



Post Office Box 10279
Wilmington, NC 28404-0279
Telephone: (910) 452-5861
Fax: (910) 452-7563

June 15, 2004

Commander
Naval Facilities Engineering Command
Atlantic Division
6506 Hampton Blvd., Bldg. A
Room 1306
Norfolk, VA 23508

Attention: EV32JC, Mr. John D. Conway, P.G.

Re: **FINAL Summary of Bio-Pulse Sparge Pilot Test**
Hadnot Point Fuel Farm
Marine Corps Base
Camp Lejeune, North Carolina

Navy Contract No. N62470-01-D-3009
Delivery Order No. 0087
CATLIN Project No. 203-082

Dear Mr. Conway:

CATLIN Engineers and Scientists (CATLIN) is pleased to submit the FINAL Summary of Bio-Pulse Sparge Pilot Test document for the above referenced site. We have reviewed the following comments to the Draft document received from Nikki Hall on June 9, 2004 and have made the appropriate revisions to the text.

1. Incorporate some reference to an implementation time frame of FY05 (starts 10/1/2004 through 9/30/2005).

Acknowledged. A reference has been made to FY05 in the text on Page 12 in the fifth paragraph.

2. Section 5.0, last paragraph has some extra dashes in the last sentence.

Acknowledged. The text has been revised as requested.

3. We discussed having a phased approach to the installation process.

Acknowledged. The phased approach has been referenced on Page 12 in the first paragraph.

As requested by Nikki Hall with the Camp Lejeune Environmental Quality Branch we are delivering a copy of the Final report to the Wilmington Regional Office of the North Carolina Department of Environment and Natural Resources. A copy of the cover letter is attached.

CATLIN Engineers and Scientists appreciates the opportunity to continue to provide services to LANTDIV and the MCB on your environmental projects.

Sincerely,

A handwritten signature in black ink, appearing to read "Michael E. Mason", followed by the word "for" in a smaller, cursive script.

Michael E. Mason, P.E.
CATLIN Program Manager

A handwritten signature in black ink, appearing to read "William J. Walsh".

William J. Walsh, P.E.
Project Engineer

Attachments: Final Report
 Copy of Cover Letter to NCDENR WiRO

cc: Ms. Pamela Argilan - Code AQ11B Contracts (correspondence only)
 Commanding General, Attn: Director I&E/EMD/EQB (1 copy)



Post Office Box 10279
Wilmington, NC 28404-0279
Telephone: (910) 452-5861
Fax: (910) 452-7563

June 15, 2004

Mr. Bruce Reed
North Carolina Department of Environment and Natural Resources
Division of Waste Management
Underground Storage Tank Section
127 Cardinal Drive
Wilmington, North Carolina 28405-3845

Re: **FINAL Summary of Bio-Pulse Sparge Pilot Test**
Hadnot Point Fuel Farm
Marine Corps Base
Camp Lejeune, North Carolina

Navy Contract No. N62470-01-D-3009
Delivery Order No. 0087
CATLIN Project No. 203-082
NCDENR Incident Nos: 3671, 10615, 22788

Dear Mr. Reed:

Please find enclosed one copy of the above referenced Summary of Bio-Pulse Sparge Pilot Test document. This report is submitted on behalf of Nikki Hall, Marine Corps Base, Camp Lejeune, UST Program Manager.

Should you have any questions or need additional information, please feel free to contact us at your convenience.

Sincerely,

Michael E. Mason, P.E.
CATLIN Program Manager

William J. Walsh, P.E.
Project Engineer

Attachments: Final Pilot Test

cc: Ms. Pamela Argilan - Code AQ11B Contracts (correspondence only)
Commanding General, Attn: Director I&E/EMD/EQB
Commander, LANTNAVFACENGCOM, Attn: EV32JC, John D. Conway, P.G.

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**SUMMARY OF
BIO-PULSE SPARGE PILOT TEST**

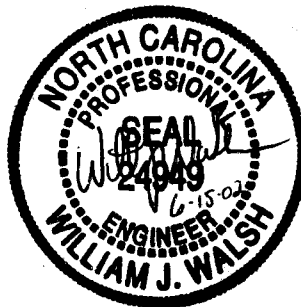
HADNOT POINT FUEL FARM

**MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA**

**NCDENR UST Incident Nos. 3671, 10615, and 22788
Facility I.D. No. 0-002740
Site Ranking: B**

ISSUED June14, 2004

**Navy Contract No. N62470-01-D-3009
Delivery Order No. 0087
CATLIN Project No. 203-082**



Prepared by:

**CATLIN Engineers and Scientists
P.O. Box 10279
Wilmington, North Carolina 28404-0279
(910) 452-5861**

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APPENDIX B	NORTH CAROLINA WELL CONSTRUCTION RECORDS
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LIST OF ACRONYMS

2000 Guidelines	Groundwater Section Guidelines for Investigation and Remediation of Soil and Groundwater.
2001 Guidelines	Guidelines for Assessment and Corrective Action, North Carolina Underground Storage Tank Section (Effective July 1, 2001)
2L GWQS	NCAC T15A:02L Groundwater Quality Standards
ARO	Asheville Regional Office
AS	Air Sparge
AST	Aboveground Storage Tank
BDL	Below Detection Limit
BN	Base/Neutral (extractables)
BNA	Base/Neutral/Acid (extractables)
BQL	Below Quantitation Limit
BLS	Below Land Surface
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
CAP	Corrective Action Plan
CATLIN	CATLIN Engineers and Scientists (Formerly RC&A)
CFR	Code of Federal Regulations
Cr	Chromium
CSA	Comprehensive Site Assessment
CNP	Carbon Nitrogen Phosphorous
CPT	Cone Penetrometer Test
DEM	Division of Environmental Management
DIPE	Diisopropyl Ether
DO	Dissolved Oxygen
DOD	Department of Defense
DPT	Direct Push Technology
DWQ	Division of Water Quality
DWM	Division of Waste Management
DTW	Depth to Water
EAD	Environmental Affairs Department
EDB	Ethylene di-bromide
EMD	Environmental Management Division
EPA	Environmental Protection Agency
EPH	Extractable Petroleum Hydrocarbons
EQB	Environmental Quality Branch
Fe	Iron
FID	Flame Ionization Detector
FOD	Foreign Object Debris
FRO	Fayetteville Regional Office
FT	Feet
GCL	Gross Contaminant Level
GIS	Geographic Information System
GPS	Global Positioning System

Guidelines Vol. I	Groundwater Section Guidelines for Investigation and Remediation of Soil and Groundwater, Volume I, Sources Other Than Petroleum Underground Storage Tanks (May 1998)
Guidelines Vol. II	Groundwater Section Guidelines for Investigation and Remediation of Soil and Groundwater, Volume II, Petroleum Underground Storage Tanks (January 2, 1998)
HDPE	High Density Polyethylene
I/C	Industrial/Commercial
ID	Identification
I&E	Installations and Environment Department
IGWQS	Interim Groundwater Quality Standards
IPE	Isopropyl Ether
LANTDIV	Atlantic Division
LSA	Limited Site Assessment
LUST	Leaking Underground Storage Tank
m-	meta
m	meter
MADEP	Massachusetts Department of Environmental Protection
MCALF	Marine Corps Auxiliary Landing Field
MCAS	Marine Corps Air Station
MCB	Marine Corps Base
MCOLF	Marine Corps Outlying Landing Field
MDL	Method Detection Limit
mg/Kg	Milligrams per Kilogram
mg/L	Milligrams per Litre
MRO	Mooresville Regional Office
MSCC	Maximum Soil Contaminant Concentration
MSL	Mean Sea Level
MTBE	Methyl tertiary butyl ether
µg/Kg	Micrograms per Kilogram
µg/L	Micrograms per Litre
NA	Not Analyzed
N/A	Not Applicable
NC	North Carolina
NCAC	North Carolina Administrative Code
NCDENR	North Carolina Department of Environment and Natural Resources
NCDOC	North Carolina Department of Corrections
NCDOT	North Carolina Department of Transportation
NCSP	North Carolina State Plane
NCSPA	North Carolina State Ports Authority
NE	None Established
NM	Not Measured
NMT	No Measurable Thickness
NS	Not Sampled
o-	ortho
OVA	Organic Vapor Analyzer
p-	para
PAH	Polynuclear Aromatic Hydrocarbons
Pb	Lead
PPB	Parts Per Billion
PPM	Parts Per Million

PID	Photo Ionization Detector
PQL	Practical Quantitation Limit
PVC	Polyvinyl chloride
RBCA	Risk-Based Corrective Action
RCRA	Resource Conservation and Recovery Act
Res	Residential
ROI	Radius of Influence
RRO	Raleigh Regional Office
SOW	Scope of Work
STGW	Soil-to-Groundwater
SVE	Soil Vapor Extraction
SVOC	Semi Volatile Organic Compound
TDHF	Toxicologically Defined Hydrocarbons Fractions
TCLP	Toxicity Characteristic Leaching Procedure
TIC	Tentatively Identified Compound
TKN	Total Kjeldahl Nitrogen
TOC	Top of Casing
TPH	Total Petroleum Hydrocarbons
US	United States
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	Underground Storage Tank
VOC	Volatile Organic Compounds
VPH	Volatile Petroleum Hydrocarbons
WaRO	Washington Regional Office
WiRO	Wilmington Regional Office
WSRO	Winston-Salem Regional Office

**SUMMARY OF
BIO-PULSE SPARGE PILOT TEST**

HADNOT POINT FUEL FARM

**MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA**

June 14, 2004

1.0 INTRODUCTION

1.1 AUTHORIZATION

CATLIN Engineers and Scientist was authorized to perform field activities and prepare this Summary of Bio-Pulse Sparge Pilot Test by LANTDIVNAVFACENGCOM, in accordance with Contract No. N62470-01-D-3009, Delivery Order No. 0087.

1.2 PURPOSE OF PILOT TEST

The purpose of this investigation was to perform tasks to aid in the understanding and feasibility of bio-pulse air sparging technology for remediation of dissolved phase contaminated groundwater at the Hadnot Point Fuel Farm project site. Specifically, the pilot test was performed in order to determine the radii of influence, the required airflow, pulse duration, post sparge recharge duration, and to confirm the operating pressure for design of a bio-pulse sparge system.

1.3 SCOPE OF WORK

The scope of work for this project was performed in two phases.

Phase I of this project involved the installation of two Type III groundwater wells. One well (USTHPFFC-SP100) was installed to a depth of 160-feet BLS, and was utilized as the bio-pulse sparge well. A second well (USTHPFFC-MW78) was installed to a depth of 160-feet BLS, and was used as an observation well during the bio-pulse sparge pilot test. During well installation, vadose zone soil samples were obtained for laboratory analysis and following well installation, groundwater samples were also obtained for laboratory analysis.

Phase II of the project involved the performance of the bio-pulse sparge pilot test (Pilot Test). This phase began with a short duration pre-sparge, equipment verification test to confirm the required airflow and help size the equipment for the Pilot Test.

Following the pre-sparge equipment verification test, the site was allowed to return to pre-sparge conditions prior to initiation of the Pilot Test.

The initial task for the pilot test was a comprehensive groundwater-gauging event of 41 selected monitoring wells to establish a baseline for the sparge test data evaluation. Depth to groundwater was gauged along with product thickness, if present, and field dissolved oxygen levels were measured.

Following the gauging event, air injection began and continued until sparging influence was noticed in a sentinel well at which time air injection was stopped. During this injection phase, selected observation/monitoring wells were gauged for depth to groundwater and observed for bubbles, i.e., evidence of sparging influence.

Periodic gauging and observation continued in selected wells for a period of 20 days after the injection phase. At the end of this period a final comprehensive gauging event on 38 selected monitoring wells was completed. This final gauging event included gauging of depth to groundwater, product thickness, if present and field dissolved oxygen levels.

The data from the pilot test was subsequently compiled and evaluated and the results documented in this report.

2.0 SITE DESCRIPTION

The former Hadnot Point Fuel Farm (HPFF) and the Building 1115 project, which has been included as part of the HPFF, are located in the industrial area of Marine Corps Base, Camp Lejeune, North Carolina. Refer to Figure 1 for a general location map. The HPFF was constructed in 1941 and consisted of one AST and 14 USTs. Products stored included diesel fuel, gasoline (leaded and unleaded) and kerosene. The site is shown on Figure 2 along with the existing monitoring well locations.

The Building 1115 site contained seven USTs utilized to store gasoline and possibly diesel fuel. Additionally, a number of underground pipelines ran from the HPFF along East Road, Ash Street and West Road to Buildings 1115, 1502, and 1601 (See Figure 2).

3.0 METHODS

The following methods were used in performance of and to obtain the necessary data to evaluate the pilot test.

3.1 PHASE I – WELL INSTALLATION

3.1.1 Bio-Pulse Sparge Well

The bio-pulse sparge well (USTHPFFC-SP100) was installed to a depth of 160-feet BLS within the core or “hot spot” of the dissolved contaminant plume. The depth of the sparge well was set to correspond with the deepest known dissolved phase contamination at the HPFF project site.

The well construction details for USTHPFFC-SP100 indicate a 6-inch diameter, schedule 40 PVC outer casing was installed to a depth of 130-feet BLS and the bore hole was tremie grouted inside and out. A 2-inch diameter stainless steel monitoring well was installed through the grouted casing to a depth of 160-feet BLS. The stainless steel well included 140-feet of riser and 20-feet of 0.010 inch slotted screen.

3.1.2 Observation Well

The observation well (USTHPFFC-MW78) was installed to a depth of 159 feet BLS. The well was constructed with a 6-inch diameter, schedule 40 PVC outer casing installed and grouted to 131 feet BLS. A 2-inch diameter, schedule 40 PVC monitoring well was installed through the grouted casing to a depth of 159 feet BLS with 139 feet of casing and 20 feet of 0.010 inch slotted screen.

3.1.3 Soil and Groundwater Sample Collection

During well construction, vadose zone soil samples were collected using split spoon samplers 2-4 feet BLS and from 7-9 feet BLS for USTHPFFC-SP100 and from 2-4 feet BLS for USTHPFFC-MW78. These soil samples were divided, placed in two pre-labeled, air tight, plastic bags. One sample bag was immediately placed on ice pending selection of appropriate laboratory sample depth. The second sample bag was left undisturbed for several minutes to allow the organic vapors to reach equilibrium. The gas within the headspace of the bag was tested with an Organic Vapor Analyzer (OVA) flame-ionization detector (FID). The sample with the highest OVA reading was submitted to the laboratory for analysis. A geologist trained in using visual/manual techniques as described in American Society for Testing and Materials (ASTM) D-2488 identified the soils in the field. The soils were classified in accordance with the Unified Soil Classification System (USCS). Split spoon samples were not collected below 7-9 feet BLS due to the number of previous wells constructed in the vicinity. Drill cuttings were continuously inspected from 130-160 feet BLS and described into the field by the on-site geologist. The boring logs and North Carolina Well Construction Records were prepared for each well and are included in Appendices A and B.

Soil samples were transported under proper Chain-of-Custody protocols to Paradigm Analytical Laboratories, Inc. in Wilmington, North Carolina. (Chain-of-Custody forms are included with the laboratory reports in Appendix C.) At the laboratory the soil samples were analyzed for Total Petroleum Hydrocarbons (TPH), Gasoline Range Organics (GRO) and Diesel Range Organics (DRO) per EPA Methods 5030 and 3550.

A minimum of 24 hours following well construction activities, each of the wells were developed by pumping until the groundwater was clear. Approximately 85-gallons of groundwater were removed from well USTHPFFC-MW78 and approximately 80-gallons from USTHPFFC-SP100 using a pre-cleaned, DC powered, electric submersible pump. The recovered groundwater was containerized and later disposed by Shaw Environmental and Infrastructure, Inc.

A minimum of 24 hours after well development, USTHPFFC-MW78 was gauged to determine the depth to groundwater and to calculate the volume of water in the well. Based on this data, the well was purged a minimum of three well volumes (approximately 80-gallons) using a pre-cleaned, DC powered, submersible pump. A groundwater sample was collected in appropriate glassware, labeled and placed on ice in an insulated cooler. The groundwater from USTHPFFC-SP100 was collected immediately after well development, placed in appropriate glassware, labeled and stored on ice in an insulated cooler. The groundwater samples were transported to Paradigm Analytical Laboratories, Inc. in Wilmington, North Carolina under proper Chain-of-Custody protocol. (Chain-of-Custody forms are included with the laboratory reports in Appendix C.) At the laboratory the groundwater samples were analyzed for Purgeable Aromatics per EPA Method 602, Polynuclear Aromatic Hydrocarbons per EPA Method 610 and Purgeable Halocarbons per EPA Method 601.

3.2 PHASE II – PILOT TEST

A general discussion of the bio-pulse sparge test follows.

Unlike conventional bio-sparging, where air is injected at a constant rate, for a pulse-sparging application air is injected at a constant pressure, allowing flow to continuously increase until the pulse is terminated. During each pulse, as air is injected into the subsurface, a de-watered sphere grows around the sparge point. If allowed, this spherical volume of air will continue to grow, displacing groundwater until the top of the sphere breaks through into the vadose zone. Upon “break through”; the dewatered sphere will short circuit into the vadose zone. To maximize the radial influence from each sparge point, pulses are terminated prior to breakthrough. At the completion of each pulse, the sparged zones are allowed to recharge, or re-saturate prior to the next pulse.

