Interim Measures (IM) Groundwater Investigation Workplan at Elementis Site August 18, 2006

El Paso Corporation

El Paso CGP Company & El Paso Merchant Energy-Petroleum Company

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INTERIM MEASURES (IM) GROUNDWATER WORKPLAN AT ELEMENTIS SITE
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Prepared for

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LIST of ACRONYMS

AOC	Administrative Order on Consent
BTEX	Benzene, Toluene, Ethyl Benzene, and Xylenes
COCs	Chemicals of Concern
CPT	Cone Penetrometer Testing
DQO	Data Quality Objective
EPA	Environmental Protection Agency
HASP	Health and Safety Plan
ID	Inside Diameter
IDW	Investigation Derived Waste
IM	Interim Measures
LNAPL	Light Non-Aqueous Phase Liquid
MDL	Method Detection Limit
MSL	Mean Sea Level
NTU	Nephelometric Turbidity Units
ORP	Oxidation/Reduction Potential
OWS	Oil/Water Separator
PID	Photoionization Detector
POCC	Port of Corpus Christi
PPE	Personal Protective Equipment
PR/VSI	Preliminary Review/Visual Site Inspection
PRG	Preliminary Remediation Goal
PVC	Poly Vinyl Chloride
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
ROST	Rapid Optical Screening Technology
STL	Severn Trent Laboratories
TCEQ	Texas Commission on Environmental Quality
TDS	Total Dissolved Solids
TPH	Total Petroleum Hydrocarbons
TW	Temporary Well
USCS	Unified Soil Classification System
USGS	United States Geological Survey
VOC	Volatile Organic Compound

1.0 INTRODUCTION

On September 6, 2002, the U.S. Environmental Protection Agency (EPA) issued an Administrative Order on Consent (AOC) to El Paso CGP Company and El Paso Merchant Energy-Petroleum Company (El Paso), formerly Coastal. The AOC[1] addresses hydrocarbon impact to groundwater underlying the Elementis Chromium, L.P. (Elementis) property to the east of Cantwell Lane and extending beyond to the north, northeast, and east of the Valero Complex 8 North to the Inner Harbor Ship Channel in Corpus Christi, Texas (see Figure 1-1) by dissolved-phase hydrocarbons and light non-aqueous phase liquid (LNAPL). Elementis, formerly American Chrome and Chemical, owns a manufacturing facility located at 3800 Buddy Lawrence Drive, Corpus Christi, Texas, which occupies approximately 425 acres along the southern bank of the Inner Harbor Ship Channel (see Figure 1-2). The Elementis plant is located to the north, east, and west of the Valero Refinery (see Figure 1-1), which is leased from El Paso Merchant Energy-Petroleum Company.

This Workplan describes the technical approach that will be used to further investigate groundwater contamination at the "Interim Measures (IM) Area" of the Facility. The Facility is defined as the area of contamination beyond the Coastal Refinery property boundary north, northeast and east of the Coastal Refinery East Plant-North (i.e., the Valero Complex 8 North) and extending onto or under the portion of the Elementis property located East of Cantwell Lane and to the Inner Harbor Ship Channel[1]. The IM Area is defined as that portion of the Facility within 350 feet landward of the mean high tide mark of the Inner Harbor Ship Channel as shown on the USGS Corpus Christi Quadrangle Map[1] in Figure 1-3. As stated in the AOC[1], the specific objectives of the groundwater investigation to be conducted at the IM Area are to:

- "Characterize and determine the lateral extent of LNAPL floating atop groundwater to non-detect thickness in the IM Area [Section VII. 1. B. (i). (a)]; and
- Characterize and determine the lateral and vertical extent of contamination to decreasing concentrations of IM chemicals of concern (COCs) to below

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> the IM preliminary remediation goals (PRGs) in groundwater at the IM Area" [Section VII. 1. B. (i). (b)].

This Workplan consists of a Sampling Plan, which is presented within Sections 1.0 through 10.0 of this Workplan, and a detailed Quality Assurance Project Plan, which is presented within Appendix A of this Workplan. Appendix B of this Workplan presents the site-specific Health and Safety Plan (HASP).

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2.0 DESCRIPTION OF CURRENT CONDITIONS

2.1 Local Physiography, Geology, and Hydrogeology

The surface elevation at the Facility generally slopes gently to the north. The Facility is dissected on an east-west axis by a bluff line located south of the Inner Harbor Ship Channel, along which the surface elevation drops approximately 10 feet to 15 feet toward the Inner Harbor Ship Channel. Natural surface drainage from the Facility is into the Corpus Christi Inner Harbor Ship Channel, which is located to the north of the Facility. The Corpus Christi Inner Harbor Ship Channel discharges into Corpus Christi Bay approximately 2.5 miles east of the Facility.

In its Preliminary Review / Visual Site Inspection (PR/VSI) Report dated August 31, 1987, the EPA stated that the uppermost aquifer in the area of the Elementis property is a very well sorted sand[1]. The PR/VSI report indicates that the top of this sand unit is generally 8 feet to 16 feet below the land surface and varies in thickness from 3 feet to 20 feet in the area, depending on location. In the Valero Complex 8 North, which is located southwest of the IM Area (see Figure 1-1), the transmissive sand unit comprising the uppermost aquifer ranges in thickness from 9 feet to greater than 30 feet, and is overlain by 10 feet to 22 feet of clay[2]. The PR/VSI Report states that a layer of clay and clayey sand, which has an average thickness of 4 feet to 6 feet, underlies the uppermost aquifer in this area. Cross-sections A-A' and B-B' (see Figure 2-1 for cross-section locations), which are presented as Figures 2-2 and 2-3, respectively, depict near-surface stratigraphy at and in the vicinity of the IM Area.

The general regional groundwater flow in the upper water-bearing zone is to the north-northeast toward the Corpus Christi Inner Harbor Ship Channel[1]. Groundwater beneath the Valero Refinery moves generally toward the Corpus Christi Inner Harbor Ship Channel, specifically, to the north-northeast in the Valero Complex 8 North. The natural groundwater gradient in the uppermost aquifer in the vicinity of the IM Area is typically less than 0.0025 foot per foot[3]. Based on pump test data, a hydraulic conductivity of 5.76

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x 10^{-3} centimeters per second was reported for the uppermost aquifer at the Valero Refinery[3].

The PR/VSI Report indicates that groundwater in the Corpus Christi area is generally very saline, with the shallower aquifers typically containing more that 3,000 parts per million (ppm) total dissolved solids (TDS). The report states that the shallower aquifers in this area are therefore not used for drinking water. A background TDS concentration of 28,000 ppm has been established for the Valero Refinery[2]. There is little geological or groundwater information available from the IM Area. The information presented here is primarily from data collected in the vicinity of the IM Area. Based on the geologic and stratigraphic setting of the Facility and its surroundings, this information appears to be generally representative of the IM Area.

2.2 Evidence of Groundwater Impact

A letter from TNRCC [now known as the Texas Commission on Environmental Quality (TCEQ)] dated May 2, 2000 included a map of a "Seep Area". Data from wells located along the bluff of the Ship Channel on Elementis property document that LNAPL was measured at thicknesses of 4.3 feet, 3.2 feet, and 2.3 feet in wells MW-U30, MW-U29, and MW-U28, respectively[1]. Historic analytical results from monitor wells at or in the vicinity of the IM Area are presented in Section 3 of this Workplan.

2.3 Previous Implementation of Corrective Action

El Paso will continue to operate the current containment, recovery, monitoring and hydrocarbon treatment system including the Cofferdam Recovery and Hydrocarbon Treatment System to prevent migration of contamination (those constituents on the Skinner List, except for MTBE and metals) into the Inner Harbor Ship Channel until the Interim Measures Containment System is operational.

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3.0 CHARACTERIZATION OF CONTAMINANT SOURCE AND ENVIRONMENTAL SETTING BASED ON EXISTING DATA

The IM Area (see Figure 1-3) is located on the south side of the Corpus Christi Ship Channel, approximately 2.5 miles west of the outlet to Corpus Christi Bay. The portion of the Corpus Christi Ship Channel that directly borders the IM Area is known as the Inner Harbor Ship Channel. The designated uses (as defined by the State of Texas) for the Inner Harbor Ship Channel, Stream Segment No. 2484 of the Nueces River Basin, include non-contact recreation (not involving a significant risk of water ingestion and fishing), commercial and recreational boating, limited human body contact to shoreline activity, and intermediate quality aquatic habitat; human consumption of fish is allowed and protection of aquatic life provided, as cited in the Texas Surface Water Quality Standards, July 26, 2000[1]. However, Corpus Christi Ordinance Code 1958 § 9-25 states that fishing from the Public Docks of the Port of Corpus Christi or from boats within the harbor is prohibited. In addition, recreational boats are not allowed in the Inner Harbor Ship Channel by order of the U.S. Coast Guard.

Land usage in the vicinity of the IM Area is for industrial purposes. The IM Area is located northeast of the Valero Complex 8 North, and is separated from the Valero Refinery by Elementis property. Elementis is engaged in the processing of chrome ore. The Citgo Deep Sea Terminal and Williams facilities are located south and southeast of the Valero Complex 8 North. These tracts are separated from the Valero Complex 8 North by the east-west trending Union Pacific Railroad right-of-way. A pipeline corridor paralleling the eastern boundary of the Valero Complex 8 North extends northward to the Port of Corpus Christi (POCC) oil docks located along the Corpus Christi Ship Channel. The pipeline corridor is used by various companies to transfer crude oil and refined products to and from barges and ships located at the POCC oil docks.

Surficial drainage and near-surface groundwater flow at the IM Area are generally northward, toward the Corpus Christi Ship Channel. The uppermost aquifer has been impacted by LNAPL and dissolved-phase hydrocarbons in the vicinity of the IM Area.

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ENSR conducted an investigation in 1998 and 1999 using Rapid Optical Screening Technology (ROST) data to delineate and characterize LNAPL occurrence at the Valero Refinery. ENSR[3] determined that LNAPL present upgradient of the IM Area is predominantly a gas oil hydrocarbon, with a benzene plume also present at the Elementis Facility and the northeastern portion of the Valero Complex 8 North. Table 3-1 presents fluid level data and LNAPL thickness data for wells at or in the vicinity of the IM Area.

Groundwater sampling of monitor wells located at or in the vicinity of the IM Area has previously been conducted. Dissolved-phase benzene has been detected within and to the south of the IM Area, as indicated in Table 3-2, which presents benzene, toluene, ethylbenzene, and xylenes (BTEX) and total petroleum hydrocarbons (TPH) groundwater analytical data. Table 3-3 contains additional analytical data for organics from monitor wells at or in the vicinity of the IM Area.

The vertical extent of IM COCs at concentrations exceeding PRGs has not been fully defined at the IM Area. Some chemical data are available for monitor well OW-L8, which is screened in the second transmissive zone (i.e., the transmissive unit underlying the uppermost transmissive zone at the IM Area). Figure 1-3 shows the location of monitor well OW-L8, and Table 3-4 presents existing chemical data for the well.

The following potential source or sources of hydrocarbon observed at or in the vicinity of the IM Area have been identified (see Figure 1-1):

- The Valero Refinery;
- The Elementis Facility;
- One or more pipelines within the pipeline corridor that parallels the eastern boundary of the Valero Complex 8 North and extends northward to the POCC oil docks at the Inner Harbor;
- The former Amerada Hess (now Williams Energy Ventures) facility located south of the Elementis Facility;
- The Flint Hills Terminal; and

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- The Citgo property located south of Valero Complex 8 North.

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4.0 IDENTIFICATION OF POTENTIAL RECEPTORS

The following potential receptors apply to the hydrocarbon present at the IM Area:

- Human receptors; and
- Ecological receptors.

The exposure pathways applicable to these receptors as defined in the AOC[1] [Section VII. 1. A. (i)] can be summarized as:

- Groundwater to Surface Water to Fish Ingestion by Humans; and
- Groundwater to Surface Water Toxicity to Aquatic Organisms.

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5.0 MONITORING AND DATA COLLECTION PROCEDURES

A combination of proven investigative tools and procedures will be used to:

- "Characterize and determine the lateral extent of LNAPL floating atop groundwater to non-detect thickness in the IM Area; and
- Characterize and determine the lateral and vertical extent of contamination to decreasing concentrations of IM COCs to below the IM PRGs in groundwater at the IM Area"[1] (Section VII. 1. B. (i)).

ROST (see Appendix C) will be used to identify the presence of LNAPL. Where LNAPL is not present, a temporary sampling point will be used to identify the presence of hydrocarbons in groundwater. Groundwater samples at temporary sampling points will be collected by means of the CPT equipment (see Appendix C ROST Information, Page 7, Groundwater Sampling). Where LNAPL is present, a piezometer may be installed to delineate the lateral extent of LNAPL. Permanent monitor wells and piezometers will be installed and adequate samples collected to "characterize and determine the extent of groundwater contamination at the IM Area to decreasing concentrations to less than IM PRGs and to non-detect thickness for LNAPL floating atop groundwater"[1] (Section VII. 1. B. (i)).

As discussed in Sections 3.0 and 4.0 of this Workplan, there are limited data on the extent and magnitude of LNAPL or hydrocarbons in the IM Area. Therefore, the investigative approach includes screening techniques to identify the locations for permanent monitor wells and sampling points. Also, the screening steps and permanent monitoring steps may be either sequential or iterative, depending on the conditions encountered.

5.1 ROST and Temporary Well Sampling

ROST is a proprietary technology owned by Fugro Geosciences, Inc. (Fugro) that is used to screen soils for petroleum hydrocarbons and determine presence and thickness of LNAPL on groundwater. This technique has been approved by the U.S. EPA (see Appendix C). ROST screening is conducted in conjunction with cone penetrometer testing (CPT),

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which uses soil resistance and shear properties measured during direct-push operations to interpret subsurface stratigraphy. The effectiveness of the ROST technology is greatly enhanced if the system can be calibrated to site-specific product samples[4]. Therefore, prior to mobilization of the ROST unit, LNAPL samples will be collected from one or more of the wells at or in the vicinity of the IM Area by immersing a stainless steel bailer (decontaminated in accordance with the procedures specified in Section 5.3.10 and suspended by previously unused disposable cord) into the well until the air/liquid interface is straddled, removing the bailer from the well, and pouring recovered LNAPL into an appropriate clean sample container. If groundwater is also recovered, then it will be disposed in accordance with the procedures specified in Section 5.3.11. These LNAPL samples will then be submitted to Fugro so that site-specific system calibration can be performed in readiness for on-site ROST activities. The LNAPL samples will be fingerprinted by Fugro to identify the wavelength or range of wavelengths that displays the maximum fluorescence intensity for the various hydrocarbon types that may be present in the area.

ROST probes will be completed as a screening process to preliminarily define the lateral extent of LNAPL at the IM Area. At a minimum, ROST probes will be completed at the 13 primary ROST locations shown in Figure 5-1. The purpose of these 13 primary ROST locations is to establish LNAPL conditions at the landward boundary of the IM Area. If ROST data indicate LNAPL presence at a given primary ROST location, then one or more secondary "step-out" ROST probes will be completed in the IM Area at the applicable lateral offset location(s) relative to the primary ROST location, as shown in Figure 5-1. Further "step-out" ROST probes will be completed in the IM Area as necessary to define the lateral extent of LNAPL presence. In addition to existing and new permanent monitor wells, piezometers will be installed as necessary to define the limit of the LNAPL plume at the IM Area. The data quality objectives (DQOs) for definition of the LNAPL plume will be a vertical thickness of less 0.01 foot (i.e., "non-detect", as measured by an oil/water interface probe[1] [Section VII. 2. C. (i) (d)]) and a horizontal distance of less than or equal to 50 feet. The geologic information presented in Figures 2-2 and 2-3 indicate that the degree of lateral stratigraphic variability at the IM

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Area is such that lateral definition of the LNAPL plume to less than or equal to 50 feet is appropriate.

Proposed ROST investigation locations will be marked in the field prior to commencement of intrusive activities to allow clearance of these locations for underground utilities. Augers and probes will be advanced manually to an approximate depth of 6 feet below grade in advance of the ROST probe, if warranted at proposed locations, based on the potential presence of subterranean lines.

Temporary sampling points will be installed at ROST locations that indicate the absence of LNAPL. As such, installation of temporary sampling points may commence as early as 1 day after commencement of ROST activities. Temporary sampling points will be installed and left in place only long enough to verify absence of LNAPL at the location and to collect a contingent groundwater sample, as described below. Temporary sampling points will be installed using direct-push technology. If geologic conditions preclude the use of direct-push sampling points, then a temporary well will be installed. Subsurface stratigraphy at temporary sampling point locations will be interpreted on the basis of CPT data. Temporary PVC wells will be constructed using 1-inch diameter 0.010-inch slotted PVC screen, which will be of sufficient length to straddle the apparent top of the saturated zone within the uppermost transmissive unit, and sufficient riser pipe to extend the well to the ground surface.

Fluid level measurements will be collected at each temporary sampling point using an oil/water interface probe. If LNAPL is not detected at a temporary sampling point, then a groundwater sample will be collected and analyzed for benzene and toluene, as a screening indicator for potential groundwater impact, by Method 8021B. If benzene or toluene impact does not exceed applicable PRGs, as listed in PRG report[5], then a permanent monitor well may be installed at that location.

If LNAPL presence or benzene or toluene presence in excess of applicable PRGs is detected at a temporary sampling point, then a ROST probe will be completed at the next

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appropriate conditional ROST location(s). This process will be repeated until one of the following conditions occurs:

- LNAPL presence and benzene and toluene presence in excess of applicable PRGs are not detected at a temporary sampling point (in which case a permanent monitor well may be installed at that location); or
- The boundary of the IM Area is reached.

If LNAPL or IM Area COCs at concentrations in excess of applicable PRGs is present at the boundary of the IM Area, then further delineation will be performed during the Facility Investigation[1] (Section VII.2.B).

At the conclusion of this effort, holes for temporary sampling points and each ROST probe will be backfilled with hydrated bentonite emplaced by the tremie method. The locations of temporary sampling points will be flagged so that their horizontal coordinates can be determined (see Section 5.3.12).

The following procedure will be applied in the IM Area:

1. CPT/ROST, and benzene and toluene samples will be collected from temporary sampling points to identify locations of permanent sampling points.
2. Piezometers will be installed in locations where LNAPL is not expected, and new monitoring wells will be installed for groundwater sampling within the IM Area.
3. Piezometer measurements will be used to delineate LNAPL and samples from monitoring wells will be collected to delineate AOC Skinner List COCs.
4. If any piezometer detects LNAPL, an additional step-out piezometers will be installed.
5. If any COC concentration is greater than the respective PRG within the IM Area, at least on additional step-out monitoring well will be installed within the IM Area for further AOC Skinner List COC sampling.

5.2 Piezometer Installations and Permanent Monitor Well Installation and Sampling

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The groundwater investigation will continue with installation of new monitor wells and piezometers and the collection of LNAPL thickness and IM COC concentration data from these and previously existing wells in the IM Area. Piezometers and new monitor wells screened at the top of the uppermost saturated zone (i.e., water table monitor wells) will be installed initially. The purpose of these wells and piezometers is to characterize and determine the lateral extent of LNAPL and IM COCs at concentrations in excess of applicable PRGs in this unit. Specific details regarding installation and construction of water table monitor wells and piezometers are provided in Sections 5.3.2 and 5.3.5, respectively.

The selection of locations for installation of monitor wells to be screened deep within or at the base of the uppermost transmissive zone will be based on:

- Evaluation of IM COC concentration data from water table monitor wells;
- Evaluation of benzene and toluene concentration data from temporary sampling points at the water table in the uppermost aquifer;
- LNAPL thickness data from wells and previously installed piezometers at the IM Area; and
- ROST fluorescence data.

The purpose of the deeper wells is to evaluate the vertical extent of IM COCs at concentrations in excess of applicable PRGs in this unit. A groundwater sample will be collected from a temporary sampling point installed deep within or at the base of the uppermost transmissive zone using direct-push technology. If benzene and toluene concentrations do not exceed applicable PRGs, then a permanent monitor well will be installed at that location and depth.

Deep upper transmissive zone monitor wells will be installed at the base of the uppermost transmissive zone if the saturated thickness of the unit is less than 40 feet. If the saturated thickness of the uppermost transmissive zone exceeds 40 feet, then a well

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screened approximately 40 feet below the top of the saturated zone will be installed. Specific details regarding installation and construction of deep upper transmissive zone monitor wells are provided in Section 5.3.3.

If a well screened at the base of the uppermost transmissive zone displays IM COCs at concentrations in excess of applicable PRGs, then a well screened in the second transmissive zone (i.e., the transmissive zone underlying the uppermost transmissive zone) will be installed (see Section 5.3.4) or sampled to define the vertical extent of IM COCs at concentrations in excess of applicable PRGs. Additionally, one or more offset wells would be installed at the base of the uppermost transmissive zone as necessary to define the lateral extent of IM COCs at concentrations in excess of applicable PRGs in the deep portion of the uppermost aquifer in the IM Area.

Piezometers will also be installed during the course of the IM Area groundwater investigation as appropriate locations for their placement are defined, based on:

- LNAPL thickness data from presently existing IM Area wells;
- ROST data;
- Presence or absence of LNAPL at temporary sampling points; and
- Locations of permanent monitor wells to be installed at the IM Area, which will be installed where LNAPL is not present.

The purpose for installation of piezometers is to "characterize and determine the lateral extent of LNAPL floating atop groundwater to non-detect thickness in the IM Area[1]" (Section VII. 1. B. (i)). Details regarding construction of piezometers are presented in Section 5.3.5.

The following procedure will be applied in the IM Area:

1. CPT/ROST, and benzene and toluene samples will be collected from temporary sampling points to identify locations of permanent sampling points.

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2. Piezometers will be installed in locations where LNAPL is not expected, and new monitoring wells will be installed for groundwater sampling within the IM Area.
3. Piezometer measurements will be used to delineate LNAPL and samples from monitoring wells will be collected to delineate AOC Skinner List COCs.
4. If any piezometer detects LNAPL, an additional step-out piezometers will be installed.
5. If any COC concentration is greater than the respective PRG within the IM Area, at least on additional step-out monitoring well will be installed within the IM Area for further AOC Skinner List COC sampling.

Figure 5-2a is a decision chart relating to the delineation work.

5.3 General Field Procedures

The following subsections describe general field procedures that will be implemented during the duration of the groundwater investigation.

5.3.1 Collection of Soil Cores during Permanent Monitor Well Installations

Selected soil cores will be collected using split-spoon samplers or Shelby tubes in association with hollow stem auger drilling techniques at each permanent monitor well location. These samples will be collected to confirm the geologic results indicated by CPT data. Soil coring devices will be decontaminated in accordance with the procedures specified in Section 5.3.10. Recovered soil cores will be logged lithologically in accordance with the Unified Soil Classification System. Each recovered soil core will be scanned using a calibrated photoionization detector (PID). The exposed soil core will be gently separated at approximate 6-inch intervals using a decontaminated stainless steel knife. The tip of the PID will then be placed in proximity to the split soil core. The maximum PID response observed within each approximate 6-inch interval will be recorded on the boring log for this monitor well installation. This information will be used for comparison to ROST results and as an indicator for health and safety-related issues.

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5.3.2 Water Table Monitor Well Installation Procedures

Water table monitor wells will be constructed with a nominal 10-foot screen set in the uppermost saturated portion of the uppermost transmissive zone. If the uppermost aquifer appears to be unconfined, then the well screen will be set so that it straddles the apparent top of the saturated zone (i.e., approximately 3 feet of screen above and approximately 7 feet of screen below the apparent top of the saturated zone). If the aquifer appears to be confined, then the screen will be set at the top of the transmissive unit, with minimal screening (e.g., 0.5 foot to 1 foot) of the overlying confining unit.

The well screen will consist of 2-inch inside diameter (ID) Schedule 40 PVC having a 0.020-inch slot size. A 0.5-foot Schedule 40 PVC sediment sump will be placed at the base of the well. Schedule 40 PVC 2-inch ID riser pipe will extend from the top of the well screen to approximately 2.5 feet above ground surface.

An appropriately graded silica sand filter pack will be installed in the annular space surrounding the screen. The filter pack will extend from the total depth of the boring to approximately 2 feet above the top of the well screen. A hydrated bentonite seal having a minimum thickness of approximately 2 feet will be placed above the top of the sand pack. The remaining annular space will be backfilled with cement/bentonite grout to the surface.

Surface completions will be installed in accordance with 16 TAC 76[6] (see Appendix D). Each monitor well will be completed as an above-grade completion with a locking protective steel collar. Each well will be surrounded by and set within a 4-foot by 4-foot by 3-inch thick concrete pad sloping away from the well. If necessary, up to four protective steel bollards measuring approximately 3 inches or more in thickness and extending vertically from at least 2 feet below grade to as high as or higher than the top of the locking steel collar will be set within the concrete pad to mitigate the potential for damage to monitor wells by vehicular traffic.

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Figure 5-2 depicts typical construction for a water table monitor well installed in an unconfined aquifer.

5.3.3 Installation of Deep Uppermost Transmissive Zone Wells

Monitor wells installed deep within or at the base of the uppermost transmissive zone will be constructed with a 2.5-foot section of 2-inch ID Schedule 40 PVC screen having a 0.020-inch slot size. If a deep monitor well is set at the base of the uppermost transmissive zone, it will be installed so that the base of the well screen is at or slightly deeper than the top of the underlying aquitard. A 0.5-foot Schedule 40 PVC sediment sump will be placed at the base of the well. Schedule 40 PVC 2-inch ID riser pipe will extend from the top of the well screen to approximately 2.5 feet above ground surface.

If a deep monitor well is to be installed at a location where LNAPL is present, then a nominal 8-inch diameter PVC surface casing will be seated at a depth below the top of the saturated zone prior to installation of the 2-inch ID monitor well through the surface casing. PVC casing will be set after the pilot hole is reamed to an appropriate diameter. A sacrificial wooden plug will be placed in the down hole portion of the casing as it is being installed to mitigate the potential for LNAPL to enter the interior of the casing. The sacrificial plug will be dislodged after the base of the casing is below the depth at which LNAPL is present. Cement/bentonite grout will be pumped through a tremie pipe into the annular space between the outside of the casing and the formation. Grout will continue to be pumped until the grout column extends from the existing total depth of the boring to the ground surface. The grout will be allowed to set for a minimum of 24 hours before further monitor well installation activities resume at that location. Further drilling activities will be conducted through the surface casing using appropriately sized hollow stem augers. Figure 5-3 depicts typical construction for a monitor well installed at the base of an aquifer at a location where LNAPL is present at the top of the saturated zone.

An appropriately graded silica sand filter pack will be installed in the annular space surrounding the screen. The filter pack will extend from the total depth of the boring to no

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more than 1 foot above the top of the well screen. A hydrated bentonite seal having a minimum thickness of approximately 2 feet will be placed above the top of the sand pack. The remaining annular space will be backfilled with cement/bentonite grout to the surface.

Surface completions will be installed in accordance with 16 TAC 76[6] (see Section 5.3.2), with an above-grade completion consisting of a locking protective steel collar set within a 4-foot by 4-foot by 3-inch thick concrete pad sloping away from the well and surrounded, as necessary, by up to four protective steel bollards measuring approximately 3 inches or more in thickness and extending vertically from at least 2 feet below grade to as high as or higher than the top of the locking steel collar.

5.3.4 Second Transmissive Zone Well Installation Procedures

For any well that is advanced into the second transmissive zone, a string of surface casing that is seated within the clay unit separating the uppermost transmissive zone from the second transmissive zone would be required in order to mitigate the potential for downward migration of hydrocarbons through the well bore. Figure 5-4 depicts typical construction of a well screened in the second transmissive zone, assuming that the second transmissive zone is a confined aquifer.

If installation of a monitor well in the second transmissive zone is required, then an 8-inch diameter Schedule 40 PVC casing will first be set at a depth approximately 2 feet below the contact between the base of the uppermost transmissive zone and the underlying confining clay layer. A pilot borehole will be advanced approximately 2 feet into the underlying clay layer. Cores will be recovered at approximate 5-foot intervals within the upper and middle portions uppermost transmissive zone to confirm the nature of the materials being penetrated. Continuous coring will be conducted in the lower portion of the uppermost transmissive zone is approached in order to more accurately locate the contact between the base of the uppermost transmissive zone and the top of the underlying confining clay layer. The borehole will then be reamed using a larger

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diameter auger string. After reaching the appropriate depth, the surface casing will be set to the desired depth through the auger string.

Cement/bentonite grout will be pumped through a tremie pipe into the annular space between the outside of the casing and the auger string as the auger string is being removed. Grout will continue to be pumped until the grout column extends from the existing total depth of the boring to the ground surface. The grout will be allowed to set for a minimum of 24 hours before further monitor well installation activities resume at that location. Further drilling activities will be conducted through the surface casing using appropriately sized hollow stem augers.

If the second transmissive zone aquifer appears to be confined, then a 5-foot screen will be set at the top of the second transmissive unit, with minimal screening (e.g., 0.5 foot to 1 foot) of the overlying confining unit. If the second transmissive zone aquifer appears to be unconfined, then a 10-foot well screen will be set so that it straddles the apparent top of the second transmissive unit saturated zone (i.e., approximately 3 feet of screen above and approximately 7 feet of screen below the apparent top of the second transmissive unit saturated zone).

The well screen will consist of 2-inch ID Schedule 40 PVC having a 0.020-inch slot size. A 0.5-foot Schedule 40 PVC sediment sump will be placed at the base of the well. Schedule 40 PVC 2-inch ID riser pipe will extend from the top of the well screen to approximately 2.5 feet above ground surface.

An appropriately graded silica sand filter pack will be installed in the annular space surrounding the screen. The filter pack will extend from the total depth of the boring to approximately 2 feet above the top of the well screen. A hydrated bentonite seal having a minimum thickness of approximately 2 feet will be placed above the top of the sand pack. The remaining annular space between the riser pipe and the formation and between the riser pipe and the interior of the surface casing will be backfilled with cement/bentonite grout to the surface.

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Surface completions will be installed in accordance with 16 TAC 76[6] (see Appendix D). Each monitor well will be completed as an above-grade completion with a locking protective steel collar. Each well will be surrounded by and set within a 4-foot by 4-foot by 3-inch thick concrete pad sloping away from the well. If necessary, up to four protective steel bollards measuring approximately 3 inches or more in thickness and extending vertically from at least 2 feet below grade to as high as or higher than the top of the locking steel collar will be set within the concrete pad to mitigate the potential for damage to monitor wells by vehicular traffic.

5.3.5 Installation of Piezometers

Piezometers will be constructed with a 10-foot screen set in the uppermost saturated portion of the uppermost transmissive zone. If the uppermost aquifer appears to be unconfined, then the well screen will be set so that it straddles the apparent top of the saturated zone (i.e., approximately 3 feet of screen above and approximately 7 feet of screen below the apparent top of the saturated zone). If the aquifer appears to be confined, then the screen will be set at the top of the transmissive unit, with minimal screening (e.g., 0.5 foot to 1 foot) of the overlying confining unit. Figure 5-5 depicts typical piezometer construction for an unconfined aquifer.

The piezometer screen will consist of 2-inch ID stainless steel screen having a 0.010-inch slot size. Stainless steel 2-inch ID riser pipe will extend from the top of the well screen to approximately 2.5 feet above ground surface.

An appropriately graded silica sand filter pack will be installed in the annular space surrounding the screen. The filter pack will extend from the total depth of the boring to approximately 2 feet above the top of the screen. A hydrated bentonite seal having a minimum thickness of approximately 2 feet will be placed above the top of the sand pack. The remaining annular space will be backfilled with cement/bentonite grout to the surface.

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Surface completions will be installed in accordance with 16 TAC 76[6] (see Section 5.3.2). Each piezometer will be completed as an above-grade completion with a locking protective steel collar. Each piezometer will be surrounded by and set within a 4-foot by 4-foot by 3-inch thick concrete pad sloping away from the well. If necessary, up to four protective steel bollards measuring approximately 3 inches or more in thickness and extending vertically from at least 2 feet below grade to as high as or higher than the top of the locking steel collar will be set within the concrete pad to mitigate the potential for damage to piezometers by vehicular traffic.

5.3.6 Monitor Well and Piezometer Nomenclature

For temporary wells, permanent monitor wells, and piezometers, the nomenclature will consist of a two-component code. The first component will identify the type of installation, with "TW" denoting a temporary well, "EMW" denoting a monitor well installed by El Paso, and "EPZ" denoting a piezometer installed by El Paso. The second component will identify the location of the temporary well, permanent monitor well, or piezometer. The first temporary well installed will be identified as Location "A", with successive temporary well locations identified as "B", "C", etc. If more than 26 temporary wells are installed, then the 27th and 28th locations will be identified as "AA" and "AB", respectively, with successive locations identified as "AC", "AD", etc. For permanent monitor wells, the second component will consist of an alpha-numeric-alpha sequence, that identifies, respectively, the transmissive zone in which the well is screened, the location of the well, and the interval of the transmissive zone in which the well is screened, as follows:

- 1st alpha: "U" indicates a well screened in the uppermost transmissive zone (an "L" would be used to indicate a well screened in the second transmissive zone, if installed);
- The second (i.e., numeric) portion of the sequence will be a "1" for the first monitor well installed by El Paso, and will increase by successive integer values for each successive monitor well installed by El Paso; and
- 2nd alpha: "T" indicates a well screened at the top of the given transmissive unit, "I" indicates a well screened at an intermediate depth

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within the given transmissive unit, and "B" indicates a well screened at the base of the given transmissive unit.

Thus, a typical well nomenclature would be EMW-U1T.

For piezometers, the second component will consist of a number that identifies the location of the piezometer, as follows:

- The second (i.e., numeric) component will be a "1" for the first piezometer installed by El Paso, and will increase by successive integer values for each successive piezometer installed by El Paso.

5.3.7 Development of Monitor Wells and Piezometers

Permanent monitor wells will be developed using a surge block, bailer, or submersible pump. Development will be performed for up to 2 hours, or until the produced groundwater is free of sand and a volume of water exceeding that emplaced into the subsurface during well installation is removed. Sediment that has entered the well screen during development will be removed while the monitor well is continuously pumped or bailed. If a pump is used, discharge will be limited to less than approximately 1 gallon per minute.

Development of piezometers will follow the general procedures described above, but will be limited to ½ hour per piezometer.

Liquids produced during piezometer and well development will be placed in 55-gallon drums for future disposal by El Paso (see Section 5.3.11).

5.3.8 Groundwater Elevation and LNAPL Thickness Measurements

Depth to groundwater measurements will be collected from newly installed monitor wells and piezometers and existing monitor wells at or in the vicinity of the IM Area. Depth to groundwater and thickness of LNAPL, if present, will be measured to the nearest 0.01-foot

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using an oil/water interface probe. The down-hole portion of the oil/water interface probe will be decontaminated after insertion in each well using the procedures described in Section 5.3.10. Fluid level measurements will be obtained in an "outside-in" sequence (i.e., proceeding successively from wells with low apparent potential for hydrocarbon impact to wells where hydrocarbon impact and LNAPL presence is suspected or previously documented) to further mitigate the potential for cross-contamination between wells. Fluid levels measurements will be recorded in the field logbook. Groundwater elevation and LNAPL thickness measurements will be performed in direct sequence from one well or piezometer to another, with no additional intervening activities, until data from all applicable monitor wells and piezometers in the IM Area are collected.

5.3.9 Collection of Groundwater Samples

Groundwater samples will be collected from IM Area monitor wells that do not contain a measurable thickness of LNAPL. Prior to sample collection from new and existing permanent monitor wells, the depth to groundwater will be determined to the nearest 0.01-foot using an oil/water interface probe, as described in Section 5.3.8.

The volume of groundwater present in each well casing will then be calculated using the depth to water measurement and the total depth of each well (as measured or from well construction data) using the formula:

Well Volume = N x (height of water column);

Where N = 0.16 gallons per foot for a 2-inch diameter well and N = 0.65 gallons per foot for a 4-inch diameter well (see derivations of "N" values in Appendix E). Monitor well construction data for newly installed monitor wells will be provided as this information becomes available.

Data for permanent monitor well purging and sampling activities will be recorded on groundwater sampling field data sheets. An example groundwater sampling field data sheet

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is provided in Figure 5-6. Permanent monitor wells will be purged with a submersible pump, using low-flow purging techniques. Use of disposable polyethylene tubing in association with pumps will preclude the need for decontamination of groundwater sampling equipment between sampling locations.

The pump intake shall be located initially in the middle or slightly above the middle of the screened interval. The pump intake may be lowered, if necessary. The initial depth of the pump intake (and any subsequent changes thereto) will be noted on the groundwater sampling field data sheet.

The pump rate will be adjusted so as to minimize drawdown during purging. The goal is minimal drawdown (<0.3 feet) during purging. Depth to water will be measured before and during purging to monitor drawdown in the well. Typical flow rates of 0.1 liter/minute (L/min) to 0.5 L/min may be appropriate; actual flow rate(s) will be determined and recorded for each well. Purged groundwater will be containerized and managed in accordance with the procedures specified in Section 5.3.11.

During purging activities at each monitor well, readings for temperature, conductivity, pH, dissolved oxygen, oxidation-reduction potential (ORP), and turbidity will be measured within a flow cell and recorded on the groundwater sampling field data sheet at successive approximate 0.5-liter intervals. Well purging will be considered complete when one of the following conditions occurs:

- 3 well volumes are removed from the well;
- Stabilization of produced groundwater is achieved (see note below) ; or
- The well is purged dry (see note below).

Stabilization is defined as variation of less than 0.1 pH units, less than 10 millivolts for ORP, less than 3 percent difference for conductivity, less than 10% for dissolved oxygen, and less than 10% for turbidity [or a turbidity reading of less than 20 nephelometric turbidity units (NTUs)], as measured in 0.5-liter intervals.

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Regarding purging of a well to dryness, the goal of the purging process is to remove groundwater from the well while minimizing drawdown. As such, purging a well to dryness is to be avoided, if possible. If a well appears to be purging to dryness (i.e., substantial drawdown is occurring), then the purge rate should be reduced. If an appropriate reduction of the purge rate cannot be achieved, then field personnel shall contact El Paso's Project Manager (or designee) to discuss purging operations before collecting a groundwater sample from a well that has been purged to dryness.

Groundwater samples will be collected directly from the discharge line of the pump, after the flow cell has been disconnected. The filled sample containers will be sealed, labeled, and placed in an ice chest containing ice for temporary storage until transferred to the analytical laboratory.

Groundwater samples from temporary sampling points will be analyzed for benzene and toluene by U.S. EPA SW-846[7] (3rd Edition, or as superseded) Method 8021. Groundwater samples from permanent monitor wells will be analyzed for the following constituents using the indicated methodologies:

- Project-specific Skinner List volatile organic compounds (VOCs) by U.S. EPA SW-846[7] (3rd Edition, or as superseded) Method 8260B;
- Project-specific Skinner List semivolatile organic compounds (SVOCs) by U.S. EPA SW-846[7] (3rd Edition, or as superseded) Method 8270C;
- Cyanide by U.S. EPA SW-846[7] (3rd Edition, or as superseded) Method 9010B/9014; and
- Hydrogen Sulfide (as sulfide) by U.S. EPA SW-846[7] (3rd Edition, or as superseded) Method 376.2.

The use of turbidity for evaluating the development of monitoring wells can be complicated when the well is screened across a wide range of materials, particularly including zones of interbedded clays, silts and sands. IM Area well boring logs indicate that the sand within the first water bearing zone contains a significant amount of fines, designated by a clayey or silty sand descriptor. Visual descriptions, well volumes, and

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turbidity readings will be recorded during well development activities so that wells with relatively high turbidity may be evaluated further during the IM investigation. Section 5.3.9 of the IM WP describes parameter collection procedures for groundwater sampling activities.

The Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures (EPA/540/S-95/504-1996) state, "The water quality indicator parameters monitored can include pH, redox potential, conductivity, dissolved oxygen (DO) and turbidity." Temperature is not identified as a potential indicator parameter in this document, in part due to the fact that the fluctuation in temperature is often due to ambient air temperature, intensity of the sun, and the ambient temperature of the actual flow through cell. Sufficient data to determine the stabilization of water quality is provided by monitoring conductivity, pH, DO, ORP, and turbidity. Temperature will be recorded during purging activities, but is not proposed to be a determining factor in groundwater stabilization.

5.3.10 Decontamination

Decontamination procedures for large- and small-scale field equipment are specified in the following subsections.

Large-Scale Equipment

The ROST/CPT vehicle, soil probe vehicle, hollow stem auger drill rig, and associated support vehicles shall be free from grease, oils, and soils from previous work prior to use in the IM Area investigation. Equipment that leaks fuel, coolant, or lubricants shall be removed and repaired prior to use.

The ROST/CPT vehicle, soil probe vehicle, and hollow stem auger drill rig will be decontaminated prior to use in each phase of the IM Area investigation and upon conclusion of each phase of project field activities. A plastic-lined decontamination area will be constructed using untreated landscape timbers or other suitable materials to contain decontamination liquids and solids. The decontamination area will be constructed next to

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the treatment compound for the cofferdam recovery system adjacent to the Cofferdam. A pump will be used to pump decontamination fluids into 55-gallon drums. The plastic will be placed into a 55-gallon drum upon conclusion of decontamination activities for each stage of field activities for the project. Remaining decontamination solids will be placed in 55-gallon drums or a roll-off container that will also be used for storage of drill cuttings.

Downhole ROST/CPT equipment will be decontaminated within a self-contained decontamination apparatus for the ROST/CPT unit.

Drill rods associated with installation of temporary wells will be steam-cleaned prior to use at each successive location. Temporary well construction materials must be either factory-sealed until immediately prior to usage at a given location or steam-cleaned prior to usage.

Augers, bits, and other downhole hollow stem auger equipment will be steam-cleaned prior to use at each successive monitor well installation location.

Small-Scale Equipment

Small-scale sample collection equipment directly contacting a sample will be decontaminated before and between each usage according to the following procedure:

- Clean with tap water and laboratory detergent (Liquinox or equivalent) using a brush, if necessary, to remove particulate matter and surface films;
- Rinse thoroughly with potable water; and
- Rinse thoroughly with distilled water.

Examples of the type of equipment to which the above procedures apply include the oil/water interface probe and down-hole equipment used for development of permanent monitor wells.

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If a downhole pump is used for collection of groundwater samples, then the pump will be decontaminated between each sample location by pumping distilled water through the pump. The use of previously unused dedicated tubing will be required at each sample location to minimize the potential for cross-contamination. Other than use of dedicated tubing, no other specific decontamination procedures are necessary if a pump is used.

The flow through cell will be decontaminated by using a clean tap water and laboratory detergent wash, using a brush to remove particulate matter, followed by a potable water rinse, followed by a distilled water rinse. This will be followed by an isopropanol mist/rinse followed by a distilled water rinse. The use of hexane is not recommended by multiple manufacturers for cleaning the plastic surface of the flow through cell.

An isopropanol mist/rinse followed by a final distilled water rinse will be conducted following decontamination procedures defined in Section 5.3.10. Due to this change, a potable water rinse may precede the isopropanol mist/rinse.

5.3.11 Investigation-Derived Waste

Soil cuttings produced during temporary well and permanent monitor well installation activities will be placed in a 55-gallon drums that will be transferred to the investigation-derived waste (IDW) storage area, which will be located as specified by El Paso. Drummed soil cuttings may then be transferred to a roll-off container at the IDW storage area. Soil cuttings will be removed from the Facility within 90 days.

Purge and decontamination (decon) water produced during piezometer and well installation, development, and sampling activities will be containerized in 55-gallon drums that will be transported to the treatment compound for disposal. Used personal protective equipment (PPE) will also be containerized in one or more 55-gallon drums at the IDW storage area. PVC temporary well materials and the plastic liner of the decontamination pad will be placed in 55-gallon drums and labeled appropriately.

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All drums and roll-off containers used for containing decontamination wastes will be properly labeled with the following information using spray paint, indelible ink, or drum labels:

- Date that the container is filled;
- Contents of the container (e.g., soil, groundwater, decon water); and
- Source of IDW (e.g., EMW- U1T).

Development water, decontamination water, and purge water will be transferred to the groundwater treatment system. Containerized solids will be characterized based on the analytical requirements of the disposal facility selected by El Paso.

Waste disposal will be coordinated with a facility designated by El Paso. An El Paso representative will sign all waste manifests.

5.3.12 Surveying

Upon completion of well installations, the top of casing and nearby ground elevation of each piezometer and permanent well at the IM Area will be surveyed relative to mean sea level (MSL) by a Texas licensed surveyor. The piezometers and permanent monitor wells and the former locations of temporary sampling points will also be surveyed to either plant coordinates or Texas grid coordinates for horizontal control. Plant coordinates will be used if they exist and can be readily tied into. If not, then State of Texas grid coordinates will be used. Top of casing elevations will be surveyed to the nearest 0.01 foot. Ground surface elevations and horizontal locations will be surveyed to the nearest 0.1 foot.

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6.0 QUALITY ASSURANCE / QUALITY CONTROL (QA/QC) PROCEDURES

The DQOs and other QA/QC procedures specified in the AOC[1] (Sections VII. 1. B. (i). (c) ii, XII, and XIII) for the IM Area groundwater investigation and the field and laboratory procedures that will be implemented to achieve them are discussed in the following subsections. A detailed Quality Assurance Project Plan (QAPP) for the IM Area groundwater investigation is presented in Appendix A.

6.1 Data Quality Objectives

DQOs are qualitative and quantitative statements developed by data users to specify the quality and quantity of data needed from a particular data collection activity to support specific decisions or regulatory actions. The DQOs for the IM Area groundwater investigation are PRGs established for groundwater at the IM Area, in accordance with U.S. EPA SW-846[7] (3rd Edition, or as superseded). For chemicals with PRGs that are less than U.S. EPA SW-846[7] method detection limits (MDLs), the DQO for these chemicals will be the U.S. EPA SW-846[7] MDL. The DQOs for definition of the LNAPL plume will be an approximate vertical thickness of 0.01 foot (as measured with an oil/water interface probe) and a horizontal distance of less than or equal to 50 feet.

The quality of data generated depends not only on the analytical methodology and conformance thereto, but also on sample point selection, sampling procedures, and sample integrity. Information pertaining to sampling locations, frequencies, and methodology is presented in Section 5 of this Workplan.

Environmental data are often characterized as screening data or definitive data, depending on the applicable level of QA/QC. Definitions and examples of screening data and definitive data are provided below.

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Screening Data (with Definitive Confirmation) - Screening data provide analyte identification and quantification, although quantification may be imprecise. Screening data are generated by rapid methods of analysis with less rigorous sample preparation than that used for definitive data. For definitive confirmation, a minimum of 10 percent of screening data is confirmed using analytical methodologies and QA/QC procedures and criteria associated with definitive data. Screening data QA/QC elements include the following:

1) Sample documentation (location, date and time collected, batch, etc.);
2) Chain of custody (when appropriate);
3) Sampling design approach (systematic, sample or stratified random, judgmental, etc.);
4) Initial and continuing calibration;
5) Determination and documentation of detection limits;
6) Analyte(s) identification;
7) Analyte(s) quantification; and
8) Definitive confirmation: at least 10% of the screening data (e.g., CPT/ROST and temporary sampling point data) must be confirmed with definitive data as described below.

Definitive data are generated using EPA-approved reference methods. Data are analyte-specific and include analyte identity and concentration. These methods produce chromatograms, spectra, digital values or other tangible raw data consisting of printouts or computer-generated electronic files. Data may be generated on-site or off-site, as long as QA/QC requirements are satisfied. Analytical or total measurement error must be determined. Definitive data QA/QC elements include the following:

1) Sample documentation (location, date and time collected, batch, etc.);
2) Chain-of-custody (when appropriate);
3) Sampling design approach (systematic, simple or stratified random, judgmental, etc.);
4) Initial and continuing calibration;
5) Determination and documentation of detection limits;

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6) Analyte(s) identification;

7) Analyte(s) quantification;

8) QC blanks (e.g., trip, method, rinsate);

9) Matrix spike recoveries;

10) Performance Evaluation samples (when specified);

11) Analytical error determination (measures precision of analytical method): An appropriate number of replicate aliquots, as specified in the QAPP, are taken from at least one thoroughly homogenized sample, the replicate aliquots are analyzed and standard laboratory QC parameters (such as variance, mean and coefficient of variation) are calculated and compared to method-specific performance requirements defined in the QAPP;

12) Total measurement error determination (measures overall precision of measurement system, from sample acquisition through analysis): An appropriate number of co-located samples as determined by the QAPP are independently collected from the same location and analyzed following standard operation procedures. Based on these analytical results, standard laboratory QC parameters such as variance, mean, and coefficient of variation should be calculated and compared to established measurements error goals. This procedure may be required for each matrix under investigation, and may be repeated for a given matrix at more than one location at the site; and

13) Laboratory evaluation.

The laboratory analytical methods selected for the IM Area groundwater investigation include:

- U.S. EPA SW-846[7] (3rd Edition, or as superseded) 8021B for benzene and toluene;
- U.S. EPA SW-846[7] (3rd Edition, or as superseded) 8260B for VOCs;
- U.S. EPA SW-846[7] (3rd Edition, or as superseded) 8270C for SVOCs;
- U.S. EPA SW-846[7] (3rd Edition, or as superseded) 9010B/9014 for Cyanide; and
- U.S. EPA SW-846[7] (3rd Edition, or as superseded) Method 376.2 for Hydrogen Sulfide.

Adherence to field and laboratory QA/QC procedures is necessary to ensure that the DQOs for the project are achieved. The following subsections describe QA/QC procedures specified in the AOC[1] (Sections VII. 1. B. (i). (c) ii, XII, and XIII), field

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QA/QC procedures that will be followed, and the QA/QC samples that will be collected during the course of the IM Area groundwater investigation. The QAPP presented in Appendix A presents further details regarding field and laboratory QA/QC procedures.

6.2 Additional QA/QC Procedures Specified in the AOC

At the request of EPA and in accordance with Section XII of the AOC[1], El Paso will allow split or duplicate samples to be collected by EPA and/or its authorized representative of any samples collected by El Paso. El Paso will notify EPA not less than 14 days in advance of well installation or sampling activities described herein. In the event of unforeseen situations in the field where well installation or sample collection must occur within a timeframe that does not allow 14-day advance notice to EPA, El Paso will so inform the EPA Project Manager by telephone and request approval to proceed within a shorter timeframe. El Paso's verbal request for approval will then be documented in writing to EPA within 10 days.

Severn Trent Laboratory (STL) will perform laboratory analysis of groundwater samples collected during the IM Area Investigation. El Paso will ensure that EPA personnel and EPA-authorized representatives have reasonable access to STL and its personnel who perform the analyses. STL participates in a QA/QC program equivalent to that which is followed by EPA. As part of their QA/QC program, STL will perform analysis of a reasonable number of known samples provided by EPA to demonstrate the quality of the analytical data.

El Paso will conform to the reporting procedures specified in the AOC[1] (Sections VII. 4 and XII), as described in Section 7.0 of this Workplan.

6.3 Documentation of Field Activities

Field activities for the IM Area groundwater investigation will be documented using field logbooks, chain-of-custody forms, groundwater sampling field data sheets (see Figure 5-

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6), and boring logs. Descriptions of the types of information required for field logbooks, chain-of-custody forms, and boring logs are provided in the following subsections.

Original data recorded in field logbooks, chain of custody records, and other forms will be written in waterproof ink. None of these documents will be altered, destroyed, or discarded, even if they are illegible or contain inaccuracies that require correction. If an error is made, the individual who made the entry will correct the document. A single line will be drawn through the incorrect information and the correct information entered. Corrections will be initialed and dated.

6.3.1 Field Logbooks

A hardbound field logbook with numbered pages will be used to record observations, data, and daily activities as they relate to the progress of the investigation. Entries in the logbook will be objective, legible, and written in waterproof ink. They will include:

- The name of the author;
- Health and safety considerations (including site control measurements, levels of PPE required, on-site monitoring activities and results, accidents, etc.);
- The date and time of entry;
- Work performed;
- The location of the activity (including project name, location number, monitor well number, etc.);
- Calibration procedures and records;
- Sampling performed (including specifics such as location, type of samples, identification numbers of samples collected, etc.);
- Field analysis performed (including results, instruments checks and calibration problems, etc.);
- Quality control activities;
- The names and affiliation of on-site personnel;
- Weather conditions during field activities (including temperature, wind speed and direction, humidity, precipitation, etc.);

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- Problems encountered and corrective actions taken (including specifics regarding sampling problems and alternate sampling methods utilized);
- Any verbal or written instructions from El Paso personnel, contractor supervisory personnel, and on-site Elementis personnel;
- Any deviations from approved workplans (and rationale or reasons for deviations); and
- Other general field observations.

Standard forms, such as boring log forms (see Section 6.3.2) and groundwater sampling field data sheets (see Figure 5-6) may be used, as applicable, to document the data described above. Data and events recorded in the field notebook will be recorded chronologically, as they occur. Tables and sketches may be included in the field notebook as necessary to organize data collection and document field activities.

6.3.2 Boring Logs

The lithologies encountered in each boring completed for installation of permanent monitor wells will be documented on a boring log form. An example boring log form is presented in Figure 6-1. Boring logs will subscribe to the following requirements:

1. Logs shall be prepared in the field, as borings are drilled, by a qualified, experienced geologist or geotechnical engineer.
2. Borehole depth information shall be from direct measurements, accurate to 0.25 foot;
3. All relevant information blanks in the log heading and log body shall be completed. If surveyed horizontal control is not available at the time of drilling, location sketches referenced by measured distances from prominent surface features shall be shown on, or attached to, the log;
4. Each type of subsurface material encountered and recovered shall be described in the boring log. Material types will be indirectly interpolated using professional judgment, drill cuttings, drill action, etc., in intervals of poor sample recovery;
5. Unconsolidated materials shall be described as outlined below and in the following sequence:

    - Descriptive USCS classification in accordance with ASTM D 2488 - 84;
    - Consistency of cohesive materials or apparent density of non-cohesive materials;

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- Moisture content assessment, e.g., moist, wet, saturated, etc.;
- Color; and
- Other descriptive features (bedding characteristics, organic materials, macrostructure of fine-grained soils [e.g., root holes, fractures, etc.,] etc.,);

6. Stratigraphic/lithologic changes shall be identified by a solid horizontal line at the appropriate scale depth on the log that corresponds to depths at which changes occur, measured and recorded to the nearest 0.25 foot. Gradational transitions, changes identified from cuttings or methods other than direct observation and measurement shall be identified by a horizontal dashed line at the appropriate scale depth based on the best judgment of the logger;
7. Logs shall show the depth intervals from which all samples are retained;
8. Logs shall identify the depth at which water is first encountered, the depth to water at the completion of drilling, and the stabilized depth to water. The absence of water in borings shall also be indicated. Stabilized water level data shall include time allowed for groundwater levels to stabilize;
9. Logs shall show borehole and sample diameters and depths at which drilling methods or sampling equipment change;
10. Logs shall show total depth of penetration and sampling. The bottom of the hole shall be clearly identified on the log with the notation "Bottom of Hole";
11. Logs shall show depths and types of any permanent or temporary casing used;
12. Any special drilling or sampling problems shall be recorded on logs, including descriptions of problem resolutions; and
13. Logs shall include all other information relevant to the investigation, including, but not limited to:

    - Odors; and
    - Any observed evidence of contamination in samples or cuttings.

6.3.3 Chain-of-Custody

Each investigation and QA/QC sample submitted to the analytical laboratory shall be documented on a chain-of-custody form (see example presented in Figure 6-2). Chain-of-custody forms will document sample possession from the time of collection to the time of receipt by the laboratory. Chain-of-custody forms will include:

- The sample identification number;

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- The date and time of sampling;
- Analyses required;
- Signature of a sampling team members; and
- Time and date of transference of samples.

A chain-of-custody record will always accompany collected samples. The sampling team will maintain sample custody until transfer or shipment to the analytical laboratory. At the time the samples are transferred, the individuals relinquishing and receiving the samples will sign and date the chain-of-custody record. A custody seal will be completed and used if shipping of samples is required.

6.4 Sample Handling Procedures

Each sample will be labeled at the time it is collected. The labels will be written in waterproof ink and include the following information:

- Sample identification number;
- Date and time of collection;
- The analysis required; and
- The type of preservative used (if any).

Groundwater samples designated for laboratory analysis will be placed in clean, laboratory-supplied sample jars, labeled in accordance with the nomenclature protocol presented in Section 6.6, and placed on ice in an insulated container for storage and subsequent transfer to the analytical laboratory. Chain-of-custody procedures, as described in Section 6.3.3, will be followed throughout the groundwater investigation.

STL will perform analysis of groundwater samples collected for the IM Area investigation. Information on STL is as follows:

Severn-Trent Laboratory
1733 N. Padre Island Drive

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Corpus Christi, Texas 78408
Attn: Tim Kellogg
Phone 361-289-2673
Fax 361-289-2471
tkellogg@stl-inc.com

If shipment of non-hazardous samples to a remote laboratory is necessitated, the samples will be handled, packed, and shipped in accordance with the following protocols.

- Place samples in waterproof metal or equivalent strength plastic ice chests or coolers.
- Place a previously unused large volume plastic trash bag in the ice chest or cooler and fill with approximately 3 inches of inert cushioning material such as vermiculite.
- Place the sample containers in the plastic bag. The sample containers should be placed upright in the cooler in such a manner that they will not touch during shipment.
- Place additional inert packing material to partially cover the sample containers (more than halfway). Place ice or chemical ice (i.e., "blue ice") on top of the sample containers and seal the plastic bag. Ice will be double bagged inside "zip lock" plastic bags.
- Fill the remainder of the cooler with cushioning material.
- Place the completed chain-of-custody form in a waterproof plastic bag and tape it to the interior lid of the shipping container.
- Secure the drain plug of the ice chest or cooler (if present) with tape.
- Secure the lid by taping with clear packing/strapping tape at a minimum of two locations.
- Attach the completed shipping label to the top of the cooler.
- Affix signed and dated custody seals on the front right and back left sides of the shipping container. Cover the seals with clear packing/strapping tape.

LNAPL samples will be collected by El Paso or contractor personnel prior to ROST mobilization for use by Fugro in calibrating the ROST unit. These samples will be considered hazardous and, as such, will be shipped in accordance with applicable U.S. Department of Transportation requirements.

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6.5 Collection of Quality Assurance/Quality Control Samples

The following types of QA/QC samples will be collected during the groundwater investigation:

- Trip Blanks;
- Field Blanks;
- Rinsate Blanks; and
- Duplicate Samples.

Discussions of the preparation, frequency of collection, and laboratory analysis of each of these types of QA/QC samples are presented in the following subsections.

6.5.1 Trip Blanks

Trip blanks are used to detect possible contamination of sample containers by VOCs during the time from when the sample containers leave the analytical laboratory until they are returned from the field to the laboratory. Trip blanks are created in the laboratory by pouring analyte-free water into sets of 40-ml vials. Trip blanks accompany other sample containers from the laboratory into the field, and remain unopened until returned to the laboratory for analysis.

Trip blanks accompanying groundwater samples collected from permanent monitor wells will be analyzed for the same VOC COCs as the associated investigation samples.

One trip blank per day will be collected for applicable VOCs analysis for each cooler containing groundwater samples designated for analysis for VOCs. A trip blank will be placed in each cooler containing soil or groundwater samples designated for VOCs analysis.

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6.5.2 Field Blanks

Field blanks are used to detect possible atmospheric contamination present at sample collection locations that could affect sample integrity. Field blanks are created in the field by pouring distilled water into sets of 40-ml vials at a sample collection location.

Field blanks will typically be collected at a rate of one field blank per day on any day during which a groundwater sample designated for VOCs analysis is collected from a permanent monitor well. Field blanks may be collected more frequently during the course of a day during which a groundwater sample designated for VOCs analysis is collected in the event that multiple instances of suspected atmospheric contamination at sample collection locations is suspected.

Field blanks accompanying groundwater samples collected from permanent monitor wells will be analyzed for the same VOC COCs as the associated investigation samples.

6.5.3 Rinsate Blanks

Rinsate blanks are used to detect possible introduction of contaminants to environmental samples from the equipment used to collect the samples. Rinsate blanks are created in the field by pouring distilled water onto or through sample collection equipment in the field and collecting the runoff from the sample collection equipment in appropriate laboratory containers.

A rinsate blank will be collected for each of the following types of sampling materials used for collection of groundwater samples during the course of the groundwater investigation project:

- PVC materials used for construction of permanent monitor wells (unless factory-sealed until immediately prior to usage);
- Previously unused down-hole tubing used for collection of groundwater samples from permanent monitor wells; and

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- Submersible pump (upon completion of typical decontamination procedure specified in Section 5.3.10).

Rinsate blanks will be analyzed for each of the project-specific IM COCs during activities pertaining to collection of groundwater samples from permanent monitor wells.

6.5.4 Duplicate Samples

Duplicate samples are field samples collected independently at a sampling location during a single act of sampling under consistent field conditions. Duplicate samples are used to test the accuracy of the analytical laboratory in obtaining like concentration data for identical samples.

A duplicate sample is assigned a sample identification number that is different from the sample identification number assigned to the corresponding original investigation-related sample. A fictitious sample collection time may be assigned to a duplicate sample to avoid tipping off the laboratory to the fact that the sample is indeed a duplicate sample. The true sample collection time of all duplicate samples and the original investigation-related samples to which the duplicate samples correspond will be noted by field sampling personnel in the field notebook for the project.

Duplicate groundwater samples are collected at the wellhead by alternately filling appropriate sample containers pertaining to an original investigation-related sample and those pertaining to the duplicate sample.

Duplicate groundwater samples will be collected at a rate of one duplicate sample for every 10 investigation-related groundwater samples collected from permanent monitor wells. Duplicate samples will be analyzed for the same IM COCs as the corresponding investigation-related samples.

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6.6 Sample Nomenclature

The following subsections present the nomenclature system that will be applied to groundwater and QA/QC samples to be collected during the groundwater investigation.

6.6.1 Groundwater Samples

The nomenclature applied to groundwater samples collected during the IM Area investigation will correspond directly to the nomenclature applied to the well from which the sample is collected, as previously described in Section 5.3.6.

6.6.2 Duplicate Samples

Duplicate groundwater samples will be assigned a similar nomenclature as corresponding investigation-related groundwater samples. Instead of identifying the location number of permanent monitor well number from which the duplicate groundwater sample is collected, a fictitious sample collection location, starting with "99" for the first duplicate groundwater sample collected and decreasing by successive integer values thereafter, will be assigned.

6.6.3 Other QA/QC Samples

A three-component code will be used to identify trip blanks, field blanks, and rinsate blanks. The first component will identify the specific QA/QC sample type, as follows:

- TB – Trip Blank;
- FB – Field Blank; and
- RB – Rinsate Blank.

The second component will consist of six digits representing the month, day, and year (i.e., *mm-dd-yr*) on which the sample is collected.

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The third component of the code will be used if more than one specific type of QA/QC sample is collected during the course of a single calendar day. The third component will start with "1" for the first QA/QC sample type collected each day, and will increase by successive integer values as necessary.

For example, the first trip blank collected on January 2, 2003 would be designated as TB-010203-1.

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7.0 DATA MANAGEMENT AND REPORTING PROCEDURES

El Paso will submit to EPA the results of all sampling and tests performed or other data pertaining to the IM Area Investigation produced with respect to implementation of the AOC[1] (Sections VII. 4 and XII). El Paso will also provide a summary of all analytical data pertaining to the IM Area Investigation produced with respect to implementation of the AOC[1] (Section XII. 1), presented in tabular format contrasting the data point and the appropriate PRG, remediation goal or level, regulatory or risk screening level and/or standard, in accordance with the reporting requirements specified in Section VII-4 of the AOC[1].

Field data will be recorded in field logbooks, boring logs, groundwater sampling field data sheets, and chain-of-custody forms, as previously described in Section 6.0. These documents will be produced at the project site and will be maintained in the contractor's project files in Houston, Texas upon conclusion of field activities.

STL will provide analytical laboratory deliverables as they are produced. Preliminary laboratory deliverables will be transferred from STL to the contractor by fax or electronically. Final hard-copy analytical reports will be maintained in the contractor's project files in Houston, Texas.

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8.0 SCHEDULE FOR ACTIVITIES

The IM Area groundwater investigation will be completed within 60 days of EPA approval, as specified in the AOC[1] (Section VII. 1. B. ii).

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9.0 HEALTH AND SAFETY PROCEDURES

On-site work will be completed in accordance with the site-specific health and safety plan provided in Appendix B.

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10.0 REFERENCES

1. United States Environmental Protection Agency. September 6, 2002. Administrative Order on Consent: El Paso CGP Company and El Paso Merchant Energy – Petroleum Company.

2. JD Consulting, L.P. September 2000. RFI Report, Coastal Refining & Marketing, Inc., Corpus Christi, Texas.

3. ENSR Corporation. June 1999. Final Report, Groundwater Contamination Delineation, Corpus Christi Refinery, 1300 Cantwell Lane, Corpus Christi, Texas.

4. Brown and Caldwell. 2002. Personal Communication between R. Rexroad (Brown and Caldwell) and M. Mason (Fugro).

5. Brown and Caldwell. 2002. Preliminary Remediation Goals Report.

6. Texas Department of Licensing and Regulation. November 8, 2001. Water Well Drillers and Pump Installers Rules, Texas Administrative Code, Chapter 76, Sections 76.1001 through 76.1010.

7. United States Environmental Protection Agency. November 1986. SW-846, 3rd Edition; Test Methods for Evaluating Solid Waste.

8. American Chrome and Chemicals. 1991. Well Summary Sheet (for wells MW-U6, MW-U11, OW-L8, and P6).

9. Coastal. 2001. Database pertaining to wells at or in the area of the Coastal Refinery in Corpus Christi, Texas.

10. El Paso Corporation and Valero Refining – Texas, L.P. September 2002. Groundwater Monitoring Program, Semiannual Report, September 15, 2002, El Paso Corporation, Valero Refining – Texas, L.P, Industrial Solid Waste Registration No. 30530.

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FIGURES

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APPENDICES

APPENDIX A

QUALITY ASSURANCE PROJECT PLAN

APPENDIX B

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APPENDIX C

ROST INFORMATION

APPENDIX D

WATER WELL DRILLERS AND PUMP INSTALLERS RULES, 16 TAC 76

APPENDIX E

WELL VOLUME CALCULATION DETAILS

Well Volume Calculation Details

Goal: Determine "N" values for 2-inch and 4-inch ID wells, where:

N = gallons of water in well per foot of water column in well (gal/ft).

Equations:

Volume of a cylinder = $(\pi) \times (r^2) \times (h)$

Volume of water in a (cylindrical) well (in gallons) = $(\pi) \times (r^2) \times (h) \times (F)$, where:

V = volume (gal);
π = 3.14 (unitless);
r = radius of well (ft);
h = height of water in well (ft); and
F = factor (7.48 gal/cubic foot).

Calculations:

For a 2-inch diameter well:

V (gal) = (3.14) x (1/12 ft^2) x (h ft) x (7.48 gal/ft)
V (gal) = (3.14) x (0.08 ft^2) x (h ft) x (7.48 gal/ft)
V (gal) = (0.02 ft^2) x (h ft) x (7.48 gal/ft)
V (gal) = (h ft) x (0.16 gal/ft)
V (gal) / h (ft) = N = 0.16 gal/ft

For a 4-inch diameter well:

V (gal) = (3.14) x (1/6 ft^2) x (h ft) x (7.48 gal/ft)
V (gal) = (3.14) x (0.17 ft^2) x (h ft) x (7.48 gal/ft)
V (gal) = (0.09 ft^2) x (h ft) x (7.48 gal/ft)
V (gal) = (h ft) x (0.65 gal/ft)
V (gal) / h (ft) = N = 0.65 gal/ft

TABLE 3-1 (Revised October 2005)
Fluid Level Measurements and Groundwater Elevations
in Wells at *or in the Vicinity of* the IM Area

Well I.D.[1]	Date	(adjusted) Top of Casing Elevation (ft.)	Depth to Product (ft.)	Depth to Ground-water (ft.)	Product Thickness (ft.)	Corrected[2] Groundwater Elevation (ft.)
COFFERDAM[3]	10/29/01	8.86	7.72	8.18	0.46	1.03
	07/12/02		8.45	8.83	0.38	0.32
	09/05/02		7.95	8.23	0.28	0.84
	09/16/02		5.03	5.28	0.25	3.77
	10/04/02		7.75	7.91	0.16	1.07
MW-U13	*12/2000*	*ND*[4]	*NR*[5]	*NR*	*> 4*	*ND*
MW-U25	09/05/02	ND	10.22	10.87	0.65	ND
	09/18/02		9.03	9.58	0.55	ND
	09/26/02		9.10	9.63	0.53	ND
	10/04/02		9.44	10.00	0.56	ND
MW-U26[3]	09/05/02	14.14	---	21.26	0.00	-7.12
	09/16/02		10.83	10.84	0.01	3.31
	10/04/02		0.00	21.35	0.00	-7.21
MW-U27	09/05/02	14.18	11.26	12.35	1.09	2.65
	09/18/02		10.52	11.63	1.11	3.38
	09/26/02		10.39	11.49	1.10	3.52
	10/04/02		10.76	11.89	1.13	3.14
MW-U28[3]	10/29/01	13.17	---	10.98	0.00	2.19
	07/12/02		---	10.90	0.00	2.27
	09/05/02		---	10.07	0.00	3.10
	10/04/02		---	10.28	0.00	2.89
MW-U29[3]	10/29/01	12.77	11.32	11.85	0.53	1.32
	07/12/02		4.02	7.97	3.95	7.76
	09/05/02		---	18.72	0.00	-5.95
	09/16/02		9.58	11.25	1.67	2.77
	10/04/02		---	21.03	0.00	-8.26
MW-U30[3]	10/29/01	12.71	10.85	13.88	3.03	1.10
	07/12/02		21.18	21.94	0.76	-8.66
	09/05/02		21.08	21.90	0.82	-8.58
	09/16/02		9.35	11.40	2.05	2.85
	10/04/02		21.02	21.42	0.40	-8.41
MW-U31	12/2000	13.69	---	NR	0.00	ND
	07/12/02		10.20	15.15	4.95	2.25
	09/05/02		---	10.50	0.00	3.19
	09/18/02		---	10.71	0.00	2.98
	09/26/02		---	10.35	0.00	3.34
	10/04/02		---	10.65	0.00	3.04
MW-U32[3]	10/29/01	12.30	9.77	12.20	2.43	1.92
	09/05/02		9.24	10.48	1.24	2.75
	09/16/02		8.95	10.50	1.55	2.96
	10/04/02		10.82	13.95	3.13	0.70
OW-L8	12/2000	25.05	---	ND	0.00	ND
OW-L15	*04/16/02*	*21.86*	---	*18.44*	*0.00*	*3.42*
	10/15/02		---	*17.87*	*0.00*	*3.99*

TABLE 3-1 (Revised October 2005)
Fluid Level Measurements and Groundwater Elevations
in Wells at *or in the Vicinity of* the IM Area

Well I.D.[1]	Date	(adjusted) Top of Casing Elevation (ft.)	Depth to Product (ft.)	Depth to Ground-water (ft.)	Product Thickness (ft.)	Corrected[2] Groundwater Elevation (ft.)
OW-U37	*1/1999*	*9.54*	---	*NR*	*0.00*	*ND*
	12/2000		---	*NR*	*0.00*	*ND*
	04/16/02		---	*5.27*	*0.00*	*4.27*
	10/15/02		---	*4.08*	*0.00*	*5.46*
OW-U38	1/1999	14.32	---	NR	0.00	ND
	12/2000		---	NR	0.00	ND
	04/16/02		---	10.86	0.00	3.46
	09/05/02		10.10	10.14	0.04	4.21
	09/18/02		8.11	8.14	0.03	6.20
	09/26/02		9.24	9.27	0.03	5.07
	10/04/02		9.42	9.43	0.01	4.90
	10/15/02		---	9.26	0.00	5.06
OW-U43	*1/1999*	*27.22*	---	*NR*	*0.00*	*ND*
	04/16/02		---	*21.30*	*0.00*	*5.92*
	10/15/02		---	*20.90*	*0.00*	*6.32*
OW-U44	*1/1999*	*29.24*	*NR*	*NR*	*2.67*	*ND*
	12/2000		*NR*	*NR*	*3.39*	*ND*
P-6	12/2000	25.42	---	NR	0.00	ND
P-8	12/2000	ND	---	NR	0.00	ND
PZ-5	09/05/02	15.06	---	12.19	0.00	2.87
	09/18/02		---	12.28	0.00	2.78
	09/26/02		---	12.22	0.00	2.84
	10/04/02		---	12.56	0.00	2.50
PZ-6	09/05/02	14.81	---	12.26	0.00	2.55
	09/18/02		---	12.02	0.00	2.79
	09/26/02		---	12.04	0.00	2.77
	10/04/02		---	12.23	0.00	2.58
PZ-7	12/2000	14.22	---	NR	0.00	ND
	09/05/02		---	11.32	0.00	2.90
	09/18/02		---	10.74	0.00	3.48
	09/26/02		---	10.50	0.00	3.72
	10/04/02		---	10.88	0.00	3.34
PZ-8		12.20				
PZ-9	09/05/02	12.05	---	9.70	0.00	2.35
	09/18/02		---	8.85	0.00	3.20
	09/26/02		---	8.86	0.00	3.19
	10/04/02		---	9.35	0.00	2.70
R1[3]	10/29/01	14.10	12.23	12.84	0.61	1.72
	07/12/02		13.66	13.68	0.02	0.44
	09/05/02		13.62	13.64	0.02	0.48
	09/16/02		---	11.34	0.00	2.76
	10/04/02		---	14.30	0.00	-0.20

TABLE 3-1 (Revised October 2005)
Fluid Level Measurements and Groundwater Elevations
in Wells at *or in the Vicinity of* the IM Area

Well I.D.[1]	Date	(adjusted) Top of Casing Elevation (ft.)	Depth to Product (ft.)	Depth to Ground-water (ft.)	Product Thickness (ft.)	Corrected[2] Groundwater Elevation (ft.)
R2[3]	12/2000	14.66	NR	NR	0.34	ND
	10/29/01		15.64	16.92	1.28	-1.30
	07/12/02		12.05	12.12	0.07	2.59
	09/05/02		15.41	16.60	1.19	-1.05
	09/16/02		10.44	10.70	0.26	4.16
	10/04/02		13.52	13.54	0.02	1.14
R3[3]	12/2000	14.82	NR	NR	0.4	ND
	10/29/01		13.83	14.14	0.31	0.91
	07/12/02		12.10	12.48	0.38	2.63
	09/05/02		13.63	14.03	0.40	1.09
	10/04/02		15.65	16.85	1.20	-1.13
R4 [3]	*10/29/01*	*8.55*	*12.09*	*12.10*	*0.01*	*-3.54*
	07/12/02		*9.00*	*9.18*	*0.18*	*-0.49*
	09/05/02		*8.00*	*10.75*	*2.75*	*-0.14*
	09/16/02		*7.13*	*9.63*	*2.50*	*0.80*
	10/04/02		*7.57*	*9.96*	*2.39*	*0.38*
R5	*12/2000*	*ND*	---	*ND*	*0.00*	*ND*
RW-EC-03 [3]	*10/16/01*	*26.06*	*21.15*	*21.29*	*0.14*	*4.88*
	04/16/02		*21.27*	*21.39*	*0.12*	*4.76*
	10/15/02		*20.93*	*21.94*	*1.01*	*4.88*
RW-EC-04 [3]	*10/16/01*	*26.74*	*22.25*	*22.54*	*0.29*	*4.42*
	04/16/02		*22.50*	*22.65*	*0.15*	*4.20*
	10/15/02		---	*21.99*	*0.00*	*4.75*
RW-EC-08 [3]	*10/16/01*	*27.63*	*22.43*	*26.66*	*4.23*	*4.14*
	04/16/02		*22.59*	*26.34*	*3.75*	*4.10*
	10/15/02		*22.49*	*25.59*	*3.10*	*4.37*
T11	*12/2000*	*ND*	*NR*	*NR*	*0.62*	*ND*
T12	*12/2000*	*ND*	---	*ND*	*0.00*	*ND*

[1] *- see Figure 1-3 for locations of wells*
[2] - Corrected ground water elevation = static water elevation + (NAPL thickness x 0.75).
[3] - indicates current recovery well
[4] - ND = Not determined.
[5] - NR = Not reported.
--- = no measurable NAPL present

Table 3-2

BTEX and TPH Analytical Results[1] for Wells at or in the Vicinity of the IM Area[2] (Uppermost Transmissive Zone)

Well ID	Location[3]	Sample Date	Benzene (PRG = 0.109 mg/L)	Ethylbenzene	Toluene (PRG = 0.95 mg/L)	Xylenes	TPH
Cofferdam 1	IM Area	Jan. 1998	**59.2**	0.041	0.029	0.117	NA[4]
		Apl 1998	**72.7**	0.0359	0.0404	0.0756	NA
		July 1998	**196**	0.0719	0.0639	0.109	NA
		Jan. 1999	**350**	ND[5]	ND	ND	NA
		Apl 1999	**558**	0.584	0.405	1.153	NA
		July 1999	**271**	ND	ND	0.391	NA
		Dec. 1999	**349**	0.311	ND	0.528	NA
		Jan. 2000	**353**	< 0.2	< 0.2	< 0.2	NA
		Apl 2000	**887**	1.86	**1.38**	2.24	NA
		July 2000	**350**	0.231	0.238	0.291	NA
		12/14/2000	**459**	0.239	0.343	0.471	NA
IW-1	IM Area	11/18/1987	**0.44**	NA	0.80	3.02	NA
IW-2	IM Area	11/18/1987	0.07	NA	0.16	0.32	NA
IW-3	IM Area	11/18/1987	0.03	NA	ND	0.32	NA
MW-U6	IM Area	Jan. 1998	**415**	ND	0.120	ND	NA
		Apl 1998	**354**	ND	ND	ND	NA
		July 1998	**37.6**	0.232	0.0168	0.054	NA
		12/10/1998	**373**	ND	ND	ND	NA
		Jan. 1999	**649**	ND	ND	ND	NA
		Apl 1999	**527**	1.06	**1.33**	3.02	NA
		July 1999	**515**	ND	ND	ND	NA
		Dec. 1999	**1,499**	ND	ND	ND	NA
		Jan. 2000	**551**	<0.5	**3.38**	6.44	NA
		Apl 2000	**618**	<0.1	0.196	<0.1	NA
		July 2000	**416**	<0.25	<0.25	<0.25	NA
		12/14/2000	**519**	ND	0.753	0.561	NA
MW-U11	South of IM Area	11/30/1990	**192**	ND	ND	ND	1.4
		1/7/1991	**36**	ND	ND	ND	2.6
MW-U12	South of IM Area	11/30/1990	**182**	ND	ND	ND	1.2
		1/7/1991	**413**	ND	ND	ND	2.4
MW-U13	South of IM Area	1/7/1991	**34.1**	ND	ND	ND	3.5
MW-U26	IM Area	Jan. 1998	**19.7**	0.015	0.011	0.010	NA
		Apl 1998	**577**	38.7	**6.49**	64.37	NA
		July 1998	**0.936**	0.289	0.127	0.648	NA
		Jan. 2000	**33.8**	0.656	0.145	1.763	NA
		Apl 2000	**618**	< 0.1	0.196	< 0.1	NA
MW-U27	IM Area	Jan. 2000	**3.33**	0.050	0.005	0.063	NA
MW-U28	IM Area	Jan. 2000	**0.691**	0.026	0.023	0.087	NA
		Apl 2000	**0.274**	0.372	**1.55**	1.226	NA
		July 2000	0.045	0.017	0.00835	0.087	NA
		12/14/2000	0.0325	0.0208	0.0133	0.1294	NA
MW-U29	IM Area	Apl 2000	**7.08**	0.278	0.0584	1.142	NA
		July 2000	**0.826**	0.022	0.0102	0.1164	NA
		12/14/2000	**10**	0.452	0.140	1.593	NA

