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Phase I Work Plan
Pilot Test to Evaluate Enhancement of Product Recovery

U.S. Naval Station
Roosevelt Roads
Ceiba, Puerto Rico

Prepared for:

Department of the Navy
Atlantic Division
Naval Facilities Engineering Command
Norfolk. Virginia

And

J.A. Jones Environmental Services

January 13, 2000

SCIENCE : STRATEGY : TECHNOLOGY : SOLUTIONS

McLaren Hart, Inc.

January 13, 2000

Tracking No. JPDGN-4519-0009-Be
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Naval Health Care Support Facility, Building A
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Norfolk, VA 23511

Attention: Mr. Christopher Penny, Code 1823

VIA Overnight Service

RE: TRANSMITTAL
PHASE 1 WORK PLAN
PILOT TEST TO EVALUATE ENHANCEMENT OF PRODUCT RECOVERY USING PNEUMATIC FRACTURING AND PUMPING TECHNIQUES
TOW WAY FUEL FACILITY
NAVAL STATION ROOSEVELT ROADS
CEIBA, PUERTO RICO
CONTRACT NO. N62470-93-D-3033, TASK ORDER #9

Dear Mr. Penny:

Enclosed is one (1) copy of the Phase 1 Work Plan prepared by McLaren\Hart, Inc. to conduct pilot tests to enhance the performance of a product recovery system at the Tow Way Fuel Facility, U.S. Naval Station Roosevelt Road, Puerto Rico.

The Work Plan is being submitted in two phases. This Phase 1 Work Plan describes a test program, which is designed to establish a pre-Pneumatic Fracture (PF) product recovery baseline for each of the two test plots using a two types of total fluids product recovery systems. The Phase 2 Work Plan (modified Draft Work Plan) will describe the details and mechanics of the proposed pilot test and will also include the recommendations and modifications to the Draft Work Plan. This Phase 2 Work Plan will be submitted under a separate cover.

If you have any questions regarding this transmittal or the project in general, please do not hesitate to contact me.

Respectfully submitted,

William A. Buccille, P.E.
Project Manager

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PHASE 1
WORK PLAN

PILOT TEST TO EVALUATE
ENHANCEMENT OF PRODUCT RECOVERY
USING
PNEUMATIC FRACTURING AND PUMPING TECHNIQUES

AT
U.S. NAVAL STATION
ROOSEVELT ROADS
CEIBA
PUERTO RICO

January 13, 2000

Prepared for:
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Naval Facilities Engineering Command
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TABLE OF CONTENTS

Section **Page**

EXECUTIVE SUMMARY ES-1

1.0 INTRODUCTION 1-1
1.1 Technology Overview 1-2
1.1.1 Pneumatic Fracturing (PF) 1-2
1.1.2 Total Fluids Product Recovery Systems 1-2
1.2 Report Organization 1-3

2.0 BACKGROUND AND PROJECT OBJECTIVES 2-1
2.1 Site Location and Background 2-1
2.2 Site Geology 2-1
2.3 Site Hydrogeology 2-1
2.4 Project Evaluation 2-2
2.4.1 RW-1 Area Soils 2-2
2.4.2 RW-1 Area LNAPL 2-3
2.4.3 PW-6 Area Soils 2-3
2.4.4 PW-6 Area LNAPL 2-3
2.5 Project Objectives 2-4

3.0 PHASE 1 TEST DESIGN
3.1 RW-1 Area 3-1
3.1.1 RW-1 Product Recovery Wells 3-1
3.1.2 MTMW-4 Product Recovery Wells 3-1
3.1.3 Monitoring Wells 3-2
3.1.4 Well Development 3-2
3.2 PW-6 Area 3-2
3.2.1 PW-6 Product Recovery Wells 3-3
3.2.2 Monitoring Wells 3-3
3.2.3 Well Development 3-3
3.3 Permit Acquisition 3-4
3.4 Site Health & Safety Plan (HASP) 3-4
3.4.1 Health & Safety Meetings 3-4
3.4.2 Personal Protection 3-4
3.5 Material Handling and Operational Procedures 3-5

4.0 PHASE 1 TEST PROGRAM 4-1
4.1 Introduction 4-1
4.2 Background Potentiometric Surface Measurements 4-1
4.3 Tidal Monitoring 4-1

TABLE OF CONTENTS (continued)

Section **Page**

4.4 Short Term Tests 4-2
4.4.1 RW-1 Area Objective 4-2
4.4.1.1 RW-1 Methodology 4-2
4.4.1.2 Recovery Test 4-2
4.4.1.3 MTMW-4 Methodology 4-3
4.4.1.4 Recovery Test 4-3
4.4.2 PW-6 Area Objective 4-3
4.4.2.1 PW-06 Methodology 4-3
4.4.2.2 Recovery Test 4-4
4.5 Long Term Tests 4-4
4.5.1 RW-1 Area Objective 4-4
4.5.2 Recovery Test 4-5
4.5.3 PW-6 Area 4-5
4.5.4 Recovery Test 4-5

5.0 TREATMENT SYSTEM DESCRIPTION 5-1
5.1 Treatment System Setup 5-1
5.2 Equipment at the Wellhead 5-1
5.3 Recovery Pumps 5-2
5.4 Vacuum Pumps & Air Treatment 5-2
5.5 Groundwater Treatment 5-2

6.0 PILOT TEST REPORT 6-1
6.1 Preparation of Final Pilot Test Report 6-1

7.0 PROJECT ORGANIZATION 7-1

8.0 PROJECT SCHEDULE 8-1

TABLE OF CONTENTS (Cont'd)

TABLES

1.1 RW-1 Short Term Tests Schedule
1.2 MTMW-4 Short Term Tests Schedule
1.3 PW-06 Short Term Tests Schedule

FIGURES

1 Site Location Map
2 Site Plan Showing Proposed Location of Pilot Test Areas
3 Soil Boring Locations in RW-1 Area
4 Geologic Cross-Section Location Map
5 Geologic Cross-Sections A-A' and B-B' for RW-1 Location
6 Soil Boring Locations in PW-6 Area
7 Geologic Cross-Section C-C' for PW-6 Location
8 Layout Showing Product Recovery and Monitoring Wells in RW-1 Area
9 Layout Showing Product Recovery and Monitoring Wells in PW-6 Area
10 Activity Flow Charts
11 Product Recovery and Treatment System Schematic
12 Site Plan – Temporary Facilities

APPENDICES

A Soil Boring Logs
1- McLaren/Hart
2 – Mantech
3 – RW-1

EXECUTIVE SUMMARY

This Phase 1 work plan is submitted as a Pilot Test approach for evaluating the effectiveness of pneumatic fracturing (PF) to enhance the performance of a product recovery system. The work plan is designed to establish a product recovery baseline for two test plots prior to commencing PF activities, and to evaluate the effectiveness of two total fluids pumping systems under these conditions.

A Phase 2 work plan will be submitted under separate cover. This work plan will describe the details and mechanics of the proposed "Pilot Test to Evaluate Enhancement of Product Recovery Using Pneumatic Fracturing and Pumping Techniques". It will also include the recommendations and modifications to the Draft Work Plan which was submitted to the Navy in Oct. 1999.

The Phase 1 test program consists of the establishment of a baseline for pre-fracture product recovery and product recovery pumping systems at two locations in the Tow Way Fuel Facility (TWFF) located at the Roosevelt Roads Site. The two locations, the RW-1 area and the PW-6 area, were selected because free product is known to be present and information on subsurface conditions (from previous investigations and pilot tests) and historical information on product recovery is available. RW-1 is an existing product recovery well, and PW-06 has been used for product recovery in the past.

In the RW-1 area, a product recovery evaluation test will be performed at the existing product recovery well (RW-1), and at the existing monitoring well (MTMW-4). This test will be performed using a controllerless pneumatic pump system. The test procedure will consist of baseline potentiometric surface measurements before testing (*i.e.,* pumping), short term total fluids product recovery tests in each well, selection of optimum operating conditions for the best-producing well, and performance of a total-fluids product recovery test at this location for a duration of 20 to 30 days.

In the PW-6 area, a similar product recovery evaluation test will be performed on the existing product recovery well, PW-06. The total-fluids product recovery test will employ a vacuum enhanced recovery (VER) System. The test will be performed using a controllerless pneumatic pump and a vacuum pump. The test program is designed to establish the benefit of applying a vacuum to a pneumatically-pumped product recovery well, and to establish optimum operating conditions for a VER system. The test procedure will consist of baseline potentiometric surface measurements, short-term product recovery tests using the pneumatic pumping system, selection of the optimum pump rate and pump intake elevation, and short term product recovery tests using various well vacuums at the selected optimum conditions. Based on the results from this test program, a combined pneumatic and vacuum pump test will be performed in the PW-06 well for approximately twenty to thirty days.

The results obtained during this Phase 1 program will be used as baseline criteria for each test plot prior to PF activities. These criteria will include: total fluid recovery rates, product recovery rates, product to total fluid ratios, estimates of hydraulic parameters, and the effectiveness of the two total fluid product recovery pumping systems.

1.0 INTRODUCTION

This work plan which describes pilot test procedures to evaluate enhancement of product recovery using Pneumatic Fracturing (PF) and pumping techniques at the US Naval Station Tow Way Fuel Facility (TWFF) – Roosevelt Roads Site (Site) will be submitted in two phases. This Phase 1 work plan describes a test program which is designed to establish a pre-Pneumatic Fracture (PF) product recovery baseline for each of the two test plots using a total fluids product recovery system. The program is also designed to evaluate the effectiveness of two total fluids pumping systems under pre-fracture conditions.

The Phase 2 work plan (modified Draft Work Plan) will describe the details and mechanics of the proposed pilot test and will also include the recommendations and modifications to the Draft Work Plan. This work plan will be submitted under separate cover.

As you know, McLaren\Hart, Inc. (McLaren\Hart) is a teamsub-contractor with J. A. Jones Environmental Services (JAJES) on the Petroleum, Oils and Lubricants Remedial Action Contract (POL RAC) operating in the Navy's Atlantic Division. McLaren\Hart is currently operating and maintaining the Interim Corrective Measures, Free Product Recovery System commissioned in 1997 at the TWFF. This study will be conducted as part of pre-design activities for the Product Recovery System at the TWFF. The work will be performed under existing POL RAC Task Order (TO) # 9. The pilot study work plans is considered an Addendum to the approved TO # 9 Work Plan for installation of the Free Product Recovery System at the Tow Way Fuel Facility, submitted on August 16, 1996.

During the period 1957 to 1986, approximately one million gallons of diesel and jet fuel leaked from tanks and pipelines at the US Naval Station – Roosevelt Roads Site (Site), impacting soil and groundwater. The cumulative volume of free product recovered since product recovery remediation activities commenced in 1994 is 15,600 gallons (Quarterly Summary Progress Report Number 8, dated February 26, 1999).

A single phase product recovery system was installed at the site in 1997 and is currently operated and maintained by McLaren/Hart. The system has removed approximately 974 gallons of product in 1997, 675 gallons in 1998 and 200 gallons in 1999. The performance of the system is poor and appears to be limited by the heterogeneity of the formation which is very dense and has a hard consistency.

The overall objectives of the pilot study at the site are two-fold. The primary objective is to evaluate the effectiveness of Pneumatic Fracturing (PF) technology to enhance the existing product recovery system at two locations (different soil types). The secondary objective is to evaluate various pumping scenarios and pumping systems. Although this pilot study will be conducted at the Roosevelt Roads Site, it is also intended to evaluate enhancement of product recovery systems on a program-wide basis for use at other US Naval Station sites.

To accomplish the first objective, PF technology will be used to fracture soils around existing and new product recovery wells. The new wells will be installed at locations where there is an accumulation of product in the formation. The fracturing process will be designed to shorten advective distances and to create a network of interconnected fractures around the fracture- and recovery-wells. The accumulated effect is expected to result in an increased production from the product recovery wells.

To accomplish the second objective, two total fluids product recovery systems will be evaluated and compared in product recovery tests. These tests will be designed to determine if the pumps can significantly increase the free product recovery rates of the product-only (i.e., single phase) pumping system currently in use.

1.1 TECHNOLOGIES OVERVIEW

The two technologies which will be used to evaluate the enhancement of product recovery rates at the site are PF and total fluids product recovery systems. The following sections briefly describe each of these technologies, as they apply to the Roosevelt Roads Site.

1.1.1 Pneumatic Fracturing (PF)

PF is a patented process that was developed in the late 1980s to increase pneumatic permeability of geologic formations. The PF process has received intensive laboratory and bench scale testing and development at the New Jersey Institute of Technology (NJIT). The process uses pressurized gas at controlled pressures and flow rates to initiate and propagate a network of fractures in low permeability soil and rock formations. PF in overconsolidated soil formations creates a network of horizontal fractures that radiate from the fracture well. In rock formations, PF opens, cleans, and interconnects existing discontinuities in the formation.

In addition to permeability enhancement, PF can improve homogeneity in the formation and access pockets of free product or contaminants previously unattainable. Since the first PF patent in 1992, PF technology has been extended to include the addition of liquid and solid amendments. To date, over 70 sites have been treated throughout the United States. Thirty of these sites have been pneumatically fractured to enhance subsurface permeability for various remedial options, including soil vapor extraction, dual phase extraction, product recovery, and pump and treat systems.

1.1.2 Total Fluids Product Recovery Systems

A total fluid recovery system is a conventional pumping method used to simultaneously recover groundwater and NAPL from the formation. Use of total fluid pumps requires an oil/water separation step after the total fluids are recovered. Because they pump water, these pumps lower the water column in the well and induce product migration to the well. Therefore, they may enhance produce accumulation in the well and thus accelerate product removal. Two types of total fluid recovery pumping systems will be tested - a pumping only system which uses a

controllerless pneumatic pump, and a vacuum enhanced recovery (VER) system which uses a controllerless pneumatic pump plus a vacuum pump. These systems will be operated to evaluate both product- and total fluid-recovery rates. The goal during this evaluation will be to minimize water collection and to maximize product collection from the treatment plots.

The application of a multi-phase (air and water) extraction system can be achieved with a single or two-pump configuration. In a single pump configuration, a single drop tube is used to remove liquid and vapor from a recovery well. Practically, this configuration is limited to depths less than 30 feet bgs. This depth limitation can be overcome with a two-pump configuration. This system uses a submersible pump for groundwater recovery in conjunction with a separate vacuum applied at the wellhead. In this configuration, liquid and vapor streams are separate at the well head and the respective streams are managed by independent air and NAPL treatment systems.

Historically, VER systems have been the standard approach for dewatering low permeability sediments and for speeding the dewatering of more permeable sediments. VER is a multi-phase extraction process which uses high vacuums on recovery wells and the geologic formation to enhance the recovery of total fluids from the well. In the process, air and water are used as carriers for the removal of contaminants from unsaturated and saturated zones. The extraction process is applied to recovery wells with some portion of the well screen extending above the water table and into the unsaturated zone. The applied vacuum increases the effective drawdown at the pumping well, extracts soil vapor, and enhances groundwater recovery. Liquid flow rates are increased due to the increased negative pressure gradient applied on the system. The applied vacuum enhances the volatilization and mobility of trapped product in the unsaturated zone, thereby accelerating the cleanup process and reducing the number of recovery wells required to achieve the same process .

1.2 Report Organization

The organization of this workplan is as follows:

- Section 2.0 presents an overview of the project background and objectives; this includes an understanding of site geology, hydrogeology and project objectives
- Section 3.0 details the Phase 1 test design
- Section 4.0 describes the Phase 1 test activities
- Section 5.0 describes the treatment system design
- Section 6.0 discusses the pilot test data interpretation and reporting format
- Section 7.0 presents a project organization chart and
- Section 8.0 presents a project schedule

All tables, figures and appendices are provided at the end of this report.

2.0 BACKGROUND AND PROJECT OBJECTIVES

2.1 SITE LOCATION AND BACKGROUND

The Site is an active U.S. Naval Station and is located near the town of Ceiba on the eastern end of Puerto Rico. A site location map is presented as Figure 1. The approximate location of the Naval Station is 18°15' 00' latitude and 65° 39' 30" longitude.

Seven fuel storage tanks constitute the Tow Way Fuel Facility (TWFF). Since 1957, spills, leaks, and sludge disposal have resulted in an estimated release of over one million gallons of product.

Free product recovery operations began in 1994 with the installation of a small scale pilot test product recovery system. From 1994 to 1995, approximately 12,600 gallons of product and water were recovered. In April 1997, a larger system was installed, and by December 1998, four product recovery wells were operating. This product recovery system is a skimming system (i.e., single phase). From April 1997 until January 1999, the total volume of free product recovered by this system was only 2,650 gallons. The total amount of product and water recovered in the 6 years of operation is estimated to be 15,600 gallons.

An analysis of the lack of recovery indicates that the primary reasons are the severe heterogeneities in the soil and fill material and the low permeabilities of the formation. Review of product thickness maps indicates that the product has accumulated at select locations, possibly due to the subsurface heterogeneities. To improve performance of the free product recovery system, a method is needed to improve the subsurface conditions, *i.e.,* allowing easier flow of the viscous oil through the overburden and shallow bedrock.

2.2 SITE GEOLOGY

The site geology is taken from the Quarterly Summary Progress Report Number 8, dated February 26, 1999. The surficial lithology from 0 feet to 42 feet bgs is predominantly clay with varying amounts of weathered volcanic rock fragments. The clays are primarily grayish-green, yellowish-brown, grayish-brown, and olive-brown as based on color matching with the Munsell soil color chart. Intermixed with the primary colors are shades of red, grayish-brown, olive-gray and bluish-gray. The clays are cohesive, stiff, and range from dry to moist. A review of boring logs from several of the recovery wells indicates that much of the near-surface geology consists of silt and clays, and that at one location (RW-4), the bedrock is fairly close to the surface.

2.3 SITE HYDROGEOLOGY

The site hydrogeology information is taken from the Quarterly Summary Progress Report Number 8, dated February 26, 1999. The hydrogeology is controlled by elevation differences across the TWFF. The average hydraulic gradient is 0.012 ft/ft towards the southwest. The

dense nature of the volcanic rock and slow recharge rates observed in monitoring wells indicate that the permeability of the rock is very low, causing it to behave as a confining or semi-confining unit.

2.4 PRODUCT EVALUATION

An evaluation of free product in the two pilot test areas was performed based on a review of soil geologic logs, evaluation of soil samples from a reconnaissance soil boring program and measurement of LNAPL in pumping and monitoring (existing and M/H temporary) wells. The site plan, showing the proposed location of the pilot test areas, is shown on Figure 2. The following summarizes the findings for each pilot test area.

2.4.1 RW-1 Area Soils

Six existing borings logs and soil samples from six McLaren/Hart soil borings were reviewed for this area. The existing soil boring logs are: RW-1, AW-1, AW-2, MTMW-1, MTMW-3, and MTMW-4. Except for RW-1, the logs were prepared by Mantech during their Chemical Oxidation Pilot test. The McLaren/Hart soil boring locations are: DP-31A, MH-SB-2, MH-SB-5, MH-SB-6, MH-SB-7 and MH-SB-8. The soil boring locations inRW-1 area are shown on Figure 3. All logs are included in Appendix B.

A review of the Mantech boring logs shows that product zones vary between a quarter of an inch and two feet. These thicknesses were observed at various elevations in the borings and were all above the water saturated zone for that location. A two foot saturated product zone was observed at MTMW-4 at a depth of 18 to 20 feet bgs. The deepest zone where product was identified was 29 to 29.5 feet bgs at MTMW-1. There is no documented evidence of free product in the boring log of RW-1.

During the McLaren/Hart reconnaissance soil boring program, samples from six soil borings were evaluated. Except for MH-SB-8 sample location (at a depth of 18 to 20 feet bgs.) there was no clear evidence of product saturated zones in any of the remaining soil samples. At some sample depths, where no product was visible but a strong odor was obvious, the locations were logged as damp.

During sampling at MH-SB-6, a damp sample, retrieved from a depth of 20 to 22 feet bgs had a diesel odor. A measurement for product was made inside of the auger at this depth, and 22 inches of diesel fuel was measured. The first evidence of water was observed at 24 feet bgs. This boring was completed to 29 feet bgs, and no further evidence of product was observed in the soil samples. A check of the open borehole approximately 30 minutes after the final depth of 29 feet was achieved show no evidence of free product. There was less than 4 inches of water in the well at the time of the measurement.

2.4.2 RW-1 Area LNAPL

A survey of existing wells and the new monitoring wells installed by McLaren/Hart shows that there is free product in some areas of the site. The results of several rounds of monitoring for free product and groundwater are summarized in Table 2. The geologic cross-section locations for the pilot test area are shown on Figure 4. The distribution of free product is also shown on the geologic cross section A-A' and B-B' in Figure 5.

In the Mantech wells on 9/25/99, product thickness varied from 3.7 feet at MTMW-4 to 5.0 feet at MTMW-2. On the same day, 1.9 feet of product was measured at the temporary McLaren/Hart monitoring well location MH-SB-6. There was no measurable product thickness in the RW-1 well on 9/25/99. Based on the groundwater data collected, the piezometric level is approximately 16 feet to 18 feet bgs. See Table 2.

This evaluation of the soil and groundwater shows that there is a free product plume in the zone 15 feet to 25 feet bgs. This plume is above a semi-confining layer which varies between 24 feet and 38 feet bgs based on the soil boring logs for this area.

