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Preliminary Engineering Report

DOC. NO. : CLEJ-00382-3.05-01/01/9

O'BRIEN & GERE

10 January 1990

Commander
Atlantic Division
Naval Facilities Engineering
Command
Gilbert Street
Building N26, Room 389
Norfolk, Virginia 23511

ATTN: Ms. Susan Clarke

File: 3543.012

Re: Hadnot Point

Dear Susan:

Please find enclosed a copy of the preliminary engineering report entitled "Product Recovery System Design, Hadnot Point Fuel Farm, Marine Corps Base Camp LeJeune, NC. This report summarizes the results of the field investigations conducted during December, 1989, and presents a preliminary design for a product recovery system.

Analytical results for groundwater samples obtained during the field investigations are not yet available; this data will be forwarded as a separate submittal. Because plume configuration has not changed substantially since 1988, water quality data collected at that time is being used to proceed with the design. This is necessitated by the tight schedule requested at the project meeting held at Camp LeJeune in November, 1989. New data will be compared with the 1988 data prior to finalizing the design.

The report presents two options for discharge of drawdown water after treatment by air stripping: an storm sewer adjacent to the proposed treatment pad, or a sanitary sewer manhole across Ash Street from the proposed treatment pad. In accordance with the scope of work, we will proceed with design assuming discharge to the storm sewer. Due to permitting considerations and associated monitoring costs, however, consideration should be given to discharge to the sanitary sewer.

If I can provide any additional information or answer any questions concerning this report, please contact me at (804) 431-2966.

Very Truly Yours,

O'BRIEN & GERE ENGINEERS, INC.

Frank D. Hale, P.E.
Managing Engineer

FDH:bh
Enclosure

cc: Edward M. Halley
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3543.012

PRELIMINARY ENGINEERING REPORT

PRODUCT RECOVERY SYSTEM DESIGN
HADNOT POINT FUEL FARM
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

CONTRACT NO. N62470-88-D-5825

NAVAL FACILITIES ENGINEERING COMMAND
NORFOLK, VIRGINIA

JANUARY 1990

PREPARED BY:

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SECTION 1 - INTRODUCTION

1.01 Site Description

Marine Corps Base (MCB) Camp Lejeune is located in Onslow County, North Carolina. The facility has a roughly triangular outline and covers approximately 170 square miles. Eleven miles of Atlantic shoreline form the eastern boundary of Camp Lejeune. The western and northeastern boundaries are U.S. Rt. 17 and State Rt. 24, respectively. The town of Jacksonville, North Carolina is the northern boundary of the base.

Construction of MCB Camp Lejeune began in 1941 at the Hadnot Point area, where major functions were centered. As the facility grew and developed, Hadnot Point became crowded with maintenance and industrial activities. The general Hadnot Point area is illustrated on Figure 1.

The Hadnot Point Industrial Area fuel farm (HPFF) is located approximately 1200 feet to the southeast of Holcomb Boulevard, adjacent to Ash Street as depicted on Figure 1. The tank farm was constructed around 1941 and consists of 15 fuel storage tanks placed on grade (Figure 2). There is one (1) 600,000 gallon tank (Tank 10), six (6) 12,000 gallon tanks (Tanks 2, 3, 7, 8, 11 and 12), and eight (8) 15,000 gallon tanks (Tanks 1, 4, 5, 6 9, 13, 14 and 15). These tanks, except the 600,000 gallon tank, are completely covered over. The existing tanks are the original tanks

that were installed in about 1941. The large 600,000 gallon tank contains diesel fuel, the other tanks contain leaded gasoline, unleaded gasoline and kerosene.

The area surrounding the tank farm is relatively flat, with the tank farm creating a mound that extends approximately 10 feet above the surrounding grade. The natural drainage has been modified by extensive areas of asphalt and concrete, and by ditches and storm sewers. The surface waters in nearest proximity to the tank farm are Wallace Creek and the New River. Wallace Creek drains into the New River and ultimately drains into the Atlantic Ocean.

1.02 History of Fuel Losses

A review of available information indicates that between 23,150 gallons and 33,150 gallons of fuel product have been lost from the tank farm. In addition, there have been three recorded episodes of fuel loss where the amounts lost were unknown. Inventory records do not reveal any known fuel losses from leakage of the tanks; most reported losses occurred through leaks in transfer lines or transfer line valves. A summary of fuel losses is given in Table 1; fuel loss locations are shown on Figure 3. Additional information about the history of fuel losses is summarized in the reports by Environmental Science and Engineering, Inc. (ESE), (1988).

Groundwater at the site is currently contaminated with free and dissolved petroleum product. Further information concerning contaminated groundwater at the site is included in the report

entitled "Contaminated Groundwater Study, MCB Camp LeJeune, N.C." (O'Brien & Gere, 1988).

1.03 Purpose and Scope

O'Brien & Gere Engineers was retained to design a product recovery system for the Hadnot Point Industrial Area fuel farm. Included in the scope of work were the hydrogeological investigations necessary to form the basis of design.

A site investigation was completed in December 1989 which included monitoring well installation, groundwater sampling and analysis, two aquifer pump tests, and product thickness measurements. This report summarizes the results of the investigation and presents a preliminary design for the product recovery system.

SECTION 2 - FIELD INVESTIGATIONS

2.01 General

The following investigations were conducted during the field study: monitoring well installation; grain size analysis; groundwater elevation and product thickness monitoring; aquifer analysis; groundwater sampling and analysis; and an engineering survey. These investigations were required to gather information to assist in the design of a recovery system that will efficiently remove the free product that exists at the HPFF. The field investigations are detailed below.

2.02 Well Installation

The locations of the groundwater monitoring wells were based upon consideration of the hydrogeologic conditions and the assessment of petroleum leakage in the study area. The placement of the wells, as illustrated in Figure 4, was selected to provide a more precise delineation of the extent of the product plume and to assist in evaluating the aquifer conditions during the pump test of the aquifer. Five (5) 2-inch PVC monitoring wells and two (2) 6-inch PVC test/recovery wells were installed at the HPFF. The 2-inch monitoring wells were constructed of Schedule 40 flush joint threaded PVC well screen (0.020 slot) and riser to a depth of 15 feet with 10 feet of screen. The 6-inch wells were constructed of Schedule 40 PVC with the screen constructed of continuous slot wire wrapped PVC (0.020 slot size). Recovery well

#1 was installed to a depth of 34 feet while recovery well #2 was installed to a depth of 33 feet below grade. Well construction diagrams and bore logs are included as Appendix A.

All wells were installed and constructed in accordance with NAVFAC guidelines and specifications, included in Appendix B. During the drilling program, boreholes were advanced using hollow stem auger. All wells were developed following installation to remove fine-grained materials that may have entered the well during construction. This was accomplished by a combination of the continuous low yield pumping; and air-lift pumping. Equipment used for well installation was decontaminated with a high pressure steam cleaner. Fluid generated from well development and equipment decontamination was discharged to the ground.

2.03 Grain Size Analysis

Grain size analysis was conducted on five (5) samples representative of the subsurface soils. Samples were initially obtained from split spoon samples; however, the split spoon did not provide enough of a sample. The augers were spun at the depth interval for 2-5 minutes to allow representative material to reach the surface and then a sediment sample was collected. The samples were obtained from each of the product recovery wells and from monitoring well #22. Each one kilogram sample of subsurface material was shipped to McCallum Testing Laboratories, Inc., located in Chesapeake, Virignia, for sieve analysis per ASTM D-422. The results of the grain size analysis are included as Appendix C,

and will be used to specify the well screen and sand pack for the proposed recovery well during the design of the recovery system.

2.04 Groundwater Elevation and Product Thickness Monitoring

Groundwater elevations and product thickness measurements were collected from all of the HPFF monitoring wells before any work was performed at the site and upon completion of well installation. An oil/water interface probe was used to measure product thickness and groundwater elevation to the nearest 0.01 ft. These measurements, as well as measurements conducted during 1988, are summarized on Tables 2 and 3. These measurements are used in Section 3 to determine the hydraulic gradient, direction of groundwater flow, and assess the extent of free-phased product currently at the HPFF.

2.05 Aquifer Analysis

A short term pump test was performed on each of the 6-inch wells. This test was conducted to estimate design flow rates, and determine the site specific aquifer transmissivity, hydraulic conductivity, and the pumping wells radius of influence.

The test was conducted over an 8 hour period under the supervision of a hydrogeologist from O'Brien & Gere. Each well was pumped with a submersible pump at a constant rate for the duration of the test. The pumping rate was measured every 15 minutes during the aquifer testing. Water levels in the pumping and neighboring monitoring wells were recorded for the duration of the aquifer

test. Following the pump test, the residual-drawdown (recovery) rate was measured until the aquifer had reached 95% recovery.

Pump test data was tabulated and analyzed using Theis type curves, the Cooper and Jacob modification of the Theis equation, and the pump test well recovery curves. Each evaluation of the data produced a slightly different value for the various aquifer parameters. This results in a range of values being presented for each paramter (Appendix D). Using the Theis nonequilibrium well equation, a radius of influence was calculated to extend 300-400 feet after 60 days of pumping. The boundary of the radius of influence for this calculation is defined at a 0.1 foot drawdown of the aquifer.

Evaluating the various coefficients that were determined using the three methods allows an estimate of aquifer characteristics for final design. For the purposes of final design the assumed aquifer characteristics are as follows:

Transmissivity:	=	500 gpd/ft
Well Yield	=	3 gpm
Saturated Thickness	=	19-22 ft
Radius of influence	=	300-400 ft

2.06 Groundwater Sampling and Analysis

Groundwater samples were collected from each of the newly installed monitoring wells on a single occasion. A total of seven (7) samples were analyzed for volatile organic compounds and lead in accordance with the procedures outlined in the sampling and analysis plan included as Appendix E. The results will be forwarded as a separate submission.

2.07 Engineering Survey

A topographic survey was conducted at the site to establish the horizontal location and elevation of above-grade features at the site. The topographic survey included the locations of catch basins, hydrants, power poles, manholes, roadways, buildings, tanks, fencing, monitoring wells, and any other indicators of subgrade utilities. Each monitoring well had the following points surveyed: top of PVC inner casing and ground elevation.

SECTION 3 - SITE ASSESSMENT

3.01 Site Geologic Conditions

The discussion of the site geology will be limited to the uppermost 35 feet of the unconsolidated soils, which is the maximum depth of the subsurface investigation for this project. The primary soils encountered during the investigation were fine and medium sands, mixed with lesser amounts of silt. Discontinuous, trace amounts of fine gravel were noted in the silty sand mixtures throughout the site. Clay stringers were found consistently throughout the silty sand mixtures with an occasional thin layer of clay (up to 2 feet thick). Minor amounts of naturally occurring organic materials, including organic silts and clays, peat, wood fragments, and plant debris were found in several of the borings, including MW-11, 13, 14 and 20, indicating the presence of a former coastal marshland. Up to 4 feet of miscellaneous fill material was found in borings that were adjacent to buildings and developed roads.

3.02 Site Groundwater Flow Patterns

Figure 4 shows the groundwater elevations measured in the twenty monitoring wells at the site in December 1989. Because the presence of a floating product layer tends to depress the water table, the groundwater elevations in the wells containing a product layer were corrected to give elevations that would be representative of the aquifer without the effects of the floating product layer. The calculation used to correct the groundwater

elevations takes into consideration the thickness of the product layer, the densities of the product and groundwater, and the soil properties. The correction factor is represented by the formula:

Ec = E + (0.73 x T), where

Ec = Corrected groundwater elevation:

E = Elevation of the groundwater under the influence of the product layer; and

T = Product thickness

Tables 2 and 3 have been complied summarizing the corrected and actual groundwater elevations and the product thickness data, respectively.

The average regional groundwater gradient within the HPIA has been interpreted to be approximately 0.20 ft/ft (ESE, 1988). Groundwater movement in the shallow aquifer in this area is generally toward the southwest, toward the New River (ESE, 1988). The groundwater elevational data collected at the HPFF indicates a very low hydraulic gradient of 0.001 ft/ft with groundwater flow in a westerly direction. Heavy surface objects (trains and tank farms) are known to have an effect on groundwater elevation and flow in water table aquifers. The groundwater flow is influenced by these factors at the HPFF as indicated by the low hydraulic gradient and the nonconformity of the groundwater contours.

3.03 Free-Phased Product

Free-phased product was detected floating on the groundwater in six of the monitoring wells installed at the site, including MW-2, 7, 12, 15, 16, and 18. The product thickness data is

summarized in Table 3. The thickness of the floating layer ranged from 0.24 feet in MW-15 to 15.34 feet in MW-16 on April 20, 1988. None of the other monitoring wells contained measurable product layers or visible sheens. The autumn 1989 results were similar to the April 1988 data with the exception that MW15 contained no product.

The product thickness data collected on April 20, 1988 is illustrated on Figure 5. It is apparent from the data that two separate product pools are present in the vicinity of the HPFF. One pool extends toward the northwest from the northwestern portion of the fuel farm, while the other pool exists at the southeastern edge of the fuel farm oriented on a northeast/southwest axis. The product pool northwest of the fuel farm is smaller in area, but thicker than the more widespread, thinner pool to the southeast.

Product samples were collected from MW-2, MW-7, MW-12, MW-16, and MW-18 on April 20, 1988. These samples were shipped to OBG Laboratories in Syracuse, NY for analysis using a Gas Chromatograph/Flame Ionization Detector (GC/FID) scan for petroleum hydrocarbon identification. The laboratory analyses identified the product as gasoline for all five of the monitoring wells sampled.

3.04 Soluble Constituents

The groundwater samples collected from the wells on April 20-21, 1988 were analyzed for petroleum hydrocarbons and solvents using the purge and trap/GC method. The analytical results are summarized in Table 4, and the laboratory reports are included in Appendix F. Figures 6 and 7 illustrate the iso-concentration

contours of the benzene and total hydrocarbon concentrations, respectively.

Table 4 and Figures 6 and 7 indicate that the groundwater analyses are consistent with the location of the product pools. The most significant concentrations of benzene and total hydrocarbons (THC) were found in the wells containing product and those adjacent to the product pool. The wells containing product had benzene concentrations of 4,700 parts per billion (ppb) to 29,000 ppb. Wells not containing product had concentrations of benzene ranging from 1 ppb in MW-9 to 19,000 ppb in MW-1. Total hydrocarbon concentrations ranged from 43,000 ppb to 300,000 ppb in wells containing product, and from 10 ppb to 97,000 ppb in wells not containing product. Other compounds found within the groundwater include toluene, ethyl benzene, xylenes, and methyl tertiary butyl ethylene (MTBE). The concentrations of the individual compounds at each well are detailed in Table 4.

The size, shape, and axial orientation of the benzene and total hydrocarbon plumes identified at the HPFF coincide closely with the product pools. It is apparent that the source of the benzene, toluene, and xylenes (BTX) and total hydrocarbons in the groundwater is the free-phased gasoline floating on the groundwater as indicated on Figure 5.

The limits of the benzene concentrations are defined in MW-9, MW-3, and MW-4 on the southeast side of the fuel farm, by MW-5 and MW-11 to the northwest and MW-13 to the northeast. These wells were below the EPA Maximum Contaminant Limit (MCL) of 5 ppb for benzene

in drinking water (40 CFR 141, 1987). The limits of benzene concentrations above the EPA MCL are undefined in those areas denoted by a dashed line on Figure 6.

The limits of the total hydrocarbon concentrations (i.e. 100 ppb) are defined by MW-9 to the south of the fuel farm, MW-4 on the east side, MW-13 to the north, and MW-5, 8, 11, and 14 on the west side of the fuel farm. The concentrations of total hydrocarbons above the 100 ppb level are undefined in those areas denoted by a dashed line on Figure 7.

The distribution of the other compounds found in the groundwater at the site is consistent with the benzene and total hydrocarbon concentrations, and iso-concentration contour maps would illustrate similar trends. Benzene, as well as toluene, ethylbenzene, and xylenes are components of gasoline, and indicate contamination by gasoline. MTBE is an additive to gasoline, and also indicates contamination by gasoline.

Only trace levels of chlorinated solvents not associated with petroleum hydrocarbons were detected within the groundwater, including 1 ppb of trichloroethylene (TCE) in MW-20, and 4 ppb of tetrachloroethylene (PERC) in MW-3. However, higher levels of these compounds as well as other chlorinated solvents were detected within the shallow groundwater in the other areas of the HPIA (ESE, 1988).

SECTION 4 - CONCEPTUAL DESIGN

4.01 Introduction

The recovery system for the HPFF must remove free product from onsite groundwater. A process flow diagram of the proposed system is presented on Figure 8. The system functions as follows:

- A water table depression pump creates a cone of depression at each recovery well. This cone of depression causes product to flow towards the recovery wells.

- A product recovery pump transfers product to a tank for temporary storage. A tank full sensor shuts the system down when tank pumping is required.

- Water from the water table depression pump is transferred to an oil water separator, where any free product is removed. Product from the oil water separator is pumped to the recovered product tank.

- Water from the oil water separator gravity flows to a surge tank. The surge tank is required to provide a continuous volume of water to downstream pumps. In addition, a free product sensor (and associated controls), mounted above the drawoff of the surge tank, prevents free product from being pumped downstream.

- Water from the surge tank is pumped through an air stripper, where dissolved product is removed. Water from the air stripper gravity flows to a storm sewer (Option I).

Alternatively, this water could gravity flow to a sanitary sewer (Option II, Figure 9)

4.02 Basis for Design and Preliminary Layout

4.02.01 Introduction

The following information was obtained from the site hydrogeolical investigations:

- Horizontal extent of groundwater contamination: Figure 5
- Recovery well radius of influence: 300 - 400 feet (after 60 days)
- Pumping rate (water table depression pumps): 3 gpm/well

For sake of discussion, it is convenient to divide the proposed design into two parts: the product recovery system, including recovery wells, recovery well equipment and controls, and piping; and the treatment system, including the oil water separator, tankage, the air stripper (if required), sensors and controls, effluent discharges, and power supply (for both the recovery and treatment systems).

Utility darawings for the HPFF area are included as Appendix G. The basis of design is tabulated in Appendix H. Catalog information for major system components is included in the Exhibit section of the report.

4.02.02 Product Recovery System

Recovery Wells: Based on the above information, it is proposed to locate four recovery wells as shown on Figure 10. The recovery system would utilize the two 6" wells (RW-1, RW-2) installed during the field investigation, plus two additional wells (RW-3, RW-4) which would require installation. The proposed locations of RW-3 and RW-4 would place a recovery well within 300 feet of product free monitoring wells which encircle the product plumes.

Recovery System: The proposed recovery system would utilize pneumatically driven water table depression pumps and product recovery pumps, as well as pneumatic controls (Exhibit 1). Power air and control air would be generated at the central treatment pad. The use of a pneumatic system eliminates the need for separate control panels at each recovery well, as electric pumps and controls require a separate above grade control panel at each recovery well. With the pneumatic system, all recovery well components would be below grade.

The water level in each recovery well is maintained at a set elevation by the use of a bubbler line sensor, which controls air flow to the water table depression pump.

Recovery System Piping: Recovery system piping will be located to avoid intersection with underground utilities where possible. It is proposed to run piping from RW-2 and RW-3 parallel to Ash Street (as shown on Figure 10), as trenching through the gas

station lot (building 1002) is not advised due to numerous underground petroleum product and electrical lines (See Figure G-1).

Piping (hoses) from each recovery well would be enclosed in a PVC conduit. Where possible, piping from individual wells would be manifolded to eliminate parallel runs. Each conduit would encase 3 air lines (water pump power, product pump power, and control air), a recovered product line, and a drawdown water line.

Recovery System Air Compressor: The proposed recovery system is pneumatically operated and controled. A duplex tank mounted air compressor with a weather cover is recommended to supply system air. (Exhibit 2)

4.02.03 Treatment System

Treatment Pad: The location of the proposed treatment pad is shown on Figure 10; system layouts are shown on Figures 11 and 12. The proposed location is:

- central to the recovery system;
- close to a storm sewer, a power supply, and a sanitary sewer;
- easily accessible from Ash Street (recovered product must be periodically pumped into a tank truck);
- is not likely to interfere with fuel farm operations; and
- is not over underground utilities.

The 20' by 45' pad would abut platform S-1007. The pad would be constructed of re-enforced concrete, and surrounded by a fence. All tanks and equipment handling product or drawdown water without

free phase removal would be within a containment curb (4000 gal capacity); the contained area would require periodic draining of rainwater. All controls and electrical equipment would be located on the pad, but outside the containment area.

Recovered Product Tank: A 3000 gallon above grade steel tank is proposed. A one foot high containment curb would adequately contain the contents of this tank.

Oil Water Separator: The proposed oil water separator is of slant rib coalescing design, and has a capacity of 30 gallons per minute (Exhibit 3). The oil water separator would be specified with an integral product pump, to transfer recovered product to the recovered product pump.

Surge Tank: A 550 gallon above grade steel tank is proposed. This tank has two functions:

- Flow of drawdown water from the water table depression pumps is likely to be unsteady, and subject to day to day hydrogeolical conditions. Intermittent operation of the drawdown pumps is also possible. A surge tank, therefore, is required to insure that a volume of water is available to the pump downstream of the oil water separator. The pump would be controlled by float switches (high level - on, low level - off) in the surge tank. A high-high float switch would also be provided to detect downstream hydraulic malfunction (pump failure, sanitary sewer backup, air stripper distributer plate fouling); the high-high float switch would deactivate the entire recovery system.

- To meet design criteria, free product must not enter the air stripper. A free product interface sensor would be mounted in the surge tank just above the tank effluent pipe. Should free product bypass the oil water separator, the free product sensor would detect it, deactivate the downstream pump, and activate a visual alarm (flag) on the control panel. The downstream pump would be reactivated by the high level float switch if water flowed into the tank, and moved the oil water interface above the level of the free product detector. The high - high float switch would shut the entire recovery system down if the surge tank became flooded with product (unlikely). The surge tank would be provided with a drain, for pump out of free product (if required).

Air Stripper Booster Pump: The proposed pump would be explosion proof and have a capacity of 20 gpm at a discharge head of 35 feet.

Air Stripper: An air stripper is proposed to remove volatile organic compounds from recovery system drawdown water. For design of the air stripper, assumptions must be made concerning drawdown water quality and required effluent water quality:

Drawdown Water Quality: Influent water quality must be based on site groundwater quality, which is summarized on Tables 3 and 4. Product has been detected in monitoring wells 2, 7, 12, 15, 16, and 18; water quality from these wells is summarized on Table 5, and is likely representative of future water quality in the recovery wells. In general, benzene concentrations in each of these wells does not differ greatly,

however, toluene, ethylbenzene, and xylene concentrations appear to be anomalously high in MW 2. Therefore, for a design basis, drawdown water quality will be taken to be the mean of the data from these six wells, plus 1 standard deviation.

Effluent Design Criteria: The USEPA has published water quality standards for the protection of aquatic life (USEPA, 1986). These standards are summarized on Table 6. As a conservative estimate, the most stringent standards (Marine Chronic Lowest Observed Effect Level) will be utilized as a design basis for effluent water quality.

The proposed air stripper is of packed bed tower design (Exhibit 4). To meet the effluent design criteria, the air stripper would require a 25 foot packed bed and a 1 horsepower blower (preliminary estimate - to be confirmed during design).

According to Gerry Clayton of the North Carolina Environmental Management Commission (EMC) (Air Quality), air strippers for ground water remediation must be registered with the regional EMC office. The mass emission rate must be specified. At a drawdown water flow rate of 12 gallons per minute, the following masses of volatile organic compounds could be expected to be discharged to the atmosphere:

Compound	Mass Rate (Pounds/day)
Benzene	4.3
Toluene	10.3
Ethylbenzene	1.0
Xylene	4.5

Drawdown Water Effluent (Option I - Discharge to Storm Sewer): Under Option I, effluent for the air stripper would be gravity piped to a 24" RCP storm sewer adjacent to the treatment pad. The storm sewer pipe would be cored and the connection would be grouted.

The effluent discharge described by Option I would require a NPDES permit; the permit would require monitoring. The cost of this monitoring (assuming monthly), and associated reports, is estimated at $2,400/year. Don Safer (EMC Water Quality) was contacted concerning NPDES permits for groundwater remediation operations in North Carolina. He stated that prior to issuance of permit, an engineering report which evaluated alternatives to direct discharge was to be prepared and submitted. He also stated that for discharges monitored before a storm sewer, treatment to chronic standards would be required; discharges monitored at a storm sewer outfall would require modification of the existing permit, and possibly only treatment to acute standards.

Drawdown Water Effluent (Option II - Discharge to Sanitary Sewer): Option II would discharge drawdown water effluent to an sanitary sewer manhole located across Ash Street (Figure G - 4). The elevation of the air stripper discharge should allow for gravity flow to the manhole; however, a discharge pump could be incorporated into the design if required.

Significant dilution of the drawdown water could be expected by discharge to the sanitary sewer. The base waste water treatment plant has a capacity of approximately 8 million gallons per day

(MGD) and is operating at approximately 5.5 MGD. Assuming a drawdown flow of 12 gpm, air stripped to the design criteria, the following would be the incremental increase in the base waste water treatment plant effluent assuming no biodegradability:

Dilution of Drawdown Water

Compound	Conc (ppb)	Incremental Increase (ppb)	Criteria (ppb)
Benzene	700	2	700
Toluene	5000	15	5000
Ethylbenzene	430	1	430

Given these dilutions, permitting difficulties would not be expected with Option II.

Power Supply: As a preliminary estimate, the recovery and treatment systems will require 30 KVA power. It was determined that the fuel farm pump house distribution system does not have excess capacity. This determination was verified by Mr. Harold Smith, planner/estimator, MCB Public Utilities. Mr. Smith recommended the installation of transformers on a power pole adjacent to the proposed treatment pad (Figure G-6).

The recovery and treatment systems will be designed under the assumption that LANTNAVFACENGCOM will have transformers installed. A better estimate of power requirements will be available after completion of design; these power requirements (for transformer specification) will be forwarded by letter to LANTNAVFACENGCOM.

4.03 Cost Estimate and Recommendations

A cost estimate for Options I and II is presented on Tables 7 and 8. Option I is estimated to cost approximately $278,000;

Option II is estimated to cost approximately $288,000. Option I also has associated with it annual operating costs (monitoring) that are approximately $2400 greater than Option II. Permitting for Option I is likely to be more difficult that for Option II.

It is recommended that design of Option I proceed as outlined above. Option I satisfies the requirements of the LANTNAVFACENGCOM Scope of Work. The design can be later modified to incorporate discharge to the sanitary sewer if requested by LANTNAVFACENGCOM.

Prepared By:

John D. Conway - Hydrogeologist
Frank D. Hale - Managing Engineer
James M. O'Loughlin - Project Engineer

REFERENCES

Code of Federal Regulations, Chapter 40, Part 141, Subpart G - National Revised Primary Drinking Water Regulations: Maximum Contaminant Levels, Section 141.61. July, 1987.

Conservation of Clean Air and Water - Europe (CONCAWE), Report No. 3, 1979. Protection of Groundwater from Oil Pollution.

Environmental Science and Engineering, Inc., May 1988. Confirmation Study to Determine Existence and Possible Migration of Specific Chemicals In Situ.

Environmental Science and Engineering, Inc., May 1988. Feasibility Study for HADNOT Point Industrial Area, Camp LeJeune, North Carolina.

North Carolina Department of Natural Resources and Community Development, 1980. Groundwater Evaluation in the Central Coastal Plain of North Carolina.

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

USEPA, May, 1986. Quality Criteria For Water

Water and Air Research, Inc., April 1983. Initial Assessment Study of Marine Corps Base - Camp LeJeune, North Carolina.

TABLE 1

HISTORY OF FUEL LOSSES
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

Location*	Date	Fuel Type	Amount of Loss	Notes
1	4/83	diesel	not noticeable in inventory	line leak (pinhole)
2	(1983)	diesel	unknown	surface seepage
3	3/82	unleaded	unknown	line leak (broken, repaired on same day)
4	1/86	unleaded	1,038 gallons	- - -
5	3/85	unleaded	1,618 gallons	valve leaks
6	(1979)	diesel, unleaded, possibly regular	20,000 - 30,000 gallons	line leak
-	8/87	unleaded	47 gallons	noticed in inventory
-	9/87	unleaded	447 gallons	noticed in inventory

* Locations correspond to Figure 3.

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TABLE 2
WELL SPECIFICATIONS AND GROUNDWATER ELEVATION DATA
HADNOT POINT FUEL FARM
CAMP LEJEUNE, NC

Well Number	Ground Elevation (ft.)	Casing Elevation (ft.)	Well Depth (ft.)	Corrected Groundwater Elevations* 3/15/88	4/20/88	11/6/89	12/15/89
MW-1	28.3	30.00	17.0	19.38	19.41	19.64	19.73
MW-2	30.0	31.68	17.0	18.41	18.53	18.50	18.60
MW-3	29.0	29.23	15.0	19.72	19.83	19.92	19.91
MW-4	29.8	31.61	15.0	21.69	21.73	20.91	22.44
MW-5	28.5	28.54	15.0	21.45	21.25	21.39	21.49
MW-6	27.8	29.95	15.0	19.26	19.20	19.79	20.20
MW-7	28.4	28.51	15.0	N/A	20.54	--	21.32
MW-8	27.8	27.80	15.0	20.12	20.18	--	21.79
MW-9	28.8	30.73	15.0	18.78	18.75	19.18	19.42
MW-10	28.1	28.01	15.0	18.26	18.42	18.86	19.23
MW-11	26.5	28.52	25.0	19.49	18.63	19.82	19.76
MW-12	26.9	28.62	25.0	20.47	19.36	19.28	19.15
MW-13	28.8	30.56	25.0	20.94	20.87	22.32	21.01
MW-14	27.7	27.87	25.0	19.72	20.05	19.37	19.22
MW-15	28.3	30.13	25.0	20.22	19.71	20.78	21.74
MW-16	28.4	30.33	25.0	18.67	18.74	17.71	17.65
MW-17	29.5	31.70	25.0	19.25	18.97	19.72	19.21
MW-18	29.9	31.80	25.0	18.68	18.86	18.65	18.74
MW-19	29.4	31.99	25.0	18.72	18.45	18.49	19.01
MW-20	26.8	31.01	25.0	20.84	19.65	21.35	21.34
MW-21	26.70	26.54	15.0			--	21.56
MW-22	27.49	27.02	15.0			--	20.42
MW-23	27.28	27.18	15.0			--	20.21
RW #1	28.59	30.65	34.0			--	18.48
RW #2	29.03	30.53	33.0			--	17.66

* Corrected groundwater elevations =
groundwater elevation + (0.73 x product thickness)

N/A = Data not available.