Table 3-2

BTEX and TPH Analytical Results[1] for Wells at or in the Vicinity of the IM Area[2] (Uppermost Transmissive Zone)

Well ID	Location[3]	Sample Date	Benzene (PRG = 0.109 mg/L)	Ethylbenzene	Toluene (PRG = 0.95 mg/L)	Xylenes	TPH
MW-U30	IM Area	Apl 2000	**454**	4.17	0.782	10.78	NA
		July 2000	**80.8**	0.42	0.0939	1.003	NA
		12/14/2000	**201**	0.882	0.193	2.294	NA
MW-U31	IM Area	Apl 2000	0.0812	0.00133	< 0.001	0.00274	NA
		July 2000	< 0.001	< 0.001	< 0.001	< 0.001	NA
		12/14/2000	0.101	ND	0.00295	0.00159	NA
MW-U32	IM Area	Apl 2000	**142**	0.208	< 0.1	0.395	NA
		July 2000	**189**	0.473	0.167	1.124	NA
		12/14/2000	**223**	ND	ND	ND	NA
OW-L15	West of IM Area	4/21/1998	0.016	ND	0.003	0.003	NA
OW-L27	IM Area	4/22/1998	**2.4**	ND	0.003	0.004	NA
OW-U30	South of IM Area	12/6/1990	**65.9**	ND	ND	3.71	ND
		1/16/1991	**3.7**	ND	**3.91**	8.43	ND
OW-U37	West of IM Area	4/22/1998	0.048	ND	ND	ND	NA
		1/12/1999	0.050	< 0.005	ND	ND	NA
OW-U38	IM Area	Jan. 2000	0.00167	< 0.001	< 0.001	< 0.001	NA
		Apl 2000	0.00866	< 0.001	< 0.001	< 0.001	NA
		July 2000	< 0.001	< 0.001	0.00105	< 0.001	NA
		12/14/2000	0.0117	ND	ND	ND	NA
OW-U43	South of IM Area	2/25/1991	0.010	ND	ND	ND	ND
OW-U44	Southwest of IM Area	2/25/1991	**0.523**	ND	ND	ND	51
P6	IM Area	4/22/1998	**26**	ND	ND	ND	NA
P8	IM Area	4/22/1998	**11**	ND	ND	ND	NA
PZ-5	IM Area	Jan. 2000	**4.53**	0.022	0.010	0.077	NA
		Apl 2000	**40.8**	0.101	0.0565	0.742	NA
PZ-6	IM Area	Jan. 1998	**5.93**	ND	0.003	0.002	NA
		Apl 1998	**0.184**	ND	0.00103	0.00515	NA
		July 1998	**0.209**	ND	ND	0.00294	NA
		12/10/1998	**0.16**	ND	ND	0.00461	NA
		Jan. 1999	**133**	ND	ND	ND	NA
		Jan. 2000	**55.4**	0.096	0.091	0.244	NA
		Apl 2000	**244**	< 0.2	< 0.2	0.206	NA
PZ-7	IM Area	Jan. 2000	**48.6**	0.034	0.043	0.041	NA
		Apl 2000	**9.31**	< 0.005	< 0.005	0.0064	NA
PZ-8	IM Area	Jan. 1998	**54.8**	0.047	0.047	0.158	NA
		Apl 1998	**94**	0.0727	0.067	0.251	NA
		July 1998	**28.4**	0.0187	0.0151	0.0616	NA
PZ-9	IM Area	Jan. 2000	**188**	0.390	0.588	0.846	NA
		Apl 2000	**383**	0.498	0.364	0.679	NA
R-1	IM Area	Jan. 1998	**6.5**	1.010	0.192	2.739	NA
		Apl 1998	**13**	1	0.117	2.356	NA
		12/10/1998	**142**	32.2	**3.58**	82.3	NA
		Jan. 2000	**377**	< 0.2	< 0.2	< 0.2	NA
		Apl 2000	**442**	< 0.5	< 0.5	0.555	NA
		July 2000	**697**	4.76	**1.12**	11.34	NA
		12/14/2000	**443**	0.406	0.262	0.942	NA

Table 3-2

BTEX and TPH Analytical Results[1] for Wells at or in the Vicinity of the IM Area[2] (Uppermost Transmissive Zone)

Well ID	Location[3]	Sample Date	Benzene (PRG = 0.109 mg/L)	Ethylbenzene	Toluene (PRG = 0.95 mg/L)	Xylenes	TPH
R-2	IM Area	Jan. 1998	**1.25**	0.007	0.009	0.005	NA
		Apl 1998	**2.18**	0.0126	0.00367	0.00315	NA
		July 1998	**119**	0.229	0.0882	0.3955	NA
		12/10/1998	**142**	0.16	0.124	0.219	NA
		Jan. 1999	**142**	ND	ND	ND	NA
		Apl 1999	**121**	0.45	0.111	0.359	NA
		Dec. 1999	**173**	0.519	0.152	0.364	NA
		Jan. 2000	**166**	0.516	0.167	0.400	NA
		Apl 2000	**268**	1.02	0.254	1.07	NA
		July 2000	**252**	0.611	0.282	0.504	NA
		12/14/2000	**247**	0.649	0.210	0.539	NA
R-3	IM Area	Jan. 1998	**0.131**	0.002	ND	0.001	NA
		Apl 1998	0.00572	ND	ND	ND	NA
		July 1998	**75.1**	0.68	0.105	0.943	NA
		12/10/1998	**62.1**	0.638	0.109	0.866	NA
		Jan. 1999	**38.4**	ND	ND	ND	NA
		Apl 1999	**16.2**	0.12	0.0173	0.1061	NA
		Dec. 1999	**75.3**	0.75	0.0928	0.63	NA
		Jan. 2000	**16.3**	0.097	0.015	0.049	NA
R-3	IM Area	Apl 2000	**362**	8.38	0.693	12.25	NA
		July 2000	**28.3**	0.262	0.0446	0.1818	NA
		12/14/2000	**98.5**	0.360	0.132	0.363	NA
R-4	West of IM Area	Jan. 1998	**0.217**	0.485	0.056	0.246	NA
		Apl 1998	**0.299**	0.259	0.0595	0.146	NA
		July 1998	**0.382**	0.313	0.0797	0.1703	NA
		12/10/1998	**2.34**	1.29	0.139	0.882	NA
		Jan. 1999	ND	ND	ND	ND	NA
		Apl 1999	**4.53**	0.145	0.0358	0.1193	NA
		July 1999	**1.99**	0.181	ND	0.107	NA
		Dec. 1999	**0.392**	0.0482	0.0121	0.0366	NA
		Jan. 2000	**0.801**	0.011	0.004	0.008	NA
		Apl 2000	**0.197**	0.11	0.0114	0.041	NA
		July 2000	**0.629**	1.9	0.136	1.065	NA
		12/14/2000	**0.313**	0.183	0.0336	0.0655	NA
SF-1	IM Area	11/21/1989	0.252	0.006	0.029	0.014	40
T-12	West of IM Area	4/22/1998	ND	ND	ND	ND	NA
T-5	South of IM Area	11/29/1989	NA	NA	NA	NA	3
		Jan. 1998	**15.8**	0.003	0.046	0.006	NA
		12/10/1998	**22.7**	ND	ND	ND	NA
		Jan. 1999	**805**	ND	ND	ND	NA
		Apl 1999	**1,150**	ND	ND	ND	NA
		July 1999	**729**	ND	ND	ND	NA
		Dec. 1999	**1,620**	ND	ND	ND	NA
		Jan. 2000	**505**	< 0.5	**1.6**	1.58	NA
		Apl 2000	**416**	< 0.5	**0.987**	0.671	NA
		12/14/2000	**481**	ND	0.162	ND	NA

(1) - in milligrms per liter (mg/L)

(2) - Data from Coastal[9]

(3) - see Figure 1-3 for monitor well locations

(4) - NA indicates Not Analyzed

(5) - ND indicates Not Detected (detection limit not specified)

Bold font indicates detection in excess of applicable PRG

Table 3-3
Additional Groundwater Analytical Data for Wells at or in the Vicinity of the IM Area[1]

Parameter	PRG (ug/L)	Well / Sample Date						
		OWL15	OWU37		OWU38		OWU43	
		Apl. 2002[2]	1/12/99[3]	Apl. 2002[2]	1/12/99[3]	Apl. 2002[2]	1/12/99[3]	Apl. 2002[2]
Volatile Organics (SW846 8260B) (ug/L)								
1,2-Dibromoethane	2.23E+00	NR[4]	<5	NR	<5	NR	<5	NR
1, 2-Dichloroethane (EDC)	4.93E+02	<5	<5	<5	<5	<5	<5	<20
1,3-Dichlorobenzene	1.42E+02	NR	<5	NR	<5	NR	<5	NR
1, 4-Dioxane	3.35E+05	<100	<100	<100	<100	<100	<100	<500
Benzene	1.09E+02	<5	50	<5	51	74	29	**830**
Carbon Disulfide	3.25E+03	<5	<5	<5	<5	<5	<5	<20
Chlorobenzene	1.05E+02	NR	<5	NR	<5	NR	<5	NR
Chloroform	4.10E+03	<5	<5	<5	<5	<5	88	60
Ethylbenzene	-	<5	<5	<5	<5	<5	<5	<20
Methyl Ethyl Ketone (2-Butanone)	9.75E+04	<10	<5	<10	<5	<10	<5	<50
Styrene	-	NR	<5	NR	<5	NR	<5	NR
Toluene	9.50E+02	<5	<5	<5	<5	<5	<5	<20
m&p-Xylenes	-	<5	<5	<5	<5	<5	<5	<20
o-Xylene	-	<5	<5	<5	<5	<5	<5	<20
Methyl tert-Butyl Ether (MTBE)	-	<5	NR	<5	NR	<5	NR	<20
Semivolatile Organics (SW846 8270C) (ug/L)								
1-Methylnaphthalene	-	<10	<10	<10	<10	<10	<10	<10
1,2-Dichlorobenzene	5-91E+02	NR	<10	NR	<10	NR	<10	NR
1,4-Dichlorobenzene	9.90E+01	NR	<10	NR	<10	NR	<10	NR
2, 4-Dimethylphenol	6.60E+01	<10	<10	<10	<10	<10	<10	<10
2, 4-Dinitrophenol	1.33E+03	NR	<50	NR	<50	NR	<50	NR
2-Methylphenol (o-cresol)	1.08E+03	<10	<10	<10	<10	<10	<10	<10
3 & 4-Methylphenol (m&p-cresol)	1.08E+03	<10	<10	<10	<10	<10	<10	<10
7,12-Dimethylbenz(a)anthracene	2.70E-05	NR	<10	NR	<10	NR	<10	NR
Anthracene	-	NR	<10	NR	<10	NR	<10	NR
Benzo(a)anthracene	5.40E+00	NR	<10	NR	<10	NR	<10	NR
Benzo(a)pyrene	5.40E+00	NR	<10	NR	<10	NR	<10	NR
Benzo(b)fluoranthene	4.90E+00	NR	<10	NR	<10	NR	<10	NR
Benzo(k)fluoranthene	-	NR	<10	NR	<10	NR	<10	NR
Bis(2-ethylhexyl)phthalate	5.90E+02	<10	<10	<10	<10	200	<10	<10
Butyl benzyl phthalate	1.47E+02	NR	<10	NR	<10	NR	<10	NR
Chrysene	5.40E+01	NR	<10	NR	<10	NR	<10	NR
Di-n-butyl phthalate	5.00E+00	NR	<10	NR	<10	NR	<10	NR
Di-n-octyl phthalate	1.06E+00	NR	<10	NR	<10	NR	<10	NR
Dibenzo(a,h)acridine	2.22E-02	NR	<10	NR	<10	NR	<10	NR
Dibenzo(a,h)anthracene	4.90E+00	NR	<10	NR	<10	NR	<10	NR
Diethyl phthalate	8.84E+02	<10	<10	<10	<10	<10	<10	<10
Dimethyl phthalate	5.80E+02	NR	<10	NR	<10	NR	<10	NR
Fluoranthene	2.96E+00	NR	<10	NR	<10	NR	<10	NR
Indene	-	NR	<10	NR	<10	NR	<10	NR
Methyl chrysene	-	NR	<10	NR	<10	NR	<10	NR
Naphthalene	2.50E+02	<10	<10	<10	<10	<10	<10	<10
Phenanthrene	-	NR	<10	NR	<10	NR	<10	NR
Phenol	5.50E+03	<10	<10	<10	<10	<10	<10	<10
Pyrene	-	NR	<10	NR	<10	NR	<10	NR
Pyridine	1.16E+04	NR	<10	NR	<10	NR	<10	NR
Quinoline (Benzo(b)pyridine)	-	NR	<10	NR	<10	NR	<10	NR
Thiophenol (Benzenethiol)	2.23E+01	<50	<20	<50	<20	<50	<20	<50

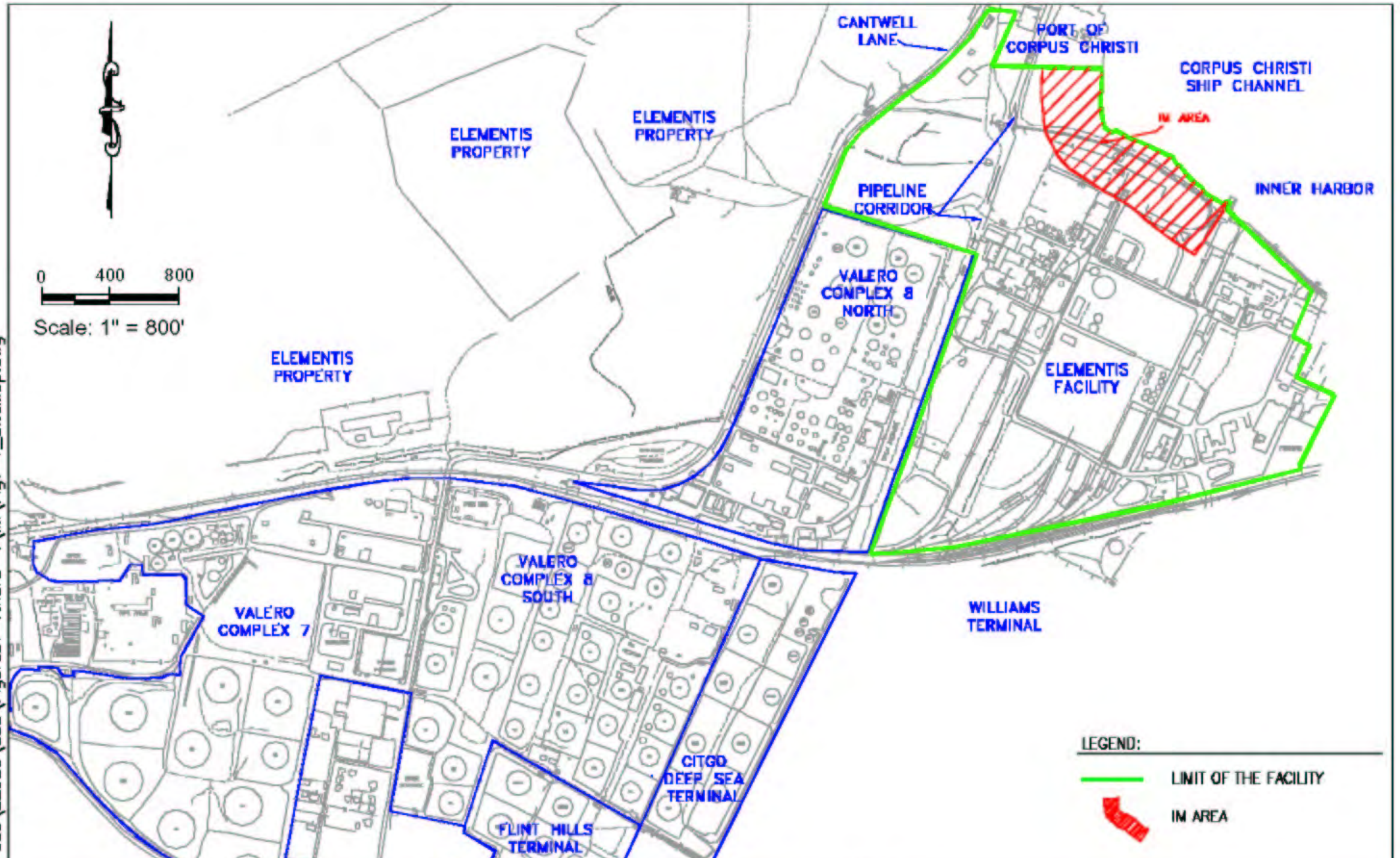
(1) - see Figure 1-3 for location of monitor wells
(2) Data from El Paso Corporation and Valero Refining – Texas, L.P.[10]
(3) Data from ENSR[3]
(4) NR = Not reported
Bold font indicates constituent detection at concentration exceeding applicable PRG

Table 3-4

Groundwater Analytical Data[1] for IM Area Monitor Well OW-L8[2] (Second Transmissive Zone)

Well ID	Location[3]	Sample Date	Benzene (PRG = 0.109 mg/L)	Ethylbenzene	Toluene (PRG = 0.95 mg/L)	Xylenes	TPH
OW-L8	IM Area	1/7/1991	ND[4]	0.265	0.742	1.700	2.1
		4/22/1998	0.002	ND	0.003	0.004	NA[5]

(1) - in milligrms per liter (mg/L)
(2) - Data from Coastal[10]
(3) - see Figure 1-3 for monitor well location
(4) - ND indicates Not Detected (detection limit not specified)
(5) - NA indicates Not Analyzed



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BROWN AND CALDWELL
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Houston, Texas 77002
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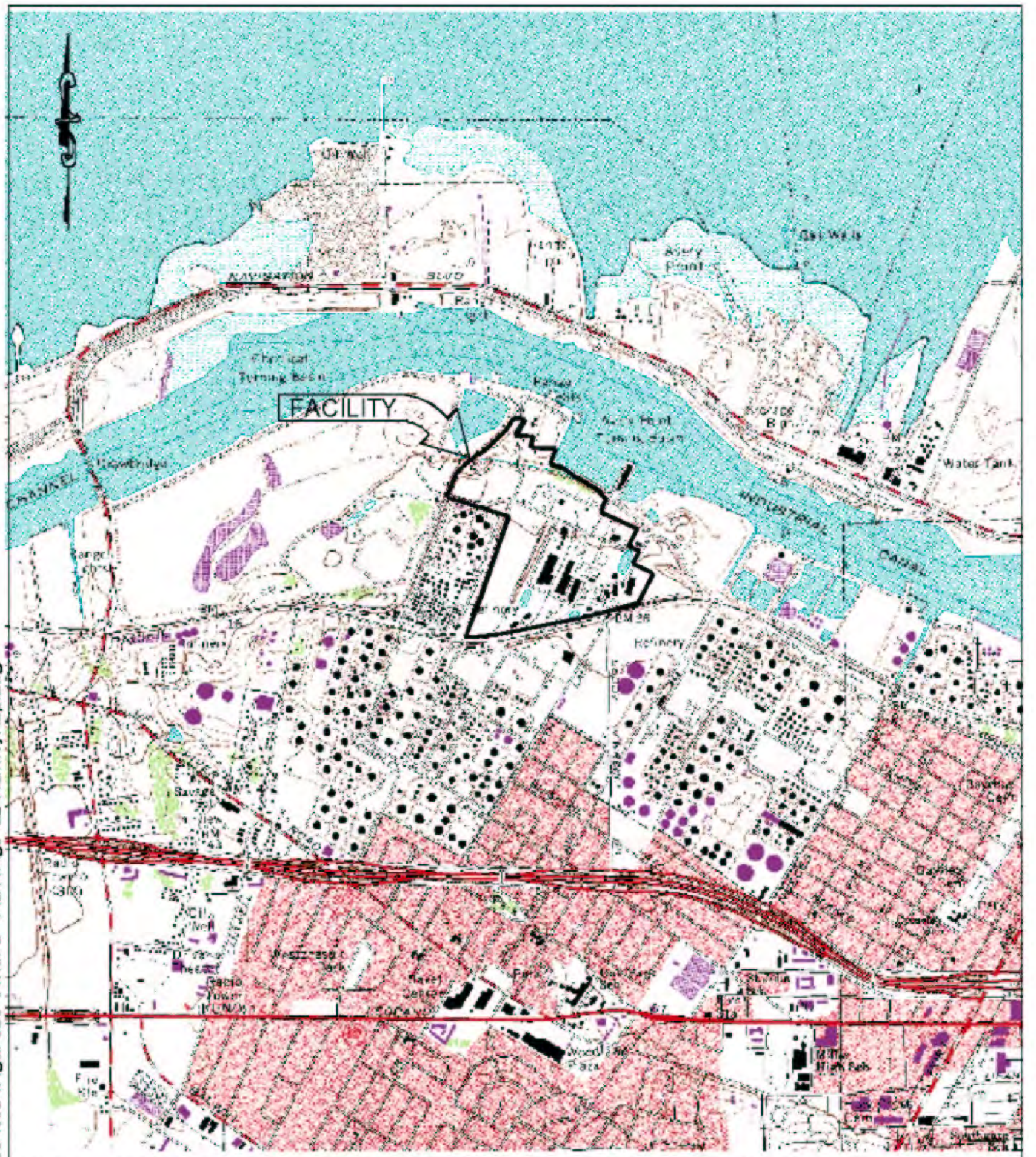
El Paso

Site Map
Elementis Site
Figure 1-1

SOURCE: SHINER, MOSELEY AND ASSOCIATES, INC. OF CORPUS CHRISTI, TEXAS.



SOURCE: USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE - CORPUS CHRISTI, TX 1968 (PHOTOREVISED 1975)

0 1000 2000

Scale: 1" = 2000'

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Vicinity Map
Elementis Site
Figure 1-2

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CORPUS CHRISTI INNER HARBOR

0 80 160
Approximate
Scale: 1" = 160'

LEGEND

- EXISTING MONITOR WELL
- EXISTING RECOVERY WELL
- FORMER CPT LOCATION
- WELL P&A'D
- LIMIT OF IM AREA
- RAILROAD TRACKS
- Elementis Property (approximate)

SOURCE: MFG, Inc - Consulting Scientists and Engineers

CANTWELL LANE
OIL DOCK #3
OS-CPT-91
PORT OF CORPUS CHRISTI PROPERTY
OS-CPT-71
PIPELINE CORRIDOR
MEAN HIGH TIDE LINE
R-4
FLUME
T-11
OS-CPT-74
OW-U38
R-3
PZ-7
R-2
BLUFF LINE
OS-CPT-73
COFFERDAM-1
MW-U27
PZ-9
MW-U26
R-1
PZ-6
MW-U32
PZ-5
MW-U30
MW-U29
MW-U28
MW-U31
RW-EC-04
OW-L27
P-8
P-6
GROUNDWATER TREATMENT SYSTEM
OW-L8
EDCS COOLING WATER TOWERS
SANITARY WASTEWATER
CITGO DOCK #7
HEARTH
EDCS SHIPPING
EDCS TANK FARM
T-5
MW-U12
MW-U13
MW-U11
RW-EC-03
BACK GATE
OW-U44
STOREROOM
OXIDE MAINTENANCE
HYDRATE
DCS WASTEWATER TREATMENT
EDCS OILL FLOOR
OS-CPT-75
BLUFF LINE

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IM Area Map
IM Area
Figure 1-3

Jan 02, 2003 - 2:53pm CKelly
P:\Cad\JOBS\ElPaso\22989\003\Figures1-1thur5-4\IM\Fig1-3_IM_AreaMap.dwg

CORPUS CHRISTI INNER HARBOR

0 80 160

Approximate Scale: 1" = 160'

LEGEND

- EXISTING MONITOR WELL
- EXISTING RECOVERY WELL
- FORMER CPT LOCATION
- WELL P&A'D
- LIMIT OF IM AREA
- RAILROAD TRACKS
- GEOLOGIC CROSS-SECTION LOCATION (SEE FIGURES 2-2 AND 2-3)
- Elementis Property (approximate)

SOURCE: MFG, Inc - Consulting Scientists and Engineers

CANTWELL LANE
OIL DOCK #3
PORT OF CORPUS CHRISTI PROPERTY
PIPELINE CORRIDOR
MEAN HIGH TIDE LINE
FLUME
BLUFF LINE
GROUNDWATER TREATMENT SYSTEM
EDCS COOLING WATER TOWERS
SANITARY WASTEWATER
HEARTH
EDCS TANK FARM
EDCS SHIPPING
EDCS CELL FLOOR
STOREROOM
OXIDE MAINTENANCE
HYDRATE
BACK GATE
CITGO DOCK #7
COFFERDAM-1

A OS-CPT-91
OS-CPT-71
OS-CPT-74
OS-CPT-73
OS-CPT-75
A'
B
B'
T-11
RW-EC-04
RW-EC-03
R-4
R-3
R-2
R-1
PZ-7
PZ-9
PZ-6
PZ-5
OW-U38
OW-U27
MW-U25
MW-U26
MW-U22
MW-U30
MW-U29
MW-U28
MW-U31
OW-L27
P-8
P-6
OW-L8
OW-U44
MW-U12
MW-U13
MW-U11
T-5

Jan 02, 2003 - 2:53pm CKelly
P:\Cad\JOBS\ElPaso\22989\003\Figures1-1thur5-4\IM\Fig2-1_Cross-SectionIM Area.dwg

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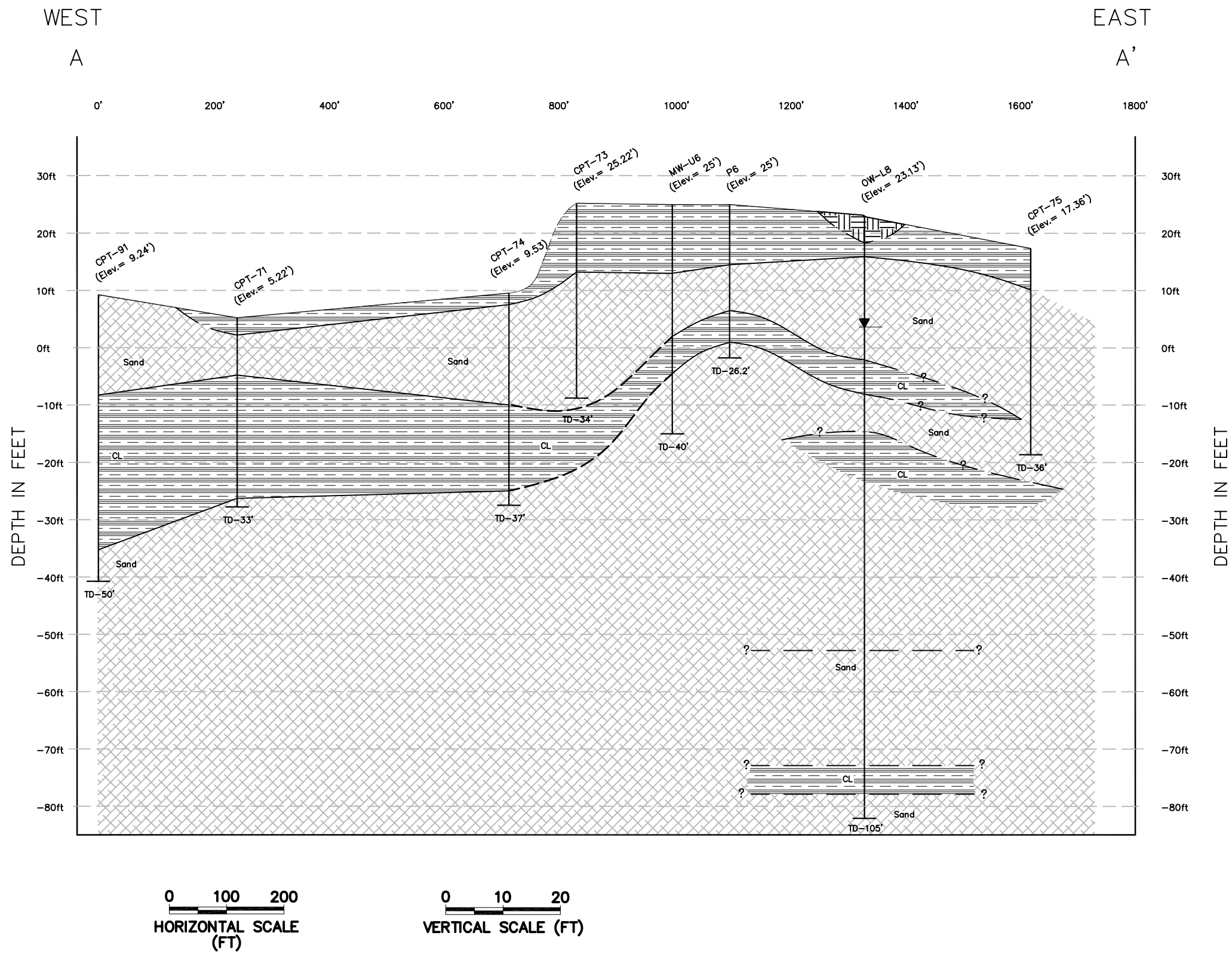
Cross-Section Location Map
IM Area
Figure 2-1



LEGEND

- Clay
- Sand
- Fill
- Approximate depth to groundwater

NOTES: 1.) Datum is Mean Sea Level
2.) Data from: American Chrome and Chemicals[23] and ENSR[22]

REVISED OCTOBER 2005

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Cross-Section A-A'
Elementis Site
Figure 2-2

CORPUS CHRISTI INNER HARBOR

0 80 160
Approximate
Scale: 1" = 160'

LEGEND

- EXISTING MONITOR WELL
- EXISTING RECOVERY WELL
- FORMER CPT LOCATION
- PRIMARY ROST LOCATION
- "STEP-OUT" LOCATION
- WELL P&A'D
- LIMIT OF IM AREA
- RAILROAD TRACKS
- Elementis Property (approximate)

SOURCE: MFG, Inc - Consulting Scientists and Engineers

OIL DOCK #3
CANTWELL LANE
OS-CPT-91
PORT OF CORPUS CHRISTI PROPERTY
OS-CPT-71
PIPELINE CORRIDOR
MEAN HIGH TIDE LINE
R-4
FLUME
T-11
OS-CPT-74
OW-U38
R-3
R-2
PZ-7
BLUFF LINE
COFFERDAM-1
MW-U27
PZ-9
MW-U25
R-1
PZ-6
MW-U32
MW-U26
PZ-5
MW-U30
MW-U29
MW-U28
MW-U31
OS-CPT-13
RW-EC-04
OW-L27
P-8
P-6
GROUNDWATER TREATMENT SYSTEM
OW-L8
EDCS COOLING WATER TOWERS
SANITARY WASTEWATER
CITGO DOCK #7
HEARTH
EDCS SHIPPING
EDCS TANK FARM
BACK GATE
OW-U44
MW-U12
MW-U13
T-5
MW-U11
OS-CPT-75
STOREROOM
OXIDE MAINTENANCE
HYDRATE
EDCS WASTEWATER TREATMENT
EDCS CELL FLOOR
BLUFF LINE

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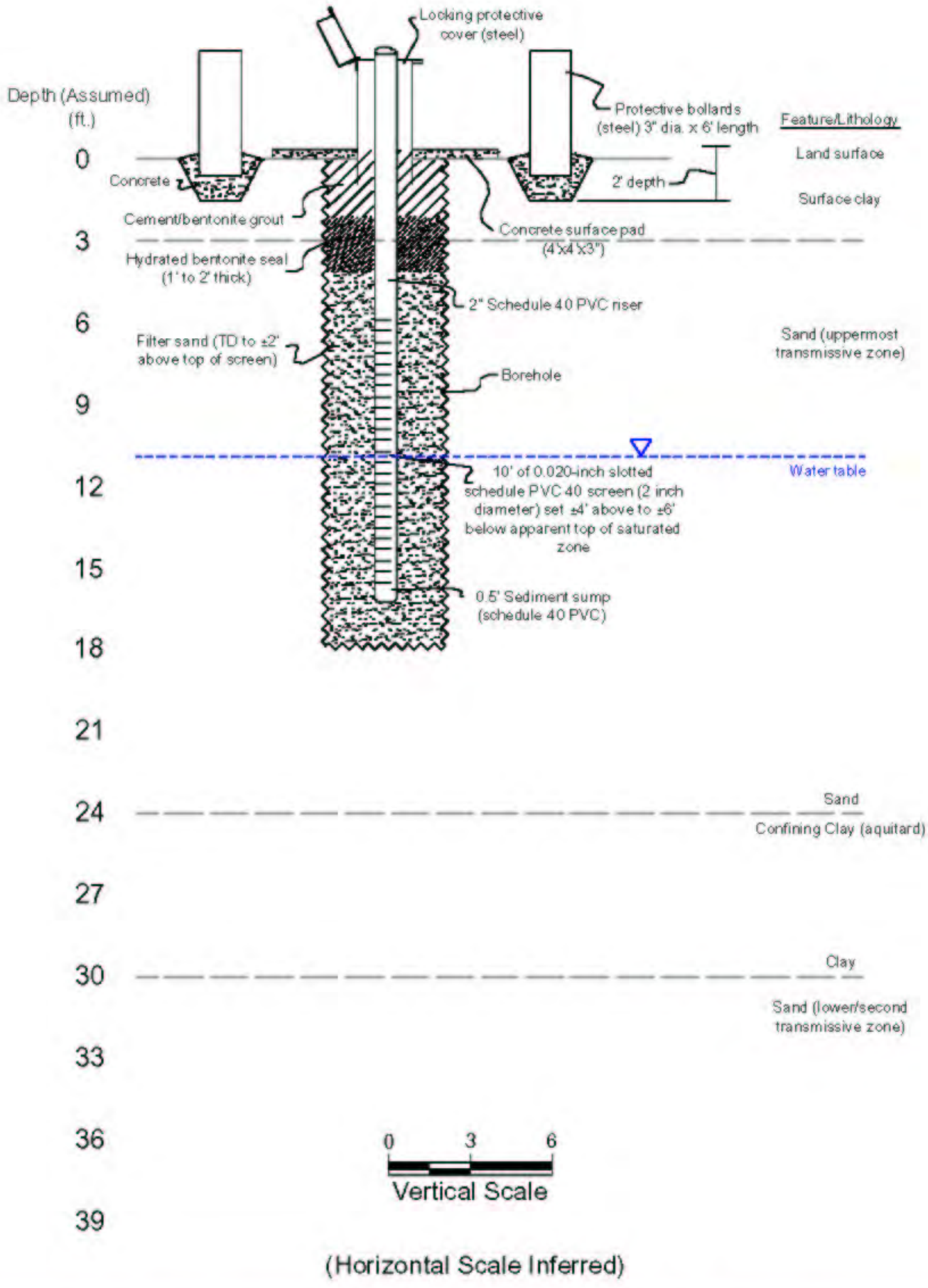
Proposed IM Area ROST Locations
IM Area
Figure 5-1

Jan 02, 2003 - 2:54pm CKelly
P:\Cad\JOBS\ElPaso\22989\003\Figures1-1thur5-4\IM\Fig5-1_IM_AreaROST_Loc.dwg

Proposed IM Area Monitor Well Construction (Typical)



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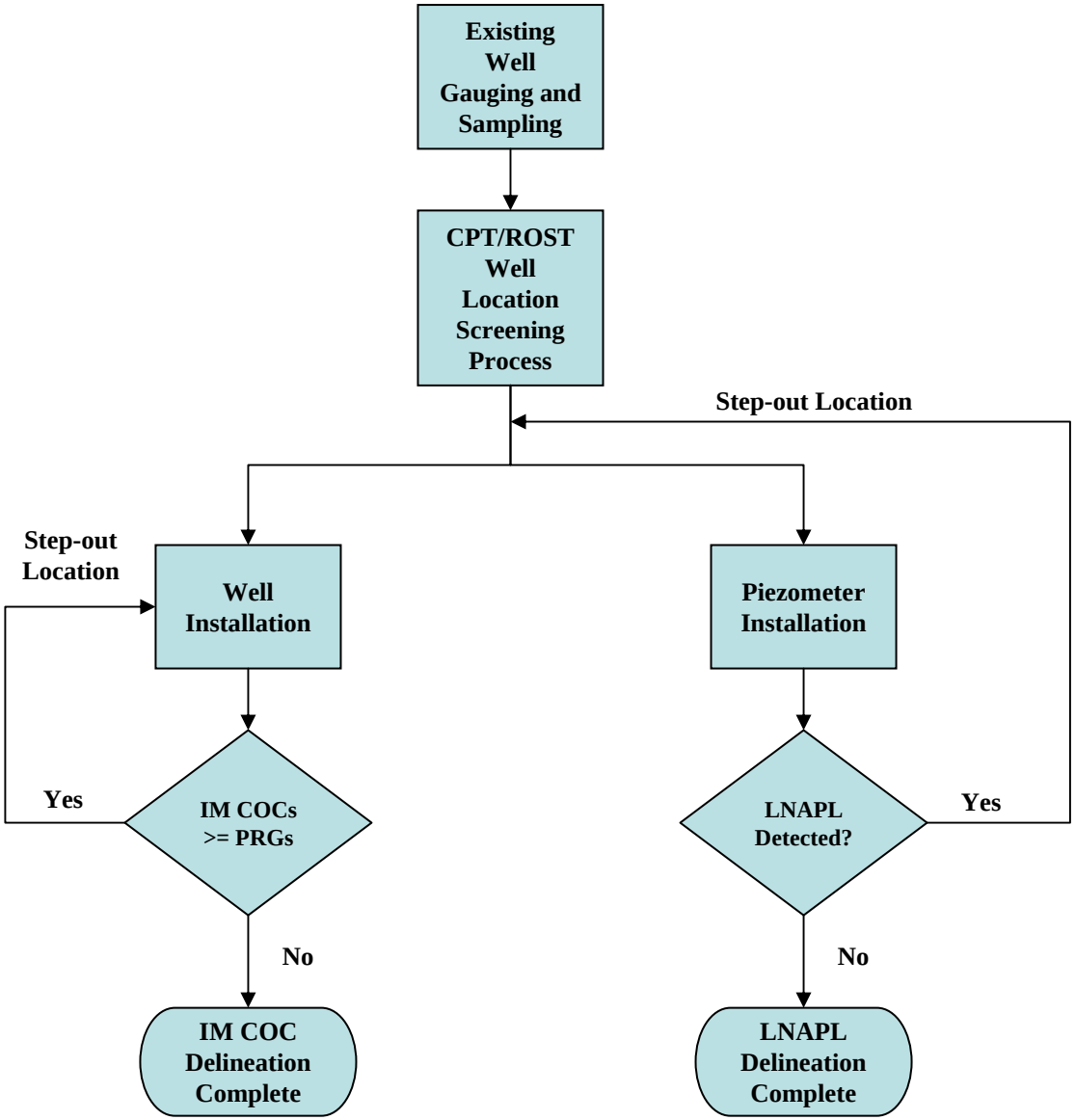
GENERALIZED HYDROGEOLOGIC DIAGRAM DEPICTING TYPICAL CONSTRUCTION OF MONITOR WELL SCREENED TO DETECT GROUNDWATER IMPACT IN UPPERMOST TRANSMISSIVE ZONE (ASSUMING UNCONFINED CONDITIONS)

