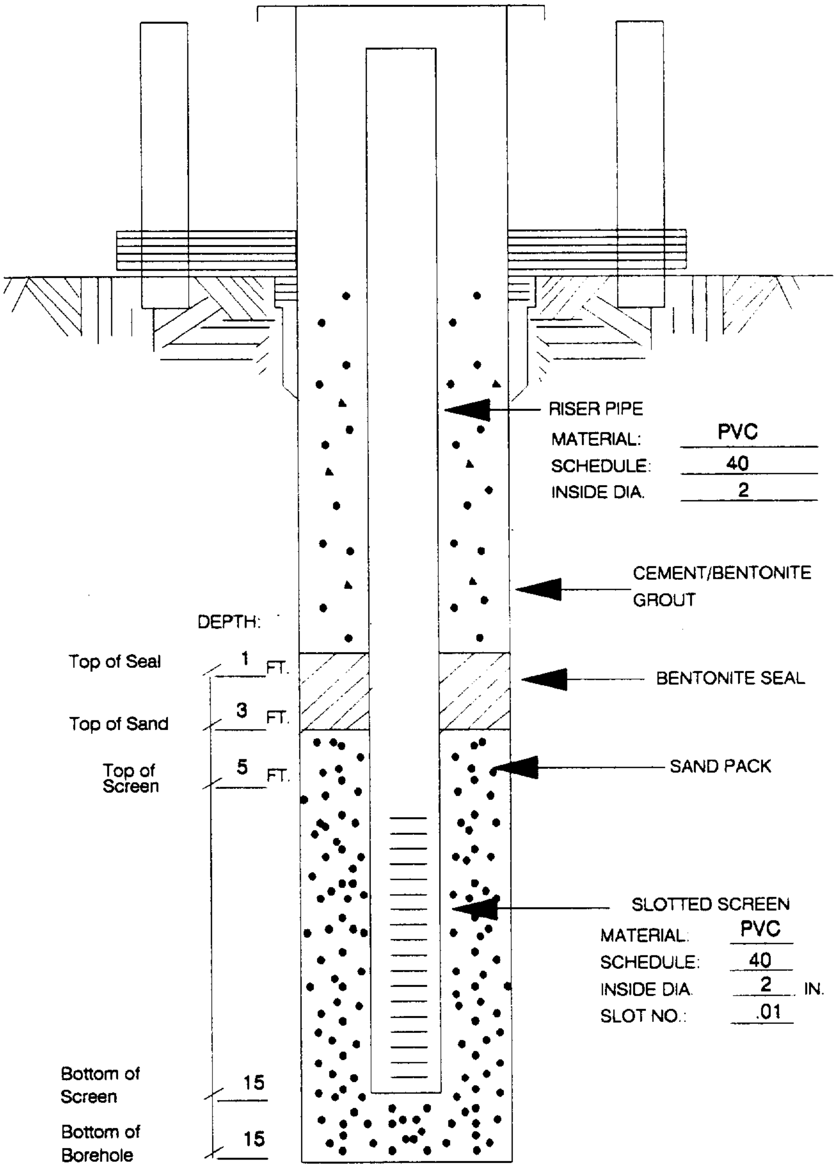


FIGURE 6

O'BRIEN & GERE ENGINEERS, INC.

Appendices

APPENDIX A



TYPICAL OVERBURDEN MONITORING WELL
N.T.S.

Tarawa Terrace
MW-1
12/12/91

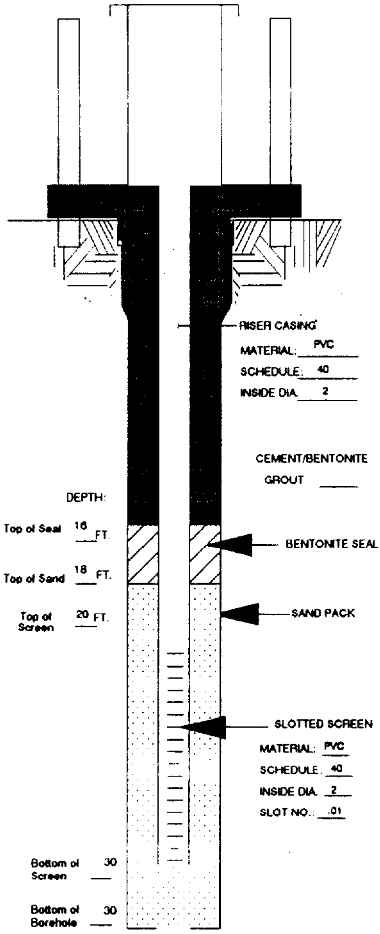
O'Brien & Gere Engineers, Inc.	Boring Log/Protective Casing Well	Report of Boring No. MW-2 Sheet 1 of 1
Location: TT61-66 Client: Navy Drilling Type: Hollow Stem	SAMPLER Type: 2" O.D. Split Spoon Hammer: 140# Fall: 30"	Ground Water Depth File No.

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

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

Depth	Sample				Sample Description
	Depth	Blows /6"	Penetr/ Recovery	PID Value	
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



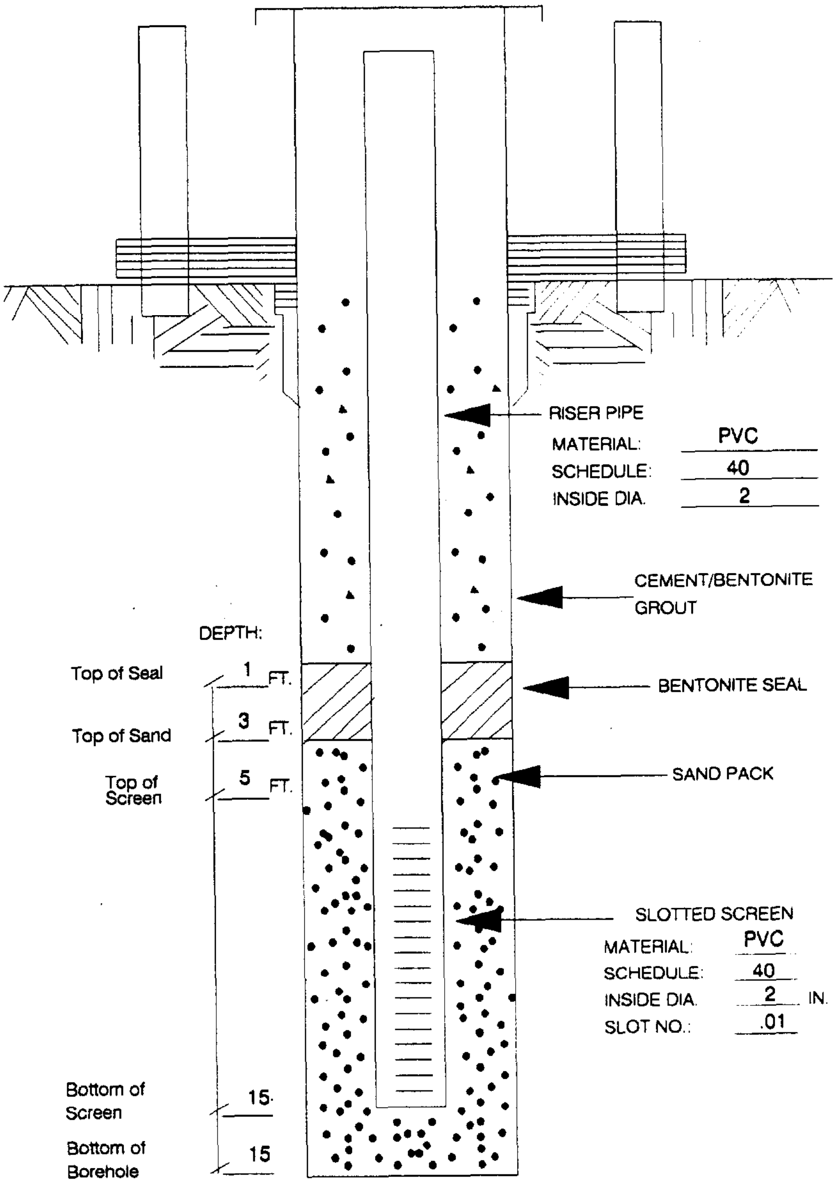
RISER CASING
MATERIAL: PVC
SCHEDULE: 40
INSIDE DIA. 2

CEMENT/BENTONITE GROUT ____

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

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

Bottom of Screen 30
Bottom of Borehole 30



TYPICAL OVERBURDEN MONITORING WELL
N.T.S.

Tarawa Terrace
MW-3
12/12/91

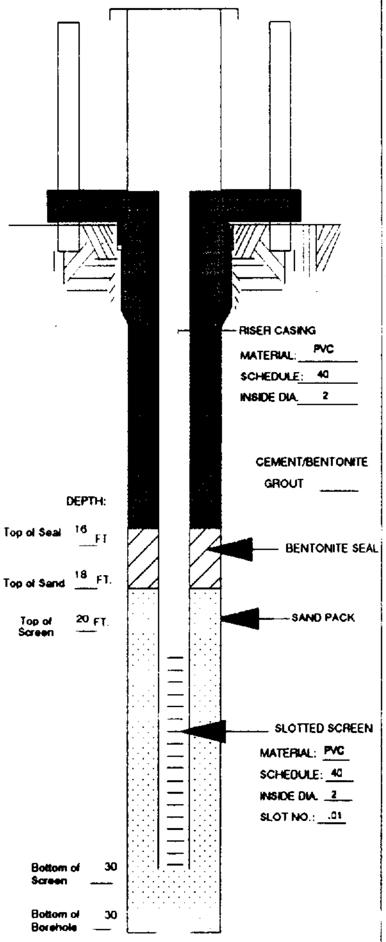
O'Brien & Gere Engineers, Inc.	Boring Log/Protective Casing Well	Report of Boring No. MW-4 Sheet 1 of 1
Location: TT61-66 Client: Navy Drilling Type: Hollow Stem	SAMPLER Type: 2" O.D. Split Spoon Hammer: 140# Fall: 30"	Ground Water Depth File No.

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

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

Depth	Sample				Sample Description
	Depth	Blows /6"	Penetr/ Recovery	PID Value	
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.

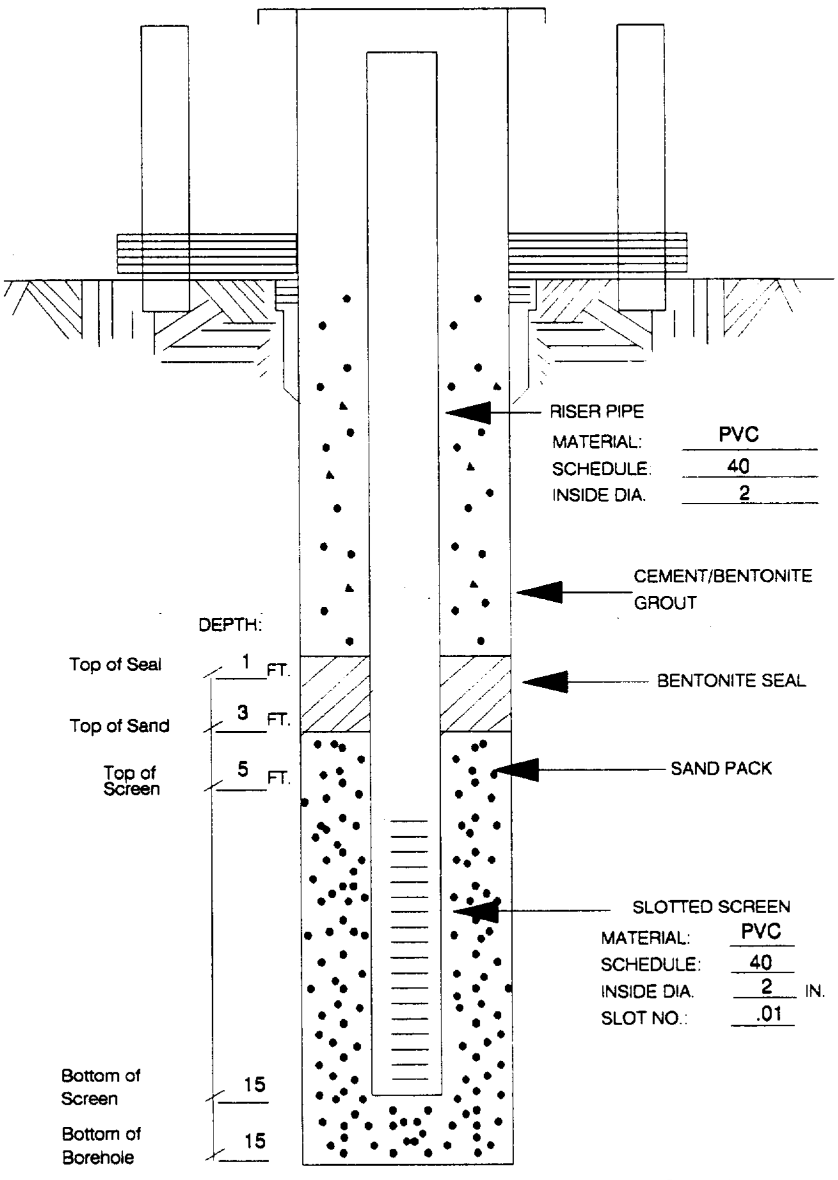
Monitoring Well Specifications


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



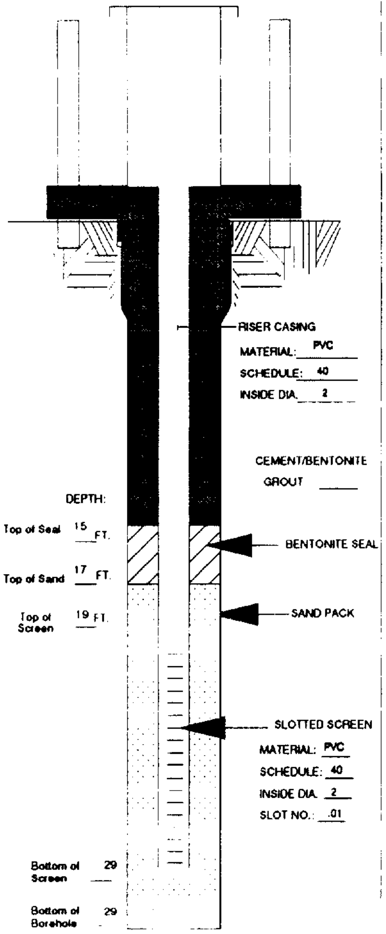
TYPICAL OVERBURDEN MONITORING WELL
N.T.S.

