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Final

TCE Plume Delineation & Source Investigation Work Plan
Tow Way Fuel Farm

Naval Station Roosevelt Roads

RCRA/HSWA Permit No. PR2170027203

Ceiba, Puerto Rico

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LIST OF ACRONYMS AND ABBREVIATIONS

bgs	below ground surface
CAO	Corrective Action Objectives
CMS	Corrective Measures Study
CMSI	Corrective Measures Study Investigation
DNAPL	Dense, Non-aqueous Phase Liquid
DO	Dissolved Oxygen
FMTUD	Facility Management Transportation and Utility Divsion
HESI	Heartland Environmental Services, Inc.
IDW	Investigation Derived Waste
LANTDIV	Atlantic Division Naval Facilities Engineering Command
LNAPL	light, non-aqueous phase liquid
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
MCL	Maximum Contaminant Level
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NSRR	Naval Station Roosevelt Roads
NTR	Navy Technical Representative
PID	Photoionization Detector
PSH	Phase Separated Hydrocarbons
PVC	polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SOP	Standard Operating Procedure
SWMU	Solid Waste Management Unit
TCE	Trichloroethene
TCL	Target Compound List
TWFF	Tow Way Fuel Farm
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

1.0 INTRODUCTION

The Tow Way Fuel Farm (TWFF), located at Solid Waste Management Unit (SWMU) 7/8, Naval Station Roosevelt Roads (NSRR), located near Ceiba, Puerto Rico, has been the subject of numerous investigations, even before the implementation of Resource Conservation and Recovery Act (RCRA) corrective action requirements. A full RCRA Facility Investigation (RFI) (Baker, 1997) has been performed, along with a United States Environmental Protection Agency (USEPA) approved RFI report for the Tow Way Fuel Farm. Additional investigations since the RFI include the Additional Well Installation (Baker, 1998), Corrective Measures Study Investigations (CMSI) (Baker, 1999), Hydraulic Characteristics Evaluation (McLaren Hart, 1999), Trichloroethene (TCE) Investigation Report (Baker, 2000), and Pier 1 Report of Findings authored by McLaren-Hart (McLaren-Hart, 2000). During the CMS, TCE was found at the TWFF in monitor well 7MW07. As a result of the various investigations and in support of ongoing efforts on the Corrective Measures Study (CMS), various additional data requirements were identified. On December 19, 2000, a meeting to present a conceptual approach on gathering the necessary data to support the CMS was held at EPA Region II New York office. In addition, on May 23, 2001 discussions continued on data collections to include data for the groundwater model being developed. It was agreed by all that a work plan to address the data needs should be developed. A work plan for additional data collection was developed and implemented as a result of those discussions (Baker, 2001). During this additional data collection effort, TCE concentrations in monitor well 7MW07 were found to have increased fourteen-fold, from 2,000J micrograms per liter (µg/L) in April 1998, to 28,000J µg/L in January 2002, a period of approximately four years (Baker, 2003a). Because of this increase in concentration, additional characterization of the source of this TCE was recommended in the Draft Final Task I CMS prior to finalization of the CMS (Baker, 2003b). It should be noted that the CMS process for the TCE plume at the TWFF is being dealt with separately from the CMS at the TWFF addressing the phase separated hydrocarbons (PSH). The TCE plume at the TWFF is located in a different area outside the known PSH contamination. An independent CMS for the TCE plume at the TWFF will be developed for the site separately from the current Final CMS Task I Report (Baker, 2003b) for the TWFF, addressing those contaminants associated with the TCE contamination at the site.

1.1 Objectives

This work plan is developed in order to identify the TCE source to the extent practical, to delineate the dissolved TCE plume at this point in time, and to assist in providing alternatives to addressing the TCE contamination in the CMS.

The TCE source may be in the form of a residual or mobile phase dense, non-aqueous phase liquid (DNAPL) located in the subsurface soil and/or groundwater near Building 46. It should be noted that this source would be a result of a historical release. No activities resulting in ongoing contamination at this site are occurring at the present time.

The TCE investigation area at TWFF is shown on Figure 1-1. The objectives and specific elements of the field effort to be performed include:

- A soil sampling program in the TCE investigation area to determine if a TCE source is present in a residual or mobile phase form of a DNAPL near monitor well 7MW07 and/or Building 46.
- A groundwater monitor well installation program to provide monitoring points downgradient of the dissolved TCE plume, including a sentinel groundwater monitor well at an appropriate depth in the aquifer.
- Sampling of new and select existing groundwater monitoring wells to establish the extent of the dissolved TCE plume at this point in time.

1.2 Organization of the TCE Plume Source Delineation Work Plan

This work plan is organized into seven sections. Section 1.0 of this document includes the objectives of this TCE plume source investigation. Section 2.0 provides a description of the current conditions of the site, including the history of the TCE area of the TWFF, a discussion of the geology and hydrogeology, as well as the nature and extent of contamination. Section 3.0 provides a description of the scope of investigations that will be utilized during the upcoming fieldwork. The proposed scope of investigations include historical information, soil sampling and analysis program, monitor well installation program, groundwater sampling and analysis program, quality assurance/quality control (QA/QC) samples, DNAPL composition, as well as other investigation considerations. The reporting activities that will be conducted following the completion of the field investigation are described in

Section 4.0. Section 5.0 discusses the proposed project schedule that will followed for this additional data collection investigation. The site management structure that will be utilized during this investigation, including project team responsibilities and field reporting requirements, is presented in Section 6.0, while Section 7.0 presents the report references.

2.0 CURRENT CONDITIONS

The following section is a discussion of the current conditions that exist in the TCE area at the TWFF.

2.1 TCE Area History

As stated in Section 1.0, the CMS Investigation findings revealed that TCE was present in the groundwater in monitor well 7MW07 at a concentration of 2000J ug/L. TCE was also detected at an estimated concentration of 3 µg/L in monitor well 7MW08 (Baker, 1999). After these concentrations were detected in the groundwater, a history of the buildings in proximity to 7MW07 was compiled based on interviews with station personnel. A substantial structure (Building 46), located on the building pad immediately northeast of 7MW07 (between Forrestal Drive and the well), was destroyed during Hurricane Hugo in September 1989. Subsequently, another structure comprised of a half-cylindrical structure constructed of cloth over a frame anchored to the existing concrete slab, was destroyed during Hurricane Georges in September 1998. The first building was reportedly used for the storage and maintenance of small watercraft used in various harbor operations. While the repair activities had apparently been somewhat limited, the fact that maintenance was performed indicates the potential for cleaning and degreasing operations. This activity could potentially have led to a release of solvents. Also, it is unclear to what extent the buildings were used for storage and what was stored. The potential of a release of stored material in the past must be considered.

2.2 Geology and Hydrogeology – TCE Area of the TWFF

Several reports have documented the regional geology and the TWFF geology at this location (i.e. Baker, 2003a). This section will focus on the geology and hydrogeology as it is currently understood in the immediate location of the TCE plume.

During the previous TCE Investigation, several borings were advanced during temporary well installation. Two transects, A-A' and B-B,' of the underlying geology in the TCE area were constructed based on the interpretation of the geology in the borings. The location of these transects, as well as locations of the temporary wells used for lithology descriptions, are shown on Figure 2-1. Figures 2-2 and 2-3 depict the lithology found in the vertical transects A-A' and B-B'.

Four different formations are shown in these transects. Two unconsolidated formations, namely fill material and marine deposits, and two bedrock layers, namely decomposed and lithofied were logged during well construction and noted on these drawings. The fill material consists predominantly of rock fragments, with lesser amounts of sand, silt, and clay. In the area of TW-2 and TW-3, the fill material consisted mostly of cobbles and boulders (Baker, 2000). Fill generally extends from the ground surface to 5 to 10 feet below ground surface (bgs) except in the areas near Forrestal Road, where the fill material extends only about 1.5 feet bgs. Marine deposits were found near Ensenada Honda, in TW-101 through TW-104. Marine sediments generally consist of sand and shell fragments. It was estimated that the marine deposits are thickest near TW-101 (4 feet bgs to 20 feet bgs) (Baker, 2003a).

Bedrock at TWFF generally consists of gabbro, described as very broken to broken, massively bedded, hard to very hard, and highly fractured due to tectonic deformation and subsequent weathering. The decomposed bedrock was generally observed as unlithofied silt, clay, and rock fragments in varying amounts. The lithofied bedrock was observed to be weathered and unweathered. The fracturing of the weathered bedrock varies in the number of fractures, but is fairly consistent in color (brown). Unweathered bedrock appears very hard, little to no fracturing, dark gray to black in color, and with an intact crystalline structure.

The depth and thickness of the decomposed and lithofied bedrock varies considerably. The decomposed bedrock was thickest in the area of 7MW07. The top of this unit dips downward from Forrestal Road toward Ensenada Honda, where it is covered by the marine deposits and fill material. The top of the lithofied bedrock was observed to be the deepest in the area of TW-1 and TW-B.

Figures 2-2 and 2-3 depict the top of the groundwater bearing zone as it was encountered during drilling operations of the TCE Investigation (Baker, 2000). Soil saturation observations were used in drawing this zone . In general, saturated soils were found anywhere from 5 feet bgs to 20 feet bgs. The presence of groundwater is controlled by secondary porosity (fractures) in the hard bedrock formation, as well as encountered during deeper drilling. The groundwater table slopes toward Ensenada Honda as shown on Figure 2-4. The groundwater contours depicted on this figure are average values from groundwater level measurements taken over a period of four years (Baker, 2003b), with the exception of monitor well 7MW10 and 7MW20, which were constructed in January 2002.

2.3 Nature and Extent of Contamination

During the CMS Investigation (Baker, 1998), dissolved TCE was detected in and around 7MW07 at a concentration of 2000J ug/L. Monitor well 7MW07 is screened from 5 feet to 25 feet bgs. During a subsequent TCE investigation, several temporary wells, both shallow and deep, were installed and sampled in the vicinity of 7MW07, as presented on Figure 2-1 (Baker, 2000). Groundwater samples from these wells were analyzed using an on-site mobile laboratory with a select number of split samples sent to a stateside analytical laboratory for confirmation. Groundwater was not purged prior to sampling and was sampled with a bottom filling bailer in order to allow for detection of the possible presence of DNAPL in the groundwater.

The TCE Investigation Report (Baker, 2000) documents the TCE concentration at 7MW07 again at 2000 ug/L with an on-site laboratory. In addition, a temporary well placed next to 7MW07 (7-TCE-MW07), and screened from 30 feet to 35 feet bgs, was sampled with a TCE concentration of 1,000 µg/L by a stateside laboratory. Another temporary well located approximately 50 feet southeast of 7MW07 (TW-C), and screened from 17 feet – 22 feet bgs (shallow) and again from 21 feet to 26 feet bgs (deep), had TCE concentrations of 25 ug/L and 1500 ug/L in the shallow and deep zones. The remaining TCE concentrations found in this investigation ranged from non-detect to 140 ug/L, with the higher concentrations found in the deeper wells.

During the Additional Data Collection Investigation (Baker, 2003a), TCE was again measured in monitor well 7MW07 with the result being a concentration of 28,000J ug/L. The concentration of TCE in the field QA/QC duplicate was found to be 23,000J ug/L. (Note that both concentrations were quantified as estimated by the laboratory based on sample dilutions.) These concentrations are approximately 2.5 percent of the solubility of TCE (TCE solubility is ~1,100,000 ug/L). The presence of DNAPL is suspected at concentrations in groundwater over 1 percent of the solubility of a compound (USEPA, 1992). Because the TCE concentration in 7MW07 is over 1 percent of its solubility, DNAPL may be present in the vicinity of this well. Four other monitor wells also had very small estimated concentrations of TCE during the Additional Data Collection Investigation. These include monitor wells 7MW08, UGW11, and 7MW20 in the area of the lower TWFF. All concentrations were estimated at less than 1 ug/L. (Monitor well 7MW18, located in the upper TWFF, not within the study area as presented on Figure 1-2, also had a small detection of TCE.) A newly installed well, 7MW10, located downgradient of 7MW07, was sampled during this investigation with the result being non-detection of TCE. It should be noted, however, that the screen

of this well was installed from 4 feet to 14 feet bgs, most likely too shallow to intercept the TCE plume should it have traveled to this point. A temporary well installed during the previous TCE Investigation near this location (TW-102), and screened from 17 feet to 22 feet bgs, yielded a TCE detection of 5.4 ug/L during the TCE Investigation (Baker, 2000). All previous concentrations of TCE found in the study area can be seen on Figure 2-5.

3.0 SCOPE OF INVESTIGATIONS

The additional investigation at the TCE plume area of the TWFF will consist of the following:

- Review of historical information
- Analysis of subsurface soil from up to 15 soil borings, including analysis of saturated soil borings
- Installation of up to 10 temporary wells and 4 permanent monitor wells, including a sentinel well downgradient of 7MW07
- Groundwater sampling of these new wells along with 7MW07, 7MW08, 7MW10, 7MW20, and UGW11.

Should free (i.e. not residual) DNAPL be available to be collected from any samples (either from a soil sample or a groundwater sample), this will also be analyzed to obtain its composition. A sample matrix for this investigation is provided as Table 3-1. The various investigation elements are described in detail in the subsections that follow.

3.1 Historical Information

DNAPL is often difficult to locate, therefore, having background information can help in narrowing the investigation area. A DNAPL investigation should be based on historical information that includes:

- Current and historical utilities – Solvents were often poured down drains, which provided a potential pathway to the environment due to the drainpipes often being cracked or broken.
- Personnel Interviews and Aerial Photographs – These provide information on site history and activities.
- Chemical information – Inventories and disposal records can provide clues as to chemical types and potential quantities, which ultimately affect the potential for DNAPL, as well as whether it is in free-phase or residual-phase form.
- Stratigraphy – DNAPL tends to accumulate in capillary barriers or traps (stratigraphic lows where higher permeable sediment overlay lower permeable sediments), which would inhibit continued downward movement.

Baker already has complied a general history regarding buildings and operations at the site, as well as site stratigraphy. Current information suggests a possible TCE DNAPL source in the vicinity of Building 46 and well 7MW07. Any additional and available information regarding utilities and chemical use will be reviewed prior to initiation of field activities.

3.2 Soil Sampling and Analysis Program

There were no soil samples obtained for analysis during the TCE Investigation (Baker 2000). During the Additional Data Collection Investigation, both surface and subsurface soil samples were analyzed for Appendix IX volatile organic compound (VOC) parameters, but these samples were not located in the TCE area.

In order to provide information of a possible source of the TCE in the soil around 7MW07, up to 15 soil borings will be advanced down to the lithofied unweathered bedrock, including both the vadose and the saturated zones. The source of the TCE is likely to be located around Building 46 (currently a concrete pad), based on the history of that building and the location of monitor well 7MW07, where TCE was detected above the 1 percent of solubility rule-of-thumb for DNAPL likelihood, either in a residual form or a mobile form. This TCE source would likely be residual in form, and also located above an impermeable layer, either a small layer of lower conductivity or near the bottom of the weathered lithofied bedrock zone. Building 46 (currently a concrete pad) is also the location of a local stratigraphic low between the interface of decomposed bedrock and lithofied unweathered bedrock (Baker, 2000) where DNAPL would reach an impermeable barrier should it have migrated downward.

During DNAPL investigations, there is the potential for mobilization of DNAPL during drilling or other investigation activity. One precaution to avoid mobilization includes avoiding complete penetration of capillary barriers during drilling. Another precaution to be considered is using an "outside–in" approach. Soil borings located outside the DNAPL zone will be drilled first to establish stratigraphy (including any capillary barriers) and to delineate uncontaminated soils. Soil borings located within the suspected DNAPL zone will be drilled last. If DNAPL is encountered, the borings will not be advanced through any capillary barriers or into the lithofied bedrock.

All soil borings will be advanced using a drill rig capable of augering, air rotary, coring, and air hammering. Soil samples will be collected continuously from the ground surface to the top of

lithofied bedrock using split-spoon samplers. Care will be taken to achieve maximum recovery so that a good stratigraphic profile can be developed. A boring log will be maintained indicating, among other things, blow counts, lithology, and water occurrence. Soil samples will initially be screened at 6-inch intervals with a photoionization detector (PID) to develop a semi-quantitative contaminant profile. A hydrophobic dye shake test will be performed on soil suspected of containing residual DNAPL (based on elevated PID readings). A standard operating procedure (SOP) for the dye shake test is given in Appendix A. A hydrophobic dye called Sudan IV, will be used to identify the presence of DNAPL. Sudan IV will preferentially stain organic liquids red. This test is qualitative, and provides a positive or negative result for the presence of DNAPL in a sample. Up to three unsaturated and/or saturated soil samples will be taken from areas of the soil core suspected of being contaminated based on visual, PID, and/or dye shake test screening results. A final saturated soil sample will be collected from the bottom of the boring just prior to refusal.

All soil samples will be analyzed for a modified target compound list (TCL) VOCs. This modified TCL VOC list was determined by a review of all analytical data received during previous groundwater investigations in the TCE area, including the Corrective Measures Study Investigation (1998), the TCE Investigation (1999), and the Additional Data Collection Investigation (2001). Summaries of these analyses are provided in Appendix B. Any compound that was detected that would be associated with a chlorinated solvent plume was added to the modified TCL VOC list. In addition, those chlorinated compounds not detected in previous investigations, but also known to be associated with chlorinated solvents, were also included in the modified TCL VOC list. These include tetrachloroethene, 1,1,1 trichloroethane, and its associated daughter products of 1,1, dichloroethane, and 1,2 dichloroethane. The modified TCL VOC list includes the following compounds:TCE, cis-1,2-dichloroethene, trans-1,2-dichloroethene, 1,1-dichloroethene, vinyl chloride, 1,1,2 trichloroethane, 1,1,1 trichloroethane, tetrachloroethene, 1,2 dichloroethane, 1,1 dichloroethane, chloroform, methylene chloride, pentachloroethane, and chloromethane. This list is also presented in Table 3-1.

This work plan is dynamic in that the boring locations are subject to change based on findings as the work progresses. Due to the above-mentioned considerations, the majority of the soil borings will initially be located southwest of the Building 46 pad. Two borings (7TCESB01 and 7TCESB02) will be located downgradient of the building pad in case the source has migrated in this direction. The first soil boring to be installed southwest of Building 46 pad will be labeled 7TCESB01. In these locations outside the suspected source area, it is expected that up to four soil samples will be collected. A minimum of eight locations (7TCESB01 through 7TCESB08) will be sampled as presented on Figure

3-1. Soil sampling will continue up to 15 locations based on PID, visual, and dye shake test results. If an area of suspected high concentrations (i.e. a source) is found, this area will be delineated to the extent possible using the "outside-in" approach. Should a source area be suspected, the sampling will continue beginning at a location approximately 30 feet from the source area in directions where delineation has not already been determined, and working inward in 15 foot intervals to the original suspected source area until it is delineated. PID readings, visual observations, and the results of the dye shake test will be used to determine if delineation has been made in the field. Finally, the presence or absence of a TCE source near the other three sides of Building 46 will be established via soil sampling from soil borings (7TCESB06 – 7TCESB08) presented on Figure 3-1. If one or all of these three soil borings contain TCE, further delineation will occur using the "outside-in" approach mentioned above.

The soil sample designations will be as follows. The first soil sample will be designated 7TCESB01. Extensions to these sample identifications will reflect the depth at which the sample was obtained. For the purposes of this work plan, two-foot discretized depths will be used. Sample identification extensions will follow the pattern shown below.

7TCESB01-01—1 to 3 feet bgs
7TCESB01-02—3 to 5 feet bgs
7TCESB01-03—5 to 7 feet bgs
7TCESB01-04—7 to 9 feet bgs, etc.

The actual environmental samples will be determined in the field.

Samples will be packed in ice and shipped next day air to the "fixed base" laboratory. Because of previously encountered delays associated with sample shipments from Puerto Rico to the United States, additional insurance to cover re-sampling costs should be claimed on the bill of laden. At least one member of the field team will remain on the island until verification by the laboratory of receipt of all shipments. This will minimize any potential re-sampling costs associated with mobilization. Tracking numbers for each shipment will be forwarded to the project manager for assisting in verification of receipt.

All VOC analysis at the laboratory will be performed using current methodologies as presented in Table 3-2. STL in Savannah, Georgia will perform the laboratory analysis, and Heartland Environmental Services, Inc. (HESI) in St. Charles, Missouri will perform the data validation.

3.3 Monitor Well Installation Program

Up to ten temporary monitor wells, labeled sequentially beginning with 7TCETW201, will be installed to assess changes in concentrations in the TCE plume in groundwater since year 1999, as well as to assist in locating permanent wells. These temporary wells will be installed to maximize the likelihood of intercepting the highest dissolved TCE concentrations. During the TCE investigation, the bulk of the higher concentrations were located at the deepest sampling location, that is, in the weathered and lithofied bedrock zone as shown in Figures 2-2 and 2-3. The same zone will be located for the well installations in this investigation. It is expected that the same geologic descriptions will be used and a determination of the proper depth of well installation will be made in the field. In order to provide consistency between the TCE Investigation (2000) and this investigation, the wells will be installed to a depth of one to two feet below the top of the lithofied bedrock. However, some temporary wells will be located close to soil borings around the former Building 46. If, during the soil sampling effort, a residual or mobile phase DNAPL is identified in a soil boring located less than 50 feet away from the proposed temporary monitoring well location, one well screen will be set to coincide with the depth of the DNAPL detection at the location of identified residual or mobile phase DNAPL. Another well will be installed adjacent to this location with the well screen set at a depth of one to two feet below the top of the lithofied bedrock in order to accurately assess the vertical pattern, if any, of the contaminant plume. Once the concentrations of TCE are known in the temporary wells, this information will be used to locate up to four permanent monitoring wells.

All monitor wells will be advanced using a drill rig capable of augering, air rotary, coring, and air hammering. All completed wells will be 2 inches in diameter. Each well will be logged and sampled continuously at 2-foot intervals unless otherwise noted. A boring log will be maintained indicating, among other things, lithology, and water occurrence. Soil borings will be logged to verify stratigraphy.

The determination of competent (or lithofied) will be made based on field observations. As shown on Figures 2-2 and 2-3, bedrock was categorized into two broad groups, decomposed and lithofied. Decomposed bedrock was observed to consist mainly of unconsolidated sand, silt, and/or clay with or

without rock fragments. Lithofied bedrock was observed to be rock fragments with or without trace amounts of unconsolidated sand, silt, and/or clay. Lithofied bedrock was observed to be weathered or unweathered. As weathered, the bedrock was generally brown in color, with evidence of fracturing. As unweathered, the bedrock was generally gray or black in color, with little or no evidence of fracturing. When field personnel observe a change in composition and/or color (to gray or black) in the recovered samples, the interface between the weathered and unweathered lithofied zones will be assumed, and the well installation will proceed.

