APPENDIX A

Remedial Investigation Report for the Petroleum, Oil, and Lubricant Outparcel

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PETROLEUM, OIL, and LUBRICANT OUTPARCEL CLOSURE REPORT BRAC PROPERTY HAMILTON ARMY AIRFIELD NOVATO, CALIFORNIA

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Table of Contents

Table of Contents (Continued)

List of Tables

List of Figures

List of Appendices

List of Acronyms

AST	aboveground storage tank(s)
ASTM	American Society for Testing and Materials
BRAC	Base Realignment and Closure
BTEX	benzene, toluene, ethylbenzene, and xylenes
CQC/SAP	Contractor Quality Control/Sampling and Analysis Plan
D.O.	dissolved oxygen
EPA	U.S. Environmental Protection Agency
ft	feet
gal	gallon
GSA	General Services Administration
HAAF	Hamilton Army Airfield
in.	inch(es)
IT	IT Corporation
JP	jet propellant
mg/kg	milligram(s) per kilogram
mg/L	milligram(s) per liter
MTBE	methyl-t-butyl ether
mV	millivolts
PCOC	potential chemical(s) of concern
PNA	polynuclear aromatic(s)
POL	Petroleum, Oil, and Lubricant
RAO	remedial action objective(s)
RCG	residential cleanup goal(s)
RWQCB	Regional Water Quality Control Board
TPH	total petroleum hydrocarbon(s)
USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force
UST	underground storage tank
°C	degrees Celsius
µg/kg	microgram(s) per kilogram
µg/L	microgram(s) per liter

NOTICE

This document was prepared by IT Corporation at the direction of the U.S. Department of the Army (Army) for the sole use of the Army and the regulatory agencies, the only intended beneficiaries of this work. No other party should rely on the information contained herein without the prior written consent of the Army. This report and the interpretations, conclusions, and recommendations contained within are based in part on information presented in other documents that are cited in the text and listed in the references. Therefore, this report is subject to the limitations and qualifications presented in the referenced documents.

Executive Summary

This Closure Report documents and summarizes the results of the remedial investigation activities performed at the Petroleum, Oil, and Lubricant (POL) Outparcel, which is located at Hamilton Army Airfield, Novato, California, and provides information to support the recommendation of closure. In addition, this report documents the conclusions to support closure of this outparcel. This report was prepared by IT Corporation for the U.S. Army Corps of Engineers, Sacramento District, under a Total Environmental Restoration Contract.

During prior activities, not associated with this remedial investigation twenty 25,000-gallon (gal) underground storage tanks (USTs), one 850,000-gal aboveground storage tank (AST) (AST-2), one 750-gal storage tank, and one 25,000-gal AST were removed from the outparcel. Contaminated soil was removed from the vicinity of the former tank farm, AST-2 and the footprint of the Landfill 26 Groundwater Treatment Facility to the extent practicable. Soil samples were collected and analyzed. All soil exceeding an agreed-upon petroleum-hydrocarbon (i.e., total petroleum hydrocarbons) cleanup criteria of 100 milligrams per kilogram was removed to concentrations below the cleanup criteria or to the limit of underlying bedrock where refusal occurred.

Remedial investigation activities at the POL Outparcel consist of

- Drilling five soil borings and collecting soil samples around the groundwater treatment facility to evaluate the extent of potential petroleum-hydrocarbon contamination
- Drilling and installing six groundwater monitoring wells to improve monitoring coverage
- Collecting groundwater samples from the newly installed and existing wells to evaluate the extent of potential contamination
- Collecting groundwater samples from the newly installed and existing wells to evaluate if natural attenuation is occurring
- Measuring water levels to evaluate groundwater flow patterns and rates
- Collecting samples of the surrounding rock outcrop to evaluate the absence or presence of petroleum-hydrocarbon contamination.

Based on results of the remedial investigation it was determined that the groundwater beneath the former tank farm was not impacted. Groundwater samples collected beneath the AST-2 area encountered petroleum-hydrocarbon contamination above the General Services Administration Residential Cleanup Goal of 1,200 micrograms per liter. However, analytical data indicate that:

- The source has been removed
- The plume is not migrating and is shrinking
- Natural attenuation has been shown to be occurring
- Impacted soil at the former tank area, area surrounding the groundwater treatment plant, and AST-2 area have been removed to the extent practicable
- Groundwater flow rates are low and flow directions are uniform
- The site does not pose a risk to human health.

Activities conducted in conjunction with the remedial investigation are sufficient to demonstrate conditions suitable for site closure. As a condition of closure, to evaluate plume stabilization and/or mass reduction of the petroleum-hydrocarbon plume, groundwater monitoring would continue on an annual basis in selected current monitoring wells.

A composite sample of the rock outcrop on Reservoir Hill indicated elevated petroleum-hydrocarbon concentrations. Remediation of the rock outcrop is not proposed since the asphaltic material, which covers the outcrop, is bound within the bedrock fractures, is not mobile, and is bound in such a manner that removal by hand is virtually impossible. The rock outcrop does not pose a human health or ecological risk.

This report documents the investigation, excavation, and sampling of the impacted soil and the related remediation activities. The data presented indicate that the remedial activities and remedial objectives necessary for transfer of the POL Outparcel have been accomplished.

In addition to the samples collected for chemical and biological testing for the monitoring program, one groundwater sample was collected from monitoring well PL-MW-107 on February 20, 1999, and analyzed for methyl-t-butyl ether (MTBE). The result was reported as

not detected with a detection limit of 2 micrograms per liter. The result indicates that there is no threat of MTBE at the POL Outparcel.

1.0 Introduction

IT Corporation (IT) prepared this Closure Report for the Petroleum, Oil, and Lubricant (POL) Outparcel, Base Realignment and Closure (BRAC) Property, at Hamilton Army Airfield (HAAF), Novato, California (Figure 1-1) for the U.S. Army through the U.S. Army Corps of Engineers (USACE), Sacramento District under Contract No. DACW05-95-D-0001, Delivery Order 0006, of the Total Environmental Restoration Contract. This closure report documents and summarizes the remedial investigation activities, which support closure of the site, and presents the details of the investigation activities in Appendix A.

The POL Outparcel lies within the upland portion of the HAAF northeast of the General Services Administration (GSA) Sale Area (Figure 1-2). The outparcel operated from 1942 until prior to May 1986, when the storage tanks were removed as the base fuel-storage center. The outparcel consists of a ridge known as Reservoir Hill and the immediate lowlands surrounding the hill (Figure 1-3). This outparcel has been previously referred to as the "POL Area" and "POL Hill." The POL Outparcel was comprised of three main features (Figure 1-3):

- A former tank farm containing one 750-gallon (gal) underground storage tank (UST), twenty 25,000-gal USTs, and one 25,000-gal aboveground storage tank (AST)
- A former 850,000 gal AST and associated piping (i.e., AST-2)
- The Landfill 26 groundwater treatment facility.

All tanks contained jet propellant (JP-4) fuel for aircraft operations; except possibly the 750-gal UST, which may have contained diesel fuel.

Each of these is discussed in greater detail in Section A.2.3 (Appendix A).

1.1 Purpose and Objectives

The purpose of this closure report is to document and summarize the results of the remedial investigation conducted at the POL Outparcel and to provide sufficient detail to demonstrate and support the recommendation of closure.

The remedial investigation activities conducted at the POL Outparcel consisted of

- Installing additional groundwater monitoring wells to improve monitoring well coverage
- Assessing the presence or absence of petroleum hydrocarbons in soil near the Landfill 26 groundwater treatment facility
- Performing groundwater monitoring, sampling, and slug or specific capacity testing to evaluate groundwater plume stability potential
- Collecting and analyzing
  - Groundwater samples to evaluate the extent of potential chemicals of concern (PCOCs)
  - Groundwater samples to evaluate if natural attenuation of the PCOCs in the groundwater is occurring
  - Samples of the rock outcrop surrounding Reservoir Hill to evaluate the absence or presence of petroleum-hydrocarbon contamination.

These activities were conducted to meet the scope of the remedial investigation, determine if natural attenuation of PCOCs was occurring, and aid in the closure of the site.

1.2 Problem Statement

Over the years, unknown amounts of JP-4 fuel may have leaked from the 850,000-gal AST (AST-2), the twenty 25,000-gal USTs, the 25,000-gal AST, the 750-gal UST and piping appurtenances and may have contaminated the surrounding soils and underlying groundwater. During removal of the AST and USTs, known and suspected impacted soils were excavated, if TPH concentrations exceeded 1,000 mg/kg, in an attempt to remediate each impacted location. Soil sampling was conducted along the periphery of each excavation to confirm contaminant removal (IT, 1987). Additional excavation activities were conducted if the impacted soils exceeded 100 mg/kg (IT, 1991). In addition, groundwater samples were collected beneath the former tank farm area and AST-2 area and analyzed to determine if the groundwater was impacted.

A rock outcrop, which surrounds the southern area immediately behind the former AST-2 location, has an area of visible staining. A composite sample of the rock outcrop was collected and analyzed to assess the staining. The environmental impacts of the staining are not

considered to be significant, and there are no associated assumed human health or ecological risks.

1.3 Closure Criteria

The basic requirements necessary to demonstrate closure are

- The leak was stopped and ongoing sources were removed or remediated
- The site was adequately characterized
- Little or no groundwater impacts exist
- No water wells, deeper drinking water aquifers, surface water, or other sensitive receptors are likely to be impacted
- The site presents no significant risk to human health.

The results of previous investigations and the remedial investigation will show that the sources (i.e., AST and USTs) were removed, impacted soil was removed to the extent practicable, and that there are no groundwater impacts, beneath the former tank farm area (that are above GSA Phase I Residential Cleanup Goals [RCGs]). There are minimal groundwater impacts in a total petroleum hydrocarbon (TPH) plume beneath Reservoir Hill (beneath the AST-2 area); however, the site does not pose a risk to human health (see Section 2.5).

1.4 Regulatory Authority

The U.S. Army is the lead agency involved in the BRAC Closure process at HAAF. The California Regional Water Quality Control Board (RWQCB) is the lead regulatory agency for the POL Outparcel. This was formally documented in a letter from the Department of Toxic Substances Control (DTSC) to the RWQCB since petroleum hydrocarbons are not regulated as hazardous substances in the California Health and Safety Code.

In addition, the U.S. Environmental Protection Agency (EPA) is an oversight agency for closure of the POL Hill Outparcel.

The work described in this report was performed pursuant to the Comprehensive Remedial Investigation/Feasibility Study Work Plan (IT, 1997a) and the Contractor Quality Control/Sampling and Analysis Plan (CQC/SAP) (IT, 1997b), which was approved by the

regulatory agencies. Additionally, the remedial investigation activities were conducted in accordance with the statutory requirements defined in the California Code of Regulations Title 23, Division 3, Chapter 16, Article 11 (Underground Storage Tanks) (1994).

Other guidance documents used in preparation of this closure report include the *Tri-Regional Board Staff Recommendations for Preliminary Evaluation and Investigation of Underground Storage Tank Sites* (TRWQCB, 1990), the *Supplemental Instructions to State Water Board, December 8, 1995, Interim Guidance on Required Cleanup at Low Risk Fuel Sites* (RWQCB, 1996), the risk-based corrective action approach documented in the American Society of Testing and Materials (ASTM) *Standard Guide for Risk Based Corrective Action Applied at Petroleum Release Sites* (1995), and ASTM *Standard Guidance for Remediation of Groundwater by Natural Attenuation at Petroleum Release Sites* (1998).

1.5 Summary

During prior activities, contaminated soil was removed from the vicinity of the former tank farm and AST-2 to the extent practicable. All soil exceeding an agreed upon petroleum-hydrocarbon cleanup criteria of 100 milligrams per kilogram (mg/kg) was removed to concentrations below the cleanup criteria or to the limit of the underlying bedrock where refusal occurred. Groundwater samples collected beneath the tank farm (i.e., USTs) did not encounter contaminants above the GSA RCGs; however, groundwater samples collected beneath Reservoir Hill (i.e., AST-2) encountered petroleum-hydrocarbon contamination (i.e., TPH) above the GSA RCGs. It has been inferred from proximity of the groundwater plume to the former tank location, that the suspected source of the groundwater contamination is AST-2, which was removed. Additionally, the petroleum-hydrocarbon plume is not migrating and natural attenuation is occurring. The activities, including site remediation and confirmation sampling, conducted at the POL Outparcel as part of the remedial investigation are sufficient to demonstrate a condition suitable for site closure. As a condition of site closure, to evaluate stabilization and/or mass reduction of the petroleum-hydrocarbon plume, groundwater monitoring will continue in selected wells.

2.0 Description of Site History and Current Site Conditions

The following subsections present a description of the outparcel, the background and history of the outparcel, and results of previous investigations. The background information discussed in this section sets the stage for the remedial investigation activities described in Section 3.0, and is also necessary for demonstrating site closure.

2.1 Hamilton Army Airfield Property Description

Hamilton Army Airfield is a 1,600-acre former military installation located approximately 22 miles north of San Francisco on San Pablo Bay in Marin County, California (see Figure 1-1). The HAAF is bounded on the north by the North Antenna Field (a formerly used defense site), private agricultural lands, and a private residential community (Bel Marin Keys); on the east by state-owned land and San Pablo Bay; on the south by private agricultural fields; and on the west by Nave Drive which parallels State Highway 101.

The BRAC Property encompasses approximately 710 acres and is located primarily within the northeastern portion of the HAAF. To the southwest, the BRAC Property is bounded by the GSA Sale Area and U.S. Coast Guard-administered military housing, both of which are located within the current Base limits. The POL Outparcel is addressed with the BRAC sites; however, the outparcel is separate from the contiguous BRAC Property (see Figure 1-2). The POL Outparcel is located on the north side of a ridge known as Reservoir Hill, southwest of West Boundary Road, and is bounded by the GSA Phase II Sale Area (see Figure 1-3).

2.2 Facility Background and History

Hamilton Army Airfield was constructed on reclaimed tidal mud flats by the Army Air Corps in 1932. The site, previously known as Marin Meadows, had been used as ranch and farm land since the Mexican Land Grant (USACE, undated). Military operations began in December 1932, first as a Base for bombers, and later as a Base for transport and fighter aircraft. The Base played a major role during World War II as a training field and staging area for Pacific operations. During the war (i.e., early- and mid-1940s), the Base hospital served as an acute care and rehabilitation facility for thousands of war casualties per month.

The Base was renamed Hamilton Air Force Base in 1947 when it was transferred to the newly created U.S. Air Force (USAF). The USAF used the Base primarily as a training and fighter

installation until 1975. The USAF ended military operations at the Base in 1976, and the property was declared surplus by the Department of Defense (Hamilton Field Association, Inc., 1988). In 1976, the U.S. Department of the Army (Army) began aircraft operations at the airfield and supporting facilities with permission from the USAF. In 1984, the airfield property was officially transferred back to the Army and renamed Hamilton Army Airfield. The Base was declared surplus under the Base Realignment and Closure Act of 1988. The Army continued to use the airfield primarily for Army Reserve aircraft operations until March 1994. Currently, the BRAC Property is managed by the Department of the Army, I Corps, at Fort Lewis, Washington.

2.3 *Petroleum, Oil, and Lubricant Outparcel Description*

The POL Outparcel lies within the upland portion of HAAF, on the north side of a ridge known as Reservoir Hill and southwest of West Boundary Road (see Figure 1-3). The POL Outparcel is separated from the main portion of the BRAC Property by approximately 200 feet (ft) and is bounded by the GSA Phase II Sale Area. The POL Outparcel contained three main environmental features (see Figure 1-3):

- A former tank farm (twenty 25,000-gal USTs, one 25,000-gal AST, and one 750-gal UST)
- A former 850,000-gal AST and associated piping (i.e., AST-2)
- The Landfill 26 groundwater treatment facility.