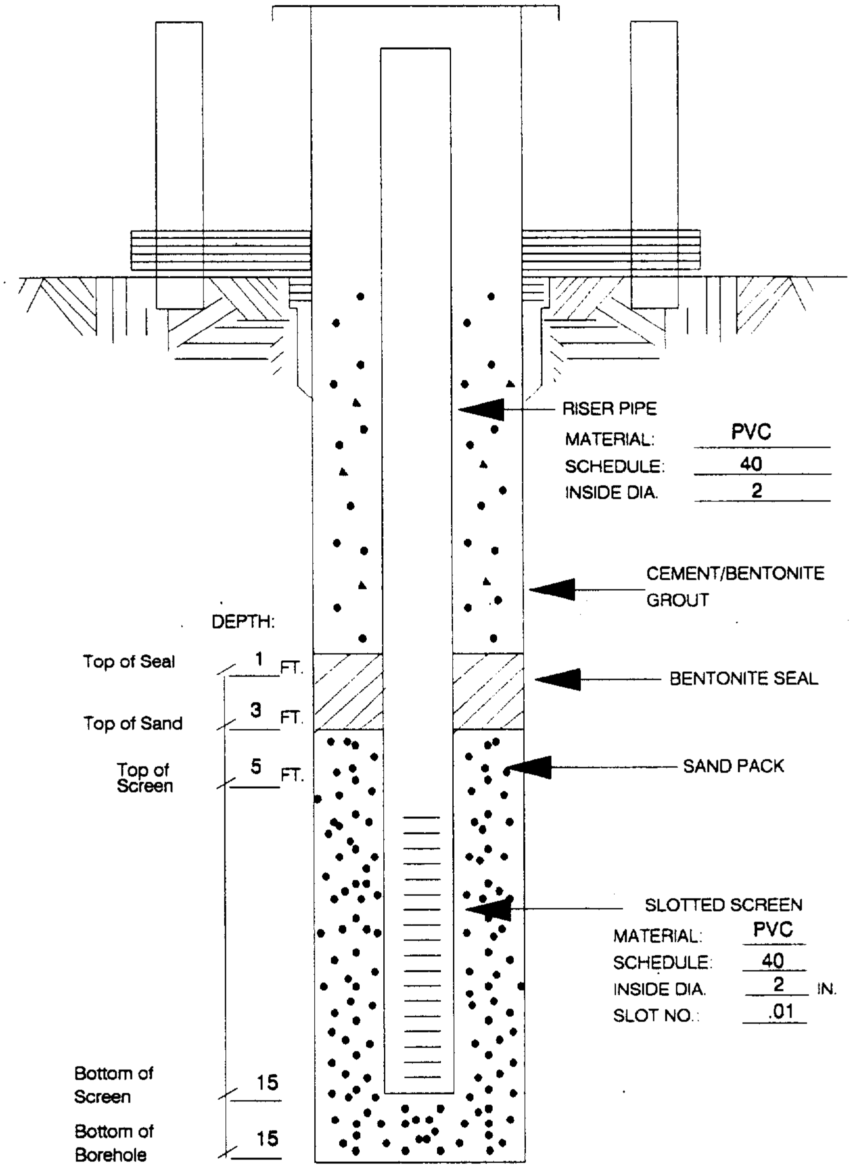
Tarawa Terrace
MW-5
12/12/91

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





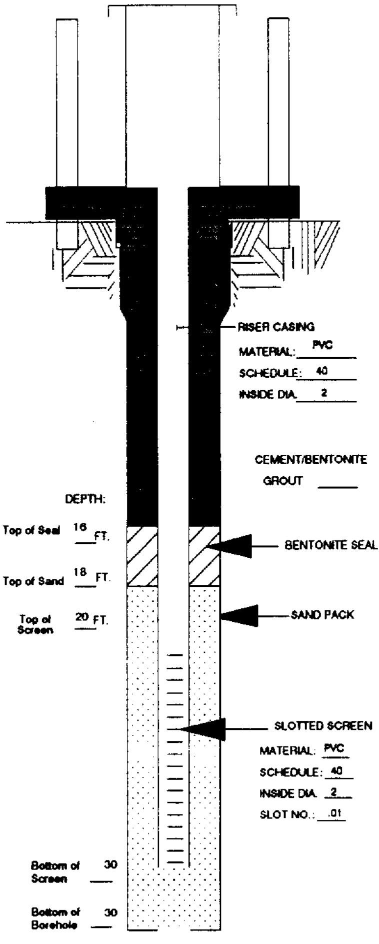
TYPICAL OVERBURDEN MONITORING WELL
N.T.S.

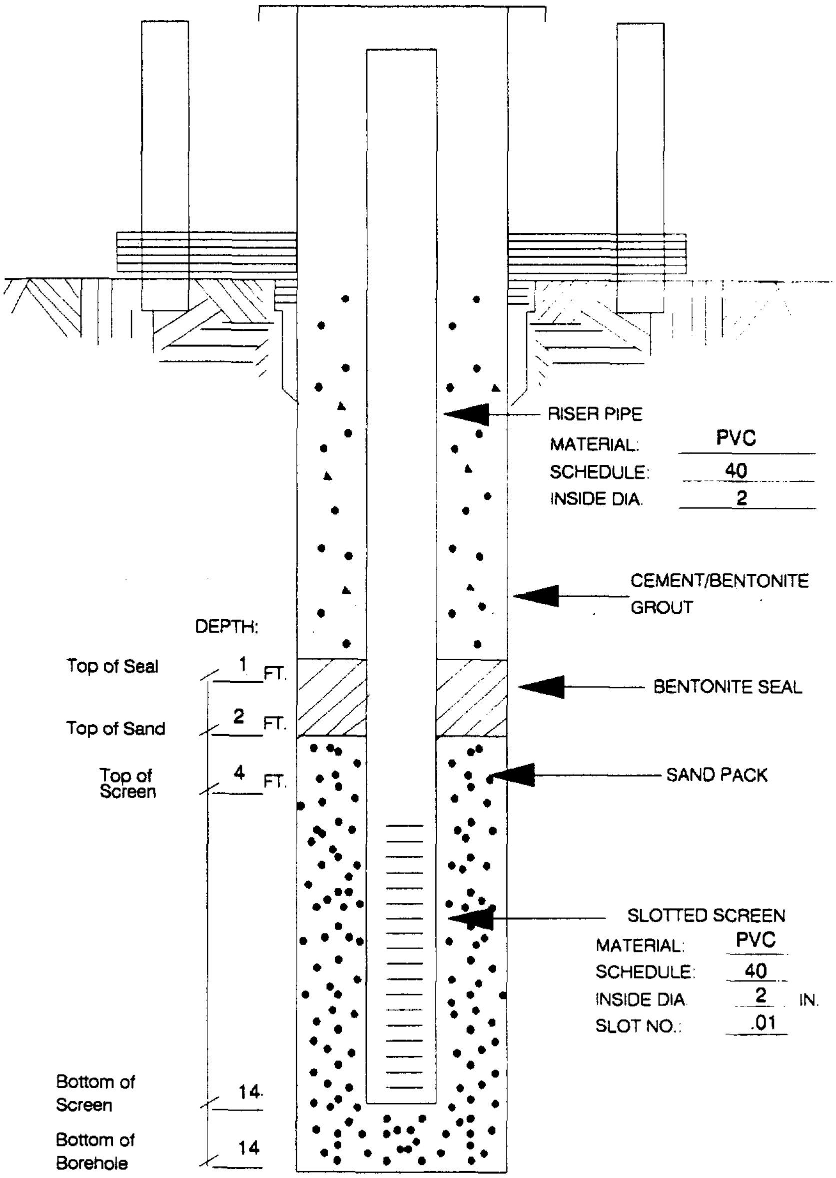
Tarawa Terrace
MW-7
1/7/92

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 Depth	Sample Blows /6"	Sample Penetr/ Recovery	Sample PID Value	Sample Description
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

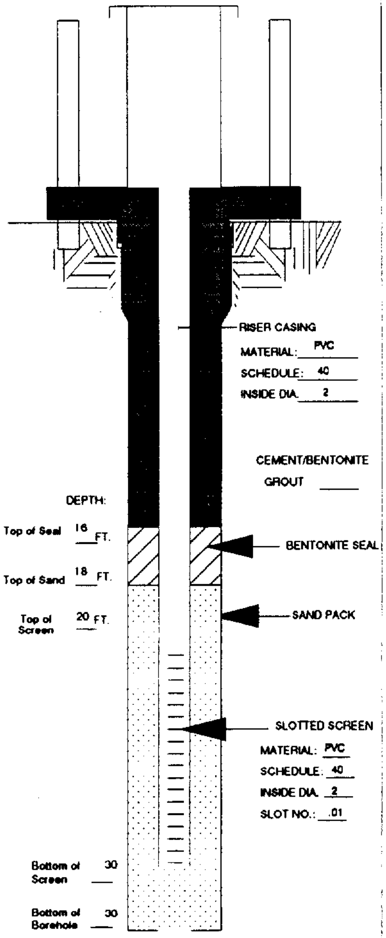
O'Brien & Gere Engineers, Inc.	Boring Log/Protective Casing Well	Report of Boring No. MW-10 Sheet 1 of 1
Location: TT61-66 Client: Navy Drilling Type: Hollow Stem	SAMPLER Type: 2" O.D. Split Spoon Hammer: 140# Fall: 30"	Ground Water Depth File No.

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

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

Depth	Sample				Sample Description
	Depth	Blows /6"	Penetr/ Recovery	PID Value	
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

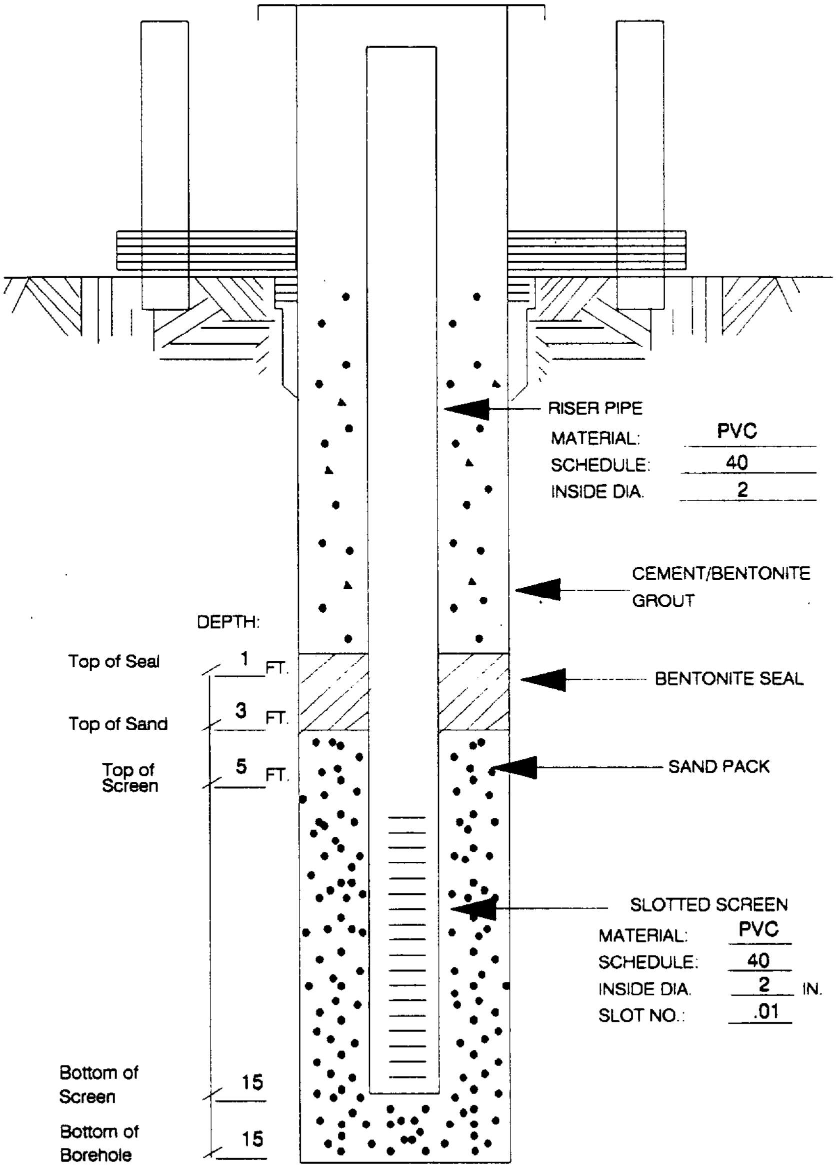
DEPTH:
Top of Seal 16 FT.
Top of Sand 18 FT.
Top of Screen 20 FT.

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

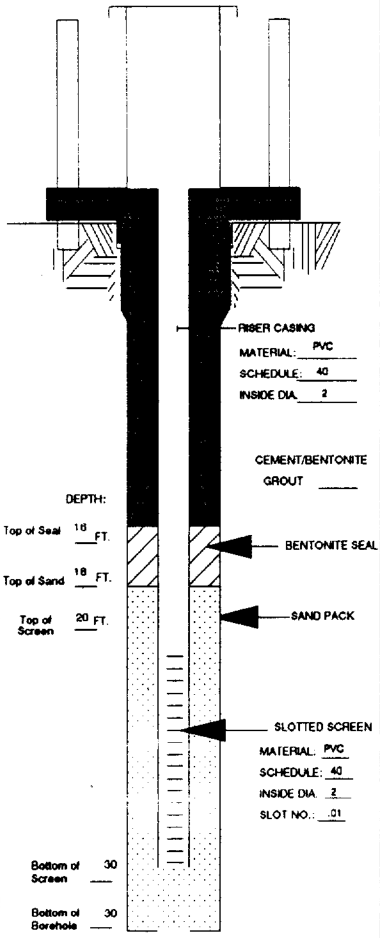
TYPICAL OVERBURDEN MONITORING WELL
N.T.S.

