

FINAL
CORRECTIVE ACTION PLAN
CAMPBELL STREET FUEL FARM
AND UST SYSTEM AS-143
MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA
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TABLE OF CONTENTS

	<u>Page</u>
1.0 INTRODUCTION	1-1
1.1 Site Location	1-1
1.2 Site Description	1-1
1.3 Purpose of CAP	1-2
1.4 Site History	1-2
1.4.1 CSFF Construction History	1-3
1.4.2 Previous Assessment Activities	1-3
2.0 OBJECTIVES	2-1
2.1 Remediation Objectives	2-1
2.2 Remediation Endpoints	2-2
2.3 Remediation Schedule	2-3
3.0 EXPOSURE ASSESSMENT	3-1
3.1 Evaluation of Contaminant Levels	3-1
3.1.1 Soil Contamination	3-1
3.1.2 Groundwater Contamination	3-1
3.2 Fate and Transport of Petroleum in the Environment	3-3
3.3 Identification of Human Exposure Pathways	3-8
3.4 Identification of Receptors	3-8
3.5 Risk Evaluation	3-9
4.0 EVALUATION OF REMEDIAL ALTERNATIVES	4-1
4.1 Remedial Options	4-1
4.1.1 Soil Remediation Technologies	4-1
4.1.2 Free Product Recovery	4-5
4.1.3 Groundwater Recovery Technologies	4-5
4.1.4 Fluid Disposal Alternatives	4-7
4.2 Selected Remediation and Disposal Alternatives	4-9
5.0 PROPOSED CORRECTIVE ACTION	5-1
5.1 Soil Excavation	5-1
5.1.1 Excavation and On-Site Testing	5-1
5.1.2 Off-Site Treatment	5-2
5.1.3 Site Restoration	5-2
5.2 UST Removal	5-3
5.3 Groundwater Recovery	5-3
5.3.1 Trench Installation	5-3
5.3.2 Subsurface Trenching	5-4
5.3.3 Pneumatic Pumping System	5-4
5.4 Groundwater Treatment	5-5
5.5 Remediation Construction Concerns	5-6
5.5.1 Site Access	5-7
5.5.2 Construction Worker Health and Safety	5-7
5.5.3 Utility Clearance	5-7
5.5.4 Equipment Installation Considerations	5-8
5.5.5 System Startup and Operation	5-9

TABLE OF CONTENTS
(Continued)

	<u>Page</u>
5.5.6 Temporary Soil Stockpiling	5-9
5.5.7 Effect of CAP on Activity Personnel	5-10
5.6 System Monitoring	5-10
5.6.1 CAP Monitoring Requirements	5-10
5.7 Monthly Reporting Requirements	5-12
5.8 Annual Reporting Requirements	5-13
5.9 Field Monitoring Procedures and QA/QC Considerations	5-13
5.10 Completion of Corrective Action and Site Restoration	5-14
5.11 Cost Estimate	5-14
6.0 PERMITS	6-1
6.1 NPDES Permit	6-1
6.2 Air Quality Permit	6-1
6.3 Well Construction Permit	6-1
6.4 Certificate of Approval	6-2
7.0 REFERENCES	7-1

APPENDICES

A	Site Sensitivity Evaluation
B	Field Testing of Contaminated Soils
C	Remediation Equipment
D	Standard Operating Procedures
E	Cost Estimate

LIST OF TABLES

Number

- 1-1 Summary of Well Construction Details - December 1991
- 1-2 Summary of Well Construction Details - November 1992
- 1-3 Summary of Fluid Level Measurements - December 7, 1992
- 1-4 Summary of Fluid Level Measurements - December 30, 1992
- 1-5 Summary of Soil Analyses - December 1991
- 1-6 Summary of Soil Analyses - December 1992
- 1-7 Summary of Chemical Analyses for Groundwater Samples Collected by Hydropunch Procedure in December 1991
- 1-8 Summary of Chemical Analyses for Groundwater Samples Collected From Monitoring Wells in January 1992
- 1-9 Summary of Chemical Analyses for Groundwater Samples Collected From Monitoring Wells in December 1992

- 2-1 Groundwater Remediation Endpoints

- 3-1 Major Components of JP-5 Jet Fuel
- 3-2 Concentrations of Select Water Soluble Components of JP-5
- 3-3 Physical-Chemical Properties and Relative Mobility Indices for JP-5 Constituents
- 3-4 Preliminary Exposure Assessment Summary

- 4-1 Screening of Potential Soil Remediation Options
- 4-2 Screening of Potential Groundwater Remediation Alternatives

- 5-1 Monitoring Plan Summary

- 6-1 NPDES Permit Monitoring Requirements

LIST OF FIGURES

Number

- 1-1 Site Location Map
- 1-2 Site Plan
- 1-3 Campbell Street Fuel Farm Pipeline
- 1-4 Site Assessment Activities
- 1-5 Hydrogeologic Cross-Section Location Map
- 1-6 Hydrogeologic Cross-Section A-A' with Soil and Groundwater Analytical Results
- 1-7 Hydrogeologic Cross-Section B-B' with Soil and Groundwater Analytical Results
- 1-8 Hydrogeologic Cross-Section C-C' with Soil and Groundwater Analytical Results
- 1-9 Potentiometric Surface Map, Shallow Aquifer, December 30, 1992
- 1-10 Potentiometric Surface Map, Deep Aquifer, December 30, 1992
- 1-11 Soil TPH (Low - Medium) Concentration Map
- 1-12 Soil TPH (Medium - High) Concentration Map
- 1-13 Benzene and Total VOC Concentrations in Groundwater

- 3-1 Supply Wells in the Vicinity of Campbell Street Fuel Farm

- 4-1 Location of Underground Utilities

- 5-1 Recommended Site Remediation Plan
- 5-2 Diagram for Temporary Containment of Petroleum Contaminated Soil
- 5-3 Schematic of Groundwater Interceptor Trench
- 5-4 Recommended Groundwater Treatment System Process Schematic

1.0 INTRODUCTION

This report presents the Corrective Action Plan (CAP) developed by Baker Environmental, Inc. (Baker), for the remediation of petroleum contamination at the Campbell Street Fuel Farm (CSFF) and related underground storage tank (UST) AS-143. This CAP has been prepared for the Department of the Navy's Naval Facilities Engineering Command Atlantic Division (LANTDIV).

1.1 Site Location

The CSFF and Building AS-143 and its associated UST, are located along Campbell Street at the Marine Corps Air Station (MCAS), New River, Jacksonville, North Carolina. The location of the site is shown on Figure 1-1.

As shown on Figure 1-2, the CSFF is located on the northwest corner of the White Street and Campbell Street intersection. Building AS-143 is located on the northeast corner of the intersection. The CSFF is situated near the MCAS flightline and is proximate to several buildings associated with flightline operations.

1.2 Site Description

The CSFF contains four aboveground storage tanks (ASTs), each with capacities of 215,000 gallons, and are used to store JP-5 aviation fuel. ASTs CSFF-9 and CSFF-10 are located within an oval concrete dike; ASTs CSFF-11 and CSFF-12 are surrounded by a rectangular concrete dike wall. Several surface water catch-basins are located within the diked areas and are connected by underground drain piping. The drain piping exits the diked areas and runs into an oil/water separator located within the southwest portion of the fuel farm.

The ASTs are connected by aboveground 6-inch fuel transfer lines which run into a filter building prior to entering the pumping station. The transfer line exits the fuel farm underground in the southeast corner. The fuel system currently used at the CSFF was installed in 1985.

An oval truck access roadway is located on the western side of the site. Fuel deliveries to the fuel farm are made by civilian tanker trucks. Military tanker trucks use the loading rack south of the filter building for transporting fuel between the fuel farm and the flightline.

The site is primarily grass-covered and enclosed by a chainlink fence. A wooded area is located north of the CSFF. To the west is an abandoned railroad line and several athletic fields. South of the site is Campbell Street. In the area immediately south and east of the site, the CSFF is bounded by a surface water drainage channel 6 to 8 feet in depth; the network of drainage channels in the vicinity of the site is shown on Figure 1-2.

Building AS-143 is located east of White Street across from the CSFF. UST AS-143 is located north of Building AS-143 as shown on Figure 1-2. This 10,000-gallon tank, installed in 1961, contains unleaded gasoline that is used solely for Government-owned vehicles. North of the UST is a concrete containment system for tanker unloading operations for UST AS-143. Fluids that may be released during unloading operations are contained and then passed to an oil/water separator. The location of the oil/water separator is shown on Figure 1-2.

1.3 Purpose of CAP

The purpose of this CAP is to describe and provide supporting documentation for the corrective action alternative selected for the remediation of petroleum contaminated soils and groundwater at the CSFF and Building AS-143 sites.

The specific objectives of this CAP are to: (1) provide background assessment information; (2) provide measures to adequately protect human health and the environment; (3) present the corrective action to be undertaken at the site; (4) outline a monitoring plan to evaluate the progress of the corrective action, and (5) comply with applicable Federal and State regulations.

This CAP has been prepared based on the North Carolina Department of Environment, Health, and Natural Resources (DEHNR), "Groundwater Section Guidelines for the Investigation and Remediation of Soils and Groundwater." The guidelines, developed by the DEHNR Division of Environmental Management - Groundwater Section, was published in March 1993.

1.4 Site History

The following sections discuss the history of the CSFF and the results of previous assessment activities performed at the site.

1.4.1 CSFF Construction History

The CSFF consists of four steel ASTs installed in 1985. Each AST has capacities of 215,000 gallons and are used to store JP-5 aviation fuel.

The ASTs are replacement tanks for a system of eight USTs of varying capacities reportedly used prior to 1985 at the CSFF. Six of the eight USTs were used to store JP-5. Three of these six USTs had capacities of 120,000-gallons, 106,000-gallons, and 100,000-gallons; the other three USTs had capacities of 50,000-gallons, each. Capacities of the other two USTs are unknown. Seven of the USTs and associated piping systems were removed and replaced by the existing AST system in 1985. One aviation gasoline (AVGAS) UST was filled with sand and has remained in place; this UST is directly behind the filter building that services the loading rack inside the fuel farm. An accurate location of the AVGAS UST has not been determined.

Some of the contaminated soil generated by the excavation and removal of the old USTs still remains on site. This soil was stockpiled on site due to problems involving the inability of the contractor to transport these soils to a disposal facility. The subcontractor also transported petroleum contaminated soils from other UST removal projects to the CSFF site. As a result, a soil mound (shown on Figure 1-2) is present in the center of the fuel farm.

The flightline for the air station is supplied with fuel from the CSFF via an underground pipeline. The underground pipeline runs south along White Street, as shown on Figure 1-3, then turns to the east and connects to the aircraft direct refueling stations, approximately 1.0 mile southeast of the CSFF.

The underground pipeline currently in use was installed in 1985 as a replacement for the previous system. The previous underground pipeline was allowed to drain before being abandoned in place. For most of its length, the current, active pipeline is adjacent to the original, abandoned pipeline system. The approximate locations of the abandoned and currently used pipelines are shown on Figure 1-3. The possibility of small amounts of JP-5 remaining in the abandoned line still exists.

1.4.2 Previous Assessment Activities

Four groundwater monitoring wells, from a previous hydrogeologic assessment, are located in the vicinity of the CSFF and UST AS-143. The location of these wells are shown on Figure 1-4.

Information regarding the reason for installation, date installed, well construction details, etc., was not obtainable for this CAP. Fluid levels in these four monitoring wells have been monitored on several occasions. No free product has been reported in any of the four wells.

In December 1991, Baker conducted the first phase of field activities at the CSFF. Field activities included the installation of seven Type II shallow monitoring wells, three Type III deep monitoring wells, four soil borings and 15 hydropunch penetrometers (hydropunches). The locations of the wells, soil borings, and hydropunches sampled during this phase are presented on Figure 1-4. Specific field activities and well installation data are described in the Final Site Assessment Report, submitted to LANTDIV in August 1992.

During the first phase of assessment activities, Baker identified several areas impacted by petroleum contamination. However, the full extent of soil and groundwater contamination was not completely defined.

A second phase of field activities was performed at the CSFF from November 16, 1992 through December 7, 1992. The services performed during the second phase of assessment activities included: installation of 18 Type II shallow monitoring wells, three Type III deep monitoring wells, eight soil borings, one six-inch monitoring well, and an aquifer test. The locations of the wells and borings are shown on Figure 1-4. Specific field activities and well installation data are described in the Draft Site Assessment Report, submitted to LANTDIV on February 15, 1993.

Summaries of the well construction details for monitoring wells installed during the first and second phase of assessment activities are provided on Tables 1-1 and 1-2, respectively. All monitoring wells were surveyed and referenced to the mean sea level elevations.

1.4.2.1 Site Geologic Conditions

Information collected during the soil boring and monitoring well installation activities was used to develop three hydrogeologic cross-sections. The location of these cross-sections are shown on Figure 1-5. The three cross-sections, identified as A-A', B-B', and C-C', are shown on Figures 1-6, 1-7, and 1-8, respectively.

In general, all three cross-sections indicate that the site overlies a clay and/or silt layer that extends downward from the ground surface. This clay/silt is fairly continuous across the site.

It is underlain by a silty sand layer which grades downward into a fine sand. This sand begins approximately 12 feet below ground surface and extends to about 22 feet. At approximately 40 feet below ground surface, a layer of white, fine gravel, limey mud/clay with bits of limestone shell fragments was encountered. This layer is believed to be the beginning of the Castle Hayne Formation.

1.4.2.2

Site Hydrogeologic Conditions

This is the River Bend Formation of the Castle Hayne Aquifer. by whom?

Groundwater beneath the site lies approximately 6 to 7 feet below ground surface. Tables 1-3 and 1-4 summarize the fluid level measurements and elevations from the CSFF obtained on December 7 and 30, 1992, respectively. As shown on Tables 1-3 and 1-4, 0.02 feet of free product was detected in monitoring well MW-13 on December 30, 1992.

Based on the data from December 30, 1992, shallow groundwater appears to flow south across the site as shown on Figure 1-9. Based on the December 30, 1992 measurements, the average horizontal groundwater gradient in the shallow groundwater zone is calculated at 7.5×10^{-3} .

The six deep monitoring wells, DW-1 through DW-6, were used to evaluate the groundwater gradient in the deeper portion of the aquifer. Based on December 30, 1992 measurements, the direction of groundwater migration in this zone is to the east, as shown on Figure 1-10. The groundwater gradient calculated for this zone is 1.7×10^{-3} .

The aquifer test performed on December 5, 1992, and other in-situ hydraulic conductivity tests performed at the site, determined an average hydraulic conductivity for the site of 4.6×10^{-1} feet/day (1.6×10^{-4} cm/sec) (Baker, 1993). Using the average hydraulic conductivity value calculated from the aquifer test, a groundwater gradient of 7.5×10^{-3} , and an effective porosity of 0.28 (Fetter, 1980), the average groundwater flow velocity is 4.5 feet/year.

1.4.2.3

Subsurface Soil Contamination

During the two separate phases of assessment activities, selected soil samples from the soil borings were analyzed for Total Petroleum Hydrocarbon (TPH). Several soil samples from the first phase of assessment activities were also analyzed for pH, flashpoint, and lead using the Toxicity Characteristic Leaching Procedure (TCLP). The analytical results of the December 1991 and December 1992 soil sampling activities are summarized on Tables 1-5 and 1-6, respectively.

Soil samples were analyzed for TPH during both phases of assessment activities using EPA Method 8015/5030 (low to medium range petroleum) and EPA Method 8015/3550 (medium to high range petroleum). These analytical methods provide a method of identifying the source of petroleum contaminant. As shown on Tables 1-5 and 1-6, soil contamination at the site consisted of weathered jet fuel, jet fuel, gasoline, and motor oil. This is most likely the result of releases from the USTs formerly located at the site, and recent, periodic releases of JP-5 from the daily operations of the fuel farm.

The highest TPH concentrations were found at soil boring locations MW-13, SB-11, and DW-2, which are located on the eastern base of the soil mound. Highest TPH concentrations in this area ranged from 147,000 mg/kg (medium to high) in boring MW-13 (2.0 to 4.0 feet) to 1,900 mg/kg (medium to high) in boring SB-11 (3.0 to 4.0 feet).

In the vicinity of UST AS-143, the highest soil TPH concentration was detected in soil boring DW-6. This soil boring had a TPH concentration of 204 mg/kg (medium to high) at 2.0 to 4.0 feet below ground surface. The remaining borings around UST AS-143 identified low concentrations of TPH. This indicates that the area of concern is limited to soils in direct contact with the northeast side of the AS-143 UST.

Analytical results from the remaining soil borings, sampled in December 1991 and December 1992, indicate low TPH values (in both the low to medium and medium to high ranges) in a scattered pattern about the fuel farm. These low concentrations can be related to the day-to-day handling of jet fuel. TPH concentration obtained from the selected soil samples are depicted on Figure 1-11 (low to medium range) and Figure 1-12 (medium to high range).

1.4.2.4 Groundwater Contamination

During the two separate phases of assessment activities, groundwater samples were collected from hydropunch penetrometers and monitoring wells. These groundwater samples were analyzed for various chemical parameters. The analytical results for the samples collected by the hydropunch procedure are summarized on Table 1-7. The analytical results of the January 1992 and December 1992 sampling activities are summarized on Tables 1-8 and 1-9, respectively.

Several analytical methods were used to evaluate the condition of the groundwater. These methods include the following:

- EPA Method 601 - Purgeable halocarbons
- EPA Method 602 - Purgeable aromatics, also referred as volatile organics compounds (VOCs)
- EPA Method 625 - Base neutral/acid extractables, also referred as polynuclear aromatic hydrocarbons (PAHs)
- EPA Method 7421 - Total lead

Of these analytical methods, only EPA Method 602, VOCs, was used to analyze all groundwater samples. Based on these analyses, Figure 1-13 was developed to depict total VOC and benzene concentration distribution in the groundwater.

As shown on Figure 1-13, groundwater has been adversely impacted in several isolated areas. This is evidenced by samples which have exceeded the North Carolina Water Quality Standard (WQS) of 1.0 µg/L for benzene. Groundwater samples from monitoring wells MW-4, DW-2, and MW-16, and hydropunch HP-10, had benzene concentrations of 2.47 µg/L, 2.05 µg/L, 69.5 µg/L, and 1.17 µg/L, respectively. This plume is estimated to begin at the base of the soil mound and extend southeast (downgradient). Total VOC concentrations for these wells are less than 100 µg/L, with the exception of monitoring well MW-16, which had a concentration of 792.9 µg/L. This concentration may be related to the buried return line for the oil/water separator in close proximity to this well.

On the east side of the CSFF, groundwater from monitoring well MW-3 and hydropunch HP-12 had benzene levels of 2.79 µg/L and 4.47 µg/L, respectively. This impacted area is located directly over the JP-5 pipeline as it exits the fuel farm. Total VOCs for these two locations are below 5 µg/L.

Several monitoring wells near UST AS-143 also show evidence of petroleum contaminated groundwater. RW-1, installed directly beside the UST, had a reported benzene concentration of 26.7 µg/L. A small contaminant plume was defined by benzene detections in hydropunch HP-15, and monitoring wells MW-24 and MW-25, which are all downgradient of the UST.

Monitoring well MW-21, which had no detected concentrations of benzene, did have the highest total VOC level of the entire site, 9,825.9 µg/L. This well is also downgradient of UST AS-143 and coincides with total VOC values of 1,789 µg/L and 4,034 µg/L for monitoring wells MW-24 and MW-25.

A benzene concentration of 7.85 µg/L was detected in monitoring well MW-8. Since it is upgradient from all other contamination sources, it appears that this area was affected by contamination from the off-loading area within the fuel farm. This is substantiated by the high level of total VOCs at this location, while nearby wells have dramatically lower values.

Monitoring well DW-2 was the deep monitoring well detected to have the highest levels of petroleum contamination. As shown on Table 1-8, 2.05 µg/L of benzene was detected in this well. The constituent detected with the highest concentration was naphthalene (258 µg/L). Other deep monitoring wells that had detectable concentrations of petroleum constituents were DW-3 (total VOC concentration of 0.94 µg/L) and DW-6 (total VOC concentration of 12.39 µg/L).

Free product was detected in one monitoring well, MW-13, which is located at the toe of the soil mound, north of the filter building. On December 30, 1992, 0.02 feet of free product was observed in the monitoring well.

2.0 OBJECTIVES

This section discusses the remediation objectives of the CAP and the proposed cleanup levels.

2.1 Remediation Objectives

Soil and groundwater contamination have been identified at several areas of the site. The extent of the soil and groundwater contaminant plume has been essentially defined. The results of the risk assessment conducted for this site suggest that the contaminants present at the site do not pose an immediate health risk and that the likelihood of contamination from the site affecting human receptors is minimal. This is because the contamination is present in the shallow aquifer. Potable supply wells obtain water from the deeper Castle Hayne aquifer.

Based upon the assessment activities performed at the CSFF, three areas of the site were identified as areas where soil and/or groundwater remediation may be required. These areas are:

- The mounded soil area located in the center of the CSFF (in the vicinity of monitoring wells MW-4 and MW-13 and soil boring SB-11): Free product (0.02 feet in monitoring well MW-13) and soil and groundwater contamination that exceeded state standards were identified in this area.
- The area south of the tanker loading facility (in the vicinity of monitoring wells MW-12 and MW-16): This area has groundwater contamination that exceeded the state standards.
- The UST and associated piping at Building AS-143: This area has groundwater contamination present that exceeded WQS criteria.

In general, the cleanup goals of the remediation approach are as follows:

- Remove measurable free product from the water table in the vicinity of the soil mound.
- Reduce TPH concentrations in the area of the soil mound to State approved levels. These levels will be based on the DEHNR Site Sensitivity Evaluation (SSE) format.

- Reduce groundwater contaminant concentrations in both the CSFF area and the AS-143 UST area to levels acceptable with the North Carolina WQSs.

2.2 Remediation Endpoints

The groundwater remediation endpoints are based on State guidelines and established WQSs. The WQSs will be used as the initial groundwater remediation endpoints. Based on the results of the risk assessment, it was determined that the impact the petroleum contaminants to human and ecological receptors at the fuel farm were minimal. With this consideration, if it is determined that attaining the WQSs is not practical, remediation activities will continue until contaminant concentrations reach asymptotic conditions. Table 2-1 summarizes the maximum concentration of groundwater contaminants in comparison to established State WQSs.

Using the State WQSs and soil SSE procedure, remediation endpoints were evaluated and established to address each phase of petroleum contamination to comply with State regulations. The remediation endpoints are:

Groundwater: Groundwater was impacted at this site from direct contamination and from leaching of petroleum constituents from contaminated soils. Groundwater remediation was evaluated using the State WQSs. If it is determined that attaining the WQSs is not practical, remediation activities will continue until contaminant concentrations reach asymptotic conditions.

Soil: Using the SSE, an evaluation score of 75 was calculated. Because the site has no contaminated water supply wells within 1,500 feet and has a sufficient potable water supply, the CSFF was classified as a Category E site. With this consideration, the site has a soil remediation level of 180 mg/kg TPH. A copy of the SSE used to determine the remediation endpoint for soil is provided in Appendix A.

Product: The presence of free product was detected in one monitoring well, MW-13 (0.02 feet). The remediation endpoint for free product will be less than 0.01 feet of free product present on the water table.

2.3 Remediation Schedule

The achieve the remediation goals established in this CAP, the excavation of petroleum contaminated soils and the recovery and treatment of groundwater will be required. To perform these tasks, it will be necessary for the U.S. Government to procure several contractors. This procurement process will extend the amount of time required to complete the remediation activities.

Other concerns will also influence the remediation schedule for the site. The CSFF is an active area and is vital to the operation of the flightline activities. Therefore, remediation activities must be completed in a manner that is non-disruption of the CSFF operations.

The following schedule provides a general time frame for the completion of major tasks associated with implementing the remediation plan.

June 1994

- Acceptance of CAP by North Carolina DEHNR.
- U.S. Navy submits National Pollutant Discharge Elimination System (NPDES) permit application for the site remediation system.
- Procure contractor to design remediation system.

September 1994

- Procure contractor to construct and install remediation system.

November 1994

- Begin excavation of contaminated soils in the mounded area at CSFF.
- Dispose of excavated soils at State permitted facility.
- Contractor procure necessary remediation equipment for groundwater recovery and treatment.
- Initiate groundwater monitoring program.

December 1994

- Excavation activities completed in the mounded area. Restore excavated areas with clean backfill and revegetate disturbed areas.
- Begin excavation activities in area of monitoring wells MW-12 and MW-16 for installation of interceptor trench.
- Install subsurface trenching to connect CSFF with AS-143 site.
- Continue groundwater monitoring program as necessary.

January 1995

- Install groundwater recovery and treatment equipment at the CSFF and UST AS-143 sites.
- Continue groundwater monitoring program as necessary.

February 1995

- Complete installation of groundwater recovery and treatment system.
- Activate groundwater recovery and treatment system.
- Continue groundwater monitoring program as necessary.

February 1996

- Continue operation of the groundwater remediation system.
- System shut-down and post operational monitoring will begin once remediation goals have been met.

The actual length of time to achieve the remediation endpoints is unknown. It is anticipated that the remediation system will be in operation for a minimum of one year.

3.0 EXPOSURE ASSESSMENT

This section discusses the results of the preliminary exposure assessment performed for the CSFF during the earlier site assessment activities. The topics that will be addressed in this section are: (1) evaluation of contaminant levels; (2) fate and transport of petroleum in the environment; (3) identification of human exposure pathways; and (4) the identification of receptors.

3.1 Evaluation of Contaminant Levels

3.1.1 Soil Contamination

The soil analytical data identified TPH concentrations in 67 of the 96 soil samples. The detected TPH concentrations for these samples ranged from 0.07 mg/kg (SB-5, 4 to 6 feet) to 14,700 mg/kg (MW-13, 2 to 4 feet). Six soil samples (from SB-9, SB-11, SB-12, MW-13, and DW-6) exceeded the DEHNR remediation level of 180 mg/kg for TPH in soil, established by the SSE.

3.1.2 Groundwater Contamination

Three different analytical methods were applied to evaluate the organic chemical concentrations in the groundwater at CSFF. EPA Methods 601, 602, and 625 were used to detect purgeable halocarbons, VOCs, and PAHs, respectively.

All 52 groundwater samples were analyzed for VOCs, four samples were analyzed for purgeable halocarbons, and two samples were analyzed for PAHs. Of the groundwater samples analyzed for purgeable halocarbons, none of the four samples contained detectable concentrations of halocarbons. For the two groundwater samples analyzed for PAHs, only monitoring well DW-2 had detectable concentrations. Four PAHs were identified: acenaphthene (46 µg/L), fluorene (36 µg/L), naphthalene (258 µg/L), and phenanthrene (11 µg/L). All four PAHs are constituents of petroleum fuels and are noncarcinogenic. At the present time there are no Federal Maximum Contaminant Levels (MCLs) or North Carolina WQSs for these constituents.

As presented on Tables 1-7, 1-8, and 1-9, VOCs analyzed using EPA Method 602 had been detected in all but 16 of the 52 groundwater samples obtained from the hydropunches and

monitoring wells. EPA Method 602 utilizes the gas chromatograph (GC) to identify compounds. The GC procedure identifies compounds based upon their retention times. Due to the similarities in solubilities of certain compounds, some tend to elute at the same time, making it difficult to differentiate compound identities by this method of analysis. This is the case for 1,3-dichlorobenzene and 1,4-dichlorobenzene; toluene and ethylene dibromide (EDB); and m-,p-xylenes and chlorobenzene. As a result the laboratory reported the concentration of these aforementioned pairs as a combined value during Phase I activities. Since all of the chemicals have State and Federal standards, a conservative resolution to this issue of combined values would be to attribute all of the contamination to the chemical constituent with the most stringent standard. This is the approach that has been taken for this qualitative risk assessment. Laboratory results from the Phase II activities were able to differentiate these compounds.

