GW - 1

WORK PLANS

1993

RCRA FACILITY INVESTIGATION
TASK 2: WORK PLAN

BLOOMFIELD REFINING COMPANY
50 COUNTY ROAD 4990
BLOOMFIELD, NEW MEXICO

MARCH 1993

Prepared For:

BLOOMFIELD REFINING COMPANY
P.O. BOX 159
BLOOMFIELD, NEW MEXICO 87413

Prepared by:

GROUNDWATER TECHNOLOGY, INC.
2501 YALE BOULEVARD S.E., SUITE 204
ALBUQUERQUE, NEW MEXICO 87106

GROUNDWATER TECHNOLOGY

Groundwater Technology, Inc.

2501 Yale Blvd. SE, Suite 204, Albuquerque, NM 87106
Tel: (505) 242-3113 Fax: (505) 242-1103

RCRA FACILITY INVESTIGATION
TASK II: DRAFT WORK PLAN

Bloomfield Refining Company
#50 County Road 4990 (Sullivan Road)
Bloomfield, New Mexico 87413

MARCH 31, 1993

Submitted to:

United States Environmental Protection Agency
Region VI
RCRA Technical Enforcement
1445 Ross Avenue
Dallas, Texas 75202-2733

Submitted by:

Bloomfield Refining Company
P.O. Box 159
Bloomfield, New Mexico 87413

Groundwater Technology, Inc.
Written/Submitted by

Cymantha Dia
Cymantha Diaz
Project Manager

Groundwater Technology, Inc.
Reviewed/Approved By:

Sara
Sara Brothers, Operations Manager
New Mexico

BRC/task2.brc

TABLE OF CONTENTS

LIST OF FIGURES

FIGURE 1 SITE PLAN

FIGURE 2 PROPOSED FACILITY INVESTIGATION

FIGURE 3 PROJECT ORGANIZATION

FIGURE 4 PROJECT SCHEDULE

FIGURE 5 TYPICAL MONITORING WELL CONSTRUCTION (FLUSH-MOUNT)

FIGURE 6 TYPICAL MONITORING WELL CONSTRUCTION (STANDPIPE)

LIST OF TABLES

TABLE 1 DATA QUALITY OBJECTIVES

TABLE 2 SUMMARY OF SAMPLING AND ANALYSIS PROGRAM

TABLE 3 SAMPLE CONTAINERS AND PRESERVATIVES FOR GEOPHYSICAL AND CHEMICAL TESTING (SOIL SAMPLES)

TABLE 4 SAMPLE CONTAINERS AND PRESERVATION GROUNDWATER SAMPLING

TABLE 5 SAMPLE CERTIFICATES AND PRESERVATION SURFACE WATER SAMPLING

TABLE 6 SAMPLE CERTIFICATES AND PRESERVATION SEDIMENT SAMPLING

LIST OF APPENDICES

APPENDIX A HEALTH AND SAFETY PLAN

APPENDIX B GROUNDWATER TECHNOLOGY, INC. QUALIFICATIONS AND EXPERIENCE

APPENDIX C FACILITY INVESTIGATION COST ESTIMATE

APPENDIX D INTER-MOUNTAIN LABORATORIES QUALITY ASSURANCE PROJECT PLAN

APPENDIX E FIELD EQUIPMENT CHECKLISTS

APPENDIX F SOIL GAS SAMPLING PROCEDURES AND WA/QC PROCEDURES

APPENDIX G FIELD EQUIPMENT CALIBRATION PROCEDURES

APPENDIX H FIELD DOCUMENTATION FORMS

1.0 INTRODUCTION

This "Task II: Draft RCRA Facility Investigation Work Plan" (RFIWP) has been prepared in accordance with item IV.2.a of the Administrative Order on Consent (Order; Docket No. VI-303-H) dated December 31, 1992 between the United States Environmental Protection Agency (USEPA) Region VI and Bloomfield Refining Company (BRC). This work plan has been prepared according to the requirements of Attachment II - Corrective Action Plan (CAP) of the Order, and is submitted concurrently with the "Task I: Description of Current Conditions" report.

The Task I report summarizes the background of the BRC facility, provides information on the nature and extent of contamination and presents the results of a preliminary evaluation of corrective measures technologies. The Task I report provides the basis for the technical approach of this work plan, by identifying additional investigative work tasks needed to complete the delineation of the nature and extent of contamination resulting from facility operations and to evaluate additional corrective measure technologies for application at the facility.

The purpose of the facility investigation is to determine the nature and extent of releases of hazardous waste or hazardous waste constituents (if any) from regulated units, solid waste management units, and other source areas at the facility. In addition, the investigation will be utilized to further define the nature and extent of releases of petroleum intermediates and products at the site. The data will be used to support a Corrective Measures Study. The investigative tasks are proposed to provide a comprehensive assessment of the site and potential areas of concern. The work plan components are as follows:

- Project Management Plan

  The Project Management Plan explains the overall management approach to conducting the investigation, as well as including qualifications of key personnel and subcontractors. The technical approach, schedule and budget are also identified in this plan.

- Data Collection Quality Assurance Plan

  The Data Collection Quality Assurance Plan describes procedures for monitoring and collection and analysis of environmental samples in order to ensure that all data is technically sound. This plan includes a data collection strategy, sampling procedures, field methods, and analytical laboratory quality assurance control procedures.

- Data Management Plan

  The Data Management Plan identifies methods used to track investigative data collected. The plan refers to sampling documentation, and establishes project filing, tabular formats and graphical displays for presenting data.

- Health and Safety Plan

  The Health and Safety Plan describes potential health hazards at the site that may be encountered during the investigation. Responses to any health hazards are described to protect the site workers.

An "Interim Measures Work Plan" was submitted to USEPA for review on February 12, 1993. The proposed interim measures consisted of adding two recovery wells to the existing subsurface hydrocarbon recovery system, equipping these wells with pumping devices, professionally surveying all wells at the site, collecting monthly water level measurements, and operating/maintaining the recovery system. Implementation of these interim measures in the short term will minimize the potential contaminant hazards and control the migration of hydrocarbons in groundwater.

1.1 Facility Description

The 287 acre BRC facility is located at 50 County Road 4990 (Sullivan Road), immediately south of the town of Bloomfield, New Mexico in San Juan County. The site is on a bluff approximately 100 feet above the south side of the San Juan River, a perennial river that flows to the west. On the bluff and between the river and the process area of the facility is the Hammond Ditch, a man-made channel for irrigation water supply that borders all but the southern portion of the site. Bordering the facility is a combination of undeveloped federal and private properties, with the majority of undeveloped land in the vicinity of the refinery used extensively for oil and gas production. The El Paso Natural Gas pipeline runs northeast to southwest bisecting the site. The topography of the active portion of the site is generally flat.

The BRC facility was originally constructed in the late 1950s, with a number of expansions since that time. The refinery currently has a crude capacity of 16,800 barrels per day. Seventy percent of the refinery's current crude supplies are delivered by pipeline and thirty percent arrive by tanker trucks. The following products are produced at the facility:

- leaded gasoline
- unleaded gasoline
- premium unleaded gasoline
- diesel fuels
- jet-A fuel

- JP-4 jet fuel
- kerosene
- heavy burner fuel
- butane
- propane
- liquefied petroleum gas

The products are transported for delivery by tanker truck from product terminals at the facility.

The current facility layout identifying all major aboveground structures is depicted in Figure 1. The refinery offices are located on the west end of the facility about one-half mile east on Sullivan Road, along with warehouse space, maintenance and shop areas, a drummed chemical storage area, raw water ponds (for temporary storage of fresh water from the San Juan River), and one cooling tower (#1). Process units are located just east of the offices and include: the crude unit, the fluidized catalytic cracking unit, the gas con unit, the treater unit, one cooling tower (#2), reformer/hydrotreater, catalytic polymerization unit, API separator, and oily water ponds (SOWP and NOWP).

Aboveground storage tanks (ASTs) occupy a large portion of the facility from north of the process units east along Sullivan Road. Two clay-lined evaporation ponds are located to the east of the tank farms for treated wastewater discharge, and the fire training and "landfill" areas are east of the evaporation ponds. South of Sullivan Road are the terminals where product trucks are loaded and crude trucks are off-loaded. The spray irrigation area and double-lined evaporation ponds are located east of the terminals.

From previous investigations, a separate-phase hydrocarbon (SPH) plume has been partially delineated at the BRC site, extending from the western area of the site (near the offices) to the eastern portion of the AST farm. The sources of this plume are believed to be product releases which occurred from ASTs and associated piping over the many years of the facility's operation as a petroleum refinery. BRC has made numerous improvements to the facility's storage and processing units and has established a systematic tank inspection and maintenance program.

1.2 Environmental Setting

The BRC facility is located within the San Juan Basin, a subprovince of the Colorado Plateau physiographic province. The site is underlain by Quaternary Jackson Lake terrace deposits, consisting of 10 to 15 feet of coarse-grained fluvioglacial outwash and loess. A permeable cobble layer directly overlying the bedrock at the site (the Tertiary Nacimiento Formation) has been encountered between five (MW-1) and 40 (MW-6) feet below ground surface at the site. The Nacimiento Formation is an interbedded, black, carbonaceous mudstone/claystone with white, medium to coarse-grained sandstones approximately 570 feet thick in this area. The bluff that crops out along the San Juan River near the site is similarly composed of these lithologies. Underlying the Nacimiento are the Ojo Alamo, Kirtland Shale, and Fruitland Formations.

Groundwater at the site occurs at depths ranging from 6 to 40 feet below ground surface, increasing in depth from west to east across the site. Groundwater flow direction is generally to the north-northwest, toward the Hammond Ditch and San Juan River. BRC dikes the Hammond Ditch during the non-irrigation season (October 15 through April 15) to maintain a year-round mounding effect to keep hydrocarbons from migrating across the ditch. Groundwater in the perched aquifer migrates through the permeable sands, silts and cobble zone along the relatively impermeable Nacimiento Formation, which is reported to dip toward the north. Periodic seeps along the bluff occur at the interface between the cobble zone and the Nacimiento.

Slug tests performed at the site to estimate characteristics of the cobble zone indicated that average hydraulic conductivity and transmissivity values of 2.08×10^{-4} feet/second and 171 square feet/day, respectively. The average saturated thickness was estimated at 9.6 feet. Using an estimated average gradient of 0.0025, the calculated flux over a 2,500 square foot area was 8,500 gallons per day or 6 gallons per minute (E-S, 1987).

Surface waters in the vicinity of the facility include the San Juan River (to the north) and the Hammond Ditch. The Hammond Ditch and the surface impoundments that are part of refinery operations distributed across the site contribute significantly to groundwater recharge at the site. The unlined Hammond Ditch is actively flowing during the irrigation season (April 15 through October 15) for agricultural purposes and is diked by BRC during the non-irrigation season. When full, the Hammond Ditch creates a mounding effect, keeping the banks loaded with relatively fresh water and inhibiting groundwater flow.

The climate is characterized by dry, cool winters with some snow and warm, dry summers. The annual average precipitation in the area is approximately nine inches. The annual average minimum and maximum temperatures are 38 and 66 degrees Fahrenheit, respectively.

1.3 Hazardous Waste Activity

A RCRA notification form of hazardous waste activity was filed on August 18, 1980 by Plateau, Inc., the previous refinery owner. A Part A application for a RCRA operating permit was filed on November 19, 1980 for the treatment, storage and/or disposal of refinery-listed hazardous wastes K049 through K052. In 1982, Plateau withdrew the Part A permit to reflect their status as a generator-only of hazardous waste. Plateau also applied for delisting of the hazardous wastes codes K049, K050, and K051, which was denied by USEPA because of petition deficiencies. On October 31, 1984 BRC acquired the facility.

In March 1985, the USEPA issued a RCRA 3013 Administrative Order (as a result of several agency inspections in the 1981 to 1984 period) identifying alleged violations and/or technical deficiencies and directing BRC to complete an investigation of geologic and hydrogeologic site conditions. A RCRA 3008(a) Compliance Order was issued to BRC one month later. BRC conducted several subsurface investigations at the site to satisfy USEPA and New Mexico Oil Conservation Division (NMOCD) directives. In response to a RCRA 3008 Order, BRC prepared a closure plan for the NOWP, SOWP, Landfill, and Landfill Pond, which included soil sample data from these areas supporting closure. The purpose of the closure plan was to make mute the issue as to whether or not these units were RCRA-regulated. In addition, BRC has subjected the waste from the Landfill (originally excavated from the SOWP and NOWP) to a delisting petition (April 1991).

The NOWP and SOWP (lined with a single 100-mil HDPE liner in late 1992) are scheduled to be double-lined by early 1994. A RCRA Part A Operating Permit Application for these units was submitted in September 1990. In September 1991, BRC submitted a Part B Operating Permit Application for these units to treat the refinery wastewater stream for benzene concentrations. The facility is currently operating the SOWP and NOWP under interim status pending approval of the permit application. All other hazardous wastes generated at the facility are disposed offsite. Hazardous waste generation is summarized as follows:

HAZARDOUS WASTES GENERATED BY BRC

HAZARDOUS WASTE	USEPA REASON FOR LISTING	AMOUNT GENERATED
Heat exchanger bundle (HEB) cleaning sludge (K050)	Hexavalent chromium	5,000 lb/3 yrs
API separator sludge (K051)	Hexavalent chromium & lead	250,000 lb/2 yrs
Leaded tank bottoms (K052)	Lead	8,000 lb/tank/5 yrs
1,1,1-Trichloroethane and methanol in naphtha (D001, F002)	Ignitable, spent halogenated solvent	None Recent - Potential Waste
Spent Solvent (D001)	Ignitable	2,000 lb/yr
Process Wastewater containing benzene (D018)	Benzene	100,800 gals/day

1.4 Areas and Hazardous Waste Constituents of Concern

A RCRA Facility Assessment (RFA) was conducted by USEPA contractors in June 1987. The purpose of an RFA is to identify releases or potential releases of hazardous waste which may require further investigation. The RFA also identifies sources for potential releases known as solid waste management units (SWMUs) or other potential areas of concern. The 1987 RFA identified a total of 13 SWMUs, including five units considered RCRA-regulated by the USEPA. It was since determined that the evaporation ponds are not considered to be RCRA-regulated. Each of these units was discussed in the Task I report with associated sampling that has been performed.

BRC considers product releases (both documented and undocumented) to be the primary (if not the only) source of soil and groundwater contamination at the site. Documented releases were listed in the Task I report. Undocumented releases are believed to have occurred in the process and bulk storage tank areas in the many years of operation of the refinery. The facility established in 1987 a more rigorous inspection/maintenance and repair program for storage tanks and associated piping. In addition, records of all reportable releases have been maintained since BRC acquired the refinery in 1984.

The Task I report divided the site into four geographic areas for the purposes of discussion. These are summarized below:

SOLID WASTE MANAGEMENT UNITS/POTENTIAL SOURCE AREAS

UNIT	UNIT TYPE	PREVIOUS CHARACTERIZATION
GEOGRAPHIC AREA 1		
API Oil/Water Separator	Process Unit	None needed-Structure intact.
Oily Water Ponds (SOWP and NOWP)	RCRA-regulated SWMUs since Sept 25, 1990	Underliner soil samples and downgradient wells MW-9, MW-20 and RW-18 monitored quarterly.
Spent Caustic Tank	Product Tank	None needed-new tank and concrete dike.
Former Drum Storage Area	SWMU (EPA's RFA)	Wells RW-1 and P-1.
Crude Unit	Spill Area (Documented)	None. Access Limited.
Tanks 3, 4, 5 Areas and Former Tanks 6 and 7 Areas	Spill Area (Suspected) - Tank Leaks Known	Wells MW-9, RW-18 and proposed wells RW-22 and RW-23.
Overall Geographic Area 1 (Process Area)	Spill Area (Suspected)	Seven RWs, 3 piezometers, 4 MWs.
GEOGRAPHIC AREA 2		
Tank 19 Area	Spill Area (Documented)	RWs 14 and 15 - active recovery.
Tanks 21 and 22 Area	Spill Area (Documented)	None.
Tank 26 Area	Spill Area (Documented)	RW-16 - active recovery.
Underground Piping (minimal)	SWMU (EPA's RFA)	RWs 14, 15, 16, 17 - active recovery.
Aboveground Storage Tanks	Spill Area (Suspected) - Tank Leaks Known	RWs 14, 15, 16, 17 - active recovery and MW-21.
GEOGRAPHIC AREA 3		
Transportation Terminal Sump	SWMU (EPA's RFA)	None.
Heat Exchanger Bundle (HEB) Cleaning Area	SWMU (EPA's RFA)	MW-13 and good condition.
Crude Loading Area	Spill Area (Documented)	None.

UNIT	UNIT TYPE	PREVIOUS CHARACTERIZATION
Crude Loading Area	Spill Area (Documented)	None.
Product Loading Rack	Spill Area (Documented) - Paved area	None.
Underground Piping	SWMU (EPA's RFA)	None.
GEOGRAPHIC AREA 4		
Evaporation Ponds (north and south)	SWMU (EPA's RFA)	MW-1 and MW-5 sampled semi-annually.
Landfill (wastepile)	Alleged RCRA-regulated SWMU	1985 soil samples, 1990 delisting char. composite soil samples, and MW-8.
Landfill Pond	Alleged RCRA-regulated SWMU	1985 soil samples.
Fire Training Area	SWMU (EPA's RFA)	None.
Spray Irrigation Area	SWMU (EPA's RFA)	MW-5 sampled semi-annually.

RW = Recovery or pumping well.
MW = Monitoring well.

Data Gaps Identified

As discussed in the Task I report, BRC intends to consider the entire site as one SWMU for investigation purposes and as one Corrective Action Management Unit (CAMU) for remediation purposes. The Task I report indicated that data gaps have been identified in the northwestern portion of the site (between the fire house and the transformer station), in the northeastern portion of the site (between the evaporation ponds and the aboveground storage tanks [ASTs]), in the southern portion of the facility (along Sullivan Road south of the ASTs and near the truck loading/off-loading terminal), and southeast of the site (on Bureau of Land Management [BLM] property). A soil vapor survey will be performed at the site to optimize the locations of additional borings/monitoring wells in these areas. Groundwater plume delineation will be useful for design of the corrective measures for the site and for development of the groundwater monitoring program.

Soil characterization has only been performed beneath the oily water ponds (SOWP and NOWP), the landfill, landfill pond and southeast of the site on the BLM property. Because of limited access and

(Area 1) is not proposed. Unsaturated soils in this area are assumed to be impacted by petroleum hydrocarbons to the water table. A pilot study for soil vapor extraction/air sparging technology is proposed to be conducted in this area for corrective measures evaluation purposes. As part of the pilot study, soil and vapor samples will be collected for laboratory analysis.

Additional soil sampling for laboratory analysis in SWMUs/potential source areas identified by USEPA will be performed. These areas include the transportation terminal sump, the clay-lined evaporation ponds, and the fire-training area. Soil samples will also be collected in the crude loading area and producting loading rack, and AST farm area since releases have/may have occurred in these areas. Soil sample locations will be determined by a soil vapor survey to minimize the number of soil samples submitted for laboratory analysis. The soil quality laboratory analyses will delineate impacts, characterize source/potential source areas and will provide design parameters for corrective measure technologies (if any are determined necessary) to be employed at the site.

Surface water and sediment sampling of both the Hammond Ditch and the San Juan River will also be performed as part of the facility investigation. Although surface water sampling was performed in 1986 and 1987, more recent and comprehensive data will be obtained.

Finally, an aquifer test will be performed to determine design parameters for the corrective measures implementation. Slug tests performed in 1986 provide preliminary information on the characteristics of the perched groundwater zone beneath the site. However, for design of a site-wide remediation program, a longer-term aquifer test is proposed to produce more reliable data.

Constituents of Concern

Groundwater sampling has been performed at the site since 1984. The analyses performed on groundwater samples have varied, although several sampling events have included comprehensive parameter lists. According to the Administrative Order on Consent (December 31, 1992) samples must be analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (BNAs), total petroleum hydrocarbons (TPH), and metals for soil and new groundwater monitoring wells.

Analyses during the soil vapor survey will be limited to total volatile hydrocarbons, benzene, toluene, ethylbenzene, and total xylenes (BTEX). Select soil samples will be collected during the soil vapor survey for laboratory analysis of VOCs (USEPA Method 8240) only. Groundwater samples collected from existing wells (that do not contain separate phase hydrocarbons [SPH]) will be analyzed only for VOCs (USEPA Method 8240) and BNAs (USEPA Method 8270). Data from this sampling will provide current, comprehensive information on the dissolved plume at the site. However, it should be noted that historic sampling for VOCs has indicated that BTEX are the primary constituents of concern, suggesting that future groundwater sampling events target only these compounds.

1.5 Data Acquisition Objectives

Data collected during the facility investigation will be used to: characterize the subsurface conditions at the site (geology, soil and aquifer properties); identify and quantify hydrocarbon contamination at potential source areas; delineate the limits of impacts identified; and evaluate corrective measure alternatives. Five analytical levels can be used to assess the soil and groundwater quality at the Bloomfield Refining Company - Bloomfield, New Mexico facility:

Level I -	field screening or analysis using portable instruments. Results are often not compound- specific and not quantitative but results are available in real-time.
Level II -	field analyses using more sophisticated portable analytical instruments such as a portable GC. Results are available in real-time or several hours.
Level III -	SW-846 routine analytical services (RAS). All analyses are performed in an off-site approved analytical laboratory following SW-846 protocols. Level III is characterized by rigorous QA/QC protocols and documentation.
Level IV -	analytical analysis by preapproved non-standard methods. All analyses are performed in an off-site approved analytical laboratory. Method development or method modification may be required for specific constituents or detection limits. Level IV is characterized by rigorous QA/QC protocols and documentation.
Level V -	physical property and engineering material analysis by approved standard or non-standard methods. All analyses are performed in an off-site laboratory. QA/QC protocols and documentation may be required for some analyses.

The technical approach of the facility investigation is presented in the following section (Section 2.0 - Project Management Plan) and consists of four phases of investigation. It should be noted that BRC intends to address the entire site as one SWMU for investigation purposes and as one Corrective Action Management Unit (CAMU) for remediation purposes. Phases I, III and IV have been designed to characterize impacts across the site, while Phase II specifically addresses individual potential source areas. The phases and corresponding analytical levels are as follows:

Phase I: Level II and Level III analytical data will be generated during this phase.

Phase I field work consists of conducting a soil vapor survey using a laboratory-grade gas chromatograph at two depths (3 and 10 feet below ground surface) for vertical and horizontal delineation of volatile hydrocarbon compounds. At select survey locations soil samples will also be collected for laboratory analysis of volatile organic compounds. It is estimated that the soil vapor survey will consist of 50 locations (two depths at each location), and that a total of 10 soil samples (or 10 percent) will be collected for laboratory analysis.

Phase II: Level I, Level III and Level V analytical data will be generated during this phase.

Phase II field work will be based on the results of Phase I activities. Soil borings will be installed in the areas indicated in Section 1.4 above. A field geologist will log lithologies and screen soil samples with a photoionization detector (PID) during soil boring installations. Depending on the water table elevation, two samples from each boring location (one exhibiting the highest PID readings and one directly above the water table interface) will be collected for laboratory analysis of VOCs, BNAs, TPH and metals. If the cobble layer is encountered during drilling, the borehole will be terminated. If the water table has not been encountered at the depth at which the cobble zone is encountered, a second soil sample will not be collected for laboratory analysis.

Select soil samples (maximum of three) from lithologically representative areas of the site will also be analyzed for soil property analyses (including grain size distribution, dry bulk density, moisture content, ion exchange capacity, total organic carbon, pH, specific conductance, total/effective porosity and hydraulic conductivity). It is estimated that 10 borings will be installed: two in the transportation terminal sump area; four around the evaporation ponds; two in the fire training area; one at the crude loading area; and one at the product loading rack area. Additional borings may be installed depending on the results of the Phase I investigation.

Phase III: Level I and Level III analytical data will be generated during this phase.

Phase III activities will be based on the results of Phase I and Phase II investigation activities. Additional groundwater monitoring wells will be installed at approximately seven locations for groundwater delineation and monitoring purposes. Preliminary locations include one in the northwest section of the site, one in the northeast (near former MW-2), and five along Sullivan Road and south on the BLM land. Wells will be constructed of fiberglass reinforced epoxy materials. The wells will be developed and surveyed (tied into the site survey to be performed as part of the Interim Measures Work Plan). The new wells that do not contain SPH will be sampled for VOCs, BNAs, TPH and metals analyses. All other site monitoring/recovery wells (not piezometers) that do not contain SPH will also be sampled for VOCs and BNAs only. Select groundwater samples (maximum of two) will also be analyzed for water quality parameters (including pH, temperature, dissolved oxygen, total dissolved solids, total organic carbon, alkalinity, hardness, and specific cations [e.g., iron, manganese]). A second round of groundwater samples will be collected after 60 days for chemical analyses only.

Phase IV: Level I and Level III analytical data will be generated during this phase.

Phase IV consists of field studies, including an aquifer test and a soil vapor extraction/air sparging pilot study. The configuration and design of these field tests will depend on the results of the Phase I, Phase II and Phase III investigations. However, in general, the aquifer test will be developed to determine the aquifer characteristics (transmissivity, hydraulic conductivity) from which a groundwater remediation system may be designed, if warranted. Similarly, the soil vapor extraction/air sparging pilot study will be conducted to observe the radius of influence of at different vacuum flow rates and determine the maximum effective radius of influence at the site. This information is used to design the extraction/sparge point layout and equipment specifications, if soil vapor extraction/air sparging technology is selected for the site.

Stream sediment and surface water samples will be collected during low flow conditions (July) which may correspond with Phase I, II, III or IV of the facility investigation. Level I and Level III analytical data will be generated during these investigations. Samples will be analyzed for VOCs, BNAs, TPH, and metals. In addition, one surface water sample will be analyzed for water quality parameters, including temperature, pH, dissolved oxygen, conductivity, biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), total dissolved solids (TDS), total organic carbon (TOC) and nutrients. Stream velocity and sediment thicknesses will also be field measured.

Section 3.0 of this plan consists of the Data Collection Quality Assurance Plan, Section 4.0 the Data Management Plan, and Section 5.0 the Community Relations Plan. Appendix A contains the site-specific Health and Safety Plan.

2.0 PROJECT MANAGEMENT PLAN

The purpose of the Project Management Plan is to identify the work that will be conducted to investigate the sources of contamination, determine the nature and extent of contamination at the facility, and evaluate corrective measure alternatives. This work is conducted to meet the requirements of a RCRA Facility Investigation and supplements existing site data described in the Task I: Description of Current Conditions report. The technical approach to addressing known and potential releases to soil, groundwater, and surface water from the SWMUs/potential source areas identified in the Task I report is described in this section. Additionally, personnel qualifications, a schedule and a budgetary estimate for the implementation of the facility investigation activities are included herein.

2.1 Technical Approach

The objectives of the RFI are to investigate the sources of contamination and determine the nature and extent of contamination in order to obtain information necessary to evaluate and design corrective measures that will reduce environmental contamination to levels that pose minimum threats to human health and the environment as appropriate for the site. Investigative data will identify the source(s), nature, and extent of contamination at the facility and will provide information on aquifer and vadose zone properties necessary to evaluate and design corrective measures. The work will be conducted to meet the requirements of a RCRA Facility Investigation.

As described in Section 1.4 - Data Acquisition Objectives, the technical approach consists of four phases of investigation. Each phase is dependent on the results of its preceding phase and therefore the actual number and locations of data points are approximate, subject to change. All proposed changes will be reported to USEPA verbally for approval and in written form with the monthly progress reports. The four phases of investigation, rationale for the approach, and collection measures are described in the following subsections. Detailed information about data collection procedures is provided in Section 3.0.

2.1.1 Phase I: Soil Vapor Survey/Soil Sampling

A soil vapor survey will be conducted to provide additional information on the nature and extent of the hydrocarbon contamination at the BRC site. Since the BRC property is 287 acres in size and the separate phase hydrocarbon (SPH) plume may extend over as much as 25 acres, the soil vapor survey will serve as an effective tool in delineating the horizontal extent of SPH and dissolved hydrocarbon impacts across the site. A soil vapor survey may be useful for indicating the vertical extent of hydrocarbon contamination in unsaturated soils, and determining the optimum locations for additional groundwater monitoring wells. Because the cobble layer overlying the Nacimiento Formation at the site makes drilling and/or hydropunch conditions difficult or impossible for soil sample retrieval, the smaller diameter (3/4-inch) soil vapor probes may penetrate this lithology, should it be encountered. Typically, low recovery of soil samples would be experienced and the integrity of soil samples may be compromised by the collection method (VOCs may be lost due to turbulence and volatilization).

Benzene, toluene, ethylbenzene and xylenes (BTEX) are volatile constituents of the lighter-end petroleum products which are readily identified during soil vapor surveys using gas chromatography. These compounds and total volatile hydrocarbons will be analyzed in soil vapor samples directly injected into a laboratory-grade gas chromatograph equipped with a flame ionization detector (FID). Tracer Research Corporation (Tucson, AZ) will be contracted to perform the soil vapor survey. Tracer has provided the following typical detection limits for the soil vapor analyses:

TYPICAL DETECTION LIMITS

COMPOUND	SOIL GAS (ug/l)	DETECTOR
Benzene	0.05	FID
Toluene	0.05	FID
Ethylbenzene	0.05	FID
Xylenes	0.05	FID
Total Volatile Hydrocarbons	0.1	FID

The direct injection method of analysis will allow for real-time analytical results and rapid field decisions. For example, survey points may be added or moved to delineate hot spots while the survey is being performed instead of waiting weeks for laboratory analyses and performing several iterations of investigation to complete delineation.

Soil vapor sampling and quality assurance procedures are described in Section 3.2.7 of this work plan. Essentially, a 3/4-inch galvanized steel sampling probe is driven to the desired depth(s), the probe is backlifted approximately six inches, a vacuum pump evacuates soil gas, a vapor sample is extracted using a syringe, and the vapor sample is directly injected into the gas chromatograph for analysis. Quality assurance/quality control (QA/QC) measures employed during the survey include the collection of field blank samples (one per day at the start), duplicate samples (one per 20 samples) and calibration standards (water blank samples and nitrogen blank samples).

The survey will consist of approximately 50 locations and two depths (three and ten feet below ground surface) at each location, for a total of 100 soil vapor samples. Approximate survey locations are shown in Figure 2. Initial soil vapor sampling locations are based on a 150-foot grid across the southern and eastern portions of the site to complete the delineation of hydrocarbon impacts. Actual locations will be based on field conditions (access, presence of above and below ground structures), and added or moved according to real-time survey results. If contamination is found at the expected plume perimeter locations, the spacing of grid points may be increased and survey locations will be added to further delineation the contamination found.

Each location will be staked for field survey and plotted on a scaled site plan. Analytical results for each constituent will be tabulated and contour maps of each at the two depths will be constructed.

Soil samples will be collected at approximately 10 percent of the soil vapor sample locations (or 10 samples) using six-inch long, 3/4-inch inside diameter brass tubes with aluminum points. These samples will be submitted to the laboratory for analysis of volatile organic compounds (USEPA Method 8240) to correlate and verify soil vapor survey data.

2.1.2 Phase II: Soil Borings/Soil Sampling and Analysis

As described in Section 2.1.1 above and based on the conditions encountered during the installation of the 26 wells onsite, drilling for sample retrieval is difficult at the BRC site due to the presence of cobbles in the unconsolidated sediments overlying the Nacimiento Formation. The depth at which the cobble layer is encountered varies across the site, generally increasing to the south and southwest. When cobbles are encountered, the boring will be terminated. Otherwise, borings will extend to the water table. Drilling and soil sampling procedures and quality assurance measures are discussed in more detail in the Data Collection Quality Assurance Plan (Section 3.0).

Soil borings will be installed in the potential source areas identified by USEPA during the 1987 inspection and in spill areas where data is not available from previous investigations at the facility. These borings will be used to: characterize the lithology of the areas using field observations and physical property analyses; determine whether the area has been impacted; identify and quantify impacts; and vertically delineate the extent of impacts based on field screening and laboratory analyses. It is estimated that 10 borings will be installed: two in the transportation terminal sump area; four around the clay-lined evaporation ponds; two in the fire training area; one at the crude loading area; and one at the product loading rack area. These locations are shown in Figure 2. Actual boring locations will depend on field conditions (access, presence of above and below ground structures). Additional borings may be installed depending on the results of the Phase I investigation, should hot spots be identified requiring further characterization.

Samples will be collected continuously during boring installations using a split-spoon sampling device. A field geologist will log lithologies and screen soil samples with a photoionization detector (PID). Depending on the water table elevation, two samples from each boring location (one exhibiting the highest PID readings and one directly above the water table interface) will be collected for laboratory analysis of VOCs (USEPA Method 8240), BNAs (USEPA Method 8270), TPH (USEPA Method 418.1) and metals (USEPA Method 6010/7000 series). As previously mentioned, if the cobble layer is encountered during drilling, the borehole will be terminated. If the water table has not been encountered at the depth at which the cobble zone is encountered, a second soil sample will not be collected for laboratory analysis.

Select soil samples (maximum of three) from lithologically representative areas of the site will be collected in Shelby tubes for soil property analyses, including grain size distribution, dry bulk density, moisture content, ion exchange capacity, total organic carbon, pH, specific conductance, total/effective porosity and hydraulic conductivity. These parameters will provide site-specific information which influence contaminant migration in the subsurface.

2.1.3 Phase III: Groundwater Monitoring Well Installations/Development/Surveying, Groundwater Sampling and Analysis

As described in the Task I report, a total of 26 wells (14 monitoring, nine recovery, and three piezometers) have been installed at the site. Seven of the recovery wells are currently active in the facility's subsurface hydrocarbon recovery system, five wells are monitored for RCRA compliance, and two wells are monitored semi-annually for discharge plan approval compliance. The Interim

Measures Work Plan (GTI, 1993) proposed an additional two recovery wells. Additional groundwater delineation is proposed as part of the facility investigation in areas where data gaps have been identified.

Based on the results of the Phase I and Phase II investigations, additional groundwater monitoring wells will be installed at approximately seven locations for groundwater delineation and monitoring purposes. Preliminary locations include: one well in the northwest section of the site, one in the northeast (near former MW-2), and five in the area along Sullivan Road to include the BLM land to the south. Approximate well locations are shown in Figure 2, although actual locations will depend on field conditions (access, presence of above and below ground structures) and results of the preceding investigation phases. Well installation, development, surveying, and groundwater sampling procedures and quality assurance measures are discussed in more detail in Section 3.0.

Wells will be installed using driven casing (percussion hammer) drilling methodology by Beeman Drilling Co. The wells will be installed to a total depth of approximately 20 feet below grade (depending on the depth of the water table occurrence) or approximately 10 feet into the water table and constructed of four-inch diameter fiberglass-reinforced epoxy (FRE) 0.020-inch slot well screen and casing. The well screen will extend from five feet above the water table to at least the top of the Nacimiento Formation (estimated to be about 10 feet). Above the screen, the well assembly will consist of FRE casing extending to the surface. A silica sandpack will be installed in the annulus between the well screen and the borehole. A two-foot thick bentonite seal will be placed at the top of the sand pack. Cement/bentonite grout will be added above the bentonite seal to fill the annulus to a level slightly below grade. Those wells installed in high traffic areas will be finished with a bolt down, flush-mounted road box assembly and a locking cap. The remaining wells will be completed above-grade inside 3-foot protective steel surface casing.

A field geologist will supervise drilling activities and will log drill cuttings. The wells will be developed by purging water until it appears sediment-free (or is purged dry) and surveyed (tied into the site survey to be performed as part of the Interim Measures Work Plan). Soil cuttings will be characterized and disposed as appropriate. Purge water will be directed to the facility's wastewater treatment plant.

All site wells will be gauged using an Interface Probe for depth to water and SPH thickness (the Interface Probe is capable of measuring SPH to an accuracy of 0.01 feet). Wells from which samples will be collected will be purged of three volumes of water, and water will be directed to the facility's wastewater treatment plant. Groundwater samples will be collected with disposable polyethylene bailers and monofilament cord into containers provided by the laboratory. The new wells that do not contain SPHs will be sampled for VOCs (USEPA Method 8240), BNAs (USEPA Method 8270), TPH (USEPA Method 418.1) and metals (USEPA Method 6010/7000 series) analyses. All other site monitoring/recovery wells (not piezometers and excluding MW-7) that do not contain SPHs will also be sampled for VOCs and BNAs only. This analytical data will provide a current, comprehensive view of the dissolved plume at the site from which corrective measures can be evaluated.

Select groundwater samples (maximum of two) will also be analyzed for water quality parameters (including pH, temperature, dissolved oxygen, total dissolved solids, total organic carbon, alkalinity, hardness, and specific cations [e.g., iron, manganese]). These analyses will provide information on site-specific contaminant transport mechanisms and will be used in the design of corrective measures.

A second groundwater sampling event will be conducted at least 60 days following the first event. Only chemical analyses (no water quality parameter) will be performed on the second round of samples.

2.1.4 Phase IV: Field Studies

Phase IV consists of field studies, including an aquifer test and a soil vapor extraction/air sparging pilot study. These studies are specifically designed to assist in the evaluation of corrective measure technologies and were identified during the preliminary evaluation included in the Task I report. The configuration and design of these field tests will depend on the results of the Phase I, Phase II and Phase III investigations.

Aquifer Test

One of the existing recovery wells will be utilized for the aquifer test, presumably one located proximate to existing piezometers or monitoring wells which will facilitate monitoring during the aquifer test. Additional piezometers may need to be installed. The operating recovery wells will be temporarily shut down during the test and groundwater allowed to re-equilibrate prior to the start of the test. Either existing pumping equipment set below the water table or other pump will be used during the test. A step-drawdown test will be performed to determine the optimum pumping rate for a 24-hour constant-rate pump test. Drawdown will be monitored in the pumping and observation wells with pressure transducers or continuous water level recorders.

Based upon the results of the step-drawdown test, a discharge rate for a constant-rate pump test will be selected. A 24-hour constant-rate pump test will then be performed with continuous monitoring of drawdown in the pumping and observation wells. The recovery of water levels in the recovery well and observation wells after pumping has stopped will be monitored. Finally, the drawdown and recovery data collected will be analyzed for determination of aquifer hydraulic conductivity (k), transmissivity (T), and storativity (S), to determine groundwater recovery/containment flow rates, and to evaluate other aquifer properties including anisotropy, heterogeneity, and boundary influences.

All pump test data will be analyzed using Graphical Well Analysis Package (GWAP) (or an equivalent modeling program such as Aquifer Test Solver (AQTESOLV)) and all resultant test data will be incorporated into the facility investigation report.

Soil Vapor Extraction/Air Sparging Pilot Test

A soil vapor extraction/air sparging pilot test will be conducted to determine the feasibility of these technologies for application at the BRC site. Soil vapor extraction consists of applying a vacuum to wells installed in the unsaturated zone which induces air flow through soil pore space. The air flowing through the soil pore space contains volatilized contaminants which are extracted from the subsurface by the vacuum device. Air sparging consists of the application of pressurized air below the water table, allowing bubblies of air to pass through contaminated soil and water as they rise to the water table surface. While passing through contaminated zones, volatile constituents are removed by the air bubbles. Air sparging works in concert with soil vapor extraction so that once the air and volatilized contaminants reach the water table surface, they are extracted from the subsurface by the vacuum system.

Constituents of the SPHs at the BRC site are sufficiently volatile based on their individual vapor pressures and will readily volatilize based on their Henry's Law constants for these technologies:

Compound	Vapor Pressure (mm Hg)	Henry's Law Constant ($atm\text{-}m^3/mol$)
Benzene	9.52E+01	5.59E-03
Toluene	2.81E+01	6.37E-03
Ethylbenzene	7.00E+00	6.43E-03
Xylenes	1.00E+01	7.04E-03

The pilot study will provide information on the radius of influence of vapor extraction points and sparge wells for use in designing the sparge well/vapor extraction point configuration and equipment specifications. Air sampling of the offgas will be used in permitting and design of a vapor emissions control device. The pilot study will be performed in a contaminated area, specifically near RW-19, to obtain air samples representative of worst-case operating conditions.

Activities for the soil vapor extraction/air sparging pilot test will include the following:

- Drilling and installation of approximately five nested pairs of soil probes at distances of 5 to 25 feet from the extraction well at approximately 72 degree spacings. This array will provide multidirectional data at varying distances from the test well, and provide information concerning potential vertical differences in response both in the unsaturated and saturated zones;
- Drilling and installation of one two-inch diameter air sparge well with approximately two feet of screen and a two-foot sand trap, and approximately 20 feet of casing. The well screen will be set at least 10 feet below the water table, if conditions permit.
- Performance of an 8-hour soil vapor extraction pilot test using an existing monitoring well (possibly RW-19) as the extraction well;
- Performance of an 8-hour air sparging pilot test with a temporary SVE system operating to control the vapor migration; and
- Field and laboratory analysis of air samples collected during the pilot tests.

Compressed air for the air sparging pilot test will be provided by the refinery. A vacuum blower will be used for the vapor extraction portion of the test. Air effluent from the vacuum blower will be treated with two portable, 55-gallon carbon-adsorption units placed in series. Prior to test commencement, notification will be made to the proper local and state air quality agencies regarding the temporary discharge of vapors during the short-term pilot test.

The following parameters will be monitored at regular time intervals during the test:

- Pre- and post-filter vacuum at the blower;
- Induced vacuum at surrounding monitor points;
- Applied vacuum at the vapor extraction wellhead;
- Pre- and post-blower air stream temperature;
- Process air stream velocity; and
- Air influent (pre-treatment) and effluent (post-treatment) organic vapor concentrations and percent lower explosive limit (LEL).

To aid in specifying the optimal air flow for a full-scale air sparge/vapor extraction system (AS/VES), a pilot vapor extraction step-test will also be conducted on the test well. During the step-test, varying degrees of vacuum (100%, 66%, and 33% blower capacities) will be applied to the test well. The vacuum and air flow rate at the wellhead will be measured. During the step-test, induced vacuums will be measured in surrounding monitoring wells.

Six vapor samples will be collected during the pilot test, three during the vapor extraction test and three during the air sparge test. Air samples will be collected immediately following test start-up, midway through the test, and at the end of the test. The vapor samples will be collected in Tedlar bags from an air sampling port located prior to the vacuum blower and will be analyzed for total nonmethane hydrocarbons (Method TO-18), purgeable aromatics and hydrocarbons (USEPA Method 8010/8020), and methane, carbon dioxide, and oxygen (GC-TCD).

Following completion of the pilot test, air sample analytical results will be used to calculate the projected mass emissions rate of hydrocarbons from a full-scale AS/VES. Field monitoring of vapor emissions and vacuum pressure in the vent monitoring probes and observation wells will be used to calculate the effective radius of influence of the system.

2.1.5 Stream Sediment and Surface Water Sampling

Stream sediment and surface water samples will be collected from both the Hammond Ditch and San Juan River to provide current information during low flow conditions (July) which may correspond with Phase I, II, III or IV of the facility investigation. Sample collection procedures and quality assurance measures are discussed in detail in Section 3.0. Samples will be collected at three locations in the San Juan River: upstream of the facility, at the facility, and downstream of the facility. Samples will be collected every 500 feet for the length of the facility (between 10 to 12 samples). A surface water and sediment sample will be collected at each location.

All samples will be analyzed for VOCs (USEPA Method 8240), BNAs (USEPA Method 8270), TPH (USEPA Method 418.1), and metals (USEPA Method 6010/7000 series). In addition, one surface water sample from the Hammond Ditch and one from the San Juan River will be analyzed for water quality parameters: including temperature, pH, dissolved oxygen, conductivity (field determined), biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), total dissolved solids (TDS), total organic carbon (TOC) and nutrients. Stream velocity and sediment thicknesses will also be field measured.

2.2 Company Profiles & Project Organization

2.2.1 Groundwater Technology Qualifications and Experience

Groundwater Technology is an international corporation providing environmental consulting and contracting services to a variety of industrial and petroleum clients. Our capabilities include planning, implementing, and documenting comprehensive site investigations, as well as the design and construction of contaminant remediation systems for soil and groundwater. We also offer analytical, health risk assessment, and pollution control equipment manufacturing services through our business units and subsidiaries: GTEL Environmental Laboratories, Risk Assessment Services, and ORS Environmental Equipment.

Founded in 1975, Groundwater Technology is among the largest and most successful environmental consulting firms, with 1992 sales of more than $190,000,000. The company employs more than 1,700 people located in over 60 offices throughout the United States, Canada, Europe, and Australia. The company has developed a strong technical team and quality assurance/quality control (QA/QC) program to assure the integrity of the work which it performs.

Groundwater Technology is, and has been, involved in many RCRA related projects including RFI workplan implementation at multiple locations. Our offices are staffed with professionals specializing in engineering, geology, hydrogeology, chemistry, biology, and administrative disciplines. The offices are supported by a broad variety of technical disciplines from our Corporate Headquarters, Regional and District offices. Additional information on Groundwater Technology is provided in Appendix B of this plan.

2.2.2 Subcontractor Qualifications

In order to successfully complete the proposed scope of work on time and within budget, selected subcontractors will be utilized to perform various tasks of the facility investigation. Groundwater Technology will coordinate closely with all subcontractors throughout the project. For all subcontractors, the Groundwater Technology project manager will prepare a specific technical statement of work, listing subcontractor requirements, and will monitor performance. Besides complying with their own safety procedures, the subcontractors will adhere to and abide by all Groundwater Technology safety procedures and protocols. Before costs are incurred, all subcontractors will be clearly briefed on their responsibilities, scheduling constraints, required work products, product formats, coordination requirements, and budgets.

All subcontractors hired directly by Groundwater Technology are currently under service contracts with Groundwater Technology and have been prequalified with respect to experience and qualifications, health and safety requirements, and insurance coverage.

Groundwater Technology anticipates using the services of the subcontractors listed below to provide soil vapor survey services, drilling services, surveying services and laboratory analytical services.

Soil Vapor Survey Services:

Tracer Research Corporation
3855 North Business Center Drive
Tucson, Arizona 85705
(602) 888-9400
Contact: Paige Santo

Drilling Services:

Beeman Bros.
31502 Highway 160
Durango, Colorado 81301
(303) 259-1195
Contact: Leo Beeman

Surveying Services:

To be determined

Laboratory Analytical Services:

Inter-Mountain Laboratories, Inc.
2506 West Main Street
Farmington, New Mexico 87401
(505) 326-4737
Contact: Charles Ballek - Laboratory Manager

2.2.3 Project Organization

Groundwater Technology will implement the RFIWP for and under the guidance of BRC. The project organization is illustrated in Figure 3, showing lines of authority and reporting structure, and resumes for all of the key personnel proposed in this project are provided in Appendix B.

Ms. Sara Brothers will serve as the project director for the facility investigation based on her management and technical experience at numerous sites in New Mexico, including petroleum and chemical manufacturing facilities. She has worked for over four years for Groundwater Technology and has over six years experience in providing environmental consulting services. Ms. Brothers is the Operations Manager of the Groundwater Technology Albuquerque, New Mexico office. Her primary responsibilities on the BRC project will be to provide technical oversight and regulatory compliance review, assist in regulatory negotiations as necessary, and ensure that the appropriate resources are available to complete the project as proposed. Ms. Brothers will also serve as client advocate to address any concerns that BRC may have regarding the project during its implementation.

Ms. Cymantha Diaz will serve as the project manager based on her previous management and technical experience at similar sites, including numerous chemical and industrial manufacturing facilities. She has worked for over five years for Groundwater Technology and has over seven years experience in providing environmental consulting services. Because of her experience and strong credentials in the investigation and remediation of RCRA-regulated facilities, Ms. Diaz acts as project coordinator for two of Groundwater Technology's major industrial clients, providing consistency and oversight for all of Groundwater Technology's projects. Her primary responsibilities on the BRC project will be the daily management of the project with respect to directing field personnel and subcontractor activities, to communicate with the BRC staff regarding the progress and the results of the project, and to assure that all technical aspects of the project are addressed. Ms. Diaz will also be responsible for adherence to the proposed project schedule and budget.

Health and safety administration for the project will be provided by Mr. Paul Kelly and Ms Dawn Nickols. A site-specific safety plan has been prepared addressing the potential chemical and physical exposures that may be encountered in the project. Any modifications to the work scope or accidents/incidents that occur during the facility investigation will be documented by the field crew and reported to the health and safety coordinators who will prescribe actions to be taken.

Ms. Jan Whiffin will provide assistance in maintaining regulatory compliance with respect to waste disposal, and in the identification and pre-approval of waste disposal facilities. Ms. Whiffin is also the project quality assurance/quality control manager and will review documents and field procedures to ensure compliance with approved QA/QC measures. Mr. Richard Lewis, CPG, Dr. Richard Brown, PhD, Dr. Peter Kroopnick, PhD, and Ms. Marion Barnes will serve as technical consultants for the project, to provide assistance and review as needed in their areas of expertise.

2.3 Facility Investigation Schedule

The schedule for the RFI activities is shown in Figure 4. As indicated, investigative activities will require approximately six months after USEPA's approval of the RFI Work Plan. The RFI Report is anticipated to be submitted within 60 to 90 days following completion of the field activities, which is well within the 365 days from USEPA approval of the work plan specified in the Administrative Order on Consent.

2.4 Facility Investigation Budget

Appendix C summarizes the estimated cost for the RFI activities. Costs are based on Level D personal protective equipment (PPE) and assume no unusual delays are encountered while in the field.

3.0 DATA COLLECTION QUALITY ASSURANCE PLAN

The Data Collection Quality Assurance Plan documents all monitoring procedures to be used for sampling, field measurements, and laboratory analysis performed during the RFI. The plan includes quality assurance objectives and quality control procedures for field and laboratory measurements. This plan will ensure that all data collected during the investigation is properly documented and technically sound.

3.1 Data Collection Strategy

The data collected during the RFI will be used to meet the following project objectives:

- Identify and characterize the contamination source areas.
- Characterize the nature and extent of contamination in soil, soil gas, groundwater, surface water, and sediment.
- Evaluate and characterize the pathways by which contaminants can migrate.
- Supplement existing data to evaluate the potential risk to human health and the environment.
- Evaluate effectiveness of potential remediation technologies.

A QA/QC plan has been designed to ensure that all data generated will be technically sound, statistically valid, and properly documented.

3.1.1 Data Quality Objectives

The level of precision and accuracy required will be dependent on the specific uses of the data. Data Quality Objectives (DQOs) have been developed and will be used to specify the quality of data required to support RFI activities. Data quality is defined as the degree of certainty of a data set with respect to precision, accuracy, reproducibility, comparability, and completeness. The five levels of data quality and the intended uses of each are as follows:

1. DQO Level 1 - This data quality level will be used for health and safety monitoring, field screening of soil samples for organic vapors using a photoionization detector, and bench scale tests used for determining remediation alternatives. This level of data provides the most rapid results.

2. DQO Level 2 - This level of quality will be used for field measurements performed in accordance with laboratory standard operating procedures but providing real-time results. DQO Level 2 data includes field measurements of pH, temperature, and specific conductance. On-site gas chromatograph analyses (soil vapor survey) will be performed using this level of quality. DQO Level 2 provides intermediate level data quality and is used for site characterization.

3. DQO Level 3 - This level of quality uses an off-site approved analytical laboratory following SW-846 protocols. Level 3 is characterized by rigorous QA/QC protocols and documentation. The Level 3 data are used for purposes of risk assessment, engineering design, and cost analyses. Data collected using this level of quality includes analysis of groundwater, surface water, sediment, and soil samples by a certified laboratory using USEPA methodologies.

4. DQO Level IV - This level of quality includes analyses performed by preapproved non-standard methods. All analyses are performed in an off-site approved analytical laboratory. Method development or method modification may be required for specific constituents or detection limits. Level IV is characterized by rigorous QA/QC protocols and documentation. The RFI activities proposed do not entail Level IV data.