TABLE 3
PRODUCT THICKNESS DATA
HADNOT POINT FUEL FARM
CAMP LEJEUNE, NC

Well Number	3/15/88	4/20/88	11/6/89	12/15/89
MW-1	--	--	--	--
MW-2	2.97	3.17	3.34	3.08
MW-3	--	--	--	--
MW-4	--	--	--	--
MW-5	--	--	--	--
MW-6	--	--	--	--
MW-7	N/A	0.35	N/A	--
MW-8	--	--	--	--
MW-9	--	--	--	--
MW-10	--	--	--	--
MW-11	--	--	--	--
MW-12	4.33	9.81	8.70	6.89
MW-13	--	--	--	--
MW-14	--	--	--	--
MW-15	0.86	0.24	--	--
MW-16	14.85	15.34	15.07	14.91
MW-17	--	--	--	--
MW-18	4.59	5.10	5.29	4.77
MW-19	--	--	--	--
MW-20	--	--	--	--

N/A = Data not available.

-- = No product layer detected.

DOC.NO.: CLEJ-00382-3.05-01/01/90

Table 4
Ground Water Sample Analysis
Hadnot Point Fuel Farm
Camp Lejeune, NC

Well No.	Date	BEN (ppb)	TOL (ppb)	EBEN (ppb)	XYL (ppb)	TCE (ppb)	PERC (ppb)	MTBE (ppb)	THC (ppb)
MW-1	4/20/88	19000	36000	3200	21000	(1000	(1000	(10000	97000
MW-2	4/21/88	29000	110000	11000	48000	(1000	(1000	(10000	300000
MW-3	4/20/88	(1	2	(1	4	(1	4	(10	480
MW-4	4/20/88	(1	(1	(1	2	(1	(1	(10	16
MW-5	4/20/88	(1	1	(1	2	(1	(1	(10	(10
MW-6	4/20/88	600	1700	1600	7100	(100	(100	(1000	13000
MW-7	4/21/88	28000	26000	2800	12000	(1000	(1000	(10000	68000
MW-8	4/20/88	19	1	(1	(1	(1	(1	(10	26
MW-9	4/20/88	(1	(1	2	8	(1	(1	(10	92
MW-10	4/20/88	51	1	9	14	(1	(1	(10	170
MW-11	4/20/88	1	1	(1	1	(1	(1	(10	(10
MW-12	4/21/88	19000	17000	1500	8400	(1000	(1000	(10000	50000
MW-13	4/20/88	2	2	2	8	(1	(1	(10	23
MW-14	4/20/88	6	(1	(1	2	(1	(1	(10	11
MW-15	4/21/88	4700	18000	2400	13000	(1000	(1000	(10000	43000
MW-16	4/21/88	28000	28000	1900	12000	(1000	(1000	(10000	79000
MW-17	4/21/88	11000	13000	2500	9100	(100	(100	2800	42000
MW-18	4/21/88	24000	42000	1900	12000	(1000	(1000	(10000	96000
MW-19	4/21/88	21	150	53	130	(1	(1	(10	640
MW-20	4/21/88	60	160	79	96	1	(1	(10	870

LEGEND: BEN - Benzene
TOL - Toluene
EBEN - Ethylbenzene
XYL - Xylenes
TCE - Trichloroethene
PERC - Tetrachloroethene
MTBE - MTBE
THC - Total Hydrocarbons

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Table 4
(continued)
Product Sample Analsis
Hadnot Point Fuel Farm
Camp Lejeune, NC

Well Number	Product Identification
MW-2	Gasoline
MW-7	Gasoline
MW-12	Gasoline
MW-16	Gasoline
MW-18	Gasoline

TABLE 5
DRAWDOWN WATER QUALITY[1]

Well	Benzene	Toluene	Ethylbenzene	Xylene
MW-2	29,000	110,000	11,000	48,000
MW-7	28,000	26,000	2,800	12,000
MW-12	19,000	17,000	1,500	8,400
MW-15	4,700	18,000	2,400	13,000
MW-16	28,000	28,000	1,900	12,000
MW-18	24,000	42,000	1,900	12,000
Mean	22,100	40,200	3,600	17,600
Standard Deviation	8,500	32,300	3,300	13,760
Mean + 1 S.D.	30,600	72,500	6,900	31,300

[1] All concentrations in ppb.

TABLE 6
EFFLUENT WATER QUALITY CRITERIA[1]

Compound	Acute LOEL[2]	Chronic LOEL[2]	Acute LOEL[2]	Chronic LOEL[2]	Drawdown Water Quality[3]
Benzene	5,300	--	5,100	700	30,600
Toluene	17,500	--	6,300	5,000	72,500
Ethylbenzene	32,000	--	430	--	6,900
Xylene	--	--	--	--	31,300

[1] All concentrations in ppb. From Quality Criteria For Water. USEPA/440/5-86/001, 1 May 1986

[2] Lowest Observed Effect Level (LOEL)

[3] See Table 5.

DOC. NO.: CLET-00385-3.05-01/01/90

TABLE 7
CONSTRUCTION COST ESTIMATE
OPTION I

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL COST
RECOVERY SYSTEM				
Recovery System and Controls	1	EA	$40,000	$40,000
Manholes	4	EA	$500	$2,000
PVC Casing Pipe	1400	LF	$10	$14,000
Trenching and Backfill	1400	LF	$12	$16,800
Pavement Restoration	400	LF	$10	$4,000
Recovery System Hoses	1400	LF	$20	$28,000
TREATMENT SYSTEM				
Treatment Pad and Curb	900	SF	$40	$36,000
Fencing and Gates	130	LF	$15	$1,950
Oil Water Separator	1	EA	$12,000	$12,000
Recovered Product Tank	1	EA	$8,000	$8,000
Surge Tank	1	EA	$3,000	$3,000
Booster Pump	1	EA	$1,200	$1,200
Air Stripper	1	EA	$25,000	$25,000
Compressor	1	EA	$15,000	$15,000
Electrical	1	LS	$20,000	$20,000
Piping and Valves	1	LS	$5,000	$5,000
SUBTOTAL				$231,950
CONSTRUCTION CONTINGENCY				$46,390
TOTAL ESTIMATED CONSTRUCTION COST				$278,340

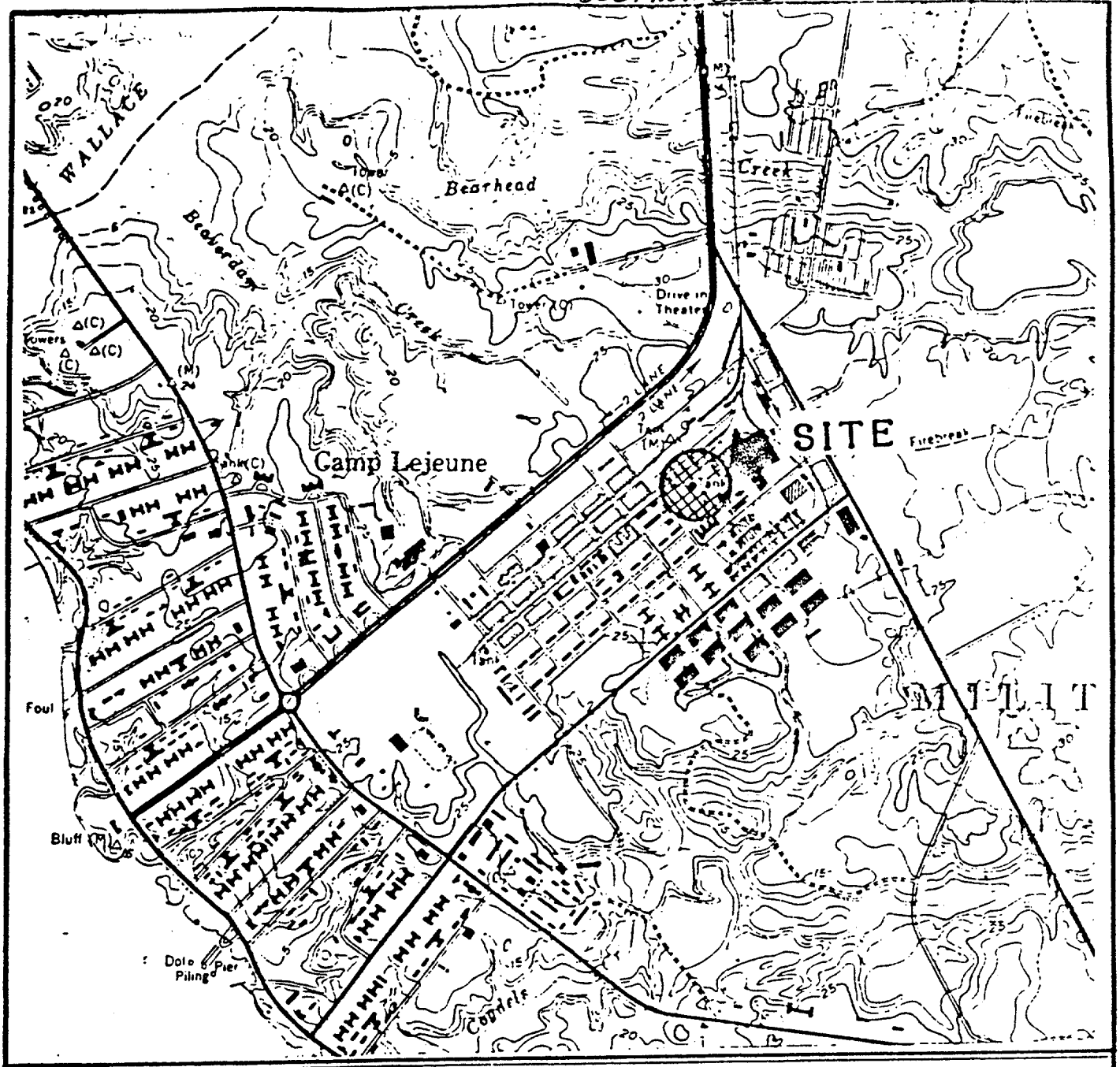
DOC. NO.: CLEJ-00382-3.05-01/01/90

TABLE 8
CONSTRUCTION COST ESTIMATE
OPTION II

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL COST
RECOVERY SYSTEM				
Recovery System and Controls	1	EA	$40,000	$40,000
Manholes	4	EA	$500	$2,000
PVC Casing Pipe	1400	LF	$10	$14,000
Trenching and Backfill	1400	LF	$12	$16,800
Pavement Restoration	400	LF	$10	$4,000
Recovery System Hoses	1400	LF	$20	$28,000
TREATMENT SYSTEM				
Treatment Pad and Curb	900	SF	$40	$36,000
Fencing and Gates	130	LF	$15	$1,950
Oil Water Separator	1	EA	$12,000	$12,000
Recovered Product Tank	1	EA	$8,000	$8,000
Surge Tank	1	EA	$3,000	$3,000
Booster Pump	1	EA	$1,200	$1,200
Air Stripper	1	EA	$25,000	$25,000
Compressor	1	EA	$15,000	$15,000
Electrical	1	LS	$20,000	$20,000
Piping and Valves	1	LS	$5,000	$5,000
Trenching and Backfill	300	LF	$12	$3,600
Pavement Restoration	300	LF	$10	$3,000
Drain Line	300	LF	$5	$1,500
SUBTOTAL				$240,050
CONSTRUCTION CONTINGENCY				$48,010
TOTAL ESTIMATED CONSTRUCTION COST				$288,060

DOC. NO: CLEJ-00382-3.05-01/01/90

DOC. NO.: CLEJ-00382-3.05-01/01/90



N

MN

5 1/2°

SITE LOCATION MAP

ADAPTED FROM USGS. 7.5 MIN. CAMP LEJEUNE, NC. QUADRANGLE
(1952 PHOTOREVISED 1971)

SCALE 1" = 2000'
CONTOUR INTERVAL 5'

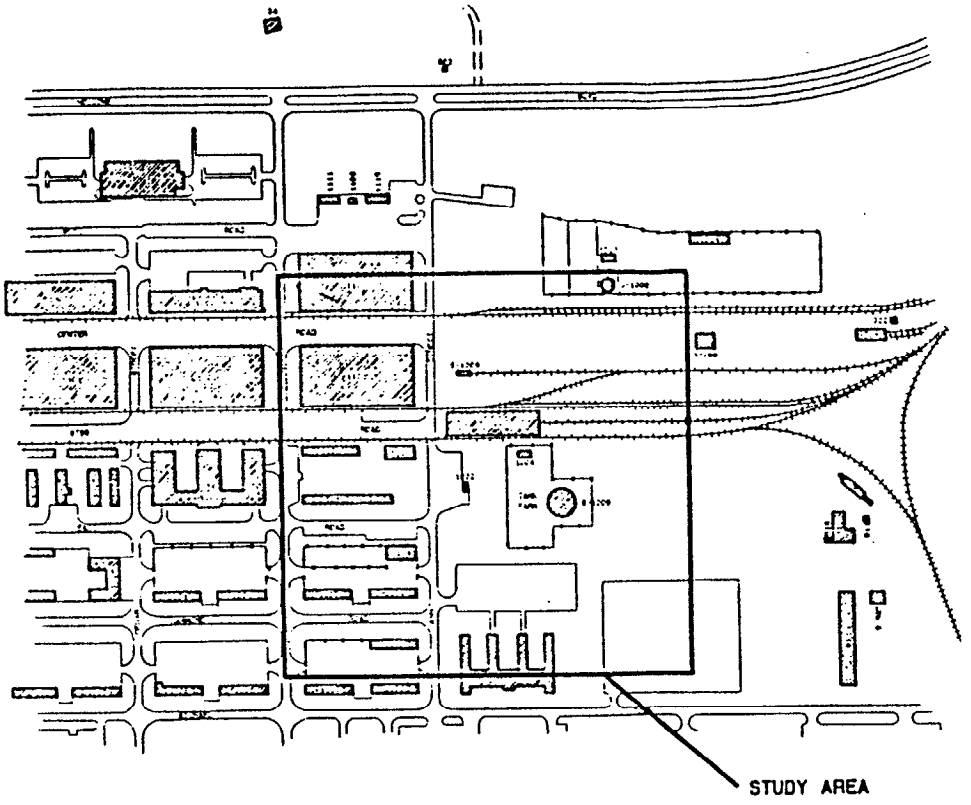
2000 0 2000 4000

1" = 200'

FIGURE 2

US NAVY
HADNOT POINT FUEL FARM
CAMP LEJEUNE, N.C.

HADNOT POINT
INDUSTRIAL AREA



LEGEND

FENCE

BUILDINGS

RAILROAD TRACKS

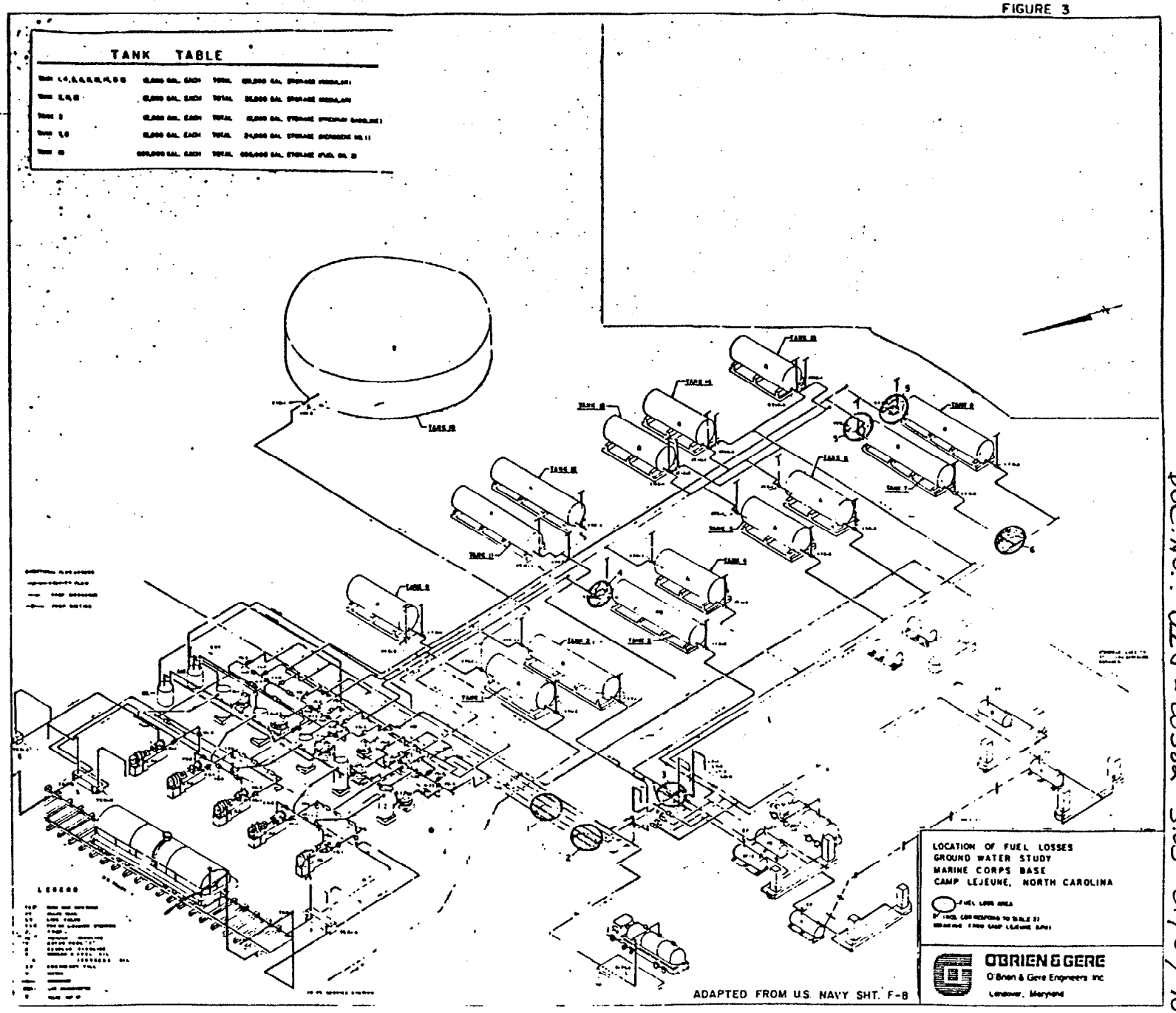
0 400 800

HORIZ. SCALE IN FEET

O'BRIEN & GERE
ENGINEERS, INC.
Syracuse New York

DOC. NO.: CLEJ-00382-3.05-01/01/90

FIGURE 3



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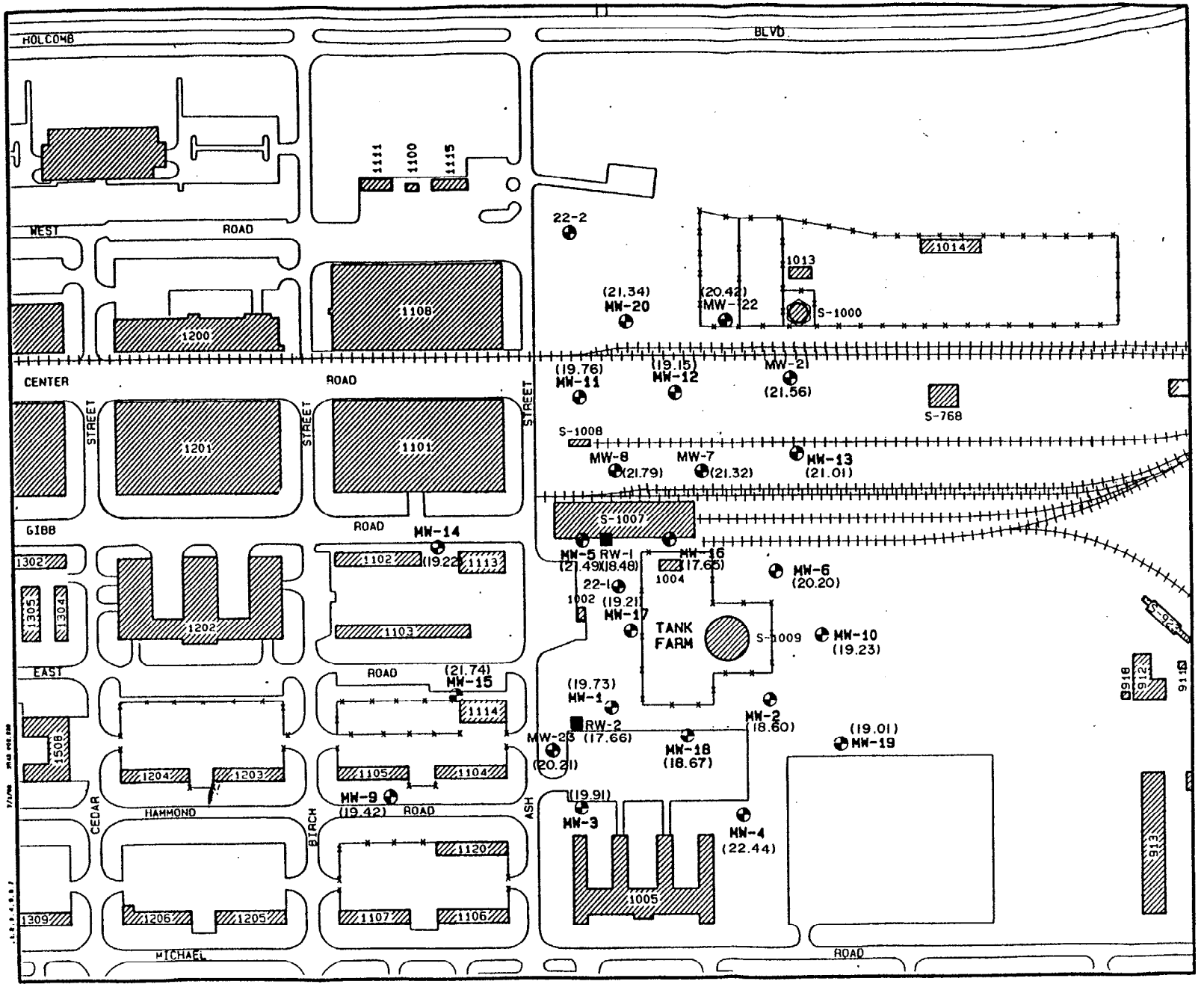


FIGURE 4

US NAVY
HADNOT POINT FUEL FARM
CAMP LEJEUNE, N.C.

SITE PLAN

LEGEND

- MONITOR WELL
- (21.34) GROUND WATER ELEVATION IN FEET ABOVE MSL
- 6" WELL INSTALLED 12/89

CORRECTED GROUND WATER ELEVATIONS 12/15/89

0 200 400

HORIZ. SCALE IN FEET

O'BRIEN & GERE ENGINEERS, INC.

DOC. NO.: CLEJ-00382-3.05-01/01/90

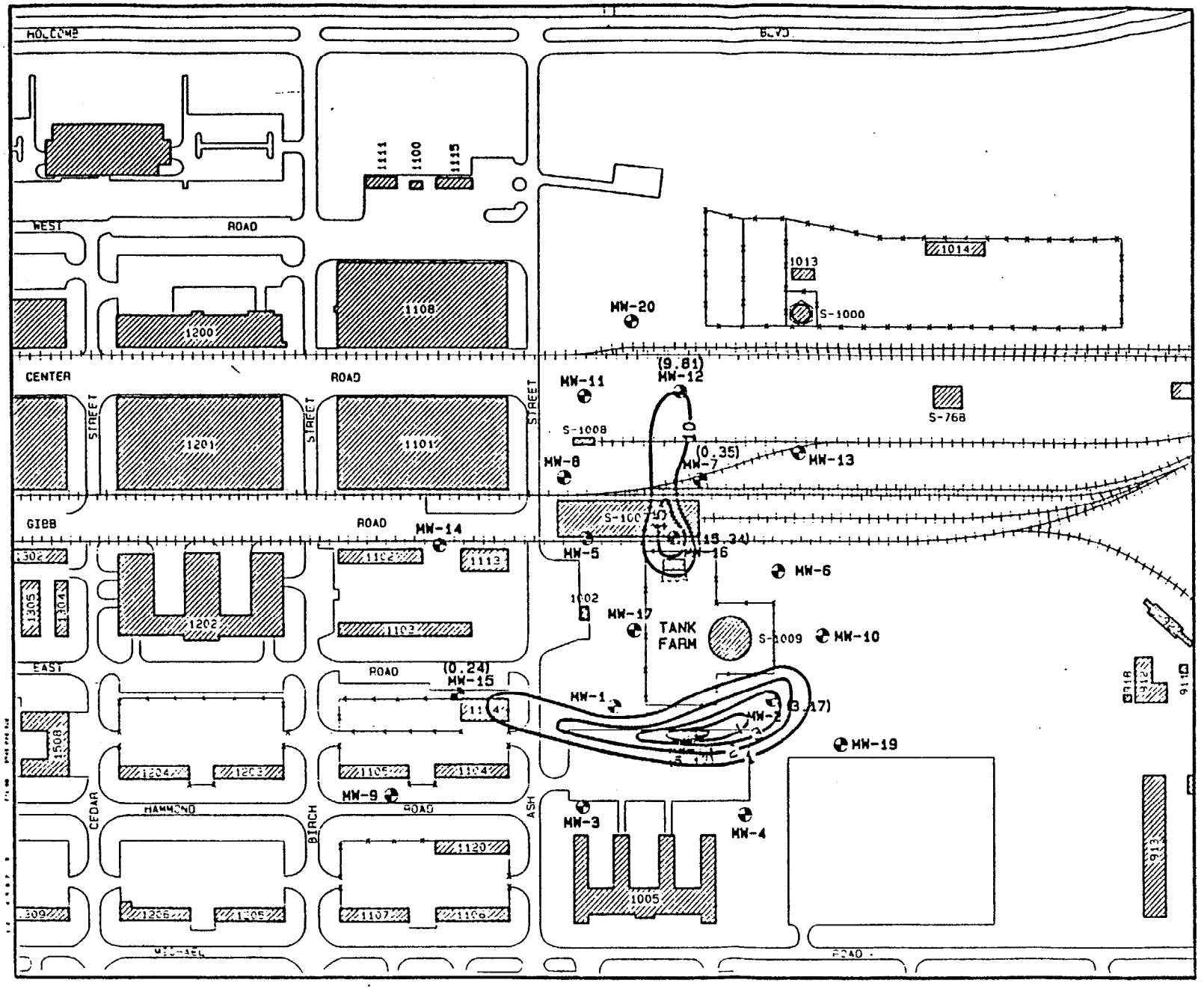


FIGURE 5

US NAVY
HADNOT POINT FUEL FARM
CAMP LEJEUNE, N.C.

PRODUCT THICKNESS
4/20/88

LEGEND

MONITOR WELL

PRODUCT THICKNESS CONTOUR (FEET)

0 200 400

HORIZ. SCALE IN FEET

O'BRIEN & GERE ENGINEERS, INC.
Syracuse, New York

DOC. NO.: CLEJ-00382-3.05-01/01/90

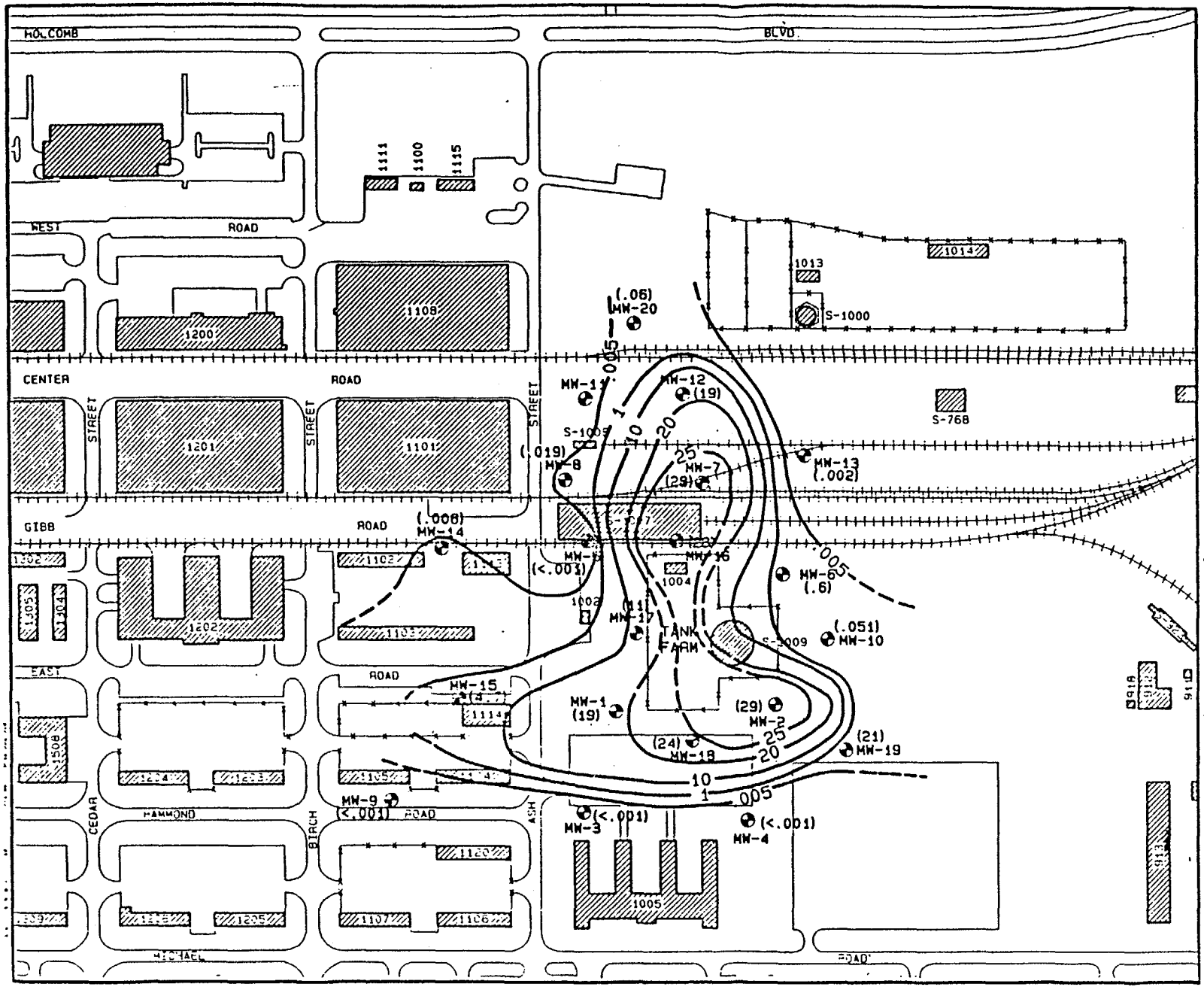


FIGURE 6

US NAVY
HADNOT POINT FUEL FARM
CAMP LEJEUNE, N.C.