The following is a summary, by compound, of the purgeable aromatic compounds identified at the CSFF:

- Benzene was detected in 14 of the 52 groundwater samples collected. The detected concentrations ranged from 0.20 µg/L in MW-2 to 73 µg/L in MW-24. Only five of the samples exceeded the Federal MCL of 5.0 µg/L. Twelve of the 14 samples, ranging in concentrations of 1.05 µg/L in HP-14 to 73 µg/L in MW-24, exceeded the State WQS of 1.0 µg/L.
- Toluene/EDB was detected in 12 of the 52 groundwater samples collected. The detected concentrations ranged from 0.23 µg/L in HP-11 to 762 µg/L in MW-24. The MCL of toluene is 1,000 µg/L; none of the groundwater samples exceeded this concentration. The MCL for EDB is 0.05 µg/L and the State WQS is 0.0005 µg/L, all 12 groundwater samples exceeded the State and Federal standards for EDB.
- Ethylbenzene was detected in 10 of the 52 groundwater samples. The detected concentrations ranged from 0.36 µg/L in DW-2 to 661 µg/L in MW-21. None of the concentrations exceeded ethylbenzene's MCL of 700 µg/L. Three samples exceeded the State WQS of 26 µg/L.
- Xylenes (total) were detected in 25 of the 52 groundwater samples collected. The detected concentrations ranged from 0.21 µg/L in HP-1 to 5,083 µg/L in MW-21.

Xylenes (total) have an MCL of 10,000 µg/L; none of the groundwater samples exceeded this concentration. Three samples exceeded the State WQS of 400 µg/L.

- 1,2-dichlorobenzene was detected in 14 of the 52 groundwater samples. The detected concentrations ranged from 0.57 µg/L in HP-15 to 486 µg/L in MW-21. The MCL for 1,2-dichlorobenzene is 600 µg/L; none of the detected concentrations exceeded this standard. The State of North Carolina has established a standard of 620 µg/L for this chemical.
- 1,3- and 1,4-dichlorobenzene were detected in 14 of the 52 groundwater samples. The detected concentrations ranged from 0.78 µg/L in HP-15 to 3,060 µg/L in MW-21. Currently there is only a MCL for 1,4-dichlorobenzene of 75 µg/L. None of the concentrations exceeded the state standard of 620 µg/L for 1,3-dichlorobenzene. Eleven samples contained concentrations that surpassed the state level of 1.8 µg/L for 1,4-dichlorobenzene.

Table 2-1 summarizes the analytical data from both phases of field activities and compares this information with State WQSs.

3.2 Fate and Transport of Petroleum in the Environment

Petroleum products are complex mixtures of hydrocarbons; more than one hundred compounds can be found in a typical fuel (EPRI, 1989). Each constituent has different chemical and physical properties that control the ultimate fate and transport of the petroleum products in the soil. In general, when petroleum hydrocarbons are released into unsaturated soils, they tend to migrate vertically under the force of gravity, with some slight lateral spread (Schwendeman, 1989). This migration pathway may be interrupted by adsorption to soil particles, inhibition by a geologic formation (i.e., low transmissive capability) or by cultural features (i.e., pipe channels or foundations). The subsurface transport of contaminants is also controlled by complex interactions between chemical, physical, and biological processes. Some conditions which affect migration are:

- Soil texture
- Soil uniformity or non-uniformity
- Soil layer configuration
- Depth to water table

- Soil structure
- Flow stability
- Soil moisture

The major constituents of JP-5 jet fuel are presented in Table 3-1. Table 3-2 presents the concentrations of water soluble components of JP-5 jet fuel detected in a mixture of 1 part JP-5 to 1,000 parts water. The chemicals, toluene, ethylbenzene, xylenes, naphthalene and methylnaphthalene, account for approximately 75 percent of the water soluble constituents of JP-5.

The physical and chemical properties of a compound are responsible for its mobility in the environment. These properties, in conjunction with site conditions, determine whether a chemical will readily volatilize into the air or be transported via advection or diffusion through the soil, groundwater, and surface water. These characteristics also describe the tendency of a chemical to adsorb onto soil/sediment particles. Environmental mobility can correspond to either an increased or decreased potential to affect human health.

Persistence of a chemical in the environment is also important in the potential risk and depends on factors such as the microbial content of soil and water, organic carbon content, the concentration of the chemical, climate, and the ability of the microbes to degrade the chemical under site conditions. In addition, chemical degradation (e.g., hydrolysis), photochemical degradation and certain fate processes such as sorption may contribute to the elimination or retention of a particular compound in a given medium.

The environmental mobility of a chemical is influenced primarily by its physical and chemical properties and the site chemistry. The following sections evaluate the properties of the chemicals or groups of chemicals detected, with emphasis on potential environmental mobility and persistence.

The following text summarizes physical and chemical properties for the primary constituents of JP-5 which directly affect the persistence and mobility of these constituents identified at the CSFF. Table 3-3 presents the physical and chemical properties associated with the chemicals detected at the site including: specific gravity; vapor pressure; water solubility; octanol/water partition coefficient; organic carbon adsorption coefficient, Henry's law constant; and mobility index. A discussion of the environmental significance of each of these properties follows.

Specific Gravity

Specific gravity is the ratio of the weight of a given volume of pure chemical at a specified temperature to the weight of the same volume of water at a given temperature. Its primary use is to determine whether a constituent will have a tendency to "float" or "sink" (as an immiscible liquid) in water only if it exceeds its corresponding water solubility. Specific gravity of a constituent must be assessed along with the constituent's water solubility to produce a qualitative estimation of movement in the water column. For example, the maximum groundwater analytical results for the constituent benzene was 73 µg/L. The specific gravity for the compound is 0.879 g/cm³ suggesting that the chemical would float in the saturated zone. However, its water solubility of 1,780 mg/L is roughly 24,000 times greater than its maximum detected value. Under these circumstances, the chemical will tend not to float but disperse throughout the aquifer.

Vapor Pressure

Vapor pressure provides an indication of the rate at which a chemical may volatilize. It is of primary significance at environmental interfaces such as surface soil/air and surface water/air. Volatilization is not as important when evaluating groundwater and subsurface soils. Vapor pressures for monocyclic aromatics and chlorinated ethenes or ethanes are generally higher than vapor pressures for semivolatiles. Chemicals with higher vapor pressures are expected to enter the atmosphere much more readily than chemicals with lower vapor pressures.

Water Solubility

The rate at which a chemical is leached from soil by infiltrating precipitation and its behavior in a water column is a function of its water solubility. More soluble chemicals are usually more readily leached than less soluble chemicals. For example, the water solubilities presented in Table 3-3 indicate that the volatile organic chemicals, (monocyclic aromatics), are usually several orders-of-magnitude more soluble than certain semivolatile compounds.

Octanol/Water Partitioning Coefficient

The octanol/water partition coefficient (K_{ow}) is a measure of the equilibrium partitioning of chemicals between octanol and water. The coefficient is also useful in characterizing the sorption of compounds by organic soils where experimental values are not available.

Organic Carbon Adsorption Coefficient

The organic carbon adsorption coefficient (K_{oc}) indicates the tendency of a chemical to adhere to soil particles containing some amount of organic carbon. Chemicals with high soil/sediment adsorption coefficients generally have low water solubilities and vice versa. For example, chemicals such as the semivolatiles are relatively immobile in the environment with respect to the volatile organics and are preferentially bound to the soil. These compounds are not as inherently likely to experience aqueous transport to the extent of compounds with higher water solubilities. Erosional properties of surface soils and the presence of dissolved organic macromolecules in groundwaters may enhance the mobility of these bound soil chemicals.

Henry's Constant

Both vapor pressure and water solubility are of use in determining volatilization rates from surface water bodies and from groundwater. These two parameters can be used to estimate an equilibrium concentration of a constituent in the water phase and in the air directly above the water. This can be expressed as Henry's Constant. As a rule, constituents having a Henry's Constant exceeding 10^{-3} volatilize readily from surface water bodies. Therefore, the constituents detected at the facility will tend to leave the water column at atmospheric pressure (i.e., shallow, unconfined aquifer or surface waters).

Mobility Indices

A quantitative assessment of mobility has been developed that uses water solubility (S), vapor pressure (VP) and organic carbon partition coefficient (K_{oc}) (Laskowski, 1983). This value is referred to as the Mobility Index (MI). It is defined as:

$$MI = \log((S \times VP)/K_{oc})$$

A scale to evaluate MI is presented by Ford and Gurba (1984):

<u>Relative MI</u>	<u>Mobility Description</u>
>5	extremely mobile
0 to 5	very mobile
-5 to 0	slightly mobile
-10 to -5	immobile
<-10	very immobile

The MIs for the chemicals selected using prevalence criteria are also presented in Table 3-3.

The following paragraphs summarize the general fate and transport data for JP-5 constituents at the site.

Volatile Organic Compounds (VOCs)

VOCs (i.e. benzene) tend to be relatively mobile in environmental media as indicated by their presence in groundwater. Their inherent mobility and their relatively high MIs result from high water solubilities, high vapor pressures, low K_{ow} and K_{oc} values.

Benzene does not tend to persist in environmental media because photolysis, oxidation, and biodegradation figure significantly in their removal, and they are seldom detected in surface soils where volatilization and other removal processes predominate. Benzene has a soil half-life of 16 days and a groundwater half-life of 128 days (Howard et al., 1991).

Polynuclear Aromatic Hydrocarbons (PAHs)

The PAH is generally less mobile than the VOC benzene. Naphthalene (-2.5) is slightly mobile by virtue of its water solubility and vapor pressure.

PAHs also tend to be more persistent environmentally. Photolysis and biodegradation figure to be the most significant removal processes. Naphthalene has a half-life of approximately 48 days in soil, and 252 days in groundwater (Howard et al., 1991).

3.3 Identification of Human Exposure Pathways

Groundwater ingestion, the potential inhalation of volatile organic chemicals from groundwater and soil, soil dermal contact and soil ingestion would most likely be the major exposure pathways of concern at this site. Since there are no identified drinking water sources within 1/4-mile radius of the site in the surficial aquifer, and all drinking water on the base is supplied by the deeper Castle Hayne Aquifer, no groundwater exposure pathways are considered to exist.

The CSFF is enclosed by a chain-link fence which limits access to the site. The fuel farm is primarily grass-covered; therefore, the potential for soil dispersion due to fugitive dust is not considered to exist and no exposure to contaminated soils is expected. Exposure to any of the contaminated soils would be contingent upon site disturbance via construction and remediation activities. In the event that soil remediation is required, there could be an exposure route due to inhalation from volatilization of the TPHs found in the soils. Since this would be an occupational exposure, the receptor analysis for these exposure pathways should be considered as part of the site remediation design plan. It is not expected that soil ingestion or dermal contact exposure pathways are likely to exist, although a potential exposure pathway due to inhalation during remediation may occur.

3.4 Identification of Receptors

No actual or potential human receptors have been identified that would be exposed to groundwater at this site since the surficial water-bearing layer is not used as a drinking water source. One water supply well is located approximately 1/4-mile south-southwest of the site. The well is screened in the deeper Castle Hayne Formation and has a maximum pumping rate of approximately 110 gallons per minute (gpm). The locations of water supply wells located in the vicinity of the CSFF are shown on Figure 3-1.

Receptors identified that could be exposed to contaminated soils are limited to the workers performing site remediation activities. No other receptors have been identified on site because the area is mostly grass-covered and, therefore, limits exposure pathways from contaminated soils.

3.5 Risk Evaluation

From a qualitative perspective, the contaminants do not appear to represent or pose a public health risk as there appear to be no opportunities for exposure to contaminants in any media, except during remediation activities. It would be during this time that soil contamination at the site could pose an immediate human health risk. It should be noted that some of the chemical constituents do exceed State (2L) and Federal groundwater and drinking water standards. A potential risk could exist if the shallow groundwater was used as a potable source. However, since there are no identified wells within the 1/4-mile of the site that use the shallow aquifer, the contaminated groundwater does not represent an immediate health threat. This potential risk could be controlled by following appropriate health and safety procedures designed for the remediation/construction site. A summary of the potential risk associated with the site is provided on Table 3-4.

4.0 EVALUATION OF REMEDIAL ALTERNATIVES

This section of the CAP discusses the type and extent of soil and groundwater contamination in the vicinity of CSFF and UST AS-143, and evaluates applicable remediation alternatives for soil and groundwater remediation. A remediation alternative consists of a combination of technologies or a single technology capable of addressing the site-specific contamination at the site. Several different types of soil and groundwater remediation alternatives have been screened for the CSFF site. Each alternative that was selected as suitable was further evaluated based upon site conditions, contaminant type, and costs. A site-specific alternative was then selected to address the contamination present.

4.1 Remedial Options

4.1.1 Soil Remediation Technologies

The objectives for the remediation of soils are to remove contaminated soils that exceed the soil remediation endpoint established by the SSE and to reduce or eliminate the effects that excessively contaminated soils have on the groundwater. The determination of the SSE score is presented in Appendix A.

Table 4-1 presents demonstrated technologies for soil remediation including an evaluation of each of technology based on applicability to the site, feasibility, and costs. Based on this evaluation, several technologies appear to be potentially applicable to the CSFF site. These soil remediation technologies are indicated, briefly discussed, and further evaluated below. As a result, the most applicable technologies will be recommended.

4.1.1.1 In-Situ Leaching

In-situ leaching is a process which involves extracting contaminants from soil by "washing" or "flushing," using water or more typically, a water-surfactant mixture. The process involves injecting or spraying a solution onto the area of contamination; the solution then percolates downward through the soil, adsorbing hydrocarbons from the soil. The mixture leaches through the soil under the influence of gravity until it reaches the groundwater table. The leached solution is then collected and pumped to the surface for removal or on-site treatment and reinjection. The use of this technology for soil remediation at a site is dependent on the

nature of the contamination and the permeability of the site soils. Costs to perform this type of remediation can range from \$150 to \$200 per cubic yard of soil.

The major advantage of in-situ leaching is that the contaminant source area can be remediated in-situ (i.e., without excavation). System application is fairly simple and a variety of solutions can be used. The major disadvantage is that it is very dependent upon site geologic conditions. Also, a disadvantage is the necessity of using this technique in conjunction with a recovery system which would require the treatment and/or disposal of recovered liquids.

Evaluation/Recommendation: The type and low permeability of soils at shallow depths reduces the effectiveness of this technology. The shallow depth to groundwater at the site is also not favorable for this alternative. The low permeability of the soils would reduce the ability of the treated fluids to "flush" out contaminants. Remediation using this method may require an extended period of time. This option may be expensive as compared to other alternatives, and may not be the best alternative for this site. Therefore, in-situ leaching is not considered an applicable technology for the CSFF site.

4.1.1.2 In-Situ Bioremediation

In-situ bioremediation is a process which relies on naturally occurring or genetically altered microorganisms to break down or transform contaminants to less hazardous compounds. The use of this technology may require the addition of nutrients and oxygen to the soil to enhance the biodegradation process. These additives are typically mixed into a water source which is introduced to the subsurface by leaching through the soil under the influence of gravity.

When this method is used in conjunction with groundwater remediation efforts, groundwater is typically extracted from the subsurface, mixed with nutrients and an oxygen source, and reintroduced into the subsurface via an infiltration gallery or injection system located upgradient of the contaminated area. The typical costs for remediation using this type of alternative is \$75 per cubic yard.

Major advantages to this method include: it will remediate the source area in-situ; it does not require treatment or disposal of water; it is unobtrusive and is not labor intensive. The major disadvantage to this method is (depending on the nature of the contaminant and host soil) the time span needed to reduce the contaminant concentration to an acceptable level.

Evaluation/Recommendation: The amount of silt and clay in the soil at the CSFF site reduces the effectiveness of this technology. The low permeability of the soils and shallow depth to groundwater at the site further reduces the suitability of this method. This option has high capital costs and may require a lengthy period of time for to reduce contaminant concentrations to the desired levels. Therefore, this technology is not recommended for the CSFF site.

4.1.1.3 Vacuum Extraction

Vacuum extraction (or in-situ venting) is a method that vents soil by volatilizing the contaminants in the soil from a liquid phase to a vapor phase, with removal of the vapor phase contaminants from the soil atmosphere. The process involves application of a vacuum through a network of wells. The vapors are drawn through the soil air spaces to the wells, where they are captured and brought to the surface. Once the contaminant-saturated vapors are brought to the surface, additional treatment may be required. This technology may be enhanced through injection of volatile-free air into the zone of contamination. The use of this technology for soil remediation at the site also appears to be an option given the moderate hydraulic conductivity of the soils, the shallow depth to groundwater, and the apparently limited area of contamination. Costs for implementing the vacuum extraction technique may range from \$50 to \$75 per cubic yard.

The major advantage of this method is that it removes the volatile components of hydrocarbon contaminated soil (which contribute to groundwater contamination) in-situ. Disadvantages include that it will not impact the nonvolatile components of hydrocarbon contaminated soil and it requires vapor phase treatment of groundwater off-gases.

Evaluation/Recommendation: Because the petroleum contamination in the vicinity of Building AS-143 is supposedly gasoline, vacuum extraction technology may be feasible in this portion of the site. However the low permeability of the soils reduces the effectiveness of this technology. Due to these low permeability soils, the extraction points would require close spacing and result in increased installation and operation costs. This technology is not recommended due to its costs and unsuitable soil conditions.

4.1.1.4 Excavation

Excavation of hydrocarbon contaminated soil (>180 mg/kg TPH) would eliminate the source of groundwater contamination. The excavated material could be handled in the following ways:

- Disposal-excavated material transported to an authorized off-site landfill.
- "Landfarming" - spreading the soil on the surface and mixing it to increase volatilization and biodegradation of the contaminant. This activity could be performed at an off-site bioremediation facility located near the activity.
- Low temperature thermal reduction (LTTR) - excavated soil placed into an apparatus where the contaminants are driven from the soil through enhanced volatilization by the application of heat. This activity may be performed at an off-site facility or a mobile unit may be brought on site. For the later case, the treated soil could be used for backfill.

Evaluation/Recommendation: Excavation with treatment either off site at an bioremediation facility or a LTTR facility, or on site treatment using a mobile LTTR unit are the recommended technologies for this site. This type of treatment would be effective on the low permeable soils present at the site. Excavation with treatment would effectively reduce elevated levels of petroleum contamination and reduce further migration of contaminants into the water table.

Excavation activities could be completed within a one month period if soils are hauled off-site. The cost of off-site disposal is \$28 per ton at nearby bioremediation and LTTR facilities. With transportation and backfilling expenses, the overall cost for the alternative would range from \$50 to \$70 per cubic yard.

Although feasible alternatives, landfarming and landfill disposal were not selected based upon site requirements and suitability to the U.S. Navy. The use of a landfill would not eliminate future liability associated with the contamination.

4.1.2 Free Product Recovery

Free product was detected in only one portion of the site. This area was the eastern edge of the soil mound located north of the tanker loading area. Monitoring well MW-13 had 0.02 feet of free product present in December, 1992.

Excavation of this portion of the soil mound is proposed to address the soil contamination present in this area (soil borings MW-13 and SB-11 had the highest TPH concentrations detected at the site, 14,700 mg/kg and 1,900 mg/kg, respectively). It is anticipated that the saturated soils associated with this free product will be removed at that time. No active free product recovery system is recommended at this time. Any remaining free product that may be present at the site will be addressed by the proposed groundwater recovery system.

4.1.3 Groundwater Recovery Technologies

As discussed in Section 3.0, several petroleum constituents exceeded established WQSS established by the State. Based on these standards it will be necessary to remediate the groundwater present at the site. Several potential technologies that may be applicable for the recovery of groundwater have been screened based on capability and limitations and are presented on Table 4-2. The technologies which appear to be potentially applicable to the CSFF site will be evaluated (with respect to advantages and disadvantages) in the following subsections. Please note that generic recovery technologies and not specific variations on each type of technology have been included in the following discussions.

4.1.3.1 Well Points

Well point technology consists of installation of a number of small diameter recovery wells on the perimeter of the free phase product plume. This technology is best suited for sandy soil conditions.

Evaluation/Recommendation: This option may have high initial capital costs to cover well installation and recovery equipment costs. Due to the geologic setting present, this method may not be the best alternative for this site.

4.1.3.2 Recovery Wells

Recovery wells are a conventional, demonstrated technology, which is useful with sandy aquifers. A typical recovery well would likely be 6 to 12 inches in diameter and extend 10 feet to 20 feet into the water table. The distance between the wells and the flow rates would be dependent on geologic conditions. A considerable quantity of groundwater would also be generated by this process depending on the geologic conditions.

Evaluation/Recommendation: The results of an eight-hour aquifer test performed at the site during the second phases of assessment activities, indicate that a single recovery well cannot generate a significant radius of influence at the site. The low permeability of the soils would require several recovery wells be installed at the site, with a close spacing pattern to effectively remediate the groundwater at the site. The costs associated with installing and maintaining each recovery well with the necessary equipment does not make this option suitable for the CSFF site.

4.1.3.3 Interceptor Trenches

An interceptor trench is excavated downgradient of a plume for the purpose of intercepting and preventing further migration of free phased product. The trench is dug to a depth several feet below the water table and should be long enough to intercept the full lateral extent of the plume. The trench must also be perpendicular to local groundwater flow direction. As the product plume migrates, free product accumulates in the trench and can be recovered manually or with pumps. An impermeable liner can be placed on the downstream side of the trench to eliminate free product from moving past the trench. Sumps or wells may also be installed in the trench to increase the rate of recovery (EPA, 1990).

Evaluation/Recommendation: This is an effective technology at sites which have silt or clay soils present. The shallow groundwater present at the site adds to the suitability of this approach. This option can inhibit the migration of the product plume. It is a recommended option for remediation at this site.

4.1.4 Fluid Disposal Alternatives

Several methods of treated groundwater disposal were evaluated. These disposal methods include:

- Disposal via infiltration galleries
- Disposal by injection well system
- Disposal to a wastewater treatment plant
- Disposal to a surface water or drainage ditch

Each disposal method was evaluated based upon cost (design, installation, maintenance, and monitoring), feasibility, and consideration to the impact to future land uses in the area. Each disposal alternative and associated evaluation are described below.

4.1.4.1 Infiltration Gallery

An infiltration gallery is an area where a permeable media, such as gravel or sand, is installed within an area of low permeability soils. The design of an infiltration gallery is similar to a trench or septic drainage field. The increased surface area of the gallery permits the infiltration of water into the soils. The treated water is discharged over the media and allowed to infiltrate into the underlying soils.

In North Carolina the gallery must operate as a "closed loop" system, (i.e. fluids introduced into the subsurface will be captured through the recovery portion of the remediation system). The installation requires documentation (computer models, results of previous pilot studies, published reports, etc.) that both supports the effectiveness of the proposed process and demonstrates that applicable water, air, or land quality will not be contravened. The level of treatment of the contaminated groundwater, prior to discharge into a gallery located outside the contaminant plume, must not contain concentrations of contaminants in excess of those specified in the groundwater quality standards (15A NCAC 2L.0202). If the treated water is infiltrated within the contaminant plume, the water shall not contain more than 5% of the concentration of contaminants in the groundwater influent.

Evaluation/Recommendation: The infiltration gallery is an acceptable method of fluid disposal in low permeability soils. However, given the soil conditions of the site, the shallow

groundwater conditions, and the available land space and usages in the area, the use of a infiltration gallery is not recommended.

4.1.4.2 Injection Well

An injection well is a well used to pump fluids into underlying geologic zones or aquifers. According to North Carolina regulations the injection well must be constructed and operated such that: (1) the injected liquid does not exit the well bore above or below the demonstrated vertical extent of the contaminant plume, (2) operation of the remediation system will not result in a contravention of groundwater quality standards at the compliance boundary (15A NCAC 2C.0107), and (3) they are operated as a "closed loop" system.

The level of treatment of the contaminated groundwater, prior to discharge into an injection well located outside the contaminant plume, must not contain concentrations of contaminants in excess of those specified in the groundwater quality standards (15A NCAC 2L.0202). If the treated water is infiltrated within the contaminant plume, the water shall not contain more than 5% of the concentration of contaminants in the groundwater influent.

Evaluation/Recommendation: Given the state requirements that the injected liquid does not exit the well bore above or below the demonstrated vertical extent of the contaminant plume, the suitability of injection wells at the site is not feasible. The shallow groundwater and low permeability of the shallow soils are not suitable for this alternative.

4.1.4.3 Wastewater Treatment Plant

This fluid disposal option uses existing sanitary sewer lines to receive treated groundwater discharge. The groundwater is treated, discharged into the sewer line, and then further treated at a municipal wastewater treatment facility. Discharge into the sewer lines is not possible without authorization from the wastewater treatment facility.

Evaluation/Recommendation: MCB Camp Lejeune operates several wastewater treatment plants. The CSFF area is serviced by the Camp Geiger Wastewater Treatment Plant. Sewage lines for the wastewater treatment plant are located in the vicinity. However, the capacity of the lines in this area are reportedly near capacity. The MCB does not want to increase the flow within the lines by receiving waste streams from remediation systems. Therefore, this disposal alternative is not acceptable.

4.1.4.4 Surface Water and Drainage Ditches

This disposal option results in treated groundwater being discharged to a surface water or drainage ditch. To utilize this option, a NPDES General Permit is required. This general permit is not acceptable for contaminants other than petroleum. Design and operation of the remediation systems that utilize this option must be accordance with 15A NCAC 2B.0100 (Wastewater Discharged to Surface Water). Major permitting considerations include (but are not limited to) types and concentrations of contaminants and daily volume of discharge.

Evaluation/Recommendation: Although there may be significant delays in receiving a NPDES permit, this alternative is the most suitable for the CSFF site. Several drainage ditches are located in the immediate vicinity of the CSFF and Building AS-143. The anticipated low flow rates of the remediation system (2 to 4 gpm) will not impact the carrying capacity of the drainage ditches. In addition, the treated groundwater will not adversely impact the quality of the water within the ditches.

4.2 Selected Remediation and Disposal Alternatives

Three areas of the site require soil and/or groundwater remediation. These areas consist of:

- The soil mound located in the center of the CSFF.
- The area south of the tanker loading area along Campbell Street.
- The UST located at Building AS-143.

Based upon the results of the two phases of site assessment activities performed at the site, and the evaluation of potential remediation technologies, the following remediation alternatives were selected for each of the areas designated above:

- The soil mound: The soils in the eastern portion of the mound (in the vicinity of soil borings SB-11 and MW-13) should be excavated. The excavated soils may be treated off site at either a permitted LTTR facility or bioremediation facility located near MCB Camp Lejeune.

Upon completion of the excavation of the eastern portion of the mound, the remaining soil mound should be sampled and analyzed. If the results are below the remediation requirements, the soils may be used as backfill.

No free product recovery is recommended at this time. It is anticipated that free product and saturated soils will be removed during the excavation activities. Any free product or contaminated groundwater that is present in this area after the excavation activities are completed will be recovered by the proposed groundwater recovery system for the other portions of the site.

- The area south of the tanker loading area (in the vicinity of monitoring wells MW-12 and MW-16): Based upon the assessment activities performed in this area, it appears that elevated soil and groundwater contamination is present in this area. Unfortunately numerous subsurface utilities are also present, as shown on Figure 4-1, which will impact the remediation alternatives that are available.

The recommended approach for this portion of the site is to excavate an interceptor trench from the western side of the loading facility access driveway and extend the trench westward toward monitoring well MW-16. This activity will assist in removing soils with elevated levels of petroleum contamination and create a hydraulic barrier to reduce the migration of contaminated groundwater. The installation of the trench is not intended to excavate all petroleum contaminated soils above 180 mg/kg, but to assist in groundwater recovery operations.

The groundwater recovered from the trench will be treated and discharged to the drainage ditch located east of Building AS-143. The water collected from the interceptor trench would be combined with groundwater generated from recovery operations located at Building AS-143.

