

**CORRECTIVE ACTION PLAN
SUPPLEMENT

FOR

BUILDING 645
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA**

**RISK CLASSIFICATION: HIGH
NCDENR INCIDENT NO.: 87556
LONGITUDE 34° 43'04"
LATITUDE 77° 20'40"**

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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)
2007 Guidelines	UST Section Guidelines for the Investigation and Remediation of Contamination from Non-UST Petroleum Releases (Effective July 1, 2007)
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

HDPE	High Density Polyethylene
I/C	Industrial/Commercial
ID	Identification
I&E	Installations and Environment Department
IGWQS	Interim Groundwater Quality Standards
IPE	Isopropyl Ether
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 Liter
MRO	Mooreville 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 Liter
NA	Not Analyzed
N/A	Not Applicable
NAVFAC Atlantic	Naval Facilities Atlantic Division
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

CORRECTIVE ACTION PLAN SUPPLEMENT

FOR

BUILDING 645

MARINE CORPS BASE CAMP LEJEUNE, NORTH CAROLINA

SEPTEMBER 8, 2008

EXECUTIVE SUMMARY

This Corrective Action Plan (CAP) Supplement report was prepared for the Building 645 project site, which is aboard Marine Corps Base (MCB) Camp Lejeune, North Carolina. The subject site is located on Brewster Boulevard near its intersection with Holcomb Boulevard and consists of the area surrounding former Building 645. Building 645 previously housed water supply well HP645 and the associated wellhead and piping. The area is bordered to the north, east, west, and directly south (across Brewster Boulevard) by woods and lightly vegetated land. Russell Marine and Family Services Center is located across Brewster Boulevard approximately 300 feet southwest of the source area.

Water supply well HP645 was reportedly 245 feet deep and screened from 90 to 100, 138 to 148, and 230 to 240 feet (ft.) below land surface (BLS). The well produced approximately 192 gallons per minute (gpm) (Geophex, 1991). The water supply well has been inactive since 1985, when water samples revealed the well to be impacted by petroleum constituents. A 110-gallon, steel above ground storage tank (AST) that supplied gasoline to a generator which powered the pump was located adjacent to the structure on a concrete pad. The AST is the assumed source of the petroleum contamination. Well HP645 was permanently abandoned in 1995 and the well house was demolished and removed.

Numerous previous assessments have confirmed the impact of petroleum constituents to the groundwater. Due to the vertical aspect of contaminant migration identified during the previous investigations, the subsurface was divided into three "zones" being the Shallow Zone (less than 40 ft. deep), Intermediate Zone (greater than or equal to 40 ft and less than 60 ft.), and Deep Zone (greater than or equal to 60 ft. and less than 90 ft.). A remediation system was installed on the subject site in 1998 by J. A. Jones Environmental Services (J.A. Jones). The system consists of 14 vertical air sparge wells, four horizontal vapor extraction wells, and 21 soil vapor collection vent borings. Six of the 14 vertical sparge wells were installed in the Deep Zone to a depth of 80 ft. BLS, and the remaining eight in the Intermediate Zone, to 50 ft. BLS. The remediation system was installed to target the confirmed impact to the groundwater in the Shallow, Intermediate, and Deep Zones at the project site. The soil and groundwater treatment system has been operational since installed by J.A. Jones in 1998 except for short

periods to accommodate groundwater gauging and sampling events and monitoring well installation. Review of groundwater monitoring data reveals that the remedial efforts have been successful in reducing the petroleum constituents in the target zones within the area of influence of the treatment system as designed. Free phase product has not been observed in any of the groundwater monitoring wells.

An Additional Site Assessment (ASA) was completed to provide data necessary to delineate and refine the boundaries of dissolved petroleum contamination identified at the subject site. Based on data presented by Sovereign Consulting Inc. (Sovereign) in a Soil and Groundwater Investigation Summary Report dated October 18, 2007, the dissolved contaminant plume in the Deep Zone had migrated beyond the monitoring well network to the northeast and southeast.

Two additional 80 ft. deep Type III and one additional 100 ft. deep Type III groundwater monitoring wells were installed during the ASA investigation. Groundwater samples were collected from the three newly installed monitoring wells and analyzed per EPA Methods 601 and 602. A groundwater gauging event and survey encompassing all Intermediate and Deep Zone monitoring wells was completed by CATLIN Engineers and Scientists (CATLIN) and incorporated with data generated by Sovereign during quarterly groundwater sampling and gauging activities.

Groundwater sampling results were incorporated with data from the October 2007 and April 2008 groundwater sampling events conducted by Sovereign. This data was used in conjunction with previous recent groundwater sampling events to estimate the approximate horizontal and vertical extent of dissolved petroleum contamination. Review of this data indicates that the contaminant plume within the Deep Zone has essentially been delineated horizontally and vertically at the subject site. There are minor data gaps in the plume definition; however, the low levels of contaminants identified in these areas indicate that the plume has not migrated substantially beyond the limits of investigation.

Based on the information presented within this CAP Supplement, CATLIN recommends a remedial method consisting of modification of the existing Air Sparge/Soil Vapor Extraction (AS/SVE) system to include the addition of five (5) deep biosparge wells in conjunction with a monthly monitoring program. The monitoring program includes weekly system checks/adjustments for the first month and then monthly to ensure proper system operation. Groundwater sampling will be performed on an annual basis unless site conditions dictate more frequent sampling intervals. Sampling data will be included in the Annual Monitoring Report for this site. In addition to the monthly system checks, a vapor monitoring program will be conducted to ensure sparge vapors do not impact nearby Russell Marine and Family Services Center. Groundwater sampling events will continue until all contaminant compounds are detected below North Carolina Administrative Code (NCAC) T15A:02L Groundwater Quality Standards (2L GWQS) for at least four (4) consecutive sampling events.

CORRECTIVE ACTION PLAN SUPPLEMENT
FOR
BUILDING 645
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA
SEPTEMBER 8, 2008

1.0 INTRODUCTION

1.1 AUTHORIZATION

CATLIN was authorized to prepare this CAP Supplement by the Naval Facilities Engineering Command Mid-Atlantic (NAVFAC Mid-Atlantic) in accordance with Order for Supplies and Services Contract No. N62470-05-D-6200, Delivery Order Number 0016.

1.2 PURPOSE OF CORRECTIVE ACTION PLAN

The purpose of this CAP Supplement is to provide a means to evaluate various remedial approaches to address the presence of dissolved phase petroleum contamination within the Deep Zone (60'-90') BLS at the former Building 645 project site aboard the MCB Camp Lejeune, North Carolina. This CAP Supplement provides conceptual plans for corrective actions in general accordance with the North Carolina Department of Environment and Natural Resources (NCDENR), "UST Section Guidelines for the Investigation and Remediation of Contamination from Non-UST Petroleum Releases", effective July 1, 2007 (2007 Guidelines) and Title 15A North Carolina Administrative Code (NCAC) Subchapter 2L Section .0106(c).

1.3 SITE INFORMATION SUMMARY

The site information discussed within is based on site reconnaissance and review of site specific data presented within previous reports. Pertinent data is summarized in the following sections.

1.3.1 Location

The subject site is located on Brewster Boulevard near its intersection with Holcomb Boulevard and consists of the area surrounding former Building 645. Building 645 previously housed water supply well HP645. Refer to Figures 1 and 2 for vicinity and site maps. The area is bordered to the north, east, west, and

directly south (across Brewster Boulevard) by woods and lightly vegetated land. Russell Marine and Family Services Center is located across Brewster Boulevard approximately 300 feet southwest of the source area.

1.3.2 Source and Type of Contamination

The former 110-gallon gasoline AST is the suspected source of the petroleum impact. Past documents revealed that the AST was routinely overfilled during maintenance activities.

1.3.3 Previous Investigations

Numerous investigations have been conducted at the subject site resulting in the following reports:

- *Three Well Site Check, Building HP-645 (AST)*, dated March 1994, R.E. Wright Associates, Inc.
- *Leaking Underground Storage Tank Comprehensive Site Assessment (CSA), 645*, dated April 28, 1995, Richard Catlin & Associates, Inc.
- *Leaking Underground Storage Tank Addendum Site Assessment (Addendum), 645*, dated June 12, 1996, Richard Catlin & Associates, Inc.
- *Leaking Underground Storage Tank Corrective Action Plan, 645*, dated September 25, 1996, Richard Catlin & Associates, Inc.
- *Annual Monitoring Report, CAP Implementation at Building 645*, dated April 2001, J.A. Jones Environmental Services Company
- *Geophysical Investigation at Building 645 Site*, dated September 2001, Geophex Services, Ltd.
- *Annual Monitoring Report, Soil and Groundwater Remediation, Building 645*, dated July 2002, J.A. Jones Environmental Services Company
- *Final Annual Monitoring Report, Soil and Groundwater Building 645*, dated January 2004, Shaw Environmental, Inc.
- *Remedial Action Optimization & Revised Corrective Action Plan Building 645*, dated August 26, 2004, Catlin Engineers and Scientists
- *Annual Groundwater Monitoring Report 2003-2005 Building 645 Site*, dated January 17, 2006, Engineering and Environment, Inc.
- *Remedial Action Optimization & Revised Corrective Action Plan Addendum Report*, dated August 9, 2006, CATLIN Engineers and Scientists
- *Soil and Groundwater Investigation Summary Report*, dated October 18, 2007, Sovereign Consulting, Inc.
- *Annual Groundwater Monitoring Report 2006-2007 - Building 645*, dated June 15, 2007, Sovereign Consulting, Inc.

- *Additional Site Assessment, Building 645, dated June 19, 2008, CATLIN Engineers and Scientists*
- *Final Annual Groundwater Monitoring Report 2007-2008 Building 645, dated June 27, 2008, Sovereign Consulting, Inc.*

Impact to the Shallow, Intermediate, and Deep Zones were confirmed in a number of the previously listed investigations. According to the reports, a remediation system was installed on the subject site in 1998 by J. A. Jones. The system consists of 14 vertical air sparge wells, four horizontal vapor extraction wells, and 21 soil vapor collection vent borings. Six of the 14 vertical sparge wells were installed to a depth of 80 ft. BLS, and the remaining eight to 50 ft. BLS. The remediation system was installed to target the confirmed impact to the groundwater in the Shallow, Intermediate, and Deep Zones at the project site. The soil and groundwater treatment system has been operational since it was installed by J.A. Jones in 1998 except for short periods to accommodate routine maintenance, groundwater gauging and sampling events and monitoring well installation. Review of groundwater monitoring data reveals that the remedial efforts have been successful in reducing the petroleum constituents in the target zones within the area of influence of the treatment system as designed. Free-phase product has not been observed in any of the groundwater monitoring wells.

In June 2007, the Air Sparge/Soil Vapor Extraction (AS/SVE) system was temporarily shutdown to evaluate static site conditions, measure rebound concentration levels, and provide possible alternatives for future remediation goals (if needed). Both soil and groundwater samples were collected. Based on laboratory results, soil contamination above State Action Levels for Total Petroleum Hydrocarbons (TPH) as Diesel Range Organics (DRO) was detected in one soil boring and groundwater contaminant concentrations are still above 2L GWQS in the Deep Zone wells; however, the highest concentrations are outside of the effective area of the existing remediation system.

1.3.4 Soil Contamination

In August 2007 Sovereign Consulting Inc. (Sovereign) conducted soil investigations around the former Building 645 concrete pad location. Four soil borings (UST645-SB-01 through UST645-SB-04) were advanced via direct push drill methods to approximately 12 to 15 feet BLS. One sample was collected for laboratory analysis from each boring. Each sample was analyzed for TPH-DRO and Gasoline Range Organics (GRO) per EPA Methods 3550 and 5030, respectively. All laboratory results indicated

concentrations below quantitation limits except for soil sample UST645-SB-02 (11-12 feet BLS), which contained 94.4 mg/kg TPH-DRO constituents. This level exceeds the State Action Level of 40 mg/kg. Refer to Appendix B for soil laboratory results.

1.3.5 Groundwater Contamination

Recent groundwater sampling events were conducted by Sovereign personnel in October 2007 and April 2008 as part of the groundwater monitoring program, the data from April 2008 was not available at the time of preparation of CATLIN's Additional Site Assessment Report. Data from the October 2007 sampling event indicated that dissolved contamination exists only in the Deep Zone groundwater monitoring wells. Refer to Appendix B for summarized laboratory results. The October data and recent CATLIN groundwater sampling performed in March 2008 is summarized herein. Groundwater samples were collected by Sovereign from deep monitoring wells UST645-MW18, UST645-MW26, UST645-MW27, UST645-MW29, UST645-MW30, and UST645-MW32 through UST645-MW34 and laboratory analyzed per EPA Methods 602 plus Diisopropyl ether (DIPE) and Methyl-tert butyl ether (MTBE) and 8270. CATLIN sampled the three newly installed monitoring wells UST645-35 through UST645-MW37. Groundwater samples collected by CATLIN personnel were laboratory analyzed per EPA Methods 601 and 602 plus DIPE and MTBE. Selected tables and figures from these sampling events are included in Appendix A and summarized as follows:

The October/March groundwater sampling results are summarized on Figure 3 and on Table 2 in Appendix A. Benzene was identified in groundwater samples collected from the following wells at concentrations above the current 2L GWQS of 1.0 µg/L:

WELL ID	WELL DEPTH (ft)	DATE COLLECTED	BENZENE (µg/L)
UST645-MW18	80	10/18/07	6.94J
UST645-MW26	80	10/18/07	1,700
UST645-MW27	81.5	10/18/07	101
UST645-MW29	80	10/18/07	42.6
UST645-MW33	80	10/19/07	2.07
UST645-MW34	80	10/19/07	7.76

J = Estimated concentration

Additional constituents identified above current 2L GWQS include Toluene at a concentration of 3,410 µg/L and Total Xylenes at a concentration of 896 µg/L in UST645-MW26. The current 2L GWQS for Toluene and Total Xylenes are 1,000 µg/L and 530 µg/L,

respectively. No EPA Method 601 or 8270 analytes were identified above current 2L GWQS.

During preparation of this CAP Supplement, Sovereign conducted an additional round of sampling in April 2008 and the groundwater data was included in the Final Annual Groundwater Monitoring report dated June 27, 2008. Review of the laboratory results from monitoring wells within the Deep Zone (60-90 ft.) indicated similar results to the October data. Benzene, Toluene and Total Xylene concentrations increased slightly. Refer to Appendix B for tabulated laboratory data from the April 2008 sampling event.

All of the groundwater samples identified with analytes above current 2L GWQS are screened within the Deep Zone between 60 and 90 ft. BLS, with the exception of shallow monitoring wells UST645-MW12 and UST645-MW23. The estimated areal extent of Benzene above current 2L GWQS in the Deep Zone is presented on Figure 3. A geologic cross section plan view is shown on Figure 4 and the estimated vertical extent of Benzene above current 2L GWQS along A-A' and B-B' geologic cross sections are presented on Figures 4A and 4B, respectively.

1.3.6 Groundwater Elevation and Flow Direction

Due to the vertical migration of contaminants at the project site, the subsurface has been divided into "zones" including the Shallow Zone (well depth less than 40 ft.), Intermediate Zone (well depths greater than or equal to 40 ft. deep and less than 60 ft.), Deep Zone (well depths greater or equal to 60 ft. and less than 90 ft.).

As part of Additional Site Assessment activities, groundwater depths were measured from the top of casing on each monitoring well in order to calculate the elevation of the groundwater surface in each monitoring well. Groundwater gauging data from the two previous gauging events is presented on Table 1 in Appendix A. Groundwater surface elevations were input into a Geographical Information System (GIS) database and contours of the groundwater surface elevations were computer generated for each of the three zones. Results of the gauging and subsequent contouring data for each of the three zones can be found in Appendix A. Overall groundwater flow trends were to the southwest for the Shallow Zone, west-southwest in the Intermediate Zone and no obvious groundwater flow trend was evident based on the potentiometric surface maps for the Deep Zone; however, a groundwater flow trend to the west southwest is likely based on current conditions as compared to historical data.

1.3.7 Free-Phase Product Contamination

No free-phase product has been observed in any of the groundwater monitoring wells.

1.4 SUMMARY OF CORRECTIVE ACTIONS TO DATE

- The former Well 645 was abandoned in 1995 and the pump house dismantled.
- J.A. Jones installed an AS/SVE system in 1998. This remedial approach has been effective in reducing groundwater contamination within the immediate area surrounding the AS/SVE system.

2.0 RECEPTOR INFORMATION

2.1 POTENTIAL RECEPTORS AT RISK

At the time of the original CAP (CATLIN, 1996) preparation, potential receptors were defined by NCDEHNR (now referred to as NCDENR) in Section .0102 of 15A NCAC 2L, to include any human, plant, animal or structure with the potential to be adversely affected by the release or migration of contaminants. Guidance documents issued by the regulatory agency indicated that structures might include items such as utility lines, basements, and elevator shafts. Although not specifically included in the rule definition (.0102 15 NCAC 2L), regulatory officials also considered potential receptors to include environmental resources such as water supply wells, surface waters, drinking water supplies, and "regions of ground water that have been identified for planned resource development".

The potential receptor survey conducted by CATLIN (1996) resulted with the following conclusions:

- Three water supply wells (HP-644, HP-645, and HP-646) were located within 1,500 feet of the site. A MCB water treatment facility (Building 670) was located on the east side of Holcomb Boulevard, approximately 1,000 feet east of the site. The potential existed for exposure to petroleum contamination via ingestion and/or dermal contact should the water supply wells become contaminated. Refer to Figure 2.1 in Appendix D.
- Underground utility services (water, electrical, and sanitary sewer) were located within the project area. Utility depths were unlikely to intersect the water table that is between 12 and 19 feet BLS. The

utilities were not considered to be at risk for impact by the petroleum hydrocarbon contamination or act as preferential migration pathways.

- Northeast Creek was located approximately 4,500 feet northwest of the site and was the nearest mapped body of surface water. A drainage ditch was located to the north of the site. The ditch was used to contain and route surface water runoff and did not appear to be a discharge point for groundwater. CATLIN concluded that it was unlikely that surface water would be impacted by the contaminant plume.

3.0 OBJECTIVES OF CORRECTIVE ACTION PLAN

3.1 GENERAL DESCRIPTION

The objective of this CAP Supplement is to present a proposed revised remedial method to reduce dissolved phase petroleum groundwater contamination within the core of the Deep Zone (60'-90' BLS) and allow natural attenuation to remediate the fringe at the Building 645 project site to below 2L GWQS. Refer to Table 1 for the site rehabilitation goals.

3.2 GOALS OF CORRECTIVE ACTION PLAN

The goals of this CAP Supplement are:

- Reduce dissolved phase petroleum groundwater contamination to below current 2L GWQS within the Deep Zone (60'-90' BLS).
- To track Deep Zone plume migration through scheduled groundwater monitoring events.
- Provide a schedule for the implementation and operation of the proposed corrective actions.
- Detail a monitoring plan with the capacity to evaluate the effectiveness of the proposed corrective actions at this site and to monitor the overall effectiveness of the air/biosparge and soil vapor extraction remediation system.
- Provide a vapor monitoring program to ensure sparge vapors do not impact nearby Russell Marine and Family Services Center.

4.0 EVALUATION OF REMEDIATION ALTERNATIVES

As part of the evaluation of remedial alternatives, CATLIN developed a Conceptual Model that was submitted to MCB Camp Lejeune for review prior to

preparation of this CAP Supplement. A copy of the Conceptual Model is provided in Appendix C.

4.1 SCREENING OF REMEDIATION ALTERNATIVES

Numerous technologies that address the remediation of dissolved phase groundwater contamination are available. Specific remedial alternatives that were reviewed include the following: groundwater depression system (pump and treat) and air sparge. Some of these technologies have demonstrated an acceptable level of success when implemented in the field, while others appear to have been ineffective. In certain instances, implementation of any available remediation technology by itself will not suffice. Hence, a combination of treatment technologies is at times more effective. Site specific conditions, nature and extent of contamination together with an analysis of a particular remediation technology's record of success with similar sites will allow the screening of technically feasible alternative technologies. The "best" remedial strategy is the one that can fulfill the established remediation objectives at the least cost.

Based on review of the previous reports, the existing air sparge system has proven to be an effective remedial option; however, further assessments have identified the dissolved plume in the Deep Zone has migrated beyond the existing remedial system network to the northeast and southeast.

4.2 REMEDIATION TECHNOLOGY SELECTION

CATLIN recommends the following remediation technology to be implemented at the subject site:

Continued use of the existing deep air sparge wells and soil vapor extraction coupled with biosparging in the vicinity of UST645-MW26.

This recommendation is based on the following observations:

- The project site is located in a large area owned by the United States Marine Corps and the migration of the petroleum hydrocarbon contaminant plume onto adjacent properties is not anticipated.
- Migration of the dissolved-phase contaminant plume within the Deep Zone (60'-90') towards potential water supply wells and the nearby services center could pose an immediate threat to human or environmental receptors.

- The existing air sparge system has proven successful in remediating the shallow and deep groundwater contamination in the source area.

5.0 PROPOSED REMEDIATION

5.1 BIOSPARGE REMEDIATION

In an effort to prevent potential vapor intrusion into nearby structures, biosparging techniques have been chosen over air sparging due to the close proximity of the services center to the contaminant plume. Biosparging typically uses a smaller amount of injected air than air sparging. The goal of biosparging is to provide just enough air/oxygen into the subsurface to enhance naturally occurring biodegradation, where as air sparging is used to volatilize petroleum hydrocarbons as the air rises up through the groundwater.

The proposed locations and depths of the additional groundwater biosparge wells are based on: the horizontal and vertical geometry of the dissolved-phase petroleum hydrocarbon contaminant plume; the performance of the existing air sparging system and pilot tests that have been conducted at the site; and previous design calculations. For pilot test results and design calculations, refer to Appendix D.

A total of five (5) vertical biosparge wells are currently proposed to remediate the Deep Zone (60-90 ft.) portions of the surficial aquifer located across Brewster Boulevard. The biosparge wells are proposed to be installed to a depth of approximately 90 feet BLS on 60 foot centers. Biosparge well spacing is based on a previous pilot test data from the deep aquifer zone performed as part of the original CAP. Since the shallow groundwater contamination is essentially below 2L GWQS, it is planned to take the existing shallow air sparge wells off line and use the air supply from these wells to provide necessary air flow requirements to the proposed biosparge wells. Existing total flow rate used for the Shallow Zone air sparge wells is 112 cubic feet minute (cfm) or 14 cfm per shallow sparge well. The proposed biosparge wells will only need approximately 5-10 cfm per well at the existing design pressure of 100 pounds per square inch (psi). If you assume 7 cfm per well times 5 proposed biosparge wells, only 35 cfm is needed from the available 112 cfm. During air/biosparging activities it is planned for the soil vapor extraction system to remain in operation.

Figure 5 shows the existing AS/SVE system configuration and Figure 6 illustrates the proposed additional biosparge wells. The biosparge wells, as shown in Figure 6, have been focused around the location of deep monitoring well UST645-MW26, due to the elevated contaminant concentrations detected.

Target dates for implementation of CAP Supplement activities are shown on Table 2. A proposed biosparge well detail is shown on Figure 7.

6.0 MONITORING PLAN

6.1 GOALS OF MONITORING PLAN

The goals of the monitoring plan are to track groundwater mounding, verify groundwater flow patterns, gauge for potential free-phase product thicknesses, and check the system and make adjustments when necessary.

6.2 MONITORING ACTIVITIES AND SCHEDULE

6.2.1 Proposed Monitoring Activities

The following monitoring activities are proposed upon installation of the biosparge wells and restarting of the existing remediation system:

- Gauge all monitoring wells monthly to determine groundwater flow patterns, potential free-phase product thickness and potential mounding effects by the air/biosparge system.
- Sampling of selected monitoring wells for groundwater analysis per EPA Methods 601 and 602 plus DIPE and MTBE parameters performed on an annual basis unless site conditions dictate more frequent sampling.
- Air/biosparge system checks will be performed quarterly in order to make adjustments to provide optimal sparge air flow and pressures.
- Monitor potential petroleum vapors in and around Russell Marine and Family Services Center located across Brewster Blvd.

6.2.2 Proposed Monitoring Schedule

Gauging activities are proposed to continue on a monthly basis until remediation objectives illustrated in Table 1 are met. Groundwater sampling will be performed on an annual basis unless site conditions dictate more frequent sampling intervals.

Termination of monitoring activities and site closeout with "No Further Action" status will be requested when all petroleum-related

constituents dissolved in groundwater are below 2L GWQS for four consecutive sampling events.

6.2.3 Reporting

All monitoring activities will be included in the Annual Monitoring Report for this site.

7.0 PERMITS

No permits are required.

8.0 PUBLIC NOTICE

In accordance with NCAC T15A:02L .0114(a), public notification is required by any person subject to the requirements of rule T15A:02L .0106(l) submitting a Corrective Action Plan proposing to cleanup groundwater contamination. The following parties are required to be notified:

- The local Health Director, and
- The chief administrative officer of each political jurisdiction in which the contamination occurs

Copies of public notification letters and certified mail receipts are included in Appendix E.

9.0 LIMITATIONS

The field and groundwater data evaluated as part of this report provide 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 from this report are based on the best available data in an effort to comply with current regulatory requirements.

10.0 REFERENCES

CATLIN Engineers and Scientists *Additional Site Assessment (ASA), Building 645*, dated June 19, 2008.

(CATLIN) Richard Catlin & Associates, Inc. *Leaking Underground Storage Tank Comprehensive Site Assessment (CSA), 645*, dated April 28, 1995.

Geophex, Ltd., Wellhead Management Program Engineering Study 91-36, Prepared for Officer in Charge of Construction Marine Corps Base Camp Lejeune, North Carolina, 1991.

North Carolina Department of Environment and Natural Resources, *Guidelines for Assessment and Corrective Action, North Carolina Underground Storage Tank Section* (Effective July 1, 2001).

Sovereign Consulting, Inc. *Annual Groundwater Monitoring Report 2006-2007 - Building 645*, dated June 15, 2007.

Sovereign Consulting, Inc. *Final Annual Groundwater Monitoring Report 2007-2008 Building 645*, dated June 27, 2008.

Sovereign Consulting, Inc. *Soil and Groundwater Investigation Summary Report*, dated October 18, 2007.

TABLES

TABLE 1 SITE REHABILITATION GOALS CORRECTIVE ACTION PLAN SUPPLEMENT BUILDING 645 MARINE CORPS BASE CAMP LEJEUNE, NORTH CAROLINA			
MEDIUM	CONTAMINANT OF CONCERN	CURRENT CONCENTRATIONS ABOVE 2L GWQS*	TARGET CLEANUP
Groundwater	Benzene	1,700	<1
	Toluene	3,410	<1,000
	Total Xylenes	896	<530

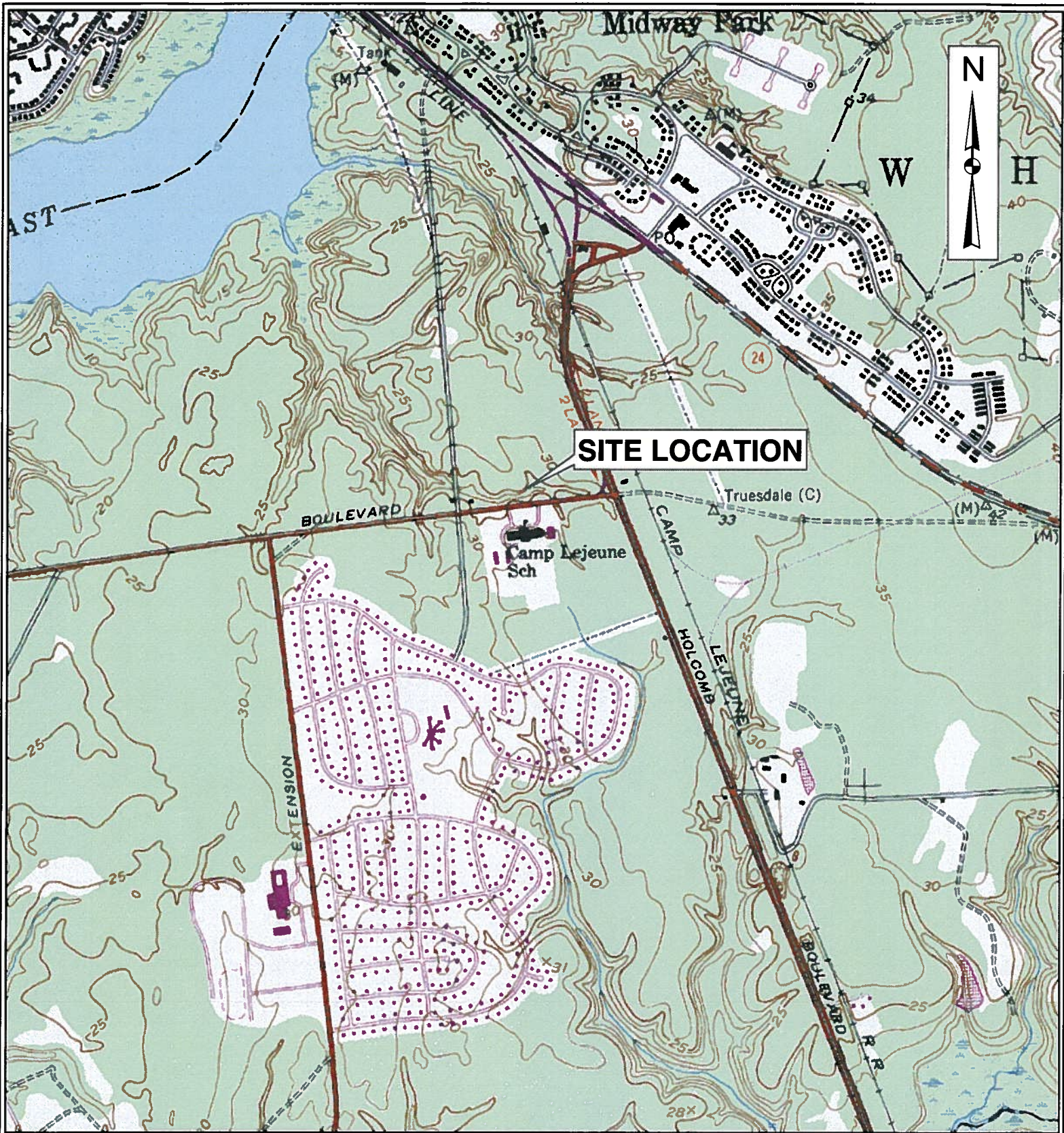
* Groundwater data collected from UST645-MW26 on October 18, 2007 and included in the FINAL Annual Monitoring Report 2007-2008 Building 645 prepared by Sovereign Consulting, Inc.