BENZENE CONCENTRATIONS
4/20/88 TO 4/21/88

LEGEND

- MONITOR WELL
- BENZENE CONCENTRATION CONTOUR (PPM)

0 200 400

HORIZ. SCALE IN FEET

O'BRIEN & GERE ENGINEERS, INC
Syracuse, New York

DOC. NO.: CLET-00382-3.05-01/01/90

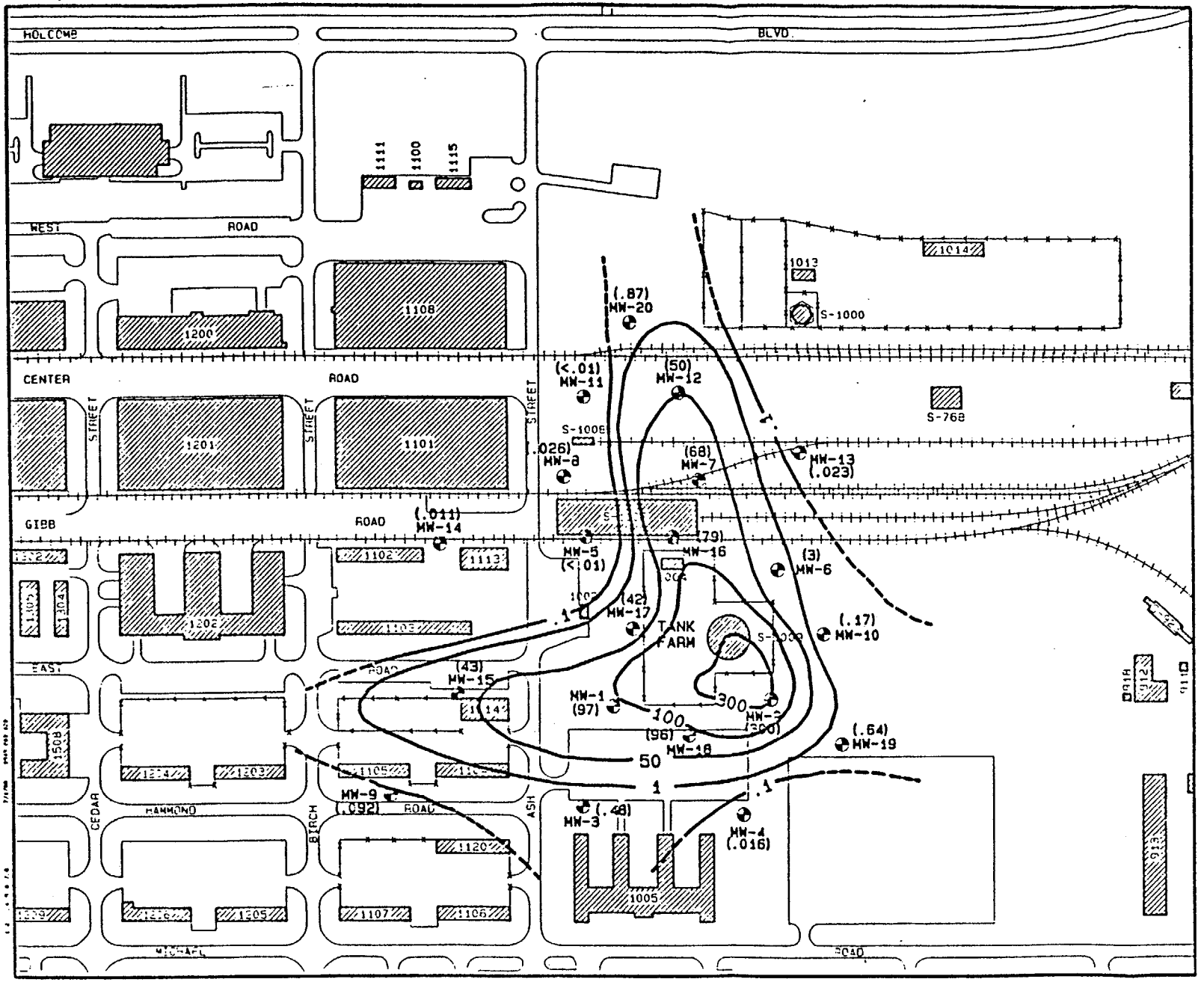


FIGURE 7

US NAVY
HADNOT POINT FUEL FARM
CAMP LEJEUNE, N.C.

TOTAL HYDROCARBONS
4/20/88 TO 4/21/88

LEGEND

MONITOR WELL

TOTAL HYDROCARBON CONTOUR (PPM)

0 200 400

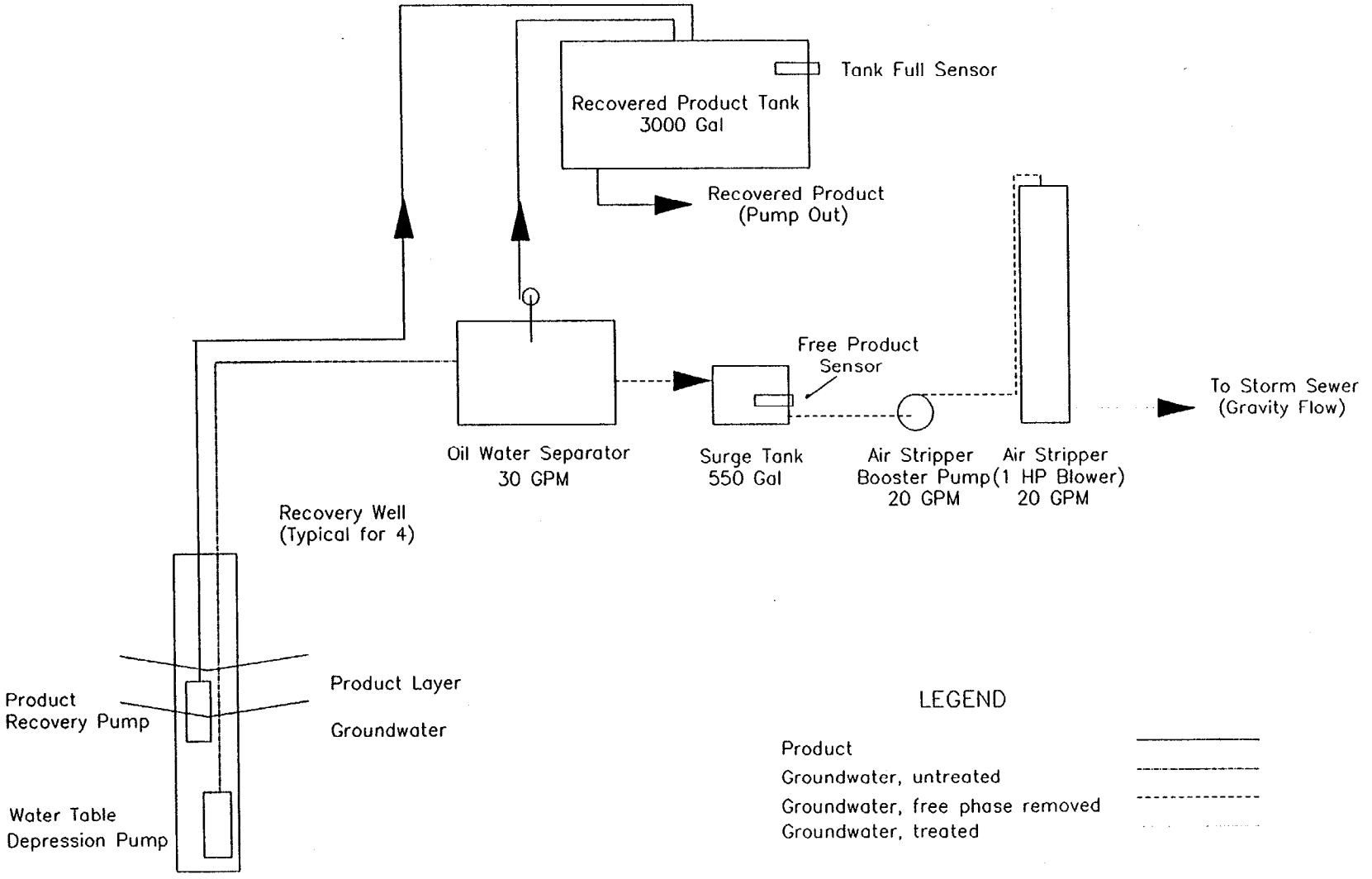
HORIZ. SCALE IN FEET

O'BRIEN & GERE ENGINEERS, INC

Syracuse New York

DOC. NO.: CLET-06382-3.05-01/01/90

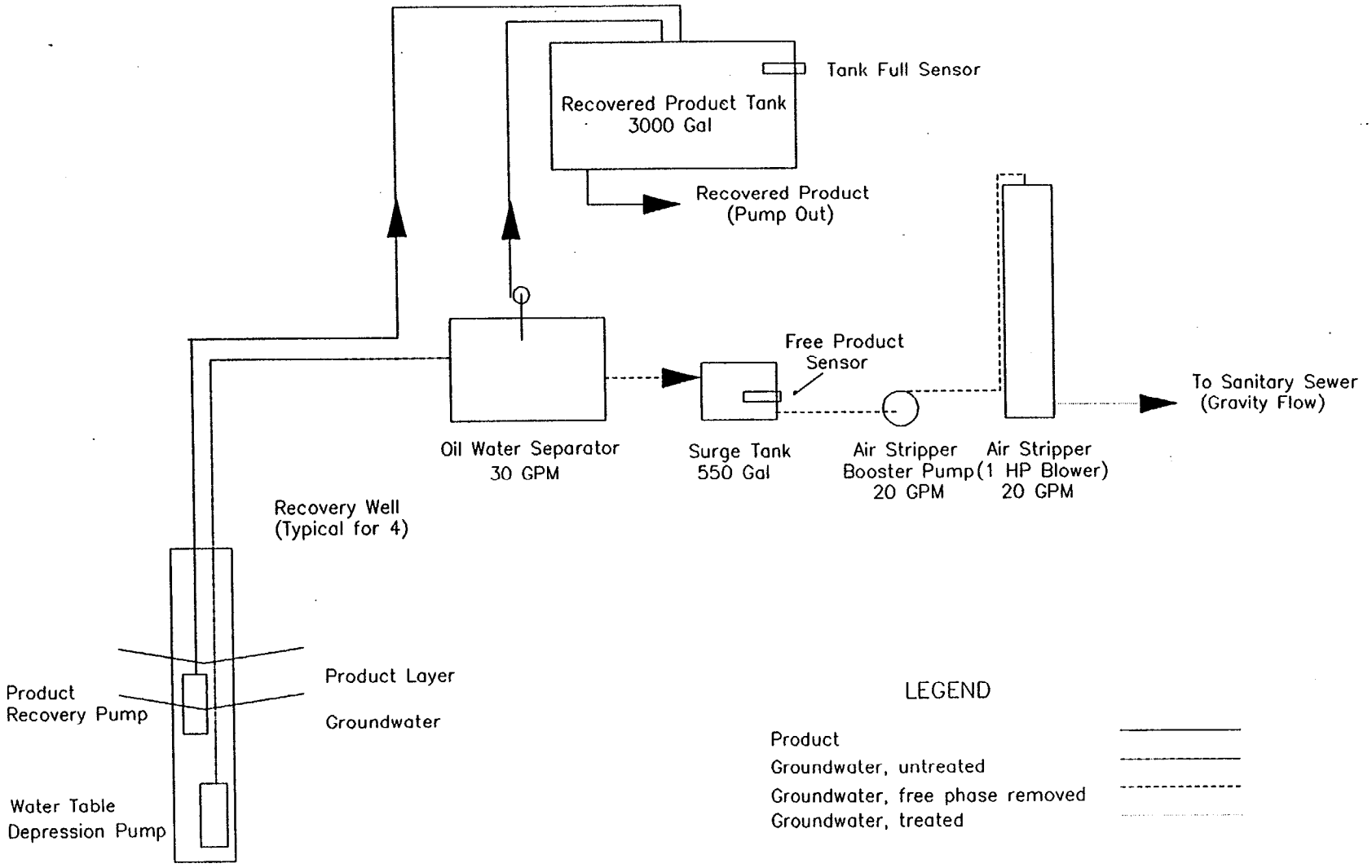
FIGURE 8
PROCESS FLOW SCHEMATIC – OPTION I



O'BRIEN & GERE ENGINEERS, INC.

DOC. NO.: CLET-00382-3.05-01/01/90

FIGURE 9
PROCESS FLOW SCHEMATIC – OPTION II



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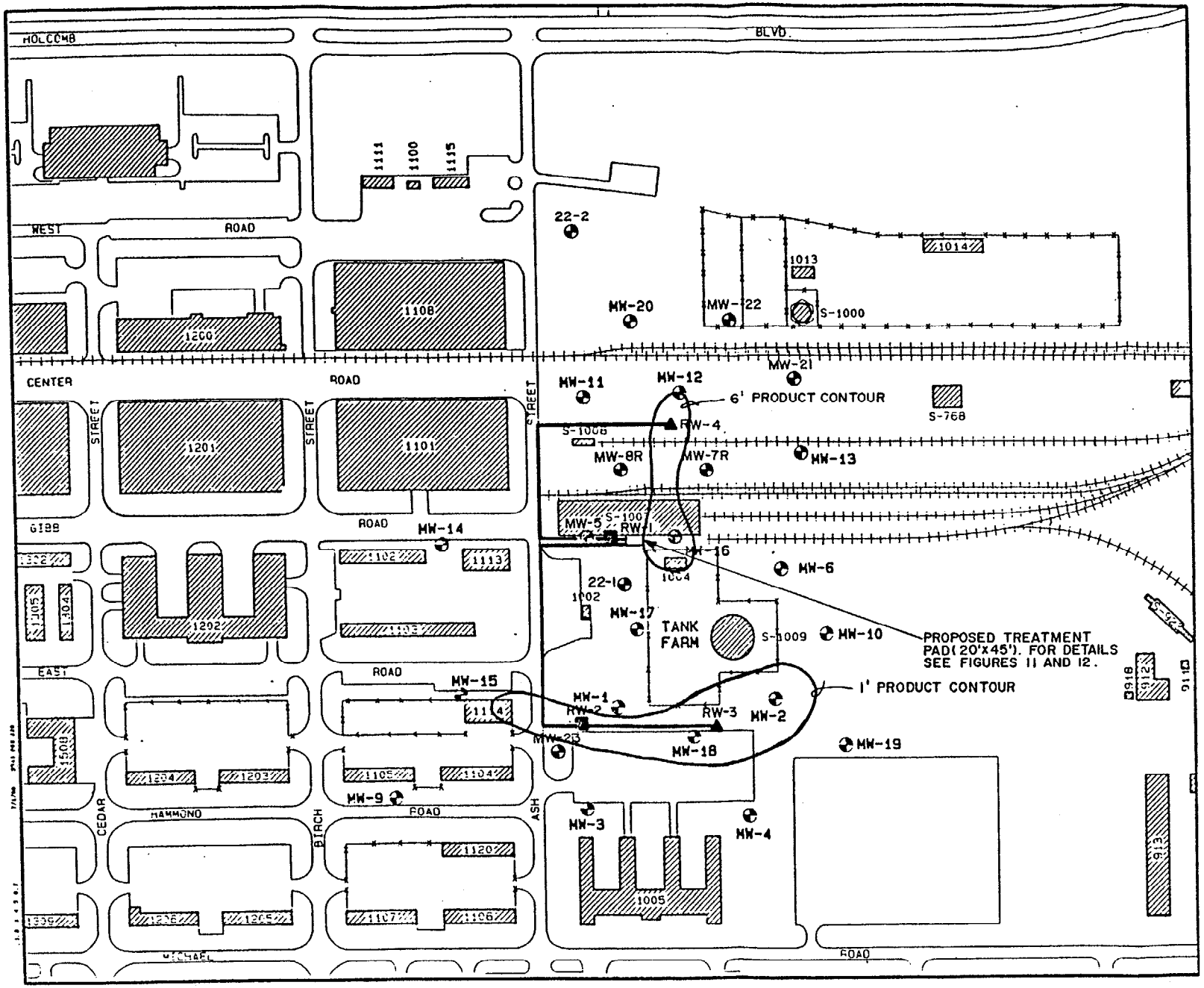


FIGURE 10

US NAVY
HADNOT POINT FUEL FARM
CAMP LEJEUNE, N.C.

PROPOSED RECOVERY SYSTEM LAYOUT

LEGEND

- MONITOR WELL
- 6" WELL, INSTALLED 12/89, TO BE UTILIZED AS A RECOVERY WELL.
- PROPOSED 6" RECOVERY WELL.
- RECOVERY SYSTEM PIPING.

0 200 400

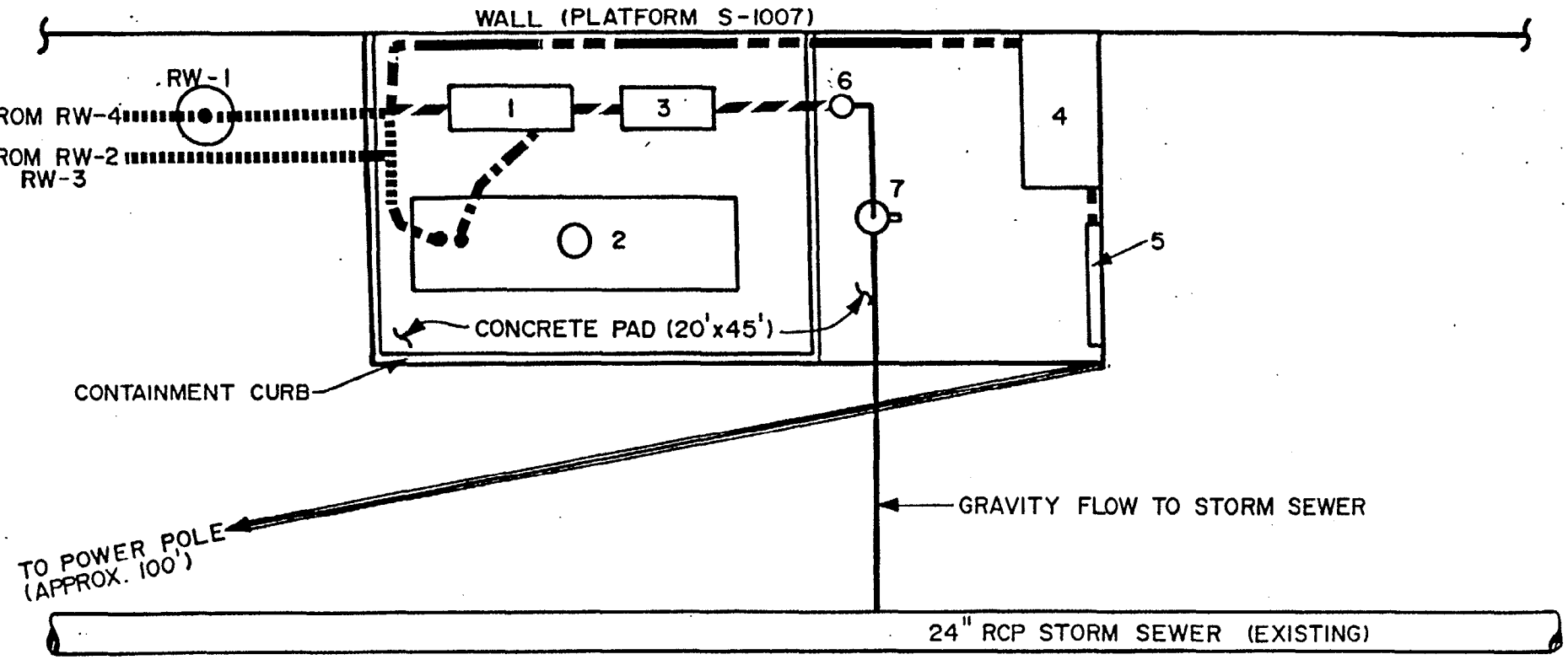
HORIZ. SCALE IN FEET

O'BRIEN & GERE ENGINEERS, INC.

DOC. NO.: CLET-00382-3.05- 01/01/90

063397

PROPOSED TREATMENT SYSTEM LAYOUT
OPTION I



LEGEND:

- CASING PIPE
- CONTROL AND POWER AIR LINES (CASING PIPE NOT SHOWN).
- PRODUCT LINES
- WATER LINES
- ELECTRICAL CONDUIT (BURIED)

MAJOR EQUIPMENT

1. OIL/WATER SEPARATOR
2. RECOVERED PRODUCT TANK
3. SURGE TANK
4. DUPLEX AIR COMPRESSOR
5. CONTROL BOARD
6. AIR STRIPPER BOOSTER PUMP
7. AIR STRIPPER

TANK FARM

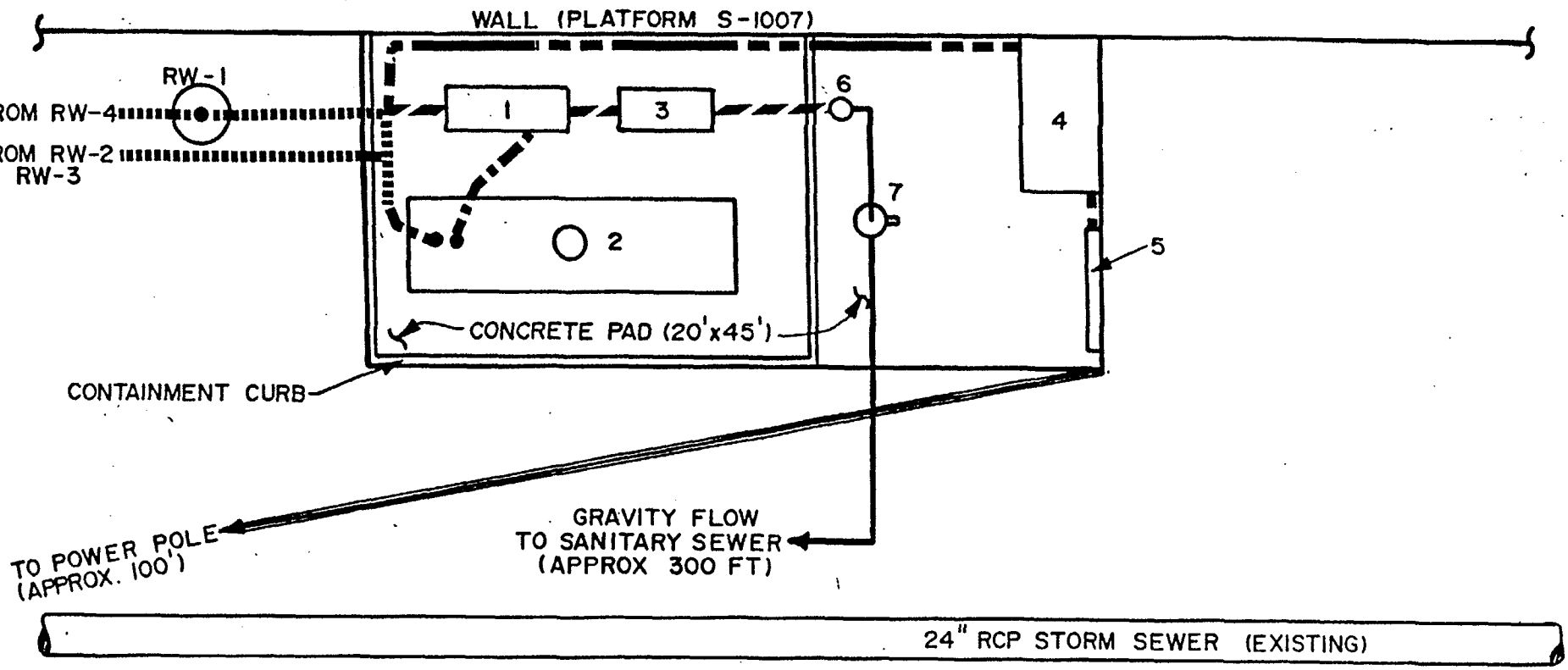
APPROX SCALE: 1" = 10'

DOC. NO.: CLET-00382-3.05-01/01/90
FIGURE 11

O'BRIEN & GERE ENGINEERS INC.

063397

PROPOSED TREATMENT SYSTEM LAYOUT
OPTION II



LEGEND:

- CASING PIPE
- CONTROL AND POWER AIR LINES (CASING PIPE NOT SHOWN).
- PRODUCT LINES
- WATER LINES
- ELECTRICAL CONDUIT (BURIED)

MAJOR EQUIPMENT

1. OIL/WATER SEPARATOR
2. RECOVERED PRODUCT TANK
3. SURGE TANK
4. DUPLEX AIR COMPRESSOR
5. CONTROL BOARD
6. AIR STRIPPER BOOSTER PUMP
7. AIR STRIPPER

TANK FARM

APPROX SCALE: 1" = 10'

DOC. NO.: CLEJ-00382 - 3.05 - 01/01/96 FIGURE 12

O'BRIEN & GERE ENGINEERS, INC.

DOC. NO.: CLEV-00382-3.05-01/01/90

APPENDIX A

DOC. NO.: CLEJ-00382-3.05-01/01/90

O'BRIEN & GERE ENGINEERS, INC.	TEST BORING LOG	Report of Boring No.: RW#1 Sheet 1 of 1
Project Location: Camp LeJeune, NC Client: Navy	SAMPLER Type: 2" O.D. Split Spoon Hammer: 140 lbs. Fall: 30"	Ground Water Depth Date Depth Date File No.: 3543.012

Boring Co.: Environmental Monitoring & Testing Corp.
Foreman: Mike Ransier
OBG Geologist: John D. Conway

Boring Location:
Ground Elevation:
Dates: Started:12/12/89 Ended:12/12/89

Depth	Sample No	Sample Depth	Blows /6"	Penetr/ Recovry	"N" Value	Sample Description	Stratum Change General Descript	Equipment Installed	Field Testing pH	Field Testing Sp Cond	Field Testing HNU	Rmks*
0						Black, dry, sandy CLAY with sand, fine to very fine.						
		5-7	4/9/24/33	20/12		White, fine, quartz SAND with little to no silt and 1-5% heavies.						
		10-12	4/7/31/32	24/20		White, fine, quartz SAND with little to no silt, 1-5% heavies, and a little tan mottling. Wet.						
		33-35	NR	24/20		Black, saturated, fine, quartz SAND with 1-5% heavies.						

DOC. NO.: CLEJ-00382-3.05-01/01/90

O'BRIEN & GERE ENGINEERS, INC.	TEST BORING LOG	Report of Boring No.: RW#2 Sheet 1 of 1
Project Location: Camp LeJeune, NC Client: Navy	SAMPLER Type: 2" O.D. Split Spoon Hammer: 140 lbs. Fall: 30"	Ground Water Depth Date Depth Date File No.: 3543.012

Boring Co.: Environmental Monitoring & Testing Corp.
Foreman: Mike Ransier
OBG Geologist: John D. Conway

Boring Location:
Ground Elevation:
Dates: Started: 12/13/89 Ended: 12/13/89

Depth	Sample No	Sample Depth	Sample Blows /6"	Sample Penetr/ Recovry	Sample "N" Value	Sample Description	Stratum Change General Descript	Equipment Installed	Field Testing pH	Field Testing Sp Cond	Field Testing HNU	Rmks*
0												
						Dry, gray, fine to medium SAND with a little silt.						
10												
12						Groundwater.						
						Wet, gray, fine to medium, quartz SAND with 1-5% heavies.						
20												
25						Wet. Black, fine to medium quartz SAND.						
33												

No spoons taken. Descriptions based on recovery of augers.