Each of these are discussed further in Section A.2.3 (Appendix A),

The POL Outparcel operated as the Base fuel-storage center from 1942 until prior to May 1986, when the storage tanks were removed. Aboveground Storage Tank-2 stood on the hillside bench (i.e., Reservoir Hill) and supplied the former tank farm area by gravity feed through a pipeline. All tanks stored JP-4, except possibly the 750-gal storage tank, for aircraft operations. Discharges of jet fuel and other petroleum products may have impacted the soil and groundwater at the POL Outparcel.

Several small buildings (Building Nos. 736, 737, and 738) existed at the POL Outparcel and were last used for temporary storage of waste oil (see Figure 1-3). Prior to construction of the Landfill 26 groundwater treatment facility, these buildings were demolished. The groundwater

treatment facility was constructed northwest of Reservoir Hill in a low-relief area that is partially paved with asphalt. The facility was to provide service for Landfill 26, but has never been used.

2.4 Previous Investigations and Reports

Several field investigations and environmental studies were conducted for the POL Outparcel. Activities have included AST and UST decommissioning and removal, contaminated soil removal, contaminated soil aeration, and investigations of soil and groundwater to identify the nature and extent of contamination resulting from site activities. These investigations included the following:

- Hamilton Air Force Base-Storage Tank Removal Project (IT, 1987)
- Final Engineering Report, Miscellaneous Contaminated Sites (IT, 1991)
- Environmental Investigation Report (ESI, 1993)
- Supplement to the Final Environmental Investigation Report (USACE, 1994).

Results of the previous investigations confirmed or suggested the presence of petroleum hydrocarbons in the soil and groundwater at the POL Outparcel. This information was used to scope the remedial investigation activities summarized in Section 3.0 and detailed in Appendix A. Results of the previous POL Outparcel investigations are summarized in Table 2-1.

2.5 Geology and Hydrogeology

Reservoir Hill lies within the San Francisco-Marin structural block of the Northern Coast Range geomorphic province of California. The higher relief area to the west and south of HAAF are generally underlain by serpentinite and sandstone bedrock from the Franciscan Complex of Jurassic to Cretaceous age. The bedrock is locally overlain by Tertiary alluvium and colluvium deposits.

Groundwater occurs in the weathered bedrock along the flanks of Reservoir Hill. Recharge occurs from rainfall on the top and slopes of the hill with groundwater percolating into the weathered material and into fractures in the bedrock. Flow within the bedrock is controlled by fractures and also follows topography.

2.6 Groundwater Yield

Groundwater at the POL Outparcel and GSA Properties was determined to occur in a low-flow fractured bedrock layer and to have low aquifer production rates. The RWQCB is responsible

for enforcement of State Water Resource Control Board Policy 88-63 (RWQCB, 1992), which specifies several criteria for determining whether groundwater is suitable for municipal or domestic water supply (i.e., drinking water). One of the criteria for suitability is recovery rate. During the investigation, the groundwater within the POL Outparcel was recovered at an average of approximately 5 gallons per day, which is below the minimum recovery rate for beneficial-use designation of 200 gal per day.

Given the low groundwater yield based on our testing (see Appendix F), the primary use of the groundwater, i.e., recharge to San Francisco Bay, from the POL Outparcel is the same as the GSA properties, and suggests that GSA Phase I RCGs for groundwater also apply at the POL Outparcel.

2.7 *Evaluation of Existence of Potential Chemicals of Concern*

Because TPH was the only PCOC suspected to be present at elevated levels at the POL Outparcel, the following discussion focuses on the derivation of the RCG for TPH. Woodward-Clyde Federal Services reviewed the limits established for TPH constituents during 1995 to establish TPH cleanup levels for the GSA Property (WCFS, 1995a). This study established cleanup levels for TPH in the groundwater for the GSA Phase I Sale Area. The GSA Phase I RCGs for each medium (i.e., soil and groundwater) were developed based upon site conditions and suspected analytes to be encountered in the comprehensive remedial investigation. The POL Outparcel is uphill and upgradient of the GSA Phase II Sale Area and will have similar future land uses. The GSA Phase I Sale Area RCGs are directly applicable for use at the GSA Phase II Sale Area. Therefore, the GSA RCGs are applicable to the POL Outparcel (Table 2-2). Typically, cleanup levels are derived from an appropriate risk-based method (e.g., drinking water standards and excess cancer risk to receptor less than 10^{-6}). However, contaminant cleanup levels were already identified for unrestricted land use within the GSA Phase I Sale Area (WCFS, 1995b). Because these cleanup criteria (i.e., GSA RCGs) were previously developed and used for evaluation of other portions of the HAAF (i.e., Outparcel A-4 and Hospital Hill Outparcel) with similar site conditions, these levels served as the basis for all investigative and closure evaluations. Residential cleanup goals were adopted to avoid conditions being placed on the site transfer and to be conservative in evaluating potentially impacted soil and groundwater.

The GSA Phase I Sale Area RCGs were developed using a series of risk-based assessments and risk-management evaluations (WCFS, 1995b). The RCG selection process included the following steps:

- Quantitative human health risk assessments and ecological risk assessments were performed in which uncertainty in each step of the evaluation process (i.e., selection of PCOCs, exposure assumptions, toxicity assessment, and risk characterization) was addressed by assuming the most conservative "worst case" situation.

- Results of the human health risk assessments and ecological risk assessments were used to generate risk-based remedial action objectives (RAOs) for both the residential and commercial land-use scenarios. Assuming that the conservative assumptions made during the risk assessments were valid, the RAO was the concentration of a chemical that could be present at a site and not pose an unacceptable risk to receptors.

- Unless an RAO was greater than a chemical's background concentration, or significantly different from a benchmark, the background concentration was adopted as the RCG since it would be impractical to remediate a site to below background concentrations.

- Analyte background concentrations, analytical method practical quantification limits, and other benchmarks were compared to each RAO to assess the viability of the RAO. A benchmark is a promulgated regulatory standard, such as acceptable TPH concentrations based on Marin County UST regulations, or a toxicity-based screening value, such as EPA Region IX Preliminary Remediation Goals.

The remainder of this discussion focuses on the derivation of the RCG for TPH measured as diesel because TPH measured as diesel and gasoline were the only PCOCs suspected to be present at elevated levels at the former POL Outparcel AST and UST sites. In 1995, Woodward-Clyde Federal Services reviewed the established limits for diesel constituents to determine applicable TPH cleanup levels for the GSA Property. The results of this study are presented in *Groundwater TPH Cleanup Levels for GSA Sale Property* (WCFS, 1995c). This study established cleanup levels for TPH in the groundwater for the GSA Phase I Sale Property.

As part of this study, each of the diesel constituents was evaluated with respect to chemical risk and percent of diesel composition. Polynuclear aromatic hydrocarbons (PNAs) were determined to be the primary risk drivers for diesel fuel. Typical diesel fuel contains between 0.7- and 2-percent total PNAs. Using the conservative estimate of 2-percent total PNAs in diesel and an aquatic maximum contaminant level of 50 µg/L, a cleanup level for diesel of 2,500 µg/L was established for groundwater. However, during GSA RCG negotiations with the regulatory

agencies, an additional degree of conservatism was introduced by reducing the RCG from the calculated value of 2,500 µg/L to 1,200 µg/L. The GSA RCG of 1,200 µg/L will be used in evaluation of the groundwater results in this closure report to determine if remedial action needs to be implemented.

2.8 Summary

The results of the previous investigations indicate that residual hydrocarbon concentrations in soil in the former tank farm area are below 100 mg/kg and the groundwater beneath the former tank farm has not been impacted. A petroleum-hydrocarbon groundwater plume is present beneath the location of former AST-2, details are presented in Section 4.0. The extent of impact appears to be limited to the vicinity of former AST-2. The highest concentration in groundwater (TPH measured as JP-4 at 5,350 micrograms per liter [µg/L]) was reported in samples collected from monitoring well PL-MW-101, located immediately adjacent to the location of former AST-2. This well also exhibited the only consistent benzene concentrations in the former AST-2 area. The detections of JP-4 are consistent with the expected nature of the petroleum-hydrocarbon chemical constituents in this area since AST-2 was known to be a JP-4 storage tank.

Construction activities at the groundwater treatment facility indicated potential soil contamination. Therefore, soil samples were collected along a grid surrounding the footprint of the facility. All soils in excess of 100 mg/kg were removed to the extent practicable (either to below 100 mg/kg) or to bedrock.

3.0 Remedial Investigation Summary

The following subsections describe and summarize the results of the remedial investigation activities conducted at the POL Outparcel. This information will be used to document and demonstrate a condition suitable for site closure. For detailed results of these activities refer to the Remedial Investigation Report for the POL Outparcel, which is included as Appendix A of this document.

3.1 Remedial Investigation Activities

On behalf of the USACE, IT conducted remedial investigation activities at the POL Outparcel commencing in the winter of 1996. The activities were conducted per the Remedial Investigation/Feasibility Study Work Plan (IT, 1997a) and the CQC/SAP (IT, 1997b). The objectives of the investigative activities were to

- Improve groundwater monitoring coverage
- Evaluate the presence or absence of petroleum hydrocarbons in soil and groundwater near the Landfill 26 groundwater treatment facility
- Perform groundwater monitoring, sampling, and slug or specific capacity testing to evaluate groundwater plume stability and the potential for migration
- Perform groundwater sampling to evaluate evidence of natural attenuation
- Determine the extent of TPH impact at the rock outcrop located on Reservoir Hill.

In order to achieve the objectives, the following tasks were completed during the field activities:

- Drilling five soil borings and collecting soil samples around the groundwater treatment facility to evaluate the extent of petroleum-hydrocarbon contamination previously detected during construction
- Drilling six monitoring well borings and coring two monitoring well borings
- Installing new monitoring wells in the six borings (MW-POLA-117A, -117B, -118, -119, -120, and -121)
- Collecting groundwater samples from the newly installed and existing wells to evaluate the extent of PCOCs

- Collecting groundwater samples from the newly installed and existing wells to evaluate if natural attenuation is occurring

- Measuring water levels in the monitoring wells to evaluate groundwater flow patterns and rates

- Collecting samples of the rock outcrop surrounding Reservoir Hill to evaluate the absence or presence of petroleum-hydrocarbon contamination.

Details regarding the investigation activities are presented in Appendix A. Analytical results were used to identify the PCOCs, which were described in Sections 2.5, 4.0, and 5.0, and are presented in Appendix B.

3.2 *Remedial Investigation Results*

A summary of the results of the remedial investigation activities is presented below. Additional discussions and summaries of groundwater monitoring and natural attenuation sampling are presented in Sections 4.0 and 5.0, respectively. In addition, a complete description of the activities and results are presented in Appendices A through F of this closure report.

Five soil borings were drilled around the periphery of the 1994 USACE investigation/excavation of the Landfill 26 groundwater treatment facility from which 12 soil samples at depths ranging between 1.5 to 10.5 ft below ground surface were collected. Multiple detections included lead (12 detects ranging from 5.4 to 16.6 mg/kg), TPH measured as diesel (4 detects ranging from an estimated 12 to 260 mg/kg), and phenanthrene (2 detects at 55 and 71 micrograms per kilogram [µg/kg]). The following were detected once: 2-methylnaphthalene (43 µg/kg), benzo(a)anthracene (47 µg/kg), benzo(a)pyrene (51 µg/kg), benzo(b)fluoranthene (71 µg/kg), dibenz(a,h)anthracene (41 µg/kg), chrysene (70 µg/kg), fluoranthene (54 µg/kg), indeno(1,2,3-cd)pyrene (36 µg/kg), and pyrene (59 µg/kg).

A composite rock sample was collected, from the area of visible staining of the rock outcrop near the former location of AST-2. The sample was analyzed for TPH, PNAs, and polychlorinated biphenyls. Only chrysene (960 µg/kg) and TPH measured as diesel (1,800 mg/kg) were detected. Additionally, the rock outcrop was visually inspected to evaluate the extent of TPH-impacted rock, the extent of impact was mapped, and a rough volume of TPH-impacted rock was estimated at 65 cubic yards.

Six additional monitoring wells (MW-POLA- 117A, - 117B, - 118, - 119, - 120, and - 121) were installed, and five rounds of groundwater sampling were conducted (February 1997, March 1997, March/April 1998, September/October 1998, and January 1999). Wells PL-MW-101 and MW-POLA-121 (both located near AST-2) were the only wells with consistent contaminant detections during all rounds. Additionally, groundwater samples were collected in March/April 1998 and September/October 1998 and analyzed for hydrogeologic chemical indicators of biodegradation of petroleum hydrocarbons. A summary of the results of the groundwater chemical and natural attenuation monitoring program are presented in Sections 4.0 and 5.0, respectively.

Slug tests were performed in wells MW-POLA- 117A, -118, -119, -121 and PL-MW-101, -103, -104, -106, -108, -112B, -113A, and -113C to provide estimates of hydraulic conductivity and a better understanding of the hydrogeologic system for the POL Outparcel. Specific capacity and single-well pumping tests were performed in wells MW-POLA-117B and -120. Hydraulic conductivity at the site ranges from 2.8×10^{-2} ft/day in PL-MW-106 to 5.3 ft/day in PL-MW-108. Details are presented in Appendix F.

4.0 Groundwater Potential Contaminant of Concern Monitoring Summary

A groundwater monitoring and sampling program, including quarterly, semiannual, and annual sampling schedules, was developed for the POL Outparcel in 1997 (IT, 1999). Due to delays in the installation of new wells for the remedial investigation, the initial sampling round of all POL Outparcel wells (new and existing) was not completed until February 1997; and a second round was performed as scheduled in March 1997. Following a delay waiting for a decision on further activities at the POL Outparcel, the quarterly groundwater monitoring program was restarted in March 1998. The third, forth, and fifth rounds of samples were collected during March/April 1998, September/October 1998, and January 1999, respectively.

All groundwater samples were analyzed for TPH measured as purgeable; TPH measured as extractable; benzene, toluene, ethylbenzene, and xylenes (BTEX); lead; and PNAs. However, the only constituent consistently detected above the cleanup level (i.e., GSA Phase I RCGs) was TPH. The BTEX, lead, and PNA concentrations were either not detected or were below RCGs. Beginning with the January 1999 monitoring event the samples were analyzed only for TPH measured as purgeable and TPH measured as extractable. Analytical results from these sampling episodes are presented in Appendix E. In addition, Figures 4-1 through 4-4 show the TPH results over time and Table 4-1 presents the analytical results for the six wells which encompass the petroleum-hydrocarbon plume beneath the former location of AST-2.

An additional suite of samples was collected in March/April 1998 and September/October 1998 and analyzed for hydrogeochemical indicators of biodegradation of petroleum hydrocarbons. Analytical results for these biodegradation parameter samples are discussed in Section 5.0.

Water-level measurements were taken from new and previously existing groundwater monitoring wells during all sampling rounds. A discussion of groundwater gradients is presented in Appendix F (Aquifer Test Data). Additionally, monitoring was conducted for immiscible phases; however, none was observed in any well.

Although speciation of JP-4 is possible during laboratory analysis, natural biodegradation of JP-4 into related fuel constituents in the groundwater and chemical interferences during analysis typically result in the quantitation of JP-4 against diesel and gasoline standards (see Section 2.5).

For this reason, the reported values for TPH measured as gasoline and TPH measured as diesel were totaled at each location to conservatively approximate the concentrations of JP-4 in the groundwater.

Former AST-2

The TPH plume, which is located in the vicinity of the former AST-2, is depicted for the March 1994, February 1997, March/April 1998, and January 1999 sampling episodes on Figures 4-1 through 4-4, respectively. The plume shown on Figures 4-1 through 4-4 is defined by contours representing combined TPH concentrations of 100 µg/L, 500 µg/L, and 1,200 µg/L. The GSA Phase I RCG for TPH measured as diesel is 1,200 µg/L. The position of the plume boundary was drawn primarily based on detected TPH concentrations, but also taking into consideration the location of former AST-2, and the groundwater flow directions (Figures 4-1 through 4-4). The only wells with combined TPH detections exceeding the GSA Phase I RCG of 1,200 µg/L were PL-MW-101 (RCG exceeded in all sampling rounds) and MW-POLA-121 (RCG exceeded in March 1997 sample only). Each of these wells is located within approximately 80 ft of the former AST-2 location.