- Building AS-143: The UST located at Building AS-143 is scheduled for removal in August, 1994. Petroleum contaminated soils generated during UST removal activities should be disposed at an off-site permitted facility. It is recommended that the UST system be replaced with a system that is within current UST requirements.

It is recommended that a groundwater interceptor trench is constructed within this area of the site. The trench would use the natural flow direction of the groundwater to

intercept and recover contaminated groundwater in this portion of the site. The existing recovery well, RW-1, would be used as a recovery sump to remove groundwater from the trench.

After the groundwater is recovered from the trench, it is recommended that the groundwater undergo a treatment process and then be discharged to the drainage stream located east of Building AS-143.

The treatment process for the recovered groundwater would consist of an oil/water separator, followed by a low-profile air stripper, and finally a carbon adsorption treatment. Filters will also be installed within the system to reduce the potential of sediments or metals fouling the system.

The oil/water separator is recommended to remove any free product that still may be present in the soils and that may eventually migrate to the interceptor trenches. Because of the low flow rates anticipated from the combined discharge of the interceptor trenches (2 to 4 gpm) and the low concentrations of organic compounds present, it is anticipated that a low-profile air stripper be used to reduce organic concentrations. A carbon adsorption unit would be used to treat groundwater after the air stripper and prior to discharge. Although it is anticipated that the air stripper will adequately reduce organic concentrations, the carbon adsorption unit will "polish" the treated water before discharge to the drainage ditch.

5.0 PROPOSED CORRECTIVE ACTION

This section of the CAP presents a discussion of the proposed remediation alternative for the CSFF and Building AS-143. The following subsections discuss the design of the remediation alternative; remediation construction concerns; and proposed system monitoring approach.

The recommended corrective action for the site is the removal of petroleum contaminated soils in the center of the CSFF, and the recovery and treatment of petroleum contaminated groundwater in the southern portion of the CSFF and vicinity of Building AS-143. Both remediation alternatives are discussed below.

5.1 Soil Excavation

Petroleum contaminated soils with TPH concentrations above 180 mg/kg will be excavated from the center area of the CSFF. It is anticipated that the excavation activities to obtain the soil remediation endpoint will also be able to achieve the free product groundwater remediation endpoint of less than 0.01 feet.

Due to the origin of the soil mound, additional soil sampling should be performed to verify TPH concentrations. This information will aid in evaluating the amount of soil to be removed. The proposed soil sampling locations are shown on Figure 5-1. The shallow soil samples may be obtained using hand augering methods.

The corrective action will include excavating the soil in the immediate vicinity of the soil mound, as depicted on Figure 5-1. Final limits of the excavation will be established in the field using visual observations and field testing procedures outlined in Section 5.1.1. The excavated soils should be transported to either an off-site LTTR facility or a bioremediation facility. The excavated area may then be backfilled with clean soil and revegetated. If the limits of the excavation are as shown on Figure 5-1, it is estimated that 1,700 cubic yards of soil will be removed. The actual quantity may vary, depending on conditions encountered during excavation activities.

5.1.1 Excavation and On-Site Testing

The area delineated on Figure 5-1 will be excavated to the top of the groundwater surface. Contaminated soils will be loaded into dump trucks and transported to the disposal facility.

As the excavation activities progress into lower contaminated areas, the excavated soils will be temporarily stockpiled as contaminated soil until further verified by laboratory testing. This soil will be stored in the area southeast of the soil mound and covered in a temporary containment area, as shown on Figure 5-2, to prevent contamination of stormwater runoff and underlying soils. If necessary, temporary shoring will be provided around any exposed utilities. The excavation will continue until field testing indicates that TPH levels in the excavation walls are below 180 mg/kg. It is anticipated that the extent of the excavation will not include roadway areas of the site that are asphalt or concrete covered.

Field testing will be performed using the EnSys RIS Test System. This is an EPA test approved as SW-846 Draft Method 4030. More information on the field testing method is provided in Appendix B. The field testing will enable the remediation contractor to differentiate contaminated and non-contaminated soil. Utilizing field testing methods will also provide same day sampling results at a cost savings compared to laboratory testing. The final extent of the soil excavation will be confirmed and supplemented with laboratory testing.

It is anticipated that the excavation activities will damage or destroy the three existing monitoring wells located in the vicinity of the soil mound. Therefore, these three monitoring wells MW-13, MW-17 and DW-5 will be properly abandoned prior to initiating excavation activities.

5.1.2 Off-Site Treatment

Due to the close proximity of off-site soil recycling companies, such as McGill Environmental Systems in Rose Hill, North Carolina and American Soils Corporation in New Bern, North Carolina, off-site treatment is recommended for the disposal of soils generated during excavation activities. The contaminated soils that require treatment will be placed into trucks with covers, and hauled to the disposal facility.

5.1.3 Site Restoration

The open excavation area will be backfilled with a certified clean fill, or with fill from an approved base borrow area. All temporary shoring will be removed upon being supported with fill material. The fill will be placed in lifts and compacted. Topsoil will be placed on top of the clean fill and graded to match the surrounding terrain, and the disturbed area will be revegetated. The temporary soil stockpiling containment structure will be decontaminated

and dismantled. The components of the containment structure will be properly disposed. General site clean up and equipment demobilization will occur upon completion of all remediation activities.

5.2 UST Removal

The UST located at Building AS-143 is scheduled for removal in August 1994. Petroleum contaminated soils generated during UST removal activities should be properly disposed at an off-site permitted facility. A replacement UST will be installed, along with clean backfill, in the same location. During the design phase of the remedial activities, removal and replacement of the UST should be verified.

5.3 Groundwater Recovery

5.3.1 Trench Installation

As discussed in Section 4.0, interceptor trenches will be used to recover groundwater. Interceptor trenches were selected over other remediation alternatives due to the shallow depth to groundwater and the low permeability of the soils. The interceptor trenches will create an area of higher permeability. As groundwater is removed from the trench, ^{really?} groundwater from the adjacent silt and clay soils will migrate into the trench and the cycle is repeated.

A recovery well will be installed within the center of the interceptor trench to be installed in the vicinity of monitoring well MW-12. The interceptor trench which will be installed in the vicinity of Building AS-143 shall be excavated to connect with the existing six-inch well (RW-1) previously installed.

The proposed locations of the interceptor trenches are shown on Figure 5-1. The actual length of the trenches will depend upon soil and groundwater conditions encountered during their construction. If soil concentration above 180 mg/kg TPH, or free product is detected, the length of the trenches may be extended. However, the actual length of the trench will depend upon site conditions such as subsurface utilities, disruption of CSFF services, traffic concerns, etc.. Soils generated during excavation activities will be disposed at an off-site permitted facility.

Both trenches will be three feet wide with a depth of 12 feet. The trench located within the CSFF will be excavated to 14 feet at the recovery well location to allow for additional room within the well for the pump.

The interceptor trenches shall be backfilled with gravel suitable for the well screen and geologic conditions. The gravel backfill shall extend 1/2 foot above the well screen. A geotextile fabric will be placed over the gravel fill to prevent shallow backfill soils from migrating into the gravel zone.

The recovery wells will be completed below grade within a lockable vault box or manhole that is capable of containing the necessary pump controls. A schematic of a typical interceptor trench is shown on Figure 5-3.

5.3.2 Subsurface Trenching

Subsurface trenching connecting the recovery wells with the air compressor and remediation system will be required. Compressed air and recovered groundwater lines will be placed within a 4-inch PVC pipe. The piping will be installed within the subsurface trenches and covered with compacted backfill.

A portion of this trench will pass beneath White Street to connect the two groundwater interceptor trenches. Additional concerns to the integrity of the piping, traffic control, and worker safety will be required to perform this task.

5.3.3 Pneumatic Pumping System

5.3.3.1 Pneumatic Pump

A pneumatic pump will be installed within each recovery well. The pneumatic pump will be designed to recover free product and petroleum contaminated groundwater. The pump must be constructed of a material that is resistant to petroleum products (JP-5). All fittings and product return lines associated with the pump must also be resistant to petroleum products.

Several companies manufacture pumps that meet the product recovery requirements for this site. Examples of such manufacturers are QED Environmental Systems, Inc. (QED) of Ann

Arbor, Michigan, and Ejector Systems of Chicago, Illinois. Pneumatic pump information supplied by Ejector Systems is provided in Appendix C.

5.3.3.2 Air Compressor

The pneumatic pumps for both recovery wells will be powered by a single air compressor. The air compressor will be an electric type of sufficient horsepower to operate both pumps and be equipped with an appropriate size receiver tank.

5.3.3.3 Equipment Storage Building

A prefabricated equipment storage building will be constructed to house both the recovery pump control panel, the electric air compressor, the oil/water separator, product storage tank, air stripper, and carbon adsorption unit. The storage building will be constructed and equipped at the factory for immediate installation and operation at the site. The building shall already be internally wired and constructed on a skid mounted platform for movement to other facilities once remediation is completed at the CSFF.

A chain-link fence will enclose the equipment storage building for added security. The fence will have a gate constructed on the two opposite sides to permit access to the equipment storage building. Each gate will be constructed to swing a minimum of 90 degrees so equipment may be replaced or repaired if needed.

5.4 Groundwater Treatment

Aquifer testing performed at the site during the second phase of assessment activities (Baker 1993), indicate that low flow rates are anticipated for the treatment system. Based upon the aquifer test results, it is estimated that the flow rate for the system will be less than 4 gallons per minute (gpm). The treatment system will be designed to treat a maximum flow rate of 10 gpm.

Based on this maximum flow rate of 10 gpm, the treatment system will have the following processes for treating groundwater:

- The pneumatic pumps will recover groundwater and direct it to the treatment system. The groundwater will first pass through an oil/water separator.

- Effluent from the oil/water separator will be sent to a low profile, low flow air stripper.
- Effluent from the air stripper will be sent to a suspended solid/iron removal filter. The suspended solids/iron removal filter will consist of a series of replaceable filter plates, or a cartridge type filter system. This filtration system is necessary to remove suspended solids prior to the carbon adsorption system.
- Effluent from the filter will be pumped through two liquid granular activated carbon (GAC) adsorbers installed in series. The GAC will reduce any remaining volatile and semivolatile compounds in the groundwater to within acceptable discharge requirements.
- The treated groundwater will be pumped to the drainage ditch located east of the site as shown on Figure 5-1.

Several companies manufacture equipment for the treatment of petroleum contaminated groundwater. Information from one such company, Ejector Systems, for the equipment discussed below is provided in Appendix C.

The proposed treatment equipment will be located within the storage building. The equipment will be preassembled by the manufacturer and ready to place into service with a minimum amount of field construction time. All electrical components will have an explosion-proof rating. A schematic of the proposed recovery system is shown on Figure 5-4.

5.5 Remediation Construction Concerns

Logistical and construction issues associated with the implementation of the recommended remedial actions should be addressed prior to initiation of construction activities. These include site access, construction worker health and safety, utility clearance, and temporary soil stockpiling, and are addressed below.

5.5.1 Site Access

The remediation contractor will have to make arrangements with the Activity for daily access to the site, and for access to the site outside normal working hours.

5.5.2 Construction Worker Health and Safety

The contractor will be required to prepare a site-specific Health and Safety Plan (HASP) to provide for the safety of construction workers during construction activities. The plan will include but is not limited, to the following items:

- An outline of the tasks to be conducted at the site and the associated physical and health hazards of these tasks.
- The potential risks to the health and safety of the construction worker.
- The physical and chemical properties of the contaminants at the site.
- Measures to detect the presence of contamination.
- Standard operating procedures for protection against hazards and a contingency plan for responding to accidents.

The HASP should be reviewed by all construction workers at the site, and should be updated as activities or conditions warrant. Only workers with the appropriate health and safety training will be permitted to work at the site.

5.5.3 Utility Clearance

A primary concern during site preparation and actual remediation activities will be locating and identifying all underground utilities in the work area. The MCB Camp Lejeune Public Works Department will provide utility clearance for those areas that will be disturbed prior to construction. A plan of the study area with approximate subsurface utility locations is provided on Figure 4-1.

5.5.4 Equipment Installation Considerations

The installation of the equipment recommended for the groundwater recovery and treatment system will include conventional construction techniques such as: installation of underground piping in utility trenches, installation of an equipment storage building, and installation of the necessary electric service, power panels and controls. The main components necessary for the groundwater treatment and recovery system is as follows:

- Installation of groundwater interceptor trench.
- Installation groundwater recovery pneumatic pumps.
- Installation of subsurface trenching to connect pumps with treatment system.
- Installation of an equipment storage building which will contain the air compressor, oil/water separator, air stripper, carbon adsorption unit, and control board.

Figures 5-1 and 5-4 show the site plan and process schematic of the recommended system, respectively. Construction considerations for the major components of the system are discussed below.

The equipment storage building will be located north of Building AS-143. This location is proposed due to the available space and close proximity of the drainage ditch. The equipment storage building will contain the remediation equipment such as: air compressor, oil/water separator, air stripper, carbon adsorption unit, and control board.

The equipment storage building will be located in a manner that will not interfere with MCB Camp Lejeune activities and will be designed to permit easy access for construction and service vehicles. The storage building will be secured with locking door. A chain-link fence will surround the building as an additional safety precaution.

Electric service of sufficient capacity will be brought to a pole or pad mounted transformer next to the equipment storage building. The power distribution and controls for the equipment should have an explosion-proof rating.

5.5.5 System Startup and Operation

The groundwater recovery system should operate continuously 24 hours a day, seven days a week. Startup of the groundwater recovery system will be the responsibility of a contractor selected by the U.S. Navy. The contractor will be required to initially operate the equipment during the initial startup. During this startup period, the contractor will be responsible for making any necessary equipment adjustments or repairs. The contractor will also be required to provide a detailed system operation and maintenance (O&M) manual to the Activity.

5.5.6 Temporary Soil Stockpiling

Temporary soil stockpiling will be necessary during trenching or excavation activities. A method to temporarily stockpile soils is shown on Figure 5-2. Excavated soils must be sampled before being used as clean backfill. A minimum of one composite sample for every 100 cubic yards (c.y.) of stockpiled soil will be obtained to evaluate the condition of the soils. If the soil contains TPH concentrations above 180 mg/kg it will be removed from the site and disposed at a state permitted LTTR or bioremediation facility.

Soils will be collected and analyzed for the following analytical parameters:

- Percent moisture (EPA Method 160)
- Total organic halogens (EPA Method 9020)
- TPH (EPA Method 418.1)
- VOCs (EPA Method 8020)
- Toxicity characteristic leaching procedure (TCLP) metals (these include arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver)
- Polychlorinated biphenols (PCBs) (EPA Method 8080)

A minimum of one composite sample will be collected for every 100 cubic yard of soil to be disposed.

5.5.7 Effect of CAP on Activity Personnel

The implementation of the remediation alternative will affect Activity personnel who work in the area. These personnel will be notified by their supervisor of the planned corrective action, and what effects it may have on their daily routine. Workers will be notified of the potential physical hazards posed during the construction and implementation of the remediation alternatives. Examples of such hazards are open trenches and excavations, exposed underground utilities, exposure to odors during excavation and the movement of construction vehicles.

In addition, workers will receive instruction on the potential hazards associated with the operation of the groundwater recovery system. These hazards include air emissions from the air stripper.

5.6 System Monitoring

An outline of the monitoring plan, including sampling frequency, sample locations, parameters to be measured, levels to be reported, and data submittal requirements, is presented for the selected remediation alternative in the following sections. Reporting requirements are discussed in Sections 5.5.2 and 5.5.3. Standard operating procedures (SOPs) suggested for the monitoring requirements are listed in Section 5.5.4, and included in Appendix D.

5.6.1 CAP Monitoring Requirements

Under the proposed remediation alternative, soil excavation and groundwater treatment will be performed to remediate the petroleum contamination. The monitoring plan has been designed to confirm that the designated remediation endpoints for soil and groundwater contamination have been met and that the remediation system is operating effectively. The components of the monitoring plan (sampling locations, sampling frequency, and method of analysis) are summarized on Table 5-1.

5.6.1.1 Soil Monitoring

Soil samples will be obtained periodically from the excavation and screened in the field to determine the condition of the soils. Once the full extent of the excavation has been reached,

confirmatory soil samples shall be obtained from the side walls of the excavation. One soil sample shall be taken every 50 feet along the excavation wall with a minimum of one sample per side of the excavation. Based upon Figure 5-1, it is estimated that 8 soil samples will be obtained to confirm the condition of the soils not excavated. Each soil sample selected for laboratory analysis will be analyzed for TPH using EPA Method 8015 (5030/3550). The laboratory detection limit will be a no greater than 10.0 mg/kg.

If soils above 180 mg/kg are detected along the excavation wall, additional soils shall be excavated until the soil remediation endpoint is reached. Additional soil samples will be obtained to confirm the condition of the soil.

5.6.1.2 Groundwater Monitoring

Groundwater monitoring will be conducted on a quarterly basis following the initiation of remediation activities, and then performed on a quarterly basis to monitor groundwater quality. Samples will be collected from existing monitoring wells MW-3, MW-11, MW-12, MW-14, MW-16, MW-21, MW-23, MW-24, MW-25, DW-2 and DW-6. The purpose of the monitoring activities are to evaluate the organic concentrations within the groundwater and the effectiveness of the remediation system.

Groundwater samples from the selected monitoring wells will be analyzed for volatile organics using EPA Method 602. In addition, groundwater samples from monitoring wells DW-2 and DW-6 will also be analyzed for PAHs using EPA method 625. The laboratory detection limit for the volatile organic and PAH analyses will be a no greater than 0.001 mg/L.

Fluid level measurements will be obtained monthly from the monitoring wells which will be sampled, and the following additional wells: MW-9, MW-10, MW-15, MW-22, and the two recovery wells within the interceptor trenches. Fluid level measurements shall include thickness of free product in addition to groundwater elevations. This information shall be used to evaluate the effectiveness of the remediation system and determine if adjustments in flow rates may be required.

5.6.1.3 System Effluent Monitoring

The discharge flow rate of the treatment system will be monitored weekly as specified by the NPDES permit requirements. In addition, effluent samples shall be obtained monthly and analyzed for toluene, benzene, and methyl teryl butyl ether using EPA Method 602.

5.6.1.4 Post-Operational Monitoring

Post-operational monitoring will be conducted at the site after the remediation goals for soil and groundwater contamination have been met. The post-operational monitoring may begin after soil and groundwater remediation endpoints have been met for one full year.

Post-operational monitoring will include sampling the selected monitoring wells for the presence of volatile organics and TPH. The groundwater sampling activities will be performed quarterly for one year after the operation of the groundwater treatment system has been terminated.

Groundwater samples will be obtained from the same monitoring wells that were sampled during the operational monitoring period. The groundwater samples will be obtained quarterly until the post-operational monitoring period is terminated.

If during the year of post-operational monitoring the groundwater remediation endpoints are exceeded, the operation of the groundwater treatment system may be resumed.

5.7 Monthly Reporting Requirements

MCB Camp Lejeune will submit monthly reports to the DEHNR regional office. These monthly reports will summarize the results of the groundwater and effluent monitoring activities performed at the site. The following information will be included in the monitoring reports:

- The results of all monitoring data, including monitoring well gauging, free product levels (if detected), effluent analytical results, and groundwater analytical results if quarterly sampling occurred during that month.
- Remediation system performance and air emissions monitoring results.

- If applicable for the reporting period, a description of the circumstances or events that caused mechanical problems with the remediation system, including dates and times of nonoperation, and actions taken or planned to correct the problem.

In addition to the monthly monitoring reports, MCB Camp Lejeune personnel will report to the DEHNR Regional Office any unpermitted or unusual discharge that may enter or affect State waters, or may endanger public health. Such reporting shall be made within 24 hours from the time the Activity becomes aware of the discharge or release.

5.8 Annual Reporting Requirements

In addition to the monthly monitoring reports, an annual report will be submitted to the DEHNR. The annual report will include monitoring results, evaluate the effectiveness of the remediation alternative and its progress toward achieving the cleanup endpoints. The first report shall be submitted within 12 months of initiation of remediation activities, and yearly thereafter, if necessary.

5.9 Field Monitoring Procedures and QA/QC Considerations

Example standard operating procedures (SOPs) for the collection of samples and field data have been included in this CAP in Appendix D. These examples may be used as guidelines to implement the monitoring plan:

- F102 Soil and Rock Sample Acquisition
- F104 Groundwater Acquisition
- F201 On-site Water Quality Testing
- F202 Water Level, Water-Product Level, and Well Depth Measurements
- F203 Photoionization Detector (PID)
- F204 Flame Ionization Detector (FID)
- F301 Sample Preservation and Handling
- F302 Chain-of-Custody
- F304 QA/QC Samples
- F502 Decontamination of Sampling and Monitoring Equipment

5.10 Completion of Corrective Action and Site Restoration

The corrective action will be complete after demonstrating that the site-specific remediation endpoints (180 mg/kg TPH in soils and specified organic concentrations in groundwater) have been met for twelve consecutive months. A request may then be submitted to the State to end remediation activities, and begin post operational monitoring.

Post operational monitoring will be conducted quarterly for a one year period after shut down of the groundwater treatment system. If levels of volatile organic concentrations in groundwater greater than the specified endpoints (or agreed upon asymptotic concentrations with the State) are detected during the post operational monitoring, the remediation system will again be activated and the operational treatment system monitoring plan implemented.

Site restoration activities will commence after all confirmatory sampling results have been evaluated to verify that contamination exceeding the remediation endpoint is removed.

Following equipment demobilization and removal of all subsurface remediation equipment and piping, the disturbed area(s) will be graded to match the previously existing ground cover. Finally, general site cleanup activities will be performed.

5.11 Cost Estimate

A cost estimate was prepared for the proposed remediation alternative (Appendix E). The estimate includes labor and equipment costs for: site preparation, soil excavation and disposal, recovery trench installation, pipe subsurface trenching, remediation equipment (i.e., air stripper, pumps, filters, carbon adsorbers) and system operation and monitoring. Although UST AS-143 is scheduled to be removed in August, 1994, an estimate for its removal was included for future reference. All assumptions are listed in Appendix E. The estimated cost to install and operate the system is \$463,592.

6.0 PERMITS

Because of the remediation alternative selected for the site; soil excavation, groundwater extraction and treatment, and discharge to a drainage ditch, several permits are required from the State of North Carolina. These permits include:

- NPDES permit
- Air quality permit/registration
- Well construction permit
- Certificate of approval

6.1 NPDES Permit

Because the treatment system shall be discharging to a drainage ditch, a NPDES permit will be required. The permit shall require weekly monitoring of the discharge rate of the treatment system. In addition, monthly chemical sampling of the system effluent shall be required. The chemical analyses to be performed, effluent limitations, and other monitoring requirements are summarized on Table 6-1.

6.2 Air Quality Permit

The treatment system shall utilize a low profile air stripper. This stripper will generate volatile emissions into the atmosphere. As required by the State of North Carolina, the air stripper must be registered with the State. However, an air quality permit shall not be required to operate the unit. Based on the organic concentrations observed in the groundwater, emissions of total organics and individual constituents such as benzene, toluene, chlorobenzene, total xylenes, and 1,2-, 1,3- and 1,4-dichlorobenzene will not exceed de minimis emission rates established by the State.

6.3 Well Construction Permit

A recovery well shall be installed within the interceptor trench located along the southern side of the CSFF. Because water will be extracted from the well, a well construction permit shall be required by the State of North Carolina.

6.4 Certificate of Approval

Disposal of petroleum contaminated soils at an off-site treatment facility requires approval from the state of North Carolina. Approval of the certificate is automatic when the soils are stored on site less than 45 days and they are stored as shown on Figure 5-2. The off-site disposal facility must be permitted to dispose of petroleum contaminated soils.

7.0 REFERENCES

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Tables

TABLE 1-1

**SUMMARY OF WELL CONSTRUCTION DETAILS - DECEMBER 1991
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265**

Well No.	Date Installed	Top of Casing Elevation ⁽¹⁾ (feet, above MSL)	Ground Surface Elevation (feet, above MSL)	Boring Depth (feet, below ground surface)	Depth of Outer Casing (feet, below ground surface)	Well Depth (feet, below ground surface)	Screen Interval Depth (feet, below ground surface)	Depth to Sand Pack (feet, below ground surface)	Depth to Bentonite (feet, below ground surface)
MW-1	12/10/91	23.24	19.6	14.0	NA	14.0	4.0 - 13.8	2.0	1.0
MW-2	12/10/91	22.83	19.1	14.0	NA	14.0	4.0 - 13.8	2.0	1.0
MW-3	12/12/91	21.69	18.3	14.0	NA	14.0	4.0 - 13.8	2.0	1.0
MW-4	12/12/91	22.77	18.6	14.0	NA	14.0	4.0 - 13.8	2.0	1.0
MW-5	12/12/91	23.85	20.7	15.1	NA	15.1	5.3 - 14.7	2.0	1.0
MW-6	12/13/91	20.40	17.3	15.0	NA	15.0	5.0 - 14.8	2.0	1.0
MW-7	12/13/91	21.04	17.5	14.0	NA	14.0	4.0 - 13.8	2.0	1.0
DW-1 ⁽³⁾	12/17/91 12/18/91	20.79	18.3	30.0	20.0	30.0	25.0 - 29.8	23.0	19.0
DW-2	1/6/92 1/7/92	22.91	19.5	30.0	20.0	30.0	25.0 - 29.8	23.0	21.0
DW-3	1/6/92 1/7/92	22.98	19.6	30.0	20.0	28.0	25.0 - 27.8	21.0	19.0

(1) MSL - Mean Sea Level

(2) NA = Not Applicable

(3) Monitoring Wells DW-1, DW-2, and DW-3 were constructed as Type III monitoring wells.

Source: Baker Environmental, Inc., August 12, 1992. "Final Site Assessment Report, Campbell Street Fuel Farm and UST System AST-143" (Contract No. N62470-89-D-4814, Contract Task Order 0013).

TABLE 1-2

**SUMMARY OF WELL CONSTRUCTION DETAILS - NOVEMBER 1992
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265**

Well No.	Date Installed	Top of Casing Elevation ⁽¹⁾ (feet, above MSL)	Ground Surface Elevation (feet, above MSL)	Boring Depth (feet, below ground surface)	Depth of Outer Casing (feet, below ground surface)	Well Depth (feet, below ground surface)	Screen Interval Depth (feet, below ground surface)	Depth to Sand Pack (feet, below ground surface)	Depth to Bentonite (feet, below ground surface)
MW-8	11-19-92	20.45	17.8	13.5	NA ⁽²⁾	13.0	2.9 to 12.4	2.0	1.5
MW-9	11-19-92	20.45	18.0	14.5	NA	14.0	3.9 to 13.5	2.0	1.0
MW-10	11-19-92	21.17	18.4	15.5	NA	15.0	4.9 to 14.4	2.6	0.5
MW-11	11-18-92	22.03	19.3	16.5	NA	16.0	5.9 to 14.6	2.5	0.5
MW-12	11-19-92	21.41	18.9	14.5	NA	14.0	3.9 to 13.5	2.5	0.5
MW-13	11-20-92	22.80	20.0	15.5	NA	15.0	4.9 to 14.5	3.0	0.5
MW-14	11-20-92	20.07	17.3	13.5	NA	13.0	3.1 to 12.6	2.0	0.5
MW-15	11-21-92	21.08	18.4	16.5	NA	16.0	5.9 to 15.4	4.0	2.0
MW-16	11-20-92	21.45	18.8	15.5	NA	15.0	4.9 to 14.5	2.7	0.5
MW-17	11-20-92	22.51	19.8	13.5	NA	13.0	3.2 to 12.6	2.0	0.5
MW-18	11-22-92	18.69	18.9	13.5	NA	13.0	3.1 to 12.7	2.0	1.0

⁽¹⁾ MSL - Mean Sea Level

⁽²⁾ NA = Not Applicable

MW-1 through MW-7 and DW-1 through DW-3 installed December 1992.