TABLE 2**TARGET DATES OF CORRECTIVE ACTION PLAN****CORRECTIVE ACTION PLAN SUPPLEMENT****BUILDING 645****MARINE CORPS BASE****CAMP LEJEUNE, NORTH CAROLINA**

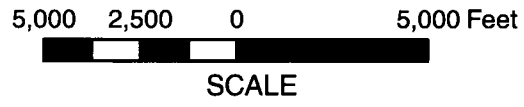
ITEM	DATE*
Prepare Design Plans and Specifications	March 2009
Installation of Biosparge Wells	May 2009
Modify of Existing AS/SVE System	June 2009
System Start-up and Testing	July 2009
Commencement of Monitoring Activities	August 2009

* All dates are estimated

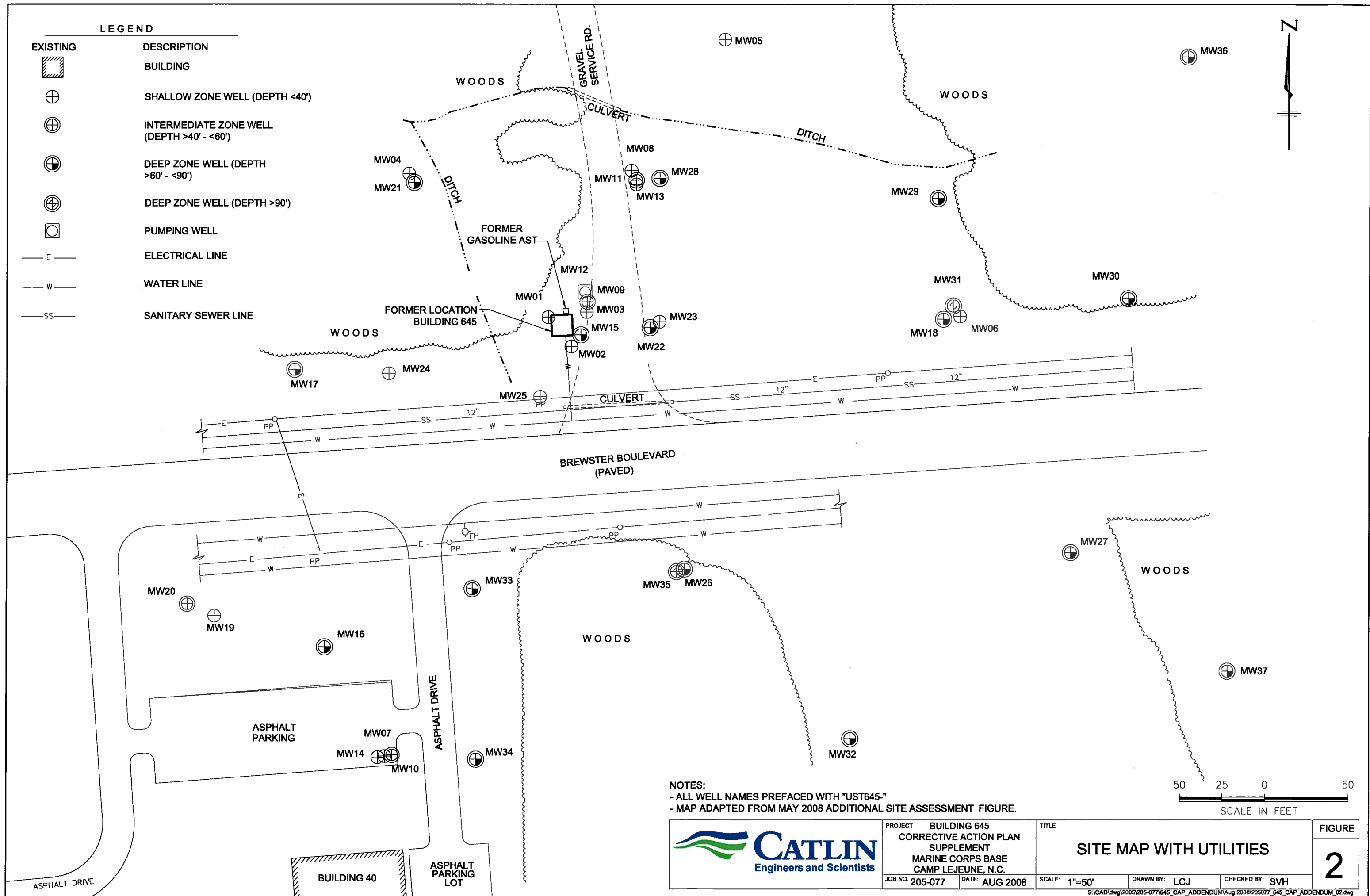
FIGURES

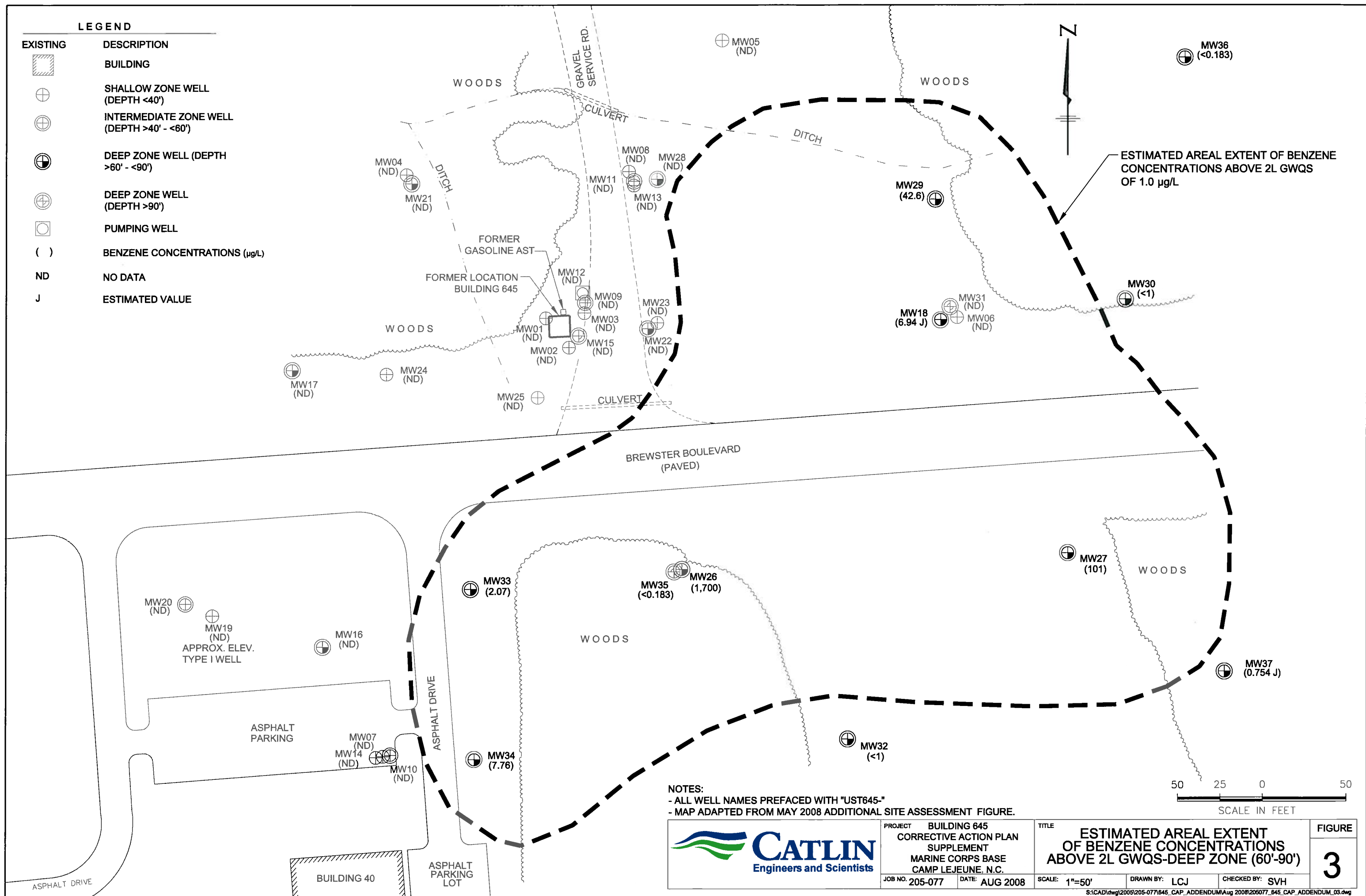


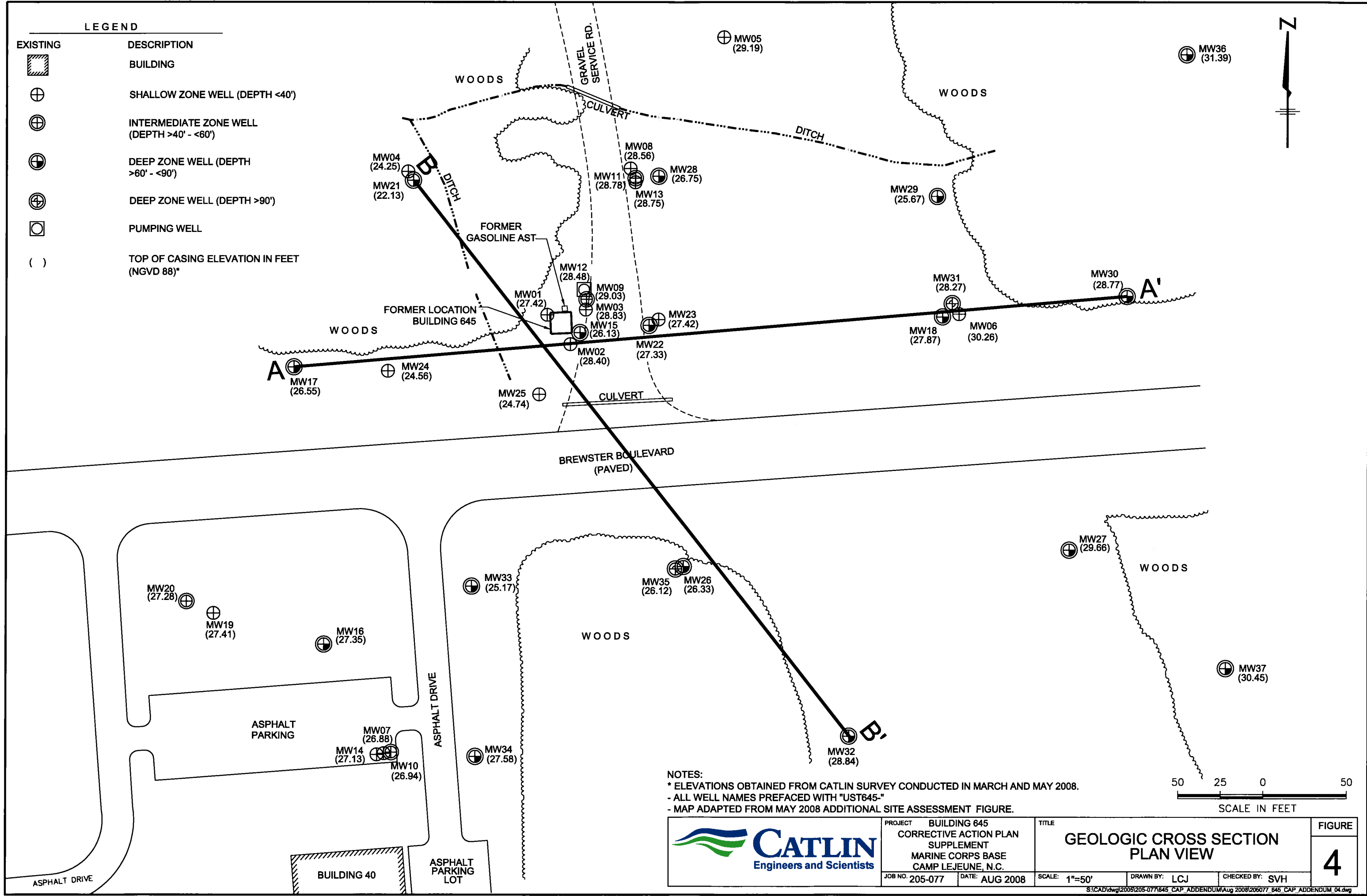
Data Sources: USGS Topographic Quadrangle
Camp Lejeune (1952, Photorevised 1971). GIS
data provided by Camp Lejeune GIS Department.



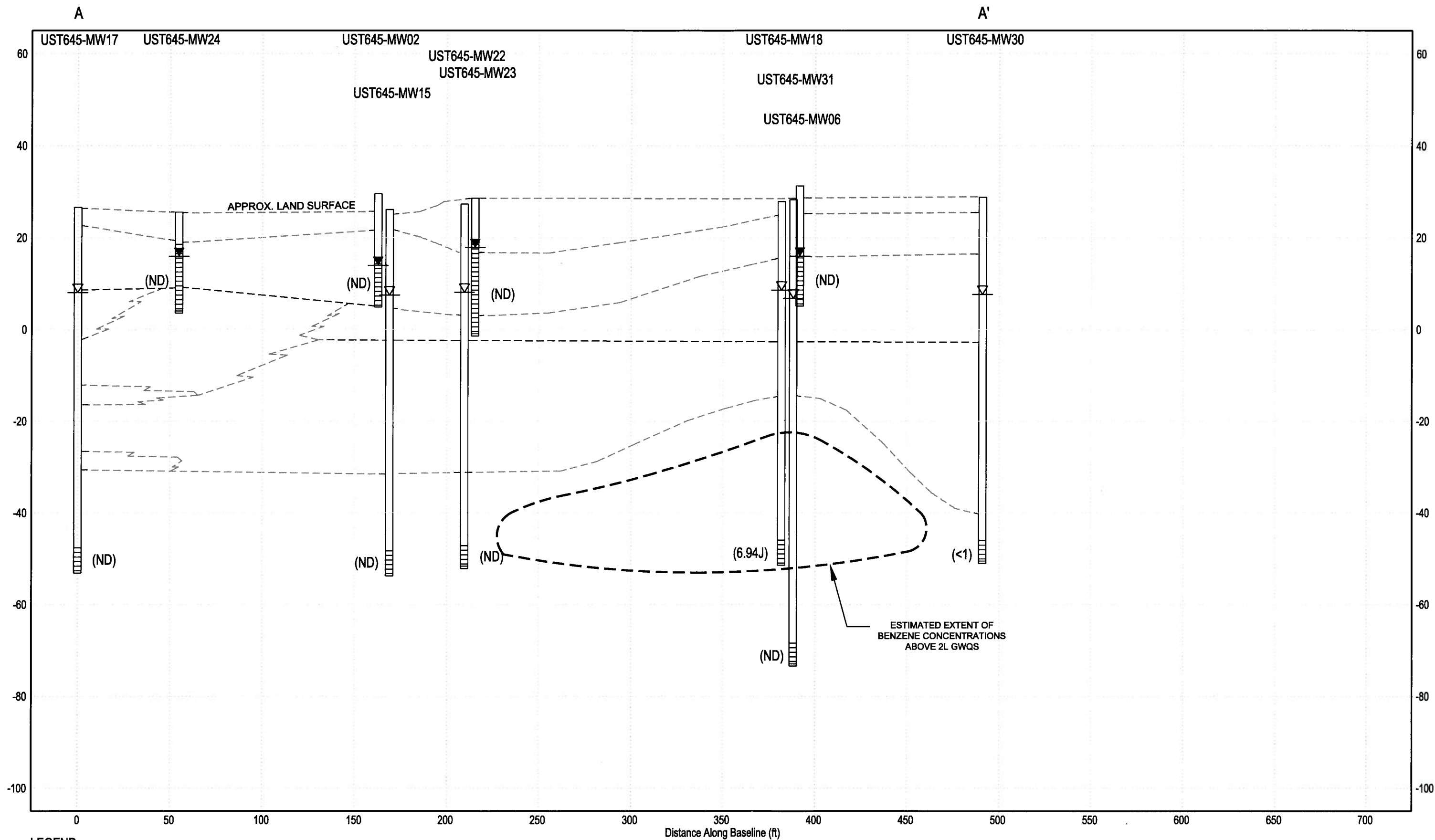
	PROJECT BUILDING 645 CORRECTIVE ACTION PLAN SUPPLEMENT MARINE CORPS BASE CAMP LEJEUNE, N.C.		TITLE GENERAL LOCATION USGS TOPOGRAPHIC QUADRANGLE			FIGURE 1
	JOB NO. 205-077	DATE AUG 2008	SCALE AS SHOWN	DRAWN BY THW	CHECKED BY SVH	



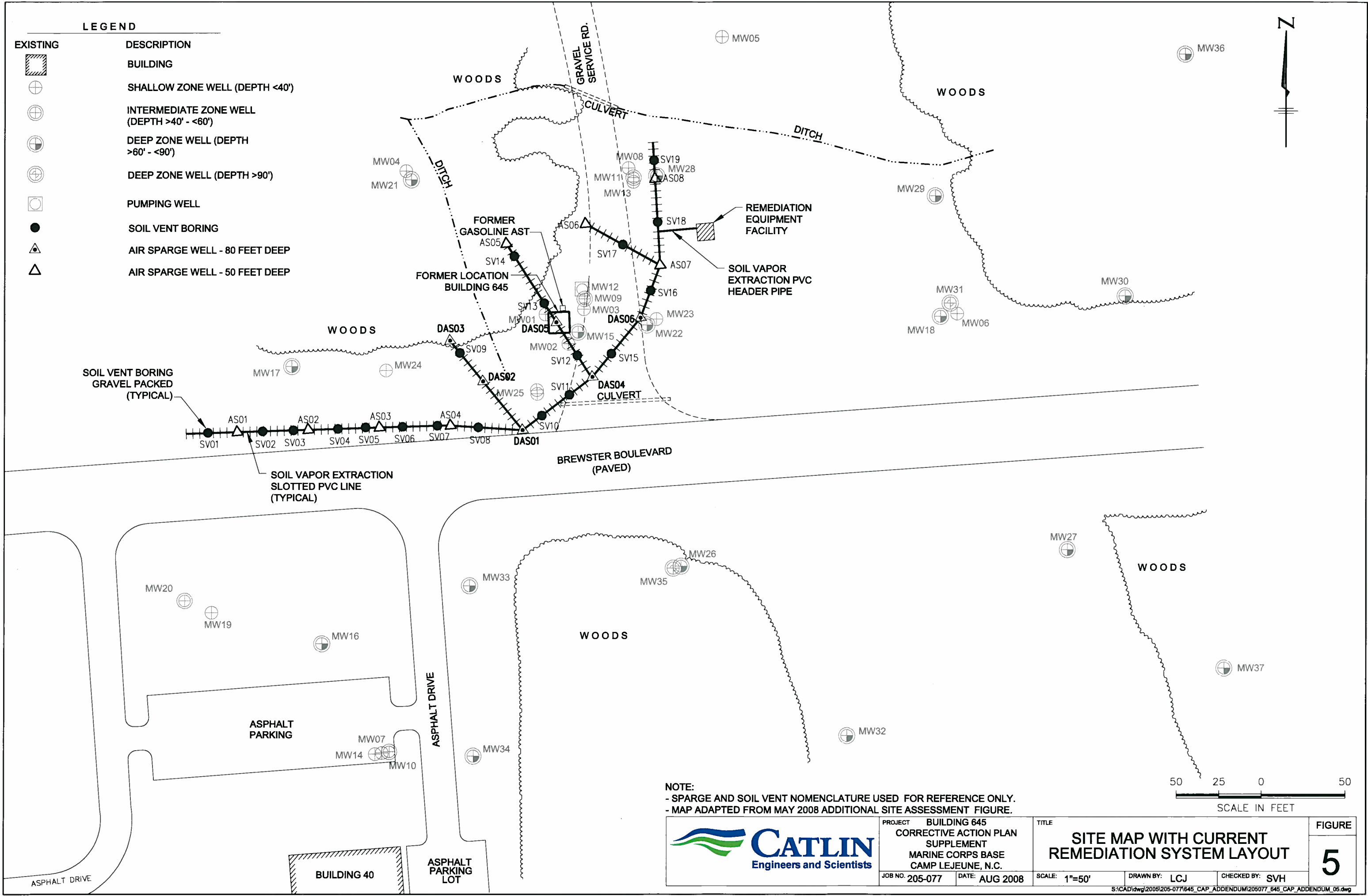


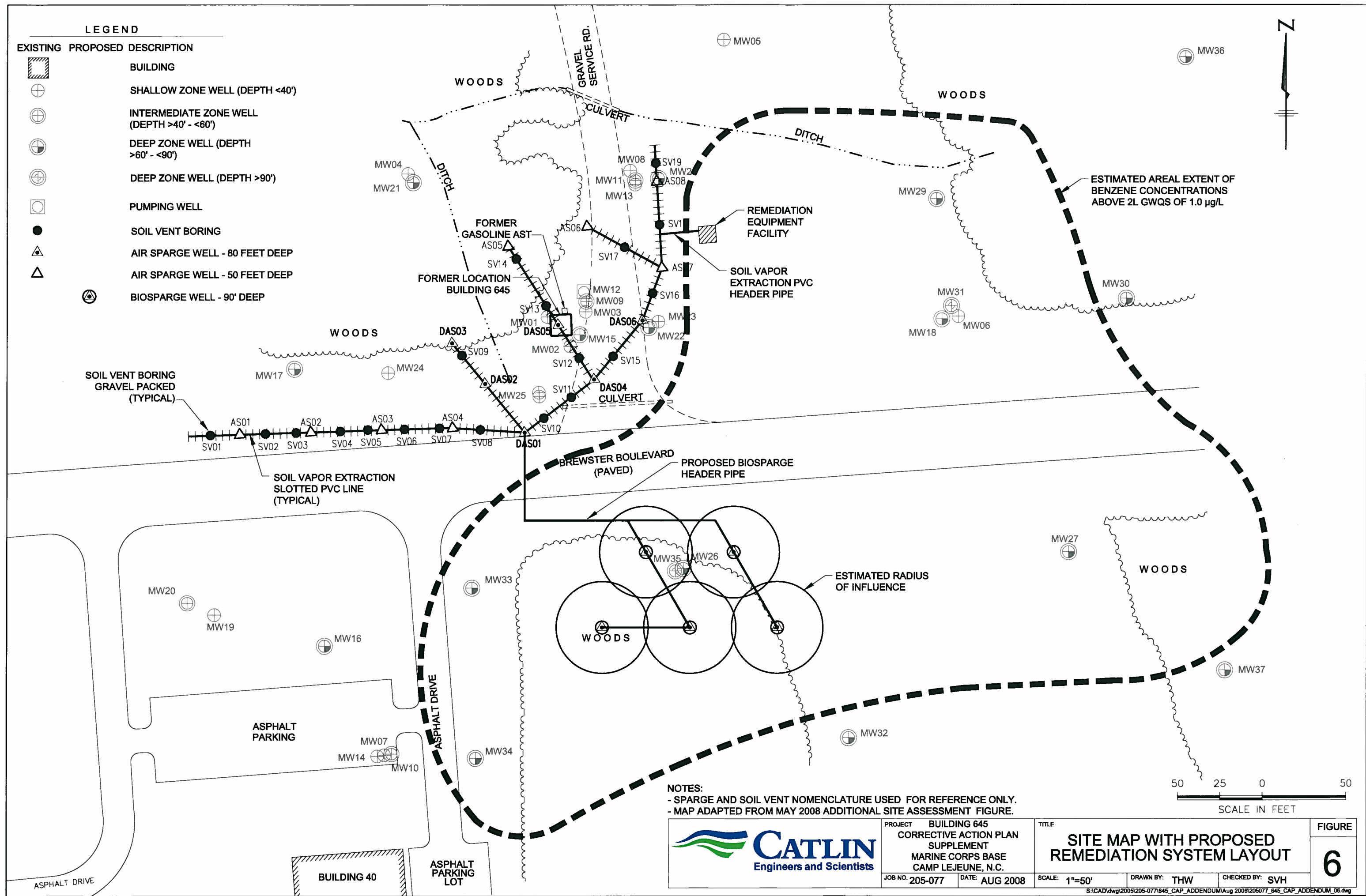


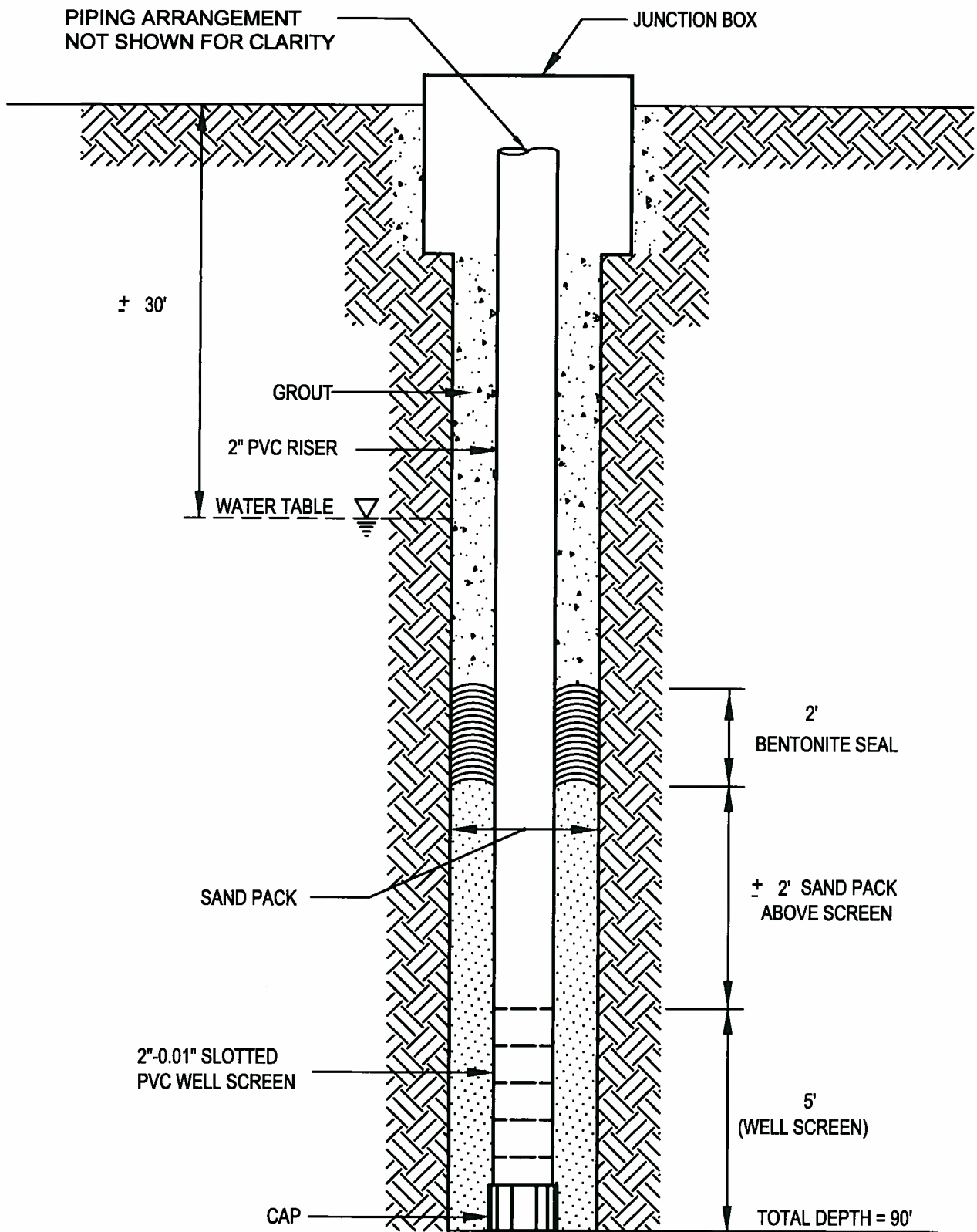
PROJECT BUILDING 645 CORRECTIVE ACTION PLAN SUPPLEMENT MARINE CORPS BASE CAMP LEJEUNE, N.C.		TITLE GEOLOGIC CROSS SECTION PLAN VIEW		FIGURE 4
JOB NO. 205-077	DATE: AUG 2008	SCALE: 1"=50'	DRAWN BY: LCJ CHECKED BY: SVH	



PROJECT BUILDING 645 CORRECTIVE ACTION PLAN SUPPLEMENT MARINE CORPS BASE CAMP LEJEUNE, N.C.		TITLE ESTIMATED VERTICAL EXTENT OF BENZENE CONCENTRATIONS ABOVE 2L GWQS- GEOLOGIC CROSS SECTION A-A'		FIGURE 4A
JOB NO. 205-077	DATE: AUG 2008	SCALE: 1"=50'	DRAWN BY: LCJ	CHECKED BY: SVH







APPENDICES

APPENDIX A

SELECTED TABLES AND FIGURES FROM THE ADDITIONAL SITE ASSESSMENT DATED JUNE 19, 2008

TABLE 1
MONITORING WELL CONSTRUCTION AND GAUGING INFORMATION

Incident Number and Name: 87556 - BUILDING 645

WELL IDENTIFICATION	DATE INSTALLED (m/dd/yy)	DATE WATER LEVEL MEASURED (m/dd/yy)	WELL CASING DEPTH (ft. BLS)	SCREENED INTERVAL (x to y ft. BLS)	BOTTOM OF WELL (ft. BLS)	TOP OF CASING ELEV.* (ft.)	DEPTH TO WATER From Top of Casing (ft.)	GROUND-WATER ELEV. *(ft.)	FREE-PHASE PRODUCT THICKNESS (ft.)	COMMENTS
UST645- MW01	10/25/93	4/18/08	11.6	11.6 - 21.6	22.0	27.42	12.61	14.81	NMT	SHALLOW ZONE MONITORING WELL
UST645- MW02	10/25/93	4/18/08	12.2	12.2 - 22.2	22.6	28.40	13.49	14.91	NMT	SHALLOW ZONE MONITORING WELL
UST645- MW03	10/25/93	4/18/08	8.1	8.1 - 23.1	23.5	28.83	13.56	15.27	NMT	SHALLOW ZONE MONITORING WELL
UST645- MW04	10/21/94	4/18/08	3.0	3.0 - 13.0	13.5	24.25	12.04	12.21	NMT	SHALLOW ZONE MONITORING WELL
UST645- MW05	10/26/94	4/18/08	11.5	11.5 - 21.5	22.0	29.19	14.05	15.14	NMT	SHALLOW ZONE MONITORING WELL
UST645- MW06	11/03/94	4/18/08	14.5	14.5 - 24.5	25.0	30.26	14.11	16.15	NMT	SHALLOW ZONE MONITORING WELL
UST645- MW07	10/31/94	4/18/08	14.5	14.5 - 24.5	25.0	26.88	18.05	8.83	NMT	SHALLOW ZONE MONITORING WELL
UST645- MW08	11/07/94	4/18/08	14.5	14.5 - 24.5	25.0	28.56	14.43	14.13	NMT	SHALLOW ZONE MONITORING WELL
UST645- MW09	10/27/94	3/13/08	44.5 Inner 40.0 Outer	44.5 - 49.5	50.0	29.03	20.58	8.45	NMT	INTERMEDIATE ZONE MONITORING WELL
UST645- MW10	11/01/94	3/13/08	44.5 Inner 40.0 Outer	44.5 - 49.5	50.0	26.94	18.89	8.05	NMT	INTERMEDIATE ZONE MONITORING WELL

* Reference Point for Elevation Measurements (GPS), NGVD 88

** If free product is present in a well, groundwater elevation was calculated by: [Top of Casing Elevation - Depth to Water] + [Free-Phase Product Thickness x 0.82]

ft. BLS = feet below land surface

NMT = No Measurable Thickness

ND = No Data

TABLE 1
MONITORING WELL CONSTRUCTION AND GAUGING INFORMATION

Incident Number and Name: 87556 - BUILDING 645

WELL IDENTIFICATION	DATE INSTALLED (m/dd/yy)	DATE WATER LEVEL MEASURED (m/dd/yy)	WELL CASING DEPTH (ft. BLS)	SCREENED INTERVAL (x to y ft. BLS)	BOTTOM OF WELL (ft. BLS)	TOP OF CASING ELEV.* (ft.)	DEPTH TO WATER From Top of Casing (ft.)	GROUND-WATER ELEV.* (ft.)	FREE-PHASE PRODUCT THICKNESS (ft.)	COMMENTS
UST645- MW11	11/05/94	3/13/08	42.5 Inner 40.0 Outer	42.5 - 47.5	48.0	28.78	20.40	8.38	NMT	INTERMEDIATE ZONE MONITORING WELL
UST645- MW12	11/03/94	3/13/08	17.5	17.5 - 37.5	38.0	28.48	19.21	9.27	NMT	SHALLOW ZONE MONITORING WELL
UST645- MW13	11/16/94	4/18/08	24.5	24.5 - 34.5	35.0	28.75	13.76	14.99	NMT	SHALLOW ZONE MONITORING WELL
UST645- MW14	11/16/94	4/18/08	22.0	22.0 - 32.0	32.5	27.13	18.42	8.71	NMT	SHALLOW ZONE MONITORING WELL
UST645- MW15	3/09/96	3/13/08	74.5 Inner 69.0 Outer	74.5 - 79.5	80.0	26.13	18.71	7.42	NMT	DEEP ZONE MONITORING WELL
UST645- MW16	3/06/96	3/13/08	74.5 Inner 70.0 Outer	74.5 - 79.5	80.0	27.35	19.80	7.55	NMT	DEEP ZONE MONITORING WELL
UST645- MW17	2/29/96	3/13/08	74.5 Inner 69.0 Outer	74.5 - 79.5	80.0	26.55	18.82	7.73	NMT	DEEP ZONE MONITORING WELL
UST645- MW18	8/08/96	3/13/08	74.5 Inner 69.0 Outer	74.5 - 79.5	80.0	27.87	19.99	7.88	NMT	DEEP ZONE MONITORING WELL
UST645- MW19	UNKNOWN	4/18/08	14.0	14.0 - 34.0	34.5	27.41	18.37	9.04	NMT	SHALLOW ZONE MONITORING WELL
UST645- MW20	UNKNOWN	3/13/08	44.5	44.5 - 49.5	50.0	27.28	19.17	8.11	NMT	INTERMEDIATE ZONE MONITORING WELL

* Reference Point for Elevation Measurements (GPS), NGVD 88

** If free product is present in a well, groundwater elevation was calculated by: [Top of Casing Elevation - Depth to Water] + [Free-Phase Product Thickness x 0.82]

ft. BLS = feet below land surface

NMT = No Measurable Thickness

ND = No Data

TABLE 1
MONITORING WELL CONSTRUCTION AND GAUGING INFORMATION

Incident Number and Name: 87556 - BUILDING 645

WELL IDENTIFICATION	DATE INSTALLED (m/dd/yy)	DATE WATER LEVEL MEASURED (m/dd/yy)	WELL CASING DEPTH (ft. BLS)	SCREENED INTERVAL (x to y ft. BLS)	BOTTOM OF WELL (ft. BLS)	TOP OF CASING ELEV.* (ft.)	DEPTH TO WATER From Top of Casing (ft.)	GROUND-WATER ELEV. *(ft.)	FREE-PHASE PRODUCT THICKNESS (ft.)	COMMENTS
UST645- MW21	7/31/01	3/13/08	75.0 Inner 70.0 Outer	75.0 - 79.5	80.0	22.13	14.28	7.85	NMT	DEEP ZONE MONITORING WELL
UST645- MW22	8/03/01	3/13/08	75.0 Inner 62.0 Outer	75.0 - 79.5	80.0	27.33	19.72	7.61	NMT	DEEP ZONE MONITORING WELL
UST645- MW23	8/07/01	4/18/08	10.0	10.0 - 29.5	30.0	27.42	10.71	16.71	NMT	SHALLOW ZONE MONITORING WELL
UST645- MW24	12/01/05	4/18/08	7.0	7.0 - 21.5	22.0	24.56	9.61	14.95	NMT	SHALLOW ZONE MONITORING WELL
UST645- MW25	12/01/05	4/18/08	9.5	9.5 - 24.0	24.5	24.74	13.44	11.30	NMT	SHALLOW ZONE MONITORING WELL
UST645- MW26	1/06/06	3/13/08	75.0 Inner 70.0 Outer	75.0 - 79.5	80.0	26.33	18.74	7.59	NMT	DEEP ZONE MONITORING WELL
UST645- MW27	1/04/06	3/13/08	76.5 Inner 70.0 Outer	76.5 - 81.0	81.5	29.66	21.81	7.85	NMT	DEEP ZONE MONITORING WELL
UST645- MW28	12/28/05	3/13/08	77.0 Inner 70.0 Outer	77.0 - 81.5	82.0	26.75	19.11	7.64	NMT	DEEP ZONE MONITORING WELL
UST645- MW29	12/28/05	3/13/08	75.0 Inner 70.0 Outer	75.0 - 79.5	80.0	25.67	18.29	7.38	NMT	DEEP ZONE MONITORING WELL
UST645- MW30	1/03/06	3/13/08	75.0 Inner 70.0 Outer	75.0 - 79.5	80.0	28.77	21.32	7.45	NMT	DEEP ZONE MONITORING WELL