At the HPFF site, air was injected at a depth of 140-160 feet BLS. This depth was chosen as it is the deepest known depth of contamination and it is within a high permeability zone (HPZ) as defined in the Revised Corrective Action Plan (RCAP) dated May 2003. The sparge air sphere was expected to expand within this HPZ and grow laterally and vertically through the interbedded sediments until it reached the lower boundary of the upper HPZ at approximately 75 feet BLS. At this time, air injection would cease and the "sphere" allowed to re-saturate as the sparge air diffused through the contaminated groundwater to the surface.

The existing sparge and bio-sparge systems at the HPFF and Building 1115 Sites were shut down November 13, 2003 and remained off for the duration of the Pilot Test. This was done to ensure there was no interference with the Pilot Test from the existing sparging system. The existing Soil Vapor Extraction Systems were allowed to remain in operation during the Pilot Test.

3.2.1 Pre-Sparge Equipment Verification Test

Prior to implementation of the Bio-Pulse Sparge Pilot Test, a short-term equipment verification test was performed. The purpose of the test was to preliminarily verify the airflow required for the Pilot Test and to help size the equipment required for the Pilot Test. This verification test was performed on December 18, 2003.

Utilizing the on-site compressor from the existing HPFF air sparge system operated by Shaw, air was injected into the sparge well (USTHPFFC-SP100) for a period of three hours. Throughout the duration of the injection period the flow rate into the sparge well was monitored along with the injection pressure. Additionally, nearby observation/monitoring wells USTHPFFC-MW10, USTHPFFC-MW11, USTHPFFC-MW12, USTHPFFC-MW60, USTHPFFC-MW65, and USTHPFFC-MW78 were gauged periodically for depth to water. Refer to Figure 3 for the sparge and observation well locations.

3.2.2 Initial Comprehensive Well Gauging

On January 16, 2004, 41 wells at the HPFF project site were gauged for depth to groundwater, product thickness and dissolved oxygen. The wells were selected to correspond with the anticipated sparge air influence expected during the pilot test. The selected wells included Type II wells screened in the shallow aquifer and Type III wells screened generally at the following depths: 40-50 feet deep, 70-90 feet deep and greater than 100 feet deep. See Table 1 for observation well construction data. The wells were gauged to provide a base line for the pilot test data evaluation.

3.2.3 Bio-Pulse Sparge Pilot Test

The Bio-Pulse Sparge Pilot Test included an injection phase and a recharge phase during which a number of observation/monitoring wells were gauged and checked for indications of sparging influence. The injection phase of the pilot test began on January 20, 2004.

During the injection phase, the pressure on the sparge well was intended to remain constant and the air flow into the well was allowed to increase as much as the aquifer would allow. The pressure on the sparge well along with the air flow rate into the sparge well was observed and recorded at thirty-minute intervals for the first four hours and then on a two hour interval for the duration for the injection phase.

A number of surrounding monitoring/observation wells were gauged for depth to groundwater and inspected for sparging influence (bubbles) during the injection phase. The wells selected for observation were in close proximity to the sparge well USTHPFFC-SP100 and were screened at depths that were likely to be influenced by sparging during the injection phase. These wells were monitored on a thirty minute basis for the first four hours. Following this four hour period, the number of wells being monitored was increased to include Type II shallow wells. These wells were checked on a two hour basis for the duration of the injection phase.

Initially, the influence from the air injection was noted in the observation wells as water table rise. In a number of wells, the water table rise neared the top of the well casing and in these cases, an observation well apparatus (see Figure 4) was installed on the well that would allow additional monitoring. During subsequent monitoring events, the pressure on each of these observation wells was gauged and the shut-off valve was opened and observed for accumulated air.

Approximately 29.5 hours into the injection phase, sparging influence was noted in the observation well USTHPFFC-MW10 and subsequently air injection was ceased.

Following the injection phase, monitoring of the observation wells continued. The intent was to track migration of the sparge air as it migrated upward through the subsurface. The observation wells were monitored for depth to groundwater and observed for sparging influence regularly for a period of 20 days.

It is important to note that wells within the Pilot Test area found to contain free product during the initial gauging event were tightly capped during the duration of the Pilot Test. This was done to ensure that sparging influence would not force free product out of the well.

3.2.4 Final Comprehensive Well Gauging

On February 10, 2004, 38 wells were re-gauged for depth to groundwater, product thickness and dissolved oxygen.

4.0 DATA ANALYSIS

4.1 RESULTS OF SOIL AND GROUNDWATER ANALYSIS

4.1.1 Soil

A total of two soil samples were submitted to the laboratory for TPH-GRO and TPH-DRO analysis per EPA Methods 5030 and 3550, respectively. The results of the analyses indicated a TPH-GRO concentration of 17 mg/kg and a TPH-DRO concentration of 86 mg/kg from the soil sample collected from 7-9 feet BLS in the borehole for well USTHPFFC-MW78. These concentrations are in excess of the established Action Levels for this site of 10 mg/kg TPH-GRO and 40 mg/kg TPH-DRO. The soil sample from well USTHPFFC-SP100 was below quantitation limit for TPH-GRO and below the Action Level for TPH-DRO. See Table 2 for a summary of analytical results for soil and Appendix C for a copy of the laboratory reports.

4.1.2 Groundwater

EPA Method 602 (Purgeable Aromatics)

Benzene was the only EPA Method 602 analyte identified in the groundwater samples collected from monitoring well USTHPFFC-MW78 or sparge well USTHPFFC-SP100 at levels above the 2L GWQS. Benzene was identified only in the sample collected from USTHPFFC-MW78 at a concentration of 10 ug/L, which is above the current 2L GWQS for benzene of 1 ug/L. All other analytes detected in the groundwater from USTHPFFC-MW78 were either BQL or below the 2L GWQS. All method 602 analytes were BQL in the groundwater sample obtained from USTHPFFC-SP100. Laboratory reports are included in Appendix C and summarized in Table 3.

EPA Method 610 (Polynuclear Aromatic Hydrocarbons)

No EPA Method 610 analytes were identified above laboratory quantitation limits from groundwater samples collected from USTHPFFC-MW78 or USTHPFFC-SP100. Laboratory reports are included in Appendix C and summarized on Table 4.

EPA Method 601 (Purgeable Halocarbons)

Only chloroform was identified in the groundwater sample collected from well USTHPFFC-SP100 by EPA Method 601 analysis. Chloroform was detected at a concentration of 2.4 ug/L, which is above the 2L GWQS for chloroform of 0.19 ug/L. No other analytes were detected above the method quantitation limit in either of the samples from USTHPFFC-MW78 or USTHPFFC-SP100. The laboratory reports are included in Appendix C and summarized in Table 5.

4.2 RESULTS OF PRE-SPARGE EQUIPMENT VERIFICATION TEST

The results of the pre-sparge equipment verification test confirmed the design injection pressure and provided data in order to estimate the required air flow for the pilot test. Results of this test indicated that a compressor capable of providing approximately 300 scfm at 95 psi would be required to inject the necessary air required to perform the Pilot Test.

As specified in the CAP dated June 13, 2003, the maximum theoretical flow rate for each well in the proposed HPFF Bio-Pulse Sparging system was 322 acfm (2,400 scfm) at 95 psi; however, there are many unknown factors which influence air injection rates in a pulse sparge scenario. Therefore, the pre-sparge equipment verification test was performed and was intended to be a short version of the actual Pilot Test.

The pre-sparge equipment verification test was performed on December 18, 2003 for a duration of three hours and utilized the existing compressor from the existing HPFF air sparge/SVE system. This compressor was reportedly rated at 640 scfm at 100 psig. The air sparge well, USTHPFFC-SP100, was plumbed to the existing air compressor as shown schematically on Figure 4.

Prior to performing the pre-sparge equipment verification test, selected monitoring wells (USTHPFFC-MW10, USTHPFFC-MW11, USTHPFFC-MW12, USTHPFFC-MW60, USTHPFFC-MW65, and USTHPFFC-MW78) were gauged for depth to groundwater to provide baseline data for mounding observations. Results of this initial gauging indicated hydrostatic groundwater levels in the selected wells ranged from approximately six to eleven (BLS). During the test, these same monitoring wells were gauged at approximately 45 minute intervals.

As the test started and air was injected into the subsurface, it became apparent that the existing treatment system compressor alone was unable to provide enough air at the design pressure (95 psig). Due to the compressor's inability to provide adequate flow at the design pressure, the pre-sparge test flow rates and pressure ratings fluctuated as the compressor cycled. To obtain beneficial data, flow rates were recorded at the sparge well as it varied from 80 psig to 84 psig at a maximum of 15 minute intervals. As shown in Table 6, injection flow rates continuously increased to 71 scfm @ 80 psig and 150 scfm @ 84 psig within approximately three hours.

During the pre-sparge equipment verification test, the hydrostatic groundwater surface rose an average of over five feet in the selected monitoring wells with the most significant rise recorded in USTHPFFC-MW78 (>7.01 feet) which rose to the ground surface and required the installation of an observation well apparatus (see Table 7 for gauging data). In general, mounding effects appeared to diminish as the distance from the sparge well increased.

Flow data collected during the Pre-Sparge Equipment Verification Test was used to extrapolate predictions for maximum flows at the intended design injection pressure. Results of this test indicated a compressor capable of providing approximately 400 scfm at 95 psig will be required to inject the necessary air required to perform the Pilot Test.

4.3 RESULTS OF INITIAL GAUGING EVENT

On January 16, 2004, 42 on-site monitoring/observation wells were gauged for depth to groundwater, product thickness and the dissolved oxygen was measured. Depth to groundwater in the shallow Type II wells ranged from 4.01 feet to 11.41 feet below top of casing. Depth to groundwater in the intermediate wells (50-90 feet deep) ranged from 6.61 feet to 13.9 feet below top of casing and depth to groundwater in the wells greater than 100 feet deep ranged from 6.91 feet to 12.06 feet below top of casing.

Free product was measured in four wells (78GW-32-03 at 0.37 feet, USTHPFFC-MW15 at 0.30 feet, USTHPFFC-MW72 at 15.43 feet, and USTHPFF-MW02 at 0.13 feet). These wells were tightly capped for the duration of the pilot test.

Dissolved oxygen (DO) levels ranged from 0.01 mg/L to 5.28 mg/L. Generally, in the shallow wells, DO levels were relatively low within the dissolved contaminant plume and higher in the fringe areas. Due to the limited number of data points, there were no obvious trends in the DO measurements in the intermediate wells and the wells greater than 100 feet deep. The well gauging data and DO measurements are summarized for the initial gauging event in Table 8.

4.4 RESULTS OF BIO-PULSE SPARGE PILOT TEST

The results of the Pilot Test indicated use of bio-pulse sparging technology at the HPFF project site was viable. A discussion of the data obtained during the Pilot Test is discussed below.

As previously mentioned, two compressors (the HPFF Treatment System compressor and one additional compressor) connected in parallel were required to deliver sufficient air to the subsurface at the designed injection pressure. In addition, special provisions were made to allow a steadily increasing flow to be measured with continuing accuracy. A dual/parallel flow-through monitoring device was constructed to allow collection of continuous flow measurement data. The dual/parallel flow through device consisted of two similar flow meters connected in

parallel with gauging controls providing the ability to allow air to pass through one or both meters. This device was necessary to accurately measure flow once it increased beyond the limits of an individual flow meter. Figure 4 depicts a schematic representation of the Bio-Pulse Sparge Pilot Test piping including monitoring points and controls.

The injection phase of the pilot test began at 10:30 am on January 20, 2004. During this phase the pressure regulator installed upstream of the flow measuring device was set to 95 psi and sparge air was allowed to enter the subsurface at a depth of 140 to 160 BLS through USTHPFFC-SP100. The following data was collected from the sparge well and associated piping at 30 minute intervals for the first four (4) hours and two-hour intervals thereafter during the injection phase:

- Record flow in both flow meters
- Pressure as observed at USTHPFFC-SP100

Air injection data is provided in Table 9.

During the injection phase of the Pilot Test, a number of monitoring/observation wells were checked at 30 minute intervals for the first four (4) hours and two-hour intervals thereafter. During the injection phase, if groundwater appeared to be getting close to the ground surface, an observation well apparatus was installed to prevent overflowing while still allowing monitoring data to be collected. Monitoring data obtained from each selected monitoring well included:

- For wells without an Observation Well Apparatus
 - Gauge each for depth to water and product thickness
 - Observer for evidence of bubbles
- For wells with an Observation Well Apparatus
 - Record pressure gauge reading
 - Open valve and check for air flow

Gauging data is included on Table 10.

During the injection phase of the Pilot Test, approximately 450,000 scf of sparge air was injected into the subsurface. This volume is equivalent to approximately 68,000 cubic feet of air at the injection pressure. The recorded flow rates during the injection phase varied from approximately 80 scfm at the start to a maximum of 310 scfm.

At a time of 1770 minutes (29.5 hours) into the injection phase of the test, the slip cap installed in monitoring well USTHPFFC-MW10 was ejected from the well and the well alternated between discharging groundwater and discharging sparged air. The injection phase of the test was terminated upon observing air discharging from USTHPFFC-MW10, as this indicated sparge air had successfully been forced at least 110 feet away from the sparge well at a depth of 75 to 80 feet BLS.

During the recharge phase of the Pilot Test, the observation wells were checked on a two-hour basis for approximately 46.5 hours. At this time, the frequency of the observation well gauging was decreased to daily for one week; and every other day for another week. Gauging data from the recharge phase is included on Table 10.

During the injection phase of the Pilot Test, mounding of the water levels in the deep wells (greater than 100 feet deep) was observed almost immediately. Generally the closer to the sparging well the greater the mounding. Within four hours, the water level in three of the deep wells had risen to the ground level and these wells were fitted with an observation well apparatus.

The mounding effects noted in the intermediate wells were similar to the mounding effects in the deep wells in that the mounding was almost immediate. Significant water level rise was noted in almost all of the deep and intermediate wells within 30 minutes of beginning sparging. Intermediate wells screened at 50 feet BLS showed a slower water level rise than the ones screened at 70-90 feet BLS. Mounding within the deep and intermediate wells appeared to crest with the end of the injection phase of the Pilot Test.

The mounding effects in the shallow wells were much less pronounced and delayed in relation to the deeper wells. The mounding in the shallow wells continued beyond the injection phase and appeared to crest approximately 24 hours after the injection phase ended. The mounding effects have been shown over time on Figures 5 through 9.

A final comprehensive gauging event was performed 20 days after the conclusion of the injection phase and the water level in all wells generally had returned to pre-spargate levels.

Sparging influence was noted at 29.5 hours into the injection phase in observation well USTHPFFC-MW10. This well is located approximately 110 feet from USTHPFFC-SP100 and is screened from 75-80 feet BLS. No other well exhibited visual evidence of sparging influence or bubbles throughout the duration of the Pilot Test.

5.0 SUMMARY AND CONCLUSIONS

Bio-pulse sparging appears to be a viable technology selection for remediation of dissolved phase groundwater contamination at the HPFF project site. Based on an evaluation of the data gathered during the Pilot Test, the following recommendations are presented to meet the purpose of the Pilot Test:

Radii of Influence:	75 feet at 150 feet BLS; 300 feet at surface
Required Air Flow:	400 scfm
Operating Pressure:	90 psi
Pulse Duration:	24-48 hours
Post Sparge Recharge Duration:	30 days minimum

It is important to note that these recommendations are based on isolated data from one pilot test and may not be representative of conditions throughout the HPFF project site. During implementation of the bio-pulse sparging system, it will be important to recognize the potential for preferential pathways allowing the short-circuiting of sparge air up through observation/monitoring wells. Therefore, it is recommended that the installation process be conducted in a phased approach allowing each bio-pulse sparge well be subjected to a pilot test. Data obtained during these Pilot Tests will be reviewed and analyzed to ensure proper placement of subsequent sparge wells.

The injection of air through the petroleum contaminated groundwater is also expected to create vapors in locations where known receptors exist. Most notably, buildings with slab on fill or crawl space foundations are prime locations for vapors to be trapped and potentially effect the inhabitants/receptors. Such buildings within the estimated extent of the sparge influence should be protected by vapor control systems. Figure 35 of the Revised CAP depicts, as a minimum, the buildings selected for vapor control.

It is also important to note that the migration of sparge air through the preferential pathways is not considered detrimental as far as the remediation objectives for this site are concerned. These preferential pathways were most likely the migration pathways for the dissolved phase contamination that has been detected at depth at this site.

Additionally, as recommended in the Revised CAP, hydrodynamic control of the plume is proposed by pumping the HPZ located at a depth of 50-80 feet BLS. This pumping may help in controlling the migration of sparge air especially within the vicinity of the pumping well.

Field activities associated with the phased implementation plan are expected to commence in Fiscal Year 2005 (after October 1, 2004).

Radius of Influence

An anticipated radius of influence (ROI) of 300 feet should be used to properly space the bio-pulse sparge wells at this site. The determination of the bio-pulse sparge radius was based on observed mounding, bubbling and dissolved oxygen measurements made during the pilot test.

