FINAL

CORRECTIVE ACTION PLAN FOR THE RISK-BASED CLOSURE OF THE BASE EXCHANGE SERVICE STATION TYNDALL AIR FORCE BASE, FLORIDA

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and

325 CES/CEVR
TYNDALL AIR FORCE BASE, FLORIDA

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Prepared by

PARSONS ENGINEERING SCIENCE, INC.
1700 Broadway, Suite 900
Denver, Colorado 80290
and
5390 Triangle Parkway, Suite 100
Norcross, Georgia 30092

20000818 033

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SECTION 1
INTRODUCTION

Parsons Engineering Science, Inc. (Parsons ES) was retained by the Air Force Center for Environmental Excellence, Technology Transfer Division (AFCEE/ERT) under Air Education and Training Command (AETC) Contract No. F41689-96-D-0710, Order No. 5015 to prepare a corrective action plan (CAP) to support a risk-based remediation decision for contaminated soil and groundwater at the Base Exchange (BX) Service Station at Tyndall Air Force Base (AFB) in Florida.

1.1 DESCRIPTION OF THE RISK-BASED APPROACH

The objective of risk-based remediation is to reduce the risk of specific chemicals to human health and/or ecological receptors such as animals or plant life. For any chemical to pose a risk, four elements must exist at the site:

- A source of chemical contamination that exceeds or could generate chemical contamination above health-protective or aesthetic standards;
- A mechanism of contaminant release;
- A human or ecological receptor available for chemical contact; and
- A completed pathway through which that receptor will contact the chemical.

If any one of these four elements is absent at a site, there is no current risk. The reduction or elimination of risk can be accomplished by limiting or removing any one of these four elements from the site.

The goal of this risk-based remediation approach is to find the most cost-effective method of reducing present and future risk by combining three risk reduction techniques:

- Chemical Source Reduction - Achieved by natural attenuation processes over time or by engineered removals such as free product recovery, soil vapor extraction (SVE), or *in situ* bioventing.
- Chemical Migration Control - Examples include natural attenuation of a groundwater plume, and SVE to prevent migration of hazardous vapors to a receptor exposure point.
- Receptor Restriction - Land use controls and site fencing to eliminate chemical exposure until natural attenuation and/or engineered remediation reduce the chemical source and/or eliminate the potential for chemical migration to an exposure point.

1.2 RISK-BASED APPROACH TASKS

The major tasks of this risk-based project are:

- Assessing available data and collecting any supplemental site characterization data necessary to define the nature, magnitude, and extent of soil and

groundwater contamination and to document to what degree natural attenuation processes are operating at the selected sites;

- Determining whether an unacceptable risk to human health or the environment currently exists or may exist in the foreseeable future using applicable Florida Department of Environmental Protection (FDEP) guidance and regulations, quantitative contaminant fate and transport models, and exposure concentration estimates;
- Evaluating and recommending a remedial alternative that both reduces the source of contamination and minimizes or eliminates risks to potential receptors; and
- Documenting the remedial action selection process in a report that satisfies FDEP requirements.

1.3 REGULATORY REQUIREMENTS

This section describes Florida's tiered approach for risk-based remedial action at sites contaminated with petroleum products. The *Petroleum Contamination Site Cleanup Criteria* rule [Chapter 62.770 of the Florida Administrative Code (FAC)] (FDEP, 1997) presents guidance for determination of remedial requirements for closure of petroleum-contaminated sites, including several mechanisms for determining matrix-specific cleanup criteria. The regulations allow closure of petroleum release sites under several different scenarios, including:

- No-Further-Action (NFA) Proposal Without Conditions,
- NFA Proposal With Conditions, or
- Monitoring-Only Proposal for Natural Attenuation.

A Remedial Action Plan (RAP) must be prepared for sites that do not meet the requirements for NFA or Natural Attenuation. Closure of a site under the NFA-Without-Conditions alternative would allow unrestricted future use of the site (e.g., residential land use), and therefore the requirements and allowable contaminant levels under this alternative are the most restrictive. The NFA-With-Conditions alternative requires that appropriate institutional or engineering controls be implemented to limit receptor exposure; sites seeking closure under this alternative are subject to potentially less stringent cleanup levels. A Natural Attenuation Monitoring Program is a recognized means of remediating a site, with the goal of achieving the NFA cleanup target levels.

The actual or potential beneficial use of the groundwater and susceptibility of the aquifer to contamination are considered in the risk-based corrective action program to determine site-specific remediation target levels. All groundwater of the State of Florida is classified according to the following uses:

> Class F-I: Potable water use: groundwater in a single source aquifer described in Rule 62-520.460, FAC. that has a total dissolved solids (TDS) content of less than 3,000 milligrams per liter (mg/L) and was specifically reclassified as Class F-I by the Commission.

Class G-I: Potable water use: groundwater in a single-source aquifer that has a TDS content of less than 3,000 mg/L.

Class G-II: Potable water use: groundwater in an aquifer that has a TDS content of less than 10,000 mg/L, unless otherwise classified by the Commission.

Class G-III: Non-potable water use: groundwater in an unconfined aquifer that has a TDS content of 10,000 mg/L or greater; or that has a TDS content of 3,000-10,000 mg/L and either has been reclassified by the Commission as having no reasonable potential as a future source of drinking water, or has been designated by the FDEP as an exempted aquifer pursuant to Rule 62-28.130(3), FAC.

Class G-IV: Non-potable water use: groundwater in a confined aquifer that has a TDS content of 10,000 mg/L or greater.

The classification of the groundwater beneath the BX Service Station is unknown.

1.3.1 No Further Action

Closure of a petroleum release site under a NFA Proposal (without or with conditions) requires that a site meet the following criteria:

- No free product is present (as specified in 62-770.680 (1)(a), FAC);
- No fire or explosion hazard is present due to release of petroleum or petroleum products ;
- No "excessively contaminated soil" (as defined in 62-770.200, FAC) is present; and
- Matrix-specific target cleanup levels are met.

The *Petroleum Contamination Site Cleanup Criteria* rule (FDEP, 1997) incorporates matrix-specific Target Cleanup Levels for petroleum constituents in the form of "look-up" tables or through reference to other applicable regulations (i.e., state groundwater or surface water regulations). Contaminant concentrations in all affected media at a site must be below all applicable Target Cleanup Levels for the site to qualify for a NFA (with or without conditions) proposal. This comparison also is known as a Tier I assessment.

The rule also allows for the development of alternative cleanup standards based on a site-specific risk assessment for use in a NFA Proposal with conditions (Tier II assessment). These site-specific alternative cleanup standards can be used in place of those presented in the look-up tables.

1.3.2 Natural Attenuation With Monitoring

The FDEP recognizes natural attenuation with monitoring as a viable site remediation strategy. The following criteria must be met to demonstrate that this strategy is appropriate for a site:

- No free product is present (as specified in 62-770.690 (1)(a),FAC);
- Contaminated soil is not present to the extent that it may increase cleanup costs;
- Groundwater contaminant concentrations above applicable target cleanup levels are not migrating beyond a temporary point of compliance (POC);
- Available data show an overall decrease in the mass of contamination; and
- Contaminant concentrations in groundwater do not exceed appropriate criteria (Table IX levels, 62-770, FAC); or the technical evaluations (as specified in 62-770.690 (1)(f), FAC) indicate that natural attenuation is an appropriate remedial alternative.

Natural attenuation with monitoring requires the establishment of a temporary POC based on site-specific conditions relating to land and groundwater use, potentially exposed populations, hydrogeology, and type and concentrations of contaminants. Concentrations of petroleum compounds at the POC cannot exceed levels presented in the rule. Monitoring of natural attenuation to show plume stability and/or contaminant reductions can eventually lead to a proposal for NFA With or Without Conditions.

1.3.3 Summary

In summary, the *Petroleum Contamination Site Cleanup Criteria* rule allows a rapid determination of whether or not a site can qualify for a NFA proposal and/or the appropriateness of natural attenuation with monitoring as a remedial strategy. The rule allows for inclusion of site-specific information in developing alternative cleanup levels for NFA with conditions, and provides guidance on preparation of a RAP if active remediation is warranted.

1.4 REPORT ORGANIZATION

This CAP consists of ten sections, including this introduction, and eight appendices. Site background, including operating history and a review of environmental site investigations conducted to date, is provided in the remainder of this section. Section 2 summarizes the 1998 site characterization activities performed by Parsons ES. Physical characteristics of the BX Service Station and surrounding environs are described in Section 3. A Tier I evaluation is completed in Section 4 to identify those site contaminants that are considered chemicals of potential concern (COPCs). Section 5 summarizes the nature and extent of COPC contamination at the site. Section 6 addresses the effects of natural chemical attenuation processes that are documented to be occurring at the site, and presents quantitative chemical fate and transport. A Tier II evaluation and receptor exposure analyses and conclusions are included in Section 7. A remedial alternatives evaluation is presented in Section 8. Section 9 presents a long-term monitoring plan (LTM). Section 10 presents references used in preparing this CAP.

Pertinent information from prior investigations is presented in Appendix A. Analytical data sheets and chain-of-custody records are in Appendix B. Boring logs, groundwater sampling forms, and well construction diagrams for all sampling activities completed by Parsons ES during the March 1998 field effort are included in Appendix C. Appendix D presents the decay coefficient calculations. The volitization from subsurface

sources model calculations are presented in Appendix E. The BIOSCREEN fate and transport model results used in the predictive chemical fate assessment are in Appendix F. Appendix G includes input and output from the IEUBK lead model. Cost tables from the remedial alternatives are included in Appendix H.

1.5 SITE DESCRIPTION AND BACKGROUND

Tyndall AFB is located in Bay County in the Florida panhandle. The BX Service Station is an active gas station located southwest of the main runway and northeast of Hog Island Sound (Figures 1.1 and 1.2). Features of the site include Building 968, a pump island, a former tank pit located southwest of Building 968, and a currently in-use tank pit located northeast of the pump island (Figure 1.3).

The former tank pit contained underground storage tanks (USTs) installed in 1948 which stored leaded and unleaded gasoline. These tanks were replaced in 1967. In approximately 1983 to 1984, the USTs were closed in place and three 10,000-gallon gasoline USTs were installed east of the pump island. One tank was fitted with a fill line directly over the tank. The other two tanks were fitted with remote fill lines. Later, a new set of remote fill lines was laid parallel to the original set. The original remote fill lines were not removed or plugged. In 1987, vapor probes indicated a release when the USTs were overfilled through the new remote fill lines and fuel leaked out into the surrounding soil through the original remote fill lines. The remote fill lines have been replaced with direct fill lines, and one cubic yard of contaminated soil was removed from the site in May 1994 (BCM Engineers Inc. [BCM], 1995; Lewis, 1998).

BCM conducted a Contamination Assessment (CA) between March 1994 and April 1995 at the BX Service Station. The main objectives of the assessment were to determine if soil and groundwater at the site were contaminated and to define the horizontal and vertical extent of any identified contamination. Soil samples were collected from 22 hand-augered borings for headspace screening with an organic vapor analyzer (OVA). Five of the soil samples were sent to a laboratory for analysis of volatile organic compounds (VOCs), total recoverable petroleum hydrocarbons (TRPH), and Resource Conservation and Recovery Act (RCRA) metals. Eight direct-push groundwater samples were collected at an average depth of 12 feet below ground surface (bgs) for onsite analysis using United States Environmental Protection Agency (USEPA) Methods 601 and 602 to aid in the placement of groundwater monitoring wells. Seven groundwater monitoring wells were installed, and groundwater samples were collected for laboratory analysis of VOCs, semivolatile organic compounds (SVOCs), TRPH, and total lead. Slug tests were conducted at each monitoring well to estimate the hydraulic conductivity of water-bearing zones (BCM, 1995).

BCM conducted a Supplemental CA between March and June 1997. Soil samples were collected from 23 hand-augered borings for OVA headspace screening; nine of the soil samples were sent to a laboratory for analysis of VOCs, TRPH, and RCRA metals. Thirty-three direct-push groundwater samples were collected for onsite analysis to aid in the placement of groundwater monitoring wells, and 11 groundwater monitoring wells were installed. Groundwater samples were collected from the seven previously installed monitoring wells and 11 newly installed monitoring wells for laboratory analysis. Slug tests were conducted at eight of the monitoring wells to estimate the hydraulic conductivity of water-bearing zones (BCM, 1997).

BCM also performed a pump test and several slug tests at the BX Service Station in March 1998 to obtain additional aquifer hydraulic conductivity data. Monitoring well MWD-11-97 was used as the pumping well during the pump test. Slug tests were performed at MW-01, MW-03, MW-02-97, MW-03-97, MW-05-97, MW-06-97, and MW-08-97.

Pertinent data from the CA report, Supplemental CA report, and the 1998 pump/slug test report are included in Appendix A.

FIGURE 1.1
REGIONAL MAP
TYNDALL AIR FORCE BASE

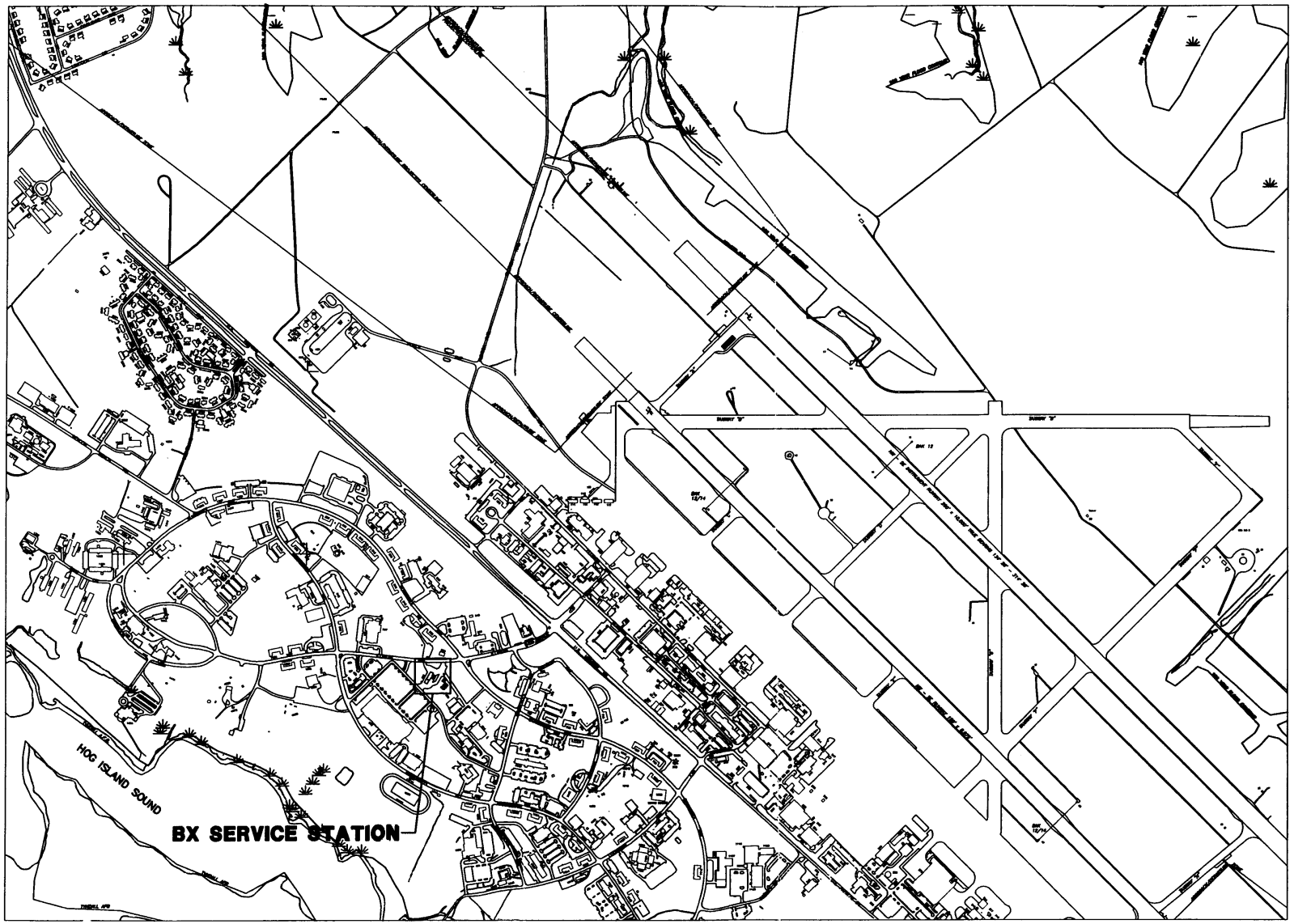
N

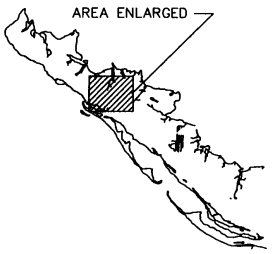
Approximate Scale

5 Miles

79
388
Vicksburg
77A
231
West Bay
Laguna
Beach
98
719
Florida Beach
Panama City
Gulf Lagoon Beach
St. Andrew Bay
East Bay
Beacon Beach
Hog Island Sound
Tyndall
Air Force Base
St. Andrew Sound
98
Crooked Island
Gulf of Mexico
Mexico Beach
Beacon Hill
St. Joseph
Point
Highland
View

J:\731854\TYNDALL\REG-MAP.cdr





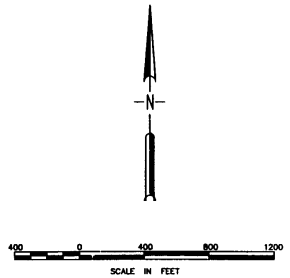


FIGURE 1.2

SITE LOCATION MAP

Risk–Based Approach
To Remediation
BX Service Station
Tyndall AFB, Florida

PARSONS ENGINEERING SCIENCE, INC.
Atlanta, Georgia

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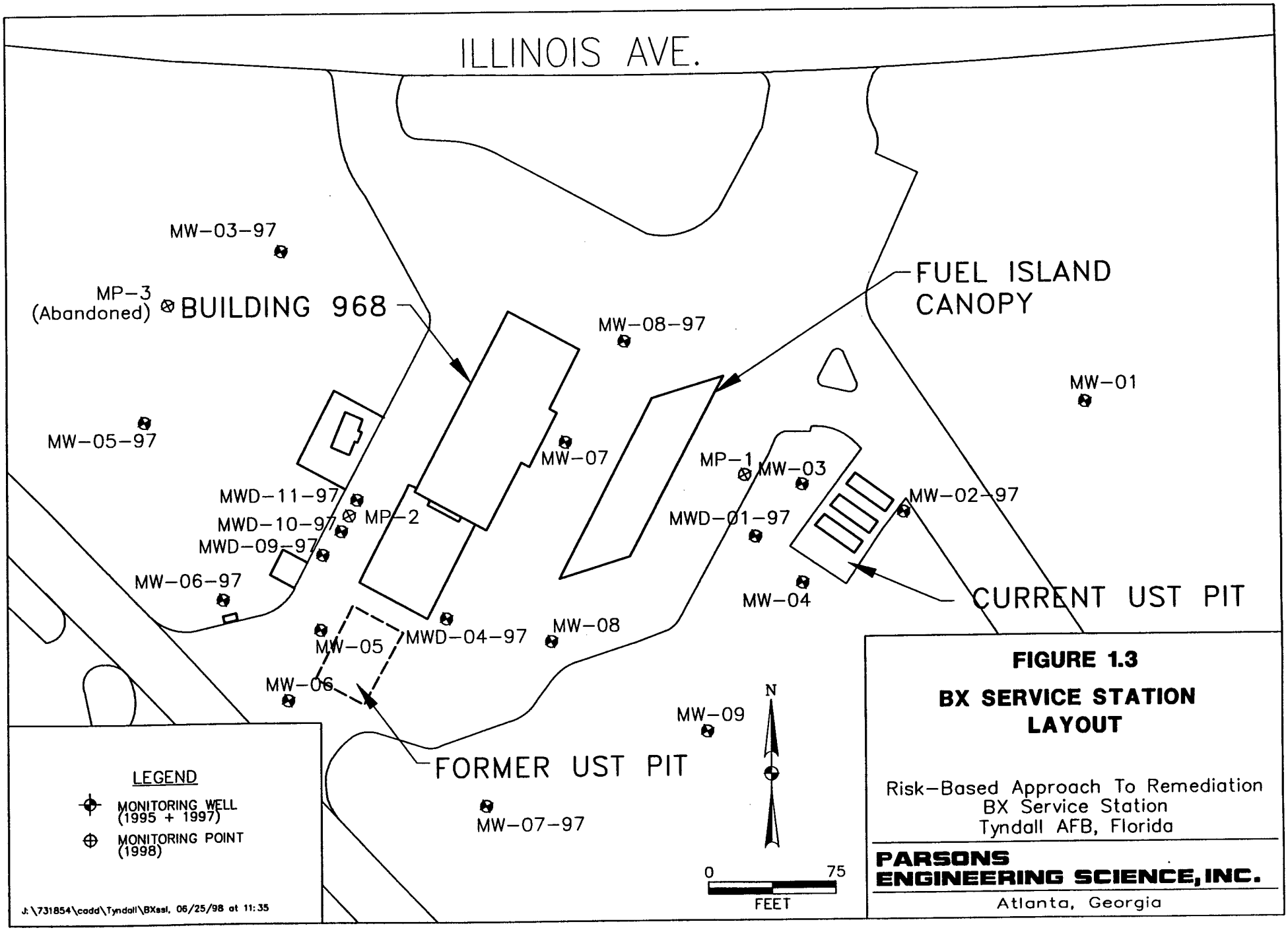
ILLINOIS AVE.
MW-03-97
MP-3
(Abandoned)
BUILDING 968
MW-08-97
FUEL ISLAND
CANOPY
MW-01
MW-05-97
MW-07
MP-1
MW-03
MWD-11-97
MP-2
MWD-10-97
MWD-09-97
MWD-01-97
MW-02-97
MW-06-97
MW-04
CURRENT UST PIT
MW-05
MWD-04-97
MW-08
MW-06
MW-09
FORMER UST PIT
MW-07-97
N
0
75
FEET
LEGEND
MONITORING WELL
(1995 + 1997)
MONITORING POINT
(1998)
J:\731854\cadd\Tyndall\BXssi, 06/25/98 at 11:35
FIGURE 1.3
BX SERVICE STATION
LAYOUT
Risk-Based Approach To Remediation
BX Service Station
Tyndall AFB, Florida
PARSONS
ENGINEERING SCIENCE, INC.
Atlanta, Georgia

SECTION 2
SITE CHARACTERIZATION ACTIVITIES

Since 1995, several soil and groundwater investigations have been conducted at the BX Service Station. These investigations focused on characterizing and delineating dissolved hydrocarbons in groundwater and residual fuel hydrocarbons in soils. Parsons ES conducted an investigation at the site during March 1998 to collect site-specific data relevant to quantifying the effects of natural contaminant attenuation processes and to facilitate development and implementation of a risk-based remedial action for the BX Service Station. Soil gas, soil, and groundwater were sampled to:

- Further delineate the extent of contamination;
- Assess temporal trends in soil and groundwater contaminant concentrations;
- Support contaminant fate and transport analyses; and
- Develop appropriate exposure-point concentrations to compare to final remediation goals.

To the extent practicable, data collected during previous investigations were used to augment this study. Emphasis was placed on collecting data documenting the natural biodegradation and attenuation of fuel hydrocarbons in soils and groundwater at the site.

The March 1998 supplemental site characterization activities performed by Parsons ES at the BX Service Station are briefly described in the remainder of this section. Most site characterization procedures (i.e., soil, soil gas, and groundwater sampling procedures) are described in detail in the project Sampling and Analysis Plan (SAP) (Parsons ES, 1997a).

2.1 SCOPE OF DATA COLLECTION ACTIVITIES

As part of the risk-based remedial approach for the BX Service Station, field data collection efforts focused on investigating specific chemical constituents that potentially pose a threat to human health or the environment. The chemicals targeted for study at this site were identified from previous site investigations and the chemical composition of the primary contaminant source (i.e., release(s) of gasoline from the former USTs). The petroleum hydrocarbon and associated constituents identified and addressed as part of this study include benzene, toluene, ethylbenzene, and total xylenes (BTEX); methyl tertiary butyl ether (MTBE), polynuclear aromatic hydrocarbons (PAHs); TRPH and lead. These analytes were targeted based on previous site assessment results.

The risk-based investigation for the BX Service Station was conducted according to the methodologies presented in the *Work Plan for the Risk-Based Investigation and Closure of the Base Exchange Service Station and Site FT-16* (Parsons ES, 1997b), hereafter referred to as the work plan. The work plan was developed according to available guidelines and requirements of the FDEP to support site closure.

The following sampling and testing activities were performed by Parsons ES during March 1998 at the site as part of this investigation:

- Drilled six soil borings;
- Collected ten subsurface soil samples for fixed-base laboratory analysis from the seven boreholes;
- Installed two permanent and one temporary small-diameter groundwater monitoring wells;
- Collected groundwater samples from seven existing groundwater monitoring wells and the three newly installed wells; and
- Collected three soil gas samples for laboratory analysis from two locations.

Analytical method detection limit (mdl) requirements were considered before site characterization work was initiated under the risk-based remediation investigation. Suitable analytical methods and quality control (QC) procedures were selected (Parsons ES, 1997a) to ensure that the data collected under this program are of sufficient quality to be used in a quantitative risk assessment.

Soil and groundwater samples were analyzed in the field and by Quanterra, Inc. of Arvada, Colorado; Tampa, Florida; and Dallas, Texas. Soil gas samples were analyzed in the field and by Air Toxics, Ltd. of Folsom, California. The laboratory data sheets and chain-of-custody records are presented in Appendix B. The analytical protocol for all samples is summarized in Table 2.1. Table 2.2 summarizes the field and fixed-base laboratory analyses performed by sampling location. These analyses and measurements were performed for various inorganic, geochemical, and physical parameters to document natural biodegradation processes and to assess the potential effectiveness of low-cost source reduction technologies.

2.2 SUBSURFACE SOIL SAMPLING

Soil samples were collected from six soil boreholes (SB-1 through SB-6) to obtain soil total organic carbon (TOC) data and to further characterize soil contamination at the site at locations where previous investigations indicated relatively high soil contaminant concentrations (Appendix A). Soils were sampled to facilitate evaluation of the potential for contaminant partitioning from soil into groundwater and soil gas, and to assess the magnitude of any changes in contaminant concentrations that have occurred over time. The soil boring locations are presented on Figure 2.1. These borings were advanced using a Geoprobe® hydraulic sampling rig as described in the SAP (Parsons ES, 1997a).

Soil samples for laboratory or field analysis were collected at regular intervals from all boreholes, both above and below the groundwater surface. A total of nine soil samples and one duplicate sample from the six boreholes were submitted to Quanterra Inc. for laboratory analysis. Samples from all six boreholes were described for lithology and field screened for volatile organic vapors using an organic vapor meter (OVM). Soil borehole information is summarized in Table 2.3, and borehole logs and completion diagrams for the newly-installed wells are included in Appendix C. Soil analytical results are summarized and discussed in Sections 4 and 5.

2.3 MONITORING WELL INSTALLATION AND DEVELOPMENT

Two permanent monitoring points (MP-1 and MP-2) and one temporary monitoring point (MP-3) were installed during the field effort. The purpose of MP-1 is to better define the lateral extent of groundwater contamination in the vicinity of the current tank pit and the pump island, to assess whether the BTEX plumes depicted east and west of the pump islands by BCM (Appendix A, Figure 19) are connected, and to obtain decay rate information. The purpose of MP-2 is to obtain shallow groundwater quality data where BTEX was detected in well MWD-10-97 (which has a 25-foot-long screen), to better define the lateral extent of the shallow groundwater plume associated with the former tank pit, and to obtain decay rate information. The purpose of MP-3 is to better define the lateral extent of the shallow groundwater plume associated with former tank pit. Table 2.3 summarizes the monitoring well completions, and Figure 2.1 presents the well locations.

MP-1 and MP-2 were constructed of schedule 80 polyvinyl chloride (PVC) screen having an internal diameter (ID) of 0.5 inch. MP-3 was constructed of schedule 40 PVC screen with an ID of 0.75 inch. All well casing and screen sections were flush-threaded; glued joints were not used. The lengths of the screened intervals for the three monitoring wells were 6 feet for MP-1 and MP-2 and 3 feet for MP-3. The field geologist recorded the borehole depth, the lengths of all casing sections, and the depth to the top of all monitoring well completion materials placed in the annulus between the casing and borehole wall.

A prepacked screen was utilized for MP-1 and MP-2. The prepacked screens are in 3-foot sections with an outside diameter (OD) of 1.5 inches and an ID of 0.5 inch. The inner component of the prepacked screen consists of 0.5-inch Schedule 80 PVC with 0.01 inch slots. The outer component of the screen is stainless steel wire mesh with a pore size of 0.011 inch. The screens are prepacked with 20/40 grade silica sand. For MP-3, medium to coarse silica sand was placed around the screened interval. A filter pack seal of hydrated sodium bentonite was placed above the screen. Well completion diagrams are included in Appendix C.

MP-1 and MP-2 were completed as flush mount wells with a 10 ½-inch diameter well vault set in an approximately 2-foot by 2-foot concrete pad. MP-3 was abandoned following sample collection by pulling the PVC pipe and backfilling the borehole with sodium bentonite chips.

Prior to sampling, monitoring wells were developed. Typically, development removes sediment from inside the well casing and flushes fines, cuttings, and drilling fluids from the sand pack and the portion of the formation adjacent to the well screen. Use of the Geoprobe® system to place monitoring wells eliminates cuttings and drilling fluids. As a result, development of monitoring wells was primarily intended to minimize the amount of fine sediment that might accumulate in the casing.

Monitoring well development was accomplished using a peristaltic pump with dedicated silicon and high density polyethylene (HDPE) tubing. The pump tubing was lowered to the bottom of the wells so that fines were agitated and removed from the well in the development water. Development was continued until ten casing volumes of water were removed from the well and the groundwater pH, temperature, conductivity, and

dissolved oxygen (DO) concentrations had stabilized. Development logs are included ion Appendix C.

2.4 GROUNDWATER SAMPLING

Groundwater samples were collected from the three newly installed monitoring points and eight existing monitoring wells at the site in March 1998. The groundwater sampling locations are shown on Figure 2.1. Samples collected from the ten wells were analyzed for fuel-related contaminants and for various inorganic and geochemical indicators to evaluate natural chemical and physical attenuation processes that are occurring at the site. Field and laboratory analytical data collected at each groundwater sampling location are summarized in Table 2.2.

All monitoring wells were purged and sampled using a peristaltic pump with dedicated HDPE and silicon tubing. Purging consisted of removing groundwater from the well until the pH, DO concentration, oxidation-reduction potential (ORP), conductivity, and temperature stabilized.

Within 24 hours of the purge event, groundwater samples were collected from the monitoring wells. The samples were transferred directly from the peristaltic pump discharge tubing into the appropriate sample containers. The water was carefully poured down the inner walls of the sample bottle to minimize aeration of the sample. Sample bottles for BTEX, MTBE, methane, and/or Hach® field analyses were filled so that there was no headspace or air bubbles within the container. One duplicate sample was collected during the groundwater sampling event.

Field and laboratory groundwater analytical results are discussed in Sections 4 and 5 of this report. These analytical results are used in Section 6 to evaluate the natural physical, chemical, and biological processes that are affecting the chemicals of potential concern (COPCs) at this site.

2.5 SOIL GAS MEASUREMENTS

Soil gas sampling was performed at the site using both field (semi-quantitative) and fixed-base laboratory (quantitative) analyses. The purpose of soil gas sampling was to assess the potential risk to future workers at the site from inhalation of volatilized contaminants, and to determine whether or not sufficient oxygen (O_2) is available in the soil gas to sustain aerobic fuel hydrocarbon biodegradation. If O_2 concentrations are significantly lower than background values, and carbon dioxide (CO_2) concentrations are higher than background levels, then the occurrence of aerobic fuel hydrocarbon biodegradation can be inferred. In addition, the O_2 levels allow an assessment of whether there is sufficient O_2 to sustain continuing aerobic biodegradation without engineered addition of oxygen via *in situ* bioventing.

Soil gas samples were collected at two locations (HA-1 and HA-15) from 2 to 3 feet below ground surface (bgs) as shown on Figure 2.1. All soil gas samples were screened using field instruments to measure O_2 and CO_2, collected in SUMMA® canisters, and submitted to Air Toxics, Ltd. in Folsom, California for analysis of total petroleum hydrocarbons (TPH) and BTEX using USEPA Method TO-3. All samples were field

screened using the test equipment and methods specified in the SAP (Parsons ES, 1997a). Analytical results for soil gas samples are summarized in Sections 4 and 5.

2.6 EQUIPMENT DECONTAMINATION PROCEDURES

All downhole soil sampling tools (e.g., stainless steel Geoprobe® pipe) were cleaned prior to collection of each sample with a clean water/phosphate-free detergent mix followed by a clean water rinse. Decontaminated tools also were used for installation of the two monitoring wells and soil gas sampling.

New, disposable HDPE and Teflon® tubing was used to collect the groundwater sample from each well. The only other equipment requiring decontamination was the water level indicator probe. The probe was decontaminated prior to each use with a clean water/phosphate-free detergent mix followed by a distilled water rinse.

2.7 SURVEYING

The newly-installed monitoring points (MP-1 and MP-2) at the BX Service Station were located by a professional surveyor (Sea Level Surveying and Mapping, Inc. of Panama City, Florida). MP-3 was abandoned before the survey was completed. Horizontal coordinates were measured to the nearest 0.1 foot using the incumbent coordinate system, and elevations of the top of the PVC well casing were measured to the nearest 0.01 foot relative to US Geological Survey (USGS) benchmarks. The survey tied into two existing monitoring wells. The locations of soil boreholes were documented via photographs and using a tape measure.

2.8 INVESTIGATION-DERIVED WASTES (IDW)

Soil cuttings, unused soil samples, and decontamination and purge water and were placed into 55-gallon, US Department of Transportation (DOT)-approved drums. All drums were moved to an on-base storage area for later disposal by the base.

2.9 ANALYTICAL DATA QUALITY ASSESSMENT

2.9.1 Introduction

A Parsons ES electronic Level III validation was performed on the March 1998 analytical results obtained from the fixed-base laboratories. The validation included internal data checks and application of data qualifiers to the analytical results based on adherence to method protocols and project-specific control limits. Method protocols reviewed included:

- Analytical holding times,
- Method blanks,
- Trip blanks,
- Surrogate spikes,
- Matrix spikes/matrix spike duplicates (MS/MSDs),
- Laboratory control samples (LCSs), and

- Sample temperatures during shipping and storage.

Data qualifiers were applied to analytical results during the data validation process. All data were validated using method applicable guidelines and in accordance with the *National Functional Guidelines for Organic Data Review* (USEPA 1994a) and the *National Functional Guidelines for Inorganic Data Review* (USEPA 1994b). The following definitions provide explanations of the USEPA (1994a and 1994b) qualifiers assigned to analytical results during data validation. The data qualifiers described were applied to both inorganic and organic results.

U The analyte was not present above the reported sample quantitation limit (SQL).

J1 The analyte was positively identified, but the associated numerical value may not be consistent with the amount actually present in the environmental sample. The data should be considered acceptable as a basis for decision-making and are usable for many purposes.

2.9.2 Data Quality

Data quality for each QC parameter where exceptions were noted during the validation is summarized in this section. Only results that exceeded quality assurance (QA)/QC criteria are presented. All frequency requirements for field sample collection of QA/QC samples (MS/MSDs and blanks) were met. The frequency requirements for laboratory specific method criteria QA/QC also were met.

Samples were collected and analyzed as specified in the methods. All samples are representative of the site and comparable with previous and future investigations (when used in accordance with the validation qualifiers).

All sample results qualified as "U or J1" and used in accordance with data validation qualifiers applied are usable for the purposes intended. Results qualified as such represent an association to non-compliant QC criteria which has caused the reported concentration to be estimated. Project objectives do not exclude the use of estimated concentrations and therefore the usability of that data point for project purposes.

In summary, accuracy and precision were in control. All method specific criteria were in control.

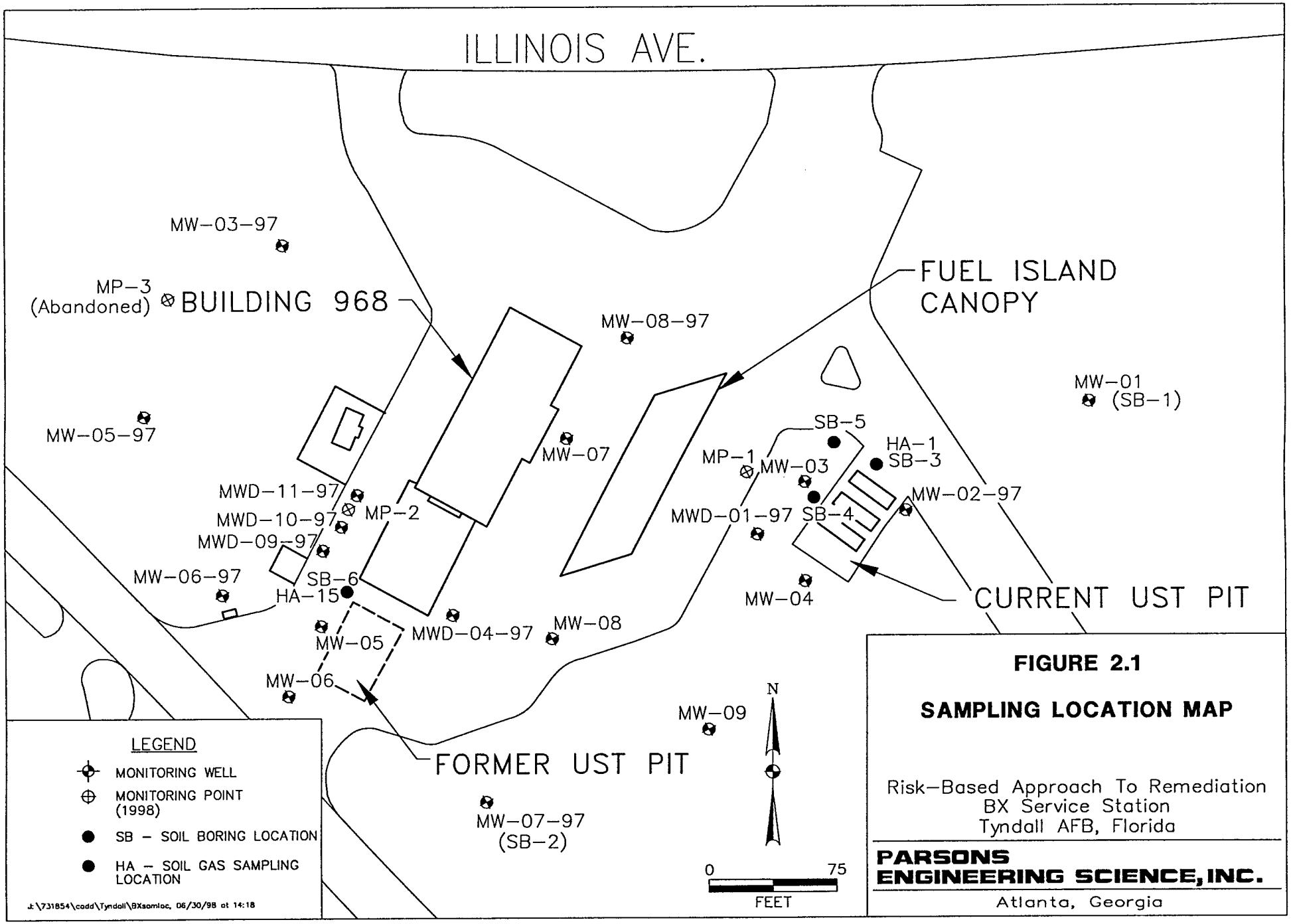

FIGURE 2.1

SAMPLING LOCATION MAP

Risk-Based Approach To Remediation
BX Service Station
Tyndall AFB, Florida

PARSONS ENGINEERING SCIENCE, INC.

Atlanta, Georgia

TABLE 2.1
ANALYTICAL PROTOCOL FOR
GROUNDWATER, SOIL, AND SOIL GAS SAMPLES
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

MATRIX	METHOD	WHERE ANALYZED
GROUNDWATER		
Ferrous Iron (Fe^{+2})	Colorimetric, Hach Method 8146	Field
Alkalinity as Calcium Carbonate ($CaCO_3$)	Titrimetric, Hach Method 8221	Field
Ammonia as Nitrogen (NH_3-N)	CHEMetrics Method 1510, ASTM 4500: NH_3	Field
Sulfate (SO_4^{-2})	Colorimetric, Hach Method 8051	Field
Total Sulfide	Colorimetric, Hach Method 8131	Field
Conductivity	Direct reading meter	Field
Oxygen	Direct reading meter	Field
pH	Direct reading meter	Field
Redox Potential	Direct reading meter	Field
Temperature	Direct reading meter	Field
BTEX + MTBE	SW8020A	QUANTERRA[a/]
Polynuclear Aromatic Hydrocarbons	SW8310	QUANTERRA
Total Recoverable Petroleum Hydrocarbons	FL-PRO (C8-C40)	QUANTERRA
Methane (CH_4)	RSK-175	QUANTERRA
Nitrate as Nitrogen (NO_3^{-1}-N)	E300.0	QUANTERRA
Lead	SW7421	QUANTERRA
SOIL		
BTEX	SW8020A	QUANTERRA
Polynuclear Aromatic Hydrocarbons	SW8310	QUANTERRA
Total Recoverable Petroleum Hydrocarbons	FL-PRO (C8-C40)	QUANTERRA
Total Organic Carbon	SW9060	QUANTERRA
SOIL GAS		
BTEX	TO-3	Air Toxics[b/]
Total Petroleum Hydrocarbons	TO-3	Air Toxics
Oxygen	Direct reading meter	Field
Carbon Dioxide	Direct reading meter	Field

Notes:

a/ Quanterra, Inc. of Arvada, Colorado; Tampa, Florida (TRPH only); and Dallas, Texas (methane only)

b/ Air Toxics LTD. of Folsom, California

TABLE 2.2
SAMPLE ANALYSES BY LOCATION
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Sampling Location	Sample Matrix	Sample Depth (ft. bgs) [a/]	Analyte and Analysis Method									
			BTEX SW8020	PAHs SW8310	TRPH FL-PRO	Total Lead SW7421	TOC SW9060	Methane RSK-175	Nitrate E300	ORP Field	Alkalinity Field	Conductivity Field
SB-1	Soil	6 - 8					X					
SB-1	Soil	9.5 - 10					X					
SB-2	Soil	6.5 - 7					X					
SB-3	Soil	2 - 3.5	X	X	X							
SB-3	Soil	4 - 5.5	X	X	X							
SB-4	Soil	4 - 7	X	X	X							
SB-4	Soil	10 - 12	X	X	X							
SB-5	Soil	4.5 - 5	X	X	X							
SB-6	Soil	7.5 - 8	X	X	X							
MW-01	Groundwater	NA	X					X	X	X	X	X
MW-03	Groundwater	NA	X	X	X	X		X	X		X	X
MW-05	Groundwater	NA	X					X	X	X	X	X
MW-07	Groundwater	NA	X					X	X	X	X	X
MW-03-97	Groundwater	NA	X	X	X	X				X	X	X
MW-05-97	Groundwater	NA	X	X	X	X				X	X	X
MW-08-97	Groundwater	NA	X					X	X	X	X	X
MP-1	Groundwater	NA	X					X	X	X	X	X
MP-2	Groundwater	NA	X	X	X	X		X	X	X	X	X
MP-3	Groundwater	NA	X							X	X	X
HA-1	Soil Gas	2										
HA-15	Soil Gas	2										

[a/] ft. bgs = feet below ground surface

NA = not applicable

TPH = Total Petroleum Hydrocarbons

BTEX = Benzene, Toluene, Ethylbenzene, and Xylenes

PAHs = Polynuclear Aromatic Hydrocarbons

TRPH = Total Recoverable Petroleum Hydrocarbons

TOC = Total Organic Carbon

DO = Dissolved Oxygen

ORP = Oxidation Reduction Potential

TABLE 2.2 (Continued)
SAMPLE ANALYSES BY LOCATION
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Sampling Location	Sample Matrix	Depth (ft. bgs) [a/]	Analyte and Analysis Method							
			DO Field	Temperature Field	pH Field	Ferrous Iron Field	Sulfate Field	Sulfides Field	Ammonia Field	BTEX/TPH TO-3
SB-1	Soil	6 - 8								
SB-1	Soil	9.5 - 10								
SB-2	Soil	6.5 - 7								
SB-3	Soil	2 - 3.5								
SB-3	Soil	4 - 5.5								
SB-4	Soil	4 - 7								
SB-4	Soil	10 - 12								
SB-5	Soil	4.5 - 5								
SB-6	Soil	7.5 - 8								
MW-01	Groundwater	NA	X	X	X	X	X	X	X	
MW-03	Groundwater	NA	X	X	X	X	X	X	X	
MW-05	Groundwater	NA	X	X	X	X	X	X	X	
MW-07	Groundwater	NA	X	X	X	X	X	X	X	
MW-03-97	Groundwater	NA	X	X	X	X	X	X	X	
MW-05-97	Groundwater	NA	X	X	X	X	X	X	X	
MW-08-97	Groundwater	NA	X	X	X	X	X	X	X	
MP-1	Groundwater	NA	X	X	X	X	X	X	X	
MP-2	Groundwater	NA	X	X	X	X	X	X	X	
MP-3	Groundwater	NA	X	X	X	X				
HA-1	Soil Gas	2								X
HA-15	Soil Gas	2								X

[a/] ft. bgs = feet below ground surface

NA = not applicable

TPH = Total Petroleum Hydrocarbons

BTEX = Benzene, Toluene, Ethylbenzene, and Xylenes

PAHs = Polynuclear Aromatic Hydrocarbons

TRPH = Total Recoverable Petroleum Hydrocarbons

TOC = Total Organic Carbon

DO = Dissolved Oxygen

ORP = Oxidation Reduction Potential

TABLE 2.3
SOIL BORING AND MONITORING POINT INSTALLATION SUMAMRY
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Well ID	Groundwater Zone	Installation Date	Top of Casing Elevation (ft msl)[a/]	Depth to Top of Screen (ft bgs) [b/]	Depth to Bottom of Screen (ft bgs)	Casing/ Screen ID (inches)	Total Depth (feet)
Soil Borings							
SB-1	NA [c/]	3/18/98	NA	NA	NA	NA	11.0
SB-2	NA	3/18/98	NA	NA	NA	NA	7.0
SB-3	NA	3/18/98	NA	NA	NA	NA	8.0
SB-4	NA	3/18/98	NA	NA	NA	NA	12.0
SB-5	NA	3/18/98	NA	NA	NA	NA	8.0
SB-6	NA	3/18/98	NA	NA	NA	NA	8.0
Groundwater Monitoring Points							
MP-1	Shallow	3/18/98	29.62	2.5	8.5	0.50	8.5
MP-2	Shallow	3/18/98	29.41	3.2	9.2	0.50	9.2
MP-3[d/]	Shallow	3/22/98	NA	2.8	7.8	0.75	7.8

a/ ft msl = feet above mean sea level
b/ ft bgs = feet below ground surface
c/ NA = not applicable
d/ MP-3 was abandoned after sampling

SECTION 3
PHYSICAL CHARACTERISTICS OF THE STUDY AREA

This section describes the physical characteristics of the BX Service Station and adjacent environs at Tyndall AFB, as determined from data collected during previous site investigations (BCM, 1997 and 1998) and by Parsons ES in March 1998 as part of the risk-based investigation. A summary of site characterization activities completed by Parsons ES to supplement existing data is presented in Section 2 of this CAP.

3.1 PHYSIOGRAPHY

Tyndall AFB is located in the East Gulf Coastal Plain Physiographic Province. This province is characterized by relatively low topographic relief, predominantly sandy soils, and a gradual slope toward the Gulf of Mexico. Physiographic districts within the Gulf Coastal Plain at Tyndall AFB include predominantly Coastal Lowlands. The Coastal Lowlands occur at approximately 25 feet above mean sea level (msl) and include coastal areas, and adjacent flood plains. The Coastal Lowlands are characterized by flat, poorly drained topography near the coast and in the flood plains of major rivers. White sand beaches and sand ridges typically border the coastline while flatlands and swamps extend 10 to 15 miles inland. Landforms in the Coastal Lowland reflect their origin in a near-shore environment.

3.2 REGIONAL GEOLOGY

Bay County is located in the south-central part of the Florida Panhandle. The county is situated on the western flank of the Appalachicola Embayment, the regional geologic structure influencing the subsurface sediments. The embayment is a relatively shallow basin between the Ocala and Chattahoochee uplifts. Bay County is underlain by Cenozoic sediments approaching 3,500 feet in thickness. The county is relatively flat in relief and is mostly covered with Pleistocene to recent age quartz sands.

The county has four physiographic provinces which include: the sand hills in the northern section, the sinks and lakes in the north-central section, the flat-woods forest located below an elevation of 70 feet msl (covers most of Bay County), and the beach dunes and wave-cut bluffs of the Gulf Coast. The beach dune deposits are the youngest sediments in the basin and are the most rapidly changing physiographic feature. The land forms along the coast are composed of barrier islands, coastal ridges, estuaries, lagoons, relief spits and bars, and sand dune ridges. In Bay County, eight terraces have been mapped based on their elevations. These terrace deposits can be up to 100 feet thick near the coast, and become thinner inland.

3.3 REGIONAL HYDROGEOLOGY

The hydrostratigraphic units in Bay County are the Surficial Aquifer System, Intermediate Aquifer System or Confining Unit, and Floridan Aquifer System. All lithostratigraphic units can usually be correlated on the basis of lithology and fossil occurrence.

The Surficial Aquifer System contains the undifferentiated Quaternary sediments and the Citronelle Formation. The typical lithology of the surficial aquifer is primarily fine to

coarse quartz sand, with clay, silt, and gravel, and clayey sand and sandy clay lenses. Limonite-cemented zones, shell beds, and carbonates are also common. The thickness of the surficial aquifer varies from 40 to 100 feet and the elevation of the water table varies from 0 to 30 feet above msl. The water within the Surficial Aquifer System is generally unconfined, however, beds of low permeability may cause semi-confined or locally confined conditions in its deeper parts. Water table elevations and horizontal gradients generally reflect contours of the land surface. Terraces influence groundwater occurrence and movement due to the elevations of terraces relative to adjacent land, in addition to size and the grading of the sands and locations of bodies of water.

The Intermediate Aquifer System or Confining Unit contains the Alum Bluff Group and Intracoastal Formation. The typical lithology of the Intermediate Aquifer System or Confining Unit is clay, sand, sandy clay, argillaceous limestone, shell beds, and occasional carbonate beds or lenses. The thickness of this unit varies from 210 to 230 feet and the elevation of the top of this unit varies from -30 to -70 feet below MSL. The Intermediate Aquifer System or Confining Unit is widespread in Florida and provides an effective aquitard for the Floridan Aquifer System. In places, this unit contains principally poorly-yielding to non-yielding strata, hence the term "Intermediate Confining Unit." In other places, one or more low-to moderate-yielding aquifers may be interlayered with the virtually impermeable confining beds. Even though Bay County contains both hydrogeologic situations, only the confining unit occurs in Southern Bay County. Therefore, there should be negligible leakage between the Surficial Aquifer System and the Floridan Aquifer System at and near Tyndall Air Force Base.

The Floridan Aquifer System contains the Bruce Creek Limestone, St. Marks Formation, Chattahoochee Formation, Suwannee Limestone, Marianna Limestone and Ocala Limestone. The typical lithology of the Floridan Aquifer System is vuggy, fossiliferous, micro-crystalline to granular, argillaceous to sandy, porous limestone and dolomite. The limestone and dolomite may be interbedded with dolomitic sand, silt and clay beds. The Ocala Limestone forms one of the most permeable zones within the Floridan Aquifer System. The extensive development of secondary porosity by dissolution and dolomitization has greatly increased the permeability of the unit. The thickness of the Floridan Aquifer System varies from 900 to 1,000 feet and the elevation of the top of this unit varies from -270 to -320 feet below msl.

When intra-aquifer confining beds are present, the Floridan Aquifer System can be subdivided into an upper and lower aquifer. The Floridan Aquifer System is well confined in southern and central Bay County.

3.4 SITE GEOLOGY AND HYDROGEOLOGY

Site geology is characterized by 2 feet of fill material overlying a fine to medium grained sand. The groundwater depth at the site is approximately 5 feet bgs. Groundwater surface elevations measured in March 1998 are summarized on Table 3.1 and Figure 3.1. Groundwater contour maps from previous investigations are presented in Appendix A. The contours indicate that groundwater flows toward the west and northwest at a hydraulic gradient which ranges from 0.003 to 0.005 foot per foot (ft/ft), with an average hydraulic gradient of 0.004 ft/ft (Figure 3.1). BCM (1998) performed slug tests on multiple wells and a pump test at the site. Slug test data indicate that the hydraulic conductivity of the surficial deposits at the site ranges from approximately

0.0022 to 0.0177 centimeters per second (cm/sec){6 to 50 feet per day (ft/day)} with an average of approximately 0.0099 cm/sec (28 ft/day). Pump test data indicate that the hydraulic conductivity of the surficial deposits at the site ranges from approximately 0.0089 to 0.013 cm/sec (25 to 37 ft/day) with an average of approximately 0.011 cm/sec (32 ft/day). The slug and pump test results are presented in Appendix A. Based on a hydraulic gradient of 0.004 ft/ft, a hydraulic conductivity of 30 ft/day, and an estimated effective porosity of 25 percent for sand (Spitz and Moreno, 1996), the average advective groundwater velocity at the site is 0.48 ft/day (175 ft/year).

3.5 SITE TOPOGRAPHY AND SURFACE WATER HYDROLOGY

The BX Service Station and the surrounding area have relatively flat topography, with ground elevations at the site at approximately 30 feet above the msl. Surface water hydrology around the site is dominated by the stormwater sewer system. Tyndall AFB occupies approximately 28,000 acres on a narrow 16-mile long peninsula bordered by St. Andrew and East Bays to the North, the Gulf of Mexico and St. Andrew Sound to the south, and St. Andrew Bay to the west. Topographic depressions which intersect the water table create shallow fresh-water pools throughout the Base. The closest surface water body to the BX Service Station is Hog Island Sound, which is located approximately 1,500 feet to the southwest.

3.6 CLIMATOLOGICAL CHARACTERISTICS

Tyndall AFB has a humid, semitropical climate. Daily average temperature in the hottest summer months, July and August, may range from a low of 70°F to a high of 88°F, with an average of approximately 82°F. Winters are mild, with occasional frost from November through February. During the coldest months, December and February, the temperature may be as low as 18°F or as high as 74°F, with the average around 50°F. Average annual rainfall is approximately 64 inches and ranges from 3.5 inches in October to almost 9 inches in July.

3.7 WATER-SUPPLY WELL SURVEY

Groundwater use in the Tyndall AFB area is restricted to industrial wells completed in the Floridan Aquifer. Three water supply wells have been identified in the vicinity of the BX Service Station. These wells include Backup Well #1 at Building 250, Backup Well #2 at Building 722, and Backup Well #3 at Building 652. Backup Well #1 is located approximately 3,200 feet east-southeast of the site; Backup Well #2 is located approximately 1,350 feet east of the site; and Backup Well #3 is located approximately 850 feet north of the site. All three wells identified are completed in the Floridan aquifer at a depth of 645 feet bgs with surface casing set at depths ranging from 338 to 360 feet. These wells are used as a backup water supply for community use and have pumping capacities ranging from 350 to 500 gpm. Table 3.2 presents additional information concerning the industrial wells near the BX Service Station, including location, construction details, and capacity.

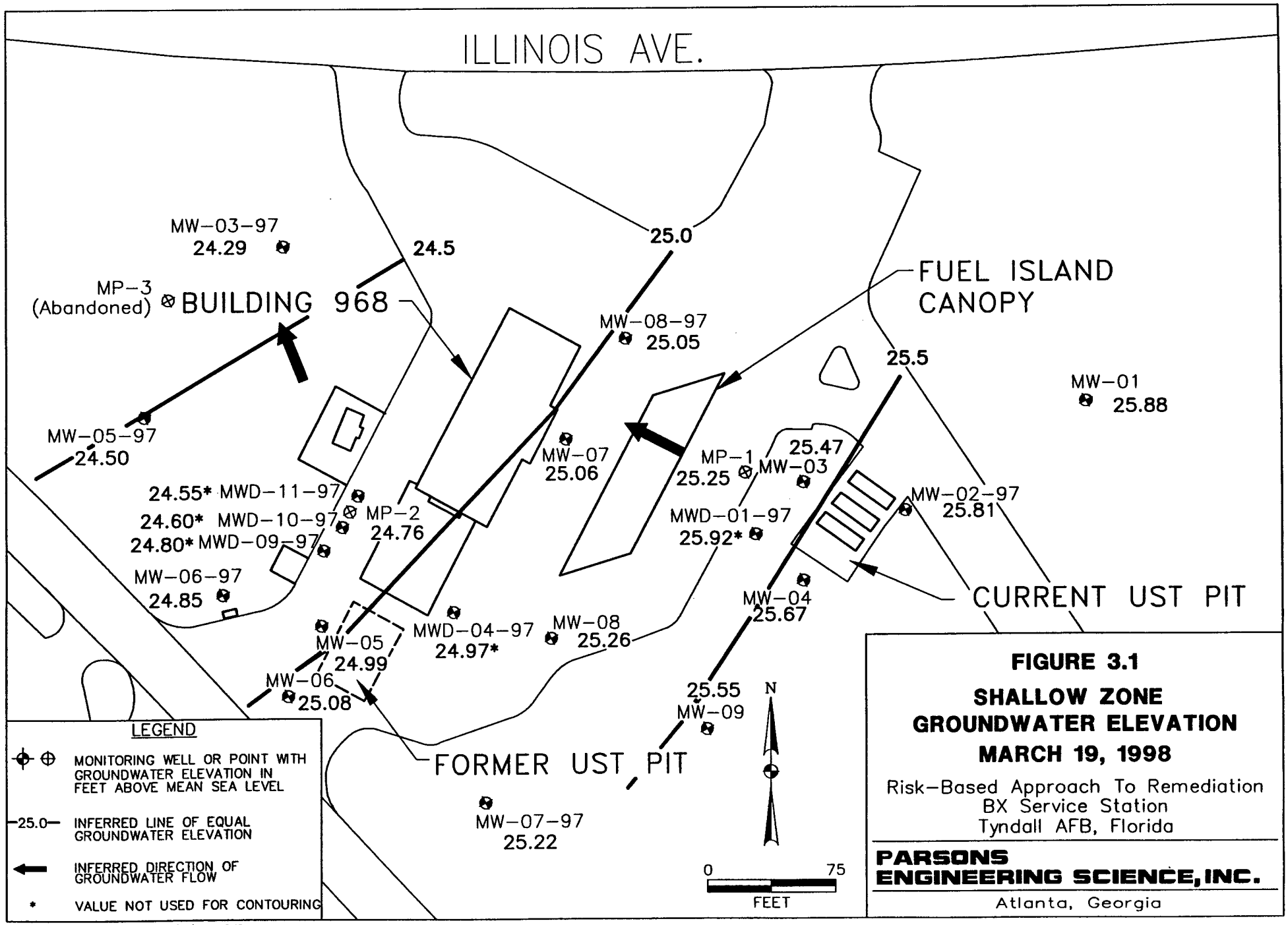
ILLINOIS AVE.
MW-03-97
24.29
24.5
25.0
MP-3
(Abandoned)
BUILDING 968
FUEL ISLAND
CANOPY
MW-08-97
25.05
25.5
MW-01
25.88
MW-05-97
24.50
MW-07
25.06
MP-1
25.25
25.47
MW-03
24.55* MWD-11-97
24.60* MWD-10-97
24.80* MWD-09-97
MP-2
24.76
MWD-01-97
25.92*
MW-02-97
25.81
MW-06-97
24.85
MW-04
25.67
CURRENT UST PIT
MW-05
24.99
MWD-04-97
24.97*
MW-08
25.26
MW-06
25.08
25.55
MW-09
FORMER UST PIT
MW-07-97
25.22
N
0
75
FEET
LEGEND
MONITORING WELL OR POINT WITH GROUNDWATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL
25.0 INFERRED LINE OF EQUAL GROUNDWATER ELEVATION
INFERRED DIRECTION OF GROUNDWATER FLOW
* VALUE NOT USED FOR CONTOURING
FIGURE 3.1
SHALLOW ZONE
GROUNDWATER ELEVATION
MARCH 19, 1998
Risk-Based Approach To Remediation
BX Service Station
Tyndall AFB, Florida
PARSONS
ENGINEERING SCIENCE, INC.
Atlanta, Georgia
J:\731854\cadd\Tyndall\BXgwelev, 06/30/98 at 13:40

TABLE 3.1
SUMMARY OF MONITORING WELL GAUGING DATA
March 19, 1998
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Well Identification	Top of Casing Elevation (ft msl)[a/]	Depth of Screened Interval (ft bgs)[b/]	Depth to Water (feet btoc)[c/]	Water Table Elevation (ft msl)
MW-01	30.85	6.5-16.5	4.97	25.88
MW-03	29.78	6.5-16.5	4.37	25.41
MW-04	30.12	4.5-14.5	4.45	25.67
MW-05	29.38	1-11	4.39	24.99
MW-06	28.44	7-17	3.36	25.08
MW-07	29.00	5.5-15.5	3.94	25.06
MW-08	29.37	5.3-15.3	4.11	25.26
MW-09	30.26	5.5-15.5	4.71	25.55
MWD-01-97	30.14	35.8-45.8	6.22	23.92
MW-02-97	29.66	2-12	3.85	25.81
MW-03-97	29.36	3-13	5.07	24.29
MWD-04-97	29.12	25.6-35.6	4.15	24.97
MW-05-97	28.66	3-13	4.16	24.50
MW-06-97	28.97	3-13	4.12	24.85
MW-07-97	29.55	3-13	4.33	25.22
MW-08-97	29.02	3-13	3.97	25.05
MWD-09-97	29.06	3.2-28.2	4.26	24.80
MWD-10-97	29.24	3.5-28.5	4.64	24.60
MWD-11-97	29.20	2.8-27.8	4.65	24.55
MP-1	29.62	2.5-8.5	4.37	25.25
MP-2	29.41	3.2-9.2	4.65	24.76

a/ ft msl = feet above mean sea level
b/ ft bgs = feet below ground surface
c/ ft btoc = feet below top of casing

TABLE 3.2
SUPPLY WELL INFORMATION
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Well	Backup Well #1	Backup Well #2	Backup Well #3
	Building 250	Building 722	Building 652
Tyndall AFB Facility No.	250	722	652
NFWMD No.	10	9	8
Use Classification *	C	C	C
Existing/Proposed Abandoned/Will Abandon	Existing	Existing	Existing
Casing Diameter (in)	16	32/12**	16
Total Well Depth (ft)	645	645	645
Casing Depth (ft)	345	360	338
Pumping Capacity (GPM)	350	350	500
Pump Type	Turbine	Turbine	Submers.
Pump Horsepower (hp)	40	30	50
Mean Withdrawal/Day (GPD)	Backup	Backup	Backup
Flow Meter	Yes	Yes	Yes
Aquifer (if known)	FL	FL	FL
Section	7	7	1
Township	5 S	5 S	5 S
Range	13 W	13 W	14 W
Longitude	30° 04'	30° 04'	30° 04'
Latitude	85° 35'	85° 35'	85° 34'
Present CUP Number	S850312	S850312	S850312
Present Permitted Consumption Capacity	240,000	240,000	240,000
Requested Consumption Capacity	504,000	504,000	720,000

* = NTNC-Nontransient, Noncommunity; C-Community; NC-Noncommunity;

OPS-Other Public Supply; IRR/OOU-Irrigation Well/Other Outside Use

** = Well 722 is 32" cased for 120', 12" cased for 242'

UNK = Unknown

N/A = Not Applicable

SECTION 4
TIER 1 ANALYSIS AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

This section presents a screening-level Tier 1 analysis used to select the COPCs that are the focus of this CAP. The COPCs for the site are identified in the Tier 1 analysis based on estimated risks to human health posed by maximum detected contaminant concentrations.

4.1 REGULATORY REVIEW OF THE TIER 1 SCREENING PROCESS

As an initial step in determining the necessity for remedial action, representative concentrations of site contaminants are compared to the NFA-With-Conditions (Direct Exposure II) generic target cleanup levels (TCLs) for soil, which are presented in the *Petroleum Contamination Site Cleanup Criteria* (FDEP, 1997). Contaminant soil concentrations must be below the Direct Exposure II presented in Table IV (based on applicable groundwater criteria specified in 62-770.680 (1)(c), FAC). Concentrations of COPCs in groundwater must be below background concentrations or less than levels presented in Table V. Maximum dissolved site contaminant concentrations also are compared to the Table IX Natural Attenuation Source Default Values. This comparison provides an initial assessment of the potential appropriateness of monitored natural attenuation as a remedial alternative.

The maximum soil contaminant concentrations were not compared to the leachability TCLs presented in Table IV of FDEP (1997). The leachability criteria were established to ensure that leaching of residual contamination adsorbed to soil particles will not result in significant impairment of groundwater quality. At the BX Service Station, the vadose zone is thin (approximately 4 to 5 feet thick), the pavement limits percolation of precipitation through site soils, and groundwater is continually or seasonally in direct contact with contaminated soil, minimizing the significance of downward leaching of contaminants from the vadose zone to the water table. In addition, the impacts of site contamination on groundwater quality have been demonstrated by the results of several years of groundwater monitoring. The gradual desorption of residual fuel contaminants from the soils and dissolution into the groundwater is significant to the extent that the contaminants in soils represent a continuing source of groundwater contamination. The length of time that the soil contamination will continue to cause groundwater contaminant concentrations to exceed Tier 1 TCLs (Table V levels in Chapter 62-770) is addressed in Section 6.

Those analytes with site concentrations that exceed the appropriate TCLs are considered to be COPCs, and are retained for further analysis concerning the risk-reduction requirements for the site. The nature and extent of these COPCs are described more fully in Section 5. Quantitative fate and transport are conducted and presented in Section 6.

4.2 PRELIMINARY CONCEPTUAL SITE MODEL REVIEW

Figure 4.1 presents the preliminary conceptual site model (CSM) developed for the BX Service Station. The model was developed using data collected during previous site

investigations, and is based on a review of potential receptors and feasible exposure scenarios. The purpose of developing a CSM is to guide the evaluation of available site information, including:

- Potential contaminant sources;
- Media affected by contaminant releases;
- Mechanisms of contaminant release (e.g., leaching and volatilization);
- Potential human and ecological receptors;
- Potential receptor exposure points based on conservative, reasonable land use assumptions; and
- Routes of possible receptor exposure (e.g., inhalation, ingestion, or dermal contact).

The CSM also was developed to provide an outline for addressing all media-specific, current and future exposure scenarios at the BX Service Station. The CSM has been constructed to identify potentially completed receptor exposure pathways. For an exposure pathway to be completed, there must be a contaminant source, a release mechanism, a contaminant migration pathway, an exposure point, a receptor, and an exposure route. If any of these components is missing, the pathway is considered incomplete, and receptors are not at risk from exposure to site contaminants.

The leaking UST fuel supply lines at the current tank pit have been replaced, and the USTs at the former tank pit were emptied and closed in place. Therefore, the initial contaminant sources have been removed. Based on the CSM, air, soil, surface water, and shallow groundwater represent the potentially affected physical media at or downgradient from the BX Service Station (Figure 4.1). On the basis of available site-specific information, current and future land use at the BX Service Station is assumed to be industrial/commercial as opposed to residential. Potential release mechanisms and pathways by which contaminants could migrate to and impact potential receptors, and that will be evaluated during the data analysis process, include the following:

- Volatilization of subsurface contaminants into the soil vapor and the atmosphere and inhalation of the volatilized contaminants by interim workers and aboveground receptors;
- Dermal contact or incidental ingestion of contaminated soil by site workers (e.g., during excavation activities);
- Ingestion of contaminants by ecological receptors (e.g., burrowing animals and their predators);
- Soil contaminants leaching to groundwater and dermal contact or incidental ingestion of contaminated groundwater by site workers (e.g., during excavation activities);

- Migration of dissolved contaminants in the groundwater and ingestion by an aboveground receptor either through a groundwater withdrawal point or groundwater discharging to surface water.

4.3 TIER 1 SCREENING ANALYSIS

It is the intention of the Air Force to obtain FDEP approval for a corrective action for the BX Service Station that will protect potential receptors from unacceptable exposures to site-related chemicals. To accomplish this objective, the COPCs that drive potential risks and impact the final remedial requirements at this site were identified.

FDEP (1997) Tier 1 TCLs are based on 1) analyte-specific toxicity data; 2) an exposure-pathway-specific cancer target risk limit of 10^{-6} (i.e., there is an added lifetime cancer risk for people near the site of 1 additional cancer above the normal background level in 1 million people, expressed as 10^{-6} or 1 in 1 million) and a noncancer hazard quotient less than or equal to 1; and 3) conservative receptor exposure assumptions.

4.3.1 Tier 1 Screening Analysis for Soil

TCLs for direct exposure of industrial workers (Direct Exposure II) were selected as the appropriate set of Tier 1 screening values for soil at the BX Service Station. The FDEP (1997) guidance provides industrial-scenario TCLs for petroleum constituents in soil that incorporate risks posed by the dermal contact, ingestion, and inhalation exposure pathways. Table 4.1 compares the maximum site concentrations for each compound measured in soil at the BX Service Station during the 1997 supplemental CA investigation (BCM, 1997) and the 1998 risk-based sampling event to the Direct-Exposure II TCLs. The soil contamination "hotspots" detected during the CA (BCM, 1995) were resampled in March 1998; therefore, the March 1998 data are used for the Tier I screening in place of the 1995 data. Based on these comparisons, no chemicals are identified as site COPCs in soil. Benzene was not detected in any sample; however, the method detection limit (mdl) for benzene associated with the 1998 sample SB-5 (4.5 -5 feet bgs), was higher than the Tier I TCL of 1.5 mg/kg by 0.9 mg/Kg. Because benzene was detected in shallow groundwater, it is suspected to be present in soil. Therefore, benzene could not at eliminated as a COPC.

4.3.2 Tier 1 Screening Analysis for Groundwater

The Tier 1 groundwater TCLs presented by the FDEP (1997) and used in this CAP are based on the conservative assumption of unrestricted future use of groundwater (e.g., use as a drinking water source). Comparisons of the TCLs for unrestricted groundwater use to maximum concentrations of compounds detected in groundwater samples collected in May 1997 (BCM, 1997) and March 1998 are presented in Table 4.2. Based on these comparisons, benzene, ethylbenzene, toluene, total xylenes, naphthalene, TRPH, MTBE, and lead are identified as the COPCs in site groundwater. It should be noted that, for all of the analytes, the concentrations exceeding Tier 1 TCLs were delineated within the monitoring well network, and therefore appear to be localized occurrences at the site. Maximum dissolved contaminant concentrations from March 1998 also are compared to Table IX Natural Attenuation Source Default Values in Table 4.2. The BTEX compounds, MTBE, and naphthalene exceeded their default values.

As with the soil screening, several of the non-detected chemicals had mdls that were elevated above the Tier 1 screening level due to sample dilution at the laboratory. These chemicals were benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. The largest difference between a mdl and a Tier I screening level in groundwater was 0.61 µg/L for dibenzo(a,h)anthracene from MW-03. The low magnitude of these differences indicate that any exceedences of the Tier 1 TCLs for these compounds would be very slight. In addition, all of the analytes are higher molecular weight PAHs which are not typically gasoline constituents. Therefore, they are not likely to be COPCs in site groundwater.

Table 4.2 also shows that groundwater was not sampled for several metals listed in the FDEP (1997) Table V. As shown in Table 4.1, these metals did not exceed soil Tier 1 screening levels, and they are not common gasoline constituents. Therefore, they will not be assessed further.

4.3.3 Tier 1 Screening Analysis for Soil Gas

FDEP (1997) guidance does not provide TCLs for screening soil gas concentrations or for directly screening ambient air quality data. However, FDEP guidance accounts for the potential for volatilization of contaminants from soils into ambient air in the calculation of the Tier 1 Direct Exposure II (Table 4.1) TCLs. No analytes were detected above Tier 1 TCLs in soil, indicating that exposure via volatilization from soil into ambient air will not present appreciable risks. The Tier 1 TCLs do not account for the presence of the concrete/asphalt cover at the site, which would act to further minimize the potential for exposure via the inhalation pathway.

As a secondary means of assessing the potential for exposure via inhalation of volatiles, soil gas samples collected in March 1998 were analyzed for BTEX, and maximum detections of each compound were compared to the chemical-specific Occupational Safety and Health Administration (OSHA) (NIOSH, 1997) 8-hour time-weighted-average Permissible Exposure Limits (PELs) and Time Weighted Average Threshold Limit Values (TWA-TLVs) (ACGIH, 1998). Table 4.3 presents the results of this comparison. Benzene was detected above the OSHA PEL and TWA-TLV. No other compounds were detected at concentrations above the PELs. The comparison of soil gas values to ambient air PELs is highly conservative. PELs are based on 8-hour time-weighted averages, whereas the maximum detected value represents a worse-case scenario at a localized "hotspot." Subsurface soil gas concentrations are not representative of potential ambient air exposure concentrations because they do not account for the presence of the asphalt/concrete cover, or the dilution which would occur as volatiles moved through the soil column and into ambient air. Neither are subsurface soil gas concentrations representative of an exposure concentration for onsite intrusive workers engaged in excavation activities because they do not account for the volatilization that could occur during excavation of soils or for the dilution of soil gas concentrations in ambient air. These exposure scenarios are discussed further in Section 6.

4.3.4 Summary of BX Service Station COPCs

Based on comparisons of the maximum detected site chemical concentrations to the Tier 1 TCLs for groundwater, benzene, ethylbenzene, toluene, total xylenes, naphthalene, lead, MTBE, and TRPH are identified as the groundwater COPCs. Benzene was

identified as a soil gas COPC. Benzene in soil was not present in detectable concentrations; however, its mdl exceeded the Tier 1 TCLs in at least one instance. Therefore, benzene in soil cannot be eliminated from further consideration as a COPC, and it will also be discussed further in Section 7.

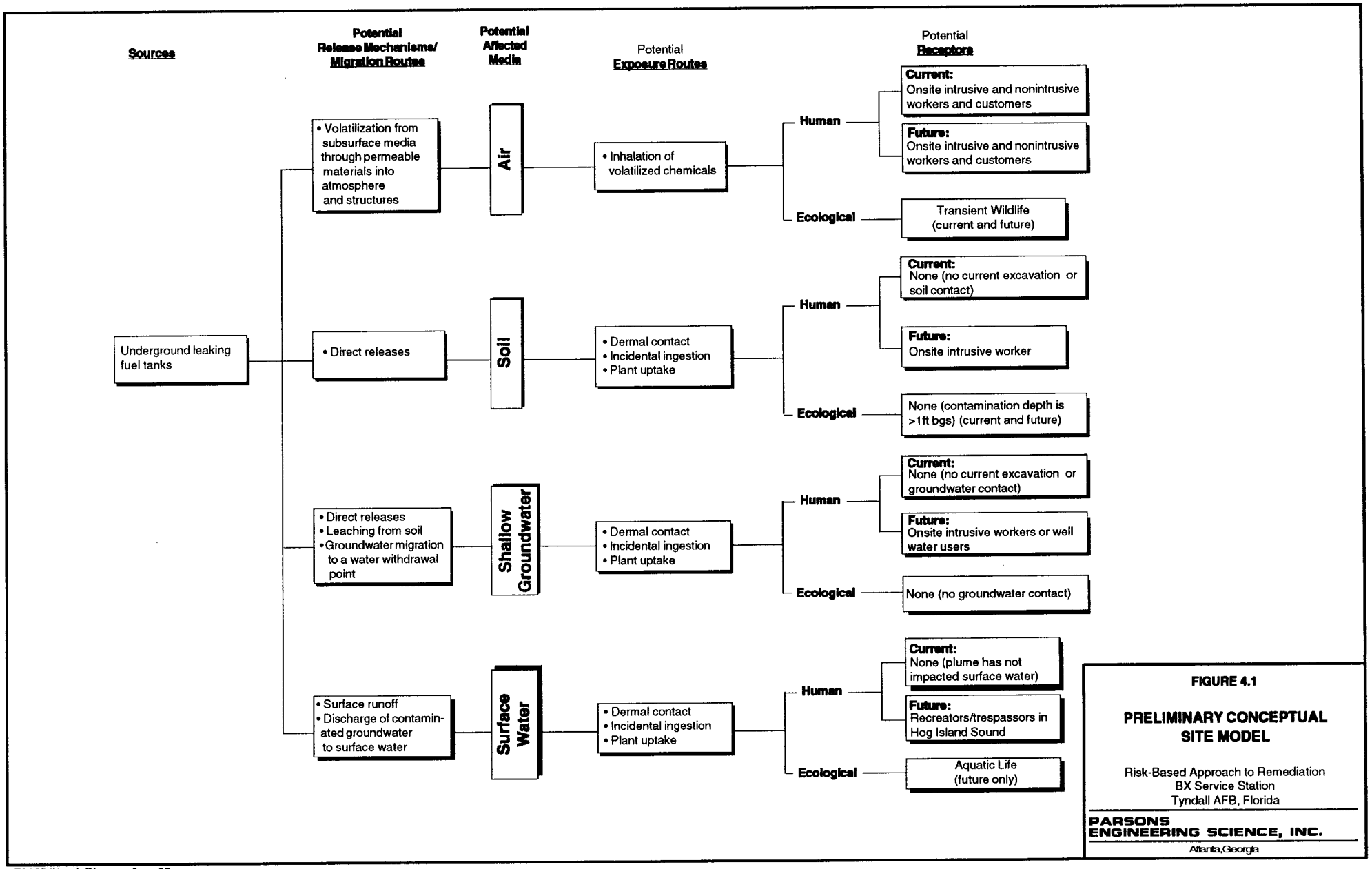

FIGURE 4.1

PRELIMINARY CONCEPTUAL SITE MODEL

Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

PARSONS ENGINEERING SCIENCE, INC.
Atlanta, Georgia

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TABLE 4.1
COMPARISON OF MAXIMUM SITE SOIL CONCENTRATIONS DETECTED IN MARCH 1997 AND MARCH 1998 TO TARGET CLEANUP LEVELS
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Chemical Name	Units	Maximum Concentration Detected	Location of Maximum Detection	Sample Collection Date	Direct Exposure [a/] II
Acenaphthene	mg/kg [b/]	0.41	BX-HA-15	Mar-97	22,000
Acenaphthylene	mg/kg	2.3U[c/]	NA [d/]	NA	11,000
Anthracene	mg/kg	0.092	SB-4	Mar-98	290,000
Benzo(a)anthracene	mg/kg	0.15	SB-4	Mar-98	5.1
Benzo(a)pyrene	mg/kg	0.13	SB-4	Mar-98	0.5
Benzo(b)fluoranthene	mg/kg	0.17	SB-4	Mar-98	5
Benzo (g,h,i)perylene	mg/kg	0.092	SB-6	Mar-98	45,000
Benzo(k)fluoranthene	mg/kg	0.064	SB-6	Mar-98	52
Chrysene	mg/kg	0.12	SB-6	Mar-98	490
Dibenzo(a,h)anthracene	mg/kg	0.23U	NA	Mar-98	0.5
Fluoranthene	mg/kg	0.14	SB-6	Mar-98	45,000
Fluorene	mg/kg	0.024	SB-4	Mar-98	24,000
Indeno(1,2,3-cd)pyrene	mg/kg	0.34	SB-4	Mar-98	5.2
Naphthalene	mg/kg	46	SB-4	Mar-98	8,600
Phenanthrene	mg/kg	0.38	SB-3	Mar-98	29,000
Pyrene	mg/kg	0.15	SB-6	Mar-98	40,000
Benzene	mg/kg	24U(2.4)[e/]	NA	Mar-98	1.50
Ethylbenzene	mg/kg	30	BX-HA-15	Mar-97	240
Toluene	mg/kg	8.4	SB-4	Mar-98	2,000
Xylenes	mg/kg	290	SB-5	Mar-98	290
1,2-DCA	mg/kg	1.4U(0.0014)	NA	Mar-97	0.9
MTBE [f/]	mg/kg	24U	NA	Mar-98	6,100
TRPH [g/]	mg/kg	1,700	SB-5	Mar-98	2,500
Arsenic	mg/kg	5U(1.8)	NA	Mar-97	3.7
Barium	mg/kg	9	BX-HA-14	Mar-97	87,000
Cadmium	mg/kg	0.5U	NA	Mar-97	1,300
Chromium	mg/kg	163	BX-HA-19	Mar-97	430
Lead	mg/kg	23	BX-HA-16	Mar-97	1,000
Mercury	mg/kg	0.02U	NA	Mar-97	28
Selenium	mg/kg	10U	NA	Mar-97	10,000
Silver	mg/kg	1U	NA	Mar-97	9,100

Notes: No maximum site concentration is above a target cleanup level

[a/] Direct Exposure II is for No Further Action With Conditions (industrial worker scenario)

[b/] mg/kg = milligrams per kilogram

[c/] U = not detected above corresponding reporting limit

[d/] NA = not applicable

[e/] When sample reporting limit is above Direct Exposure II target cleanup level and chemical is not detected (U), then the method detection limit (mdl) is given in parentheses; the analyte concentration is below the mdl

[e/] MTBE = methyl tert-butyl ether

[f/] TRPH = total recoverable petroleum hydrocarbons

TABLE 4.2
COMPARISON OF MAXIMUM SITE GROUNDWATER CONCENTRATIONS DETECTED IN MARCH 1997 AND MARCH 1998 TO TARGET CLEANUP LEVELS
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Chemical Name	Units	Maximum Concentration Detected	Sample Location of Maximum Detection	Date of Sample	Table V Target Cleanup Level [a]	Table IX Natural Attenuation Source Default [b]
Benzene	µg/L [c]	3,400	MP-2	Mar-98	1	100
Ethylbenzene	µg/L	3,100	MW-03	May-97	30	300
Toluene	µg/L	5,000	MW-03	May-97	40	400
Xylenes	µg/L	16,000	MW-03	May-97	20	200
MTBE [d]	µg/L	1,300	MW-03	May-97	35	350
Acenaphthene	µg/L	11U	NA [g]	Mar-98	20	200
Acenaphthylene	µg/L	11U	NA	Mar-98	210	2,100
Anthracene	µg/L	11.1U	NA	Mar-98	2,100	21,000
Benzo(a)anthracene	µg/L	1.4U (0.64) [f]	NA	Mar-98	0.2	20
Benzo(a)pyrene	µg/L	2.4U (0.69)	NA	Mar-98	0.2	20
Benzo(b)fluoranthene	µg/L	1.9U (0.63)	NA	Mar-98	0.2	20
Benzo (g,h,i)perylene	µg/L	2.1U	NA	Mar-98	210	2,100
Benzo(k)fluoranthene	µg/L	1.8 U (0.63)	NA	Mar-98	0.5	50
Chrysene	µg/L	2.1 U	NA	Mar-98	5	500
Dibenzo(a,h)anthracene	µg/L	3.2 U (0.81)	NA	Mar-98	0.2	20
Fluoranthene	µg/L	2.1 U	NA	Mar-98	280	2,800
Fluorene	µg/L	2.1 U	NA	Mar-98	280	2,800
Indeno(1,2,3-cd)pyrene	µg/L	4.6 U (0.59)	NA	Mar-98	0.2	20
Naphthalene	µg/L	320	MP-2	Mar-98	20	200
Phenanthrene	µg/L	2.1 U	NA	Mar-98	210	2,100
Pyrene	µg/L	2.1 U	NA	Mar-98	210	2,100
1,2-dichloroethane	µg/L	100U (0.26)	NA	May-97	3	300
EDB [h]	µg/L	0.02U	NA	May-97	0.02	2
Arsenic	µg/L	NR [i]	NA	NA	50	500
Barium	µg/L	NR	NA	NA	2,000	20,000
Cadmium	µg/L	NR	NA	NA	5	50
Chromium	µg/L	NR	NA	NA	100	1,000
Lead	µg/L	62	MW-05	May-97	15	150
Mercury	µg/L	NR	NA	NA	2	20
Selenium	µg/L	NR	NA	NA	50	500
Silver	µg/L	NR	NA	NA	100	1,000
TRPH [j]	mg/L	41	MW-03	Mar-98	5	50
Chloride	mg/L	NR	NA	NA	250	2,500
Sulfate	mg/L	38	MW-08-97	Mar-98	250	2,500
TDS [k]	mg/L	NR	NA	NA	500	5,000

Note: Shading indicates maximum site concentration is above target cleanup level

[a] Cleanup level for No Further Action With or Without Conditions

[b] Allowable maximum concentration for remediation by natural attenuation with monitoring

[c] µg/L = micrograms per liter

[d] MTBE = methyl tert-butyl ether

[e] U = The analyte was analyzed for but was not present above the reporting limit.

[f] When reporting limit is above target clean-up level and chemical is not detected (U), then the method detection limit (mdl) is given in parentheses; the analyte concentration is below the mdl

[g] NA = not applicable

[h] EDB = ethylene dibromide, 1,2-dibromoethane

[i] NR = no results available; sample may not have been analyzed for this parameter

[j] TRPH = total recoverable petroleum hydrocarbons

[k] TDS = total dissolved solids

TABLE 4.3
COMPARISON OF MAXIMUM SITE SOIL GAS CONCENTRATIONS DETECTED IN MARCH 1998 TO OSHA PERMISSIBLE EXPOSURE LIMITS
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Chemical	Maximum Detected Concentration (ppmv [a/])	OSHA PEL (ppmv) [b/]	TWA-TLV (ppmv) [c/]	Maximum Concentration Above PEL or TLV?
Benzene	24	1	0.5	Yes
Toluene	40	200	100	No
Ethylbenzene	46	100	50	No
Xylenes	12	100	100	No
TPH [d/]	10,000	-- [e/]	-- [e/]	--

[a/] ppmv = parts per million, volume per volume.

[b/] OSHA PEL = Occupational Safety and Health Administration (NIOSH, 1997) 8-hour time-weighted average permissible exposure limit.

[c/] TWA-TLV = Time Weighted Average Threshold Limit Value recommended by the American Conference of Governmental Industrial Hygienists (ACGIH, 1998).

[d/] TPH = Total petroleum hydrocarbons.

[e/] "--" = No PEL or TLV available.

SECTION 5
ANALYTICAL DATA SUMMARY AND MAGNITUDE AND EXTENT OF CHEMICALS OF POTENTIAL CONCERN

5.1 OVERVIEW

This section presents analytical results from the March 1998 field sampling event in tabular form, and summarizes the magnitude and extent of COPC contamination in sampled media at the BX Service Station. Discussion in this section is primarily limited to those chemicals that were identified as COPCs based on the Tier 1 screening analysis presented in Section 4.

5.2 SOIL SAMPLING RESULTS

Soil sampling was performed as part of the recent risk-based investigation; analytical results are summarized in Table 5.1. Soil borings were advanced in "hotspots" of fuel contamination (based on previous BCM investigations) to determine worst case hydrocarbon concentrations in soil (Figure 2.1). The BCM locations that were resampled were HA-1, HA-9, and HA-4 (Appendix A, Figure 12). Maximum detected concentrations of individual fuel hydrocarbon-related compounds were compared to RBSLs (Table 4.1). Available soil analytical data indicate that there are no exceedences of RBSLs, except for the elevated benzene mdl as discussed in Section 4.

Two soil samples were collected beneath the water table to assess the vertical extent of contamination. The samples were collected in the areas of greatest soil contamination at the former and current UST pit based on previous investigation results. As shown on Table 5.2, hydrocarbon concentrations decreased significantly with depth.

5.3 GROUNDWATER SAMPLING RESULTS

Groundwater sampling was performed as part of the recent risk-based investigation; analytical results are summarized in Table 5.3. Sampled monitoring wells were selected based on the results of previous investigations. The sampling strategy was to determine the areal extent and magnitude of fuel hydrocarbon and total lead concentrations in groundwater. As shown in Table 4.2, benzene, ethylbenzene, toluene, total xylenes, naphthalene, MTBE, lead, and TRPH for groundwater exceeded Tier 1 RBSLs and are, therefore, the groundwater COPCs.

During the March 1998 field effort, the maximum concentrations of six of the groundwater COPCs were detected at MP-2. The six COPCs and their maximum concentrations were benzene (3,400 micrograms per liter [µg/L]), toluene (4,800 µg/L), ethylbenzene (1,400 µg/L), total xylenes (7,200 µg/L), naphthalene (320 µg/L), and lead (9.8 µg/L). The maximum TRPH concentration was detected at MW-03 (41,000 µg/L). MTBE was not detected in 1998. The March 1998 distribution of six of the dissolved COPCs detected in 1998 is presented on Figure 5.1. As shown on this figure, the dissolved contaminant plume appears to be contained within the existing monitoring well/point network. The distributions of lead and MTBE in groundwater are not shown on Figure 5.1 because concentrations exceeding the TCLs were not detected in March 1998.

5.4 SOIL GAS SAMPLING RESULTS

Soil gas samples were collected at the site to facilitate assessment of the potential risk to future site workers from inhalation of volatile organic chemicals (VOCs), and to determine whether or not sufficient O_2 is available in the soil gas to sustain aerobic fuel hydrocarbon biodegradation. Two soil gas samples were collected and analyzed in the field for concentrations of O_2 and CO_2. Both samples also were submitted to Air Toxics, Ltd. of Folsom, California for analysis of BTEX and TPH (referenced to gasoline). Field and laboratory analytical results for the 1998 soil gas samples are summarized in Table 5.4. Comparison of maximum soil gas BTEX concentrations to OSHA 8-hour time-weighted average PELs (Table 4.3) indicated that benzene was a soil gas COPC. The maximum benzene concentration of 24 parts per million, volume per volume (ppmv) was detected in the proximity of the former UST pit at HA-15 (Figure 2.1). Benzene was not detected in the other sample collected (HA-1) at the BX Service Station.

The field screening data indicate that the soil gas O_2 level at both HA-1 and HA-15, which are in an areas of fuel-contaminated groundwater and soil, has been reduced due to microbial respiration during aerobic biodegradation of the fuel compounds. The oxygen content of ambient air is 20.8 percent. The concentration of CO_2, which is a metabolic byproduct of biodegradation reactions, is correspondingly elevated. The CO_2 content of ambient air is 0.05 percent.

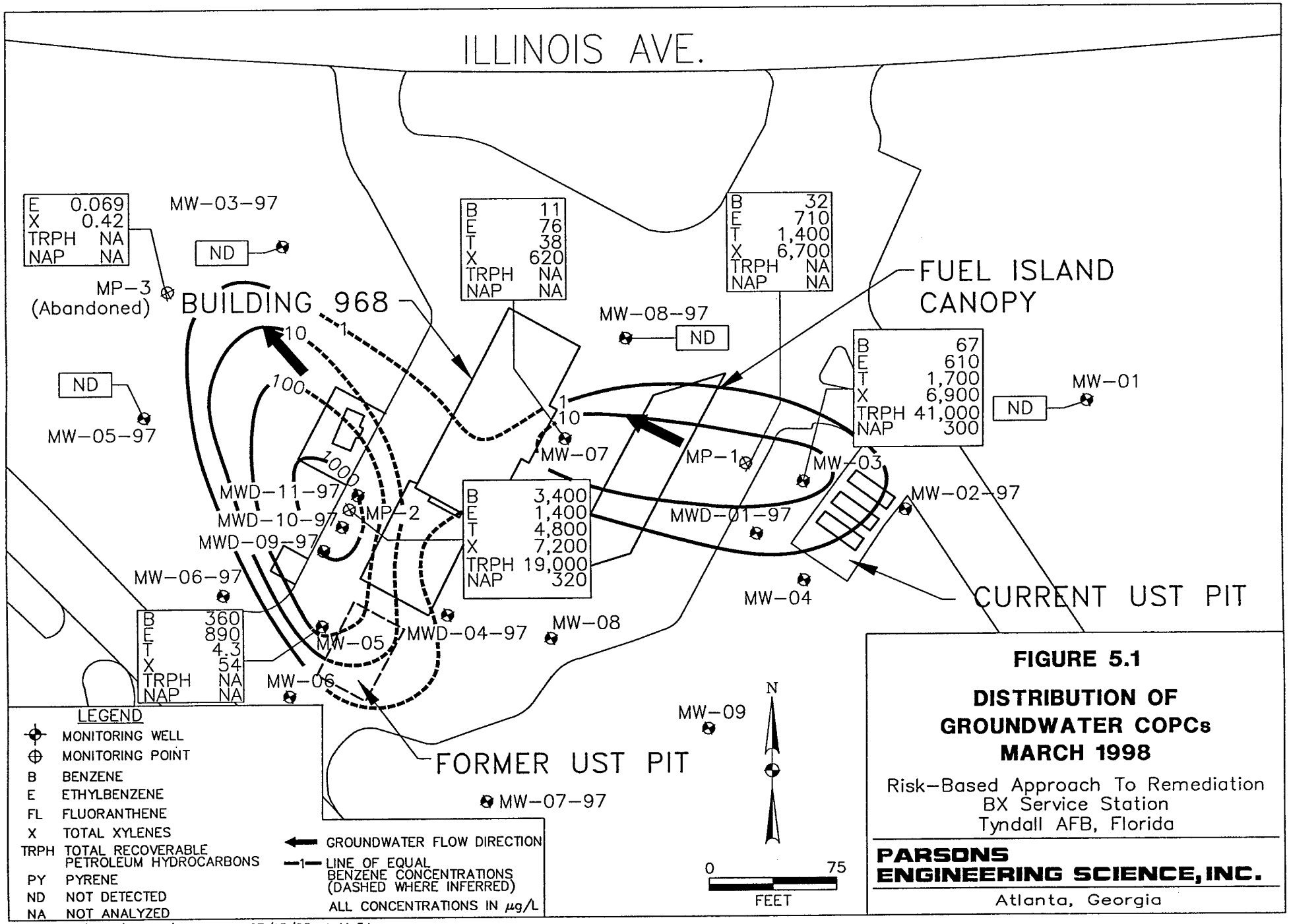

FIGURE 5.1

DISTRIBUTION OF GROUNDWATER COPCs MARCH 1998

Risk-Based Approach To Remediation
BX Service Station
Tyndall AFB, Florida

PARSONS ENGINEERING SCIENCE, INC.

Atlanta, Georgia

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TABLE 5.1
SUMMARY OF MARCH 1998 SOIL ANALYTICAL DATA
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Analyte	Units	Sample Locations, Intervals, and Dates				
		SB-1 (6 - 8) 18-Mar-98	SB-1 (9.5 - 10) 18-Mar-98	SB-2 (6.5 - 7) 18-Mar-98	SB-3 (2 - 3.5) 18-Mar-98	SB-3 (4 - 5.5) 18-Mar-98
Benzene	mg/kg[a/]	NA[b/]	NA	NA	0.0060 U[c/]	1.2 U
Ethylbenzene	mg/kg	NA	NA	NA	0.0024 U	0.48 U
Toluene	mg/kg	NA	NA	NA	0.0060 U	1.2 U
Xylenes (total)	mg/kg	NA	NA	NA	0.0060 U	1.2 U
Total BTEX[d/]	mg/kg	NA	NA	NA	0.0204 U	4.08 U
Methyl-tert-butyl ether	mg/kg	NA	NA	NA	0.0060 U	1.2 U
TRPH (C8-C40)[e/]	mg/kg	NA	NA	NA	**110**	**400**
Acenaphthene	mg/kg	NA	NA	NA	0.24 U	0.24 U
Acenaphthylene	mg/kg	NA	NA	NA	0.24 U	0.24 U
Anthracene	mg/kg	NA	NA	NA	**0.11**	0.024 U
Benzo(a)anthracene	mg/kg	NA	NA	NA	0.024 U	0.024 U
Benzo(a)pyrene	mg/kg	NA	NA	NA	**0.010 J1**[f/]	0.018 U
Benzo(b)fluoranthene	mg/kg	NA	NA	NA	0.014 U	0.014 U
Benzo(g,h,i)perylene	mg/kg	NA	NA	NA	0.06 U	0.059 U
Benzo(k)fluoranthene	mg/kg	NA	NA	NA	0.013 U	0.013 U
Chrysene	mg/kg	NA	NA	NA	**0.087**	0.048 U
Dibenz(a,h)anthracene	mg/kg	NA	NA	NA	0.024 U	0.024 U
Fluoranthene	mg/kg	NA	NA	NA	0.048 U	0.048 U
Fluorene	mg/kg	NA	NA	NA	0.048 U	0.048 U
Indeno(1,2,3-cd)pyrene	mg/kg	NA	NA	NA	0.036 U	0.036 U
Naphthalene	mg/kg	NA	NA	NA	0.24 U	0.24 U
Phenanthrene	mg/kg	NA	NA	NA	**0.38**	0.048 U
Pyrene	mg/kg	NA	NA	NA	0.048 U	0.048 U
Total Organic Carbon	mg/kg	2000 U	2000 U	2000 U	NA	NA

a/ mg/kg = milligrams per kilogram

b/ NA = not analyzed

c/ U = The analyte was analyzed for and was not present above the associated reporting limit

d/ BTEX = benzene, toluene, ethylbenzene, and total xylenes

e/ TRPH = total recoverable petroleum hydrocarbons

f/ J1 = The analyte was positively identified and had a concentration between the method detection limit and the reporting limit

SB-4 duplicate (4-7) named SB-B (4-7) on chain-of-custody record

TABLE 5.1 (Continued)
SUMMARY OF MARCH 1998 SOIL ANALYTICAL DATA
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Analyte	Units	Sample Locations, Intervals, and Dates				
		SB-4 (4 - 7) 18-Mar-98	SB-4 (4 - 7) 18-Mar-98 Duplicate	SB-4 (10 - 12) 18-Mar-98	SB-5 (4.5 - 5) 18-Mar-98	SB-6 (7.5 - 8) 18-Mar-98
Benzene	mg/Kg[a/]	12 U	12 U	0.72 U	24 U	1.2 U
Ethylbenzene	mg/Kg	**6.0**	**13**	**1.5**	9.6 U	**2.2**
Toluene	mg/Kg	**5.6 J1**	**8.4 J1**	0.72 U	**6.3 J1**	1.2 U
Xylenes (total)	mg/Kg	**260**	**220**	**0.27 J1**	**290**	1.2 U
Total BTEX	mg/Kg	**271.6**	**241.4**	**1.77**	**296.3**	**2.2**
Methyl-tert-butyl ether	mg/Kg	12 U	12 U	0.72 U	24 U	1.2 U
TRPH (C8-C40)	mg/Kg	**900**	**470**	**17 J1**	**1700**	**390**
Acenaphthene	mg/Kg	2.3 U	2.3 U	0.29 U	1.2 U	0.24 U
Acenaphthylene	mg/Kg	2.3 U	2.3 U	0.29 U	1.2 U	0.24 U
Anthracene	mg/Kg	**0.046 J1**	**0.092 J1**	**0.0047 J1**	**0.027 J1**	**0.018 J1**
Benzo(a)anthracene	mg/Kg	0.23 U	0.23 U	**0.15**	0.12 U	**0.085**
Benzo(a)pyrene	mg/Kg	0.18 U	0.17 U	**0.13**	0.09 U	**0.13**
Benzo(b)fluoranthene	mg/Kg	0.14 U	0.14 U	**0.14**	0.072 U	**0.17**
Benzo(g,h,i)perylene	mg/Kg	0.59 U	0.58 U	**0.049 J1**	0.3 U	**0.092**
Benzo(k)fluoranthene	mg/Kg	0.13 U	0.13 U	**0.076**	0.066 U	**0.064**
Chrysene	mg/Kg	0.47 U	0.46 U	0.058 U	0.24 U	**0.12**
Dibenz(a,h)anthracene	mg/Kg	0.23 U	0.23 U	0.029 U	0.12 U	0.024 U
Fluoranthene	mg/Kg	0.47 U	0.46 U	**0.052 J1**	0.24 U	**0.14**
Fluorene	mg/Kg	0.47 U	0.46 U	**0.024 J1**	0.24 U	0.048 U
Indeno(1,2,3-cd)pyrene	mg/Kg	0.35 U	0.35 U	**0.034 J1**	0.18 U	0.036 U
Naphthalene	mg/Kg	**32**	**46**	**0.28 J1**	**18**	**1.1**
Phenanthrene	mg/Kg	0.47 U	0.46 U	**0.019 J1**	0.24 U	**0.085**
Pyrene	mg/Kg	0.47 U	0.46 U	**0.09**	0.24 U	**0.15**
Total Organic Carbon	mg/Kg	NA	NA	NA	NA	NA

a/ mg/kg = milligrams per kilogram

b/ NA = not analyzed

c/ U = The analyte was analyzed for and was not present above the associated reporting limit

d/ BTEX = benzene, toluene, ethylbenzene, and total xylenes

e/ TRPH = total recoverable petroleum hydrocarbons

f/ J1 = The analyte was positively identified and had a concentration between the method detection limit and the reporting limit

SB-4 duplicate (4-7) named SB-B (4-7) on chain-of-custody record

TABLE 5.2
SUMMARY OF VERTICAL EXTENT OF SOIL CONTAMINATION
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Analyte	Units	Sample Locations, Intervals, and Dates			
		SB-4 (4 - 7) 18-Mar-98	SB-4 (10 - 12) 18-Mar-98	HA-15 (2.5-4.5) 20-Mar-97	SB-6 (7.5 - 8) 18-Mar-98
Benzene	mg/kg[a/]	12 U[b/]	0.72 U	1.4 U	1.2 U
Ethylbenzene	mg/kg	**13**	**1.5**	**30**	**2.2**
Toluene	mg/kg	**8.4 J1**	0.72 U	**3.2**	1.2 U
Xylenes (total)	mg/kg	**260**	**0.27 J1[c/]**	**127**	1.2 U
Total BTEX[d/]	mg/kg	**281.4**	**1.77**	**160.2**	**2.2**
TRPH[e/]	mg/kg	**900**	**17 J1**	**1000**	**390**
Acenaphthene	mg/kg	2.3 U	0.29 U	**0.41**	0.24 U
Anthracene	mg/kg	**0.092 J1**	**0.0047 J1**	0.370 U	**0.018 J1**
Naphthalene	mg/kg	**46**	**0.28 J1**	**39**	**1.1**

a/ mg/kg = Milligrams per kilogram

b/ U = The analyte was analyzed for and is not present above the associated reporting limit

c/ J1 = The analyte was positively identified between the method detection limit and the reporting limit

d/ BTEX = benzene, toluene, ethylbenzene, and total xylenes

e/ TRPH = total recoverable petroleum hydrocarbons

HA-15 was advanced by BCM and is at the same location as SB-6

TABLE 5.3
SUMMARY OF GROUNDWATER ANALYTICAL DATA
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Analyte	Units	Sample Locations and Dates					
		MP-1 22-Mar-98	MP-2 22-Mar-98	MP-2 22-Mar-98 Duplicate	MP-3 22-Mar-98	MW-01 22-Mar-98	MW-03 22-Mar-98
Benzene	µg/L[a/]	**32 J1**	**3,400**	**3,100**	2.0 U[b/]	2.0 U	**67 J1**
Ethylbenzene	µg/L	**710**	**1,400**	**1,300**	**0.069 J1**[c/]	2.0 U	**610**
Toluene	µg/L	**1,400**	**4,800**	**4,500**	2.0 U	2.0 U	**1,700**
Xylenes (total)	µg/L	**6,700**	**7,200**	**6,800**	**0.42 J1**	2.0 U	**6,900**
Total BTEX[d/]	µg/L	**8,842**	**16,800**	**15,700**	**0.489**	**8.0 U**	**9,277**
Methyl-tert-butyl ether	µg/L	250 U	1000 U	1000 U	5.0 U	5.0 U	250 U
TRPH (C8-C40)[e/]	µg/L	NA[f/]	**19,000**	**20,000**	NA	NA	**41,000**
Total Lead	mg/L	NA	**0.0078**	**0.0098**	NA	NA	**0.0030 J1**
Acenaphthene	µg/L	NA	10 U	10 U	NA	NA	11 U
Acenaphthylene	µg/L	NA	10 U	10 U	NA	NA	11 U
Anthracene	µg/L	NA	1.0 U	1.0 U	NA	NA	1.1 U
Benzo(a)anthracene	µg/L	NA	1.4 U	1.3 U	NA	NA	1.4 U
Benzo(a)pyrene	µg/L	NA	2.4 U	2.3 U	NA	NA	2.4 U
Benzo(b)fluoranthene	µg/L	NA	1.9 U	1.8 U	NA	NA	1.9 U
Benzo(g,h,i)perylene	µg/L	NA	2.1 U	2.0 U	NA	NA	2.1 U
Benzo(k)fluoranthene	µg/L	NA	1.8 U	1.7 U	NA	NA	1.8 U
Chrysene	µg/L	NA	2.1 U	2.0 U	NA	NA	2.1 U
Dibenz(a,h)anthracene	µg/L	NA	3.1 U	3.0 U	NA	NA	3.2 U
Fluoranthene	µg/L	NA	2.1 U	2.0 U	NA	NA	2.1 U
Fluorene	µg/L	NA	2.1 U	2.0 U	NA	NA	2.1 U
Indeno(1,2,3-cd)pyrene	µg/L	NA	4.5 U	4.4 U	NA	NA	4.6 U
Naphthalene	µg/L	NA	**320**	**250**	NA	NA	**300**
Phenanthrene	µg/L	NA	2.1 U	2.0 U	NA	NA	2.1 U
Pyrene	µg/L	NA	2.1 U	2.0 U	NA	NA	2.1 U

a/ µg/L = micrograms per liter

b/ U = The analyte was analyzed for and was not present above the associated reporting limit

c/ J1 = The analyte was positively identified and had a concentration between the method detection limit and the reporting limit

d/ BTEX = benzene, toluene, ethylbenzene, and total xylenes

e/ TRPH = total recoverable petroleum hydrocarbons

f/ NA = Not analyzed

MP-2 duplicate named BX-MW-20 on chain-of-custody record

TABLE 5.3 (Continued)
SUMMARY OF GROUNDWATER ANALYTICAL DATA
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Analyte	Units	Sample Locations and Dates				
		MW-05 22-Mar-98	MW-07 22-Mar-98	MW-03-97 22-Mar-98	MW-05-97 22-Mar-98	MW-08-97 22-Mar-98
Benzene	µg/L	**360**	**11 J1**	2.0 U	2.0 U	2.0 U
Ethylbenzene	µg/L	**890**	**76**	2.0 U	2.0 U	2.0 U
Toluene	µg/L	**4.3 J1**	**38 J1**	2.0 U	2.0 U	2.0 U
Xylenes (total)	µg/L	**54 J1**	**620**	2.0 U	2.0 U	2.0 U
Total BTEX	µg/L	**1,308**	**745**	8.0 U	8.0 U	8.0 U
Methyl-tert-butyl ether	µg/L	250 U	120 U	5.0 U	5.0 U	5.0 U
TRPH (C8-C40)	µg/L	NA	NA	500 U	500 U	NA
Total Lead	mg/L	NA	NA	0.005 U	0.005 U	NA
Acenaphthene	µg/L	NA	NA	1.0 U	1.0 U	NA
Acenaphthylene	µg/L	NA	NA	1.0 U	1.0 U	NA
Anthracene	µg/L	NA	NA	0.1 U	0.1 U	NA
Benzo(a)anthracene	µg/L	NA	NA	0.13 U	0.14 U	NA
Benzo(a)pyrene	µg/L	NA	NA	0.24 U	0.24 U	NA
Benzo(b)fluoranthene	µg/L	NA	NA	0.18 U	0.19 U	NA
Benzo(g,h,i)perylene	µg/L	NA	NA	0.21 U	0.21 U	NA
Benzo(k)fluoranthene	µg/L	NA	NA	0.17 U	0.18 U	NA
Chrysene	µg/L	NA	NA	0.21 U	0.21 U	NA
Dibenz(a,h)anthracene	µg/L	NA	NA	0.31 U	0.31 U	NA
Fluoranthene	µg/L	NA	NA	0.21 U	0.21 U	NA
Fluorene	µg/L	NA	NA	0.21 U	0.21 U	NA
Indeno(1,2,3-cd)pyrene	µg/L	NA	NA	0.44 U	0.45 U	NA
Naphthalene	µg/L	NA	NA	1.0 U	1.0 U	NA
Phenanthrene	µg/L	NA	NA	0.21 U	0.21 U	NA
Pyrene	µg/L	NA	NA	0.21 U	0.21 U	NA

a/ µg/L = micrograms per liter

b/ U = The analyte was analyzed for and was not present above the associated reporting limit

c/ J1 = The analyte was positively identified and had a concentration between the method detection limit and the reporting limit

d/ BTEX = benzene, toluene, ethylbenzene, and total xylenes

e/ TRPH = total recoverable petroleum hydrocarbons

f/ NA = Not analyzed

MP-2 duplicate named BX-MW-20 on chain-of-custody record

TABLE 5.4
SUMMARY OF SOIL GAS ANALYTICAL DATA
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Analyte	Sample Locations, Dates, and Units								
	HA-1 21-Mar-98			HA-15 21-Mar-98			HA-A[a/] 21-Mar-98		
	ppmv	µg/L	percent	ppmv	µg/L	percent	ppmv	µg/L	percent
Benzene	<0.0020	<0.0065	NA	**24**	**78**	NA	**23**	**74**	NA
Toluene	**0.0036**	**0.014**	NA	**40**	**150**	NA	**35**	**130**	NA
Ethylbenzene	<0.0020	<0.0088	NA	**46**	**200**	NA	**38**	**160**	NA
Xylenes (total)	**0.0068**	**0.030**	NA	**12**	**100**	NA	**22**	**98**	NA
Total BTEX	**0.0104**	**0.044**	NA	**122**	**528**	NA	**118**	**462**	NA
TPH (C5+ Hydrocarbons)	**0.49**	**2.0**	NA	**10,000**	**44,000**	NA	**10,000**	**41,000**	NA
C2 - C4 Hydrocarbons	<0.020	<0.036	NA	<10	<18	NA	<9.9	<18	NA
Oxygen	NA	NA	**14.8**	NA	NA	**6.0**	NA	NA	NA
Carbon Dioxide	NA	NA	**3.2**	NA	NA	**6.4**	NA	NA	NA

a/ = BX-HA-A is a duplicate of BX-HA-15
ppmv = parts per million, volume per volume
µg/L = micrograms per liter
Analysis methods is TO-3 (Aromatic Volatiles in Air)
Analysis performed by Air Toxics Ltd. of Folsom, California
BTEX = benzene, toluene, ethylbenzene, and total xylenes
TPH = total petroleum hydrocarbons referenced to gasoline

SECTION 6
CHEMICAL FATE ASSESSMENT

6.1 INTRODUCTION

Biodegradation of dissolved fuel constituents and the future migration and persistence of the dissolved COPCs are assessed in this section to support selection of an appropriate remedial alternative at the BX Service Station. As used throughout this report, the term "remediation by natural attenuation" (RNA) refers to a subsurface contaminant management strategy that relies on natural physical, chemical, and biological mechanisms to control exposure of potential receptors to concentrations of contaminants in soil, soil gas, and groundwater that exceed regulatory levels. These mechanisms include the processes of advection, hydrodynamic dispersion, dilution from recharge, sorption, volatilization, and biodegradation, which facilitate RNA of a variety of anthropogenic chemicals.

This section summarizes and interprets specific site characterization data relevant to documenting the effectiveness of RNA at minimizing dissolved COPC migration and reducing COPC concentration, mass, and toxicity over time.

6.2 OPERATIVE MECHANISMS OF CONTAMINANT ATTENUATION

Understanding the fate of COPCs in environmental media is critical to evaluating and predicting contaminant distribution patterns. There are several physical, chemical, and biological processes that influence how a chemical behaves in soil and groundwater.

Nondestructive attenuation processes can be described as those physical and chemical processes that may prohibit significant contaminant migration but will not result in a permanent reduction in contaminant mass. Examples of nondestructive attenuation processes include volatilization, sorption, dilution from recharge, advection, and hydrodynamic dispersion. These processes must be evaluated when determining whether some type of remediation is warranted because chemical contamination poses or has the potential to pose a risk to human or ecological receptors. If contamination cannot reach a potential receptor exposure point, the contamination poses no risk.

In comparison to nondestructive chemical attenuation processes, destructive chemical attenuation processes result in the permanent removal of contaminant mass from the environment. Documenting and distinguishing the effects of destructive attenuation processes, such as biodegradation, from nondestructive attenuation processes is critical to evaluating the potential for RNA to bring about a reduction in contaminant mass over time. The effectiveness of destructive attenuation processes at reducing contaminant mass at a site depends on how susceptible the chemical is to biodegradation and whether the site is characterized by physical, chemical, and biological conditions favorable to such processes.

6.2.1 Biodegradation of Dissolved BTEX and Naphthalene

Numerous laboratory and field studies have shown that hydrocarbon-degrading bacteria can participate in the degradation of many of the chemical components of different types of fuels (e.g., gasoline) under both aerobic and anaerobic conditions.

Biodegradation of fuel hydrocarbons such as BTEX and naphthalene will occur when an indigenous population of hydrocarbon-degrading microorganisms is present in the soil and groundwater, and sufficient concentrations of electron acceptors and nutrients, including fuel hydrocarbons, are available to these organisms. Soils and groundwater with a history of exposure to fuel hydrocarbon compounds, such as at the BX Service Station, generally contain microbial populations capable of facilitating biodegradation reactions (Wiedemeier *et al.*, 1995). The chemical basis for the biodegradation of dissolved BTEX and naphthalene is described in more detail in Section 6.5, where geochemical data relevant to documenting biodegradation at the field scale at the BX Service Station are presented.

6.2.2 Biodegradation of MTBE

MTBE is much less biodegradable than the BTEX compounds, due primarily to the presence and strength of MTBE tertiary bonds. However, natural biodegradation of MTBE by naturally-occurring microorganisms has been documented (Lee, 1986; Salanitro *et al.*, 1994; Mormile *et al.*, 1994; Yeh and Novak, 1994; Daniel, 1995; Park and Cowan, 1997; and Javanmardian and Glasser, 1997). Likewise, several studies have documented the lack of MTBE biodegradation (Hubbard, *et al.*, 1994; and Mormile *et al.*, 1994). Biodegradation of MTBE is poorly understood, and while both aerobic and anaerobic biodegradation have been documented, aerobic degradation has been reported to have the most potential. Howard *et al.* (1991) report a range of biodegradation half-lives for MTBE in groundwater of 8 weeks to 12 months (1,344 to 8,640 hours). Daniel (1995) reports degradation rates ranging from 0.01 to 0.18 percent per day.

As with BTEX and PAH compounds, the driving force behind redox reactions resulting in MTBE degradation is electron transfer, which is quantified by the Gibbs free energy of the reaction ($\Delta G°_r$). As with BTEX, the value of $\Delta G°_r$ represents the quantity of free energy consumed or yielded to the system during the reaction. Table 6.1 lists stoichiometry of potential redox reactions involving MTBE. Although thermodynamically favorable, most of the reactions involved in MTBE reduction and oxidation cannot proceed abiotically because of the lack of activation energy. Microorganisms are capable of providing the necessary activation energy; however, they will facilitate only those redox reactions that have a net yield of energy. While biodegradation of MTBE has been demonstrated and measured in laboratory studies, there are little published data on the field-scale biodegradation of MTBE.

6.2.3 Properties of MTBE

The physical and chemical properties of MTBE differ significantly from benzene and the other BTEX compounds. MTBE differs from benzene in the following ways (USEPA, 1998; Zogorski, *et al.*, 1997):

- MTBE's low octanol:water distribution coefficient indicates that MTBE will preferentially leach at a faster rate from fuel products relative to BTEX and other fuel components.

- MTBE's pure component solubility (43,000,000 µg/L) is higher than benzene (1,780 µg/L), which may result in significantly higher concentrations of MTBE in groundwater relative to benzene.

- MTBE has a lower affinity for organic carbon (Koc), resulting in lower retardation rates. In many cases MTBE may migrate in groundwater at approximately the rate of advective groundwater velocity.

- MTBE has a lower potential for biodegradation, therefore MTBE is more recalcitrant and more persistent in groundwater plumes.

In general, MTBE plumes will migrate faster and degrade slower than benzene or other fuel hydrocarbon plumes. However, MTBE plumes may still naturally attenuate due to the effects of advection, dispersion and dilution. Therefore, natural attenuation of MTBE may still be a suitable remedial strategy if it can be shown that MTBE concentrations will attenuate to concentrations that are not a threat to human health or the environment before potential receptors are impacted.

6.3 EVIDENCE OF CONTAMINANT BIODEGRADATION OVER TIME

The first step in determining whether COPC constituents are biodegrading in soils and groundwater at the BX Service Station was to compare contaminant concentrations at selected sampling locations over time. The purpose of this comparison was to assess the evidence of field-scale contaminant mass loss. Decreases in the magnitude of contaminant concentrations at a site over time that cannot be explained by physical processes (e.g., source removal, mass transport in groundwater) may be the first indication that contaminants are biodegrading at the site.

6.3.1 Hydrocarbon Concentration Trends in Soil

Biodegradation of soil hydrocarbon COPCs present in the vadose zone can proceed if the soil particles to which the contaminants are adsorbed are covered with a water film that supports microbial populations. The presence of abundant soil moisture in the vadose zone can be inferred from the shallow water table depth, the relatively warm ambient air temperature, and presence of the asphalt/concrete cap over much of the site that would inhibit evaporation of subsurface moisture into the atmosphere. Aerobic degradation appears to be occurring based on depleted oxygen levels in shallow soil gas, however, near the water table anaerobic conditions may prevail.

Soil BTEX, naphthalene, and TRPH concentrations from four samples collected in March 1995 are compared to samples collected in March 1998 in Table 6.2. All four samples are located near the current UST pit. Soil BTEX and TRPH concentrations decreased significantly at three locations, and increased slightly at one location. Temporal soil hydrocarbon concentration trends in the proximity of the former UST pit were not assessed because no available soil analytical data were collected prior to 1997.

6.3.2 Hydrocarbon Concentration Trends in Groundwater

Hydrocarbon concentrations measured at three monitoring wells from 1995 to 1998 are summarized in Table 6.3. MW-03 and MW-07 are located at and downgradient of the current UST pit, respectively. MW-05 is located at the former UST pit. Hydrocarbon concentrations at MW-03 and MW-07 increased from 1995 to 1997, but have decreased substantially from 1997 to 1998. These data suggest that the dissolved hydrocarbon plume associated with the current UST pit may be receding due to the effects of source biodegradation and leaching. Hydrocarbon concentrations at MW-05 were highest in

1995, decreased from 1995 to 1997, and were stable from 1997 to 1998. Stabilization or reduction of the dissolved plume is indicated by the fact that hydrocarbons have not been detected in downgradient monitoring wells MW-03-97 and MW-05-97 despite an average groundwater velocity of 175 ft/yr. Groundwater from downgradient monitoring point MP-3 had a very low concentration of ethylbenzene and total xylenes that was below the reporting limit but above the detection limit. Stable plume length indicates that the mass of hydrocarbons input into the groundwater system in the source area (through leaching of residual hydrocarbons in soils) is approximately equal to the mass of hydrocarbons being removed via destructive attenuation processes (e.g., biodegradation).

6.4 SITE SPECIFIC CONTAMINANT BIODEGRADATION RATES

It is important to distinguish between the effects of nondestructive attenuation processes (i.e., advection, dispersion, and sorption) and of destructive attenuation processes (i.e., biodegradation) on the mass of dissolved groundwater hydrocarbon COPCs in the groundwater at the BX Service Station. Comparison of analytical data spatially and temporally suggests that most of the groundwater hydrocarbon COPCs are being removed from saturated soils and groundwater by mechanisms other than dispersion, advection, and sorption. To quantify these effects, Buscheck and Alcantar (1996) derived a relationship that allows calculation of first-order decay rate constants for steady-state plumes. This method involves coupling the regression of contaminant concentration (plotted on a logarithmic scale) versus distance downgradient (plotted on a linear scale) to an analytical solution for one-dimensional, steady-state contaminant transport that includes advection, dispersion, sorption, and biodegradation. This method requires groundwater data from at least two locations near the centerline of a dissolved plume. Data from monitoring wells/points MW-03, MP-1, and MW-07 were utilized. These wells/points are related to the current UST pit. The decay rates were based on the average advective groundwater velocity of 0.48 ft/day (Section 3.4), retardation coefficients calculated in Table 6.4, and an estimated plume length of 250 feet (current UST pit).

Calculated decay coefficients (lambda) and corresponding half-lives for the BTEX compounds and total BTEX are presented on Table 6.5. As shown in this table, the calculated half-lives correlate well with literature values. Supporting information is presented in Appendix D.

6.5 EVIDENCE OF CONTAMINANT BIODEGRADATION VIA MICROBIALLY MEDIATED REDOX REACTIONS

Groundwater geochemical data also can be used to show that hydrocarbon COPCs are biodegrading in saturated soil and groundwater at the BX Service Station. Fuel hydrocarbon constituents are typically utilized as electron donors in biologically mediated redox reactions under a wide range of geochemical conditions. Therefore, analytical data on potential electron acceptors can be used as geochemical indicators of fuel hydrocarbon biodegradation (Wiedemeier *et al.,* 1995). Reductions in the concentrations of oxidized chemical species that are used by microorganisms to facilitate the oxidation of fuel hydrocarbon compounds within contaminated media are an indication that contaminants are biodegrading. Alternately, an increase in the metabolic byproducts resulting from the reduction of electron acceptors can be used as an indicator of contaminant biodegradation. The availability of potential electron acceptors to participate in contaminant

biodegradation reactions can be used to estimate the total contaminant mass that can be biodegraded over time at this site. Coupled with calculated biodegradation rates, this information can be used to predict how much and how quickly COPCs can be removed from saturated soils and groundwater at the BX Service Station as a result of natural processes only.

6.5.1 Relevance of Redox Couples in Biodegradation

Microorganisms obtain energy to replenish enzymatic systems and to reproduce by oxidizing organic matter. Biodegradation of dissolved hydrocarbons is the result of a series of redox reactions that maintain the charge balance within the natural environment. Microorganisms facilitate the degradation of these organic compounds by transferring electrons from the electron donor (i.e., fuel hydrocarbons and native organic carbon) to available electron acceptors. Electron acceptors are elements or compounds that occur in relatively oxidized states and can participate in redox reactions involving these available electron donors. Electron acceptors known to be present in saturated soil and groundwater at the BX Service Station are oxygen, nitrate/nitrogen, sulfate, ferric iron, and carbon dioxide.

Microorganisms facilitate fuel hydrocarbon biodegradation to produce energy for their use. The amount of energy that can be released when a reaction occurs or is required to drive the reaction to completion is quantified by the free energy of the reaction (Stumm and Morgan, 1981). Microorganisms are able to utilize electron transport systems and chemiosmosis to combine energetically favorable and unfavorable reactions to produce energy for life processes (i.e., cell production and maintenance). Microorganisms will facilitate only those redox reactions that will yield energy. By coupling the oxidation of fuel hydrocarbon compounds, which requires energy, to the reduction of other compounds (e.g., oxygen, nitrate/nitrite, manganese, ferric iron, sulfate, and carbon dioxide), which yields energy, the overall reaction will yield energy. Detailed information on the redox reactions required to biodegrade dissolved COPCs is included in Table 6.1. The reader is encouraged to review this information to more fully understand the chemical basis of biodegradation.

Figure 6.1 illustrates the sequence of microbially mediated redox processes based on the amount of free energy released for microbial use. In general, reactions yielding more energy tend to take precedence over processes that yield less energy (Stumm and Morgan, 1981). As Figure 6.1 shows, oxygen reduction would be expected to occur in an aerobic environment with microorganisms capable of aerobic respiration because oxygen reduction yields significant energy. However, once the available oxygen is depleted and anaerobic conditions dominate the interior regions of the contaminant plume, anaerobic microorganisms can utilize other electron acceptors in the following order of preference: nitrate/nitrite, manganese, ferric iron, sulfate, and finally carbon dioxide. Each successive redox reaction provides less energy to the system, and each step down in redox energy yield would have to be paralleled by an ecological succession of microorganisms capable of facilitating the pertinent redox reactions.