Reference Point for Elevation Measurements (GPS), NGVD 88

** If free product is present in a well, groundwater elevation was calculated by: [Top of Casing Elevation - Depth to Water] + [Free-Phase Product Thickness x 0.82]

ft. BLS = feet below land surface

NMT = No Measurable Thickness

ND = No Data

TABLE 1
MONITORING WELL CONSTRUCTION AND GAUGING INFORMATION

Incident Number and Name: 87556 - BUILDING 645

WELL IDENTIFICATION	DATE INSTALLED (m/dd/yy)	DATE WATER LEVEL MEASURED (m/dd/yy)	WELL CASING DEPTH (ft. BLS)	SCREENED INTERVAL (x to y ft. BLS)	BOTTOM OF WELL (ft. BLS)	TOP OF CASING ELEV.* (ft.)	DEPTH TO WATER From Top of Casing (ft.)	GROUND-WATER ELEV.* (ft.)	FREE-PHASE PRODUCT THICKNESS (ft.)	COMMENTS
UST645- MW31	12/30/05	3/13/08	97.0 Inner 90.0 Outer	97.0 - 101.5	102.0	28.27	21.78	6.49	NMT	DEEP ZONE MONITORING WELL
UST645- MW32	4/09/06	3/13/08	74.5 Inner 70.0 Outer	74.5 - 79.5	80.0	28.84	21.12	7.72	NMT	DEEP ZONE MONITORING WELL
UST645- MW33	9/13/07	3/13/08	75.0 Inner 70.0 Outer	75.0 - 79.5	80.0	25.17	17.83	7.34	NMT	DEEP ZONE MONITORING WELL
UST645- MW34	9/13/07	3/13/08	75.0 Inner 70.0 Outer	75.0 - 79.5	80.0	27.58	20.17	7.41	NMT	DEEP ZONE MONITORING WELL
UST645- MW35	1/31/08	3/13/08	101.0 Inner 96.0 Outer	101.0 - 105.5	106.0	26.12	19.81	6.31	NMT	DEEP ZONE MONITORING WELL
UST645- MW36	2/29/08	3/13/08	75.0 Inner 70.0 Outer	75.0 - 79.5	80.0	31.39	23.81	7.58	NMT	DEEP ZONE MONITORING WELL
UST645- MW37	2/06/08	3/13/08	75.0 Inner 70.0 Outer	75.0 - 79.5	80.0	30.45	22.96	7.49	NMT	DEEP ZONE MONITORING WELL

Reference Point for Elevation Measurements (GPS), NGVD 88

** If free product is present in a well, groundwater elevation was calculated by: [Top of Casing Elevation - Depth to Water] + [Free-Phase Product Thickness x 0.82]

ft. BLS = feet below land surface

NMT = No Measurable Thickness

ND = No Data

TABLE 2
SUMMARY OF GROUNDWATER LABORATORY RESULTS
EPA METHODS 601, 602, AND 8270

Incident Name and No.: Building 645 - 87556

Well ID	EPA Method		602						601	8270	
	Sample ID	Date Collected	Ethylbenzene	Diisopropyl ether (DIPE)	Toluene	Methyl-tert butyl ether (MTBE)	Benzene	Total Xylenes	All EPA Method 601 Analytes	Phenol	All Other EPA Method 8270 Analytes
2L GWQS (µg/L)			550	70	1,000	200	1	530	Varies	300	Varies
UST645-MW18	UST645 MW-18*	10/18/2007	55	<8	<8	<16	6.94 J	<32	NA	<10	BMDL
UST645-MW26	UST645 MW-26*	10/18/2007	287	<160	3,410	<320	1,700	896	NA	20.7	BMDL
UST645-MW27	UST645 MW-27*	10/18/2007	64	<10	4.28 J	109	101	<40	NA	<10	BMDL
UST645-MW29	UST645 MW-29*	10/18/2007	<1	<1	0.4 J	<2	42.6	<4	NA	<10	BMDL
UST645-MW30	UST645 MW-30*	10/18/2007	<1	<1	0.4 J	<2	<1	<4	NA	<10	BMDL
UST645-MW32	UST645 MW-32*	10/18/2007	<1	<1	0.22 J	<2	<1	<4	NA	<10	BMDL
UST645-MW33	UST645 MW-33*	10/19/2007	<1	<1	0.26 J	<2	2.07	<4	NA	<10	BMDL
UST645-MW34	UST645 MW-34*	10/19/2007	<1	<1	0.34 J	<2	7.76	<4	NA	<10	BMDL
UST645 MW-DUP	UST645 MW-DUP*	10/19/2007	<1	<1	0.34 J	<2	2.17	<4	NA	<10	BMDL
UST645-MW35	UST645-MW35	3/7/2008	<0.181	<0.229	0.22 J	<0.359	<0.183	<1.065	BMDL	NA	NA
UST645-MW36	UST645-MW36	3/7/2008	<0.181	<0.229	<0.157	<0.359	<0.183	<1.065	BMDL	NA	NA
UST645-MW36 DUP	UST645-MW36 DUP	3/7/2008	NA	NA	NA	NA	NA	NA	BMDL	NA	NA
UST645-MW37	UST645-MW37	3/7/2008	<0.181	<0.229	0.249 J	<0.359	0.754 J	<1.065	BMDL	NA	NA

All results in micrograms per liter (µg/L).

BMDL = Below Method Detection Limit

NA = Not Analyzed

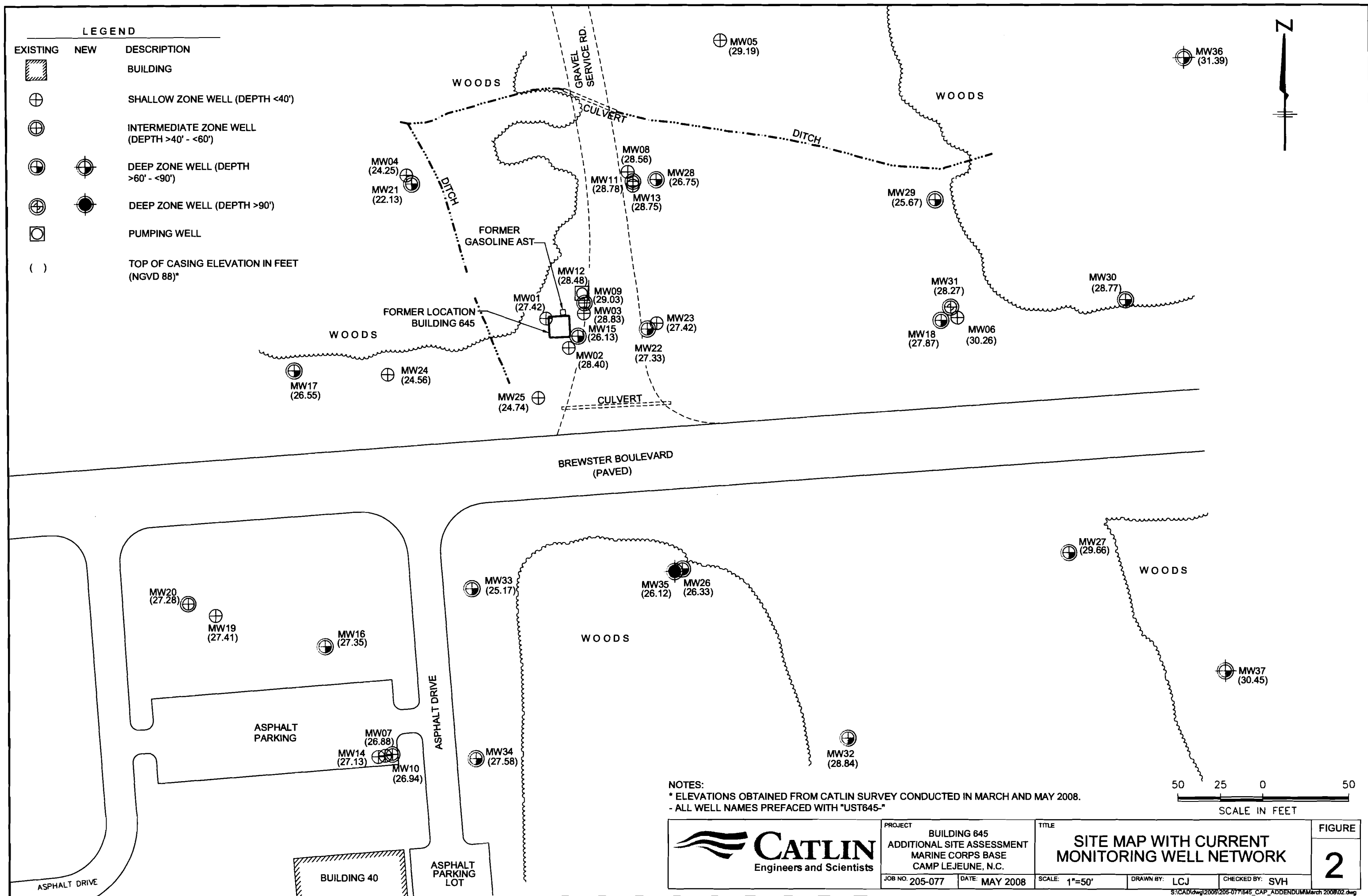
J = Estimated concentration, below calibration range and above method detection limit

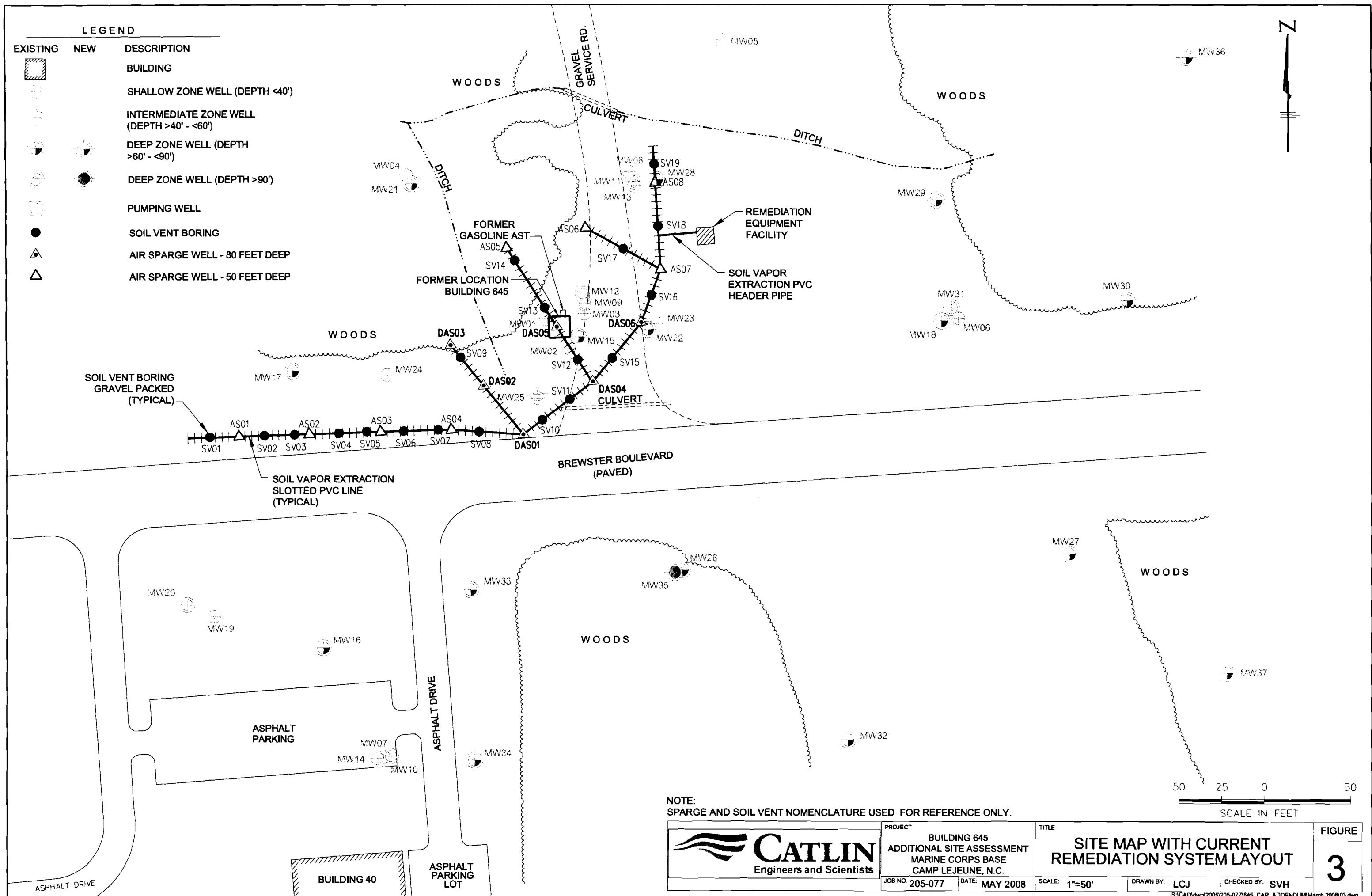
2L GWQS = NCAC T15A:02L Groundwater Quality Standards

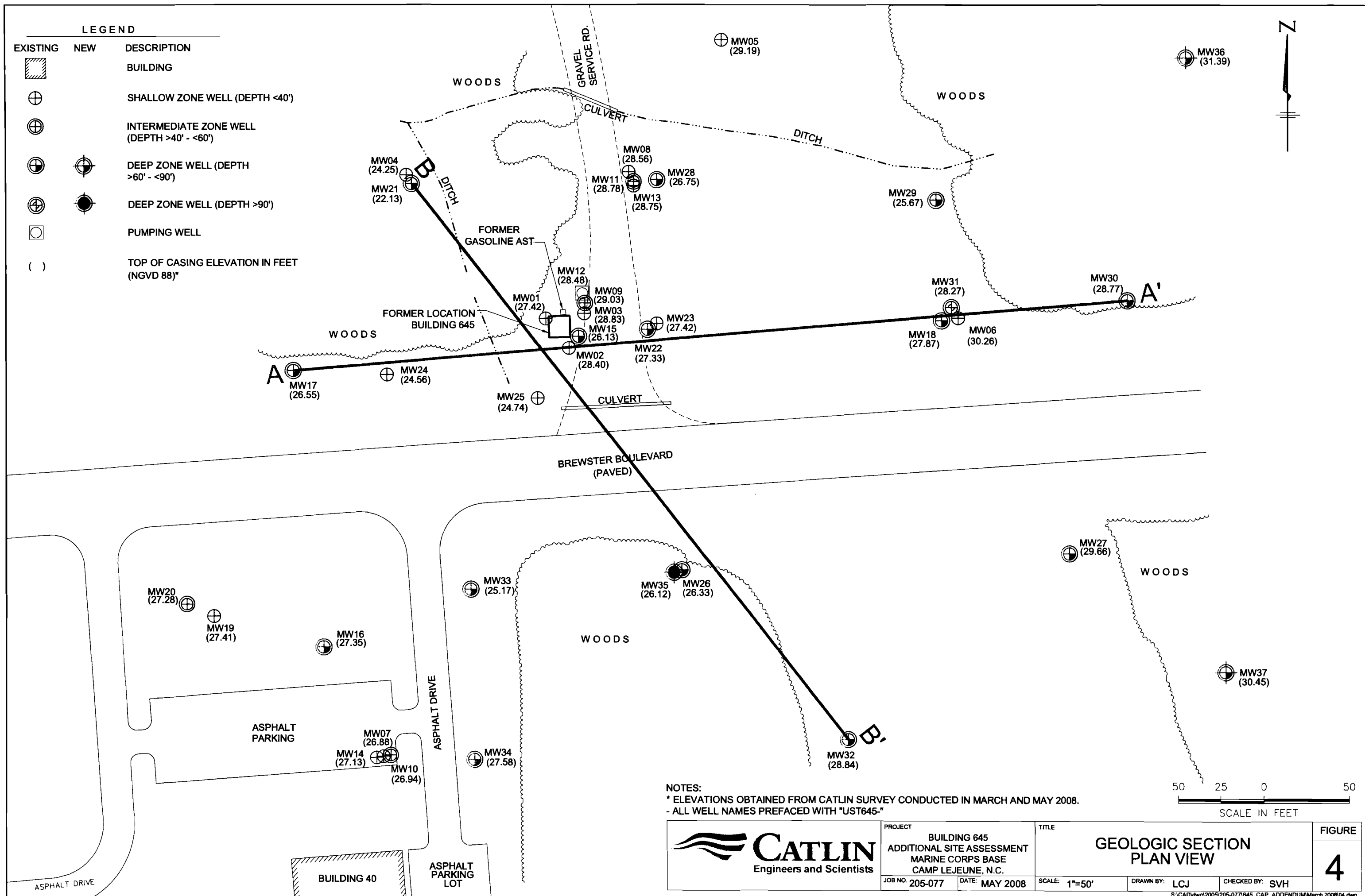
Bold results indicate concentrations above 2L GWQS.

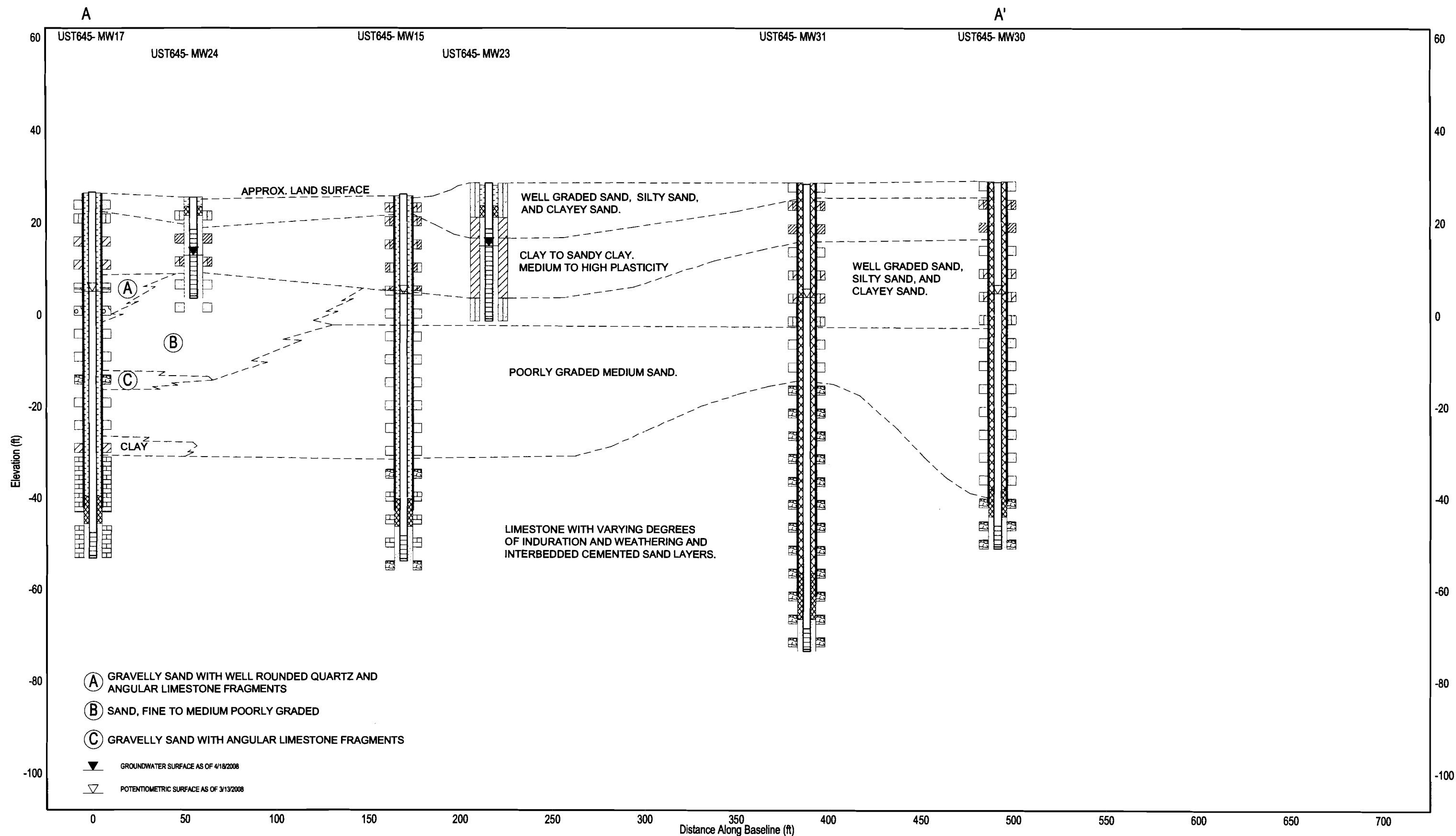
< = Less than method detection limit

* = Samples collected by Sovereign



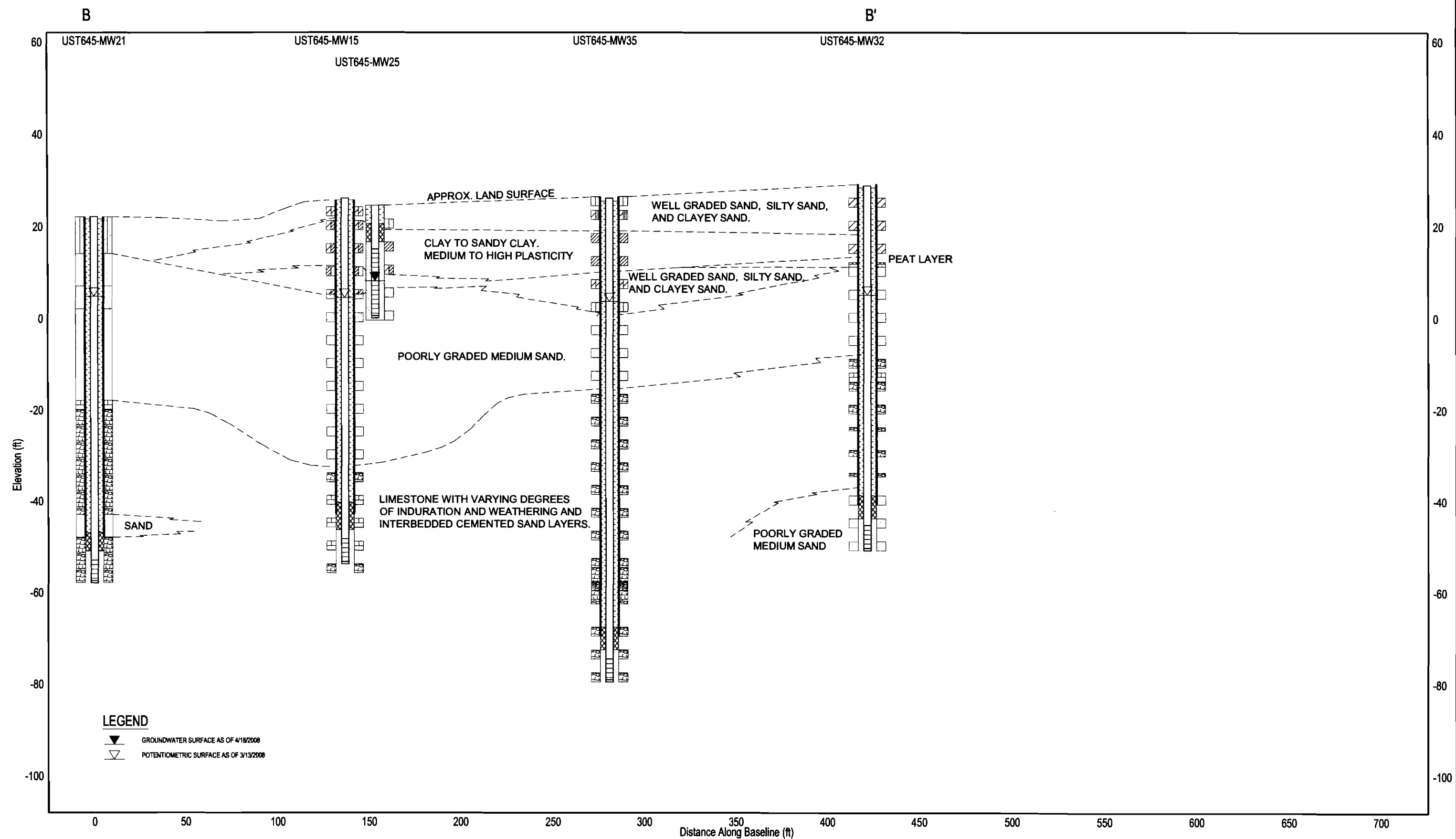






PROJECT: BUILDING 645
 ADDITIONAL SITE ASSESSMENT
 MARINE CORPS BASE
 CAMP LEJEUNE, N.C.
 JOB NO. 205-077 DATE: MAY 2008

TITLE: GEOLOGIC SECTION A - A'
 SCALE: 1"=50'
 DRAWN BY: LCJ CHECKED BY: SVH
 FIGURE 4A



SOILS LEGEND

	(SC-CL) Clayey Sand to Sandy Clay		(SW) Well-graded Sand		Limestone
	USCS Low to High Plast. Clay		(SP) Poorly-graded Sand		(SM) Silty Sand
	(CH) Interbedded High Plast. Clay and Poorly Graded Sand		Weathered Limestone		(CH) High Plasticity Clay
					(SC) Clayey Sand
					(CL) Low to Med. Plasticity Inorganic Clay
					(PT) Peat or Highly Organic Soils

WELL BACKFILL

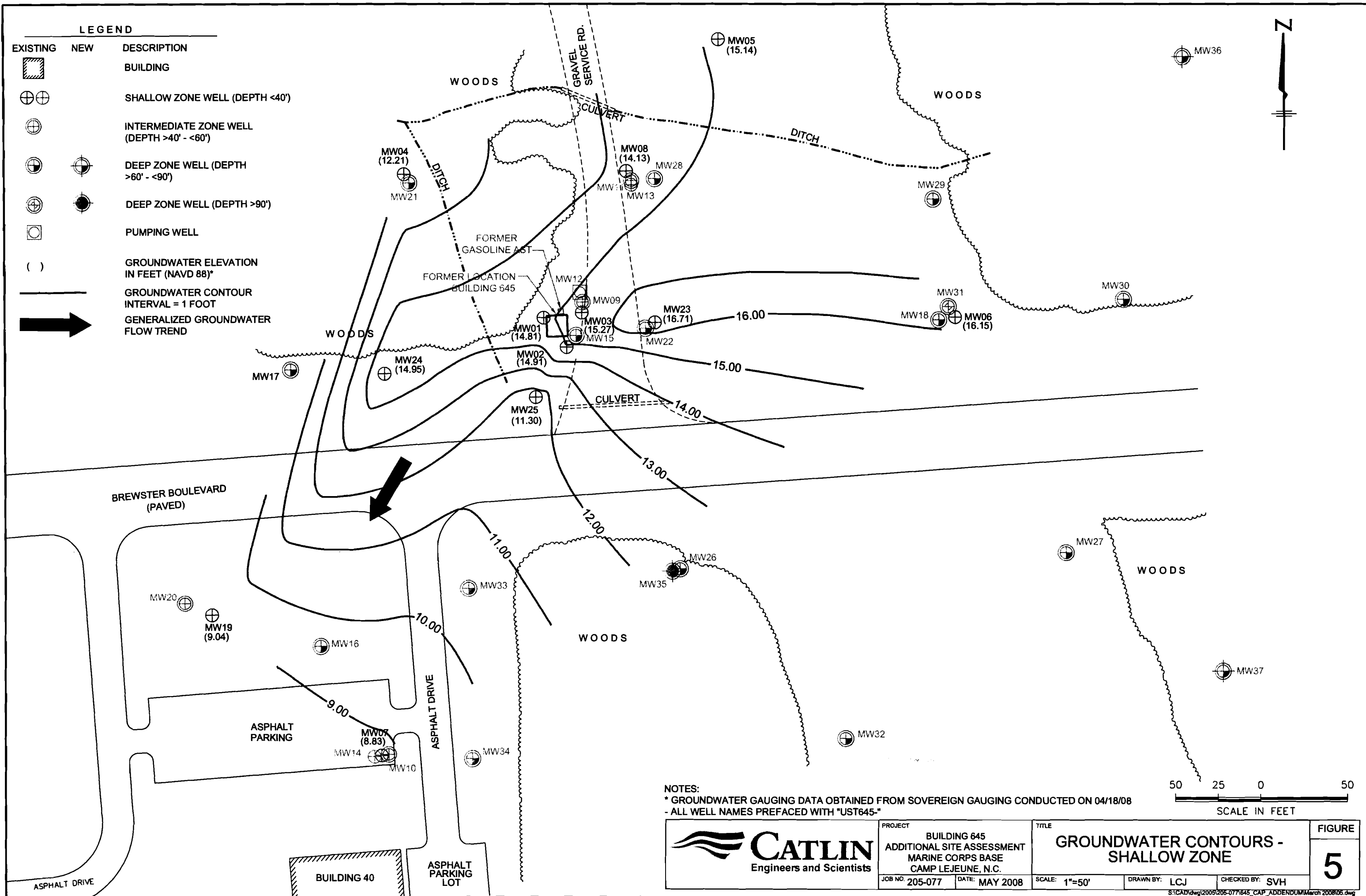
	Portland Cement
	Bentonite Pellets
	#2 Medium Sand