Source: Baker Environmental, Inc., February 15, 1993 Draft Site Assessment Report, Additional Assessment Activities, Campbell Street Fuel Farm and UST System 125-143 (Contract No. N62470-89-D-4814, Contract Task Order 0013).

TABLE 1-2

**SUMMARY OF WELL CONSTRUCTION DETAILS - NOVEMBER 1992
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265**

Well No.	Date Installed	Top of Casing Elevation ⁽¹⁾ (feet, above MSL)	Ground Surface Elevation (feet, above MSL)	Boring Depth (feet, below ground surface)	Depth of Outer Casing (feet, below ground surface)	Well Depth (feet, below ground surface)	Screen Interval Depth (feet, below ground surface)	Depth to Sand Pack (feet, below ground surface)	Depth to Bentonite (feet, below ground surface)
MW-19	11-23-92	19.10	19.2	14.0	NA ⁽²⁾	13.9	4.0 to 13.5	2.0	1.0
MW-20	11-23-92	19.40	19.7	15.0	NA	14.0	4.6 to 14.1	3.0	1.0
MW-21	11-21-92	21.76	19.1	14.5	NA	14.0	3.9 to 13.5	2.0	0.5
MW-22	11-23-92	21.69	18.9	13.0	NA	13.0	2.9 to 12.5	1.5	0.5
MW-23	11-21-92	21.35	18.9	13.5	NA	13.0	2.9 to 12.5	2.0	0.5
MW-24	11-22-92	21.56	19.0	11.5	NA	11.0	2.8 to 10.8	2.0	0.5
MW-25	11-23-92	21.17	18.6	14.5	NA	14.0	3.9 to 13.5	2.5	0.5
DW-4	11-22-92	21.07	18.5	52.0	41.0	51.0	45.6 to 50.4	39.5	37.0
DW-5	11-19-92	22.79	20.0	43.0	33.0	43.0	37.8 to 42.5	33.0	31.0
DW-6	12-02-92	21.83	19.1	42.5	32.0	42.5	37.3 to 42.0	35.0	29.0
RW-1	11-23-92	21.79	19.1	23.5	NA	23.0	3.0 to 22.4	1.5	0.5

(1) MSL - Mean Sea Level

(2) NA = Not Applicable

MW-1 through MW-7 and DW-1 through DW-3 installed December 1992.

Source: Baker Environmental, Inc., February 15, 1993 Draft Site Assessment Report, Additional Assessment Activities, Campbell Street Fuel Farm and UST System 125-143 (Contract No. N62470-89-D-4814, Contract Task Order 0013).

TABLE 1-3

**SUMMARY OF FLUID LEVEL MEASUREMENTS
DECEMBER 7, 1992
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265**

Well No.	Top of Casing Elevation ⁽¹⁾ (feet, above MSL)	Depth to Product (feet, below top of casing)	Depth to Groundwater (feet, below top of casing)	Product Thickness (feet)	Product Elevation (feet, above MSL)	Groundwater Elevation (feet, above MSL)
MW-1	23.24	NR ⁽²⁾	NR	NR	NR	NR
MW-2	22.83	NR	NR	NR	NR	NR
MW-3	21.69	-- ⁽³⁾	6.80	--	--	14.89
MW-4	22.77	--	8.58	--	--	14.19
MW-5	23.85	--	8.95	--	--	14.90
MW-6	20.40	NR	NR	NR	NR	NR
MW-7	21.04	--	4.96	--	--	16.08
MW-8	20.45	--	4.35	--	--	16.10
MW-9	20.45	--	6.08	--	--	14.37
MW-10	21.17	--	5.07	--	--	16.10
MW-11	22.03	--	7.72	--	--	14.31
MW-12	21.41	--	7.40	--	--	14.01
MW-13	22.80	--	12.33	--	--	10.47
MW-14	20.07	--	6.05	--	--	14.02
MW-15	21.08	--	7.59	--	--	13.49
MW-16	21.45	--	7.18	--	--	14.27

- Notes: (1) MSL - Mean Sea Level
 (2) NR = Not recorded on this date.
 (3) -- = Not Detected

Source: Baker Environmental, Inc. February 15, 1993, Draft Site Assessment Report, Additional Assessment Activities, Campbell Street Fuel Farm and UST System AS-143 (Contract No. N62470-89-D-4814, Contract Task Order 0013).

**SUMMARY OF FLUID LEVEL MEASUREMENTS
DECEMBER 7, 1992
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265**

Well No.	Top of Casing Elevation ⁽¹⁾ (feet, above MSL)	Depth to Product (feet, below top of casing)	Depth to Groundwater (feet, below top of casing)	Product Thickness (feet)	Product Elevation (feet, above MSL)	Groundwater Elevation (feet, above MSL)
MW-17	22.51	--(2)	6.59	--	--	15.92
MW-18	18.69	--	4.34	--	--	14.35
MW-19	19.10	--	4.77	--	--	14.33
MW-20	19.40	--	4.07	--	--	15.33
MW-21	21.76	--	7.49	--	--	14.27
MW-22	21.69	--	7.38	--	--	14.31
MW-23	21.35	--	7.97	--	--	13.38
MW-24	21.56	--	7.88	--	--	13.68
MW-25	21.17	--	7.80	--	--	13.37
DW-1	20.79	--	6.92	--	--	13.87
DW-2	22.91	--	8.64	--	--	14.27
DW-3	22.98	NR ⁽³⁾	NR	NR	NR	NR
DW-4	21.07	--	6.63	--	--	14.44
DW-5	22.79	--	9.23	--	--	13.56
DW-6	22.83	--	8.15	--	--	14.68
RW-1	21.79	--	7.91	--	--	13.88

- Notes: (1) MSL - Mean Sea Level
 (2) NR = Not recorded on this date.
 (3) -- = Not Detected

Source: Baker Environmental, Inc. February 15, 1993, Draft Site Assessment Report, Additional Assessment Activities, Campbell Street Fuel Farm and UST System AS-143 (Contract No. N62470-89-D-4814, Contract Task Order 0013).

TABLE 1-4

**SUMMARY OF FLUID LEVEL MEASUREMENTS
DECEMBER 30, 1992
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265**

Well No.	Top of Casing Elevation ⁽¹⁾ (feet, above MSL)	Depth to Product (feet, below top of casing)	Depth to Groundwater (feet, below top of casing)	Product Thickness (feet)	Product Elevation (feet, above MSL)	Groundwater Elevation (feet, above MSL)	Corrected Groundwater Elevation ⁽²⁾ (feet, above MSL)
MW-1	23.24	NR ⁽³⁾	NR	NR	NR	NR	NR
MW-2	22.83	NR	NR	NR	NR	NR	NR
MW-3	21.69	-- ⁽⁴⁾	5.83	--	--	15.86	--
MW-4	22.77	--	8.17	--	--	14.60	--
MW-5	23.85	--	8.97	--	--	14.88	--
MW-6	20.40	NR	NR	NR	NR	NR	NR
MW-7	21.04	NR	NR	NR	NR	NR	NR
MW-8	20.45	--	3.99	--	--	16.46	--
MW-9	20.45	--	5.61	--	--	14.84	--
MW-10	21.17	--	4.35	--	--	16.82	--
MW-11	22.03	--	6.86	--	--	15.17	--
MW-12	21.41	--	7.09	--	--	14.32	--
MW-13	22.80	8.33	8.35	0.02	14.47	14.45	14.46
MW-14	20.07	--	5.60	--	--	14.47	--
MW-15	21.08	--	7.10	--	--	13.98	--
MW-16	21.45	--	6.81	--	--	14.64	--

Notes: (1) MSL - Mean Sea Level

(2) Corrected groundwater elevations were determined by using the following equation:

CGE = Apparent Groundwater Elevation + (Product Thickness x 0.82) where 0.82 is the estimated specific gravity for JP-5 jet fuel.

(3) NR = Not recorded on this date.

(4) -- = Not Detected

Source: Baker Environmental, Inc. February 15, 1993, Draft Site Assessment Report, Additional Assessment Activities, Campbell Street Fuel Farm and UST System AS-143 (Contract No. N62470-89-D-4814, Contract Task Order 0013).

TABLE 1-4

**SUMMARY OF FLUID LEVEL MEASUREMENTS
DECEMBER 30, 1992
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265**

Well No.	Top of Casing Elevation ⁽¹⁾ (feet, above MSL)	Depth to Product (feet, below top of casing)	Depth to Groundwater (feet, below top of casing)	Product Thickness (feet)	Product Elevation (feet, above MSL)	Groundwater Elevation (feet, above MSL)	Corrected Groundwater Elevation ⁽²⁾ (feet, above MSL)
MW-17	22.51	-- ⁽³⁾	5.99	--	--	16.52	--
MW-18	18.69	--	3.84	--	--	14.85	--
MW-19	19.10	--	4.41	--	--	14.69	--
MW-20	19.40	--	3.78	--	--	15.62	--
MW-21	21.76	--	7.30	--	--	14.46	--
MW-22	21.69	--	7.05	--	--	14.64	--
MW-23	21.35	--	7.70	--	--	13.65	--
MW-24	21.56	--	7.62	--	--	13.94	--
MW-25	21.17	--	7.58	--	--	13.59	--
DW-1	20.79	--	6.48	--	--	14.31	--
DW-2	22.91	--	8.19	--	--	14.72	--
DW-3	22.98	NR ⁽⁴⁾	NR	NR	NR	NR	NR
DW-4	21.07	--	6.22	--	--	14.85	--
DW-5	22.79	--	8.25	--	--	14.54	--
DW-6	21.83	--	7.72	--	--	14.11	--
RW-1	21.79	--	7.51	--	--	14.28	--

Notes: (1) MSL - Mean Sea Level

(2) Corrected groundwater elevations were determined by using the following equation:

CGE = Apparent Groundwater Elevation + (Product Thickness x 0.82) where 0.82 is the estimated specific gravity for JP-5 jet fuel.

(3) -- = Not Detected

(4) NR = Not recorded on this date.

Source: Baker Environmental, Inc. February 15, 1993, Draft Site Assessment Report, Additional Assessment Activities, Campbell Street Fuel Farm and UST System AS-143 (Contract No. N62470-89-D-4814, Contract Task Order 0013).

TABLE 1-5

**SUMMARY OF SOIL ANALYSES, DECEMBER 1991
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265**

Boring No.	Field Sample No.	Parameter						Sample Depth (feet, below ground surface)
		Total Petroleum Hydrocarbons (mg/kg)		Petroleum Type ⁽¹⁾	TCLP Lead (mg/l)	pH	Flashpoint (°F)	
		Low-Med (5030)	Med-High (3550)					
MW-1	FF-S-1-01	0.75	1.71	weathered jet fuel	NA ⁽²⁾	NA	NA	2.0 - 4.0
MW-1	FF-S-1-02	0.70	1.63	weathered jet fuel	-- ⁽³⁾	5.29	>140	4.0 - 6.0
MW-2	FF-S-2-01	1.82	4.26	weathered jet fuel	NA	NA	NA	2.0 - 4.0
MW-2	FF-S-2-02	0.20	0.48	weathered jet fuel	--	4.84	>140	4.0 - 6.0
MW-3	FF-S-3-01	0.59	1.53	weathered jet fuel	NA	NA	NA	2.0 - 4.0
MW-3	FF-S-3-02	0.86	1.92	weathered jet fuel	.0005	4.75	>140	4.0 - 6.0
MW-4	FF-S-4-01	7.63	19.6	weathered jet fuel	NA	NA	NA	2.0 - 4.0
MW-4	FF-S-4-02	79.0	184	weathered jet fuel	--	5.28	>140	4.0 - 6.0
MW-5	FF-S-5-01	0.16	0.37	weathered jet fuel	NA	NA	NA	4.0 - 6.0 ⁽⁴⁾
MW-5	FF-S-12-01 ⁽⁵⁾	--	0.27	weathered jet fuel	NA	NA	NA	4.0 - 6.0
MW-5	FF-S-5-02	--	--	Not Distinct	.0009	5.55	>140	6.0 - 8.0
MW-5	FF-S-12-02 ⁽⁶⁾	--	0.57	weathered jet fuel	--	5.08	>140	6.0 - 8.0

Notes:

- (1) EPA Method 5030/3550 estimated range of petroleum type
- (2) NA = Not Analyzed
- (3) -- = Not detected
- (4) 2.0-4.0 not analyzed due to ability to recover sample closer to lower measured water table.
- (5) Duplicate sample of FF-S-5-01.
- (6) Duplicate sample of FF-S-5-02.

Soil samples collected December 1991 through January 1992.

TCLP Lead - Toxicity Characteristic Leaching Procedure analyzed using Method SW846-1311/7421.

Total Petroleum Hydrocarbons analyzed using EPA Method 5030/3550, Modified 8015.

Source: Baker Environmental Inc., August 12, 1992. "Final Site Assessment Report, Campbell Street Fuel Farm and UST System AS-143 (Contract No. N62470-89-D-4814, Contract Task Order 0013).

TABLE 1-5

**SUMMARY OF SOIL ANALYSES, DECEMBER 1991
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265**

Boring No.	Field Sample No.	Parameter						Sample Depth (feet, below ground surface)
		Total Petroleum Hydrocarbons (mg/kg)		Petroleum Type ⁽¹⁾	TCLP Lead (mg/L)	pH	Flashpoint (°F)	
		Low-Med (5030)	Med-High (3550)					
MW-6	FF-S-6-01	1.05	2.24	weathered jet fuel	NA ⁽²⁾	NA	NA	2.0 - 4.0
MW-6	FF-S-6-02	1.02	2.37	weathered jet fuel	0001	3.96	>140	4.0 - 6.0
MW-7	FF-S-7-01	0.29	0.57	weathered jet fuel	NA	NA	NA	2.0 - 4.0
MW-7	FF-S-7-02	0.65	1.23	weathered jet fuel	--	4.20	>140	4.0 - 6.0
SB-1	FF-S-8-01	-- ⁽³⁾	0.30	weathered jet fuel	NA	NA	NA	2.0 - 4.0
SB-1	FF-S-8-02	0.49	1.25	weathered jet fuel	.0005	4.53	>140	4.0 - 6.0
SB-2	FF-S-9-01	--	0.49	Not Distinct	NA	NA	NA	2.0 - 4.0
SB-2	FF-S-9-02	2.29	6.86	weathered jet fuel	--	5.63	>140	4.0 - 6.0
SB-3	FF-S-10-01	0.68	1.37	weathered jet fuel	NA	NA	NA	2.0 - 4.0
SB-3	FF-S-10-02	2.59	5.26	weathered jet fuel	.001	4.07	>140	6.0 - 8.0
SB-4	FF-S-11-01	--	0.53	weathered jet fuel	NA	NA	NA	2.0 - 4.0
SB-4	FF-S-11-02	2.92	6.80	weathered jet fuel	--	4.73	>140	4.0 - 6.0

Notes:

(1) EPA Method 5030/3550 estimated range of petroleum type

(2) NA = Not Analyzed

(3) -- = Not detected

Soil samples collected December 1991 through January 1992.

TCLP Lead - Toxicity Characteristic Leaching Procedure analyzed using Method SW846-1311/7421.

Total Petroleum Hydrocarbons analyzed using EPA Method 5030/3550, Modified 8015.

Source: Baker Environmental Inc., August 12, 1992. "Final Site Assessment Report, Campbell Street Fuel Farm and UST System AS-143 (Contract No. N62470-89-D-4814, Contract Task Order 0013).

TABLE 1-5

**SUMMARY OF SOIL ANALYSES, DECEMBER 1991
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265**

Boring No.	Field Sample No.	Parameter						Sample Depth (feet, below ground surface)
		Total Petroleum Hydrocarbons (mg/kg)		Petroleum Type ⁽¹⁾	TCLP Lead (mg/L)	pH	Flashpoint (°F)	
		Low-Med (5030)	Med-High (3550)					
DW-1	FF-S-DW1-01	1.11	2.24	weathered jet fuel	NA ⁽²⁾	NA	NA	2.0 - 4.0
DW-1	FF-S-DW1-02	0.66	1.47	weathered jet fuel	NA	NA	NA	4.0 - 6.0
DW-2	FF-S-DW2-01	0.88	2.27	weathered jet fuel	NA	NA	NA	2.0 - 4.0
DW-2	FF-S-DW2-02	7.76	18.1	weathered jet fuel	NA	NA	NA	4.0 - 6.0
DW-3	FF-S-DW3-01	3.10	6.97	weathered jet fuel	NA	NA	NA	2.0 - 4.0
DW-3	FF-S-DW3-02	0.32	0.71	weathered jet fuel	NA	NA	NA	4.0 - 6.0

Notes:

(1) EPA Method 5030/3550 estimated range of petroleum type

(2) NA = Not Analyzed

Soil samples collected December 1991 through January 1992.

TCLP Lead - Toxicity Characteristic Leaching Procedure analyzed using Method SW846-1311/7421.

Total Petroleum Hydrocarbons analyzed using EPA Method 5030/3550, Modified 8015.

Source: Baker Environmental Inc., August 12, 1992. "Final Site Assessment Report, Campbell Street Fuel Farm and UST System AS-143 (Contract No. N62470-89-D-4814, Contract Task Order 0013).

TABLE 1-6

**SUMMARY OF SOIL ANALYSES, DECEMBER 1992
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265**

Boring No.	Field Sample No.	Parameter			Sample Depth (feet, below ground surface)
		Total Petroleum Hydrocarbons (mg/kg)		Petroleum Type ⁽¹⁾	
		Low-Med Boiling Point (5030)	Med-High Boiling Point (3550)		
SB-5	FF-S-SB5-01	0.37	--(2)	Jet Fuel	2-4
SB-5	FF-S-SB5-02	--	0.17	ND ⁽³⁾	4-6
SB-6	FF-S-SB6-01	0.07	0.22	ND	2-4
SB-6	FF-S-SB6-02	0.05	--	ND	4-6
SB-7	FF-S-SB7-01	1.56	--	Jet Fuel	4-6
SB-7	FF-S-SB7-02	--	--	--	14-16
SB-8	FF-S-SB8-01	--	--	--	2-4
SB-8	FF-S-SB8-02	--	--	--	4-6
SB-9	FF-S-SB9-01	24.0	50.4	Jet Fuel	4-5
SB-9	FF-S-SB9-02	26.2	301	Jet Fuel	8-9
SB-10	FF-S-SB10-01	0.10	--	ND	10-12
SB-10	FF-S-SB10-02	--	--	--	14.5-15.5
SB-11	FF-S-SB11-01	291	1900	Jet Fuel	3-4
SB-11	FF-S-SB11-02	--	--	--	6.5-7.5
SB-11	FF-S-SB11-03 ⁽⁴⁾	13.4	24.6	Jet Fuel	3-4

Notes:

(1) EPA Method 5030/3550 estimated range of petroleum type.

(2) Below method detection limit.

(3) ND = Not Determined

(4) Duplicate sample of SB-11-01.

Total Petroleum Hydrocarbons analyzed by EPA Method 5030/3550, Modified 8015.

The calculated site sensitivity evaluation for TPH at this site is 35 mg/kg.

Source: Baker Environmental, Inc. February 15, 1993, Draft Site Assessment Report, Additional Assessment Activities, Campbell Street Fuel Farm and UST System AS-143 (Contract No. N62470-89-D-4814, Contract Task Order 0013).

TABLE 6

**SUMMARY OF SOIL ANALYSES, DECEMBER 1992
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265**

Boring No.	Field Sample No.	Parameter			Sample Depth (feet, below ground surface)
		Total Petroleum Hydrocarbons (mg/kg)		Petroleum Type ⁽¹⁾	
		Low-Med Boiling Point (5030)	Med-High Boiling Point (3550)		
SB-12	FF-S-SB12-01	35.6	870	Jet Fuel	3-4
SB-12	FF-S-SB12-02	2.64	19.0	Jet Fuel	7-8
MW-8	FF-S-MW8-01	--(2)	--	--	3-4
MW-8	FF-S-MW8-02	--	1.89	Jet Fuel	4.5-5.5
MW-9	FF-S-MW9-01	--	--	--	3-4
MW-9	FF-S-MW9-02	--	5.53	Jet Fuel	7-8
MW-10	FF-S-MW10-01	--	--	--	3-4
MW-10	FF-S-MW10-02	--	--	--	5-6
MW-11	FF-S-MW11-01	--	--	--	3-4
MW-11	FF-S-MW11-02	--	--	--	6-8
MW-12	FF-S-MW12-01	2.04	6.94	Jet Fuel	3-4
MW-12	FF-S-MW12-02	87.0	1.17	Jet Fuel	5-6
MW-12	FF-S-MW12-03 ⁽³⁾	151	34.0	Jet Fuel	3-4
MW-13	FF-S-MW13-01	283	14700	Jet Fuel	2-4
MW-13	FF-S-MW13-02	2.15	0.74	Jet Fuel	4-6

Notes:

⁽¹⁾ EPA Method 5030/3550 estimated range of petroleum type.

⁽²⁾ Below method detection limit.

⁽³⁾ Duplicate sample of MW-12-01.

Total Petroleum Hydrocarbons analyzed by EPA Method 5030/3550, Modified 8015.

The calculated site sensitivity evaluation for TPH at this site is 35 mg/kg.

Source: Baker Environmental, Inc. February 15, 1993, Draft Site Assessment Report, Additional Assessment Activities, Campbell Street Fuel Farm and UST System AS-143 (Contract No. N62470-89-D-4814, Contract Task Order 0013).

TABLE 6

**SUMMARY OF SOIL ANALYSES, DECEMBER 1992
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265**

Boring No.	Field Sample No.	Parameter			Sample Depth (feet, below ground surface)
		Total Petroleum Hydrocarbons (mg/kg)		Petroleum Type ⁽¹⁾	
		Low-Med Boiling Point (5030)	Med-High Boiling Point (3550)		
MW-14	FF-S-MW14-01	51.0	3.67	Jet Fuel	3-4
MW-14	FF-S-MW14-02	0.16	2.74	Jet Fuel	4-6
MW-14	FF-S-MW14-03 ⁽³⁾	15.0	19.5	Jet Fuel	3-4
MW-15	FF-S-MW15-01	--(2)	--	--	2-4
MW-15	FF-S-MW15-02	--	--	--	4-6
MW-16	FF-S-MW16-01	166	96.4	Jet Fuel	2-4
MW-16	FF-S-MW16-02	21.0	11.9	Jet Fuel	4-6
MW-17	FF-S-MW17-01	--	--	--	2-4
MW-17	FF-S-MW-17-02	--	--	--	4-6
MW-18	FF-S-MW18-01	0.14	5.26	Jet Fuel	2-4
MW-18	FF-S-MW18-02	--	23.6	Jet Fuel	4-6
MW-19	FF-S-MW19-01	--	--	--	2-4
MW-19	FF-S-MW19-02	--	--	--	4-6
MW-20	FF-S-MW20-01	--	--	--	2-4
MW-20	FF-S-MW20-02	--	--	--	4-6

Notes:

(1) EPA Method 5030/3550 estimated range of petroleum type.

(2) Below method detection limit.

(3) Duplicate sample of MW-14-01.

Total Petroleum Hydrocarbons analyzed by EPA Method 5030/3550, Modified 8015.

The calculated site sensitivity evaluation for TPH at this site is 35 mg/kg.

Source: Baker Environmental, Inc. February 15, 1993, Draft Site Assessment Report, Additional Assessment Activities, Campbell Street Fuel Farm and UST System AS-143 (Contract No. N62470-89-D-4814, Contract Task Order 0013).

TABLE 6

**SUMMARY OF SOIL ANALYSES, DECEMBER 1992
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265**

Boring No.	Field Sample No.	Parameter			Sample Depth (feet, below ground surface)
		Total Petroleum Hydrocarbons (mg/kg)		Petroleum Type ⁽¹⁾	
		Low-Med Boiling Point (5030)	Med-High Boiling Point (3550)		
MW-21	FF-S-MW21-01	0.49	16.7	Jet Fuel	2-4
MW-21	FF-S-MW21-02	37.2	7.86	Jet Fuel	5-6
MW-21	FF-S-MW21-03 ⁽³⁾	82.8	--	Jet Fuel	5-6
MW-22	FF-S-MW22-01	-- ⁽²⁾	--	--	2-4
MW-22	FF-S-MW22-02	--	--	--	4-6
MW-23	FF-S-MW23-01	--	--	--	2-4
MW-23	FF-S-MW23-02	--	0.75	Jet Fuel	4-6
MW-24	FF-S-MW24-01	--	--	--	2-4
MW-24	FF-S-MW24-02	--	--	--	4-6
MW-25	FF-S-MW25-01	2.79	14.2	Gas	2-4
MW-25	FF-S-MW25-02	20.3	9.85	Gas	6-6.5
MW-25	FF-S-MW25-03 ⁽⁴⁾	--	4.45	Gas	6-6.5
DW-4	FF-S-DW4-01	--	--	--	2-4
DW-4	FF-S-DW4-02	--	--	--	48-50
DW-4	FF-S-DW4-03 ⁽⁵⁾	--	--	--	2-4

Notes:

(1) EPA Method 5030/3550 estimated range of petroleum type.

(2) Below method detection limit.

(3) Duplicate sample of MW-21-02.

(4) Duplicate sample of MW-25-02.

(5) Duplicate sample of DW-4-01.

Total Petroleum Hydrocarbons analyzed by EPA Method 5030/3550, Modified 8015.

The calculated site sensitivity evaluation for TPH at this site is 35 mg/kg.

Source: Baker Environmental, Inc. February 15, 1993, Draft Site Assessment Report, Additional Assessment Activities, Campbell Street Fuel Farm and UST System AS-143 (Contract No. N62470-89-D-4814, Contract Task Order 0013).

TABLE 6

**SUMMARY OF SOIL ANALYSES, DECEMBER 1992
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265**

Boring No.	Field Sample No.	Parameter			Sample Depth (feet, below ground surface)
		Total Petroleum Hydrocarbons (mg/kg)		Petroleum Type ⁽¹⁾	
		Low-Med Boiling Point (5030)	Med-High Boiling Point (3550)		
DW-5	FF-S-DW5-01	19.0	118	Jet Fuel	6-8
DW-5	FF-S-DW5-02	--(2)	5.80	M. Oil	40-42
DW-6	FF-S-DW6-01	5.10	204	Jet Fuel	2-4
DW-6	FF-S-DW6-02	--	--	--	40-42
RW-1	FF-S-RW1-01	--	0.99	ND ⁽³⁾	2-4
RW-1	FF-S-RW1-02	--	--	--	4-6

Notes:

⁽¹⁾ EPA Method 5030/3550 estimated range of petroleum type.

⁽²⁾ Below method detection limit.

⁽³⁾ ND = Not Determined

Total Petroleum Hydrocarbons analyzed by EPA Method 5030/3550, Modified 8015.

The calculated site sensitivity evaluation for TPH at this site is 35 mg/kg.

Source: Baker Environmental, Inc. February 15, 1993, Draft Site Assessment Report, Additional Assessment Activities, Campbell Street Fuel Farm and UST System AS-143 (Contract No. N62470-89-D-4814, Contract Task Order 0013).