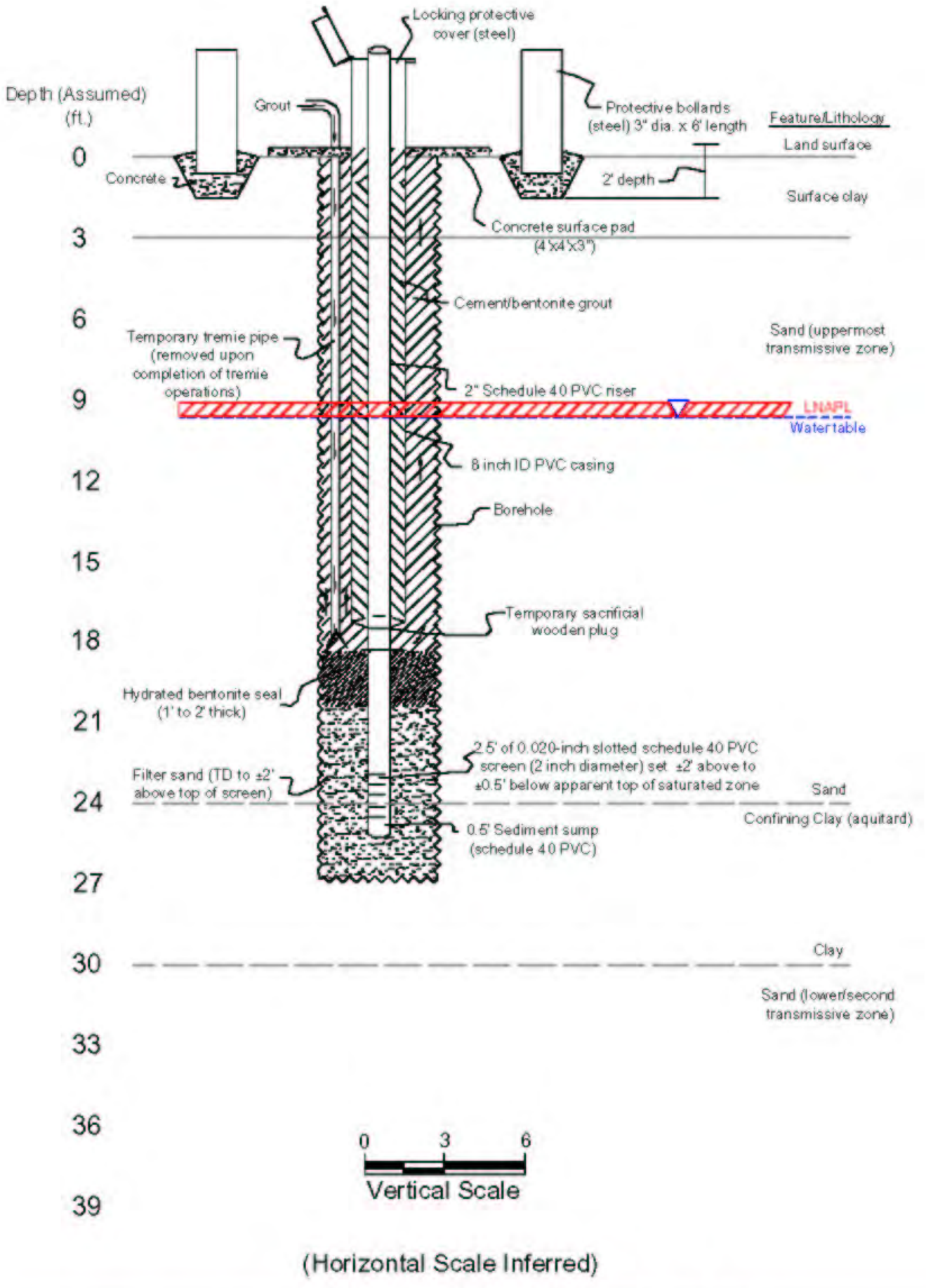
FIGURE 5-2

Jan 02, 2003 - 2:55pm CKelly
P:\Cad\JOBS\ElPaso\22989\003\Figures1-11hur5-4\IM\Fig5-2_TypicalMonWellDiagram.dwg

Figure 5-2a
Well Installation Decision Chart



Proposed IM Area Monitor Well Construction (Typical)



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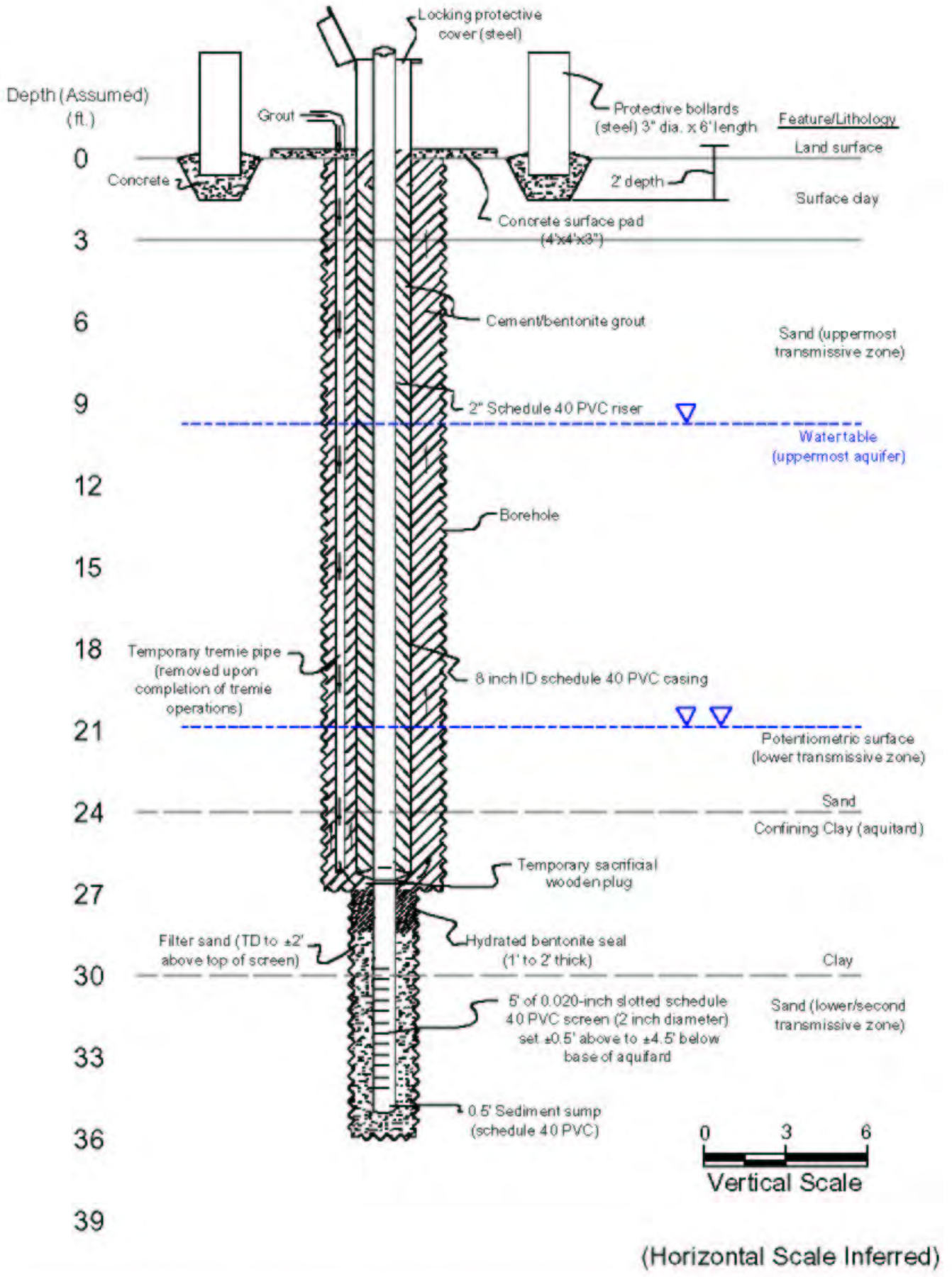
GENERALIZED HYDROGEOLOGIC DIAGRAM DEPICTING TYPICAL CONSTRUCTION OF MONTIOR WELL SCREENED TO DETECT GROUNDWATER IMPACT AT BASE OF UPPERMOST TRANSMISSIVE ZONE

FIGURE 5-3

Jan 02, 2003 - 2:55pm CKelly
P:\Cad\JOBS\ElPaso\22989\003\Figures1-1thur5-4\IM\Fig5-3_TypicalMonWellDiagram.dwg

Proposed IM Area Monitor Well Construction (Typical)



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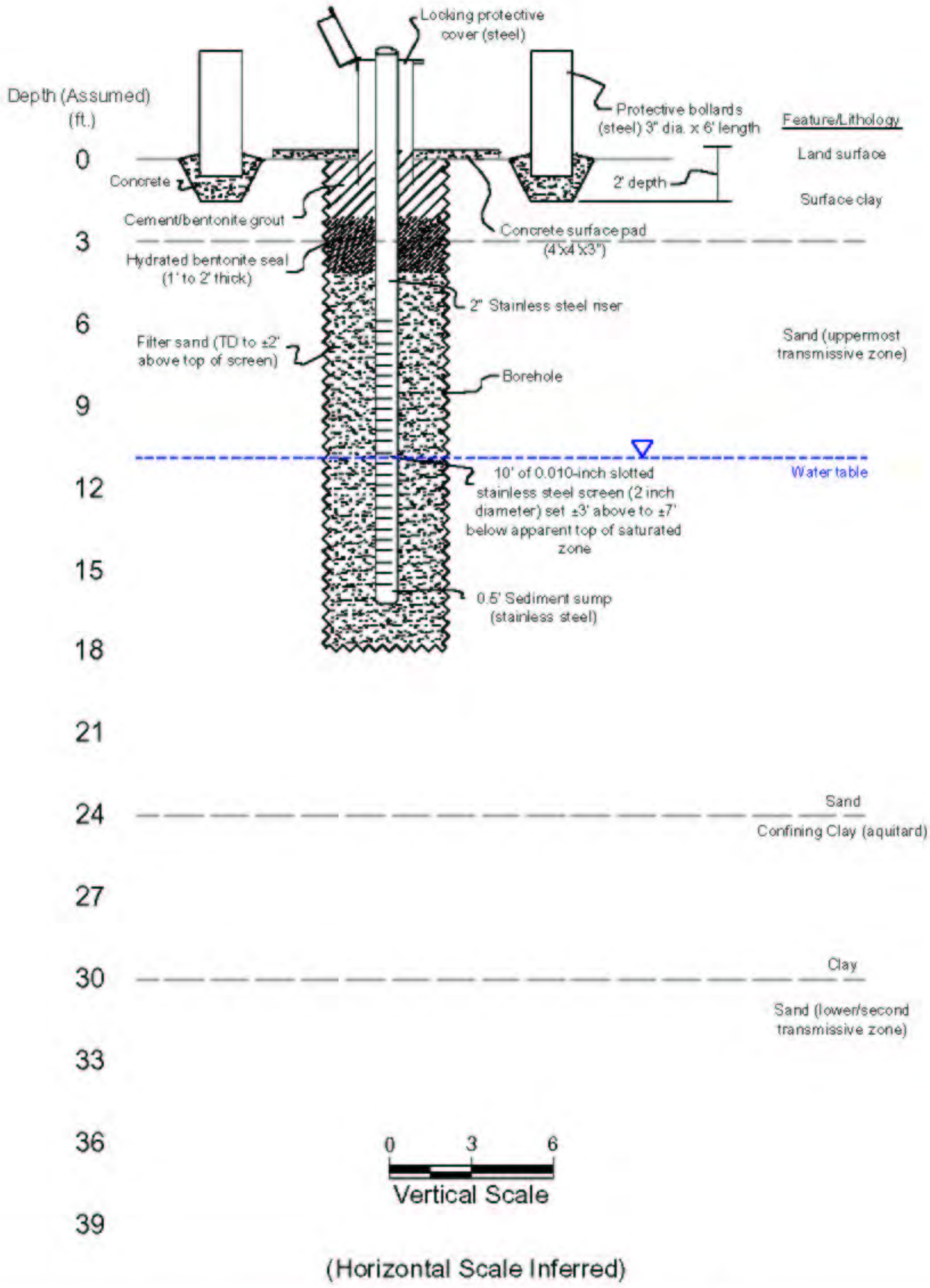
GENERALIZED HYDROGEOLOGIC DIAGRAM DEPICTING TYPICAL CONSTRUCTION OF MONITOR WELL SCREENED TO DETECT GROUNDWATER IMPACT AT TOP OF LOWER TRANSMISSIVE ZONE (ASSUMING CONFINED CONDITIONS IN LOWER ZONE)

FIGURE 5-4

Jan 02, 2003 - 2:55pm CKelly
P:\Cad\JOBS\ElPaso\22989\003\Figures1-1thur5-4\IM\Fig5-4_TypicalMonWellDiagram.dwg

Proposed IM Area Piezometer Construction (Typical)



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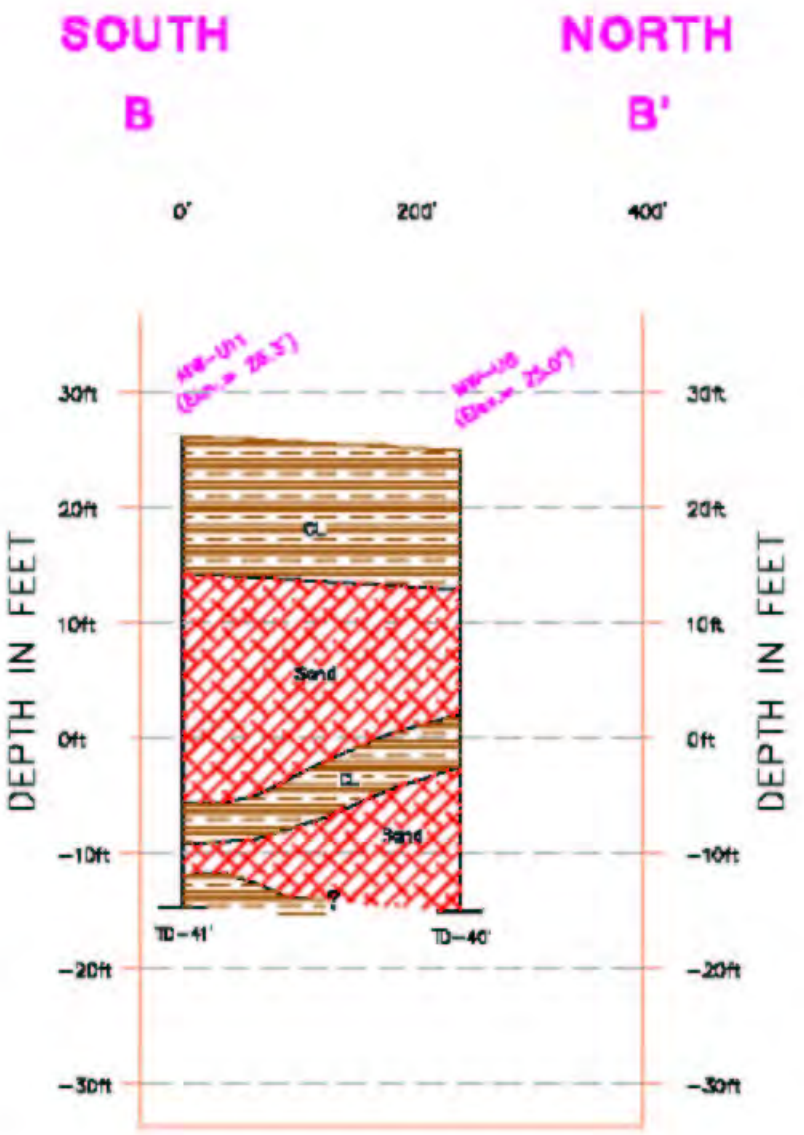
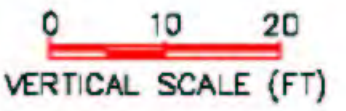
GENERALIZED HYDROGEOLOGIC DIAGRAM DEPICTING TYPICAL CONSTRUCTION OF PIEZOMETER SCREENED TO DETECT LNAPL PRESENCE IN UPPERMOST TRANSMISSIVE ZONE (ASSUMING UNCONFINED CONDITIONS)

FIGURE 5-5

Jan 02, 2003 - 2:56pm CKelly
P:\Cad\JOBS\ElPaso\22989\003\Figures1-1thur5-4\IM\Fig5-5_TypicalPiezometerDiagram.dwg





NOTES: 1.) Datum is Mean Sea Level
2.) Data from: American Chrome and Chemicals [8]

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Cross-Section B-B'
Elementis Site
Figure 2-3

Jan 02, 2003 - 2:54pm CKelly
P:\Cad\JOBS\ElPaso\22989\003\Figures1-1thur5-4\IM\Fig2-3_CrossSectionB-B'.dwg

COMPREHENSIVE QUALITY ASSURANCE PROJECT PLAN

FOR

INTERIM MEASURES AREA

OF THE ELEMENTIS FACILITY

CORPUS CHRISTI, TEXAS

Prepared For:

El Paso Corporation

Prepared By:

Brown and Caldwell
Houston, Texas

January 4, 2003

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APPENDICES

1 QA/QC Procedures and SOPs for CPT and ROST

1.0 PLAN OBJECTIVES AND ORGANIZATION

This Comprehensive Quality Assurance Project Plan (QAPP) specifies field and laboratory procedures that will be effected during the project to ensure that requirements set forth by the U.S. Environmental Protection Agency (EPA) in its Administrative Order on Consent issued to El Paso CGP Company and El Paso Merchant Energy-Petroleum Company, formerly known as Coastal Refining & Marketing (El Paso) are met. This QAPP has been prepared in accordance with the requirements and guidelines established by the U.S. EPA for data collection and program management. This QAPP is intended to meet the requirements set forth in the EPA's September 6, 2002 Administrative Order on Consent (Order) issued to El Paso Merchant Energy-Petroleum Company (El Paso), formerly Coastal (EPA, 2002; Section XIII).

1.1 Plan Description and Components

This Comprehensive QAPP consists of the following sections:

1. Plan Objectives and Organization;
2. Background;
3. Field Methods and Procedures;
4. Disposal of Residual Materials;
5. Documentation and Shipment;
6. Laboratory Methods and Procedures; and
7. References

Plan Objectives and Organization explains what the purpose of Comprehensive QAPP is, provides an overview of the Data Quality Objectives (DQO) Process, and describes the type of data, sample media, sample areas, and laboratory that the Plan covers.

The *Background* section components include site location, site description, operational history, previous investigations, regulatory involvement, and a statement of problems that are specific to that project or mine unit.

Field Methods and Procedures provides standard operating procedures (SOP) for the collection of soil and groundwater. These SOPs include a description of instruments used in the field to measure various parameters and the procedures used to calibrate the instruments, preparation of quality control (QC) samples such as blanks and duplicates, and decontamination procedures.

Disposal of Residual Materials describes the general protocol for containment, labeling, manifesting, transport, and treatment or disposal of materials used or generated during fieldwork.

Documentation and Shipment describes the procedures involved with accurate recording of field activities and sample and chain-of-custody, proper packaging of samples, and sample handling and transport

Laboratory Methods and Procedures provides the general requirements necessary to achieve proper laboratory quality assurance (QA) and QC for analysis of soil and groundwater samples. These requirements include the methods and detection limits necessary for each type of medium collected, the format that will be used to report data analysis results and QA/QC results, and the training and certification for laboratory personnel.

1.2 QAPP Components Checklist

The U.S. Environmental Protection Agency[1] lists the 24 elements of a QAPP. Table 1 is a checklist of these elements. Each of the elements listed in Table 1 are included in this QAPP, although some titles are worded differently, and the Table 1 sequence of titles is not strictly adhered to.

Table 1
QAPP Elements

Included in QAPP	Title
X	1. Title and Approval Page
X	2. Table of Contents
(1)	3. Distribution List
X	4. QAPP Organization
X	5. Problem Identification/ Background
X	6. Project/Task Description
X	7. Data Quality Objectives for Measurement Data
X	8. Training Requirements/ Certification
X	9. Documentation and Records
X	10. Sampling Process Design
X	11. Sampling Methods Requirements
(1)	12. Sample Handling and Custody Requirements
X	13. Analytical Methods Requirements
X	14. Quality Control Requirements
X	15. Instrument/Equipment Testing, Inspection, and Maintenance Requirements
X	16. Instrument Calibration and Frequency
X	17. Inspection/Acceptance Requirements for Supplies
X	18. Data Acquisition Requirements

Included in QAPP	Title
(1)	19. Data Management
X	20. Assessment and Response Actions
(1)	21. Reports
X	22. Data Review, Validation, and Verification Requirements
X	23. Validation and Verification Methods
X	24. Reconciliation with Data Quality Objectives

(1) – See associated Interim Measures (IM) Investigation Workplan

1.3 Purpose of the QAPP

The primary purpose of the Comprehensive QAPP is to ensure that implementation of the IM Investigation Workplan generates environmental data which will provide sufficient resources to support QA objectives. The intended procedures for data collection and data quality objectives (DQOs) of environmental data will be defined in the workplan prior to actual field work and collection of the data, and approved by project management. The specific QA/QC activities for a particular workplan are a function of the DQOs. Oversight of data collection activities will be performed in the field and deficiencies or problems will be corrected expeditiously.

QA is performed in three stages during data collection:

1. Preliminary Planning
Before any work is done, data needs, DQOs, and QA/QC procedures are established and agreed upon. Preliminary planning is critical in programs where standard procedures are not defined, or constituents of concern or action levels are not specified by regulations.

2. Implementation
During the actual environmental data collection process, problems can be identified and corrected. The impact of field and laboratory techniques and sampling and analysis conditions on data quality are determined using field and laboratory QC samples and periodic audits. Oversight and corrective action can prevent improper procedures from becoming routine.

3. Review
The review process utilizes data validation to ensure that the quality of the collected data is sufficient for its intended use. Through data validation the data quality is documented, assessed, and communicated to the data users.

As conditions in the field may vary, it may become necessary to implement minor modifications to DQOs or sampling protocol. Requests for such modifications will be made in writing to El Paso. A written approval will be obtained before implementing the modifications. A copy of the approved modification(s) will be attached to the workplan.

1.4 Data Quality Objectives Process

DQOs are qualitative and quantitative statements of the quality of data needed to support specific decisions or regulatory actions. DQO development consists of determining what data are needed, why they are needed, how they will be used and who will use them, evaluating alternative measurement approaches based on cost and available resources, and selecting the most cost-effective approach; and formulating data quality goals[2]. In order to ensure that data of sufficient quality and quantity are collected to meet the project objectives, a seven-step DQO process listed below[3] was established to guide development of work activities described in each individual workplan:

- Step 1. State the Problem (identify and discuss sources, potential pathways and receptors, and ecological and human health risks);
- Step 2. Identify the Decision (describes the monitoring, sampling and analytical activities that will serve to address the stated problems, assess the potential risk to human health and the environment);
- Step 3. Identify the Inputs to the Decision (identifies the kind of information that is needed to address the question posed under Step 2);
- Step 4. Define the Boundaries of the Study (defines the spatial and temporal aspects of the field monitoring, sampling and analytical activities proposed in the workplan);
- Step 5. Develop a Decision Rule;
- Step 6. Specify Limits on Decision Errors; and
- Step 7. Optimize the Design for Obtaining Data.

The choice between a probability-based (statistical) data collection design versus a nonrandom (judgmental) data collection methodology depends on the ultimate use of the data being collected. This information is specified in Steps 5 and 6 of the DQO Process.

1.5 Objectives for Use of Data

The DQOs for field sampling and analytical activities described in the IM Investigation Workplan include the collection of data appropriate to:

- "Characterize and determine the lateral extent of LNAPL floating atop groundwater to non-detect thickness in the IM Area; and
- Characterize and determine the lateral and vertical extent of contamination to decreasing concentrations of IM chemicals of concern (COCs) to below the IM preliminary remediation goals (PRGs) in groundwater at the IM Area"[4].

1.6 Action Levels and Response

The PRG Report has established PRGs for COCs in groundwater.

All field and laboratory activities are subject to review and response by EPA QA officers. El Paso and Brown and Caldwell will work with the responding authority(s) to correct any procedural problems identified during the course of, or prior to, field and laboratory activities.

1.7 Data Quality Indicators and Tolerance Limits

QA objectives provide the mechanism for ongoing control and evaluation of measurement data quality throughout the course of the program and will ultimately be used to define data quality for the various measurement parameters. The QA/QC effort will focus on controlling measurement error within the limits established and will ultimately provide a database for estimating the actual uncertainty in the measurement data. Accuracy and precision limits are experimentally determined by the laboratory on a yearly basis by the QA Coordinator. These limits are compared to existing method limits specified in Test Methods for Evaluating Solid Waste, SW-846 Third Edition[5]. Where the laboratory calculated limits exceed EPA guidelines, the laboratory will carefully review their procedures to ensure that these procedures are proper. Method adjustments can then be made, as appropriate. Method control limits will be used as acceptance criteria for this project.

Precision

Precision is a measure of the reproducibility of measurements of a particular condition or constituent. The precision of a data set is a measure of the probability that a measurement will fall within certain confidence limits. The statistical techniques encountered in field sampling are designed to measure precision, but not accuracy. When the difference between background concentration and some action level is small, it will be necessary to meet precision standards that are relatively stringent.

Precision is frequently expressed as the standard error of the mean value of a set of replicate determinations at a stated mean (or true) value. The standard error is related to the standard deviation by:

$$S_s = s \div \sqrt{n}$$

Where:
s_E = standard error
s = standard deviation
n = number of replicate determinations or values

Increasing the number of replicates at an established level of precision will generally improve the level of confidence (reduce random error) in the data. Duplicate sample values that differ by less than $^{+}/-50\%$ relative difference indicate good error control[6].

Relative percent difference (RPD) for a particular analytical method can be estimated through the analysis of duplicates and matrix spike duplicates.

The calculation for relative percent difference is calculated using one of the following methods:

$$\frac{(R_1 - R_2) \times 100}{R_{Bar}} \quad \text{or} \quad \frac{(S_1 - S_2) \times 100}{S_{Bar}}$$

where R_1 and R_2 are the original and duplicate results, R_{Bar} is the average of the two, S_1 and S_2 are the spike and duplicate spike results, and S_{Bar} is the average of the two. Historical limits for RPD are determined from pairs of either replicates or spikes. The RPDs must be greater than zero to determine upper warning and control limits. The Upper Control Limit for pairs of data can be defined as follows:

$$3.27\ R$$

where R = the average range divided by the number of sets of duplicate measurements.

The Upper Warning Limit is set at 2.51 R.

Accuracy

Accuracy is the correctness of the measurement to an actual, known value. Accuracy is somewhat difficult to assess. Spike recovery determinations, regular analysis of laboratory control standards, and use of external check samples contribute to the general assurance that the accuracy of a determination is within acceptable limits. The ultimate accuracy of a determination also depends on factors external to the laboratory, such as sampling and storage conditions. Statistical treatment of the data can provide some objective measure of accuracy. The Federal Register includes calculations for accuracy on spiked samples for several organics methods. The same calculation may be used for any test amenable to spiking:

$$P = 100(A - B)/T$$

Where:

P = Percent spike recovery;
A = Concentration determined on spiked sample;
B = Concentration determined on original unspiked sample; and
T = True value of spike added.

Bias

Bias is most often used to reflect the accuracy of the analytical method. Therefore, analytical bias only looks at one very small component of the total sample bias. Sampling bias cannot be measured because (typically) the true concentration of a constituent of concern in a sample is unknown. The tools that are used to extract a sample, the preparation of the sample, and the analysis can all introduce bias into the measurement results. Spiked samples are often used to determine if bias is present in the analysis. Procedures such as those outlined by Van Ee, et al., which attempt to identify whether bias is present in a measurement process, should be considered when designing a field sampling plan[7].

Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the anticipated amount to be obtained under correct normal conditions. It is a difficult characteristic to assess, because it depends upon such factors as representativeness of sampling and subsampling, selection of the appropriate analytical constituents, and scope of the sampling program relative to the size of the environmental question being addressed. Many of these factors are determined exterior to the laboratory and without the involvement of laboratory staff.

The laboratory's impact on completeness is restricted to the validity of the data generated for the samples delivered to the laboratory. Sample storage, holding time compliance, and the validity of data in terms of the acceptability of quality controls are the primary factors controlled by the laboratory. Overall, the laboratory accepts the responsibility that random error will occur in the operation of the laboratory. The comprehensive quality assurance plan described within this document is designed to minimize those errors and the effect that they will have on data generated by the laboratory. Analytical data goals are specified at 95 percent completeness for this program, except for analysis within holding times, which has a specified goal of 100 percent.

Comparability

Comparability is the confidence with which one data set can be compared to another. Comparability of data is ensured through the use of standard analytical methods or methods with demonstrable equivalency in terms of method performance criteria and equivalent reported units.

Quality Control Samples

Quality control samples are used to validate the sampling, transportation and laboratory conditions associated with the samples. The IM Workplan details the number of blind duplicates to be submitted. Laboratory QC Samples, as discussed in Section 6.10, apply after the samples are delivered to the laboratory. These include laboratory control standards (LCSs), LCS duplicates, method and calibration blanks, duplicates, matrix spikes and matrix spike duplicates.

1.8 Sampling Plan for Data Quality Objectives

Conceptual Model of the Site

A conceptual model of how the constituents of concern are distributed over the site and how they might impact the environment or the public can be a useful tool for designing a sampling plan. Data for the model may be accumulated through a search of existing information. These data can then be used to test the model, providing an assessment of the hazards created by the presence of constituents in the particular medium. If the model does not fit the data, then it can be modified to better reflect the conditions as they are discovered through sampling of the medium. The model should only be considered as a tool for aid in sampling designs and for reducing the sampling errors.

Determining the Number of Samples

Determination of the number of samples to collect is based upon the coefficient of variation of the sample population. In some cases the number of samples required by this method may not be acceptable because of cost factors or by the inability of the laboratory to process a large number of analyses.

The number of samples required to achieve the precision and accuracy specified in the DQOs can be estimated by the use of one of the following equations:

For a one-sided, one sample t-test:

$$n \geq [(Z_a + Z_b)/D]^2 + 0.5\ {}^2Z_a$$

For a one-sided, two sample t-test[12].

$$n > 2\ [(Z_a + Z_b)/D]^2 + 0.25 Z_a^2$$

where:
n= number of samples;
Za= the percentile of the standard normal distribution such that P (Z >or= Za) = infinity;
Zb = the percentile of the standard normal distribution such that P (Z >or= Zb) = infinity;
a= probability of a Type I error;
b= probability of a Type II error;
D = minimum relative detectable difference/CV; and
CV = coefficient of variation.

For a two-tailed test, the terms for a and b would be divided by two.

Random Sampling

The concept of random or probabilistic sample collection forms the basis for many sampling plans. In random sampling of a site, each sample point within the site must have an equal probability of being selected. Properly designed sampling plans based

upon the laws of probability provide information for making sound decisions that are not likely to be biased. Random sampling may be preferred over so-called "grab samples" or judgmental sampling that is often used to do a quick evaluation of a site, especially if statistical validity is involved, such as in legal cases.

1.9 Data Review and Validation

Data validation is the assessment of the quality of data. It is performed by evaluating the field and analytical QC results and the completeness of the QC documentation, for the purpose of determining whether the data are acceptable for the intended uses.

Professionals trained in data validation procedures will review information, "flag" data with qualifiers when QA/QC criteria are not met, and prepare the data validation report. The validation reports are then used as sources of data quality indicators, which are used to conduct a data quality assessment relative to pre-established DQOs[8].

Laboratory data packages submitted for data validation will consist of five sections:

- Case narrative;
- Chain-of-custody documentation;
- Summary of results for environmental samples (including quantitation limits);
- Summary of QA/QC results; and
- Raw data.

EPA[8] provides descriptions of each of these sections, along with other documentation requirements for laboratory data packages. Laboratory QA/QC is discussed in Section 6.0 (Laboratory Methods and Procedures).

1.10 Laboratory

Severn-Trent Laboratory (STL) will perform analysis of samples for the IM Investigation. Section 6.4 of the IM Investigation Workplan lists pertinent information for STL, including address, phone and fax number, e-mail address, and personal contact.

2.0 BACKGROUND

The IM Investigation Workplan provides information on the site, where the samples will be collected, and the regulatory agencies that will be involved with data requirements and data QA. Background information will be used as inputs in the DQO process Step 3, Inputs to the Decision. Information presented in the IM Investigation Workplan may include, but is not limited to, the following:

- Location;
- Site Description;
- Operational History;
- Previous Investigations;
- Regulatory Involvement; and
- Statement of Specific Problems.

2.1 Location

The location of the site must be described as accurately and comprehensively as possible, including, but not limited to, one or more of the following means:

- Relation to readily identifiable landmarks (e.g., towns, mountain peaks, rivers, roads and highways);
- Township, range, section, and quarter sections;
- Longitude and latitude coordinates;
- Location on a map (e.g., topographical map or atlas); or
- Legal description (where practicable).

2.2 Site Description

The area should be described as accurately as possible, including, but not limited to, the following types of information, as applicable:

- Topography (e.g., land slope gradient and direction, terrain features);
- Vegetation (e.g., sagebrush, grasses, trees);
- Structures (e.g., buildings, fences, towers);
- Landmarks (e.g., survey markers, USGS markers);

- Climate (e.g., annual rainfall, seasonal average temperatures);
- Hydrologic (e.g., wetlands, lakes, rivers, runoff, groundwater); and
- Geologic (e.g., lithology, shallow subsurface soil types).

2.3 Operational History

The workplan should describe the location where the work will occur, the operations associated with the location, and, if possible, the period of time over which operations occurred. Descriptions of past or present operations should emphasize those operations that are or were associated with specific areas where data collection will occur, or that have the potential to influence data that will be collected. Descriptions of past operations should also be reviewed for information that would be useful in developing health and safety plans. Examples of land use and operational history include:

- Manufacturing processes (what was produced and how it was produced);
- Service operations (e.g., repair facilities, utility shops);
- Storage (e.g., hazardous waste, non-hazardous waste, processing solutions); and
- Handling and Transport (how specific materials were packaged and transported into or out of the site).

2.4 Previous Investigations

The workplan should provide descriptions and summarized results and data from previous investigations. Results from previous investigations should also be reviewed for information that could be useful in developing health and safety plans. Types of investigations and summarized results and data from those investigations may include, but are not limited to:

- Subsurface investigations (e.g., subsurface lithology logs, groundwater and soil field data, laboratory analysis results for soil and groundwater);
- Surface investigations (e.g., surface water field data, laboratory analysis results for surface water and sediments);
- Air sampling (e.g., long-term particulate/fugitive dust sampling analysis results, short-term personal air monitoring results, indoor air sampling results); and
- Ecological investigations (e.g., vegetative studies, wildlife habitat studies, threatened/endangered species studies).

2.5 Regulatory Involvement

The workplan should describe governmental agencies that will be involved with establishing standards or guidelines for data collection and analysis, including methods, detection limits, action levels or regulatory thresholds, and QA/QC protocol. These agencies may include, but are not limited to:

- EPA;
- TCEQ; and
- Texas Department of Water Resources.

2.6 Statement of Specific Problems

This section of the workplan should provide an idea of how certain conditions at the site came to someone's attention. Discuss how the conditions became apparent, such as citizen's complaints, public agency inspections during which apparent problems were observed, or conditions that were observed by facility personnel. The statement of specific problems should list the conditions and discuss how each condition came to exist. These discussions will form part of the basis for establishing DQOs.

3.0 FIELD METHODS AND PROCEDURES

Quality assurance of environmental data begins in the field at time of sample collection. Experienced field personnel, appropriate sampling equipment, rigorous sampling procedures, and quality control checks are essential to quality data production. The following subsections address procedures that will be used to collect soil and groundwater data for the IM Area investigation. Appendix 1 describes QA/QC procedures and SOPs for cone penetrometer testing (CPT) and Rapid Optical Screening Technology (ROST) that will be used during the screening activities that are described in Section 5.1 of the IM Investigation Workplan[9]. ROST was demonstrated to be an effective in situ field screening method for characterizing the subsurface distribution of hydrocarbons in a variety of soil textures in unsaturated and saturated zones[10].

3.1 Temporary and Permanent Monitor Well and Piezometer Construction and Surveying

Permanent monitor well boreholes will be drilled using a drilling technique that allows for lithologic logging of borehole samples to assist in the assessment of site hydrostratigraphy. Permanent monitor wells will be constructed to allow for the collection of groundwater elevation measurements and water quality samples at locations where light, non-aqueous phase liquid (LNAPL) is not currently present. Groundwater elevation measurements will also be collected from piezometers. Temporary wells (see Section 5.1 of the IM Investigation Workplan) will be used for collection of screening level groundwater samples.

Permanent monitor wells will be constructed of two-inch diameter, Schedule 40 PVC flush-coupled well casing and slotted screens. Piezometers will be constructed of two-inch diameter, stainless steel flush-coupled well casing and slotted screens. Screened intervals of permanent monitor wells and piezometers (of lengths specified in the IM Investigation Workplan) will be installed within a filter pack consisting of silica sand, overlain by a hydrated bentonite seal. The remaining annulus of permanent monitor wells and piezometers will be backfilled with cement-bentonite grout to the natural ground surface. Permanent monitor wells and piezometers will be completed with a nominal 2-foot casing above the ground surface. Completed permanent monitor wells and piezometers will be cemented in-place and locking caps installed at the top of the well or piezometer casings.

Temporary wells will be installed using direct-push soil probe technology. Temporary PVC wells will be constructed using 1-inch diameter 0.010-inch slotted PVC screen, which will be of sufficient length to straddle the apparent top of the saturated zone within the uppermost transmissive unit, and sufficient riser pipe to extend the well to the ground surface.

PVC used in construction of permanent monitor wells and stainless steel used in construction of piezometers will remain factory-sealed until ready for usage. PVC used in construction of temporary wells will remain factory-sealed until ready for usage or will be decontaminated between usages in accordance with the procedures specified in Section 5.3.9 of the IM Investigation Workplan. Brown and Caldwell field personnel shall inspect well construction materials (i.e., stainless steel PVC, filter sand, bentonite, cement) to ensure that they meet project requirements and are factory-sealed and not contaminated prior to usage.

Measurement of horizontal coordinates and top-of-casing elevations for existing and new monitor wells will be conducted by a Texas registered professional land surveyor to an accuracy of at least 0.1 foot horizontally and 0.01 foot vertically. This degree of accuracy is sufficient for water level measurements to be used in the calculation of groundwater direction and hydraulic gradient. For the purpose of field measurement, the top of the well casing elevation shall be measured from the north rim of the casing.