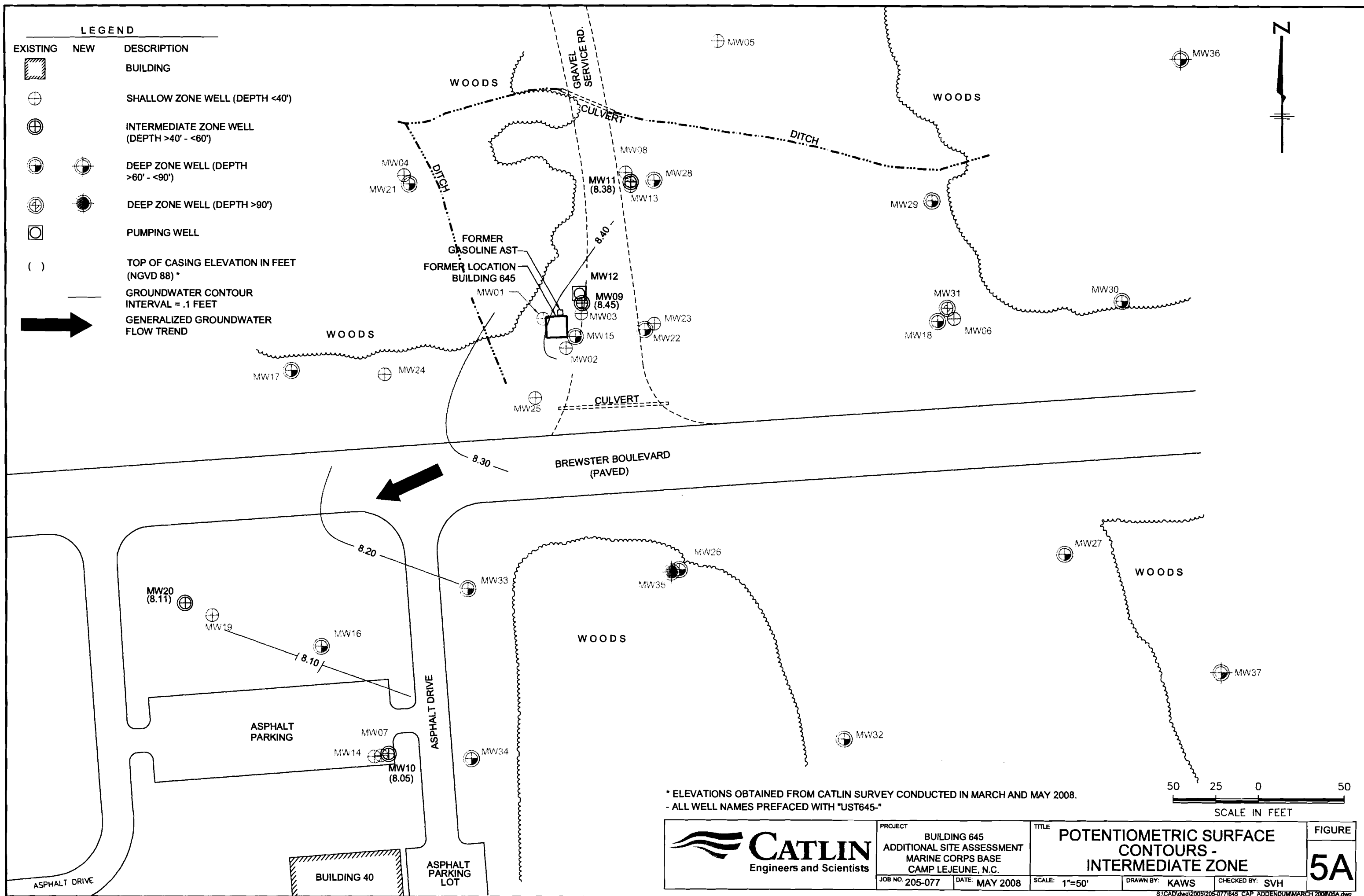


PROJECT	BUILDING 645 ADDITIONAL SITE ASSESSMENT MARINE CORPS BASE CAMP LEJEUNE, N.C.
JOB NO.	205-077
DATE	MAY 2008

TITLE	GEOLOGIC SECTION B - B'	FIGURE	4B
SCALE	1"=50'	DRAWN BY	LCJ
		CHECKED BY	SVH

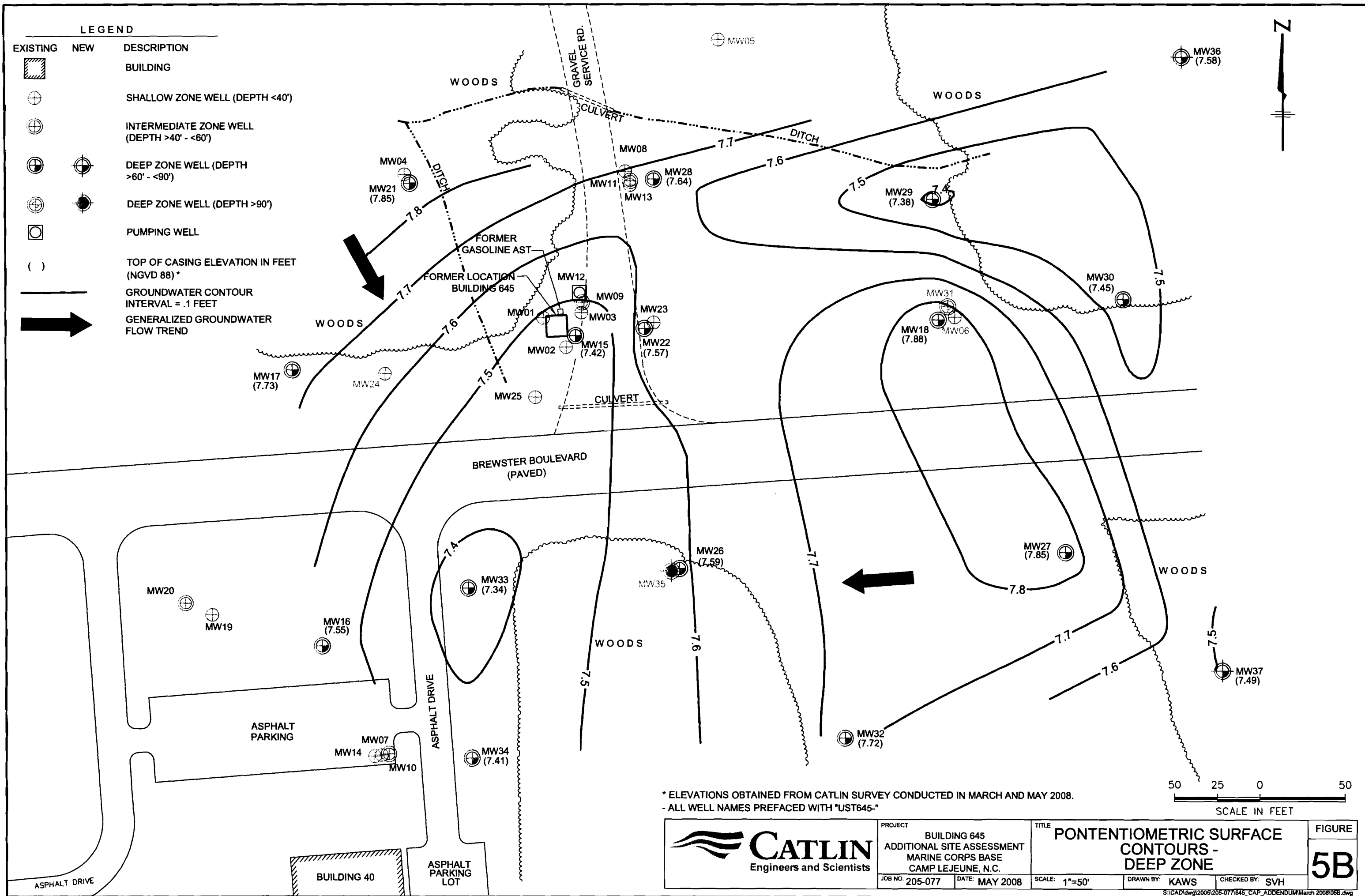
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 CATLIN Engineers and Scientists	PROJECT BUILDING 645 ADDITIONAL SITE ASSESSMENT MARINE CORPS BASE CAMP LEJEUNE, N.C.	TITLE POTENTIOMETRIC SURFACE CONTOURS - INTERMEDIATE ZONE	FIGURE 5A
	JOB NO. 205-077 DATE: MAY 2008	SCALE: 1"=50' DRAWN BY: KAWS CHECKED BY: SVH	

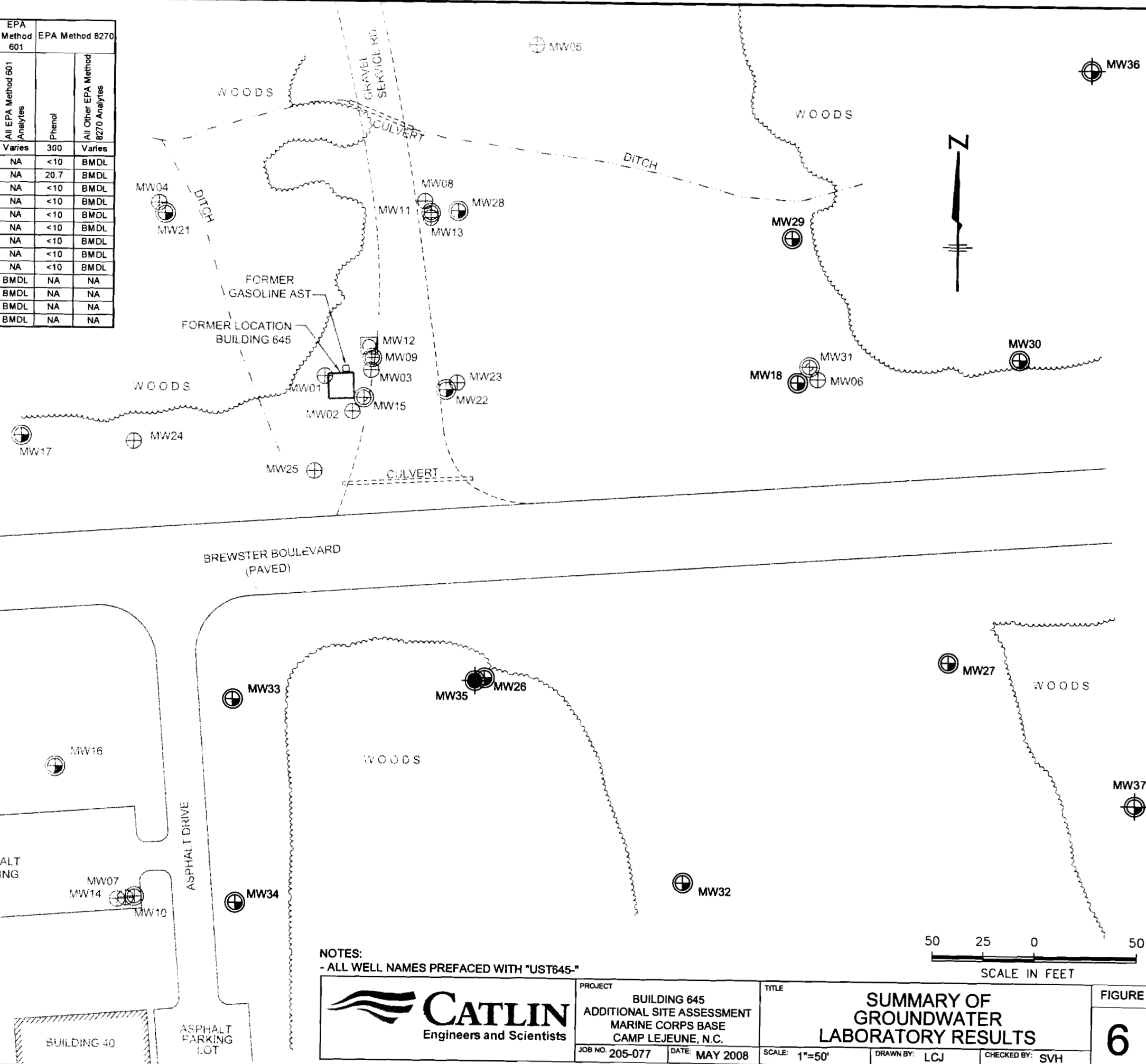
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EPA METHODS 601, 602, AND 8270

Well ID	Contaminant of Concern		EPA Method 602						EPA Method 601	EPA Method 8270	
	Sample ID	Date Collected	Ethylbenzene	Disopropyl ether (DIPE)	Toluene	Methyl-tert butyl ether (MTBE)	Benzene	Total Xylenes	All EPA Method 601 Analytes	Phenol	All Other EPA Method 8270 Analytes
2L GWQS (µg/L)			550	70	1,000	200	1	530	Varies	300	Varies
UST645-MW18*	UST645 MW-18	10/18/2007	55	<8	<8	<16	6.94 J	<32	NA	<10	BMDL
UST645-MW26*	UST645 MW-26	10/18/2007	287	<160	3,410	<320	1,700	896	NA	20.7	BMDL
UST645-MW27*	UST645 MW-27	10/18/2007	64	<10	4.28 J	109	101	<40	NA	<10	BMDL
UST645-MW29*	UST645 MW-29	10/18/2007	<1	<1	0.4 J	<2	42.8	<4	NA	<10	BMDL
UST645-MW30*	UST645 MW-30	10/18/2007	<1	<1	0.4 J	<2	<1	<4	NA	<10	BMDL
UST645-MW32*	UST645 MW-32	10/18/2007	<1	<1	0.22 J	<2	<1	<4	NA	<10	BMDL
UST645-MW33*	UST645 MW-33	10/19/2007	<1	<1	0.26 J	<2	2.07	<4	NA	<10	BMDL
UST645-MW34*	UST645 MW-34	10/19/2007	<1	<1	0.34 J	<2	7.76	<4	NA	<10	BMDL
UST645-MW-DUP*	UST645 MW-DUP	10/19/2007	<1	<1	0.34 J	<2	2.17	<4	NA	<10	BMDL
UST645-MW35	UST645-MW35	3/7/2008	<0.181	<0.229	0.22 J	<0.359	<0.183	<1.065	BMDL	NA	NA
UST645-MW36	UST645-MW36	3/7/2008	<0.181	<0.229	<0.157	<0.359	<0.183	<1.065	BMDL	NA	NA
UST645-MW36 DUP	UST645-MW36 DUP	3/7/2008	NA	NA	NA	NA	NA	NA	BMDL	NA	NA
UST645-MW37	UST645-MW37	3/7/2008	<0.181	<0.229	0.249 J	<0.359	0.754 J	<1.065	BMDL	NA	NA

All results in micrograms per liter (µg/L).
 BMDL = Below Method Detection Limit
 NA = Not Analyzed
 2L GWQS = NCAC T15A.02L Groundwater Quality Standards
 Bold results indicate concentrations above 2L GWQS
 J = Estimated Value
 < = Less than method detection limit
 * = Samples collected by Sovereign



LEGEND	
EXISTING	NEW
BUILDING	
SHALLOW ZONE WELL (DEPTH <40')	
INTERMEDIATE ZONE WELL (DEPTH >40' - <60')	
DEEP ZONE WELL (DEPTH >60' - <90')	
DEEP ZONE WELL (DEPTH >90')	
PUMPING WELL	

NOTES:
 - ALL WELL NAMES PREFACED WITH "UST645-"

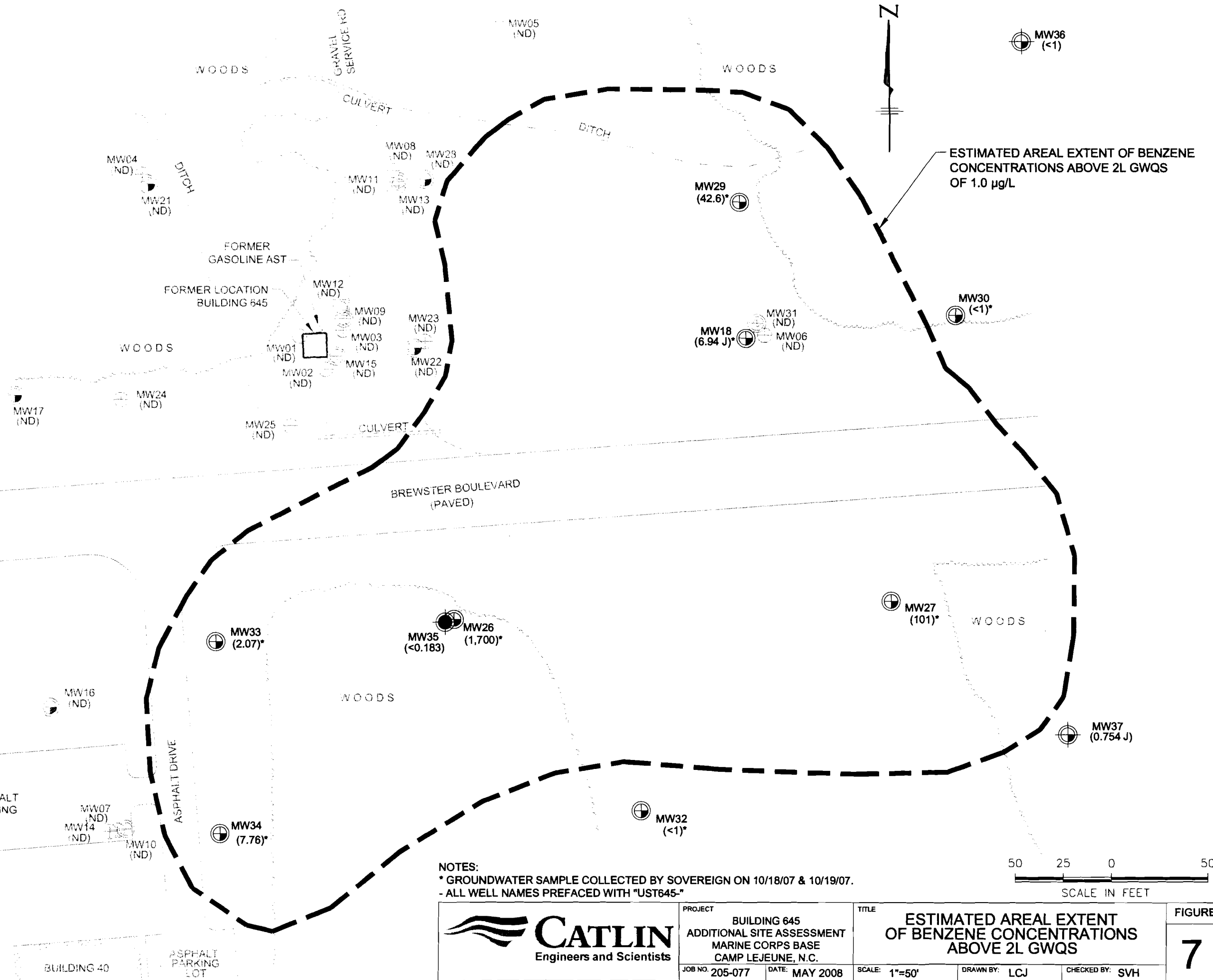
CATLIN Engineers and Scientists	PROJECT BUILDING 645 ADDITIONAL SITE ASSESSMENT MARINE CORPS BASE CAMP LEJEUNE, N.C.	TITLE SUMMARY OF GROUNDWATER LABORATORY RESULTS	FIGURE 6
JOB NO. 205-077	DATE MAY 2008	SCALE 1"=50'	DRAWN BY: LCJ CHECKED BY: SVH

S:\CADD\dwg\2005\205-077\645_CAP_ADDENDUMMarch 2008\06.dwg

LEGEND

EXISTING NEW DESCRIPTION

-  BUILDING
-  SHALLOW ZONE WELL (DEPTH <40')
-  INTERMEDIATE ZONE WELL (DEPTH >40' - <60')
-  DEEP ZONE WELL (DEPTH >60' - <90')
-  DEEP ZONE WELL (DEPTH >90')
-  PUMPING WELL
-  () BENZENE CONCENTRATIONS (µg/L)
-  ND NO DATA
-  J ESTIMATED VALUE

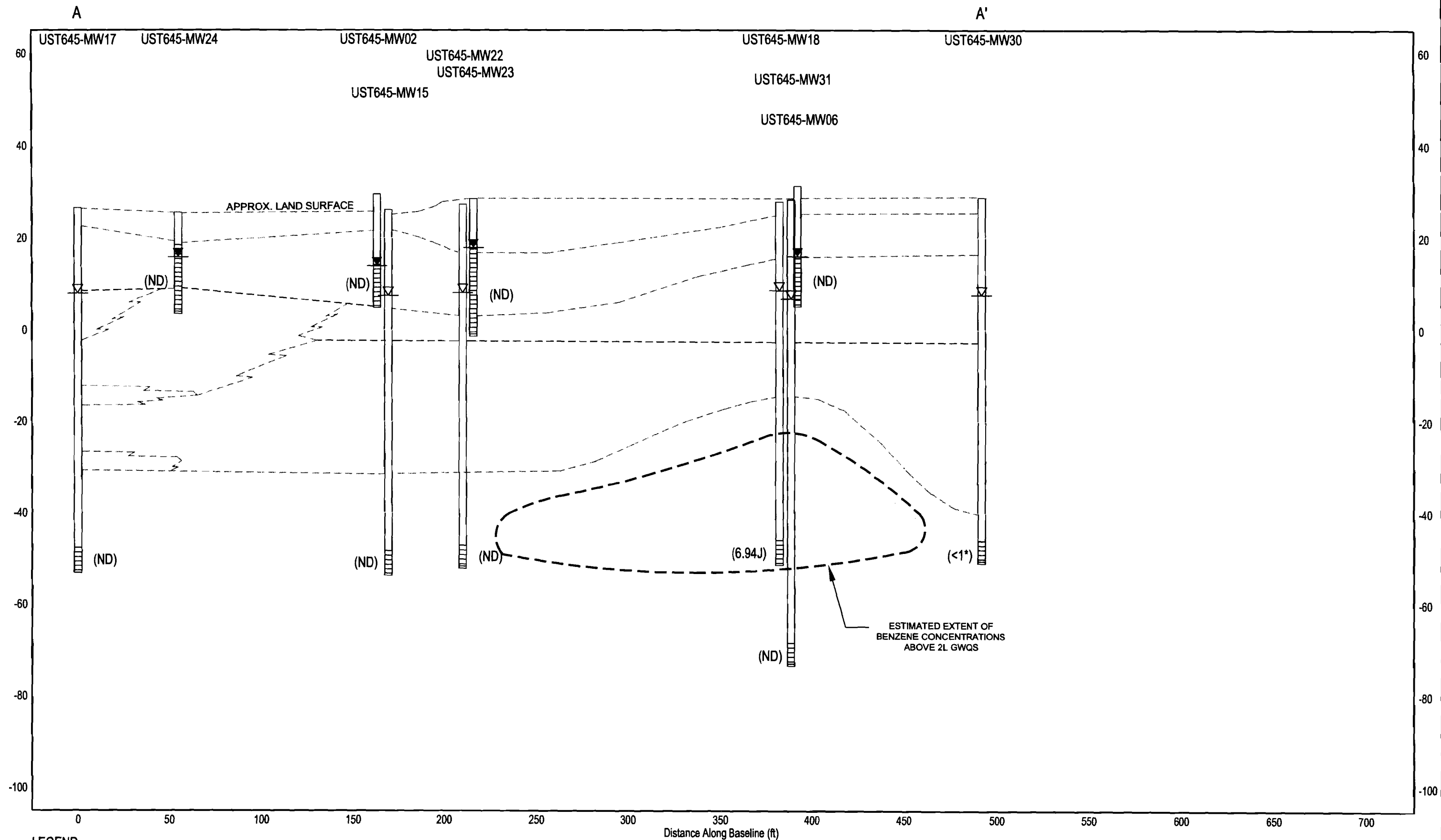


NOTES:
 * GROUNDWATER SAMPLE COLLECTED BY SOVEREIGN ON 10/18/07 & 10/19/07.
 - ALL WELL NAMES PREFACED WITH "UST645-"

50 25 0 50
 SCALE IN FEET

 CATLIN Engineers and Scientists	PROJECT BUILDING 645 ADDITIONAL SITE ASSESSMENT MARINE CORPS BASE CAMP LEJEUNE, N.C.	TITLE ESTIMATED AREAL EXTENT OF BENZENE CONCENTRATIONS ABOVE 2L GWQS	FIGURE 7
JOB NO. 205-077	DATE: MAY 2008	SCALE: 1"=50'	DRAWN BY: LCJ CHECKED BY: SVH

S:\CAD\dwg\2005\205-077\645_CAP_ADDENDUM\March 2008\07.dwg



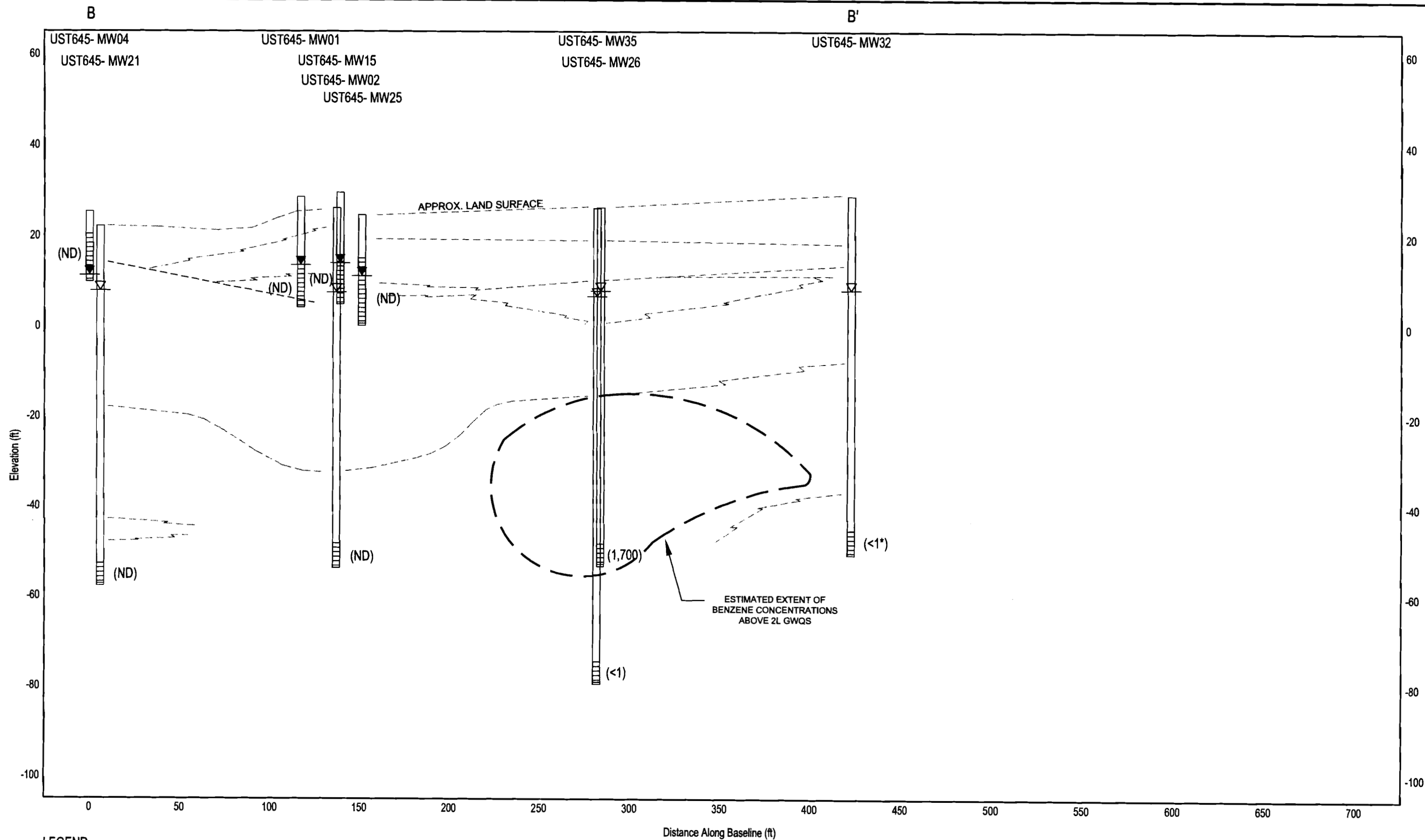
PROJECT
BUILDING 645
ADDITIONAL SITE ASSESSMENT
MARINE CORPS BASE
CAMP LEJEUNE, N.C.

JOB NO. 205-077 DATE: MAY 2008

TITLE
ESTIMATED VERTICAL EXTENT OF BENZENE
CONCENTRATIONS ABOVE 2L GWQS
SECTION A-A'

SCALE: 1"=50' DRAWN BY: LCJ CHECKED BY: SVH

FIGURE
7A



LEGEND

- ▼ GROUNDWATER SURFACE AS OF 4/18/2008
- ▽ POTENTIOMETRIC SURFACE AS OF 3/13/2008
- () BENZENE CONCENTRATION ($\mu\text{g/L}$)
- ND NO DATA
- J ESTIMATED VALUE
- GROUNDWATER SAMPLE COLLECTED BY SOVEREIGN 10/18/07 & 10/19/07.



PROJECT
BUILDING 645
ADDITIONAL SITE ASSESSMENT
MARINE CORPS BASE
CAMP LEJEUNE, N.C.

JOB NO. 205-077 DATE: MAY 2008

TITLE
ESTIMATED VERTICAL EXTENT OF BENZENE
CONCENTRATIONS ABOVE 2L GWQS
SECTION B-B'

SCALE: 1"=50' DRAWN BY: LCJ CHECKED BY: SVH

FIGURE
7B

APPENDIX B

SELECTED TABLES AND FIGURES FROM THE SOIL AND GROUNDWATER INVESTIGATION SUMMARY REPORT DATED OCTOBER 18, 2007 AND ANNUAL MONITORING REPORT DATED JUNE 27, 2008

**SOIL AND GROUNDWATER INVESTIGATION SUMMARY REPORT 2006-2007
DATED OCTOBER 18, 2007**

TABLES

TABLE 2
SUMMARY OF SOIL SAMPLING RESULTS
 Date: August 20, 2007
 Incident Number and Name: 87556 - Building 645
 Analytical Method: EPA Method 3550 and 5030

Comment	Sample ID	Contaminant of Concern →		TPH-DRO	TPH-GRO
		Date Collected (mm/dd/yy)	Sample Depth (ft BGS)		
UST645	SB01	8/20/2007	10-11	BQL	BQL
UST645	SB02	8/20/2007	11-12	94.4	BQL
UST645	SB03	8/20/2007	11-12	BQL	BQL
UST645	SB04	8/20/2007	11-12	BQL	BQL
NCDENR Action Level (mg/kg)				40	10

- Results reported in mg/kg
- mg/kg = milligrams per kilogram
- **BOLDED** = detected concentration
- **BOLDED** and **shaded** = detected concentration above NCDENR action level.
- ft. BGS = feet below ground surface

TABLE 3
SUMMARY OF GROUNDWATER SAMPLING RESULTS
2006-2007

Incident Number and Name: 87556 - Building 645

Analytical Method: EPA Method 601

Contaminant of Concern			Chloroform	1,2-Dichloroethane	Other Target Analytes
Well ID	Sample ID	Date Collected			
UST645-MW01	UST645-MW01	7/18/2007	BQL	BQL	BQL
UST645-MW02	UST645-MW02	7/18/2007	BQL	BQL	BQL
UST645-MW03	UST645-MW03	7/18/2007	BQL	BQL	BQL
UST645-MW04	UST645-MW04	7/18/2007	BQL	BQL	BQL
UST645-MW05	UST645-MW05	7/19/2007	BQL	BQL	BQL
UST645-MW06	UST645-MW06	7/19/2007	BQL	BQL	BQL
UST645-MW07	UST645-MW07	7/19/2007	BQL	BQL	BQL
UST645-MW08	UST645-MW08	7/17/2007	BQL	BQL	BQL
UST645-MW09	UST645-MW09	7/18/2007	BQL	BQL	BQL
UST645-MW10	UST645-MW10	7/18/2007	BQL	BQL	BQL
UST645-MW11	UST645-MW11	7/17/2007	BQL	BQL	BQL
UST645-MW12	UST645-MW12	7/17/2007	BQL	BQL	BQL
UST645-MW13	UST645-MW13	7/17/2007	BQL	BQL	BQL
UST645-MW14	UST645-MW14	7/19/2007	BQL	BQL	BQL
UST645-MW15	UST645-MW15	7/17/2007	BQL	BQL	BQL
UST645-MW16	UST645-MW16	7/19/2007	BQL	BQL	BQL
UST645-MW17	UST645-MW17	7/18/2007	BQL	BQL	BQL
UST645-MW18	UST645-MW18	7/19/2007	BQL	BQL	BQL
UST645-MW19	UST645-MW19	7/18/2007	BQL	BQL	BQL
UST645-MW20	UST645-MW20	7/18/2007	BQL	BQL	BQL
UST645-MW21	UST645-MW21	7/18/2007	BQL	BQL	BQL
UST645-MW22	UST645-MW22	7/17/2007	BQL	BQL	BQL
UST645-MW23	UST645-MW23	7/18/2007	BQL	BQL	BQL
UST645-MW24	UST645-MW24	7/18/2007	BQL	BQL	BQL
UST645-MW25	UST645-MW25	7/18/2007	BQL	BQL	BQL
UST645-MW26	UST645-MW26	7/19/2007	BQL	BQL	BQL
UST645-MW27	UST645-MW27	7/19/2007	BQL	0.159	BQL
UST645-MW28	UST645-MW28	7/17/2007	BQL	BQL	BQL
UST645-MW29	UST645-MW29	7/19/2007	BQL	BQL	BQL
UST645-MW30	UST645-MW30	7/19/2007	BQL	BQL	BQL
UST645-MW31	UST645-MW31	7/19/2007	0.964	BQL	BQL
UST645-MW32	UST645-MW32	7/19/2007	BQL	BQL	BQL
Duplicate	Duplicate	7/18/2007	BQL	BQL	BQL
2L Standard (µg/l)			70	0.38	Varies

- Duplicate sample MW23 in July 2007.
- All results reported in µg/l
- µg/L =micrograms per liter
- BQL = Below Quantitation Limits
- **BOLD** = Detected concentration.
- **BOLD** and shaded = detected concentration above applicable standard

TABLE 4
SUMMARY OF GROUNDWATER SAMPLING RESULTS
 July 2007

Incident Number and Name: 87556 - Building 645

Analytical Method: EPA Method 602

Contaminant of Concern			Benzene	Diisopropyl ether (DIPE)	Ethylbenzene	Methyl-tert butyl ether (MTBE)	Toluene	Total Xylenes
Well ID	Sample ID	Date Collected						
UST645-MW01	UST645-MW01	7/18/2007	BQL	BQL	BQL	BQL	BQL	BQL
UST645-MW02	UST645-MW02	7/18/2007	BQL	BQL	BQL	BQL	BQL	BQL
UST645-MW03	UST645-MW03	7/18/2007	BQL	BQL	11.0	BQL	BQL	BQL
UST645-MW04	UST645-MW04	7/18/2007	BQL	BQL	BQL	BQL	BQL	BQL
UST645-MW05	UST645-MW05	7/19/2007	BQL	BQL	BQL	BQL	BQL	BQL
UST645-MW06	UST645-MW06	7/19/2007	BQL	BQL	BQL	BQL	BQL	BQL
UST645-MW07	UST645-MW07	7/19/2007	BQL	BQL	BQL	BQL	BQL	BQL
UST645-MW08	UST645-MW08	7/17/2007	BQL	BQL	BQL	BQL	BQL	BQL
UST645-MW09	UST645-MW09	7/18/2007	BQL	BQL	BQL	BQL	BQL	BQL
UST645-MW10	UST645-MW10	7/18/2007	BQL	BQL	BQL	BQL	BQL	BQL
UST645-MW11	UST645-MW11	7/17/2007	BQL	BQL	BQL	BQL	BQL	BQL
UST645-MW12	UST645-MW12	7/17/2007	BQL	BQL	146	BQL	BQL	361
UST645-MW13	UST645-MW13	7/17/2007	BQL	BQL	BQL	BQL	BQL	BQL
UST645-MW14	UST645-MW14	7/19/2007	BQL	BQL	BQL	BQL	BQL	BQL
UST645-MW15	UST645-MW15	7/17/2007	BQL	BQL	BQL	2.34	BQL	BQL
UST645-MW16	UST645-MW16	7/19/2007	BQL	BQL	BQL	BQL	BQL	BQL
UST645-MW17	UST645-MW17	7/18/2007	BQL	BQL	BQL	BQL	BQL	BQL
UST645-MW18	UST645-MW18	7/19/2007	7.20	BQL	72.8	BQL	BQL	BQL
UST645-MW19	UST645-MW19	7/18/2007	BQL	BQL	BQL	BQL	BQL	BQL
UST645-MW20	UST645-MW20	7/18/2007	BQL	BQL	BQL	BQL	BQL	BQL
UST645-MW21	UST645-MW21	7/18/2007	BQL	BQL	BQL	BQL	BQL	BQL
UST645-MW22	UST645-MW22	7/17/2007	BQL	BQL	BQL	5.07	BQL	BQL
UST645-MW23	UST645-MW23	7/18/2007	BQL	BQL	BQL	BQL	BQL	BQL
UST645-MW24	UST645-MW24	7/18/2007	BQL	BQL	BQL	BQL	BQL	BQL
UST645-MW25	UST645-MW25	7/18/2007	BQL	BQL	BQL	BQL	BQL	BQL
UST645-MW26	UST645-MW26	7/19/2007	1,180	BQL	50.8	BQL	3,900	BQL
UST645-MW27	UST645-MW27	7/19/2007	25.3	BQL	BQL	52.2	BQL	BQL
UST645-MW28	UST645-MW28	7/17/2007	4.33	BQL	BQL	BQL	BQL	BQL
UST645-MW29	UST645-MW29	7/19/2007	22.4	BQL	BQL	BQL	BQL	BQL
UST645-MW30	UST645-MW30	7/19/2007	BQL	BQL	BQL	BQL	BQL	BQL
UST645-MW31	UST645-MW31	7/19/2007	BQL	BQL	BQL	BQL	BQL	BQL
UST645-MW32	UST645-MW32	7/19/2007	BQL	BQL	BQL	BQL	BQL	BQL
Duplicate	Duplicate	7/18/2007	BQL	BQL	BQL	BQL	BQL	BQL
2L Standard (µg/l)			1	70	550	200	1,000	530

- Duplicate sample MW23 in July 2007.