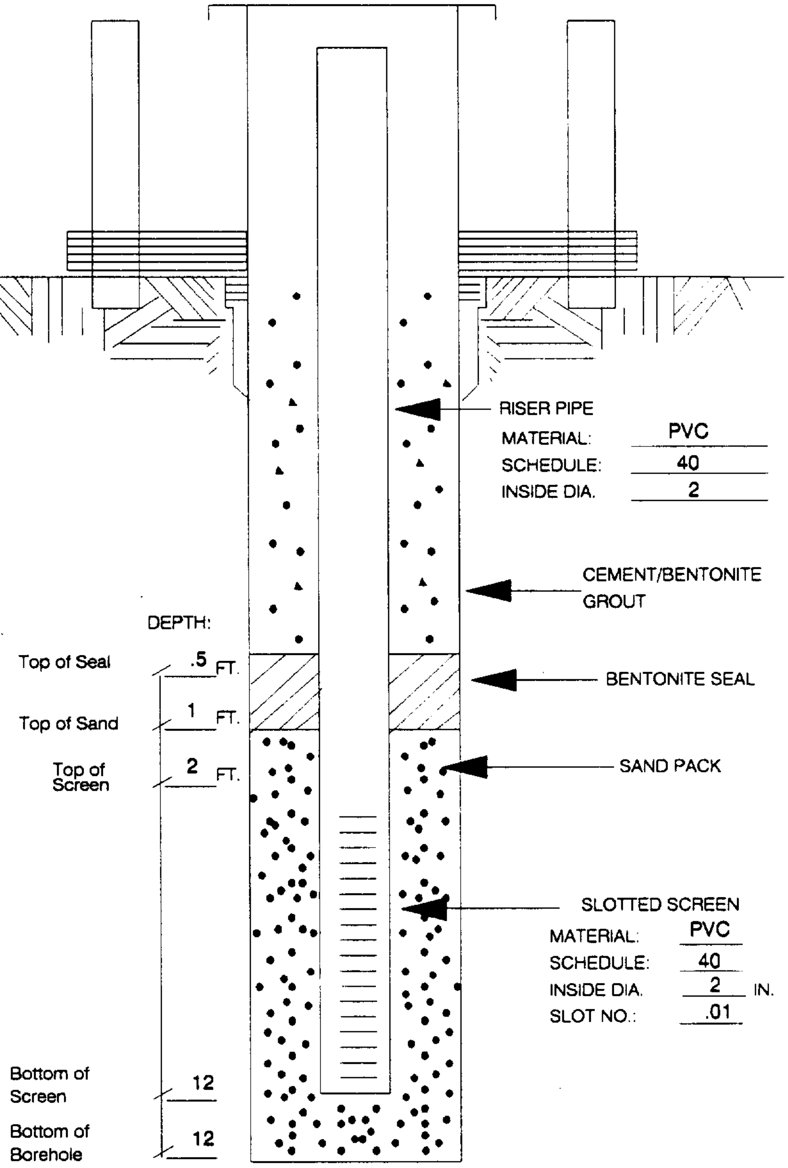
Tarawa Terrace
MW-11
1/8/92

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 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 .5 FT.

Top of Sand 1 FT.

Top of Screen 2 FT.

Bottom of Screen 12

Bottom of Borehole 12

TYPICAL OVERBURDEN MONITORING WELL

N.T.S.

Tarawa Terrace

MW-13

1/9/92

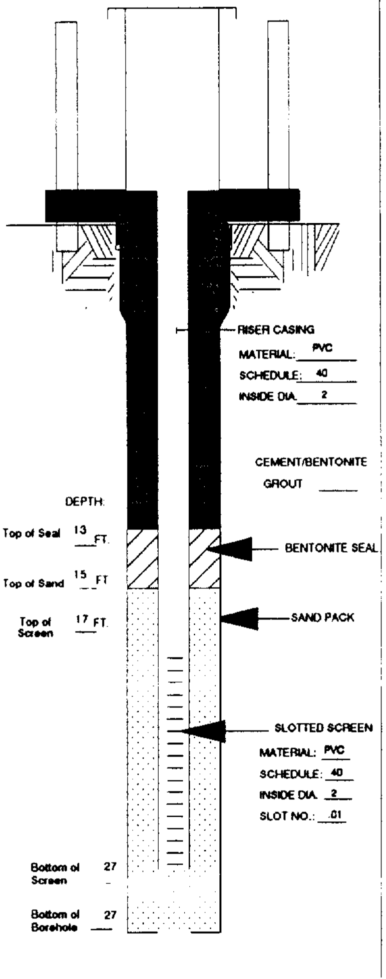
O'Brien & Gere Engineers, Inc.	Boring Log/Protective Casing Well	Report of Boring No. MW-14 Sheet 1 of 1
Location: TT61-66 Client: Navy Drilling Type: Hollow Stem	SAMPLER Type: 2" O.D. Split Spoon Hammer: 140# Fall: 30"	Ground Water Depth File No.

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

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

Depth	Sample Depth	Sample Blows /6"	Sample Penetr/ Recovery	Sample PID Value	Sample Description
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.	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

Depth	Sample				Sample Description	Stratum Change General Description
	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

NOTE - Analytical methods EPA 8010,8020 and 8100 are equivalent to methods EPA 601, 602 and 610, respectively.

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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 1-7-92 **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

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

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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 1-7-92 **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.

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Date: January 28, 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 1-7-92 **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

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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.

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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** 1-23-92

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.

Page 1 of 2

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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/1

Page 2 of 2

Authorized: Monika 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 1-11-92 **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

OBG
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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/1

Authorized: Monika 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

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.

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
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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 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
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				
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/l

Authorized: Monika Santucci
Date: February 24, 1992

APPENDIX C

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

Anne L 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 16, 1992

ANALYTICAL SERVICES REPORT SHEET

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

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Quality Control Officer

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

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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

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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

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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

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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: 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

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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

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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: 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

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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

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Quality Control Officer

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

APPENDIX D

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

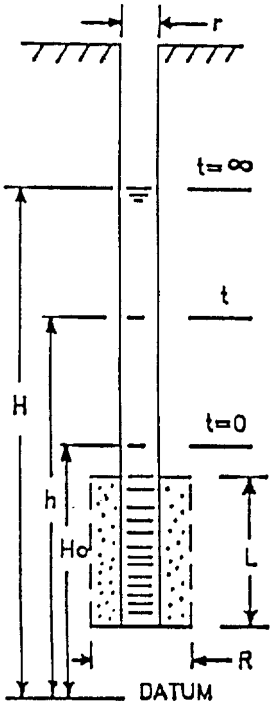
Values of hydraulic conductivity will be calculated from the change in head versus the change in time data using Hvorselv's formula.

Revised
6/26/91

IN-SITU PERMEABILITY TEST
FIELD LOG

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

LOCATION Tarawa Terrace
ELEVATION



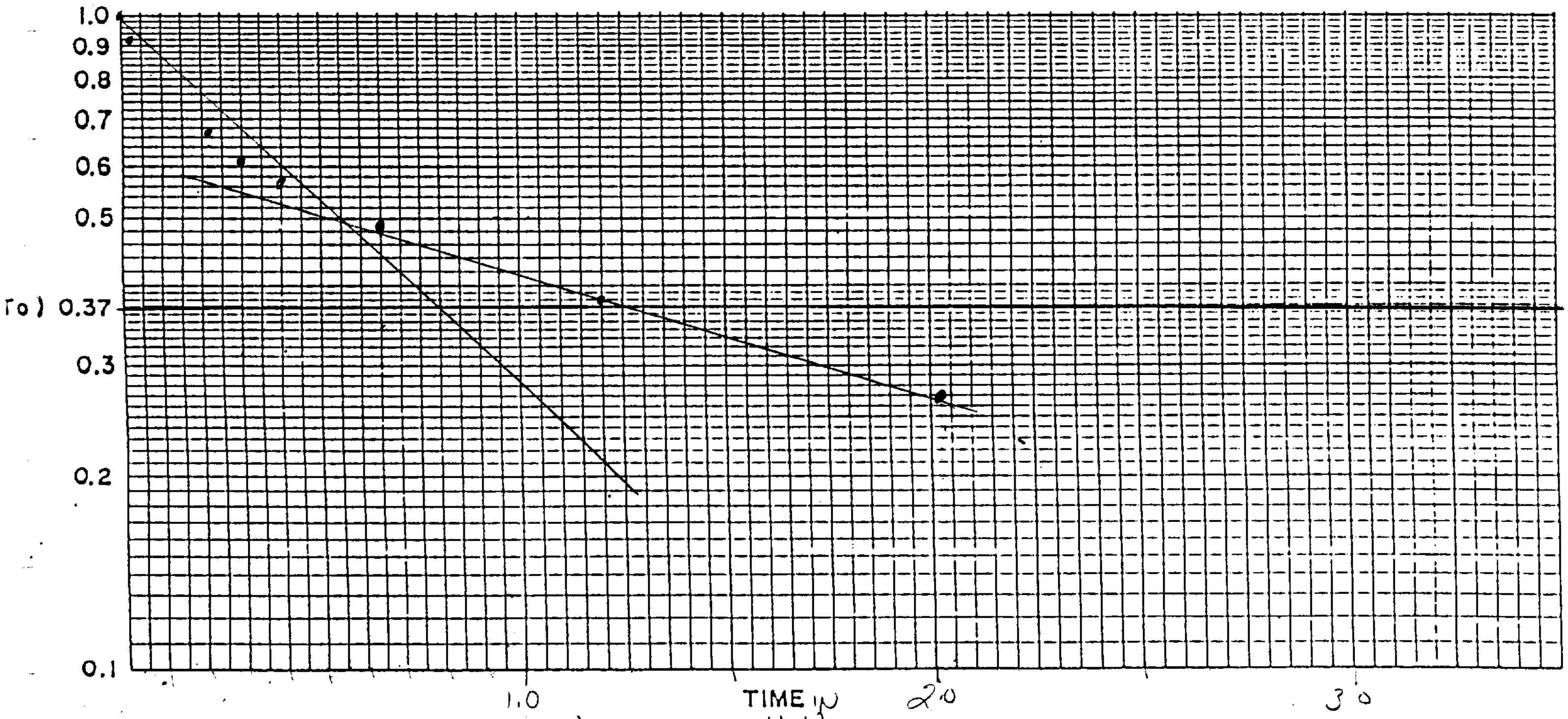
STATIC HEAD (H) 6.27
PIPE RADIUS (r) .08
SCREEN RADIUS (R) .35
SCREEN LENGTH (L) 8.73
INITIAL HEAD (Ho) 16.0

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

HYDRAULIC CONDUCTIVITY :

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

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

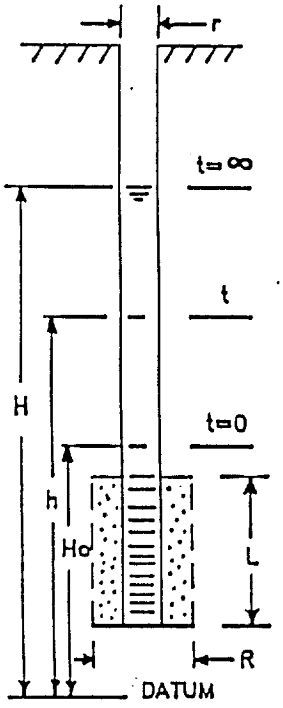


To - .80 min = 48 sec   To = 1.25 min = 75 sec   T̄ = 61.5

IN–SITU PERMEABILITY TEST
FIELD LOG

PROJECT TT61-66
WELL NUMBER mw2
DATE 1-8-92

LOCATION Tarawa Terrace
ELEVATION

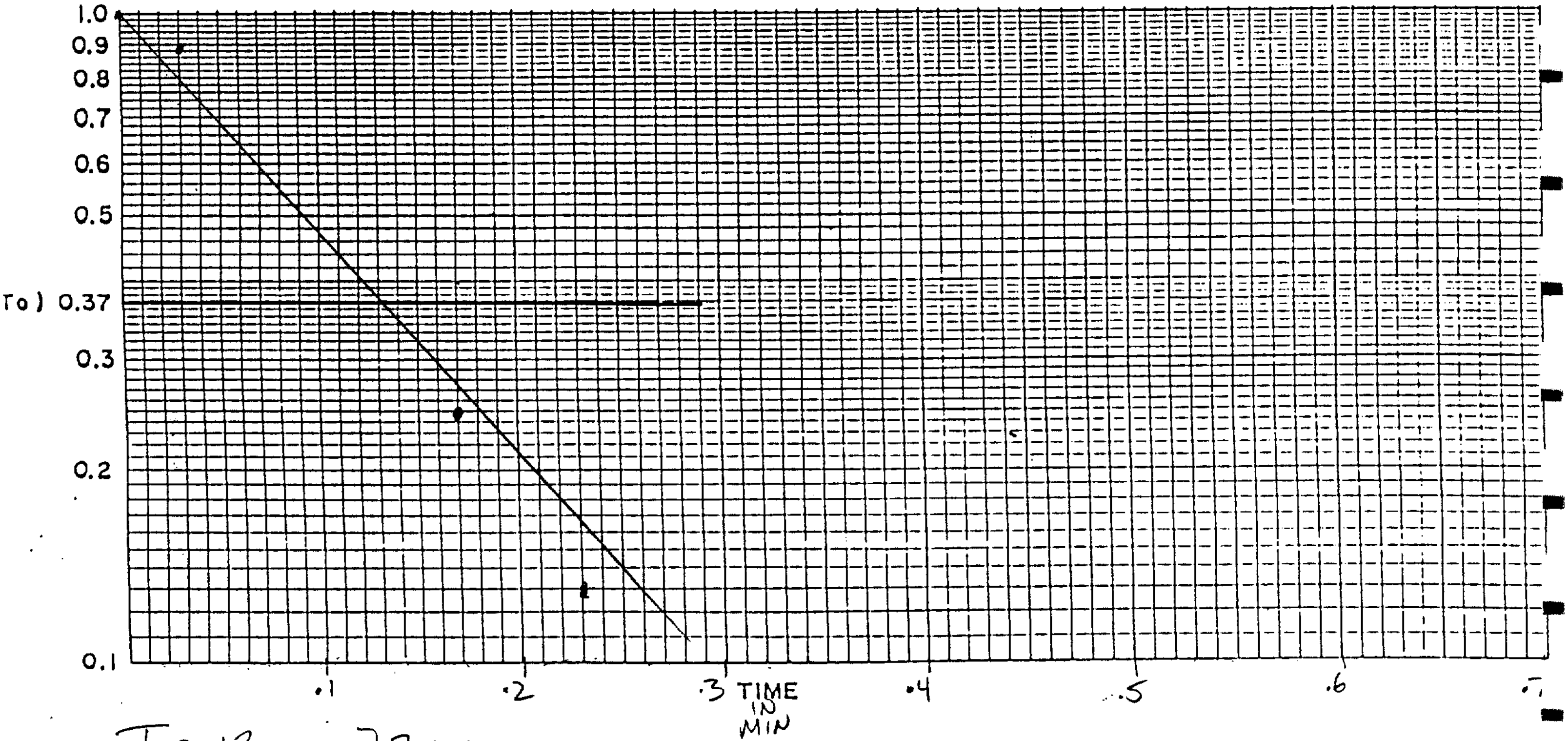


STATIC HEAD (H) 6.57
PIPE RADIUS (r) .08
SCREEN RADIUS (R) .35
SCREEN LENGTH (L) 10
INITIAL HEAD (Ho) 11.5
HYDRAULIC CONDUCTIVITY :