The expected sequence of redox processes can be estimated by the oxidation/reduction potential (ORP) of the groundwater. The ORP measures the relative tendency of a solution or chemical reaction to accept or transfer electrons, and can be measured in the field. This measurement can be used as a crude indicator of which redox

reactions may be operating at a site. High ORPs mean that the solution (or available redox couple) has a relatively high oxidizing potential.

Microorganisms can only facilitate the biodegradation (oxidation) of the fuel hydrocarbon compounds using redox couples that have a higher ORP than the contaminants. This is why these electron acceptors can be used to oxidize the fuel hydrocarbon compounds. The reduction of highly oxidized species results in an overall decrease in the oxidizing potential of the groundwater. As shown in Figure 6.1, the reduction of oxygen and nitrate will reduce the oxidizing potential to levels at which ferric iron (Fe^{3+}) reduction can occur. As each chemical species that can be used to oxidize the contaminants is exhausted, the microorganisms are forced to use other available electron acceptors with lower oxidizing capacity. When sufficiently low (negative) ORP levels have been developed as a result of these redox reactions, sulfate reduction, and methanogenesis can occur almost simultaneously (Stumm and Morgan, 1981).

ORP values measured in shallow groundwater at the BX Service Station in March 1998 ranged from 22.2 to -280 millivolts (mV) (Table 6.6). Areas with the lowest ORP measurements generally coincided with the presence of fuel-contaminated groundwater, indicating that the progressive use of electron acceptors in the order shown on Figure 6.1 has caused the groundwater in the contaminated areas to become more reducing. These data imply that oxygen, nitrate, manganese, and ferric iron may be used to biodegrade fuel hydrocarbon contaminants at this site. However, many authors have noted that field ORP data alone cannot be used to reliably predict all of the electron acceptors that may be operating at a site, because the platinum electrode probes are not sensitive to some redox couples (e.g., sulfate/sulfide) (Stumm and Morgan, 1981; Godsey, 1994; Lovley *et al.*, 1994). Analytical data on oxidized and reduced species are presented in the following subsections to verify which electron acceptors are actually being used to biodegrade the hydrocarbon COPCs in saturated soil and groundwater at the BX Service Station.

Throughout the following subsections, the distributions of geochemical parameters are examined by comparing background concentrations to COPC plume core concentrations. Analytical data from upgradient well MW-01 and cross-gradient well MW-08-97 are used for background concentrations. Analytical data from MW-03, MW-05, MP-1, and MP-2 are used for COPC plume core concentrations.

6.5.2 Dissolved Oxygen

Almost all types of fuel hydrocarbons can be biodegraded under aerobic conditions (Borden, 1994). Mineralization of fuel hydrocarbons to carbon dioxide and water under aerobic conditions involves the use of oxygen as a cosubstrate during the initial stages of metabolism, and as a terminal electron acceptor during the later stages of metabolism for energy production. The reduction of molecular oxygen during the oxidation of the fuel hydrocarbon compounds yields a significant amount of free energy that the microorganisms could utilize.

DO concentrations were measured at groundwater sampling locations in March 1998. Table 6.6 presents the analytical results for DO by sampling location. As shown on the table, DO concentrations were uniformly low at all sampling locations (0.16 to 1.20 mg/L). The presence of the lowest observed DO concentration in the core of the

dissolved COPC plume and the highest DO concentration at the upgradient well is an indication that biodegradation through aerobic respiration is occurring. However, the overall low magnitude of DO concentrations indicates that oxygen is not currently a significant electron acceptor during microbially mediated degradation of fuel hydrocarbons at the BX Service Station.

6.5.3 Nitrate

Because anaerobic conditions generally prevail in the site groundwater, nitrate can be used as an electron acceptor by indigenous facultative anaerobes that mineralize fuel hydrocarbon compounds via either denitrification or nitrate reduction processes. Concentrations of nitrate (as nitrogen [N]) measured at the site in March 1998 are summarized in Table 6.6. Background nitrate (as N) concentrations measured in upgradient and cross-gradient wells MW-01 and MW-08-97 ranged from 0.13 to 0.15 mg/L. Nitrate (as N) concentrations measured in plume core area wells exhibiting dissolved fuel contamination (MW-03, MW-05, MP-1 and MP-2) ranged from below the reporting limit of 0.5 mg/L to 0.16 mg/L. These data indicate that there is a poor correlation between nitrate concentrations within the dissolved plume and measured background concentrations. The use of nitrate as an electron acceptor in microbially facilitated redox reactions is consistent with the range of ORP values measured at the BX Service Station (Figure 6.1). However, the poor correlation described above limits the importance of this degradation reaction.

6.5.4 Ammonia

The presence of ammonia in groundwater can result from either nitrate reduction (facilitated by microbes) or fixing of atmospheric nitrogen (also a microbial process). Nitrate is not widespread in groundwater within the aquifer; however, the fixation of atmospheric nitrogen may occur under the anaerobic, methanogenic conditions observed at the site. The presence of ammonia in groundwater is a strong indication of microbial activity.

Ammonia (as N) concentrations measured in groundwater samples collected in March 1998 are summarized in Table 6.6. Ammonia was detected in all of the samples analyzed. The pale-yellow natural color of the shallow groundwater may have interfered with the ammonia analysis, causing the background concentrations to be biased high. Ammonia concentrations detected in shallow groundwater varied across the site, with elevated ammonia concentrations occurring in the COPC plume core area. Therefore, production of ammonia appears to be occurring due to increased microbial activity stimulated by the relative abundance of organic carbon (fuel hydrocarbons).

6.5.5 Ferrous Iron

Although relatively little is known about the anaerobic metabolic pathways involving the reduction of ferric iron (Fe^{3+}), this process has been shown to be a major metabolic pathway for some microorganisms (Lovley and Phillips, 1988; Chapelle, 1993). Elevated concentrations of ferrous iron (Fe^{2+}) often are found in anaerobic, fuel-contaminated groundwater systems. Concentrations of dissolved ferrous iron once were attributed to the spontaneous and reversible reduction of ferric oxyhydroxides, which are thermodynamically unstable in the presence of organic compounds such as benzene. However, more recent studies suggest that the reduction of ferric iron cannot proceed at

all without microbial mediation (Lovley and Phillips, 1988; Lovley *et al.*, 1991; Chapelle, 1993). None of the common organic compounds found in low-temperature, neutral, reducing groundwater could reduce ferric oxyhydroxides to ferrous iron under sterile laboratory conditions (Lovley *et al.*, 1991). This means that the reduction of ferric iron to ferrous iron requires mediation by microorganisms with the appropriate enzymatic capabilities.

To determine if ferric iron is being used as an electron acceptor for fuel biodegradation at the BX Service Station, ferrous (reduced) iron concentrations were measured at groundwater sampling locations in March 1998. Elevated ferrous iron concentrations were detected in the COPC plume core wells (1.47 mg/L to 11.95 mg/L; Table 6.6). The occurrence of ferrous iron concentrations within contaminated areas indicates that ferric iron is acting as an electron acceptor at these locations. In addition, the measured redox potentials of the groundwater at this site are within the range that would be expected for the ferric iron-reducing conditions implied by the observed ferrous iron distributions (Figure 6.1).

6.5.6 Sulfate

Sulfate also may be used as an electron acceptor during microbial degradation of fuel hydrocarbons under anaerobic conditions (Grbic-Galic, 1990). Sulfate can be reduced to sulfide during the oxidation of the fuel hydrocarbon compounds. The presence of decreased concentrations of sulfate (and increased concentrations of sulfide) in the source area relative to background concentrations indicates that sulfate is participating in redox reactions at the site. To investigate the potential for sulfate reduction at the BX Service Station, sulfate and sulfide concentrations were measured during the March 1998 groundwater sampling event.

Table 6.6 shows the analytical results for sulfate and sulfide in groundwater at the BX Service Station. In general, areas characterized by elevated concentrations of dissolved COPCs are depleted in sulfate concentrations relative to measured background concentrations. Background concentrations of sulfate at the site ranged from 24.37 mg/L at well MW-01 to 37.55 mg/L at MW-08-97. Sulfate concentrations measured at plume core area wells exhibiting dissolved fuel contamination (MW-03, MW-05, MP-1 and MP-2) ranged from 0.0 mg/L to 20.39 mg/L. This general depletion of sulfate within the contaminated areas indicates that this compound is acting as an electron acceptor during fuel biodegradation reactions.

Table 6.6 also shows that elevated concentrations of sulfide, which can be produced when sulfate is reduced during fuel hydrocarbon oxidation, generally coincide with depleted sulfate concentrations and elevated fuel hydrocarbon concentrations. The apparent production of sulfide within the contaminated area supports the observation that microbial populations are using sulfate to oxidize fuel hydrocarbons at the site.

The measured ORPs of the groundwater at this site are not within the range that would be expected for the sulfate-reducing conditions implied by the observed sulfate and sulfide distributions. However, as described in Section 6.5.1, field ORP data alone cannot be used to reliably predict the electron acceptors that may be operating at a site.

6.5.7 Dissolved Methane

On the basis of free energy yield and the oxidizing potential of the site groundwater, the carbon dioxide/methane (CO_2/CH_4) redox couple also could be used to oxidize fuel hydrocarbon compounds to carbon dioxide and water once the groundwater is sufficiently reducing. To attain these reducing levels, other highly oxidizing chemical species such as oxygen, nitrate, ferric iron, and sulfate must first be reduced. This redox reaction is called methanogenesis or methane fermentation. Methanogenesis yields the least free energy to the system in comparison to other chemical species (Figure 6.1). The presence of methane in groundwater at elevated concentrations relative to background concentrations is a good indicator of methane fermentation.

Dissolved methane was measured at groundwater monitoring wells sampled during the March 1998 sampling event. Table 6.6 presents the analytical data for methane. Methane concentrations detected at the contaminant source areas were elevated relative to background concentrations. Methane concentrations measured at plume core area wells MW-03, MW-05, MP-1 and MP-2 ranged from 1.2 mg/L to 4.3 mg/L. In contrast, background concentrations ranged from 0.017 mg/L to 0.018 mg/L. The presence of elevated methane levels in groundwater at the BX Service Station strongly indicates that biodegradation is occurring via methanogenesis.

6.5.8 pH

The pH of groundwater samples collected from groundwater monitoring points and monitoring wells in March 1998 was measured (Table 6.6). The pH of a solution is the negative logarithm of the hydrogen ion concentration [H^+]. Groundwater pH values measured at the site were slightly acidic, ranging from 4.78 to 7.01 standard units (SU) with an average of 6.41 SU. This average pH is within the optimal range for fuel hydrocarbon-degrading microbes of 6 to 8 SU. The presence of more acidic pH values indicates that the groundwater alkalinity may be insufficient to fully buffer the groundwater pH against the organic acids produced during microbial reactions.

6.5.9 Temperature

Groundwater temperature was measured at groundwater monitoring wells in March 1998 (Table 6.6). Temperature affects the types and growth rates of bacteria that can be supported in the groundwater environment, with higher temperatures generally resulting in higher growth rates. The temperature of groundwater samples collected from the shallow monitoring wells varied from 18.1 degrees Celsius (°C) to 20.8 °C. These temperatures are warm enough to promote microbial growth and may enhance rates of hydrocarbon biodegradation.

6.6 THEORETICAL ASSIMILATIVE CAPACITY ESTIMATES

The preceding discussions have been devoted to determining if fuel hydrocarbons are biodegrading in saturated soils and groundwater at the BX Service Station. Analytical data on reduced and oxidized chemical species indicate that indigenous microorganisms are facilitating the oxidation of fuel hydrocarbons and the reduction of electron acceptors to generate free energy for cell maintenance and production. The question of how much contaminant mass can be biodegraded must be addressed to assess the full potential for long-term intrinsic bioremediation to minimize plume size and mass over time.

Mass balance relationships can be used to determine how much contaminant mass can be degraded by each of the redox reactions that the microorganisms might use to make free energy available for cell maintenance and production. The stoichiometric relationship between the contaminant and the electron acceptor can be used to estimate the expressed assimilative capacity of the groundwater. Once the redox reactions operating at the site have been defined, it is possible to estimate how much contaminant mass can be assimilated or oxidized by available electron acceptors.

Table 6.1 presents the coupled redox reactions that represent the biodegradation of the individual hydrocarbon COPCs, including the stoichiometric mass ratio of electron acceptors needed to oxidize each compound. These stoichiometric mass ratios can be used to estimate the assimilative capacity of the groundwater at the BX Service Station. For oxygen, nitrate, and sulfate, this is accomplished by first determining the initial (background) mass of each electron acceptor available in the groundwater. Data on these chemical species were collected at sampling locations upgradient (MW-01) and cross-gradient (MW-08-97) from the dissolved plume. As groundwater slowly migrates into the source area, electron acceptors are brought into contact with hydrocarbon-degrading microorganisms and site contamination. The change in the electron acceptor mass from background sampling locations to sampling locations within the plume core is divided by the mass of electron acceptors required to mineralize the COPCs. For ferrous iron, ammonia, and methane, the highest observed concentration in the plume core wells is divided by the mass of electron acceptors required to mineralize each COPC. However, the change in ammonia mass was used to correct for the natural yellow color of the groundwater at the site. These numbers are summed to estimate the expressed intrinsic capacity of the groundwater to biodegrade COPCs.

Estimates of the background and plume core concentrations were used to calculate the expressed assimilative capacity of the groundwater system attributable to aerobic respiration and sulfate reduction (Table 6.7). Table 6.7 also presents the source area concentrations of ammonia, ferrous iron, and methane. These concentrations are used to "back-calculate" the expressed assimilative capacity that is attributable to nitrogen fixation, ferric iron reduction, and methanogenesis. Nitrate is not listed in Table 6.7. As discussed above, nitrate is ultimately reduced to ammonia; however, ammonia can be produced from the reduction of nitrate and from fixation of atmospheric nitrogen. Therefore, only ammonia is used to calculate the intrinsic capacity. On the basis of these calculations, one pore volume of saturated soils and groundwater at the BX Service Station has the capacity to oxidize an average COPC concentration of approximately 16.78 mg/L (16,780 µg/L).

This estimate essentially represents an estimate of the COPC reduction capability of one pore volume of groundwater at the BX Service Station. The estimate identifies how much contaminant mass can be theoretically oxidized as one pore volume travels through the plume core. In reality, over 1 pore volume is expected to move through the contaminated aquifer material in the source area every 2.5 years based on the estimated groundwater velocity of 175 ft/yr and a source area length of approximately 450 feet.

A closed system containing 2 liters of water can be used to help visualize the physical meaning of assimilative capacity. Assume that the first liter contains no fuel hydrocarbons, but it contains fuel-degrading microorganisms and has an assimilative capacity of exactly "x" mg of fuel hydrocarbons. The second liter has no assimilative

capacity; however, it contains fuel hydrocarbons. As long as these 2 liters of water are kept separate, biodegradation of fuel hydrocarbons will not occur. If these 2 liters are combined in a closed system, biodegradation will commence and continue until the fuel hydrocarbons or electron acceptors are depleted. If less than "x" mg of fuel hydrocarbons are in the second liter, all of the fuel hydrocarbons will eventually degrade given a sufficient time; likewise, if greater than "x" mg of fuel hydrocarbons were in the second liter of water, only "x" mg of fuel hydrocarbons would ultimately degrade.

This example shows that in a closed system, the measured expressed assimilative capacity eventually should be equivalent to the loss in contaminant mass; however, the groundwater beneath the site is an open system. Electron acceptors can continually enter the system from upgradient flow. Furthermore, contaminant mass can be added to the system through dissolution or leaching from LNAPL or contaminated soils. This means that the assimilative capacity is not fixed as it would be in a closed system, and therefore should not be quantitatively compared to concentrations of dissolved contaminants in the groundwater. Rather, the expressed assimilative capacity of groundwater is intended to serve as a qualitative tool. The fate of COPCs in groundwater is dependent on the relationship between the kinetics of biodegradation and the solute transport velocities (Chapelle, 1994).

6.7 PREDICTING CONTAMINANT TRANSPORT AND FATE

Understanding the effects of natural physical, chemical, and biological processes on chemicals in the subsurface is an important step in determining potential long-term risks associated with chemical migration in the environment. The behavior of COPCs under the influence of these processes must be quantified to assess the expected persistence, mass, concentration, and toxicity of dissolved COPCs over time at the site; and to estimate potential receptor exposure-point concentrations. If destructive and nondestructive attenuation processes can minimize or eliminate the concentration of contaminants to which a receptor could be exposed, engineered remedial action may not be warranted because no reasonable exposure pathway exists or the exposure pathway would result in insignificant risks. The focus of this section is to predict how the COPCs will be transported and transformed over time in soil, soil vapor, and groundwater based on site data and site-specific contaminant transport and fate models.

6.7.1 Volatilization from Subsurface Sources

6.7.1.1 Inhalation Risks Posed to Aboveground Receptors

Maximum detected soil gas concentrations were conservatively compared to OSHA PELs in Section 4 to define ambient atmosphere COPCs. However, as discussed previously, this comparison is overly conservative because soil gas measurements do not reflect the exposure-point concentrations in outdoor ambient air or within onsite structures. To determine whether subsurface sources (i.e., contaminated soils and dissolved contamination) could cause exposure-point concentrations in either outdoor or indoor air that may pose an unacceptable risk to potential onsite receptors via the inhalation exposure route, several different kinds of chemical flux and atmospheric transport equations were coupled to simulate the concentrations of benzene present in outdoor ambient air under normal atmospheric conditions and accumulating within onsite buildings. Two models [i.e., the Farmer Model (USEPA, 1992) and the indoor air dispersion model (Michelson *et al.,* 1993)] were utilized for this task.

A diffusion model was used to predict the transport of benzene from subsurface sources through unsaturated soils and manmade structures (e.g., building foundations), and within ambient air. The maximum measured soil gas benzene concentration was used to represent the observed subsurface source term. Flux equations were then used to estimate that mass of benzene that migrated to the target mixing area (i.e., outdoor ambient atmosphere and indoor building space). Simple "box" mixing equations were used to translate flux measurements into predicted exposure-point concentrations for air within the outdoor and indoor breathing zones. Outdoor air quality impacts were conservatively estimated assuming that benzene diffuses/convects through native soils only (i.e., the pavement capping a portion of the site is not present), and that only minimal atmospheric dispersion above the flux area is possible (i.e., virtual upwind point-source dispersion assumption). Indoor air quality impacts were conservatively estimated by allowing benzene to seep through foundation cracks and mix within a ventilated but confined structure. Both site-specific and conservative default values were used as input parameters. The predictive model equations and input parameters are presented in Table 6.8.

The maximum benzene concentration detected in soil vapor samples in March 1998 (Table 5.4) was used in the diffusion model that is based on measured soil gas concentrations. This model predicted an outdoor benzene exposure concentration of 0.00186 mg/m^3, which is three orders of magnitude less than the PEL for this compound of 1 mg/m^3 (Table 6.8).

The predictive migration model equations for indoor air indicate that subsurface sources at the BX Service Station are not expected to cause indoor air concentrations of benzene to exceed the OSHA PEL. The predictive migration model indicates that the indoor air concentration of benzene is conservatively expected to be five orders of magnitude less than the OSHA PEL (Table 6.8). Therefore, no engineered remediation is warranted to prevent migration of benzene into indoor air at concentrations above the OSHA PEL.

6.7.1.2 Inhalation Risks Posed to Intrusive Workers

A box mixing model was used to estimate the concentration of benzene that would be present in the breathing zone in an excavated trench based on the maximum soil gas benzene concentration detected in March 1998. The mixing model and the parameter values used in the model were developed by toxicologists at the University of Florida for a similar site at Homestead AFB, Florida (University of Florida, 1998). Calculations are contained in Appendix E. The model indicated that the resulting benzene concentration would be 0.034 mg/m^3, which is approximately two orders of magnitude lower than the OSHA PEL of 1 mg/m^3. Therefore, no engineered remediation is warranted to prevent migration of benzene into excavations at concentrations above the OSHA PEL.

6.7.2 BIOSCREEN Modeling

BIOSCREEN® is a screening model which simulates RNA of dissolved hydrocarbons at petroleum fuel release sites (Newell and McLeod, 1996). The software is based on the Domenico (1987) analytical solute transport model and is designed to simulate advection, dispersion, adsorption, and aerobic decay as well as anaerobic reactions that have been shown to be the dominant biodegradation processes at many petroleum release sites.

6.7.2.1 Description of BIOSCREEN Model

BIOSCREEN® includes three different model types:

1) Solute transport without decay;
2) Solute transport with biodegradation modeled as a first-order decay process (simple, lumped parameter approach); and
3) Solute transport with biodegradation modeled as an "instantaneous" biodegradation reaction.

The first model is appropriate for predicting the movement of conservative (non-degrading) solutes such as chloride. The only attenuation mechanisms simulated are dispersion in the longitudinal, transverse, and vertical directions and adsorption of the chemical to the soil matrix.

With the second model, the solute degradation rate is proportional to the initial solute concentration. This is a conventional method for simulating biodegradation in dissolved hydrocarbon plumes. With this method, dispersion, sorption, and biodegradation parameters are lumped together in a single calibration parameter. The first-order decay model does not account for site-specific information such as the availability of electron acceptors. In addition, it does not assume any biodegradation of dissolved constituents in the source zone. In other words, this model assumes that biodegradation starts immediately downgradient from the source and that it does not decrease the concentrations of dissolved organic compounds in the source zone itself.

First-order expressions may not be accurate for describing biodegradation of organic chemicals in groundwater because electron acceptor limitations are not considered. A more accurate prediction of biodegradation effects may be realized by incorporating the instantaneous reaction equation into a transport model (Newell and McLeod, 1996).

At almost all petroleum release sites, biodegradation is present and can be verified by demonstrating the consumption of aerobic and anaerobic electron acceptors. Therefore, results from the No Biodegradation model are intended only to be used for comparison purposes and to demonstrate the effects of biodegradation on plume migration. The Instantaneous Reaction model is recommended either alone or in addition to the First-Order Decay model for most sites where electron acceptor and metabolic byproduct concentration data have been collected (Newell and McLeod, 1996).

6.7.2.2 Modeling Objectives

The BIOSCREEN® modeling was performed for the BX Service Station site to accomplish the following three objectives:

- To estimate the maximum migration distance of the plumes associated with the current and former UST pit over time;
- To assess the persistence of both plumes over time; and
- To support future remedial actions.

It was necessary to perform modeling for both the current and former UST pits to support development of future remedial options. The lateral migration potential and

persistence of benzene at the former UST pit was modeled because, of the groundwater COPCs identified in Section 4, benzene is both mobile in the groundwater environment and considered a toxic carcinogen (has the lowest Table V TCL of any of the volatile COPCs). Therefore, benzene will likely be a primary "risk-driver" at this site. Xylene was modeled at the current UST pit because it exceeded its Table V TCL by 800 times, which was the greatest exceedence.

6.7.2.3 Conceptual Model Design and Limiting Assumptions

BIOSCREEN® has the following limitations:

- As an analytical model, BIOSCREEN® assumes simple groundwater flow conditions; and
- As a screening tool, BIOSCREEN® only approximates the more complicated processes that occur in the field.

Because the model is not capable of simulating a complicated flow regime, the hydraulic input parameters for the site were based on slug and pump tests performed at site monitoring wells. As discussed previously, there are multiple sources at the site. The highest benzene concentration was detected at MP-2, which is associated with the former UST pit. The highest xylene concentration was detected at MW-03, which is associated with the current UST pit. Therefore, the BIOSCREEN models that are presented in this section predict the migration and persistence of benzene associated with the former UST pit and xylene associated with the current UST pit.

At the former UST pit, a twenty-three-year calibration simulation (1975 to 1998) was run using the dissolved benzene data collected in 1998 as calibration targets. As discussed in Section 1.5, the original USTs at the former UST pit were activated in 1948. The tanks were replaced in 1967 and closed in 1983. There is no information available about when a release occurred at the former UST pit. This simulation assumes that the contamination was first introduced into the environment in 1978 at the midpoint of the replacement tanks' life. This model will be referenced as model 1 for the remainder of this discussion.

At the current UST pit, a ten-year calibration simulation (1987 to 1997) was run using the dissolved xylene data collected in 1997 as calibration targets. Dissolved xylene concentrations decreased significantly from 1997 to 1998, however, the drop may be due to seasonal fluctuations. To be conservative, the BIOSCREEN model was calibrated to the 1997 data. As discussed in Section 1.5, a release occurred in 1987 when the USTs were overfilled through the new remote fill lines and fuel leaked out into the surrounding soil through the original remote fill lines. This simulation assumes that the contamination was first introduced into the environment in 1987 as a result of this release. This model will be referenced as model 2 for the remainder of this discussion.

6.7.2.4 Initial Model Input Data

Input data for the BIOSCREEN® model are used to specify/calculate groundwater velocity, aquifer dispersivity, a retardation factor, a chemical-specific decay coefficient, dissolved hydrocarbon concentrations in the source area, a half-life of the hydrocarbon source, and the dimensions of the source zone. The parameters were obtained from site-

specific data and commonly accepted literature values. The BIOSCREEN® input screens is presented in Appendix F. Each of these input values is described in more detail below.

6.7.2.4.1 Hydrogeology

Seepage Velocity (V_s)

Seepage velocity is the actual interstitial groundwater velocity. It is defined as the hydraulic conductivity times the hydraulic gradient divided by the effective porosity. The value of this parameter was the same for both models (175 ft/yr).

$$V_s = \left(\frac{K}{n_e}\right)\left(\frac{dH}{dL}\right)$$

Hydraulic Conductivity (K)

Hydraulic conductivity (K) is a term that describes the relative ease with which water can move through a permeable medium. The horizontal K value used for shallow aquifer modeling, 1.1 x 10^{-2} centimeters per second (cm/s) (30 ft/day), was derived from slug and pump tests performed by BCM (Section 3.4, and Appendix A).

Hydraulic Gradient (dH/dL)

The hydraulic gradient is a unitless value which represents the change in water table elevation per unit distance in a direction parallel to groundwater flow. The average hydraulic gradient at the site was calculated to be 0.004 ft/ft based on water table elevation data.

Effective Porosity (n_e)

The effective porosity of a medium is the ratio of the volume of interconnected voids to the bulk volume of the aquifer matrix. The effective porosity is typically less than total porosity because of non-interconnected pores, dead-end pores, and boundary effects of aquifer solids. An effective porosity of 0.25 (25%) was used for the model. This value is commonly used for silt and sand lithologies (Newell and McLeod, 1996).

6.7.2.4.2 Dispersion

Dispersivity is a property of a porous medium that determines the dispersion or spreading characteristics of the medium by a relationship between pore-water velocity and dispersion coefficients. Bioscreen® computes the longitudinal dispersivity based on an estimated plume length, and the transverse dispersivity by using 10% of the longitudinal dispersivity. The default vertical dispersivity is zero.

An important step in the Bioscreen® model calibration process is the manipulation of the model's dispersivity, as the value of dispersivity can vary between 2 to 3 orders of magnitude across a site (Newell and McLeod, 1996). During calibration of model 1, dispersivity was varied, and final values of 450 feet, 45 feet, and 0 feet were input for longitudinal dispersivity, transverse dispersivity, and vertical dispersivity, respectively. The calibrated value of longitudinal dispersivity is within 2 to 3 orders of magnitude of

the initial value of 17.9 feet computed by the model based on an assumed maximum plume length of 500 feet.

6.7.2.4.3 Adsorption

Retardation Factor

The retardation factor is a measure of the degree of retardation of dissolved organic chemical movement through the aquifer. A retardation value of 1.15 was calculated using the following formula and input parameters:

$R=1+(K_d\rho_b/n)$

where

$K_d = (K_{oc})(f_{oc})$

K_{oc} = Organic Carbon Partition Coefficient

f_{oc} = Fraction Organic Carbon

ρ_b = Soil Bulk Density of Aquifer Matrix

n_e = Effective Porosity

Organic Carbon Partition Coefficient (K_{oc})

The organic carbon partition coefficient (K_{oc}) is a chemical-specific partition coefficient between organic carbon and water (Newell and McLeod, 1996). The selected K_{oc} value for model 1 was 79 milliliters per gram [mL/g] which corresponds to benzene. For model 2, a value of 422 mL/g was chosen for xylene (Weidemeier *et al.*, 1995).

Fraction Organic Carbon (f_{oc})

The fraction organic carbon (f_{oc}) is the weight fraction of organic carbon in soil and is used in the estimation of the retardation factor. Typical f_{oc} values range from 0.0002 to 0.02 (Newell and McLeod, 1996). Total organic carbon concentration was not detected in site soils, so half of the mdl (550 mg/kg) was assumed to exist in site soils. This assumption means 275 mg/kg are in site soils, which translates to a f_{oc} value of 2.75×10^{-4}.

Effective Porosity (n_e)

The effective porosity of a medium is the ratio of the volume of interconnected voids to the bulk volume of the aquifer matrix. The effective porosity is typically less than total porosity because of non-interconnected pores, dead-end pores, and boundary effects of aquifer solids. An effective porosity of 0.25 (25%) was used for the model. This value is commonly used for silt and sand lithologies (Newell and McLeod, 1996).

Soil Bulk Density (ρ_b)

The soil bulk density is the bulk density of the aquifer matrix and is related to the porosity and pure solids density. An estimated value of 1.7 grams per cubic centimeter

(g/cm^3) (or kilograms per liter [kg/L]) was used in this model (Newell and McLeod, 1996).

6.7.2.4.4 Biodegradation

First Order Decay Coefficient and Solute Half- Life

The solute half-life is a chemical specific value which specifies the amount of time it takes for a compound to degrade to half its original concentration. The first-order decay coefficient is equal to 0.693 divided by the half life of the chemical in groundwater. The half-life of benzene and xylene published in literature typically ranges from 0.02 to 2 years and 0.038 to 1 year, respectively (Newell and McLeod, 1996). Instead of using a literature value, a first-order decay coefficient was calculated using site-specific data and the method of Buscheck and Alcantar (1995). These values are discussed in Section 6.4 and presented in Table 6.5. A half-life of 0.28 years was used for benzene in model 1 and a half-life of 0.26 years for xylene was used in model 2.

First-order expressions may not be accurate for describing biodegradation of organic chemicals in groundwater because electron acceptor limitations are not considered. A more accurate prediction of biodegradation effects may be realized by incorporating the instantaneous reaction equation into a transport model (Newell and McLeod, 1996). For this reason, both models 1 and 2 were calibrated using the instantaneous reaction model.

Instantaneous Reaction Model

Using field and laboratory analytical data, background concentrations (wells MW-08 and MW-01) and concentrations within the COPC plume core area (wells MP-1, MP-2, MW-03, and MW-05) for each of the electron acceptors/by-products listed below were calculated. Although BTEX compounds dominate the dissolved plumes of gasoline spills, there are non-BTEX hydrocarbons that exert a demand on the available electron acceptors. A conservative approach is to reduce all available electron acceptor/by-product concentrations used in the model by thirty percent to account for the possible impacts of non-BTEX organics in groundwater (Newell and McLeod, 1997). Therefore, the delta for each of the indicators was reduced by thirty percent. Since benzene or xylene were the only constituents being modeled, the deltas were reduced by an additional seventy-five percent before being input into the model. Then, Bioscreen® calculates biodegradation capacities (BCs) for individual parameters. The BC is the amount (in mg/L) of a parameter utilized to biodegrade 1 mg/L of hydrocarbon. The calculated differences are provided below.

Difference in DO

17.5% of {(Background Oxygen Conc.) - (Core Oxygen Conc)}

Change in DO = 0.175*(0.76-0.16) = 0.11 mg/L

Difference in Nitrate

17.5% of {(Background Nitrate Conc.) - (Core Nitrate Conc.)}

Change in Nitrate = 0.175*(0-0) = 0 mg/L

Difference in Ferrous Iron

17.5% of {(Core Ferrous Iron Conc.)}
Change in Ferrous Iron = 0.175*(11.95) = 2.09 mg/L

Difference in Sulfate

17.5% of {(Background Sulfate Conc.) - (Core Sulfate Conc.)}
Change in Sulfate = 0.175*(30.96-0.0) = 5.42 mg/L

Difference in Methane

17.5% of {(Core Methane Conc.)}
Methane = 0.175*(4.3) = 0.75 mg/L

6.7.2.4.5 General

For model 1, the modeled area length and width were set at 600 feet and 120 feet, respectively. The model area dimensions were estimated from site groundwater monitoring data. The calibration period extended from 1975 to 1998 (23 years), and the model was run for 43 years (1975 to 2018) for predictive purposes.

For model 2, the modeled area length and width were set at 500 feet and 100 feet, respectively. The model area dimensions were estimated from site groundwater monitoring data. The calibration period extended from 1987 to 1997 (10 years), and the model was run for 80 years (1987 to 2067) for predictive purposes.

6.7.2.4.6 Source Data

Source Thickness in Saturated Zone

The source thickness in the aquifer was input as 10 feet. This simple assumption is appropriate for many petroleum release sites (Newell and McLeod, 1996).

Source Area Dimensions and Concentrations

BIOSCREEN® assumes a source represented by a vertical plane perpendicular to groundwater flow. The cross-sectional area of the vertical plane was estimated to be the maximum concentration. For model 1 this value was manipulated until the model predicted that a maximum of 3.4 mg/L of benzene would exist 23 years after the release occurred. For model 2 this value was manipulated until the model predicted that a maximum of 16 mg/L of xylene would exist 10 years after the release occurred.

Source Half-Life

BIOSCREEN® incorporates an approximation for a declining source concentration over time. The declining source term assumes that the mass of modeled constituent in the source area dissolves slowly as fresh groundwater passes through, and that the change in source zone concentration can be approximated as a first-order decay process. The model will compute an estimated source half-life given the estimated mass of modeled constituent present in the source area. Calibrated values of 530 kg and 1000 kg were employed for models 1 and 2, respectively.

6.7.2.4.7 Field Data for Comparison

An optional function of the BIOSCREEN® model is to incorporate field data along the centerline of the plume to compare to the model results. Data from the recent sampling events were used for this comparison.

6.7.2.5 Model Calibration

The analytical model was calibrated by altering input parameters in a trial-and-error fashion until the simulated plume calculated by the instantaneous reaction model approximated observed field data. The parameters varied during calibration were the dispersivity, source zone concentration, and the source mass. The parameters were varied within a realistic range of values until the simulation results of the both models closely matched the data from the recent sampling events.

6.7.2.6 Model Results

Model 1 indicates the benzene plume from the former UST pit migrated to its maximum distance of approximately 540 feet seven years after its release (1983). The model predicts that concentrations of benzene in excess of the TCL of 1 µg/L will persist in the aquifer for 43 years after 1975 (2018). Model output is presented in Appendix F.

Model 2 indicates the xylene plume from the current UST pit migrated to its maximum distance of approximately 300 feet eight years after its release (1995). The model predicts that concentrations of xylene in excess of the TCL of 20 µg/L will persist in the aquifer for 80 years after 1987 (2067). The model may be overly conservative because it is based on 1997 xylene data instead of lower magnitude 1998 data. Model output is presented in Appendix F.

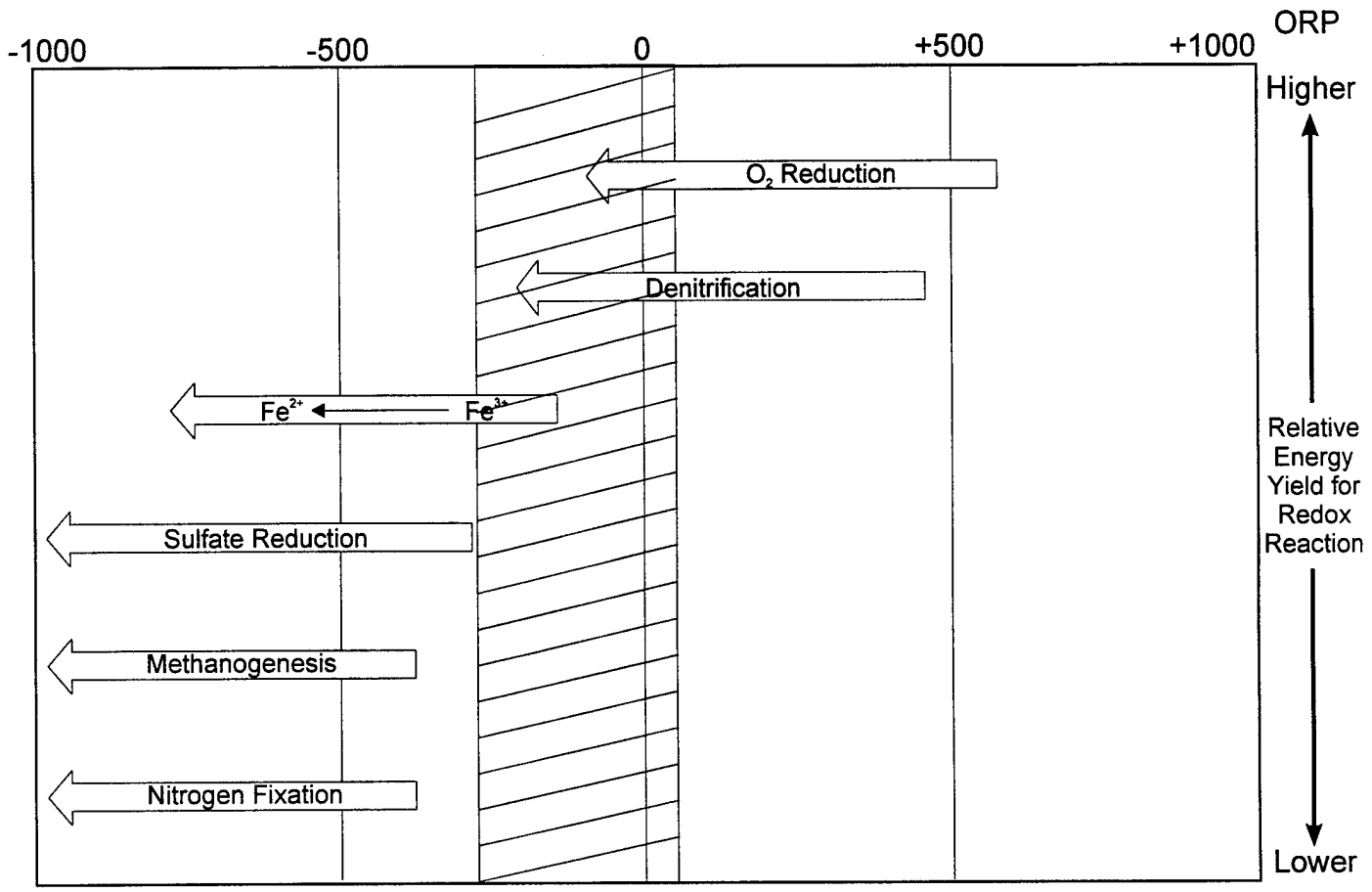
6.7.2.7 Simulated Source Removal

The BIOSCREEN model also was utilized to evaluate the effectiveness of future remedial actions. This task was completed for the dissolved plumes at both the current and former UST pits. Model input and output is included in Appendix F.

For model 1 (former UST pit), the only input parameters that were changed were the maximum dissolved benzene concentration and the estimated mass of benzene in the source area. This model assumes that the future remedial action will remove 80 percent of the source benzene over 3 years. Based on model 1 results, it is estimated that 110 kg of source are left in 1998. This value was decreased by an additional 80 percent, which is the assumed removal capacity of the future remedial action. The final value of 22 kg was input into the model. The maximum benzene concentration from the calibration year (1998) of 3.4 mg/L was input as the maximum dissolved concentration. The result of the model indicates that after 80 percent of the source is removed, the benzene will completely attenuate in 3 years. If the 80 percent source removal takes 3 years, then the model predicts that benzene will attenuate 6 years after implementation of the remedial action.

The same source removal simulation was performed for the current UST pit as the former UST pit. This model also assumes that the future remedial action will remove 80 percent of the source xylene over 3 years. Based on model 2 results, it is estimated that

700 kg of source are left in 1998. This value was decreased by an additional 80 percent, which is the assumed removal capacity of the future remedial action. The final value of 140 kg was input into the model. To be conservative, the maximum xylene concentration from the calibration year (1997) of 16 mg/L was input as the maximum dissolved concentration. The result of the model indicates that after 80 percent of the source is removed, the xylene will completely attenuate in 14 years. If the 80 percent source removal takes 3 years, then the model predicts that xylene will attenuate 17 years after implementation of the remedial action.



Notes

ORP = Oxidation Reduction Potential

Range of ORP measured at the BX Service Station

1. These reactions would be expected to occur in sequence if the system is moving toward equilibrium.

2. These redox processes occur in order of their energy-yielding potential (provided microorganisms are available to mediate a specific reaction). Reduction of a highly oxidized species decreases the ORP of the system.

3. The ORP of the system determines which electron acceptors are available for organic carbon oxidation.

4. Redox reaction sequence is paralleled by an ecological succession of biological mediators.

Adapted from Stumm and Morgan, 1981.

FIGURE 6.1

SEQUENCE OF MICROBIALLY MEDIATED REDOX PROCESSES

Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

PARSONS ENGINEERING SCIENCE, INC.
Atlanta, Georgia

J:\731854\Tyndall\Redx-seq.cdr

TABLE 6.1
COUPLED OXIDATION REACTIONS FOR COPC COMPOUNDS
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Coupled Benzene Oxidation Reactions	Stoichiometric Mass Ratio of Electron Acceptor/Byproduct to Compound
$7.5O_2 + C_6H_6 \Rightarrow 6CO_{2,g} + 3H_2O$ *Benzene oxidation /aerobic respiration*	3.07:1
$6NO_3^- + 6H^+ + C_6H_6 \Rightarrow 6CO_{2,g} + 6H_2O + 3N_{2,g}$ *Benzene oxidation / denitrification*	4.77:1
$3.75NO_3^- + C_6H_6 + 7.5H^+ + 0.75H_2O \Rightarrow 6CO_2 + 3.75NH_4^+$ *Benzene oxidation / nitrate reduction*	2.98:1
$60H^+ + 30\underline{Fe(OH)_{3,a}} + C_6H_6 \Rightarrow 6CO_2 + 30Fe^{2+} + 78H_2O$ *Benzene oxidation / iron reduction*	21.5:1
$7.5H^+ + 3.75SO_4^{2-} + C_6H_6 \Rightarrow 6CO_{2,g} + 3.75H_2S^o + 3H_2O$ *Benzene oxidation / sulfate reduction*	4.61:1
$5N_2 + C_6H_6 + 10H^+ + 12H_2O \Rightarrow 6CO_2 + 10NH_4^+$ *Benzene oxidation / nitrogen fixation*	2.31:1
$4.5H_2O + C_6H_6 \Rightarrow 2.25CO_{2,g} + 3.75CH_4$ *Benzene oxidation / methanogenesis*	0.77:1

Coupled Toluene Oxidation Reactions	Stoichiometric Mass Ratio of Electron Acceptor/Byproduct to Compound
$9O_2 + C_6H_5CH_3 \Rightarrow 7CO_{2,g} + 4H_2O$ *Toluene oxidation /aerobic respiration*	3.13:1
$7.2NO_3^- + 7.2H^+ + C_6H_5CH_3 \Rightarrow 7CO_{2,g} + 7.6H_2O + 3.6N_{2,g}$ *Toluene oxidation / denitrification*	4.85:1
$4.5NO_3^- + 9H^+ + 0.5H_2O + C_6H_5CH_3 \Rightarrow 7CO_2 + 4.5NH_4^+$ *Toluene oxidation / nitrate reduction*	3.03:1
$72H^+ + 36\underline{Fe(OH)_{3,a}} + C_6H_5CH_3 \Rightarrow 7CO_2 + 36Fe^{2+} + 94H_2O$ *Toluene oxidation / iron reduction*	21.86:1
$9H^+ + 4.5SO_4^{2-} + C_6H_5CH_3 \Rightarrow 7CO_{2,g} + 4.5H_2S^o + 4H_2O$ *Toluene oxidation / sulfate reduction*	4.7:1
$6N_2 + C_6H_5CH_3 + 12H^+ + 14H_2O \Rightarrow 7CO_2 + 12NH_4^+$ *Toluene oxidation / nitrogen fixation*	2.35:1
$5H_2O + C_6H_5CH_3 \Rightarrow 2.5CO_{2,g} + 4.5CH_4$ *Toluene oxidation / methanogenesis*	0.78:1

TABLE 6.1 (CONTINUED)
COUPLED OXIDATION REACTIONS FOR COPC COMPOUNDS

Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Coupled Ethylbenzene Oxidation reactions	Stoichiometric Mass Ratio of Electron Acceptor/Byproduct to Compound
$10.5O_2 + C_6H_5C_2H_5 \Rightarrow 8CO_{2,g} + 5H_2O$ *Ethylbenzene oxidation /aerobic respiration*	3.17:1
$8.4NO_3^- + 8.4H^+ + C_6H_5C_2H_5 \Rightarrow 8CO_{2,g} + 9.2H_2O + 4.2N_{2,g}$ *Ethylbenzene oxidation / denitrification*	4.92:1
$5.25NO_3^- + 10.5H^+ + 0.25H_2O + C_6H_5C_2H_5 \Rightarrow 8CO_2 + 5.25NH_4^+$ *Ethylbenzene oxidation / nitrate reduction*	3.07:1
$84H^+ + 42\underline{Fe(OH)_{3,a}} + C_6H_5C_2H_5 \Rightarrow 8CO_2 + 42Fe^{2+} + 110H_2O$ *Ethylbenzene oxidation / iron reduction*	22:1
$10.5H^+ + 5.25SO_4^{2-} + C_6H_5C_2H_5 \Rightarrow 8CO_{2,g} + 5.25H_2S^o + 5H_2O$ *Ethylbenzene oxidation / sulfate reduction*	4.75:1
$7N_2 + C_6H_5C_2H_5 + 14H^+ + 16H_2O \Rightarrow 8CO_2 + 14NH_4^+$ *Ethylbenzene oxidation / nitrogen fixation*	2.38:1
$5.5H_2O + C_6H_5C_2H_5 \Rightarrow 2.75CO_{2,g} + 5.25CH_4$ *Ethylbenzene oxidation / methanogenesis*	0.79:1

Coupled m-Xylene Oxidation Reactions	Stoichiometric Mass Ratio of Electron Acceptor/Byproduct to Compound
$10.5O_2 + C_6H_4(CH_3)_2 \Rightarrow 8CO_{2,g} + 5H_2O$ *m-Xylene oxidation /aerobic respiration*	3.17:1
$8.4NO_3^- + 8.4H^+ + C_6H_4(CH_3)_2 \Rightarrow 8CO_{2,g} + 9.2H_2O + 4.2N_{2,g}$ *m-Xylene oxidation / denitrification*	4.92:1
$5.25NO_3^- + 10.5H^+ + 0.25H_2O + C_6H_4(CH_3)_2 \Rightarrow 8CO_2 + 5.25NH_4^+$ *m-Xylene oxidation / nitrate reduction*	3.07:1
$84H^+ + 42\underline{Fe(OH)_{3,a}} + C_6H_4(CH_3)_2 \Rightarrow 8CO_2 + 42Fe^{2+} + 110H_2O$ *m-Xylene oxidation / iron reduction*	22:1
$10.5H^+ + 5.25SO_4^{2-} + C_6H_4(CH_3)_2 \Rightarrow 8CO_{2,g} + 5.25H_2S^o + 5H_2O$ *m-Xylene oxidation / sulfate reduction*	4.75:1
$7N_2 + C_6H_4(CH_3)_2 + 14H^+ + 16H_2O \Rightarrow 8CO_2 + 14NH_4^+$ *m-Xylene oxidation / nitrogen fixation*	2.38:1
$5.5H_2O + C_6H_4(CH_3)_2 \Rightarrow 2.75CO_{2,g} + 5.25CH_4$ *m-Xylene oxidation / methanogenesis*	0.79:1

TABLE 6.1 (CONTINUED)
COUPLED OXIDATION REACTIONS FOR COPC COMPOUNDS

Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Coupled Naphthalene Oxidation Reactions	Stoichiometric Mass Ratio of Electron Acceptor/Byproduct to Compound
$12O_2 + C_{10}H_8 \Rightarrow 10CO_2 + 4H_2O$ *Naphthalene oxidation /aerobic respiration*	3.00:1
$9.6NO_3^- + 9.6H^+ + C_{10}H_8 \Rightarrow 10CO_2 + 8.8H_2O + 4.8N_{2,g}$ *Naphthalene oxidation / denitrification*	4.65:1
$24MnO_2 + 48H^+ + C_{10}H_8 \Rightarrow 10CO_2 + 24Mn^{2+} + 28H_2O$ *Naphthalene oxidation / manganese reduction*	10.30:1
$48Fe(OH)_{3,a} + 96H^+ + C_{10}H_8 \Rightarrow 10CO_2 + 48Fe^{2+} + 124H_2O$ *Naphthalene oxidation / iron reduction*	20.94:1
$6SO_4^{2-} + 12H^+ + C_{10}H_8 \Rightarrow 10CO_2 + 6H_2S^o + 4H_2O$ *Naphthalene oxidation / sulfate reduction*	4.50:1
$8\,N_2 + C_{10}H_8 + 16\,H^+ + 20\,H_2O \Rightarrow 10\,CO_2 + 16\,NH_4^+$ *Naphthalene oxidation / nitrogen fixation*	2.25:1
$8H_2O + C_{10}H_8 \Rightarrow 4CO_2 + 6CH_4$ *Naphthalene oxidation / methanogenesis*	0.75:1

Coupled Methyl tert-Butyl Ether Oxidation Reactions	Stoichiometric Mass Ratio of Electron Acceptor/Byproduct to Compound
$6NO_3^- + 6H^+ + C_5OH_{12} \Rightarrow 5CO_2 + 9H_2O + 3N_2$ *Methyl tert butyl ether oxidation/denitrification*	4.23:1
$15MnO_2 + 30H^+ + C_5OH_{12} \Rightarrow 5CO_2 + 15Mn^{2+} + 21H_2O$ *Methyl tert butyl ether oxidation/manganese reduction*	9.36:1
$30\,Fe(OH)_3 + 60H^+ + C_5OH_{12} \Rightarrow 5CO_2 + 30Fe^{2+} + 81H_2O$ *Methyl tert butyl ether oxidation/iron reduction*	19.04:1
$3.75SO_4^{2-} + 7.5H^+ + C_5OH_{12} \Rightarrow 5CO_2 + 3.75H_2S + 6H_2O$ *Methyl tert butyl ether oxidation/sulfate reduction*	4.09:1
$5\,N_2 + C_5OH_{12} + 10\,H^+ + 9\,H_2O \Rightarrow 5\,CO_2 + 10\,NH_4^+$ *Methyl tert butyl ether oxidation / nitrogen fixation*	2.04:1
$1.5H_2O + C_5H_{12}O \Rightarrow 1.25CO_2 + 3.75CH_4$ *Methyl tert butyl ether oxidation/methanogenesis*	0.68:1

TABLE 6.2
HISTORICAL COMPARISON OF SOIL ANALYTICAL DATA
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Analyte	Units	Sample Locations, Intervals, and Dates							
		HA-1 (2 - 3.5) 17-Mar-95	SB-3 (2 - 3.5) 18-Mar-98	HA-1 (4 - 5.5) 17-Mar-95	SB-3 (4 - 5.5) 18-Mar-98	HA-4 (4-5.5) 17-Mar-95	SB-4 (4 - 7) 18-Mar-98	HA-9 (4.5 - 5) 24-Mar-95	SB-5 (4.5 - 5) 18-Mar-98
Benzene	mg/kg[a/]	ND[b/]	0.0060 U[c/]	ND	1.2 U	ND	12 U	ND	24 U
Ethylbenzene	mg/kg	7.01 U	0.0024 U	**14.7**	0.48 U	0.681 U	**13**	**38.9**	9.6 U
Toluene	mg/kg	7.01 U	0.0060 U	**24.9**	1.2 U	**1.43**	**8.4 J1**[c/]	**36.6**	**6.3 J1**
Xylenes (total)	mg/kg	**362**	0.0060 U	**295**	1.2 U	**82.4**	**260**	**457**	**290**
Total BTEX[e/]	mg/kg	**362**	0.0204 U	**334.6**	4.08 U	**83.83**	**281.4**	**532.5**	**296.3**
TRPH[f/]	mg/kg	**551**	**110**	**888**	**400**	**2290**	**900**	**741**	**1700**
Naphthalene	mg/kg	**7.92**	0.24 U	**18.1**	0.24 U	**49.5**	**46**	**11.4**	**18**

a/ mg/kg = Milligrams per kilogram

b/ ND = not detected

c/ U = The analyte was analyzed for and was not present above the reporting limit

d/ J1 = The analyte was positively identified and had a concentration between the method detection limit and the reporting limit

e/ BTEX = benzene, toluene, ethylbenzene, and total xylenes

f/ TRPH = total recoverable petroleum hydrocarbons

HA-1, HA-4, and HA-9 advanced by BCM

HA-1, HA-4, and HA-9 are in the same locations as SB-3, SB-4, and SB-5, respectively

TABLE 6.3
COMPARSION OF HISTORICAL GROUNDWATER ANALYTICAL DATA
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Analyte	Units	Sample Locations and Dates								
		MW-03			MW-05			MW-07		
		5-Apr-95	21-May-97	22-Mar-98	27-Sep-95	21-May-97	22-Mar-98	27-Sep-95	22-May-97	22-Mar-98
Benzene	µg/L[a/]	**530**	**420**	**67**	**510**	**370**	**360**	10U[b/]	**130**	**11 J1**[c/]
Ethylbenzene	µg/L	**890**	**2100**	**610**	**420**	**830**	**890**	10U	**250**	**76**
Toluene	µg/L	**3600**	**5000**	**1,700**	**590**	5U	**4.3 J1**	10U	**140**	**38 J1**
Xylenes (total)	µg/L	**8400**	**16000**	**6,900**	**1,810**	**55**	**54 J1**	**7**	**980**	**620**
Total BTEX[d/]	µg/L	**13,420**	**23,520**	**9,277**	**3,330**	**1,255**	**1,308**	**7**	**1,500**	**745**
Naphthalene	µg/L	**290**	NA[e/]	**300**	**66**	NA	NA	10U	NA	NA
Total Lead	µg/L	**4**	**6**	**3**	NA	0.02U	NA	NA	0.02U	NA

a/ µg/L = micrograms per liter

b/ U = The analyte was analyzed for and was not present above the reporting limit

c/ J1 = The analyte was positively identified and had a concentration between the method detection limit and the reporting limit

d/ BTEX = benzene, toluene, ethylbenzene, and total xylenes

e/ NA = not analyzed

TABLE 6.4
RETARDATION COEFFICIENT CALCULATION
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Compound	K_{oc} (L/kg [a/])	Average Fraction Organic Carbon [b/]	Distribution Coefficient K_d (L/kg) Average [c/]	Bulk Density (kg/L) [d/]	Effective Porosity [d/]	Coefficient of Retardation Average
Benzene	79	0.000275	0.021725	1.7	0.25	1.15
Toluene	190	0.000275	0.05225	1.7	0.25	1.36
Ethylbenzene	468	0.000275	0.1287	1.7	0.25	1.88
Total Xylenes	422	0.000275	0.11605	1.7	0.25	1.79
Total BTEX						1.54

Notes:

[a/] From technical protocol (Wiedemeier *et al.*, 1996)

[b/] From laboratory analyses of site soil samples

[c/] K_d = Average Fraction Organic Carbon x K_{oc}

[d/] Estimated Value

TABLE 6.5
COMPOUND-SPECIFIC FIRST-ORDER DECAY COEFFICIENTS AND HALF-LIVES
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Chemical	Lambda[a/] (day^{-1})[b/]	Lambda ($year^{-1}$)	Site-Specific Half-Life[c/] (days)	Site-Specific Half-Life (years)	Literature Half-Life[d/] (years)
Benzene	0.0067	2.5	103	0.28	0.02 to 2
Toluene	0.017	6.4	40	0.11	0.02 to 0.17
Ethylbenzene	0.0059	2.2	117	0.32	0.016 to 0.62
Total Xylenes	0.0073	2.6	96	0.26	0.038 to 1
Total BTEX	0.0089	3.3	78	0.21	0.024 to 0.95

[a/] Lambda is the first-order decay coefficient

[b/] Lambda estimated using method of Buscheck and Alcantar (1996)

[c/] Half-life equals 0.693 divided by lambda

[d/] Literature half-life values from ASTM, 1995

TABLE 6.6
SUMMARY OF GROUNDWATER GEOCHEMICAL DATA
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Parameter	Units	MP-1 22-Mar-98	MP-2 22-Mar-98	MP-3 22-Mar-98	MW-01 22-Mar-98	MW-03 22-Mar-98	MW-05 22-Mar-98	MW-07 22-Mar-98	MW-03-97 22-Mar-98	MW-05-97 22-Mar-98	MW-08-97 22-Mar-98
Ferrous Iron	mg/L	6.45	2.75	1.60	0.09	1.47	11.95	0.41	0.15	0.36	0.14
Sulfate	mg/L	0.39	17.16	NM	24.37	20.39	0.00	0.19	30.77	34.23	37.55
Sulfide	mg/L	1.050	0.497	NM	0.024	0.547	0.048	0.780	0.048	0.039	0.037
Alkalinity	mg/L	107	59	10	26	67	365	41	36	6	7
Ammonia	mg/L	3	5	NM	0.3	2	7	1	0.6	1	1
Nitrate	mg/L	0.5 U	0.13 J	NM	0.15	0.13	0.16	0.5 U	NM	NM	0.13
Methane	mg/L	1.6	1.8	NM	0.017	1.2	4.3	0.42	NM	NM	0.018
Temperature	Deg C	18.1	20.3	18.2	19.4	18.7	20.8	20.7	19.1	19.3	20.3
pH	SU	6.76	6.24	6.05	6.59	6.50	7.01	6.54	6.77	4.78	6.83
Conductivity	mS/cm	273	236	520	149	236	703	165	188	143	164
Dissolved Oxygen	mg/L	0.16	0.20	0.49	1.20	0.25	0.21	0.16	0.64	0.44	0.32
ORP	mV	-277.3	-214.0	-141.1	22.2	NM	-179.3	-114.8	-72.0	5.6	17.0

Notes:

Natural yellow color may have interferred with sulfate analysis at MP-2 causing a high bias

Methane analysis performed by Quanterra Laboratories of Dallas, Texas

ORP = oxidation reduction potential

mg/L = milligrams per liter

Deg C = degrees Celcius

SU = Standard Units

mS/cm = microsiemens per centimeter

mV = millivolts

NM = not measured

TABLE 6.7
ESTIMATED ASSIMILATIVE CAPACITY OF
SATURATED SOIL AND GROUNDWATER
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Electron Acceptor or Metabolic Byproduct	Background Concentration (mg/L)[b/]	Concentration in Core of Plume (mg/L)	COPC Assimilative Capacity[a/] (mg/L)	Benzene Assimilative Capacity[a/] (mg/L)	Toluene Assimilative Capacity[a/] (mg/L)	Ethylbenzene Assimilative Capacity[a/] (mg/L)	Xylenes Assimilative Capacity[a/] (mg/L)	Naphthalene Assimilative Capacity[a/] (mg/L)	MTBE Assimilative Capacity[a/] (mg/L)
Oxygen	0.76	0.16	0.20	0.20	0.19	0.19	0.19	0.20	0.22
Ferrous Iron	NA[c/]	11.95	0.56	0.56	0.55	0.54	0.54	0.57	0.63
Sulfate	30.96	0.00	6.78	6.72	6.59	6.52	6.52	6.88	7.57
Ammonia[d/]	0.84	9.03	3.58	3.55	3.49	3.44	3.44	3.64	4.02
Methane	NA	4.30	5.66	5.58	5.51	5.44	5.44	5.73	6.32
	Total		16.78	16.60	16.32	16.14	16.14	17.02	18.76
	Max. 1997 and 1998 Concentration		23.52, 17.12						

[a/] Calculation based on the ratio of the total mass of electron acceptor required to oxidize a given mass of the COPC

[b/] mg/L = milligrams per liter

[c/] NA = not applicable

[d/] Concentration of ammonia = concentration of ammonia reported as N x 1.29 to convert to ammonia as NH_4

TABLE 6.8
MODELING MIGRATION FROM SUBSURFACE MEDIA TO AMBIENT AND INDOOR AIR
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Equations		Input Parameters	
Measured Vapor Phase in Soils	$C_{v,eq}$	Equilibrium vapor concentration (g/cm^3)	chemical-specific
$C_{v,eq}$ = Maximum measured soil gas concentration	H	Henry's law constant (dimensionless)	chemical-specific
	M_w	Molecular weight (g/mol)	chemical-specific
Effective Vapor Diffusion Coefficient	RT	Gas constant*temperature (cm^3-atm/mol)	2.44E+04
$D^{eff} = (\phi_a^{3.33}/\phi_T^{3.33})*D_{air} + (1/H)*(\phi_w^{3.33}/\phi_T^{3.33})*D_w$	ϕ_a	Volumetric content of pore vapor (dimensionless)	0.12
	ϕ_T	Total volumetric content in soil (dimensionless)	0.3
Maximum Vapor Flux to Open Space	D_{air}	Diffusion coefficient in air (cm^2-day)	chemical-specific
$F_{max} = R_v u_{v,max} C_{v,eq} - (R_v u_{v,max} C_{v,eq})/[1-\exp(R_v u_{v,max} d/D^{eff})]$	D_w	Diffusion coefficient in water (cm^2/day)	chemical-specific
	R_v	Porous media retardation (dimensionless)	k_s*p_s
Ambient Outdoor Concentration (g/cm^3)	$u_{v,max}$	Convective transport of vapors (cm/day)	100
$C_{outdoor} = F_{max} L/u_w \delta$	d	Distance below ground to source (cm)	30
	L	Downwind length of source area (cm)	2500
Maximum Vapor Flux to Enclosed Space	u_w	Wind speed (cm/day)	1.94E+07
$E_{max} = (D^{eff} C_{v,eq} \phi_a^{3.33})/(\phi_T^2 d)$	δ	Breathing height (cm)	1.89E+02
	A_{bldg}	Surface area of building (cm^2)	3.10E+06
Ambient Indoor Concentration (g/cm^3)	F_{crack}	Fraction of cracks in foundation (dimensionless)	0.01
$C_{indoor} = (E_{max} A_{bldg} F_{crack})/(Air_{exch} V_{bldg} MF)$	Air_{exch}	Air exchanges per day	36
	V_{bldg}	Volume of building (cm^3)	7.50E+08
	MF	Mixing factor (dimensionless)	0.5

Compound	H	M_w	D_{air}	D_w	Measured $C_{v,eq}$	$C_{outdoor}$ (mg/m^3)	C_{indoor} (mg/m^3)
Benzene	0.232	78	8.04E+03	0.95	7.80E-08	1.86E-03	2.17E-05

SECTION 7
TIER 2 ANALYSIS AND IDENTIFICATION OF FINAL CHEMICALS OF CONCERN

7.1 OBJECTIVE OF SITE-SPECIFIC EVALUATION

The Tier 1 analysis conducted in this CAP (Section 4) identified benzene, ethylbenzene, toluene, total xylenes, naphthalene, MTBE, lead, and TRPH as COPCs in groundwater and benzene as a COPC in soil gas. These analytes are evaluated in detail to better define/assess the potential adverse health effects they may cause in current or future human receptors.

The Tier 1 screening process is considered protective of human health because the Tier 1 risk-based screening criteria are based on conservative exposure assumptions. However, analytes identified as COPCs in Section 4 of this CAP (i.e., analytes with representative site concentrations exceeding Tier 1 TCLs) should not automatically be considered to be present at the BX Service Station at levels that pose unacceptable threats to human health given the current and future exposure potential at this site. Rather, the exceedences of the screening criteria indicated that further evaluation under more site-specific exposure scenarios is warranted.

In summary, the objectives of developing site-specific target levels (SSTLs) that include exposure assumptions more representative of actual site conditions are 1) to determine whether current or predicted future site concentrations of COPCs present an unacceptable risk to current and future receptors; and 2) to provide a mechanism or reference to assess the cost and time required to lower site concentrations to achieve adequate risk reduction at the site.

7.2 REVISED CONCEPTUAL SITE MODEL

The preliminary CSM presented in Section 4 was used to qualitatively identify potential human and ecological receptors that may be exposed to site-related contaminants, and to define the types of these potential exposures at or in the vicinity of the BX Service Station (Figure 4.1). The preliminary CSM describes onsite release points, the affected physical media, the types of contaminant transport and fate mechanisms that may be involved at the site, each group of potentially exposed populations or receptors, and how each receptor group could come into contact with site-related contamination. This CSM was used to identify which of the exposure assumptions used to develop generic cleanup criteria most closely approximate site conditions. The exposure assumptions incorporated into the generic industrial TCLs (i.e., Table IV Direct-Exposure II TCLs) were identified as generally representative of the types of exposure that could occur at the BX Service Station, but perhaps greatly overestimated the magnitude of exposure specific to current and expected future site conditions. For example, Tier 1 screening of groundwater assumed unrestricted future use of groundwater. Therefore, the target cleanup criteria presented in Table V (FDEP, 1997) which were developed assuming potable use of groundwater, were used in the Tier 1 screening. The preliminary CSM exposure pathways are reevaluated in this section using the Tier 2 chemical fate information presented in Section 6. It is important to emphasize that the purpose of using the preliminary CSM and the conservative, nonsite-specific TCLs to identify COPCs was to ensure that all subsequent assessment activities

beyond the Tier 1 screening evaluation address the full range of contaminants that may present some risk to current or future receptors.

The revised CSM for the BX Service Station, which is presented on Figure 7.1 and briefly reviewed in the following subsections, identifies only those receptors and exposure pathways that realistically may be involved in actual current or hypothetical future exposures. The outcome of the chemical fate assessment presented in Section 6 and the types of exposures likely to occur at this industrial site are reflected in this revised CSM. Justification for each site-specific exposure assumption is provided in subsequent discussions.

7.2.1 Sources, Affected Media, Release Mechanisms, and Contaminant Environmental Transport

The likelihood of release from a source, the nature of the contaminants involved, the affected environmental media, and the probable magnitude of their release all are included in the revised CSM (Figure 7.1). As described in the preliminary CSM (Figure 4.1), releases from the former gasoline USTs have contaminated site soil, soil gas, and groundwater with fuel hydrocarbons. The predominant ongoing release mechanism for groundwater COPCs is leaching from contaminated soils. The lack of mobile LNAPL (free product) detections at the site indicates that mobile LNAPL is not a significant, continuing source of groundwater contamination. Site data indicate that RNA is acting to limit migration of contaminants in concentrations above the TCLs. Therefore, future offsite migration of the contaminant plume is not anticipated to occur to a significant degree, and dissolved contaminants should not impact water supply wells (the closest water-supply well is located approximately 850 feet to the north [Section 3.7]) or downgradient surface water bodies.

7.2.2 Potentially Exposed Receptors, Exposure Points, and Exposure Routes

The revised CSM for the BX Service Station also refines the identification of potentially exposed receptor populations, receptor exposure points, and exposure routes for realistic scenarios based on specific site conditions. These components better reflect the likelihood and extent of human or ecological receptor contact with site-related contaminants. As described in Section 2, the BX Service Station is entirely within the boundaries of the Base. Therefore, potential receptor groups are currently limited to onsite workers and customers. There are currently no completed pathways to offsite receptors, and the fate and transport analyses presented in Section 6 indicate that pathways to offsite receptors will not be completed in the future. Furthermore, the asphalt/concrete cover over much of the site, the current lack of intrusive excavation activity at the site, and the lack of contamination in surface soils, prevents contact with contaminated soil or groundwater by current Base personnel and service station customers.

The industrial nature of the site, and the pavement covering much of the site, precludes the existence of suitable wildlife habitat. No resident ecological receptors were identified for which soils and/or groundwater are likely contaminant exposure media. No exposure pathways involving potential offsite ecological receptors are or will be complete based on the lack of significant offsite contaminant migration.

Using the most conservative exposure assumptions appropriate for the BX Service Station, the only realistic receptors that are likely to become exposed to site-related contaminants are the onsite intrusive worker involved in demolition, removal, and/or construction activities and the nonintrusive worker or service station customer. Inhalation of VOCs (partitioning from either contaminated soil or groundwater) in ambient air at the site could result in a completed pathway for the onsite intrusive worker or for aboveground workers and customers. As described in Section 6, rapid dilution by ambient air will decrease benzene concentrations to levels that are below the OSHA PEL; therefore, this pathway is assumed to be insignificant. Therefore, soil gas concentrations are not expected to pose a significant inhalation risk to aboveground or intrusive workers. However, there are potential risks to future construction workers posed by dermal contact with or incidental ingestion of contaminated soil or groundwater during excavation activities. Therefore, these exposure pathways may be completed in the future.

7.2.3 Summary of Exposure Pathway completion

Given the current and planned future uses of the BX Service Station and the outcome of the chemical fate assessment presented in Section 6, only onsite intrusive workers could be exposed to significant concentrations of site-related contamination in soils and groundwater during excavation activities. Therefore, health-based Tier 2 SSTLs developed for the BX Service Station are those designed to protect hypothetical future onsite intrusive workers from carcinogenic risks and noncarcinogenic hazards via direct contact with or incidental ingestion of soil and groundwater.

7.3 TIER II ANALYSIS FOR SOIL

Table 7.1 presents the chemical-specific soil SSTLs for the BX Service Station. The mdl for benzene in soils exceeded the Tier 1 TCL in at least one sample; therefore, this analyte could not be eliminated from further consideration as a COPC. Note that two sets of SSTLs are presented; a reasonable maximum exposure (RME) and a central tendency (CT). The RME SSTLs are designed to illustrate the residual concentration that can persist in onsite soil given "high-end" (reasonable maximum) exposure potential, whereas the CT SSTLs better illustrate the residual concentration that can persist in onsite soil given mean or average exposure potential. The CT SSTLs are presented for comparative purposes only to provide a less-than-maximum-exposure perspective. RME and CT exposure assumptions are presented on Tables 7.2 and 7.3, respectively.

The construction worker exposure assumptions used to derive the SSTLs were developed for use at Eglin AFB, Florida (McLain, 1998), and have been reviewed and accepted by the FDEP. The exposure pathways incorporated in the SSTLs include dermal exposure, incidental ingestion, and inhalation. COPC toxicity values used in the SSTL derivations are based on toxicity data reported in the Integrated Risk Information System (IRIS) (Micromedex, Inc., 1998) or used by the FDEP to derive the generic Tier 1 target cleanup levels.

As shown in Table 4.1, the maximum mdl for benzene in soils was 2.4 mg/kg, which is the maximum possible soil benzene concentration present in a site soil sample. As shown on Table 7.1, the SSTL for benzene in soils is calculated to be 35.8 mg/kg, indicating that this compound does not pose an appreciable risk to future potential receptors under reasonable site-specific construction worker exposure scenarios.

7.4 TIER II ANALYSIS FOR GROUNDWATER

Table 7.4 presents the chemical-specific groundwater SSTLs for the BX Service Station. As with the soil Tier II analysis, the RME and CT analyses are presented. The groundwater SSTLs are health-based values calculated to protect onsite intrusive workers from health risks associated with exposure to chemical contamination in groundwater. As stated earlier, the generic health-based TCLs are calculated assuming purposeful ingestion of onsite groundwater by onsite workers under residential-type exposure conditions (i.e., 30-year exposure duration, 2 liters per day consumption rate, etc.). In reality, these TCLs would apply only if impacted groundwater from the BX Service Station migrated to offsite locations where a residential land use assumption is more representative of exposure conditions. The groundwater quality data collected at the site since 1995, and the Tier 2 quantitative chemical fate assessment completed in Section 6, demonstrate that no groundwater COPC is expected to migrate to an offsite receptor location.

Tables 7.5 and 7.6 present the exposure assumptions for the RME and CT analyses, respectively. As described in Section 7.3, the construction worker exposure assumptions derived for use at Eglin AFB (McLain, 1998) were used to compute the SSTLs. The exposure pathways incorporated into the groundwater SSTLs are the same as those described for soil in Section 7.3. The approach used to incorporate the inhalation pathway in the SSTL calculations was derived by toxicologists at the University of Florida for a similar site at Homestead AFB, Florida (University of Florida, 1998).

Based on the data presented in Table 7.4, only benzene dissolved in groundwater slightly exceeds its Tier II SSTL. TRPH and total lead SSTLs for groundwater were not calculated because sufficient toxicity data were not available. Total lead is addressed in Section 7.5. Benzene was detected at concentrations above the SSTL of 2,980 µg/L only at monitoring point MP-2 in March 1998. This monitoring point is located immediately downgradient (northwest) from the former tank pit. It should be noted that the benzene concentration in the field duplicate sample was 3,100 µg/L (Table 5.3). Site data indicates that the areal extent of groundwater containing benzene concentrations in excess of the SSTLs is limited to the immediate vicinity of MP-2 (Figure 5.1).

7.5 LEAD IN GROUNDWATER AND SOIL

Given that the maximum detected concentration of lead in groundwater (62 ug/L) exceeded the Tier I TCL of 15 ug/L, it was retained for Tier II analysis. However, unlike the other COPCs, there is insufficient toxicity data available to compute a Tier II SSTL for lead. Therefore, it was evaluated for potential effects on the future residential child receptor using the EPA Integrated Exposure Uptake Biokinetic (IEUBK) model (EPA, 1994c). The IEUBK model provides an estimate of potential blood lead levels in residential children associated with exposure to all site media. The use of residential children as the receptor group makes this model very conservative since, as discussed in Section 7.2, the only potential receptor group is currently limited to onsite intrusive workers. The model was evaluated using the mean lead concentration in groundwater [the 95 percent upper confidence limit on the arithmetic mean (12.3 ug/L) was derived to provide a conservative assessment of potential risk]. Given that the maximum detected concentration of lead in soils (23 mg/kg) did not exceed the Tier I TCL of 1,000 mg/kg,

the maximum soil concentration was used in the evaluation to provide a conservative assessment of potential risk.

Per USEPA (1994c) guidance, the probability of an individual in a population having a blood lead level exceeding 10 micrograms per deciliter (ug/dL) should be less than 5 percent. The results of the IEUBK lead model for the BX Service Station indicate that an individual in a population would have only a 0.12% chance of exceeding a blood lead level of 10 ug/dL. This percentage falls below the criteria of 5%, therefore, the impacts of lead in site media on potential future residents are not considered to be significant. The geometric mean blood lead level derived for the population was 2.4 ug/dL, which is well below the level of 10 ug/dL. The input and output of the IEUBK model estimate are provided in Appendix G.

7.6 SUMMARY OF RISK-REDUCTION REQUIREMENTS

Soil contaminant concentrations did not exceed health-protective Tier 2 SSTLs, and soil vapor modeling results (Section 6) indicate that contaminant concentrations in soil gas should not pose a significant risk to potential receptors. Comparison of maximum detected COPC concentrations in groundwater to SSTLs indicate that dissolved benzene at a single location (MP-2) exceeded the RME SSTL. Data collected on destructive and nondestructive attenuation at the site indicate that elevated concentrations of groundwater contaminants are not migrating off-site, and are being reduced over time by natural attenuation processes. Consequently, implementation of engineered remediation to reduce dissolved contaminant concentrations in groundwater is not required to protect human receptors and underlying groundwater quality, given the types of exposure likely to occur at this site. However, engineering controls that eliminate excavation below the water table or that require ambient air monitoring and the use of appropriate personal protective equipment should excavation be required near MP-2 should be implemented to prevent exposure of intrusive workers to site-related benzene concentrations that exceed the benzene SSTL. These administrative controls would need to be in place and enforced until maximum benzene concentrations in groundwater decrease to below the Tier 2 SSTL of 2,980 µg/L (estimated to occur in 2 to 3 years [year 2000]) (Appendix F). After all SSTLs are met, excavations that intercept the water table could proceed, however, worker protection and ambient air monitoring are still recommended.

Fate and transport modeling results presented in Section 6 indicate that residual concentrations of groundwater COPCs above Tier 1 TCLs (the long-term cleanup goals) may persist for up to seventy years unless engineered source reduction is implemented at the site. Although seventy years is a conservative estimate, long-term monitoring/ site management may not be a reasonable option. Therefore, Section 8 describes candidate source removal technologies that could be used to achieve Tier 1 TCLs within a reasonable time frame.

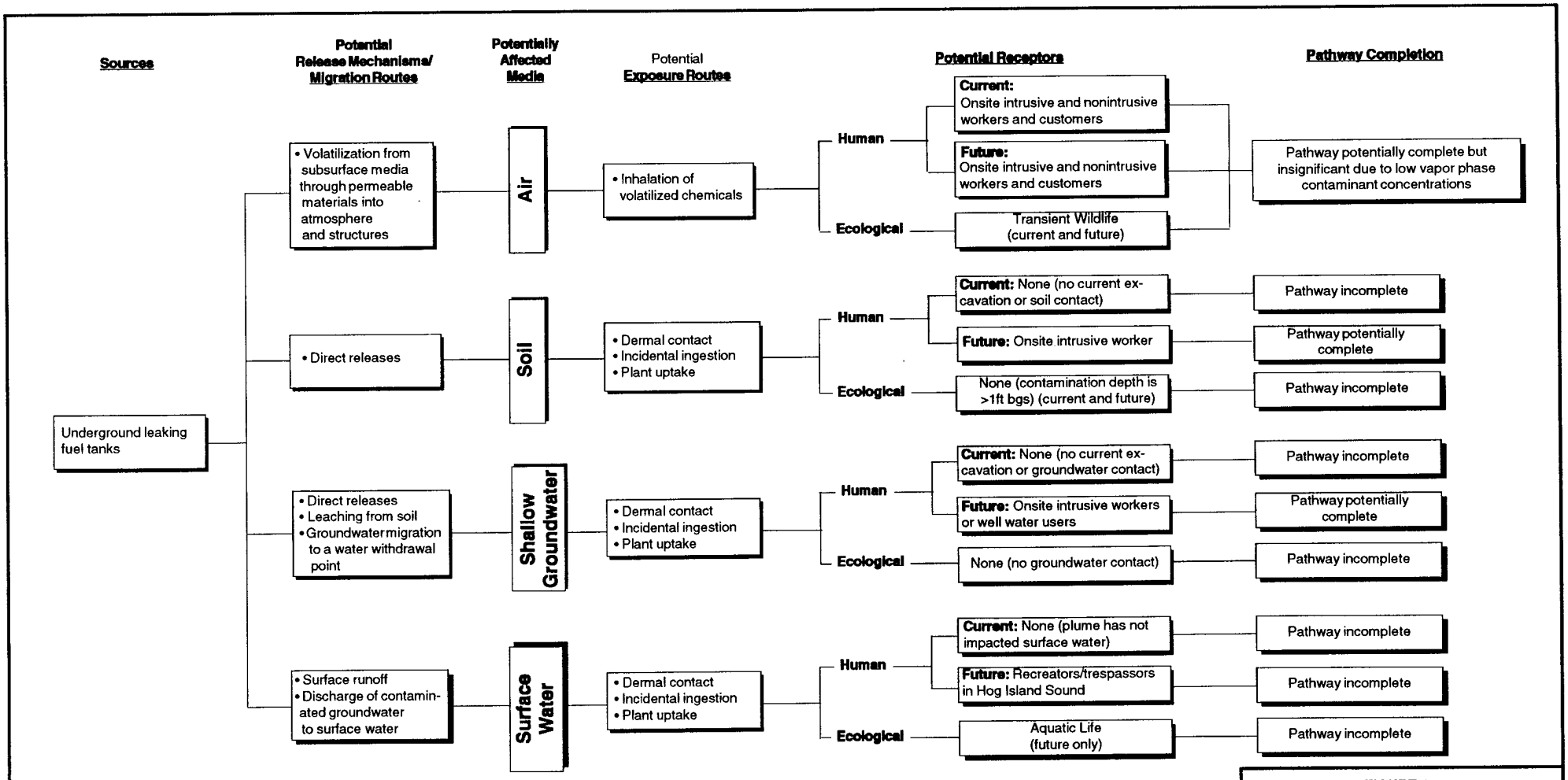


FIGURE 7.1

REVISED CONCEPTUAL SITE MODEL

Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

PARSONS ENGINEERING SCIENCE, INC.
Atlanta, Georgia

j:\731854\tyndall\bx-csm3.pm65

TABLE 7.1
COMPARISON OF MAXIMUM SOIL DETECTIONS TO SITE-SPECIFIC TARGET LEVELS (SSTLs)
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Chemical of Potential Concern	Units	Detected Site Maximum Concentration[a/]	Tier 2 Health-Based SSTL		Does Detected Site Maximum Concentration Exceed SSTL?	
			RME	CT	RME	CT
Benzene	mg/kg [b/]	2.40E+00	3.58E+01	6.32E+02	No	No

[a/] Maximum detection at BX Service Station

[b/] mg/L = milligrams per kilogram

TABLE 7.2
CALCULATION OF SITE-SPECIFIC TARGET LEVELS (SSTLs) - SOIL
INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO
RME SCENARIO
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Exposure Assumptions		
Body Weight(BW)	70	kg
Exposure Frequency (EF)	180	days/yr
Exposure Duration (ED)	1	yr
Fraction Ingested (FI)	1	unitless
Ingestion Rate (IR)	480	mg/day
Surface Area (SA)	5300	cm^2
Adherence Factor (AF)	1	mg/cm^2-day
Dermal Absorption Factor (DABS)	0.01	unitless
Volatilization Factor (VF)	chem-specific	m^3/kg
Particulate Emission Factor (PEF)	1.24E+09	m^3/kg
Conversion Factor (CF)	1.00E-06	kg/mg
Averaging Time (AT)		
Noncarcinogens	365	days
Carcinogens	25550	days
Inhalation Rate (IRi)	20	m^3/day
Target Risk Level (TR)	1.00E-06	unitless
Target Hazard Quotient (THQ)	1	unitless

Toxicity Value Definitions

RfDo = Reference Dose (Oral)	mg/kg-day
RfDd = Reference Dose (Dermal)	mg/kg-day
RfDi = Reference Dose (Inhalation)	mg/kg-day
SFo = Oral Slope Factor	kg-day/mg
SFd = Dermal Slope Factor	kg-day/mg
SFi = Inhalation Slope Factor	kg-day/mg
SSTL-non = Noncarcinogenic PRG	mg/kg
SSTL-car = Carcinogenic PRG	mg/kg

SSTL Calculations

Noncarcinogens

SSTL (mg/kg) = ((THQ*BW*AT)/((1/RfDo*CF*EF*ED*IR*FI)+
(1/RfDd*CF*SA*AF*DABS*EF*ED)+(1/RfDi*IRi*EF*ED*(1/VF+1/PEF)))

Carcinogens

SSTL (mg/kg) = ((TR*BW*AT)/((SFo*CF*EF*IR*FI*ED)+
(SFd*CF*SA*AF*DABS*EF*ED)+(SFi*IRi*EF*ED*(1/VF+1/PEF)))

Chemical of Potential Concern	Carcinogen Classification [a/]	VF [b/]	RfDo [c/]	OABS [c/]	RfDd [c/]	RfDi [c/]	SFo [c/]	SFd [c/]	SFi [c/]	SSTL-non (mg/kg)	SSTL-car (mg/kg)
Volatiles											
Benzene	A	3.11E+03	3.00E-03	9.00E-01	2.70E-03	1.70E-03	2.90E-02	3.22E-02	2.90E-02	3.58E+01	4.92E+01

[a/] USEPA classification system for carcinogens: A = human carcinogen

[b/] Volatilization factors taken from Table 3a of *Technical Report: Development of Soil Cleanup Target Levels (SCTLs) for Chapter 62-770, F.A.C.* (FDEP, 1997).

[c/] Toxicity values taken from Tables 4a and 4b of *Technical Report: Development of Soil Cleanup Target Levels (SCTLs) for Chapter 62-770, F.A.C.* (FDEP, 1997).

TABLE 7.3
CALCULATION OF SITE-SPECIFIC TARGET LEVELS (SSTLs) - SOIL
INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO
CT SCENARIO
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Exposure Assumptions		
Body Weight(BW)	70	kg
Exposure Frequency (EF)	60	days/yr
Exposure Duration (ED)	1	yr
Fraction Ingested (FI)	1	unitless
Ingestion Rate (IR)	200	mg/day
Surface Area (SA)	3160	cm^2
Adherence Factor (AF)	0.2	mg/cm^2-day
Dermal Absorption Factor (DABS)	0.01	unitless
Volatilization Factor (VF)	chem-specific	m^3/kg
Particulate Emission Factor (PEF)	1.24E+09	m^3/kg
Conversion Factor (CF)	1.00E-06	kg/mg
Averaging Time (AT)		
Noncarcinogens	365	days
Carcinogens	25550	days
Inhalation Rate (IRi)	3.2	m^3/day
Target Risk Level (TR)	1.00E-06	unitless
Target Hazard Quotient (THQ)	1	unitless

Toxicity Value Definitions

RfDo = Reference Dose (Oral)	mg/kg-day
RfDd = Reference Dose (Dermal)	mg/kg-day
RfDi = Reference Dose (Inhalation)	mg/kg-day
SFo = Oral Slope Factor	kg-day/mg
SFd = Dermal Slope Factor	kg-day/mg
SFi = Inhalation Slope Factor	kg-day/mg
SSTL-non = Noncarcinogenic PRG	mg/kg
SSTL-car = Carcinogenic PRG	mg/kg

SSTL Calculations

Noncarcinogens

SSTL (mg/kg) = ((THQ*BW*AT)/((1/RfDo*CF*EF*ED*IR*FI)+
(1/RfDd*CF*SA*AF*DABS*EF*ED)+(1/RfDi*IRi*EF*ED*(1/VF+1/PEF)))

Carcinogens

SSTL (mg/kg) = ((TR*BW*AT)/((SFo*CF*EF*IR*FI*ED)+
(SFd*CF*SA*AF*DABS*EF*ED)+(SFi*IRi*EF*ED*(1/VF+1/PEF)))

Chemical of Potential Concern	Carcinogen Classification [a/]	VF [b/]	RfDo [c/]	OABS [c/]	RfDd [c/]	RfDi [c/]	SFo [c/]	SFd [c/]	SFi [c/]	SSTL-non (mg/kg)	SSTL-car (mg/kg)
Volatiles											
Benzene	A	3.11E+03	3.00E-03	9.00E-01	2.70E-03	1.70E-03	2.90E-02	3.22E-02	2.90E-02	6.32E+02	8.32E+02

[a/] USEPA classification system for carcinogens: A = human carcinogen

[b/] Volatilization factors taken from Table 3a of *Technical Report: Development of Soil Cleanup Target Levels (SCTLs) for Chapter 62-770, F.A.C.* (FDEP, 1997).

[c/] Toxicity values taken from Tables 4a and 4b of *Technical Report: Development of Soil Cleanup Target Levels (SCTLs) for Chapter 62-770, F.A.C.* (FDEP, 1997).

TABLE 7.4
COMPARISON OF MAXIMUM GROUNDWATER DETECTION TO SITE-SPECIFIC TARGET LEVELS (SSTLs)
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Chemical of Potential Concern	Units	Detected Site Maximum Concentration[a/]	Tier 2 Health-Based SSTL		Does Detected Site Maximum Concentration Exceed SSTL?	
			RME	CT	RME	CT
Benzene	µg/L [b/]	3.40E+03	2.98E+03	3.06E+04	Yes	No
Ethylbenzene	µg/L	1.40E+03	5.33E+04	5.91E+05	No	No
MTBE	µg/L	1.30E+03	4.18E+04	4.72E+05	No	No
Toluene	µg/L	5.00E+03	1.26E+05	1.34E+06	No	No
Xylenes	µg/L	1.60E+04	1.16E+06	1.30E+07	No	No
Naphthalene	µg/L	3.20E+02	2.60E+04	2.85E+05	No	No
TRPH [c/]	mg/L [d/]	4.10E+01	-- [e/]	--	--	--
Total Lead	µg/L	6.20E+00	--	--	--	--

[a/] Maximum detection at BX Service Station
[b/] ug/L = micrograms per liter
[c/] TRPH = total recoverable petroleum hydrocarbon
[d/] mg/L = milligrams per liter
[e/] SSTL could not be calculated

TABLE 7.5
CALCULATION OF SITE-SPECIFIC TARGET LEVELS (SSTLs) - GROUNDWATER
INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO
RME SCENARIO
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Exposure Assumptions		
Body Weight (BW)	70	kg
Exposure Frequency (EF)	46	days/yr
Exposure Duration (ED)	1	yr
Ingestion Rate (IR)	0.005	L/hr
Conversion Factor (CF)	0.001	L/cm^3
Exposure Time Dermal(ET_D)	2	hr/day
Permeability Constant (PC)	chem-specifi	cm/hr
Surface Area (SA)	5300	cm^2
Oral Absorption Factor (OABS)	chem-specifi	unitless
Exposure Time Inhalation (ET_I)	8	hrs/day
Inhalation Rate (InhR)	2.5	m^3/hr
Area of Trench (A)	300000	cm^2
Length of Side Perpendicular to Wind (LS)	15	m
Average Wind Speed (V)	4.47	m/sec
Mixing Height Above Water (MH)	2	m
Molecular Weight (MW)	chem-specifi	g/mol
Henry's Law Constant (HLC)	chem-specifi	atm m^3/mol
Averaging Time (AT)		
Noncarcinogens	365	days
Carcinogens	25550	days
Target Risk Level (TR)	1.00E-06	unitless
Target Hazard Quotient (THQ)	1	unitless

Toxicity Value Definitions

RfDo = Reference Dose (Oral)	mg/kg-day
RfDd = Reference Dose (Dermal)	mg/kg-day
RfDi = Reference Dose (Inhalation)	mg/kg-day
SFo = Oral Slope Factor	kg-day/mg
SFd = Dermal Slope Factor	kg-day/mg
SFi = Inhalation Slope Factor	kg-day/mg
SSTL-non = Noncarcinogenic SSTL	mg/L
SSTL-car = Carcinogenic SSTL	mg/L

Mass Transfer Coefficient (K) (cm/s) chem-specific

$$1/K = 1/K(l) + [(8.2E\text{-}5(atm\ m^3/mol\ ^oK)*298^oK)/(HCL*K(g))]$$

Liquid Mass Transfer Coefficient (K(l)) (cm/s) chem-specific

$$K(l) = ([32(g/mol)/MW]^{0.5})*0.0061(cm/sec)$$

Gas Mass Transfer Coefficient (K(g)) (cm/s) chem-specific

$$K(g) = ([18(g/mol)/MW]^{0.335})*1.39(cm/sec)$$

Noncarcinogens

SSTL (mg/L) = (THQ*BW*AT)/[ED*EF([1/RfDo*IR*ET]+[1/RfDd*SA*PC*ET*CF]+ [(ET*InhR*CF*K*A)/(RfDi*LS*V*MH)])]

Carcinogens

SSTL (mg/L) = (TR*BW*AT)/[ED*EF([SFo*IR*ET]+[SFd*SA*PC*ET*CF]+ [(SFi*ET*InhR*CF*K*A)/(LS*V*MH)])]

Chemical Name	MW	HLC [a/]	PC [b/]	OABS [c/]	RfDo [d/]	RfDd	RfDi	SFo	SFd	SFi	K(g)	K(l)	K	SSTL Carcinogen mg/L	SSTL Non-Carc. mg/L
Volatiles															
Benzene	78.11	5.60E-03	2.10E-02	9.00E-01	3.00E-03	2.70E-03	1.70E-03	2.90E-02	3.22E-02	2.90E-02	8.50E-01	3.90E-03	3.83E-03	3.10E+00	2.98E+00
Ethylbenzene	106.17	7.90E-03	7.40E-02	8.00E-01	1.00E-01	8.00E-02	2.90E-01	-- [e/]	--	--	7.67E-01	3.35E-03	3.30E-03	--	5.33E+01
MTBE	88.15	5.87E-04	4.20E-03	8.00E-01	5.00E-03	4.00E-03	8.60E-01	--	--	--	8.16E-01	3.68E-03	3.10E-03	--	4.18E+01
Toluene	92.14	6.60E-03	4.50E-02	8.00E-01	2.00E-01	1.60E-01	1.14E-01	--	--	--	8.04E-01	3.59E-03	3.54E-03	--	1.26E+02
Xylene	106.17	6.70E-03	8.00E-02	8.95E-01	2.00E+00	1.79E+00	1.80E+00	--	--	--	7.67E-01	3.35E-03	3.30E-03	--	1.16E+03

TABLE 7.5 (Continued)
CALCULATION OF SITE-SPECIFIC TARGET LEVELS (SSTLs) - GROUNDWATER
INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO
RME SCENARIO
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Exposure Assumptions		
Body Weight (BW)	70	kg
Exposure Frequency (EF)	46	days/yr
Exposure Duration (ED)	1	yr
Ingestion Rate (IR)	0.005	L/hr
Conversion Factor (CF)	0.001	L/cm^3
Exposure Time Dermal(ET_D)	2	hr/day
Permeability Constant (PC)	chem-specific	cm/hr
Surface Area (SA)	5300	cm^2
Oral Absorption Factor (OABS)	chem-specific	unitless
Exposure Time Inhalation (ET_I)	8	hrs/day
Inhalation Rate (InhR)	2.5	m^3/hr
Area of Trench (A)	300000	cm^2
Length of Side Perpendicular to Wind (LS)	15	m
Average Wind Speed (V)	4.47	m/sec
Mixing Height Above Water (MH)	2	m
Molecular Weight (MW)	chem-specific	g/mol
Henry's Law Constant (HLC)	chem-specific	atm m^3/mol
Averaging Time (AT)		
Noncarcinogens	365	days
Carcinogens	25550	days
Target Risk Level (TR)	1.00E-06	unitless
Target Hazard Quotient (THQ)	1	unitless

Toxicity Value Definitions

RfDo = Reference Dose (Oral) mg/kg-day
RfDd = Reference Dose (Dermal) mg/kg-day
RfDi = Reference Dose (Inhalation) mg/kg-day
SFo = Oral Slope Factor kg-day/mg
SFd = Dermal Slope Factor kg-day/mg
SFi = Inhalation Slope Factor kg-day/mg
SSTL-non = Noncarcinogenic SSTL mg/L
SSTL-car = Carcinogenic SSTL mg/L

Mass Transfer Coefficient (K) (cm/s) chem-specific

$1/K = 1/K(l) + [(8.2E\text{-}5(atm\ m^3/mol\ ^oK)*298^oK)/(HCL*K(g))]$

Liquid Mass Transfer Coefficient (K(l)) (cm/s) chem-specific

K(l) = ([32(g/mol)/MW]^0.5)*0.0061(cm/sec)

Gas Mass Transfer Coefficient (K(g)) (cm/s) chem-specific

K(g) = ([18(g/mol)/MW]^0.335)*1.39(cm/sec)

Noncarcinogens

SSTL (mg/L) = (THQ*BW*AT)/[ED*EF([1/RfDo*IR*ET]+[1/RfDd*SA*PC*ET*CF]+ [(ET*InhR*CF*K*A)/(RfDi*LS*V*MH)])]

Carcinogens

SSTL (mg/L) = (TR*BW*AT)/[ED*EF([SFo*IR*ET]+[SFd*SA*PC*ET*CF]+ [(SFi*ET*InhR*CF*K*A)/(LS*V*MH)])]

Chemical Name	MW	HLC [a/]	PC [b/]	OABS [c/]	RfDo [d/]	RfDd	RfDi	SFo	SFd	SFi	K(g)	K(l)	K	SSTL Carcinogen mg/L	SSTL Non-Carc. mg/L
PAHs															
Naphthalene	128.18	4.80E-04	6.90E-02	1.00E+00	4.00E-02	4.00E-02	4.00E-02	--	--	--	7.20E-01	3.05E-03	2.51E-03	--	2.60E+01

a/ Henry's Law Constants taken from Table 3a of Technical Report: Development of Soil Cleanup Target Levels (SCTLs) for Chapter 62-770, F.A.C. (FDEP, 1997).
b/ Permeability constants taken from or calculated per Dermal Exposure Assessment: Principles and Application (USEPA, 1992).
c/ The oral absorption values were taken from Tables 4a and 4b of Technical Report: Development of Soil Cleanup Target Levels (SCTLs) for Chapter 62-770, F.A.C. (FDEP, 1997).
d/ Toxicity values taken from Tables 4a and 4b of Technical Report: Development of Soil Cleanup Target Levels (SCTLs) for Chapter 62-770, F.A.C. (FDEP, 1997).
e/ "--" indicates that no toxicity data is available.

TABLE 7.6
CALCULATION OF SITE-SPECIFIC TARGET LEVELS (SSTLs) - GROUNDWATER
INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO
CT SCENARIO
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Exposure Assumptions		
Body Weight (BW)	70	kg
Exposure Frequency (EF)	15	days/yr
Exposure Duration (ED)	1	yr
Ingestion Rate (IR)	0.0025	L/hr
Conversion Factor (CF)	0.001	L/cm^3
Exposure Time Dermal(ET_D)	1	hr/day
Permeability Constant (PC)	chem-specifi	cm/hr
Surface Area (SA)	2910	cm^2
Oral Absorption Factor (OABS)	chem-specifi	unitless
Exposure Time Inhalation (ET_I)	8	hrs/day
Inhalation Rate (InhR)	0.8	m3/hr
Area of Trench (A)	300000	cm^2
Length of Side Perpendicular to Wind (LS)	15	m
Average Wind Speed (V)	4.47	m/sec
Mixing Height Above Water (MH)	2	m
Molecular Weight (MW)	chem-specifi	g/mol
Henry's Law Constant (HLC)	chem-specifi	atm m^3/mol
Averaging Time (AT)		
Noncarcinogens	365	days
Carcinogens	25550	days
Target Risk Level (TR)	1.00E-06	unitless
Target Hazard Quotient (THQ)	1	unitless

Toxicity Value Definitions

RfDo = Reference Dose (Oral)	mg/kg-day
RfDd = Reference Dose (Dermal)	mg/kg-day
RfDi = Reference Dose (Inhalation)	mg/kg-day
SFo = Oral Slope Factor	kg-day/mg
SFd = Dermal Slope Factor	kg-day/mg
SFi = Inhalation Slope Factor	kg-day/mg
SSTL-non = Noncarcinogenic SSTL	mg/L
SSTL-car = Carcinogenic SSTL	mg/L

Mass Transfer Coefficient (K) (cm/s) chem-specific

$$1/K = 1/K(l) + [(8.2E\text{-}5(\text{atm } m^3/\text{mol } {}^\circ K)*298^\circ K)/(HCL*K(g))]$$

Liquid Mass Transfer Coefficient (K(l)) (cm/s) chem-specific

$$K(l) = ([32(g/mol)/MW]^{0.5})*0.0061(cm/sec)$$

Gas Mass Transfer Coefficient (K(g)) (cm/s) chem-specific

$$K(g) = ([18(g/mol)/MW]^{0.335})*1.39(cm/sec)$$

Noncarcinogens

SSTL (mg/L) = (THQ*BW*AT)/[ED*EF([1/RfDo*IR*ET]+[1/RfDd*SA*PC*ET*CF]+ [(ET*InhR*CF*K*A)/(RfDi*LS*V*MH)])]

Carcinogens

SSTL (mg/L) = (TR*BW*AT)/[ED*EF([SFo*IR*ET]+[SFd*SA*PC*ET*CF]+ [(SFi*ET*InhR*CF*K*A)/(LS*V*MH)])]

Chemical Name	MW	HLC [a/]	PC [b/]	OABS [c/]	RfDo [d/]	RfDd	RfDi	SFo	SFd	SFi	K(g)	K(l)	K	SSTL Carcinogen mg/L	SSTL Non-Carc. mg/L
Volatiles															
Benzene	78.11	5.60E-03	2.10E-02	9.00E-01	3.00E-03	2.70E-03	1.70E-03	2.90E-02	3.22E-02	2.90E-02	8.50E-01	3.90E-03	3.83E-03	3.26E+01	3.06E+01
Ethylbenzene	106.17	7.90E-03	7.40E-02	8.00E-01	1.00E-01	8.00E-02	2.90E-01	-- [e/]	--	--	7.67E-01	3.35E-03	3.30E-03	--	5.91E+02
MTBE	88.15	5.87E-04	4.20E-03	8.00E-01	5.00E-03	4.00E-03	8.60E-01	--	--	--	8.16E-01	3.68E-03	3.10E-03	--	4.72E+02
Toluene	92.14	6.60E-03	4.50E-02	8.00E-01	2.00E-01	1.60E-01	1.14E-01	--	--	--	8.04E-01	3.59E-03	3.54E-03	--	1.34E+03
Xylene	106.17	6.70E-03	8.00E-02	8.95E-01	2.00E+00	1.79E+00	1.80E+00	--	--	--	7.67E-01	3.35E-03	3.30E-03	--	1.30E+04

TABLE 7.6 (Continued)
CALCULATION OF SITE-SPECIFIC TARGET LEVELS (SSTLs) - GROUNDWATER
INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO
CT SCENARIO
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Exposure Assumptions		
Body Weight (BW)	70	kg
Exposure Frequency (EF)	15	days/yr
Exposure Duration (ED)	1	yr
Ingestion Rate (IR)	0.0025	L/hr
Conversion Factor (CF)	0.001	L/cm^3
Exposure Time Dermal(ET_D)	1	hr/day
Permeability Constant (PC)	chem-specific	cm/hr
Surface Area (SA)	2910	cm^2
Oral Absorption Factor (OABS)	chem-specific	unitless
Exposure Time Inhalation (ET_I)	8	hrs/day
Inhalation Rate (InhR)	0.8	m3/hr
Area of Trench (A)	**300000**	cm^2
Length of Side Perpendicular to Wind (LS)	15	m
Average Wind Speed (V)	4.47	m/sec
Mixing Height Above Water (MH)	2	m
Molecular Weight (MW)	chem-specific	**g/mol**
Henry's Law Constant (HLC)	chem-specific	**atm m^3/mol**
Averaging Time (AT)		
Noncarcinogens	365	days
Carcinogens	25550	days
Target Risk Level (TR)	1.00E-06	unitless
Target Hazard Quotient (THQ)	1	unitless

Toxicity Value Definitions

RfDo = Reference Dose (Oral)	mg/kg-day
RfDd = Reference Dose (Dermal)	mg/kg-day
RfDi = Reference Dose (Inhalation)	mg/kg-day
SFo = Oral Slope Factor	kg-day/mg
SFd = Dermal Slope Factor	kg-day/mg
SFi = Inhalation Slope Factor	kg-day/mg
SSTL-non = Noncarcinogenic SSTL	mg/L
SSTL-car = Carcinogenic SSTL	mg/L

Mass Transfer Coefficient (K) (cm/s) chem-specific

$$1/K = 1/K(l) + [(8.2E\text{-}5(atm\ m^3/mol\ ^oK)*298^oK)/(HCL*K(g))]$$

Liquid Mass Transfer Coefficient (K(l)) (cm/s) chem-specific

$$K(l) = ([32(g/mol)/MW]^{0.5})*0.0061(cm/sec)$$

Gas Mass Transfer Coefficient (K(g)) (cm/s) chem-specific

$$K(g) = ([18(g/mol)/MW]^{0.335})*1.39(cm/sec)$$

Noncarcinogens

SSTL (mg/L) = (THQ*BW*AT)/[ED*EF([1/RfDo*IR*ET]+[1/RfDd*SA*PC*ET*CF]+ [(ET*InhR*CF*K*A)/(RfDi*LS*V*MH)])]

Carcinogens

SSTL (mg/L) = (TR*BW*AT)/[ED*EF([SFo*IR*ET]+[SFd*SA*PC*ET*CF]+ [(SFi*ET*InhR*CF*K*A)/(LS*V*MH)])]

Chemical Name	MW	HLC [a/]	PC [b/]	OABS [c/]	RfDo [d/]	RfDd	RfDi	SFo	SFd	SFi	K(g)	K(l)	K	SSTL Carcinogen mg/L	SSTL Non-Carc. mg/L
PAHs															
Naphthalene	128.18	4.80E-04	6.90E-02	1.00E+00	4.00E-02	4.00E-02	4.00E-02	--	--	--	7.20E-01	3.05E-03	2.51E-03	--	2.85E+02

a/ Henry's Law Constants taken from Table 3a of Technical Report: Development of Soil Cleanup Target Levels (SCTLs) for Chapter 62-770, F.A.C. (FDEP, 1997).
b/ Permeability constants taken from or calculated per Dermal Exposure Assessment: Principles and Application (USEPA, 1992).
c/ The oral absorption values were taken from Tables 4a and 4b of Technical Report: Development of Soil Cleanup Target Levels (SCTLs) for Chapter 62-770, F.A.C. (FDEP, 1997).
d/ Toxicity values taken from Tables 4a and 4b of Technical Report: Development of Soil Cleanup Target Levels (SCTLs) for Chapter 62-770, F.A.C. (FDEP, 1997).
e/ "--" indicates that no toxicity data is available.

SECTION 8
REMEDIAL ALTERNATIVES EVALUATION

As described in Section 7, benzene was detected in groundwater at monitoring point MP-2 at a concentration that exceeded its matrix-specific Tier 2 SSTL. Fate and transport modeling results presented in Section 6 suggest that maximum dissolved benzene concentrations should decrease below the Tier 2 SSTL for benzene within approximately 3 years. However, the modeling results also indicate that residual concentrations of groundwater COPCs above Tier 1 TCLs are expected to persist for forty to eighty years unless some type of active source removal is implemented at the site. Two potential remedial alternatives are described in this section. Alternative 1 consists of RNA with institutional controls and long-term monitoring (LTM). Alternative 2 consists of all of the elements of Alternative 1, plus *in situ* biosparging and SVE.

8.1 REMEDIAL ALTERNATIVE 1 – RNA WITH INSTITUTIONAL CONTROLS AND LTM

Land and groundwater use restrictions are considered necessary components of any corrective action at this site to ensure that the exposure assumptions used to develop the Tier 2 SSTLs are representative of site exposure conditions. Maintaining the light industrial land use at this site, and barring unrestricted access to use of groundwater are consistent with the planned near-term use of this site. Limitations on groundwater use (i.e., groundwater cannot be used as a potable drinking water source until Tier 1 TCLs have been uniformly achieved throughout the site) will not impose additional restrictions on the current or planned new-term future use of this site.

Groundwater monitoring also should be implemented to track the progress of both natural and engineered remediation and to verify that no unacceptable receptor exposures could occur while remediation is in progress. The Bioscreen model results presented in Section 6 indicate that groundwater contaminant concentrations may not uniformly decrease below Tier 1 TCLs for 70 years. The present worth cost of 70 years of LTM at the site is estimated to be approximately $214,000. An annual adjustment factor of 7 percent was assumed in present-worth calculations. The annual adjustment factor is the difference between the rate of inflation and the cost of money (USEPA, 1988). Cost calculations are contained in Appendix H. This cost assumes that 8 wells are sampled annually for three years, followed by biennial (every other year) sampling for the remaining 67 years.

8.2 REMEDIAL ALTERNATIVE 2 – RNA WITH INSTITUTIONAL CONTROLS, LTM, AND SOURCE AREA BIOSPARGING/SVE

The vertical extent of contamination at the BX Service Station is not known with precision. However, available data indicate that residual soil contamination is present both above and below the average water table. Implementation of vadose zone remediation technologies such as bioventing or SVE would rapidly remediate the area above the water table; however, residual contamination in the capillary fringe and saturated zone would only be remediated during low-water periods when this contaminated interval is dewatered and aerated. Implementation of biosparging in the source area would expedite reductions in contaminant concentrations in vadose zone,

capillary fringe, and saturated soils in the source area. Biosparging should increase the DO concentration in saturated soils and groundwater to about 1 to 2 mg/L within the source area. Incidental bioventing of vadose zone soils is anticipated as oxygen injected into the subsurface diffuses through the groundwater and capillary fringe soils. An SVE system could be operated concurrently to remove vapor-phase contamination generated by the biosparging system and prevent potential transport to occupied buildings. The reduction of contamination in the source area via the biosparging/SVE system will serve to reduce the total mass of contamination in groundwater (i.e., expedite attainment of Tier 2 SSTLs and eventually Tier 1 RBSLs).

Bioscreen modeling results presented in Section 6 indicate that groundwater contaminant concentrations would uniformly decrease below Tier 1 TCLs within approximately 17 years if a source removal action similar to the one described above is implemented at the site. The present worth cost of three years of biosparging and SVE, combined with 17 years of annual groundwater sampling of 8 wells, is estimated to be $505,000. Cost calculations are contained in Appendix H. The cost assumes operation of an internal combustion engine for vapor treatment for six months, a 15-foot spacing for biosparging wells, and installation of a total of 18 sparging wells and two SVE wells at the former and current tank pits in the areas characterized by excessively contaminated soil as defined by BCM (1995 and 1997). The biosparging/SVE system would be operated for the three years.

8.3 REMEDIAL ALTERNATIVE 3 – RNA WITH INSTITUTIONAL CONTROLS AND LTM TO VERIFY ATTAINMENT OF SSTLS, FOLLOWED BY INACTIVE STATUS

Under Alternative 3, the site would be monitored annually for an estimated 3 years to document the attainment of Tier II groundwater SSTLs, verify that the groundwater plumes are stable or receding, and more firmly establish temporal groundwater quality trends. Following this monitoring period, LTM would cease and the site would be placed in an inactive (but managed) status or would only be monitored infrequently (e.g. every five years). Groundwater monitoring would be resumed or performed more frequently, if land use and/or ownership at the site changed (e.g. became residential). Implementation of this alternative would require that the site remain administratively "on the books" during the inactive period so that the proper institutional controls were enforced (e.g. proper worker protection procedures were followed in the event that excavation work was required) and the appropriate personnel remained aware of the site's status.

8.4 RECOMMENDED REMEDIAL ALTERNATIVE

Alternative 3 achieves the best combination of risk reduction and cost effectiveness; therefore, implementation of this alternative is recommended if it is accepted by the regulatory community. If Alternative 3 is not acceptable to the regulatory community, then limited additional groundwater sampling should be performed prior to selecting either Remedial Alternative 1 or 2. Specifically, well MW-03 should be resampled at least once to assess if the 1998 data are representative of contaminant concentrations at the site or is indicative of seasonal fluctuation. This sampling is recommended because as discussed above, the 70 years to reach TCLs in Alternative 1 is based on one dissolved xylene concentration of 16 mg/L detected at MW-03 in 1997. In 1998, the dissolved xylene concentration at the same location decreased to 6.9 mg/L. When the 6.9 mg/L is

input into the BIOSCREEN model instead of the 16 mg/L, xylene is predicted to fall below TCLs within 30 years after 1998 instead of 70 years (Appendix F).

If the resampling of MW-03 confirms a decrease in xylene concentration, an engineered remedial action like Alternative 2 may not be necessary. If the predicted time frame to achieve TCLs remains unacceptably long, then Alternative 2 should be selected.

The progress of source removal and RNA will be monitored using the existing network of monitoring wells and two proposed monitoring wells. Additional details on the well locations and the frequency and types of groundwater analysis recommended to confirm the effectiveness of source removal and ongoing natural processes and to verify the completion of a cleanup appropriate for an industrial site are presented in the LTM plan included in Section 9.

SECTION 9
LONG-TERM MONITORING PLAN

9.1 OVERVIEW

The objectives of the LTM are as follows:

- To assess site conditions over time;
- To confirm the effectiveness of naturally occurring processes of reducing contaminant mass and minimizing contaminant migration; and
- To evaluate the effectiveness of RNA or any engineered remedial actions.

The LTM plan consists of identifying groundwater sampling locations and developing a sampling and analysis strategy. The strategy described in this section is designed to assess the effectiveness of current remedial actions through measurement of the reduction of contaminant mass, and the rate of groundwater remediation. In the event that data collected under this LTM program indicate that current remedial actions are insufficient to be protective of human health and the environment, additional engineered controls may be necessary. A site-specific groundwater SAP and institutional control plan should be prepared prior to initiating the LTM program.

9.2 LONG-TERM GROUNDWATER MONITORING WELLS

A total of 8 monitoring wells should be included in the LTM program. These wells include MW-01, MW-03, MW-05, MW-07, MW-03-97, MW-05-97, a replacement well for MP-2, and a replacement well for MP-3. These wells include four wells without or very little hydrocarbon concentrations (one upgradient and three downgradient) and four wells with historical hydrocarbon concentrations (Figure 2.1).

9.3 SAMPLING DURATION AND FREQUENCY

The frequency of groundwater monitoring will depend on which remedial alternative in Section 8 is selected. If the data collected during the LTM program support the effectiveness of the selected remedial alternative at this site, it may be possible to reduce or eliminate sampling. If the data collected at any time during the monitoring period indicate the need for additional remedial activities at the site, sampling frequency should be adjusted accordingly. Previous monitoring results can be used to select the optimum time for performing the annual sampling events (e.g., during the time when maximum concentrations are detected).

9.4 ANALYTICAL PROTOCOL

All LTM wells will be sampled and analyzed to verify the effectiveness of naturally-occurring remediation processes at the site. At the beginning of each sampling event, water levels should be measured in all site monitoring wells. Groundwater samples collected from the LTM wells should be analyzed for the parameters listed in Table 9.1.

TABLE 9.1
LONG-TERM GROUNDWATER MONITORING ANALYTICAL PROTOCOL
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Analyte	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Ferrous Iron (Fe^{2+})	Colorimetric A3500-Fe D or Hach 25140-25	Filter if turbid	May indicate an anaerobic degradation process due to the depletion of oxygen, nitrate, and manganese	Every Sampling Event	Collect 100 mL of water in a glass container; for Method A3500-FeD, acidify with hydrochloric acid per method	Field
Temperature	E170.1, direct-reading meter	Measure at well-head	Purging adequacy; metabolism rates for microorganisms depend on temperature	Every Sampling Event	Measure at well-head using a flow-through cell	Field
Dissolved Oxygen	Dissolved oxygen meter	Measure at well-head; refer to Method A4500 for a comparable laboratory procedure	Purging adequacy; concentrations less than 1 mg/L generally indicate an anaerobic pathway	Every Sampling Event	Measure at well-head using a flow-through cell	Field
pH	E150.1/SW9040, direct-reading meter	Measure at well-head	Purging adequacy; aerobic and anaerobic processes are pH-sensitive	Every Sampling Event	Measure at well-head using a flow-through cell	Field
Conductivity	E120.1/SW9050, direct-reading meter	Measure at well-head	General water quality parameter used as a marker to verify that site samples are obtained from the same groundwater system	Every Sampling Event	Collect 100–250 mL of water in a glass or plastic container or measure at wellhead using flow-through cell	Field
Ammonia (NH_3)	CHEMetrics Method 1510, ASTM 4500: NH3	Filter if turbid	Most reduced form of nitrogen; metabolic byproduct of anaerobic microbial respiration	Every Sampling Event	Collect water samples in a 100 mL plastic container;	Field
Total Lead	SW 7421	Do not filter	Measured for regulatory compliance.	Every Sampling Event	Collect water samples in a 500 mL plastic container; cool to 4°C; add nitric acid	Fixed-base

TABLE 9.1 (Continued)
LONG-TERM GROUNDWATER MONITORING ANALYTICAL PROTOCOL
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Analyte	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Sulfate (SO_4^{2-})	IC method E300 or method SW9056 or Hach SulfaVer 4 method	Method E300 is a Handbook method; method SW9056 is an equivalent procedure. Hach method is Photometric	Substrate for anaerobic microbial respiration	Every Sampling Event	Collect up to 40 mL of water in a glass or plastic container; cool to 4°C	Fixed-base or field (for Hach method)
Oxidation-Reduction Potential (ORP)	A2580 B, direct-reading meter	Measurements are made with electrodes; results are displayed on a meter; samples should be protected from exposure to atmospheric oxygen	The redox potential of groundwater influences and is influenced by biologically mediated reactions; the redox potential of groundwater may range from more than 200 mV to less than -400 mV	Every Sampling Event	Measure at well-head using a flow-through cell	Field
Methane	RSKSOP-114 modified to analyze water samples for methane by headspace sampling with dual thermal conductivity and flame ionization detection.	Method published and used by the USEPA National Risk Management Research Laboratory	The presence of methane indicates the presence of sufficiently reducing conditons for reductive dehalogenation to occur	Every Sampling Event	Collect water samples in 40 mL volatile organic analysis (VOA) vials with butyl gray/Teflon-lined caps (zero headspace); cool to 4°C	Fixed-base
BTEX, MTBE, and Naphthalene	SW8260	GC/MS Method	Measured for regulatory compliance.	Every Sampling Event	Collect water samples in a 40 mL VOA vial; cool to 4°C; add hydrochloric acid to pH < 2	Fixed-base

Handbook refers to the AFCEE (1993) "Handbook for the Installation Restoration Program (IRP) Remedial Investigations and Feasibility Studies (RI/FS)."