The purpose of these new wells will be to obtain representative groundwater samples from a dissolved TCE plume, and as such, the screens will be located to obtain representative TCE plume concentrations (i.e. well screen will be set at 1 to 2 feet in the competent [or lithofied] bedrock and/or at a location consistent with any DNAPL detection that may have occurred during soil sampling). It should be noted that existing permanent monitor wells at TWFF have historically been screened to intersect the seasonal high and low water table to obtain light, non-aqueous phase liquid (LNAPL) thickness measurements and samples. To date, there have been no LNAPL detections at any of the wells located downgradient of Building 46 in the TCE area and this requirement will not be considered necessary in this investigation. All permanent monitor wells will be screened with a ten-foot screen length. Each temporary well will consist of 1- or 2-inch diameter, schedule 40 polyvinyl chloride (PVC), riser with a five-foot screen.

All permanent monitoring wells will use 20/40 sand filter pack to 2 feet above the top of screen, followed by a 2-foot bentonite seal. The remaining annulus will be grouted to surface and finished with a flush mount cover (round 6-inch bolt down well vault) inside a 2-feet by 2-feet cement pad. Drill cuttings generated during the installation of permanent wells will be handled as described in Section 3.6.2.

All new permanent monitor wells will be developed by continuously pumping the groundwater from the well using the drill rig pump and/or waterra pump, as described in the SOP section of the base RFI work plan (Baker, 1995). All development water will be captured in 55-gallon drums for disposal as described in Section 3.6.2. The monitor well will be allowed to recover overnight prior to sampling.

Each temporary well will be sealed with plastic sheeting at the surface to prevent inflow of surface water or accidental introduction of foreign material into the hole. A groundwater sample for a modified TCL VOC analysis (see Table 3-1) will be obtained from each temporary well after allowing

the groundwater to enter the screen overnight. A 24-hour turnaround time on analysis will be requested so that new permanent monitoring wells can be installed during the same field event.

3.3.1 Sentinel Well

The first temporary well to be installed will be at the proposed sentinel well location (7MW21 on Figure 3-1) at an appropriate depth, as mentioned above. This location will be called 7TCETW201. The well will be sampled after allowing the groundwater to enter the screen overnight. A 24-hour turnaround time on the analysis will be requested to determine whether the new permanent sentinel well will be installed in this location, or moved to a different location depending on the sample results. If the results of the analysis come back with positive detections for the modified TCL VOCs, the permanent sentinel well location will be moved toward Ensenada Honda to the extent practical. If the results of the analysis come back negative for detections of the modified TCL VOCs, a permanent sentinel well will be installed at this location. Once the permanent sentinel monitor well is installed, it will be labeled 7MW21.

3.3.2 Plume Area Temporary Monitor Wells

Up to nine additional temporary wells, besides the one located in the sentinel location, will be installed at locations close to those in the initial TCE investigation that had positive detections for TCE (Baker, 2000). These temporary monitor wells will be installed in order to establish current groundwater concentrations. A minimum of five temporary monitor wells will be installed as presented on Figure 3-1. Also shown on this figure are the locations of the 1999 TCE Investigation temporary wells. Again, these will be sampled, and the samples shipped and analyzed for modified TCL VOCs with 24-hour turnaround to determine suitable locations for the new permanent wells. Once the sample results are identified, they will be compared to their corresponding Federal Maximum Contaminant Level (MCL) to determine if another temporary well location will need to be established further out from the potential source area. If additional temporary monitor wells are deemed necessary, the field crew will install another temporary monitor well approximately 50 feet out from the previous temporary monitor well sampled. This temporary monitor well will be installed in the direction perpendicular to groundwater flow, which in this case, is parallel to the Ensenada Honda. Drill cuttings generated during the installation of temporary wells will be handled as described in Section 3.6.2.

3.3.3 Permanent Monitor Wells

Four permanent monitor wells, including 7MW21 (sentinel well), will be installed in various locations (Figure 3-1), based on the results of the rapid turnaround of the temporary monitor well sample analyses. One monitor well will be located in each source zone should a source be encountered that is not near the current well 7MW07. These source zone monitor wells will be named starting with well name 7MW24, and continuing up from there (i.e 7MW25, 7MW26, etc.), if required. However, if a source other than the one suspected in the area of 7MW07 is not found, then 7MW24 will not be installed. Two new monitor wells (7MW22 and 7MW23), will be located downgradient from 7MW07. These wells will assist in determining the extent of the dissolved TCE plume for purposes of assisting in the CMS process at the site. It is likely that these wells will be collocated with temporary well locations, should these locations be in a representative area of the plume and/or provide delineation. Potential locations for these new wells are shown on Figure 3-1.

3.4 Groundwater Sampling and Analysis Program

Figure 3-1 identifies the eight permanent monitor wells (4 new and 4 existing monitor wells) and 5 temporary wells selected for sampling. An additional 5 temporary monitor wells may be installed as mentioned in Section 3.3.2. The groundwater sampling is to assist in delineating the dissolved plume down gradient of the TCE source area. The eight permanent monitor wells to be sampled are UGW11, 7MW07, 7MW08, 7MW20, 7MW21, 7MW22, 7MW23, and 7MW24. Monitor wells UGW11 and 7MW20, although they are located outside of the immediate investigation area, had small estimated detections of TCE during the Additional Data Collection Investigation (Baker, 2003a). As a result, these two wells will be sampled again to obtain confirmation of TCE in these locations.

Table 3-2 identifies the appropriate analytical method for each individual constituent to be reported by the laboratory. Section 3.2 describes the rationale for the selection of reported constituents. Individual constituents selected for analysis were based on a review of compounds associated with chlorinated solvent contamination, including degradation products, should they be present. All chlorinated compounds previously detected at TWFF were included in this constituent list. Also, chlorinated compounds not previously detected at TWFF but typically associated with chlorinated solvent plumes were included.

Prior to groundwater sample collection, each permanent and temporary well will be checked for the presence of DNAPL. An interface probe will be used to determine the depth to water and the depth to product. If product is detected in a given well, a bottom-filling bailer will be lowered to the bottom of the well to verify the presence of the DNAPL and thickness measured. If sufficient product is available for analysis the product will be drained from the bottom of the bailer into the appropriate sample container.

If DNAPL is present in one or more wells, a representative sample of DNAPL will be collected from one well located nearest the TCE source (Table 3-1) as described above. The analysis of DNAPL at the laboratory will be performed using current methodologies presented in Table 3-2. This analysis will assist in determining the DNAPL physical and chemical properties and its composition in order to assess various remedial alternatives. This analysis is dependent on locating and collecting a sufficient quantity of a free phase DNAPL, should it be present at this site.

The groundwater will be sampled using a low flow sampling technique. Appendix C includes a detailed description of low flow sampling technique. Field parameters of pH, temperature, turbidity, conductivity, and oxidation-reduction potential will be obtained with appropriate instrumentation during sampling. In addition, dissolved oxygen (DO) will be measured using colorimetric methods. If DNAPL is present in a well to be sampled, the intake will be placed above the interface and the flow rate will be low enough as not to draw in any product.

Samples will be packed in ice and shipped next day air to the “fixed base” laboratory. Because of previously encountered delays associated with sample shipments from Puerto Rico to the United States, additional insurance to cover re-sampling costs should be claimed on the bill of laden. At least one member of the field team will remain on the island until verification by the laboratory of receipt of all shipments. This will minimize any potential re-sampling costs associated with mobilization. Tracking numbers for each shipment will be forwarded to the project manager for assisting in verification of receipt.

All VOC analysis at the laboratory will be performed using current methodologies as presented in Table 3-2. STL in Savannah, Georgia will perform the laboratory analysis. In the case of the temporary wells, a 24-hour turnaround time will be required. Data validation will be performed by HESI in St. Charles, Missouri, on all groundwater samples collected.

3.5 Quality Assurance/Quality Control Samples

QA/QC requirements for the investigation are as follows and are identified in the sample matrix presented in Table 3-1.

3.5.1 Trip Blanks

Trip blanks will be required to accompany the samples because there are volatile organic constituent samples scheduled for collection. One trip blank sample will accompany each cooler containing samples requiring the modified TCL VOC analysis.

3.5.2 Equipment Rinsates

Equipment rinsate samples are collected from analyte-free water rinse of decontaminated equipment. Equipment rinsate blanks will be collected and submitted to an analytical laboratory for analysis. The results from the blanks will be used to determine if the sampling equipment was free of contamination. The rinsates are analyzed for the same parameters as the related samples.

It is anticipated that a total of three equipment rinsates will be collected. These samples will be associated with the subsurface soil and groundwater sampling. One of the samples will be obtained from a stainless steel spoon, while another will be collected using the split-spoon as presented on Table 3-1. The remaining sample will be collected using the silicon tubing used during the collection of groundwater.

3.5.3 Field Blanks

Field blanks consist of the source water used in equipment decontamination procedures. At a minimum, one field blank for each event and each source of water must be collected and analyzed for the same parameters as the related samples. It is anticipated that three different sources of water will be utilized for this investigation as shown in Table 3-1.

3.5.4 Field Duplicates

Field duplicate samples of the subsurface soil and groundwater will be collected during the same time the corresponding environmental sample is collected. One duplicate sample will be collected for every 10 subsurface soil and groundwater samples collected. A minimum of one duplicate sample will be collected of subsurface soil and groundwater during this investigation.

3.5.5 Matrix Spike/Matrix Spike Duplicates

Matrix Spike/Matrix Spike Duplicates (MS/MSDs) are laboratory derived and are collected to evaluate the matrix effect of the sample upon the analytical methodology. One MS/MSD will be collected for every 20 samples collected of a similar matrix. At a minimum, one MS/MSD will be collected during the subsurface soil sampling, while a minimum of one MS/MSD will be collected during the groundwater sampling.

3.6 Other Investigation Considerations

3.6.1 Utility Clearance

Fifteen days prior to the initiation of the proposed fieldwork, a digging permit request will be submitted by Baker to the Facility Management Transportation and Utility Division (FMTUD) of the Public Works Department at NSRR. All proposed soil borings and well locations will be cleared by the base utility department. Figure 3-2 presents the utilities that are located within the proposed investigation area.

3.6.2 Investigation Derived Wastes (IDW)

The generation of IDW associated with soil sampling and well installation, including development and purged water from groundwater sampling, will be collected and stored temporarily in 55-gallon drums. However, the soil cuttings from the subsurface soil sampling, as well as from the temporary monitor wells that are not converted to permanent monitor wells, will be placed back into the boring from which they came, unless contamination is present. As much as possible, soils last out of the hole will be returned first, thereby, approximating original stratigraphy.

Two IDW samples will be collected, one composite soil sample from all drums containing drill cuttings, and one aqueous sample from all drums containing development and purge water. The samples will be analyzed for parameters as shown in Table 3-1, as well as by methods presented in Table 3-2 . Upon completion of the field program, the drums will be moved and stored per the direction of PWD personnel. The soil and water IDW will be removed from the site by an approved vendor upon receipt and review of the IDW sample analytical data.

3.6.3 Decontamination

The drill rig, including all applicable soil sampling equipment (i.e. split-spoons, augers, etc.), will be decontaminated between each monitor well in accordance with the EPA approved RCRA Facility Investigation Work Plans (Baker, 1995). The remaining contaminant free sampling equipment and materials utilized during this investigation will be disposable.

3.6.4 Surveying

All sampling locations (soil borings and new temporary and permanent monitor wells) will be flagged in the field and will be surveyed for vertical (+/- 0.01 feet) and horizontal (+/- 0.1 feet) location using established control. The same firm that has performed previous work for Baker at the TWFF will perform the survey. This will ensure that the same level of survey quality and detail is attained.

3.6.5 Health and Safety Procedures

The Health and safety procedures found in the base RFI work plan (Baker, 1995), will be employed during this investigation.

3.6.6 Chain-of-Custody

Chain-of-Custody procedures will be followed to ensure a documented, traceable link between measurement results and the sample/parameter that they represent. These procedures are intended to provide a legally acceptable record of sample preparation, storage, and analysis.

To track sample custody transfers before ultimate disposition, sample custody will be documented using a similar chain-of-custody form as presented in the base RFI work plan (Baker, 1995).

A chain-of-custody form will be completed for each container in which the samples are shipped. After the samples are properly packaged, the shipping container will be sealed and prepared for shipment to the analytical laboratory.

4.0 REPORTING

This section outlines the reporting activities that are associated with the field investigation. A TCE Source Identification Report will be developed and is discussed in the following subsection.

4.1 TCE Source Identification Report

The TCE Source Identification Report will discuss the findings of the subsurface soil and groundwater sampling effort. The report shall include at a minimum:

Site History

Scope and Objectives

Sampling and Analysis Data

- Sampling and Analysis Results
- Comparison of April 1998; January 2002, with the TCE source identification sampling effort
- Comparison of soil sample data to EPA Region III RBCs. Comparison of groundwater data to EPA Region III RBCs, NSRR ecological screening values, and the established Corrective Action Objectives (CAOs) for TCE at the TWFF
- Laboratory sampling parameters and methods

Discussion on any necessary revisions to be made to the CMS Task I CAOs if required

Conclusions and Recommendations

Baker will incorporate the new sample data from the TCE plume delineation and source investigation into a new CMS Task I Report, which will include among other sections, an Ecological Risk Assessment section and a Human Health Risk Assessment section. This new CMS Task I Report will be developed utilizing the procedures listed in Appendix B of Module III of the Final RCRA/HSWA Permit No. PR2170027203 dated October 20, 1994 (USEPA, 1994).

5.0 SCHEDULE

A schedule for the implementation of this work plan, and follow-up reports for the TWFF, is provided as Figure 5-1. It should be noted that this schedule is dependent upon EPA review time. Many other factors can also extend the schedule such as resampling if further re-characterization is required, weather delays in the field, funding is delayed by the Navy, or consensus cannot be reached on how the USEPA's comments are to be incorporated.

6.0 SITE MANAGEMENT

An organization chart presenting the proposed staffing for this project is provided on Figure 6-1. This section also outlines the responsibilities and reporting requirements of field personnel and staff.

6.1 Project Team Responsibilities

Mr. Mark Kimes, P.E, will manage the Baker Project Team. His responsibilities will be to direct the technical performance of the project staff, costs and schedule, ensuring that QA/QC procedures are followed during the course of the project. He will maintain communication with the Atlantic Division Naval Facilities Engineering Command (LANTDIV) Navy Technical Representative (NTR), Mr. Kevin Cloe, P.E.

The field portion of this project will consist of one field team managed by the Environmental Scientist, Mr. Jon C. Edel, Jr. Mr. Edel's responsibilities include directing the Baker field team and subcontractors. Ms. Christine Harwood, P.E. will direct the reporting effort of the field investigation. Ms. Harwood will direct and ensure that all necessary staffing is utilized to assist in developing the TCE Source Identification Report for the TWFF.

6.2 Field Reporting Requirements

The Environmental Scientist will maintain a daily summary of each day's field activities. The following information will be included in this summary:

- Baker and subcontractor personnel on site
- Major activities of the day
- Samples collected
- Problems encountered
- Other pertinent site information

The Environmental Scientist will receive direction from the Project Manager regarding any changes in scope of the investigation.

7.0 REFERENCES

Baker Environmental, Inc. (Baker), 1995. Final RCRA Facility Investigation Management Plans, Naval Station Roosevelt Roads, Ceiba, Puerto Rico. September 14, 1995. Coraopolis, Pennsylvania.

Baker, 1997. Revised Draft RCRA Facility Investigation Report for Operable Unit 2 (SWMU 7/8), Naval Station Roosevelt Roads, Ceiba, Puerto Rico. June 16, 1997. Coraopolis, Pennsylvania.

Baker, 1998. Additional Well Installation Tow Way Fuel Farm Interim Corrective Measure, Naval Station Roosevelt Roads, Ceiba, Puerto Rico. March 6, 1998. Coraopolis, Pennsylvania.

Baker, 1999. Final Corrective Measures Study Investigations Tow Way Fuel Farm, Naval Station Roosevelt Roads, Ceiba, Puerto Rico. April 21, 1999. Coraopolis, Pennsylvania.

Baker, 2000. Final TCE Investigation Report for SWMU 7/8 – Tow Way Fuel Farm, Naval Station Roosevelt Roads, Ceiba, Puerto Rico. February 15, 2000. Coraopolis, Pennsylvania.

Baker, 2001. Final Work Plan for Additional Data Collection, Tow Way Fuel Farm, Naval Station Roosevelt Roads, Ceiba, Puerto Rico. September 27, 2001. Coraopolis, Pennsylvania.

Baker, 2003a. Final Additional Data Collection Investigation Report, Tow Way Fuel Farm, Naval Station Roosevelt Roads, Ceiba, Puerto Rico. April 22, 2003, Coraopolis, Pennsylvania.

Baker. 2003b. Final Corrective Measures Study, Task I Report, Tow Way Fuel Farm, Naval Station Roosevelt Roads, Ceiba, Puerto Rico. April 22, 2003, Coraopolis, Pennsylvania.

McLaren-Hart, 1999. Hydraulic Characteristics Evaluation, Free Product Recovery System, Tow Way Fuel Facility, Naval Station Roosevelt Roads, Ceiba, Puerto Rico. August 31, 1999.

McLaren-Hart, 2000. Report of Findings Quantification of Product Release Pier 1 – Tow Way Fuel Farm Facility, Naval Station Roosevelt Roads, Ceiba, Puerto Rico. March 16, 2000.

Unites States Environmental Protection Agency (USEPA), 1992. Estimating Potential for Occurrence of DNAPL at Superfund Sites. Office of Solid Waste and Emergency Response, Washington, D.C.

TABLES

TABLE 3-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
TCE PLUME DELINEATION AND SOURCE INVESTIGATION WORK PLAN
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

	Solid Samples				Aqueous Samples					
	Fixed Base Analytical Lab Analysis Requested			Dye	Fixed Base Analytical Lab Analysis Requested					
Sample ID	TCL VOCs (1)	TCLP VOCs (2)	IRC	Hydrophobic Shake Test	TCL VOCs (1)	Solvent (DNAPL) Screen	Interfacial Tension	Viscosity	IRC	Comments
SUBSURFACE SOIL SAMPLES										
7TCESB01-XX	X			X (3)						
7TCESB01-XX	X			X (3)						
7TCESB01-XX*	X			X (3)						
7TCESB01-XX*	X			X (3)						
7TCESB02-XX	X			X (3)						
7TCESB02-XX	X			X (3)						
7TCESB02-XX*	X			X (3)						
7TCESB02-XX*	X			X (3)						
7TCESB03-XX	X			X (3)						
7TCESB03-XX	X			X (3)						
7TCESB03-XXD	X			X (3)						Duplicate
7TCESB03-XXMS/MSD	X			X (3)						Matrix Spike/Matrix Spike Duplicate
7TCESB03-XX*	X			X (3)						
7TCESB03-XX*	X			X (3)						
7TCESB04-XX*	X			X (3)						
7TCESB04-XX*	X			X (3)						
7TCESB04-XX*	X			X (3)						
7TCESB04-XX*	X			X (3)						
7TCESB05-XX*	X			X (3)						
7TCESB05-XX*	X			X (3)						
7TCESB05-XX*	X			X (3)						
7TCESB05-XX*	X			X (3)						
7TCESB06-XX*	X			X (3)						
7TCESB06-XXD*	X			X (3)						Duplicate
7TCESB06-XX*	X			X (3)						
7TCESB06-XX*	X			X (3)						
7TCESB06-XX*	X			X (3)						
7TCESB07-XX*	X			X (3)						
7TCESB07-XX*	X			X (3)						
7TCESB07-XX*	X			X (3)						
7TCESB07-XX*	X			X (3)						
7TCESB08-XX*	X			X (3)						
7TCESB08-XX*	X			X (3)						

TABLE 3-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
TCE PLUME DELINEATION AND SOURCE INVESTIGATION WORK PLAN
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

	Solid Samples				Aqueous Samples					
	Fixed Base Analytical Lab Analysis Requested			Dye	Fixed Base Analytical Lab Analysis Requested					
Sample ID	TCL VOCs (1)	TCLP VOCs (2)	IRC	Hydrophobic Shake Test	TCL VOCs (1)	Solvent (DNAPL) Screen	Interfacial Tension	Viscosity	IRC	Comments
SUBSURFACE SOIL SAMPLES (Cont.)										
7TCESB08-XXD*	X			X (3)						Duplicate
7TCESB08-XXMS/MSD*	X			X (3)						Matrix Spike/Matrix Spike Duplicate
7TCESB08-XX*	X			X (3)						
7TCESB08-XX*	X			X (3)						
7TCESB09-XX*	X			X (3)						
7TCESB09-XX*	X			X (3)						
7TCESB09-XX*	X			X (3)						
7TCESB09-XX*	X			X (3)						
7TCESB10-XX*	X			X (3)						
7TCESB10-XX*	X			X (3)						
7TCESB10-XX*	X			X (3)						
7TCESB10-XX*	X			X (3)						
7TCESB10-XXD*	X			X (3)						Duplicate
7TCESB11-XX*	X			X (3)						
7TCESB11-XX*	X			X (3)						
7TCESB11-XX*	X			X (3)						
7TCESB11-XX*	X			X (3)						
7TCESB12-XX*	X			X (3)						
7TCESB12-XX*	X			X (3)						
7TCESB12-XX*	X			X (3)						
7TCESB12-XX*	X			X (3)						
7TCESB13-XX*	X			X (3)						
7TCESB13-XX*	X			X (3)						
7TCESB13-XXD*	X			X (3)						Duplicate
7TCESB13-XXMS/MSD*	X			X (3)						Matrix Spike/Matrix Spike Duplicate
7TCESB13-XX*	X			X (3)						
7TCESB13-XX*	X			X (3)						
7TCESB14-XX*	X			X (3)						
7TCESB14-XX*	X			X (3)						
7TCESB14-XX*	X			X (3)						
7TCESB14-XX*	X			X (3)						
7TCESB15-XX*	X			X (3)						
7TCESB15-XX*	X			X (3)						

TABLE 3-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
TCE PLUME DELINEATION AND SOURCE INVESTIGATION WORK PLAN
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

	Solid Samples				Aqueous Samples					
	Fixed Base Analytical Lab Analysis Requested			Dye	Fixed Base Analytical Lab Analysis Requested					
Sample ID	TCL VOCs (1)	TCLP VOCs (2)	IRC	Hydrophobic Shake Test	TCL VOCs (1)	Solvent (DNAPL) Screen	Interfacial Tension	Viscosity	IRC	Comments
SUBSURFACE SOIL SAMPLES (Cont.)										
7TCESB15-XX*	X			X (3)						
7TCESB15-XX*	X			X (3)						
7TCESB15-XXD*	X			X (3)						Duplicate
GROUNDWATER SAMPLES										
7TCETW201					X					
7TCETW202					X					
7TCETW203					X					
7TCETW203D					X					Duplicate
7TCETW204					X					
7TCETW205					X					
7TCETW206*					X					
7TCETW207*					X					
7TCETW208*					X					
7TCETW209*					X					
7TCETW210*					X					
7MW07					X					
7MW08					X					
7MW10					X					
7MW20					X					
7MW20D					X					Duplicate
7MW20MS					X					Matrix Spike
7MW20MS					X					Matrix Spike Duplicate
7MW21					X					
7MW22					X					
7MW23					X					
7MW24					X					
UGW11					X					
TRIP BLANKS										
7TCETB01					X					
7TCETB02					X					
7TCETB03					X					
FIELD BLANKS										
7TCEFB01					X					Lab Grade DI Water
7TCEFB02					X					Store Bought DI Water
7TCEFB03					X					Potable Water Supply
EQUIPMENT RINSATE BLANKS										
7TCEER01					X					Stainless steel spoon
7TCEER02					X					Split-Spoon and
7TCEER03					X					Silicon Tubing

TABLE 3-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
TCE PLUME DELINEATION AND SOURCE INVESTIGATION WORK PLAN
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

	Solid Samples				Aqueous Samples					
	Fixed Base Analytical Lab Analysis Requested			Dye	Fixed Base Analytical Lab Analysis Requested					
Sample ID	TCL VOCs [1]	TCLP VOCs [2]	IRC	Hydrophobic Shake Test	TCL VOCs [1]	Solvent (DNAPL) Screen	Interfacial Tension	Viscosity	IRC	Comments
DNAPL SAMPLE										
7TCEDNAPL01						X	X	X		If present and possible
IDW SAMPLES										
7TCEIDW01	X	X	X							Subsurface Soil
7TCEIDW02					X				X	Groundwater

Notes:
TCL - Target Compound List
TCLP - Toxicity Characteristics Leachate Potential
IRC - Ignitability, Reactivity, and Corrositivity.
[1] - Analysis will consist of Trichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, 1-1-dichloroethene, vinyl chloride, 1,1,2 trichloroethane, 1,1,1 trichloroethane, tetrachloroethene, 1,2 dichloroethane, 1,1 dichloroethane, chloroform, methylene chloride, pentachloroethane, and chloromethane only.
[2] - TCLP analysis will be conducted on Trichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, 1-1-dichloroethene, vinyl chloride, 1,1,2 trichloroethane, 1,1,1 trichloroethane, tetrachloroethene, 1,2 dichloroethane, 1,1 dichloroethane, chloroform, methylene chloride, pentachloroethane, and chloromethane only.
[3] - Test will only be performed on soil suspected of containing residual DNAPL (based on elevated PID readings).
XX - The sample depth designator in which the sample was collected (i.e. 01 = 1-3 ft bgs, 02 = 3-5 ft bgs, etc) will be established in the field.
* - Samples may or may not be collected depending on field analysis results.
ft bgs - feet below ground surface.