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

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	6.4	.05

$$K=\frac{(.08)^2\ln(10/.35)=.02}{2(10\cdot 7.8)=156} 1.4\times10^{-4}\text{ ft/sec}(6.464\times10^5)=88.9\text{ gpd/ft}^2$$

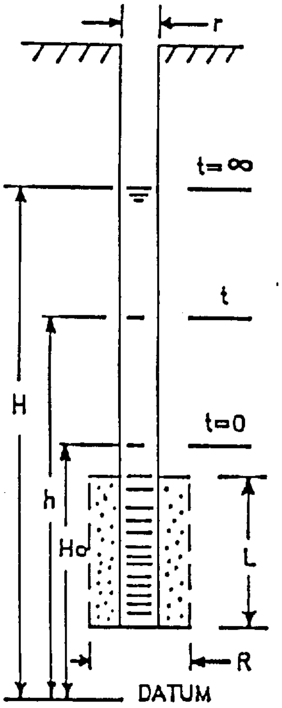


To= 13min = 7.7 sec

IN–SITU PERMEABILITY TEST
FIELD LOG

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

LOCATION Tarawa Terrace
ELEVATION

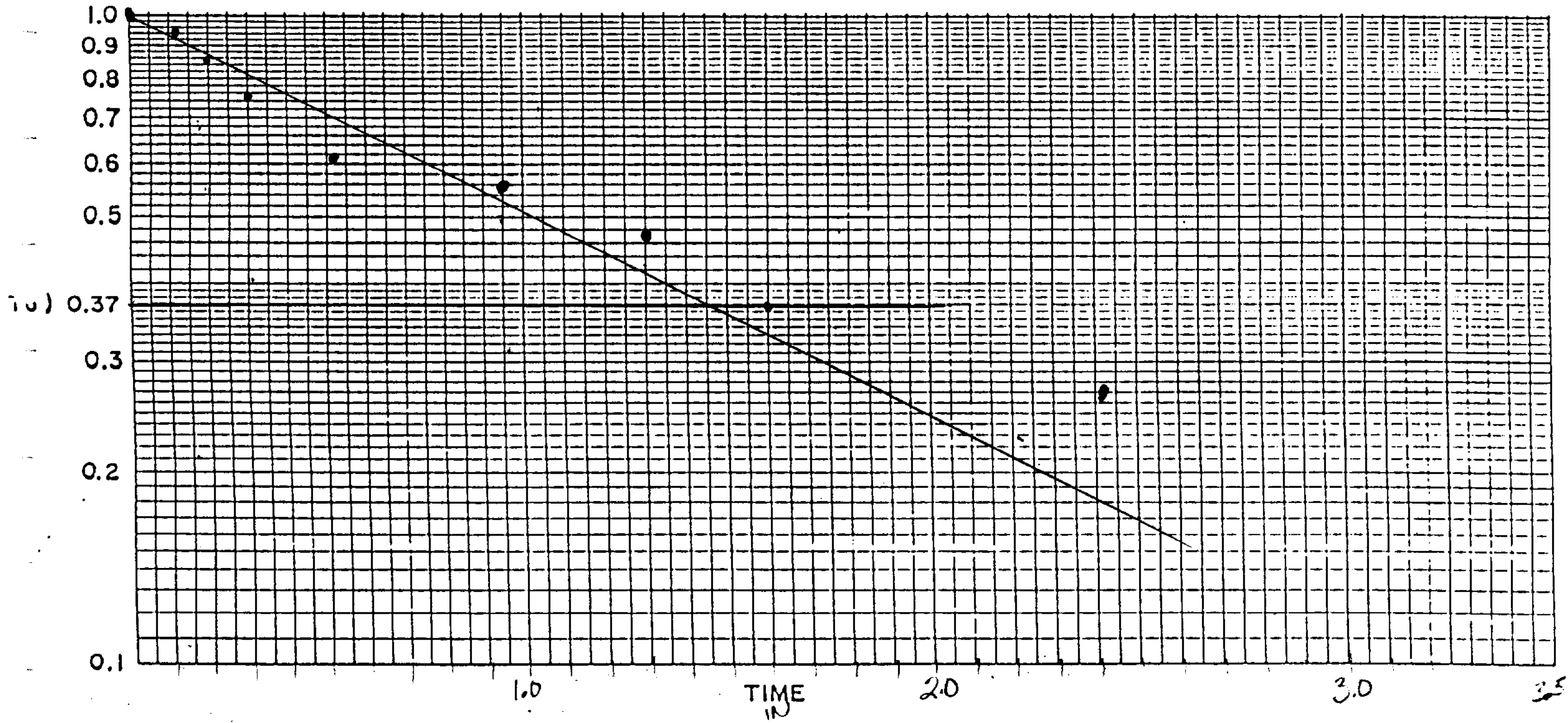


STATIC HEAD (H) 6.67
PIPE RADIUS (r) .08
SCREEN RADIUS (R) .35
SCREEN LENGTH (L) 8.33
INITIAL HEAD (Ho) 17.0
HYDRAULIC CONDUCTIVITY :

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

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

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

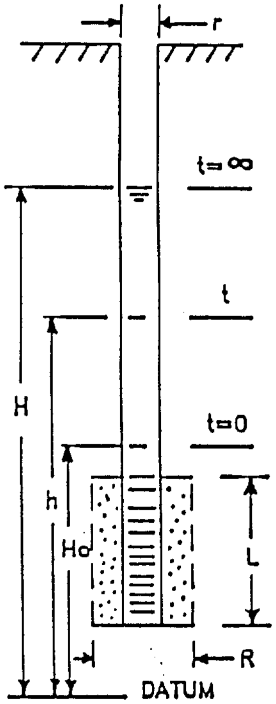


To=1.45min=87se

IN–SITU PERMEABILITY TEST
FIELD LOG

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

LOCATION Tarawa Terrace
ELEVATION

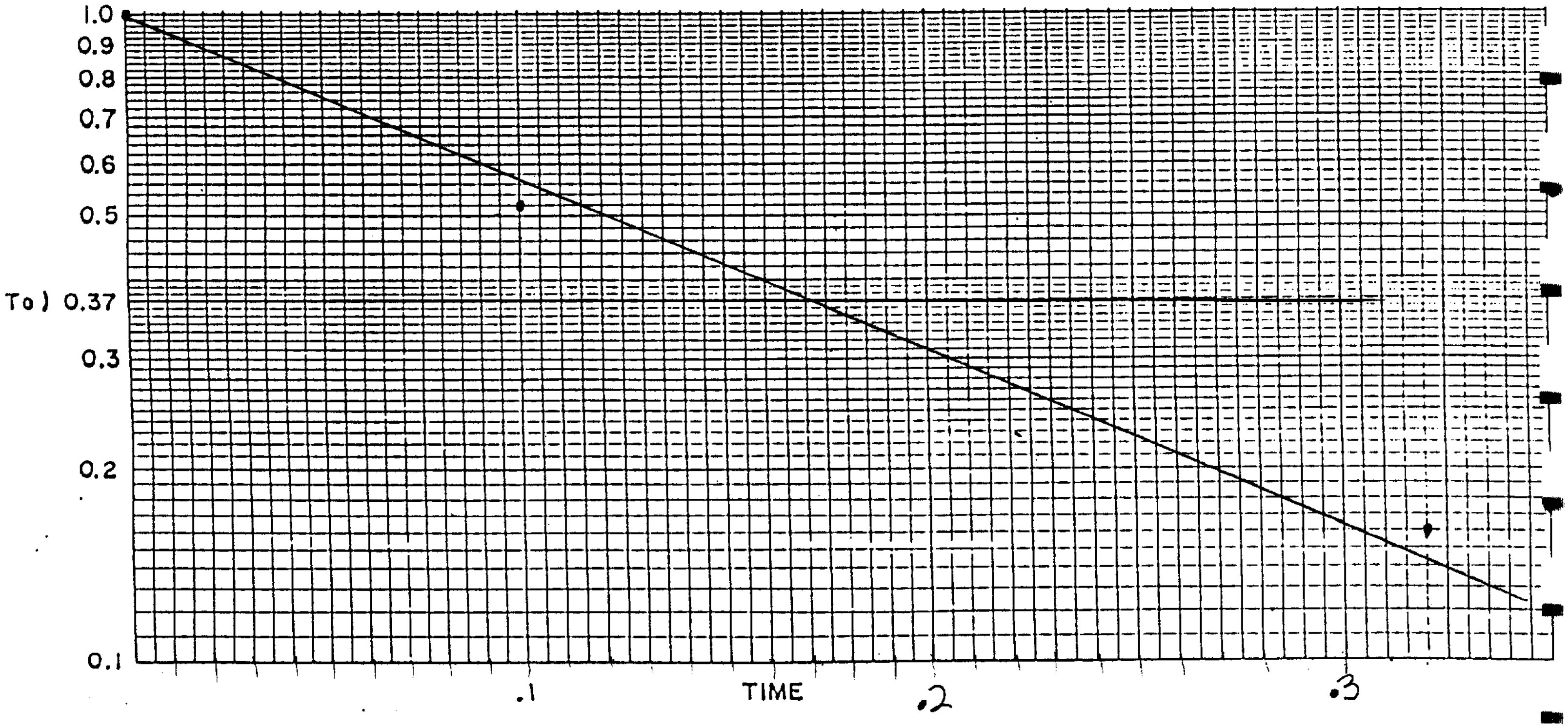


STATIC HEAD (H) 6.89
PIPE RADIUS (r) .08
SCREEN RADIUS (R) .35
SCREEN LENGTH (L) 10
INITIAL HEAD (Ho) 14.
HYDRAULIC CONDUCTIVITY :

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

$$K=\frac{(.08^2)\ln(10/.35)=.02}{2(10\cdot 10.8)\,216}\ 9.2\times10^{-5}\,ft/sec\,(6464\times10^5)=59.8\,gpd/ft^2$$