5. DQO Level V - Level 5 data includes physical property and engineering material analyses by approved standard or non-standard methods. All analyses are performed in an off-site laboratory. QA/QC protocols and documentation may be required for some analyses.

Table 1 below presents a summary of the DQOs for the site.

TABLE 1
DATA QUALITY OBJECTIVES
BLOOMFIELD REFINING COMPANY RFI

PROJECT OBJECTIVES	TECHNICAL APPROACH	DATA TO BE COLLECTED	DQO LEVEL
Background Characterization	Soil vapor survey	Soil gas chemical composition	2
		Chemical composition	3
Extent of Contamination	Soil sampling	Chemical composition	3
		Organic vapor concentration (PID)	1
		Material property analysis	5
	Sediment sampling	Chemical composition	3
		Chemical property analysis-check	2
	Groundwater sampling	Water quality	3
		Water quality field parameters	2
	Surface water sampling	Water quality	3
		Water quality field parameters	2
Source Characteristics	Soil sampling	Chemical composition	3
		Organic vapor concentration (PID)	1
	Groundwater sampling	Water quality	3
		Water quality field parameters	2
Health and Safety	On-site monitoring	Organic vapor concentration (PID)	1
Risk Assessment	Soil sampling	Chemical composition	3
	Groundwater sampling	Water quality	3
	Surface water sampling	Water quality	3
	Sediment Sampling	Chemical composition	3
Assessment of Remediation Alternatives	Soil vapor extraction/air sparge pilot study	Soil gas chemical composition	3
		Organic vapor concentration (PID)	1
		Radius of influence	3
	Aquifer Pump Test		

Procedures used to assess the quality of data are specified in Section 3.6.3 of this Quality Assurance Plan and Section 5 of the Quality Assurance Project Plan, Laboratory Analyses in Appendix D.

3.1.2 Representativeness of Data

The technical approach for the facility investigation was presented in Section 2.0 - Project Management Plan. The sampling network was designed to provide data representative of site conditions. Data gaps identified in the Task 1 report were used to determine sampling locations. Selection of the specific sampling locations and sample analyses was based on existing knowledge of the release configuration, existing analytical data, and potential sources of contamination. Soil vapor survey points, soil borings and monitoring well locations were placed near the perimeter of the plume and in areas of potential contamination in order to supplement existing data. Surface water and sediment samples will be collected along the entire length of the Hammond Ditch surrounding the facility on all but the southern sides in order to obtain a representative set of samples.

3.1.3 Comparison of Data

All RFI data will be generated according to the Data Collection Quality Assurance Plan and the Data Management Plan. The following measures will be taken to ensure comparability of data sets:

- Standardized written field sampling procedures;
- Standardized written sample preparation and analytical procedures;
- Standard handling and shipping procedures used for all samples collected;
- Results reported in consistent formats and units.

Data previously generated by BRC will be used as a guideline for planning additional monitoring efforts, qualitative trend analysis, and selection of target parameters for future analyses.

3.1.4 Internal Quality Control Checks

Internal quality control procedures for laboratory analyses are described in Section 11 of the Quality Assurance Project Plan, Laboratory Analyses in Appendix D. Internal quality control procedures for field measurements include checking the reproducibility of measurements using duplicate samples, using field blanks to check for contamination that may be introduced during sampling procedures, and calibrating instruments prior to use.

3.1.5 Data Reduction, Validation, and Reporting

Data reduction and validation procedures for laboratory analyses are described in Section 10 of the Quality Assurance Project Plan, Laboratory Analyses in Appendix D. The format for laboratory analytical reports prepared by Inter-Mountain Laboratories, Inc. is outlined in Section 11 of the laboratory plan. Any data reduction and validation procedures used for field measurements will be described in the RFI report.

3.1.6 Performance and System Audits

Performance audits for laboratory activities are described in Section 12 of the Quality Assurance Project Plan, Laboratory Analyses in Appendix D. The Project Quality Assurance Manager will ensure proper execution of RFI field activities by routinely reviewing field notes and documentation. The objectives of project quality assurance are:

- To verify that a system for project documentation is established and the documentation plan is being followed.
- To verify that quality control procedures are established for all activities that generate environmental data and information.
- To identify non-conformance with the established system of quality control procedures.
- To recommend corrective actions for identified non-conformance.
- To verify implementation of corrective action.
- To provide written reports of audits.

The Project Quality Assurance Manager will ensure compliance with the following items:

- Written procedures for sample collection are available and are being followed.
- Chain-of-custody procedures are being followed.
- Appropriate QC checks are being performed and QC checks are documented.
- Equipment is available, calibrated, and in proper working order.
- Field personnel are properly trained.
- All field procedures are being documented in field notebooks and appropriate tracking forms.

3.1.7 Preventative Maintenance

Preventative maintenance for laboratory instruments and equipment is described in Section 13 of the Quality Assurance Project Plan, Laboratory Analyses in Appendix D. Preventative maintenance for field instruments will be conducted in accordance with the manufacturer's specifications described in each instrument's manual. The field personnel will be responsible for implementing and documenting the maintenance procedures.

3.1.8 Corrective Action

Any non-conformance with the established QC procedures in the Data Collection Quality Assurance Plan will be identified and corrected. Corrective action for laboratory instruments, procedures, or personnel is described in Section 15 of the Quality Assurance Project Plan, Laboratory Analyses in Appendix D. Corrective action for field measurements may include repeating a measurement, checking batteries on a field instrument, checking calibration of instruments, replacing an instrument, or stopping work until equipment is functioning properly. The Groundwater Technology Project Manager is responsible for controlling and tracking any necessary corrective action. The field personnel are responsible for implementing the corrective action and documenting the action in a field notebook.

3.2 Sampling

The sampling program includes the collection of soil, soil gas, surface water, groundwater, and sediment samples. Table 2 summarizes the RFI sampling and analysis program, with more detailed information included in Section 2.0 of the Project Management Plan. Field equipment checklists for each sample matrix are included in Appendix E.

TABLE 2
SUMMARY OF SAMPLING AND ANALYSIS PROGRAM
BLOOMFIELD REFINING COMPANY

SAMPLE MATRIX	FIELD PARAMETERS	LABORATORY PARAMETERS	INVESTIGATIVE SAMPLE NO.*	FREQ.
Groundwater	pH	VOCs (EPA 8240)	26	2
	Temperature	BNAs (EPA 8270)	26	2
	Specific conductance	TPH (EPA 418.1)	6	2
		PP Metals (EPA 6010/7000 Series)	6	2
Surface Water	pH	VOCs (EPA 8240)	14	1
	Temperature	BNAs (EPA 8270)	14	1
	Specific conductance	TPH (EPA 418.1)	14	1
	Dissolved Oxygen	PP Metals (EPA 6010/7000 Series)	14	1
		BOD	2	1
		COD	2	1
		TSS	2	1
		TDS	2	1
		TOC	2	1
		Nutrients	2	1
Soil	PID screening	VOCs (EPA 8240)	20	1
		BNAs (EPA 8270)	20	1
		TPH (EPA 418.1)	20	1
		PP Metals (EPA 6010/7000 Series)	20	1
		Grain size	3	1
		Effective/total porosity	3	1
		Hydraulic conductivity	3	1
		TOC	3	1
		Dry bulk density	3	1
		Ion exchange capacity	3	1
		pH	3	1
		Moisture content	3	1
		Specific conductance	3	1
Sediment	PID Screening	VOCs (EPA 8240)	14	1
		BNAs (EPA 8270)	14	1
		TPH (EPA 418.1)	14	1
		PP Metals (EPA 6010/7000 Series)	14	1
		pH	2	1
		Specific conductance	2	1
		TOC	2	1
		Nutrients	2	1
Soil Gas	On-site GC Analysis for: BTEX Total Volatile Hydrocarbons	N/A	100	1
Soil Sampling		VOCs (EPA 8240)	10	1

* - In addition to the samples listed in the table, field blanks and duplicates will also be submitted for laboratory analysis.

3.2.1 Background Characterization

Prior to determining final locations of soil borings and monitoring wells, a soil vapor survey will be conducted to assist in delineating the contaminant plume. The data obtained during this survey will be used to determine the optimum boring/monitoring well locations. Since the contaminants of concern have high volatility, soil gas sampling will be an effective investigative measure.

Soil Vapor Survey

Tracer Research Corporation will be contracted to conduct the soil vapor survey under the supervision of Groundwater Technology personnel. The soil vapor survey is designed to cover the southern and eastern portions of the site with a grid of sampling locations based on 150 foot centers. The southern and eastern portions were selected because additional contaminant delineation is required in this area of the site. The proposed sampling locations are shown in Figure 2. These locations are subject to modification based on field conditions, such as the presence of aboveground or underground structures.

The specific objectives of the soil vapor survey are:

- To identify areas of contaminant impact and delineate contaminated zones.
- To identify and quantify specific contaminants of concern and map their areal distribution across the site.
- To determine the optimum locations for borings and monitoring wells.

The soil vapor survey will be conducted using the direct injection method to a laboratory-grade gas chromatograph equipped with a flame ionization detector (FID). Samples will be collected from two depths, three feet and ten feet below grade, at each location. The sampling procedures and quality assurance/quality control procedures are outlined in Appendix F, Soil Gas Sampling Procedures. The samples will be analyzed for benzene, ethylbenzene, toluene, total xylenes, and total volatile hydrocarbons (TVHC). Typical detection limits for these compounds are listed in Appendix F.

In addition to the soil vapor sample analyses, confirmation soil samples will be collected from approximately 10 percent of the soil vapor sample locations (or 10 samples). The soil samples will be collected using six-inch long, 3/4-inch inside diameter brass tube with aluminum points. These samples will be submitted to the laboratory for analysis of volatile organic compouns (USEPA Method 8240) to correlate and verify soil vapor survey data.

3.2.2 Soil Borings

As described in Section 2.0, approximately 10 soil borings will be installed in areas identified by USEPA during the 1987 inspection or other potential source areas based on the facility's spill history or the results of the soil vapor survey. These borings will be installed in order to characterize the horizontal and vertical extent of soil contamination. The number of borings may be adjusted based on the results of the soil vapor survey. Soil samples will be analyzed in order to characterize the nature and extent of contamination at these areas.

The borings will be advanced just beyond the depth of detectable contamination, which will be determined by PID screening. However, borings will not be advanced into the cobble layer, if encountered, the water table interface, or the top of the Nacimiento Formation (which is the impermeable lower boundary of the gravel and cobble aquifer). Samples will be collected continuously and will be screened in the field using a PID as described in section 3.2.2.3 below. Two soil samples from each boring (the sample exhibiting the highest PID reading and the sample collected at the water table interface) will be submitted for laboratory analysis. The parameters to be analyzed for are outlined in section 3.2.2.2 below. Borings will be properly abandoned following sample collection.

3.2.2.1 Monitoring Well Locations

The locations for the monitoring wells will be determined based on the results of the soil vapor survey. Preliminary locations for an estimated seven monitoring wells are presented in Figure 2. The wells are located in areas near the anticipated perimeter of the plume. The intent of these locations is to define the contaminant plume boundaries and to obtain data that will supplement existing information on the extent of contamination.

3.2.2.2 Measurement Parameters

Soil samples selected for laboratory analysis will be analyzed for volatile organic compounds (VOCs) using USEPA Method 8240, base/neutral/acid extractable semivolatile organic compounds (BNAs) using USEPA Method 8270, total petroleum hydrocarbons (TPH) using USEPA Method 418.1, and priority pollutant metals using USEPA Method 6010/7000 Series. Laboratory measurement parameters were determined based on the composition of known or suspected sources of soil contamination and in accordance with the requirements of the Administrative Order on Consent. In addition, a maximum of three representative soil samples will be analyzed for soil property analyses, including: grain size distribution, total porosity, effective porosity, hydraulic conductivity, total organic carbon (TOC), dry bulk density, ion exchange capacity, pH, moisture content, and specific conductance.

3.2.2.3 Field Measurements

Field Screening

Field screening of soil samples for VOCs will be used to evaluate the relative degree of contamination in the samples. The screening will be conducted by performing a headspace analysis on air in contact with a soil sample in a closed container. Selection of soil samples for laboratory analysis will be based on the field screening results.

A MicroTIP® MP-100 hand held air monitoring device will be used for the field screening during soil boring installations. This instrument is a microprocessor controlled instrument used for measuring the presence of photoionizable chemicals in air at parts per million levels. A pump continuously pulls air to be tested through the MicroTIP's PID. The PID measures the concentration of ionizable chemicals in the gas stream and produces an electrical signal for the microprocessor. Chemicals are ionized by a 10.6 electron-volt (eV) ultraviolet lamp. If the ionization potential of any molecule present in the air sample is less than or equal to 10.6 eV, ionization will take place and an electrical signal will be sent to the microprocessor.

Isobutylene at a known concentration (100 parts per million; ppm) will be used to calibrate the instrument. Therefore, concentrations are expressed in units equivalent to ppm of isobutylene. The instrument has a medium sensitivity to isobutylene and may respond more or less readily to other chemicals. The MicroTIP® does not distinguish one type of chemical from another, but displays a number indicating the total concentration of all ionizable compounds in the sample relative to isobutylene. The instrument will be calibrated once a day prior to use. The calibration procedure is summarized in Appendix G.

The MicroTIP® has the following limitations:

- Individual compounds are not identified.
- Compounds with ionization potentials greater than 10.6 eV will not be detected.
- Methane gas will not be detected.

- During cold weather, condensation may form on the UV lamp window. This could produce an erroneous reading.
- Instrument readings can be affected by humidity.
- Concentrations are expressed in units relative to isobutylene.

If the weather is cold, field screening will be performed inside a heated vehicle or building.

Measurement Procedure

The procedure to be used for measuring sample headspace relative VOC concentration is as follows:

1. Record the background ambient air concentration in a designated site field notebook. Locations with background readings greater than 3.0 ppm should not be used for field screening.
2. Fill a clean 8 ounce glass jar with the soil sample until the jar is one-third full. Immediately cover the top of the jar with a sheet of aluminum foil and screw on the jar cap.
3. Shake the jar vigorously for approximately 15 seconds and place the sample in an environment with a temperature of 55 degrees Fahrenheit or greater. Allow ten minutes for headspace development of VOCs and then shake the jar again.
4. Remove the jar cap and puncture the foil with the MicroTIP® sampling probe. Lower the probe into the jar until it reaches one-half of the headspace depth.
5. Record the maximum reading displayed on the instrument. Maximum response should be displayed within 5 seconds. If the instrument response is erratic due to high moisture content in the headspace, this should be noted.

Data Recording

PID data will be recorded in a site field notebook and on the Soil Boring Log shown in Appendix H - Field Documentation Forms. The PID data recorded in the field notebook will include verification of calibration, sample identification, sample depth, background reading, sample reading, time sample collected, time sample analyzed, instrument user, date, and instrument identification number. Additionally, instrument calibration records and maintenance records will be generated and kept up to date.

3.2.2.4 Field Sampling Operations and Procedures

Drilling Procedures

The drill-through casing driver method (percussion hammer) will be used for drilling since gravel and cobbles of the Quaternary Jackson Lake Terrace deposits will be encountered. This method has been selected since high drilling rates are achieved in gravel and cobble formations, drilling fluids are not introduced into the formation, and disturbance of subsurface materials is minimized. Boreholes used for the installation of monitoring wells will be advanced using an eight-inch diameter tungsten button bit to obtain an eight-inch diameter borehole. Steel casing (8 and 5/8-inch outer diameter, 8-inch inner diameter) will be driven simultaneously during drilling. Four-inch diameter boreholes will be drilled when monitoring wells will not be installed. A four-inch diameter button bit and four-inch diameter steel casing will be used for these boreholes. Boreholes that will not be used to install monitoring wells will be properly abandoned by filling with a cement-bentonite grout, which will be pumped into place, and sealing with a concrete cap.

Samples will be collected continuously during soil boring installations in advance of the drill bit using standard split-barrel sampling techniques as specified in ASTM Method D-1586-84. A portion of each sample will be placed in a 4 oz., wide mouth, glass jar with a teflon lined cap for possible laboratory analysis. The jar will be filled to the top to minimize loss of volatile organic compounds to headspace. If an adequate amount of sample is recovered, separate 4 oz. jars will be filled for each analysis required. Otherwise, one 4 oz. jar will be filled for VOC analysis and one 8 oz. jar will be filled for BNA, TPH, and metals analyses.

Another portion of each split-spoon sample will be transferred to an 8-ounce glass jar for headspace analysis. The procedure for headspace analysis and data recording is described in section 3.2.2.3. The soil sample above the water table exhibiting the highest PID reading will be submitted for laboratory analysis. The QA/QC sampling plan is described in Section 3.6.

Due to the nature of the cobble and gravel formation, it may not be possible to obtain samples from this formation using the split-barrel technique. Other sample collection techniques were evaluated and discussed with the drilling company. In the event that undisturbed samples cannot be obtained, drill cuttings will be collected for PID screening only.

All sample jars submitted to the laboratory will be labeled with the project number, borehole identification (B-sample #), sample depth (in feet from surface), date, time collected, sample type (grab or composite), and sampler name. All soil samples will be preserved by cooling to approximately four degrees Celsius. Samples to be analyzed will be placed on ice for delivery within 24 hours of sample collection to Inter-Mountain Laboratories in Farmington, New Mexico using proper chain-of-custody procedures. Chain-of-custody procedures are described in Section 3.2.7 and shipping procedures are described in Section 3.2.8.

In addition, a minimum of three representative soil samples will be collected and analyzed for grain size, total porosity, effective porosity, hydraulic conductivity, total organic carbon (TOC), dry bulk density, ion exchange capacity, pH, moisture content, and specific conductivity. Above the cobble and gravel formation, grab samples will be collected using thin-walled sampling tubes. Composite samples of the gravel formation will be collected from the drill cuttings for these analyses. The sample containers required for each analysis are shown in Table 3 below.

TABLE 3
SAMPLE CONTAINERS AND PRESERVATION FOR GEOTECHNICAL AND CHEMICAL TESTING SOIL SAMPLES

Analysis	Sample Container	Number of Containers	Preservation
Grain size distribution	4 oz. plastic or glass jar	1/2	N/A
Effective/total Porosity	4 oz. plastic or glass jar	1/2	N/A
Hydraulic conductivity	1 inch diameter, 1 ft. long sampling tube	1	N/A
TOC	8 oz. glass jar with teflon cap	1	Cool to 4°C
Dry bulk density	8 oz. glass jar with teflon cap	1	N/A
Ion exchange capacity	8 oz. glass jar with teflon cap	1	N/A
pH	8 oz. glass jar with teflon cap	2	Cool to 4°C
Moisture content	8 oz. glass jar with teflon cap	1	Cool to 4°C
Specific conductivity	8 oz. glass jar with teflon cap	1	N/A

Soil cuttings will be directed away from the drill crew during drilling operations using a directional pipe. The cuttings will be directed onto heavy plastic sheeting, characterized and disposed appropriately.

Data Recording

Each sample will be visually classified by a Groundwater Technology geologist in accordance with ASTM Method D2488-84 using the Unified Soil Classification System (USCS). Descriptions will be recorded in a designated site field notebook. The descriptions will include soil type, soil color, organic material content, grain size distribution, odor, consistency, density, grain shape and lithology, and PID reading. In addition, the borehole identification, sample depth, date, time collected, sample type (grab or composite), and sampler name will be recorded in the field notebook. This information will be used to prepare a lithologic borehole log for each borehole using the Boring/Monitoring Well Log shown in Appendix H - Field Documentation Forms. Each borehole location will be marked on the site map and distances from the borehole to at least three reference points will be measured and recorded on the map.

Decontamination Procedures

Prior to drilling, the drill rig and associated drilling equipment will be steam cleaned to minimize the potential for cross-contamination between locations. All downhole drilling equipment and associated tools will also be steam cleaned between each borehole to minimize cross contamination between boreholes. In addition, excess soil on the drill rig will be removed by using steel brushes. If it is necessary to store drill pipe or casing prior to use, the pipe and casing will be stored on racks and covered with plastic sheeting until used. All downhole sampling equipment will be cleaned between samples by scrubbing with potable water to remove soil particles, washing with an Alconox® solution, and rinsing with potable water.

A designated decontamination area will be set up for cleaning operations. The area will be lined with heavy plastic sheeting which will be bermed to prevent run off of decontamination water. The water collected on the plastic will be allowed to evaporate daily. At the close of each working day, the remaining water will be pumped into containers and transferred to BRC's oil/water separator, which is part of the facility's wastewater treatment system, for treatment.

3.2.3 Monitoring Well Installation

Based on the results of the Phase I and Phase II investigations, additional groundwater monitoring wells will be installed at approximately seven locations. Monitoring wells will be installed to determine the water table elevations over time, the presence or absence of separate-phase hydrocarbons on the groundwater surface, the presence or absence of specific contaminant compounds in the groundwater, and the concentration distribution of dissolved contaminants. Additionally, monitoring well data will be used to evaluate the mechanisms and direction of groundwater flow within the subsurface.

Monitoring wells will be installed using a drill-through casing driver method. Boreholes will be advanced using an eight-inch diameter tungsten button bit. Steel casing will be driven simultaneously during drilling. Monitoring wells will be installed to a depth of approximately ten feet below the water table.

3.2.3.1 Well Materials

Monitoring wells will be constructed using fiberglass-reinforced epoxy (FRE) casing and well screen. This material is resistant to most forms of corrosion, is not conductive, and has a strength similar to steel. All joints heat-treated to connect. Well casings and screens will be steam cleaned and sealed in plastic prior to use or will remain sealed in factory plastic until use. Well materials will be visually inspected for defects and defective material will not be used.

Typical monitoring well constructions are illustrated in Figures 5 and 6. Figure 5 illustrates a flush-mounted well and Figure 6 illustrates a well with casing extended above the ground surface. Monitoring wells will be constructed using four-inch diameter, 20 foot, 0.020-inch continuous slotted screens. Well casing length will depend on depth to the groundwater table. Wells located in high traffic areas will be set approximately six inches below grade and will be protected with an eight-inch diameter manhole cover, which will be secured in concrete and set at grade. Each flush-mounted well will be equipped with a vented, compression sealing well cap and lock. Wells located in non-traffic areas will extend approximately two feet above grade and will be protected with a six foot long metal protective casing. The protective casing will have an inside diameter of six inches and will be equipped with a locking cap. In addition, a compression sealing, vented well cap will be placed on each above grade well.

Clean, Global No. 5 silica sand filter pack will be used to fill the annular space surrounding the well screen. The effective size of this pack is 90 percent retained on 0.036-inch slot openings. The filter pack will extend from 0.5 feet below the screen to two feet above the screen. A two foot thick bentonite seal will be placed above the filter pack. The remaining annular space will be sealed with a five percent bentonite-cement grout. The protective casing or manhole around each well will be set in concrete.

3.2.3.2 Installation Procedures

Upon borehole completion, six inches of filter pack will be placed in the bottom of the borehole. The well screen and casing will be lowered through the center of the steel-cased borehole by personnel wearing clean gloves. Monitoring wells will be installed to a depth of approximately ten feet below the water table. Filter pack will be placed in the annular space between the well screen and the borehole, pulling the temporary casing out of the hole as the filter pack is installed. A tape measure will be used to ensure the pack material is installed evenly and over the proper depth interval. After installing the two-foot bentonite seal, the bentonite-cement grout will be tremied into place. The protective casing or manhole cover will be centered over the well casing and set into place with a concrete cap. Protective casing for above ground wells will extend from 3.5 feet below grade to 2.5 feet above the ground surface. A concrete seal will be placed between the protective casing and the borehole. The concrete seal will extend from 3.5 feet below grade to above the ground surface and will be finished to slope away from the protective casing. The well will be set such that it is six inches below the top of the protective casing. Flush-mounted monitoring wells will be set six inches below grade.

3.2.3.3 Well Development

Well development will be conducted to remove the effects of drilling and monitoring well installation. The wells will be developed using a stainless steel, submersible pump. Groundwater will be purged from each well until approximately three well volumes have been removed, until sediment free water is produced, or until the well is purged dry. Well volumes will be calculated using the following equations:

$X - Y = Z$
$Z \times B = C$

Where:

X = Total depth of well
Y = Depth to water
Z = Linear feet of water column
B = Gallons/linear foot of casing
C = Amount of standing water in well

The volume of standing water in the well (C) will be multiplied by three to identify the appropriate gallons of water to be removed from the well. Periodic measurements of temperature, specific conductance, and pH will be made on purged water to check the stability of these parameters. Water level measurements will be obtained prior to development and after water levels have stabilized following development.

The pumping equipment will be decontaminated between wells by disassembling and scrubbing with an Alconox® solution, rinsing with tap water, and rinsing with distilled water. The purge water and decontamination water will be pumped to BRC's oil/water separator for treatment.

3.2.3.4 Data Recording

The calculated and actual amounts of each type of material used to construct the monitoring wells will be recorded. Well construction data will be recorded in a site field notebook and on a Boring/Monitoring Well Log. The data will include date and time of construction, drilling method used, well location, borehole and well casing diameter, well depth, well construction materials used (filter pack, casing, screen, and sealants) and a detailed drawing of the well. Each monitoring well location will be marked on the site map and the distance from each well to at least three reference points will be measured and recorded on the map.

Measurements taken during well development, the amount of purged water, and visual appearance of water will be recorded on the Well Development Form, which is included in Appendix H.

3.2.4 Groundwater Sampling

Groundwater sampling will be performed to determine the nature, extent, and magnitude of groundwater impacts. In addition, the groundwater data will be used to further characterize the site environmental setting and potential pathways of contaminant migration.

Groundwater samples will be collected from all new and existing recovery and monitoring wells that do not contain separate-phase hydrocarbons, with the exception of MW-7 and the three piezometers (P-1, P-2 and P-3). Two groundwater sampling events will be conducted during the investigation. The first round of samples will be collected shortly after development of all the new wells is complete. The second round will be collected after a minimum of 60 days from the date of the first sampling event.

3.2.4.1 Measurement Parameters

Groundwater water samples collected from the new wells will be analyzed for VOCs using USEPA Method 8240, BNAs using USEPA Method 8270, total petroleum hydrocarbons (TPH) using USEPA Method 418.1, and priority pollutant metals using USEPA 6010/7000 Series. Groundwater samples collected from previously installed wells will be analyzed for VOCs and BNAs only using USEPA Methods 8240 and 8270. Laboratory measurement parameters were determined based on the composition of known or suspected sources of groundwater contamination.

3.2.4.2 Groundwater Sampling Procedures

Prior to sampling, static liquid levels will be measured in all new and existing wells. The measurement procedures are outlined in Section 3.4. In addition, the total well depth will be measured in the new monitoring wells. This data will be recorded on the Well Gauging Data Form shown as in Appendix H.

Stagnant water will be purged from each well prior to sampling so that samples will be representative of in-situ groundwater quality. Approximately three well volumes of groundwater will be removed from each well using a stainless steel, pneumatic, submersible pump. The pump will be operated at a rate that does not cause recharge water to be excessively agitated. The pumping equipment will be decontaminated between wells by scrubbing with an Alconox® solution, rinsing with tap water, and rinsing with distilled water.

During purging, measurements will be made periodically of pH and temperature using a Cole-Parmer Model 5985-80 Digi-Sense® pH meter and specific conductance using a YSI 33 S-C-T Meter. Samples will be collected for laboratory analysis when these parameters have stabilized or when three well volumes have been removed from the well, whichever occurs first. After sample collection, pH, specific conductance, and temperature will be measured again to check stability of the water. Measurements will be recorded on the Conductivity/Temperature/pH Meter Calibration and Results Log shown in Appendix H.

Groundwater samples will be collected using dedicated, disposable bailers and monofilment cord or a stainless steel, pneumatic, submersible pump and Teflon™ tubing. If pumps are used, they will be operated in a continuous manner so that groundwater is not aerated. While sampling for volatile constituents, the pumping rate will not be allowed to exceed 100 milliliters/minute. The pumping equipment will be decontaminated between wells by scrubbing with an Alconox® solution, rinsing with tap water, and rinsing with distilled water. All purged water and decontamination water will be pumped to BRC's oil/water separator for treatment.

Samples will be transferred directly from the sampling equipment into the container that has been specifically prepared for each type of analysis. The sample containers for volatile organic analyses will be filled so that there is no headspace in the sample container to minimize the possibility of volatilization. Samples collected for metals analysis will be filtered in the field using a Nalgene® filter holder and receiver, a 47-mm membrane filter, and a hand operated vacuum pump.

The wells will be sampled from least impacted to most impacted based on results of previous groundwater analyses. For wells not previously sampled, upgradient wells will be sampled before downgradient wells and suspected degree of contamination will be taken into account. Sample containers will be filled in the following order as recommended by EPA:

- VOCs
- TPH
- BNAs
- Dissolved metals

All sample containers will be labeled with the following information:

- Project identification number
- Sample identification number, which will include sample type, i.e. groundwater and sample location (MW-#)
- Name of sampler
- Date and time of sample collection
- Analysis required
- Preservation used

Replicate groundwater samples, field blanks, and trip blanks will be collected to monitor quality assurance objectives. The QA/QC sampling plan is described in Section 3.6. All samples will be transported to the laboratory following procedures described in Sections 3.2.7 and 3.2.8.

3.2.4.3 Sample Containers and Preservation

Groundwater samples will be collected in clean, pre-labeled containers supplied by the laboratory. Table 4 below summarizes the sample containers and preservation that will be used for each analysis. The table also specifies how many containers will be collected per sample for each analysis.

TABLE 4
SAMPLE CONTAINERS AND PRESERVATION
GROUNDWATER SAMPLING

Analysis	Sample Container	Number of Containers	Preservative
VOCs	40 ml glass vial with teflon septum cap	3	adjust pH to <2 with 1:1 HCl, cool to 4° C
BNAs	1 liter amber glass bottle with teflon lined cap	3	cool to 4° C
TPH	1 liter amber glass bottle with teflon lined cap	2	adjust pH to <2 with 1:1 HCl, cool to 4° C
Metals	500 ml plastic bottle	1	adjust pH to <2 with HNO_3
Specific Conductance	16 ounce glass jar	field determined	N/A
pH/Temperature	16 ounce glass jar	field determined	N/A

3.2.4.4 Field Measurements

During purging prior to groundwater sampling, measurements will be made periodically of pH, specific conductance, and temperature. Measurements will be recorded on the Conductivity/Temperature/pH Meter Calibration and Results Log shown in Appendix H. Calibration procedures for these instruments are outlined in Appendix I and quality control procedures are described in Section 3.6.2. All instrument probes will be cleaned in between each sample measurement according to the instrument manufacturer's cleaning instructions.

pH Measurement/Temperature Measurement

Groundwater sample pH will be measured in the field using a Cole-Parmer Model 5985-80 Digi-Sense® pH meter. The pH meter will be calibrated daily prior to sample measurement. After calibration, the instrument will be used to measure pH and temperature as follows:

1. Connect the pH electrode and the automatic temperature compensation probe (ATC) to the meter.
2. Push the ON/OFF switch to turn the unit on.

3. Then push RANGE until the display indicates the desired mode. Note: When the instrument is switched on, it is in the pH mode.

4. Dip the pH electrode and the temperature sensor into the water sample. The pH value displayed will stabilize within a few seconds.

5. Remove the electrode and sensor from the water sample.

6. Press the RANGE key until the symbol °C appears on the display.

7. Dip the temperature sensor in the solution until the reading stabilizes.

8. Press the ON/OFF switch again to turn the unit off.

Specific Conductance Measurement

Specific conductance of groundwater will be measured in the field using a YSI 33 S-C-T Meter. The conductivity meter will be calibrated daily prior to sample measurement. Conductivity will be measured according to the following procedure:

1. Plug the conductivity/temperature probe into the jack on the side of the instrument.

2. Put the probe in the sample to be measured.

3. Switch the scale to X100. If the reading is below 50 on the 0-100 range, switch to X10. If the reading is still below 50, switch to the x1 scale. Read the meter scale and multiply the reading by the appropriate factor. The result is expressed in micromhos/cm. Note: Measurements are not temperature compensated.

4. When measuring on the X100 and X10 scales, depress the CELL TEST button. The meter reading should fall less than 2%. If the decrease is greater, clean the probe and remeasure conductivity of the sample.

3.2.4.5 Data Recording

Groundwater sampling data will be recorded on the Well Sampling Field Log and the Well Sampling Chart shown in Appendix H. Any additional information will be recorded in the site field notebook.

3.2.5 Surface Water Sampling

The surface water sampling plan is designed to determine whether surface water bodies are carrying contaminants from the facility to off-site locations. Surface water samples will be collected from the Hammond Ditch and the San Juan River. Three water samples will be collected from the San Juan

River: one upstream, one downstream, and one midway between the first two. Water samples will be collected every 500 feet from the Hammond Ditch.

3.2.5.1 Measurement Parameters

Surface water samples will be analyzed for VOCs using USEPA Method 8240, BNAs using USEPA Method 8270, total petroleum hydrocarbons using USEPA Method 418.1, and priority pollutant metals using USEPA 6010/7000 Series. Additional water samples will be collected from one representative location and analyzed for pH, temperature, specific conductance, dissolved oxygen, biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), total dissolved solids (TDS), total organic carbon (TOC), and nutrients. Temperature, specific conductance, dissolved oxygen and pH will be measured in the field following procedures described in Section 3.2.4.4 above. The remaining analyses will be performed by Inter-Mountain Laboratories, Inc. in Farmington, New Mexico following procedures listed in Table 5.

3.2.5.2 Sampling Procedures

The water samples will be collected in clean containers supplied by the laboratory and specifically prepared for each type of analysis. Samples will be collected from mid-depth at a point as close as possible to the center of the water body at each selected sampling location. The sample containers will be lowered into the water while still capped, uncapped and allowed to fill, and then recapped before removing from the water. The mouth of the container will face into the flow of water and the sampler will be downstream of the sample bottle to minimize disturbance of the bottom sediments. For VOC analyses, the sample containers will be completely filled to avoid volatilization. Samples collected for metals analysis will be filtered in the field using a Nalgene® filter holder and receiver, a 47-mm membrane filter, and a hand operated vacuum pump.

The samples will be collected in the following order as recommended by the USEPA:

- VOCs
- BNAs
- TOC
- TPH
- Dissolved metals
- BOD
- COD
- TSS
- TDS
- Nutrients

The sample containers will be labeled with the following information:

- Project identification number
- Sample identification number, which will include sample type, i.e. surface water and sample location
- Name of sampler
- Date and time of sample collection
- Analysis required
- Preservation used

All laboratory samples will be packaged and transported to the laboratory following procedures described in Sections 3.2.7 and 3.2.8. Replicate field samples and field blanks will be collected to monitor quality assurance objectives. The QA/QC sampling plan is described in Section 3.6.

3.2.5.3 Sample Containers and Preservation

Sample containers and preservation for each analysis are listed in Table 5 below.

TABLE 5
SAMPLE CONTAINERS AND PRESERVATION
SURFACE WATER SAMPLING

Analysis	Sample Container	Number of Containers	Preservative
VOCs	40 ml glass vial with teflon septum cap	3	adjust pH to <2 with 1:1 HCl, cool to 4° C
TOC	40 ml glass vial with teflon septum cap	2	adjust pH to <2 with 1:1 H_2SO_4, cool to 4° C
TPH	1 liter amber glass bottle with teflon lined cap	2	adjust pH to <2 with 1:1 HCl, cool to 4° C
BNAs	1 liter amber glass bottle with teflon lined cap	1	adjust pH to <2 with HNO_3
Dissolved metals	500 ml plastic bottle	1	adjust pH to <2 with HNO_3
BOD	1 liter plastic bottle	1	cool to 4° C
COD	100 ml plastic bottle	1	adjust pH to <2 with 1:1 H_2SO_4, cool to 4° C
TSS	500 ml plastic bottle	1	cool to 4° C
TDS	500 ml plastic bottle	1	cool to 4° C
Nutrients	250 ml plastic bottle	1	adjust pH to <2 with 1:1 H_2SO_4
Specific Conductance/Dissolved Oxygen	16 ounce glass jar	field determined	N/A
pH/Temperature	16 ounce glass jar	field determined	N/A

3.2.5.4 Data Recording

Field data will be recorded in a site designated field notebook and on the Sediment/Surface Water Sampling Field Log shown in Appendix H. Each sampling location will be marked on the site map and distances from the sample location to at least three reference points will be measured and recorded on the map.

3.2.6 Sediment Sampling

The sediment sampling plan is designed to assess the potential for sediment in the San Juan River and the Hammond Ditch to impact groundwater quality and surface water quality. Three sediment samples will be collected from the southern bank of the San Juan River: one upstream, one downstream, and one midway between the first two. Sediment samples will be collected every 500 feet from the banks of the Hammond Ditch. A estimated total of 14 sediment samples will be collected.

3.2.6.1 Measurement Parameters

Sediment samples will be analyzed for VOCs using USEPA Method 8240, BNAs using USEPA Method 8270, TPH using USEPA Method 418.1, and priority pollutant metals using USEPA Method 6010/7000 Series. Sample analyses will be performed by Inter-Mountain Laboratories, Inc. in Farmington, New Mexico following procedures listed in Table 6. Measurement parameters were determined based on the composition of known or suspected sources of sediment contamination.

3.2.6.2 Sampling Procedures

The sediment samples will be collected in clean containers supplied by the laboratory and specifically prepared for each type of analysis. Bottom sediment samples will be collected along the banks of each water body. If possible, the upper six inches of sediment will be removed using a clean stainless steel trowel. After decontamination of the trowel, a sediment sample will be collected. A second sample will be collected from each location for field screening using a PID. PID measurements will be performed following procedures described in Section 3.2.2.3.

The trowel will be decontaminated by scrubbing with potable water to remove soil particles, washing with an Alconox® solution, and rinsing with potable water. The sediment sample will be packed tightly into the appropriate containers and the containers will be immediately sealed. All sample jars will be labeled with the project number, sample identification, sample depth, date, time collected, sample type (grab or composite), and sampler name.

The samples will be collected in the following order as recommended by the USEPA:

- VOCs
- BNAs
- TOC
- TPH
- Metals

Replicate field samples and field blanks will be collected to monitor quality assurance objectives. The QA/QC sampling plan is described in Section 3.6. All samples will be placed on ice to cool to 4° Celsius and transported to the laboratory for analysis following the procedures described in Sections 3.2.7 and 3.2.8.

3.2.6.3 Sample Containers and Preservation

TABLE 6
SAMPLE CONTAINERS AND PRESERVATION
SEDIMENT SAMPLING

Analysis	Sample Container	Number of Containers	Preservative
VOCs	4 oz. glass jar with teflon cap	1	cool to 4° C
BNAs	8 oz. glass jar with teflon cap	1	cool to 4° C
TPH	4 oz. glass jar with teflon cap	1	cool to 4° C
Metals	8 oz. glass jar with teflon cap	1	cool to 4° C

3.2.6.4 Data Recording

Field data will be recorded in a site designated field notebook and on the Sediment/Surface Water Sampling Field Log shown in Appendix H. Each sampling location will be marked on the site map and distances from the sample location to at least three reference points will be measured and recorded on the map.

3.2.7 Sampling During the Pilot Tests

An aquifer pump test and a soil vapor extraction/air sparge pilot test will be performed as part of the RFI activities at the BRC site. No chemical analyses are proposed to be performed during the aquifer test. Monitoring of drawdown will be conducted automatically using an ORS Environmental Equipment DL-120 Data Logger and pressure transducers at pre-programmed time intervals and manually using an ORS Interface Probe at regular time intervals. The Data Logger will be calibrated at the factory and shipped directly to the site. The Interface Probe will be calibrated and maintained in the field using manufacturer's recommendations. Manual gauging will serve as quality assurance of the programmed logger.

Magnehelic gauges will be used to monitor vacuum rates during the air sparge/soil vapor extraction pilot study. Calibration and maintenance of these gauges and Kurz flow meters, the MSA LEL/O_2 meter, thermometer, and PID used during the pilot study will be performed in accordance with manufacturer's specifications. During the test, the following measurements will be recorded:

- Pre- and post-filter vacuum at the blower;
- Induced vacuum at surrounding monitor points;
- Applied vacuum at the vapor extraction wellhead;
- Pre- and post-blower air stream temperature;
- Process air stream velocity; and
- Air influent (pre-treatment) and effluent (post-treatment) organic vapor concentrations and percent lower explosive limit (LEL).

Air bag sampling will be conducted during the soil vapor extraction/air sparging pilot study as described in Section 2.0. Three air bag samples will be collected during the soil vapor extraction test and three during the combined soil vapor extraction/air sparging test. Samples will be collected right after startup, midway and right before the end of the tests, at a sampling port located prior to the blower and before the treatment units (granular activated carbon). These samples will provide information for the permitting of a full-scale system should pilot testing indicate that the technology is feasible. Additionally, air bag sample concentrations will be used to design vapor abatement equipment for the full-scale system.

3.2.7.1 Measurement Parameters

The six air bag samples will be analyzed for total nonmethane hydrocarbons (USEPA Method TO-18), purgeable aromatics and hydrocarbons (USEPA Method 8010/8020), and methane, carbon dioxide, and oxygen (GC-TCD). Sample analyses will be performed by Inter-Mountain Laboratories, Inc. in Farmington, New Mexico following procedures listed above. Measurement parameters were determined based on the composition of known or suspected soil vapor contamination.

3.2.7.2 Sampling Procedures

The air samples will be collected in clean Tedlar air bags supplied by the laboratory and labeled with the project number, sample identification, date, time collected, sampler name and notation about which point (beginning, midway, end) of the pilot study the sample was collected.

3.2.7.3 Data Recording

Field data will be recorded in a site designated field notebook. Each bag will clearly indicate whether it was taken at the beginning, midpoint or end of the test, and whether the soil vapor extraction system was operating alone or in conjunction with the air sparging system.

3.2.8 Sample Custody Procedures

The chain of custody program will allow for the tracking of possession and handling of each sample from the time of field collection through completion of laboratory analysis. The chain-of-custody program includes:

- Sample labels - The information required on sample labels for each type of sample has been described in previous sections (Sections 3.2.2.4, 3.2.4.2, 3.2.5.2, and 3.2.6.2).
- Sample seals - Seals will be placed on individual sample containers to ensure that the samples were not disturbed during transportation.

- Field notebook - All field sampling data will be recorded in a designated site field notebook.
- Chain-of-custody record - A chain-of-custody will be filled out and accompany every sample submitted to the lab. The chain-of-custody will include project identification, sample identification, signature of sampler, date and time of sample collection, sample type, sample preservation, number of containers, parameters requested for analysis, signatures of all persons involved in the chain of possession, dates of possession, and temperature of each container upon receipt by the laboratory. The original chain-of-custody will accompany the shipment and the sampler will retain one copy as a record of samples submitted to the laboratory. A copy of the chain-of-custody form that will be provided by Inter-Mountain Laboratories, Inc. is included in Appendix D.
- Laboratory logbooks - The laboratory chain-of custody procedures and documentation of the processing steps that are applied to samples once they have been received by the laboratory are described in the Quality Assurance Project Plan, Laboratory Analyses prepared by Inter-Mountain Laboratories, Inc. This plan is included as Appendix D.

3.2.9 Sample Shipping Procedures

Samples will either be hand delivered to the laboratory by Groundwater Technology personnel or picked up from the site by Inter-Mountain Laboratories, Inc. personnel. All glass containers, except VOA vials, will be wrapped in bubble pack, which will be secured with tape. VOA vials will be placed in their original foam packing containers. A sturdy cooler will be used as a transporting container. The drain plug on the cooler will be taped shut and a large plastic bag will be used as a liner for the cooler. Approximately one inch of packing material will be placed in the bottom of the liner. Samples will be placed in the cooler and covered with bagged ice. Enough ice will be packed in the cooler to keep the samples cooled until the laboratory receives the samples. The remaining space in the cooler will be filled with packing material and the plastic liner will be taped shut. The chain-of-custody form will be placed in a plastic "zip-lock" bag, which will be sealed and taped to the inside of the cooler lid. The cooler will be closed and taped shut with packing tape.

3.3 Sample Analysis

3.3.1 Analytical Laboratory Procedures

The Quality Assurance Project Plan, Laboratory Analyses (Appendix D) prepared by Inter-Mountain Laboratories, Inc. specifies the following information:

- USEPA analytical methods to be used for sample analysis, including potential interferences, detection limits, and the required precision and accuracy
- Sample preparation methods
- Sample storage and handling procedures
- Chain-of-custody procedures
- Responsibilities of the laboratory staff
- Quality assurance objectives and criteria
- Internal quality control procedures
- Calibration and quality control parameters
- Data reduction and validation procedures
- Preventative maintenance procedures
- Corrective action procedures
- Quality assurance reporting procedures
- Laboratory results reporting

The third addition of SW-846 (Test Methods for Evaluating Solid Waste, November 1986) and EPA-600/4-79-020 (Methods for Chemical Analysis of Water and Waste, March 1983) specify the analytical procedures to be used for sample analyses.

3.3.2 Field Procedures

The procedures for field measurements of pH, specific conductivity, temperature, and PID field screening are described in Sections 3.2.2.3 and 3.2.4.4. These procedures follow instrument manufacturer guidelines and USEPA guidelines.

3.3.3 Material Property Testing

Material property testing, which will be performed by Inter-Mountain Laboratories, Inc., includes grain size analysis, total and effective porosity, hydraulic conductivity, dry bulk density, ion exchange capacity, and moisture content. The methods used for these analyses will follow American Society for Testing and Materials (ASTM) procedures or other standard procedures.

3.4 Fluid Level Measurement

Water level measurements will be performed to determine the configuration and the temporal variation of the water table elevation. This information will be used to determine vertical and horizontal groundwater flow directions, hydraulic gradient(s), and potential fluid migration pathways. Liquid level measurements will be collected once a month during the RFI.

3.4.1 Static Liquid Level Measurement

Static liquid level measurements will be collected using an ORS Interface Probe®. The probe is capable of measuring depth to fluids to the nearest 0.01 foot. After removing the well cap, the air in the casing will be screened using a PID to determine if vapors are present. The interface probe will be lowered into the well until it reaches the fluid level. The probe indicates the presence of separate phase hydrocarbons by producing a solid tone and the presence of water by a beeping tone. The thickness of each layer will be determined by measuring the length of cable in the well at each interface. Measurements will be taken from the north side of the casing, which will be permanently marked. The probe will be lowered to the bottom of the well to determine the total well depth.

The fluid elevations will be calculated using the depth to fluid and the top of casing elevation data. If separate phase hydrocarbons are detected, the water table elevation will be corrected to account for water table depression resulting from the hydrocarbon layer.

To minimize the potential for cross contamination, liquid level measurements will be collected from least impacted to most impacted wells. The probes will be decontaminated between wells by washing with an Alconox® solution and triple rinsing with distilled water. All decontamination water will be placed into appropriate containers and transferred to BRC's oil/water separator for treatment.

3.4.2 Data Recording

Measurements will be recorded to the nearest 0.01 foot in a designated site field notebook and on the Well Gauging Data Form included in Appendix H. The well location, diameter, depth, date and time of measurement, and any additional comments will also be recorded on the gauging form.

3.5 Surveying

The location, elevation of the top of casing and elevation of the ground surface for each monitoring well and boring will be surveyed by professional certified surveyors. Elevations will be measured to the nearest 0.01 foot and will be referenced to a United States Geological Survey (USGS) benchmark. All elevations will be documented on the Boring/Monitoring Well Log form and recorded in a field notebook. Lateral locations will be determined to the nearest 0.1 feet, and the monitoring well locations will be presented on a scaled site map.

3.6 Quality Assurance Objectives for Measurement Data

The overall quality assurance objective is to develop and implement procedures for field sampling, sample analysis, and reporting that will provide legally defensible data. Specific procedures for sampling, sample custody, field measurements, laboratory analysis, data reduction and validation, reporting, internal quality control, audits, preventative maintenance, and corrective actions are provided in other sections of this Data Collection Quality Assurance Plan. This section defines the goals for the parameters used to evaluate data quality.

3.6.1 Regulatory Requirements

The laboratory analytical methods and detection limits required to meet the data quality objectives and the regulatory requirements are listed in the Quality Assurance Project Plan, Laboratory Analysis prepared by Inter-Mountain Laboratories. This plan is included as Appendix D.

3.6.2 Field Measurement Quality Control Procedures

Field duplicates and field blanks will be collected and submitted to the laboratory for analysis to assess the quality of the data resulting from the field sampling program. Duplicate samples will be analyzed to check for sampling and analytical reproducibility. Blank samples will be analyzed to check for contamination that may be introduced during sampling procedures.

One field duplicate will be collected for every ten aqueous samples, i.e. groundwater and surface water. Duplicates will not be collected for soil or sediment samples. One trip blank will be included along with each shipment of aqueous VOA samples. Equipment blanks will be prepared each day that groundwater monitoring wells are sampled. Blanks will not be collected for soil or sediment samples.

Trip blanks will be prepared by the laboratory using laboratory demonstrated analyte-free water. The trip blank sample will be transported to the site, handled like a sample, and returned to the laboratory for analysis. Equipment blanks will be prepared by pumping deionized water through the sampling pump after cleaning, collecting a sample of the water running through the pump, and submitting the sample to the laboratory for analysis (or rinsing a disposable bailer and collecting the rinse water).

The quality control effort for the field measurement of pH and specific conductance consists of daily calibration prior to measurement and post-measurement verification using standard reference solutions. Post-measurement verification will be performed for each sample tested.

If sufficient sample is available, headspace analysis will be performed in duplicate. In addition, a blank sample will be measured after every 10 soil samples measured to determine if any contamination is being introduced during the measurement procedure. The same procedure outlined in Section 3.2.2.3 will be followed for the blank except no soil will be placed in the jar.

Quality control of liquid level measurements consists of comparing the current field measurement to the previous measurement, site conditions, and monthly rainfall. If discrepancies are observed, liquid levels will be remeasured.

Quality control procedures to be used during the soil vapor survey are specified in the document prepared by Tracer Research Corporation titled Soil Gas Sampling Procedures, Quality Assurance and Quality Control Procedures. This document is included in Appendix F.

3.6.3 Field Measurement Quality Assurance Objectives and Criteria

The accuracy of field measurements of pH will be assessed through daily calibration and post-measurement verifications using at least two standard buffer solutions. Each of the measurements must be within plus or minus 0.05 standard units of the buffer solution values. Precision will be assessed through duplicate measurements. The electrode will be withdrawn, rinsed with distilled water, and immersed in the duplicate sample. The relative percent difference (RPD) for the duplicates will be calculated. Verification will be performed after the second replicate measurement. Temperature measurements will be to the nearest degree (plus or minus 0.5 degrees).

Specific conductance measurements will be assessed through daily calibration and post-measurement verification using a standard solution. Each verification measurement must be within plus or minus 6 % of the standard solution value. Precision will be assessed through duplicate measurements. The RPD for the duplicates will be calculated. Verification will be performed after each replicate has been measured.

Duplicate PID readings will be compared. Replicate values should be within plus or minus 20 percent. Accuracy will be verified by confirming instrument calibration after every 20 measurements. Verification of calibration should provide readings within one percent of the calibration gas concentration. If the reading is not with one percent, calibration of the instrument will be repeated.

Quality assurance procedures to be used during the soil vapor survey are specified in the document prepared by Tracer Research Corporation titled Soil Gas Sampling Procedures, Quality Assurance and Quality Control Procedures. This document is included in Appendix F, and includes equipment calibration, blank samples and duplicate samples.

3.6.4 Laboratory Quality Control Procedures

Quality control parameters used within the laboratory are described in Section 8 of the Quality Assurance Project Plan, Laboratory Analyses in Appendix D. Method blanks, duplicate analysis, spiked analysis, spiked duplicate analysis, and laboratory control samples will be used to evaluate the validity of the laboratory results.

3.6.5 Laboratory Quality Assurance Objectives and Criteria

The accuracy, precision, representativeness, completeness, and comparability requirements are specified in Section 5 of the Quality Assurance Project Plan, Laboratory Analyses included in Appendix D.