TABLE 3-2

LABORATORY ANALYTICAL METHODS
DRAFT TCE PLUME DELINEATION AND SOURCE INVESTIGATION WORK PLAN
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Volatiles	Quantitation Limits* Water (mg/L)	Quantitation Limits* Low Soil (mg/kg)	Method Number
cis-1,2-dichloroethene	5.0	5.0	5035\8260B
trans-1,2-dichloroethene	5.0	5.0	5035\8260B
1,1-Dichloroethene	5.0	5.0	5035\8260B
Trichloroethene	5.0	5.0	5035\8260B
1,1,2-trichloroethane	5.0	5.0	5035\8260B
1,1,1-trichloroethane	5.0	5.0	5035\8260B
tetrachloroethene	5.0	5.0	5035\8260B
1,2-dichloroethane	5.0	5.0	5035\8260B
1,1-Dichloroethene	5.0	5.0	5035\8260B
chloroform	5.0	5.0	5035\8260B
methylene chloride	5.0	5.0	5035\8260B
pentachloroethane	5.0	5.0	5035\8260B
chloromethane	5.0	5.0	5035\8260B
Vinyl Chloride	10	10	5035\8260B

DNAPL	Quantitation Limits* Water (mg/L)	Quantitation Limits* Low Soil (mg/kg)	Method Number
Solvent Screen	NA	NA	EPA 8260
Interfacial Tension	NA	NA	ASTM 1331A
Viscosity	NA	NA	50C ASTM D445

TCLP Volatiles	Quantitation Limits* Low Soil (mg/L)	Method Number
cis-1,2-dichloroethene	5.0	EPA 1311\8260
trans-1,2-dichloroethene	5.0	EPA 1311\8260
1,1-Dichloroethene	5.0	EPA 1311\8260
Trichloroethene	5.0	EPA 1311\8260
1,1,2-trichloroethane	5.0	EPA 1311\8260
1,1,1-trichloroethane	5.0	EPA 1311\8260
tetrachloroethene	5.0	EPA 1311\8260
1,2-dichloroethane	5.0	EPA 1311\8260
1,1-Dichloroethene	5.0	EPA 1311\8260
chloroform	5.0	EPA 1311\8260
methylene chloride	5.0	EPA 1311\8260
pentachloroethane	5.0	EPA 1311\8260
chloromethane	5.0	EPA 1311\8260
Vinyl Chloride	10	EPA 1311\8260

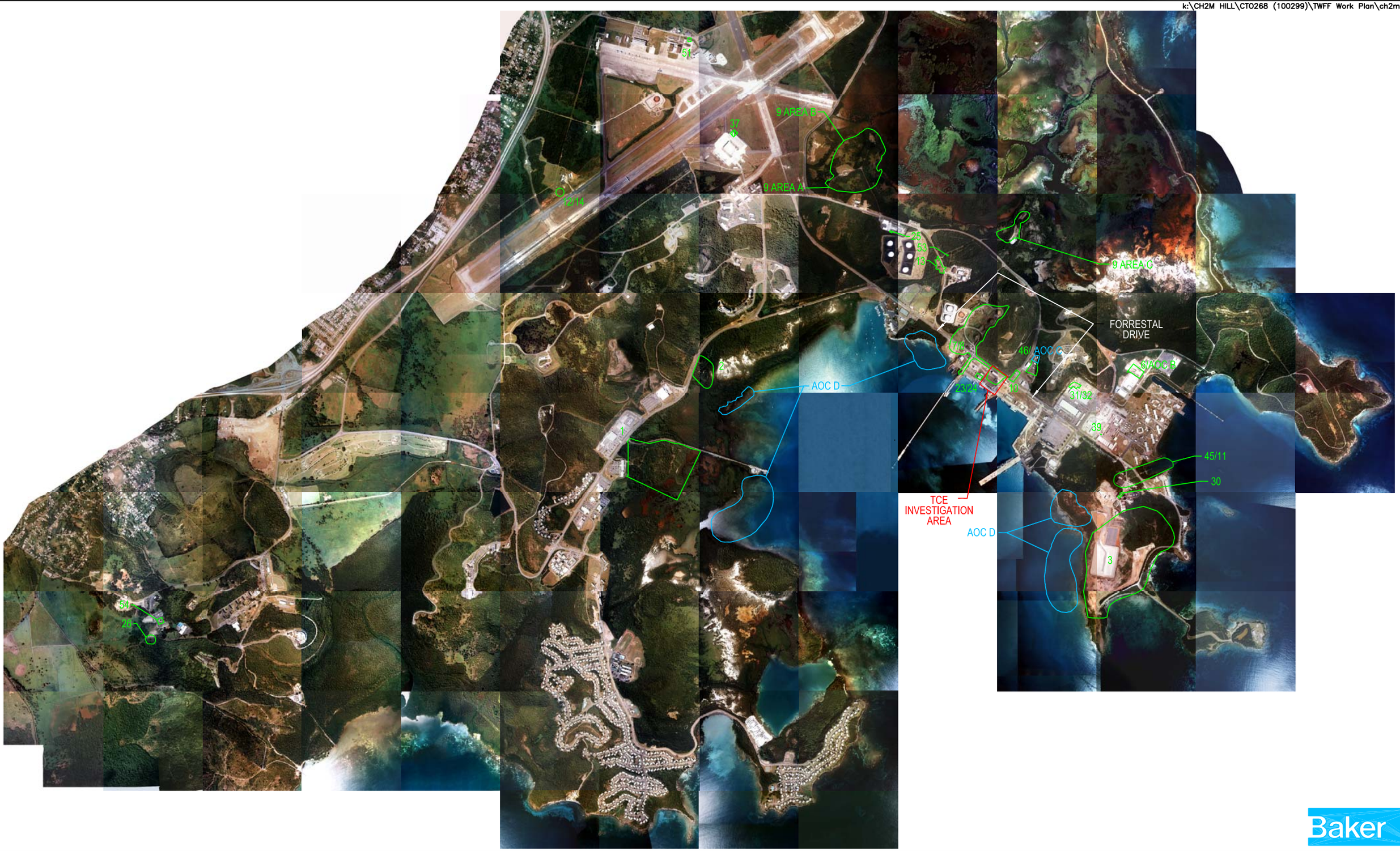
RCRA Hazardous Waste Constituents	Method Number
Ignitability	SW846 1010 (Liquid), SW846 1030 (Solids)
Reactivity	Reactive Cyanide (7.3.3.2), Reactive Sulfide (7.3.4.2)
Corrositivity	9040 (Liquid), 9045 (Solid)

Notes:

* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, will be higher.
µg/L - micrograms per liter.
µg/kg - micrograms per kilogram.
NA - Not Applicable

FIGURES

k:\CH2M HILL\CTO268 (100299)\TWFF Work Plan\ch2m26F09



Baker

LEGEND

1 – SWMUs

AOC D – AOCs

– AREA OF WHICH THIS INVESTIGATION PERTAINS TO

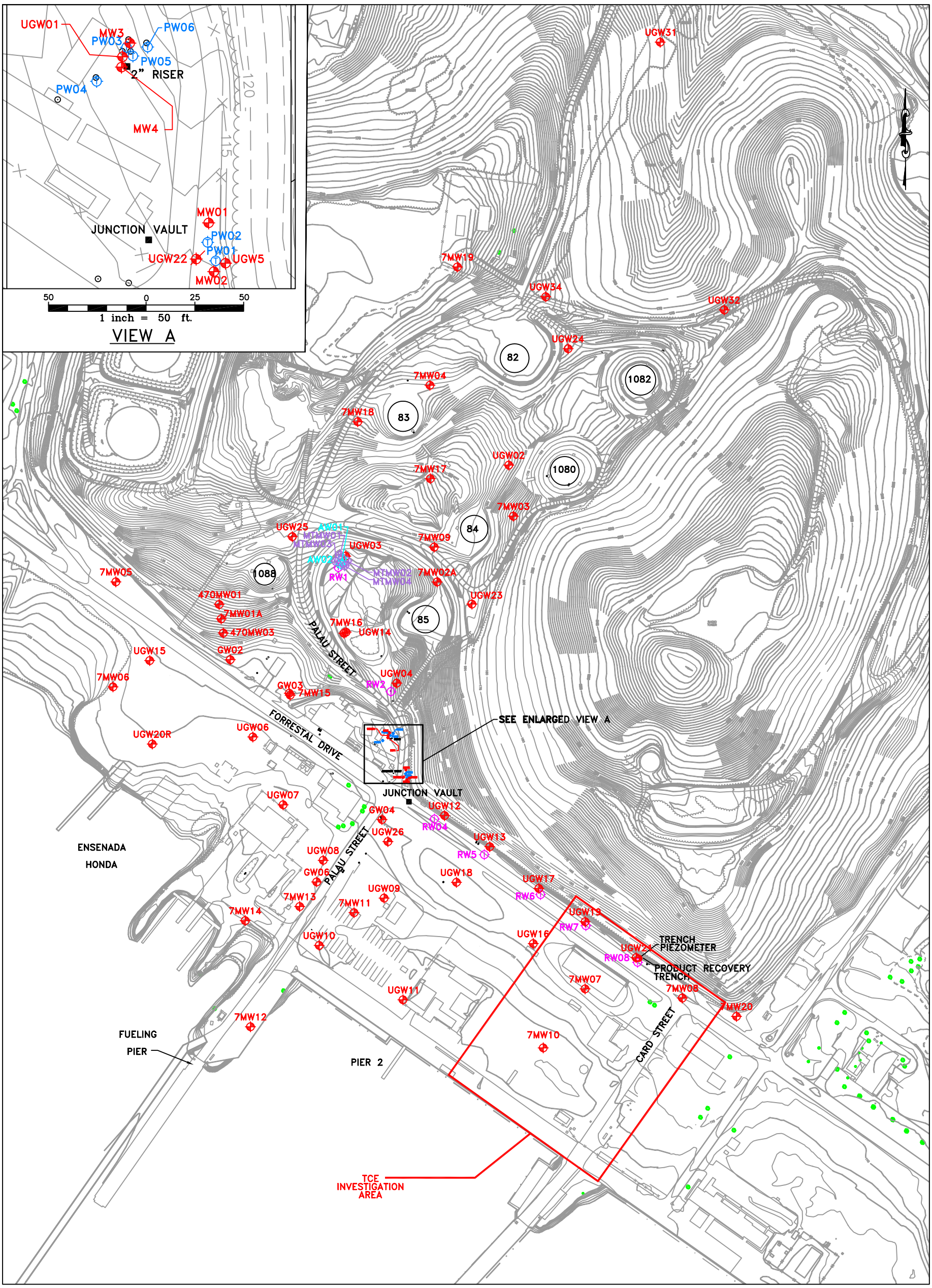
SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

2500 0 1250 2500

1 inch = 2500 ft.

FIGURE 1-1
SWMU/AOC LOCATION MAP

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



250 0 125 250
1 inch = 250 ft.

NOTE:
DATUM PLAN USED IS MEAN LOW WATER = 100.00 FT. AS ESTABLISHED BY U.S. NAVY SURVEY SECTION AS OF NOVEMBER 1941.

Baker

K:_CH2M Hill\CT0268 (100299)\Draft TWFF TCE Work Plan\CAD Figs\ch2m268F10.dwg

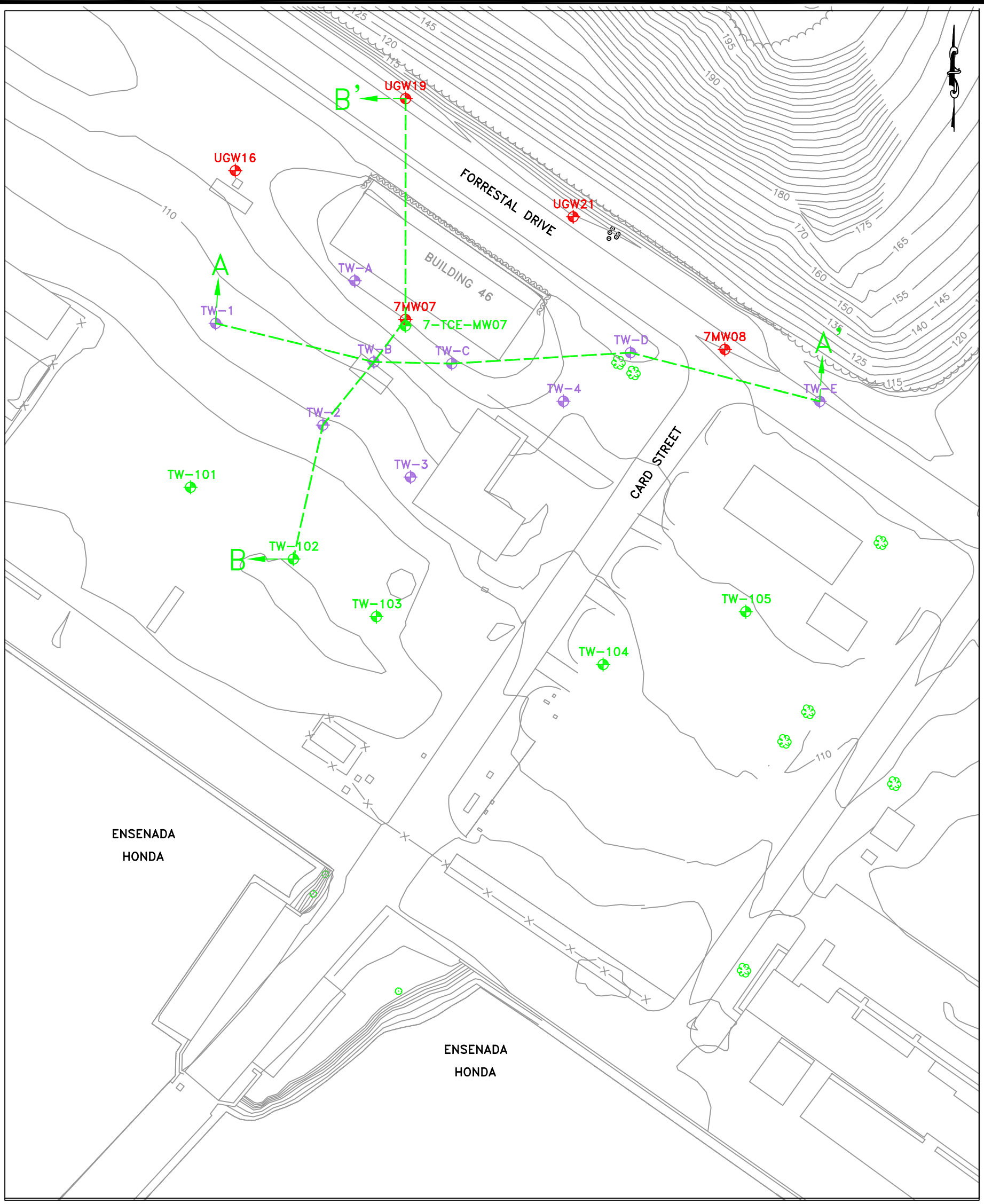
LEGEND

- MONITOR WELL LOCATION
- TERRAVAC PRODUCT RECOVERY WELL LOCATION
- ICHOR PRODUCT RECOVERY WELL LOCATION
- MANTECH MONITOR WELL
- MANTECH CLEANOx APPLICATION WELL

SOURCE: LANTDIV, FEB. 1992/1997

FIGURE 1-2
SITE LOCATION MAP
TOW WAY FUEL FARM

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



80 0 40 80

1 inch = 80 ft.

NOTE:
DATUM PLAN USED IS MEAN LOW WATER = 100.00 FT. AS ESTABLISHED BY U.S. NAVY SURVEY SECTION AS OF NOVEMBER 1941.
LOCATION OF TW-105 IS APPROXIMATED.

k:\CH2M HILL\CTO268 (100299)\TWFF Work Plan\ch2m26F01

Baker

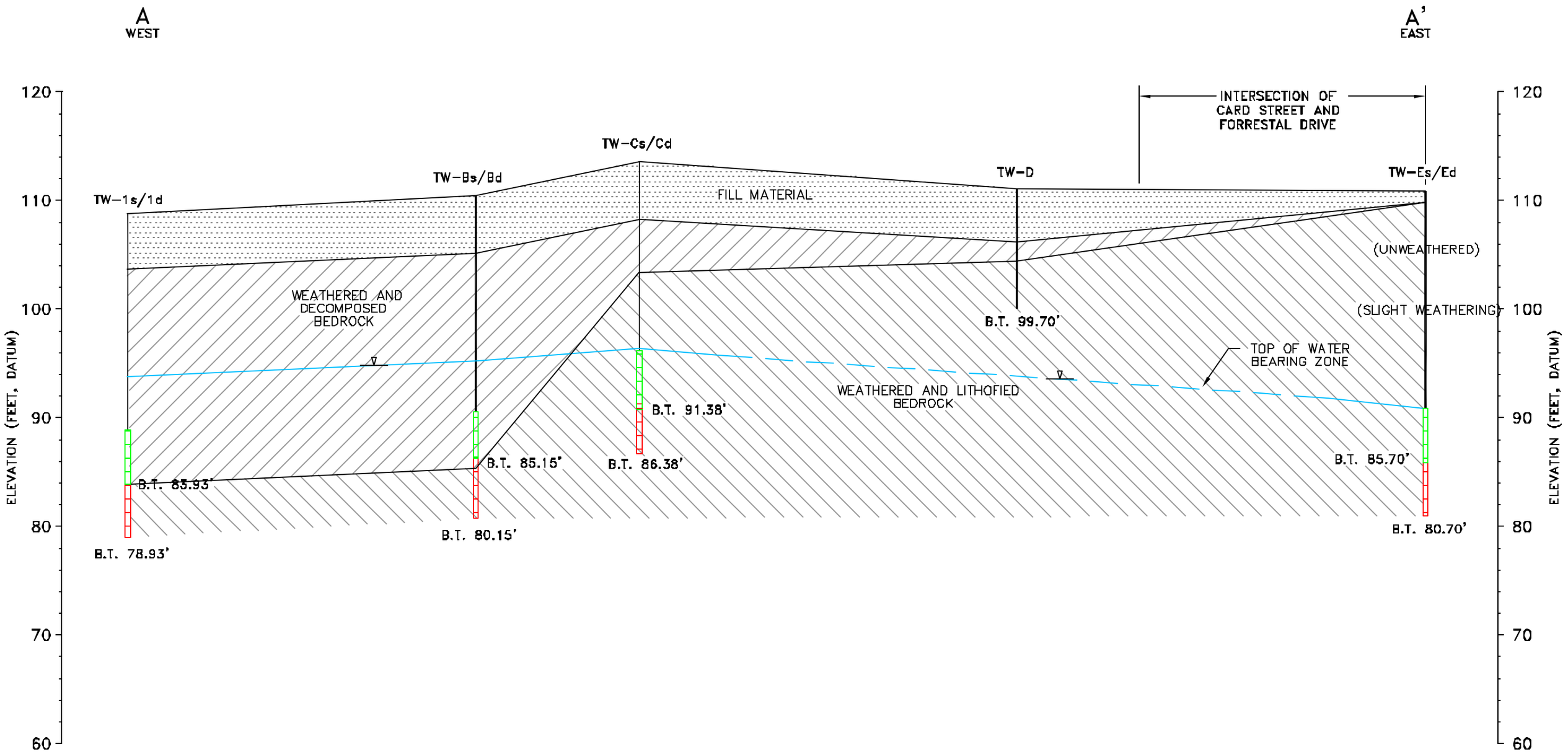
LEGEND

- EXISTING MONITORING WELL LOCATION
- TEMPORARY MONITORING WELL LOCATION (SHALLOW AND DEEP)
- TEMPORARY MONITORING WELL LOCATION (DEEP ONLY)
- CROSS SECTION LOCATION

SOURCE: LANTDIV, FEB. 1992/1997

FIGURE 2-1
CROSS SECTION LOCATION MAP
SWMU 7 - TCE INVESTIGATION, 1999
TOW WAY FUEL FARM

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



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Baker Environmental, Inc.