SECTION 10
REFERENCES

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APPENDIX A
PERTINENT DATA FROM PREVIOUS SITE INVESTIGATIONS

BCM PUMP AND SLUG TEST ANALYSIS

U.S. ARMY CORPS OF ENGINEERS
MOBILE DISTRICT

MODIFIED PUMP TEST AND REMEDIAL ACTION PLAN

BX SERVICE STATION TYNDALL AIR FORCE BASE
BAY COUNTY, FLORIDA

CONTRACT NO. DACA01-94-D-0005
DELIVERY ORDER NO. 0017
BCM PROJECT NO. 09-5000-17

APRIL 1998

TABLE 1

BX SERVICE STATION
WELL CONSTRUCTION DETAILS AND GROUNDWATER ELEVATIONS

WELL NO.	WELL DIAMETER INCHES	ELEVATION - TOC FEET	ELEVATION - GROUND FEET	TOTAL DEPTH FEET - BTOC	SCREEN LENGTH FEET	GW ELEVATION 3/10/98
MW-01	4	30.85	30.98	16.5	10	27.22
MW-02	4	30.12	29.68	15	10	Abandoned
MW-03	4	29.78	30.09	16.5	10	26.80
MW-04	4	30.12	30.35	14.5	10	26.87
MW-05	4	29.38	29.62	11	10	25.98
MW-06	4	28.44	29.29	17	10	26.07
MW-07	4	29.00	29.34	15.5	10	26.17
MW-08	4	29.37	29.62	15.3	10	26.44
MW-09	4	30.26	30.35	15.5	10	26.77
MWD01-97	2	30.14	30.50	45.80	10	25.04
MW02-97	4	29.66	29.90	12.00	10	27.06
MW03-97	4	29.36	29.60	13.00	10	25.12
MWD04-97	2	29.12	29.42	35.60	10	26.06
MW05-97	4	28.66	28.80	13.00	10	25.56
MW06-97	4	28.97	29.10	13.00	10	25.81
MW07-97	4	29.55	29.73	13.00	10	26.43
MW08-97	4	29.02	29.29	13.00	10	26.07
MWD09-97	2	29.06	29.32	28.20	25	26.08
MWD10-97	4	29.24	29.44	28.50	25	25.34
MWD11-97	2	29.20	29.73	27.83	25	25.56

TABLE 2

PERMEABILITY COEFFICIENTS DERIVED FROM PUMP TEST

MW-ID	Discharge (Q) GPM	Radial Distance (R_1) - Feet Radial Distance (R_2) - Feet	Head (H_1) - Feet Head (H_2) - Feet	Permeability Coefficient (K) cm/sec
MWD-11-97 MWD-09-97	~17.5	9.5 30.8	33.42 34.16	0.0089
MWD-11-97 MW-05-97	~17.5	9.5 81.3	33.42 34.48	0.011
MWD-11-97 MW-04	~17.5	9.5 195.7	33.42 34.74	0.013
MWD-11-97 MW-06-97	~17.5	9.5 74.6	33.42 34.49	0.011
MWD-10-97 MW-06	~17.5	9.5 84.4	33.42 34.46	0.012

$$K = \frac{1055\ Q \log (r_2 / r_1)}{(h_2)^2 - (h_1)^2}$$

Where:

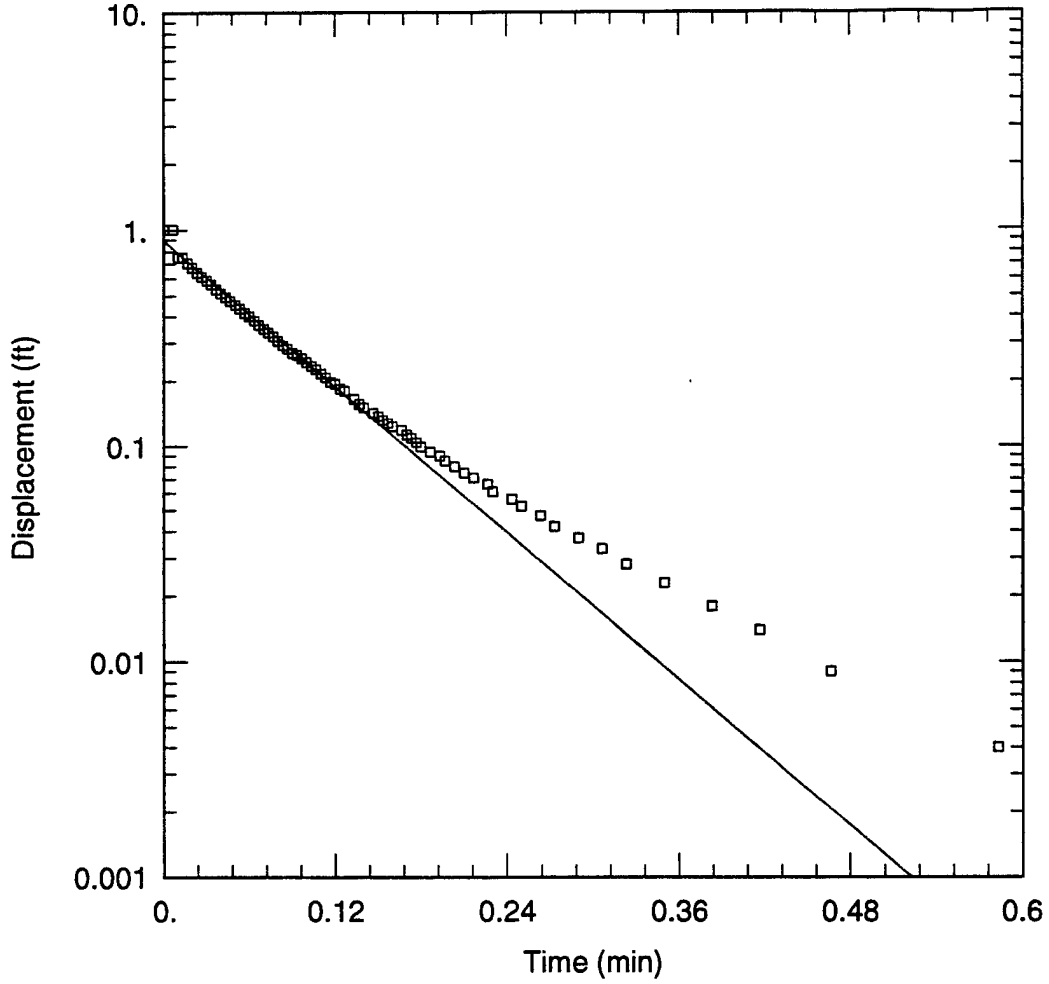
Q = Pumping rate in recovery well
R_1 = Radial distance to near observation well
R_2 = Radial distance to distant observation well
H_1 = Head in near observation well
H_2 = Head in distant observation well

TABLE 3

PERMEABILITY COEFFICIENTS DERIVED FROM SLUG TEST

MW-ID	Permeability Coefficient (K) cm/sec
MW-01	0.0177
MW-03	0.0103
MW-02-97	0.0113
MW-03-97	0.0047
MW-05-97	0.0133
MW-06-97	0.0022
MW-08-97	0.0098

Bouwer-Rice Unconfined Aquifer Solution Method



MW-01 SLUG OUT TEST

Data Set: I:\DOUG\SLUGTEST\TYNDALL\MW01O.AQT
Date: 05/29/98 Time: 11:15:40

PROJECT INFORMATION

Company: BCM Engineers
Client: USACE-Mobile
Project: 09-5000-17
Test Location: Tyndall AFB
Test Well: MW-01

AQUIFER DATA

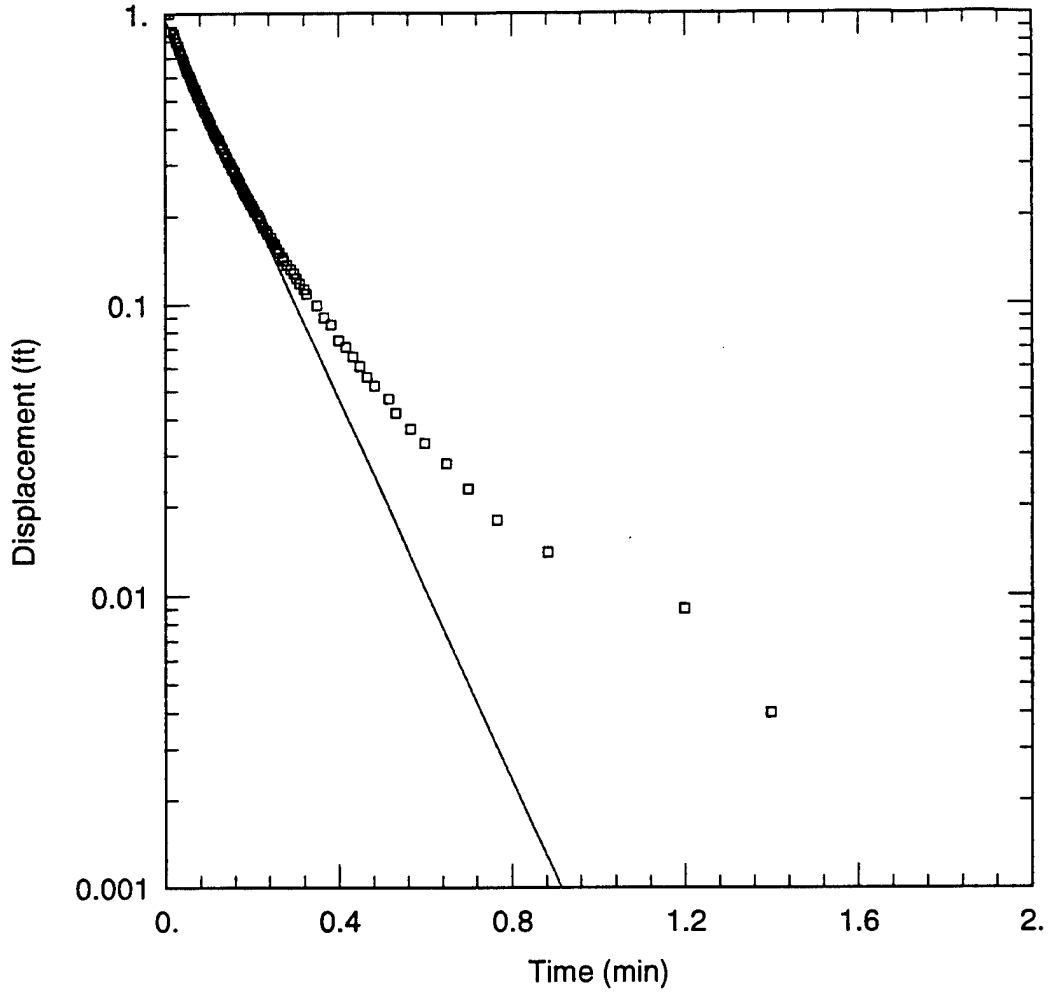
Saturated Thickness: 10.9 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Initial Displacement: 1.009 ft Water Column Height: 10.9 ft
Casing Radius: 0.1667 ft Wellbore Radius: 0.75 ft
Screen Length: 10. ft

SOLUTION

Aquifer Model: Unconfined K = 0.01771 cm/sec
Solution Method: Bouwer-Rice y0 = 0.8953 ft



MW-03 SLUG OUT TEST

Data Set: I:\DOUG\SLUGTEST\TYNDALL\MW03O.AQT
Date: 05/29/98 Time: 11:15:15

PROJECT INFORMATION

Company: BCM Engineers
Client: USACE-Mobile
Project: 09-5000-17
Test Location: Tyndall AFB
Test Well: MW-03

AQUIFER DATA

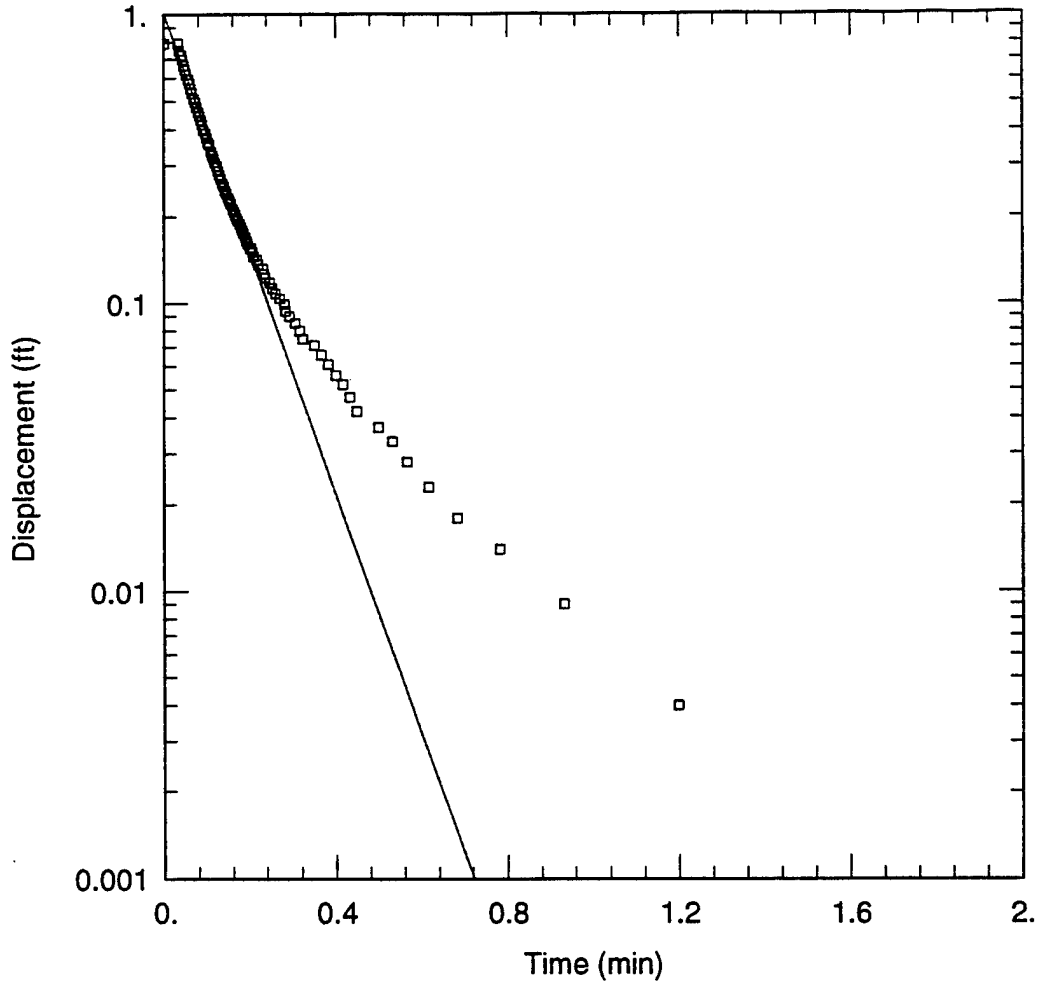
Saturated Thickness: 11.29 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Initial Displacement: 0.995 ft Water Column Height: 11.29 ft
Casing Radius: 0.1667 ft Wellbore Radius: 0.75 ft
Screen Length: 10. ft

SOLUTION

Aquifer Model: Unconfined K = 0.0103 cm/sec
Solution Method: Bouwer-Rice y0 = 0.9507 ft



MW-02-97 SLUG OUT TEST

Data Set: I:\DOUG\SLUGTEST\TYNDALL\MW0297O.AQT
Date: 05/29/98 Time: 11:14:45

PROJECT INFORMATION

Company: BCM Engineers
Client: USAF
Project: 09-5000-17
Test Location: Tyndall AFB
Test Well: MW-02-97

AQUIFER DATA

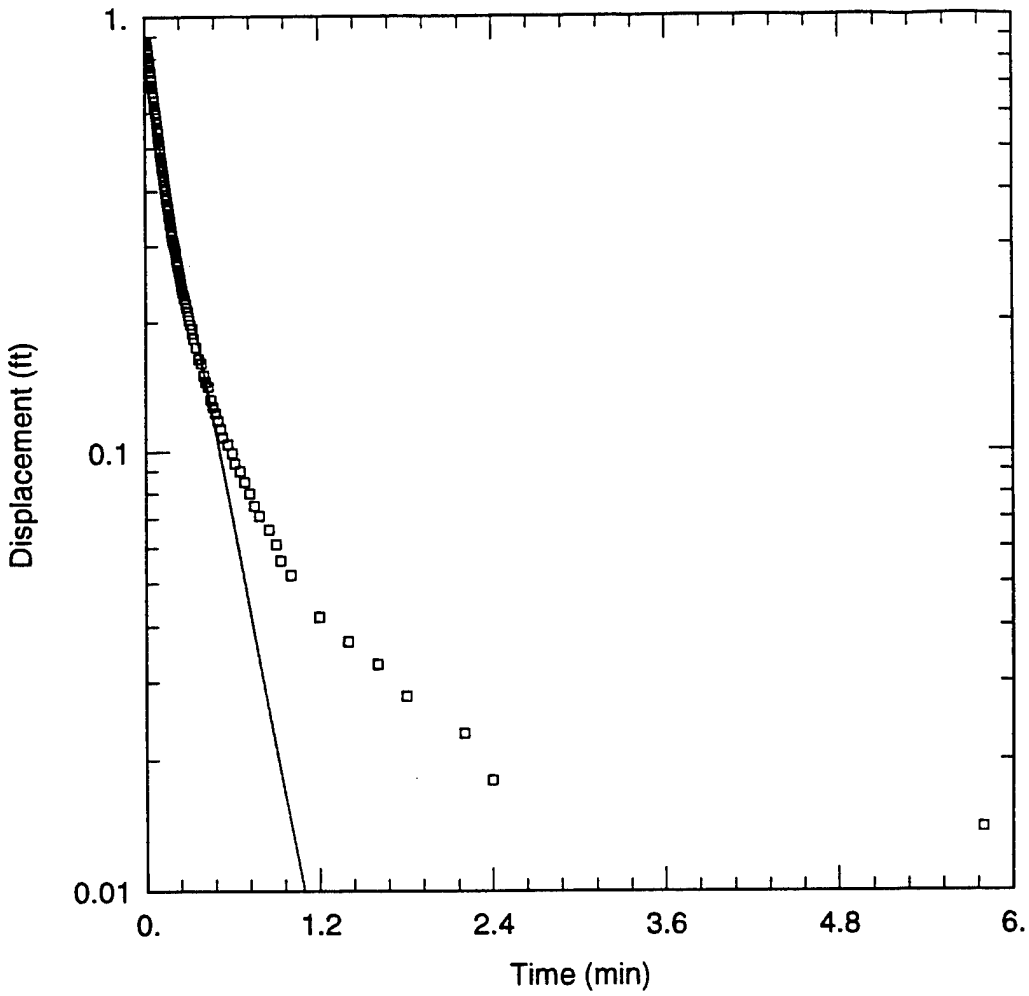
Saturated Thickness: 7. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Initial Displacement: 0.791 ft Water Column Height: 7. ft
Casing Radius: 0.1667 ft Wellbore Radius: 0.75 ft
Screen Length: 10. ft

SOLUTION

Aquifer Model: Unconfined K = 0.0113 cm/sec
Solution Method: Bouwer-Rice y0 = 1.024 ft



MW-03-97 SLUG OUT TEST

Data Set: I:\DOUG\SLUGTEST\TYNDALL\MW0397O.AQT
Date: 05/29/98 Time: 11:16:25

PROJECT INFORMATION

Company: BCM Engineers
Client: USAF
Project: 09-5000-17
Test Location: Tyndall AFB
Test Well: MW-03-97

AQUIFER DATA

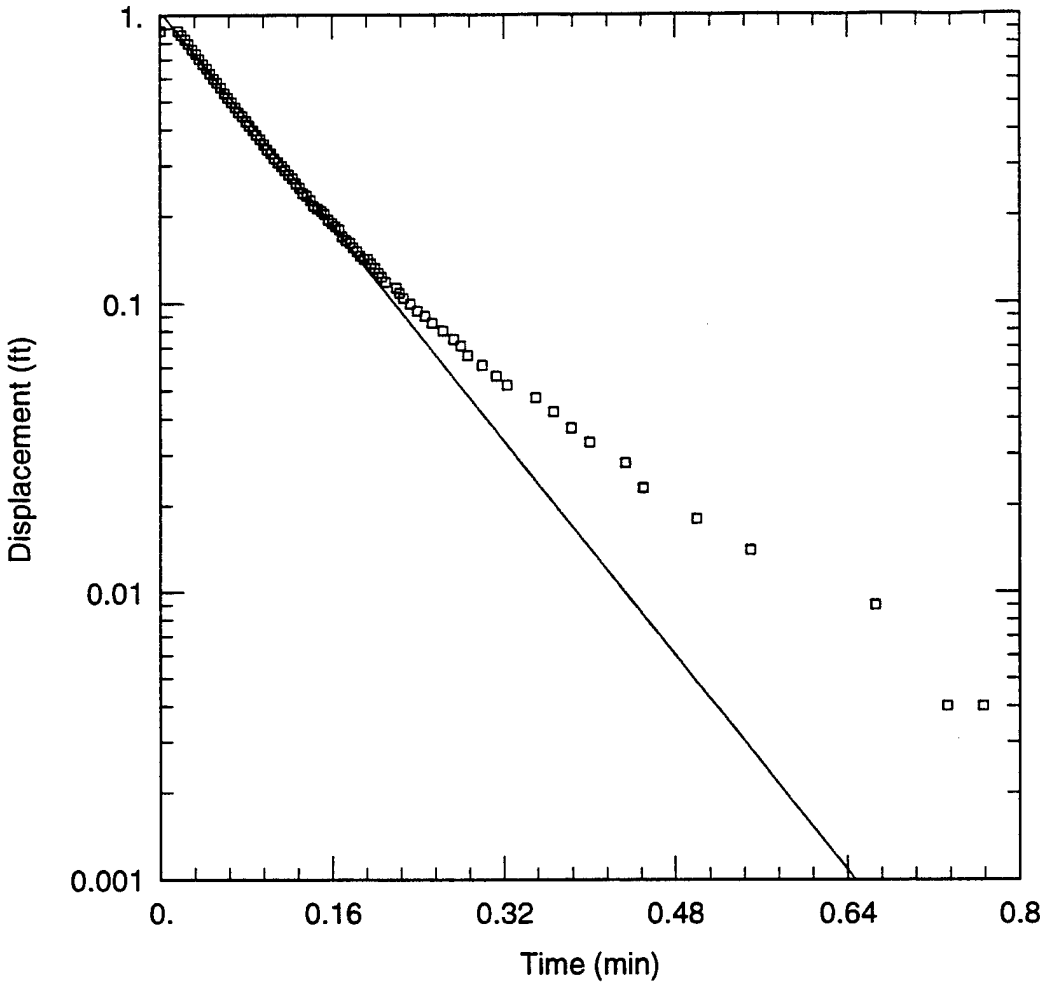
Saturated Thickness: 7.45 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Initial Displacement: 0.876 ft Water Column Height: 7.45 ft
Casing Radius: 0.1667 ft Wellbore Radius: 0.75 ft
Screen Length: 10. ft

SOLUTION

Aquifer Model: Unconfined K = 0.004759 cm/sec
Solution Method: Bouwer-Rice y0 = 0.7499 ft



MW-05-97 SLUG OUT TEST

Data Set: I:\DOUG\SLUGTEST\TYNDALL\MW0597O.AQT
Date: 05/29/98 Time: 11:16:48

PROJECT INFORMATION

Company: BCM Engineers
Client: USACE-Mobile
Project: 09-5000-17
Test Location: Tyndall AFB
Test Well: MW-05-97

AQUIFER DATA

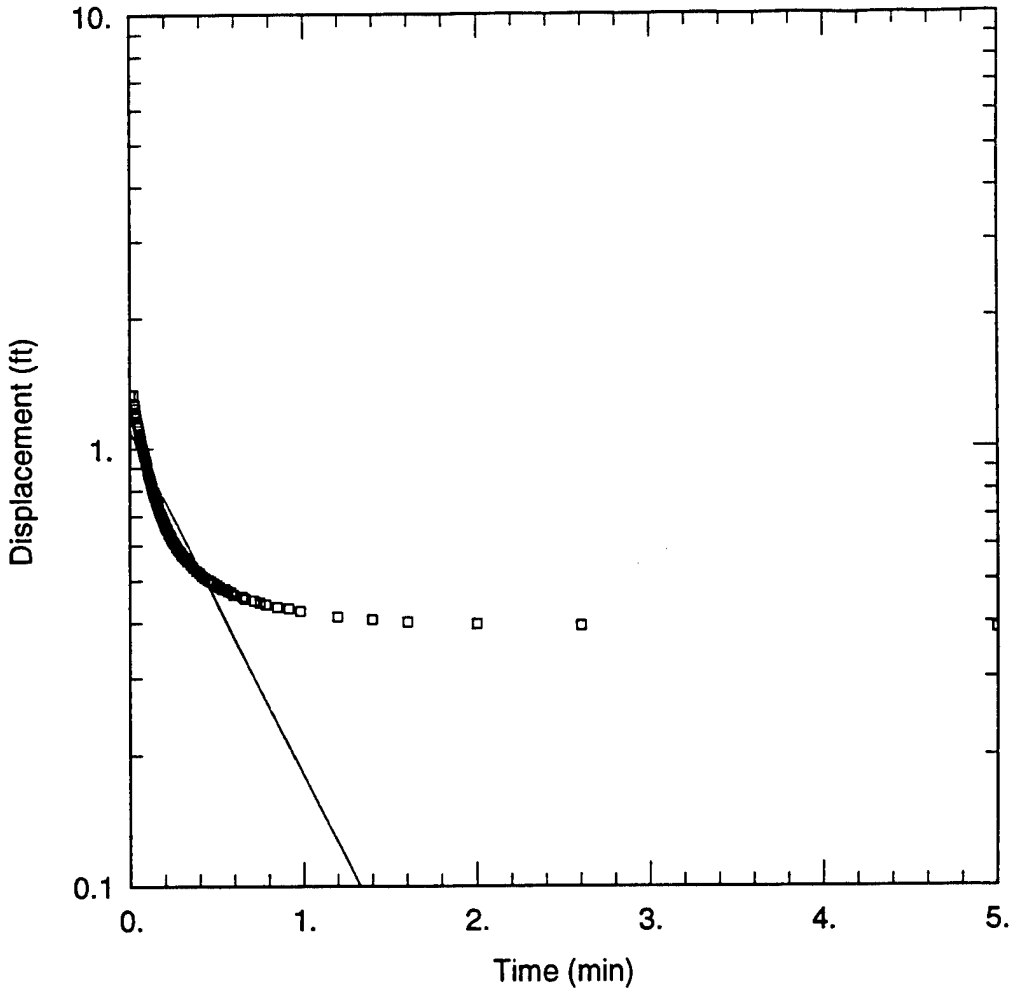
Saturated Thickness: 8.15 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Initial Displacement: 0.881 ft
Water Column Height: 8.15 ft
Casing Radius: 0.1667 ft
Wellbore Radius: 0.75 ft
Screen Length: 10. ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.01331 cm/sec
y0 = 1.037 ft



MW-06-97 SLUG OUT TEST

Data Set: I:\DOUG\SLUGTEST\TYNDALL\MW0697O.AQT
Date: 05/29/98 Time: 11:17:21

PROJECT INFORMATION

Company: BCM Engineers
Client: USACE-Mobile
Project: 09-5000-17
Test Location: Tyndall AFB
Test Well: MW-06-97

AQUIFER DATA

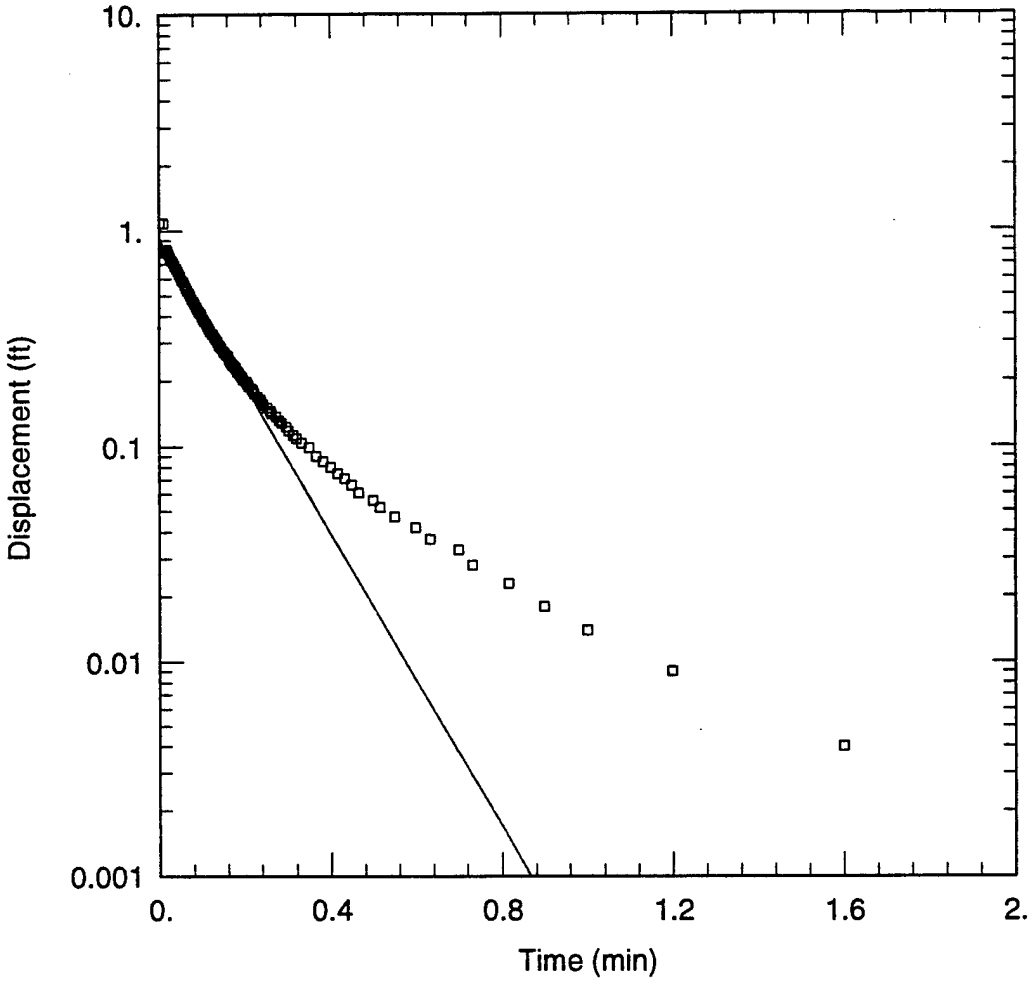
Saturated Thickness: 8. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Initial Displacement: 1.335 ft
Water Column Height: 8. ft
Casing Radius: 0.1667 ft
Wellbore Radius: 0.75 ft
Screen Length: 10. ft

SOLUTION

Aquifer Model: Unconfined
K = 0.00222 cm/sec
Solution Method: Bouwer-Rice
y0 = 1.095 ft



MW-08-97 SLUG OUT TEST

Data Set: I:\DOUG\SLUGTEST\TYNDALL\MW0897O.AQT
Date: 05/29/98 Time: 11:17:45

PROJECT INFORMATION

Company: BCM Enginners
Client: USACE-Mobile
Project: 09-5000-17
Test Location: Tyndall AFB
Test Well: MW-08-97

AQUIFER DATA

Saturated Thickness: 8.22 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Initial Displacement: 1.085 ft Water Column Height: 8.22 ft
Casing Radius: 0.1667 ft Wellbore Radius: 0.75 ft
Screen Length: 10. ft

SOLUTION

Aquifer Model: Unconfined K = 0.009789 cm/sec
Solution Method: Bouwer-Rice y0 = 0.9239 ft

$$K = \frac{1055\ Q\ \log\ r_2/r_1}{(h_2^2 - h_1^2)}$$

where: Q = pumping rate in gpm

r_1 = radial distance to near observation well (Ft)

r_2 = radial distance to distant observation well (Ft)

h_1 = head (saturated thickness) in near observation well (ft)

h_2 = head (saturated thickness) in distant observation well (ft)

MWD-11-97 & MWD-09-97

Q = 17.5 gpm

MWD-11-97 — $r_1 = 9.5'$

MWD-09-97 — $r_2 = 30.8'$

MWD-11-97 — $h_1 = 35' - 1.581 = 33.419'$

MWD-09-97 — $h_2 = 35' - 0.838 = 34.162'$

$$K = \frac{1055 \cdot 17.5\ gpm \cdot \log \frac{30.8}{9.5}}{(34.162\ Ft)^2 - (33.419\ ft)^2}$$

$$K = \frac{9431.14\ gpm}{1167\ Ft^2 - 1117\ Ft^2}$$

$$K = \frac{9431.14}{50}$$

$$K = 188.62\ gpd/Ft^2$$

$$K = 188.62\ gpd/Ft^2 \cdot \frac{0.134\ Ft/day}{1\ gpd/Ft^2}$$

$$K = 25.27\ Ft/day$$

$$K = 25.27\ Ft/day \quad \frac{3.53 \cdot 10^{-4}\ cm/sec}{1\ Ft/day} = 0.0089\ cm/sec$$

$$K = \frac{1055\ Q\ \log r_2/r_1}{(h^2 - h'^2)}$$

MWD-11-97 & MW-05-97

$Q = 17.5$ gpm

$r_1 = 9.5'$

$r_2 = 81.3'$

$h_1 = 35' - 1.581' = 33.42'$

$h_2 = 35' - 0.517' = 34.48'$

$$K = \frac{1055 \cdot 17.5 \cdot \log 81.3/9.5}{(34.48)^2 - (33.42)^2}$$

$$K = \frac{17213.8}{1188.8 - 1116.9}$$

$$K = \frac{17213.8}{71.9} = 239.4 \text{ gal/day/ft}^2$$

$$K = 239.4 \text{ gpd/Ft}^2 \cdot \frac{0.134 \text{ ft/day}}{1 \text{ gpd/ft}^2} = 32.08 \text{ ft/day}$$

$$K = 32.08 \text{ Ft/day} \cdot \frac{3.53 \cdot 10^{-4} \text{ cm/sec}}{1 \text{ Ft/day}} = 0.011 \text{ cm/sec}$$

$$K = \frac{1055\ Q\ \log r_2/r_1}{(h_2^2 - h_1^2)}$$

MWD-11-97 & MW-04

$Q = 17.5$ gpm

$r_1 = 9.5'$

$r_2 = 195.7'$

$h_1 = 35' - 1.581' = 33.42$

$h_2 = 35' - 0.258' = 34.742$

$$K = \frac{1055 \cdot 17.5\ \log 195.7/9.5}{(34.74)^2 - (33.42)^2}$$

$$K = \frac{24257.3}{1206.9 - 1116.9}$$

$$K = \frac{24257.3}{90} = 269.5 \text{ gpd/Ft}$$

$$K = 269.5 \text{ gpd/Ft} \cdot \frac{0.134 \text{ Ft/day}}{1 \text{ gpd/Ft}} = 36.1 \text{ Ft/day}$$

$$K = 36.1 \text{ Ft/day} \cdot \frac{3.53 \cdot 10^{-4} \text{ cm/sec}}{1 \text{ Ft/day}} = 0.013 \text{ cm/sec}$$

$$K = \frac{1055\ Q \log r_2/r_1}{(h_2^2 - h_1^2)}$$

MW-11-97 & MW-06-97

$Q = 17.5$ gpm

$r_1 = 9.5'$

MW-06-97 $r_2 = 74.6'$

MW-11-97 $h_1 = 35 - 1.581 = 33.42'$

MW-06-97 $h_2 = 35 - 0.512 = 34.49'$

$$K = \frac{1055 \cdot 17.5\ \text{gpm} \cdot \log 74.6/9.5}{(34.49)^2 - (33.42)^2}$$

$$K = \frac{16524.2}{1189.6 - 1116.9}$$

$$K = \frac{16524.2}{72.7}$$

$K = 228.2$ gpd/Ft²

$$K = 228.2\ \text{gpd/Ft}^2 \cdot \frac{0.134\ \text{Ft/day}}{1\ \text{gpd/Ft}^2}$$

$K = 30.58$ Ft/day

$$K = 30.58\ \text{Ft/day} \cdot \frac{3.53 \cdot 10^{-4}\ \text{cm/sec}}{1\ \text{Ft/day}} = 0.0108\ \text{cm/sec}$$

$$K = \frac{1055\ Q\ \log r_2/r_1}{(h_2^2 - h_1^2)}$$

MWD-10-97 & MW-06

$Q = 17.5$ gpm

$r_1 = 9.5'$

$r_2 = 84.4'$

$h_1 = 33.42$

$h_2 = 35 - 0.543 = 34.46$

$$K = \frac{1055 \cdot 17.5 \cdot \log 84.4/9.5}{(34.46)^2 - (33.42)^2}$$

$$K = \frac{17513.9}{1187.5 - 1116.9}$$

$$K = \frac{17513.9}{70.6}$$

$K = 248.1$

$$k = 248.1 \text{ gpd/Ft}^2 \frac{0.134 \text{ Ft/day}}{1 \text{ gpd/Ft}^2} = 33.24 \text{ Ft/day}$$

$$k = 33.24 \text{ Ft/day} \cdot \frac{3.53 \cdot 10^{-4} \text{ cm/sec}}{1 \text{ Ft/day}} = 0.012 \text{ cm/sec}$$

K:\09500017\PUMPTEST\FIG-1

BCM ENGINEERS
A Division of ATC

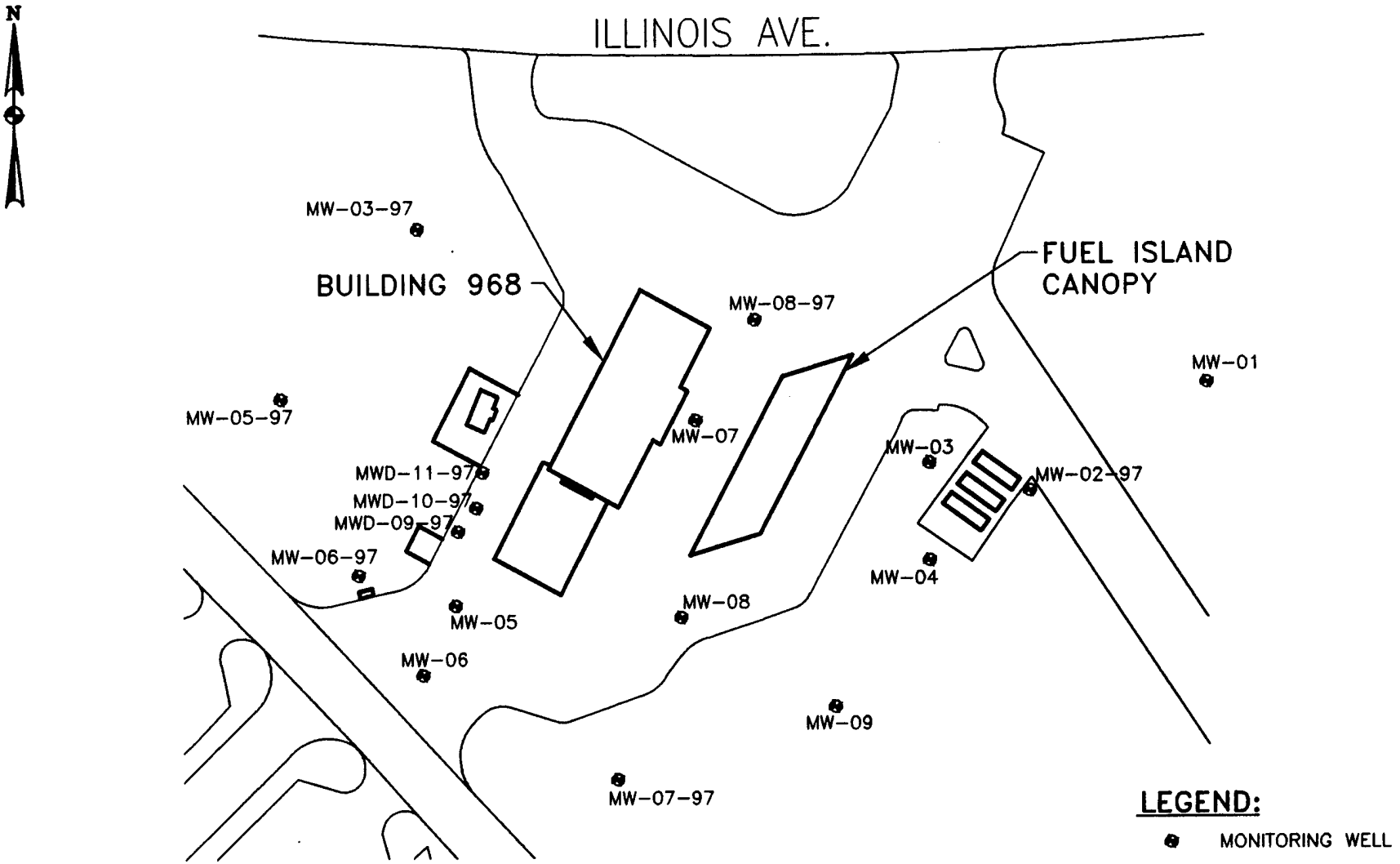
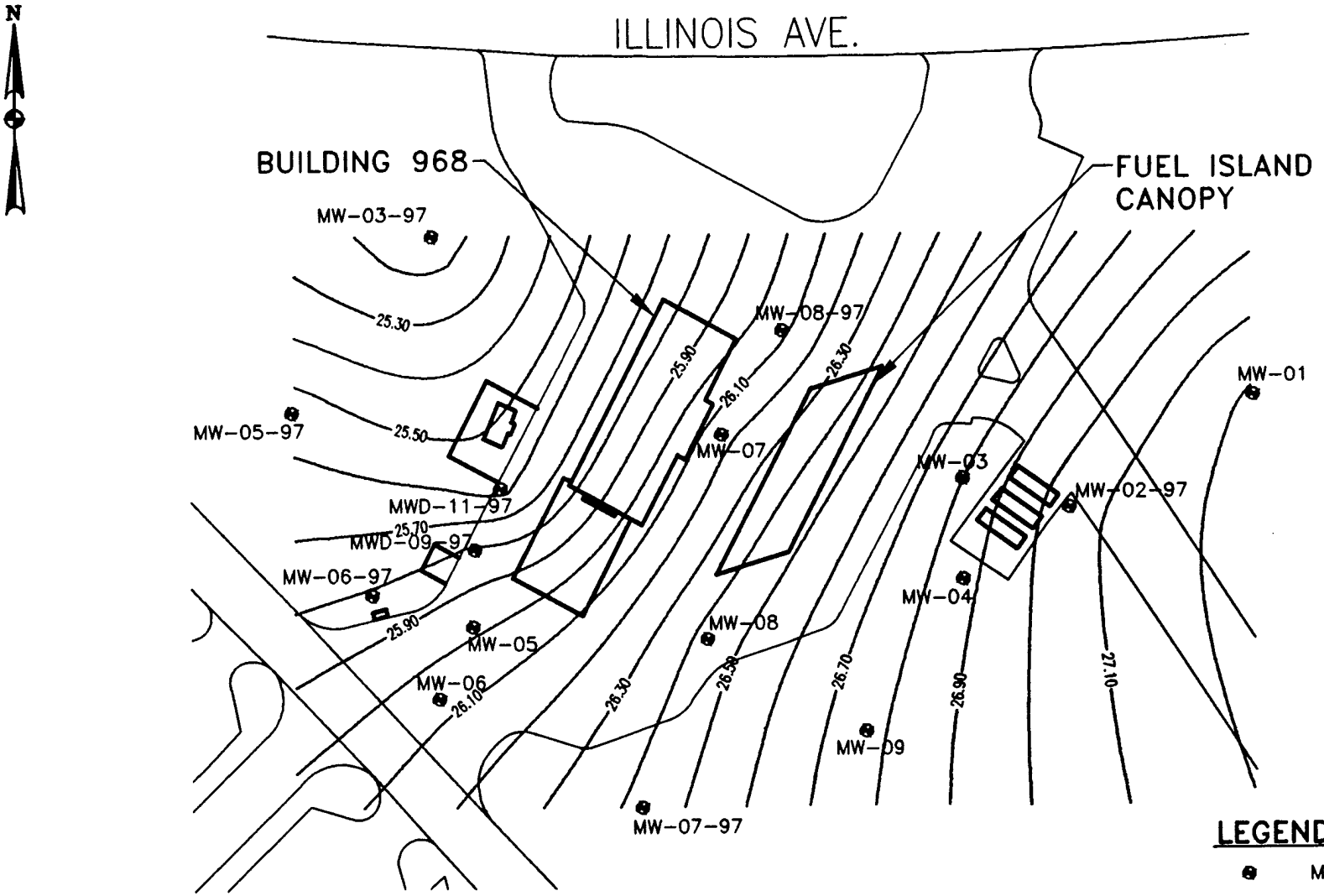


FIGURE 1
MONITORING WELL LOCATION MAP
BX PUMP TEST-TYNDALL AFB
SCALE: 1 = 60

BCM Project No. 09-5000-17
APRIL 1998

K:\09500017\PUMPTEST\FIG-2

BCM ENGINEERS
A Division of ATC



LEGEND:

- MONITORING WELL
- 26.00 EQUIPOTENTIAL CONTOUR
- 25.40 EQUIPOTENTIAL REFERENCE CONTOUR

FIGURE 2
GROUNDWATER ELEVATION CONTOUR MAP
BX PUMP TEST-TYNDALL AFB
SCALE: 1 = 60

BCM Project No. -5000-17
AP 9

K:\09500017\PUMPTEST\FIG-3

BCM ENGINEERS
A Division of ATC

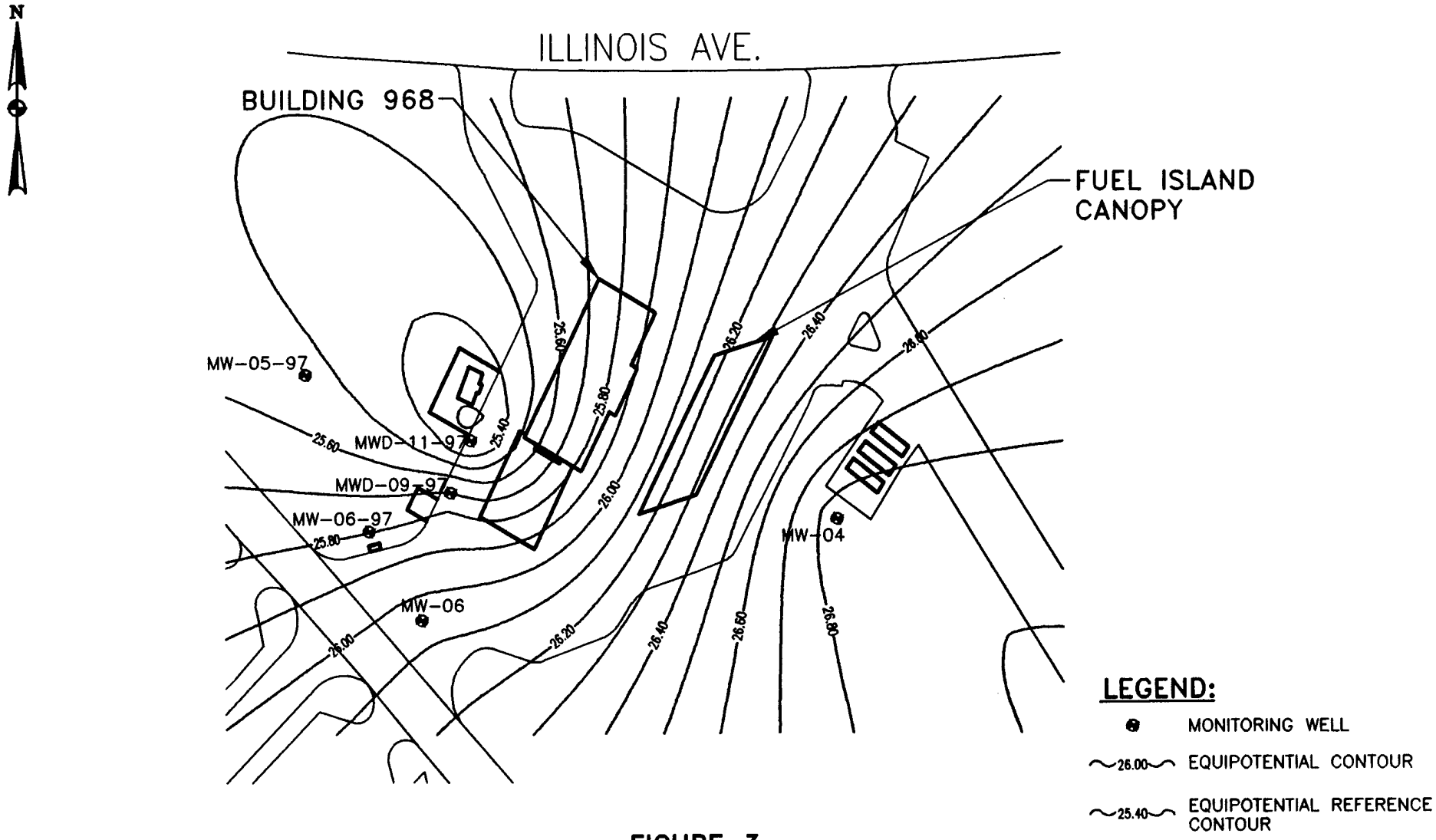


FIGURE 3
10-MINUTE GROUNDWATER ELEVATION CONTOUR MAP
BX PUMP TEST-TYNDALL AFB
SCALE: 1 = 60

BCM Project No. 09-5000-17
APRIL 1998

K:\09500017\PUMPTEST\FIG-4

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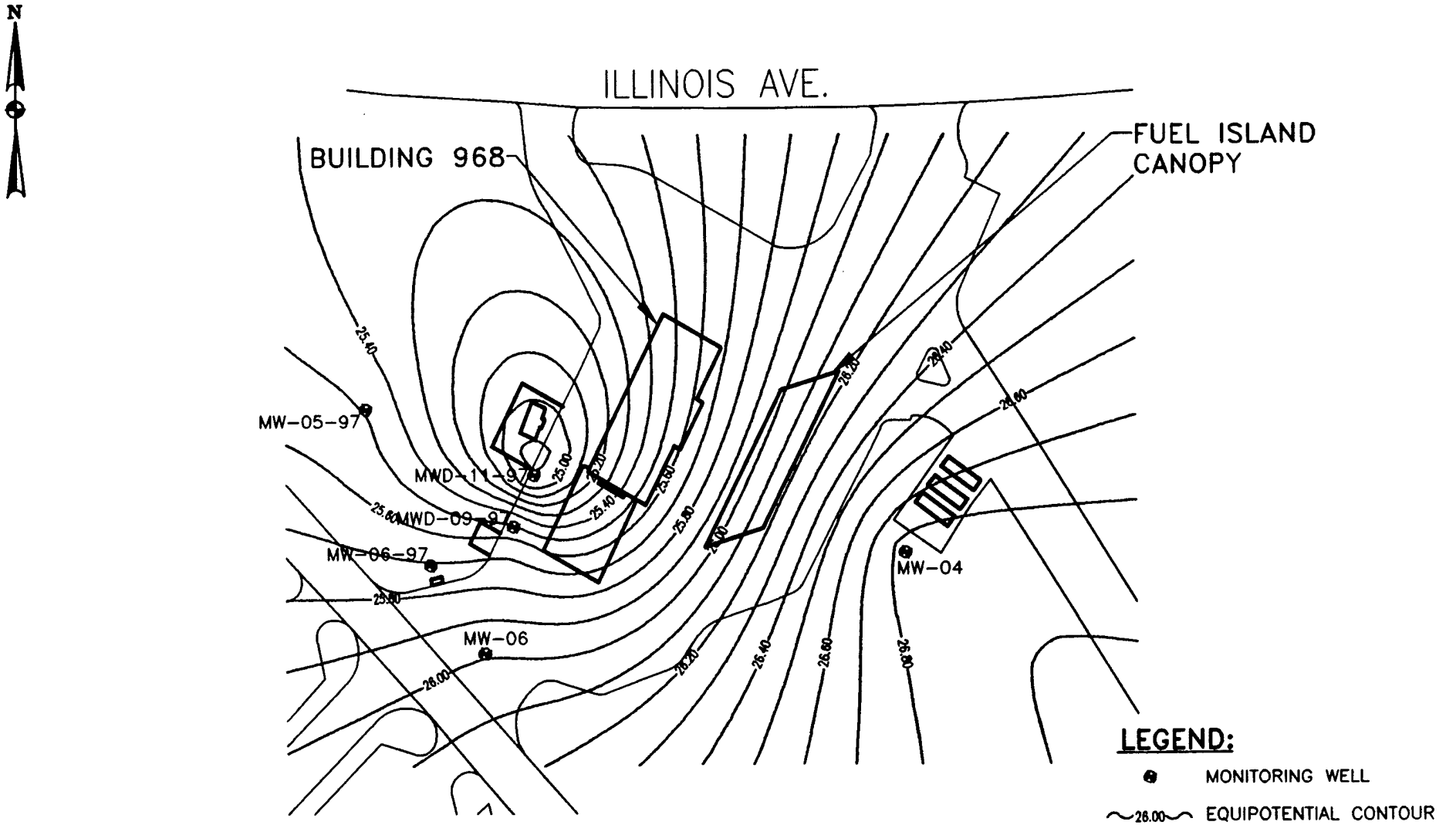

FIGURE 4
1-HOUR GROUNDWATER ELEVATION CONTOUR MAP
BX PUMP TEST-TYNDALL AFB
SCALE: 1 = 60

BCM Project [illegible] 5000-17
AP[illegible]3

K:\09500017\PUMPTEST\FIG-5

BCM ENGINEERS
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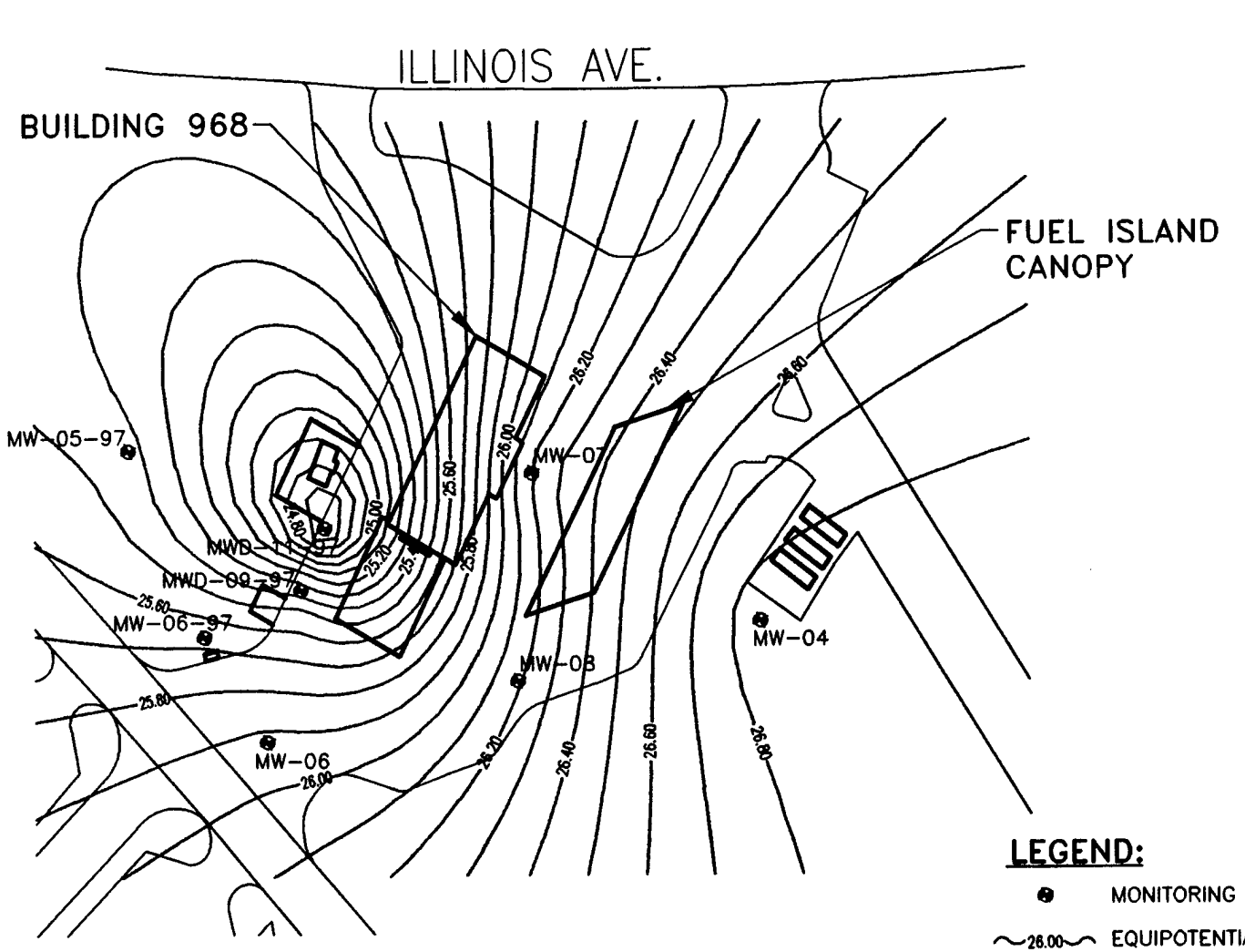

FIGURE 5
3-HOUR GROUNDWATER ELEVATION CONTOUR MAP
BX PUMP TEST-TYNDALL AFB
SCALE: 1 = 60

BCM Project No. 09-5000-17
APRIL 1998

BCM ENGINEERS
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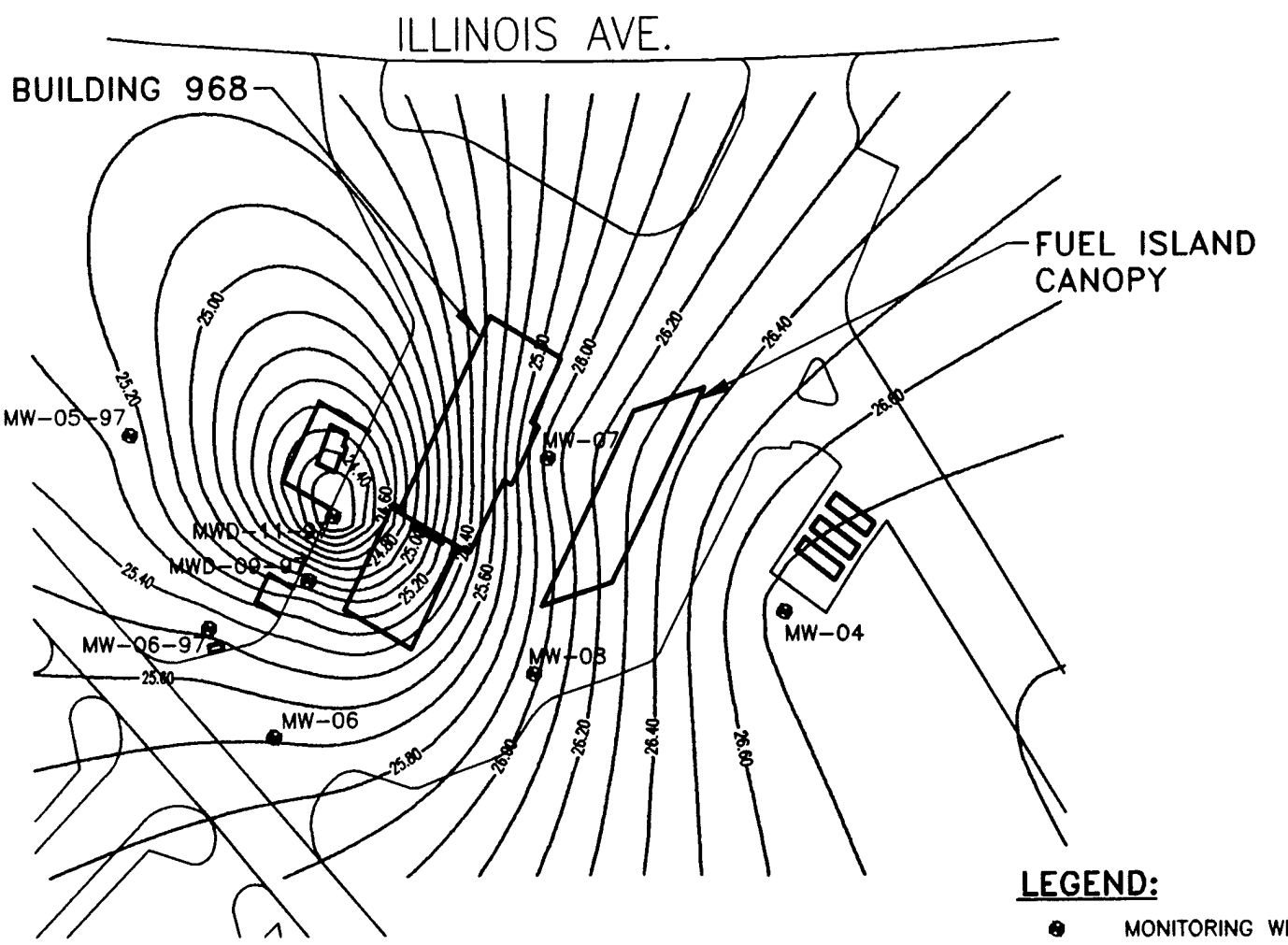

FIGURE 6
10-HOUR GROUNDWATER ELEVATION CONTOUR MAP
BX PUMP TEST-TYNDALL AFB

SCALE: 1 = 60

BCM Project N[illegible] 5000-17
AF[illegible]

K:\09500017\PUMPTEST\FIG-7

BCM ENGINEERS
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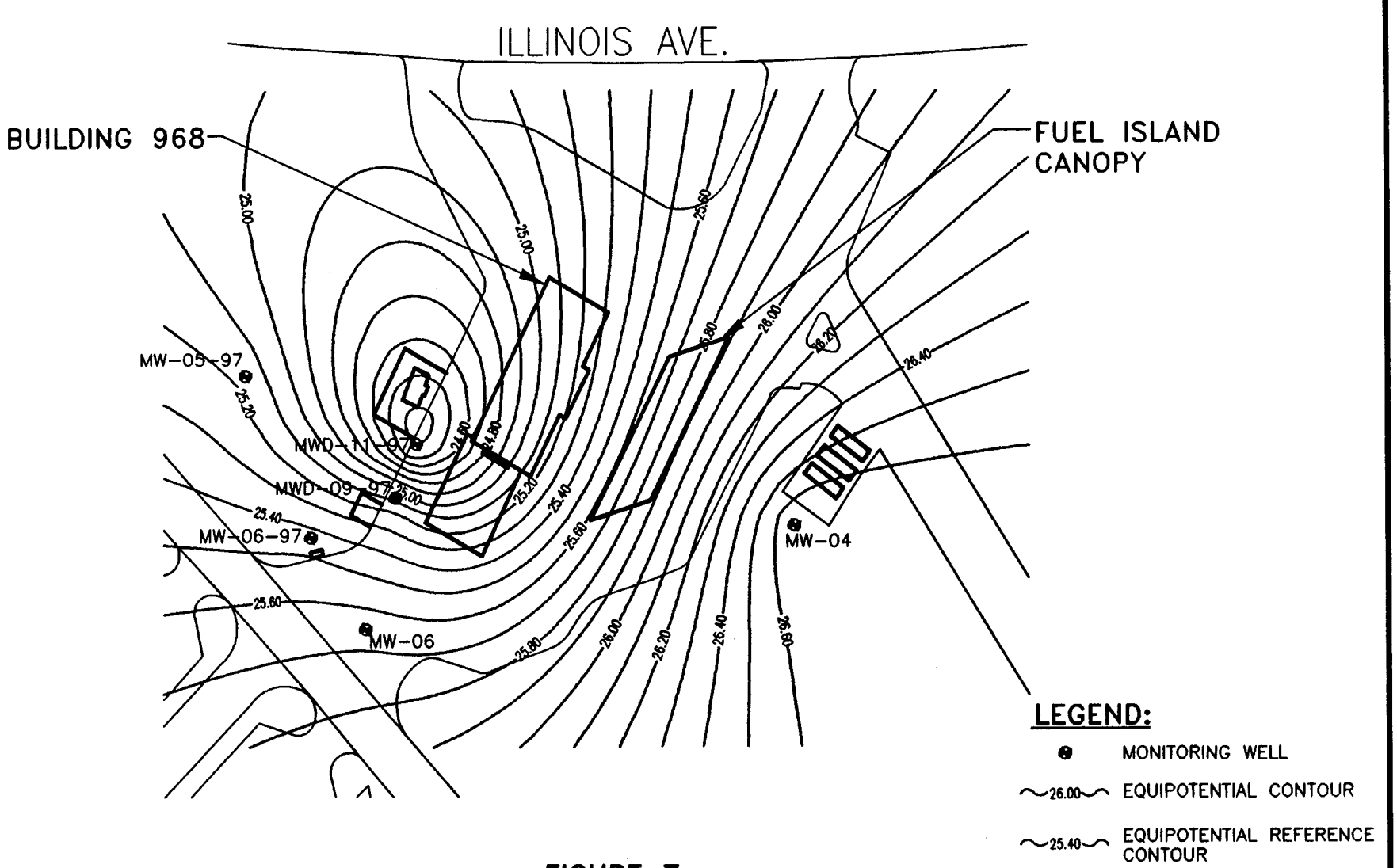

FIGURE 7
15-HOUR GROUNDWATER ELEVATION CONTOUR MAP
BX PUMP TEST-TYNDALL AFB
SCALE: 1 = 60

BCM Project No. 09-5000-17
APRIL 1998

BCM ENGINEERS
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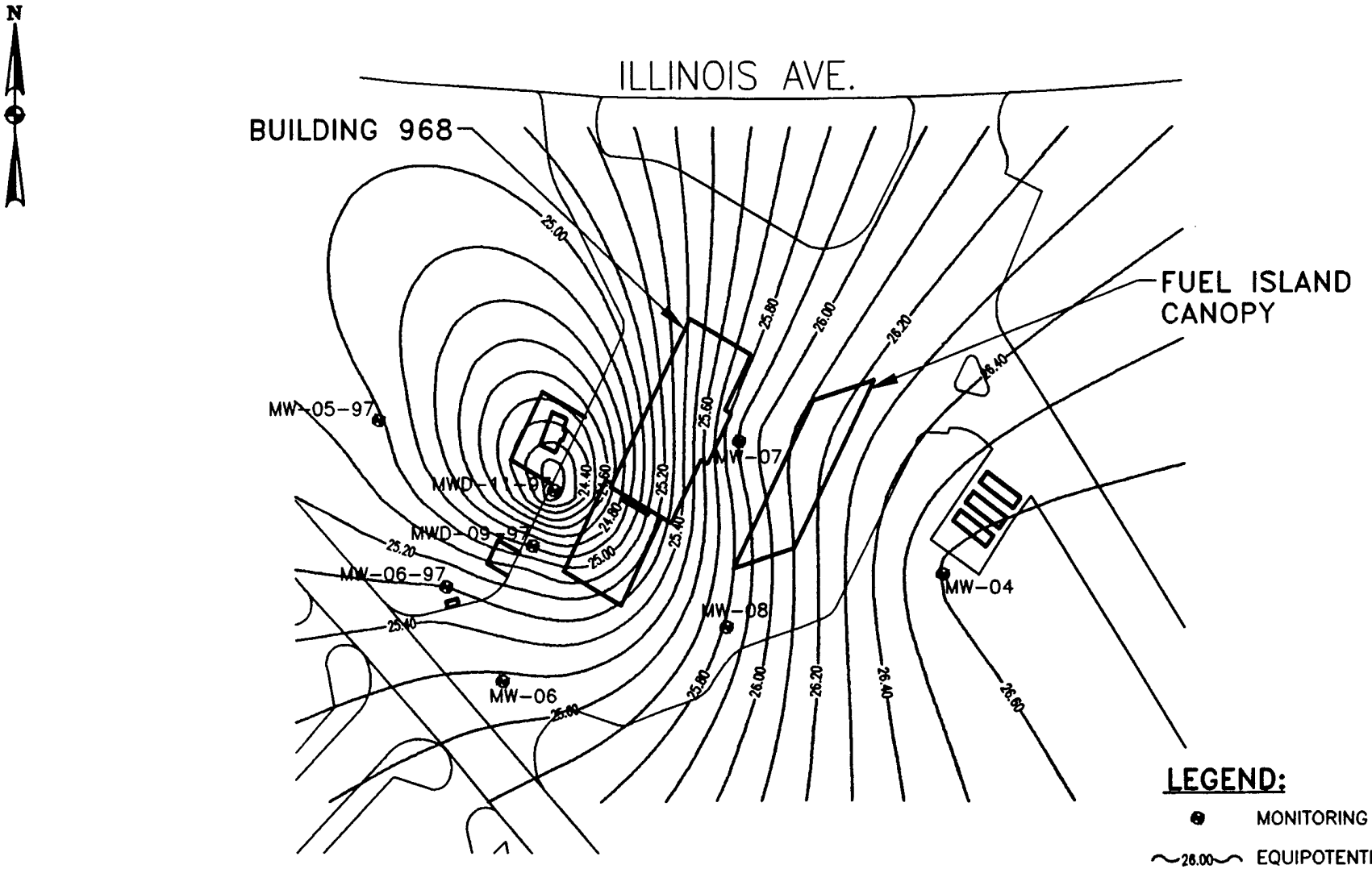

FIGURE 8
24-HOUR GROUNDWATER ELEVATION CONTOUR MAP
BX PUMP TEST-TYNDALL AFB

SCALE: 1 = 60

BCM Project N... 5000-17
AP...

TABLES

TABLE 11

HYDRAULIC CONDUCTIVITY (SLUG) TEST RESULTS

SLUG TEST DATA

WELL NO.	Hydraulic Conductivity			Groundwater Flow Velocity (Ft/day)
	Ft/Sec	Ft/Day	CM/SEC	
MW-02-97				
Slug In	5.7×10^{-4}	49.99	0.01763	0.26
Slug Out	6.4×10^{-4}	55.88	0.01971	0.29
MW-03-97				
Slug In	3.2×10^{-4}	28.14	0.009926	0.14
Slug Out	3.5×10^{-4}	30.90	0.0109	0.16
MW-05-97				
Slug In	8.6×10^{-4}	74.36	0.02323	0.38
Slug Out	7.4×10^{-4}	64.52	0.02276	0.33
MW-06-07				
Slug In	*	*	*	*
Slug Out	1.2×10^{-4}	10.78	0.003803	0.06
MW-07-97				
Slug In	*	*	*	*
Slug Out	7.5×10^{-4}	65.49	0.0231	0.33
MW-08-97				
Slug In	*	*	*	*
Slug Out	5.4×10^{-4}	47.38	0.01672	0.24
MW-01				
Slug In	*	*	*	*
Slug Out	9.6×10^{-4}	83.21	0.02936	0.43
MW-03				
Slug in	*	*	*	*
Slug Out	5.5×10^{-4}	48.25	0.01702	0.25
AVERAGE VALUES				
Slug In	5.83×10^{-4}	50.83	0.0178	0.26
Slug Out	5.81×10^{-4}	50.80	0.0179	0.26
Average Hydraulic Conduct. Results/ Groundwater Flow Velocity	5.82×10^{-4}	50.815	0.01785	0.26

* Invalid data

TABLE 10

GROUNDWATER LEAD CONCENTRATION
PARTS PER MILLION (ppm)
BX SERVICE STATION
TYNDALL AIR FORCE BASE
BAY COUNTY, FLORIDA

Location I.D.	Date	Reportable Limits	Results	MCL[1]
MWD-01-97	21 May 97	0.003	ND	0.015
MW-02-97	21 May 97	0.003	**0.028**	0.015
MW-03-97	21 May 97	0.003	ND	0.015
MW-04-97	22 May 97	0.003	ND	0.015
MW-05-97	21 May 97	0.003	0.003	0.015
MW-06-97	21 May 97	0.003	ND	0.015
MW-07-97	21 May 97	0.003	ND	0.015
MW-08-97	22 May 97	0.003	ND	0.015
MWD-10-97	22 May 97	0.003	ND	0.015
MW-01	21 May 97	0.003	ND	0.015
MW-03	21 May 97	0.003	0.006	0.015
MW-04	21 May 97	0.003	ND	0.015
MW-05	21 May 97	0.003	**0.062**	0.15
MW-06	21 May 97	0.003	ND	0.015
MW-07	22 May 97	0.003	0.004	0.015
MW-08	21 May 97	0.003	ND	0.015
MW-09	21 May 97	0.003	0.004	0.015
MW-20	21 May 97	0.003	**0.057**	0.015
MW-21	22 May 97	0.003	ND	0.015
Initial Equip. Blank	21 May 97	0.003	ND	0.015
Equip. Blank # 2	22 May 97	0.003	ND	0.015

ND = Non Detected

Bold/Shade = Exceeds Regualtory Threshold

(1) = FDEP, Chapter 62-770, Petroleum Contamination Site Clean up Criteria.

TABLE 9

EDB GROUNDWATER CONCENTRATION
PARTS PER BILLION (ppb)

Location I.D.	Date	Reportable Limits	Results	MCL[1]
MWD-01-97 Deep	21 May 97	0.02	ND	0.02
MW-02-97	21 May 97	0.02	ND	0.02
MW-03-97	21 May 97	0.02	ND	0.02
MW-04-97 Deep	22 May 97	0.02	ND	0.02
MW-05-97	21 May 97	0.02	ND	0.02
MW-06-07	21 May 97	0.02	ND	0.02
MW-07-97	21 May 97	0.02	ND	0.02
MW-08-97	22 May 97	0.02	ND	0.02
MWD-10-97	22 May 97	0.02	ND	0.02
MW-01	21 May 97	0.02	ND	0.02
MW-03	21 May 97	0.02	ND	0.02
MW-04	21 May 97	0.02	ND	0.02
MW-05	21 May 97	0.02	ND	0.02
MW-06	21 May 97	0.02	ND	0.02
MW-07	22 May 97	0.02	ND	0.02
MW-08	21 May 97	0.02	ND	0.02
MW-09	21 May 97	0.02	ND	0.02
MW-20	21 May 97	0.02	ND	0.02
MW-21	22 May 97	0.02	ND	0.02
Initial Equip. Blank	21 May 97	0.02	ND	0.02
Equip. Blank # 2	22 May 97	0.02	ND	0.02

(1) = FDEP, Chapter 62-770, Petroleum Contemaination Site Clean up Criteria.
ND = Non Detected

TABLE 8 (Con't)
GROUNDWATER VOLATILE ANALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (ug/l)					
	Laboratory Detection Limits	MW-21	Initial Equip. Blank	Equip.Blank #2	Standards(1)	
		5/22/97	5/21/97	5/21/97	MCL	Source
Volatiles						
Benzene	1	ND	ND	ND	1	FDEP/62-770
Bromodichloromethane	1	ND	ND	ND	0.6	FDEP GW Criteria
Bromoform	2	ND	ND	ND	4	FDEP GW Criteria
Bromomethane	2	ND	ND	ND	10	FDEP GW Criteria
Carbon Tetrachloride	1	ND	ND	ND	3	FDEP GW Criteria
Chlorobenzene	1	ND	ND	ND	100	FDEP GW Criteria
Chloroethane	5	ND	ND	ND	140	FDEP GW Criteria
2-chloroethylvinylether	5	ND	ND	ND	1	NA
Chloroform	2	ND	ND	ND	6	FDEP GW Criteria
Chloromethane	5	ND	ND	ND	2.7	FDEP GW Criteria
Dibromochloromethane	5	ND	ND	ND	1	FDEP GW Criteria
1,2-dichlorobenzene	2	ND	ND	ND	600	FDEP GW Criteria
1,3-dichlorobenzene	2	ND	ND	ND	10	FDEP GW Criteria
1,4-dichlorobenzene	2	ND	ND	ND	75	FDEP GW Criteria
Dichlorodifluoromethane	5	ND	ND	ND	1400	NA
1,1-dichloroethane	1	ND	ND	ND	700	FDEP GW Criteria
1,2-dichloroethane	1	ND	ND	ND	3	FDEP GW Criteria
1,1-dichloroethene	1	ND	ND	ND	7	FDEP GW Criteria
Trans-1,2-dichloroethene	1	ND	ND	ND	—	NA
1,2-dichloropropane	1	ND	ND	ND	5	FDEP GW Criteria
Cis-1,3-dichloropropene	1	ND	ND	ND	—	NA
Trans-1,3-dichloropropene	1	ND	ND	ND	0.077	NA
Ethylbenzene	1	ND	ND	ND	30	FDEP GW Criteria
Methylene Chloride	5	ND	ND	ND	2.7	FDEP GW Criteria
Methyl-T-butyl ether	5	ND	ND	ND	50	NA
1,1,2,2-tetrachloroethane	1	ND	ND	ND	0.2	FDEP GW Criteria
Tetrachloroethene	3	ND	ND	ND	3	FDEP GW Criteria
Toluene	5	ND	ND	ND	40	FDEP GW Criteria
1,1,1-trichloroethane	1	ND	ND	ND	200	FDEP GW Criteria
1,1,2-trichloroethane	2	ND	ND	ND	5	FDEP GW Criteria
Trichloroethene	1	ND	ND	ND	3	FDEP GW Criteria
Trichlorofluoromethane	2	ND	ND	ND	2100	NA
Vinyl Chloride	1	ND	ND	ND	1	FDEP GW Criteria
Xylenes (Total)	2	4	2	2	10,000	FDEP GW Criteria
Total VOA	-	4	2	2	50	FDEP/62-770

(1) = Levels derived from Florida Department Groundwater Guidance concentrations, dated June 1994, and FDEP, Chapter 62-700, Petroleum Contamination Site Clean-up Criteria

ND = Non-Detection of Analyte

Bold/Shade = Chemical of Potential Concern

NA = None Available

— = Not Applicable

TABLE 8 (Con't)
GROUNDWATER VOLATILE ANALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (ug/l)					
	Laboratory Detection Limits	MW-08	MW-09	DUP MW-05 MW-20	Standards(1)	
		5/21/97	5/21/97	5/21/97	MCL	Source
Volatiles						
Benzene	1	ND	ND	[redacted]	1	FDEP/62-770
Bromodichloromethane	1	ND	ND	ND	0.6	FDEP GW Criteria
Bromoform	2	ND	ND	ND	4	FDEP GW Criteria
Bromomethane	2	ND	ND	ND	10	FDEP GW Criteria
Carbon Tetrachloride	1	ND	ND	ND	3	FDEP GW Criteria
Chlorobenzene	1	ND	ND	ND	100	FDEP GW Criteria
Chloroethane	5	ND	ND	ND	140	FDEP GW Criteria
2-chloroethylvinylether	5	ND	ND	ND	1	NA
Chloroform	2	ND	ND	ND	6	FDEP GW Criteria
Chloromethane	5	ND	ND	ND	2.7	FDEP GW Criteria
Dibromochloromethane	5	ND	ND	ND	1	FDEP GW Criteria
1,2-dichlorobenzene	2	ND	ND	ND	600	FDEP GW Criteria
1,3-dichlorobenzene	2	ND	ND	ND	10	FDEP GW Criteria
1,4-dichlorobenzene	2	ND	ND	ND	75	FDEP GW Criteria
Dichlorodifluoromethane	5	ND	ND	ND	1400	NA
1,1-dichloroethane	1	ND	ND	ND	700	FDEP GW Criteria
1,2-dichloroethane	1	ND	ND	ND	3	FDEP GW Criteria
1,1-dichloroethene	1	ND	ND	ND	7	FDEP GW Criteria
Trans-1,2-dichloroethene	1	ND	ND	ND	—	NA
1,2-dichloropropane	1	ND	ND	ND	5	FDEP GW Criteria
Cis-1,3-dichloropropene	1	ND	ND	ND	—	NA
Trans-1,3-dichloropropene	1	ND	ND	ND	0.077	NA
Ethylbenzene	1	ND	ND	[redacted]	30	FDEP GW Criteria
Methylene Chloride	5	ND	ND	ND	2.7	FDEP GW Criteria
Methyl-T-butyl ether	5	ND	ND	[redacted]	50	NA
1,1,2,2-tetrachloroethane	1	ND	ND	ND	0.2	FDEP GW Criteria
Tetrachloroethene	3	ND	ND	ND	3	FDEP GW Criteria
Toluene	5	ND	ND	ND	40	FDEP GW Criteria
1,1,1-trichloroethane	1	ND	ND	ND	200	FDEP GW Criteria
1,1,2-trichloroethane	2	ND	ND	ND	5	FDEP GW Criteria
Trichloroethene	1	ND	ND	ND	3	FDEP GW Criteria
Trichlorofluoromethane	2	ND	ND	ND	2100	NA
Vinyl Chloride	1	ND	ND	ND	1	FDEP GW Criteria
Xylenes (Total)	2	ND	ND	48	10,000	FDEP GW Criteria
Total VOA	-	ND	ND	[redacted]	50	FDEP/62-770

(1) = Levels derived from Florida Department Groundwater Guidance concentrations dated June 1994, and FDEP Chapter 62-700, Petroleum Contamination Site Clean-up Criteria

ND = Non-Detection of Analyte

Bold/Shade = Chemical of Potential Concern

NA = None Available

— = Not Applicable

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TABLE 8 (Con't)
GROUNDWATER VOLATILE ANALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (ug/l)					
	Laboratory Detection Limits	MW-05	MW-06	MW-07	Standards(1)	
		5/21/97	5/21/97	5/22/97	MCL	Source
Volatiles						
Benzene	1	[redacted]	ND	[redacted]	1	FDEP/62-770
Bromodichloromethane	1	ND	ND	ND	0.6	FDEP GW Criteria
Bromoform	2	ND	ND	ND	4	FDEP GW Criteria
Bromomethane	2	ND	ND	ND	10	FDEP GW Criteria
Carbon Tetrachloride	1	ND	ND	ND	3	FDEP GW Criteria
Chlorobenzene	1	ND	ND	ND	100	FDEP GW Criteria
Chloroethane	5	ND	ND	ND	140	FDEP GW Criteria
2-chloroethylvinylether	5	ND	ND	ND	1	NA
Chloroform	2	ND	ND	ND	6	FDEP GW Criteria
Chloromethane	5	ND	ND	ND	2.7	FDEP GW Criteria
Dibromochloromethane	5	ND	ND	ND	1	FDEP GW Criteria
1,2-dichlorobenzene	2	ND	ND	ND	600	FDEP GW Criteria
1,3-dichlorobenzene	2	ND	ND	ND	10	FDEP GW Criteria
1,4-dichlorobenzene	2	ND	ND	ND	75	FDEP GW Criteria
Dichlorodifluoromethane	5	ND	ND	ND	1400	NA
1,1-dichloroethane	1	ND	ND	ND	700	FDEP GW Criteria
1,2-dichloroethane	1	ND	ND	ND	3	FDEP GW Criteria
1,1-dichloroethene	1	ND	ND	ND	7	FDEP GW Criteria
Trans-1,2-dichloroethene	1	ND	ND	ND	—	NA
1,2-dichloropropane	1	ND	ND	ND	5	FDEP GW Criteria
Cis-1,3-dichloropropene	1	ND	ND	ND	—	NA
Trans-1,3-dichloropropene	1	ND	ND	ND	0.077	NA
Ethylbenzene	1	[redacted]	[redacted]	[redacted]	30	FDEP GW Criteria
Methylene Chloride	5	ND	ND	ND	2.7	FDEP GW Criteria
Methyl-T-butyl ether	5	[redacted]	ND	[redacted]	50	NA
1,1,2,2-tetrachloroethane	1	ND	ND	ND	0.2	FDEP GW Criteria
Tetrachloroethene	3	ND	ND	ND	3	FDEP GW Criteria
Toluene	5	ND	ND	[redacted]	40	FDEP GW Criteria
1,1,1-trichloroethane	1	ND	ND	ND	200	FDEP GW Criteria
1,1,2-trichloroethane	2	ND	ND	ND	5	FDEP GW Criteria
Trichloroethene	1	ND	ND	ND	3	FDEP GW Criteria
Trichlorofluoromethane	2	ND	ND	ND	2100	NA
Vinyl Chloride	1	ND	ND	ND	1	FDEP GW Criteria
Xylenes (Total)	2	[redacted] 55	ND	[redacted] 980	10,000	FDEP GW Criteria
Total VOA	-	[redacted]	[redacted] 6	[redacted]	50	FDEP/62-770

(1) = Levels derived from Florida Department Groundwater Guidance concentrations, dated June 1994, and FDEP, Chapter 62-700, Petroleum Contamination Site Clean-up Criteria

ND = Non-Detection of Analyte

Bold/Shade = Chemical of Potential Concern

NA = None Available

— = Not Applicable

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TABLE 8 (Con't)
GROUNDWATER VOLATILE ANALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (ug/l)					
	Laboratory Detection Limits	MW-01	MW-03	MW-04	Standards(1)	
		5/21/97	5/21/97	5/21/97	MCL	Source
Volatiles						
Benzene	1	ND	[redacted]	ND	1	FDEP/62-770
Bromodichloromethane	1	ND	ND	ND	0.6	FDEP GW Criteria
Bromoform	2	ND	ND	ND	4	FDEP GW Criteria
Bromomethane	2	ND	ND	ND	10	FDEP GW Criteria
Carbon Tetrachloride	1	ND	ND	ND	3	FDEP GW Criteria
Chlorobenzene	1	ND	ND	ND	100	FDEP GW Criteria
Chloroethane	5	ND	ND	ND	140	FDEP GW Criteria
2-chloroethylvinylether	5	ND	ND	ND	1	NA
Chloroform	2	ND	ND	ND	6	FDEP GW Criteria
Chloromethane	5	ND	ND	ND	2.7	FDEP GW Criteria
Dibromochloromethane	5	ND	ND	ND	1	FDEP GW Criteria
1,2-dichlorobenzene	2	ND	ND	ND	600	FDEP GW Criteria
1,3-dichlorobenzene	2	ND	ND	ND	10	FDEP GW Criteria
1,4-dichlorobenzene	2	ND	ND	ND	75	FDEP GW Criteria
Dichlorodifluoromethane	5	ND	ND	ND	1400	NA
1,1-dichloroethane	1	ND	ND	ND	700	FDEP GW Criteria
1,2-dichloroethane	1	ND	ND	ND	3	FDEP GW Criteria
1,1-dichloroethene	1	ND	ND	ND	7	FDEP GW Criteria
Trans-1,2-dichloroethene	1	ND	ND	ND	—	NA
1,2-dichloropropane	1	ND	ND	ND	5	FDEP GW Criteria
Cis-1,3-dichloropropene	1	ND	ND	ND	—	NA
Trans-1,3-dichloropropene	1	ND	ND	ND	0.077	NA
Ethylbenzene	1	ND	[redacted]	[redacted]	30	FDEP GW Criteria
Methylene Chloride	5	ND	ND	ND	2.7	FDEP GW Criteria
Methyl-T-butylether	5	ND	[redacted]	ND	50	NA
1,1,2,2-tetrachloroethane	1	ND	ND	ND	0.2	FDEP GW Criteria
Tetrachloroethene	3	ND	ND	ND	3	FDEP GW Criteria
Toluene	5	ND	[redacted]	ND	40	FDEP GW Criteria
1,1,1-trichloroethane	1	ND	ND	ND	200	FDEP GW Criteria
1,1,2-trichloroethane	2	ND	ND	ND	5	FDEP GW Criteria
Trichloroethene	1	ND	ND	ND	3	FDEP GW Criteria
Trichlorofluoromethane	2	ND	ND	ND	2100	NA
Vinyl Chloride	1	ND	ND	ND	1	FDEP GW Criteria
Xylenes (Total)	2	ND	[redacted]	2300	10,000	FDEP GW Criteria
Total VOA	-	-	[redacted]	[redacted]	50	FDEP/62-770

(1) = Levels derived from Florida Department Groundwater Guidance concentrations, dated June 1994, and FDEP, Chapter 62-700, Petroleum Contamination Site Clean-up Criteria

ND = Non-Detection of Analyte

Bold/Shade = Chemical of Potential Concern

NA = None Available

— = Not Applicable

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TABLE 8 (Con't)
GROUNDWATER VOLATILE ANALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (ug/l)					
	Laboratory Detection Limits	MW-07-97	MW-08-97	MW-10-97	Standards(1)	
		5/21/97	5/22/97	5/22/97	MCL	Source
Volatiles						
Benzene	1	ND	ND	[redacted]	1	FDEP/62-770
Bromodichloromethane	1	ND	ND	ND	0.6	FDEP GW Criteria
Bromoform	2	ND	ND	ND	4	FDEP GW Criteria
Bromomethane	2	ND	ND	ND	10	FDEP GW Criteria
Carbon Tetrachloride	1	ND	ND	ND	3	FDEP GW Criteria
Chlorobenzene	1	ND	ND	ND	100	FDEP GW Criteria
Chloroethane	5	ND	ND	ND	140	FDEP GW Criteria
2-chloroethylvinylether	5	ND	ND	ND	1	NA
Chloroform	2	ND	ND	ND	6	FDEP GW Criteria
Chloromethane	5	ND	ND	ND	2.7	FDEP GW Criteria
Dibromochloromethane	5	ND	ND	ND	1	FDEP GW Criteria
1,2-dichlorobenzene	2	ND	ND	ND	600	FDEP GW Criteria
1,3-dichlorobenzene	2	ND	ND	ND	10	FDEP GW Criteria
1,4-dichlorobenzene	2	ND	ND	ND	75	FDEP GW Criteria
Dichlorodifluoromethane	5	ND	ND	ND	1400	NA
1,1-dichloroethane	1	ND	ND	ND	700	FDEP GW Criteria
1,2-dichloroethane	1	ND	ND	ND	3	FDEP GW Criteria
1,1-dichloroethene	1	ND	ND	ND	7	FDEP GW Criteria
Trans-1,2-dichloroethene	1	ND	ND	ND	—	NA
1,2-dichloropropane	1	ND	ND	ND	5	FDEP GW Criteria
Cis-1,3-dichloropropene	1	ND	ND	ND	—	NA
Trans-1,3-dichloropropene	1	ND	ND	ND	0.077	NA
Ethylbenzene	1	ND	ND	[redacted]	30	FDEP GW Criteria
Methylene Chloride	5	ND	ND	ND	2.7	FDEP GW Criteria
Methyl-T-butyl ether	5	ND	ND	ND	50	NA
1,1,2,2-tetrachloroethane	1	ND	ND	ND	0.2	FDEP GW Criteria
Tetrachloroethene	3	ND	ND	ND	3	FDEP GW Criteria
Toluene	5	ND	ND	[redacted]	40	FDEP GW Criteria
1,1,1-trichloroethane	1	ND	ND	ND	200	FDEP GW Criteria
1,1,2-trichloroethane	2	ND	ND	ND	5	FDEP GW Criteria
Trichloroethene	1	ND	ND	ND	3	FDEP GW Criteria
Trichlorofluoromethane	2	ND	ND	ND	2100	NA
Vinyl Chloride	1	ND	ND	ND	1	FDEP GW Criteria
Xylenes (Total)	2	ND	ND	[redacted] 2300	10,000	FDEP GW Criteria
Total VOA	-	ND	ND	[redacted]	50	FDEP/62-770

(1) = Levels derived from Florida Department Groundwater Guidance concentrations, dated June 1994, and FDEP, Chapter 62-700, Petroleum Contamination Site Clean-up Criteria.

ND = Non-Detection of Analyte

Bold/Shade = Chemical of Potential Concern

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— = Not Applicable

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TABLE 8 (Con't)
GROUNDWATER VOLATILE ANALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (ug/l)					
	Laboratory Detection Limits	MWD-04-97	MW-05-97	MW-06-97	Standards(1)	
		5/22/97	5/21/97	5/21/97	MCL	Source
Volatiles						
Benzene	1	ND	ND	ND	1	FDEP/62-770
Bromodichloromethane	1	ND	ND	ND	0.6	FDEP GW Criteria
Bromoform	2	ND	ND	ND	4	FDEP GW Criteria
Bromomethane	2	ND	ND	ND	10	FDEP GW Criteria
Carbon Tetrachloride	1	ND	ND	ND	3	FDEP GW Criteria
Chlorobenzene	1	ND	ND	ND	100	FDEP GW Criteria
Chloroethane	5	ND	ND	ND	140	FDEP GW Criteria
2-chloroethylvinylether	5	ND	ND	ND	1	NA
Chloroform	2	ND	ND	ND	6	FDEP GW Criteria
Chloromethane	5	ND	ND	ND	2.7	FDEP GW Criteria
Dibromochloromethane	5	ND	ND	ND	1	FDEP GW Criteria
1,2-dichlorobenzene	2	ND	ND	ND	600	FDEP GW Criteria
1,3-dichlorobenzene	2	ND	ND	ND	10	FDEP GW Criteria
1,4-dichlorobenzene	2	ND	ND	ND	75	FDEP GW Criteria
Dichlorodifluoromethane	5	ND	ND	ND	1400	NA
1,1-dichloroethane	1	ND	ND	ND	700	FDEP GW Criteria
1,2-dichloroethane	1	ND	ND	ND	3	FDEP GW Criteria
1,1-dichloroethene	1	ND	ND	ND	7	FDEP GW Criteria
Trans-1,2-dichloroethene	1	ND	ND	ND	—	NA
1,2-dichloropropane	1	ND	ND	ND	5	FDEP GW Criteria
Cis-1,3-dichloropropene	1	ND	ND	ND	—	NA
Trans-1,3-dichloropropene	1	ND	ND	ND	0.077	NA
Ethylbenzene	1	ND	ND	ND	30	FDEP GW Criteria
Methylene Chloride	5	ND	ND	ND	2.7	FDEP GW Criteria
Methyl-T-butyl ether	5	ND	ND	ND	50	NA
1,1,2,2-tetrachloroethane	1	ND	ND	ND	0.2	FDEP GW Criteria
Tetrachloroethene	3	ND	ND	ND	3	FDEP GW Criteria
Toluene	5	ND	ND	ND	40	FDEP GW Criteria
1,1,1-trichloroethane	1	ND	ND	ND	200	FDEP GW Criteria
1,1,2-trichloroethane	2	ND	ND	ND	5	FDEP GW Criteria
Trichloroethene	1	ND	ND	ND	3	FDEP GW Criteria
Trichlorofluoromethane	2	ND	ND	ND	2100	NA
Vinyl Chloride	1	ND	ND	ND	1	FDEP GW Criteria
Xylenes (Total)	2	**5**	ND	ND	10,000	FDEP GW Criteria
Total VOA	-	**5**	ND	ND	50	FDEP/62-770

(1) = Levels derived from Florida Department Groundwater Guidance concentrations, dated June 1994, and FDEP Chapter 62-700, Petroleum Contamination Site Clean-up Criteria

ND = Non-Detection of Analyte

Bold/Shade = Chemical of Potential Concern

NA = None Available

— = Not Applicable

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TABLE 8
GROUNDWATER VOLATILE ANALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (ug/l)					
	Laboratory Detection Limits	MWD-01-97 5/21/97	MW-02-97 5/21/97	MW-03-97 5/21/97	Standards(1) MCL	Source
Volatiles						
Benzene	1	ND	ND	ND	1	FDEP/62-770
Bromodichloromethane	1	ND	ND	ND	0.6	FDEP GW Criteria
Bromoform	2	ND	ND	ND	4	FDEP GW Criteria
Bromomethane	2	ND	ND	ND	10	FDEP GW Criteria
Carbon Tetrachloride	1	ND	ND	ND	3	FDEP GW Criteria
Chlorobenzene	1	ND	ND	ND	100	FDEP GW Criteria
Chloroethane	5	ND	ND	ND	140	FDEP GW Criteria
2-chloroethylvinylether	5	ND	ND	ND	—	NA
Chloroform	2	ND	ND	ND	6	FDEP GW Criteria
Chloromethane	5	ND	ND	ND	2.7	FDEP GW Criteria
Dibromochloromethane	5	ND	ND	ND	1	FDEP GW Criteria
1,2-dichlorobenzene	2	ND	ND	ND	600	FDEP GW Criteria
1,3-dichlorobenzene	2	ND	ND	ND	10	FDEP GW Criteria
1,4-dichlorobenzene	2	ND	ND	ND	75	FDEP GW Criteria
Dichlorodifluoromethane	5	ND	ND	ND	—	NA
1,1-dichloroethane	1	ND	ND	ND	700	FDEP GW Criteria
1,2-dichloroethane	1	ND	ND	ND	3	FDEP GW Criteria
1,1-dichloroethene	1	ND	ND	ND	7	FDEP GW Criteria
Trans-1,2-dichloroethene	1	ND	ND	ND	—	NA
1,2-dichloropropane	1	ND	ND	ND	5	FDEP GW Criteria
Cis-1,3-dichloropropene	1	ND	ND	ND	—	NA
Trans-1,3-dichloropropene	1	ND	ND	ND	0.077	NA
Ethylbenzene	1	[redacted]	[redacted]	ND	30	FDEP GW Criteria
Methylene Chloride	5	ND	ND	ND	2.7	FDEP GW Criteria
Methyl-T-butyl ether	5	ND	ND	ND	—	NA
1,1,2,2-tetrachloroethane	1	ND	ND	ND	0.2	FDEP GW Criteria
Tetrachloroethene	3	ND	ND	ND	3	FDEP GW Criteria
Toluene	5	ND	ND	ND	40	FDEP GW Criteria
1,1,1-trichloroethane	1	ND	ND	ND	200	FDEP GW Criteria
1,1,2-trichloroethane	2	ND	ND	ND	5	FDEP GW Criteria
Trichloroethene	1	ND	ND	ND	3	FDEP GW Criteria
Trichlorofluoromethane	2	ND	ND	ND	—	NA
Vinyl Chloride	1	ND	ND	ND	1	FDEP GW Criteria
Xylenes (Total)	2	10	1500	ND	10,000	FDEP GW Criteria
Total VOA	-	[redacted]	[redacted]	ND	50	FDEP/62-770

(1) = Levels derived from Florida Department Groundwater Guidance concentrations, dated June 1994, and FDEP, Chapter 62-700, Petroleum Contamination Site Clean-up Criteria

ND = Non-Detection of Analyte

Bold/Shade = Chemical of Potential Concern

NA = None Available

— = Not Applicable

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TABLE 7 (Cont'd)

DIRECT PUSH GROUNDWATER ANALYTICAL RESULTS (ppb)
BX SERVICE STATION
TYNDALL AIR FORCE BASE
BAY COUNTY, FLORIDA

PARAMETER	DIRECT PUSH SAMPLE I.D., DATE SAMPLED AND RESULTS (PPB)						
	BX-DP-30 4/10/97	BX-DP-31 4/10/97	BX-DP-32 4/10/97	BX-DP-33 4/10/97	Rinse 4/10/97	MCL's	REFERENCE STANDARD
VOLATILES							
Benzene	ND	43	ND	ND	ND	1	FDEP 62-770 (1)
Toluene	ND	ND	ND	ND	ND	1000	FDEP GW-Criteria (2)
Ethylbenzene	ND	120	ND	4.2	ND	700	FDEP GW-Criteria
Total Xylenes	ND	340	ND	29.3	ND	10000	FDEP GW-Criteria
Total BTEX	ND	503	ND	33.5	ND	50	FDEP 62-770
Naphthalene	ND	20.1	ND	ND	ND	100	FDEP 62-770
PQL for BTEX	2.0	2.0	2.0	2.0	2.0	NA	---
PQL for Naphthalene	10	10	10	10	10	NA	---

(1) = Florida Department of Environmental Protection s(FDEP) Chapter 62-770, Petroleum Contamination Site Clean-up Critera.
(2) = FDEP, Florida Groundwater Guidance concentrations, June 1994.

TABLE 7 (Cont'd)

DIRECT PUSH GROUNDWATER ANALYTICAL RESULTS (ppb)
BX SERVICE STATION
TYNDALL AIR FORCE BASE
BAY COUNTY, FLORIDA

PARAMETER	DIRECT PUSH SAMPLE I.D., DATE SAMPLED AND RESULTS (PPB)							MCL	REFERENCE
	BX-DP-23 4/10/97	BX-DP-24 4/10/97	BX-DP-25 4/10/97	BX-DP-26 4/10/97	BX-DP-27 4/10/97	BX-DP-28 4/10/97	BX-DP-29 4/10/97		STANDARD
VOLATILES									
Benzene	ND	ND	160	ND	5.6	51	ND	1	FDEP 62-770 [1]
Toluene	ND	ND	ND	ND	4.1	ND	ND	1000	FDEP GW-Criteria [2]
Ethylbenzene	ND	ND	1400d	ND	39	470	ND	700	FDEP GW-Criteria
Total Xylenes	ND	ND	940	ND	210	850	ND	10000	FDEP GW-Criteria
Total BTEX	ND	ND	2500	ND	258.7	1371	ND	50	FDEP 62-770
Naphthalene	ND	ND	67.5	ND	ND	47.5	ND	100	FDEP 62-770
PQL for BTEX	2.0	2.0	10	2.0	2.0	10	2.0	NA	---
PQL for Naphthalene	10	10	10	10	10	10	10	NA	---

(1) = Florida Department of Environmental Protection s(FDEP) Chapter 62-770, Petroleum Contamination Site Clean-up Critera.
(2) = FDEP, Florida Groundwater Guidance concentrations, June 1994.

TABLE 7 (Cont'd)

DIRECT PUSH GROUNDWATER ANALYTICAL RESULTS (ppb)
BX SERVICE STATION
TYNDALL AIR FORCE BASE
BAY COUNTY, FLORIDA

PARAMETER	DIRECT PUSH SAMPLE I.D., DATE SAMPLED AND RESULTS (PPB)							MCL's	REFERENCE
	BX-DP-16 4/9/97	BX-DP-17 4/9/97	BX-DP-18 4/9/97	BX-DP-19 4/9/97	BX-DP-20 4/9/97	BX-DP-21 4/9/97	BX-DP-22 4/10/97		STANDARD
VOLATILES									
Benzene	4900	2700	190	ND	ND	ND	ND	1	FDEP 62-770 (1)
Toluene	6000	3100	3.3	ND	ND	ND	ND	1000	FDEP GW-Criteria (2)
Ethylbenzene	2500	3100	170	ND	ND	ND	ND	700	FDEP GW-Criteria
Total Xylenes	12000	21000	2	2.1	ND	ND	ND	10000	FDEP GW-Criteria
Total BTEX	25400	29900	365.3	2.1	ND	ND	ND	50	FDEP 62-770
Naphthalene	143.9	85.3	37.2	ND	ND	ND	ND	100	FDEP 62-770
PQL for BTEX	2.0	200	2.0	2.0	2.0	2.0	2.0	NA	---
PQL for Naphthalene	10	10	10	10	10	10	10	NA	---

(1) = Florida Department of Environmental Protection s(FDEP) Chapter 62-770, Petroleum Contamination Site Clean-up Critera.
(2) = FDEP, Florida Groundwater Guidance concentrations, June 1994.

TABLE 7

DIRECT PUSH GROUNDWATER ANALYTICAL RESULTS (ppb)
BX SERVICE STATION
TYNDALL AIR FORCE BASE
BAY COUNTY, FLORIDA

PARAMETER	DIRECT PUSH SAMPLE I.D., DATE SAMPLED AND RESULTS (PPB)								
	BX-DP-09 4/9/97	BX-DP-10 4/9/97	BX-DP-11 4/9/97	BX-DP-12 4/9/97	BX-DP-13 4/9/97	BX-DP-14 4/9/97	BX-DP-15 4/9/97	MCL's	REFERENCE STANDARD
VOLATILES									
Benzene	ND	ND	200	1400	330	3.9	3800	1	FDEP 62-770 (1)
Toluene	ND	ND	7.2	1300	1600	20	240	1000	FDEP GW-Criteria (2)
Ethylbenzene	ND	ND	ND	2100	6300	22	2400	700	FDEP GW-Criteria
Total Xylenes	ND	ND	3.9	7200	28000	120	5000	10000	FDEP GW-Criteria
Total BTEX	ND	ND	211.1	12200	36430	165.9	11440	50	FDEP 62-770
Naphthalene	ND	ND	95.2	152	257	ND	133.3	100	FDEP 62-770
PQL for BTEX	2.0	2.0	2.0	20	40	2.0	100	NA	---
PQL for Naphthalene	10	10	10	10	10	10	10	NA	---

(1) = Florida Department of Environmental Protection s(FDEP) Chapter 62-770, Petroleum Contamination Site Clean-up Critera.
(2) = FDEP, Florida Groundwater Guidance concentrations, June 1994.
d = Diluted Sample

TABLE 5-4 (Continued)
Groundwater Analytical Results Above Method Quantification Limits
BX Service Station
Tyndall Air Force Base
Bay County, Florida

PARAMETER	SAMPLE I.D., DATE SAMPLED AND RESULT (PPB)					
	BX MW-5 (7)	BX MW-5 (7)	BX MW-5S (7)	BX MW-6 (8)	BX MW-7 (8)	MCLS*
	9/27/96	9/27/96	9/27/96	9/27/96	9/27/96	
HALOGENATED VOLATILES						
Methylene Chloride	<1.0	<1.0	<1.0	10 B	<50	5.0
AROMATIC VOLATILES						
Benzene	510	500	406	<10	<10	1
Ethylbenzene	420	420	355	<10	<10	700
Toulene	590	740	706	<10	<10	1000
Total Xylenes	1810	1560	2780	<10	7	10000
Total Aromatic Volatiles	3300	3220	4249	<10	7	50
DBCP	BMQL	BMQL	BMQL	BMQL	BMQL	-----
EDB	BMQL	BMQL	BMQL	BMQL	BMQL	-----
SEMIVOLATILES						
Naphthalene	66	69	107	<10	<10	**100
2-Methylnaphthalene	47	51	82	<10	<10	**100
TRPH	3640	3510	2630	<400	<400	**5000
METALS						
Lead	10	13	21	3	2	50

TRPH = Total Recoverable Petroleum Hydrocarbons
** = Florida Clean-Up Standards for Hydrocarbon Contaminated Groundwater
* = Florida Drinking Water Standards, Florida administrative code, Title 62, Dept. of Environmental Protection, Chapter 62-770
BMQL = Below Method Quantification Limits
S = USACE Split Sample
DUP = Duplicate Sample
B = Methylene Chloride detected in method blank at 11.0 ppb
Bold/Shade = Value exceeds a regulatory threshold
E = Concentration exceeds the Calibration range for that specific analysis
EDB and DBCP - Ethylene dibromide and 1,2-dibromo-3-chloropropane

TABLE 5-4
Groundwater Analytical Results Above Method Quantification Limits
BX Service Station
Tyndall Air Force Base
Bay County, Florida

PARAMETER	SAMPLE I.D., DATE SAMPLED AND RESULT (PPB)						
	BX MW-1	BX MW-2	BX MW-2 DUP	BX MW-2 S	BX MW-3	BX MW-4	MCLS*
	4/6/95	4/6/95	4/6/95	4/4/95	4/6/95	4/6/95	
HALOGENATED VOLATILES							
Methylene Chloride	<1.0	<50	110	10 B	<50	<50	5.0
AROMATIC VOLATILES							
Benzene	<1.0	97	110	61	530	<50	1
Ethylbenzene	<1.0	940	1100	900	890	1500	700
Toulene	<1.0	4900	6000	5040	3600	590	1000
Total Xylenes	<1.0	10,000	13,000	10,400	8400	6500	10000
Total Aromatic Volatiles	<1.0	15,937	20,210	16,391	13,420	8590	50
DBCP	BMQL	BMQL	BMQL	BMQL	BMQL	BMQL	-----
EDB	BMQL	BMQL	BMQL	BMQL	BMQL	BMQL	-----
SEMIVOLATILES							
Naphthalene	<10	370	370	388	290	120	**100
2-Methylnaphthalene	<10	150	140	NA	100	<50	**100
TRPH	<400	6640	5220	2930	2600	1290	**5000
METALS							
Lead	5	9	13	18	4	3	50

TRPH = Total Recoverable Petroleum Hydrocarbons
** = Florida Clean-Up Standards for Hydrocarbon Contaminated Groundwater
* = Florida Drinking Water Standards, Florida administrative code, Title 62, Dept. of Environmental Protection, Chapter 62-770
BMQL = Below Method Quantification Limits
S = USACE Split Sample
DUP = Duplicate Sample
B = Methylene Chloride detected in method blank at 11.0 ppb
Bold/Shade = Value exceeds a regulatory threshold
E = Concentration exceeds the Calibration range for that specific analysis
EDB and DBCP - Ethylene dibromide and 1,2-dibromo-3-chloropropane

TABLE 6

SOIL TOTAL PETROLEUM HYDROCARBONS (TPH) CONCENTRATION
PARTS PER MILLION (ppm)
BX SERVICE STATION
TYNDALL AIR FORCE BASE
BAY COUNTY, FLORIDA

Location I.D.	Date	Reportable Limits (mg/kg)	Result (mg/kg)	OVA HEADSPACE (PPM)	
BX-HA-14 (0.5-2.5')	20 Mar 97	11	86	145	
BX-HA-16 (2.5-4.5')	20 Mar 97	11	520 Δ=0%	385	DUP
BX-HA-24 (2.5-4.5')	20 Mar 97	11	520	NR	
BX-HA-15 (2.5-4.5')	20 Mar 97	11	1000	>10,000	*
BX-HA-10 (2.5-4.5')	20 Mar 97	11	450	1490	
BX-HA-17 (0.5-2.5')	20 Mar 97	11	60	155	
BX-HA-25 (2.5-4.5')	2 Apr 97	11	400	3500	*
BX-HA-29 (2.5-4.5')	2 Apr 97	11	740	3100	
BX-HA-31 (2.5-4.5')	3 Apr 97	11	750	7000	
BX-HA-32 (2.5-4.5')	3 Apr 97	11	620 Δ=10%	2000	DUP
BX-HA-36 (2.5-4.5')	3 Apr 97	11	690	NR	

NR = No Reading Available

* PUMP ISLANDS - ALL OTHERS FORMER TANK PIT

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TABLE 5 (Con't)
SOIL - ACID AND BASE EXTRACTABLE ANALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (mg/kg)			
	Laboratory Detection Limits	BX-HA-32 (2.5-4.5) 4/03/97	BX-HA-36 (2.5-4.5) 4/03/97	Florida Selected Soil Clean-up Golas[1]
A-,A-dimethylphenethylamine	0.35	ND	ND	NA
Dimethylphthalate	0.35	ND	ND	630,000
Di-n-butylphthalate	0.35	ND	ND	7300
2,4-dinitrotoluene	0.35	ND	ND	130
2,6-dinitrotoluene	0.35	ND	ND	71
Di-n-octylphthalate	0.35	ND	ND	1500
Diphenylamine	0.35	ND	ND	NA
1,2-diphenylhydrazine	0.35	ND	ND	NA
Fluoranthene	0.35	ND	ND	2900
Fluorene	0.35	ND	ND	2400
Hexachlorobenzene	0.35	ND	ND	0.6
Hexachlorobutadiene	0.35	ND	ND	3.1
Hexachlorocyclopentadiene	0.35	ND	ND	NA
Hexachloroethane	0.35	ND	ND	27
Indeno(1,2,3,-cd)pyrene	0.35	ND	ND	1.4
Isophorone	0.35	ND	ND	NA
3-methylcholanthrene	0.35	ND	ND	NA
2-methylnaphthalene	0.35	41	46	960
Naphthalene	0.35	4.9	20	1300
1-naphthylamine	0.35	ND	ND	NA
2-naphthylamine	0.35	ND	ND	NA
2-nitroaniline	0.35	ND	ND	NA
3-nitroaniline	0.35	ND	ND	NA
4-nitroaniline	0.35	ND	ND	NA
Nitrobenzene	0.35	ND	ND	22
N-nitrosodimethyamine	0.35	ND	ND	0.003
N-mitrosodi-n-butylamine	0.35	ND	ND	NA
N-nitrosodiphenylamine	0.35	ND	ND	73
N-nitroso-di-n-propylamine	0.35	ND	ND	0.02
N-nitrosopiperdine	0.35	ND	ND	NA
Pentachlorobenzene	0.35	ND	ND	NA
Pentachloronitrobenzene(pcnb)	0.35	ND	ND	NA
Phenacetin	0.35	ND	ND	NA
Phenanthrene	0.35	ND	ND	1700
2-picoline	0.35	ND	ND	NA
Pronamide	0.35	ND	ND	NA
Pyrene	0.35	ND	ND	2200
1,2,4,5-tetrachlorobenzene	0.35	ND	ND	NA
1,2,4 trichlorobenzene	0.35	ND	ND	590

(1) = Screening Levels derived from Florida Soil Clean-up Goals, dated September 27, 1995. Residental Goals are used.
ND = Non-Detection of Analyte
NA = No Clean-up Goal Available

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TABLE 5 (Con't)
SOIL - ACID AND BASE EXTRACTABLE ANALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (mg/kg)			
	Laboratory Detection Limits	BX-HA-32 (2.5-4.5) 4/03/97	BX-HA-36 (2.5-4.5) 4/03/97	Florida Selected Soil Clean-up Golas[1]
Acid & Base Extractables				
Benzoic Acid	1.8	ND	ND	130,000
4-chloro-3-methylphenol	0.35	ND	ND	NA
2-chlorophenol	0.35	ND	ND	280
2,4-dichlorophenol	0.35	ND	ND	220
2,6-dichlorophenol	0.35	ND	ND	NA
2,4-dimethylphenol	0.35	ND	ND	1800
4,6-dinitro-2-methylphenol	1.8	ND	ND	NA
2,4-dinitrophenol	1.8	ND	ND	NA
2-methyphenol	0.35	ND	ND	2600
4-methylphenol	0.35	ND	ND	340
2-nitrophenol	0.35	ND	ND	NA
4-nitrophenol	1.8	ND	ND	NA
Pentachlorophenol	1.8	ND	ND	5.4
Phenol	0.35	ND	ND	34,000
2,3,4,6-tetrachlorophenol	0.35	ND	ND	NA
2,4,5-trichlorophenol	1.8	ND	ND	7100
2,4,6-trichlorophenol	0.35	ND	ND	87
Acenaphthene	0.35	ND	ND	2800
Acenaphthylene	0.35	ND	ND	670
Acetophenone	0.35	ND	ND	NA
4-aminobiphenyl	0.35	ND	ND	NA
Aniline	0.35	ND	ND	NA
Anthracene	0.35	ND	ND	20,000
Benzidine	0.35	ND	ND	NA
Benzo(a)anthracene	0.35	ND	ND	1.4
Benzo(a)pyrene	0.35	ND	ND	0.1
Benzo(b)fluoranthene	0.35	ND	ND	1.4
Benzo(g,h,i)perylene	0.35	ND	ND	14
Benzo(k)fluoranthene0.	0.35	ND	ND	14
Benzyl alcohol	0.35	ND	ND	NA
Bis(2-chloroethoxy)methane	0.35	ND	ND	170
Bis(2-chloroethyl)ether	0.35	ND	ND	0.5
Bis(2-chloroisopropyl)ether	0.35	ND	ND	NA
Bis(2-ethylhexyl)phthalate	0.35	ND	ND	48
4-bromophenyl phenyl ether	0.35	ND	ND	NA
Butylbenzyl phthalate	0.35	ND	ND	15000
4-chloroaniline	0.35	ND	ND	240
1-chloronaphthalene	0.35	ND	ND	NA
2-chlorophenyl phenyl ether	0.35	ND	ND	NA
Chrysene	0.35	ND	ND	140
Dibenz(a,j)acridine	0.35	ND	ND	NA
Dibenzo(a,h)anthracene	0.35	ND	ND	0.1
Dibenzofuran	0.35	ND	ND	240
1,2-dichlorobenzene	0.35	ND	ND	820
1,3-dichlorobenzene	0.35	ND	ND	1700
1,4-dichlorobenzene	0.35	ND	ND	7.5
3,3'-dichlorobenzidine	1.8	ND	ND	NA
Diethyphthalate	0.35	ND	ND	56,000
P-dimethyllaminoazobenzene	0.35	ND	ND	NA
7,12-dimethylbenz(a)anthracene	0.35	ND	ND	NA

(1) = Screening Levels derived from Florida Soil Clean-up Goals, dated September 27, 1995. Residental Goals are used.
ND = Non-Detection of Analyte
NA = No Clean-up Goal Available

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TABLE 5 (Con't)
SOIL - ACID AND BASE EXTRACTABLE ANALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (mg/kg)				
	Laboratory Detection Limits	BX-HA-25 (2.5-4.5) 4/02/97	BX-HA-29 (2.5-4.5) 4/02/97	BX-HA-31 (2.5-4.5) 4/03/97	Florida Selected Soil Clean-up Golas[1]
7,2-dimethylbenz(a)anthracene	0.35	ND	ND	ND	NA
A-,A-dimethylphenethylamine	0.35	ND	ND	ND	NA
Dimethylphthalate	0.35	ND	ND	ND	630.00
Di-n-butylphthalate	0.35	ND	ND	ND	7300
2,4-dinitrotoluene	0.35	ND	ND	ND	130
2,6-dinitrotoluene	0.35	ND	ND	ND	71
Di-n-octylphthalate	0.35	ND	ND	ND	1500
Diphenylamine	0.35	ND	ND	ND	NA
1,2-diphenylhydrazine	0.35	ND	ND	ND	NA
Fluoranthene	0.35	ND	ND	ND	2900
Fluorene	0.35	ND	ND	ND	2400
Hexachlorobenzene	0.35	ND	ND	ND	0.6
Hexachlorobutadiene	0.35	ND	ND	ND	3.1
Hexachlorocyclopentadiene	0.35	ND	ND	ND	NA
Hexachloroethane	0.35	ND	ND	ND	27
Indeno(1,2,3,-cd)pyrene	0.35	ND	ND	ND	1.4
Isophorone	0.35	ND	ND	ND	NA
3-methylcholanthrene	0.35	ND	ND	ND	NA
2-methylnaphthalene	0.35	6.6	47	47	960
Naphthalene	0.35	4.4	20	22	1300
1-naphthylamine	0.35	ND	ND	ND	NA
2-naphthylamine	0.35	ND	ND	ND	NA
2-nitroaniline	0.35	ND	ND	ND	NA
3-nitroaniline	0.35	ND	ND	ND	NA
4-nitroaniline	0.35	ND	ND	ND	NA
Nitrobenzene	0.35	ND	ND	ND	22
N-nitrosodimethyamine	0.35	ND	ND	ND	0.003
N-mitrosodi-n-butylamine	0.35	ND	ND	ND	NA
N-nitrosodiphenylamine	0.35	ND	ND	ND	73
N-nitroso-di-n-propylamine	0.35	ND	ND	ND	0.02
N-nitrosopiperdine	0.35	ND	ND	ND	NA
Pentachlorobenzene	0.35	ND	ND	ND	NA
Pentachloronitrobenzene(pcnb)	0.35	ND	ND	ND	NA
Phenacetin	0.35	ND	ND	ND	NA
Phenanthrene	0.35	ND	ND	ND	1700
2-picoline	0.35	ND	ND	ND	NA
Pronamide	0.35	ND	ND	ND	NA
Pyrene	0.35	ND	ND	ND	2200
1,2,4,5-tetrachlorobenzene	0.35	ND	ND	ND	NA
1,2,4 trichlorobenzene	0.35	ND	ND	ND	590

(1) = Screening Levels derived from Florida Soil Clean-up Goals, dated September 27, 1995. Residental Goals are used.
ND = Non-Detection of Analyte
NA = No Clean-up Goal Available

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TABLE 5 (Con't)
SOIL - ACID AND BASE EXTRACTABLE ANALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (mg/kg)				
	Laboratory Detection Limits	BX-HA-25 (2.5-4.5) 4/02/97	BX-HA-29 (2.5-4.5) 4/02/97	BX-HA-31 (2.5-4.5) 4/03/97	Florida Selected Soil Clean-up Golas[1]
Acid & Base Extractables					
Benzoic Acid	1.8	ND	ND	ND	130,000
4-chloro-3-methylphenol	0.35	ND	ND	ND	NA
2-chlorophenol	0.35	ND	ND	ND	280
2,4-dichlorophenol	0.35	ND	ND	ND	220
2,6-dichlorophenol	0.35	ND	ND	ND	NA
2,4-dimethylphenol	0.35	ND	ND	ND	1800
4,6-dinitro-2-methylphenol	1.8	ND	ND	ND	NA
2,4-dinitrophenol	1.8	ND	ND	ND	NA
2-methyphenol	0.35	ND	ND	ND	2600
4-methylphenol	0.35	ND	ND	ND	340
2-nitrophenol	0.35	ND	ND	ND	NA
4-nitrophenol	1.8	ND	ND	ND	NA
Pentachlorophenol	1.8	ND	ND	ND	5.4
Phenol	0.35	ND	ND	ND	34,000
2,3,4,6-tetrachlorophenol	0.35	ND	ND	ND	NA
2,4,5-trichlorophenol	1.8	ND	ND	ND	7100
2,4,6-trichlorophenol	0.35	ND	ND	ND	87
Acenaphthene	0.35	ND	ND	ND	2800
Acenaphthylene	0.35	ND	ND	ND	670
Acetophenone	0.35	ND	ND	ND	NA
4-aminobiphenyl	0.35	ND	ND	ND	NA
Aniline	0.35	ND	ND	ND	NA
Anthracene	0.35	ND	ND	ND	20,000
Benzidine	0.35	ND	ND	ND	NA
Benzo(a)anthracene	0.35	ND	ND	ND	1.4
Benzo(a)pyrene	0.35	ND	ND	ND	0.1
Benzo(b)fluoranthene	0.35	ND	ND	ND	1.4
Benzo(g,h,i)perylene	0.35	ND	ND	ND	14
Benzo(k)fluoranthene	0.35	ND	ND	ND	14
Benzyl alcohol	0.35	ND	ND	ND	NA
Bis(2-chloroethoxy)methane	0.35	ND	ND	ND	170
Bis(2-chloroethyl)ether	0.35	ND	ND	ND	0.5
Bis(2-chloroisopropyl)ether	0.35	ND	ND	ND	NA
Bis(2-ethylhexyl)phthalate	0.35	ND	ND	ND	48
4-bromophenyl phenyl ether	0.35	ND	ND	ND	NA
Butylbenzyl phthalate	0.35	ND	ND	ND	15000
4-chloroaniline	0.35	ND	ND	ND	240
1-chloronaphthalene	0.35	ND	ND	ND	NA
2-chlorophenyl phenyl ether	0.35	ND	ND	ND	NA
Chrysene	0.35	ND	ND	ND	140
Dibenz(a,j)acridine	0.35	ND	ND	ND	NA
Dibenzo(a,h)anthracene	0.35	ND	ND	ND	0.1
Dibenzofuran	0.35	ND	ND	ND	240
1,2-dichlorobenzene	0.35	ND	ND	ND	820
1,3-dichlorobenzene	0.35	ND	ND	ND	1700
1,4-dichlorobenzene	0.35	ND	ND	ND	7.5
3,3'-dichlorobenzidine	1.8	ND	ND	ND	NA
Diethyphthalate	0.35	ND	ND	ND	56,000
P-dimethyllaminoazobenzene	0.35	ND	ND	ND	NA

(1) = Screening Levels derived from Florida Soil Clean-up Goals. dated September 27, 1995. Residental Goals are used.
ND = Non-Detection of Analyte
NA = No Clean-up Goal Available

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TABLE 5 (Con't)
SOIL - ACID AND BASE EXTRACTABLE ANALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (mg/kg)				
	Laboratory Detection Limits	BX-HA-15 (0.5-2.5) 3/20/97	BX-HA-10 (2.5-4.5) 3/20/97	BX-HA-17 (0.5-2.5) 3/20/97	Florida Selected Soil Clean-up Golas[1]
7,12-dimethylbenz(a)anthracene	0.35	ND	ND	ND	NA
A-,A-dimethylphenethylamine	0.35	ND	ND	ND	NA
Dimethylphthalate	0.35	ND	ND	ND	630,000
Di-n-butylphthalate	0.35	ND	ND	ND	7300
2,4-dinitrotoluene	0.35	ND	ND	ND	130
2,6-dinitrotoluene	0.35	ND	ND	ND	71
Di-n-octylphthalate	0.35	ND	ND	ND	1500
Diphenylamine	0.35	ND	ND	ND	NA
1,2-diphenylhydrazine	0.35	ND	ND	ND	NA
Fluoranthene	0.35	ND	ND	ND	2900
Fluorene	0.35	ND	ND	ND	2400
Hexachlorobenzene	0.35	ND	ND	ND	0.6
Hexachlorobutadiene	0.35	ND	ND	ND	3.1
Hexachlorocyclopentadiene	0.35	ND	ND	ND	NA
Hexachloroethane	0.35	ND	ND	ND	27
Indeno(1,2,3,-cd)pyrene	0.35	ND	ND	ND	1.4
Isophorone	0.35	ND	ND	ND	NA
3-methylcholanthrene	0.35	ND	ND	ND	NA
2-methylnaphthalene	0.35	60	7.5	ND	960
Naphthalene	0.35	38	6.2	ND	1300
1-naphthylamine	0.35	ND	ND	ND	NA
2-naphthylamine	0.35	ND	ND	ND	NA
2-nitroaniline	0.35	ND	ND	ND	NA
3-nitroaniline	0.35	ND	ND	ND	NA
4-nitroaniline	0.35	ND	ND	ND	NA
Nitrobenzene	0.35	ND	ND	ND	22
N-nitrosodimethyamine	0.35	ND	ND	ND	0.003
N-nitrosodi-n-butylamine	0.35	ND	ND	ND	NA
N-nitrosodiphenylamine	0.35	ND	ND	ND	71
N-nitroso-di-n-propylamine	0.35	ND	ND	ND	0.02
N-nitrosopiperdine	0.35	ND	ND	ND	NA
Pentachlorobenzene	0.35	ND	ND	ND	NA
Pentachloronitrobenzene(pcnb)	0.35	ND	ND	ND	NA
Phenacetin	0.35	ND	ND	ND	NA
Phenanthrene	0.35	ND	ND	ND	1700
2-picoline	0.35	ND	ND	ND	NA
Pronamide	0.35	ND	ND	ND	NA
Pyrene	0.35	ND	ND	ND	2200
1,2,4,5-tetrachlorobenzene	0.35	ND	ND	ND	NA
1,2,4 trichlorobenzene	0.35	ND	ND	ND	590

(1) = Screening Levels derived from Florida Soil Clean-up Goals, dated September 27, 1995. Residental Goals are used.
ND = Non-Detection of Analyte
NA = No Clean-up Goal Available

TABLE 5 (Con't)
SOIL - ACID AND BASE EXTRACTABLE ANALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (mg/kg)				
	Laboratory Detection Limits	BX-HA-15 (0.5-2.5) 3/20/97	BX-HA-10 (2.5-4.5) 3/20/97	BX-HA-17 (0.5-2.5) 3/20/97	Florida Selected Soil Clean-up Golas[1]
Acid & Base Extractables					
Benzoic Acid	1.8	ND	ND	ND	130,000
4-chloro-3-methylphenol	0.35	ND	ND	ND	NA
2-chlorophenol	0.35	ND	ND	ND	280
2,4-dichlorophenol	0.35	ND	ND	ND	220
2,6-dichlorophenol	0.35	ND	ND	ND	NA
2,4-dimethylphenol	0.35	ND	ND	ND	1800
4,6-dinitro-2-methylphenol	1.8	ND	ND	ND	NA
2,4-dinitrophenol	1.8	ND	ND	ND	NA
2-methyphenol	0.35	ND	ND	ND	2600
4-methylphenol	0.35	ND	ND	ND	340
2-nitrophenol	0.35	ND	ND	ND	NA
4-nitrophenol	1.8	ND	ND	ND	NA
Pentachlorophenol	1.8	ND	ND	ND	5.4
Phenol	0.35	ND	ND	ND	34,000
2,3,4,6-tetrachlorophenol	0.35	ND	ND	ND	NA
2,4,5-trichlorophenol	1.8	ND	ND	ND	7100
2,4,6-trichlorophenol	0.35	ND	ND	ND	87
Acenaphthene	0.35	0.41	ND	ND	2800
Acenaphthylene	0.35	ND	ND	ND	670
Acetophenone	0.35	ND	ND	ND	NA
4-aminobiphenyl	0.35	ND	ND	ND	NA
Aniline	0.35	ND	ND	ND	NA
Anthracene	0.35	ND	ND	ND	20,000
Benzidine	0.35	ND	ND	ND	NA
Benzo(a)anthracene	0.35	ND	ND	ND	1.4
Benzo(a)pyrene	0.35	ND	ND	ND	0.1
Benzo(b)fluoranthene	0.35	ND	ND	ND	1.4
Benzo(g,h,i)perylene	0.35	ND	ND	ND	14
Benzo(k)fluoranthene0.	0.35	ND	ND	ND	14
Benzyl alcohol	0.35	ND	ND	ND	NA
Bis(2-chloroethoxy)methane	0.35	ND	ND	ND	170
Bis(2-chloroethyl)ether	0.35	ND	ND	ND	0.5
Bis(2-chloroisopropyl)ether	0.35	ND	ND	ND	NA
Bis(2-ethylhexyl)phthalate	0.35	ND	ND	ND	48
4-bromophenyl phenyl ether	0.35	ND	ND	ND	NA
Butylbenzyl phthalate	0.35	ND	ND	ND	15,000
4-chloroaniline	0.35	ND	ND	ND	240
1-chloronaphthalene	0.35	ND	ND	ND	NA
2-chlorophenyl phenyl ether	0.35	ND	ND	ND	NA
Chrysene	0.35	ND	ND	ND	140
Dibenz(a,j)acridine	0.35	ND	ND	ND	NA
Dibenzo(a,h)anthracene	0.35	ND	ND	ND	0.1
Dibenzofuran	0.35	ND	ND	ND	240
1,2-dichlorobenzene	0.35	ND	ND	ND	820
1,3-dichlorobenzene	0.35	ND	ND	ND	1700
1,4-dichlorobenzene	0.35	ND	ND	ND	7.5
3,3'-dichlorobenzidine	1.8	ND	ND	ND	NA
Diethyphthalate	0.35	ND	ND	ND	56,000
P-dimethyllaminoazobenzene	0.35	ND	ND	ND	NA

(1) = Screening Levels derived from Florida Soil Clean-up Goals, dated September 27, 1995. Residental Goals are used.