A significant water level rise was recorded within all the deep wells (screened greater than 100 feet bls) located within 230 feet of the sparge well and one well (USTHPFFC-MW62) located approximately 450 feet from the sparge well. Although, no air bubbles or significant D.O. increases were observed/recorded in any of the deep wells, the relative mounding was used as a general indicator of sparge influence. Based on the results of this pilot test the connectivity of the deep portion of the aquifer appears to be conducive to horizontal migration of sparge air beyond the 75 ft radius of influence calculated in the Revised CAP. Due to the lack of physical evidence of sparge air migration in the deep aquifer, any increased ROI estimation is not recommended.

The only definitive recorded sparging influence was observed approximately 110 feet from the sparge well within intermediate depth well, USTHPFFC-MW10 (screened from 75 to 80 feet BLS) in the form of bubbles. Mounding effects from the bio-pulse sparge injection observed in intermediate wells were more pronounced within wells screened between 70 and 90 feet BLS than in the shallower intermediate depth wells screened at approximately 50 feet BLS. This relative decreased mounding influence is most likely attributed to the horizontal dissipation of sparge air as it rises. Dissolved Oxygen levels, as measured during the two comprehensive gauging events, increased significantly in four intermediate observation wells (USTHPFFC-MW06, USTHPFFC-MW07, USTHPFFC-MW09, and USTHPFFC-MW66). However, the remote location of these wells in relation to the sparge well prevents basing ROI directly on the D.O. results.

Within the shallow observation wells, sparging influence was only observed in the form of water table rise. As the sparge air rises through the subsurface, hydrostatic pressures decrease allowing air volumes (bubbles) to expand. This expected expansion should exaggerate the mounding effects within the shallower wells; however, considerably less mounding was observed within the shallow wells than within the deeper wells. The relatively lesser mounding in the shallower wells is most likely attributed to the horizontal dissipation of sparge air as it rises. All monitored shallow wells showed some degree of mounding with the greatest mounding recorded in the shallow wells USTHPFFC-MW06, USTHPFFC-MW18, USTHPFFC-MW14, and USTHPFFC-MW30 located at distances of approximately 320 feet, 330 feet, 250 feet and 250 feet, respectively, from the sparge well.

Results of this Pilot Test indicate influence from a bio-pulse sparge well screened from 140 to 160 feet bls extends to beyond 300 feet in the shallow aquifer. The results of this pilot test confirm the ROI calculated in the Revised CAP are generally representative of site conditions.

Flow

During performance of the bio-pulse pilot test, air sparge injection flow rates were monitored to aid in the selection of a suitable compressor that meets the requirements for a permanent system.

Sparge air injection rates were monitored during this pilot test to determine system compressor requirements. The maximum flow rate recorded during the test was approximately 310 scfm at 90 psig. This value was considerably less than the predicted maximum flow calculated in the CAP. The justification for this anomaly is that the calculated flows from the CAP, were based on theoretical values of site conditions (ie. percent of dewatered pore spaces). Whereas, the pilot test results represent actual field measurements collected during a bio-pulse sparge event.

Based on results of this pilot test, a compressor capable of providing a minimum of 400 scfm at the design injection pressure (90 psig) is required.

Operating Pressure

Based on the data obtained from the Pilot Test, the recommended operating pressure is 90

psi.

The operating pressure from the Revised CAP was 95 psi based on the pressure required for the sphere to expand to 225 feet BLS from the sparge injection depth of 150 feet BLS. Based on a satisfactory radius of influence obtained during the Pilot Test, the recommended operating pressure has been chosen from the Pilot Test.

Pulse Duration

Based on the results of the Pilot Test, it is reasonable to assume that a pulse duration of 24-48 hours may be necessary to obtain the targeted ROI time limit. The objective of this Pilot Test was to build the "sphere" until it reached the lower boundary of the HPZ located at a depth of 50-80 feet BLS. As noted previously, sparge air was detected in observation/monitoring well USTHPFFC-MW10, that is screened from 75-80 feet BLS; however, it is suspected that preferential pathways may have caused this well to be influenced by the sparge air. Therefore, a longer duration of the pulse may be required at other locations.

Post Sparge Recharge Period

The post sparge recharge duration is proposed for a minimum of 30 days. This is based on the groundwater gauging events performed after the injection phase of the Pilot Test. A review of the gauging data indicate that water levels within the observation/monitoring wells had essentially returned to pre-sparge levels 20 days after the injection phase. Allowing a factor of safety of 1.5, a recharge period of at least 30 days is recommended.

6.0 LIMITATIONS

The data obtained as part of this investigation only provides isolated data points and may not represent conditions at every location in the project area. Analyses and conclusions of this report, being based on interpolation between data points at the project area, may not be completely representative of all site conditions. Conclusions and recommendations of this investigation and report are based on the best available data in an effort to comply with current regulatory requirements.

7.0 REFERENCES

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Dowler, D.A., Hook, T.A., *Pulsed Air Sparging with Remote Soil Vapor Extraction: Theory and Pilot Test Case Study*, 1997.

State of North Carolina, Department of Environment, Health and Natural Resources, Division of Water Quality, Groundwater Section, *Guidelines for the Investigation and Remediation of Soil and Groundwater*, March 17, 1997.

TABLES

TABLE 1

OBSERVATION WELL CONSTRUCTION DATA

HADNOT POINT FUEL FARM MARINE CORPS BASE CAMP LEJEUNE, NORTH CAROLINA

WELL IDENTIFICATION	DATE INSTALLED	TOTAL DEPTH (Ft BLS)	CASING DEPTH (Ft BLS)	SCREEN INTERVAL (Ft BLS)	TOP OF CASING ELEV. (ft. MSL)	OUTER CASING DEPTH (Ft BLS) (Type III)	THIRD CASING DEPTH (Ft BLS) (Triple Cased Type III)
78GW-32 -02	12/20/90	77.0	64.0	64.0 - 74.0	27.20		
78GW-32 -03	12/20/90	153.0	140.0	140.0 - 150.0	27.20		
USTHPFF- MW01	02/24/88	17.0	7.0	7.0 - 17.0	30.18		
USTHPFF- MW02	02/24/88	17.0	7.0	7.0 - 17.0	31.86		
USTHPFF- MW03	02/25/88	15.0	5.0	5.0 - 15.0	29.22		
USTHPFF- MW05	02/25/88	15.0	5.0	5.0 - 15.0	28.17		
USTHPFF- MW06	03/01/88	15.0	5.0	5.0 - 15.0	30.10		
USTHPFF- MW10R	03/30/95	15.0	5.0	5.0 - 15.0	33.96		
USTHPFF- MW15	03/08/88	25.0	5.0	5.0 - 25.0	30.45		
USTHPFF- MW17	03/09/88	25.0	5.0	5.0 - 25.0	31.33		
USTHPFF- MW18	03/11/88	25.0	5.0	5.0 - 25.0	31.97		
USTHPFF- MWA			4.0	4.0 - 14.0	28.61		
USTHPFFC- MW02	11/21/95	15.0	5.0	5.0 - 15.0	29.47		
USTHPFFC- MW05	11/21/95	15.0	5.0	5.0 - 15.0	27.33		
USTHPFFC- MW06	11/08/95	50.0	45.0	45.0 - 50.0	30.93	40.0	
USTHPFFC- MW07	11/10/95	49.5	44.5	44.5 - 49.5	28.28	40.0	
USTHPFFC- MW08	11/17/95	49.5	44.5	44.5 - 49.5	34.90	40.0	
USTHPFFC- MW09	11/16/95	50.0	45.0	45.0 - 50.0	27.13	40.0	
USTHPFFC- MW10	07/17/97	80.0	75.0	75.0 - 80.0	32.50	70.0	40.0
USTHPFFC- MW11	07/28/97	110.0	105.0	105.0 - 110.0	32.28	100.0	40.0
USTHPFFC- MW12	07/16/97	110.0	105.0	105.0 - 110.0	27.12	100.0	40.0
USTHPFFC- MW14	06/25/97	15.0	5.0	5.0 - 15.0	27.02		
USTHPFFC- MW15	06/25/97	15.0	5.0	5.0 - 15.0	27.69		
USTHPFFC- MW17	06/26/97	15.0	5.0	5.0 - 15.0	27.61		
USTHPFFC- MW19	07/08/97	15.0	5.0	5.0 - 15.0	26.43		
USTHPFFC- MW20	07/08/97	15.0	5.0	5.0 - 15.0	28.74		
USTHPFFC- MW21	01/17/00	14.5	4.5	4.5 - 14.5	27.27		
USTHPFFC- MW28	01/19/00	14.0	4.0	4.0 - 14.0	27.48		
USTHPFFC- MW30	01/21/00	12.0	2.0	2.0 - 12.0	26.80		
USTHPFFC- MW38	01/31/00	14.0	4.0	4.0 - 14.0	30.31		
USTHPFFC- MW59	02/06/02	80.0	75.0	75.0 - 80.0	27.94	70.0	40.0
USTHPFFC- MW60	10/17/01	150.0	145.0	145.0 - 150.0	27.19	140.0	40.0
USTHPFFC- MW61	10/17/01	50.0	45.0	45.0 - 50.0	27.34	40.0	
USTHPFFC- MW62	02/06/02	155.0	150.0	150.0 - 155.0	26.86	145.0	75.0
USTHPFFC- MW64	10/10/01	50.0	45.0	45.0 - 50.0	27.58	40.0	
USTHPFFC- MW65	02/06/02	80.0	75.0	75.0 - 80.0	29.79	70.0	40.0
USTHPFFC- MW66	10/09/01	50.0	45.0	45.0 - 50.0	27.41	40.0	

TABLE 1

OBSERVATION WELL CONSTRUCTION DATA

**HADNOT POINT FUEL FARM
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA**

WELL IDENTIFICATION	DATE INSTALLED	TOTAL DEPTH (Ft BLS)	CASING DEPTH (Ft BLS)	SCREEN INTERVAL (Ft BLS)	TOP OF CASING ELEV. (ft. MSL)	OUTER CASING DEPTH (Ft BLS) (Type III)	THIRD CASING DEPTH (Ft BLS) (Triple Cased Type III)
USTHPFFC- MW69	10/03/01	50.0	45.0	45.0 - 50.0	29.87	40.0	
USTHPFFC- MW72	03/06/02	30.0	18.0	18.0 - 30.0	27.84		
USTHPFFC- MW75	03/31/03	80.0	55.0	55.0 - 75.0	30.01		
USTHPFFC- MW78	11/05/03	159.0	139.0	139.0 - 159.0	30.00	131.0	

FT = FEET
BLS = BELOW LAND SURFACE
MSL = MEAN SEA LEVEL

TABLE 2

SUMMARY OF ANALYTICAL RESULTS - SOIL (EPA METHODS 5030 AND 3550)

HADNOT POINT FUEL FARM
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

SAMPLE ID	Date Sampled	ANALYTE	
		Gasoline Range Organics	Diesel Range Organics
STATE ACTION LEVEL (mg/kg)		10	40
USTHPFFC-SP100 (7-9)	10/28/03	17	86
USTHPFFC-MW78 (2-4)	10/28/03	BQL	13

*All Results in mg/kg.

Shaded areas indicate concentrations in excess of State Action Levels.

BQL = Below Quantitation Limits.

TABLE 3

SUMMARY OF ANALYTICAL RESULTS - GROUNDWATER (EPA METHOD 602)

HADNOT POINT FUEL FARM
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

WELL ID	Date Sampled	ANALYTE					
		Benzene	Diisopropyl ether	Ethylbenzene	Methyl-tert-butyl ether	Toluene	Total Xylenes
2L GWQS (µg/L)		1	70	29	200	1,000	530
USTHPFFC-SP100	11/26/2003	BQL	BQL	BQL	BQL	BQL	BQL
USTHPFFC-MW78	11/26/2003	10	BQL	16	BQL	71	80

All results in $\mu\text{g/L}$

Shaded areas indicate concentrations in excess of 2L GWQS.

BQL = Below Quantitation Limits. Refer to analytical report for a complete list of compounds and quantitation limits.

TABLE 4

**SUMMARY OF ANALYTICAL RESULTS - GROUNDWATER
(EPA METHOD 610)**

**HADNOT POINT FUEL FARM
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA**

WELL ID	Date Sampled	Analytes
		All Analytes *
2L GWQS (µg/L)		Varies
USTHPFFC-SP100	11/26/03	BQL
USTHPFFC-MW78	11/26/03	BQL

Results in ug/L.

* All compounds listed in laboratory analytical reports.

BQL = Below Quantitation Limits. Refer to analytical report for a complete list of compounds and quantitation limits.

TABLE 5

**SUMMARY OF ANALYTICAL RESULTS - GROUNDWATER
(EPA METHOD 601)**

**HADNOT POINT FUEL FARM
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA**

WELL ID	Date Sampled	ANALYTE	
		Chloroform	All Other Analytes *
2L GWQS (ug/L)		0.19	Varies
USTHPFFC-SP100	11/26/03	2.4	BQL
USTHPFFC-MW78	11/26/03	BQL	BQL

Results in ug/L.

* All compounds listed in laboratory analytical reports.

Shaded areas indicate concentrations in excess of 2L GWQS.

BQL = Below Quantitation Limits. Refer to analytical report for a complete list of compounds and quantitation limits.

TABLE 6**PRE-SPARGE EQUIPMENT VERIFICATION TEST FLOW DATA**

**HADNOT POINT FUEL FARM
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA**

Time (min)	80psig		84psig	
	Observed (cfm)	Corrected (scfm)	Observed (cfm)	Corrected (scfm)
0	0	0	0	0
1	2	5.1	2	5.2
6	6	15.2	10	25.9
11	10	25.4	28	72.6
21	14	35.5	34	88.1
36	16	40.6	36	93.3
51	18	45.7	46	119.2
66	22	55.8	48	124.4
81	22	55.8	50	129.6
96	22	55.8	50	129.6
111	25	63.5	52	134.7
126	25	63.5	50	129.6
141	26	66.0	54	139.9
156	26	66.0	56	145.1
171	28	71.1	58	150.3
186	28	71.1	58	150.3

min = minute

cfm = cubic feet per minute

scfm = standard cubic feet per minute

psig = pounds per square inch gauge

TABLE 7

PRE-SPARGE EQUIPMENT VERIFICATION TEST GAUGING DATA

**HADNOT POINT FUEL FARM
MARINE CORPS BASE
CAMP LEJUENE, NORTH CAROLINA**

Time (min)	USTHPFFC-10	USTHPFFC-11	USTHPFFC-60	USTHPFFC-65	USTHPFFC-78	USTHPFFC-12
0	10.97	10.76	6.28	8.63	7.01	5.9
51	7.21	8.96	5.78	5.78	2.92	5.13
96	5.39	7.29	5.73	4.07	0.92	4.16
141	4.03	6.12	5.67	2.92	0	3.52
186	3.11	5.4	5.6	2.14	0	2.98

Measurements are depth to water in feet.
min = Minute

TABLE 8

COMPREHENSIVE WELL GAUGING (INITIAL AND FINAL)

HADNOT POINT FUEL FARM
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

WELL IDENTIFICATION	January 16, 2004			February 10, 2004		
	DEPTH TO WATER (FT)	PRODUCT THICKNESS (FT)	DISSOLVED OXYGEN (mg/L)	DEPTH TO WATER (FT)	PRODUCT THICKNESS (FT)	DISSOLVED OXYGEN (mg/L)
78GW-32 -02	7.25	NMT	0.07	7.30	NMT	0.16
78GW-32 -03	8.03	0.37	NM	7.95	NMT	0.19
USTHPFFC-MW02	6.03	NMT	1.61	6.10	NMT	1.79
USTHPFFC-MW05	5.81	NMT	0.07	5.74	NMT	0.23
USTHPFFC-MW06	9.25	NMT	0.06	9.23	NMT	5.88
USTHPFFC-MW07	7.59	NMT	0.04	7.74	NMT	5.08
USTHPFFC-MW08	13.90	NMT	0.30	13.89	NMT	0.37
USTHPFFC-MW09	6.82	NMT	0.045	7.04	NMT	5.50
USTHPFFC-MW10	12.22	NMT	1.55	12.24	NMT	0.22
USTHPFFC-MW11	12.06	NMT	0.735	11.22	NMT	0.38
USTHPFFC-MW12	7.38	NMT	0.03	DAMAGED		
USTHPFFC-MW14	5.07	NMT	0.02	5.18	NMT	0.25
USTHPFFC-MW15	5.68	0.30	NM	5.59	0.29	NM
USTHPFFC-MW17	6.34	NMT	0.06	6.49	NMT	0.34
USTHPFFC-MW19	4.75	NMT	0.01	4.51	NMT	0.24
USTHPFFC-MW20	6.25	NMT	0.07	6.25	NMT	0.13
USTHPFFC-MW21	4.57	NMT	4.81	4.35	NMT	4.28
USTHPFFC-MW28	5.84	NMT	NM	5.62	NMT	0.22
USTHPFFC-MW30	4.01	NMT	0.31	3.77	NMT	0.17
USTHPFFC-MW38	6.16	NMT	5.28	NM	NM	NM
USTHPFFC-MW59	8.17	NMT	0.03	7.43	NMT	0.93
USTHPFFC-MW60	6.91	NMT	0.03	7.03	NMT	0.16
USTHPFFC-MW61	8.17	NMT	1.91	7.86	NMT	1.74
USTHPFFC-MW62	7.59	NMT	0.07	7.67	NMT	1.58
USTHPFFC-MW64	6.61	NMT	0.24	7.05	NMT	0.13
USTHPFFC-MW65	9.79	NMT	0.28	9.97	NMT	0.16
USTHPFFC-MW66	6.90	NMT	0.37	7.04	NMT	6.40
USTHPFFC-MW69	8.78	NMT	2.95	8.63	NMT	0.15
USTHPFFC-MW72	18.70	15.43	NM	12.05	3.03	NM
USTHPFFC-MW75	9.64	NMT	0.05	10.42	NMT	0.17
USTHPFFC-MW78	NM	NM	NM	8.33	NMT	0.22
USTHPFF-MW01	8.07	NMT	NM	7.82	NMT	0.18
USTHPFF-MW02	9.12	0.13	NM	9.19	SHEEN	NM
USTHPFF-MW03	7.01	NMT	3.93	6.79	NMT	4.05
USTHPFF-MW05	4.95	NMT	0.05	4.85	NMT	0.38
USTHPFF-MW06	7.71	NMT	0.05	7.48	NMT	0.69
USTHPFF-MW10R	11.14	NMT	NM	11.25	NMT	0.28