DOC. NO.: CLEJ-00382-3.05-01/01/90

O'BRIEN & GERE ENGINEERS, INC.	TEST BORING LOG	Report of Boring No.: 7R Sheet 1 of 1
Project Location: Camp LeJeune, NC Client: Navy	SAMPLER Type: 2" O.D. Split Spoon Hammer: 140 lbs. Fall: 30"	Ground Water Depth Date Depth Date File No.: 3543.012

Boring Co.: Environmental Monitoring & Testing Corp.
Foreman: Mike Ransier
OBG Geologist: John D. Conway

Boring Location:
Ground Elevation:
Dates: Started: 12/14/89 Ended: 12/14/89

Depth	Sample No	Sample Depth	Blows /6"	Penetr/ Recovry	"N" Value	Sample Description	Stratum Change General Descript	Equipment Installed	Field Testing pH	Field Testing Sp Cond	Field Testing HNU	Rmks*
0												
						Gray, fine to medium SAND.						
10												
15						Black, fine to medium SAND.						

DOC. NO.: CLEJ-00382-3.05-01/01/90

O'BRIEN & GERE ENGINEERS, INC.	TEST BORING LOG	Report of Boring No.: 8R Sheet 1 of 1
Project: Location: Camp LeJeune, NC Client: Navy	SAMPLER Type: 2" O.D. Split Spoon Hammer: 140 lbs. Fall: 30"	Ground Water Depth Date Depth Date File No.: 3543.012

Boring Co.: Environmental Monitoring & Testing Corp.
Foreman: Mike Ransier
OBG Geologist: John D. Conway

Boring Location:
Ground Elevation:
Dates: Started: 12/14/89 Ended: 12/14/89

Depth	Sample No	Sample Depth	Blows /6"	Penetr/ Recovry	"N" Value	Sample Description	Stratum Change General Descript	Equipment Installed	Field Testing pH	Field Testing Sp Cond	Field Testing HNU	Rmks*
0						Gray, fine to medium, quartz SAND with a little silt.						
15												

DOC. NO.: CLEJ-00382-3.05-01/01/90

O'BRIEN & GERE ENGINEERS, INC.	TEST BORING LOG	Report of Boring No.: 21 Sheet 1 of 1
P : Location: Camp LeJeune, NC Client: Navy	SAMPLER Type: 2" O.D. Split Spoon Hammer: 140 lbs. Fall: 30"	Ground Water Depth Date Depth Date File No.: 3543.012

Boring Co.: Environmental Monitoring & Testing Corp.
Foreman: Mike Ransier
OBG Geologist: John D. Conway

Boring Location:
Ground Elevation:
Dates: Started:12/14/89 Ended:12/14/89

Depth	Sample No	Sample Depth	Blows /6"	Penetr/ Recovry	"N" Value	Sample Description	Stratum Change General Descript	Equipment Installed	Field Testing pH	Field Testing Sp Cond	Field Testing HNU	Rmks*
0												
						Black, dry, sandy CLAY.						
5						Tan, moist, silty SAND.						
10						Gray, very fine to fine SAND with a little silt.						
19						Bottom of boring.						

DOC. NO.: CLEJ-00382-3.05-01/01/90

O'BRIEN & GERE ENGINEERS, INC.	TEST BORING LOG	Report of Boring No.: 22 Sheet 1 of 1
Project Location: Camp LeJeune, NC Client: Navy	SAMPLER Type: 2" O.D. Split Spoon Hammer: 140 lbs. Fall: 30"	Ground Water Depth Date Depth Date File No.: 3543.012

Boring Co.: Environmental Monitoring & Testing Corp.
Foreman: Mike Ransier
OBG Geologist: John D. Conway

Boring Location:
Ground Elevation:
Dates: Started:12/14/89 Ended:12/14/89

Depth	Sample No	Sample Depth	Blows /6"	Penetr/ Recovry	"N" Value	Sample Description	Stratum Change General Descript	Equipment Installed	Field Testing pH	Field Testing Sp Cond	Field Testing HNU	Rmks*
0												
						Grayish-white, finne SAND with a little silt.						
10												
12						Black, fine SAND.						
15						Bottom of boring.						

DOC. NO.: CLEJ-00382-3.05-01/01/90

O'BRIEN & GERE ENGINEERS, INC.	TEST BORING LOG	Report of Boring No.: 23 Sheet 1 of 1
Project Location: Camp LeJeune, NC Client: Navy	SAMPLER Type: 2" O.D. Split Spoon Hammer: 140 lbs. Fall: 30"	Ground Water Depth Date Depth Date File No.: 3543.012

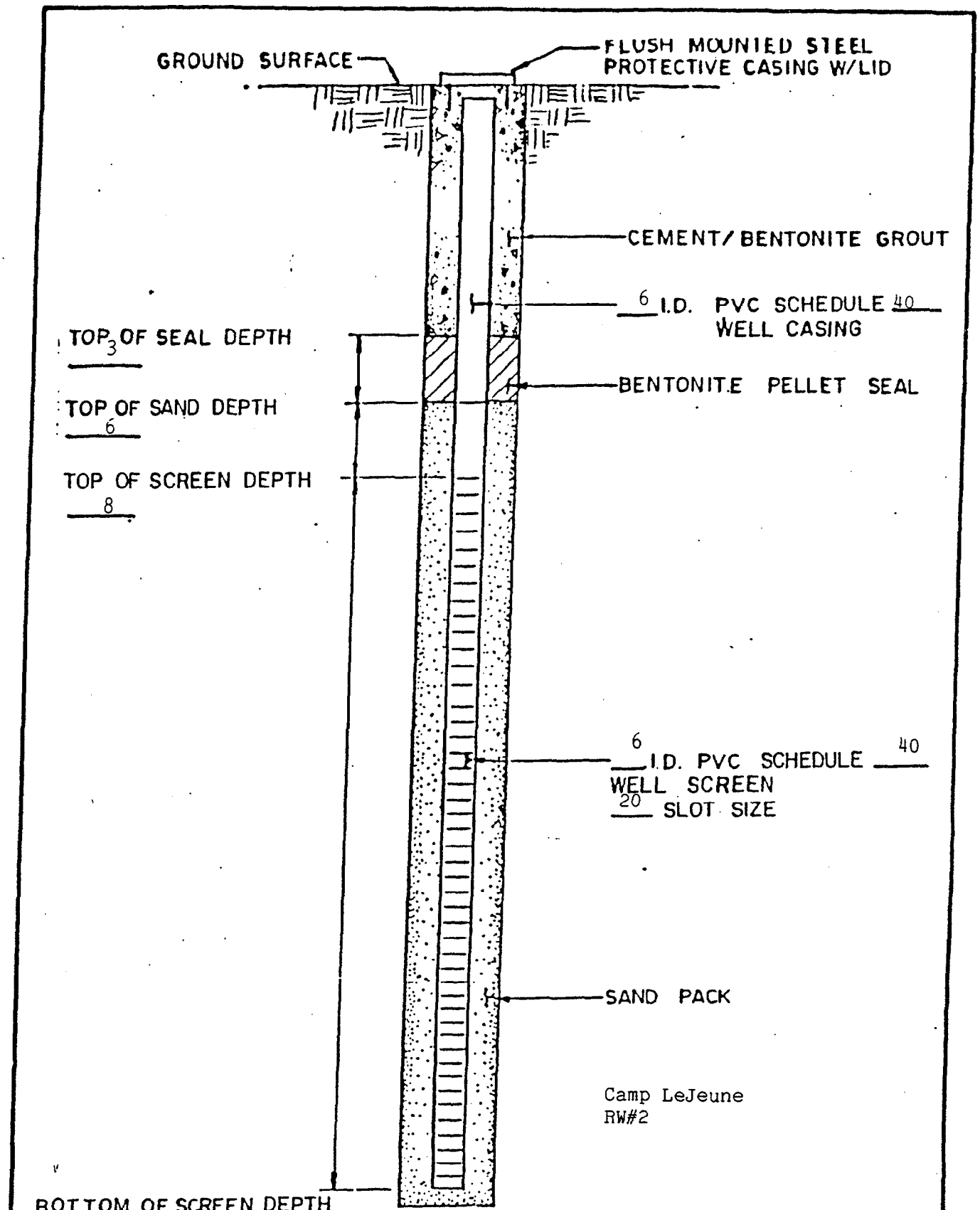
Boring Co.: Environmental Monitoring & Testing Corp.
Foreman: Mike Ransier
OBG Geologist: John D. Conway

Boring Location:
Ground Elevation:
Dates: Started: 12/14/89 Ended: 12/14/89

Depth	Sample No	Sample Depth	Blows /6"	Penetr/ Recovry	"N" Value	Sample Description	Stratum Change General Descript	Equipment Installed	Field Testing pH	Field Testing Sp Cond	Field Testing HNU	Rmks*
0						Black, sandy and silty CLAY.						
5						Gray, moist CLAY with fine sand, strong petroleum odor.						
9						Grayish-white, fine SAND with a a little silt and 5-10% heavies. Strong petroleum odor.						
10						Groundwatre level.						
15						Brown, fine to medium SAND with silt.						
						Bottom of boring.						

Description based on material off augers.

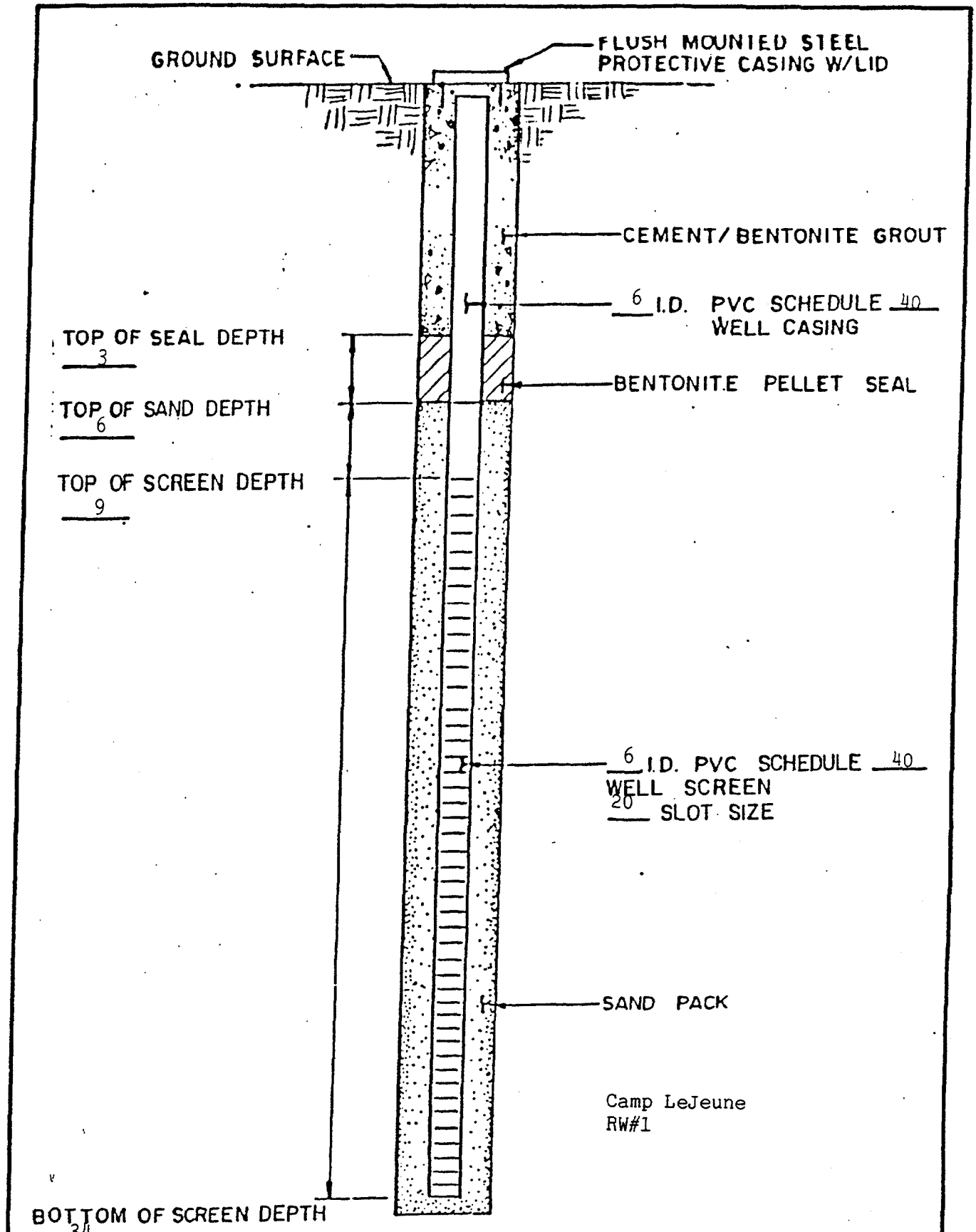
DOC. NO.: CLEJ-00382-3.05-01/01/90



MONITORING WELL SPECIFICATIONS

N.T.S.

DOC. NO.: CLEJ-00382-3.05-01/01/90

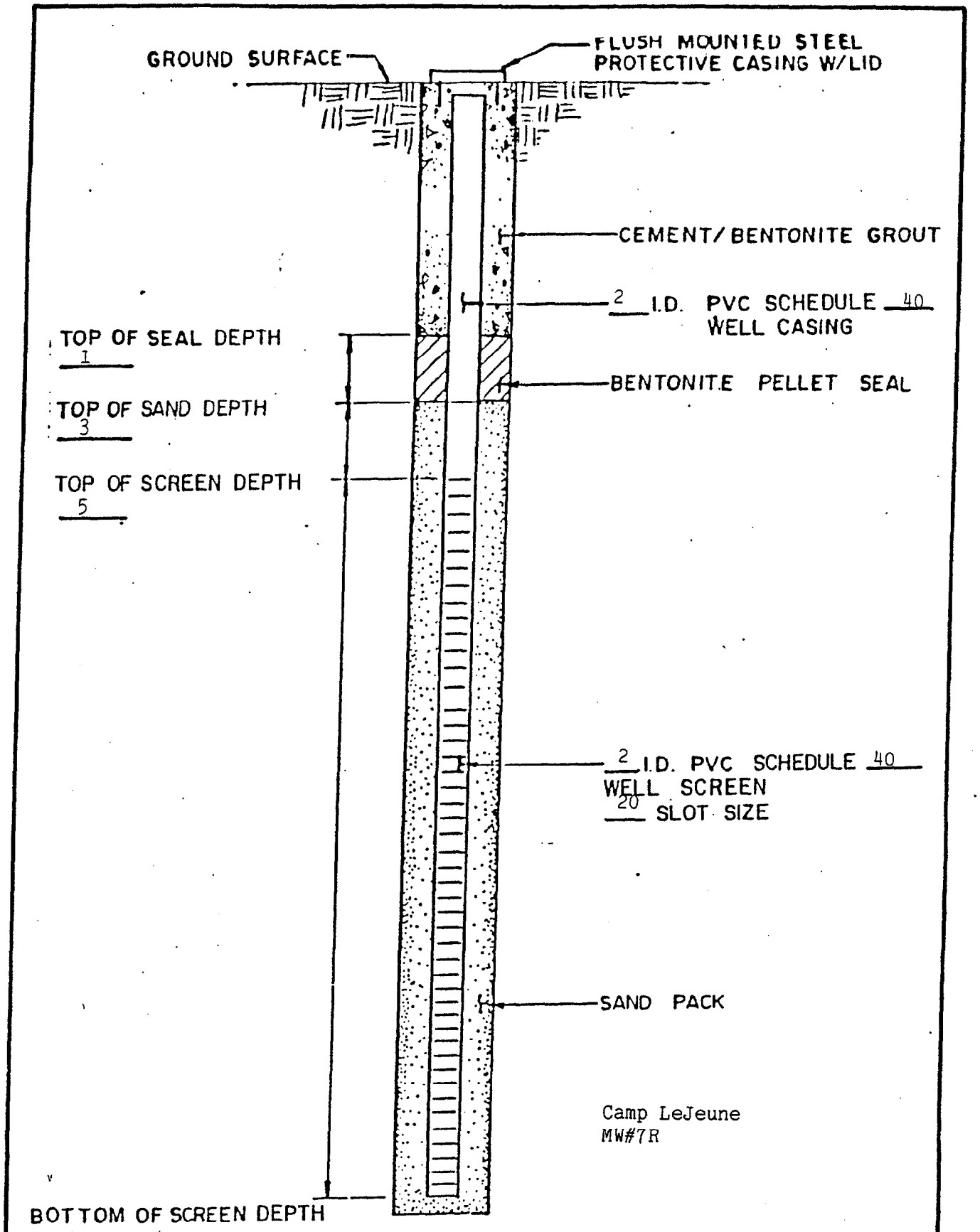


MONITORING WELL SPECIFICATIONS

N.T.S.

O'BRIEN&GERE

DOC. NO.: CLEJ-00382-3.05-01/01/90

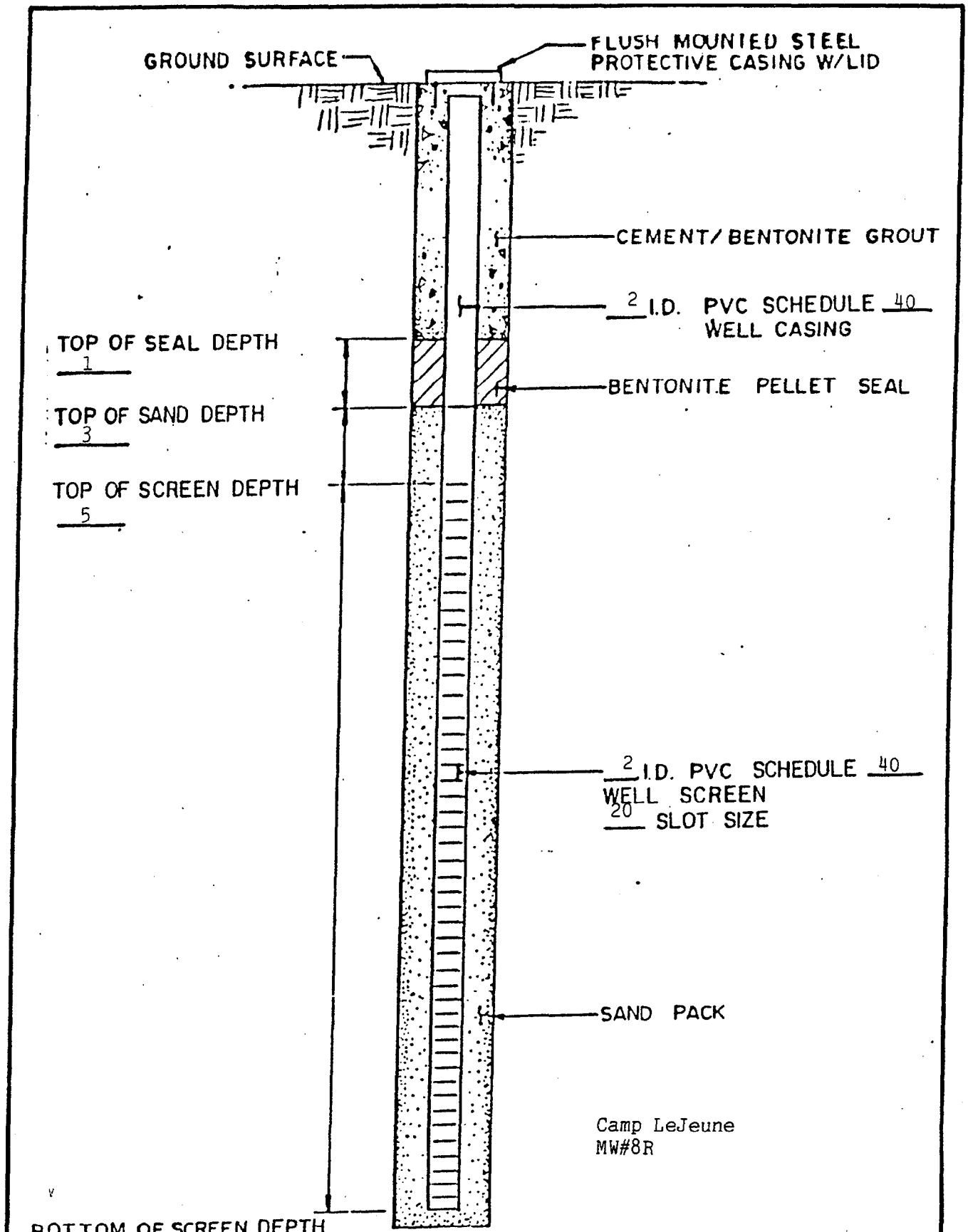


MONITORING WELL SPECIFICATIONS

N.T.S.

O'BRIEN & GERE

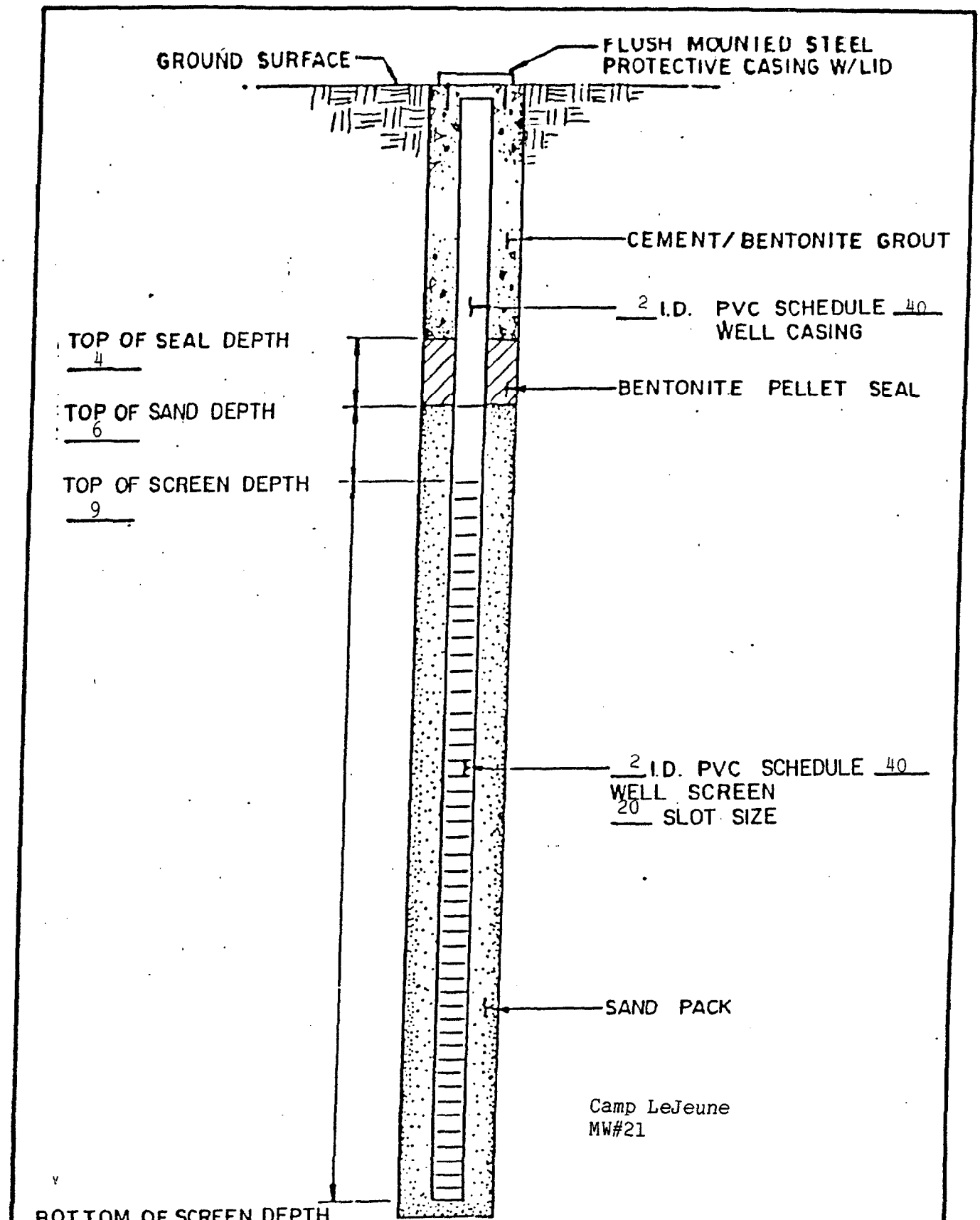
DOC. NO. : CLET-00382-3.05-01/01/90



MONITORING WELL SPECIFICATIONS

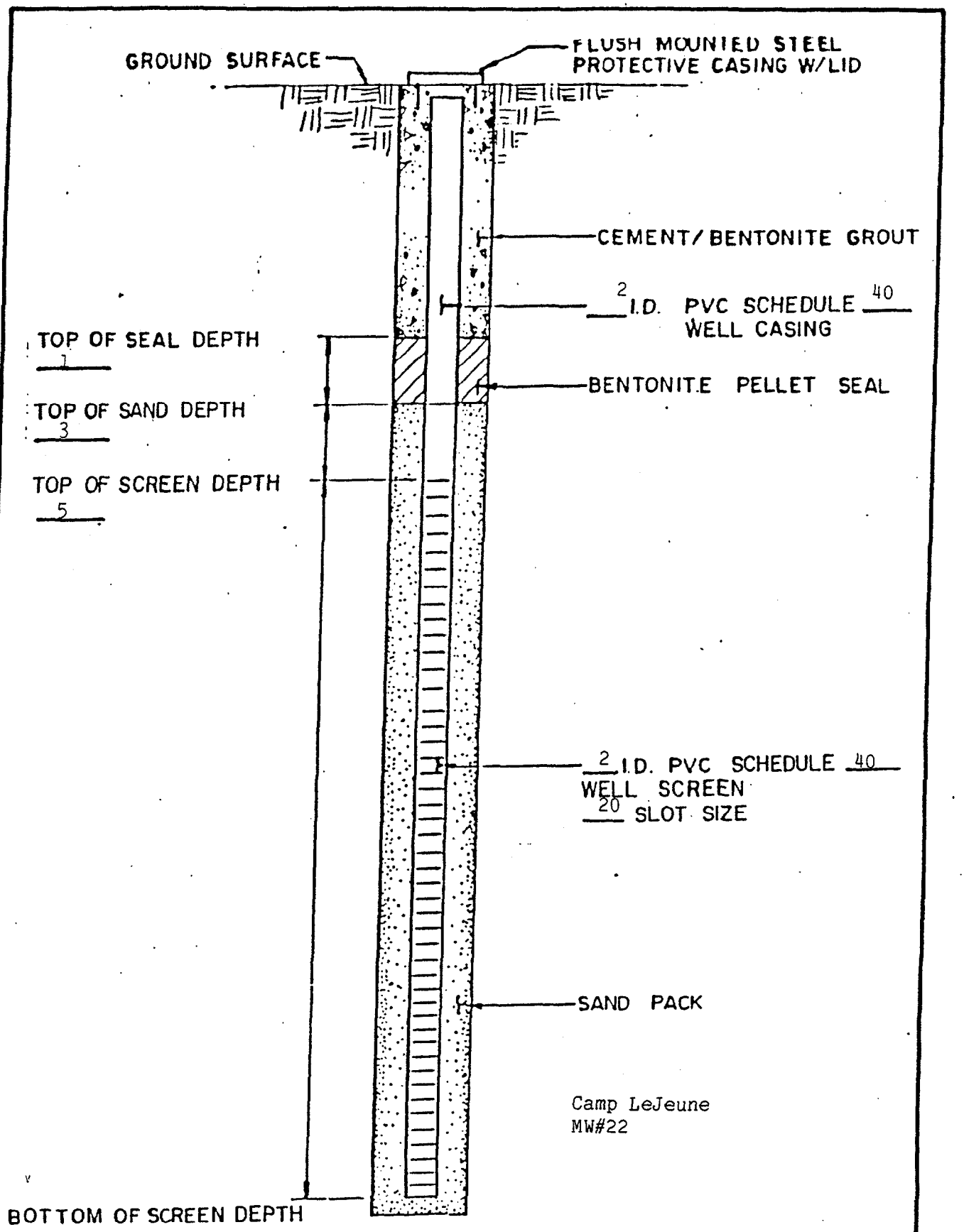
N.T.S.