3.2 Groundwater Sampling

3.2.1 Equipment and Calibration

Equipment and instruments used for groundwater sampling and field monitoring include, but are not limited to:

- Temperature/pH/conductivity (probe/meter);
- Dissolved oxygen (probe/meter);
- Groundwater level indicator or oil/water interface probe (probe/audible indicator);
- Purging devices (e.g., pumps or bailers); and
- Sampling devices (e.g., pumps or disposable bailers).

3.2.2 Field Parameter Measurements

Field measurements of groundwater at monitor wells may include static groundwater elevation, dissolved oxygen, pH, specific conductivity, and temperature. Field parameter measurements will be recorded to the accuracy allowed by the measurement method and equipment, with particular attention being given to proper calibration of instruments.

Prior to use, the pH, dissolved oxygen, temperature, and electrical conductivity probe(s) shall be calibrated and the conductivity probe shall be checked with a standard. Proper operation of the groundwater elevation probe shall be checked prior to use by immersing the probe in water to ensure the audible signal is produced. The methods and minimum

detection limits of the pH, dissolved oxygen, temperature, and electrical conductivity devices are shown below:

TABLE 3-1		
GROUNDWATER FIELD PARAMETERS		
Parameter	**Method**	**Detection Limit**
Conductivity	EPA 120.1, meter	1.0 µS/cm
Dissolved Oxygen	EPA 360.1, probe	0.1 mg/l
pH	EPA 150.1, meter	0.1 standard units
Temperature	Standard Methods 212, Thermometer	0.1 °C

Groundwater elevations will be measured in 1 day, if possible, to limit error in calculating hydraulic gradient or flow direction due to potential diurnal fluctuations in groundwater elevation, and will be recorded in a bound field notebook. Measurement of field parameters in monitor wells shall occur in order of least contaminated to greatest contaminated, as determined by the previous quarter's laboratory analytical results. Equipment used to measure depth-to-water and other physical parameters in each well will be decontaminated between wells by washing in an Alconox-type detergent solution with subsequent clean-water rinse.

3.2.3 Sample Collection

The hydrogeologic conditions where groundwater samples will be collected should be assessed for the potential impacts that site conditions may have on the development of the sampling and monitoring program and the quality of the resulting data. Consideration must be given to the types and distribution of geologic materials, the occurrence and movement of groundwater through those materials, the location of the site in the regional groundwater flow system, and the relative permeability of the materials, as well as to potential interactions between contaminants and the geochemical and biological constituents of the formation(s) of interest[6].

Monitor Wells

Field measurements shall be collected in monitor wells prior to groundwater sample collection. Monitor wells will be purged using either a submersible pump or clean, disposable Teflon bailer, depending on depth-to-water, total depth of the well, and well diameter. The equipment and purging method used for monitor wells will be noted on each field data sheet.

During purging, pH, oxidation-reduction potential, dissolved oxygen, and specific conductivity will be monitored with calibrated, portable field instruments to determine stabilization of these parameters between each purged well casing volume. Three consecutive measurements displaying stable values of pH and conductivity will be recorded prior to sampling. Stabilization is defined as variation of less than 0.1 pH units, less than 10 millivolts for oxidation-reduction potential, less than 3 percent difference for conductivity, and less than 10% for dissolved oxygen, as measured in 0.5-liter intervals.

If stabilization does not occur, then a minimum of three casing volumes will be purged from each well. If a well is purged dry, no sample will be collected until it has recharged to within 80 percent of its original depth-to-water, or no more than 24 hours.

After stabilization, a groundwater sample will be collected using a disposable Teflon bailer or discharge from a submersible pump. If samples are to be analyzed for volatile organic compounds, a pump flow rate of less than 100 milliliters per minute is recommended to minimize volatilization[11]. Vials for volatile organic compound analysis will be filled first to minimize aeration of water in the well. The sample will be decanted into an appropriate sample container depending on the required analysis.

Immediately following collection, samples shall be placed into an insulated cooler chilled with ice to an approximate temperature of 4°C. The samples will then be transported to the analytical laboratory via overnight mail or personal delivery.

3.2.4 Sample Identification and Preservation

Sample Identification

Sample labels shall be completed with a permanent waterproof marker and attached to each laboratory sample container upon sample collection, and shall include the following information:

- Sample identification;
- Sample date;
- Sample time;
- Sample preparation and preservative; and
- Analyses to be performed.

Each sample will be tracked according to a unique sample field identification number assigned when the sample is collected. The site-specific nomenclature is detailed in the IM Investigation Workplan. Duplicate samples shall be labeled in the same fashion as regular samples, with no indication of their contents. Documentation of the identity of duplicate samples will be maintained in the field notebook.

Sample Preservation

The following sample preservation methods will be followed for collected groundwater samples:

- Volatile organic compounds: A test vial will be prepared at the laboratory by adding a measured volume of hydrochloric acid (HCl) to a typical sample container of groundwater to determine the amount of acid needed to lower the pH to less than 2. The appropriate amount of HCI will then be added to the sample vials at the laboratory. The vials will be filled in the field, capped, then inverted and checked for air bubbles to ensure zero headspace. If a 1/8-inch or larger air bubble appears, the vial contents will be emptied into the measured container, the vial discarded, and a new sample will be collected. Under certain groundwater geochemical conditions, groundwater will react with various acid preservatives to produce off-gas. Preservation of sample aliquots designated for VOCs analysis should not be performed under these circumstances. Cool the sample to 4°C with ice immediately after sample collection.

- Semivolatile organic compounds. No chemical preservatives are required. The sample containers will be filled in the field, capped, and labeled. Cool the sample to 4°C with ice immediately after sample collection.

- Cyanide. A test container will be prepared at the laboratory by adding a measured volume of ascorbic acid to a typical sample container of groundwater to determine the necessary amount of acid. An appropriate amount of ascorbic acid will then be added to the sample containers at the laboratory. The sample containers will be filled in the field, capped, and labeled. Under certain groundwater geochemical conditions, groundwater will react with various acid preservatives to produce off-gas. Preservation of sample aliquots designated for cyanide analysis should not be performed under these circumstances. Cool the sample to 4°C with ice immediately after sample collection.

- Hydrogen sulfide. A test container will be prepared at the laboratory by adding measured volumes of zinc acetate and sodium hydroxide to a typical sample container of groundwater to determine the necessary amounts of these chemicals. Appropriate amounts of zinc acetate and sodium hydroxide will then be added to the sample containers at the laboratory. The sample containers will be filled in the field, capped, and labeled. Cool the sample to 4°C with ice immediately after sample collection.

Table 3-2[5] outlines the proper amounts and containers for soil and groundwater samples for applicable analyses.

TABLE 3-2 SAMPLE COLLECTION AND STORAGE PARAMETERS					
Parameter	**Amount for Analysis**	**Container**	**Maximum Hold Time**	**Storage Conditions**	**Preservatives**
GROUNDWATER					
Volatile Organic Compounds	(3) 40-mL glass vials	40-mL glass vial	14 days	4°C	HCl to pH<2
Semi-volatile Organic Compounds	(2) 1-liter amber glass	1-liter amber glass	7 days (extraction) ;28 days (analysis)	4°C	None
Cyanide (total)	1-liter	glass or polyetheylene	14 days	4°C	Ascorbic acid
Hydrogen Sulfide	1-liter	glass or polyetheylene	7 days	4°C	Zinc acetate and sodium hydroxide

3.2.5 Decontamination

Buckets used for decontamination of groundwater sampling equipment should be placed on plastic sheeting to prevent spillage to the ground, and to help keep the decontamination area and equipment as clean as possible. The buckets should be filled half to three-quarters full as follows:

Bucket 1: Tap water with non-phosphate detergent such as Alconox-Nox;
Bucket 2: Clean tap water or de-ionized water; and
Bucket 3: Clean tap water or de-ionized water.

After the decontamination area is set up, equipment decontamination of groundwater sampling equipment is comprised of four general steps:

1. *Removal of gross (visible) contamination.* Gross (visible) contamination can be removed by dry-brushing or scraping, with water rinse.

2. *Removal of residual contamination.* Sampling equipment must be cleaned prior to any sampling effort, after each sample is collected, and after the sampling effort is accomplished. Removal of residual contamination consists of the following steps:

a. Place the item in the first bucket (detergent wash) and scrub the entire surface area of each piece of equipment to be decontaminated. Utilize scrub brushes to remove all visible contamination. Change the water periodically to minimize the amount of residue carried over into the second rinse.

b. Place the item in the second bucket (clear water rinse – tap or deionized water) and rinse. Change the water periodically to minimize the amount of residue carried over into the third rinse.

c. Place the item in the third bucket (deionized or distilled water) and repeat the rinsing procedure. Change water as necessary.

d. Place the item on a clean surface such as plastic sheeting to await reuse or packaging for storage (e.g., wrapping foil).

Decontamination of purging equipment is performed between each well by submerging and scrubbing the outside of the pump and associated hosing in an Alconox-type detergent bath, then twice rinsing the outside of the pump in deionized water. At least 5 gallons of detergent solution and then 5 gallons of deionized water are run through the internal portion of the pump to reduce the potential of cross contamination between wells.

3. *Prevention of recontamination.*
After the decontamination process, equipment should be stored to preserve its clean state to the extent practical. The method will vary by the nature of the equipment. Protection measures include covering or wrapping in plastic or sealable plastic bags, or wrapping with oil-free aluminum foil.

4. *Disposal of wastes associated with the decontamination.*
Washing and rinsing solutions are considered IDW and should be containerized. After use, gloves and other disposable PPE should also be containerized and handled as IDW.

Purged groundwater and decontamination water will be collected in DOT-approved 55-gallon drums and properly disposed of or recycled.

3.3 Training and Certification - Field Methods and Procedures

Appropriate education and training are integral to any sampling or monitoring program that seeks to obtain reliable data. Personnel assigned to field sampling or monitoring activities are expected to have met the educational, work experience, and training requirements for the particular type of sampling or monitoring. Records on personnel qualifications and training should be maintained and should be accessible for review.

The following describes health and safety training that is required.

Health and Safety Training
Contractor and subcontractor personnel working on any El Paso (Coastal) field site or facility must have successfully completed training appropriate for the working conditions. This includes hazardous waste site operations in accordance with the Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response (HAZWOPER) requirements specified in 29 CFR 1910.120(e) and review of the El Paso Energy Corporation Safety & Health Handbook. In addition,

personnel must be familiar with the requirements of the site-specific health and safety plan (HASP) and participate in site activity and safety briefings.

Field Managers, H&S Coordinators, or a fully qualified designee will conduct site-specific training for the field personnel. The training, at a minimum, is to include a review of the HASP, the El Paso Energy Corporation Safety & Health Handbook, individual task descriptions and responsibilities, task hazards, and other H&S-related issues, hazards, and requirements unique to the site. In addition, field personnel complete the appropriate checklists and forms included in the HASP. Site training will be documented, and the documentation will be maintained in the HASP.

4.0 DISPOSAL OF RESIDUAL MATERIALS

This section describes how investigation-derived residual materials will be disposed. Most of the descriptions and protocol listed in this section are from the EPA's Region IX Field Operations Branch Annotated Field Sample Plan[11]. Depending upon site-specific conditions and applicable federal, state, and local regulations; other provisions for residual materials disposal may be required. If analyses of residual materials are required, plans for such analyses should be made prior to field investigation activities. If residual materials are to be drummed, labeling for the drums should be discussed beforehand to ensure appropriate disposal of drummed materials (see Section 5.3.9 of the IM Area Workplan).

Residual materials may include, but are not limited to, the following:

- Used PPE;
- Disposable sampling equipment;
- Decontamination fluids;
- Soil cuttings from soil borings; and
- Purged groundwater and excess groundwater collected for sample container filling.

The EPA's National Contingency Plan (NCP) requires that management of IDW (residual materials) generated during site investigations comply with all applicable or relevant and appropriate requirements (ARARs) to the extent practicable. Sampling plans will follow the Office of Emergency and Remedial Response (OERR) Directive 9345.3-02 (May 1991), which provides the guidance for the management of residual materials during investigations. In addition, other legal and practical considerations that may affect the handling of IDW will be considered.

5.0 FIELD DOCUMENTATION AND SAMPLE HANDLING PROCEDURES

Samples will be handled in accordance with the general procedures established in the IM Area Workplan. The procedures for sample labels, chain-of-custody, transfer of custody and shipment, and laboratory custody procedures are presented in this section and in the project Workplan. The purpose of these procedures is to maintain the integrity (i.e., quality) of all samples during collection, transportation, analysis and reporting. Procedures stated herein are necessary to validate the history of sample data from collection through reporting by providing adequate documentation.

Proper sampling procedures for sampling must include the use of strict sample custody procedures to prevent loss of sample integrity, as well as appropriate equipment, containers and preservation. The sampler will provide the laboratory with a unique sample description, time and date of sample collection, and statement of analytical requirements. This procedure is designed to insure sample integrity and that analyses are performed within the method-specified holding time.

5.1 Field Logbooks

Field measurement and sampling activities will be recorded in a bound site logbook. Entries must contain accurate and inclusive documentation of project activities. Field logbooks will document where, when, how, and from whom any vital project information was obtained. Logbook entries will be complete and accurate enough to permit reconstruction of field activities. Logbooks will have all pages permanently bound with consecutively numbered pages. Each page will be dated and the time of entry noted in military time. Entries will be legible, written in waterproof ink, and signed by the individual making the entries. Erasing is not permitted; errors shall be single-lined out and initialed and dated. Language will be factual, objective, and free of personal opinions or other terminology that might prove inappropriate. At a minimum, the following information will be recorded when the applicable procedure is being conducted:

- Sample location and description;
- Site sketch showing sample location and measured distances;
- References to photograph locations and numbers (if applicable);
- Samplers' name(s);
- Date and time of sample collection;
- Sample matrix;
- Type of sampling equipment used;

- Calibration of equipment described;
- Onsite measurement data (e.g., PID, temperature, pH, conductivity, etc.);
- Field observations and details important to analysis or integrity of samples (e.g., heavy rains, atmospheric odors, etc.); and
- Shipping arrangements (overnight air bill number).

A QA/QC record will be maintained in the field notebook. Sample numbers for all rinsate samples, reference samples, blanks, QC samples, and duplicates shall be noted in the notebook.

5.2 Bottles and Preservatives

Sample containers will be supplied by the laboratory and will be pre-cleaned for one-time use. Sample containers will not be rinsed prior to sample collection. Preservatives, if required, will be added to the containers at the laboratory prior to shipment to the field. Preservatives will be checked in the field as well as upon receipt at the laboratory. Any deviations will be noted on the chain-of-custody form when received at the laboratory.

All samples will be packed with natural ice. Coolers must be received at the laboratory at 4° C +/- 2° C.

5.3 Chain-of-Custody

Chain-of-custody records are used to document sample collection and shipment to laboratory for analysis. A chain-of-custody record will accompany all sample shipments for laboratory analyses. Forms will be completed and sent with the samples for each laboratory shipment. If multiple insulated sample chests are sent to a single laboratory on a single day, then a form specific to the contents of each chest will be completed and sent to the laboratory. The chain-of-custody record will identify the contents of each shipment and maintain the custodial integrity of the samples.

To maintain a record of sample collection, transfer between personnel, shipment, and receipt by the laboratory, a chain-of-custody record is filled out for each sample type at each sampling location. Each time that a sample is transferred to another custodian, signatures of the person relinquishing the sample and receiving the sample, as well as the time and date, will document the transfer. Also noted on the chain-of-custody form are the requested analyses to be performed by the laboratory. The original record accompanies the shipment, with any additional information required by the client. Copies of all chain-of-custody forms will be included with the final report deliverable.

5.4 Labeling, Packaging, and Shipment

Samples will be labeled in a clear and precise way for proper identification in the field and for tracking in the laboratory, in accordance with the corresponding section on sample identification. Sample containers will be placed in a solid, durable shipping container. Insulated ice chests will be used for laboratory samples that must be kept cold. The sample packaging guidelines presented in Section 6.3 of the IM Area Workplan will be followed.

Each shipping label (e.g., Federal Express, UPS) shall be completed in full and a copy of the shipping label will be kept on record for the purpose of tracking. Shipping labels will be securely attached to the sample container. Samples sent to an out-of-town laboratory shall be sent to the laboratory by overnight delivery.

When transferring samples, the individual(s) relinquishing and receiving will sign, date, and note the time on the record. This record documents sample custody transfer. Copies of the chain-of-custody forms will be placed in the appropriate shipping container and will accompany the sample(s). Shipping containers will be sealed with custody seals for shipment to the laboratory via common carrier. The method of shipment, courier name, and other pertinent information (e.g., air bill number) may be entered in the "Remarks" section of the chain-of-custody form.

5.5 Laboratory Custody Procedures

Upon receipt by the laboratory, the sample custodian will prepare a sample condition log-in sheet. This sheet is used to record the condition of samples upon receipt and to note discrepancies such as temperature, custody seal breakage, missing, or broken containers. The sample custodian will examine the shipment, noting whether the custody seals (if applicable) are still intact. The sample temperature will be documented on the log-in sheet and on the chain-of-custody form. The chain-of-custody form will be signed and dated. The contents of the ice chests will be compared to the chain-of-custody record. Any discrepancies will be noted on the log-in sheet and the laboratory shall be instructed to immediately notify the Project Manager of any problems.

A laboratory tracking number will be assigned to each shipment. This number will be recorded in a bound, paginated notebook. A unique laboratory number will be assigned to each sample and transferred to the proper analyst or stored in an appropriate secured area. Laboratory personnel will be responsible for the care and custody of samples from the time they are received until the sample is exhausted or returned to the sample custodian.

6.0 LABORATORY METHODS AND PROCEDURES

Performance criteria, DQOs, and regulatory criteria will influence the choice of analytical methods. Once the decision has been made on methods and detection limits to be employed and analyses are underway, the laboratory monitors the precision and accuracy of the results of their analytical procedures through analysis of QC samples. Internal laboratory QC consists of matrix spike analyses, blanks, and matrix spike duplicate analyses. Field QC consists of rinsate blanks, field and trip blanks, and duplicate samples. The laboratory will analyze both internal and field QC preparations.

Laboratory methods and detection limits for analyses of soil and groundwater samples are listed in the IM Area Workplan.

6.1 Data Package and Reporting Format

The general reporting format for laboratory data packages submitted for data validation will consist of five sections:

- Case narrative;
- Chain-of-custody documentation;
- Summary of results for environmental samples (including quantitation limits);
- Summary of QA/QC results; and
- Raw data.

The EPA Laboratory Documentation Requirements For Data Validation Draft[8] provides descriptions of each of these sections, along with other documentation requirements for laboratory data packages. In addition, the laboratory should make available for inclusion in their data package, if requested, analytical methodology that includes the following:

- Standard Operating Procedures (SOPs);
- Standard methods used;
- Calibration standards and concentrations used;
- Description of matrix blanks, replicates, and other QA/QC procedures;
- Description of adaptations or modifications of a "standard" method; and
- References to procedures in other text.

6.2 QA Requirements

Laboratory sample preparation procedures should be described and standard methods cited and used where possible. The sampling containers, condition of samples received, holding times, holding conditions, number and types of QA/QC samples to be prepared and analyzed, and percent recovery.

Laboratory SOPs should ensure consistent conformance with organizational practices, serve as training aids, provide ready reference and documentation of proper procedures, reduce work effort, reduce error occurrences in data, and improve data comparability, credibility, and defensibility. They should be sufficiently clear and written in a step-by-step format to be readily understood by a person knowledgeable in the general concept of the procedure. Elements to include in laboratory SOPs are:

1. Scope and Applicability;
2. Summary of Method;
3. Definitions;
4. Health and Safety Warnings;
5. Cautions;
6. Interferences;
7. Personnel Qualifications;
8. Apparatus and Materials;
9. Instrument or Method Calibration;
10. Sample Collection;
11. Handling and Preservation Sample Preparation and Analysis;
12. Troubleshooting;
13. Data Acquisition, Calculations & Data Reduction;
14. Computer Hardware & Software (used to manipulate analytical results and report data); and
15. Data Management and Records Management.

6.3 QC Requirements

Laboratory will analyze all submitted field QC duplicates and blanks. Rinsate blanks, field blanks, and trip blanks are submitted "blind" to the laboratory, packaged like other samples and each with its own unique identification number. In addition to field QC, laboratory will prepare and analyze internal QC spikes and blanks.

6.4 Laboratory Chemicals

All reagent chemicals used will be of ACS reagent grade or better, and are to be purchased from reputable laboratory supply companies. Blanks will be run with each analytical batch to check reagent quality. Pre-screening of chemical lots will be performed on extraction solvents, such as methylene chloride, hexane, methanol and sodium sulfate, to determine batch quality. Each analytical SOP describes standard preparation. Standards will either be prepared in the laboratory from high-purity starting materials, or will be purchased as standard concentrates.

6.5 Laboratory Equipment

The laboratory will be equipped with refrigerated storage areas, fume hoods, central deionized water systems and general utilities appropriate for modern analytical work. Specialized instruments may supplement common equipment such as ovens, incubators and distillation apparatus. Instrumentation will be continually upgraded in order to provide state-of-the-art technology.

6.6 Calibration and Internal Quality Control Procedures

Method-specific calibration criteria and corrective actions are provided in EPA SW-846. Each method has analytical control limits maintained for laboratory control standards, spike recoveries, duplicates, surrogate and quality control check standards recoveries. These limits must be met for blanks and laboratory control standards to validate the instrument and analyst performance.

The laboratory's goal will be to meet 100% of all criteria 100% of the time. For the times that this goal is not met for samples, blanks, laboratory control standards, matrix spikes or replicates, the analyst will be required to complete a batch corrective action sheet.

Corrective action may take several forms, but the following steps are almost always included:

1) Check the calculations;
2) Check the instrument for proper setup; and
3) Re-analyze the sample, blank, laboratory control standard, matrix spike or replicate.

If these steps fail to eliminate the problem, more serious action will be implemented. The LCS and spike recoveries may be compared to reveal matrix interferences. Recalibration of the instrument may be required. In certain cases, an entire batch may be re-analyzed.

A record of all corrective action will be maintained in the laboratory notebook, signed and dated by the analyst.

If a problem cannot be corrected as outlined, or if a check sample failure is identified, the analyst will obtain assistance from laboratory staff, the laboratory's Technical Resource Manager, and/or the laboratory's Quality Assurance Coordinator.

6.7 Maintenance

Each piece of equipment used in laboratory activities that has the potential to affect data quality is and will be maintained to specifications presented by the manufacturer.

A record of maintenance, including a description of specific activities performed, will be made in the laboratory equipment logbook. This book will be kept nearby the instrument. Instruments will be calibrated to proper specifications following maintenance to ensure proper completion of the maintenance procedure. If the equipment or instrument cannot be maintained to manufacturer's specifications or cannot be properly calibrated, it will be returned to the manufacturer or other repair facility for proper maintenance and repair. Upon return from the manufacturer, the instrument will be checked for compliance to project specifications before being returned to routine use.

6.8 Analytical Procedures

6.8.1 Standard Methods

Laboratory analytical methods to be used are taken from EPA SW-846[5] and Methods for Chemical Analysis of Water and Wastes, EPA Manual 600/4-79-020.

6.8.2 Method Detection Limits (MDLs)

The limit of detection is the minimum concentration of a substance that can be measured and reported with 99% confidence that the true value is greater than zero.

The laboratory calculates the detection limits for all requested parameters and matrices in accordance with the EPA Method as defined in the Federal Register, Volume 49 No. 209, page 199, 26 October 1984 on a yearly basis. Minimum detection limits achievable are based on methods and equipment used. The detection limit will be set at the "worst case" MDL, that is, the highest calculated MDL for the particular compound for the instruments to be used.

6.8.3 Practical Quantitation Limits (PQLs)

The PQLs for this project have been defined as the concentration of the lowest standard in the calibration curve. Data between the MDL and PQL will be "J" flagged as estimated.

6.8.4 Sample Quantitation Limits (SQLs)

The SQLs is defined as the MDL adjusted to reflect sample-specific actions such as dilution or use of smaller aliquot sizes than prescribed in the analytical method, and takes into account sample characteristics, sample preparation and analytical adjustments.

6.9 Data Reduction, Validation, and Reporting

The deliverables package for this project consists of the analytical report (with dry weight for soil samples), results, QC report, case narrative, chain-of-custody copies and the Electronic Data Deliverable (EDD). This section describes the processes by which the laboratory information arrives at this end stage.

6.9.1 Data Reduction

Most of the data produced in the laboratory is generated through the use of dedicated instrumentation with microcomputer interfaces. These PC-based systems receive the original signal from the instrument to which the sample or extract has been submitted. The PC (or, for some larger instruments, a dedicated minicomputer) transforms the raw signal into a quantitative value. An experienced analyst reviews this "candidate" result, either on-screen or on a paper printout. Identifications are verified, quantitative formulas are double-checked, and final numerical values are acquired.

Data flags are applied at this time to call attention to confirmations, blank contamination or surrogate outliers or dilutions. The flags are entered by leaving a space between the result and the flag.

Whenever a result has been confirmed by second column analysis, the primary column result must have a "C" flag entered next to the result, e.g., 0.88 C.

When the surrogates are out of control, a "Q" flag is reported.

Whenever an analyte of interest is present in the laboratory blank at or above the reporting detection limit, then associated sample results must be flagged with a "B."

The analyst then enters calculated results or checks off computer-produced results directly into the computer.

Some instruments are configured to operate independently without computers. For these, the signal is recorded as a strip chart trace, numerical output on a printer strip, or direct reading from a digital or analog dial. In such cases, additional work is required by the analyst to reduce the data to a reportable format. The original signal must be multiplied by a calibration factor or compared with a standard curve. The aliquot result must be divided by the mass or volume of sample to produce a concentration-based result. Most calculations are performed on scientific calculators; simple programs are used for some. These data are recorded in a dedicated bench book for the particular determination in question. Results for single or multiple component tests are hand-entered by the analyst in the assigned book.

Some lab tests, such as titrations or sensory evaluations, do not use instrumentation. For these, the quantitative result or observation is recorded directly in a bound book by the assigned analyst. Calculations like those described above may be needed; these are recorded in the same book.

For all methods of data reduction, the final analytical value is entered into the laboratory information management system (LIMS). Ancillary information, such as analyst name, method number, equipment ID, and so forth, is entered into the computer system.

6.9.2 Data Approval

Data approval has two principal components. Expert human evaluation is accompanied by automated systems for data checking. After all results for the day are input to the LIMS, a batch process is invoked to produce work approval program sheets (WAPS). Printed out overnight, the WAPS display each result as it was entered, and carry a blank space for each value on which the results approver will initial the item. In the process of generating the WAPS, a computer program compares QC results with archived limits for both reagent (LCS) and matrix spikes. These limits are updated in each laboratory on a yearly basis, with none to be greater than those established in EPA methods.

If there is not sufficient QC reported with the analytical batch, or if the reported QC fails the limits, a special report called the Early Warning Report (EWR) is printed for that test. Where warning limits only have been exceeded, the EWR and WAPS both contain results on the samples of interest. Then the assigned approver may evaluate the data for reporting purposes. If that evaluation leads to a decision to report, the WAPS may be initialed and the process continued. If not, corrective action is taken and the batch is subject to reanalysis. If control limits (more strict than warning limits) are exceeded, the results appear only on the EWR; not on the WAPS. That process forces review of the outlier results, including special manual entry of approval to release any of the records for the batch.

The automated review is supplemental to the expert review by the analyst and reviewer. Each analyst reviews his or her own work for consistency and compliance with QC criteria at the time it is entered into the LIMS. The data approvers regularly review run logs, raw data packages, and bench books. These are stamped with a review notice and signed and dated by the reviewer.

Final approval occurs after results have been approved through the WAPS process. When a report is complete in the database, another computer program prints it. A trained, designated final inspector reviews the hardcopy output. Under the direction of STL's Client Manager, this individual verifies the consistency and reasonableness of results.

6.9.3 Reporting

After review of the initial report, several other programs are run to begin the careful review of data and preparation of the final deliverable.

The data are then prepared for the final package. The report is checked for QC completeness. If the batches are not complete, the data are sent back for review and correction. The order QC report is printed to evaluate any out of control incidences which must be reported in the case narrative. The Batch Supplemental Report is printed to check for correct method numbers, dates or missing information. The surrogate recoveries are evaluated for potential flagging.

A case narrative is prepared to include the following information: condition upon receipt, holding time compliance, surrogate recoveries, and batch outliers.

Finally, the completed report is presented to the Laboratory Director or Program Manager for final review and signature.

6.9.4 Records Custody and Retention

All copies of final reports, notebooks, and raw data are retained for ten years. Typically, records are kept at the laboratory facility 6 months to 12 months. Records are then transferred to a secure offsite records facility. After 10 years, data records are destroyed.

6.10 Internal Quality Control Checks

Laboratory quality control checks include several procedures to assess laboratory accuracy and precision. Analytical instrument performance is determined by routinely conducting the following checks:

- Calibration verification;

- Instrument sensitivity checks; and
- Daily performance checks.

Method-specific control checks will be performed in accordance with the requirements of the applicable analytical methodology. Further, the following types of blanks are used to determine laboratory contamination or ensure instrument performance.

6.10.1 Method Blanks

Method blanks consist of organic-free or deionized water that is carried through the analytical scheme like a sample. They serve to measure contamination associated with laboratory storage, preparation, or instrumentation. For most analyses, a method blank is analyzed on a daily basis, and at a frequency of one per twenty samples. If the analyte of interest is above the practical quantitation limit, corrective action should be taken.

6.10.2 Calibration Blanks

Calibration blanks are prepared with standards to create a calibration curve. They differ from the other standards only by the absence of analyte, and provide the "zero-point" for the curve.

6.10.3 Internal Standards

Internal standards are measured amounts of certain compounds added after preparation or extraction of a sample. They are used in an internal standard calibration method to correct sample results suffering from capillary column injection losses, purging losses, or viscosity effects. Internal standard calibration is currently used for volatile organics and gas chromatography/mass spectrometry (GC/MS) extractables.

6.10.4 Surrogates

Surrogates are measured amounts of certain compounds added before preparation or extraction of a sample. The recovery of a surrogate is measured to determine systematic extraction problems. Surrogates are added to all samples analyzed for diesel, GC/MS extractables, and volatiles.

6.10.5 Spikes

Spikes are aliquots of samples to which known amounts of analyte have been added. They are subjected to the sample preparation or extraction procedure and analyzed as

samples. The spike recovery measures the effects of interferences in the sample matrix, and reflects the accuracy of the determination. Spike recoveries are calculated as follows:

$$\% \text{ Recovery} = \frac{S-R_{av}}{T-R_{av}} \times 100$$

where S is the observed concentration of analyte in the spiked sample, R_{av} is the average determination of the analyte concentration in the original sample, and T is the theoretical concentration of analyte in the spiked sample that includes both the amount found in the sample and the amount spiked.

Spikes are prepared and analyzed in every batch of 1-20 samples, and at a frequency of at least one per twenty samples if more than twenty samples are run in a given batch.

Spike recoveries are stored in the laboratory database and are retrievable for statistical analysis. Laboratory control limits are calculated for individual matrix types when twenty data points become available.

6.10.6 Duplicates and Duplicate Spikes

Duplicates are additional aliquots of samples subjected to the same preparation and analytical scheme as the original sample. In cases where the analyte concentration is consistently below the detection limit, duplicate spikes are substituted for duplicates. The relative percent difference between duplicates or duplicate spikes measures the precision of a given analysis. Relative percent differences are calculated as follows:

$$\% \text{ RPD} = \frac{R_1-R_2}{R_{av}} \times 100$$

$$= \frac{S_1-S_2}{S_{av}} \times 100$$

where R_1 and R_2 are duplicate determinations of the analyte in the sample, S_1 and S_2 are the observed concentrations of analyte in the spike and its duplicate, R_{av} is the average determination of the analyte concentration in the original sample and S_{av} is the average of the observed analyte concentrations in the spike and its duplicate.

Duplicates (or duplicate spikes) are prepared and analyzed at a frequency of at least one for every 20 project samples.

Relative percent differences are stored in the laboratory database and are retrievable for statistical analysis.

6.10.7 Laboratory Control Standards

LCSs are aliquots of organic-free or deionized water to which known amounts of analyte have been added. They are subjected to the sample preparation or extraction procedure and analyzed as samples. The stock solutions used for LCSs are purchased or prepared independently of calibration standards. The LCS recovery tests the function of analytical methods and equipment.

LCSs are prepared and analyzed in every batch of 1-20 samples and at a frequency of one per twenty samples if more than twenty samples are run in a given batch.

The Early Warning Report requires that an LCS be reported with every batch of 1-20 samples logged in for a particular determination. The true value and recovered concentration are archived and retrievable for statistical analysis. Laboratory control limits are calculated when twenty data points become available.

6.11 Performance and System Audits

6.11.1 System Audits

System audits will be performed in accordance with the policies and procedures established by the laboratory's Quality Assurance Program. All audits will be initiated by the Project Quality Assurance Officer and will consist of periodic reviews to ensure that:

- The necessary procedures for each step of the project operation plans are established;
- Standards, procedures, and records are properly maintained and documented; and
- Verification that QC records are adequately filed and maintained to assure protection, retrievability and traceability.

The system audit will consist of observations and documentations of all aspects of the analytical system to assess its overall effectiveness. The auditor will act functionally independent of the program staff. A system audit will be performed at least once per year.

6.11.2 Performance Audits

Performance audits are conducted to quantitatively evaluate the quality of data outputs with respect to the requirements specified in the analytical method. The Project Quality Assurance Officer will be responsible for the identification of tasks to be audited and for appointing an auditor. The performance audit will be performed to:

- Evaluate the accuracy of data generated during analysis;
- Assure that control standards are being measured at specified intervals; and
- Check the status of reference materials.

A performance audit will be conducted at least biennially.

6.11.3 Audits

Annual audits cover areas of operation from sample custody and sample management through analysis and data validation to data archival, as well as general laboratory quality assurance measures. The laboratory's QA Group typically develops an extensive checklist that is used by the Quality Assurance Coordinator during the audit. At the completion of each audit the Quality Assurance Coordinator scores the laboratory and provides a written report detailing areas of concern. The Quality Assurance Coordinator is responsible for developing a written corrective action plan and overseeing its implementation.

6.12 Preventive Maintenance

Preventive maintenance is a crucial element of the quality assurance program in an analytical laboratory. Laboratory analysts perform routine preventive maintenance, such as the replacement of minor parts, cleaning of exterior components and providing the instruments with a clean, climate-controlled environment. Major instruments, such as gas chromatographs, atomic absorption spectrophotometers, analytical balances, and GC/MS systems, are maintained under commercial service contracts. Instrument maintenance is recorded in the associated instrument logbook for future reference and validation of scheduled maintenance.

Instruments are constantly monitored by the use of daily calibration, sensitivity, and response checks to determine when non-scheduled maintenance is required. In the event that an instrument fails, every effort is made to meet obligations to clients concerning holding times and analysis due dates. In the event that a holding time will be missed, the project manager will notify the client contact.

Laboratory support systems such as the deionized water supplies, refrigerators and ovens are also monitored and serviced regularly. In many instances the improper functioning of such basic equipment as a refrigerator is enough to invalidate costly data. The laboratory's quality assurance program is designed to minimize data loss by monitoring and recording the functioning of these systems, allowing rapid correction of any malfunction before data loss can occur.

6.13 Quality Assurance Reports to Management

Quality assurance is to be a vital concern to all levels of management at the laboratory. A major component of the quality assurance program is the feedback mechanism designed to keep managers and supervisors aware of quality issues and performance in the laboratory.

6.13.1 Early Warning Report

Resource Managers receive daily reports of all quality control parameters that are outside warning and/or acceptance limits (the Early Warning Report). This allows for prompt corrective action at the bench and immediate flow of information to the client, when appropriate. It is important to note that data cannot be approved and reported to the client until corrective action validates the result. The Quality Assurance Coordinator receives a copy of the Early Warning Report so that confirmation of corrective action can proceed in a timely fashion. At the discretion of the individual resource manager or quality assurance coordinator, quality control data can be retrieved from the computer for any analysis for a specified time period. This historical data can demonstrate trends and can be used to revise control limits.

6.13.2 Quality Assurance Reports

In addition to reports to internal management, the laboratory will provide a quality assurance summary with every report. Quality control data including blanks, LCSs, duplicate and spike results will be included.

6.14 Laboratory Safety

The laboratory's safety program is designed to:

- Provide the management systems and support necessary to achieve and maintain safe and healthful working conditions for all employees;
- Minimize accidents through proactive anticipation and prevention rather than reaction after the fact;
- Provide training for employees to ensure safety awareness and proper work habits;
- Comply with or exceed the requirements, regulations, and standards imposed on the laboratory by government agencies;

- Ensure proper storage, use, and disposal of chemicals and hazardous materials; and
- Require adoption of and adherence to the laboratory's safety procedures and practices.

6.15 Training

Most laboratory employees have a college degree in a science-related field. Regardless of their educational background or assigned duties, each employee is processed through a rigorous training program. This training includes detailed safety information about the chemicals to be used. Each employee is required to read the safety manual and sign a document stating that they have read it. Upon hire or change in responsibilities, the employee is provided a technical training schedule.

The analyst is required to complete a personal check sample and/or run a LCS four times to demonstrate the ability to generate acceptable accuracy and precision. A bench level review by the Quality Assurance Coordinator or Resource Manager may be completed. Corrective action and retraining are initiated where appropriate. If the analyst passes this review process, they are declared approved to perform the designated analyses.

6.16 Corrective Action

Corrective action is taken as required in response to out-of-control situations. Failures occur in two categories: Quality control failures, which are random or isolated events, and systematic failures, which require changes in protocol or extensive investigation to determine the cause of the failure.

When specific QC parameters are outside control limits, specific actions must be taken. Quality control outliers must be documented in the lab notebook or raw data and communicated to the final report reviewer. Documentation includes, at a minimum, the date, analyst initials, batch number, condition requiring corrective action, and action taken. This information is relayed to the client in a report footnote, cover letter, or case narrative, as appropriate. Guidelines for corrective actions in response to batch QC failures are presented below.

- Method blank

  When any analyte is detected above the reporting limit in the method blank, the analyte level in each of the batch samples is inspected. If the sample analyte is less than the reporting limit or greater than 10 times the method blank level, the sample result is reported. Any samples between the reporting limit and 10 times the method blank level are re-extracted and /or reanalyzed in a new batch, whenever possible.

- Matrix Spikes and Laboratory Control Standards

  Corrective actions for matrix spike and laboratory control standard failures depend on the relationship between the percent recoveries and relative percent difference. These relationships give rise to various combinations of in-control and out-of-control QC parameters. The following chart describes the eight possible relationships along with the corresponding batch evaluation. (Where "+" indicates an in-control parameter and "-" indicates an out-of-control parameter.)