TAB 7
SUMMARY OF CHEMICAL ANALYSES FOR GROUNDWATER SAMPLES COLLECTED BY HYDROPUNCH PROCEDURE IN DECEMBER 1991
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265

Well No.	Field Sample No.	Parameter (µg/L)									Total VOCs ⁽⁴⁾
		MTBE ⁽¹⁾	1,3 and 1,4-Dichlorobenzene	1,2-Dichlorobenzene	Benzene	Toluene/EDB ⁽²⁾	Ethylbenzene	Chlorobenzene and m- & p-Xylenes	o-Xylene	Total Xylene ⁽³⁾	
HP-1	FF-W-H-1	-- ⁽⁵⁾	--	--	--	--	--	0.2	--	0.21	0.21
HP-2	FF-W-H-2	0.31	--	--	--	--	--	--	--	--	0.31
HP-3	FF-W-H-3	--	--	--	--	--	--	--	--	--	--
HP-4	FF-W-H-4	--	--	--	--	--	--	--	--	--	--
HP-5	FF-W-H-5	--	--	--	0.54	--	--	--	--	--	0.54
HP-6	FF-W-H-6	--	--	--	--	--	--	--	--	--	--
HP-7	FF-W-H-7	--	--	--	--	--	--	0.83	--	0.83	0.83
HP-8	FF-W-H-8	--	--	--	--	--	--	0.50	--	0.50	0.50
HP-9	FF-W-H-9	0.48	--	--	--	--	--	--	--	--	0.48
HP-10	FF-W-H-10	--	--	--	1.17	--	0.74	--	--	--	1.91
HP-11	FF-W-H-11	0.66	--	--	--	0.23	--	--	--	--	0.89
HP-12	FF-W-H-12	0.47	5.76	2.86	4.47	2.27	1.32	1.83	1.32	3.15	20.30
HP-13	FF-W-H-13	0.25	--	--	--	0.89	--	0.97	--	0.97	2.11
HP-13	FF-W-H-16 ⁽⁶⁾	0.52	--	--	--	--	--	--	--	--	0.52
HP-14	FF-W-H-14	0.27	--	--	1.05	0.72	--	0.89	--	0.89	2.93
HP-14	FF-W-H-17 ⁽⁶⁾	0.42	--	--	--	0.73	--	1.01	--	1.01	2.16
HP-15	FF-W-H-15	2.08	0.78	0.57	23.77	0.82	2.52	5.72	2.18	7.90	38.44
Federal MCLs ⁽⁷⁾		NE ⁽⁹⁾	NE/75	600	5.0	1,000/0.05	700	100/NE	NE	10,000	
State NC WQS ⁽⁸⁾		50 ⁽¹⁰⁾	620/1.8	620	1.0	1,000/0.0005	29	300/NE	NE	400	

Notes:

- | | |
|--|--|
| (1) MTBE = Methyl Tertiary Butyl Ether | (6) Duplicate sample |
| (2) EDB = Ethylene Dibromide | (7) MCL = Maximum Contaminant Level |
| (3) Include a combined value of chlorobenzene and m- & p-Xylenes | (8) NC WQS = North Carolina Water Quality Standard |
| (4) Sum of total organic compounds detected using EPA Method 602 | (9) NE = Not Established |
| (5) -- = Not Detected | (10) MTBE NC WQS is an interim standard |

Samples analyzed using EPA Method 602. Method could not distinguish a difference between 1,3- and 1,4-dichlorobenzene; toluene and EDB; chlorobenzene and m- and p-Xylenes. Laboratory reported the concentration as a combined value.

Source: Baker Environmental, Inc. February 15, 1993, Draft Site Assessment Report, Additional Assessment Activities, Campbell Street Fuel Farm and UST System AS-143 (Contract No. N62470-89-D-4814, Contract Task Order 0013).

**SUMMARY OF CHEMICAL ANALYSES FOR GROUNDWATER SAMPLES COLLECTED FROM MONITORING WELLS IN JANUARY 1992
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265**

Parameter/Method	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8 ⁽⁸⁾	DW-1	DW-2	DW-3	Trip Blank	Maximum Contaminant Level (µg/L)	NC Water Quality Standard (µg/L)
EPA Method 601 (µg/L) Purgeable Halocarbons ⁽¹⁾	-- ⁽⁶⁾	NA ⁽⁷⁾	NA	NA	NA	--	--	--	NA	--	NA	--		
EPA Method 602 ⁽²⁾ (µg/L)														
MTBE ⁽³⁾	--	0.21	--	--	--	--	--	--	--	--	--	--	NE ⁽⁹⁾	50 ⁽¹¹⁾
Benzene	--	0.20	2.79	2.47	--	--	--	--	--	2.05	--	--	5.0	1.0
Toluene/EDB ⁽⁴⁾	--	--	--	--	--	--	--	--	--	--	0.94	--	1,000/0.05	1,000/0.0005
Ethyl Benzene	--	--	--	0.42	--	--	--	--	--	0.36	--	--	700	29
m-, p- Xylene and Chlorobenzene	--	--	0.81	1.73	--	--	--	--	--	22.70	--	--	NE/100	NE/300
o-Xylene	--	--	0.76	--	0.79	--	--	--	--	--	--	--	NE	400
1,3 & 1,4-Dichlorobenzene	--	--	--	10.64	--	--	1.04	--	--	23.35	--	--	75	620/1.8
1,2-Dichlorobenzene	--	--	--	6.33	--	--	1.22	--	--	2.31	--	--	600	620
EPA Method 625 ⁽⁵⁾ (µg/L)	NA	NA	NA	NA	NA	--	NA	--	NA		NA			
Acenaphthene						--	--	--		46		--	NE	NE
Fluorene						--	--	--		36		--	NE	NE
Naphthalene						--	--	--		258		--	NE	NE
Phenanthrene						--	--	--		11		--	NE	NE
EPA Method 7421 (µg/L)														
Lead, total	--	3.4	--	2.6	2.0	0.9	0.5	1.0	0.8	4.3	0.7	NA	50 ⁽¹⁰⁾	50
Total Xylenes	--	--	1.57	1.73	0.79	--	--	--	--	22.70	--	--	10,000	400
Total VOCs	--	0.41	4.36	21.59	0.79	--	2.26	--	--	50.77	0.94	--	NE	NE

Notes:

- (1) Purgeable halocarbons analyzed using EPA Method 601. No purgeable halocarbons were detected.
- (2) Purgeable aromatics analyzed using EPA Method 602. Method could not distinguish a difference between toluene and EDB; m-, p-Xylene and chlorobenzene; 1,3- and 1,4-dichlorobenzene. Laboratory reported the concentrations as a combined value.
- (3) MTBE = Methyl Tertiary Butyl Ether
- (4) EDB = Ethylene Dibromide
- (5) Base Neutral/Acid Extractables (BNAs) analyzed using EPA Method 625. Only four contaminants were detected.
- (6) -- = Not Detected
- (7) NA - Not Analyzed
- (8) MW-8 was the number assigned to the duplicate sample for monitoring well MW-6 at time of sampling. Actual monitoring well MW-8 was installed during the second phase of work.
- (9) NE - Not Established
- (10) Standard based on dissolved lead concentrations.
- (11) MTBE NC WQS is an interim standard.

Table reflects only those parameters which were detected.

Source: Baker Environmental, Inc. February 15, 1993, Draft Site Assessment Report, Additional Assessment Activities, Campbell Street Fuel Farm and UST System AS-143 (Contract No. N62470-89-D-4814, Contract Task Order 0013).

TABLE 1-9

**SUMMARY OF CHEMICAL ANALYSES FOR GROUNDWATER SAMPLES COLLECTED FROM MONITORING WELLS IN DECEMBER 1992
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265**

Parameter/Method	MW-8	MW-9	MW-10	MW-11	MW-12	MW-13	MW-14	MW-15	MW-16	MW-17	MW-18	Federal Maximum Contaminant Level (µg/L)	NC Water Quality Standard (µg/L)
EPA Method 602 ⁽¹⁾ (µg/L)													
Purgeable Aromatic Hydrocarbons													
MTBE ⁽²⁾	-- ⁽⁵⁾	--	--	--	2.4	--	--	--	416	--	--	NE ⁽⁶⁾	50 ⁽⁸⁾
Benzene	7.85	--	--	--	--	--	--	--	69.5	--	--	5.0	1.0
Toluene/EDB ⁽³⁾	--	--	--	--	--	--	--	--	40.6	--	5.8	1,000/0.05	1,000/0.0005
Chlorobenzene	--	--	--	--	--	--	--	--	--	--	--	100	300
Ethylbenzene	12.9	--	--	--	--	11.8	--	--	--	--	--	700	29
m-, p-Xylene	52.8	--	--	--	4.34	8.09	--	--	125	--	13.2	NE	NE
o-Xylene	--	--	--	--	--	--	--	--	--	--	--	NE	NE
1,3-Dichlorobenzene	--	--	--	--	--	--	--	--	--	--	9.27	NE	620
1,4-Dichlorobenzene	--	--	--	--	--	30.8	--	--	113	--	--	75	1.8
1,2-Dichlorobenzene	--	--	--	--	--	--	--	--	28.8	--	13.0	600	620
Total Xylenes	52.8	--	--	--	4.34	8.09	--	--	125	--	13.2	10,000 ⁽⁷⁾	400 ⁽⁸⁾
Total VOCs ⁽⁴⁾	73.55	--	--	--	6.74	50.69	--	--	792.9	--	41.27	NE	NE

Notes:

- (1) Purgeable aromatics analyzed by EPA Method 602. Method could not resolve toluene and EDB. Laboratory reported the concentrations as a combined value.
- (2) MTBE = Methyl Tertiary Butyl Ether
- (3) EDB = Ethylene Dibromide. Method could not resolve toluene and EDB. Concentrations reported as a combined value.
- (4) Sum of total volatile organic compounds detected by EPA Method 602.
- (5) -- = Less than method detection limit.
- (6) NE = Not Established
- (7) The MCL and NCWQS for xylene (total) includes meta, para, and ortho xylenes.
- (8) MTBE WQS is an interim standard.

Source: Baker Environmental, Inc. February 15, 1993, Draft Site Assessment Report, Additional Assessment Activities, Campbell Street Fuel Farm and UST System AS-143 (Contract No. N62470-89-D-4814, Contract Task Order 0013).

TABLE 1-9

SUMMARY OF CHEMICAL ANALYSES FOR GROUNDWATER SAMPLES COLLECTED FROM MONITORING WELLS IN DECEMBER 1992
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265

Parameter/Method	MW-19	MW-20	MW-21	MW-22	MW-23	MW-24	MW-25	MW-26 ⁽⁹⁾	MW-27 ⁽¹⁰⁾	DW-4	DW-5	DW-6	RW-1	Federal Maximum Contaminant Level (µg/L)	NC Water Quality Standard (µg/L)
EPA Method 602 ⁽¹⁾ (µg/L)															
Purgeable Aromatic Hydrocarbons															
MTBE ⁽²⁾	160	-- ⁽⁵⁾	21.9	--	--	400	1490	--	29.4	--	--	--	147	NE ⁽⁶⁾	50 ⁽⁸⁾
Benzene	--	--	--	--	--	73	58.1	--	--	--	--	--	26.7	5.0	1.0
Toluene/EDB ⁽³⁾	--	--	514	--	--	762	241	--	64.3	--	--	--	--	1,000/0.05	1,000/0.0005
Chlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	100	300
Ethylbenzene	--	--	661	--	--	--	63.9	--	30	--	--	--	--	700	29
m-, p-Xylene	--	--	4700	--	5.46	199	1130	5.89	755	--	--	3.93	62.9	NE	NE
o-Xylene	--	--	383	--	--	--	400	--	818	--	--	--	--	NE	NE
1,3-Dichlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	620
1,4-Dichlorobenzene	--	--	3060	--	--	207	550	--	3045	--	--	8.46	30.1	75	1.8
1,2-Dichlorobenzene	--	--	486	--	--	148	101	--	97	--	--	--	25.7	600	620
Total Xylenes	--	--	5083	--	5.46	199	1530	5.89	1573	--	--	3.93	62.9	10,000 ⁽⁷⁾	400 ⁽⁸⁾
Total VOCs ⁽⁴⁾	160	--	9825.9	--	5.46	1789	4034	5.89	4838.7	--	--	12.39	292.4	NE	NE

Notes:

- (1) Purgeable aromatics analyzed by EPA Method 602. Method could not resolve toluene and EDB. Laboratory reported the concentrations as a combined value.
- (2) MTBE = Methyl Tertiary Butyl Ether
- (3) EDB = Ethylene Dibromide. Method could not resolve toluene and EDB. Concentrations reported as a combined value.
- (4) Sum of total volatile organic compounds detected by EPA Method 602.
- (5) -- = Less than method detection limit.
- (6) NE = Not Established
- (7) The MCL and NCWQS for xylene (total) includes meta, para, and ortho xylenes.
- (8) MTBE WQS is an interim standard.
- (9) MW-26 is a duplicate for MW-23.
- (10) MW-27 is a duplicate for MW-25.

Source: Baker Environmental, Inc. February 15, 1993, Draft Site Assessment Report, Additional Assessment Activities, Campbell Street Fuel Farm and UST System AS-143 (Contract No. N62470-89-D-4814, Contract Task Order 0013).

TABLE 2-1

**GROUNDWATER REMEDIATION ENDPOINTS
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265**

Parameter	NC Water quality Standard (µg/L)	Maximum Concentration Detected (µg/L)	Sampling Point with Highest Concentration	Number of Sampling Points above WQS (µg/L)
MTBE	50.0	1490	MW-24	5
Benzene	1.0	73.0	MW-24	12
Toluene	1,000	762	MW-24	0
Ethylbenzene	29	661	MW-21	3
Xylenes	400	5,083	MW-21	3
EDB	0.0005	762	MW-24	12
Chlorobenzene	300	22.7	DW-2	0
1,2-Dichlorobenzene	620	486	MW-21	0
1,3-Dichlorobenzene	620	23.65	MW-21	0
1,4-Dichlorobenzene	1.8	3,060	MW-21	11
Naphthalene	NE	258	DW-2	NA
Acenaphthene	NE	46	DW-2	NA

Notes: NE = Not established
 MTBE = Methyl Tertiary Butyl Ether
 EDB = Ethylene Dibromide
 NA = Not Applicable

NC Water Quality Standard shall be used as the initial groundwater remediation endpoints

TABLE 3-1

MAJOR COMPONENTS OF JP-5 JET FUEL
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265

Benzene	Naphthalene
Toluene	2-Methylundecane
Ethylbenzene	n-Dodecane
n-Octane	2,6-Dimethylundecane
1,3,5-Trimethylcyclohexane	1,2,4-Triethylbenzene
1,1,3-Tremethylcyclohexane	2-Methylnaphthalene
3-Methyloctane	1-Methylnaphthalene
2,4,6-Trimethylheptane	1-Tridecene
o-Xylene	Phenylcyclohexane
p-Xylene	n-Tridecane
m-Xylene	1-t-Butyl-3,4,5-trimethylbenzene
n-Nonane	n-Heptylcyclohexane
1,2,4-Trimethylbenzene	n-Heptylbenzene
n-Decane	Biphenyl
n-Butylcyclohexane	1-Ethyl-naphthalene
1,3-Diethylbenzene	2,6-Dimethylnaphthalene
1,4-Diethylbenzene	n-Tetradecane
4-Methyldecane	2,3-Dimethylnaphthalene
2-Methyldecane	n-Octylbenzene
1-Ethylpropylbenzene	n-Pentadecane
n-Undecane	n-Hexadecane
2,6-Dimethyldecane	n-Heptadecane
1,2,3,4-Tetramethylbenzene	

Source: "Analysis and Environmental Fate of Air Force Distillate and High Density Fuels."
SRI International. October 1981.

TABLE 3-2

**CONCENTRATIONS OF SELECT WATER SOLUBLE
COMPONENTS OF JP-5
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265**

Constituent	Concentration (mg/L) ⁽¹⁾
Toluene	0.6
Ethylbenzene	0.3
m,p-xylenes	0.16
o-xylene	0.09
Naphthalene	0.46
2-Methylnaphthalene	0.23

Notes: (1) Concentration of the constituent detected in a mixture of 1 part JP-5 to 1,000 parts water

Benzene was not detected as a water soluble component.

Source: "Analysis and Environmental Fate of Air Force Distillate and High Density Fuels." SRI International. October 1981.

TABLE 3-3

**PHYSICAL-CHEMICAL PROPERTIES AND RELATIVE MOBILITY INDICES FOR JP-5 CONSTITUENTS
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265**

Constituent	Molecular Weight (g/mol.)	Specific Gravity (g/cm ³ @ 20/4°C)	Water Solubility (ppm @ 20°C)	Vapor Pressure (mm Hg @ 25°C)	Henry's Law Coefficient (atm m ³ /mol-1)	log K _{ow}	log K _{oc}	Relative Mobility Index
Benzene	78.1	0.879	1,780	76	5.5 x 10 ⁻³	2.13	1.92	3.0
Toluene	92.13	0.867	534.8 (25°C)	28.7 (25°C)	6.6 x 10 ⁻³	2.48	2.79	1.5
Ethylbenzene	106.16	0.873	152	7	6.6 x 10 ⁻³	3.34	3.04	-0.01
Xylene, Total	106.16	0.870	180	6	4.64 x 10 ⁻³	2.84	3.02	0.19
Naphthalene	128.2	1.162	31.7 (25°C)	8.7 x 10 ⁻²	4.6 x 10 ⁻⁴	3.29	2.97	-2.5
Acenaphthylene	152.2	1.18	3.93 (25°C)	2.9 x 10 ⁻² (20°C)	1.45 x 10 ⁻³	3.72	3.40	-4.3
Acenaphthene	154.2	1.189	3.42 (25°C)	1.55 x 10 ⁻³	9.1 x 10 ⁻⁵	3.98	3.66	-5.9

Notes: NC = Not calculated

References: USEPA, 1982. Aquatic Fate Process Data for Organic Priority Pollutants.
 Verscheueren, 1983. Handbook of Environmental Data on Organic Chemicals. 2nd Edition.
 Lyman, et al., 1982. Handbook of Chemical Property Estimation Methods.
 Ford and Gurba, 1984. Methods of Determining Relative Contaminant Mobilities and Migration Pathways Using Physical-Chemical Data.

TABLE 3-4

**PRELIMINARY EXPOSURE ASSESSMENT SUMMARY
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265**

Exposure Pathways	Maximum Detected Levels (1)	Potential for Migration of Contaminants	Potential for Human Exposure
Soil	TPH: 14700 mg/kg TCLP Lead: 0.001 pH: 5.63 FP: >140°F Only 8 of 96 samples had TPH values above 180 mg/kg (samples collected during both phases of work)	Soils are generally a mixture of silt and clay, underlain by a fine-grained sand. Because of the lesser permeability of the silt and clay soils, minimal migration through the soil is considered possible. In general, the highest concentrations were detected at depths of 2 to 6 feet.	Covered by grass top soil and concrete, the site poses no immediate exposure. If the site is disturbed due to construction or remediation activities, exposure to workers does exist by both direct contact and the inhalation of dust generated from the site.
Groundwater	Benzene: 73 µg/L Toluene: 762 µg/L Ethylbenzene: 661 µg/L Xylene: 5083 µg/L EPA Method 601: (2) Total Lead: 4.3 µg/L	Groundwater, on the average, was 6 to 8 feet below ground surface. It is believed that groundwater migration through this type of soil would be limited. However, a flow velocity of 70 feet/year would indicate that this medium would allow for greatest contamination migration.	Because the base drinking water is supplied by the deeper Castle Hayne Aquifer and there are no water supply wells within a 1/4-mile radius of the site in the surficial aquifer, no groundwater exposure pathways are believed to exist.
Vapor	No detection by use of Dräger tubes. Maximum vapor detected using PID is 600 ppm (Boring MW-12)	The type of soils present (silt/clay) may reduce the rate of vapor migration. However, subsurface utilities in the area may increase the rate of migration in portions of the site.	The ground surface conditions at the site will promote the dispersion of vapors. Subsurface utility trenches may create areas for vapors to accumulate. In the event that the site is disturbed due to construction or remediation activities, inhalation from the volatilization of the TPH could occur.

- (1) Analytical Results listed are based on both phases of work.
 (2) Concentrations were below detection limits.

TABLE 4-1

**SCREENING OF POTENTIAL SOIL REMEDIATION OPTIONS
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265**

Option	Process	Estimated Costs ⁽¹⁾	Practical Constraints	Remarks	Applicable to Site (Y/N)
Excavation and disposal as hazardous waste	Excavate and haul to Class I landfill; emplace and compact clean fill	\$300/yd ³	Cradle-to-grave liability as waste generator	High cost	N
Excavation and disposal as solid waste (nonhazardous)	Excavate and haul to Class III landfill; backfill with clean fill	\$60/yd ³	Location of a suitable landfill	Economical on small projects	Y
Excavation, aeration and disposal off site (off-site bioremediation)	Excavate and spread on site; turn repeatedly to aerate, haul to clean fill disposal site; emplace and compact new clean fill	\$30/ton Plus transportation and backfill costs	Emission considerations	Technically feasible; permitted facilities located near activity; may require numerous analytical tests	Y
Excavation, landfarming and replacement	Excavate and spread on site; aerate and add nutrients and water; re-emplace and compact	\$50/yd ³	Emission considerations; leaves excavation open during treatment	Technically feasible, permitting may be difficult; requires numerous analytical tests	N
Mechanically enhanced volatilization	Excavate, pass through crusher, aerator, and re-emplace	\$250/yd ³	Requires dust control and vapor treatment	High cost, but suitable for specific locations	N
<i>In-situ</i> venting (vacuum extraction)	Investigate extent of contamination and soil conditions; design and install venting system; permit system; operate system; reinvestigate to monitor effectiveness	\$20-50/yd ³	Fine-grained soils and low volatility of hydrocarbon in soils limit the effectiveness of this method	Not a technically viable option for sites with clayey soils; requires disposal of air filtration medium	Y
Excavation and low temperature thermal reduction (LTTR)	Contamination in soil reduced through volatilization by the application of heat	\$50/ton + transportation	Emissions considerations	Effective method of reducing contaminant concentrations	Y

⁽¹⁾ Estimated costs reflect 1990 dollars.

Source: Testa, Stephen M. and Duane L. Winegardner. Restoration of Petroleum-Contaminated Aquifers. Lewis Publishers, Inc., Chelsea, Michigan. 1991.

TABLE 4-1
(Continued)
SCREENING OF POTENTIAL SOIL REMEDIATION OPTIONS
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265

Option	Process	Estimated Costs ⁽¹⁾	Practical Constraints	Remarks	Applicable to Site (Y/N)
<i>In-situ</i> biodegradation or chemical degradation	Investigate extent of contamination and soil and groundwater conditions; conduct feasibility study; design and install pumping and injection system; permit system; operate system; reinvestigate to monitor effectiveness	\$75/yd ³	Fine-grained soils limit ability to inject and pump fluids through soils. System could be engineered to be installed and operated around existing facilities; requires ongoing operation and maintenance (O&M) and monitoring. Requires periodic soil sampling and final investigation	Overall effectiveness cannot be assured; pending results of pilot study; requires on site monitoring	Y
Steam injection and stripping	Investigate extent of contamination and soil and groundwater conditions; conduct feasibility study; design and install steam injection and recovery system; permit system; operate system; monitor effectiveness on an ongoing basis	\$100-200/yd ³	Fine-grained soils limit ability to inject steam and recover fluids from soils	Overall effectiveness cannot be assured, pending pilot study results; O&M cost	N
Asphalt incorporation	Excavate and transport	\$125/ton	Soil must pass flash-test before acceptance	Very good option for low-volatile hydrocarbon affected soils	N
Passive remediation	Passive remediation		No risk to public health, safety and welfare. No risk to surface water or groundwater; considered of beneficial use	Site-specific. High concentrations present at the site may require a significant period of time to degrade to acceptable levels	N

(1) Estimated costs reflect 1990 dollars.

Source: Testa, Stephen M. and Duane L. Winegardner. Restoration of Petroleum-Contaminated Aquifers. Lewis Publishers, Inc., Chelsea, Michigan. 1991.

TABLE 1
(Continued)

SCREENING OF POTENTIAL SOIL REMEDIATION OPTIONS
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265

Option	Process	Estimated Costs ⁽¹⁾	Practical Constraints	Remarks	Applicable to Site (Y/N)
Soil washing/extraction	Excavate, crush, mix with wash fluid, separate, replace, treat wash water		Limited to granular soils, wash fluid treatment may be difficult	Technically feasible, high cost, limited applications	N
In-situ leaching	Construct infiltration and recovery systems, irrigate washing fluid, retrieve fluid, treat fluid	\$150 to \$200/yd ³	Limited to permeable soils, and higher solubility hydrocarbons	Often used in conjunction with biotreatment practices; permit approval may be difficult	Y
Aboveground leaching/replacement	Excavate, crush, place over collector bed, flush with wash fluid, replace, treat fluid		Total washing fluid collection, temperature and odor control; requires fairly large open area	May be used in association with biotreatment, often effective; permitting not as difficult	N

(1) Estimated costs reflect 1990 dollars.

Source: Testa, Stephen M. and Duane L. Winegardner. Restoration of Petroleum-Contaminated Aquifers. Lewis Publishers, Inc., Chelsea, Michigan. 1991.

**SCREENING OF POTENTIAL GROUNDWATER RECOVERY ALTERNATIVES
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265**

Alternative	Description	Capability	Limitation	Evaluation	Applicable to Site (Y/N)
1. Passive Remediation	Take no action - continue groundwater monitoring to determine if product plume is migrating off site.	Simplest, least costly option	Does not facilitate containment, control or recovery of product.	The option does not actively improve site groundwater quality.	N
2. Subsurface Flow Controls (barriers)	Install slurry, membrane or structural walls around plume to isolate it and preclude further migration.	A conventional, demonstrated technology	This option is usually very expensive. Many slurry wall mixtures or membranes may not provide long-term durability.	This option does not improve site groundwater quality. It may not provide long-term benefits.	N
3. Well Points	Install several closely-spaced small diameter wells around the plume.	A conventional, demonstrated technology	Requires a large number of well points to be effective. Large quantities of water would be generated. Requires frequent maintenance.	Effective for sites with high permeability and shallow water table.	Y
4. Recovery wells	Install groundwater/free product recovery wells at selected locations.	A conventional, demonstrated technology	Several wells required to renovate the aquifer. Usually suited for use in sandy aquifers.	Effective for sites with groundwater levels over 25 feet deep.	Y
5. Large-Diameter Sumps	Install a few large diameter sumps at selected locations.	A conventional, demonstrated technology	Only effective in shallow aquifers with low permeabilities.	May be effective in shallow conditions where low permeabilities exist.	N
6. Interceptor Trenches	Construct trenches with sumps at right angles to existing groundwater flow patterns.	A conventional, demonstrated technology	Only effective in shallow aquifers with low permeabilities. Construction may disrupt facility operations. Installation may not be possible in many areas.	May be effective in shallow conditions where low permeabilities exist. Construction is limited to open areas.	Y
7. In-Situ Biotreatment	Utilize recovery and injection wells along with a fixed film biotreatment unit to biodegrade contaminants.	A conventional, demonstrated technology	Requires large capital costs. Usually maintenance is extensive. Biotreatment is slow as compared to other remediation methods.	Presence of lead makes this option less effective.	N

Note: Estimated costs for remediation alternatives are not possible due to variables such as volume of groundwater to be removed, number of pumps required, etc.