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

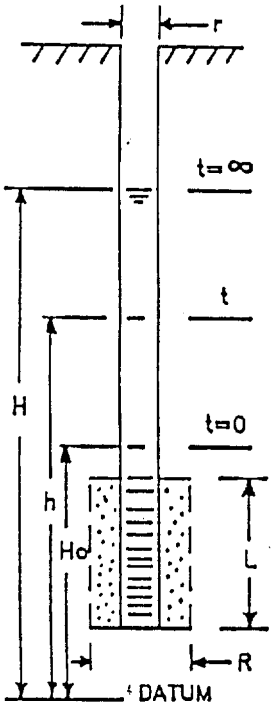


To= 18 min = 10.8 sec

IN–SITU PERMEABILITY TEST
FIELD LOG

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

LOCATION Tarawa Terrace
ELEVATION

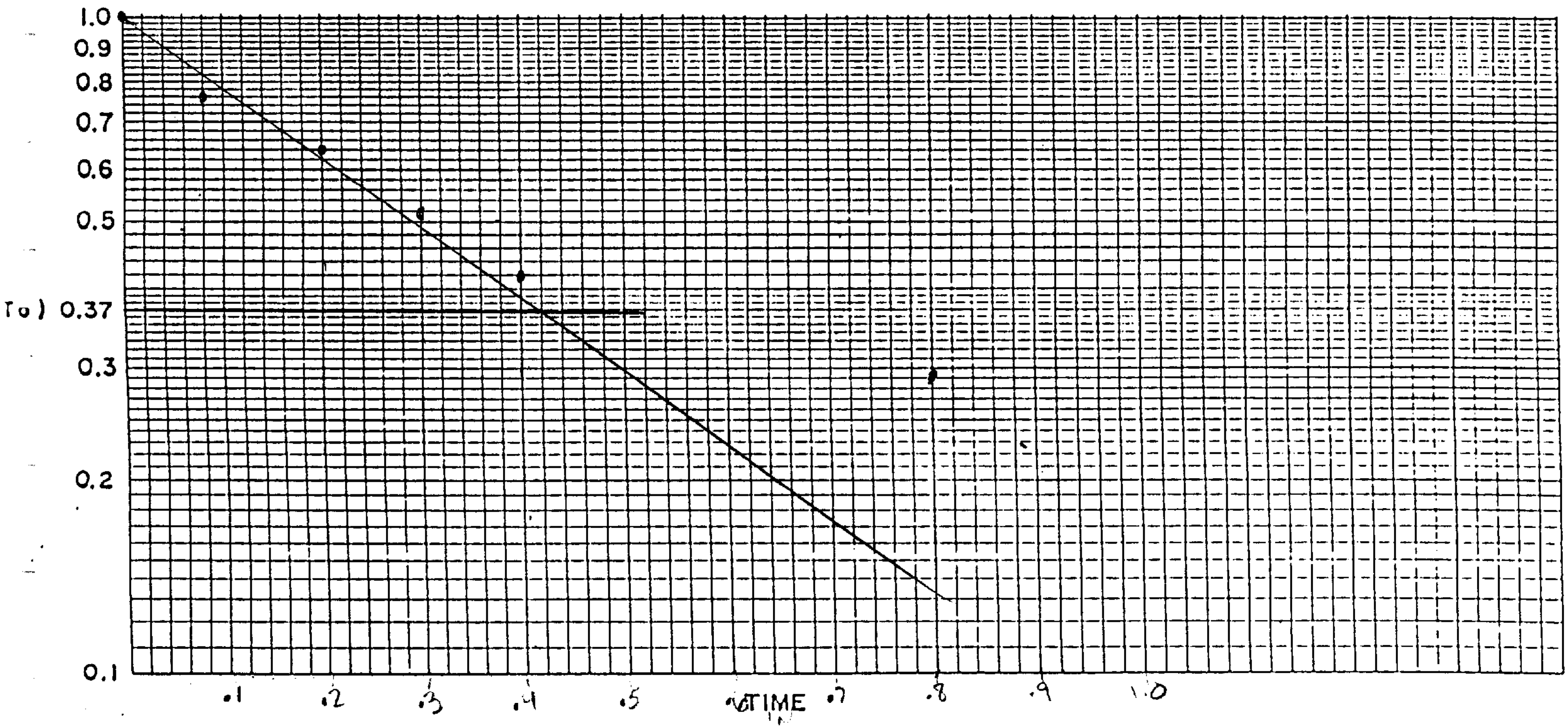


STATIC HEAD (H) 6.57
PIPE RADIUS (r) .08
SCREEN RADIUS (R) .35
SCREEN LENGTH (L) 8.43
INITIAL HEAD (Ho) 15.0
HYDRAULIC CONDUCTIVITY :

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

$$K= \frac{(.08^2)\ln(8.43/.35) = .02}{2(8.43 \cdot 25.2) = 424.87}$$ 4.7×10⁻⁵ ft/sec (6.464×10⁵) = 30.4 gpd/ft²

TIME sec.	WATER DEPTH	t MIN	h	$\frac{H-h}{H-Ho-8.43}$
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 = .42 min = 25.2 sec

IN–SITU PERMEABILITY TEST
FIELD LOG

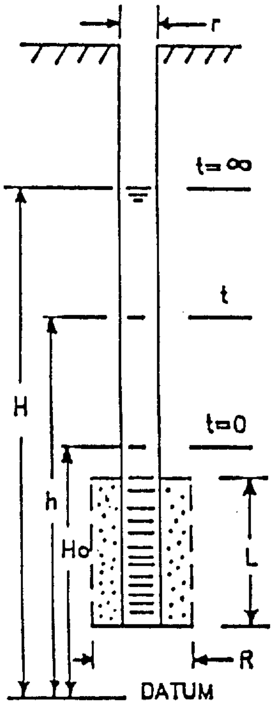
PROJECT TT61-66

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

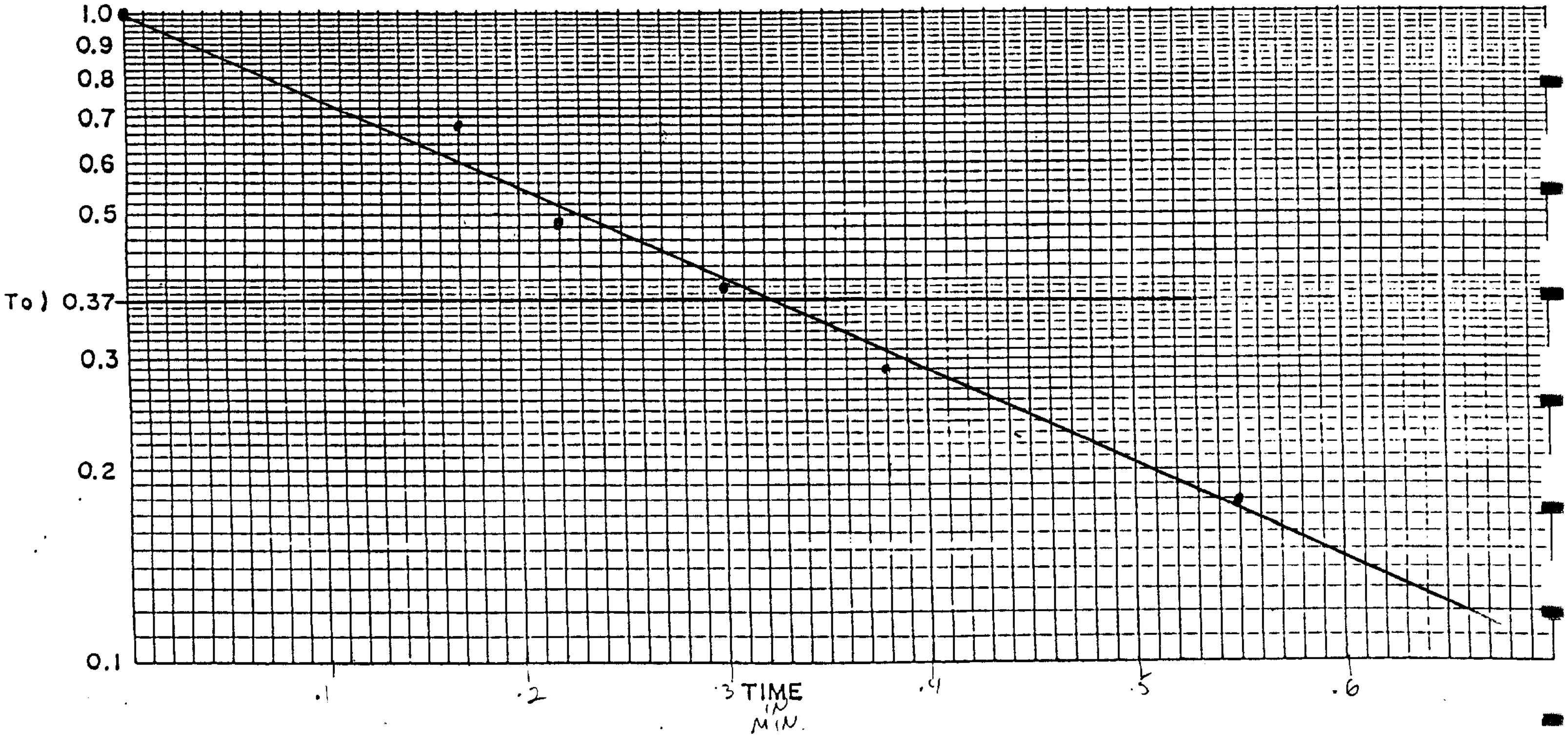
INITIAL HEAD (Ho) 17

HYDRAULIC CONDUCTIVITY :

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

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

$$K = \frac{(.08^2)\ln(10/.35) = .02}{2(10 \cdot 19.2) \quad 384} = 5.2 \times 10^{-5} \text{ ft/sec } (6.464 \times 10^5) = 33.7 \text{ gpd/ft}^2$$



T_o = .32 min = 19.2 sec

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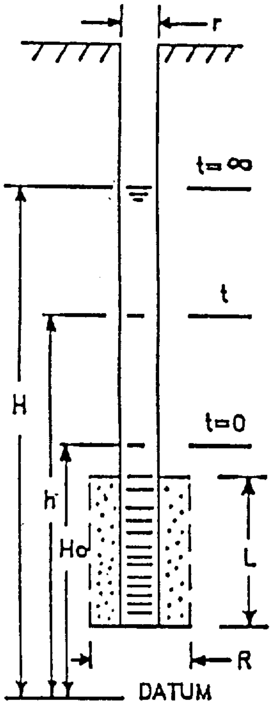
IN–SITU PERMEABILITY TEST
FIELD LOG

PROJECT TT 61-66
WELL NUMBER mw 7
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

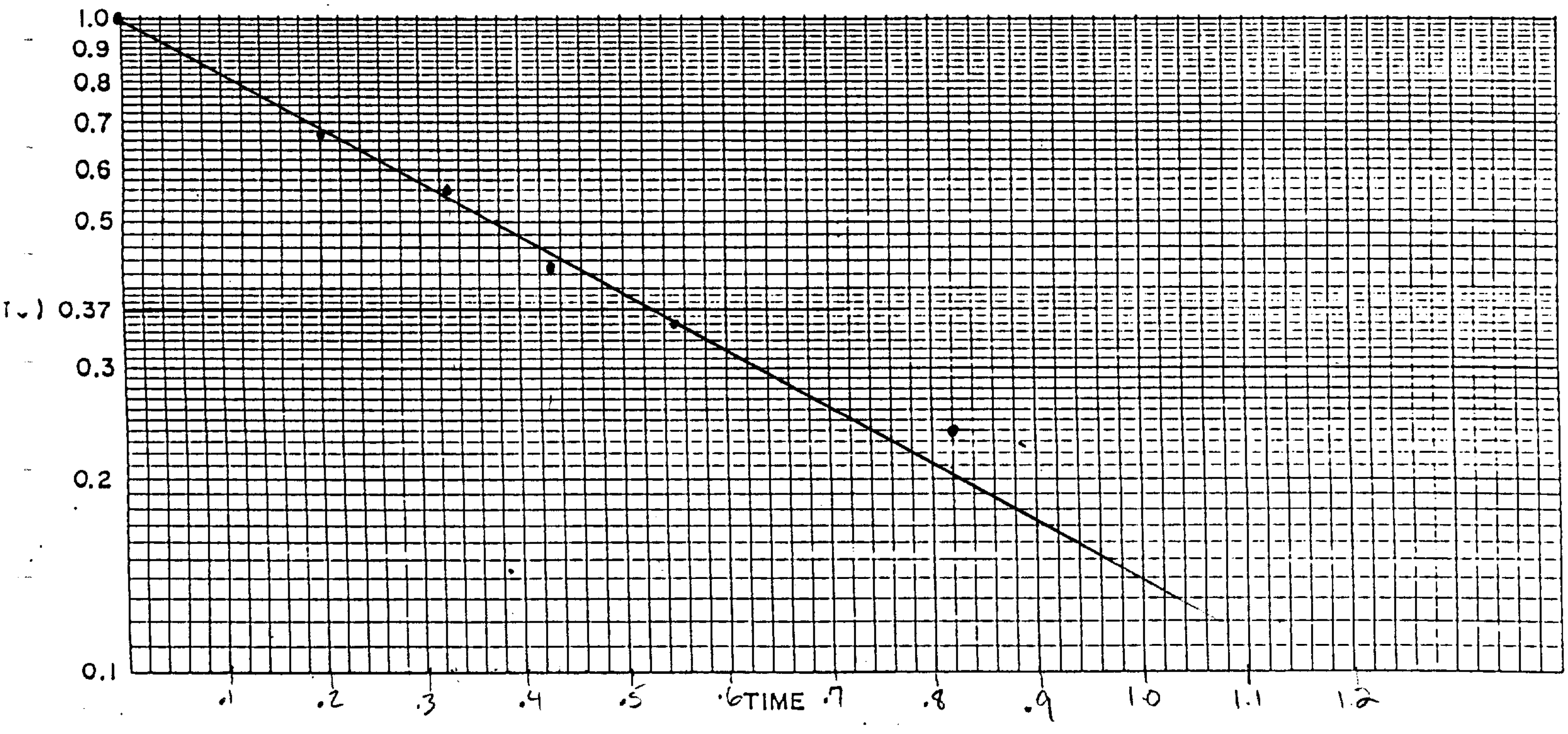
INITIAL HEAD (Ho) 16.0

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	$\frac{H-h}{H-Ho}$ -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