2.4.3 PW-6 Area Soils

No soil borings or well construction logs for existing wells were available for review. Evaluation of soils in this area was based on samples from three McLaren/Hart soil borings: MH-SB-1, MH-SB-3 and MH-SB-4. The soil boring locations in the PW-6 area are shown on Figure 6. These logs are included in Appendix B.

During sampling at the MH-SB-1 location, evidence of product was observed in a moist zone 10 feet to 12 feet bgs. There was also a petroleum odor at this zone. Samples collected above and below this zone were dry. At the MH-SB-3 location, a damp to moist zone was observed 16 feet to 18 feet bgs on 9/20/99. Before continuing the boring on 9/21/99, one foot of product was measured in the borehole. Continued sampling at this location showed a moist zone of product at approximately 22.5 feet to 24 feet bgs. There was no further evidence of product in samples collected from this location. At the MH-SB-4 location, product was observed at 16.5 feet to 17 feet bgs on 9/21/99. Prior to sampling on the following day (9/22/99), 2 feet of product was measured in this borehole. During split spoon sampling, the 20 to 22 foot zone was observed to be saturated with product.

2.4.4 PW-6 Area LNAPL

A survey of existing wells and the temporary wells installed by McLaren/Hart show that there is some evidence of free product in this area. The results of several rounds of monitoring for free product and groundwater is summarized in Table 2. The geologic cross-section location is shown on Figure 4 and the distribution of free product is also shown on the geologic cross section CC' in Figure 7.

In existing wells, product thickness varies from 0.3 feet at PW-06 to 0.2 feet at PW-05. In the temporary McLaren/Hart monitoring wells, product was observed in all wells, with product

thickness varying from 1 foot at MH-SB-3 to 10 feet at MH-SB-1. It should be noted that the thickness at MH-SB-1 might be an anomaly based on well construction technique. Based on the groundwater measurements, the piezometric level is approximately 14 feet bgs. (See Table 2.)

This evidence shows that there is a free product plume in the zone 10 feet to 25 feet bgs. This plume is above a semi-confining layer.

2.5 PROJECT OBJECTIVES

The Phase 1 activities of the pilot test will be conducted in two areas (RW-1 and PW-6) of the TWFF site where product recovery wells RW-1 and PW-06 are currently being operated. In the RW-1 area, monitoring well MTMW-4 will also be used in the evaluation since this well currently has an apparent product thickness of 4 feet. The proposed locations for the pilot test are shown in Figure 2.

The goal of Phase 1 pilot test activities is two-fold: establishment of a total fluids product recovery baseline for the two test plots and evaluation of the performance of two total fluid pumping systems to remove product from the unfractured formation at the Roosevelt Roads Site. This pumping system baseline will be based on product recovery rates using controllerless pneumatic pumps in RW-1 test plot and a VER system (controllerless pneumatic pumps and vacuum pump) in the PW-6 test plot.

The objectives of this pilot test are to:

1) Establish a potentiometric surface baseline for the test area prior to product recovery pump evaluations.
2) Conduct short duration product recovery tests in RW-1, MTMW-4 and PW-06 wells. During the test, product removal will be monitored from the recovery well; product levels in selected wells surrounding the pumped well will also be monitored.
3) Based on the results of the short duration tests, conduct longer term (i.e., thirty day) product recovery tests using the optimum pump and/or vacuum settings in the respective test wells.
4) Calculate estimates of hydraulic parameters for the two pilot test areas.

3.0 PHASE 1 TEST DESIGN

The Phase 1 test design consists of implementing a total fluids product recovery program at selected product recovery and monitoring wells within the RW-1 and PW-6 pilot test areas. The program will provide a pre-fracture product recovery baseline for each test plot and will also provide performance information on two types of total fluid product recovery options for unfractured soil conditions at the site. Test preparation activities include: 1) selection and development of product recovery and monitoring wells in the test plots, 2) service of existing and/or obtaining 2" and 4" controllerless pneumatic pumps, 3) set up and shake down testing of the treatment skid, 4) set up and shake down testing of the vacuum pump skid, and 5) determination of groundwater treatment monitoring protocols. The following section discusses the non-mechanical activities of the test program. All mechanical activities will be discussed in Section 5 of this work plan

3.1 RW-1 AREA

In the RW-1 area, product recovery testing will be performed at two well, RW-1 and MTMW-4. For the test program, six wells will be monitored for hydraulic influence (*i.e.*, draw down) during testing of each recovery well. These wells are MTMW-1, MTMW-2, MTMW-3, AW-1, AW-2, and UGW-3. Figure 8 shows the location of the recovery and monitoring well in the RW-1 test area.

3.1.1 RW-1 Product Recovery Wells

RW-1 is an existing product recovery well which was installed in October 1996. This well is one of eight recovery wells which are part of a product-only recovery system. The system was installed by McLaren/Hart and has been in operation since 1997. The treatment system was shut down in October 1999, to allow product recovery rates to be established for the test areas. Since October 1999, the maximum apparent product thickness measured in the RW-1 well is 0.25 feet.

Recovery Well RW-1 is 30 feet deep and is screened from 10 to 30 feet bgs. It is a 4-inch diameter PVC well that was drilled and installed using 8¼-inch hollow stem augers. For the pilot test, no modifications to the well are required. Well construction details are provided as part of the RW-1 Soil Boring Log. See Appendix A.

3.1.2 MTMW-4 Product Recovery Wells

MTMW-4 is an existing well in the pilot test area. This well was selected to provide an additional product recovery well in a location where product is known to be present. The well was installed by Mantech Environmental in January 1999 and was used as a monitoring well in a chemical oxidation pilot test. Since completion of the chemical oxidation test in 1999, the well has not been used for any other site activities except for gauging of apparent product thickness.

The well is a 2-inch diameter PVC well that was drilled and installed using 4¼-inch hollow stem augers. It is 36 feet deep and is screened from approximately 15 to 35 feet bgs. For the pilot test, no modifications to the well are required. Well construction details are provided as part of the Mantech Environmental Soil Boring Log. See Appendix A.

3.1.3 Monitoring Wells

As summarized in Tables 1.1 and 1.2, six wells, MTMW-1, MTMW-2, MTMW-3, AW-1, AW-2, and UGW-3 will be used as monitoring wells during the test program in RW-1 area. These wells, located in the area of the two product recovery wells, were constructed by Mantech as part of the chemical oxidation pilot test.

Monitoring wells MTMW-1, MTMW-2, and MTMW-3 are similar in construction to the MTMW-4 well. They are constructed of 2-inch diameter, Schedule 40 PVC with 0.01-inch screen. MTMW-1 was drilled to 39.5 feet bgs. and is screened from 19.5 to 39.5 feet bgs. MTMW-2 was drilled to 38 feet bgs. and is screened from 18 to 38 feet bgs. MTMW-3 was drilled to 35 feet bgs. and is screened from 15 to 35 feet bgs.

AW-1 and AW-2 were constructed of 2 inch diameter stainless steel risers with 15 feet of 0.01 inch slotted stainless steel screen. These wells were used as delivery wells in the chemical oxidation pilot test, but will be used as monitoring wells in this pilot test program. AW-1 was drilled to 35.5 feet bgs. and is screened from 20.5 to 35.5 feet bgs. AW-2 was drilled to 31 feet bgs. and is screened from 16 to 31 feet bgs. The wells were drilled and installed using 4¼-inch hollow stem augers. For the pilot test, no modifications to the monitoring wells are required. Well construction details are provided as part of the Mantech Environmental Soil Boring Logs. See Appendix A.

UGW-3 is an existing 2-inch Schedule 40 PVC monitoring well. Well construction details for this well are unavailable at the time of writing this work plan.

3.1.4 Well Development

The wells have been pumped on and off for a couple of years, or they have been inactive since installation. Therefore, prior to testing and monitoring, the wells will be developed to restore hydraulic characteristics and maximize hydraulic communication between the wells and the geologic deposits. Development will be accomplished by mechanical surging techniques (i.e., surge block). All surge water will be containerized and passed through the on-site treatment system.

3.2 PW-6 AREA

In the PW-6 area, product recovery testing will be performed at one well, PW-06. For the test program, six wells will be monitored for hydraulic influence (i.e., draw down) during testing of

each recovery well. These wells are: PW-02, PW-03, PW-04, PW-05, UGW-01 and MW-01. Figure 9 shows the location of the recovery and monitoring well in the RW-1 test area.

3.2.1 PW-6 Product Recovery Wells

PW-06, installed in 1994, is one of nine product recovery wells which are part of a product-only recovery system. The treatment system was shut down in October 1999 to allow product recovery rates to be established for the test area. Since October 1999, the maximum apparent product thickness measured in the PW-06 well is 0.8 feet.

Recovery Well PW-06 is 24 feet deep and is screened from 4 to 23.5 feet bgs. It is a 4-inch diameter PVC well that was drilled and installed using 8¼-inch hollow stem augers. Neither well construction details nor a boring log were available for this well at the time of work plan preparation. For the pilot test, the following modifications to the wellhead are required.

- Install 4"x4"x2" tee for the 4-inch wells, and 2"x2"x2" tee for the 2-inch well for the 2-inch vacuum line. Provide well caps with fittings for ½-inch compressed air line, 1-inch total fluid recovery line and attachment for well pump support cables.
- Install pressure regulator, control valve, pressure indicator, and airflow meter in the ½ -inch compressed air supply line at the wellhead.
- Install vacuum indicator, control valve, sampling port, and airflow meter in the 2-inch vacuum line at the wellhead.
- Install pressure indicator, check valve, control valve, strainer, sampling port and flow meter in the 1-inch fluid recovery line.

3.2.2 Monitoring Wells

As summarized in Table 1.3, five wells (PW-03, PW-04, PW-05, UGW-01 and MW-03) will be used as monitoring wells during the test program in the PW-6 area. These well are located in the area of the product recovery wells. Well construction details are unavailable for these wells at the time of work plan preparation.

3.2.3 Well Development

The wells have been pumped on and off for a couple of years, or they have been inactive since installation. Therefore, prior to testing and monitoring, the wells will be developed to restore hydraulic characteristics and maximize hydraulic communication between the wells and the geologic deposits. Development will be accomplished by mechanical surging techniques (i.e., surge block). All surge water will be containerized and passed through the on-site treatment system.

3.3 PERMIT ACQUISITION

Based on conversations with the U.S Naval Station Environmental Management team in Puerto Rico, no permits for the performance of a pilot test at the TWFF site are required. Upon acceptance of the workplan, the Environmental Quality Board (EQB) will grant an approval letter for the duration of the pilot test.

Notification will be provided to the US Environmental Protection Agency (EPA) regarding a temporary change to the flow rates anticipated from the Naval Station sanitary treatment during the pilot tests.

3.4 SITE HEALTH & SAFETY PLAN (HASP)

McLaren/Hart will update the site-specific HASP plan to ensure it addresses all issues related to the safe implementation of a PF pilot study. A signed copy of the HASP plan, together with all attachments, will be maintained on-site during all field activities. The HASP plan will included:

- General site information
- Project information including a site description, purpose of work, scope of work, and project schedule
- Hazard analysis, non-chemical hazards, site Chemicals of Concern (COCs), and chemical hazards
- Requirements for Personal Protective Equipment (PPE), monitoring equipment, site zone delineation, and site communication protocol
- Site operating procedures
- Emergency response procedures
- Record keeping requirements
- Hospital route map

3.4.1 Health and Safety Meetings

Prior to the commencement of the Phase 1 test program, a health and safety meeting for all personnel actively involved in this phase of the pilot test will be held. Also, tailgate health and safety meetings will be conducted daily to remind personnel of hazards and the objectives for the day.

3.4.2 Personal Protection

All field activities will be conducted in Modified Level D which consists of Steel-toed work shoes, safety glasses and hard hat.

3.5 MATERIAL HANDLING AND OPERATIONAL PROCEDURES

The materials, which will be handled during this test are extracted groundwater and product. The pumped fluid will be transferred to an on-site temporary treatment system. Features of the treatment system are described in Section 5 of this work plan. The operation of the treatment system is described in Section 5.2 of this work plan.

4.0 PHASE 1 TEST PROGRAM

4.1 INTRODUCTION

This section details McLaren/Hart's technical approach for performing a pre-fracture product recovery baseline for each of the two test plots using a total fluids product recovery system, and also evaluating the effectiveness of two total fluids pumping systems under pre-fracture conditions.

The main tasks required to accomplish the goals are:

RW-1 Area	• Baseline potentiometric surface measurements • Tidal monitoring • Short-term tests at two locations (RW-1 and MTMW-4) • potentiometric surface levels recovery monitoring for stabilization • Long-term product recovery test at one location
PW-6 Area	• Baseline potentiometric surface measurements • Tidal monitoring • Short-term tests at one location (PW-06) • Potentiometric surface levels recovery monitoring for stabilization • Long-term product recovery test at one location

The activities associated with the test program are described below and shown on the activity flow charts (Figure 10).

4.2 BASELINE POTENTIOMETRIC SURFACE MEASUREMENTS

Background monitoring of water levels will be conducted for 24 hours before the commencement of short term tests at selected wells in the two test areas. In the RW-1 area the monitoring program will involve water level monitoring at RW-1, MTMW-4, AW-2 and UGW-3 using data loggers.

In the PW-6 area the monitoring program will involve water level monitoring at PW-06, PW-04 and MW-03 using data loggers; barometric pressure measurements will be performed at PW-06 to account for fluctuations in water levels. 10 psi pressure transducers will be installed in the referenced wells and measurements will be recorded at 20 minute intervals.

4.3 TIDAL MONITORING

If water level changes are observed during the background monitoring program, information on the tides will be obtained from the National Oceanic and Atmosphere Administration (NOAA), and used to adjust the baseline water level monitoring program.

4.4 SHORT TERM TESTS

4.4.1 RW-1 Area Objective

The objective of the short term test is to use a total fluids product recovery system, consisting of controllerless pneumatic pumps, to determine the following: 1) highest producing product recovery well, 2) optimum pump elevation, 3) difficulty of separating the product and groundwater, and 4) estimates of hydraulic parameters for the test area.

4.4.1.1 RW-1 Methodology

Three short-term tests (4 hrs. each) will be conducted on the RW-1 well after completing the baseline potentiometric surface-monitoring program. The program schedule including observation wells details, is presented in Table 1.1.

Prior to the initiation of the short-term test program a controllerless pneumatic pump will be installed in the RW-1 well. The RW-1 boring log, however, does not show or reference a product zone. The pump will therefore be placed at approximately 22 feet bgs. (approximately two feet below the product-containing zone of MTMW-4). A small diameter pipe will be installed in the well to facilitate manual water levels measurements.

Data loggers originally placed in AW-2 and UGW-3 will be checked and a round of manual water levels taken in these wells. A synoptic round of water levels will also be taken in the monitoring wells AW-1, MTMW-1, MTMW-2 and MTMW-3 using an M-Scope.

Following the completion of the first test, the pump will be lowered to the second and then to the third pump elevation, and the test repeated. For the second and third tests, initial planning recommends a depth of approximately 25 feet bgs and 30 feet bgs respectively. The final elevations will be based on the findings from the first test and can be modified by the field team leader, in consultation with the project engineer or project manager. All three tests will follow the same protocol as performed for the initial test.

4.4.1.2 Recovery Test

A 24-hour recovery test will commence on completion of the short-term tests. The duration of this test may be shortened if 90 % water level recovery occurs in the pumped well before the 24-hour period is completed.

During the recovery tests, the pressure transducers will be programmed to record water level data at log cycle during the test. At the time the pressure transducers are installed in the wells, a depth to water level measurement will be recorded with an M-Scope. The elevation of the water level in the well will be determined by subtracting the depth to water measurement from the surveyed top of casing elevation. The pressure transducer will then be configured to record variations in head relative to the initial water level elevation that is programmed prior to the start

of the test. Manual water level measurements will be recorded twice during the test to confirm the water level measurement data recorded by the transducers.

Upon completion of the recovery test, all of the data will be downloaded from the data loggers onto a computer. Hydrographs will then be prepared for each well to evaluate hydraulic characteristics of the aquifer.

4.4.1.3 MTMW-4 Methodology

A similar test program (*i.e.*, three short-term 4 hour tests) as described (Section 4.4.2) for the RW-1 well will be performed on the MTMW-4 well. These tests will be conducted upon completion of the RW-1 recovery test. The complete test schedule, including information on observation wells, is presented in Table 1.2.

During this test, the same monitoring wells as those used for the RW-1 test, will be monitored manually and with data loggers. Experience gained from the RW-1 test will be incorporated into this test. Based upon the MTMW-4 boring log, the initial pump intake setting will be approximately 22 feet bgs, since the split spoon soil sample shows evidence of product between 18 and 20 feet bgs. The second and third elevation will be at 25 and 30 feet bgs respectively. Pumping well and observation wells AW-2 and UGW-3 will be monitored with data loggers, and monitoring wells AW-1, MTMW-1, MTMW-2, and MTMW-3 will be monitored using an M-Scope.

4.4.1.4 Recovery Test

The 24-hour recovery test program will be similar to the test procedure described in Section 4.4.1.2.

4.4.2 PW-6 Area Objective

The objective of the short term test is to use a total fluids product recovery system, consisting of controllerless pneumatic pumps and a vacuum pump, to determine the following: 1) elevation for optimum product recovery using a pneumatic pump only, 2) optimum vacuum to maximize the recovery of product while pumping from the selected elevation using a pneumatic pump, 3) difficulty of separating the product and groundwater, and 4) estimates of hydraulic parameters for the test area.

4.4.2.1 PW-06 Methodology

Three short-term tests will be conducted on the PW-06 well after completing the baseline potentiometric surface monitoring program and the RW-1 short term tests. The program schedule, including observation wells details, is presented in Table 1.3. The test procedure in this test plot is similar in methodology to the RW-1 test program. The only differences are: 1) only one well will be tested in this test plot and 2) a vacuum will be applied to the well to

evaluate the effect a negative pressure can have on the removal of product from the formation. This test program is equivalent to a VER system using a pneumatic pump.

Since a drop tube can also be used for the removal of product and groundwater, a test will be performed at the end of the short test program to determine the maximum depth at which the drop tube system is effective. The use of the pump option provides an assurance that all possible depths to be evaluated will be possible irrespective of the vacuum pump setting.

For this test plot, pressure transducers will be installed in the PW-06, PW-04, and MW-03 wells. The pressure transducers will be programmed to record water level data at an hourly frequency during the test. Prior to the commencement of the test, a round of water levels will be taken from these wells, in addition to monitoring wells UGW-1, PW-03, and PW-05.

Following the completion of the first test, the pump will be lowered to the second and then to the third pump elevation, and the tests repeated. For the second and third test, initial planning recommends a depth of approximately 25 feet bgs and 30 feet bgs respectively. The final elevations will be based on the findings from the first test, and can be modified by the field team leader, in consultation with the senior project engineer or project manager. The same test protocol, as performed for the initial test, will be followed in test two and three.

Upon completion of the three tests, all of the data will be downloaded from the pressure transducers onto a computer. Hydrographs will be prepared for each well to allow an assessment of the pumping influences on product recovery and water levels at the site.

Based on this information, the elevation and pump settings which result in the maximum product to total fluids ratio will be selected, and the VER phase of the test will be conducted. The objective is to determine which combination of pump setting and vacuum gives the maximum removal of product and the minimum removal of groundwater. This phase consists of conducting three vacuum step tests (e.g., 15, 20 and 25 inches of mercury) to the well at the pre-selected pneumatic pump elevation.

4.4.2.2 Recovery Test

The 24-hour recovery test program will be similar to the test procedure described in Section 4.4.1.2.

4.5 LONG TERM TESTS

4.5.1 RW-1 Area Objective

Based on the results of short term testing at RW-1 and MTMW-4, the highest yielding product well and the pump settings which gave these results will be selected and will form the basis of the long term (i.e., 30 day test). The pneumatic pump will be placed in this well and a product

recovery test performed. The wells that were instrumented in the short term test program will continue to monitor the development of the pumping program and the drawdown of the groundwater and product interface at the wells with time. During the test, the wells will be monitored daily for the first week and three to five times per week thereafter for the duration of the test.

4.5.2 Recovery Test

The 24-hour recovery test program will be similar to the test procedure described in Section 4.4.1.2.

4.5.3 PW-6 Area

Based on the results of short term testing at PW-06, the highest yielding pump setting and well vacuum product will form the basis of the long term, 30-day test. The pneumatic pump will be placed in the well and operated at this setting for approximately seven days. This will provide a representative baseline for product removal rates by pumping only in the test plot. Next the optimum vacuum will be slowly applied to the well over an eight-hour period. The duration of the test will be performed at these settings. This approach will be more definitive in terms of the effect of the applied vacuum to the net removal of product.

Surrounding wells will be monitored with data loggers and an M-Scope at a frequency determined by the findings of the short term tests and experience gained during the tests. As conditions change within the test program, the field team will continually adjust the test performance parameters to ensure optimum performance of the system is achieved. These adjustments may include: variation in the order of recommended pumping schedules, pump and transducer placement depths, monitoring of observation wells depending on field conditions, etc.

4.5.4 Recovery Test

The 24-hour recovery test program will be similar to the test procedure described in Section 4.4.1.2.