TABLE 5-1
MONITORING PLAN SUMMARY
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265

PHASE OF CONTAMINATION	PROPOSED CLEANUP ENDPOINTS	PROPOSED MONITORING TO ACHIEVE ENDPOINTS					SYSTEM	PROPOSED POST OPERATION MONITORING	
		SAMPLING LOCATION	SAMPLING FREQUENCY AND TYPE	METHOD OF ANALYSIS	SCHEDULE TO ACHIEVE ENDPOINTS	SCHEDULE TO MAINTAIN ENDPOINTS		SAMPLING FREQUENCY AND TYPE	POST OPERATION MONITORING SCHEDULE
Free Product- JP-5	< 0.01 Feet	Monitoring wells MW-3, MW-9, MW-10, MW-11 MW-12, MW-14 MW-15, MW-16 MW-21, MW-22 MW-23, MW-24 MW-25, DW-2 DW-6, RW-1 and RW-2	Monthly Free product measurement	Electronic interface probe or tape, chalk, and water indicating paste method	Free product is to be removed by excavation activities	12 months	S Y S T E M	Monthly Free product measurement	Monitoring will continue for 12 consecutive months no free product detection
Dissolved Petroleum Contamination in Groundwater	State WQS or asymptotic conditions	Monitoring wells MW-3, MW-11, MW-12, MW-14, MW-16, MW-21, MW-23, MW-24, MW-25, DW-2 and DW-6	Quarterly Grab	All Monitoring wells EPA Method 602 Monitoring wells DW-2 and DW-6 EPA Method 625	1 - 2 years	Endpoints must be maintained for 12 months before post-operational monitoring is initiated	S H U T D O W N	Quarterly sampling of monitoring wells MW-3, MW-11, MW-12, MW-14, MW-16, MW-21, MW-23, MW-24, MW-25, DW-2 and DW-6	Endpoints must be maintained for 12 months before post-operational monitoring is terminated
Treated Effluent	As specified on NPDES Permit	Effluent discharge point	Monthly	EPA Method 602	1 - 2 years	12 months		System will not be in operation during post monitoring period	N/A
Residual Product in Soils	TPH 180 (mg/kg)	One for every 50 ft. along excavation wall	At time of excavation Grab	EPA Method 8015 (5030/3550)	Less than 30 days	Endpoints are to be attained by the completion of excavation activities		Sampling will not be performed during post monitoring period	N/A

TABLE 6-1

**NPDES PERMIT MONITORING REQUIREMENTS
CAMPBELL STREET FUEL FARM
CONTRACT TASK ORDER 0265**

Effluent Characteristics	Discharge Limitation		Monitoring Requirements		
	Monthly Average	Daily Maximum	Measurement Frequency	Sample Type	Sample Location
Flow			Weekly	Pump or Meter Log	Effluent
Toluene	11 µg/L	22 µg/L	Monthly	Grab	Effluent
Benzene	71.4 µg/L	142.8 µg/L	Monthly	Grab	Effluent
Methyl Tertiary Butyl Ether			Monthly	Grab	Effluent

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Additional Chemical constituents analyzed by EPA Methods 602 and EPA Method 625 shall also be reported. No discharge limitations are specified for these constituents.

Source: State of North Carolina Department of Environment, Health, and Natural Resources , Division of Environmental Management.

Figures

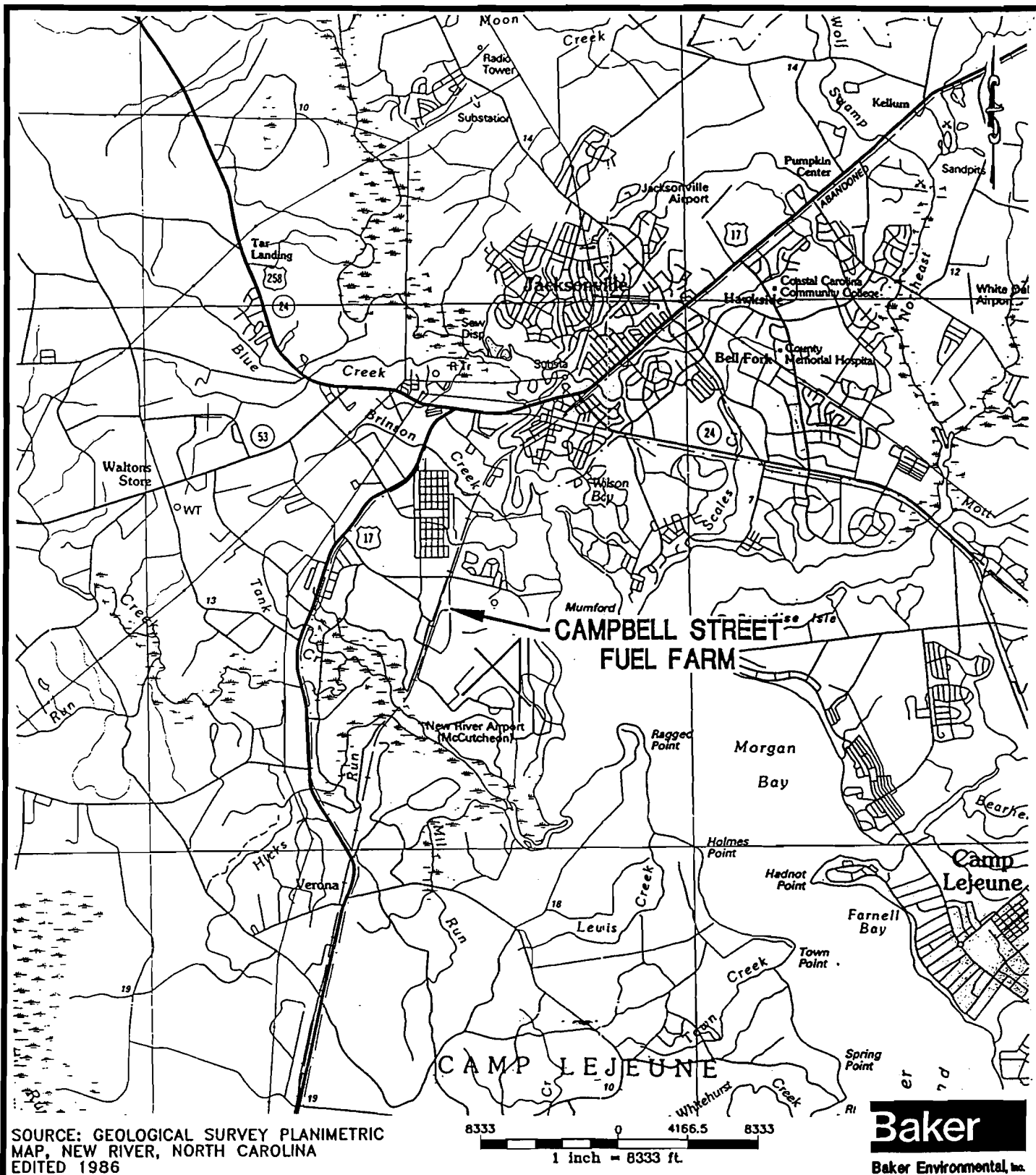
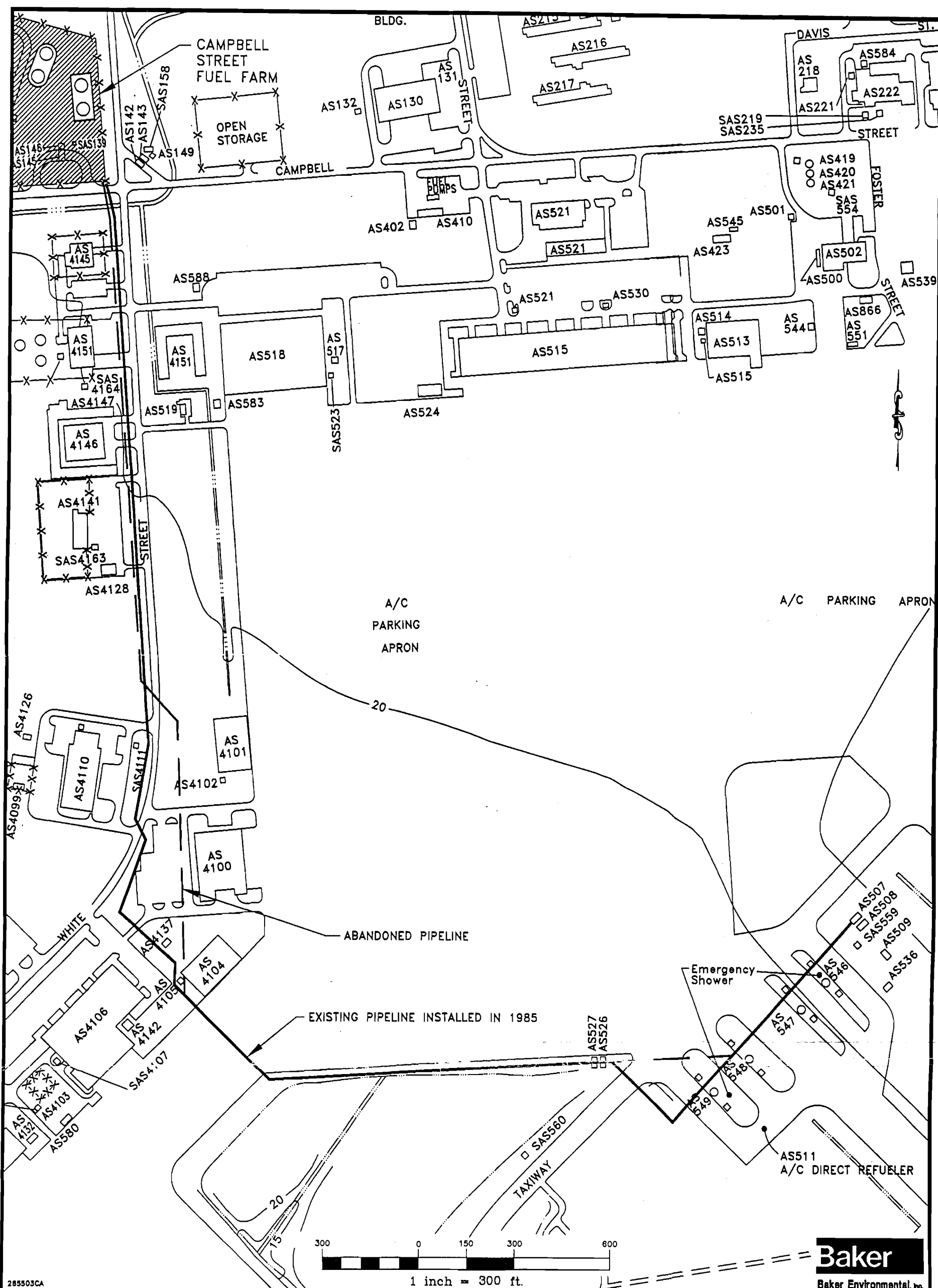


FIGURE 1-1
SITE LOCATION MAP
CAMPBELL STREET FUEL FARM
AND UST AS-143

MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA



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MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA



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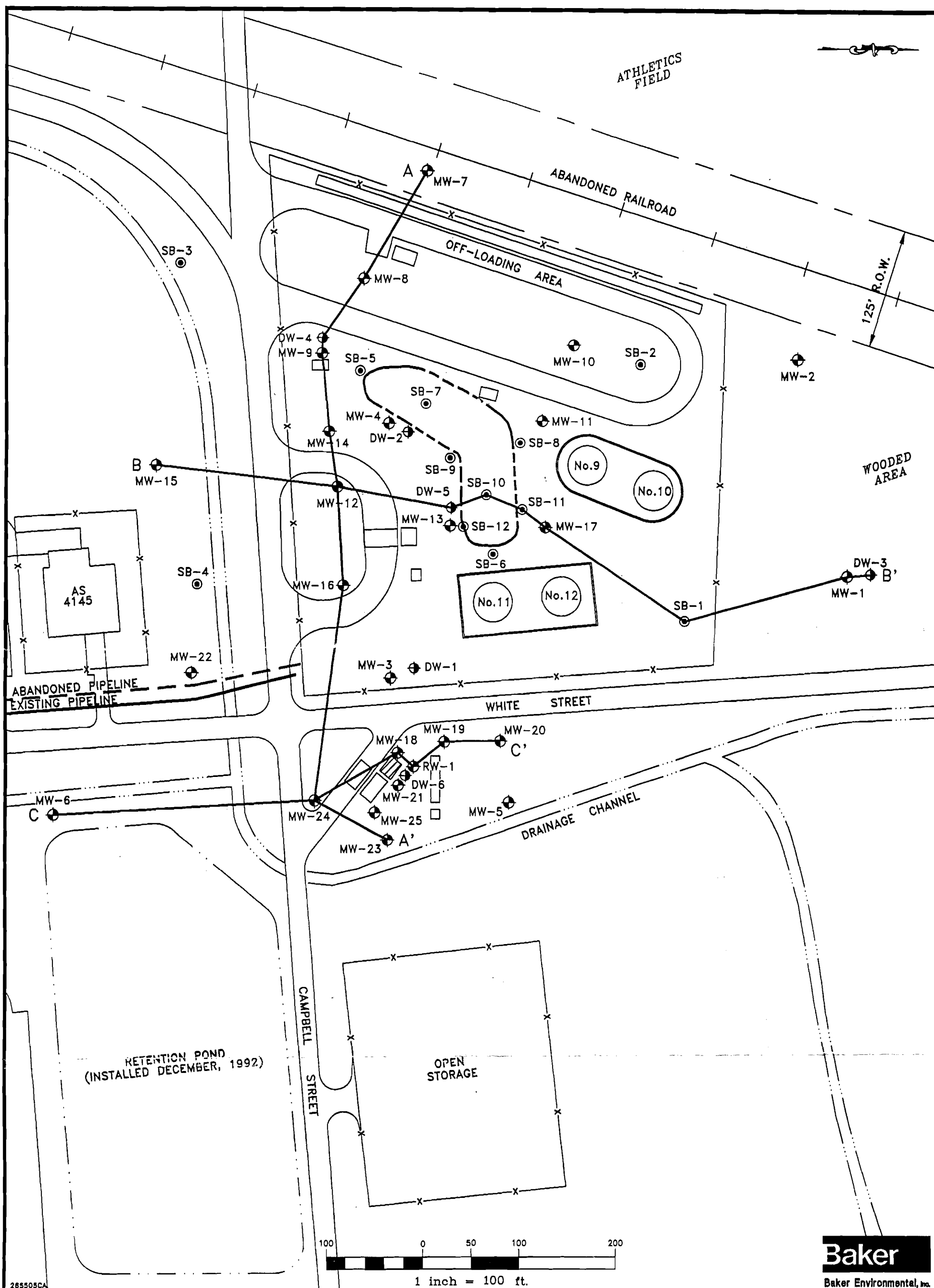
FIGURE 1-4
SITE ASSESSMENT ACTIVITIES
CAMPBELL STREET FUEL FARM
AND UST AS-143

MARINE CORPS AIR STATION, NEW RIVER
 JACKSONVILLE, NORTH CAROLINA

LEGEND

MW-1	TYPE II SHALLOW MONITORING WELL INSTALLED DECEMBER, 1991	MW-8	TYPE II SHALLOW MONITORING WELL INSTALLED NOVEMBER, 1992
DW-1	TYPE III DEEP MONITORING WELL INSTALLED DECEMBER, 1991	DW-4	TYPE III DEEP MONITORING WELL INSTALLED NOVEMBER, 1992
SB-1	SOIL BORING INSTALLED DECEMBER, 1991	SB-5	SOIL BORING INSTALLED NOVEMBER, 1992
HP-1	HYDROPUNCH INSTALLED DECEMBER, 1991	HP-1	2-INCH PVC MONITORING WELL ORIGIN UNKNOWN

SOURCE: LANTDIV, OCT. 1991



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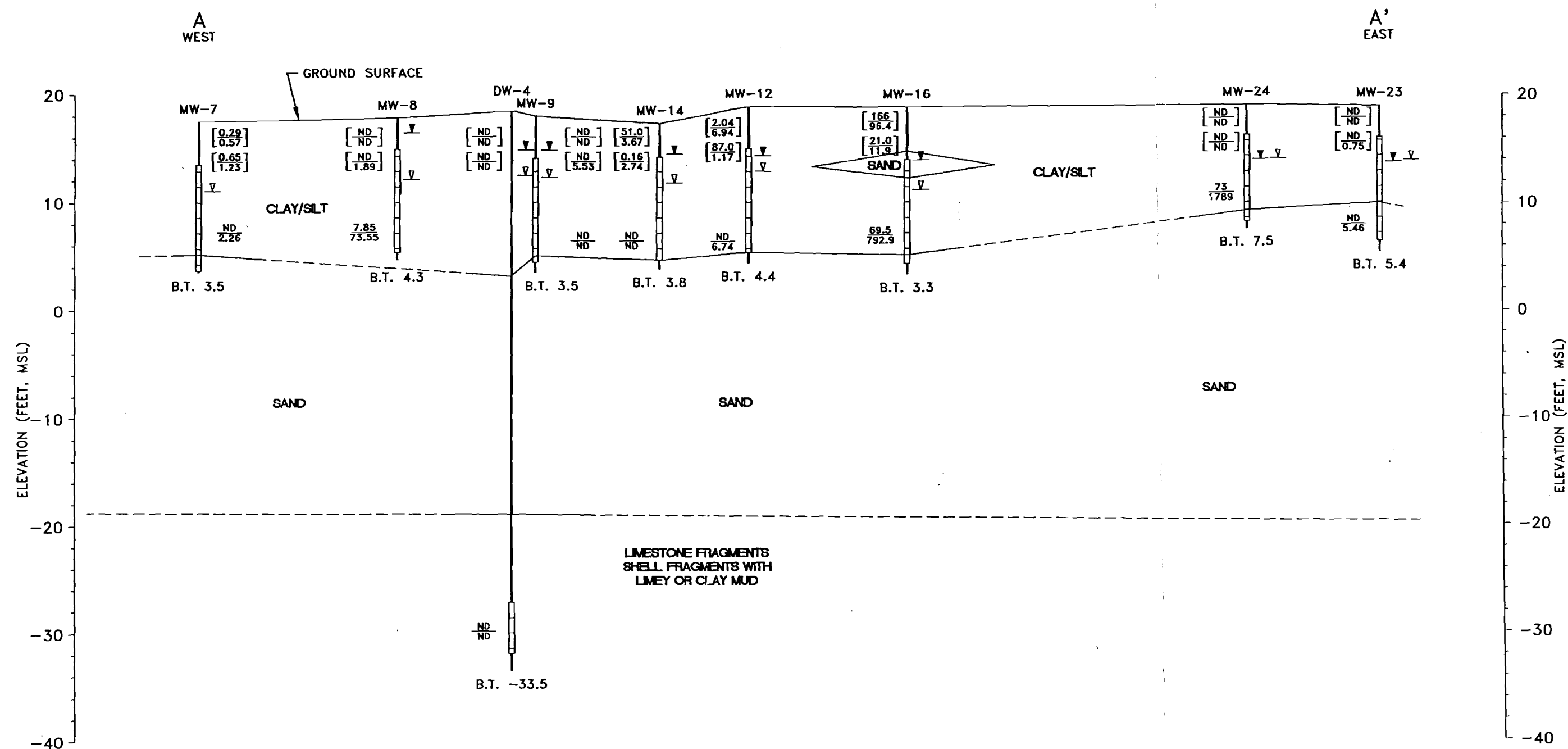
A-A' HYDROGEOLOGIC CROSS-SECTION TRAVERSE
B-B' HYDROGEOLOGIC CROSS-SECTION TRAVERSE
C-C' HYDROGEOLOGIC CROSS-SECTION TRAVERSE

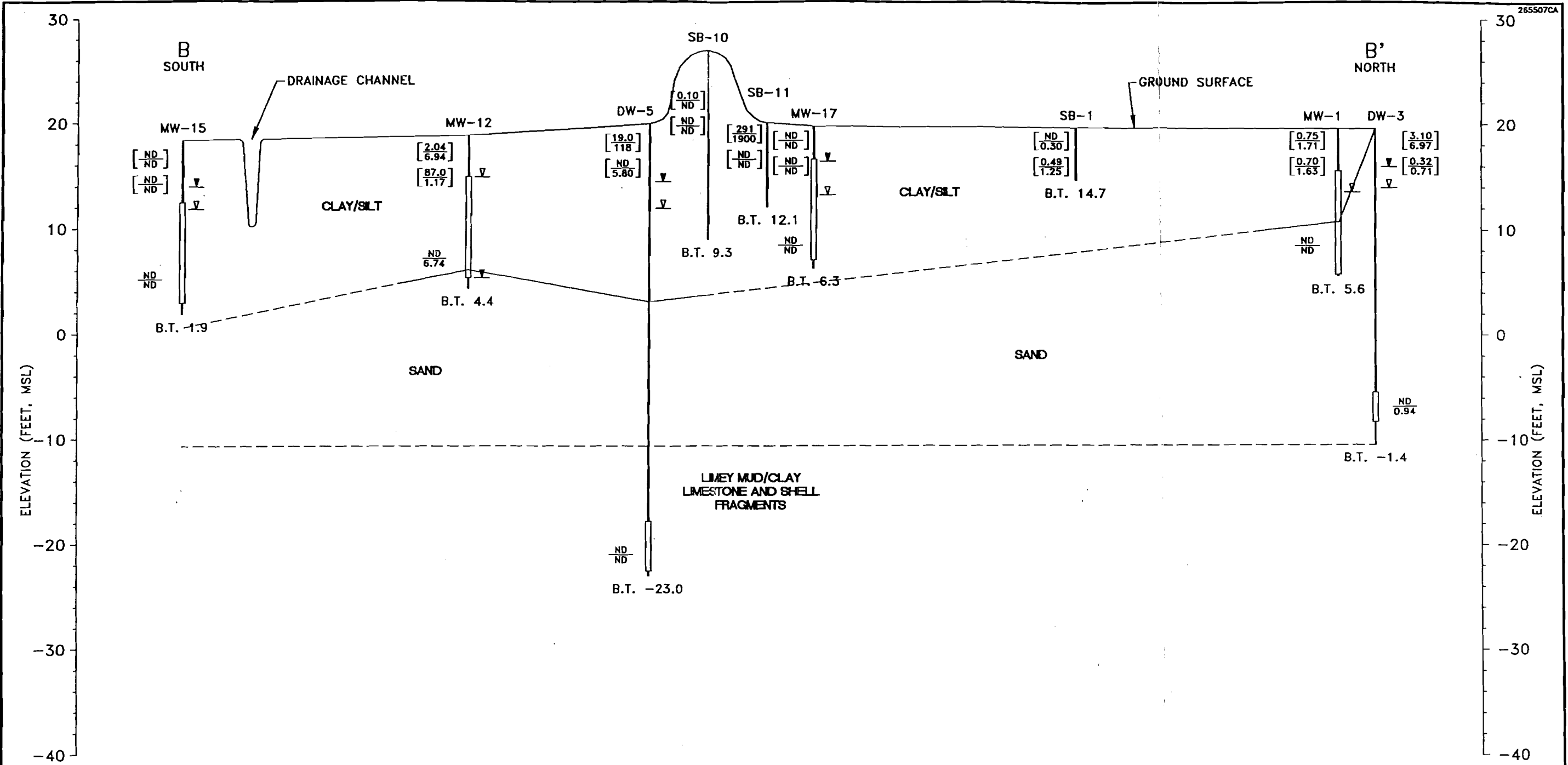
LEGEND

MW-1 TYPE II SHALLOW MONITORING WELL
DW-1 TYPE III DEEP MONITORING WELL
SB-1 SOIL BORING LOCATION

FIGURE 1-5
HYDROGEOLOGIC CROSS-SECTION LOCATION MAP
CAMPBELL STREET FUEL FARM
AND UST AS-143

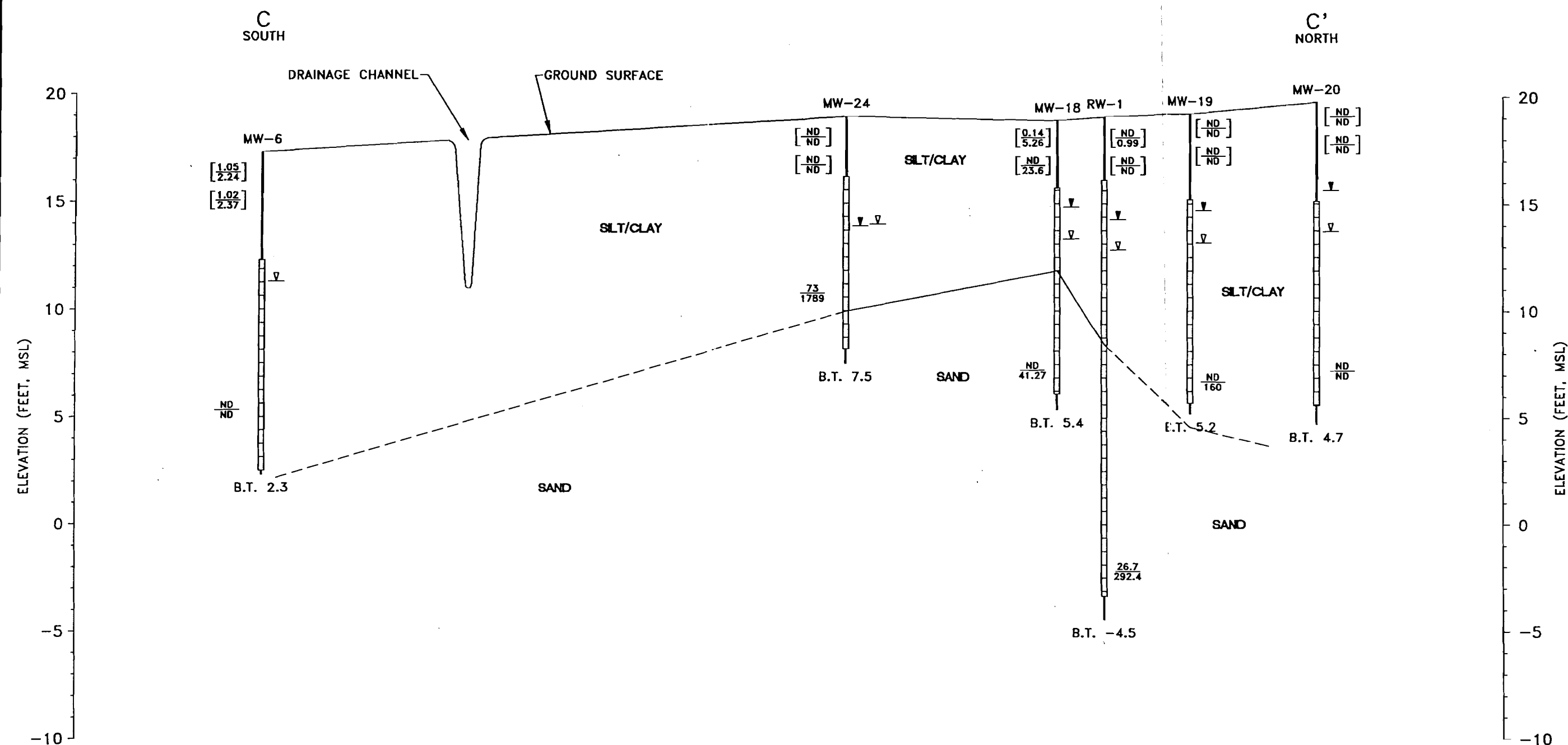
MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA





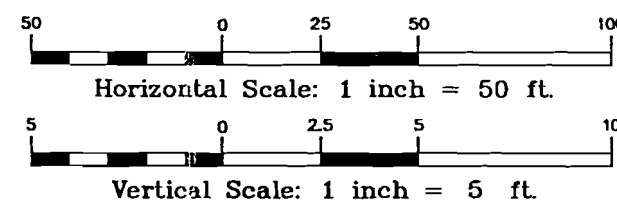
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LEGEND GROUNDWATER ELEVATION (DECEMBER 30, 1992) GROUNDWATER ENCOUNTERED DURING DRILLING B.T. 4.4 BORING TERMINATED, ELEVATION MSL BENZENE CONCENTRATIONS (ug/L) IN GROUNDWATER TOTAL VOC CONCENTRATIONS (ug/L) IN GROUNDWATER TPH CONCENTRATIONS LOW-MEDIUM (mg/kg) IN SOILS TPH CONCENTRATIONS MEDIUM-HIGH (mg/kg) IN SOILS WELL SCREEN INTERVAL NOT DETECTED AT METHOD DETECTION LIMITS ESTIMATED PROJECTED	Horizontal Scale: 1 inch = 70 ft. Vertical Scale: 1 inch = 10 ft.	FIGURE 1-7 HYDROGEOLOGIC CROSS-SECTION B-B' WITH SOIL AND GROUNDWATER ANALYTICAL RESULTS CAMPBELL STREET FUEL FARM AND UST AS-143 MARINE CORPS AIR STATION, NEW RIVER JACKSONVILLE, NORTH CAROLINA
THE SOIL BORING INFORMATION IS CONSIDERED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THE RESPECTIVE BORING LOCATIONS. SUBSURFACE CONDITIONS INTERPOLATED BETWEEN BORINGS ARE ESTIMATED BASED ON ACCEPTED SOIL ENGINEERING PRINCIPLES AND GEOLOGIC JUDGEMENT.		