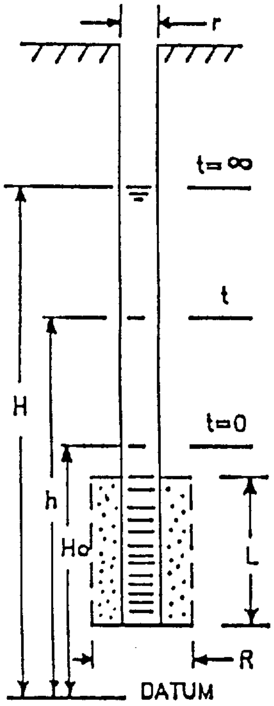


T_o = .53 min = 31.8 sec

IN–SITU PERMEABILITY TEST
FIELD LOG

PROJECT TT 61-66
WELL NUMBER MW8
DATE 1-9-92

LOCATION Tarawa Terrace
ELEVATION



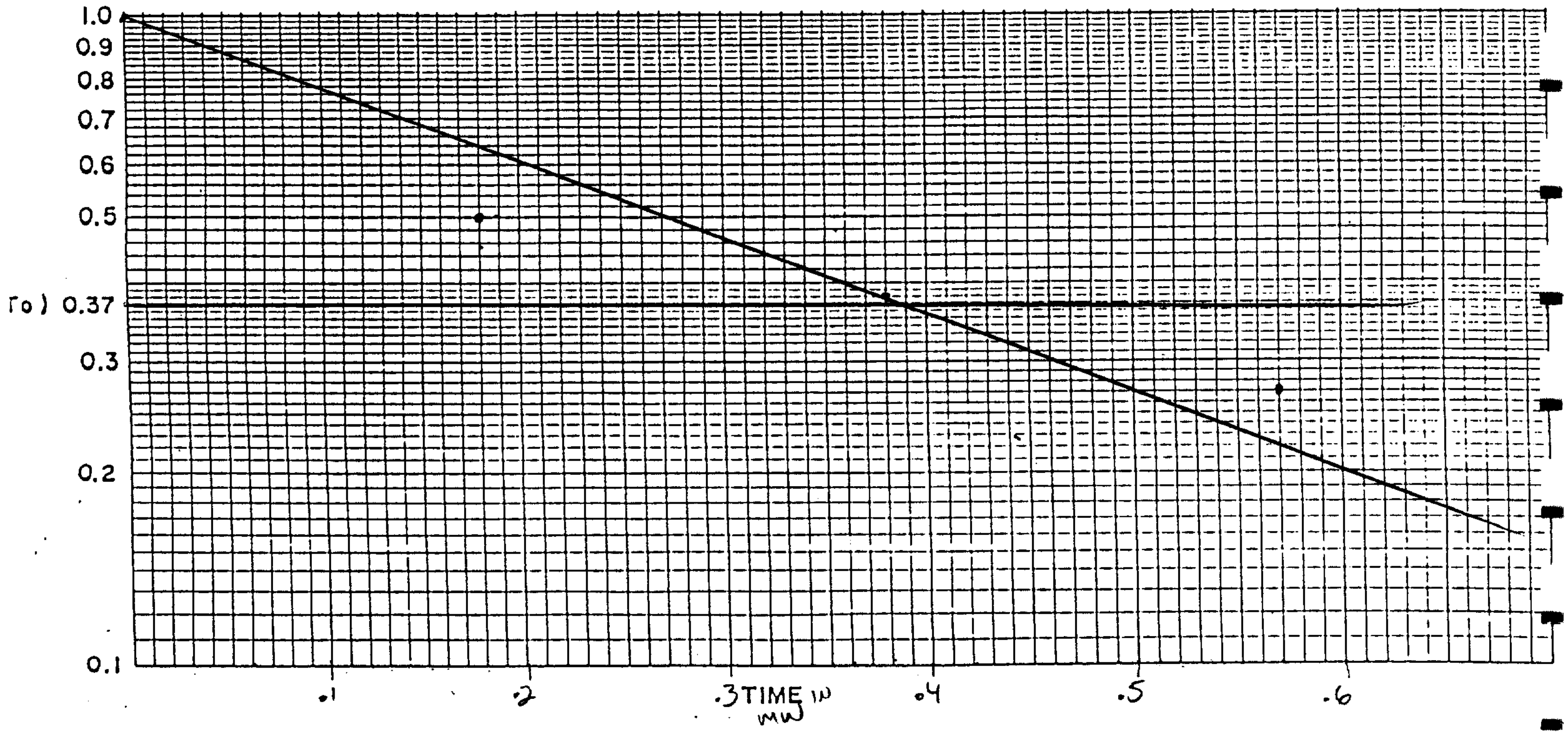
STATIC HEAD (H) 7.93
PIPE RADIUS (r) .08
SCREEN RADIUS (R) .35
SCREEN LENGTH (L) 10.0
INITIAL HEAD (Ho) 16.0

HYDRAULIC CONDUCTIVITY :

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

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

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

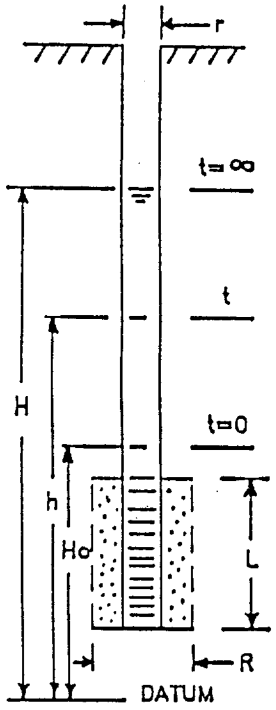


To = 39 min = 23.4

IN-SITU PERMEABILITY TEST
FIELD LOG

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

LOCATION Tarawa Terrace
ELEVATION

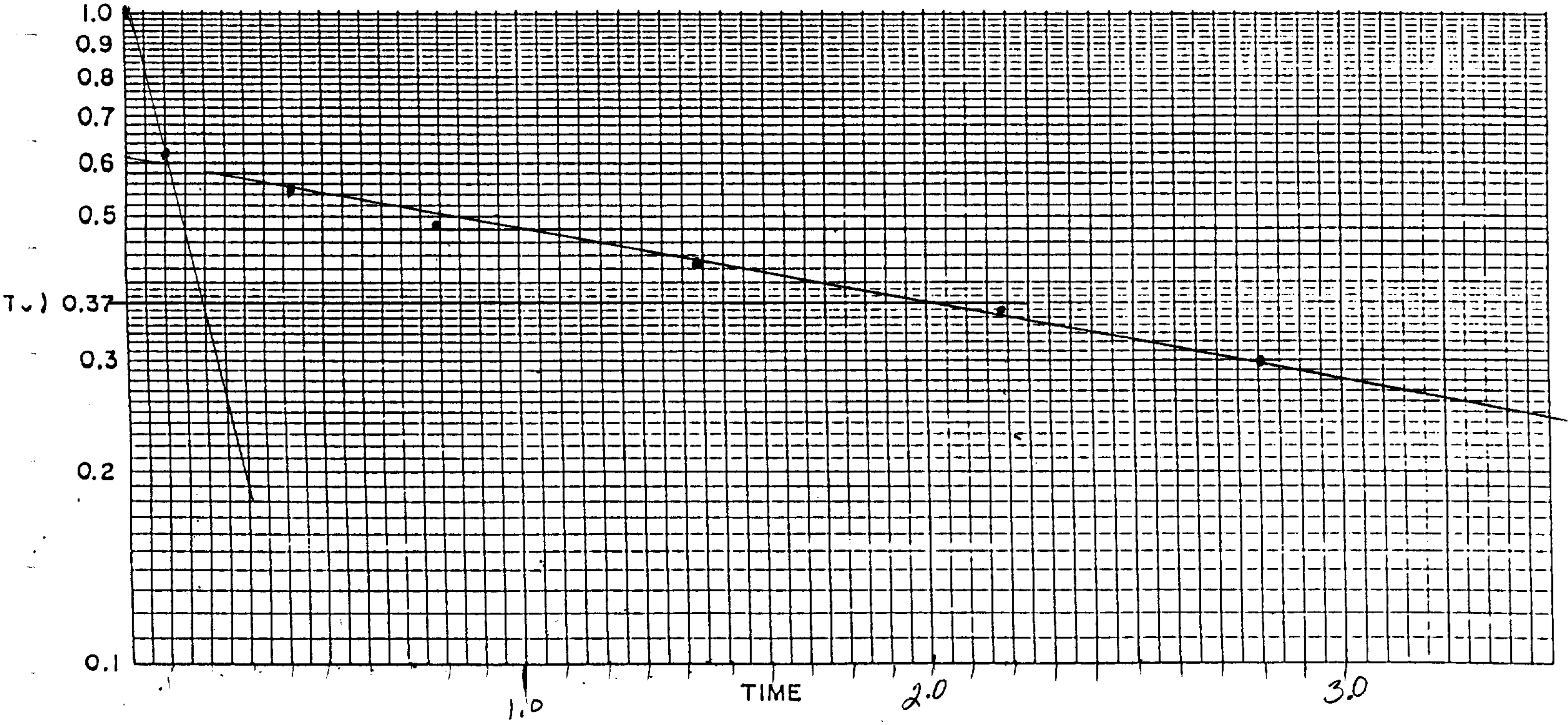


STATIC HEAD (H) 6.15
PIPE RADIUS (r) .08
SCREEN RADIUS (R) .35
SCREEN LENGTH (L) 7.85
INITIAL HEAD (Ho) 14.0
HYDRAULIC CONDUCTIVITY :

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

$$K=\frac{(.08^2)\ln(7.85/.35)=.02}{2(7.85\cdot 120)=1884}=1.1\times10^{-5}\text{ ft/sec}(6.464\times10^5)=6.83\text{ gpd/ft}^2$$

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		.78	10.0	.49
86		1.43	9.5	.43
130		2.17	9.0	.36
179		2.98	8.5	.30

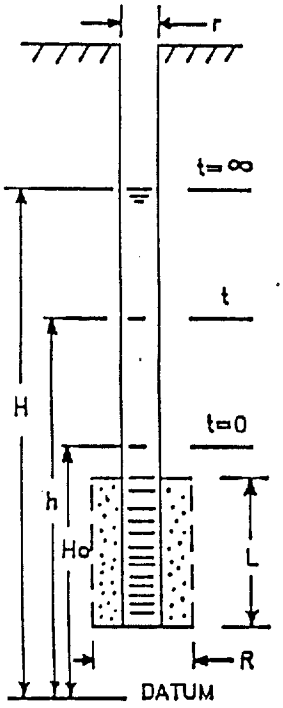


To= 2.0 min = 120 sec

IN–SITU PERMEABILITY TEST
FIELD LOG

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

LOCATION Tarawa Terrace
ELEVATION

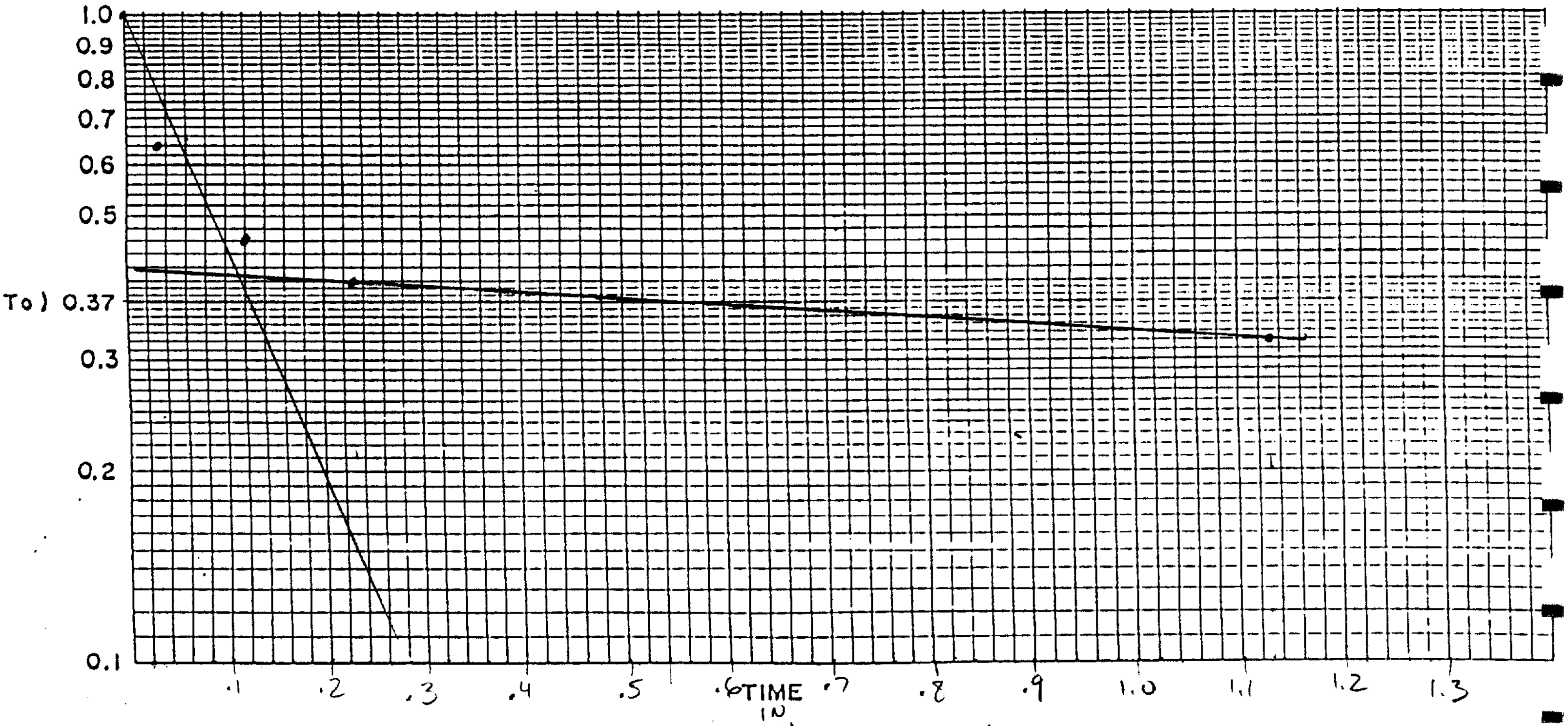


STATIC HEAD (H) 6.32
PIPE RADIUS (r) .08
SCREEN RADIUS (R) .35
SCREEN LENGTH (L) 10'
INITIAL HEAD (Ho) 8.0
HYDRAULIC CONDUCTIVITY :

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

$$K=\frac{(.08^2)\ln(10/.35)=.02}{2(10\cdot 20.1)\ 402}\ 5.0\times10^{-5}\ ft/sec\ (6\,464\times10^5)=32.1\ gpd/ft^2$$

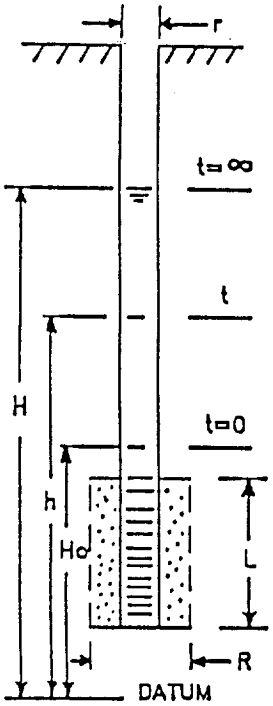
TIME sec	WATER DEPTH	t min	h	$\frac{H-h}{H-Ho}$ -1.68
0		0	8.0	1
2		.03	7.4	.64
7		.12	7.1	.46
14		.23	7.0	.40
68		1.13	6.9	.34