Former Tank Farm and Groundwater Treatment Plant

The area downgradient of the former AST-2 location consists of the former tank farm and groundwater treatment plant, groundwater samples collected from wells in these areas yielded lower TPH concentrations than those at the former AST-2 location. Samples collected from well PL-MW-104 during each of the three sampling episodes yielded TPH identified as "unknown (extractable)" at concentrations slightly above 200 µg/L and also yielded TPH identified as "unknown (purgeable)" at concentrations less than 200 µg/L. Total petroleum hydrocarbons identified as "unknown (extractable)" were detected sporadically at low levels (200 µg/L or below) in wells PL-MW-103, -107, -112B, -113A, -113C, and -115 and MW-POLA-117A. In six of these wells (all except well PL-MW-115), "unknown (extractable)" TPH was detected in only one of the three rounds of sampling. Well PL-MW-115 only had three detections out of seven rounds of sampling, and the last three rounds have been non-detect. These "unknown" hydrocarbon compounds are assumed to be degradation products of JP-4. Samples collected from the remaining wells have yielded no detectable TPH or BTEX compounds. It is concluded from sampling results that the groundwater beneath the former tank farm has not been impacted. Further discussions on the historical groundwater monitoring data and plume stability are presented in Section 5.2.

Miscellaneous Activities

One groundwater sample was collected from PL-MW-107 for methyl-t-butyl ether (MTBE) analysis on February 20, 1999. The result was reported as not detected with a detection limit of 2 µg/L. The results indicate that there is no threat of MTBE at the POL Outparcel.

Shea Homes and North Bay Construction are developing residential property adjacent to POL Hill. Two of the POL Hill monitoring wells, POLA-115 and POLA-120, are located on the adjacent property. Monitoring well 115 is located in a cul-de-sac of the planned development. It will be extended to accommodate future monitoring. The developer will coordinate the protection, raising of the well and covering with a traffic rated monitoring well street box as part of their backfill and paving operations at monitoring well 115. Monitoring well 120 has been abandoned.

To accomplish the well extension, an appropriate length of polyvinyl chloride pipe with a bell end will be installed on the existing 4 inch (in.) diameter well casing. The new length of 4-in. polyvinyl chloride well casing will be extended to within 3 to 4 in. of the finish asphalt grade. A comparable length of 8½-in.-diameter pipe will be attached to the existing "monument" pipe and will extend to within 6 in. of finish asphalt grade. The well casing will be capped and a slurry of neat cement grout will be placed in the annular space between the casing and outer well conductor casing (monument pipe). The grout will be placed to within 8 in. of finish grade.

The street box will be set and secured before asphalt is placed. The box will be placed approximately 1 in. above finish asphalt grade and the paving will be brought up to this level. This will create a slight mound to allow rain water to shed away from the box and prevent surface runoff contamination of the well. The well will be protected from hydrocarbon cross-contamination during paving.

Additionally, well POLA-120 was abandoned and destroyed on November 11, 1999, under local permit number WD94/00-10. Gregg Drilling and Testing of Martinez, California performed the well destruction. An earlier attempt to overdrill the well was unsuccessful due to the inability of the drill rig to penetrate bedrock. On November 9, 1999 Mr. Jock Smith of the Marin County Environmental Health Department gave approval to abandon the well in place by pressure grouting.

5.0 Natural Attenuation Summary

In conjunction with the March/April 1998 and September/October 1998 groundwater monitoring events, groundwater samples were collected and analyzed for hydrogeologic chemical indicators of biodegradation of petroleum hydrocarbons. This section provides the evidence that natural attenuation is occurring at the POL Outparcel, including

- A petroleum-hydrocarbon (i.e., TPH) plume is evident under the former location of AST-2. The plume orientation tends to conform with groundwater flow patterns. However, the plume is not migrating and is shrinking.
- Trend shows either a static or diminishing petroleum-hydrocarbon groundwater plume.
- Benzene, toluene, ethylbenzene, and xylene do not appear to be present in most of the wells, and where present, have diminished over time.
- Geochemical indicators of natural attenuation are present.

These lines of evidence are defined in ASTM *Standard Guide for Remediation of Groundwater by Natural Attenuation at Petroleum Release Sites* (1998) and are necessary for demonstrating the appropriateness of remediation by natural attenuation. The primary line of evidence is generally considered enough to demonstrate natural attenuation at the site is a viable remedial alternative, but secondary lines of evidence are required when the monitoring data are limited or are not conclusive.

This section is organized into four subsections. Section 5.1 describes the operative mechanisms of contaminant attenuation and geochemical indicators that demonstrate natural attenuation is occurring. Sections 5.2 and 5.3 discuss historical TPH concentrations and the results of two rounds of monitoring for geochemical indicators of natural attenuation at the site. Section 5.4 summarizes the primary and secondary lines of evidence that natural attenuation is occurring at the POL Outparcel.

5.1 Operative Mechanisms and Geochemical Indicators of Natural Attenuation

Natural attenuation is the reduction in concentration and mass of a contaminant plume due to processes occurring naturally in the environment. Natural attenuation occurs through a combination of physical, chemical, and biological processes, including volatilization, dispersion,

dilution, sorption, and biodegradation (also known as intrinsic bioremediation). All of these processes contribute to a measurable reduction of the concentrations of contaminants within the plume. Biodegradation, however, is the only process that can produce significant reduction of the total mass of the contaminant plume via conversion of the hydrocarbons into carbon dioxide and water (Buscheck et al., 1996).

Hydrocarbon biodegradation is a series of microbially mediated chemical reactions that produce changes in the ambient geochemistry of the groundwater in which the reactions occur (AFCEE, 1995). The occurrence of biodegradation is indicated by measured trends in several geochemical parameters. In general, any of the following trends observed across a dissolved TPH plume (with increasing contaminant concentration) would suggest the occurrence of natural biodegradation:

A relative *decrease* in:	A relative *increase* in:
dissolved oxygen	ferrous iron
oxidation-reduction potential (redox)	alkalinity
nitrate	methane
sulfate	sulfide

Dissolved oxygen (D.O.) is the most thermodynamically favored electron acceptor used in the biodegradation of petroleum hydrocarbons (AFCEE, 1995). Aerobic biodegradation decreases the available D.O. in the groundwater and provides one of the best indicators of fuel biodegradation. However, it is difficult to collect representative readings when monitoring wells do not recharge adequately during purging and sampling. Excessive drawdown (greater than 5 percent of the standing water in the well) during the purge cycle tends to aerate the well water and inflate the D.O. readings above ambient levels. The POL Outparcel wells are screened in relatively low permeability bedrock and aeration of the well water during purging is a problem with many of the wells.

Oxidation-reduction (redox) potential of groundwater is a measure of the electron activity and indicates the relative tendency of a solution to accept or transfer electrons (AFCEE, 1995). Redox reactions in petroleum-hydrocarbon-contaminated groundwater are usually biologically mediated; therefore, the redox potential of a groundwater system depends upon and influences rates of biodegradation. Redox potentials within the plume are lower than those outside the plume and are often correlative with dissolved oxygen concentrations. The areas where oxygen has been depleted by biodegradation tend to have the lowest redox potentials.

After the D.O. is depleted by biodegradation, nitrate, iron, and sulfate may be used as electron acceptors for anaerobic biodegradation. Utilization of nitrate during biodegradation can produce a marked decrease of nitrate in wells screened within the hydrocarbon plume. Utilization of ferric iron and sulfate for anaerobic degradation produces ferrous iron and sulfide, respectively. An increase in these parameters (above background concentrations) within the plume provides another indicator of biodegradation.

Methanogenesis is another biodegradation process that can occur under anaerobic conditions. This process generally occurs after oxygen, nitrate, iron, and sulfate have been depleted by biodegradation (AFCEE, 1995). During methanogenesis, carbon dioxide is used as an electron acceptor and methane is produced. The presence of methane in groundwater within the plume provides an indication of microbial degradation when concentrations exceed background.

Alkalinity variations across the hydrocarbon plume can also provide evidence of biodegradation. Alkalinity tends to be higher in wells located within the hydrocarbon plume than those positioned outside the plume.

Other parameters that provide useful information about biodegradation include pH and temperature. These parameters do not provide direct evidence that biodegradation is occurring, but indicate if the physical and chemical conditions of the groundwater system are conducive to biodegradation. For example, biodegradation operates best when the pH is between six and eight and at temperatures between 16 and 20 degrees Celsius (°C) (Buscheck and O'Reilly, 1995).

5.2 *Historical Total Petroleum Hydrocarbon/Benzene, Toluene, Ethylbenzene, and Xylene Concentrations*

Groundwater monitoring data have been collected at the POL Outparcel since 1992, but the monitoring frequency and analytical procedures have varied, creating some difficulties in evaluating temporal and spatial plume trends. Monitoring was sporadic from 1992 to 1996 as only three events were conducted. Since February 1997, most of the POL Outparcel wells have been sampled five or six times. During the initial two monitoring events conducted between July and September 1992, TPH was quantified using EPA Method 418.1 (EPA, 1995). This method is nonspecific and does not accurately quantify petroleum hydrocarbons in the volatile range. In subsequent monitoring events, TPH was quantified using the more accurate EPA Method 8015M. The TPH results from 1992; therefore, are not comparable to later TPH results and the EPA Method 418.1 results have been omitted from discussion of TPH trends below.

Total petroleum hydrocarbon concentrations have decreased since groundwater monitoring was implemented in 1992. Table 4-1 summarizes the TPH and BTEX concentrations for wells PL-MW-101, -103, -104, -114, and -115 and MW-POLA-121 located in or immediately downgradient of the source area (AST-2). Total petroleum hydrocarbon concentrations have decreased in all of these wells except PL-MW-101, where concentrations have fluctuated between 3,900 to 11,600 µg/L. Concentrations of TPH in wells PL-MW-103, -114, and -115 and MW-POLA-121 have actually decreased to just above or below 50 µg/L, the method detection limit for TPH.

Initial concentrations of BTEX detected in wells PL-MW-101 and MW-POLA-121 (Table 5-1) have declined significantly since 1992. Benzene and toluene were detected in PL-MW-101 in 1992, but have not been detected in subsequent events. Ethylbenzene and total xylenes in well PL-MW-101 have decreased from initial concentrations of 110 and 290 µg/L in July 1992 to 39 and 47 µg/L in October 1998, respectively. Benzene, ethylbenzene, and total xylenes were detected in well MW-POLA-121 during the February and March 1997 monitoring events, but these hydrocarbons were not detected during the subsequent monitoring events. Benzene, toluene, ethylbenzene, and xylenes have not been detected in wells PL-MW-103, -104, -114, and -115 during any monitoring events.

Total petroleum hydrocarbon isoconcentration contours for the March 1994, February 1997, March/April 1998, and January 1999 monitoring events show that the plume is shrinking (see Figure 4-1). The isoconcentration contours for 100 and 500 µg/L have clearly receded toward the source area since 1994, and the areal extent of the plume has been reduced by approximately 50 percent. The portion of the plume containing TPH concentrations in excess of the GSA Phase I Sale Area RCG of 1,200 µg/L also appears to be shrinking.

5.3 Geochemical Indicators

The geochemical parameters collected during the March/April 1998 and September/October 1998 monitoring events provide additional evidence for biodegradation of the TPH plume (Tables 5-1 and 5-2). Of the parameters, D.O., redox potential, ferrous iron, and methane data follow the expected trends described in Section 5.1 for evidence of biodegradation. Isoconcentration maps of these parameters are provided in Figures 5-1 through 5-8.

The data are contoured for wells PL-MW-101, -103, -104, -114, -115, and -116 and MW-POLA-120 and -121 only because these wells are located within and just outside the petroleum-hydrocarbon groundwater plume.

The geochemical parameters show the following conditions and lateral trends that are indicative of TPH biodegradation (Tables 5-1 and 5-2):

- Dissolved oxygen concentrations are lowest at wells PL-MW-101 and -104 and MW-POLA-121, these are the closest to the former AST-2. Dissolved oxygen concentrations in these wells ranged from 0.5 to 0.6 milligrams per liter (mg/L) and 0.8 to 1.94 mg/L during the March/April 1998 and September/October 1998 monitoring events, respectively. Also, these wells have the highest hydrocarbon concentrations, i.e., low D.O. coincides with high concentration portion of the hydrocarbon plume. The September/October 1998 D.O. concentrations were probably lower than actually measured, but some aeration occurred due to excessive drawdown during well purging. Dissolved oxygen concentrations generally increase with distance from these wells and the source area. This pattern provides a strong indication that aerobic biodegradation of the hydrocarbons has occurred.

- Redox potentials are lowest at PL-MW-101, MW-POLA-121, and PL-MW-104, ranging from -255.6 to 11.5 millivolts (mV). The lowest redox potentials (-255.6 and -228.8 mV) were measured in well PL-MW-101, which also had the highest concentrations of TPH and lowest D.O. concentrations. Except for well PL-MW-115, which had a redox potential of 11 mV during the September/October 1998 monitoring event, all other wells had higher redox potentials in March/April 1998. These data indicate that conditions have become reducing (through oxygen depletion) in the area of highest TPH concentrations, and support the conclusion drawn from the D.O. concentrations that aerobic biodegradation of the hydrocarbons has occurred.

- Ferrous iron concentrations were highest in wells nearest the former AST, which is consistent with the results for D.O. and redox. Ferrous iron concentrations were much higher during the September/October 1998 monitoring event, with a maximum concentration of 2.88 mg/L detected in well MW-POLA-121.

- Methane concentrations were consistently highest in wells PL-MW-101, -104, and -115 and MW-POLA-121, 0.04 to 2.8 mg/L and 0.05 to 3.2 mg/L, respectively. This indicates that methanogenesis has occurred in the center of the hydrocarbon plume.

- The pH of all samples ranged from roughly six to eight, the range most favorable for TPH biodegradation.

- The temperature of the groundwater samples ranged from 16 to 20°C during the March/April 1998 monitoring event and 20 to 27°C during the September/October 1998 monitoring event. These differences in temperature probably reflect normal seasonal variation. The lower temperature range measured in March/April 1998 is more favorable for biodegradation of fuels because oxygen is more soluble in cold water.

- Nitrate may not be a suitable electron acceptor at this site because it was not detected in wells near the former AST, and the maximum concentration in wells outside the plume was only 1.3 mg/L. It is possible that the available nitrate was consumed by biodegradation of the TPH plume, but the low concentrations detected in wells outside the plume suggest that it is not an important electron acceptor for the POL Outparcel.

- The total alkalinity (expressed as $CaCO_3$) data are not conclusive, as concentrations within the plume are comparable to those outside the plume. In general, areas contaminated by fuel hydrocarbons may exhibit a total alkalinity that is higher than that seen in background areas. However, a trend may never be evident since naturally occurring calcite in the Franciscan bedrock would affect the alkalinity of the pore water. This is because the microbially-mediated reactions causing biodegredation can yield an increase in the total alkalinity of the system. Changes in alkalinity are most pronounced during aerobic respiration, denitrification, iron reduction, and sulfate reduction, and less pronounced during methanogenesis.

- The sulfate and sulfide data are not conclusive. After dissolved oxygen, nitrate, and bioavailable iron have been depleted in the microbial treatment zone, sulfate may be used as an electron acceptor for anaerobic biodegredation. This process is termed sulfate reduction and results in the production of sulfide. Sulfate concentrations are used as an indicator of anaerobic degradation of fuel compounds. Therefore, the expected trend is decreasing sulfate and increasing sulfide toward the center of the plume. In general, sulfate concentrations are lower in wells nearest the former AST-2, but sulfide was not detected in any wells during the March/April 1998 monitoring event. However, if the dissolved oxygen, nitrate, and bioavailable iron have not been depleted, sulfate may not have yet been reduced, and therefore, sulfides may have not been produced. A maximum sulfide concentration of 0.36 mg/L was detected in the source area well, well PL-MW-101 during the September/October 1998 monitoring event, but sulfide was also detected in many wells outside the plume. However, sulfide detections in the wells outside the plume may be influenced by the chemical composition of the Bay Mud (where some of the wells are screened) compared to the result of microbial reactions.