3.7 Contaminated Material Disposal

All purge water and decontamination water generated during RFI field activities will be placed into temporary labeled containers and transferred daily to BRC's oil/water separator, which is part of the water treatment system, for treatment.

Soil cuttings will be screened during the investigation using a PID. Clean soils and cuttings will be left in place. Contaminated cuttings will be characterized and disposed as appropriate.

4.0 DATA MANAGEMENT PLAN

This Data Management Plan identifies procedures which document data collected under the RCRA Facility Investigation (RFI) at the Bloomfield Refinery Company i Bloomfield, New Mexico. The management plan insures that the data is correct, readily available, and of high quality to support the Corrective Measures Study. The plan identifies field documentation procedures, transfer of data to organized forms, tabulation of data for evaluation and report presentation, project file format, and the contents of monthly progress reports.

Data will be collected from: drilling of soil borings, installation of monitoring wells, surveying wells, gauging wells, collecting soil gas, soil, sediment, surface water, and groundwater samples; and performing an aquifer and a soil vapor extraction/air sparge pilot test. Data collection procedures and detailed field documentation procedures are identified in the Data Collection and Quality Assurance Plan. This plan further identifies the documentation procedures as well as procedures for tabulation and presentation of the data.

4.1 Field Documentation Procedures

Field activities will be recorded in various forms including the field notebook, field documentation forms, chains of custody, and sample labels. Field personnel will review their data documentation before leaving the site each day to ensure it is complete and correct. The project manager or a technically qualified individual will also review the field notes for accuracy and completeness prior to having them filed.

4.1.1 Field Notebook

The primary document for recording information is the field notebook. The field notebook is a hard cover bound book, to which entries are made legibly using waterproof ink. Data in the field book will be organized similar to the data required in the field logs. The field notebook will contain the following information, with general information included daily regardless of the specific field activity.

General Information

- Site name, project number, task number;

- Date, weather, time of arrival;
- Workers, subcontractors, and visitors to the site;
- Time of each activity conducted throughout the day;
- Health and safety monitoring equipment and results;
- Equipment used and identification number;
- Unusual occurrences;
- Number, type of containers, and management of waste materials generated; and
- Signature.

Well Gauging, Sediment, Surface Water, and Groundwater Sampling

- Condition of well casing, well box, locks, and plugs;
- Gauging data - depth to water, depth to other liquid material, bottom of well;
- Volume of water evacuated and method, approximate rate of recovery;
- Order of wells sampled;
- Time and method of sample collection;
- Field analysis equipment and results;
- Sample containers and preservatives used;
- Sample analysis, laboratory, and shipment method; and
- Other observations.

Logging, Soil Sample Collection and Monitoring Well Installation

- Drilling contractor, names, license;
- Drilling method and equipment used;
- Boring identification, sketch map showing location;
- Time of boring and well installation;
- Sample collection and decontamination procedures;
- Field equipment used and field screening results;
- Soil sample identification, description, moisture;
- Depth to water;
- Monitoring well construction and listing of materials used;
- Well development procedures and observations;
- Sample analysis, laboratory, and shipment method;
- Well gauging data;

- Decontamination procedures, water containment and time; and
- Other observations.

4.1.2 Field Documentation Forms

Field documentation forms include similar information to that contained in the field notebook. However, the information is more readable and specific data can be easily extracted for evaluation. Standard forms are included in Appendix H. The forms are identified below with a summary of their contents. All forms require the identification of the field person responsible for the given activity, date, and site name.

- Conductivity/Temperature/pH Meter Calibration and Results Log to document the calibration of the meter and present the results of each sample.
- Boring/Monitoring Well Log to document the boring/well installation procedures, well construction, field analysis, and soil lithology.
- Well Gauging Data Form to record the depth to water and the depth to product (other liquid material) in monitoring wells.
- Well Sampling Field Log to document the well development and sample collection procedures.
- Well Sampling Chart which includes gauging and purging data.
- Chain-of-Custody supplied by Inter-Mountain Laboratories to identified sample collection and analysis information and to document personnel responsible for sample custody from sample collection to delivery of the sample to the laboratory for analysis.
- Soil Gas Investigative Background Information to identify general site conditions relevant to the soil gas survey such as depth to water, target VOCs, and sources of contamination.
- Soil Vapor Extraction Test Data form to record the time, sample number, probe, vacuum, sample volume and time evacuated, and other notes.
- Daily Summary to document the days activities and decontamination procedures used (Log Book).
- Aquifer Test Data Form to record the time of water level measurements, elapsed time since the start of the test, flow rate, water level measurements and drawdown.
- Surveying will be conducted by a licensed surveyor and will be documented by the surveyor according to standard industrial practice.

4.1.3 Sample Identification Procedures

Samples of media collected from the site will be identified by a label or other appropriate techniques. Labels will be completed with waterproof ink and firmly affixed to the sample containers. The labels are typically provided by the laboratory. The following information will be included on the label.

- Project name and number;
- Name of the individual collecting the sample;
- Date and time of sample collection;
- Preservative used, if any;
- Sample identification indicating areal and depth (if appropriate) of collection point; and
- Analysis required.

The sample identification will be according to Section 3.0. Each sample collected will be recorded in the field book, and if appropriate, the field log and chain-of-custody form.

4.2 Data Tabulation and Storage

4.2.1 Data Tabulation

Data collected during the RFI will be tabulated to facilitate evaluation and clear presentation. Gauging data will be presented in tabular form to include the following information:

- Date of gauging (DD-MM-YY);
- Well ID No.;
- Surveyed well elevation [feet above mean sea level (MSL)];
- Depth to water from top of well casing (in feet);
- Depth to separate-phase hydrocarbon (SPH) layer from top of well casing, if present (in feet);
- Calculated SPH thickness, if present (in feet); and
- Calculated water table elevation (in feet above MSL).

Groundwater laboratory analytical data may be tabulated several different ways, depending upon the use of data. One method of tabulation presents well identification, chemical parameters, and multiple dates of sampling to show variations through time. Another tabulation presents multiple well identification, chemical parameters, and a single data of sampling (see Table X below).

TABLE X: LABORATORY ANALYTICAL RESULTS (GROUNDWATER)		
Sample ID	MW-1	MW-2
Sample Date		
Analyte #1 (ppb)		
Analyte #2 (ppb)		

Soil laboratory analytical results will also be tabulated to help identify contaminants by the vertical or horizontal extent of selected chemicals (see Table Y below).

TABLE Y: LABORATORY ANALYTICAL RESULTS (SOIL)				
Sample ID (Depth)	MW-1 5'-6.5'	MW-1 16.5'-18'	MW-2 10'-11.5'	MW-2 17'-18.5'
Sample Date				
Analyte #1 (ppm)				
Analyte #2 (ppm)				

Data collected from the soil vapor extraction pilot test will be tabulated identifying wellhead vacuum, vent flow rate, emission rate, and radius of influence. Semilogarithmic graphs will also be used presenting the log of the vacuum at a point versus distance from the vapor extraction point (wellhead) for a given flow rate.

The aquifer test data will be presented on tabular form showing time elapsed, water table elevation, and drawdown for each observation well monitored. This data will be directly downloaded from the field instruments to the computer to eliminate mistakes by manual re-entry of data. A time-drawdown curve will be generated for each observation well using the GWAP software program.

Facility and areal maps will also be used to tabulate certain data such as groundwater elevations and contaminant concentrations. Data will be numerically identified on the map at the point of collection. This mechanism for tabulating data allows data to be evaluated from an areal perspective. Data points may also be contoured.

4.2.2 Data Storage

Data collected under the RFI and any other environmental activities being conducted at the site will be stored in a central file system in the environmental consultant's office. A copy of selected investigative information and all community relations documents (local contacts, press releases, fact sheets) will be stored at a central location at the facility. The laboratory will also maintain a filing system for documents necessary for the analytical process. The standard file system contains the following folders:

- Project Management - (project organization, contracts, billing, quality issues, etc...);
- Correspondence - (phone logs, correspondence, meeting notes, etc...);
- Reports - (monthly status, quarterly status, permit compliance, end of phase, etc...);
- Permits & Licenses - (well records, water discharge, air emmissions, construction, waste activity, waste compliance, etc...);
- Site Safety - (site safety plan, signed acknowledgements, safety monitoring, etc...);
- Data - (site visit forms, well logs, liquid level and well monitoring data, lab analysis, etc...);
- Analysis/Design - (potentiometric surface maps, APT data, SVE data, hydrographs, product recovery forms, etc...);
- Miscellaneous - (photos, legal, newspaper articles, etc...).

Field notes will be reviewed by the project manager or another technical person for completeness and accuracy. The field notes will then promptly be filed in a central file system in the consultant's office. Correspondence, contracts, billing information, and reports and all other information will be added to the file promptly after review and finalization. A project administrator will be responsible for maintaining the project file.

4.3 Reports

4.3.1 Monthly Progress Reports

Monthly progress reports, as required by Task VI of Attachment II to the Consent Order, will be submitted to the New Mexico Environmental Division and the USEPA throughout the duration of the RFI. Three copies of the progress reports will be submitted to USEPA on the 10th day of the following months, by hand or by certified mail (return receipt requested). The progress reports will contain the following information:

- A description and estimate of the percentage of the RFI completed;
- Summaries of all findings for the month;
- Summaries of all changes made in the RFI during the reporting period;
- Summaries of all contacts with representatives of the local community, public interest groups, or the New Mexico government during the reporting period;
- Summaries of all problems or potential problems encountered during the repoting period;
- Actions being taken to rectify problems;
- Projected work for the next reporting period;
- Copies of all field data notes; and
- Copies of laboratory analytical results and laboratory quality control data obtained during the reporting period.

4.3.2 RFI Report

A draft RFI report (Task III) will be submitted to the USEPA following the completion of the investigation activities. The report will contain an analysis and summary of all facility investigations implemented pursuant to the workplan. Specifically, the RFI Report will describe the nature and extent of contamination, potential impacts to human health and the environment, and the results of pilot tests or bench scale studies. The RFI report will consolidate information provided in the monthly status reports and present a complete evaluation of data. Data will be presented in a report narrative and data summaries in the form of figures, maps, tables, and graphs. Field notes, laboratory analytical results, and other raw data will be contained in the Appendices. The report will be submitted to USEPA as a draft for review and comment. A final report including USEPA's comments will be submitted within 30 days of receipt of USEPA comments.

4.3.3 Other Reports

Other reports specific to the interim measures, pilot tests, or community relations (if necessary) may be written during the course of the RFI. The reports may contain data, evaluations, and conclusions to meet the purpose of the report. A copy of these reports would be mailed to USEPA, as well as stored in the comprehensive filing system.

5.0 COMMUNITY RELATIONS PLAN

5.1 Purpose

This Community Relations Plan describes how the public will be informed of environmental investigation and remediation activities conducted at the Bloomfield Refining Company's (BRC) Bloomfield, New Mexico facility. To date, there has been little, if any, public inquiry regarding petroleum releases to the environment, or regarding environmental investigations and remediation. Although the amount of public interest is not expected to change, BRC is prepared to respond to inquiries as explained in this Community Relations Plan.

A RCRA Facility Investigation (RFI), interim measures, and an evaluation of remediation technologies (Corrective Measures Study, CMS) are being/will be conducted under the Adminstrative Order on Consent issued under Section 3008(h) of the Resoucre Conservation and Recovery Act (RCRA) finalized by the USEPA on December 31, 1992. The RCRA federal law requires that environmental investigations be conducted at all facilities that treat, store, or dispose of hazardous waste when there is a potential for a contaminant release to the environment. Corrective action provides protection of human health and the environment from hazardous wastes or hazardous waste constituents released to the environment.

5.2 Facility Description

The Bloomfield Refining Company facility is located at #50 County Road 4990 (Sullivan Road), south of the Town of Bloomfield. The facility is directly surrounded by undeveloped private and public land primarily used for oil and gas production. The refinery is constructed on 287 acres of land owned by the company, and was originally constructed in 1959, with a number of expansions since that time. The refinery has a crude capacity of 16,800 barrels per calendar day. Currently, seventy percent of the refinery's crude supplies are delivered by pipeline and thirty percent arrive by tanker truck. The following products are produced by BRC at the facility: leaded and unleaded gasoline, diesel fuels, jet-A fuel, jet fuel, kerosene, heavy burner fuel, butane, propane and liquified petroleum gas. The products are transported for delivery by tanker truck from product terminals at the facility.

The refinery property is bordered on the south by federal property managed by the Bureau of Land Management. The San Juan River and the Town of Bloomfield are located north of the refinery. Portions of the San Juan River are considered recreational areas (Navajo Lake and up to 1/4 mile borden the property to the east, south and west. Highway 44 is located approximately 1/4 mile west of the facility. An El Paso Natural Gas Pipeline easement runs southwest through the center of the facility property.

The nearest residences are two homes located about 400 feet south of the eastern half of the facility. Additional residences are located in Bloomfield, approximately 1,400 feet north of the facility across the San Juan River.

5.3 Response to Inquiries and Repository

Inquiries from the public regarding RCRA corrective action at the facility will be directed to Mr. Chris Hawley, Environmental Manager at the facility. Inquiries can be made to Mr. Hawley by mail or he can be contacted at telephone number (505) 632-8013. Mr. Hawley is usually available at the facility during normal working hours. If Mr. Hawley is not available, the manager of the refinery, Mr. David Roderick, can be contacted at the same telephone number. Mr. Hawley and Mr. Roderick will respond to public inquiries on an as-needed basis. They will also provide to the public, if appropriate, names of USEPA and New Mexico Environmental Division personnel or environmental consultants familiar with environmental investigations and remediation at the facility.

The community surrounding the facility will have access by appointment to critical RCRA corrective action documents. The documents will be located in an information repository at the facility. The repository will contain the following documents:

- Final Interim Measures Workplan
- Final Interim Measures Report
- Preliminary Report: Description of Current Conditions
- Final RFI Workplan
- Final RFI and CMS Report

Documents will be added to the repository promptly after they are approved by USEPA. Other documents may be added to the repository if BRC or USEPA determines the need exists for the public to have available the additional information contained in those reports.

5.4 Public Notice

Upon approval by USEPA of the RFI and CMS Final Report(s), the RFI and CMS Reports will be placed in the repository for public review and comment for at least 30 calendar days. This public comment period is required by the consent order. A summary and justification of the proposed corrective measure(s), selected by USEPA will also be made public at that time. A public notice will be published in the Sunday edition of the Farmington Daily Times. The newspaper selected for the public notice will ensure that potentially concerned people will be aware of corrective actions at the facility since the Farmington Daily Times is the major newspaper servicing the area. The notice will be placed in the news section of the paper where it will attract the most attention. The public notice will identify the following:

- repository location,
- hours of operation,
- documents that are available for review,
- the names and phone numbers of contact persons at the repository,
- the names and phone numbers of USEPA contact persons, and
- the names and phone numbers of facility contact persons.

Following the public comment and review period, the RFI/CMS Final Reports may need modification based on public comment, at the direction of USEPA. USEPA will consider public comments when selecting the final remedy. Upon selection of the final remedy(s), EPA will notify BRC of the remedy(s).

5.5 Fact Sheet and Public Meeting

A fact sheet, if warranted by questions from the public, will be prepared to communicate specific, complex issues to the public. The fact sheet will be placed in the repository and distributed by BRC, upon request. Fact sheets are generally four to six pages in length and contain an introduction, facility background, map, and specific information dependent upon the phase of work. The specific information may include the purpose and scope of an RFI and/or CMS; or the clean up levels, point of compliance, corrective measure technologies, anticipated duration of cleanup, and the rationale for selecting the technology and cleanup levels.

A public meeting will be held upon request from a number of citizens or if USEPA and BRC deem a public meeting is appropriate based on public concern and misunderstandings. The major objective of a public meeting usually is to give the public the opportunity to discuss the corrective measures with USEPA, and for USEPA to further describe and explain the remediation technologies that were evaluated. USEPA will lead the public meeting effort, identifying the location, date, notice of the meeting, agenda, and written summary.

5.6 Directory

Bloomfield Refining Company (Repository)
#50 County Road 4990
P. O. Box 159
Bloomfield, New Mexico 87413
Mr. Chris Hawley - Environmental Manager
Mr. David Roderick - Facility Manager
Tel:(505) 632-8013

Farmington Daily Times
201 North Allen Avenue
Farmington, NM 87401
Tel:(505) 325-4545

Groundwater Technology, Inc.
2501 Yale Boulevard S.E., Suite 204
Albuquerque, New Mexico 87106
Ms. Cymantha Diaz, Project Manager
(505) 242-3113

New Mexico Environmental Division
Hazardous Waste Bureau
P.O. Box 26110
Santa Fe, NM 87502
Mr. Ed Horst
Tel:(505) 827-4300

New Mexico Oil Conservation Division
P.O. Box 2088
Land Office Building
Santa Fe, NM 87504-2088
Mr. Roger Anderson
Tel:(505) 827-5800

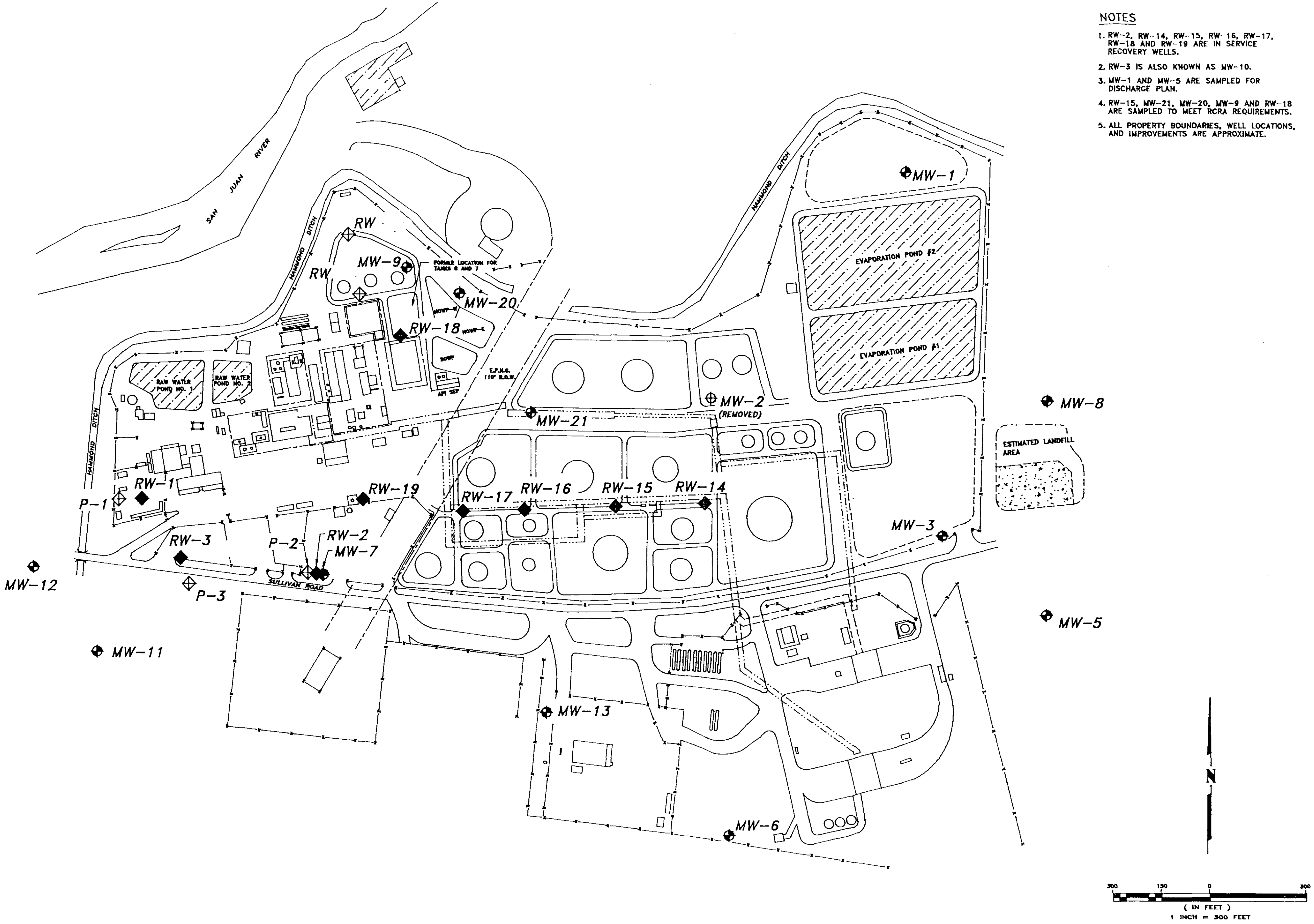
U. S. EPA, Region VI
RCRA Technical Enforcement
First International Building
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733
Mr. Greg J. Lyssy
Tel:(214) 655-8317

[redacted]

NO.	DATE	BY	REVISION

LEGEND

-·-·-·-	PIPEWAY
- - - - -	UNDERGROUND PIPEWAY
—x—	FENCE
⊕ MW-1	EXISTING MONITORING WELL
◆ RW-1	EXISTING RECOVERY WELL
⊕ P-1	PROPOSED RECOVERY WELL
⊕ MW-2	FORMER MONITORING WELL



NOTES

1. RW-2, RW-14, RW-15, RW-16, RW-17, RW-18 AND RW-19 ARE IN SERVICE RECOVERY WELLS.
2. RW-3 IS ALSO KNOWN AS MW-10.
3. MW-1 AND MW-5 ARE SAMPLED FOR DISCHARGE PLAN.
4. RW-15, MW-21, MW-20, MW-9 AND RW-18 ARE SAMPLED TO MEET RCRA REQUIREMENTS.
5. ALL PROPERTY BOUNDARIES, WELL LOCATIONS, AND IMPROVEMENTS ARE APPROXIMATE.

ATTENTION

THIS DRAWING AND ANY ATTACHMENTS ("DRAWINGS") HAVE BEEN PRODUCED FOR THE SOLE USE OF THE RECIPIENT AND MUST NOT BE USED, REUSED, REPRODUCED, MODIFIED OR COPIED ("USED") IN ANY MANNER WITHOUT PRIOR WRITTEN APPROVAL OF GROUNDWATER TECHNOLOGY, INC.. THIS DRAWING MAY CONTAIN CONFIDENTIAL AND PROPRIETARY INFORMATION OF GROUNDWATER TECHNOLOGY, INC.. ANY UNAUTHORIZED USE OF THIS DRAWING IS STRICTLY PROHIBITED.

SIGNATURE	DATE
PROJECT GEO:	
PROJECT ENGR:	
PROJECT MGR:	
CLIENT:	

Bloomfield Refining Company
A Gary Energy Corporation Subsidiary
#50 COUNTY ROAD 4990
BLOOMFIELD, NEW MEXICO

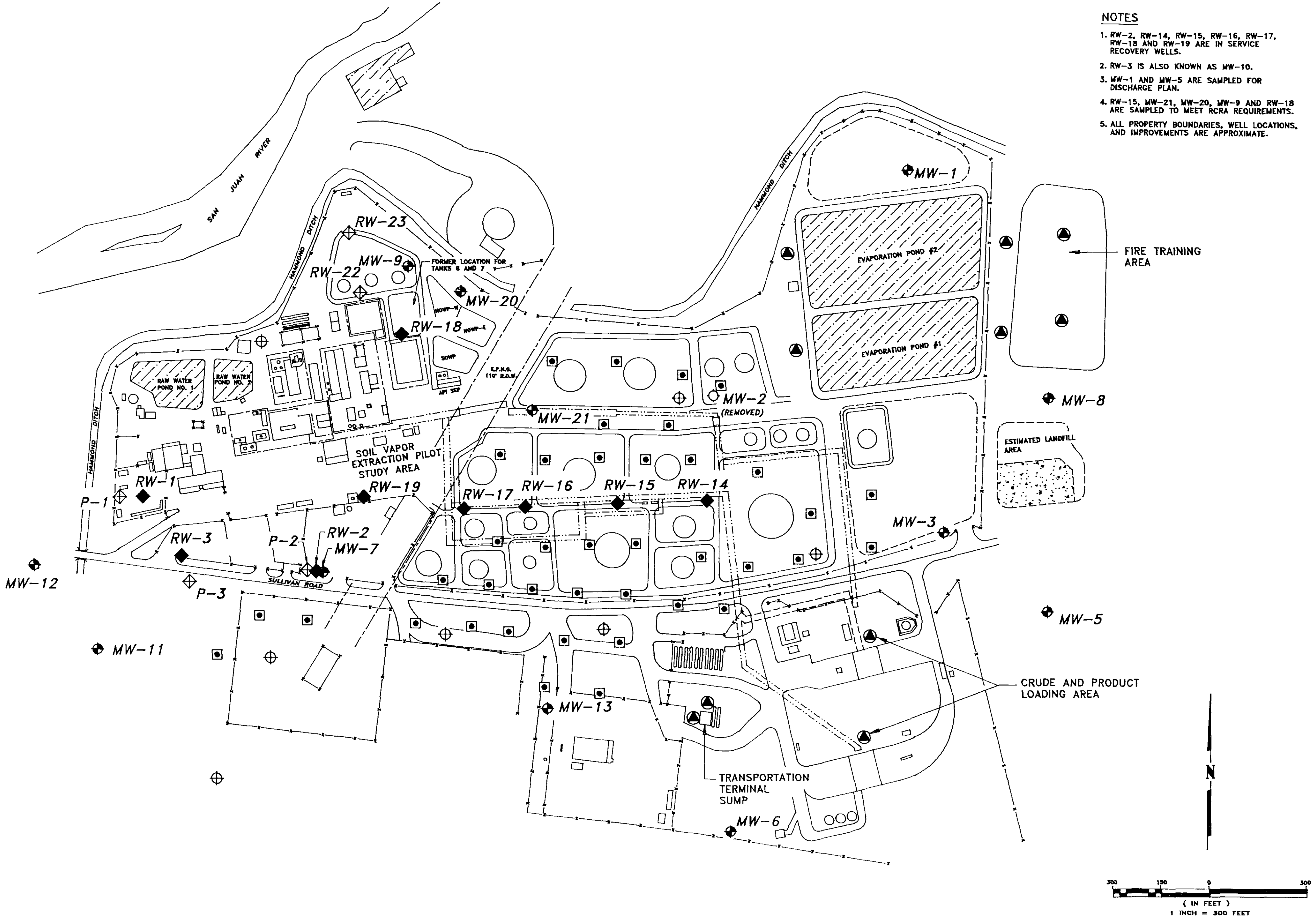
GROUNDWATER TECHNOLOGY
2501 YALE BLVD. SE, SUITE 204
ALBUQUERQUE, NEW MEXICO 87106
(505) 242-3113

SITE PLAN

DESIGNED BY:
DRAFTED BY: J. ML
CHECKED BY:
DATE: MARCH - 1993
FILE: WELLS-B4.DWG
PROJECT NO.: 023353014
CONTRACT:
DRAWING: FIGURE 1
REVISION:

NOTES

1. RW-2, RW-14, RW-15, RW-16, RW-17, RW-18 AND RW-19 ARE IN SERVICE RECOVERY WELLS.
2. RW-3 IS ALSO KNOWN AS MW-10.
3. MW-1 AND MW-5 ARE SAMPLED FOR DISCHARGE PLAN.
4. RW-15, MW-21, MW-20, MW-9 AND RW-18 ARE SAMPLED TO MEET RCRA REQUIREMENTS.
5. ALL PROPERTY BOUNDARIES, WELL LOCATIONS, AND IMPROVEMENTS ARE APPROXIMATE.



NO.	DATE	BY	REVISION

LEGEND

- ·—··—··— PIPEWAY
- — — — — UNDERGROUND PIPEWAY
- ——x—— FENCE
- ⊕ MW-1 EXISTING MONITORING WELL
- ◆ RW-1 EXISTING RECOVERY WELL
- ◇ P-1 PROPOSED RECOVERY WELL
- ○ MW-2 FORMER MONITORING WELL
- ⊕ PROPOSED MONITORING WELL
- ▲ PROPOSED BORING
- ▣ PROPOSED SOIL VAPOR SURVEY POINT

ATTENTION

THIS DRAWING AND ANY ATTACHMENTS ("DRAWINGS") HAVE BEEN PRODUCED FOR THE SOLE USE OF THE RECIPIENT AND MUST NOT BE USED, REUSED, REPRODUCED, MODIFIED OR COPIED ("USED") IN ANY MANNER WITHOUT PRIOR WRITTEN APPROVAL OF GROUNDWATER TECHNOLOGY, INC.. THIS DRAWING MAY CONTAIN CONFIDENTIAL AND PROPRIETARY INFORMATION OF GROUNDWATER TECHNOLOGY, INC.. ANY UNAUTHORIZED USE OF THIS DRAWING IS STRICTLY PROHIBITED.

SIGNATURE	DATE
PROJECT GEO:	
PROJECT ENGR:	
PROJECT MGR:	
CLIENT:	

Bloomfield Refining Company
A Gary Energy Corporation Subsidiary
#50 COUNTY ROAD 4990
BLOOMFIELD, NEW MEXICO

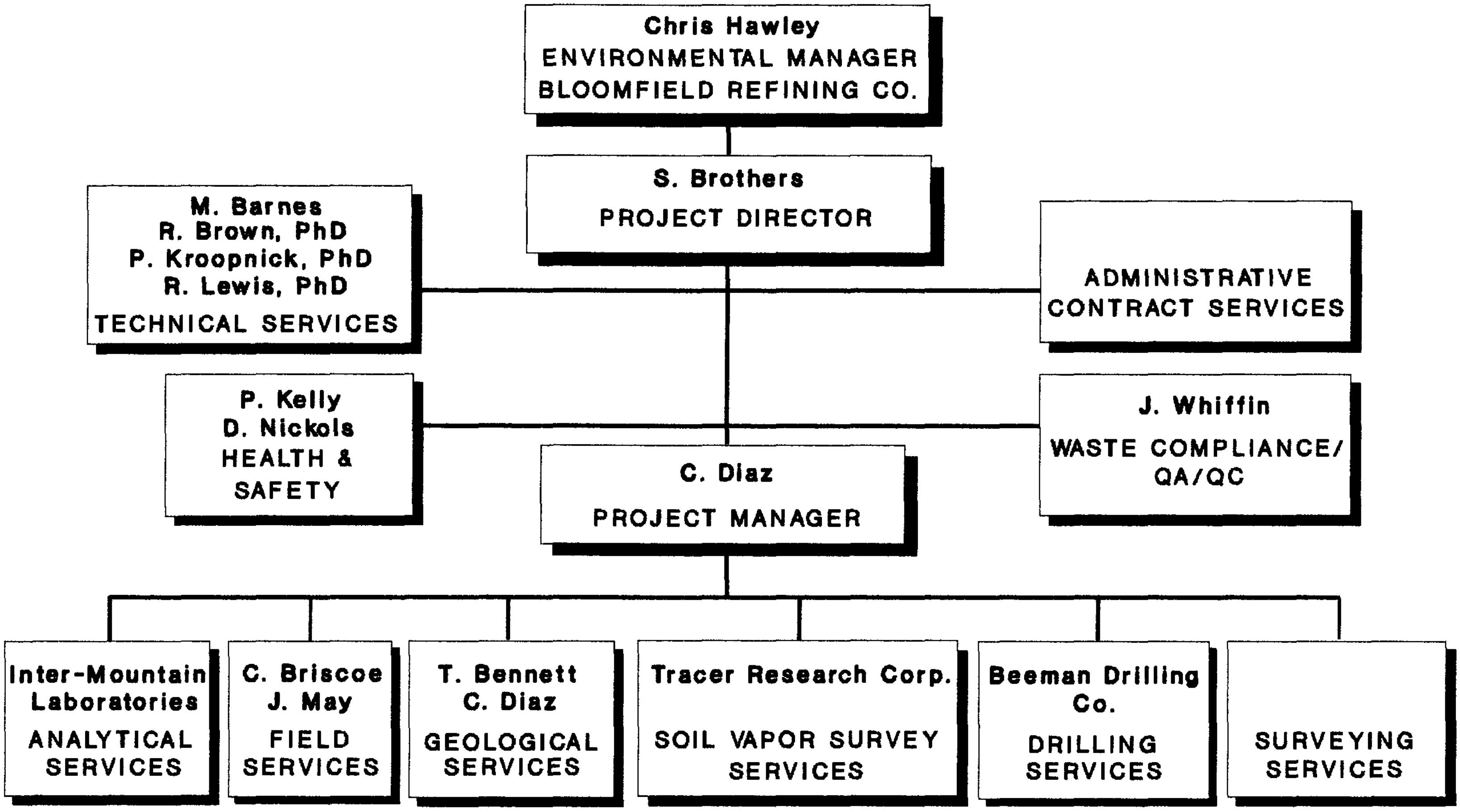
GROUNDWATER TECHNOLOGY
2501 YALE BLVD. SE, SUITE 204
ALBUQUERQUE, NEW MEXICO 87106
(505) 242-3113

PROPOSED FACILITY INVESTIGATION

DESIGNED BY:	DRAFTED BY:	CHECKED BY:
	J. ML	

DATE: MARCH – 1993	FILE: FAC-B4.DWG
PROJECT NO.: 023353014	CONTRACT:
DRAWING: FIGURE 2	REVISION:

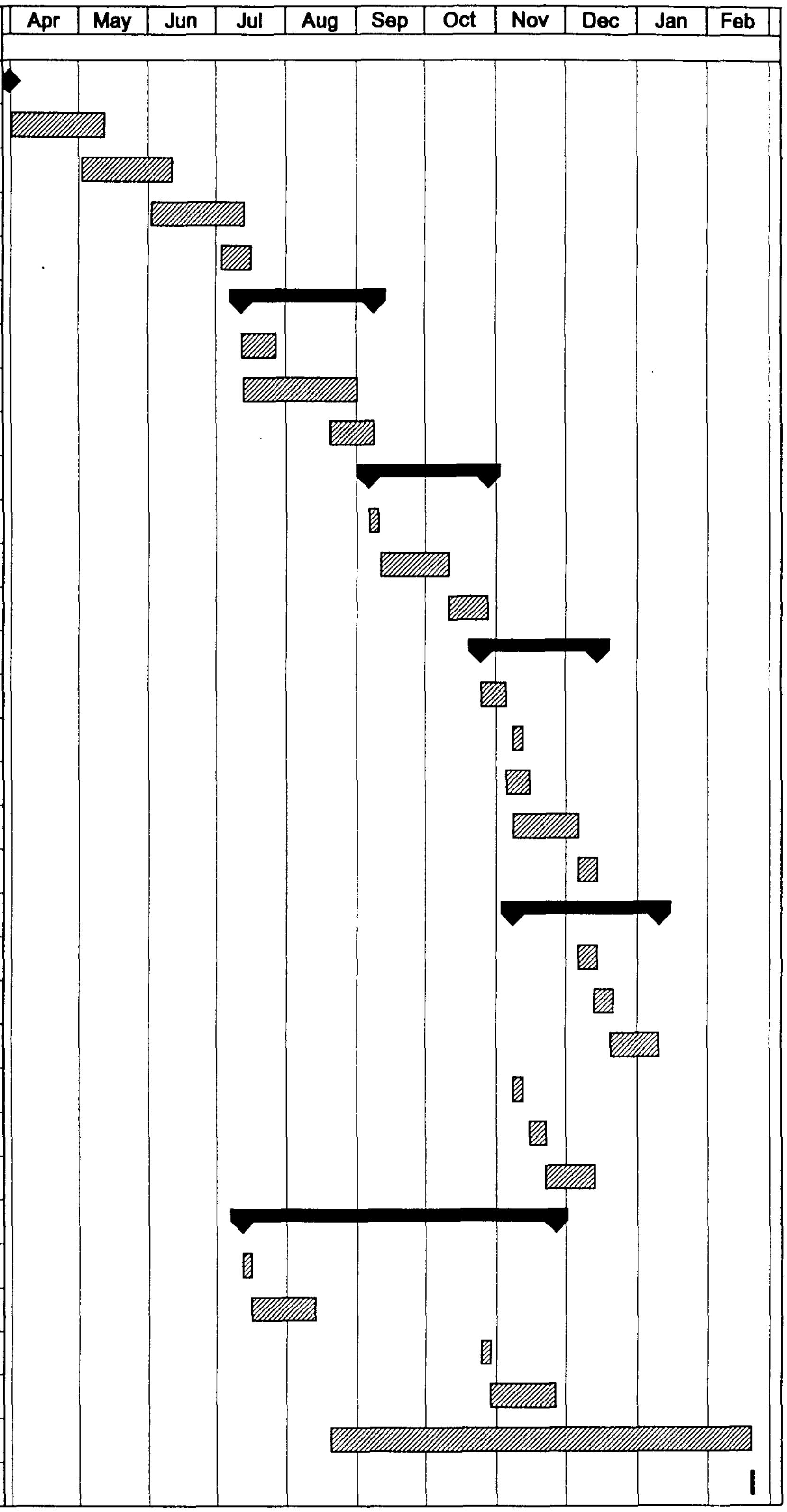
Figure 3: Project Organization
RCRA Facility Investigation
Bloomfield Refining Company
Bloomfield, New Mexico



SKH\BRCRef

FIGURE 4
PROJECT SCHEDULE
RCRA FACILITY INVESTIGATION, BLOOMFIELD REFINING COMPANY BLOOMFIELD NEW MEXICO

TASK	Start	Finish
Submittal of Draft RFIWP	3/31/93	3/31/93
USEPA Review/Comments	4/1/93	5/12/93
Finalization of RFIWP	5/2/93	6/11/93
USEPA Review/Approval	6/2/93	7/13/93
Scheduling/Coordination	7/3/93	7/16/93
Phase I Facility Investigation	7/12/93	9/8/93
Soil Vapor Survey/Soil Sampling	7/12/93	7/27/93
Soil Sample Analyses	7/13/93	9/1/93
Data Evaluation/Phase II Prep	8/20/93	9/8/93
Phase II Facility Investigation	9/6/93	10/28/93
Soil Borings/Sampling	9/6/93	9/10/93
Soil Sample Analyses	9/11/93	10/11/93
Data Evaluation/Phase III Prep	10/11/93	10/28/93
Phase III Facility Investigation	10/25/93	12/14/93
Groundwater Well Installations	10/25/93	11/5/93
Groundwater Sampling	11/8/93	11/12/93
Survey	11/5/93	11/15/93
Sample Analyses	11/8/93	12/6/93
Data Evaluation/Phase IV Prep	12/6/93	12/14/93
Phase IV Facility Investigation	11/8/93	1/10/94
Aquifer Test Setup	12/6/93	12/14/93
Aquifer Test Perform	12/13/93	12/21/93
Data Evaluation	12/20/93	1/10/94
AS/VE Point Installations	11/8/93	11/12/93
VE Test/AS Test/AS/VE Test	11/15/93	11/22/93
Data Evaluation	11/22/93	12/13/93
Stream Sampling	7/12/93	11/26/93
San Juan River	7/12/93	7/16/93
Laboratory Analysis	7/16/93	8/13/93
Hammond Ditch	10/25/93	10/29/93
Laboratory Analysis	10/29/93	11/26/93
Draft RFI Report Prep	8/20/93	2/20/94
Submittal of RFI Report	2/20/94	2/21/94



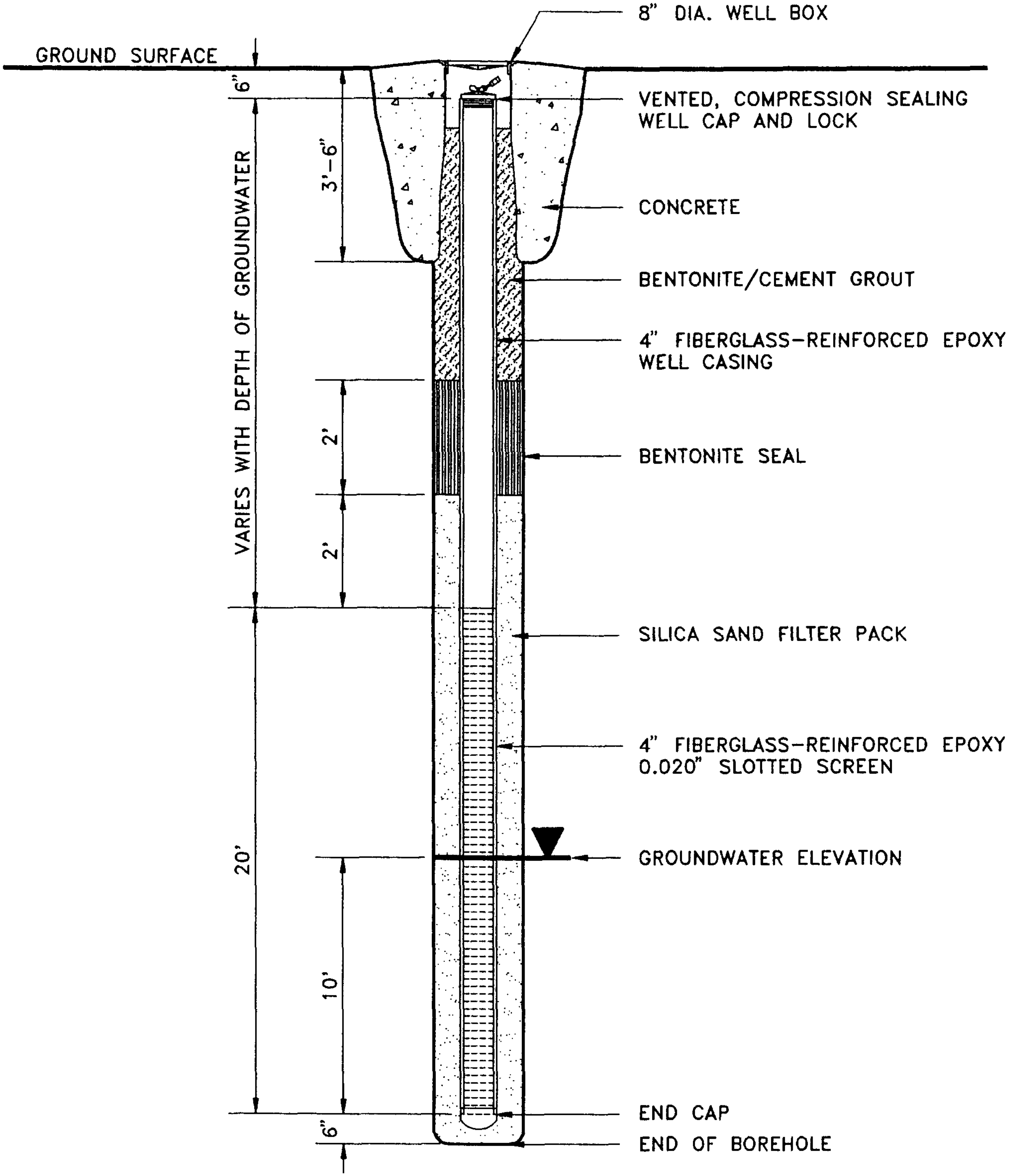
Project: 023353014
Date: 3/15/93

Critical ▨ Progress ▬ Summary ▬
Noncritical ■ Milestone ◆

FIGURE 5

TYPICAL FLUSH-MOUNTED MONITORING WELL

NOT TO SCALE



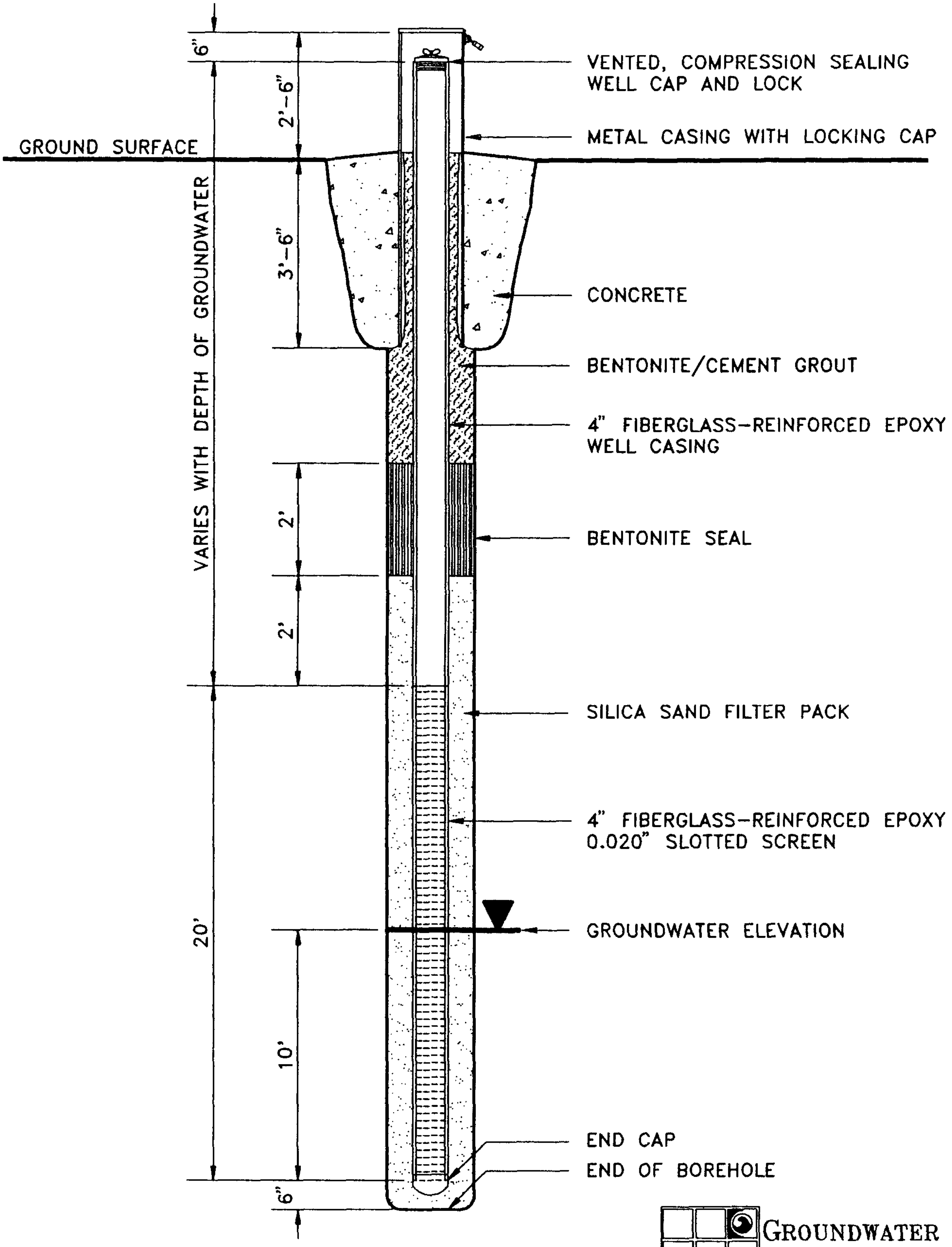
GROUNDWATER TECHNOLOGY

3014FM1/MWS/3-15-93

FIGURE 6

TYPICAL STICK-UP MONITORING WELL

NOT TO SCALE



GROUNDWATER TECHNOLOGY

3014SU1/MWS/3-12-93

APPENDIX A

HEALTH AND SAFETY PLAN

SITE SAFETY PLAN

Prepared for:

Bloomfield Refining Company
#50 County Road 4990
Bloomfield, New Mexico

February 25, 1993

Cymantha Dia
Cymantha Diaz
Project Manager

Dawn Nickols
Health and Safety Manager

GROUNDWATER
TECHNOLOGY

SITE EMERGENCY FORM
Contaminants of Concern: Crude Oil and Refining Products
Minimum Level of Protection: Modified Level D

Do not endanger your life. Survey the situation before taking any action.

GTI Office Telephone: 505-242-3113

Site Location Address: #50 County Road 4990

P.O. Box 159, Bloomfield, New Mexico

Telephone Located at facility in several locations

EMERGENCY PHONE NUMBERS

IN THE EVENT OF ANY EMERGENCY, CONTACT PROJECT MANAGER OR HEALTH AND SAFETY REPRESENTATIVE

Ambulance:	911	Project Manager:	Cymantha Diaz
Fire:	Internal extension 147	Health and Safety Mgr:	Dawn Nickols
		Client Contact:	Chris Hawley 505-632-8013 Dave Roderick
Hospital Name:	San Juan Regional	Hospital Phone:	505-325-5011

FIRST AID FOR CHEMICAL EMERGENCIES

Ingestion: DO NOT INDUCE VOMITING. Call Poison Control; follow instructions. Administer CPR, if necessary. Seek medical attention.

Inhalation: Remove person from contaminated environment. DO NOT ENTER A CONFINED SPACE TO RESCUE SOMEONE WHO HAS BEEN OVERCOME UNLESS PROPERLY EQUIPPED AND A STANDBY PERSON IS PRESENT. Administer CPR if necessary. Seek medical attention.

Skin Contact: Brush off dry material, remove wet or contaminated clothing. Flush skin thoroughly with water. Seek medical attention if irritation persists.

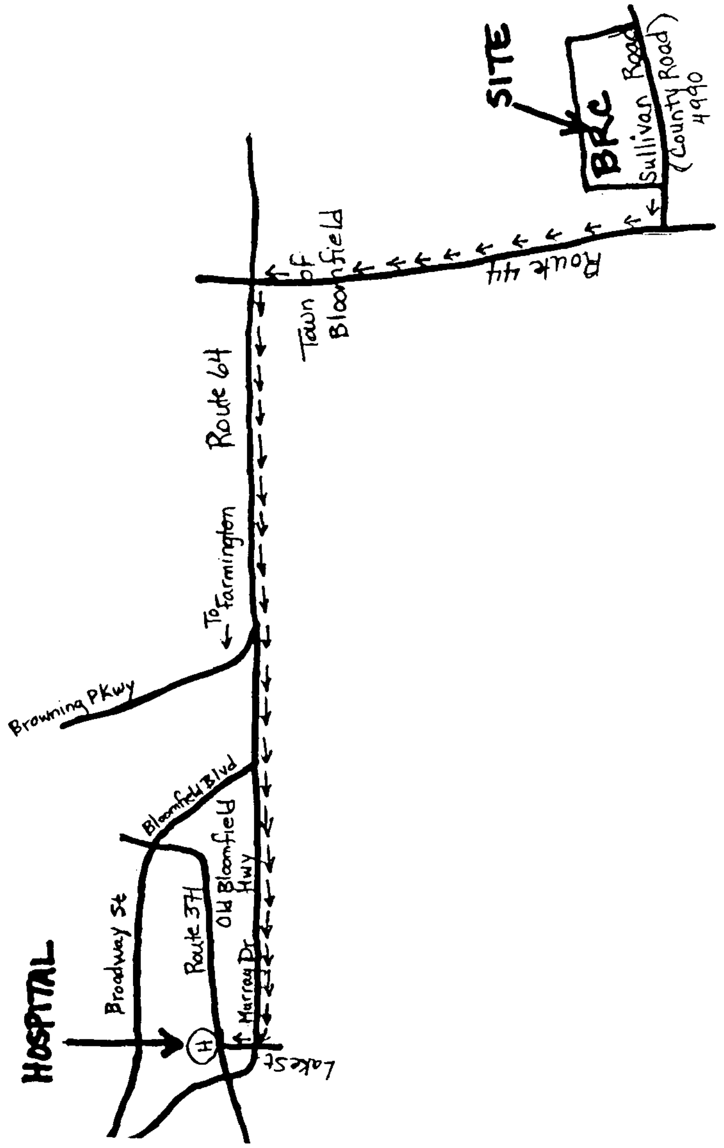
Eye Contact: Flush eyes with water for 15 minutes. Seek medical attention.

Exposure Symptoms: Headache, dizziness, nausea, drowsiness, irritation of eyes, nose, throat, breathing difficulties.

Contingency Plan: Report incident to Project Manager and Regional Health and Safety Manager after emergency procedures have been implemented.

GROUNDWATER
TECHNOLOGY

HOSPITAL LOCATION MAP



Hospital Directions

Rt. 4990 West to Rt. 44. Rt. 44 North to Hwy. 64. Hwy. 64 West to hospital.