LEGEND

- ESTIMATED CONTACT
- PROJECTED CONTACT
- ESTIMATED WATER-BEARING ZONE
- PROJECTED WATER-BEARING ZONE
- B.T. 78.93' BORING TERMINATED, DATUM ELEVATION
- SHALLOW WELL SCREEN INTERVAL
- DEEP WELL SCREEN INTERVAL
- WELL SCREEN INTERVAL

40 0 20 40 80
Horizontal Scale: 1 inch = 40 ft.

10 0 5 10 20
Vertical Scale: 1 inch = 10 ft.

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

FIGURE 2-2
CROSS SECTION A-A'
SWMU 7 - TCE INVESTIGATION, 1999
TOW WAY FUEL FARM

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

B
SOUTH

B'
NORTH

ELEVATION (FEET, DATUM)

120
110
100
90
80
70
60

FORRESTAL DRIVE

UGW-19

7MW07

7-TCE-MW07

TW-Bs/Bd

TW-102

TW-2s/2d

FILL MATERIAL

TOP OF WATER BEARING ZONE

WEATHERED AND DECOMPOSED BEDROCK

MARINE SEDIMENTS

B.T. 92.07'

B.T. 88.59'

B.T. 84.55'

B.T. 83.09'

B.T. 83.32'

WEATHERED AND LITHOFIED BEDROCK

B.T. 80.15'

B.T. 73.32'

Baker
Baker Environmental, Inc.

LEGEND

- ESTIMATED CONTACT
- PROJECTED CONTACT
- ESTIMATED WATER-BEARING ZONE
- PROJECTED WATER-BEARING ZONE
- B.T. 84.55' BORING TERMINATED, DATUM ELEVATION
- SHALLOW WELL SCREEN INTERVAL
- DEEP WELL SCREEN INTERVAL
- WELL SCREEN INTERVAL

40 0 20 40 80

Horizontal Scale: 1 inch = 40 ft.

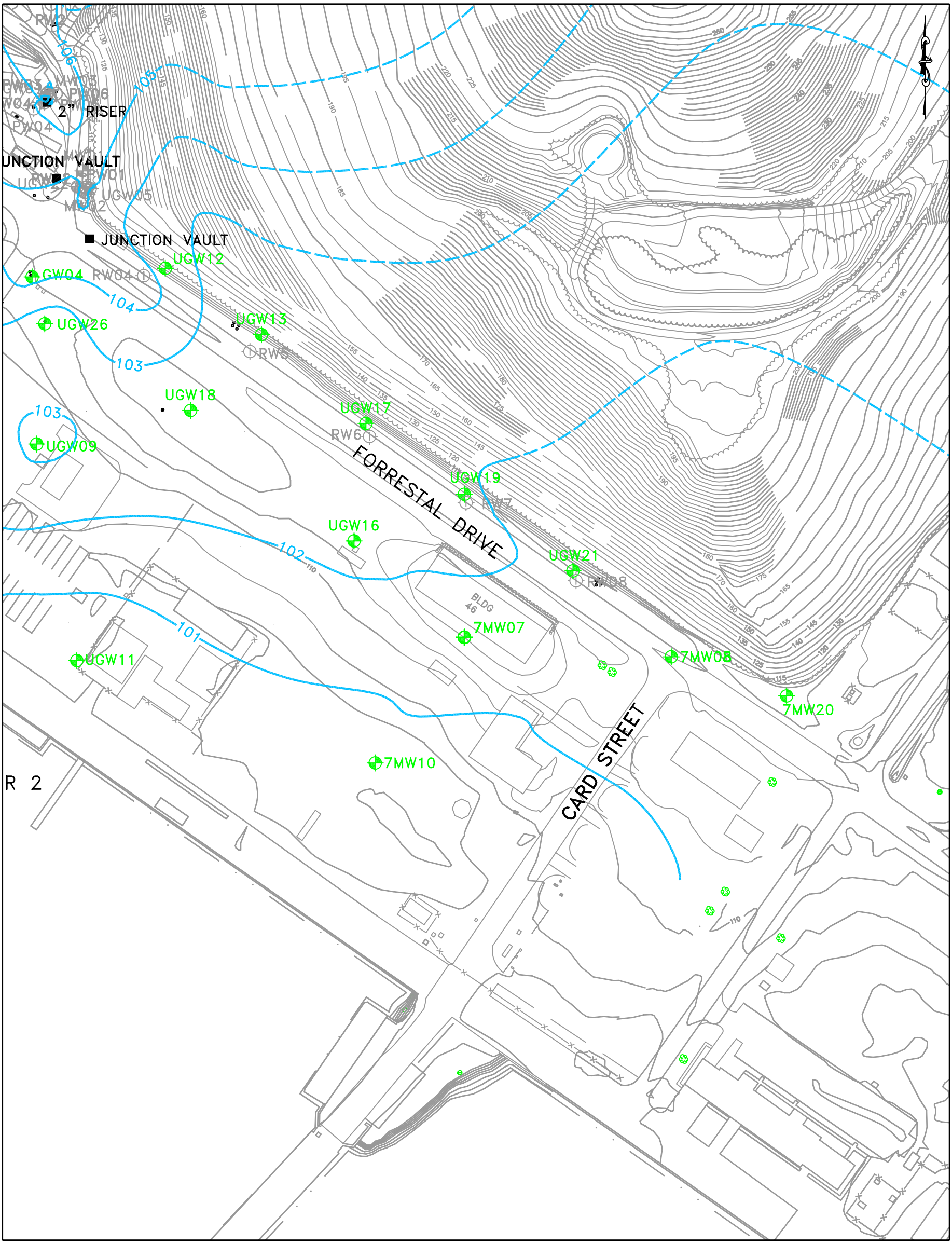
10 0 5 10 20

Vertical Scale: 1 inch = 10 ft.

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

FIGURE 2-3
CROSS SECTION B-B'
SWMU 7 - TCE INVESTIGATION, 1999
TOW WAY FUEL FARM

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



120 0 60 120

1 inch = 120 ft.

NOTE:
–DATUM PLAN USED IS MEAN LOW WATER = 100.00 FT. AS ESTABLISHED BY U.S. NAVY SURVEY SECTION AS OF NOVEMBER 1941.

Baker

k:\CH2M HILL\CTO268 (100299)\TWFF Work Plan\ch2m26F02

SOURCE: LANTDIV, FEB. 1992/1997

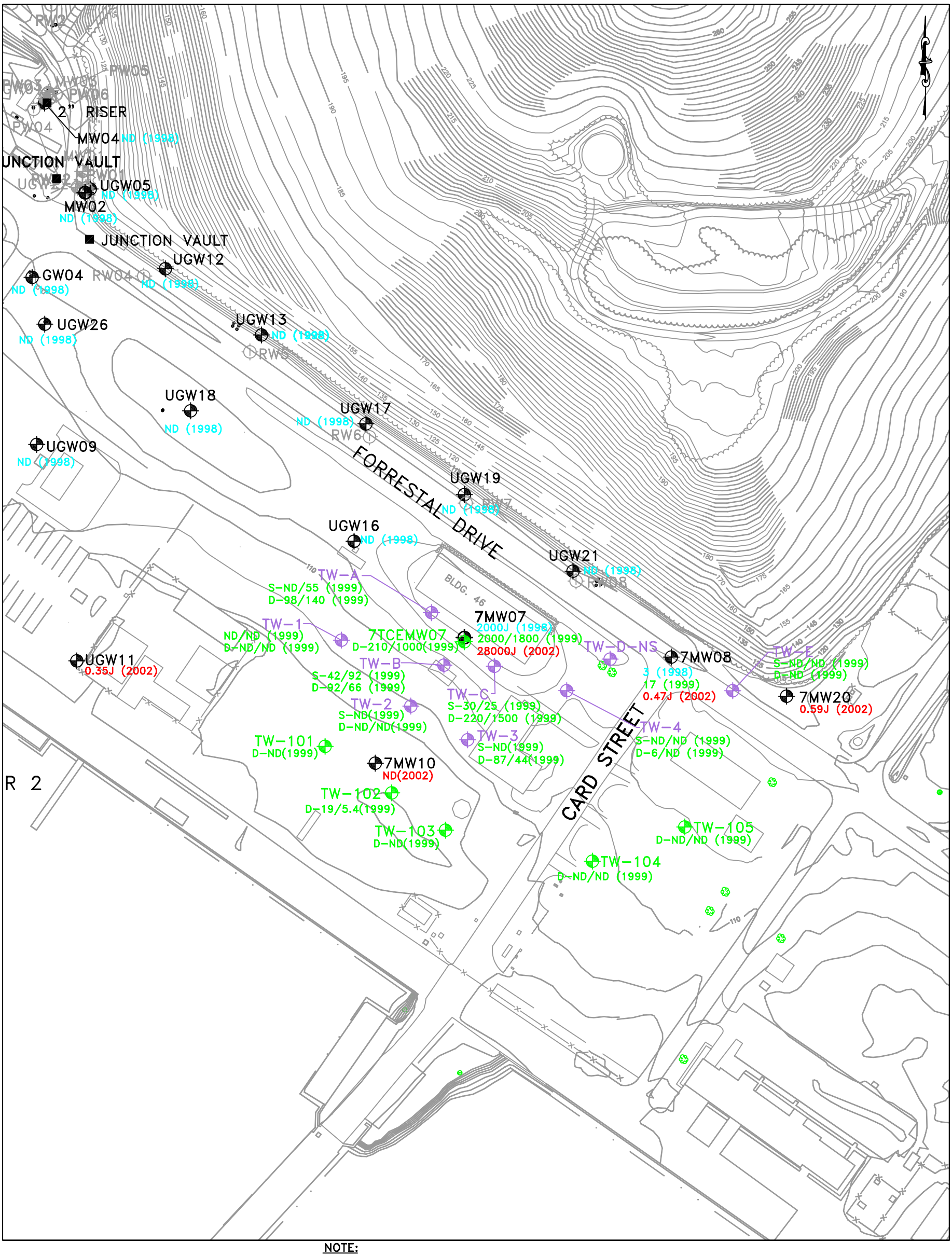
LEGEND

- MONITOR WELL LOCATION
- TERRAVAC PRODUCT RECOVERY WELL LOCATION
- ICHOR PRODUCT RECOVERY WELL LOCATION
- AVERAGE GROUNDWATER HEAD (FEET ABOVE MEAN SEA LEVEL)
- INFERRED GROUNDWATER HEAD, NO DATA AVAILABLE IN THIS AREA

NOTE: GROUNDWATER CONTOURS ARE AVERAGE VALUES

FIGURE 2–4
AVERAGE GROUNDWATER CONTOUR MAP
TCE INVESTIGATION AREA
TOW WAY FUEL FARM

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



120 0 60 120

1 inch = 120 ft.

k:\CH2M HILL\CTO268 (100299)\TWFF Work Plan\ch2m26F04

NOTE:
DATUM PLAN USED IS MEAN LOW WATER = 100.00 FT.
AS ESTABLISHED BY U.S. NAVY SURVEY SECTION AS
OF NOVEMBER 1941. LOCATION OF TW-105 APPROXIMATED.

Baker

LEGEND

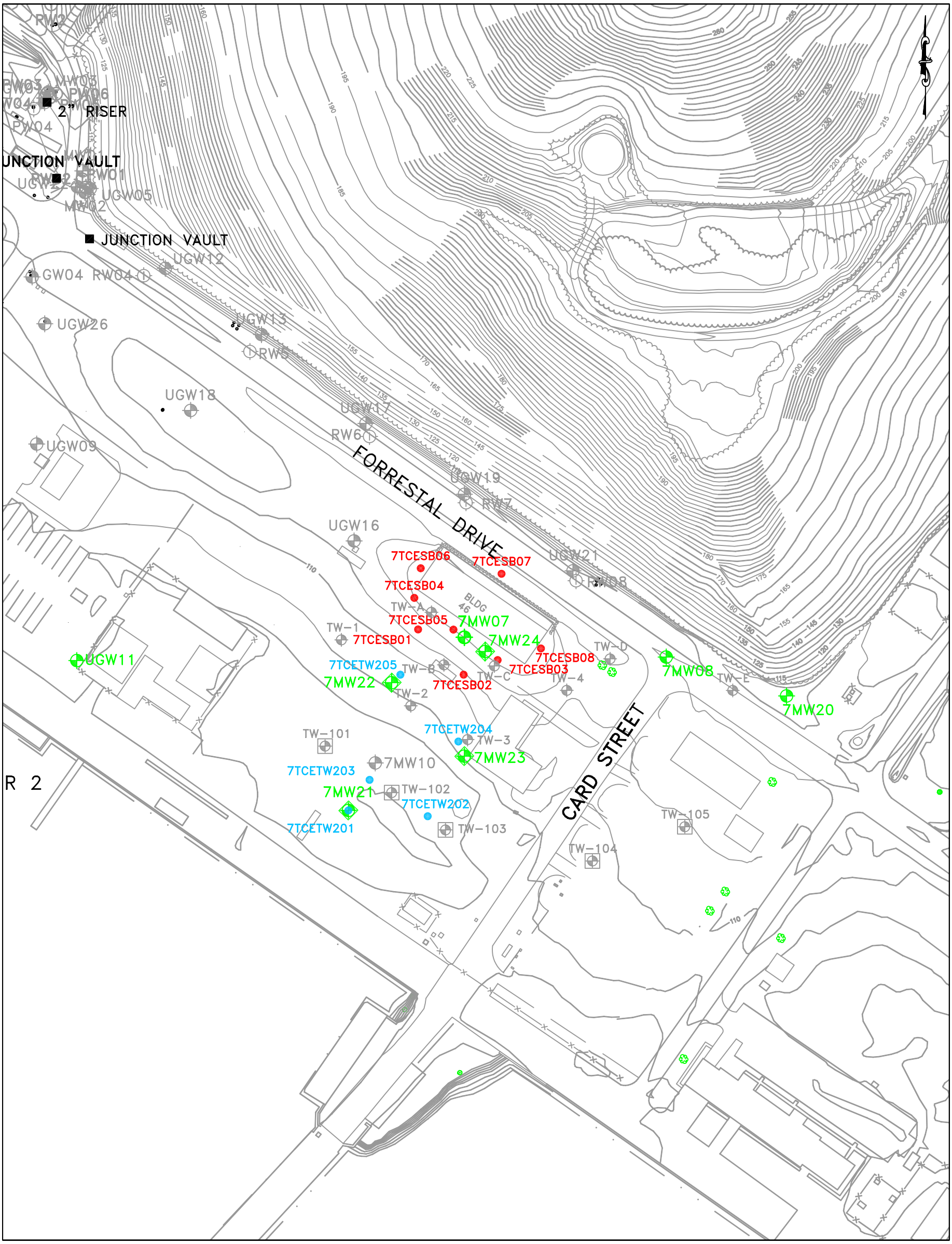
- EXISTING MONITOR WELL LOCATION
- TEMPORARY MONITOR WELL LOCATION (SHALLOW AND DEEP)
- TEMPORARY MONITOR WELL LOCATION (DEEP ONLY)

ND – NOT DETECTED
NS – NOT SAMPLED
S – SHALLOW WELL
D – DEEP WELL
J – ESTIMATED CONCENTRATION
1998 AND 2002 CONCENTRATIONS ARE STATESIDE LABORATORY ONLY
1999 CONCENTRATIONS ARE ONSITE / STATESIDE LABORATORY IF APPLICABLE,
1999 SINGLE VALUES ARE ONSITE LABORATORY ONLY

SOURCE: LANTDIV, FEB. 1992/1997

FIGURE 2-5
TCE CONCENTRATIONS FROM ALL
PREVIOUS INVESTIGATIONS
TOW WAY FUEL FARM

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



120 0 60 120

1 inch = 120 ft.

NOTE:
–DATUM PLAN USED IS MEAN LOW WATER = 100.00 FT. AS ESTABLISHED BY U.S. NAVY SURVEY SECTION AS OF NOVEMBER 1941.

Baker

k:\CH2M HILL\CTO268 (100299)\Draft TWFF TCE Work Plan\CAD Figs\3299502W

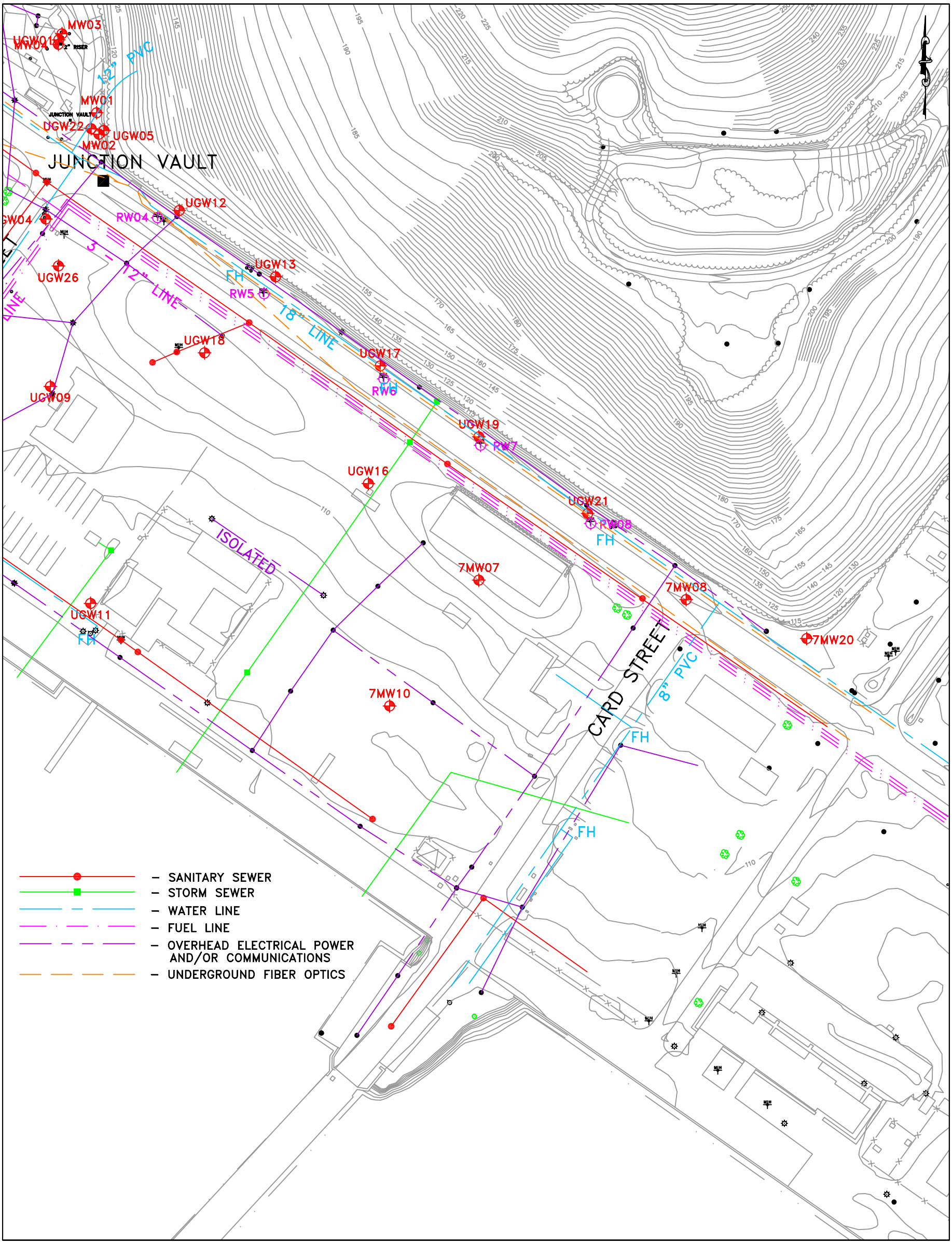
SOURCE: LANTDIV, FEB. 1992/1997

LEGEND

- EXISTING MONITOR WELL
- EXISTING MONITOR WELL LOCATION TO BE SAMPLED
- PROPOSED TEMPORARY WELL LOCATION
- PROPOSED SOIL SAMPLE LOCATION
- PROPOSED NEW MONITOR WELL LOCATION
- TERRAVAC PRODUCT RECOVERY WELL LOCATION
- ICHOR PRODUCT RECOVERY WELL LOCATION
- TEMPORARY MONITORING WELL LOCATION (SHALLOW AND DEEP)
- TEMPORARY MONITORING WELL LOCATION (DEEP ONLY)

FIGURE 3–1
PROPOSED SOIL AND GROUNDWATER SAMPLING LOCATIONS
TOW WAY FUEL FARM

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



120 0 60 120

1 inch = 120 ft.

k:\CH2M HILL\CTO268 (100299)\TWFF Work Plan\ch2m26F07

NOTE:
DATUM PLAN USED IS MEAN LOW WATER = 100.00 FT. AS ESTABLISHED BY U.S. NAVY SURVEY SECTION AS OF NOVEMBER 1941.