	LCS	RPD	Spike	Batch Evaluation
Case 1	+	+	+	In-control
Case 2	-	-	-	Out-of-control
Case 3	+	+	-	In-control
Case 4	-	+	+	Out-of-control unless documented isolated failure
Case 5	-	+	+	Out-of-control unless documented isolated failure
Case 6	+	-	-	Out-of-control unless documented isolated failure
Case 7	-	+	-	Out-of-control
Case 8	-	-	+	Out-of-control

7.0 REFERENCES

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BROWN AND CALDWELL

SITE-SPECIFIC
PROJECT SITE HEALTH AND SAFETY PLAN

El Paso Corporation, Elementis Site

Project 22989 / Corpus Christi AOC

IM Investigation, Elementis Site, Corpus Christi, Texas

	Name	Signature	Title	Date
Prepared By:	**Lynn Wright**		**Project Manager**	**November 21, 2002**
Revised By:				
Reviewed By:				
Reviewed By:	**Jerry Fields**		**Regional Health & Safety Coordinator**	**November 26, 2002**
Effective Dates:	**December 1, 2002 through December 1, 2003**			

PROJECT HEALTH AND SAFETY PLAN

1.0 PROJECT DESCRIPTION

On September 6, 2002, the U.S. Environmental Protection Agency (EPA) issued an Administrative Order on Consent (Order) to El Paso Merchant Energy-Petroleum Company (El Paso), formerly Coastal. The Order (EPA, 2002) addresses hydrocarbon impact to groundwater underlying the Elementis Chromium, L.P. (Elementis) property (i.e., "the Facility") to the east of Cantwell Lane and extending beyond the north, northeast, and east of the Valero Complex 8 North to the Inner Harbor Ship Channel in Corpus Christi, Texas by dissolved-phase hydrocarbons and light non-aqueous phase liquid (LNAPL). Elementis, formerly American Chrome and Chemical, owns a manufacturing facility located at 3800 Buddy Lawrence Drive, Corpus Christi, Texas, which occupies approximately 425 acres along the southern bank of the Inner Harbor Ship Channel. The Elementis plant is located to the north, east, and west of the Valero Refinery, which is leased from El Paso Corporation.

This Project Site Health and Safety Plan (HASP) describes the health and safety procedures that will be used during groundwater investigation activities at the "Interim Measures (IM) Area" of the Facility. The IM Area is defined as that portion of the Facility within 350 feet landward of the mean high tide mark of the Inner Harbor Ship Channel as shown on the USGS Corpus Christi Quadrangle Map (EPA, 2002). As stated in the Order, the specific objectives of the groundwater investigation to be conducted at the IM Area are to:

- "Characterize and determine the lateral extent of LNAPL floating atop groundwater to non-detect thickness in the IM Area; and
- Characterize and determine the lateral and vertical extent of contamination to decreasing concentrations of IM chemicals of concern (COCs) to below the IM preliminary remediation goals (PRGs) in groundwater at the IM Area" (EPA, 2002).

The following activities will be performed during the IM Area Investigation:

1. Advance soil borings with a cone pentrometer-testing (CPT) rig equipped

with a rapid optical screening tool (ROST) to determine the lateral extent of LNAPL in the IM Area.

2. Install temporary monitoring wells with a direct push rig to verify the lateral extent of LNAPL and to determine the lateral extent of IM COCs in groundwater in the IM Area.

3. Install permanent monitoring wells to determine the lateral and vertical extent of contamination to decreasing concentrations of IM COCs to below the IM PRGs in groundwater at the IM Area.

4. Install permanent piezometers to monitor the lateral extent and thickness of LNAPL in the IM Area.

2.0 PROJECT PERSONNELL

2.1 Project Personnel Identification and Responsibilities

Lynn Wright is the project manager (PM). Anne Baptiste, Certified Industrial Hygienist (CIH), is the Health and Safety Director (HSD). Jerry Fields, Regional Health and Safety Coordinator (RHSC), will provide Health and Safety Technical Assistance. Cory Green is the project geologist/engineer and will (also) function as the SSO. The project field staff has completed 40 hours of comprehensive health and safety training, which meets the requirements of Title 29, Code of Federal Regulations Part 1910.210 (29 CFR 1910.120).

PROJECT MANAGER (PM)

The PM is responsible for generating, organizing, and compiling the HASP, which describes all planned field activities and potential hazards that may be encountered at the site. The PM is also responsible for ensuring that adequate training and safety briefing(s) for the project are provided to the project team. The PM has provided a copy of the HASP to each member of the project field team and one copy to the subcontractor before the start of field activities.

Field personnel working at El Paso (Coastal) facilities are required to review The EL Paso Energy Corporation Safety & Health Handbook. A copy of this document is attached as Appendix E. The project manager will be responsible to assure that field personnel receive, read, and understand the contents of this document and that a signed acknowledgement is on file. Field personnel will also be required to complete required safety orientation for the Elementis Facility prior to conducting the IM Investigation.

HEALTH AND SAFETY DIRECTOR (HSD)

The HSD is responsible for developing and coordinating the Brown and Caldwell (BC) health and safety program. For specific projects, the RHSC is responsible for reviewing and approving the draft HASP for accuracy and incorporating new information or guidelines that aid the PM and SSO in further definition and control of the potential health and safety hazards associated with the project.

SITE SAFETY OFFICER (SSO)

The SSO has on-site responsibility for ensuring that all team members, including subcontractors, comply with the HASP. It is the SSO's responsibility to inform the subcontractors and other field personnel of chemical and physical hazards, as he/she becomes aware of them. Deviations from the plan must be based on field conditions encountered and well documented in the field notes. The SSO has the authority to monitor and correct BC health and safety problems as noticed on site. Additional SSO responsibilities include:

1. Following the HASP and applicable El Paso Corporation, Elementis Chromium, and Valero Refinery safety requirements.
2. Reporting to the PM any unsafe conditions or practices.
3. Reporting to the PM all facts pertaining to incidents that result in injury or exposure to toxic materials.
4. Reporting to the PM equipment malfunctions or deficiencies.
5. Providing site safety briefing for team members.
6. Updating equipment or procedures to be used on site on the basis of new information gathered during the site investigation.
7. Inspecting all personal protective equipment (PPE) before on-site use.
8. Assisting the PM in documenting compliance with the HASP by completing the standard BC forms.
9. Assisting in and evaluating the effectiveness of decontamination procedures for personnel, protective equipment, sampling equipment and containers, and heavy equipment and vehicles.
10. Enforcing the "buddy system" as appropriate for site activities.
11. Posting location and route to the nearest medical facility; arranging for emergency transportation to the nearest medical facility.
12. Posting the telephone numbers of local public emergency services; i.e., police and fire departments.
13. Stopping operations that threaten the health and safety of the field team or surrounding populace.
14. Entering the exclusion area in emergencies after he/she has notified emergency services.
15. Observing field team members for signs of exposure, stress, or other conditions related to pre-existing physical conditions or site work activities.

2.2 Client Contact

Kevin Frenzel, El Paso Corporation

Phone Number: (361) 643-3574

Cell: (361) 728-8086

2.3 Regulatory Agency Contact

Sue Westbrook, U.S. EPA Region 6

Phone Number: (214) 665-8321

2.4 Brown and Caldwell Project Manager

Lynn Wright

Phone Number: (713) 646-1112

Cell: (713) 818-6758

2.5 Brown and Caldwell Regional Health & Safety Coordinator

Jerry Fields

Phone Number: (602) 567-3827

Cell: (602) 770-4376

Pager: (602) 673-5909

2.6 Brown and Caldwell Project Safety Officer

Cory Green

Phone Number: (713) 646-1118

2.7 Subcontractor Contact

Drilling – ESN South (Cheryl Smith)

Phone Number: (713) 646-1118

Fugro Geosciences, Inc. (Mary Mason)

Phone Number (713) 346-4000

2.8 Emergency Telephone Numbers

Police: (361) 886-2600 or 911

Hospital:(361) 902-4000

Fire Dept:(361) 880-3900 or 911

2.9 Subcontractor Responsibilities

All subcontractors are responsible for their own health and safety programs and the health and safety of their own employees. This requirement is based on OSHA regulations, which recognize the employer-to-employee responsibility for health and safety. A copy of their written program must be submitted for review to BC prior to the start of field activities. In an effort to assist the subcontractors, and to comply with hazard communication requirements, Brown and Caldwell will provide a copy of the site safety and health plan for this project to the subcontractor for implementation for the subcontractor's employees.

3.0 HAZARD ANALYSIS

The potential hazards to personnel working on this project include: chemicals, flammability, noise, slips, falls, overhead hazards, electrical lines, working around heavy equipment, traffic, and chemical exposures.

3.1 Chemical Contamination

Health hazards associated with potential chemical exposures at the IM Area located at the Elementis Facility include toxicity that may occur following inhalation of chemical vapors that could potentially be released from contaminated soil and/or groundwater and direct contact with contaminated soil and/or groundwater. The table below presents general information on the chemical exposure limits and characteristics associated with the principal chemicals of concern that may be present at the site. Material safety data sheets for additional information on products brought on to the site are contained in Appendix A.

PRINCIPAL CHEMICALS OF CONCERN

CHEMICAL NAME	TLV - TWA (ppm/8 hrs)*	STEL (ppm/15 min)*	IDLH (mg/m^3)	REMARKS
Benzene	0.5 ppm	2.5	500 ppm	See Respective MSDS
Benzyl chloride	1 ppm	Ceiling 0.5	10 ppm	
n-Butanol	Skin 50 ppm ceiling	ND	ND	
Carbon tetrachloride	10 ppm	2 ppm	200 ppm	CA – ceiling 25 ppm
Chloroform	Ceiling 50 ppm	2 ppm	500 ppm	CA
Ethyl acetate	400 ppm	ND	2000 ppm	
Ethyl ether	400 ppm	ND	ND	
Ethylbenzene	100 ppm	125	800 ppm	See Respective MSDS
Tetrachloroethene	100 ppm	ND	ND	
Toluene	50 ppm	NPV	800 ppm	See Respective MSDS
1,1,1-Trichloroethane	350 ppm	ND	ND	
Vinyl chloride	1 ppm	Ceiling 5 ppm	ND	CA
Xylene	100 ppm	150	900 ppm	See Respective MSDS
Benzo(a)anthracene	NE	ND	ND	Recommend .2 mg/m3
Bis(2-ethylhexyl)phthalate	5 mg/m3	ND	ND	
Chrysene	.2 mg/m3	ND	ND	
Dibenzofuran	NE	ND	ND	Recommend .2 mg/m3
Fluoranthene	NE	ND	ND	Recommend .2 mg/m3
Fluorene	NE	ND	ND	Recommend .2 mg/m3
2-Methylnapthalene	NE	ND	ND	Recommend .2 mg/m3
Naphthalene	10 ppm	ND	ND	
Phenanthrene	.2 mg/m3	ND	ND	
Pyrene	.2 mg/m3	ND	ND	
Aluminum	15 mg/m3	ND	ND	
Arsenic	.5 mg/m3	ND	ND	
Barium	.5 mg/m3	50 mg/m3	ND	As BA
Cadmium	.005 mg/m3	ND	9 mg/m3	Dust CD (CA)
Chromium	1 mg/m3	ND	250 mg/m3	Chromium III metal
Hexavalent Chromium	1 mg/m3	ND	ND	
Lead	0.05 mg/m^3	NPV	100 mg/m^3	See Respective MSDS
Nickel	1 mg/m3	ND	10 mg/m3	CA metal
Selenium	,.2 mg/m3	ND	1 mg/m3	

Vanadium	Ceiling .5 mg/m3	ND	35 mg/m3	Dust
Zinc (oxide)	5 mg/m3 Fume	ND	500 mg/m3	5 mg/m3 Resp. Dust
MTBE	40 ppm	NPV	NPV	See Respective MSDS

* = Units and duration unless otherwise noted. NPV = No published value. NE = Not Established ND = Not Determined

General information on other chemicals identified at the site is discussed in the following paragraphs.

BTEX COMPOUNDS

In general, BTEX compounds (benzene, toluene, ethylbenzene, and xylenes) may cause irritation to the eyes, nose and respiratory system, and dermatitis. Acute exposure can lead to central nervous system effects including headache, dizziness, confusion, and irritability.

Benzene

Benzene is a colorless to light-yellow flammable liquid with an aromatic odor. It is incompatible with strong oxidizers, many fluorides, perchlorates, and nitric acid. Benzene is a minor component of petroleum distillate fuels with concentrations ranging from non-detectable to 3%, with gasoline typically at 1%. Benzene is regulated by OSHA as an occupational carcinogen and has been associated with leukemia. Acute health effects include irritation to the eyes, nose and respiratory system, headache, giddiness, nausea, and anorexia. Benzene exposure can also lead to disturbances in gait, dermatitis, and bone marrow depression.

Toluene

Toluene is a colorless flammable liquid with a sweet, pungent, benzene-like odor. It is incompatible with strong oxidizers. The substance is readily absorbed through the skin. Exposure could cause central nervous system depression. Exposure at high levels may result in cardiac dysrhythmia, unconsciousness, and death. Symptoms of exposure include pupil dilatation; eye and respiratory tract irritation; nervousness; and insomnia.

Ethylbenzene

Ethylbenzene is a colorless flammable liquid with an aromatic odor. It is incompatible with strong oxidizers. It also attacks plastic and rubber. The substance irritates the eyes, the skin, and the respiratory tract. Swallowing the liquid may cause aspiration into the lungs with the risk of chemical pneumonitis. Ethylbenzene may cause effects on the central nervous system.

Xylene and its isomers

Xylene is a colorless flammable liquid with an aromatic odor. It is incompatible with strong oxidizers and strong acids. The substance irritates the eyes. Elevated concentrations of xylene may lead to corneal damage, and gastrointestinal symptoms including abdominal pain, nausea and vomiting.

MTBE

Methyl tert-butyl ether is an extremely flammable, highly volatile substance with moderate toxicity. Inhalation or skin absorption can cause effects with the Central Nervous System, blood, and kidneys. Symptoms include lightheadedness, dizziness, nausea, weakness, or headache. MTBE is also an eye and skin irritant. Splashes can damage eye tissue. It can aggravate pre-existing skin, eye, or respiratory conditions.

METALS AND METAL IONS

Metal and metal ions present no volatility or flammability problems. They can present both acute and chronic effects if the host material is inhaled in the form of a dust or fume. Metals such as chromium, nickel, cadmium, silver and zinc and their ions can cause irritation of mucous membranes and lung tissues. Chromates (ionic chromium compounds in the +6 oxidation state) are known human carcinogens when inhaled. To minimize inhalation of chromates, host dusts should be minimized as much as possible.

Cadmium

Cadmium has toxic health effects that include irritation of the respiratory system from mild to severe depending on the concentration and duration of exposure. Chronic exposure to cadmium leads to lung damage resulting in a characteristic form of emphysema, and kidney damage. It is also a suspected carcinogen, and is regulated by OSHA through a comprehensive occupational health standard. The current exposure limit for cadmium is 0.005 Mg/m^3 as an 8-hour time-weighted average (TWA) airborne dust concentration.

Chromium

Chromium has toxic health effects that can range from allergic skin reactions to mild, and eventually severe, respiratory system irritation. Chromium may exist in one of three valence states in compounds (+2, +3, or +6). Toxic health effects are primarily associated with Cr+6 (hexavalent chromium) exposure. It is a suspect carcinogen as Cr+6. Symptoms of acute exposure include coughing, wheezing, painful deep inspiration, and fever. Pulmonary edema may persist after other symptoms subside. Other effects include dermatitis, ulceration of the skin, conjunctivitis and asthma.

Chronic exposure may be associated with lung cancer. The current exposure limit for chromium as Cr+6 is 0.05 Mg/m^3 as an 8-hour time-weighted average (TWA) airborne dust concentration.

Inorganic Carbons

Arsenic has toxic health effects, which include dermatitis, gastrointestinal upset, peripheral neuritis, irritation to the respiratory system, and discoloration of the skin. Arsenic is associated with skin cancer and lung cancer due to chronic exposure. Arsenic is an occupational carcinogen, and is regulated by OSHA through a comprehensive occupational health standard. The current PEL for arsenic is 0.01 Mg/m^3 as an 8-hour time-weighted average (TWA) airborne dust concentration. The regulatory action level is 0.005 Mg/m^3 TWA dust concentration. No employee may be exposed to any skin or eye contact with arsenic trichloride or to skin or eye contact likely to cause skin or eye irritation.

Nickel and Nickel Compounds

Nickel metal is a hard, silver-white, malleable, magnetic metal that has wide industrial applications. It is incompatible with strong acids, sulfur, selenium, wood and other combustibles. Nickel is poorly absorbed from the gastrointestinal tract. Soluble nickel compounds are readily absorbed after inhalation. Nickel is associated with nasal and lung cancer. The most common manifestations of exposure to soluble nickel compounds are dermatalogic. Nickel is a common cause of skin allergy and may cause erythema and vesiculation at points of contact in sensitized individuals. Exposure to high concentrations of soluble nickel aerosols may also cause rhinitis, sinusitis, and septal perforation. Symptoms of exposure include sensitization dermatitis, allergic asthma, and pneumonitis.

Zinc

Zinc is a silver-white metal with a blue tinge that is widely distributed in nature. In the presence of moisture, zinc metal can spontaneously combust. Zinc reacts with acids, strong alkalies, chlorides, chlorates, oxides, nitrates, fluorine, and carbon disulfide. Zinc may cause an eczematous dermatitis or skin sensitization. Ingestion of soluble zinc compounds causes nausea, vomiting, and diarrhea due to irritation of the gastrointestinal tract.

Lead

Lead in its elemental form is a heavy, ductile, soft gray metal. The permissible exposure limit for lead is 0.05 Mg/m^3 in air based on an 8-hour TWA; IDLH exposure limit is 700 Mg/m^3. To present a health hazard, lead must be in such a form as to gain entrance into the body or tissue in measurable quantities. The primary

mode of entry that is of concern is inhalation of lead dust, and secondary, is ingestion if poor personal hygiene is practiced. Lead is a cumulative poison. It is stored in the body and acts as a cellular poison to all organ systems before symptoms and disability is evident. Lead poisoning creates a red cell anemia and damages organs and tissues of the body such as kidneys, liver, blood vessels, nervous system, and reproductive organs. . Severe exposure may produce several symptoms including weakness, eye irritation, facial pallor, pale eyes, lassitude, insomnia, anemia, tremors, malnutrition, constipation, paralysis of the wrists and ankles, abdominal pain, colic, nephropathy, encephalopathy, gingival lead line, hypotension, anorexia, and weight loss. Chemical and physical properties may vary depending upon the specific lead compound.

OSHA considers lead an occupational carcinogen. OSHA specifically regulates lead occupational exposures and has a standard associated with it. Lead's airborne permissible exposure level (PEL) is 0.05 Mg/m^3. The blood lead action level for adults is equal to or less than 30 micrograms per deciliter (g/dl) of blood. There is no safe level of lead exposure for children. Therefore, decontamination of adults and their clothing is a primary concern.

Organic Compounds and HALOCARBON SOLVENTS

Bis(2-Ethylhexyl)Phthalate

Bis(2-ethylhexyl)phthalate is colorless combustible oily liquid with a slight odor. It is incompatible with nitrates, strong oxidizers, acids and alkalis. The substance can be absorbed into the body by inhalation and by ingestion. A harmful contamination of the air will not or will only very slowly be reached on evaporation of this substance at room temperature. The substance irritates the eyes, the skin, and the respiratory tract. The substance may cause effects on the gastrointestinal tract. DEHP is associated with liver damage and teratogenic effects in animals.

Carbon Tetrachloride

Carbon tetrachloride is a colorless, nonflammable liquid with a characteristic odor. The use of this chemical as a solvent for cleaning and resins was common in aerospace during World War II. Inhalation is the primary route of entry and excessive skin contact can cause defatting of the skin. Excessive exposure may result in CNS depression and gastrointestinal symptoms. Carbon tetrachloride is a carcinogen. Following acute and chronic exposure, liver and kidney damage may result. The hazard of systemic effects is increased when carbon tetrachloride exposures occur in conjunction with ingested alcohol.

Tetrachloroethylene

Tetrachloroethylene is a colorless liquid with a mild, chloroform-like odor. It is incompatible and reacts with strong oxidizers; chemically active metals such as lithium, beryllium and barium; caustic soda; sodium hydroxide; and potash. Exposure routes include inhalation, skin absorption, ingestion, skin and/or eye contact. The substance irritates the eyes, the skin and the respiratory tract. Swallowing the liquid may cause aspiration into the lungs with the risk of chemical pneumonitis. The substance may cause effects on the central nervous system. Repeated or prolonged contact with skin may cause dermatitis. The substance may have effects on the liver and kidney. Tumors have been detected in experimental animals but may not be relevant to humans

Chloroform

Chloroform is widely used as a solvent in the lacquer industry and in the manufacture of plastics. Though non-flammable, it decomposes to form hydrochloric acid, phosgene, and chlorine upon contact with extreme heat or flame.

Chloroform may produce burns if left in contact with the skin. It is relatively potent anesthetic at high concentrations. Death from its use as an anesthetic has resulted from liver damage and from cardiac arrest. Exposure may cause lassitude, digestive disturbance, dizziness, mental dullness, and coma. Chronic overexposure has been shown to cause enlargement of the liver and kidney damage. Alcoholics seem to be affected sooner and more severely from chloroform exposure. Disturbance of the liver is more characteristic of exposure than central nervous system depression or renal injury. Chloroform is a suspected human carcinogen.

Vinyl Chloride(VC)

Vinyl Chloride is a flammable gas at room temperature. Its vapor has a pleasant ethereal odor. It is used in the manufacture of PVC and other resins; as a chemical intermediate in the decomposition of chlorinated hazardous waste solvents; and as a solvent.

Vinyl chloride gas is absorbed by inhalation. Skin absorption of the vapor has been suggested but experimental evidence is presently lacking. Vinyl chloride is a skin irritant, and contact with the liquid may cause frostbite upon evaporation. The eyes may be immediately and severely irritated. Vinyl chloride depresses the central nervous system causing symptoms that resemble mild alcohol intoxication. Lightheadedness, some nausea, and dulling of visual and auditory responses may develop in acute exposures. Death from severe vinyl chloride exposure has been reported.

Chronic exposure of workers involved in reactor vessel entry and hand cleaning may result in the triad of acro-osteolysis, Raynaud's phenomenon, and sclerodermatus skin changes. Chronic exposure may also cause hepatic damage.

Vinyl chloride is regarded as a human carcinogen, and a causal agent of angiosarcoma of the liver. Excess cancer of the lung and the lymphatic and nervous systems has also been reported. Experimental evidence of tumor induction in a variety of organs, including liver, lung, brain, and kidney, as well as nonmalignant alterations, such as fibrosis and connective tissue deterioration, indicate the multisystem oncogenic and toxicological effects of vinyl chloride. OSHA considers vinyl chloride an occupational carcinogen. OSHA specifically regulates VC occupational exposures and has a standard associated with it.

Polynuclear Aromatic Hydrocarbons

Residues of gasoline and diesel fuels may contain polyaromatic hydrocarbons (PAHs), also called polynuclear aromatic hydrocarbons (PNAHs). Although their presence is not likely, most of these coal tar derivatives and products of combustion are known as human carcinogens. Routes of entry include inhalation, gastrointestinal and skin contact. They are not usually very volatile. Therefore, unless they are known to be present at significant concentrations, high odors of fuels are evident, or dust clouds are present, the primary method of protection is by avoiding skin contact. The ACGIH Time Weighted Average TLV for coal tar pitch volatiles is 0.2 Mg/m^3. Sampling for coal tar pitch volatiles should be conducted if they are truly suspected.

Components of coal tar pitch volatiles include naphthalene, pyrene, phenanthrene, anthracene, chrysene, fluoranthene and acenaphthene. Phenanthrene and acenaphthene do not have established exposure limits. The TLV for naphthalene is 10 ppm or 52 Mg/m^3. Additional information for the other compounds is provided as follows (Use the following only if truly suspect significant PAH contamination for the individual component):

Benzo(A)Pyrene—Hazard Summary

- Benzo(a)pyrene is a CARCINOGEN
- Exposure may damage the fetus
- Exposure can cause skin and eye irritation with burning sensations.
- Except in laboratories, Benzo(a)pyrene is usually mixed with other "Coal Tar Pitch" chemicals.
- The ACGIH TLV is 0.2 Mg/m^3

Identification. Benzo(a)pyrene is a pale yellow, crystalline solid or a powder. In its pure form it is used as a laboratory reagent. Benzo(a)pyrene also forms as a gaseous by-product when certain carbon substances burn, such as the coal tar pitch chemicals listed above.

Benzo(B)Fluoranthene—Hazard Summary

- Benzo(b)fluoranthene is a CARCINOGEN
- Skin contact may cause irritation or a skin allergy that is greatly aggravated by sunlight on contaminated skin.
- Repeated contact may cause thickening, pigment changes and skin growths.
- Eye contact or "fume" exposure may cause irritation, and a reaction greatly aggravated by sunlight during or shortly after exposure.
- There is no established exposure limit for this product.

Identification. Benzo(b)fluoranthene is a colorless needle-shaped solid used as a research chemical. It is not manufactured but can be found in coke oven emissions, engine exhaust, cigarette smoke and coal tar.

Benzo(K)Fluoranthene—Hazard Summary

- Human exposure to benzo(k)fluoranthene occurs primarily through smoking, inhalation of polluted air; food and water contaminated with products of combustion
- The major hazards encountered in the use and handling of benzo(k)fluoranthene stem from its toxicological properties.
- Exposure to this pale yellow crystalline substance may occur from its ubiquitous presence in products of incomplete combustion from such activities as running gasoline engines, or using coal or oil burning stoves.
- The major toxicological effect of concern is the possible carcinogenicity to humans.
- Smoking, eating, and drinking should be prohibited in benzo(k)fluoranthene work areas.
- Transport of this substance should be in a securely sealed container that is placed in a second unbreakable, leakproof container.
- There is no established e exposure limit for this substance

Identification. Benzo(k)fluoranthene is a pale yellow crystalline substance. There is no commercial production or known use of this compound

Chrysene—Hazard Summary

- Chrysene may be mutagenic. Handle with extreme caution.

- If skin contaminated with Chrysene is exposed to sunlight, a rash or sunburn effect can occur.
- Chrysene is almost always found in coal tar pitch, coal tar creosote, or other coal tar roducts. Work with coal, tar, soot, pitch, asphalt, etc., may expose and individual to Chrysene.
- There is no established exposure limit.

Identification. Pure Chrysene is a colorless to off-white flake that is used in laboratories and dye manufacturing. Chrysene is most often found in black or brown tars and pitches.

Dibenz(A,H)Anthracene—Hazard Summary

- This is a flammable/combustible material; may be ignited by heat, sparks, or flames. May burn rapidly with flare-burning effect
- Fire may produce irritating or poisonous gases. Contact may cause burns to skin and eyes. Runoff from fire control or dilution water may cause pollution. When heated to decomposition it emits acrid smoke & irritating fumes

Working Around Heavy Equipment

Vehicles, drilling rigs, dump trucks, concrete trucks, cranes, backhoes, carts, and forklifts may be present both outside and inside the plant structures. When working near this equipment, stay alert to what the equipment is doing especially when a backup alarm is sounding. Maintain eye contact with operator at all times and wear an orange vest to increase visibility. Never enter the swing radius of articulating equipment and be aware of pinch points.

Electrical Equipment

Observation of existing Motor Control Centers, pumps, and mixing equipment can present electrocution and/or physical entanglement/amputation hazards. Only qualified "Plant" personnel will remove covers of electrical equipment to expose energized electrical parts. Entering electrical rooms/vaults or areas with live exposed electrical part by Brown and Caldwell Team members will be permitted only when accompanied by a qualified "Plant" employee after notification and approval of the appropriate "Plant" area supervisor.

Observation of operating machinery will take place from a safe distance. Only qualified “Plant” personnel will remove guards, hatch covers, or safety chains if necessary. Equipment lockout procedures and an appropriate work permit will be followed.

All electrical circuits must incorporate Ground Fault Circuit Interrupters (GFCI). Extension cords must be removed from service if they are worn, frayed, or the grounding prong is missing. Small electrical tools and equipment must be grounded or double insulated and removed from service if defective.

Lock-out/Tag-out procedures will be utilized during inspection and maintenance of the pump and treat system. See Sections 206 and 207in Appendix C for additional information on Electrical Hazards, and Lock-out/Tag-out procedures.

Excavations

No Brown and Caldwell employee shall enter any trench or excavation that is five (5) feet or greater unless a protective system is provided. Protective systems include sloping or benching, shoring, or shielding. In addition, a method of access and egress must be provided and must be within 25 lateral feet of the employee. A competent person should inspect all excavations at least daily and as conditions change to determine the integrity of the protective systems.

Some excavations may be considered a confined space especially if there is an actual hazardous atmosphere or reason to believe there may potentially be a hazardous atmosphere. Any trench or excavation that falls under these conditions must NOT be entered until they have been evaluated according to the confined space entry regulations.

Confined space entry is not anticipated for this particular project.

Drilling Operations

During all drilling operations, ensure that the appropriate level of protection and safety procedures is utilized. Hard hats, steel-toed boots, and ear and eye protection will be required at all times when working around drill rigs. The proximity of the chemical, water, sewer, and electrical lines is identified before any drilling is attempted. Additionally, the employee can effectively manage hazards associated with working around heavy equipment if a constant awareness of these hazards is maintained. These hazards include the risk of becoming physically entangled in the equipment or being run over, slipping and falling, impact injury to eyes, head and body, and injury from machinery operations. Never work or walk under a load suspended on drill rigs or heavy equipment. Never work or walk on piles of well casings. Make sure all high-pressure lines and hoses have whip checks attached. Constant visual or verbal contact with the equipment operator will facilitate such awareness.

NOISE

Noise is a potential hazard in areas where heavy equipment including backhoes, power tools, pumps, or generators are operated. Heavy equipment operation may produce noise levels that reach or exceed 85 decibels (85 dBA), the action level established by the Occupational Safety and Health Administration (OSHA). Elevated noise levels will be evaluated by the SSO when the drill rig is operated. Exposure to elevated noise levels can lead to temporary or permanent hearing loss, and can also cause muscle tension and irritability. The SSO will ensure that hearing protection is utilized when noise levels are elevated such as when the excavator is in operation.

SLIPS AND FALLS

Slipping hazards may exist due to uneven terrain, wet surfaces, leaking hydraulic fluid, or spills of chemicals. Tripping hazards may be present from elevation changes, debris, poor housekeeping, or equipment. Some specific hazards may include: scaffolding, climbing/descending ladders, and concrete forms during inspections. Collectively, these types of injuries account for nearly 50 percent of all occupational injuries and accepted disabling claims. Prevention requires alertness, following and enforcing proper procedures, and appropriate protective equipment.

FIRE PREVENTION

Fire extinguishers shall be provided so that the travel distance from any work area to the nearest extinguisher is less than 100 feet. When 5 gallons or more of a flammable or combustible liquid are being used, an extinguisher must be within 50 feet. Extinguishers must:

- be maintained in a fully charged and operable condition,
- be visually inspected each month, and
- undergo a maintenance check each year.

  - The area in front of extinguishers must be kept clear.
  - Combustible materials stored outside should be at least 10 feet from any building.
  - Solvent waste and oily rags must be kept in a fire-resistant, covered container until removed from the Site.
  - Flammable/combustible liquids must be kept in approved containers, and must be stored in an approved storage cabinet.

No incompatible materials, lighters, or matches are allowed in the exclusion zone. Equipment will be intrinsically safe or spark-proof unless authorized by the SSO.

ELECTRICAL HAZARDS, UTILITIES, AND POWER LINES

The Underground Service Alert (USA) or other local underground utility line locating service will be contacted a minimum of 48 hours prior to field activities involving intrusive activities are to commence. The underground utility locating service will notify private utility companies about their responsibility to locate and mark all buried utility lines. Underground utility locating services can typically be reached through an 800 number that is listed in the white pages for the local area. Alternatively, local law enforcement or fire prevention officials may be able to provide assistance in reaching local underground utility locating services. Be sure to understand what underground utilities will be defined by the locating service you have contact (i.e., the service may not contract with all possible utility providers in a given area.) It is important that the list of underground utilities contacted and verified include, at a minimum, the following:

- Electricity
- Gas
- Water
- Sewer
- Telephone

All field vehicles and heavy equipment will be maintained at a minimum distance of 20 feet in all vertical and horizontal directions from electrical power lines (energized lines) and/or electrical equipment with a voltage less than or equal to 50 kV. If the voltage exceeds 50 kV, the clearance shall be increased by four inches for every 10 kV over that voltage. SOP Section 206 provides additional information on electrical hazards, utilities, and power lines.

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Proposed subsurface investigation locations will be marked in the field prior to commencement of intrusive activities to allow site personnel to clear these locations for underground utilities. Hand augers or probes will be advanced manually to an approximate depth of 6 feet below grade in advance of the ROST probe, direct-push soil probe, and hollow stem augers at proposed locations based on potential presence of subterranean lines.

Underground Utilities

No Brown and Caldwell employee shall commence any drilling or excavation activity without prior underground utility clearance. Please use the table below to document underground utility clearance.

Organization	Case Number	Date
Texas One Call System 1-800-245-4545	_____	_____
Lone Star Notification Center 1-800-669-8344	_____	_____
Texas Excavation Safety Systems 1-800-344-8377	_____	_____
Elementis (Robbin Jackson) (contact through Kevin Frenzel)	_____	_____

Note: The above utility clearances expire after ten days. Renewal is required after the expiration of the clearance, if required.

Site Clearance Obtained:

YES _____ NO _____ By: _____ _____

(Name) **(Date)**

Utilities Checked:

_____ ELECTRIC:

_____ GAS:

_____ TELEPHONE:

_____ TV CABLE:

_____ WATER/SEWER:

_____ FIBER OPTIC CABLE:

Pipelines (Individually List)

Sunburn

Working outdoors on sunny days, or on overcast days, for extended periods of time can cause sunburn to the skin. Excessive exposure to sunlight is associated with the development of skin cancer. Field staff should take precautions to prevent sunburn by using sunscreen lotion and/or wearing hats and long-sleeved garments.

Heat Stress

The potential for heat stress is a concern when field activities are performed on warm, sunny days and is accentuated when chemical protective clothing is worn. Heat stress prevention measures and monitoring will be implemented if site temperatures are above 70 degrees Fahrenheit (F).

Precautions to prevent heat stress will include work/rest cycles so that rest periods are taken before excessive fatigue occurs and regular intake of water to replace water lost from sweating. Work/rest cycles will be based on results of monitoring the heart rate (pulse) of each individual worker. Rest breaks will be long enough to reduce the heart rate (HR) to levels below those calculated according to the following method:

1. The worker will initially determine his or her resting HR before starting work activities.
2. At the start of the first rest period, the worker will determine his or her HR. This initial HR should not exceed the individual's age-adjusted maximum HR, which equals [(0.7)(220 - age in years)]. At 1 minute into the rest period, the recovery HR will be determined. The recovery HR should not exceed 100 beats per minute.
3. If the initial HR exceeds the age-adjusted maximum HR, or the 1-minute recovery HR is greater than 110 beats per minute, then the next work period will be decreased by 10 minutes.

Heat stress due to water loss can be prevented. To prevent dehydration, water intake must approximate sweat loss. Water intake guidelines are as follows:

1. The sense of thirst is not an adequate regulator of water replacement needs during heat exposure. Therefore, water must be replaced at prescribed intervals.
    a. Before work begins, drink two 8-ounce glasses of water.
    b. During each rest period, drink at least two 8-ounce glasses

of water.

2. Plain water, served cool, is excellent. An adequate supply of potable water and drinking cups will be readily available, such as in a support vehicle, to provide water during rest periods.

3. Adding salt to water is not recommended. Acceptable alternatives to water include dilute fruit juices and electrolyte replacement drinks diluted 3:1 with water. Do not use salt tablets!

An initial work/rest cycle of 1-hour work and 15 minutes rest is recommended for protection of staff when the heat stress hazard is high. The recommended cycle will be adjusted up or down on the basis of worker monitoring data, environmental conditions, and the judgment of the SSO. If at any time field team members recognize the signs or symptoms of heat stress before a scheduled rest period, they will notify the SSO immediately in order that a rest period can be called.

Heat stress, if not prevented, results in heat stress illnesses. Two critical illnesses, if not recognized and treated immediately, can become life threatening. These are heat exhaustion and heat stroke. Heat exhaustion will result if the prevention measures described above are not implemented. Ignoring the signs and symptoms of heat exhaustion will lead to the development of heat stroke.

Heat stroke is an immediate, life-threatening condition that results because the body's heat-regulating mechanisms shut down and the body cannot cool itself sufficiently. As heat is excessively stored in the body, brain damage can result, causing permanent disability or death.

Heat Exhaustion

The signs and symptoms of heat exhaustion are headache, dizziness, nausea, weakness, fainting, profuse sweating, loss of appetite, approximately normal body temperature, dilated pupils, weak and rapid pulse, shallow and rapid breathing, possible cramps in abdomen and extremities, possible vomiting, difficulty walking, and/or skin that is cool and sweaty to the touch and pale to ashen-gray coloring.

First aid for heat exhaustion is as follows:

1. Immediately remove victim to the support area, or if you are the victim, proceed to the support area.

2. Decontaminate, if practical, before entering support area.

3. Start cooling, but be careful not to cause a chill (i.e., rest in shad and apply wet towel to forehead; open up and/or remove clothing to the extent practical, especially chemical-resistant clothing).
4. Have victim drink cool water slowly, but only if conscious and not in shock.
5. If the victim is vomiting and/or other signs and symptoms are not lessening within an hour, call for emergency help and/or transport the victim to the emergency room.

It is likely that a heat exhaustion victim will be unable to work for the remainder of the day.

Heat Stroke (a.k.a. Sun Stroke)

The signs and symptoms of heat stroke are skin that is hot and dry to the touch; flushing of the skin; body temperature > 105 degrees F; absence of sweating; mental confusion; deep, rapid breathing that sounds like snoring progressing to shallow, weak breathing; headache; dizziness; nausea; vomiting; weakness; dry mouth; convulsions, muscular twitching, sudden collapse; possible unconsciousness.

First aid for heat stroke is as follows:

1. Immediately remove the victim to the support area (before entering the support area, remove and dispose of the victim's chemical-resistant clothing).
2. Cool the victim rapidly using whatever means are available, including placing the victim in the shade, opening up and/or removing clothing, soaking clothing/skin with water and fanning, and placing the victim in vehicle using air conditioning on maximum.
3. Do not give drinking water to victim.
4. Treat for shock, if needed.
5. Transport the victim to the emergency room or call for emergency help; no exceptions for heat stroke victim.

3.3 Biological Hazards

The potential to encounter various reptiles, insects, and poison ivy/oak in the course of completing the work plan covered by this HASP is considered highly probable. The geographic location, the climate, the biota, and the location of the site tend towards the

creation of a suitable habitat for snakes, insects, and poison ivy/oak. Precautions will be taken by all on site personnel to avoid prime snake and insect habitats, to protect oneself, and assist other personnel from attack or encounter (Note: An encounter with a poisonous snake require immediate professional medical attention). If the real potential exists, certain protection equipment should be on hand, such as individual snakebite kits for each person on site.

Ants, bees, and wasps are considered to be the most common insects that may be encountered. Although their bite is not considered life-threatening, an allergic reaction to these bites could occur. Avoid insect habitats whenever possible. If bitten by insects, remove the stinger by gently scraping it out (do not use tweezers). Apply ice to the affected area. Instant ice packs are to be kept in the work area. If the worker is bitten by an insect, immediately apply an ice pack to the affected area and wash area with soap, apply antiseptic. If an allergic reaction occurs, transport worker to the closest medical facility for treatment.

Also, use protection against bacteria and other microbiota that could be present in the water and sediment. Be aware that mosquitoes are a common vector for human disease.

POISONOUS PLANTS

Many of our projects are located where there is a possibility of poisonous plants such as poison oak, poison ivy, and poison sumac. Contact with these plants can cause irritation with symptoms such as itching and inflammation, skin rash, swelling and weeping sores. Contamination can occur through direct or indirect contact with any part of the plant or by exposure to smoke from burning plants. Contact with clothes that have been contaminated can also cause an allergic reaction.