TABLE 8

COMPREHENSIVE WELL GAUGING (INITIAL AND FINAL)

HADNOT POINT FUEL FARM
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

WELL IDENTIFICATION	January 16, 2004			February 10, 2004		
	DEPTH TO WATER (FT)	PRODUCT THICKNESS (FT)	DISSOLVED OXYGEN (mg/L)	DEPTH TO WATER (FT)	PRODUCT THICKNESS (FT)	DISSOLVED OXYGEN (mg/L)
USTHPFF-MW15	5.97	NMT	NM	6.94	NMT	0.15
USTHPFF-MW17	9.64	NMT	1.30	9.56	NMT	0.28
USTHPFF-MW18	9.83	NMT	NM	9.75	TRACE	NM
USTHPFF-MWA	5.91	NMT	NM	NM	NM	NM

NMT = No Measurable Thickness

NM = Not Measured

Depth to Water measured from Top of Casing

FT = Feet

mg/L = milligrams per Liter

TABLE 9

BIO-PULSE SPARGE PILOT TEST INJECTION DATA

HADNOT POINT FUEL FARM
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

Time	Time (min)	Pressure at Regulator (psig)	Flow Meter 1		Flow Meter 2		Total Flow (scfm)	Total Injected Air (scf)	Total Air Injected at Injection Pressure (cf)
			Observed (cfm)	Adjusted (scfm)	Observed (cfm)	Adjusted (scfm)			
10:30	0	0	0	0	0	0	0	0	0
11:00	30	90	14	37.4	15	40.0	77.4	2,321.85	325.99
11:30	60	94	27	73.4	29	78.9	152.3	6,890.26	931.80
12:30	120	93	34.5	93.4	35.5	96.1	189.5	18,258.64	2,492.13
1:00	150	92	36.5	98.3	38	102.4	200.7	24,280.09	3,345.05
1:30	180	92	37	99.7	39	105.1	204.8	30,422.78	4,191.33
2:30	240	91	42	112.6	39	104.6	217.2	43,454.90	6,043.40
4:30	360	90	44.5	118.8	47	125.4	244.2	72,758.23	10,215.34
6:30	480	91	45	120.7	48.5	130.1	250.7	102,844.73	14,302.91
8:30	600	90.5	49	131.1	52.5	140.4	271.5	135,428.14	18,923.89
10:30	720	90	51.5	137.4	54.5	145.4	282.9	169,375.17	23,780.47
12:30	840	89	53	140.8	57	151.4	292.2	204,434.58	28,979.64
2:30	960	89	55	146.1	57	151.4	297.5	240,131.44	34,039.85
4:30	1080	89	56	148.7	58.5	155.4	304.1	276,625.10	39,213.01
* 6:30	1200	87.5	56	147.7	59	155.6	303.2	313,012.07	45,022.28
* 8:30	1320	87	57	149.9	61	160.4	310.4	350,256.82	50,627.09
* 10:30	1440	86.5	56	146.9	58.5	153.5	300.4	386,307.90	56,113.89
* 11:15	1485	76	33.5	83.2	35	86.9	170.2	393,964.71	63,850.95
12:30	1560	81.5	52.5	134.3	62.5	159.9	294.2	416,028.90	63,571.98
2:20	1670	84	55	142.5	56	145.1	287.6	447,667.38	66,673.87
2:30	1680	82.5	53	136.3	56.5	145.3	281.6	450,483.09	68,128.62
4:00	1770	Test Stopped							

The observed flowmeter reading was adjusted to standard operating conditions in accordance with Dwyer FR# 52-440241-00 Rev.2

* Only one compressor on line

min = Minute

cfm = cubic feet per minute

scfm = standard cubic feet per minute

psig = pounds per square inch gauge

scf = standard cubic feet

cf = cubic feet

TABLE 10
BIO-PULSE SPARGE PILOT TEST DATA

HADNOT POINT FUEL FARM
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

Time (minutes)	DEPTH TO WATER (FEET)																						
	Deep Wells					Intermediate Depth Wells								Shallow Wells									
	USTHPFFC-MW11	USTHPFFC-MW78	USTHPFFC-MW12	USTHPFFC-MW60	USTHPFFC-MW62	USTHPFFC-MW65	USTHPFFC-MW08	USTHPFFC-MW10	USTHPFFC-MW64	USTHPFFC-MW75	USTHPFFC-MW61	USTHPFFC-MW69	78GW32-2	USTHPFF-MW17	USTHPFF-MW05	USTHPFF-MW10R	USTHPFF-MW01	USTHPFFC-MW30	USTHPFFC-MW14	USTHPFFC-MW28	USTHPFF-MW06	USTHPFFC-MW19	USTHPFF-MW18
0	12.18	8.38	7.50	6.98	7.60	10.05	13.85	12.31	7.02	10.73	7.81	8.80	7.23	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
30	11.79	4.02	7.03	7.34	7.86	7.43	12.50	9.20	7.38	10.05	7.44	9.03	7.51	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
60	9.92	0.39	5.90	7.32	7.83	4.83	14.20	6.48	7.36	8.96	6.29	9.02	7.42	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
90	8.00	NM	4.70	7.28	7.70	2.65	14.11	3.63	7.32	7.95	5.07	8.98	7.22	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
120	6.15	NM	3.76	7.20	7.58	1.27	14.00	1.96	7.25	7.02	3.98	8.94	6.92	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
150	4.62	NM	2.85	7.10	7.25	NM	13.81	0.33	7.15	6.18	3.00	8.82	6.54	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
180	3.77	NM	2.25	7.05	7.00	NM	13.69	NM	7.08	5.64	2.34	8.74	6.31	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
210	2.82	NM	1.60	6.95	6.61	NM	13.51	NM	6.97	5.01	1.67	8.63	5.94	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
240	2.11	NM	1.10	6.87	6.29	NM	13.36	NM	6.89	4.50	1.17	8.54	5.65	9.62	5.11	11.30	8.08	4.13	5.25	5.86	7.76	4.80	9.96
360	NM	NM	NM	6.44	4.66	NM	12.47	NM	6.38	2.65	NM	7.97	4.27	9.63	5.10	11.17	7.95	4.14	5.26	5.72	7.74	4.75	9.93
480	NM	NM	NM	6.02	3.36	NM	11.87	NM	5.92	1.22	NM	7.56	3.25	9.65	5.11	11.20	7.97	4.17	5.26	5.73	7.76	4.81	9.87
600	NM	NM	NM	5.57	2.32	NM	11.27	NM	5.45	NM	NM	7.12	2.36	9.65	5.13	11.20	7.97	4.17	5.27	5.73	7.77	4.82	9.84
720	NM	NM	NM	5.12	1.38	NM	10.70	NM	4.97	NM	NM	6.70	1.57	9.65	5.14	11.22	7.99	4.21	5.27	5.76	7.75	4.82	9.73
840	NM	NM	NM	4.62	0.58	NM	9.97	NM	4.35	NM	NM	6.22	0.79	9.60	5.16	11.21	7.92	4.19	5.14	5.75	7.79	4.80	9.62
960	NM	NM	NM	4.12	NM	NM	9.47	NM	3.91	NM	NM	5.82	0.18	9.53	5.23	11.17	7.92	4.18	5.25	5.73	7.65	4.75	9.50
1080	NM	NM	NM	3.68	NM	NM	9.17	NM	3.52	NM	NM	5.54	NM	9.56	5.14	11.14	8.02	4.20	5.25	5.73	7.60	4.77	9.41
1200	NM	NM	NM	3.25	NM	NM	8.62	NM	3.12	NM	NM	5.17	NM	9.54	5.25	11.19	7.85	4.20	5.26	5.71	7.56	4.77	9.30
1320	NM	NM	NM	2.85	NM	NM	8.29	NM	2.74	NM	NM	4.93	NM	9.54	5.18	11.21	7.90	4.21	5.25	5.73	7.54	4.80	9.22
1440	NM	NM	NM	2.42	NM	NM	7.87	NM	2.32	NM	NM	4.63	NM	9.49	5.17	11.17	7.84	4.19	5.25	5.72	7.45	4.77	9.09
1560	NM	NM	NM	2.05	NM	NM	7.67	NM	2.02	NM	NM	4.42	NM	9.40	5.12	11.13	7.78	4.15	5.21	5.70	7.32	4.69	8.92
1680	NM	NM	NM	1.76	NM	NM	7.59	NM	1.79	NM	NM	4.34	NM	9.31	5.09	11.09	7.71	4.08	5.20	5.65	7.20	4.61	8.75
1800	NM	NM	NM	1.57	NM	NM	7.58	NM	1.66	NM	NM	4.30	NM	9.28	5.09	11.07	7.68	4.06	5.17	5.63	7.12	4.55	8.64
1920	NM	NM	NM	1.63	NM	NM	8.06	NM	1.79	NM	NM	4.58	NM	9.23	5.04	11.06	7.56	4.04	5.17	5.62	7.06	4.51	8.53
2040	NM	NM	NM	1.91	NM	NM	8.70	NM	2.13	NM	NM	5.00	NM	9.18	5.02	11.02	7.63	4.02	5.16	5.58	6.96	4.45	8.49
2160	NM	NM	NM	2.15	NM	NM	9.13	NM	2.40	NM	NM	5.29	NM	9.17	5.01	11.02	7.62	4.00	5.15	5.56	6.92	4.41	8.47
2280	NM	NM	NM	2.44	NM	NM	9.69	NM	2.81	NM	NM	5.70	NM	9.15	5.01	10.99	7.55	3.98	5.16	5.52	6.93	4.35	8.43
2400	NM	NM	NM	2.74	NM	NM	9.68	NM	3.10	NM	NM	5.93	NM	9.13	4.99	11.00	7.57	3.91	5.25	5.43	6.94	4.28	8.46
2520	NM	NM	NM	2.73	NM	NM	9.69	NM	3.11	NM	NM	5.93	NM	9.12	4.99	10.99	7.56	3.93	5.24	5.43	6.93	4.29	8.46
2640	NM	NM	NM	3.30	NM	NM	9.67	NM	3.13	NM	NM	5.91	NM	9.15	4.94	10.97	7.57	3.91	5.12	5.44	6.93	4.28	8.47
2760	NM	NM	NM	3.52	NM	NM	10.95	NM	3.92	NM	NM	6.56	NM	9.09	4.95	10.92	7.53	3.85	5.15	5.44	6.76	4.19	8.52
2880	NM	NM	NM	3.75	NM	NM	11.20	NM	4.12	NM	NM	6.74	NM	9.08	4.94	10.89	7.52	3.84	5.11	5.42	6.76	4.16	8.58

TABLE 10
BIO-PULSE SPARGE PILOT TEST DATA

HADNOT POINT FUEL FARM
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

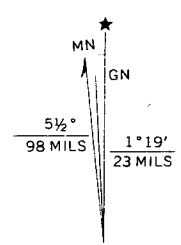
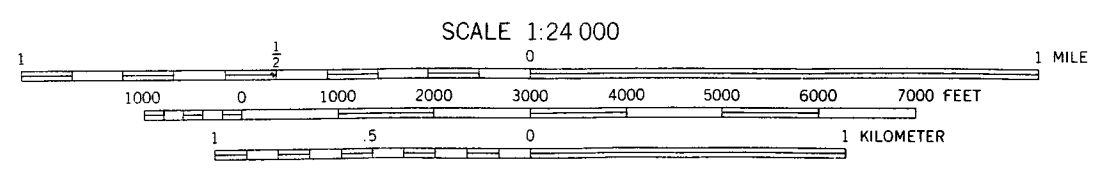
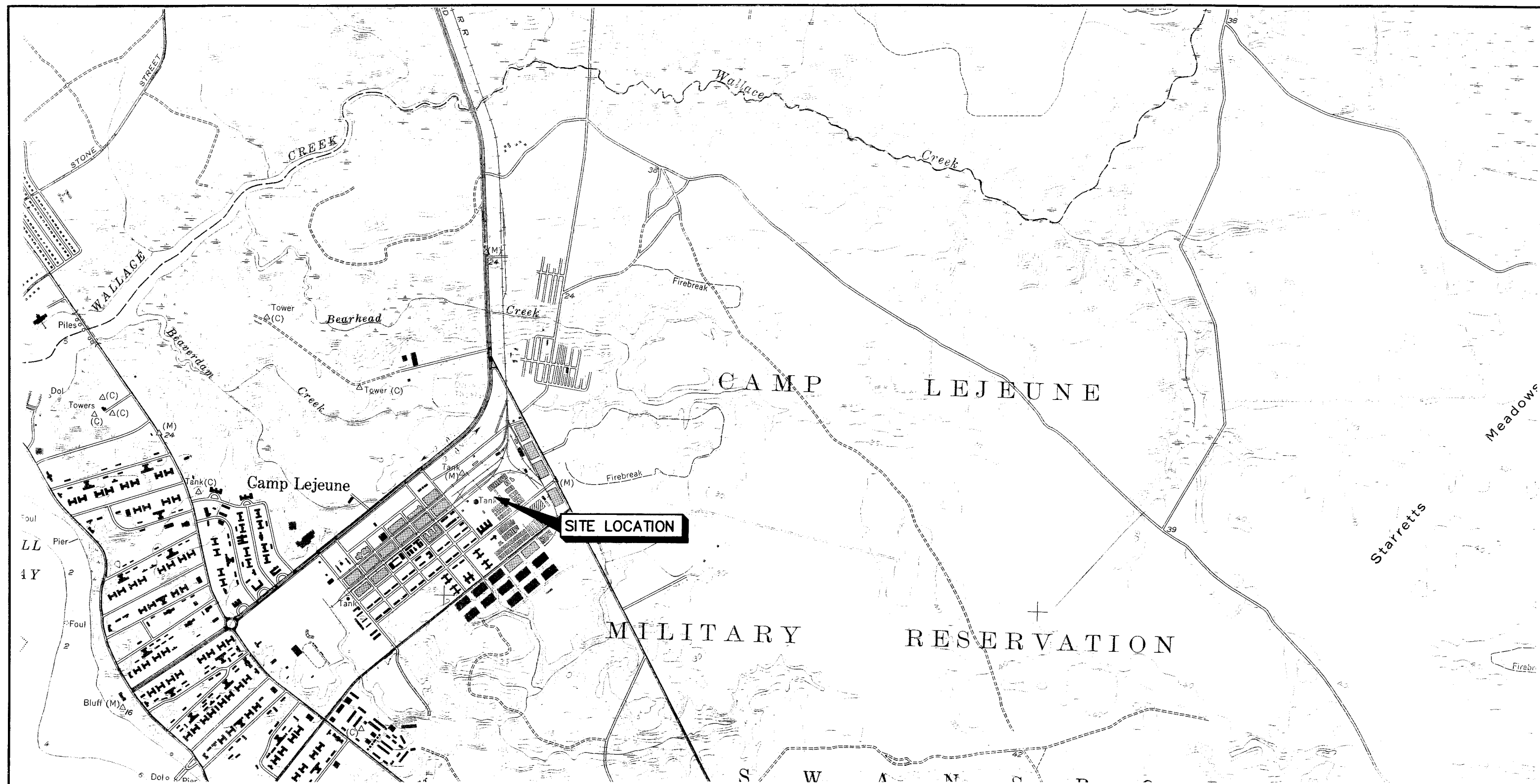
Time (minutes)	DEPTH TO WATER (FEET)																						
	Deep Wells					Intermediate Depth Wells								Shallow Wells									
	USTHPFFC-MW11	USTHPFFC-MW78	USTHPFFC-MW12	USTHPFFC-MW60	USTHPFFC-MW62	USTHPFFC-MW65	USTHPFFC-MW08	USTHPFFC-MW10	USTHPFFC-MW64	USTHPFFC-MW75	USTHPFFC-MW61	USTHPFFC-MW69	78GW32-2	USTHPFF-MW17	USTHPFF-MW05	USTHPFF-MW10R	USTHPFF-MW01	USTHPFFC-MW30	USTHPFFC-MW14	USTHPFFC-MW28	USTHPFF-MW06	USTHPFFC-MW19	USTHPFF-MW18
3000	NM	NM	NM	3.94	NM	NM	11.39	NM	4.28	NM	NM	6.85	NM	9.03	4.90	10.84	7.48	3.78	5.10	5.39	6.70	4.09	8.56
3120	NM	NM	NM	4.08	NM	NM	11.54	NM	4.43	NM	NM	6.96	NM	8.99	4.86	10.80	7.42	3.74	5.10	5.35	6.64	4.01	8.55
3240	NM	NM	NM	4.26	NM	NM	11.71	NM	4.52	NM	NM	7.09	NM	8.92	4.85	10.79	7.40	2.92	5.27	5.46	6.67	4.00	8.54
3360	NM	NM	NM	4.44	NM	NM	NM	NM	4.76	NM	NM	7.31	NM	9.02	4.85	10.84	7.48	3.70	5.07	5.34	6.72	3.99	8.69
3480	NM	NM	NM	4.49	NM	NM	NM	NM	4.93	NM	NM	7.31	NM	9.02	4.86	10.82	7.48	3.72	5.09	5.30	6.74	4.03	8.75
3600	NM	NM	NM	4.77	NM	NM	NM	NM	5.05	NM	NM	7.39	NM	9.04	4.84	10.82	7.48	3.75	5.10	5.35	6.76	3.88	8.80
3720	NM	NM	NM	4.91	NM	NM	12.17	NM	5.20	NM	NM	7.49	NM	9.08	4.85	10.85	7.52	3.76	5.11	5.35	6.85	4.08	8.85
3840	NM	NM	NM	5.02	4.25	NM	12.29	NM	5.28	NM	NM	7.55	6.42	9.09	4.85	10.86	7.52	3.78	4.90	5.35	6.90	4.10	8.92
3960	NM	NM	NM	5.16	5.94	NM	12.36	NM	5.39	NM	NM	7.59	6.51	9.13	4.88	10.89	7.51	3.80	5.11	5.37	6.87	4.12	8.94
4080	NM	NM	NM	5.30	6.69	NM	12.47	NM	5.52	NM	NM	7.72	6.58	9.19	4.91	10.92	7.61	3.84	5.15	5.40	7.01	4.20	9.08
4200	NM	NM	NM	5.43	NM	NM	12.54	NM	5.64	NM	NM	7.79	NM	9.23	4.94	10.92	7.64	3.88	5.16	5.41	7.08	4.28	9.16
4320	NM	NM	NM	5.42	NM	NM	12.61	NM	5.69	NM	NM	7.85	NM	9.24	4.96	10.92	7.66	3.90	5.18	5.41	7.10	4.31	9.20
4440	NM	NM	NM	5.53	NM	NM	12.61	NM	5.70	NM	NM	7.83	NM	9.19	4.95	10.87	7.59	3.84	5.16	5.37	7.05	4.25	9.16
4560	NM	NM	NM	5.59	NM	NM	12.63	NM	5.73	NM	NM	7.86	NM	9.18	4.92	10.87	7.60	3.88	5.14	5.37	7.07	4.23	9.17
5730	NM	NM	NM	5.90	NM	NM	12.92	NM	6.02	NM	NM	8.05	NM	9.13	4.83	10.83	7.54	3.84	5.15	5.36	7.12	4.22	9.24
6630	NM	NM	NM	6.62	NM	NM	13.59	NM	6.70	NM	NM	8.53	NM	9.40	5.08	11.00	7.70	4.14	5.21	5.54	7.50	4.55	9.61
8805	NM	8.42	NM	6.58	6.91	10.39	13.58	NM	6.67	10.00	NM	8.47	NM	9.29	4.99	10.97	7.68	3.97	4.46	5.42	7.27	4.44	9.56
10065	NM	8.37	NM	6.55	7.01	10.04	13.52	NM	6.69	9.15	NM	8.41	NM	9.21	4.14	10.92	7.38	3.42	3.92	5.21	6.81	4.39	9.48
11520	NM	8.29	NM	6.91	7.56	10.05	13.81	NM	6.99	10.45	NM	8.57	7.26	9.43	4.21	11.08	7.61	3.56	4.03	5.26	7.09	NM	9.75
13230	NM	8.20	NM	6.86	7.57	9.84	13.71	NM	6.92	10.32	NM	8.49	7.16	9.36	4.41	11.00	7.57	3.41	4.88	5.27	7.05	4.41	9.58