Hospital Information:

Name	San Juan Regional
Address	801 W. Maple
City, State	Farmington, New Mexico
Phone	505-325-5011

EMERGENCY FIRST AID

1. Survey the situation. Do not endanger your own life. **DO NOT ENTER A CONFINED SPACE TO RESCUE SOMEONE WHO HAS BEEN OVERCOME UNLESS PROPERLY EQUIPPED AND A STANDBY PERSON IS PRESENT.**

2. Call 911 (if available) or the fire department **IMMEDIATELY**. Explain the physical injury, chemical exposure, fire, or release.

3. Decontaminate the victim without delaying life-saving procedures.

4. If the victim's condition appears to be noncritical, but seems to be more severe than minor cuts, he/she should be transported to the nearest hospital by trained Emergency Medical Services (EMS) personnel: Let the doctor assume the responsibility for determining the severity of the injury. If the condition is obviously serious, EMS must transport the victim.

5. Notify the Project Manager and the Regional Health and Safety Manager. Complete the Groundwater Technology Accident/Incident (near miss) Form within 24 hours.

EMERGENCY FIRST AID PROCEDURES	
To Stop Bleeding	**Cardiopulmonary Resuscitation (CPR)**
1. Give medical statement. 2. Assure airway, breathing, circulation 3. Use **DIRECT PRESSURE** over the wound with clean dressing or your hand (use nonpermeable gloves). Direct pressure will control most bleeding. 4. Bleeding from an artery or several injury sites may require **DIRECT PRESSURE** on a **PRESSURE POINT**. Use pressure points for 30-60 seconds to help control severe bleeding. 5. Continue primary care and seek medical aid as needed.	1. Give medical statement. 2. Arousal: Check for consciousness. 3. Open airway with chin-lift. 4. Look, listen, and feel for breathing. 5. If breathing is absent, give 2 slow, full rescue breaths. 6. Check the pulse for 5 to 10 seconds. 7. If pulse is present, continue rescue breathing: **1 breath every 5 seconds**

TABLE OF CONTENTS

Site Emergency Form i

Hospital Location Map ii

Emergency First Aid iii

1.0 INTRODUCTION 1

2.0 HAZARD IDENTIFICATION AND CONTROL 3

3.0 AIR MONITORING 6

- 3.1 Air Monitoring 6

4.0 CHEMICAL HAZARD CONTROL 9

- 4.1 Chemical Handling Procedures 9
- 4.2 Personal Protective Equipment 10
- 4.3 Site Control: Work Zones 10
- 4.4 Decontamination Procedures 11

5.0 CONTINGENCY PLANS 12

- 5.1 Evacuation 12
- 5.2 Medical Emergency 12
- 5.3 Fire Emergency 12
- 5.4 Spill/Release 13

APPENDICES

A: ADMINISTRATIVE INFORMATION

- A-1 Amendment Sheet
- A-2 Agreement and Acknowledgement Sheet
- A-3 Visitor/Trainee Guidelines
- A-4 Accident/Incident (Near Miss) Report Form

B: CHEMICAL PROFILES

- B-1 MSDS Definitions
- B-2 MSDSs
- B-3 Vapor Monitoring Forms

C: OPERATIONS INFORMATION

- C-1 Site Specific Lockout/Tagout Procedures
- C-2 Cold Work Permits
- C-3 Hot Work Permits

D: MAPS/DIAGRAMS

- D-1 Site Maps

F: BLOOMFIELD REFINING COMPANY CONTRACTOR SAFETY REGULATIONS

1.0 INTRODUCTION

Bloomfield Refining Company has retained Groundwater Technology, Inc. to perform environmental services at their facility at #50 County Road 4990, Bloomfield, New Mexico.

Facility Location

The Bloomfield Refining Company facility is located near latitude 30° 41' 50" and longitude 107° 58' 20". The facility is situated such that approximately 30.76 undeveloped acres of the plant lie north of the center line of the San Juan River. The remainder of the facility including the refinery, is located south of the San Juan River.

Federal property managed by the Bureau of Land Management borders the facility property to the south, and undeveloped company property, the San Juan River and the Town of Bloomfield are located north of the refinery. Undeveloped private and public lands in addition to several gravel pits border the property to the east, and private undeveloped land and an auto salvage yard lie beyond Highway 44 to the west. The majority of undeveloped land in the vicinity of the refinery is used for oil and gas production, and in some instances, grazing.

An El Paso Natural Gas Pipeline and a San Juan Crude pipeline easement run southwest through the center of the facility. The nearest residences include two homes located about 400 feet south of the property line, south of the terminals. Additional residences are located just north of the undeveloped refinery property across the San Juan River in the town of Bloomfield, New Mexico (about 1400 feet north of the active refinery site).

The Site Safety Plan is written to ensure the well being of all field personnel and the community surrounding the site. Accordingly, project staff and approved Groundwater Technology subcontractors must follow the policies and procedures established in the Site Safety Plan. All personnel assigned to this project must sign the Agreement and Acknowledgement Sheet (Appendix A-2) to confirm that they understand and agree to abide by the provisions of the plan.

All work will comply with the OSHA Standard, "Hazardous Waste Operations and Emergency Response," (29 CFR 1910.120) and other federal, state and local procedures that require the development and implementation of a Site Safety Plan.

This plan addresses the safety issues associated with the following site tasks:

- Field Survey/Walkover
- Drilling/Boring/Soil Sampling
- Well Installation
- Well Monitoring and Maintenance
- Soil Gas Survey
- Aquifer Pump Test
- Groundwater Sampling
- Surface Water Sampling

All activities of this project will be carried out under Modified Level D or Level C Personal Protective Equipment (PPE). This Site Safety Plan must be modified or amended when circumstances or conditions develop that are beyond this scope of work.

Any changes in project work scope and/or site conditions as described must be amended in writing by the Health and Safety Representative (HSR) on the Site Safety Plan Amendment Sheet (Appendix A-1).

Table 1-1 presents an overview of the Groundwater Technology health and safety programs in which all field personnel are required to participate. These include the medical surveillance and comprehensive training programs in accordance with OSHA Hazardous Waste Operations and Emergency Response regulation, 29 CFR 1910.120.

TABLE 1-1
GROUNDWATER TECHNOLOGY, INC.
HEALTH AND SAFETY PROGRAMS

Activity	Description	Action
Medical Surveillance	■ The program tracks the physical condition of the Company's employees in compliance with DOT and OSHA regulations, and other customer requirements. ■ Specific components of the medical surveillance program are described in Groundwater Technology's Health and Safety Procedure Manual.	■ Medical examinations and consultations are completed for all employees prior to assignment, annually, upon termination, and in the event of injury and/or illness resulting from exposure at the work site.
Training	■ Training requirements and programs comply with the OSHA Hazardous Waste Operations and Emergency Response regulation, 29 CFR 1910.120.	■ Field personnel must complete a minimum of 40 hours of hazardous waste activity instruction. ■ Field personnel must complete a minimum of three days supervised field instruction. ■ Field personnel assigned to the site will also receive eight hours of refresher training each year. ■ On-site managers and supervisors directly responsible for employees engaged in hazardous waste operations receive an additional eight hours of supervisory training.

2.0 HAZARD IDENTIFICATION AND CONTROL

Precautions must be taken to prevent injuries and exposures to the following potential hazards.

TABLE 2-1
POTENTIAL HAZARDS AND CONTROL

Potential Hazard	Control
Exposure to Chemical Products (See Appendices B-1: MSDS Definitions and B-2: MSDSs)	1. Stand up-wind of chemical products whenever possible. 2. Minimize contact and contact time with chemical products. 3. Avoid walking through discolored areas, puddles, leaning on drums, or contacting anything that is likely to be contaminated. 4. Do not eat, drink, smoke and/or apply cosmetics in the hot or warm zones. 5. Wear gloves when in contact with contaminated surfaces. 6. Safety glasses must be worn at a minimum. 7. Splash goggles must be worn when working with liquids. 8. >50 ppm organic vapors in breathing zone requires upgrade to Level C. 9. >250 ppm organic vapors in breathing zone requires upgrade from Level C to Level B. 10. If unknown materials are encountered, call the HSR.
Vehicular Traffic	1. Wear traffic safety vest when vehicle hazard exists. 2. Use cones, flags, barricades, and caution tape to define work area. 3. Use vehicle to block work area. 4. Engage police detail for high-traffic situations.
Inclement Weather	1. Stop outdoor work during electrical storms and other extreme weather conditions such as extreme heat or cold temperatures. 2. Take cover indoors or in vehicle. 3. Listen to local forecasts for warnings about specific weather hazards such as tornados, hurricanes and flash floods.
Noise	1. Wear hearing protection when equipment such as a drill rig, jackhammer, cut saw, air compressor, blower or other heavy equipment is operating on the site. 2. Wear hearing protection whenever you need to raise your voice above normal conversational speech due to a loud noise source; this much noise indicates the need for protection. (more)
Electric Shock	1. Maintain appropriate distance from overhead utilities; **20-foot minimum clearance from power lines required; 10-foot minimum clearance from shielded power lines.** 2. Use ground-fault circuit interrupters as required. 3. Perform lockout/tagout procedures (Appendix C-1). 4. Use three-pronged plugs and extension cords. 5. Contact your local underground utility-locating service. 6. Follow code requirements for electrical installations in hazardous locations.

TABLE 2-1
POTENTIAL HAZARDS AND CONTROL

Potential Hazard	Control
Physical Injury	1. Wear hard hats and safety glasses when on site. 2. Maintain visual contact with the equipment operator and wear orange safety vest when heavy equipment is used on site. 3. Avoid loose-fitting clothing (driller and driller's helper). 4. Prevent slips, trips and falls; keep work area uncluttered. 5. Keep your hands away from moving parts (i.e. augers). 6. Test the emergency shutoff switch on the drill rig daily.
Back Injury	1. Use a mechanical lifting device or a lifting aid where appropriate. 2. If you must lift, plan the lift before doing it. 3. Check your route for clearance. 4. Bend at the knees and use leg muscles when lifting. 5. Use the buddy system when lifting heavy or awkward objects. 6. Do not twist your body while lifting.
Heat Stress	1. Increase water intake while working. 2. Increase number of rest breaks and/or rotate workers in shorter work shifts. 3. Watch for signs and symptoms of heat exhaustion and fatigue. 4. Plan work for early morning or evening during hot months. 5. Use ice vests when necessary. 6. Rest in cool, dry areas. 7. In the event of heat stroke, bring the victim to a cool environment and initiate first aid procedures.
Cold Stress	1. Take breaks in heated shelters when working in extremely cold temperatures . 2. Remove the outer layer of clothing and loosen other layers to promote evaporation of perspiration, upon entering the shelter. 3. Drink warm liquids to reduce the susceptibility to cold stress.
High Crime Areas	1. Be aware of surroundings. 2. Use the buddy system. 3. Request police detail when appropriate.
Insects	1. Tuck pants into socks. 2. Wear long sleeves. 3. Use insect repellent. (more)
Poisonous Plants (such as poison ivy, oak or sumac)	1. Don't enter areas infested with poisonous plants. 2. Immediately wash any areas that come into contact with poisonous plants.

TABLE 2-1
POTENTIAL HAZARDS AND CONTROL

Potential Hazard	Control
Ladders	1. Make sure ladder rungs are sturdy and free of cracks. 2. Use ladders with secure safety feet. 3. Pitch ladders at a 4:1 ratio. 4. Secure ladders at the top when possible. 5. Do not use ladders for access to air stripper towers. 6. Use non-conductive ladders near electrical wires.
Fire Control	1. Smoke only in designated areas. 2. Keep flammable liquids in closed containers. 3. Keep site clean; avoid accumulating combustible debris such as paper. 4. Follow Hot Work Safety Procedures when welding or performing other activities requiring an open flame. 5. Isolate flammable and combustible materials from ignition sources. 6. Ensure fire safety integrity of equipment installations according to Hazard Classification Diagram (Appendix D).
Surface Water and Sediment Sampling	1. Wear slip-proof and water-resistant foot wear. 2. Approved flotation device required for sampling. 3. Manned lifeline to shore required. 4. Chemical-resistant gloves required.

3.0 AIR MONITORING

3.1 Air Monitoring

Air monitoring must be performed on all sites in accordance with Groundwater Technology practices. Organic vapor concentrations are monitored in the field with a flame ionization detector (FID) or photoionization detector (PID). All readings are taken in the workers' breathing zone to determine whether an action level has been met and/or exceeded. Air monitoring results must be documented on the Vapor Monitoring Form (Appendix B-3).

Air monitoring action levels (Table 3-1) have been developed by Groundwater Technology to indicate the chemical concentrations in the breathing zone that require an upgrade in level of personal protective equipment (PPE). The action levels apply to all tasks performed on this site. Guidelines for frequency of air monitoring are presented in Table 3-2.

TABLE 3-1
AIR MONITORING ACTION LEVELS

Instrument*	Function	Measurement	Action
Photoionization Detector (PID), Flame Ionization Detector (FID)	**Measures total organic vapors**		
		0-50 ppm	Level D required
		51-250 ppm	Upgrade to Level C
		>250 ppm	Stop work. Contact PM and HSR for guidance.
Oxygen/Combustimeter (O_2/LEL)	**Measures oxygen level (O_2) and lower explosive limit (LEL)**		
		O_2 19.5-22%	▪ Acceptable conditions. Continue normal activity.
		O_2 <19.5%	▪ Ventilate the space. ▪ Notify PM or HSR if unable to achieve acceptable conditions.
		O_2 >22%	▪ **Leave area immediately**; this atmosphere is extremely flammable. ▪ Notify PM or HSR.
		LEL <10%	▪ Acceptable conditions. Continue normal activity.
		LEL >10%	▪ **Leave area immediately.** ▪ Contact PM or HSR for guidance on venting and other safety measures.

*** Note: Instruments must be calibrated according to manufacturer's recommendations.**

TABLE 3-2
AIR MONITORING FREQUENCY GUIDELINES

Conduct periodic monitoring when: (1) it is possible that an IDLH condition or a flammable atmosphere has developed or (2) there is an indication that exposures may have risen over permissible exposure limits or published exposure levels since the last monitoring. Look for a possible rise in exposures associated with these situations:

- **Change in Site Area** - work begins on a different section of the site
- **Change in Contaminants** - handling contaminants other than those first identified
- **Change in On-Site Activity** - one operation ends and another begins
- **Handling Leaking Drums or Containers**
- **Working with Obvious Liquid Contamination** (e.g, a spill or lagoon)

Conduct air monitoring when the possibility of volatilization exists (such as with a new monitoring well or a well containing known product).

Conduct air monitoring on a well at a site known to have little contamination (documented by experience or laboratory data), **only** if an odor emanates from the well.

Real Time Air Monitoring

To obtain and document historical employee exposure levels to organic vapors during these field activities real time air sampling will be conducted. Activities that pose the highest exposure potential will be targeted with 8 hour sampling followed by laboratory analysis of the sampling media.

4.0 CHEMICAL HAZARD CONTROL

4.1 Chemical Handling Procedures

Personnel must practice the chemical-specific handling procedures outlined below.

TABLE 4-1
CHEMICAL HANDLING PROCEDURES

Chemical	Description	Procedures
Acids and Bases Acids: including hydrochloric, nitric and sulfuric acids Bases: including sodium hydroxide	Extremely corrosive materials with a variety of uses.	■ Wear gloves and eye-splash protection while using acid dispensed from a small dropper bottle during water sampling. ■ Wear a full-face, air-purifying respirator equipped with combination cartridges (organic vapor/acid gas) as well as Tyvek coveralls and nitrile and/or NBR gloves for large volume applications. ■ Have an eye wash bottle or portable eye wash station on site. ■ Cap all drums after dispensing chemicals. ■ Do not add anything into a virgin chemical drum, including unused product. ■ Avoid mixing strong acids and bases. Consult HSR for task-specific evaluation. If mixing is absolutely necessary, do it slowly. Avoid vapors or fumes that are generated. ■ When diluting acids, add the acid to water in small quantities and mix cautiously. ■ When diluting bases, add water to the base in small quantities and mix cautiously.
Activated Carbon	Granular adsorbent medium used to remove residual hydrocarbons from water and/or air.	■ Use respiratory protection when activated carbon creates a dusty environment. ■ Contact HSR for task-specific evaluation.

4.2 Personal Protective Equipment (PPE)

Modified Level D is the minimum acceptable level for this site.

TABLE 4-2
PERSONAL PROTECTIVE EQUIPMENT

Level	Requirements
Modified Level D	▪ Work uniform ▪ Steel-toed boots ▪ Approved safety glasses or goggles ▪ Hard hat ▪ Fluorescent vest, when vehicular traffic is on or adjacent to the site ▪ Nitrile gloves for water sampling handling ▪ PE-coated Tyvek® suit, NBR outer and nitrile inner gloves if skin contact with contaminants is possible
Level C	▪ NIOSH-approved full-face respirator with organic vapor/acid gas cartridges ▪ Work uniform ▪ Steel-toed boots ▪ Hard hat ▪ PE-coated Tyvek® suit, NBR outer and nitrile inner gloves, if skin contact with contaminants is possible

4.3 Site Control: Work Zones

Work zones will be established in order to: (1) delineate high-traffic locations, (2) identify hazardous locations and (3) contain contamination within the smallest area possible. Employees entering the work zone must wear the proper personal protective equipment for that area. Work and support areas will be established based on ambient air data, necessary security measures, and site-specific conditions.

4.4 Decontamination Procedures

Operations conducted at this site have the potential to contaminate field equipment and personal protective equipment. To prevent the transfer of contamination to vehicles, administrative offices and personnel, the procedures presented in Table 4-3 must be followed.

TABLE 4-3
DECONTAMINATION PROCEDURES

Item	Examples	Procedure
Field Equipment	Bailers, interface probes, hand tools, drill augers and miscellaneous sampling equipment	▪ Decontaminate with a solution of detergent and water; rinse with water prior to leaving the site. ▪ Protect from exposure by covering with disposable covers such as plastic to minimize required decontamination activities.
Disposable PPE	Tyvek® suits, inner latex gloves, respirator cartridges	▪ Dispose of according to the requirements of the client and state and federal agencies.
Nondisposable PPE	Respirators	▪ Wipe out respirator with disinfecting pad prior to donning. ▪ Decontaminate on site at the close of each day with a solution of an approved sanitizing powder and water.

Equipment decontamination procedures are also discussed in the quality assurance project plan.

5.0 CONTINGENCY PLANS

Table 5-1 (Sections 5.1 - 5.4) presents contingency plans for potential emergency situations.

TABLE 5-1
CONTINGENCY PLANS FOR SITE EMERGENCIES

Situation	Action
5.1 Evacuation	1. Immediately notify all on-site personnel of an emergency requiring evacuation. 2. Leave the dangerous area and report to a designated rally point. 3. Notify Emergency Services, as appropriate. 4. Account for all personnel. 5. Contact the PM and the HSR as soon as possible. 6. Maintain site security and control measures for community safety until emergency responders arrive.
5.2 Medical Emergency	1. Survey the Situation: **Do not enter an area that may jeopardize your safety.** ■ Establish the patient's level of consciousness. ■ Call for help. ■ Contact Emergency Medical Services and inform them of patient's condition. 2. Primary Assessment (patient unconscious) ■ Arousal ■ Airway ■ Breathing ■ Circulation **Only trained personnel should perform CPR or First Aid.** 3. Secondary Assessment (patient conscious) ■ Check for bleeding: Control with direct pressure. ■ Do not move patient (unless location is not secure). ■ Monitor vital signs. ■ Provide First Aid to the level of your training. ■ Contact the PM and HSR as soon as possible. ■ Document the incident on Groundwater Technology's Accident/Incident form.
5.3 Fire Emergency	1. **Evacuate the area.** 2. Notify the Emergency Services. 3. Extinguish small fires with an all-purpose extinguisher. 4. Contact the PM and HSR. 5. Document the incident using the Accident/Incident Form.

TABLE 5-1
CONTINGENCY PLANS FOR SITE EMERGENCIES

Situation	Action
5.4 Spill/Release	Prevent problems by documenting the location of underground lines (e.g. product, sewer, telephone) before starting site work. If you drill through a line or tank or another leak occurs, document the spill/release in writing. Include dates, times, actions taken, agreements reached and names of people involved. In the event of a spill/release, follow this plan. 1. Wear appropriate PPE; stay upwind of the spill/release. 2. Turn off equipment and other sources of ignition. 3. Turn off pumps and shut valves to stop the flow/leak. 4. Plug the leak or collect drippings in a bucket, when possible. 5. Place sorbent pads to collect product, if possible. 6. Call Fire Department immediately if fire emergency develops. 7. Inform Groundwater Technology PM about the situation. 8. Determine if the client wants Groundwater Technology to repair the damage or if the client will use an emergency repair contractor. 9. Based on agreements, contact emergency spill contractor for containment of free product. 10. Advise the client of spill discharge notification requirements and determine who will complete and submit forms. Do not submit or report to agencies without the client's consent. Document each interaction with the client and regulators and note, in writing: name, title, authorizations, refusals, decisions, and commitments to actions. 11. Do not transport or approve transportation of contaminated soils or product until proper manifests have been completed and approved. Be aware that soils/product may meet criteria for hazardous waste. 12. Do not sign manifests as generator of waste; contact the regional compliance manager to discuss waste transportation.

Notifications

The Project Manager must contact the client or generator. The generator is under obligation to report to the proper government agencies. If the spill extends into waterways, the Coast Guard and the National Guard Response Center (1-800-424-8802) must be notified immediately by the client or with his permission.

APPENDIX A-1: AMENDMENT SHEET

Project Name: ______________________________

Project Number: ______________________________

Project Manager: ______________________________

Location: ______________________________

Changes in field activities or hazards:

Approved by: ____________________ ____________
Regional Health and Safety Representative Date

APPENDIX A-2: AGREEMENT AND ACKNOWLEDGEMENT SHEET

Groundwater Technology personnel have the authority to stop field activities at this site if any activity is not performed in accordance with the requirements of the Site Safety Plan. All Groundwater Technology project personnel, subcontractor personnel and visitors are required to sign the Agreement and Acknowledgement Sheet **prior** to conducting field activities at this site.

APPENDIX A-2
GROUNDWATER TECHNOLOGY, INC.
AGREEMENT AND ACKNOWLEDGEMENT SHEET

1. **I have read and fully understand the SSP and my responsibilities.**
2. **I agree to abide by the provisions of the SSP.**

Name	**Signature**
Company	**Date**
Name	**Signature**
Company	**Date**
Name	**Signature**
Company	**Date**
Name	**Signature**
Company	**Date**
Name	**Signature**
Company	**Date**
Name	**Signature**
Company	**Date**
Name	**Signature**
Company	**Date**
Name	**Signature**
Company	**Date**
Name	**Signature**
Company	**Date**

GROUNDWATER
TECHNOLOGY

APPENDIX A-3: VISITOR/TRAINEE GUIDELINES

Groundwater Technology, Inc. is committed to providing a safe environment on all work sites for visitors, trainees, employees and/or passersby. In order to accomplish this, the following guidelines must be followed.

1. VISITORS

Any person not actively participating in the work at the site is regarded as a "visitor" and must follow Groundwater Technology's visitor/trainee guidelines. Visitors must be accompanied by a representative while on site.

Sites must be marked with signs, placards, and/or barricades to designate hazardous boundaries. Visitors will not be allowed on any site that is not adequately marked.

2. TRAINEES

Trainees are employees of Groundwater Technology who have not yet completed Groundwater Technology's required safety training program. New hires and in-house company transfers will be considered trainees until safety training requirements are met.

Trainees will be informed of restrictions by their supervisor and must abide by them before visiting active sites.

Trainees will be permitted to visit Groundwater Technology sites as observers as long as the following conditions are met:

- Trainees are supervised at all times while observing on site.
- Trainees do not perform work functions of any type while on site.
- Trainees do not handle any equipment, tools and/or supplies while on site.
- Trainees do not enter any hazardous or hot zone or confined space areas while on site.

Supervisors will be responsible for informing trainees of the above conditions and for ensuring that the conditions are met. Supervisors will also ensure that trainees will not be asked to violate the conditions listed above.

A Trainee/Observer Agreement Form must be signed by both the trainee and the supervisor and placed on file in the Regional Human Resources department.

Infractions of the above agreement will be viewed as extremely serious and will be subject to discipline up to and including termination for either the trainee and/or supervisor.

TRAINEE/OBSERVER AGREEMENT FORM

Groundwater Technology is committed to providing a safe working environment for all employees. In addition, Groundwater Technology will comply with OSHA requirements for employee safety training prior to working on any hazardous site.

The following section is to be filled out by trainee.

Agreement between:

______________________________ ________________ and Groundwater Technology.
Name (print/type) SS#

Because we have your safety in mind, you will be considered a trainee until all training criteria are met. This means you must complete all training requirements prior to performing work activities on site. As a requirement of the training program, you will be asked to visit Groundwater Technology sites as an observer. You must be supervised on all of these site visits.

As an on-site observer trainee, your signature below indicates your agreement to these restrictions.

You may not:

1. Perform work functions of any type.
2. Handle any equipment/tools and/or supplies of any type.
3. Enter any hazardous or hot zone areas.

I agree to adhere to the above conditions in all instances while on site as a trainee/observer.

______________________________ ________________
Signature Date

- -

This section is to be filled out by supervisor.

As supervisor to the above trainee, I agree to the above restrictions and agree not to request him/her to perform activities contrary to those restrictions.

______________________________ ________________
Signature Date

GROUNDWATER
TECHNOLOGY

APPENDIX A-4: ACCIDENT/INCIDENT (NEAR MISS) REPORT FORM

Employee's Name:____________________ D.O.B.__________
Address:____________________ D.O.H.__________
____________________ SS#__________
Job Title:____________________Supervisor's Name:__________
Office Location:____________________
Location at Time of Incident:____________________
Date/Time of Incident:____________________
Project Name:____________________
Project Number:____________________Project Mgr.__________

= =

Describe clearly how the accident occurred:____________________
____
____
Was incident: Physical____________________Chemical__________
Parts of body affected____________________Exposure: Dermal__________
right _____ left _____ Inhalation__________
Ingestion__________
Witnesses: 1)____________________2)__________
Conditions/acts contributing to this incident____________________
____
____

= =

Managers must complete this section:

Explain specifically the corrective action you have taken to prevent a recurrence:__________
____
____
Did injured go to doctor:____________________Where:__________
____________________When:__________
Did injured go to hospital:____________________Where:__________
____________________When:__________

= =

Signatures:

Employee	Reporting Manager	Health & Safety Representative
Date	Date	Date

Accidents must be reported immediately; this form must be completed, signed and returned to the Health and Safety Representative within 24 hours. The Health and Safety Representative will forward a copy to Corporate Health and Safety.

GROUNDWATER
TECHNOLOGY

APPENDIX B-1: MSDS DEFINITIONS

(TLV-TWA)	Threshold Limit Value - Time Weighted Average. The time-weighted average concentration for a normal 8-hour work day and a 40-hour work week, to which nearly all workers may be repeatedly exposed without adverse effect.
(PEL)	Time-weighted average concentrations similar to (and in many cases derived from) the Threshold Limit Values.
(REL)	Recommended Exposure Limit as defined by NIOSH similar to the Threshold Limit Values.
(IDLH)	Immediately dangerous to life or health - Any atmospheric condition that poses an immediate threat to life, or which is likely to result in acute or immediate severe health effects. Oxygen deficiency is IDLH.
(LEL)	Lower Explosive Limit - The minimum concentration of vapor in air below which propagation of a flame will not occur in the presence of an ignition source.
(UEL)	Upper Explosive Limit - The maximum concentration of vapor in air above which propagation of a flame will not occur in the presence of an ignition source.
Flash Point (F.P.)	The lowest temperature at which the vapor of a combustible liquid can be made to ignite momentarily in air.
Vapor Pressure (V.P.)	The pressure characteristic at any given temperature of a vapor in equilibrium with its liquid or solid form, often expressed in millimeters of mercury (mm Hg).
Odor Threshold	A property displayed by a particular compound. Low detection indicates a physiological sensation due to molecular contact with the olfactory nervous system (based on 50% of the population).
Ionization Potential (I.P.)	The amount of ionization characteristic a particular chemical compound displays.

CONTAMINANTS PROFILE

Chemical	Exposure Route	Symptoms of Overexposure	Incompatibilities
Gasoline	Inhalation	▪ Intense burning of mucous membranes, throat, and respiratory tract, flushing of face, staggering gait, slurred speech, mental confusion.	Oxidizing agents such as hydrogen peroxide, nitric acid.
	Ingestion	▪ Inebriation, drowsiness, blurred vision, dizziness, confusion, vomiting, cyanosis.	
	Skin Contact	▪ Prolonged skin contact may cause dermatitis	
Diesel Fuel Jet Fuel Fuel Oils	Inhalation and/or Ingestion	▪ Irritation to respiratory passages, headache, dizziness and nausea, vomiting, loss of coordination	Oxidizing agents such as hydrogen peroxide, nitric acid.
		▪ Chemical pneumonitis (when oil is aspirated in the lungs)	
	Skin Contact	▪ Irritation, rash of acne pimples and spots	

APPENDIX B-2: MATERIAL SAFETY DATA SHEETS

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 316
Benzene

Issued: 11/78 Revision: E, 8/90

Section 1. Material Identification

32

Benzene (C_6H_6) Description: Derived by fractional distillation of coal tar, hydrodealkylation of toluene or pyrolysis of gasoline, catalytic reforming of petroleum, and transalkylation of toluene by disproportionation reaction. Used as a fuel; a chemical reagent; a solvent for a large number of materials such as paints, plastics, rubber, inks, oils, and fats; in manufacturing phenol, ethylbenzene (for styrene monomer), nitrobenzene (for aniline), dodecylbenzene (for detergents), cyclohexane (for nylon), chlorobenzene, diphenyl, benzene hexachloride, maleic anhydride, benzene-sulfonic acid, artificial leather, linoleum, oil cloth, varnishes, and lacquers; for printing and lithography; in dry cleaning; in adhesives and coatings; for extraction and rectification; as a degreasing agent; in the tire industry; and in shoe factories. Benzene has been banned as an ingredient in products intended for household use and is no longer used in pesticides.

Other Designations: CAS No. 0071-43-2, benzol, carbon oil, coal naphtha, cyclohexatriene, mineral naphtha, nitration benzene, phene, phenyl hydride, pyrobenzol.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.

R 1
I 4
S 2*
K 4
*Skin absorption

NFPA
3
2 0
-

HMIS
H 3
F 3
R 0
PPG†
† Sec. 3

Cautions: Benzene is a confirmed *human carcinogen* by the IARC. *Chronic low-level exposure may cause cancer (leukemia) and bone marrow damage, with injury to blood-forming tissue.* It is also a dangerous fire hazard when exposed to heat or flame.

Section 2. Ingredients and Occupational Exposure Limits

Benzene, ca 100%*

1989 OSHA PELs
(29 CFR 1910.1000, Table Z-1-A)
8-hr TWA: 1 ppm, 3 mg/m³
15-min STEL: 5 ppm, 15 mg/m³

(29 CFR 1910.1000, Table Z-2)
8-hr TWA: 10 ppm
Acceptable Ceiling Concentration: 25 ppm
Acceptable Maximum Peak: 50 ppm (10 min)†

1989-90 ACGIH
TLV-TWA: 10 ppm, 32 mg/m³

1988 NIOSH RELs
TWA: 0.1 ppm, 0.3 mg/m³
Ceiling: 1 ppm, 3 mg/m³

1985-86 Toxicity Data‡
Man, oral, LD_{Lo}: 50 mg/kg; no toxic effect noted
Man, inhalation, TC_{Lo}: 150 ppm inhaled intermittently over 1 yr in a number of discrete, separate doses affects the blood (other changes) and nutritional and gross metabolism (body temperature increase)
Rabbit, eye: 2 mg administered over 24 hr produces severe irritation

* OSHA 29 CFR 1910.1000, Subpart Z, states that the final benzene standard in 29 CFR 1910.1028 applies to all occupational exposures to benzene except in some subsegments of industry where exposures are consistently under the action level (i.e., distribution and sale of fuels, sealed containers and pipelines, coke production, oil and gas drilling and production, natural gas processing, and the percentage exclusion for liquid mixtures); for the excepted subsegments, the benzene limits in Table Z-2 apply.

† Acceptable maximum peak above the acceptable ceiling concentration for an 8-hr shift.

‡ See NIOSH, *RTECS* (CY1400000), for additional irritative, mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 176 °F (80 °C)
Melting Point: 42 °F (5.5 °C)
Vapor Pressure: 100 mm Hg at 79 °F (26.1 °C)
Vapor Density (Air = 1): 2.7
Evaporation Rate (Ether = 1): 2.8

Molecular Weight: 78.11
Specific Gravity (15 °C/4 °C): 0.8787
Water Solubility: Slightly (0.180 g/100 g of H_2O at 25 °C)
% Volatile by Volume: 100
Viscosity: 0.6468 mPa at 20 °C

Appearance and Odor: A colorless liquid with a characteristic sweet, aromatic odor. The odor recognition threshold (100% of panel) is approximately 5 ppm (unfatigued) in air. Odor *is not* an adequate warning of hazard.

Section 4. Fire and Explosion Data

Flash Point: 12 °F (-11.1 °C), CC	Autoignition Temperature: 928 °F (498 °C)	LEL: 1.3% v/v	UEL: 7.1% v/v

Extinguishing Media: Use dry chemical, foam, or carbon dioxide to extinguish benzene fires. Water may be ineffective as an extinguishing agent since it can scatter and spread the fire. Use water spray to cool fire-exposed containers, flush spills away from exposures, disperse benzene vapor, and protect personnel attempting to stop an unignited benzene leak.

Unusual Fire or Explosion Hazards: Benzene is a Class 1B flammable liquid. A concentration exceeding 3250 ppm is considered a potential fire explosion hazard. Benzene vapor is heavier than air and can collect in low lying areas or travel to an ignition source and flash back. Explosive and flammable benzene vapor-air mixtures can easily form at room temperature. Eliminate all ignition sources where benzene is used, handled, or stored.

Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Structural firefighter's protective clothing provides limited protection. Stay out of low areas. Be aware of runoff from fire control methods. Do not release to sewers or waterways. Runoff to sewer can create pollution, fire, and explosion hazard.

Section 5. Reactivity Data

Stability/Polymerization: Benzene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous lymerization cannot occur.

emical Incompatibilities: Benzene explodes on contact with diborane, permanganic acid, bromine pentafluoride, peroxodisulfuric acid, and peroxomonosulfuric acid. It ignites on contact with dioxygen difluoride, dioxygenyl tetrafluoroborate, iodine heptafluoride, and sodium peroxide + water. Benzene forms sensitive, explosive mixture with iodine pentafluoride, ozone, liquid oxygen, silver perchlorate, nitryl perchlorate, nitric acid, and arsenic pentafluoride + potassium methoxide (explodes above 30 °C). A vigorous or incandescent reaction occurs with bromine trifluoride, uranium hexafluoride, and hydrogen + Raney nickel [above 410 °F (210 °C)]. Benzene is incompatible with oxidizing materials.

Conditions to Avoid: Avoid heat and ignition sources.

Hazardous Products of Decomposition: Thermal oxidative decomposition of benzene can produce toxic gases and vapors such as carbon monoxide.

Section 6. Health Hazard Data

[illegible]inogenicity: The ACGIH, OSHA, and IARC list benzene as, respectively, a supected human carcinogen, a cancer hazard, and, based on [illegible]cient human and animal evidence, a human carcinogen (Group 1).
Summary of Risks: Prolonged skin contact or excessive inhalation of benzene vapor may cause headache, weakness, appetite loss, and fatigue. The most important health hazards are cancer (leukemia) and bone marrow damage with injury to blood-forming tissue from chronic low-level exposure. Higher level exposures may irritate the respiratory tract and cause central nervous system (CNS) depression.
Medical Conditions Aggravated by Long-Term Exposure: Exposure may worsen ailments of the heart, lungs, liver, kidneys, blood, and CNS.
Target Organs: Blood, central nervous system, bone marrow, eyes, upper respiratory tract, and skin.
Primary Entry Routes: Inhalation, skin contact.
Acute Effects: Symptoms of acute overexposure include irritation of the eyes, nose, and respiratory tract, breathlessness, euphoria, nausea, drowsiness, headache, dizziness, and intoxication. Severe exposure may lead to convulsions and unconsciousness. Skin contact may cause a drying rash (dermatitis).
Chronic Effects: Long-term chronic exposure may result in many blood disorders ranging from aplastic anemia (an inability to form blood cells) to leukemia.

FIRST AID

Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Immediately rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air. Emergency personnel should protect against inhalation exposure. Provide CPR to support breathing or circulation as necessary. Keep awake and transport to a medical facility.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* since aspiration may be fatal. Call a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: Evaluate chronic exposure with a CBC, peripheral smear, and reticulocyte count for signs of myelotoxicity. Follow up any early indicators of leukemia with a bone marrow biopsy. Urinary phenol conjugates may be used for biological monitoring of recent exposure. Acute management is primarily supportive for CNS depression.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Design and practice a benzene spill control and countermeasure plan (SCCP).* Notify safety personnel, evacuate all unnecessary personnel, eliminate all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against vapor inhalation, eye contact, and skin absorption. Absorb as much benzene as possible with an inert, noncombustible material. For large spills, dike far ahead of spill and contain liquid. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of confined spaces such as sewers, watersheds, and waterways because of explosion danger. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

L[illegible]ed as a RCRA Hazardous Waste (40 CFR 261.33), Hazardous Waste No. U019
[illegible] as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1000 lb (454 kg) [* per Clean Water Act, Sec. 307 (a), [illegible] (b)(4), 112; and per RCRA, Sec. 3001]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Tables Z-1-A and Z-2)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations at least below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from all heat and ignition sources and incompatible materials. *Caution! Benzene vapor may form explosive mixtures in air.* To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations in production and storage areas. When opening or closing benzene containers, use nonsparking tools. Keep fire extinguishers readily available.
Engineering Controls: Because OSHA specifically regulates benzene (29 CFR 1910.1028), educate workers about its potential hazards and dangers. Minimize all possible exposures to carcinogens. If possible, substitute less toxic solvents for benzene; use this material with extreme caution and only if absolutely essential. Avoid vapor inhalation and skin and eye contact. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Designate regulated areas of benzene use (see legend in the box below) and label benzene containers with "DANGER, CONTAINS BENZENE, CANCER HAZARD."
Other Precautions: Provide preplacement and periodic medical examinations with emphasis on a history of blood disease or previous exposure.

Transportation Data (49 CFR 172.101, .102)

D[illegible] Shipping Name: Benzene (*benzol*)
D[illegible] Hazard Class: Flammable liquid
ID No.: UN1114
DOT Label: Flammable liquid
DOT Packaging Exceptions: 173.118
DOT Packaging Requirements: 173.119

IMO Shipping Name: Benzene
IMO Hazard Class: 3.2
ID No.: UN1114
IMO Label: Flammable liquid
IMDG Packaging Group: II

DANGER
BENZENE
CANCER HAZARD
FLAMMABLE–NO SMOKING
AUTHORIZED PERSONNEL ONLY
RESPIRATOR REQUIRED

MSDS Collection References: 1, 2, 12, 26, 73, 84-94, 100, 101, 103, 109, 124, 126, 127, 132, 134, 136, 138, 139, 143

Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS

Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 318

XYLENE (Mixed Isomers)
(Revision D)
Issued: November 1980
Revised: August 1988

SECTION 1. MATERIAL IDENTIFICATION

26

Material Name: XYLENE (Mixed Isomers)

Description (Origin/Uses): Used as a raw material for the production of benzoic acid, phthalic anhydride, isophthalic and terephthalic acids and their dimethyl esters in the manufacture of polyester fibers; in sterilizing catgut; with Canadian balsam as oil-immersion in microscopy; and as a cleaning agent in microscopic techniques.

Other Designations: Dimethylbenzene; Xylol; C_8H_{10}; CAS No. 1330-20-7

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

Comments: Although there are three different isomers of xylene (*ortho*, *meta*, and *para*), the health and physical hazards of all three isomers are very similar. This MSDS is written for a xylene mixture of all three isomers, which is usually commercial xylene.

3
2 0
-
NFPA

HMIS
H 2
F 3
R 0
PPG*
*See sect. 8

R 1
I 3
S 2
K 3

SECTION 2. INGREDIENTS AND HAZARDS

SECTION 2. INGREDIENTS AND HAZARDS	%	EXPOSURE LIMITS
Xylene (Mixed Isomers), CAS No. 1330-20-7* *o-Xylene, CAS No. 0095-47-6 *m*-Xylene, CAS No. 0108-38-3 *p*-Xylene, CAS No. 0106-42-3 **Check with your supplier to determine if there are additions, contaminants, or impurities (such as benzene) that are present in reportable quantities per 29 CFR 1910. ***Immediately dangerous to life and health. **** See NIOSH, *RTECS* (No. ZE2100000), for additional data with references to reproductive, irritative, and mutagenic effects.	**	IDLH*** Level: 1000 ppm OSHA PEL 8-Hr TWA: 100 ppm, 435 mg/m³ ACGIH TLVs, 1987-88 TLV-TWA: 100 ppm, 435 mg/m³ TLV-STEL: 150 ppm, 655 mg/m³ Toxicity Data**** Human, Inhalation, TC_{Lo}: 200 ppm Man, Inhalation, LC_{Lo}: 10000 ppm/6 Hrs Rat, Oral, LD_{50}: 4300 mg/kg

SECTION 3. PHYSICAL DATA

Boiling Point: 275°F to 293°F (135°C to 145°C)*
Melting Point: -13°F (-25°C)
Evaporation Rate: 0.6 Relative to BuAc = 1
Specific Gravity (H_2O = 1): 0.86

Water Solubility (%): Insoluble
Molecular Weight: 106 Grams/Mole
% Volatile by Volume: Ca 100
Vapor Pressure: 7 to 9 Torrs at 68°F (20°C)
Vapor Density (Air = 1): 3.7

Appearance and Odor: A clear liquid; aromatic hydrocarbon odor.

*Materials with wider and narrower boiling ranges are commercially available.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
81°F to 90°F (27°C to 32°C)	867°F (464°C)	% by Volume	1%	7%

Extinguishing Media: Use foam, dry chemical, or carbon dioxide. Use water sprays to reduce the rate of burning and to cool containers.

Unusual Fire or Explosion Hazards: Xylene vapor is heavier than air and may travel a considerable distance to a low-lying source of ignition and flash back.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Xylene is stable in closed containers during routine operations. It does not undergo hazardous polymerization.

Chemical Incompatibilities: This material may react dangerously with strong oxidizers.

Conditions to Avoid: Avoid any exposure to sources of ignition and to strong oxidizers.

Hazardous Products of Decomposition: Carbon monoxide (CO) may be evolved during xylene fires.

SECTION 6. HEALTH HAZARD INFORMATION

Xylene is not listed as a carcinogen by the IARC, NTP, or OSHA.
Summary of Risks: Liquid xylene is a skin irritant and causes erythema, dryness, and defatting; prolonged contact may cause listering. Inhaling xylene can depress the central nervous system (CNS), and ingesting it can result in gastrointestinal disturbance; and possibly hematemesis (vomiting blood). Effects on the eyes, kidneys, liver, lungs, and the CNS are also reported. **Medical Conditions Aggravated by Long-Term Exposure:** Problems with eyes, skin, central nervous system, kidneys, and liver may be worsened by exposure to xylene. **Target Organs:** CNS, eyes, gastrointestinal tract, blood, liver, kidneys, skin. **Primary Entry:** Inhalation, skin contact/absorption. **Acute Effects:** Dizziness; excitement; drowsiness; incoordination; staggering gait; irritation of eyes, nose, and throat; corneal vacuolization; anorexia; nausea; vomiting; abdominal pain; and dermatitis. **Chronic Effects:** Reversible eye damage, headache, loss of appetite, nervousness, pale skin, and skin rash.
FIRST AID: Eyes. Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. **Skin.** Immediately wash the affected area with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have a trained person administer oxygen. **Ingestion.** Never give anything by mouth to someone who is unconscious or convulsing. Vomiting may occur spontaneously, but do not induce it. If vomiting should occur, keep exposed person's head below his or her hips to prevent aspiration (breathing the liquid xylene into the lungs). Severe hemorrhagic pneumonitis with grave, possibly fatal, pulmonary injury can occur from aspiring very small quantities of xylene.

GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid. If exposure is severe, hospitilization for at least 72 hours with careful monitoring for delayed onset of pulmonary edema is recommended.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, provide ventilation, and eliminate all sources of ignition immediately. Cleanup personnel need protection against contact with and inhalation of xylene vapor (see sect. 8). Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways.
Waste Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.
OSHA Designations
Air Contaminant (29 CFR 1910.1000 Subpart Z)
EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste, No. U239
CERCLA Hazardous Substance, Reportable Quantity: 1000 lbs (454 kg), per the Clean Water Act (CWA), section 311 (b) (9)

SECTION 8. SPECIAL PROTECTION INFORMATION

oggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield as a supplementary protective measure. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Use a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine use (leaks or cleaning reactor vessels and storage tanks), wear an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, gauntlets, etc., as required by the specifics of the work operation to prevent prolonged or repeated skin contact with xylene. **Ventilation:** Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of xylene below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of xylene into general work areas by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations.
Safety Stations: Make eyewash stations, safety/quick-drench showers, and washing facilities available in areas of use and handling.
Contaminated Equipment: Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean xylene from shoes and equipment. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material. Keep it off of your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale xylene vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store xylene in a cool, dry, well-ventilated area away from sources of ignition and strong oxidizers. Protect containers from physical damage.

Special Handling/Storage: Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. Ground and bond all containers, pipelines, etc., used in shipping, transferring, reacting, producing, and sampling operations.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Xylene	**DOT Label:** Flammable Liquid	**IMO Label:** Flammable Liquid
DOT ID No. UN1307	**DOT Hazard Class:** Flammable Liquid	**IMO Class:** 3.2 or 3.3

ferences: 1, 2, 12, 73, 84-94, 100, 103.

Prepared by PJ Igoe, BS

Industrial Hygiene Review: DJ Wilson, CIH

Medical Review: MJ Hardies, MD

Material Safety Data Sheet

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 317
TOLUENE
(Revision D)

Issued: August 1979
Revised: April 1986

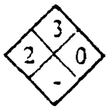
SECTION 1. MATERIAL IDENTIFICATION 20

MATERIAL NAME: TOLUENE

OTHER DESIGNATIONS: Methyl Benzene, Methyl Benzol, Phenylmethane, Toluol, C_7H_8, CAS #0108-88-3

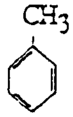
MANUFACTURER/SUPPLIER: Available from many suppliers, including:
Allied Corp., PO Box 2064R, Morristown, NJ 07960; Telephone: (201) 455-4400
Ashland Chemical Co., Industrial Chemicals & Solvents Div., PO Box 2219,
Columbus, OH; Telephone: (614) 889-3844

HMIS
H: 2
F: 3
R: 0
PPE*
*See sect. 8



R 1
I 3
S 2
K 4

SECTION 2. INGREDIENTS AND HAZARDS

SECTION 2. INGREDIENTS AND HAZARDS	%	HAZARD DATA
Toluene  * Current (1985-86) ACGIH TLV. The OSHA PEL is 200 ppm with an acceptable ceiling concentration of 300 ppm and an acceptable maximum peak of 500 ppm/10 minutes. ** Skin designation indicates that toluene can be absorbed through intact skin and contribute to overall exposure. *** Affects the mind.	ca 100	8-hr TLV: 100 ppm, or 375 mg/m^3* (Skin)** Man, Inhalation, TCLo: 100 ppm: Psychotropic*** Rat, Oral, LD_{50}: 5000 mg/kg Rat, Inhalation, LCLo: 4000 ppm/4 hrs. Rabbit, Skin, LD_{50}: 14 gm/kg Human, Eye: 300 ppm

SECTION 3. PHYSICAL DATA

Boiling Point ... 231°F (111°C)
Vapor Pressure @ 20°C, mm Hg ... 22
Water Solubility @ 20°C, wt. % ... 0.05
Vapor Density (Air = 1) ... 3.14

Evaporation Rate (BuAc = 1) ... 2.24
Specific Gravity (H_2O = 1) ... 0.866
Melting Point ... -139°F (-95°C)
Percent Volatile by Volume ... ca 100
Molecular Weight ... 92.15

Appearance and odor: Clear, colorless liquid with a characteristic aromatic odor. The odor is detectable to most individuals in the range of 10 to 15 ppm. Because olfactory fatigue occurs rapidly upon exposure to toluene, odor is not a good warning property.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
40°F (4°C) CC	896°F (480°C)	% by Volume	1.27	7.1

EXTINGUISHING MEDIA: Carbon dioxide, dry chemical, alcohol foam. Do not use a solid stream of water because the stream will scatter and spread the fire. Use water spray to cool tanks/containers that are exposed to fire and to disperse vapors.

UNUSUAL FIRE/EXPLOSION HAZARDS: This OSHA class IB flammable liquid is a dangerous fire hazard. It is a moderate fire hazard when exposed to oxidizers, heat, sparks, or open flame. Vapors are heavier than air and may travel a considerable distance to an ignition source and flash back.

SPECIAL FIRE-FIGHTING PROCEDURES: Fire fighters should wear self-contained breathing apparatus with full facepiece operated in a positive-pressure mode when fighting fires involving toluene.

SECTION 5. REACTIVITY DATA

CHEMICAL INCOMPATIBILITIES: Toluene is stable in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization. This material is incompatible with strong oxidizing agents, dinitrogen tetraoxide, silver perchlorate, tetranitromethane, and uranium hexafluoride. Contact with these materials may cause fire or explosion. Nitric acid and toluene, especially in the presence of sulfuric acid, will produce nitrated compounds that are dangerously explosive.

CONDITIONS TO AVOID: Avoid exposure to sparks, open flame, hot surfaces, and all sources of heat and ignition. Toluene will attack some forms of plastics, rubber, and coatings. Thermal decomposition or burning produces carbon dioxide and/or carbon monoxide.

SECTION 6. HEALTH HAZARD INFORMATION |TLV

oluene is not considered a carcinogen by the NTP, IARC, or OSHA. SUMMARY OF RISKS: Vapors of toluene may cause irritation of the eyes, nose, upper respiratory tract, and skin. Exposure to 200 ppm for 8 hours causes mild fatigue, weakness, confusion, lacrimation (tearing) and paresthesia (a sensation of prickling, tingling, or creeping on the skin that has no objective cause). Exposure to higher concentrations may cause headache, nausea, dizziness, dilated pupils, and euphoria, and, in severe cases, may cause unconsciousness and death. The liquid is irritating to the eyes and skin. Contact with the eyes may cause transient corneal damage, conjunctival irritation, and burns if not promptly removed. Repeated and/or prolonged contact with the skin may cause drying and cracking. It may be absorbed through the skin in toxic amounts. Ingestion causes irritation of the gastrointestinal tract and may cause effects resembling those from inhalation of the vapor. Chronic overexposure to toluene may cause reversible kidney and liver injury. FIRST AID: EYE CONTACT: Immediately flush eyes, including under eyelids, with running water for at least 15 minutes. Get medical attention if irritation persists.* SKIN CONTACT: Immediately flush skin (for at least 15 minutes) while removing contaminated shoes and clothing. Wash exposed area with soap and water. Get medical attention if irritation persists or if a large area has been exposed.* INHALATION: Remove victim to fresh air. Restore and/or support breathing as required. Keep victim warm and quiet. Get medical help.* INGESTION: Give victim 1 to 2 glasses of water or milk. Contact a poison control center. Do not induce vomiting unless directed to do so. Transport victim to a medical facility. Never give anything by mouth to a person who is unconscious or convulsing. * GET MEDICAL ASSISTANCE = In plant, paramedic, community. Get medical help for further treatment, observation, and support after first aid, if indicated.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK: Notify safety personnel of large spills or leaks. Remove all sources of heat and ignition. Provide maximum explosion-proof ventilation. Limit access to spill area to necessary personnel only. Remove leaking containers to safe place if feasible. Cleanup personnel need protection against contact with liquid and inhalation of vapor (see sect. 8).
WASTE DISPOSAL: Absorb small spills with paper towel or vermiculite. Contain large spills and collect if feasible, or absorb with vermiculite or sand. Place waste solvent or absorbent into closed containers for disposal using nonsparking tools. Liquid can be flushed with water to an open holding area for handling. Do not flush to sewer, watershed, or waterway.
COMMENTS: Place in suitable container for disposal by a licensed contractor or burn in an approved incinerator. Consider reclaiming by distillation. Contaminated absorbent can be buried in a sanitary landfill. Follow all Federal, state, and local regulations. TLm 96: 100-10 ppm. Toluene is designated as a hazardous waste by the EPA. The EPA (RCRA) HW No. is U220 (40 CFR 261). The reportable quantity (RQ) is 1000 lbs/454 kg (40 CFR 117).