DOC. NO.: CLEJ-00382-3.05-01/01/90



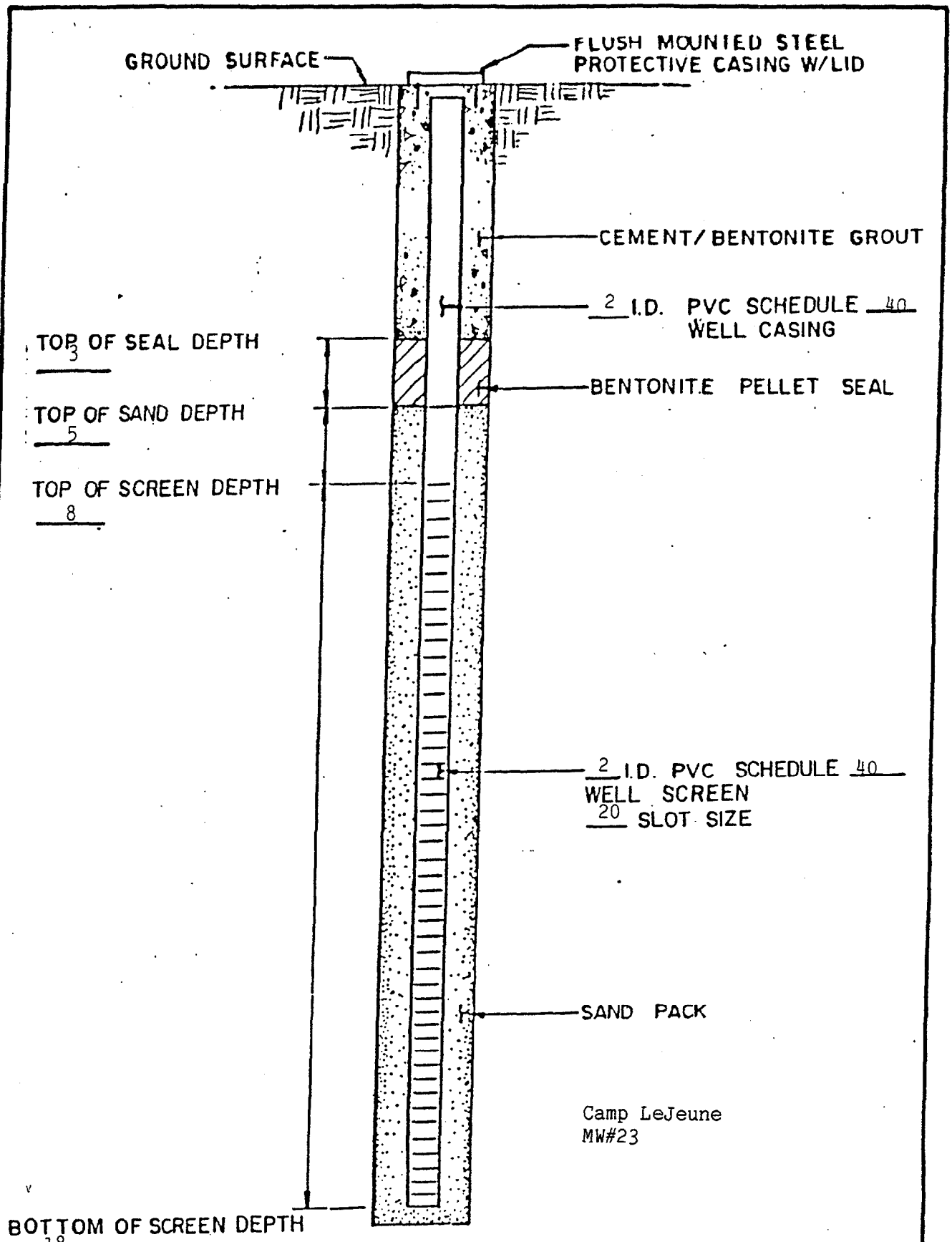
MONITORING WELL SPECIFICATIONS

N.T.S.



MONITORING WELL SPECIFICATIONS

N.T.S.



MONITORING WELL SPECIFICATIONS

N.T.S.

APPENDIX B

MONITORING WELL INSTALLATION PROCEDURES

Drilling and Sampling Procedures

All monitoring wells will be installed using the hollow stem auger drilling method. A drill crew shall consist of an experienced driller and a driller assistant to work on each rig. A geologist experienced in hazardous waste site investigations shall be on site to supervise the drilling and monitor for safety control. The well depths will be specified by the supervising hydrogeologist, however, the wells shall not exceed a maximum depth of 25 feet. A potable water source on base will be designated by the government.

During the drilling samples of the encountered subsurface materials shall be collected at a minimum of every five feet and/or change in material at the discretion of the supervising hydrogeologist. The sampling method employed shall be ASTM-D-1586/Split Barrel Sampling for standard penetration tests. Upon retrieval of the sampling barrel, the collected sampie shall be placed in glass jars labelled and retained for future reference. The hydrogeologist will prepare a descriptive log of each boring which will include: soil texture, odor, moisture content, depth to ground water and any visual indications of contamination. Additionally, the supervising hydrogeologist will monitor organic vapors using an HNU PID to assess the presence of contaminated soil and assess site safety conditions and the need for respiratory protection while drilling.

Monitoring Well Completion

After the completion of the soil sampling and drilling to the specified depth, a monitoring well will be installed in accordance with the attached well detail. The wells will be constructed of either two inch or four inch diameter, flush joint threaded, Schedule 40 or 80, PVC well screen and casing. A ten to twenty foot section of PVC well screen with a .020 slot size will be used in each well. The well casing and screen assembly will be placed into the borehole to the specified depth and a suitable sand pack will be placed in the annular space around the screen, extending two feet above the top of the screen. The sand pack shall consist of a well sorted silica sand that allows a maximum of ten percent of the material to pass through the screen slots. A one foot thick layer of bentonite pellets will be installed on top of the sand pack. A grout mixture consisting of two parts sand, one part cement and up to ten percent bentonite will be thoroughly mixed with the specified amount of water and place in the annular space above the sand pack.

In non-traffic areas, and when the casing will not cause an obstruction, a four inch diameter protective steel casing shali be installed over the PVC casing and extend at least 2.5 feet into the ground and two to three feet above the ground surface, as shown on Figure 7. The steel casing will be provided with a vented hinged locking cap for security. In areas of heavy traffic or when tile casing may cause an obstruction, the protective casing will be grouted inside a 12-inch diameter watertight manhole that is flush with the ground surface, as shown on Figure 8. A concrete apron

measuring five feet by five feet by 0.5 feet will be constructed around each well. The concrete will consist of 3,000 psi ready mixed concrete and will be crowned 3/4-inch above the existing surface to promote surface runoff away from the wall. The above ground wells will be protected with three Schedule 40 steel pipes, three inch ID, imbedded in a minimum of 2.5 feet of 3,000 psi concrete. The concrete to secure the three pipes will be poured at the same time as the five feet by five feet by 0.5 feet concrete apron and be an integral part of the pad. The steel pipes will be filled with concrete and painted day-glow yellow. Each well will be properly labelled by metal stamping on the exterior of the locking cap or manhole cover and by labelling the exterior of the security pipe. A sign reading **"Not for Potable Use or Disposal"** shall be firmly attached to each well. Well permits by state agencies will be the responsibility of the drilling contractor.

Well Development

Following well construction each monitoring well will be developed or cleared of fine grained materials and sediments that have settled in or around the well to ensure the well screen is transmitting a representative flow groundwater. The development will be accomplished using either the bailing or continuous low-yield pumping methods. Well development discharge may be disposed of on the ground surface near each well.

Decontamination

All drilling equipment including augers, drilling rods and split spoon sampling equipment, will be cleaned between each drilling location using a high pressure steam cleaner to avoid

potential cross contamination of the monitoring wells. Wash water will not be contained and allowed to seep into the ground locally, unless otherwise directed by the E.I.C.

APPENDIX C

DOC. NO.: CLET-00382-3.05-01/01/96

McCallum Testing Laboratories, Inc.
1808 HAYWARD AVENUE
P. O. Box 13266
CHESAPEAKE, VIRGINIA 23325

Our File Number L-2245
Client's Order No.
Client's Req'n No.
Date 12/21/89

REPORT ON SOIL

Lab. No. 61-1 Chesapeake, Va.
Sample of Proposed Use
Sample No. RW #1 From Had Not Point, Jacksonville, NC
Depth Taken Depth From 20' to 32'
Depth of Cut Height of Fill Represents
Submitted by O'Brien & Gere
Sampled Received 12/19/89

MECHANICAL ANALYSIS

COARSE AGGREGATE

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

SOIL MORTAR

SIEVE ANALYSIS		TOTAL % PASSING	
Coarse Sand #4-#10	0.0 %	#4 4.75	100.0 %
Medium Sand #10-#40	1.9 %	# 10 2.0	100.0 %
Fine Sand #40-#200	88.3 %	# 40 .425	98.1 %
Silt #200—0.005 mm	%	#100 .15	25.4 %
Clay-Smaller than 0.005 mm	%	#200 .075	9.8 %
Colloids-Smaller than 0.001 mm	%		

OTHER TEST DATA

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

Remarks: Sample Contained

Lab. No.

Our letters and reports are for the exclusive use of the client to whom they are addressed. The use of our name must receive our prior written approval. Our letters and reports apply only to the sample tested and/or inspected, and are not necessarily indicative of the qualities of apparently identical or similar products.

FORM CLET ... (illegible) ...

DOC. NO.: CLEJ-00382-3.05 -01/01/90

McCallum Testing Laboratories, Inc.
1808 HAYWARD AVENUE
P. O. Box 13266
CHESAPEAKE, VIRGINIA 23325

Our File Number L-2245
Client's Order No.
Client's Req'n No.
Date 12/21/89

REPORT ON SOIL

Lab. No. 61-2 Chesapeake, Va.
Sample of Proposed Use
Sample No. RW #2 From Had Not Point, Jacksonville, NC
Depth Taken Depth From 10' to 15'
Depth of Cut Height of Fill Represents
Submitted by O'Brien & Gere
Sampled Received 12/19/89

MECHANICAL ANALYSIS

COARSE AGGREGATE

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

SOIL MORTAR

SIEVE ANALYSIS		TOTAL % PASSING	
Coarse Sand #4-#10	0.0 %	# 4	100.0 %
Medium Sand #10-#40	1.9 %	# 10	100.0 %
Fine Sand #40-#200	86.3 %	# 40	98.1 %
Silt #200—0.005 mm	%	#100	40.7 %
Clay-Smaller than 0.005 mm	%	#200	11.8 %
Colloids-Smaller than 0.001 mm	%		

OTHER TEST DATA

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

Remarks: Sample Contained

Lab. No.

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FORM L-111 DARLING BUSINESS FORMS CO., INC., NORFOLK, VA. 23502

DOC. NO.: CLEJ-00382-3.05-01/01/90

McCallum Testing Laboratories, Inc.
1808 HAYWARD AVENUE
P. O. Box 13266
CHESAPEAKE, VIRGINIA 23325

Our File Number L-2245
Client's Order No.
Client's Req'n No.
Date 12/21/89

REPORT ON SOIL

Lab. No. 61-3 Chesapeake, Va
Sample of Proposed Use
Sample No. RW #1 From Had Not Point, Jacksonville, NC
Depth Taken Depth From 10' to 15'
Depth of Cut Height of Fill Represents
Submitted by O'Brien & Gere
Sampled Received 12/19/89

MECHANICAL ANALYSIS

COARSE AGGREGATE

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

SOIL MORTAR

SIEVE ANALYSIS		TOTAL % PASSING	
Coarse Sand #4-#10	0.0 %	# 4	100.0 %
Medium Sand #10-#40	4.9 %	# 10	100.0 %
Fine Sand #40-#200	88.7 %	# 40	95.1 %
Silt #200—0.005 mm	%	#100	24.6 %
Clay-Smaller than 0.005 mm	%	#200	6.4 %
Colloids-Smaller than 0.001 mm	%		

OTHER TEST DATA

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

Remarks: Sample Contained

Lab. No.

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FORM L-111 DARLING BUSINESS FORMS CO., INC. NORFOLK, VA. 23501

DOC. NO.: CLET-00382-3.05-01/01/90

McCallum Testing Laboratories, Inc.
1808 HAYWARD AVENUE
P. O. Box 13266
CHESAPEAKE, VIRGINIA 23325

Our File Number L-2245
Client's Order No.
Client's Req'n No.
Date 12/21/89

REPORT ON SOIL

Lab. No. 61-4 Chesapeake, Va.
Sample of Proposed Use
Sample No. RW #2 From Had Not Point, Jacksonville, NC
Depth Taken Depth From 20' to 25'
Depth of Cut Height of Fill Represents
Submitted by O'Brien & Gere
Sampled Received 12/19/89

MECHANICAL ANALYSIS

COARSE AGGREGATE

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

SOIL MORTAR

SIEVE ANALYSIS		TOTAL % PASSING	
Coarse Sand #4-#10	0.0 %	# 4	100.0 %
Medium Sand #10-#40	1.8 %	# 10	100.0 %
Fine Sand #40-#200	86.0 %	# 40	98.2 %
Silt #200—0.005 mm	%	#100	39.7 %
Clay-Smaller than 0.005 mm	%	#200	12.2 %
Colloids-Smaller than 0.001 mm	%		

OTHER TEST DATA

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

Remarks: Sample Contained

Lab. No.

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FORM C-111 DARLING BUSINESS FORMS CO., INC. NORFOLK, VA. 23502

DOC. NO.: CLEJ-00382-3.05-01/01/90

McCallum Testing Laboratories, Inc.
1808 HAYWARD AVENUE
P. O. Box 13266
CHESAPEAKE, VIRGINIA 23325

Our File Number L-2245
Client's Order No.
Client's Req'n No.
Date 12/21/89

REPORT ON SOIL

Lab. No. 61-5 Chesapeake, Va.
Sample of Proposed Use
Sample No. MW #2 From Had Not Point, Jacksonville, NC
Depth Taken Depth From to
Depth of Cut Height of Fill Represents
Submitted by O'Brien & Gere
Sampled Received 12/19/89

MECHANICAL ANALYSIS

COARSE AGGREGATE

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

SOIL MORTAR

SIEVE ANALYSIS		TOTAL % PASSING	
Coarse Sand #4-#10	0.5 %	# 4	100.0 %
Medium Sand #10-#40	4.9 %	# 10	99.5 %
Fine Sand #40-#200	63.3 %	# 40	94.6 %
Silt #200—0.005 mm	%	#100	72.6 %
Clay-Smaller than 0.005 mm	%	#200	31.3 %
Colloids-Smaller than 0.001 mm	%		

OTHER TEST DATA

Liquid Limit 29 Water Content as Received %
Plastic Limit 17 Plasticity Index 12 Loss on Ignition (corrected) %
Specific Gravity Coefficient of permeability Ft. per day
Classification SC H.R.B.

Remarks: Sample Contained

Lab. No.

Our letters and reports are for the exclusive use of the client to whom they are addressed. The use of our name must receive our prior written approval. Our letters and reports apply only to the sample tested and/or inspected, and are not necessarily indicative of the qualities of apparently identical or similar products.

FORM L-111 GAYLING BUSINESS FORMS CO., INC., NORFOLK, VA. 23502

APPENDIX D

DOC. NO.: CLEJ-00382-3.05-01/01/90

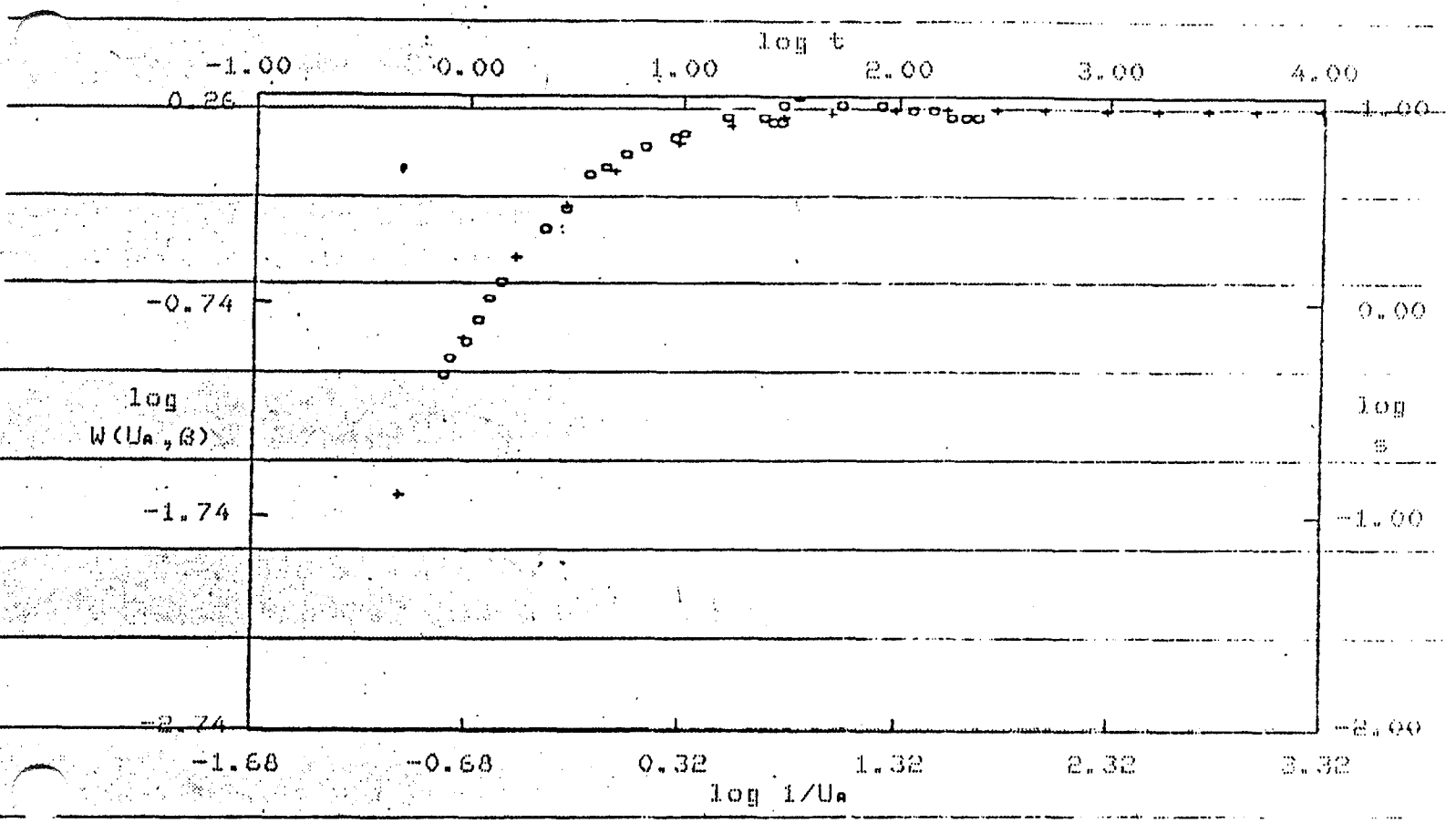
Well Name: RW#1 Date of Test: 12/15/09

Aquifer Thickness (b): 22.000 feet
Pumped Well Discharge(Q) = 3.000 gpm
Radius of Pumping Well = 0.500 feet

Distance of Observation Well from Pumping Well = 0.500 feet

Entry No.	Time(t) (min.)	Drawdown(s) (ft.)	t / d^2 (min./sq.ft.)
1	0.000	12.350	
2	0.780	0.450	3.12E+00
3	0.830	0.550	3.32E+00
4	0.980	0.650	3.92E+00
5	1.120	0.850	4.48E+00
6	1.250	1.050	5.00E+00
7	1.410	1.250	5.64E+00
8	2.280	2.250	9.12E+00
9	2.910	2.850	1.16E+01
10	3.670	4.150	1.47E+01
11	4.380	4.650	1.75E+01
12	5.380	5.150	2.15E+01
13	6.630	5.650	2.65E+01
14	9.083	6.420	3.63E+01
15	10.083	6.650	4.03E+01
16	15.670	7.050	6.27E+01
17	23.330	7.770	9.33E+01
18	26.000	7.550	1.04E+02
19	28.000	7.500	1.12E+02
20	29.000	8.950	1.16E+02
21	34.000	10.150	1.36E+02
22	54.000	9.150	2.16E+02
23	84.000	9.080	3.36E+02
24	114.000	8.870	4.56E+02
25	144.000	8.550	5.76E+02
26	174.000	8.060	6.96E+02
27	204.000	7.950	8.16E+02
28	234.000	7.850	9.36E+02
29	264.000	10.830	1.06E+03
30	294.000	10.810	1.18E+03
31	324.000	10.850	1.30E+03

hadnot point recovery well #1



o - Data

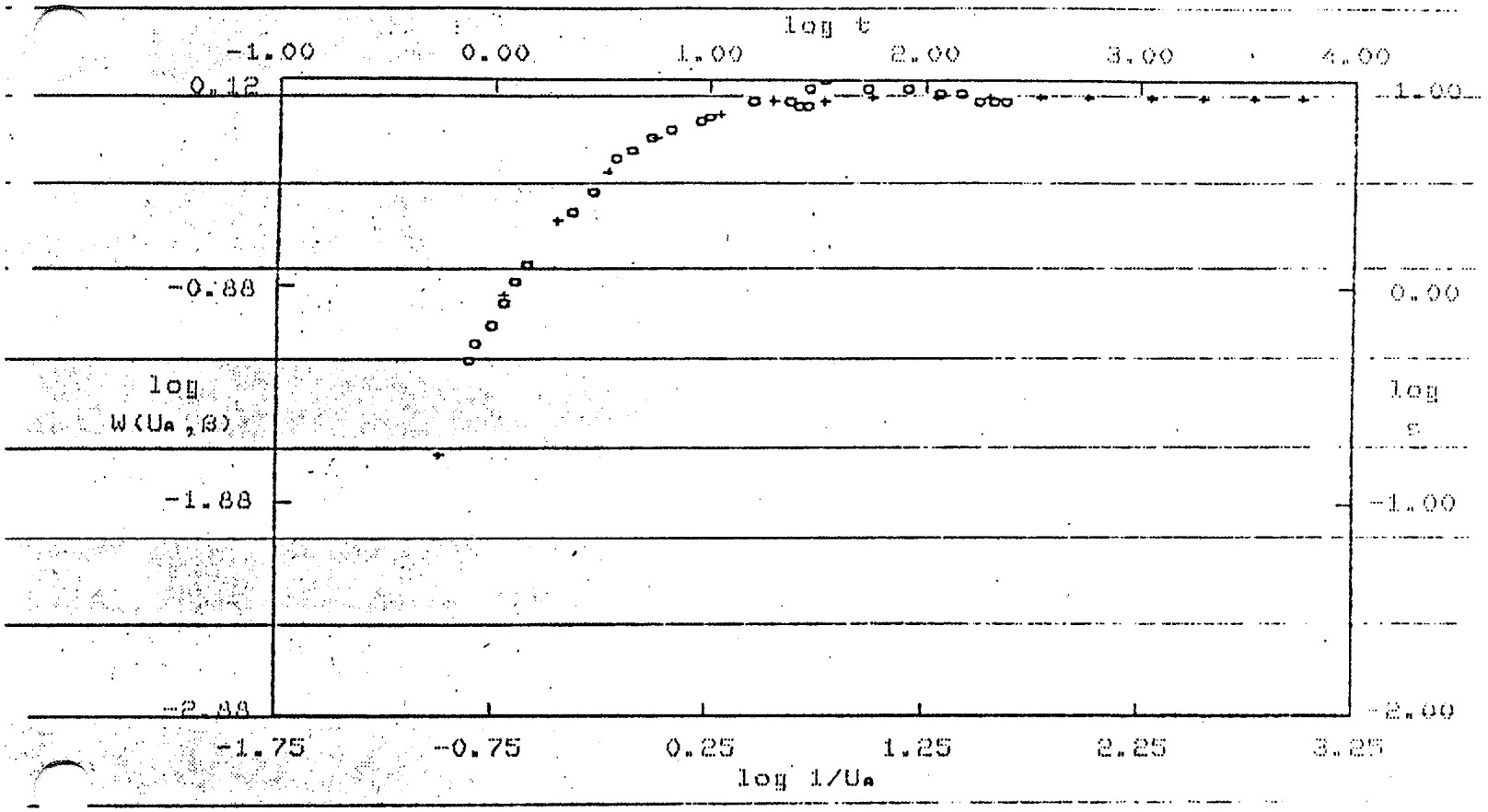
\+ - Type Curve
Unconfined Elastic: beta = 0.10

SOLUTION

Transmissivity = 6.255E+01 gal/day/ft
Aquifer Thick. = 2.200E+01 ft
Hydraulic Cond.= 2.843E+00 gal/day/sq ft
Storativity = 1.112E-01

DOC. NO. CLEJ-00382-3.05-01/01/98

hadnot point recovery well #1



o - Data

\+ - Type Curve

Unconfined Elastic: beta = 0.20

SOLUTION

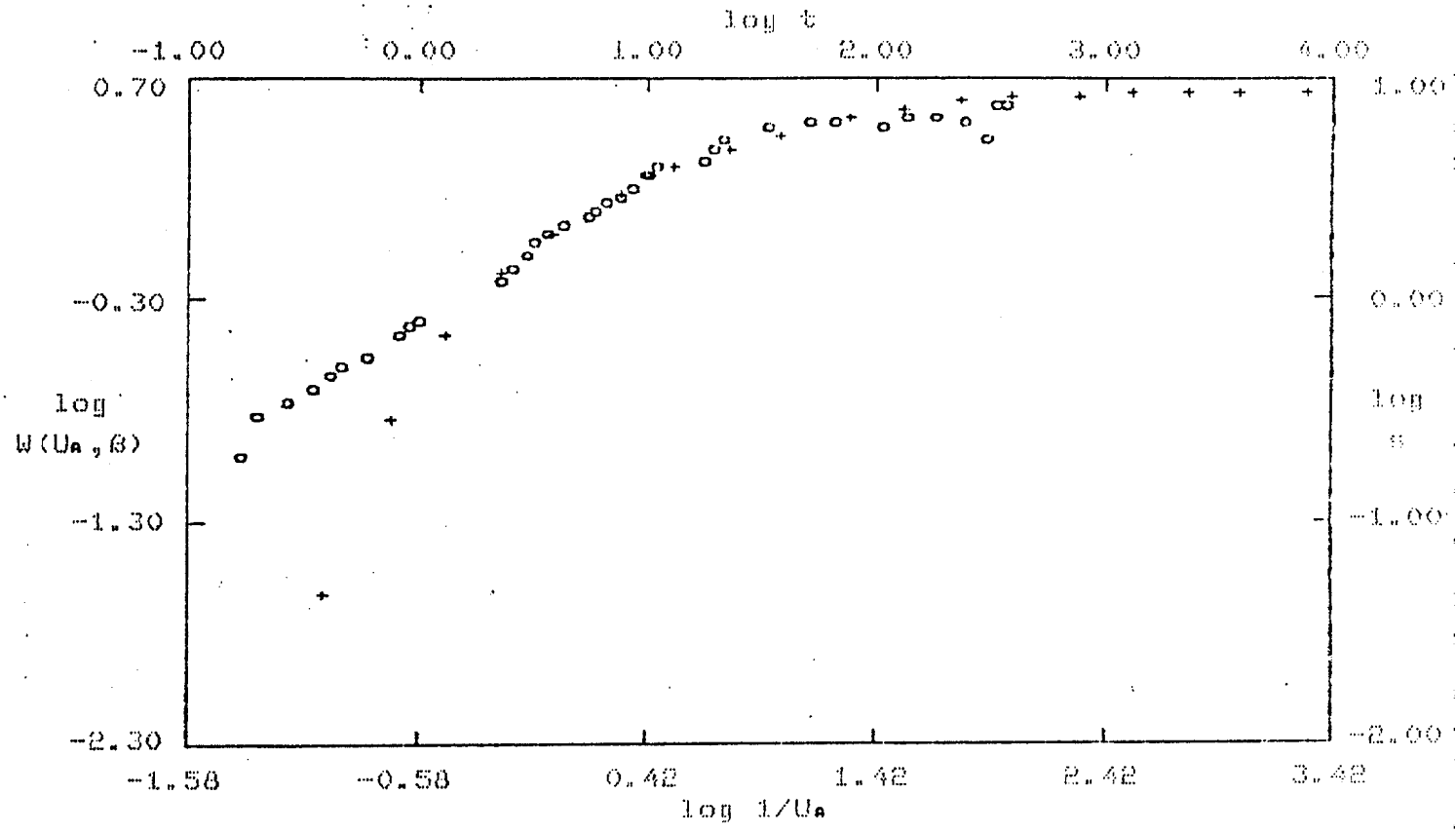
Transmissivity = 4.531E+01 gal/day/ft
Aquifer Thick. = 2.200E+01 ft
Hydraulic Cond.= 2.060E+00 gal/day/sq ft
Storativity = 9.463E-02

Data for Pump Test

Well Name: rw2 Date of Test: 12/15/89
Aquifer Thickness (b): 19.000 feet
Pumped Well Discharge(Q) = 2.000 gpm
Radius of Pumping Well = 0.500 feet
Distance of Observation Well from Pumping Well = 0.100 feet

Entry No.	Time(t) (min.)	Drawdown(s) (ft.)	t / d^2 (min./sq.ft.)
1	0.000	14.400	
2	0.170	0.200	1.70E+01
3	0.200	0.300	2.00E+01
4	0.270	0.350	2.70E+01
5	0.350	0.400	3.50E+01
6	0.420	0.450	4.20E+01
7	0.470	0.490	4.70E+01
8	0.600	0.550	6.00E+01
9	0.830	0.700	8.30E+01
10	0.920	0.760	9.20E+01
11	1.000	0.800	1.00E+02
12	2.300	1.200	2.30E+02
13	2.570	1.400	2.57E+02
14	2.920	1.600	2.92E+02
15	3.250	1.800	3.25E+02
16	3.600	2.000	3.60E+02
17	4.270	2.200	4.27E+02
18	5.500	2.400	5.50E+02
19	5.930	2.500	5.93E+02
20	6.670	2.700	6.67E+02
21	7.670	2.900	7.67E+02
22	8.730	3.100	8.73E+02
23	9.670	3.600	9.67E+02
24	10.350	3.700	1.03E+03
25	11.000	3.900	1.10E+03
26	17.630	4.250	1.76E+03
27	19.630	4.700	1.96E+03
28	21.480	5.150	2.15E+03
29	33.930	6.100	3.39E+03
30	50.700	6.260	5.07E+03
31	65.650	6.250	6.56E+03
32	108.000	5.950	1.08E+04
33	134.000	6.750	1.34E+04
34	180.000	6.580	1.80E+04
35	240.000	6.300	2.40E+04
36	300.000	5.150	3.00E+04
37	330.000	7.430	3.30E+04
38	360.000	7.580	3.60E+04

hadnot point Rw#?