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LEGEND

– EXISTING MONITOR WELL
– ICHOR PRODUCT RECOVERY WELL LOCATION

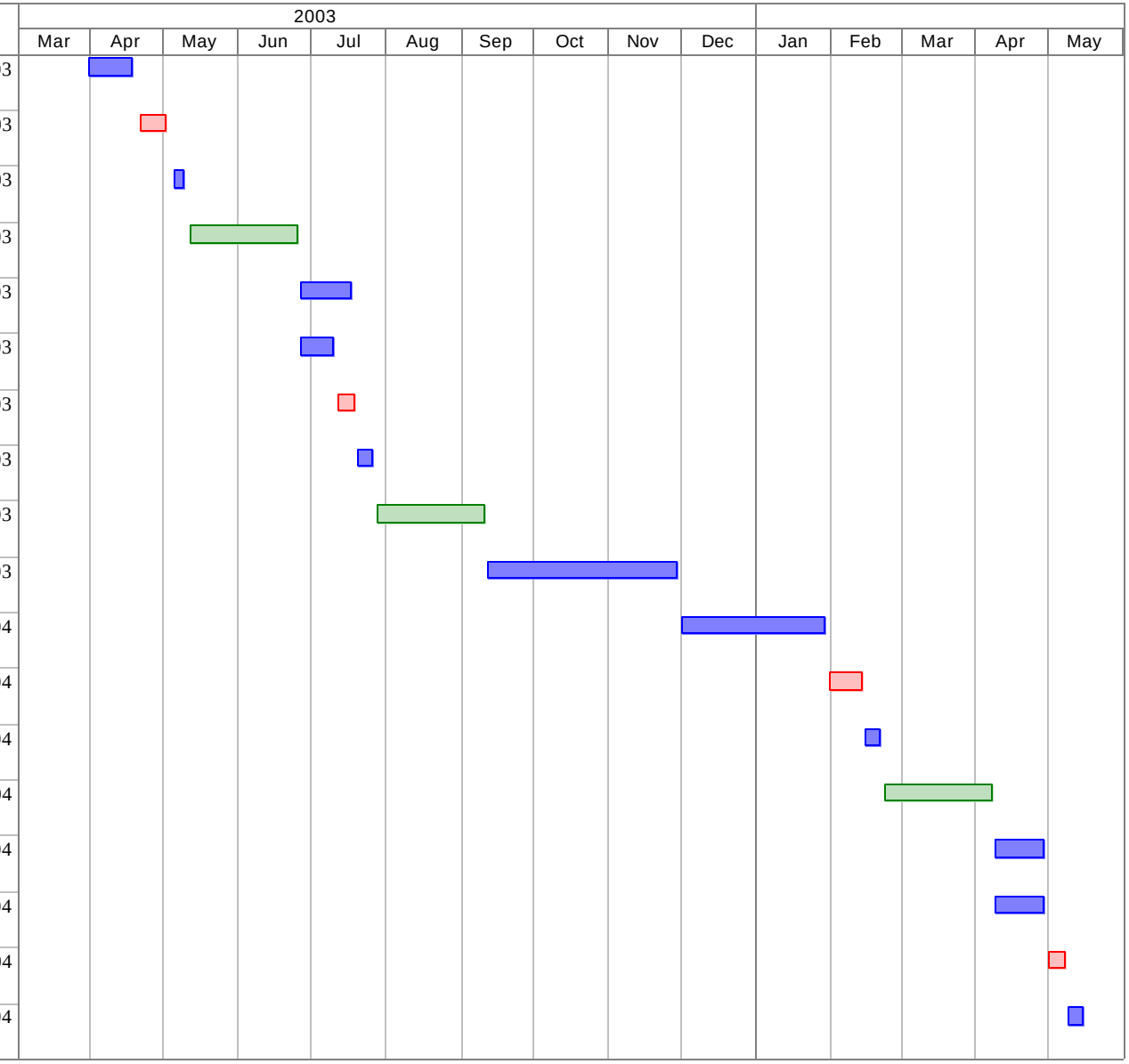
SOURCE: LANTDIV, FEB. 1992/1997

FIGURE 3–2
UTILITY LOCATIONS
TOW WAY FUEL FARM

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

FIGURE 5-1
PROPOSED PROJECT SCHEDULE
TCE PLUME DELINEATION AND SOURCE INVESTIGATION WORK PLAN
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

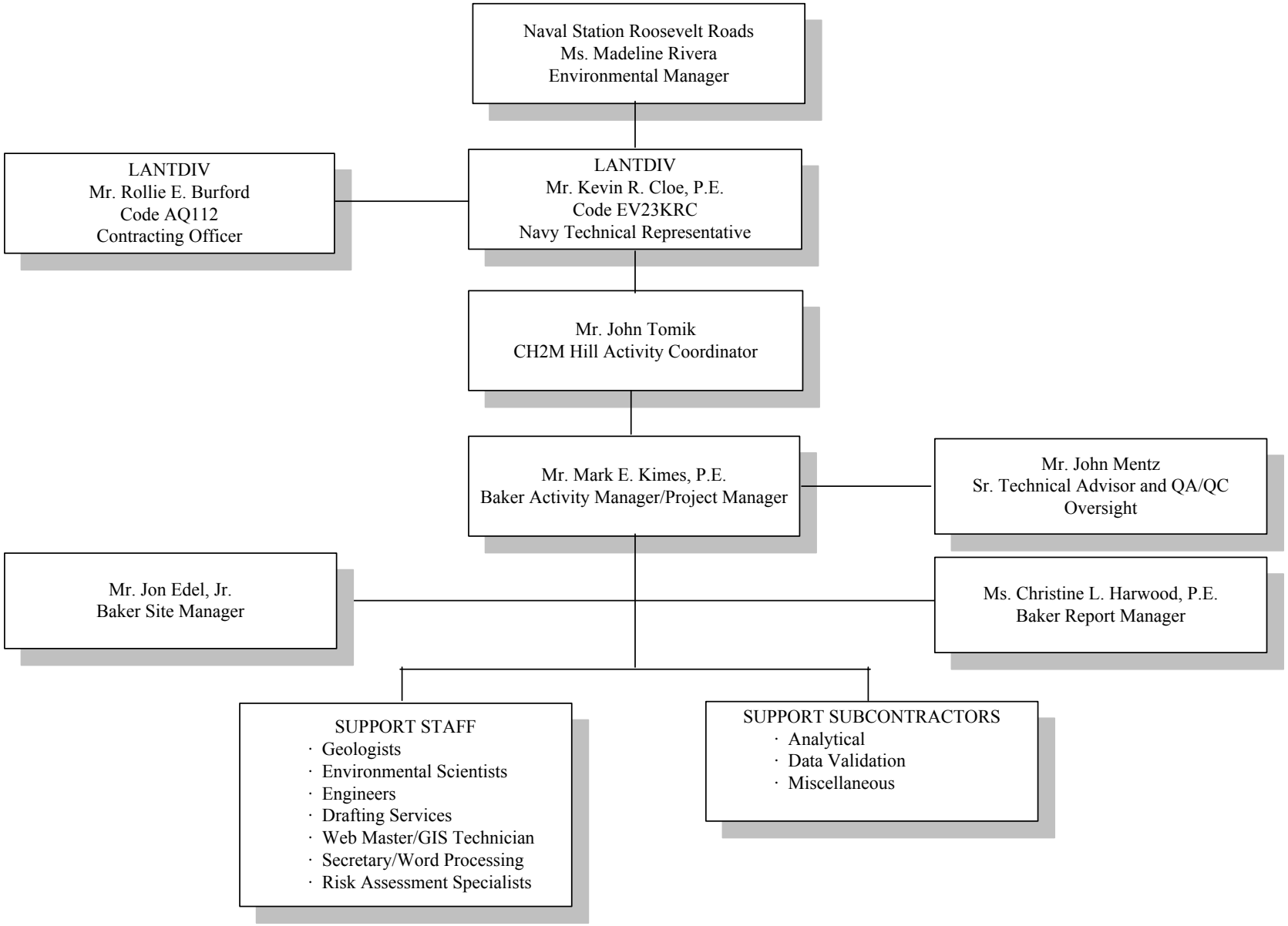
Task Name	Duration	Start	Finish
Draft TCE Plume Source Delineation Work Plan to Navy	18 edays	3/31/03	4/18/03
Navy Review	11 edays	4/21/03	5/2/03
Draft TCE Plume Source Delineation Work Plan to EPA	4 edays	5/5/03	5/9/03
EPA Review	45 edays	5/12/03	6/26/03
Respond to EPA Comments	21 edays	6/27/03	7/18/03
Final TCE Plume Source Delineation Work Plan to Navy	14 edays	6/27/03	7/11/03
Navy Review	7 edays	7/12/03	7/19/03
Final TCE Plume Source Delineation Work Plan to EPA	7 edays	7/20/03	7/27/03
EPA Review and Approval	45 edays	7/28/03	9/11/03
Field Investigaton	79 edays	9/12/03	11/30/03
Draft TCE Plume Source Delineation Report to Navy	60 edays	12/1/03	1/30/04
Navy Review	14 edays	1/31/04	2/14/04
Draft TCE Plume Source Delineation Report to EPA	7 edays	2/15/04	2/22/04
EPA Review	45 edays	2/23/04	4/8/04
Respond to EPA Comments	21 edays	4/9/04	4/30/04
Final TCE Plume Source Delineation Report to Navy	21 edays	4/9/04	4/30/04
Navy Review	7 edays	5/1/04	5/8/04
Final TCE Plume Source Delineation Report to EPA	7 edays	5/9/04	5/16/04



Project: NSRR-TCE
Date: 7/18/03

Baker Environmental NAVY Review EPA Review

FIGURE 6-1
PROJECT ORGANIZATION
TCE PLUME DELINEATION - TWFF
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO



APPENDIX A

Standard Operating Procedure – Hydrophobic Dye Shake Test

APPENDIX A

STANDARD OPERATING PROCEDURE: HYDROPHOBIC DYE SHAKE TEST

The soil-water shake test involves the transfer of a soil sample to a clear centrifuge tube with an equal volume of water. The tube is stopped and the mixture shaken by hand. As an alternative, clear glass wide-mouth sample containers with screw on lids may be used. The DNAPL is identified by examination of the tube walls and bottom. This test can be enhanced by centrifugation of the mixture to facilitate the accumulation of the DNAPL at the bottom of the tube. It can also be enhanced by the addition of a small amount of hydrophobic dye such as red Sudan IV or Oil Red O to the mixture. (These dyes are insoluble in water, but are soluble in many organic liquids.) Any DNAPLs that are present in the sample thereby become red in color. They can be manifested in red-stained DNAPL coated soil particles or red immiscible liquid that sometimes coats the container walls. The methods can be performed readily in the field during drilling and soil sampling activities.

Taken from Pankow, J. and Cherry, J. (1996) "Dense Chlorinated Solvents" Waterloo Press, Portland, Oregon, p. 414.

APPENDIX B
Summary of Analytical Data from Previous Investigations

TABLE 3-7

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
CMS INVESTIGATION
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (ug/l)	EPA Region III Tap Water RB (ug/l)	470-MW1 04/18/98	470-MW3 04/17/98	7MW01A 04/20/98	7MW02 04/19/98	7MW03 04/15/98	7MW04 04/15/98	7MW05 04/19/98
Volatiles (ug/l)									
1,1-Dichloroethene	7	0.044	50 U	250 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methylene chloride	5	4.1	50 U	250 U	0.6 U	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,2-Dichloroethene	70	61	50 U	250 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloroform	100	0.15	50 U	250 U	34 U	0.5 U	0.5 U	0.5 U	0.5 U
Benzene	5	0.36	**26,000**	**18,000**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichloroethene	5	1.6	50 U	250 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromodichloromethane	100	0.17	50 U	250 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Toluene	1,000	750	**7,800**	**4,400**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloroethane	5	0.19	50 U	250 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Ethylbenzene	700	1,300	**2,100**	**2,900**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
m/p-xylene	NE	NE	9,400	13,000	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
o-Xylene	NE	12,000	4,600	5,900	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Isopropylbenzene	NE	3,700	130	250 U	0.5 U	2	0.5 U	0.5 U	0.5 U
n-Propylbenzene	NE	61	**340**	250 U	0.5 U	3	0.5 U	0.5 U	0.5 U
1,3,5-Trimethylbenzene	NE	12	**1,100**	250 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
tert-Butylbenzene	NE	61	50 U	250 U	0.5 U	1	0.5 U	0.5 U	0.5 U
1,2,4-Trimethylbenzene	NE	12	**3,900**	**4,600**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
sec-Butylbenzene	NE	61	50 U	250 U	0.5 U	6	0.5 U	0.5 U	0.5 U
p-Isopropyltoluene	NE	NE	50 U	250 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
n-Butylbenzene	NE	61	50 U	250 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Naphthalene	NE	1,500	970	250 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methane	NE	NE	17	1.2	0.15	55	0.02	1.4	0.05

Data Qualifiers:

J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associate number indicates the approximate sample concentration necessary to be detected.
UJ - Not detected, quantitation limit may be inaccurate or imprecise.
NE - Not established.

TABLE 3-7 (continued)

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
CMS INVESTIGATION
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (ug/l)	EPA Region III Tap Water RB (ug/l)	470-MW1 04/18/98	470-MW3 04/17/98	7MW01A 04/20/98	7MW02 04/19/98	7MW03 04/15/98	7MW04 04/15/98	7MW05 04/19/98
TPH (ug/l)									
Diesel Range Organics	NE	NE	21,000	33,000	120 J	1,400	130 U	150	130 U
Gasoline Range Organics	NE	NE	100,000	89,000	76 U	540	50 U	50 U	50 U
Engineering Properties (ug/l)									
Alkalinity	NE	NE	1,400,000	728,000	998,000	681,000	354,000	582,000	650,000
Nitrate-N by IC	10,000	58,000	100 U	1,300	10,000 U	100 U	10,000 U	10,000 U	870
Sulfate by IC	500,000	NE	200 U	200 U	1,200	580	244,000	508,000	112,000
Chloride	NE	NE	130,000	1,320,000	1,040,000	80,700	5,280,000	3,000,000	314,000
Ferrous Iron	NE	NE	1,830	9,750	80	3,540	1,320	740	900

Data Qualifiers:
J - Analyte present. Reported value may not be accurate or precise.
U - Not detected. The associate number indicates the approximate sample concentration necessary to be detected.
UJ - Not detected, quantitation limit may be inaccurate or imprecise.
NE - Not established.

TABLE 3-7 (continued)

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
CMS INVESTIGATION
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (ug/l)	EPA Region III Tap Water RB (ug/l)	7MW06 04/19/98	7MW07 04/19/98	7MW08 04/18/98	7MW09 04/18/98	GW-02 04/21/98	GW-03 04/21/98	GW-04 04/16/98
Volatiles (ug/l)									
1,1-Dichloroethene	7	0.044	0.5 U	0.5 U	0.5 U	0.5 U	5 UJ	0.5 UJ	12 U
Methylene chloride	5	4.1	0.5 U	0.5 U	0.5 U	0.5 U	5 UJ	0.5 UJ	12 U
cis-1,2-Dichloroethene	70	61	0.5 U	6	0.5 U	0.5 U	5 UJ	0.5 UJ	12 U
Chloroform	100	0.15	0.5 U	0.5 U	0.5 U	0.5 U	5 UJ	0.5 UJ	12 U
Benzene	5	0.36	0.5 U	0.5 U	0.5 U	0.5 U	**3,000**	0.5 UJ	12 U
Trichloroethene	5	1.6	0.5 U	**2,000** J	**3**	0.5 U	5 UJ	0.5 UJ	12 U
Bromodichloromethane	100	0.17	0.5 U	0.5 U	0.5 U	0.5 U	5 UJ	0.5 UJ	12 U
Toluene	1,000	750	0.5 U	0.5 U	0.5 U	0.5 U	85 J	0.5 UJ	12 U
1,1,2-Trichloroethane	5	0.19	0.5 U	**0.5**	0.5 U	0.5 U	5 UJ	0.5 UJ	12 U
Ethylbenzene	700	1,300	0.5 U	0.5 U	0.5 U	0.5 U	**820**	0.5 UJ	12 U
m/p-xylene	NE	NE	0.5 U	0.5 U	0.5 U	0.5 U	760 J	0.5 UJ	12 U
o-Xylene	NE	12,000	0.5 U	0.5 U	0.5 U	0.5 U	270 J	0.5 UJ	12 U
Isopropylbenzene	NE	3,700	0.5 U	0.5 U	0.5 U	0.5 U	69 J	0.5 J	12 U
n-Propylbenzene	NE	61	0.5 U	0.5 U	0.5 U	0.5 U	**220** J	0.8 J	12 U
1,3,5-Trimethylbenzene	NE	12	0.5 U	0.5 U	0.5 U	0.5 U	**300** J	1 J	12 U
tert-Butylbenzene	NE	61	0.5 U	0.5 U	0.5 U	0.5 U	5 UJ	0.5 UJ	12 U
1,2,4-Trimethylbenzene	NE	12	0.5 U	0.5 U	0.5 U	0.5 U	**740** J	5 J	12 U
sec-Butylbenzene	NE	61	0.5 U	0.5 U	0.5 U	0.5 U	5 UJ	1 J	35
p-Isopropyltoluene	NE	NE	0.5 U	0.5 U	0.5 U	0.5 U	11 J	0.6 J	12 U
n-Butylbenzene	NE	61	0.5 U	0.5 U	0.5 U	0.5 U	59 J	2 J	12 U
Naphthalene	NE	1,500	0.5 U	0.5 U	18	0.5 U	89 J	7 J	12 U
Methane	NE	NE	0.38	0.75	0.058	0	6	1	43

Data Qualifiers:
J - Analyte present. Reported value may not be accurat
U - Not detected. The associate number indicates the a sample concentration necessary to be detected.
UJ - Not detected, quantitation limit may be inaccurate
NE - Not established.

TABLE 3-7 (continued)

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
CMS INVESTIGATION
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (ug/l)	EPA Region III Tap Water RB (ug/l)	7MW06 04/19/98	7MW07 04/19/98	7MW08 04/18/98	7MW09 04/18/98	GW-02 04/21/98	GW-03 04/21/98	GW-04 04/16/98
TPH (ug/l)									
Diesel Range Organics	NE	NE	140 U	130 U	360	100 J	4,700	3,100 J	270,000
Gasoline Range Organics	NE	NE	50 U	560	34 J	50 U	23,000	140 U	24,000
Engineering Properties (ug/l)									
Alkalinity	NE	NE	900,000	234,000	473,000	936,000	894,000	676,000	515,000
Nitrate-N by IC	10,000	58,000	10,000 U	770	1,300	640	190	10,000 U	100 U
Sulfate by IC	500,000	NE	382,000	23,100	223,000	188,000	6,500	445,000	440
Chloride	NE	NE	8,340,000	57,500	1,630,000	831,000	463,000	2,710,000	14,500
Ferrous Iron	NE	NE	2,900	320	190	0	140	1,020	290

Data Qualifiers:
J - Analyte present. Reported value may not be accurat
U - Not detected. The associate number indicates the a sample concentration necessary to be detected.
UJ - Not detected, quantitation limit may be inaccurate
NE - Not established.

TABLE 3-7 (continued)

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
CMS INVESTIGATION
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (ug/l)	EPA Region III Tap Water RB (ug/l)	GW-06 04/16/98	MW-2 04/17/98	MW-4 04/19/98	UGW-10 04/16/98	UGW-11 04/17/98	UGW-12 04/20/98	UGW-13 04/21/98
Volatiles (ug/l)									
1,1-Dichloroethene	7	0.044	0.5 U	0.5 U	2 U	0.5 U	0.5 UJ	25 U	12 UJ
Methylene chloride	5	4.1	0.5 U	0.5 U	2 U	0.5 U	0.5 UJ	25 U	12 UJ
cis-1,2-Dichloroethene	70	61	0.5 U	0.5 U	2 U	0.5 U	0.5 UJ	25 U	12 UJ
Chloroform	100	0.15	0.5 U	0.5 U	2 U	0.5 U	0.5 UJ	25 U	12 UJ
Benzene	5	0.36	0.5 U	**0.8** J	**2**	0.5 U	**0.8** J	25 U	12 UJ
Trichloroethene	5	1.6	0.5 U	0.5 U	2 U	0.5 U	0.5 UJ	25 U	12 UJ
Bromodichloromethane	100	0.17	0.5 U	0.5 U	2 U	**0.8**	0.5 UJ	25 U	12 UJ
Toluene	1,000	750	0.5 U	0.5 U	2 U	0.5 U	0.5 UJ	25 U	12 UJ
1,1,2-Trichloroethane	5	0.19	0.5 U	0.5 U	2 U	0.5 U	0.5 UJ	25 U	12 UJ
Ethylbenzene	700	1,300	0.5 U	2 J	40	0.5 U	2 J	120	86 J
m/p-xylene	NE	NE	0.5 U	0.5 U	28	0.5 U	0.5 UJ	170	86 J
o-Xylene	NE	12,000	0.5 U	0.5 U	2 U	0.5 U	0.5 UJ	25 U	12 UJ
Isopropylbenzene	NE	3,700	0.5 U	15 J	34	3	12 J	44	69 J
n-Propylbenzene	NE	61	0.5 U	25 J	**68**	3	20 J	**92**	**150** J
1,3,5-Trimethylbenzene	NE	12	0.5 U	2 J	**54**	0.5 U	3 J	**180**	**250** J
tert-Butylbenzene	NE	61	0.5 U	0.5 U	2 U	0.5 U	0.5 UJ	25 U	12 UJ
1,2,4-Trimethylbenzene	NE	12	0.5 U	8 J	**120**	0.5 U	9 J	**780**	**530** J
sec-Butylbenzene	NE	61	0.5 U	13 J	**70**	2	13 J	**81**	**160** J
p-Isopropyltoluene	NE	NE	0.5 U	3 J	46	0.5 U	0.5 UJ	93	170 J
n-Butylbenzene	NE	61	0.5 U	12 J	2 U	2	14 J	**210**	**360** J
Naphthalene	NE	1,500	0.5 U	110 J	430 J	0.5 U	260 J	690	760 J
Methane	NE	NE	0	22	41	27	6	37	26

Data Qualifiers:
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U - Not detected. The associate number indicates the a sample concentration necessary to be detected.
UJ - Not detected, quantitation limit may be inaccurate
NE - Not established.

TABLE 3-7 (continued)

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
CMS INVESTIGATION
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (ug/l)	EPA Region III Tap Water RB (ug/l)	GW-06 04/16/98	MW-2 04/17/98	MW-4 04/19/98	UGW-10 04/16/98	UGW-11 04/17/98	UGW-12 04/20/98	UGW-13 04/21/98
TPH (ug/l)									
Diesel Range Organics	NE	NE	320	29,000	250,000	1,600	24,000	390,000	120,000
Gasoline Range Organics	NE	NE	50 U	1,000 U	28,000	280 U	3,600	9,800	15,000 J
Engineering Properties (ug/l)									
Alkalinity	NE	NE	478,000	494,000	832,000	796,000	510,000	629,000	281,000
Nitrate-N by IC	10,000	58,000	20,000 U	100 U	290	100 U	440	5,000 U	100 U
Sulfate by IC	500,000	NE	681,000	400	200 U	930	255,000	610	1,200
Chloride	NE	NE	3,920,000	44,300	86,400	77,100	804,000	123,000	357,000
Ferrous Iron	NE	NE	2,340	440	5,000	550	1,630	3,000	2,030

Data Qualifiers:
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U - Not detected. The associate number indicates the a sample concentration necessary to be detected.
UJ - Not detected, quantitation limit may be inaccurate
NE - Not established.