ECTION 8. SPECIAL PROTECTION INFORMATION

Provide general and local exhaust ventilation to meet TLV requirements. Ventilation fans and other electrical service must be nonsparking and have an explosion-proof design. Exhaust hoods should have a face velocity of at least 100 lfm (linear feet per minute) and be designed to capture heavy vapor. For emergency or nonroutine exposures where the TLV may be exceeded, use an organic chemical cartridge respirator if concentration is less than 200 ppm and an approved canister gas mask or self-contained breathing apparatus with full facepiece if concentration is greater than 200 ppm.
Safety glasses or splash goggles should be worn in all work areas. Neoprene gloves, apron, face shield, boots, and other appropriate protective clothing and equipment should be available and worn as necessary to prevent skin and eye contact. Remove contaminated clothing immediately and do not wear it until it has been properly laundered.

Eyewash stations and safety showers should be readily available in use and handling areas.

Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

STORAGE SEGREGATION: Store in a cool, dry, well-ventilated area away from oxidizing agents, heat, sparks, or open flame. Storage areas must meet OSHA requirements for class IB flammable liquids. Use metal safety cans for handling small amounts. Protect containers from physical damage. Use only with adequate ventilation. Avoid contact with eyes, skin, or clothing. Do not inhale or ingest. Use caution when handling this compound because it can be absorbed through intact skin in toxic amounts. SPECIAL HANDLING/STORAGE: Ground and bond metal containers and equipment to prevent static sparks when making transfers. Do not smoke in use or storage areas. Use nonsparking tools. ENGINEERING CONTROLS: Preplacement and periodic medical exams emphasizing the liver, kidneys, nervous system, lungs, heart, and blood should be provided. Workers exposed to concentrations greater than the action level (50 ppm) should be examined at least once a year. Use of alcohol can aggravate the toxic effects of toluene.
COMMENTS: Emptied containers contain product residues. Handle accordingly!
Toluene is designated as a hazardous substance by the EPA (40 CFR 116). DOT Classification: Flammable liquid. UN1294.
Data Source(s) Code: 1-9, 12, 16, 20, 21, 24, 26, 34, 81, 82. CR

Approvals JO. Accrocco, 11/96.
Indust. Hygiene/Safety JW 10-86
Medical Review Oct 86

Material Safety Data Sheet

from Genium's Reference Collection

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 385

ETHYL BENZENE

(Revision A)
Issued: August 1978
Revised: November 1988

SECTION 1. MATERIAL IDENTIFICATION

27

Material Name: ETHYL BENZENE

Description (Origin/Uses): Used as a solvent and as an intermediate in the production of styrene monomer.

Other Designations: Phenylethane; Ethylbenzol; $C_2H_5C_6H_5$; CAS No. 0100-41-4

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

3
2 0
-
NFPA

HMIS	
H 2	R 1
F 3	I 3
R 0	S 2
PPG*	K 4
*See sect. 8	

SECTION 2. INGREDIENTS AND HAZARDS

SECTION 2. INGREDIENTS AND HAZARDS	%	EXPOSURE LIMITS
Ethyl Benzene, CAS No. 0100-41-4 *See NIOSH, *RTECS* (DA0700000), for additional data with references to reproductive, irritative, and mutagenic effects.	Ca 100	OSHA PELs 8-Hr TWA: 100 ppm, 435 mg/m³ 15- Min STEL: 125 ppm, 545 mg/m³ ACGIH TLVs, 1988-89 TLV-TWA: 100 ppm, 435 mg/m³ TLV-STEL: 125 ppm, 545 mg/m³ Toxicity Data* Human, Inhalation, TC_{Lo}: 100 ppm (8 Hrs) Rat, Oral, LD_{50}: 3500 mg/kg

SECTION 3. PHYSICAL DATA

Boiling Point: 277°F (136°C)
Melting Point: -139°F (-95°C)
Vapor Pressure: 7.1 Torrs at 68°F (20°C)
Vapor Density (Air = 1): 3.7
% Volatile by Volume: Ca 100

Molecular Weight: 106 Grams/Mole
Solubility in Water (%): Slight
Specific Gravity (H_2O = 1): 0.86258 at 77°F (25°C)

Appearance and Odor: A clear, colorless, flammable liquid; characteristic aromatic hydrocarbon odor.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method: 64°F (18°C) CC	Autoignition Temperature: 810°F (432.22°C)	LEL: 1% v/v	UEL: 6.7% v/v

Extinguishing Media: Use foam, dry chemical, or carbon dioxide to put out ethyl benzene fires. A water spray may be ineffective in extinguishing the fire, because it can scatter and spread the burning liquid. Use water spray to cool fire-exposed containers of ethyl benzene, to disperse ethyl benzene vapor, and to protect personnel attempting to stop an ethyl benzene leak. Unusual Fire or Explosion Hazards: This liquid can readily form explosive vapor-air mixtures, especially when heated. Ethyl benzene vapor is heavier than air and may travel a considerable distance to a low-lying source of ignition and flash back to its origin. Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Stability/Polymerization: Ethyl benzene is stable in closed containers during routine operations. Hazardous polymerization cannot occur. Chemical Incompatibilities: Hazardous chemical reactions can occur between ethyl benzene and strong oxidizing agents, acids, ammonia, and bases. Conditions to Avoid: Avoid any exposure to sources of ignition such as heat, sparks, open flame, and lighted tobacco products, etc., and to incompatible chemicals. Use caution when entering confined spaces, particularly low-lying areas where explosive concentrations of ethyl benzene vapor may be present. Provide good ventilation to such areas to prevent the concentration of this vapor. Hazardous Products of Decomposition: Thermal-oxidative degradation can include toxic gases such as carbon monoxide and/or aromatic hydrocarbon gases.

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: Ethyl benzene is not listed as a carcinogen by the NTP, IARC, or OSHA.
Summary of Risks: Ethyl benzene vapor is severely irritating to the eyes and to the mucous membranes of the respiratory system. Sustained inhalation of excessive levels can cause depression of the central nervous system (CNS) characterized by dizziness, headache, narcosis, and coma. Skin contact with liquid ethyl benzene causes irritation; dermatitis and defatting can also develop. The acute oral toxicity of ethyl benzene is low; however, ingestion of it presents a serious aspiration hazard. Aspirating even a small amount into the lungs can result in extensive edema (lungs filled with fluid) and hemorrhaging of the lung tissue. No systemic effects are expected at the levels that produce pronounced, unignorable, disagreeable skin and eye irritation. The TLVs cited in section 2 are set to prevent this intolerable irritation. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Skin, eyes, respiratory system, and CNS. **Primary Entry:** Inhalation, skin contact **Acute Effects:** Irritation of the skin, eyes, and respiratory system. Also, cardiac-rhythm disturbance due to sensitization; acute bronchitis, bronchospasm, pulmonary and laryngeal edema; euphoria; headache; giddiness; dizziness; and incoordination, as well as possible depression; confusion; and coma. **Chronic Effects:** None reported. **First Aid:** Eyes. Immediately

SECTION 6. HEALTH HAZARD INFORMATION, cont.

lush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. **Skin.** Rinse he [illegible]cted area with plenty of water, then wash it with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or upp[illegible] his or her breathing as needed. Have qualified medical personnel administer oxygen as required. **Ingestion.** Unlikely. Should his type of exposure occur, the aspiration hazard must be considered. Do not induce vomiting unless directed to do so by a physician. To revent aspiration by spontaneous vomiting, keep the victim's head low (between his or her knees). Get medical help (in plant, paramedic, community) for all exposures. Seek prompt medical assistance for further treatment, observation, and support after first aid. **Note o Physician:** Professional judgment is required as to whether or not to induce vomiting because of the possibility of aspiration. A gastric avage may be administered, followed by saline catharsis, if this procedure is appropriate to the specific incident. Monitor cardiac and ulmonary functions.

ECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

pill/Leak: Notify safety personnel, evacuate unnecessary personnel, eliminate all sources of ignition immediately, and provide adequate xplosion-proof ventilation. Cleanup personnel need protection against skin or eye contact with this liquid as well as inhalation of its vapor see sect. 8). Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Use nonsparking ools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways. **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

SHA Designations
isted as an Air Contaminant (29 CFR 1910.1000 Subpart Z).
PA Designations (40 CFR 302.4)
ERCLA Hazardous Substance, Reportable Quantity: 1000 lbs (454 kg), per the Clean Water Act (CWA), §§ 311 (b) (4) and 307 (a).

ECTION 8. SPECIAL PROTECTION INFORMATION

oggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield. Follow SHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Wear a NIOSH-approved respirator per Genium reference 88 or the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). or emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying espirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets, etc., to revent prolonged or repeated skin contact with this material. **Ventilation:** Install and operate general and local maximum, explosion-proof entilation systems powerful enough to maintain airborne levels of this material below the OSHA PEL standard cited in section 2. Local xhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. o[illegible] the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make emergency eyewash stations, afe[illegible]quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special azard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from shoes and equipment. **Comments:** Practice good personal ygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. eep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* at, drink, or smoke in any work area. Do not inhale ethyl benzene vapor.

ECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

torage/Segregation: Store ethyl benzene in closed containers in a cool, dry, well-ventilated area away from sources of ignition and trong oxidizers. Protect containers from physical damage. **Special Handling/Storage:** Outside, isolated, detached, or remote storage is ecommended for large quantities of ethyl benzene. Isolate bulk storage areas from acute fire hazards. **Engineering Controls:** Make sure ll engineering systems (production, transportation) are of maximum explosion-proof design. To prevent static sparks, electrically ground nd bond all containers, pipelines, etc., used in shipping, transferring, reacting, production, and sampling operations. **Other:** Use safety ans for transferring small amounts of ethyl benzene.

ransportation Data (49 CFR 172.101-2)

OT Shipping Name: Ethyl Benzene
OT Hazard Class: Flammable Liquid
D No. UN1175
OT Label: Flammable Liquid
OT Packaging Exceptions: 49 CFR 173.118
OT Packaging Requirements: 49 CFR 173.119

MO Shipping Name: Ethylbenzene
MO Hazard Class: 3.2
MO Label: Flammable Liquid
MDG Packaging Group: II

eferences: 1, 26, 38, 84-94, 100, 116, 117, 120, 122.

Prepared by PJ Igoe, BS
Industrial Hygiene Review: DJ Wilson, CIH
Medical Review: W Silverman, MD

APPENDIX B-3
GROUNDWATER TECHNOLOGY, INC.
VAPOR MONITORING FORM

Project Name:

Project Number:

Contaminants:

Date	Time	Ionization Detector Reading		Explosimeter Reading		Radiation Monitor Reading	Location	Purpose	Initials
		FID	PID	%LEL	$\%O_2$	mR/hr			

GROUNDWATER TECHNOLOGY

APPENDIX C-1: SITE-SPECIFIC LOCKOUT/TAGOUT PROCEDURES

APPENDIX C-1 SITE-SPECIFIC LOCKOUT/TAGOUT PROCEDURES		
Equipment	Operation	Lockout Method/Location

APPENDIX C-2: COLD WORK PERMITS

PERMITS

Safe Work Permits (COLD WORK)

ALL COLD WORK performed by contract personnel in Bloomfield Refining Company operating areas must be authorized by the appropriate Operations personnel. It is the intent of this procedure to establish a standardized authorization system for all work in operating areas that will provide the necessary communication and job preparation to ensure safe work conditions.

Authorization Procedures:

It is the responsibility of all contract personnel entering an operating area to perform work, to first obtain authorization from the appropriate Operations representative. This authorization may be written or verbal, at the discretion of the Operations representative and consistent with local procedures for "cold work" authorization. Verbal authorization may be given for work which is external in scope to the process equipment,(i.e., inspection of job sites, planning of jobs, or other visual activity that is external in scope to process equipment.

Short term vehicle entry (confined to designated roadway) may be authorized by verbal permission from the Shift Supervisor.

The Safe Work Permit will be issued in accordance with the following:

1.The Operations representative and contract supervisor will fully discuss the details of work to be performed.

2.The Operations representative will check the equipment to verify that it is properly prepared and ready for work to be performed. In this way he/she will ensure that safe working conditions exist, prior to any work commencing. The Operations representative must assure that the facilities are depressured, free of hydrocarbons and chemicals, and inactivated or "locked out", as required by plant orders.

3.The Operations representative and contract supervisor will jointly inspect the jobsite and positively identify the equipment to be worked on. The Operations representative will issue explicit verbal instructions to the contractor to warn him/her of any hazards, or special protective equipment or procedures which may be required (i.e., goggles, gloves, toxicity instructions, etc.).

4.The Operations representative shall then issue the Safe Work Permit, taking care that pertinent safe work instructions are indicated on the forms. (A copy of the Safe Work Permit form is attached).

5.The contract supervisor will then sign the Safe Work Permit, verifying that he/she has been instructed.

6.When the Safe Work Permit is signed by the contract supervisor, the yellow copy shall be posted on the bulletin board provided for that purpose in the control room. The white copy shall be retained by the contractor, and all details pertinent to the job discussed with his/her employees.

7.A Safe Work Permit is valid until completion of the contractors' shift, or 24 hours if work is on a continuous basis. Permit is void and requires reissuance if work is suspended for more than a four (4) hour period.

8.It is the contractor supervision's responsibility upon shift changes that proper information and permit form is transferred to the new shift and that permit form is signed by the oncoming contract foreman or supervisor.

9.Upon completion of the job or at the end of the work day, it is the responsibility of the contract supervisor to return the white copy of the Safe Work Permit to the responsible Operations representative, thereby verifying status of the job. The contractor at this time of each work day shall clean up construction material and debris related to his work to provide a safe area for Bloomfield Refining Company operations to perform their duties.

SAFE WORK PERMIT

DATE:

TIME:

OPER. DEPT.

LOCATION:

W.O. #

JOB DESCRIPTION:

PROTECTIVE EQUIPMENT REQD.
- ☐ GOGGLES
- ☐ FACE SHIELD
- ☐ GLOVES: RUBBER/THERMAL
- ☐ SUIT: RUBBER/THERMAL
- ☐ RUBBER BOOTS
- ☐ SAFETY BELT & LINE
- ☐ EAR PROTECTION
- ☐ RESPIRATOR

PRODUCT OR CHEMICAL

CHEMICAL NAME ______________________

MSDS # ______________________

HAZARDS ______________________

☐ FIRE ☐ HEALTH ☐ REACTIVITY

PUMPS OR COMPRESSORS, ETC:

DRIVE END:
- ☐ SWITCH TAGGED
- ☐ ELECTRICAL BREAKER LOCKED OUT
- ☐ STEAM BLOCKED, TAGGED, DEPRESSURED

PROCESS END
- ☐ BLOCKED, TAGGED, DEPRESSURED
- ☐ BLINDED
- ☐ PURGED/WASHED
- ☐ BLINDING REQUIRED

PIPING, VESSELS, ETC:
- ☐ BLOCKED, TAGGED, DEPRESSURED
- ☐ BLINDED
- ☐ PURGED — WASHED
- ☐ STEAMED
- ☐ CATHODIC PROTECTION BONDING REQUIRED

☐ MOTORIZED EQUIPMENT

TYPE: ______________________

AIR IN AREA TESTED OK:

OPERATOR ______________________

SHIFT SUP: ______________________

ADDITIONAL PRECAUTIONS NOT ON CHECK LIST	OPERATOR (OR SHIFT SUPERVISOR)
	WORKMAN
	WORKMAN ☑ JOB COMPLETED ☑ CLEAN UP COMPLETED
	OPERATOR (OR SHIFT SUPERVISOR) ☐ JOB COMPLETED ☐ CLEAN UP COMPLETED

FORM NO. A81-309A

GROUNDWATER
TECHNOLOGY

APPENDIX C-3: HOT WORK PERMITS

FIRE & SAFETY PERMITS (HOT WORK)

General:

All Hot Work performed by contractor personnel in Bloomfield Refining Company operating areas must be authorized by the appropriate Operations person. It is the intent of this procedure to establish a standardized authorization system for all work in the refinery that will provide the necessary communication and job preparation to ensure safe working conditions. All work of high risk levels, such as spark-producing, arc or flame, personnel entry into enclosed spaces or special hazard, will be authorized by procedures outlined in this order.

HIGH RISK LEVEL WORK IN OPERATING AREAS SHOULD BE AVOIDED WHERE PRACTICABLE BY RELOCATING THE WORK TO UNRESTRICTED AREAS.

This work order recognizes that certain identifiable risk levels of work exist and that authorization procedures should increase appropriately with risk. High risk work, involving flame or arc or personnel entry into equipment, requires authorization with a Fire and Safety Permit issued by an Operations Supervisor with a mandatory separate audit and approval by a Safety Department representative. Lower risk work, involving spark-producing procedures or equipment, requires authorization with a Fire and Safety Permit issued by an Operation Supervisor, without a mandatory separate audit by a Safety Department representative.

Typical Jobs Requiring a Fire and Safety Permit:

A. Supervisor/Safety Supervisor Permit

The following types of jobs will be authorized by a Fire and Safety Permit, issued by an Operations Supervisor with a mandatory, separate audit and approval by a Safety Department representative.

1. Flame - gas welding, gas torches, melting pot, electric welding or any other flame.
2. Personnel entry into equipment - to enter a vessel, furnace, tank, sump, or any enclosed space.
3. Sandblasting on atmospheric storage tanks.

B. Supervisor Permit

The following types of jobs will be authorized by a Fire and Safety Permit, issued by an Operations Supervisor.

1. Sandblasting (except atmospheric storage tanks, see Item 3 above).

2. Spark-producing jobs, such as grinding, chipping, concrete breaking, and electric drilling on nonprocess equipment.

3. Spark-producing electrical equipment, such as portable electric motors, open electric switches, ordinary electric plug-in connections, soldering irons, electric heating devices, and camera flash equipment.

4. Additionally, all x-ray work shall be authorized by a Fire and Safety Permit issued by the appropriate Operations Supervisor.

Special Application of The Fire and Safety Permit:

Certain jobs may be encountered that pose special risks or that require considerable communication and planning to ensure safe work conditions. The Fire and Safety Permit may be used to authorize such work.

Examples are:

1. Opening of flare systems - in accordance with specific plant or departmental order for opening flare system.

2. Interdepartmental pipelines.

3. When particularly hazardous materials or conditions are to be encountered, requiring the additional precautions obtained by the use of the Fire and Safety Permit. Such situations will be at the discretion of appropriate Plant management.

Such special application of the Fire and Safety Permit shall be issued by the appropriate Operations Supervisor and does not require an audit by the Safety Department representative.

WORK IN NONOPERATING AREAS:

Fire and Safety Permits are required in nonoperating areas for the type of work described in the Section entitled, "Supervisor/Safety Supervisor Permit". The Safety Department representative shall issue these permits.

For personnel entry into enclosed spaces, these are no exceptions to the need for a Fire and Safety Permit.

Responsibilities:

Fundamental responsibility for Safety within an operating area lies with operating departments. Operating personnel are most knowledgeable about the operating area and equipment with regard to hazards and how to neutralize the hazards.

Accordingly, it is the responsibility of the operating department to prepare the Fire and Safety Permit for all jobs that must be performed in an operating area.

The Safety Department representative is responsible for performing an independent audit of work in operating areas. Further, the Safety Department representative will issue Fire and Safety Permits in nonoperating areas.

Contract personnel are responsible for being aware of the conditions under which the permit is issued and for working within these conditions throughout the job.

PROCEDURES:

Step 1 - Setting Conditions

The Operations Supervisor (Operations Manager, Operations Day Supervisor, or Shift Supervisor) will decide what conditions must be met to achieve safe work conditions and will set down these conditions in writing on the Fire and Safety Permit form. The Operations Supervisor is encouraged to consult the Safety Department Representative, however, the primary responsibility for setting the condition lies with the Operations Supervisor.

Step 2 - Achieving Conditions

The Operations and Contract Supervisors will be responsible for achieving the conditions specified in Step 1 (see Preparatory Work).

Step 3 - Auditing Conditions

When the specified conditions have been met, the Operations Supervisor shall audit the job to ensure that all the specified conditions have been achieved, and that no additional safety precautions are necessary.

For jobs of risk level outlined in the section entitled "Supervisor Permit", the Operations Supervisor is then ready to issue the Fire and Safety Permit.

For jobs of risk level outlined in the section entitled, "Supervisor/Safety Supervisor Permit", the Safety Department representative shall then perform an independent audit to ensure that all necessary safety precautions have been taken. The Safety Department representative can, at this time, add whatever additional conditions are required to ensure job safety.

Step 4 - Notifying Adjacent Areas

It will be the joint responsibility of the Operations Supervisor and Safety Department representative to inform other parties of the pending work (such as adjacent, but separate, operating areas).

Step 5 - Issuing the Permit

a. The Operations Supervisor will sign the permit, indicating that the conditions for safe work have been set, achieved, and audited, and that Operations is ready for the work to begin. The Operator responsible for the are will sign the permit to indicate that he/she is aware of the job and the specified safe work conditions and intends to comply with the conditions of the permit. The Shift Supervisor responsible for the operating area shall always sign the permit.

b. The Safety Department representative will then sign the permit (for jobs outlined in the section entitled, "Supervisor/Safety Supervisor Permit") indicating that an independent audit has been performed of the entire job preparation and that work can proceed.

c. The Contract Supervisor responsible for the job will sign the permit indicating that he/she understands the conditions of the permit and has instructed the craftsman regarding the job and the conditions to be maintained.

d. The Fire and Safety Permit is in effect when above steps have been completed. The job can be started after the Operations Supervisor has distributed the appropriate copies of the permit as follows:

White Copy - remain at jobsite; issued to contract supervisor

Yellow Copy - post in Control Room

Blue Copy - retained by Safety Department

Step 6 - Maintaining Conditions of Permit

A permit is valid as long as the permit conditions are maintained and the work is not suspended for more than a four hour period.

Permits on continuous or around-the-clock jobs shall be renewed on the next daylight shift between the hours of 8:30 a.m. and 10:00 a.m.

OPEN OR "GREEN BELT" AREA PERMITS

Contractor with work and staging sites in open or "green belt" areas may be issued a job duration Fire and Safety Permit. The permit will authorize work only within assigned areas and the contractor will be required to install necessary signs indicating area limits. Job duration permits will be canceled, and permits issued on a daily basis near job end when work is still in progress and hydrocarbons have been brought into equipment piping.

FIRE AND SAFETY PERMIT

(FOR PROCEDURAL DETAILS REFER TO SAFETY ORDER S-8)

OPERATING DEPARTMENT ____________________ DATE ISSUED ____________

LOCATION ____________________

JOB DESCRIPTION: ☐ HOT WORK ☐ ENTRY

CHECKED PRECAUTIONS TO BE OBSERVED:

☐ AIR IN AREA AND EQUIPMENT TESTED OK BY: ____________

ELECTRIC EQUIPMENT:

☐ DISCONNECT AND TAG

☐ LOCKED OUT

LINES:

☐ BLINDED

☐ DISCONNECTED

☐ VALVES CLOSED & TAGGED

☐ BLEEDERS OPEN

☐ ELECTRIC TOOLS GROUNDED

☐ AIR MOVER OPERATING

☐ HOLE WATCH

☐ FIRE WATCH

☐ STOP WORK, SHUT DOWN MOTORS IF LEAK OCCURS

☐ SHUT DOWN MOTORS TO REFUEL

☐ ALERT TO OVERHEAD WORK

☐ DRAINS SEALED

☐ SEWERS PLUGGED

☐ FIRE EXTINGUISHER AT SITE

☐ PRESSURED FIRE HOSE AT SITE

☐ CONTAIN SPARKS

☐ GROUND WELDING MACHINE TO PIECE BEING WELDED AT PROPER LOCATION

☐ KEEP ACETYLENE/OXYGEN CYLINDERS OUTSIDE VESSELS: WHEN WORK IS STOPPED REMOVE TORCH AND LINES OUTSIDE

☐ HOT TAP FORM COMPLETE

☐ POSITIVE PRESSURE & FLOW IN LINE

☐ TANK STATIC: HOT WORK 12 IN. OR MORE BELOW LEVEL

☐ NO SAMPLING, VENTING, DRAINING

PROTECTIVE EQUIPMENT REQUIRED

☐ GOGGLES/FACESHIELD

☐ GLOVES-CHEMICAL/THERMAL

☐ HOOD-CHEMICAL/THERMAL

☐ SUIT-CHEMICAL/THERMAL

☐ BOOTS

☐ HEARING PROTECTION

☐ SAFETY BELT AND LINE

☐ RESPIRATOR-SPECIFY

☐ WEAR FRESH AIR MASK

☐ STANDBY WITH FRESH AIR MASK

☐ WEAR PROTECTIVE EQUIPMENT FOR HOT ELECTRICAL WORK

☐ ____________

☐ ____________

ADDITIONAL PRECAUTIONS NOT LISTED ABOVE: ____________

APPROVALS TO BEGIN WORK:

OPER. SUPERVISOR/TIME: ____________

SAFETY SUPERVISOR/TIME: ____________
(Write in NR if not required)

MAINT. SUPERVISOR/TIME: ____________

PERMIT POSTING PROCEDURES

White Copy —	Given to Workman for Hot Work Permits or posted at jobsite for Entry Permits
Yellow Copy—	Posted in Control Room
Blue Copy —	To Safety

PERMIT REQUIREMENTS ACKNOWLEDGED:

OPERATOR	WORKMAN

JOB CLOSE-OUT (Entry Permits)

		DATE	TIME
MAINT. SUPERVISOR			

SIGN-IN (Entry Permits)

COMPANY/DEPT.	WORKMAN OR REPRESENTATIVE

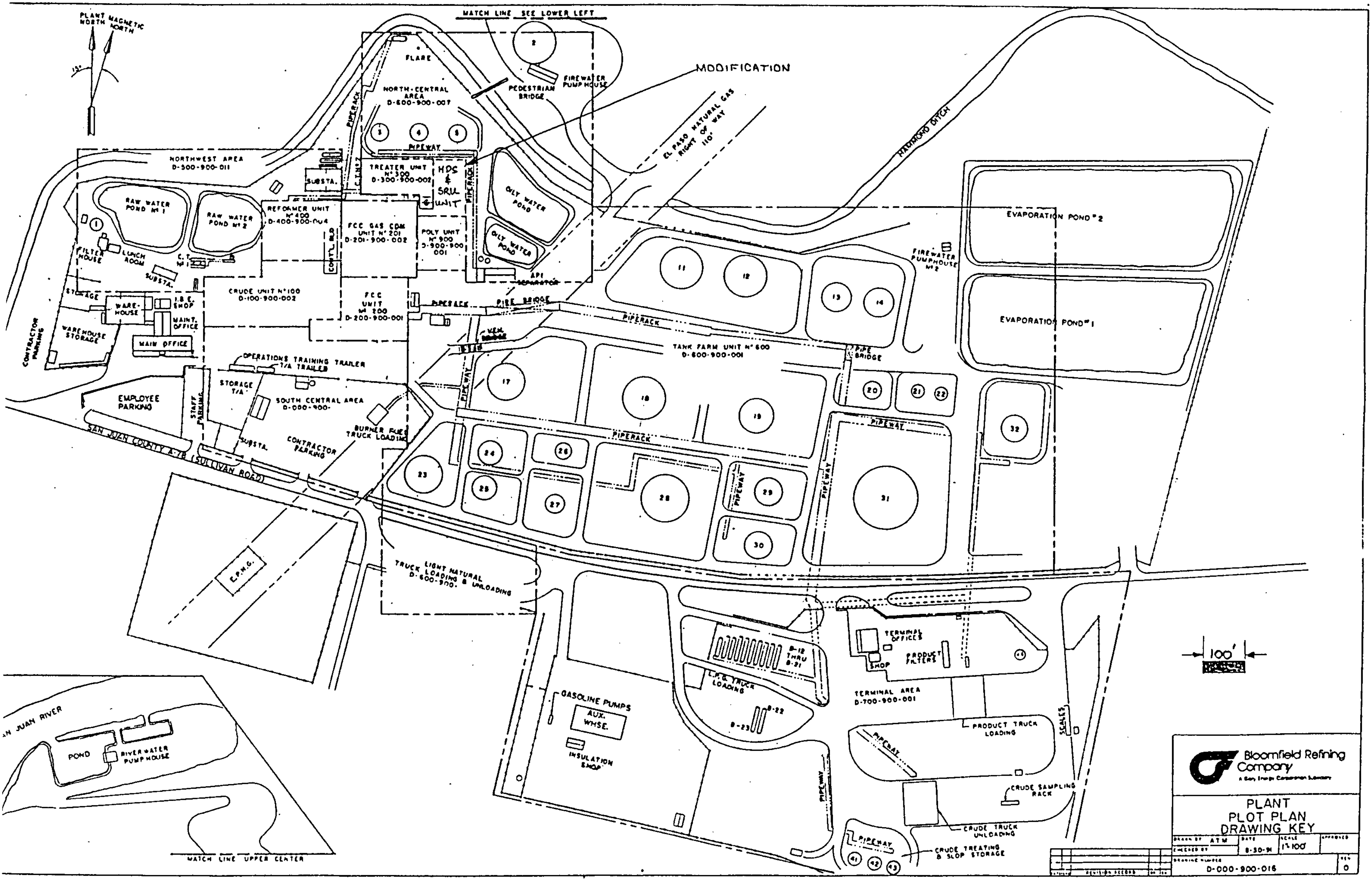
SIGN-OFF (Entry Permits)

COMPANY/DEPT.	WORKMAN OR REP.	DATE	TIME

PERMIT VOID IF CONDITIONS CHANGE

FORM NO. U81-31

APPENDIX D-1: SITE MAP - BLOOMFIELD REFINING COMPANY



Bloomfield Refining Company
A Gary Energy Corporation Subsidiary

PLANT
PLOT PLAN
DRAWING KEY

DRAWN BY ATM
CHECKED BY
DATE 8-30-91
SCALE 1"=100'
APPROVED
DRAWING NUMBER D-000-900-016
REV 0

APPENDIX E: BLOOMFIELD REFINING COMPANY CONTRACTOR SAFETY REGULATIONS

BLOOMFIELD REFINING COMPANY

Bloomfield, New Mexico

CONTRACTOR
SAFETY REGULATIONS
& PROCEDURES MANUAL

FORWARD

Periodically, it becomes necessary to employ the services of a contractor to repair, rebuild, or install equipment. It is Bloomfield Refining Company's desire that contractors, subcontractors, and their employees work in a safe efficient manner so as to compliment our own employees efforts to prevent accidents and control losses.

To insure the achievement of this objective, Bloomfield Refining Company has developed specific safety regulations and procedures with respect to the conduct of independent contractors, subcontractors and their employees. Acceptance of these regulations and procedures, and the agreement to honor them, is a requirement Bloomfield Refining Company asks of all contractors.

The purpose of this booklet is to acquaint contractors with the fire, safety and security regulations which must be followed while working in this refinery.

It should be understood that no set of written regulations and procedures regardless of completeness, can provide for all situations, contingencies, or emergencies which may arise; therefore, each contract supervisor is responsible for employing all practical, safe methods in the performance of the work they direct. By following the safety practices in this book along with the safe procedures of your craft, you can help in making this refinery a safe place in which to work.

TABLE OF CONTENTS

Page Number

Contractor Safety Program..............................5

Assistance Phone Numbers...............................7

Contractor Accidents...................................8
    Sample Investigation Report........................9

General Safety Procedures.............................10
    Entrance Regulations..............................10
    Housekeeping......................................11
    Hazardous Chemicals...............................12
    Safety Equipment..................................12
    Vehicle Traffic Rules.............................13
    Fire Reporting & Emergency Procedures.............13
    Fire Prevention...................................14
    Switches and Valves...............................15
    Goggle Areas......................................15
    Tools...15
    Control Room......................................15
    Smoking...15
    Excavations.......................................15
    Scaffolding 15
    Lockout/Tagout 16
    Opening Lines and Equipment.......................16
    Mechanical Guards 16
    Violations..16

Permits...17

    Safe Work Permits (Cold Work).....................17
    Safe Work Permit Form 19
    Fire & Safety Permits (Hot Work)..................20
    Fire & Safety Permits (Entry) 25
    Hole Watch Instructions 29
    Fire & Safety Permit Form 30

Contractor Preparatory work...........................31

    Tie-ins and Blinding..............................32

CONTRACTOR SAFETY PROGRAM

Contractors and their subcontractors working in the refinery shall comply with all applicable federal, state, and local safety regulations and those established by their own organization in the performance of their work. They also shall comply with all safety regulations listed in the Refinery Safety Orders (available for inspection) and Contractor Safety Regulations and Procedures Manual when working on Bloomfield Refining Company (BRC) properties.

As part of the bid process and/or before any work is awarded or begun any prospective contractor must furnish to BRC, when requested, the following information:

1. a completed "Bid Package Request for Safety Information".
2. proof of Insurance in the amounts of $1,000,000 general liability; $1,000,000 auto liability, $100,000 employers liability, and current statutory limits on workers compensation.
3. a signed and dated cover sheet from this "Contractors Safety Regulations and Procedures" manual.
4. Documentation that contractor's employees have received training in the contents of this manual; the known potential fire, explosion, or toxic release hazards associated with their jobs; and the applicable provisions of the BRC emergency action plan.

[illegible] meet with a member of the BRC safety department for an orientation session. Information to be discussed during this orientation will be the contents of this manual, known hazards, applicable refinery Safety Orders, the Emergency Plan, and any questions the contractor may have.

Contractors shall be responsible for safety and shall designate one individual in their field organization as Safety Coordinator.

Bloomfield Refining Company may, at its option, inspect work sites to ascertain the contractor safety practices are in accordance with applicable laws, ordinance and regulations. In event that such inspection reveals that conditions or procedures are not in compliance, Bloomfield Refining Company's Safety Representative will notify the contractor's Safety Coordinator verbally and/or in writing. Bloomfield Refining Company's inspection will not constitute an acceptance of the contractor's practices nor relieve the contractor of responsibility for safety and compliance.

Contractors must maintain well-equipped first-aid kits and/or first-aid rooms with qualified first-aid personnel available.

Contractors shall make and confirm arrangements for use of area doctors, ambulance, and hospital service. Arrangements shall be made on or before moving to the job site and contractors shall furnish Bloomfield Refining Company's Project Engineer and Safety Representative with the name, address, and phone number of the following personnel or services on contractor's letterhead stationery.

1. Doctor
2. Ambulance
3. Hospital
4. Insurance Carrier
5. Safety Coordinator and authorized alternate

The Contractor Assistance - Telephone Numbers form on page 7 will be completed and posted in the contractor's on-site office. Additional posting copies can be obtained from the Safety Department.

CONTRACTOR ASSISTANCE - TELEPHONE NUMBERS

EMERGENCY NUMBERS

Ambulance.................................... 911

Doctor__________________________ Phone No...........__________

Hospital________________________ Phone No...........__________

____
Address

Refinery Fire Brigade .... extension 147
Give name, location, type & extent of fire

Main Offices:

Bloomfield Refining Company - Refinery 632-8013

Bloomfield Refining Company - Terminals 632-8052

Bloomfield Refining Company - Transportation.......632-3377

Project Engineer______________________.............__________

Safety Department____________________ ....extension 160
extension 161

CONTRACTOR ACCIDENTS

In case of an accident requiring the use of an ambulance service, contractor's Safety Coordinator or authorized alternate shall be responsible for placing the order for the ambulance and all requests shall be in the name of the contract company. Instructions shall state that the patient is to picked up at Bloomfield Refining Company and the entry shall be through the Refinery's main gate. The Coordinator will then notify the Safety Department and project Engineer that an accident has occurred and give the following information:

1. Name and Title of the caller
2. Name of Contractor
3. Name of Ambulance service
4. Name of doctor or medical examiner, if called
5. Job site location of patient

The Contractors Safety Coordinator or authorized alternate shall then report immediately to the Main Gate to escort doctor and/or ambulance to location of patient.

All accidents involving contractor personnel are to be reported as soon as possible to the Bloomfield Refining Company Safety Department and Project Engineer. The accident should be thoroughly investigated and an accident report completed as soon as possible. A copy must be delivered to the Safety Department. The accident report forms are available from the Safety Department. All parts if the report must be completed giving special emphasis in obtaining information concerning personal injuries and damages to company property.

All accidents and/or incidents causing product release, equipment damage or personal injury will be investigated by Bloomfield Refining Company representatives in addition to any contractor investigation completed.

CONTRACTOR ACCIDENT INVESTIGATION REPORT

COMPANY			
EXACT LOCATION	DATE OF OCCURRENCE	TIME	DATE REPORTED

PERSONAL INJURY OR ILLNESS		**PROPERTY DAMAGE**	
NAME		PROPERTY DAMAGED	
OCCUPATION	PART OF BODY AFFECTED	ESTIMATED COST $	ACTUAL COST $
NATURE OF INJURY OR ILLNESS		NATURE OF DAMAGE	
OBJECT/EQUIPMENT/SUBSTANCE/INFLICTING INJURY OR ILLNESS		OBJECT/EQUIPMENT/SUBSTANCE/INFLICTING DAMAGE	
PERSON WITH MOST CONTROL OF OBJECT/EQUIPMENT /SUBSTANCE		PERSON WITH MOST CONTROL OF OBJECT/EQUIPMENT /SUBSTANCE	

DESCRIBE CLEARLY HOW THE ACCIDENT OCCURRED: ATTACH ACCIDENT DIAGRAM FOR ALL MOTOR VEHICLE ACCIDENTS.

WHAT ACTS, FAILURES TO ACT AND/OR CONDITIONS CONTRIBUTED MOST DIRECTLY TO THIS ACCIDENT?

WHAT ARE THE BASIC OR FUNDAMENTAL REASONS FOR THE EXISTENCE OF THESE AND/OR CONDITIONS?

LOSS SEVERITY POTENTIAL: [ ] Major [ ] Serious [ ] Minor

PROBABLE RECURRENCE RATE: [ ] Frequent [ ] Occasional [ ] Rare

WHAT ACTION HAS OR WILL BE TAKEN TO PREVENT RECURRENCE? PLACE X BY ITEMS COMPLETED.

INVESTIGATED BY	DATE	REVIEWED BY	DATE

Form# S81-271

GENERAL SAFETY PROCEDURES

General:

Bloomfield Refining Company requires all contractors to comply with all applicable OSHA regulations and all plant safety requirements and to fully cooperate with Bloomfield Refining Company employees. It is the responsibility of the contractor to maintain adequate protection for employees and company property from any damage or loss in connection with the performance of a project.

The following rules and regulations are by no means all-inclusive in the safe performance of the project. They highlight major areas of concern covered by Bloomfield Refining Company's general safety rules.

All contract employees must be trained in the proper safety procedures and hazards of their craft.

All work performed on BRC property requires authorization by the proper responsible operations employee. (See Permit Section later in this manual).

Entrance Regulations:

Contractor employees shall follow a designated direct route to their job site from the contractor parking lot. Entering other areas of the plant without approval is not permitted. New employees shall be picked up at main gate by contractor's representative and escorted to the project site until said employee is familiar with route.

A terminated contractor employee shall be escorted to the gate by an authorized representative of the contractor. It is the responsibility of the contractor to relieve the terminated employee of all contractor's or BRC property.

Inattention while at work may endanger equipment and/or other employees as well as yourself. The following indicate inattention and are not permitted in the refinery.

Intoxicating beverages, narcotics or person appearing to be under the influence of either;

Firearms of any type;

Smoking in any location other than designated smoking areas;

Personal radios or television sets;

Horseplay, gambling, or fighting;

Cameras are not allowed within the refinery limits without permission from the Refinery Manager;

Magazines, newspapers, books, etc. will be restricted to contractor's field office and/or cars and trucks;

Disregard for instruction or of posted instructional signs.

Housekeeping:

It is the company's belief that good housekeeping breeds good morale, good workmanship, and reduction of employee injuries, therefore, it is the contractor's responsibility to maintain a clean, organized work area.

1. Personnel should not leave equipment of any kind on the ground in walking areas, even for a short period, since this causes a serious tripping hazard.

2. There should be no running in buildings or on refinery grounds at any time because of slipping, tripping, and collision hazards.

3. All walking areas should be kept clear of all obstructions, including extension cords, cables, hoses and leads. Boards with protruding nails holes should receive special attention and correction.

4. Areas around equipment should be kept clear of all obstructions, and in non-slippery condition. All spilled oil or grease should be cleaned up immediately.

5. All tools should be kept in their proper place when not in use.

6. Care should be taken to ensure that access to fire equipment and electrical equipment is not blocked at any time.

7. No loose materials or objects should be allowed to accumulate in the work areas.

8. All pits and other openings shall be barricaded and proper warning signs erected. These signs and warning devices shall stay in place as long as the possibility of personal injury caused from falling into openings is possible.

9. Nails must be removed or bent under from all scrap lumber.

10. Broken glass should be cleaned up immediately.

Hazardous Chemicals:

All chemicals defined as hazardous by the "Hazardous Communication Standard" (OSHA 29 CFR 1910.1200), commonly called right-to-know law, require a Material Safety Data Sheet (MSDS) which must be available for all hazardous chemicals. Bloomfield Refining Company requires that all contractors furnish the identity and MSDS of all hazardous chemicals to the Company before they are brought on site by the contractor.

Hazardous material that contract employees could potentially be exposed will be identified and an MSDS will be furnished by BRC at the orientation meeting before any work is begun. Contractors are required to see that this information is communicated with their employees and sufficient training given to assure employees are familiar with the materials hazards, protection required, and proper emergency action.

Safety Equipment:

Bloomfield Refining Company realizes that the wearing of personal protective equipment will not prevent an accident from occurring. It will, however, minimize the results of the accident by preventing or lessening the personal injury which may result. Bloomfield Refining Company safety regulations require that proper personal protective equipment be worn for any operation that could cause injury to employees. Approved hard hats, safety glasses, and footwear designed to protect the employee against the hazards to which he/she is exposed are required while employees are on company property. The Safety Department has specifications for personal protective equipment used by its employees. If the contractor does not have the proper safety equipment needed for use on the job, Bloomfield Refining Company's Safety Department should be consulted for advice on selecting proper equipment. Under normal conditions, Bloomfield Refining Company's safety equipment and facilities are not available for use by contractor.

All personnel whose job duties require use of a respiratory protective equipment will be clean shaven.

Because of special hazards that exist in the refining business contact lenses will not be worn in the refinery.

Long pants, shirts that cover the shoulders, socks and substantial quality footwear are the minimum required personal attire.

For further information on personal protective equipment review Refinery Safety Orders S-3, 5, 10, and 15. These safety orders are available at the refinery office.

Vehicle Traffic Rules:

Speed limit within process area - 5 mph.

Speed limit on all other plant property - 15 mph.

Use of vehicles in process areas will be restricted as much as possible, and once a vehicle has delivered material or otherwise served its purpose, it shall be removed.

Before any vehicle enters into a process area, the driver should first check with Operations Shift Supervisor and receive special permission.

Vehicles shall be parked and operated in such a manner as not to block roadways. Vehicles parked in area other than designated parking areas shall have the keys left in the ignition.

Do not drive over unprotected hoses, or beyond roadblocks or barricades.

Trailer mounted vehicles, when parked, must be secured by chocks to prevent accidental movement.

No vehicle shall be driven across pipe racks or any other equipment.

Vehicles must not be parked in a manner that would obstruct fire equipment.

Riding on vehicles is restricted to inside the cab or seated on the bed. Hands, feet, and legs must not extend over the sides or ends of the vehicles.

Riding on running boards or jumping off vehicles are prohibited.

Fire Reporting and Emergency Procedures:

All fires shall be reported to the Operation's Control Room. This includes small fires that are extinguished immediately by contractor personnel.

In the event the refinery emergency alarm is sounded, all work activities shall cease immediately and all contract personnel shall report to their designated entrance gate and remain there until clearance is given to return to work. (The Refinery emergency alarm is sounded every day at 12:00 noon, for testing purposes). All permits will have to be reissued before resuming work after an emergency.

Fire hoses and extinguishers are located throughout the plant and are for emergency fire use only. Any unauthorized use of this equipment, for any reason except for its designated purpose, is prohibited.

(See Refinery Safety Order S-1 for additional information)

Fire Prevention:

Good housekeeping shall be maintained in the working areas to minimize possible fire/safety hazards.

Fire fighting equipment, such as hoses, fire extinguishers, fire hydrants, etc., located throughout the plant, shall not be used for any other purposes.

Containers for motor fuels used for internal combustion engines must be stored in a designated area with proper venting for heat expansion from the sun. Hot work shall not be performed near this storage area without a written permit.

All flammable liquids, oils, paints, varnishes, cleaners, etc. must be stored in approved locations. These locations shall be such that if a fire should occur, its spread would be limited.

No equipment, such as gasoline driven welding machines, trucks, tractors, or air compressors shall be fueled while the motor is running.

In order to eliminate the hazard from compressed gas cylinders they must be handled with care to prevent dropping or banging them together. When in use, the cylinders shall be secured in an upright position. Acetylene cylinders must never be placed in a horizontal position. Never allow oil or grease to come in contact with oxygen under pressure. Any compressed gas cylinder not in use shall be secured and valve cap properly attached.

All portable heaters, commonly used for heating or drying must be carefully located so as not to set fire to combustible framework or structures. The use of such equipment must be approved by the Operations' Shift Supervisor and a permit issued. Wood heaters are prohibited.

Lifting material over working lines or equipment shall be avoided where possible. Work of this nature will require special permission from the department involved.

All equipment used in performing any job shall be in such mechanical condition as not to constitute a fire hazard, particularly when operated in areas where flammable substances may be present. Internal combustion engines shall be equipped with mufflers. Equipment producing or causing arcs or open flames shall be operated only when the proper permit is issued and in areas designated by the permit.

Switches and Valves:

Electrical switches and process valves shall not be operated. BRC operators are the only employees authorized to operate any process valve or electrical switch.

Goggle Areas:

Several areas within Refinery limits have been designated "Goggle Area". The Treator unit and both cooling tower acid locations require goggles at all times. All "Goggle Areas" will be marked with appropriate signs. All persons entering these areas must have goggles, worn properly, on at all times.

Tools:

Only proper tools in good condition shall be used. Tools and equipment will not be thrown from above ground work.

Open air hoses shall not be directed at other persons or be used to blow chips or dust from clothing.

Control Room:

Contract craftsmen will not walk through or congregate in the Control Room unless their duties require them to do so. Contract foremen or supervisors are responsible for obtaining proper permits for their respective work crews.

Smoking:

Smoking on Bloomfield Refining Company property is permitted only in specially designed areas. Contractors should make themselves and their employees aware of smoking areas before the project begins.

Excavations:

All excavation work will be conducted in accordance with OSHA regulations 29 CFR 1926.560 thru .652 and Bloomfield Refining Company's Safety Order S-6. A designated "Competent Person" will be responsible for the excavation work in progress. All excavations, trenches, or ditches 5 feet deep or greater will require shoring and/or sloping as well as an Entry Permit.

Scaffolding:

All scaffolding will be erected in accordance with OSHA regulations 29 CFR 1910.28 and 29 CFR 1926.451. All scaffolding will be inspected before use by an individual who has received the proper training on scaffolding inspection and has been duly certified.

Lock-out/Tag-out:

A lock-out/tag-out is required when servicing and maintaining machinery and equipment in which the unexpected energization or start up of the machine or equipment, or release of stored energy could cause injury to employees. Lockout of machinery and equipment will be performed in accordance with Refinery Safety Order S-4 and OSHA standard 29 CFR 1910.147. The contractor foreman or leadman will perform the lockout/tagout of equipment for his/her workgroup. BRC will furnish all tags and locks to be used by the contractor. The BRC supervisor in charge of the contractor will supervise and verify proper procedures are followed by the contractor.

Opening Lines and/or Equipment:

Before removing any nuts, studs or bolts, or opening lines or equipment, all valves to the line or piece of equipment must be closed and bleeders opened to relieve pressure or liquid from the system. Even after the above procedure, lines and equipment are to be opened with extreme caution. Cold service equipment may freeze off and still retain pressure. Cold service equipment should be steamed to prevent this from happening.

Mechanical Guards:

Mechanical guards have been provided to protect the workers from personal injury that might arise from moving machinery, broken gauge glasses, burns from hot materials, falls from elevated positions and other causes. These guards are not to be removed except as authorized and shall be replaced immediately upon completion of repairs.

Violations:

Any contractor employee who is observed in violation of Bloomfield Refining Company's safety rules and regulations or in the willful performance of an unsafe act on company property, will have - minimum - a letter of reprimand filed with his superintendent in charge of the project.

The filing of a second letter against the same individual will constitute grounds for that person being barred from further work on Bloomfield Refining Company's property. The contractor is responsible for ensuring that contractor employees and subcontractors are fully aware of Bloomfield Refining Company's Safety rules and regulations and the disciplinary procedure outlined.

IF YOU DON'T KNOW...........ASK!

PERMITS

Safe Work Permits (COLD WORK)

All COLD WORK performed by contract personnel in Bloomfield Refining Company operating areas must be authorized by the appropriate Operations personnel. It is the intent of this procedure to establish a standardized authorization system for all work in operating areas that will provide the necessary communication and job preparation to ensure safe work conditions.

Authorization Procedures:

It is the responsibility of all contract personnel entering an operating area to perform work, to first obtain authorization from the appropriate Operations representative. This authorization may be written or verbal, at the discretion of the Operations representative and consistent with local procedures for "cold work" authorization. Verbal authorization may be given for work which is external in scope to the process equipment, (i.e., inspection of job sites, planning of jobs, or other visual activity that is external in scope to process equipment).

Short term vehicle entry (confined to designated roadway) may be authorized by verbal permission from the Shift Supervisor.

The Safe Work Permit will be issued in accordance with the following:

1. The Operations representative and contract supervisor will fully discuss the details of work to be performed.

2. The Operations representative will check the equipment to verify that it is properly prepared and ready for work to be performed. In this way he/she will ensure that safe working conditions exist, prior to any work commencing. The Operations representative must assure that the facilities are depressured, free of hydrocarbons and chemicals, and inactivated or "locked out", as required by plant orders.

3. The Operations representative and contract supervisor will jointly inspect the jobsite and positively identify the equipment to be worked on. The Operations representative will issue explicit verbal instructions to the contractor to warn him/her of any hazards, or special protective equipment or procedures which may be required (i.e., goggles, gloves, toxicity instructions, etc.).

4. The Operations representative shall then issue the Safe Work Permit, taking care that pertinent safe work instructions are indicated on the form. (A copy of the Safe

Work Permit form is attached).

5. The contract supervisor will then sign the Safe Work Permit, verifying that he/she has been instructed.

6. When the Safe Work Permit is signed by the contract supervisor, the yellow copy shall be posted on the bulletin board provided for that purpose in the control room. The white copy shall be retained by the contractor, and all details pertinent to the job discussed with his/her employees.

7. A Safe Work Permit is valid until completion of the contractors' shift, or 24 hours if work is on a continuous basis. Permit is void and requires reissuance if work is suspended for more than a four (4) hour period.