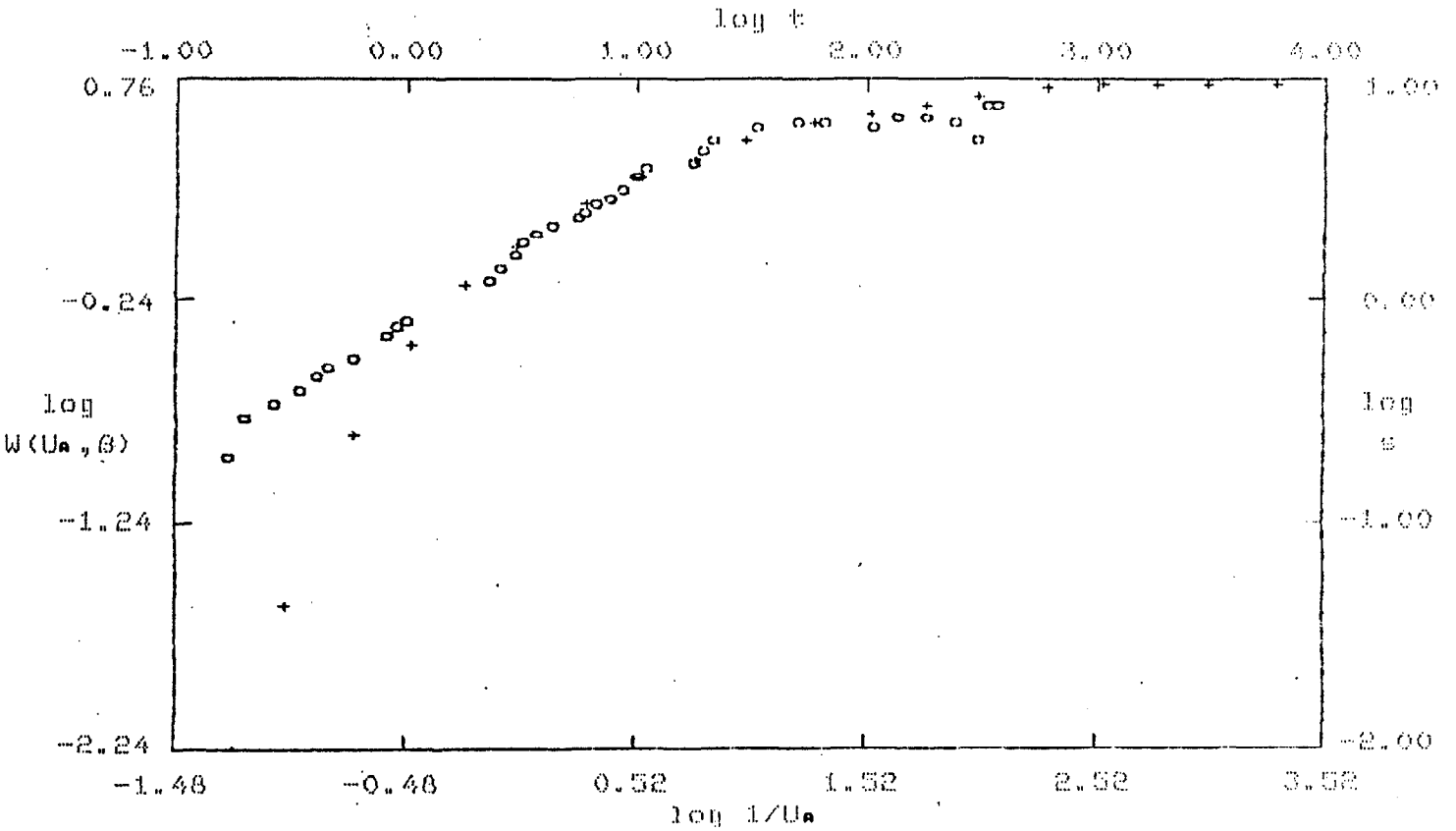
o - Data

\+ - Type Curve
Unconfined Elastic: beta = 0.004

SOLUTION

Transmissivity = 1.148E+02 gal/day/ft
Aquifer Thick. = 1.900E+01 ft
Hydraulic Cond.= 6.044E+00 gal/day/sq ft
Storativity = 4.054E+00

hadnot point Rw#2



o - Data

\+ - Type Curve
Unconfined Elastic: beta = 0.001

SOLUTION

Transmissivity = 1.319E+02 gal/day/ft
Aquifer Thick. = 1.900E+01 ft
Hydraulic Cond.= 6.940E+00 gal/day/sq ft
Storativity = 3.697E+00

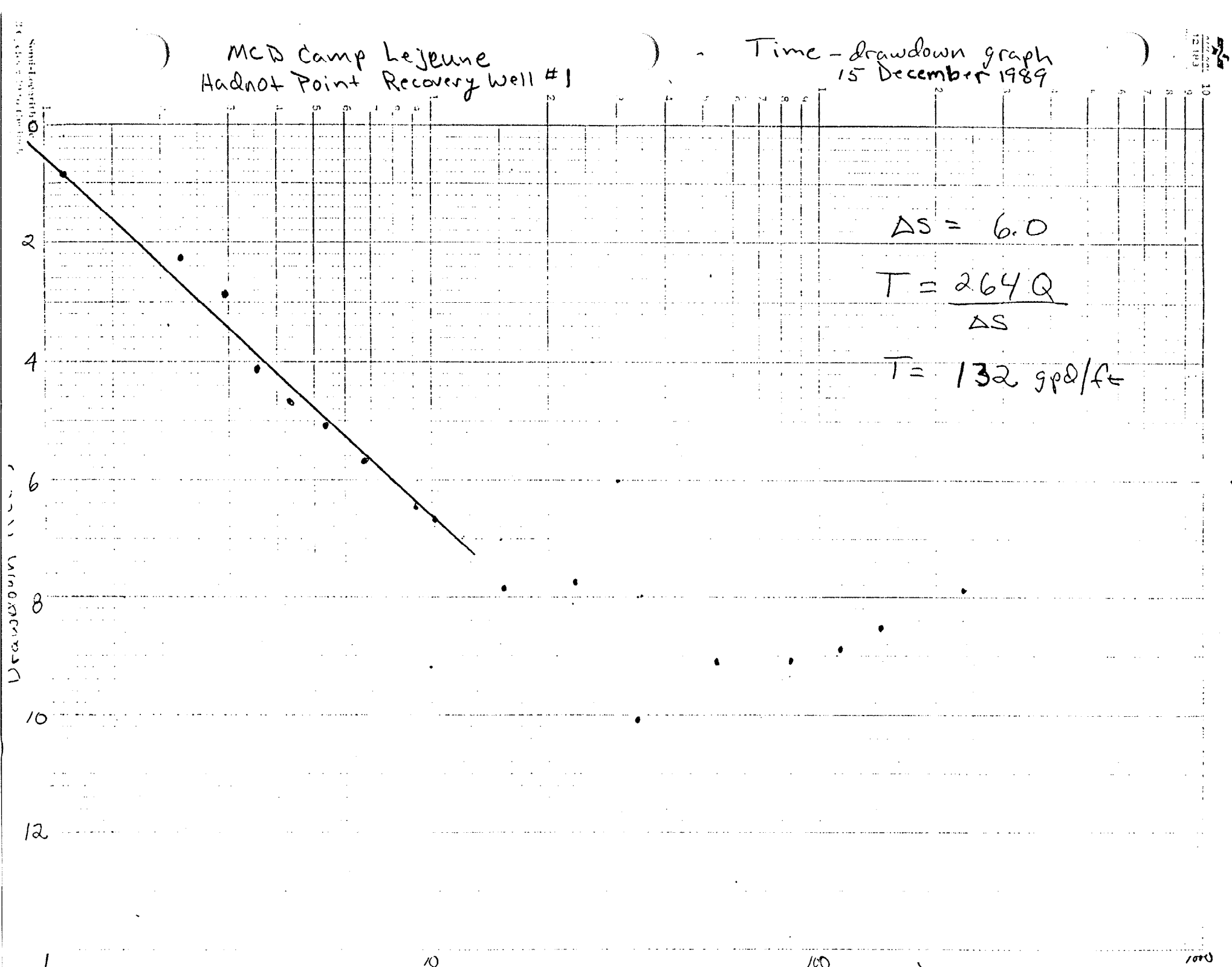
MCB Camp Lejeune
Hadnot Point Recovery Well #1

Time - drawdown graph
15 December 1989

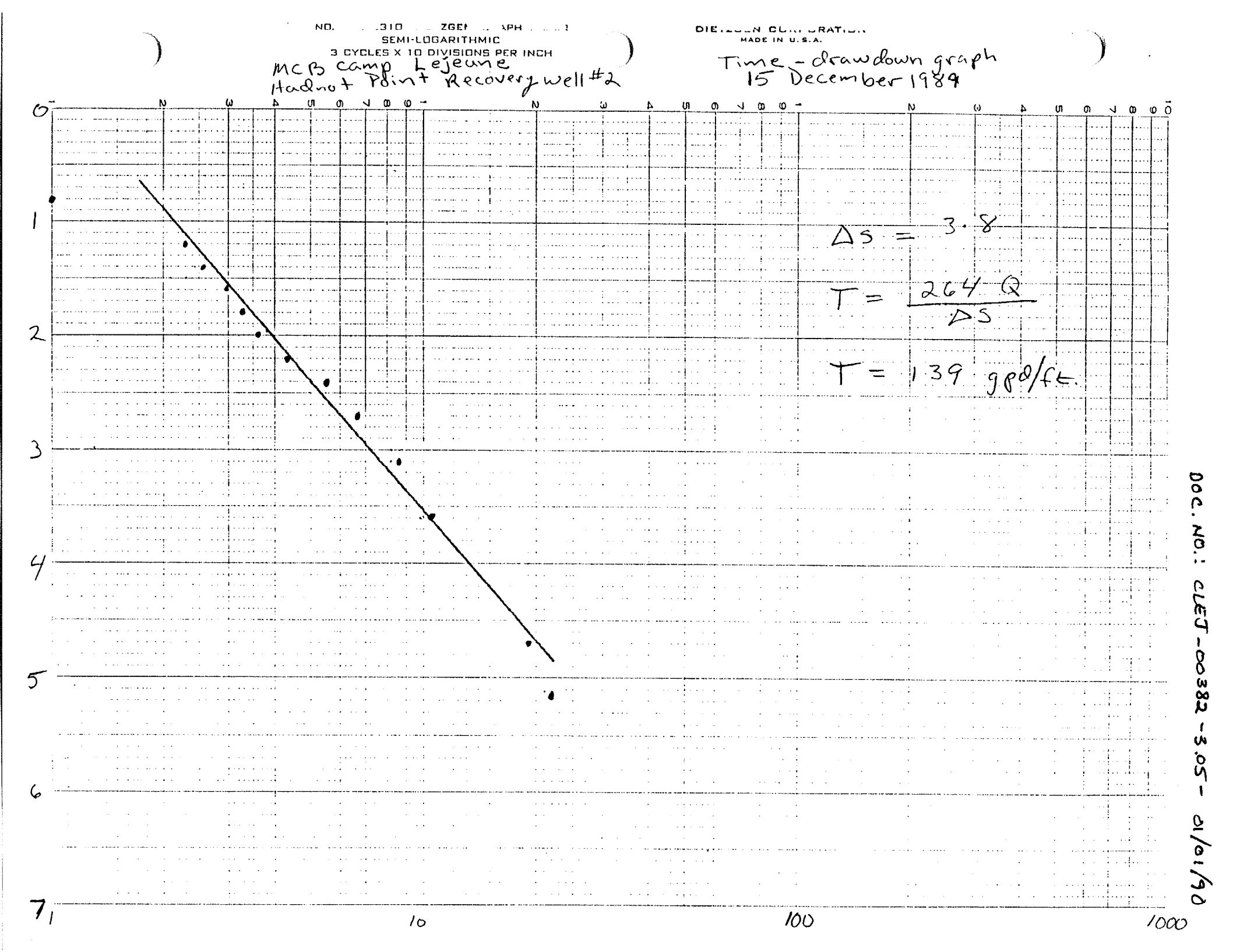
$\Delta S = 6.0$

$T = \frac{264Q}{\Delta S}$

$T = 132$ gpd/ft



DOC. NO.: CLET-00382-3.05-01/01/90



Doc. No.: CLEJ-00382-3.05-01/01/90

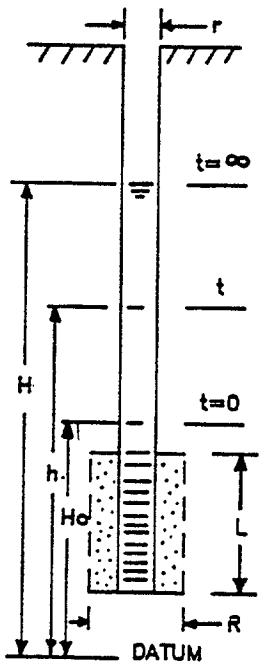
DOC. NO.: CLEJ-00382-3.05-01/01/90

O'BRIEN & GERE

IN-SITU PERMEABILITY TEST
FIELD LOG

PROJECT 3543.002
WELL NUMBER RW41
DATE 12/15/89

LOCATION Camp Lejeune.
ELEVATION _____



STATIC HEAD (H) 12.35
PIPE RADIUS (r) .5
SCREEN RADIUS (R) 1.0
SCREEN LENGTH (L) 25.0
INITIAL HEAD (Ho) 23.3

HYDRAULIC CONDUCTIVITY :

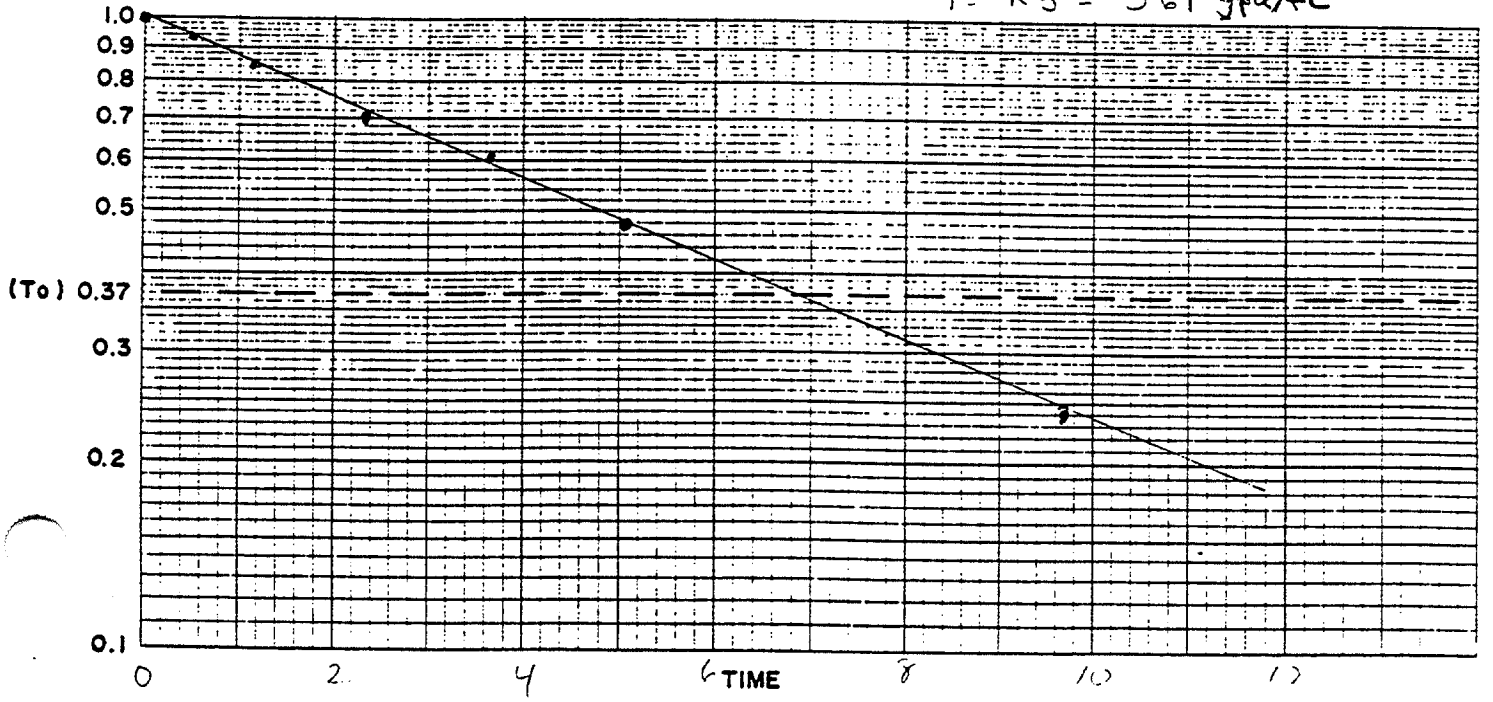
$$K = \frac{r^2 \ln(L/R)}{2LTo}$$

$$K = \frac{(.5)^2 \ln(25/1)}{2(25)(408)} = 3.9 \times 10^{-5} \text{ ft/s} = 25.5 \text{ gpd/ft}^2$$

$T = kb = 561$ gpd/ft

TIME	WATER DEPTH	t	h	H−h / H−Ho
0		0	23.3	1
0:28		.47	22.7	.94
1:09		1.15	21.6	.84
2:21		2.35	20.0	.70
3:39		3.65	19.0	.61
5:04		5.04	17.5	.47
9:41		9.68	15.0	.24
11:15		11.25	14.5	

10.95



$T_o = 6.8$ min = 408 sec

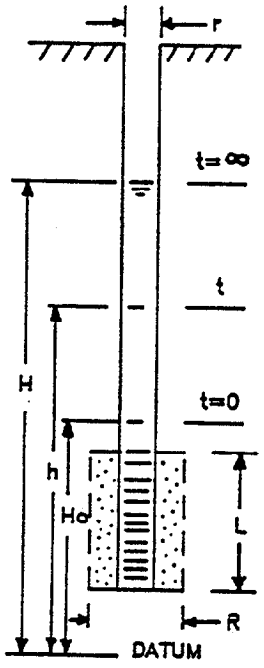
O'BRIEN & GERE

DOC. NO.: CLEJ - 00382 - 3.05 - 01/01/90

IN-SITU PERMEABILITY TEST
FIELD LOG

PROJECT 3543.012
WELL NUMBER RW#2
DATE 12/15/89

LOCATION Camp Lejeune
ELEVATION



STATIC HEAD (H) 14.40

PIPE RADIUS (r) .5

SCREEN RADIUS (R) 1.0

SCREEN LENGTH (L) 25

INITIAL HEAD (Ho) 21.9

HYDRAULIC CONDUCTIVITY :

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

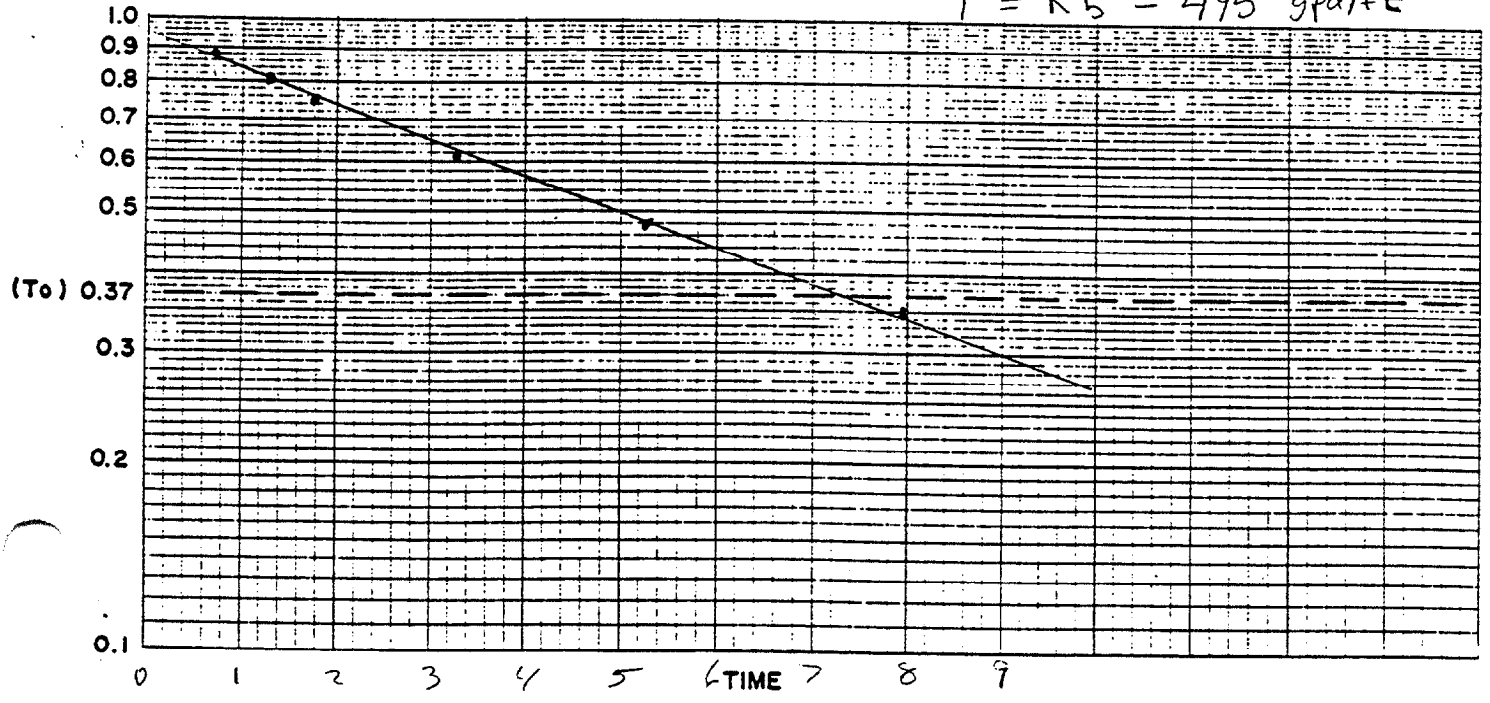
$$K = \frac{(.5)^2 \ln\left(\frac{25}{1}\right)}{2\,(25)\,(441)}$$

$= 3.65 \times 10^{-5}$ ft/s $= 23.6$ gpd/ft^2

$T = Kb = 495$ gpd/ft

TIME	WATER DEPTH	t	h	(H-h)/(H-Ho)
40		.67	21.0	.38
1:13		1.27	20.5	.81
1:45		1.75	20	.75
3:15		3.25	19.0	.61
5:14		5.23	18.0	.48
7:56		7.93	17.0	.35
9:58		9.97	16.0	.21

7.5



$T_o = .35_{min} = 441$ sec

APPENDIX E

GROUNDWATER SAMPLING AND ANALYSIS PLAN

Sampling

Use of the following procedures for sampling cf groundwater 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 groundwater samples from wells containing only a few gallons of groundwater and no product present, the bailing procedures are preferred. To obtain representative groundwater 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 Groundwater 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 Groundwater 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 Groundwater 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 groundwater 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 groundwater only.

10. Record the physical appearance of the ground water on the Groundwater 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 bottles cannot be filled quickly, keep them cool with the caps on until they are filled. The vials labeled "volatiles" analysis should be filled from one bailer then securely capped. Add 0.2 ml of a mixture of 1 part A.C.S. reagent grade, concentrated hydrochloric acid (approximately 38%) to 1 part of organic-free water to each 40 ml VOA vial. This will adjust the pH to less than 2. Carefully fill the 40 ml VOA vials to minimize agitation. This is usually done by pouring the sample into a tilted VOA vial. Cap the VOA vial, turn it upside down and check for air bubbles. If properly filled,

there should be no visible air bubbles. Filter samples for metals analysis through a 0.45 micron filter and adjust the pH to less than 2 with A.C.S. reagent grade, concentrated (approximately 69-71%) nitric acid. Alternatively, metals samples may be filtered in the laboratory. If this option is selected, do not add the nitric acid preservative. Return each sample bottle to its proper transport container. 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 groundwater following the procedures outlined in the equipment operation manuals. Record this information on the Groundwater Sampling Field Log. The 200 ml beaker must then be rinsed with distilled water prior to reuse.

19. Begin the Chain of Custody Record.

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

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

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

Sampling Procedures (PUMP)

1. Identify the well and record the location on the Groundwater 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 Groundwater 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 Groundwater 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 groundwater 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 groundwater only.

10. Record the physical appearance of the groundwater on the Groundwater 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 groundwater 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 Groundwater 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. Always fill the vials labeled "volatiles" (40 ml VOA vials) first. Filter samples for metals analysis and add nitric acid, as previously discussed in the "Bailer" section, to adjust the pH to less than 2. Alternatively, metals samples may be filtered in the laboratory. If this option is selected, do not add the nitric acid preservative. Preserve the volatiles samples with hydrochloric acid as previously discussed in the "Bailer" section. Return each sampling bottle to its proper transport container.

15. If the sample bottle cannot be filled quickly, keep them cool with the caps on until they are filled. The vials labeled "volatiles" analysis should be filled first, then 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 groundwater following the procedures outlined in the equipment operation manuals. Record this information on the Groundwater 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.

Analyses

A total of ten (10) samples will be analyzed for volatile organic compounds utilizing USEPA Methods 601 and 602 to assess the extent of soluble petroleum hydrocarbons (i.e., benzene, toluene, and xylene) and chlorinated solvents within the groundwater. Each will be analyzed for total lead by induction coupled argon plasma (ICAP).

The following eight wells will be sampled: monitoring well 22GW1 (ESE, 1988); the two recovery wells and 5 newly installed monitoring wells as indicated on the proposed well location map. For quality assurance/quality control purposes, one field blank and one replicate sample will be analyzed for each parameter. All analyses will be conducted by a laboratory in the Tidewater Virginia area with validation to be conducted by an independent laboratory.

DOC. NO.: CLEJ-00382-3.05-01/01/90

APPENDIX F
LABORATORY REPORTS

OBG LABORATORIES, INC.

Laboratory Report

CLIENT NAVY JOB NO. 3543.004.517

DESCRIPTION Camp Lejeune - Hadnot Point

Results reported as ppb

DATE COLLECTED 4-20 & 21, 1988 DATE REC'D. 4-22-88 DATE ANALYZED 4-29 to 5-3, 1988

Description	MW#13	MW#14	MW#15	MW#16	MW#17	MW#18	MW#19	MW#20	Replicate	Wash Blank	Q C Trip Blank
Sample #	G7946	G7947	G7948	G7949	G7950	G7951	G7952	G7953	G7954	G7955	G7961
Petroleum Hydrocarbons and Solvents by Purge & Trap/GC											
BENZENE	6.	4.	4700.	28000.	11000.	24000.	21.	60.	12000.	<1.	<1.
TOLUENE	2.	<1.	18000.	28000.	13000.	42000.	150.	160.	35000.		
ETHYLBENZENE	2.	<1.	2400.	1900.	2500.	1900.	53.	79.	2400.		
XYLENES	8.	2.	13000.	12000.	9100.	12000.	130.	96.	11000.		
TRICHLOROETHENE	<1.	<1.	<1000.	<1000.	<100.	<1000.	<1.	<1.	<1000.	<1.	<1.
TETRACHLOROETHENE	<1.	<1.	<1000.	<1000.	<100.	<1000.	<1.	<1.	<1000.	<1.	<1.
1,2-DICHLOROETHANE	<1.	<1.	<1000.	1800.	200.	<1000.	<1.	<1.	<1000.	<1.	<1.
MTBE	<10.	<10.	<10000.	<10000.	2800.	<10000.	<10.	<10.	<10000.	<10.	<10.
TOTAL HYDROCARBONS	23.	11.	43000.	79000.	42000.	96000.	640.	870.	62000.	<10.	<10.
COMMENTS	-	-	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	-	-

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

Units: mg/l (ppm) unless otherwise noted

Comments:

Authorized: Grant

Date: June 9, 1988

OBG Laboratories, Inc.
Box 4942 / 1304 Buckley Rd. / Syracuse, NY 13221 / (315) 457-1494

DOC. NO.: CLET-00382-3.05-01/01/90

OBG LABORATORIES, INC.