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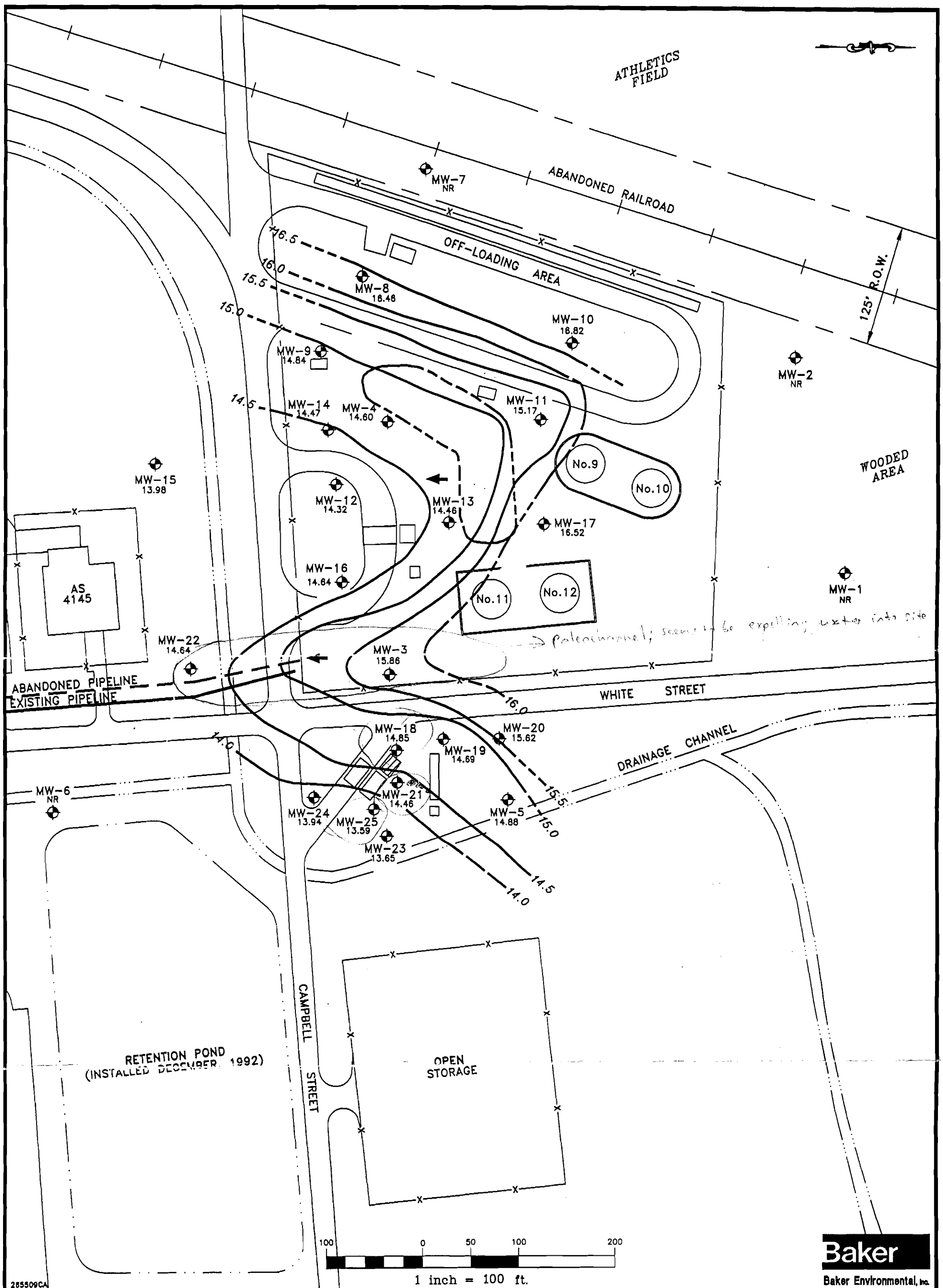
LEGEND	
	GROUNDWATER ELEVATION (DECEMBER 30, 1992)
	GROUNDWATER ENCOUNTERED DURING DRILLING
	BORING TERMINATED, ELEVATION MSL
	BENZENE CONCENTRATIONS (ug/L) IN GROUNDWATER
	TOTAL VOC CONCENTRATIONS (ug/L) IN GROUNDWATER
	TPH CONCENTRATIONS LOW-MEDIUM (mg/kg) IN SOILS
	TPH CONCENTRATIONS MEDIUM-HIGH (mg/kg) IN SOILS
	WELL SCREEN INTERVAL
	NOT DETECTED AT METHOD DETECTION LIMITS
	ESTIMATED
	PROJECTED



THE SOIL BORING INFORMATION IS CONSIDERED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THE RESPECTIVE BORING LOCATIONS. SUBSURFACE CONDITIONS INTERPOLATED BETWEEN BORINGS ARE ESTIMATED BASED ON ACCEPTED SOIL ENGINEERING PRINCIPLES AND GEOLOGIC JUDGEMENT.

FIGURE 1-8
HYDROGEOLOGIC CROSS-SECTION C-C'
WITH SOIL AND GROUNDWATER ANALYTICAL RESULTS
CAMPBELL STREET FUEL FARM
AND UST AS-143

MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA



LEGEND

MW-3 15.86
 TYPE II SHALLOW MONITORING WELL WITH WATER LEVEL
 ELEVATION (WELL SPECIFIC, MSL)

— GROUNDWATER CONTOUR ELEVATION (MSL)

➔ ESTIMATED GROUNDWATER FLOW DIRECTION

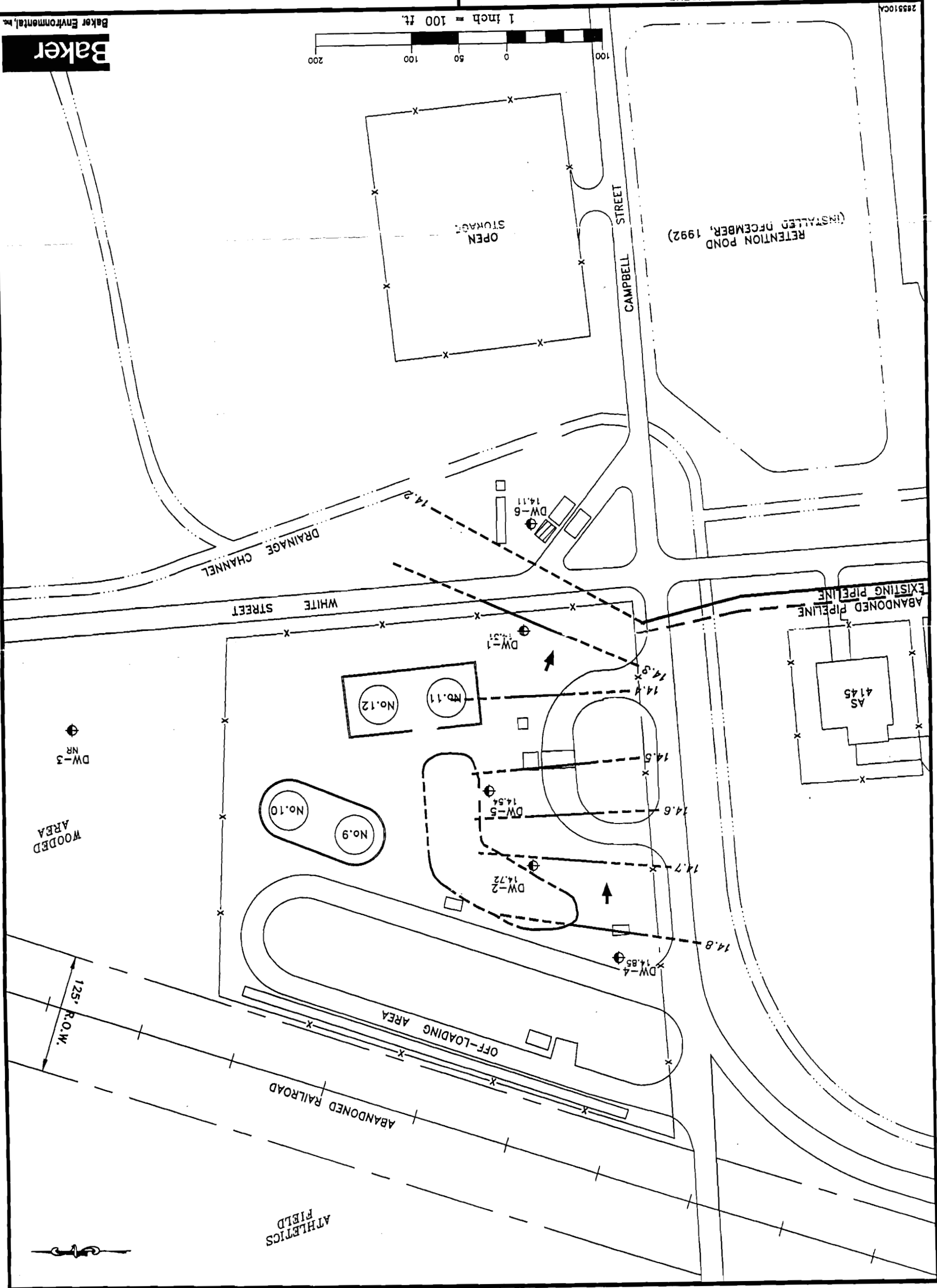
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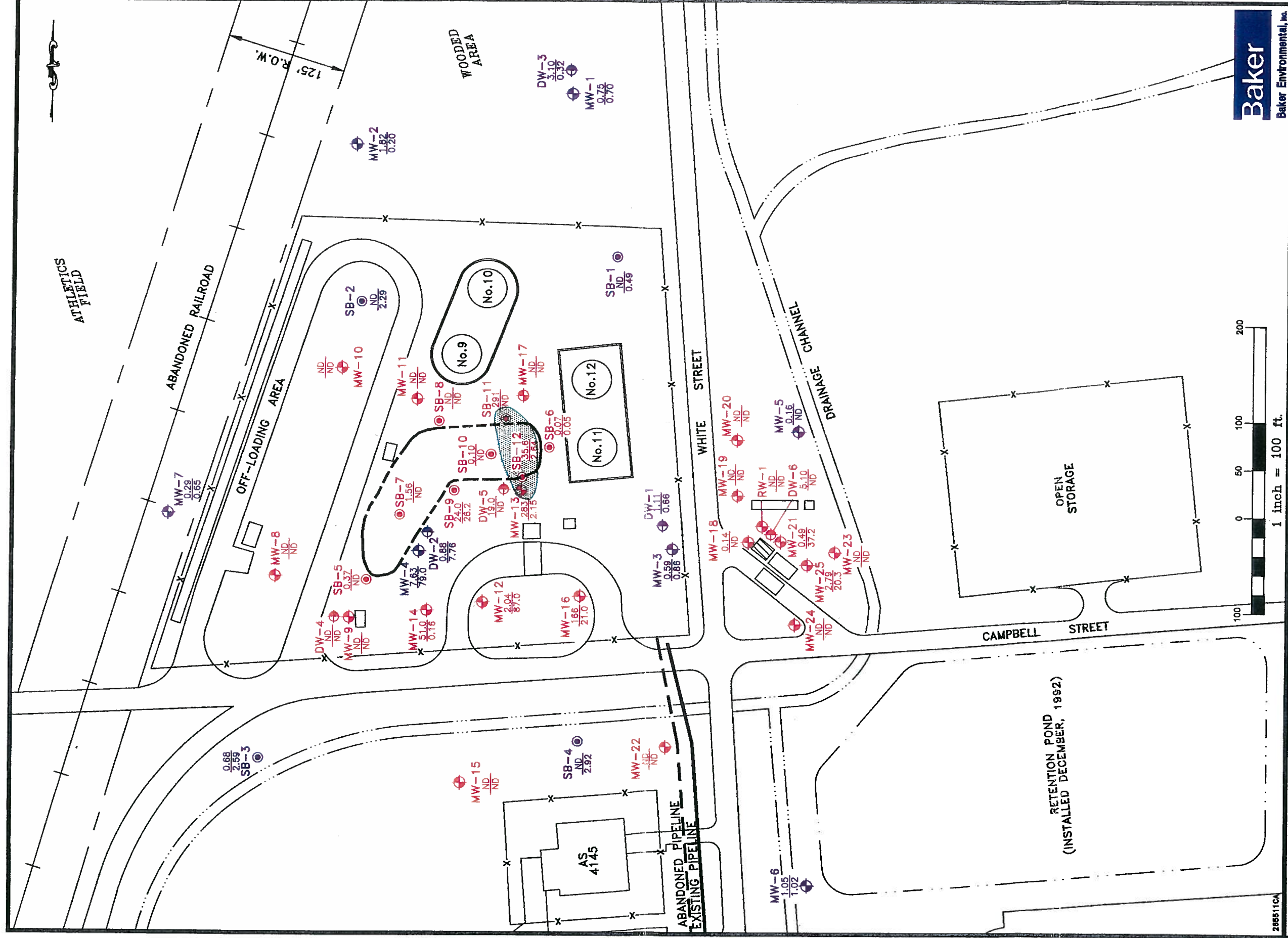
FIGURE 1-9
POTENTIOMETRIC SURFACE MAP
SHALLOW AQUIFER - DECEMBER 30, 1992
CAMPBELL STREET FUEL FARM AND UST AS-143
MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA

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FIGURE 1-10
POTENTIOMETRIC SURFACE MAP
DEEP AQUIFER - DECEMBER 30, 1992
CAMPBELL STREET FUEL FARM AND UST AS-143
MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA

LEGEND
DW-1 TYPE III DEEP MONITORING WELL WITH WATER LEVEL
ELEVATION (WELL SPECIFIC, MSL)
GROUNDWATER CONTOUR ELEVATION (MSL)
ESTIMATED GROUNDWATER FLOW DIRECTION
NR NOT MEASURED ON THIS DATE





LEGEND

MW-1 TYPE II SHALLOW MONITORING WELL
 INSTALLED DECEMBER, 1991

DW-1 TYPE III DEEP MONITORING WELL
 INSTALLED DECEMBER, 1991

SB-1 SOIL BORING INSTALLED
 DECEMBER, 1991

ESTIMATED EXTENT OF SOILS
 > 180 mg/kg TPH

SOURCE: LANTDIV, OCT. 1991

MW-8 TYPE II SHALLOW MONITORING WELL
 INSTALLED NOVEMBER, 1992

DW-4 TYPE III DEEP MONITORING WELL
 INSTALLED NOVEMBER, 1992

SB-5 SOIL BORING INSTALLED
 NOVEMBER, 1992

ND SAMPLE-01
 ND SAMPLE-02

FIGURE 1-11
SOIL TPH (LOW-MEDIUM) CONCENTRATION MAP
CAMPBELL STREET FUEL FARM AND UST AS-143

MARINE CORPS AIR STATION, NEW RIVER
 JACKSONVILLE, NORTH CAROLINA

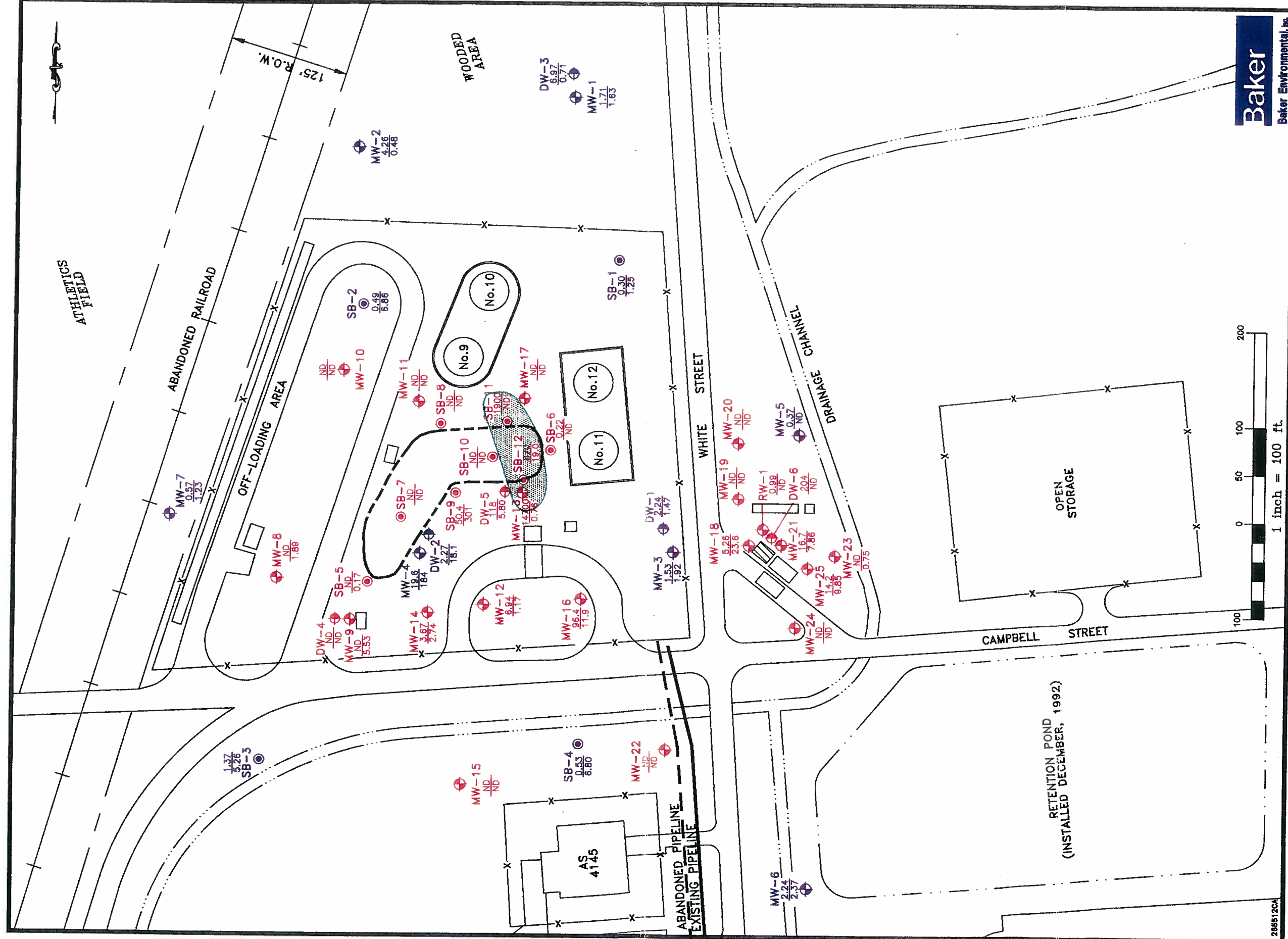


FIGURE 1-12
SOIL TPH (MEDIUM-HIGH) CONCENTRATION MAP
CAMPBELL STREET FUEL FARM AND UST AS-143

MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA

- LEGEND**
- MW-1 TYPE II SHALLOW MONITORING WELL
INSTALLED DECEMBER, 1991
 - DW-1 TYPE III DEEP MONITORING WELL
INSTALLED DECEMBER, 1991
 - SB-1 SOIL BORING INSTALLED
DECEMBER, 1991
 - ESTIMATED EXTENT OF SOILS
>180 mg/kg TPH
 - SOURCE: LANTDIV, OCT. 1991
 - MW-8 TYPE II SHALLOW MONITORING WELL
INSTALLED NOVEMBER, 1992
 - DW-4 TYPE III DEEP MONITORING WELL
INSTALLED NOVEMBER, 1992
 - SB-5 SOIL BORING INSTALLED
NOVEMBER, 1992
 - ND SAMPLE-01
SAMPLE-02

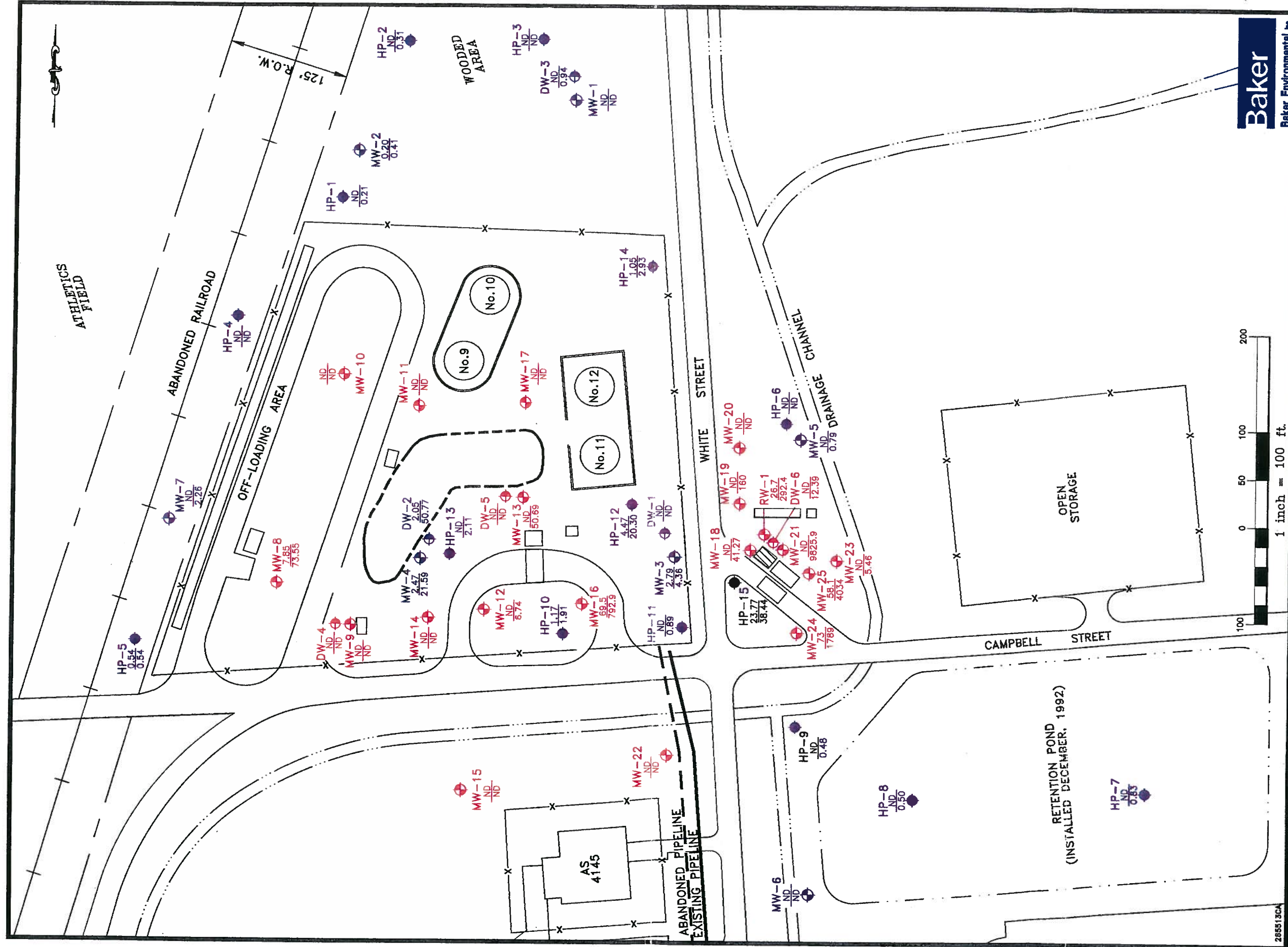


FIGURE 1-13
BENZENE AND TOTAL VOC CONCENTRATIONS
IN GROUNDWATER
CAMPBELL STREET FUEL FARM AND UST AS-143
 MARINE CORPS AIR STATION, NEW RIVER
 JACKSONVILLE, NORTH CAROLINA