NM = Not Measured

Time is measured from start of the Bio-Pulse Sparge Pilot Test.

Stopped injecting at time = 1770 minutes.

FIGURES

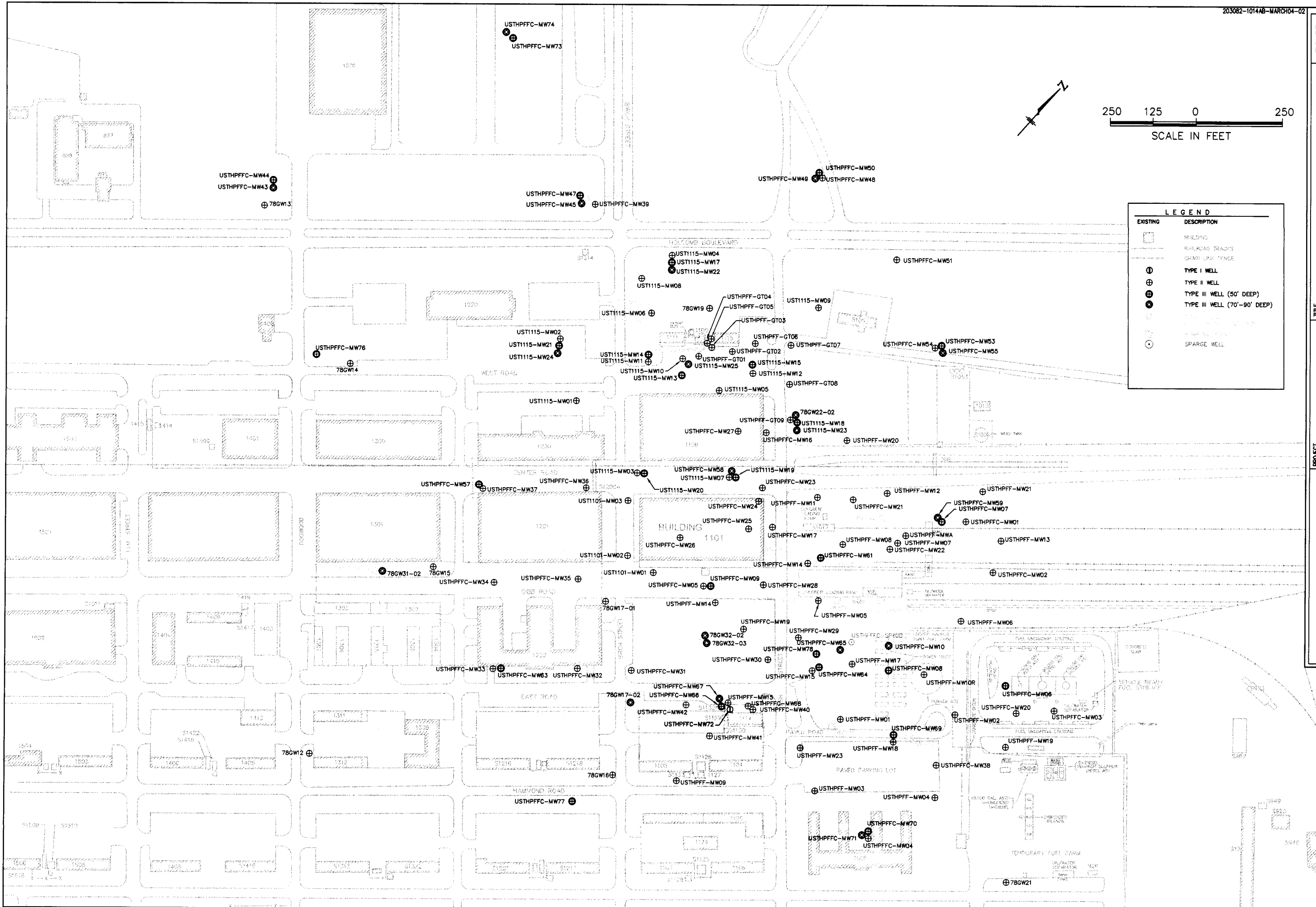


UTM GRID AND 1971 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET



CAMP LEJEUNE, N. C.
N3437.5—W7715/7.5
1952
PHOTOREVISED 1971

CATLIN ENGINEERS and SCIENTISTS WILMINGTON, NORTH CAROLINA	PROJECT BIO-PULSE SPARGE PILOT TEST HADNOT POINT FUEL FARM MARINE CORPS BASE CAMP LEJEUNE, N.C. JOB NO. 203-082 DATE MAR 2004	TITLE GENERAL LOCATION USGS TOPOGRAPHIC QUADRANGLE SCALE: AS SHOWN DRAWN BY: HCS CHECKED BY: MEM	FIGURE 1
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FIGURE

2

SITE MAP WITH

MONITORING WELL LOCATIONS

PROJECT

BIO-PULSE SPARGE PILOT TEST
HADNOT POINT FUEL FARM
MARINE CORPS BASE
CAMP LEJEUNE, N.C.

TITLE

JOB NO.

203-082

DATE

MAR 2004

SCALE

1"=250'

DRAWN BY

HCS

CHECKED BY

MEM

CALLEN

ENGINEERS AND SCIENTISTS

WILMINGTON, NORTH CAROLINA



LEGEND

EXISTING

BUILDING

RAILROAD TRACKS

CHAIN LINK FENCE

⊕

TYPE I WELL

⊕

TYPE II WELL

⊕

TYPE III WELL (50' DEEP)

⊕

TYPE III WELL (70'-90' DEEP)

⊕

SPARGE WELL

DESCRIPTION

BUILDING

RAILROAD TRACKS

CHAIN LINK FENCE

LEGEND

EXISTING	DESCRIPTION
	BUILDING
	RAILROAD TRACKS
	CHAIN LINK FENCE
	TYPE I WELL
	TYPE II WELL
	TYPE III WELL (50' DEEP)
	TYPE III WELL (70'-90' DEEP)
	SPARGE WELL

Scale: 80 40 0 80
SCALE IN FEET

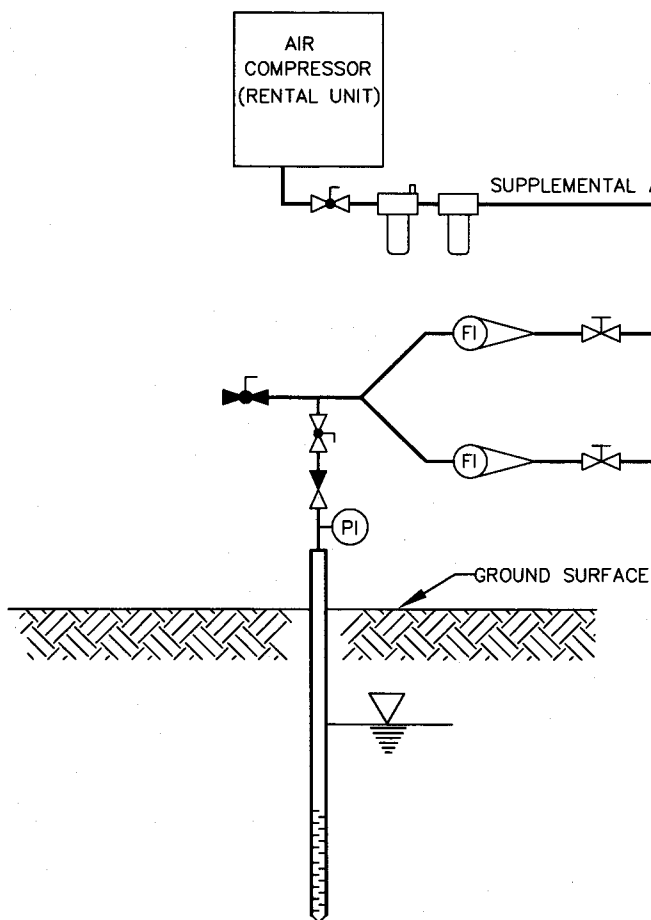
PROJECT: BIO-PULSE SPARGE PILOT TEST
HADNOT POINT FUEL FARM
MARINE CORPS BASE
CAMP LEJEUNE, N.C.

JOB NO.: 203-082 **DATE:** MAR 2004 **SCALE:** 1"=80' **DRAWN BY:** HCS **CHECKED BY:** MEM

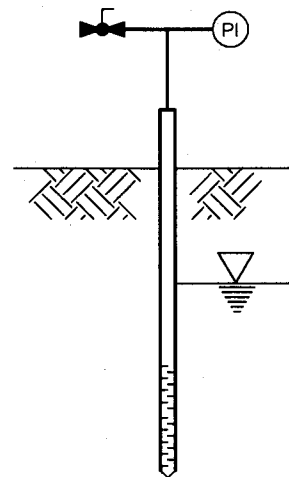
TITLE: SITE MAP WITH PILOT TEST OBSERVATION WELL LOCATIONS

FIGURE: 3

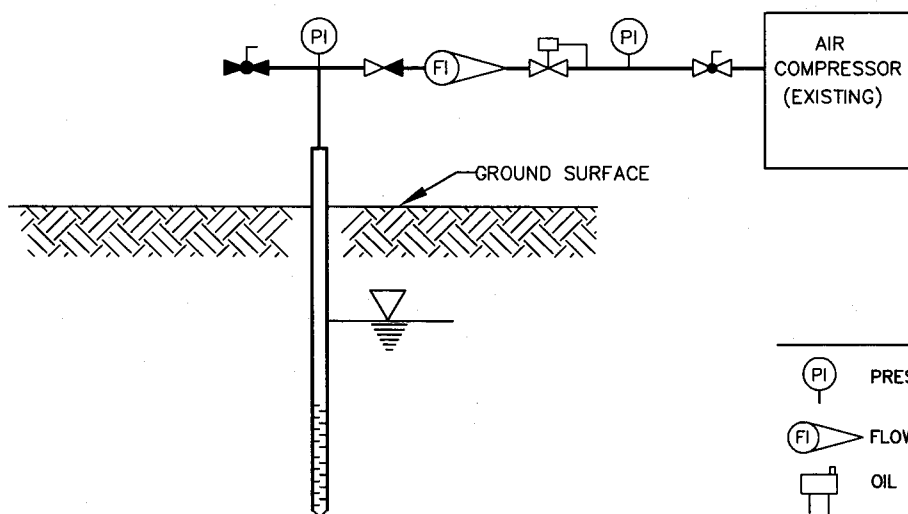
203082-1014AB-MARCH2004-03



BIO-PULSE SPARGE
PILOT TEST SET-UP



OBSERVATION WELL
APPARATUS



PRE-SPARGE EQUIPMENT
VERIFICATION SET-UP

LEGEND	
(PI)	PRESSURE INDICATOR
(FI)	FLOW INDICATOR
	OIL FILTER
	WATER FILTER
	PRESSURE REGULATOR
	GATE VALVE
	BALL VALVE (CLOSED)
	BALL VALVE (OPEN)
	BACKFLOW PREVENTER

CALIN
ENGINEERS and SCIENTISTS

WILMINGTON, NORTH CAROLINA

PROJECT
BIO-PULSE SPARGE PILOT TEST
HADNOT POINT FUEL FARM
MARINE CORPS BASE
CAMP LEJEUNE, N.C.

JOB NO: 203082 DATE: MARCH 2004

TITLE
PILOT TEST WELL SCHEMATICS

SCALE: N.T.S.