ND = Non-Detection of Analyte

NA = No Clean-up Goal Available

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TABLE 5 (Con't)
SOIL - ACID AND BASE EXTRACTABLE ANALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (mg/kg)				
	Laboratory Detection Limits	BX-HA-14 (0.5-2.5) 3/20/97	BX-HA-16 (2.5-4.5) 3/20/97	BX-HA-24 (2.5-4.5) 3/20/97	Florida Selected Soil Clean-up Golas[1]
Dimethylphthalate	0.35	ND	ND	ND	630.000
Di-n-butylphthalate	0.35	ND	ND	ND	7,300
2,4-dinitrotoluene	0.35	ND	ND	ND	130
2,6-dinitrotoluene	0.35	ND	ND	ND	71
Di-n-octylphthalate	0.35	ND	ND	ND	1500
Diphenylamine	0.35	ND	ND	ND	NA
1,2-diphenylhydrazine	0.35	ND	ND	ND	NA
Fluoranthene	0.35	ND	ND	ND	2900
Fluorene	0.35	ND	ND	ND	2400
Hexachlorobenzene	0.35	ND	ND	ND	0.6
Hexachlorobutadiene	0.35	ND	ND	ND	3.1
Hexachlorocyclopentadiene	0.35	ND	ND	ND	NA
Hexachloroethane	0.35	ND	ND	ND	27
Indeno(1,2,3,-cd)pyrene	0.35	ND	ND	ND	1.4
Isophorone	0.35	ND	ND	ND	NA
3-methylcholanthrene	0.35	ND	ND	ND	NA
2-methylnaphthalene	0.35	ND	31	26	960
Naphthalene	0.35	ND	18	14	1300
1-naphthylamine	0.35	ND	ND	ND	NA
2-naphthylamine	0.35	ND	ND	ND	NA
2-nitroaniline	0.35	ND	ND	ND	NA
3-nitroaniline	0.35	ND	ND	ND	NA
4-nitroaniline	0.35	ND	ND	ND	NA
Nitrobenzene	0.35	ND	ND	ND	22
N-nitrosodimethyamine	0.35	ND	ND	ND	0.003
N-nitrosodi-n-butylamine	0.35	ND	ND	ND	NA
N-nitrosodiphenylamine	0.35	ND	ND	ND	73
N-nitroso-di-n-propylamine	0.35	ND	ND	ND	0.02
N-nitrosopiperdine	0.35	ND	ND	ND	NA
Pentachlorobenzene	0.35	ND	ND	ND	NA
Pentachloronitrobenzene(pcnb)	0.35	ND	ND	ND	NA
Phenacetin	0.35	ND	ND	ND	NA
Phenanthrene	0.35	ND	ND	ND	1700
2-picoline	0.35	ND	ND	ND	NA
Pronamide	0.35	ND	ND	ND	NA
Pyrene	0.35	ND	ND	ND	2200
1,2,4,5-tetrachlorobenzene	0.35	ND	ND	ND	NA
1,2,4 trichlorobenzene	0.35	ND	ND	ND	590

(1) = Screening Levels derived from Florida Soil Clean-up Goals, dated September 27, 1995. Residental Goals are used.
ND = Non-Detection of Analyte
NA = No Clean-up Goal Available

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TABLE 5
SOIL - ACID AND BASE EXTRACTABLE ANALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (mg/kg)				
	Laboratory Detection Limits	BX-HA-14 (0.5-2.5)	BX-HA-16 (2.5-4.5)	BX-HA-24 (2.5-4.5)	Florida Selected Soil Clean-up Golas[1]
		3/20/97	3/20/97	3/20/97	
Acid & Base Extractables					
Benzoic Acid	1.8	ND	ND	ND	130,000
4-chloro-3-methylphenol	0.35	ND	ND	ND	NA
2-chlorophenol	0.35	ND	ND	ND	280
2,4-dichlorophenol	0.35	ND	ND	ND	220
2,6-dichlorophenol	0.35	ND	ND	ND	NA
2,4-dimethylphenol	0.35	ND	ND	ND	1800
4,6-dinitro-2-methylphenol	1.8	ND	ND	ND	NA
2,4-dinitrophenol	1.8	ND	ND	ND	NA
2-methyphenol	0.35	ND	ND	ND	2600
4-methylphenol	0.35	ND	ND	ND	340
2-nitrophenol	0.35	ND	ND	ND	NA
4-nitrophenol	1.8	ND	ND	ND	NA
Pentachlorophenol	1.8	ND	ND	ND	5.4
Phenol	0.35	ND	ND	ND	34,000
2,3,4,6-tetrachlorophenol	0.35	ND	ND	ND	NA
2,4,5-trichlorophenol	1.8	ND	ND	ND	7100
2,4,6-trichlorophenol	0.35	ND	ND	ND	87
Acenaphthene	0.35	ND	ND	ND	2800
Acenaphthylene	0.35	ND	ND	ND	670
Acetophenone	0.35	ND	ND	ND	NA
4-aminobiphenyl	0.35	ND	ND	ND	NA
Aniline	0.35	ND	ND	ND	NA
Anthracene	0.35	ND	ND	ND	20,000
Benzidine	0.35	ND	ND	ND	NA
Benzo(a)anthracene	0.35	ND	ND	ND	1.4
Benzo(a)pyrene	0.35	ND	ND	ND	0.1
Benzo(b)fluoranthene	0.35	ND	ND	ND	1.4
Benzo(g,h,i)perylene	0.35	ND	ND	ND	14
Benzo(k)fluoranthene	0.35	ND	ND	ND	14
Benzyl alcohol	0.35	ND	ND	ND	NA
Bis(2-chloroethoxy)methane	0.35	ND	ND	ND	170
Bis(2-chloroethyl)ether	0.35	ND	ND	ND	0.5
Bis(2-chloroisopropyl)ether	0.35	ND	ND	ND	NA
Bis(2-ethylhexyl)phthalate	0.35	ND	ND	ND	48
4-bromophenyl phenyl ether	0.35	ND	ND	ND	NA
Butylbenzyl phthalate	0.35	ND	ND	ND	15,000
4-chloroaniline	0.35	ND	ND	ND	240
1-chloronaphthalene	0.35	ND	ND	ND	NA
2-chlorophenyl phenyl ether	0.35	ND	ND	ND	NA
Chrysene	0.35	ND	ND	ND	140
Dibenz(a,j)acridine	0.35	ND	ND	ND	NA
Dibenzo(a,h)anthracene	0.35	ND	ND	ND	0.1
Dibenzofuran	0.35	ND	ND	ND	240
1,2-dichlorobenzene	0.35	ND	ND	ND	820
1,3-dichlorobenzene	0.35	ND	ND	ND	1700
1,4-dichlorobenzene	0.35	ND	ND	ND	7.5
3,3'-dichlorobenzidine	1.8	ND	ND	ND	NA
Diethyphthalate	0.35	ND	ND	ND	56,000
P-dimethylaminoazobenzene	0.35	ND	ND	ND	NA
7,12-dimethylbenz(a)anthracene	0.35	ND	ND	ND	NA
A-,A-dimethylphenethylamine	0.35	ND	ND	ND	NA

(1) = Screening Levels derived from Florida Soil Clean-up Goals, dated September 27, 1995. Residental Goals are used.
ND = Non-Detection of Analyte
NA = No Clean-up Goal Available

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TABLE 4 (Con't)
SOIL - METALS ANALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (mg/kg)			
	Laboratory Detection Limits	BX-HA-32 (2.5-4.5)	BX-HA-36 (2.5-4.5)	Florida Selected Soil Clean-up Golas[1]
		4/03/97	4/03/97	
RCRA Metals				
Silver	1	ND	ND	390
Arsenic	5	ND	ND	0.7
Barium	1	ND	ND	5200
Cadmium	0.5	ND	ND	37
Chromium	1	1	2	290
Mercury	0.02	ND	ND	23
Lead	5	11	22	500
Selenium	10	ND	ND	390

(1) = Screening Levels derived from Florida Soil Clean-up Goals, dated September 27, 1995. Residental Goals are used.

ND = Non-Detection of Analyte

TABLE 4 (Con't)
SOIL - METALS ANALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (mg/kg)				
	Laboratory Detection Limits	BX-HA-25 (2.5-4.5)	BX-HA-29 (2.5-4.5)	BX-HA-31 (2.5-4.5)	Florida Selected Soil Clean-up Golas[1]
		4/02/97	4/02/97	4/03/97	
RCRA Metals					
Silver	1	ND	ND	ND	390
Arsenic	5	ND	ND	ND	0.7
Barium	1	ND	1	1	5200
Cadmium	0.5	ND	ND	ND	37
Chromium	1	1	2	3	290
Mercury	0.02	ND	ND	ND	23
Lead	5	ND	9	19	500
Selenium	10	ND	ND	ND	390

(1) = Screening Levels derived from Florida Soil Clean-up Goals, dated September 27, 1995. Residental Goals are used.

ND = Non-Detection of Analyte

TABLE 4 (Con't)
SOIL - METALS ANALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (mg/kg)				
	Laboratory Detection Limits	BX-HA-15 (0.5-2.5)	BX-HA-10 (2.5-4.5)	BX-HA-17 (0.5-2.5)	Florida Selected Soil Clean-up Golas[1]
		3/20/97	3/20/97	3/20/97	
RCRA Metals					
Silver	1	ND	ND	ND	390
Arsenic	5	ND	ND	ND	0.7
Barium	1	2	ND	4	5200
Cadmium	0.5	ND	ND	ND	37
Chromium	1	2	1	9	290
Mercury	0.02	ND	ND	ND	23
Lead	5	18	9	ND	500
Selenium	10	ND	ND	ND	390

(1) = Screening Levels derived from Florida Soil Clean-up Goals. dated September 27, 1995. Residental Goals are used.

ND = Non-Detection of Analyte

TABLE 4
SOIL - METALS ANALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (mg/kg)				
	Laboratory Detection Limits	BX-HA-14 (0.5-2.5)	BX-HA-16 (2.5-4.5)	BX-HA-24 (2.5-4.5)	Florida Selected Soil Clean-up Golas[1]
		3/20/97	3/20/97	3/20/97	
RCRA Metals					
Silver	1	ND	ND	ND	390
Arsenic	5	ND	ND	ND	0.7
Barium	1	9	6	6	5200
Cadmium	0.5	ND	ND	ND	37
Chromium	1	14	5	5	290
Mercury	0.02	ND	ND	ND	23
Lead	5	ND	23	13	500
Selenium	10	ND	ND	ND	390

(1) = Screening Levels derived from Florida Soil Clean-up Goals, dated September 27, 1995. Residental Goals are used.

ND = Non-Detection of Analyte

TABLE 3 (Con't)
SOIL - VOLATILE ANALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (mg/kg)			
	Laboratory Detection Limits	BX-HA-32 (2.5-4.5) 4/03/97	BX-HA-36 (2.5-4.5) 4/03/97	Florida Selected Soil Clean-up Golas[1]
Tert-butyl benzene	0.005	ND	ND	NA
1,1,1,2-tetrachloroethane	0.005	ND	ND	5.9
1,1,2,2-tetrachloroethane	0.005	ND	ND	0.9
Tetrachloroethe.ne	0.005	ND	ND	12
Toluene	0.005	ND	ND	520
Trans1,2 Dichloroethylene	0.005	ND	ND	62
1,1,1-trichloroethane	0.005	ND	ND	610
1,1,2-trichloroethane	0.005	ND	ND	2.0
1,2,3-trichlorobenzene	0.005	ND	ND	NA
1,2,4-trichlorobenzene	0.005	ND	ND	590
Trichloroethene	0.005	ND	ND	6.5
Trichlorofluoromethane	0.005	ND	ND	6.6
1,2,3-trichlorofluorobenzene	0.005	ND	ND	NA
1,2,4-trimethylbenzene	0.005	130	120	6.2
1,3,5-trimethylbenzene	0.005	57	31	3.7
Vinyl chloride	0.005	ND	ND	0.005
M,P-xylene	0.005	6.2	7.5	NA
O-Xylene	0.005	4.9	4.7	NA
Heptane	0.005	ND	ND	NA
ıropyl acetate	0.022	ND	ND	NA
hyl cyclohexane	0.011	ND	ND	NA
Propyl acetate	0.022	ND	ND	NA

(1) = Screening Levels derived from Florida Soil Clean-up Goals, dated September 27, 1995. Residental Goals are used.
ND = Non-Detection of Analyte
Bold/Shade = Exceeds Florida Clean-up Goals, Chemical of Potential Concern
NA = No Clean-up Goal Available

TABLE 3 (Con't)
SOIL - VOLATILE ANALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (mg/kg)			
	Laboratory Detection Limits	BX-HA-32 (2.5-4.5) 4/03/97	BX-HA-36 (2.5-4.5) 4/03/97	Florida Selected Soil Clean-up Golas[1]
Volatiles				
Benzene	0.005	ND	ND	1.4
Bromobenzene	0.005	ND	ND	NA
Bromochloromethane	0.005	ND	ND	NA
Bromodichloromethane	0.005	ND	ND	0.7
Bromoform	0.005	ND	ND	65
Bromomethane	0.005	ND	ND	NA
Carbon Tetrachloride	0.005	ND	ND	0.6
Chlorobenzene	0.005	ND	ND	44
Chloroethane	0.005	ND	ND	NA
Chloroform	0.005	ND	ND	0.6
Chloromethane	0.005	ND	ND	0.2
2-chlorotoluene	0.005	ND	ND	NA
4-chlorotoluene	0.005	ND	ND	NA
Cis1,2 Dichloroethylene	0.005	ND	ND	NA
Chlorodibromomethane	0.005	ND	ND	NA
Dibromomethane	0.005	ND	ND	NA
1,4-dichlorobenzene	0.005	ND	ND	7.5
1,3-dichlorobenzene	0.005	ND	ND	1700
[illegible]-dichlorobenzene	0.005	ND	ND	820
[illegible]hlorodifluoromethane	0.005	ND	ND	NA
[illegible],1-dichloroethane	0.005	ND	ND	310
1,2-dichloroethane	0.005	ND	ND	0.7
1,1-dichloroethene	0.005	ND	ND	0.1
1,3-dichloropropane	0.005	ND	ND	NA
2,2-dichloropropane	0.005	ND	ND	NA
1,2-dichloropropane	0.005	ND	ND	0.8
Cis-1,3-dichloropropene	0.005	ND	ND	0.3
Trans-1,3-dichloropropene	0.005	ND	ND	0.3
1,1 Dichloropropene	0.005	ND	ND	NA
Ethylbenzene	0.005	ND	2.6	1400
Hexachlorobutadiene	0.005	ND	ND	3.1
Isopropyl benzene	0.005	ND	1.1	NA
P-isopropyltoluene	0.005	3	2.6	NA
Methylene Chloride	0.005	ND	ND	16
Napthalene	0.005	4.4	48	1300
N-butyl benzene	0.005	ND	ND	NA
N-propyl benzene	0.005	1.9	4.5	NA
Sec-butyl benzene	0.005	2	2.5	NA
Styrene	0.005	ND	ND	4100

(1) = Screening Levels derived from Florida Soil Clean-up Goals, dated September 27, 1995. Residental Goals are used.

= Non-Detection of Analyte

hade = Exceeds Florida Clean-up Goals, Chemical of Potential Concern

= No Clean-up Goal Available

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TABLE 3 (Con't)
SOIL - VOLATILE ANALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (mg/kg)				
	Laboratory Detection Limits	BX-HA-25 (2.5-4.5) 4/02/97	BX-HA-29 (2.5-4.5) 4/02/97	BX-HA-31 (2.5-4.5) 4/03/97	Florida Selected Soil Clean-up Golas[1]
Tert-butyl benzene	0.005	ND	ND	ND	NA
1,1,1,2-tetrachloroethane	0.005	ND	ND	ND	5.9
1,1,2,2-tetrachloroethane	0.005	ND	ND	ND	0.9
Tetrachloroethene	0.005	ND	ND	ND	12
Toluene	0.005	ND	ND	ND	520
Trans1,2 Dichloroethylene	0.005	ND	ND	ND	62
1,1,1-trichloroethane	0.005	ND	ND	ND	610
1,1,2-trichloroethane	0.005	ND	ND	ND	2.0
1,2,3-trichlorobenzene	0.005	ND	ND	ND	NA
1,2,4-trichlorobenzene	0.005	ND	ND	ND	590
Trichloroethene	0.005	ND	ND	ND	6.5
Trichlorofluoromethane	0.005	ND	ND	ND	6.6
1,2,3-trichlorofluorobenzene	0.005	ND	ND	ND	NA
1,2,4-trimethylbenzene	0.005	**24**	**130**	**160**	6.2
1,3,5-trimethylbenzene	0.005	**9**	**49**	**36**	3.7
Vinyl chloride	0.005	ND	ND	ND	0.005
M,P-xylene	0.005	1.8	9.1	8.5	NA
O-Xylene	0.005	0.84	5.7	5	NA
Heptane	0.005	ND	ND	ND	NA
propyl acetate	0.022	ND	ND	ND	NA
hyl cyclohexane	0.011	ND	ND	ND	NA
.opyl acetate	0.022	ND	ND	ND	NA

(1) = Screening Levels derived from Florida Soil Clean-up Goals, dated September 27, 1995. Residental Goals are used.
ND = Non-Detection of Analyte
Bold/Shade = Exceeds Florida Clean-up Goals, Chemical of Potential Concern
NA = No Clean-up Goal Available

TABLE 3 (Con't)
SOIL - VOLATILE ANALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (mg/kg)				
	Laboratory Detection Limits	BX-HA-25 (2.5-4.5) 4/02/97	BX-HA-29 (2.5-4.5) 4/02/97	BX-HA-31 (2.5-4.5) 4/03/97	Florida Selected Soil Clean-up Golas[1]
Volatiles					
Benzene	0.005	ND	ND	ND	1.4
Bromobenzene	0.005	ND	ND	ND	NA
Bromochloromethane	0.005	ND	ND	ND	NA
Bromodichloromethane	0.005	ND	ND	ND	0.7
Bromoform	0.005	ND	ND	ND	65
Bromomethane	0.005	ND	ND	ND	NA
Carbon Tetrachloride	0.005	ND	ND	ND	0.6
Chlorobenzene	0.005	ND	ND	ND	44
Chloroethane	0.005	ND	ND	ND	NA
Chloroform	0.005	ND	ND	ND	0.6
Chloromethane	0.005	ND	ND	ND	0.2
2-chlorotoluene	0.005	ND	ND	ND	NA
4-chlorotoluene	0.005	ND	ND	ND	NA
Cis1,2 Dichloroethylene	0.005	ND	ND	ND	NA
Chlorodibromomethane	0.005	ND	ND	ND	NA
Dibromomethane	0.005	ND	ND	ND	NA
1,4-dichlorobenzene	0.005	ND	ND	ND	7.5
1,3-dichlorobenzene	0.005	ND	ND	ND	1700
[illegible]chlorobenzene	0.005	ND	ND	ND	820
[illegible]rodifluoromethane	0.005	ND	ND	ND	NA
[illegible]-dichloroethane	0.005	ND	ND	ND	310
1,2-dichloroethane	0.005	ND	ND	ND	0.7
1,1-dichloroethene	0.005	ND	ND	ND	0.1
1,3-dichloropropane	0.005	ND	ND	ND	NA
2,2-dichloropropane	0.005	ND	ND	ND	NA
1,2-dichloropropane	0.005	ND	ND	ND	0.8
Cis-1,3-dichloropropene	0.005	ND	ND	ND	0.3
Trans-1,3-dichloropropene	0.005	ND	ND	ND	0.3
1,1 Dichloropropene	0.005	ND	ND	ND	NA
Ethylbenzene	0.005	ND	5	2.9	1400
Hexachlorobutadiene	0.005	ND	ND	ND	3.1
Isopropyl benzene	0.005	ND	1.8	1.2	NA
P-isopropyltoluene	0.005	ND	2.2	2.9	NA
Methylene Chloride	0.005	ND	ND	ND	16
Napthalene	0.005	7	34	29	1300
N-butyl benzene	0.005	ND	ND	ND	NA
N-propyl benzene	0.005	1.2	7.8	5.1	NA
Sec-butyl benzene	0.005	ND	3.4	2.7	NA
Styrene	0.005	ND	ND	ND	4100

(1) = Screening Levels derived from Florida Soil Clean-up Goals, dated September 27, 1995. Residental Goals are used.
= Non-Detection of Analyte
[illegible]ade = Exceeds Florida Clean-up Goals, Chemical of Potential Concern
= No Clean-up Goal Available

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TABLE 3 (Con't)
SOIL - VOLATILE ANALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (mg/kg)				
	Laboratory Detection Limits	BX-HA-15 (2.5-4.5) 3/20/97	BX-HA-10 (2.5-4.5) 3/20/97	BX-HA-17 (0.5-2.5) 3/20/97	Florida Selected Soil Clean-up Golas[1]
Sec-butyl benzene	0.005	7.4	ND	ND	NA
Styrene	0.005	ND	ND	ND	4100
Tert-butyl benzene	0.005	ND	ND	ND	NA
1,1,1,2-tetrachloroethane	0.005	ND	ND	ND	5.9
1,1,2,2-tetrachloroethane	0.005	ND	ND	ND	0.9
Tetrachloroethene	0.005	ND	ND	ND	12
Toluene	0.005	3.2	ND	ND	520
Trans1,2 Dichloroethylene	0.005	ND	ND	ND	62
1,1,1-trichloroethane	0.005	ND	ND	ND	610
1,1,2-trichloroethane	0.005	ND	ND	ND	2.0
1,2,3-trichlorobenzene	0.005	ND	ND	ND	NA
1,2,4-trichlorobenzene	0.005	ND	ND	ND	590
Trichloroethene	0.005	ND	ND	ND	6.5
Trichlorofluoromethane	0.005	ND	ND	ND	6.6
1,2,3-trichlorofluorobenzene	0.005	ND	ND	ND	NA
1,2,4-trimethylbenzene	0.005	350	25	0.11	6.2
1,3,5-trimethylbenzene	0.005	110	8.3	ND	3.7
Vinyl chloride	0.005	ND	ND	ND	0.005
M,P-xylene	0.005	79	ND	ND	NA
Xylene	0.005	48	ND	ND	NA
tane	0.005	ND	ND	ND	NA
sopropyl acetate	0.022	ND	ND	ND	NA
Methyl cyclohexane	0.011	8.3	ND	ND	NA
Propyl acetate	0.022	ND	ND	ND	NA

(1) = Screening Levels derived from Florida Soil Clean-up Goals, dated September 27, 1995. Residental Goals are used.
ND = Non-Detection of Analyte
Bold/Shade = Exceeds Florida Clean-up Goals, Chemical of Potential Concern
NA = No Clean-up Goal Available

TABLE 3 (Con't)
SOIL - VOLATILE ANALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (mg/kg)				
	Laboratory Detection Limits	BX-HA-15 (2.5-4.5) 3/20/97	BX-HA-10 (2.5-4.5) 3/20/97	BX-HA-17 (0.5-2.5) 3/20/97	Florida Selected Soil Clean-up Golas[1]
Volatiles					
Benzene	0.005	ND	ND	ND	1.4
Bromobenzene	0.005	ND	ND	ND	NA
Bromochloromethane	0.005	ND	ND	ND	NA
Bromodichloromethane	0.005	ND	ND	ND	0.7
Bromoform	0.005	ND	ND	ND	65
Bromomethane	0.005	ND	ND	ND	NA
Carbon Tetrachloride	0.005	ND	ND	ND	0.6
Chlorobenzene	0.005	ND	ND	ND	44
Chloroethane	0.005	ND	ND	ND	NA
Chloroform	0.005	ND	ND	ND	0.6
Chloromethane	0.005	ND	ND	ND	0.2
2-chlorotoluene	0.005	ND	ND	ND	NA
4-chlorotoluene	0.005	ND	ND	ND	NA
Cis1,2 Dichloroethylene	0.005	ND	ND	ND	NA
Chlorodibromomethane	0.005	ND	ND	ND	NA
Dibromomethane	0.005	ND	ND	ND	NA
1,4-dichlorobenzene	0.005	ND	ND	ND	7.5
1,3-dichlorobenzene	0.005	ND	ND	ND	1700
[illegible]-dichlorobenzene	0.005	ND	ND	ND	820
[illegible]hlorodiifluoromethane	0.005	ND	ND	ND	NA
[illegible]-dichloroethane	0.005	ND	ND	ND	310
1,2-dichloroethane	0.005	ND	ND	ND	0.7
1,1-dichloroethene	0.005	ND	ND	ND	0.1
1,3-dichloropropane	0.005	ND	ND	ND	NA
2,2-dichloropropane	0.005	ND	ND	ND	NA
1,2-dichloropropane	0.005	ND	ND	ND	0.8
Cis-1,3-dichloropropene	0.005	ND	ND	ND	0.3
Trans-1,3-dichloropropene	0.005	ND	ND	ND	0.3
1,1 Dichloropropene	0.005	ND	ND	ND	NA
Ethylbenzene	0.005	**30**	ND	ND	1400
Hexachlorobutadiene	0.005	ND	ND	ND	3.1
Isopropyl benzene	0.005	**6.8**	ND	ND	NA
P-isopropyltoluene	0.005	**21**	ND	ND	NA
Methylene Chloride	0.005	ND	ND	ND	16
Napthalene	0.005	**39**	**8.8**	ND	1300
N-butyl benzene	0.005	**31**	**4**	ND	NA
N-propyl benzene	0.005	**37**	ND	ND	NA

(1) = Screening Levels derived from Florida Soil Clean-up Goals, dated September 27, 1995. Residential Goals are used.
ND = Non-Detection of Analyte
Bold/Shade = Exceeds Florida Clean-up Goals, Chemical of Potential Concern
NA = No Clean-up Goal Available

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TAB

SOIL - VOLATILE ANALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (mg/kg)				
	Laboratory Detection Limits	BX-HA-14 (0.5-2.5) 3/20/97	BX-HA-16 (2.5-4.5) 3/20/97	BX-HA-24 (2.5-4.5) 3/20/97	Florida Selected Soil Clean-up Golas[1]
Styrene	0.005	ND	ND	ND	4100
Tert-butyl benzene	0.005	ND	ND	ND	NA
1,1,1,2-tetrachloroethane	0.005	ND	ND	ND	5.9
1,1,2,2-tetrachloroethane	0.005	ND	ND	ND	0.9
Tetrachloroethene	0.005	ND	ND	ND	12
Toluene	0.005	ND	ND	ND	520
Trans1,2 Dichloroethylene	0.005	ND	ND	ND	62
1,1,1-trichloroethane	0.005	ND	ND	ND	610
1,1,2-trichloroethane	0.005	ND	ND	ND	2.0
1,2,3-trichlorobenzene	0.005	ND	ND	ND	NA
1,2,4-trichlorobenzene	0.005	ND	ND	ND	590
Trichloroethene	0.005	ND	ND	ND	6.5
Trichlorofluoromethane	0.005	ND	ND	ND	6.6
1,2,3-trichlorofluorobenzene	0.005	ND	ND	ND	NA
1,2,4-trimethylbenzene	0.005	0.18	[illegible]	[illegible]	6.2
1,3,5-trimethylbenzene	0.005	ND	[illegible]	[illegible]	3.7
Vinyl chloride	0.005	ND	ND	ND	0.005
M,P-xylene	0.005	0.006	2	2.2	NA
O-Xylene	0.005	ND	0.95	0.95	NA
ptane	0.005	ND	ND	ND	NA
ropyl acetate	0.022	ND	ND	ND	NA
ethyl cyclohexane	0.011	ND	ND	ND	NA
Propyl acetate	0.022	ND	ND	ND	NA

(1) = Screening Levels derived from Florida Soil Clean-up Goals, dated September 27, 1995. Residental Goals are used.
ND = Non-Detection of Analyte
Bold/Shade = Exceeds Florida Clean-up Goals, Chemical of Potential Concern
NA = No Clean-up Goal Available

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TABL[illegible]
SOIL - VOLATILE [illegible]ALYTICAL RESULTS

Parameters	SAMPLE ID, DATE SAMPLED, AND RESULTS (mg/kg)				
	Laboratory Detection Limits	BX-HA-14 (0.5-2.5) 3/20/97	BX-HA-16 (2.5-4.5) 3/20/97	BX-HA-24 (2.5-4.5) DUP 3/20/97	Florida Selected Soil Clean-up Golas[1]
Volatiles					
Benzene	0.005	ND	ND	ND	1.4
Bromobenzene	0.005	ND	ND	ND	NA
Bromochloromethane	0.005	ND	ND	ND	NA
Bromodichloromethane	0.005	ND	ND	ND	0.7
Bromoform	0.005	ND	ND	ND	65
Bromomethane	0.005	ND	ND	ND	NA
Carbon Tetrachloride	0.005	ND	ND	ND	0.6
Chlorobenzene	0.005	ND	ND	ND	44
Chloroethane	0.005	ND	ND	ND	NA
Chloroform	0.005	ND	ND	ND	0.6
Chloromethane	0.005	ND	ND	ND	0.2
2-chlorotoluene	0.005	ND	ND	ND	NA
4-chlorotoluene	0.005	ND	ND	ND	NA
Cis1,2 Dichloroethylene	0.005	ND	ND	ND	NA
Chlorodibromomethane	0.005	ND	ND	ND	NA
Dibromomethane	0.005	ND	ND	ND	NA
1,4-dichlorobenzene	0.005	ND	ND	ND	7.5
[illegible]dichlorobenzene	0.005	ND	ND	ND	1700
[illegible]-dichlorobenzene	0.005	ND	ND	ND	820
Dichlorodifluoromethane	0.005	ND	ND	ND	NA
1,1-dichloroethane	0.005	ND	ND	ND	310
1,2-dichloroethane	0.005	ND	ND	ND	0.7
1,1-dichloroethene	0.005	ND	ND	ND	0.1
1,3-dichloropropane	0.005	ND	ND	ND	NA
2,2-dichloropropane	0.005	ND	ND	ND	NA
1,2-dichloropropane	0.005	ND	ND	ND	0.8
Cis-1,3-dichloropropene	0.005	ND	ND	ND	0.3
Trans-1,3-dichloropropene	0.005	ND	ND	ND	0.3
1,1 Dichloropropene	0.005	ND	ND	ND	NA
Ethylbenzene	0.005	ND	1.8	1.9	1400
Hexachlorobutadiene	0.005	ND	ND	ND	3.1
Isopropyl benzene	0.005	ND	ND	ND	NA
P-isopropyltoluene	0.005	ND	1.4	1.6	NA
Methylene Chloride	0.005	ND	ND	ND	16
Naphthalene	0.005	ND	24	12	1300
N-butyl benzene	0.005	ND	7.6	8	NA
N-propyl benzene	0.005	0.001	5	5.6	NA
Sec-butyl benzene	0.005	ND	1.8	1.9	NA

(1) = Screening Levels derived from Florida Soil Clean-up Goals, dated September 27, 1995. Residental Goals are used.

= Non-Detection of Analyte

[illegible]hade = Exceeds Florida Clean-up Goals, Chemical of Potential Concern

= No Clean-up Goal Available

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2nd Lift - from tank farm

B ND
T ND
E HA24 (5)
X HA24 (17.7)
Naph HA24 (42)

Min detects - former tank farm

B ND
T HA15 2.5-4.5 (3.2)
E HA15 2.5-4.5 (30) ↓ (127)
X
Naph HA15 (0.5-2.5) 38

Min detects - center area

ND
ND
ND
2.5 HA25
5.8 HA25

TABLE 5-3
Soil Analytical Results Above Method Quantification Limits
BX Service Station
Tyndall Air Force Base, Florida

PARAMETER	SAMPLE I.D., DATE SAMPLED, AND RESULTS (PPM)										
	BX-HA1 (2-3.5')	BX-HA1 (4-5.5')	BX-HA1 S (4-5.5')	BX-HA4 (4-5.5')	BX-HA7 (4-5.5')	BX-HA9 (2-3.5')	BX-HA9 (4-5.5')	BX-HA19 (4-5.5')	BX-HA19 DUP (4-5.5')	BX-HA19S (4-5.5')	Petroleum Standards*
	3/17/95	3/17/95	3/17/95	3/17/95	3/24/95	3/24/95	3/24/95	3/24/95	3/24/95	3/24/95	
VOLATILES											
Acetone	<13.6	<13.6	<11.4	<1.32	0.015 B	<1.51	<2.97	<1.32	<1.32	---	---
Ethlybenzene	<7.01	14.7	20	<0.681	<0.00578	<0.781	38.9	<0.684	7.6	---	---
Toluene	<7.01	24.9	30.3	1.43	<0.00578	<0.781	36.6	<0.684	7.93	10.2	---
Total Xylenes	362	295	106	82.4	<0.00578	15.1	457	103	286	385	---
Total Volatiles	362	334.6	156.3	83.83	0.015 B	15.1	532.50	103	301.53	395.2	100
SEMIVOLATILES											
Naphthalene	7.92	18.1	12.5	49.5	<0.382	1.51	11.4	8.1E	11.0 E	15.1	---
2-Methylnaphthalene	12.4	19.3	15.9	62.6	<0.382	3.65	20.6	14.0 E	18.0 E	19.3	---
Total PAH	20.32	37.4	28.4	112.1	<0.382	5.16	32	22.2	29	34.4	6
TRPH	651	888	251	2290	<8.67	<9.45	741	754	1340	401	50
METALS											
Barium	<1.13	<1.13	<1.1	<1.10	<1.16	1.46	<1.14	2.1	2.3	<1.3	2750
Chromium	0.908	0.536	<1.1	<0.275	1.62	1.89	1.01	1.3	163	<1.3	875
Mercury	<0.113	<0.113	<0.130	<0.110	<0.116	0.166	<0.114	0.11	0.11	<0.130	17
Lead	13.3	4.22	2.2	3.03	5.58	2.93	5.83	8.9	3.6	3.8	77
Selenium	<0.226	<0.227	<1.10	<0.220	0.347	<0.252	<0.229	0.33	0.37	<1.28	165

* = Guidelines for assessment and remediation of petroleum contaminated soils; Florida Department of Environmental Protection, Chapter 62-775, Applies only to Total Volatiles, Total PAHs and Metals.
S = USACE Split Sample
DUP = Duplicate Sample
Bold/Shade = [illegible]ceeds a regulatory threshold.
E = C[illegible]ation exceeds the calibration range for that specific analysis.

TABLE 2A
ORIGINAL CA SOIL HEADSPACE RESULTS
BX SERVICE STATION
TYNDALL AIR FORCE BASE
BAY COUNTY, FLORIDA

Location I.D.	Sample Interval	OVA Reading Unfiltered	OVA Reading Filtered	OVA Reading Total
BX-HA1	0-1	70	20	50
	2-3.5	**>1000**	ND	**>1000**
	4-5.5	**>1000**	160	**840**
BX-HA2	0-1	ND	ND	ND
	2-3.5	2	ND	2
	4-5.5	70	50	20
BX-HA3	0-1	ND	ND	ND
	2-3.5	1	ND	1
	4-5.5	300	220	80
BX-HA4	0-1	14	2.8	11.2
	2-3.5	260	40	220
	4-5.5	**>1000**	440	**560**
BX-HA5	0.5-2	180	10	170
	3.5-5	280	30	250
	6.5-8	**>1000**	ND	**>1000**
BX-HA6	0-1	ND	ND	ND
	2-3.5	ND	ND	ND
	4-5.5	200	80	120
BX-HA7	0-1	ND	ND	ND
	2-3.5	ND	ND	ND
	4-5.5	**820**	260	**560**
BX-HA8	0-1	ND	ND	ND
	2-3.5	ND	ND	ND
	4-5.5	ND	ND	ND
BX-HA9	0-1	ND	ND	ND
	2-3.5	**>1000**	90	**910**
	4-5.5	**>1000**	150	**850**

ND = Non Detected

Bold = Exceedance of 500 ppm standard for excessively contaminated soil. Petroleum Contamination Site Clean-up Crtieria, FDEP 62-7-70; September 1994

TABLE 2 (Cont'd)

SOIL HEADSPACE RESULTS REPORTED IN PARTS PER MILLION (ppm)
BX SERVICE STATION
TYNDALL AIR FORCE BASE
BAY COUNTY, FLORIDA

Location I.D.	Sample Interval	OVA Reading Unfiltered	OVA Reading Filtered	GVA Reading Total
BX-HA-29	0.5 -2.5	**900**	ND	**900**
	2.5 -4.5	**3100**	ND	**3100**
BX-HA-30	0.5- 2.5	40	ND	40
	2.5 -4.5	45	ND	45
BX-HA-31	0.5 -2.5	**1050**	ND	**1050**
	2.5 -4.5	**7000**	ND	**7000**
BX-HA-32	0.5 -2.5	**1000**	ND	**1000**
	2.5 4.5	**2000**	ND	**2000**
BX-HA -33	0.5 -2.5	2	ND	2
	2.5 -4.5	2	ND	2

ND = Non Detected
Bold = Exceedance of 500 ppm standard for excessively contaminated soil. Petroleum Contamination Site Clean-up Crtieria, FDEP 62-7-70; September 1994

TABLE 2

SOIL HEADSPACE RESULTS REPORTED IN PARTS PER MILLION (ppm)
BX SERVICE STATION
TYNDALL AIR FORCE BASE
BAY COUNTY, FLORIDA

Location I.D.	Sample Interval	OVA Reading Unfiltered	OVA Reading Filtered	OVA Reading Total
BX-HA-10	0.5 - 2.5'	145	ND	145
	2.5 - 4.5'	**1490**	ND	**1490**
BX-HA-11	0.5 - 2.5'	45	ND	45
	2.5 - 4.5'	30	ND	30
BX-HA-12	0.5 - 2.5'	25	ND	25
	2.5 - 4.5'	45	ND	45
BX-HA-13	0.5 - 2.5'	35	ND	35
	2.5 - 4.5'	ND	ND	ND
BX-HA-14	0.5 - 2.5'	160	15	145
	2.5 - 4.5'	115	ND	115
BX-HA-15	0.5 - 2.5'	**2240**	ND	**2240**
	2.5 - 4.5'	**>10000**	ND	**>10000**
BX-HA-16	0.5 - 2.5'	385	ND	385
	2.5 - 4.5'	**>10000**	ND	**>10000**
BX-HA-17	0.5 - 2.5'	155	ND	155
	2.5 - 4.5'	115	ND	115
BX-HA-18	0.5 - 2.5'	45	15	30
	2.5 - 4.5'	45	20	25
BX-HA-19	0.5 - 2.5'	120	80	40
	2.5 - 4.5'	95	80	15
BX-HA-20	0.5 - 2.5'	5	ND	5
	2.5 - 4.5'	1	ND	1
BX-HA-21	0.5 - 2.5'	31	ND	31
	2.5 - 4.5'	20	ND	20
BX-HA-22	0.5 - 2.5'	120	16	104
	2.5 - 4.5'	85	5	80
BX-HA-23	0.5 - 2.5'	75	35	40
	2.5 - 4.5'	15	ND	15
BX-HA-25	0.5 - 2.5'	15	ND	15
	2.5 - 4.5'	**3500**	ND	**3500**
BX-HA-26	0.5 -2.5'	4	ND	4
	2.5 -4.5'	4	ND	4
BX-HA-27	0.5 -2.5'	4	ND	4
	2.5 -4.5'	4	ND	4
BX-HA-28	0.5 -2.5	31	ND	31
	2.5 -4.5	20	ND	20

ND = Non Detected

Bold = Exceedance of 500 ppm standard for excessively contaminated soil. Petroleum Contamination Site Clean-up Criteria, FDEP 62-7-70; September 1994

TABLE 1

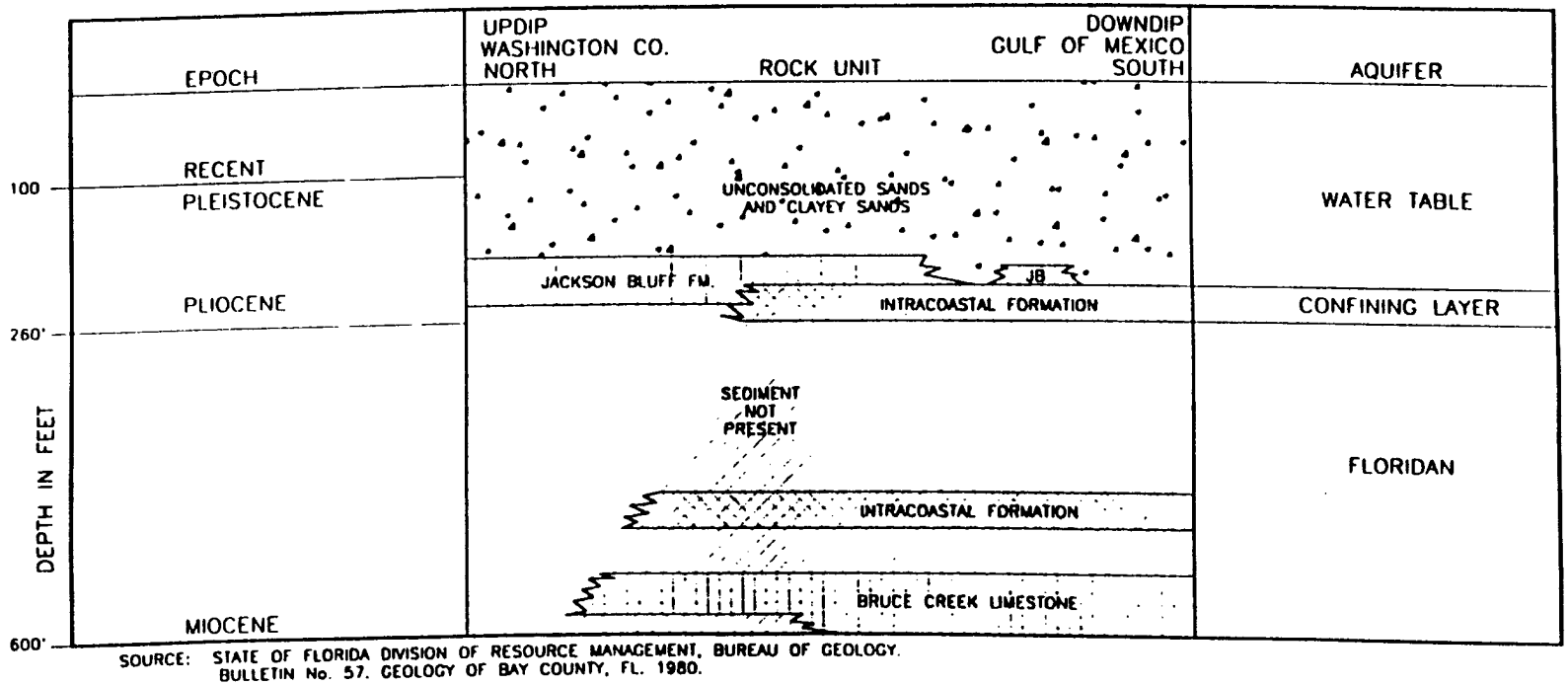
BX SERVICE STATION
WELL CONSTRUCTION DETAILS

WELL NO.	WELL DIAMETER INCHES	ELEVATION - TOC FEET	ELEVATION - GROUND FEET	TOTAL DEPTH FT. - BTOC	SCREEN LENGTH - FEET	GW ELEVATION 4/7/95
MW-01	4	30.85	30.98	16.5	10	24.85
MW-02	4	30.12	29.68	15	10	Abandoned
MW-03	4	29.78	30.09	16.5	10	24.57
MW-04	4	30.12	30.35	14.5	10	24.57
MW-05	4	29.38	29.62	11	10	24.08
MW-06	4	28.44	29.29	17	10	24.12
MW-07	4	29.00	29.34	15.5	10	24.25
MW-08	4	29.37	29.62	15.3	10	24.27
MW-09	4	30.26	30.35	15.5	10	24..53
MWD01-97	2	30.14	30.50	45.80	10	22.11
MW02-97	4	29.66	29.90	12.00	10	24.66
MW03-97	4	29.36	29.60	13.00	10	23.81
MWD04-97	2	29.12	29.42	35.60	10	24.07
MW05-97	4	28.66	28.80	13.00	10	23.81
MW06-97	4	28.97	29.10	13.00	10	23.97
MW07-97	4	29.55	29.73	13.00	10	24.47
MW08-97	4	29.02	29.29	13.00	10	24.24
MWD09-97	2	29.06	29.32	28.20	25	23.96
MWD10-97	4	29.24	29.44	28.50	25	23.89
MWD11-97	2	29.20	29.73	27.83	25	23.84

TOC = Top of Casing
BTOC = Below Top of Casing
GW = Groundwater

FIGURES

BCM



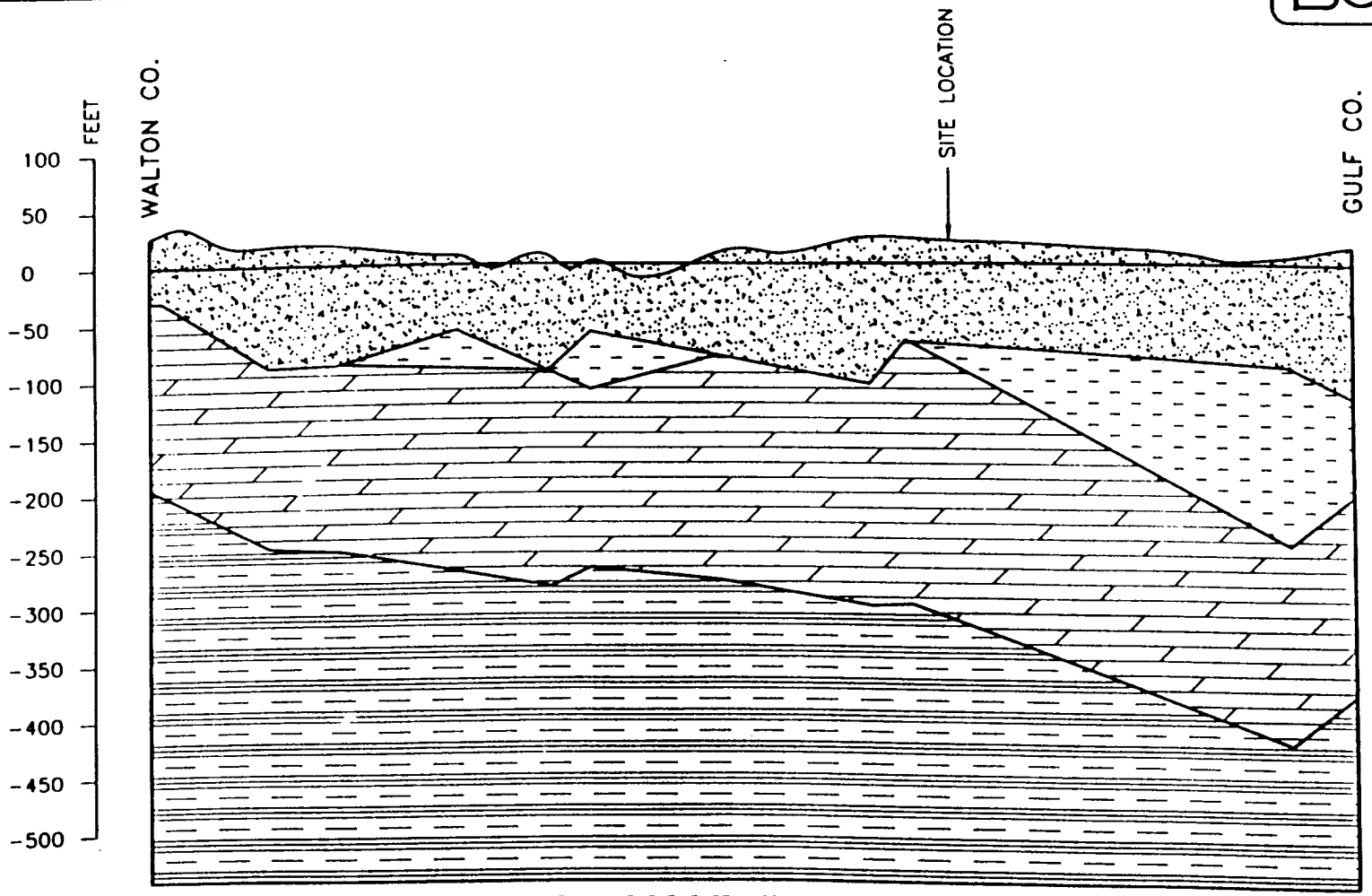
SOURCE: STATE OF FLORIDA DIVISION OF RESOURCE MANAGEMENT, BUREAU OF GEOLOGY. BULLETIN No. 57. GEOLOGY OF BAY COUNTY, FL. 1980.

FIGURE 2

GENERALIZED STRATIGRAPHIC COLUMN
TYNDALL AFB, FLORIDA

SCALE: 1"=200'

BCM



SOURCE: STATE OF FLORIDA DIVISION OF RESOURCE MANAGEMENT, BUREAU OF GEOLOGY. BULLETIN No. 57. GEOLOGY OF BAY COUNTY, FL. 1980.

LEGEND

- PLIOCENE–RECENT SANDS
- JACKSON BLUFF
- INTRACOASTAL FORMATION
- BRUCE CREEK LIMESTONE

FIGURE 3

GEOLOGIC CROSS–SECTION
TYNDALL AFB, FLORIDA

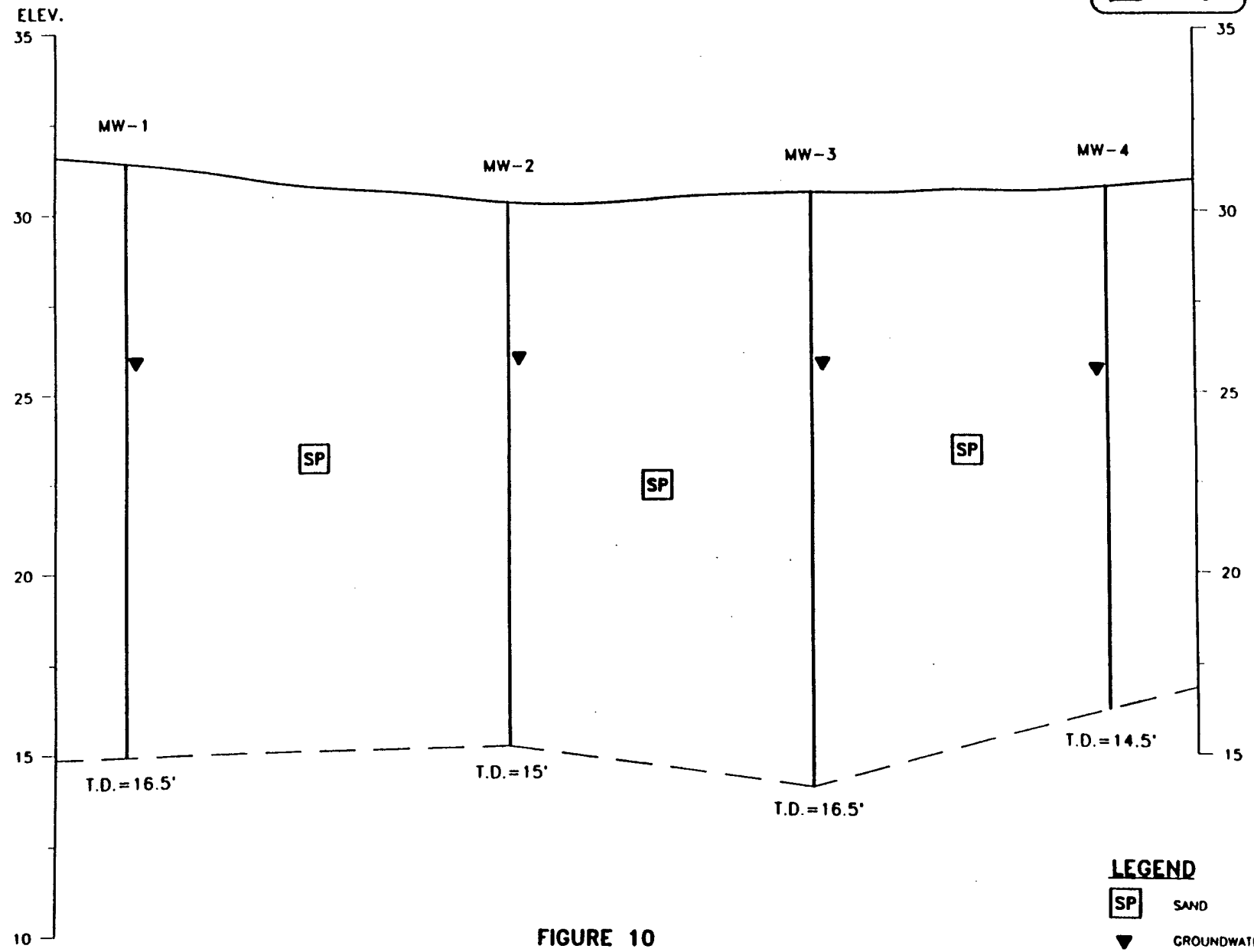
SCALE: N.T.S.

BCM Project [illegible]

00-17
1 1997

K:\09500017\BX\8-27-97\FIG10

BCM



LEGEND

SP SAND

▼ GROUNDWATER

T.D. TOTAL DEPTH

FIGURE 10

LITHOLOGIC CROSS SECTION
BX SERVICE STATION
TYNDALL AFB, FLORIDA

SCALE:
HORIZ: 1"=20'
VERT: 1"= 4'

BCM Project No 09-5000-17
August 1997

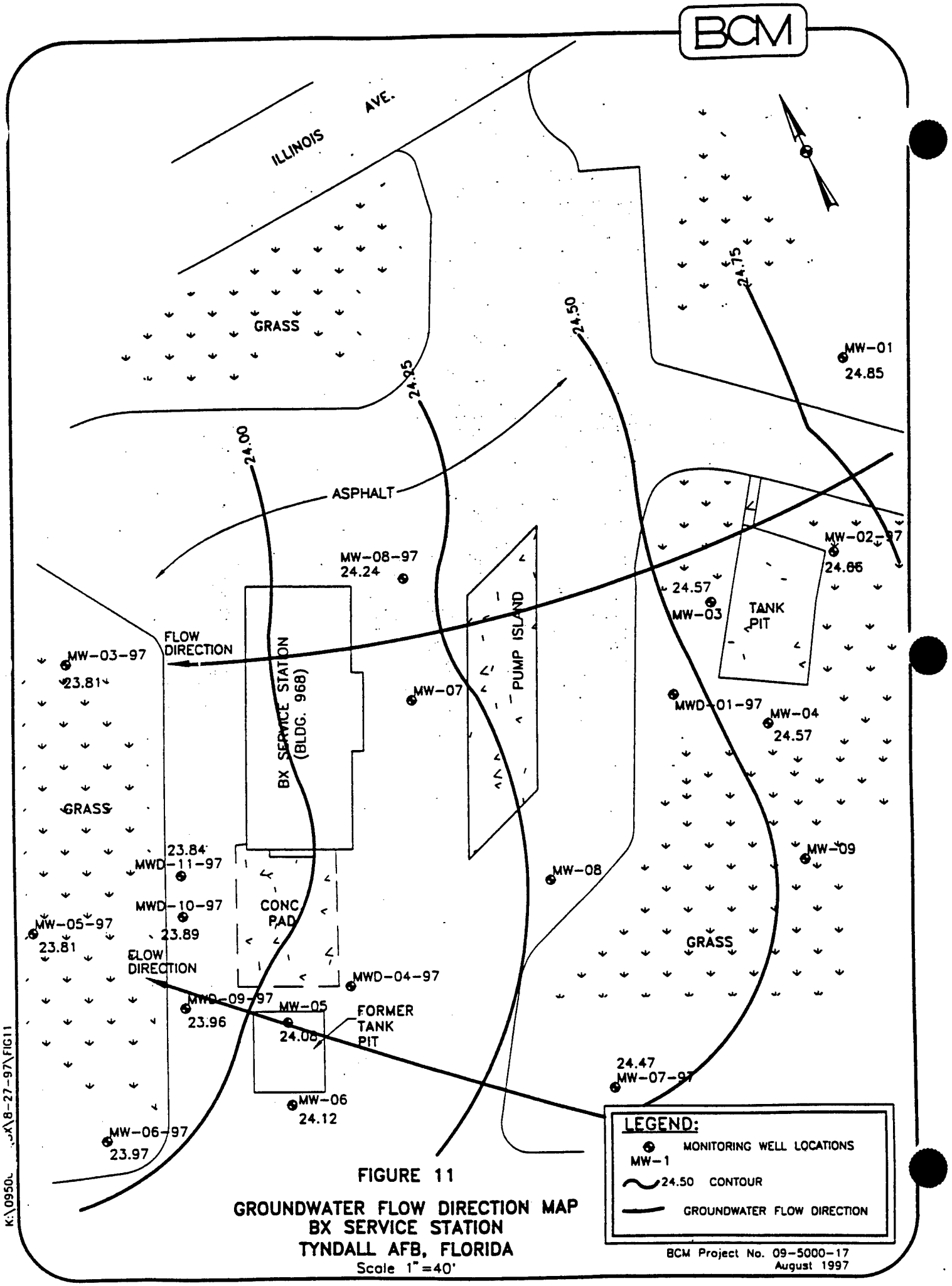
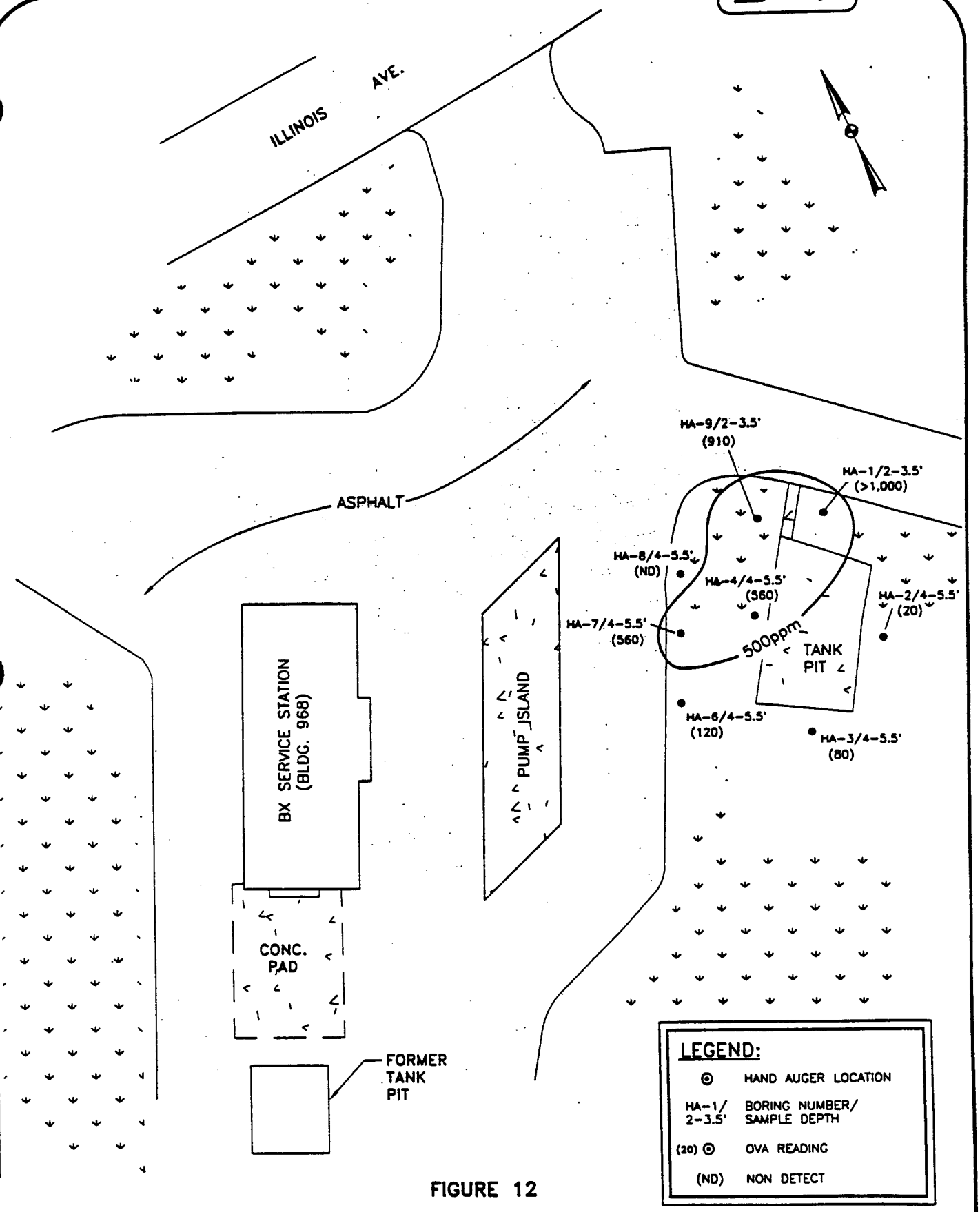


FIGURE 11

GROUNDWATER FLOW DIRECTION MAP
BX SERVICE STATION
TYNDALL AFB, FLORIDA
Scale 1" =40'

BCM Project No. 09-5000-17
August 1997

K:\0950L...\8-27-97\FIG11



X\8-27-97\FIG12

K:\

FIGURE 12

INITIAL HEADSPACE SAMPLING LOCATION MAP (PPM)
BX SERVICE STATION
TYNDALL AFB, FLORIDA

1" = 40'

BCM Project No. 09-5000-17
November 1995

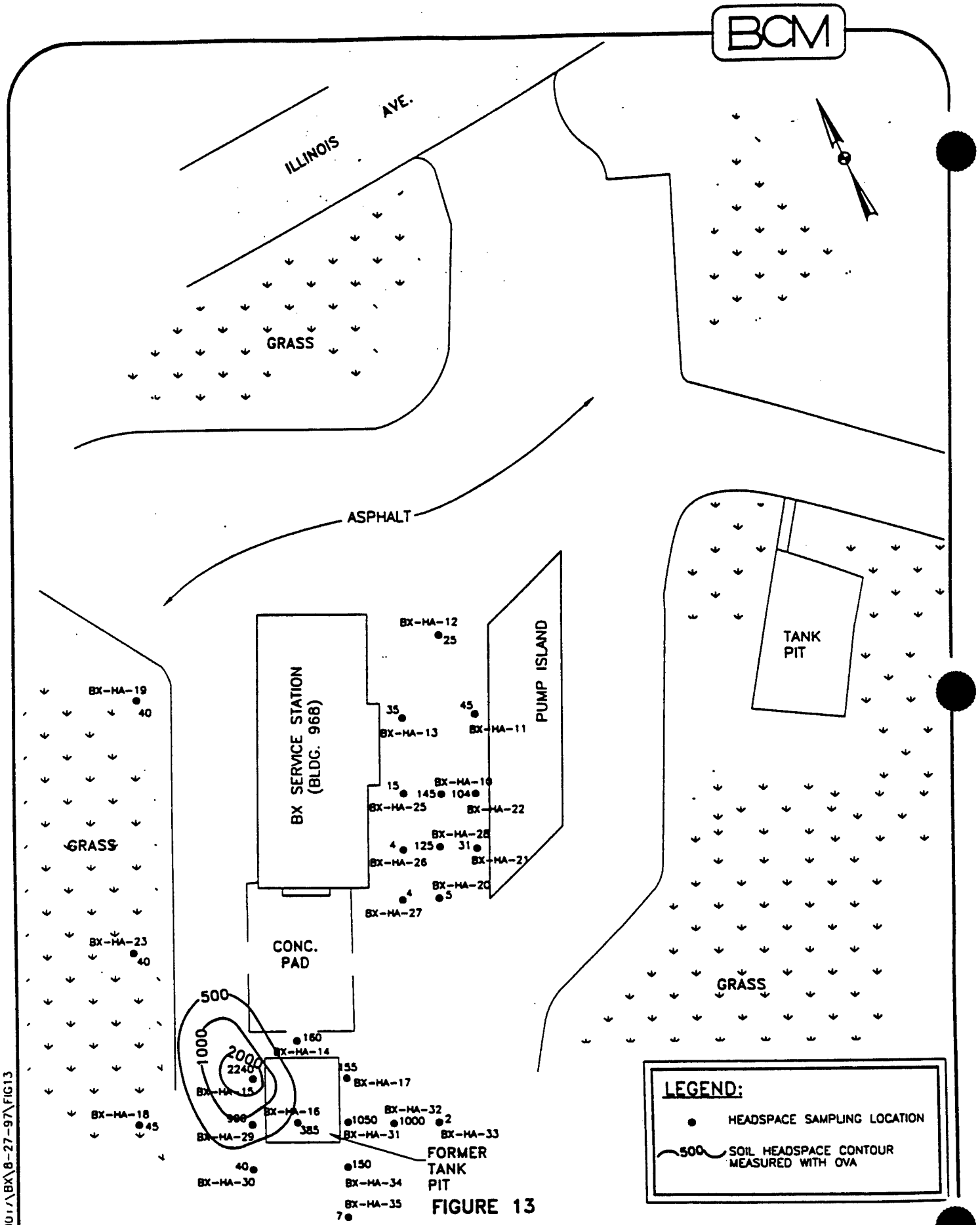
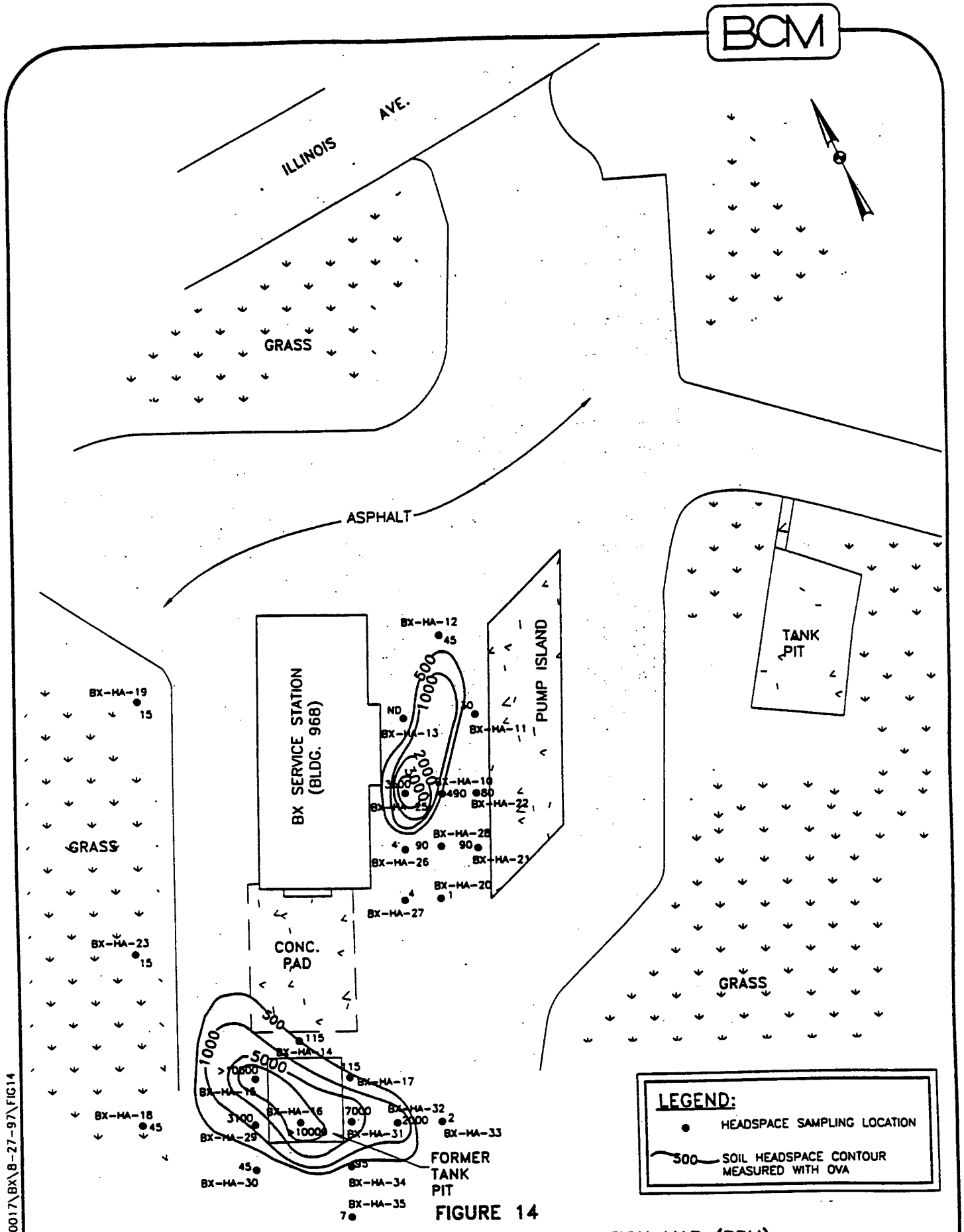


FIGURE 13

0.5'–2.5' HEADSPACE SAMPLING LOCATION MAP (PPM)
APRIL 1997
BX SERVICE STATION
TYNDALL AFB, FLORIDA
Scale 1" = 40'

BCM Project No. 09-5000-17
August 1997

K:\09500017\BX\8-27-97\FIG13



K:\09500017\BX\8-27-97\FIG14

FIGURE 14

2.5' – 4.5' HEADSPACE SAMPLING LOCATION MAP (PPM)
APRIL 1997
BX SERVICE STATION
TYNDALL AFB, FLORIDA
Scale 1"=40'

BCM Project No. 09-5000-17
August 1997

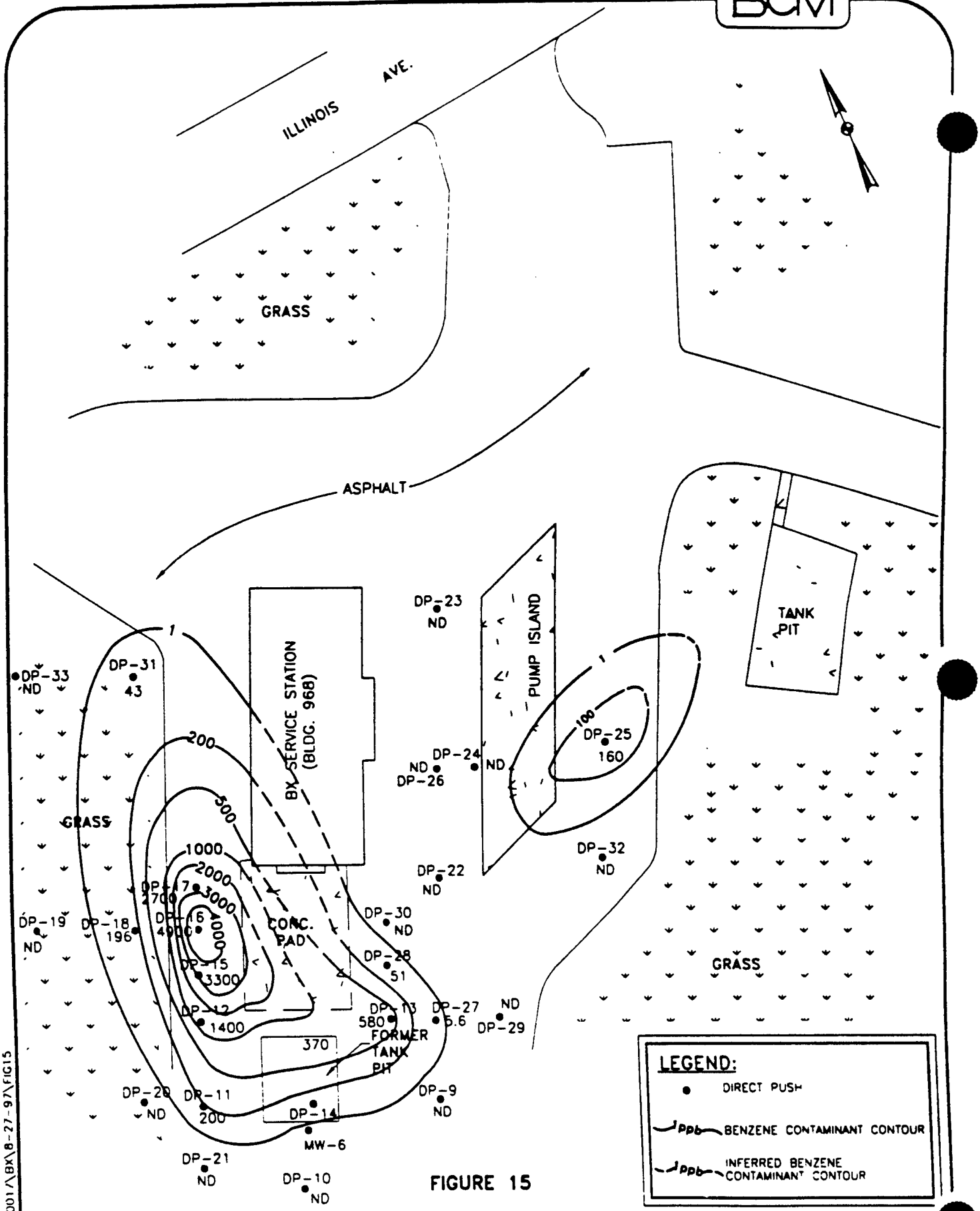


FIGURE 15

SECONDARY BENZENE DIRECT PUSH CONCENTRATION MAP, PPB
APRIL 1997
BX SERVICE STATION
TYNDALL AFB, FLORIDA
Scale 1" = 40'

BCM Project No. 09-5000-17
August 1997

K:\09500017\BX\8-27-97\FIG15

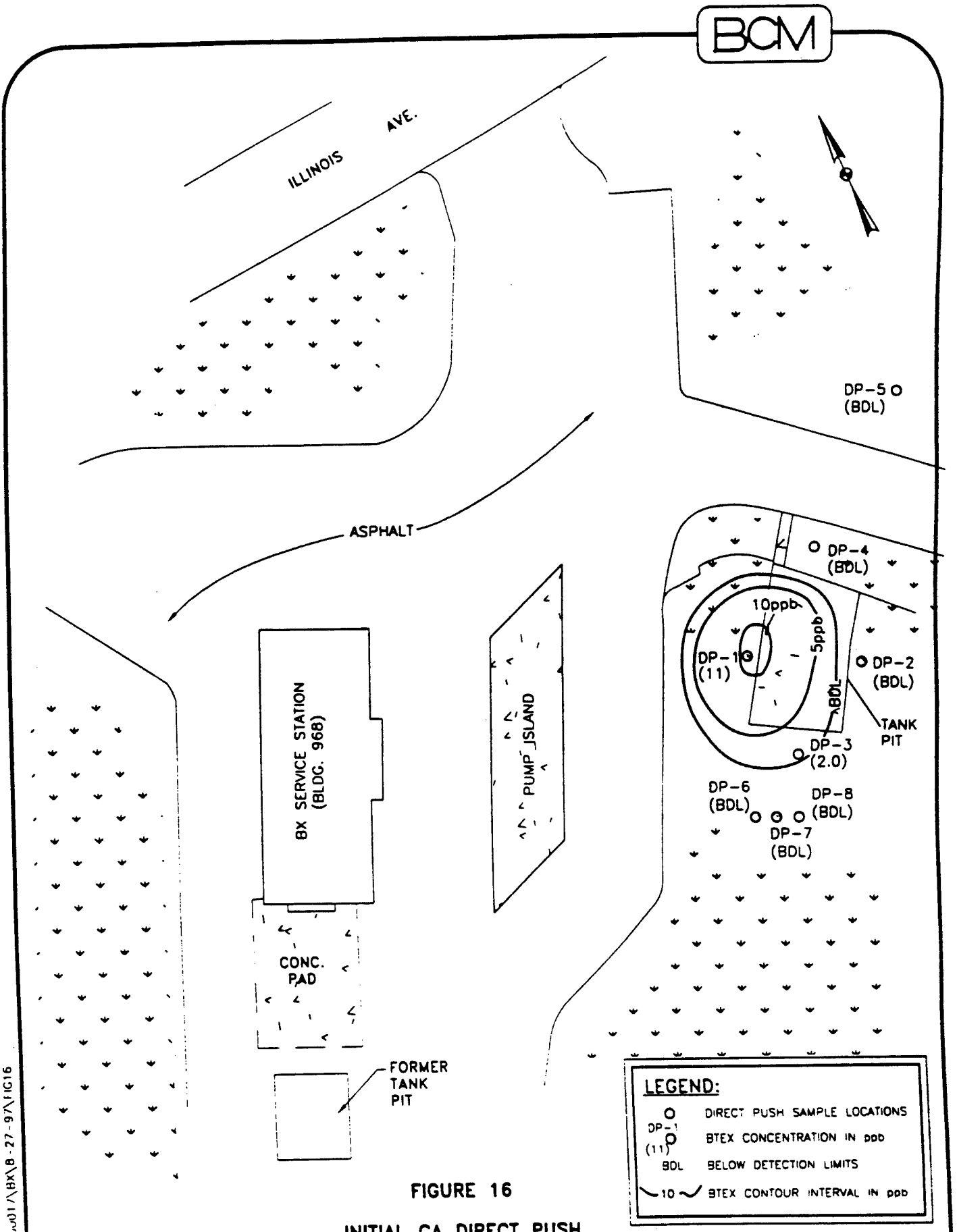


FIGURE 16

INITIAL CA DIRECT PUSH
BTEX CONCENTRATIONS IN GROUNDWATER
BX SERVICE STATION
TYNDALL AFB, FLORIDA
1" = 40'

BCM Project No. 09-5000-17
June 1995

k\09-5000\BX\8-27-97\FIG16

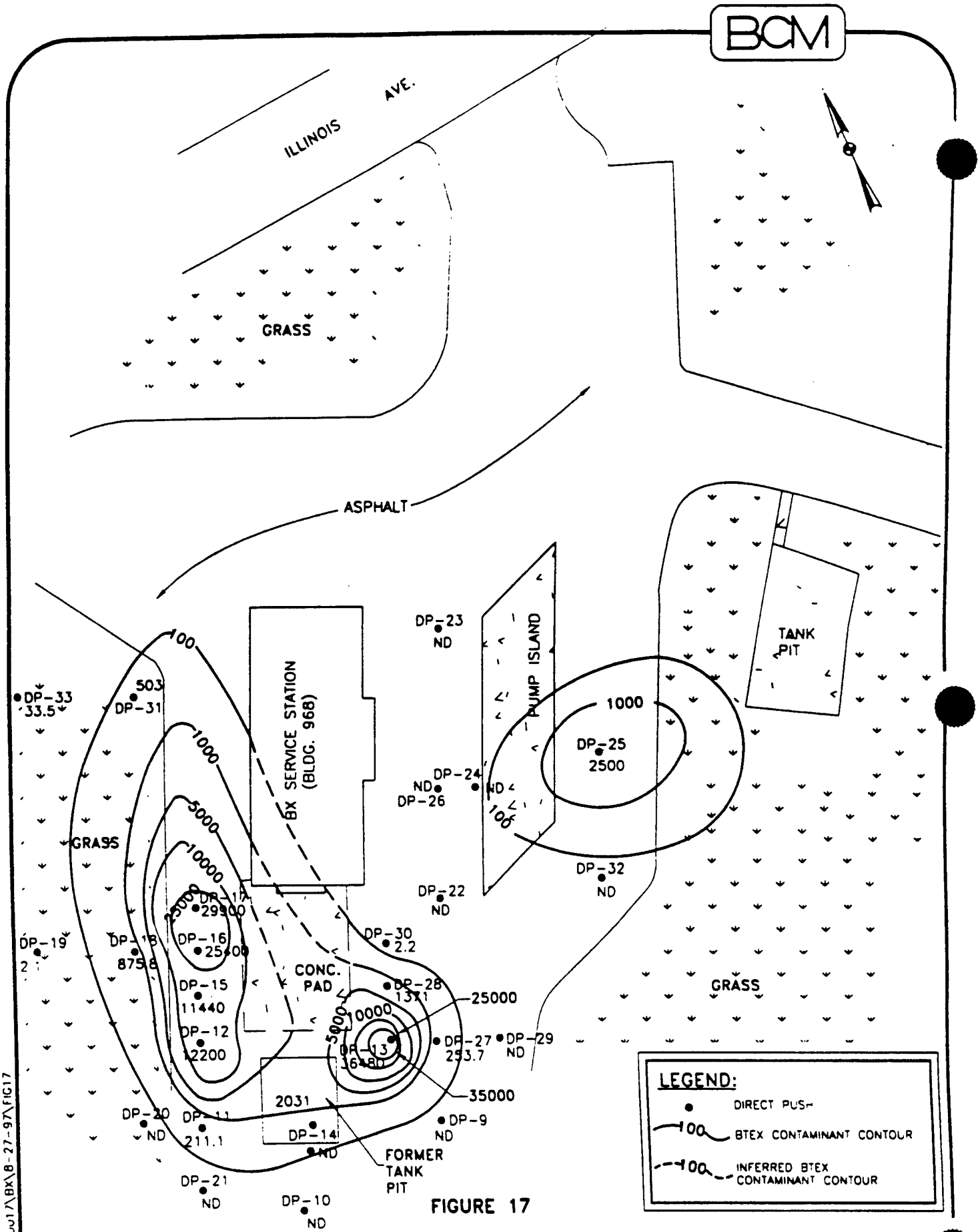
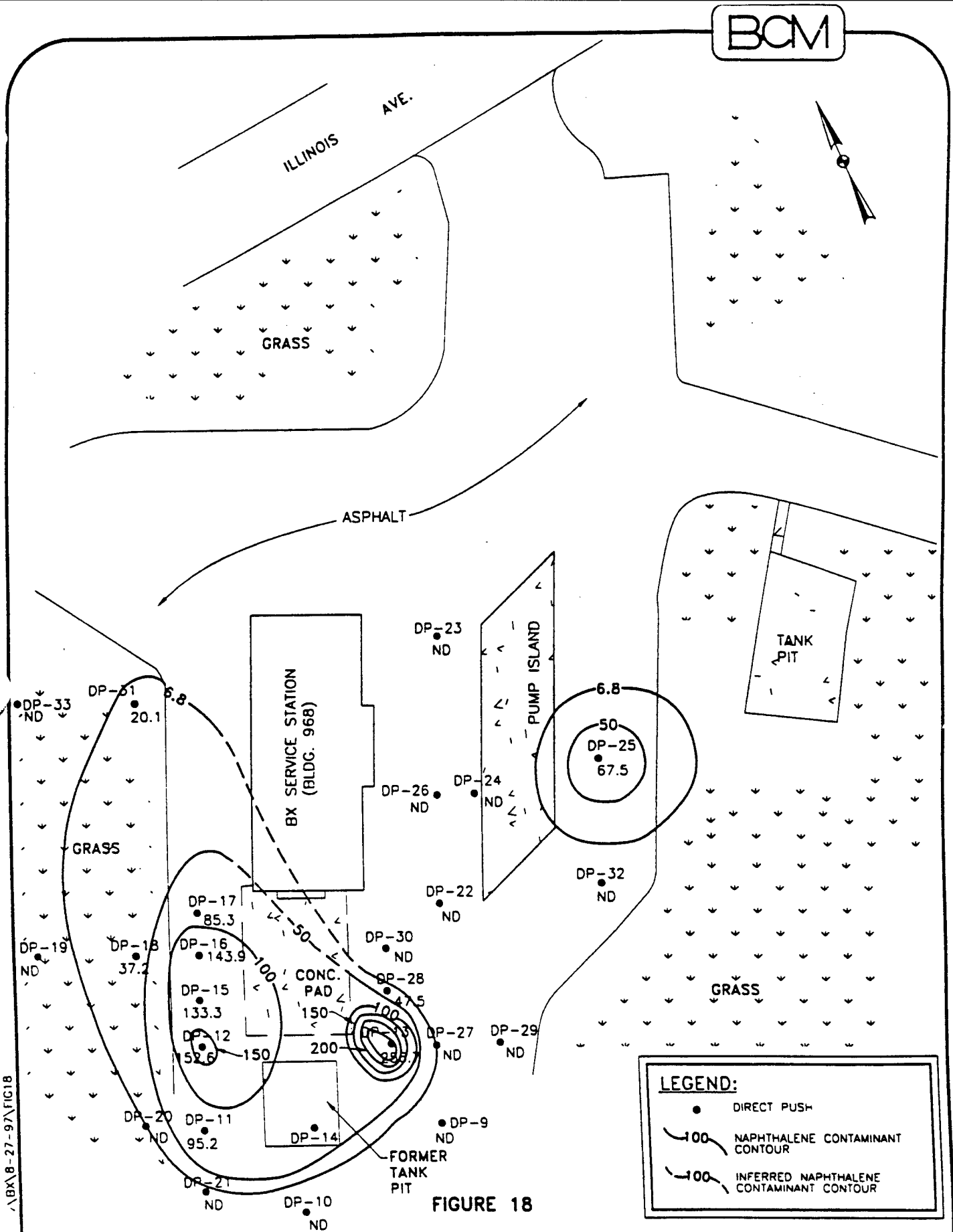


FIGURE 17

SECONDARY BTEX DIRECT PUSH CONCENTRATION MAP, PPB
APRIL 1997
BX SERVICE STATION
TYNDALL AFB, FLORIDA
Scale 1" = 40'

BCM Project No 09-5000-17
August 1997

K:\095000\17\BX\8-27-97\FIG17



K:\BX\8-27-97\FIG18

FIGURE 18

SECONDARY NAPHTHALENE DIRECT PUSH MAP, (PPB)
APRIL 1997
BX SERVICE STATION
TYNDALL AFB, FLORIDA
Scale 1"=40'

BCM Project No. 09-5000-17
August 1997

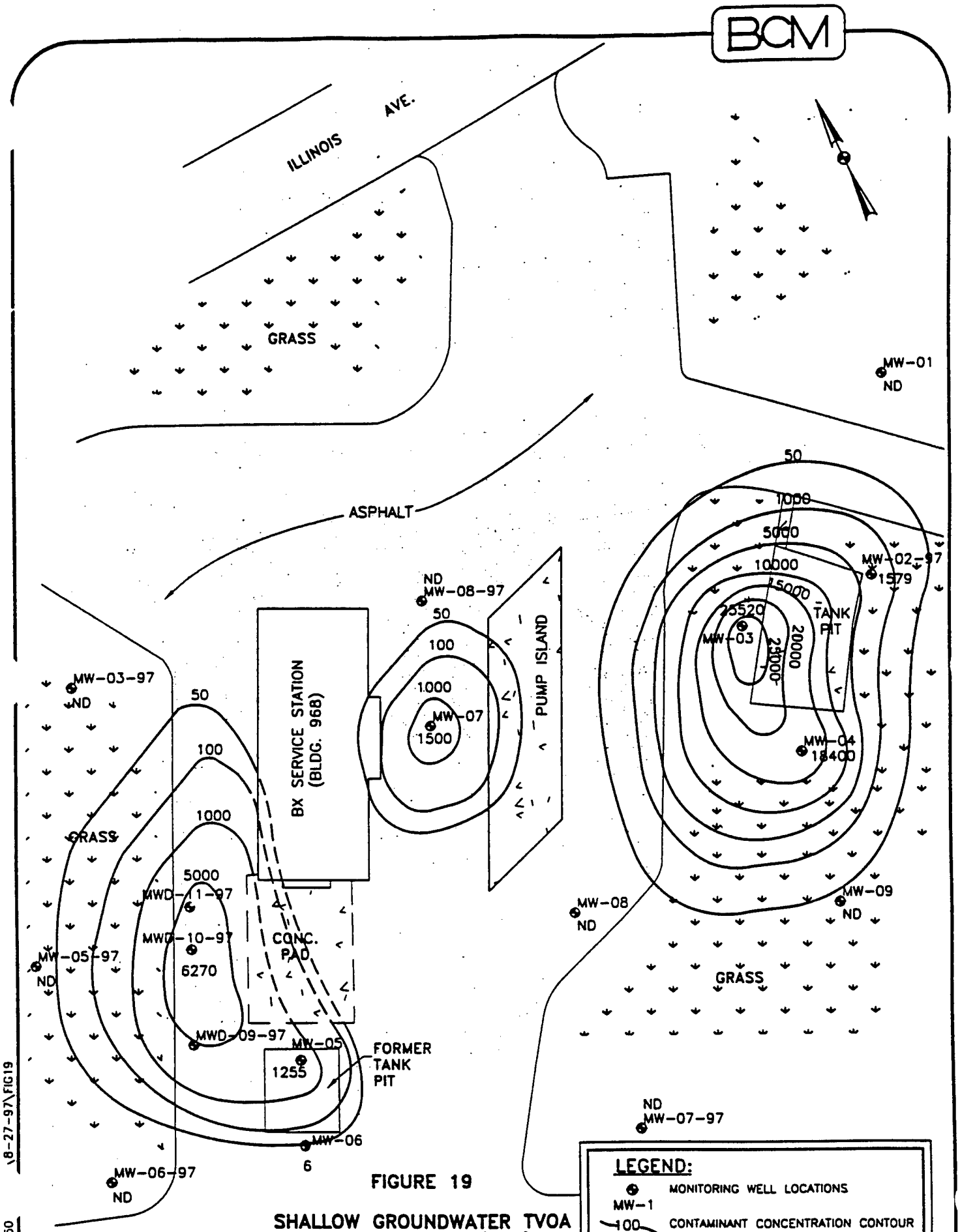


FIGURE 19

SHALLOW GROUNDWATER TVOA CONCENTRATION (PPB)
BX SERVICE STATION
TYNDALL AFB, FLORIDA
Scale 1"=40'

BCM Project No. 09-5000-17
August 1997

K:\0950\8-27-97\FIG19

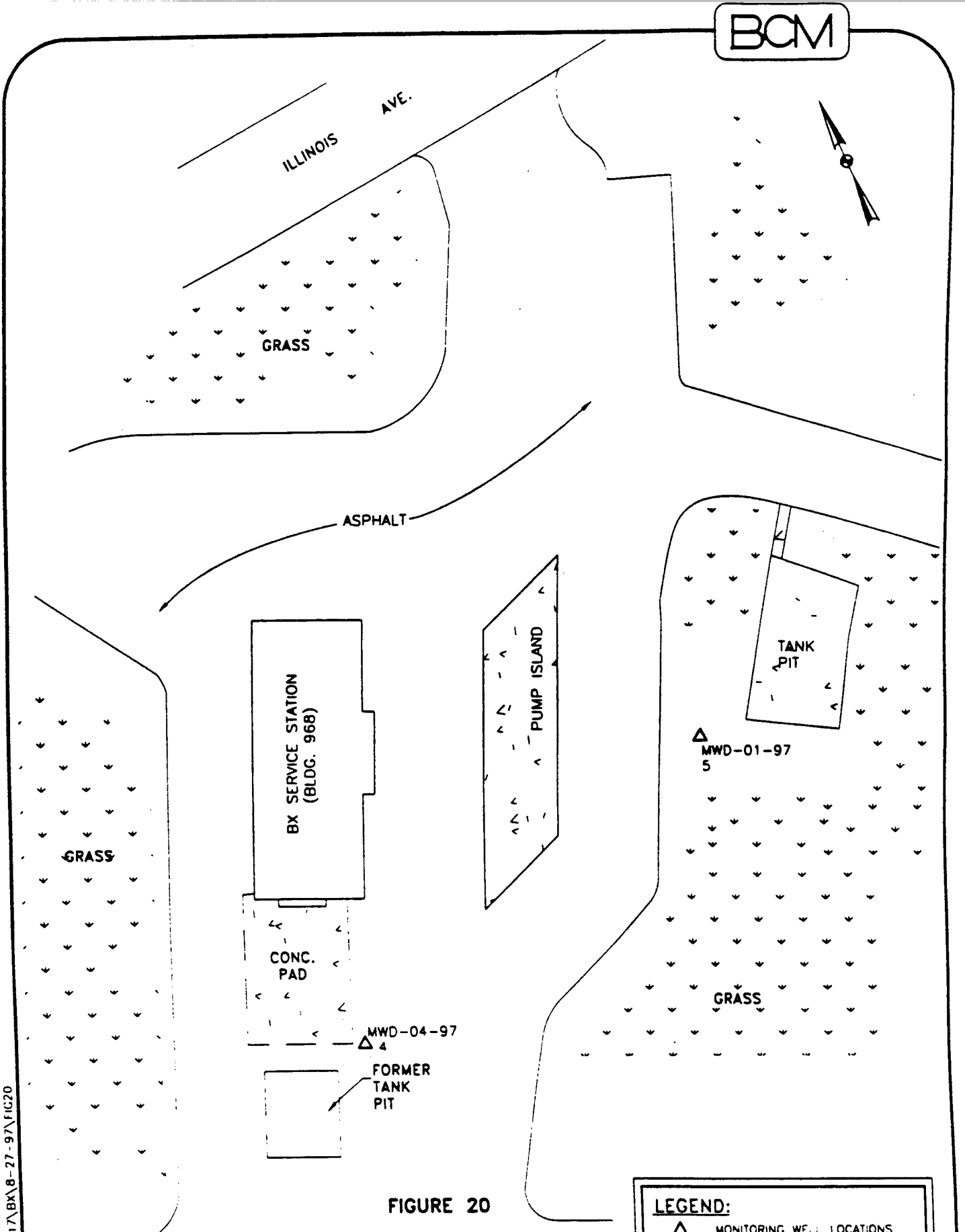


FIGURE 20

DEEP GROUNDWATER TVOA CONCENTRATION (PPB)
BX SERVICE STATION
TYNDALL AFB, FLORIDA
Scale 1"=40'

BCM Project No. 09-5000-17
August 1997

K:\09500017\BX\8-27-97\FIG20

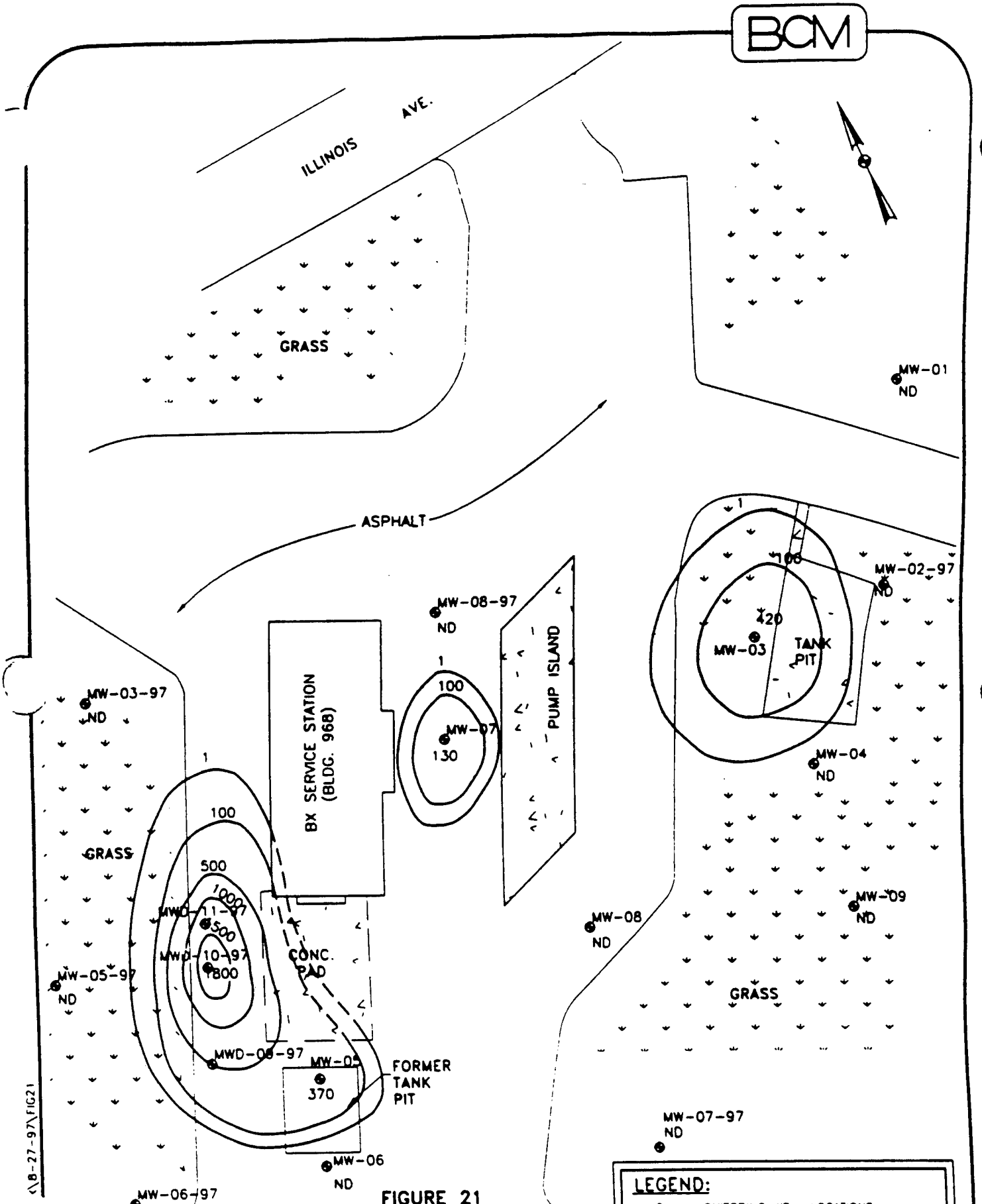


FIGURE 21

SHALLOW GROUNDWATER BENZENE CONCENTRATION (PPB)
BX SERVICE STATION
TYNDALL AFB, FLORIDA
Scale 1" = 40'

BCM Project No. 09-5000-17
August 1997

K:\09-27-97\FIG21

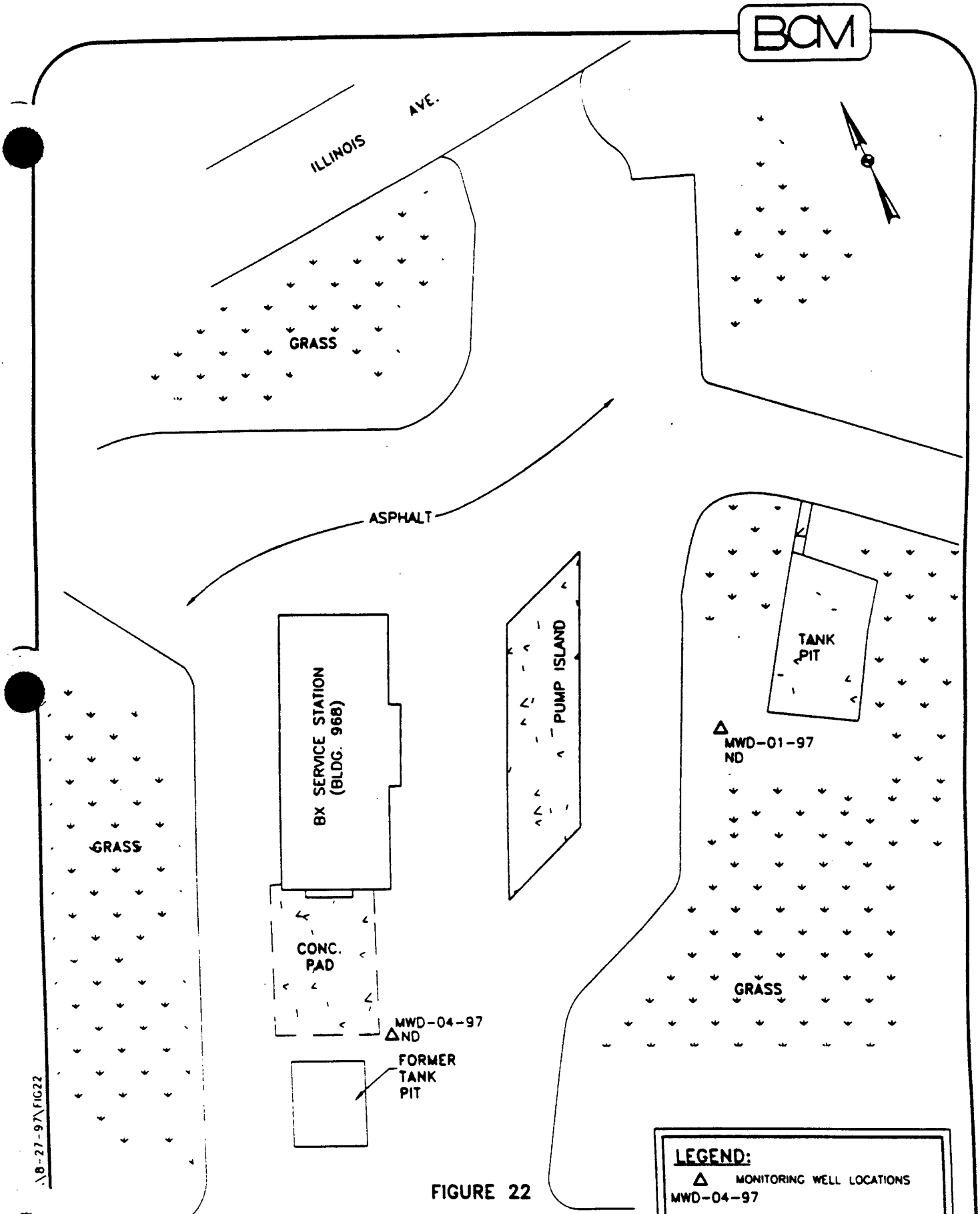


FIGURE 22

DEEP GROUNDWATER BENZENE CONCENTRATION (PPB)
BX SERVICE STATION
TYNDALL AFB, FLORIDA
Scale 1"=40'

BCM Project No 09-5000-17
August 1997

K:\09\8-27-97\FIG22

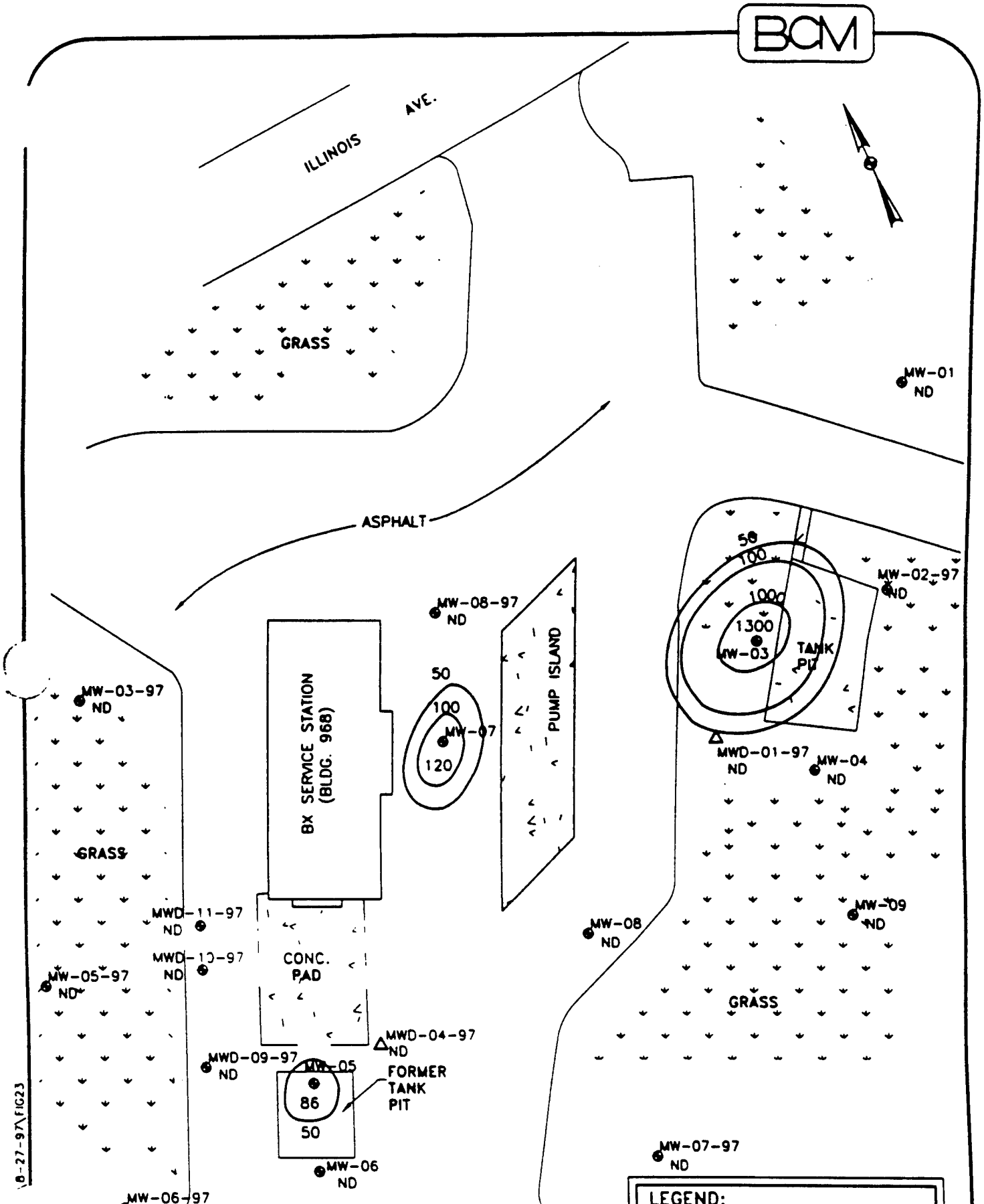


FIGURE 23

METHYL-T-BUTYL GROUNDWATER CONCENTRATION (PPB)
BX SERVICE STATION
TYNDALL AFB, FLORIDA
Scale 1" = 40'

BCM Project No. 09-5000-17
August 1997

K:\0950\8-27-97\FIG23

SOIL BORING LOGS/ MONITORING WELL CONSTRUCTION DIAGRAMS

BCM Engineers — Drilling/Boring Log

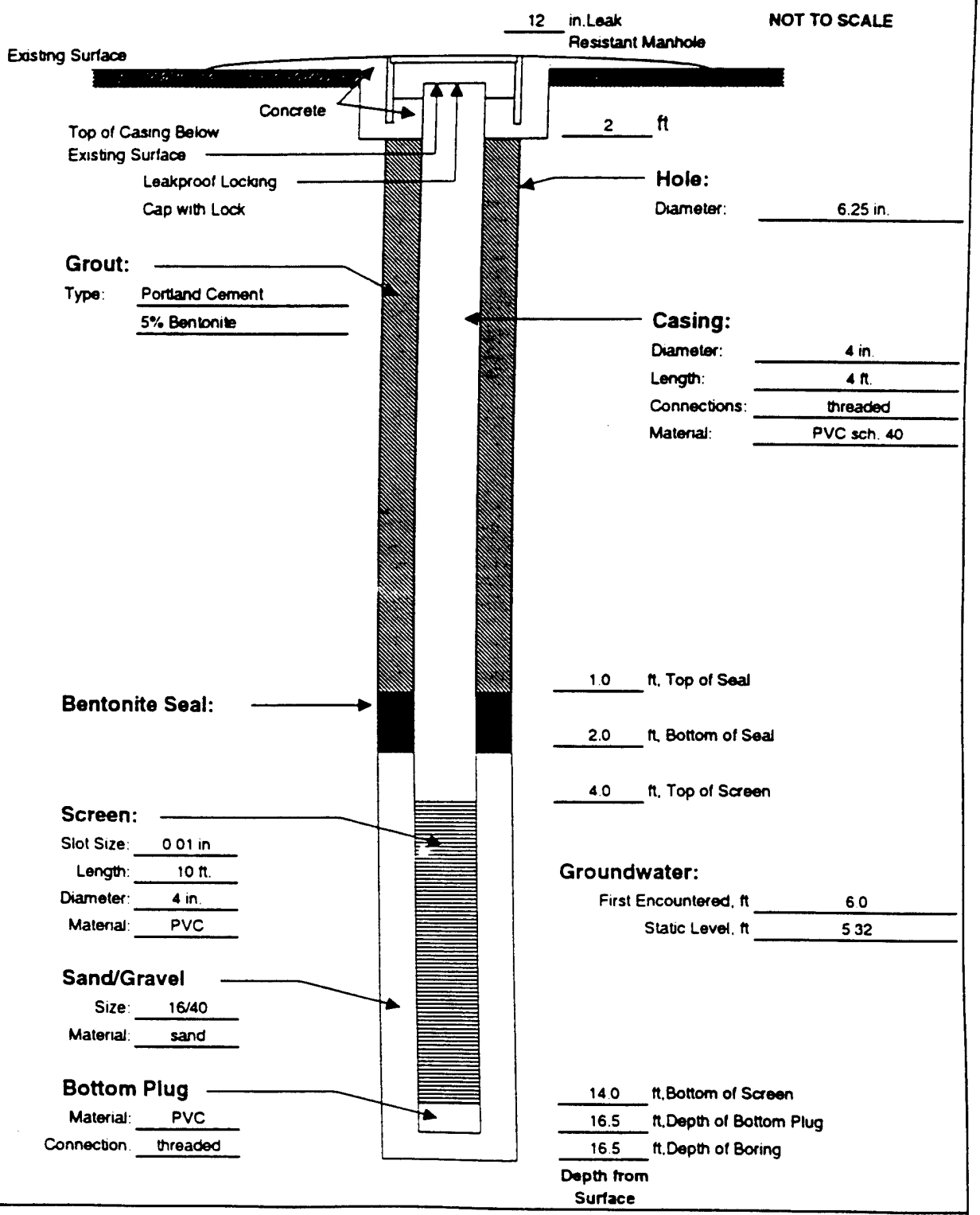
Project: COE-Tyndall AFB Contamination Assessment-5 sites
Sheet: 1 of 1
Project No.: 09-5000-17
Date(s): 3/23/95
Well/Boring: BX-MW 1
Well/Boring Location: N 390321 E 1653808
Logged By: David Britain
Drilling Method: Hollow Stem Auger
Drilling Contractor: Ardaman & Associates
Depth to Groundwater: 5.32 ft.
Date: 4/6/95
Reference: TOC
Elevations - Ground Surface: 30.96 ft.
Inner Casing: 30.85 ft.
Outer Casing: N/A
Water Table: 25.53 ft.
Date: 4/6/95
Reference: TOC
Remarks: Monitoring well set at 16.5 feet BGS

Depth, Sample Pt.	Sample Location	OVA Readings	Lithologic Description	Graphical Logs: Strata	Graphical Logs: Well Construction	Blow Count	Elevation
2	1	ND				2-3-3	
4	2	ND				3-4-4	
6	3	ND	SAND(SP) Light gray to dark gray to lilght brown to tan, fine to medium, well to poorly sorted, sub angular to sub rounded, very loose to loose, moist to saturated at 6-7.5', no odor			3-4-5	
8							
10	4	ND				2-3-3	
12	5	ND				7-8-8	
14							
16	6	1.0				6-7-9	

Note: Not to scale unless otherwise noted. Not to be used separately.

BCM Engineers — Monitoring Well Schematic

Project: COE-Contamination Assessment. Tyndall AFB. Florida
Well/Boring No.: BX-MW 1
Project No.: 09-5000-17
Drilling Supervisor: David Britain
Boring Location: N 390321 E 1653808
Date(s): 3/23/95
Drilling Method: Hollow stem auger
Drilling Contractor: Ardaman & Associates



Comments

6/91

BCM Engineers — Drilling/Boring Log

Sheet: 1 of 1

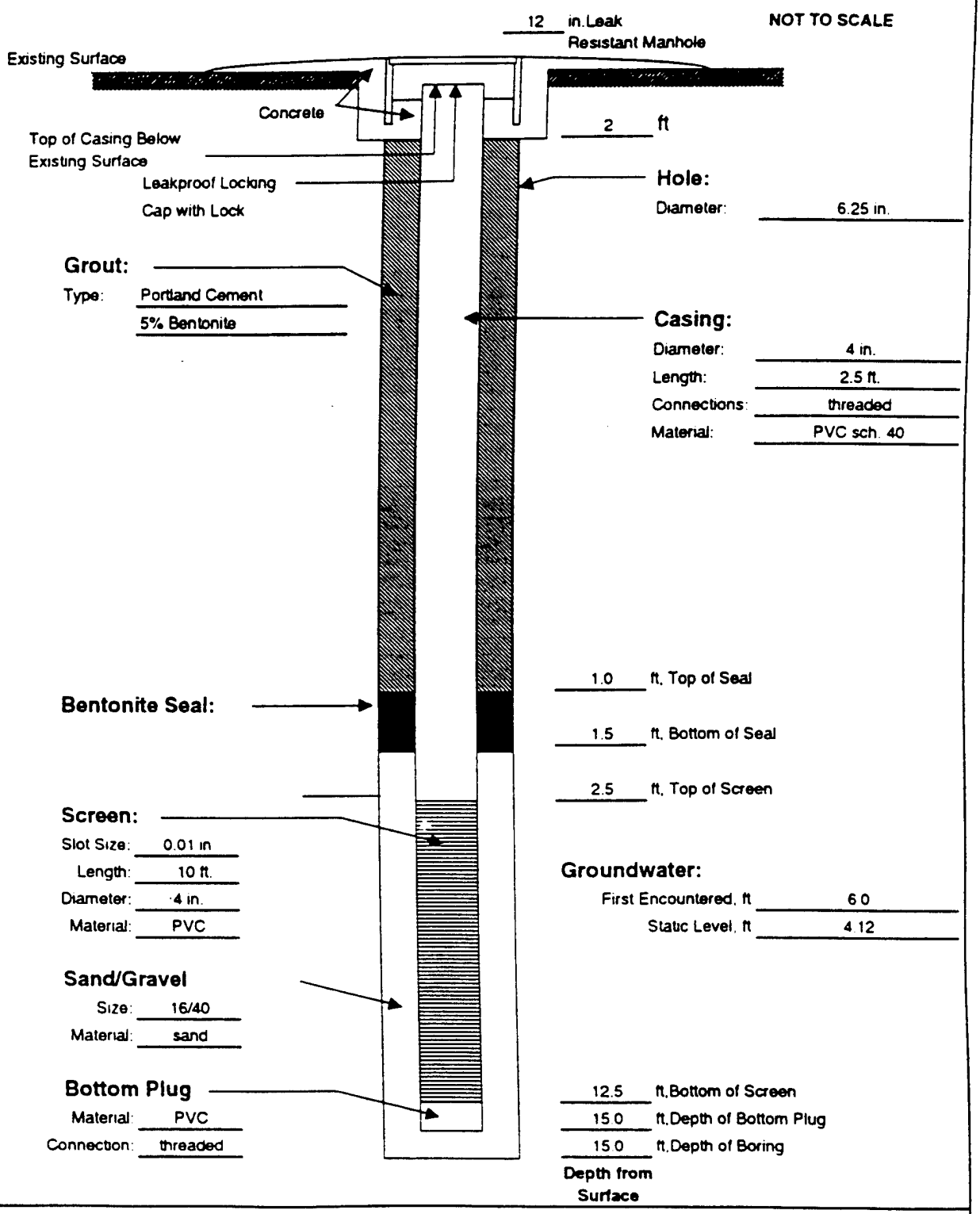
Project: COE-Tyndall AFB Contamination Assessment-5 sites
Well/Boring: BX-MW 2
Project No.: 09-5000-17
Date(s): 3/27/95
Logged By: David Britain
Well/Boring Location: N 390291 E 1653740
Drilling Method: Hollow Stem Auger
Drilling Contractor: Ardaman & Associates
Depth to Groundwater: 4.12 ft. Date: 4/6/95 Reference: TOC
Elevations - Ground Surface: 29.68 ft. Inner Casing: 29.44 ft. Outer Casing: N/A
Water Table: 25.32 ft. Date: 4/6/95 Reference: TOC
Remarks: Monitoring well set at 15.0 feet BGS

Depth, Sample Pt.	Sample Location	OVA Readings	Lithologic Description	Graphical Logs: Strata	Graphical Logs: Well Construction	Blow Count	Elevation
2	1	ND				1-2-2	
4	2	71,000				2-3-4	
6	3	560	SAND(SP) Tan, dark gray, brown, fine to medium, poorly sorted, sub angular to sub rounded,very loose, moist to saturated from 6-7.5', petroleum odor from 3-13.5'			3-3-5	
8							
10	4	10.0				1-2-3	
12	5	2.0				4-7-8	
14							
16							

BCM Engineers — Monitoring Well Schematic

Project: COE-Contamination Assessment, Tyndall AFB, Florida
Well/Boring No.: BX-MW 2
Project No.: 09-5000-17
Drilling Supervisor: David Britain
Boring Location: N 390291 E 1653740
Date(s): 3/27/95
Drilling Method: Hollow stem auger
Drilling Contractor: Ardaman & Associates

NOT TO SCALE



Comments

6/91

BCM Engineers — Drilling/Boring Log

Sheet: 1 of 1

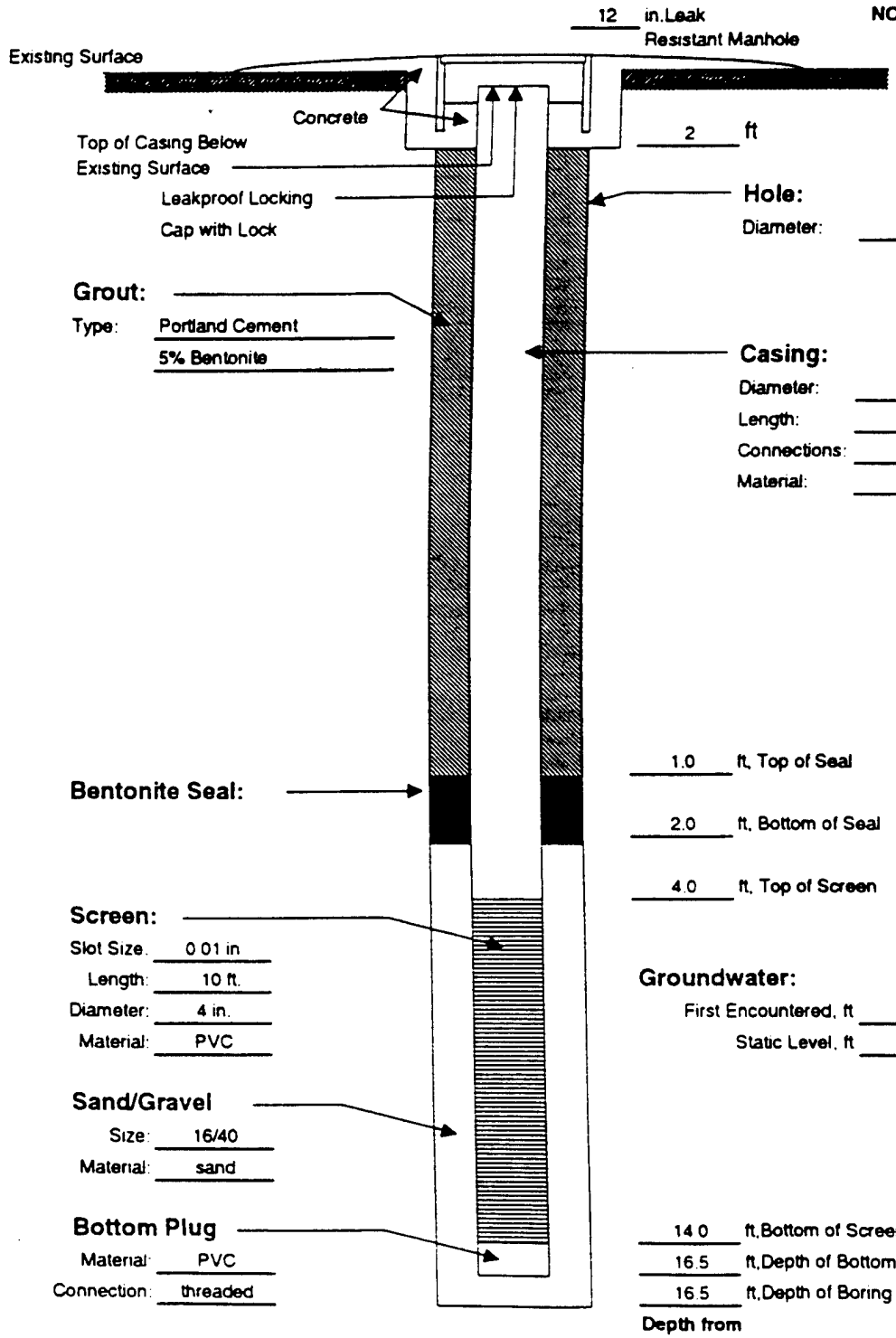
Project: COE-Tyndall AFB Contamination Assessment-5 sites
Well/Boring: BX-MW 3
Project No.: 09-5000-17
Date(s): 3/27/95
Logged By: David Britain
Well/Boring Location: N 390292 E 1653708
Drilling Method: Hollow Stem Auger
Drilling Contractor: Ardaman & Associates
Depth to Groundwater: 4.58 ft.
Date: 4/6/95
Reference: TOC
Elevations - Ground Surface: 30.09 ft.
Inner Casing: 29.78 ft.
Outer Casing: N/A
Water Table: 25.20 ft.
Date: 4/6/95
Reference: TOC
Remarks: Monitoring well set at 16.5 feet BGS

Depth, Sample Pt.	Sample Location	OVA Readings	Lithologic Description	Graphical Logs: Strata	Graphical Logs: Well Construction	Blow Count	Elevation
2	1	ND				2-2-3	
4	2	100 0				3-3-5	
6	3	280	SAND(SP) Light gray, light brown, tan, dark brown, dark gray, fine to medium, poorly sorted, sub angular to sub rounded, very loose to loose, moist to saturated at 6-7.5', petroleum odor from 3-13.5'.			3-3-4	
8							
10	4	360				2-2-2	
12	5	200				3-5-7	
14							
16							

BCM Engineers — Monitoring Well Schematic

Project: COE-Contamination Assessment, Tyndall AFB, Florida
Well/Boring No.: BX-MW 3
Project No.: 09-5000-17
Drilling Supervisor: David Britain
Boring Location: N 390292 E 1653708
Date(s): 3/27/95
Drilling Method: Hollow stem auger
Drilling Contractor: Ardaman & Associates

NOT TO SCALE



Comments

6/91

BCM Engineers — Drilling/Boring Log

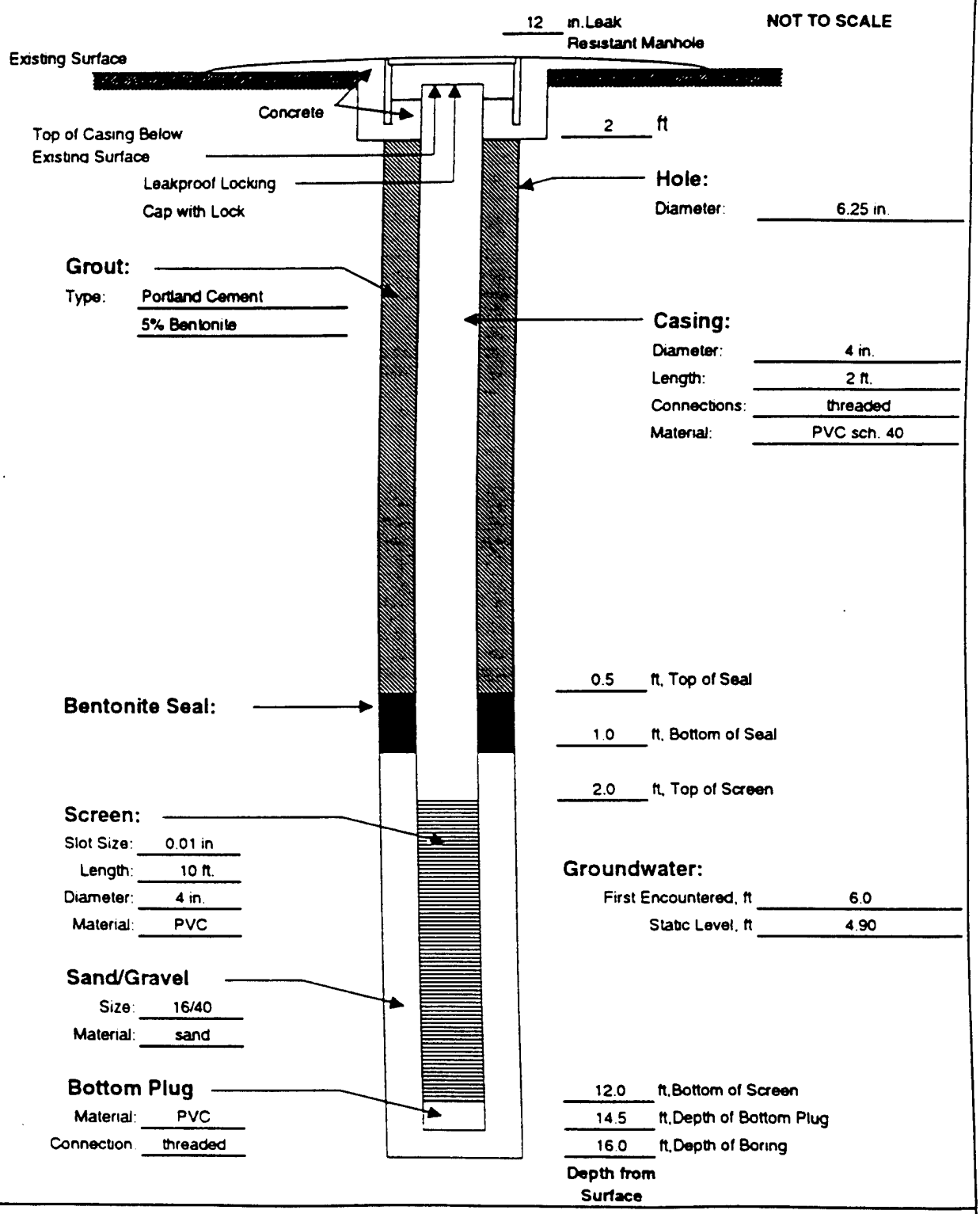
Sheet: 1 of 1

Project: COE-Tyndall AFB Contamination Assessment-5 sites
Well/Boring: BX-MW 4
Project No.: 09-5000-17
Date(s): 3/23/95
Logged By: David Britain
Well/Boring Location: N 390257 E 1653704
Drilling Method: Hollow Stem Auger
Drilling Contractor: Ardaman & Associates
Depth to Groundwater: 4.90 ft.
Date: 4/6/95
Reference: TOC
Elevations - Ground Surface: 30.35 ft.
Inner Casing: 30.12 ft.
Outer Casing: N/A
Water Table: 25.22 ft.
Date: 4/6/95
Reference: TOC
Remarks: Monitoring well set at 14.5 feet BGS

Depth, Sample Pt.	Sample Location	OVA Readings	Lithologic Description	Graphical Logs: Strata	Graphical Logs: Well Construction	Blow Count	Elevation
2	1	ND				1-1-2	
4	2	ND				1-1-2	
6	3	16	SAND(SP) Light brown to dark gray, fine to medium grain, well rounded 0-1.5', sub angular to sub rounded, very loose to loose, well sorted to poorly sorted, moist to saturated at 6-7.5', trace of wood 6-10.5', trace of petroleum odor 6-10.5'			3-3-5	
8							
10	4	100				2-2-4	
12	5	9.6				2-3-4	
14							

BCM Engineers — Monitoring Well Schematic

Project: COE-Contamination Assessment, Tyndall AFB, Florida
Well/Boring No.: BX-MW 4
Project No.: 09-5000-17
Drilling Supervisor: David Britain
Boring Location: N 390257 E 1653704
Date(s): 3/23/95
Drilling Method: Hollow stem auger
Drilling Contractor: Ardaman & Associates



Comments

6/91

BCM Engineers — Drilling/Boring Log

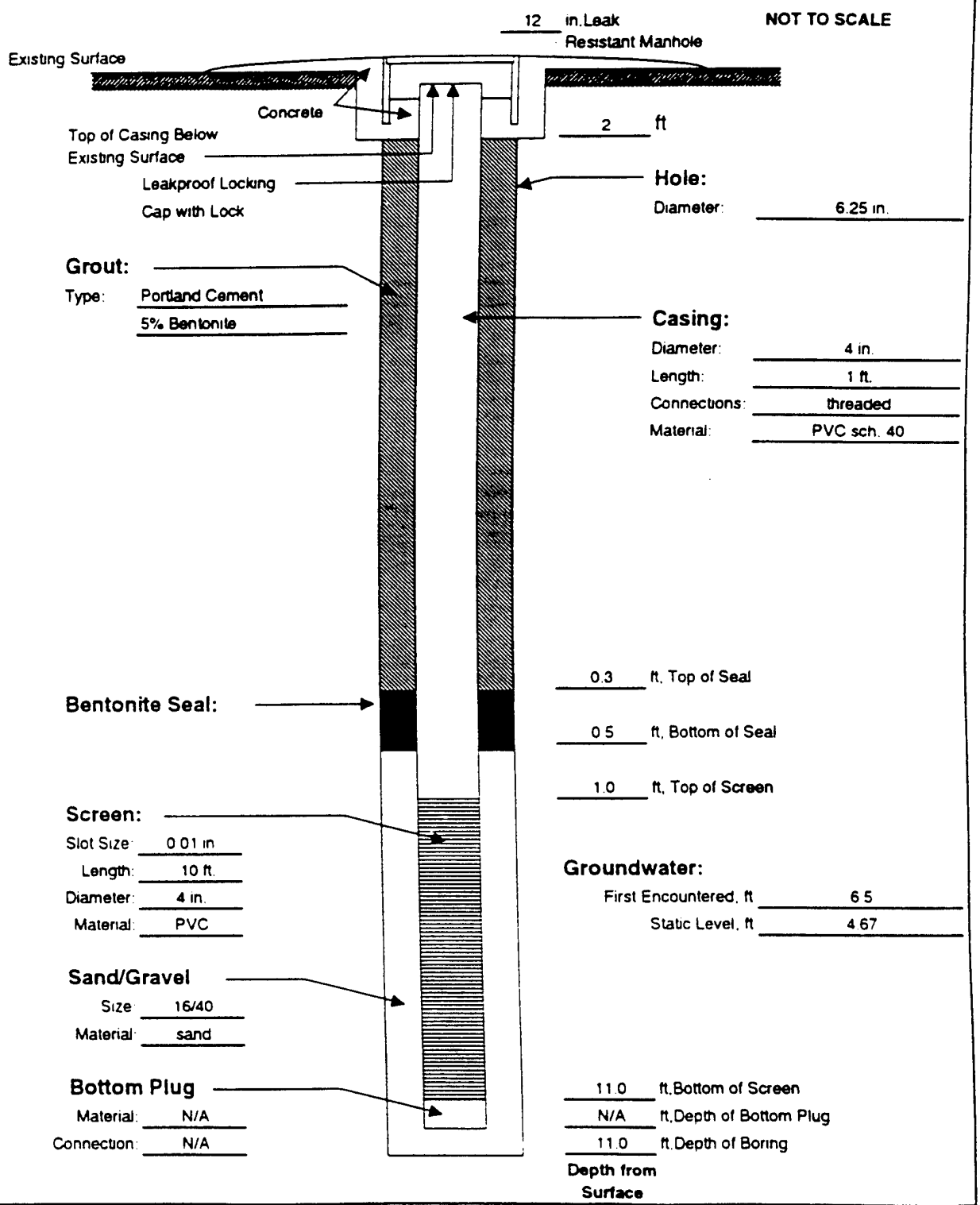
Sheet: 1 of 1

Project: COE-Tyndall AFB Contamination Assessment-5 sites
Well/Boring: BX-MW 5
Project No.: 09-5000-17
Date(s): 3/28/95
Logged By: David Britain
Well/Boring Location: N 390239 E 1653506
Drilling Method: Hollow Stem Auger
Drilling Contractor: Ardaman & Associates
Depth to Groundwater: 4.67 ft.
Date: 4/6/95
Reference: TOC
Elevations - Ground Surface: 29.62 ft.
Inner Casing: 29.38 ft.
Outer Casing: N/A
Water Table: 24.71 ft.
Date: 4/6/95
Reference: TOC
Remarks: Monitoring well set at 11.0 feet BGS

Depth, Sample Pt.	Sample Location	OVA Readings	Lithologic Description	Graphical Logs: Strata	Graphical Logs: Well Construction	Blow Count	Elevation
			0-0.5' Asphalt				
2	1	180				2-2-3	
4	2	280	SANDY CLAY(CL) 0.5-1', fine to medium, poorly sorted, sub angular to sub rounded, loose, yellowish orange, moist, petroleum odor grading into SAND(SP) Dark gray, fine to medium, poorly sorted, sub angular to sub rounded, loose to very loose, moist to saturated at 6.5-8', strong petroleum odor 6.5'			3-3-5	
6							
8	3	1,800				2-2-2	
10	4	1,800				3-2-4	
12							

BCM Engineers — Monitoring Well Schematic

Project: COE-Contamination Assessment, Tyndall AFB, Florida
Well/Boring No.: BX-MW 5
Project No.: 09-5000-17
Drilling Supervisor: David Britain
Boring Location: N 390239 E 1653506
Date(s): 3/28/95
Drilling Method: Hollow stem auger
Drilling Contractor: Ardaman & Associates



Comments: John Baehr, of the COE, ok'd placement of well on top of obstruction, and not using a 2.5 ft sediment trap.