- All results reported in µg/l
- µg/L =micrograms per liter
- BQL = Below Quantitation Limits
- **BOLD** = Detected concentration.
- **BOLD** and shaded = detected concentration above applicable standard

Historical Groundwater Data Table
Analytical Data for March 2007 Sampling Event
Building 645

Parameter	NCGWQS	GCL	MW-18	MW-26	MW-27	MW-29	MW-30	MW-32
VOCs by EPA Method 601/602 (µg/L)								
All Compounds	Varies	Varies	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00
Benzene	1	5,000	3.97	2,060.0	<1.00	36.6	<1.00	<1.00
Diisopropyl ether (DIPE)	70	70,000	<1.00	<1.00	<1.00	<1.00	0.493J	80.4
Ethylbenzene	550	84,500	16.8	325J	<1.00	<1.00	<1.00	<1.00
Methyl-tert butyl ether (MTBE)	200	200,000	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Toluene	1,000	257,500	0.520 J	13,900.0	<1.00	0.600J	<1.00	0.634J
<i>Xylenes (total)</i>	530	87,500	<2.00	436J	<2.00	<2.00	<2.00	<2.00
SVOCs by EPA Method 625 (µg/L)								
Bis(2-ethylhexyl)phthalate	2.5	2,500	NA	NA	NA	NA	NA	NA
Flourene	280	950	NA	NA	NA	NA	NA	NA
Naphthalene	21	15,500	NA	NA	NA	NA	NA	NA
Phenol	300	300,000	NA	NA	NA	NA	NA	NA
TICs (total)			NA	NA	NA	NA	NA	NA
All other Compounds	Varies	Varies	NA	NA	NA	NA	NA	NA
EPA 200.7 / SM 3030C (ug/L)								
Lead (EPA 6010B / SM 3030C) (ug/L)	15	15,000	NA	NA	NA	NA	NA	NA

Bold type indicates detectable concentrations

Bold and highlighted indicates detectable concentrations above the GCL

NCGWQS - North Carolina Groundwater Quality Standard

GCL - Gross Contaminant Level

<# - not detected at the indicated reporting limit

mg/L - milligrams per liter

ug/L - micrograms per liter

NE - Not established

RL - the NCGWQS for the constituent is the reporting limit

ND - None detected (no summed constituents were detected)

J - estimated concentration between minimum detection limit and reporting limit

NA - Not analyzed; laboratory quantitation for the indicated analyte was not conducted

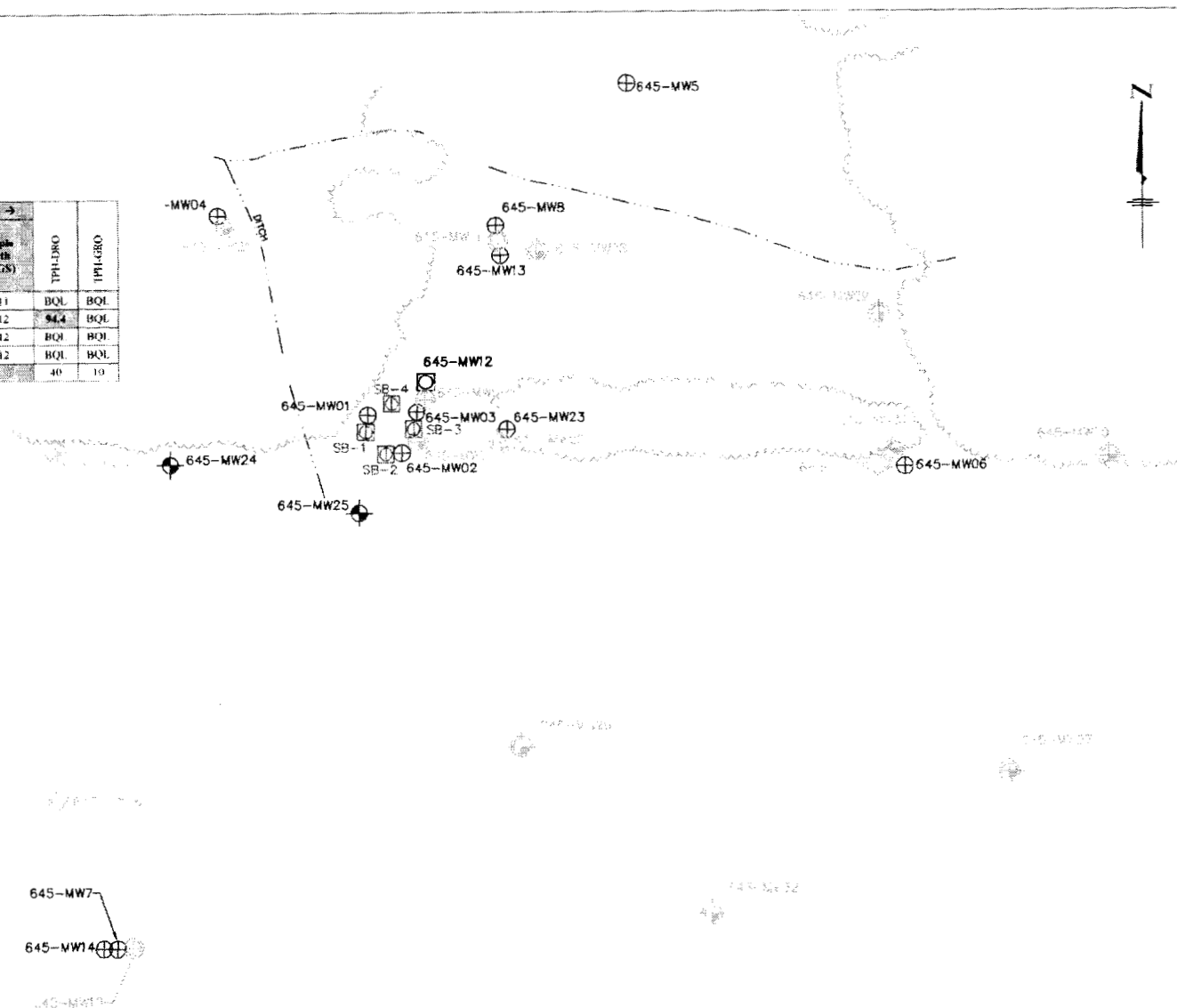
NS - Not sampled; the indicated location was not designated for sampling during the event

E - estimated concentration above the linear quantitation range

FIGURES

SUMMARY OF SOIL SAMPLING RESULTS
 Date: August 20, 2007
 Incident Number and Name: 87556 - Building 645
 Analytical Method: EPA Method 3650 and 5030

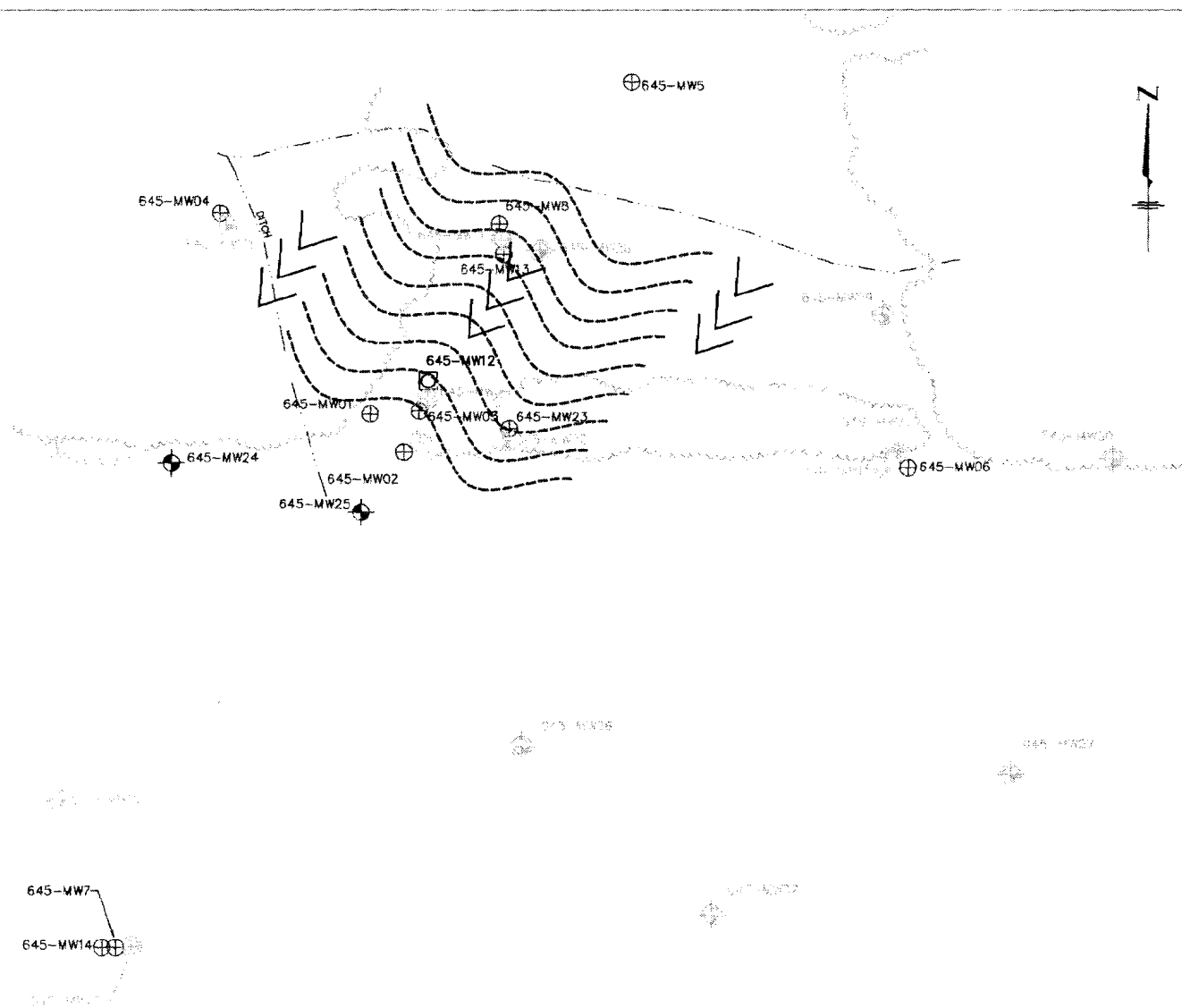
Comment	Sample ID	Date Collected (mm/dd/yyyy)	Sample Depth (ft/BGS)	Contaminant of Concern →	
				TPH-DMO	TPH-CRO
UST645	SB01	8/20/2007	10-11	BQL	BQL
UST645	SB02	8/20/2007	11-12	94.4	BQL
UST645	SB03	8/20/2007	11-12	BQL	BQL
UST645	SB04	8/20/2007	11-12	BQL	BQL
NCDEMR Action Level (mg/kg)				40	10



-
-
-
-
-

SOVEREIGN CONSULTING INC. VIRGINIA BEACH, VIRGINIA	PROJECT BUILDING 645 SUMMARY REPORT MARINE CORPS BASE CAMP LEJEUNE, N.C.	TITLE SITE MAP DEPICTING AUGUST 2007 SOIL SAMPLE LOCATIONS	FIGURE 3
	JOB NO. _____	DATE _____	SCALE _____

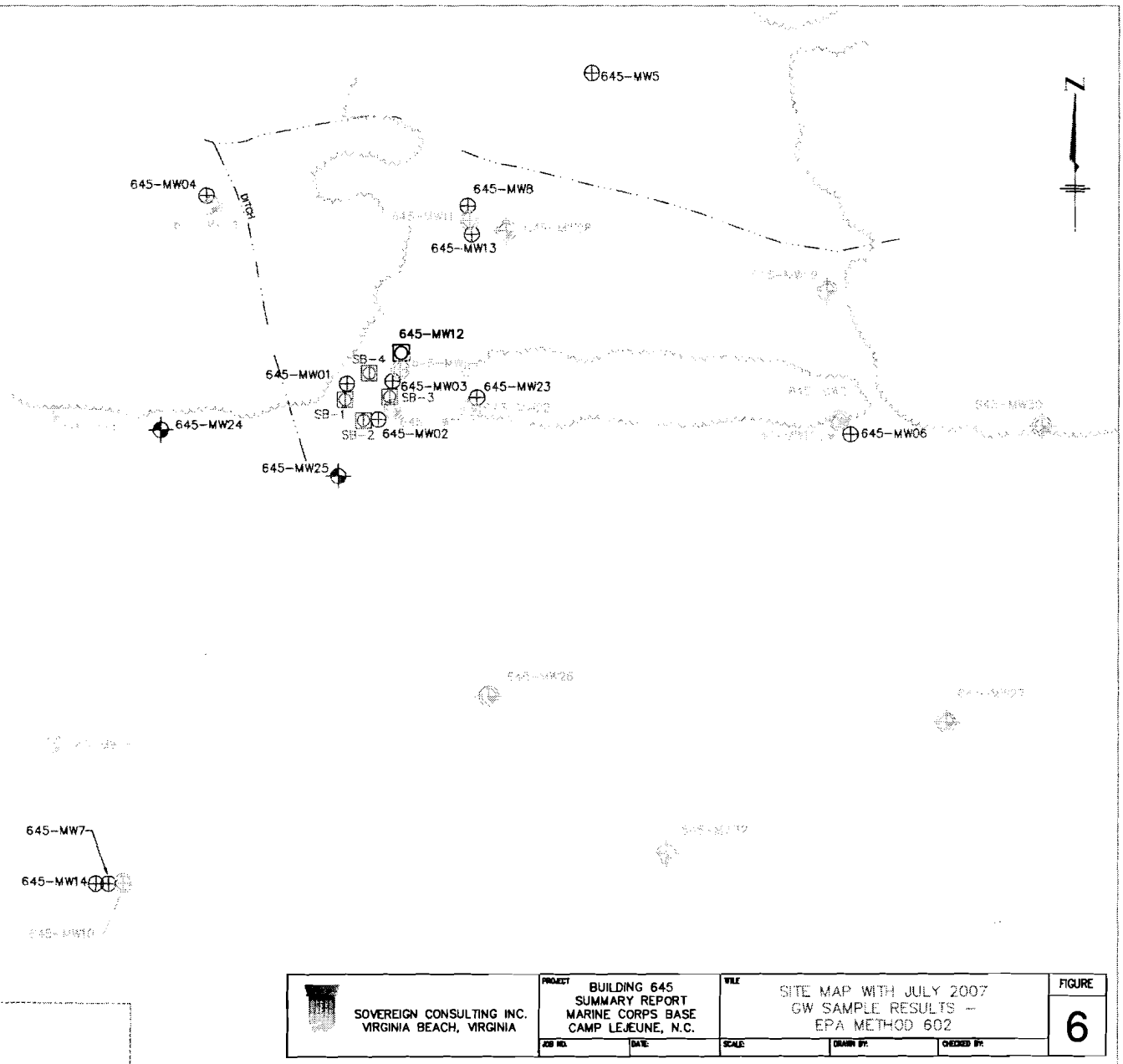
Monitoring Well	Top of Casing Elevation (feet)	Groundwater Elevation (feet)	
		7/17/2007	No Product
645-MW01	28.54	13.48	
645-MW02	27.53	13.40	
645-MW03	26.70	13.42	
645-MW04	25.33	13.37	
645-MW05	24.07	14.75	
645-MW06	23.35	13.05	
645-MW07	22.52	12.44	
645-MW08	20.63	12.83	
645-MW09	20.29	12.2	
645-MW10	20.57	12.77	
645-MW11	20.23	12.52	
645-MW12	20.40	12.09	
645-MW13	20.32	11.69	
645-MW14	19.11	12.78	
645-MW15	22.08	12.44	
645-MW16	28.57	12.57	
645-MW17	22.28	12.66	
645-MW18	21.46	12.46	
645-MW19	28.57	12.84	
645-MW20	28.54	12.60	
645-MW21	23.06	12.84	
645-MW22	25.52	13.06	
645-MW23	24.58	13.11	
645-MW24	25.57	12.27	
645-MW25	24.66	12.55	
645-MW26	21.31	11.72	
645-MW27	20.20	11.96	
645-MW28	20.87	11.77	
645-MW29	20.06	12.06	
645-MW30	20.14	12.11	
645-MW31	20.24	11.84	
645-MW32	20.35	12.37	



 SOVEREIGN CONSULTING INC. VIRGINIA BEACH, VIRGINIA	PROJECT BUILDING 645 SUMMARY REPORT MARINE CORPS BASE CAMP LEJEUNE, N.C.	TITLE SHALLOW GROUNDWATER ELEVATION CONTOUR MAP - JULY 2007	FIGURE 4	
	JOB NO.	DATE	SCALE	DRAWN BY:

Analytical Method: EPA Method 602

Well ID	Sample ID	Date Collected	Parameter	Units	Value	Units	Value	Units	Value	Units	Value
US1645-MW01	US1645-MW01	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW02	US1645-MW02	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW03	US1645-MW03	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW04	US1645-MW04	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW05	US1645-MW05	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW06	US1645-MW06	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW07	US1645-MW07	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW08	US1645-MW08	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW09	US1645-MW09	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW10	US1645-MW10	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW11	US1645-MW11	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW12	US1645-MW12	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW13	US1645-MW13	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW14	US1645-MW14	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW15	US1645-MW15	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW16	US1645-MW16	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW17	US1645-MW17	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW18	US1645-MW18	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW19	US1645-MW19	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW20	US1645-MW20	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW21	US1645-MW21	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW22	US1645-MW22	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW23	US1645-MW23	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW24	US1645-MW24	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW25	US1645-MW25	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW26	US1645-MW26	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW27	US1645-MW27	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW28	US1645-MW28	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW29	US1645-MW29	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW30	US1645-MW30	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW31	US1645-MW31	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
US1645-MW32	US1645-MW32	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
Duplicate	Duplicate	7/18/2007	DO	mg/L	DO	DO	DO	DO	DO	DO	DO
2L Standard (mg/L)			1	70	550	700	1,000	416			



SOVEREIGN CONSULTING INC. VIRGINIA BEACH, VIRGINIA	PROJECT: BUILDING 645 SUMMARY REPORT MARINE CORPS BASE CAMP LEJEUNE, N.C.	FILE: SITE MAP WITH JULY 2007 GW SAMPLE RESULTS - EPA METHOD 602	FIGURE 6
	JOB NO. _____ DATE _____	SCALE _____ DRAWN BY _____	CHECKED BY _____

ANNUAL MONITORING REPORT DATED JUNE 27, 2008

TABLE 5
SUMMARY OF GROUNDWATER SAMPLING RESULTS

Incident Number and Name: 87556 - Building 645

Analytical Method: EPA Method 602

Contaminant of Concern →			Benzene	Diisopropyl ether (DIPE)	Ethylbenzene	Methyl-tert butyl ether (MTBE)	Toluene	Total (m/p, o) Xylenes
Well ID	Sample ID	Date Collected						
2L Standard (µg/l)			1	70	550	200	1,000	530
UST645-MW01	UST645-MW01	7/18/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
		1/23/2008	<0.183	<0.229	15.1	<0.359	12.1	18.35
UST645-MW02	UST645-MW02	7/18/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
		1/23/2008	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW03	UST645-MW03	7/18/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
		1/23/2008	<0.183	<0.229	1.14	<0.359	<0.157	<1.065
UST645-MW04	UST645-MW04	7/18/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW05	UST645-MW05	7/19/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW06	UST645-MW06	7/19/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW07	UST645-MW07	7/19/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW08	UST645-MW08	7/17/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW09	UST645-MW09	7/18/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
		1/23/2008	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW10	UST645-MW10	7/19/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW11	UST645-MW11	7/17/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW12	UST645-MW12	7/18/2007	<1.46	<1.83	146	<2.87	<1.26	361
		1/23/2008	4.65J	<1.83	117	<2.87	3.77J	351
UST645-MW13	UST645-MW13	7/17/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW14	UST645-MW14	7/19/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW15	UST645-MW15	7/18/2007	<0.183	<0.229	<0.181	2.34	<0.157	<1.065
		1/23/2008	<0.183	<0.229	<0.181	3.04	<0.157	<1.065
UST645-MW16	UST645-MW16	7/19/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW17	UST645-MW17	7/18/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW18	UST645-MW18	7/19/2007	7.20	<0.916	72.8	<1.44	<0.628	<4.26
		10/18/2007	6.94J	<1.836	55.0	<2.87	<1.26	<8.52
		1/23/2008	4.44	<0.458	37.3	<0.718	<0.314	1.45J
		4/17/2008	4.09	<0.458	45.9	<0.718	<0.314	<2.132
UST645-MW19	UST645-MW19	7/18/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW20	UST645-MW20	7/18/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW21	UST645-MW21	7/18/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
		1/23/2008	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW22	UST645-MW22	7/18/2007	<0.183	<0.229	<0.181	5.07	<0.157	<1.065
		1/23/2008	<0.183	<0.229	<0.181	6.00	<0.157	<1.065
UST645-MW23	UST645-MW23	7/18/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
		1/23/2008	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW24	UST645-MW24	7/18/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW25	UST645-MW25	7/18/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW26	UST645-MW26	7/19/2007	1,180	<45.8	50.8J	<71.8	3,900	<213.2
		10/18/2007	1,700	<36.6	287	<57.4	3,410	896
		4/17/2008	1,780	<36.6	318	<57.4	4,500	1,011
		7/19/2007	25.3	<0.458	<0.362	52.2	<0.314	<2.132
UST645-MW27	UST645-MW27	10/18/2007	101	<2.29	64.0	109	4.28J	<10.65
		4/17/2008	96.9	3.26J	<1.45	136	4.64J	<8.52

Contaminant of Concern →			Benzene	Diisopropyl ether (DIE)	Ethylbenzene	Methyl-tert butyl ether (MTBE)	Toluene	Total (m/p, o) Xylenes
Well ID	Sample ID	Date Collected						
2L Standard (µg/l)			1	70	550	200	1,000	530
UST645-MW28	UST645-MW28	7/17/2007	4.33	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW29	UST645-MW29	7/19/2007	22.4	<0.229	<0.181	<0.359	<0.157	<1.065
		10/18/2007	42.6	<0.229	<0.181	<0.359	0.406J	<1.065
		4/17/2008	32.1	<0.229	<0.181	1.11J	<0.157	<1.065
UST645-MW30	UST645-MW30	7/19/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
		10/18/2007	<0.183	<0.229	<0.181	<0.359	0.406J	<1.065
		4/17/2008	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW31	UST645-MW31	7/19/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW32	UST645-MW32	7/19/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
		10/18/2007	<0.183	<0.229	<0.181	<0.359	0.226J	<1.065
		4/18/2008	<0.183	<0.229	<0.181	<0.359	1.14	<1.065
UST645-MW33	UST645-MW33	10/19/2007	2.07	<0.229	<0.181	<0.359	0.265J	<1.065
UST645-MW34	UST645-MW34	10/19/2007	7.76	<0.229	<0.181	<0.359	0.341J	<1.065
Duplicate	Duplicate	7/18/2007	<0.183	<0.229	<0.181	4.93	<0.157	<1.065
		10/19/2007	2.17	<0.229	<0.181	<0.359	0.343J	<1.065
		1/23/2008	<0.183	<0.229	<0.181	6.28	<0.157	<1.065
		4/17/2008	87.2	<0.916	<0.724	129	2.56J	<4.26

- Duplicate sample UST645-Duplicate1 from MW23 in July 2007, USTG45MW-DUP from MW34 in Oct 2007, UST645-Duplicate from MW22 in Jan 2008, and UST645-Duplicate from MW27 in April 2008.
- All results reported in µg/l; µg/L =micrograms per liter
- BQL = Below Quantitation Limit (Method Detection Limit (MDL)).
- J = Estimated concentration; below calibration range and above MDL.
- NS = Not Sampled; well installed 9/2007
- **Bold** results indicate a concentration above 2L Standards.

Analytical Method: EPA Method 602 - SHALLOW CONDITIONS

Contaminant of Concern →			Benzene	Diisopropyl ether (DIPE)	Ethylbenzene	Methyl-tert butyl ether (MTBE)	Toluene	Total (m/p, o) Xylenes
Well ID	Sample ID	Date Collected						
UST645-MW01	UST645-MW01	7/18/2007 1/23/2008	<0.183 <0.183	<0.229 <0.229	<0.181 15.1	<0.359 <0.359	<0.157 12.1	<1.065 18.35
UST645-MW02	UST645-MW02	7/18/2007 1/23/2008	<0.183 <0.183	<0.229 <0.229	<0.181 <0.181	<0.359 <0.359	<0.157 <0.157	<1.065 <1.065
UST645-MW03	UST645-MW03	7/18/2007 1/23/2008	<0.183 <0.183	<0.229 <0.229	<0.181 1.14	<0.359 <0.359	<0.157 <0.157	<1.065 <1.065
UST645-MW04	UST645-MW04	7/18/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW05	UST645-MW05	7/19/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW06	UST645-MW06	7/19/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW07	UST645-MW07	7/19/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW08	UST645-MW08	7/17/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW14	UST645-MW14	7/19/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW19	UST645-MW19	7/18/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW23	UST645-MW23	7/18/2007 1/23/2008	<0.183 <0.183	<0.229 <0.229	<0.181 <0.181	<0.359 <0.359	<0.157 <0.157	<1.065 <1.065
UST645-MW24	UST645-MW24	7/18/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW25	UST645-MW25	7/18/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
Duplicate	Duplicate	7/18/2007	<0.183	<0.229	<0.181	4.93	<0.157	<1.065
2L Standard (µg/l)			1	70	550	200	1,000	530

- Duplicate sample UST645-Duplicate1 from MW23 in July 2007.
- All results reported in µg/l; µg/L =micrograms per liter
- BQL = Below Quantitation Limit (Method Detection Limit (MDL)).
- J = Estimated concentration; below calibration range and above MDL.
- **Bold** results indicate a concentration above 2L Standards.

Analytical Method: EPA Method 602 - DEEP CONDITIONS

Contaminant of Concern →			Benzene	Diisopropyl ether (DIPE)	Ethylbenzene	Methyl-tert butyl ether (MTBE)	Toluene	Total (m/p, o) Xylenes
Well ID	Sample ID	Date Collected						
UST645-MW09	UST645-MW09	7/18/2007 1/23/2008	<0.183 <0.183	<0.229 <0.229	<0.181 <0.181	<0.359 <0.359	<0.157 <0.157	<1.065 <1.065
UST645-MW10	UST645-MW10	7/19/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW11	UST645-MW11	7/17/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW15	UST645-MW15	7/18/2007 1/23/2008	<0.183 <0.183	<0.229 <0.229	<0.181 <0.181	2.34 3.04	<0.157 <0.157	<1.065 <1.065
UST645-MW16	UST645-MW16	7/19/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW17	UST645-MW17	7/18/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW18	UST645-MW18	7/19/2007	7.20	<0.916	72.8	<1.44	<0.628	<4.26
		10/18/2007	6.94J	<1.836	55.0	<2.87	<1.26	<8.52
		1/23/2008	4.44	<0.458	37.3	<0.718	<0.314	1.45J
		4/17/2008	4.09	<0.458	45.9	<0.718	<0.314	<2.132
UST645-MW20	UST645-MW20	7/18/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW21	UST645-MW21	7/18/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
		1/23/2008	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW22	UST645-MW22	7/18/2007	<0.183	<0.229	<0.181	5.07	<0.157	<1.065
		1/23/2008	<0.183	<0.229	<0.181	6.00	<0.157	<1.065
UST645-MW26	UST645-MW26	7/19/2007	1,180	<45.8	50.8J	<71.8	3,900	<213.2
		10/18/2007	1,700	<36.6	287	<57.4	3,410	896
		4/17/2008	1,780	<36.6	318	<57.4	4,500	1,011
UST645-MW27	UST645-MW27	7/19/2007	25.3	<0.458	<0.362	52.2	<0.314	<2.132
		10/18/2007	101	<2.29	64.0	109	4.28J	<10.65
		4/17/2008	96.9	3.26J	<1.45	136	4.64J	<8.52
UST645-MW28	UST645-MW28	7/17/2007	4.33	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW29	UST645-MW29	7/19/2007	22.4	<0.229	<0.181	<0.359	<0.157	<1.065
		10/18/2007	42.6	<0.229	<0.181	<0.359	0.406J	<1.065
		4/17/2008	32.1	<0.229	<0.181	1.11J	<0.157	<1.065
UST645-MW30	UST645-MW30	7/19/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
		10/18/2007	<0.183	<0.229	<0.181	<0.359	0.406J	<1.065
		4/17/2008	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW31	UST645-MW31	7/19/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
UST645-MW32	UST645-MW32	7/19/2007	<0.183	<0.229	<0.181	<0.359	<0.157	<1.065
		10/18/2007	<0.183	<0.229	<0.181	<0.359	0.226J	<1.065
		4/18/2008	<0.183	<0.229	<0.181	<0.359	1.14	<1.065
UST645-MW33	UST645-MW33	10/19/2007	2.07	<0.229	<0.181	<0.359	0.265J	<1.065
UST645-MW34	UST645-MW34	10/19/2007	7.76	<0.229	<0.181	<0.359	0.341J	<1.065
Duplicate	Duplicate	10/19/2007	2.17	<0.229	<0.181	<0.359	0.343J	<1.065
		1/23/2008	<0.183	<0.229	<0.181	6.28	<0.157	<1.065
		4/17/2008	87.2	<0.916	<0.724	129	2.56J	<4.26
2L Standard (µg/l)			1	70	550	200	1,000	530

- Duplicate sample USTG45MW-DUP from MW34 in Oct 2007, UST645-Duplicate from MW22 in Jan 2008, and UST645-Duplicate from MW27 in April 2008.
- All results reported in µg/l; µg/L = micrograms per liter
- BQL = Below Quantitation Limit (Method Detection Limit (MDL)).
- J = Estimated concentration; below calibration range and above MDL.
- NS = Not Sampled; well installed 9/2007
- **Bold** results indicate a concentration above 2L Standards.