DRAWN BY: WHW

CHECKED BY: MDM

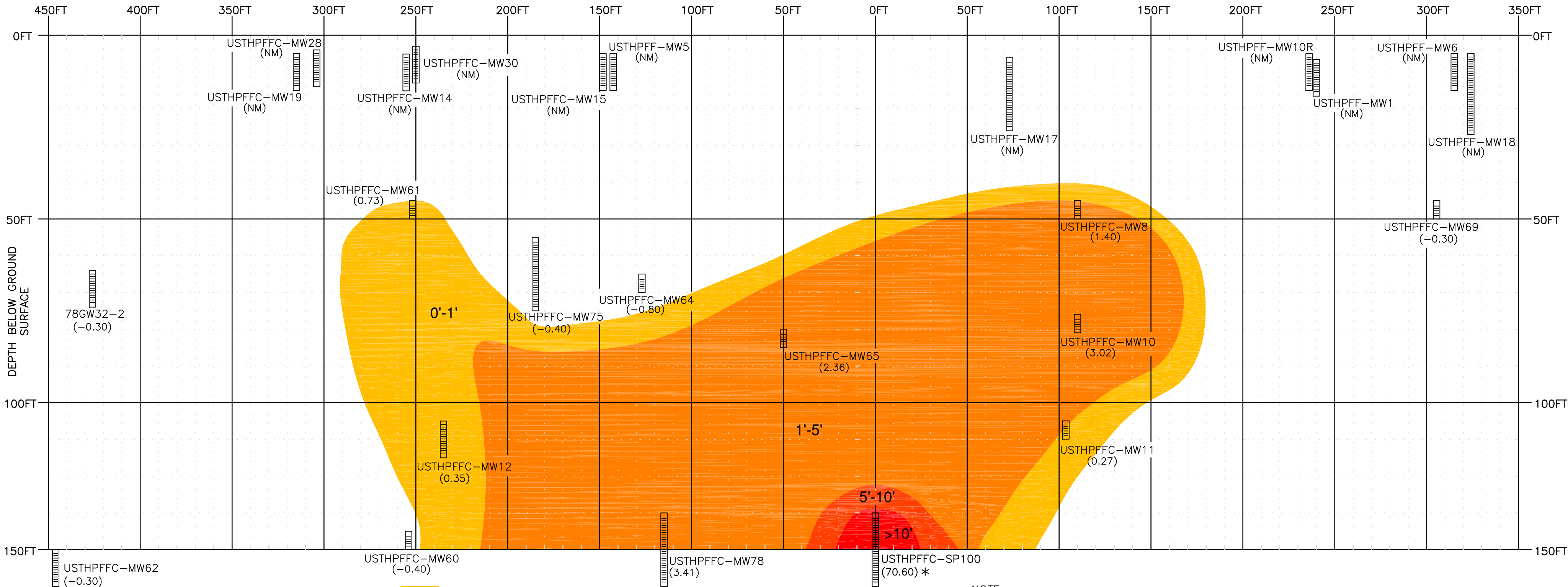
FIGURE

4

203082-1014AB-MARCH04-04

30 MINUTES

DISTANCE FROM SPARGE WELL



LEGEND

() CHANGE IN GROUNDWATER TABLE ELEVATION SINCE SPARGING BEGAN; POSITIVE NUMBER INDICATES GROUNDWATER RISE
* INFLUENCE AT SPARGE WELL BASED ON MEASURED INJECTION PRESSURE

- 0'-1' OF CHANGE IN GROUNDWATER TABLE ELEVATION
- 1'-5' OF CHANGE IN GROUNDWATER TABLE ELEVATION
- 5'-10' OF CHANGE IN GROUNDWATER TABLE ELEVATION
- >10' OF CHANGE IN GROUNDWATER TABLE ELEVATION

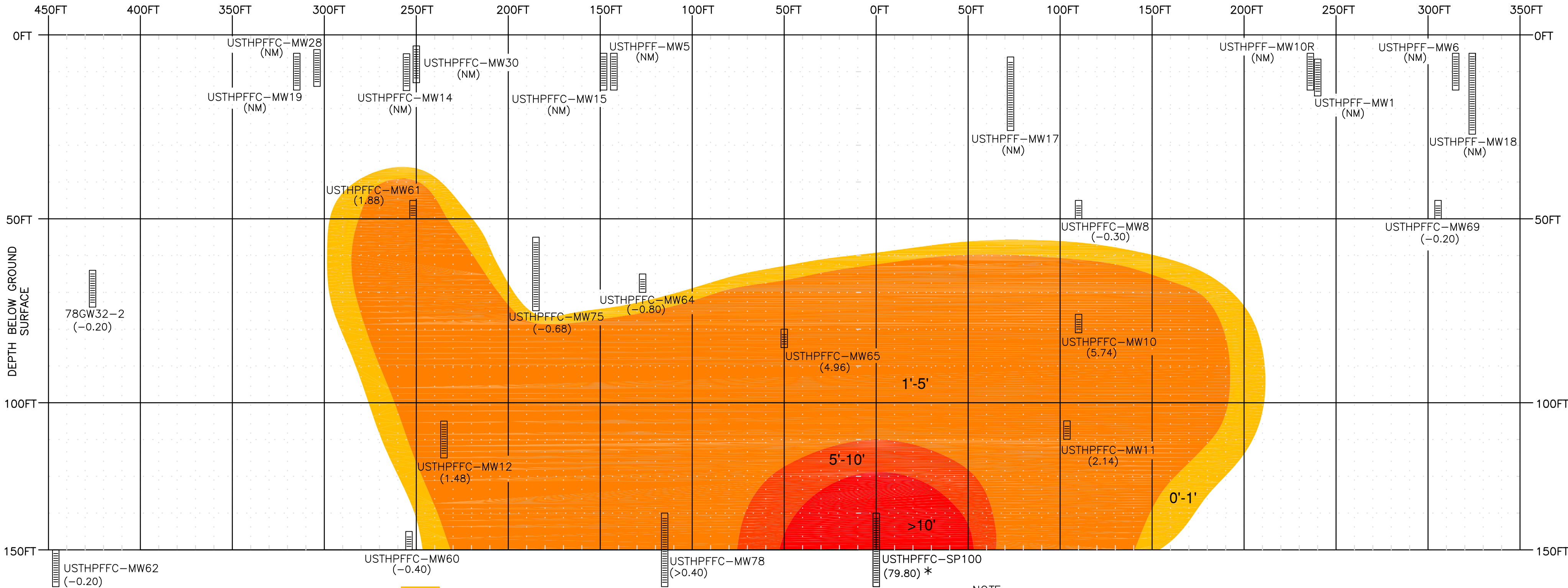
SCALE
VERTICAL 1"=20'
HORIZONTAL 1"=40'

NOTE:
1. PRE SPARGE DEPTH TO WATER MEASUREMENTS CONDUCTED ON JANUARY 16, 2004, WITH THE EXCEPTION OF USTHPFFC-MW78, WHICH WAS GAUGED ON NOVEMBER 24, 2003.

CAELIN ENGINEERS and SCIENTISTS WILMINGTON, NORTH CAROLINA	PROJECT BIO-PULSE SPARGE PILOT TEST HADNOT POINT FUEL FARM MARINE CORPS BASE CAMP LEJEUNE, N.C.	TITLE WATER TABLE INFLUENCE AT 30 MINUTES		FIGURE 5
	JOB NO. 203-082 DATE: MAR 2004	SCALE: AS SHOWN	DRAWN BY: HCS CHECKED BY: WJW	

60 MINUTES

DISTANCE FROM SPARGE WELL



LEGEND

- () CHANGE IN GROUNDWATER TABLE ELEVATION SINCE SPARGING BEGAN; POSITIVE NUMBER INDICATES GROUNDWATER RISE
- * INFLUENCE AT SPARGE WELL BASED ON MEASURED INJECTION PRESSURE

- 0'-1' OF CHANGE IN GROUNDWATER TABLE ELEVATION
- 1'-5' OF CHANGE IN GROUNDWATER TABLE ELEVATION
- 5'-10' OF CHANGE IN GROUNDWATER TABLE ELEVATION
- >10' OF CHANGE IN GROUNDWATER TABLE ELEVATION

SCALE

VERTICAL 1"=20'

HORIZONTAL 1"=40'

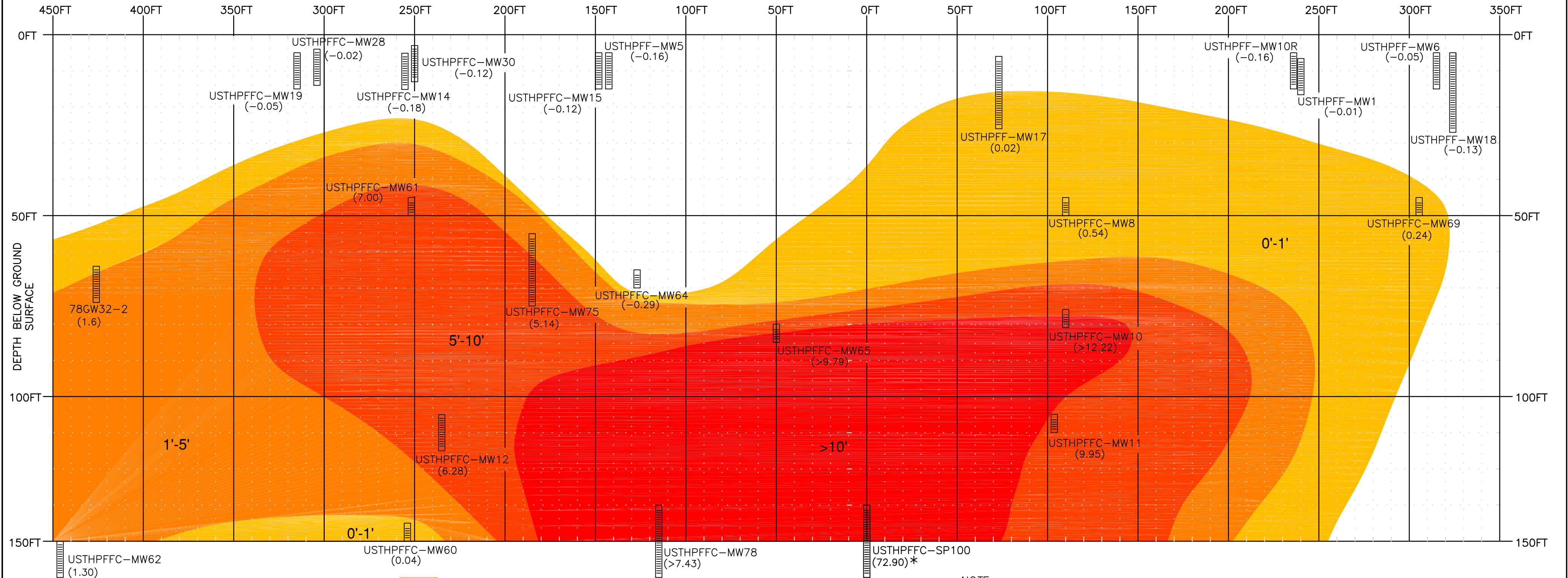
NOTE:

1. PRE SPARGE DEPTH TO WATER MEASUREMENTS CONDUCTED ON JANUARY 16, 2004, WITH THE EXCEPTION OF USTHPFFC-MW78, WHICH WAS GAUGED ON NOVEMBER 24, 2003.

CAELIN ENGINEERS and SCIENTISTS WILMINGTON, NORTH CAROLINA	PROJECT BIO-PULSE SPARGE PILOT TEST HADNOT POINT FUEL FARM MARINE CORPS BASE CAMP LEJEUNE, N.C.	TITLE WATER TABLE INFLUENCE AT 60 MINUTES		FIGURE 6
	JOB NO. 203-082 DATE: MAR 2004	SCALE: AS SHOWN	DRAWN BY: HCS CHECKED BY: WJW	

4 HOURS

DISTANCE FROM SPARGE WELL



LEGEND

- () CHANGE IN GROUNDWATER TABLE ELEVATION SINCE SPARGING BEGAN; POSITIVE NUMBER INDICATES GROUNDWATER RISE
- * INFLUENCE AT SPARGE WELL BASED ON MEASURED INJECTION PRESSURE

- 0'-1' OF CHANGE IN GROUNDWATER TABLE ELEVATION
- 1'-5' OF CHANGE IN GROUNDWATER TABLE ELEVATION
- 5'-10' OF CHANGE IN GROUNDWATER TABLE ELEVATION
- >10' OF CHANGE IN GROUNDWATER TABLE ELEVATION

SPARGE WELL

SCALE
VERTICAL 1"=20'
HORIZONTAL 1"=40'

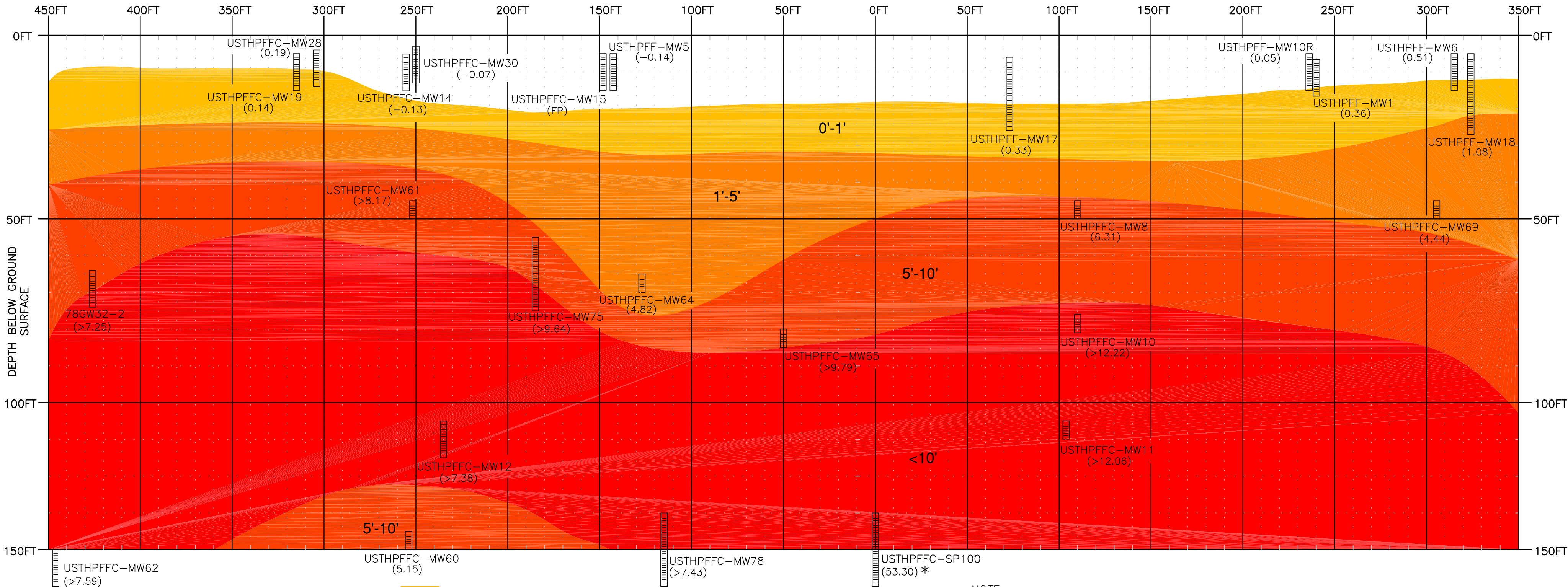
NOTE:

1. PRE SPARGE DEPTH TO WATER MEASUREMENTS CONDUCTED ON JANUARY 16, 2004, WITH THE EXCEPTION OF USTHPFFC-MW78, WHICH WAS GAUGED ON NOVEMBER 24, 2003.

CAELIN ENGINEERS and SCIENTISTS WILMINGTON, NORTH CAROLINA	PROJECT BIO-PULSE SPARGE PILOT TEST HADNOT POINT FUEL FARM MARINE CORPS BASE CAMP LEJEUNE, N.C. JOB NO. 203-082 DATE: MAR 2004	TITLE WATER TABLE INFLUENCE AT 4 HOURS SCALE: AS SHOWN DRAWN BY: HCS CHECKED BY: WJW	FIGURE
			7

28 HOURS

DISTANCE FROM SPARGE WELL



LEGEND

() CHANGE IN GROUNDWATER TABLE ELEVATION SINCE SPARGING BEGAN; POSITIVE NUMBER INDICATES GROUNDWATER RISE
* INFLUENCE AT SPARGE WELL BASED ON MEASURED INJECTION PRESSURE

- 0'-1' OF CHANGE IN GROUNDWATER TABLE ELEVATION
- 1'-5' OF CHANGE IN GROUNDWATER TABLE ELEVATION
- 5'-10' OF CHANGE IN GROUNDWATER TABLE ELEVATION
- >10' OF CHANGE IN GROUNDWATER TABLE ELEVATION

SPARGE WELL

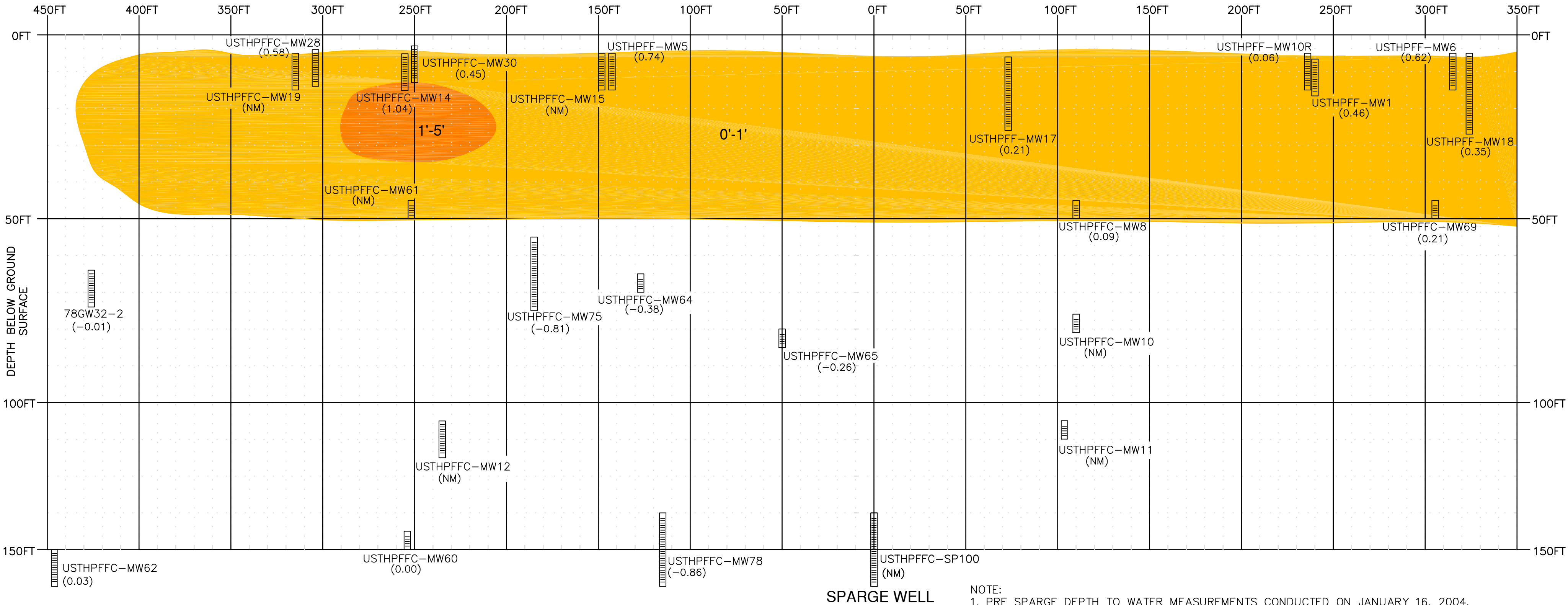
SCALE
VERTICAL 1"=20'
HORIZONTAL 1"=40'

NOTE:
1. PRE SPARGE DEPTH TO WATER MEASUREMENTS CONDUCTED ON JANUARY 16, 2004, WITH THE EXCEPTION OF USTHPFFC-MW78, WHICH WAS GAUGED ON NOVEMBER 24, 2003.