6/91

BCM Engineers — Drilling/Boring Log

Sheet: 1 of 1

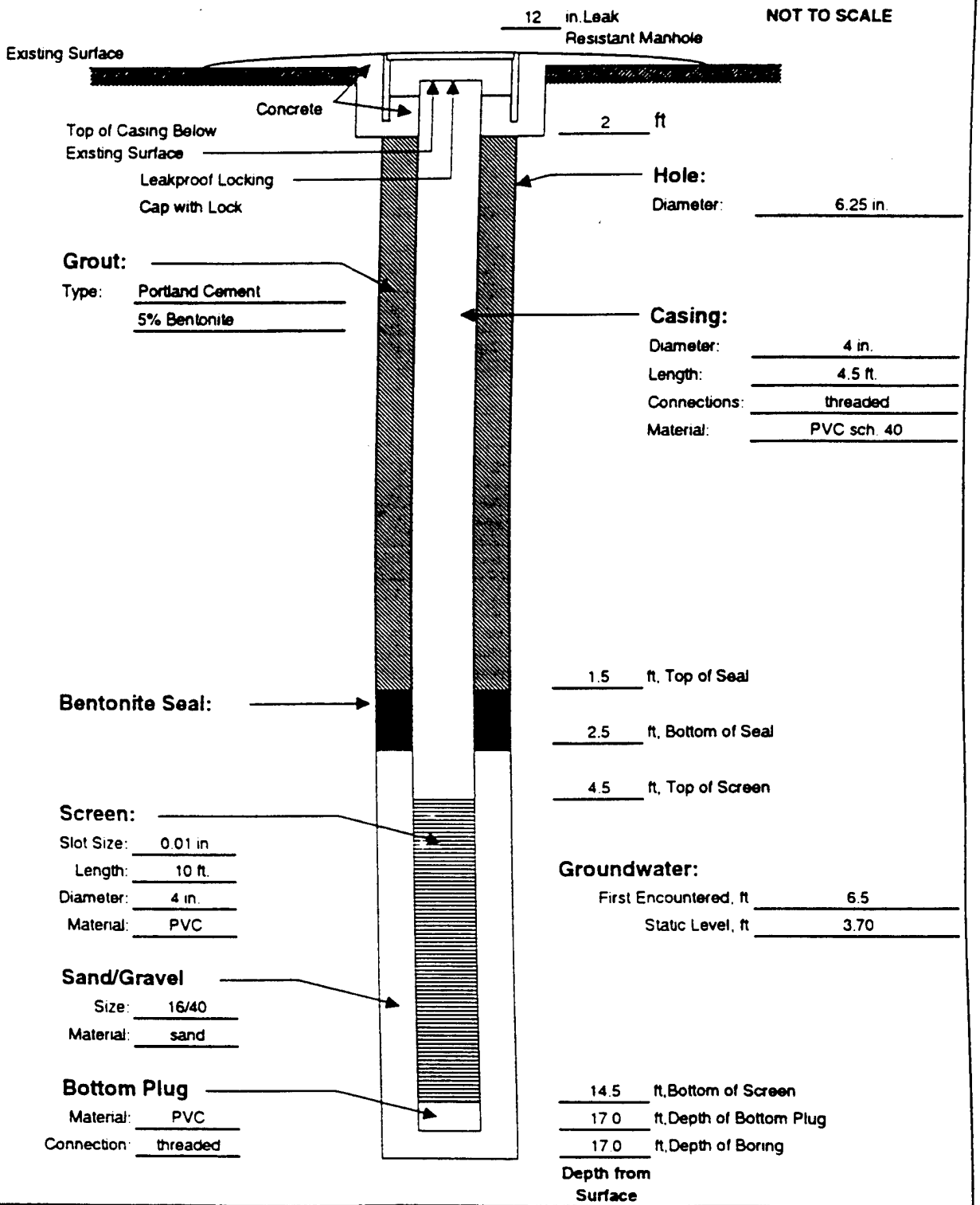
Project: COE-Tyndall AFB Contamination Assessment-5 sites
Well/Boring: BX-MW 6
Project No.: 09-5000-17
Date(s): 3/28/95
Logged By: David Britain
Well/Boring Location: N 390212 E 1653493
Drilling Method: Hollow Stem Auger
Drilling Contractor: Ardaman & Associates
Depth to Groundwater: 3.70 ft. Date: 4/6/95 Reference: TOC
Elevations - Ground Surface: 29.29 ft. Inner Casing: 28.44 ft. Outer Casing: N/A
Water Table: 24.74 ft. Date: 4/6/95 Reference: TOC
Remarks: Monitoring well set at 17.0 feet BGS

Depth, Sample PL	Sample Location	OVA Readings	Lithologic Description	Graphical Logs: Strata	Graphical Logs: Well Construction	Blow Count	Elevation
			0-0.5' Asphalt				
2	1	1.0				2-3-3	
4	2	110 ppm				3-3-4	
6	3	20.0	SANDY CLAY(CL) 0.5-1', fine to medium, poorly sorted, sub angular to sub rounded, very loose, yellowish orange, moist, no odor, grading into SAND(SP) Dark gray to light brown, to tan fine to medium, poorly sorted, sub angular to sub rounded, loose to very loose, moist to saturated at 6.5-8', trace of petroleum odor 3.5-8', no odor 9.5-17'			5-6-7	
8							
10	4	0.8				3-4-7	
12	5	6.2				6-7-7	
14							
16	6	ND				5-7-8	
18							

BCM Engineers — Monitoring Well Schematic

Project: COE-Contamination Assessment, Tyndall AFB, Florida
Well/Boring No.: BX-MW 6
Project No.: 09-5000-17
Drilling Supervisor: David Britain
Boring Location: N 390212 E 1653493
Date(s): 3/28/95
Drilling Method: Hollow stem auger
Drilling Contractor: Ardaman & Associates

NOT TO SCALE



Comments:

6/91

BCM Engineers — Drilling/Boring Log

Sheet: 1 of 1

Project: COE-Tyndall Contamination Assessment
Well/Boring: BX-MW5 (7)
Project No.: 09-5000-17
Date(s): 9/13/95
Logged By: David Britain
Well/Boring Location: N 390394.77 E 1622119.47
Drilling Method: Hollow stem auger
Drilling Contractor: Kelly Environmental Drilling
Depth to Groundwater:
Date: 9/1/95
Reference: TOC
Elevations - Ground Surface:
Inner Casing:
Outer Casing:
Water Table:
Date:
Reference: TOC
Remarks:

Depth, Sample Pt.	Sample Location	Blows	Lithologic Description	Graphical Logs: Strata / Well Construction	Blow Counts	Elevation
2	1	n/a	SAND(SP) fine to medium, poorly sorted, sub angular to sub rounded from 4' to 11.5', dark gray, brown, tan, saturated from 5' to 14', petroleum odor from 2.5' to 14', swampy odor from 10.5' to 12'		N/A	
4	2				N/A	
6	3				N/A	
8	4				4-5-10	
10	5				8-10-12	
12	6				6-12-14	
14	7				7-9-12	
16						
18						
20						

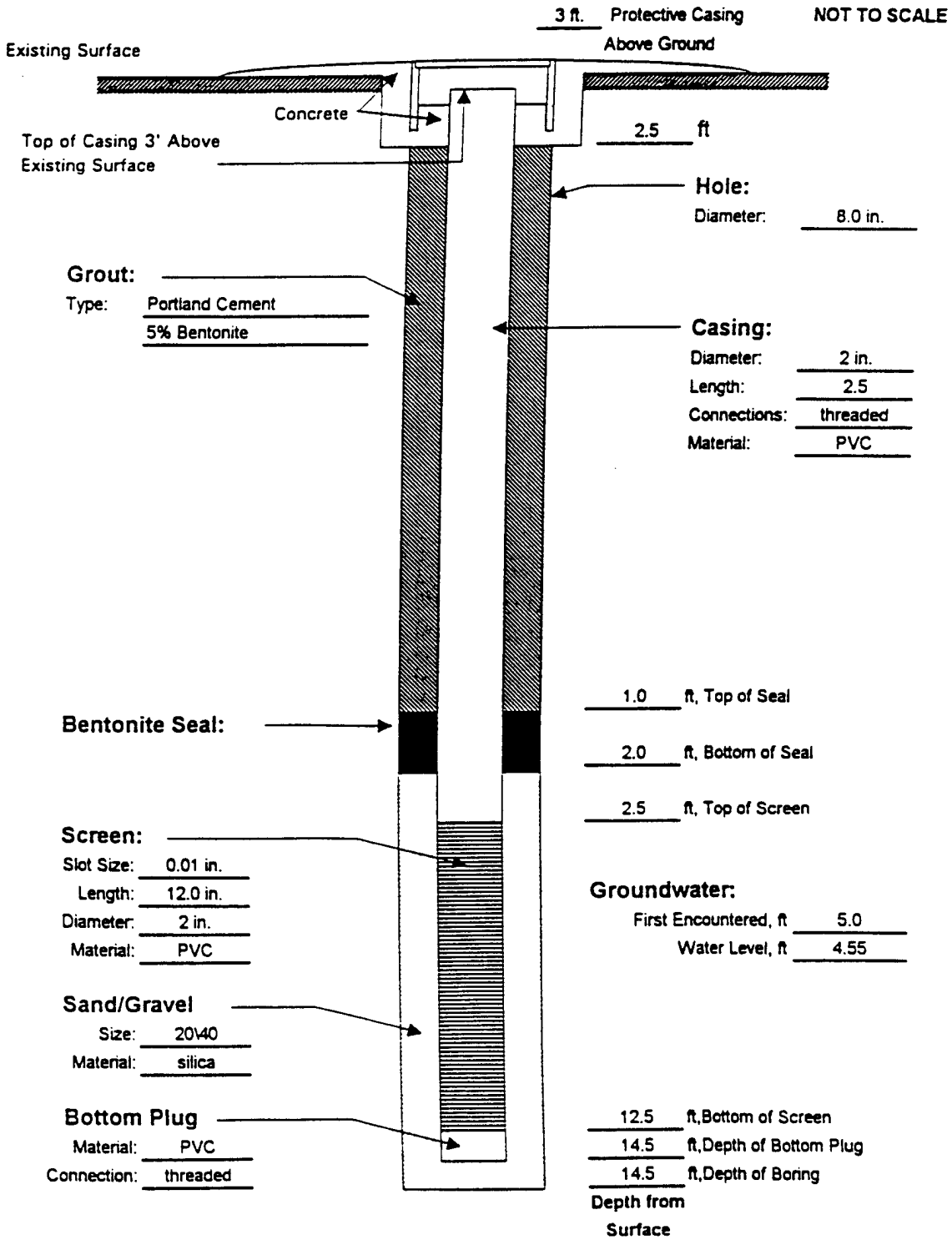
Note: Not all portions of this form are applicable to all projects

6/91

BCM Engineers

Monitoring Well Schematic

Project: Tyndall Contamination Assesement
Well/Boring No.: BX-MW5 (7)
Project No.: 09-5000-17
Drilling Supervisor: David Britain
Boring Location:
Date(s): 9-Sep-95
Drilling Method: Hollow stem auger
Drilling Contractor: Kelly Environmental Drilling



Comments:

6/91

BCM Engineers — Drilling/Boring Log

Sheet: 1 of 1

Project: COE-Tyndall Contamination Assessment
Well/Boring: BX-MW6 (8)
Project No.: 09-5000-17
Date(s): 9/13/95
Logged By: David Britain
Well/Boring Location: N 390317.98 E 1622113.17
Drilling Method: Hollow stem auger
Drilling Contractor: Kelly Environmental Drilling
Depth to Groundwater:
Date: 9/1/95
Reference: TOC
Elevations - Ground Surface:
Inner Casing:
Outer Casing:
Water Table:
Date:
Reference: TOC
Remarks:

Depth, Sample Pt.	Sample Location	Blows	Lithologic Description	Graphical Logs: Strata	Graphical Logs: Well Construction	Blow Counts	Elevation
2	1	n/a	SAND(SP) fine to medium, poorly sorted, sub angular to sub rounded, orange to dark gray, brown, tan, white, saturated from 4' to 14', no odor			N/A	
4	2					N/A	
6	3					N/A	
8	4					4-5-10	
10	5					8-10-12	
12	6					6-12-14	
14	7					7-9-12	
16							
18							
20							

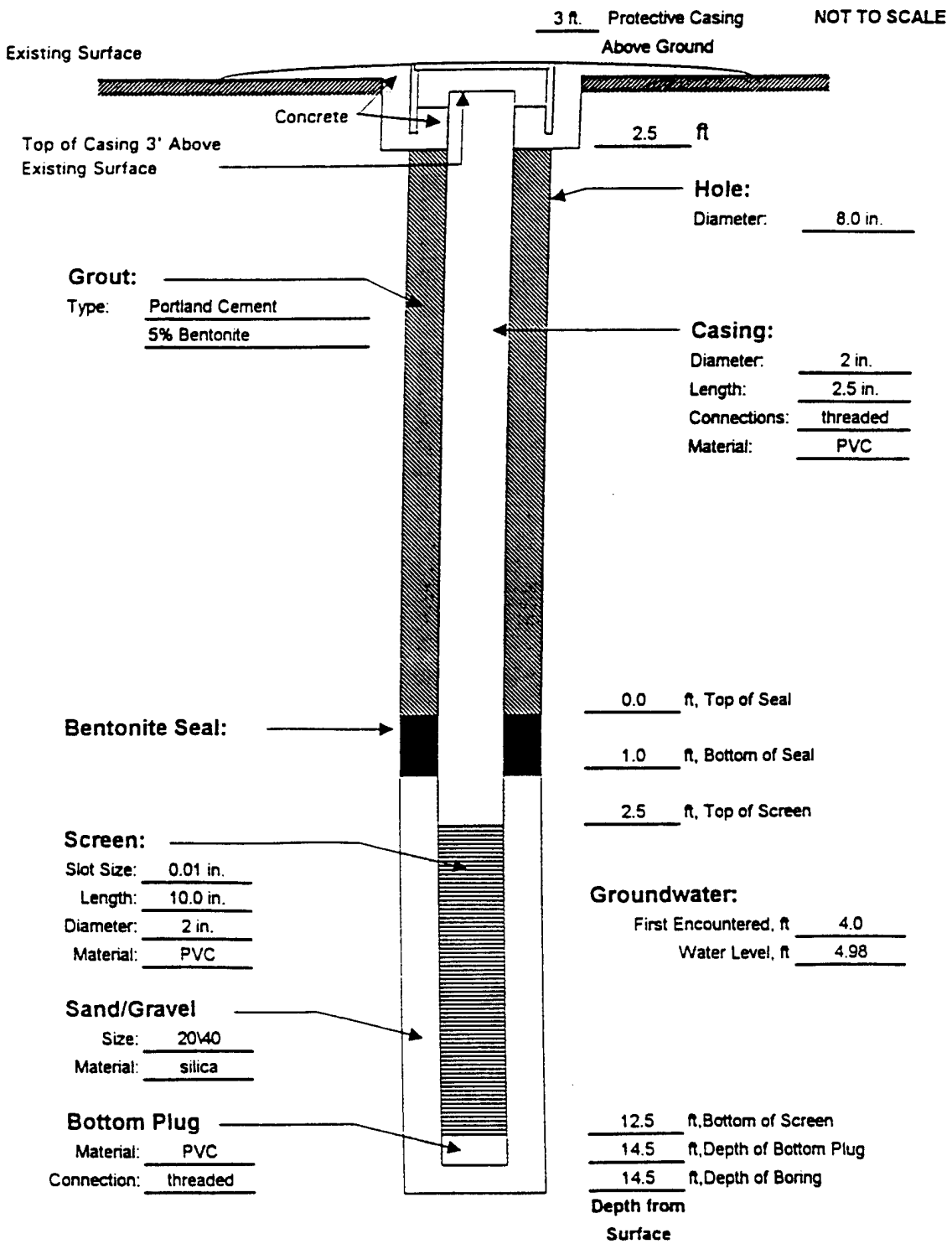
Note: Not all portions of this form are applicable to all projects

6/91

BCM Engineers

Monitoring Well Schematic

Project: Tyndall Contamination Assesement
Well/Boring No.: BX-MW6 (8)
Project No.: 09-5000-17
Drilling Supervisor: David Britain
Boring Location:
Date(s): 9-Sep-95
Drilling Method: Hollow stem auger
Drilling Contractor: Kelly Environmental Drilling



Comments:

6/91

BCM Engineers — Drilling/Boring Log

Sheet: 1 of 1

Project: COE-Tyndall Contamination Assessment
Well/Boring: BX-MW7 (9)
Project No.: 09-5000-17
Date(s): 9/14/95
Logged By: David Britain
Well/Boring Location: N 390282.56 E1622175.50
Drilling Method: Hollow stem auger
Drilling Contractor: Kelly Environmental Drilling
Depth to Groundwater:
Date: 9/1/95
Reference: TOC
Elevations - Ground Surface:
Inner Casing:
Outer Casing:
Water Table:
Date:
Reference: TOC
Remarks:

Depth, Sample Pt.	Sample Location	Blows	Lithologic Description	Graphical Logs: Strata	Graphical Logs: Well Construction	Blow Counts	Elevation
2	1	n/a				N/A	
4	2					N/A	
6	3					N/A	
8	4		SAND(SP) fine to medium, poorly sorted, sub angular to sub rounded, brown, tan, saturated from 6' to 13.5', no odor			3-6-11	
10	5					2-5-7	
12	6					5-7-7	
14	7					5-9-15	
16							
18							
20							

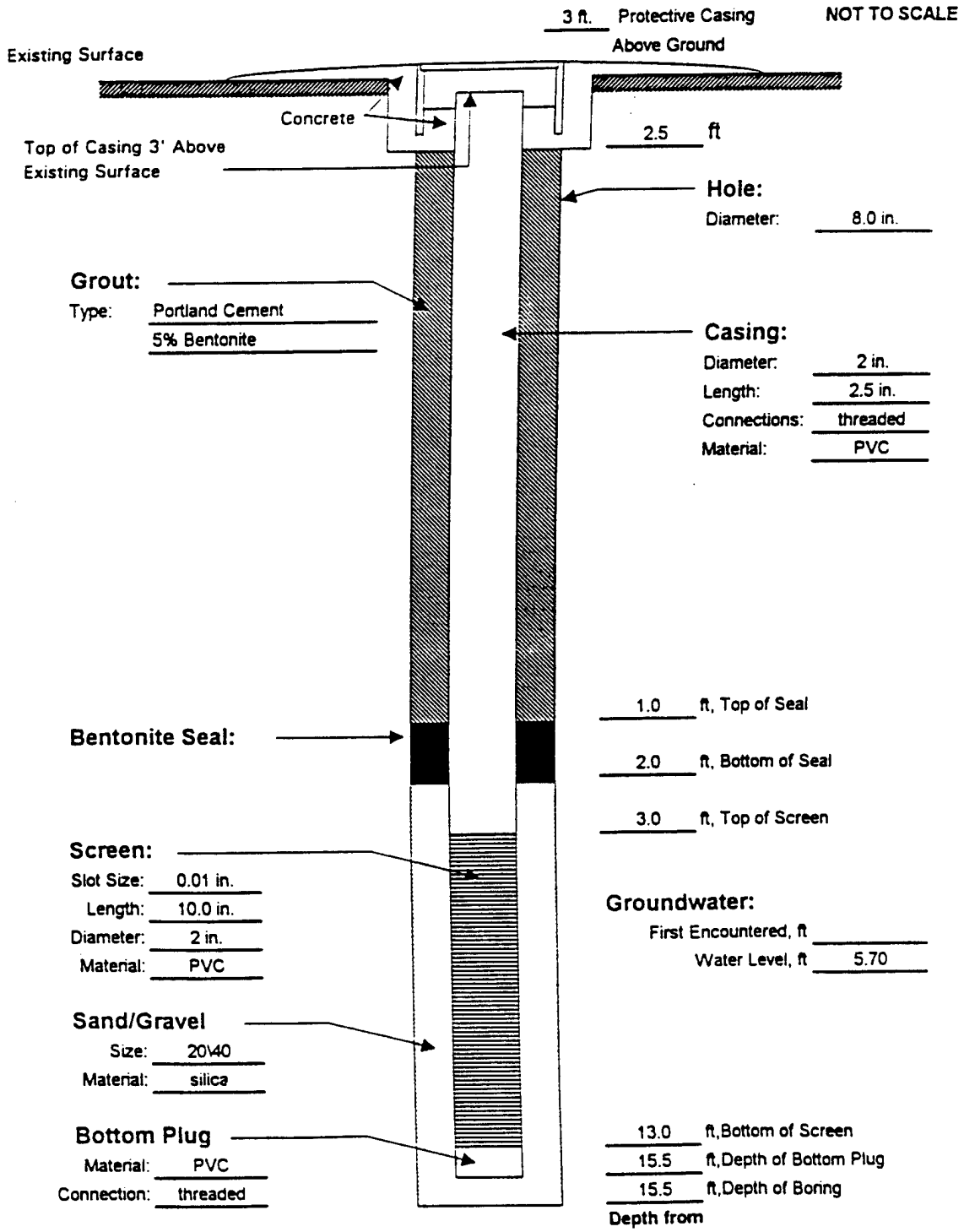
Note: Not all portions of this form are applicable to all projects

6/91

BCM Engineers

Monitoring Well Schematic

Project: Tyndall Contamination Assesement
Well/Boring No.: BX-MW7 (9)
Project No.: 09-5000-17
Drilling Supervisor: David Britain
Boring Location:
Date(s): 14-Sep-95
Drilling Method: Hollow stem auger
Drilling Contractor: Kelly Environmental Drilling



Comments:

6/91

BCM Engineers — Drilling/Boring Log

Sheet: 1 of 3

Project: 5 Petroleum Contaminated Sites — Well/Boring: MWD-01-97

Project No.: 09-5000-17 — Date(s): 05/07/97 — Logged By: Robert Spencer

Well/Boring Location: BX Service Station, Tyndall AFB; N-390346, E-1622193

Drilling Method: Hollow stem auger — Drilling Contractor: Kelly Environmental Drilling

Depth to Groundwater: 8.03 — Date: 5/20/1997 — Reference: TOC

Elevations - Ground Surface: 30.50 — Inner Casing: 2" — Outer Casing:

Water Table: 22.11 — Date: 5/20/1997 — Reference: TOC

Remarks:

Depth, Sample Pt.	Sample Location	OVA Reading(ppm)	Lithologic Description	Graphical Logs: Strata	Graphical Logs: Well Construction	Blow Counts	Elevation
2		ND	SAND (SW) 0-3' Light gray, loose, fine sand; Peat layer at 2.5' several inches thick				
4			Static water at 4.5' bls				
6	1		SAND (SW) Tan, loose, wet fine sand; gasoline odor			6-14-21-24	
8							
10	2		SAND (SW) Brown, fine, sand with petroleum odor			2-4-9-14	
12	3		SAND (SW) Brown, fine, sand with petroleum odor			15	
14							
16	4		SAND (SW) Brown, fine, sand with petroleum odor			5-6-15-26	

BCM Engineers

Drilling/Boring Log

Sheet: 2 of 3

Project: 5 Petroleum Contaminated Sites
Well/Boring: MWD-01-97
Project No.: 09-5000-17
Date(s): 05/07/97
Logged By: Robert Spencer
Well/Boring Location: BX Service Station, Tyndall AFB; N-390346, E-1622193
Drilling Method: Hollow stem auger
Drilling Contractor: Kelly Environmental Drilling
Depth to Groundwater: 8.03
Date: 05/20/97
Reference: TOC
Elevations - Ground Surface: 30.50
Inner Casing: 2"
Outer Casing:
Water Table: 22.11
Date: 05/20/97
Reference: TOC
Remarks:

Depth, Sample Pt.	Sample Location	OVA Reading(ppm)	Lithologic Description	Graphical Logs: Strata	Graphical Logs: Well Construction	Blow Counts	Elevation
18	5		SAND (SW) 0-3' Dark brown, fine sand with faint petroleum odor			11-15-20-27	
20	6		SAND (SW) Light beige, fine sand; no odor			18-50-75	
22	7		SAND (SW) Same as above				
24	8		SAND (SW) Same as above				
26	9		SAND (SW) Light brown, fine sand			9-12-17-20	
28	10		SAND (SW) Same as above			3-5-7-9	
30	11		SAND (SW) Same as above			7-15-11-19	
32							

BCM Engineers

Drilling/Boring Log

Sheet: 3 of 3

oject: 5 Petroleum Contaminated Sites — Well/Boring: MWD-01-97

Project No.: 09-5000-17 — Date(s): 05/07/97 — Logged By: Robert Spencer

Well/Boring Location: BX Service Station, Tyndall AFB; N-390346, E-1622192

Drilling Method: Hollow stem auger — Drilling Contractor: Kelly Environmental Drilling

Depth to Groundwater: 8.03 — Date: 05/20/97 — Reference: TOC

Elevations - Ground Surface: 30.50 — Inner Casing: 2" — Outer Casing:

Water Table: 22.11 — Date: 05/20/97 — Reference: TOC

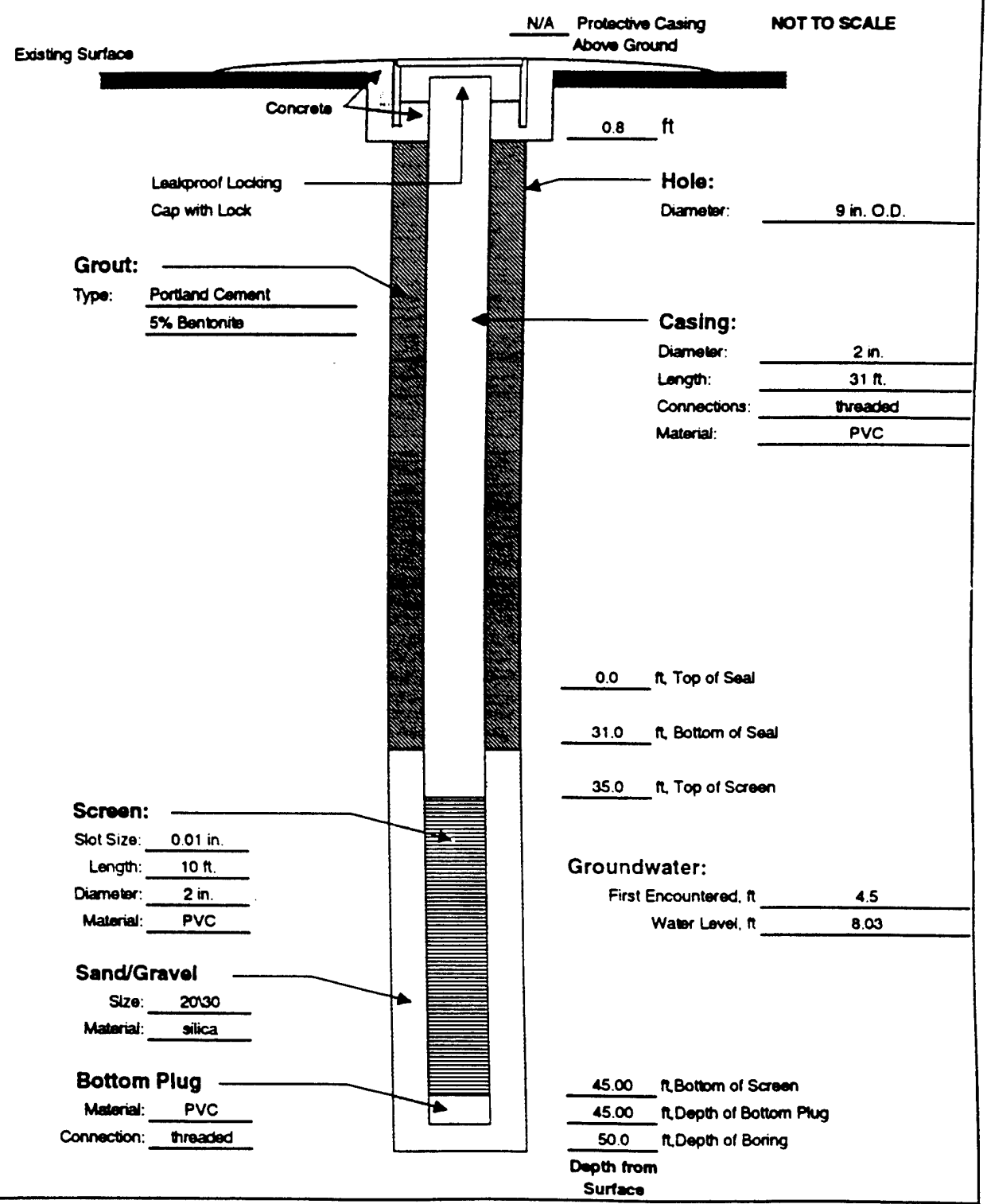
Remarks:

Depth, Sample Pt.	Sample Location	OVA Reading(ppm)	Lithologic Description	Graphical Logs: Strata	Graphical Logs: Well Construction	Blow Counts	Elevation
34	12		SAND (SW) Same as above			3-8-18-50	
36	13		SAND (SW) Same as above				
38	14		SAND (SW) Same as above			3-6-40-43	
40	15		SAND (SW) Brown, fine sand			3-18-50	
42	16		SAND (SW) Same as above			21-24-40-50	
44						9-12-17-20	
46	17		SAND (SW) Same as above to 46'; SILTY-SAND(SM) Gray silty-sand from 46-47'			12-23-50	
48	18		SILTY-SAND (SM) Gray silty-sand			6-6-9-14	

BCM Engineers

Monitoring Well Schematic

Project: USACE- Tyndall AFB BX
Well/Boring No.: MWD-01-97
Project No.: 09-5000-17
Drilling Supervisor: Robert Spencer
Boring Location:
Date(s): 29 Apr 1997
Drilling Method: Hollow stem auger
Drilling Contractor: Kelly Environmental Drilling



Comments:

6/91

BCM Engineers — Drilling/Boring Log

Sheet: 1 of 1

Project: 5 Petroleum Contaminated Sites — Well/Boring: MW-02-97

Project No.: 09-5000-17 — Date(s): 05/05/97 — Logged By: Shawn E. Duelitt

Well/Boring Location: BX Service Station, Tyndall AFB; N-390361, E-1622260

Drilling Method: Hollow stem auger — Drilling Contractor: Kelly Environmental Drilling

Depth to Groundwater: 5.00 — Date: 05/20/97 — Reference: TOC

Elevations - Ground Surface: 29.90 — Inner Casing: 4" — Outer Casing:

Water Table: 24.66 — Date: 05/20/97 — Reference: TOC

Remarks:

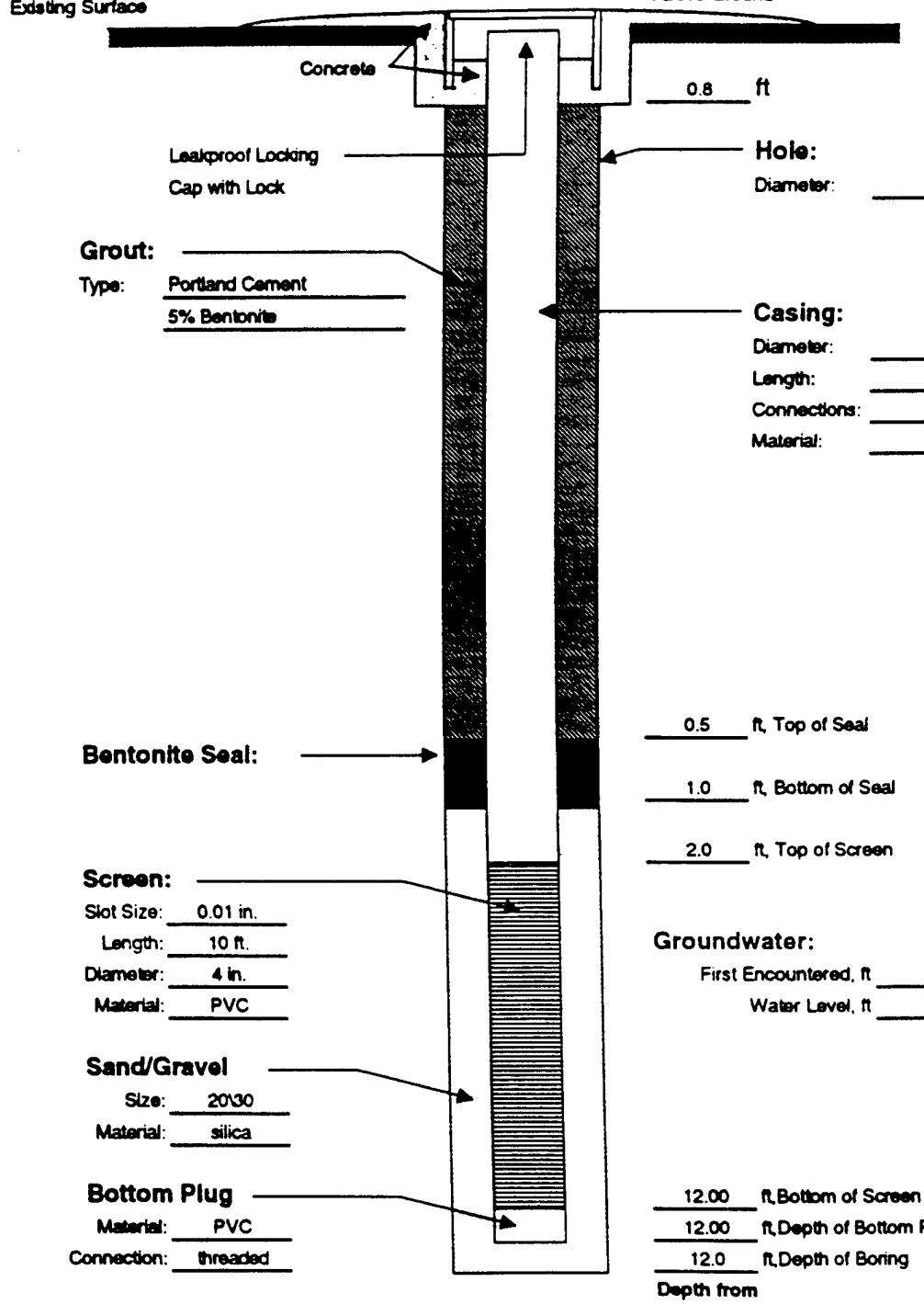
Depth, Sample Pt.	Sample Location	OVA Reading(ppm)	Lithologic Description	Graphical Logs: Strata / Well Construction	Blow Counts	Elevation
2		5 ppm	SAND (SP) Gray to brown, loose, medium to fine sand with organics			
4			Static water at 4' bls			
6	1		SAND (SP) Tan to gray, loose, wet, medium to fine sand with some organics		4-6-8-12	
8						
10	2		SAND (SP) Tan, loose, wet, medium to fine sand with some organics		4-8-12-16	
12			Boring terminated at 12 feet BGS.			
14						
16						

BCM Engineers

Monitoring Well Schematic

Project: USACE- Tyndall AFB BX
Well/Boring No.: MW-02-97
Project No.: 09-5000-17
Drilling Supervisor: Shawn E. Dueitt
Boring Location:
Date(s): 29 Apr 96
Drilling Method: Hollow stem auger
Drilling Contractor: Kelly Environmental Drilling

NOT TO SCALE



N/A Protective Casing Above Ground

0.8 ft

Hole:
Diameter: 12 in. O.D

Casing:
Diameter: 4 in.
Length: 2 ft
Connections: threaded
Material: PVC

0.5 ft, Top of Seal

1.0 ft, Bottom of Seal

2.0 ft, Top of Screen

Groundwater:
First Encountered, ft 4.0
Water Level, ft 5.00

12.00 ft, Bottom of Screen
12.00 ft, Depth of Bottom Plug
12.0 ft, Depth of Boring
Depth from Surface

Comments:

6/91

BCM Engineers — Drilling/Boring Log

Sheet: 1 of 1

Project: 5 Petroleum Contaminated Sites — Well/Boring: MW-03-97

Project No.: 09-5000-17 — Date(s): 05/05/97 — Logged By: Shawn E. Dueitt

Well/Boring Location: BX Service Station, Tyndall AFB; N-390470, E-1622007

Drilling Method: Hollow stem auger — Drilling Contractor: Kelly Environmental Drilling

Depth to Groundwater: 5.55 — Date: 05/20/97 — Reference: TOC

Elevations - Ground Surface: 29.60 — Inner Casing: 4" — Outer Casing:

Water Table: 23.81 — Date: 05/20/97 — Reference: TOC

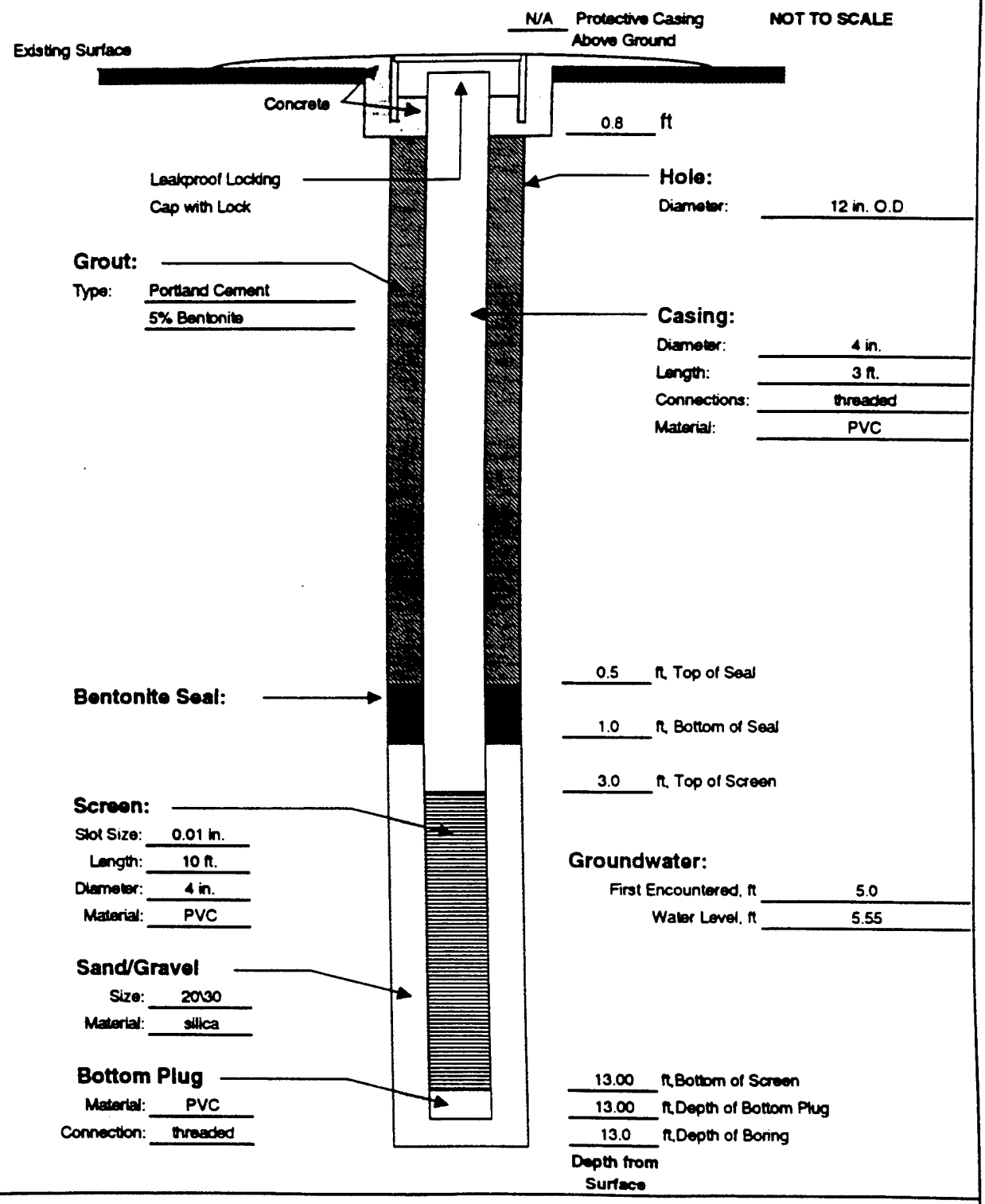
Remarks:

Depth, Sample Pt.	Sample Location	OVA Reading(ppm)	Lithologic Description	Graphical Logs: Strata	Graphical Logs: Well Construction	Blow Counts	Elevation
2		5 ppm	SAND (SP) Gray to dark gray, loose, medium to fine sand with some organics				
4			Static water at 5' bls				
6	1		SAND (SP) Dark brown, loose, wet, medium to fine sand. Organics at 6-6.2' (wood)			3-7-9-11	
8							
10	2		SAND (SP) Dark brown, loose, wet, medium to fine sand. Organics at 10' (wood)			3-3-7-12	
12							
14			Boring terminated at 13 feet BGS.				
16							

BCM Engineers

Monitoring Well Schematic

Project: USACE- Tyndall AFB BX
Well/Boring No.: MW-03-97
Project No.: 09-5000-17
Drilling Supervisor: Shawn E. Dueitt
Boring Location:
Date(s): 29 Apr 96
Drilling Method: Hollow stem auger
Drilling Contractor: Kelly Environmental Drilling



Comments:

6/91

CM Engineers — Drilling/Boring Log

Sheet: 1 of 3

Project: 5 Petroleum Contaminated Sites — Well/Boring: MWD-04-97

Project No.: 09-5000-17 — Date(s): 05/07/97 — Logged By: Robert Spencer

Well/Boring Location: BX Service Station, Tyndall AFB; N-390319, E-1622058

Drilling Method: Hollow stem auger — Drilling Contractor: Kelly Environmental Drilling

Depth to Groundwater: 5.05 — Date: 05/20/97 — Reference: TOC

Elevations - Ground Surface: 29.42 — Inner Casing: 2" — Outer Casing:

Water Table: 24.07 — Date: 05/20/97 — Reference: TOC

Remarks:

Depth, Sample Pt.	Sample Location	OVA Reading(ppm)	Lithologic Description	Graphical Logs: Strata	Graphical Logs: Well Construction	Blow Counts	Elevation
2		>10,000	SILTY-SAND (SM) 0-3' Silty-sand and red fill with petroleum odor				
			Static water at 4.5' bls				
6	1		SAND (SW) Light brown, loose, wet fine sand; petroleum odor			4-5-9-2	
8							
10	2		SAND (SW) Light beige, fine, sand with petroleum odor			1-1-9-13	
12	3		SAND (SW) Light tan, fine to medium sand			9-8-36-26	
14							
16	4		SAND (SW) White, fine, sand			16-21-40-45	

BCM Engineers — Drilling/Boring Log

Sheet: 2 of 3

Project: 5 Petroleum Contaminated Sites — Well/Boring: MWD-04-97

Project No.: 09-5000-17 — Date(s): 05/07/97 — Logged By: Robert Spencer

Well/Boring Location: BX Service Station, Tyndall AFB; N-390319, E-1622058

Drilling Method: Hollow stem auger — Drilling Contractor: Kelly Environmental Drilling

Depth to Groundwater: 5.05 — Date: 05/20/97 — Reference: TOC

Elevations - Ground Surface: 29.42 — Inner Casing: 2" — Outer Casing:

Water Table: 24.07 — Date: 05/20/97 — Reference: TOC

Remarks:

Depth, Sample Pt.	Sample Location	OVA Reading(ppm)	Lithologic Description	Graphical Logs: Strata	Graphical Logs: Well Construction	Blow Counts	Elevation
18							
20	5		SAND (SW) Light brown, fine, sand			14-21-25-30	
22							
24							
26	6		SAND (SW) White, fine, sand			9-36-50-57	
28							
30	7		SAND (SW) Brown, fine, sand			18-60	
32							

RCM Engineers

Drilling/Boring Log

Sheet: 3 of 3

Project: 5 Petroleum Contaminated Sites | Well/Boring: MWD-04-97

Project No.: 09-5000-17 | Date(s): 05/07/97 | Logged By: Robert Spencer

Well/Boring Location: BX Service Station, Tyndall AFB; N-390319, E-1622007

Drilling Method: Hollow stem auger | Drilling Contractor: Kelly Environmental Drilling

Depth to Groundwater: 5.05 | Date: 05/20/97 | Reference: TOC

Elevations - Ground Surface: 29.42 | Inner Casing: 2" | Outer Casing:

Water Table: 24.07 | Date: 05/20/97 | Reference: TOC

Remarks:

Depth, Sample Pt	Sample Location	OVA Reading(ppm)	Lithologic Description	Graphical Logs: Strata	Graphical Logs: Well Construction	Blow Counts	Elevation
34							
36	8		SILTY-SAND (SM) Dark brown, silty-sand with minor peat layer (approx. 1-2") at 36.5'			3-7-12-26	
38							
40	9		SAND (SP) Brown sand with some silt			9-11-9-27	
42							
44							
46	10		SILTY-SAND (SM) Gray silty-sand with possible clay stringers				
48							
	11		CLAYEY-SAND (SC) Gray clayey-sand			1-4-6-7	

BCM Engineers — Drilling/Boring Log

Sheet: 1 of 1

oject: 5 Petroleum Contaminated Sites — Well/Boring: MW-05-97

Project No.: 09-5000-17 — Date(s): 05/05/97 — Logged By: Shawn E. Duelitt

Well/Boring Location: BX Service Station, Tyndall AFB; N-390404, E-1621952

Drilling Method: Hollow stem auger — Drilling Contractor: Kelly Environmental Drilling

Depth to Groundwater: 4.85 — Date: 05/20/97 — Reference: TOC

Elevations - Ground Surface: 28.80 — Inner Casing: 4" — Outer Casing:

Water Table: 23.81 — Date: 05/20/97 — Reference: TOC

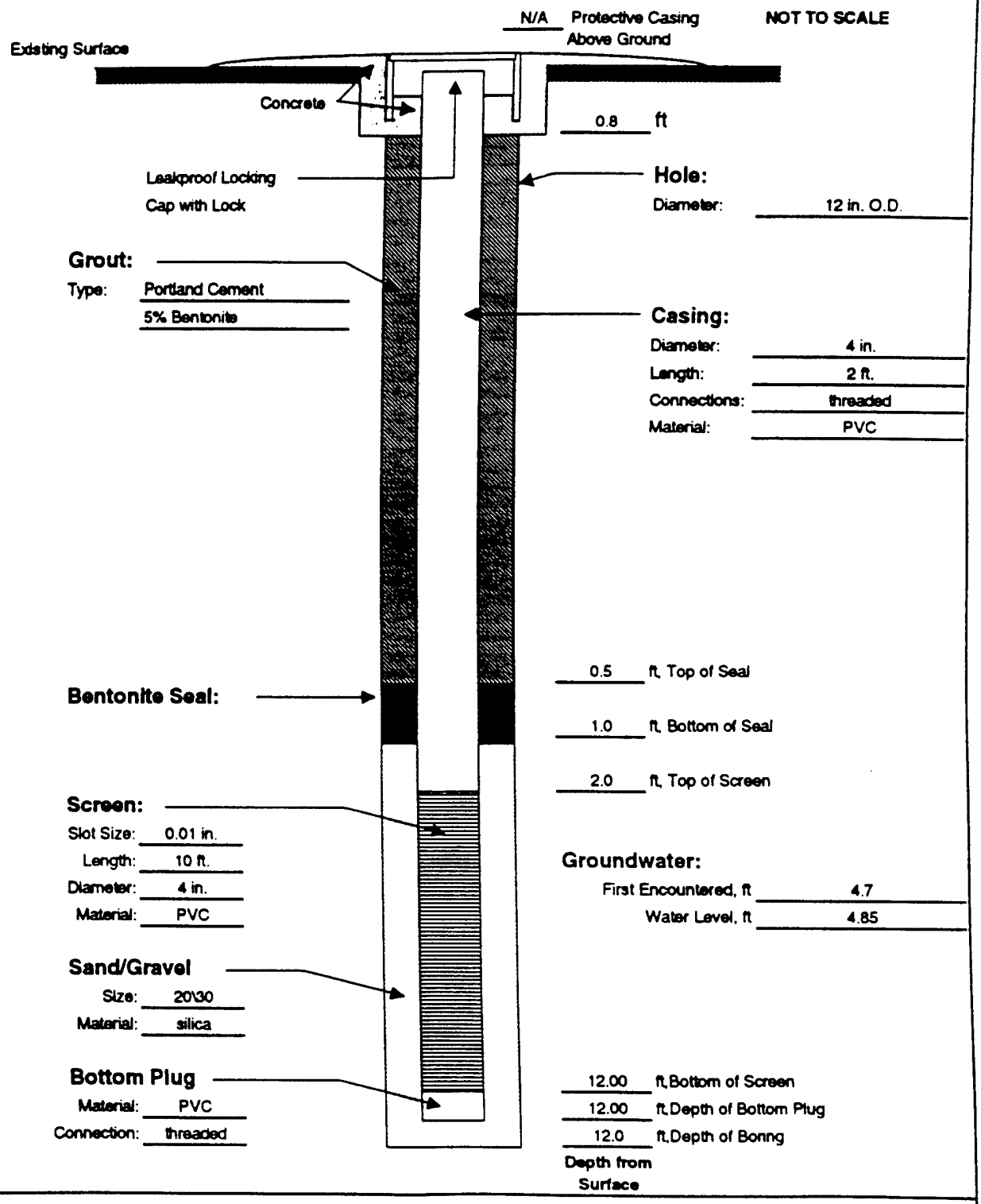
Remarks:

Depth, Sample Pt.	Sample Location	OVA Reading(ppm)	Lithologic Description	Graphical Logs: Strata	Graphical Logs: Well Construction	Blow Counts	Elevation
2		5 ppm	SAND (SP) Gray to black, loose, medium to fine sand with abundant organics (wood & roots)				
4			Static water at 4.7' bls				
6	1		SAND (SP) Dark gray at 6-6.5' and light brown from 6.5-8; loose, wet, medium to fine sand			4-10-12-16	
8							
10	2		SAND (SP) Brown to tan, loose, wet, medium to fine sand with little organics at 9.5'			4-8-12-14	
12			Boring terminated at 12 feet BGS.				
14							
16							

BCM Engineers

Monitoring Well Schematic

Project: USACE- Tyndall AFB BX
Well/Boring No.: MW-05-97
Project No.: 09-5000-17
Drilling Supervisor: Shawn E. Dueitt
Boring Location:
Date(s): 30 Apr 1997
Drilling Method: Hollow stem auger
Drilling Contractor: Kelly Environmental Drilling



Comments:

6/91

BCM Engineers

Drilling/Boring Log

Sheet: 1 of 1

Project: 5 Petroleum Contaminated Sites — Well/Boring: MW-06-97

Project No.: 09-5000-17 — Date(s): 05/05/97 — Logged By: Shawn E. Duelitt

Well/Boring Location: BX Service Station, Tyndall AFB; N-390335, E-1621968

Drilling Method: Hollow stem auger — Drilling Contractor: Kelly Environmental Drilling

Depth to Groundwater: 5.00 — Date: 05/20/97 — Reference: TOC

Elevations - Ground Surface: 29.10 — Inner Casing: 4" — Outer Casing:

Water Table: 23.97 — Date: 05/20/97 — Reference: TOC

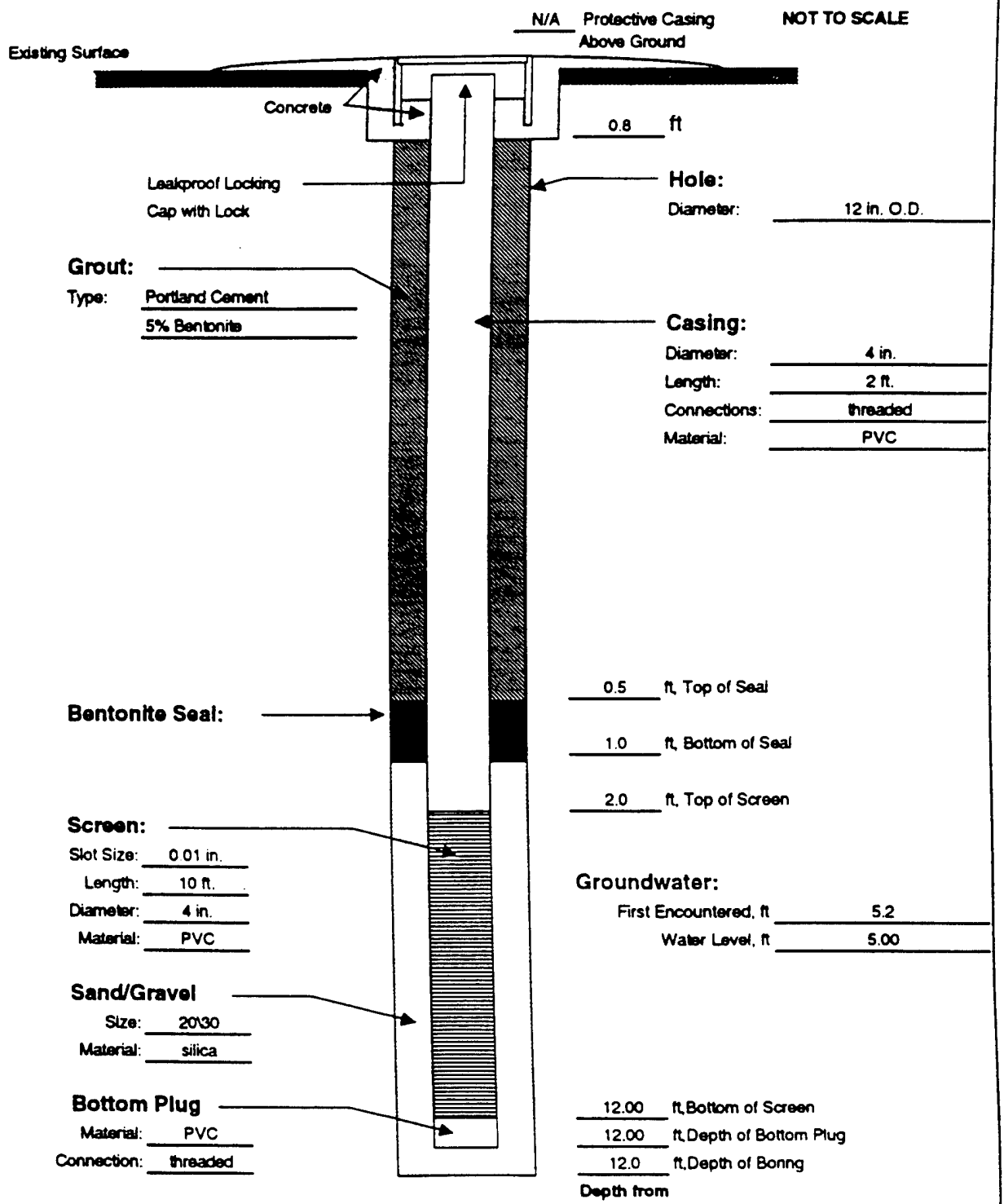
Remarks:

Depth, Sample Pt.	Sample Location	OVA Reading(ppm)	Lithologic Description	Graphical Logs: Strata	Graphical Logs: Well Construction	Blow Counts	Elevation
2		5 ppm	SAND (SP) Dark gray to gray, loose, medium to fine sand with some orgaincs (roots)				
4			Static water at 5.2' bls				
6	1		SAND (SP) Dark gray to gray, loose, wet, medium to fine sand with some organics near base			1-1-1-1	
8							
10	2		SAND (SP) Brown, loose, wet, medium to fine sand			2-3-4-5	
12			Boring terminated at 12 feet BGS.				
14							
16							

BCM Engineers

Monitoring Well Schematic

Project: USACE- Tyndall AFB BX
Well/Boring No.: MW-06-97
Project No.: 09-5000-17
Drilling Supervisor: Shawn E. Duett
Boring Location:
Date(s): 30 Apr 1997
Drilling Method: Hollow stem auger
Drilling Contractor: Kelly Environmental Drilling



Comments:

6/91

BCM Engineers — Drilling/Boring Log

Sheet: 1 of 1

Project: 5 Petroleum Contaminated Sites — Well/Boring: MW-07-97

Project No.: 09-5000-17 — Date(s): 05/05/97 — Logged By: Shawn E. Duelitt

Well/Boring Location: BX Service Station, Tyndall AFB; N-390255, E-1622087

Drilling Method: Hollow stem auger — Drilling Contractor: Kelly Environmental Drilling

Depth to Groundwater: 5.32 — Date: 05/20/97 — Reference: TOC

Elevations - Ground Surface: 29.73 — Inner Casing: 4" — Outer Casing:

Water Table: 24.47 — Date: 05/20/97 — Reference: TOC

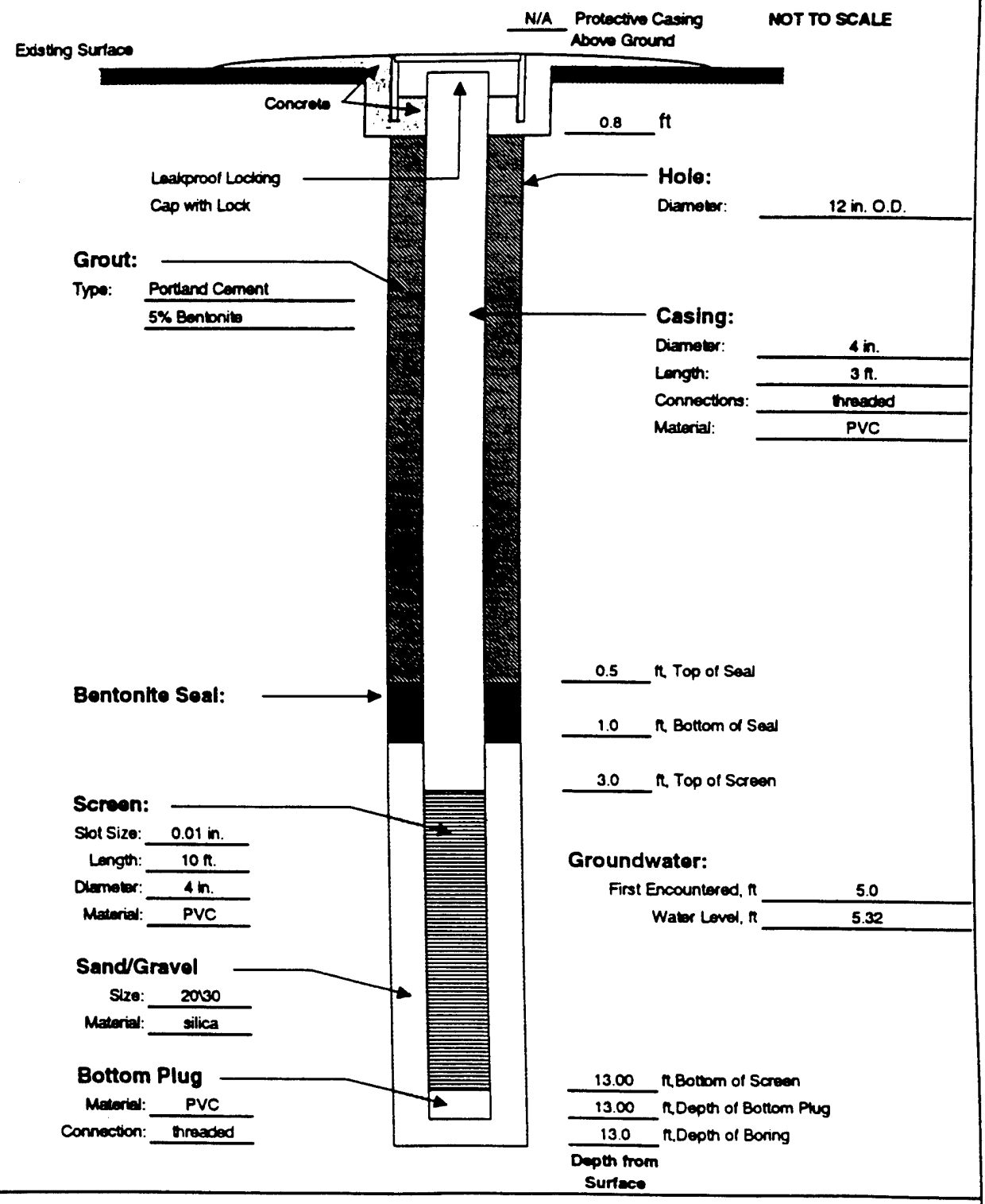
Remarks:

Depth, Sample Pt.	Sample Location	OVA Reading(ppm)	Lithologic Description	Graphical Logs: Strata	Graphical Logs: Well Construction	Blow Counts	Elevation
2		3 ppm	SAND (SP) Gray to light gray, loose, medium to fine sand with dew organincs (roots)				
4			Static water at 5.2' bls				
6	1		SAND (SP) Black, loose, wet, medium to fine sand from 6-6.3'; Light brown, loose, wet, medium to fine sand from 6.3-8'			7-11-13-13	
8							
10	2		SAND (SP) Light brown to beige, semi-loose, wet, medium to fine sand			4-7-32	
12							
14			Boring terminated at 13 feet BGS.				
16							

BCM Engineers

Monitoring Well Schematic

Project: USACE- Tyndall AFB BX
Well/Boring No.: MW-07-97
Project No.: 09-5000-17
Drilling Supervisor: Shawn E. Dueitt
Boring Location:
Date(s): 30 Apr 1997
Drilling Method: Hollow stem auger
Drilling Contractor: Kelly Environmental Drilling



Comments:

6/91

BCM Engineers — Drilling/Boring Log

Sheet: 1 of 1

Project: 5 Petroleum Contaminated Sites — Well/Boring: MW-06-97

Project No.: 09-5000-17 — Date(s): 05/05/97 — Logged By: Shawn E. Duelitt

Well/Boring Location: BX Service Station, Tyndall AFB; N-390434, E-1622010

Drilling Method: Hollow stem auger — Drilling Contractor: Kelly Environmental Drilling

Depth to Groundwater: 4.78 — Date: 05/20/97 — Reference: TOC

Elevations - Ground Surface: 29.29 — Inner Casing: 4" — Outer Casing:

Water Table: 24.24 — Date: 05/20/97 — Reference: TOC

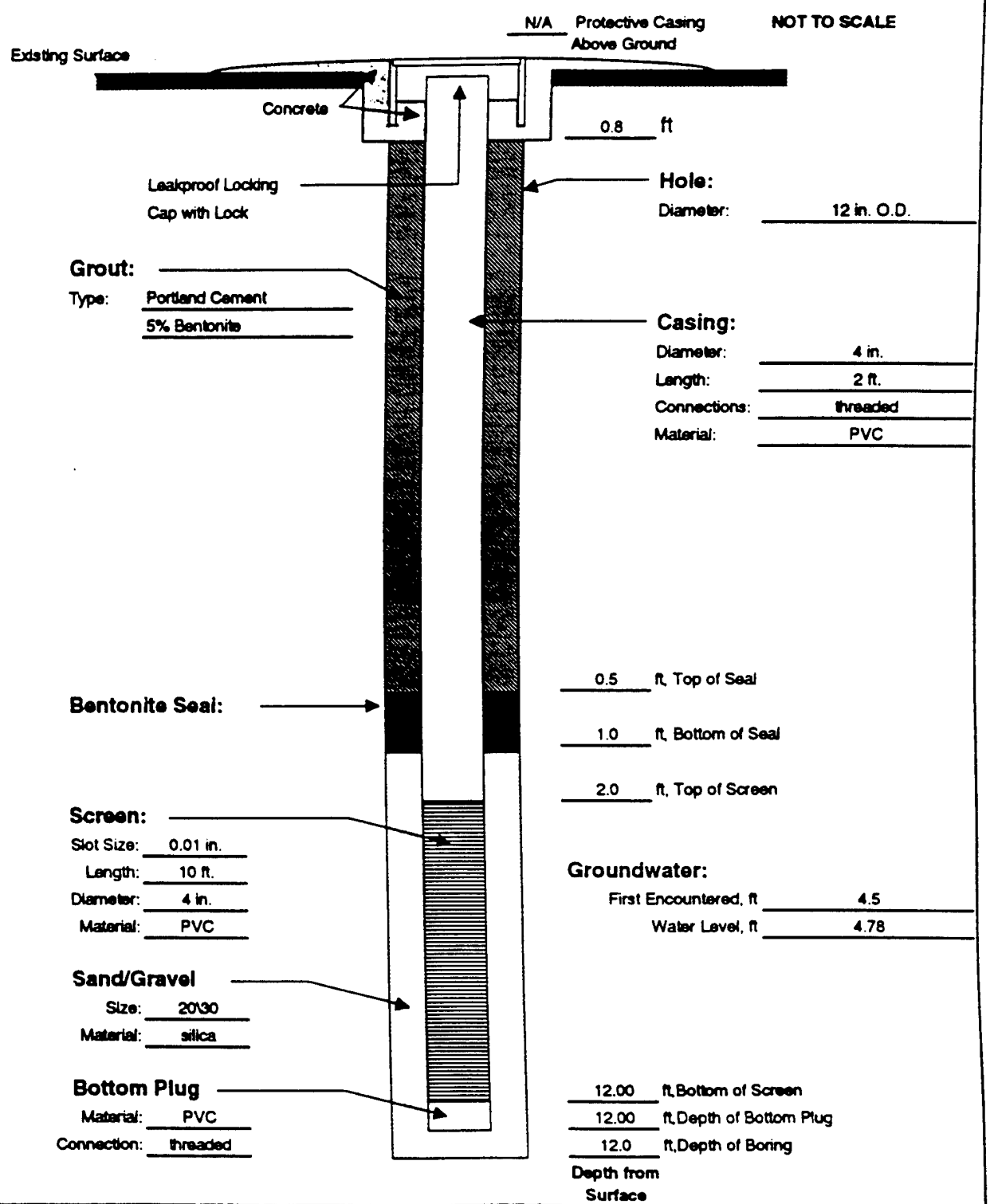
Remarks:

Depth, Sample Pt.	Sample Location	OVA Reading(ppm)	Lithologic Description	Graphical Logs: Strata	Graphical Logs: Well Construction	Blow Counts	Elevation
2		4 ppm	SAND (SP) 0-4" Asphalt; 4-10" Red-orange clayey-sand; 10"-3' Dark gray to light gray, loose, medium to fine sand				
4			Static water at 4.5' bls				
6	1		SAND (SP) Dark gray to light brown, loose, wet medium to fine sand			4-8-16-18	
8							
10	2		SAND (SP) Light gray to white, loose, wet, medium to fine sand			4-8-10-14	
12			Boring terminated at 12 feet BGS.				
14							
16							

BCM Engineers

Monitoring Well Schematic

Project: USACE- Tyndall AFB BX
Well/Boring No.: MW-08-97
Project No.: 09-5000-17
Drilling Supervisor: Shawn E. Duelitt
Boring Location:
Date(s): 30 Apr 1997
Drilling Method: Hollow stem auger
Drilling Contractor: Kelly Environmental Drilling



Comments:

6/91

BCM Engineers

Drilling/Boring Log

Sheet: 1 of 2

Project: 5 Petroleum Contaminated Sites — Well/Boring: MWD-09-97

Project No.: 09-5000-17 — Date(s): 05/07/97 — Logged By: Robert Spencer

Well/Boring Location: BX Service Station, Tyndall AFB, N-390343, E-1622010

Drilling Method: Hollow stem auger — Drilling Contractor: Kelly Environmental Drilling

Depth to Groundwater: 5.10 — Date: 05/20/97 — Reference: TOC

Elevations - Ground Surface: 29.32 — Inner Casing: 2" — Outer Casing:

Water Table: 23.96 — Date: 05/20/97 — Reference: TOC

Remarks: MWD-09-97 will be an observation well positioned 30' from the pumping well location

Depth, Sample Pt.	Sample Location	OVA Reading(ppm)	Lithologic Description	Graphical Logs: Strata	Graphical Logs: Well Construction	Blow Counts	Elevation
2		>10,000	SILTY-SAND (SM) 0-3' Silty-sand and red fill with petroleum odor				
4			Static water at 4.5' bls				
6	1		SAND (SW) Light brown, loose, wet sand with some silt; Black layer above sand at 4-5.5'; Strong petroleum odor, color may be due to petroleum			5-10-14-22	
8							
10	2		SAND (SW) Brown sand with slight petroleum odor			3-8-20-22	
12							
14							
16	3		SAND (SW) Light brown, fine sand			10-70	

BCM Engineers

Drilling/Boring Log

Sheet: 2 of 2

Project: 5 Petroleum Contaminated Sites — Well/Boring: MWD-09-97

Project No.: 09-5000-17 — Date(s): 05/07/97 — Logged By: Robert Spencer

Well/Boring Location: BX Service Station, Tyndall AFB; N-390343, E-1622010

Drilling Method: Hollow stem auger — Drilling Contractor: Kelly Environmental Drilling

Depth to Groundwater: 5.10 — Date: 05/20/97 — Reference: TOC

Elevations - Ground Surface: 29.32 — Inner Casing: 2" — Outer Casing:

Water Table: 23.96 — Date: 05/20/97 — Reference: TOC

Remarks:

Depth, Sample Pt.	Sample Location	OVA Reading(ppm)	Lithologic Description	Graphical Logs: Strata	Graphical Logs: Well Construction	Blow Counts	Elevation
18							
20	4		SAND (SW) White, fine, sand			5-11-21-33	
22							
24							
26	5		SAND (SW) White grading to brown, fine, sand				
28							
30	6		SAND (SW) White, fine, sand to 31'; Dark brown, fine sand to 32'			21-34-45-50	
32							

CM Engineers

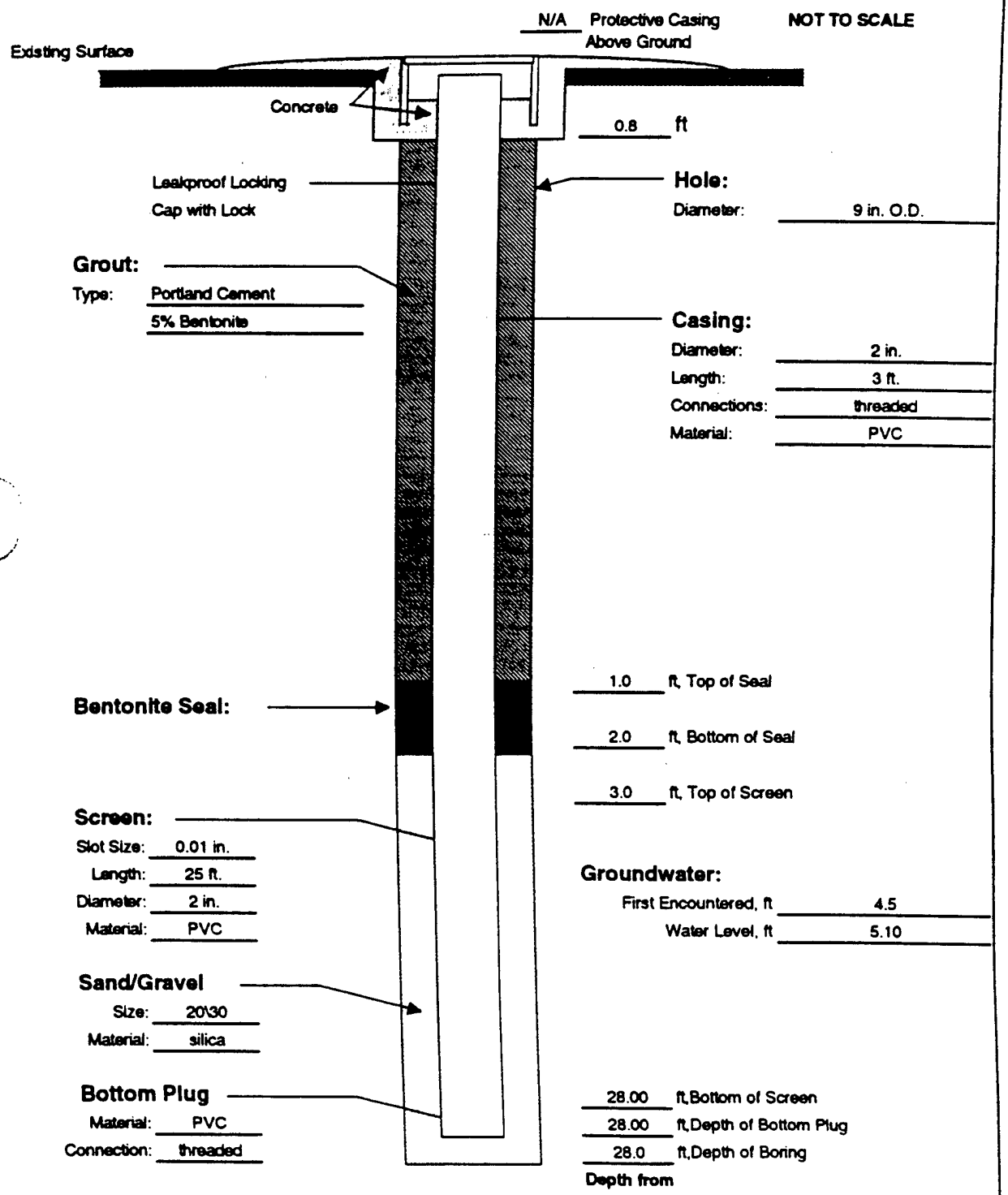
Monitoring Well Schematic

ject: USACE- Tyndall AFB BX — Well/Boring No.: MWD-09-97

Project No.: 09-5000-17 — Drilling Supervisor: Robert Spencer

Boring Location: — Date(s): 30 Apr 1997

Drilling Method: Hollow stem auger — Drilling Contractor: Kelly Environmental Drilling



Comments:

6/91

BCM Engineers — Drilling/Boring Log

Sheet: 1 of 2

Project: 5 Petroleum Contaminated Sites — Well/Boring: MWD-10-97

Project No.: 09-5000-17 — Date(s): 05/07/97 — Logged By: Robert Spencer

Well/Boring Location: BX Service Station, Tyndall AFB, N-390370, E-1622025

Drilling Method: Hollow stem auger — Drilling Contractor: Kelly Environmental Drilling

Depth to Groundwater: 5.35 — Date: 05/20/97 — Reference: TOC

Elevations - Ground Surface: 29.44 — Inner Casing: 2" — Outer Casing:

Water Table: 23.89 — Date: 05/20/97 — Reference: TOC

Remarks:

Depth, Sample Pt	Sample Location	OVA Reading(ppm)	Lithologic Description	Graphical Logs: Strata	Graphical Logs: Well Construction	Blow Counts	Elevation
2		>10,000	SAND (SP) 0-3' Brown to black sand with some silt; strong petroleum odor				
4			Static water at 4.5' bls				
6	1		SAND (SW) Brown, wet, fine sand; strong petroleum odor			18-33-34-46	
8							
10	2		SAND (SW) Light brown fine to medium sand with slight petroleum odor			2-3-6-18	
12							
14							
16	3		SAND (SW) Brown, fine to medium sand			6-8-15-30	

BCM Engineers

Drilling/Boring Log

Sheet: 2 of 2

Project: 5 Petroleum Contaminated Sites — Well/Boring: MWD-10-97

Project No.: 09-5000-17 — Date(s): 05/07/97 — Logged By: Robert Spencer

Well/Boring Location: BX Service Station, Tyndall AFB, N-390370, E-1622025

Drilling Method: Hollow stem auger — Drilling Contractor: Kelly Environmental Drilling

Depth to Groundwater: 5.35 — Date: 05/20/97 — Reference: TOC

Elevations - Ground Surface: 29.44 — Inner Casing: 2" — Outer Casing:

Water Table: 23.89 — Date: 05/20/97 — Reference: TOC

Remarks:

Depth, Sample Pt.	Sample Location	OVA Reading(ppm)	Lithologic Description	Graphical Logs: Strata	Graphical Logs: Well Construction	Blow Counts	Elevation
18							
20	4		SAND (SW) Tan, fine, sand			6-18-21-25	
22							
24							
26	5		SAND (SW) Same as above				
28							
30	6		SAND (SW) Same to 32'; Black dense peat at approximately 32'				
32							

CM Engineers

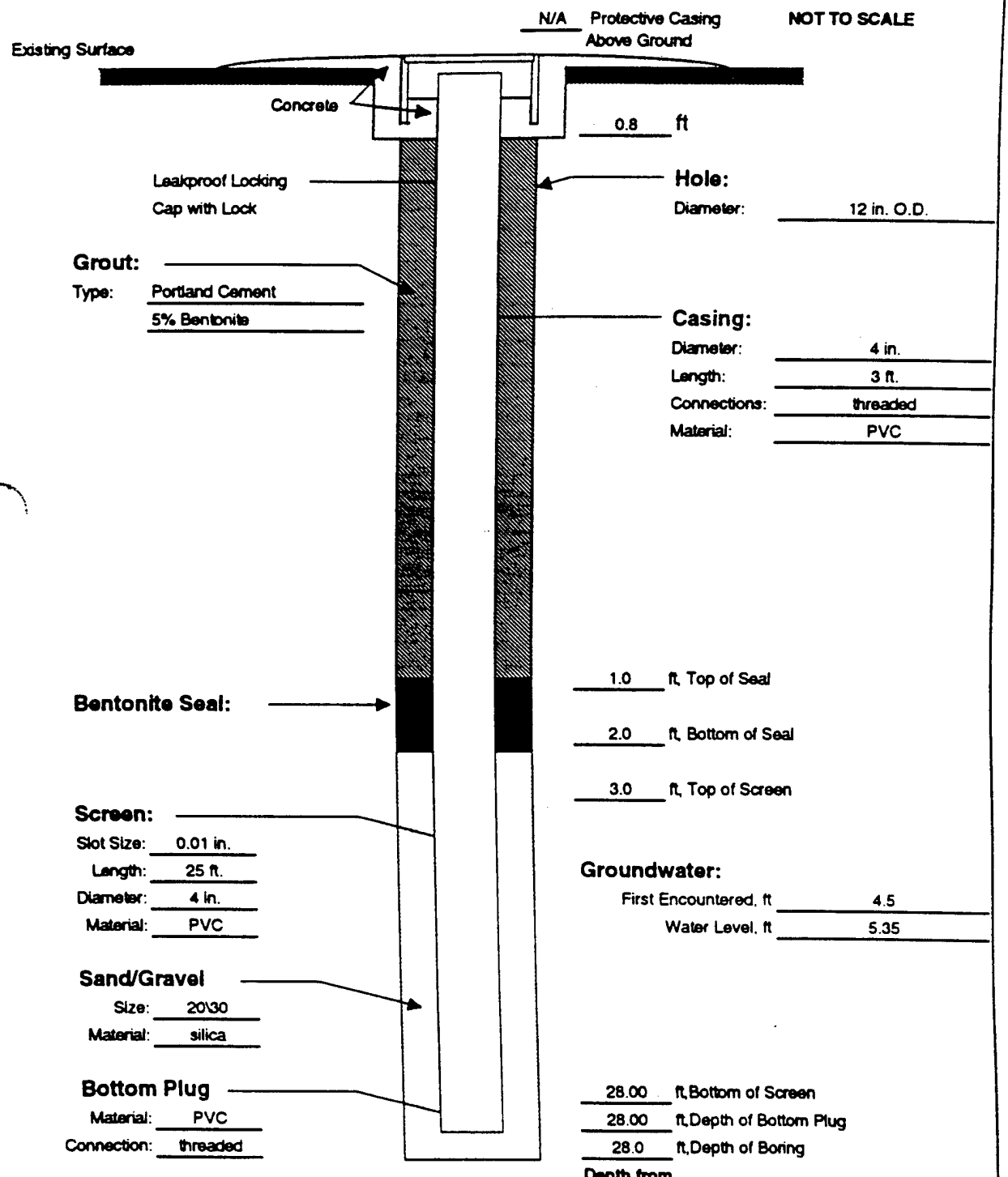
Monitoring Well Schematic

ct: USACE- Tyndall AFB BX — Well/Boring No.: MWD-10-97

Project No.: 09-5000-17 — Drilling Supervisor: Robert Spencer

Boring Location: — Date(s): 1 May 1997

Drilling Method: Hollow stem auger — Drilling Contractor: Kelly Environmental Drilling



Comments:

6/91

BCM Engineers

Drilling/Boring Log

Sheet: 1 of 2

oject: 5 Petroleum Contaminated Sites — Well/Borng: MWD-11-97

Project No.: 09-5000-17 — Date(s): 05/07/97 — Logged By: Robert Spencer

Well/Boring Location: BX Service Station, Tyndall AFB; N-390378, E-1622029

Drilling Method: Hollow stem auger — Drilling Contractor: Kelly Environmental Drilling

Depth to Groundwater: 5.36 — Date: 05/20/97 — Reference: TOC

Elevations - Ground Surface: 29.43 — Inner Casing: 2" — Outer Casing:

Water Table: 23.84 — Date: 05/20/97 — Reference: TOC

Remarks: MWD-11-97 will be an observation well positioned 10' from the pumping well location.
No sampling occurred since the well is positioned so close to MWD-10-97.

Depth, Sample Pt.	Sample Location	OVA Reading(ppm)	Lithologic Description	Graphical Logs: Strata	Graphical Logs: Well Construction	Blow Counts	Elevation
2		950 ppm					
4							
6							
8							
10							
12							
14							
16							

BCM Engineers

Drilling/Boring Log

Sheet: 2 of 2

Project: 5 Petroleum Contaminated Sites
Well/Boring: MWD-11-97
Project No.: 09-5000-17
Date(s): 05/07/97
Logged By: Robert Spencer
Well/Boring Location: BX Service Station, Tyndall AFB; N-390378, E-1622029
Drilling Method: Hollow stem auger
Drilling Contractor: Kelly Environmental Drilling
Depth to Groundwater: 5.36
Date: 05/20/97
Reference: TOC
Elevations - Ground Surface: 29.43
Inner Casing: 2"
Outer Casing:
Water Table: 23.84
Date: 05/20/97
Reference: TOC
Remarks:

Depth, Sample Pt.	Sample Location	OVA Reading(ppm)	Lithologic Description	Graphical Logs: Strata	Graphical Logs: Well Construction	Blow Counts	Elevation
18							
20							
22							
24							
26							
28							
30							
32							

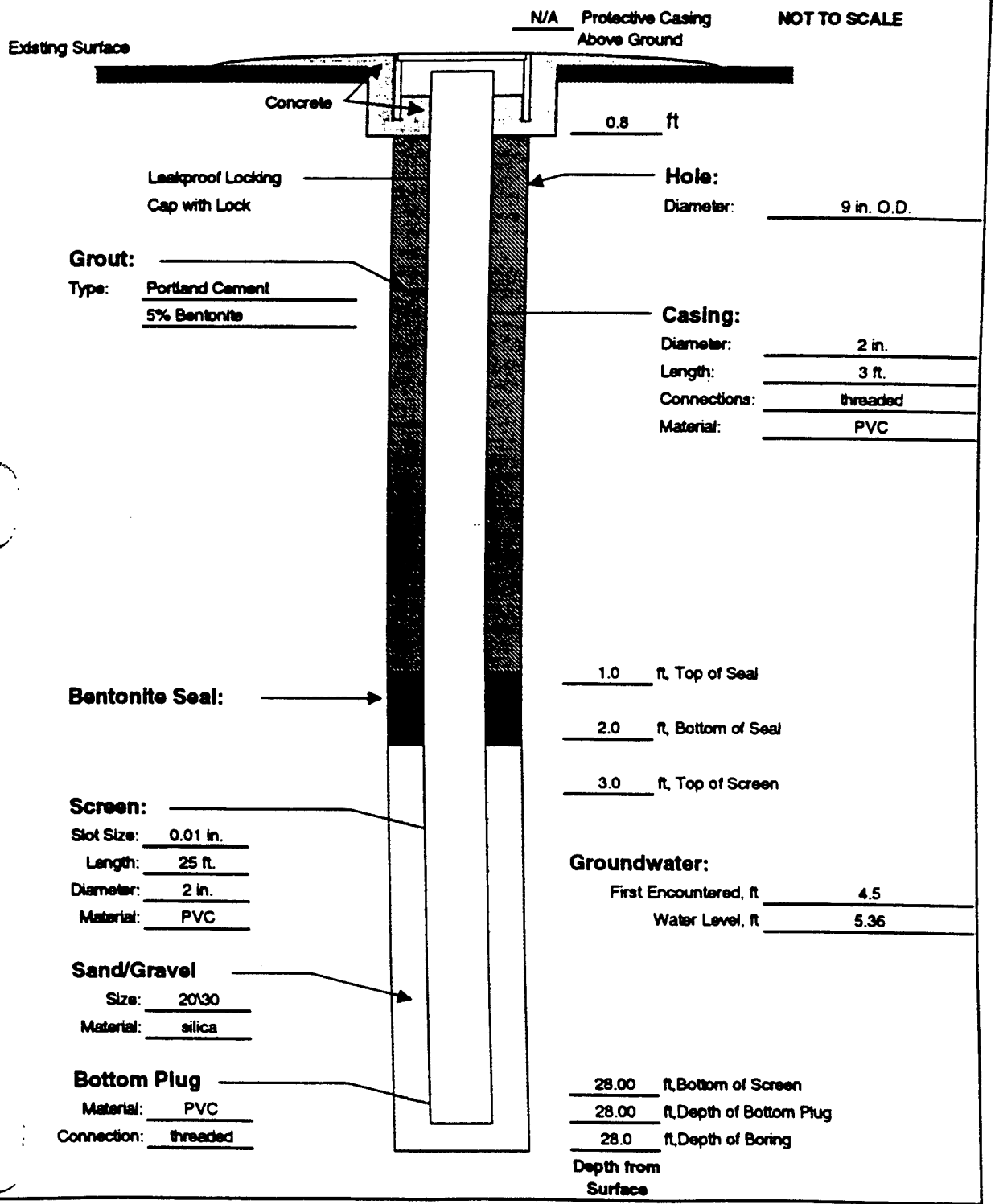
CM Engineers — Monitoring Well Schematic

Project: USACE- Tyndall AFB BX — Well/Boring No.: MWD-11-97

Project No.: 09-5000-17 — Drilling Supervisor: Robert Spencer

Boring Location: — Date(s): 1 May 1997

Drilling Method: Hollow stem auger — Drilling Contractor: Kelly Environmental Drilling



Comments:

6/91

APPENDIX B
LABORATORY ANALYTICAL DATA SHEETS AND CHAIN-OF-CUSTODY RECORDS FROM MARCH 1998 SAMPLING EVENT

@AIR TOXICS LTD.
AN ENVIRONMENTAL ANALYTICAL LABORATORY

WORK ORDER #: 9803254

Work Order Summary

CLIENT: Mr. Brad Lewis
Parsons Engineering Science
5390 Triangle Pkwy #100
Norcross, GA 30092

BILL TO: Same

PHONE: 770-446-4900
FAX: 770-446-4910
DATE RECEIVED: 3/24/98
DATE COMPLETED: 4/16/98

P.O. # 731854.1
PROJECT # 731854.10 TYNDALL

FRACTION #	NAME	TEST	RECEIPT VAC./PRES.
01A	BX-HA-A	TO-3	0.4 psi
02A	BX-HA-15	TO-3	0 "Hg
03A	BX-HA-1	TO-3	0.2 psi
04A	FT16-HA-72	TO-3	0.2 psi
05A	FT16-HA-61	TO-3	0.2 psi
06A	FT16-HA-49	TO-3	7.0 "Hg
07A	Lab Blank	TO-3	NA
08A	Method Spike	TO-3	NA

CERTIFIED BY: Debbie Pearce
Laboratory Director

DATE: 4-16-98

Certification numbers: CA ELAP - 1149, NY ELAP - 11291, UT ELAP - E-217

180 BLUE RAVINE ROAD, SUITE B FOLSOM, CA 95630
(916) 985-1000 • (800) 985-5955 • FAX (916) 985-1020

AIR TOXICS LTD.

SAMPLE NAME : BX-HA-A

ID#: 9803254-01A

EPA Method TO-3 GC/PID/FID

File Name:	6040413	Date of Collection:	3/21/98
Dil. Factor:	985	Date of Analysis:	4/ 4/98

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.99	3.2	23	74
Toluene	0.99	3.8	35	130
Ethyl Benzene	0.99	4.3	38	160
Total Xylenes	0.99	4.3	22	98
TPH (C5+ Hydrocarbons) ref. to Gasoline	9.9	41	10000	41000
C2-C4 Hydrocarbons ref. to Gasoline	9.9	18	Not Detected	Not Detected

Container Type: 1 Liter Summa Canister

Surrogates	% Recovery	Method Limits
Fluorobenzene (PID)	149	50-150
Fluorobenzene (FID)	86	50-150

AIR TOXICS LTD.

SAMPLE NAME : BX-HA-A Duplicate

ID#: 9803254-01AA

EPA Method TO-3 GC/PID/FID

File Name:	6040414	**Date of Collection:**	3/21/98
Dil. Factor:	985	**Date of Analysis:**	4/ 4/98

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.99	3.2	18	60
Toluene	0.99	3.8	28	110
Ethyl Benzene	0.99	4.3	29	130
Total Xylenes	0.99	4.3	16	71
TPH (C5+ Hydrocarbons) ref. to Gasoline	9.9	41	8500	35000
C2-C4 Hydrocarbons ref. to Gasoline	9.9	18	Not Detected	Not Detected

Container Type: 1 Liter Summa Canister

Surrogates	% Recovery	Method Limits
Fluorobenzene (PID)	142	50-150
Fluorobenzene (FID)	84	50-150

AIR TOXICS LTD.

SAMPLE NAME : BX-HA-15

ID#: 9803254-02A

EPA Method TO-3 GC/PID/FID

File Name:	6040415	Date of Collection:	3/21/98
Dil. Factor:	1010	Date of Analysis:	4/ 4/98

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	1.0	3.3	24	78
Toluene	1.0	3.9	40	150
Ethyl Benzene	1.0	4.5	46	200
Total Xylenes	1.0	4.5	23	100
TPH (C5+ Hydrocarbons) ref. to Gasoline	10	42	10000	44000
C2-C4 Hydrocarbons ref. to Gasoline	10	18	Not Detected	Not Detected

Container Type: 1 Liter Summa Canister

Surrogates	% Recovery	Method Limits
Fluorobenzene (PID)	150	50-150
Fluorobenzene (FID)	78	50-150

AIR TOXICS LTD.

SAMPLE NAME : BX-HA-1

ID#: 9803254-03A

EPA Method TO-3 GC/PID/FID

File Name:	**6040411**	**Date of Collection:**	**3/21/98**
Dil. Factor:	**1.99**	**Date of Analysis:**	**4/ 4/98**

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.0020	0.0065	Not Detected	Not Detected
Toluene	0.0020	0.0076	0.0036	0.014
Ethyl Benzene	0.0020	0.0088	Not Detected	Not Detected
Total Xylenes	0.0020	0.0088	0.0068	0.030
TPH (C5+ Hydrocarbons) ref. to Gasoline	0.020	0.083	0.49	2.0
C2-C4 Hydrocarbons ref. to Gasoline	0.020	0.036	Not Detected	Not Detected

Q = Exceeds Quality Control limits, possibly due to matrix effects.

Container Type: 1 Liter Summa Canister

Surrogates	% Recovery	Method Limits
Fluorobenzene (PID)	24 Q	50-150
Fluorobenzene (FID)	102	50-150

AIR TOXICS LTD.

SAMPLE NAME : FT16-HA-72

ID#: 9803254-04A

EPA Method TO-3 GC/PID/FID

File Name:	6040412	Date of Collection:	3/21/98
Dil. Factor:	1.99	Date of Analysis:	4/ 4/98

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.0020	0.0065	Not Detected	Not Detected
Toluene	0.0020	0.0076	0.0067	0.026
Ethyl Benzene	0.0020	0.0088	Not Detected	Not Detected
Total Xylenes	0.0020	0.0088	Not Detected	Not Detected
TPH (C5+ Hydrocarbons) ref. to Gasoline	0.020	0.083	0.13	0.55
C2-C4 Hydrocarbons ref. to Gasoline	0.020	0.036	Not Detected	Not Detected

Q = Exceeds Quality Control limits, possibly due to matrix effects.

Container Type: 1 Liter Summa Canister

Surrogates	% Recovery	Method Limits
Fluorobenzene (PID)	25 Q	50-150
Fluorobenzene (FID)	85	50-150

AIR TOXICS LTD.

SAMPLE NAME : FT16-HA-61

ID#: 9803254-05A

EPA Method TO-3 GC/PID/FID

File Name:	**6040410**	**Date of Collection:**	**3/21/98**
Dil. Factor:	**1.99**	**Date of Analysis:**	**4/ 4/98**

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.0020	0.0065	Not Detected	Not Detected
Toluene	0.0020	0.0076	0.0027	0.010
Ethyl Benzene	0.0020	0.0088	Not Detected	Not Detected
Total Xylenes	0.0020	0.0088	Not Detected	Not Detected
TPH (C5+ Hydrocarbons) ref. to Gasoline	0.020	0.083	0.12	0.48
C2-C4 Hydrocarbons ref. to Gasoline	0.020	0.036	Not Detected	Not Detected

Q = Exceeds Quality Control limits, possibly due to matrix effects.

Container Type: 1 Liter Summa Canister

Surrogates	% Recovery	Method Limits
Fluorobenzene (PID)	20 Q	50-150
Fluorobenzene (FID)	91	50-150

AIR TOXICS LTD.

SAMPLE NAME : FT16-HA-49

ID#: 9803254-06A

EPA Method TO-3 GC/PID/FID

File Name:	6040408	Date of Collection:	3/21/98
Dil. Factor:	2.64	Date of Analysis:	4/ 4/98

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.0026	0.0086	Not Detected	Not Detected
Toluene	0.0026	0.010	Not Detected	Not Detected
Ethyl Benzene	0.0026	0.012	Not Detected	Not Detected
Total Xylenes	0.0026	0.012	0.0034	0.015
TPH (C5+ Hydrocarbons) ref. to Gasoline	0.026	0.11	0.51	2.1
C2-C4 Hydrocarbons ref. to Gasoline	0.026	0.048	0.027	0.050

Q = Exceeds Quality Control limits, possibly due to matrix effects.

Container Type: 1 Liter Summa Canister

Surrogates	% Recovery	Method Limits
Fluorobenzene (PID)	18 Q	50-150
Fluorobenzene (FID)	82	50-150

AIR TOXICS LTD.

SAMPLE NAME : Lab Blank

ID#: 9803254-07A

EPA Method TO-3 GC/PID/FID

File Name:	**6040407**	**Date of Collection: NA**	
Dil. Factor:	**1.00**	**Date of Analysis: 4/ 4/98**	

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.0010	0.0032	Not Detected	Not Detected
Toluene	0.0010	0.0038	Not Detected	Not Detected
Ethyl Benzene	0.0010	0.0044	Not Detected	Not Detected
Total Xylenes	0.0010	0.0044	Not Detected	Not Detected
TPH (C5+ Hydrocarbons) ref. to Gasoline	0.010	0.042	Not Detected	Not Detected
C2-C4 Hydrocarbons ref. to Gasoline	0.010	0.018	Not Detected	Not Detected

Container Type: NA

Surrogates	% Recovery	Method Limits
Fluorobenzene (PID)	102	50-150
Fluorobenzene (FID)	108	50-150

AIR TOXICS LTD.

SAMPLE NAME : LCS

ID#: 9803254-08A

EPA Method TO-3 GC/PID/FID

File Name:	**6040404**	**Date of Collection: NA**
Dil. Factor:	**1.00**	**Date of Analysis: 4/ 4/98**

Compound	Rpt. Limit (ppmv)	Rpt. Limit (uG/L)	% Recovery
Benzene	0.0010	0.0032	85
Toluene	0.0010	0.0038	91
Ethyl Benzene	0.0010	0.0044	105
Total Xylenes	0.0010	0.0044	103
TPH (C5+ Hydrocarbons) ref. to Gasoline	0.010	0.042	101
C2-C4 Hydrocarbons ref. to Gasoline	0.010	0.018	101

Container Type: NA

Surrogates	% Recovery	Method Limits
Fluorobenzene (PID)	99	50-150
Fluorobenzene (FID)	109	50-150

AIR TOXICS LTD.
AN ENVIRONMENTAL ANALYTICAL LABORATORY

180 BLUE RAVINE ROAD, SUITE B
FOLSOM, CA 95630-4719
(916) 985-1000 FAX: (916) 985-1020

CHAIN-OF-CUSTODY RECORD

Nº 014535 Page 1 of 1

Contact Person: BRAD LEWIS
Company: PARSONS ES
Address: 5390 TRIANGLE PKWY SUITE 100 City: NORCROSS State: GA Zip: 30092
Phone: (676) 969-2489 FAX: (770) 446-4900
Collected By: Signature:

Project info:
P.O. #:
Project #: 731854.10
Project Name: TYNDALL

Turn Around Time:
☒ Normal
☐ Rush Specify

Lab I.D.	Field Sample I.D.	Date & Time	Analyses Requested	Canister Pressure / Vacuum Initial	Final	Receipt
01N	BX-HA-A	3/21/98 1530	TO-3 BTEX + TVH	27.5	0	4psi
02N	BX-HA-15	3/21/98 1545	TO-3 BTEX + TVH	29.5	0	0" Hg
03N	BX-HA-1	3/21/98 1625	TO-3 BTEX + TVH	29.5	0	.2psi
04N	FT16-HA-72	3/21/98 1650	TO-3 BTEX + TVH	28	0	.2psi
05N	FT16-HA-61	3/21/98 1705	TO-3 BTEX + TVH	29.5	0	.2psi
06N	FT16-HA-49	3/21/98 1740	TO-3 BTEX + TVH	29	7.5	7" Hg

3/21/98 2100 4198

Relinquished By: (Signature) Date/Time: 3/22/98 1200 Print Name:
Relinquished By: (Signature) Date/Time:
Received By: (Signature) Date/Time: 3/24/98 1135
Relinquished By: (Signature) Date/Time:
Received By: (Signature) Date/Time:

Notes:

Lab Use Only	Shipper Name	Air Bill #	Opened By:	Date/Time	Temp. (°C)	Condition	Custody Seals Intact?	Work Order #
	Fed Ex	803561841833		3/24/98 11:35	Ambient	(cold)	Yes No None N/A	9803254

Air Toxics Limited

Data file : /chem/gc6.i/04Apr1998.b/6040407b.d
Lab Smp Id: Client Smp ID: Lab Blank
Inj Date : 04-APR-1998 10:57
Operator : Inst ID: gc6.i
Smp Info : 250 ml,uhp blank
Misc Info :
Comment :
Method : /chem/gc6.i/04Apr1998.b/to3f0403.m/TO3b0403.m
Meth Date : 04-Apr-1998 11:01 samerson Quant Type: ESTD
Cal Date : 03-APR-1998 16:38 Cal File: 6040319b.d
Als bottle: 1
Dil Factor: 1.00000
Integrator: Falcon Compound Sublist: all.sub
Target Version: 3.40
Processing Host: frodo

Concentration Formula: Amt * DF

4/4/98

			RT	EXP RT	DLT RT	RESPONSE	CONCENTRATIONS ON-COLUMN (PPMV)	CONCENTRATIONS FINAL (PPMV)
	1	Methyl t-Butyl Ether	Compound Not Detected.					
	2	tba (0211)	Compound Not Detected.					
	3	Benzene	Compound Not Detected.					
S	4	Fluorobenzene-SURROGATE	8.037	8.030	0.007	235294	0.10392	0.1039
	5	Toluene	Compound Not Detected.					
	6	Ethyl Benzene	Compound Not Detected.					
	7	m,p-Xylenes	Compound Not Detected.					
	8	o-Xylene	Compound Not Detected.					
M	9	Total Xylenes	Compound Not Detected.					

Air Toxics Limited

RECOVERY REPORT

Client Name:
Sample Matrix: GAS
Lab Smp Id:
Level: LOW
Data Type: GC DATA
SpikeList File:
Sublist File: all.sub
Client SDG: 04Apr1998
Fraction: VOA
Client Smp ID: Lab Blank
Operator:
SampleType: SAMPLE
Quant Type: ESTD
Method File: /chem/gc6.i/04Apr1998.b/to3f0403.m/TO3b0403.m
Misc Info:

SURROGATE COMPOUND	CONC ADDED PPMV	CONC RECOVERED PPMV	% RECOVERED	LIMITS
$ 4 Fluorobenzene-SURR	0.1020	0.1039	101.88	50-150

4/4/98

Data File: /chem/gc6.i/04Apr1998.b/6040407.d
Report Date: 04-Apr-1998 11:41

Air Toxics Limited

Data file : /chem/gc6.i/04Apr1998.b/6040407.d
Lab Smp Id:
Client Smp ID: Lab Blank
Inj Date : 04-APR-1998 10:57
Operator :
Inst ID: gc6.i
Smp Info : 250 ml,uhp blank
Misc Info :
Comment :
Method : /chem/gc6.i/04Apr1998.b/to3f0403.m
Meth Date : 04-Apr-1998 11:14 samerson
Quant Type: ESTD
Cal Date : 11-JAN-1998 16:43
Cal File: 6011120.d
Als bottle: 1
Dil Factor: 1.00000
Integrator: Falcon
Compound Sublist: all.sub
Target Version: 3.40
Processing Host: frodo

Concentration Formula: Amt * DF

						CONCENTRATIONS	
						ON-COLUMN	FINAL
	Compounds	RT	EXP RT	DLT RT	RESPONSE	(PPMV)	(PPMV)
S	1 Fluorobenzene *SURR0403*	8.040	8.037	0.303	124257	0.10988	0.1099
S	2 C2- (to-12BP0311)	Compound Not Detected.					
S	3 C2- (jp40110)	Compound Not Detected.					
S	4 C2C4 (jp40110)	Compound Not Detected.					
S	5 C3- (jp40110)	Compound Not Detected.					
S	6 C2- (jp50303)	Compound Not Detected.					
S	7 C2C4 (jp50303)	Compound Not Detected.					
S	8 C3- (jp50303)	Compound Not Detected.					
S	9 C2- (gas0114f)	Compound Not Detected.					
S	10 C2-C4 (gas01114f)	Compound Not Detected.					
S	11 C3- (gas0114f)	Compound Not Detected.					
S	12 C9- (gas0114f)	Compound Not Detected.					
S	62 stod0330	Compound Not Detected.					

✓ 4/4/98

Air Toxics Limited

RECOVERY REPORT

Client Name:
Sample Matrix: GAS
Lab Smp Id:
Level: LOW
Data Type: GC DATA
SpikeList File:
Sublist File: all.sub
Method File: /chem/gc6.i/04Apr1998.b/to3f0403.m
Misc Info:

Client SDG: 04Apr1998
Fraction: VOA
Client Smp ID: Lab Blank
Operator:
SampleType: SAMPLE
Quant Type: ESTD

SURROGATE COMPOUND	CONC ADDED PPMV	CONC RECOVERED PPMV	% RECOVERED	LIMITS
$ 1 Fluorobenzene *SUR	0.1020	0.1099	107.73	50-150

4/4/98

Data File: /chem/gc6.i/04Apr1998.b/6040403b.d
Report Date: 04-Apr-1998 10:47

BTEX CAL CHECK

Air Toxics Limited

CONTINUING CALIBRATION COMPOUNDS

Instrument ID: gc6.i
Lab File ID: 6040403b.d
Analysis Type: AIR
Lab Sample ID:
Quant Type: ESTD

Injection Date: 04-APR-1998 08:07
Init. Calibration Date(s): 04/03/98 04/03/98
Init. Calibration Times: 14:58 16:38
Method File: /chem/gc6.i/04Apr1998.b/to3f0403.m/TO3b

	COMPOUND	RRF	RF0	MIN RRF	%D	MAX %D	
1	Methyl t-Butyl Ether	1702962.617	1767943.925	0.010	-3.8	~~30.0~~	
2	cba (0211)	1618773.364	~~~~	0.010	~~~~	40.0	<-
3	Benzene	3646533.178	3199556.075	0.010	12.3	~~30.0~~	
S 4	Fluorobenzene-SURROGATE	2264250.980	2076647.059	0.010	8.3	50.0	
5	Toluene	4248749.688	3764672.897	0.010	11.4	~~30.0~~	
6	Ethyl Benzene	4395232.555	3904742.991	0.010	11.2	30.0	
7	m,p-Xylenes	5227043.380	4622605.140	0.010	11.6	30.0	
8	o-Xylene	4588299.533	4069836.449	0.010	11.3	30.0	
M 9	Total Xylenes	5014128.764	4438348.910	0.010	11.5	~~30.0~~	

15

15

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Data File: /chem/gc6.i/04Apr1998.b/6040403b.d
Report Date: 04-Apr-1998 10:47

Air Toxics Limited

Data file : /chem/gc6.i/04Apr1998.b/6040403b.d
Lab Smp Id:
Inj Date : 04-APR-1998 08:07
Operator : sa Inst ID: gc6.i
Smp Info : 10ml,290-30 btex std=.0428ppmv on col
Misc Info :
Comment :
Method : /chem/gc6.i/04Apr1998.b/to3f0403.m/TO3b0403.m
Meth Date : 04-Apr-1998 10:47 g Quant Type: ESTD
Cal Date : 03-APR-1998 16:38 Cal File: 6040319b.d
Als bottle: 1 Continuing Calibration Sample
Dil Factor: 1.00000
Integrator: Falcon Compound Sublist: all.sub
Target Version: 3.40
Processing Host: frodo

Concentration Formula: Amt * DF

	Compounds	RT	EXP RT	DLT RT	RESPONSE	AMOUNTS CAL-AMT (PPMV)	AMOUNTS ON-COL (PPMV)
	1 Methyl t-Butyl Ether	5.500	5.500	0.000	75668	0.04280	0.04443
	2 tba (0211)	Compound Not Detected.					
	3 Benzene	7.737	7.737	0.000	136941	0.04280	0.03755
S	4 Fluorobenzene-SURROGATE	8.030	8.030	0.000	211818	0.10200	0.09355
	5 Toluene	9.377	9.377	0.000	161128	0.04280	0.03792
	6 Ethyl Benzene	10.453	10.453	0.000	167123	0.04280	0.03802
	7 m,p-Xylenes	10.533	10.533	0.000	395695	0.08560	0.07570
	8 o-Xylene	10.803	10.803	0.000	174189	0.04280	0.03796
M	9 Total Xylenes				569884	0.12840	0.1137

4/4/98

GAS CAL CHECK

Data File: /chem/gc6.i/04Apr1998.b/6040405.d
Report Date: 04-Apr-1998 11:14

Air Toxics Limited

RECOVERY REPORT

Client Name:
Sample Matrix: GAS
Lab Smp Id:
Level: LOW
Data Type: GC DATA
SpikeList File: par358-82.spk
Sublist File: c2gas.sub
Method File: /chem/gc6.i/04Apr1998.b/to3f0403.m
Misc Info: 386ppmv std

Client SDG: 04Apr1998
Fraction: VOA
Operator:
SampleType: METHSPIKE
Quant Type: ESTD

SPIKE COMPOUND	CONC ADDED PPMV	CONC RECOVERED PPMV	% RECOVERED	LIMITS
S 9 C2+ (gas0114f)	1.544	1.444	93.55	85-115

SURROGATE COMPOUND	CONC ADDED PPMV	CONC RECOVERED PPMV	% RECOVERED	LIMITS
$ 1 Fluorobenzene *SUR	0.1020	0.1094	107.29	50-150

Data File: /chem/gc6.i/04Apr1998.b/6040405.d
Report Date: 04-Apr-1998 11:14

Air Toxics Limited

Data file : /chem/gc6.i/04Apr1998.b/6040405.d
Lab Smp Id:
Inj Date : 04-APR-1998 09:35
Operator :
Inst ID: gc6.i
Smp Info : 1.0 ml,358-82 gas,1.544 ppmv on col
Misc Info : 386ppmv std
Comment :
Method : /chem/gc6.i/04Apr1998.b/to3f0403.m
Meth Date : 04-Apr-1998 11:14 samerson
Quant Type: ESTD
Cal Date : 11-JAN-1998 16:43
Cal File: 6011120.d
Als bottle: 1
QC Sample: METHSPIKE
Dil Factor: 1.00000
Integrator: Falcon
Compound Sublist: c2gas.sub
Target Version: 3.40
Processing Host: frodo

Concentration Formula: Amt * DF

						CONCENTRATIONS	
						ON-COLUMN	FINAL
Compounds	RT	EXP RT	DLT RT	RESPONSE		(PPMV)	(PPMV)
S 9 CC• (gas01141)	0.900	18.000		2918956		1.44449	1.444
S 1 Fluorobenzene *SURR0403*	8.023	8.037	-0.014	123752		0.10944	0.1094

4/4/98

Data File: /chem/gc6.i/04Apr1998.b/6040404b.d
Report Date: 04-Apr-1998 10:48

Air Toxics Limited

RECOVERY REPORT

Client Name:
Sample Matrix: GAS
Lab Smp Id:
Level: LOW
Data Type: GC DATA
SpikeList File: 358-21-50.spk
Sublist File: all.sub
Method File: /chem/gc6.i/04Apr1998.b/to3f0403.m/TO3b0403.m
Misc Info:

Client SDG: 04Apr1998
Fraction: VOA
Operator:
SampleType: METHSPIKE
Quant Type: ESTD

BTEX LCS

	SPIKE COMPOUND	CONC ADDED PPMV	CONC RECOVERED PPMV	% RECOVERED	LIMITS
	3 Benzene	0.1000	0.08512	85.12	75-125
	5 Toluene	0.1000	0.09145	91.45	75-125
	6 Ethyl Benzene	0.1000	0.1051	105.11	75-125
	7 m,p-Xylenes	0.2000	0.2011	100.57	75-125
	8 o-Xylene	0.1000	0.1078	107.76	75-125
M	9 Total Xylenes	0.3000	0.3089	102.97	75-125

	SURROGATE COMPOUND	CONC ADDED PPMV	CONC RECOVERED PPMV	% RECOVERED	LIMITS
$	4 Fluorobenzene-SURR	0.1020	0.1006	98.60	50-150

Data File: /chem/gc6.i/04Apr1998.b/6040404b.d
Report Date: 04-Apr-1998 10:47

Air Toxics Limited

Data file : /chem/gc6.i/04Apr1998.b/6040404b.d
Lab Smp Id:
Inj Date : 04-APR-1998 08:57
Operator : Inst ID: gc6.i
Smp Info : 358-21,50ppmv=0.10ppmv on col
Misc Info :
Comment :
Method : /chem/gc6.i/04Apr1998.b/to3f0403.m/TO3b0403.m
Meth Date : 04-Apr-1998 10:47 g Quant Type: ESTD
Cal Date : 03-APR-1998 16:38 Cal File: 6040319b.d
Als bottle: 1 QC Sample: METHSPIKE
Dil Factor: 1.00000
Integrator: Falcon Compound Sublist: all.sub
Target Version: 3.40
Processing Host: frodo

Concentration Formula: Amt * DF

	Compounds	RT	EXP RT	DLT RT	RESPONSE	CONCENTRATIONS ON-COLUMN (PPMV)	CONCENTRATIONS FINAL (PPMV)
	1 Methyl t-Butyl Ether	Compound Not Detected.					
	2 tba (0211)	5.400	5.553	-0.153	315874	0.19513	0.1951
	3 Benzene	7.713	7.737	-0.024	310380	0.08512	0.08512
S	4 Fluorobenzene-SURROGATE	8.020	8.030	-0.010	227729	0.10058	0.1006
	5 Toluene	9.367	9.377	-0.010	388545	0.09145	0.09145
	6 Ethyl Benzene	10.443	10.453	-0.010	461964	0.10511	0.1051
	7 m,p-Xylenes	10.527	10.533	-0.006	1051414	0.20115	0.2011
	8 o-Xylene	10.793	10.803	-0.010	494448	0.10776	0.1078
M	9 Total Xylenes				1545862	0.30891	0.3089

4/4/98

Data File: /chem/gc6.i/04Apr1998.b/6040406.d
Report Date: 04-Apr-1998 11:14

Air Toxics Limited

RECOVERY REPORT

Client Name:
Sample Matrix: GAS
Lab Smp Id:
Level: LOW
Data Type: GC DATA
SpikeList File: par358-82-A.spk
Sublist File: c2gas.sub
Method File: /chem/gc6.i/04Apr1998.b/to3f0403.m
Misc Info:

Client SDG: 04Apr1998
Fraction: VOA
Operator:
SampleType: METHSPIKE
Quant Type: ESTD

GAS LCS

SPIKE COMPOUND	CONC ADDED PPMV	CONC RECOVERED PPMV	% RECOVERED	LIMITS
S 9 C2+ (gas0114f)	1.570	1.591	101.33	75-125

SURROGATE COMPOUND	CONC ADDED PPMV	CONC RECOVERED PPMV	% RECOVERED	LIMITS
S 1 Fluorobenzene *SUR	0.1020	0.1114	109.17	50-150

4/4/98

Air Toxics Limited

Data file : /chem/gc6.i/04Apr1998.b/6040406.d
Lab Smp Id:
Inj Date : 04-APR-1998 10:21
Operator : Inst ID: gc6.i
Smp Info : 1.0 ml 358-82a gas std,393ppmv=1.57ppmv on c1
Misc Info :
Comment :
Method : /chem/gc6.i/04Apr1998.b/to3f0403.m
Meth Date : 04-Apr-1998 11:14 samerson Quant Type: ESTD
Cal Date : 11-JAN-1998 16:43 Cal File: 6011120.d
Als bottle: 1 QC Sample: METHSPIKE
Dil Factor: 1.00000
Integrator: Falcon Compound Sublist: c2gas.sub
Target Version: 3.40
Processing Host: frodo

Concentration Formula: Amt * DF

	Compounds	RT	EXP RT	DLT RT	RESPONSE	CONCENTRATIONS ON-COLUMN (PPMV)	CONCENTRATIONS FINAL (PPMV)
S	9 C2- (gas0114f)	0.900-18.300			3214837	1.59091	1.591
S	1 Fluorobenzene *SURR0403*	8.020	8.037	-0.017	125915	0.11135	0.1114

4/4/98

BTEX End Check

Data File: /chem/gc6.i/04Apr1998.b/6040421b.d
Report Date: 04-Apr-1998 18:36

Air Toxics Limited

CONTINUING CALIBRATION COMPOUNDS

Instrument ID: gc6.i
Lab File ID: 6040421b.d
Analysis Type: AIR
Lab Sample ID:
Quant Type: ESTD

Injection Date: 04-APR-1998 18:13
Init. Calibration Date(s): 04/03/98 04/03/98
Init. Calibration Times: 14:58 16:38
Method File: /chem/gc6.i/04Apr1998.b/to3f0403.m/TO3b

	COMPOUND	RRF	RF0	MIN RRF	%D	MAX %D	
	1 Methyl t-Butyl Ether	1702962.617	2118528.037	0.010	-24.4	~~30.0~~	15
	2 tba (0211)	1618773.364	----	0.010	----	40.0	<-
	3 Benzene	3646533.178	3851261.682	0.010	-5.6	~~20.0~~	
S	4 Fluorobenzene-SURROGATE	2264250.980	2573058.824	0.010	-13.6	50.0	
	5 Toluene	4248749.688	4566495.327	0.010	-7.5	~~30.0~~	15
	6 Ethyl Benzene	4395232.555	4912570.093	0.010	-11.8	30.0	
	7 m,p-Xylenes	5227043.380	5829556.075	0.010	-11.5	30.0	
	8 o-Xylene	4588299.533	5148457.944	0.010	-12.2	30.0	
M	9 Total Xylenes	5014128.764	5602523.364	0.010	-11.7	30.0	

4/14/98

4/14/98

Data File: /var/chem/gc6.i/04Apr1998.b/6040421b.d
Report Date: 04-Apr-1998 18:34

Air Toxics Limited

Data file : /var/chem/gc6.i/04Apr1998.b/6040421b.d
Lab Smp Id:
Inj Date : 04-APR-1998 18:13
Operator : Inst ID: gc6.i
Smp Info : 10ml,290-30 BTEX END STD=.0428ppmv on col
Misc Info :
Comment :
Method : /chem/gc6.i/04Apr1998.b/to3f0403.m/TO3b0403.m
Meth Date : 04-Apr-1998 16:07 samerson Quant Type: ESTD
Cal Date : 03-APR-1998 16:38 Cal File: 6040319b.d
Als bottle: 1
Dil Factor: 1.00000
Integrator: Falcon Compound Sublist: all.sub
Target Version: 3.40
Processing Host: frodo

Concentration Formula: Amt * DF

	Compounds	RT	EXP RT	DLT RT	RESPONSE	CONCENTRATIONS ON-COLUMN (PPMV)	CONCENTRATIONS FINAL (PPMV)
	1 Methyl t-Butyl Ether	5.507	5.553	-0.046	90671	0.05324	0.05324
	2 tba (0211)	Compound Not Detected.					
	3 Benzene	7.737	7.740	-0.003	164834	0.04520	0.04520
S	4 Fluorobenzene-SURROGATE	8.030	8.033	-0.003	262452	0.11591	0.1159
	5 Toluene	9.377	9.377	0.000	195446	0.04600	0.04600
	6 Ethyl Benzene	10.450	10.453	-0.003	210258	0.04784	0.04784
	7 m,p-Xylenes	10.533	10.533	0.000	499010	0.09547	0.09547
	8 o-Xylene	10.800	10.800	0.000	220354	0.04803	0.04802
M	9 Total Xylenes				719364	0.14349	0.1435

GAS END CHECK

Data File: /chem/gc6.i/04Apr1998.b/6040422.d
Report Date: 04-Apr-1998 18:59

Air Toxics Limited

RECOVERY REPORT

Client Name:
Sample Matrix: GAS
Lab Smp Id:
Level: LOW
Data Type: GC DATA
SpikeList File: par358-82.spk
Sublist File: all.sub
Method File: /chem/gc6.i/04Apr1998.b/to3f0403.m
Misc Info:

Client SDG: 04Apr1998
Fraction: VOA
Operator:
SampleType: METHSPIKE
Quant Type: ESTD

SPIKE COMPOUND	CONC ADDED PPMV	CONC RECOVERED PPMV	% RECOVERED	LIMITS
S 9 C2+ (gas0114f)	1.544	1.663	107.69	85-115

SURROGATE COMPOUND	CONC ADDED PPMV	CONC RECOVERED PPMV	% RECOVERED	LIMITS
S 1 Fluorobenzene *SUR	0.1020	0.1140	111.80	50-150

4/4/98

Data File: /var/chem/gc6.i/04Apr1998.b/6040422.d
Report Date: 04-Apr-1998 18:57

Air Toxics Limited

Data file : /var/chem/gc6.i/04Apr1998.b/6040422.d
Lab Smp Id:
Inj Date : 04-APR-1998 18:36
Operator : Inst ID: gc6.i
Smp Info : 1.0ml,358-82 gas END STD=1.544ppmv on col
Misc Info :
Comment :
Method : /chem/gc6.i/04Apr1998.b/to3f0403.m
Meth Date : 04-Apr-1998 16:47 samerson Quant Type: ESTD
Cal Date : 11-JAN-1998 16:43 Cal File: 6011120.d
Als bottle: 1
Dil Factor: 1.00000
Integrator: Falcon Compound Sublist: all.sub
Target Version: 3.40
Processing Host: frodo

Concentration Formula: Amt * DF

Compounds	RT	EXP RT	DLT RT	RESPONSE	CONCENTRATIONS ON-COLUMN (PPMV)	FINAL (PPMV)
S 1 Fluorobenzene *SURR0403*	8.033	8.037	-0.004	128954	0.11404	0.1140
S 2 C2- (to-12BP0311)	0.900-18.000			3359940	1.85591	1.856
S 3 C2- (jp40110)	0.900-18.000			3359940	2.98023	2.980
S 4 C2C4 (jp40110)	1.800-18.000			3284030	2.91290	2.913
S 5 C3- (jp40110)	1.800-18.000			3284030	2.91290	2.913
S 6 C2- (jp50303)	0.900-18.000			3359940	4.19624	4.196
S 7 C2C4 (jp50303)	0.900-1.800			75910	0.09480	0.09480
S 8 C3- (jp50303)	1.800-18.000			3284030	4.10143	4.101
S 9 C2- (gas0114f)	0.900-18.000			3359940	1.66272	1.663
S 10 C2-C4 (gas01114f)	0.900-1.800			75910	0.03757	0.03756
S 11 C3- (gas0114f)	1.800-18.000			3284030	1.62515	1.625
S 12 C9- (gas0114f)	9.398-18.000			1205102	0.59636	0.5964
S 62 stod0330	0.900-18.000			3359940	1.51145	1.511

4/4/98

Air Toxics Limited

INITIAL CALIBRATION DATA

Start Cal Date : 03-APR-1998 14:58
End Cal Date : 03-APR-1998 16:38
Quant Method : ESTD
Origin : Disabled
Target Version : 3.40
Integrator : Falcon
Method file : /chem/gc6.i/03Apr1998.b/to3f0403.m/TO3b0403.m
Cal Date : 03-Apr-1998 19:48 g
Curve Type : Average

Calibration File Names:
Level 1: /chem/gc6.i/03Apr1998.b/6040315b.d
Level 2: /chem/gc6.i/03Apr1998.b/6040316b.d
Level 3: /chem/gc6.i/03Apr1998.b/6040317b.d
Level 4: /chem/gc6.i/03Apr1998.b/6040318b.d
Level 5: /chem/gc6.i/03Apr1998.b/6040319b.d

	Compound	0.00428 Level 1	0.04280 Level 2	0.08560 Level 3	0.12840 Level 4	0.21400 Level 5	RRF	% RSD
	1 Methyl t-Butyl Ether	2039720	2075467	2013458	1214603	1171565	1702963	27.377
	2 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	3 Benzene	4127103	3756238	3567558	3419182	3362584	3646533	8.469
	5 Toluene	4831776	4389065	4205269	3941083	3876556	4248750	9.075
	6 Ethyl Benzene	4784112	4564930	4312161	4165997	4148963	4395233	6.232
	7 m,p-Xylenes	6130374	5415759	4991676	4816947	4780460	5227043	10.800
	8 o-Xylene	5169159	4721308	4419942	4287757	4343332	4588300	7.961
M	9 Total Xylenes	5809969	5184276	4801098	4640550	4634751	5014129	9.928
S	4 Fluorobenzene-SURROGATE	2126157	2240245	2343627	2311392	2299833	2264251	3.789

4/3/98

4/4/98

49.58

Air Toxics Limited

INITIAL CALIBRATION DATA

Start Cal Date : 31-DEC-1997 06:11
End Cal Date : 14-JAN-1998 15:15
Quant Method : ESTD
Origin : Disabled
Target Version : 3.40
Integrator : Falcon
Method file : /chem/gcs.i/17Jan1998.b/gas011414.m = ~~Formed to to 3 g 0114 on for AOF~~ 4/14/98
Cal Date : 17-Jan-1998 11:23 samerson
Curve Type : Average

Calibration File Names:
Level 1: /chem/gcs.i/14Jan1998.b/6011412.d
Level 2: /chem/gcs.i/14Jan1998.b/6011405.d
Level 3: /chem/gcs.i/14Jan1998.b/6011406.d
Level 4: /chem/gcs.i/14Jan1998.b/6011407.d
Level 5: /chem/gcs.i/14Jan1998.b/6011408.d

Compound	0.08360 Level 1	1.672 Level 2	3.344 Level 3	8.360 Level 4	16.720 Level 5	— RRF	— %RSD
5 [illegible](C-)	13577521	13613370	[illegible]	13849312	20857793	20207541	6.629
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

11/20/98
MG 3/19/98

1/17/98

Air Toxics Limited

INITIAL CALIBRATION DATA

tart Cal Date : 03-APR-1998 14:58
nd Cal Date : 03-APR-1998 16:38
uant Method : ESTD
rigin : Disabled
arget Version : 3.40
ntegrator : Falcon
ethod file : /chem/gc6.i/03Apr1998.b/surr0403.m = To3fc403.m
al Date : 03-Apr-1998 19:21 samerson
urve Type : Average

For TARGET

alibration File Names:
evel 1: /chem/gc6.i/03Apr1998.b/6040319.d
evel 2: /chem/gc6.i/03Apr1998.b/6040318.d
evel 3: /chem/gc6.i/03Apr1998.b/6040317.d
evel 4: /chem/gc6.i/03Apr1998.b/6040316.d
evel 5: /chem/gc6.i/03Apr1998.b/6040315.d

Compound	0.10200 Level 1	0.10200 Level 2	0.10200 Level 3	0.10200 Level 4	0.10200 Level 5	RRF	% RSD
1 FLUOROBENZENE *SURROGATE*	1067382	1116961	1174520	1165284	1129824	1130794	3.782

FID

4/3/98

4.9.98

Quanterra Environmental Services

Quanterra Incorporated
4955 Yarrow Street
Arvada, Colorado 80002

303 421-6611 Telephone
303 431-7171 Fax

ANALYTICAL RESULTS
FOR
PARSONS ENGINEERING SCIENCE, INC.