5.0 TREATMENT SYSTEM DESCRIPTION

The groundwater and product recovery pilot tests at RW-1 area will be performed on one 4 - inch (RW-1) and one 2-inch (MTMW-4) recovery wells. The recovery test in the PW-6 area will be performed on the 4-inch (PW-06) well. During testing , each well in the RW-1 area will consist of a pneumatic recovery pump, a holding tank, and a transfer pump. PW-6 well testing will consist of the same components as in RW-1 except that a vacuum pump will be added to apply negative pressure to the well. A groundwater/product treatment system will be installed to treat the influent from both areas. Each recovery well will contain a pneumatically-operated total fluid recovery pump to remove groundwater/product. The flow from each of the wells will be directed through a flow gauge then into a dedicated 55-gallon drum to determine each well's extraction rate and quantity of product recovered. The groundwater and product that is collected during this test will be processed through a treatment system consisting of an product/water separator, intermediate holding tanks, and liquid phase carbon. The product recovery and treatment schematic is shown on Figure 11.

5.1 TREATMENT SYSTEM SETUP

- Install product/water separator and connect the discharge lines from the transfer pump to the influent of the separator. The flow rate will be controlled by a globe valve.
- Install pump and piping to pump separated free product from the separator to the temporary product storage tank.
- Install the surge tank and accessories and connect the separator effluent pipe to the surge tank.
- Install the liquid phase carbon units and piping to direct the flow from the surge tank. Carbon units will be piped to operate in series and parrallel.
- Install the treated water holding tanks and connect the effluent form the carbon units to the tanks.
- Install discharge pump to pump the treated water into the site sanitary sewer. Install the piping and valves so that the discharge will have the option of recycling through the treatment system once more, if the treatment is not adequate.

5.2 EQUIPMENT AT THE WELLHEAD

- Install the total fluid recovery pump in the well with discharge hose, air supply hose and discharge hose.
- Connect the discharge hose and air supply hose to the bottom of the well cap.

- Connect the discharge hose and air supply hose form the top of the well cap to continue the piping.
- Install the vacuum pump with liquid knockout tank and connect the vacuum line to the well head.
- Install coalescing filter on the pressure side of the vacuum pump.
- Install pump to evacuate liquids from the liquid knock out tank.
- Install 55-gallon tanks at each wellhead and connect the pump discharge to them. The 55-gallon tanks will gravity drain into the holding tank(s).
- Install water holding tanks and piping to gravity drain from the 55-gallon tank.
- Install transfer pumps and piping to pump from the water holding tanks.
- Interconnect the piping to incorporate the vacuum extraction system, compressed air supply, and product recovery system to the wellhead.

5.3 RECOVERY PUMPS

Pneumatic submersible pumps will be utilized to recover the product and groundwater from the pilot test recovery wells. The pumps will be operated using an on-site compressed air source. The pumps are controllerless, top loading submersible pumps that are designed to operate continuously, provided the liquid in the well is sufficient to fill the pump body. The total fluid stream recovered will be directed to 55-gallon drums to accurately gauge the pumping rate and the quantity of product recovered from each well.

5.4 VACUUM PUMPS & AIR TREATMENT

A high vacuum extraction pump will be utilized to induce a vacuum at the recovery well head to enhance the total fluid recovery of the collection system. The high vacuum system will be capable of providing 140 scfm flow with a vacuum of 20–25 inches of mercury. This high vacuum system will consist of a condensate/vapor knockout tank, a vacuum pump, and a vapor phase carbon system for the treatment of the vacuum pump air effluent. The knockout tank will remove the condensate/vapor that may be carried over from the recovery well into the vacuum system. The knockout tank will be equipped with a pumping system and liquid levels controls to process the collected condensate through the liquid treatment system.

5.5 GROUNDWATER TREATMENT

The product and groundwater collected in the 55-gallon tanks from RW-1 area and PW-6 area will be drained by gravity to the 5,000-gallon and 2,000-gallon holding tanks respectively. The product and groundwater from the holding tanks will be pumped, utilizing a progressive cavity pump, to a product/water separator for separation and removal of the free product. The product collected in the 55-gallon tanks, holding tanks and separator will be transferred pumped to the

existing product storage tank for proper disposal. The water from the product separator will be pumped to a surge tank and then processed through liquid phase carbon units for the removal of any dissolved contaminants. The treated water will be collected in one of the two 500-gallon water holding tanks prior to discharge to the site sanitary sewer. The final effluent will be tested to ensure it meets the requirements of the discharge standards prior to release to the sanitary sewer for final treatment by the on-site treatment plant. If the final effluent does not meet the discharge requirements, it will be re-directed to the head of the treatment system for additional processing.

6.0 PILOT TEST REPORTS

A separate report will not be prepared for this phase of the work plan. On completion of PF and total fluids pump evaluation activities in the pilot test areas, McLaren/Hart will prepare a pilot test report which will be completed in two volumes. The Volume 1 report will combine the results of the Phase 1 work plan and several pilot test activities from the Phase 2 work plan. These include: construction of test plots, pre-fracture tests, PF activities and short duration post-PF test results. The Volume 2 report will supplement the findings of the Volume 1 report by including the results of the long-term product recovery and pump evaluation program. A draft of both documents will be submitted to the Navy for review.

6.1 Preparation of Final Pilot Test Report

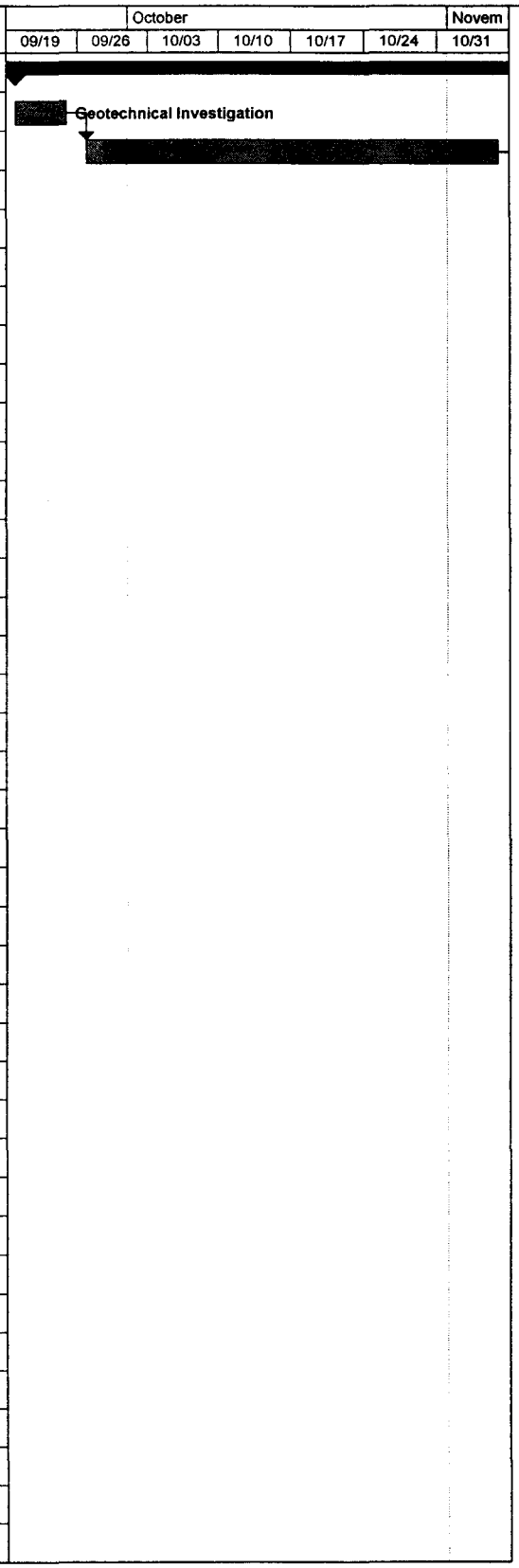
Upon receiving one set of consolidated comments for the Phase 1 and Phase 2 Report from the Navy, McLaren/Hart will revise the Draft Report and submit the appropriate copies of the Final Report to the Navy.

7.0 PROJECT ORGANIZATION

The project team is structured to provide the Roosevelt Roads U.S. Naval Management team with a strong, streamlined group of technical experts who collectively will implement and evaluate the pilot study. This team of engineers, geologists, and scientists will be selected from McLaren/Hart, Inc. and New Jersey Institute of Technology's staff. During the Phase 1 pilot test activities, field activities will be conducted by a team of engineers and hydrogeologists. The team is experienced in pump testing, VER systems, pneumatic pump systems, and pilot test activities. This team will receive guidance from the Senior Project Engineer or the Technical Project Manager. A project organization chart is attached.

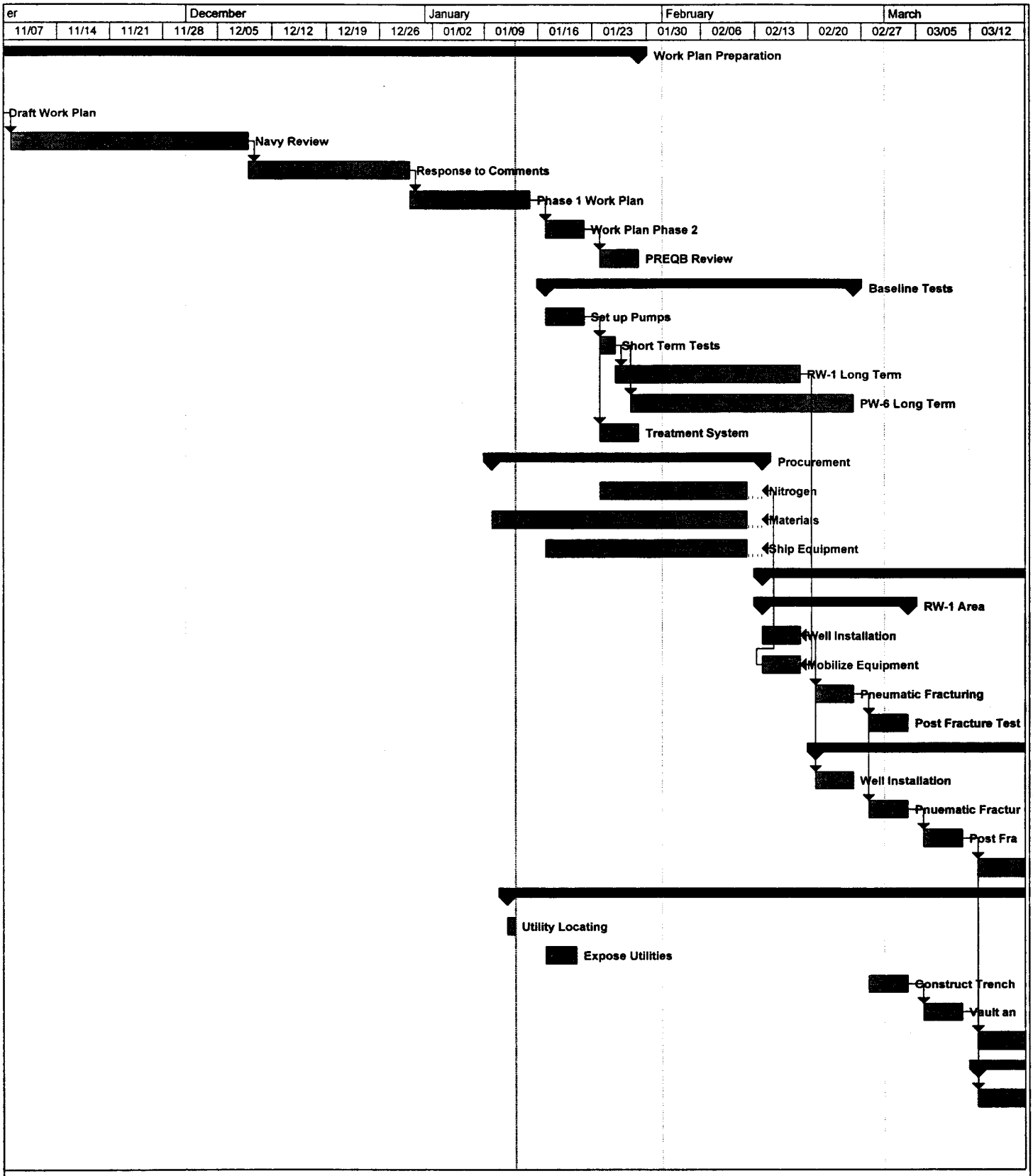
8.0 PROJECT SCHEDULE

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Work Plan Preparation**	**95 days**	**Mon 09/20/99**	**Fri 01/28/00**	
2	Geotechnical Investigation	5 days	Mon 09/20/99	Fri 09/24/99	
3	Draft Work Plan	30 days	Mon 09/27/99	Fri 11/05/99	2
4	Navy Review	23 days	Mon 11/08/99	Wed 12/08/99	3
5	Response to Comments	15 days	Thu 12/09/99	Wed 12/29/99	4
6	Phase 1 Work Plan	12 days	Thu 12/30/99	Fri 01/14/00	5
7	Work Plan Phase 2	5 days	Mon 01/17/00	Fri 01/21/00	6
8	PREQB Review	5 days	Mon 01/24/00	Fri 01/28/00	7
9	**Baseline Tests**	**30 days**	**Mon 01/17/00**	**Fri 02/25/00**	
10	Set up Pumps	5 days	Mon 01/17/00	Fri 01/21/00	
11	Short Term Tests	2 days	Mon 01/24/00	Tue 01/25/00	10
12	RW-1 Long Term	18 days	Wed 01/26/00	Fri 02/18/00	11
13	PW-6 Long Term	21 days	Fri 01/28/00	Fri 02/25/00	11FS+2 days
14	Treatment System	5 days	Mon 01/24/00	Fri 01/28/00	10
15	**Procurement**	**25 days**	**Mon 01/10/00**	**Mon 02/14/00**	
16	Nitrogen	15 days	Mon 01/24/00	Mon 02/14/00	22SF
17	Materials	25 days	Mon 01/10/00	Mon 02/14/00	22SF
18	Ship Equipment	20 days	Mon 01/17/00	Mon 02/14/00	22SF
19	**Pilot Tests**	**110 days**	**Mon 02/14/00**	**Fri 07/14/00**	
20	**RW-1 Area**	**15 days**	**Mon 02/14/00**	**Fri 03/03/00**	
21	Well Installation	5 days	Mon 02/14/00	Fri 02/18/00	12FF
22	Mobilize Equipment	5 days	Mon 02/14/00	Fri 02/18/00	21FF
23	Pneumatic Fracturing	5 days	Mon 02/21/00	Fri 02/25/00	22
24	Post Fracture Testing	5 days	Mon 02/28/00	Fri 03/03/00	23
25	**PW-6 Area**	**105 days**	**Mon 02/21/00**	**Fri 07/14/00**	
26	Well Installation	5 days	Mon 02/21/00	Fri 02/25/00	21
27	Pnuematic Fracturing	5 days	Mon 02/28/00	Fri 03/03/00	23
28	Post Fracture Testing	5 days	Mon 03/06/00	Fri 03/10/00	27
29	Longterm Tests	90 days	Mon 03/13/00	Fri 07/14/00	28
30	**Recovery Trench**	**133 days**	**Wed 01/12/00**	**Fri 07/14/00**	
31	Utility Locating	1 day	Wed 01/12/00	Wed 01/12/00	
32	Expose Utilities	4 days	Mon 01/17/00	Thu 01/20/00	
33	Construct Trench	5 days	Mon 02/28/00	Fri 03/03/00	
34	Vault and Conveyance	5 days	Mon 03/06/00	Fri 03/10/00	33
35	Operate	90 days	Mon 03/13/00	Fri 07/14/00	34
36	**Reporting**	**95 days**	**Mon 03/13/00**	**Fri 07/21/00**	
37	Draft Pilot Test Report	10 days	Mon 03/13/00	Fri 03/24/00	28
38	Draft Performance Report	10 days	Mon 06/05/00	Fri 06/16/00	29FF-20 days
39	Final Report	5 days	Mon 07/17/00	Fri 07/21/00	35



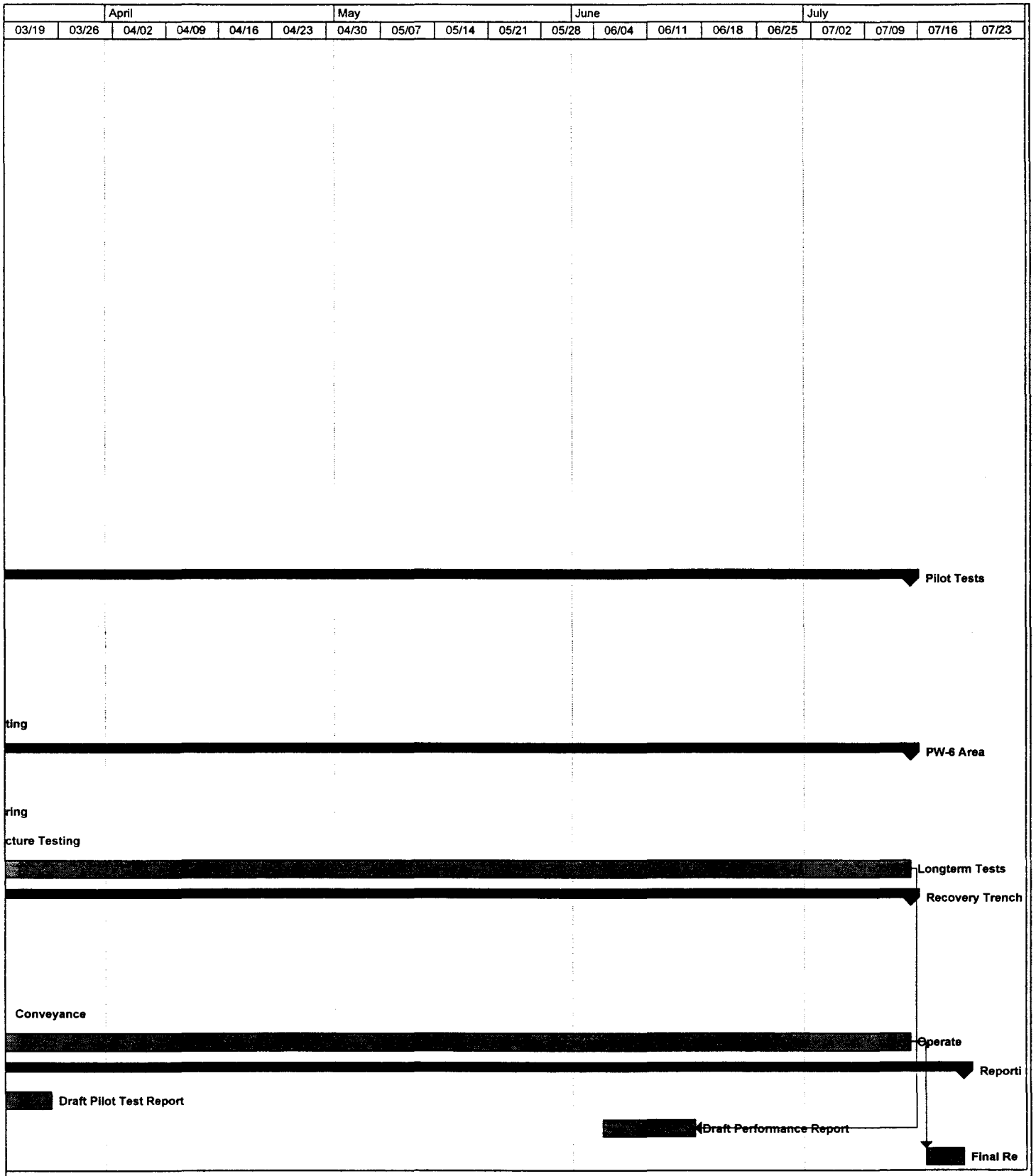
Project: Pilot Study - Scope of Work
Date: Thu 01/13/00

Task		Summary		Rolled Up Progress	
Split		Rolled Up Task		External Tasks	
Progress		Rolled Up Split		Project Summary	
Milestone		Rolled Up Milestone			



Project: Pilot Study - Scope of Work
Date: Thu 01/13/00

Task		Summary		Rolled Up Progress	
Split		Rolled Up Task		External Tasks	
Progress		Rolled Up Split		Project Summary	
Milestone		Rolled Up Milestone			



Project: Pilot Study - Scope of Work
Date: Thu 01/13/00

Task		Summary		Rolled Up Progress	
Split		Rolled Up Task		External Tasks	
Progress		Rolled Up Split		Project Summary	
Milestone		Rolled Up Milestone			

Table 1.1
RW-1 Short Term Tests Schedule

Well Number	Status	Depth (feet)	Screen Interval (feet)	Static Water Level, 9/25/99 (feet)	Pumping Test			Transducer Installation Depth (feet)	Water Level Measurements Frequency	Water Level Measurement Method
					Pump Intake	Duration	Pumping Rate			
RW-1	Pumping Well	30	10-30	16.5	20	4 Hrs.	NA	34	1 hour	Data Logger/M-Scope
					25	4 Hrs.	NA			
					30	4 Hrs.	NA			
AW-2	Observation Well	31	16-31	Not Available	NA	4 Hrs.	NA	2-3' below SWL	1 hour	Data Logger/M-Scope
UGW-3	Observation Well	Not Available	Not Available	17.62	NA	4 Hrs.	NA	2-3' below SWL	1 hour	Data Logger/M-Scope
MTMW-1	Observation Well	39.5	19.5-39.5	21.68	NA	4 Hrs.	NA	NA	1 hour	M-Scope
MTMW-2	Observation Well	38	18-38	22.13	NA	4 Hrs.	NA	NA	1 hour	M-Scope
MTMW-3	Observation Well	35	15-35	20.38	NA	4 Hrs.	NA	NA	1 hour	M-Scope
AW-1	Observation Well	35.5	20-35.5	21.15	NA	4 Hrs.	NA	NA	1 hour	M-Scope