The data collected on these parameters (especially D.O. and redox potential) strongly indicate that intrinsic bioremediation has occurred at the POL Outparcel. The data show the typical progression from aerobic to anaerobic biodegradation as oxygen is depleted in the area of highest TPH concentrations.

5.4 Summary

The groundwater monitoring data collected at the POL Outparcel indicate the TPH plume is shrinking and natural attenuation is occurring. The lines of evidence for natural attenuation include the following:

- With the exception of well PL-MW-101 that is located near the center of the source area, TPH concentrations have declined significantly since March 1994. The areal extent of the TPH plume was reduced by approximately 50 percent since March 1994.

- Concentrations of TPH in well PL-MW-101 does appear to be relatively stable, i.e., not increasing (see Table 4-1).

- Concentrations of BTEX constituents have declined in all wells since 1992, including well PL-MW-101. Except for well PL-MW-101, BTEX was not detected in any other wells since March 1997.

- Geochemical indicators (i.e., D.O., redox potential, ferrous iron, methane, and sulfate) follow the expected trends for a TPH plume undergoing biodegradation.

These data trends indicate natural attenuation, with groundwater monitoring as a viable remedial action for the POL Outparcel.

6.0 Summary and Conclusions

The purpose of this Closure Report is to document the remedial investigation activities performed and describe the process used to determine the appropriateness of closing the outparcel. The remedial investigation activities were conducted in accordance with a regulatory- and USACE-approved work plan (IT, 1997a) and the CQC/SAP (IT, 1997b). This section summarizes the need for corrective actions at the POL Outparcel. To document the remedial investigation for the POL Outparcel and subsequent closure of the outparcel, this Closure Report presented

- A summary of pertinent findings from previous investigations
- A description of the remedial investigation activities conducted
- The analytical results for these activities
- The condition of the outparcel following remedial investigation activities.

6.1 Need for Corrective Action

Analytes detected during the remedial investigation were evaluated to determine if PCOCs were present in the soil, rock, or groundwater at the POL Outparcel at concentrations above GSA Phase I RCGs. Results of this evaluation concluded that all impacted soil, exceeding an agreed upon petroleum-hydrocarbon cleanup criteria of 100 mg/kg (IT, 1991), was removed, to the extent practicable, during previous investigations, and replaced with clean fill material, or was removed to the limit of the underlying bedrock where refusal occurred.

The groundwater beneath the former tank farm was not impacted; however, petroleum hydrocarbons are present in the groundwater in the vicinity of the former location of AST-2. The extent of impact appears to be limited to the vicinity of the former AST-2. The highest concentrations in groundwater were reported in samples collected from well PL-MW-101, located immediately adjacent to the location of former AST-2. Additionally, evidence supports the fact that the petroleum-hydrocarbon plume at the POL Outparcel is static or is shrinking, and that natural attenuation is occurring.

Additionally, a composite sample of the rock outcrop on Reservoir Hill indicated that elevated concentrations of TPH measured as diesel were detected. However, remediation of the rock outcrop is not proposed since the asphaltic material that covers the outcrop is bound within the

bedrock fractures, is not mobile, and is bound in such a manner that removal by hand is virtually impossible.

6.2 Conclusions

All remedial investigation activities were completed as specified in the work plan (IT, 1997a). All analytical data were compared to applicable GSA Phase I RCGs, which indicate that:

- The source of contamination (i.e., USTs and AST) has been removed
- The impacted soil at the former tank farm area, the AST-2 area, and the area surrounding the groundwater treatment plant has been removed to the extent practicable
- The site has been adequately characterized, no groundwater impacts exist in the former tank farm area
- A petroleum-hydrocarbon groundwater plume exists in the vicinity of former AST-2
- The hydrocarbon plume is stable and shrinking
- Natural attenuation has been shown to be occurring at the site
- Groundwater flow rates are low and flow directions are uniform
- The site does not pose a risk to human health.

This closure report documents the investigation and related remediation activities. The information presented in this document indicates that the removal actions conducted at the site are believed to have completed source removal, and that remedial activities and remedial action objectives necessary to transfer the POL Outparcel have been accomplished and the outparcel is suitable for closure.

All requirements for closure of the POL Outparcel have been achieved. However, due to the presence of elevated petroleum-hydrocarbon concentrations (i.e., above GSA Phase I RCGs) in the groundwater plume in the vicinity of the former AST-2, groundwater monitoring (chemical parameters only) of selected existing monitoring wells would continue on an annual basis.

7.0 References

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Tables

Table 2-1
Summary of Previous Investigations at the Petroleum, Oil, and Lubricant Outparcel
(Page 1 of 2)

Investigation	Remedial and/or Investigation Activities	References[a]
Hamilton Air Force Base Storage Tank Removal Project - IT Corporation	Removed twenty 25,000-gallon USTs[b], one 850,000-gallon AST[c] (AST-2), one 25,000-gal AST, one 750-gallon storage tank, and associated fuel lines and pumping system. Excavated soil with TPH[d] concentrations greater than 1,000 mg/kg[e] from the area around the removed tanks and piping systems. Approximately, 13,000 cubic yards of impacted soil was disposed off-site at a Class I landfill.	IT, 1987
Final Engineering Report, Miscellaneous Contaminated Sites - IT Corporation	Additional investigation of soil from the tank/piping system area resulted in the removal of contaminated soil exceeding TPH-concentrations of 100 mg/kg.	IT, 1991
Field Investigation Report - Engineering-Science, Inc.	Phase I: Thirteen composite soil samples were collected from the drill cuttings during construction of 13 of 15 monitoring wells. Concentrations of contaminants detected included bis(2-ethylhexyl)phthalate (7 detects ranging from 0.82 to 3.02 mg/kg), 2-methylnaphthalene (0.3 mg/kg), and lead (13 detects ranging from 5.94 to 15.2 mg/kg). One groundwater sample was collected from each monitoring well. Monitoring well PL-MW-101 was the only well with consistent detections of benzene (9.69 µg/L[f], ethylbenzene (210 µg/L), xylene (371 µg/L), 1,3-dimethylbenzene (479 µg/L), bis(2-ethylhexyl)phthalate (14.7 µg/L), and 2-methylnaphthalene (89 µg/L). Phase II: Two composite soil samples were collected from the drill cuttings during construction of 2 additional monitoring wells. Lead was the only constituent detected (8.7 and 16 mg/kg). Thirty soil samples were collected from 16 shallow auger borings; however, no contaminants were detected. Seventeen groundwater samples were collected during 2 sampling rounds from 17 wells. Monitoring well PL-MW-101 was the only well with consistent detections during both rounds of benzene (6.05 µg/L), toluene (10 µg/L), ethylbenzene (110 µg/L), xylene (290 µg/L), and 1,3-dimethylbenzene (280 µg/L).	ESI, 1993

Refer to references at end of table.

Table 2-1
Summary of Previous Investigations at the Petroleum, Oil, and Lubricant Outparcel

Investigation	Remedial and/or Investigation Activities	References[a]
Letter to J. Nusrala, Regional Water Quality Control Board, from the USACE[g]	Soil samples were collected along a system grid (approximately 14.5 to 14.5 ft[h]) surrounding the proposed groundwater treatment facility footprint after construction activities indicated that contamination existed. Samples were collected above the water table from 2 to 11 ft below ground surface. Analytical results indicated that the soils to the south/southeast of the treatment facility exhibited the highest concentrations (two samples in excess of 1,000 mg/kg of TPH measured as diesel, other detections greater than 100 mg/kg of TPH measured as diesel). According to the USACE personnel onsite during soil removal and sampling activities, all soils exceeding 100 mg/kg (TPH measured as diesel) beneath the treatment system footprint were excavated to the extent practicable (to bedrock).	USACE, 1993
Supplement to the Final Environmental Investigation Report - USACE	Two soil samples were collected during drilling and installation of monitoring well PL-MW-116 (see Figure A-1). No contaminants were detected. Collected groundwater samples from wells PL-MW-101, -103, -104, -106, -114, -115, and -116 (see Figure A-1). Detected TPH measured as diesel (5,350 µg/L[i]), ethylbenzene (129µg/L), and xylenes (405 µg/L). Additionally, TPH measured as diesel was detected in wells PL-MW-103, -104, -114, and -115 (417, 464, 355, and 803 µg/L, respectively).	USACE, 1994

[a] References

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[b] underground storage tank(s)
[c] above ground storage tank(s)
[d] total petroleum hydrocarbon(s)
[e] milligram(s) per kilogram
[f] microgram(s) per kilogram
[g] U.S. Army Corps of Engineers
[h] feet
[i] micrograms per liter

Checked By: Mat 12-23-99
Approved By: AWS 12-23-99

Table 4-1. Petroleum, Oil, and Lubricant Outparcel Wells
Total Petroleum Hydrocarbon and Benzene, Toluene, Ethylbenzene, and Total Xylenes Concentrations
(July 1992 to January 1999)

	PL-MW-101								
Analyte	Jul-92	Aug-92	Mar-94	Feb-97	Mar-97	Apr-98	Jul-98	Oct-98	Jan-99
Benzene	6	6	<5	<10	<1	<1	<1	<1	NA (a)
Toluene	10	4.3	<5	<10	<1	<1	<1	<1	NA
Ethylbenzene	110	94	129	78	77	46	42	39	NA
Xylenes	290	260	405	140	120	52	34	47	NA
Total TPH (b)	(c)	(c)	5350	11400	8500	4800	3900	7600	9700
TPH-P (d)	(c)	(c)	(e)	4800	4600	2700	2300	2900	4400
TPH-E (f)	(c)	(c)	5350	6600	3900	2100	1600	4700	5300

	PL-MW-103								
Analyte	Jul-92	Aug-92	Mar-94	Feb-97	Mar-97	Apr-98	Jul-98	Oct-98	Jan-99
Benzene	<1	<1	<0.5	<1	<1	<1	<1	<1	NA
Toluene	<1.5	<1.5	<0.5	<1	<1	<1	<1	<1	NA
Ethylbenzene	<1.4	<1.4	<0.5	<1	<1	<1	<1	<1	NA
Xylenes	<1.4	<1.4	<0.5	<1	<1	<1	<1	<1	NA
Total TPH (b)	(c)	(c)	417	110	<50	200	76	<50	<50
TPH-P (d)	(c)	(c)	(e)	<50	<50	(e)	76	<50	<50
TPH-E (f)	(c)	(c)	417	110	<50	200	<50	<50	<50

	PL-MW-104								
Analyte	Jul-92	Aug-92	Mar-94	Feb-97	Mar-97	Apr-98	Jul-98	Oct-98	Jan-99
Benzene	<1.1	<1.1	<0.5	<1	<1	<1	<1	<1	NA
Toluene	<1.5	<1.5	<0.5	<1	<1	<1	<1	<1	NA
Ethylbenzene	<1.4	<1.4	<0.5	<1	<1	<1	<1	<1	NA
Xylenes	<1.4	<1.4	<0.5	<1	<1	<1	<1	<1	NA
Total TPH (b)	(c)	(c)	464	400	410	287	<50	263	370
TPH-P	(c)	(c)	(e)	130	180	67	<50	83	200
TPH-E	(c)	(c)	464	270	230	220	<50	180	170

	PL-MW-114								
Analyte	Jul-92	Aug-92	Mar-94	Feb-97	Mar-97	Apr-98	Jul-98	Oct-98	Jan-99
Benzene	<1.1	<1.1	<0.5	<1	<1	<1	<1	<1	NA
Toluene	<1.5	<1.5	<0.5	<1	<1	<1	<1	<1	NA
Ethylbenzene	<1.4	<1.4	<0.5	<1	<1	<1	<1	<1	NA
Xylenes	<1.4	<1.4	<0.5	<1	<1	<1	<1	<1	NA
Total TPH (b)	(c)	(c)	355	<50	<50	<50	<50	<50	<50
TPH-P	(c)	(c)	(e)	<50	<50	<50	<50	<50	<50
TPH-E	(c)	(c)	355	<50	<50	<50	<50	<50	<50

	PL-MW-115								
Analyte	Jul-92	Aug-92	Mar-94	Feb-97	Mar-97	Apr-98	Jul-98	Oct-98	Jan-99
Benzene	<1.1	<1.1	<0.5	<1	<1	<1	<1	<1	NA
Toluene	<1.5	<1.5	<0.5	<1	<1	<1	<1	<1	NA
Ethylbenzene	<1.4	<1.4	<0.5	<1	<1	<1	<1	<1	NA
Xylenes	<1.4	<1.4	<0.5	<1	<1	<1	<1	<1	NA
Total TPH (b)	(c)	(c)	803	140	<50	100	<50	<50	<50
TPH-P	(c)	(c)	(e)	<50	<50	<50	<50	<50	<50
TPH-E	(c)	(c)	803	140	<50	100	<50	<50	<50

	MW-POLA-121								
Analyte	Jul-92	Aug-92	Mar-94	Feb-97	Mar-97	Apr-98	Jul-98	Oct-98	Jan-99
Benzene	NS (g)	NS	NS	2.7	4.6	<1	<1	<1	NA
Toluene	NS	NS	NS	<1	<1	<1	<1	<1	NA
Ethylbenzene	NS	NS	NS	7.3	10	<1	<1	<1	NA
Xylenes	NS	NS	NS	7.7	13	<1	<1	<1	NA
Total TPH (b)	NS	NS	NS	1060	1360	100	<50	<50	54
TPH-P	NS	NS	NS	480	630	<50	<50	<50	54
TPH-E	NS	NS	NS	580	730	100	<50	<50	<50

All detected analytes are shown in bold.
Units are in milligrams per liter.