QUANTERRA INCORPORATED, DENVER
PROJECT NUMBER 059549

May 1, 1998

Written by: _____

Ellen La Riviere, Program Manager

Quanterra
Environmental Services

Overview

On March 27, 1998, Quanterra Incorporated; Denver Laboratory received ten soil samples from Parsons Engineering Science, Inc.

This report presents the analytical results as well as supporting information to aid in the evaluation and interpretation of the data and is arranged in the following order:

Overview
Sample Description Information/Analytical Test Requests
Analytical Results
Quality Control Report

Aromatic Volatile Organics Data Review

Each sample was analyzed to achieve the lowest possible reporting limits within the constraints of the method. In some cases, due to interferences or analytes present at concentrations above the linear calibration range of the instrument, samples were diluted. For diluted samples, the reporting limits are adjusted relative to the dilutions required. Quanterra samples 059549-0005-SA, -0006-SA, -0007-SA, -0008-SA, -0009-SA and -0010-SA were analyzed at dilutions for Method 8020A due to the concentration of target compounds present in the samples. Quanterra samples 059549-0005-SA, -0006-SA, -0007-SA, -0008-SA and -0010-SA surrogates were diluted out and reported as ND.

Polynuclear Aromatic Hydrocarbons Data Review

Samples 059549-0006-SA, -0007-SA and -0008-SA were analyzed at dilutions for Method 8310 due to the concentration of target compounds in the samples. The reporting limits have been raised accordingly. As a result of the dilutions required, the surrogates were diluted to less than detectable concentrations in samples 059549-0006-SA and -0007.

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LIMs Report Key

Section	Description
Cover Letter	Signature page, report narrative as applicable.
Sample Description Information	Tabulated cross-reference between the Lab ID and Client ID, including matrix, date and time sampled, and the date received for all samples in the project.
Sample Analysis Results Sheets	Lists sample results, test components, reporting limits, dates prepared and analyzed, and any data qualifiers. Pages are organized by test.
QC LOT Assignment Report	Cross-reference between lab IDs and applicable QC batches (DCS, LCS, Blank, MS/SD, DU)
Duplicate Control Sample Report	Percent recovery and RPD results, with acceptance limits, for the laboratory duplicate control samples for each test are tabulated in this report. These are measures of accuracy and precision for each test. Acceptance limits are based upon laboratory historical data.
Laboratory Control Sample Report	Percent recovery results for a single Laboratory Control Sample (if applicable) are tabulated in this report, with the applicable acceptance limits for each test.
Matrix Spike/Matrix Spike Duplicate Report	Percent recovery and RPD results for matrix-specific QC samples and acceptance limits, where applicable. This report can be used to assess matrix effects on an analysis.
Single Control Sample Report	A tabulation of the surrogate recoveries for the blank for organic analyses.
Method Blank Report	A summary of the results of the analysis of the method blank for each test.

List of Abbreviations and Terms

Abbreviation	Term	Abbreviation	Term
DCS	Duplicate Control Sample	MSD	Matrix Spike Duplicate
DU	Sample Duplicate	QC Run	Preparation Batch
EB	Equipment Blank	QC Category	LIMs QC Category
FB	Field Blank	QC Lot	DCS Batch
FD	Field Duplicate	ND	Not Detected at or above the reporting limit expressed
IDL	Instrument Detection Limit (Metals)	QC Matrix	Matrix of the laboratory control sample(s)
LCS	Laboratory Control Sample	RL	Reporting Limit
MB	Method Blank	QC	Quality Control
MDL	Method Detection Limit	SA	Sample
MS	Matrix Spike	SD	Spike Duplicate
RPD	Relative Percent Difference	TB	Trip Blank
ppm (part-per-million)	mg/L or mg/kg (usually)	ppb (part-per-billion)	ug/L or ug/kg (usually)
QUAL	Qualifier flag	DIL	Dilution Factor

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SAMPLE DESCRIPTION INFORMATION
for
Parsons Engineering Science

Lab ID	Client ID	Matrix	Sampled Date	Sampled Time	Received Date
059549-0001-SA	SB-1 (6.00,8.00)	SOIL	18 MAR 98	10:45	21 MAR 98
059549-0001-MS	SB-1 (6.00,8.00)	SOIL	18 MAR 98	10:45	21 MAR 98
059549-0001-SD	SB-1 (6.00,8.00)	SOIL	18 MAR 98	10:45	21 MAR 98
059549-0002-SA	SB-1 (9.50,10.00)	SOIL	18 MAR 98	10:55	21 MAR 98
059549-0003-SA	SB-2 (6.50,7.00)	SOIL	18 MAR 98	13:00	21 MAR 98
059549-0004-SA	SB-3 (2.00,3.50)	SOIL	18 MAR 98	13:20	21 MAR 98
059549-0005-SA	SB-3 (4.00,5.50)	SOIL	18 MAR 98	13:25	21 MAR 98
059549-0006-SA	SB-4 (4.00,7.00)	SOIL	18 MAR 98	14:10	21 MAR 98
059549-0007-SA	SB-B (4.00,7.00)	SOIL	18 MAR 98	14:30	21 MAR 98
059549-0008-SA	SB-5 (4.50,5.00)	SOIL	18 MAR 98	14:40	21 MAR 98
059549-0009-SA	SB-4 (10.00,12.00)	SOIL	18 MAR 98	15:10	21 MAR 98
059549-0010-SA	SB-6 (7.50,8.00)	SOIL	18 MAR 98	16:05	21 MAR 98

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ANALYTICAL TEST REQUESTS
for
Parsons Engineering Science

Lab ID: 059549	Group Code	Analysis Description	Custom Test?
0001 - 0003	A	Total Organic Carbon (TOC)	N
		Prep - Total Organic Carbon	N
		Total Organic Carbon (TOC)	N
		Total Organic Carbon (TOC)	N
		Total Organic Carbon (TOC)	N
0004 - 0010	B	Percent Water	N
		AFCEE	Y
		Aromatic Volatile Organics with MTBE	Y
		GC Prep For Soils	N
		AFCEE	Y
		Polynuclear Aromatic Hydrocarbons, HPLC	Y
		AFCEE	N
		Prep - Polynuclear Aromatic Hydrocarbons, HPLC	N
		AFCEE	Y
		Polynuclear Aromatic Hydrocarbons, HPLC (ConfirYat	
		Method FL-PRO - TPH (C8-C40)	N
		Prep - TPH (C8-C40) - FL-PRO	N
		AFCEE	Y
		Aromatic Volatile Organics with MTBE (Second CoYum	

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Footnotes and Data Qualifiers

The data sheets contained in this report may contain a variety of footnotes and data qualifiers. Some footnotes are used with specific tests; for example, footnotes used with the GC/FID Petroleum Hydrocarbon methods to indicate (in the analyst's judgment) the product that appears to be present. Finally, there are a number of general qualifiers that serve to identify problems and pertinent observations made during sample analysis that may not be discussed in the Overview. These are described below:

B Compound is also detected in the blank. The indicated compound was detected in the sample as well as the method blank. Please note that the B flag is not used when the sample result is ND (Not Detected).

G Reporting limit raised due to the matrix of the sample. Indicates that reporting limits were raised due to the presence of non-target compounds or other matrix interferences. The sample may or may not have been diluted. For inorganic methods, the footnote applies only to the flagged analyte. For organic methods, the footnote pertains to all analytes determined by the method.

J Result is detected below the reporting limit or is an estimated concentration. Most commonly, a "J" value indicates that the reported result for the analyte is below the stated reporting limit and is an estimated value. "J" values are applied to organic analytes detected above the MDL but below the reporting limit and for inorganic analytes detected above the IDL but below the reporting limit. Analytes which are not detected at or below the reporting limit are reported as "ND" and do not have "J" flags. Because "J" values may represent false positive concentrations, care should be used when interpreting these data. If there is uncertainty about the quantitation of an analyte such as due to metals serial dilution failure, this footnote may also indicate that a reported result is an estimated concentration, even if it is above the reporting limit.

N Spiked sample recovery not within limits. This qualifier is applied to the parent sample when MS/MSD recoveries are not within acceptable limits.

r This footnote is analyst defined. The data sheets will list "r" footnotes with consecutive numbers. The electronic data deliverable will show "r" data qualifiers. Please see datasheet for exact definition.

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AFCEE^Aromatic Volatile Organics with MTBE
Method 8020A

Client Name: Parsons Engineering Science
Client ID: SB-3 (2.00,3.50)
LAB ID: 059549-0004-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCPID-H

Sampled: 18 MAR 98
Prepared: 23 MAR 98
Dilution: 1.0

Received: 21 MAR 98
Analyzed: 23 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		0.0060	0.00060	mg/kg
Toluene	ND		0.0060	0.0014	mg/kg
Ethylbenzene	ND		0.0024	0.00060	mg/kg
Xylenes (total)	ND		0.0060	0.0018	mg/kg
Methyl-tert-butyl ether	ND		0.0060	0.0018	mg/kg

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	106	%	34 - 175
Fluorobenzene	102	%	34 - 175

Percent moisture is 16.8%. All results and limits are reported on a dry weight basis.

ND = Not Detected

Reported By: Shawn Hadley

Approved By: Audrey Cornell

A B

Quanterra
Environmental Services

AFCEE^Aromatic Volatile Organics with MBTE
Method 8020A

Client Name: Parsons Engineering Science
Client ID: SB-3 (4.00,5.50)
LAB ID: 059549-0005-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCPID-H

Sampled: 18 MAR 98
Prepared: 23 MAR 98
Dilution: 10

Received: 21 MAR 98
Analyzed: 24 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		1.2	0.12	mg/kg
Toluene	ND		1.2	0.29	mg/kg
Ethylbenzene	ND		0.48	0.12	mg/kg
Xylenes (total)	ND		1.2	0.36	mg/kg
Methyl-tert-butyl ether	ND		1.2	0.36	mg/kg

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	ND	%	34 - 175
Fluorobenzene	ND	%	34 - 175

Percent moisture is 15.9%. All results and limits are reported on a dry weight basis.

ND = Not Detected

Reported By: Shawn Hadley

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic Volatile Organics with MBTE
Method 8020A

Client Name: Parsons Engineering Science
Client ID: SB-4 (4.00,7.00)
LAB ID: 059549-0006-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCPID-H

Sampled: 18 MAR 98
Prepared: 23 MAR 98
Dilution: 100

Received: 21 MAR 98
Analyzed: 24 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		12	1.2	mg/kg
Toluene	15	d	12	2.8	mg/kg
Ethylbenzene	9.0	dB	4.7	1.2	mg/kg
Xylenes (total)	280	d	12	3.5	mg/kg
Methyl-tert-butyl ether	ND		12	3.5	mg/kg

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	ND	%	34 - 175
Fluorobenzene	ND	%	34 - 175

Percent moisture is 14.5%. All results and limits are reported on a dry weight basis.

B = Compound is also detected in the blank.
d = See Preferred Result on Other Column
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic Volatile Organics with MBTE (Second Column)
Method 8020A

Client Name: Parsons Engineering Science
Client ID: SB-4 (4.00,7.00)
LAB ID: 059549-0006-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCPID-H

Sampled: 18 MAR 98
Prepared: 23 MAR 98
Dilution: 100

Received: 21 MAR 98
Analyzed: 24 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		12	1.2	mg/kg
Toluene	5.6	JM	12	2.8	mg/kg
Ethylbenzene	6.0	JBM	4.7	1.2	mg/kg
Xylenes (total)	260	M	12	3.5	mg/kg
Methyl-tert-butyl ether	ND		12	3.5	mg/kg

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	ND	%	34 - 175
Fluorobenzene	ND	%	34 - 175

Percent moisture is 14.5%. All results and limits are reported on a dry weight basis.

B = Compound is also detected in the blank.
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic Volatile Organics with MBTE
Method 8020A

Client Name: Parsons Engineering Science
Client ID: SB-B (4.00,7.00)
LAB ID: 059549-0007-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCPID-H

Sampled: 18 MAR 98
Prepared: 23 MAR 98
Dilution: 100

Received: 21 MAR 98
Analyzed: 24 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		12	1.2	mg/kg
Toluene	16	d	12	2.8	mg/kg
Ethylbenzene	13	BM	4.6	1.2	mg/kg
Xylenes (total)	240	d	12	3.5	mg/kg
Methyl-tert-butyl ether	ND		12	3.5	mg/kg

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	ND	%	34 - 175
Fluorobenzene	ND	%	34 - 175

Percent moisture is 13.2%. All results and limits are reported on a dry weight basis.

B = Compound is also detected in the blank.
d = See Preferred Result on Other Column
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic Volatile Organics with MBTE (Second Column)
Method 8020A

Client Name: Parsons Engineering Science
Client ID: SB-B (4.00,7.00)
LAB ID: 059549-0007-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCPID-H

Sampled: 18 MAR 98
Prepared: 23 MAR 98
Dilution: 100

Received: 21 MAR 98
Analyzed: 24 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		12	1.2	mg/kg
Toluene	8.4	JM	12	2.8	mg/kg
Ethylbenzene	14	dB	4.6	1.2	mg/kg
Xylenes (total)	220	M	12	3.5	mg/kg
Methyl-tert-butyl ether	ND		12	3.5	mg/kg

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	ND	%	34 - 175
Fluorobenzene	ND	%	34 - 175

Percent moisture is 13.2%. All results and limits are reported on a dry weight basis.

B = Compound is also detected in the blank.
d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic Volatile Organics with MBTE
Method 8020A

Client Name: Parsons Engineering Science
Client ID: SB-5 (4.50,5.00)
LAB ID: 059549-0008-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCPID-H

Sampled: 18 MAR 98
Prepared: 23 MAR 98
Dilution: 200

Received: 21 MAR 98
Analyzed: 24 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		24	2.4	mg/kg
Toluene	ND	d	24	5.8	mg/kg
Ethylbenzene	ND		9.6	2.4	mg/kg
Xylenes (total)	300	d	24	7.2	mg/kg
Methyl-tert-butyl ether	ND		24	7.2	mg/kg

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	ND	%	34 - 175
Fluorobenzene	ND	%	34 - 175

Percent moisture is 16.6%. All results and limits are reported on a dry weight basis.

d = See Preferred Result on Other Column
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic Volatile Organics with MBTE (Second Column)
Method 8020A

Client Name: Parsons Engineering Science
Client ID: SB-5 (4.50,5.00)
LAB ID: 059549-0008-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCPID-H

Sampled: 18 MAR 98
Prepared: 23 MAR 98
Dilution: 200

Received: 21 MAR 98
Analyzed: 24 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		24	2.4	mg/kg
Toluene	6.3	JM	24	5.8	mg/kg
Ethylbenzene	ND		9.6	2.4	mg/kg
Xylenes (total)	290	M	24	7.2	mg/kg
Methyl-tert-butyl ether	ND		24	7.2	mg/kg

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	ND	%	34 - 175
Fluorobenzene	ND	%	34 - 175

Percent moisture is 16.6%. All results and limits are reported on a dry weight basis.

J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic Volatile Organics with MBTE
Method 8020A

Client Name: Parsons Engineering Science
Client ID: SB-4 (10.00,12.00)
LAB ID: 059549-0009-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCPID-H

Sampled: 18 MAR 98
Prepared: 23 MAR 98
Dilution: 5.0

Received: 21 MAR 98
Analyzed: 24 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		0.72	0.072	mg/kg
Toluene	ND		0.72	0.17	mg/kg
Ethylbenzene	1.5	dB	0.29	0.072	mg/kg
Xylenes (total)	0.29	Jd	0.72	0.22	mg/kg
Methyl-tert-butyl ether	ND		0.72	0.22	mg/kg

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	92	%	34 - 175
Fluorobenzene	97	%	34 - 175

Percent moisture is 30.8%. All results and limits are reported on a dry weight basis.

B = Compound is also detected in the blank.
d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic Volatile Organics with MBTE (Second Column)
Method 8020A

Client Name: Parsons Engineering Science
Client ID: SB-4 (10.00,12.00)
LAB ID: 059549-0009-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCPID-H

Sampled: 18 MAR 98
Prepared: 23 MAR 98
Dilution: 5.0

Received: 21 MAR 98
Analyzed: 24 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		0.72	0.072	mg/kg
Toluene	ND		0.72	0.17	mg/kg
Ethylbenzene	1.5	MB	0.29	0.072	mg/kg
Xylenes (total)	0.27	JM	0.72	0.22	mg/kg
Methyl-tert-butyl ether	ND		0.72	0.22	mg/kg

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	90	%	34 - 175
Fluorobenzene	97	%	34 - 175

Percent moisture is 30.8%. All results and limits are reported on a dry weight basis.

B = Compound is also detected in the blank.
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic Volatile Organics with MBTE
Method 8020A

Client Name: Parsons Engineering Science
Client ID: SB-6 (7.50,8.00)
LAB ID: 059549-0010-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCPID-H

Sampled: 18 MAR 98
Prepared: 23 MAR 98
Dilution: 10

Received: 21 MAR 98
Analyzed: 24 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		1.2	0.12	mg/kg
Toluene	ND		1.2	0.29	mg/kg
Ethylbenzene	2.2	MB	0.48	0.12	mg/kg
Xylenes (total)	ND		1.2	0.36	mg/kg
Methyl-tert-butyl ether	ND		1.2	0.36	mg/kg

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	ND	%	34 - 175
Fluorobenzene	ND	%	34 - 175

Percent moisture is 15.8%. All results and limits are reported on a dry weight basis.

B = Compound is also detected in the blank.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic Volatile Organics with MBTE (Second Column)
Method 8020A

Client Name: Parsons Engineering Science
Client ID: SB-6 (7.50,8.00)
LAB ID: 059549-0010-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCPID-H

Sampled: 18 MAR 98
Prepared: 23 MAR 98
Dilution: 10

Received: 21 MAR 98
Analyzed: 24 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		1.2	0.12	mg/kg
Toluene	ND		1.2	0.29	mg/kg
Ethylbenzene	3.7	dB	0.48	0.12	mg/kg
Xylenes (total)	ND		1.2	0.36	mg/kg
Methyl-tert-butyl ether	ND		1.2	0.36	mg/kg

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	ND	%	34 - 175
Fluorobenzene	ND	%	34 - 175

Percent moisture is 15.8%. All results and limits are reported on a dry weight basis.

B = Compound is also detected in the blank.
d = See Preferred Result on Other Column
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Audrey Cornell

Quanterra
Environmental Services

QC LOT ASSIGNMENT REPORT
Organics by Chromatography

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
059549-0004-SA	SOIL	8020-PR-LS	23 MAR 98-H	23 MAR 98-H
059549-0004-SA	SOIL	8020-PR-LS	23 MAR 98-H	23 MAR 98-H
059549-0005-SA	SOIL	8020-PR-MS	23 MAR 98-01	23 MAR 98-01
059549-0005-SA	SOIL	8020-PR-MS	23 MAR 98-01	23 MAR 98-01
059549-0006-SA	SOIL	8020-PR-MS	23 MAR 98-01	23 MAR 98-01
059549-0006-SA	SOIL	8020-PR-MS	23 MAR 98-01	23 MAR 98-01
059549-0007-SA	SOIL	8020-PR-MS	23 MAR 98-01	23 MAR 98-01
059549-0007-SA	SOIL	8020-PR-MS	23 MAR 98-01	23 MAR 98-01
059549-0008-SA	SOIL	8020-PR-MS	23 MAR 98-01	23 MAR 98-01
059549-0008-SA	SOIL	8020-PR-MS	23 MAR 98-01	23 MAR 98-01
059549-0009-SA	SOIL	8020-PR-MS	23 MAR 98-01	23 MAR 98-01
059549-0009-SA	SOIL	8020-PR-MS	23 MAR 98-01	23 MAR 98-01
059549-0010-SA	SOIL	8020-PR-MS	23 MAR 98-01	23 MAR 98-01
059549-0010-SA	SOIL	8020-PR-MS	23 MAR 98-01	23 MAR 98-01

Quanterra
Environmental Services

LABORATORY CONTROL SAMPLE REPORT
Organics by Chromatography
Project: 059549

Category: 8020-PR-LS Aromatic Volatile Organics (AFCEE-Low Level) with MTBE
Date Analyzed: 23 MAR 98
Matrix: SOIL
QC Run: 23 MAR 98-H
Concentration Units: mg/kg

Analyte	Concentration Spiked	Concentration Measured	Accuracy(%) LCS	Accuracy(%) Limits
Benzene	0.0500	0.0559	112	66-135
Toluene	0.0500	0.0517	103	60-135
Chlorobenzene	0.0500	0.0525	105	66-139
Ethylbenzene	0.0500	0.0523	105	61-139
Xylenes (total)	0.150	0.157	105	61-143
1,3-Dichlorobenzene	0.0500	0.0521	104	60-141
1,4-Dichlorobenzene	0.0500	0.0531	106	66-136
1,2-Dichlorobenzene	0.0500	0.0509	102	51-144
Methyl-tert-butyl ether	0.0500	0.0589	118	25-175

Surrogates	Concentration Spiked	Concentration Measured	Accuracy(%) LCS	Accuracy(%) Limits
a,a,a-Trifluorotoluene	0.0750	0.0783	104	34-175
Fluorobenzene	0.0750	0.0723	96	34-175

Category: 8020-PR-MS Aromatic Volatile Organics with MBTE (AFCEE-Medium Level)
Date Analyzed: 24 MAR 98
Matrix: SOIL
QC Run: 23 MAR 98-01
Concentration Units: mg/kg

Analyte	Concentration Spiked	Concentration Measured	Accuracy(%) LCS	Accuracy(%) Limits
Benzene	1.00	1.11	111	66-135
Toluene	1.00	1.06	106	60-135
Chlorobenzene	1.00	1.04	104	66-139
Ethylbenzene	1.00	1.03	103	61-139
Xylenes (total)	3.00	3.11	104	61-143
1,3-Dichlorobenzene	1.00	1.03	103	60-141
1,4-Dichlorobenzene	1.00	1.04	104	66-136
1,2-Dichlorobenzene	1.00	1.03	103	51-144
Methyl-tert-butyl ether	1.00	1.07	107	25-175

Surrogates	Concentration Spiked	Concentration Measured	Accuracy(%) LCS	Accuracy(%) Limits
a,a,a-Trifluorotoluene	1.50	1.56	104	34-175
Fluorobenzene	1.50	1.48	99	34-175

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental Services

SINGLE CONTROL SAMPLE REPORT
Organics by Chromatography

Analyte	Concentration Spiked	Measured	Accuracy(%) SCS	Limits
Category: 8020-PR-LS				
Matrix: SOIL				
QC Lot: 23 MAR 98-H QC Run: 23 MAR 98-H				
Concentration Units: mg/kg				
a,a,a-Trifluorotoluene	0.0750	0.0788	105	34-175
Fluorobenzene	0.0750	0.0728	97	34-175
Category: 8020-PR-MS				
Matrix: SOIL				
QC Lot: 23 MAR 98-01 QC Run: 23 MAR 98-01				
Concentration Units: mg/kg				
a,a,a-Trifluorotoluene	1.50	1.59	106	34-175
Fluorobenzene	1.50	1.50	100	34-175

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental Services

METHOD BLANK REPORT
Organics by Chromatography
Project: 059549

Test: 8020-PAR-MDL-L-S AFCEE Aromatic Volatile Organics with MTBE
Matrix: SOIL
QC Lot: 23 MAR 98-H QC Run: 23 MAR 98-H Date Analyzed: 23 MAR 98

Analyte	Result		Units	RL	MDL
Benzene	ND		mg/kg	0.0050	0.00050
Toluene	ND		mg/kg	0.0050	0.0012
Ethylbenzene	ND		mg/kg	0.0020	0.00050
Xylenes (total)	ND		mg/kg	0.0050	0.0015
Methyl-tert-butyl ether	ND		mg/kg	0.0050	0.0015

Test: 8020-PAR-MDL-M-S AFCEE Aromatic Volatile Organics with MBTE
Matrix: SOIL
QC Lot: 23 MAR 98-01 QC Run: 23 MAR 98-01 Date Analyzed: 24 MAR 98

Analyte	Result		Units	RL	MDL
Benzene	ND		mg/kg	0.10	0.010
Toluene	ND		mg/kg	0.10	0.024
Ethylbenzene	0.012	J	mg/kg	0.040	0.010
Xylenes (total)	ND		mg/kg	0.10	0.030
Methyl-tert-butyl ether	ND		mg/kg	0.10	0.030

Test: 8020-PAR-MDL-2-L-S AFCEE Aromatic Volatile Organics with MTBE (Second Column)
Matrix: SOIL
QC Lot: 23 MAR 98-H QC Run: 23 MAR 98-H Date Analyzed: 23 MAR 98

Analyte	Result		Units	RL	MDL
Benzene	ND		mg/kg	0.0050	0.00050
Toluene	ND		mg/kg	0.0050	0.0012
Ethylbenzene	ND		mg/kg	0.0020	0.00050
Xylenes (total)	ND		mg/kg	0.0050	0.0015
Methyl-tert-butyl ether	ND		mg/kg	0.0050	0.0015

J = Result is detected below the reporting limit or is an estimated concentration.
ND = Not Detected

Quanterra
Environmental Services

METHOD BLANK REPORT
Organics by Chromatography
Project: 059549

Test: 8020-PAR-MDL-2-M-S AFCEE Aromatic Volatile Organics with MBTE (Second Column)
Matrix: SOIL
QC Lot: 23 MAR 98-01 QC Run: 23 MAR 98-01 Date Analyzed: 24 MAR 98

Analyte	Result		Units	RL	MDL
Benzene	ND		mg/kg	0.10	0.010
Toluene	ND		mg/kg	0.10	0.024
Ethylbenzene	0.012	J	mg/kg	0.040	0.010
Xylenes (total)	ND		mg/kg	0.10	0.030
Methyl-tert-butyl ether	ND		mg/kg	0.10	0.030

J = Result is detected below the reporting limit or is an estimated concentration.
ND = Not Detected

Quanterra
Environmental Services

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC REPORT
Organics by Chromatography
Project: 059549

Category: 8020-PR-LS Aromatic Volatile Organics (AFCEE-Low Level) with MTBE
Matrix: SOIL
Sample: 059549-0004
MS Run: 23 MAR 98-H
Units mg/kg Units Qualifier: Dry weight

Analyte	Sample Result	MS Result	MSD Result	Amount Spiked MS	Amount Spiked MSD	% Recovery MS	% Recovery MSD	Recov. Accep. Limits	RPD MS-MSD	RPD Accept Limits
		Concentration								
Benzene	ND	0.0573	0.0603	0.05000	0.0500	115	121	66-135	5.1	30
Toluene	ND	0.0517	0.0537	0.05000	0.0500	103	107	60-135	3.8	30
Chlorobenzene	ND	0.0517	0.0535	0.05000	0.0500	103	107	66-139	3.4	30
Ethylbenzene	ND	0.0497	0.0500	0.05000	0.0500	99	100	61-139	0.6	30
Xylenes (total)	ND	0.148	0.145	0.150	0.150	99	96	61-143	2.3	30
1,3-Dichlorobenzene	ND	0.0465	0.0460	0.05000	0.0500	93	92	60-141	1.1	30
1,4-Dichlorobenzene	ND	0.0481	0.0479	0.05000	0.0500	96	96	66-136	0.4	30
1,2-Dichlorobenzene	ND	0.0429	0.0418	0.05000	0.0500	86	84	51-144	2.6	30
Methyl-tert-butyl ether	ND	0.0587	0.0639	0.05000	0.0500	117	128	25-175	8.5	50
Surrogates		%Recovery						Rec. Accept. Limits		
a,a,a-Trifluorotoluene	106	103	103					34-175		
Fluorobenzene	102	100	106					34-175		

Category: 8020-PR-MS Aromatic Volatile Organics with MBTE (AFCEE-Medium Level)
Matrix: SOIL
Sample: 059549-0005
MS Run: 23 MAR 98-01
Units mg/kg Units Qualifier: Dry weight

Analyte	Sample Result	MS Result	MSD Result	Amount Spiked MS	Amount Spiked MSD	% Recovery MS	% Recovery MSD	Recov. Accep. Limits	RPD MS-MSD	RPD Accept Limits
		Concentration								
Benzene	ND	ND	ND	1.19	1.19	NC	NC	66-135	NC	30
Toluene	ND	ND	ND	1.19	1.19	NC	NC	60-135	NC	30
Chlorobenzene	ND	ND	ND	1.19	1.19	NC	NC	66-139	NC	30
Ethylbenzene	ND	ND	ND	1.19	1.19	NC	NC	61-139	NC	30
Xylenes (total)	ND	ND	ND	3.57	3.57	NC	NC	61-143	NC	30
1,3-Dichlorobenzene	ND	ND	ND	1.19	1.19	NC	NC	60-141	NC	30
1,4-Dichlorobenzene	ND	ND	ND	1.19	1.19	NC	NC	66-136	NC	30
1,2-Dichlorobenzene	ND	ND	ND	1.19	1.19	NC	NC	51-144	NC	30
Methyl-tert-butyl ether	ND	ND	ND	1.19	1.19	NC	NC	25-175	NC	50

NC = Not Calculated, calculation not applicable.
ND = Not Detected

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental Services

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC REPORT
Organics by Chromatography
Project: 059549 (cont.)

Category: 8020-PR-MS Aromatic Volatile Organics with MBTE (AFCEE-Medium Level)
Matrix: SOIL
Sample: 059549-0005
MS Run: 23 MAR 98-01 (cont.)
Units mg/kg Units Qualifier: Dry weight

Analyte	Sample Result	Concentration MS Result	Concentration MSD Result	Amount Spiked MS	Amount Spiked MSD	% Recovery MS	% Recovery MSD	Recov. Accep. Limits	RPD MS-MSD	RPD Accept Limits
Surrogates		%Recovery		Rec. Accept. Limits						
a,a,a-Trifluorotoluene	ND	ND	ND					34-175		
Fluorobenzene	ND	ND	ND					34-175		

ND = Not Detected

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name: Parsons Engineering Science
Client ID: SB-3 (2.00,3.50)
LAB ID: 059549-0004-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: HPLC-Q

Sampled: 18 MAR 98
Prepared: 31 MAR 98
Dilution: 1.0

Received: 21 MAR 98
Analyzed: 17 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		0.24	0.043	mg/kg
Acenaphthylene	ND		0.24	0.059	mg/kg
Anthracene	0.24	d	0.024	0.0031	mg/kg
Benzo(a)anthracene	ND		0.024	0.0041	mg/kg
Benzo(a)pyrene	0.010	JM	0.018	0.0026	mg/kg
Benzo(b)fluoranthene	ND		0.014	0.0030	mg/kg
Benzo(g,h,i)perylene	ND		0.060	0.0036	mg/kg
Benzo(k)fluoranthene	ND		0.013	0.0042	mg/kg
Chrysene	0.087	M	0.048	0.0024	mg/kg
Dibenz(a,h)anthracene	ND		0.024	0.0041	mg/kg
Fluorene	ND		0.048	0.0077	mg/kg
Fluoranthene	ND		0.048	0.0029	mg/kg
Indeno(1,2,3-cd)pyrene	ND		0.036	0.0036	mg/kg
Naphthalene	ND		0.24	0.055	mg/kg
Phenanthrene	0.50	d	0.048	0.0066	mg/kg
Pyrene	ND		0.048	0.0031	mg/kg

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	130	%	22 - 167

Percent moisture is 16.8%. All results and limits are reported on a dry weight basis.

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Blake Besser

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC (Confirmation)
Method 8310

Client Name: Parsons Engineering Science
Client ID: SB-3 (2.00.3.50)
LAB ID: 059549-0004-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: HPLC-Q

Sampled: 18 MAR 98
Prepared: 31 MAR 98
Dilution: 1.0

Received: 21 MAR 98
Analyzed: 17 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		0.24	0.043	mg/kg
Acenaphthylene	ND		0.24	0.059	mg/kg
Anthracene	0.11	M	0.024	0.0031	mg/kg
Benzo(a)anthracene	ND		0.024	0.0041	mg/kg
Benzo(a)pyrene	0.026	d	0.018	0.0026	mg/kg
Benzo(b)fluoranthene	ND		0.014	0.0030	mg/kg
Benzo(g,h,i)perylene	ND		0.060	0.0036	mg/kg
Benzo(k)fluoranthene	ND		0.013	0.0042	mg/kg
Chrysene	0.089	d	0.048	0.0024	mg/kg
Dibenz(a,h)anthracene	ND		0.024	0.0041	mg/kg
Fluorene	ND		0.048	0.0077	mg/kg
Fluoranthene	ND		0.048	0.0029	mg/kg
Indeno(1,2,3-cd)pyrene	ND		0.036	0.0036	mg/kg
Naphthalene	ND		0.24	0.055	mg/kg
Phenanthrene	0.38	M	0.048	0.0066	mg/kg
Pyrene	ND		0.048	0.0031	mg/kg

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	140	%	22 - 167

Percent moisture is 16.8%. All results and limits are reported on a dry weight basis.

d = See Preferred Result on Other Column
M = Preferred Result
ND = Not Detected

Reported By: Blake Besser

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name: Parsons Engineering Science
Client ID: SB-3 (4.00,5.50)
LAB ID: 059549-0005-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: HPLC-Q

Sampled: 18 MAR 98
Prepared: 31 MAR 98
Dilution: 1.0

Received: 21 MAR 98
Analyzed: 17 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		0.24	0.043	mg/kg
Acenaphthylene	ND		0.24	0.058	mg/kg
Anthracene	ND		0.024	0.0031	mg/kg
Benzo(a)anthracene	ND		0.024	0.0040	mg/kg
Benzo(a)pyrene	ND		0.018	0.0026	mg/kg
Benzo(b)fluoranthene	ND		0.014	0.0030	mg/kg
Benzo(g,h,i)perylene	ND		0.059	0.0036	mg/kg
Benzo(k)fluoranthene	ND		0.013	0.0042	mg/kg
Chrysene	ND		0.048	0.0024	mg/kg
Dibenz(a,h)anthracene	ND		0.024	0.0040	mg/kg
Fluorene	ND		0.048	0.0076	mg/kg
Fluoranthene	ND		0.048	0.0029	mg/kg
Indeno(1,2,3-cd)pyrene	ND		0.036	0.0036	mg/kg
Naphthalene	ND		0.24	0.055	mg/kg
Phenanthrene	ND		0.048	0.0065	mg/kg
Pyrene	ND		0.048	0.0031	mg/kg

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	100	%	22 - 167

Percent moisture is 15.9%. All results and limits are reported on a dry weight basis.

ND = Not Detected

Reported By: Blake Besser

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name: Parsons Engineering Science
Client ID: SB-4 (4.00,7.00)
LAB ID: 059549-0006-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: HPLC-Q

Sampled: 18 MAR 98
Prepared: 31 MAR 98
Dilution: 10

Received: 21 MAR 98
Analyzed: 17 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		2.3	0.42	mg/kg
Acenaphthylene	ND		2.3	0.57	mg/kg
Anthracene	0.046	JM	0.23	0.030	mg/kg
Benzo(a)anthracene	ND		0.23	0.040	mg/kg
Benzo(a)pyrene	ND		0.18	0.026	mg/kg
Benzo(b)fluoranthene	ND		0.14	0.029	mg/kg
Benzo(g,h,i)perylene	ND		0.59	0.035	mg/kg
Benzo(k)fluoranthene	ND		0.13	0.041	mg/kg
Chrysene	ND		0.47	0.023	mg/kg
Dibenz(a,h)anthracene	ND		0.23	0.040	mg/kg
Fluorene	ND		0.47	0.075	mg/kg
Fluoranthene	ND		0.47	0.028	mg/kg
Indeno(1,2,3-cd)pyrene	ND		0.35	0.035	mg/kg
Naphthalene	33	d	2.3	0.54	mg/kg
Phenanthrene	ND		0.47	0.064	mg/kg
Pyrene	ND		0.47	0.030	mg/kg

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	ND	%	22 - 167

Percent moisture is 14.5%. All results and limits are reported on a dry weight basis.

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Blake Besser

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC (Confirmation)
Method 8310

Client Name: Parsons Engineering Science
Client ID: SB-4 (4.00,7.00)
LAB ID: 059549-0006-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: HPLC-Q

Sampled: 18 MAR 98
Prepared: 31 MAR 98
Dilution: 10

Received: 21 MAR 98
Analyzed: 17 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		2.3	0.42	mg/kg
Acenaphthylene	ND		2.3	0.57	mg/kg
Anthracene	0.073	Jd	0.23	0.030	mg/kg
Benzo(a)anthracene	ND		0.23	0.040	mg/kg
Benzo(a)pyrene	ND		0.18	0.026	mg/kg
Benzo(b)fluoranthene	ND		0.14	0.029	mg/kg
Benzo(g,h,i)perylene	ND		0.59	0.035	mg/kg
Benzo(k)fluoranthene	ND		0.13	0.041	mg/kg
Chrysene	ND		0.47	0.023	mg/kg
Dibenz(a,h)anthracene	ND		0.23	0.040	mg/kg
Fluorene	ND		0.47	0.075	mg/kg
Fluoranthene	ND		0.47	0.028	mg/kg
Indeno(1,2,3-cd)pyrene	ND		0.35	0.035	mg/kg
Naphthalene	32	M	2.3	0.54	mg/kg
Phenanthrene	ND		0.47	0.064	mg/kg
Pyrene	ND		0.47	0.030	mg/kg

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	ND	%	22 - 167

Percent moisture is 14.5%. All results and limits are reported on a dry weight basis.

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Blake Besser

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name: Parsons Engineering Science
Client ID: SB-B (4.00,7.00)
LAB ID: 059549-0007-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: HPLC-Q

Sampled: 18 MAR 98
Prepared: 31 MAR 98
Dilution: 10

Received: 21 MAR 98
Analyzed: 17 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		2.3	0.41	mg/kg
Acenaphthylene	ND		2.3	0.56	mg/kg
Anthracene	0.092	JM	0.23	0.030	mg/kg
Benzo(a)anthracene	ND		0.23	0.039	mg/kg
Benzo(a)pyrene	ND		0.17	0.025	mg/kg
Benzo(b)fluoranthene	ND		0.14	0.029	mg/kg
Benzo(g,h,i)perylene	ND		0.58	0.035	mg/kg
Benzo(k)fluoranthene	ND		0.13	0.040	mg/kg
Chrysene	ND		0.46	0.023	mg/kg
Dibenz(a,h)anthracene	ND		0.23	0.039	mg/kg
Fluorene	ND		0.46	0.074	mg/kg
Fluoranthene	ND		0.46	0.028	mg/kg
Indeno(1,2,3-cd)pyrene	ND		0.35	0.035	mg/kg
Naphthalene	48	d	2.3	0.53	mg/kg
Phenanthrene	ND		0.46	0.063	mg/kg
Pyrene	ND		0.46	0.030	mg/kg

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	ND	%	22 - 167

Percent moisture is 13.2%. All results and limits are reported on a dry weight basis.

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Blake Besser

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC (Confirmation)
Method 8310

Client Name: Parsons Engineering Science
Client ID: SB-B (4.00,7.00)
LAB ID: 059549-0007-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: HPLC-Q

Sampled: 18 MAR 98
Prepared: 31 MAR 98
Dilution: 10

Received: 21 MAR 98
Analyzed: 17 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		2.3	0.41	mg/kg
Acenaphthylene	ND		2.3	0.56	mg/kg
Anthracene	0.11	Jd	0.23	0.030	mg/kg
Benzo(a)anthracene	ND		0.23	0.039	mg/kg
Benzo(a)pyrene	ND		0.17	0.025	mg/kg
Benzo(b)fluoranthene	ND		0.14	0.029	mg/kg
Benzo(g,h,i)perylene	ND		0.58	0.035	mg/kg
Benzo(k)fluoranthene	ND		0.13	0.040	mg/kg
Chrysene	ND		0.46	0.023	mg/kg
Dibenz(a,h)anthracene	ND		0.23	0.039	mg/kg
Fluorene	ND		0.46	0.074	mg/kg
Fluoranthene	ND		0.46	0.028	mg/kg
Indeno(1,2,3-cd)pyrene	ND		0.35	0.035	mg/kg
Naphthalene	46	M	2.3	0.53	mg/kg
Phenanthrene	ND		0.46	0.063	mg/kg
Pyrene	ND		0.46	0.030	mg/kg

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	ND	%	22 - 167

Percent moisture is 13.2%. All results and limits are reported on a dry weight basis.

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Blake Besser

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name: Parsons Engineering Science
Client ID: SB-5 (4.50,5.00)
LAB ID: 059549-0008-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: HPLC-Q

Sampled: 18 MAR 98
Prepared: 31 MAR 98
Dilution: 5.0

Received: 21 MAR 98
Analyzed: 17 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		1.2	0.22	mg/kg
Acenaphthylene	ND		1.2	0.29	mg/kg
Anthracene	0.027	JM	0.12	0.016	mg/kg
Benzo(a)anthracene	ND		0.12	0.020	mg/kg
Benzo(a)pyrene	ND		0.090	0.013	mg/kg
Benzo(b)fluoranthene	ND		0.072	0.015	mg/kg
Benzo(g,h,i)perylene	ND		0.30	0.018	mg/kg
Benzo(k)fluoranthene	ND		0.066	0.021	mg/kg
Chrysene	ND		0.24	0.012	mg/kg
Dibenz(a,h)anthracene	ND		0.12	0.020	mg/kg
Fluorene	ND		0.24	0.038	mg/kg
Fluoranthene	ND		0.24	0.014	mg/kg
Indeno(1,2,3-cd)pyrene	ND		0.18	0.018	mg/kg
Naphthalene	19	d	1.2	0.28	mg/kg
Phenanthrene	ND		0.24	0.033	mg/kg
Pyrene	ND		0.24	0.016	mg/kg

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	110	%	22 - 167

Percent moisture is 16.6%. All results and limits are reported on a dry weight basis.

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Blake Besser

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC (Confirmation)
Method 8310

Client Name: Parsons Engineering Science
Client ID: SB-5 (4.50,5.00)
LAB ID: 059549-0008-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: HPLC-Q

Sampled: 18 MAR 98
Prepared: 31 MAR 98
Dilution: 5.0

Received: 21 MAR 98
Analyzed: 17 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		1.2	0.22	mg/kg
Acenaphthylene	ND		1.2	0.29	mg/kg
Anthracene	0.045	Jd	0.12	0.016	mg/kg
Benzo(a)anthracene	ND		0.12	0.020	mg/kg
Benzo(a)pyrene	ND		0.090	0.013	mg/kg
Benzo(b)fluoranthene	ND		0.072	0.015	mg/kg
Benzo(g,h,i)perylene	ND		0.30	0.018	mg/kg
Benzo(k)fluoranthene	ND		0.066	0.021	mg/kg
Chrysene	ND		0.24	0.012	mg/kg
Dibenz(a,h)anthracene	ND		0.12	0.020	mg/kg
Fluorene	ND		0.24	0.038	mg/kg
Fluoranthene	ND		0.24	0.014	mg/kg
Indeno(1,2,3-cd)pyrene	ND		0.18	0.018	mg/kg
Naphthalene	18	M	1.2	0.28	mg/kg
Phenanthrene	ND		0.24	0.033	mg/kg
Pyrene	ND		0.24	0.016	mg/kg

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	140	%	22 - 167

Percent moisture is 16.6%. All results and limits are reported on a dry weight basis.

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Blake Besser

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name: Parsons Engineering Science
Client ID: SB-4 (10.00,12.00)
LAB ID: 059549-0009-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: HPLC-Q

Sampled: 18 MAR 98
Prepared: 31 MAR 98
Dilution: 1.0

Received: 21 MAR 98
Analyzed: 17 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		0.29	0.052	mg/kg
Acenaphthylene	ND		0.29	0.071	mg/kg
Anthracene	0.0070	Jd	0.029	0.0038	mg/kg
Benzo(a)anthracene	0.15	M	0.029	0.0049	mg/kg
Benzo(a)pyrene	0.13	M	0.022	0.0032	mg/kg
Benzo(b)fluoranthene	0.14	M	0.017	0.0036	mg/kg
Benzo(g,h,i)perylene	0.060	Jd	0.072	0.0043	mg/kg
Benzo(k)fluoranthene	0.076	M	0.016	0.0051	mg/kg
Chrysene	ND		0.058	0.0029	mg/kg
Dibenz(a,h)anthracene	ND		0.029	0.0049	mg/kg
Fluorene	0.040	Jd	0.058	0.0092	mg/kg
Fluoranthene	0.052	JM	0.058	0.0035	mg/kg
Indeno(1,2,3-cd)pyrene	0.045	d	0.043	0.0043	mg/kg
Naphthalene	0.28	Jd	0.29	0.066	mg/kg
Phenanthrene	0.019	JM	0.058	0.0079	mg/kg
Pyrene	0.097	d	0.058	0.0038	mg/kg

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	100	%	22 - 167

Percent moisture is 30.8%. All results and limits are reported on a dry weight basis.

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Blake Besser

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC (Confirmation)
Method 8310

Client Name: Parsons Engineering Science
Client ID: SB-4 (10.00,12.00)
LAB ID: 059549-0009-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: HPLC-Q

Sampled: 18 MAR 98
Prepared: 31 MAR 98
Dilution: 1.0

Received: 21 MAR 98
Analyzed: 17 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		0.29	0.052	mg/kg
Acenaphthylene	ND		0.29	0.071	mg/kg
Anthracene	0.0047	JM	0.029	0.0038	mg/kg
Benzo(a)anthracene	0.23	d	0.029	0.0049	mg/kg
Benzo(a)pyrene	0.14	d	0.022	0.0032	mg/kg
Benzo(b)fluoranthene	0.20	d	0.017	0.0036	mg/kg
Benzo(g,h,i)perylene	0.049	JM	0.072	0.0043	mg/kg
Benzo(k)fluoranthene	0.084	d	0.016	0.0051	mg/kg
Chrysene	ND		0.058	0.0029	mg/kg
Dibenz(a,h)anthracene	ND		0.029	0.0049	mg/kg
Fluorene	0.024	JM	0.058	0.0092	mg/kg
Fluoranthene	0.069	Jd	0.058	0.0035	mg/kg
Indeno(1,2,3-cd)pyrene	0.034	JM	0.043	0.0043	mg/kg
Naphthalene	0.28	JM	0.29	0.066	mg/kg
Phenanthrene	0.029	Jd	0.058	0.0079	mg/kg
Pyrene	0.090	M	0.058	0.0038	mg/kg

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	140	%	22 - 167

Percent moisture is 30.8%. All results and limits are reported on a dry weight basis.

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Blake Besser

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name: Parsons Engineering Science
Client ID: SB-6 (7.50,8.00)
LAB ID: 059549-0010-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: HPLC-Q

Sampled: 18 MAR 98
Prepared: 31 MAR 98
Dilution: 1.0

Received: 21 MAR 98
Analyzed: 17 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		0.24	0.043	mg/kg
Acenaphthylene	ND		0.24	0.058	mg/kg
Anthracene	0.018	JM	0.024	0.0031	mg/kg
Benzo(a)anthracene	0.085	M	0.024	0.0040	mg/kg
Benzo(a)pyrene	0.16	d	0.018	0.0026	mg/kg
Benzo(b)fluoranthene	0.17	M	0.014	0.0030	mg/kg
Benzo(g,h,i)perylene	0.10	d	0.059	0.0036	mg/kg
Benzo(k)fluoranthene	0.064	M	0.013	0.0042	mg/kg
Chrysene	0.12	M	0.048	0.0024	mg/kg
Dibenz(a,h)anthracene	ND		0.024	0.0040	mg/kg
Fluorene	ND		0.048	0.0076	mg/kg
Fluoranthene	0.14	M	0.048	0.0029	mg/kg
Indeno(1,2,3-cd)pyrene	0.079	d	0.036	0.0036	mg/kg
Naphthalene	1.1	d	0.24	0.055	mg/kg
Phenanthrene	0.085	M	0.048	0.0065	mg/kg
Pyrene	0.19	d	0.048	0.0031	mg/kg

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	100	%	22 - 167

Percent moisture is 15.8%. All results and limits are reported on a dry weight basis.

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Blake Besser

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC (Confirmation)
Method 8310

Client Name: Parsons Engineering Science
Client ID: SB-6 (7.50,8.00)
LAB ID: 059549-0010-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: HPLC-Q

Sampled: 18 MAR 98
Prepared: 31 MAR 98
Dilution: 1.0

Received: 21 MAR 98
Analyzed: 17 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		0.24	0.043	mg/kg
Acenaphthylene	ND		0.24	0.058	mg/kg
Anthracene	0.022	Jd	0.024	0.0031	mg/kg
Benzo(a)anthracene	0.15	d	0.024	0.0040	mg/kg
Benzo(a)pyrene	0.13	M	0.018	0.0026	mg/kg
Benzo(b)fluoranthene	0.19	d	0.014	0.0030	mg/kg
Benzo(g,h,i)perylene	0.092	M	0.059	0.0036	mg/kg
Benzo(k)fluoranthene	0.066	d	0.013	0.0042	mg/kg
Chrysene	0.17	d	0.048	0.0024	mg/kg
Dibenz(a,h)anthracene	ND		0.024	0.0040	mg/kg
Fluorene	ND		0.048	0.0076	mg/kg
Fluoranthene	0.19	d	0.048	0.0029	mg/kg
Indeno(1,2,3-cd)pyrene	ND	M	0.036	0.0036	mg/kg
Naphthalene	1.1	M	0.24	0.055	mg/kg
Phenanthrene	0.14	d	0.048	0.0065	mg/kg
Pyrene	0.15	M	0.048	0.0031	mg/kg

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	110	%	22 - 167

Percent moisture is 15.8%. All results and limits are reported on a dry weight basis.

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Blake Besser

Approved By: Audrey Cornell

Quanterra
Environmental Services

QC LOT ASSIGNMENT REPORT
High Performance Liquid Chromatography

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
059549-0004-SA	SOIL	8310AF-S	31 MAR 98-01	31 MAR 98-01
059549-0004-SA	SOIL	8310AF-S	31 MAR 98-01	31 MAR 98-01
059549-0005-SA	SOIL	8310AF-S	31 MAR 98-01	31 MAR 98-01
059549-0006-SA	SOIL	8310AF-S	31 MAR 98-01	31 MAR 98-01
059549-0006-SA	SOIL	8310AF-S	31 MAR 98-01	31 MAR 98-01
059549-0007-SA	SOIL	8310AF-S	31 MAR 98-01	31 MAR 98-01
059549-0007-SA	SOIL	8310AF-S	31 MAR 98-01	31 MAR 98-01
059549-0008-SA	SOIL	8310AF-S	31 MAR 98-01	31 MAR 98-01
059549-0008-SA	SOIL	8310AF-S	31 MAR 98-01	31 MAR 98-01
059549-0009-SA	SOIL	8310AF-S	31 MAR 98-01	31 MAR 98-01
059549-0009-SA	SOIL	8310AF-S	31 MAR 98-01	31 MAR 98-01
059549-0010-SA	SOIL	8310AF-S	31 MAR 98-01	31 MAR 98-01
059549-0010-SA	SOIL	8310AF-S	31 MAR 98-01	31 MAR 98-01

Quanterra
Environmental Services

LABORATORY CONTROL SAMPLE REPORT
High Performance Liquid Chromatography
Project: 059549

Category: 8310AF-S AFCEE - Polynuclear Aromatic Hydrocarbons
Matrix: SOIL
QC Run: 31 MAR 98-01
Concentration Units: mg/kg
Date Analyzed: 17 APR 98

Analyte	Concentration Spiked	Concentration Measured	Accuracy(%) LCS	Accuracy(%) Limits
Acenaphthene	0.533	0.479	90	33-140
Acenaphthylene	0.533	0.511	96	39-135
Anthracene	0.533	0.458	86	44-135
Benzo(a)anthracene	0.533	0.475	89	29-145
Benzo(a)pyrene	0.533	0.479	90	42-135
Benzo(b)fluoranthene	0.533	0.501	94	25-147
Benzo(g,h,i)perylene	0.533	0.516	97	43-135
Benzo(k)fluoranthene	0.533	0.502	94	50-139
Chrysene	0.533	0.494	93	49-144
Dibenz(a,h)anthracene	0.533	0.502	94	41-135
Fluorene	0.533	0.491	92	43-135
Fluoranthene	0.533	0.512	96	32-135
Indeno(1,2,3-cd)pyrene	0.533	0.502	94	45-135
Naphthalene	0.533	0.514	96	33-135
Phenanthrene	0.533	0.484	91	42-139
Pyrene	0.533	0.479	90	45-135

Surrogates	Concentration Spiked	Concentration Measured	Accuracy(%) LCS	Accuracy(%) Limits
Terphenyl-d14	3.33	3.48	105	22-167

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental Services

SINGLE CONTROL SAMPLE REPORT
High Performance Liquid Chromatography

Analyte	Concentration Spiked	Measured	Accuracy(%) SCS	Limits
Category: 8310AF-S				
Matrix: SOIL				
QC Lot: 31 MAR 98-01 QC Run: 31 MAR 98-01				
Concentration Units: mg/kg				
Terphenyl-d14	3.33	3.43	103	22-167

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental Services

METHOD BLANK REPORT
High Performance Liquid Chromatography
Project: 059549

Test: 8310-AFCEE-MDL-S AFCEE Polynuclear Aromatic Hydrocarbons, HPLC
Matrix: SOIL
QC Lot: 31 MAR 98-01 QC Run: 31 MAR 98-01 Date Analyzed: 17 APR 98

Analyte	Result	Units	RL	MDL
Acenaphthene	ND	mg/kg	0.20	0.036
Acenaphthylene	ND	mg/kg	0.20	0.049
Anthracene	ND	mg/kg	0.020	0.0026
Benzo(a)anthracene	ND	mg/kg	0.020	0.0034
Benzo(a)pyrene	ND	mg/kg	0.015	0.0022
Benzo(b)fluoranthene	ND	mg/kg	0.012	0.0025
Benzo(g,h,i)perylene	ND	mg/kg	0.050	0.0030
Benzo(k)fluoranthene	ND	mg/kg	0.011	0.0035
Chrysene	ND	mg/kg	0.040	0.0020
Dibenz(a,h)anthracene	ND	mg/kg	0.020	0.0034
Fluorene	ND	mg/kg	0.040	0.0064
Fluoranthene	ND	mg/kg	0.040	0.0024
Indeno(1,2,3-cd)pyrene	ND	mg/kg	0.030	0.0030
Naphthalene	ND	mg/kg	0.20	0.046
Phenanthrene	ND	mg/kg	0.040	0.0055
Pyrene	ND	mg/kg	0.040	0.0026

Test: 8310-AFCEE-MDL-2-S AFCEE Polynuclear Aromatic Hydrocarbons, HPLC (Confirmation)
Matrix: SOIL
QC Lot: 31 MAR 98-01 QC Run: 31 MAR 98-01 Date Analyzed: 17 APR 98

Analyte	Result	Units	RL	MDL
Acenaphthene	ND	mg/kg	0.20	0.036
Acenaphthylene	ND	mg/kg	0.20	0.049
Anthracene	ND	mg/kg	0.020	0.0026
Benzo(a)anthracene	ND	mg/kg	0.020	0.0034
Benzo(a)pyrene	ND	mg/kg	0.015	0.0022
Benzo(b)fluoranthene	ND	mg/kg	0.012	0.0025
Benzo(g,h,i)perylene	ND	mg/kg	0.050	0.0030
Benzo(k)fluoranthene	ND	mg/kg	0.011	0.0035
Chrysene	ND	mg/kg	0.040	0.0020
Dibenz(a,h)anthracene	ND	mg/kg	0.020	0.0034
Fluorene	ND	mg/kg	0.040	0.0064
Fluoranthene	ND	mg/kg	0.040	0.0024
Indeno(1,2,3-cd)pyrene	ND	mg/kg	0.030	0.0030
Naphthalene	ND	mg/kg	0.20	0.046
Phenanthrene	ND	mg/kg	0.040	0.0055
Pyrene	ND	mg/kg	0.040	0.0026

ND = Not Detected

Quanterra
Environmental Services

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC REPORT
High Performance Liquid Chromatography
Project: 059549

Category: 8310AF-S AFCEE - Polynuclear Aromatic Hydrocarbons
Matrix: SOIL
Sample: 059549-0004
MS Run: 31 MAR 98-01
Units mg/kg Units Qualifier: Dry weight

Analyte	Sample Result		Concentration MS Result	Concentration MSD Result	Amount Spiked MS	Amount Spiked MSD	% Recovery MS	% Recovery MSD	Recov. Accep. Limits	RPD MS-MSD	RPD Accept Limits
Acenaphthene	ND		0.369	0.513	0.533	0.533	69	96	33-140	33	50
Acenaphthylene	ND		0.427	0.487	0.533	0.533	80	91	39-135	13	50
Anthracene	0.238	d	0.581	0.565	0.533	0.533	72	69	44-135	2.8	50
Benzo(a)anthracene	ND		0.610	0.603	0.533	0.533	114	113	29-145	1.2	50
Benzo(a)pyrene	0.0102	JM	0.534	0.524	0.533	0.533	99	97	42-135	1.9	50
Benzo(b)fluoranthene	ND		0.519	0.505	0.533	0.533	97	95	25-147	2.7	50
Benzo(g,h,i)perylene	ND		0.514	0.511	0.533	0.533	96	96	43-135	0.5	50
Benzo(k)fluoranthene	ND		0.502	0.507	0.533	0.533	94	95	50-139	0.9	50
Chrysene	0.0874	M	0.552	0.513	0.533	0.533	90	83	49-144	7.3	50
Dibenz(a,h)anthracene	ND		0.540	0.558	0.533	0.533	101	105	41-135	3.3	50
Fluorene	ND		0.584	0.555	0.533	0.533	110	104	43-135	5.1	50
Fluoranthene	ND		0.492	0.537	0.533	0.533	92	101	32-135	8.7	50
Indeno(1,2,3-cd) pyrene	ND		0.492	0.499	0.533	0.533	92	94	45-135	1.4	50
Naphthalene	ND		0.541	0.537	0.533	0.533	102	101	33-135	0.7	50
Phenanthrene	0.497	d	0.800	0.778	0.533	0.533	73	68	42-139	2.8	50
Pyrene	ND		0.554	0.662	0.533	0.533	104	124	45-135	18	50

Surrogates		%Recovery		Rec. Accept. Limits
Terphenyl-d14	134	89.4	91.2	22-167

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental Services

General Inorganics

Client Name: Parsons Engineering Science
Client ID: SB-1 (6.00,8.00)
Lab ID: 059549-0001-SA
Matrix: SOIL
Authorized: 21 MAR 98

Sampled: 18 MAR 98
Prepared: See Below

Received: 21 MAR 98
Analyzed: See Below

Parameter	Result	Qual	Dil	RL	Units	Test Method	Prepared Date	Analyzed Date
Total Organic Carbon	ND		1.0	2000	mg/kg	9060	30 MAR 98	01 APR 98
Total Organic Carbon	ND		1.0	2000	mg/kg	9060	30 MAR 98	01 APR 98
Total Organic Carbon	ND		1.0	2000	mg/kg	9060	30 MAR 98	01 APR 98
Total Organic Carbon	ND		1.0	2000	mg/kg	9060	30 MAR 98	01 APR 98

ND = Not Detected

Reported By: Patty Jungk

Approved By: Jan Ecos

Quanterra
Environmental Services

General Inorganics

Client Name: Parsons Engineering Science
Client ID: SB-1 (9.50,10.00)
Lab ID: 059549-0002-SA
Matrix: SOIL
Authorized: 21 MAR 98

Sampled: 18 MAR 98
Prepared: See Below

Received: 21 MAR 98
Analyzed: See Below

Parameter	Result	Qual	Dil	RL	Units	Test Method	Prepared Date	Analyzed Date
Total Organic Carbon	ND		1.0	2000	mg/kg	9060	30 MAR 98	01 APR 98
Total Organic Carbon	ND		1.0	2000	mg/kg	9060	30 MAR 98	01 APR 98
Total Organic Carbon	ND		1.0	2000	mg/kg	9060	30 MAR 98	01 APR 98
Total Organic Carbon	ND		1.0	2000	mg/kg	9060	30 MAR 98	01 APR 98

ND = Not Detected

Reported By: Patty Jungk

Approved By: Jan Ecos

Quanterra
Environmental Services

General Inorganics

Client Name: Parsons Engineering Science
Client ID: SB-2 (6.50,7.00)
Lab ID: 059549-0003-SA
Matrix: SOIL
Authorized: 21 MAR 98

Sampled: 18 MAR 98
Prepared: See Below

Received: 21 MAR 98
Analyzed: See Below

Parameter	Result	Qual	Dil	RL	Units	Test Method	Prepared Date	Analyzed Date
Total Organic Carbon	ND		1.0	2000	mg/kg	9060	30 MAR 98	01 APR 98
Total Organic Carbon	ND		1.0	2000	mg/kg	9060	30 MAR 98	01 APR 98
Total Organic Carbon	ND		1.0	2000	mg/kg	9060	30 MAR 98	01 APR 98
Total Organic Carbon	ND		1.0	2000	mg/kg	9060	30 MAR 98	01 APR 98

ND = Not Detected

Reported By: Patty Jungk

Approved By: Jan Ecos

Quanterra
Environmental Services

QC LOT ASSIGNMENT REPORT
Wet Chemistry Analysis and Preparation

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
059549-0001-SA	SOIL	TOC-MG-S	01 APR 98-N2	30 MAR 98-N1
059549-0001-SA	SOIL	TOC-MG-S	01 APR 98-N2	30 MAR 98-N1
059549-0001-SA	SOIL	TOC-MG-S	01 APR 98-N2	30 MAR 98-N1
059549-0001-SA	SOIL	TOC-MG-S	01 APR 98-N2	30 MAR 98-N1
059549-0001-MS	SOIL	TOC-MG-S	01 APR 98-N2	30 MAR 98-N1
059549-0001-SD	SOIL	TOC-MG-S	01 APR 98-N2	30 MAR 98-N1
059549-0002-SA	SOIL	TOC-MG-S	01 APR 98-N2	30 MAR 98-N1
059549-0002-SA	SOIL	TOC-MG-S	01 APR 98-N2	30 MAR 98-N1
059549-0002-SA	SOIL	TOC-MG-S	01 APR 98-N2	30 MAR 98-N1
059549-0002-SA	SOIL	TOC-MG-S	01 APR 98-N2	30 MAR 98-N1
059549-0003-SA	SOIL	TOC-MG-S	01 APR 98-N2	30 MAR 98-N1
059549-0003-SA	SOIL	TOC-MG-S	01 APR 98-N2	30 MAR 98-N1
059549-0003-SA	SOIL	TOC-MG-S	01 APR 98-N2	30 MAR 98-N1
059549-0003-SA	SOIL	TOC-MG-S	01 APR 98-N2	30 MAR 98-N1

Quanterra
Environmental Services

DUPLICATE CONTROL SAMPLE REPORT
Wet Chemistry Analysis and Preparation

Analyte	Concentration Spiked	Measured DCS1	Measured DCS2	AVG	Accuracy Average(%) DCS	Accuracy Limits	Precision (RPD) DCS	Precision Limits
Category: TOC-MG-S Matrix: SOIL QC Lot: 01 APR 98-N2 Concentration Units: mg/kg								
Total Organic Carbon	120000	120000	115000	117000	98	91-111	4.2	10

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental Services

METHOD BLANK REPORT
Wet Chemistry Analysis and Preparation
Project: 059549

Test: TOC-9060-MG-MDL-S Total Organic Carbon (TOC)
Matrix: SOIL
QC Lot: 01 APR 98-N2 QC Run: 30 MAR 98-N1 Date Analyzed: 01 APR 98

Analyte	Result	Units	RL	MDL
Total Organic Carbon	ND	mg/kg	2000	550

ND = Not Detected

Quanterra
Environmental Services

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC REPORT
Wet Chemistry Analysis and Preparation
Project: 059549

Category: TOC-MG-S Total Organic Carbon for soils reported in mg/kg.
(Limits for TOC-S also apply for this QC category)

Matrix: SOIL
Sample: 059549-0001
MS Run: 01 APR 98-N2
Units: mg/kg

Analyte	Sample Result	Concentration MS Result	Concentration MSD Result	Amount Spiked MS/MSD	%Recovery MS	%Recovery MSD	%RPD	Acceptance Limit Recov.	Acceptance Limit RPD
Total Organic Carbon	ND	114000	110000	120000	95	92	4.1	91-111	10

ND = Not Detected

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental Services

Method FL-PRO - TPH (C8-C40)
Method FL-PRO

Client Name: Parsons Engineering Science
Client ID: SB-3 (2.00,3.50)
LAB ID: 059549-0004-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCFID-I

Sampled: 18 MAR 98
Prepared: 01 APR 98
Dilution: 1.0

Received: 21 MAR 98
Analyzed: 03 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
TPH (C8-C40)	110		13	12	mg/kg

Surrogate	Recovery		Acceptable Range
o-Terphenyl	101	%	22 - 166
Nonatriacontane	111	%	10 - 192

Percent moisture is 16.8%. All results and limits are reported on a dry weight basis.

Reported By: Quanterra-Tampa

Approved By: Lynn S. Calvin

Quanterra
Environmental Services

Method FL-PRO - TPH (C8-C40)
Method FL-PRO

Client Name: Parsons Engineering Science
Client ID: SB-3 (4.00,5.50)
LAB ID: 059549-0005-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCFID-I

Sampled: 18 MAR 98
Prepared: 01 APR 98
Dilution: 1.0

Received: 21 MAR 98
Analyzed: 03 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
TPH (C8-C40)	400		14	13	mg/kg

Surrogate	Recovery		Acceptable Range
o-Terphenyl	103	%	22 - 166
Nonatriacontane	121	%	10 - 192

Percent moisture is 15.9%. All results and limits are reported on a dry weight basis.

Reported By: Quanterra-Tampa

Approved By: Lynn S. Calvin

Quanterra
Environmental Services

Method FL-PRO - TPH (C8-C40)
Method FL-PRO

Client Name: Parsons Engineering Science
Client ID: SB-4 (4.00,7.00)
LAB ID: 059549-0006-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCFID-I

Sampled: 18 MAR 98
Prepared: 01 APR 98
Dilution: 4.0

Received: 21 MAR 98
Analyzed: 03 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
TPH (C8-C40)	900		56	51	mg/kg

Surrogate	Recovery		Acceptable Range
o-Terphenyl	85	%	22 - 166
Nonatriacontane	82	%	10 - 192

Percent moisture is 14.5%. All results and limits are reported on a dry weight basis.

Reported By: Quanterra-Tampa

Approved By: Lynn S. Calvin

Quanterra
Environmental Services

Method FL-PRO - TPH (C8-C40)
Method FL-PRO

Client Name: Parsons Engineering Science
Client ID: SB-B (4.00,7.00)
LAB ID: 059549-0007-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCFID-I

Sampled: 18 MAR 98
Prepared: 01 APR 98
Dilution: 1.0

Received: 21 MAR 98
Analyzed: 03 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
TPH (C8-C40)	470		14	12	mg/kg

Surrogate	Recovery		Acceptable Range
o-Terphenyl	93	%	22 - 166
Nonatriacontane	98	%	10 - 192

Percent moisture is 13.2%. All results and limits are reported on a dry weight basis.

Reported By: Quanterra-Tampa

Approved By: Lynn S. Calvin

Quanterra
Environmental Services

Method FL-PRO - TPH (C8-C40)
Method FL-PRO

Client Name: Parsons Engineering Science
Client ID: SB-5 (4.50,5.00)
LAB ID: 059549-0008-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCFID-I

Sampled: 18 MAR 98
Prepared: 01 APR 98
Dilution: 4.0

Received: 21 MAR 98
Analyzed: 03 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
TPH (C8-C40)	1700		64	57	mg/kg

Surrogate	Recovery		Acceptable Range
o-Terphenyl	83	%	22 - 166
Nonatriacontane	86	%	10 - 192

Percent moisture is 16.6%. All results and limits are reported on a dry weight basis.

Reported By: Quanterra-Tampa

Approved By: Lynn S. Calvin

Quanterra
Environmental Services

Method FL-PRO - TPH (C8-C40)
Method FL-PRO

Client Name: Parsons Engineering Science
Client ID: SB-4 (10.00,12.00)
LAB ID: 059549-0009-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCFID-I

Sampled: 18 MAR 98
Prepared: 01 APR 98
Dilution: 1.0

Received: 21 MAR 98
Analyzed: 03 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
TPH (C8-C40)	17	J	20	18	mg/kg

Surrogate	Recovery		Acceptable Range
o-Terphenyl	87	%	22 - 166
Nonatriacontane	106	%	10 - 192

Percent moisture is 30.8%. All results and limits are reported on a dry weight basis.

J = Result is detected below the reporting limit or is an estimated concentration.

Reported By: Quanterra-Tampa

Approved By: Lynn S. Calvin

Quanterra
Environmental Services

Method FL-PRO - TPH (C8-C40)
Method FL-PRO

Client Name: Parsons Engineering Science
Client ID: SB-6 (7.50,8.00)
LAB ID: 059549-0010-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCFID-I

Sampled: 18 MAR 98
Prepared: 01 APR 98
Dilution: 2.0

Received: 21 MAR 98
Analyzed: 03 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
TPH (C8-C40)	390		30	27	mg/kg

Surrogate	Recovery		Acceptable Range
o-Terphenyl	94	%	22 - 166
Nonatriacontane	92	%	10 - 192

Percent moisture is 15.8%. All results and limits are reported on a dry weight basis.

Reported By: Quanterra-Tampa

Approved By: Lynn S. Calvin

Quanterra
Environmental Services

QC LOT ASSIGNMENT REPORT
Sent OUT to Subcontractors

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
059549-0004-SA	SOIL	TPHFLPROS	01 APR 98-S1	01 APR 98-S1
059549-0005-SA	SOIL	TPHFLPROS	01 APR 98-S1	01 APR 98-S1
059549-0006-SA	SOIL	TPHFLPROS	01 APR 98-S1	01 APR 98-S1
059549-0007-SA	SOIL	TPHFLPROS	01 APR 98-S1	01 APR 98-S1
059549-0008-SA	SOIL	TPHFLPROS	01 APR 98-S1	01 APR 98-S1
059549-0009-SA	SOIL	TPHFLPROS	01 APR 98-S1	01 APR 98-S1
059549-0010-SA	SOIL	TPHFLPROS	01 APR 98-S1	01 APR 98-S1

Quanterra
Environmental Services

DUPLICATE CONTROL SAMPLE REPORT
Sent OUT to Subcontractors
Project: 059549

Category: TPHFLPROS Method FL-PRO, TPH (C8-C40)
Matrix: SOIL
QC Lot: 01 APR 98-S1
Concentration Units: mg/kg

Date Analyzed: 03 APR 98

Analyte	Concentration Spiked	Measured DCS1	Qual	DCS2	Qual	AVG	Accuracy Average(%) DCS	Limits	Precision (RPD) DCS	Limit
TPH (C8-C40)	56.7	53.0		49.4		51.2	90	63-135	7.0	25

Surrogate	Concentration Spiked	Measured DCS1	Qual	DCS2	Qual	Accuracy Average(%) DCS	Limits
o-Terphenyl	3.33	3.22		2.99		93	22-166
Nonatriacontane	20.0	11.0		13.9		62	10-192

Calculations are performed before rounding to avoid round-off errors in calculated results.

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Environmental Services

SINGLE CONTROL SAMPLE REPORT
Sent OUT to Subcontractors

Analyte	Concentration Spiked	Measured	Accuracy(%) SCS	Limits
Category: TPHFLPROS				
Matrix: SOIL				
QC Lot: 01 APR 98-S1 QC Run: 01 APR 98-S1				
Concentration Units: mg/kg				
o-Terphenyl	3.33	2.92	88	22-166
Nonatriacontane	20.0	15.6	78	10-192

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental Services

METHOD BLANK REPORT
Sent OUT to Subcontractors
Project: 059549

Test: TPH-FL-PRO-OUT-S Method FL-PRO - TPH (C8-C40)
Matrix: SOIL
QC Lot: 01 APR 98-S1 QC Run: 01 APR 98-S1 Date Analyzed: 03 APR 98

Analyte	Result	Units	RL	MDL
TPH (C8-C40)	ND	mg/kg	10	9.0

ND = Not Detected

Chain of Custody Record

Quanterra

QUA-4124 0797

Client: PARSONS ES	Project Manager: BRAD LEWIS	Date: 3/20/98	Chain of Custody Number: 02281
Address: 5320 TRIANGLE PKWY	Telephone Number (Area Code)/Fax Number: (678) 969-2489 / (770) 446-4910	Lab Number: 55549	Page 1 of 1
City: NORCROSS State: GA Zip Code: 30092	Site Contact:	Lab Contact: LaRiviere	
Project Name: TYNDALL - BX SERVICE STATION	Carrier/Waybill Number:		
Contract/Purchase Order/Quote No.			

	Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix: Aqueous	Sed.	Soil	Containers & Preservatives: Unpres.	H_2SO_4	HNO_3	HCl	NaOH	ZnAc/NaOH	Analysis: TOC 9060	BTEX + MTBE	PAH 8310	TRPH - FL	Special Instructions/ Conditions of Receipt
1, MS/MSD	SB-1 (6-8')	3/18/98	1045			X	1						X				MS/MSD
2	SB-1 (9.5-10')	3/18/98	1055			X	1						X				
3	SB-2 (6.5-7')	3/18/98	1300				1						X				
4	SB-3 (2-3.5')	3/18/98	1320				2							X	X	X	
5	SB-3 (4-5.5')	3/18/98	1325				2							X	X	X	
6	SB-4 (4-7')	3/18/98	1410				2							X	X	X	
7	SB-B (4-7')	3/14/98	1430				2							X	X	X	
8	SB-5 (4.5-5')	3/14/98	1440				2							X	X	X	
9	SB-4 (10-12')	3/18/98	1510				1							X	X	X	IF NO BENZENE IN SOIL DO BTEX
10	SB-6 (7.5-8')	3/18/98	1605				2							X	X	X	

Possible Hazard Identification
☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal
☐ Return To Client ☐ Disposal By Lab ☐ Archive For _____ Months (A fee may be assessed if samples are retained longer than 3 months)

Turn Around Time Required
☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☐ Other _____

QC Requirements (Specify)

	Date	Time		Date	Time
1. Relinquished By	3/20/98	1600	1. Received By	5-21-98	0835
2. Relinquished By			2. Received By		
3. Relinquished By			3. Received By		

Comments

DISTRIBUTION: WHITE - Stays with the Sample; CANARY - Returned to Client with Report; PINK - Field Copy

Quanterra

SAMPLE CHECKLIST

Project #: 55549 Date/Time Received: 3-21-98 @ 0855

Company Name & Sampling Site: Parsons ES

*Cooler #(s): 1 2 3 ____ ____ ____ ____ ____

Temperatures: 1.3 0.7 0.3 ____ ____ ____ ____ ____

Unpacking & Labeling Check Points:

N/A	Yes	No		Initials
	☑	☐	1. Radiation checked, record if reading > 0.5 mR/hr. (_____mR/hr)	
	☑	☐	2. Cooler seals intact.	
	☑	☐	3. Chain of custody present.	
	☐	☑	4. Bottles broken and/or are leaking, comment if yes.	
			PHOTOGRAPH BROKEN BOTTLES	
	☑	☐	5. Containers labeled, comment if no.	
	☑	☐	6. pH of all samples checked and meet requirements, note exceptions.	
	☑	☐	7. Chain of custody includes "received by" and "relinquished" by signatures, dates, and times.	
	☐	☑	8. Receipt date(s) > 48 hours past the collection date(s)? If yes, notify PA/PM.	
	☑	☐	9. Chain of custody agrees with bottle count, comment if no.	
	☑	☐	10. Chain of custody agrees with labels, comment if no.	
☑	☐	☐	11. VOA samples filled completely, comment if no.	
☐	☐	☐	12. VOA bottles preserved, check for labels.	
	☐	☑	13. Did samples require preservation with sodium thiosulfate?	
☐	☐	☐	14. If yes to #12, did the samples contain residual chlorine?	
☑	☐	☐	15. Sediment present in "D," dissolved, bottles.	
	☐	☑	16. Are analyses with short holding times requested?	
☐	☑	☐	17. Is extra sample volume provided for MS, MSD or matrix duplicates?	
	☐	☑	18. Multiphase samples present? If yes, comment below.	
	☐	☑	19. Any subsampling for volatiles? If yes, list samples.	
			PHOTOGRAPH MULTIPHASE SAMPLES	
	☑	☐	20. Clear picture taken, labeled, and stapled to project folder.	
☐	☐	☐	21. Subout COC signed and sent with samples to bottle prep?	
	☐	☑	22. Was sample labeling double checked?	

Comments: Include action taken to resolve discrepancies/problems. Include a hard copy of e-mail or use extra paper if more space is needed. _____

_____

_____ Initials: _____

Quanterra
Environmental Services

Quanterra Incorporated
4955 Yarrow Street
Arvada, Colorado 80002

303 421-6611 Telephone
303 431-7171 Fax

ANALYTICAL RESULTS
FOR
PARSONS ENGINEERING SCIENCE, INC.

QUANTERRA INCORPORATED, DENVER
PROJECT NUMBER 059558

APRIL 28, 1998

Written by: Ellen La Riviere

Ellen La Riviere, Program Manager

Quanterra
Environmental Services

Table Of Contents

Standard Deliverables With Supporting Documentation

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Overview

On March 27, 1998, Quanterra Incorporated; Denver Laboratory received sixteen aqueous samples from Parsons Engineering Science, Inc.

This report presents the analytical results as well as supporting information to aid in the evaluation and interpretation of the data and is arranged in the following order:

Overview
Sample Description Information/Analytical Test Requests
Analytical Results
Quality Control Report

Aromatic Volatile Organics Data Review

Each sample was analyzed to achieve the lowest possible reporting limits within the constraints of the method. In some cases, due to interferences or analytes present at concentrations above the linear calibration range of the instrument, samples were diluted. For diluted samples, the reporting limits are adjusted relative to the dilutions required. Quanterra samples 059558-0001-SA, -0002-SA, -0008-SA, -0012-SA, -0014-SA and –0016-SA were analyzed at dilutions for Method 8020A due to the concentration of target compounds present in the samples

Polynuclear Aromatic Hydrocarbons Data Review

Samples 059558-0001-SA, -0002-SA and –0008-SA were analyzed at dilutions for Method 8310 due to the concentration of target compounds in the samples. The reporting limits have been raised accordingly. As a result of the dilutions required, the surrogates were diluted to less than detectable concentrations in these samples.

Dibenz(a,h)anthracene was recovered above the upper control limit in the laboratory control sample (LCS) associated with the Method 8310 QC lot 26 MAR 98-01. Because this would indicate a high bias to the data, and this compound was not detected in the samples, the data was not adversely affected, and no further action was required.

Methane Data Review

The RSK-175 analysis for methane was performed by Quanterra's Austin laboratory.

Due to limitations of the laboratory information management system (LIMS) the spike amount in the duplicate control samples (DCS) represent an average of the spike amounts for the individual DCS. Therefore, the results presented in the summary report differ slightly from the results in the raw data package.

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Samples 059558-0001-SA ,-0002-SA, -0006-SA, -0008-SA, -0012-SA, -0014-SA and –0016-SA were analyzed at dilutions for Methane by RSK-175 due to the concentration of the target compound in the samples. The reporting limits have been raised relative to the dilutions required.

Total Petroleum Hydrocarbons Data Review

Analysis for total petroleum hydrocarbons (TPH) by the FL-PRO method was performed by Quanterra's Tampa laboratory.

Samples 059558-0001-SA ,-0002-SA - and –0008-SA were analyzed at dilutions for TPH due to the concentration of the target compound in the samples. The reporting limits have been raised accordingly. As a result of the dilutions required the surrogates were diluted to less than detectable concentrations in sample 059558-0008-SA.

Method 504 Data Review

Analysis for 1,2-Dibromoethane (EDB) by Method 504 was performed by Quanterra's Tampa laboratory.

The 1,1,1,2-tetrachloroethane surrogate was recovered above the upper control limit in sample 059558-0004-SA. Because this would indicate a high bias to the data, and EDB was not detected in the sample, no further action was required by the laboratory.

With the above noted exception, standard analytical protocols were followed in the analysis of the samples and no problems were encountered or anomalies observed. All laboratory quality control samples analyzed in conjunction with the samples in this project were within established control limits.

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Footnotes and Data Qualifiers

The data sheets contained in this report may contain a variety of footnotes and data qualifiers. Some footnotes are used with specific tests; for example, footnotes used with the GC/FID Petroleum Hydrocarbon methods to indicate (in the analyst's judgment) the product that appears to be present. Finally, there are a number of general qualifiers that serve to identify problems and pertinent observations made during sample analysis that may not be discussed in the Overview. These are described below:

B Compound is also detected in the blank. The indicated compound was detected in the sample as well as the method blank. Please note that the B flag is not used when the sample result is ND (Not Detected).

G Reporting limit raised due to the matrix of the sample. Indicates that reporting limits were raised due to the presence of non-target compounds or other matrix interferences. The sample may or may not have been diluted. For inorganic methods, the footnote applies only to the flagged analyte. For organic methods, the footnote pertains to all analytes determined by the method.

J Result is detected below the reporting limit or is an estimated concentration. Most commonly, a "J" value indicates that the reported result for the analyte is below the stated reporting limit and is an estimated value. "J" values are applied to organic analytes detected above the MDL but below the reporting limit and for inorganic analytes detected above the IDL but below the reporting limit. Analytes which are not detected at or below the reporting limit are reported as "ND" and do not have "J" flags. Because "J" values may represent false positive concentrations, care should be used when interpreting these data. If there is uncertainty about the quantitation of an analyte such as due to metals serial dilution failure, this footnote may also indicate that a reported result is an estimated concentration, even if it is above the reporting limit.

N Spiked sample recovery not within limits. This qualifier is applied to the parent sample when MS/MSD recoveries are not within acceptable limits.

r This footnote is analyst defined. The data sheets will list "r" footnotes with consecutive numbers. The electronic data deliverable will show "r" data qualifiers. Please see datasheet for exact definition.

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LIMs Report Key

Section	Description
Cover Letter	Signature page, report narrative as applicable.
Sample Description Information	Tabulated cross-reference between the Lab ID and Client ID, including matrix, date and time sampled, and the date received for all samples in the project.
Sample Analysis Results Sheets	Lists sample results, test components, reporting limits, dates prepared and analyzed, and any data qualifiers. Pages are organized by test.
QC LOT Assignment Report	Cross-reference between lab IDs and applicable QC batches (DCS, LCS, Blank, MS/SD, DU)
Duplicate Control Sample Report	Percent recovery and RPD results, with acceptance limits, for the laboratory duplicate control samples for each test are tabulated in this report. These are measures of accuracy and precision for each test. Acceptance limits are based upon laboratory historical data.
Laboratory Control Sample Report	Percent recovery results for a single Laboratory Control Sample (if applicable) are tabulated in this report, with the applicable acceptance limits for each test.
Matrix Spike/Matrix Spike Duplicate Report	Percent recovery and RPD results for matrix-specific QC samples and acceptance limits, where applicable. This report can be used to assess matrix effects on an analysis.
Single Control Sample Report	A tabulation of the surrogate recoveries for the blank for organic analyses.
Method Blank Report	A summary of the results of the analysis of the method blank for each test.

List of Abbreviations and Terms

Abbreviation	Term	Abbreviation	Term
DCS	Dupiicate Control Sample	MSD	Matrix Spike Duplicate
DU	Sample Duplicate	QC Run	Preparation Batch
EB	Equipment Blank	QC Category	LIMs QC Category
FB	Field Blank	QC Lot	DCS Batch
FD	Field Duplicate	ND	Not Detected at or above the reporting limit expressed
IDL	Instrument Detection Limit (Metals)	QC Matrix	Matrix of the laboratory control sample(s)
LCS	Laboratory Control Sample	RL	Reporting Limit
MB	Method Blank	QC	Quality Control
MDL	Method Detection Limit	SA	Sample
MS	Matrix Spike	SD	Spike Duplicate
RPD	Relative Percent Difference	TB	Trip Blank
ppm (part-per-million)	mg/L or mg/kg (usually)	ppb (part-per-billion)	ug/L or ug/kg (usually)
QUAL	Qualifier flag	DIL	Dilution Factor

Quanterra
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SAMPLE DESCRIPTION INFORMATION
for
Parsons Engineering Science

Lab ID	Client ID	Matrix	Sampled Date	Sampled Time	Received Date
059558-0001-SA	BX-MW-20	GRND-H2O	22 MAR 98	07:00	23 MAR 98
059558-0002-SA	BX-MP-2	GRND-H2O	22 MAR 98	07:30	23 MAR 98
059558-0003-SA	FT-16, MP-1	GRND-H2O	21 MAR 98	09:00	23 MAR 98
059558-0004-SA	FT-16, MP-2	GRND-H2O	21 MAR 98	10:00	23 MAR 98
059558-0005-SA	FT-16, SB-2	GRND-H2O	21 MAR 98	11:15	23 MAR 98
059558-0006-SA	FT-16, MP-3	GRND-H2O	21 MAR 98	12:15	23 MAR 98
059558-0007-SA	FT-16, MP-3	GRND-H2O	22 MAR 98	07:00	23 MAR 98
059558-0008-SA	BX-MW-03	GRND-H2O	22 MAR 98	13:15	23 MAR 98
059558-0009-SA	BX-MW-03-97	GRND-H2O	22 MAR 98	16:30	23 MAR 98
059558-0010-SA	BX-MW-05-97	GRND-H2O	22 MAR 98	10:00	23 MAR 98
059558-0010-MS	BX-MW-05-97	GRND-H2O	22 MAR 98	10:00	23 MAR 98
059558-0010-SD	BX-MW-05-97	GRND-H2O	22 MAR 98	10:00	23 MAR 98
059558-0011-SA	MW-01	GRND-H2O	22 MAR 98	11:30	23 MAR 98
059558-0011-MS	MW-01	GRND-H2O	22 MAR 98	11:30	23 MAR 98
059558-0011-SD	MW-01	GRND-H2O	22 MAR 98	11:30	23 MAR 98
059558-0012-SA	BX-MW-05	GRND-H2O	22 MAR 98	08:45	23 MAR 98
059558-0013-SA	BX-MW-08-97	GRND-H2O	22 MAR 98	14:30	23 MAR 98
059558-0014-SA	BX-MW-07	GRND-H2O	22 MAR 98	15:30	23 MAR 98
059558-0015-SA	MP-3	GRND-H2O	22 MAR 98	17:30	23 MAR 98
059558-0016-SA	MP-1	GRND-H2O	22 MAR 98	18:30	23 MAR 98

Quanterra
Environmental Services

ANALYTICAL TEST REQUESTS
for
Parsons Engineering Science

Lab ID: 059558	Group Code	Analysis Description	Custom Test?
0001 - 0002, 0008	A	Method EPA-9 RSK-175 by GC/FID	Y
		AFCEE	N
		Nitrate, Ion Chromatography	N
		Prep - Total Metals, Furnace AA	N
		AFCEE	N
		Lead, Furnace AA (Totals)	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
		GC Prep For Waters	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
		Method FL-PRO - TPH (C8-C40)	N
		Prep - TPH (C8-C40)	N
		AFCEE	N
		Polynuclear Aromatic Hydrocarbons, HPLC	N
		AFCEE	N
		Prep - Polynuclear Aromatic Hydrocarbons - HPLC	N
		AFCEE	N
		Polynuclear Aromatic Hydrocarbons, HPLC	N
0011 - 0014, 0016	B	Method EPA-9 RSK-175 by GC/FID	Y
		AFCEE	N
		Nitrate, Ion Chromatography	N
		GC Prep For Waters	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
0005 , 0015	C	GC Prep For Waters	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
0003 - 0004	D	Prep - Total Metals, Furnace AA	N
		AFCEE	N
		Lead, Furnace AA (Totals)	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
		GC Prep For Waters	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y

Quanterra
Environmental Services

ANALYTICAL TEST REQUESTS
for
Parsons Engineering Science

Lab ID: 059558	Group Code	Analysis Description	Custom Test?
		Method FL-PRO - TPH (C8-C40)	N
		Prep - TPH (C8-C40)	N
		AFCEE	N
		Polynuclear Aromatic Hydrocarbons, HPLC	N
		AFCEE	N
		Prep - Polynuclear Aromatic Hydrocarbons - HPLC	N
		AFCEE	N
		Polynuclear Aromatic Hydrocarbons, HPLC	N
		Method 504 - EDB	N
		Prep-1,2-Dibromoethane (EDB)	N
0006	E	Method EPA-9 RSK-175 by GC/FID	Y
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
		GC Prep For Waters	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
0007	F	AFCEE	N
		Nitrate, Ion Chromatography	N
0009 - 0010	G	Prep - Total Metals, Furnace AA	N
		AFCEE	N
		Lead, Furnace AA (Totals)	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
		GC Prep For Waters	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
		Method FL-PRO - TPH (C8-C40)	N
		Prep - TPH (C8-C40)	N
		AFCEE	N
		Polynuclear Aromatic Hydrocarbons, HPLC	N
		AFCEE	N
		Prep - Polynuclear Aromatic Hydrocarbons - HPLC	N
		AFCEE	N
		Polynuclear Aromatic Hydrocarbons, HPLC	N

Quanterra
Environmental Services

AFCEE^Aromatic VOAs by Method 8020A with MTBE & TMBs
Method 8020A

Client Name: Parsons Engineering Science
Client ID: BX-MW-20 (0.00,0.00)
LAB ID: 059558-0001-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 24 MAR 98 Analyzed: 26 MAR 98
Instrument: GCPID-H Dilution: 200

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	3100	M	400	11	ug/L
Toluene	4500	M	400	30	ug/L
Ethylbenzene	1300	d	400	11	ug/L
Xylenes (total)	6800	M	400	30	ug/L
tert-Butyl methyl ether	ND		1000	2.0	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	100	%	44 - 165
Fluorobenzene	90	%	44 - 165

d = See Preferred Result on Other Column
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic VOAs by Method 8020A (Second Column)
Method 8020A

Client Name: Parsons Engineering Science
Client ID: BX-MW-20 (0.00,0.00)
LAB ID: 059558-0001-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: N/A Analyzed: 26 MAR 98
Instrument: GCPID-H Dilution: 200

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	3200	d	400	11	ug/L
Toluene	4500	d	400	30	ug/L
Ethylbenzene	1300	M	400	11	ug/L
Xylenes (total)	6800	d	400	30	ug/L
tert-Butyl methyl ether	ND		1000	2.0	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	103	%	44 - 165
Fluorobenzene	91	%	44 - 165

d = See Preferred Result on Other Column
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic VOAs by Method 8020A with MTBE & TMBs
Method 8020A

Client Name: Parsons Engineering Science
Client ID: BX-MP-2 (0.00,0.00)
LAB ID: 059558-0002-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 24 MAR 98 Analyzed: 25 MAR 98
Instrument: GCPID-H Dilution: 200

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	3400	M	400	11	ug/L
Toluene	4800	M	400	30	ug/L
Ethylbenzene	1400	d	400	11	ug/L
Xylenes (total)	7200	M	400	30	ug/L
tert-Butyl methyl ether	ND		1000	2.0	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	98	%	44 - 165
Fluorobenzene	96	%	44 - 165

d = See Preferred Result on Other Column
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic VOAs by Method 8020A (Second Column)
Method 8020A

Client Name: Parsons Engineering Science
Client ID: BX-MP-2 (0.00,0.00)
LAB ID: 059558-0002-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 24 MAR 98 Analyzed: 25 MAR 98
Instrument: GCPID-H Dilution: 200

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	3400	d	400	11	ug/L
Toluene	4900	d	400	30	ug/L
Ethylbenzene	1400	M	400	11	ug/L
Xylenes (total)	7200	d	400	30	ug/L
tert-Butyl methyl ether	ND		1000	2.0	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	103	%	44 - 165
Fluorobenzene	97	%	44 - 165

d = See Preferred Result on Other Column
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic VOAs by Method 8020A with MTBE & TMBs
Method 8020A

Client Name: Parsons Engineering Science
Client ID: FT-16, MP-1 (0.00,0.00)
LAB ID: 059558-0003-SA
Matrix: GRND-H2O Sampled: 21 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 24 MAR 98 Analyzed: 25 MAR 98
Instrument: GCPID-H Dilution: 1.0

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		2.0	0.056	ug/L
Toluene	ND		2.0	0.15	ug/L
Ethylbenzene	ND		2.0	0.054	ug/L
Xylenes (total)	ND		2.0	0.15	ug/L
tert-Butyl methyl ether	ND		5.0	0.010	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	101	%	44 - 165
Fluorobenzene	95	%	44 - 165

ND = Not Detected

Reported By: Shawn Hadley

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic VOAs by Method 8020A with MTBE & TMBs
Method 8020A

Client Name: Parsons Engineering Science
Client ID: FT-16, MP-2 (0.00,0.00)
LAB ID: 059558-0004-SA
Matrix: GRND-H2O Sampled: 21 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 24 MAR 98 Analyzed: 25 MAR 98
Instrument: GCPID-H Dilution: 1.0

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		2.0	0.056	ug/L
Toluene	ND		2.0	0.15	ug/L
Ethylbenzene	ND		2.0	0.054	ug/L
Xylenes (total)	ND		2.0	0.15	ug/L
tert-Butyl methyl ether	ND		5.0	0.010	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	102	%	44 - 165
Fluorobenzene	96	%	44 - 165

ND = Not Detected

Reported By: Shawn Hadley Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic VOAs by Method 8020A with MTBE & TMBs
Method 8020A

Client Name: Parsons Engineering Science
Client ID: FT-16, SB-2 (0.00,0.00)
LAB ID: 059558-0005-SA
Matrix: GRND-H2O Sampled: 21 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 24 MAR 98 Analyzed: 25 MAR 98
Instrument: GCPID-H Dilution: 1.0

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		2.0	0.055	ug/L
Toluene	0.14	JM	2.0	0.065	ug/L
Ethylbenzene	8.2	d	2.0	0.053	ug/L
Xylenes (total)	40	d	2.0	0.32	ug/L
tert-Butyl methyl ether	ND		5.0	0.061	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	104	%	44 - 165
Fluorobenzene	107	%	44 - 165

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic VOAs by Method 8020A (Second Column)
Method 8020A

Client Name: Parsons Engineering Science
Client ID: FT-16, SB-2 (0.00,0.00)
LAB ID: 059558-0005-SA
Matrix: GRND-H2O Sampled: 21 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 24 MAR 98 Analyzed: 25 MAR 98
Instrument: GCPID-H Dilution: 1.0

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		2.0	0.056	ug/L
Toluene	0.19	Jd	2.0	0.15	ug/L
Ethylbenzene	8.1	M	2.0	0.054	ug/L
Xylenes (total)	39	M	2.0	0.15	ug/L
tert-Butyl methyl ether	ND		5.0	0.010	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	121	%	44 - 165
Fluorobenzene	100	%	44 - 165

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic VOAs by Method 8020A with MTBE & TMBs
Method 8020A

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, MP-3	(0.00,0.00)	
LAB ID:	059558-0006-SA		
Matrix:	GRND-H2O	Sampled: 21 MAR 98	Received: 23 MAR 98
Authorized:	24 MAR 98	Prepared: 24 MAR 98	Analyzed: 25 MAR 98
Instrument:	GCPID-H	Dilution: 1.0	

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		2.0	0.056	ug/L
Toluene	ND		2.0	0.15	ug/L
Ethylbenzene	1.0	JM	2.0	0.054	ug/L
Xylenes (total)	0.78	Jd	2.0	0.15	ug/L
tert-Butyl methyl ether	ND		5.0	0.010	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	97	%	44 - 165
Fluorobenzene	93	%	44 - 165

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic VOAs by Method 8020A (Second Column)
Method 8020A

Client Name: Parsons Engineering Science
Client ID: FT-16, MP-3 (0.00,0.00)
LAB ID: 059558-0006-SA
Matrix: GRND-H2O Sampled: 21 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 24 MAR 98 Analyzed: 25 MAR 98
Instrument: GCPID-H Dilution: 1.0

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		2.0	0.056	ug/L
Toluene	ND		2.0	0.15	ug/L
Ethylbenzene	1.1	Jd	2.0	0.054	ug/L
Xylenes (total)	0.67	JM	2.0	0.15	ug/L
tert-Butyl methyl ether	ND		5.0	0.010	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	97	%	44 - 165
Fluorobenzene	93	%	44 - 165

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic VOAs by Method 8020A with MTBE & TMBs
Method 8020A

Client Name: Parsons Engineering Science
Client ID: BX-MW-03 (0.00,0.00)
LAB ID: 059558-0008-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 24 MAR 98 Analyzed: 25 MAR 98
Instrument: GCPID-H Dilution: 50

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	70	Jd	100	2.8	ug/L
Toluene	1700	M	100	7.5	ug/L
Ethylbenzene	620	d	100	2.7	ug/L
Xylenes (total)	6900	M	100	7.5	ug/L
tert-Butyl methyl ether	ND		250	0.50	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	96	%	44 - 165
Fluorobenzene	89	%	44 - 165

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic VOAs by Method 8020A (Second Column)
Method 8020A

Client Name: Parsons Engineering Science
Client ID: BX-MW-03 (0.00,0.00)
LAB ID: 059558-0008-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 24 MAR 98 Analyzed: 25 MAR 98
Instrument: GCPID-H Dilution: 50

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	67	JM	100	2.8	ug/L
Toluene	1800	d	100	7.5	ug/L
Ethylbenzene	610	M	100	2.7	ug/L
Xylenes (total)	7000	d	100	7.5	ug/L
tert-Butyl methyl ether	ND		250	0.50	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	98	%	44 - 165
Fluorobenzene	91	%	44 - 165

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic VOAs by Method 8020A with MTBE & TMBs
Method 8020A

Client Name: Parsons Engineering Science
Client ID: BX-MW-03-97 (0.00,0.00)
LAB ID: 059558-0009-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 24 MAR 98 Analyzed: 25 MAR 98
Instrument: GCPID-H Dilution: 1.0

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		2.0	0.056	ug/L
Toluene	ND		2.0	0.15	ug/L
Ethylbenzene	ND		2.0	0.054	ug/L
Xylenes (total)	ND		2.0	0.15	ug/L
tert-Butyl methyl ether	ND		5.0	0.010	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	101	%	44 - 165
Fluorobenzene	94	%	44 - 165

ND = Not Detected

Reported By: Shawn Hadley

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic VOAs by Method 8020A with MTBE & TMBs
Method 8020A

Client Name:	Parsons Engineering Science		
Client ID:	BX-MW-05-97	(0.00,0.00)	
LAB ID:	059558-0010-SA		
Matrix:	GRND-H2O	Sampled: 22 MAR 98	Received: 23 MAR 98
Authorized:	24 MAR 98	Prepared: 24 MAR 98	Analyzed: 26 MAR 98
Instrument:	GCPID-H	Dilution: 1.0	

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		2.0	0.056	ug/L
Toluene	ND		2.0	0.15	ug/L
Ethylbenzene	ND		2.0	0.054	ug/L
Xylenes (total)	ND		2.0	0.15	ug/L
tert-Butyl methyl ether	ND		5.0	0.010	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	100	%	44 - 165
Fluorobenzene	94	%	44 - 165

ND = Not Detected

Reported By: Shawn Hadley

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic VOAs by Method 8020A with MTBE & TMBs
Method 8020A

Client Name: Parsons Engineering Science
Client ID: Mw-01 (0.00,0.00)
LAB ID: 059558-0011-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 24 MAR 98 Analyzed: 26 MAR 98
Instrument: GCPID-H Dilution: 1.0

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		2.0	0.055	ug/L
Toluene	ND		2.0	0.065	ug/L
Ethylbenzene	ND		2.0	0.053	ug/L
Xylenes (total)	ND		2.0	0.32	ug/L
tert-Butyl methyl ether	ND		5.0	0.061	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	99	%	44 - 165
Fluorobenzene	94	%	44 - 165

ND = Not Detected

Reported By: Shawn Hadley

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic VOAs by Method 8020A with MTBE & TMBs
Method 8020A

Client Name: Parsons Engineering Science
Client ID: BX-MW-05 (0.00,0.00)
LAB ID: 059558-0012-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 24 MAR 98 Analyzed: 26 MAR 98
Instrument: GCPID-H Dilution: 50

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	360	M	100	2.8	ug/L
Toluene	8.2	Jd	100	3.2	ug/L
Ethylbenzene	900	d	100	2.6	ug/L
Xylenes (total)	54	JM	100	16	ug/L
tert-Butyl methyl ether	ND		250	3.0	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	100	%	44 - 165
Fluorobenzene	100	%	44 - 165

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic VOAs by Method 8020A (Second Column)
Method 8020A

Client Name: Parsons Engineering Science
Client ID: BX-MW-05 (0.00,0.00)
LAB ID: 059558-0012-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 24 MAR 98 Analyzed: 26 MAR 98
Instrument: GCPID-H Dilution: 50

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	360	d	100	2.8	ug/L
Toluene	4.3	JM	100	7.5	ug/L
Ethylbenzene	890	M	100	2.7	ug/L
Xylenes (total)	55	Jd	100	7.5	ug/L
tert-Butyl methyl ether	ND		250	0.50	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	113	%	44 - 165
Fluorobenzene	97	%	44 - 165

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic VOAs by Method 8020A with MTBE & TMBs
Method 8020A

Client Name: Parsons Engineering Science
Client ID: BX-MW-08-97 (0.00,0.00)
LAB ID: 059558-0013-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 24 MAR 98 Analyzed: 25 MAR 98
Instrument: GCPID-H Dilution: 1.0

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		2.0	0.055	ug/L
Toluene	ND		2.0	0.065	ug/L
Ethylbenzene	ND		2.0	0.053	ug/L
Xylenes (total)	ND		2.0	0.32	ug/L
tert-Butyl methyl ether	ND		5.0	0.061	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	101	%	44 - 165
Fluorobenzene	93	%	44 - 165

ND = Not Detected

Reported By: Shawn Hadley Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic VOAs by Method 8020A with MTBE & TMBs
Method 8020A

Client Name: Parsons Engineering Science
Client ID: BX-MW-07 (0.00,0.00)
LAB ID: 059558-0014-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 24 MAR 98 Analyzed: 26 MAR 98
Instrument: GCPID-H Dilution: 25

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	11	JM	50	1.4	ug/L
Toluene	41	Jd	50	1.6	ug/L
Ethylbenzene	79	d	50	1.3	ug/L
Xylenes (total)	620	M	50	8.0	ug/L
tert-Butyl methyl ether	ND		120	1.5	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	101	%	44 - 165
Fluorobenzene	102	%	44 - 165

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic VOAs by Method 8020A (Second Column)
Method 8020A

Client Name: Parsons Engineering Science
Client ID: BX-MW-07 (0.00,0.00)
LAB ID: 059558-0014-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 24 MAR 98 Analyzed: 26 MAR 98
Instrument: GCPID-H Dilution: 25

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	15	Jd	50	1.4	ug/L
Toluene	38	JM	50	3.8	ug/L
Ethylbenzene	76	M	50	1.4	ug/L
Xylenes (total)	620	d	50	3.8	ug/L
tert-Butyl methyl ether	ND		120	0.25	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	108	%	44 - 165
Fluorobenzene	106	%	44 - 165

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic VOAs by Method 8020A with MTBE & TMBs
Method 8020A

Client Name: Parsons Engineering Science
Client ID: MP-3 (0.00,0.00)
LAB ID: 059558-0015-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 24 MAR 98 Analyzed: 26 MAR 98
Instrument: GCPID-H Dilution: 1.0

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		2.0	0.055	ug/L
Toluene	ND		2.0	0.065	ug/L
Ethylbenzene	0.069	JM	2.0	0.053	ug/L
Xylenes (total)	0.42	Jd	2.0	0.32	ug/L
tert-Butyl methyl ether	ND		5.0	0.061	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	99	%	44 - 165
Fluorobenzene	94	%	44 - 165

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic VOAs by Method 8020A (Second Column)
Method 8020A

Client Name: Parsons Engineering Science
Client ID: MP-3 (0.00,0.00)
LAB ID: 059558-0015-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 24 MAR 98 Analyzed: 26 MAR 98
Instrument: GCPID-H Dilution: 1.0

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		2.0	0.056	ug/L
Toluene	ND		2.0	0.15	ug/L
Ethylbenzene	0.15	Jd	2.0	0.054	ug/L
Xylenes (total)	0.42	JM	2.0	0.15	ug/L
tert-Butyl methyl ether	ND		5.0	0.010	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	99	%	44 - 165
Fluorobenzene	96	%	44 - 165

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic VOAs by Method 8020A with MTBE & TMBs
Method 8020A

Client Name: Parsons Engineering Science
Client ID: MP-1 (0.00,0.00)
LAB ID: 059558-0016-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 24 MAR 98 Analyzed: 26 MAR 98
Instrument: GCPID-H Dilution: 50

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	32	Jd	100	2.8	ug/L
Toluene	1400	d	100	3.2	ug/L
Ethylbenzene	730	d	100	2.6	ug/L
Xylenes (total)	6800	d	100	16	ug/L
tert-Butyl methyl ether	ND		250	3.0	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	99	%	44 - 165
Fluorobenzene	98	%	44 - 165

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
ND = Not Detected

Reported By: Shawn Hadley Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE^Aromatic VOAs by Method 8020A (Second Column)
Method 8020A

Client Name: Parsons Engineering Science
Client ID: MP-1 (0.00,0.00)
LAB ID: 059558-0016-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 24 MAR 98 Analyzed: 26 MAR 98
Instrument: GCPID-H Dilution: 50

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	32	JM	100	2.8	ug/L
Toluene	1400	M	100	7.5	ug/L
Ethylbenzene	710	M	100	2.7	ug/L
Xylenes (total)	6700	M	100	7.5	ug/L
tert-Butyl methyl ether	ND		250	0.50	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	101	%	44 - 165
Fluorobenzene	100	%	44 - 165

J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley Approved By: Audrey Cornell

Quanterra
Environmental Services

QC LOT ASSIGNMENT REPORT
Organics by Chromatography

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
059558-0001-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H2	25 MAR 98-H2
059558-0001-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H2	25 MAR 98-H2
059558-0002-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H	25 MAR 98-H
059558-0002-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H	25 MAR 98-H
059558-0003-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H	25 MAR 98-H
059558-0004-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H	25 MAR 98-H
059558-0005-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H	25 MAR 98-H
059558-0005-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H	25 MAR 98-H
059558-0006-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H	25 MAR 98-H
059558-0006-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H	25 MAR 98-H
059558-0008-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H	25 MAR 98-H
059558-0008-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H	25 MAR 98-H
059558-0009-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H	25 MAR 98-H
059558-0010-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H2	25 MAR 98-H2
059558-0010-MS	AQUEOUS	8020-PAR-A	25 MAR 98-H2	25 MAR 98-H2
059558-0010-SD	AQUEOUS	8020-PAR-A	25 MAR 98-H2	25 MAR 98-H2
059558-0011-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H2	25 MAR 98-H2
059558-0011-MS	AQUEOUS	8020-PAR-A	25 MAR 98-H2	25 MAR 98-H2
059558-0011-SD	AQUEOUS	8020-PAR-A	25 MAR 98-H2	25 MAR 98-H2
059558-0012-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H2	25 MAR 98-H2
059558-0012-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H2	25 MAR 98-H2
059558-0013-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H	25 MAR 98-H
059558-0014-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H2	25 MAR 98-H2
059558-0014-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H2	25 MAR 98-H2
059558-0015-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H2	25 MAR 98-H2
059558-0015-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H2	25 MAR 98-H2
059558-0016-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H2	25 MAR 98-H2
059558-0016-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H2	25 MAR 98-H2

Quanterra
Environmental Services

LABORATORY CONTROL SAMPLE REPORT
Organics by Chromatography
Project: 059558

Category: 8020-PAR-A Method 8020A - AFCEE Aromatic Volatile Organics with MTBE
Matrix: AQUEOUS
Date Analyzed: 26 MAR 98
QC Run: 25 MAR 98-H2
Concentration Units: ug/L

Analyte	Concentration Spiked	Concentration Measured	Accuracy(%) LCS	Accuracy(%) Limits
Benzene	20.0	22.5	112	75-125
Toluene	20.0	21.7	108	70-125
Chlorobenzene	20.0	21.6	108	75-129
Ethylbenzene	20.0	21.4	107	71-129
Xylenes (total)	60.0	65.0	108	71-133
1,3-Dichlorobenzene	20.0	21.6	108	70-131
1,2-Dichlorobenzene	20.0	21.6	108	61-134
1,4-Dichlorobenzene	20.0	22.1	110	75-126
tert-Butyl methyl ether	20.0	24.6	123	65-138
Surrogates				
a,a,a-Trifluorotoluene	30.0	30.3	101	44-165
Fluorobenzene	30.0	28.6	95	44-165

Category: 8020-PAR-A Method 8020A - AFCEE Aromatic Volatile Organics with MTBE
Matrix: AQUEOUS
Date Analyzed: 25 MAR 98
QC Run: 25 MAR 98-H
Concentration Units: ug/L

Analyte	Concentration Spiked	Concentration Measured	Accuracy(%) LCS	Accuracy(%) Limits
Benzene	20.0	21.2	106	75-125
Toluene	20.0	20.6	103	70-125
Chlorobenzene	20.0	20.4	102	75-129
Ethylbenzene	20.0	20.3	102	71-129
Xylenes (total)	60.0	61.7	103	71-133
1,3-Dichlorobenzene	20.0	20.7	104	70-131
1,2-Dichlorobenzene	20.0	20.7	104	61-134
1,4-Dichlorobenzene	20.0	20.9	104	75-126
tert-Butyl methyl ether	20.0	22.3	112	65-138
Surrogates				
a,a,a-Trifluorotoluene	30.0	29.8	99	44-165
Fluorobenzene	30.0	28.2	94	44-165

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental Services

SINGLE CONTROL SAMPLE REPORT
Organics by Chromatography

Analyte	Concentration Spiked	Measured	Accuracy(%) SCS	Limits
Category: 8020-PAR-A				
Matrix: AQUEOUS				
QC Lot: 25 MAR 98-H2 QC Run: 25 MAR 98-H2				
Concentration Units: ug/L				
a,a,a-Trifluorotoluene	30.0	30.0	100	44-165
Fluorobenzene	30.0	27.4	91	44-165
Category: 8020-PAR-A				
Matrix: AQUEOUS				
QC Lot: 25 MAR 98-H QC Run: 25 MAR 98-H				
Concentration Units: ug/L				
a,a,a-Trifluorotoluene	30.0	29.8	99	44-165
Fluorobenzene	30.0	27.9	93	44-165

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental Services

METHOD BLANK REPORT
Organics by Chromatography
Project: 059558

Test: 8020-PAR-MDL-AP AFCEE Aromatic VOAs by Method 8020A with MTBE & TMBs
Matrix: AQUEOUS
QC Lot: 25 MAR 98-H2 QC Run: 25 MAR 98-H2 Date Analyzed: 26 MAR 98

Analyte	Result	Units	RL	MDL
Benzene	ND	ug/L	2.0	0.056
Toluene	ND	ug/L	2.0	0.15
Ethylbenzene	ND	ug/L	2.0	0.054
Xylenes (total)	ND	ug/L	2.0	0.15
tert-Butyl methyl ether	ND	ug/L	5.0	0.010

QC Lot: 25 MAR 98-H QC Run: 25 MAR 98-H Date Analyzed: 25 MAR 98

Analyte	Result	Units	RL	MDL
Benzene	ND	ug/L	2.0	0.056
Toluene	ND	ug/L	2.0	0.15
Ethylbenzene	ND	ug/L	2.0	0.054
Xylenes (total)	ND	ug/L	2.0	0.15
tert-Butyl methyl ether	ND	ug/L	5.0	0.010

Test: 8020-PAR-MDL-2-AP AFCEE Aromatic VOAs by Method 8020A with MTBE & TMBs
Matrix: AQUEOUS
QC Lot: 25 MAR 98-H2 QC Run: 25 MAR 98-H2 Date Analyzed: 26 MAR 98

Analyte	Result	Units	RL	MDL
Benzene	ND	ug/L	2.0	0.056
Toluene	ND	ug/L	2.0	0.15
Ethylbenzene	ND	ug/L	2.0	0.054
Xylenes (total)	ND	ug/L	2.0	0.15
tert-Butyl methyl ether	ND	ug/L	5.0	0.010

QC Lot: 25 MAR 98-H QC Run: 25 MAR 98-H Date Analyzed: 25 MAR 98

Analyte	Result	Units	RL	MDL
Benzene	ND	ug/L	2.0	0.056
Toluene	ND	ug/L	2.0	0.15
Ethylbenzene	ND	ug/L	2.0	0.054
Xylenes (total)	ND	ug/L	2.0	0.15
tert-Butyl methyl ether	ND	ug/L	5.0	0.010

ND = Not Detected

Quanterra
Environmental Services

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC REPORT
Organics by Chromatography
Project: 059558

Category: 8020-PAR-A Method 8020A - AFCEE Aromatic Volatile Organics with MTBE
Matrix: AQUEOUS
Sample: 059558-0011
MS Run: 25 MAR 98-H3
Units: ug/L

Analyte	Concentration Sample Result	MS Result	MSD Result	Amount Spiked MS	Amount Spiked MSD	% Recovery MS	% Recovery MSD	Recov. Accep. Limits	RPD MS-MSD	RPD Accept Limits
Benzene	ND	22.5	22.7	20.0	20.0	112	114	75-125	0.8	20
Toluene	ND	21.7	22.0	20.0	20.0	108	110	70-125	1.4	20
Chlorobenzene	ND	21.4	21.7	20.0	20.0	107	108	75-129	1.4	20
Ethylbenzene	ND	21.3	21.5	20.0	20.0	106	108	71-129	0.9	20
Xylenes (total)	ND	64.6	65.2	60.0	60.0	108	109	71-133	0.9	20
1,3-Dichlorobenzene	ND	21.4	21.8	20.0	20.0	107	109	70-131	1.9	20
1,2-Dichlorobenzene	ND	21.5	21.8	20.0	20.0	108	109	61-134	1.4	20
1,4-Dichlorobenzene	ND	21.7	22.1	20.0	20.0	108	110	75-126	1.8	20
tert-Butyl methyl ether	ND	24.1	24.4	20.0	20.0	120	122	65-138	1.2	20

Surrogates		%Recovery		Rec. Accept. Limits
a,a,a-Trifluorotoluene	99.1	100	100	44-165
Fluorobenzene	93.6	95.3	96.6	44-165

NA = Not Applicable
NC = Not Calculated, calculation not applicable.
ND = Not Detected

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental Services

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC REPORT
Organics by Chromatography
Project: 059558 (cont.)

Category: 8020-PAR-A Method 8020A - AFCEE Aromatic Volatile Organics with MTBE
Matrix: AQUEOUS
Sample: 059558-0010
MS Run: 25 MAR 98-H2
Units: ug/L

Analyte	Sample Result	Concentration MS Result	Concentration MSD Result	Amount Spiked MS	Amount Spiked MSD	% Recovery MS	% Recovery MSD	Recov. Accep. Limits	RPD MS-MSD	RPD Accept Limits
Benzene	ND	22.3	22.2	20.0	20.0	112	111	75-125	0.4	20
Toluene	ND	21.4	21.2	20.0	20.0	107	106	70-125	0.9	20
Chlorobenzene	ND	21.4	21.2	20.0	20.0	107	106	75-129	0.9	20
Ethylbenzene	ND	21.1	21.0	20.0	20.0	106	105	71-129	0.4	20
Xylenes (total)	ND	63.0	63.8	60.0	60.0	105	106	71-133	1.3	20
1,3-Dichlorobenzene	ND	21.5	21.4	20.0	20.0	108	107	70-131	0.4	20
1,2-Dichlorobenzene	ND	21.6	21.6	20.0	20.0	108	108	61-134	0.0	20
1,4-Dichlorobenzene	ND	21.7	21.8	20.0	20.0	108	109	75-126	0.4	20
tert-Butyl methyl ether	ND	25.0	25.1	20.0	20.0	125	126	65-138	0.4	20

Surrogates		%Recovery		Rec. Accept. Limits
a,a,a-Trifluorotoluene	100	99.4	98.4	44-165
Fluorobenzene	94.3	96.9	95.4	44-165

NA = Not Applicable
NC = Not Calculated, calculation not applicable.
ND = Not Detected

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental Services

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC REPORT
Organics by Chromatography
Project: 059558 (cont.)