NA: Not Applicable
SWL: Static Water Level

Table 1.2
MTMW-4 Short Term Tests Schedule

Well Number	Status	Depth (feet)	Screen Interval (feet)	Static Water Level, 9/25/99 (feet)	Pumping Test			Transducer Installation Depth (feet)	Water Level Measurements Frequency	Water Level Measurement Method
					Pump Intake	Duration	Pumping Rate			
MTMW-4	Pumping Well	36	15-35	Not Available	22	4 Hrs.	NA	1' above the bottom of the well	1 hour	Data Logger/M Scope
					25	4 Hrs.	NA			
					30	4 Hrs.	NA			
AW-2	Observation Well	31	16-31	Not Available	NA	4 Hrs.	NA	2-3' below SWL	1 hour	Data Logger/M Scope
UGW-3	Observation Well	Not Available	Not Available	17.62	NA	4 Hrs.	NA	2-3' below SWL	1 hour	Data Logger/M Scope
MTMW-1	Observation Well	39.5	19.5-39.5	21.68	NA	4 Hrs.	NA	NA	1 hour	M-Scope
MTMW-2	Observation Well	38	18-38	22.13	NA	4 Hrs.	NA	NA	1 hour	M-Scope
MTMW-3	Observation Well	35	15-35	20.38	NA	4 Hrs.	NA	NA	1 hour	M-Scope
AW-1	Observation Well	35.5	20-35.5	21.15	NA	4 Hrs.	NA	NA	1 hour	M-Scope

NA: Not Applicable
SWL: Static Water Level

Table 1.3
PW-06 Short Term Tests Schedule

Well Number	Status	Depth (feet)	Screen Interval (feet)	Static Water Level, 9/25/99 (feet)	Pumping Test			Transducer Installation Depth (feet)	Water Level Measurements Frequency	Water Level Measurement Method
					Pump Intake	Duration	Pumping Rate			
PW-06	Pumping Well	Not Available	Not Available	11.52	20	4 Hrs.	NA	1' above the bottom of the well	1 hour	Data Logger/M-Scope
					25	4 Hrs.	NA			
					30	4 Hrs.	NA			
UGW-1	Observation Well	Not Available	Not Available	Not Available	NA	4 Hrs.	NA	NA	1 hour	M-Scope
PW-05	Observation Well	Not Available	Not Available	9.4	NA	4 Hrs.	NA	NA	1 hour	M-Scope
PW-03	Observation Well	Not Available	Not Available	9.98	NA	4 Hrs.	NA	NA	1 hour	M-Scope
PW-04	Observation Well	Not Available	Not Available	Not Available	NA	4 Hrs.	NA	2-3' below SWL	1 hour	Data Logger/M-Scope
MW-03	Observation Well	Not Available	Not Available	Not Available	NA	4 Hrs.	NA	2-3' below SWL	1 hour	Data Logger/M-Scope

NA: Not Applicable
SWL: Static Water Level

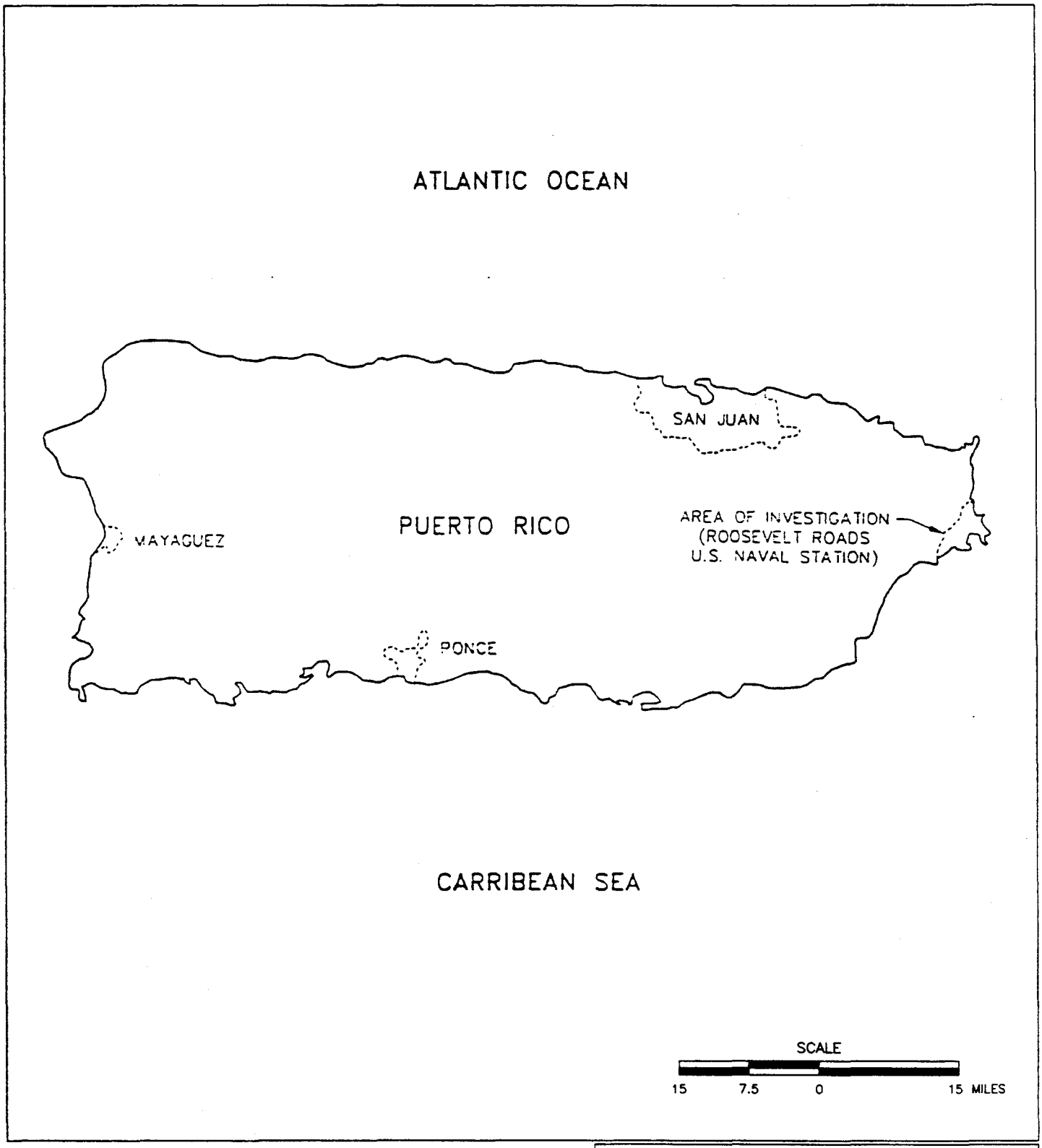


FIGURE 1

SITE LOCATION MAP

ROOSEVELT ROADS U.S. NAVAL STATION –
TOW WAY FUEL FACILITY, CEIBA, PUERTO RICO

McLaren Hart INC.

DRWN: S.F.H.	CHK'D: T.K.
SCALE: AS SHOWN	DATE: 01/13/00

QUADRANGLE LOCATION

DWG: 45800927 01/13/00

RW1 PILOT TEST AREA

PW6 PILOT TEST AREA

UGW25
UGW03
RW1
1088
84
7MW03
7MW09
7MW02A
UGW23
85
SURFACE DRAIN
PIPE
470-MW01
7MW01A
470-MW03
UGW14
GW02
GW03
UGW04
RW2
FORRESTAL DRIVE
UGW06
MW03
UGW01
MW04
UGW05
MW02
UGW22

N
W
E
S

LEGEND

- FENCE
- VEGETATION
- EXISTING MONITORING WELL LOCATION
- McLAREN/HART PRODUCT RECOVERY WELL LOCATION
- TERRAVAC PRODUCT RECOVERY WELL LOCATION
- APPROXIMATE LOCATION OF PILOT TEST

SCALE

80 40 0 80 FEET

FIGURE 2

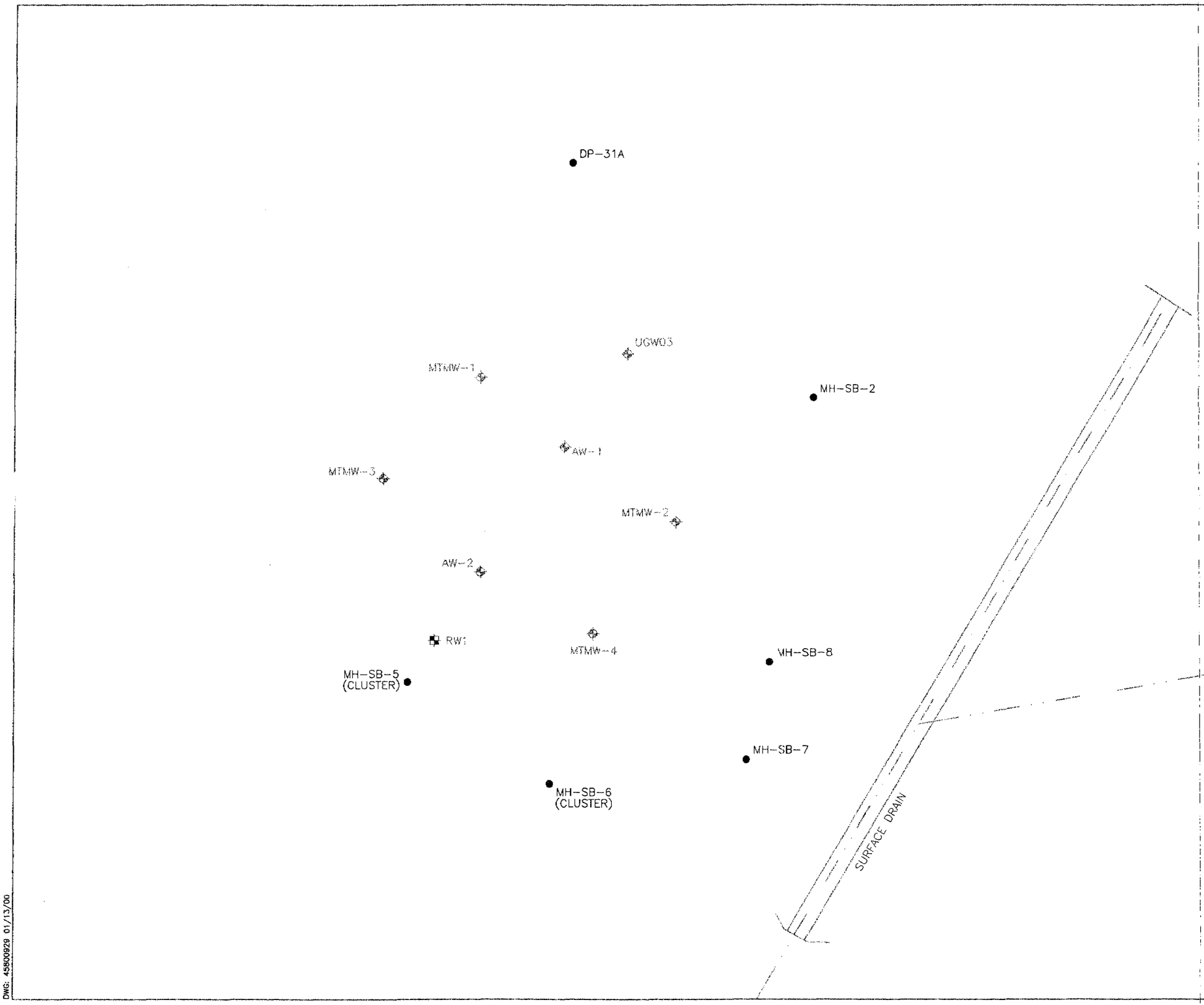
SITE PLAN SHOWING PROPOSED LOCATION OF PILOT TEST AREAS

ROOSEVELT ROADS U.S. NAVAL STATION – TOW WAY FUEL FACILITY, CEIBA, PUERTO RICO

McLaren Hart INC.

DRWN: S.F.H.	CHK'D: T.K.
SCALE: AS SHOWN	DATE: 01/13/00

DWG: 45800928 01/13/00



N
W E
S

LEGEND

- EXISTING WELL LOCATION
- McLAREN/HART PRODUCT RECOVERY WELL LOCATION
- McLAREN/HART SOIL BORING LOCATION

SCALE

10 5 0 10 FEET

FIGURE 3

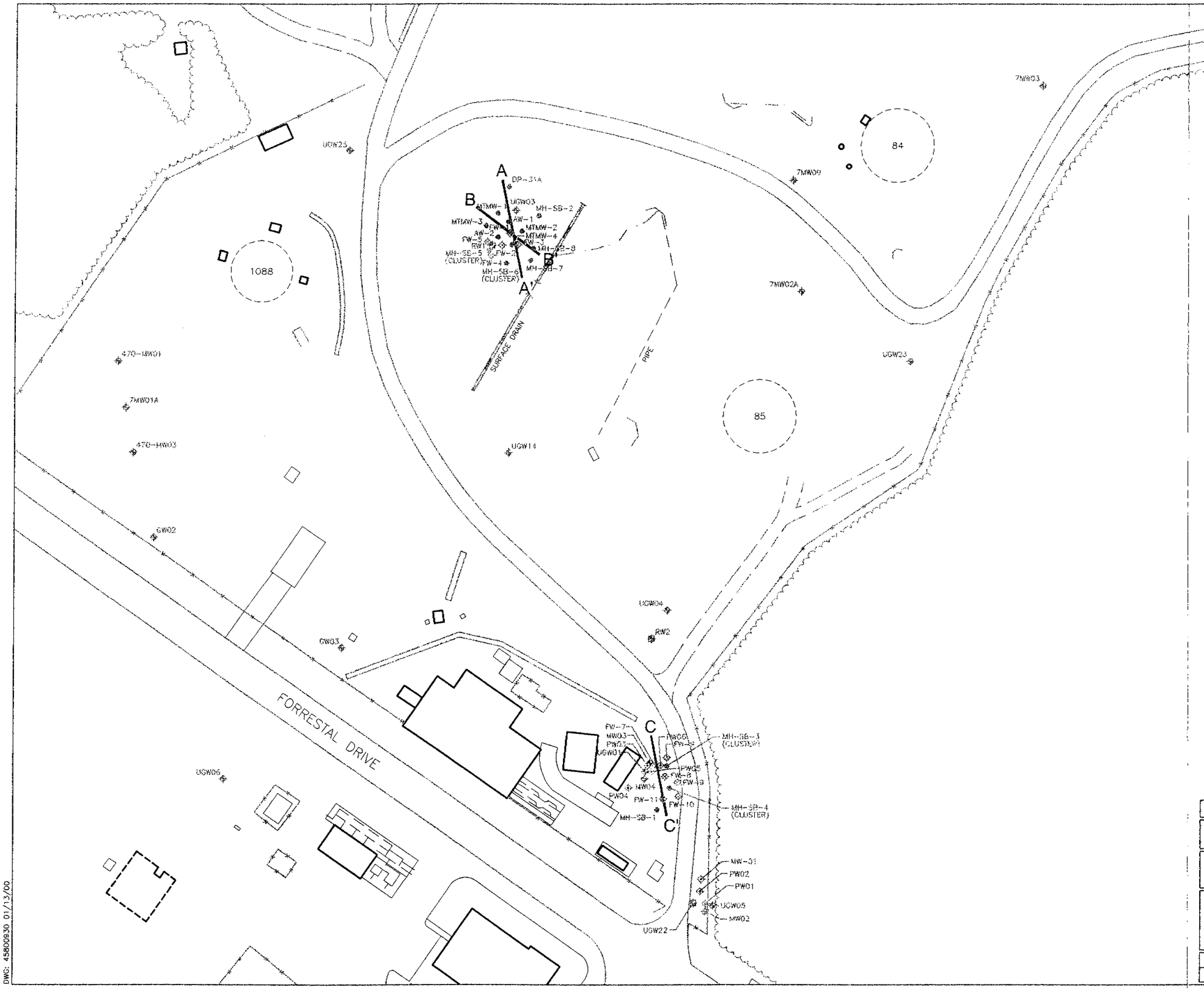
SOIL BORING LOCATIONS IN RW1 AREA

ROOSEVELT ROADS U.S. NAVAL STATION –
TOW WAY FUEL FACILITY, CEIBA, PUERTO RICO

McLaren Hart INC.

DRWN: S.F.H.	CHK'D: T.K.
SCALE: AS SHOWN	DATE: 01/13/00

DWG: 45B00929 01/13/00



N
W E
S

LEGEND

- FENCE
- VEGETATION
- EXISTING MONITORING WELL LOCATION
- McLAREN/HART PRODUCT RECOVERY WELL LOCATION
- TERRAVAC PRODUCT RECOVERY WELL LOCATION
- McLAREN/HART SOIL BORING LOCATION
- PNEUMATIC FRACTURE LOCATION
- CROSS-SECTION LOCATION

SCALE

80 40 0 80 FEET

FIGURE 4

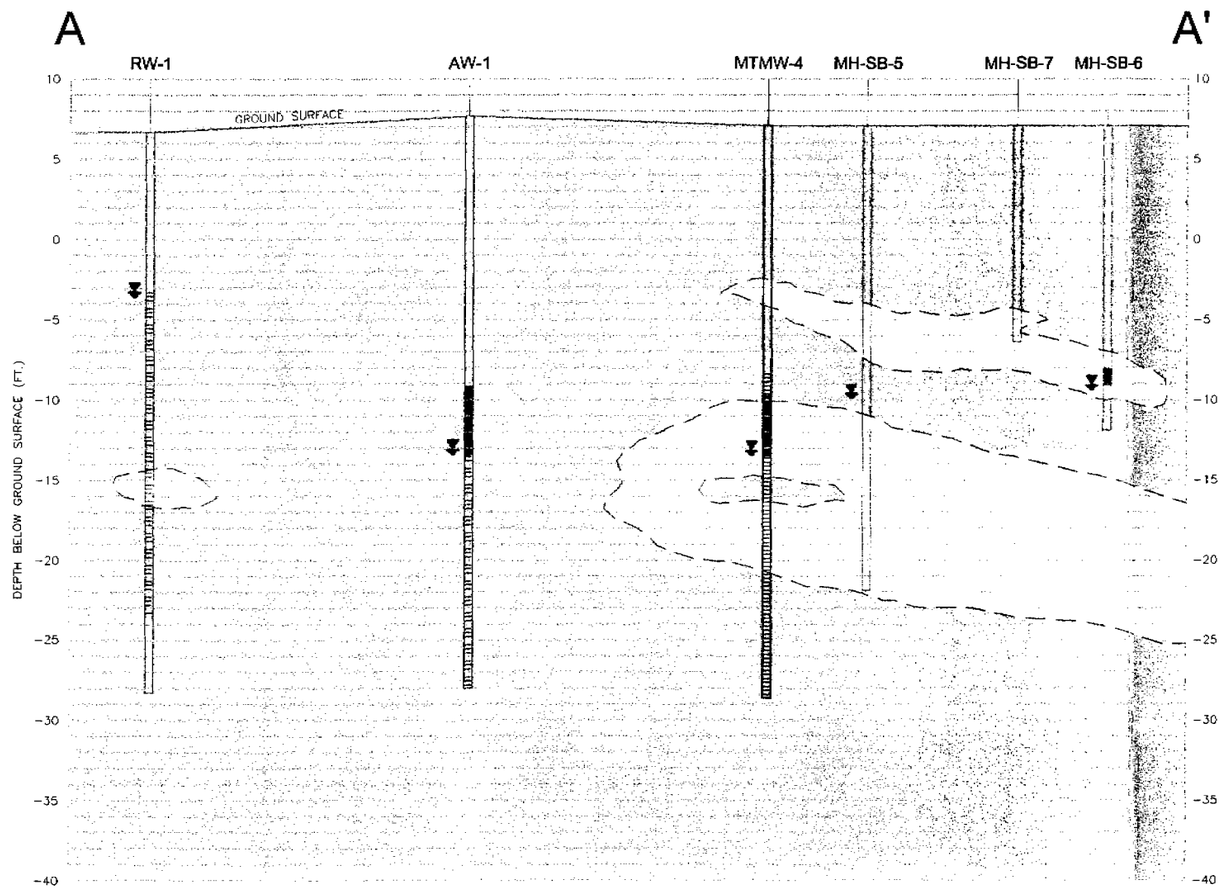
GEOLOGIC CROSS-SECTION LOCATION MAP

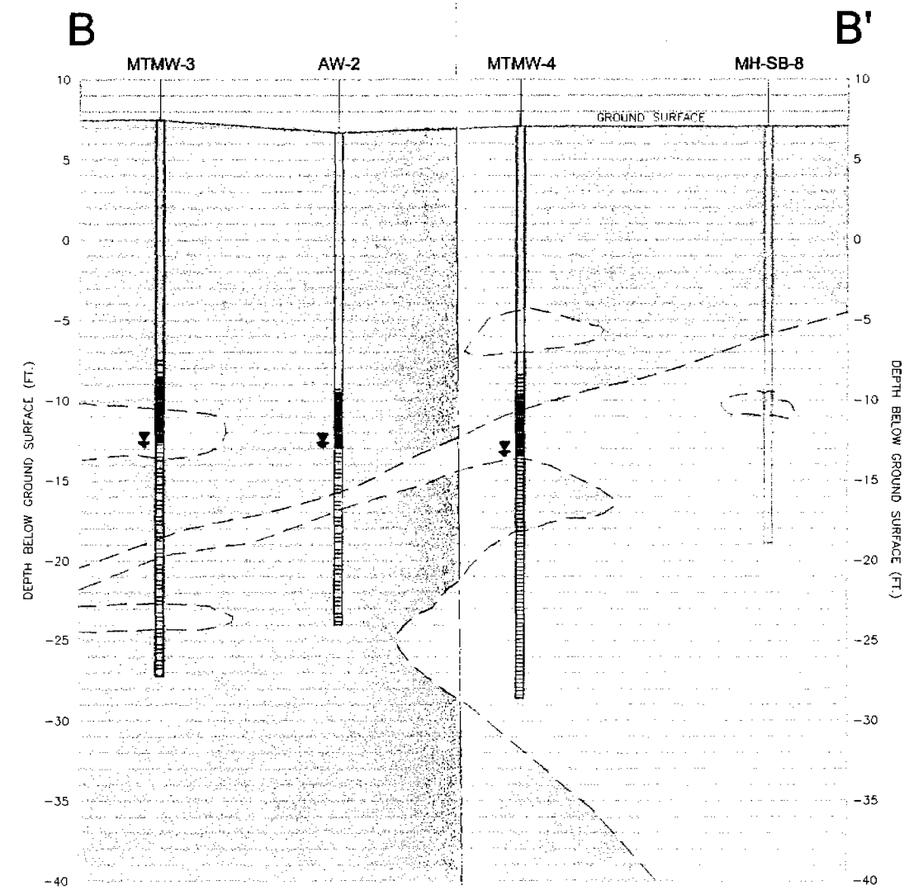
ROOSEVELT ROADS U.S. NAVAL STATION – TOW WAY FUEL FACILITY, CEIBA, PUERTO RICO

McLaren Hart INC.