(a) not analyzed
(b) Total petroleum hydrocarbons (extractable and purgeable). The extractable and purgeable hydrocarbon results were added together to provide a conservative estimate of the residual hydrocarbon contamination.
(c) Total petroleum hydrocarbons were quantified using EPA Method 418.1. These results are not considered equivalent to the EPA Method 8015M results obtained from the March 1994 and later monitoring events.
(d) Total petroleum hydrocarbons measured as purgeable
(e) no associated result
(f) Total petroleum hydrocarbons measured as extractable
(g) not sampled, well was not installed until January 1997

Checked by MM 12-23-99
Approved by AWS 12-23-99

Table 2-2
General Services Administration Residential Cleanup Goals

Chemical	Soil (mg/kg[a])[b]	Groundwater (mg/L[c])[d]
Polychlorinated Biphenyls	0.16	8.2
Benzene	0.84	0.35
cis-1,2-dichloroethylene	25	8.4
1,1-dichloroethane	11	7.5
1,1-dichloroethylene	0.034	0.0083
trans-1,2-dichloroethylene	338	149
Trichloroethylene	7.7	2.3
Vinyl Chloride	0.0047	0.00085
Benzo(a)anthracene	0.11	200
Benzo(a)pyrene	0.186	19
Benzo(b)fluoranthene	0.11	56
Benzo(k)fluoranthene	0.11	19
Dibenz(a,h)anthracene	0.037	29
Indeno(1,2,3-cd)pyrene	0.11	301
Lead (total)	190	2.3
Oil and grease	500	NA[e]
TPH[f] measured as gasoline (purgeable)	100	0.6
TPH measured as diesel (extractable)	200	1.2

[a] milligram(s) per kilogram
[b] Woodward-Clyde Federal Services, 1995c, *Hamilton Army Airfield GSA Phase I Sale Area Cleanup Goals for Soil and Groundwater*, Oakland, CA.
[c] milligram(s) per liter
[d] Woodward-Clyde Federal Services, 1995d, *Corrective Action Work Plan, Hamilton Army Airfield, GSA Phase I Sale Area*, Revision 1, Oakland, CA.
[e] not applicable
[f] total petroleum hydrocarbon(s)

Checked by: MMS 12-23-99

Approved by: AWS 12-23-99

Table 5-1. Geochemical Indicators
March/April 1998 Monitoring Event

Well	Dissolved Oxygen (mg/L)[a]	Redox (millivolts)	Ferrous Iron (mg/L)	Methane (mg/L)	Sulfate (mg/L)	Total Sulfide (mg/L)	Nitrate (mg/L)	Total Alkalinity as $CaCO_3$ (mg/L)	pH	Temperature (°C)[b]
PL-MW-101	0.50	-225.6	0.07	2.8	53	ND (<0.05)[c]	ND (<0.05)	516	6.96	19.4
PL-MW-103	0.70	121.1	ND (<0.05)	0.0039	69	ND (<0.05)	0.24	205	6.87	16.8
PL-MW-104	0.60	24.6	0.01	0.04	10	ND (<0.05)	ND	509	6.78	18.7
PL-MW-105	6.40	217.1	0.01	ND (<0.002)	56	ND (<0.05)	0.45	239	7.47	19.2
PL-MW-106	5.20	217.7	ND (<0.05)	0.0028	105	ND (<0.05)	0.09	493	7.30	16.6
PL-MW-107	6.50	174.0	0.01	ND (<0.002)	261	ND (<0.05)	0.10	749	8.05	19.7
PL-MW-108	3.30	221.1	NS[d]	ND (<0.002)	31	ND (<0.05)	ND (<0.05)	248	7.43	18.9
PL-MW-109	5.50	214.0	NS	0.0056	48	ND (<0.05)	ND (<0.05)	413	7.03	19.0
PL-MW-111A[e]	5.70	197.3	ND (<0.05)	ND (<0.002)/ND (<0.002)[f]	249/252	ND (<0.05)	ND (<0.05)/ND (<0.05)	369/368	7.12	12.6
PL-MW-111B	5.00	224.7	ND (<0.05)	ND (<0.002)	234	ND (<0.05)	ND (<0.05)	388	7.32	20.0
PL-MW-112A[e]	2.80	217.3	ND (<0.05)	ND (<0.002)	357	ND (<0.05)	0.10	445	7.55	16.3
PL-MW-112B	4.20	146.5	ND (<0.05)	ND (<0.002)	175	ND (<0.05)	0.19	403	7.99	20.2
PL-MW-113A[e]	2.60	114.0	0.01	0.0022	6360	ND (<0.05)	ND (<0.05)	654	6.90	16.5
PL-MW-113C	2.90	187.4	ND (<0.05)	0.0096	277	ND (<0.05)	ND (<0.05)	596	7.65	17.7
PL-MW-114	1.40	179.0	0.01	ND (<0.002)	49	ND (<0.05)	0.06	176	7.40	17.7
PL-MW-115	1.00	144.5	0.02	0.058/0.062	132/130	ND (<0.05)	ND (<0.05)/ND (<0.05)	300/301	7.35	17.0
PL-MW-116	6.70	197.4	ND (<0.05)	ND (<0.002)	26	ND (<0.05)	1.3	165	6.94	17.3
PL-MW-117A[e]	2.60	190.7	0.01	ND (<0.002)	137	ND (<0.05)	0.27	320	7.50	16.1
PL-MW-117B	3.60	137.4	ND (<0.05)	ND (<0.002)/ND (<0.002)	125/122	ND (<0.05)	0.50/0.49	275/277	8.12	19.9
MW-POLA-118	3.20	184.1	ND (<0.05)	ND (<0.002)	173	ND (<0.05)	0.90	273	7.30	17.1
MW-POLA-119	1.90	146.9	0.01	ND (<0.002)	191	ND (<0.05)	0.22	337	7.12	20.6
MW-POLA-120	2.60	203.7	0.02	ND (<0.002)	119	ND (<0.05)	0.62	242	7.11	19.9
MW-POLA-121	0.60	11.5	ND (<0.05)	0.12	15	ND (<0.05)	ND (<0.05)	128	6.42	17.9

[a] Milligrams per liter
[b] Degrees Celsius
[c] Not detected above practical quantitation limit (practical quantitation limit is in parenthesis)
[d] Not sampled
[e] These are nested well pairs which are completed with a shallow zone (A) and deep zone (B)
[f] Original sample result/field duplicate result

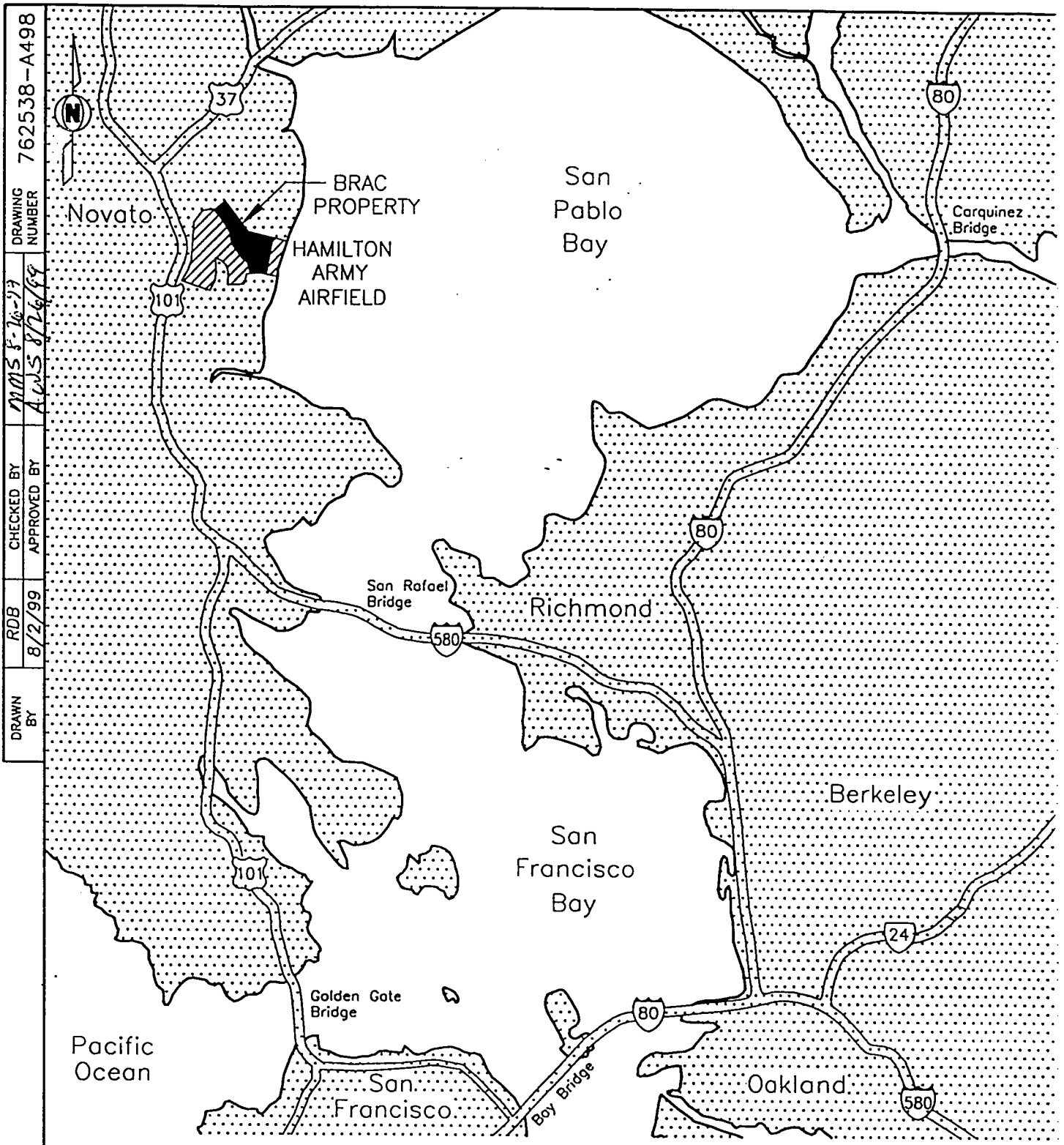
Checked by MMS 12-23-99
Approved by AWS 12-23-99

Table 5-2. Geochemical Indicators
September/October 1998 Monitoring Event

Well	Dissolved Oxygen (mg/L)[a]	Redox (millivolts)	Ferrous Iron (mg/L)	Methane (mg/L)	Sulfate (mg/L)	Total Sulfide (mg/L)	Nitrate (mg/L)	Total Alkalinity as $CaCO_3$ (mg/L)	pH	Temperature (^{o}C)[b]
PL-MW-101	0.82	-228.8	0.22	3.2	53	0.36	ND (<0.05)[c]	544	6.94	21.23
PL-MW-103	2.85	79.9	0.29	0.010	109	0.01	ND (<0.05)	240	6.94	22.24
PL-MW-104	1.94	-50.2	0.01	0.15	8	ND (<0.05)	ND (<0.05)	556	6.77	25.38
PI-MW-105	5.59	350.2	ND (<0.05)	ND (<0.002)	58	0.01	ND (<0.05)	242	7.25	23.15
PL-MW-106	2.12	131.3	ND (<0.05)	0.0046	107	0.03	0.088	514	7.24	25.49
PL-MW-107	7.99	285.2	ND (<0.05)	ND (<0.002)	210	0.12	0.06	756	8.12	22.49
PL-MW-108	4.31	254.7	0.05	ND (<0.002)	64	0.04	0.065	462	7.18	24.07
PL-MW-109	5.45	215.8	0.03	ND (<0.002)	51	0.02	ND (<0.05)	429	7.04	25.42
PL-MW-111A[d]	1.00	145.1	0.02	ND (<0.002)/ND (<0.002)[e]	270/261	0.05	ND (<0.05)/ND (<0.05	389/391	6.91	25.91
PL-MW-111B	1.05	172.4	0.01	ND (<0.002)	250	ND (<0.05)	ND (<0.05)	397	6.93	25.76
PL-MW-112A[d]	2.90	205.4	0.01	ND (<0.002)	571	0.13	0.13	562	7.14	22.46
PL-MW-112B	1.35	190.8	ND (<0.05)	ND (<0.002)	202	0.01	0.18	416	7.50	21.02
PL-MW-113A[d]	3.60	204.5	0.01	ND (<0.002)	7360	0.01	ND (<0.05)	688	6.80	25.92
PL-MW-113C	2.13	184.0	ND (<0.05)	0.0059	282	0.01	ND (<0.05)	614	7.55	23.29
PL-MW-114	1.52	225.6	ND (<0.05)	0.13	78	ND (<0.05)	0.055	227	7.06	20.73
PL-MW-115	2.10	10.6	ND (<0.05)	0.052/0.051	137/148	0.01	ND (<0.05)/ND (<0.05	281/283	7.09	21.16
PL-MW-116	6.11	285.5	0.01	ND (<0.002)	29	0.04	0.98	166	6.96	22.24
PL-MW-117A[d]	3.61	231.2	ND (<0.05)	ND (<0.002)	143	0.05	0.42	322	7.57	25.71
PL-MW-117B	2.00	242.3	ND (<0.05)	ND (<0.002)/ND (<0.002)	125/125	0.01	0.54/0.55	264/264	7.89	25.47
MW-POLA-118	1.50	186.2	0.81	ND (<0.002)	219	0.26	1	303	7.04	27.80
MW-POLA-119	2.11	144.1	0.08	ND (<0.002)	196	0.02	0.35	315	7.18	25.60
MW-POLA-120	2.82	183.3	ND (<0.05)	ND (<0.002)	114	ND (<0.05)	0.9	231	7.05	20.74
MW-POLA-121	1.91	-61.5	2.88	0.6	13	0.06	ND (<0.05)	404	6.81	22.77

[a] Milligrams per liter
[b] Degrees Celcius
[c] Not detected above practical quantitation limit (practical quantitation limit is in parenthesis)
[d] These are nested well pairs which are completed within a shallow zone (A) and deep zone (B)
[e] Original sample/duplicate sample

Checked by MMS 12-23-99
Approved by AWS 12-23-99



DRAWING NUMBER 762538-A498

DRAWN BY	CHECKED BY	DRAWING NUMBER
RDB 8/2/99	APPROVED BY	MMS 8-16-99 AWS 8/26/99

FIGURE 1-1

SITE LOCATION MAP
HAMILTON ARMY AIRFIELD

PREPARED FOR

USACE SACRAMENTO DISTRICT
TOTAL ENVIRONMENTAL RESTORATION CONTRACT

INTERNATIONAL TECHNOLOGY CORPORATION

REFERENCE: WOODWARD-CLYDE DRAWING SK-1 FIGURE 1-1

BRAC POL

slmbphaa

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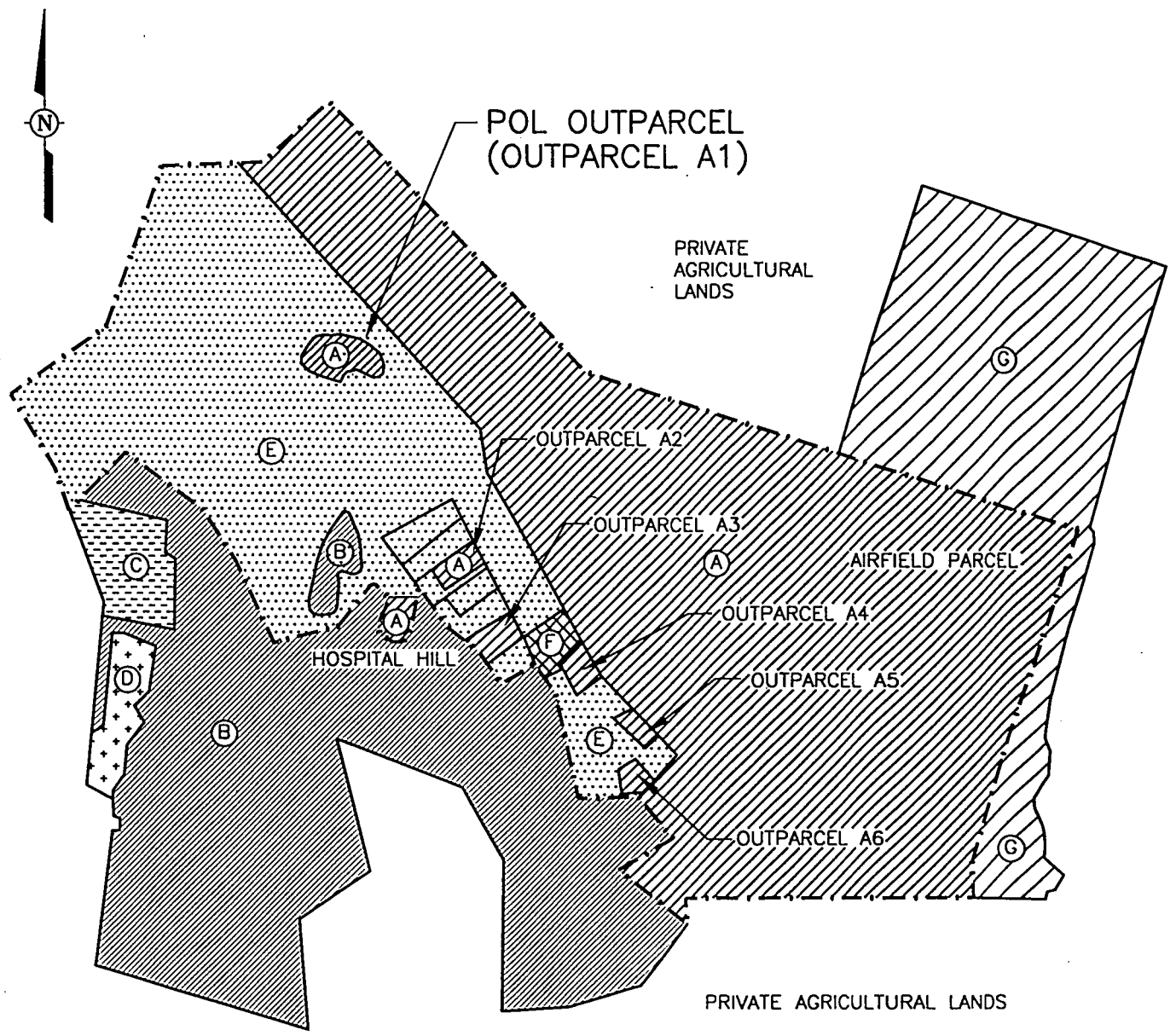
	8/24/99	APPROVED BY	762538-A315



LEGEND:

- ARMY-OWNED PROPERTY BOUNDARY
- (A) BRAC PROPERTY
- (B) NAVY HOUSING
- (C) LANHAM HOUSING
- (D) NOVATO SCHOOL DISTRICT
- (E) GSA SALE PARCEL
- (F) US COAST GUARD
- (G) STATE OF CALIFORNIA

APPROXIMATE SCALE

0 1000 2000 FEET

FIGURE 1-2

BRAC PROPERTY LOCATION MAP
HAMILTON ARMY AIRFIELD

PREPARED FOR

USACE SACRAMENTO DISTRICT
TOTAL ENVIRONMENTAL
RESTORATION CONTRACT

INTERNATIONAL TECHNOLOGY CORPORATION

REFERENCE:
WOODWARD-CLYDE FEDERAL SERVICES DRAWING SK9469.