Category: 8020-PAR-A Method 8020A - AFCEE Aromatic Volatile Organics with MTBE
Matrix: AQUEOUS
Sample: 059550-0002
MS Run: 25 MAR 98-H
Units: ug/L

Analyte	Concentration Sample Result	MS Result	MSD Result	Amount Spiked MS	Amount Spiked MSD	% Recovery MS	% Recovery MSD	Recov. Accep. Limits	RPD MS-MSD	RPD Accept Limits
Benzene	ND	21.8	21.7	20.0	20.0	109	108	75-125	0.4	20
Toluene	ND	21.2	21.2	20.0	20.0	106	106	70-125	0.0	20
Chlorobenzene	ND	21.1	21.0	20.0	20.0	106	105	75-129	0.4	20
Ethylbenzene	ND	20.6	20.4	20.0	20.0	103	102	71-129	0.9	20
Xylenes (total)	ND	63.5	62.9	60.0	60.0	106	105	71-133	0.9	20
1,3-Dichlorobenzene	ND	21.4	21.4	20.0	20.0	107	107	70-131	0.0	20
1,2-Dichlorobenzene	ND	21.5	21.5	20.0	20.0	108	108	61-134	0.0	20
1,4-Dichlorobenzene	ND	21.4	21.4	20.0	20.0	107	107	75-126	0.0	20
tert-Butyl methyl ether	ND	22.8	23.7	20.0	20.0	114	118	65-138	3.9	20

Surrogates		%Recovery		Rec. Accept. Limits
a,a,a-Trifluorotoluene	98.8	100	99.2	44-165
Fluorobenzene	93.7	94.8	96.1	44-165

NA = Not Applicable
NC = Not Calculated, calculation not applicable.
ND = Not Detected

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name: Parsons Engineering Science
Client ID: BX-MW-20 (0.00,0.00)
LAB ID: 059558-0001-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 26 MAR 98 Analyzed: 18 APR 98
Instrument: HPLC-Q Dilution: 10

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		10	0.94	ug/L
Acenaphthylene	ND		10	0.41	ug/L
Anthracene	ND		1.0	0.30	ug/L
Benzo(a)anthracene	ND		1.3	0.61	ug/L
Benzo(a)pyrene	ND		2.3	0.66	ug/L
Benzo(b)fluoranthene	ND		1.8	0.60	ug/L
Benzo(g,h,i)perylene	ND		2.0	0.72	ug/L
Benzo(k)fluoranthene	ND		1.7	0.60	ug/L
Chrysene	ND		2.0	0.74	ug/L
Dibenz(a,h)anthracene	ND		3.0	0.77	ug/L
Fluorene	ND		2.0	0.36	ug/L
Fluoranthene	ND		2.0	0.37	ug/L
Indeno(1,2,3-cd)pyrene	ND		4.4	0.56	ug/L
Naphthalene	300	d	10	0.60	ug/L
Phenanthrene	ND		2.0	0.30	ug/L
Pyrene	ND		2.0	0.44	ug/L

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	ND	%	25 - 157

d = See Preferred Result on Other Column
ND = Not Detected

Reported By: Blake Besser Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC (Second Column)
Method 8310

Client Name: Parsons Engineering Science
Client ID: BX-MW-20 (0.00,0.00)
LAB ID: 059558-0001-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 26 MAR 98 Analyzed: 18 APR 98
Instrument: HPLC-Q Dilution: 10

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		10	0.94	ug/L
Acenaphthylene	ND		10	0.41	ug/L
Anthracene	ND		1.0	0.30	ug/L
Benzo(a)anthracene	ND		1.3	0.61	ug/L
Benzo(a)pyrene	ND		2.3	0.66	ug/L
Benzo(b)fluoranthene	ND		1.8	0.60	ug/L
Benzo(g,h,i)perylene	ND		2.0	0.72	ug/L
Benzo(k)fluoranthene	ND		1.7	0.60	ug/L
Chrysene	ND		2.0	0.74	ug/L
Dibenz(a,h)anthracene	ND		3.0	0.77	ug/L
Fluorene	ND		2.0	0.36	ug/L
Fluoranthene	ND		2.0	0.37	ug/L
Indeno(1,2,3-cd)pyrene	ND		4.4	0.56	ug/L
Naphthalene	250	M	10	0.60	ug/L
Phenanthrene	ND		2.0	0.30	ug/L
Pyrene	ND		2.0	0.44	ug/L

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	ND	%	25 - 157

M = Preferred Result
ND = Not Detected

Reported By: Blake Besser

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name: Parsons Engineering Science
Client ID: BX-MP-2 (0.00,0.00)
LAB ID: 059558-0002-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 26 MAR 98 Analyzed: 21 APR 98
Instrument: HPLC-Q Dilution: 10

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		10	0.97	ug/L
Acenaphthylene	ND		10	0.42	ug/L
Anthracene	ND		1.0	0.31	ug/L
Benzo(a)anthracene	ND		1.4	0.63	ug/L
Benzo(a)pyrene	ND		2.4	0.68	ug/L
Benzo(b)fluoranthene	ND		1.9	0.62	ug/L
Benzo(g,h,i)perylene	ND		2.1	0.74	ug/L
Benzo(k)fluoranthene	ND		1.8	0.62	ug/L
Chrysene	ND		2.1	0.76	ug/L
Dibenz(a,h)anthracene	ND		3.1	0.80	ug/L
Fluorene	ND		2.1	0.37	ug/L
Fluoranthene	ND		2.1	0.38	ug/L
Indeno(1,2,3-cd)pyrene	ND		4.5	0.58	ug/L
Naphthalene	400	d	10	0.62	ug/L
Phenanthrene	ND		2.1	0.31	ug/L
Pyrene	ND		2.1	0.45	ug/L

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	ND	%	25 - 157

d = See Preferred Result on Other Column
ND = Not Detected

Reported By: Blake Besser Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC (Second Column)
Method 8310

Client Name: Parsons Engineering Science
Client ID: BX-MP-2 (0.00,0.00)
LAB ID: 059558-0002-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 26 MAR 98 Analyzed: 21 APR 98
Instrument: HPLC-Q Dilution: 10

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		10	0.97	ug/L
Acenaphthylene	ND		10	0.42	ug/L
Anthracene	ND		1.0	0.31	ug/L
Benzo(a)anthracene	ND		1.4	0.63	ug/L
Benzo(a)pyrene	ND		2.4	0.68	ug/L
Benzo(b)fluoranthene	ND		1.9	0.62	ug/L
Benzo(g,h,i)perylene	ND		2.1	0.74	ug/L
Benzo(k)fluoranthene	ND		1.8	0.62	ug/L
Chrysene	ND		2.1	0.76	ug/L
Dibenz(a,h)anthracene	ND		3.1	0.80	ug/L
Fluorene	ND		2.1	0.37	ug/L
Fluoranthene	ND		2.1	0.38	ug/L
Indeno(1,2,3-cd)pyrene	ND		4.5	0.58	ug/L
Naphthalene	320	M	10	0.62	ug/L
Phenanthrene	ND		2.1	0.31	ug/L
Pyrene	ND		2.1	0.45	ug/L

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	ND	%	25 - 157

M = Preferred Result
ND = Not Detected

Reported By: Blake Besser

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name: Parsons Engineering Science
Client ID: FT-16, MP-1 (0.00,0.00)
LAB ID: 059558-0003-SA
Matrix: GRND-H2O Sampled: 21 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 26 MAR 98 Analyzed: 14 APR 98
Instrument: HPLC-Q Dilution: 1.0

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		1.0	0.094	ug/L
Acenaphthylene	ND		1.0	0.041	ug/L
Anthracene	0.89	d	0.10	0.030	ug/L
Benzo(a)anthracene	ND		0.13	0.061	ug/L
Benzo(a)pyrene	ND		0.23	0.066	ug/L
Benzo(b)fluoranthene	ND		0.18	0.060	ug/L
Benzo(g,h,i)perylene	ND		0.20	0.072	ug/L
Benzo(k)fluoranthene	ND		0.17	0.060	ug/L
Chrysene	ND		0.20	0.074	ug/L
Dibenz(a,h)anthracene	ND		0.30	0.077	ug/L
Fluorene	6.4	d	0.20	0.036	ug/L
Fluoranthene	1.2	M	0.20	0.037	ug/L
Indeno(1,2,3-cd)pyrene	ND		0.44	0.056	ug/L
Naphthalene	4.0	d	1.0	0.060	ug/L
Phenanthrene	ND		0.20	0.030	ug/L
Pyrene	1.4	d	0.20	0.044	ug/L

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	120	%	25 - 157

d = See Preferred Result on Other Column
M = Preferred Result
ND = Not Detected

Reported By: Blake Besser Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC (Second Column)
Method 8310

Client Name: Parsons Engineering Science
Client ID: FT-16, MP-1 (0.00,0.00)
LAB ID: 059558-0003-SA
Matrix: GRND-H2O Sampled: 21 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 26 MAR 98 Analyzed: 14 APR 98
Instrument: HPLC-Q Dilution: 1.0

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		1.0	0.094	ug/L
Acenaphthylene	ND		1.0	0.041	ug/L
Anthracene	0.29	M	0.10	0.030	ug/L
Benzo(a)anthracene	ND		0.13	0.061	ug/L
Benzo(a)pyrene	ND		0.23	0.066	ug/L
Benzo(b)fluoranthene	ND		0.18	0.060	ug/L
Benzo(g,h,i)perylene	ND		0.20	0.072	ug/L
Benzo(k)fluoranthene	ND		0.17	0.060	ug/L
Chrysene	ND		0.20	0.074	ug/L
Dibenz(a,h)anthracene	ND		0.30	0.077	ug/L
Fluorene	5.7	M	0.20	0.036	ug/L
Fluoranthene	1.4	d	0.20	0.037	ug/L
Indeno(1,2,3-cd)pyrene	ND		0.44	0.056	ug/L
Naphthalene	1.9	M	1.0	0.060	ug/L
Phenanthrene	ND		0.20	0.030	ug/L
Pyrene	0.87	M	0.20	0.044	ug/L

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	124	%	25 - 157

d = See Preferred Result on Other Column
M = Preferred Result
ND = Not Detected

Reported By: Blake Besser Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name: Parsons Engineering Science
Client ID: FT-16, MP-2 (0.00,0.00)
LAB ID: 059558-0004-SA
Matrix: GRND-H2O Sampled: 21 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 26 MAR 98 Analyzed: 17 APR 98
Instrument: HPLC-Q Dilution: 1.0

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		1.0	0.097	ug/L
Acenaphthylene	ND		1.0	0.042	ug/L
Anthracene	ND		0.10	0.031	ug/L
Benzo(a)anthracene	ND		0.14	0.063	ug/L
Benzo(a)pyrene	ND		0.24	0.068	ug/L
Benzo(b)fluoranthene	ND		0.19	0.062	ug/L
Benzo(g,h,i)perylene	ND		0.21	0.074	ug/L
Benzo(k)fluoranthene	ND		0.18	0.062	ug/L
Chrysene	ND		0.21	0.076	ug/L
Dibenz(a,h)anthracene	ND		0.31	0.080	ug/L
Flucrene	ND		0.21	0.037	ug/L
Fluoranthene	ND		0.21	0.038	ug/L
Indeno(1,2,3-cd)pyrene	ND		0.45	0.058	ug/L
Naphthalene	ND		1.0	0.062	ug/L
Phenanthrene	ND		0.21	0.031	ug/L
Pyrene	ND		0.21	0.045	ug/L

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	107	%	25 - 157

ND = Not Detected

Reported By: Blake Besser

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name: Parsons Engineering Science
Client ID: BX-MW-03 (0.00,0.00)
LAB ID: 059558-0008-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 26 MAR 98 Analyzed: 18 APR 98
Instrument: HPLC-Q Dilution: 11

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		11	0.99	ug/L
Acenaphthylene	ND		11	0.43	ug/L
Anthracene	ND		1.1	0.32	ug/L
Benzo(a)anthracene	ND		1.4	0.64	ug/L
Benzo(a)pyrene	ND		2.4	0.69	ug/L
Benzo(b)fluoranthene	ND		1.9	0.63	ug/L
Benzo(g,h,i)perylene	ND		2.1	0.76	ug/L
Benzo(k)fluoranthene	ND		1.8	0.63	ug/L
Chrysene	ND		2.1	0.78	ug/L
Dibenz(a,h)anthracene	ND		3.2	0.81	ug/L
Fluorene	ND		2.1	0.37	ug/L
Fluoranthene	ND		2.1	0.38	ug/L
Indeno(1,2,3-cd)pyrene	ND		4.6	0.59	ug/L
Naphthalene	360	d	11	0.63	ug/L
Phenanthrene	ND		2.1	0.32	ug/L
Pyrene	ND		2.1	0.46	ug/L

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	ND	%	25 - 157

d = See Preferred Result on Other Column
ND = Not Detected

Reported By: Blake Besser Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC (Second Column)
Method 8310

Client Name: Parsons Engineering Science
Client ID: BX-MW-03 (0.00,0.00)
LAB ID: 059558-0008-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 26 MAR 98 Analyzed: 18 APR 98
Instrument: HPLC-Q Dilution: 11

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		11	0.99	ug/L
Acenaphthylene	ND		11	0.43	ug/L
Anthracene	ND		1.1	0.32	ug/L
Benzo(a)anthracene	ND		1.4	0.64	ug/L
Benzo(a)pyrene	ND		2.4	0.69	ug/L
Benzo(b)fluoranthene	ND		1.9	0.63	ug/L
Benzo(g,h,i)perylene	ND		2.1	0.76	ug/L
Benzo(k)fluoranthene	ND		1.8	0.63	ug/L
Chrysene	ND		2.1	0.78	ug/L
Dibenz(a,h)anthracene	ND		3.2	0.81	ug/L
Fluorene	ND		2.1	0.37	ug/L
Fluoranthene	ND		2.1	0.38	ug/L
Indeno(1,2,3-cd)pyrene	ND		4.6	0.59	ug/L
Naphthalene	300	M	11	0.63	ug/L
Phenanthrene	ND		2.1	0.32	ug/L
Pyrene	ND		2.1	0.46	ug/L

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	ND	%	25 - 157

M = Preferred Result
ND = Not Detected

Reported By: Blake Besser

Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name: Parsons Engineering Science
Client ID: BX-MW-03-97 (0.00,0.00)
LAB ID: 059558-0009-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 26 MAR 98 Analyzed: 17 APR 98
Instrument: HPLC-Q Dilution: 1.0

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		1.0	0.095	ug/L
Acenaphthylene	ND		1.0	0.041	ug/L
Anthracene	ND		0.10	0.031	ug/L
Benzo(a)anthracene	ND		0.13	0.062	ug/L
Benzo(a)pyrene	ND		0.24	0.067	ug/L
Benzo(b)fluoranthene	ND		0.18	0.061	ug/L
Benzo(g,h,i)perylene	ND		0.21	0.073	ug/L
Benzo(k)fluoranthene	ND		0.17	0.061	ug/L
Chrysene	ND		0.21	0.075	ug/L
Dibenz(a,h)anthracene	ND		0.31	0.078	ug/L
Fluorene	ND		0.21	0.036	ug/L
Fluoranthene	ND		0.21	0.037	ug/L
Indeno(1,2,3-cd)pyrene	ND		0.44	0.056	ug/L
Naphthalene	ND		1.0	0.061	ug/L
Phenanthrene	ND		0.21	0.031	ug/L
Pyrene	ND		0.21	0.044	ug/L

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	90	%	25 - 157

ND = Not Detected

Reported By: Blake Besser Approved By: Audrey Cornell

Quanterra
Environmental Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name: Parsons Engineering Science
Client ID: BX-MW-05-97 (0.00,0.00)
LAB ID: 059558-0010-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 26 MAR 98 Analyzed: 17 APR 98
Instrument: HPLC-Q Dilution: 1.0

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		1.0	0.097	ug/L
Acenaphthylene	ND		1.0	0.042	ug/L
Anthracene	ND		0.10	0.031	ug/L
Benzo(a)anthracene	ND		0.14	0.063	ug/L
Benzo(a)pyrene	ND		0.24	0.068	ug/L
Benzo(b)fluoranthene	ND		0.19	0.061	ug/L
Benzo(g,h,i)perylene	ND		0.21	0.074	ug/L
Benzo(k)fluoranthene	ND		0.18	0.061	ug/L
Chrysene	ND		0.21	0.076	ug/L
Dibenz(a,h)anthracene	ND		0.31	0.079	ug/L
Fluorene	ND		0.21	0.036	ug/L
Fluoranthene	ND		0.21	0.038	ug/L
Indeno(1,2,3-cd)pyrene	ND		0.45	0.057	ug/L
Naphthalene	ND		1.0	0.061	ug/L
Phenanthrene	ND		0.21	0.031	ug/L
Pyrene	ND		0.21	0.045	ug/L

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	105	%	25 - 157

ND = Not Detected

Reported By: Blake Besser

Approved By: Audrey Cornell

Quanterra
Environmental Services

QC LOT ASSIGNMENT REPORT
High Performance Liquid Chromatography

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
059558-0001-SA	WATER	8310AF-A	26 MAR 98-01	26 MAR 98-01
059558-0001-SA	WATER	8310AF-A	26 MAR 98-01	26 MAR 98-01
059558-0002-SA	WATER	8310AF-A	26 MAR 98-01	26 MAR 98-01
059558-0002-SA	WATER	8310AF-A	26 MAR 98-01	26 MAR 98-01
059558-0003-SA	WATER	8310AF-A	26 MAR 98-01	26 MAR 98-01
059558-0003-SA	WATER	8310AF-A	26 MAR 98-01	26 MAR 98-01
059558-0004-SA	WATER	8310AF-A	26 MAR 98-01	26 MAR 98-01
059558-0008-SA	WATER	8310AF-A	26 MAR 98-01	26 MAR 98-01
059558-0008-SA	WATER	8310AF-A	26 MAR 98-01	26 MAR 98-01
059558-0009-SA	WATER	8310AF-A	26 MAR 98-01	26 MAR 98-01
059558-0010-SA	WATER	8310AF-A	26 MAR 98-01	26 MAR 98-01
059558-0010-MS	WATER	8310AF-A	26 MAR 98-01	26 MAR 98-01
059558-0010-SD	WATER	8310AF-A	26 MAR 98-01	26 MAR 98-01

Quanterra
Environmental Services

LABORATORY CONTROL SAMPLE REPORT
High Performance Liquid Chromatography
Project: 059558

Category: 8310AF-A AFCEE - Polynuclear Aromatic Hydrocarbons
Matrix: WATER
QC Run: 26 MAR 98-01
Concentration Units: ug/L
Date Analyzed: 14 APR 98

Analyte	Concentration Spiked	Concentration Measured	Accuracy(%) LCS		Accuracy(%) Limits
Acenaphthene	4.00	3.60	90		43-130
Acenaphthylene	4.00	4.20	105		49-125
Anthracene	4.00	3.86	96		54-125
Benzo(a)anthracene	4.00	4.37	109		39-135
Benzo(a)pyrene	4.00	4.19	105		52-125
Benzo(b)fluoranthene	4.00	4.38	110		31-137
Benzo(g,h,i)perylene	4.00	4.45	111		53-125
Benzo(k)fluoranthene	4.00	4.39	110		60-129
Chrysene	4.00	4.26	106		59-134
Dibenz(a,h)anthracene	4.00	4.18	104	#	35-103
Fluorene	4.00	4.01	100		53-125
Fluoranthene	4.00	4.28	107		42-125
Indeno(1,2,3-cd)pyrene	4.00	4.55	114		53-153
Naphthalene	4.00	3.71	93		43-125
Phenanthrene	4.00	4.34	108		52-129
Pyrene	4.00	4.42	110		55-125

Surrogates	Concentration Spiked	Concentration Measured	Accuracy(%) LCS	Accuracy(%) Limits
Terphenyl-d14	20.0	21.6	108	25-157

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental Services

SINGLE CONTROL SAMPLE REPORT
High Performance Liquid Chromatography

Analyte	Concentration Spiked	Measured	Accuracy(%) SCS	Limits
Category: 8310AF-A				
Matrix: WATER				
QC Lot: 26 MAR 98-01 QC Run: 26 MAR 98-01				
Concentration Units: ug/L				
Terphenyl-d14	20.0	22.8	114	25-157

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental Services

METHOD BLANK REPORT
High Performance Liquid Chromatography
Project: 059558

Test: 8310-AFCEE-MDL-A AFCEE Polynuclear Aromatic Hydrocarbons, HPLC
Matrix: WATER
QC Lot: 26 MAR 98-01 QC Run: 26 MAR 98-01 Date Analyzed: 14 APR 98

Analyte	Result	Units	RL	MDL
Acenaphthene	ND	ug/L	1.0	0.093
Acenaphthylene	ND	ug/L	1.0	0.040
Anthracene	ND	ug/L	0.10	0.030
Benzo(a)anthracene	ND	ug/L	0.13	0.060
Benzo(a)pyrene	ND	ug/L	0.23	0.065
Benzo(b)fluoranthene	ND	ug/L	0.18	0.059
Benzo(g,h,i)perylene	ND	ug/L	0.20	0.071
Benzo(k)fluoranthene	ND	ug/L	0.17	0.059
Chrysene	ND	ug/L	0.20	0.073
Dibenz(a,h)anthracene	ND	ug/L	0.30	0.076
Fluorene	ND	ug/L	0.20	0.035
Fluoranthene	ND	ug/L	0.20	0.036
Indeno(1,2,3-cd)pyrene	ND	ug/L	0.43	0.055
Naphthalene	ND	ug/L	1.0	0.059
Phenanthrene	ND	ug/L	0.20	0.030
Pyrene	ND	ug/L	0.20	0.043

Test: 8310-AFCEE-MDL-2-A AFCEE Polynuclear Aromatic Hydrocarbons, HPLC
Matrix: WATER
QC Lot: 26 MAR 98-01 QC Run: 26 MAR 98-01 Date Analyzed: 14 APR 98

Analyte	Result	Units	RL	MDL
Acenaphthene	ND	ug/L	1.0	0.093
Acenaphthylene	ND	ug/L	1.0	0.040
Anthracene	ND	ug/L	0.10	0.030
Benzo(a)anthracene	ND	ug/L	0.13	0.060
Benzo(a)pyrene	ND	ug/L	0.23	0.065
Benzo(b)fluoranthene	ND	ug/L	0.18	0.059
Benzo(g,h,i)perylene	ND	ug/L	0.20	0.071
Benzo(k)fluoranthene	ND	ug/L	0.17	0.059
Chrysene	ND	ug/L	0.20	0.073
Dibenz(a,h)anthracene	ND	ug/L	0.30	0.076
Fluorene	ND	ug/L	0.20	0.035
Fluoranthene	ND	ug/L	0.20	0.036
Indeno(1,2,3-cd)pyrene	ND	ug/L	0.43	0.055
Naphthalene	ND	ug/L	1.0	0.059
Phenanthrene	ND	ug/L	0.20	0.030
Pyrene	ND	ug/L	0.20	0.043

ND = Not Detected

Quanterra
Environmental Services

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC REPORT
High Performance Liquid Chromatography
Project: 059558

Category: 8310AF-A AFCEE - Polynuclear Aromatic Hydrocarbons
Matrix: WATER
Sample: 059558-0010
MS Run: 26 MAR 98-01
Units: ug/L

Analyte	Sample Result	Concentration MS Result	Concentration MSD Result	Amount Spiked MS	Amount Spiked MSD	% Recovery MS	% Recovery MSD	Recov. Accep. Limits	RPD MS-MSD	RPD Accept Limits
Acenaphthene	ND	3.86	2.91	4.06	3.85	95	76	43-130	23	30
Acenaphthylene	ND	3.92	3.36	4.06	3.85	97	87	49-125	10	30
Anthracene	ND	3.66	3.05	4.06	3.85	90	79	54-125	13	30
Benzo(a)anthracene	ND	4.02	3.31	4.06	3.85	99	86	39-135	14	30
Benzo(a)pyrene	ND	4.17	3.24	4.06	3.85	103	84	52-125	20	30
Benzo(b)fluoranthene	ND	4.21	3.56	4.06	3.85	104	92	31-137	11	30
Benzo(g,h,i)perylene	ND	4.28	3.56	4.06	3.85	105	92	53-125	13	30
Benzo(k)fluoranthene	ND	4.20	3.52	4.06	3.85	103	91	60-129	12	30
Chrysene	ND	4.13	3.58	4.06	3.85	102	93	59-134	9.0	30
Dibenz(a,h)anthracene	ND	4.16	3.49	4.06	3.85	102	91	35-103	12	30
Fluorene	ND	4.07	3.55	4.06	3.85	100	92	53-125	8.4	30
Fluoranthene	ND	4.27	3.63	4.06	3.85	105	94	42-125	11	30
Indeno(1,2,3-cd) pyrene	ND	4.16	3.49	4.06	3.85	102	91	53-153	12	30
Naphthalene	ND	4.22	3.72	4.06	3.85	104	97	43-125	7.3	30
Phenanthrene	ND	4.00	3.50	4.06	3.85	99	91	52-129	8.0	30
Pyrene	ND	4.07	3.45	4.06	3.85	100	90	55-125	11	30

Surrogates	%Recovery			Rec. Accept. Limits
Terphenyl-d14	105	131	118	25-157

ND = Not Detected

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra Environmental Services

Memo (NCM)

NCM Log Number: 13357

OUA-4187 59558 | Sample Numbers: 1-5, 9-10, 10MS/SD | NCM Initiated by/Date: MM 4-21-98 | Project Manager: E. LaRiviere

Project ID/Client: 59558 Parsons

Analyst/Team: B Besser

Tests: 8310-AF-MDL-A

Analytical Area (check appropriate box)

☐ Sample control ☐ Organic preparation ☐ Inorganic preparation ☐ GC ☑ HPLC ☐ GC/MS ☐ Wet chemistry

☐ Metals ☐ Reporting ☐ Data review ☐ Radiochemistry ☐ _____

Non-Conformance (check appropriate box) To be completed by analyst

Holding Time Violation (exceeded by _____ days)

Category I: Laboratory Independent

☐ 1. Holding time expired in transit

☐ 2. Sample received > 48 hours or 1/2 holding time has expired

☐ 3. Test added by client after expiration

Category II: Laboratory Dependent

☐ 4. Instrument failure

☐ 5. Analyst error

☐ 6. Log-in error

☐ 7. Miscommunication

☐ 8. Other (explanation required)

Category III: Analysis Reruns (QA/QC)

☐ 9. Surrogates

☐ 10. Internal standards

☐ 11. Spike recoveries

☐ 12. Blank contamination

Category IV: Analysis Reruns (Confirmation)

☐ 13. Second column

☐ 14. Contamination check

☐ 15. Confirmation of matrix effects

☐ 16. Other (explanation required) _____

Quality Assurance/Quality Control

☑ 17. QC data reported outside of controls

☐ 18. Incorrect procedure used

☐ 19. SOP intentionally modified with QA and tech approval

☐ 20. Invalid instrument calibration

☐ 21. Received insuffient sample for proper analysis

Incorrect or Incomplete Client Deliverable

☐ 22. Hardcopy deliverable error

☐ 23. Electronic deliverable error

Reported Detection Limits Elevated Due to:

☐ 24. Sample matrix: Does not include high analyte content

☐ 25. Insufficient sample volume

☐ 26. Other (explanation required)

Miscellaneous

☐ 27. Instrument Tag-out

☐ 28. Other (explanation required) _____

Notification (check appropriate box) To be completed by project manager

☐ Required ☒ Not Required

Client notified by - Name | Date | ☐ In writing ☐ By telephone ☐ By facsimile ☐ Other (explain) _____

Client's name and response | ☐ Process "as is" ☐ On hold until _____ ☐ Re-sample ☐ Other (explain) _____

Project manager signature: Elaine LaRiviere | Date: 4/21/98

A 57

Quanterra Environmental Services

Laboratory Non-Conformance Memo (NCM)

NCM Log Number: 13367

QUA-4187

Corrective Action (To be completed and reviewed by all associates involved)

Problem Description/Root Cause: Dibenzo-a,h-Anthracene recovery is above limit in DCS's 1047 & 1112 (limit is 103%)

Author's initials and date: KH 4-21-98

Corrective Actions (Short Term): MSQC in limits. No reportable target compound. Data accepted

Author's initials and date: BS 4-21-98

Corrective Actions to Prevent Reoccurence (Long Term)

Corrective Action approved by (Supervisor/Group Leader) and date: BS 4-21-98

Additional Comments

Corrective Action to be completed by (if other than Supervisor/Group Leader)

Date Corrective Action is to be completed

Quality Assurance Review (To be completed by a QA associate)

Log ID ☐ Anomaly ☒ Deficiency ☐ Notified Ops/Sys Manager (Initials)

☐ Further action required

☐ Further action assigned to

QA signature: [signature] Date: 4/23/98

Corrective Action Verification (To be completed by a QA associate)

☐ Verification not required or requested ☐ Verified/CA completed on _____ by _____

☐ Cannot verify (specify reason)

Verified by

Date

Nonconformance Memo Closure

QA signature: [signature] Date: 4/23/98

The office of Quality Assurance maintains a copy of this NCM indicating its final status.

Quanterra
Environmental Services

AFCEE
Total Metals

Client Name: Parsons Engineering Science
Client ID: BX-MW-20 (0.00,0.00)
LAB ID: 059558-0001-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: See Below Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Lead	0.0098		1.0	0.0010	0.0050	mg/L	SW7421	31 MAR 98	01 APR 98

Reported By: Robin Proctor

Approved By: Kathy Wakeman

Quanterra
Environmental Services

AFCEE
Total Metals

Client Name: Parsons Engineering Science
Client ID: BX-MP-2 (0.00,0.00)
LAB ID: 059558-0002-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: See Below Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Lead	0.0078		1.0	0.0010	0.0050	mg/L	SW7421	31 MAR 98	01 APR 98

Reported By: Robin Proctor

Approved By: Kathy Wakeman

Quanterra
Environmental Services

AFCEE
Total Metals

Client Name: Parsons Engineering Science
Client ID: FT-16, MP-1 (0.00,0.00)
LAB ID: 059558-0003-SA
Matrix: GRND-H2O Sampled: 21 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: See Below Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Lead	ND		1.0	0.0010	0.0050	mg/L	SW7421	31 MAR 98	01 APR 98

ND = Not Detected

Reported By: Robin Proctor Approved By: Kathy Wakeman

Quanterra
Environmental Services

AFCEE
Total Metals

Client Name: Parsons Engineering Science
Client ID: FT-16, MP-2 (0.00,0.00)
LAB ID: 059558-0004-SA
Matrix: GRND-H2O Sampled: 21 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: See Below Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Lead	ND		1.0	0.0010	0.0050	mg/L	SW7421	31 MAR 98	01 APR 98

ND = Not Detected

Reported By: Robin Proctor Approved By: Kathy Wakeman

Quanterra
Environmental Services

AFCEE
Total Metals

Client Name: Parsons Engineering Science
Client ID: BX-MW-03 (0.00,0.00)
LAB ID: 059558-0008-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: See Below Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Lead	0.0030	J	1.0	0.0010	0.0050	mg/L	SW7421	31 MAR 98	01 APR 98

J = Result is detected below the reporting limit or is an estimated concentration.

Reported By: Robin Proctor Approved By: Kathy Wakeman

Quanterra
Environmental Services

AFCEE
Total Metals

Client Name: Parsons Engineering Science
Client ID: BX-MW-03-97 (0.00,0.00)
LAB ID: 059558-0009-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: See Below Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Lead	ND		1.0	0.0010	0.0050	mg/L	SW7421	31 MAR 98	01 APR 98

ND = Not Detected

Reported By: Robin Proctor

Approved By: Kathy Wakeman

Quanterra
Environmental Services

AFCEE
Total Metals

Client Name: Parsons Engineering Science
Client ID: BX-MW-05-97 (0.00,0.00)
LAB ID: 059558-0010-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: See Below Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Lead	ND		1.0	0.0010	0.0050	mg/L	SW7421	31 MAR 98	01 APR 98

ND = Not Detected

Reported By: Robin Proctor

Approved By: Kathy Wakeman

Quanterra
Environmental Services

QC LOT ASSIGNMENT REPORT
Metals Analysis and Preparation

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
059558-0001-SA	AQUEOUS	PB-LAW-AT	31 MAR 98-R3	31 MAR 98-R3
059558-0002-SA	AQUEOUS	PB-LAW-AT	31 MAR 98-R3	31 MAR 98-R3
059558-0003-SA	AQUEOUS	PB-LAW-AT	31 MAR 98-R3	31 MAR 98-R3
059558-0004-SA	AQUEOUS	PB-LAW-AT	31 MAR 98-R3	31 MAR 98-R3
059558-0008-SA	AQUEOUS	PB-LAW-AT	31 MAR 98-R3	31 MAR 98-R3
059558-0009-SA	AQUEOUS	PB-LAW-AT	31 MAR 98-R3	31 MAR 98-R3
059558-0010-SA	AQUEOUS	PB-LAW-AT	31 MAR 98-R3	31 MAR 98-R3
059558-0010-MS	AQUEOUS	PB-LAW-AT	31 MAR 98-R3	31 MAR 98-R3
059558-0010-SD	AQUEOUS	PB-LAW-AT	31 MAR 98-R3	31 MAR 98-R3

Quanterra
Environmental Services

LABORATORY CONTROL SAMPLE REPORT
Metals Analysis and Preparation

Analyte	Concentration Spiked	Measured	Accuracy(%) LCS	Limits
Category: PB-LAW-AT				
Matrix: AQUEOUS				
QC Lot: 31 MAR 98-R3	QC Run: 31 MAR 98-R3			
Concentration Units: mg/L				
Lead	0.0400	0.0455	114	74-124

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental Services

METHOD BLANK REPORT
Metals Analysis and Preparation
Project: 059558

Test: PB-AFCEE2-MDL-AT AFCEE Lead, Furnace AA (Totals)
Matrix: AQUEOUS
QC Lot: 31 MAR 98-R3 QC Run: 31 MAR 98-R3 Date Analyzed: 01 APR 98

Analyte	Result	Units	RL	MDL
Lead	ND	mg/L	0.0050	0.0010

ND = Not Detected

Quanterra
Environmental Services

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC REPORT
Metals Analysis and Preparation
Project: 059558

Category: PB-LAW-AT Lead, Furnace AA / Totals
Matrix: AQUEOUS
Sample: 059558-0010
MS Run: 31 MAR 98-R3
Units: mg/L

Analyte	Concentration Sample Result	MS Result	MSD Result	Amount Spiked MS/MSD	%Recovery MS	%Recovery MSD	%RPD	Acceptance Limit Recov.	Acceptance Limit RPD
Lead	ND	0.0440	0.0436	0.0400	110	109	0.9	74-124	15

ND = Not Detected

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental Services

General Inorganics

Client Name: Parsons Engineering Science
Client ID: BX-MW-20 (0.00,0.00)
LAB ID: 059558-0001-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: See Below Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Nitrate as N	0.12	J	1.0	0.040	0.50	mg/L	9056	NA	23 MAR 98

J = Result is detected below the reporting limit or is an estimated concentration.

Reported By: Mark Foster Approved By: Linda Sullivan

Quanterra
Environmental Services

General Inorganics

Client Name: Parsons Engineering Science
Client ID: BX-MP-2 (0.00,0.00)
LAB ID: 059558-0002-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: See Below Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Nitrate as N	0.13	J	1.0	0.040	0.50	mg/L	9056	NA	23 MAR 98

J = Result is detected below the reporting limit or is an estimated concentration.

Reported By: Mark Foster Approved By: Linda Sullivan

Quanterra
Environmental Services

General Inorganics

Client Name: Parsons Engineering Science
Client ID: FT-16, MP-3 (0.00,0.00)
LAB ID: 059558-0007-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: See Below Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Nitrate as N	0.12	J	1.0	0.040	0.50	mg/L	9056	NA	23 MAR 98

J = Result is detected below the reporting limit or is an estimated concentration.

Reported By: Mark Foster Approved By: Linda Sullivan

Quanterra
Environmental Services

General Inorganics

Client Name: Parsons Engineering Science
Client ID: BX-MW-03 (0.00,0.00)
LAB ID: 059558-0008-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: See Below Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Nitrate as N	0.13	J	1.0	0.040	0.50	mg/L	9056	NA	24 MAR 98

J = Result is detected below the reporting limit or is an estimated concentration.

Reported By: Mark Foster Approved By: Linda Sullivan

Quanterra
Environmental Services

General Inorganics

Client Name: Parsons Engineering Science
Client ID: MW-01 (0.00,0.00)
LAB ID: 059558-0011-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: See Below Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Nitrate as N	0.15	J	1.0	0.040	0.50	mg/L	9056	NA	24 MAR 98

J = Result is detected below the reporting limit or is an estimated concentration.

Reported By: Mark Foster Approved By: Linda Sullivan

Quanterra Environmental Services

General Inorganics

Client Name: Parsons Engineering Science
Client ID: BX-MW-08-97 (0.00.0.00)
LAB ID: 059558-0013-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: See Below Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Nitrate as N	0.13	J	1.0	0.040	0.50	mg/L	9056	NA	24 MAR 98

J = Result is detected below the reporting limit or is an estimated concentration.

Reported By: Mark Foster Approved By: Linda Sullivan

Quanterra
Environmental Services

General Inorganics

Client Name: Parsons Engineering Science
Client ID: BX-MW-07 (0.00,0.00)
LAB ID: 059558-0014-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: See Below Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Nitrate as N	ND		1.0	0.040	0.50	mg/L	9056	NA	24 MAR 98

ND = Not Detected

Reported By: Mark Foster

Approved By: Linda Sullivan

Quanterra
Environmental Services

General Inorganics

Client Name: Parsons Engineering Science
Client ID: MP-1 (0.00,0.00)
LAB ID: 059558-0016-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: See Below Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Nitrate as N	0.13	J	1.0	0.040	0.50	mg/L	9056	NA	24 MAR 98

J = Result is detected below the reporting limit or is an estimated concentration.

Reported By: Mark Foster Approved By: Linda Sullivan

Quanterra
Environmental Services

QC LOT ASSIGNMENT REPORT
Wet Chemistry Analysis and Preparation

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
059558-0001-SA	AQUEOUS	NO3-PAR-A	23 MAR 98-N1	23 MAR 98-N1
059558-0002-SA	AQUEOUS	NO3-PAR-A	23 MAR 98-N1	23 MAR 98-N1
059558-0007-SA	AQUEOUS	NO3-PAR-A	23 MAR 98-N1	23 MAR 98-N1
059558-0008-SA	AQUEOUS	NO3-PAR-A	23 MAR 98-N1	23 MAR 98-N1
059558-0011-SA	AQUEOUS	NO3-PAR-A	23 MAR 98-N1	23 MAR 98-N1
059558-0011-MS	AQUEOUS	NO3-PAR-A	23 MAR 98-N1	23 MAR 98-N1
059558-0011-SD	AQUEOUS	NO3-PAR-A	23 MAR 98-N1	23 MAR 98-N1
059558-0012-SA	AQUEOUS	NO3-PAR-A	23 MAR 98-N1	23 MAR 98-N1
059558-0013-SA	AQUEOUS	NO3-PAR-A	23 MAR 98-N1	23 MAR 98-N1
059558-0014-SA	AQUEOUS	NO3-PAR-A	23 MAR 98-N1	23 MAR 98-N1
059558-0016-SA	AQUEOUS	NO3-PAR-A	23 MAR 98-N1	23 MAR 98-N1

Quanterra
Environmental Services

LABORATORY CONTROL SAMPLE REPORT
Wet Chemistry Analysis and Preparation

Analyte	Concentration Spiked	Measured	Accuracy(%) LCS	Limits
Category: NO3-PAR-A Matrix: AQUEOUS QC Lot: 23 MAR 98-N1	QC Run: 23 MAR 98-N1			
Concentration Units: mg/L				
Nitrate as N	10.0	10.5	105	90-110

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental Services

METHOD BLANK REPORT
Wet Chemistry Analysis and Preparation
Project: 059558

Test: NO3-AF-IC-PAR-MDL-A AFCEE Nitrate, Ion Chromatography
Matrix: AQUEOUS
QC Lot: 23 MAR 98-N1 QC Run: 23 MAR 98-N1 Date Analyzed: 23 MAR 98

Analyte	Result	Units	RL	MDL
Nitrate as N	ND	mg/L	0.50	0.040

ND = Not Detected

Quanterra
Environmental Services

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC REPORT
Wet Chemistry Analysis and Preparation
Project: 059558

Category: NO3-PAR-A Nitrate as N by Ion Chromatography (Cape Canaveral)
Matrix: AQUEOUS
Sample: 059558-0011
MS Run: 23 MAR 98-N1
Units: mg/L

Analyte	Concentration Sample Result	MS Result	MSD Result	Amount Spiked MS/MSD	%Recovery MS	%Recovery MSD	%RPD	Acceptance Limit Recov.	Acceptance Limit RPD
Nitrate as N	0.15 J	20.3	20.2	20.0	101	100	0.4	90-110	20

J = Result is detected below the reporting limit or is an estimated concentration.

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental Services

Method EPA-9 RSK-175 by GC/FID
Method EPA-9 RSK-175

Client Name: Parsons Engineering Science
Client ID: BX-MW-20 (0.00,0.00)
LAB ID: 059558-0001-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: N/A Analyzed: 27 MAR 98
Instrument: GCFID-K1A Dilution: 50

Parameter	Result	Qualifier	RL	MDL	Units
Methane	1800	B	25	2.6	ug/L

B = Compound is also detected in the blank.

Reported By: Quanterra-Austin Approved By: Cynthia Prentice

Quanterra
Environmental Services

Method EPA-9 RSK-175 by GC/FID
Method EPA-9 RSK-175

Client Name: Parsons Engineering Science
Client ID: BX-MP-2 (0.00,0.00)
LAB ID: 059558-0002-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: N/A Analyzed: 27 MAR 98
Instrument: GCFID-K1A Dilution: 50

Parameter	Result	Qualifier	RL	MDL	Units
Methane	1800	B	25	2.6	ug/L

B = Compound is also detected in the blank.

Reported By: Quanterra-Austin Approved By: Cynthia Prentice

Quanterra
Environmental Services

Method EPA-9 RSK-175 by GC/FID
Method EPA-9 RSK-175

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, MP-3 (0.00,0.00)		
LAB ID:	059558-0006-SA		
Matrix:	GRND-H2O	Sampled: 21 MAR 98	Received: 23 MAR 98
Authorized:	24 MAR 98	Prepared: N/A	Analyzed: 27 MAR 98
Instrument:	GCFID-K1A	Dilution: 20	

Parameter	Result	Qualifier	RL	MDL	Units
Methane	490	B	10	1.0	ug/L

B = Compound is also detected in the blank.

Reported By: Quanterra-Austin

Approved By: Cynthia Prentice

Quanterra
Environmental Services

Method EPA-9 RSK-175 by GC/FID
Method EPA-9 RSK-175

Client Name: Parsons Engineering Science
Client ID: BX-MW-03 (0.00,0.00)
LAB ID: 059558-0008-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: N/A Analyzed: 27 MAR 98
Instrument: GCFID-K1A Dilution: 25

Parameter	Result	Qualifier	RL	MDL	Units
Methane	1200	B	12	1.3	ug/L

B = Compound is also detected in the blank.

Reported By: Quanterra-Austin Approved By: Cynthia Prentice

Quanterra
Environmental Services

Method EPA-9 RSK-175 by GC/FID
Method EPA-9 RSK-175

Client Name: Parsons Engineering Science
Client ID: MW-01 (0.00,0.00)
LAB ID: 059558-0011-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: N/A Analyzed: 27 MAR 98
Instrument: GCFID-K1A Dilution: 1.0

Parameter	Result	Qualifier	RL	MDL	Units
Methane	17	B	0.50	0.052	ug/L

B = Compound is also detected in the blank.

Reported By: Quanterra-Austin Approved By: Cynthia Prentice

Quanterra
Environmental Services

Method EPA-9 RSK-175 by GC/FID
Method EPA-9 RSK-175

Client Name: Parsons Engineering Science
Client ID: BX-MW-05 (0.00,0.00)
LAB ID: 059558-0012-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: N/A Analyzed: 27 MAR 98
Instrument: GCFID-K1A Dilution: 75

Parameter	Result	Qualifier	RL	MDL	Units
Methane	4300	B	38	3.9	ug/L

B = Compound is also detected in the blank.

Reported By: Quanterra-Austin Approved By: Cynthia Prentice

Quanterra
Environmental Services

Method EPA-9 RSK-175 by GC/FID
Method EPA-9 RSK-175

Client Name:	Parsons Engineering Science		
Client ID:	BX-MW-08-97 (0.00,0.00)		
LAB ID:	059558-0013-SA		
Matrix:	GRND-H2O	Sampled: 22 MAR 98	Received: 23 MAR 98
Authorized:	24 MAR 98	Prepared: N/A	Analyzed: 27 MAR 98
Instrument:	GCFID-K1A	Dilution: 1.0	

Parameter	Result	Qualifier	RL	MDL	Units
Methane	18	B	0.50	0.052	ug/L

B = Compound is also detected in the blank.

Reported By: Quanterra-Austin

Approved By: Cynthia Prentice

Quanterra
Environmental Services

Method EPA-9 RSK-175 by GC/FID
Method EPA-9 RSK-175

Client Name: Parsons Engineering Science
Client ID: BX-MW-07 (0.00.0.00)
LAB ID: 059558-0014-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: N/A Analyzed: 27 MAR 98
Instrument: GCFID-K1A Dilution: 20

Parameter	Result	Qualifier	RL	MDL	Units
Methane	420	B	10	1.0	ug/L

B = Compound is also detected in the blank.

Reported By: Quanterra-Austin Approved By: Cynthia Prentice

Quanterra
Environmental Services

Method EPA-9 RSK-175 by GC/FID
Method EPA-9 RSK-175

Client Name: Parsons Engineering Science
Client ID: MP-1 (0.00,0.00)
LAB ID: 059558-0016-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: N/A Analyzed: 27 MAR 98
Instrument: GCFID-K1A Dilution: 50

Parameter	Result	Qualifier	RL	MDL	Units
Methane	1600	B	25	2.6	ug/L

B = Compound is also detected in the blank.

Reported By: Quanterra-Austin Approved By: Cynthia Prentice

Quanterra
Environmental Services

QC LOT ASSIGNMENT REPORT
Subcontracted to Quanterra Lab

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
059558-0001-SA	AQUEOUS	GAS-AUS-A	27 MAR 98-S1	27 MAR 98-S1
059558-0002-SA	AQUEOUS	GAS-AUS-A	27 MAR 98-S1	27 MAR 98-S1
059558-0006-SA	AQUEOUS	GAS-AUS-A	27 MAR 98-S1	27 MAR 98-S1
059558-0008-SA	AQUEOUS	GAS-AUS-A	27 MAR 98-S1	27 MAR 98-S1
059558-0011-SA	AQUEOUS	GAS-AUS-A	27 MAR 98-S1	27 MAR 98-S1
059558-0011-MS	AQUEOUS	GAS-AUS-A	27 MAR 98-S1	27 MAR 98-S1
059558-0011-SD	AQUEOUS	GAS-AUS-A	27 MAR 98-S1	27 MAR 98-S1
059558-0012-SA	AQUEOUS	GAS-AUS-A	27 MAR 98-S1	27 MAR 98-S1
059558-0013-SA	AQUEOUS	GAS-AUS-A	27 MAR 98-S1	27 MAR 98-S1
059558-0014-SA	AQUEOUS	GAS-AUS-A	27 MAR 98-S1	27 MAR 98-S1
059558-0016-SA	AQUEOUS	GAS-AUS-A	27 MAR 98-S2	27 MAR 98-S2

Quanterra
Environmental Services

LABORATORY CONTROL SAMPLE REPORT
Subcontracted to Quanterra Lab
Project: 059558

Category: GAS-AUS-A Gases by Method AUS GC-0019 (Quanterra-Austin)
Matrix: AQUEOUS
Date Analyzed: 27 MAR 98
QC Run: 27 MAR 98-S1
Concentration Units: ug/L

Analyte	Concentration Spiked	Concentration Measured	Accuracy(%) LCS	Accuracy(%) Limits
Methane	34.5	32.1	93	70-130
Ethane	64.7	55.8	86	70-130
Ethene	60.4	52.7	87	70-130

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental Services

DUPLICATE CONTROL SAMPLE REPORT
Subcontracted to Quanterra Lab
Project: 059558

Category: GAS-AUS-A Gases by Method AUS GC-0019 (Quanterra-Austin)
Matrix: AQUEOUS
QC Lot: 27 MAR 98-S2
Concentration Units: ug/L

Date Analyzed: 27 MAR 98

Analyte	Concentration Spiked	Measured DCS1	Qual	DCS2	Qual	AVG	Accuracy Average(%) DCS	Limits	Precision (RPD) DCS	Limit
Methane	34.1	30.7		30.7		30.7	90	70-130	0.06	30
Ethane	63.9	53.1		53.2		53.1	83	70-130	0.24	30
Ethene	59.7	50.8		51.0		50.9	85	70-130	0.29	30

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental Services

METHOD BLANK REPORT
Subcontracted to Quanterra Lab
Project: 059558

Test: GASES-AUSTIN-MDL-A Method EPA-9 RSK-175 by GC/FID
Matrix: AQUEOUS
QC Lot: 27 MAR 98-S1 QC Run: 27 MAR 98-S1 Date Analyzed:

Analyte	Result		Units	RL	MDL
Methane	0.12	J	ug/L	0.50	0.052

QC Lot: 27 MAR 98-S2 QC Run: 27 MAR 98-S2 Date Analyzed: 27 MAR 98

Analyte	Result		Units	RL	MDL
Methane	0.15	J	ug/L	0.50	0.052

J = Result is detected below the reporting limit or is an estimated concentration.

Quanterra
Environmental Services

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC REPORT
Subcontracted to Quanterra Lab
Project: 059558

Category: GAS-AUS-A Gases by Method AUS GC-0019 (Quanterra-Austin)
Matrix: AQUEOUS
Sample: 059558-0011
MS Run: 27 MAR 98-S1
Units: ug/L

Analyte	Concentration Sample Result	MS Result	MSD Result	Amount Spiked MS	Amount Spiked MSD	% Recovery MS	% Recovery MSD	Recov. Accep. Limits	RPD MS-MSD	RPD Accept Limits
Methane	17 B	53.1 B	56.1 B	33.8	34.2	107	114	70-130	4.4	30

B = Compound is also detected in the blank.
NA = Not Applicable
NC = Not Calculated, calculation not applicable.
ND = Not Detected

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental Services

Method FL-PRO - TPH (C8-C40)
Method FL-PRO

Client Name: Parsons Engineering Science
Client ID: BX-MW-20 (0.00,0.00)
LAB ID: 059558-0001-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 26 MAR 98 Analyzed: 03 APR 98
Instrument: GCFID-I Dilution: 4.0

Parameter	Result	Qualifier	RL	MDL	Units
TPH (C8-C40)	20		2.0	0.76	mg/L

Surrogate	Recovery		Acceptable Range
o-Terphenyl	99	%	33 - 162
Nonatriacontane	89	%	10 - 109

Reported By: Quanterra-Tampa

Approved By: Lynn S. Calvin

Quanterra
Environmental Services

Method FL-PRO - TPH (C8-C40)
Method FL-PRO

Client Name: Parsons Engineering Science
Client ID: BX-MP-2 (0.00,0.00)
LAB ID: 059558-0002-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 26 MAR 98 Analyzed: 03 APR 98
Instrument: GCFID-I Dilution: 4.0

Parameter	Result	Qualifier	RL	MDL	Units
TPH (C8-C40)	19		2.0	0.76	mg/L

Surrogate	Recovery		Acceptable Range
o-Terphenyl	92	%	33 - 162
Nonatriacontane	87	%	10 - 109

Reported By: Quanterra-Tampa

Approved By: Lynn S. Calvin

Quanterra
Environmental Services

Method 504 - EDB
Method 504

Client Name: Parsons Engineering Science
Client ID: FT-16, MP-1 (0.00,0.00)
LAB ID: 059558-0003-SA
Matrix: GRND-H2O Sampled: 21 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 31 MAR 98 Analyzed: 31 MAR 98
Instrument: GCFID-I Dilution: 1.0

Parameter	Result	Qualifier	RL	MDL	Units
EDB (1,2-Dibromoethane)	ND		0.020	0.0060	ug/L

Surrogate	Recovery		Acceptable Range
1,1,1,2-Tetrachloroethane	89.0	%	80 - 120

ND = Not Detected

Reported By: Quanterra-Tampa

Approved By: Lynn S. Calvin

Quanterra
Environmental Services

Method FL-PRO - TPH (C8-C40)
Method FL-PRO

Client Name: Parsons Engineering Science
Client ID: FT-16, MP-1 (0.00,0.00)
LAB ID: 059558-0003-SA
Matrix: GRND-H2O Sampled: 21 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 26 MAR 98 Analyzed: 02 APR 98
Instrument: GCFID-I Dilution: 1.0

Parameter	Result	Qualifier	RL	MDL	Units
TPH (C8-C40)	0.18	J	0.50	0.19	mg/L

Surrogate	Recovery		Acceptable Range
o-Terphenyl	99	%	33 - 162
Nonatriacontane	53	%	10 - 109

J = Result is detected below the reporting limit or is an estimated concentration.

Reported By: Quanterra-Tampa Approved By: Lynn S. Calvin

Quanterra
Environmental Services

Method 504 - EDB
Method 504

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, MP-2 (0.00,0.00)		
LAB ID:	059558-0004-SA		
Matrix:	GRND-H2O	Sampled: 21 MAR 98	Received: 23 MAR 98
Authorized:	24 MAR 98	Prepared: 31 MAR 98	Analyzed: 31 MAR 98
Instrument:	GCFID-I	Dilution: 1.0	

Parameter	Result	Qualifier	RL	MDL	Units
EDB (1,2-Dibromoethane)	ND		0.020	0.0060	ug/L

Surrogate	Recovery		Acceptable Range
1,1,1,2-Tetrachloroethane	122	%	80 - 120

ND = Not Detected

Reported By: Quanterra-Tampa

Approved By: Lynn S. Calvin

Quanterra
Environmental Services

Method FL-PRO - TPH (C8-C40)
Method FL-PRO

Client Name: Parsons Engineering Science
Client ID: FT-16, MP-2 (0.00,0.00)
LAB ID: 059558-0004-SA
Matrix: GRND-H2O Sampled: 21 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 26 MAR 98 Analyzed: 02 APR 98
Instrument: GCFID-I Dilution: 1.0

Parameter	Result	Qualifier	RL	MDL	Units
TPH (C8-C40)	ND		0.50	0.19	mg/L

Surrogate	Recovery		Acceptable Range
o-Terphenyl	97	%	33 - 162
Nonatriacontane	55	%	10 - 109

ND = Not Detected

Reported By: Quanterra-Tampa Approved By: Lynn S. Calvin

Quanterra
Environmental Services

Method FL-PRO - TPH (C8-C40)
Method FL-PRO

Client Name: Parsons Engineering Science
Client ID: BX-MW-03 (0.00,0.00)
LAB ID: 059558-0008-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 26 MAR 98 Analyzed: 03 APR 98
Instrument: GCFID-I Dilution: 5.0

Parameter	Result	Qualifier	RL	MDL	Units
TPH (C8-C40)	41		2.5	0.95	mg/L

Surrogate	Recovery		Acceptable Range
o-Terphenyl	ND	%	33 - 162
Nonatriacontane	ND	%	10 - 109

ND = Not Detected

Reported By: Quanterra-Tampa Approved By: Lynn S. Calvin

Quanterra
Environmental Services

Method FL-PRO - TPH (C8-C40)
Method FL-PRO

Client Name: Parsons Engineering Science
Client ID: BX-MW-03-97 (0.00,0.00)
LAB ID: 059558-0009-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 26 MAR 98 Analyzed: 02 APR 98
Instrument: GCFID-I Dilution: 1.0

Parameter	Result	Qualifier	RL	MDL	Units
TPH (C8-C40)	ND		0.50	0.19	mg/L

Surrogate	Recovery		Acceptable Range
o-Terphenyl	104	%	33 - 162
Nonatriacontane	72	%	10 - 109

ND = Not Detected

Reported By: Quanterra-Tampa Approved By: Lynn S. Calvin

Quanterra
Environmental Services

Method FL-PRO - TPH (C8-C40)
Method FL-PRO

Client Name: Parsons Engineering Science
Client ID: BX-MW-05-97 (0.00,0.00)
LAB ID: 059558-0010-SA
Matrix: GRND-H2O Sampled: 22 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 26 MAR 98 Analyzed: 03 APR 98
Instrument: GCFID-I Dilution: 1.0

Parameter	Result	Qualifier	RL	MDL	Units
TPH (C8-C40)	ND		0.50	0.19	mg/L

Surrogate	Recovery		Acceptable Range
o-Terphenyl	92	%	33 - 162
Nonatriacontane	75	%	10 - 109

ND = Not Detected

Reported By: Quanterra-Tampa Approved By: Lynn S. Calvin

Quanterra
Environmental Services

QC LOT ASSIGNMENT REPORT
Sent OUT to Subcontractors

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
059558-0001-SA	AQUEOUS	TPHFLPROA	26 MAR 98-S1	26 MAR 98-S1
059558-0002-SA	AQUEOUS	TPHFLPROA	26 MAR 98-S1	26 MAR 98-S1
059558-0003-SA	AQUEOUS	TPHFLPROA	26 MAR 98-S1	26 MAR 98-S1
059558-0003-SA	AQUEOUS	504-PAR-A	31 MAR 98-S1	31 MAR 98-S1
059558-0004-SA	AQUEOUS	TPHFLPROA	26 MAR 98-S1	26 MAR 98-S1
059558-0004-SA	AQUEOUS	504-PAR-A	31 MAR 98-S1	31 MAR 98-S1
059558-0008-SA	AQUEOUS	TPHFLPROA	26 MAR 98-S1	26 MAR 98-S1
059558-0009-SA	AQUEOUS	TPHFLPROA	26 MAR 98-S1	26 MAR 98-S1
059558-0010-SA	AQUEOUS	TPHFLPROA	26 MAR 98-S1	26 MAR 98-S1
059558-0010-MS	AQUEOUS	TPHFLPROA	26 MAR 98-S1	26 MAR 98-S1
059558-0010-SD	AQUEOUS	TPHFLPROA	26 MAR 98-S1	26 MAR 98-S1

Quanterra
Environmental Services

DUPLICATE CONTROL SAMPLE REPORT
Sent OUT to Subcontractors
Project: 059558

Category: TPHFLPROA TPH - Method FL-PRO - Florida TPH Method
Matrix: AQUEOUS
QC Lot: 26 MAR 98-S1
Concentration Units: mg/L

Date Analyzed: 02 APR 98

Analyte	Concentration Spiked	Measured DCS1 Qual	DCS2 Qual	AVG	Accuracy Average(%) DCS	Limits	Precision (RPD) DCS	Limit
TPH (C8-C40)	1.70	1.70	1.53	1.62	95	55-118	11	20

Surrogate	Concentration Spiked	Measured DCS1 Qual	DCS2 Qual	Accuracy Average(%) DCS	Limits
o-Terphenyl	0.100	0.102	0.0938	98	33-162
Nonatriacontane	0.600	0.318	0.366	57	10-109

Category: 504-PAR-A EDB - Method 504 - Cape Canaveral
Matrix: AQUEOUS
QC Lot: 31 MAR 98-S1
Concentration Units: ug/L

Date Analyzed: 31 MAR 98

Analyte	Concentration Spiked	Measured DCS1 Qual	DCS2 Qual	AVG	Accuracy Average(%) DCS	Limits	Precision (RPD) DCS	Limit
EDB (1,2-Dibromoethane)	0.200	0.200	0.206	0.203	102	75-126	3.0	20

Surrogate	Concentration Spiked	Measured DCS1 Qual	DCS2 Qual	Accuracy Average(%) DCS	Limits
1,1,1,2-Tetrachloroethane	0.400	0.432	0.427	107	80-120

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental Services

SINGLE CONTROL SAMPLE REPORT
Sent OUT to Subcontractors

Analyte	Concentration Spiked	Measured	Accuracy(%) SCS	Limits
Category: TPHFLPROA				
Matrix: AQUEOUS				
QC Lot: 26 MAR 98-S1 QC Run: 26 MAR 98-S1				
Concentration Units: mg/L				
o-Terphenyl	0.100	0.0987	99	33-162
Nonatriacontane	0.600	0.382	64	10-109
Category: 504-PAR-A				
Matrix: AQUEOUS				
QC Lot: 31 MAR 98-S1 QC Run: 31 MAR 98-S1				
Concentration Units: ug/L				
1,1,1,2-Tetrachloroethane	0.400	0.417	104	80-120

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental Services

METHOD BLANK REPORT
Sent OUT to Subcontractors
Project: 059558

Test: TPH-FL-PRO-OUT-A Method FL-PRO - TPH (C8-C40)
Matrix: AQUEOUS
QC Lot: 26 MAR 98-S1 QC Run: 26 MAR 98-S1 Date Analyzed: 02 APR 98

Analyte	Result	Units	RL	MDL
TPH (C8-C40)	ND	mg/L	0.50	0.19

Test: 504-PAR-OUT-A Method 504 - EDB
Matrix: AQUEOUS
QC Lot: 31 MAR 98-S1 QC Run: 31 MAR 98-S1 Date Analyzed: 31 MAR 98

Analyte	Result	Units	RL	MDL
EDB (1,2-Dibromoethane)	ND	ug/L	0.020	0.0060

ND = Not Detected

Quanterra
Environmental Services

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC REPORT
Sent OUT to Subcontractors
Project: 059558

Category: TPHFLPROA TPH - Method FL-PRO - Florida TPH Method
Matrix: AQUEOUS
Sample: 059558-0010
MS Run: 26 MAR 98-S1
Units: mg/L

Analyte	Sample Result	Concentration MS Result	Concentration MSD Result	Amount Spiked MS	Amount Spiked MSD	% Recovery MS	% Recovery MSD	Recov. Accep. Limits	RPD MS-MSD	RPD Accept Limits
TPH (C8-C40)	ND	3.2	3.7	3.4	3.4	94	108	41-101	15	20
Surrogates		%Recovery				Rec. Accept. Limits				
o-Terphenyl	92.0	95.2	110			33-162				
Nonatriacontane	75.0	55.8	54.9			10-109				

ND = Not Detected

Calculations are performed before rounding to avoid round-off errors in calculated results.

Chain of Custody Record

59558

Quanterra

QUA-4124 0797

Client: PARSONS ES	Project Manager: BRAD LEWIS	Date: 3/23/98	Chain of Custody Number: 02284
Address: 5390 TRIANGLE PKWY	Telephone Number (Area Code)/Fax Number: (678) 969-2489 / (770) 446-4910	Lab Number:	Page 1 of 1
City: NORCROSS / State: GA / Zip Code: 30092	Site Contact:	Lab Contact: LaRiviere	
Project Name: TYNDALL - BX SERVICE STATION	Carrier/Waybill Number:		
Contract/Purchase Order/Quote No.			

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix: Aqueous	Sed.	Soil	Containers & Preservatives: Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/NaOH	Analysis (Attach list if more space is needed): BTEX + MTBE Sprue	PAH 8310	TRPH FL-PRO	TOT LEAD 7421	NITRATE 300.0	METHANE RSK
1 BX-MP-20	3/22/98	0700	X			3		1	B			X	X	X	X	X	X
2 BX-MP-2	3/22/98	0730	X			3		1	B			X	X	X	X	X	X

Special Instructions/ Conditions of Receipt

Possible Hazard Identification: [X] Non-Hazard [ ] Flammable [ ] Skin Irritant [ ] Poison B [ ] Unknown

Sample Disposal: [ ] Return To Client [ ] Disposal By Lab [ ] Archive For _____ Months (A fee may be assessed if samples are retained longer than 3 months)

Turn Around Time Required: [ ] 24 Hours [ ] 48 Hours [ ] 7 Days [ ] 14 Days [ ] 21 Days [ ] Other _____

QC Requirements (Specify)

	Date	Time		Date	Time
1. Relinquished By	3/23/98	0600	1. Received By: Anna M. Weber	3/23/98	1510
2. Relinquished By			2. Received By		
3. Relinquished By			3. Received By		

Comments

DISTRIBUTION: WHITE - Stays with the Sample; CANARY - Returned to Client with Report; PINK - Field Copy

A 110

59558

Chain of Custody Record

Quanterra

QUA-4124 0797

Client: PARSONS ES	Project Manager: BRAD LEWIS	Date: 3/23/98	Chain of Custody Number: 02285
Address: 5390 TRIANGLE PKWY	Telephone Number (Area Code)/Fax Number: (678) 969-2489 / (770) 446-4910		Lab Number:
City: NORCROSS / State: GA / Zip Code: 30092	Site Contact:	Lab Contact: LaRivierre	Page 1 of 1
Project Name: TYNDALL - FT-16	Carrier/Waybill Number:		
Contract/Purchase Order/Quote No.			

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix: Aqueous	Sed.	Soil	Containers & Preservatives: Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/NaOH	Analysis: BTEX + MTBE 8020	PAH 8310	EDB 8011	10 Lead 7421	TRPH 418.1	Nitrate 300.0	Methane RSK-175
3 FT-16, MP-1	3/21/98	0900	X			5		1	5			X	X	X	X	X		
4 FT-16, MP-2	3/21/98	1000	X			5		1	5			X	X	X	X	X		
5 FT-16, SB-2	3/21/98	1115	X						3			X						
6 FT-16, MP-3	3/21/98	1215	X						6			X						X
FT-16, MP-3	3/22/98	0700	X			1											X	

Special Instructions/ Conditions of Receipt

Possible Hazard Identification: [X] Non-Hazard [ ] Flammable [ ] Skin Irritant [ ] Poison B [ ] Unknown

Sample Disposal: [ ] Return To Client [ ] Disposal By Lab [ ] Archive For ____ Months (A fee may be assessed if samples are retained longer than 3 months)

Turn Around Time Required: [ ] 24 Hours [ ] 48 Hours [ ] 7 Days [ ] 14 Days [ ] 21 Days [ ] Other ____

QC Requirements (Specify): (23)

1. Relinquished By	Date: 3/23/98	Time: 0600	1. Received By: Anna Marie Weber	Date: 3/23/98	Time: 1613 3:52 144
2. Relinquished By	Date	Time	2. Received By	Date	Time
3. Relinquished By	Date	Time	3. Received By	Date	Time

Comments

DISTRIBUTION: WHITE - Stays with the Sample; CANARY - Returned to Client with Report; PINK - Field Copy

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CHAIN OF CUSTODY RECORD / ANALYTICAL SERVICES REQUEST

59558

Page 1 of 1

~~Evergreen Analytical Inc.~~ QUANTERRA (303) 421-1025

~~4036 Youngfield Str~~
~~Wheat Ridge, Colorado 80033~~
~~(303) 425-6021~~
~~FAX (303) 425-6854~~
~~(800) 645-7400~~

COMPANY PARSONS ES
ADDRESS 5390 TRIANGLE PKWY
CITY NORCROSS STATE GA ZIP 30092
PHONE# 678 969 2489 FAX # 770 446 4910 FAX RESULTS Y / N

CLIENT CONTACT (print) BRAD LEWIS
PROJECT I.D. 731854.10
P.O. #
TURNAROUND REQUIRED* STANDARD
*expedited turnaround subject to additional fee

Sampler Name:
(signature)
(print) Brad Lewis
Evergreen Analytical Cooler No.
Cooler Received

Please **PRINT** all information:

	CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	MATRIX: Water-Drinking/Discharge/Ground (circle)	MATRIX: Soil / Solid	MATRIX: Oil / Sludge	TCLP VOA/BNA/Pest/Herb/Metals (circle)	VOA 8260/624/524.2 (circle)	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	Herbicides 8150/515 (circle)	PCB Screen	BTEX 8020/602 (circle) MTBE (circle)	TAPH 418.1/Oil & Grease 413.1 (circle)	TVPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (Circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	METHANE RSK-175	NITRATE 300.0	TOT ALK 310.1	PAH 8310				EAL Sample No.
98	BX-MW-03	3/22/98	1315	12	X										X	X					X	X	X	X				
99	BX-MW-03-97	3/22/98	1630	8	X										X	X							X	X				
	HT:																										Location	
	DD:																										Container Size	

EAL use only
Do not write in shaded area

EAL
Project #
Custodian

Instructions:

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
[redacted]	3/23/98 0600	Anne M. Weber	3/23/98 1445				

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CHAIN OF CUSTODY RECORD / ANALYTICAL SERVICES REQUEST

59558

Page 1 of 1

~~Evergreen Analytical Inc.~~ QUANTERRA (303) 421-1025

~~4036 Youngfield St.~~
~~Wheat Ridge, Colorado 80033~~
~~(303) 425-6021~~
~~FA : (303) 425-6854~~
~~(800) 334-7490~~

COMPANY PARSONS ES
ADDRESS 5390 TRIANGLE
CITY NORCROSS STATE GA ZIP 30071
PHONE# 678 969 2489 FAX # 770 446 4910 FAX RESULTS Y / N

CLIENT CONTACT (print) BRAD LEWIS
CLIENT PROJ. I.D. 731854.10
EAL. QUOTE # _____ P.O.# _____
TURNAROUND REQUIRED* ~~X~~ STD ~~(2 wks)~~ ☐ UST
☐ Other (Specify)* _____
*expedited turnaround subject to additional fee

Sampler Name (signature) _____
(print) Brad Lewis

Please **PRINT** all information:

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	Water-Drinking/Discharge/Ground (circle)	Soil / Solid / Air / Gas	Oil / Sludge / Multi-phase	TCLP VCA/BNA/Pest./Herb/Metals (circle)	VCA 8260/624/524.2 (circle)	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	PesPCBs 8080/608/508 (circle)	PCB Screen	Herbicides 8150/515 (circle)	BTEX 8020/602 (circle)/MTBE	TVPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	total Metals-DW / NPDES / SW846 (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	Oil & Grease 413.1	~~TRPH 418.1~~ FLPRO	METHANE RSK-175	NITRATE 300.0	TOT LEAD 7421	PAH 8310	1874
~~BX-MW-05~~	~~3/22/98~~	0845	7	X										X							X	X			
BX-MW-05-97	3/22/98	1000	24	X										X						X			X	X	

Sample Fraction
Instructions: Container
BX-MW-05-97- IS MS/MSD

For Laboratory use only
W.O. # _____
B.O.F. # _____
C/S (O) _____ / _____
C/S (I) _____ / _____
Cooler Temp. °C _____
Seals Intact Y / N / NA
Samples Pres. Y / N / NA
Headspace Y / N / NA
By _____ / _____
Loc

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
[signature]	3/23/98/0800	Anna M. Wilcox	3/23/98 1445	KB			

CHAIN OF CUSTODY RECORD / ANALYTICAL SERVICES REQUEST

59558

Page 1 of 1

Evergreen Analytical Inc.
4036 Youngfield St.
Wheat Ridge, Colorado 80033
(800) 423-6021
FAX (303) 425-6854
(800) 845-7400

COMPANY PARSONS ES
ADDRESS 5390 TRIANGLE PKWY
CITY NORCROSS STATE GA ZIP 30092
PHONE# 678 969 2489 FAX # 770 446 4910 FAX RESULTS Y / N

CLIENT CONTACT (print) BRAD LEWIS
PROJECT I.D. 731854.10
P.O. #
TURNAROUND REQUIRED* STANDARD
*expedited turnaround subject to additional fee

Sampler Name:
(signature)
(print) BRAD LEWIS
Evergreen Analytical Cooler No.
Cooler Received

Please **PRINT** all information:

MS/MSD	CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	MATRIX: Water-Drinking/Discharge/Ground (circle)	MATRIX: Soil / Solid	MATRIX: Oil / Sludge	ANALYSIS REQUESTED: TCLP VOA/BNA/Pest/Herb/Metals (circle)	VOA 8260/624/524.2 (circle)	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	Herbicides 8150/515 (circle)	PCB Screen	BTEX 8020/602 (circle) MTBE (circle)	TRPH 418.1/modified GC/FID 418.1 (circle)	TVPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	METHANE RSK-175	NITRATE 300.0	TOT LEAD 7421	PART 8310	EAL Sample No.
X	MW-01	3/22/98	1130	21	X									X	X						X	X			
2	BX-MW-05	3/22/98	0845	7	X									X	X						X	X			
DUP 3	BX-MW-08-97	3/22/98	1430	7	X									X	X						X	X			
4	BX-MW-07-	3/22/98	1530	7	X									X	X						X	X			
5	MP-3	3/22/98	1730	3	X									X											
6	MP-1	3/22/98	1830	7	X									X	X						X	X			

EAL use only
Do not write in shaded area

EAL
Project #
Custodian

HT:
DD:

Location
Container Size

Instructions:

MW-01 IS A MS/MSD

Relinquished: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
	3/23/98	0600 Anna M. Wilson		3/23/98		

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Quanterra

SAMPLE CHECKLIST

(23 bottles and 4127 and 4127)

Project #: 059558 Date/Time Received: 3-23-98 1445

Company Name & Sampling Site: Carson E.S - GA

*Cooler #(s):	#1	#2	#3	#4	#5			
Temperatures:	4.1°	3.3°	5.5°	3.7°	1.3°			

Unpacking & Labeling Check Points:

N/A	Yes	No		Initials
	☑	☐	1. Radiation checked, record if reading > 0.5 mR/hr. (_____mR/hr)	KB
	☐	☐	2. Cooler seals intact.	
	☐	☐	3. Chain of custody present.	
	☐	☑	4. Bottles broken and/or are leaking, comment if yes.	
			PHOTOGRAPH BROKEN BOTTLES	
	☑	☐	5. Containers labeled, comment if no.	
	☐	☐	6. pH of all samples checked and meet requirements, note exceptions.	
	☐	☐	7. Chain of custody includes "received by" and "relinquished" by signatures, dates, and times.	
	☐	☐	8. Receipt date(s) > 48 hours past the collection date(s)? If yes, notify PA/PM. Cole	
	☐	☐	9. Chain of custody agrees with bottle count, comment if no.	
	☐	☐	10. Chain of custody agrees with labels, comment if no.	
☐	☐	☐	11. VOA samples filled completely, comment if no.	
☐	☐	☐	12. VOA bottles preserved, check for labels.	
	☐	☐	13. Did samples require preservation with sodium thiosulfate?	
☐	☐	☐	14. If yes to #12, did the samples contain residual chlorine?	
☐	☐	☐	15. Sediment present in "D," dissolved. bottles.	
	☐	☐	16. Are analyses with short holding times requested?	
☐	☐	☐	17. Is extra sample volume provided for MS. MSD or matrix duplicates?	
	☐	☐	18. Multiphase samples present? If yes. comment below.	
	☐	☐	19. Any subsampling for volatiles? If yes, list samples.	
			PHOTOGRAPH MULTIPHASE SAMPLES	
	☐	☐	20. Clear picture taken, labeled. and stapled to project folder.	
☐	☐	☐	21. Subout COC signed and sent with samples to bottle prep?	KB
	☐	☐	22. Was sample labeling double checked?	KB

Comments: Include action taken to resolve discrepancies/problems. Include a hard copy of e-mail or use extra paper if more space is needed. Too was called #'s on COC Chain - Lif 3 vials broken

Initials: _____

APPENDIX C
FIELD FORMS FROM MARCH 1998 FIELD EFFORT

BORING NO.: SB-7 CONTRACTOR: PARSONS DATE SPUD: 3/18/98
CLIENT: AFLEE RIG TYPE: GEOPROBE DATE CMPL.: 3/18/98
JOB NO.: 731854.09 DRLG METHOD: DP ELEVATION:
LOCATION: BY SEAUSTA BORING DIA.: 2" TEMP:
GEOLOGIST: B LEWIS DRLG FLUID: — WEATHER: RAIN
COMENTS:

Elev (ft)	Depth (ft)	Pro-file	US CS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
	1		1030	0-2 SAND, fine orange red to dark grey, DRY loose no odor					0			
	5		1035	2-4 SAND, fine, grey to tan, DRY, loose, no odor					0			
	10		1040	4-6 SAND, fine, grey-brown to brown, water at ≃ 5' BGS, loose, no odor					0			
	15		1045	6-8 SAND, fine, tan-brown, wet, loose, no odor					0			
	20		1055	?-11 SAA					0			
	25											
	30											
	35											

NOTES
bgs – Below Ground Surface
GS – Ground Surface
TOC – Top of Casing
NS – Not Sampled
SAA – Same As Above

SAMPLE TYPE
D – DRIVE
C – CORE
G – GRAB

▼ Water level drilled

ENGINEERING-SCIENCE, INC.

94DN0155, 02/28/94 at 10:52

BORING NO.: SB-2 CONTRACTOR: PARSONS DATE SPUD: 3/18/94
CLIENT: ~~PARSONS ARDE~~ RIG TYPE: GEOPROBE DATE CMPL.: 3/18/94
JOB NO.: ~~A-731854.09~~ DRLG METHOD: DP ELEVATION:
LOCATION: BX SEAD SITE BORING DIA.: 2" TEMP:
GEOLOGIST: B LEWIS DRLG FLUID: WEATHER: RAIN
COMENTS:

Elev (ft)	Depth (ft)	Pro-file	US CS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
	1		1245	0-2 SAND, fine, lt brown to brown, loose, moist, no odor					0			
	5								0			
			1250	2-4 SAA								
	10		1255	4-6 SAA wet at BOTTOM					0			
			1300	6-7 SAA					0			
	15											
	20											
	25											
	30											
	35											

NOTES
bgs – Below Ground Surface
GS – Ground Surface
TOC – Top of Casing
NS – Not Sampled
SAA – Same As Above

SAMPLE TYPE
D – DRIVE
C – CORE
G – GRAB

▼ Water level drilled

ENGINEERING-SCIENCE, INC.

94DN0155, 02/28/94 at 10:52

BORING NO.: CB-3 CONTRACTOR: DAWSONS DATE SPUD: 3/18/98
CLIENT: AFLOE RIG TYPE: GEOPROBE DATE CMPL.: 3/18/98
JOB NO.: 231854.09 DRLG METHOD: DP ELEVATION:
LOCATION: BX SERV STA BORING DIA.: 2" TEMP:
GEOLOGIST: B LEWIS DRLG FLUID: WEATHER: RAIN
COMENTS:

Elev (ft)	Depth (ft)	Pro-file	US CS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
	1											
				1315 0-2 SAND, brown, loose					0			
	5			1320 2-4 SAA w/ odor					107			
				1325 4-6 SAA					0			
	10											
				1330 6-8 SAA					0			
	15											
	20											
	25											
	30											
	35											

NOTES
bgs – Below Ground Surface
GS – Ground Surface
TOC – Top of Casing
NS – Not Sampled
SAA – Same As Above

SAMPLE TYPE
D – DRIVE
C – CORE
G – GRAB

▼ Water level drilled

ENGINEERING-SCIENCE, INC.

94DN0155, 02/28/94 at 10:52

BORING NO.: SB-4 CONTRACTOR: PARSONS DATE SPUD: 3/18/98
CLIENT: AMOCO RIG TYPE: GEOPROBE DATE CMPL.: 3/18/98
JOB NO.: 731854.09 DRLG METHOD: DP ELEVATION:
LOCATION: BP SEMU STA BORING DIA.: 2" TEMP:
GEOLOGIST: B LEWIS DRLG FLUID: WEATHER: RAIN
COMENTS:

Elev (ft)	Depth (ft)	Pro-file	US CS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
	1	1400		0-2 SAND, dk brown, loose, no odor					0			
	5	1405		2-4 SAND, dk brown loose, strong odor wet					397			
	10	1410		4-6 SAA					380			
	15	1415		6-8 SAA					255			
	20	1510		10-12 SAA				NOT ENOUGH SOIL				
	25											
	30											
	35											

NOTES
bgs – Below Ground Surface
GS – Ground Surface
TOC – Top of Casing
NS – Not Sampled
SAA – Same As Above

SAMPLE TYPE
D – DRIVE
C – CORE
G – GRAB

▼ Water level drilled

ENGINEERING-SCIENCE, INC.

94DN0155, 02/28/94 at 10:52

BORING NO.: SB-5 CONTRACTOR: PARSONS DATE SPUD: 3/18/98
CLIENT: AFCEE RIG TYPE: GEOPROBE DATE CMPL.: 3/18/98
JOB NO.: 731854.09 DRLG METHOD: DP ELEVATION:
LOCATION: BX SERSTA BORING DIA.: 2" TEMP:
GEOLOGIST: B LEWIS DRLG FLUID: — WEATHER: RAIN
COMENTS:

Elev (ft)	Depth (ft)	Pro-file	US CS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
	1											
			1430	0-2 SAND, fine grey, loose, moist no odor					225			
	5											
			1435	2-4 SAND, SAA wet w/odor					334			
	10											
			1440	4-6 SAND H brown to brown strong odor					237			
	15											
			1445	6-8 SAA					35			
	20											
	25											
	30											
	35											

NOTES
bgs – Below Ground Surface
GS – Ground Surface
TOC – Top of Casing
NS – Not Sampled
SAA – Same As Above

SAMPLE TYPE
D – DRIVE
C – CORE
G – GRAB

▼ Water level drilled

ENGINEERING-SCIENCE, INC.

BORING NO.: SB-6 CONTRACTOR: PAULSONS DATE SPUD: 3/18/98
CLIENT: AECOM RIG TYPE: GEOPROBE DATE CMPL.: 3/18/98
JOB NO.: 231854 DRLG METHOD: DP ELEVATION:
LOCATION: BX SER BORING DIA.: 2" TEMP:
GEOLOGIST: B LEWIS DRLG FLUID: — WEATHER: RAIN
COMENTS:

Elev (ft)	Depth (ft)	Pro-file	US CS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
	1			ASPHALT								
			1550	0-2 SAND, fine to coarse, grey, loose, moist to dry, slight odor					0			
	5											
			1555	2-4 SAA, stronger odor					26			
	10											
			1600	4-6 SAA, wet					28			
	15											
			1605	6-8 SAA					129			
	20											
	25											
	30											
	35											

NOTES
bgs – Below Ground Surface
GS – Ground Surface
TOC – Top of Casing
NS – Not Sampled
SAA – Same As Above

SAMPLE TYPE
D – DRIVE
C – CORE
G – GRAB

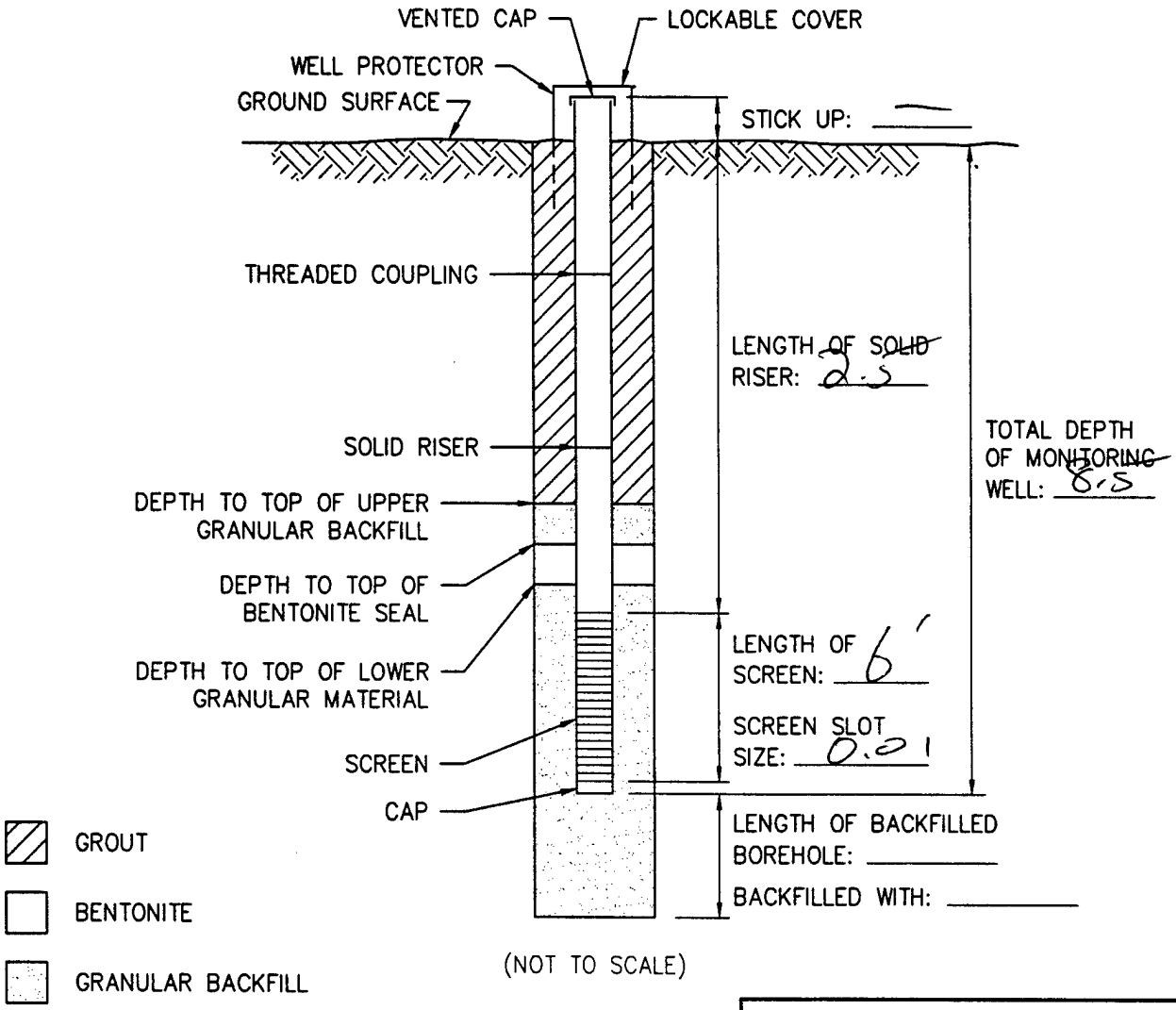
▼ Water level drilled

ENGINEERING-SCIENCE, INC.

94DN0155, 02/28/94 at 10:52

MONITORING WELL INSTALLATION RECORD

JOB NAME TINDALE RESIC WELL NUMBER MP-1
JOB NUMBER 731854 INSTALLATION DATE _____ LOCATION ~~BOX~~ SERV
DATUM ELEVATION _____ GROUND SURFACE ELEVATION _____
DATUM FOR WATER LEVEL MEASUREMENT _____
SCREEN DIAMETER & MATERIAL SCH 80 PVC 0.5" 01A SLOT SIZE 0.01"
RISER DIAMETER & MATERIAL SCH 80 PVC 0.5" 01A BOREHOLE DIAMETER 2"
GRANULAR BACKFILL MATERIAL SAND & BENTONITE ES REPRESENTATIVE B LEWIS
DRILLING METHOD DP DRILLING CONTRACTOR PARSONS



STABILIZED WATER LEVEL _____ FEET
BELOW DATUM.
MEASURED ON _____

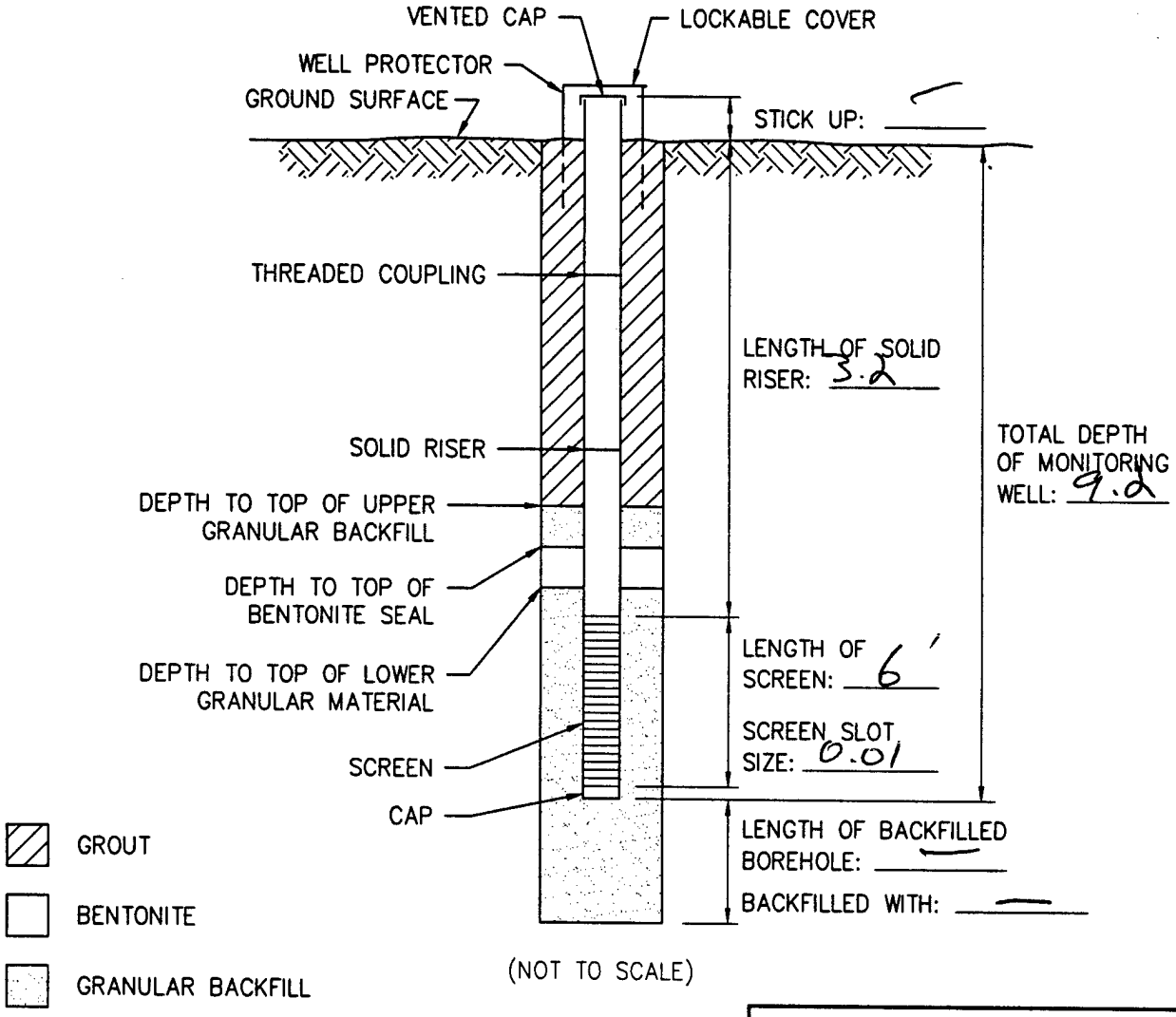
MONITORING WELL
INSTALLATION RECORD

ENGINEERING-SCIENCE, INC.

94DN0199, 03/01/94 at 10:22

MONITORING WELL INSTALLATION RECORD

JOB NAME TYNDALL RBIC WELL NUMBER MP-2
JOB NUMBER 731854 INSTALLATION DATE _____ LOCATION BX SERVICE
DATUM ELEVATION _____ GROUND SURFACE ELEVATION _____
DATUM FOR WATER LEVEL MEASUREMENT _____
SCREEN DIAMETER & MATERIAL SCH 80 PVC 0.5" DIA SLOT SIZE 0.01
RISER DIAMETER & MATERIAL SCH 80 PVC 0.5" BOREHOLE DIAMETER _____
GRANULAR BACKFILL MATERIAL SAND ES REPRESENTATIVE BLOWS
DRILLING METHOD DIRECT PUSH DRILLING CONTRACTOR _____



STABILIZED WATER LEVEL _____ FEET
BELOW DATUM.
MEASURED ON _____

MONITORING WELL
INSTALLATION RECORD

ENGINEERING-SCIENCE, INC.

94DN0199, 03/01/94 at 10:22

MONITORING WELL DEVELOPMENT RECORD

Job Number: 730308.03000
Location PNM - Person Gen. Station
Well Identification BX MP1

Job Name: AFCEE-RNA
by Ray Brammer Date: 3-22-94
Measurement Datum TOC

Pre-Development Information

Time (Start): 1745

Water Level: 4.37

Total Depth of Well: 8.4

Water Characteristics

Color Brown Clear (Cloudy)
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material none
pH 6.76 Temperature (°C) 18.0
Specific Conductance (µS/cm) .281
Dissolved Oxygen (mg/L) 0.43
Redox (mV) -228.4

Interim Water Characteristics

Gallons Removed 2

pH 6.76

Temperature (°C) 18.1

Specific Conductance(µS/cm) .276

Dissolved Oxygen (mg/L) 0.14

Redox (mV) -263.1

Post-Development Information

Time (Finish):

Water Level: 4.2

Total Depth of Well: 8.4

Approximate Volume Removed: ~4.5

Water Characteristics

Color (Clear) Cloudy
Odor: None (Weak) Moderate Strong
Any Films or Immiscible Material none
pH 6.76 Temperature (°C)
Specific Conductance (µS/cm) .273
Dissolved Oxygen (mg/L) 0.16
Redox (mV) -247.3

Comments:

MONITORING WELL DEVELOPMENT RECORD

Job Number: 730308.03000
Location PNM - Person Gen. Station
Well Identification BX-MP2

Job Name: AFCEE-RNA
by Roy Brewer Date: 3-22-98
Measurement Datum TOC

Pre-Development Information

Time (Start): 0600

Water Level: 4.65

Total Depth of Well: 8.7

Water Characteristics

Color Brown Clear (Cloudy)
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material none
pH 6.08 Temperature (°C) 19.4
Specific Conductance (µS/cm) .260
Dissolved Oxygen (mg/L) 0.53
Redox (mV) -171.3

Interim Water Characteristics

Gallons Removed ~2

pH 6.22

Temperature (°C) 20.2

Specific Conductance(µS/cm) ~~.250~~ .238

Dissolved Oxygen (mg/L) 0.24

Redox (mV) -217.1

Post-Development Information

Time (Finish): 0730

Water Level: 4.7

Total Depth of Well: 8.7

Approximate Volume Removed: ~5

Water Characteristics

Color Yellow Clear (Cloudy)
Odor: None Weak (Moderate) Strong
Any Films or Immiscible Material none
pH 6.24 Temperature (°C) 20.3
Specific Conductance (µS/cm) .236
Dissolved Oxygen (mg/L) 0.20
Redox (mV) -214.0

Comments:

GROUNDWATER SAMPLING RECORD

Sampling Location BX MP1
Sampling Dates 3-22-98

GROUND WATER SAMPLING RECORD - MONITORING WELL BX MP1
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 3-22-98, 1998 1830 a.m./p.m.
SAMPLE COLLECTED BY: KDB of Parsons ES
WEATHER: Clear ~ 55°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC TOP OF CASING

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: OK
INNER PVC CASING CONDITION IS: OK
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [X] EQUIPMENT CLEANED BEFORE USE WITH Alconox, DI, ISO, DI
Items Cleaned (List): all instrument probes

2 [Y] PRODUCT DEPTH none FT. BELOW DATUM
Measured with:

WATER DEPTH ~~dry~~ 4.37 FT. BELOW DATUM
Measured with: Slope water level indicator

3 [Y] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Very cloudy brown
Odor: none
Other Comments:

4 [Y] WELL EVACUATION:
Method: pump
Volume Removed: 4.5 gal
Observations: Water (slightly - very) ~~cloudy~~ clear
Water level (rose - fell - no change)
Water odors: weak
Other comments:

Groundwater Sampling Record

Monitoring Well No. BK MP1 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[X] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

Time							Measured With
Temp (°C)	18.0	18.1	18.1	18.1	18.1		YSI 55
pH	6.76	6.76	6.76	6.76	6.76		Orion 250A
Cond (µS/cm)	.281	.277	.276	.273	.273		Hach
Do (mg/L)	0.43	0.11	0.14	0.15	0.16		YSI 55
Redox (mv)	-228.4	-293.2	-263.1	-271.5	-277.3		Orion 250A
gallons purged		1	2	3	4		

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate			
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron			
(7) Total Iron			
(8) Alkalinity			
(9) Carbon Dioxide			
(10) Chloride			

Additional Comments:_____

7 [X] SAMPLE CONTAINERS (material, number, size): 6-40ml glass vials, 1-1 liter poly

8 [X] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____

[X] Preservatives added: HCL BTEX-MTBE
Method Methanol Containers: 40ml vials

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[ ] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

GROUNDWATER SAMPLING RECORD

Sampling Location BX MP3
Sampling Dates 3-22-98

GROUND WATER SAMPLING RECORD - MONITORING WELL BX MP3
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 3-22-98, 1998 _____ a.m./p.m.
SAMPLE COLLECTED BY: of Parsons ES
WEATHER: _____
DATUM FOR WATER DEPTH MEASUREMENT (Describe): Ground surface

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: rusted
INNER PVC CASING CONDITION IS: ok
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[X] MONITORING WELL REQUIRED REPAIR (describe): to be abandoned

Check-off
1 [X] EQUIPMENT CLEANED BEFORE USE WITH Alconox, DI, ISO, DI
Items Cleaned (List): all instrument probes

2 [ ] PRODUCT DEPTH none FT. BELOW DATUM
Measured with: _____

WATER DEPTH 4.6' FT. BELOW DATUM
Measured with: slope water level indicator

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Brown to Black
Odor: none
Other Comments: _____

4 [ ] WELL EVACUATION:
Method: pump
Volume Removed: ~ 3gal
Observations: Water (slightly - (very) cloudy) Brown
Water level (rose - fell - no change)
Water odors: none
Other comments: _____

Groundwater Sampling Record

Monitoring Well No. BX MW3 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[X] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

Time	18.2						Measured With
Temp (°C)	18.2	18.3	18.2				
pH	6.06	6.05	6.05				
Cond (µS/cm)	0.62	0.53	0.52				
Do (mg/L)	0.66	0.49	0.49				
Redox (mv)	-102.5	-126.9	-141.1				
gallons purged		2	3				

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate			
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron			
(7) Total Iron			
(8) Alkalinity			
(9) Carbon Dioxide			
(10) Chloride			

Additional Comments:_____

7 [ ] SAMPLE CONTAINERS (material, number, size): 3-40ml glass vials

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____

[X] Preservatives added: HCL BTEX-MTBE
Method_____ Containers: 40 ml vials

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[ ] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

GROUNDWATER SAMPLING RECORD

Sampling Location Bx mw-03-97
Sampling Dates 3-22-98

GROUND WATER SAMPLING RECORD - MONITORING WELL Bx mw-03-97 (number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 3-22-98, 1998 1630 (a.m.) p.m.
SAMPLE COLLECTED BY: of Parsons ES
WEATHER: Sunny ~62°F Sl. Breeze
DATUM FOR WATER DEPTH MEASUREMENT (Describe): Toc Top of casing

MONITORING WELL CONDITION:

[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - ~~IS NOT~~) APPARENT
STEEL CASING CONDITION IS: OK
INNER PVC CASING CONDITION IS: OK
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [X] EQUIPMENT CLEANED BEFORE USE WITH Alconox, DI, ISO, DI
Items Cleaned (List):

2 [X] PRODUCT DEPTH none FT. BELOW DATUM
Measured with:

WATER DEPTH FT. BELOW DATUM
Measured with:

3 [X] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Clear
Odor: none
Other Comments:

4 [ ] WELL EVACUATION:
Method: pump
Volume Removed: ~7 gal
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: none
Other comments:

Groundwater Sampling Record

Monitoring Well No. BK mw-03-97 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: _____
[X] Pump, type: Parastaltic
[ ] Other, describe: _____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

Time							Measured With
Temp (°C)	18.8	19.3	19.3	19.2	19.2	19.1	YSI 55
pH	6.76	6.77	6.77	6.77	6.77	6.71	Orion 250A
Cond (µS/cm)	.213	.212	.206	.201	.195	.188	Hach
Do (mg/L)	2.17	1.31	1.01	0.91	0.79	0.64	YSI 55
Redox (mv)	15.5	4.8	6.2	-17.3	-35	-72	Orion 250A
gallons purged		1	2	3	4	7	

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate			
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron			
(7) Total Iron			
(8) Alkalinity			
(9) Carbon Dioxide			
(10) Chloride			

Additional Comments: _____

7 [X] SAMPLE CONTAINERS (material, number, size): 4-liter glass, 3-40ml glass, 1-500ml poly and 1-liter poly

8 [X] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method _____ Containers: _____
Method _____ Containers: _____
[X] Preservatives added: HCl TPH + BTEX + MTBE Method _____ Containers: 1 liter glass, 40ml vials

9 [X] CONTAINER HANDLING:

[X] Container Sides Labeled
[ ] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [X] OTHER COMMENTS: _____

GROUNDWATER SAMPLING RECORD

Sampling Location BX MW-07
Sampling Dates 3-22-98

GROUND WATER SAMPLING RECORD - MONITORING WELL BX MW-07
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 3-22-95, 1998 1530 a.m./(p.m.)
SAMPLE COLLECTED BY: RO3 of Parsons ES
WEATHER: Sunny ~62°F SI breeze
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC TOP of Casing

MONITORING WELL CONDITION:
[ ] LOCKED: [x] UNLOCKED
WELL NUMBER (IS - (IS NOT) APPARENT
STEEL CASING CONDITION IS: OK
INNER PVC CASING CONDITION IS: OK
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [X] EQUIPMENT CLEANED BEFORE USE WITH alconox, DI, ISO, DI
Items Cleaned (List): all instrument probes

2 [ ] PRODUCT DEPTH none FT. BELOW DATUM
Measured with:

WATER DEPTH 3.94 FT. BELOW DATUM
Measured with: Slope water level indicator

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Brown
Odor: none
Other Comments:

4 [ ] WELL EVACUATION:
Method: pump
Volume Removed: 2 gal
Observations: Water (slightly - very) ~~cloudy~~ Yellow
Water level (rose - fell - (no change)
Water odors: none
Other comments:

Groundwater Sampling Record

Monitoring Well No. BX mw-07 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[x] Pump, type: Peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

Time							Measured With
Temp (°C)	20.7	20.7	20.7	20.7	20.7		YSI 55
pH	6.54	6.54	6.54	6.54	6.54		Orion 250A
Cond (µS/cm)	.175	.172	.167	.166	.165		Hach
Do (mg/L)	0.30	0.19	0.17	0.16	0.16		YSI 55
Redox (mv)	45.0	-17.0	-84.1	-113.5	-114.8		Orion 250A
gallons purged		1	2	3	4		

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate			
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron			
(7) Total Iron			
(8) Alkalinity			
(9) Carbon Dioxide			
(10) Chloride			

Additional Comments:_____

7 [ ] SAMPLE CONTAINERS (material, number, size): 6-40ml glass vials, 1-1 Liter Poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____

[X] Preservatives added: HCL Method Methyl-tert-butyl ether Containers: 40ml vials

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[ ] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

GROUNDWATER SAMPLING RECORD

Sampling Location BX mw-08-97
Sampling Dates 3-22-98

GROUND WATER SAMPLING RECORD - MONITORING WELL BX mw-08-97
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 3-22-98, 1998 1430 a.m./(p.m.)
SAMPLE COLLECTED BY: RDS of Parsons ES
WEATHER: warm ~ 60°F SI Breeze
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC Top of casing

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: OK
INNER PVC CASING CONDITION IS: OK
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [X] EQUIPMENT CLEANED BEFORE USE WITH Alconox, DI, ISO, DI
Items Cleaned (List): all instrument probes

2 [ ] PRODUCT DEPTH none FT. BELOW DATUM
Measured with:

WATER DEPTH 3.97 FT. BELOW DATUM
Measured with: Slope water level indicator

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Yellow
Odor: none
Other Comments:

4 [ ] WELL EVACUATION:
Method: pump
Volume Removed: ~X
Observations: Water (slightly - very) ~~cloudy~~ Yellow
Water level (rose - fell - no change)
Water odors: none
Other comments:

Groundwater Sampling Record

Monitoring Well No. BX mw-08-97 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[X] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

Time							Measured With
Temp (°C)	20.1	20.4	20.3	20.4	20.3		YSI 55
pH	6.83	6.83	6.83	6.83	6.83		Orion 250A
Cond (µS/cm)	.177	.174	.169	.164	.164		Hach
Do (mg/L)	1.0	0.40	0.35	0.32	0.32		YSI 55
Redox (mv)	6.19	13.5	17.9	16.6	17.0		Orion 250A
gallons purged		1	2	3	4		

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate			
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron			
(7) Total Iron			
(8) Alkalinity			
(9) Carbon Dioxide			
(10) Chloride			

Additional Comments:_____

7 [X] SAMPLE CONTAINERS (material, number, size): 6-40ml glass vials, 1-1L HCl poly

8 [X] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____

[X] Preservatives added: HCl BTEX-MTBE
Method methanol Containers: 40ml vials

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[ ] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

GROUNDWATER SAMPLING RECORD

Sampling Location Bx mw-03
Sampling Dates 3-22-98

GROUND WATER SAMPLING RECORD - MONITORING WELL Bx mw-03 (number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 3-22-98, 1998 1315 a.m. (p.m)
SAMPLE COLLECTED BY: TOB of Parsons ES
WEATHER: Sunny ~60°F Breeze ~3mph N
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC Top of casing

MONITORING WELL CONDITION:
[ ] LOCKED: [x] UNLOCKED
WELL NUMBER (IS - (IS NOT) APPARENT
STEEL CASING CONDITION IS: OK
INNER PVC CASING CONDITION IS: OK
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [C] EQUIPMENT CLEANED BEFORE USE WITH Alconox DI, ISO, DI
Items Cleaned (List): all Instrument probes

2 [ ] PRODUCT DEPTH none FT. BELOW DATUM
Measured with:

WATER DEPTH 4.37 FT. BELOW DATUM
Measured with: Slope water level indicator

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Yellow
Odor: Hydro carbon
Other Comments:

4 [ ] WELL EVACUATION:
Method: pump
Volume Removed: 24 gal
Observations: Water (slightly - very) ~~cloudy~~ yellow
Water level (rose - fell - no change)
Water odors: Hydro carbons
Other comments:

Groundwater Sampling Record

Monitoring Well No. BX MW-03 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[X] Pump, type: Parastaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

Time	~~15:00~~						Measured With
Temp (°C)	19.0	19.0	18.9	18.7			YSI 55
pH	6.50	6.50	6.50	6.50			Orion 250A
Cond (µS/cm)	.244	.240	.239	.236			Hach
Do (mg/L)	1.09	0.36	0.31	0.25			YSI 55
Redox (mv)	9.41	9.98	10.05	10.20			Orion 250A
gallons purged		1	2	3			

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate			
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron			
(7) Total Iron			
(8) Alkalinity			
(9) Carbon Dioxide			
(10) Chloride			

Additional Comments:_____

7 [ ] SAMPLE CONTAINERS (material, number, size): 6-40 ml glass vials, 4-1 Liter glass, 1-liter poly, 1-500 ml poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____

[ ] Preservatives added: HCL BTEX-MTBE
Method methane HNO3 nitrate Containers: 40 ml vial / 500 ml poly

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[ ] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

GROUNDWATER SAMPLING RECORD

MS/MSD

Sampling Location BX MW-01
Sampling Dates 3-22-98

GROUND WATER SAMPLING RECORD - MONITORING WELL BX MW-01
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 3-22-98, 1998 1130 a.m./p.m.
SAMPLE COLLECTED BY: [illegible] of Parsons ES
WEATHER: Warm ~65°F SI Breeze
DATUM FOR WATER DEPTH MEASUREMENT (Describe): Toc Top of Casing

MONITORING WELL CONDITION:
[ ] LOCKED: [✓] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: OK
INNER PVC CASING CONDITION IS: OK
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [X] EQUIPMENT CLEANED BEFORE USE WITH Alconox, DI, ISO, DI
Items Cleaned (List): all instrument probes

2 [ ] PRODUCT DEPTH none FT. BELOW DATUM
Measured with:

WATER DEPTH 4.97 FT. BELOW DATUM
Measured with: Slope water level indicator

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Yellow
Odor: None
Other Comments:

4 [ ] WELL EVACUATION:
Method: Pump
Volume Removed: ~4 gal
Observations: Water (slightly - very) ~~cloudy~~ Yellow
Water level (rose - fell - no change)
Water odors: none
Other comments:

Groundwater Sampling Record

Monitoring Well No. BX MW-01 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[ ] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

Time							Measured With
Temp (°C)	19.8	19.6	19.4	19.4			YSI 55
pH	6.63	6.59	6.59	6.59			Orion 250A
Cond (µS/cm)	.144	.143	.144	.149			Hach
Do (mg/L)	2.30	1.73	1.59	1.20			YSI 55
Redox (mv)	86.6	71.7	64.1	22.2			Orion 250A
gallons purged		1	2	4			

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate			
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron			
(7) Total Iron			
(8) Alkalinity			
(9) Carbon Dioxide			
(10) Chloride			

Additional Comments:_____

7 [ ] SAMPLE CONTAINERS (material, number, size): 6-40 ml glass vials, 1-1 liter Poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____

[X] Preservatives added: HCL Method Methanol Containers: 40 ml vial

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[ ] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

GROUNDWATER SAMPLING RECORD

Sampling Location BX mw05
Sampling Dates 3-22-98

GROUND WATER SAMPLING RECORD - MONITORING WELL BX mw05
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 3-22-98, 1998 0845 a.m./p.m.
SAMPLE COLLECTED BY: of Parsons ES
WEATHER: Fair ~ 50° F Pc luby SI breeze
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC Top of Casing

MONITORING WELL CONDITION:
[ ] LOCKED: [x] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: OK
INNER PVC CASING CONDITION IS: OK
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH alconox, DI, ISO, DI
Items Cleaned (List): all instantaneous probes

2 [ ] PRODUCT DEPTH none FT. BELOW DATUM
Measured with:

WATER DEPTH 4.16 FT. BELOW DATUM
Measured with: Slope water level indicator

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Yellow
Odor: Hydro carbon
Other Comments:

4 [ ] WELL EVACUATION:
Method: Pump
Volume Removed: ~5 gal
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: Hydrocarbon
Other comments:

Groundwater Sampling Record

Monitoring Well No. BX MW05 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[X] Pump, type: Peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

Time							Measured With
Temp (°C)	19.3	20.6	20.7	20.7	20.8	20.8	YSI 55
pH	6.87	6.91	6.94	6.99	6.99	7.01	Orion 750A
Cond (µS/cm)	.570	.650	.699	.703	.696	.703	Hach
Do (mg/L)	1.13	0.46	0.30	0.21	0.20	0.21	YSI 55
Redox (mv)	-107.3	-140.9	-155.3	-165.9	-176.5	-179.3	Orion 250A
gallons purged		1	2	3	4	5	

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate			
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron			
(7) Total Iron			
(8) Alkalinity			
(9) Carbon Dioxide			
(10) Chloride			

Additional Comments:_____

7 [X] SAMPLE CONTAINERS (material, number, size): 6-40ml glass vials, 1-1 liter Poly

8 [X] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____

[X] Preservatives added: HCL BTEX-MTBE
Method Methanol Containers: 40 ml vials

9 [X] CONTAINER HANDLING:

[X] Container Sides Labeled
[ ] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

GROUNDWATER SAMPLING RECORD

MS/MSD

Sampling Location BX MW-05-97
Sampling Dates 3-22-98

GROUND WATER SAMPLING RECORD - MONITORING WELL BX MW-05-95
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 3-22-98, 1998 ____ a.m./p.m.
SAMPLE COLLECTED BY: RWB of Parsons ES
WEATHER: Cool ~ 50°F Partly Cloudy Sl. Breeze
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC Top of casing

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: OK
INNER PVC CASING CONDITION IS: OK
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [X] EQUIPMENT CLEANED BEFORE USE WITH alconox, DI, TSO, DI
Items Cleaned (List): all instrument probes

2 [ ] PRODUCT DEPTH none FT. BELOW DATUM
Measured with:

WATER DEPTH 4.16 FT. BELOW DATUM
Measured with: Slope water level indicator

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Yellow
Odor: none
Other Comments:

4 [ ] WELL EVACUATION:
Method: Pump
Volume Removed: ~ 4 gal
Observations: Water (slightly - very) ~~cloudy~~ Yellow
Water level (rose - fell - no change)
Water odors: none
Other comments:

Groundwater Sampling Record

Monitoring Well No. BX MW-05-97 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[✓] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

Time							Measured With
Temp (°C)	~~1200~~ 19	19.1	19.2	19.3			YSI 55
pH	4.78	4.78	4.78	4.78			Orion 250A
Cond (µS/cm)	.142	.142	.143	.143			Hach
Do (mg/L)	1.12	0.60	0.46	0.44			YSI 55
Redox (mv)	12.3	6.5	2.5	5.6			Orion 250A
gallons purged		1	2	4			

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate			
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron			
(7) Total Iron			
(8) Alkalinity			
(9) Carbon Dioxide			
(10) Chloride			

Additional Comments:_____

7 [✓] SAMPLE CONTAINERS (material, number, size): 3-40 ml glass vials, 4-liter amber glass, 500ml poly

8 [✓] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____

[✓] Preservatives added: HCl TRIH
Method BTEX-MTBE Containers: 1 liter glass, 40ml vials

9 [ ] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

GROUNDWATER SAMPLING RECORD

BX MP20 Dup of BX MP2

Sampling Location BX MP2
Sampling Dates 3-22-98

GROUND WATER SAMPLING RECORD - MONITORING WELL BX MP2
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 3-22-98, 1998 0730 a.m./p.m.
SAMPLE COLLECTED BY: KDS of Parsons ES
WEATHER: Cool ~ 45° F cloudy
DATUM FOR WATER DEPTH MEASUREMENT (Describe): Toc Top of casing

MONITORING WELL CONDITION:
[ ] LOCKED: [Y] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: OK
INNER PVC CASING CONDITION IS: OK
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [Y] EQUIPMENT CLEANED BEFORE USE WITH Alconox, DI, ISO, DI
Items Cleaned (List): all instrument probes

2 [ ] PRODUCT DEPTH none FT. BELOW DATUM
Measured with:

WATER DEPTH 4.65 FT. BELOW DATUM
Measured with: Slope water level indicator

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Cloudy
Odor: none
Other Comments:

4 [ ] WELL EVACUATION:
Method: pump
Volume Removed: ~5
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: Hydrocarbon
Other comments:

Groundwater Sampling Record

Monitoring Well No. OX MP2 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____

[X] Pump, type: Peristaltic

[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

Time							Measured With
Temp (°C)	19.4	20.3	20.2	20.4	20.3		
pH	6.08	6.18	6.22	6.24	6.24		
Cond (µS/cm)	.260	.246	.238	.236	.236		
Do (mg/L)	0.53	0.36	0.24	0.20	0.20		
Redox (mv)	-171.3	-185.3	-217.1	-212.4	-214.0		
gallons purged		1	2	3	4		

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate			
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron			
(7) Total Iron			
(8) Alkalinity			
(9) Carbon Dioxide			
(10) Chloride			

Additional Comments:_____

7 [X] SAMPLE CONTAINERS (material, number, size): 6-40 ml glass vials, 1 liter poly, 1 500 ml poly 4-1 liter glass

8 [X] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____

Method_____ Containers:_____

[Y] Preservatives added: HCL, ~~HNO3~~ ~~Methanol~~ NaOH

Method Methane Containers: 40 ml vials & 500 ml poly

HNO3 Total lead

9 [ ] CONTAINER HANDLING:

[Y] Container Sides Labeled

[ ] Container Lids Taped

[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

ON-SITE MEASUREMENTS
HACH AND CHEMetrics ANALYSES
~~Keesler AFB, BX Service Station, AOC-A (ST-06)~~ TYNDALL RBIC

SAMPLE DATE	3/22/98	TIME SAMPLED	0730
SAMPLE I.D.	BX MP-2	TIME ANALYSIS START	0740
		TIME ANALYSIS END	

FILTERED (circle) (YES) NO

COLOR / ODOR: Yellow / odor

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Reading	Concentration	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	0.75	mg/L	sample
					mg/L	sample
~~Manganese~~	52.13.1	0 - 20.0 mg/L			mg/L	sample
					mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	17.16	mg/L	DI or 50mg/L
					mg/L	DI or 50mg/L
Sulfide	61.12.1	0 - 0.600 mg/L	5	0.497	mg/L	DI
					mg/L	DI

HACH Titrations:

Alkalinity Sample Size = 100 Titrate with 1.6 N H_2SO_4

Phenolphthalein Alkalinity	0 digits
BGR	59 digits
	59 total digits

Digit Multiplier X Total Digits = Total Alkalinity (mg/L) = 59

CHEMetrics Color Tests:

Ammonia 5 ppm

Technician: BL

[a/] Sulfate, and sulfide blanks contain respective reagents;
Ferrous iron and manganese blanks are without reagents.

[b/] Ferrous, and manganese blanks should be diluted accordingly if samples are diluted.

* Color may have interfered

ON-SITE MEASUREMENTS
HACH AND CHEMetrics ANALYSES
~~Keesler AFB, BX Service Station, AOC-A (ST-06)~~ TYNDALL RBIC.

SAMPLE DATE	3/22/98	TIME SAMPLED	0845
SAMPLE I.D.	MW-05	TIME ANALYSIS START	0910
		TIME ANALYSIS END	0928

FILTERED (circle) (YES) NO

COLOR / ODOR: VERY PALE YELLOW / STRONG ODOR

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Reading	Concentration	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	5	2.39	mg/L	sample
					mg/L	sample
~~Manganese~~	52.13.1	0 - 20.0 mg/L			mg/L	sample
					mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	6.83	mg/L	DI or 50mg/L
					mg/L	DI or 50mg/L
Sulfide	61.12.1	0 - 0.600 mg/L	1	0.048	mg/L	DI
					mg/L	DI

HACH Titrations:

Alkalinity Sample Size = 100

Phenolphthalein Alkalinity

BGR

Titrate with 1.6 N H_2SO_4

0	digits
365	digits
365	total digits

Digit Multiplier X Total Digits = Total Alkalinity (mg/L) = 365

CHEMetrics Color Tests:

Ammonia 7 ppm

Technician: BL

[a/] Sulfate, and sulfide blanks contain respective reagents;
Ferrous iron and manganese blanks are without reagents.

[b/] Ferrous, and manganese blanks should be diluted accordingly if samples are diluted.

PALE YELLOW COLOR MAY HAVE NOD AFFECTED ANALYSIS TO SLIGHTLY

SULFATE 7.02 W/ NO REAGENTS

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ON-SITE MEASUREMENTS
HACH AND CHEMetrics ANALYSES
~~Keesler AFB, BX Service Station, AOC-A (ST-06)~~ TYNDALL RBIC

SAMPLE DATE: 3/22/98
SAMPLE I.D.: BX MW-05-97
TIME SAMPLED: 1000
TIME ANALYSIS START: 1003
TIME ANALYSIS END: 1015

FILTERED (circle): (YES) NO

COLOR / ODOR: PALE YELLOW / NO ODOR

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Reading	Concentration	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	0.36	mg/L	sample
					mg/L	sample
~~Manganese~~	52.13.1	0 - 20.0 mg/L			mg/L	sample
					mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	40.79	mg/L	(DI) or 50mg/L
				8.56	mg/L	~~DI or 50mg/L~~ NO LEAD
Sulfide	61.12.1	0 - 0.600 mg/L	1	0.039	mg/L	DI
					mg/L	DI

HACH Titrations:
Alkalinity Sample Size = 100 Titrate with 1.6 N H_2SO_4

Phenolphthalein Alkalinity: 0 digits
BGR: 6 digits
6 total digits

Digit Multiplier X Total Digits = Total Alkalinity (mg/L) = 6

CHEMetrics Color Tests:
Ammonia: 1 ppm *

Technician: RL

[a/] Sulfate, and sulfide blanks contain respective reagents;
Ferrous iron and manganese blanks are without reagents.

[b/] Ferrous, and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMetrics ANALYSES
~~Keesler AFB, BX Service Station, AOC-A (ST-06)~~ TYNDALL RBIC

SAMPLE DATE 5/22/98

SAMPLE I.D. BX-MW-01

TIME SAMPLED 1130
TIME ANALYSIS START 1220
TIME ANALYSIS END 1236

FILTERED (circle) (YES) NO

COLOR / ODOR: Brown cloudy No odor

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Reading	Concentration		Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	0.09	0.09	mg/L	sample
						mg/L	sample
~~Manganese~~	52.13.1	0 - 20.0 mg/L				mg/L	sample
						mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	31.44		mg/L	(DI) or 50mg/L
				7.07		mg/L	~~DI or 50mg/L~~ w/o
Sulfide	61.12.1	0 - 0.600 mg/L	1	0.024		mg/L	DI
						mg/L	DI

HACH Titrations:

Alkalinity Sample Size = 100

Titrate with 1.6 N H_2SO_4

Phenolphthalein Alkalinity	0 digits
BGR	26 digits
	26 total digits

Digit Multiplier X Total Digits = Total Alkalinity (mg/L) = 26

CHEMetrics Color Tests:

Ammonia 0-3 ppm

Technician: ML

[a/] Sulfate, and sulfide blanks contain respective reagents;
Ferrous iron and manganese blanks are without reagents.

[b/] Ferrous, and manganese blanks should be diluted accordingly if samples are diluted.

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ON-SITE MEASUREMENTS
HACH AND CHEMetrics ANALYSES
~~Keesler AFB, BX Service Station, AOC-A (ST-06)~~ TYNDALL RBIC

SAMPLE DATE: 3/22/98
SAMPLE I.D. BX- MW-03

TIME SAMPLED: 1315
TIME ANALYSIS START: 1325
TIME ANALYSIS END: 1345

FILTERED (circle): (YES) NO

COLOR / ODOR: PALE YELLOW/ STRONG ODOR

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Reading	Concentration		Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	1.47	1.47	mg/L	sample
						mg/L	sample
~~Manganese~~	52.13.1	0 - 20.0 mg/L				mg/L	sample
						mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	32.07		mg/L	(DI) or 50mg/L
				11.6x		mg/L	DI or 50mg/L
Sulfide	61.12.1	0 - 0.600 mg/L	1	0.547		mg/L	DI
						mg/L	DI

w/o

HACH Titrations:

Alkalinity — Sample Size = 100 — Titrate with 1.6 N H_2SO_4

Phenolphthalein Alkalinity	0 digits
BGR	67 digits
	67 total digits

Digit Multiplier X Total Digits = Total Alkalinity (mg/L) = 67

CHEMetrics Color Tests:

Ammonia: 2 ppm

Technician: BL

[a/] Sulfate, and sulfide blanks contain respective reagents;
Ferrous iron and manganese blanks are without reagents.

[b/] Ferrous, and manganese blanks should be diluted accordingly if samples are diluted.

0

ON-SITE MEASUREMENTS
HACH AND CHEMetrics ANALYSES
~~**Keesler AFB, BX Service Station, AOC-A (ST-06)**~~ TYNDALL RBIC

SAMPLE DATE	3/22/98	TIME SAMPLED	1430
		TIME ANALYSIS START	1500
SAMPLE I.D.	MW-04-97	TIME ANALYSIS END	1530

FILTERED (circle) (YES) NO

COLOR / ODOR: Yellow / No odor

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Reading	Concentration	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	0.14	mg/L	sample
					mg/L	sample
~~Manganese~~	52.13.1	0 - 20.0 mg/L			mg/L	sample
					mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	46.92	mg/L	DI or 50mg/L
				9.55	mg/L	DI or 50mg/L
Sulfide	61.12.1	0 - 0.600 mg/L	1	0.006	mg/L	DI
					mg/L	DI

HACH Titrations:

Alkalinity Sample Size = 100 Titrate with 1.6 N H_2SO_4

Phenolphthalein Alkalinity	0 digits
BGR	6 digits
	6 total digits

Digit Multiplier X Total Digits = Total Alkalinity (mg/L) = 6

CHEMetrics Color Tests:

Ammonia 1 ppm

Technician: BL

[a/] Sulfate, and sulfide blanks contain respective reagents;
Ferrous iron and manganese blanks are without reagents.

[b/] Ferrous, and manganese blanks should be diluted accordingly if samples are diluted.

6D

ON-SITE MEASUREMENTS
HACH AND CHEMetrics ANALYSES
~~**Keesler AFB, BX Service Station, AOC-A (ST-06)**~~ TYNDALL RBIC

SAMPLE DATE	3/20/97	TIME SAMPLED	1435
SAMPLE I.D.	MW-08-97 (DUP)	TIME ANALYSIS START	1500
		TIME ANALYSIS END	1530

FILTERED (circle) (YES) NO

COLOR / ODOR: YELLOW / NO ODOR

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Reading	Concentration		Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	0.14		mg/L	sample
						mg/L	sample
~~Manganese~~	52.13.1	0 - 20.0 mg/L				mg/L	sample
						mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	45.43		mg/L	DI or 50mg/L
				7.58		mg/L	DI or 50mg/L
Sulfide	61.12.1	0 - 0.600 mg/L	1	0.037		mg/L	DI
						mg/L	DI

HACH Titrations:

Alkalinity Sample Size = 100

Titrate with 1.6 N H_2SO_4

Phenolphthalein Alkalinity	0 digits
BGR	7 digits
	7 total digits

Digit Multiplier X Total Digits = Total Alkalinity (mg/L) = 7

CHEMetrics Color Tests:

Ammonia 1 ppm

Technician: BL

[a/] Sulfate, and sulfide blanks contain respective reagents;
Ferrous iron and manganese blanks are without reagents.