IN–SITU PERMEABILITY TEST
FIELD LOG

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

LOCATION Tarawa Terrace
ELEVATION

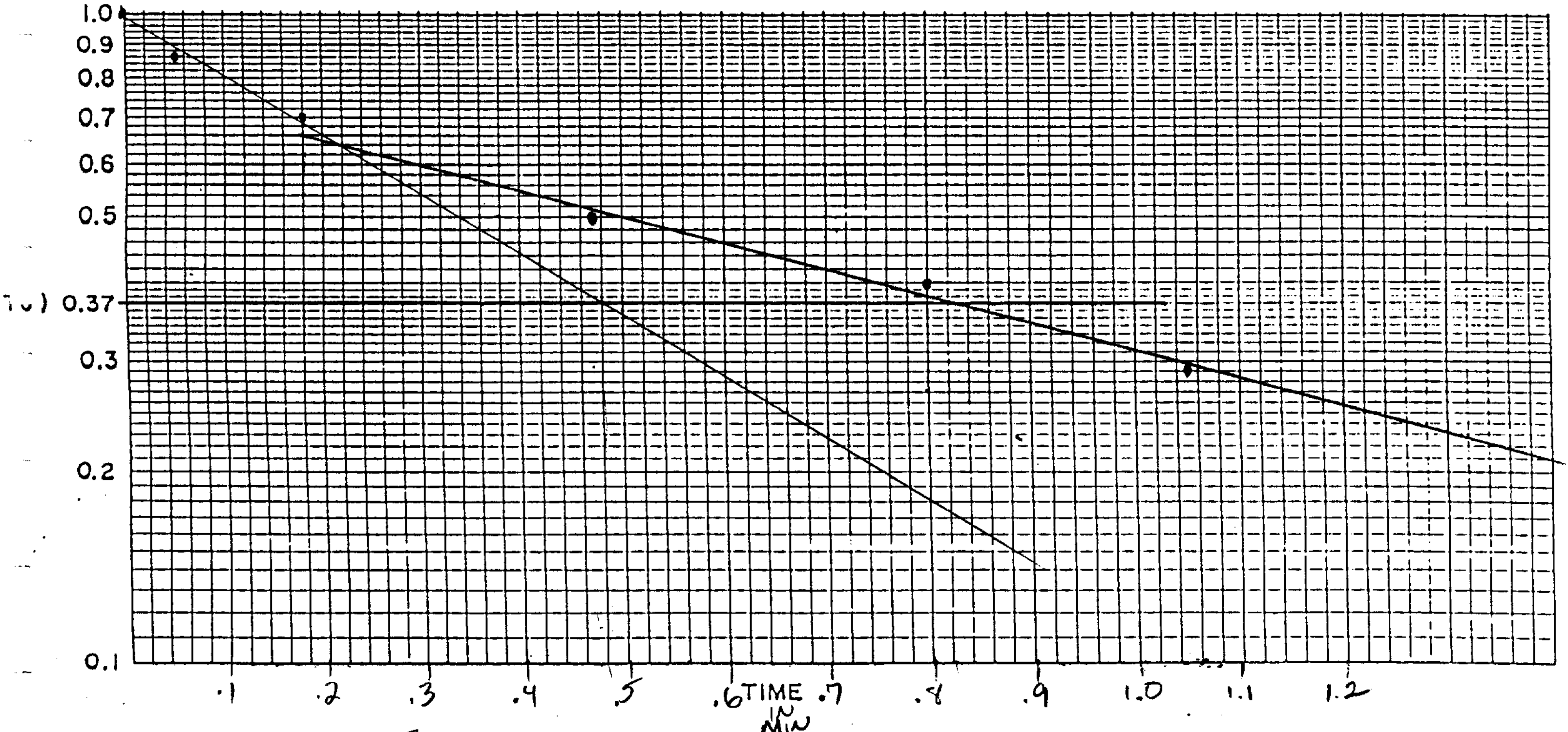


STATIC HEAD (H) 6.54
PIPE RADIUS (r) .08
SCREEN RADIUS (R) .35
SCREEN LENGTH (L) 8.46
INITIAL HEAD (Ho) 11.5
HYDRAULIC CONDUCTIVITY :

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

$$K=\frac{(.08^2)\ln(8.46/.35)=.02}{2(8.46\cdot39)=659.9}\ 3.0\times10^{-5}\ \text{ft/sec}(6.464\times10^5)=19.6\ \text{gpd/ft}^2$$

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

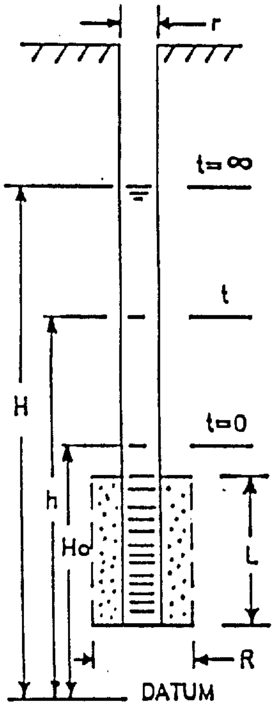


To = 48m [illegible] T = .82 m = 49.2 sec T = 39 sec

IN–SITU PERMEABILITY TEST
FIELD LOG

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

LOCATION Tarawa Terrace
ELEVATION ______

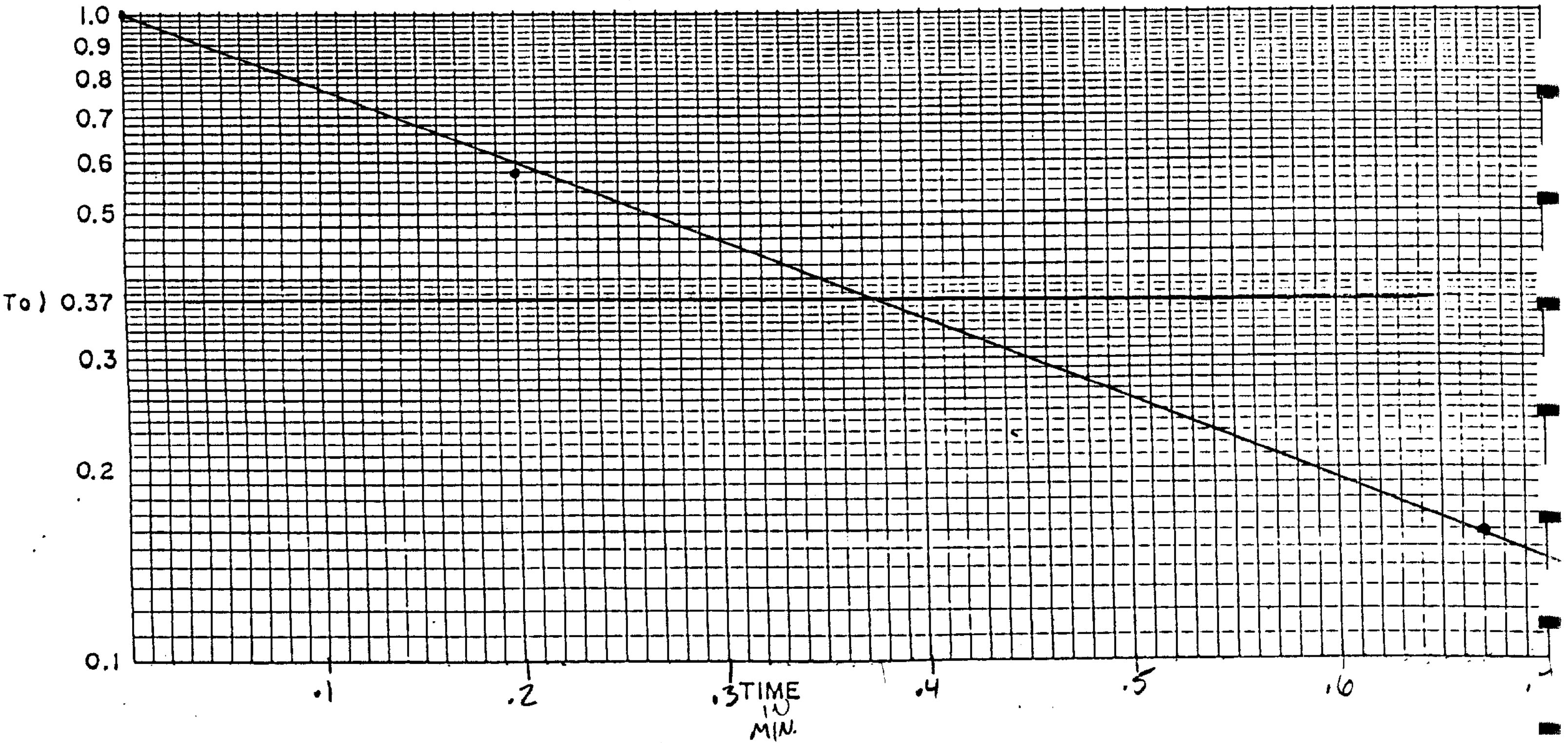


STATIC HEAD (H) 7.80
PIPE RADIUS (r) .08
SCREEN RADIUS (R) .35
SCREEN LENGTH (L) 10'
INITIAL HEAD (Ho) 9.0
HYDRAULIC CONDUCTIVITY :

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

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

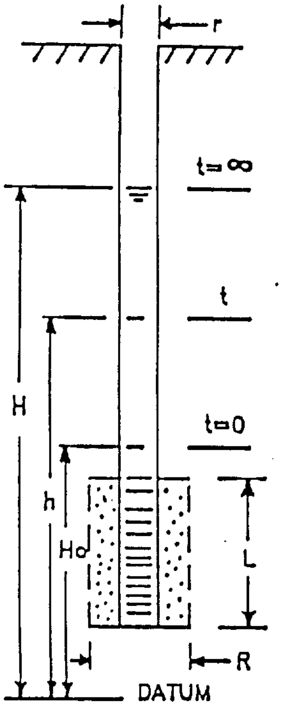
TIME sec	WATER DEPTH	t MIN	h	$\frac{H-h}{H-Ho-1.2}$
0		0	9.0	1
12		.20	8.5	.58
40		.67	8.0	.16
62		1.03	7.9	.08



IN–SITU PERMEABILITY TEST
FIELD LOG

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

LOCATION Tarawa Terrace
ELEVATION

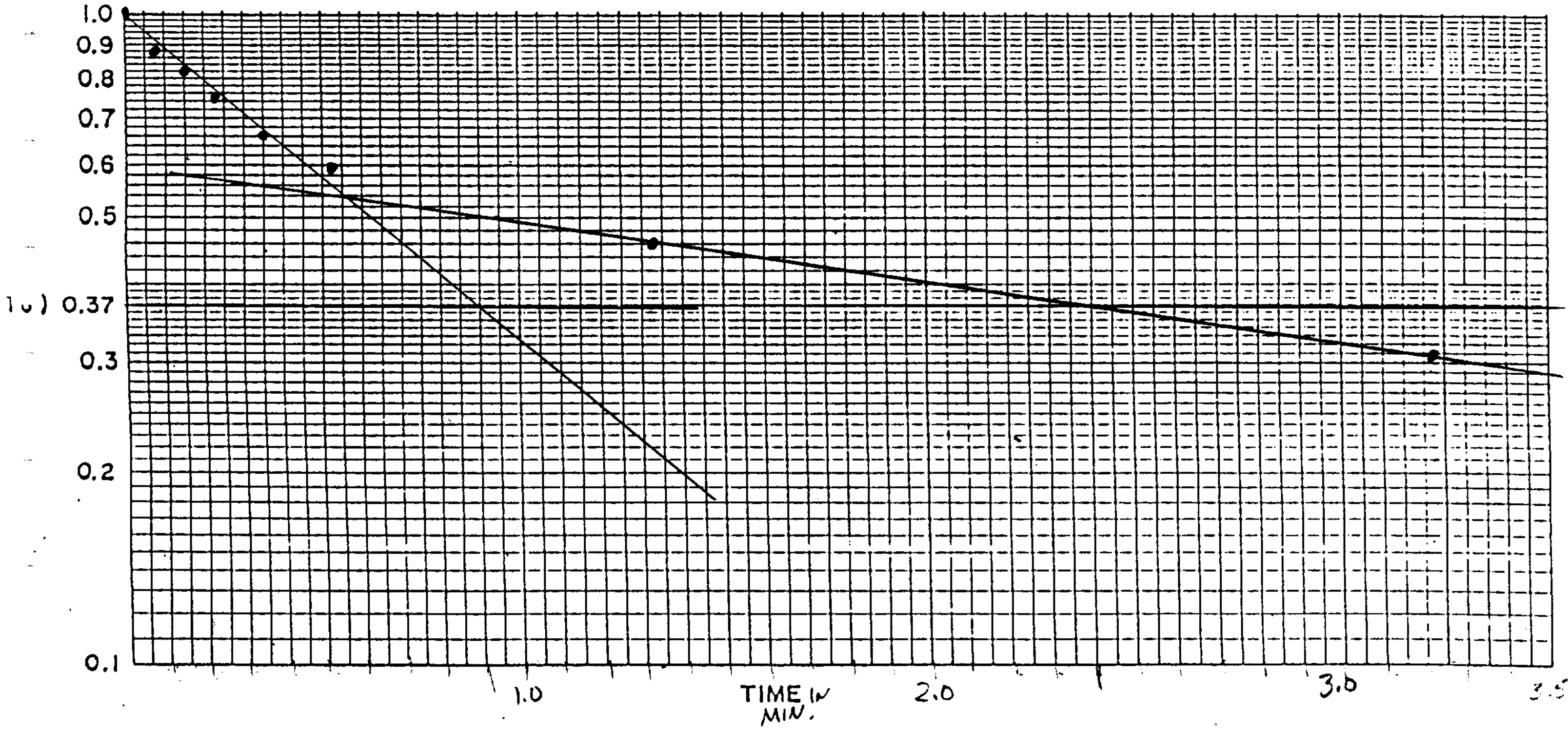


STATIC HEAD (H) 5.85
PIPE RADIUS (r) .08
SCREEN RADIUS (R) .35
SCREEN LENGTH (L) 6.15
INITIAL HEAD (Ho) 12.7
HYDRAULIC CONDUCTIVITY :

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

$$K=\frac{(.08^2)\ln(6.15/.35)=.02}{2(6.15\cdot 99)=1217.7}=1.5\times10^{-5}\text{ ft/sec}(6464\times10^5)=9.7\text{ gpd/ft}^2$$