BRAC POL

bplm

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	10/13/99	APPROVED BY	11/16/99		

LIMIT OF 1993 USACE INVESTIGATION

FORMER ABERDEEN ROAD

FORMER BUILDING 737

LANDFILL 26 GROUNDWATER TREATMENT FACILITY

DRAINAGE DITCH

WEST BOUNDARY ROAD

LIMIT OF 1991 USACE INVESTIGATION

LANDFILL 26

RAMP

HYDRANT

FORMER BUILDING 738

FORMER BUILDING 736

SLOPE

ABERDEEN ROAD

DRAINAGE

LEVEE CONSTRUCTION HAUL ROAD

FORMER JP-4 PUMPS

STAIRWAY

FORMER TANK FARM

LEVELED AREA ON BENCHED SLOPE

FORMER AST 2 EL. 52'

RESERVOIR HILL

LEGEND:

- FENCE
- FORMER STRUCTURES
- APPROXIMATE LIMITS OF USACE EXCAVATION
- NHP LEVEE AND EASEMENT
- POL OUTPARCEL BRAC PROPERTY BOUNDARY
- GSA PHASE I TRANSFERRED PROPERTY BOUNDARY
- LANDFILL 26 BOUNDARY

APPROXIMATE SCALE

70 0 70 FEET

FIGURE 1-3

POL OUTPARCEL SITE MAP

BRAC PROPERTY

HAMILTON ARMY AIRFIELD

PREPARED FOR

USACE SACRAMENTO DISTRICT TOTAL ENVIRONMENTAL RESTORATION CONTRACT

INTERNATIONAL TECHNOLOGY CORPORATION

BRAC POL

POLOSM XREF: HBASE12S

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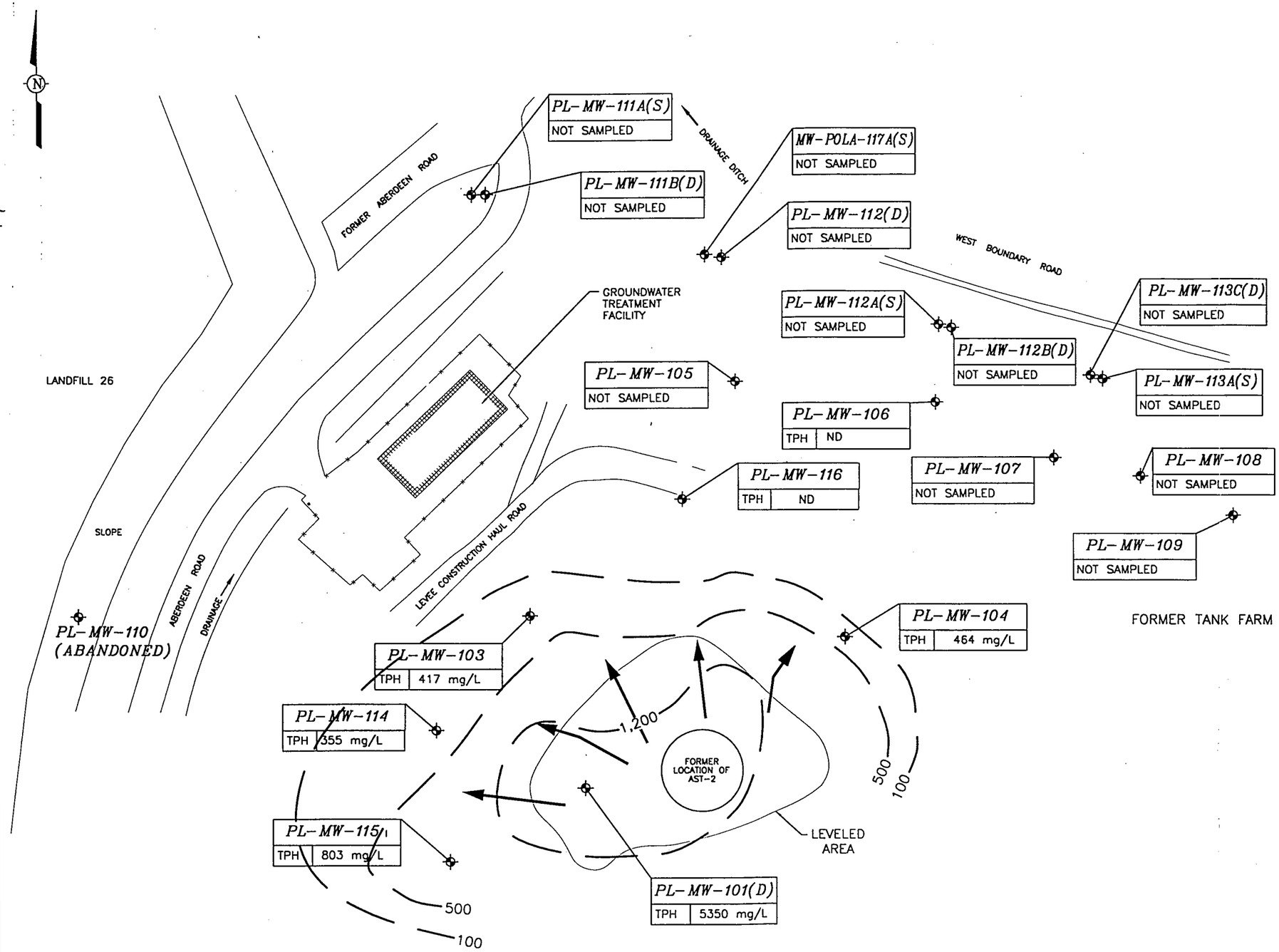
	10/13/99	APPROVED BY	Aw/s	12/16/99		



LEGEND:

- FENCE
- EXISTING MONITORING WELL
- INFERRED GROUNDWATER FLOW DIRECTION
- 100 — CONTOURS REPRESENT COMBINED TPH-DIESEL, TPH-GASOLINE, AND TPH-JP4 DETECTIONS. CONCENTRATIONS ARE IN µG/L.
- ND — NOT DETECTED (DETECTION LIMIT=50µG/L FOR TPH COMPOUNDS AND 1µG/L FOR BTEX)
- (S) SHALLOW MONITORING WELL
- (D) DEEPER MONITORING WELL

NOTE:

- BASED ON PROCESS KNOWLEDGE, JP-4 WAS STORED IN THE TANKS. HOWEVER, BASED ON CHEMICAL INTERFERENCES AND DEGRADATION RESULTING IN THE QUANTIFICATION OF JP-4 AGAINST DIESEL AND GASOLINE STANDARDS, THE REPORTED VALUES FOR TPH-DIESEL AND TPH-GASOLINE WERE TOTALLED AT EACH LOCATION TO CONSERVATIVELY ESTIMATE THE EXTENT AND MAGNITUDE OF JP-4 GROUNDWATER CONTAMINATION.

SCALE
0 80 160 FEET

FIGURE 4-1

TOTAL PETROLEUM HYDROCARBON CONCENTRATIONS IN GROUNDWATER
POL OUTPARCEL
MARCH 1994
BRAC PROPERTY
HAMILTON ARMY AIRFIELD

PREPARED FOR

USACE SACRAMENTO DISTRICT
TOTAL ENVIRONMENTAL RESTORATION CONTRACT

INTERNATIONAL TECHNOLOGY CORPORATION

BRAC POL

tph0394

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CHECKED BY	MMS 12-16-99
APPROVED BY	[illegible] 12/16/99
RDB	10/15/99
DRAWN BY	

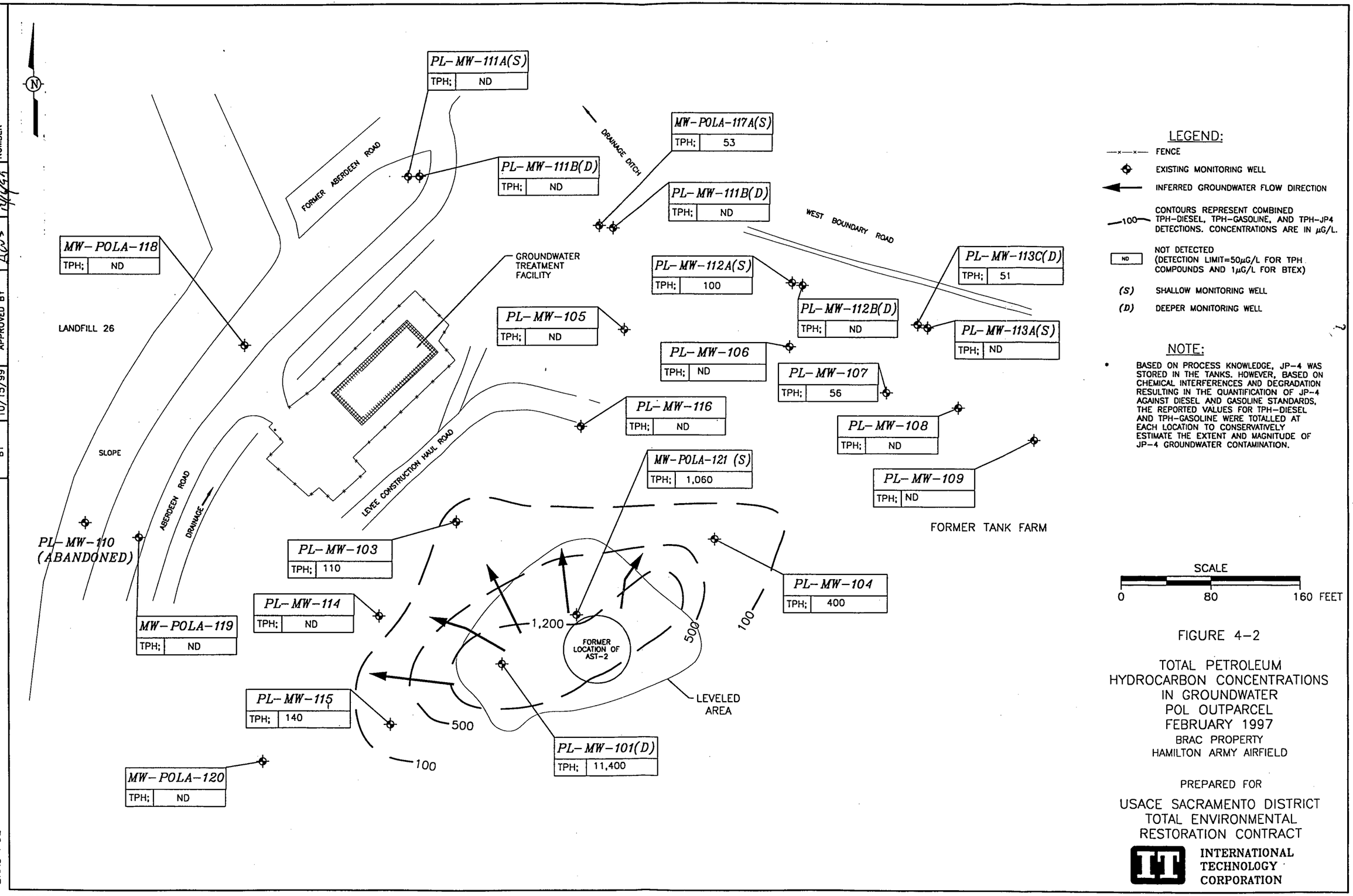

FIGURE 4-2

TOTAL PETROLEUM HYDROCARBON CONCENTRATIONS IN GROUNDWATER
POL OUTPARCEL
FEBRUARY 1997
BRAC PROPERTY
HAMILTON ARMY AIRFIELD

PREPARED FOR

USACE SACRAMENTO DISTRICT
TOTAL ENVIRONMENTAL RESTORATION CONTRACT

INTERNATIONAL TECHNOLOGY CORPORATION

BRAC POL

tph0297

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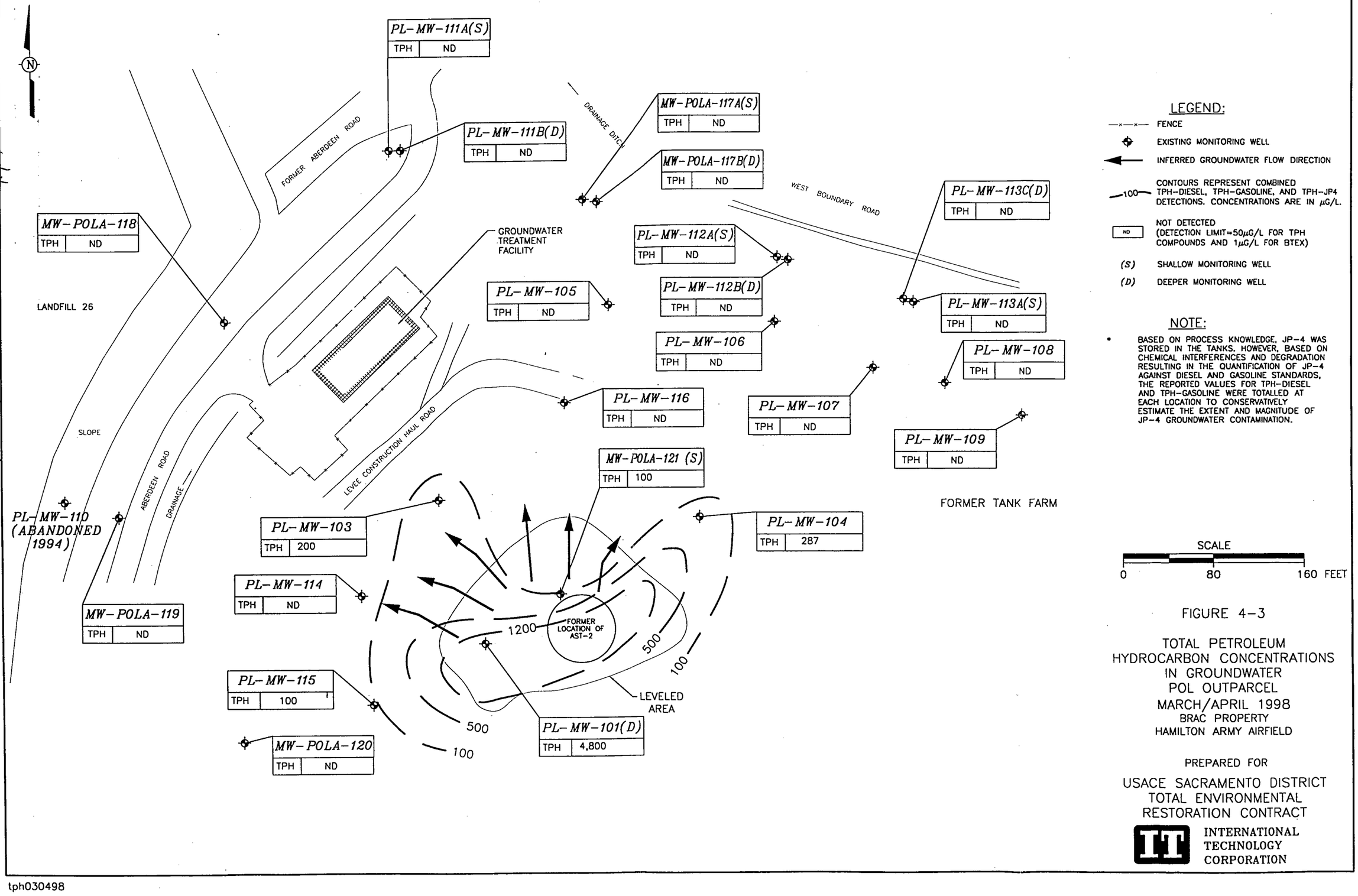
RDB 12/15/99	APPROVED BY	762538-B514