8. It is the contractor supervision's responsibility upon shift changes that proper information and permit form is transferred to the new shift and that permit form is signed by the oncoming contract foreman or supervisor.

9. Upon completion of the job or at the end of the work day, it is the responsibility of the contract supervisor to return the white copy of the Safe Work Permit to the responsible Operations representative, thereby verifying status of the job. The contractor at this time of each work day shall clean up construction material and debris related to his work to provide a safe area for Bloomfield Refining Company operations to perform their duties.

SAFE WORK PERMIT

DATE:

TIME:

OPER. DEPT.

LOCATION:

W.O. #

JOB DESCRIPTION:

PROTECTIVE EQUIPMENT REQD:

- ☐ GOGGLES:
- ☐ FACE SHIELD
- ☐ GLOVES: RUBBER/THERMAL
- ☐ SUIT: RUBBER/THERMAL
- ☐ RUBBER BOOTS
- ☐ SAFETY BELT & LINE
- ☐ EAR PROTECTION
- ☐ RESPIRATOR

PRODUCT OR CHEMICAL.

CHEMICAL NAME ________________

MSDS # ________________

HAZARDS ________________

☐ FIRE ☐ HEALTH ☐ REACTIVITY

PUMPS OR COMPRESSORS, ETC:

DRIVE END:

- ☐ SWITCH TAGGED
- ☐ ELECTRICAL BREAKER LOCKED OUT
- ☐ STEAM BLOCKED, TAGGED, DEPRESSURED

PROCESS END

- ☐ BLOCKED, TAGGED, DEPRESSURED
- ☐ BLINDED
- ☐ PURGED/WASHED
- ☐ BLINDING REQUIRED

PIPING, VESSELS, ETC:

- ☐ BLOCKED, TAGGED, DEPRESSURED
- ☐ BLINDED
- ☐ PURGED — WASHED
- ☐ STEAMED
- ☐ CATHODIC PROTECTION BONDING REQUIRED

☐ MOTORIZED EQUIPMENT

TYPE: ________________

AIR IN AREA TESTED OK:

OPERATOR ________________

SHIFT SUP: ________________

ADDITIONAL PRECAUTIONS NOT ON CHECK LIST	OPERATOR (OR SHIFT SUPERVISOR)
	WORKMAN.
	WORKMAN ☑ JOB COMPLETED ☑ CLEAN UP COMPLETED
	OPERATOR (OR SHIFT SUPERVISOR) ☐ JOB COMPLETED ☐ CLEAN UP COMPLETED

FORM NO. A81-309A

FIRE & SAFETY PERMITS (HOT WORK)

General:

All Hot Work performed by contractor personnel in Bloomfield Refining Company operating areas must be authorized by the appropriate Operations person. It is the intent of this procedure to establish a standardized authorization system for all work in the refinery that will provide the necessary communication and job preparation to ensure safe working conditions. All work of high risk levels, such as spark-producing, arc or flame, personnel entry into enclosed spaces or special hazard, will be authorized by procedures outlined in this order.

HIGH RISK LEVEL WORK IN OPERATING AREAS SHOULD BE AVOIDED WHERE PRACTICABLE BY RELOCATING THE WORK TO UNRESTRICTED AREAS.

This order recognizes that certain identifiable risk levels of work exist and that authorization procedures should increase appropriately with risk. High risk work, involving flame or arc or personnel entry into equipment, requires authorization with a Fire and Safety Permit issued by an Operations Supervisor with a mandatory separate audit and approval by a Safety Department representative. Lower risk work, involving spark-producing procedures or equipment, requires authorization with a Fire and Safety Permit issued by an Operation Supervisor, without a mandatory separate audit by a Safety Department representative.

Typical Jobs Requiring a Fire and Safety Permit:

A. Supervisor/Safety Supervisor Permit

The following types of jobs will be authorized by a Fire and Safety Permit, issued by an Operations Supervisor with a mandatory, separate audit and approval by a Safety Department representative.

1. Flame - gas welding, gas torches, melting pots, electric welding or any other flame.

2. Personnel entry into equipment - to enter a vessel, furnace, tank, sump, or any enclosed space.

3. Sandblasting on atmospheric storage tanks.

B. Supervisor Permit

The following types of jobs will be authorized by a Fire and Safety Permit, issued by an Operations Supervisor.

1. Sandblasting (except atmospheric storage tanks, see

Item 3 Above).

2. Spark-producing jobs, such as grinding, chipping, concrete breaking, and electric drilling on nonprocess equipment.

3. Spark-producing electrical equipment, such as portable electric motors, open electric switches, ordinary electric plug-in connections, soldering irons, electric heating devices, and camera flash equipment.

4. Additionally, all x-ray work shall be authorized by a Fire and Safety Permit issued by the appropriate Operations Supervisor.

Special Application of The Fire and Safety Permit:

Certain jobs may be encountered that pose special risks or that require considerable communication and planning to ensure safe work conditions. The Fire and Safety Permit may be used to authorize such work. Examples are:

1. Opening of flare systems - in accordance with specific plant or departmental order for opening flare system.

2. Interdepartmental pipelines.

3. When particularly hazardous materials or conditions are to be encountered, requiring the additional precautions obtained by the use of the Fire and Safety Permit. Such situations will be at the discretion of appropriate Plant management.

Such special application of the Fire and Safety Permit shall be issued by the appropriate Operations Supervisor and does not require an audit by the Safety Department representative.

WORK IN NONOPERATING AREAS:

Fire and Safety Permits are required in nonoperating areas for the type of work described in the Section entitled, "Supervisor/Safety Supervisor Permit". The Safety Department representative shall issue these permits.

For personnel entry into enclosed spaces, these are no exceptions to the need for a Fire and Safety Permit.

Responsibilities:

Fundamental responsibility for Safety within an operating area lies with operating departments. Operating personnel are most knowledgeable about the operating area and equipment with regard to hazards and how to neutralize the hazards.

Accordingly, it is the responsibility of the operating department to prepare the Fire and Safety Permit for all jobs that must be performed in an operating area.

The Safety Department representative is responsible for performing an independent audit of work in operating areas. Further, the Safety Department representative will issue Fire and Safety Permits in nonoperating areas.

Contract personnel are responsible for being aware of the conditions under which the permit is issued and for working within these conditions throughout the job.

PROCEDURES:

Step 1 - Setting Conditions

The Operations Supervisor (Operations Manager, Operations Day Supervisor, or Shift Supervisor) will decide what conditions must be met to achieve safe work conditions and will set down these conditions in writing on the Fire and Safety Permit form. The Operations Supervisor is encouraged to consult the Safety Department Representative, however, the primary responsibility for setting the condition lies with the Operations Supervisor.

Step 2 - Achieving Conditions

The Operations and Contract Supervisors will be responsible for achieving the conditions specified in Step 1 (see Preparatory Work)

Step 3 - Auditing Conditions

When the specified conditions have been met, the Operations Supervisor shall audit the job to ensure that all the specified conditions have been achieved, and that no additional safety precautions are necessary.

For jobs of risk level outlined in the section entitled, "Supervisor Permit", the Operations Supervisor is then ready to issue the Fire and Safety Permit.

For jobs of risk level outlined in the section entitled, "Supervisor/Safety Supervisor Permit", the Safety Department representative shall then perform an independent audit to ensure that all necessary safety precautions have been taken. The Safety Department representative can, at this time, add whatever additional conditions are required to ensure job safety.

Step 4 - Notifying Adjacent Areas

It will be the joint responsibility of the Operations

Supervisor and Safety Department representative to inform other parties of the pending work (such as adjacent, but separate, operating areas).

Step 5 - Issuing the Permit

a. The Operations Supervisor will sign the permit, indicating that the conditions for safe work have been set, achieved, and audited, and that Operations is ready for the work to begin. The Operator responsible for the area will sign the permit to indicate that he/she is aware of the job and the specified safe work conditions and intends to comply with the conditions of the permit. The Shift Supervisor responsible for the operating area shall always sign the permit.

b. The Safety Department representative will then sign the permit (for jobs outlined in the section entitled, "Supervisor/Safety Supervisor Permit") indicating that an independent audit has been performed of the entire job preparation and that work can proceed.

c. The Contract Supervisor responsible for the job will sign the permit indicating that he/she understands the conditions of the permit and has instructed the craftsman regarding the job and the conditions to be maintained.

d. The Fire and Safety Permit is in effect when above steps have been completed. The job can be started after the Operations Supervisor has distributed the appropriate copies of the permit as follows:

White Copy - remain at jobsite; issued to contract supervisor.
Yellow Copy - post in Control Room

Blue Copy - retained by Safety Department

Step 6 - Maintaining Conditions of Permit

A permit is valid as long as the permit conditions are maintained and the work is not suspended for more than a four hour period.

Permits on continuous or around-the-clock jobs shall be renewed on the next daylight shift between the hours of 8:30 a.m. and 10:00 a.m.

OPEN OR "GREEN BELT" AREA PERMITS

Contractors with work and staging sites in open or "green belt" areas may be issued a job duration Fire and Safety Permit. The permit will authorize work only within assigned areas and the contractor will be required to install necessary signs indicating area limits. Job duration permits will be cancelled, and permits issued on a daily basis near job end when work is still in progress and hydrocarbons have been brought into equipment and piping.

FIRE & SAFETY PERMITS (ENTRY)

General:

The intent of this order is to protect personnel against hazards associated with oxygen deficient, toxic, and /or flammable atmosphere within enclosed and/or confined spaces.

"Enclosed spaces" include vessels, tanks, columns, furnace fireboxes, etc. For the remaining portion of this guideline, all such enclosed spaces will be referred to as "vessels".

"Confined spaces" include pits, sewer boxes, column skirts, etc.

Conditions For Entry Into Vessels And/Or Confined Spaces:

1. The vessel or confined space must be thoroughly cleaned and decontaminated to place it in a safe condition prior to entry.

2. All connecting lines to the vessel must be physically disconnected or blinded at a point near the vessel.

3. All power-driven electrical equipment internal to the vessel (mixers, agitators, etc.) shall be locked out or the breaker disconnected in accordance with Safety Order S-4.

4. An independent fresh air ventilation system must be provided and be in operation for all vessel entry.

5. In all cases, the atmosphere inside the vessel or confined space must be checked for explosivity, oxygen deficiency and toxic vapors. The inside work atmosphere must meet the following criteria:

Explosivity - zero (0)

Oxygen Deficiency - a minimum of 19.5% v.

Toxicity - below applicable threshold limit values (TLV) or permissible exposure limits (PER), whichever is lower.

Additional audits are to be made as work in vessels proceeds if there exists a possibility of hydrocarbon release or oxygen deficiency.

6. A standby person (hole watch) shall be required when persons are entering vessels and/or confined spaces. The hole watch shall be instructed by the Supervisor of the personnel entering the vessel and shall be familiar with the "Hole Watch" instruction (see Attachment I)

7. Temporary electrical systems entering vessels for lighting purposes shall be limited to 12 volts. 110 volts with a Ground Fault Circuit Interrupter and proper load breakers may be authorized by the Safety Department. Electrically driven tools may not be used inside vessel, unless specifically authorized by the Safety Department.

8. Pneumatic driven tools shall be powered only by air. Use of any other compressed gas can cause extreme fire or suffocation hazards

Minimum Oxygen Requirements:

Work planning and preparations shall ensure that a minimum oxygen content of 19.5% is achieved and sustained prior to authorizing entry. Entry will not be permitted into vessels or confined spaces containing less than 19.5% v. oxygen with two exceptions, which are as follows:

Emergency Rescue: Entry for emergency rescue of personnel will be permitted regardless of oxygen content, providing that the person entering the vessel wears air supplied breathing apparatus and a lifeline, and additional personnel are immediately available and prepared to assist. A standby person should never enter a vessel until help has arrived.

Special Tasks: Entry may be permitted into oxygen deficient or alien atmospheres for special tasks with appropriate advanced planning and Safety Department approval. For such planned entry into oxygen deficient or alien atmospheres, a contractor who specializes in such work should be employed. In addition to the "Conditions for Entry" outlined previously, minimum planning shall also include a joint meeting, prior to starting the job, between Operations, Maintenance, Safety, and the contractor. In addition to all normal approvals, the entry permit shall also be signed by the appropriate Manager. The persons entering the vessel must wear air supplied breathing apparatus, appropriate protective clothing or suits, and a lifeline. Standby personnel shall include at least one person wearing the appropriate respirators and equipment, ready to execute a pre-planned rescue.

Protection From Materials

In some cases, it may be necessary to enter vessels or confined spaces that are not completely cleaned or purged of all materials, even though sufficient oxygen level has been achieved and ensured. In these cases, entry will be permitted provided the "Conditions for Entry" , previously outlined, are followed, coupled with protective equipment appropriate for the situation. The respiratory protection and other protective equipment required (such as rubber suits, gloves, boots, goggles, etc.) will be specified on the

Fire and Safety Permit and will be based on the following guidelines:

1. Protective clothing shall be worn if irritation to the skin is possible.

2. Appropriate respirators shall be worn when vapors or dust may be irritating to the eyes or the respiratory system, or when present in excess of the permissible exposure limits, or when such materials may be encountered during the course of the work.

3. A standby person will be required in all cases where respiratory protection is required. The standby person shall be supplied with equivalent protection.

Special Procedures For Entry Permits

Entry permits will be issued in accordance with Safety Order S-8, ("Fire and Safety Permits") after the appropriate conditions for entry defined in this order have been met. Further, the following special procedures will be followed:

1. The white copy of the permit will be posted at the jobsite in a special plastic envelope provided for that purpose.

2. The yellow copy of the permit will be posted in the Control Room.

3. When an approved entry permit has been issued and posted, employees and contractor employees may enter. However, a representative from each contractor or Bloomfield Refining Company department that enters the equipment must sign in and sign off the posted white copy of the permit in the space provided. "Signing in" means that employees of a particular Bloomfield Refining Company department or contractor firm are implementing work inside the vessel. "Signing off" means that the work of the department or firm is complete and that employees of that department or firm are out of the vessel. (See Permit form attached).

4. "Closing Out" of an entry permit will be as follows:

   a. Bloomfield Refining Company's Maintenance Supervisor responsible for the job shall check that all maintenance personnel (contract and Bloomfield Refining Company) have completed their tasks, exited the equipment and signed off the entry permit. The Maintenance Supervisor shall advise the Operations Supervisor that all maintenance responsibilities have been fulfilled and complete the "job close-out" section of the white copy with name, date, and time, indicating that all maintenance work is complete.

b. The Operations Supervisor shall close-out the entry permit by removing the white and yellow copies of the entry permit and by advising the appropriate Operator. Both copies of the permit should be forwarded to the Safety Department for retention with the blue copy.

Hot Work Inside Equipment:

Hot work inside equipment shall be performed under a separate Fire and Safety Permit issued in accordance with Safety Order S-8 for hot work.

STANDBY ("HOLE WATCH") INSTRUCTIONS

You should be thoroughly familiar with the following duties when you assume the responsibilities of standby for a person or persons working inside a vessel or confined space.

Your primary responsibilities are:

1. The safety of personnel working in the vessel or confined space.
2. Maintaining the conditions and requirements listed on the fire and safety permit.
3. Evacuating the vessel if you observe any condition which you consider hazardous.
4. Getting help if an emergency develops — Never attempt to enter the vessel or confined space, even in an emergency, until help has arrived.

The circumstances and conditions of the job will determine the safety requirements and what your standby duties are. However, the following duties are basic to all jobs.

1. Do not leave your assignment while personnel are inside the vessel or confined space (the only exception is to get help in an emergency). If other duties require you to leave your standby assignment, have all personnel evacuate the enclosure
2. If you have any questions regarding the job, check with your foreman.
3. Be on the alert. Try to anticipate and prevent any conditions that would be hazardous.
4. Prevent the fouling of air lines and/or lifelines (when required).
5. If you are required to have respiratory equipment or lifelines available, be certain that you know how to use this equipment.
6. Upon completion of the job, clean and return all special equipment to its original location.

FORM NO. 578-201

FIRE AND SAFETY PERMIT

(FOR PROCEDURAL DETAILS REFER TO SAFETY ORDER S-8)

OPERATING DEPARTMENT

DATE ISSUED

LOCATION

JOB DESCRIPTION: ☐ HOT WORK ☐ ENTRY

CHECKED PRECAUTIONS TO BE OBSERVED:

☐ AIR IN AREA AND EQUIPMENT TESTED OK BY:

ELECTRIC EQUIPMENT:
- ☐ DISCONNECT AND TAG
- ☐ LOCKED OUT

LINES:
- ☐ BLINDED
- ☐ DISCONNECTED
- ☐ VALVES CLOSED & TAGGED
- ☐ BLEEDERS OPEN
- ☐ ELECTRIC TOOLS GROUNDED
- ☐ AIR MOVER OPERATING
- ☐ HOLE WATCH
- ☐ FIRE WATCH
- ☐ STOP WORK, SHUT DOWN MOTORS IF LEAK OCCURS
- ☐ SHUT DOWN MOTORS TO REFUEL
- ☐ ALERT TO OVERHEAD WORK

- ☐ DRAINS SEALED
- ☐ SEWERS PLUGGED
- ☐ FIRE EXTINGUISHER AT SITE
- ☐ PRESSURED FIRE HOSE AT SITE
- ☐ CONTAIN SPARKS
- ☐ GROUND WELDING MACHINE TO PIECE BEING WELDED AT PROPER LOCATION
- ☐ KEEP ACETYLENE/OXYGEN CYLINDERS OUTSIDE VESSELS: WHEN WORK IS STOPPED REMOVE TORCH AND LINES OUTSIDE
- ☐ HOT TAP FORM COMPLETE
- ☐ POSITIVE PRESSURE & FLOW IN LINE
- ☐ TANK STATIC: HOT WORK 12 IN. OR MORE BELOW LEVEL
- ☐ NO SAMPLING, VENTING, DRAINING

PROTECTIVE EQUIPMENT REQUIRED

- ☐ GOGGLES/FACESHIELD
- ☐ GLOVES-CHEMICAL/THERMAL
- ☐ HOOD-CHEMICAL/THERMAL
- ☐ SUIT-CHEMICAL/THERMAL
- ☐ BOOTS
- ☐ HEARING PROTECTION
- ☐ SAFETY BELT AND LINE
- ☐ RESPIRATOR-SPECIFY
- ☐ WEAR FRESH AIR MASK
- ☐ STANDBY WITH FRESH AIR MASK
- ☐ WEAR PROTECTIVE EQUIPMENT FOR HOT ELECTRICAL WORK
- ☐
- ☐

ADDITIONAL PRECAUTIONS NOT LISTED ABOVE:

APPROVALS TO BEGIN WORK:

OPER. SUPERVISOR/TIME:

SAFETY SUPERVISOR/TIME:
(Write in NR if not required)

MAINT. SUPERVISOR/TIME:

PERMIT POSTING PROCEDURES

White Copy — Given to Workman for Hot Work Permits or posted at jobsite for Entry Permits

Yellow Copy— Posted in Control Room

Blue Copy — To Safety

PERMIT REQUIREMENTS ACKNOWLEDGED:

OPERATOR	WORKMAN

JOB CLOSE-OUT (Entry Permits)

	DATE	TIME
MAINT. SUPERVISOR		

SIGN-IN (Entry Permits)

COMPANY/DEPT.	WORKMAN OR REPRESENTATIVE

SIGN-OFF (Entry Permits)

COMPANY/DEPT.	WORKMAN OR REP.	DATE	TIME

PERMIT VOID IF CONDITIONS CHANGE

FORM NO. U81-310

CONTRACTOR PREPARATORY WORK

In order to schedule issuance of "Hot Work" permits, the contractor shall review with the Operations representative, all preparatory work required by the contractor for the job before issuance of a permit.

Preparatory Work (Job Preparation)

Conditions established by the issuer of a "Hot Work" permit will assure that situations involving hazards to personnel or operating equipment do not arise when flame or spark-producing activities are in progress.

Some examples of these conditions may be:

Sewers: Are to be sealed with a vapor barrier (no plastic) and covered with sand.

Spark Containment: May be required in operating units and pipe racks to ensure safety of personnel and operating equipment.

Blinding Isolation: Piping (existing) may require isolation by blinding for tie-ins. Contractor may be required to prepare line for product decontamination by Bloomfield Refining Company Operations in order to work on "existing" piping or "existing" equipment. This work shall be scheduled through the Project Engineer as specified in this Contractor Safety Regulations and Procedures Manual, captioned, "Tie-ins and Blinding".

Any system, piping, or equipment put in service by Bloomfield Refining Company Operations, that has been installed by the contractor, shall be classified "existing". Any proposed work on system after being in service shall be scheduled through Project Engineer as specified above, "Tie-ins and Blinding".

Atmospheric Vents, Sample Pots: Covered or sealed with fireproof blankets or wet rags, etc.

Firewatch: Firewatch requirements must be reviewed by contractor and Bloomfield Refining Company's Project Engineer with appropriate Operations Department representative.

Each job requires some degree of preparation, some minor, some extensive, depending on potential hazards that could occur based on judgement of issuer of "Hot Work" Permit for each area of activity.

It is to be understood that the contractor shall review with the Operations representative and/or Safety Department representative each job to be authorized by a "Hot Work" permit prior to request for same. At that time, preparatory work (conditions) will be specified and the contractor may then request a "Safe Work" permit to satisfy these conditions.

A "Hot Work" permit will not be issued to the contractor until the issuer of the permit has audited the work area and is satisfied that all conditions are completed and air test of area is satisfactory.

The contractor shall not request a "Hot Work" permit to be issued at the beginning of their work day if preparatory work is not completed as specified in review session the previous day.

NOTE: Bloomfield Refining Company's Safety Department representative and Operation' Supervisors have a large area of responsibility. Therefore, if contractor has requested a "time of day" for a "Hot Work" permit to be issued, and the Safety Department representative or Operations Supervisor finds preparatory work not completed, or the requesting contractor representative not present to accept permit, the Safety Department representative will proceed to his/her next scheduled duties.

It is to the contractor's advantage to be realistic in planning and implementing the preparatory work, and especially realistic in specifying the "time of day" the "Hot Work permit is requested.

In the event abnormal delays in permit issuance are encountered, the contractor shall submit in writing to the Safety representative, preferably the same day, a report of causes for delay. This information will be evaluated and steps taken to rectify the problem.

TIE-INS AND BLINDING

If contractor is required to make a tie-in to an existing line by use of welding, burning or cold-cutting, he/she shall be responsible for scheduling through Bloomfield Refining Company's Project Engineer. Line washing or necessary preparation shall be done by the responsible operating department who will also isolate system affected by tie-in.

At least one week in advance of the expected tie-in date, contractor shall schedule, through Bloomfield Refining Company's Project Engineer, a preliminary investigation with Bloomfield Refining Company's authorized departmental representative (or representatives if more than one department is involved) and Bloomfield Refining Company's Safety Department representative. At this time, a visit to the tie-in location will be made to positively identify and mark line at approximate tie-in point. Complete procedure for performing tie-in will be discussed and shall include the following items:

1. How much notice will be required by operating department(s) concerned to release line?

2. Obtain name(s) of departmental representative(s) to contact for final scheduling and blocking.

3. How much time will be allowed to complete tie-in?

4. Locate and identify all block valves and points of blinding necessary to isolate system prior to start of work. A blind list for attachment to permit may be required.

5. Determine if system is to be cleaned by water washing and/or steaming and if system vents are available or if installation of any blinds is required.

6. Determine if initial line cut is to be made with acetylene torch or by cold cut method, and if subsequent welding or fitting to be direct or if vented pipe plugs and flanges are required.

7. Determine necessary work to make area safe for welding.

8. Discuss alternate methods for performing tie-in.

On the morning the tie-in is to be made, contractor, Bloomfield Refining Company's Safety Department representative and departmental representative(s) shall review the procedure and if all conditions warrant, a Fire and Safety Permit will be issued for the tie-in.

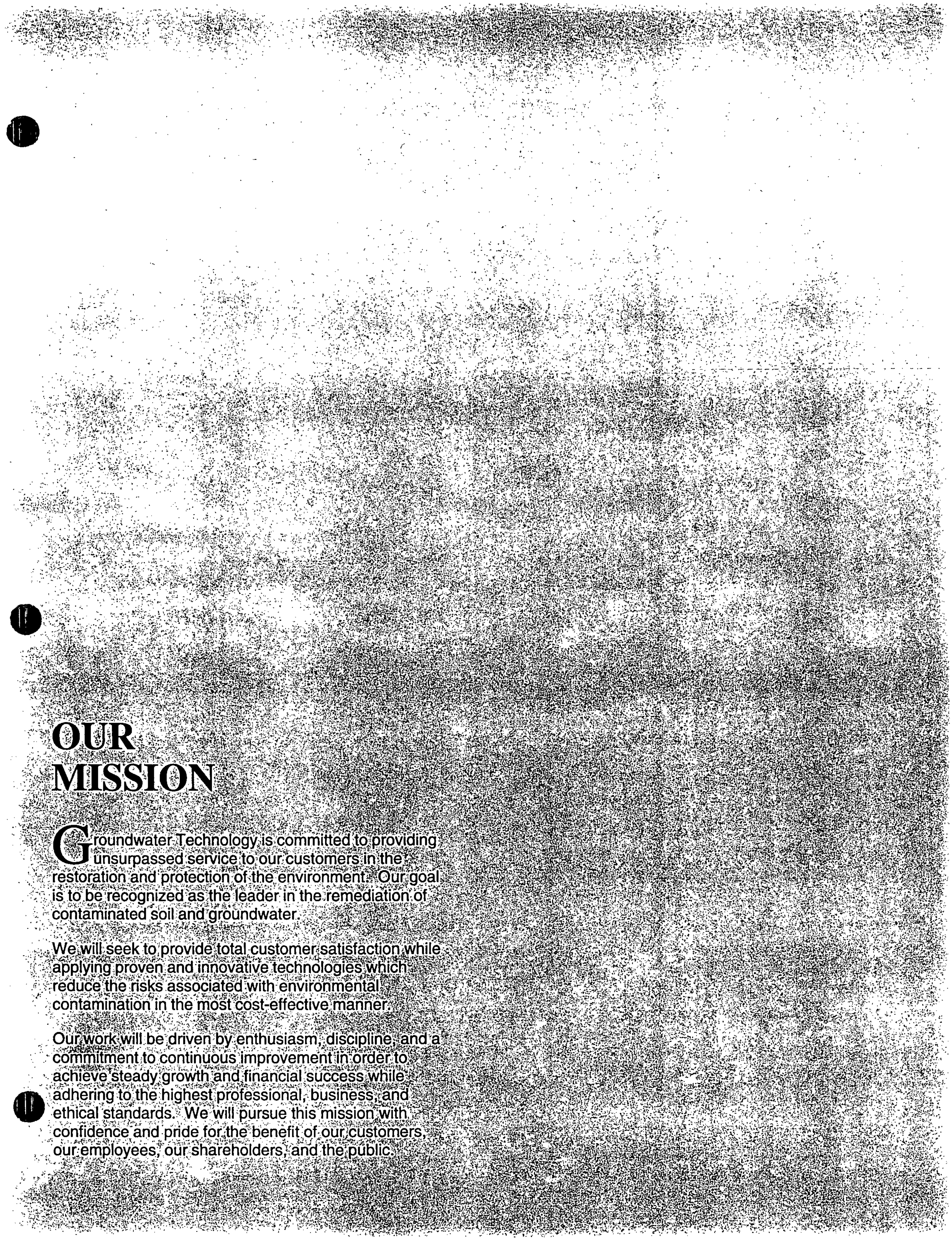
Upon completion of the tie-in, contractor shall obtain approval from operations Shift Supervisor and BRC Project Supervisor to remove all blinds and make up all flanges, necessary to restore the department's system to serviceable condition. Any blinds left by contractor to isolate his line shall be discussed with Project Supervisor and noted on master blind list.

APPENDIX B

QUALIFICATIONS AND EXPERIENCE

Statement of
QUALIFICATIONS AND EXPERIENCE

GROUNDWATER
TECHNOLOGY



OUR MISSION

Groundwater Technology is committed to providing unsurpassed service to our customers in the restoration and protection of the environment. Our goal is to be recognized as the leader in the remediation of contaminated soil and groundwater.

We will seek to provide total customer satisfaction while applying proven and innovative technologies which reduce the risks associated with environmental contamination in the most cost-effective manner.

Our work will be driven by enthusiasm, discipline, and a commitment to continuous improvement in order to achieve steady growth and financial success while adhering to the highest professional, business, and ethical standards. We will pursue this mission with confidence and pride for the benefit of our customers, our employees, our shareholders, and the public.

TABLE OF CONTENTS

CORPORATE OVERVIEW

SERVICES

CASE HISTORIES

BIOGRAPHICAL INFORMATION

SUPPLEMENTAL INFORMATION

CORPORATE OVERVIEW

COMPANY PROFILE

Groundwater Technology, Inc. is an international corporation providing environmental consulting services to producers, suppliers, bulk terminals and transporters of petroleum products. We develop comprehensive assessment and remediation plans, with each program taking into account the special needs confronting our clients. We also design, manufacture and market our own line of pollution abatement and monitoring equipment which is uniquely able to withstand harsh conditions. Our years of translating advanced technological theories and concepts into practical working projects have made us the industry leader in on-site remediation of soil and groundwater.

Founded in 1975, Groundwater Technology is among the largest and most successful environmental remediation firms, with 1992 sales of more than $193,000,000. The company employs more than 1,700 people located in over 70 offices throughout the U.S., Canada, Europe, and Australia. Today our geologists, hydrogeologists, engineers, toxicologists, chemists, and technicians have completed 14,000 on-site assessment and remediation projects.

Our extensive knowledge of the regulatory issues which affect the petroleum industry has proven beneficial to clients who must meet complex requirements for site assessment and remediation. We are recognized for our strength in project design and for our success in negotiating cleanup standards based on risks posed to human health and the environment. We function as client advocates to assure that compliance is reached through the most cost-effective means.

Our services include real estate transfer investigations, chemical hazards management, storage tank testing and management, site monitoring, air quality management, laboratory analysis, and process engineering. We serve a broad range of clients in every sector of the petroleum industry.

This Qualifications and Experience package contains information about Groundwater Technology's services, representative projects and key personnel. We welcome your questions and will be happy to provide you with additional information.

CORPORATE PHILOSOPHY

At Groundwater Technology we solve environmental concerns. We don't perpetuate them. We believe that it takes more than theories, flow charts and open-ended studies to resolve contamination problems. Instead, Groundwater Technology is known for its ability to move decisively, while controlling costs and minimizing interruptions to our clients' operations.

We are internationally recognized for our role in the development and application of cost-effective methods which eliminate contamination on-site rather than transporting it and creating future liability. We draw upon practical experience gained from thousands of remediation projects which we have implemented around the world. We also utilize our clients' existing resources and data base, preventing false starts and maximizing the value produced for each dollar spent.

We approach every project with an eye to reducing client liability. In our work with regulatory agencies, our objective is to achieve a cleaner environment at the least cost and inconvenience to our client. We strive to ensure that the demands placed upon our clients are both fair and realistic.

PROJECT MANAGEMENT

To solve a client's problem, we are able to reach into our organization to assemble the appropriate talent. Hundreds of staff engineers, geologists, hydrogeologists, medical scientist, chemists, and microbiologists form specific project teams which evaluate problems and develop action plans.

These project teams bring a practical knowledge of all the available technologies to bear upon the specific circumstances at a site. We understand the synergistic effect which combining more than one remediation technology can have in getting the job done faster. The goal is to address the problem through the most efficient, least disruptive means.

Most projects are approached in three phases:

- Assessment
- Remediation/Corrective Action
- Monitoring and Closure

Once the project scope and methodologies have been defined and agreed upon, our skilled project managers oversee accurate scheduling, cost management, and quality workmanship throughout the course of the project. The Project Manager coordinates all resources, both internal and external, to achieve successful project completion.

A key responsibility of the Project Manager is consistent and timely communication with the customer concerning work in progress, scheduling, and costs, or any changes in the scope of work which would effect these. As the interface between Groundwater Technology's staff and the customer, the Project Manager ensures the orderly flow of information on decisions, approvals, and inspections.

We consider effective project management to be of critical importance in getting the job completed on time, and on budget.

DIVISIONS AND SUBSIDIARIES

Groundwater Technology has a number of units, divisions and subsidiaries which do business under the following names:

ORS Environmental Equipment - equipment manufacturing division

GTEL Environmental Laboratories, Inc.- analytical services subsidiary

Groundwater Technology Government Services, Inc. - governmental sector subsidiary

Groundwater Technology Canada Ltd./Ltee - Canadian subsidiary

Groundwater Technology Australia Pty Limited - Australian subsidiary

Groundwater Technology International, Ltd. - United Kingdom subsidiary

Groundwater Technology Italia S.r.l. - Italian subsidiary

Groundwater Technology B.V. - Netherlands subsidiary

BGT Boden- und Grundwassertechnologie GmbH - joint venture in Germany, with subsidiaries in Austria, Belgium and Hungary

Applied Air Technology - air quality services unit

INNOVATIONS

Groundwater Technology has focused on developing innovative cost-effective remediation methods since its founding in 1975. Some of our critical contributions to environmental technology have been:

1975	Developed oleophilic/hydrophobic oil skimming device (FILTER SCAVENGER™ Oil/Water Separator System) for selective removal of lighter-than-water hydrocarbons from water.
1977	Developed sensor-controlled water table depression pumps to increase recovery of separate-phase hydrocarbons in the subsurface.
1979	Developed small diameter, down-hole selective oil recovery pump (SMALL DIAMETER PROBE SCAVENGER™ Oil/Water Separator System) for deep well recovery.
1980	Engineered, constructed, installed, operated, and documented air stripping technology as a cost-effective alternative to activated carbon technology for dissolved-phase cleanups.
1981	Designed, engineered and installed an *in situ* closed loop remediation system using several technologies, including bioremediation, to treat dissolved and adsorbed phase contamination at a service station in Pennsylvania. Nutrients and oxygen (via air sparging) were added to enhance bacterial degradation of contaminants. Recognized the potential of bioremediation processes also known as END™ Enhanced Natural Degradation, began introducing regulators and industry to the concept and applying the technology at additional sites.
1981	Demonstrated the utility of *in situ* soil venting technology for the removal of volatile organic compounds from the adsorbed-phase. Now widely used as the most cost-effective remediation technique for volatile organics.
1981	Developed battery operated, hand-held INTERFACE PROBE™ Well Monitoring System to rapidly and accurately measure depth to oil and water in wells and tanks.
1982	Developed and implemented environmental risk analysis programs for major oil companies and utilities as cost-effective approach to prioritizing cleanups.
1982	Demonstrated the use of gas analysis as a rapid and cost-effective field technique for assessing the areal extent of contamination in soils. The technique produces a three-dimensional view of a chemical loss.
1983	Developed an alternative to the conventional corrosion prediction method for prioritizing tank replacements, using environmental risk assessment.
1984	Installed first dual pumping system for DNAPL recovery.
1984	Established a bioremediation laboratory in Chadds Ford, Pennsylvania, dedicated to continual improvements in biological treatments of contamination.

1987	Demonstrated vapor-phase incineration of air stripper and soil vent off-gas to be a cost-competitive alternative to carbon adsorption for vapor-phase volatile organic compound (VOC) remediation. Patents pending on process and equipment.
1988	Introduced and applied the concept of *risk driven remediation* to determine acceptable cleanup standards for individual sites. *Risk driven remediation* considers the toxicity of a chemical and the likelihood of human contact with that chemical, to arrive at a logically prioritized remediation program. The concept provides a powerful and increasingly accepted decision making tool to ensure that remedial activity is appropriate at a particular site.
1989	Introduced the concept of *in situ biostabilization* to address high molecular weight contaminants such as organochlorides. By degrading lower molecular weight carrier solvents which transport the contaminants, *in situ biostabilization* reduces the leachability of hazardous waste constituents so that site soils may meet the criteria of the EPA TCLP (Toxicity Characteristic Leaching Procedure).
1990	Constructed the first permanent on-site biotreatment facility for petroleum contaminated soils at a Canadian refinery.
1990	Installed the first air sparging/soil venting system for treating chlorinated solvents in soils and groundwater without groundwater extraction for a dry cleaning facility. Closure achieved at the site within a year.
1990	Applied horizontal well drilling technology for site assessment, migration control and remediation at a major refinery.
1990	Enhanced a modelling system to predict groundwater flow in a well field by combining contouring and analytical software packages.
1991	Applied steam sparging to a groundwater aquifer to enhance solvent extraction. Process removes 10 times more solvent on a daily basis than groundwater extraction.
1991	Developed the LO-PRO™ Low Profile Air Stripper to obtain high removal efficiencies comparable to counter-flow aeration towers, while providing modular construction features which make the system easy to install and maintain. Compared with other low profile air strippers, the LO-PRO system keeps the required air flow volume to a minimum.

SERVICES

BIOREMEDIATION

Groundwater Technology's involvement with bioremediation is without parallel. Since pioneering the commercial use of *in situ* bioremediation more than a decade ago, the company has completed more of these projects than all other environmental firms combined. Bioremediation is rapidly gaining favor with regulators as a cost-effective means for on-site destruction of contaminants. Compared with excavation and removal of contaminated soil, bioremediation is often significantly less costly, while at the same time avoiding the liability of transporting it elsewhere.

Our distinctive services include:

END™ Enhanced Natural Degradation

- Recognized as the most advanced *in situ* biological process available
- Low capital cost and minimal site disruption
- Regulator approved remediation technology
- Rapid cleanup time of both soils and groundwater
- Proven effective for petroleum hydrocarbons, chlorinated solvents, pesticides, herbicides, polynuclear aromatic hydrocarbons, industrial chemicals, ionic metals and coal tars

Advanced Biological Surface Treatment

- Most cost-effective treatment of previously excavated contaminated soil
- Meets air quality regulations
- Uses naturally occurring bacteria

Impoundment Lagoon and Production Pit Remediation

- Low cost on-site remediation
- Inoculation of waste ponds to create on-site digesters
- Utilization of physical and chemical treatments to complement biodegradation

Bioreactors for Treatment of Waste Water Streams

- Activated sludge designs
- Fixed film systems

Bioremediation Laboratory Services

- Fully staffed and automated bioremediation laboratories
- Treatability studies, degradation microcosm studies
- Culture selection and development
- Nutrient optimization
- Contract research and development

12/92

HYDROGEOLOGIC AND GEOCHEMICAL MODELING

Groundwater models are mathematical formulations that seek to represent the physical, chemical, and biological processes occurring in an aquifer. Models can be used to synthesize diverse results from a site assessment, evaluate engineering designs, and demonstrate compliance with environmental regulations. Successful simulation of natural phenomena requires the integration of site specific geological, chemical, and hydraulic information. Groundwater Technology modelers work with the project staff to ensure accurate model representation. Statistical analysis is used to validate the results, and convenient access is provided by use of fourth generation data management systems.

Both large and small sites can benefit from groundwater modeling. We have found that relatively simple models accurately simulate the remediation of a site by evaluating the location and pumping rate for extraction and injection wells, drainage through a trench system, and the placement of a barrier well. More complex sites, in which the heterogeneous physical conditions of an aquifer require more sophisticated techniques, can be simulated using three-dimensional, finite element contaminant transport models. Several scenarios, including no-action, are always considered to support the establishment of cost-effective, risk-driven remediation goals. Our Hydrogeological Services Group uses state-of-the-art computer and telecommunications equipment to process data and customize simulations to fit the needs of our customers.

Site Assessment

- Data management planning and support
- Application of geostatistics to determine sample reliability
- Well field analysis to determine variations in time and space

Remedial Investigation

- Preparation of contour and perspective maps
- Volumetric calculations
- Plume simulation and source identification

Feasibility Study/Remedial Design

- Capture zone determination
- Achievement of hydraulic control
- Optimization of well field design
- Estimation of time to achieve cleanup objectives
- Life cycle cost evaluation of remedial alternatives

Litigation Support/Expert Testimony

- Fate and transport modeling
- Inverse modeling
- Assignment of proportional cost responsibility for site mitigation
- Graphic representation of complex site conditions

GROUNDWATER
TECHNOLOGY

ENGINEERING

In approaching any environmental problem, a critical step in choosing and implementing the most cost-effective solution is the unbiased evaluation of the vast array of potentially applicable technologies. Extensive hands-on experience in applying remediation technologies, coupled with multidisciplinary process engineering teams, allows us to consistently select a technological solution measured to the problem.

At Groundwater Technology, all project managers have engineering teams capable of providing whatever level of design service is required. Our engineering teams include chemical, civil, structural, electrical, mechanical, and process engineers with diverse environmental remediation and industrial process experience. These teams are dedicated to taking innovative conceptual approaches and creating sound designs which can be expediently and efficiently implemented in the field. The designs are reduced into the following standard engineering documentation products where applicable:

- Process flow schematics
- Piping and instrument diagrams
- Facility layouts
- Construction details
- Electrical one-line diagrams
- Control schematics
- Control panel design
- Specifications
- Construction cost estimating

CONSTRUCTION

Essential to the success of any project is the effective communication between individuals responsible for designing the appropriate solution and those responsible for its implementation. This is especially true for remediation projects, due to the dynamic aspects of the problems faced when addressing subsurface contamination. Groundwater Technology's Construction Group is structured to allow construction experts responsible for implementing a remedial solution to be integrally involved in the planning and design of the approach. This ensures that technical issues likely to arise in the construction phase are anticipated, analyzed, and resolved early in the design process.

Groundwater Technology is unique in its ability to implement solutions with in-house field personnel who specialize in facility construction, system installation, and system operation. This hands-on approach allows us to respond to client needs rapidly and efficiently

The construction group comprises construction engineers, field supervisors, technicians, and equipment operators experienced in the specific technologies applied to environmental remediation. Construction engineers provide estimating, planning, scheduling, cost control, and site activity coordination. Field supervisors manage skilled technicians and equipment operators in the execution of a project in accordance with specific standards of performance.

All personnel involved in construction projects are fully trained in health and safety procedures required for this work.

Construction capabilities include:

- Waste water treatment system installation
- Bioremediation cell construction and operation
- Hazardous waste excavation
- Underground storage tank removal
- *In situ* remediation system installation
- Construction management
- Construction engineering

WASTE CHARACTERIZATION AND MINIMIZATION

TECHNOLOGY AND MANAGEMENT ASSESSMENTS

The Resource Conservation and Recovery Act (RCRA) and the Hazardous and Solid Waste Amendments (HSWA) place responsibility upon generators to determine the characteristics of produced wastes. Generators must also determine whether these wastes classify as hazardous and are subject to strict permitting, compliance, and enforcement programs. In addition, the law requires generators and those who treat, store, or dispose of hazardous waste to reduce the volume and toxicity of managed waste, and to certify that all practical waste minimization efforts have been practiced.

Groundwater Technology provides a range of services designed to assist clients in compliance with waste production, minimization, classification and management requirements. These services include:

Waste Characterization

- Regulatory determinations
- Waste sampling
- Hazardous waste classification assistance
- TCLP testing, and SW-846 analyses
- Waste analysis plans
- Land disposal determinations

Waste Minimization

- Waste generation assessments
- Waste production process evaluations
- Alternative process technology assessments
- Alternative raw materials and feeds assessments
- Waste reduction evaluations
- Physical, chemical, and biological waste reduction technology design

Technology and Management Assessments

- Waste practices assessments
- Alternative technology identification
- Waste treatment feasibility studies
- Waste management option evaluations
- Process engineering studies

RCRA CORRECTIVE ACTION

Groundwater Technology has long been recognized as a leader in the use of practical, innovative techniques for corrective action. Our programs offer a multidisciplinary approach to correcting releases of hazardous waste or its constituents from solid waste management units (SWMUs) at hazardous waste treatment, storage, or disposal facilities.

Groundwater Technology provides the following RCRA Corrective Action services:

Release Identification

- Regulatory determinations
- SWMU identification
- Waste and facility inventories
- Records review
- Site inspection and investigation
- Sampling and analysis plans and conduct
- Negotiation with regulatory agencies
- Interim corrective measures

Release Characterization

- RFI work plans
- Environmental waste and facility characterizations
- Air, soil, surface water, sediment, hydrogeological, and subsurface gas characterization
- Release movement and fate transport assessment
- Statistical analyses and data interpretation
- Groundwater, surface water, soil, and air sampling analysis
- Laboratory, bench, and pilot scale remedial technology studies
- Environmental and human health risk assessments

Corrective Measures Studies

- Media cleanup standard evaluation
- Corrective action technology evaluation
- Technology effectiveness studies
- Remedy cost estimates, selection, and documentation
- Remedial technology system design, installation, operation, and maintenance
- Construction quality assurance programs
- Groundwater monitoring system design and installation

12/92

GROUNDWATER
TECHNOLOGY

PERMITTING, MONITORING, AND COMPLIANCE ASSESSMENTS

The Resource Conservation and Recovery Act (RCRA) and authorized state programs require comprehensive permitting for the design, construction and operation of hazardous waste treatment, storage, and disposal facilities. Once operational, these facilities must also comply with stringent air, surface water, and groundwater monitoring requirements. These facilities must comply with complex standards for design, operation, monitoring, inspection, and closure and post closure care.

Groundwater Technology's capabilities for providing permitting, monitoring, and compliance assessments include:

Permitting Assistance

- Regulatory determinations
- Permit application development and preparation
- Waste analyses and contingency plans
- Personnel training
- Closure and post closure plans
- Monitoring and inspection plans

Groundwater, Surface Water, and Air Monitoring

- Hydrogeological assessments and characterizations
- ACL determination
- Detection, compliance, and corrective action groundwater monitoring systems
- Groundwater sampling and analysis
- Ambient air toxics testing and continuous monitoring
- Design and manufacturing of VOC/air toxics emissions control systems
- Air toxics release investigations
- Surface water testing and monitoring system design
- Discharge evaluations

Compliance Assessments

- Facility design and operation assessments
- Compliance certification and documentation
- Compliance assistance and regulatory negotiations

SITE ASSESSMENT AND REMEDIATION

Groundwater Technology uses a scientific, step-by-step approach to contamination cleanup. This approach allows us great flexibility in evaluating and solving individual problems. The main steps are *assessment, remediation, monitoring, and closure.*

Assessments identify the presence, extent and concentration of any contamination, and are performed for groundwater, surface water, or soil. Using a variety of tools, our hydrogeologists:

- Research site history
- Drill monitoring wells to obtain groundwater and soil samples for analysis, and measure depth and direction of groundwater flow
- Determine quantities and types of liquid (separate-phase) contaminants
- Determine levels of organic vapors in soils using soil points and portable gas chromatography/mass spectrometry (GC/MS) units
- Detect surface contamination using instruments such as organic vapor meters and metal detection units

The assessment is used to develop a focused remediation plan. Engineers, biochemists, toxicologists and other risk management personnel contribute to the design of the remediation project. Engineered designs address all four phases of contamination: separate, dissolved, vapor and adsorbed.

The *remediation* step implements the plan. After cleanup goals have been reached, the site is monitored to ensure that contamination does not become a problem again. When the job is complete, we supervise site *closure* with the proper regulatory agencies.

Typical remediation methods include:

Biological Treatments

- END™ Enhanced Natural Biodegradation systems for *in situ* bioremediation
- Fungal Remediation
- In vessel bioreactors
- Above - ground treatment cells
- *In situ* biostabilization
- Land farming and composting
- Treatability, feasibility, and pilot studies

Continued on next page

Physical Treatments

- Pumping for recovery of hydrocarbon contamination including chlorinated solvents
- Soil venting
- Air sparging
- Air stripping
- Carbon adsorption
- Multi-media filtration
- Reverse osmosis/ultrafiltration

Chemical Treatments

- Catalytic, chemical and advanced oxidation
- pH adjustment and precipitation
- Chemical fixation
- Sequestering, chelation, and dispersion

HEALTH AND ENVIRONMENTAL RISK ASSESSMENT

Where the existence of toxic substances creates the potential for adverse impact on human health, our Risk Assessment Services group performs comprehensive risk assessments. This process overlays demographic data with medical and environmental science to establish the probable levels of risk to humans and the environment as a result of exposure to hazardous materials. The product of this study is a scientifically credible basis for prioritizing remediation activities and establishing realistic cleanup goals. Groundwater Technology is one of the few environmental firms with a fully integrated risk assessment capability.

Our goal is to help clients undertake remediation programs which successfully mate environmental needs with business realities.

Chemical Hazard Identification and Exposure Assessment

- Site-specific exposure modeling
- Toxicity assessment

Risk Assessments for Environmental Permitting

- Industrial facility siting
- Resource recovery incinerators
- Environmental emissions, effluents or soil contaminants

Waste Site Closure Assessments

- Risk-based evaluations
- Recommendations based on risk based alternative concentration limits (ACLs) or other appropriate goals

Remedial Investigations and Feasibility Studies

- Risk-driven evaluations and recommendations for acceptable cleanup levels
- Risk assessments for remedial action alternatives

Expert Testimony and Regulatory Assistance

- Dialogue and negotiations with regulatory agencies
- Communication with news media and the public in clear, straightforward language
- Testimony provided in the fields of toxicology, and environmental sciences, as well as the effects of chemicals on human health.

ENVIRONMENTAL AUDITS

Complex permitting, compliance, and enforcement programs at the state and federal levels place industries and waste management companies at risk for strict liability actions. These programs apply to active and inactive hazardous waste facilities. As a result of these programs, and increasing public awareness, many industries have undertaken comprehensive environmental audits of all operations and installations to ensure compliance, initiate corrective action, and lessen the consequences of uncorrected violations of environmental laws and regulations.

Groundwater Technology's expertise and comprehensive experience with environmental regulatory programs can assist industry in identifying violations and providing necessary correction. Our services include:

Environmental Audit Design

- Identification of RCRA, CERCLA, CWA, CAA, and TSCA obligations
- Development of audit procedures
- Development of audit check lists
- Development of audit manuals
- Identification of engineering, scientific, and regulatory expertise
- Formation and staffing of audit teams
- Audit planning and scheduling

Environmental Audit Conduct

- Records review
- Plan and specifications review
- Personnel interviews
- Physical inspection of facilities
- Identification of violations
- Site and media sampling and analysis
- Corrective action identification
- Follow-up inspection

CASE HISTORIES

GROUNDWATER TECHNOLOGY, INC.
PARTIAL LIST OF REFINERY PROJECTS

Refinery Project	***Location***	***Fuel Type***	***Activity***
Mobil	Torrance, CA	Gas, diesel	Assessment of storm water retention basin; monitoring and sampling program of over 80 wells
Mobil	Paulsboro, NJ	Mixed refined product	Free product recovery
Texaco	Tulsa, OK	Light distillates	Free product recovery
Chevron	Oahu, Hawaii	Mixed fuels	Free product, dissolved recovery
Unocal	Wilmington, CA	Mixed fuels	NESHAP and TCLP sampling, closure plan for surface impoundments, Part "A" and "B" RCRA permitting, corrective action plan, RCRA training sessions for refinery staff, and assessment
Unocal	Santa Maria, CA	Crude	Part "A" RCRA permitting, groundwater sampling and analysis, hydrogeologic assessment, regulatory compliance
Unocal	Rodeo, CA	Diesel	Aboveground soil bioremediation
Witco	Bakersfield, CA	Crude oil, lube oil	Subsurface refinery assessment neutralized acid pits characterization/toxic "hot spots" EIP, EIR and health risk assessment, regulatory compliance
Chevron	El Segundo, CA	Refined gasoline	Recovery well installation
Texaco	Bakersfield, CA	Mixed fuels	NESHAP sampling of waste water
Powerine	Santa Fe Springs, CA (Liquid Carbonic Unit)	Anhydrous ammonia	Risk Management and Prevention Program (RMPP)
Lagoven	Venezuela	Gasoline	Assessment and free product recovery
AGIP	Italy	Mixed fuel	Assessment and free product recovery
Conoco	Ponca City, OK	Mixed fuel, gasoline	Assessment, soil venting, free product recovery

Design and Construction of an Aboveground Bioremediation Facility at a Refinery

---

CLIENT/FACILITY

Confidential petroleum client/Refinery, California

REGULATORY INVOLVEMENT

California EPA, Regional Water Quality Control Board (RWQCB)

COMPOUNDS OF CONCERN

Petroleum hydrocarbon

NATURE AND EXTENT OF PROBLEM

During a detailed assessment of a former aboveground storage tank area, Groundwater Technology discovered that over 50,000 cubic yards of soil contained diesel fuel, crude, and fuel oil.