DRWN: S.F.H.	CHK'D: T.K.
SCALE: AS SHOWN	DATE: 01/13/00

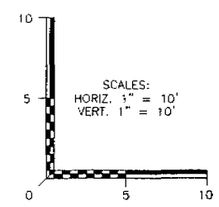
DWG: 458000930 01/13/00





LEGEND

- SCREENED INTERVAL
- PETROLEUM PRODUCT ZONE
- WATER TABLE
- SAND & GRAVEL
- CLAY & SILT



SCALE IN FEET

FIGURE 5

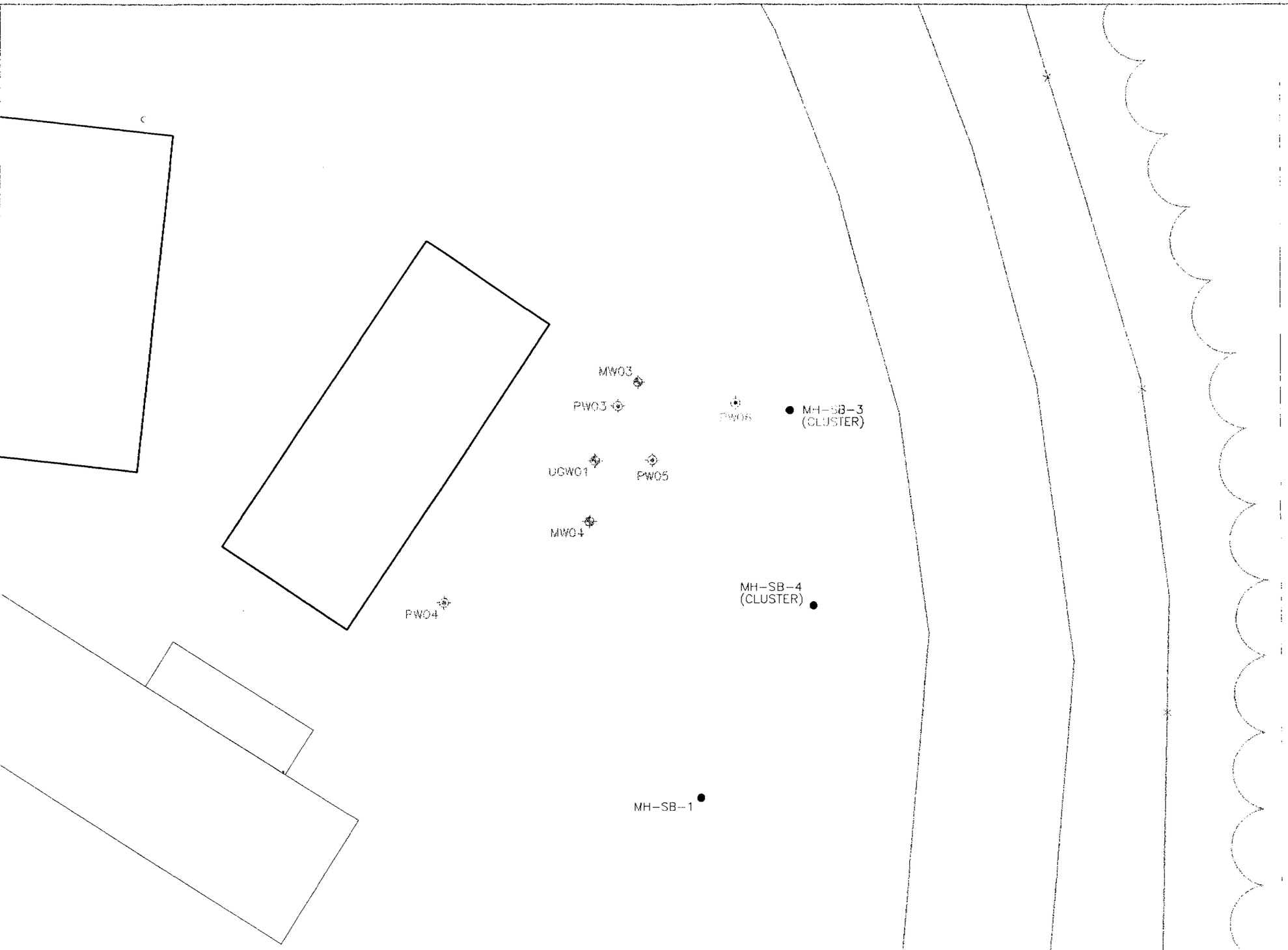
GEOLOGIC CROSS-SECTIONS
A-A' AND B-B' FOR RW1 LOCATION

ROOSEVELT ROADS U.S. NAVAL STATION –
TOW WAY FUEL FACILITY, CEIBA, PUERTO RICO

McLaren Hart INC.

DRWN: S.F.H.	CHK'D: T.K.
SCALE: AS SHOWN	DATE: 01/13/00

DWG: 45800931 01/13/00



LEGEND

- FENCE
- VEGETATION
- EXISTING WELL LOCATION
- TERRAVAC PRODUCT RECOVERY WELL LOCATION
- McLAREN/HART SOIL BORING LOCATION

SCALE

10 5 0 10 FEET

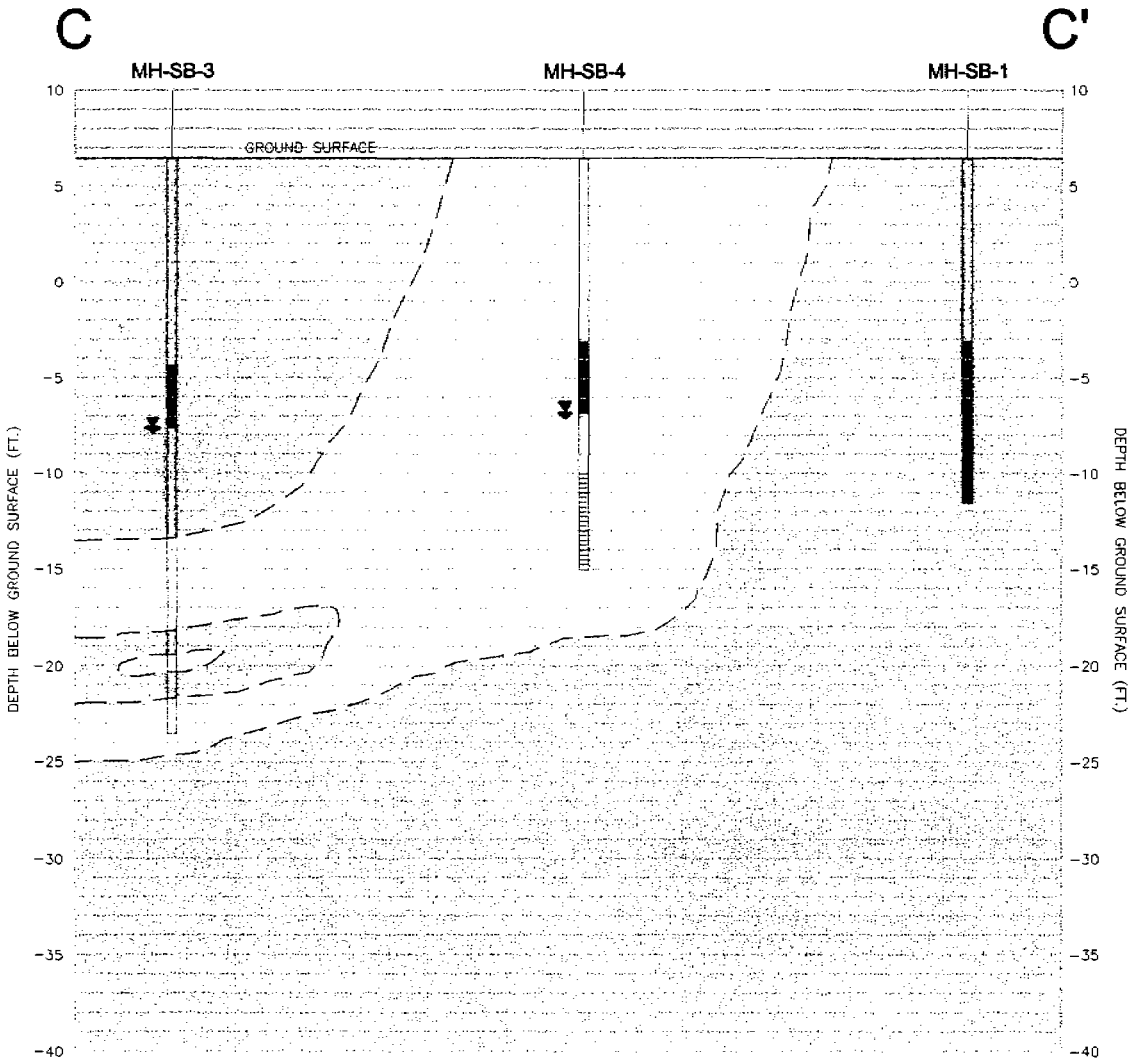
FIGURE 6

SOIL BORING LOCATIONS IN PW6 AREA

ROOSEVELT ROADS U.S. NAVAL STATION –
TOW WAY FUEL FACILITY, CEIBA, PUERTO RICO

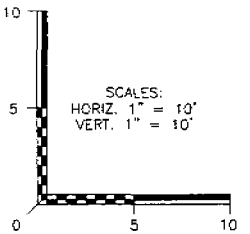
McLaren Hart INC.

DRWN: S.F.H.	CHK'D: T.K.
SCALE: AS SHOWN	DATE: 01/13/00



LEGEND

- SCREENED INTERVAL
- PETROLEUM PRODUCT ZONE
- WATER TABLE
- SAND & GRAVEL
- CLAY & SILT



SCALE IN FEET

FIGURE 7

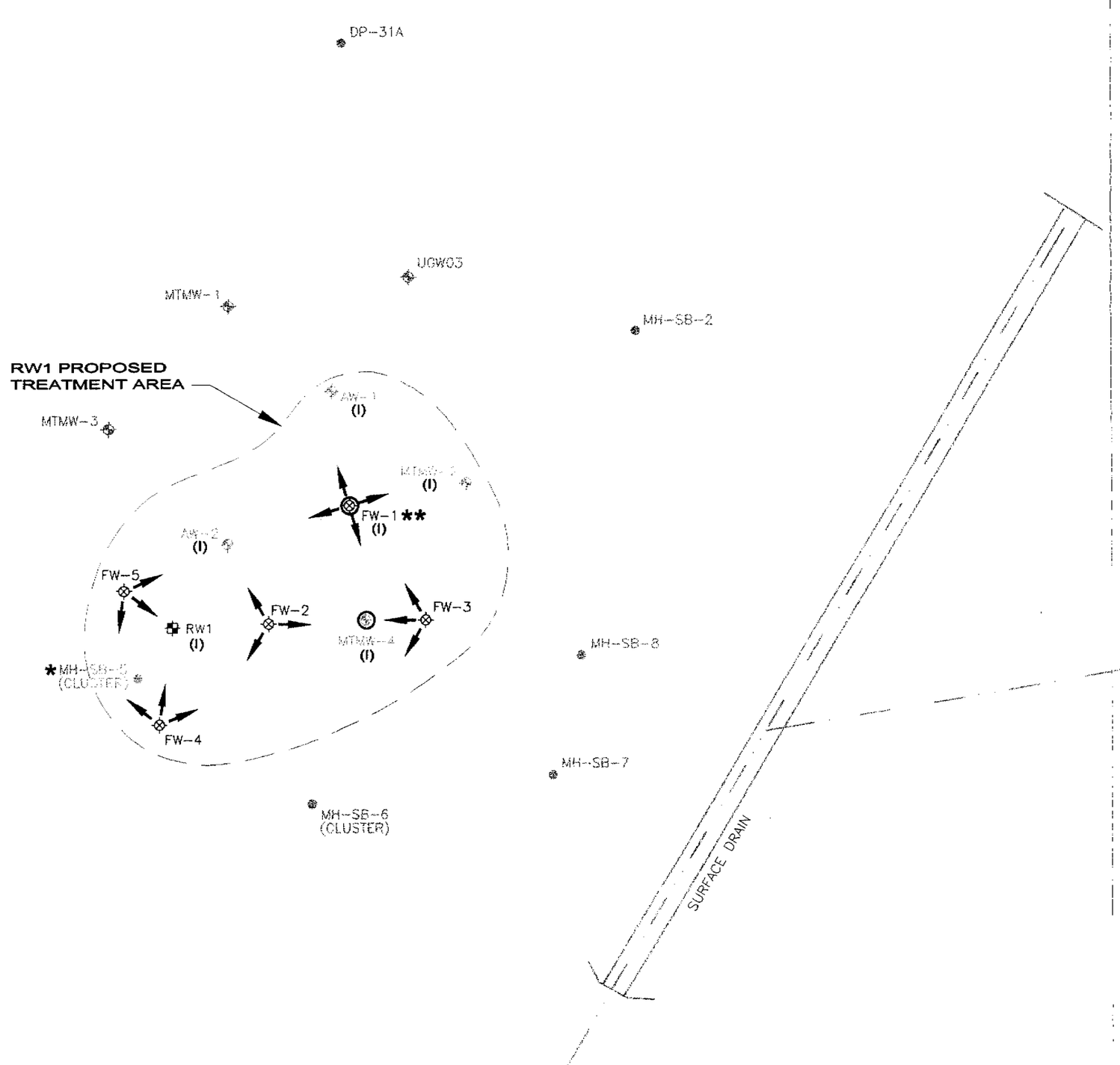
GEOLOGIC CROSS-SECTIONS
C-C' FOR PW06 LOCATION

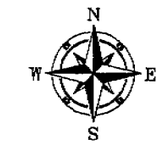
ROOSEVELT ROADS U.S. NAVAL STATION –
TOW WAY FUEL FACILITY, CEIBA, PUERTO RICO

McLaren Hart INC.

DRWN: S.F.H.	CHK'D: T.K.
SCALE: AS SHOWN	DATE: 01/13/00

DWG: 45800933 01/13/00





LEGEND

- EXISTING WELL LOCATION
- McLAREN/HART PRODUCT RECOVERY WELL LOCATION
- LOCATION COVERTED TO PRODUCT RECOVERY WELL
- McLAREN/HART SOIL BORING LOCATION
- RADIAL PNEUMATIC FRACTURE LOCATION
- DIRECTIONAL PNEUMATIC FRACTURE LOCATION
- (I) WELLS INSTRUMENTED DURING FRACTURING
- * SOIL BORING LOCATION TO BE GROUTED IN PLACE
- ** CUSTOMIZED FRACTURE WELL TO EVALUATE FRACTURING THROUGH SCREEN. (SEE FIGURE 13)
- ESTIMATED TREATMENT AREA = 780 ft²

SCALE

10 5 0 10 FEET

FIGURE 8

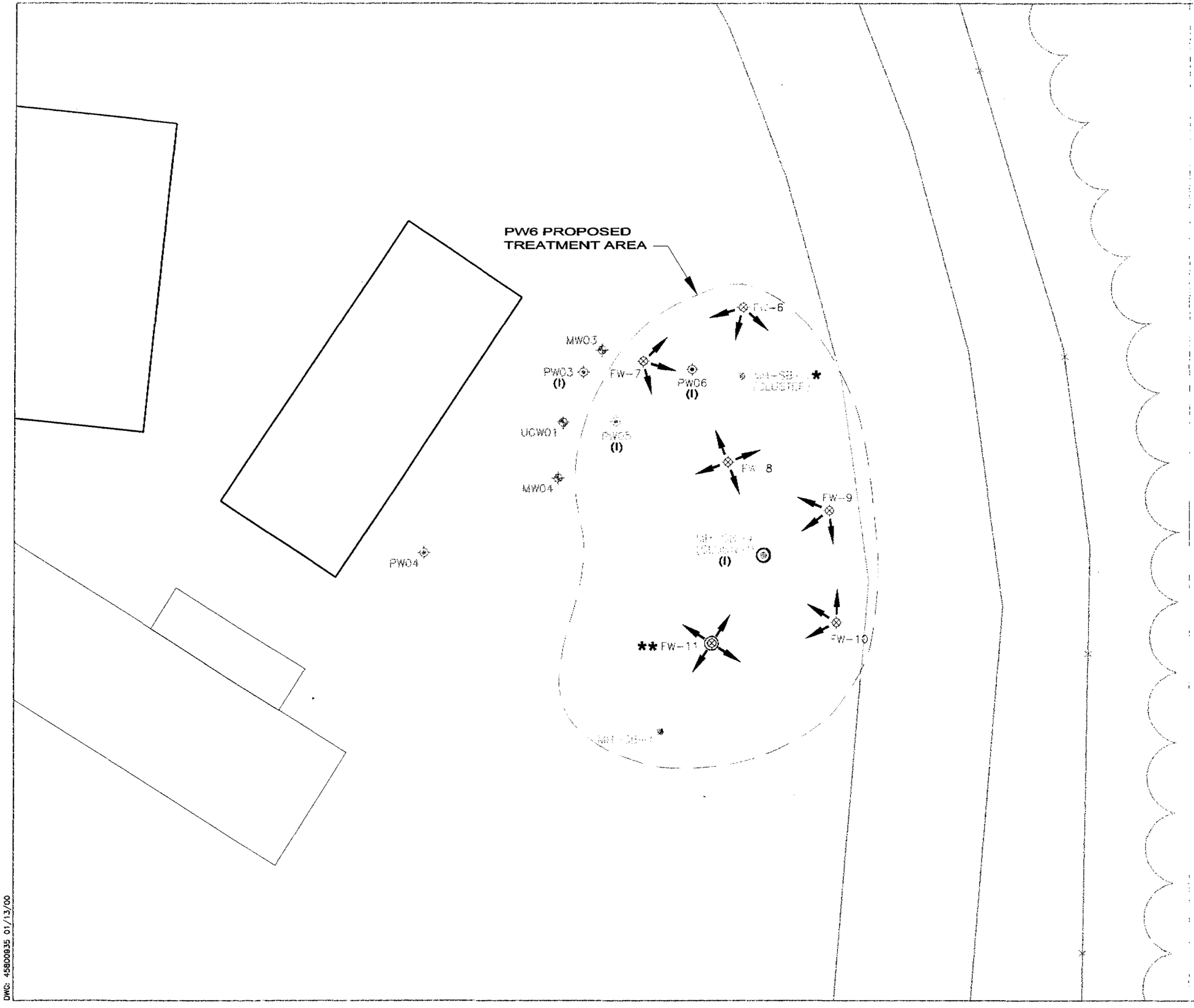
LAYOUT OF PRODUCT RECOVERY AND MONITORING WELLS IN AREA RW1

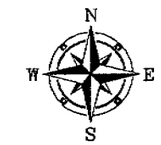
ROOSEVELT ROADS U.S. NAVAL STATION – TOW WAY FUEL FACILITY, CEIBA, PUERTO RICO

McLaren Hart INC.