LEGEND:

- FENCE
- EXISTING MONITORING WELL
- INFERRED GROUNDWATER FLOW DIRECTION
- 100 — CONTOURS REPRESENT COMBINED TPH-DIESEL, TPH-GASOLINE, AND TPH-JP4 DETECTIONS. CONCENTRATIONS ARE IN µG/L.
- ND — NOT DETECTED (DETECTION LIMIT=50µG/L FOR TPH COMPOUNDS AND 1µG/L FOR BTEX)
- (S) SHALLOW MONITORING WELL
- (D) DEEPER MONITORING WELL

NOTE:

* BASED ON PROCESS KNOWLEDGE, JP-4 WAS STORED IN THE TANKS. HOWEVER, BASED ON CHEMICAL INTERFERENCES AND DEGRADATION RESULTING IN THE QUANTIFICATION OF JP-4 AGAINST DIESEL AND GASOLINE STANDARDS, THE REPORTED VALUES FOR TPH-DIESEL AND TPH-GASOLINE WERE TOTALLED AT EACH LOCATION TO CONSERVATIVELY ESTIMATE THE EXTENT AND MAGNITUDE OF JP-4 GROUNDWATER CONTAMINATION.

SCALE
0 80 160 FEET

FIGURE 4-3

TOTAL PETROLEUM HYDROCARBON CONCENTRATIONS IN GROUNDWATER
POL OUTPARCEL
MARCH/APRIL 1998
BRAC PROPERTY
HAMILTON ARMY AIRFIELD

PREPARED FOR

USACE SACRAMENTO DISTRICT
TOTAL ENVIRONMENTAL RESTORATION CONTRACT

INTERNATIONAL TECHNOLOGY CORPORATION

BRAC POL

tph030498

DRAWN BY	RDB	CHECKED BY	AMS	DRAWING NUMBER	762538-B515
	10/15/99	APPROVED BY	AMS 12-16-99		

N

PL-MW-111A(S)
NOT SAMPLED

PL-MW-111B(D)
NOT SAMPLED

FORMER ABERDEEN ROAD

DRAINAGE DITCH

MW-POLA-117A(S)
NOT SAMPLED

MW-POLA-117B(D)
NOT SAMPLED

WEST BOUNDARY ROAD

PL-MW-113C(D)
NOT SAMPLED

MW-POLA-118
NOT SAMPLED

GROUNDWATER TREATMENT FACILITY

PL-MW-112A(S)
NOT SAMPLED

PL-MW-112B(D)
NOT SAMPLED

PL-MW-113A(S)
NOT SAMPLED

LANDFILL 26

PL-MW-105
NOT SAMPLED

PL-MW-106
NOT SAMPLED

PL-MW-107
NOT SAMPLED

PL-MW-108
NOT SAMPLED

PL-MW-116
TPH ND

SLOPE

ABERDEEN ROAD

DRAINAGE

LEVEE CONSTRUCTION HAUL ROAD

PL-MW-109
NOT SAMPLED

MW-POLA-121 (S)
TPH 54

PL-MW-104
TPH 370

FORMER TANK FARM

PL-MW-110
(ABANDONED)

PL-MW-103
TPH ND

PL-MW-114
TPH ND

MW-POLA-119
NOT SAMPLED

1,200

500

100

FORMER LOCATION OF AST-2

500

100

LEVELED AREA

PL-MW-115
TPH ND

MW-POLA-120
TPH ND

PL-MW-101(D)
TPH 9,700

LEGEND:

- FENCE
- EXISTING MONITORING WELL
- INFERRED GROUNDWATER FLOW DIRECTION
- 100 — CONTOURS REPRESENT COMBINED TPH-DIESEL, TPH-GASOLINE, AND TPH-JP4 DETECTIONS. CONCENTRATIONS ARE IN µG/L.
- ND — NOT DETECTED (DETECTION LIMIT=50µG/L FOR TPH COMPOUNDS AND 1µG/L FOR BTEX)
- (S) SHALLOW MONITORING WELL
- (D) DEEPER MONITORING WELL

NOTE:

- BASED ON PROCESS KNOWLEDGE, JP-4 WAS STORED IN THE TANKS. HOWEVER, BASED ON CHEMICAL INTERFERENCES AND DEGRADATION RESULTING IN THE QUANTIFICATION OF JP-4 AGAINST DIESEL AND GASOLINE STANDARDS, THE REPORTED VALUES FOR TPH-DIESEL AND TPH-GASOLINE WERE TOTALLED AT EACH LOCATION TO CONSERVATIVELY ESTIMATE THE EXTENT AND MAGNITUDE OF JP-4 GROUNDWATER CONTAMINATION.

SCALE
0 80 160 FEET

FIGURE 4-4

TOTAL PETROLEUM HYDROCARBON CONCENTRATIONS IN GROUNDWATER
POL OUTPARCEL
JANUARY 1999
BRAC PROPERTY
HAMILTON ARMY AIRFIELD

PREPARED FOR

USACE SACRAMENTO DISTRICT
TOTAL ENVIRONMENTAL RESTORATION CONTRACT

INTERNATIONAL TECHNOLOGY CORPORATION

BRAC POL

tph0199

DRAWN BY	CHECKED BY	DRAWING NUMBER
BRAC POL	RDB 10/15/99	762538-B516

N

FORMER ABERDEEN ROAD

DRAINAGE DITCH

WEST BOUNDARY ROAD

GROUNDWATER TREATMENT FACILITY

LANDFILL 26

SLOPE

ABERDEEN ROAD

DRAINAGE

LEVEE CONSTRUCTION HAUL ROAD

PL-MW-111A(S)	
CH_4	ND

PL-MW-111B(D)	
CH_4	ND

MW-POLA-117A(S)	
CH_4	ND

MW-POLA-117B(D)	
CH_4	ND

PL-MW-112B(D)	
CH_4	ND

PL-MW-112A(S)	
CH_4	ND

PL-MW-113C(D)	
CH_4	0.0096 mg/L

PL-MW-113A(S)	
CH_4	0.0022 mg/L

MW-POLA-118	
CH_4	ND

PL-MW-105	
CH_4	ND

PL-MW-106	
CH_4	0.0028 mg/L

PL-MW-116	
CH_4	ND

PL-MW-107	
CH_4	ND

PL-MW-108	
CH_4	ND

PL-MW-109	
CH_4	0.0056 mg/L

PL-MW-103	
CH_4	0.0039 mg/L

MW-POLA-119	
CH_4	ND

PL-MW-110 (ABANDONED)

PL-MW-114	
CH_4	ND

PL-MW-115	
CH_4	0.058 mg/L

MW-POLA-120	
CH_4	ND

PL-MW-101(D)	
CH_4	2.8 mg/L

MW-POLA-121 (S)	
CH_4	0.12 mg/L

PL-MW-104	
CH_4	0.04 mg/L

0.1

1.0

0.01

0.01

FORMER LOCATION OF AST-2

FORMER TANK FARM

LEVELED AREA

LEGEND:

- FENCE
- PAVEMENT BOUNDARY
- EXISTING MONITORING WELL
- 0.1 — METHANE CONCENTRATION CONTOUR (mg/L)
- ND NOT DETECTED
- (S) SHALLOW MONITORING WELL
- (D) DEEPER MONITORING WELL

SCALE

0 80 160 FEET

FIGURE 5-1

METHANE (CH_4) CONCENTRATIONS
MARCH/APRIL 1998
POL OUTPARCEL
BRAC PROPERTY
HAMILTON ARMY AIRFIELD

PREPARED FOR

USACE SACRAMENTO DISTRICT
TOTAL ENVIRONMENTAL RESTORATION CONTRACT

INTERNATIONAL TECHNOLOGY CORPORATION

meth030498

DRAWN BY	CHECKED BY	DRAWING NUMBER
BRAC POL	RDB 10/15/99	762538-B517

N

PL-MW-111A(S)
Fe2+ ND

PL-MW-111B(D)
Fe2+ ND

DRAINAGE DITCH

MW-POLA-117A(S)
Fe2+ 0.01 mg/L

MW-POLA-117B(D)
Fe2+ ND

PL-MW-112A(S)
Fe2+ ND

PL-MW-112B(D)
Fe2+ ND

PL-MW-113C(D)
Fe2+ ND

PL-MW-113A(S)
Fe2+ 0.01 mg/L

WEST BOUNDARY ROAD

FORMER ABERDEEN ROAD

MW-POLA-118
Fe2+ ND

LANDFILL 26

GROUNDWATER TREATMENT FACILITY

PL-MW-105
Fe2+ 0.01 mg/L

PL-MW-106
Fe2+ ND

PL-MW-107
Fe2+ 0.01 mg/L

PL-MW-108
Fe2+ NS

PL-MW-109
Fe2+ NS

PL-MW-116
Fe2+ ND

SLOPE

ABERDEEN ROAD

DRAINAGE

LEVEE CONSTRUCTION HAUL ROAD

PL-MW-103
Fe2+ ND

MW-POLA-119
Fe2+ 0.01 mg/L

PL-MW-110
(ABANDONED)

PL-MW-104
Fe2+ 0.01 mg/L

PL-MW-114
Fe2+ 0.01 mg/L

0.02 0.04 0.06

FORMER LOCATION OF AST-2

MW-POLA-121 (S)
Fe2+ ND

FORMER TANK FARM

LEVELED AREA

MW-POLA-120
Fe2+ 0.02 mg/L

PL-MW-101(D)
Fe2+ 0.07 mg/L

PL-MW-115
Fe2+ 0.02 mg/L

LEGEND:

- FENCE
- PAVEMENT BOUNDARY
- EXISTING MONITORING WELL
- 0.02 FERROUS IRON CONCENTRATION CONTOUR (mg/L)
- ND NOT DETECTED
- (S) SHALLOW MONITORING WELL
- (D) DEEPER MONITORING WELL

SCALE
0 80 160 FEET

FIGURE 5-2

FERROUS IRON (FE^{2+}) CONCENTRATIONS
MARCH/APRIL 1998
POL OUTPARCEL
BRAC PROPERTY
HAMILTON ARMY AIRFIELD

PREPARED FOR

USACE SACRAMENTO DISTRICT
TOTAL ENVIRONMENTAL RESTORATION CONTRACT

INTERNATIONAL TECHNOLOGY CORPORATION

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DRAWN BY	CHECKED BY	DRAWING NUMBER
RDB 10/15/99	MJS 12-16-99	762538-B518
	APPROVED BY	
	Links 12/16/99	

N

PL-MW-111A(S)
Eh 197.3 mV

PL-MW-111B(D)
Eh 224.7 mV

MW-POLA-117A(S)
Eh 190.7 mV

MW-POLA-117B(D)
Eh 143.7 mV

PL-MW-112A(S)
Eh 217.3 mV

PL-MW-112B(D)
Eh 146.5 mV

PL-MW-106
Eh 217.7 mV

PL-MW-113C(D)
Eh 187.4 mV

PL-MW-113A(S)
Eh 114.0 mV

MW-POLA-118
Eh 184.1 mV

PL-MW-105
Eh 217.1 mV

PL-MW-116
Eh 197.4 mV

PL-MW-107
Eh 174.0 mV

PL-MW-108
Eh 221.1 mV

PL-MW-109
Eh 214 mV

MW-POLA-119
Eh 146.9 mV

PL-MW-103
Eh 121.1 mV

PL-MW-104
Eh 24.6 mV

PL-MW-110
(ABANDONED)

PL-MW-114
Eh 179.0 mV

PL-MW-115
Eh 144.5 mV

MW-POLA-121 (S)
Eh 11.5 mV

PL-MW-101(D)
Eh -255.6 mV

MW-POLA-120
Eh 203.7 mV

FORMER ABERDEEN ROAD
DRAINAGE DITCH
WEST BOUNDARY ROAD
GROUNDWATER TREATMENT FACILITY
LANDFILL 26
SLOPE
ABERDEEN ROAD
DRAINAGE
CONSTRUCTION HAUL ROAD
FORMER LOCATION OF AST-2
LEVELED AREA
FORMER TANK FARM

150
100
50
0
-50
-100
-200

LEGEND:
- FENCE
- PAVEMENT BOUNDARY
- EXISTING MONITORING WELL
- 50 — OXIDATION/REDUCTION POTENTIAL (millivolts)
- ND NOT DETECTED
- (S) SHALLOW MONITORING WELL
- (D) DEEPER MONITORING WELL

SCALE
0 80 160 FEET

FIGURE 5-3

OXIDATION/REDUCTION POTENTIAL (Eh)
MARCH/APRIL 1998
POL OUTPARCEL
BRAC PROPERTY
HAMILTON ARMY AIRFIELD

PREPARED FOR

USACE SACRAMENTO DISTRICT
TOTAL ENVIRONMENTAL RESTORATION CONTRACT

INTERNATIONAL TECHNOLOGY CORPORATION

BRAC POL

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DRAWN BY	RDB	CHECKED BY	MWS	12-16-99	DRAWING NUMBER	762538-B519
	10/15/99	APPROVED BY	ALS	12/16/99		

N

PL-MW-111A(S)
D.O. 5.7 mg/L

PL-MW-111B(D)
D.O. 5.0 mg/L

FORMER ABERDEEN ROAD

DRAINAGE DITCH

MW-POLA-117A(S)
D.O. 2.6 mg/L

MW-POLA-117B(D)
D.O. 3.6 mg/L

PL-MW-112A(S)
D.O. 2.8 mg/L

PL-MW-112B(D)
D.O. 2.9 mg/L

WEST BOUNDARY ROAD

PL-MW-113C(D)
D.O. 4.2 mg/L

PL-MW-113A(S)
D.O. 2.6 mg/L

MW-POLA-118
D.O. 3.2 mg/L

LANDFILL 26

GROUNDWATER TREATMENT FACILITY

PL-MW-105
D.O. 6.4 mg/L

PL-MW-106
D.O. 5.2 mg/L

PL-MW-107
D.O. 6.5 mg/L

PL-MW-108
D.O. 3.3 mg/L

PL-MW-116
D.O. 6.7 mg/L

SLOPE

ABERDEEN ROAD

DRAINAGE

LEVEE CONSTRUCTION HAUL ROAD

2.0

1.0

PL-MW-109
D.O. 5.5 mg/L

PL-MW-103
D.O. 0.7 mg/L

MW-POLA-119
D.O. 1.9 mg/L

PL-MW-110
(ABANDONED)