Plant Identification

Poison Ivy is a trailing or climbing woody vine or a shrub like plant with leaves that are each divided into three broad, pointed leaflets. The leaflets are commonly dark glossy green on top and slightly hairy underneath. They produce small yellowish or greenish flowers followed by berry-like drupes.

Poison Oak is a member of the same family as poison ivy and has very similar appearances. Poison oak has leaves divided into three leaflets and generally has three to seven distinct lobes. Typically, they are a shrubby type plant that can grow to eight feet in height, or sometimes can be a climbing plant.

Exposure Prevention

The best way to prevent exposure is the ability to recognize these plants, conduct an initial survey of the area to determine if the plants are present in the work area, and

avoid contact with them.

If plants are located and work must be conducted in that area, have the plants removed if possible. If this is not possible, wear long sleeved shirts, gloves, and a heavy material type pants. Remember not to touch contaminated clothing. There are products available on the market that can be applied to exposed skin, (similar to sunscreen products) prior to working around the plants.

Symptoms and Treatment

The first symptoms are reddening skin and itching. This usually occurs several hours after contact. Small watery blisters soon appear and itching becomes intense. In severe cases, large watery swellings appear and coalesce.

To care for poison plant contact, immediately wash the affected area thoroughly with soap and water. If a rash or weeping sore has already begun to develop, you may apply a boric acid solution, a paste of sodium bicarbonate (baking soda), and calamine or caladryl lotion to help soothe the area. Antihistamines, such as Benadryl may also help dry up the sores.

A physician should be consulted in severe cases, if sensitive parts of the body, such as eyelids and face, or if the condition gets worse and effects large parts of the body.

REPTILE AND INSECT BITES

Since the potential exists for possible serious bites from rattlesnakes and scorpions, care and preparation should be taken to mitigate the potential for injury to field staff employees. Certain protective equipment should be on hand, such as individual snakebite kits for each person on site.

Spiders and Other Insects

Almost all spiders produce toxic venoms, but their fangs are too small and weak to penetrate the skin, the venom is too weak, or the volume of venom is too small to pose a significant threat to humans. The black widow is the only spider found in the US that is capable of routinely producing serious illness by its bite. The “tarantula” native to the US Southwest bites only after extreme provocation. Its weak and ineffective fangs can only penetrate thin skin, such as that on the sides of the fingers; the effects of the bite are no worse than an insect sting.

Black Widow Spider

Widow spiders prefer to nest near the ground, in dark, undisturbed areas. Nest sites

often are near holes produced by small animals, or around construction openings and wood piles. Low shrubs also are common sites for widows to occur. Widows similarly occur in dark, undisturbed sites such as vaults, pipe, and outbuildings.

Symptoms

Painful rigidity of the abdominal wall muscles, tremors, nausea, vomiting, leg cramps, "tightness'" of chest, and rise of blood pressure. Severe cases are hallmarked by difficulty in breathing and unconsciousness, which may lead to death due to asphyxia preceded by convulsions. Fewer than 5 percent of people bitten by the black widow die.

First-aid

Apply ice pack, household ammonia or alcohol directly to the bite area to relieve local swelling and pain. Apply tincture of iodine or other antiseptic to the site of the bite to prevent infection. Bring along the spider for identification, if possible, should antivenin be available. Antivenin is available to treat some widow spider bites.

Brown Recluse Spider

The brown recluse spider lives throughout the Southern half of the United States. There are ten different species, six of which are confirmed to be poisonous. The spiders are tan to brown and most species exhibit a violin-shaped marking on the dorsum of the cephalothorax. They tend to live in dark dry spaces such as attics, closets and woodpiles, and generally they are not aggressive but rather bite when forced to.

The bite generally causes some mild stinging or burning and ulcerative necrosis may follow within several hours to several weeks. The initial lesion may be red,

edematous or blanched and later may develop a blue-gray halo around the puncture. Other clinical findings may include fever, maliase, a scarlatiniform rash, leukocytosis, arthralgias, vomiting, and diarrhea. In rare cases there may be hemoglobinuria and shock.

Bees

Typically, bees are not aggressive creatures. Their stingers are for defense, not attack. Honeybees die when they sting. Preventing stings is best for all concerned. Traditional insect repellents are of no use in preventing bee stings.

Effective prevention means not attracting bees and not frightening them if they are present. Prevention techniques are especially important in the fall, when most stings occur. It takes 2 million visits to flowers to make one pound of honey. In the autumn, as flowers disappear, bees search more widely for food and take more risks.

How to avoid stings?

Flowers attract bees by their fragrant aroma, their bright colors, and their sweet taste.

To avoid attracting bees, try the following:

- Avoid fragrances, including hair spray, scented soaps, lotions, and oils. Bees usually approach children with a sweet scent. Avon's Skin-So-Soft may make bees less apt to explore, and it is safe even on young children.
- Don't wear brightly colored clothing, particularly floral patterns, i.e. don't look like a flower patch. Bees also see in the ultraviolet range. If the pattern lights up under black light, it is particularly interesting to bees.
- Be very careful with food. Cans of soda are notorious: Bees climb in unobserved, and are frightened into stinging when the child drinks. Something as small as a forgotten raspberry jam stain on a sweater can be a problem.

If a bee does land, take steps to avoid frightening it:

- Hold still. Tell kids to pretend they're statues. Rapid movement startles the bee and encourages stinging.
- Try blowing gently on the bee. This can encourage it to move on while not startling it.
- Wear shoes. Bees will of course be frightened if you step on or near them. Shoes don't make them less frightened, but they do protect feet from frightened bees.
- Wear long pants when you know you are going to be in an area that is likely to have bees in it, such as a field.
- Wear a hat. Furry animals steal honey from bees. Bees are in a heightened state of readiness when they are close to hair or fur. They have been proven to have a lower threshold for stinging people with hats. The beekeeper today was wearing a pastel baseball cap.

First Aid

The bee's stinger is barbed. In the act of stinging, the stinger is torn from the bee, along with the venom-filled poison sac and attached muscles. The barbs continue to work the stinger deeper into the flesh for several minutes, while venom continues to be injected. The stinger should be removed with a scraping motion by using the rigid edge of a credit card or a dull butter knife. Never attempt to pull out the stinger using fingers or tweezers, since this will result in the injection of more venom."
If one is stung, the wound can be treated in the following ways:

- Remove the stinger with all haste, in whatever manner is most convenient. If you see a little black dot in the wound, part of the stinger is still present.
- Apply a solution of one part meat tenderizer to 4 parts water. Papain, the enzyme in meat tenderizer, breaks down the protein in bee venom responsible for the pain and itching. Don't leave this on for more than 30 minutes, or it can irritate the skin. If this isn't available, you might try an antiperspirant. Aluminum chlorohydrate reduces the effect of bee venom, but to a lesser extent.
- Apply cold. Use ice or cool water for 10 to 30 minutes after the sting. This blunts the body's allergic response.
- An antihistamine such as Benadryl, taken by mouth, can give some added relief, and help prevent the reaction from spreading.
- A shake lotion such as calamine can be helpful. A paste made of baking soda and water can have a similar effect.
- Topical hydrocortisone can also provide some symptomatic relief.
- Give acetaminophen or ibuprofen for systemic pain relief.

Scorpions

Scorpions are found throughout the US but the species lethal for man are limited to Arizona, New Mexico, Texas, Southern California, and northern Mexico. Stings can be avoided by exercising care when picking up stones, logs, or similar objects. Shoes and clothing kept in the field should be shaken vigorously before dressing. Scorpions are nocturnal creatures.

The lethal species are typically yellow to greenish yellow color and can be distinguished from other species by a small, knob-like projection at the base of their stingers. Adults measure about 3 inches in length and 3/8 inch in width. One subspecies has two irregular dark stripes down its back. Lethal scorpion stings are usually painful, but fatalities are generally limited to small children.

Symptoms of a scorpion sting include a pricking sensation initially; pain follows in 5 to 60 minutes and may be severe. The sting is sensitive to the touch. Tapping the site produces a painful tingling or burning sensation that travels up the extremity toward the body. Sensitivity may persist for up to ten days.

Only a medical facility has the equipment and supplies necessary to monitor and deal with any complications that may arise. An ice cube may be applied to the site to help reduce pain, but no other therapy is possible outside a hospital.

Snakes

The most common poisonous snake is the rattlesnake (pit vipers). Any snake that inflicts a bite should be precisely identified if possible. Many people are injured by unnecessary treatment for bites of nonpoisonous snakes. More significantly, a bite by a Mojave rattlesnake may produce very little reaction in the hours immediately after it occurs, when treatment is most effective. Only if the species of snake is known can optimal therapy be started without delay. Preferably, the snake should be killed and brought to a medical center with the person who was bitten so that the exact species can be determined.

Snakebites are best avoided, not treated!

Pit vipers are so named because they have a small pit located between the eye and the nostril, a feature found only in these poisonous species. The pit is an infrared sensing organ instrumental in detecting the small, warm-blooded animals these snakes eat. They have a characteristic triangle head and heavy body. Rattlesnakes belong to the pit viper family. If fangs are present, the snake is undoubtedly poisonous; however, searching for fangs is hazardous. If they have rattles they are obviously rattlesnakes and poisonous. However, the absence of rattles is not a good indicator because the rattles can be broken off, or even shed with the skin.

The reaction following the bite (envenomation) from a pit viper is one of the best indications that the snake was poisonous and is the only indication that envenomation has occurred and treatment may be needed. This reaction begins within minutes after the bite, but is usually less marked after other pit viper bites. The severity of the reaction varies depending on the species of snake. The earliest symptom is pain or burning at the site of the bite, although some people experience relatively little pain. Shortly afterward, the area begins to swell as fluid pours into the tissues. Bleeding usually produces a purple or green discoloration, but this change may take several hours to appear.

Following moderate envenomation, the swelling and discoloration extend farther from the site of the bite, large blisters containing clear or bloody fluid appear, and the regional lymph nodes (particularly in the armpit or the inguinal crease) become enlarged and tender. Severe envenomation is indicated by the development of a systemic reaction. The individual becomes weak and dizzy and develops signs of shock, particularly cold, clammy skin, and a weak pulse.

When the individual can be hospitalized within two hours time, the only treatment needed is limiting the spread of the venom and immobilizing the extremity. No other measures, particularly incision and suction, should be attempted. Tourniquets are not recommended to help reduce the spread of the venom because they are rarely applied correctly and commonly do more harm than good. The immobilized extremity should be kept at the same level as the heart, and the individual must be transported to a hospital with as little effort on his or her part as possible. No other treatment should be attempted. Wrapping of the wound should not be applied unless envenomation is known to be moderate or severe.

Copperheads

With their bands of gray and/or brown, the four subspecies of Texas copperheads are colored to blend in with leaf-covered forest floors. It's possible to stare right at a copperhead without seeing it. Fortunately, copperheads are the least dangerous poisonous snakes. Because they are so well camouflaged, most bites occur when a snake is accidentally picked up or sat or laid on. Always use care when picking up or flipping over logs, boards, old tin or other items where copperheads may be resting.

Copperhead

Cottonmouths

The cottonmouth, or water moccasin, rarely strays far from water and can be found in marshes, swamps, ponds, lakes, ditches, and canals in East and Central Texas and along the Gulf coast. It is a stubby, muscular snake and can grow to nearly six feet. Moccasins can bite underwater. These snakes can be very defensive and sometimes aggressive. Swimmers, bathers and anglers on river banks should always keep an eye open for these snakes.

Cottonmouth (water moccasin)

Pit Vipers

Any of the following "pit viper" snakes cause poisonous bites:

- Rattlesnake
- Copperhead
- Cottonmouth Water Moccasin

Symptoms of poisonous bites:

While each individual may experience symptoms differently, the following are the most common symptoms of poisonous snake bites:

- bloody wound discharge
- fang marks in the skin and swelling at the site of the bite
- severe localized pain
- diarrhea
- burning
- convulsions
- fainting
- dizziness
- weakness
- blurred vision
- excessive sweating
- fever
- increased thirst
- loss of muscle coordination
- nausea and vomiting
- numbness and tingling
- rapid pulse

Treating Snake Bites

Call for emergency assistance immediately if someone has been bitten by a snake. Responding quickly in this type of emergency is crucial. While waiting for emergency assistance:

- Wash the bite with soap and water.
- Immobilize the bitten area and keep it lower than the heart.
- Cover the area with a clean, cool compress or a moist dressing to minimize swelling and discomfort.
- Monitor vital signs.

If a victim is unable to reach medical care within 30 minutes, the American Red Cross recommends:

- Apply a bandage, wrapped two to four inches above the bite, to help slow the venom. This should not cut off the flow of blood from a vein or artery - the band should be loose enough to slip a finger under it.
- A suction device can be placed over the bite to help draw venom out of the wound without making cuts. These devices are often included in commercial snakebite kits.

Most often, physicians use antivenin -- an antidote to snake venom -- to treat serious snakebites. Antivenin is derived from antibodies created in a horse's blood serum when the animal is injected with snake venom. Because antivenin is obtained from horses, snakebite victims sensitive to horse products must be carefully managed.

Preventing snake bites:

Some bites, such as those inflicted when you accidentally step on a snake in the woods, are nearly impossible to prevent. However, there are precautions that can reduce your chances of being bitten by a snake. These include:

- Leave snakes alone. Many people are bitten because they try to kill a snake or get too close to it.
- Stay out of tall grass unless you wear thick leather boots and remain on hiking paths as much as possible.
- Keep hands and feet out of areas you cannot see. Do not pick up rocks or firewood unless you are out of a snake's striking distance.
- Be cautious and alert when climbing rocks.

4.0 TRAINING REQUIREMENTS

All BC staff working on site will have completed training in hazard recognition and basic health and safety issues as required by the occupational safety and health regulations contained in 29 CFR 1910.120(e). In addition, each employee will be familiar with the requirements of this HASP and will participate in site activity and safety briefings. All BC field personnel will provide their OSHA 1910 certification to El Paso's on-site coordinator (Kevin Frenzel) prior to the start of field activities.

Field personnel working at El Paso sites are required to review The EL Paso Energy Corporation Safety & Health Handbook. A copy of this document is attached as Appendix E. The project manager will be responsible to assure that field personnel receive, read, and understand the contents of this document and that a signed acknowledgement is on file. Field personnel will also be required to complete required safety orientation for the Elementis Facility prior to conducting the IM Investigation. The SSO will have completed the 8-hour Site Supervisor course, have current training in first aid and CPR, and any additional training appropriate to the level of site hazards.

5.0 PERSONAL PROTECTIVE EQUIPMENT

On the basis of the hazard analysis for this project, the following levels of Protection will be required and used (see items below). Changes to these specified items of PPE for each level of protection will not be made without the approval of the SSO.

The minimum level of PPE to be worn at this site is:

_____ Level A _____ Level B _____ Level C __X__ **Level D**

Level "D" Equipment Specifications

__X__	Hard Hat	__X__	Goggles	__X__	Safety Glasses
__X__	Steel Toed Boots	__X__	Hearing Protection	____	Cotton Work Gloves
_____	Surgical Gloves	_____	Tyvek	____	Poly-Coated Tyvek
_____	Face Shield	_____	Neoprene, Nitrile or Rubber Gloves		

Modified Level "D" Equipment Specifications

__X__	Hard Hat	__X__	Goggles	__X__	Safety Glasses
__X__	Steel Toed Boots	__X__	Hearing Protection	__X__	Work Gloves
____	Surgical Gloves	__X__	Coveralls or Tyvek	____	Poly-Coated Tyvek
____	Face Shield	____	Neoprene, Nitrile or Rubber Gloves		
____	Other Equipment				

Level "C" Equipment Specifications

__X__	Hard Hat	__X__	Goggles	__X__	Safety Glasses
__X__	Steel Toed Boots	__X__	Hearing Protection	____	Cotton Work Gloves
_____	Face Shield	__X__	Neoprene, Nitrile or Rubber Gloves – Outer		
__X__	Surgical Gloves - Inner	__X__	Coveralls or Tyvek	____	Poly-Coated Tyvek
__X__	Half or full-face respirator with organic vapor/acid gas cartridges.	____	Chemical resistant safety boots		
__X__	Other Equipment				

The End of Service Life (ESL) for cartridge change out is approximately 21.4 hours of actual use based on the respirator manufacturer's recommendation for organic vapor/acid gas cartridges (See attachment in Appendix D).

6.0 ENVIRONMENTAL MONITORING PLAN

Identification of potential hazards in the hazard analysis portion of this HASP identified the following need for initial and/or ongoing monitoring for assessment of exposure.

Environmental Monitoring Plan

Chemicals of Concern	Monitoring Instrument	Action Level Upgrade to Level C	Action Level Evacuate
Fuels and petroleum hydrocarbons – Gasoline based	PID w/Benzene Cal Gas PID w/Isobutylene Cal Gas FID w/Methane Cal Gas	4 ppm 6 ppm 10 ppm	40 ppm 60 ppm 100 ppm

Heat stress will be monitored as described in the hazard analysis portion of this HASP.

7.0 AIR MONITORING PLAN (AMP)

7.1 Air Monitoring Location and Frequency

Prior to entering an exclusion zone, all field personnel will, at a minimum, utilize the level of protection outline in this plan. Periodic confirmatory air sampling will be performed to ensure that field personnel are not exposed to airborne contaminant concentrations in excess of action levels.

BASELINE

Conducting a downwind and an upwind sampling walk-around survey of the exclusion zone perimeter will accomplish baseline (background) monitoring.

7.2 Monitoring of Active Work Areas

During the period of active work in any exclusion zone, real time monitoring and indirect monitoring will be performed by or under the direction of the SSO (or designated representative) in each active work area as deemed necessary. Real-time measurements will be made as near as feasible to the breathing zone of the worker with the greatest exposure potential in each active work area, (i.e. dropping and cutting tower). Any concentration above the action levels will be reported to the SSO and action taken. As a minimum real time measurements will be taken every fifteen minutes, or when task or exposure conditions change (whichever frequency is less). Real time measurements will cease being taken when enough historical data is generated to warrant its cessation. All indirect sampling media will be analyzed by an AIHA (American Industrial Hygiene Association) accredited laboratory.

7.3 Calibration of Monitoring Equipment

It is essential that each piece of Site monitoring equipment be calibrated on a routine basis. This assures that a given monitoring instrument is both working and working with a reasonable degree of accuracy. The manufacturers' instruction manual should always be available for specific calibration procedures and other information.

8.0 MEDICAL SURVEILLANCE REQUIREMENTS

Medical surveillance is conducted as a routine program for BC field staff in accordance with the requirements of 29 CFR 1910.120(f). There will not be any special medical tests or examinations required for staff involved in this project.

9.0 SITE CONTROL MEASURES

A map of the site is included as Figure 1.

Communication between field members will consist of verbal communication.

Local authorities will be contacted to establish traffic control patterns if required.

Emergency numbers are listed in the section 2.8.

9.1 Work Practices

Safe work practices are part of ensuring a safe and healthful working environment. These practices are standardized for all field activities, and it is the responsibility of BC employees to follow safe work practices when conducting field activities. Safe work practices to be employed during the entire progress of fieldwork are as follows:

1. Set up, assemble, and check out all equipment for integrity and proper function before starting work activities.
2. Do not use faulty or suspect equipment.
3. Use only new and intact protective clothing. Change the suit, gloves, etc., if they tear.
4. Do not use hands to wipe sweat away from face. Use a clean towel or paper towels.
5. Practice contamination avoidance at all times.
6. Do not smoke, eat, drink, or apply cosmetics while in the contaminated areas of the site, or before decontamination.
7. Wash hands, face, and arms before taking rest breaks and lunch breaks and before leaving the site and the end of the workday.
8. Check in and out with the SSO upon arrival and departure from the site.
9. Perform decontamination procedures completely as required by this HASP.
10. Notify the SSO immediately if there is an accident that causes an injury or illness.
11. Use the buddy system when working in the contaminated areas of the site.

12. Do no approach or enter an area where oxygen deficiency or toxic or explosive concentrations of airborne contaminants may exist without the proper personal protective equipment and appropriate support personnel.

13. Use respirators correctly and as required for the site; check the fit of the respirator with a negative or positive pressure test; do not wear respirator with facial hair or other conditions that prevent a face-to-facepiece seal; do not wear contact lenses when the use of a respirator is required.

14. There are no major chemical spills anticipated during this project.

10.0 DECONTAMINATION

Decontamination will take place in the decontamination area determined on site by the SSO. All workers, PPE, sampling equipment, and heavy equipment leaving established exclusion area will be decontaminated, as determined by the SSO, to prevent the spread of hazardous materials. All workers will wash hands, arms, and face after removing PPE. Disposable items will be bagged for disposal along with other hazardous wastes removed from property. Sampling equipment will be decontaminated using water and an alconox or equivalent detergent. Support vehicles are to be left outside the exclusion area so that decontamination of them will not be necessary. All heavy equipment will be steam-cleaned before removal from the site. There are no special emergency decontamination procedures anticipated for this project.

Deleted: identified on site and shown on Figure 1.

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Deleted: and before leaving the site.

Deleted: a steam cleaner and

11.0 EMERGENCY PROCEDURES

In the event of an emergency on site, the SSO will direct the course of action. It may be necessary for the SSO to depend on the other on-site personnel for assistance. The SSO will call for emergency assistance if needed. As soon as practical, the SSO will contact the PM, RHSC and the HSD. All staff assigned to this project will be briefed on the procedures and responsibilities for implemented.

The emergency shut-off switch for the drill rig will be identified, and all field personnel working in the area will be informed of its location and function during the site safety briefing.

The emergency telephone numbers to be used to call for assistance are listed in the Key Personnel and Responsibilities section with the reference list of project contacts (See Section 2.0).

11.1 Location of Emergency Medical Facilities (See Figure 2)

Christus Memorial Hospital
2606 Hospital Blvd.
Corpus Christi, Texas 78405-1818
Phone: (361) 902-4000

Driving Directions
From the site, go south on Buddy Lawrence Drive, turn east on Interstate 37 (I-37), turn south on the Crosstown Expressway (Hwy 288 south), take the 19TH Street/Morgan Ave. exit and turn west on Morgan Ave., turn right on Baylor Ave. and the road will intersect with Hospital Drive.

11.2 Accident Reporting Procedures

Immediately report all accidents, injuries, and/or chemical exposures to the Site Safety Officer, Cory Green, Lynn Wright, and Kevin Frenzel and Jerry Fields, RHSC.

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11.3 Chemical Spill Response and Reporting Procedures

Immediately report all chemical spills and releases to the Site Safety Officer, Cory Green, Lynn Wright, and Kevin Frenzel and Jerry Fields, RHSC.

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12.0 DOCUMENTATION

The implementation of the HASP must be documented to ensure employee participation and protection. In addition, the regulatory requirements must be met for record keeping on training, medical surveillance, injuries and illnesses, exposure monitoring, health risk information, and respirator fit-tests. Documentation of each employee's activities is maintained by the HSD in Walnut Creek, California.

Documentation of the implementation of this plan will be accomplished using Attachments A through E (included in Appendix B). Attachment A must be completed by each BC employee at the initiation of fieldwork for the project. The SSO is responsible for ensuring that each BC employee has completed this form and for submitting copies to the Health & Safety staff. The SSO is also responsible for completing the other attachments as required for a specific project. Copies should be maintained in the project file.

13.0 MISCELLANEOUS
(Special instructions, remarks, etc. Attach additional sheets as needed)

1. BC personnel will field proof all marked lines and all proposed excavation areas.
2. No eating, drinking or use of tobacco products will be allowed in areas where site investigation activities are being conducted.
3. All personnel will wash hands thoroughly before eating.

SITE SPECIFIC
PROJECT HEALTH AND SAFETY PLAN

FIGURES

Figure 1 Site Map

Figure 2 Hospital Route Map

SITE SPECIFIC
PROJECT HEALTH AND SAFETY PLAN

APPENDICIES

APPENDIX A	Material Safety Data Sheets
APPENDIX B	HS-BG-101 Forms
APPENDIX C	Electrical Hazards, Lock-out/Tag-out Procedures, & Noise/Hearing Conservation
APPENDIX D	The End of Service Life (ESL) for cartridge change out
APPENDIX E	El Paso Corporation Safety and Health Handbook

SITE SPECIFIC

PROJECT HEALTH AND SAFETY PLAN

APPENDIX-A: Material Safety Data Sheets

SITE SPECIFIC
PROJECT HEALTH AND SAFETY PLAN

APPENDIX-B: HS-BG-101 Forms

SITE SPECIFIC
PROJECT HEALTH AND SAFETY PLAN

APPENDIX-C: Electrical Hazards, Lock-out/Tag-out Procedures, & Noise/Hearing Conservation.

SITE SPECIFIC
PROJECT HEALTH AND SAFETY PLAN

APPENDIX-D: The End of Service Life (ESL) for cartridge change out.

SITE SPECIFIC
PROJECT HEALTH AND SAFETY PLAN

APPENDIX-E: El Paso Corporation Safety and Health Handbook

APPENDIX C

ROST INFORMATION

6105 Rookin
Houston, TX 77074
Tel: (713) 346-4000
Fax: (713) 346-4002

FUGRO GEOSCIENCES, INC.

TECHNICAL INFORMATION – INVESTIGATIVE SERVICES

Introduction

The Fugro organization has been developing and deploying cone penetrometer testing (CPT) systems since the early 1940's. We currently own and operate over 125 onshore and offshore cone deployment systems worldwide. Fugro developed the first electrical cone penetrometer in the 1960s, and has manufactured and utilized the industry standard in electronic cone penetrometers since that time.

In addition to developing the first electric cone penetrometers, Fugro has been a leader in adapting CPT technology to hydrogeologic and environmental site investigations. We have designed, manufactured, and commercialized numerous soil, soil gas, and groundwater sampling tools as well as in-situ delineation tools and systems. We have utilized these tools on numerous Department of Defense (DOD), Department of Energy (DOE), Department of Transportation (DOT), Superfund, and private industry site investigations. Services we have provided at these sites include:

- Hydrogeological soil characterization and determination of in-situ permeability's using Fugro's family of cone penetrometers.
- Delineation of petroleum hydrocarbons using laser-induced fluorescence (ROST™)
- Delineation of chlorinated solvents using our membrane interface probe (MIP).
- Determination of shear wave velocities using Fugro's seismic/piezocones.
- Determination of soil characteristics using our Marchetti Flat Dilatometer.
- Installation of push-in piezometers / monitoring wells using stainless steel and PVC materials.
- ORC, HRC, and various other types of bioremedial injections.
- Soil and groundwater sampling using our fleet of Geoprobe direct push rigs.
- Grouting of cone holes during or after retrieval of cones and/or cone rods.

The following pages provide a brief description of our CPT and related technologies.

Offices and Personnel

Fugro provides CPT services from our operational centers located in Los Angeles, CA, Baton Rouge, LA, Atlanta, GA, and our headquarters in Houston, TX. All field personnel have completed the OSHA HAZWOPER 40 Hour Training course and the necessary 8 Hour Refresher courses as required in OSHA 29 CFR. In addition, field personnel are trained in CPR and first aide. All field personnel are also on an annual medical monitoring program that includes annual and random drug-screening program.

In addition to the above-mentioned health and safety training, all Fugro personnel are involved in ongoing equipment and technical training on the services we offer. This training is provided by both in-house and outsourced training programs.

CPT Overview

Cone Penetration testing (CPT) is the technique of pushing various instruments directly into the earth to collect in-situ geotechnical and hydrogeological measurements and samples. Descended from the Mechanical Dutch Cone developed in the 1920s, CPT is now a well-recognized and accepted procedure for soil and groundwater investigations throughout the world. CPT test procedures and cone design specifications are outlined in ASTM Standard D-5778-95.

CPT soundings are performed by "pushing" tools into the earth. This is accomplished using hydraulic rams that are mounted inside the CPT rig. The weight of the CPT rig (approximately 25 tons) acts as a reaction force to the downward pushing action of the hydraulic rams. Also mounted in the CPT rig is an electrical system, which provides signal conditioning, excitation voltages, and 110 volt AC current for powering the rig's computer system, data measuring and recording devices.

The actual cone penetrometer consists of various load cells, which are monitored with strain gauges. Excitation voltages are carried to the strain gauges from the CPT rig's electrical system via an umbilical cable, which is pre-strung through the CPT rods. Testing is performed by advancing the cone at a constant rate of 2 cm per second, as stipulated in the ASTM standard, and adding CPT rods as necessary until the target depth is reached. Pressure readings from the load cells and strain gauges are carried back through the umbilical cable to the rigs analog strip chart recorder and laptop computer.

Measurements from the cone include resistance to advancement of a 60 degree conical "tip", drag friction along a cylindrical "sleeve" located immediately behind the tip, and angle of inclination. Tip and sleeve measurements are used to calculate friction ratio, ((Sleeve/tip)*100). Tip resistance and friction ratio are then used as primary components in determining soil type. In addition to the tip and sleeve readings, sensors can be added to the cone penetrometer to measure pore water pressures and electrical conductivity of soil.

As part of Fugro's QA procedures, readings from the cone penetrometer are recorded in both analog and digital formats. In addition, prior to each test, cone specific calibration factors are entered into the rigs signal conditioner, and electronic baselines are measured and recorded prior to and upon completion of each sounding.

Soil stratigraphy is classified using Robertson and Campanella's Simplified Soil Behavior Chart. Please note that the soil behavior chart is empirical in nature, and soil classification should be verified locally.

Fugro's Cone Penetrometer Equipment

The Fugro Cone Penetration Testing System is purpose-designed for collecting high quality geotechnical, hydrogeological, and environmental site characterization data. We utilize various tools for collection of in-situ data and for the collection of physical samples for analysis.

CPT Rigs

A primary component of any CPT system is the CPT rig. Fugro currently owns and operates ten (10) truck mounted CPT units, two (2) ATV-mounted units, and two (2) skid mounted unit in the USA. All of our rigs have self contained electrical, hydraulic, and climate control systems. These units range in weight from 15 to 35 tons and all have hydraulic jacking systems to lift and level the pushing platform. The "dead weight" of the rigs provides the reaction force necessary for advancing the CPT tools, eliminating the need for time-consuming earth anchoring.

Data Acquisition Systems

Our basic data acquisition system consists of an electronic signal conditioner, a three-pen analog strip chart recorder, a portable laptop computer, and a laser printer. When performing seismic cone testing we add a seismograph and trigger unit.

Standard CPT data Acquisition System

The data acquisition system converts the analog signal from the cone penetrometer to a digital signal, which is recorded and presented real time on the laptop computer. As stipulated in ASTM D-5778, Fugro uses a three-pen strip chart recorder to display the analog signals directly from the cone penetrometer. By recording the analog signals, we ensure an accurate recording of the collected data, regardless of the analog to digital conversion. Upon completion of testing, the strip chart record of the analog readings is compared to the digital readings recorded on the laptop computer. This comparison of analog to digital signals provides a quality control system to ensure that Fugro is providing our clients with the highest quality data in the industry.

Seismic Cone Acquisition System

Fugro's Seismic Cone Acquisition System (SECAS) is a user-friendly seismograph specially developed for seismic cone penetration testing. Its menu-driven interface controls all acquisition parameters using high performance, graphically oriented software.

The seismograph consists of a personal computer with a built-in data acquisition board, software, and a terminal box that is connected to the PC. The software is based on the DADiSP graphical spreadsheet. This spreadsheet software has been customized using menus, dialogue boxes, command files, macros, and additional C and FORTRAN programs. SECAS is suitable for both single array and dual array seismic cone testing. Seismic data is processed and presented using the Fugro "SEISPLT" software, which can be installed on the field computer.

Cone Penetrometers and Probes

Fugro, as a leader in onshore and offshore in-situ testing, understands the importance of quality cone penetrometers. All of Fugro's electronic cone penetrometers are equipped with inclinometers to verify verticality of testing and are temperature compensated. We have developed and utilized the following specialized cones:

- Standard Cone (Tip and Sleeve)
- Piezocone (Tip, Sleeve, and Pore Pressure)
- Conductivity Cone (Tip, Sleeve, and Electrical Conductivity of Soil)
- Seismic Piezocone (Single Array and Dual Array)
- Conductivity/Piezocone (Supercone – Tip, Sleeve, Pore Pressure and Conductivity)
- Natural Gamma Probe
- Laser Induced Fluorescence Probe (ROST™ LIF System)
- Membrane Interface Probe (MIP)
- Marchetti Flat Dilatometer

Fugro's cone penetrometers have undergone extensive testing by various educational and testing companies throughout the world. In addition, the Norwegian Geotechnical Institute ranked Fugro's as the most accurate and precise cones in the world.

Calibrations

Fugro's cone penetrometer manufacturing and calibration procedures include ISO 9001, ASTM D-5778, and European cone penetration standards. Fugro's cone penetrometer calibration test include load testing over the full range of output for each cone. Cones are tested and calibrated for the following:

Mechanical Calibration
- Cross-talk Check
- Dimension Check
- Seal / O-Ring Check

Electronic Calibration
- Temperature Effect
- Pre and Post Voltage Readings
- Full Scale Output Load Readings

Water Pressure Calibration
- Pore Pressure effect on tip and friction readings
- Seal / O-Ring Check
- Pore Pressure Transducer calibration

Fugro's cone penetrometer calibrations are checked and verified before and after each sounding. Periodic full-scale calibration will be conducted according to our Quality Assurance and Quality Control procedures.

Pore Pressure Dissipation Testing

Conducting pore pressure dissipation tests can identify the piezometric surface. The dissipation test involves stopping the advancement of the cone at any given depth and measuring the excess pore pressure decay with time. When the excess pore pressure is fully dissipated, the measured pore pressure will be the hydraulic head, which can be used to calculate the piezometric surface. The time required to achieve full dissipation of the excess pore pressure depends on the permeability of the soil surrounding the piezocone. In sandy soils, typically only a few minutes are required for full dissipation. However, full dissipation in clays can take up to several hours. For this reason, dissipation tests in clays are usually conducted to t_{50} levels.

Seismic Piezocone Testing

Fugro's seismic piezocones have either three (3) geophones (x, y, and z directions) single array or six (6) geophones, dual array (two arrays of three geophones located at 0.5 or 1.0 meter intervals) configurations. Testing is performed as outlined in ASTM D-5778 and "Seismic Cone Penetration Test" by Robertson, Campanella, and Gilliespie. Shear waves are transmitted into the ground by striking a wooden beam with a hammer. The wooden beam is coupled tightly with the ground using the weight of the Cone truck. By hitting the wooden beam alternately at opposite sides, shear waves with opposite polarity are produced. A seismograph is triggered by the hammer blows, and records the arrival time of the generated shear waves. Compression waves are generated by dropping a weight on the ground surface, and are recorded in a similar fashion to the shear waves. The arrangement of the wave source at ground surface and the geophones embedded within the cone assembly allow us to make pseudo-interval measurements of material damping as the cone is advanced. Waveforms are digitally recorded in the time domain for analysis in the office.

Dilatometer Testing

Dilatometer (DMT) testing is performed using a Marchetti DMT. The blade is constructed of high strength stainless steel to specifications outlined in the ASTM Suggested Method. Testing is performed by advancing the blade to predetermined test depths (typically 20 cm or 1 foot intervals). Gas pressure supplied through tubing from a control unit at the surface is then used to expand a thin membrane on the face of the blade. The operator determines the A-pressure required to initiate movement of the membrane and the B-pressure required to move the membrane's center 1 mm in to the soil. The gas pressure is then vented, and the blade is advanced to the next test depth.

Data determined by DMT testing includes:

- Tangent Modulus
- Lateral Stress
- Preconsolidated stress
- Water table and pressure (sands)
- Soil Stratigraphy
- Undrained shear strength (clays)
- Drained friction angle (sands)
- Young's Modulus
- Quick settlement calculations
- Compaction control
- P-Y curves for lateral loaded piles.

ROST – Laser Induced Fluorescence (LIF)

Fugro Geosciences' Rapid Optical Screening Tool (ROST) is used in conjunction with the CPT to screen soils for petroleum hydrocarbons and to determine the thickness of phase-separated product on the groundwater. The ROST system is a Laser-Induced Fluorescence (LIF) probe consisting of a tunable laser, fiber optic cables, a sapphire window mounted in the cone rods, an optical detection system, and a desktop computer. All of these systems are mounted in the CPT rig. ROST screening is performed simultaneously with a CPT sounding at each test location.

ROST screening is performed as follows:

The ROST system's laser generates 50 pulses of excitation energy, in the form of light, per second. Due to the tunable design of the system's laser, the wavelength of this excitation energy can be varied from 266 nanometers to 300 nanometers, depending on the optimum wavelength for a particular project. Typically, an excitation wavelength of 290 nanometers is used.

Prior to testing, two fiber optic cables are coupled with the CPT cable, and are then pre-strung through the CPT rods. Excitation energy created by the ROST system's onboard laser is carried through one of the fiber optic cables to the sapphire window mounted immediately behind the cone penetrometer. The excitation energy is then reflected through the sapphire window and is absorbed by any aromatic hydrocarbon molecules that are in contact with the window. This absorption of energy causes the aromatic hydrocarbons to emit fluorescence. A portion of this emitted fluorescence is carried to the onboard optical detection system via the second fiber optic cable. The emitted fluorescence is measured by the optical detection system in either single-wavelength mode (SWL) or multi-wavelength mode (MWL). Once the fluorescence has been measured, it is averaged into one reading per one-second intervals, (approximately one reading per 2-cm vertical interval) and is recorded on the ROST system's computer. Typically, measurements are made and recorded in the MWL mode.

In the MWL mode, the ROST system's optical detection device monitors the emitted fluorescence simultaneously for four (4) specific wavelengths (340, 390, 440, and 490 nanometers). These four monitored wavelengths represent the most common range of light produced by aromatic hydrocarbons consistent with light fuels through heavy contaminants such as coal tar and creosote. These four wavelengths also allow for the detection of multiple products that vary widely in molecular weight (i.e. kerosene and lubricating oil) and enhance the possibility of detecting additional hydrocarbons that may be present associated with DNAPLs or solvents. The monitored fluorescence is recorded and displayed in real time as a continuous fluorescence intensity versus depth graph.

Upon completion of testing a computer printout of the total fluorescence versus depth (FVD) graph is generated. In addition to the FVD graph, a second graph showing the measured fluorescence at each of the four monitored wavelengths as a relative percentage is presented as continuous "color bands". For general interpretation purposes,

lighter aromatic hydrocarbon molecules will emit fluorescence at the shorter monitored wavelengths, and heavier, longer chained, hydrocarbon molecules will emit fluorescence at the longer monitored wavelengths.

In many instances, comparison of the relative percentage of each monitored wavelength to a known reference product allows for interpretation of product type. However, product identification is often dependent upon the degree of similarity between the reference product and the in-situ product composition.

Fugro's Reference Solution:

To ensure system performance, and as a quality control check, the fluorescence intensity of a reference solution is measured prior to and upon completion of each test. This measurement of the reference solution also allows for the normalization of data from multiple test locations. The reference solution used is Fugro's standard M1 reference, which

is a proprietary petroleum hydrocarbon solution. M1 provides a consistent fluorescence response across all of the ROST monitored wavelengths, and therefore allows the collected fluorescence data to be consistently normalized to intensities recorded as a percentage of M1.

ROST is the only fluorescence sensor to have its performance independently verified by the U.S. Environmental Protection Agency (EPA). ROST was evaluated by EPA under the Environmental Technology Verification (ETV) Program in 1995. The resulting report concluded, "All developer's claims were met. Further, the system was demonstrated to be an effective, rapid in-situ field screening method for characterizing the subsurface and should meet the expectations of regulators or site owners interested in compliance with EPA's sampling guidance. The ROST system appears to be capable of meeting EPA's guidance of performance criteria for comparison of laboratory versus screening data."