SITE CHARACTERIZATION

The refinery is located in a major metropolitan area, upgradient of commercial and residential developments, and downgradient of other industrial facilities that have off-site migration. The site consists of silty sands and marine sands. Groundwater is encountered at greater than 120 feet below grade.

SOLUTION

Groundwater Technology subsequently designed and constructed an aboveground soil treatment unit. The liner and leachate collection system were designed to meet local rainfall requirements. The unit was constructed in the former aboveground tank area, near the stockpile of excavated soil. Remedial design also took advantage of the refinery's in-house construction and engineering services. By considering site constraints and using refinery resources, the remedial design significantly reduced the client's costs; on-site treatment saves approximately $55 per cubic yard when compared to off-site disposal.

Groundwater Technology also developed a statistically based field sampling protocol. To further reduce costs, Groundwater Technology trained refinery staff to perform routine sampling. Baseline samples are being obtained from under the abandoned tank area to establish background levels and demonstrate that there is no migration.

The unit is being used to remediate excavated soil from the former aboveground tank area. The cleaned soil will then be used as backfill when other contaminated soils at the refinery are excavated for treatment in the bioremediation facility.

GROUNDWATER
TECHNOLOGY, INC.

Comprehensive Environmental Services at a Refinery

CLIENT/FACILITY	Confidential petroleum client/Refinery, California
REGULATORY INVOLVEMENT	California EPA, Regional Water Quality Control Board (RWQCB)
COMPOUNDS OF CONCERN	Petroleum hydrocarbons, benzene, metals (including RCRA lead), sludges
NATURE AND EXTENT OF PROBLEM	The 400-acre site is located in a major city, upgradient of commercial and residential developments, and downgradient of industrial facilities that have off-site migration. The refinery has been in operation for over 70 years.
SITE CHARACTERIZATION	The site consists of silty sands and Pleistocene marine sands. Groundwater is encountered at approximately 35 feet below grade.
SOLUTION	Groundwater Technology has consulted to the refinery since 1990. The following environmental programs and areas of concern are in varying stages of completion.

NESHAPS

Groundwater Technology sampled every process water waste stream, identified benzene-laden waste streams, and designed a benzene treatment reduction system to comply with benzene NESHAPS regulations.

RCRA Part A and B Permitting for a Surface Impoundment

Following changes in federal hazardous waste regulations, the impoundment became a hazardous waste storage unit. The impoundment stored refinery wastewater, which generates a primary oil/water/solids separation sludge (Federal Hazardous Waste Number F038). Because the impoundment did not meet minimum technical requirements of applicable federal and state regulations, upgrading or closure was required. Groundwater Technology researched the site, assembled the required documentation, and prepared a Part A application, which was subsequently approved. The impoundment continued to operate under interim status while Groundwater Technology prepared a Part B permit application.

RCRA Closure Plan for a Surface Impoundment

Groundwater Technology also prepared a closure plan to obtain regulatory closure of the refinery wastewater surface impoundment. Closure of the unit in a timely manner allowed exemption from some of the requirements of the Toxic Pits Control Act, as well as continued operation until alternative units could be constructed. All compliance requirements were prepared and submitted under the guidance of Groundwater Technology, preventing potential fines by EPA.

NA

Hazardous Waste Management
Groundwater Technology developed RCRA training sessions for refinery personnel to manage hazardous waste management units.

Assessment
The refinery planned to construct additional crude oil processing units on the site of an inactive unlined disposal unit. Groundwater Technology assessed the soil and sludges at the disposal unit, and scheduled all assessment activities to accommodate construction. Groundwater Technology's detailed study identified three distinct zones. Our assessment indicated that RCRA lead was confined to the topmost layer, thus reducing the volume of soil that would require pretreatment prior to disposal. Groundwater Technology subsequently prepared a Remedial Action Plan (RAP) and designed a dynamic statistical sampling plan to facilitate separate excavation and treatment of the RCRA lead, thus reducing treatment costs by approximately $2 million.

Groundwater Monitoring
Groundwater Technology has completed three consecutive quarters of facility-wide groundwater monitoring and modelling as required to continue operation under RCRA interim status and to meet state water board regulations. Groundwater Technology has also been retained to monitor groundwater quality for four additional quarters.

Hydrogeologic Study
Groundwater Technology compiled all available groundwater monitoring and geologic assessment data and developed a comprehensive hydrogeologic study of the entire facility. The study incorporated a three-dimensional model of subsurface lithology and the water-bearing zones.

Design and Construction of an Aboveground Bioremediation Facility
During a detailed assessment of a former aboveground storage tank area, Groundwater Technology discovered that over 50,000 cubic yards of soil contain diesel fuel, crude, and fuel oil. Groundwater Technology subsequently designed and constructed an aboveground soil treatment unit. The remedial design reduced costs by considering site constraints and using refinery resources. To further reduce costs, Groundwater Technology is training refinery staff to perform routine sampling, and will write a field sampling protocol.

Initially, the unit will be used to remediate excavated soil from the former aboveground tank area. The cleaned soil can then be used as backfill when other contaminated soils at the refinery are excavated for treatment in the bioremediation facility.

Assessment of an Oil Pipeline Leak

CLIENT/FACILITY	Major oil pipeline company/Oil pipeline, southern California
REGULATORY INVOLVEMENT	City fire department, Regional Water Quality Control Board, County Health Services
COMPOUNDS OF CONCERN	Crude oil
NATURE AND EXTENT OF PROBLEM	While performing routine maintenance, pipeline workers noticed stained soil and petroleum odors.
SITE CHARACTERIZATION	The site is located at an intersection in a residential area. Depth to groundwater is approximately 27 feet. A perched water zone exists at 14 feet below grade. Subsurface lithology consists of well graded low- to moderate-permeability clays, silts, and sands. The entire site is underlain by a low permeability clay layer at approximately 8 to 11 feet.
SOLUTION	Groundwater Technology developed an assessment workplan and performed an extensive site assessment to determine the nature and extent of the leak. Assessment tasks included defining the extent of contamination in soil and groundwater, characterizing the chemistry of the contaminants, conducting a health risk assessment, and determining geotechnical parameters for possible excavation and shoring. Sixteen soil borings were drilled and six monitoring wells were installed. In addition to on-site assessment work, Groundwater Technology contacted area homeowners and rental companies to obtain permission to drill borings on private properties adjacent to the site. Shallow (approximately 15 to 45 feet below grade) borings were drilled using equipment that would minimize disruption and allow access to the property. Samples were analyzed for benzene, toluene, ethylbenzene, and xylene (BTEX); and total petroleum hydrocarbons (TPH). A human health risk assessment was performed to determine the level of exposure to the contaminants and calculate potential danger to pipeline workers and area residents. Other tasks included a soil-gas survey and fuel fingerprinting. Based on the data obtained from soil physical property analysis, chromatography, and soil-gas survey, Groundwater Technology determined that the leak was encapsulated by the clay, and that human health risk was near zero. A "no action" closure was recommended.

GROUNDWATER
TECHNOLOGY, INC.

Remedial Investigation at a Refinery

CLIENT/FACILITY	Confidential petroleum client/Refinery, California
REGULATORY INVOLVEMENT	EPA Region IX, California EPA, Regional Water Quality Control Board (RWQCB)
COMPOUNDS OF CONCERN	RCRA regulated lead, benzene, and total petroleum hydrocarbons (TPH) as crude oil
NATURE AND EXTENT OF PROBLEM	The refinery planned to construct additional crude oil processing units on the site of an inactive disposal unit. The earthen-lined unit was filled in during previous construction activities.
SITE CHARACTERIZATION	The refinery is located in a major metropolitan area, upgradient of a wildlife sanctuary, a public recreation area, and commercial and residential developments, and downgradient of other industrial facilities that have off-site migration. The site consists of silty sands and Pleistocene marine sands. Groundwater is encountered at approximately 34 feet below grade.
SOLUTION	Groundwater Technology assessed the buried soil and sludges at the disposal unit, and scheduled all assessment activities to accommodate construction activities. Groundwater Technology's detailed study was designed to limit the amount of material that would require disposal as a RCRA-regulated waste. A review of historical records and interviews with facility personnel confirmed the historical deposition of the material. The five-phase assessment combined multiple techniques, including hand augering, continuous coring, extensive cone penetrometer testing, and a vapor extraction pilot test. Although previous investigations found two layers of contamination, Groundwater Technology identified three distinct zones of contaminated artificial fill. Our assessment indicated that RCRA regulated lead contamination was confined to the uppermost layer. Approximately 19,000 cubic yards of the originally identified 36,000 cubic yards contained RCRA lead requiring pretreatment before disposal. Definition of this contaminated layer substantially reduced the volume of soil that would require treatment prior to disposal. Groundwater Technology subsequently prepared a Remedial Action Plan (RAP) and designed a dynamic statistical sampling program that would facilitate separate excavation and treatment of the RCRA regulated lead contaminated sludge, thereby limiting disposal costs and saving the client approximately $2 million. The remaining structurally incompetent and TPH-bearing soils will be segregated and treated appropriately.

Feasibility Study for Soil and Groundwater Remediation

CLIENT/FACILITY	Major oil company/Pipeline, southern California
REGULATORY INVOLVEMENT	California Regional Water Quality Control Board (RWQCB)
COMPOUNDS OF CONCERN	Gasoline, diesel fuel, and crude oil
NATURE AND EXTENT OF PROBLEM	The leaks were discovered when gasoline fumes migrated into the basement of a building and exploded. The pipeline leaks occurred beneath a public street, private and public buildings, and a recreation area. Twenty-five pipelines underlie a main thoroughfare that terminates in an oil company transfer facility. A nearby bulk terminal facility has been used for petroleum hydrocarbon storage and transfer since 1910. The areal extent of contamination is more than 10 acres.
SITE CHARACTERIZATION	Depth to groundwater ranges from 2 to 48 feet below grade. The site consists of coarse to medium sand, silty sand, and clayey sand.
SOLUTION	Groundwater Technology performed the last of five subsurface assessments and a feasibility study to evaluate and recommend remedial alternatives for soil and groundwater impacted by diesel fuel and gasoline. Data from three previous assessments were reviewed and correlated to determine lateral and vertical extent of contamination. Volume calculations indicated approximately 7,200 gallons of adsorbed-phase gasoline and 15,300 gallons of diesel fuel were present in the subsurface, with only 10 to 15 gallons of dissolved-phase gasoline and diesel fuel in groundwater. RWQCB determined that crude oil concentrations posed no threat to human health or groundwater. Alternative remedial technologies were identified, screened, and ranked based on effectiveness, implementability, and cost. Nine soil technologies and five groundwater technologies were reviewed. The ranking indicated a combination of vapor extraction and bioremediation, in conjunction with groundwater monitoring, as the most appropriate remedial technology for the site. Groundwater Technology then performed a detailed analysis of low, medium, and high flowrate vapor extraction treatment systems, and recommended a thermal oxidizer with a flowrate of 1,500 cubic feet per minute. Groundwater Technology is developing a remedial action plan.

GROUNDWATER
TECHNOLOGY, INC.

Feasibility Study for Control of Benzene Air Emissions

CLIENT/FACILITY	Petroleum refinery, Los Angeles, California
REGULATORY INVOLVEMENT	United States Environmental Protection Agency (US EPA)
COMPOUNDS OF CONCERN	Benzene
NATURE AND EXTENT OF PROBLEM	On March 7, 1990, the EPA promulgated regulations regarding benzene waste operations that apply to petroleum refineries. These regulations were established under the National Emission Standards for Hazardous Air Pollutants (NESHAP) program as described in Title 40 Code of Federal Regulations, Part 61, Subpart FF. The benzene NESHAP program requires identification of all benzene waste streams and calculation of total annual benzene waste in Megagrams per year (Mg/yr). Facilities with more than 10 Mg/yr of benzene waste will be required to treat those waste streams with benzene concentrations over 10 parts per million by weight.
SOLUTION	Groundwater Technology worked closely with refinery personnel to identify all benzene waste streams. Stream types included process sour water, pump leaks, wash down water, and tank draws. Each individual waste stream was sampled in triplicate from concrete induction boxes. The refinery's waste water flow rates were determines using a paddle wheel flowmeter and checked for accuracy against refinery records. Groundwater Technology was successful in compiling the data, calculating the total annual benzene waste quantity, and submitting a report to the EPA within the 90-day compliance date. Groundwater Technology was further retained to re-sample and confirm the original data, sample closer to points of generation where possible, sample under upset conditions, and complete an engineering feasibility study for benzene waste treatment.

Design and Construction of an Aboveground Bioremediation Facility at a Refinery

CLIENT/FACILITY	Confidential petroleum client/Refinery, California
REGULATORY INVOLVEMENT	California EPA, Regional Water Quality Control Board (RWQCB)
COMPOUNDS OF CONCERN	Petroleum hydrocarbon
NATURE AND EXTENT OF PROBLEM	During a detailed assessment of a former aboveground storage tank area, Groundwater Technology discovered that over 50,000 cubic yards of soil contained diesel fuel, crude, and fuel oil.
SITE CHARACTERIZATION	The refinery is located in a major metropolitan area, upgradient of commercial and residential developments, and downgradient of other industrial facilities that have off-site migration. The site consists of silty sands and marine sands. Groundwater is encountered at greater than 120 feet below grade.
SOLUTION	Groundwater Technology subsequently designed and constructed an aboveground soil treatment unit. The liner and leachate collection system were designed to meet local rainfall requirements. The unit was constructed in the former aboveground tank area, near the stockpile of excavated soil. Remedial design also took advantage of the refinery's in-house construction and engineering services. By considering site constraints and using refinery resources, the remedial design significantly reduced the client's costs; on-site treatment saves approximately $55 per cubic yard when compared to off-site disposal. Groundwater Technology also developed a statistically based field sampling protocol. To further reduce costs, Groundwater Technology trained refinery staff to perform routine sampling. Baseline samples are being obtained from under the abandoned tank area to establish background levels and demonstrate that there is no migration. The unit is being used to remediate excavated soil from the former aboveground tank area. The cleaned soil will then be used as backfill when other contaminated soils at the refinery are excavated for treatment in the bioremediation facility.

Comprehensive Environmental Services at a Refinery

CLIENT/FACILITY	Confidential petroleum client/Refinery, California
REGULATORY INVOLVEMENT	California EPA, Regional Water Quality Control Board (RWQCB)
COMPOUNDS OF CONCERN	Petroleum hydrocarbons, benzene, metals (including RCRA lead), sludges
NATURE AND EXTENT OF PROBLEM	The 400-acre site is located in a major city, upgradient of commercial and residential developments, and downgradient of industrial facilities that have off-site migration. The refinery has been in operation for over 70 years.
SITE CHARACTERIZATION	The site consists of silty sands and Pleistocene marine sands. Groundwater is encountered at approximately 35 feet below grade.

SOLUTION

Groundwater Technology has consulted to the refinery since 1990. The following environmental programs and areas of concern are in varying stages of completion.

NESHAPS

Groundwater Technology sampled every process water waste stream, identified benzene-laden waste streams, and designed a benzene treatment reduction system to comply with benzene NESHAPS regulations.

RCRA Part A and B Permitting for a Surface Impoundment

Following changes in federal hazardous waste regulations, the impoundment became a hazardous waste storage unit. The impoundment stored refinery wastewater, which generates a primary oil/water/solids separation sludge (Federal Hazardous Waste Number F038). Because the impoundment did not meet minimum technical requirements of applicable federal and state regulations, upgrading or closure was required. Groundwater Technology researched the site, assembled the required documentation, and prepared a Part A application, which was subsequently approved. The impoundment continued to operate under interim status while Groundwater Technology prepared a Part B permit application.

RCRA Closure Plan for a Surface Impoundment

Groundwater Technology also prepared a closure plan to obtain regulatory closure of the refinery wastewater surface impoundment. Closure of the unit in a timely manner allowed exemption from some of the requirements of the Toxic Pits Control Act, as well as continued operation until alternative units could be constructed. All compliance requirements were prepared and submitted under the guidance of Groundwater Technology, preventing potential fines by EPA.

Hazardous Waste Management
Groundwater Technology developed RCRA training sessions for refinery personnel to manage hazardous waste management units.

Assessment
The refinery planned to construct additional crude oil processing units on the site of an inactive unlined disposal unit. Groundwater Technology assessed the soil and sludges at the disposal unit, and scheduled all assessment activities to accommodate construction. Groundwater Technology's detailed study identified three distinct zones. Our assessment indicated that RCRA lead was confined to the topmost layer, thus reducing the volume of soil that would require pretreatment prior to disposal. Groundwater Technology subsequently prepared a Remedial Action Plan (RAP) and designed a dynamic statistical sampling plan to facilitate separate excavation and treatment of the RCRA lead, thus reducing treatment costs by approximately $2 million.

Groundwater Monitoring
Groundwater Technology has completed three consecutive quarters of facility-wide groundwater monitoring and modelling as required to continue operation under RCRA interim status and to meet state water board regulations. Groundwater Technology has also been retained to monitor groundwater quality for four additional quarters.

Hydrogeologic Study
Groundwater Technology compiled all available groundwater monitoring and geologic assessment data and developed a comprehensive hydrogeologic study of the entire facility. The study incorporated a three-dimensional model of subsurface lithology and the water-bearing zones.

Design and Construction of an Aboveground Bioremediation Facility
During a detailed assessment of a former aboveground storage tank area, Groundwater Technology discovered that over 50,000 cubic yards of soil contain diesel fuel, crude, and fuel oil. Groundwater Technology subsequently designed and constructed an aboveground soil treatment unit. The remedial design reduced costs by considering site constraints and using refinery resources. To further reduce costs, Groundwater Technology is training refinery staff to perform routine sampling, and will write a field sampling protocol.

Initially, the unit will be used to remediate excavated soil from the former aboveground tank area. The cleaned soil can then be used as backfill when other contaminated soils at the refinery are excavated for treatment in the bioremediation facility.

Assessment of an Oil Pipeline Leak

CLIENT/FACILITY	Major oil pipeline company/Oil pipeline, southern California
REGULATORY INVOLVEMENT	City fire department, Regional Water Quality Control Board, County Health Services
COMPOUNDS OF CONCERN	Crude oil
NATURE AND EXTENT OF PROBLEM	While performing routine maintenance, pipeline workers noticed stained soil and petroleum odors.
SITE CHARACTERIZATION	The site is located at an intersection in a residential area. Depth to groundwater is approximately 27 feet. A perched water zone exists at 14 feet below grade. Subsurface lithology consists of well graded low- to moderate-permeability clays, silts, and sands. The entire site is underlain by a low permeability clay layer at approximately 8 to 11 feet.
SOLUTION	Groundwater Technology developed an assessment workplan and performed an extensive site assessment to determine the nature and extent of the leak. Assessment tasks included defining the extent of contamination in soil and groundwater, characterizing the chemistry of the contaminants, conducting a health risk assessment, and determining geotechnical parameters for possible excavation and shoring. Sixteen soil borings were drilled and six monitoring wells were installed. In addition to on-site assessment work, Groundwater Technology contacted area homeowners and rental companies to obtain permission to drill borings on private properties adjacent to the site. Shallow (approximately 15 to 45 feet below grade) borings were drilled using equipment that would minimize disruption and allow access to the property. Samples were analyzed for benzene, toluene, ethylbenzene, and xylene (BTEX); and total petroleum hydrocarbons (TPH). A human health risk assessment was performed to determine the level of exposure to the contaminants and calculate potential danger to pipeline workers and area residents. Other tasks included a soil-gas survey and fuel fingerprinting. Based on the data obtained from soil physical property analysis, chromatography, and soil-gas survey, Groundwater Technology determined that the leak was encapsulated by the clay, and that human health risk was near zero. A "no action" closure was recommended.

Soil Excavation and Site Restoration

CLIENT/FACILITY	Major oil company/Petroleum pipeline, California
REGULATORY INVOLVEMENT	Regional Water Quality Control Board, County Health Services Department
COMPOUNDS OF CONCERN	Petroleum hydrocarbons, crude oil
NATURE AND EXTENT OF PROBLEM	A crude oil loss occurred adjacent to a canal when a hole was inadvertently ground into the side of a pipeline. An estimated two to three barrels of crude oil were released before an isolation valve could be shut. Because of the elevation difference between the valve and leak location (the valve was higher than the leak), an additional unknown volume of crude oil may have leaked into the subsurface.
SITE CHARACTERIZATION	The pipeline traverses government property, crossing under a canal. Impacted soil was observed and excavated east and west of the canal.
SOLUTION	Groundwater Technology assisted the client in beginning a preliminary excavation to remove contaminated soil. Because impacted soil was observed on both sides of the canal, the client decided to conduct a subsurface assessment and evaluate corrective action options. Groundwater Technology was also retained by the client to provide assessment services at the site. The assessment was designed to investigate the subsurface soil and groundwater conditions and to determine the extent of petroleum hydrocarbon impacted soil in the area adjacent to the leak location. Data was collected from eleven soil borings and four monitoring wells were drilled at the site in March 1990. This preliminary data indicated that the vadose-zone soils and groundwater had been impacted by petroleum hydrocarbons. The extent of impacted soil on the east side of the canal appeared to be confined to an area 15 feet in diameter. The results of groundwater sample analyses indicated that groundwater in the vicinity of the leak had been impacted by petroleum hydrocarbons. Groundwater Technology was subsequently retained by the client to prepare a Remedial Action Plan (RAP) to restore the site to its original condition. Based on site conditions and timelines, Groundwater Technology proposed excavating the impacted soil and removing it for disposal or treatment. On behalf of the client, Groundwater Technology notified the appropriate interested parties and obtained the necessary permits. Thirteen soil borings were drilled and the collected data were used to define the extent of the excavation.

Soil was excavated on both sides of the canal in four phases: pipeline exposure, backhoe potholeing, clean overburden soil excavation, and excavation of impacted soil. After the excavation, the excavation pit was backfilled and compacted.

Soil excavation and site restoration were performed according to the RAP presented to the regulatory agencies. The excavation removed the soils containing petroleum hydrocarbon concentrations greater than 100 parts per million to a depth of approximately two feet below the water table.

The excavated soil was classified as nonhazardous based on the laboratory analyses performed. The client has transported all excavated soils off site to a Class III landfill.

Groundwater Technology is finishing the fourth event of quarterly monitoring and sampling. No target hydrocarbons have been detected in groundwater. We anticipate closure by RWQCB in early 1992.

Aboveground Bioremediation

CLIENT/FACILITY	Confidential petroleum client/Refinery, San Francisco bay area
REGULATORY INVOLVEMENT	Regional Water Quality Control Board, Bay Area Air Quality Management District
COMPOUNDS OF CONCERN	Diesel range hydrocarbons
NATURE AND EXTENT OF PROBLEM	Excavation from a facility expansion generated approximately 16,000 cubic yards of soil. Laboratory analyses of the soil indicated diesel range hydrocarbons with concentrations ranging from 42 to 770 parts per million (ppm). Metals were present at levels below the Total Threshold Limit Concentrations as set by the California Department of Health Services. The source of contamination was a pipeline release of diesel fuels combined with general refinery petroleum products introduced over the 100-year life of the facility. Planned development at the facility calls for the use of a large quantity of fill material. Refinery management wanted to remediate the diesel-contaminated soil to acceptable regulatory levels, allowing its reuse in the planned development.
SITE CHARACTERIZATION	Clayey fill and bay mud soils
SOLUTION	Ten representative samples were collected to obtain background moisture, pH, and bacterial levels. Based on the analytical results, Groundwater Technology determined that relatively high background levels of hydrocarbon-using bacteria existed in the soils under pH and moisture conditions that were within the optimal range for maximum biodegradation rates. Because of the clayey nature of the soil, physical conditioning was necessary to completely mix nutrients and atmospheric oxygen with the hydrocarbon-contaminated soil. This required extensive soil handling and the use of large earth-moving equipment. Soil was removed from the original soil pile and spread into an open area where large chunks of clay were crushed. Soil samples from the site consistently contained no detectable levels of gasoline constituents, so volatilization during soil conditioning was not a problem. After the soil was sufficiently conditioned, the treatment cells were constructed.

Upon completion of the treatment cells, venting pipes were manifolded to a high vacuum blower. The aeration system was designed by considering the atmospheric oxygen needed for complete hydrocarbon degradation, the relatively impermeable nature of the soils, and the friction losses associated with drawing air through the length of the piping system.

During treatment cell construction, soil samples were collected at specified locations. The samples were analyzed for diesel hydrocarbon concentrations to provide a baseline for monitoring diesel concentration degradation throughout the life of the project. Weekly readings of carbon dioxide and volatile hydrocarbon concentrations were taken from the blower and carbon canister effluent. The readings were used to determine the rate of hydrocarbon biodegradation occurring in the treatment cells and to assess breakthrough of hydrocarbon emissions from the carbon canisters.

After 45 days of operation, samples of diesel-contaminated soils indicated an average level of diesel hydrocarbons of 22 ppm, with 58 percent of the results below detection limits (less than 10 ppm). Soil with these concentrations is no longer considered a "designated waste" (as defined under Title 23 of the California Code of Regulations, Chapter 3, Subchapter 15, Section 2522) and can be used for various purposes as approved by local regulatory agencies.

This project demonstrates the effectiveness of aboveground bioremediation on a large volume of clayey soil. The success of this project involved understanding the micro-environment and the required mass transport of inorganic nutrients and atmospheric oxygen for optimum biodegradation rates, and engineering a system that provided the necessary requirements.

Environmental Liability Consulting for a Refinery Acquisition

CLIENT/FACILITY

Major oil refining company, southern California

REGULATORY INVOLVEMENT

EPA Region IX, California Department of Toxic Substance Control, Regional Water Quality Control Board, and South Coast Air Quality Management District

COMPOUNDS OF CONCERN

Petroleum hydrocarbons, lead, dissolved air flotation, API separator sludge

NATURE AND EXTENT OF PROBLEM

Our client was preparing to purchase another refinery and needed to review the potential liabilities that would be assumed as a result of the purchase.

SITE CHARACTERIZATION

The refinery, which is located in a major metropolitan area, began operations in the early 1900s.

SOLUTION

Groundwater Technology assembled a project team to support the client and legal counsel during a due diligence investigation. The team provided administrative and project management support for a comprehensive analysis of regulatory compliance issues. All historic documents relating to environmental issues were cataloged in a library for copying and retrieval. Because of the magnitude of the issues involved, the project team divided into four work groups to analyze specific areas of concern. Each work group was coordinated by a task manager, who in turn reported to the project manager.

One group researched hazardous waste management practices of the former operator. The group developed a compliance matrix to track the status of each designated or potential solid waste unit at the facility. The operation and permitting history of each unit was researched and documented; many of the solid waste units were also designated as hazardous waste management units. Special consideration was given to recent changes in Resource Conservation and Recovery Act regulations, such as the TCLP characterization of hazardous waste.

This group also established the criteria for transfer of permits for hazardous waste storage, industrial waste and stormwater discharge. Following negotiations with regulatory agencies, the group prepared and submitted the appropriate permits.

A second group reviewed issues pertaining to surface water management, including wet and dry flow conditions. Effluent discharge data was reviewed to determine permit compliance with recent effluent standards established by the publicly owned treatment works.

The third group assessed soil and groundwater conditions at the facility. All data generated from the environmental site investigation were compiled to determine the hydrogeologic setting and estimate the contaminant distribution below the facility.

The fourth group evaluated two groundwater remediation systems that had been installed but had not been operated at full capacity. These systems included a groundwater interceptor system and a liquid-phase product recovery system. The groundwater interceptor system, located on the downgradient boundary, was designed to prevent off-site contaminant migration. The liquid-phase product recovery system was designed to recover approximately 200,000 barrels of product associated with the unconfined aquifer below the facility. Both systems were evaluated for viability as well as dollar value.

The findings of the investigation were compiled within six weeks. Potential liabilities were quantified and used by our client during successful final negotiations of the sale.

Hydrogeologic Assessment of Two Surface Impoundments

CLIENT/FACILITY

Confidential petroleum client/Refinery, California

REGULATORY INVOLVEMENT

Regional Water Quality Control Board (RWQCB)

COMPOUNDS OF CONCERN

Petroleum hydrocarbons

NATURE AND EXTENT OF PROBLEM

California's Toxic Pits Clean-up Act of 1984 requires facilities with surface impoundments that store and treat hazardous wastes to prepare and submit a Hydrogeological Assessment Report (HAR). The HAR is designed to provide RWQCB with information regarding surface and groundwater quality, and the impact that the hazardous waste surface impoundments have had on water quality. Based on this information, RWQCB determines what action should be taken to maintain water quality in the vicinity of the impoundments.

Following changes in federal hazardous waste regulations, two impoundments recently became hazardous waste storage units. Both impoundments store refinery wastewater, which generates a primary oil/water/solids separation sludge (Federal Hazardous Waste Number F037).

SITE CHARACTERIZATION

The site consists of poorly graded dune sands. Groundwater is encountered at 50 feet below grade under the coke pond, and at 30 feet below grade under the safety basin.

SOLUTION

Groundwater Technology installed four groundwater monitoring wells around each impoundment. All 8 new wells and 12 existing wells were surveyed. Groundwater samples were taken from the eight new wells. The samples were analyzed for TTLC metals, volatile organic compounds (VOCs), semi-volatiles, total petroleum hydrocarbons (TPH), groundwater contamination indicators, groundwater quality parameters, and primary drinking water standards.

Groundwater Technology also drilled two background soil borings. Soil samples were analyzed for TTLC metals, VOCs, semi-volatiles, and TPH.

Some semi-volatile contamination was found in one sample from one upgradient well, but no contamination was detected in the other samples. The HAR has been prepared and submitted.

Part A and Part B RCRA Permitting of a Surface Impoundment

CLIENT/FACILITY

Confidential petroleum client/Refinery, California

REGULATORY INVOLVEMENT

US EPA, Region IX; California EPA; Regional Water Quality Control Board (RWQCB)

COMPOUNDS OF CONCERN

Petroleum hydrocarbons

NATURE AND EXTENT OF PROBLEM

Following changes in federal hazardous waste regulations, a stormwater impoundment recently became a hazardous waste storage unit. The impoundment temporarily stores refinery wastewater, which generates a primary oil/water/solids separation sludge (Federal Hazardous Waste Number F037). The stormwater basin was used as needed when additional wastewater storage capacity was required.

SITE CHARACTERIZATION

The refinery is in a major metropolitan area, upgradient of commercial and residential developments, and downgradient of other industrial facilities that have off-site migration. The site consists of silty sands and Pleistocene marine sands. Groundwater is encountered at approximately 35 feet below grade.

SOLUTION

Groundwater Technology researched the site and assembled the documentation required for a Part A permit application. Documentation included lists of existing permits to operate, topographic maps, facility drawings, and photographs of the impoundment. The Part A permit application was then prepared, submitted, and approved.

The stormwater holding impoundment operated as a TSDF under interim status while a Part B permit application was prepared. Groundwater Technology assembled pertinent information (such as health and safety training documentation, corrective action plan, and a closure plan) to accompany the application. The application was submitted during September 1991 and was subsequently approved.

As required for continued operation under interim status, groundwater has been monitored upgradient of the impoundment for four quarters to establish a statistical background value for groundwater quality. Groundwater Technology has begun detection monitoring of downgradient point-of-compliance wells. Data from the point-of-compliance wells are compared to background data. Based on the results of the first quarter of detection monitoring, a statistically significant evidence of a release is anticipated. Therefore, at the end of one year of quarterly monitoring, an evaluation monitoring program will begin.

RCRA Closure Plan for a Surface Impoundment

CLIENT/FACILITY

Confidential client/Refinery, Los Angeles, California

REGULATORY INVOLVEMENT

Regional Water Quality Control Board (RWQCB), Department of Health Services (DOHS), and USEPA

COMPOUNDS OF CONCERN

Metals, volatile and semi-volatile organic compounds, F037 and F038 sludge

NATURE AND EXTENT OF PROBLEM

California's Toxic Pits Clean-up Act of 1984 requires facilities with surface impoundments that store and treat hazardous wastes to prepare and submit a Hydrogeological Assessment Report (HAR). The HAR is designed to provide RWQCB with information regarding surface and groundwater quality, and the impact that the hazardous waste surface impoundments have had on water quality. Based on this information, RWQCB determines what action should be taken to maintain water quality in the vicinity of the impoundments.

Following changes in federal hazardous waste regulations, the impoundment recently became a hazardous waste storage unit. The impoundment stores refinery wastewater, which generates a primary oil/water/solids separation sludge (Federal Hazardous Waste Number F037).

SITE CHARACTERIZATION

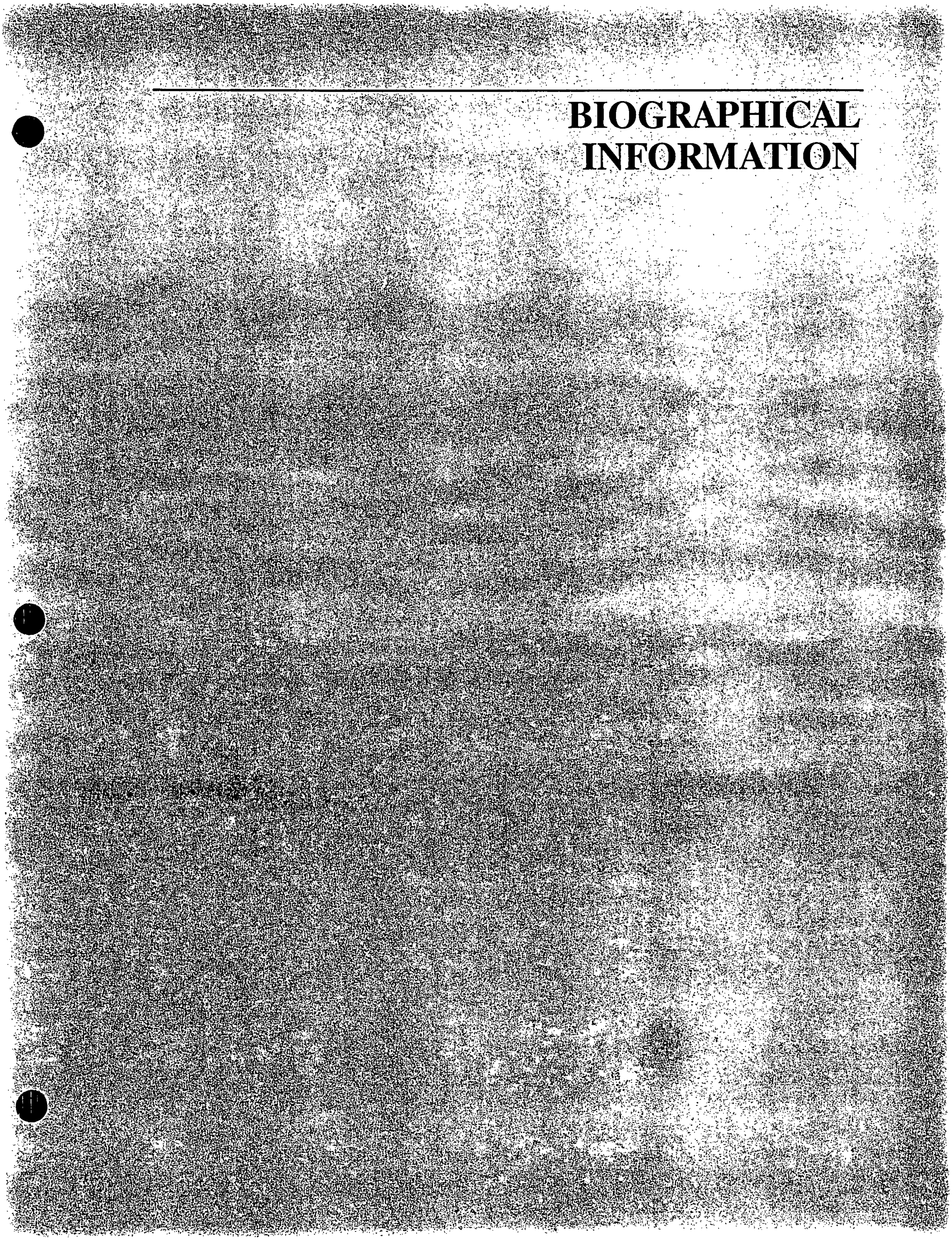
The refinery is located in a major metropolitan area, upgradient of commercial and residential developments, and downgradient of other industrial facilities that have off-site migration. The site consists of silty sands and Pleistocene marine sands. Groundwater is encountered at approximately 35 feet below grade.

The surface impoundment used to store the regulated materials did not meet minimum technical requirements of applicable federal and state regulations, and therefore required upgrading or closure.

SOLUTION

Groundwater Technology prepared a closure plan to obtain regulatory closure of the surface impoundment. Closure of the unit in a timely manner allowed exemption from some of the requirements of the Toxic Pits Control Act, as well as continued operation until alternative units could be constructed. The plan was developed using site-specific physical parameters, chemical and physical properties of the waste materials, and statistical methods. In the interim, an operating record and all other compliance requirements were prepared and submitted under the guidance of Groundwater Technology, preventing potential fines by EPA.

BIOGRAPHICAL INFORMATION



Marian J. Barnes
Regulatory Specialist
Hydrogeologist

EDUCATION

M.S., Geology, Northern Illinois University, 1985

B.A., Geology, Albion College, 1983

PROFESSIONAL PROFILE

Ms. Barnes is a regulatory specialist with Groundwater Technology. In this position she provides support to project managers on RCRA, CERCLA, and Clean Water Act-driven projects. Specifically, she gives project direction and writes proposals, RCRA closure plans, RFI/CMS/CMI work plans, and conducts phase I and compliance audits. She responds to job-specific questions regarding regulatory policies, hazardous waste management and corrective action. She assists clients in management of soil and groundwater generated from investigation and remediation activities. She conducts RCRA training seminars for Groundwater Technology personnel, and gives presentations to clients and other organizations.

She is also editor of the monthly RCRA/CERCLA Newsletter (distribution 2,400) which presents pertinent information relating to hazardous waste remediation.

Ms. Barnes was a project manager with Groundwater Technology for two years prior to becoming the regulatory specialist. She managed projects ranging from initial site assessment to hydrocarbon remediation system installation and operation with multiple pumping systems, air stripping, and soil vapor extraction.

Prior to employment with Groundwater Technology, Ms. Barnes was employed by U.S. EPA in their Chicago, Illinois Region V office. She worked in the RCRA Enforcement Section evaluating groundwater monitoring systems at hazardous waste disposal sites for compliance with RCRA. She wrote, negotiated and overviewed the implementation of several RCRA and CERCLA corrective action orders in which remedial investigations were being conducted for groundwater contamination. She also wrote and negotiated settlements for compliance orders regarding RCRA violations at hazardous waste sites. She assisted in the development of the RCRA programs in Michigan and Wisconsin.

Research work as a graduate student consisted of developing, writing, and implementing a finite difference groundwater computer model to qualify the movement of mineralized water in the deep water-supply aquifer in the Chicago metropolitan area.

Other experience includes mapping the groundwater table and contaminant plumes at a Department of Energy National Laboratory, and working at a college/community nature center.

PROJECT EXPERIENCE

Environmental Audit
Conducted a comprehensive environmental audit for two operating facilities of a company which was recently purchased. The audit included identification of environmental regulations the facilities were subject to, an inspection of the facilities for areas of noncompliance, and recommendations to achieve current and future compliance.

RCRA Closure
Wrote and negotiated with Illinois EPA a RCRA closure plan for a container storage area at a facility under enforcement action.

Wrote and modified a RCRA closure plan to work toward certification of clean closure of an underground spent solvents storage tank in Illinois.

Wrote closure, contingent closure and post closure plans for underground storage tanks and a container storage area that stored spent solvents in Iowa (EPA Region VII).

Wrote and assisted in standardization of closure plans in New England states for a solvent recycler with numerous facilities in the area.

RCRA Corrective Action
Wrote and standardized work plans for RCRA Facility Investigations and Corrective Measures Implementation for a large chemical manufacturer and distributor.

RCRA Groundwater Monitoring Plans
Prepared outlines for project geologists to complete for an alternative assessment groundwater monitoring plan at a refinery, and for compliance monitoring and remediation monitoring at a chemical research facility.

SPECIAL QUALIFICATIONS

Professional Affiliations
Institute of Hazardous Materials Management, Board of Examiners

Registration
Certified Hazardous Materials Manager

Publications
Abstract of M.S. thesis: Groundwater, May-June 1986.
Paper on M.S. thesis: FOCUS Conference on Midwest Groundwater Issues, Indianapolis, Indiana, March 1987.

Continuing Education
OSHA 29 CFR 1910.120 40-Hour Safety Training
OSHA 29 CFR 1910.120 8-Hour Annual Refresher Course

Teresa J. Bennett
Geologist

EDUCATION

B.S., Geology and Biology, Eastern New Mexico University, Portales, New Mexico

M.S., Geology, Northern Arizona University, Flagstaff, Arizona

PROFESSIONAL PROFILE

Ms. Bennett is a Geologist in the Ohio office. She is responsible for collecting, interpreting and reporting hydrogeologic data from field monitoring of wells and hydrocarbon recovery equipment. She coordinates all phases of a project from the initial proposal writing through the final report compilation and presentation to the client.

Prior to joining Groundwater Technology, Ms. Bennett was employed by an oil production company where she was an exploration and production geologist for Europe, Latin America and the Far East region. Ms. Bennett completed geological maps of offshore Trinidad holdings and successfully recommended development drilling and exploratory prospects to upper management. She also was the operations geologist of the Ireland office and interfaced frequently with foreign partners and government.

PROJECT EXPERIENCE

Site Preparation
Supervision of monitoring well placement and construction.

Site Assessment
Collection and interpretation of geology/hydrogeology data to obtain groundwater flow direction and gradient. Conducted field tests to determine the permeability, transmissivity, and storativity of an aquifer.

Site Remediation
Implementation and maintenance of remediation abatement systems to address hydrocarbon and other volatile organic contaminants

Site Remediation
Duties included geologic and geophysical subsurface mapping, well cutting and core description, well log interpretation, computer projects and oral and written report presentations.

SPECIAL QUALIFICATIONS

Affiliations
National Water Well Association
American Association of Petroleum Geologists

Publications
Bennett, T. J., 1986 American Translocation in Acid Precipitation, Project RAIN, Norway Shallow

(Abstract and Oral Presentation). American Geophysical Union Front Range Branch, Sixth Annual "Hydrology Days," Colorado State University, Fort Collins, Colorado. (Publication in progress.)

Continuing Education

Introduction to Hydrogeology, short course, October, 1988

Graduate level Hydrogeology course, University of Houston, Houston, Texas, Spring, 1989

Underground Storage Tanks, Seminar, May, 1989

Sara C. Brothers
Hydrogeologist

EDUCATION

A.B., Geological Sciences, Harvard University, Cambridge, Massachusetts, 1983

M.S., Geology, University of New Mexico, Albuquerque, New Mexico, 1987

Post-Masters study in Hydrogeology, Organic Chemistry, and Geochemistry at the University of New Mexico, New Mexico

PROFESSIONAL PROFILE

Ms. Brothers is a hydrogeologist for Groundwater Technology Inc. with responsibility for implementing hydrogeologic assessments and remediation of hydrocarbon-contaminated properties, in addition to performance of environmental assessments in conjunction with real estate property transfers. Ms. Brothers has experience in conducting hydrogeologic assessments in a variety of geologic environments in addition to providing technical support in the preparation of RCRA Part B permit applications and closure and contingency plans for hazardous waster facilities. She has also provided a review for technical adequacy and regulatory compliance of work plans for remedial investigations/ feasibility studies at CERCLA-regulated sites, and prepared quality assurance/quality control plans for RCRA groundwater monitoring activities.

Previously Ms. Brothers served as an Assistant Project Hydrogeologist for an environmental firm where she had experience in the supervision and implementation of all aspects of hydrogeologic assessments at hydrocarbon contaminated properties. Prepared cost estimates for remediation systems and preparation of RCRA part B permits for hazardous waste facilities. She also evaluated remedial alternatives, including analysis of slug and pump test data. As a graduate student, Ms. Brothers received a National Science Foundation Graduate Fellowship and a Caswell-Silver Graduate Fellowship. Her work during this time included geochemical modeling and geologic mapping and sampling of Pre-Cambrian terrains in northern New Mexico and Central Australia.

PROJECT EXPERIENCE

Site Assessment and Remediation

Implementation of hydrogeologic assessments and remediation at petroleum storage and distribution facilities, including aquifer analysis, soil vapor surveys, soil venting pilot tests, supervision of test-hole drilling and monitor well installation, soil and ground water sampling, preparation of scopes of work and cost estimates for remedial alternatives, and final report preparation and review.

Site Assessment, Real Estate Transfer

Preparation of real-estate transfer environmental assessments, involving site inspections, interviews, records search and review, evaluation of compliance with federal, state and local regulations, waste-stream sampling, and final report preparation.

Site Investigation
Subsurface investigation of CERCLA designated facility, including preparation of scopes of work, cost estimates, test hole drilling and soil sampling, monitor well installation and groundwater sampling, regulatory and client interface, data review, computer modeling of hydrogeologic and chemical data, and final report preparation.

Site Assessment
Supervision and implementation of all aspects of hydrogeologic assessments at hydrocarbon-contaminated properties, including preparation of cost estimates, supervision of hollow-stem auger and air rotary drilling, split-spoon sampling and preparation of lithologic logs, monitor well installation, ground-water sampling, fluid-level measurements, well record searches, computer modeling of ground-water and soil vapor quality data, client and regulatory interface, and final report preparation and review.

Site Remediation, Underground Storage Tanks
Implementation of hydrogeologic assessment and groundwater remediation at abandoned sites in New Mexico under the State of New Mexico UST Superfund contract.

Permitting
Preparation of RCRA Part B Permit applications and closure plans for hazardous waste facilities.

Site Monitoring
Implementation of RCRA groundwater detection monitoring at a hazardous waste landfill, preparation of quality assurance/quality control and sampling and analysis plans.

SPECIAL QUALIFICATIONS

Affiliations
Association of Groundwater Scientists and Engineers

Continuing Education
Site Remediation, International Technology Corporation, May, 1988 (Qualified Supervisor per 29 CFR 1910.120)

Hazards and Protection, International Technology Corporation, August, 1988 and April, 1989 (OSHA 29 CFR 1910.120 8-Hour Refresher Training)

Richard A. Brown, Ph.D.
Vice President, Remediation Technology

EDUCATION

Ph.D., Organometallic Chemistry, Cornell University, 1977

M.S., Inorganic and Analytical Chemistry, Cornell University, 1974

B.A., Chemistry, Harvard University, 1971

PROFESSIONAL PROFILE

Dr. Brown is Vice President of Remediation Technology for Groundwater Technology, Inc. His responsibilities include the development and implementation of remediation technologies such as bioremediation, soil vapor extraction and air sparging. Dr. Brown also chairs Groundwater Technology's Development Program, looking at new technologies for soil and groundwater treatment. Prior to this position, Dr. Brown was Director of Remediation Technology for Groundwater Technology's Remediation Technology Group and was responsible for developing Groundwater Technology's Soil Vapor Extraction and Air Sparging Technology.

Previously Dr. Brown also served as a manager of Bioreclamation Services, where his responsibilities included project management, system design and business development for *in situ* and on-site treatment of hazardous wastes. Dr. Brown has developed and implemented remediation systems using biological and vapor extraction technologies; he holds several patents in hazardous waste treatment for the use of hydrogen peroxide as a continuous oxygen source in the *in situ* aerobic biodegradation of petroleum hydrocarbons, for an improved nutrient formulation for stimulating oil-degrading bacteria, and for soil treatment using an ambient-air-assisted bioreclamation process.

Dr. Brown has been active in the research and development of bioreclamation technology for treatment of soils and groundwater. He is an author of "Field Study of Enhanced Subsurface Biodegradation Using Hydrogen Peroxide as an Oxygen Source" for the American Petroleum Institute (API) and was principle investigator on the study, "Hazard Assessment and Remedial Techniques for Soils Impacted by Petroleum Products." He worked on new technology for the investigation and treatment of complex, contaminated sites including wood treating, coal gasification and Superfund sites.

Previous experience includes serving as Director of Business Development for Cambridge Analytical Associate's Bioremediation Systems and Technology Manager for FMC Corporation's Aquifer Remediation Systems. Prior to working in the environmental industry, Dr. Brown was Manager of Energy Development and Group Leader for FMC's Specialty Chemicals Division, working on product development in mining, energy production, waste treatment, and chemical synthesis. Dr. Brown is an expert in hydrogen peroxide chemistry.

PROJECT EXPERIENCE

Superfund Site, OK
Expert witness for PRP committee on the applicability of soil vapor extraction to hazardous waste disposal site during trial on remedy selection.

Gasoline Terminal, NJ
Design and installation of an integrated soil vapor extraction bioremediation system for treating gasoline contaminated soils. Site is in closure.

Dry Cleaner, DE
Design and installation of air sparging/soil vapor extraction system for removing PCE and TCE from soils and groundwater. Site is in closure.

Manufacturing Site, VA
Design of soil treatment system for chlorobenzene contaminated soils which used bioaugmented soil vapor extraction.

Refinery, Montreal
Design of permanent soil biotreatment facility to handle soils from refinery construction and operations.

Pesticide Site, MA
Site investigation and evaluation of remedial options including vapor extraction and bioreclamation. Design of final remedial system.

Industrial Site, OH
Site investigation and design of vapor extraction system for treatment of chlorinated hydrocarbons. Site investigation included soil gas surveying and supervision of drilling.

Coal Tar Site, NY
Design of *in situ* chemical oxidation system for the treatment of iron contamination in groundwater discharge. Field study of biodegradation of coal tar organics.

Manufacturing Site, CT
Field design and implementation of vapor extraction system for treatment of chlorinated hydrocarbon contamination.

Gasoline Station, CA
Design and implementation of remedial system combining bioreclamation and soil venting for the treatment of gasoline-contaminated soil and groundwater.

Manufacturing Facility, MI
Treatment of solvent contamination in tank pit utilizing free-product recovery, bioreclamation, and carbon adsorption.

Manufacturing Facility, MA
Treatment of a formaldehyde spill with *in situ* chemical oxidation using hydrogen peroxide injection.

Gasoline Terminal, IN
Supervision of field research project on the use of hydrogen peroxide as an oxygenating agent for *in situ* enhanced bioreclamation.

SPECIAL QUALIFICATIONS

Professional Affiliations

Association of Groundwater Scientists and Engineers
American Chemical Society
Society of Petroleum Engineers
Water Environment Federation
National Ground Water Association

Presentations/Publications

Course Director: Center for Professional Advancement, "Biological Treatment of Contaminated Soil and Groundwater", Short Course.

Lecturer: National Ground Water Association, "Ground Water Treatment Technology", Short Course.
University of Connecticut , "Soil Vapor Extraction"

Member: Executive Committee, National Research Council, "Committee on In-Situ Bioremediation", May 1992 - February 1993.

Brown, R.A., and W. Leonard, November 4-6, 1992. "Air Sparging: An Optimal Solution", NGWA Petroleum Hydrocarbon Conference, Houston, Texas.

Brown, R.A., et al., August 9-12, 1992. "The Evolution of a Technology: Soil Vapor Extraction", American Institute of Chemical Engineers, Minneapolis, Minnesota.

Brown, R.A., and T. Hawke, June 21-26, 1992. "The Biological Treatment of Soils and Sludges", Air & Waste Management Association, Kansas City, Missouri.

Brown, R.A., June 21-24, 1992. "Air Sparging: A Primer for Application and Design", Subsurface Restoration Conference, Dallas, Texas.