CAELIN ENGINEERS and SCIENTISTS WILMINGTON, NORTH CAROLINA	PROJECT BIO-PULSE SPARGE PILOT TEST HADNOT POINT FUEL FARM MARINE CORPS BASE CAMP LEJEUNE, N.C. JOB NO. 203-082 DATE: MAR 2004	TITLE WATER TABLE INFLUENCE AT 28 HOURS SCALE: AS SHOWN DRAWN BY: HCS CHECKED BY: WJW	FIGURE
			8

8 DAYS

DISTANCE FROM SPARGE WELL



SPARGE WELL

NOTE:
1. PRE SPARGE DEPTH TO WATER MEASUREMENTS CONDUCTED ON JANUARY 16, 2004,
WITH THE EXCEPTION OF USTHPFFC-MW78, WHICH WAS GAUGED ON NOVEMBER 24, 2003.

LEGEND

() CHANGE IN GROUNDWATER TABLE ELEVATION SINCE SPARGING BEGAN; POSITIVE NUMBER INDICATES GROUNDWATER RISE

0'-1' OF CHANGE IN GROUNDWATER TABLE ELEVATION
1'-5' OF CHANGE IN GROUNDWATER TABLE ELEVATION

SCALE
VERTICAL 1"=20'
HORIZONTAL 1"=40'

 ENGINEERS and SCIENTISTS WILMINGTON, NORTH CAROLINA	PROJECT BIO-PULSE SPARGE PILOT TEST HADNOT POINT FUEL FARM MARINE CORPS BASE CAMP LEJEUNE, N.C.	TITLE WATER TABLE INFLUENCE AT 8 DAYS		FIGURE 9
	JOB NO. 203-082 DATE: MAR 2004	SCALE: AS SHOWN	DRAWN BY: HCS	CHECKED BY: WJW

APPENDIX A
BORING LOGS

#2 Medium Sand

CATLIN BORING LOG 203-082 HPEF GPJ CATLIN GDT 3/15/04

#2 Medium Sand

CATLIN BORING LOG 203-082 HPEE GPJ CATLIN GDT 3/15/04

APPENDIX B

NORTH CAROLINA WELL CONSTRUCTION RECORDS

WELL CONSTRUCTION RECORD

North Carolina - Department of Environment and Natural Resources - Division of Water Quality - Groundwater Section

WELL CONTRACTOR (INDIVIDUAL) NAME (print) Bobbie Fowler CERTIFICATION # 2869
WELL CONTRACTOR COMPANY NAME CATLIN Engineers & Scientists PHONE # (910) 452-5861
STATE WELL CONSTRUCTION PERMIT # 2869 ASSOCIATED WO PERMIT # N/A
(if applicable) (if applicable)

USTHPFFC- MW78

1. WELL USE (Check Applicable Box): Residential ☐ Municipal/Public ☐ Industrial ☐ Agricultural ☐
Monitoring ☒ Recovery ☐ Heat Pump Water Injection ☐ Other ☐ If Other, List Use _____
2. WELL LOCATION: (Show sketch of the location below)
Nearest Marine Corps Base, Camp Lejeune County: Onslow
Holcolmb Blvd.
(Road Name and Numbers, Community, Subdivision, Lot No., Zip Code)
3. OWNER: LANTDIV NAVFACENGCOM Commanding General
Address: AC/S EMD/Marine Corps Base/PSC Box 20004
(Street or Route No.)
Camp Lejeune NC 28542-0004
City or Town State Zip Code
Area code - Phone number _____
4. DATE DRILLED: 11/5/2003
5. TOTAL DEPTH: 159
6. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒
7. STATIC WATER LEVEL Below Top of Casing 7.93 FT.
(Use "+" if Above Top of Casing)
8. TOP OF CASING IS 0 FT. Above Land Surface*
* Top of casing terminated at/or below land surface requires a variance in accordance with 15A NCAC 2C.0118
9. YIELD (gpm): N/A METHOD OF TEST N/A
10. WATER ZONES (depth): Surficial Aquifer
12. DISINFECTION: Type N/A Amount N/A
13. CASING:
- | Depth | Diameter | Wall Thickness or Weight/Ft. | Material |
|---------------------------------|--------------|------------------------------|------------|
| From <u>0</u> To <u>139</u> ft. | <u>2</u> in. | <u>Sch. 40</u> | <u>PVC</u> |
| From <u>0</u> To <u>131</u> ft. | <u>6</u> in. | <u>Sch. 40</u> | <u>PVC</u> |
| From _____ To _____ ft. | _____ in. | _____ | _____ |
14. GROUT:
- | Depth | Material | Method |
|-----------------------------------|------------------------|---------------------|
| From <u>0</u> To <u>129</u> ft. | <u>Portland Cement</u> | <u>Tremie</u> |
| From <u>129</u> To <u>136</u> ft. | <u>Bent. Pellets</u> | <u>Surface Pour</u> |
15. SCREEN:
- | Depth | Diameter | Slot Size | Material |
|-----------------------------------|--------------|----------------------|------------|
| From <u>139</u> To <u>159</u> ft. | <u>2</u> in. | <u>Slot .010 in.</u> | <u>PVC</u> |
| From _____ To _____ ft. | _____ in. | _____ in. | _____ |
16. SAND/GRAVEL PACK:
- | Depth | Size | Material |
|-----------------------------------|------------------|---------------------|
| From <u>136</u> To <u>159</u> ft. | <u>#2 Medium</u> | <u>Torpedo Sand</u> |
| From _____ To _____ ft. | _____ | _____ |
17. REMARKS: _____
- Topographic/Land Setting
☐ Ridge ☐ Slope ☐ Valley ☒ Flat
(check appropriate box)
Northing/Easting of well location
339683.9/2501540.712
NCSP NAD 83 (ft)
Latitude/longitude source: ☒ GPS ☐ Topo. map
(check box)
DEPTH DRILLING LOG
From To Formation Description
- SEE
ATTACHED
- LOCATION SKETCH
Show direction and distance in miles from at least two State Roads or County Roads. Include road numbers and common road names.
- SEE
ATTACHED

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

SIGNATURE OF PERSON CONSTRUCTING THE WELL

DATE

Submit original to Division of Water Quality, Groundwater Section, 1636 Mail Service Center - Raleigh, NC 27699-1636 Phone No. (919) 733-3221, within 30 days.

Modified from:
GW-1 REV.07/2001

WELL CONSTRUCTION RECORD

North Carolina - Department of Environment and Natural Resources - Division of Water Quality - Groundwater Section

WELL CONTRACTOR (INDIVIDUAL) NAME (print) Bobbie Fowler CERTIFICATION # 2869
WELL CONTRACTOR COMPANY NAME CATLIN Engineers & Scientists PHONE # (910) 452-5861
STATE WELL CONSTRUCTION PERMIT # 2869 (if applicable) ASSOCIATED WQ PERMIT # N/A (if applicable)

USTHPFFC -SP100

1. WELL USE (Check Applicable Box): Residential ☐ Municipal/Public ☐ Industrial ☐ Agricultural ☐
Monitoring ☐ Recovery ☐ Heat Pump Water Injection ☐ Other ☒ If Other, List Use Sparge
2. WELL LOCATION: (Show sketch of the location below)
Nearest Marine Corps Base, Camp Lejeune County: Onslow
Holcolmb Blvd.
(Road Name and Numbers, Community, Subdivision, Lot No., Zip Code)
3. OWNER: LANTDIV NAVFACENGCOM Commanding General
Address: AC/S EMD/Marine Corps Base/PSC Box 20004
(Street or Route No.)
Camp Lejeune NC 28542-0004
City or Town State Zip Code
Area code - Phone number
4. DATE DRILLED: 11/25/2003
5. TOTAL DEPTH: 160
6. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒
7. STATIC WATER LEVEL Below Top of Casing 12.59 FT.
(Use "+" if Above Top of Casing)
8. TOP OF CASING IS 0 FT. Above Land Surface*
* Top of casing terminated at/or below land surface requires a variance in accordance with 15A NCAC 2C.0118
9. YIELD (gpm): N/A METHOD OF TEST N/A
10. WATER ZONES (depth): Surficial Aquifer
12. DISINFECTION: Type N/A Amount N/A
13. CASING:
- | Depth | Diameter | Wall Thickness or Weight/Ft. | Material |
|---------------------------------|--------------|------------------------------|------------|
| From <u>0</u> To <u>140</u> ft. | <u>2</u> in. | <u>Slot .010</u> | <u>SS</u> |
| From <u>0</u> To <u>130</u> ft. | <u>6</u> in. | <u>Sch. 40</u> | <u>PVC</u> |
| From _____ To _____ ft. | _____ in. | _____ | _____ |
14. GROUT:
- | Depth | Material | Method |
|-----------------------------------|------------------------|---------------------|
| From <u>0</u> To <u>128</u> ft. | <u>Portland Cement</u> | <u>Tremie</u> |
| From <u>128</u> To <u>138</u> ft. | <u>Bent. Pellets</u> | <u>Surface Pour</u> |
15. SCREEN:
- | Depth | Diameter | Slot Size | Material |
|-----------------------------------|--------------|----------------------|-----------|
| From <u>140</u> To <u>160</u> ft. | <u>2</u> in. | <u>Slot .010</u> in. | <u>SS</u> |
| From _____ To _____ ft. | _____ in. | _____ in. | _____ |
16. SAND/GRAVEL PACK:
- | Depth | Size | Material |
|-----------------------------------|------------------|---------------------|
| From <u>138</u> To <u>160</u> ft. | <u>#2 Medium</u> | <u>Torpedo Sand</u> |
| From _____ To _____ ft. | _____ | _____ |
17. REMARKS: _____
- SEE ATTACHED
- SEE ATTACHED

LOCATION SKETCH

Show direction and distance in miles from at least two State Roads or County Roads. Include road numbers and common road names.

SEE ATTACHED

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

SIGNATURE OF PERSON CONSTRUCTING THE WELL

DATE

Submit original to Division of Water Quality, Groundwater Section, 1636 Mail Service Center - Raleigh, NC 27699-1636 Phone No. (919) 733-3221, within 30 days.

Modified from: GW-1 REV.07/2001

APPENDIX C

LABORATORY ANALYTICAL REPORTS

FILE COPY

PARADIGM ANALYTICAL LABORATORIES, INC.

5500 Business Drive
Wilmington, North Carolina 28405
(910) 350-1903
Fax (910) 350-1557

Mr. Mike E. Mason
Richard Catlin & Associates
P.O. Box 10279
Wilmington, NC 28404-0279

November 12, 2003

Report Number: G128-1217

Client Project ID: HPFF

Dear Mr. Mason,

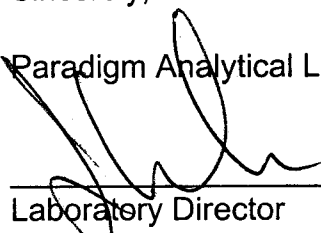
Enclosed are the results of the analytical services performed under the referenced project. Copies of this report and supporting data will be retained in our files for a period of five years in the event they are required for future reference. Any samples submitted to our laboratory will be retained for a maximum of thirty (30) days from the date of this report unless other arrangements are requested.

If there are any questions about the report or the services performed during this project, please call for assistance. We will be happy to answer any questions or concerns which you may have.

Thank you for using Paradigm Analytical Labs for your analytical services. We look forward to working with you again on any additional analytical needs which you may have.

Sincerely,

Paradigm Analytical Laboratories, Inc.



Laboratory Director
J. Patrick Weaver

PARADIGM ANALYTICAL LABORATORIES, INC.

Results for Total Petroleum
Hydrocarbons
by GC 8015B

Client Sample ID: SP-100 (7-9)
Client Project ID: HPFF
Lab Sample ID: 83097
Lab Project ID: G128-1217
Matrix: Soil

Date Collected: 10/28/03
Date Received: 11/6/03
Analyzed By: BMS
%Solids: 88.7

Compound	Result (MG/KG)	Quantitation Limit	Method	Dilution Factor	Date Analyzed
Gasoline Range Organics	17	6.8	5030/8015B	1.0	11/6/03
Diesel Range Organics	86	7.0	3550/8015B	1.0	11/10/03

Comments:

Quantitation Limits are fully calculated using dilution factors and % solids.
BQL = Undetected or below quantitation limit.

PARADIGM ANALYTICAL LABORATORIES, INC.

Results for Total Petroleum
Hydrocarbons
by GC 8015B

Client Sample ID:	USTHPFF-78 (2-4)	Date Collected:	10/28/03
Client Project ID:	HPFF	Date Received:	11/6/03
Lab Sample ID:	83098	Analyzed By:	BMS
Lab Project ID:	G128-1217	%Solids:	88.0
Matrix:	Soil		

Compound	Result (MG/KG)	Quantitation Limit	Method	Dilution Factor	Date Analyzed
Gasoline Range Organics	BQL	6.8	5030/8015B	1.0	11/6/03
Diesel Range Organics	13	7.1	3550/8015B	1.0	11/10/03

Comments:

Quantitation Limits are fully calculated using dilution factors and % solids.
BQL = Undetected or below quantitation limit.

hone: (910)-350-1903 FAX: (910)-350-1557

Chain-of Custody Record & Analytical Request

COC# 34661

Page 7 of _____

Client: Catlin Eng. & Sci. Project ID: HPEF

Project ID: **HDPF**

address: 220 Old Dairy Rd.
Contact: Mike C.

Contact: Mike C.

address: Wilmington NC 28405 Phone: 452-5861

Phone: 452-58

note #: _____
Fax: _____

Fax: _____

Date: 10-28-03

Turnaround: 544

Job Number: 203-082

P.O. Number:

Report To: Mick C.

Invoice To: Keith

Sample ID	Date	Time	Matrix	Preservatives			Analyses					Comments: Please specify any special reporting requirements	
P-100(7-9)	10/28/03		S										Summary EDD format
STAFF-78(24)	10/28/03		S										G128-1217
Relinquished By	Date	Time	Received By			Date	Time	Temperature	State Certification Requested				
Chell L. T.	11/6/03	800	Dina A. ST			06 Nov 03	0800		NC SC Other				
Dina A. ST	11/6/03	0900	J. L. J. J.			11/6/03	0900	on ice	SEE REVERSE FOR TERMS AND CONDITIONS				

263-087
FILE COPY

PARADIGM ANALYTICAL LABORATORIES, INC.

5500 Business Drive
Wilmington, North Carolina 28405
(910) 350-1903
Fax (910) 350-1557

Mr. Mike E. Mason
Richard Catlin & Associates
P.O. Box 10279
Wilmington, NC 28404-0279

December 10, 2003

Report Number: G128-1227

Client Project ID: Hadnot Point Biosparge pilot test (HPFF)

Dear Mr. Mason,

Enclosed are the results of the analytical services performed under the referenced project. Copies of this report and supporting data will be retained in our files for a period of five years in the event they are required for future reference. Any samples submitted to our laboratory will be retained for a maximum of thirty (30) days from the date of this report unless other arrangements are requested.

If there are any questions about the report or the services performed during this project, please call for assistance. We will be happy to answer any questions or concerns which you may have.

Thank you for using Paradigm Analytical Labs for your analytical services. We look forward to working with you again on any additional analytical needs which you may have.

Sincerely,

Paradigm Analytical Laboratories, Inc.



Laboratory Director
J. Patrick Weaver

PARADIGM ANALYTICAL LABORATORIES, INC.