Laboratory Report

CLIENT NAVY JOB NO. 3543.004.517

DESCRIPTION Camp Lejeune - Hadnot Point

Results reported as ppb

DATE COLLECTED 4-20 & 21, 1988 DATE REC'D. 4-22-88 DATE ANALYZED 4-29 to 5-3, 1988

Description	MW#1	MW#2	MW#3	MW#4	MW#5	MW#6	MW#7	MW#8	MW#9	MW#10	MW#11	MW#12
Sample #	G7934	G7935	G7936	G7937	G7938	G7939	G7940	G7941	G7942	G7943	G7944	G7945
Petroleum Hydrocarbons and Solvents by Purge/Trap/GC												
BENZENE	1900.	29000.	<1.	<1.	<1.	600.	28000.	19.	<1.	51.	1.	19000.
TOLUENE	36000.	110000.	2.		1.	1700.	26000.	1.	<1.	1.	1.	17000.
ETHYLBENZENE	3200.	11000.	<1.		<1.	1600.	2800.	<1.	2.	9.	<1.	1500.
XYLENES	21000.	48000.	4.	2.	2.	7100.	12000.	<1.	8.	14.	1.	8400.
TRICHLOROETHENE	<1000.	<1000.	<1.	<1.	<1.	<100.	<1000.	<1.	<1.	<1.	<1.	<1000.
TETRACHLOROETHENE	<1000.	<1000.	<1.	<1.	<1.	<100.	<1000.	<1.	<1.	<1.	<1.	<1000.
1,2-DICHLOROETHANE	1000.	<1000.	<1.	<1.	<1.	<100.	1000.	<1.	<1.	1.	<1.	2000.
MTBE	<10000.	<10000.	<10.	<10.	<10.	<1000.	<10000.	<10.	<10.	<10.	<10.	<10000.
TOTAL HYDROCARBONS	97000.	300000.	480.	16.	<10.	13000.	68000.	26.	92.	170.	<10.	50000.
COMMENTS	Gasoline	Gasoline	Gasoline	-	-	Gasoline	Gasoline	-	Gasoline	Gasoline	-	Gasoline

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

Units: mg/l (ppm) unless otherwise noted

Comments:

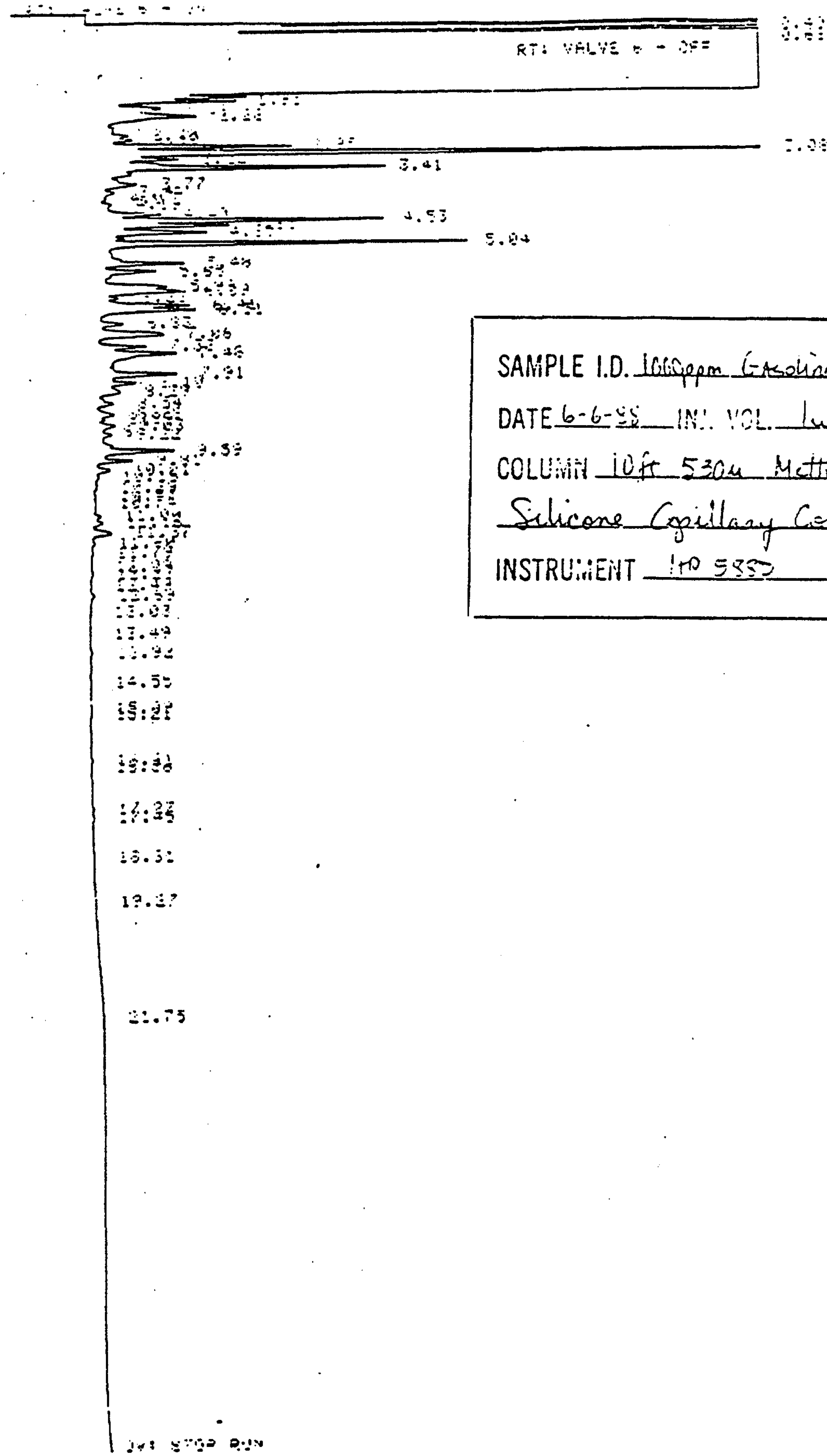
Authorized: Conat

Date: June 9, 1988

OBG Laboratories, Inc.
Box 4942 • 304 Buckley Rd. • Syracuse, NY / 13221 / (315) 457-1494

DOC. NO.: CLEJ-00382-3.05-01/01/90

DOC. NO.: CLEJ-00382-3.05-01/01/90



SAMPLE I.D. 1000ppm Gasoline

DATE 6-6-88 INJ. VOL. 1ul

COLUMN 10ft 530u Methyl Silicone Capillary Column

INSTRUMENT HP 5890

009

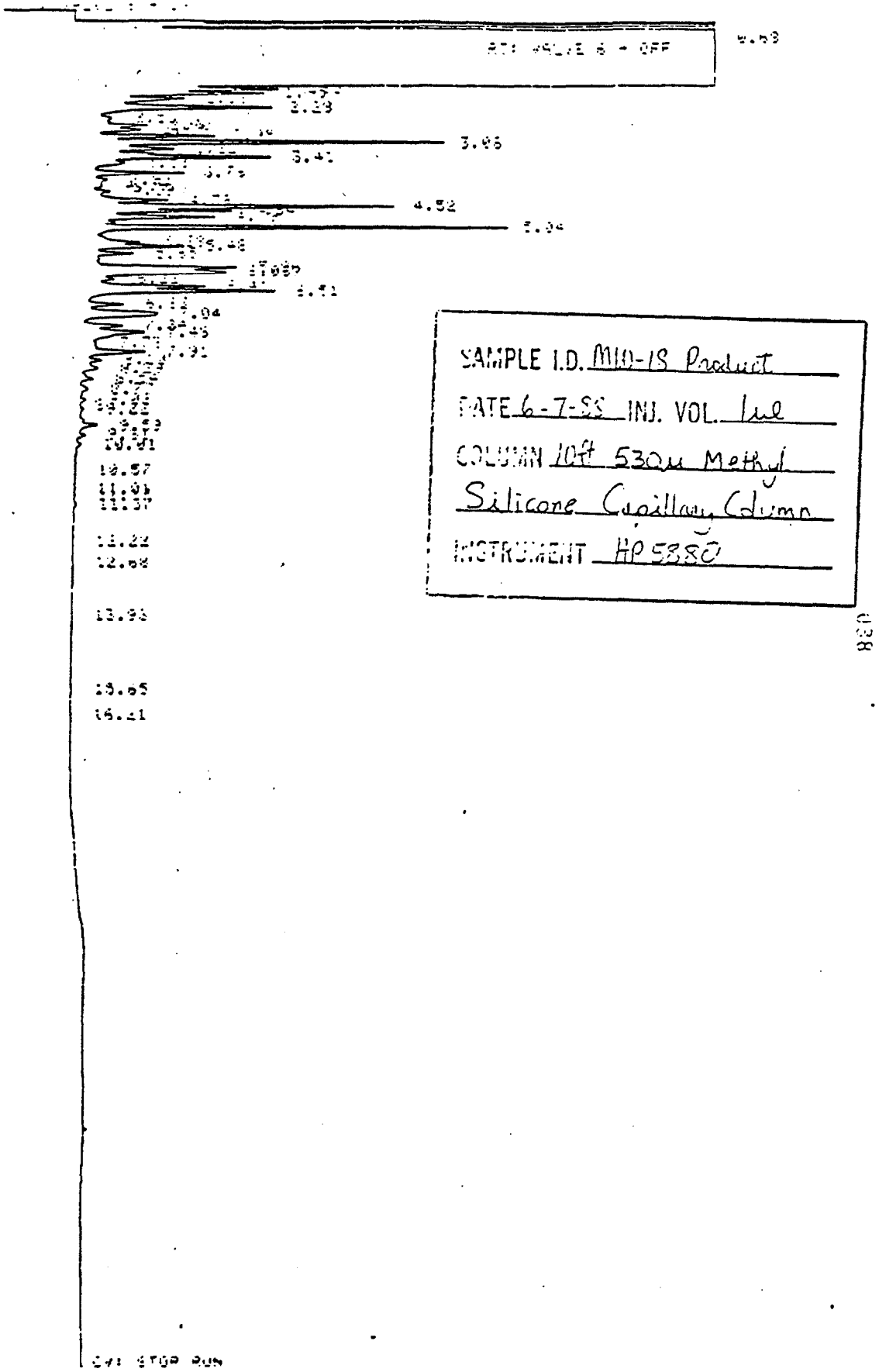
010

[HP] 3388A SAMPLER INJECTION @ 17:33 JUN 6, 1988
SAMPLE # : ID CODE :
1000,GAS

AREA %

RT	AREA	TYPE	AREA %
0.40	5121.71	BB	0.039
[illegible]	[illegible]	[illegible]	[illegible]

DOC. NO.: CLEJ-00382-3.05 -01/01/90

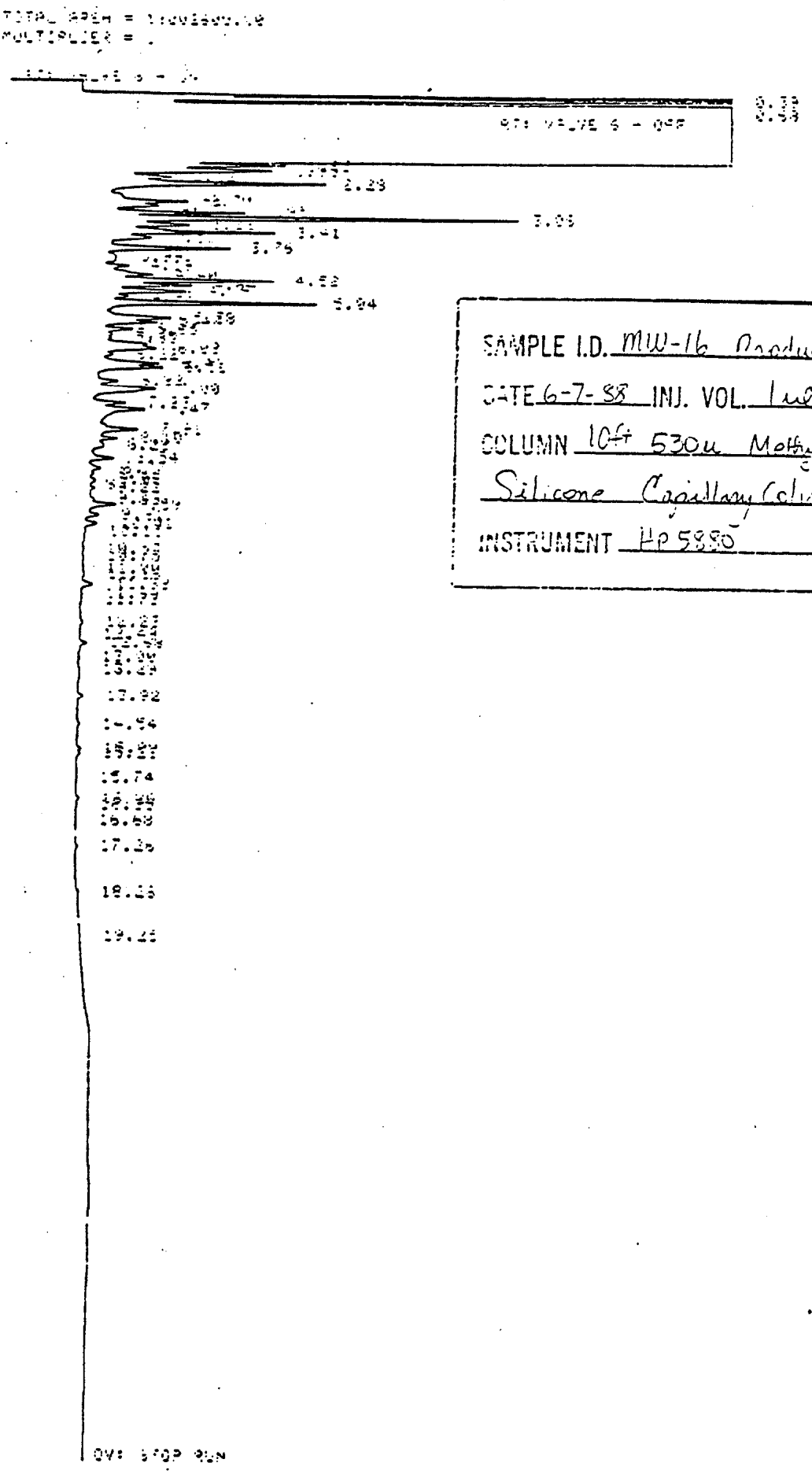


EXP: 5880A SAMPLER INJECTION @ 02:12 JUN 7, 1988
SAMPLE # : 10 CODE 1
17 GT360

AREA %

RT	AREA	TYPE	AREA %
9.68	1283e082.20	VBB	99.969
1.35	e3.42	BP	0.0MM

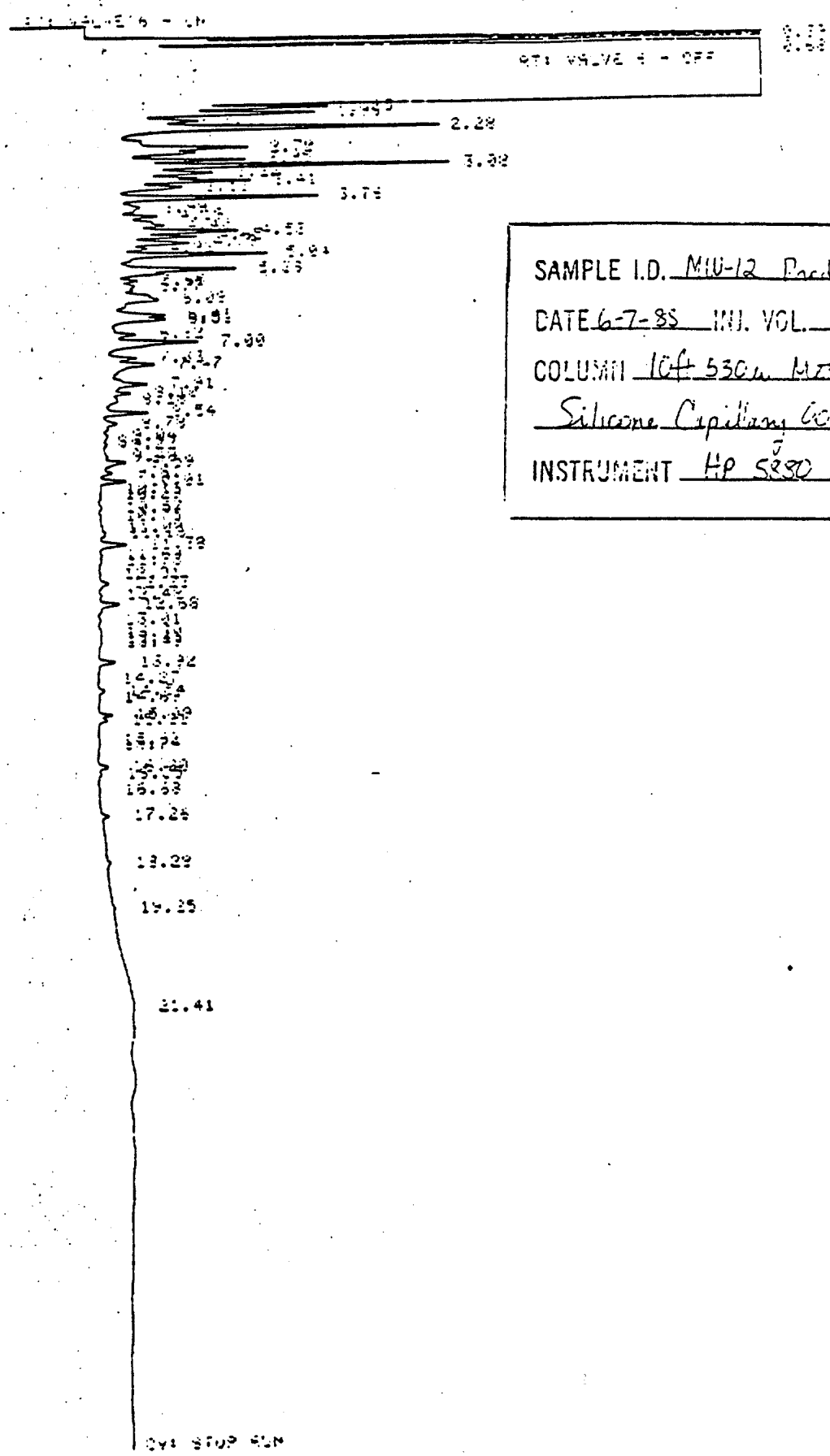
DOC. NO.: CLET-00382-3.05-01/01/90



0135

0136

DOC. NO.: CLEJ-00382-3.05-01/01/90



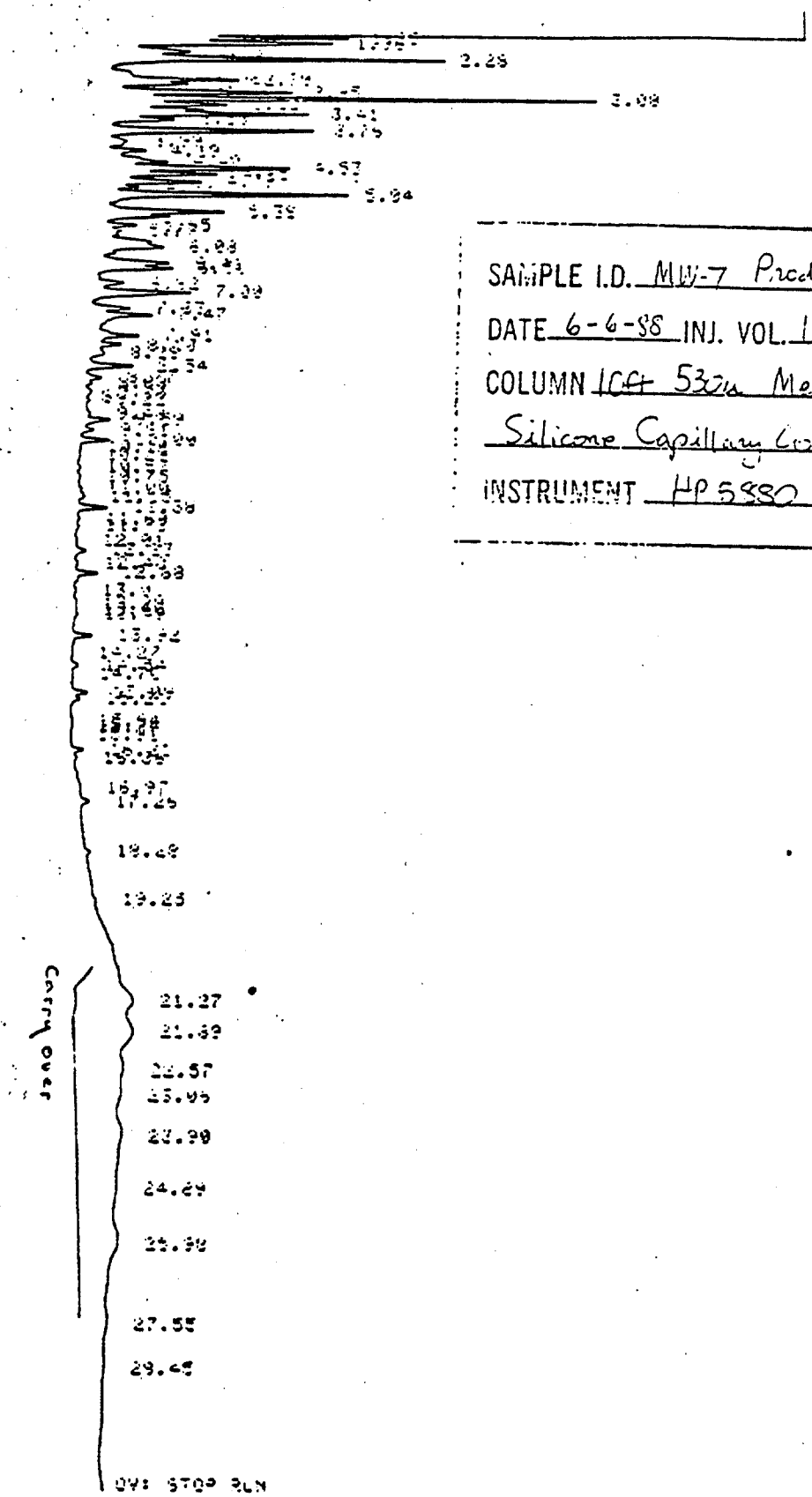
SAMPLE I.D. MW-12 Product
DATE 6-7-88 INJ. VOL. 1ul
COLUMN 10ft 530m Methyl Silicone Capillary Column
INSTRUMENT HP 5880

[HP] 5890A SAMPLER INJECTION @ 09:12 JUN 7, 1988
SAMPLE # : ID CODE :
14 07459

AREA %

RT	AREA TYPE	AREA %

032



SAMPLE I.D. MW-7 Product

DATE 6-6-98 INJ. VOL. 1uL

COLUMN 10ft 530u Methyl Silicone Capillary Column

INSTRUMENT HP 5880

620

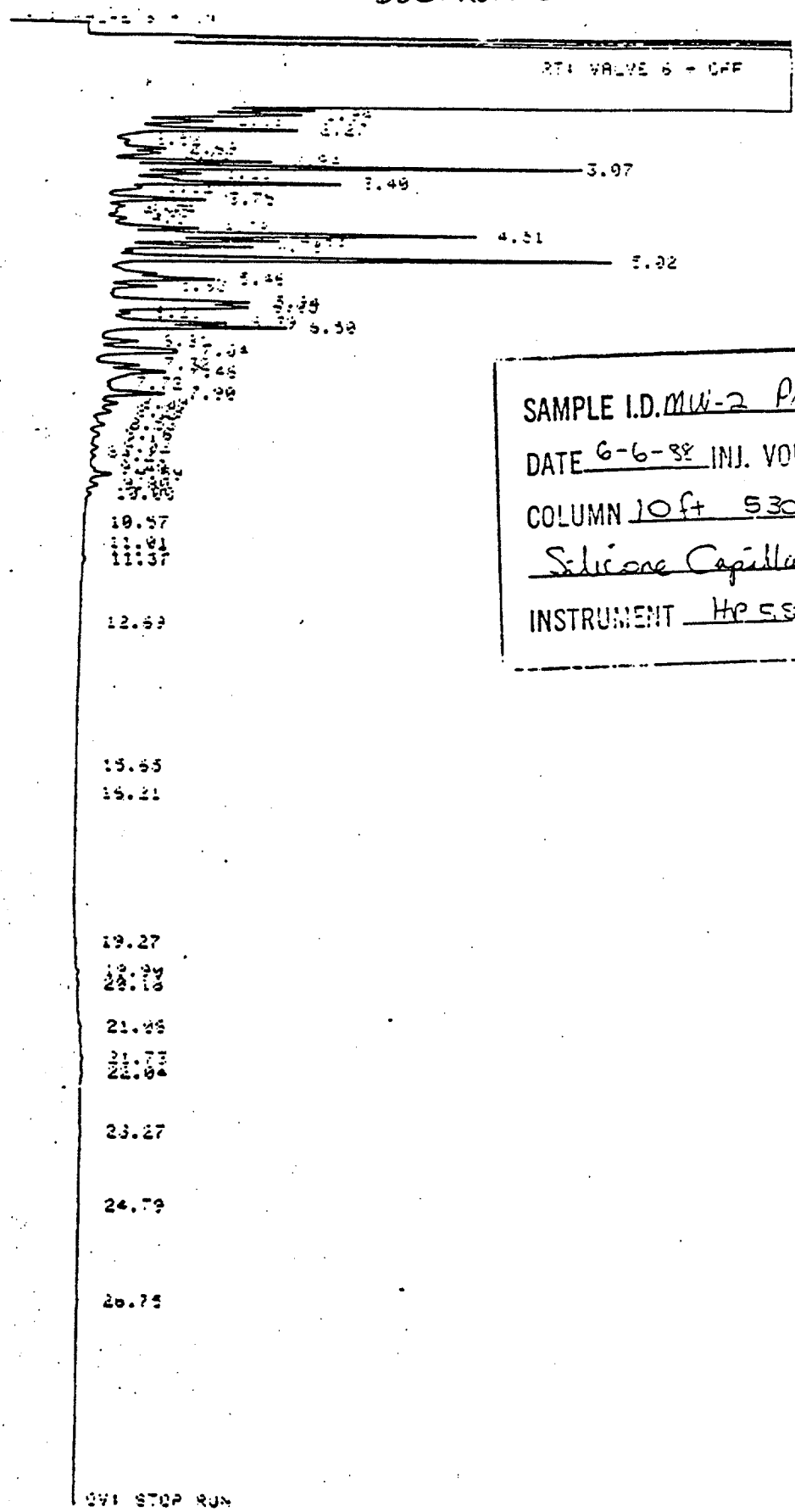
HP3 5880A SAMPLER INJECTION 9 23:33 JUN 6, 1998

SAMPLE # :	ID CODE :
13	G7957

AREA %

RT	AREA	TYPE	AREA %
8.39	1451.26	BB	0.011
8.68	12961304.82	BBB	99.353
1.85	119.23	BB	0.001
1.96	281.44	BB	0.002
2.13	47.13	BB	0.000

DOC. NO.: CLEJ-00382-3.05-01/01/90



SAMPLE I.D. MW-2 Product
DATE 6-6-88 INJ. VOL. 1ml
COLUMN 10ft 530m Methyl Silicone Capillary Column
INSTRUMENT HP 5880

[HP] 5880A SAMPLER INJECTION @ 10:53 JUN 7, 1988
SAMPLE # : ID CODE :
12 07356
AREA %

RT	AREA	TYPE	AREA %
0.06	12[illegible]08.34	BB	99.966
1.94	[illegible]5.25	PB	0.391

DOC. NO.: CLEJ-00382-3.05-01/01/90

OBG LABORATORIES, INC.

Laboratory Report

CLIENT NAVY JOB NO. 3543.004.517

DESCRIPTION Camp Lejeune - Hadnot Pt.

DATE COLLECTED 4-20-88 DATE REC'D. 4-22-88 DATE ANALYZED 6-3-88

Description	Sample #	Petroleum Identification
MW-2 Product	G7956	Gasoline
MW-7 Product	G7957	Gasoline
MW-12 Product	G7958	Gasoline
MW-16 Product	G7959	Gasoline
MW-18 Product	G7960	Gasoline

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

Units: mg/l (ppm) unless otherwise noted

Comments:

Authorized: [signature]

Date: June 9, 1988

OBG Laboratories, Inc.
Box 4942 / 1304 Buckley Rd. / Syracuse. NY / 13221 / (315) 457-1494

CLEC LABORATORIES, INC.

Laboratory Report

CLIENT NAVY JOB NO. 3543.004.517

DESCRIPTION Camp Lejeune - Hadnot Point

Results reported as ppb

DATE COLLECTED 4-20 & 21, 1988 DATE REC'D. 4-22-88 DATE ANALYZED 4-29 to 5-3, 1988

Description	MW#13	MW#14	MW#15	MW#16	MW#17	MW#18	MW#19	MW#20	Replicate	Wash Blank	Q C Trip Blank
Sample #	G7946	G7947	G7948	G7949	G7950	G7951	G7952	G7953	G7954	G7955	G7961
Petroleum Hydrocarbons and Solvents by Purge & Trap/GC											
BENZENE	2.	6.	4700.	28000.	11000.	24000.	21.	60.	12000.	<1.	<1.
TOLUENE	2.	<1.	18000.	28000.	13000.	42000.	150.	160.	35000.	↓	↓
ETHYLBENZENE	2.	<1.	2400.	1900.	2500.	1900.	53.	79.	2400.		
XYLENES	8.	2.	13000.	12000.	9100.	12000.	130.	96.	11000.		
TRICHLOROETHENE	<1.	<1.	<1000.	<1000.	<100.	<1000.	<1.	<1.	<1000.	<1.	<1.
TETRACHLOROETHENE	<1.	<1.	<1000.	<1000.	<100.	<1000.	<1.	<1.	<1000.	<1.	<1.
1,2-DICHLOROETHANE	<1.	<1.	<1000.	1800.	200.	<1000.	<1.	<1.	<1000.	<1.	<1.
MTBE	<10.	<10.	<10000.	10000.	2800.	<10000.	<10.	<10.	<10000.	<10.	<10.
TOTAL HYDROCARBONS	23.	11.	43000.	79000.	42000.	96000.	640.	870.	62000.	<10.	<10.
COMMENTS	-	-	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	-	-

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

Units: mg/l (ppm) unless otherwise noted

Comments:

CLEC Laboratories, Inc.

June 9, 1988

DOC. NO.: CLET-00382-3.05-01/01/90

CLG LABORATORIES, INC.