DRWN: S.F.H.	CHK'D: T.K.
SCALE: AS SHOWN	DATE: 01/13/00

DWG: 45800934 01/13/00





LEGEND

- FENCE
- VEGETATION
- EXISTING MONITORING WELL LOCATION
- TERRAVAC PRODUCT RECOVERY WELL LOCATION
- LOCATION COVERTED TO PRODUCT RECOVERY WELL
- McLAREN/HART SOIL BORING LOCATION
- RADIAL PNEUMATIC FRACTURE LOCATION
- DIRECTIONAL PNEUMATIC FRACTURE LOCATION
- (I) WELLS INSTRUMENTED DURING FRACTURING
- * SOIL BORING LOCATION TO BE GROUTED IN PLACE
- ** LOCATION COVERTED TO PRODUCT RECOVERY WELL AFTER FRACTURING (SEE FIGURE 12, NOTE 7)
- ESTIMATED TREATMENT AREA = 1,240 ft²

SCALE

10 5 0 10 FEET

FIGURE 9

LAYOUT OF PRODUCT RECOVERY AND MONITORING WELLS IN AREA PW6

ROOSEVELT ROADS U.S. NAVAL STATION – TOW WAY FUEL FACILITY, CEIBA, PUERTO RICO

McLaren Hart INC.

DRWN: S.F.H.	CHK'D: T.K.
SCALE: AS SHOWN	DATE: 01/13/00

DWG: 45800935 01/13/00

FIGURE 10
ACTIVITY FLOW CHART FOR RW-1 AREA

Phase 1 of Pilot Studies to Evaluate Enhancement of Product Recovery
Tow Way Fuel Facility
Naval Station, Roosevelt Roads
Ceiba, Puerto Rico

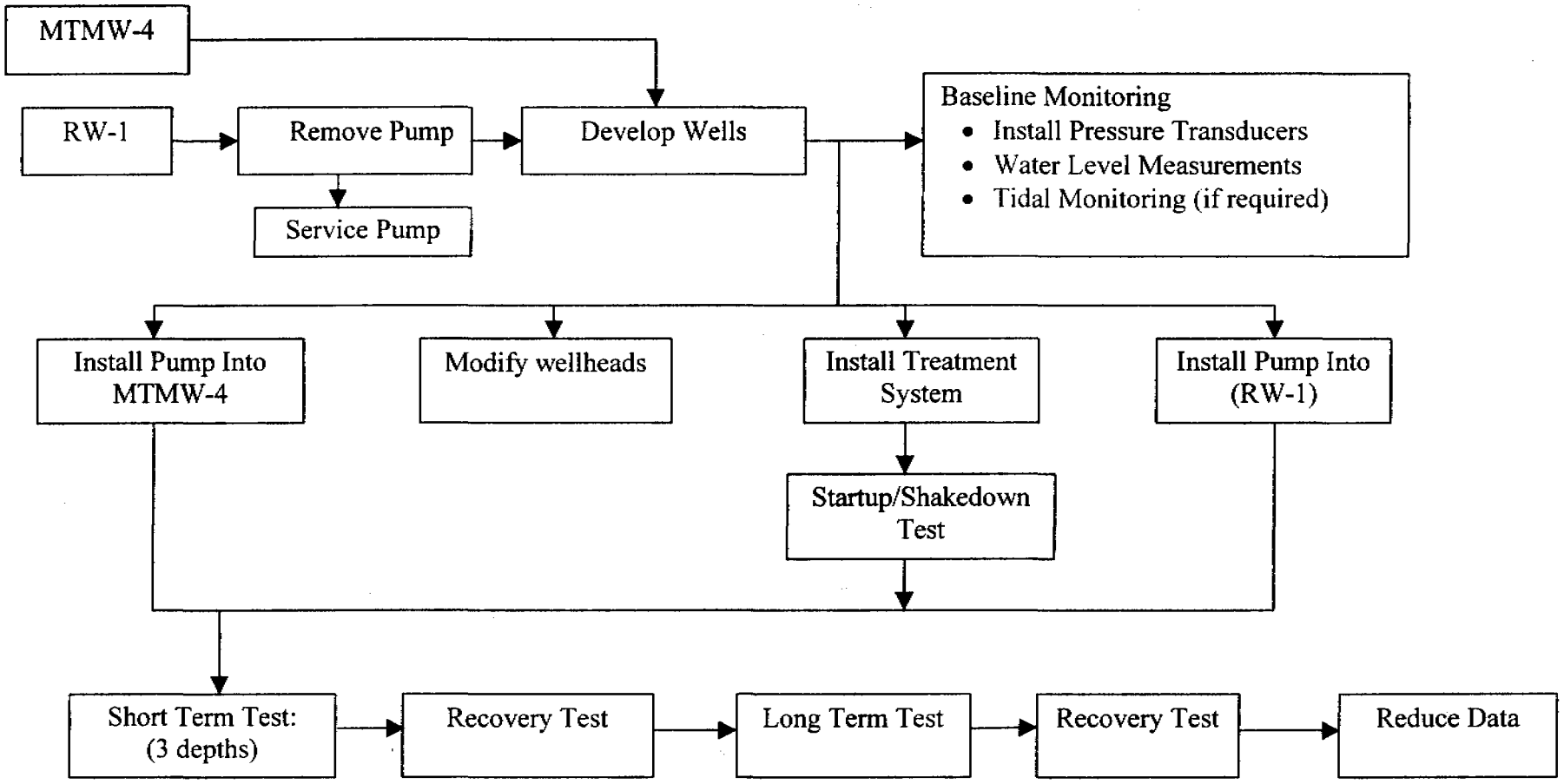
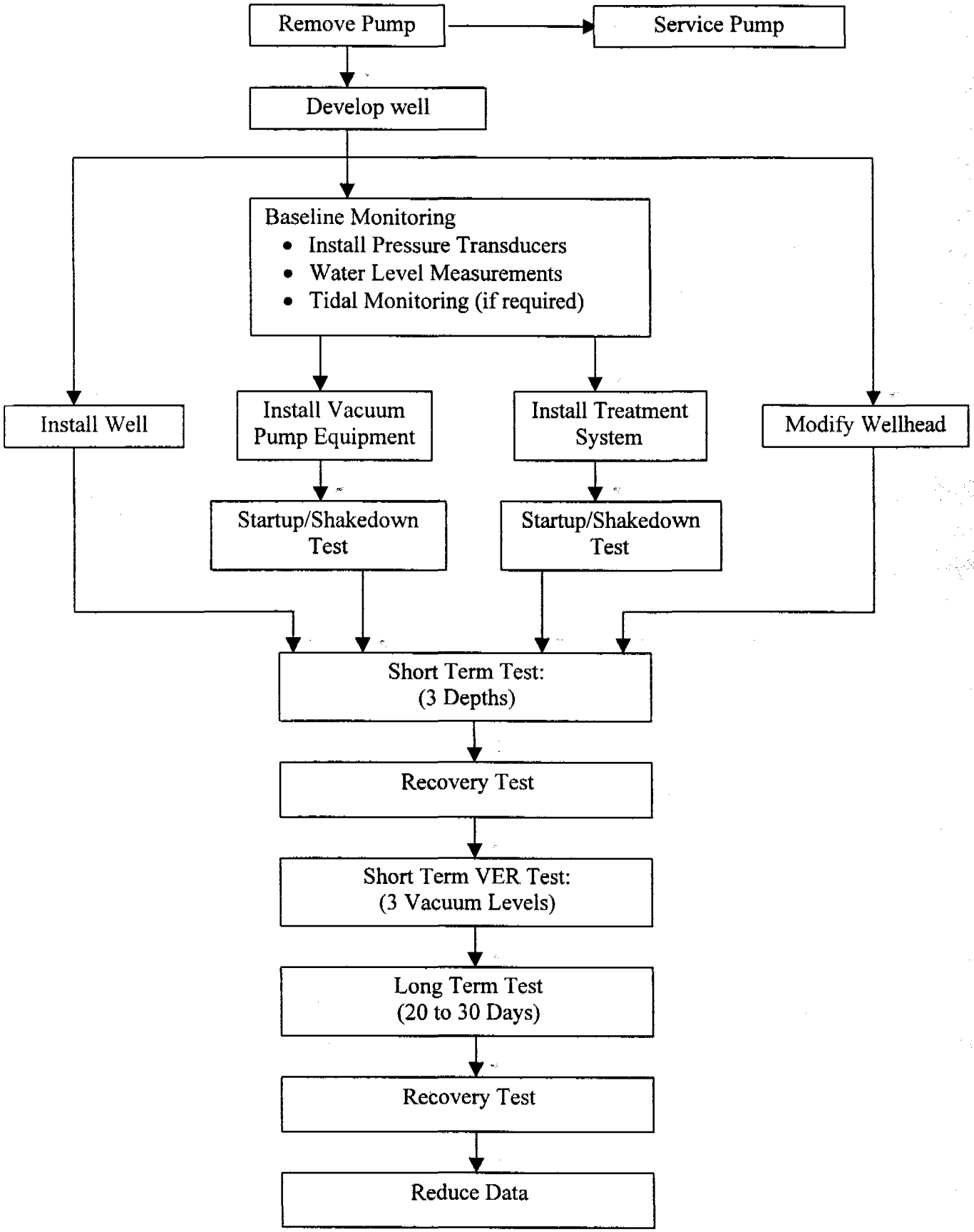
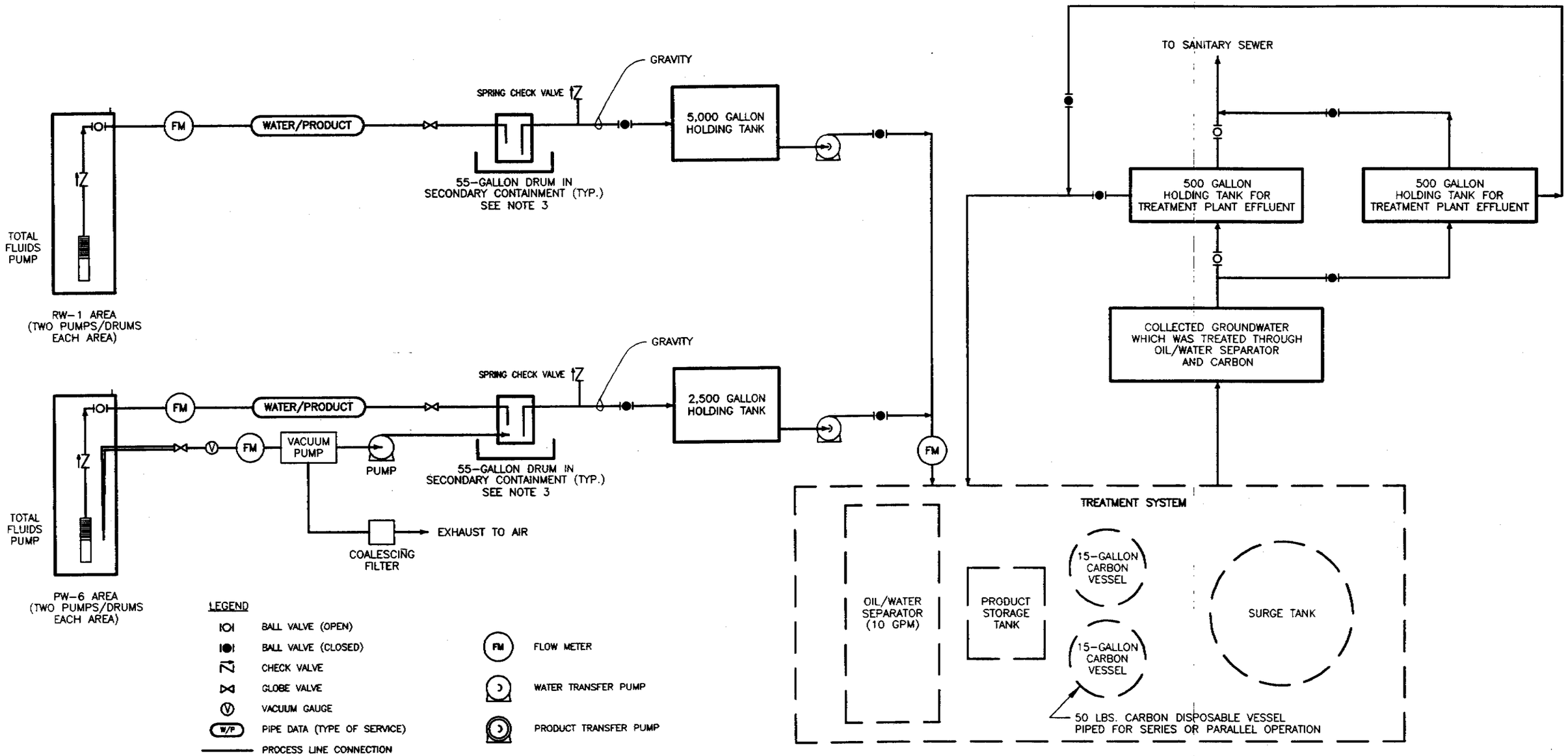


FIGURE 10
ACTIVITY FLOW CHART FOR THE PW-6 AREA

Phase 1 of Pilot Studies to Evaluate Enhancement of Product Recovery
Tow Way Fuel Facility, Naval Station, Roosevelt Roads





LEGEND

- BALL VALVE (OPEN)
- BALL VALVE (CLOSED)
- CHECK VALVE
- GLOBE VALVE
- VACUUM GAUGE
- W/P — PIPE DATA (TYPE OF SERVICE)
- PROCESS LINE CONNECTION
- PNEUMATIC TOTAL FLUID RECOVERY PUMP
- FM — FLOW METER
- WATER TRANSFER PUMP
- PRODUCT TRANSFER PUMP

NOTES:

1. ALL PRODUCT SHALL BE REMOVED FROM HOLDING TANKS PRIOR TO TREATMENT OF COLLECTED GROUNDWATER.
2. COLLECTED GROUNDWATER WILL BE TREATED UTILIZING AN OIL/WATER SEPARATOR AND BE DISCHARGED TO ON-SITE SANITARY SEWER FOR FINAL TREATMENT BY ON-SITE WASTEWATER TREATMENT PLANT.
3. GAUGE PRODUCT AND WATER IN 55-GALLON DRUM.
4. PRODUCT ACCUMULATED IN THE 55-GALLON DRUM AND 5,000/2,500-GALLON HOLDING TANKS WILL BE PUMPED OUT MANUALLY AND TRANSPORTED TO THE EXISTING PRODUCT STORAGE TANK.

PILOT STUDY

PRODUCT RECOVERY SYSTEM SCHEMATIC

ROOSEVELT ROADS U.S. NAVAL STATION
TOW WAY FUEL FACILITY
CEIBA, PUERTO RICO

CHECKED BY:	DWG. NO.	FIGURE NO.
APPROVED BY:	45809B5	11

McLaren Hart INC.

RW1 PILOT TEST AREA

PW06 PILOT TEST AREA

5,000-GALLON HOLDING TANK

2,500-GALLON HOLDING TANK

TREATMENT SYSTEM

500-GALLON EFFLUENT TANK (2)

OFFICE TRAILER

PRODUCT LINE (2)

CONTAMINATED SOIL STOCKPILE

NON-CONTAMINATED SOIL STOCKPILE

TEMPORARY ROAD CROSSING

EXISTING OIL/ WATER SEPARATOR

EXISTING PRODUCT RECOVERY SYSTEM

FORRESTAL DRIVE

1088

85

470-MW01

7MW01A

470-MW03

GW02

GW03

UGW03

UGW14

UGW04

UGW06

UGW23

7MW02A

RW1

RW9

RW2

RW10

JB-1

MW03

PW03

GW01

MW04

PW04

PW06

RW05

MW01

PW02

UGW22

PW01

UGW05

MW02

N

LEGEND

- ABOVEGROUND GROUNDWATER LINE
- ABOVEGROUND TREATED WATER DISCHARGE LINE
- UNDERGROUND PRODUCT LINE (1)
- FENCE
- VEGETATION
- EXISTING MONITORING WELL LOCATION
- McLAREN/HART PRODUCT RECOVERY WELL LOCATION
- TERRAVAC PRODUCT RECOVERY WELL LOCATION
- APPROXIMATE LOCATION OF PILOT TEST

NOTES:

1. THE TREATMENT SYSTEM, PRODUCT STORAGE, AND PRODUCT LINES FROM THE TREATMENT SYSTEM SHALL BE SECONDARY CONTAINED. EXISTING BELOW GRADE CONVEYANCE LINES TO BE USED TO THE EXTENT PRACTICAL.
2. REFER TO FIGURE 16 FOR DETAILS OF THE TREATMENT SYSTEM.

SCALE

60 30 0 60 FEET

PILOT STUDY

SITE PLAN – TEMPORARY FACILITIES

ROOSEVELT ROADS U.S. NAVAL STATION
TOW WAY FUEL FACILITY
CEIBA, PUERTO RICO

CHECKED BY:	DWG. NO.	FIGURE NO.
APPROVED BY:	45809B4	12

McLaren Hart INC.

APPENDIX A

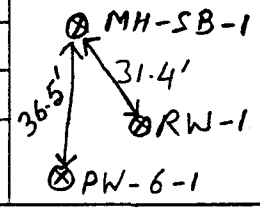
SOIL BORING LOGS:

1 - McLaren/Hart
2 – Mantech
3 – RW-1

McLaren Hart INC.

Site: Tow Way Fuel Farm, Roosevelt Roads	Location: Roosevelt Roads , Puerto Rico	Boring ID: **MH-SB-1**
Client: U.S. Naval Station	Boring Location: MH-SB-1	Northing: 18.23204716 Easting: -65.61994268	Start - Finish Date: 9/17/99 - 9/17/99
Drilling Contractor: STC	Driller: Robert Marrero Mojica	Logged By: Will Whitesell/Pittsburgh	Boring Permit: N/A
Drilling Method: Hollow-stem auger	Drilling Equipment: BK-51		
Total Depth (ft): 18.0	Ground Elevation (ft): NA	Vertical Datum:	Horiz Coor Sys: Lat/Long 1983
Sampling Method: 2" Split spoon	Borehole Diameter (in): 6		
Memo:			

Location Sketch

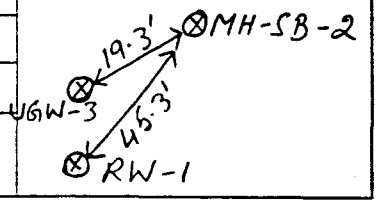


Depth (ft)	Geoprobe Sample	Recovery (ft)	Soil Description	Lithology	PID/FID (ppm)	Sample ID
		1.63/2	SILT, clayey, stiff, light brown, tan; with fill. Dry.			S-1
2		1.25/2	SILT, clayey, stiff, reddish brown and light gray; with some silty sand. Dry.		0	S-2
4		0.83/2	SILT and GRAVEL, very stiff, gray red; with some pebbles and cobbles.		1	S-3
6		0.75/2	SILT, very soft, light brownish tan; with some orange stained fresh and weathered gabbro. Dry.			S-4
			SILT, medium stiff brown; with light gray and orange severly weathered and fresh gabbro.			
8		1.17/2				S-5
10		1/1	SILT, clayey, very stiff, light brown; with some reddish orange silt, moist petroleum, heavy odor. Moist.			S-6
			SILT, very soft, light brown; with some gray highly weathered gabbro, heavy odor. Dry.			
12		0.38/0				S-7
			SILT, very soft, light brown; with some gray highly weathered gabbro, heavy odor.			
14		0.67/0				S-8
			No recovery.			
16		0/0				S-9
		0/1				S-10
18			End of boring at 18' bgs.			

McLaren Hart INC.

Site: Tow Way Fuel Farm, Roosevelt Roads	Location: Roosevelt Roads , Puerto Rico	Boring ID: **MH-SB-2**
Client: U.S. Naval Station	Boring Location: MH-SB-2	Northing: 18.2338933 Easting: -65.62022733	Start - Finish Date: 9/18/99 - 9/19/99
Drilling Contractor: STC	Driller: Robert Marrero Mojica	Logged By: Trevor King/Warren	Boring Permit: N/A
Drilling Method: Hollow-stem auger	Drilling Equipment: BK-51		
Total Depth (ft): 30.3	Ground Elevation (ft): NA	Vertical Datum:	Horiz Coor Sys: Lat/Long 1983
Sampling Method: 2" Split spoon	Borehole Diameter (in): 6		
Memo:			

Location Sketch

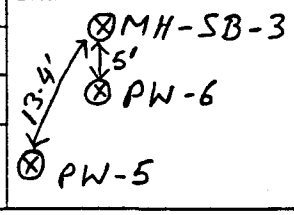


Depth (ft)	Geoprobe Sample	Recovery (ft)	Soil Description	Lithology	PID/FID (ppm)	Sample ID
		1.08/2	SILT, sandy, very soft, brown with fill. Dry.			S-1
2		1.29/2	CLAY, sandy, very stiff, light brown and reddish with fresh gabbro cobbles and pebbles. Moist.			S-2
4		0.83/2	CLAY, sandy, very stiff, light brown and reddish with some fresh gabriel or fill pebbles, cobbles. Moist.			S-3
6		0.21/2	CLAY, stiff reddish brown, with some granular sand and moderatly weathered pebble gabbro. Moist.			S-4
8		1.33/2	CLAY, stiff reddish brown with trace light gray coloring. Moist.			S-5
10		1.79/2	CLAY, stiff reddish brown with trace light gray coloring. Moist.			S-6
12		1.75/2	CLAY, stiff reddish brown with trace light gray coloring. Moist.			S-7
14		1.96/2	SILT, sandy, very stiff, light brown; with light gray and light tan fine to coarse weathered gabbro, heavy odor. Slightly moist. SILT, sandy, very stiff, brown; with some highly weathered gabbro, granular pebbles with reddish orange coloring. Slightly moist.			S-8
16		0.92/2	CLAY, sandy, stiff, gray; with highly weathered gabbro and staining. Large pebbles, gabbro or fill between 15 to 15.5', heavy odor. Moist. SILT, clayey, hard, greenish gray; with dark gray highly weathered gabbro and staining. Dry.			S-9
18		0.13/1	ROCK, slightly weathered gabbro; with some clayey silt, odor. Dry.			S-10
20		1.92/2	ROCK, very stiff, dark gray, slightly weathered gabbro; with some sandy silt, possible staining, odor. Dry. ROCK, and debries, fresh gabbro.			S-11
22		2/2	CLAY, sandy, hard olive gray and dark gray; with trace highly weathered rock or gabbro, odor. Moist.			S-12
24		0.46/1	SILT, soft, light brown to tan; with highly weathered gabbro. Refusal: 23.5-24', slight odor.			S-13
		0.42/1	CLAY, silty, very stiff, olive gray and reddish orange; with fine grained highly weathered gabbro. Refusal: 24.5-25', slight odor. Dry.			S-14
		0.86/2	SILT, sandy, stiff, dark gray; with some white fine to medium stiff debries. Moist.			S-15
26		0.83/1	SILT, sandy, soft, olive gray reddish brown, top 1" saturated. Moist.			S-16
28		0.58/1	SILT, sandy, soft, olive gray reddish brown, with semi moderate to highly weathered gabbro. Wet.			S-17
		1.33/2	SILT, sandy, stiff, reddish orange; with some weathered gabbro, dark gray, dark staining. Fresh to slightly weathered gabbro towards to bottom, Wet and saturated sample. Wet.			S-18
30		0.25/0	End of boring at 30.25' bgs.			S-19
32						

McLaren Hart INC.