[b/] Ferrous, and manganese blanks should be diluted accordingly if samples are diluted.

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ON-SITE MEASUREMENTS
HACH AND CHEMetrics ANALYSES
~~Keesler AFB, BX Service Station, AOC A (ST 06)~~ TYNDALL RBIC.

SAMPLE DATE: 3/22/98
SAMPLE I.D.: FB/MW-07

TIME SAMPLED: 1530
TIME ANALYSIS START: 1535
TIME ANALYSIS END: 1547

FILTERED (circle): (YES) NO

COLOR / ODOR: PALE YELLOW / HYDROCARBON ODOR

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Reading	Concentration	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	0.41	mg/L	sample
					mg/L	sample
~~Manganese~~	52.13.1	0 - 20.0 mg/L			mg/L	sample
					mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	10.00	mg/L	(DI) or 50mg/L
			1	9.41	mg/L	~~DI or 50mg/L~~
Sulfide	61.12.1	0 - 0.600 mg/L	5	0.156	mg/L	DI
					mg/L	DI

w/o

HACH Titrations:

Alkalinity — Sample Size = 100 — Titrate with 1.6 N H_2SO_4

Phenolphthalein Alkalinity	0 digits
BGR	41 digits
	41 total digits

Digit Multiplier X Total Digits = Total Alkalinity (mg/L) = 41

CHEMetrics Color Tests:

Ammonia: ____ ppm

Technician: BL

[a/] Sulfate, and sulfide blanks contain respective reagents;
Ferrous iron and manganese blanks are without reagents.

[b/] Ferrous, and manganese blanks should be diluted accordingly if samples are diluted.

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ON-SITE MEASUREMENTS
HACH AND CHEMetrics ANALYSES
~~Keesler AFB, BX Service Station, AOC-A (ST-06)~~ TYNDALL RBIC

SAMPLE DATE	5/22/98	TIME SAMPLED	1630
SAMPLE I.D.	MW-03-97	TIME ANALYSIS START	1650
		TIME ANALYSIS END	1700

FILTERED (circle) (YES) NO

COLOR / ODOR: PALE YELLOW / NO ODOR

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Reading	Concentration	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	0.05	mg/L	sample
					mg/L	sample
~~Manganese~~	52.13.1	0 - 20.0 mg/L			mg/L	sample
					mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	39.76	mg/L	(DI) or 50mg/L
				8.99	mg/L	~~DI or 50mg/L~~
Sulfide	61.12.1	0 - 0.600 mg/L	1	0.048	mg/L	DI
					mg/L	DI

n/o

HACH Titrations:

Alkalinity Sample Size = 100 Titrate with 1.6 N H_2SO_4

Phenolphthalein Alkalinity 0 digits

BGR 36 digits

36 total digits

Digit Multiplier X Total Digits = Total Alkalinity (mg/L) = 36

CHEMetrics Color Tests:

Ammonia 0.6 ppm

Technician: BL

[a/] Sulfate, and sulfide blanks contain respective reagents;
Ferrous iron and manganese blanks are without reagents.

[b/] Ferrous, and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMetrics ANALYSES
~~Keesler AFB, BX Service Station, AOC-A (ST-06)~~ TYNDALL RBIC

SAMPLE DATE	3/22/98	TIME SAMPLED	1730
SAMPLE I.D.	MP-3	TIME ANALYSIS START	1731
		TIME ANALYSIS END	1737

FILTERED (circle) (YES) NO

COLOR / ODOR: VERY CLOUDY, YELLOW, NO ODOR

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Reading	Concentration	Blank[a/,b/]
Ferrous	50.01.1.	0 - 5.10 mg/L		1.60	mg/L	sample
					mg/L	sample
~~Manganese~~	52.13.1	0 - 20.0 mg/L			mg/L	sample
					mg/L	sample
Sulfate	45.000	0 - 100 mg/L		NA	mg/L	DI or 50mg/L
					mg/L	DI or 50mg/L
Sulfide	61.12.1	0 - 0.600 mg/L		NA	mg/L	DI
					mg/L	DI

HACH Titrations:

Alkalinity Sample Size = 20 Titrate with 1.6 N H_2SO_4

Phenolphthalein Alkalinity	0 digits
BGR	2 digits
	2 total digits

5 2
Digit Multiplier X Total Digits = Total Alkalinity (mg/L) = 10

CHEMetrics Color Tests:

Ammonia NA ppm

Technician: BL

[a/] Sulfate, and sulfide blanks contain respective reagents;
Ferrous iron and manganese blanks are without reagents.

[b/] Ferrous, and manganese blanks should be diluted accordingly if samples are diluted.

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ON-SITE MEASUREMENTS
HACH AND CHEMetrics ANALYSES
~~Keesler AFB, BX Service Station, AOC-A (ST-06)~~ TYNDALL RBIC

SAMPLE DATE	3/22/98	TIME SAMPLED	1830
SAMPLE I.D.	MP-1, 13X	TIME ANALYSIS START	1838
		TIME ANALYSIS END	1851

FILTERED (circle) (YES) NO

COLOR / ODOR: PALE YELLOW, STRONG ODOR

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Reading	Concentration	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	5	1.29	mg/L	sample
					mg/L	sample
~~Manganese~~	52.13.1	0 - 20.0 mg/L			mg/L	sample
					mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	10.82	mg/L	(DI) or 50mg/L
				10.43	mg/L	DI or 50mg/L
Sulfide	61.12.1	0 - 0.600 mg/L	5	0.210	mg/L	DI
					mg/L	DI

w/o

HACH Titrations:

Alkalinity Sample Size = 100 Titrate with 1.6 N H_2SO_4

Phenolphthalein Alkalinity: 0 digits

BGR: 107 digits

107 total digits

Digit Multiplier X Total Digits = Total Alkalinity (mg/L) = 107

CHEMetrics Color Tests:

Ammonia: 3 ppm

Technician: BL

[a/] Sulfate, and sulfide blanks contain respective reagents;
Ferrous iron and manganese blanks are without reagents.

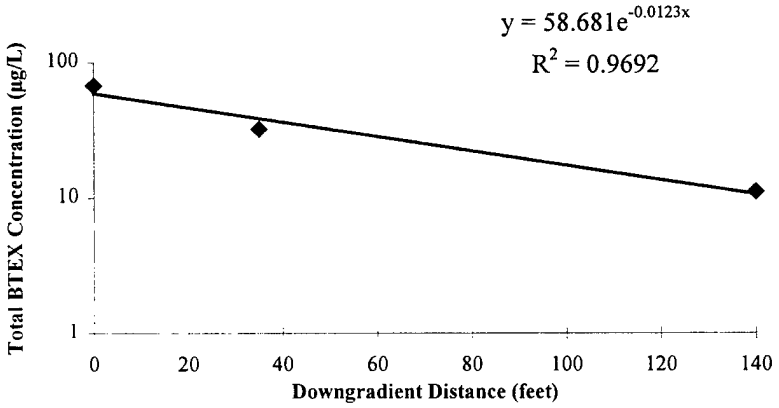
[b/] Ferrous, and manganese blanks should be diluted accordingly if samples are diluted.

APPENDIX D
FIRST-ORDER DECAY COEFFICIENT CALCULATIONS

FIRST-ORDER RATE CONSTANT CALCULATION
USING THE METHOD OF BUSCHECK AND ALCANTAR
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Point	Northing (feet)	Easting (feet)	Distance Downgradient (feet)	Benzene (µg/L) Feb 1998
MW-03			0	67
MP-1			35	32
MW-07			140	11

PLOT OF BENZENE CONCENTRATION VERSUS DISTANCE



$$\lambda = \frac{v_c}{4\alpha_x}\left(\left[1 + 2\alpha_x\left(\frac{k}{v_x}\right)\right]^2 - 1\right)$$

where v_c = 0.417 ft/day (advective velocity =0.48, R = 1.15)

α_x = 25 ft (Literature; approximately 1/10th of plume length)

k/v_x = 0.0123 µg/L per foot (1st-order curve fit)

Therefore λ = 0.00671259 day^{-1}

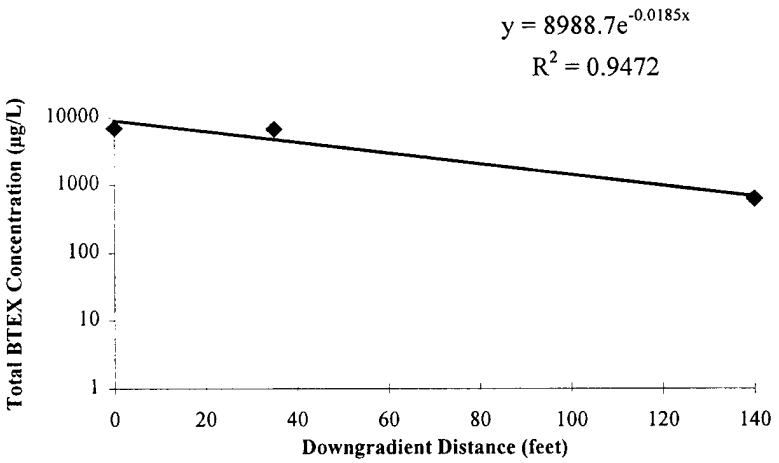
2.45009583 $year^{-1}$

Benzene half life= 0.28 year

FIRST-ORDER RATE CONSTANT CALCULATION
USING THE METHOD OF BUSCHECK AND ALCANTAR
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Point	Northing (feet)	Easting (feet)	Distance Downgradient (feet)	Total Xylene (µg/L) Feb 1998
MW-03			0	6900
MP-1			35	6700
MW-07			140	620

PLOT OF TOTAL XYLENE CONCENTRATION VERSUS DISTANCE



$$\lambda = \frac{v_c}{4\alpha_x}\left(\left[1+2\alpha_x\left(\frac{k}{v_x}\right)\right]^2 - 1\right)$$

where v_c = 0.268156425 ft/day (advective velocity = .48, R = 1.79)

α_x = 25 ft (Literature; approximately 1/10th of plume length)

k/v_x = 0.0185 µg/L per foot (1st-order curve fit)

Therefore λ = 0.00725531 day^{-1}

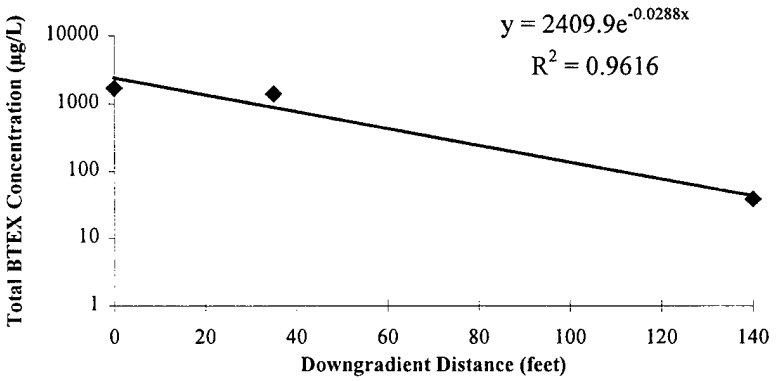
2.64818715 $year^{-1}$

Xylene half life= 0.26 year

FIRST-ORDER RATE CONSTANT CALCULATION
USING THE METHOD OF BUSCHECK AND ALCANTAR
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Point	Northing (feet)	Easting (feet)	Distance Downgradient (feet)	Toluene (µg/L) Feb 1998
MW-03			0	1700
MP-1			35	1400
MW-07			140	38

PLOT OF TOLUENE CONCENTRATION VERSUS DISTANCE



$$\lambda = \frac{v_c}{4\alpha_x}\left(\left[1+2\alpha_x\left(\frac{k}{v_x}\right)\right]^2 - 1\right)$$

where v_c = 0.352941176 ft/day (advective velocity =0.48, R = 1.36)

α_x = 25 ft (Literature; approximately 1/10th of plume length)

k/v_x = 0.0288 µg/L per foot (1st-order curve fit)

Therefore λ = 0.01748329 day^{-1}

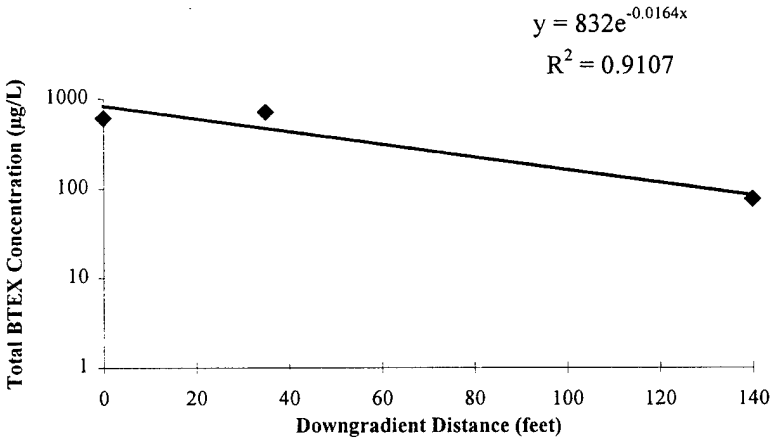
6.38140235 $year^{-1}$

Toluene half life= 0.11 year

FIRST-ORDER RATE CONSTANT CALCULATION
USING THE METHOD OF BUSCHECK AND ALCANTAR
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Point	Northing (feet)	Easting (feet)	Distance Downgradient (feet)	Ethylbenzene (µg/L) Feb 1998
MW-03			0	610
MP-1			35	710
MW-07			140	76

PLOT OF TOTAL ETHYLBENZENE CONCENTRATION VERSUS DISTANCE



$$\lambda = \frac{v_c}{4\alpha_x}\left(\left[1+2\alpha_x\left(\frac{k}{v_x}\right)\right]^2 - 1\right)$$

where v_c = 0.255 ft/day (advective velocity =0.48, R = 1.88)

α_x = 25 ft (Literature; approximately 1/10th of plume length)

k/v_x = 0.0164 µg/L per foot (1st-order curve fit)

Therefore λ = 0.00590400 day^{-1}

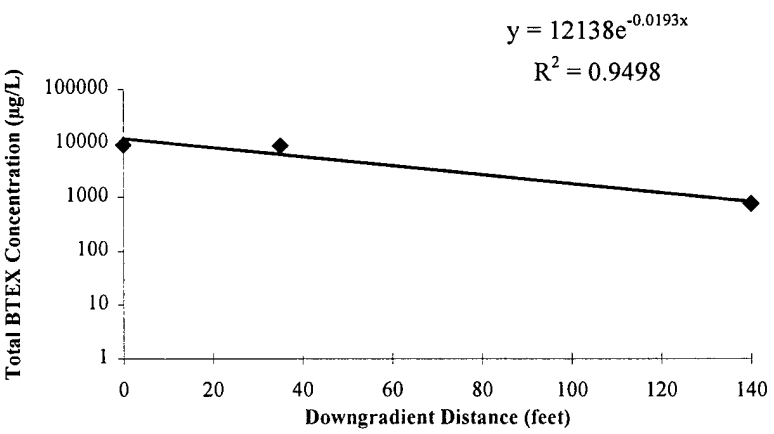
2.15496000 $year^{-1}$

Total Ethylbenzene half life= 0.32 year

FIRST-ORDER RATE CONSTANT CALCULATION
USING THE METHOD OF BUSCHECK AND ALCANTAR
Risk-Based Approach to Remediation
BX Service Station
Tyndall AFB, Florida

Point	Northing (feet)	Easting (feet)	Distance Downgradient (feet)	Total BTEX (µg/L) Feb 1998
MW-03			0	9277
MP-1			35	8842
MW-07			140	745

PLOT OF TOTAL BTEX CONCENTRATION VERSUS DISTANCE



$$\lambda = \frac{v_c}{4\alpha_x}\left(\left[1 + 2\alpha_x\left(\frac{k}{v_x}\right)\right]^2 - 1\right)$$

where v_c = 0.311688312 ft/day (advective velocity =0.48, R = 1.54)

α_x = 25 ft (Literature; approximately 1/10th of plume length)

k/v_x = 0.0193 µg/L per foot (1st-order curve fit)

Therefore λ = 0.00891810 day^{-1}

3.25510792 $year^{-1}$

Total BTEX half life= 0.21 year

APPENDIX E
SUPPORTING INFORMATION FOR VOLATILIZATION FROM SUBSURFACE SOURCES MODELS

Calculation of Benzene Concentration in Ambient Air From Soil Gas Concentration 7/21/98 SB.

Use equations for K(g): gas mass transfer coefficient and equation for K: mass transfer coefficient to estimate flux based on soil gas concentration. Use Flux in box model to estimate concentrations in the breathing zone.

$$K(g) = \left(\frac{18\ g/mol}{MW\ g/mol}\right)^{0.335} \times (1.39)$$

$$K = 1/\left[(8.25\times10^{-5}\times 298)/(HLC \times K(g))\right]$$

$$E_u = C_{soilgas} \times K \times A \times CF$$

$$C_{air} = E_u/(LS \times V \times MH)$$

Benzene

MW = 78.11 g/mol

HLC = 5.60×10^{-3} atm m^3/mol

A (Area of trench) = 300,000 cm^2

V (average wind speed) = 4.47 m/s

MH (mixing height) = 2 m

LS (length of side perpendicular to wind) = 15 m

CF = 1×10^{-3} L/cm^3

$C_{soilgas}$ (max detect) = 78 µg/L

$$K_{(g)} = \left(18 / 78.11\right)^{0.335} \times 1.39 =$$

$$= 0.6116 \times 1.39 = 0.85$$

$$K = 1 / \left[\left(8.25 \times 10^{-5} \times 298\right) / \left(5.60 \times 10^{-3} \times 0.85\right)\right]$$

$$= 1 / 5.16 = 0.194$$

$$E_u = 78\ \mu g/L \times 0.194\ cm/s \times 300{,}000\ cm^2 \times .001\ L/cm^3$$

$$= 4{,}540\ \mu g/s$$

$$C_{air} = \frac{4{,}540\ \mu g/s}{15\ m \times 4.47\ m/s \times 2\ m}$$

$$= 33.9\ \mu g/m^3$$

$$= \boxed{0.034\ mg/m^3}$$

constants taken from UofF ~~resp~~ comments on Homestead Report

APPENDIX F
SUPPORTING INFORMATION FOR BIOSCREEN MODEL

CURRENT UST PIT WITH 1997 XYLENE DATA

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Tyndall AFB
BX Service Station
Current UST Pit

Data Input Instructions:

115 (or 0.02) — 1. Enter value directly... or 2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.

20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	175.2	(ft/yr)
or		*or*	
Hydraulic Conductivity	K	1.1E-02	(cm/sec)
Hydraulic Gradient	i	0.004	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	925.0	(ft)
Transverse Dispersivity*	alpha y	92.5	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		*or*	
Estimated Plume Length	Lp	NA	(ft)

3. ADSORPTION

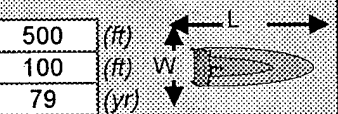
Retardation Factor*	R	1.8	(-)
or		*or*	
Soil Bulk Density	rho	1.7	(kg/l)
Partition Coefficient	Koc	422	(L/kg)
FractionOrganicCarbon	foc	2.8E-4	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	2.7E+0	(per yr)
or		*or*	
Solute Half-Life	t-half	0.26	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0.11	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	2.09	(mg/L)
Delta Sulfate*	SO4	5.42	(mg/L)
Observed Methane*	CH4	0.75	(mg/L)

5. GENERAL

Modeled Area Length*	500	(ft)
Modeled Area Width*	100	(ft)
Simulation Time*	79	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 10 (ft)

Source Zones:

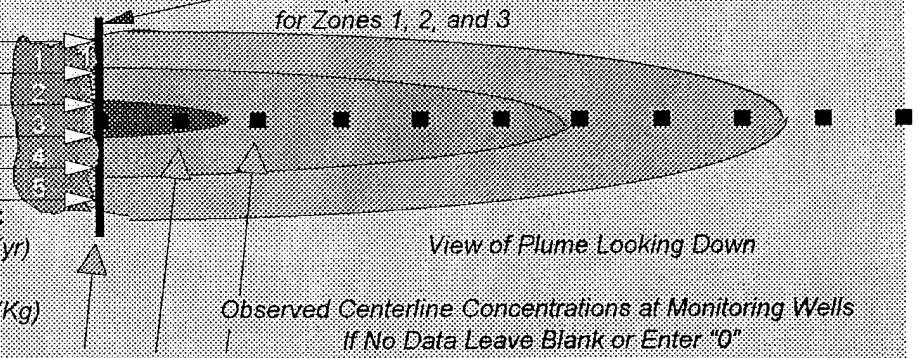
Width* (ft)	Conc. (mg/L)*
100	22
0	0
0	0

Source Halflife (see Help):

Inst. Reactant	1st Order
20	30 (yr)

Soluble Mass 1000 (Kg)
In Source NAPL, Soil

Vertical Plane Source. Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Dist. from Source (ft)	Concentration (mg/L)
0	16.0
50	
100	
150	.98
200	
250	
300	
350	
400	
450	
500	

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — View Output

RUN ARRAY — View Output

Help

Recalculate This Sheet

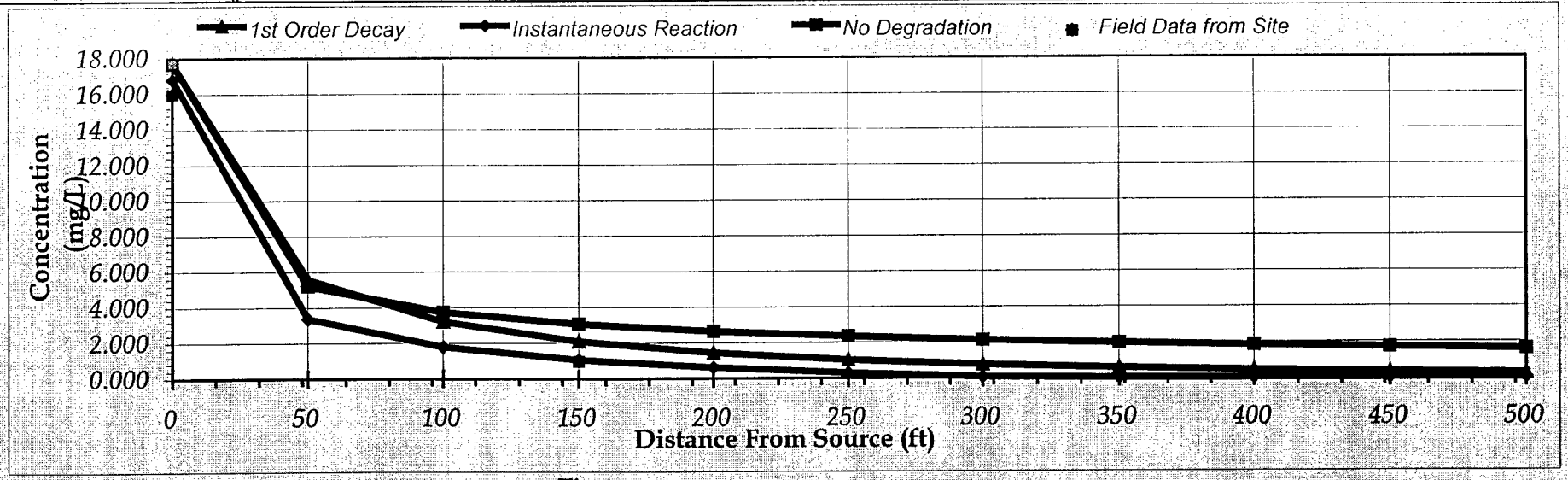
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	50	100	150	200	250	300	350	400	450	500
No Degradation	17.689	5.188	3.729	3.049	2.631	2.340	2.120	1.946	1.802	1.680	1.574
1st Order Decay	17.689	5.568	3.192	2.083	1.436	1.021	0.741	0.544	0.404	0.303	0.228
Inst. Reaction	16.820	3.354	1.785	1.054	0.606	0.294	0.059	0.000	0.000	0.000	0.000
Field Data from Site	16.000			0.980							



Time:

8 Years

Calculate Animation

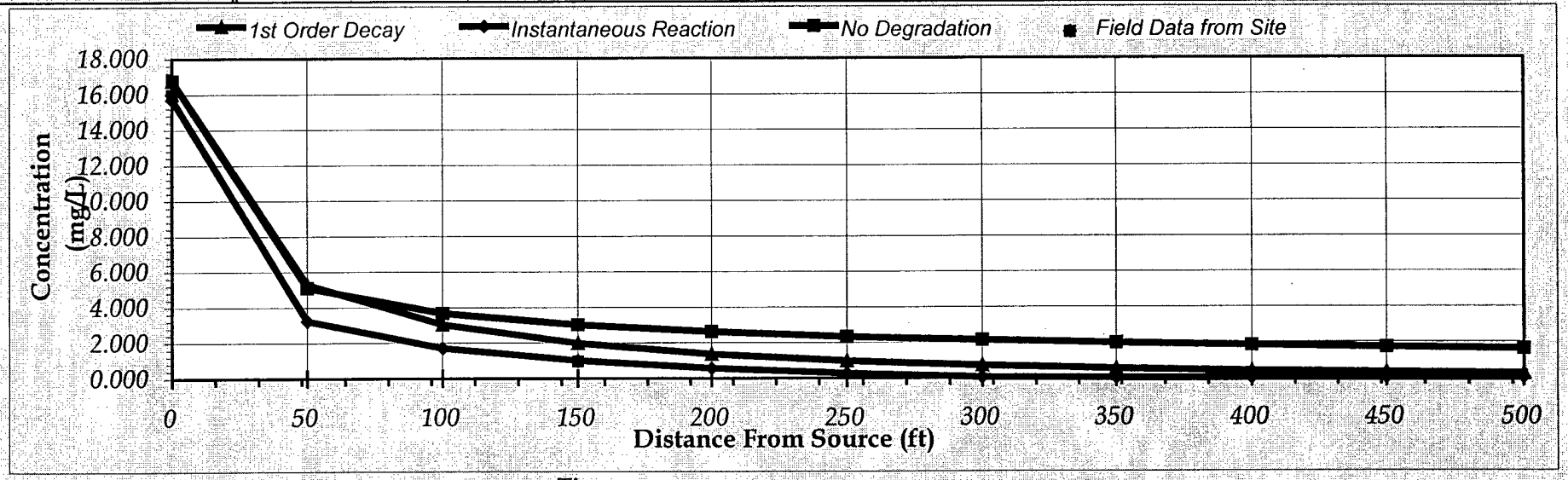
Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	50	100	150	200	250	300	350	400	450	500
No Degradation	16.750	5.089	3.671	3.012	2.610	2.331	2.121	1.956	1.820	1.705	1.607
1st Order Decay	16.750	5.273	3.023	1.972	1.360	0.967	0.701	0.516	0.383	0.287	0.216
Inst. Reaction	15.708	3.217	1.701	0.997	0.568	0.270	0.047	0.000	0.000	0.000	0.000
Field Data from Site	16.000			0.980							



Calculate Animation

Time:

10 Years

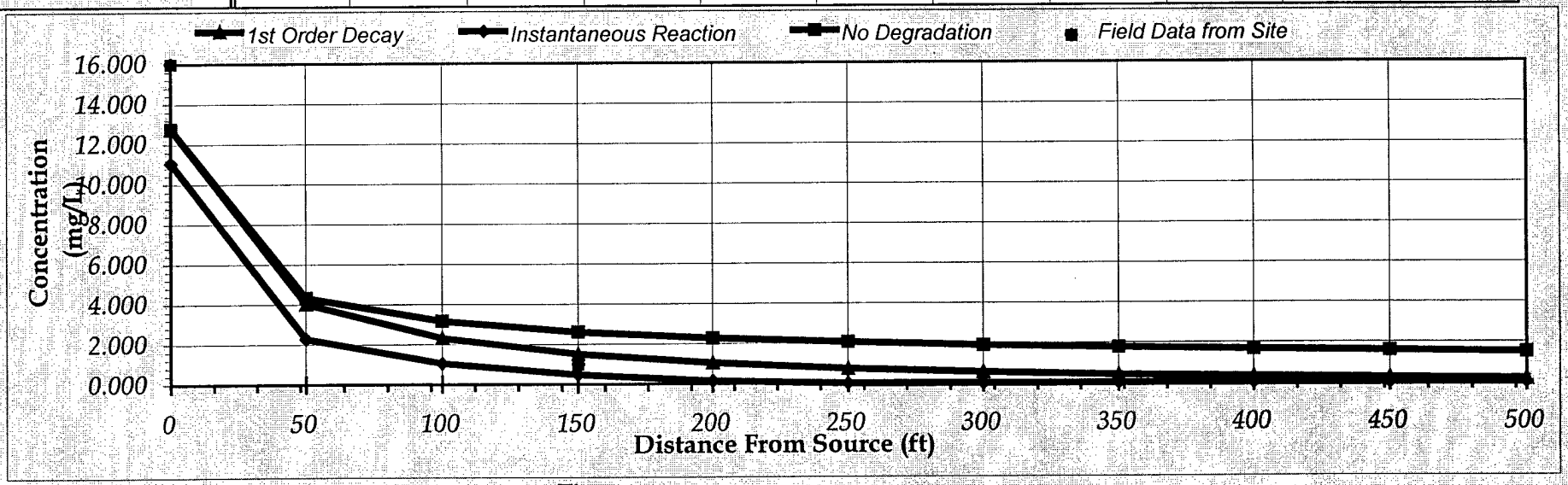
Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	50	100	150	200	250	300	350	400	450	500
No Degradation	12.753	4.321	3.143	2.601	2.274	2.049	1.883	1.754	1.650	1.563	1.490
1st Order Decay	12.753	4.015	2.302	1.502	1.035	0.736	0.534	0.393	0.291	0.218	0.164
Inst. Reaction	11.048	2.265	1.040	0.477	0.138	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	16.000			0.980							



Calculate Animation

Time:

20 Years

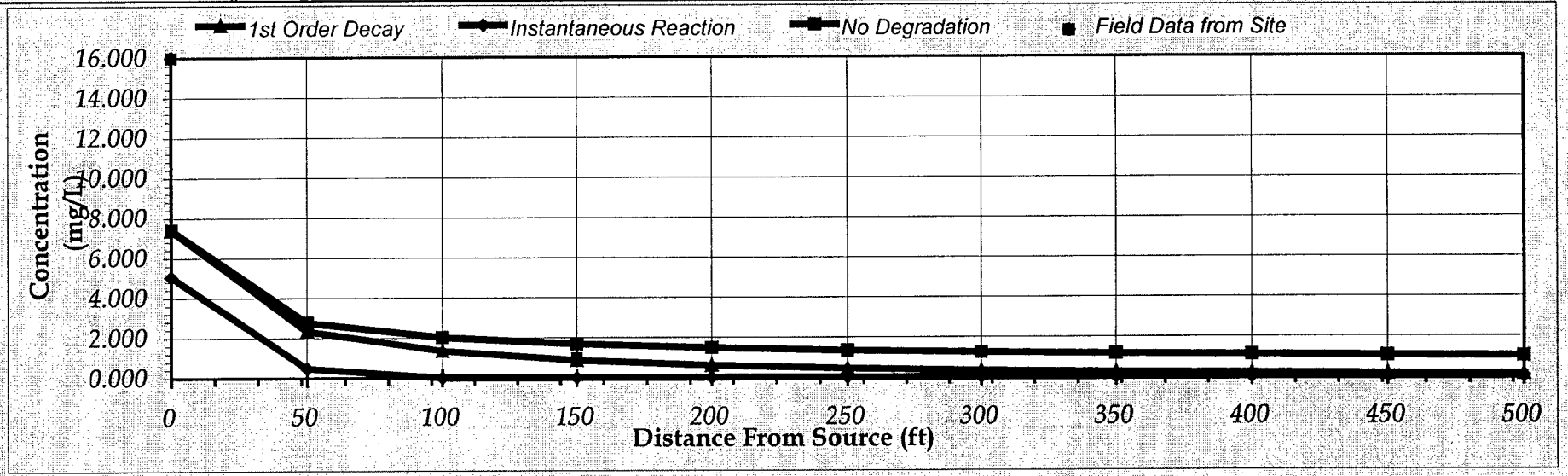
Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	50	100	150	200	250	300	350	400	450	500
No Degradation	7.393	2.750	2.010	1.672	1.469	1.331	1.230	1.152	1.090	1.039	0.996
1st Order Decay	7.393	2.327	1.334	0.871	0.600	0.427	0.310	0.228	0.169	0.126	0.095
Inst. Reaction	5.043	0.470	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	16.000			0.980							



Time:

40 Years

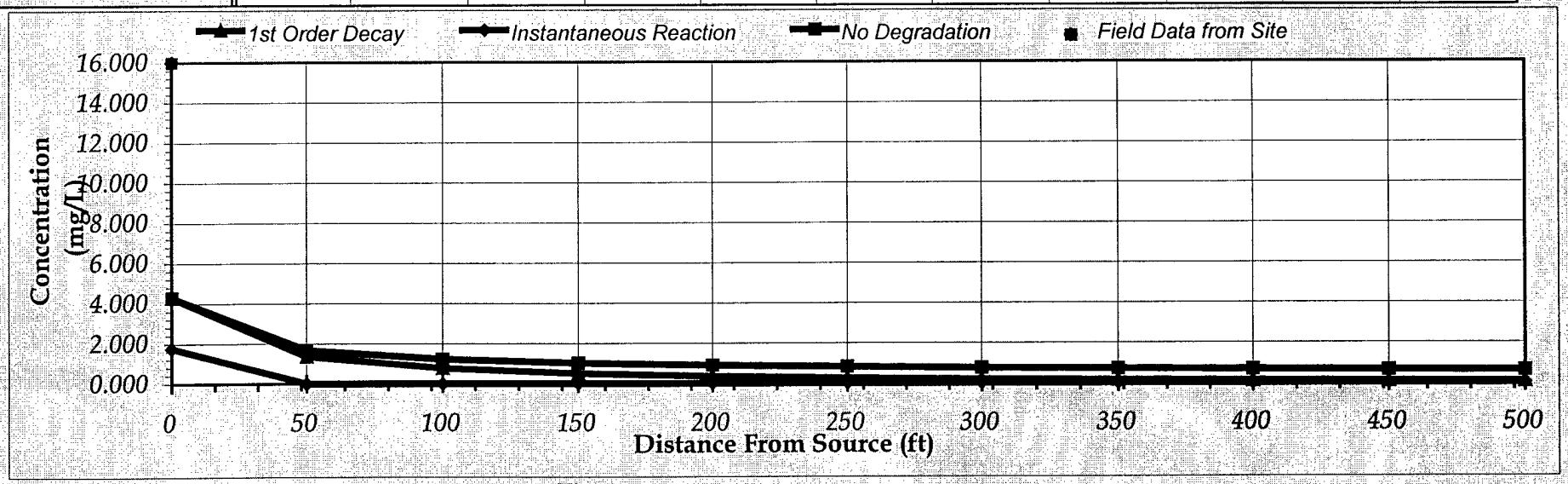
Calculate Animation

Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	50	100	150	200	250	300	350	400	450	500
No Degradation	4.285	1.658	1.213	1.011	0.890	0.807	0.747	0.701	0.665	0.635	0.610
1st Order Decay	4.285	1.349	0.773	0.505	0.348	0.247	0.179	0.132	0.098	0.073	0.055
Inst. Reaction	1.751	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	16.000			0.980							



Calculate Animation

Time: 60 Years

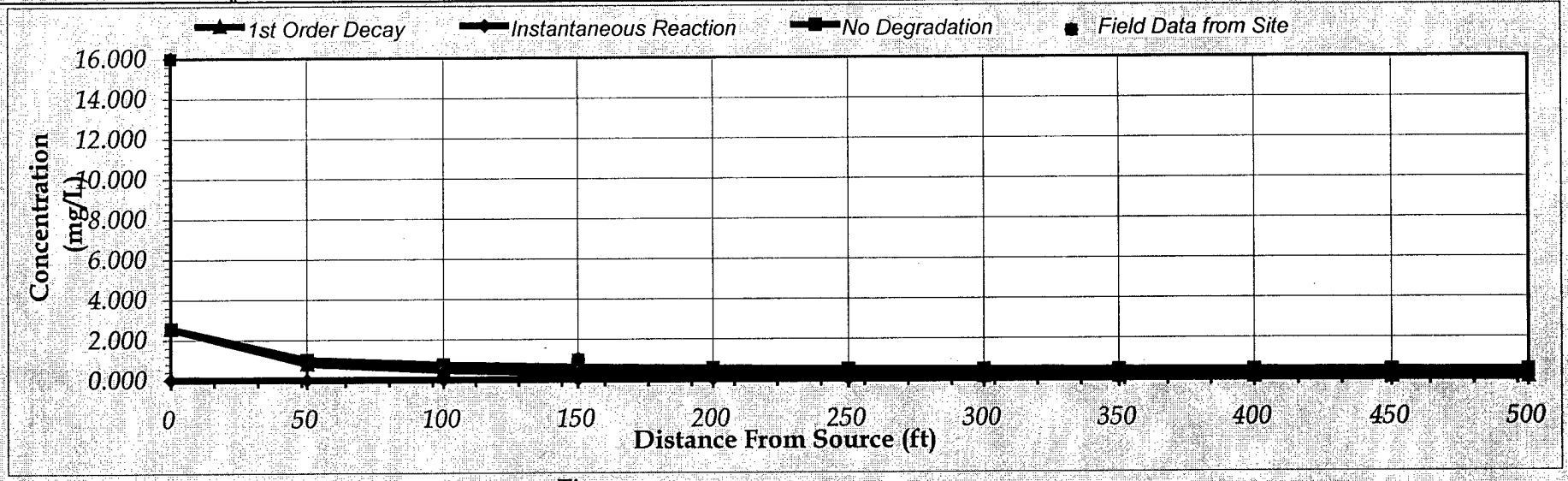
Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	50	100	150	200	250	300	350	400	450	500
No Degradation	2.553	1.006	0.737	0.614	0.541	0.491	0.455	0.427	0.405	0.387	0.372
1st Order Decay	2.553	0.804	0.461	0.301	0.207	0.147	0.107	0.079	0.058	0.044	0.033
Inst. Reaction	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	16.000			0.980							



Time:

79 Years

Calculate Animation

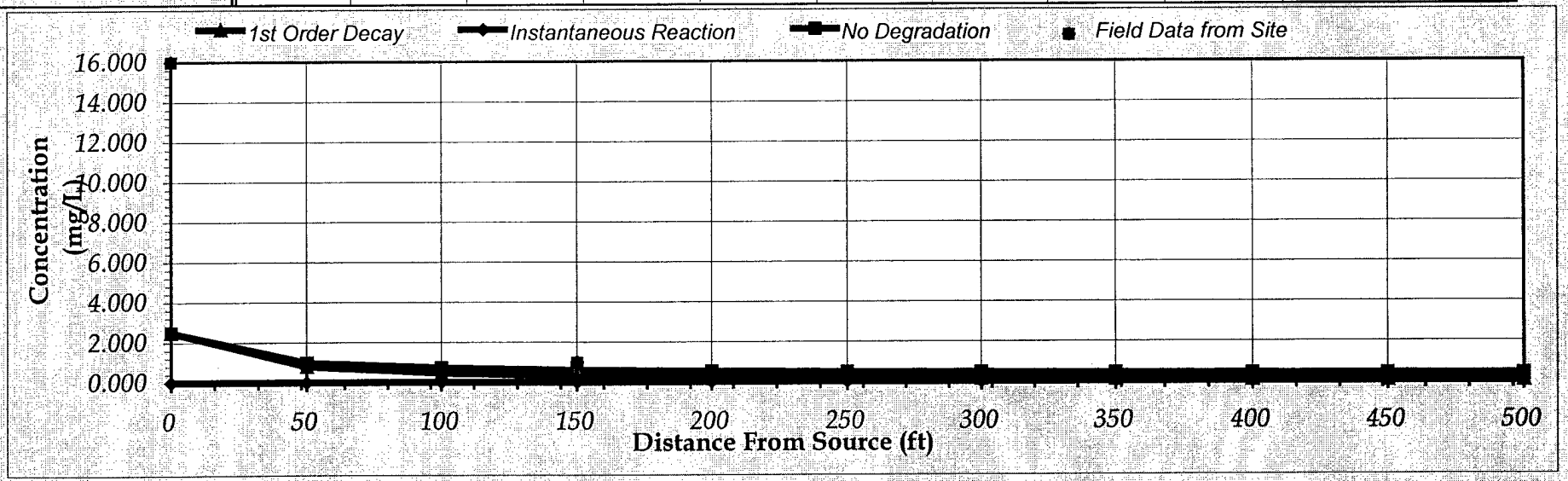
Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	50	100	150	200	250	300	350	400	450	500
No Degradation	2.484	0.979	0.717	0.598	0.527	0.478	0.443	0.416	0.395	0.377	0.363
1st Order Decay	2.484	0.782	0.448	0.293	0.202	0.143	0.104	0.076	0.057	0.042	0.032
Inst. Reaction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	16.000			0.980							



Time:

80 Years

Calculate Animation

Return to Input

Recalculate This Sheet

CURRENT UST PIT WITH 1998 XYLENE DATA

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Tyndall AFB
BX Service Station
Current UST Pit

Data Input Instructions:

115 (or 0.02) — 1. Enter value directly... or 2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.

20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	175.2	*(ft/yr)*
or		or	
Hydraulic Conductivity	*K*	1.1E-02	*(cm/sec)*
Hydraulic Gradient	*i*	0.004	*(ft/ft)*
Effective Porosity	*n*	0.25	*(-)*

2. DISPERSION

Longitudinal Dispersivity*	*alpha x*	400.0	*(ft)*
Transverse Dispersivity*	*alpha y*	40.0	*(ft)*
Vertical Dispersivity*	*alpha z*	0.0	*(ft)*
or		or	
Estimated Plume Length	*Lp*	250	*(ft)*

3. ADSORPTION

Retardation Factor*	*R*	1.8	*(-)*
or		or	
Soil Bulk Density	*rho*	1.7	*(kg/l)*
Partition Coefficient	*Koc*	422	*(L/kg)*
FractionOrganicCarbon	*foc*	2.8E-4	*(-)*

4. BIODEGRADATION

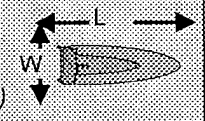
1st Order Decay Coeff*	*lambda*	2.7E+0	*(per yr)*
or		or	
Solute Half-Life	*t-half*	0.26	*(year)*

or Instantaneous Reaction Model

Delta Oxygen*	*DO*	0.11	*(mg/L)*
Delta Nitrate*	*NO3*	0	*(mg/L)*
Observed Ferrous Iron*	*Fe2+*	2.09	*(mg/L)*
Delta Sulfate*	*SO4*	5.42	*(mg/L)*
Observed Methane*	*CH4*	0.75	*(mg/L)*

5. GENERAL

Modeled Area Length*	500	*(ft)*
Modeled Area Width*	100	*(ft)*
Simulation Time*	40	*(yr)*



6. SOURCE DATA

Source Thickness in Sat.Zone* 10 *(ft)*

Source Zones:

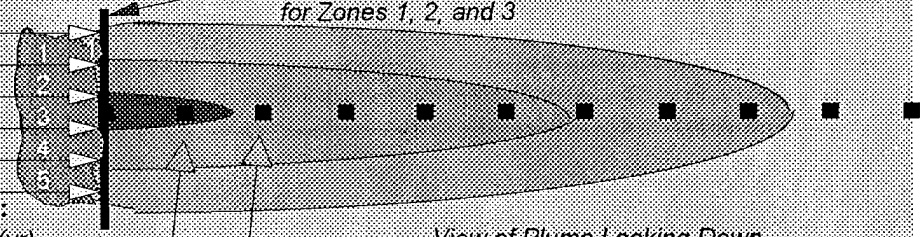
Width* (ft)	Conc. (mg/L)*
100	13
0	0
0	0

Source Halflife (see Help):

Inst. Reactant	1st Order
10	20 *(yr)*

Soluble Mass 400 *(Kg)*
In Source NAPL, Soil

Vertical Plane Source. Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Dist. from Source (ft)	Concentration (mg/L)
0	6.9
50	
100	
150	.62
200	
250	
300	
350	
400	
450	
500	

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

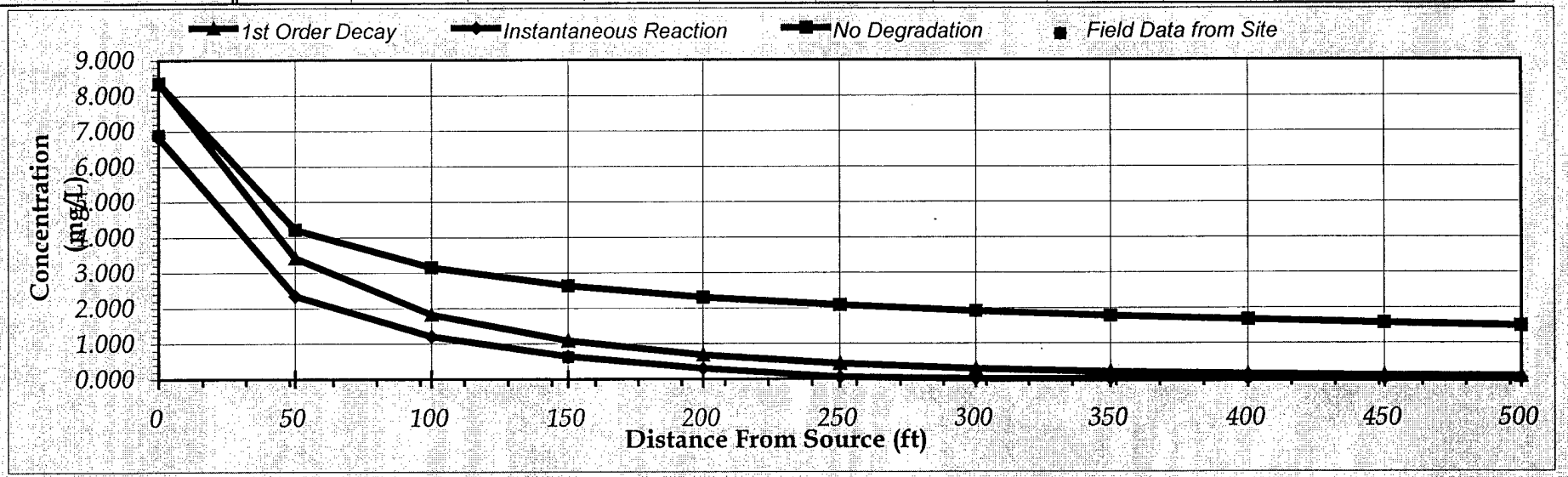
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	50	100	150	200	250	300	350	400	450	500
No Degradation	8.347	4.210	3.147	2.628	2.305	2.080	1.909	1.774	1.662	1.566	1.483
1st Order Decay	8.347	3.411	1.814	1.078	0.674	0.434	0.285	0.189	0.127	0.086	0.058
Inst. Reaction	6.822	2.345	1.198	0.640	0.295	0.054	0.000	0.000	0.000	0.000	0.000
Field Data from Site	6.900			0.620							



Calculate Animation

Time:

11 Years

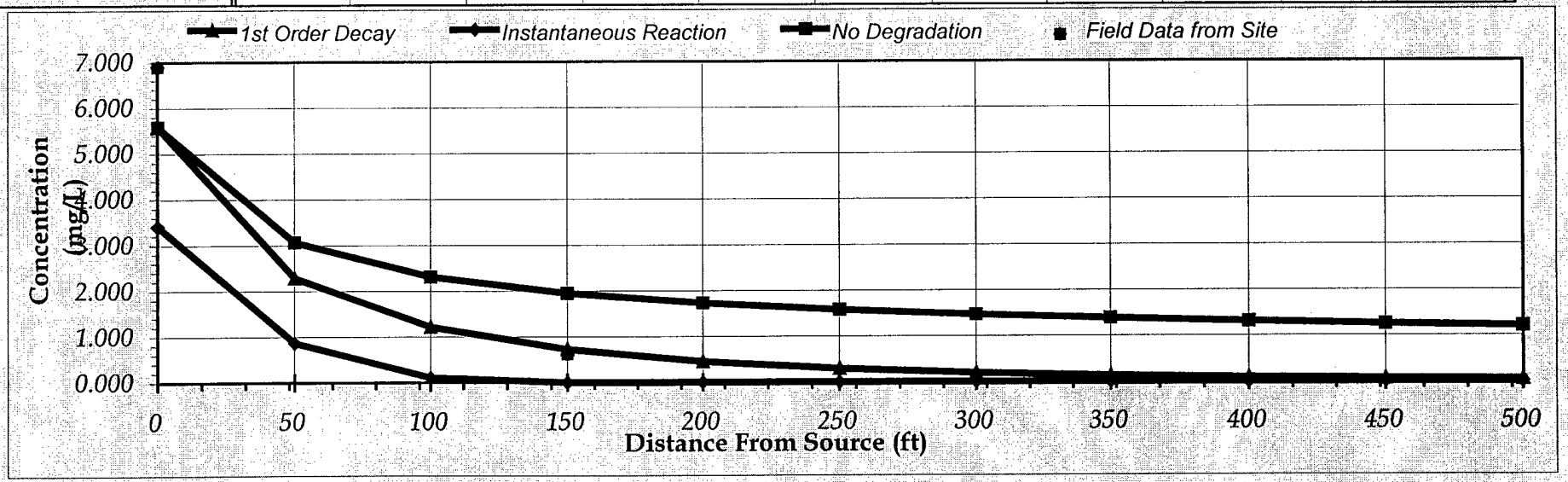
Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	50	100	150	200	250	300	350	400	450	500
No Degradation	5.580	3.060	2.308	1.945	1.724	1.573	1.461	1.375	1.306	1.249	1.201
1st Order Decay	5.580	2.280	1.212	0.721	0.451	0.290	0.190	0.126	0.085	0.057	0.039
Inst. Reaction	3.409	0.866	0.109	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	6.900			0.620							



Time:

21 Years

Calculate Animation

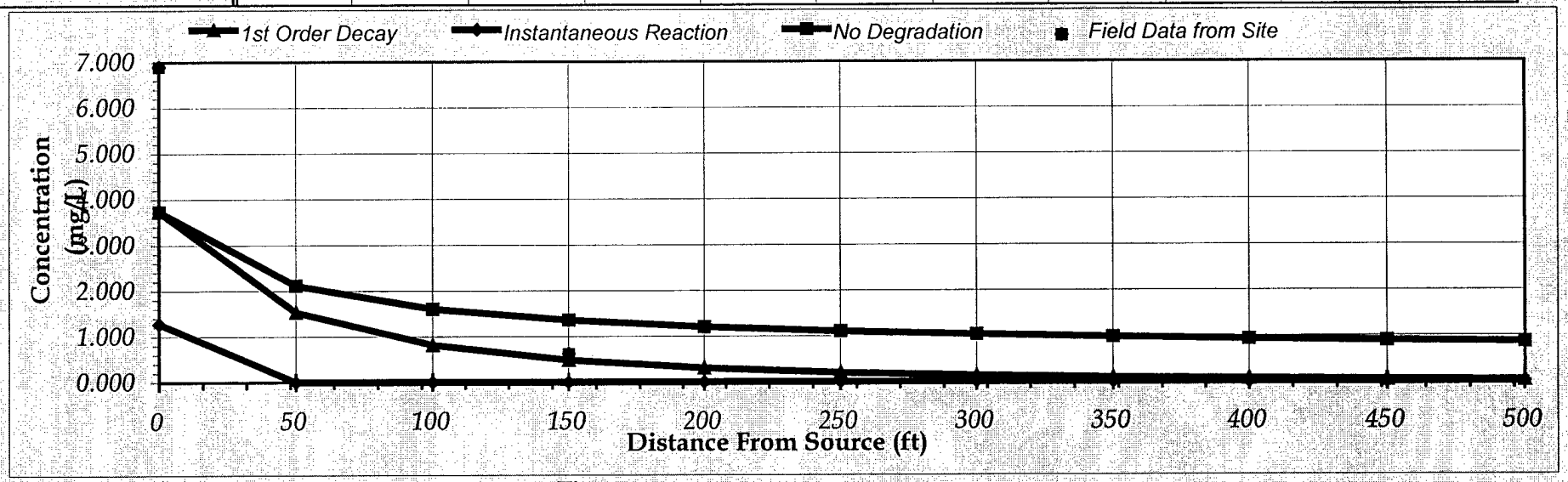
Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	50	100	150	200	250	300	350	400	450	500
No Degradation	3.730	2.113	1.598	1.351	1.202	1.100	1.026	0.969	0.924	0.888	0.858
1st Order Decay	3.730	1.524	0.810	0.482	0.301	0.194	0.127	0.084	0.057	0.038	0.026
Inst. Reaction	1.280	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	6.900			0.620							



Time:

31 Years

Calculate Animation

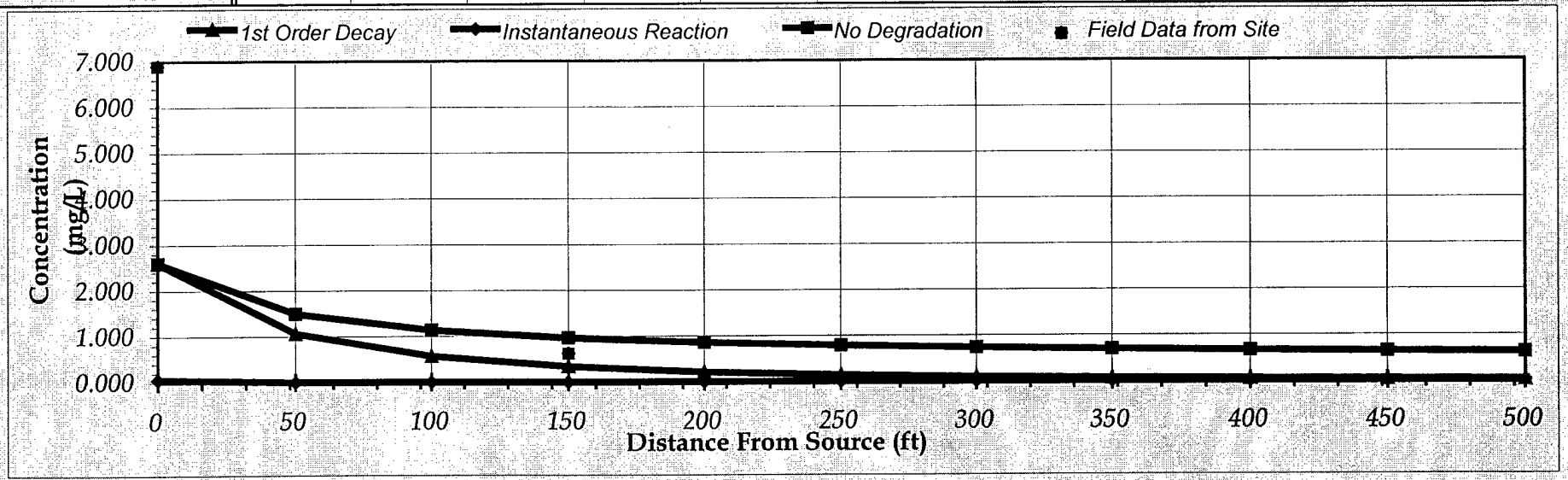
Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	50	100	150	200	250	300	350	400	450	500
No Degradation	2.596	1.491	1.129	0.955	0.851	0.780	0.728	0.689	0.658	0.633	0.613
1st Order Decay	2.596	1.061	0.564	0.335	0.210	0.135	0.088	0.059	0.039	0.027	0.018
Inst. Reaction	0.059	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	6.900			0.620							



Time:

40 Years

Calculate Animation

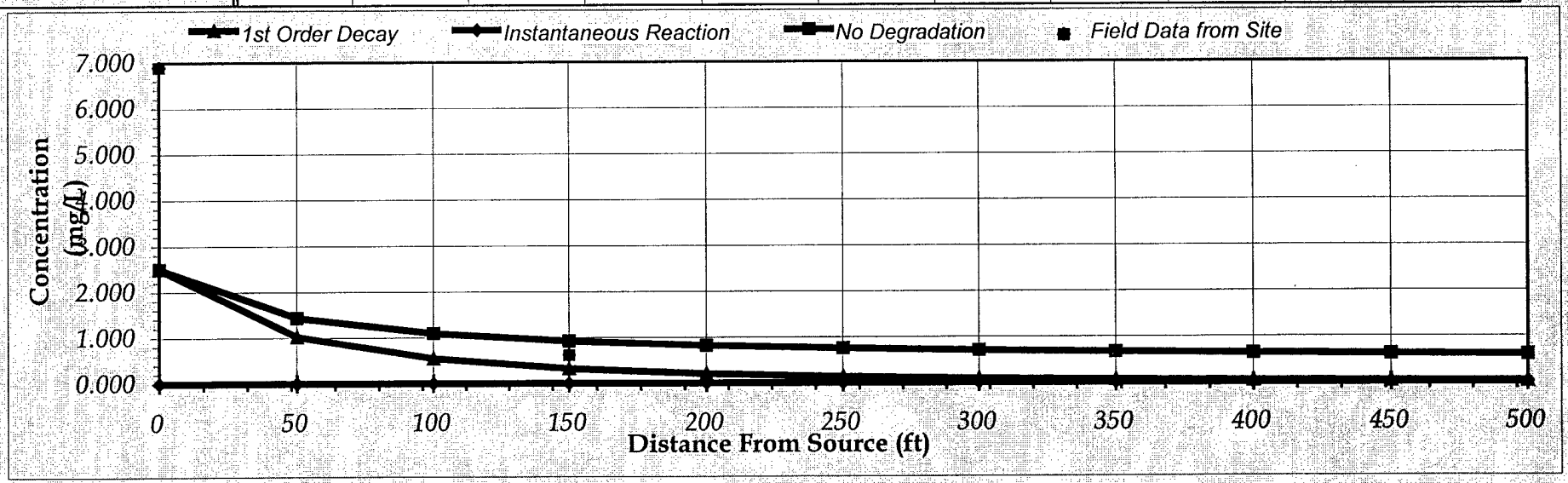
Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	50	100	150	200	250	300	350	400	450	500
No Degradation	2.493	1.433	1.085	0.919	0.818	0.750	0.700	0.663	0.633	0.609	0.590
1st Order Decay	2.493	1.019	0.542	0.322	0.201	0.130	0.085	0.056	0.038	0.026	0.017
Inst. Reaction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	6.900			0.620							



Calculate Animation

Time:

41 Years

Return to Input

Recalculate This Sheet

FORMER UST PIT WITH 1998 BENZENE DATA

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Tyndall AFB
BX Service Station
Former UST Pit

Data Input Instructions:

115 ▷ 1. Enter value directly... or
or
0.02 ◁ 2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* ▷ Data used directly in model.
20 ▷ Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	175.2	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.1E-02	(cm/sec)
Hydraulic Gradient	i	0.004	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	400.0	(ft)
Transverse Dispersivity*	alpha y	40.0	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	NA	(ft)

3. ADSORPTION

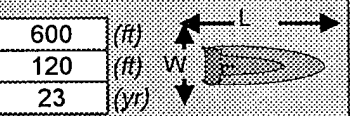
Retardation Factor*	R	1.1	(-)
or		or	
Soil Bulk Density	rho	1.7	(kg/l)
Partition Coefficient	Koc	79	(L/kg)
FractionOrganicCarbon	foc	2.8E-4	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	2.5E+0	(per yr)
or		or	
Solute Half-Life	t-half	0.28	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0.11	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	2.09	(mg/L)
Delta Sulfate*	SO4	5.42	(mg/L)
Observed Methane*	CH4	0.75	(mg/L)

5. GENERAL

Modeled Area Length*	600	(ft)
Modeled Area Width*	120	(ft)
Simulation Time*	23	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 10 (ft)

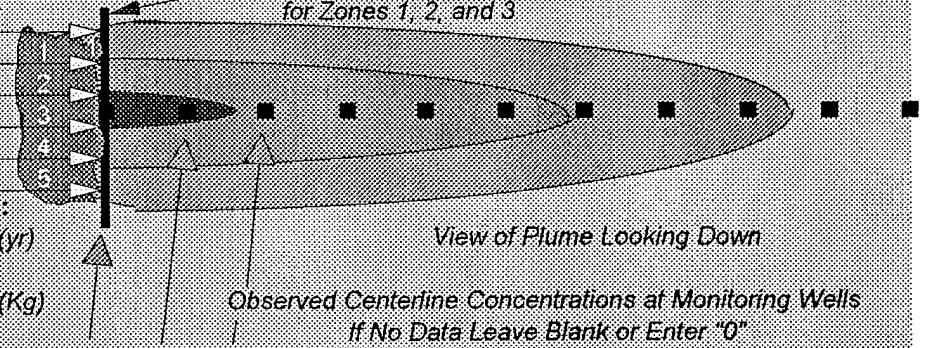
Source Zones:

Width* (ft)	Conc. (mg/L)*
120	15
0	0
0	0

Source Halflife (see Help):

10	20	(yr)
Inst. React.	1st Order	
Soluble Mass	530	(Kg)
In Source NAPL, Soil		

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Dist. from Source (ft)	Concentration (mg/L)
0	3.4
60	
120	
180	.0
240	
300	
360	
420	
480	
540	
600	

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

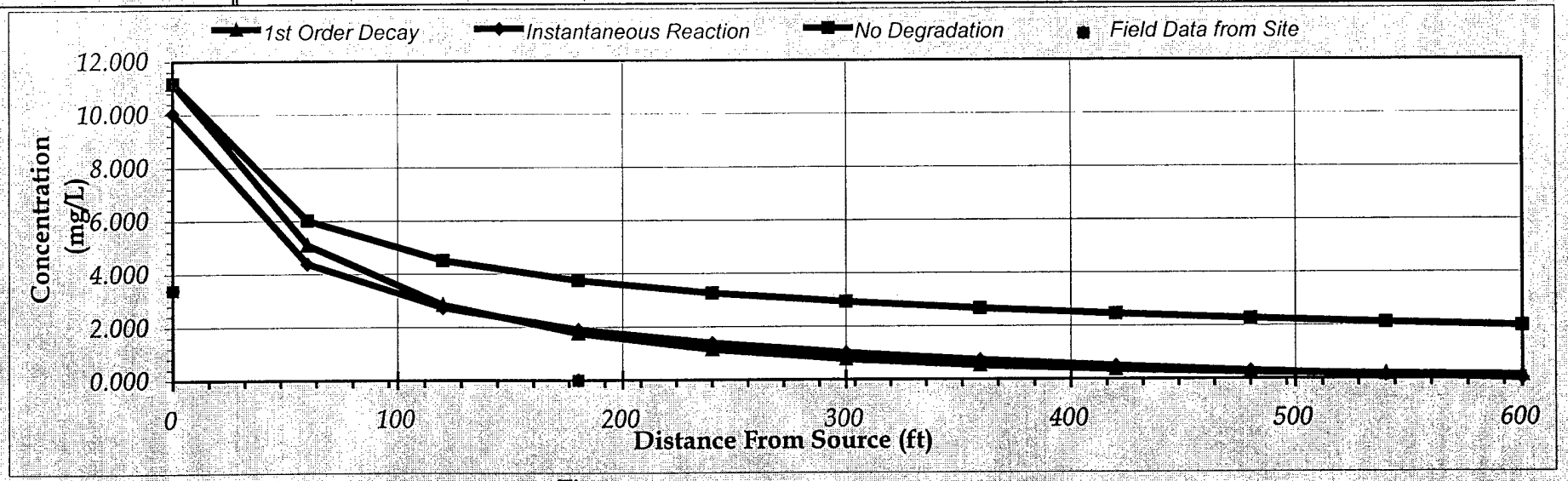
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	60	120	180	240	300	360	420	480	540	600
No Degradation	11.172	6.009	4.499	3.739	3.258	2.916	2.653	2.441	2.263	2.109	1.974
1st Order Decay	11.172	5.089	2.831	1.751	1.137	0.760	0.517	0.357	0.248	0.174	0.123
Inst. Reaction	10.045	4.381	2.729	1.899	1.375	1.002	0.717	0.487	0.294	0.127	0.000
Field Data from Site	3.400			0.000							



Time:

7 Years

Calculate Animation

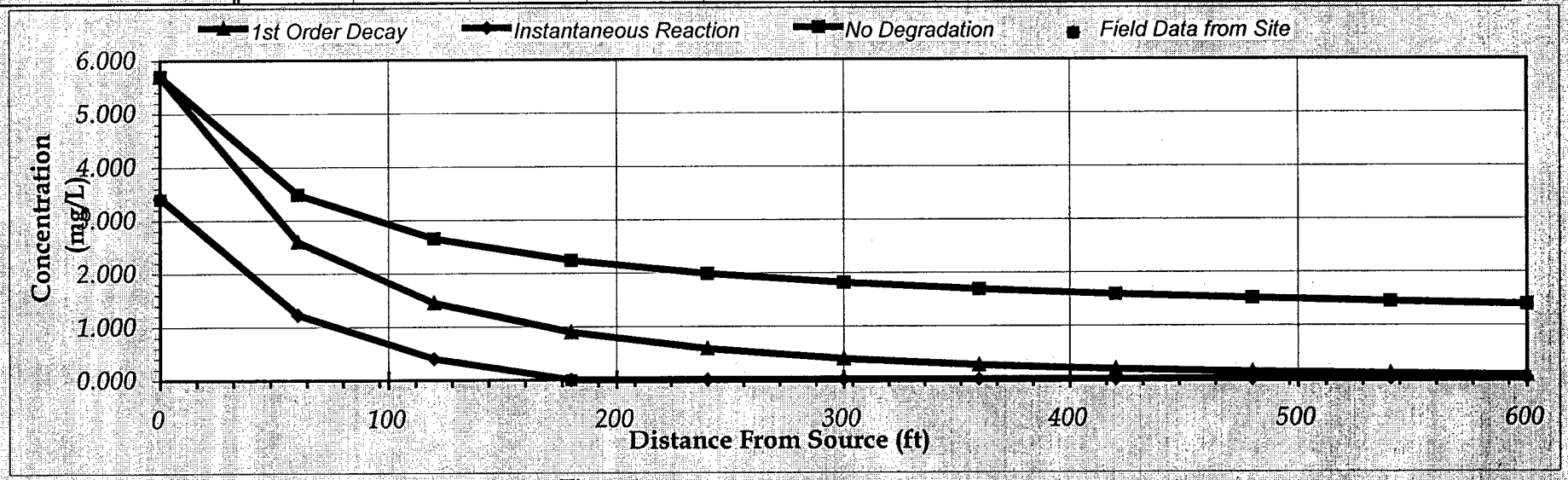
Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	60	120	180	240	300	360	420	480	540	600
No Degradation	5.697	3.484	2.649	2.239	1.987	1.814	1.686	1.588	1.509	1.445	1.391
1st Order Decay	5.697	2.595	1.444	0.893	0.580	0.388	0.264	0.182	0.127	0.089	0.063
Inst. Reaction	3.421	1.228	0.402	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	3.400			0.000							



Calculate Animation

Time:

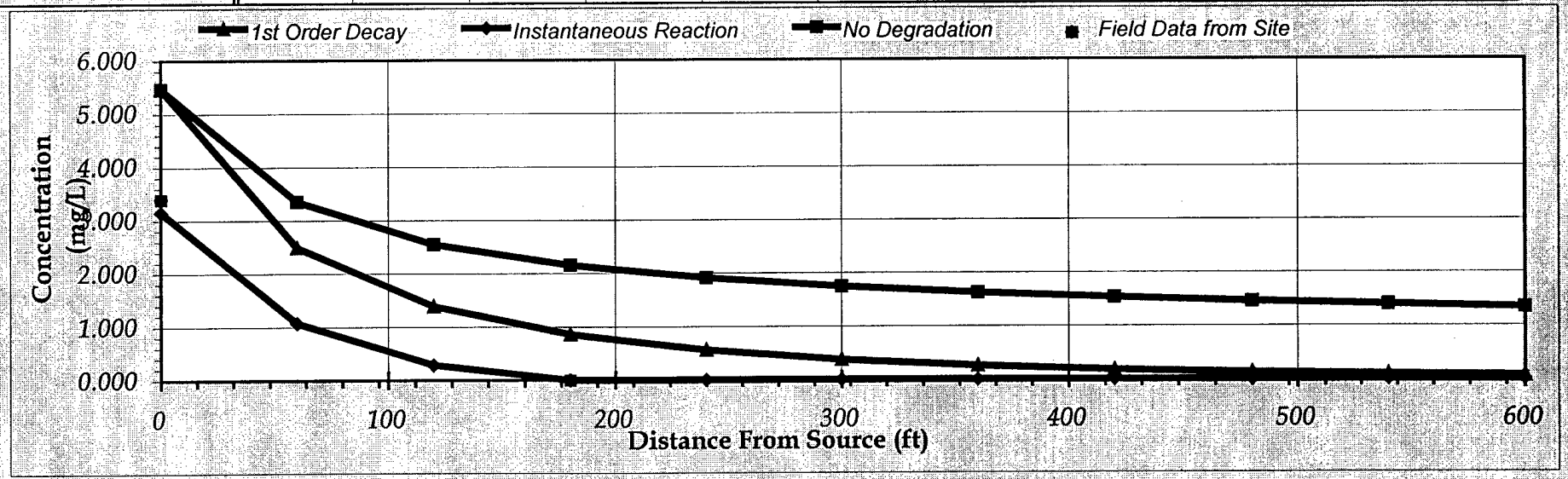
23 Years

Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	60	120	180	240	300	360	420	480	540	600
No Degradation	5.463	3.347	2.546	2.152	1.911	1.745	1.622	1.528	1.453	1.391	1.340
1st Order Decay	5.463	2.488	1.384	0.856	0.556	0.372	0.253	0.174	0.121	0.085	0.060
Inst. Reaction	3.153	1.071	0.283	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	3.400			0.000							



Time:

24 Years

Calculate Animation

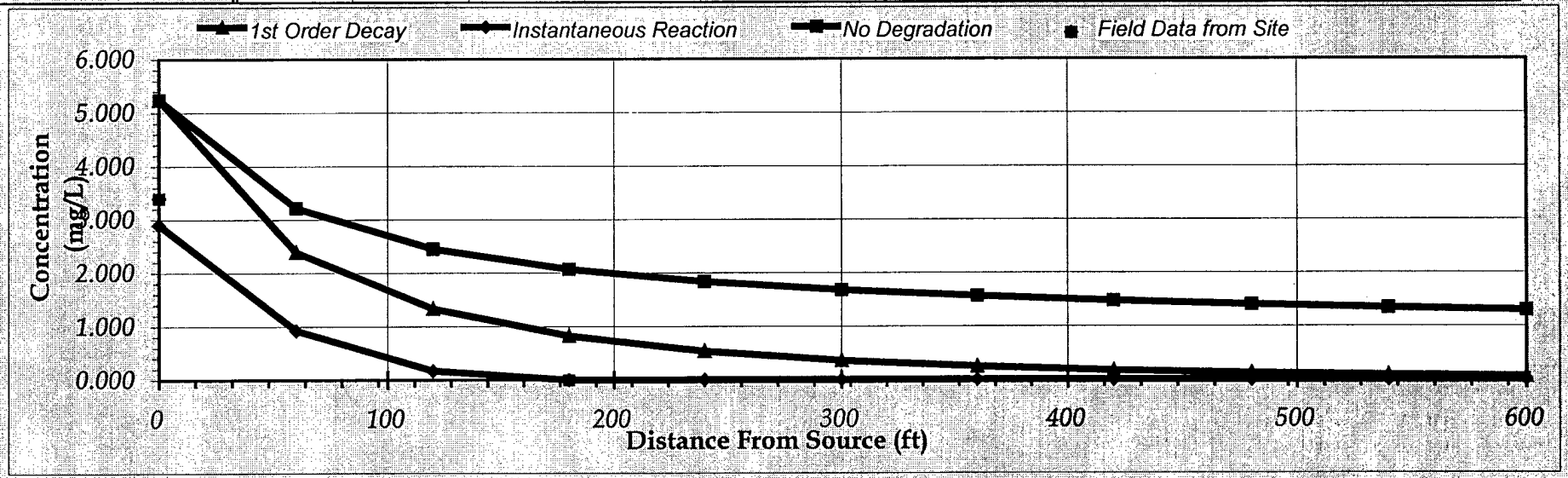
Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	60	120	180	240	300	360	420	480	540	600
No Degradation	5.237	3.215	2.446	2.068	1.836	1.677	1.560	1.470	1.398	1.339	1.290
1st Order Decay	5.237	2.386	1.327	0.821	0.533	0.356	0.242	0.167	0.116	0.082	0.058
Inst. Reaction	2.898	0.920	0.169	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	3.400			0.000							



Calculate Animation

Time:

25 Years

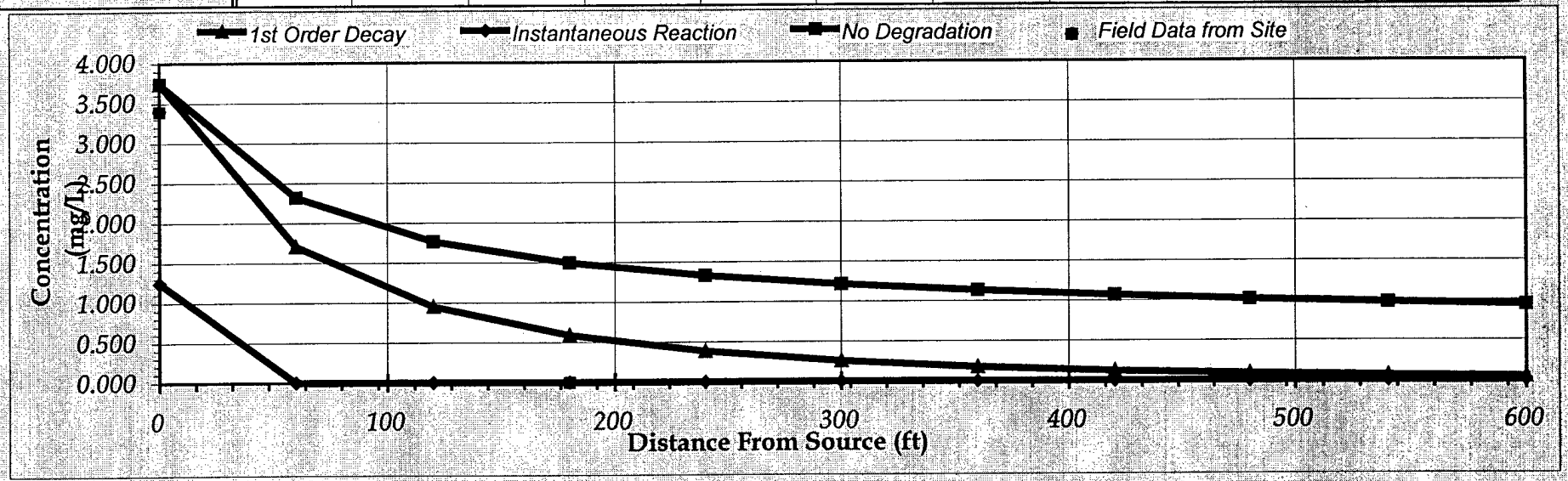
Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	60	120	180	240	300	360	420	480	540	600
No Degradation	3.740	2.318	1.765	1.493	1.327	1.214	1.130	1.066	1.015	0.974	0.940
1st Order Decay	3.740	1.704	0.948	0.586	0.381	0.254	0.173	0.119	0.083	0.058	0.041
Inst. Reaction	1.247	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	3.400			0.000							



Time:

33 Years

Calculate Animation

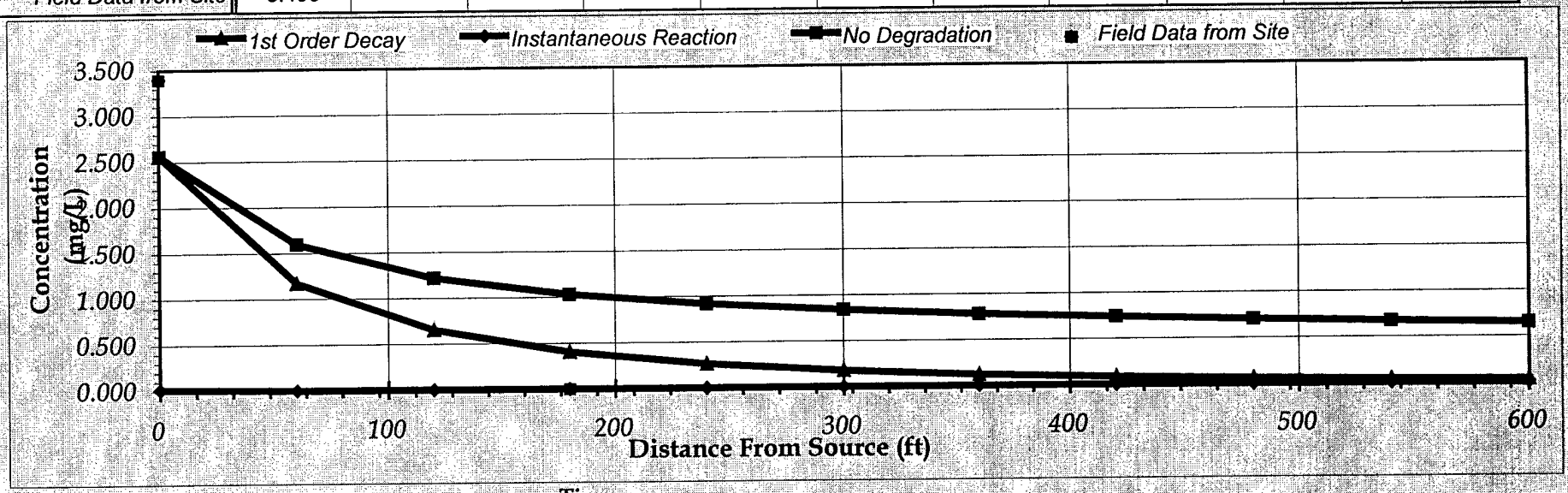
Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	60	120	180	240	300	360	420	480	540	600
No Degradation	2.561	1.593	1.214	1.027	0.914	0.836	0.779	0.735	0.700	0.672	0.649
1st Order Decay	2.561	1.167	0.649	0.401	0.261	0.174	0.119	0.082	0.057	0.040	0.028
Inst. Reaction	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	3.400			0.000							



Time:

42 Years

Calculate Animation

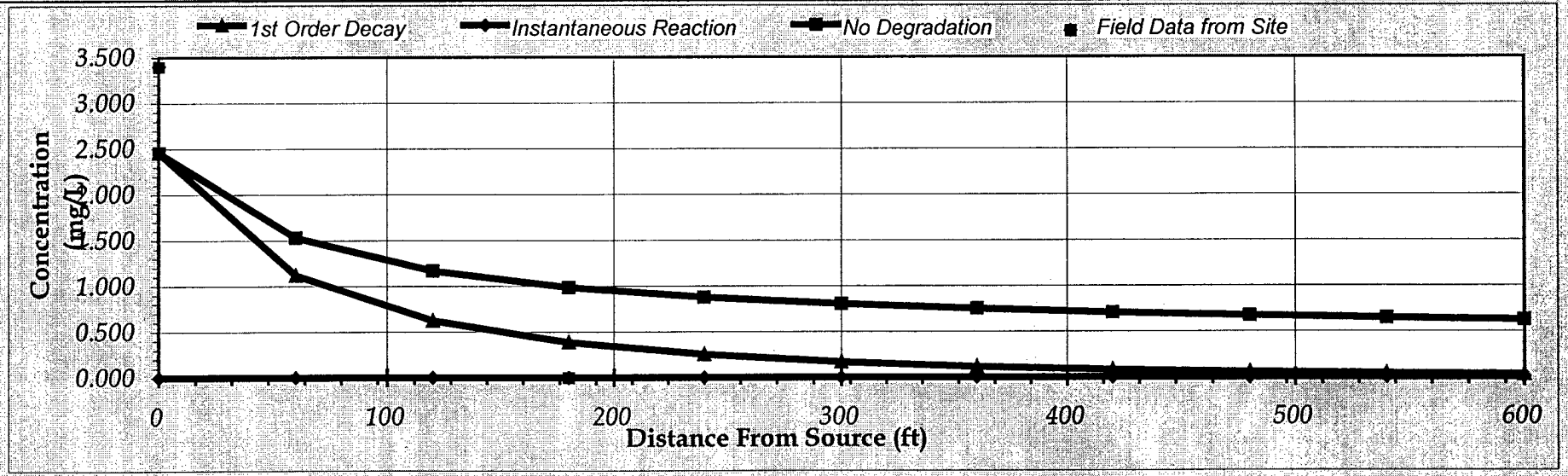
Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	60	120	180	240	300	360	420	480	540	600
No Degradation	2.455	1.528	1.164	0.985	0.876	0.802	0.747	0.705	0.672	0.645	0.622
1st Order Decay	2.455	1.118	0.622	0.385	0.250	0.167	0.114	0.078	0.055	0.038	0.027
Inst. Reaction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	3.400			0.000							



Calculate Animation

Time:

43 Years

Return to Input

Recalculate This Sheet

CURRENT UST PIT WITH 1997 XYLENE DATA AND THREE YEARS OF SOURCE REMOVAL

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Tyndall AFB
BX Service Station
Current UST Pit

Data Input Instructions:

115 (or 0.02) — 1. Enter value directly... or 2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.

20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	175.2	*(ft/yr)*
or		or	
Hydraulic Conductivity	*K*	1.1E-02	*(cm/sec)*
Hydraulic Gradient	*i*	0.004	*(ft/ft)*
Effective Porosity	*n*	0.25	*(-)*

2. DISPERSION

Longitudinal Dispersivity*	*alpha x*	925.0	*(ft)*
Transverse Dispersivity*	*alpha y*	92.5	*(ft)*
Vertical Dispersivity*	*alpha z*	0.0	*(ft)*
or		or	
Estimated Plume Length	*Lp*	NA	*(ft)*

3. ADSORPTION

Retardation Factor*	*R*	1.8	*(-)*
or		or	
Soil Bulk Density	*rho*	1.7	*(kg/l)*
Partition Coefficient	*Koc*	422	*(L/kg)*
FractionOrganicCarbon	*foc*	2.8E-4	*(-)*

4. BIODEGRADATION

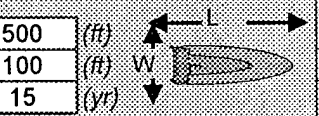
1st Order Decay Coeff*	*lambda*	2.7E+0	*(per yr)*
or		or	
Solute Half-Life	*t-half*	0.26	*(year)*

or Instantaneous Reaction Model

Delta Oxygen*	*DO*	0.11	*(mg/L)*
Delta Nitrate*	*NO3*	0	*(mg/L)*
Observed Ferrous Iron*	*Fe2+*	2.09	*(mg/L)*
Delta Sulfate*	*SO4*	5.42	*(mg/L)*
Observed Methane*	*CH4*	0.75	*(mg/L)*

5. GENERAL

Modeled Area Length*	500	*(ft)*
Modeled Area Width*	100	*(ft)*
Simulation Time*	15	*(yr)*



6. SOURCE DATA

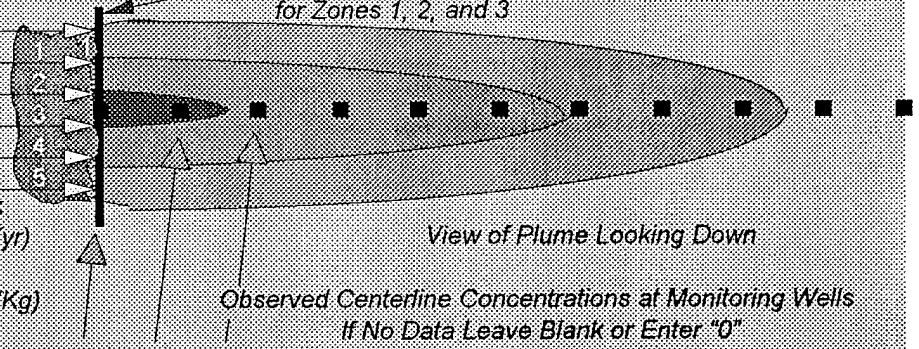
Source Thickness in Sat.Zone* 10 *(ft)*

Source Zones: Width* (ft)	Conc. (mg/L)*
100	16
0	0
0	0

Source Halflife (see Help):

4	5	*(yr)*
Inst. React.	1st Order	
Soluble Mass	140	*(Kg)*
In Source NAPL, Soil		

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Dist. from Source (ft)	Concentration (mg/L)
0	
50	
100	
150	
200	
250	
300	
350	
400	
450	
500	

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

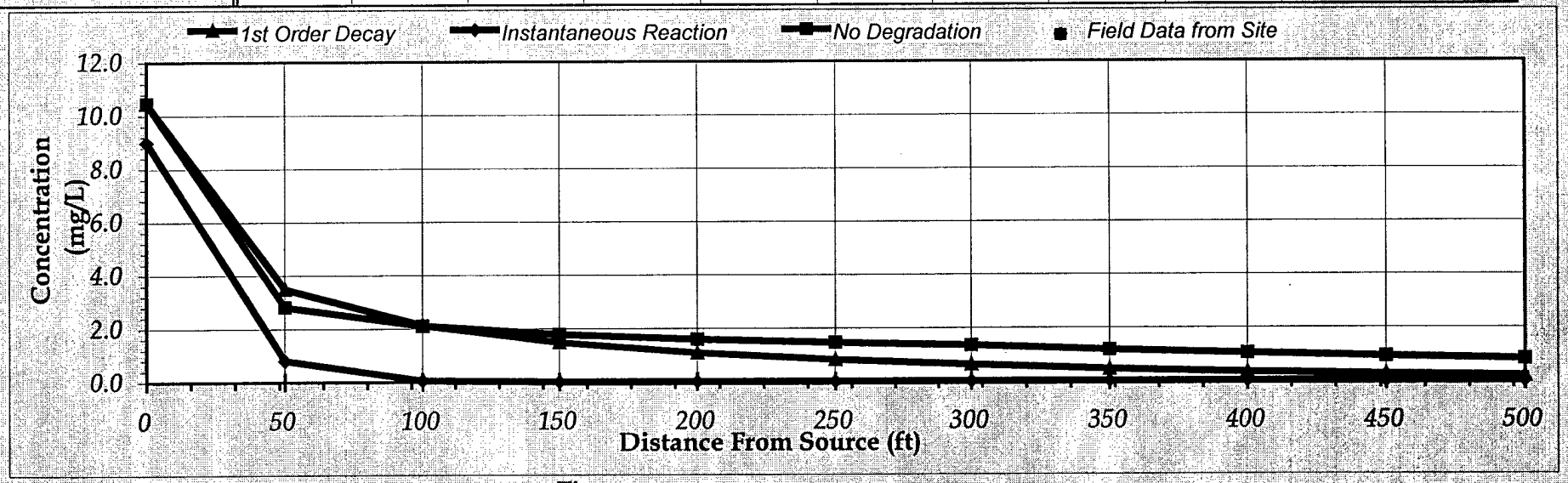
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	50	100	150	200	250	300	350	400	450	500
No Degradation	10.461	2.810	2.093	1.770	1.578	1.446	1.335	1.170	1.033	0.916	0.814
1st Order Decay	10.461	3.491	2.122	1.468	1.073	0.809	0.616	0.447	0.327	0.241	0.179
Inst. Reaction	8.993	0.804	0.049	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Time:

3 Years

Replay Animation

Next Timestep

Prev Timestep

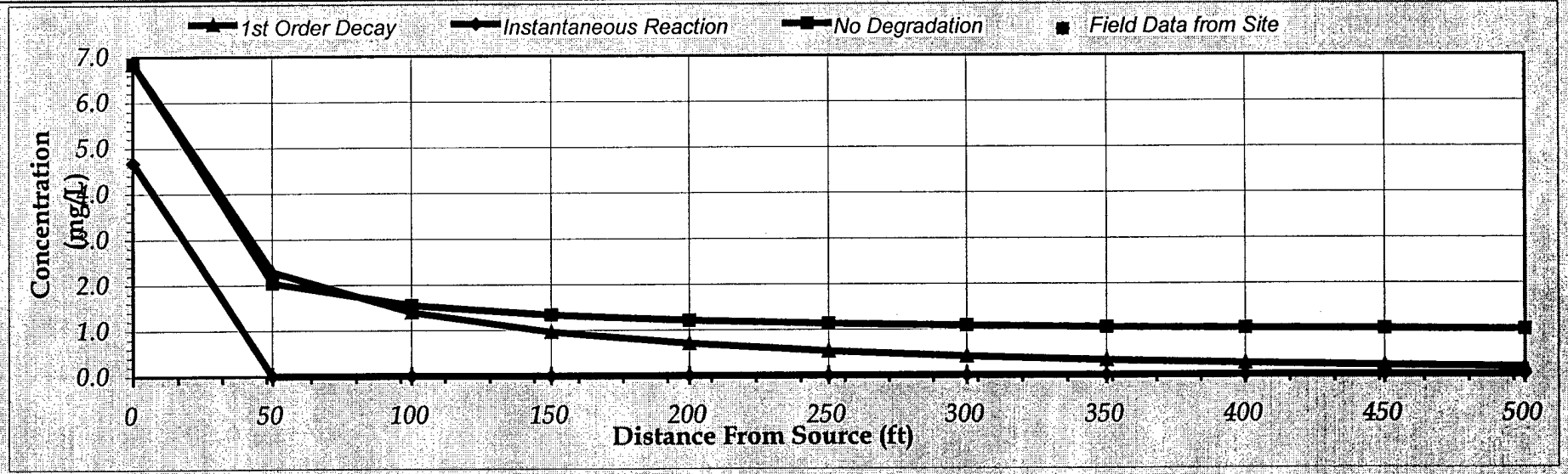
Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	50	100	150	200	250	300	350	400	450	500
No Degradation	6.840	2.034	1.542	1.328	1.208	1.132	1.080	1.043	1.017	0.997	0.982
1st Order Decay	6.840	2.283	1.387	0.960	0.702	0.529	0.407	0.317	0.249	0.198	0.158
Inst. Reaction	4.678	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Time:

6 Years

Replay Animation

Next Timestep

Prev Timestep

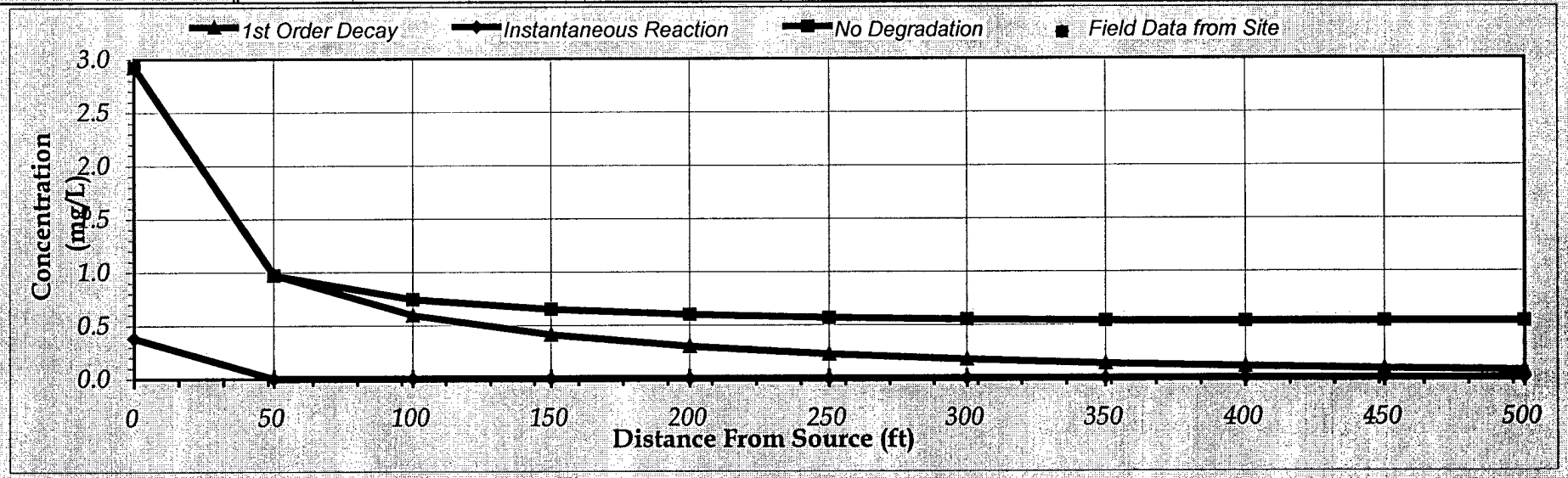
Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	50	100	150	200	250	300	350	400	450	500
No Degradation	2.924	0.970	0.743	0.648	0.597	0.567	0.549	0.538	0.533	0.531	0.532
1st Order Decay	2.924	0.976	0.593	0.410	0.300	0.226	0.174	0.135	0.107	0.085	0.068
Inst. Reaction	0.381	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Replay Animation

Next Timestep

Prev Timestep

Time:

12 Years

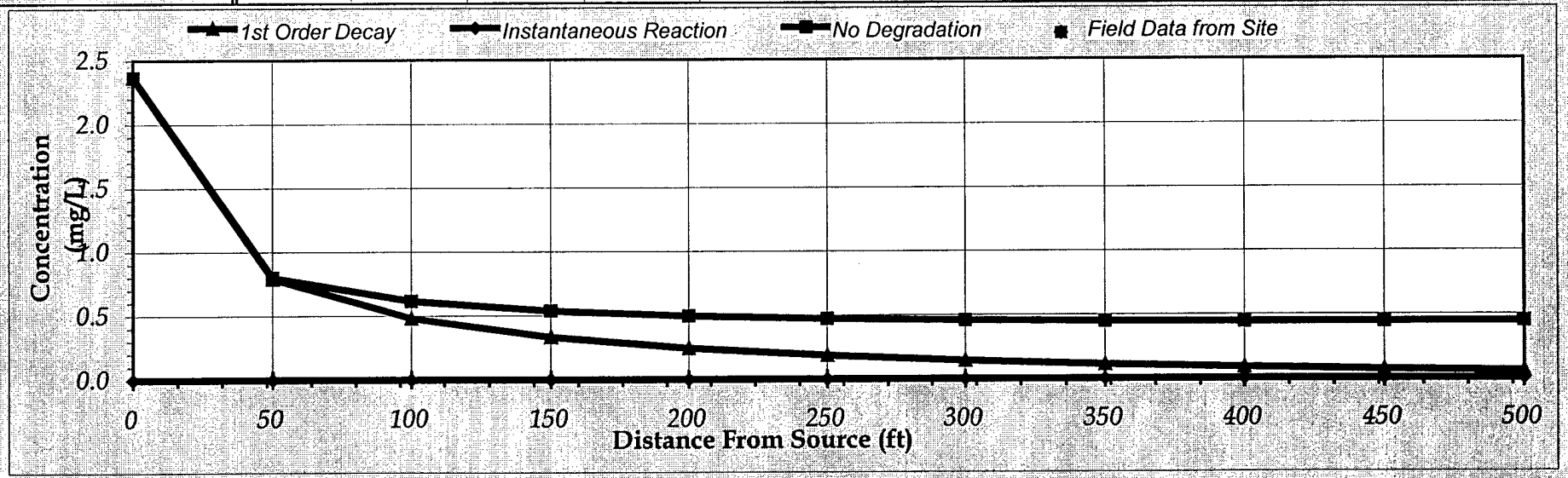
Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	50	100	150	200	250	300	350	400	450	500
No Degradation	2.365	0.799	0.613	0.536	0.494	0.470	0.456	0.448	0.444	0.444	0.446
1st Order Decay	2.365	0.789	0.480	0.332	0.243	0.183	0.141	0.110	0.086	0.068	0.055
Inst. Reaction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Replay Animation | Next Timestep | Prev Timestep

Time: 14 Years

Return to Input | Recalculate This Sheet

FORMER UST PIT WITH 1998 BENZENE DATA AND THREE YEARS OF SOURCE REMOVAL

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Tyndall AFB
BX Service Station
Former UST Pit

Data Input Instructions:

115 (or 0.02) — 1. Enter value directly... or 2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.

20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	175.2	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.1E-02	(cm/sec)
Hydraulic Gradient	I	0.004	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	400.0	(ft)
Transverse Dispersivity*	alpha y	40.0	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	NA	(ft)

3. ADSORPTION

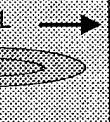
Retardation Factor*	R	1.1	(-)
or		or	
Soil Bulk Density	rho	1.7	(kg/l)
Partition Coefficient	Koc	79	(L/kg)
FractionOrganicCarbon	foc	2.8E-4	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	2.5E+0	(per yr)
or		or	
Solute Half-Life	t-half	0.28	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0.11	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	2.09	(mg/L)
Delta Sulfate*	SO4	5.42	(mg/L)
Observed Methane*	CH4	0.75	(mg/L)

5. GENERAL

Modeled Area Length*	600	(ft)
Modeled Area Width*	120	(ft)
Simulation Time*	5	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 10 (ft)

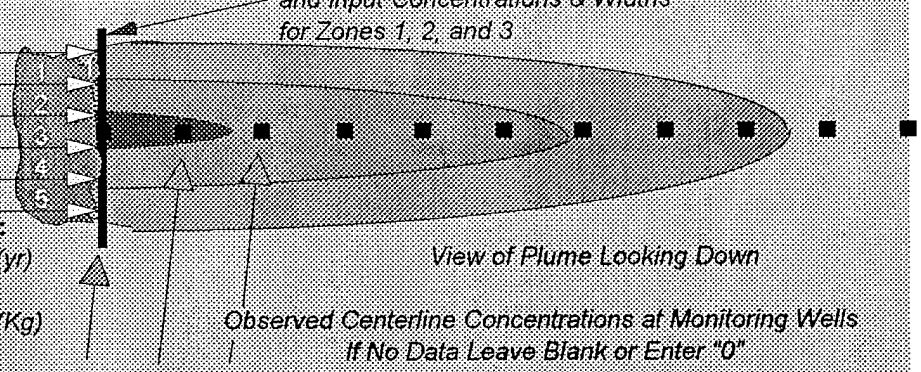
Source Zones:

Width* (ft)	Conc. (mg/L)*
120	3.4
0	0
0	0

Source Halflife (see Help):

2	3	(yr)
Inst. React.	1st Order	
Soluble Mass In Source NAPL, Soil	22	(Kg)

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Dist. from Source (ft)	0	60	120	180	240	300	360	420	480	540	600
Concentration (mg/L)											

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — View Output

RUN ARRAY — View Output

Help

Recalculate This Sheet

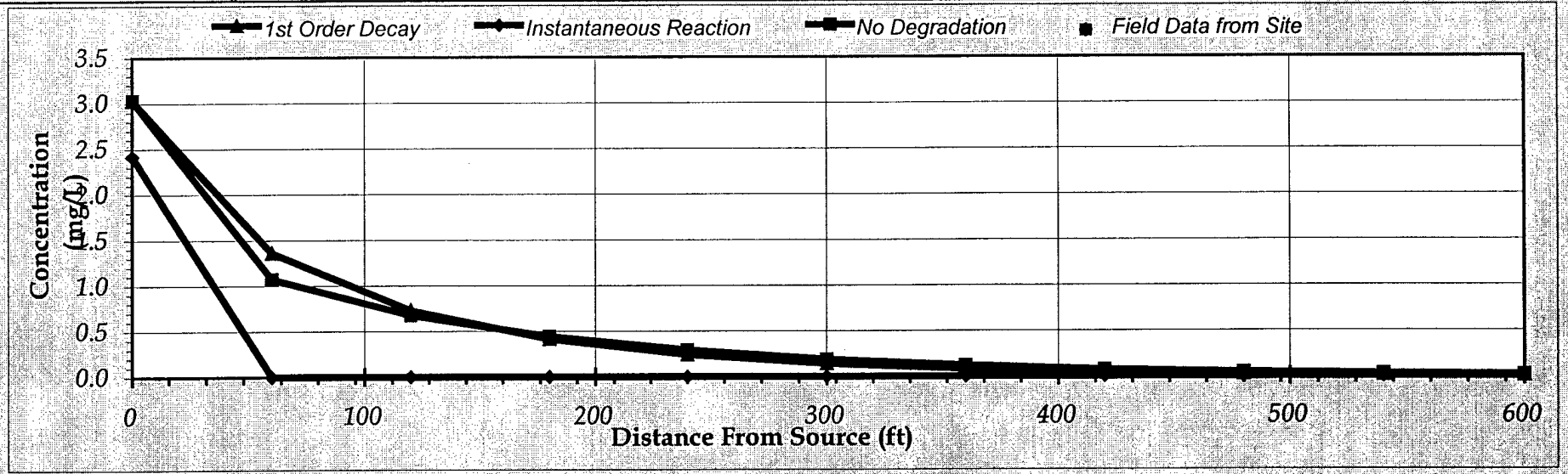
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	60	120	180	240	300	360	420	480	540	600
No Degradation	3.031	1.071	0.672	0.439	0.289	0.187	0.118	0.072	0.042	0.023	0.012
1st Order Decay	3.031	1.357	0.724	0.410	0.239	0.139	0.080	0.045	0.024	0.013	0.006
Inst. Reaction	2.419	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



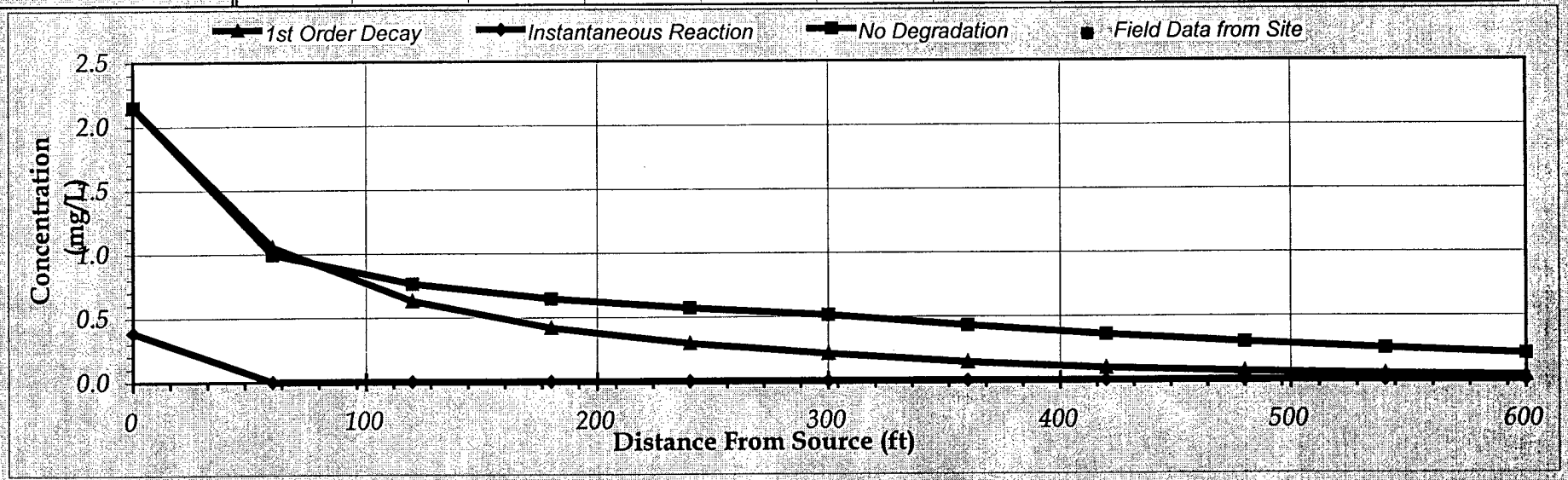
Time:

1 Years

Replay Animation | Next Timestep | Prev Timestep | Return to Input | Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	60	120	180	240	300	360	420	480	540	600
No Degradation	2.147	0.995	0.764	0.647	0.570	0.513	0.428	0.356	0.296	0.245	0.202
1st Order Decay	2.147	1.052	0.630	0.419	0.293	0.210	0.142	0.096	0.065	0.045	0.031
Inst. Reaction	0.386	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Replay Animation

Next Timestep

Prev Timestep

Time:

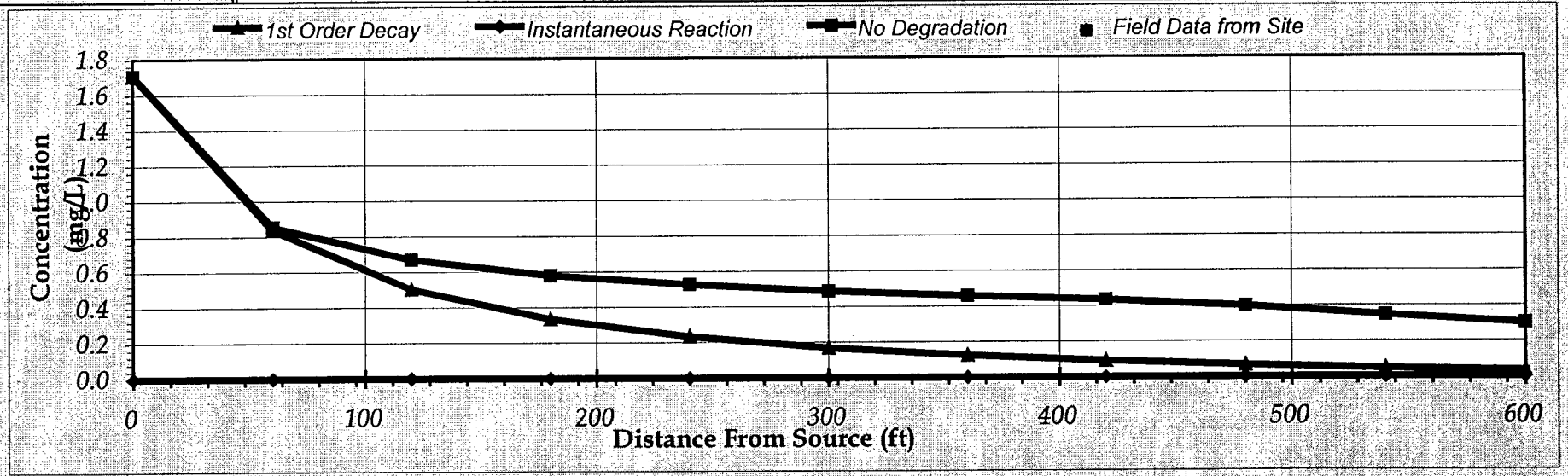
2 Years

Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	60	120	180	240	300	360	420	480	540	600
No Degradation	1.706	0.853	0.669	0.580	0.526	0.487	0.457	0.433	0.397	0.344	0.299
1st Order Decay	1.706	0.837	0.501	0.334	0.233	0.168	0.123	0.091	0.066	0.046	0.032
Inst. Reaction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Replay Animation | Next Timestep | Prev Timestep

Time: 3 Years

Return to Input | Recalculate This Sheet

APPENDIX G
USEPA IEUBK MODEL INPUT AND OUTPUT

LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 12.30 ug Pb/L
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: Multiple Source Analysis

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	23.0	26.1
1-2	23.0	26.1
2-3	23.0	26.1
3-4	23.0	26.1
4-5	23.0	26.1
5-6	23.0	26.1
6-7	23.0	26.1

Additional Dust Sources: None DEFAULT
Soil contribution conversion factor: 0.70
Air contribution conversion factor: 100.0

PAINT Intake: 0.00 ug Pb/day DEFAULT

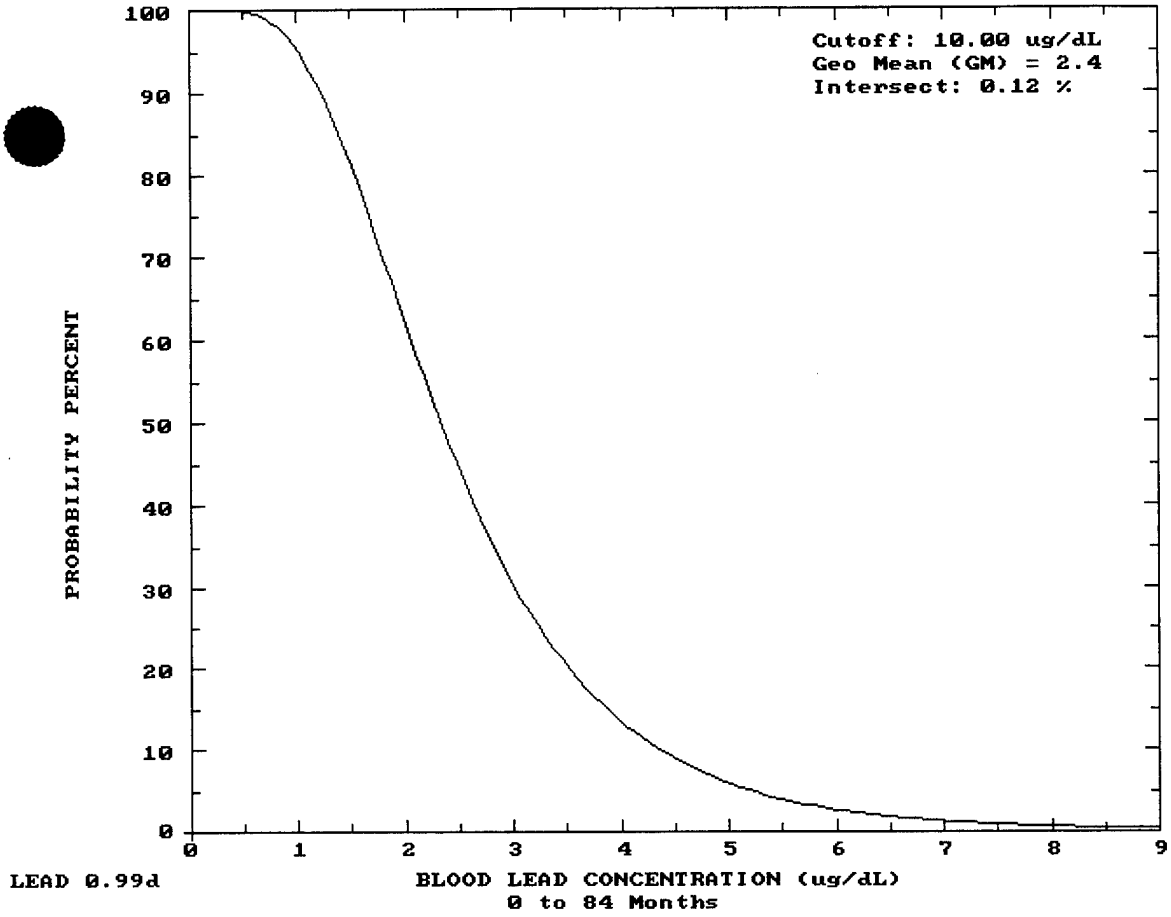
MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	2.4	4.42	0.60
1-2:	2.7	6.61	0.94
2-3:	2.6	7.12	0.95
3-4:	2.5	7.12	0.96
4-5:	2.3	6.93	0.71
5-6:	2.2	7.25	0.64
6-7:	2.1	7.60	0.61

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	2.63	1.17	0.00	0.02

1-2:	2.73	2.90	0.00	0.03
2-3:	3.08	3.03	0.00	0.06
3-4:	2.98	3.12	0.00	0.07
4-5:	2.89	3.26	0.00	0.07
-6:	3.06	3.45	0.00	0.09
-7:	3.39	3.51	0.00	0.09


Cutoff: 10.00 ug/dL
Geo Mean (GM) = 2.4
Intersect: 0.12 %
PROBABILITY PERCENT
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
9
LEAD 0.99d
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months

APPENDIX H
COST TABLES FOR REMEDIAL ALTERNATIVES

ALTERNATIVE 1 Cost Estimate
Tyndall AFB BX Service Station
731854.10000.30000

Author: JRH
Date: 7/21/98
Checked by:
Date:

Groundwater Sampling - Years 1999--2001 then biennially 2002 to 2069 -- 8 wells sampled each event

Sampling Labor	50	hours x	$60	/hour	$3,000
8 Long-Term Monitoring Wells					
5 QA/QC (1 dupl, 1 field blank, 1 trip blank, 1 MS, 1 MSD)					
13 Total Samples					
Analytical Subcontractor					
	13	BTEX/napthalene/ MTBE	$150	/each	$1,950
	8	Methane	$100	/each	$800
	12	Field Parameters	$20	/each	$240
Supplies			$500	lump sum	$500
Travel			$400	lump sum	$400
Data Management (20 hr x $60hr)			$1,200		$1,200
Data Validation (15 hr x $60/hr)			$900		$900
Reporting/Project Management Labor					
Word Processing	5	hours x	$25	/hour	$125
CADD	10	hours x	$50	/hour	$500
Reproduction	8	hours x	$20	/hour	$160
Staff Level	40	hours x	$60	/hour	$2,400
Proj. Manager	15	hours x	$80	/hour	$1,200
Editor	5	hours x	$60	/hour	$300
Reporting/Project Management ODCs			$400	lump sum	$400

Total for 1 Sampling Event $14,075

LTM 1 Cost Estimate
Tyndall AFB BX Service Station
731854.10000.30000

Author: JRH
Date: 7/21/98
Checked by:
Date:

Summary of Capital and Present Worth Costs

Capital Costs

Design/Construct 2 LTM Wells in 1999 — $7,776
P/F i=7% n=1

Monitoring Costs

Annual Monitoring of 8 Wells 1999-2001
Annual Cost = $14,075
P/A i=7% n=3 PWF = 2.62431604
Present Worth Cost $36,937

Biennial Monitoring of 7 wells, 2002-2040
(20 events)

Cost per Event	$14,075	
P/A i=7%, n=4	2002	$10,737.75
P/A i=7%, n=6	2004	$9,378.77
P/A i=7%, n=8	2006	$8,191.78
P/A i=7%, n=10	2008	$7,155.02
P/A i=7%, n=12	2010	$6,249.47
P/A i=7%, n=14	2012	$5,458.53
P/A i=7%, n=16	2014	$4,767.69
P/A i=7%, n=18	2016	$4,164.28
P/A i=7%, n=20	2018	$3,637.25
P/A i=7%, n=22	2020	$3,176.91
P/A i=7%, n=24	2022	$2,774.84
P/A i=7%, n=26	2024	$2,423.65
P/A i=7%, n=28	2026	$2,116.91
P/A i=7%, n=30	2028	$1,848.99
P/A i=7%, n=32	2030	$1,614.98
P/A i=7%, n=34	2032	$1,410.59
P/A i=7%, n=36	2034	$1,232.06
P/A i=7%, n=38	2036	$1,076.13
P/A i=7%, n=40	2038	$939.93
P/A i=7%, n=42	2040	$820.97
P/A i=7%, n=44	2042	$717.07
P/A i=7%, n=46	2044	$626.32
P/A i=7%, n=48	2046	$547.05
P/A i=7%, n=50	2048	$477.81
P/A i=7%, n=52	2050	$417.34
P/A i=7%, n=54	2052	$364.52

LTM 1 Cost Estimate
Tyndall AFB BX Service Station
731854.10000.30000

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Date:

P/A i=7%, n=56	2054	$318.39	
P/A i=7%, n=58	2056	$278.09	
P/A i=7%, n=60	2058	$242.90	
P/A i=7%, n=62	2060	$212.16	
P/A i=7%, n=64	2062	$185.30	
P/A i=7%, n=66	2064	$161.85	
P/A i=7%, n=68	2066	$141.37	
P/A i=7%, n=70	2068	$123.48	
P/A i=7%, n=72	2070	$107.85	
		Total Present Worth Cost	$84,098

Site Management every year (70 years)

Annual Cost	$6,000	
P/A i=7% n=70	PWF = 14.1603893	
	Present Worth Cost	$84,962

Total Capital and Present Worth Costs of LTM Program $213,773

Remedial Alternative 2 Cost Estimate
Tyndall AFB BX Service Station
731854.10000.30000

Author: JRH
Date: 7/21/98
Checked by:
Date:

Capital Costs

Biosparging Pilot Test Performance				
Pilot Test Workplan				$4,000
Pilot Test Kit Rental (blower, accessories, etc.)	5 days x	$500	/day	$2,500
Labor	112 hours	$70	/hour	$7,840
Per Diem	14 days	$136	/day	$1,904
Mob/Demob/Data Analysis	80 hours	$70	/hour	$5,600
Travel (1 tround trip from Denver @ $1500 and one trip from Atlanta @ $200)		$1,700	lump sum	$1,700
Misc. Supplies			lump sum	$500
Contingency (10%)				$2,404
			Subtotal	$26,448
Installation of the 18-Well Biosparging System				
Design/Procure/Install System	360 hours x	$70	/hour	$25,200
Blower/Shed/Accessories		$5,000	lump sum	$5,000
Asphalt Cutting/ Well point Installation/trenching		$10,000	lump sum	$10,000
Electrical Subcontractor		$5,000	lump sum	$5,000
Per Diem	20 days x	$90	/day	$1,800
Travel		$2,000	lump sum	$2,000
Geprobe Rental (2 weeks)		$4,000	lump sum	$4,000
O & M Manual Preparation	40 hours x	$60	/hour	$2,400
Contingency (10%)		$5,540	lump sum	$5,540
			Subtotal	$60,940
Installation of the 2-well SVE System				
Design/Procure/Install System	130 hours x	$70	/hour	$9,100
ICE Unit (V3)		$65,000	lump sum	$65,000
Asphalt Cutting/ Well Installation		$2,500	lump sum	$2,500
Electrical Subcontractor (included with biosparging system abov		$0	lump sum	$0
Per Diem	10 days x	$90	/day	$900
Travel		$1,500	lump sum	$1,500
O & M Manual Preparation	40 hours x	$60	/hour	$2,400

Remedial Alternative 2 Cost Estimate
Tyndall AFB BX Service Station
731854.10000.30000

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Date:

Emissions Permitting		$1,000	lump sum	$1,000
Contingency (10%)		$8,240	lump sum	$8,240
			Subtotal	$90,640

Future Costs

Confirmatory Soil Sampling at 6 Locations

Sampling Labor 12 Soil Samples 5 QA/QC 17 Total Samples	60 hours x	$60	/hour	$3,600
Analytical Subcontractor	17 BTEX + naphthalen	$150	/each	$2,550
Geoprobe Rental	2 days x	$500	/day	$1,000
Supplies		$500	lump sum	$500
Travel		$1,500	lump sum	$1,500
Per Diem	4 days x	$90	day	$360
Office ODC		$300	lump sum	$300
Contingency (10%)		$981	lump sum	$981
			Total Future Cost	$10,791

Annual and Operational Costs

Soil Gas Sampling/ Respiration Testing at 6 Locations - Semiannually

Soil Gas Analysis (EPA TO-3)	6 samples x	$130	/sample	$780
Sampling Labor	64 hours x	$60	/hour	$3,840
Sample Shipping		$250	lump sum	$250
Per Diem	8 days x	$90	/day	$720
Travel		$1,500	lump sum	$1,500

Remedial Alternative 2 Cost Estimate
Tyndall AFB BX Service Station
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Equipment Rental (Meters)		$500	lump sum	$500
Progress Report	20 hours x	$70	/hour	$1,400
Contingency (10%)		$899	lump sum	$899
			Subtotal	$9,889
	Total for 1 year (two sampling events)			$19,778

Groundwater Sampling - Annually for 5 years Biennial for 12 years (8 wells, 11 events)

Total for 1 sampling event (from Alternative 1 cost estimate)				$14,075

Operation and Maintenance of the Biosparging/SVE System -1 trip per month

System Monitoring				
Monitoring Labor	180 hours x	$60	/hour	$10,800
Travel		$1,200	lump sum	$1,200
Per Diem	12 days x	$90	/day	$1,080
Equipment Rental		$1,200	lump sum	$1,200
Electrical Usage		$5,000	lump sum	$5,000
			Annual O&M Cost	$19,280
Site Management - per year	100 hrs/yr x	$60	/hour	$6,000

Summary of Capital Costs and 1st Year of Operation

Biosparging System Pilot Test	$26,448
Installation of the 18-Well Biosparging System	$60,940
Installation of the 2-well SVE System	$90,640
Groundwater Sampling per year	$14,075
Soil Gas Sampling/ Respiration Testing at 6 Locations for First year	$19,778
Site Managment for first year	$6,000
Annual O&M Cost	$19,280
Total Capital Costs	$237,161

Remedial Alternative 2 Cost Estimate
Tyndall AFB BX Service Station
731854.10000.30000

Author: JRH
Date: 7/21/98
Checked by:
Date:

Annual Costs

Groundwater Annual Sampling for 5 years

		Annual Cost	$14,075
	P/A i=7%, n=5	PWF = 4.10019744	

Groundwater Biennial Sampling for 12 years

	P/A i=7%, n=6	2004	$9,378.77
	P/A i=7%, n=8	2006	$8,191.78
	P/A i=7%, n=10	2008	$7,155.02
	P/A i=7%, n=12	2010	$6,249.47
	P/A i=7%, n=14	2012	$5,458.53
	P/A i=7%, n=16	2014	$4,767.69
		Present Worth Cost	$98,912
	Groundwater sampling Present Worth Cost		$98,912

Biosparging/SVE System Maintenance (3 years)

	Annual Cost	$19,280
P/A i=7%, n=3	PWF = 2.62431604	
	Present Worth Cost	$50,597

Soil Gas Sampling Semiannually for three years

	Annual Cost	$19,778
P/A i=7%, n=3	PWF = 2.62431604	
	Present Worth Cost	$51,904

Site Management every year (17 years)

	Annual Cost	$6,000
P/A i=7% n=17	PWF = 9.76322299	
	Present Worth Cost	$58,579

Future Costs

Present Worth of Confirmatory Soil Sampling P/F i=7% n=4	$8,232
Total Present Worth of Annual Costs =	$259,991

Total Cost Estimate of Proposed Corrective Action = $505,385

Design/Construct 2 LTM Wells Tyndall AFB BX Service Station

Standard Rate Schedule

Billing Category Cost Code/(Billing Category)	Billing Rate	Task 1 (hrs)	Install New LTM/POC Wells ($)	Task 2 (hrs)	Subcon-tracting ($)	Task 3 (hrs)	Reporting & PM ($)
Word Processor 88/(15)	$30	0	$0	2	$60	2	$60
CADD Operator 58/(25)	$47	0	$0	0	$0	5	$235
Technician 42/(50)	$40	5	$200	0	$0	0	$0
Staff Level 16/(65)	$57	15	$855	30	$1,710	10	$570
Project Level 12/(70)	$65	4	$260	8	$520	2	$130
Senior Level 10/(80)	$85	2	$170	2	$170	2	$170
Principal 02/(85)	$97	0	$0	0	$0	0	$0
Total Labor (hrs|$)		26	$1,485	42	$2,460	21	$1,165
ODCs							
Phone			$20		$20		$0
Photocopy			$10		$0		$10
Mail			$0		$10		$20
Computer			$0		$20		$20
CAD			$0		$0		$50
WP			$0		$20		$20
Travel			$150		$0		$0
Per Diem			$0		$0		$0
Eqpt. & Supplies			$150		$0		$0
Total ODCs			$330		$200		$120
Outside Services							
LTM/POC Well Installation Costs			$2,160		$0		$0
Surveying			$400		$0		$0
Other: Maintain Institutional Controls			$0		$0		$0
Total Outside Services			$2,560		$0		$0

Proposal Estimate	Task 1	Task 2	Task 3
Labor	$1,485	$2,460	$1,165
ODC's	$330	$200	$120
Outside Services	$2,560	$0	$0
Total by Task	$4,375	$2,660	$1,285

Total Labor	$5,110
Total ODCs	$650
Total Outside Services	$2,560
Total Project	$8,320

Task 1: Install 2 New LTM wells

Task 2: Subcontracting/Permitting

Task 3: Reporting/PM per Event.

Tyndall AFB BX Service Station Backup Calculations

Long-Term Monitoring

Misc calculations

Number of LTM wells:		
Number of wells:	2	
Depth each:	13	ft

Cost calculations

Description	Unit	Qty.	Unit Price	Subtotal	Total	Source (If applicable)
Well Installation					$ 2,160	
Mobilization	ea	1	$ 500	$ 500		
Well Installation	ln ft	26	$ 60	$ 1,560		
Soil Disposal	drum	1	$ 100	$ 100		