TABLE 3-7 (continued)

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
CMS INVESTIGATION
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (ug/l)	EPA Region III Tap Water RB (ug/l)	UGW-14 04/19/98	UGW-15 04/15/98	UGW-16 04/16/98	UGW-17 04/21/98	UGW-18 04/16/98	UGW-19 04/17/98	UGW-2 04/15/98
Volatiles (ug/l)									
1,1-Dichloroethene	7	0.044	0.5 U	0.5 U	**2**	50 UJ	0.5 U	5 UJ	50 U
Methylene chloride	5	4.1	0.5 U	0.5 U	0.5 U	50 UJ	0.5 U	5 UJ	**54**
cis-1,2-Dichloroethene	70	61	0.5 U	0.5 U	0.5 U	50 UJ	0.5 U	5 UJ	50 U
Chloroform	100	0.15	0.5 U	0.5 U	0.5 U	50 UJ	**2**	5 UJ	50 U
Benzene	5	0.36	0.5 U	0.5 U	0.5 U	50 UJ	0.5 U	5 UJ	50 U
Trichloroethene	5	1.6	0.5 U	0.5 U	0.5 U	50 UJ	0.5 U	5 UJ	50 U
Bromodichloromethane	100	0.17	0.5 U	0.5 U	0.5 U	50 UJ	0.5 U	5 UJ	50 U
Toluene	1,000	750	0.5 U	0.5 U	0.5 U	50 UJ	0.5 U	5 UJ	50 U
1,1,2-Trichloroethane	5	0.19	0.5 U	0.5 U	0.5 U	50 UJ	0.5 U	5 UJ	50 U
Ethylbenzene	700	1,300	2	0.5 U	0.5 U	50 UJ	0.5 U	5 UJ	78
m/p-xylene	NE	NE	0.5 U	0.5 U	0.5 U	50 UJ	0.5 U	11 J	50 U
o-Xylene	NE	12,000	0.5 U	0.5 U	0.5 U	50 UJ	0.5 U	5 UJ	50 U
Isopropylbenzene	NE	3,700	8	0.6	0.5 U	50 UJ	0.5 U	15 J	50 U
n-Propylbenzene	NE	61	15	0.5 U	0.5 U	50 UJ	0.5 U	18 J	50 U
1,3,5-Trimethylbenzene	NE	12	0.5 U	0.5 U	0.5 U	50 UJ	0.5 U	**72** J	50 U
tert-Butylbenzene	NE	61	0.5 U	0.5 U	0.5 U	50 UJ	0.5 U	5 UJ	50 U
1,2,4-Trimethylbenzene	NE	12	0.5 U	0.5 U	0.5 U	**150** J	0.5 U	**310** J	50 U
sec-Butylbenzene	NE	61	18	0.5 U	0.5 U	**62** J	0.5 U	21 J	50 U
p-Isopropyltoluene	NE	NE	0.5 U	0.5 U	0.5 U	50 UJ	0.5 U	27 UJ	50 U
n-Butylbenzene	NE	61	0.5 U	0.5 U	0.5 U	**92** J	0.5 U	5 UJ	50 U
Naphthalene	NE	1,500	22	0.5 U	0.5 U	250 J	0.5 U	290 J	50 U
Methane	NE	NE	17	1	0	17	0	18	20

Data Qualifiers:
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U - Not detected. The associate number indicates the a sample concentration necessary to be detected.
UJ - Not detected, quantitation limit may be inaccurate
NE - Not established.

TABLE 3-7 (continued)

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
CMS INVESTIGATION
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (ug/l)	EPA Region III Tap Water RB (ug/l)	UGW-14 04/19/98	UGW-15 04/15/98	UGW-16 04/16/98	UGW-17 04/21/98	UGW-18 04/16/98	UGW-19 04/17/98	UGW-2 04/15/98
TPH (ug/l)									
Diesel Range Organics	NE	NE	3,600	180	130 U	180,000	120 U	22,000	270,000
Gasoline Range Organics	NE	NE	2,500	110	48 U	3,400	31 U	7,200	360,000
Engineering Properties (ug/l)									
Alkalinity	NE	NE	1,030,000	936,000	317,000	598,000	156,000	458,000	463,000
Nitrate-N by IC	10,000	58,000	2,100	20,000 U	420	100 U	760	100 U	1,000 U
Sulfate by IC	500,000	NE	17,700	497,000	60,700	9,500	110,000	260	4,500
Chloride	NE	NE	1,500,000	6,150,000	125,000	81,000	543,000	14,100	5,220,000
Ferrous Iron	NE	NE	2,110	700	90	460	510	2,320	28,000

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U - Not detected. The associate number indicates the a sample concentration necessary to be detected.
UJ - Not detected, quantitation limit may be inaccurate
NE - Not established.

TABLE 3-7 (continued)

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
CMS INVESTIGATION
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (ug/l)	EPA Region III Tap Water RB (ug/l)	UGW-20 04/14/98	UGW-21 04/17/98	UGW-23 04/18/98	UGW-24 04/19/98	UGW-25 04/19/98	UGW-26 04/20/98	UGW-3 04/20/98
Volatiles (ug/l)									
1,1-Dichloroethene	7	0.044	0.5 U	250 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methylene chloride	5	4.1	0.5 U	250 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,2-Dichloroethene	70	61	0.5 U	250 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloroform	100	0.15	0.5 U	250 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Benzene	5	0.36	0.5 U	250 U	0.5 U	0.5 U	**13**	0.5 U	**9**
Trichloroethene	5	1.6	0.5 U	250 U	0.5 U	**2**	0.5 U	0.5 U	0.5 U
Bromodichloromethane	100	0.17	0.5 U	250 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Toluene	1,000	750	0.5 U	250 U	0.5 U	0.5 U	1	0.5 U	3
1,1,2-Trichloroethane	5	0.19	0.5 U	250 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Ethylbenzene	700	1,300	0.5 U	250 U	0.5 U	0.5 U	7	0.5 U	22
m/p-xylene	NE	NE	0.5 U	250 U	0.5 U	0.5 U	33	0.5 U	17
o-Xylene	NE	12,000	0.5 U	250 U	0.5 U	0.5 U	7	0.5 U	11
Isopropylbenzene	NE	3,700	0.5 U	250 U	0.5 U	0.5 U	19	0.5 U	10
n-Propylbenzene	NE	61	0.5 U	250 U	0.5 U	0.5 U	20	0.5 U	16
1,3,5-Trimethylbenzene	NE	12	0.5 U	250 U	0.5 U	0.5 U	**54** J	0.5 U	**22**
tert-Butylbenzene	NE	61	0.5 U	250 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2,4-Trimethylbenzene	NE	12	0.5 U	**260**	0.5 U	0.5 U	**160** J	0.5 U	**150**
sec-Butylbenzene	NE	61	0.5 U	250 U	0.5 U	0.5 U	27	0.5 U	10
p-Isopropyltoluene	NE	NE	0.5 U	250 U	0.5 U	0.5 U	19	0.5 U	10
n-Butylbenzene	NE	61	0.5 U	250 U	0.5 U	0.5 U	0.5 U	0.5 U	18
Naphthalene	NE	1,500	0.5 U	250 U	0.5 U	0.5 U	200 J	0.5 U	220
Methane	NE	NE	27	42	0	0	36	1	3

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TABLE 3-7 (continued)

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
CMS INVESTIGATION
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (ug/l)	EPA Region III Tap Water RB (ug/l)	UGW-20 04/14/98	UGW-21 04/17/98	UGW-23 04/18/98	UGW-24 04/19/98	UGW-25 04/19/98	UGW-26 04/20/98	UGW-3 04/20/98
TPH (ug/l)									
Diesel Range Organics	NE	NE	65 J	79,000	180	91 J	960,000	130 U	32,000
Gasoline Range Organics	NE	NE	50 U	420,000 J	41 J	29 J	420,000 J	50 U	2,800
Engineering Properties (ug/l)									
Alkalinity	NE	NE	962,000	494,000	832,000	749,000	1,010,000	614,000	801,000
Nitrate-N by IC	10,000	58,000	10,000 U	100 U	3,200	800	670	1,200	10,000 U
Sulfate by IC	500,000	NE	20,200	610	46,600	252,000	37,700	361,000	194,000
Chloride	NE	NE	7,770,000	40,100	105,000	554,000	241,000	1,150,000	2,340,000
Ferrous Iron	NE	NE	9,280	6,960	180	0	3,210	80	1,030

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U - Not detected. The associate number indicates the a sample concentration necessary to be detected.
UJ - Not detected, quantitation limit may be inaccurate
NE - Not established.

TABLE 3-7 (continued)

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
CMS INVESTIGATION
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (ug/l)	EPA Region III Tap Water RB (ug/l)	UGW-4 04/20/98	UGW-5 04/17/98	UGW-6 04/15/98	UGW-7 04/15/98	UGW-8 04/16/98	UGW-9 04/16/98
Volatiles (ug/l)								
1,1-Dichloroethene	7	0.044	12 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methylene chloride	5	4.1	12 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,2-Dichloroethene	70	61	12 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloroform	100	0.15	12 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Benzene	5	0.36	12 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichloroethene	5	1.6	12 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromodichloromethane	100	0.17	12 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Toluene	1,000	750	12 U	0.5	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloroethane	5	0.19	12 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Ethylbenzene	700	1,300	27	3	0.5 U	0.5 U	0.5 U	0.5 U
m/p-xylene	NE	NE	42	0.6	0.5 U	0.5 U	0.5 U	0.5 U
o-Xylene	NE	12,000	12 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Isopropylbenzene	NE	3,700	16	33	0.5 U	0.5 U	1	0.5 U
n-Propylbenzene	NE	61	31	**360** J	0.5 U	0.5 U	0.5 U	0.5 U
1,3,5-Trimethylbenzene	NE	12	**57**	**18**	0.5 U	0.5 U	0.5 U	0.5 U
tert-Butylbenzene	NE	61	12 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2,4-Trimethylbenzene	NE	12	**230**	**37**	0.5 U	0.5 U	0.5 U	0.5 U
sec-Butylbenzene	NE	61	21	24	0.5 U	0.5 U	0.5 U	0.5 U
p-Isopropyltoluene	NE	NE	23	15	0.5 U	0.5 U	0.5 U	0.5 U
n-Butylbenzene	NE	61	12 U	27	0.5 U	0.5 U	0.5 U	0.5 U
Naphthalene	NE	1,500	300	430 J	0.5 U	0.5 U	0.5 U	0.5 U
Methane	NE	NE	10	34	0	3	9	0

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NE - Not established.

TABLE 3-7 (continued)

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
CMS INVESTIGATION
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (ug/l)	EPA Region III Tap Water RB (ug/l)	UGW-4 04/20/98	UGW-5 04/17/98	UGW-6 04/15/98	UGW-7 04/15/98	UGW-8 04/16/98	UGW-9 04/16/98
TPH (ug/l)								
Diesel Range Organics	NE	NE	700,000	82,000	88 J	120 U	310	180
Gasoline Range Organics	NE	NE	2,400	5,000	36 J	35 J	500	29 U
Engineering Properties (ug/l)								
Alkalinity	NE	NE	1,080,000	624,000	338,000	988,000	832,000	411,000
Nitrate-N by IC	10,000	58,000	5,000 U	100 U	100 U	2,200	100 U	110
Sulfate by IC	500,000	NE	2,700	1,100	9,800	402,000	3,400	86,100
Chloride	NE	NE	145,000	117,000	67,900	2,220,000	133,000	183,000
Ferrous Iron	NE	NE	850	840	250	810	1,750	320

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U - Not detected. The associate number indicates the a sample concentration necessary to be detected.
UJ - Not detected, quantitation limit may be inaccurate
NE - Not established.

TABLE 3-7 (continued)

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
CMS INVESTIGATION
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (ug/l)	EPA Region III Tap Water RB (ug/l)	Number Exceeding Federal MCL	Range Exceeding Federal MCL	Number Exceeding EPA Region III Tap Water RBC	Range Exceeding EPA Region III Tap Water RBC	Location of Maximum Detect
Volatiles (ug/l)							
1,1-Dichloroethene	7	0.044	0/41		1/41	2	UGW-16
Methylene chloride	5	4.1	1/41	54	1/41	54	UGW-2
cis-1,2-Dichloroethene	70	61	0/41		0/41		7MW07
Chloroform	100	0.15	0/41		1/41	2-2	UGW-18
Benzene	5	0.36	5/41	9-26,000	8/41	0.8 J-26,000	470-MW1
Trichloroethene	5	1.6	1/41	2,000 J	3/41	2-2,000 J	7MW07
Bromodichloromethane	100	0.17	0/41		1/41	8	UGW-10
Toluene	1,000	750	2/41	4,400-7,800	2/41	4,400-7,800	470-MW1
1,1,2-Trichloroethane	5	0.19	0/41		1/41	0.5	7MW07
Ethylbenzene	700	1,300	3/41	820-2,900	2/41	2,100-2,900	470-MW3
m/p-xylene	NE	NE	NE		NE		470-MW3
o-Xylene	NE	12,000	NE		0/41		470-MW3
Isopropylbenzene	NE	3,700	NE		0/41		470-MW1
n-Propylbenzene	NE	61	NE		6/41	68-360 J	UGW-5
1,3,5-Trimethylbenzene	NE	12	NE		10/41	18-1,100	470-MW1
tert-Butylbenzene	NE	61	NE		0/41		7MW02
1,2,4-Trimethylbenzene	NE	12	NE		13/41	37-4,600	470-MW3
sec-Butylbenzene	NE	61	NE		4/41	62 J-160 J	UGW-13
p-Isopropyltoluene	NE	NE	NE		NE		UGW-13
n-Butylbenzene	NE	61	NE		3/41	92 J-360 J	UGW-13
Naphthalene	NE	1,500	NE		0/41		470-MW1
Methane	NE	NE	NE		NE		7MW02

Data Qualifiers:
J - Analyte present. Reported value may not be accurat
U - Not detected. The associate number indicates the a sample concentration necessary to be detected.
UJ - Not detected, quantitation limit may be inaccurate
NE - Not established.

TABLE 3-7 (continued)

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
CMS INVESTIGATION
TOW WAY FUEL FARM
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Sample ID Sample Date	Federal MCL (ug/l)	EPA Region III Tap Water RB (ug/l)	Number Exceeding Federal MCL	Range Exceeding Federal MCL	Number Exceeding EPA Region III Tap Water RBC	Range Exceeding EPA Region III Tap Water RBC	Location of Maximum Detect
TPH (ug/l)							
Diesel Range Organics	NE	NE	NE		NE		UGW-25
Gasoline Range Organics	NE	NE	NE		NE		UGW-21, UGW-25
Engineering Properties (ug/l)							
Alkalinity	NE	NE	NE		NE		470-MW1
Nitrate-N by IC	10,000	58,000	0/41		0/41		UGW-23
Sulfate by IC	500,000	NE	2/41	508,000-681,000	NE		GW-06
Chloride	NE	NE	NE		NE		7MW06
Ferrous Iron	NE	NE	NE		NE		UGW-2

Data Qualifiers:
J - Analyte present. Reported value may not be accurat
U - Not detected. The associate number indicates the a sample concentration necessary to be detected.
UJ - Not detected, quantitation limit may be inaccurate
NE - Not established.

TABLE 5-1

ON-SITE LABORATORY ANALYTICAL DATA SUMMARY
SWMU 7 - TCE INVESTIGATION
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

		EPA Region III	"First Row" Temporary Wells							
	Federal	**Tap Water**	Shallow Wells				Deep Wells			
Sample ID	MCL	**RBC**	7TCE-As	7TCE-Bs	7TCE-Cs	7TCE-Es	7TCE-Ad	7TCE-Bd	7TCE-Cd	7TCE-Ed
Sample Date	(ug/l)	(ug/l)	06/25/99	06/24/99	06/26/99	06/30/99	06/30/99	06/30/99	06/30/99	07/01/99
Sample Type			Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary
Volatile Organic Compounds (ug/l)										
Benzene	5	0.36	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Bromodichloromethane	100	0.17	NA	NA	NA	5 U	5 U	5 U	5 U	5 U
Bromoform	100	8.50	NA	NA	NA	5 U	5 U	5 U	5 U	5 U
Chlorodibromomethane	100	0.13	NA	NA	NA	5 U	5 U	5 U	5 U	5 U
Chloroform	100	0.15	NA	NA	NA	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	700	1300	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Methylene chloride	5	4.10	NA	NA	NA	5 U	5 U	5 U	5 U	5 U
Toluene	1000	750.0	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5	1.60	5 U	**42**	**30**	5 U	**98**	**92**	**220**	5 U
Xylene (total)	10000	12,000	15 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U

Notes:
Shading indicates value exceeds Federal Maximum Contaminant Level for drinking water.
Bold face type indicates value exceeds USEPA Region III Tap water Risk Based Criteria.
U = Not detected; value presented is analytical reporting limit for compound.
NA = Not analyzed
(1) Field sample was actually 7TCE-102x (replaces data for 7TCE-102).

TABLE 5-1

ON-SITE LABORATORY ANALYTICAL DATA SUMMARY
SWMU 7 - TCE INVESTIGATION
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

		EPA Region III	"Second Row" Temporary Wells							
	Federal	**Tap Water**	Shallow Wells				Deep Wells			
Sample ID	MCL	**RBC**	7TCE-1s	7TCE-2s	7TCE-3s	7TCE-4s	7TCE-1d	7TCE-2d	7TCE-3d	7TCE-4d
Sample Date	(ug/l)	(ug/l)	06/27/99	06/28/99	06/28/99	06/28/99	06/29/99	06/29/99	06/29/99	06/29/99
Sample Type			Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary
Volatile Organic Compounds (ug/l)										
Benzene	5	0.36	5 U	5 U	5 U	5 U	5 U	**28**	5 U	5 U
Bromodichloromethane	100	0.17	5 U	5 U	5 U	5 U	5 U	**8**	5 U	**7**
Bromoform	100	8.50	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Chlorodibromomethane	100	0.13	5 U	5 U	5 U	5 U	5 U	**5**	5 U	**6**
Chloroform	100	0.15	5 U	5 U	5 U	5 U	5 U	5 U	5 U	**18**
Ethylbenzene	700	1300	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Methylene chloride	5	4.10	5 U	5 U	5 U	5 U	5 U	**23**	5 U	**9**
Toluene	1,000	750.0	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5	1.60	5 U	5 U	5 U	5 U	5 U	5 U	**87**	**6**
Xylene (total)	10,000	12,000	15 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U

Notes:
Shading indicates value exceeds Federal Maximum Contaminant Level for drinking water.
Bold face type indicates value exceeds USEPA Region III Tap water Risk Based Criteria.
U = Not detected; value presented is analytical reporting limit for compound.
NA = Not analyzed
(1) Field sample was actually 7TCE-102x (replaces data for 7TCE-102).

TABLE 5-1

ON-SITE LABORATORY ANALYTICAL DATA SUMMARY
SWMU 7 - TCE INVESTIGATION
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID Sample Date Sample Type	Federal MCL (ug/l)	**EPA Region III Tap Water RBC** (ug/l)	"Third Row" Temporary Wells					Adjacent to 7MW07
			7TCE-101 07/01/99 Primary	7TCE-102 (1) 07/02/99 Primary	7TCE-103 07/01/99 Primary	7TCE-104 07/02/99 Primary	7TCE-105 07/02/99 Primary	7TCE-MW07 07/02/99 Primary
Volatile Organic Compounds (ug/l)								
Benzene	5	0.36	5 U	5 U	5 U	5 U	5 U	5 U
Bromodichloromethane	100	0.17	5 U	5 U	5 U	5 U	5 U	5 U
Bromoform	100	8.50	5 U	5 U	5 U	5 U	5 U	5 U
Chlorodibromomethane	100	0.13	5 U	5 U	5 U	5 U	5 U	5 U
Chloroform	100	0.15	5 U	5 U	5 U	5 U	5 U	**6**
Ethylbenzene	700	1300	5 U	5 U	5 U	5 U	5 U	5 U
Methylene chloride	5	4.10	5 U	5 U	5 U	5 U	5 U	5 U
Toluene	1000	750.0	5 U	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5	1.60	5 U	**19**	5 U	5 U	5 U	**210**
Xylene (total)	10000	12,000	15 U	15 U	15 U	15 U	15 U	15 U

Notes:
Shading indicates value exceeds Federal Maximum Contaminant Level for drinking water.
Bold face type indicates value exceeds USEPA Region III Tap water Risk Based Criteria.
U = Not detected; value presented is analytical reporting limit for compound.
NA = Not analyzed
(1) Field sample was actually 7TCE-102x (replaces data for 7TCE-102).

TABLE 5-1

ON-SITE LABORATORY ANALYTICAL DATA SUMMARY
SWMU 7 - TCE INVESTIGATION
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID Sample Date Sample Type	Federal MCL (ug/l)	**EPA Region III Tap Water RBC** (ug/l)	Permanent Wells 7MW07 06/27/99 Primary	7MW07D 06/27/99 Duplicate	7MW08 06/27/99 Primary	UGW24 06/27/99 Primary	Number Exceeding Federal MCL	Range Exceeding Federal MCL	**Number Exceeding Region III Tap Water RBC**	**Range Exceeding Region III Tap Water RBC**	Location Maximum Detect
Volatile Organic Compounds (ug/l)											
Benzene	5	0.36	5 U	5 U	5 U	5 U	1/26	28	1/26	28	7TCE-2D
Bromodichloromethane	100	0.17	5 U	5 U	5 U	5 U	0/23		2/23	7-8	7TCE-2D
Bromoform	100	8.50	5 U	5 U	5 U	5 U	0/23		0/23		
Chlorodibromomethane	100	0.13	5 U	5 U	5 U	5 U	0/23		2/23	5-6	7TCE-4D
Chloroform	100	0.15	**29**	**13**	5 U	5 U	0/23		4/23	6-29	7MW07
Ethylbenzene	700	1300	5 U	5 U	5 U	5 U	0/26		0/26		
Methylene chloride	5	4.10	5 U	5 U	5 U	5 U	2/23	9-23	2/23	9-23	7TCE-2D
Toluene	1,000	750.0	5 U	5 U	5 U	5 U	0/26		0/26		
Trichloroethene	5	1.60	**2,000**	**1,800**	**17**	5 U	12/26	6-2,000	12/26	6-2,000	7MW07
Xylene (total)	10,000	12,000	15 U	15 U	15 U	15 U	0/26		0/26		

Notes:
Shading indicates value exceeds Federal Maximum Contaminant Level for drinking water.
Bold face type indicates value exceeds USEPA Region III Tap water Risk Based Criteria.
U = Not detected; value presented is analytical reporting limit for compound.
NA = Not analyzed

TABLE 5-2 (Continued)

STATESIDE LABORATORY ANALYTICAL DATA SUMMARY
SWMU 7 - TCE INVESTIGATION
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Location	Federal	**EPA Region III Tap Water**	"First Row" Temporary Wells							
			Shallow Wells					Deep Wells		
Sample ID	MCL	**RBC**	7TCE-As	7TCE-Bs	7TCE-Cs	7TCE-Es	7TCE-EsD	7TCE-Ad	7TCE-Bd	7TCE-Cd
Sample Date	(ug/l)	(ug/l)	06/25/99	06/25/99	06/27/99	06/30/99	06/30/99	06/30/99	06/30/99	06/30/99
Sample Type			Primary	Primary	Primary	Primary	Duplicate	Primary	Primary	Primary
Volatile Organic Compounds (ug/l)										
Acetone	NE	610	50 U	50 U	50 U	50 U	50 U	50 U	50 U	500 U
Benzene	5	0.36	5 U	5 U	5 U	5 U	5 U	5 U	5 U	50 U
Bromodichloromethane	100	0.17	5 U	5 U	5 U	5 U	5 U	5 U	5 U	50 U
Bromoform	100	8.5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	50 U
2-Butanone (MEK)	NE	1,900	25 U	25 U	25 U	25 U	25 U	25 U	25 U	250 U
Carbon disulfide	NE	1,000	5 U	5 U	5 U	5 U	5 U	5 U	5 U	50 U
Carbon tetrachloride	5	0.16	5 U	5 U	5 U	5 U	5 U	5 U	5 U	50 U
Chlorobenzene	NE	110	5 U	5 U	5 U	5 U	5 U	5 U	5 U	50 U
Chloroethane	NE	3.6	10 U	10 U	10 U	10 U	10 U	10 U	10 U	100 U
Chloroform	100	0.15	5 U	5 U	5 U	5 U	5 U	5 U	5 U	50 U
Chloromethane	NE	2.1	10 U	10 U	10 U	10 U	10 U	10 U	10 U	100 U
1,1-Dichloroethane	NE	800	5 U	5 U	5 U	5 U	5 U	5 U	5 U	50 U
1,2-Dichloroethane	5	0.12	5 U	5 U	5 U	5 U	5 U	5 U	5 U	50 U
1,1-Dichloroethene	7	0.044	5 U	**3.8** J	5 U	5 U	5 U	**5**	5 U	50 U
cis-1,2-Dichloroethene	70	61	5 U	5 U	5 U	5 U	5 U	5 U	5 U	50 U
trans-1,2-Dichloroethene	100	120	5 U	5 U	5 U	5 U	5 U	5 U	5 U	50 U
1,2-Dichloropropane	5	0.16	5 U	5 U	5 U	5 U	5 U	5 U	5 U	50 U

Notes:
Shading indicates exceedance of Federal MCL for drinking water.
Bold indicates exceedance of USEPA Region III Tap water RBC.
U - Not detected.
NE - Criteria Not Established.