Site: Tow Way Fuel Farm, Roosevelt Roads	Location: Roosevelt Roads , Puerto Rico	Boring ID: **MH-SB-3**
Client: U.S. Naval Station	Boring Location: MH-SB-3	Northing: 18.23215581 Easting: -65.61992843	Start - Finish Date: 9/20/99 - 9/21/99
Drilling Contractor: STC	Driller: Robert Marrero Mojica	Logged By: Will Whitesell/Pittsburgh	Boring Permit: N/A
Drilling Method: Hollow-stem auger	Drilling Equipment: BK-51		
Total Depth (ft): 30.0	Ground Elevation (ft): NA	Vertical Datum:	Horiz Coor Sys: Lat/Long 1983
Sampling Method: 2" Split spoon	Borehole Diameter (in): 6		
Memo:			

Location Sketch

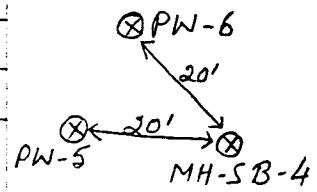


Depth (ft)	Geoprobe Sample	Recovery (ft)	Soil Description	Lithology	PID/FID (ppm)	Sample ID
		0.7/2	CLAY, sandy, very stiff, dark gray; with rock fill. Slightly moist.			S-1
2		1.4/2	CLAY, sandy, very soft, yellowish red; with some grayish pebbles and coarse sand, highly weathered, heavy odor. Moist.			S-2
4		1.25/2	SILT, sandy, soft, light brown; with trace clay, heavy odor. Moist.			S-3
			CLAY, sandy, very stiff, greenish and olive gray; with some moderate to highly weathered gabbro, slight odor. Dry.			
6		1/2	CLAY, sandy, very stiff, greenish and olive gray; with highly weathered large pebble gabbro. Slightly moist.			S-4
8		1.4/2	CLAY, sandy, very stiff, greenish and olive gray, dark gray to blackish staining; with highly weathered large pebble gabbro, heavy odor.			S-5
10		1.3/2	SILT, sandy, stiff, dark gray; with reddish and black trace clay, staining, some highly weathered gabbro. Moist.		8-12	S-6
12		1.3/2	SILT, sandy, stiff, dark gray; with reddish and black trace clay, dark staining, some fresh to moderatly weathered gabbro with trace sandy silt. Dry.		10-19	S-7
14		1.25/2	SILT, sandy, stiff, dark gray; with reddish and black trace clay, dark staining, some fresh to moderatly weathered gabbro with trace sandy silt. Dry.		25-43	S-8
16		1.7/2	CLAY, silty, very stiff, dark gray; with mostly highly weathered gabbro \ rock, trace reddish color, dark staining. Moist.		37-50	S-9
18		0.5/1	SILT, clayey, stiff, dark brown to dark olive gray; with trace of some moderatly weathered gabbro.		30-40	S-10
		0.8/1	GRAVEL, very dense, gray-rust-brown; some medium to coarse sand, little silty clay. Slightly moist.		30-40	S-11
20		1.5/2	GRAVEL, sandy, very dense, rust brown, gray mottling and some silty clay.		50-100	S-12
22		1.7/2	0-6": GRAVEL, sandy, very dense, rust brown, gray mottling and some silty clay. 6-8": SAND, medium to coarse, red-gray-white. 8-20": GRAVEL, sandy dark gray , red, little silty clay. Slightly moist.		250	S-13
24		1.7/2	0-3": SAND, medium to coarse, medium dense, light gray (rock, some gravel). 3-6": SILT, clayey, very stiff, light gray-rust-brown, trace gravel. Slightly moist.		35	S-14
26		1.8/2	0-7": SILT, clayey, very stiff, light gray brown. 7-22": Silt, clayey, hard rust brown, light gray.		20	S-15
28		1.3/2	0-6": Sand, gravely, very dense, light gray-rust brown; some clayey silt. 6-16": SAND, silty, very dense, rust brown light gray; trace gravel, trace clay. Slightly moist.		20-70 15-40	S-16
30			End of boring at 30' bgs.			
32						

McLaren Hart INC.®

Site:	Tow Way Fuel Farm, Roosevelt Roads
Location:	Roosevelt Roads , Puerto Rico
Boring ID:	**MH-SB-4**
Client:	U.S. Naval Station
Boring Location:	MH-SB-4
Northing:	18.23209721
Easting:	-65.61990645
Start - Finish Date:	9/21/99 - 9/22/99
Drilling Contractor:	STC
Driller:	Luciano Rodriguez Velez
Logged By:	T. King/Warren & W. Whiteseil/Pittsburg
Boring Permit:	N/A
Drilling Method:	Hollow-stem auger
Drilling Equipment:	BK-51
Total Depth (ft):	21.5
Ground Elevation (ft):	NA
Vertical Datum:	
Horiz Coor Sys:	Lat/Long 1983
Sampling Method:	2" Split spoon
Borehole Diameter (in):	6
Memo:	

Location Sketch

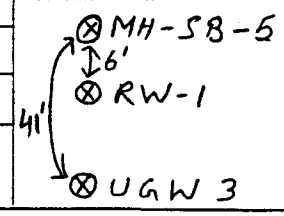


Depth (ft)	Geoprobe Sample	Recovery (ft)	Soil Description	Lithology	PID/FID (ppm)	Sample ID
		1.7/2	GRAVEL, sandy, medium to very dense light gray and rust-brown highly weathered, some clayey silt. Dry.			S-1
2		1.4/2	GRAVEL, sandy, very dense light gray highly weathered (saprolitic), little clayey silt. Dry.			S-2
4		1.5/2	SAND, gravelly, very dense light gray (saprolitic), trace fine sand. Dry.		21	S-3
6		1.25/2	SAND, gravelly, very dense light gray, brown; trace fine sand. Dry.		20-50	S-4
8		1.6/2			8-10	S-5
10		1.4/2	SAND, gravelly, very dense light gray, brown; trace fine sand, trace clayey silt. Dry.			S-6
12		1.4/2				S-7
			SAND, gravelly, very dense reddish-gray (saprolitic); trace clayey silt. Dry.			
14		1.3/2	SAND, gravelly, very dense light gray (saprolitic); trace clayey silt, refusal at 15.5'. Dry.		5.5-10	S-8
			Auger advanced to 16'. No recovery.			
16		1.3/2	SAND, gravelly, very dense reddish-gray (saprolitic); trace clayey silt. Moist.			S-9
			SAND, dark brown fine to medium grained, moist to wet with product from 16.5-17'. Dry with odor from 17-18'. 2 feet of diesel in auger (16-18').			
18		0.7/1	SAND, gravelly, very dense rust-brown and gray highly weathered (saprolitic). Refusal at 18.8'. Moist.			S-10
			Auger to 19.5', difficult drilling. No recovery. Auger to 20'.			
20		0.8/1	SAND, gravelly, very dense rust-brown and gray highly weathered (saprolitic). Refusal at 20.9', wet.			S-11
		0.5/1	1' SAND. Difficulty drilling; refusal at 21.5'. Auger cuttings like slop with diesel.			S-12
22			End of boring at 21.5' bgs.			

McLaren Hart INC.

Site:	Tow Way Fuel Farm, Roosevelt Roads
Location:	Roosevelt Roads , Puerto Rico
Boring ID:	**MH-SB-5**
Client:	U.S. Naval Station
Boring Location:	MH-SB-5
Northing:	18.23330955
Easting:	-65.62034561
Start - Finish Date:	9/22/99 - 9/22/99
Drilling Contractor:	STC
Driller:	Robert Marrero Mojica
Logged By:	Trevor King/Warren
Boring Permit:	N/A
Drilling Method:	Hollow-stem auger
Drilling Equipment:	BK-51
Total Depth (ft):	29.0
Ground Elevation (ft):	NA
Vertical Datum:	
Horiz Coor Sys:	Lat/Long 1983
Sampling Method:	2" Split spoon
Borehole Diameter (in):	6
Memo:	

Location Sketch

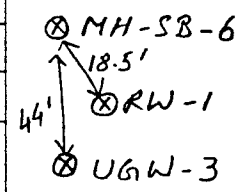


Depth (ft)	Geoprobe Sample	Recovery (ft)	Soil Description	Lithology	PID/FID (ppm)	Sample ID
		0.8/2	0-5": SILT, clayey, medium stiff, dark brown; trace fine sand and gravel, grass roots. 5-8": SAND, medium to coarse grained, soft to medium hard, brown and gray. 8-10": same as 0-5".. Moist.			S-1
2		1.08/2	CLAY, silty, stiff rust-brown, mottling gray; trace gravel and fine sand. Moist.		0	S-2
4		1.08/2	CLAY, silty, stiff rust-brown mottling gray; trace fine sand. Moist.			S-3
6		1.17/2	CLAY, silty. 0-9": very stiff to hard, rust-brown mottling gray, trace fine sand. 9-14": hard, rust-brown, mottling of gray and black color; some fine to coarse sand.		0	S-4
8		0/2	No recovery. Augered soil same as between 6-8"..		0	S-5
10		1.75/2	0-5": CLAY, silty, very stiff, rust-brown mottling gray. 5-2" : GRAVEL, sandy, medium dense to dense; trace clayey silt.. Slightly moist.		0	S-6
12		0.92/2	GRAVEL, fine and sand, dense, light and dark gray, rust brown; trace coarse gravel, trace clayey silt. Slightly moist.		0	S-7
14		1.58/2	SILT, clayey, hard, rust-brown and gray; some fine to coarse sand. 15-18": fine to coarse sand - dry.		20-50	S-8
16		1.17/2	SAND, fine to coarse grained, very stiff to hard, dark gray and rust brown; some clayey silt, trace gravel. Slightly moist.		10-30	S-9
18		1.33/2	SAND,fine to coarse, very dense, rust-brown and gray; trace gravel, trace clayey silt. Slightly moist.		100-200	S-10
20		1.42/2	0-8", 14-17": SAND,fine to coarse, very dense, rust-brown and gray; trace gravel, trace clayey silt. 8-14": same but less clay and sand. Dry.		90-110	S-11
22		0/1	SAND,fine to coarse, very dense, rust-brown and gray; trace gravel, trace clayey silt. Refusal at 22', auger to 23'. Moist.		100-120	S-12
		0/1				S-13
		0/1				S-14
24		0/1				S-15
		0/1				S-16
		0/1				S-17
26		0/1				S-18
		1.83/2	0-14": SAND, very dense, rust-brown and dark gray mottlings; some gravel and fine sand, little to some clayey silt. 14-22": SAND, clayey, hard, light gray, white, rust-brown mottled, trace coarse sand (saprolitic appearance). Slightly moist.			S-19
28		0.67/1	CLAY, mottled, hard, light gray, white, rust-brown; some fine to coarse sand, trace gravel. Refusal at 28'7" ~~End of boring at 29' bgs.~~ Auger to 29'.		3-10	S-20
30						S-21

McLaren Hart INC.

Site:	Tow Way Fuel Farm, Roosevelt Roads
Location:	Roosevelt Roads , Puerto Rico
Boring ID:	**MH-SB-6**
Client:	U.S. Naval Station
Boring Location:	MH-SB-6
Northing:	18.23328684
Easting:	-65.62029761
Start - Finish Date:	9/22/99 - 9/22/99
Drilling Contractor:	STC
Driller:	Robert Marrero Mojica
Logged By:	Trevor King/Warren
Boring Permit:	N/A
Drilling Method:	Hollow-stem auger
Drilling Equipment:	BK-51
Total Depth (ft):	29.0
Ground Elevation (ft):	NA
Vertical Datum:	
Horiz Coor Sys:	Lat/Long 1983
Sampling Method:	2" Split spoon
Borehole Diameter (in):	6
Memo:	

Location Sketch

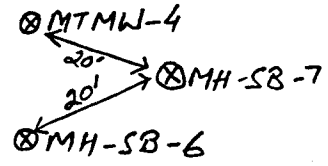


Depth (ft)	Geoprobe Sample	Recovery (ft)	Soil Description	Lithology	PID/FID (ppm)	Sample ID
			Auger advanced to 10' below ground surface (b.g.s.). Moist.			
10		1.7/2	CLAY, silty. 0-9": hard rust- brown gray, trace sand. 9-20": dense, light and dark gray; with some rust-brown fine gravel and sand. Moist.		120 210	S-1 S-2
12		1.6/2	CLAY, sandy, hard olive gray rust-brown and white mottling(saprolitic appearance), trace gravel. Moist.		150	S-3
14		1.6/2	CLAY, sandy, very stiff to hard olive gray rust-brown and white mottling(saprolitic appearance), trace gravel. 9-14": fine to coarse sand, trace gravel. Dry.		200 60	S-4
16		1.75/2	CLAY, sandy, hard olive gray rust-brown and white mottling(saprolitic appearance), trace gravel. Moist.		120 30	S-5
18		1.7/2	CLAY, sandy, hard olive gray rust-brown and white mottling(saprolitic appearance), friable and crumbling; trace gravel. Slightly moist.		120 70	S-6
20		1.4/2	CLAY, sandy, hard olive gray rust-brown and white mottling(saprolitic appearance), friable and crumbling; trace gravel. 10-12": dry sand and gravel. Moist.		160	S-7
22		1.7/2	SAND, 0-9": very dense, rust-brown and gray, gravelly fine to coarse grained; little clay. 9-20": very dense, rust-brown with some gray white mottling clayey sand, trace gravel. Wet.		100	S-8
24		1.4/2	SAND, very light gray brown, fine to medium grained, trace coarse sand. 5-7": gray sand and gravel. 7-17": sandy clay, very stiff to hard olive gray/rust brown and white mottling (saprolitic appearance), trace gravel. Wet and saturated towards the bottom. Wet.			S-9
26		1.5/2	SAND, 0-6": clayey, very dense rust-brown and white mottling (saprolitic appearance). 6-18": fine to medium grained, very dense, rust-brown with white/gray crystals, trace gravel, trace clay.			S-10
28			Auger to 29'.			S-11
30			End of boring at 29' bgs.			

McLaren Hart INC.

Site: Tow Way Fuel Farm, Roosevelt Roads	Location: Roosevelt Roads , Puerto Rico	Boring ID: **MH-SB-7**
Client: U.S. Naval Station	Boring Location: MH-SB-7	Northing: 18.23329614 Easting: -65.62023884	Start - Finish Date: 9/24/99 - 9/24/99
Drilling Contractor: STC	Driller: Robert Marrero Mojica	Logged By: Trevor King/Warren	Boring Permit: N/A
Drilling Method: Hollow-stem auger	Drilling Equipment: BK-51		
Total Depth (ft): 13.4	Ground Elevation (ft): NA	Vertical Datum:	Horiz Coor Sys: Lat/Long 1983
Sampling Method: 2" Split spoon	Borehole Diameter (in): 6		
Memo:			

Location Sketch

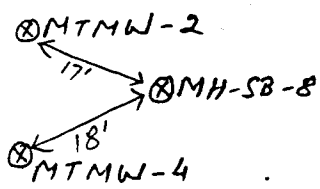


Depth (ft)	Geoprobe Sample	Recovery (ft)	Soil Description	Lithology	PID/FID (ppm)	Sample ID
			CLAY, silty, soft to medium stiff, olive gray and brown; trace fine to medium sand. Moist.			S-1
2						
4						
			CLAY, silty, soft to medium stiff, olive gray and light brown; trace fine to medium sand. Moist.			S-2
6						
8						
10		1.08/2	0-5": CLAY, silty, soft rust-brown gray; trace fine to medium sand. 5-19": SAND and gravel, light gray; little silty clay. Moist.			S-3
12		1.58/2	0-7": CLAY, silty, very stiff rust-brown gray; trace fine to medium sand. 7-16": SAND and gravel, very dense light gray; trace silty clay. 16-19": SAND and gravel, very dense rust-brown; trace silty clay. Slightly moist.			S-4
			End of boring at 13.42' bgs.			
14						

McLaren Hart INC.

Site: Tow Way Fuel Farm, Roosevelt Roads	Location: Roosevelt Roads , Puerto Rico	Boring ID: **MH-SB-8**
Client: U.S. Naval Station	Boring Location: MH-SB-8	Northing: 18.23333816 Easting: -65.62023577	Start - Finish Date: 9/24/99 - 9/24/99
Drilling Contractor: STC	Driller: Robert Marrero Mojica	Logged By: Trevor King/Warren	Boring Permit: N/A
Drilling Method: Hollow-stem auger	Drilling Equipment: BK-51		
Total Depth (ft): 26.0	Ground Elevation (ft): NA	Vertical Datum:	Horiz Coor Sys: Lat/Long 1983
Sampling Method: 2" Split spoon	Borehole Diameter (in): 6		
Memo:			

Location Sketch

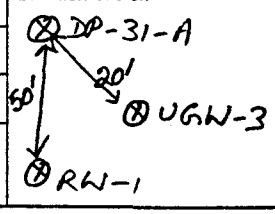


Depth (ft)	Geoprobe Sample	Recovery (ft)	Soil Description	Lithology	PID/FID (ppm)	Sample ID
2, 4		NA	CLAY, silty, soft to medium stiff, yellowish orange; trace fine to medium sand. Moist.			S-1
6, 8		NA	CLAY, silty, soft to medium stiff, yellowish orange; trace fine to medium sand. Moist.			S-2
10		1.83/2	0-5": CLAY, silty, stiff rust-brown; trace sand. 5-13": CLAY, sandy, hard rust-brown, gray and white crystals (saprolitic appearance); trace gravel. 13-22": GRAVEL and sand, dense rust-brown gray and white crystals (saprolitic appearance); little silty cl. Slightly moist.			S-3
12		1.5/2	SAND, clayey, dense to very dense rust-brown (saprolitic appearance), gray and white crystals; little gravel. Moist.			S-4
14		1.33/2	SAND, fine to medium grained, medium dense to dense, yellowish orange, light gray; trace gravel, little clay (saprolitic and crumbling). Moist.			S-5
16		1.5/2	0-9": CLAY, silty, hard rust-brown light gray and white crystals; trace sand. 9-18": SAND, fine to coarse, very dense, light gray; trace gravel, trace clayey silt (smell of diesel in cuttings). Wet.			S-6
18		1.33/2	SAND, fine to coarse, very dense, light and olive gray and white crystals, trace gravel (smell of diesel, core not well defined). Slightly moist.			S-7
20		1.67/2	SAND, fine to medium grained, very dense, light gray and brown; trace coarse sand, trace clayey silt. Moist.			S-8
22		1.75/2	SAND, fine to medium grained, very dense, light gray and brown; trace coarse sand, trace clayey silt (6-10": crumbled), several horizontal breaks.			S-9
24		1.42/2	0-9": SAND,very dense rust-brown. 9-17": SAND, and gravel, very dense light brown; trace clay. Dry.			S-10
26			End of boring at 26' bgs.			
28						

McLaren Hart INC.