Membrane Interface Probe

Fugro's Membrane Interface Probe (MIP) is deployed in conjunction with our CPT system or with one of our Geoprobe direct push rigs. The MIP is a screening tool for free phase and dissolved phase volatile organic compounds (VOCs). The MIP consists of a heater block and a hydrophobic, permeable membrane. The heater block heats the area around the permeable membrane causing vaporization of potential VOCs in soil or groundwater. The vaporized VOCs then diffuse through the membrane and are "swept" by an inert carrier gas to a detector system located in the CPT or MIP rig. This detector system consists of a Flame Ionization Detector (FID), a Photo Ionization Detector (PID), and a Dry Electrolytic Conductivity Detector (DELCD). These detectors are designed to identify VOCs ranging from aromatic hydrocarbons (BTEX, PAHs) chlorinated hydrocarbons (TCE, PCE, VC), and aliphatics (methane).

Data concerning soil type and potential contamination are reported real time on the CPT and MIP computers. Upon completion of testing, all data is given a thorough QA/QC check and reported in both digital and hard copy formats showing elevated detector readings versus depth. The digital data can then be imported into traditional mapping software to generate three dimensional models of the subsurface.

Push-In Soil Sampler

Fugro's push-in soil sampler consists of a sample barrel, cutting shoe, and a surface activated, retractable tip. The soil sampler is pushed to the required sampling depth with the tip locked into the cutting shoe with a latching mechanism. Once the sampling depth is reached, a weight is lowered from the rig, through the CPT rods, to release the latching mechanism. The retractable tip is then free to move upwards as the entire sample assembly is advanced the length of the sampler. Once the sample has been collected, the entire sampler assembly is retrieved to the surface.

Samples are collected in liners mounted inside the sample barrel. These liners can be constructed of various materials, including acetate, plastic, brass, and stainless steel. If necessary, catchers can be used in silty and sandy soils to prevent lose of sample as the sampler is retrieved to the surface. Once the sample has been collected and the sampler assembly retrieved to the surface, the liners are removed from the sample barrel for analysis. The entire assembly is then decontaminated for use at the next sampling location or the next sample depth.

Soil Gas Sampling

Fugro has several soil gas samplers designed for various applications. These samplers include discreet depth samplers that are pushed to a predetermined depth and collect a single soil gas sample, and multiple depth samplers that can collect multiple samples, or continuous samples as the sampler is advanced. These samplers can also be used in conjunction with a cone penetrometer to allow for the identification of specific sampling layers in the subsurface. All of our soil gas samplers allow for collecting samples in sample vials, Tedlar bags, or monitored with an FID/PID.

Groundwater Sampling

Fugro offers a variety of direct push groundwater samplers that may be selected based on project requirements, sampling conditions, and sample volume requirements. All of these samplers are designed to be depth discreet and to minimize the possibility of cross contamination. In addition, since all of these samplers are deployed with CPT techniques, no drill cuttings or fluids are generated during sampling. A brief description of each of these samplers follows:

Push-In Water Sampler

Fugro's standard Push-In Water Sampler consists of a stainless steel screen and screen housing. Sampling with the Push-In Water Sampler is performed by pushing the sampler to the predetermined sampling depth. During pushing, the screen is sealed in the screen housing with o-rings. These o-rings prevent any potential contaminants from coming in contact with the screen. Once the sampling depth has been reached, the rod string and screen housing are retracted one (1) screen length. Retracting of the rod string exposes the screen and allows natural hydrostatic pressure to push water through the screen and into the screen housing and rod string. A bailer or peristaltic pump is then used to extract the groundwater sample. Screen lengths can vary from 6 inches, to three (3) feet. Upon completion of sampling the entire sampler and rod string are retrieved from the borehole for decontamination and reuse.

Advantages of this sampler include an unlimited sample volume, flexible screen lengths, and the fact that if the formation does not quickly produce groundwater, the rod string can be disconnected from the CPT rig, and the rig can move to the net sampling location. When sample collection is completed, the CPT rig then moves back over the rod string and retracts the sampler.

Hydro-Trap

The Hydro-Trap is a depth discreet groundwater sampler that collects groundwater samples without exposure to ambient atmosphere or conditions. The Hydro-Trap consists of a stainless steel screen, a sample chamber, a check valve assembly and an umbilical gas tube. Sampling is performed by pushing the Hydro-Trap to the predetermined sampling depth with the screen closed and sealed inside the sample chamber. When the sampling interval has been reached, inert gas pressure is applied to the sample chamber and the rod string is retracted one (1) screen length. Retracting of the rod string exposes the screen. Hydrostatic pressure then pushes groundwater through the screen and into the sample chamber. This inflow of groundwater is monitored at the surface. Once the sampler is full, inert gas pressure is again applied to the sample chamber. This gas pressure closes and seals the check valve assembly, "trapping" the groundwater sample. The entire assembly is then retrieved to the surface where the sample is decanted directly into sample vials for laboratory analysis.

Advantages of the Hydro-Trap include the collection of a high quality sample that has minimal exposure to ambient air and therefore allows little or no volatilization to occur. A limiting factor of the Hydro-Trap is its limited sample volume of approximately 750 ml.

ConeSipper®

The ConeSipper® is a groundwater sampler designed for collecting samples at multiple depths in conjunction with a CPT sounding. The ConeSipper consists of a three (3) inch stainless steel screen and a series of check valves and

tubes. The ConeSipper is attached into the CPT rod string immediately behind the cone penetrometer. Once the CPT/ConeSipper assembly has entered the water table, pushing can be stopped at any interval and a groundwater sample collected. Samples are collected by allowing hydrostatic pressure to push water through the screen and into a small sample chamber. Inert gas is then used to activate the check valve and "lift" the sample to land surface. Upon completion of sampling, the sample tubes and valves are purged with inert gas or distilled water and the CPT/ConeSipper assembly is advanced to the next sampling depth.

Advantages of the ConeSipper include collecting CPT data as the sampler is advanced, and speed of sampling due to the fact that the sampler is not withdrawn between sample depths. A disadvantage of this system is that thorough decontamination is not performed between sample depths, which increases the possibility of cross contamination.

Push-In Well Points / Piezometers

Well points and piezometers can also be installed using CPT techniques. Installation is performed by advancing a steel casing and sacrificial "dummy" tip to the desired piezometers depth. Piezometer material (stainless steel or PVC) is then lowered through the casing. Once the piezometer is in place, the steel casing is retrieved to land surface, leaving the dummy tip and piezometers in place.

Advantages of push-in piezometers and well points is that any combination of screen length and riser can be used, a long term sample point is left in the ground, no cuttings or drill fluids are generated during installation, and that numerous points can be installed per day.

Borehole Abandonment and Decontamination

Fugro understands the importance of properly abandoning the remaining boreholes upon completion of testing. A support truck and grout trailer accompanies all of our CPT rigs. The grout trailer includes a water tank, grout mixer, and grout pump, typically an L3 moyno pump. We provide two (2) primary methods for borehole abandonment, tremmie pipe and dummy tip. The tremmie pipe grout method is performed by inserting PVC tremmie pipe into the open borehole. Grout is then pumped through the tremmie pipe to allow for jetting the tremmie pipe to total depth. Once total depth has been reached, the tremmie pipe is withdrawn from the borehole as grout is injected. The dummy tip rod method is performed by using the CPT rig to push dedicated CPT rods and a sacrificial tip down the remaining borehole upon completion of testing. Once the grout rods have been inserted, grout is pumped through the rods and into the formation as the grout rods are retracted. On larger projects we can provide a dedicated "pull truck" to retrieve the grout rods, allowing the CPT rig to move to the next sampling location.

In addition to the grout equipment, Fugro mobilizes complete decontamination equipment to our jobsites. This includes a pressure washer/steam cleaner and materials to construct a fluid containment system. Decontamination procedures are typically dictated by project requirements. However, we have experience using the seven (7) step EPA approved method that includes steam cleaning, detergent scrub, deionized water rinse, and alcohol spray.

Geoprobe® Direct Push Sampling Systems

Fugro offers a fleet of Geoprobe® units that include both 5400 and 6600 series probe machines mounted on 4 x 4 trucks, vans, skids and all-terrain vehicles. Geoprobe® direct push rigs utilize a combination of static hydraulic force and a percussion hammer to advance sampling tools. We utilize both in-house and commercially available Geoprobe soil and groundwater sampling tools. In addition, we can install direct push wells up to two (2) inches in diameter with some of our Geoprobe rigs. As with our CPT rigs, complete grouting and decontamination are available with our Geoprobe units.

Fugro's Experience

Fugro has successfully completed environmental and geotechnical at industry, DOE and DOD sites throughout the United States, and Central and South America. The following information summarizes our involvement in selected site investigations.

(1)	Name/Location of Project:	Wood Preserving Facility
		Houston, Texas
	Owner/Client:	Terranext
	Site Activities:	CPT/ROST™ were used to provide real-time, in-situ characterization of stratigraphy and distribution and differentiation of contaminants across an approximately 30-acre site. More than 40 CPT/ROST™ soundings (2,165+ft) were completed in 5 ½ days. Vertical and lateral distributions of creosote wastes were delineated within surface soils without sampling. A minimal number of soil samples were then selectively collected to confirm the understanding of subsurface conditions.
	Contact:	Mr. Roger Lamb (Jacobs Engineering Group, Inc. – 913-429-9218)
(2)	Name/Location of Project:	Robins Air Force Base Macon, Georgia
	Owner/Client:	RUST / Earth Tech
	Site Activities:	All Fugro Geoscience's services were utilized including CPT/ROST™ to delineate the extent of JP-5 and JP-8 jet fuel released at the base. Over 125 CPT/ROST soundings were completed to depths ranging from 20 to 180 feet.
	Contact:	Mr. Jim Aldridge 912-329-8870
(3)	Name/Location of Project:	Savannah River Site Aiken, South Carolina
	Owner/Client:	DOE / MACTEC, Inc.
	Site Activities:	25 CPT/Soil Gas soundings were completed to an average of 100 feet. Based on the soil gas sampling results, Fugro installed over 100 2-inch diameter stainless steel wells to depths ranging from 50 feet to 110 feet.
	Contact:	Mr. Martin Lunn 803-652-3785
(4)	Name/Location of Project:	Navy CLEAN I Program
		Marine Corps Air Station
		Yuma, Arizona
	Owner/Client:	Jacobs Engineering Group, Inc.
	Site Activities:	Base-wide site investigation operating 24 hours per day was carried out over a six-month period. Cone penetration testing, soil and ground water sampling operations were conducted.
	Contact:	Mr. Jeffrey L. Weiner 818-568-7158
(5)	Name/Location of Project:	Woodrow Wilson Bridge Expansion Washington DC
	Owner/Client:	DOT / Haley & Aldrich
	Site Activities:	Over 75 Piezocone Penetrometer Testing (PCPT) and pore pressure dissipation tests were performed in conjunction with a major multi-lane bridge expansion design. Out track mounted ATV unit was utilized.
	Contact:	Mr. Richard Allen 904-269-7012

(6)	Name/Location of Project:	Hill Air Force Base
		Utah
	Owner/Client:	Montgomery Watson
		Radian Corporation
		CH2M Hill
	Site Activities:	Standard, piezocone and conductivity cone penetrometer tests were conducted. Also, soil-gas, soil and ground water samples were collected throughout the base.
	Contact:	Mr. Dave Shank 801-272-1900
(7)	Name/Location of Project:	Vienna PCE Superfund Site Vienna, West Virginia
	Owner/Client:	EPA / CDM Federal
	Site Activities:	Over 70 locations were multiple depth groundwater samples were collected using the ConeSipper® from depths ranging from 60 feet to 110 feet throughout a residential neighborhood. Decontamination, borehole abandonment, and concrete coring were also performed.
	Contact:	Mr. Richard Douchette 703-968-0900
(9)	Name/Location of Project:	Navy CLEAN II Program
		North Island Naval Air Station
		Long Beach Naval Shipyard
	Owner/Client:	Bechtel National, Inc.
	Site Activities:	Piezocone penetrometer testing, soil and ground water sampling were conducted, including grouting remaining holes.
	Contact:	Ms. Carol Fenner 619-687-8717 or Mr. Hank Jong 818-449-2171
(10)	Name/Location of Project:	Naval Weapon Industrial Reserve Plant (NWIRP)
		Dallas, Texas
	Owner/Client:	Ensafe/Allen & Hoshall
	Site Activities:	Performed cone penetrometer testing throughout the site in order to determine subsurface stratigraphy including the top of bed rock. Also ground water sampling operations were also conducted
	Contact:	Mr. Ray Kruse 901-383-9115

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Phone (225) 292-5082
Fax (225) 292-8084
Contact: Mr. Ray Reed

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
Washington, D.C. 20460

ET
ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM VERIFICATION STATEMENT

TECHNOLOGY TYPE:	**CONE PENETROMETER-DEPLOYED SENSOR**
APPLICATION:	**IN-SITU DETECTION OF PETROLEUM HYDROCARBONS**
TECHNOLOGY NAME:	**RAPID OPTICAL SCREENING TOOL (ROST)**
COMPANY:	**FUGRO GEOSCIENCES, INC.**
ADDRESS:	**6105 ROOKIN, HOUSTON, TEXAS 77074**
PHONE:	**713/778-5580**

The U. S. Environmental Protection Agency (EPA) has created a program to facilitate the deployment of innovative technologies through performance verification and information dissemination. The goal of the Environmental Technology Verification (ETV) Program is to further environmental protection by substantially accelerating the acceptance and use of improved and more cost effective technologies. The ETV Program is intended to assist and inform those involved in the design, distribution, permitting, and purchase of environmental technologies. This document summarizes the results of a demonstration of a cone penetrometer-deployed Rapid Optical Screening Tool (ROST™) marketed by Fugro Geosciences, Inc.

PROGRAM OPERATION

The EPA, in partnership with recognized testing organizations, objectively and systematically evaluates the performance of innovative technologies. Together, with the full participation of the technology developer, they develop plans, conduct tests, collect and analyze data, and report findings. The evaluations are conducted according to a rigorous demonstration plan and established protocols. EPA's National Exposure Research Laboratory which conducts demonstrations of field characterization and monitoring technologies, selected the U. S. Department of Energy's Sandia National Laboratories as a testing organization.

DEMONSTRATION DESCRIPTION

In May and October, 1995, two cone penetrometer-deployed sensor systems were demonstrated to evaluate how well they could measure subsurface petroleum hydrocarbon contamination. The performance of each system was evaluated by comparing field analysis results to those obtained using conventional sampling and analytical methods. These methods included using a hollow stem auger in conjunction with a split spoon sampler and subsequent analysis of the collected sample by a reference laboratory using EPA Method 418.1 for total recoverable petroleum hydrocarbons (TRPH) and California Department of Health Services Method 8015-Modified for total petroleum hydrocarbons.

The primary objectives of the demonstration were to (1) verify technology performance, (2) determine how well the developer's field instrument performs in comparison to conventional laboratory methods, (3) determine the logistical and economic resources needed to operate the instrument, and (4) produce a verified data set for use in considering the technology for future use in hazardous waste investigations.

Field demonstrations were conducted at two geologically and climatologically different sites: (1) the Hydrocarbon National Test Site located at Naval Construction Battalion Center (NCBC) Port Hueneme, California, and (2) the Steam Plant Tank Farm at Sandia National Laboratories (SNL), Albuquerque, New Mexico. The conditions at each of these sites represent what are considered typical under which the technology would be expected to operate, but are not considered all inclusive. Details of the demonstration, including a data summary and a discussion of results may be found in the report entitled "The Rapid Optical Screening Tool (ROST™) Laser Induced Fluorescence System for Screening Petroleum Hydrocarbons in Subsurface Soil." The EPA document number for this report is EPA/600/R-97/020.

TECHNOLOGY DESCRIPTION

The ROST™ sensor evolved from the tunable laser instrumentation originally developed at North Dakota State University (NDSU) with U.S. Air Force research support. The technology had been commercialized and marketed by a consortium of government and industry led by Loral Corporation and Dakota Technologies. ROST™ was acquired by Fugro Geosciences, Inc., in May 1996 and is now offered as an integrated service with their cone penetrometer (CPT) systems worldwide.

The sensor uses a wavelength tunable ultraviolet laser source coupled with an optical detector to measure fluorescence via optical fibers, a technique known as laser-induced fluorescence spectroscopy (LIF). The measurement is made through a sapphire window on a probe that is pushed into the ground with a truck-mounted cone penetrometer. The optical fibers are integrated with the geotechnical probe and umbilical of the CPT system.

During the period of this demonstration, the ROST™ technology was available for use within the 48 contiguous United States for a cost of approximately $5,300 per day or site-specific footage rates, which includes a CPT rig provided by a commercial vendor. Crew per diem and mobilization costs are additional and site specific. The ROST™ subassembly can be integrated with any commercially available industry-standard CPT rig. Typical crew members include a ROST™ system operator, CPT operator, and an assistant. Under normal conditions, an average of 300 feet of pushes can be completed in a day. This translates to a total cost of under $20 per foot. As of January 1997, Fugro has reduced the cost for the ROST™ and a CPT to approximately $4250 per day.

VERIFICATION OF PERFORMANCE

The findings of the demonstration are as follows:

- The ROST™ system was easily integrated with a conventional cone penetrometer truck. Full integration was accomplished in less than two hours.

- Data was collected every 0.2 ft. or less if the cone slowed or stopped. Push rate is dependent on the CPT. Standard data collection rate is one sample per 1.2 seconds.

- At Port Hueneme, the correlation with conventional TPH analysis was 89.2% with 5.4% false negatives. At the Sandia tank farm, the TPH correlation was 93.4% with 3.3% false negatives.

- Real time data acquisition was achieved at both sites.

The results of this study satisfied the requirements of the demonstration plan. The ROST™ system successfully located the perimeter of the plume and showed acceptable correlation to conventional methods. The false negative rate combined from both demonstrations was less than 5% and was within the performance specifications of the instrument. Any disagreements with the laboratory results were primarily confined to regions where contaminant concentration levels were close to the detection threshold. A portion of these discrepancies could be the result of variability in laboratory results where random errors are estimated to be in the range of 10 to 15 percent.

The ROST™ system is an emerging technology worthy of consideration for site investigations where aromatic hydrocarbons (e.g., petroleum, oils, lubricants, and coal tars) are suspected. The technology offers a number of advantages over conventional drilling and sampling technologies for the purpose of screening a site to determine the nature and extent of contamination. The information obtained from this technology could provide a complete picture of the contamination and it can be used to predict optimal sampling locations. As with any technology, there are some limitations which a prospective user should be aware when designing an environmental investigation. Stratigraphy and unidentifiable fluorescent interferences are issues that could prevent the sole use of the ROST™ LIF system. The technology has been used to identify lighter fuels but this capability was not evaluated in these demonstrations. Because the technology does not provide species-specific quantitation, it should be used in conjunction with conventional sampling and analysis if risk assessment or cleanup criteria must be met. As a screening technology to identify the nature and extent of aromatic hydrocarbon contamination, this technology has many advantages over conventional techniques.

Gary J. Foley, Ph.D.
Director
National Exposure Research Laboratory
Office of Research and Development

NOTICE: EPA verifications are based on an evaluation of technology performance under specific, predetermined criteria and the appropriate quality assurance procedures. EPA makes no expressed or implied warranties as to the performance of the technology and does not certify that a technology will always, under circumstances other than those tested, operate at the levels verified. The end user is solely responsible for complying with any and all applicable Federal, State and Local requirements.

APPENDIX D

WATER WELL DRILLERS AND PUMP INSTALLERS RULES, 16 TAC 76

Texas Department of Licensing and Regulation

P.O. Box 12157
Austin, Texas 78711
(512) 463-6599 or (800) 803-9202 (in Texas)

TDLR's Enabling Statute
Air Conditioning and Refrigeration
Architectural Barriers
Auctioneers
Boilers
Career Counselors
Combative Sports
Elevators, Escalators and Related Equipment
Industrialized Housing and Buildings
Licensed Court Interpreters
Personnel Employment Services
Property Tax Consultants
Service Contract Providers
Staff Leasing Services
Talent Agencies
Temporary Common Worker
Transportation Service Providers
Vehicle Protection Product Warrantors
Water Well Drillers and Pump Installers
Weather Modification

Water Well Drillers and Pump Installers Administrative Rules, Sections 76.1001 through 76.1010

76.1001. Technical Requirements - Standards of Completion for Water Wells Encountering Undesirable Water or Constituents. *(Effective January 3, 1999, 23 TexReg 13059; section repealed effective November 8, 2001, 26 TexReg 8814; new section effective November 8, 2001, 26 TexReg 8814)*

If a well driller knowingly encounters undesirable water or constituents and the well is not plugged or made into a completed monitoring well, the licensed well driller shall see that the well drilled, deepened, or altered is forthwith completed in accordance with the following:

(1) When undesirable water or constituents are encountered in a water well, the undesirable water or constituents shall be sealed off and confined to the zone(s) of origin.

(2) When undesirable water or constituents are encountered in a zone overlying fresh water, the driller shall case the water well from an adequate depth below the undesirable water or constituent zone to the land surface to ensure the protection of water quality.

(3) The annular space between the casing and the wall of the borehole shall be pressure grouted with positive displacement technique or the well is tremie pressured filled provided the annular space is three inches larger than the casing with cement or bentonite grout from an adequate depth below the undesirable water or constituent zone to the land surface to ensure the protection of groundwater. Bentonite grout may not be used if a water zone contains chlorides above one thousand five hundred (1,500) parts per million (milligrams per liter) or if hydrocarbons are present.

(4) When undesirable water or constituents are encountered in a zone underlying a fresh water zone, the part of the wellbore opposite the undesirable

TDLR Home
Online Services
Report Violations online
Well Construction and Plugging Specifications
Texas Well Report Submission and Retrieval System
Water Well Driller and Pump Installer Forms
Frequently Asked Questions

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76.200. License Requirements - General
76.201. Requirements for Issuance of a License
76.202. Applications for Licenses and Renewals
76.203. Examinations
76.204. License Renewal
76.205. Registration for Driller or Pump Installer Apprenticeship
76.206. Responsibilities of the Apprenticeship
76.220. Continuing Education
76.300. Exemptions
76.600. Responsibilities of the Department - Certification by the xecutive Director
76.601. Responsibilities of the Department - General
76.602. Responsibilities of the Department - Undesirable Water
76.650. Advisory Council
76.700. Responsibilities of the Licensee - State Well Reports
76.701. Responsibilities of the Licensee - Reporting Undesirable Water or Constituents
76.702. Responsibilities of the Licensee and Landowner Well Drilling, Completion, Capping and Plugging
76.703. Responsibilities of the Licensee - Standards of Completion for Public

water or constituent zone shall be filled with pressured cement or bentonite grout to a height that will prevent the entrance of the undesirable water or constituents into the water well. Bentonite grout may not be used if a water zone contains chlorides above one thousand five hundred (1,500) parts per million (milligrams per liter) or if hydrocarbons are present.

(5) For class V injection wells, which encounter undesirable water or constituents, the driller must comply with applicable requirements of the Texas Natural Resource Conservation Commission under 30 TAC, Chapter 331.

76.1002. Technical Requirements - Standards for Wells Producing Undesirable Water or Constituents. ***(Effective January 3, 1999, 23 TexReg 13059; section repealed effective November 8, 2001, 26 TexReg 8814; new section effective November 8, 2001, 26 TexReg 8814)***

(a) Wells completed to produce undesirable water or constituents shall be cased to prevent the mixing of water or constituent zones.

(b) The annular space between the casing and the wall of the borehole shall be pressured grouted with cement or bentonite grout to the land surface. Bentonite grout may not be used if a water zone contains chloride water above one thousand five hundred (1,500) parts per million (milligrams per liter) or if hydrocarbons are present.

(c) Wells producing undesirable water or constituents shall be completed in such a manner that will not allow undesirable fluids to flow onto the land surface except when the Department's authorization is obtained by the landowner or the person(s) having the well drilled.

76.1003. Technical Requirements - Re-completions. ***(Effective January 3, 1999, 23 TexReg 13059; section repealed effective November 8, 2001, 26 TexReg 8814; new section effective November 8, 2001, 26 TexReg 8814)***

The landowner shall have the continuing responsibility of ensuring that a well does not allow the commingling of undesirable water or constituents with fresh water through the wellbore to other porous strata.

(1) If a well is allowing the commingling of undesirable water or constituents and fresh water or the unwanted loss of water, and the casing in the well cannot be removed and the well re-completed in

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accordance with the applicable rules, the casing in the well shall be perforated and squeeze cemented in a manner that will prevent the commingling or loss of water. If such a well has no casing then the well shall be cased and cemented, or plugged in a manner that will prevent such commingling or loss of water.

(2) The Executive Director may direct the landowner to take proper steps to prevent the commingling of undesirable water or constituents with fresh water, or the unwanted loss of water.

76.1004. Technical Requirements - Standards for Capping and Plugging of Wells and Plugging Wells that Penetrate Undesirable Water or Constituent Zones. ***(Effective January 3, 1999, 23 TexReg 13059; section repealed effective November 8, 2001, 26 TexReg 8814; new section effective November 8, 2001, 26 TexReg 8814)***

(a) If a well is abandoned or deteriorating, all removable casing shall be removed from the well and the entire well pressure filled via a tremie pipe with cement from bottom up to the land surface.

(b) In lieu of the procedure in subsection (a) of this section, the well shall be pressure filled via a tremie tube with clean bentonite grout of a minimum 9.1 pounds per gallon weight followed by a cement plug extending from land surface to a depth of not less than two (2) feet, or if the well to be plugged has one hundred 100 feet or less of standing water the entire well may be filled with a solid column of 3/8 inch or larger granular sodium bentonite hydrated at frequent intervals while strictly adhering to the manufacturers' recommended rate and method of application. If a bentonite grout is used, the entire well from not less than two (2) feet below land surface may be filled with the bentonite grout. The top two (2) feet above any bentonite grout or granular sodium bentonite shall be filled with cement as an atmospheric barrier.

(c) Undesirable water or constituents, or the fresh water zone(s) shall be isolated with cement plugs and the remainder of the wellbore filled with clean bentonite grout of a minimum 9.1 weight followed by a cement plug extending from land surface to a depth of not less than two (2) feet.

(d) Large diameter hand dug and bored wells to one hundred (100) feet in depth may be plugged by back filling with compacted clay or caliche to surface. Leave mounded to compensate for settling.

(e) Drillers may petition the Department, in writing, for

a variance from the methods stated in subsection (a) of this section. The variance should state in detail, an alternative method proposed and all conditions applicable to the well that would make the alternative method preferable to those methods stated in subsections (a) and (b) of this section.

(f) A non-deteriorated well which contains casing in good condition and is beneficial to the landowner can be capped with a covering capable of preventing surface pollutants from entering the well and sustaining weight of at least four hundred (400) pounds and constructed in such a way that the covering cannot be easily removed by hand.

76.1005. Technical Requirements - Standards for Water Wells (drilled before June 1, 1983). ***(Effective January 3, 1999, 23 TexReg 13059; section repealed effective November 8, 2001, 26 TexReg 8814; new section effective November 8, 2001, 26 TexReg 8814)***

(a) Wells drilled prior to June 1, 1983, unless abandoned, shall be grandfathered from this chapter without further modification unless the well is found to be a threat to public health and safety or to water quality. The following will be considered a threat to public health and safety or to groundwater quality:

(1) annular space around the well casing is open at or near the land surface;

(2) an unprotected opening into the well casing that is above ground level;

(3) top of well casing below known flood level and not appropriately sealed;

(4) deteriorated well casing allowing commingling of aquifers or zones of water of different quality.; and

(5) water wells with the well head below ground level unless the Department grants a variance.

(b) If the annular space around the well casing is not adequately sealed as set forth in this section, it shall be the responsibility of each licensed driller or licensed pump installer to inform the landowner that the well is considered to be a deteriorated well and must be recompleted when repairs are made to the pump or well in accordance with this chapter, and the following specifications.

(1) The well casing shall be excavated to a minimum depth of four (4) feet and the annular space shall be filled from ground

level to a depth of not less than four (4) feet below the land surface with cement. In areas of shallow, unconfined groundwater aquifers, the cement need not be placed below the static water level. In areas of shallow, confined groundwater aquifers having artesian head, the cement need not be placed below the top of the water bearing strata.

(2) A cement slab or sealing block shall be placed above the cement around the well at the ground surface except when a pitless adapter as described in §76.1000 (d)(2) of this title (relating to Technical Requirements - Locations and Standards of Completion for Wells) or a steel or plastic sleeve as described in §76.1000(d) (1) of this title is used.

(A) The slab or block shall extend laterally at least two (2) feet from the well in all directions and have a minimum thickness of four inches.

(B) The surface of the slab shall be sloped to drain away from the well.

(C) The top of the casing shall extend a minimum of twelve 12 inches above ground level or thirty six 36 inches above known flood prone areas and unprotected openings into the well casing that is above ground shall be sealed water tight.

(3) If deteriorated well casing is allowing commingling of aquifers or zones of water of different quality and causing degradation of any water including groundwater, the well shall be plugged according to §76.1004 of this title (relating to Technical Requirements - Standards for Capping and Plugging of Wells and Plugging Wells that Penetrate Undesirable Water or Constituent Zones) or repaired. Procedures for repairs shall be submitted to the Department for approval prior to implementation.

(c) If a licensed well driller or pump installer finds any of the procedures described by this section to be inapplicable, unworkable, or inadequate, alternative procedures may be employed provided that the

proposed alternative procedures will prevent injury and pollution and that the procedures shall be submitted to the Department for approval prior to their implementation, except for class V injection wells pursuant to 30 TAC, Chapter 331.

(d) Well covers shall be capable of supporting a minimum of four hundred 400 pounds and constructed in such a way that they cannot be easily removed by hand.

(e) This section shall not apply to a public water supply system well.

76.1006. Technical Requirements - Water Distribution and Delivery Systems. ***(Effective January 3, 1999, 23 TexReg 13059; section repealed effective November 8, 2001, 26 TexReg 8814; new section effective November 8, 2001, 26 TexReg 8814)***

(a) The licensee shall inform the landowner and well owner that the landowner and well owner are responsible for complying with the rules and regulations under the standards set forth in this chapter.

(b) A buried discharge line between the pump discharge and the pressure tank or pressure system in any installation, including a deep well turbine or a submersible pump, shall not be under negative pressure at any time. With the exception of jet pumps, a check valve or an air gap shall be installed in a water line between the well casing and the pressure tank. Either a check valve or an air gap, as applicable, shall be required on all irrigation well pumps whenever a pump is installed or repaired. All wells shall have either a check valve, or an air gap as applicable.

(c) Wells shall be vented with watertight joints except as provided by subsection (b) of this section.

(1) Watertight joints, where applicable pursuant to the provisions of this rule, shall terminate at least two (2) feet above the regional flood level or one (1) foot above the established ground surface or the floor of a pump room or well room, whichever is higher.

(2) The casing vent shall be screened and point downward.

(3) Vents may be offset provided they meet the provisions of this rule.

(4) Toxic or flammable gases, if present, shall be vented from the well. The vent shall extend to the outside atmosphere

above the roof level at a point where the gases will not produce a hazard.

76.1007. Technical Requirements - Chemical Injection, Chemigation, and Foreign Substance Systems. ***(Effective January 3, 1999, 23 TexReg 13059; section repealed effective November 8, 2001, 26 TexReg 8814; new section effective November 8, 2001, 26 TexReg 8814)***

(a) All irrigation distribution systems or water distribution systems into which any type of chemical (except disinfecting agents) or other foreign substances will be injected into the water pumped from water wells shall be equipped with an in-line, automatic quick-closing check valve capable of preventing pollution of the ground water. The required equipment shall be installed on all systems whenever a pump is installed or repaired or at the time of a chemical injection, Chemigation or foreign substance unit is added to a water delivery system or not later than January 1, 2000, if the well has a chemical injection, Chemigation, or foreign substance unit in the delivery system. The type of check valve installed shall meet the following specifications:

(b) The body of the check valve shall be constructed of cast iron, stainless steel, cast aluminum, cast steel, or of a material and design that provides a sturdy integrity to the unit and is resistant to the foreign substance being injected. All materials shall be corrosion resistant or coated to prevent corrosion. The valve working pressure rating shall exceed the highest pressure to which the valve will be subjected.

(c) The check valve shall contain a suitable automatic, quick-closing and tight-sealing mechanism designed to close at the moment water ceases to flow in the downstream or output direction. The device shall, by a mechanical force greater than the weight of the closing device, provide drip-tight closure against reverse flow. Hydraulic backpressure from the system does not satisfy this requirement.

(d) The check valve construction should allow for easy access for internal and external inspection and maintenance. All internal parts shall be corrosion resistant. All moving parts shall be designed to operate without binding, distortion, or misalignment.

(e) The check valve shall be installed in accordance with the manufacturer's specifications and maintained in a working condition during all times in which any fertilizer, pesticide, chemical, animal waste, or other foreign substance is injected into the water system. The check valve shall be installed between the pump discharge and the point of chemical injection or foreign substance injection.

(f) A vacuum-relief device shall be installed between the pump discharge and the check valve in such a position and in such a manner that insects, animals, floodwater, or other pollutants cannot enter the well through the vacuum-relief device. The vacuum-relief device may be mounted on the inspection port as long as it does not interfere with the inspection of other anti-pollution devices.

(g) An automatic low pressure drain shall also be installed between the pump discharge and the check valve in such a position and in such a manner that any fluid which may seep toward the well around the flapper will automatically flow out of the pump discharge pipe. The drain must discharge away from rather than flow into the water supply. The drain must not collect on the ground surface or seep into the soil around the well casing.

(1) The drain shall be at least three-quarter (3/4) inch in diameter and shall be located on the bottom of the horizontal pipe between the pump discharge and the check valve.

(2) The drain must be flush with the inside surface of the bottom of the pipe unless special provisions, such as a dam made downstream of the drain, forces seepage to flow into the drain.

(3) The outside opening of the drain shall be at least two (2) inches above the grade.

(h) An easily accessible inspection port shall be located between the pump discharge and the check valve, and situated so the automatic low-pressure drain can be observed through the port and the flapper can be physically manipulated.

(1) The port shall allow for visual inspection to determine if leakage occurs past the flapper, seal, seat, and/or any other components of the checking device.

(2) The port shall have a minimum four (4) inch diameter orifice or viewing area. For irrigation distribution systems with pipe lines too small to install a four-inch diameter inspection port, the check valve and other anti-pollution devices shall be mounted with quick disconnects, flange fittings, dresser couplings, or other fittings that allow for easy removal of these devices.

(i) Any check valve not fully meeting the specifications

set forth in this section may on request to the Executive Director be considered for a variance

76.1008. Technical Requirements - Pump Installation. ***(Effective January 3, 1999, 23 TexReg 13059; section repealed effective November 8, 2001, 26 TexReg 8814; new section effective November 8, 2001, 26 TexReg 8814)***

(a) During any repair or installation of a water well pump, the licensed installer shall make a reasonable effort to maintain the integrity of ground water and to prevent contamination by elevating the pump column and fittings, or by other means suitable under the circumstances.

(b) This section shall include every type of connection device, including but not limited to, flange connections, hose-clamp connections, and other flexible couplings. Except as provided by this chapter, a pump shall be constructed so that no unprotected openings into the interior of the pump or well casing exist.

(1) A hand pump, hand pump head, stand, or similar device shall have a spout, directed downward.

(2) A power driven pump shall be attached to the casing or approved suction or discharge line by a closed connection. For the purposes of this section a closed connection is defined to be a sealed connection.

(c) The provisions of this section relating to the requirement of closed connections shall not apply to the following types of pumps and pumping equipment:

(1) sucker rod pumps and windmills; and

(2) hand pumps.

(d) A new, repaired, or reconditioned well, or pump installation or repair on a well used to supply water for human consumption shall be properly disinfected. The landowner may waive the disinfection process by submitting a written request to the driller or pump installer.

76.1009. Technical Requirements - Alternative Standards. ***(Effective January 3, 1999, 23 TexReg 13059; section repealed effective November 8, 2001, 26 TexReg 8814; new section effective November 8, 2001, 26 TexReg 8814)***

(a) If the party having the well drilled, deepened or altered, the licensed well driller, or the party, landowner

or person drilling or plugging the well, finds any of the procedures prescribed by §76.1000 of this title (relating to Technical Requirements - Locations and Standards of Completion for Wells), §76.1001 of this title (relating to Technical Requirements - Standards of Completion for Water Wells Encountering Undesirable Water or Constituents), §76.1002 of this title (relating to Technical Requirements - Standards for Wells Producing Undesirable Water or Constituents), §76.1003 of this title (relating to Technical Requirements - Re-completions), §76.1004 of this title (relating to Technical Requirements - Standards for Capping and Plugging of Wells and Plugging Wells that Penetrate Undesirable Water or Constituent Zones) and §76.1005 of this title (relating to Technical Requirements - Standards for Water Wells drilled before June 1, 1983) inapplicable, unworkable, or inadequate, combinations of the prescribed procedures or alternative procedures may be employed, provided that the proposed alternative procedures will prevent injury and pollution.

(b) Proposals to use combinations of prescribed procedures or alternative procedures shall be considered application for a variance and must be submitted to the Department and provide a copy of the variance to the local groundwater conservation district for approval prior to their implementation.

(c) If a variance is not submitted prior to construction and the licensee or landowner or the designated agent believes a request is justified, such request shall be submitted to the Department and a copy of the variance provided to the local groundwater conservation district as soon as possible following completion of the well.

(d) This section shall not apply to a public water system well.

76.1010. Appeals - Variances. ***(Effective November 8, 2001, 26 TexReg 8814)***

(a) Appeal of staff decision disapproving a variance or waiver application shall be submitted to the Executive Director and a copy of the appeal provided to the local groundwater conservation district within 14 days of notification of staff decision.

(b) The Executive Director shall determine whether or not to uphold the disapproval of the variance.

(c) The party making the appeal shall be advised in writing of the Executive Director's determination.

APPENDIX E

WELL VOLUME CALCULATION DETAILS

Well Volume Calculation Details

Goal: Determine "N" values for 2-inch and 4-inch ID wells, where:

N = gallons of water in well per foot of water column in well (gal/ft).

Equations:

Volume of a cylinder = $(\pi) \times (r^2) \times (h)$

Volume of water in a (cylindrical) well (in gallons) = $(\pi) \times (r^2) \times (h) \times (F)$, where:

V = volume (gal);
π = 3.14 (unitless);
r = radius of well (ft);
h = height of water in well (ft); and
F = factor (7.48 gal/cubic foot).

Calculations:

For a 2-inch diameter well:

V (gal) = $(3.14) \times (1/12\ ft^2) \times (h\ ft) \times (7.48\ gal/ft)$
V (gal) = $(3.14) \times (0.08\ ft^2) \times (h\ ft) \times (7.48\ gal/ft)$
V (gal) = $(0.02\ ft^2) \times (h\ ft) \times (7.48\ gal/ft)$
V (gal) = $(h\ ft) \times (0.16\ gal/ft)$
V (gal) / h (ft) = N = 0.16 gal/ft

For a 4-inch diameter well:

V (gal) = $(3.14) \times (1/6\ ft^2) \times (h\ ft) \times (7.48\ gal/ft)$
V (gal) = $(3.14) \times (0.17\ ft^2) \times (h\ ft) \times (7.48\ gal/ft)$
V (gal) = $(0.09\ ft^2) \times (h\ ft) \times (7.48\ gal/ft)$
V (gal) = $(h\ ft) \times (0.65\ gal/ft)$
V (gal) / h (ft) = N = 0.65 gal/ft