Results for Volatiles

by GC 601

Client Sample ID: SP-100

Analyzed By: DCS

Client Project ID: Hadnot Point Biosparge pilot test (HPFF) Date Collected: 11/26/03

Lab Sample ID: 84360

Date Received: 11/26/03

Lab Project ID: G128-1227

Matrix: Water

Analyte	Result ug/L	RL ug/L	Dilution Factor	Date Analyzed
Bromodichloromethane	BQL	1.0	1	12/4/03
Bromoform	BQL	2.0	1	12/4/03
Bromomethane	BQL	1.0	1	12/4/03
Carbon tetrachloride	BQL	1.0	1	12/4/03
Chlorobenzene	BQL	1.0	1	12/4/03
Chloroethane	BQL	1.0	1	12/4/03
Chloroform	2.4	1.0	1	12/4/03
Chloromethane	BQL	1.0	1	12/4/03
Dibromochloromethane	BQL	1.0	1	12/4/03
1,2-Dibromoethane (EDB)	BQL	1.0	1	12/4/03
1,2-Dichlorobenzene	BQL	1.0	1	12/4/03
1,3-Dichlorobenzene	BQL	1.0	1	12/4/03
1,4-Dichlorobenzene	BQL	1.0	1	12/4/03
1,1-Dichloroethane	BQL	1.0	1	12/4/03
1,2-Dichloroethane	BQL	1.0	1	12/4/03
1,1-Dichloroethene	BQL	1.0	1	12/4/03
cis-1,2-Dichloroethene	BQL	1.0	1	12/4/03
trans-1,2-Dichloroethene	BQL	1.0	1	12/4/03
1,2-Dichloropropane	BQL	1.0	1	12/4/03
cis-1,3-Dichloropropene	BQL	1.0	1	12/4/03
trans-1,3-Dichloropropene	BQL	1.0	1	12/4/03
Methylene Chloride	BQL	5.0	1	12/4/03
1,1,2,2-Tetrachloroethane	BQL	1.0	1	12/4/03
Tetrachloroethene	BQL	1.0	1	12/4/03
1,1,1-Trichloroethane	BQL	1.0	1	12/4/03
1,1,2-Trichloroethane	BQL	1.0	1	12/4/03
Trichloroethene	BQL	1.0	1	12/4/03
Trichlorofluoromethane	BQL	1.0	1	12/4/03
Vinyl Chloride	BQL	1.0	1	12/4/03

Surrogate Spike Recoveries

	Spike Added	Spike Result	Percent Recovery
1,4-Dichlorobutane	40	40.6	101

Comments:

All values corrected for dilution.

BQL = Below quantitation limit.

PARADIGM ANALYTICAL LABORATORIES, INC.

Results for Volatiles

by GC 601

Client Sample ID: USTHPFFMW-78

Analyzed By: DCS

Client Project ID: Hadnot Point Biosparge pilot test (HPFF) Date Collected: 11/26/03

Lab Sample ID: 84361

Date Received: 11/26/03

Lab Project ID: G128-1227

Matrix: Water

Analyte	Result ug/L	RL ug/L	Dilution Factor	Date Analyzed
Bromodichloromethane	BQL	1.0	1	12/4/03
Bromoform	BQL	2.0	1	12/4/03
Bromomethane	BQL	1.0	1	12/4/03
Carbon tetrachloride	BQL	1.0	1	12/4/03
Chlorobenzene	BQL	1.0	1	12/4/03
Chloroethane	BQL	1.0	1	12/4/03
Chloroform	BQL	1.0	1	12/4/03
Chloromethane	BQL	1.0	1	12/4/03
Dibromochloromethane	BQL	1.0	1	12/4/03
1,2-Dibromoethane (EDB)	BQL	1.0	1	12/4/03
1,2-Dichlorobenzene	BQL	1.0	1	12/4/03
1,3-Dichlorobenzene	BQL	1.0	1	12/4/03
1,4-Dichlorobenzene	BQL	1.0	1	12/4/03
1,1-Dichloroethane	BQL	1.0	1	12/4/03
1,2-Dichloroethane	BQL	1.0	1	12/4/03
1,1-Dichloroethene	BQL	1.0	1	12/4/03
cis-1,2-Dichloroethene	BQL	1.0	1	12/4/03
trans-1,2-Dichloroethene	BQL	1.0	1	12/4/03
1,2-Dichloropropane	BQL	1.0	1	12/4/03
cis-1,3-Dichloropropene	BQL	1.0	1	12/4/03
trans-1,3-Dichloropropene	BQL	1.0	1	12/4/03
Methylene Chloride	BQL	5.0	1	12/4/03
1,1,2,2-Tetrachloroethane	BQL	1.0	1	12/4/03
Tetrachloroethene	BQL	1.0	1	12/4/03
1,1,1-Trichloroethane	BQL	1.0	1	12/4/03
1,1,2-Trichloroethane	BQL	1.0	1	12/4/03
Trichloroethene	BQL	1.0	1	12/4/03
Trichlorofluoromethane	BQL	1.0	1	12/4/03
Vinyl Chloride	BQL	1.0	1	12/4/03

Surrogate Spike Recoveries

	Spike Added	Spike Result	Percent Recovery
1,4-Dichlorobutane	40	40.0	100

Comments:

All values corrected for dilution.

BQL = Below quantitation limit.

PARADIGM ANALYTICAL LABORATORIES, INC.

Results for Volatiles

by GC 602

Client Sample ID: SP-100

Analyzed By: DCS

Client Project ID: Hadnot Point Biosparge pilot test (HPFF) Date Collected: 11/26/03

Lab Sample ID: 84360

Date Received: 11/26/03

Lab Project ID: G128-1227

Matrix: Water

Analyte	Result ug/L	RL ug/L	Dilution Factor	Date Analyzed
Benzene	BQL	1.0	1	12/4/03
Diisopropyl ether (DIPE)	BQL	1.0	1	12/4/03
Ethylbenzene	BQL	1.0	1	12/4/03
Methyl-tert butyl ether (MTBE)	BQL	2.0	1	12/4/03
Toluene	BQL	1.0	1	12/4/03
m/p-Xylene	BQL	2.0	1	12/4/03
o-Xylene	BQL	2.0	1	12/4/03

Surrogate Spike Recoveries

	Spike Added	Spike Result	Percent Recovery
Trifluorotoluene	40	38.5	96.3

Comments:

All values corrected for dilution.

BQL = Below quantitation limit.

PARADIGM ANALYTICAL LABORATORIES, INC.

Results for Volatiles

by GC 602

Client Sample ID: USTHPFFMW-78

Analyzed By: DCS

Client Project ID: Hadnot Point Biosparge pilot test (HPFF)

Date Collected: 11/26/03

Lab Sample ID: 84361

Date Received: 11/26/03

Lab Project ID: G128-1227

Matrix: Water

Analyte	Result ug/L	RL ug/L	Dilution Factor	Date Analyzed
Benzene	10	4.0	4	12/3/03
Diisopropyl ether (DIPE)	BQL	4.0	4	12/3/03
Ethylbenzene	16	4.0	4	12/3/03
Methyl-tert butyl ether (MTBE)	BQL	8.0	4	12/3/03
Toluene	71	4.0	4	12/3/03
m/p-Xylene	56	8.0	4	12/3/03
o-Xylene	24	8.0	4	12/3/03

Surrogate Spike Recoveries

	Spike Added	Spike Result	Percent Recovery
Trifluorotoluene	40	38.5	96.1

Comments:

All values corrected for dilution.

BQL = Below quantitation limit.

PARADIGM ANALYTICAL LABORATORIES, INC.

Results for Polynuclear Aromatic Hydrocarbons

EPA 610 by GCMS 625

Client Sample ID: SP-100

Client Project ID: Hadnot Point Biosparge pilot test (HPFF)

Lab Sample ID: 84360

Lab Project ID: G128-1227

Matrix: Water

Date Collected: 11/26/03

Date Received: 11/26/03

Date Analyzed: 12/5/03

Analyzed By: MRC

Dilution: 1

Compound	Quantitation Limit (ug/L)	Result (ug/L)
Acenaphthene	10	BQL
Acenaphthylene	10	BQL
Anthracene	10	BQL
Benzo[a]anthracene	10	BQL
Benzo[a]pyrene	10	BQL
Benzo[b]fluoranthene	10	BQL
Benzo[g,h,i]perylene	10	BQL
Benzo[k]fluoranthene	10	BQL
Chrysene	10	BQL
Dibenzo[a,h]anthracene	10	BQL
Fluoranthene	10	BQL
Fluorene	10	BQL
Indeno(1,2,3-c,d)pyrene	10	BQL
1-Methylnaphthalene	10	BQL
2-Methylnaphthalene	10	BQL
Naphthalene	10	BQL
Phenanthrene	10	BQL
Pyrene	10	BQL

Surrogate Spike Recoveries	Spike Added	Spike Result	Percent Recovered
2-Fluorobiphenyl	10	9.2	92
Nitrobenzene-d5	10	9.1	91
4-Terphenyl-d14	10	11.6	116

Comments:

Results are corrected for %solids and dilution where applicable.

Flags:

BQL = Below Quantitation Limit.

Reviewed By: mc

PARADIGM ANALYTICAL LABORATORIES, INC.

Results for Polynuclear Aromatic Hydrocarbons

EPA 610 by GCMS 625

Client Sample ID: USTHPFFMW-78

Client Project ID: Hadnot Point Biosparge pilot test (HPFF)

Lab Sample ID: 84361

Lab Project ID: G128-1227

Matrix: Water

Date Collected: 11/26/03

Date Received: 11/26/03

Date Analyzed: 12/5/03

Analyzed By: MRC

Dilution: 1

Compound	Quantitation Limit (ug/L)	Result (ug/L)
Acenaphthene	10	BQL
Acenaphthylene	10	BQL
Anthracene	10	BQL
Benzo[a]anthracene	10	BQL
Benzo[a]pyrene	10	BQL
Benzo[b]fluoranthene	10	BQL
Benzo[g,h,i]perylene	10	BQL
Benzo[k]fluoranthene	10	BQL
Chrysene	10	BQL
Dibenzo[a,h]anthracene	10	BQL
Fluoranthene	10	BQL
Fluorene	10	BQL
Indeno(1,2,3-c,d)pyrene	10	BQL
1-Methylnaphthalene	10	BQL
2-Methylnaphthalene	10	BQL
Naphthalene	10	BQL
Phenanthrene	10	BQL
Pyrene	10	BQL

Surrogate Spike Recoveries	Spike Added	Spike Result	Percent Recovered
2-Fluorobiphenyl	10	8.7	87
Nitrobenzene-d5	10	8.8	88
4-Terphenyl-d14	10	9.6	96

Comments:

Results are corrected for %solids and dilution where applicable.

Flags:

BQL = Below Quantitation Limit.

Reviewed By: mw

PARADIGM ANALYTICAL LABORATORIES, INC.

Results for TCLP Volatiles

by GCMS 8260B

Client Sample ID: Waste Soil

Client Project ID: Hadnot Point Biosparge pilot test (HPFF)

Lab Sample ID: 84363

Lab Project ID: G128-1227

Matrix: Leachate

Date Analyzed: 12/4/03

Analyzed By: JTF

Date Collected: 11/26/03

Date Received: 11/26/03

Dilution: 10

Compound	Quantitation Limit (mg/L)	Result (mg/L)
Benzene	0.01	BQL
2-Butanone (MEK)	0.25	BQL
Carbon tetrachloride	0.01	BQL
Chlorobenzene	0.01	BQL
Chloroform	0.01	BQL
1,4-Dichlorobenzene	0.01	BQL
1,1-Dichloroethene	0.01	BQL
1,2-Dichloroethane	0.01	BQL
Tetrachloroethene	0.01	BQL
Trichloroethene	0.01	BQL
Vinyl chloride	0.01	BQL

Surrogate Spike Recoveries

Compound	Spike Added (mg/L)	Surrogate Result (mg/L)	%Rec
Bromofluorobenzene	0.100	0.105	105
1,2-Dichloroethane-d4	0.100	0.100	100
Toluene-d8	0.100	0.104	104

Comments:

All results are corrected for dilution.

Reviewed by: 

Flags: BQL = Below Quantitation Limit

N.C. Certification #481 S.C. Certification #99029

Page 1 of 1

Results for TCLP Semivolatiles
by GCMS 8270

Client Sample ID: Waste Soil

Client Project ID: Hadnot Point Biosparge pilot test (HPFF)

Lab Sample ID: 84364

Lab Project ID: G128-1227

Matrix: Leachate

Date Collected: 11/26/03

Date Received: 11/26/03

Date Analyzed: 12/4/03

Analyzed By: MRC

Dilution: 1

Compound	Quantitation Limit (mg/L)	Result (mg/L)
1,4-Dichlorobenzene	0.75	BQL
2,4-Dinitrotoluene	0.013	BQL
Hexachlorobenzene	0.013	BQL
Hexachlorobutadiene	0.05	BQL
Hexachloroethane	0.3	BQL
2-Methylphenol	20	BQL
3- & 4-Methylphenol	20	BQL
Nitrobenzene	0.2	BQL
Pentachlorophenol	10	BQL
Pyridine	0.5	BQL
2,4,5-Trichlorophenol	40	BQL
2,4,6-Trichlorophenol	0.2	BQL

Surrogate Spike Recoveries	Spike Added	Spike Result	Percent Recovered
2-Fluorobiphenyl	10	9.2	92
2-Fluorophenol	10	8.9	89
Nitrobenzene-d5	10	9.0	90
Phenol-d6	10	9.0	90
2,4,6-Tribromophenol	10	9.8	98
4-Terphenyl-d14	10	9.7	97

Comments:

Results are corrected for %solids and dilution where applicable.

Flags:

BQL = Below Quantitation Limit.

Reviewed By: me

PARADIGM ANALYTICAL LABORATORIES, INC.

Results for Metals

Client Sample ID: Waste Soil

Analyzed By: RML

Client Project ID: Hadnot Point Biosparge pilot test (HPFF)

Date Collected: 11/26/03

Lab Sample ID: 84364

Date Received: 11/26/03

Lab Project ID: G128-1227

Matrix: Leachate

Batch ID: 3051 3050

Metals TCLP	Result	RL	DF	Units	Method	Date Analyzed
Arsenic	BQL	0.200	1	MG/L	6010B	12/8/03
Barium	BQL	5.00	1	MG/L	6010B	12/5/03
Cadmium	BQL	0.100	1	MG/L	6010B	12/8/03
Chromium	BQL	0.100	1	MG/L	6010B	12/8/03
Lead	BQL	0.100	1	MG/L	6010B	12/8/03
Mercury	BQL	0.000500	1	MG/L	7470	12/5/03
Selenium	BQL	0.200	1	MG/L	6010B	12/5/03
Silver	BQL	0.100	1	MG/L	6010B	12/5/03

Comments

BQL = Below Quantitation Limits

DF = Dilution Factor

J = Between MDL and RL

PARADIGM ANALYTICAL LABORATORIES, INC.

5500 Business Drive, Wilmington, NC 28405

Phone: (910)-350-1903 FAX: (910)-350-1557

Chain-of Custody Record & Analytical Request

COC# 0100118

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Client: Catlin Project ID: Hednet Point Biosurge Date: 11-26-03 Report To: Mike E. Mason
 Address: 220 Old Dairy Rd. Contact: Mike E. Mason Turnaround: Standard
 Address: Wilmington NC 28405 Phone: 910-452-5861 Job Number: 203-082
 Quote #: DOD 101 Fax: 910-452-7563 P.O. Number: 230909-5 Invoice To: Shelika @ Catlin

Sample ID	Date	Time	Matrix	Preservatives		Analyses				Comments: Please specify any special reporting requirements
				16	12H	CO2 + xylene + 1PE + MTBE	610	TCLP (organic solvents only)	610	
SP-100	11-26	11:30	GW	✓	✓	✓	✓			please submit in: Summary EDD format
JUST HPPF MW-78	11-26	12:30	GW	✓	✓	✓	✓			Leleune EDD format
waste Soil	11-26	11:40	soil	✓				✓		
										G128-1227
										TUT-8240, 8270,
										MTAS is per
										MIKE R. MASON on 12/2/03
										228

Relinquished By	Date	Time	Received By	Date	Time	Temperature	State Certification Requested
Tam Bat	11-26	2:35	Shelika @ Catlin	11/26/03	2:35	none	NC ☒ SC ☐ Other ☐
						11-20 low	
						comparing	

SEE REVERSE FOR TERMS AND CONDITIONS

Client:	Catlin	Project ID:	Hadnot Point Biospgrge	Date:	11-26-03	Report To:	Mike E. Mason @
Address:	220 Old Dairy Rd	Contact:	Mike E. Mason	Turnaround:	Standard		Catlin
Address:	Wilmington NC 28405	Phone:	910-452-5861	Job Number:	203-082		
Quote #:	DOD 101	Fax:	910-452-7563	P.O. Number:	230709-5	Invoice To:	Sheila @ Catlin

Sample ID	Date	Time	Matrix	Preservatives			Analyses						Comments: Please specify any special reporting requirements	
				1c	HCl		601	602 + 44 hrs + 19F + MTBE	610	TCLP (organics + metals only)				
SP-100	11-26	11:30	GW	✓	✓		✓	✓	✓					please submit in Summary EDD format
USTHFFEMW-78	11-26	12:30	GW	✓	✓		✓	✓	✓					Leleune EDD format
waste Soil	11-26	11:40	soil	✓					✓					