Site: Tow Way Fuel Farm, Roosevelt Roads	Location: Roosevelt Roads , Puerto Rico	Boring ID: **DP-31A**
Client: U.S. Naval Station	Boring Location: DP-31A	Northing: / Easting:
Start - Finish Date: 9/15/99 - 9/15/99	Drilling Contractor: STC	Driller: Robert Marrero Mojica
Logged By: T. King/Warren & W. Whitesell/Pittsburg	Boring Permit: N/A	Drilling Method: Hollow-stem auger
Drilling Equipment: SIMCO 2400 SK-1	Total Depth (ft): 18.0	Ground Elevation (ft): NA
Vertical Datum:	Horiz Coor Sys: Lat/Long 1983	Sampling Method: 2" Split spoon
Borehole Diameter (in): 6	Memo:	

Location Sketch



Depth (ft)	Geoprobe Sample	Recovery (ft)	Soil Description	Lithology	PID/FID (ppm)	Sample ID
		0.33/2	FILL, very soft, clay and conglomerate fill. Very moist.			S-1
2		1.17/2	CLAY, very stiff, brown; with some fine gravel fill.			S-2
4		0.79/2	CLAY, very stiff, brown; with some fine gravel fill.			S-3
6		1.08/2	FILL, blueish-gray, coarse sand; trace clay. Moist.			S-4
			GABBRO, fresh dark gray jointed. 8.0': refusal. Jointing due to pneumatic system (not geological).			
8		1.58/2	GABBRO, highly weatnered reddish brown and gray olive. Dry.			S-5
10		1.5/2	GABBRO, weathered blue gray; some coarse sand and red staining. Moist.			S-6
12		1.75/2	GABBRO, (coarse sand) highly weathered brown and gray; red staining, trace clay. Moist.			S-7
14		2/2	GABBRO, (fine gravel) highly weathered light gray, strong organic odor. Dry.			S-8
16		1.91/2	CLAY, silty, stiff, tan white orange; some fine sand, less weathered towards the bottom, slight odor. Moist.			S-9
18			End of boring at 18' bgs.			

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LOG OF BORING AW-1

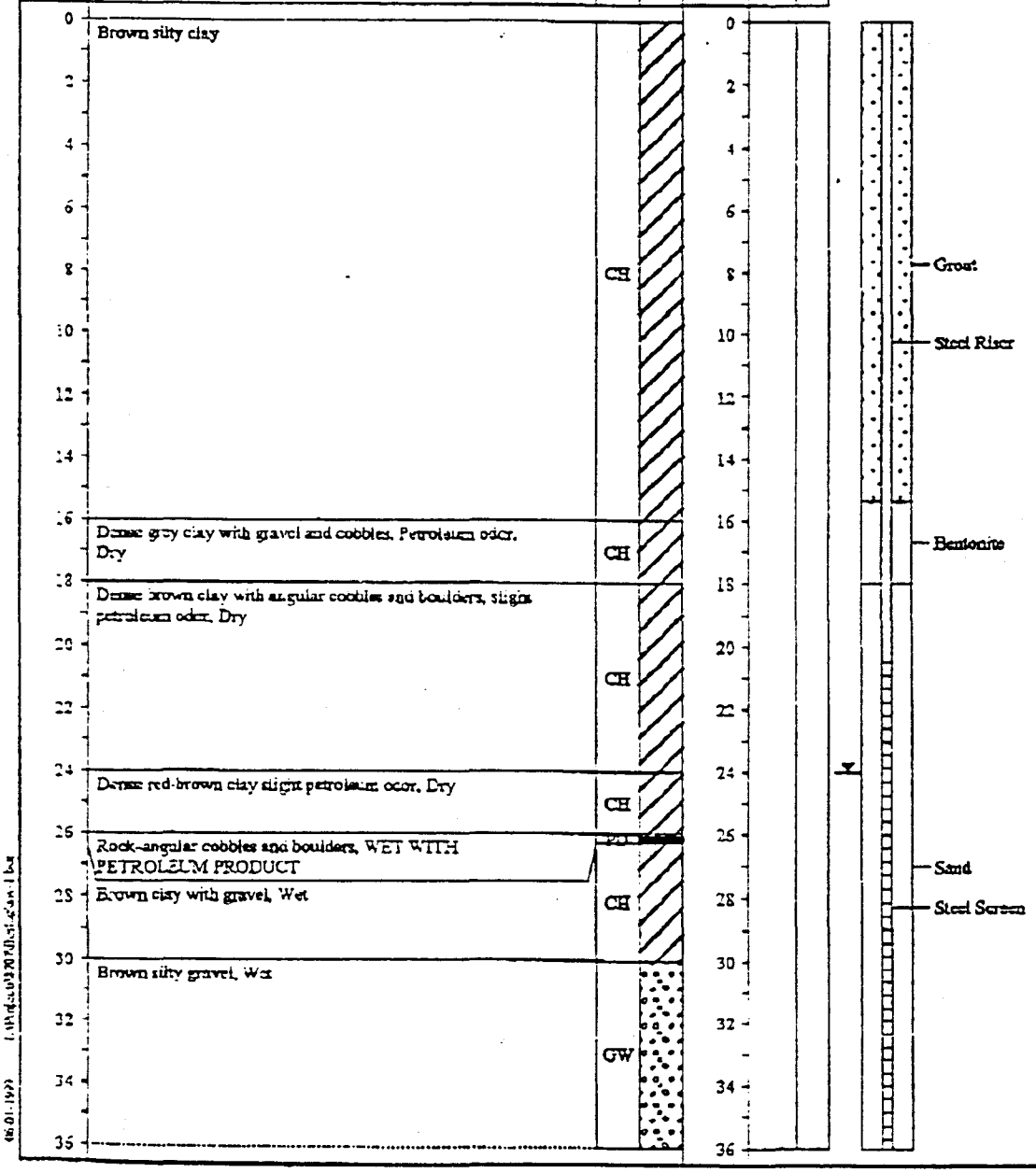
(Page 1 of 1)

Naval Station Roosevelt Roads
Tow Way Fuel Farm
Ceiba, PR
Project # 8207.000

Drilling Method	: Hollow Stem Auger	Static Water Level	: 24 feet bgs
Driller	: Soil Tech	Stick Up	: 0
ManTech Rep.	: Carol Callaghan	Well Inner Diameter	: 2 inch
Sample Type	: Split Spoon, Grab	Well Construction	: PVC Screen/Riser
Hole Diameter	: 8 inches	Well Depth	: 36 Feet

Well1: AW-1
Elev.: 7.7 Feet Above Mean Sea Level

Depth in Feet	DESCRIPTION	USCS
0	Brown silty clay	CH
16	Dense grey clay with gravel and cobbles. Petroleum odor. Dry	CH
18	Dense brown clay with angular cobbles and boulders, slight petroleum odor. Dry	CH
24	Dense red-brown clay slight petroleum odor. Dry	CH
26	Rock-angular cobbles and boulders, WET WITH PETROLEUM PRODUCT	PO
28	Brown clay with gravel, Wet	CH
30	Brown silty gravel, Wet	GW



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LOG OF BORING AW-2

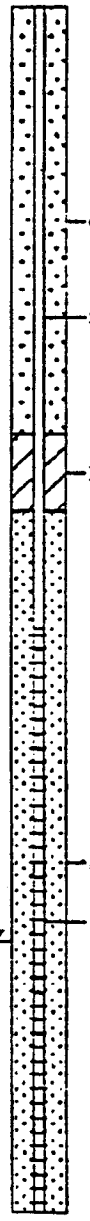
(Page 1 of 1)

Naval Station Roosevelt Roads
Tow Way Fuel Farm
Ceiba, PR
Project # S207.000

Drilling Method	: Hollow Stem Auger	Static Water Level	: 24 Feet bgs
Driller	: Soil Tech	Stick Up	: 0
ManTech Rep.	: Carol Callagian	Well Inner Diameter	: 2 inches
Sample Type	: Split Spoon, Grab	Well Construction	: Steel Screen/Riser
Hole Diameter	: 8 Inches	Well Depth	: 31

Well1: AW-2
Elev.: 6.7 Feet Above Mean Sea Level

Depth in feet	DESCRIPTION	USCS
0–8	Cuttings brown silty clay, then light brown - red clay	CH
8–9	Red brown silty clay, Dry	CH
9–10	Brown and grey mottled clay, Dry	CH
10–12	Dense brown clay, Dry	CH
12–16	Dense brown clay with cobbles, Dry	CH
16–20	Grey silty clay with cobbles, petroleum odor, Dry	CH
20–22	Dense grey clay with cobbles WET WITH PETROLEUM PRODUCT	CH
22–23	Dense grey clay with cobbles, Dry	
23–24	Angular cobbles of gabbro petroleum stained, Wet	GW
24–25	Red Clay, Dry	CH
25–31	Silty clay with cobbles, petroleum stained, Wet	CH



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LOG OF BORING MTMW-1

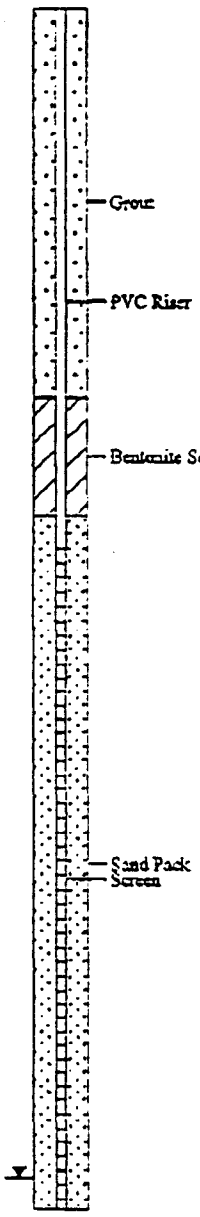
(Page 1 of 1)

Naval Station Roosevelt Roads
Tow Way Fuel Farm
Ceiba, PR
Project # 8207.000

Drilling Method	: Hollow Stem Auger	Static Water Level	: 39 Feet bgs
Driller	: Soil Tech	Stick Up	: 0
ManTech Rep.	: Carol Callaghan	Well Inner Diameter	: 2 inches
Sample Type	: Split Spoon, Grab	Well Construction	: PVC Screen/Riser
Hole Diameter	: 8 Inches	Well Depth	: 40

Well1: MTMW-1
Elev.: 8.6 Feet Above Mean Sea Level

Depth in Feet	DESCRIPTION	USCS	GRAPHIC	Depth in Feet	Samples	Blow Count
0	Brown silty clay, Dry.			0		
2				2		
4				4		
6				6		
8				8		
10				10		
12				12		
14		CH		14		
16				16		
18				18		
20				20		
22				22		
24				24		
26				26		
28				28		
	WET WITH PETROLEUM PRODUCT.	PD				
30	Brown silty clay, Wet at 39 feet bgs.			30		
32				32		
34		CH		34		
36				36		
38				38		
40				40		



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Chantilly, Virginia 20151

LOG OF BORING MTMW-3

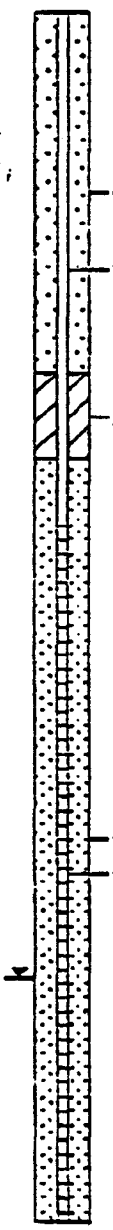
(Page 1 of 1)

Naval Station Roosevelt Roads
Tow Way Fuel Farm
Ceiba, PR
Project # 8207.000

Drilling Method	: Hollow Stem Auger	Static Water Level	: 28 feet bgs
Driller	: Soil Tech	Stick Up	: 0
ManTech Rep.	: Carol Callaghan	Well Inner Diameter	: 2 inch
Sample Type	: Split Spoon, Grab	Well Construction	: PVC Screen/Riser
Hole Diameter	: 8 inches	Well Depth	: 35 Feet

Well1: MTMW-3
Elev.: 7.5 Feet Above Mean Sea Level

Depth in Feet	DESCRIPTION	USCS	GRAPHIC	Depth in Feet	Samples	Blow Count
0–10	Silty clay	CH		0–10		
10–14	Dense red brown to olive silty clay with cobbles. Dry	CH		10–14		
14–15	Dense red and grey mottled clay, Dry	CH		14–15		
15–18	Gravel and cobbles, Dry	GW		15–18		
18–20	Dense greyish gabbro saprolite, strong petroleum odor, dry	GW		18–20		
20–22	Dense petroleum stained brown silty clay with cobbles, dry	CH		20–22		
22–24	Dense petroleum stained grey silty clay with cobbles, Dry	CH		22–24		
24–25	Dense petroleum stained grey silty clay with cobbles, WET WITH PETROLEUM PRODUCT	PD / CH		24–25		
25–26	Silty sand with cobbles, Dry	CH		25–26		
26–27	Red brown silty clay with cobbles	CH		26–27		
27–30	Silty sand with cobbles, Wet at 30 Feet	CH		27–30		
30–35	Silty clay	CH		30–35		



MANTECH ENVIRONMENTAL
14290 Sullyfield Circle, Suite 100
Chantilly, Virginia 20151

LOG OF BORING MTMW-4

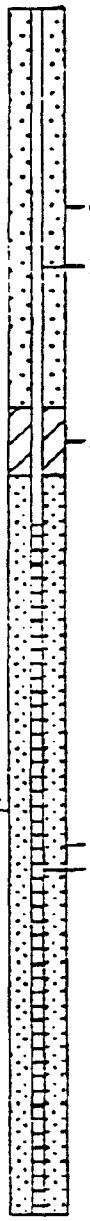
(Page 1 of 1)

Naval Station Roosevelt Roads
Tow Way Fuel Farm
Ceiba, PR
Project # 8207.000

Drilling Method	: Hollow Stem Auger	Static Water Level	: 22
Driller	: Soil Tech	Stick Up	: 0
ManTech Rep.	: Carol Callaghan	Well Inner Diameter	: 2 inch
Sample Type	: Split Spoon, Grab	Well Construction	: PVC Screen/Riser
Hole Diameter	: 8 in.	Well Depth	: 36 Feet

Well1: MTMW-4
Elev.: 7.1 Feet Above Mean Sea Level

Depth in Feet	DESCRIPTION	USCS	GRAPHIC	Depth in Feet	Samples	Blow Count
0–8	Brown silty clay	CH		0–8		
8–9	Dense brown and grey mottled clay, dry	CH		8–9		
9–10	Gravel, dry	GW		9–10		
10–12	Red clay, dry	CH		10–12		
12–13	Grey clay, strong petroleum odor, dry	CH		12–13		
13–14	Grey clay some angular gravel, strong petroleum odor, dry	CH		13–14		
14–16	Green silty clay with angular gabbro gravel, petroleum odor, dry	CH		14–16		
16–18	Angular gabbro gravel, dry	GW		16–18		
18–20	Angular gabbro gravel, WET WITH PETROLEUM PRODUCT	PD		18–20		
20–22	Silty clay with gravel, strong petroleum odor, dry	CH		20–22		
22–25	Gabbro gravel, wet	GW		22–25		
25–36	Olive silty clay, wet	CH		25–36		

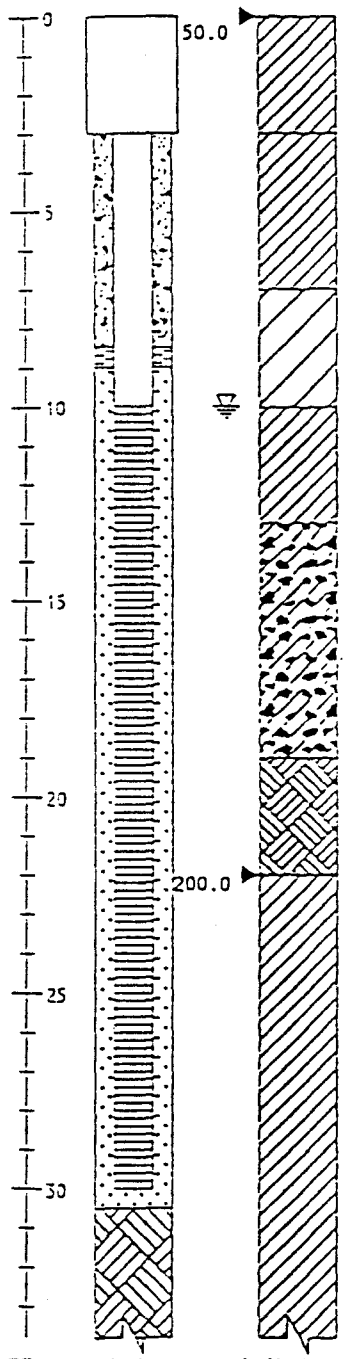


BORING / WELL LOG

BORING NO.: RW-1

PROJECT: Free Product Recovery
PROJECT NO.: 945809
CLIENT/OWNER: U.S. Navy
BORING LOCATION: Upper Tow-Way Fuel Facility
DRILLING CO.: Soil Tech
DRILLER: Jorge Diaz
DRILLING METHOD: 8 1/4" HSA
DRILL RIG: Mobile B-90

DATE DRILLED: 10/17/96
TOC ELEVATION:
GS ELEVATION:
DTW AT COMPLETION: 10'9"
DTW AFTER 24 HOURS:
LOGGED BY: D. Drozd



ELEVATION/ DEPTH (feet)	WELL DETAIL	PID READINGS, SOIL SYMBOLS, SAMPLERS, AND TEST DATA	USCS	DESCRIPTION	SAMPLE No.	SAMPLE Rec.	STANDARD PENETRATION TEST DEPTH	STANDARD PENETRATION TEST N	CURVE 10 30 50
0		50.0	cl	SILT and CLAY, little gravel, brown, moist, fill					
3.0			cl	CLAY, some silt, some gravel, gray-green, strong odor, moist, compacted					
7.0			ch	CLAY, light brown, strong odor, moist, compacted					
10.0			cl	CLAY, some silt, little gravel, angular to subangular, light brown, slight odor, compacted					
13.0			gc	GRAVEL, little clay, light brown, medium odor, moist, uncompacted					
19.0			rock	ROCK, subangular, gray-green, hard, little clay, medium brown, wet, medium odor					
22.0		200.0	cl	CLAY, little sand, medium to coarse grained, trace gravel, wet, strong odor, compacted					

Borehole was redrilled to a depth of 35 feet because well originally collapsed and to allow room for installation of the well if the borehole collapsed.

CHECKED BY:

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

BORING / WELL LOG

BORING NO.: RW-7

PROJECT: Free Product Recovery
PROJECT NO.: 945809
CLIENT/OWNER: U.S. Navy
BORING LOCATION: Forrestal Road
DRILLING CO.: Soil Tech
DRILLER: Jorge Diaz
DRILLING METHOD: 8 1/4" HSA
DRILL RIG: Mobile B-90

DRAFT

DATE DRILLED: 10/18/96
TOC ELEVATION:
GS ELEVATION:
DTW AT COMPLETION: 11'3"
DTW AFTER 24 HOURS:
LOGGED BY: D. Drozd

ELEVATION/ DEPTH (feet)	WELL DETAIL	PID READINGS, SOIL SYMBOLS, SAMPLERS, AND TEST DATA	USCS	DESCRIPTION	SAMPLE No.	SAMPLE Rec.	STANDARD PENETRATION TEST DEPTH	N	CURVE 10 30 50
0			0.5	ASPHALT					
			vg 1.0	BEDDING					
			GP-GM	GRAVEL, some silt, trace sand, brown, dry, uncompacted, fill					
5			5.0 rock	ROCK, grey-green, hard, subangular to angular, little silt, brown, dry, medium odor, uncompacted					
10			12.0 rock	ROCK, grey-green, hard, slight to medium odor, dry, uncompacted					
15			18.0 cl	CLAY, trace gravel, trace sand, light to medium brown, medium odor, wet, compacted					
20									
25			25.0	Bottom of Boring					
30									

NOTE: *Borehole was drilled to a depth of approximately 25 feet to allow room for installation of well if borehole collapsed.*

CHECKED BY:

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

BORING / WELL LOG

BORING NO.: RW-8

PROJECT: Free Product Recovery
PROJECT NO.: 945809
CLIENT/OWNER: U.S. Navy
BORING LOCATION: Forrestal Road
DRILLING CO.: Soil Tech
DRILLER: Jorge Diaz
DRILLING METHOD: 8 1/4" HSA
DRILL RIG: Mobile B-90

DRAFT

DATE DRILLED: 10/21/96
TOC ELEVATION:
GS ELEVATION:
DTW AT COMPLETION:
DTW AFTER 24 HOURS:
LOGGED BY: D. Drozd

LEVATION/ DEPTH (feet)	WELL DETAIL	PID READINGS, SOIL SYMBOLS, SAMPLERS, AND TEST DATA	USCS	DESCRIPTION	SAMPLE No.	SAMPLE Rec.	STANDARD PENETRATION TEST DEPTH	N	CURVE 10 30 50
0			0.5	ASPHALT					
			vg 1.0	BEDDING					
			SM-GM 3.0	GRAVEL and SAND, some silt, trace clay, medium brown, dry, uncompacted, fill					
5			gm 4.0	GRAVEL and SILT, some sand, medium brown, dry, uncompacted, fill					
			ml	SILT, some gravel, some sand, dry, light to medium brown, uncompacted					
10									
15									
			18.0 rock	ROCK, dark grey, light brown, hard, angular, wet					
20									
25			25.0	Bottom of Boring					
30									

NOTE: *Borehole was drilled to a depth of approximately 25 feet to allow room for installation of well if borehole collapsed.*

CHECKED BY:

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

ICHOR Services, Inc.

KEY TO SYMBOLS

Symbol	Description
Strata symbols	
	Low plasticity clay
	High plasticity clay
	Clayey gravel
	Basalt (or generic rock)
	Silt
	Paving
	Variable gravel and silty sand mix
	Silty sand
	Poorly graded gravel with silt
	Silty sandy gravel
	Silty gravel

Symbol	Description
Misc. Symbols	
	Boring continues
	Water table at completion
▶	PID readings
Monitor Well Details	
	flush-mount cover
	concrete seal
	bentonite pellets
	silica sand, blank PVC
	slotted pipe w/ sand
	silica sand, no pipe (end plug)
	no pipe, filler material

Notes:

None.

DRAFT