TABLE 6
SUMMARY OF GROUNDWATER SAMPLING RESULTS
2007-2008

Incident Number and Name: 87556 - Building 645

Analytical Method: EPA Method 625

Contaminant of Concern →			Bis(2-ethylhexyl) phthalate	Naphthalene	Phenol	Tentatively Identified Compounds (TICs)	All Other 625 Compounds
Well ID	Sample ID	Date Collected					
UST645-MW01	UST645-MW01	1/23/2008	<1.33	4.60J	<3.38	306.9	BQL
UST645-MW02	UST645-MW02	1/23/2008	<1.33	<1.08	<3.38	ND	BQL
UST645-MW03	UST645-MW03	1/23/2008	<1.33	<1.08	<3.38	ND	BQL
UST645-MW04	UST645-MW04	NS	NS	NS	NS	NS	NS
UST645-MW05	UST645-MW05	NS	NS	NS	NS	NS	NS
UST645-MW06	UST645-MW06	NS	NS	NS	NS	NS	NS
UST645-MW07	UST645-MW07	NS	NS	NS	NS	NS	NS
UST645-MW08	UST645-MW08	NS	NS	NS	NS	NS	NS
UST645-MW09	UST645-MW09	1/23/2008	<1.33	<1.08	<3.38	ND	BQL
UST645-MW10	UST645-MW10	NS	NS	NS	NS	NS	NS
UST645-MW11	UST645-MW11	NS	NS	NS	NS	NS	NS
UST645-MW12	UST645-MW12	1/23/2008	2.10J	60.4	<3.38	770.5	BQL
UST645-MW13	UST645-MW13	NS	NS	NS	NS	NS	NS
UST645-MW14	UST645-MW14	NS	NS	NS	NS	NS	NS
UST645-MW15	UST645-MW15	1/23/2008	<1.33	<1.08	<3.38	4.8	BQL
UST645-MW16	UST645-MW16	NS	NS	NS	NS	NS	NS
UST645-MW17	UST645-MW17	NS	NS	NS	NS	NS	NS
UST645-MW18	UST645-MW18	10/18/2007	<1.33	<1.08	<3.38	25.67	BQL
		1/23/2008	<1.33	<1.08	<3.38	5.97	BQL
UST645-MW19	UST645-MW19	NS	NS	NS	NS	NS	NS
UST645-MW20	UST645-MW20	NS	NS	NS	NS	NS	NS
UST645-MW21	UST645-MW21	1/23/2008	<1.33	<1.08	<3.38	5.34	BQL
UST645-MW22	UST645-MW22	1/23/2008	<1.33	<1.08	<3.38	ND	BQL
UST645-MW23	UST645-MW23	1/23/2008	4.20J	<1.08	<3.38	ND	BQL
UST645-MW24	UST645-MW24	NS	NS	NS	NS	NS	NS
UST645-MW25	UST645-MW25	NS	NS	NS	NS	NS	NS
UST645-MW26	UST645-MW26	10/18/2007	<1.33	<1.08	20.7	595.7	BQL
UST645-MW27	UST645-MW27	10/18/2007	<1.33	<1.08	<3.38	8.21	BQL
UST645-MW28	UST645-MW28	NS	NS	NS	NS	NS	NS
UST645-MW29	UST645-MW29	10/18/2007	<1.33	<1.08	<3.38	24.09	BQL
UST645-MW30	UST645-MW30	10/18/2007	<1.33	<1.08	<3.38	8.21	BQL
UST645-MW31	UST645-MW31	NS	NS	NS	NS	NS	NS
UST645-MW32	UST645-MW32	10/18/2007	<1.33	<1.08	<3.38	9.38	BQL
UST645-MW33	UST645-MW33	10/19/2007	<1.33	<1.08	<3.38	15.76	BQL
UST645-MW34	UST645-MW34	10/19/2007	<1.33	<1.08	<3.38	14.88	BQL
Duplicate	Duplicate	10/19/2007	<1.33	<1.08	<3.38	8.42	BQL
		1/23/2008	<1.33	<1.08	<3.38	ND	BQL
2L Standard (µg/l)			2.5	21	300	None Established	Varies

- Duplicate sample USTG45MW-DUP from MW34 in Oct 2007 and UST645-Duplicate from MW22 in Jan 2008.
- All results reported in µg/l; µg/L = micrograms per liter
- BQL = Below Quantitation Limit (Method Detection Limit (MDL)).
- J = Estimated concentration; below calibration range and above MDL.
- ND = None Detected
- NS = Not Sampled; well not part of scope of work.
- **Bold** results indicate a concentration above 2L Standards.

Analytical Method: EPA Method 625 – SHALLOW CONDITIONS

Contaminant of Concern →			Bis(2-ethylhexyl) phthalate	Naphthalene	Phenol	Tentatively Identified Compounds (TICs)	All Other 62.5 Compounds
Well ID	Sample ID	Date Collected					
UST645-MW01	UST645-MW01	1/23/2008	<1.33	4.60J	<3.38	306.9	BQL
UST645-MW02	UST645-MW02	1/23/2008	<1.33	<1.08	<3.38	ND	BQL
UST645-MW03	UST645-MW03	1/23/2008	<1.33	<1.08	<3.38	ND	BQL
UST645-MW04	UST645-MW04	NS	NS	NS	NS	NS	NS
UST645-MW05	UST645-MW05	NS	NS	NS	NS	NS	NS
UST645-MW06	UST645-MW06	NS	NS	NS	NS	NS	NS
UST645-MW07	UST645-MW07	NS	NS	NS	NS	NS	NS
UST645-MW08	UST645-MW08	NS	NS	NS	NS	NS	NS
UST645-MW14	UST645-MW14	NS	NS	NS	NS	NS	NS
UST645-MW19	UST645-MW19	NS	NS	NS	NS	NS	NS
UST645-MW23	UST645-MW23	1/23/2008	4.20J	<1.08	<3.38	ND	BQL
UST645-MW24	UST645-MW24	NS	NS	NS	NS	NS	NS
UST645-MW25	UST645-MW25	NS	NS	NS	NS	NS	NS
2L Standard (µg/l)			2.5	21	300	None Established	Varies

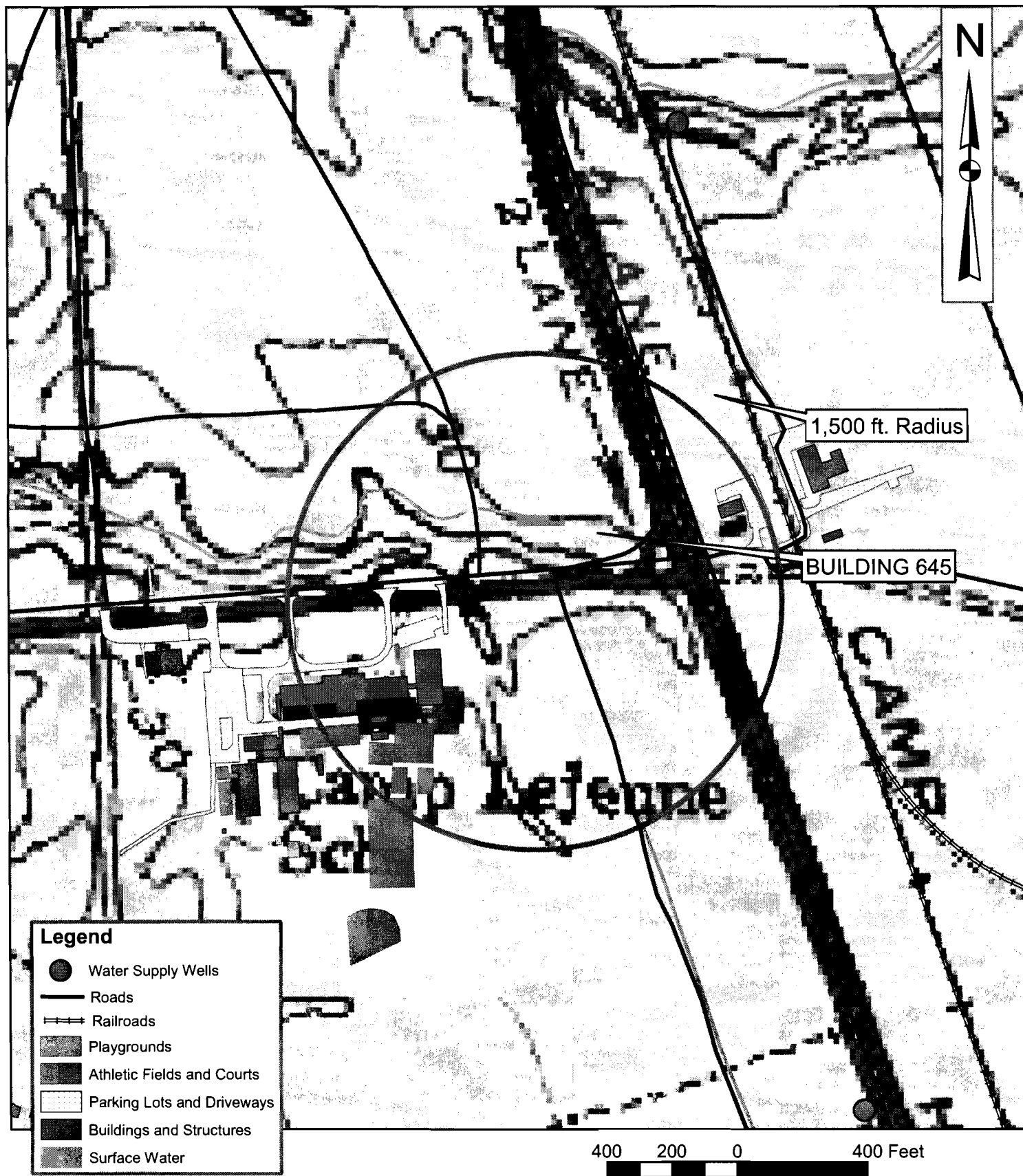
- All results reported in µg/l; µg/L =micrograms per liter
- BQL = Below Quantitation Limit (Method Detection Limit (MDL)).
- J = Estimated concentration; below calibration range and above MDL.
- ND = None Detected
- NS = Not Sampled; well not part of scope of work.
- **Bold** results indicate a concentration above 2L Standards.

Analytical Method: EPA Method 625 – DEEP CONDITIONS

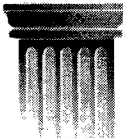
Contaminant of Concern →			Bis(2-ethylhexyl) phthalate	Naphthalene	Phenol	Tentatively Identified Compounds (TICs)	All Other 625 Compounds
Well ID	Sample ID	Date Collected					
UST645-MW09	UST645-MW09	1/23/2008	<1.33	<1.08	<3.38	ND	BQL
UST645-MW10	UST645-MW10	NS	NS	NS	NS	NS	NS
UST645-MW11	UST645-MW11	NS	NS	NS	NS	NS	NS
UST645-MW15	UST645-MW15	1/23/2008	<1.33	<1.08	<3.38	4.8	BQL
UST645-MW16	UST645-MW16	NS	NS	NS	NS	NS	NS
UST645-MW17	UST645-MW17	NS	NS	NS	NS	NS	NS
UST645-MW18	UST645-MW18	10/18/2007	<1.33	<1.08	<3.38	25.67	BQL
		1/23/2008	<1.33	<1.08	<3.38	5.97	BQL
UST645-MW20	UST645-MW20	NS	NS	NS	NS	NS	NS
UST645-MW21	UST645-MW21	1/23/2008	<1.33	<1.08	<3.38	5.34	BQL
UST645-MW22	UST645-MW22	1/23/2008	<1.33	<1.08	<3.38	ND	BQL
UST645-MW26	UST645-MW26	10/18/2007	<1.33	<1.08	20.7	595.7	BQL
UST645-MW27	UST645-MW27	10/18/2007	<1.33	<1.08	<3.38	8.21	BQL
UST645-MW28	UST645-MW28	NS	NS	NS	NS	NS	NS
UST645-MW29	UST645-MW29	10/18/2007	<1.33	<1.08	<3.38	24.09	BQL
UST645-MW30	UST645-MW30	10/18/2007	<1.33	<1.08	<3.38	8.21	BQL
UST645-MW31	UST645-MW31	NS	NS	NS	NS	NS	NS
UST645-MW32	UST645-MW32	10/18/2007	<1.33	<1.08	<3.38	9.38	BQL
UST645-MW33	UST645-MW33	10/19/2007	<1.33	<1.08	<3.38	15.76	BQL
UST645-MW34	UST645-MW34	10/19/2007	<1.33	<1.08	<3.38	14.88	BQL
Duplicate	Duplicate	10/19/2007	<1.33	<1.08	<3.38	8.42	BQL
		1/23/2008	<1.33	<1.08	<3.38	ND	BQL
2L Standard (µg/l)			2.5	21	300	None Established	Varies

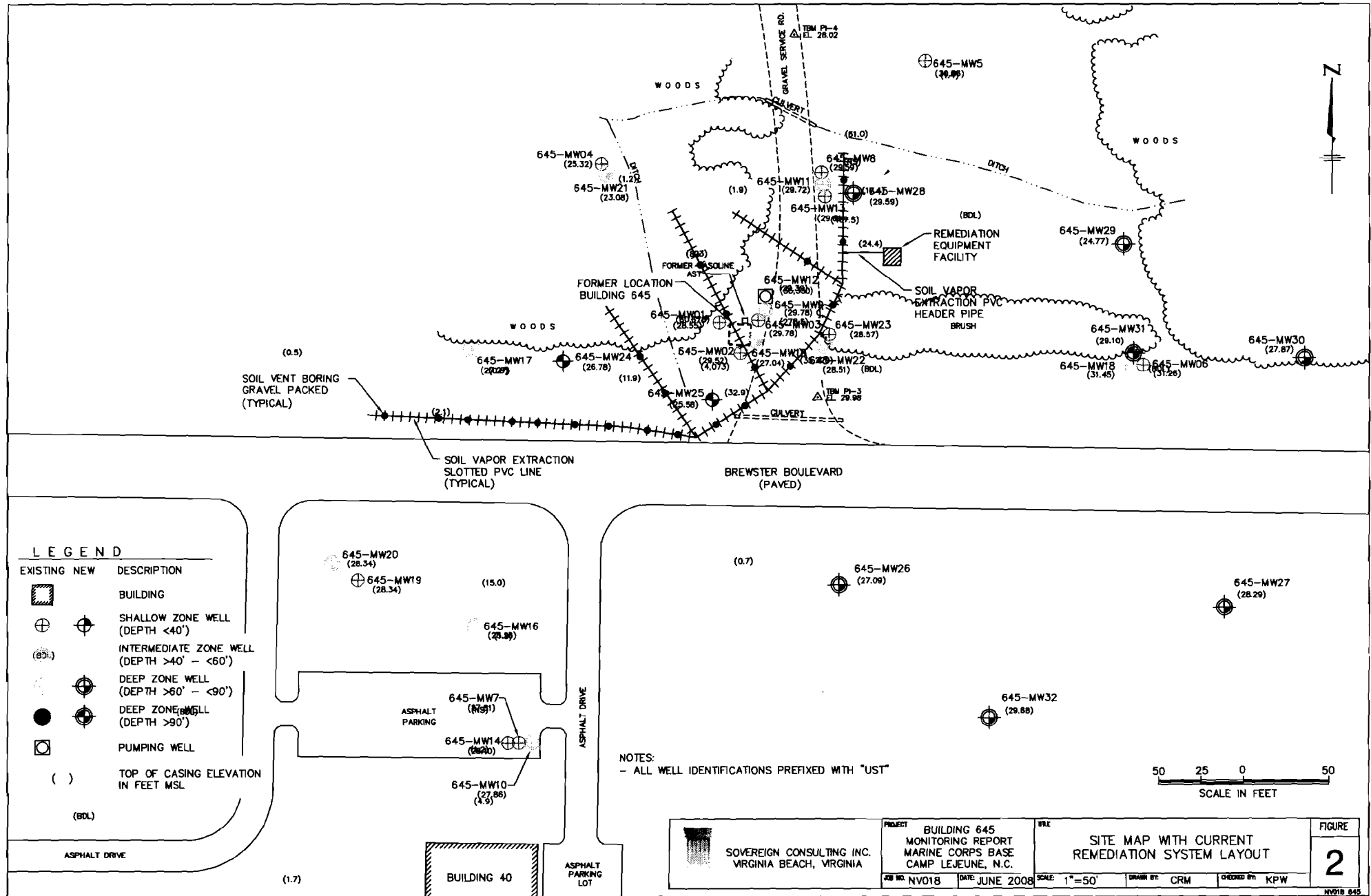
- Duplicate sample USTG45MW-DUP from MW34 in Oct 2007 and UST645-Duplicate from MW22 in Jan 2008.
- All results reported in µg/l; µg/L =micrograms per liter
- BQL = Below Quantitation Limit (Method Detection Limit (MDL)).
- J = Estimated concentration; below calibration range and above MDL.
- ND = None Detected
- NS = Not Sampled; well not part of scope of work.
- **Bold** results indicate a concentration above 2L Standards.

FIGURES



Data Sources: Data Layers provided by MCB Camp Lejeune GIS Office.

 SOVEREIGN CONSULTING INC. VIRGINIA BEACH, VIRGINIA	PROJECT BUILDING 645 MARINE CORPS BASE CAMP LEJEUNE, NC		TITLE GENERAL VICINITY TOPOGRAPHIC SITE MAP			FIGURE
	JOB NO. 206-063	DATE MAY 2007	SCALE AS SHOWN	DRAWN BY KAWS	CHECKED BY JAC	1



APPENDIX C
PRELIMINARY CONCEPTUAL MODEL

Conceptual Model for Corrective Action

**Building 645
Marine Corps Base
Camp Lejeune**

Prepared By:



Introduction

CATLIN was requested by NAVFAC Mid-Atlantic to prepare a Corrective Action Plan Supplement specifically to address dissolved phase contamination within the deep zone 60-90 feet deep for the Building 645 project site. This presentation of our conceptual model is outlined as follows:

- Existing Site Conditions
- Goals of Remediation
- Remediation Technology Evaluation
- Recommendations

Existing Site Conditions

➤ **Free-Phase Product**

- Free-phase product is not present at the project site.

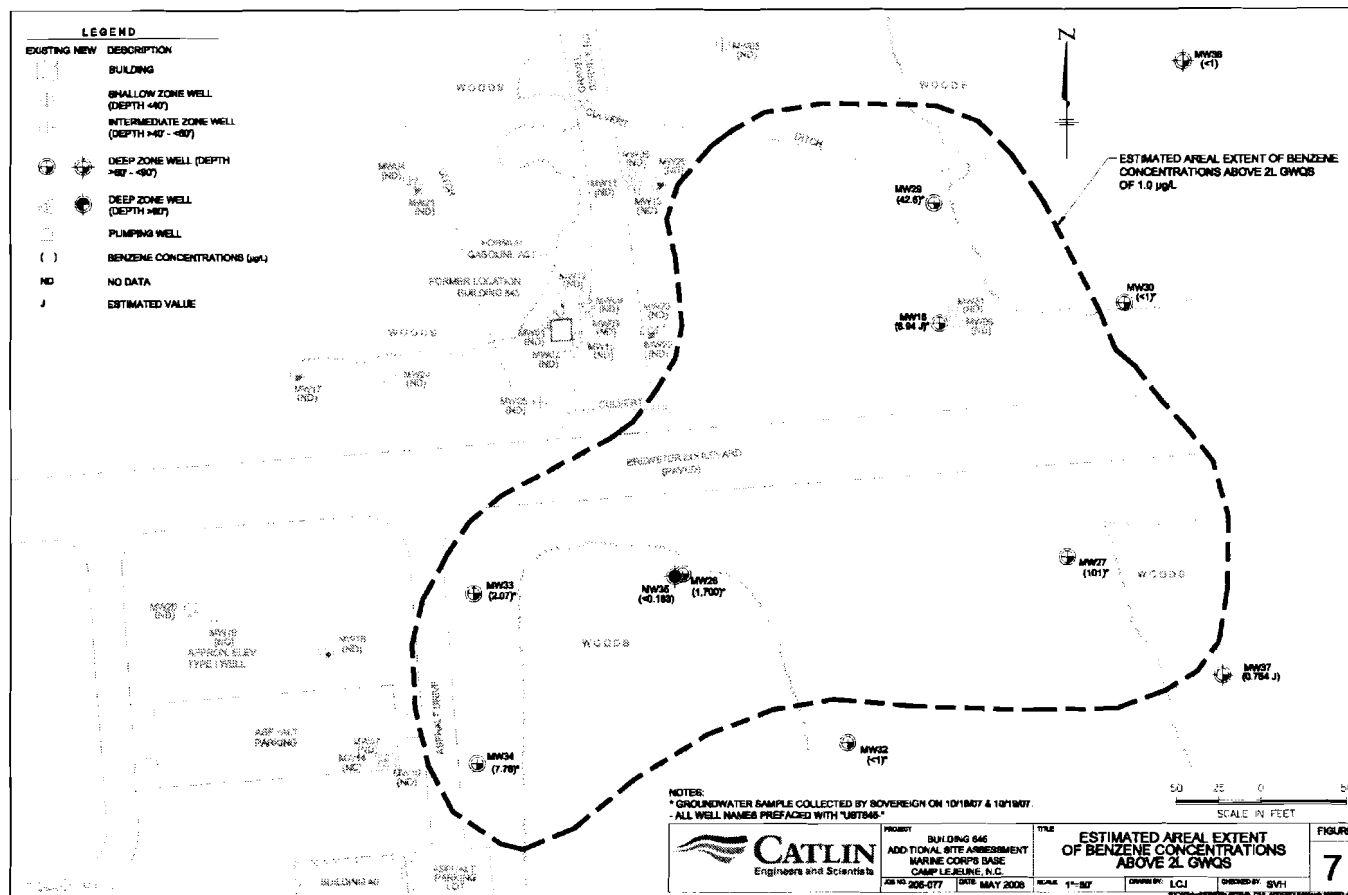
◆ **Dissolved Contamination**

- Shallow zone dissolved phase contamination has essentially been remediated.
- Limited Deep Zone (60-90 feet below land surface).
- Dissolved contamination plume has migrated across Brewster Boulevard to the northeast and southeast.

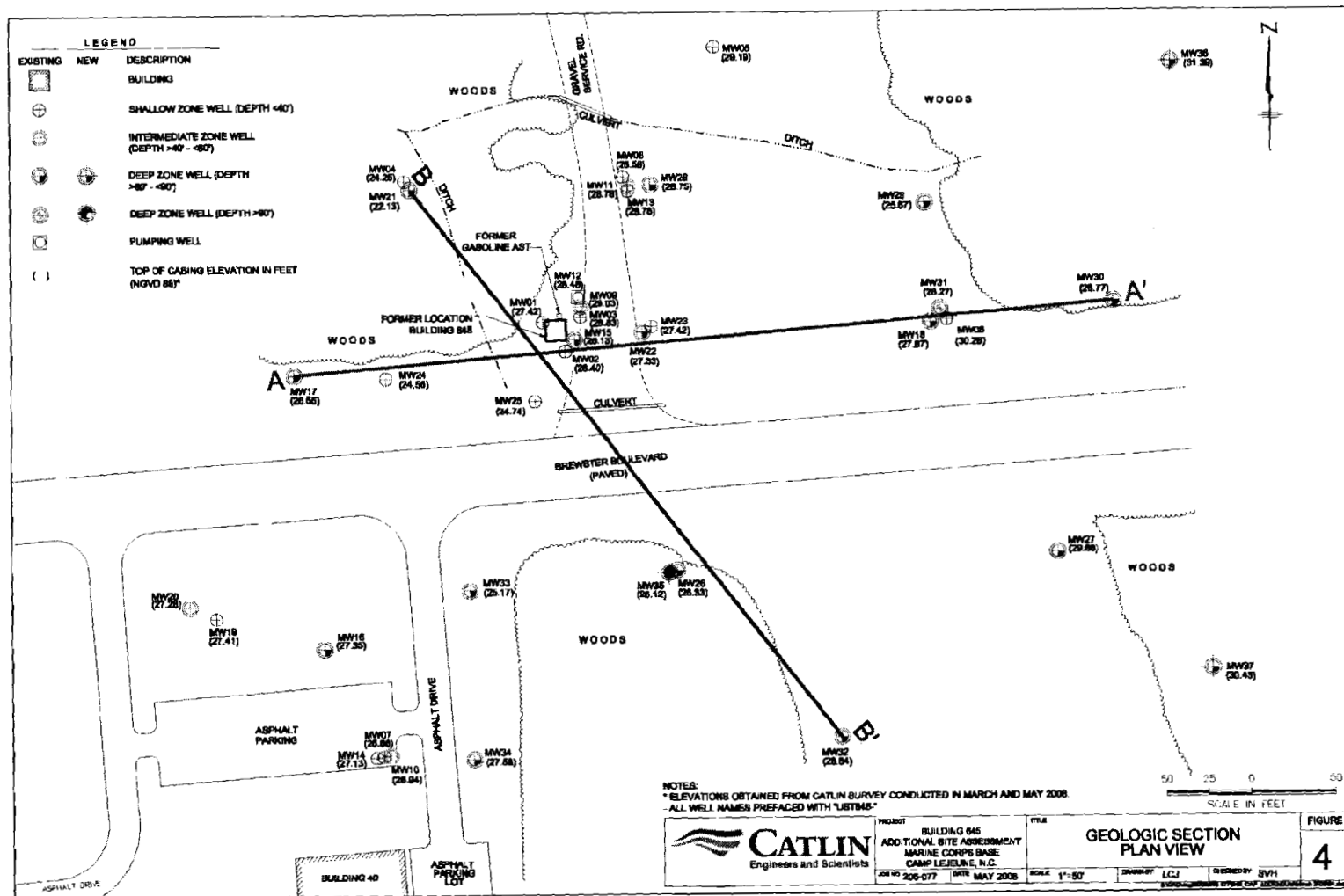
◆ **Soil**

- Soil contamination has been identified at the project site in the vicinity of former AST slab at one location ± 11.5 feet deep. Additional sampling in this area is recommended after deep zone groundwater contamination is addressed.

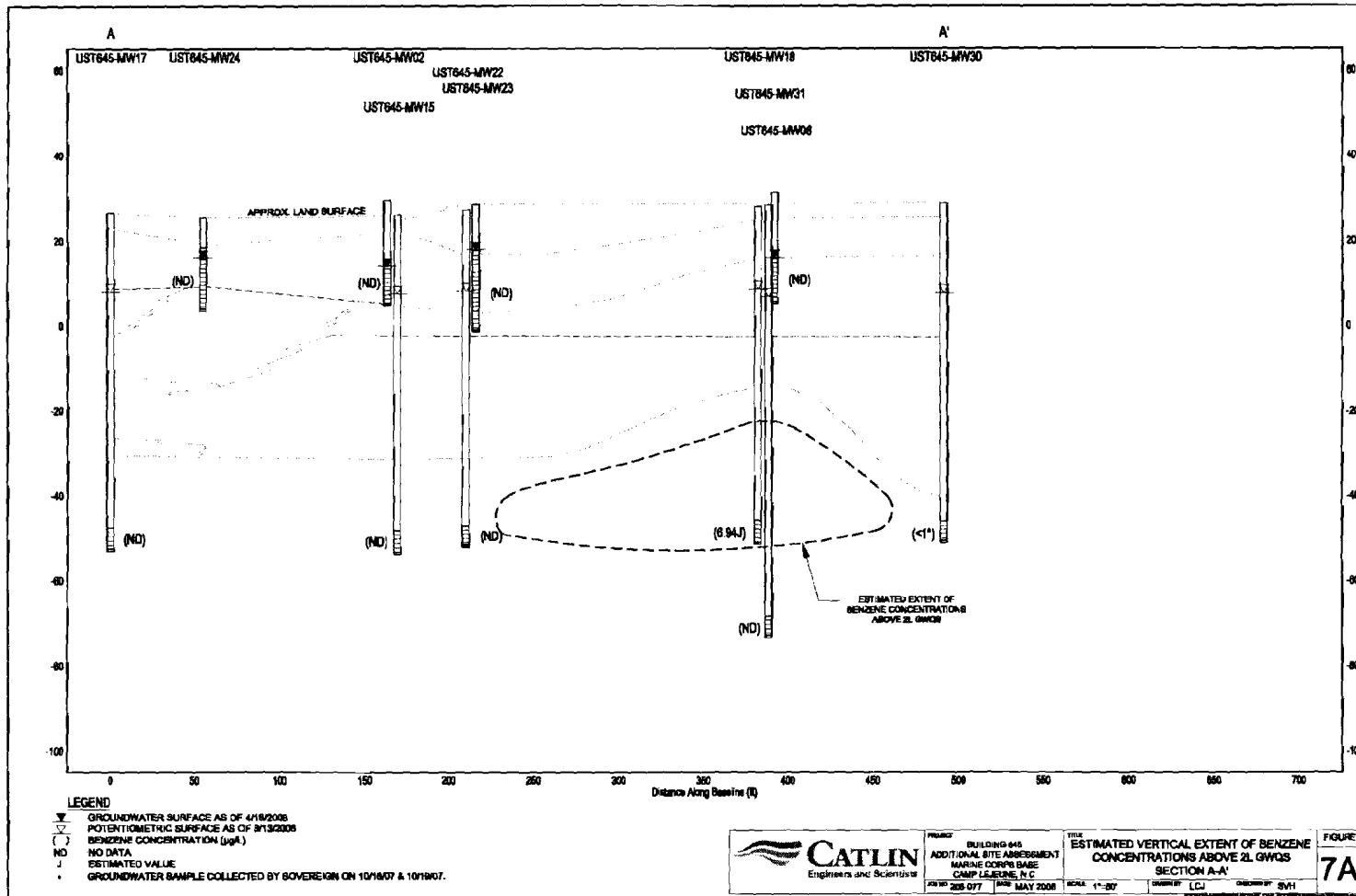
Horizontal Extent



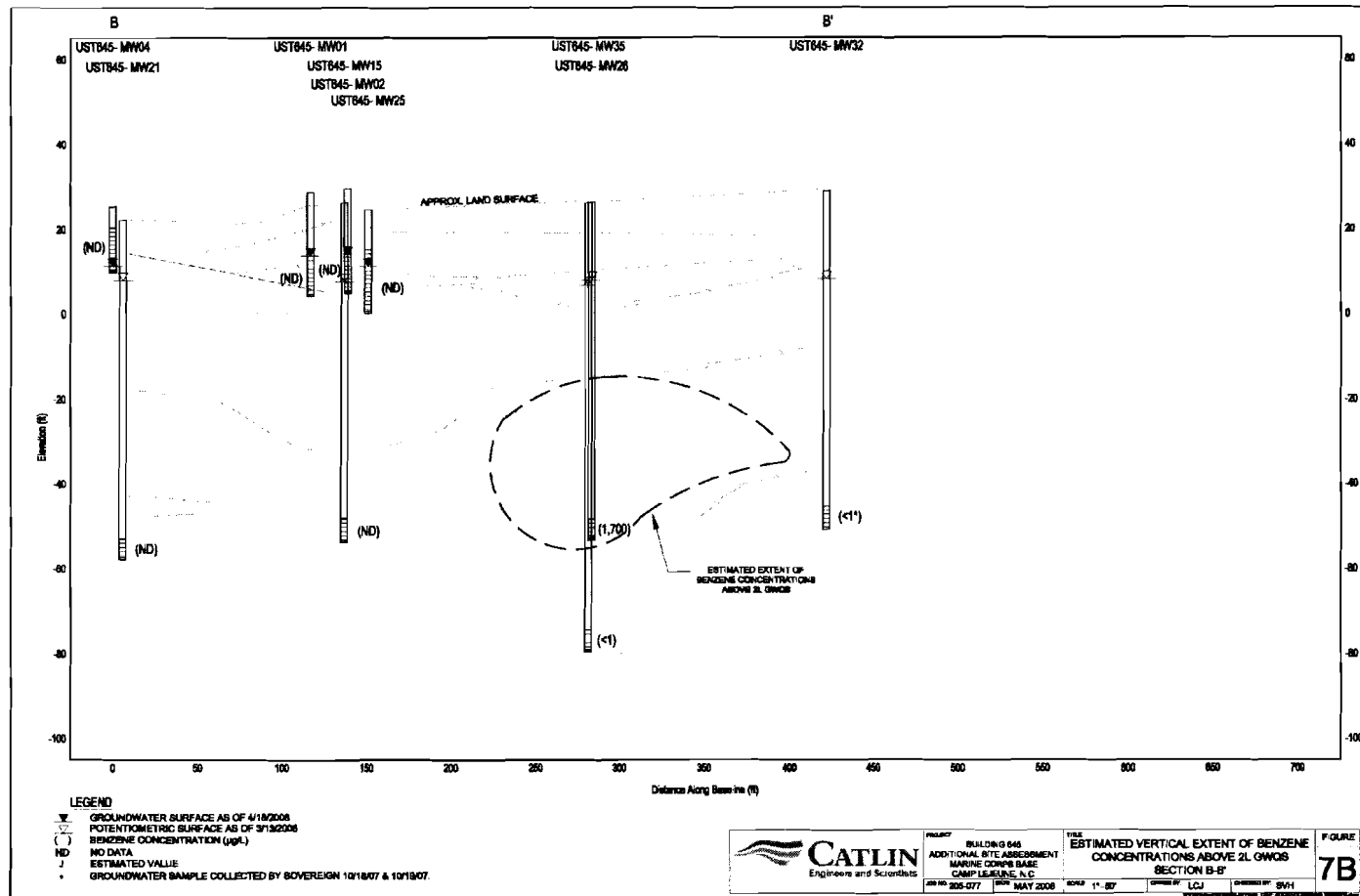
Cross Section Plan View



Cross Section A-A'



Cross Section B-B'



Site Remediation Goals

- To reduce dissolved groundwater contaminant concentrations (60-90') to below current 2L GWQS.
- To control deep zone plume migration.