Laboratory Report

CLIENT NAVY JOB NO 3543.004.517

DESCRIPTION Camp Lejeune - Hadnot Point

Results reported as ppb

DATE COLLECTED 4-20 & 21, 1988 DATE REC'D. 4-22-88 DATE ANALYZED 4-29 to 5-3, 1988

Description	MW#1	MW#2	MW#3	MW#4	MW#5	MW#6	MW#7	MW#8	MW#9	MW#10	MW#11	MW#12
Sample #	G7934	G7935	G7936	G7937	G7938	G7939	G7940	G7941	G7942	G7943	G7944	G7945
Petroleum Hydrocarbons and Solvents by Purge & Trap/GC												
BENZENE	19000.	29000.	<1.	<1.	<1.	600.	28000.	19.	<1.	51.	1.	19000.
TOLUENE	36000.	110000.	2.	↓	1.	1700.	26000.	1.	<1.	1.	1.	17000.
ETHYLBENZENE	3200.	11000.	<1.	↓	<1.	1600.	2800.	<1.	2.	9.	<1.	1500.
XYLENES	21000.	48000.	4.	2.	2.	7100.	12000.	<1.	8.	11.	1.	8400.
TRICHLOROETHENE	<1000.	<1000.	<1.	<1.	<1.	<100.	<1000.	<1.	<1.	<1.	<1.	<1000.
TETRACHLOROETHENE	<1000.	<1000.	4.	<1.	<1.	<100.	<1000.	<1.	<1.	<1.	<1.	<1000.
1,2-DICHLOROETHANE	1000.	<1000.	<1.	<1.	<1.	<100.	1000.	<1.	<1.	1.	<1.	2000.
MTBE	<10000.	<10000.	<10.	<10.	<10.	<1000.	<10000.	<10.	<10.	<10.	<10.	<10000.
TOTAL HYDROCARBONS	97000.	300000.	480.	16.	<10.	13000.	68000.	26.	92.	170.	<10.	50000.
COMMENTS	Gasoline	Gasoline	Gasoline	-	-	Gasoline	Gasoline	-	Gasoline	Gasoline	-	Gasoline

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

Units: mg/l (ppm) unless otherwise noted

Comments:

June 9, 1988

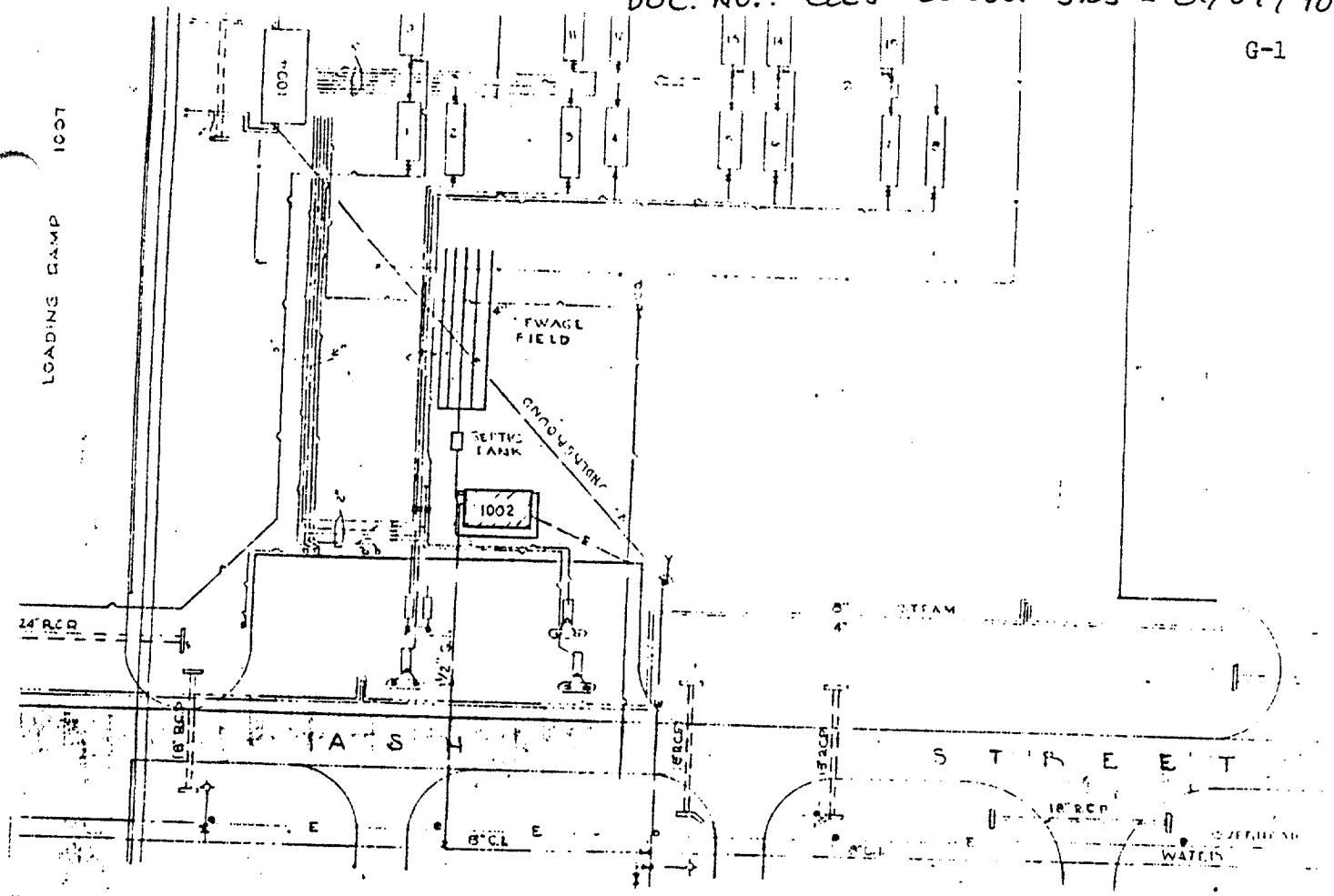
DOC. NO.: CLET-00382-3.05-01/01/90

DOC. NO.: CLET-00382-3.05-01/01/90

APPENDIX G - UTILITIES

DOC. NO.: CLEJ-00382-3.05 - 01/01/90

G-1



SITE PLAN

SCALE 1" = 50'-0"

REVISION	DATE	APPD.	DESCRIPTION

P W DRAWING NO.
6949

MARINE BARRACKS
CAMP LEJEUNE, N. C.

DES	
DRWN	
TR B.M.	
CHK G.C.B. (Site)	
SUPV	
IN CHARGE	

AS-BUILT DRAWING

GAS AND OIL FILLING STATION
BUILDING NO. 1002

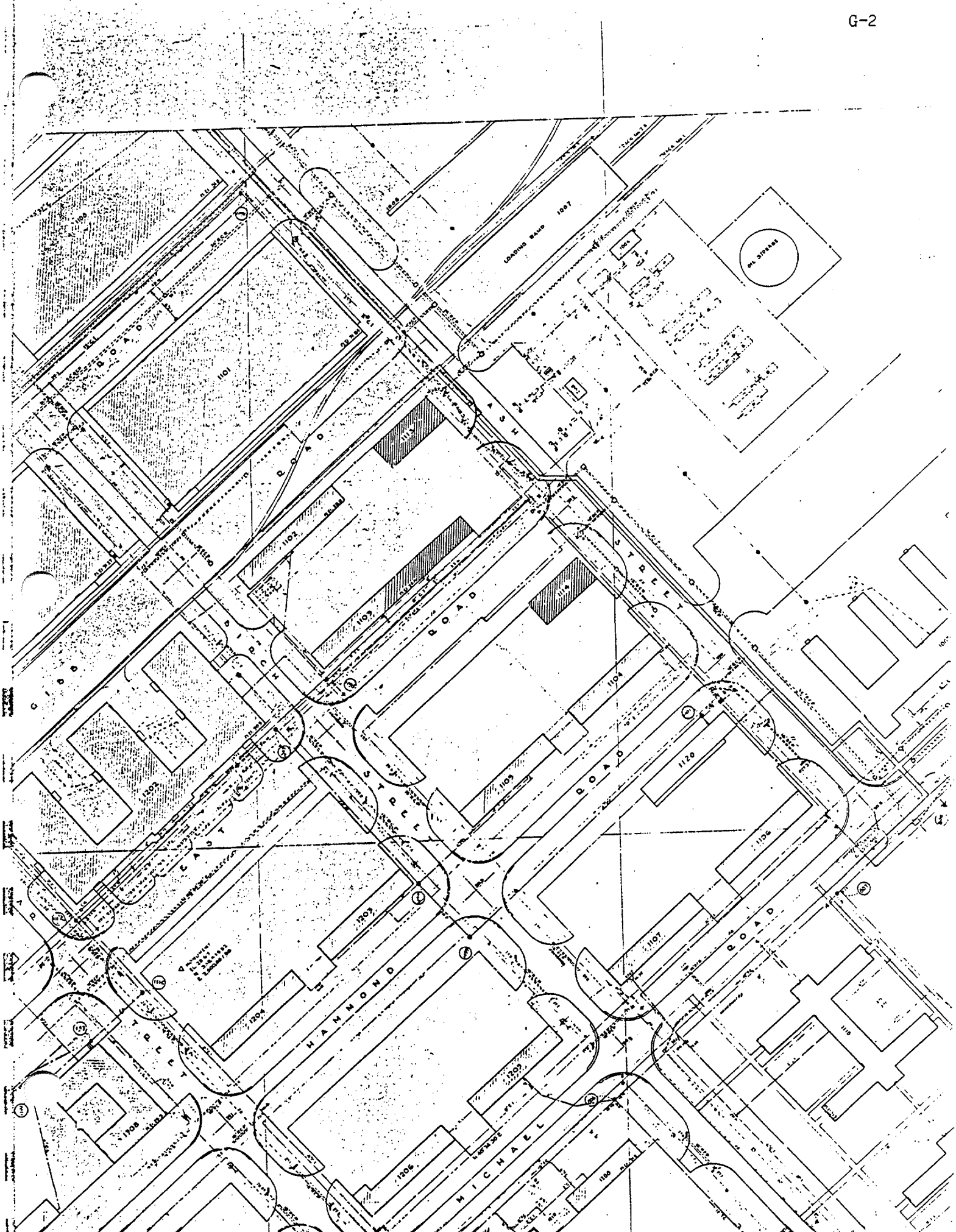
APPROVED E.R. Bennett DATE 7/27/51
PUBLIC WORKS OFFICER

APPROVED
THE QUARTERMASTER GENERAL OF

SCALE As Noted | SPEC
SHEET ___ OF ___ | NOy ___

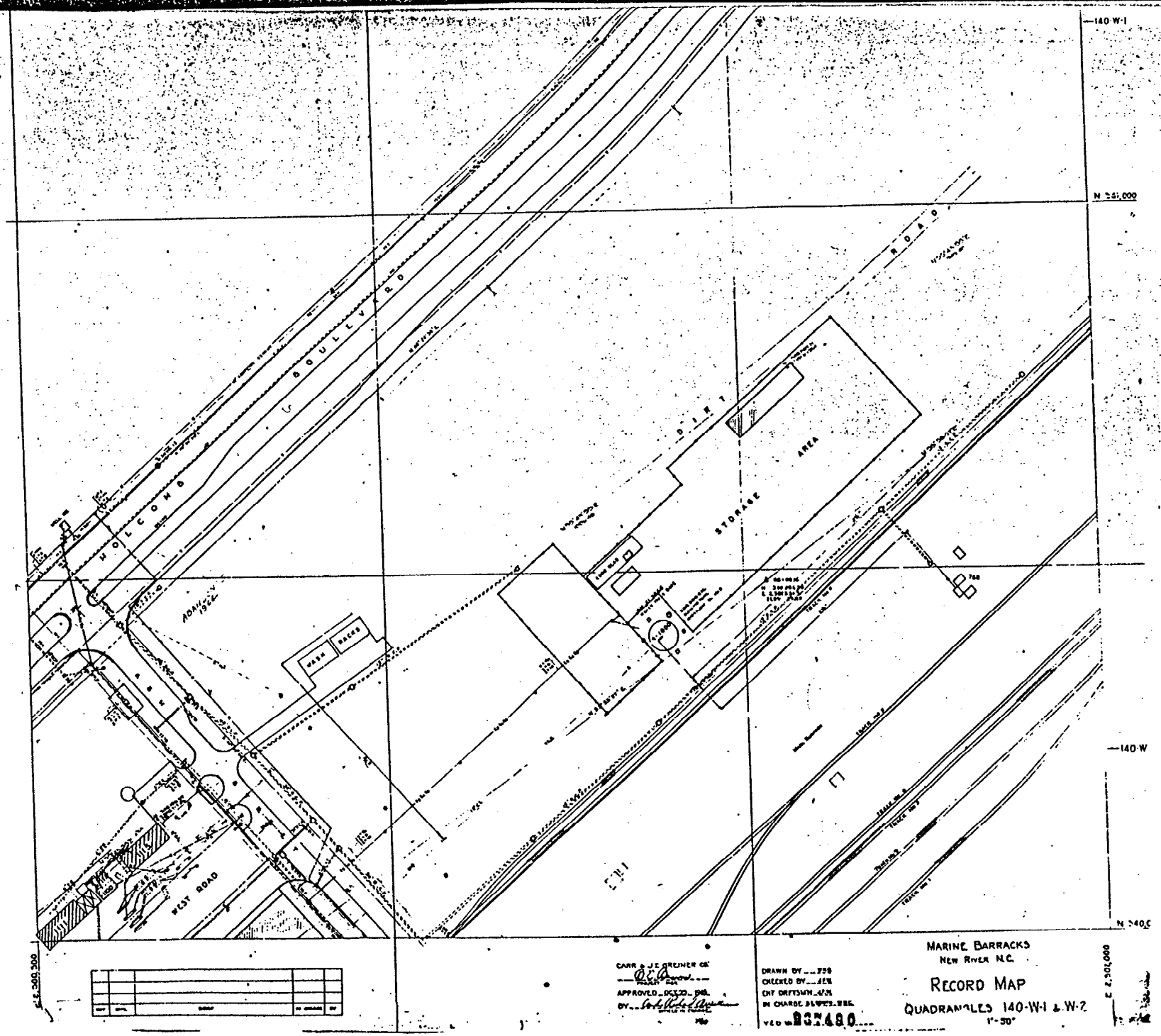
DOC. NO.: CLET-00382-3.05-01/01/98

G-2



DOC. NO.: CLET-00382 - 3.05-01/01/90

G-3



LEGEND

- BUILDINGS AND STRUCTURES
- ROADS AND HIGHWAYS
- ROADS (Unpaved)
- FENCE
- 5' CONTOUR (Source - USGS Maps)
- HELICOPTER LANDING ZONE
- SWAMP OR MARSH
- SANITARY SEWER
- MANHOLE
- SERVICE LINE
- FORCE MAIN
- SEWAGE PUMPING STATION
- JUNCTION BOX
- OIL/WATER SEPARATOR
- STORAGE TANK
- SEPTIC TANK

MATERIAL OF CONSTRUCTION

AC - ASBESTOS CEMENT
CI - CAST IRON
VC - VITRIFIED CLAY
DI - DUCTILE IRON
PVC - POLYVINYL CHLORIDE

NOTES:

ALL GRAVITY SEWERS ARE TERRA COTTA UNLESS NOTED OTHERWISE.

NORTH

0 200 400 600 800

GRAPHIC SCALE IN FEET

NO	DESCRIPTION OF REVISION	DATE	INT.

DEPARTMENT OF THE NAVY
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

WASTEWATER COLLECTION SYSTEM
EXISTING CONDITIONS

DATE 31 JULY 84	SCALE GRAPHIC	SHEET F-8 OF 73

DOC. NO. CLEST-00382-3.05-01/01/90

F-4

KEY MAP

LEGEND

- BUILDINGS AND STRUCTURES
- ROADS AND HIGHWAYS
- ROADS (Unpaved)
- FENCE
- 5' CONTOUR (Source - USGS Maps)
- SL-4 / 12 HELICOPTER LANDING ZONE
- SWAMP OR MARSH
- POST INDICATOR VALVE
- POTABLE WATER MAIN
- RAW WATER MAIN
- VALVE
- AIR RELEASE VALVE
- FIRE HYDRANT
- WATER WELL
- ELEVATED STORAGE TANK
- WATER METER
- CAPPED MAIN

MATERIALS OF CONSTRUCTION
AC - ASBESTOS CEMENT

NOTES:
ALL WATER MAINS ARE CAST IRON UNLESS NOTED OTHERWISE.

NORTH

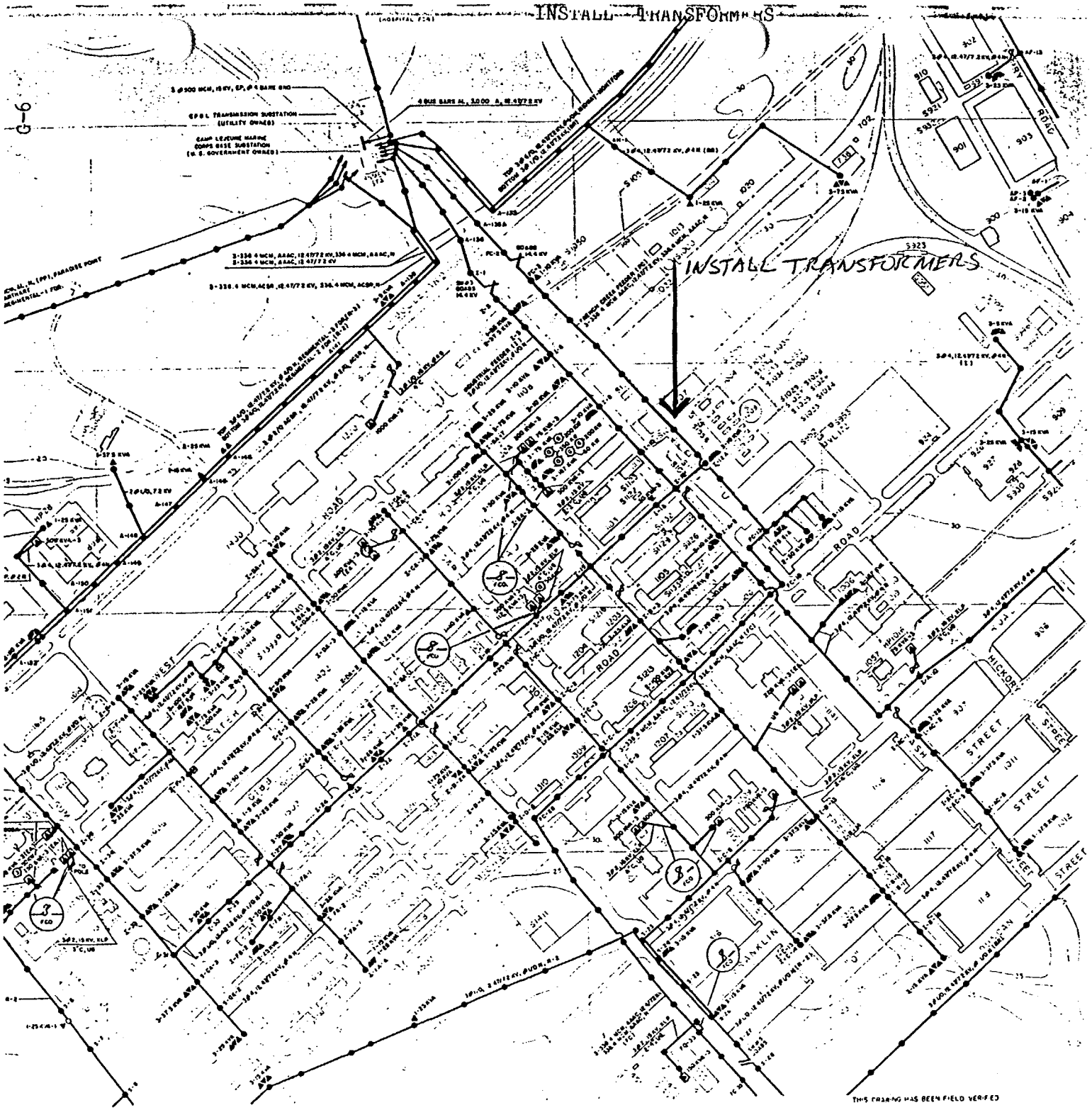
0 200 400 600 800
GRAPHIC SCALE IN FEET

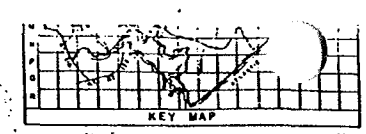
NO	DESCRIPTION OF REVISION	DATE	INT

DEPARTMENT OF THE NAVY
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

WATER DISTRIBUTION SYSTEM
EXISTING CONDITIONS

DOC. NO.: LEJET-00382-3.05-01/01/90





LEGEND

- BUILDINGS AND STRUCTURES
- ROADS AND HIGHWAYS
- ROADS (Unpaved)
- FENCE
- 5' CONTOUR (Source - USGS Maps)
- HELICOPTER LANDING ZONE
- SWAMP OR MARSH
- OVERHEAD PRIMARY POLE LINE 3 PHASE, UNLESS SINGLE PHASE NOTED.
- OVERHEAD DISTRIBUTION TRANSFORMER
- FUSED CUTOUT (CLOSED POSITION UNLESS INDICATED BY N.O.)
- AIR SWITCH OPEN POSITION OR CLOSED POSITION
- UNDERGROUND PRIMARY LINE, 3 PHASE, UNLESS SINGLE PHASE NOTED.
- PAD MOUNTED TRANSFORMER
- PAD MOUNTED SWITCH
- GENERATOR
- METER

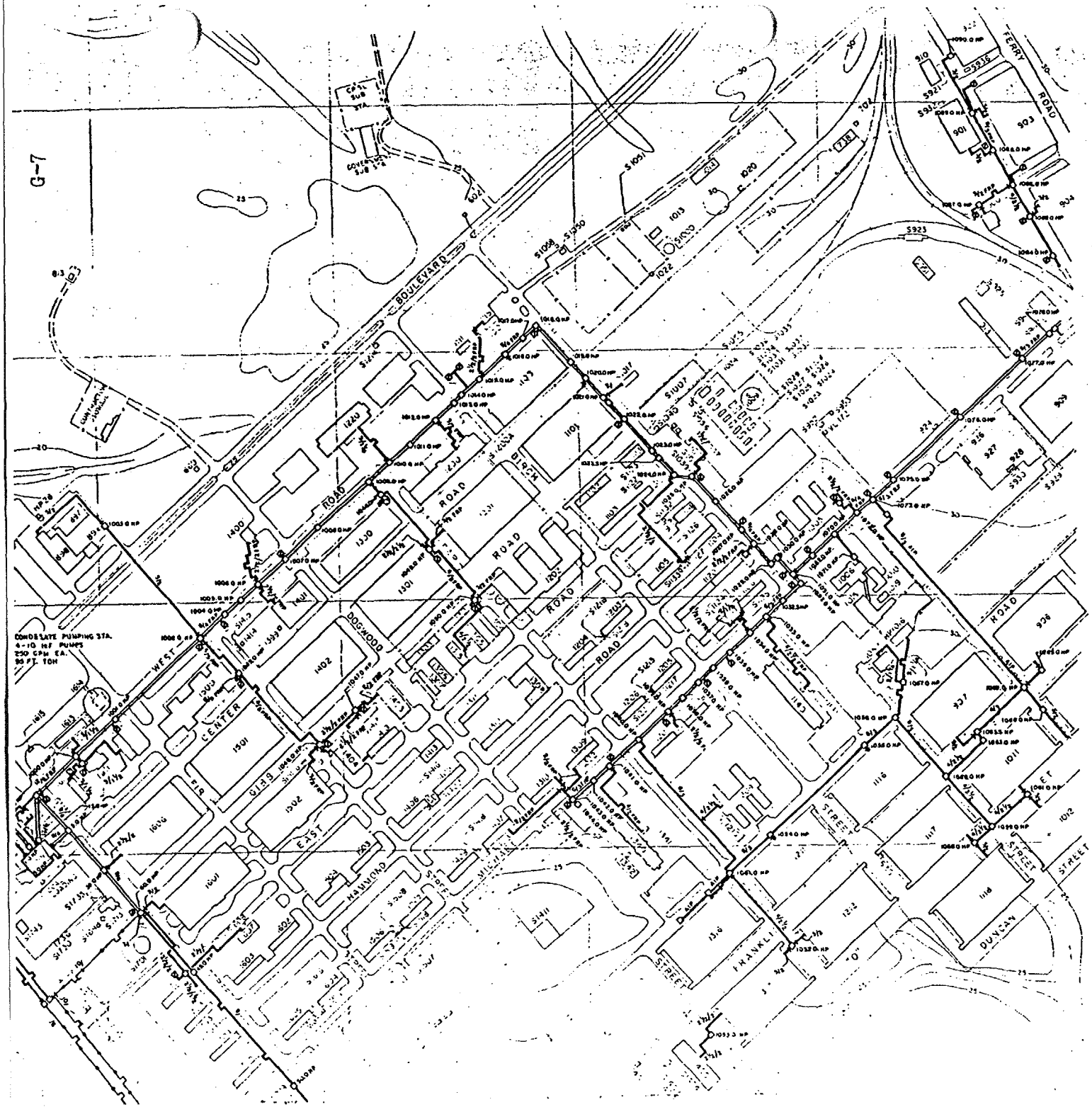
NO	DESCRIPTION OF REVISION	DATE	INT

DEPARTMENT OF THE NAVY
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

ELECTRICAL DISTRIBUTION
EXISTING CONDITIONS

DATE 31 JULY 90 | SCALE GRAPHIC | SHEET F-8 OF 73

DOC. NO. CLEJ-00382-3.05-01/01/90



KEY MAP

LEGEND

- BUILDINGS AND STRUCTURES
- ROADS AND HIGHWAYS
- ROADS (Unpaved)
- FENCE
- 5' CONTOUR (Source - USGS Maps)
- HELICOPTER LANDING ZONE
- SWAMP OR MARSH
- UNDERGROUND MAIN - DIRECT BURIAL
- UNDERGROUND MAIN IN TUNNEL
- ABOVE GROUND MAIN
- STEAM PIT
- CONDENSATE COOLING PIT
- VALVES IN PIT - MARK INDICATES DIRECTION OF CONTROL
- EXPANSION LOOP
- ABANDONED IN PLACE

MATERIALS OF CONSTRUCTION
FRP - FIBERGLASS REINFORCED PLASTIC

NOTES:
ALL STEAM PIPING IS SCHEDULE 80 STEEL. CONDENSATE PIPING IS SCHEDULE 80 STEEL UNLESS NOTED OTHERWISE.
EXPANSION JOINTS FOR LINES IN TUNNEL LOCATED AT ALTERNATE ANCHOR POINTS - ACCESSIBLE BY MANHOLE COVER
PIPE INSULATION THICKNESS AND TYPE:
STEAM AND CONDENSATE - 1 1/2" TO 2" CALCIUM SILICATE
EXCEPT BLDGS 1810 - 1813 - 4" CALCIUM SILICATE ON STEAM
- 1 1/2" CALCIUM SILICATE ON CONDENSATE

NORTH

0 200 400 600 800
GRAPHIC SCALE IN FEET

NO	DESCRIPTION OF REVISION	DATE	INT.

DEPARTMENT OF THE NAVY
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

STEAM/CONDENSATE DISTRIBUTION SYSTEM
EXISTING CONDITIONS

DATE 31 JULY 84	SCALE GRAPHIC	SHEET F-8 OF 73

DOC NO.: CLEJ-00382-3.95-01/01/90

APPENDIX H

BASIS FOR DESIGN

DOC. NO.: CLET-00382-3.05-01/01/90

HADNOT POINT
RECOVERY AND TREATMENT SYSTEM
BASIS OF DESIGN

I. General

Recovery of free product: Pneumatic ejector system (four six inch recovery wells)

Treatment of drawdown water: Oil/water separation; air stripping

Discharge of drawdown water): Storm sewer

II. Aquifer Characteristics:

Transmissivity: 500 gpd/ft

Recovery Well Radius of Influence: 300 - 400 ft

Well Yield: 3 gpm

III. Drawdown Water Characteristics and Effluent Limitations:

Flow:

Average: 12 GPM

System Design Capacity: 20 GPM

Drawdown Water Quality:

Benzene:	30,600 ppb
Toluene:	72,500 ppb
Ethyl Benzene:	6,900 ppb
Xylene:	31,300 ppb

Effluent Limitations:

Benzene:	700 ppb
Toluene:	5000 ppb
Ethyl Benzene:	430 ppb
Xylene:	no limit

IV. Major Processes

Product Recovery

Drawdown Water Treatment

Oil/Water Separation

Air Stripping

Fluid Transfer and Storage

V. Product Recovery

1. Recovery Wells

Number:	4
Diameter:	6 inches
Depth:	35 feet
Drawdown:	10 feet

2. Recovery System

Type:	Pneumatic Ejector
Components:	Water Table Depression Pump (1/well) Product Recovery Pump (1/well) Remote Air Valve Assembly (1/well) Bellows Liquid Level Control (1/well)
Enclosure:	Manhole below grade (1/well)

3. Control Panel

Number:	1
Location:	Treatment Pad
Type:	Pneumatic

4. Compressor

Number:	1
Type:	Duplex Tank Mounted
Size:	TBD

V. Drawdown Water Treatment:

1. Oil/Water Separator

Number:	1
Capacity:	30 gpm
Coalescing Area:	670 square feet
Rating:	10 microns
Type:	Slant Rib Coalescing
Accessories:	Integral Product Pump

2. Air Stripper

Number:	1
Capacity:	20 gpm
Diameter:	10 inches
Packed Bed Height:	25 feet
Matl of Constr:	Aluminum
Blower:	1 HP

VI. Fluid Transfer and Storage:

1. Recovery System Hoses

Description:	Recovered Product Hose Drawdown Water Hose Air Hose - Drawdown Ejector Air Hose - Product Ejector Air Hose - Control Air
Location:	Below grade in PVC Conduit

2. Recovered Product Tank

Number:	1
Size:	3000 gallons
Matl of Const:	Steel
Accessories:	Tank Full Sensor Normal Vent Manhole w/cover (Emer. Vent) Tank Drain
Overflow:	To containment area (4000 gal)

3. Surge Tank

Number:	1
Size:	550 gallons
Matl of Const:	Steel
Accessories:	Free Product Sensor Float Switches (low, high, high-high) Normal Vent Manhole w/cover (Emer. Vent) Tank Drain
Overflow:	To containment area (4000 gal)

4. Air Stripper Booster Pump

Number:	1
Capacity:	20 GPM @ 35 feet TDH

5. Treatment System Piping

Description:	PVC, sized as required

DOC.NO.: CLEJ-00382-3.05-01/01/90