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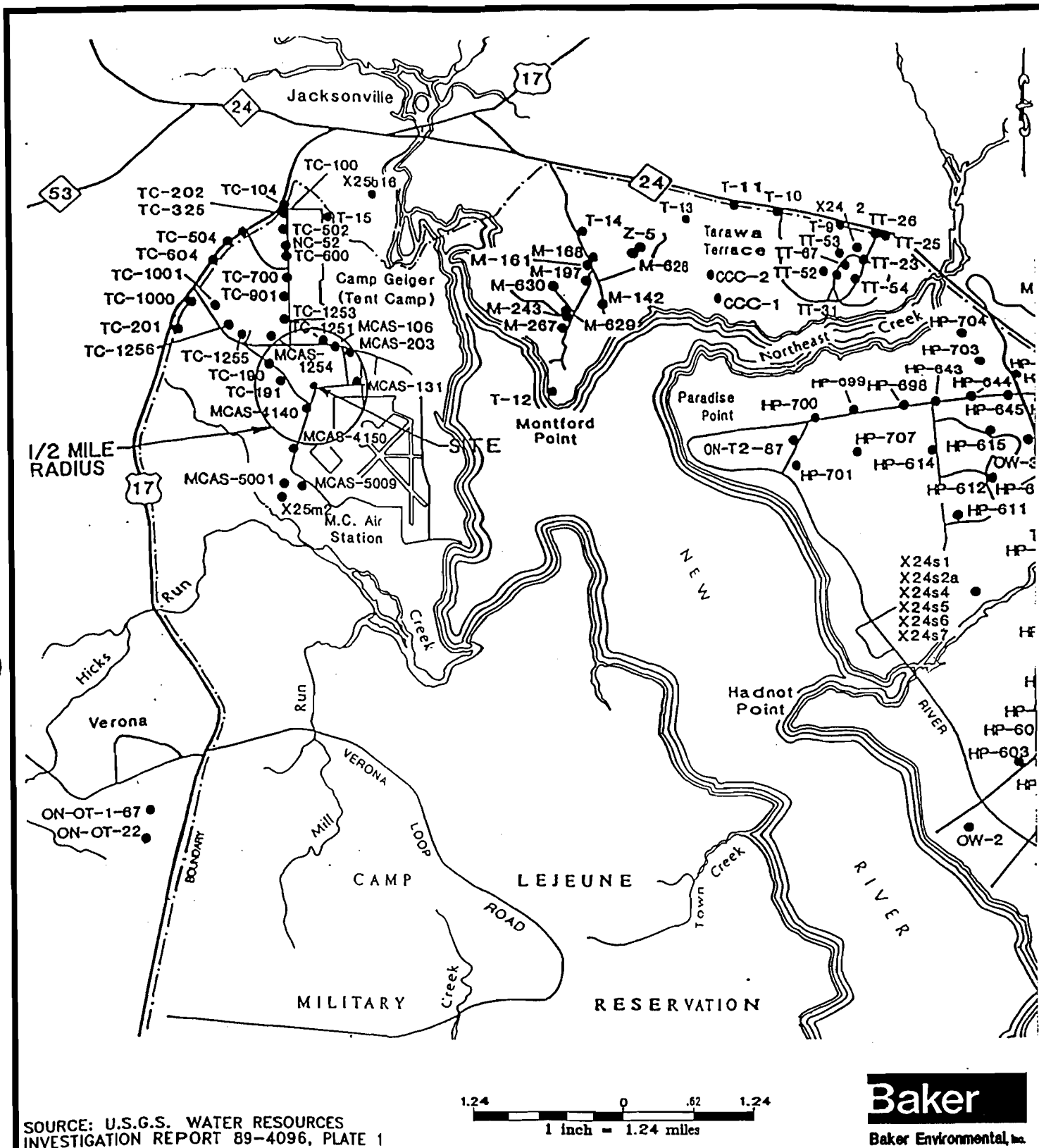
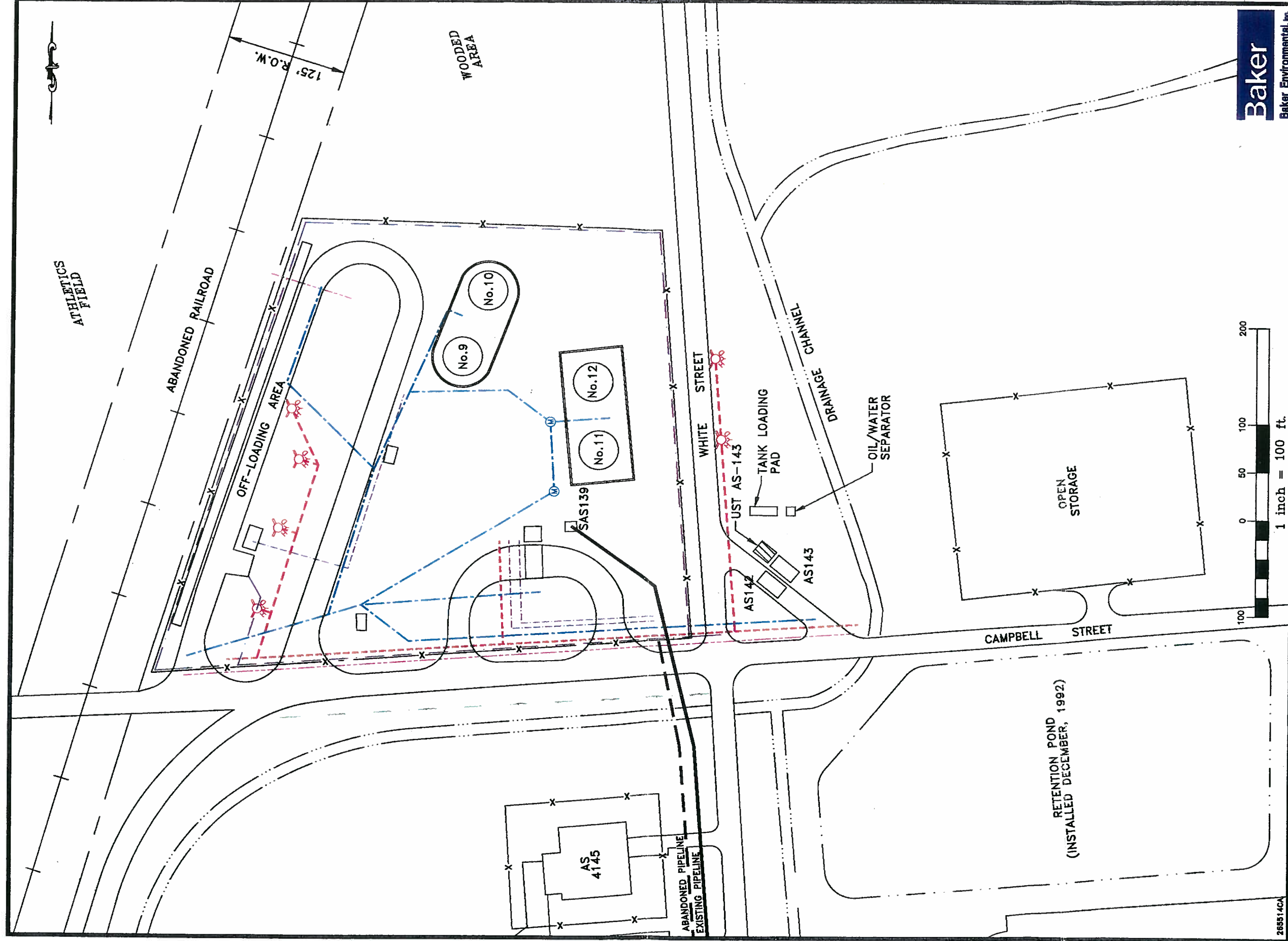


FIGURE 3-1
SUPPLY WELLS IN VICINITY OF
CAMPBELL STREET FUEL FARM
AND UST AS-143

MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA



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FIGURE 4-1
LOCATION OF UNDERGROUND UTILITIES
CAMPBELL STREET FUEL FARM AND UST AS-143
MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA

SOURCE: LANTDIV, OCT. 1991; NAVFAC DRAWING NO. 4164666, "REPLACE FUEL STORAGE TANKS", JULY 17, 1987

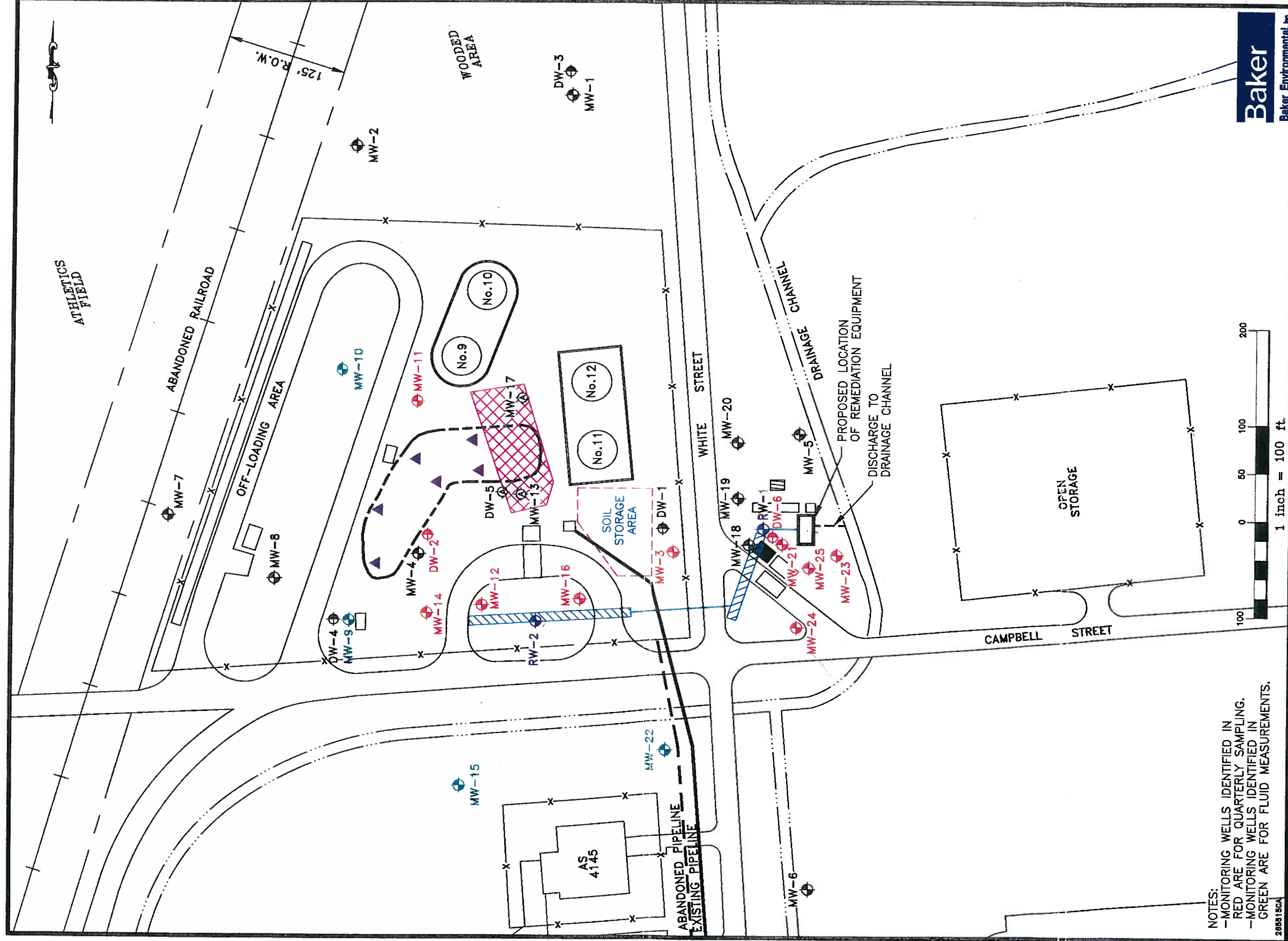


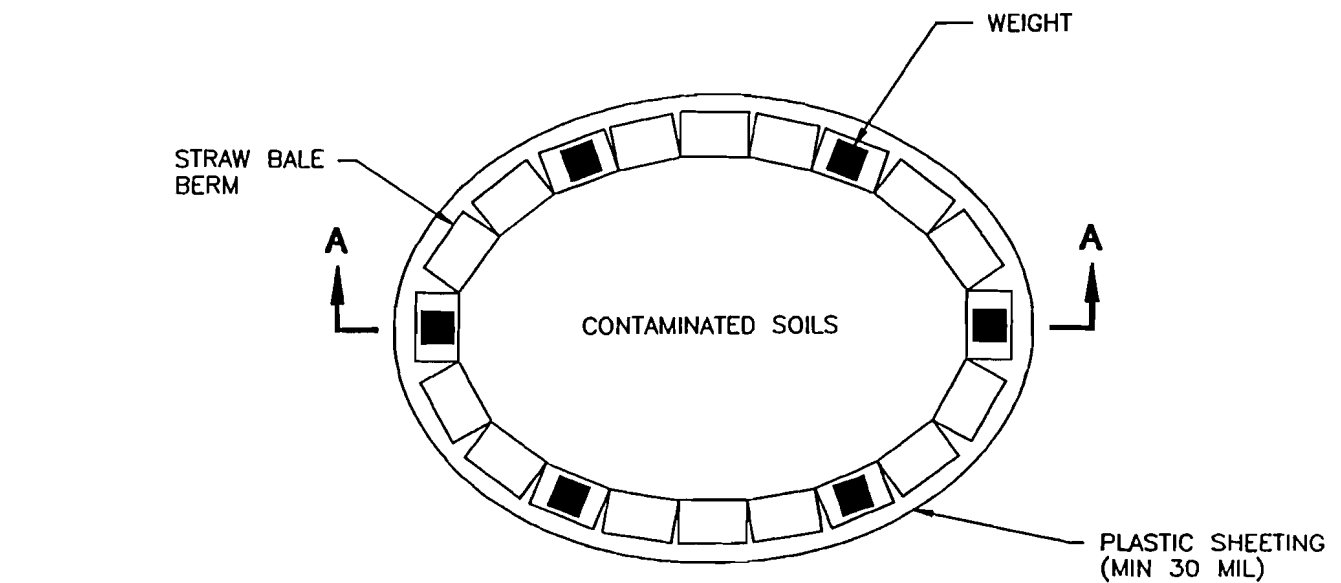
FIGURE 5-1
RECOMMENDED SITE REMEDIATION PLAN
CAMPBELL STREET FUEL FARM
AND UST AS-143
MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA

NOTES:
 - MONITORING WELLS IDENTIFIED IN RED ARE FOR QUARTERLY SAMPLING.
 - MONITORING WELLS IDENTIFIED IN GREEN ARE FOR FLUID MEASUREMENTS.

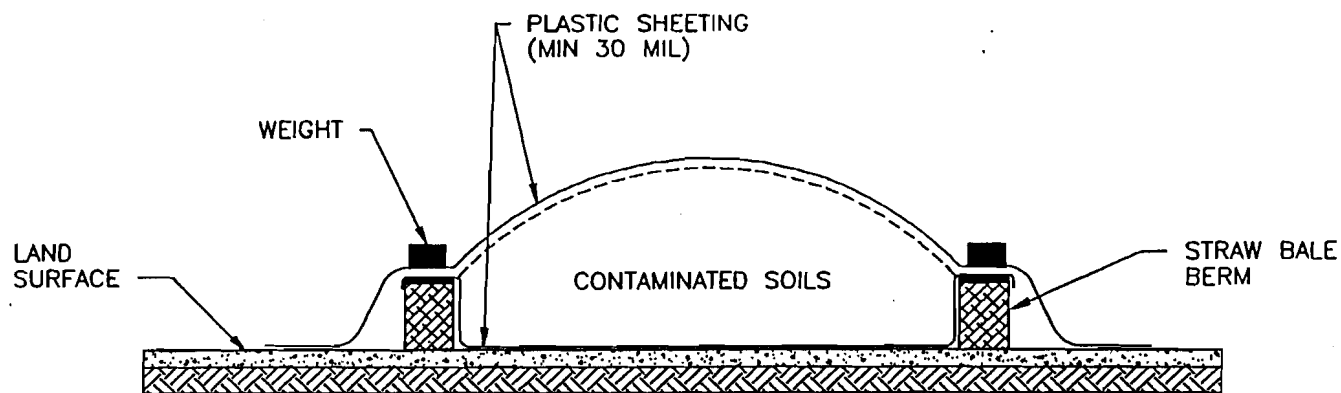
LEGEND

- MW-1 SHALLOW MONITORING WELL
- MW-13 MONITORING WELL TO BE ABANDONED
- SHALLOW SUBSURFACE EQUIPMENT TRENCH
- PROPOSED LOCATION OF INTERCEPTOR TRENCH
- PROPOSED EXTENT OF SOILS TO BE EXCAVATED
- DW-1 DEEP MONITORING WELL
- RW-1 RECOVERY WELL
- PROPOSED HAND AUGER LOCATION
- UST TO BE REMOVED
- PROPOSED LOCATION OF NEW UST

SOURCE: LANTDIV, OCT. 1991



PLAN VIEW

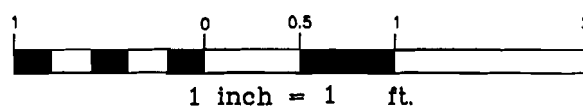
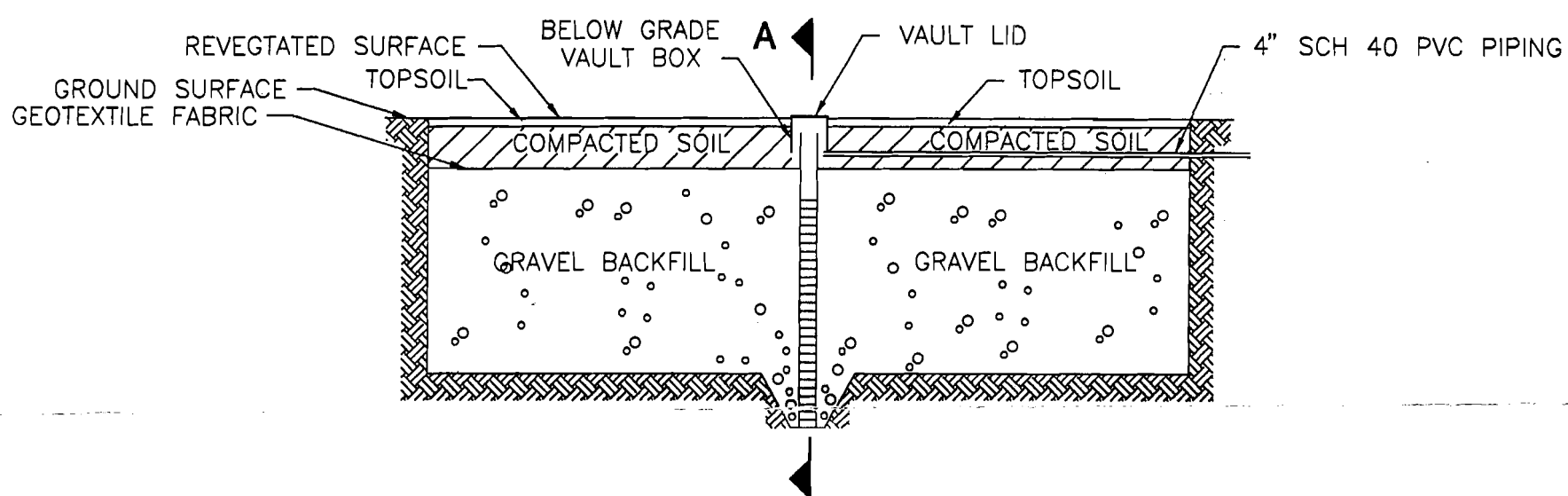
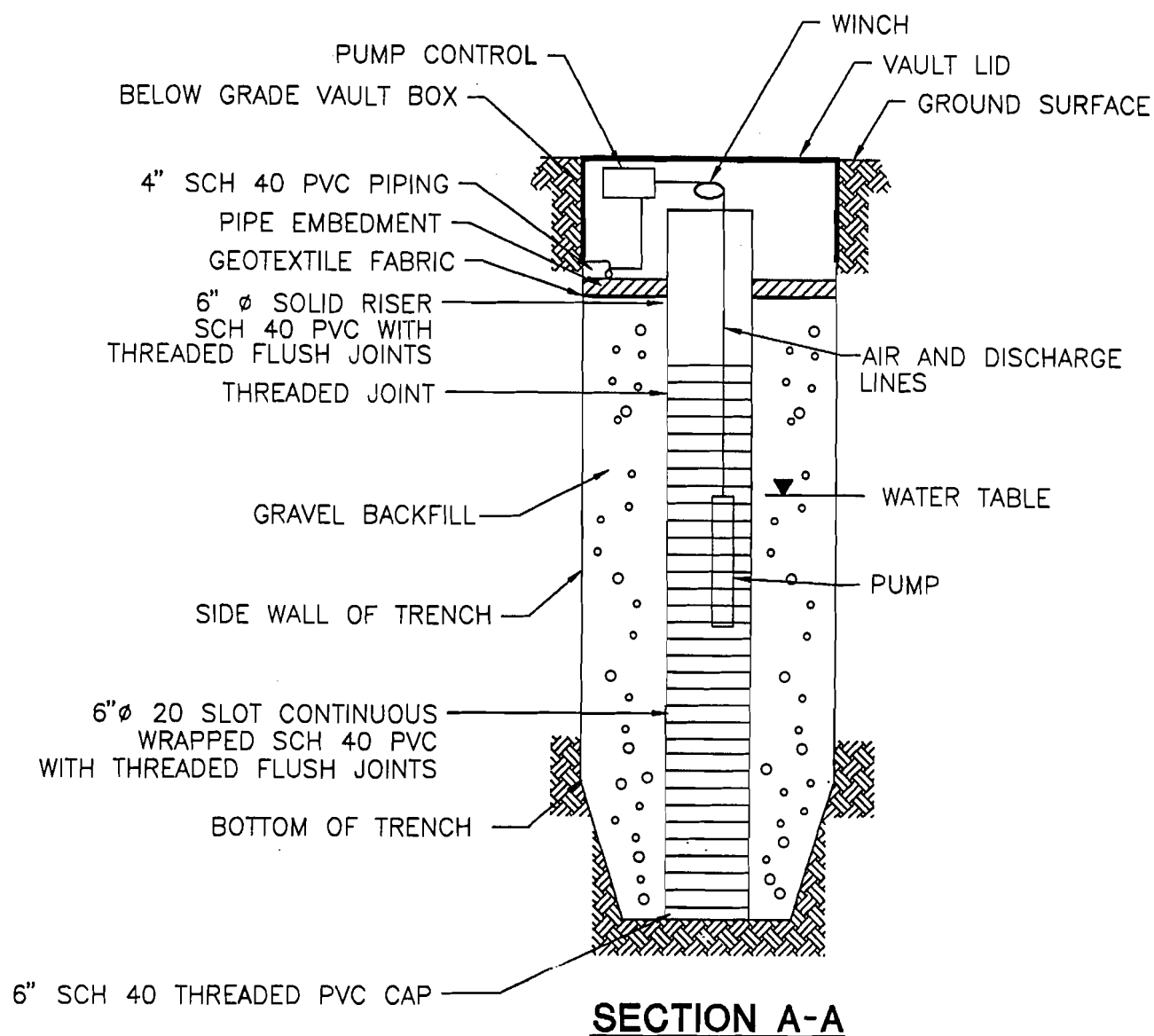


SECTION A-A

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FIGURE 5-2
DIAGRAM FOR TEMPORARY CONTAINMENT
OF PETROLEUM CONTAMINATED SOIL
CAMPBELL STREET FUEL FARM
AND UST AS-413
MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA

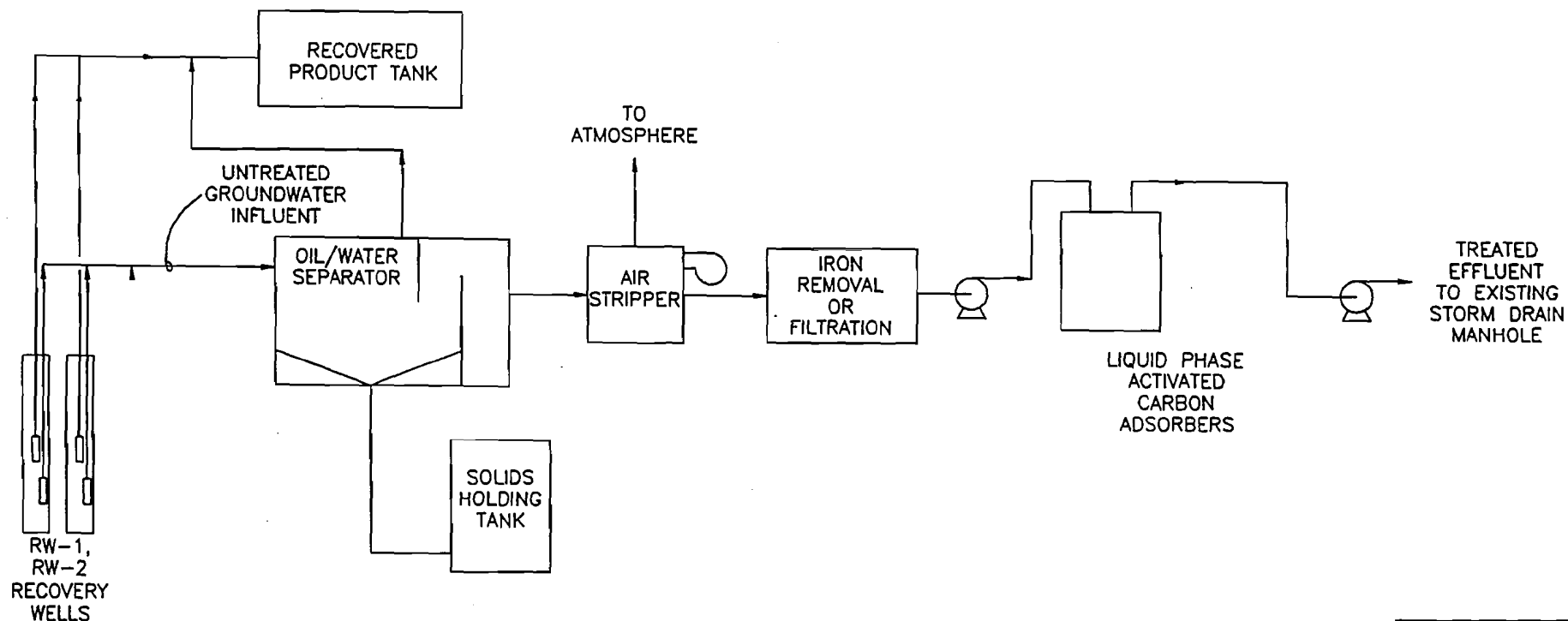


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FIGURE 5-3
SCHEMATIC OF GROUNDWATER
INTERCEPTOR TRENCH

MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA



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FIGURE 5-4
RECOMMENDED GROUNDWATER
TREATMENT SYSTEM PROCESS
SCHEMATIC

MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA

Appendix A

Site Sensitivity Evaluation

Site Sensitivity Evaluation (SSE)

Site Characteristics Evaluation (Step 1)

Characteristic	Condition	Rating	
Grain Size*	Gravel	150	50
	Sand	100	
	Silt	50	
	Clay	0	
Are relic structures, sedimentary structures, and/or textures present in the zone of contamination and underlying "soils"?	Present and intersecting the water table.	10	0
	Present but <u>not</u> intersecting the water table.	5	
	None present.	0	
Distance from location of deepest contaminated soil** to water table.	0 - 5 feet	20	20
	(C, D & E sites only)	20	
	5 - 10 feet	10	
	>10 - 40 feet	0	
	> 40 feet	0	
Is the top of bedrock or transmissive indurated sediments located above the water table?	Yes	20	0
	No	0	
Artificial conduits present within the zone of contamination.	Present and intersecting the water table.	10	5
	Present but <u>not</u> intersecting the water table.	5	
	Not present.	0	

Total Site Characteristics Score: 75

* Predominant grain size based on Unified Soil Classification System or U.S. Dept. of Agriculture's Soil Classification Method.

** (>10 ppm TPFH by Method 5030; >40 ppm TPFH by Method 3550; >250 ppm O&G by Method 9071)

Site Sensitivity Evaluation (SSE)

Initial Cleanup Level
(Step 2)

Final Cleanup Level
(Step 3)

EPA Method 5030 for Low Boiling Point Hydrocarbons such as Gasoline, Aviation Fuels, Gasohol

Total Site Characteristics Score	Initial Cleanup Level TPFH (ppm)		Category A & B (Multiply initial cleanup level by 1)	Final Cleanup Level
>150	≤10	Select Site Category* →	1 x _____ = _____ ppm	
121-150	20		Category C & D (Multiply initial cleanup level by 2)	2 x _____ = _____ ppm
91-120	40			
61-90	60		Category E (Multiply initial cleanup level by 3)	3 x <u>60</u> = <u>180</u> ppm
31-60	80			
0-30	100			

EPA Method 3550 for High Boiling Point Hydrocarbons such as Kerosene, Diesel, Varsol, Mineral Spirits, Naphtha

Total Site Characteristics Score	Initial Cleanup Level TPFH (ppm)		Category A & B (Multiply initial cleanup level by 1)	Final Cleanup Level
>150	≤40	Select Site Category* →	1 x _____ = _____ ppm	
121-150	80		Category C & D (Multiply initial cleanup level by 2)	2 x _____ = _____ ppm
91-120	160			
61-90	240		Category E (Multiply initial cleanup level by 3)	3 x _____ = _____ ppm
31-60	320			
0-30	400			

EPA Method 9071 for Heavy Fuels - Oil & Grease (O&G) such as Fuel Oil #4, #5, #6, Motor Oil, Hydraulic Fluid

Total Site Characteristics Score	Initial Cleanup Level O&G (ppm)		Category A & B (Multiply initial cleanup level by 1)	Final Cleanup Level
>150	≤250	Select Site Category* →	1 x _____ = _____ ppm	
121-150	400		Category C & D (Multiply initial cleanup level by 2)	2 x _____ = _____ ppm
91-120	550			
61-90	700		Category E (Multiply initial cleanup level by 3)	3 x _____ = _____ ppm
31-60	850			
0-30	1000			

* See Site Category Descriptions, Table 3

TABLE 3

SSE SITE CATEGORY DESCRIPTIONS

CATEGORY A (*Site meets any one of the criteria*)

1. Water supply well(s) contaminated and not served by accessible public water supply.
2. Vapors present in confined areas at explosive or health concern levels.
3. Treated surface water supply in violation of the safe drinking water standards.

CATEGORY B (*Site meets any one of the criteria*)

1. Water supply well(s) contaminated, but served by accessible public water supply.
2. Water supply well(s) within 1500 feet of site, but not contaminated and not served by accessible public water supply.
3. Vapors present in confined areas but not at explosive or health concern levels.

CATEGORY C (*Site meets both of the criteria*)

1. No known water supply well(s) contaminated.
2. Water supply well(s) greater than 1500 feet from site but not served by accessible public water supply.

CATEGORY D (*Site meets both of the criteria*)

1. No known water supply well(s) contaminated.
2. Water supply well(s) within 1500 feet of site but served by accessible public water supply.

CATEGORY E (*Site meets both of the criteria*)

1. No known water supply well(s) contaminated or within 1500 feet of site.
2. Area served by accessible public water supply.