PL-MW-114
D.O. 1.4 mg/L

1.0

2.0

0.5

PL-MW-104
D.O. 0.6 mg/L

FORMER TANK FARM

FORMER LOCATION OF AST-2

0.5

LEVELED AREA

PL-MW-101(D)
D.O. 0.5 mg/L

MW-POLA-121 (S)
D.O. 0.6 mg/L

MW-POLA-120
D.O. 2.6 mg/L

PL-MW-115
D.O. 1.0 mg/L

2.0

LEGEND

- FENCE
- PAVEMENT BOUNDARY
- EXISTING MONITORING WELL
- 0.5 DISSOLVED OXYGEN CONCENTRATION CONTOUR (mg/L)
- ND NOT DETECTED
- (S) SHALLOW MONITORING WELL
- (D) DEEPER MONITORING WELL

SCALE
0 80 160 FEET

FIGURE 5-4

DISSOLVED OXYGEN (DO) CONCENTRATIONS
MARCH/APRIL 1998
POL OUTPARCEL
BRAC PROPERTY
HAMILTON ARMY AIRFIELD

PREPARED FOR

USACE SACRAMENTO DISTRICT
TOTAL ENVIRONMENTAL RESTORATION CONTRACT

IT INTERNATIONAL TECHNOLOGY CORPORATION

BRAC POL

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DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
BRAC POL	RDB 10/15/99	MMS 12/16/99	762538-B520

N

PL-MW-111A(S)
CH4 ND

PL-MW-111B(D)
CH4 ND

FORMER ABERDEEN ROAD

DRAINAGE DITCH

MW-POLA-117A(S)
CH4 ND

MW-POLA-117B(D)
CH4 ND

WEST BOUNDARY ROAD

MW-POLA-118
CH4 ND

GROUNDWATER TREATMENT FACILITY

PL-MW-112A(S)
CH4 ND

PL-MW-113C(D)
CH4 0.0059 mg/L

LANDFILL 26

PL-MW-105
CH4 ND

PL-MW-112B(D)
CH4 ND

PL-MW-113A(S)
CH4 ND

PL-MW-106
CH4 0.0046 mg/L

PL-MW-108
CH4 ND

PL-MW-107
CH4 ND

SLOPE

ABERDEEN ROAD

DRAINAGE

LEVEE CONSTRUCTION HAUL ROAD

PL-MW-116
CH4 ND

PL-MW-109
CH4 ND

FORMER TANK FARM

PL-MW-103
CH4 0.01 mg/L

MW-POLA-119
CH4 ND

PL-MW-104
CH4 0.15 mg/L

PL-MW-110
(ABANDONED)

PL-MW-114
CH4 0.13

0.1

0.01

1.0

FORMER LOCATION OF AST-2

MW-POLA-121 (S)
CH4 0.6 mg/L

PL-MW-115
CH4 0.052 mg/L

LEVELED AREA

PL-MW-101(D)
CH4 3.2 mg/L

MW-POLA-120
CH4 ND

LEGEND:

- FENCE
- PAVEMENT BOUNDARY
- EXISTING MONITORING WELL
- 0.1 — METHANE CONCENTRATION CONTOUR (mg/L)
- ND NOT DETECTED
- (S) SHALLOW MONITORING WELL
- (D) DEEPER MONITORING WELL

SCALE

0 80 160 FEET

FIGURE 5-5

METHANE (CH4) CONCENTRATIONS
SEPTEMBER/OCTOBER 1998
POL OUTPARCEL
BRAC PROPERTY
HAMILTON ARMY AIRFIELD

PREPARED FOR

USACE SACRAMENTO DISTRICT
TOTAL ENVIRONMENTAL RESTORATION CONTRACT

INTERNATIONAL TECHNOLOGY CORPORATION

meth091098

DRAWN BY	RDB	CHECKED BY		DRAWING NUMBER
	10/15/99	APPROVED BY		762538-B521

N

PL-MW-111A(S)
Fe2+ 0.02

PL-MW-111B(D)
Fe2+ 0.01

FORMER ABERDEEN ROAD

DRAINAGE DITCH

MW-POLA-117A(S)
Fe2+ ND

MW-POLA-117B(D)
Fe2+ ND

WEST BOUNDARY ROAD

PL-MW-113C(D)
Fe2+ ND

MW-POLA-118
Fe2+ 0.81

GROUNDWATER TREATMENT FACILITY

PL-MW-112A(S)
Fe2+ 0.01

PL-MW-112B(D)
Fe2+ ND

LANDFILL 26

PL-MW-105
Fe2+ ND

PL-MW-113A(S)
Fe2+ 0.01

PL-MW-106
Fe2+ ND

PL-MW-108
Fe2+ 0.05

SLOPE

PL-MW-116
Fe2+ 0.01

PL-MW-107
Fe2+ ND

ABERDEEN ROAD

DRAINAGE

LEVEE CONSTRUCTION HAUL ROAD

PL-MW-109
Fe2+ 0.03

MW-POLA-121 (S)
Fe2+ 2.88

PL-MW-103
Fe2+ 0.29 mg/L

0.1

1.0

MW-POLA-119
Fe2+ 0.08

PL-MW-104
Fe2+ 0.01

PL-MW-110
(ABANDONED)

PL-MW-114
Fe2+ ND

FORMER LOCATION OF AST-2

PL-MW-115
Fe2+ ND

LEVELED AREA

PL-MW-101(D)
Fe2+ 0.22

MW-POLA-120
Fe2+ ND

FORMER TANK FARM

LEGEND:

- FENCE
- PAVEMENT BOUNDARY
- EXISTING MONITORING WELL
- 0.02 FERROUS IRON CONCENTRATION CONTOUR (mg/L)
- ND NOT DETECTED
- (S) SHALLOW MONITORING WELL
- (D) DEEPER MONITORING WELL

SCALE
0 80 160 FEET

FIGURE 5-6
FERROUS Fe^{2+})
CONCENTRATIONS
SEPTEMBER/OCTOBER 1998
POL OUTPARCEL

BRAC PROPERTY
HAMILTON ARMY AIRFIELD

PREPARED FOR

USACE SACRAMENTO DISTRICT
TOTAL ENVIRONMENTAL
RESTORATION CONTRACT

INTERNATIONAL TECHNOLOGY CORPORATION

BRAC POL

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DRAWN BY	CHECKED BY	DRAWING NUMBER
RDB 10/15/99	APPROVED BY	762538-B522

N

PL-MW-111A(S) Eh 145

PL-MW-111B(D) Eh 172

FORMER ABERDEEN ROAD

DRAINAGE DITCH

MW-POLA-117A(S) Eh 231

MW-POLA-117B(D) Eh 242

WEST BOUNDARY ROAD

PL-MW-113C(D) Eh 184

MW-POLA-118 Eh 186

GROUNDWATER TREATMENT FACILITY

PL-MW-112A(S) Eh 205

PL-MW-112B(D) Eh 191

PL-MW-105 Eh 350

PL-MW-113A(S) Eh 205

LANDFILL 26

PL-MW-106 Eh 131

PL-MW-108 Eh 255

PL-MW-116 Eh 286

PL-MW-107 Eh 285

PL-MW-109 Eh 216

SLOPE

ABERDEEN ROAD

DRAINAGE

LEVEE CONSTRUCTION HAUL ROAD

FORMER TANK FARM

MW-POLA-119 Eh 144

PL-MW-103 Eh 80

PL-MW-104 Eh -50

PL-MW-110 (ABANDONED)

PL-MW-114 Eh 226

-50 0 100

FORMER LOCATION OF AST-2

MW-POLA-121 (S) Eh -62

-100

PL-MW-115 Eh 11

-50 0 100

LEVELED AREA

PL-MW-101(D) Eh -229

MW-POLA-120 Eh 183

LEGEND

- FENCE
- PAVEMENT BOUNDARY
- EXISTING MONITORING WELL
- 50 OXIDATION/REDUCTION POTENTIAL (millivolts)
- ND NOT DETECTED
- (S) SHALLOW MONITORING WELL
- (D) DEEPER MONITORING WELL

SCALE

0 80 160 FEET

FIGURE 5-7

OXIDATION/REDUCTION POTENTIAL (Eh)
SEPTEMBER/OCTOBER 1998
POL OUTPARCEL
BRAC PROPERTY
HAMILTON ARMY AIRFIELD

PREPARED FOR

USACE SACRAMENTO DISTRICT
TOTAL ENVIRONMENTAL RESTORATION CONTRACT

IT INTERNATIONAL TECHNOLOGY CORPORATION

BRAC POL

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RDB	MMS 12-16-98	762538-B523
10/15/99	APPROVED BY Ans 12/16/98	

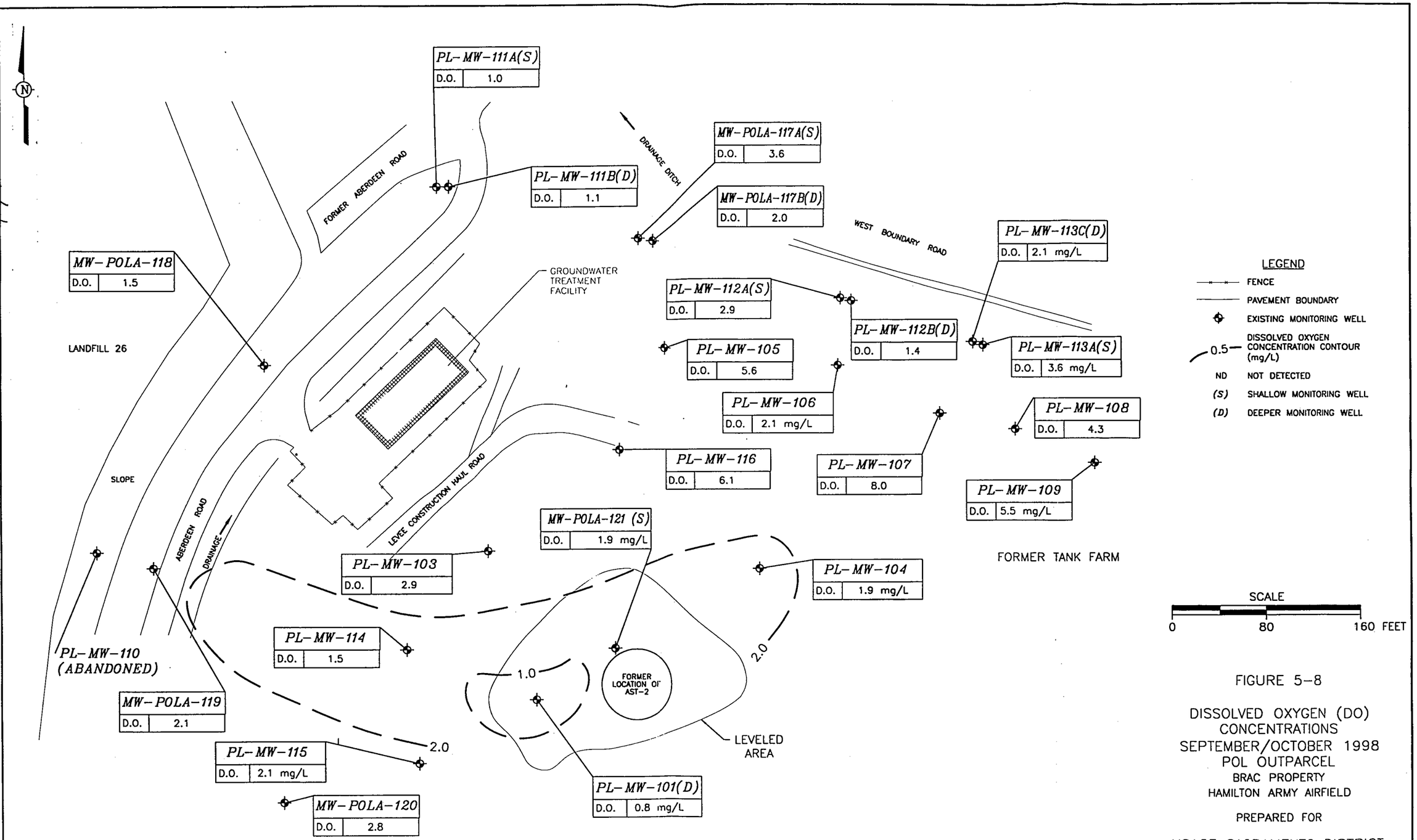

FIGURE 5-8

DISSOLVED OXYGEN (DO) CONCENTRATIONS
SEPTEMBER/OCTOBER 1998
POL OUTPARCEL
BRAC PROPERTY
HAMILTON ARMY AIRFIELD

PREPARED FOR

USACE SACRAMENTO DISTRICT
TOTAL ENVIRONMENTAL RESTORATION CONTRACT

INTERNATIONAL TECHNOLOGY CORPORATION

BRAC POL

doc091098

TABLE A-1
Monitoring Well Construction Details
POL Outparcel, Hamilton Army Airfield

Well Number	Date Completed	Drilled Depth (ft)	Well Depth (ft)	Borehole Diameter (in)	Screen Interval (ft)	PVC Stickup	Ground Elevation (ft above MSL)	Depth to Water (ft bgs)	Steel Monument Stickup (ft)
MW-101	1/31/1991	53.0	49.6	10	29.8-49.3	0	47.1	28.0	0.5
MW-103	1/30/1991	27.0	26.8	10	11.5-26.5	0	14.8	1.0	0.5
MW-104	1/31/1991	42.8	42.6	10	27.8-42.3	0	24.8	18.8	0.5
MW-105	12/27/1990	19.8	19.5	10	4.8-19.2	0	9.1	8.8	0.5
MW-106	1/23/1991	18.0	17.6	10	7.8-17.3	0	4.4	5.7	0.5
MW-107	1/23/1991	17.3	17.0	10	7.2-16.7	0	4.6	7.2	0.5
MW-108	1/24/1991	17.2	16.9	10	7.1-16.6	0	4.5	7.1	0.5
MW-109	1/25/1991	18.2	18.0	10	8.1-17.7	0	5.2	6.9	0.5
MW-110*	1/17/1991	17.1	16.8	10	6.9-16.5	0	17.5	7.3	0.5
MW-111A	1/18/1991	17.4	17.1	10	7.3-16.8	0	5.2	3.1	0.5
MW-111B	1/28/1991	29.5	29.3	10	24.0-29.0	0	5.2	3.9	0.5
MW-112A	1/22/1991	17.1	17.1	10	7.4-16.9	0	1.7	13.7	0.5
MW-112B	1/18/1991	29.8	29.5	10	24.7-29.2	0	1.8	1.5	0.5
MW-113A	1/22/1991	17.0	16.5	10	6.7-16.2	0	2.6	5.9	0.5
MW-113C	1/29/1991	30.0	29.8	10	24.0-29.5	0	2.8	3.5	0.5
MW-114	8/18/1992	27.8	27.3	10	12.0-27.0	0	20.6	6.7	0.5
MW-115	8/21/1992	28.0	27.8	10	17.5-27.5	0	22.5	7.6	0.5
MW-116	3/1/1994	35.0	21.6	8.5	11.3-21.3	2.15	15.8	6.2	2.5
MW-117A	10/18/1996	17.6	15.0	10.0	5.0-15.0	3.2	5.26	no data	3.1
MW-117B	10/19/1996	28.0	26.0	10.0	16.0-26.0	2.1	5.15	no data	2.4
MW-118	10/24/1996	16.4	15.0	10.0	5.0-15.0	2.1	12.39	no data	2.6
MW-119	10/11/1996	17.0	14.4	12.0	4.4-14.4	2.2	19.3	no data	3.0
MW-120**	1/30/1997	40	30.66	8.63	15.0-30.0	2.9	25.5	no data	3.6
MW-121	1/31/1997	40	32.67	8.63	7.0-32.0	2.4	46	no data	3.4

Sources: ES, 1993;USACE, 1994; IT,1999
All wells have 4" Schedule 40 PVC pipe, with 0.010 inch slot screens
All wells installed according to USATHAMA geotechnical specifications, with a minimum of 2.0 ft of grout/cement seal and 2.0 ft of bentonite seal
* Abandoned in place sometime after 1992
** Abandoned and destroyed in 1999 to permit development of the area
Abbreviations: ft = feet, in = inches, MSL = mean sea level, bgs = below ground surface