Potential Remedial Technologies

- Expand Existing Air Sparge System (60-90' Deep Zone)
- Groundwater Depression System

Remediation Evaluation

➤ **Air Sparge System Expansion**

- Requires modification of existing air sparge system components to expand system across Brewster Boulevard.
- Existing air sparge system has effectively remediated shallow zone contamination, shutting down shallow sparge wells may provide adequate air supply for proposed deep sparging.
- Requires additional deep (60'-90') air sparge wells.
- Historical contaminant concentrations in the vicinity of existing system have shown a declining trend since system installation.

➤ **Groundwater Depression System**

- May Require the recovery, treatment, and disposal of a large volume of groundwater.
- May not be cost-effective due to the treatment and disposal of nuisance water.
- Requires construction of water treatment system.

Recommendations

- Based on review of previous reports, the existing air sparge system has proven to be an effective remedial option at the 645 project site. CATLIN recommends modification of the existing air sparge system. This options appears to be the most feasible and economical remedial approach.
- Perform an air sparge test on monitoring well UST645MW-35 to determine design criteria such as pressure and flow rate within the 60-90' deep zone. Install 2 to 3 observation wells relative to UST645MW-35 to determine radius of influence.

Recommendations (cont.)

- Prepare revised Corrective Action Plan Supplement based on air sparge pilot test results.

APPENDIX D

AIR SPARGE PILOT TEST RESULTS, DESIGN CALCULATIONS AND SELECTED FIGURES FROM CAP DATED SEPTEMBER 25, 1996

**SUMMARY OF
AIR SPARGING PILOT TESTING
(SHALLOW AQUIFER SECTION)**

WELL 645

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

AUGUST 19, 1996

**Contract No. N62470-93-D-4020
Delivery Order No. 0171
Richard Catlin & Associates, Inc. Project No. 94107-P**

**Prepared by:
Richard Catlin & Associates, Inc.
Wilmington, North Carolina**

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3.0 DATA COLLECTION	2
4.0 SUMMARY AND CONCLUSIONS	2

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Figure 1	Site Map with Pilot Testing Data Point Locations
Figure 2	As-Built Sparging Well Detail
Figure 3	As-Built Pilot Testing Well Detail

TABLES

Table 1	Air Sparging Pilot Test Data
Table 2	Air Sparging Pilot Test Field Data

**SUMMARY OF
AIR SPARGING PILOT TESTING
(SHALLOW AQUIFER SECTION)
FOR WELL 645
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA**

AUGUST 19, 1996

1.0 PURPOSE

The purpose of the air sparging pilot test was to evaluate the aquifer's response to air injected below the water table. Specifically, the testing focused on determining the radial extent of sparging influence at various air injection rates.

2.0 METHODS

The following methods and equipment were used to perform the testing:

- Telescoping well 645-9, screened from 45 to 50 feet below land surface (BLS) was used as the sparging well (see Figures 1 and 2).
- Two sets of nested pilot test observation wells (PT-1 and PT-2) were installed adjacent to the sparging well. Each set contained three wells (A, B, and C) screened from 20 to 25 feet BLS, 35 to 40 feet BLS, and 60 to 65 feet BLS, respectively (see Figure 3). For this pilot test, wells PT-1C and PT-2C were not utilized for data measurement.
- Air was injected into the subsurface through the air sparging well at three different flow rates.
 - For each flow rate data collected from the pilot testing wells included:
 - a) Depth to water
 - b) Off-gas air screening by Flame Ionization Detector (FID)
 - c) Sparging influence (noticeable agitation of water table)
 - In addition, an existing monitoring well (645-3) was also used to gather the following data:
 - a) Depth to water
 - b) Off-gas air screening by FID
 - c) Sparging influence (noticeable agitation of water table)

- Prior to start-up, depth to water and dissolved oxygen measurements were taken from each well.
- Upon test completion, depth to water, dissolved oxygen, off-gas screening, and sparging influence oxygen were collected from all wells.

3.0 DATA COLLECTION

Tables 1 and 2 show the data collected during the shallow aquifer air sparging pilot test.

4.0 SUMMARY AND CONCLUSIONS

During the pilot test, three separate injection flow rates were used; 5.0 cubic feet per minute (cfm), 10.0 cfm, and 15.0 cfm. Data was collected at 15-minute intervals for each separate flow rate as described in the Methods section of this document. As shown in Table 2, effects on the water table were noticed in the form of agitation of the ground water interface. Agitation was observed in pilot test wells PT-1B and PT-2B and in existing monitoring well 645-3. The greatest distance at which agitation was noticed was in the water table was in observation well PT-2B located approximately 25 feet west of the air sparging well.

Dissolved oxygen (D.O.) readings were taken to determine if the dissolved oxygen concentrations had risen due to air sparging. The data in Table 2 shows that D.O. concentrations increased significantly during the pilot test in wells PT-1B and PT-2B and 645-3.

Depth to water (DTW) measurements in the pilot test wells as well as the monitoring well showed a mounding trend.

The pilot test data indicates that the site is responsive to air sparging technology. This is apparent due to the absence of noticeable water table agitation in wells PT-1A and PT-2A, which were screened from 20 to 25 feet BLS and potentiometric water level rise which was greater in PT-1B and PT-2B. The data also indicates that the air movement may be influenced by the horizontal permeability in the unconsolidated sediments which normally is greater than the vertical permeability. Another explanation for these differences may be that the aquifer did not reach equilibrium during the pilot test. Based on the data collected, a 30-foot radius of influence can be expected from an air sparging well at this site.

TABLES

TABLE 1
AIR SPARGING PILOT TEST FIELD DATA
(SHALLOW AQUIFER SECTION)

SITE:	Well 645
CONTRACT NO.:	N62470-93-D-4020
DELIVERY ORDER:	0171
DATE OF TEST:	August 19, 1996
COMPANY NAME:	Richard Catlin & Associates, Inc.
PROJECT NO.:	94107-P
PERSONNEL ON SITE:	Ira Hines Bill Walsh
SPARGING WELL:	645-9
PILOT TESTING WELLS:	PT-1A, PT-1B PT-2A, PT-2B
OTHER OBSERVATION WELLS:	645-3

TABLE 2
AIR SPARGING PILOT TEST FIELD DATA (SHALLOW AQUIFER SECTION)
WELL 645
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA
AUGUST 20, 1996

(PAGE 1 OF 6)

ELAPSED TIME (MIN)	PRESSURE AT SPARGE WELL (PSI)	FLOW (CFM)		645-9	PT-1A (14.0')*	PT-1B (14.0')*	PT-2A (25.0')*	PT-2B (25.0')*	645-3 (6.0')*
0	0.0	0.0	D.O.	0.3	0.1	0.1	1.8	0.2	0.2
			DTW (feet)	26.84	13.34	25.22	22.40	27.80	16.96
			FID (ppm)	NM	NM	NM	NM	NM	NM
			INFL	NM	NM	NM	NM	NM	NM
15	11	5.0	D.O.	NM	NM	NM	NM	NM	NM
			DTW (feet)	NM	12.75	24.27	20.85	25.80	16.96
			FID (ppm)	NM	11	11	14	5.2	0
			INFL	NM	No	**	**	**	No
30	10	5.0	D.O.	NM	NM	NM	NM	NM	NM
			DTW (feet)	NM	12.66	23.82	20.75	25.10	16.46
			FID (ppm)	NM	2.0	4.0	2.0	6.0	0
			INFL	NM	No	**	**	**	No

Notes:

* Distance from Sparge Well
D.O. Dissolved Oxygen (mg/l)
DTW Depth to Water (feet)
NM Not Measured

** Could Not See
FID Flame Ionization Detector
INFL Influence
ppm Parts Per Million

TABLE 2
AIR SPARGING PILOT TEST FIELD DATA (SHALLOW AQUIFER SECTION)
WELL 645
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA
AUGUST 20, 1996

(PAGE 2 OF 6)

ELAPSED TIME (MIN)	PRESSURE AT SPARGE WELL (PSI)	FLOW (CFM)		645-9	PT-1A (14.0')*	PT-1B (14.0')*	PT-2A (25.0')*	PT-2B (25.0')*	645-3 (6.0')*
45	10	5.0	D.O.	NM	NM	NM	NM	NM	NM
			DTW (feet)	NM	12.62	23.45	20.70	24.92	16.94
			FID (ppm)	NM	5.0	30	1.0	5.0	0
			INFL	NM	No	**	**	**	No
60	10	5.0	D.O.	NM	NM	NM	NM	NM	NM
			DTW (feet)	NM	12.43	23.02	20.62	24.67	16.46
			FID (ppm)	NM	0	6.0	1.0	0	0
			INFL	NM	No	**	**	**	No
75	10	5.0	D.O.	NM	NM	NM	NM	NM	NM
			DTW (feet)	NM	12.19	23.50	20.36	24.37	15.41
			FID (ppm)	NM	0	20	1.0	2.0	14
			INFL	NM	No	No	**	**	Yes

Notes:

* Distance from Sparge Well
D.O. Dissolved Oxygen (mg/l)
DTW Depth to Water (feet)
NM Not Measured

** Could Not See
FID Flame Ionization Detector
INFL Influence
ppm Parts Per Million

TABLE 2
AIR SPARGING PILOT TEST FIELD DATA (SHALLOW AQUIFER SECTION)
WELL 645
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA
AUGUST 20, 1996

(PAGE 3 OF 6)

ELAPSED TIME (MIN)	PRESSURE AT SPARGE WELL (PSI)	FLOW (CFM)		645-9	PT-1A (14.0')*	PT-1B (14.0')*	PT-2A (25.0')*	PT-2B (25.0')*	645-3 (6.0')*
90	10	5.0	D.O.	NM	NM	NM	NM	NM	NM
			DTW (feet)	NM	12.04	21.87	20.03	24.12	14.92
			FID (ppm)	NM	1.0	20	4.0	6.0	>1,000
			INFL	NM	No	Yes	**	**	Yes
105	10	5.0	D.O.	NM	NM	NM	NM	NM	NM
			DTW (feet)	NM	11.90	21.28	19.67	23.92	14.58
			FID (ppm)	NM	1.0	60	2.2	5.0	>1,000
			INFL	NM	No	Yes	**	**	Yes
120	10	5.0	D.O.	NM	NM	NM	NM	NM	NM
			DTW (feet)	NM	11.85	21.00	19.34	23.80	14.38
			FID (ppm)	NM	0	200	7.0	4.0	>1,000
			INFL	NM	No	Yes	**	**	Yes

Notes:

* Distance from Sparge Well
D.O. Dissolved Oxygen (mg/l)
DTW Depth to Water (feet)
NM Not Measured

** Could Not See
FID Flame Ionization Detector
INFL Influence
ppm Parts per million

TABLE 2
AIR SPARGING PILOT TEST FIELD DATA (SHALLOW AQUIFER SECTION)
WELL 645
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA
AUGUST 20, 1996

(PAGE 4 OF 6)

ELAPSED TIME (MIN)	PRESSURE AT SPARGE WELL (PSI)	FLOW (CFM)		645-9	PT-1A (14.0')*	PT-1B (14.0')*	PT-2A (25.0')*	PT-2B (25.0')*	645-3 (6.0')*
135	10	10.0	D .O.	NM	NM	NM	NM	NM	NM
			DTW (feet)	NM	11.80	20.45	19.04	23.45	14.28
			FID (ppm)	NM	0	430	6.0	3.0	>1,000
			INFL	NM	No	Yes	**	**	Yes
150	10	10.0	D.O.	NM	NM	NM	NM	NM	NM
			DTW (feet)	NM	11.77	20.61	18.75	23.50	14.18
			FID (ppm)	NM	0	650	9.0	1.0	>1,000
			INFL	NM	No	Yes	**	**	Yes
165	10	10.0	D.O.	NM	NM	NM	NM	NM	NM
			DTW (feet)	NM	11.75	20.11	18.59	23.30	14.13
			FID (ppm)	NM	0	>1,000	8.2	6.5	>1,000
			INFL	NM	No	Yes	**	**	Yes

Notes:

* Distance from Sparge Well
D.O. Dissolved Oxygen (mg/l)
DTW Depth to Water (feet)
NM Not Measured

** Could Not See
FID Flame Ionization Detector
INFL Influence
ppm Parts Per Million

TABLE 2
AIR SPARGING PILOT TEST FIELD DATA (SHALLOW AQUIFER SECTION)
WELL 645
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA
AUGUST 20, 1996

(PAGE 5 OF 6)

ELAPSED TIME (MIN)	PRESSURE AT SPARGE WELL (PSI)	FLOW (CFM)		645-9	PT-1A (14.0')*	PT-1B (14.0')*	PT-2A (25.0')*	PT-2B (25.0')*	645-3 (6.0')*
180	10.0	10.0	D .O.	NM	NM	NM	NM	NM	NM
			DTW (feet)	NM	11.70	19.70	18.20	23.57	13.92
			FID (ppm)	NM	0	>1,000	6.0	5.0	>1,000
			INFL	NM	No	Yes	**	**	Yes
195	11.5	15.0	D.O.	NM	NM	NM	NM	NM	NM
			DTW (feet)	NM	11.62	18.16	18.30	21.25	13.67
			FID (ppm)	NM	0.6	>1,000	18	10.0	>1,000
			INFL	NM	No	Yes	No	**	Yes
210	11.5	15.0	D.O.	NM	NM	NM	NM	NM	NM
			DTW (feet)	NM	11.54	17.63	17.55	20.23	13.50
			FID (ppm)	NM	1.2	>1,000	12	20	>1,000
			INFL	NM	No	Yes	No	**	Yes

Notes:

* Distance from Sparge Well
D.O. Dissolved Oxygen (mg/l)
DTW Depth to Water (feet)
NM Not Measured

** Could Not See
FID Flame Ionization Detector
INFL Influence
ppm Parts Per Million

TABLE 2
AIR SPARGING PILOT TEST FIELD DATA (SHALLOW AQUIFER SECTION)
WELL 645
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA
AUGUST 20, 1996

(PAGE 6 OF 6)

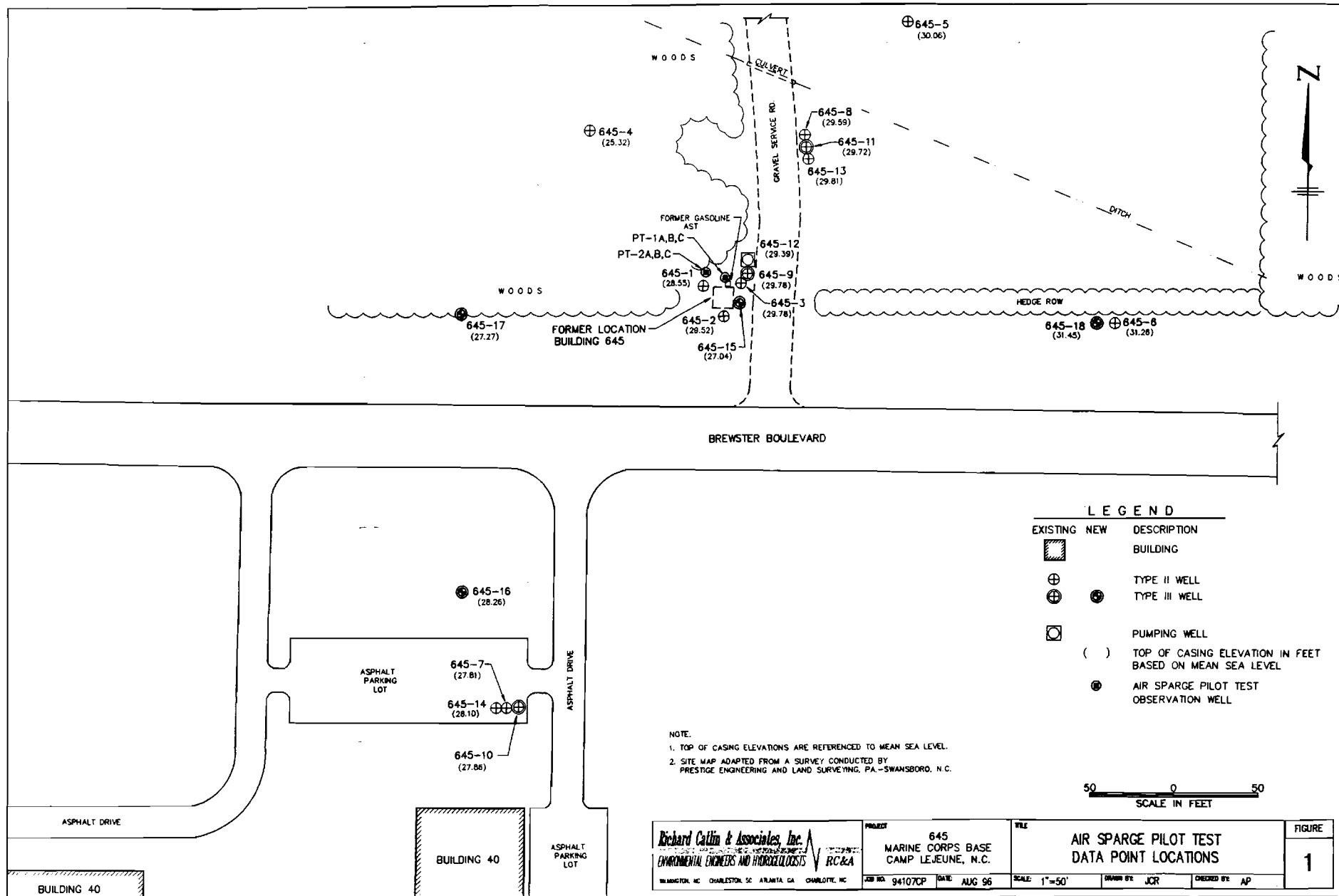
ELAPSED TIME (MIN)	PRESSURE AT SPARGE WELL (PSI)	FLOW (CFM)		645-9	PT-1A (14.0')*	PT-1B (14.0')*	PT-2A (25.0')*	PT-2B (25.0')*	645-3 (6.0')*
225	12.0	15	D.O.	NM	NM	NM	NM	NM	NM
			DTW (feet)	NM	11.41	16.14	16.94	19.33	13.12
			FID (ppm)	NM	0.6	>1,000	20	400	>1,000
			INFL	NM	No	Yes	No	Yes	Yes
240	12.0	15	D.O.	9.80	0.6	8.5	0.6	4.2	7.5
			DTW (feet)	NM	11.34	15.80	16.46	18.93	12.90
			FID (ppm)	NM	0.2	>1,000	30	>1,000	>1,000
			INFL	NM	No	Yes	No	Yes	Yes

Notes:

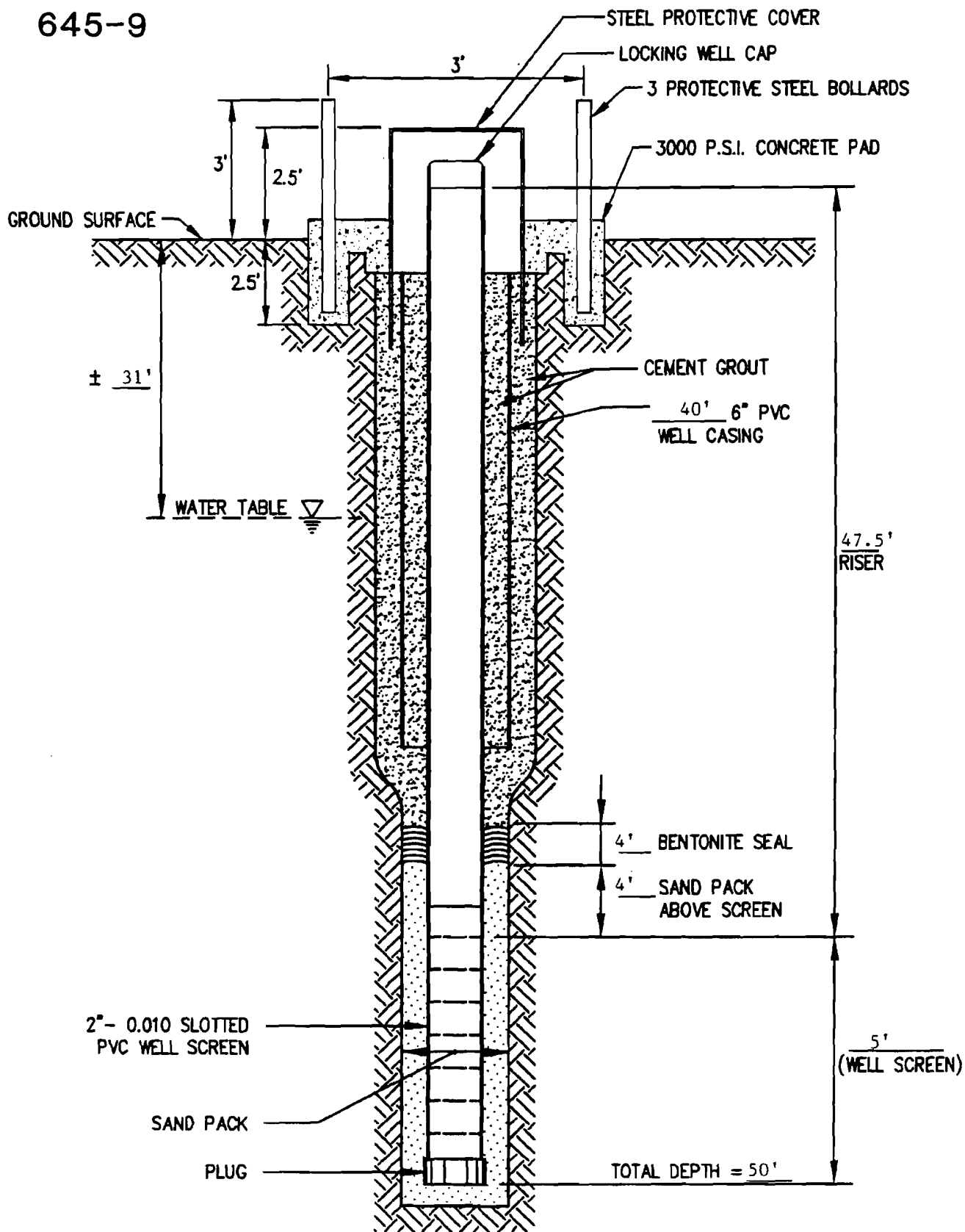
* Distance from Sparge Well
D.O. Dissolved Oxygen (mg/l)
DTW Depth to Water (feet)
NM Not Measured

** Could Not See
FID Flame Ionization Detector
INFL Influence
ppm Parts Per Million

FIGURES



645-9



Richard Catlin & Associates, Inc.
 ENVIRONMENTAL ENGINEERS
 AND HYDROGEOLOGISTS
 WILMINGTON, NC CHARLESTON, SC ATLANTA, GA WINSTON-SALEM, NC

PROJECT 645
 MARINE CORPS BASE
 CAMP LEJEUNE, N.C.

TITLE
 ABOVE GROUND TYPE III
 MONITORING WELL DETAIL

FIGURE

2

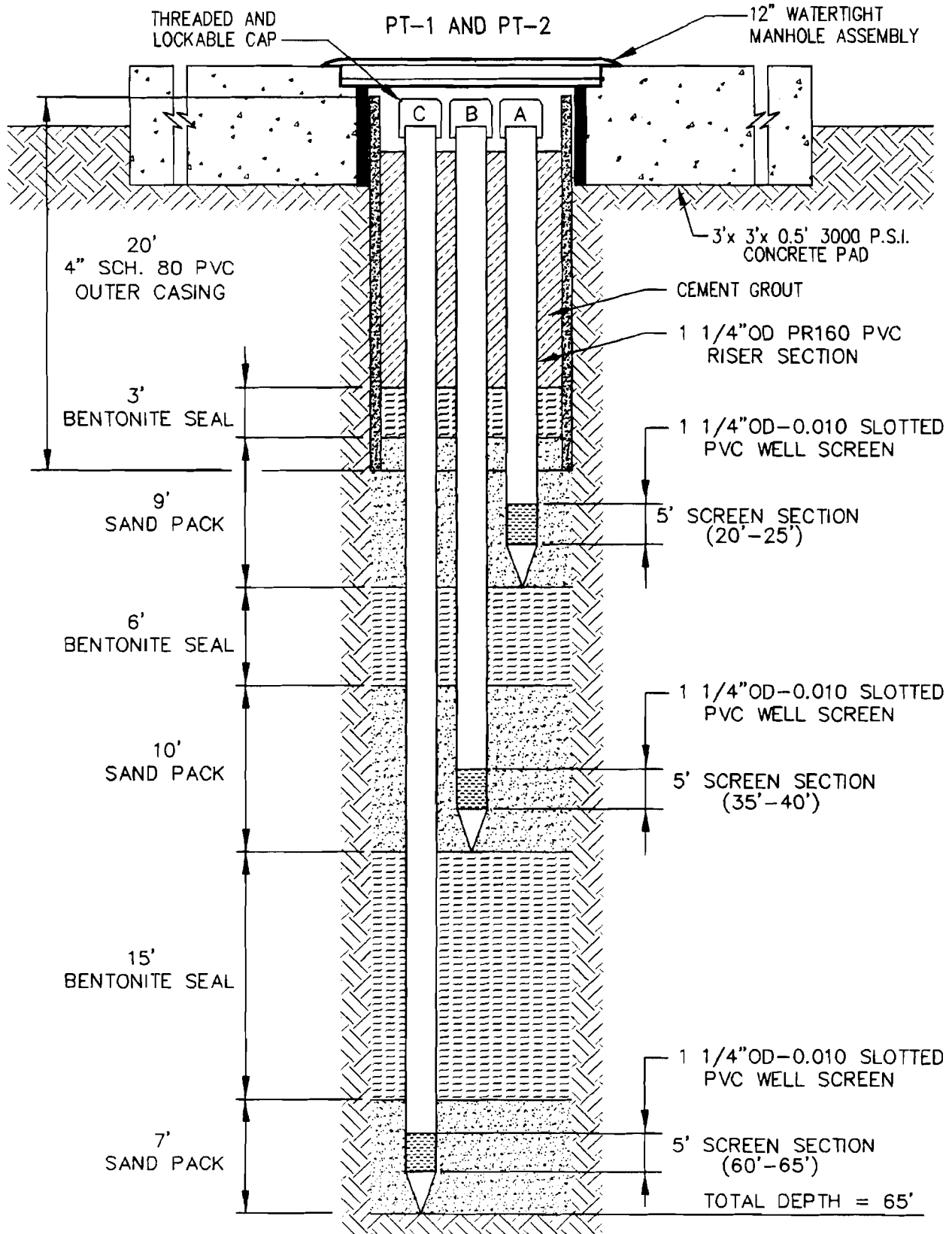
JOB NO. 94107

DATE: 11-18-94

SCALE: NTS

DRAWN BY: WHW

CHECKED BY: JC



Richard Callin & Associates, Inc.
 ENVIRONMENTAL ENGINEERS AND HYDROGEOLOGISTS
 WILMINGTON, NC CHARLESTON, SC ATLANTA, GA CHARLOTTE, NC

PROJECT 645
 MARINE CORPS BASE
 CAMP LEJEUNE, N.C.
 JOB NO: 94107CP DATE: AUG 1996

TITLE AS-BUILT
 PILOT TEST WELL DETAIL
 SCALE: NTS DRAWN BY: WHW CHECKED BY: AP

FIGURE
3

**SUMMARY OF
AIR SPARGING PILOT TESTING
(DEEP AQUIFER SECTION)**

WELL 645

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

AUGUST 20, 1996

**Contract No. N62470-93-D-4020
Delivery Order No. 0171
Richard Catlin & Associates, Inc. Project No. 94107-P**

**Prepared by:
Richard Catlin & Associates, Inc.
Wilmington, North Carolina**

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FIGURES

Figure 1	Site Map with Pilot Testing Data Point Locations
Figure 2	As-Built Sparging Well Detail
Figure 3	As-Built Pilot Testing Well Detail

TABLES

Table 1	Air Sparging Pilot Test Data
Table 2	Air Sparging Pilot Test Field Data

**SUMMARY OF
AIR SPARGING PILOT TESTING
(DEEP AQUIFER SECTION)
FOR WELL 645
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA**

AUGUST 20, 1996

1.0 PURPOSE

The purpose of the air sparging pilot test was to evaluate the aquifer's response to air injected below the water table. Specifically, the testing focused on determining the radial extent of sparging influence at various air injection rates.

2.0 METHODS

The following methods and equipment were used to perform the testing:

- Telescoping well 645-15, screened from 75 to 80 feet below land surface (BLS) was used as the sparging well (see Figures 1 and 2).
- Two sets of nested pilot test observation wells (PT-1 and PT-2) were installed adjacent to the sparging well. These wells were each screened from 20 to 25 feet BLS (PT-1A and PT-1B), 35 to 40 feet BLS (PT-1B and PT-2B), and 60 to 65 feet BLS (PT-1C and PT-2C). See Figure 3.
- Air was injected into the subsurface through the air sparging well at three different flow rates.
 - For each flow rate data collected from the pilot testing wells included:
 - a) Depth to water
 - b) Off-gas air screening by Flame Ionization Detector (FID)
 - c) Sparging influence (noticeable agitation of water table)
 - In addition, an existing monitoring well (645-2) was also used to gather the following data:
 - a) Depth to water
 - b) Off-gas air screening by FID
 - c) Sparging influence (noticeable agitation of water table)

- All data measurements were collected prior to start-up. Depth to water, sparging influence, and off-gas air screening were measured at specific time intervals. Dissolved oxygen was measured at the beginning and end of the test only.

3.0 DATA COLLECTION

Tables 1 and 2 show the data collected during the air sparging pilot test.

4.0 SUMMARY AND CONCLUSIONS

During the pilot test, three separate injection flow rates were used; 5.0 cubic feet per minute (cfm), 10.0 cfm, and 15.0 cfm. Data was collected at 15-minute intervals for each separate flow rate as described in the Methods section of this document. As shown in Table 2, effects on the potentiometric water table were noticed in the form of agitation of the ground water interface. Agitation was observed in both pilot test wells at a depth of 30 feet to 35 feet, and in PT-2 at a depth of 20 feet to 25 feet. The greatest distance at which agitation was noticed was in PT-2 located approximately 28 feet northwest of the air sparging well. In addition to the noticeable agitation within the wells, air was observed bubbling from the subsurface through a surface water puddle located approximately 15.5 feet northwest of the sparging well.

Dissolved oxygen (D.O.) readings were taken to determine if the dissolved oxygen concentrations had risen due to air sparging. The data in Table 2 shows that D.O. concentrations increased dramatically during the pilot test in PT-1 and PT-2 at a depth of 30 feet to 35 feet and in PT-2 at a depth of 20 feet to 25 feet.

Depth to water (DTW) measurements in the pilot test wells as well as the monitoring well showed a mounding trend. The mounding was observed in all monitoring points with the greatest measured in PT-1B.