TABLE 5-2 (Continued)

STATESIDE LABORATORY ANALYTICAL DATA SUMMARY
SWMU 7 - TCE INVESTIGATION
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Location	Federal MCL	**EPA Region III Tap Water RBC**	"First Row" Temporary Wells							
			Shallow Wells					Deep Wells		
Sample ID			7TCE-As	7TCE-Bs	7TCE-Cs	7TCE-Es	7TCE-EsD	7TCE-Ad	7TCE-Bd	7TCE-Cd
Sample Date	(ug/l)	(ug/l)	06/25/99	06/25/99	06/27/99	06/30/99	06/30/99	06/30/99	06/30/99	06/30/99
Sample Type			Primary	Primary	Primary	Primary	Duplicate	Primary	Primary	Primary
Volatile Organic Compounds (ug/l)										
cis-1,3-Dichloropropene	NE	NE	5 U	5 U	5 U	5 U	5 U	5 U	5 U	50 U
trans-1,3-Dichloropropene	NE	NE	5 U	5 U	5 U	5 U	5 U	5 U	5 U	50 U
Dibromochloromethane	100	0.13	5 U	5 U	5 U	5 U	5 U	5 U	5 U	50 U
Ethylbenzene	700	1300	5 U	5 U	5 U	5 U	5 U	5 U	5 U	50 U
2-Hexanone	NE	1500	25 U	25 U	25 U	25 U	25 U	25 U	25 U	250 U
Methyl bromide	NE	8.5	10 U	10 U	10 U	10 U	10 U	10 U	10 U	100 U
Methyl isobutyl ketone (MIBK)	NE	140	25 U	25 U	25 U	25 U	25 U	25 U	25 U	250 U
Methylene chloride	5	4.10	5 U	5 U	5 U	5 U	5 U	5 U	5 U	50 U
Styrene	100	1600	5 U	5 U	5 U	5 U	5 U	5 U	5 U	50 U
1,1,2,2-Tetrachloroethane	NE	0.053	5 U	5 U	5 U	5 U	5 U	5 U	5 U	50 U
Tetrachloroethene	5	1.1	5 U	5 U	5 U	5 U	5 U	5 U	5 U	50 U
Toluene	1,000	750	5 U	5 U	5 U	5 U	5 U	5 U	5 U	50 U
1,1,1-Trichloroethane	200	540	5 U	5 U	5 U	5 U	5 U	5 U	5 U	50 U
1,1,2-Trichloroethane	5	0.19	5 U	5 U	5 U	5 U	5 U	5 U	5 U	50 U
Trichloroethene	5	1.6	**55**	**92**	**25**	5 U	5 U	**140**	**66**	**1,500**
Vinyl chloride	2	0.019	10 U	10 U	10 U	10 U	10 U	10 U	10 U	100 U
Xylene (total)	10,000	12,000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	100 U

Notes:
Shading indicates exceedance of Federal MCL for drinking water.
Bold indicates exceedance of USEPA Region III Tap water RBC.
U - Not detected.
NE - Criteria Not Established.

TABLE 5-2 (Continued)

STATESIDE LABORATORY ANALYTICAL DATA SUMMARY
SWMU 7 - TCE INVESTIGATION
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Location	Federal MCL	**EPA Region III Tap Water RBC**	"Second Row" Temporary Wells					
			Shallow Wells		Deep Wells			
Sample ID			7TCE-1s	7TCE-4s	7TCE-1d	7TCE-2d	7TCE-3d	7TCE-4d
Sample Date	(ug/l)	(ug/l)	06/26/99	06/28/99	06/29/99	06/29/99	06/29/99	06/29/99
Sample Type			Primary	Primary	Primary	Primary	Primary	Primary
Volatile Organic Compounds (ug/l)								
Acetone	NE	610	50 U	50 U	50 U	50 U	50 U	50 U
Benzene	5	0.36	5 U	5 U	5 U	5 U	5 U	5 U
Bromodichloromethane	100	0.17	5 U	5 U	5 U	5 U	5 U	5 U
Bromoform	100	8.5	5 U	5 U	5 U	5 U	5 U	5 U
2-Butanone (MEK)	NE	1,900	25 U	25 U	25 U	25 U	25 U	25 U
Carbon disulfide	NE	1,000	5 U	5 U	5 U	5 U	5 U	5 U
Carbon tetrachloride	5	0.16	5 U	5 U	5 U	5 U	5 U	5 U
Chlorobenzene	NE	110	5 U	5 U	5 U	5 U	5 U	5 U
Chloroethane	NE	3.6	10 U	10 U	10 U	10 U	10 U	10 U
Chloroform	100	0.15	5 U	5 U	5 U	5 U	5 U	5 U
Chloromethane	NE	2.1	**13**	10 U	10 U	10 U	**9** J	10 U
1,1-Dichloroethane	NE	800	5 U	5 U	5 U	5 U	5 U	5 U
1,2-Dichloroethane	5	0.12	5 U	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethene	7	0.044	5 U	5 U	5 U	5 U	**3** J	5 U
cis-1,2-Dichloroethene	70	61	5 U	5 U	5 U	5 U	5 U	5 U
trans-1,2-Dichloroethene	100	120	5 U	5 U	5 U	5 U	5 U	5 U
1,2-Dichloropropane	5	0.16	5 U	5 U	5 U	5 U	5 U	5 U

Notes:
Shading indicates exceedance of Federal MCL for drinking water.
Bold indicates exceedance of USEPA Region III Tap water RBC.
U - Not detected.
NE - Criteria Not Established.

TABLE 5-2 (Continued)

STATESIDE LABORATORY ANALYTICAL DATA SUMMARY
SWMU 7 - TCE INVESTIGATION
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Location	Federal MCL	**EPA Region III Tap Water RBC**	"Second Row" Temporary Wells					
			Shallow Wells		Deep Wells			
Sample ID			7TCE-1s	7TCE-4s	7TCE-1d	7TCE-2d	7TCE-3d	7TCE-4d
Sample Date	(ug/l)	(ug/l)	06/26/99	06/28/99	06/29/99	06/29/99	06/29/99	06/29/99
Sample Type			Primary	Primary	Primary	Primary	Primary	Primary
Volatile Organic Compounds (ug/l)								
cis-1,3-Dichloropropene	NE	NE	5 U	5 U	5 U	5 U	5 U	5 U
trans-1,3-Dichloropropene	NE	NE	5 U	5 U	5 U	5 U	5 U	5 U
Dibromochloromethane	100	0.13	5 U	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	700	1300	5 U	5 U	5 U	5 U	5 U	5 U
2-Hexanone	NE	1500	25 U	25 U	25 U	25 U	25 U	25 U
Methyl bromide	NE	8.5	10 U	10 U	10 U	10 U	10 U	10 U
Methyl isobutyl ketone (MIBK)	NE	140	25 U	25 U	25 U	25 U	25 U	25 U
Methylene chloride	5	4.10	5 U	5 U	5 U	5 U	5 U	5 U
Styrene	100	1600	5 U	5 U	5 U	5 U	5 U	5 U
1,1,2,2-Tetrachloroethane	NE	0.053	5 U	5 U	5 U	5 U	5 U	5 U
Tetrachloroethene	5	1.1	5 U	5 U	5 U	5 U	5 U	5 U
Toluene	1,000	750	5 U	5 U	5 U	5 U	5 U	5 U
1,1,1-Trichloroethane	200	540	5 U	5 U	5 U	5 U	5 U	5 U
1,1,2-Trichloroethane	5	0.19	5 U	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5	1.6	5 U	5 U	5 U	5 U	**44**	5 U
Vinyl chloride	2	0.019	10 U	10 U	10 U	10 U	10 U	10 U
Xylene (total)	10,000	12,000	10 U	10 U	10 U	10 U	10 U	10 U

Notes:
Shading indicates exceedance of Federal MCL for drinking water.
Bold indicates exceedance of USEPA Region III Tap water RBC.
U - Not detected.
NE - Criteria Not Established.

TABLE 5-2 (Continued)

STATESIDE LABORATORY ANALYTICAL DATA SUMMARY
SWMU 7 - TCE INVESTIGATION
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Location Sample ID Sample Date Sample Type	Federal MCL (ug/l)	**EPA Region III Tap Water RBC** (ug/l)	"Third Row" Temporary Wells			Adjacent to 7MW07
			7TCE-102 07/01/99 Primary	7TCE-104 07/01/99 Primary	7TCE-105 07/01/99 Primary	7TCEMW7 07/01/99 Primary
Volatile Organic Compounds (ug/l)						
Acetone	NE	610	50 U	50 U	50 U	500 U
Benzene	5	0.36	5 U	5 U	5 U	50 U
Bromodichloromethane	100	0.17	5 U	5 U	5 U	50 U
Bromoform	100	8.5	5 U	5 U	5 U	50 U
2-Butanone (MEK)	NE	1,900	25 U	25 U	25 U	250 U
Carbon disulfide	NE	1,000	5 U	5 U	5 U	50 U
Carbon tetrachloride	5	0.16	5 U	5 U	5 U	50 U
Chlorobenzene	NE	110	5 U	5 U	5 U	50 U
Chloroethane	NE	3.6	10 U	10 U	10 U	100 U
Chloroform	100	0.15	5 U	5 U	5 U	50 U
Chloromethane	NE	2.1	10 U	10 U	10 U	100 U
1,1-Dichloroethane	NE	800	5 U	5 U	5 U	50 U
1,2-Dichloroethane	5	0.12	5 U	5 U	5 U	50 U
1,1-Dichloroethene	7	0.044	5 U	5 U	5 U	50 U
cis-1,2-Dichloroethene	70	61	5 U	5 U	5 U	50 U
trans-1,2-Dichloroethene	100	120	5 U	5 U	5 U	50 U
1,2-Dichloropropane	5	0.16	5 U	5 U	5 U	50 U

Notes:
Shading indicates exceedance of Federal MCL for drinking water.
Bold indicates exceedance of USEPA Region III Tap water RBC.
U - Not detected.
NE - Criteria Not Established.

TABLE 5-2 (Continued)

STATESIDE LABORATORY ANALYTICAL DATA SUMMARY
SWMU 7 - TCE INVESTIGATION
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Location Sample ID Sample Date Sample Type	Federal MCL (ug/l)	**EPA Region III Tap Water RBC** (ug/l)	"Third Row" Temporary Wells			Adjacent to 7MW07
			7TCE-102 07/01/99 Primary	7TCE-104 07/01/99 Primary	7TCE-105 07/01/99 Primary	7TCEMW7 07/01/99 Primary
Volatile Organic Compounds (ug/l)						
cis-1,3-Dichloropropene	NE	NE	5 U	5 U	5 U	50 U
trans-1,3-Dichloropropene	NE	NE	5 U	5 U	5 U	50 U
Dibromochloromethane	100	0.13	5 U	5 U	5 U	50 U
Ethylbenzene	700	1300	5 U	5 U	5 U	50 U
2-Hexanone	NE	1500	25 U	25 U	25 U	250 U
Methyl bromide	NE	8.5	10 U	10 U	10 U	100 U
Methyl isobutyl ketone (MIBK)	NE	140	25 U	25 U	25 U	250 U
Methylene chloride	5	4.10	5 U	5 U	5 U	50 U
Styrene	100	1600	5 U	5 U	5 U	50 U
1,1,2,2-Tetrachloroethane	NE	0.053	5 U	5 U	5 U	50 U
Tetrachloroethene	5	1.1	5 U	5 U	5 U	50 U
Toluene	1,000	750	5 U	5 U	5 U	50 U
1,1,1-Trichloroethane	200	540	5 U	5 U	5 U	50 U
1,1,2-Trichloroethane	5	0.19	5 U	5 U	5 U	50 U
Trichloroethene	5	1.6	**5.4**	5 U	5 U	**1,000**
Vinyl chloride	2	0.019	10 U	10 U	10 U	100 U
Xylene (total)	10,000	12,000	10 U	10 U	10 U	100 U

Notes:
Shading indicates exceedance of Federal MCL for drinking water.
Bold indicates exceedance of USEPA Region III Tap water RBC.
U - Not detected.
NE - Criteria Not Established.

TABLE 5-2 (Continued)

STATESIDE LABORATORY ANALYTICAL DATA SUMMARY
SWMU 7 - TCE INVESTIGATION
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Location Sample ID Sample Date Sample Type	Federal MCL (ug/l)	**EPA Region III Tap Water RBC** (ug/l)	Criteria Exceedance Summary				
			Number Exceeding Federal MCL	Range Exceeding Federal MCL	Number Exceeding Tap Water RBCs	Range Exceeding Tap Water RBCs	Location Maximum Detect
Volatile Organic Compounds (ug/l)							
Acetone	NE	610	NE		0/12		
Benzene	5	0.36	0/18		0/18		
Bromodichloromethane	100	0.17	0/18		0/18		
Bromoform	100	8.5	0/18		0/18		
2-Butanone (MEK)	NE	1,900	NE		0/18		
Carbon disulfide	NE	1,000	NE		0/18		
Carbon tetrachloride	5	0.16	0/18		0/18		
Chlorobenzene	NE	110	NE		0/18		
Chloroethane	NE	3.6	NE		0/18		
Chloroform	100	0.15	0/18		0/18		
Chloromethane	NE	2.1	NE		2/18	9 J - 13	7TCE-1S
1,1-Dichloroethane	NE	800	NE		0/18		
1,2-Dichloroethane	5	0.12	0/18		0/18		
1,1-Dichloroethene	7	0.044	0/18		3/18	3 J - 5	7TCE-AD
cis-1,2-Dichloroethene	70	61	0/18		0/18		
trans-1,2-Dichloroethene	100	120	0/18		0/18		
1,2-Dichloropropane	5	0.16	0/18		0/18		

Notes:
Shading indicates exceedance of Federal MCL for drinking water.
Bold indicates exceedance of USEPA Region III Tap water RBC.
U - Not detected.
NE - Criteria Not Established.

TABLE 5-2 (Continued)

STATESIDE LABORATORY ANALYTICAL DATA SUMMARY
SWMU 7 - TCE INVESTIGATION
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Location Sample ID Sample Date Sample Type	Federal MCL (ug/l)	**EPA Region III Tap Water RBC** (ug/l)	Criteria Exceedance Summary				
			Number Exceeding Federal MCL	Range Exceeding Federal MCL	Number Exceeding Tap Water RBCs	Range Exceeding Tap Water RBCs	Location Maximum Detect
Volatile Organic Compounds (ug/l)							
cis-1,3-Dichloropropene	NE	NE	NE		NE		
trans-1,3-Dichloropropene	NE	NE	NE		NE		
Dibromochloromethane	100	0.13	0/18		0/18		
Ethylbenzene	700	1300	0/18		0/18		
2-Hexanone	NE	1500	NE		0/18		
Methyl bromide	NE	8.5	NE		0/18		
Methyl isobutyl ketone (MIBK)	NE	140	NE		0/18		
Methylene chloride	5	4.10	0/18		0/18		
Styrene	100	1600	0/18		0/18		
1,1,2,2-Tetrachloroethane	NE	0.053	NE		0/18		
Tetrachloroethene	5	1.1	0/18		0/18		
Toluene	1,000	750	0/18		0/18		
1,1,1-Trichloroethane	200	540	0/18		0/18		
1,1,2-Trichloroethane	5	0.19	0/18		0/18		
Trichloroethene	5	1.6	9/18	5.4 - 1,500	9/18	5.4 - 1,500	7TCE-CD
Vinyl chloride	2	0.019	0/18		0/18		
Xylene (total)	10,000	12,000	0/18		0/18		

Notes:
Shading indicates exceedance of Federal MCL for drinking water.
Bold indicates exceedance of USEPA Region III Tap water RBC.
U - Not detected.
NE - Criteria Not Established.

TABLE 4-4

SUMMARY OF ORGANIC DETECTIONS IN GROUNDWATER
TWFF - ADDITIONAL DATA COLLECTION INVESTIGATION
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	470MW01	470MW03	7MW03	7MW05	7MW06	7MW07	7MW07D	7MW08
Site ID	470MW01	470MW03	7MW03	7MW05	7MW06	7MW07	7MW07	7MW08
Sample Date	01/15/02	01/15/02	01/25/02	01/09/02	01/09/02	01/13/02	01/13/02	01/13/02
Volatiles (ug/L)								
Ethylbenzene	580	1,400	5 U	5 U	5 U	1,000 U	1,000 U	5 U
Acrolein	2,000 R	10,000 R	100 R	100 R	100 R	20,000 R	20,000 R	100 J
Propionitrile	720 J	10,000 U	100 U	100 UJ	100 UJ	20,000 U	20,000 U	100 U
Acrylonitrile	400 J	10,000 U	100 U	100 U	100 U	20,000 UJ	20,000 UJ	100 U
Toluene	3,900 D	500 U	5 U	5 U	5 U	1,000 U	170 J	5 U
Xylene	6,300	6,100	10 U	10 U	10 U	2,000 U	2,000 U	10 U
Carbon tetrachloride	100 U	500 U	5 U	5 U	5 U	1,000 U	1,000 U	5 U
Acetone	1,000 U	5,000 U	50 U	50 UJ	50 UJ	10,000 U	10,000 U	50 U
Chloroform	100 U	500 U	5 U	5 U	5 U	1,000 U	1,000 U	5 U
Benzene	19,000 D	11,000	5 U	5 U	5 U	1,000 U	1,000 U	0.54 J
Acetonitrile	1,700 J	20,000 U	200 UJ	200 UJ	200 U	40,000 UJ	40,000 UJ	200 U
Methylene chloride	100 U	500 U	5 U	5 U	5 U	95 J	1,000 U	5 U
Bromodichloromethane	100 U	500 U	5 U	5 U	5 U	1,000 U	1,000 U	5 U
1,1-Dichloroethene	100 U	500 U	5 U	5 U	5 U	1,000 U	1,000 U	5 U
Trichlorofluoromethane	100 U	500 U	5 U	5 U	5 U	1,000 U	1,000 U	5 U
Pentachloroethane	500 U	2,500 U	25 R	25 R	25 R	5,000 UJ	5,000 UJ	25 J
Isobutanol	2,500 J	20,000 R	200 R	200 R	200 R	40,000 U	40,000 U	200 R
2-Butanone	810 J	2,500 U	25 U	25 UJ	25 UJ	5,000 U	5,000 U	25 U
Trichloroethene	100 U	500 U	5 U	5 U	5 U	28,000 J	23,000 J	0.47 J
Methyl methacrylate	100 U	500 U	5 U	5 U	5 U	1,000 U	1,000 U	5 U
1,2-Dibromo-3-chloropropane	100 U	500 U	5 U	5 U	5 U	1,000 UJ	1,000 UJ	5 J

Notes:

ug/L - micrograms per liter.
J - Estimated value.
U - Not Detected.
R - Result is rejected and unusable.
D - Result value based on dilution analysis.
UJ - Report quantitation limit is qualified as estimated.
DJ - Estimated value based on dilution analysis.
B - Analyte found in associated method blank.
NA - Not Analyzed.
mg/L - milligrams per liter.

TABLE 4-4

SUMMARY OF ORGANIC DETECTIONS IN GROUNDWATER
TWFF - ADDITIONAL DATA COLLECTION INVESTIGATION
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7MW09	7MW10	7MW11	7MW12	7MW13	7MW14	7MW15	7MW16
Site ID	7MW09	7MW10	7MW11	7MW12	7MW13	7MW14	7MW15	7MW16
Sample Date	01/24/02	01/26/02	01/27/02	02/01/02	01/27/02	01/29/02	01/29/02	02/01/02
Volatiles (ug/L)								
Ethylbenzene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	34
Acrolein	100 R	100 R	100 R	100 R	100 R	100 R	100 R	100 R
Propionitrile	100 U	100 U	100 U	100 U	100 U	12 J	100 U	100 U
Acrylonitrile	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U
Toluene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	2 J
Xylene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	41
Carbon tetrachloride	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Acetone	50 U	50 U	50 U	50 R	50 U	50 U	50 U	16 J
Chloroform	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Benzene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	2 J
Acetonitrile	200 UJ	200 UJ	200 UJ	200 U	200 UJ	200 UJ	200 UJ	200 U
Methylene chloride	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Bromodichloromethane	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Trichlorofluoromethane	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Pentachloroethane	25 R	25 R	25 R	25 R	25 R	25 R	25 R	25 R
Isobutanol	200 R	200 R	200 R	200 R	270 J	200 R	33 J	200 R
2-Butanone	25 U	25 U	25 U	25 U	25 U	25 U	25 U	25 U
Trichloroethene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Methyl methacrylate	5 U	5 U	5 U	5 U	5 U	5 U	4 J	5 U
1,2-Dibromo-3-chloropropane	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U

Notes:

ug/L - micrograms per liter.
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UJ - Report quantitation limit is qualified as estimated.
DJ - Estimated value based on dilution analysis.
B - Analyte found in associated method blank.
NA - Not Analyzed.
mg/L - milligrams per liter.