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

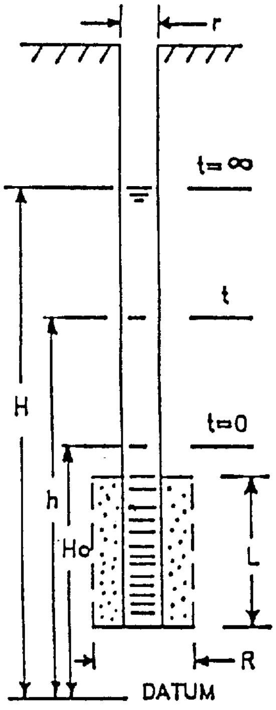


To= .90min =54sec [illegible] To= 2 [illegible] =1111 sec T= 99 sec

IN-SITU PERMEABILITY TEST
FIELD LOG

PROJECT TT61-66
WELL NUMBER MW14
DATE 1-11-92

LOCATION Tarawa Terrace
ELEVATION

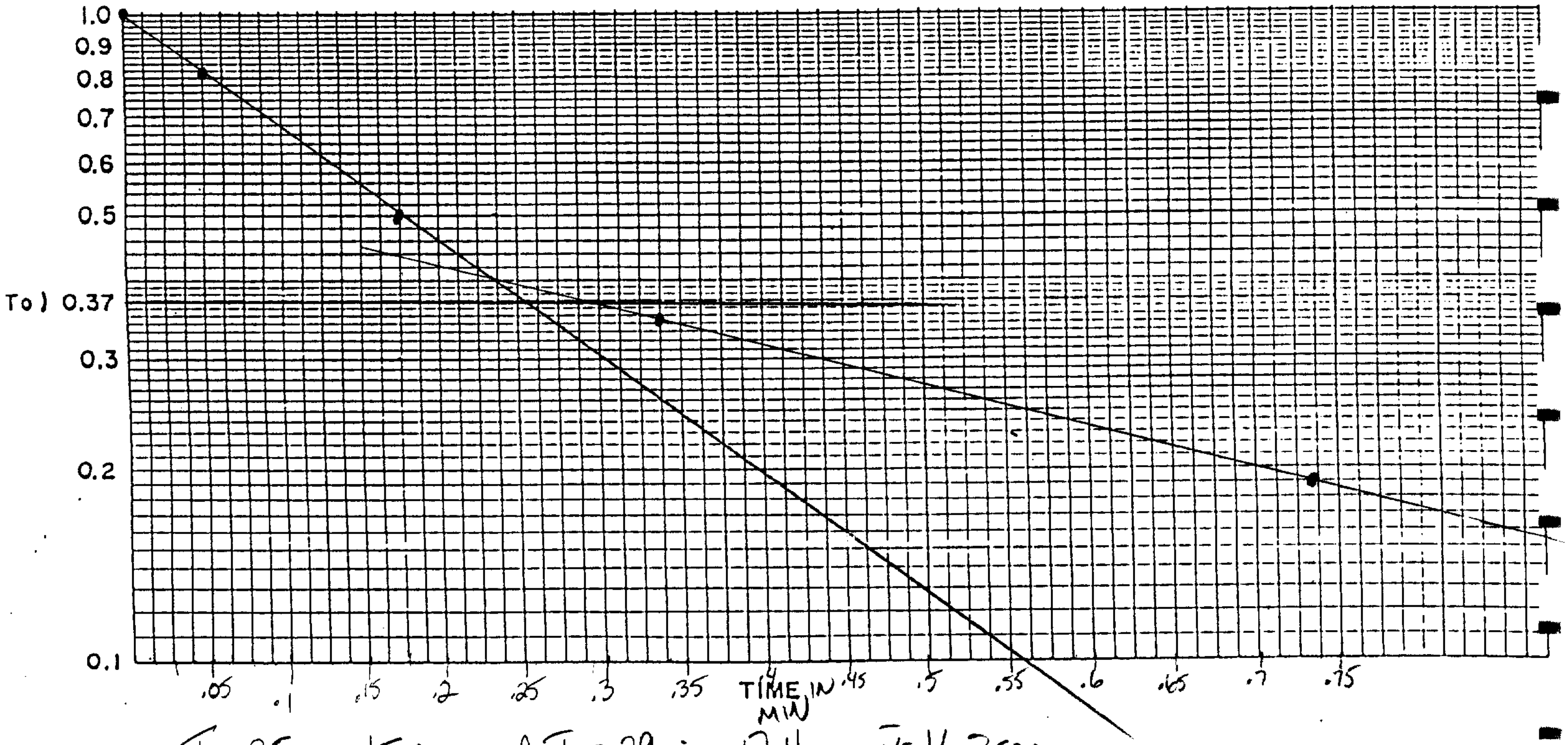


STATIC HEAD (H) 6.41
PIPE RADIUS (r) .08
SCREEN RADIUS (R) .35
SCREEN LENGTH (L) 10'
INITIAL HEAD (Ho) 9.0
HYDRAULIC CONDUCTIVITY :

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

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

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 = .25 min = 15 sec and To = .29 min = 17.4 sec T̄ = 16.2 sec

APPENDIX E

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.

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

GROUNDWATER SAMPLING PROTOCOL

Use of the following procedures for sampling cf 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.

<u>Sampling Procedures (PUMP)</u>

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.

Exhibits

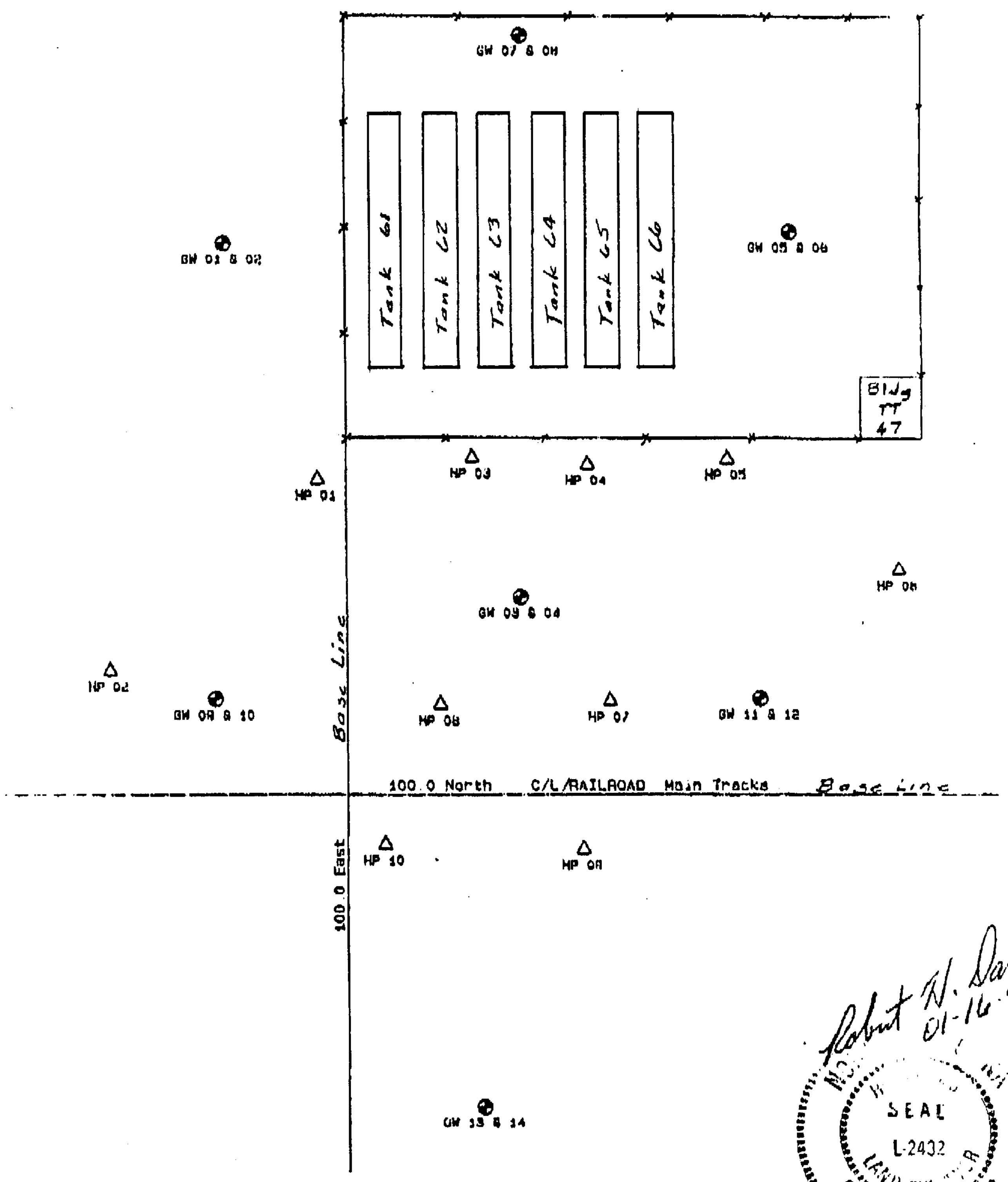
O'BRIEN & GERE

EXHIBIT A

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

Tina Bickerstaff

JOB 91130 06 O'Brien & [illegible]
SHEET NO 1 OF
CALCULATED BY R. Davis DATE 01-16-92
CHECKED BY R. Davis DATE 01-16-92
SCALE 1" = 40'
Fax 804-431-9006



Robert H. Davis 01-16-92

SEAL
L-2432
ROBERT H. DAVIS

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Tina Bickerstaff

JOB 91130 06 O'Brien & Gere

SHEET NO 2 OF

CALCULATED BY R. Davis DATE 01-16-92

CHECKED BY R. Davis DATE 01-16-92

SCALE None

Point	Northing	Easting	Elevation
HP 01	182.7	92.5	100.00
HP 02	132.8	38.1	97.65
HP 03	188.4	132.7	100.15
HP 04	186.5	162.6	100.00
HP 05	187.8	198.9	100.48
HP 06	158.9	243.6	97.88
HP 07	124.7	168.1	99.14
HP 08	123.9	124.1	99.39
HP 09	85.3	161.2	99.30
HP 10	86.6	109.7	98.95
GW 01	245.1	68.3	100.88
GW 02	245.1	68.3	100.81
GW 03	152.0	145.0	101.09
GW 04	152.0	145.0	100.99
GW 05	248.1	215.5	101.53
GW 06	248.1	215.5	101.61
GW 07	299.7	145.6	101.74
GW 08	299.7	145.6	101.70
GW 09	125.5	65.7	101.08
GW 10	125.5	65.7	100.98
GW 11	125.4	207.2	101.63
GW 12	125.4	207.2	101.54
GW 13	17.1	135.2	100.20
GW 14	17.1	135.2	100.18

SEAL

Robert H. Davis
01-16-92

Note:
Elevations based on TBM at site marked 100.00 Assumed
Actual BM elevation would be approximately 30' MSL

EXHIBIT B

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:

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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–TRICHLOROTRIFLUOROETHANE	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	8.97/39.0	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) "0.294/1.9" 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'	N/A
	1.5'-2'	GRADING GREYISH TAN, TRACE DECAYING ODOR.	56 PPM	
	2'-2.3'	BLACK ORGANIC SILT AND SAND, WOOD, MOIST.	DIESEL	
	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	N/A
	2'-2.5'	BLACK ORGANIC SILT AND PEAT, MOIST.	DIESEL	
	2.5'-3'	DARK BROWN TO GREY FINE SAND AND SILT, MOIST.	5390 PPM	
	3'-4'	GREY FINE SAND, SOME SILT, DECAYING ODOR.	TOTAL	
TTHA-3	0'-0.3'	WHITE FINE TO COARSE SAND.	0'-4'	N/A
	0.3'-1.7'	TAN TO GREY FINE SAND, LITTLE SILT, SLIGHT DECAYING ODOR, MOIST.	21 PPM DIESEL	
	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.		
TTSB-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

Figure 2

Site Sensitivity Evaluation (SSE)

Guidelines for Remediation of Soil Contaminated by Petroleum
North Carolina Division of Environmental Management

Characteristic	Condition	Rating	
Soil pH	pH<5.0 or pH >9.0 8.0 < pH <9.0 5.0 ≤ pH <6.0 6.0 ≤ pH ≤8.0	4 2 2 0	4
Grain Size* Udden-Wentworth Scale	Contains >2/3, Gravel to Coarse Sand, (>1/2mm) Contains >2/3, Medium to Fine Sand (<1/2mm - 1/8mm) Contains >2/3, Very Fine Sand to Coarse Silt (<1/8mm - 1/32mm) Contains >2/3, Medium Silt and Clay (<1/32mm)	10 7 4 0	7
Are Relict Structures, Sedimentary Structures, and/or Textures present in the zone of contamination & underlying "soils"	Present and Intersecting the Seasonal High Water Table Present but not Intersecting the Seasonal High Water Table None Present	10 5 0	0
Contaminant Class	I Low to Medium Boiling Point Hydrocarbons [C1-C15] and "some military jet fuels" II High Boiling Hydrocarbons [C12-C20] and "other jet fuels"	10 5	5*
Distance from Location of Deepest Contaminated Soil (>10 ppm TPH) to Seasonal High Water Table	5 - 10 feeet >10-40 >40 feet	10 5 0	10
Is the Top of Bedrock located above the Seasonal Low Water Table ?	Yes No	5 0	0
Is a Confining Layer present between bottom of contaminated soil and water table ?	No Yes	5 0	5
Time since release of contaminant has occurred	>1 yr. or unknown 6 months-1 year <6 months	10 5 0	10
Artifical Conduits present within the zone of contamination	Present & Intersecting the Seasonal High Water Table Present but not intersecting the Seasonal High Water Table Not Present	10 5 0	0
		TOTAL SCORE	41

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* Figure 3

*CONTAMINANT IS WASTE LUBRICATING OIL WHICH MAY BE HEAVIER THAN THE C12-C20 RANGE INDICATED.

	Site Sensitivity Evaluation Score	Maximum Soils Cleanup Level ppm of TPH
Very Sensitive	>44	10
.	36-43	35
.	21-35	60
Least Sensitive	5-20	85