TABLES

TABLE 1
AIR SPARGING PILOT TEST FIELD DATA
(DEEP AQUIFER SECTION)

SITE:	Well 645
CONTRACT NO.:	N62470-93-D-4020
DELIVERY ORDER:	0171
DATE OF TEST:	August 20, 1996
COMPANY NAME:	Richard Catlin & Associates, Inc.
PROJECT NO.:	94107-P
PERSONNEL ON SITE:	Ira Hines Bill Walsh Tony Pelliccia
SPARGING WELL:	645-15
PILOT TESTING WELLS:	PT-1A, PT-1B, PT-1C PT-2A, PT-2B, PT-2C
OTHER OBSERVATION WELLS:	645-2

TABLE 2
AIR SPARGING PILOT TEST FIELD DATA (DEEP AQUIFER SECTION)

WELL 645
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA
AUGUST 20, 1996

ELAPSED TIME (MIN)	PRESSURE AT SPARGE WELL (PSI)	FLOW (CFM)	0.0	D.O.	0.3	0.2	3.0	0.1	1.2	0.2	4.0		
				DTW (feet)	24.64	12.42	25.49	27.72	20.97	27.78	16.81		
				FID (ppm)	NM	NM	NM	NM	NM	NM	NM	NM	
				INFL	NM	NM	NM	NM	NM	NM	NM	NM	
15	53	5.0			DTW (feet)	NM	12.12	24.93	24.33	20.46	26.20	24.70	16.84
					D.O.	NM	NM	NM	NM	NM	NM	NM	NM
					FID (ppm)	NM	4.0	3.0	18	25	17	8.0	
					INFL	NM	No	**	**	**	**	No	
30	50	5.0			D.O.	NM	NM	NM	NM	NM	NM	NM	
					DTW (feet)	NM	11.96	23.85	23.51	20.24	25.15	24.04	16.80
					FID (ppm)	NM	3.5	23.0	22.5	17.0	40.0	5.0	
					INFL	NM	No	Yes	**	**	**	No	

Notes:

* Distance from Sparge Well
D.O. Dissolved Oxygen (mg/l)
DTW Depth to Water (feet)
NM Not Measured
** Could Not See/Could Not Hear
ppm Parts Per Million
FID Flame Ionization Detector
INFL Influence

TABLE 2
AIR SPARGING PILOT TEST FIELD DATA (DEEP AQUIFER SECTION)
WELL 645
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA
AUGUST 20, 1996

(PAGE 2 OF 5)

ELAPSED TIME (MIN)	PRESSURE AT SPARGE WELL (PSI)	FLOW (CFM)		645-15	PT-1A (18.0')*	PT-1B (18.0')*	PT-1C (18.0')*	PT-2A (30.0')*	PT-2B (28.0')*	PT-2C (28.0')*	645-2 (13.0')*
45	49	5.0	D.O.	NM	NM	NM	NM	NM	NM	NM	NM
			DTW (feet)	NM	11.21	22.37	23.02	19.96	24.37	23.60	16.84
			FID (ppm)	NM	5.0	295	45	25	94	3.0	4.0
			INFL	NM	No	Yes	No	**	**	**	No
60	48	5.0	D.O.	NM	NM	NM	NM	NM	NM	NM	NM
			DTW (feet)	NM	11.70	20.92	22.78	19.69	23.67	23.40	16.82
			FID (ppm)	NM	4.0	640	7.0	30	120	5.0	2.0
			INFL	NM	No	Yes	No	**	**	**	No
75	53	10.0	D.O.	NM	NM	NM	NM	NM	NM	NM	NM
			DTW (feet)	NM	11.56	20.37	22.24	19.41	22.44	22.83	16.80
			FID (ppm)	NM	5.5	3,300	15.0	38	155	6.0	2.0
			INFL	NM	No	Yes	No	**	Yes	**	No

Notes:

* Distance from Sparge Well
D.O. Dissolved Oxygen (mg/l)
DTW Depth to Water (feet)
NM Not Measured

** Could Not See/Could Not Hear
ppm Parts Per Million
FID Flame Ionization Detector
INFL Influence

TABLE 2
AIR SPARGING PILOT TEST FIELD DATA (DEEP AQUIFER SECTION)
WELL 645
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA
AUGUST 20, 1996

(PAGE 3 OF 5)

ELAPSED TIME (MIN)	PRESSURE AT SPARGE WELL (PSI)	FLOW (CFM)		645-15	PT-1A (18.0')*	PT-1B (18.0')*	PT-1C (18.0')*	PT-2A (30.0')*	PT-2B (28.0')*	PT-2C (28.0')*	645-2 (13.0')*
90	51	10.0	D.O.	NM	NM	NM	NM	NM	NM	NM	NM
			DTW (feet)	NM	11.46	19.57	21.61	19.12	21.64	22.22	16.80
			FID (ppm)	NM	6.0	8,700	37	48	140	8.0	2.0
			INFL	NM	No	Yes	No	No	Yes	No	No
105	51	10.0	D.O.	NM	NM	NM	NM	NM	NM	NM	NM
			DTW (feet)	NM	11.38	18.12	21.31	18.83	21.01	21.94	16.78
			FID (ppm)	NM	5.5	4,800	10.0	84	124	10.5	4.5
			INFL	NM	No	Yes	No	No	Yes	No	No
120	51	10.0	D.O.	NM	NM	NM	NM	NM	NM	NM	NM
			DTW (feet)	NM	11.28	17.42	21.19	18.57	20.58	21.82	16.73
			FID (ppm)	NM	4.0	3,200	3.0	144	490	14.0	6.0
			INFL	NM	No	Yes	No	No	Yes	No	No

Notes:

* Distance from Sparge Well
D.O. Dissolved Oxygen (mg/l)
DTW Depth to Water (feet)
NM Not Measured

** Could Not See/Could Not Hear
ppm Parts Per Million
FID Flame Ionization Detector
INFL Influence

TABLE 2
AIR SPARGING PILOT TEST FIELD DATA (DEEP AQUIFER SECTION)
WELL 645
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA
AUGUST 20, 1996

(PAGE 4 OF 5)

ELAPSED TIME (MIN)	PRESSURE AT SPARGE WELL (PSI)	FLOW (CFM)		645-15	PT-1A (18.0')*	PT-1B (18.0')*	PT-1C (18.0')*	PT-2A (30.0')*	PT-2B (28.0')*	PT-2C (28.0')*	645-2 (13.0')*
135	64	15	D.O.	NM	NM	NM	NM	NM	NM	NM	NM
			DTW (feet)	NM	11.20	17.04	20.50	18.35	20.13	21.08	16.66
			FID (ppm)	NM	9.0	2,200	9.0	85	740	11	4.5
			INFL	NM	No	Yes	No	No	Yes	No	No
150	64	15	D.O.	NM	NM	NM	NM	NM	NM	NM	NM
			DTW (feet)	NM	11.12	16.17	19.43	18.11	19.30	20.11	16.56
			FID (ppm)	NM	7.0	2,220	13	350	6,200	16	4.0
			INFL	NM	No	Yes	No	No	Yes	No	No
165***	63	15	D.O.	NM	NM	NM	NM	NM	NM	NM	NM
			DTW (feet)	NM	11.04	15.10	18.89	17.85	18.54	19.60	16.42
			FID (ppm)	NM	5.7	1,760	27	350	>10,000	24	7.0
			INFL	NM	Yes	Yes	No	No	Yes	No	No

Notes:

* Distance from Sparge Well
D.O. Dissolved Oxygen (mg/l)
DTW Depth to Water (feet)
NM Not Measured

*** Water puddle 15.5' away from 645-9, bubbling at 165 minutes
FID Flame Ionization Detector
INFL Influence
ppm Parts Per Million

TABLE 2
AIR SPARGING PILOT TEST FIELD DATA (DEEP AQUIFER SECTION)
WELL 645
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA
AUGUST 20, 1996

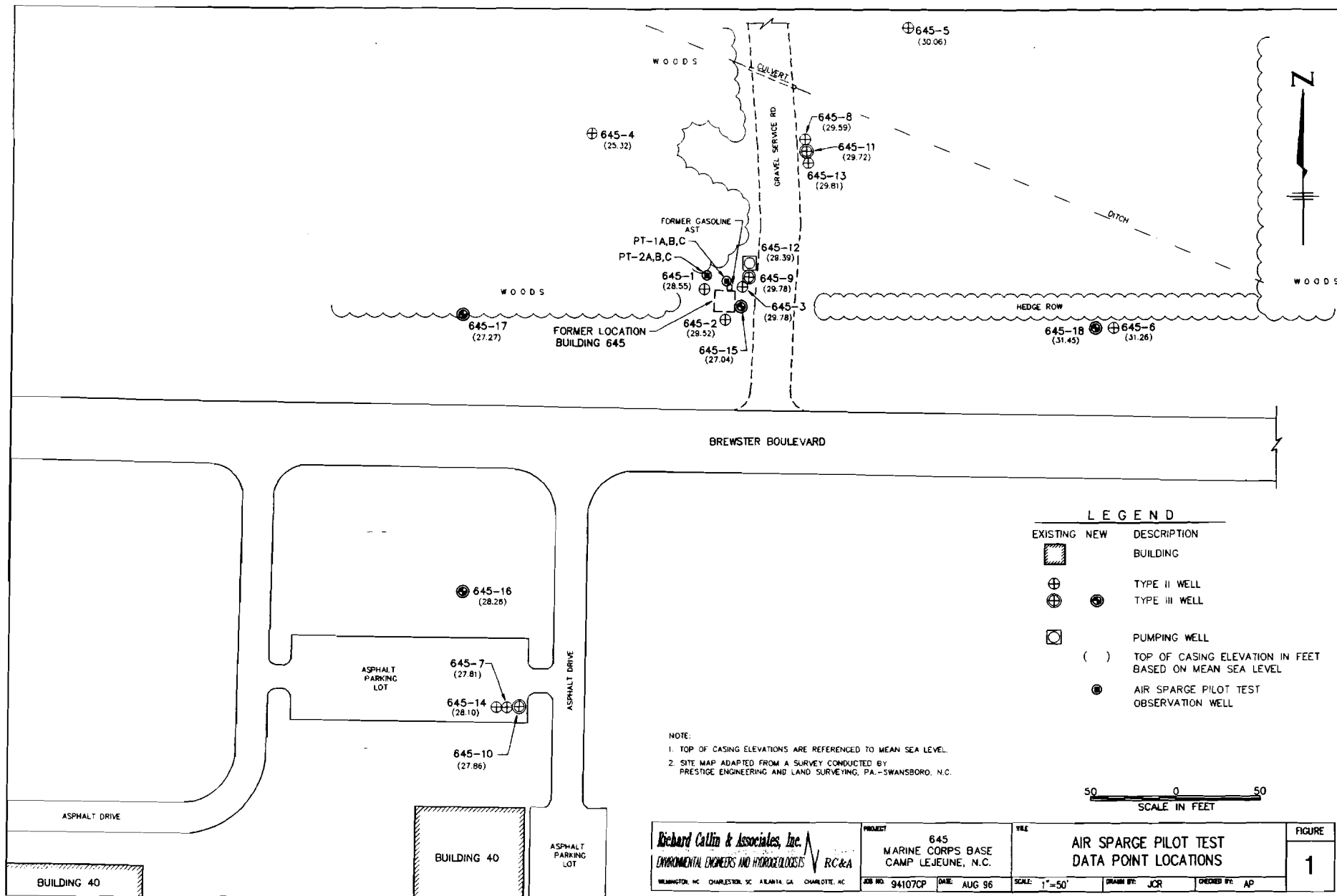
(PAGE 5 OF 5)

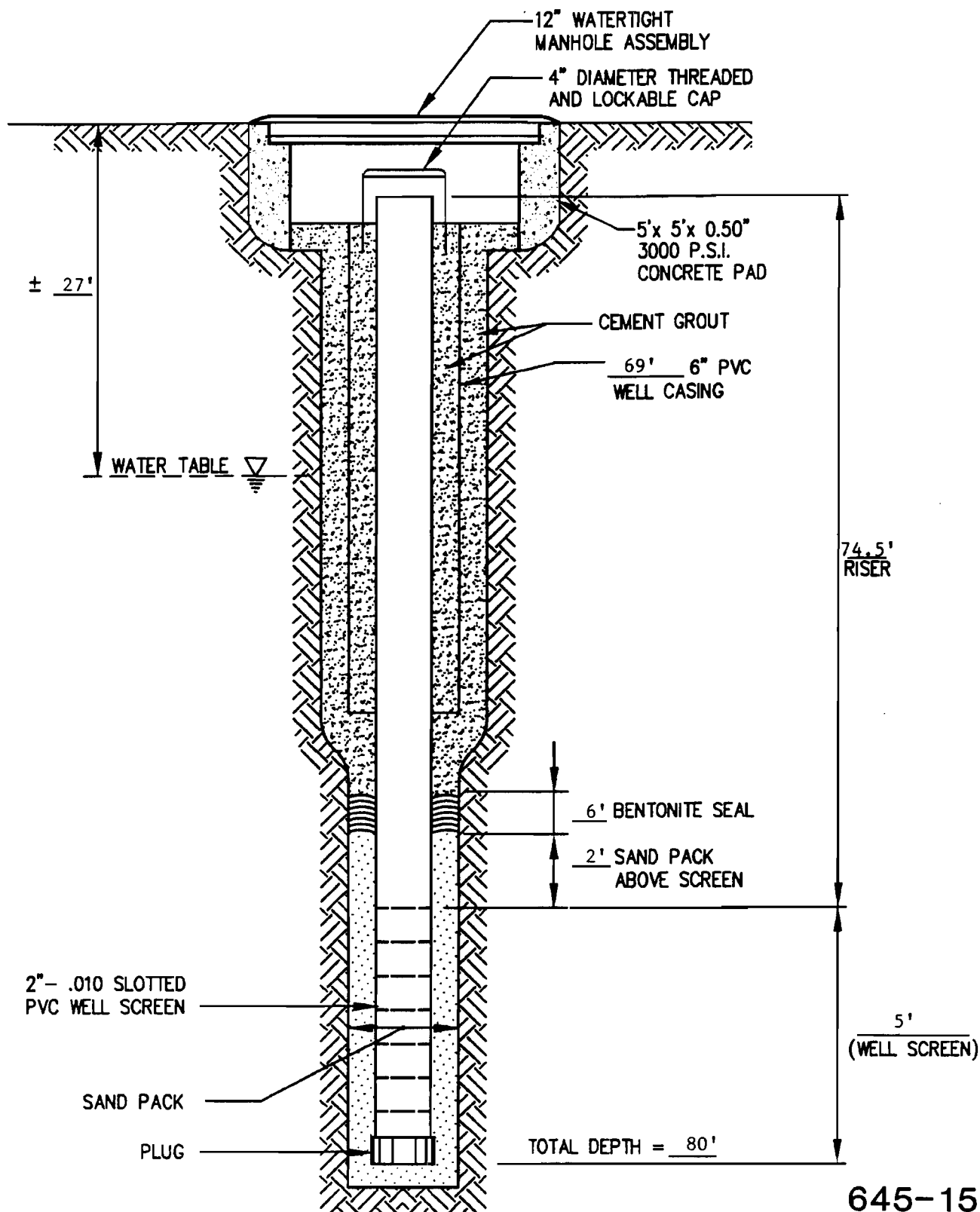
ELAPSED TIME (MIN)	PRESSURE AT SPARGE WELL (PSI)	FLOW (CFM)		645-15	PT-1A (18.0')*	PT-1B (18.0')*	PT-1C (18.0')*	PT-2A (30.0')*	PT-2B (28.0')*	PT-2C (28.0')*	645-2 (13.0')*
180	62	15	D.O.	NM	NM	NM	NM	NM	NM	NM	NM
			DTW (feet)	NM	10.96	14.29	18.66	17.61	17.99	19.38	16.32
			FID (ppm)	NM	18.9	1,500	12.3	1,220	>10,000	51	9.8
			INFL	NM	No	Yes	No	Yes	Yes	No	No
195	62	15	D.O.	NM	NM	NM	NM	NM	NM	NM	NM
			DTW (feet)	NM	10.86	13.84	18.93	17.32	17.55	18.66	16.07
			FID (ppm)	NM	16.5	1,540	17	2,830	>10,000	34	7.5
			INFL	NM	Slight	Yes	No	Yes	Yes	No	No
205			D.O.	NM	0.4	10.0	0.4	2.4	6.3	0.4	0.4

* Distance from Sparge Well
D.O. Dissolved Oxygen (mg/l)
DTW Depth to Water (feet)
NM Not Measured

ppm Parts Per Million
FID Flame Ionization Detector
INFL Influence

FIGURES





645-15

Richard Catlin & Associates, Inc.
 ENVIRONMENTAL ENGINEERS AND HYDROGEOLOGISTS

RC&A

WILMINGTON, NC CHARLESTON, SC ATLANTA, GA CHARLOTTE, NC

PROJECT
 645
 MARINE CORPS BASE
 CAMP LEJEUNE, N.C.
 JOB NO: 94107 DATE MARCH 96

TITLE
 UNPAVED SURFACE TYPE III
 MONITORING WELL DETAIL
 SCALE: DRAWN BY: CHECKED BY: TP

FIGURE
 2

GeoChem, Incorporated

Environmental Laboratories

Certified Analytical Laboratory

NC # 37745 , NC # 336, NC # 461, EPA ID # 155

Client Project Manager

Mr. Tony Pelliccia

Site Name:

Well 645

94107

R. Catlin & Assoc.

P.O. Box 10279

Wilmington NC

28405

Report Date

Tuesday, August 20, 1996

PO #

Date Received in lab:

Friday, August 16, 1996

GCI Project #: 9608-047

Summary of requested analytical work

Sample type code #s :	1 = solid samples;	2 = liquid samples;	3 = Air samples;	4 = sludges/unknowns
Field Number: 645-9	Lab ID 3493	Sample Type: 2	Date Analyzed: 8/20/96	for Dissolved Fe by FI
Date Sampled 8/16/96	at 2:30			

J

Diana J. Barrett

Here by certify that I have Reviewed and approve this data set

2500 Gate Way Centre Blvd., Suite 300 • Morrisville, NC 27560
Telephone: 919-460-8093 • FAX: 919-460-0187

GeoChem Incorporated Certified Analytical Laboratory

NC # 37745 , NC # 336, NC # 461, EPA ID # 155

Tuesday, August 20, 1996

Site Name: Well 645

GCI Project # 9608-047

Field ID 645-9

Lab ID 3493

Date Analyzed: 8/20/96

Dissolved Fe by FI

**Conc. in
mg/l**

**PQL in
mg/l**

**Dilution
Factor**

**NCAC 2L
in mg/l**

Iron

1.

0.3

1.0

0.3

GeoChem Incorporated Quality Control Results

NC # 37745 , NC # 336, NC # 461, EPA ID # 155

Tuesday, August 20, 1996

GCI Project # 9608-047

**Percent
Recovery**

Lab Blank:

**lowest detection limit @ ideal conditions
MDL in
mg/l**

Dissolved Fe by FI

Iron

110

0

0.1

Report To: Tony Vellica

GeoChem, Incorporated

Environmental Laboratories

**2500 Gate Way Centre Blvd., Suite 300
Morrisville, NC 27560**

Bill To:

RC8A

WILMINGTON

Chain of Custody Record

Page 1 of 1

[illegible]

This Chain of Custody is considered a written contract to perform the services requested in the analysis on this sample.

APPENDIX V
DESIGN CALCULATIONS

JOB: Not SpecificCOMPUTED BY: WALTONDATE: 1/91

DESCRIPTION: _____

CHECKED BY: ARDATE: 9/28/951/3DERIVATION FOR AERATOR DESIGN

Minimum Air Requirements for gas to liquid mass transfer:

$$\left(\frac{G}{L}\right)_{\min} = \left(1 - \frac{x_2}{x_1}\right) \frac{P_T}{H} \quad \leftarrow \text{from "Water Treatment Principles & Design", Montgomery, 1985, pg. 91}$$

where:

$$\frac{x_2}{x_1} = \frac{\text{moles of dissolved gas in effluent liquid}}{\text{moles of dissolved gas in influent liquid}}$$

$$\frac{G}{L} = \frac{\text{moles gas}}{\text{moles liquid}}, \text{ and}$$

$$\frac{P_T}{H} = \frac{\text{Operating pressure (in atmospheres)}}{\text{Henry's constant (in atmospheres)}}$$

Note: $\left(1 - \frac{x_2}{x_1}\right) = \text{Dissolved gas removal fraction}$

$$\therefore \text{Removal efficiency} \equiv \eta = 100 \left(1 - \frac{x_2}{x_1}\right)$$

$$\text{or } \left(1 - \frac{x_2}{x_1}\right) = \frac{\eta}{100}$$

$$\left(\frac{G}{L}\right)_{\min} = \left(\frac{\eta}{100}\right) \left(\frac{P_T}{H}\right)$$

$$\text{for air} \rightarrow \frac{G}{L} = \frac{29 \text{ lb air}}{18 \text{ lb water}} \rightarrow$$

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JOB: _____ COMPUTED BY: WALTON DATE: 1/91

DESCRIPTION: _____ CHECKED BY: AP DATE: 9/15/91
2/3

$$\frac{[(29 \text{ lb}_{\text{air}})(13.26 \text{ ft}^3/\text{lb})]}{[(18 \text{ lb}_{\text{water}}) \div (8.34 \text{ lb/gal})]} = \frac{178.2 \text{ ft}^3_{\text{air}}}{\text{gal water}} = \frac{178.2 \text{ cfm water}}{\text{gpm water}}$$

Let $\text{cfm air} = Q_a$

$\text{gpm water} = Q_w$

$$(Q_a)_{\min} = \left(\frac{178.2 \text{ cfm air}}{\text{gpm water}} \right) \left(\frac{M}{100} \right) \left(\frac{P_T}{H} \right) Q_w \quad (\text{EQ. 1})$$

* Note: Actual air requirements may be as much as 10 times greater than predicted

AERATOR DESIGN

Procedure: (1) Specify: Influent concentration desired removal percentage water flow rate
 (2) Determine air/water ratio

Governing equations are: $\left(\frac{G}{L} \right)_{\min} = \left(1 - \frac{x_2}{x_1} \right) \frac{P_T}{H}$

and

$$Q_{\text{air}}^{**} = \left(\frac{G}{L} \right)_{\min} \left(\frac{178.2 \text{ ft}^3_{\text{air}}}{\text{gal water}} \right) (Q_w)$$

** from "Water Treatment Principles & Design", Montgomery, pg. 91

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JOB: _____ COMPUTED BY: WALTON DATE: 1/91
DESCRIPTION: _____ CHECKED BY: AP DATE: 9/15/91
3/3

$$\therefore (Q_{air})_{min} = \left(\frac{M}{100}\right) \left(\frac{P_T}{H}\right) (178.2) (Q_{water}) \quad (EQ. 2)$$

Note: Clearly, equation 1 and 2 are identical;

Units on $Q_{air} = \text{cfm}$

$Q_w = \text{gpm}$

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RC&A

JOB: 94107-G

COMPUTED BY: ~~AD~~

DATE: 8/22/96

DESCRIPTION: LANTANA 1-77

CHECKED BY: MEM

DATE: 8-26-96

1/4

REQUIRED AIR SPARGING VOLUMETRIC FLOW RATE DETERMINATION

Let "H" designate the potentiometric head as determined from the point of air sparging application to potentiometric surface. Then:

$$H = 80 \text{ ft} - 20 \text{ ft} = 60 \text{ ft. (DEEP WELLS)}$$

Install air sparge point to a depth of 80 ft. below grade

- Hydraulic Conductivity (K)

$$K = 254.7 \text{ ft/day (from pump test on well 645-12)}$$

- Hydraulic gradient (J)

$$J = 0.0048 \text{ (between 645-9 & 645-10)}$$

- Radius of influence = 30 ft.

* Assume 100% product volatilization

Determine volumetric flow rate of ground water per aquifer's unit width:

$$\frac{Q_w}{\text{unit width}} = q = K J H = 254.7 \frac{\text{ft}}{\text{day}} (0.0048 \frac{\text{ft}}{\text{ft}}) (60 \text{ ft.})$$

$$q = 73.4 \frac{\text{ft}^3}{\text{ft-day}}$$

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JOB: 94107-G COMPUTED BY: AS DATE: 8/22/96
DESCRIPTION: ANT-11 243 CHECKED BY: WEN DATE: 3/26/96

converting "q" from $\text{ft}^3/\text{ft-day}$ to gpm/ft , get: 2/4
$$= 173.4 \frac{\text{ft}^3}{\text{ft-day}} \left(7.48 \frac{\text{gal}}{\text{ft}^3} \right) \left(\frac{24 \text{ hr}}{1440 \text{ min}} \right) = 8.38 \frac{\text{gpm}}{\text{ft}}$$

Aeration Requirements

let ' Q_{air} ' designate the volumetric flow rate of air sparged through each sparging well.

let ' Q_w ' designate the volumetric flow rate of ground water as observed from the air sparging point

Governing equation for computation of ' Q_{air} ' is:

$$\frac{Q_{\text{air}}}{\text{well}} = \left(\frac{M}{100} \right) \left(\frac{P_T}{H_c} \right) (\alpha) (Q_w) (\beta) (2 \cdot r)$$

where:

M = percent of product vapor removal (assumed @ 100%)

P_T = atmospheric pressure

H_c = Henry's constant for benzene (= 278 atm.)

β = safety factor (= 10)

α = conversion factor (= 178.2 ft^3 of air per gallon water)

r = air sparging well's radius of influence

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JOB: 24107-G COMPUTED BY: ~~AS~~ DATE: 8/22/96
DESCRIPTION: LANDFILL GAS CHECKED BY: MEW DATE: 8-2-96

3/4

For,

$$Q_{air} = (1.0) \left(\frac{1 \text{ ATM}}{278} \right) \left(178.2 \frac{\text{ft}^3}{\text{gal}} \right) \left(0.38 \frac{\text{cm}}{\text{ft}} \right) \cdot 5 (2 \times 30)$$

$$Q_{air} = 21.9 \text{ cfm/well}$$

$$(Q_{air})_{TOTAL} = (21.9 \text{ cfm/well}) (6 \text{ wells}) = 131.4 \text{ cfm}$$

FOR SHALLOW WELLS:

$$H = 50 - 12 = 38 \text{ ft.}$$

$$\frac{Q}{\text{unit-width}} = q = KJH = (254.7 \text{ ft/day}) (0.0048 \text{ ft/ft}) (38 \text{ ft.})$$
$$q = 46.5 \text{ ft}^3/\text{g-day} = 0.24 \text{ gpm/ft}$$

$$(Q_{air})_{TOTAL} = (13.9 \text{ cfm/well}) (8 \text{ wells}) = 111.20 \text{ cfm}$$

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JOB: 94107-6 COMPUTED BY: AD DATE: 8/22/96
DESCRIPTION: LANTDIV 645 CHECKED BY: MEI DATE: 8-26-96

4/4

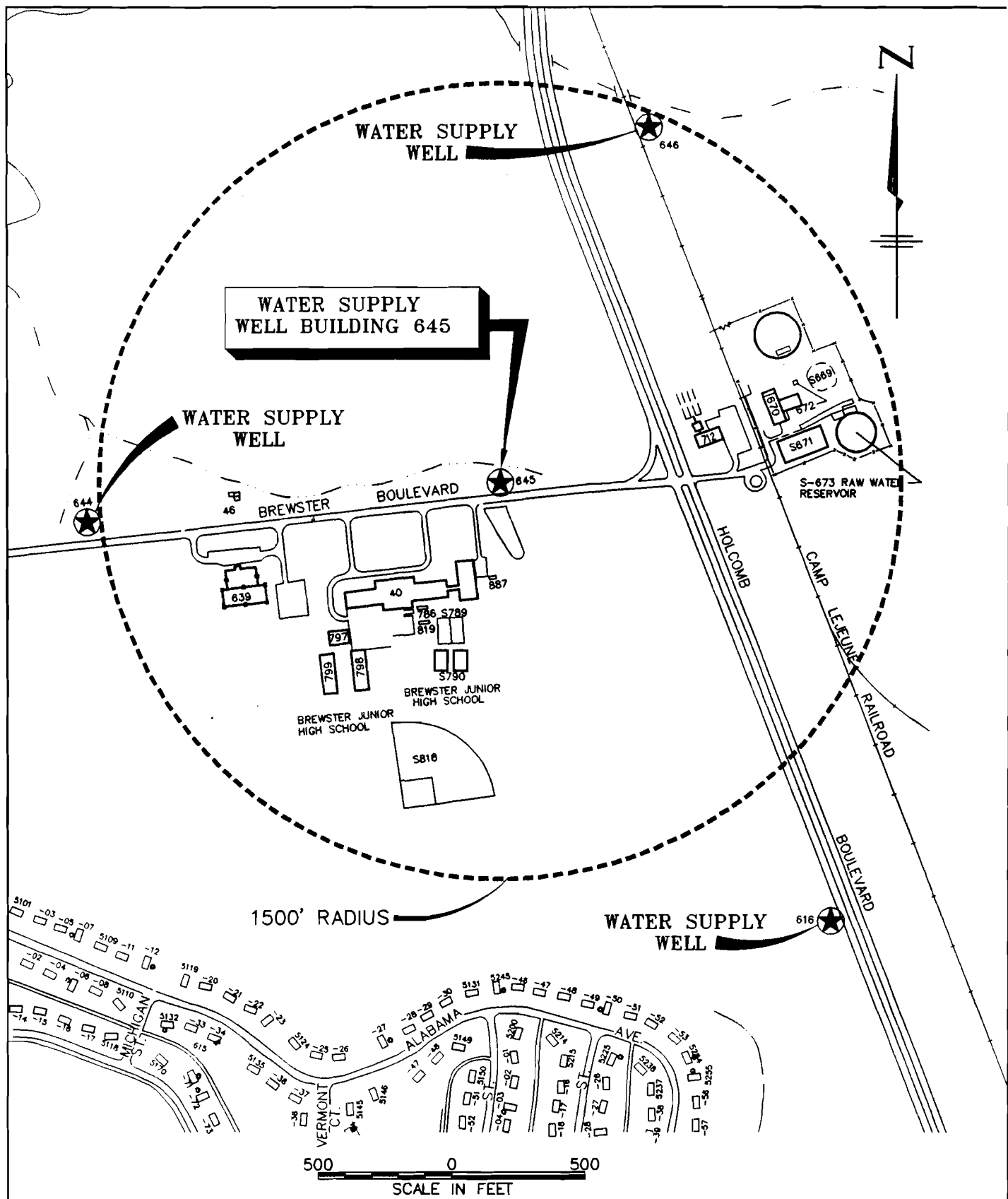
Spec Value Extension rate is twice the
total air seeping rate:

$$2 \times [(131.4 \text{ cfm} + 111.20 \text{ cfm})] = 485.2 \text{ cfm}$$

Richard Catlin & Associates, Inc.

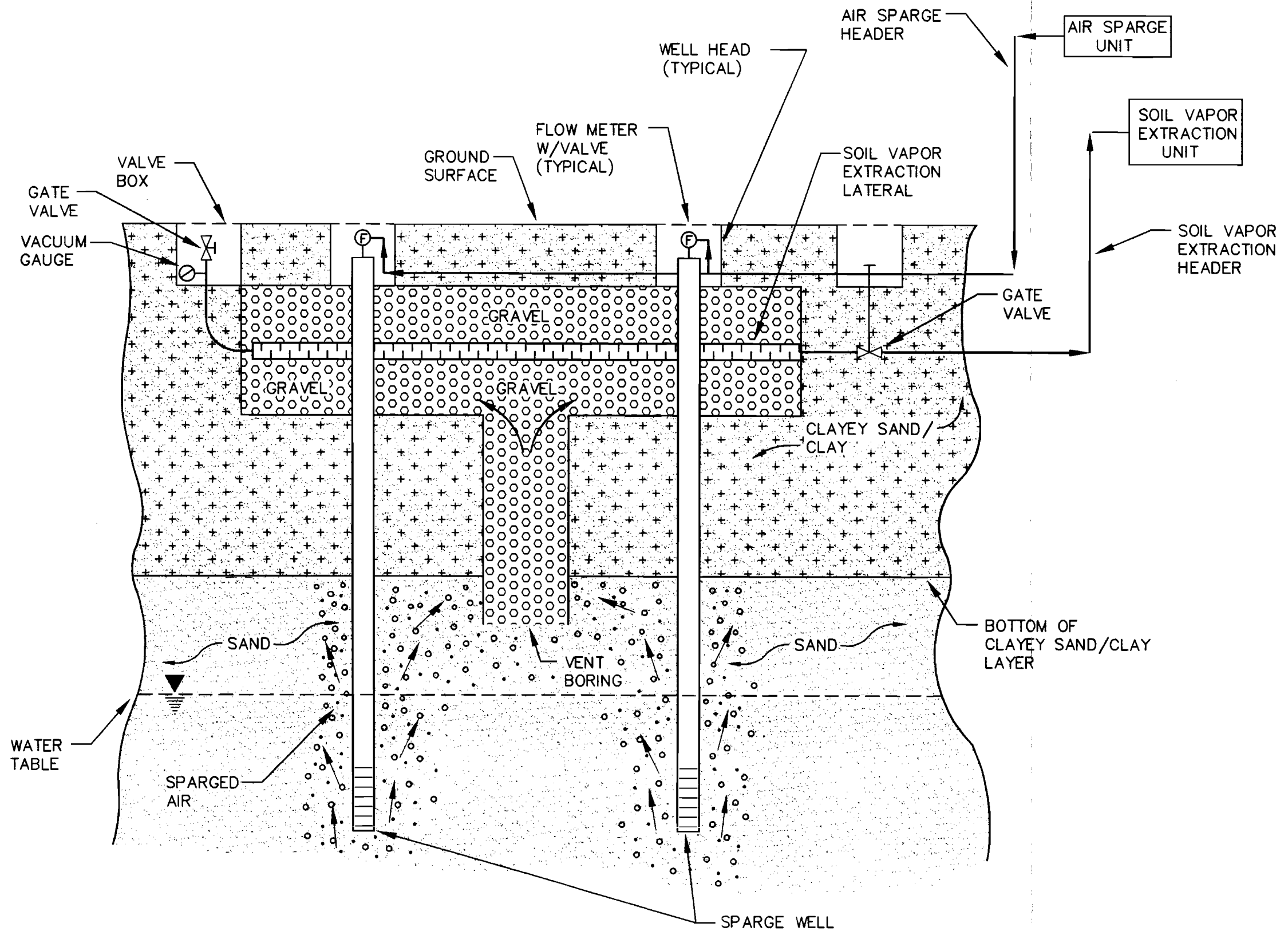
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WELL LOCATIONS ARE FROM THE AUTOCAD DATABASE FURNISHED BY THE CAMP LEJEUNE ENGINEERING OFFICE.
ALL WELL LOCATIONS ARE APPROXIMATED AND CURRENT THROUGH 1984.

Richard Catlin & Associates, Inc. ENVIRONMENTAL ENGINEERS AND HYDROGEOLOGISTS WILMINGTON, NC CHARLESTON, SC ATLANTA, GA CHARLOTTE, NC	PROJECT 645 LANTDIV NAVFACENGCOM CAMP LEJEUNE, N.C.		TITLE WATER SUPPLY WELL LOCATION MAP		FIGURE
	JOB NO: 94107CP DATE: AUG 96		SCALE: 1"=500' DRAWN BY: WHW CHECKED BY: AP		2.1



REMEDIATION SYSTEM SCHEMATIC
NTS

Richard Collin & Associates, Inc. ENVIRONMENTAL ENGINEERS AND HYDROGEOLOGISTS WILMINGTON, NC CHARLESTON, SC ATLANTA, GA CHARLOTTE, NC		PROJECT 645 MARINE CORPS BASE CAMP LEJEUNE, N.C.	TITLE REMEDIATION SYSTEM SCHEMATIC	FIGURE 5.3
JOB NO. 94107CP DATE AUG 1996		SCALE: NTS	DRAWN BY: JCR	CHECKED BY: AP