TABLE 4-4

SUMMARY OF ORGANIC DETECTIONS IN GROUNDWATER
TWFF - ADDITIONAL DATA COLLECTION INVESTIGATION
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	7MW17	7MW18	7MW18D	7MW19	7MW20	GW04	GW06	UGW06
Site ID	7MW17	7MW18	7MW18	7MW19	7MW20	GW04	GW06	UGW06
Sample Date	03/01/02	01/31/02	01/31/02	01/30/02	01/26/02	01/10/02	01/11/02	01/10/02
Volatiles (ug/L)								
Ethylbenzene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Acrolein	100 R	100 R	100 R	100 R	100 R	100 R	100 R	100 R
Propionitrile	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U
Acrylonitrile	100 U	100 U	100 U	100 U	100 U	100 UJ	100 UJ	100 UJ
Toluene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Xylene	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Carbon tetrachloride	5 U	1 J	5 U	5 U	5 U	5 U	5 U	5 U
Acetone	50 UJ	50 R	50 R	50 R	50 U	50 U	50 U	50 U
Chloroform	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Benzene	5 U	1 J	5 U	5 U	5 U	5 U	5 U	5 U
Acetonitrile	200 UJ	200 U	200 U	200 U	200 UJ	200 UJ	200 UJ	200 UJ
Methylene chloride	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Bromodichloromethane	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Trichlorofluoromethane	5 U	5 U	5 U	11	5 U	5 U	5 U	5 U
Pentachloroethane	25 UJ	25 R	25 R	25 R	25 R	25 UJ	25 UJ	25 UJ
Isobutanol	200 R	200 R	200 R	200 R	200 R	200 U	200 U	200 U
2-Butanone	25 UJ	25 U	25 U	25 U	25 U	25 U	25 U	25 U
Trichloroethene	5 U	0.48 J	5 U	5 U	0.59 J	5 U	5 U	5 U
Methyl methacrylate	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
1,2-Dibromo-3-chloropropane	5 UJ	5 U	5 U	5 U	5 U	5 UJ	5 UJ	5 UJ

Notes:

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J - Estimated value.
U - Not Detected.
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DJ - Estimated value based on dilution analysis.
B - Analyte found in associated method blank.
NA - Not Analyzed.
mg/L - milligrams per liter.

TABLE 4-4

SUMMARY OF ORGANIC DETECTIONS IN GROUNDWATER
TWFF - ADDITIONAL DATA COLLECTION INVESTIGATION
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	UGW06D	UGW07	UGW08	UGW08D	UGW09	UGW10	UGW11
Site ID	UGW06	UGW07	UGW08	UGW08	UGW09	UGW10	UGW11
Sample Date	01/10/02	01/10/02	01/11/02	01/11/02	01/12/02	01/12/02	01/12/02
Volatiles (ug/L)							
Ethylbenzene	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Acrolein	100 R	100 R	100 R	100 R	100 R	100 R	100 R
Propionitrile	100 U	100 U	100 U	100 U	100 U	100 U	100 U
Acrylonitrile	100 UJ	100 UJ	100 UJ	100 UJ	100 UJ	100 UJ	100 UJ
Toluene	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Xylene	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Carbon tetrachloride	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Acetone	50 U	50 U	50 U	50 U	50 U	50 U	50 U
Chloroform	5 U	5 U	5 U	5 U	75	5 U	5 U
Benzene	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Acetonitrile	200 UJ	200 UJ	200 UJ	200 UJ	200 UJ	200 UJ	200 UJ
Methylene chloride	5 U	5 U	5 U	5 U	2 J	5 U	5 U
Bromodichloromethane	5 U	5 U	5 U	5 U	3 J	5 U	5 U
1,1-Dichloroethene	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Trichlorofluoromethane	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Pentachloroethane	25 UJ	25 UJ	25 UJ	25 UJ	25 UJ	25 UJ	25 UJ
Isobutanol	200 U	200 U	200 U	200 U	200 U	200 U	200 U
2-Butanone	25 U	25 U	25 U	25 U	25 U	25 U	25 U
Trichloroethene	5 U	5 U	5 U	5 U	5 U	5 U	0.35 J
Methyl methacrylate	5 U	5 U	5 U	5 U	5 U	5 U	5 U
1,2-Dibromo-3-chloropropane	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ

Notes:

ug/L - micrograms per liter.
J - Estimated value.
U - Not Detected.
R - Result is rejected and unusable.
D - Result value based on dilution analysi

UJ - Report quantitation limit is qualified as estimated.
DJ - Estimated value based on dilution analysis.
B - Analyte found in associated method blank.
NA - Not Analyzed.
mg/L - milligrams per liter.

TABLE 4-4

SUMMARY OF ORGANIC DETECTIONS IN GROUNDWATER
TWFF - ADDITIONAL DATA COLLECTION INVESTIGATION
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID	UGW15	UGW16	UGW18	UGW20R	UGW23	UGW26	UGW31
Site ID	UGW15	UGW16	UGW18	UGW20R	UGW23	UGW26	UGW31
Sample Date	01/09/02	01/12/02	01/12/02	01/11/02	01/24/02	01/11/02	01/16/02
Volatiles (ug/L)							
Ethylbenzene	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Acrolein	100 R	100 R	100 R	100 R	100 R	100 R	100 R
Propionitrile	100 UJ	100 U	100 U	100 U	100 U	100 U	100 U
Acrylonitrile	100 U	100 UJ	100 UJ	100 U	100 U	100 UJ	100 U
Toluene	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Xylene	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Carbon tetrachloride	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Acetone	50 UJ	50 U	50 U	50 U	50 U	50 U	50 U
Chloroform	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Benzene	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Acetonitrile	200 UJ	200 UJ	200 UJ	200 U	200 UJ	200 UJ	200 U
Methylene chloride	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Bromodichloromethane	5 U	5 U	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethene	5 U	2 J	5 U	5 U	5 U	5 U	5 U
Trichlorofluoromethane	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Pentachloroethane	25 R	25 UJ	25 UJ	25 UJ	25 R	25 UJ	25 U
Isobutanol	200 R	200 U	200 U	200 R	200 R	200 U	200 R
2-Butanone	25 UJ	25 U	25 U	25 U	25 U	25 U	25 U
Trichloroethene	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Methyl methacrylate	5 U	5 U	5 U	5 U	5 U	5 U	5 U
1,2-Dibromo-3-chloropropane	5 U	5 UJ	5 UJ	5 UJ	5 U	5 UJ	5 U

Notes:

ug/L - micrograms per liter.
J - Estimated value.
U - Not Detected.
R - Result is rejected and unusable.
D - Result value based on dilution analysi

UJ - Report quantitation limit is qualified as estimated.
DJ - Estimated value based on dilution analysis.
B - Analyte found in associated method blank.
NA - Not Analyzed.
mg/L - milligrams per liter.

TABLE 4-4

SUMMARY OF ORGANIC DETECTIONS IN GROUNDWATER
TWFF - ADDITIONAL DATA COLLECTION INVESTIGATION
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

Sample ID Site ID Sample Date	UGW32 UGW32 01/16/02	UGW34 UGW34 01/16/02	Number of Positive Detections	Range of Positive Detections	Location of Maximum Detection
Volatiles (ug/L)					
Ethylbenzene	5 U	5 U	3/41	34 - 1,400	470MW03
Acrolein	100 R	100 R	1/1	100J	7MW08
Propionitrile	100 U	100 U	2/41	12J - 720J	470MW03
Acrylonitrile	100 U	100 U	1/41	400J	470MW01
Toluene	5 U	5 U	3/41	2J - 3,900D	470MW01
Xylene	10 U	10 U	3/41	41 - 6,300	470MW01
Carbon tetrachloride	5 U	5 U	1/41	1J	7MW18
Acetone	50 U	50 U	1/36	16J	7MW16
Chloroform	5 U	5 U	1/41	75	UGW09
Benzene	5 U	5 U	5/41	0.54J - 19,000D	470MW01
Acetonitrile	200 U	200 UJ	1/41	1,700J	470MW01
Methylene chloride	5 U	5 U	2/41	2J - 95J	7MW07
Bromodichloromethane	5 U	5 U	1/41	3J	UGW09
1,1-Dichloroethene	5 U	5 U	1/41	2J	UGW16
Trichlorofluoromethane	5 U	5 U	1/41	11	7MW19
Pentachloroethane	25 U	25 U	1/23	25J	7MW08
Isobutanol	200 R	200 R	3/18	33J - 2,500J	470MW01
2-Butanone	25 U	25 U	1/41	810J	470MW01
Trichloroethene	5 U	5 U	6/41	0.35J - 28,000J	7MW07
Methyl methacrylate	5 U	5 U	1/41	4J	7MW15
1,2-Dibromo-3-chloropropane	5 U	5 U	1/41	5J	7MW08

Notes:

ug/L - micrograms per liter.
J - Estimated value.
U - Not Detected.
R - Result is rejected and unusable.
D - Result value based on dilution analysi

UJ - Report quantitation limit is qualified as estimated.
DJ - Estimated value based on dilution analysis.
B - Analyte found in associated method blank.
NA - Not Analyzed.
mg/L - milligrams per liter.

APPENDIX C
USEPA Region II – Groundwater Sampling Procedure
Low Stress (Low Flow) Purging and Sampling

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION II

GROUND WATER SAMPLING PROCEDURE
LOW STRESS (Low Flow) PURGING AND SAMPLING

I. SCOPE & APPLICATION

This Low Stress (or Low-Flow) Purging and Sampling Procedure is the EPA Region II standard method for collecting low stress (low flow) ground water samples from monitoring wells. Low stress Purging and Sampling results in collection of ground water samples from monitoring wells that are representative of ground water conditions in the geological formation. This is accomplished by minimizing stress on the geological formation and minimizing disturbance of sediment that has collected in the well. The procedure applies to monitoring wells that have an inner casing with a diameter of 2.0 inches or greater, and maximum screened intervals of ten feet unless multiple intervals are sampled. The procedure is appropriate for collection of ground water samples that will be analyzed for volatile and semi-volatile organic compounds (VOCs and SVOCs), pesticides, polychlorinated biphenyls (PCBs), metals, and microbiological and other contaminants in association with all EPA programs.

This procedure does not address the collection of light or dense non-aqueous phase liquids (LNAPL or DNAPL) samples, and should be used for aqueous samples only. For sampling NAPLs, the reader is referred to the following EPA publications: DNAPL Site Evaluation (Cohen & Mercer, 1993) and the RCRA Ground-Water Monitoring: Draft Technical Guidance (EPA/530-R-93-001), and references therein.

II. METHOD SUMMARY

The purpose of the low stress purging and sampling procedure is to collect ground water samples from monitoring wells that are representative of ground water conditions in the geological formation. This is accomplished by setting the intake velocity of the sampling pump to a flow rate that limits drawdown inside the well casing.

Sampling at the prescribed (low) flow rate has three primary benefits. First, it minimizes disturbance of sediment in the bottom of the well,

thereby producing a sample with low turbidity (i.e., low concentration of suspended particles). Typically, this saves time and analytical costs by eliminating the need for collecting and analyzing an additional filtered sample from the same well. Second, this procedure minimizes aeration of the ground water during sample collection, which improves the sample quality for VOC analysis. Third, in most cases the procedure significantly reduces the volume of ground water purged from a well and the costs associated with its proper treatment and disposal.

III. ADDRESSING POTENTIAL PROBLEMS

Problems that may be encountered using this technique include a) difficulty in sampling wells with insufficient yield; b) failure of one or more key indicator parameters to stabilize; c) cascading of water and/or formation of air bubbles in the tubing; and d) cross-contamination between wells.

Insufficient Yield

Wells with insufficient yield (i.e., low recharge rate of the well) may dewater during purging. Care should be taken to avoid loss of pressure in the tubing line due to dewatering of the well below the level of the pump=s intake. Purging should be interrupted before the water level in the well drops below the top of the pump, as this may induce cascading of the sand pack. Pumping the well dry should therefore be avoided to the extent possible in all cases. Sampling should commence as soon as the volume in the well has recovered sufficiently to allow collection of samples. Alternatively, ground water samples may be obtained with techniques designed for the unsaturated zone, such as lysimeters.

Failure to Stabilize Key Indicator Parameters

If one or more key indicator parameters fails to stabilize after 4 hours, one of four options should be considered: a) continue purging in an attempt to achieve stabilization; b) discontinue purging, do not collect samples, and document attempts to reach stabilization in the log book; c) discontinue purging, collect samples, and document attempts to reach stabilization in the log book; or d) Secure the well, purge and collect samples the next day (preferred). The key indicator parameter for samples to be analyzed for VOCs is dissolved oxygen. The key indicator parameter for all other samples is turbidity.

Cascading

To prevent cascading and/or air bubble formation in the tubing, care should be taken to ensure that the flow rate is sufficient to maintain pump suction. Minimize the length and diameter of tubing (i.e., 1/4 or 3/8 inch ID) to ensure that the tubing remains filled with ground water during sampling.

Cross-Contamination

To prevent cross-contamination between wells, it is strongly recommended that dedicated, in-place pumps be used. As an alternative, the potential for cross-contamination can be reduced by performing the more thorough Adaily@ decontamination procedures between sampling of each well in addition to the start of each sampling day (see Section VII, below).

Equipment Failure

Adequate equipment should be on-hand so that equipment failures do not adversely impact sampling activities.

IV. PLANNING DOCUMENTATION AND EQUIPMENT

< Approved site-specific Field Sampling Plan/Quality Assurance Project Plan (QAPP). This plan must specify the type of pump and other equipment to be used. The QAPP must also specify the depth to which the pump intake should be lowered in each well. Generally, the target depth will correspond to the mid-point of the most permeable zone in the screened interval. Borehole geologic and geophysical logs can be used to help select the most permeable zone. However, in some cases, other criteria may be used to select the target depth for the pump intake. In all cases, the target depth must be approved by the EPA hydrogeologist or EPA project scientist.

< Well construction data, location map, field data from last sampling event.

< Polyethylene sheeting.

< Flame Ionization Detector (FID) and Photo Ionization Detector (PID).

< Adjustable rate, positive displacement ground water sampling pump (e.g., centrifugal or bladder pumps constructed of stainless steel or Teflon). A peristaltic pump may only be used for inorganic sample collection.

< Interface probe or equivalent device for determining the presence or absence of NAPL.

< Teflon or Teflon-lined polyethylene tubing to collect samples for organic analysis. Teflon or Teflon-lined polyethylene, PVC, Tygon or polyethylene tubing to collect samples for inorganic analysis. Sufficient tubing of the appropriate material must be available so that each well has dedicated tubing.

< Water level measuring device, minimum 0.01 foot accuracy, (electronic preferred for tracking water level drawdown during all pumping operations).

< Flow measurement supplies (e.g., graduated cylinder and stop watch or in-line flow meter).

< Power source (generator, nitrogen tank, etc.).

< Monitoring instruments for indicator parameters. Eh and dissolved oxygen must be monitored in-line using an instrument with a continuous readout display. Specific conductance, pH, and temperature may be monitored either in-line or using separate probes. A nephalometer is used to measure turbidity.

< Decontamination supplies (see Section VII, below).

< Logbook (see Section VIII, below).

< Sample bottles.

< Sample preservation supplies (as required by the analytical methods).

< Sample tags or labels, chain of custody.

V. SAMPLING PROCEDURES

Pre-Sampling Activities

1. Start at the well known or believed to have the least contaminated ground water and proceed systematically to the well with the most contaminated ground water. Check the well, the lock, and the locking cap for damage or evidence of tampering. Record observations.

2. Lay out sheet of polyethylene for placement of monitoring and sampling equipment.

3. Measure VOCs at the rim of the unopened well with a PID and FID instrument and record the reading in the field log book.

4. Remove well cap.

5. Measure VOCs at the rim of the opened well with a PID and an FID instrument and record the reading in the field log book.
6. If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), make one. Note that the reference point should be surveyed for correction of ground water elevations to the mean geodesic datum (MSL).

7. Measure and record the depth to water (to 0.01 ft) in all wells to be sampled prior to purging. Care should be taken to minimize disturbance in the water column and dislodging of any particulate matter attached to the sides or settled at the bottom of the well.

8. If desired, measure and record the depth of any NAPLs using an interface probe. Care should be taken to minimize disturbance of any sediment that has accumulated at the bottom of the well. Record the observations in the log book. If LNAPLs and/or DNAPLs are detected, install the pump at this time, as described in step 9, below. Allow the well to sit for several days between the measurement or sampling of any DNAPLs and the low-stress purging and sampling of the ground water.

Sampling Procedures

9. Install Pump: Slowly lower the pump, safety cable, tubing and electrical lines into the well to the depth specified for that

well in the EPA-approved QAPP or a depth otherwise approved by the EPA hydrogeologist or EPA project scientist. The pump intake must be kept at least two (2) feet above the bottom of the well to prevent disturbance and resuspension of any sediment or NAPL present in the bottom of the well. Record the depth to which the pump is lowered.

10. Measure Water Level: Before starting the pump, measure the water level again with the pump in the well. Leave the water level measuring device in the well.

11. Purge Well: Start pumping the well at 200 to 500 milliliters per minute (ml/min). The water level should be monitored approximately every five minutes. Ideally, a steady flow rate should be maintained that results in a stabilized water level (drawdown of 0.3 ft or less). Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. As noted above, care should be taken to maintain pump suction and to avoid entrainment of air in the tubing. Record each adjustment made to the pumping rate and the water level measured immediately after each adjustment.

12. Monitor Indicator Parameters: During purging of the well, monitor and record the field indicator parameters (turbidity, temperature, specific conductance, pH, Eh, and DO) approximately every five minutes. The well is considered stabilized and ready for sample collection when the indicator parameters have stabilized for three consecutive readings as follows (Puls and Barcelona, 1996):

    ±0.1 for pH
    ±3% for specific conductance (conductivity)
    ±10 mv for redox potential
    ±10% for DO and turbidity

    Dissolved oxygen and turbidity usually require the longest time to achieve stabilization. The pump must not be removed from the well between purging and sampling.

13. Collect Samples: Collect samples at a flow rate between 100 and 250 ml/min and such that drawdown of the water level within the well does not exceed the maximum allowable drawdown of 0.3 ft. VOC samples must be collected first and directly into sample containers. All sample containers should be filled with minimal

turbulence by allowing the ground water to flow from the tubing gently down the inside of the container.

Ground water samples to be analyzed for volatile organic compounds (VOCs) require pH adjustment. The appropriate EPA Program Guidance should be consulted to determine whether pH adjustment is necessary. If pH adjustment is necessary for VOC sample preservation, the amount of acid to be added to each sample vial prior to sampling should be determined, drop by drop, on a separate and equal volume of water (e.g., 40 ml). Ground water purged from the well prior to sampling can be used for this purpose.

14. Remove Pump and Tubing: After collection of the samples, the tubing, unless permanently installed, must be properly discarded or dedicated to the well for resampling by hanging the tubing inside the well.

15. Measure and record well depth.

16. Close and lock the well.

VI. FIELD QUALITY CONTROL SAMPLES

Quality control samples must be collected to determine if sample collection and handling procedures have adversely affected the quality of the ground water samples. The appropriate EPA Program Guidance should be consulted in preparing the field QC sample requirements of the site-specific QAPP.

All field quality control samples must be prepared exactly as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples should be collected during the sampling event:

< Field duplicates
< Trip blanks for VOCs only
< Equipment blank (not necessary if equipment is dedicated to the well)

As noted above, ground water samples should be collected systematically from wells with the lowest level of contamination through to wells with highest level of contamination. The equipment

blank should be collected after sampling from the most contaminated well.

VII. DECONTAMINATION

Non-disposable sampling equipment, including the pump and support cable and electrical wires which contact the sample, must be decontaminated thoroughly each day before use (Adaily decon@) and after each well is sampled (Abetween-well decon@). Dedicated, in-place pumps and tubing must be thoroughly decontaminated using Adaily decon@ procedures (see #17, below) prior to their initial use. For centrifugal pumps, it is strongly recommended that non-disposable sampling equipment, including the pump and support cable and electrical wires in contact with the sample, be decontaminated thoroughly each day before use (Adaily decon@).

EPA=s field experience indicates that the life of centrifugal pumps may be extended by removing entrained grit. This also permits inspection and replacement of the cooling water in centrifugal pumps. All non-dedicated sampling equipment (pumps, tubing, etc.) must be decontaminated after each well is sampled (Abetween-well decon,@ see #18 below).

17. **Daily Decon**

A) Pre-rinse: Operate pump in a deep basin containing 8 to 10 gallons of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

B) Wash: Operate pump in a deep basin containing 8 to 10 gallons of a non-phosphate detergent solution, such as Alconox, for 5 minutes and flush other equipment with fresh detergent solution for 5 minutes. Use the detergent sparingly.

C) Rinse: Operate pump in a deep basin of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

D) Disassemble pump.

E) Wash pump parts: Place the disassembled parts of the pump into a deep basin containing 8 to 10 gallons of non-phosphate detergent solution. Scrub all pump parts with a test tube brush.

F) Rinse pump parts with potable water.

G) Rinse the following pump parts with distilled/ deionized water: inlet screen, the shaft, the suction interconnector, the motor lead assembly, and the stator housing.

H) Place impeller assembly in a large glass beaker and rinse with 1% nitric acid (HNO_3).

I) Rinse impeller assembly with potable water.

J) Place impeller assembly in a large glass bleaker and rinse with isopropanol.

K) Rinse impeller assembly with distilled/deionized water.

18. **Between-Well Decon**

A) Pre-rinse: Operate pump in a deep basin containing 8 to 10 gallons of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.
B) Wash: Operate pump in a deep basin containing 8 to 10 gallons of a non-phosphate detergent solution, such as Alconox, for 5 minutes and flush other equipment with fresh detergent solution for 5 minutes. Use the detergent sparingly.

C) Rinse: Operate pump in a deep basin of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

D) Final Rinse: Operate pump in a deep basin of distilled/deionized water to pump out 1 to 2 gallons of this final rinse water.

VIII. FIELD LOG BOOK

A field log book must be kept each time ground water monitoring activities are conducted in the field. The field log book should document the following:

< Well identification number and physical condition.

< Well depth, and measurement technique.

- Static water level depth, date, time, and measurement technique.
- Presence and thickness of immiscible liquid layers and detection method.
- Collection method for immiscible liquid layers.
- Pumping rate, drawdown, indicator parameters values, and clock time, at three to five minute intervals; calculate or measure total volume pumped.
- Well sampling sequence and time of sample collection.
- Types of sample bottles used and sample identification numbers.
- Preservatives used.
- Parameters requested for analysis.
- Field observations of sampling event.
- Name of sample collector(s).
- Weather conditions.
- QA/QC data for field instruments.

IX. REFERENCES

Cohen, R.M. and J.W. Mercer, 1993, DNAPL Site Evaluation, C.K. Smoley Press, Boca Raton, Florida.

Puls, R.W. and M.J. Barcelona, 1996, Low-Flow (Minimal Drawdown) Ground-water Sampling Procedures, EPA/540/S-95/504.

U.S. EPA, 1993, RCRA Ground-Water Monitoring: Draft Technical Guidance, EPA/530-R-93-001.

U.S. EPA Region II, 1989, CERCLA Quality Assurance Manual.