Brown, R.A., E. Henry and C. Herman, June 14-17, 1992. "The Use of Site Air Sparging/Soil Vapor Extraction", Eco World '92, Washington, D.C.

Brown, R.A., P. Rosenwinkel and R. Stempkovski, June 10-12, 1992. "A Comparative Analysis of Pilot Soil Vapor Extraction Data with Both Hydrogeologic Parameters and Subsequent System Performance Data", HazMat International 1992, Atlantic City, New Jersey.

Brown, R.A., and W. Leonard, June 10-12, 1992. "The Use of Air Sparging for the Rapid Remediation of Solvent Contaminated Sites", HazMat International 1992, Atlantic City, New Jersey.

Brown, R.A., et al., April 28-30, 1992. "Lowering the Cost of Site Investigation Through On-Site and Alternative Laboratory Analyses", New England Environmental Expo, Boston, Massachusetts.

Brown, R.A., April 15, 1992. "The Advantages and Disadvantages of Bioventing and Vapor Extraction Technology", Bioventing and Vapor Extraction Satellite Seminar, Raleigh, NC.

Brown, R.A., G. Batchelder, and S. Unger, April 7-9, 1992. "Technology Selection in the Remediation of UST Sites", ETEX '92, Washington, D.C.

Brown, R.A., E. Henry, and C. Herman, March 29 - April 2, 1992. "Treatment of a Solvent Contaminated Site with Air Sparging/Soil Vapor Extraction", American Institute of Chemical Engineers, New Orleans, Louisiana.

Brown, R.A., et. al, February 4-6, 1992. "*In-Situ* Treatment of Chlorinated Solvents in Shallow Aquifers with Air Sparging/Soil Venting (ASV Technology)", Air & Waste Management Association, Cincinnati, Ohio.

Brown, R.A., E. Henry, C. Herman, and W. Leonard, November 20-22, 1991. "The Use of Aeration in Environmental Clean-Ups", National Water Well Association, Houston, Texas.

Brown, R.A., et. al, November 13-15, 1991. "Remediation of Subsurface Chromium Contamination Utilizing Above Ground and *In-Situ* Methods", The Society of American Military Engineers, Technology Transfer Conference, Denver, Colorado.

Brown, R.A., D. Arnold, and C. W. Dittmar II, November 13-15, 1991. "The Use of Field Methods in Site Investigations", The Society of American Military Engineers, Technology Transfer Conference, Denver, Colorado.

Brown, R.A., and C.J. Harper, October 6-10, 1991. "Comprehensive Site Remediation - A Case Study in Vermont", Water Pollution Control Federation, Toronto, Ontario.

Brown, R.A., and J. Daggett, August 1991. "Control Compliance Costs", Hydrocarbon Processing, pp. 61-63.

Brown, R.A., and R.J. Falotico, May 21-23, 1991. "Environmental Engineering for the Petroleum Refining Industry", Refining Process Services Seminar, Houston, TX.

Brown, R.A., and K. Sullivan, May 1991. "Integrating Technologies Enhances Remediation", Pollution Engineering, pp. 62-68.

Brown, R.A., P. Kroopnick and D. Bush, May 21-23, 1991. "Soil Vapor Extraction: A Short Term, Cost Effective Process or the Next "Pump and Treat"?", New England Environmental Expo, Boston, MA.

Brown, R.A., and F. Jasiulewicz, May 7-8, 1991. "Remediation of Fuel Spills Contaminating Groundwater with Floating Product Through the Use of Integrated Site Remediation", U.S. Air Force Environmental Restoration Technology Symposium, San Antonio, TX.

Brown, R.A., and R. Fraxedas, April 29-May 1, 1991. "Air Sparging - Extending

Volatilization to Contaminated Aquifers", Symposium on Soil Venting, Houston, TX.

Brown, R.A., C.J. Harper and J. Oppenheim, March 19-21, 1991. "Application of *In Situ* Bioreclamation to a Low-Permeable Heterogeneous Formation", In Situ and On-Site Bioreclamation International Symposium, San Diego, CA.

Brown, R.A., and G.E. Hoag, February 20-22, 1991. "*In Situ* Treatment of Volatile Organic Compounds With Soil Vapor Extraction", HMCRI R & D Conference, Anaheim, CA.

Brown, R.A., January 1991. "Emerging Technologies in On-Site Remediation", Engineering Society of Detroit, Detroit, MI.

Brown, R.A., G. Batchelder and R. Lewis, January 1991. "Chlorinated Solvent Contamination: A Challenge to Find and Remove", Chemical Processing Magazine, Chicago, IL.

Brown, R.A., J.D. Dey and W.E. McFarland, November 26-28, 1990. "Integrated Site Remediation Combining Groundwater Treatment, Soil Vapor Recovery and Bioremediation", Superfund '90, Washington, DC.

Brown, R.A., October 29-November 2, 1990. "The Bioremediation of Petroleum Hydrocarbons", Biofor/Bioqual '90, Fredericton, New Brunswick, Canada.

Brown, R.A., and T. Hawke, October 16-17, 1990. "Treatment of Contaminated Soil - Excavation - On-Site Bioreclamation", A Conference on "Prevention and Treatment of Soil and Groundwater Contamination in the Petroleum Refining and Distribution Industry", Montreal, Quebec.

Brown, R.A., and R.T. Cartwright, October 1990. "Biotreat Sludges and Soils", Hydrocarbon Processing, pp. 93-96.

Brown, R.A., September 1990. "Treatment Technology for Contaminated Groundwater", Association of Groundwater Scientists and Engineers American Petroleum Institute.

Brown, R.A., December 1989. "Oxygen Sources for Biotechnological Applications", proceedings of the 1989 Biotechnology Work Group, U.S. Navy Civil Engineering Laboratory/U.S. Army Construction Engineering Laboratory, Monterey, CA.

Brown, R.A., December 7, 1989. "A Practical Guide to Remedial Technology", The Chem Show, New York, NY.

Brown, R.A., June 1989. "Oxygen Sources for *In Situ* Bioremediation", Hazardous Materials Control Research Institute, Baltimore, MD.

Brown, R.A., W.S. Clayton and K.L. Brody, May 1989. "The Reduction of Groundwater Contamination by Vapor Extraction of Volatile Organics From the Vadose Zone", New England Environmental Expo, Boston, MA.

Brown, R.A., E.L. Crockett and R.D. Norris, December 3-5, 1987. "The Principles of *In Situ* Biological Treatment," Haz Mat West, Long Beach, CA.

Brown, R.A., and J.F. Ridler, October 18-21, 1987. "Early Detection, Rapid Response" Expo '87, Chicago, IL.

Brown, R.A., G.E. Hoag and R.D. Norris, October 5-8, 1987. "The Remediation Game: Pump, Dig or Treat," Water Pollution Control Federation, Philadelphia, PA.

Brown, R.A., R.D. Norris and J.F. Ridler, August 13-15, 1987. "Contaminated Soils, the Unseen Problem," Haztec International Conference, St. Louis, MO.

Brown, R.A., and R.D. Norris, June 2-4, 1986. "An In-Depth Look at Bioreclamation." Presented at Haz Mat. Atlantic City, N.J.

Brown, R.A., and R.D. Norris. May 21, 1986. "Field Demonstration of Enhanced Bioreclamation." Presented at the Sixth National Symposium and Exposition on Aquifer Restoration and Groundwater Monitoring. Columbus, OH.

Brown, R.A., and E.J. Salmon, May 13-15, 1986. "Application of Risk Assessment to Selection Among Site Remediation Alternatives." Presented at the Purdue Industrial Wastes *Conference*. Lafayette, IN.

Brown, R.A., D.C. McGarvey and J.R. Loper, May 5-7, 1986. "*In Situ* Treatment of Groundwater: Issues and Answers." Presented at 1986 Hazardous Materials Spills Conference. St. Louis, MO.

Brown, R.A., R.D. Norris and M. Westray, April 1-3, 1986. "*In Situ* Treatment of Groundwater." Presented at Haz Pro '86. Baltimore, MD.

Brown, R.A., and R.D. Norris, December 4, 1985. "*In Situ* Bioreclamation--A Complete On-site Solution." Haz Mat West. Long Beach, CA.

Brown, R.A., and M. Westray, November 10-14, 1985. "Groundwater Microbiology and Pollution Control." AICHE, Chicago, IL.

Brown, R.A., J.Y. Longfield, R.D. Norris and G.A. Wolf, October 6-10, 1985. "Enhanced Bioreclamation: Designing a Complete Solution to Groundwater Problems." Presented at the WPCF Industrial Wastes Symposia in Kansas City.

Brown, R.A., and M. Brenoel, May 21, 1985. "Remediation of a Leaking Underground Storage Tank with Enhanced Bioreclamation." Presented at the Fifth National Symposium and Exposition on Aquifer Restoration and Groundwater Monitoring. Columbus, OH.

Brown, R.A., R.D. Norris and R.L. Raymond, November 5-7, 1984. "Oxygen Transport in Contaminated Aquifers." Presented at National Water Well Association and American Petroleum Institute Conference "Petroleum Hydrocarbon and Organic Chemicals in Groundwater: Prevention, Detection, and Restoration." Houston, TX.

Brown, R.A., February 14-17, 1982. "Separation and Recovery of By-Product and Secondary Metals with Peroxygen Chemicals." Presented at the 111th AIME Meeting. Dallas, TX.

Brown, R.A., December 1978. "Phenolic Problems Solved with Hydrogen Peroxide Oxidation." Industrial Water Engineering. pp. 22-27.

Patents
U.S. Patent No.4,594,170. Method for Liquefying Chloride Based Heavy Brine Well Completion Fluids.

U.S. Patent No. 4,591,433. Method for Decontamination of Subterranean Formations.

U.S. Patent No. 4,588,506. Stimulation of Bioxidation in Subterranean Formation.

U.S. Patent No. 4,552,675. Composition and Method for Treating a Subterranean Formation.

U.S. Patent No. 4,552,674. Composition and Method for Treating a Subterranean Formation.

U.S. Patent No. 4,552,668. Oxidation of Sulfides in Polymer-thickened Aqueous Solution.

U.S. Patent No. 4,526,762. Recovery of Vanadium form Acid Solutions.

U.S. Patent No. 4,453,597. Stimulation of Hydrocarbon Flow from a Geological Formation.

U.S. Patent No. 4,418,051. Process for Preparing Thallium (III).

U.S. Patent No. 4,362,487. Control of Hydrogen Sulfide Emission from Geothermal Steam Plants with Hydrogen Peroxide and Sodium Vanadate.

U.S. Patent No. 4,320,097. Recovery of Vanadium from Acid Solutions

U.S. Patent Disclosure No. 1,102,906. Method of Removing Phosphate Impurities from Yellowcake.

Cymantha Diaz
Senior Geologist
Project Coordinator

EDUCATION

B.S., Geology, Duke University, 1985

PROFESSIONAL PROFILE

Project coordinator for two key industrial customers on a national level. Responsibilities include communicating customer requirements to all Groundwater Technology, Inc. offices managing projects for these customers, and technical review of all reports and proposals submitted to these customers for quality and consistency. Also central customer contact for RFPs. Coordinator for new joint venture program with an industrial client for marketing remediation and assessment services to their customer base.

Hydrogeologist and Project Manager for four years in the New Jersey District of the Eastern Region, providing technical management for site assessment and soil and groundwater remediation projects. Experience includes preparation of proposals and remedial action programs/work plans for enforcement cases, underground storage tank sites, NJPDES cases, NJ-ECRA projects and RCRA-regulated facilities. Coordination and implementation of field services for hydrogeologic investigations and interpretation of data; construction management of large-scale site cleanups; liaison between clients and regulatory agencies; management of resources, project budgets and schedules.

Two years previous experience as a geologist on a multi-disciplinary staff providing technical assistance on CERCLA cleanups and assessments, and CWA-regulated facilities (SPCC Inspections and emergency response.)

PROJECT EXPERIENCE

RCRA RFI/CMS and CMI Plan Preparation
Project manager for chemical distribution facility RCRA compliance project, involving delineation of soil and groundwater impacts, implementation of interim measures such as DNAPL recovery, and preparation of required work plans and reports for compliance. CMI Work Plan entails groundwater recovery and treatment and feasibility testing of soil venting and air sparging technologies for "source area" soils. Negotiations with regulators for cleanup strategies and criteria are ongoing.

ECRA Cleanup Plan Preparation/Implementation
Project manager for preparation of ECRA cleanup plan for 25 acre industrial site with heavy metal contaminated soils and volatile organic and base neutral compound contaminated soil and groundwater. Facility had operated for over 60 years as a chemical, foods, and specialty products manufacturer. Health-based contaminant calculations and evaluation of site-specific exposure pathways and migration routes were utilized to recommend alternate action levels for site remediation. Remedial actions proposed for soils at the site include soil excavation and disposal (PCBs), *in situ* soil venting (volatiles) and soil fixation (heavy metals and base neutrals). The proposed groundwater cleanup plan consisting of groundwater recovery from twelve wells and treatment using air stripping technology has been approved by ECRA and is currently underway.

Underground Storage Tank Site Remediation
Supervisor of site assessments for petroleum retail facilities to determine impact to soil and groundwater associated with underground storage of petroleum products. Manager of remediation programs that include product recovery, groundwater recovery and treatment, *in situ* soil venting and soil excavation. Negotiated monitoring, corrective action, and closure requirements with regulatory agencies.

RCRA Closure Plan Preparation/Implementation
Prepared closure plans for several RCRA-regulated facilities operated by a national client undertaking the replacement of underground storage tanks (USTs) with aboveground tanks, as well as full facility closures. Supervised the implementation of closure plans, including pre-closure assessments, UST removals, and remediations involving various *in situ* technologies. Currently negotiating alternate cleanup levels (ACLs) with regulators to eliminate or reduce post-closure care requirements.

RCRA Treatment, Storage and Disposal Facility (TSDF) Site Remediation
Project Manager for compliance and remediation activities at a 11-acre TSDF, which has been active for over 50 years as a solvent recycling facility. Requires extensive coordination between construction, remediation and compliance divisions of a major corporation. Site is regulated under NJPDES, RCRA, ECRA, Bureau of Hazardous Waste Engineering (BHWE) and Bureau of Ground Water Pollution Abatement (BGWPA) enforcement groups. Compliance activities include quarterly monitoring pursuant to a NJPDES permit, stack testing for air emissions, and Administrative Order (AO) conditions.

Remediation activities include the design, installation and operation/ maintenance/monitoring of soil and groundwater treatment systems. A site-wide *in situ* soil venting system and off-gas treatment will be implemented in phases at the site to address volatile organics adsorbed to soils. Risk and statistical analyses will be used to support ACLs for heavy metals and PCBs in soils.

Groundwater has been impacted with chlorinated hydrocarbons. The proposed remediation program consists of recovery and treatment by ultraviolet oxidation, and long-term monitoring. A 90-day pilot study is being performed to demonstrate the feasibility of this technology at the site.

Site Characterization/Feasibility Study.
Investigation and feasibility study to define the extent of contamination resulting from the failure of underground gasoline storage tanks. The investigation included a soil gas survey, a soil vent radius of influence test, soil and groundwater quality assessment, bioremediation feasibility study, nutrient optimization study, and aquifer tests. Using the data generated from these studies, a comprehensive remediation program was developed to include pump-and-treat via air stripping, soil venting, catalytic oxidation and *in situ* bioremediation technologies. Provided expert testimony during litigation to defend estimated cleanup costs. Provided comments to draft corrective action permit with preliminary risk analysis resulting in reduced regulatory requirements/permit conditions and closure requirements.

ECRA Sampling Plan/Cleanup Plan.
ECRA sampling and cleanup plan preparation for a site which involved discharge of industrial wastewater to a drywell system. Sampling plan implementation involved high quality assurance/quality control field sampling and decontamination protocol. An extensive file search to investigate the chemical inventory and biodegradation products was performed for source determination. Negotiated cleanup criteria with regulatory agencies for approved cleanup plan.

ECRA Cleanup Plan Preparation/Implementation
Project Manager for ECRA cleanup of a 22-acre industrial site, formerly involved in the manufacture of display screens, assembly of circuit boards and fabrication of magnetic data storage units. Supervised large-scale cleanup of soils contaminated with heavy metals, PCBs and chlorinated organics. Involved extensive excavation, post-excavation sampling and off-site disposal coordination. Provided thorough documentation of cleanup procedures. Coordinated residential well water treatment system installations, maintenance and monitoring for impacted homes. Remediation of on-site wetlands and groundwater is ongoing, involving numerous permits through the state and local agencies.

Risk Assessment for Construction Project at Former Landfill.
Landfill air monitoring, soil gas, soil and groundwater sampling comprised and environmental assessment for future land use, risk assessment, and potential liability evaluation.

CERCLA Environmental Cleanup, Utica, NY.
Supervised the technical staff on site for former custom steel products fabrication facility. Project involved PCBs, mercury, asbestos, and acids. Cleanup technologies included high pressure water laser of concrete floors and walls in conjunction with an on-site carbon water treatment system. Performed air monitoring and extensive documentation of site activities. Implemented safety programs such as heat stress monitoring and confined space entries.

Environmental Cleanup of CERCLA Site, Granby, NY.
Supervised the technical staff on site for project involving over 2,300 buried drums of hazardous wastes from over 70 responsible parties. Responsibilities included overseeing contractors, conducting continuous site control programs, drum and soil sampling, creating and maintaining a computerized inventory of drums and samples, and coordinating waste stream classification and disposal options.

Community Relations for CERCLA Site, Mt. Vernon, NY.
Provided assistance for community relations for a multi-jurisdictional site cleanup involving a warehouse containing explosives, dioxin, cylinders, pesticides, and lab packing of approximately 10,000 containers of chemicals. Site was located in a densely populated area, causing public concern.

CERCLA Emergency Response, Arecibo, Puerto Rico.
Provided technical assistance on an emergency removal action for a Superfund site involving a warehouse in a densely populated area containing explosives, fuming acids, and phosgene, among other hazardous materials. Supervised contractor in lab-packing operations, on-site neutralization of chemicals, and off-site disposal/recycling of materials. coordinated with the local regulators (Environmental Quality Board and Civil Defense) for community relations and area detoxification efforts.

SPECIAL QUALIFICATIONS

Registrations/Certifications

Registered Professional Geologist, Delaware
New Jersey Licensed N-2 Industrial Wastewater Treatment System Operator.
New Jersey UST Certification for Closures and Subsurface Investigations.

Awards

Groundwater Technology's, Inc. 1991 William T. Sullivan Award - The company's highest honor granted annually by the Board of Directors for demonstrating a commitment to education and fostering greater intra-company understanding.

Paul G. Kelly
Health and Safety Manager
Western Region, Sacramento

EDUCATION

M.S., Health Science (Industrial Hygiene), California State University, Northridge, 1980

B.S., Industrial Hygiene, California State University, Northridge, 1977

PROFESSIONAL PROFILE

Ten years experience in industrial and corporate safety, industrial hygiene, and environmental programs. Develops and provides employee health and safety training and emergency preparedness programs, industrial hygiene sampling programs, Occupational Safety and Health Administration compliance, and industrial facilities compliance.

PROJECT EXPERIENCE

Led the environmental compliance assessment team for a 500-acre explosive device manufacturer and authored the report with extensive recommendations.

Managed an air toxics "hot spots" health risk assessment and a refined risk assessment for a major glass manufacturer.

Team leader for a hazardous waste source reduction project for a Central Valley glass manufacturer.

Performed environmental assessments for the acquisition of new properties; performed primary environmental engineering for an Austin, Texas, facility.

Developed and implemented a nationwide asbestos training program to reduce the impact of asbestos on employees during telecommunication system installation and maintenance.

Developed a chemical right-to-know training program for approximately 1,200 employees in three locations; trained 25 on-site personnel to deliver right-to-know information.

Provided health and safety programs to a startup semiconductor company including the design and installation of state-of-the-art safety and security monitoring systems.

Developed and implemented health and safety training programs for semiconductor manufacturing facilities.

Developed and implemented focused 24-hour training program for the Department of Energy employees in hazardous materials handling and spill response.

Developed a site closure plan for hazardous waste units at a Hewlett Packard facility.

Obtained environmental permits through the Bay Area Air Quality Management District for an electronics manufacturing facility.

Peter M. Kroopnick, PhD, REA, CGWP
Senior Scientist
Manager, Hydrogeological Services

EDUCATION

PhD, Earth Sciences, University of California, San Diego, 1971

M.S., Chemistry, University of California, Berkeley, 1965

B.S., Chemistry, Wayne State University, Detroit, 1963

PROFESSIONAL PROFILE

Provides hydrological and chemical modeling support for Groundwater Technology projects throughout the world. Results are used for EPA Superfund litigation support and risk-based design of remediation strategies. Supervises and trains regional staff in groundwater modeling, data base management, and statistical evaluation of environmental data.

Develops quality assurance/quality control procedures. Oversees application of advanced technologies to the remediation of contaminated sites. Conducts environmental audits of industrial properties.

Wrote Standard Operating Procedures for many of the tasks performed by Groundwater Technology field personnel. Prepared inspection criteria for the environmental assessment of industrial and residential properties.

As first regional Regulatory Compliance Director, coordinated the permitting of hazardous waste activities with the DOHS, WRCB, and various air quality agencies. Actively participated in the California Department of Health Services permit streamlining program task group. In this capacity, wrote draft regulations for the permitting of on-site hazardous waste treatment technologies.

Implemented Regional Health and Safety program. In less than one year, brought entire region into compliance with OSHA regulations. Recruited industrial hygienist to manage the program.

Conceived, operated, and built mobile laboratory which conducts on-site analyses for contaminated water, soil, air, and soil gas. The technically and financially successful operation was then spun-off to GTEL Environmental Laboratories, Inc. for routine operation.

PROJECT EXPERIENCE

University of California, Davis, California. Visiting Professor of Geology and Resource Science. Taught graduate and undergraduate courses in environmental chemistry, geochemistry, isotope methodologies, and hazardous waste management. Consulted on projects for radioactive waste management, data base design, and advanced analytical instrumentation design.

Exxon Production Research Company
Group leader for source rock and porosity prediction. Established a $500,000 mineral isotope analysis facility. Directed development of new methods for gas and oil exploration using statistical and numerical modeling techniques. Designed and constructed computerized data bases of global climatological and geochemical data. Organized and directed projects to build portable computer systems for hydrocarbon analyses and petrologic data acquisition and reporting.

University of Hawaii, and Hawaii Institute of Geophysics. Associate Chairman and Professor of Oceanography.
Taught and researched in oceanography, environmental chemistry, geology, isotope tracers and alternative energy utilization. Vice Chairman of the Hawaii State Radiological safety committee which wrote legislation, procedures and standards for monitoring radiation in coastal waters.

Consultant to government and private industry on the environmental effects of dredging and waste disposal.

Member, Hawaii State Technical Committee on Water Quality Standards, which wrote procedures for conforming to EPA estuarine receiving water standards.

SPECIAL QUALIFICATIONS

Continuing Education
Geochemistry of Groundwater, National Water Well Association, 1988
Petroleum Hydrocarbons and Organic Chemicals in Groundwater - Use of Models for Assessment and Remediation, Virginia Polytechnic Institute, 1990.
Update to SARA, Section 113, Regulations On Preparing Toxic Release Inventory Reports, EPA, 1991.

Certifications
OSHA 29 CFR 1910.120 40-Hour Safety Training
OSHA 29 CFR 1910.120 8-Hour Supervisor Training

Instructor
University of California Continuing Education, Certification Program in Hazardous Materials Management.

Professional Affiliations
Association of Engineering Geologists
National Water Well Association, Association of Groundwater Scientists & Engineers
American Association for the Advancement of Science
American Chemical Society, Geochemistry Section
American Geophysical Union
American Society of Limnology and Oceanography

Registrations
Registered Environmental Assessor, California No. 79
Certified Ground Water Professional, National Ground Water Association, No. 370

Publications and Presentations (partial list)

Kroopnick, P.M. and G. Pietruszka, 1992. "Calculating True Costs for the Treatment of Hydrocarbon Vapor Extracted During Soil Venting". Third Annual West Coast Conference on Hydrocarbon Contaminated Soils. March 9-12. Long Beach, CA.

Kroopnick, P.M., 1992. "The Chemical Composition of Gasoline Vapor Extracted During Soil Venting". Ninth Annual Hazmacon. April 2-5. Long Beach, CA.

Kroopnick, P.M., 1992. "Modeling the In Situ Venting of Hydrocarbon Contaminated Soil." The American Preparedness Association's Environmental Systems Division, Feb. Alexandria, VA.

Kroopnick, P. M., 1991. "Life-Cycle Costs for the Treatment of Hydrocarbon Vapor Extracted During Soil Venting." Proceedings: Petroleum Hydrocarbon Chemicals in Groundwater. National Ground Water Association. Houston, TX.

Kroopnick, P. M., 1991. "Modeling in *In Situ* Venting of Hydrocarbon Contaminanted Soil." Society of American Military Engineers. Denver, CO.

Kroopnick, P. M., and A. Storm, 1990. "Modeling the In Situ Venting of Soil for Hydrocarbon Remediation." ENSOL 90.

Kroopnick, P. M., 1990. "Soil-Gas Surveys: Correlation with Laboratory Measured Values of Total Volatile Hydrocarbons from Soil and Groundwater Samples." Hazmacon 90.

Nelson, C., P. Horton, R. Hughes, B. Barrie, and P. M. Kroopnick, 1990. "Large Scale Aboveground Bioremediation: A Case Study." Hazmacon 90.

Kroopnick, P. M., J. Whiffin, B. Barrie, and A. Storm, 1989. "Soil Vent Model Calibration for Remediation of Hydrocarbon Contaminated Soil." EOS, Transactions of the American Geophysical Union, 70:1099.

Kroopnick, P. M., 1988. "Soil-Gas TVH: Correlation with Laboratory Measures Values of Total Volatile Hydrocarbons from Soil and Groundwater Samples." EOS, Transactions of the American Geophysical Union, 69:1222.

Kroopnick, P. M., S. Fischbein, and E. Popek, 1989. "Mineral Spirits, Detection and Remedial Alternatives in Soil and Groundwater." EOS, Transactions of the American Geophysical Union, 69:1213.

Kroopnick, P. M., J. Szabo, and S. Paxton, 1986. "Porosity Prediction in Sandstone Reservoirs." Internal Exxon report.

Kroopnick, P. M., 1985. "The Distribution of C-13 of TCO_2 in the World Oceans." Deep-Sea Research, 32:57-84.

Kroopnick, P. M., and R. Slater, 1984. "Controls on Dissolved Oxygen Distribution and Organic Carbon Deposition in the Arabian Sea and Coastal Pakistan." Van Nostrand Reinhold Co., N.Y.

Kroopnick, P. M., T. Loutit, and J. Dravis, 1983. "The Application of Oxygen and Carbon Isotopes of Carbonates and Other Minerals to Petroleum Exploration." Internal Exxon Report.

Kroopnick, P. M., and S. Smith, 1981. "Carbon-13 Isotopic Fractionation as a Measure of Aquatic Metabolism." Nature, 294:252-253.

Margolis, S.V., P. M. Kroopnick, and W.J. Showers, 1981. "Paleoceanography: The History of the Ocean's Changing Environment," in W. Rubey Memorial Colloquium Volume, Environment of the Deep Sea. W.G. Ernst, ed. Chapter 2, 75 pgs. Prentice Hall.

Kroopnick, P. M., and S.V. Margolis, 1979. "Trace Element Concentrations In Hawaiian Coastal Sediments." ACS Symposium, Honolulu, Hawaii.

Kroopnick, P. M., and D. Thomas, 1978. "Isotopes and Gases in Hawaiian Geothermal Systems: HGP-A." Transactions of the Geothermal Resources Council. 2:653-654.

Kroopnick, P. M., and H. Craig, 1976. "Oxygen-18 Variations in Dissolved Oxygen in the Sea." Earth and Planet. Sci. Lett., 32:217-219.

Richard W. Lewis, C.P.G.
Senior Vice President
Principal Hydrogeologist

EDUCATION

B.S., Geology and Biology with a concentration in Chemistry, State University of New York at Brockport, New York, 1975

M.S., Geology Science, State University of New York at Fredonia, New York, 1977

PROFESSIONAL PROFILE

Mr. Lewis is Principal Hydrogeologist for Groundwater Technology. His areas of expertise include hydrologic evaluations of hazardous waste spills and subsequent migration, hydrocarbon recovery (substances such as fuels, solvents, halogenated organics) from groundwater aquifers, groundwater monitoring, surface and borehole geophysical exploration, municipal and monitoring well design, and preparation of hazardous waste site permits. He has also served on numerous occasions as a guest lecturer and as an expert witness concerning hazardous waste disposal and cleanup practices.

Mr. Lewis has been in charge of investigations of hazardous waste sites, RCRA facilities, inorganic pollution and chlorinated organic groundwater contamination, surface impoundment assessment and underground injection control programs. Other responsibilities include review of controlled industrial waste disposal sites as to their hydrologic and geologic suitability, and field investigations concerning possible surface and groundwater pollution. His experience and project work have covered more than 30 states, Canada, New Zealand, Australia and several European countries.

PROJECT EXPERIENCE

Superfund/Remedial Investigation, Feasibility Study (RI/FS)

Directed or reviewed more than ten RI/FS studies. Designed remedial investigations implemented to collect data crucial to the characterization of National Priority List (NPL) facilities. These data are configured to establish and conduct appropriate feasibility studies. The feasibility studies and analyses result in significant cost-saving strategies when applied to the design and implementation of selected remedial programs.

Bulk Storage Terminals

Directed the investigation of more than 70 assessments at bulk storage facilities across the United States and overseas. Investigations evaluated a wide variety of organic substances and hydrologic settings. The evaluation of petroleum products detected in conjunction with the geology has led to the discovery of previously unknown underground leak problems. The results of many of the investigations led to the design and construction of petroleum recovery/aquifer restoration programs.

Refineries, Midwest

Representative projects include: (1) senior staff geologist responsible for contract negotiations, system design and construction for the evaluation of petroleum leaks in shallow Arkansas alluvial sediments and the projected recovery of more than 10 million gallons of refined product using equipment manufactured by Oil Recovery Systems Environmental Equipment and (2) senior hydrogeologist in charge of investigation of underground petroleum leaks and design of recovery system; petroleum seepage to river was curtailed, and 1.5 million gallons of valuable petroleum product were recovered.

Chemical Company, MA
Directed hydrogeologic evaluation of petroleum recovery program. This program involved documenting extent of leaked petroleum products, the rate of their migration, and design of a recovery program to intercept those hydrocarbons over 50 feet below ground level.

Gasoline Stations, various U.S. sites
Determined the source and direction of migration of petroleum products at numerous gas stations. Evaluated free-product migration and recovery alternatives, vapor interception and water treatment related to dissolved volatile organic compounds (including benzene, toluene and xylene). These projects have covered more than 30 states and 10 countries in various geologic/hydrologic settings.

Refinery, Canada
Senior hydrogeologist for the evaluation of seepage of fuels from dock gulf heads along the St. Lawrence River. A complex multiple aquifer system consisting of fill and various geologic strata was encountered. After extensive pump testing and hydraulic analysis of the dock area, a multiple well pumping system was designed and installed to control seepage.

Chemical Company, NY
Senior hydrogeologist responsible for evaluation of volatile organic compound contamination of groundwater. Evaluated the most practical cleanup techniques for the curtailment of pollutant migration. Conducted pilot field study for the treatment of chlorobenzene by air stripping techniques. Also designed and tested pumping system for recovery of heavier-than-water, separate-phase liquids.

Defense Contractor, MA
Directed hydrogeologic investigation and tank removal program for chlorinated chemicals. The program included soil treatment and negotiations with state and federal regulators regarding site restoration. A treatment system was designed and installed to treat soils and groundwater that contained residual chlorinated compounds. A treatment system was designed and installed that effected a greater than 99.9% removal of volatile organics.

SPECIAL QUALIFICATIONS

Registrations
Certified Professional Geologist with the American Institute of Professional Geologists, Reg. No. 6111

Expert Witness Testimony
Mr. Lewis has served as a qualified expert witness on litigations in Massachusetts, New York, Maine, New Hampshire, Georgia, Florida, Kentucky, Kansas and Oklahoma.

Continuing Education
Postgraduate courses in Hazardous Waste Management, Environmental Engineering, Toxicology, Hydrology and Clay Mineralogy: Oklahoma University

Affiliations
American Institute of Professional Geologists
National Water Well Association, Technical Division
The American Association of Petroleum Geologists
Pollution Control Federation
ASTM Subcommittee D18, Ground Water Monitoring Standards

Publications/Presentations
Lewis, R.W., R. Brown, and G. Batchelder, 1991, "Chlorinated Solvent Contamination A Challenge to Find and Remove" Chemical Processing, January 1991, pages 73-78.

Lewis, R.W., R.J. Falotico, 1990, "A Simplified Two-Step Groundwater Modeling Technique for Small-Scale Aquifer Restoration Projects Proceedings of the Eastern Focus Conference, National Water Well Association, October 1990.

Lewis, R.W. and M. Robbins, 1991, "Multiphase Plume Groundwater Remediation and DNAPL Recovery using Groundwater Extraction and Treatment." Proceedings of the Northeastern Section of the Water Pollution Control Federation Conference, January 1991

Lewis, R.W., 1987, "Evaluating Aquifer Properties: Pump Tests vs. Slug Tests." Presentation at ASTM Section D-18.01 for Standards for Ground Water Monitoring, January 1987

Lewis, R.W., 1986, "Enhanced Natural Degradation and Soil Ventilation as Aquifer Remediation Techniques for Volatile Organic Contaminants." Proceedings of the EPA/NE Regional Wastewater Institute.

Lewis, R.W., Penzo, M.A. 1984, "Evaluation of Groundwater Contamination by Dissolved Hydrocarbons in a Variety of Hydrogeologic Settings." Proceedings of the Fourth National Symposium on Aquifer Restorations and Groundwater Monitoring.

Lewis, R.W., 1984, "Characterization of Aquifers Containing Halogenated Organic Compounds and Selection of Appropriate Aquifer Restoration Measure." Fourth Annual Meeting of the Halogenated Solvents Industry Alliance.

Lewis, R.W., 1982, "Custom Designing Monitoring Wells for Specific Conditions," Proceedings of the Second National Symposium on Aquifer Restoration and Groundwater Monitoring.

Lewis, R.W., Blake, S. 1982, "Underground Oil Recovery," Groundwater Monitoring Review, Spring 1983.

Lewis, R.W., 1977 "Water Quality and Bathymetry of the Cassadage Lake, Chautauqua County, New York," Abstract for the Northeastern Section, Geological Society of America, Binghamton, New York.

Lewis, R.W., 1977, "A Characterization and Comparison of Water Quality in the Three Cassadage Lakes, Chautauqua County, New York," Master's thesis, Department of Geology, State University of New York at Fredonia.

Dawn Nickols ASP, CET
Regional Health and Safety Manager

EDUCATION

B.S. in Industrial Safety, Illinois State University, Normal, Illinois, 1986

PROFESSIONAL PROFILE

Ms. Nickols is the Health and Safety Manager for Groundwater Technology's Midwest Region. Her responsibilities include evaluating hazards in the work place, implementing and managing site safety programs, training, and employee health. She is also responsible for Health and Safety consultation on client projects.

Previous work experience includes: Health and Safety Management on a corporate level for an environmental remediation firm and hazardous waste disposal facility managing the Health and Safety program. In addition she was involved with Health and Safety work in an agricultural chemical plant.

Ms. Nickols other related experiences include: Fire ground experience in structural, transportation, chemical, and radiation fire emergencies and six years of emergency medical experience in the field as well as hospital settings.

PROJECT EXPERIENCE

Site Remediation

Health and Safety Manager on all coal tar sites in the Midwest Region. Developed and implemented protocol for personnel protective equipment, decontamination procedures, ambient air monitoring, site hazards, and emergency procedures for intrusive site activities.

Site Assessment and Remediation

Health and Safety manager for several industrial clients, involving: Aquifer sparge with soil vapor extraction for chlorinated solvents; Free-phase DNAPL recovery with groundwater treatment for trichloroethylene contamination; A surface treatment system for trivalent and hexavalent chromium contamination.

Site Remediation

All aspects of Health and Safety, covering assessment, remediation, and closure phases for thirty major petroleum suppliers covering 200 operating sites.

Site Assessment

Involved with all aspects of Health and Safety in assessing extent of contamination on two Superfund sites, one involving an abandoned pesticide manufacturing facility and the other a chemical landfill which involved large-scale excavation under Level B conditions, as well as drilling and recovery system placement.

Technical Assessment

On current Health and Safety programs in a pipeline gas plant, several manufacturing facilities, and a petroleum bulk storage terminal.

Site Remediation

Health and Safety support on several petroleum hydrocarbon, waste oils, and metals remediation sites involving rail yards, air terminals, and operating utility companies.

Health and Safety Management

Technical and regulatory support in the areas of Health and Safety, involving the State Environmental Agencies in Indiana, Wyoming, Colorado, South Dakota, and Iowa. This involved document review as well as state program technical reports.

SPECIAL QUALIFICATIONS

Certification

Associate Safety Professional
Certified Environmental Trainer
Illinois Registered EMT-I
State-certified Fire-Fighter II
State-certified Fire Apparatus Engineer
Hazardous Materials First Responder

Instructor

Medic First Aid Instructor
CPR Instructor: American Heart Association
Over 500 hours of instructor hours of Hazardous Waste Operations and Emergency Response to fulfill 29 CFR 1910.120 requirements.

Affiliations

American Society of Safety Engineers
Regulatory Compliance Manager: OSHA, EPA, DOT
National Environmental Training Association

Continuing Education

Ongoing courses in Industrial Hygiene, Emergency Medicine, Regulatory Compliance and Environmental Affairs

Over 2,000 hours of field experience and instruction addressing operational issues in the areas of first-aid, CPR, fire protection, decontamination, respiratory protection, site control, work zones, personal protective equipment, industrial hygiene, air monitoring, and public relations.

Expert Witness

Functioned as a technical expert in several public meetings involving residential and public buildings being impacted by subsurface contamination.

Jan Jacobson Whiffin
Regulatory Compliance Manager
West Region, Concord

EDUCATION

B.S., Geology with Groundwater Emphasis, San Jose State University, 1984

PROFESSIONAL PROFILE

Ensures project compliance with federal and state regulations regarding project approach (assessment, remediation, and closure tasks), permitting, waste classification and project reporting; includes education and training of staff and development of standard operating procedures and internal audit programs. Actively participates in the development of state guidelines and regulations through workshops, public hearings, and written comment periods. Oversees politically and/or environmentally sensitive and complex projects as Project Director.

PROJECT EXPERIENCE

Regulatory Compliance Monitoring

Currently serving as Regional Regulatory Compliance Manager, responsible for maintaining updated information on federal environmental regulations, as well as state environmental regulations throughout the Western Region. She maintains a Regulatory Hotline, publishes monthly RCRA, CERCLA, and state hazardous waste control law updates, and disseminates news flashes on significant regulatory changes throughout the Region as they occur.

Resource Conservation and Recovery Act (RCRA)

Developed regulatory compliance strategies for implementation of corrective action and closure programs for facilities regulated under RCRA. Corrective action and closure tasks were related to solid waste management units such as underground and aboveground storage tanks, drum storage areas and surface impoundments. Representative industries include organic chemicals blending and packaging, spent solvent recycling, electronics (disk manufacturers), inorganic chemical (metals) manufacturing, wood preserving involving organic and inorganic compounds and petroleum refining. Work included regulatory negotiations, preparation/review of corrective action documents (i.e., RFI work plans and reports, CMS report, CMI workplan); preparation and review of closure plans addressing clean and "dirty" closure (e.g., closure as a landfill) scenarios.

Comprehensive Environmental Response, Compensation & Liability Act (CERCLA)

Nature of work typically involves:(1) ensuring NCP compliance is established for future cost recovery, (2) preparing and reviewing CERCLA documents (RI/FS workplan and report, QAPPs, SAPs, CRP, RAP, RAW), (3) participating in community relations activities (e.g., public hearing for the RAP), (4) regulatory negotiations. Types of projects requiring services include manufacturing firms with releases of organic chemicals, aerospace facilities and various other sites located in highly industrialized areas with commingled plumes. Project work involved definition and application of state and local regulations with regards to definition of cleanup objectives and document approvals.

Underground Storage Tanks
Developed project strategies for cleanup of releases from underground storage tanks impacting soil and groundwater, and compliance with tank construction, monitoring and operating requirements. Project work has included retail petroleum sites, production facilities, manufacturing industries and military bases. Remediation strategies have included in situ and aboveground bioremediation, in situ soil venting and pump-and-treat. Agency involvement has included state and local implementing agencies in California, Washington, Hawaii, Idaho, New Mexico, and Arizona.

California Hazardous Waste Control Law (HWCL)
Similar services as those provided for RCRA regulated projects, though focus is on projects which involves activities related to RCRA hazardous waste which are exempt from federal RCRA requirements and activities related to non-RCRA (California) hazardous wastes. Project work subject to the state HWCL include projects regulated under the Toxic Pits Control Act (TPCA) and the state Superfund program. Project strategies are based on California Code of Regulations - Title 22, and the California Health and Safety Code - Division 20. Project tasks includes regulatory negotiations, application of California's tiered hazardous waste permitting system for waste treatment, preparation and review of corrective action documents, and preparation and review of closure documents for clean and "dirty" closure scenarios.

California TPCA Project Work
Developed compliance strategy for facility engaged in inorganic products manufacturing which operated a surface impoundment subject TPCA. The soil and groundwater beneath the impoundment was impacted with high levels of zinc and lesser amounts of lead and copper. A closure plan was prepared and implemented providing for closure as a landfill, leaving materials in place. Achieving agency acceptance of closure as a landfill resulted in millions of dollars of savings to the facility owner. The lead agency was the RWQCB, with involvement by the DTSC.

California State Superfund Work
Managed California State SuperFund site in Central Valley, California, adjacent to municipal well system. Project scope involved design and implementation of remedial investigation, feasibility study and remedial action plan including community involvement and hearings. Division of remedial action plan into a soil remedial action plan and groundwater remedial action plan allowed more efficient approval processing Remediation includes: in situ soil venting with catalytic oxidation of off-gases and pump-and-treat using a multiple well point system. Soil remediation completion expected in 1993; groundwater remediation completion expected in 1995. Lead agency - DTSC, with RWQCB involvement.

California Water Quality
Developed project strategies for determining groundwater cleanup objectives for remediation sites based on compliance with the state Porter-Cologne Water Quality Act, regulations in Title 23 and pertinent state resolutions. Involved identification of beneficial uses of impacted and potentially impacted waters, application of appropriate water quality objectives and interaction with RWQCBs. Project work also involved developing strategies for compliance with Discharge to Land requirements for reuse of remediated soils and proposals to leave impacted soils in place; and groundwater compliance monitoring for units receiving discharges to land.

Regulatory Compliance for Water Quality Control Board
Previously employed with California State Regional Water Quality Control Board II (San Francisco Bay Area) as an assistant engineering geologist. Primary focus was the review of hydrogeologic data for compliance with CCR Title 23 Subchapter 15.

SPECIAL QUALIFICATIONS

Continuing Education
OSHA 40-Hour Hazardous Waste Operations and Emergency Response Training
OSHA 8-hour Supervisory Course for Hazardous Waste Activities
Environmental Regulations, Executive Enterprises, 1991
California Regulatory Update, Executive Enterprises, 1992

Affiliations
Association of Engineering Geologists
National Water Well Association

Publications
Jacobson, J., F. Aceto, and W. Smith: "Considerations for Optimization of Recovery Well Designs." Proceedings from NWWA/API Conference. Petroleum Hydrocarbons and Organic Chemicals in Ground: Prevention, Detection and Restoration, 1985.

Jacobson, J., and G. Hoehn: "Working with Developing Air Quality Regulations: A Case Study Incorporating On-Site Aeration Standards for a Vadose Zone Remediation Alternative." Proceedings from NWWA/API Conference - Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Detection and Restoration, 1987.

Presentations
Petroleum Industry/RWQCB Members, Anaheim and Walnut Creek, California., 1992. Title 22 Update and Impact to Petroleum Industry.

Kurita Industries, Concord, California, 1992. History of Regulatory Development, RCRA/CERCLA Overview.

EPA-Region IV, 1988. Soil Venting as a Remediation Technique.

NWWA/API Conference, Houston, Texas, 1987. Hazmacon, Santa Clara, California, 1986 - Working with Developing Air Quality Regulations: A Case Study Incorporating On-Site Aeration Standards for a Vadose Zone Remediation Alternative.

RWQCB-V, Sacramento, California, 1987. Soil Venting as a Remediation Technique.

South Central Valley Regulators, Stockton, California, 1987. Soil Venting as a Remediation Technique.

SUPPLEMENTAL INFORMATION

FACILITY LOCATIONS

■ Groundwater Technology Office
● GTEL Environmental Laboratories
▲ ORS Environmental Equipment
★ Corporate Headquarters
◆ Regional Headquarters

Australia

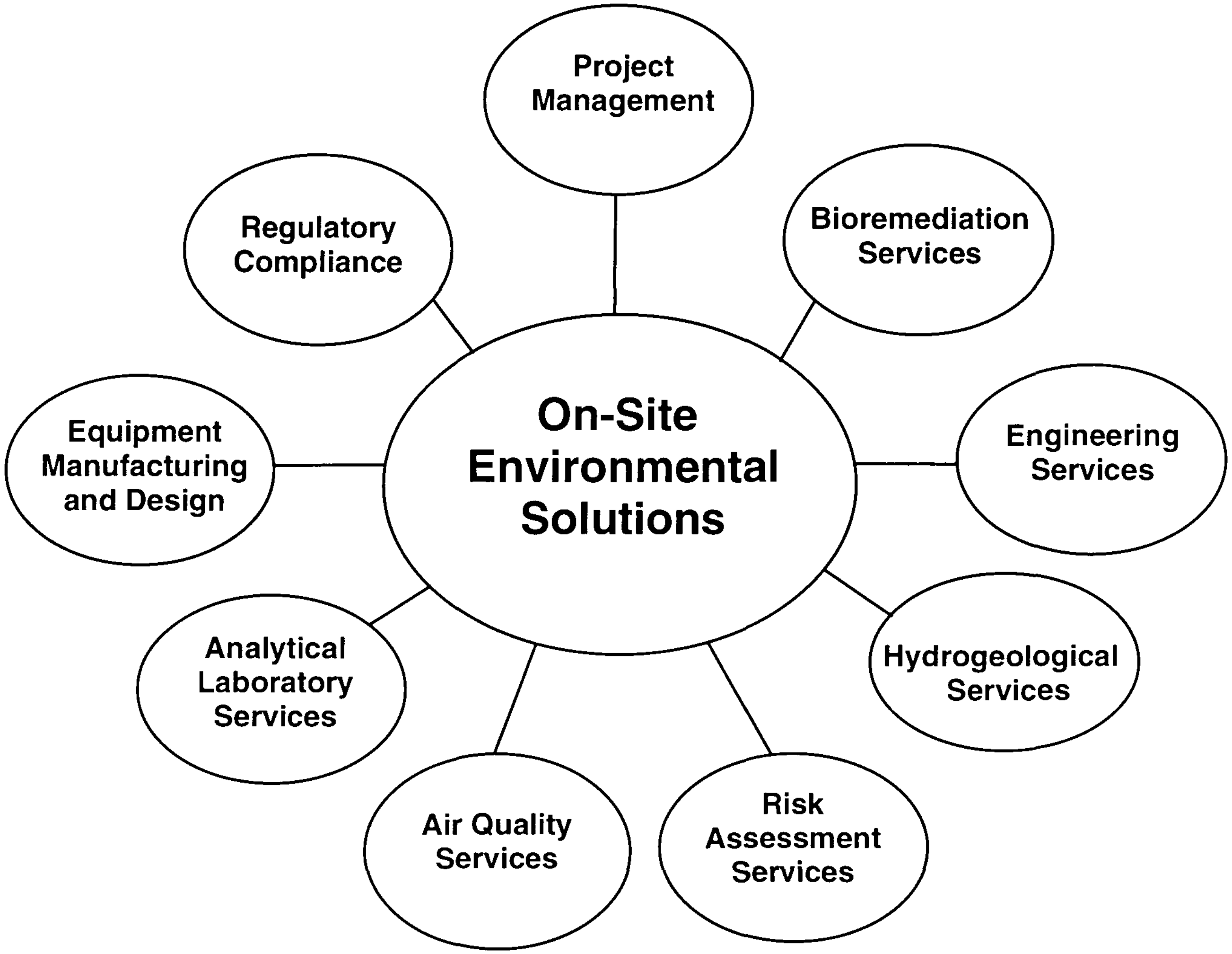
Perth, Western Australia
Sydney, New South Wales
Adelaide, South Australia
Brisbane, Queensland
Melbourne, Victoria

Europe

Manchester, England
London, England
Gent, Belgium
Rotterdam, Netherlands
Essen, Germany
Stuttgart, Germany
Berlin, Germany
Leipzig, Germany
Vienna, Austria
Budapest, Hungary
Milan, Italy

GROUNDWATER TECHNOLOGY

12/92


Project Management
Regulatory Compliance
Bioremediation Services
Equipment Manufacturing and Design
On-Site Environmental Solutions
Engineering Services
Analytical Laboratory Services
Hydrogeological Services
Air Quality Services
Risk Assessment Services

APPENDIX C

FACILITY INVESTIGATION COST ESTIMATE

APPENDIX C

SUMMARY OF COST ESTIMATE
FI WP IMPLEMENTATION
BLOOMFIELD REFINING COMPANY
BLOOMFIELD, NEW MEXICO

TASK	TOTAL	
TASK 1: SOIL VAPOR SURVEY	$25,175.25	
TASK 2: SOIL BORINGS	$16,163.00	
TASK 3: GROUNDWATER MONITORING WELL INSTALLATION	$19,314.50	
TASK 4: GROUNDWATER SAMPLING	$9,001.00	
TASK 5: PROFESSIONAL SURVEY	$3,300.00	
TASK 6: AQUIFER PUMP TEST	$21,629.25	
TASK 7: SOIL VAPOR EXTRACTION/AIR SPARGE PILOT TEST	$34,212.25	
TASK 8: STREAM/DITCH SAMPLING	$4,604.00	
FI REPORT PREPARATION	$18,636.50	
PROJECT MEETINGS/STATUS REPORTS/GENERAL PROJECT MANAGEMENT	$9,859.00	
LABORATORY COSTS	$84,600.00	
PROJECT TOTAL		$241,890.75

BLOOMFIELD REFINING COMPANY - BLOOMFILED, NEW MEXICO
COST ESTIMATE- WP IMPLEMENTATION

TASK 1: SOIL VAPOR SURVEY

OBJECT ACCOUNT	RESOURCE	UNITS	QTY	UNIT COST	COST FACTOR	BUDGET	OBJECT TOTALS	TASK TOTAL
DIRECT LABOR								
SITE SUPERVISION	PI	HRS	70	$62.00	1	$4,340.00		
						TOTAL	$4,340.00	
TRAVEL								
CAR RENTAL	HERTZ	EACH	7	$50.00	1.15	$402.50		
AIRFARE	MESA	EACH	1	$160.00	1.15	$184.00		
HOTEL/MEALS	ALLOCATION	DAILY	7	$75.00	1.15	$603.75		
						TOTAL	$1,190.25	
SUBCONTRACTOR								
SOIL VAPOR SURVEY	TRACER	QUOTE	1	$19,645.00	1	$19,645.00		
						TOTAL	$19,645.00	
							TOTAL TASK 1	**$25,175.25**

TASK 2: SOIL BORING

OBJECT ACCOUNT	RESOURCE	UNITS	QTY	UNIT COST	COST FACTOR	BUDGET	OBJECT TOTALS	TASK TOTAL
DIRECT LABOR								
PREPARATION/TRAVEL	PI	HRS	6	$62.00	1	$372.00		
ONSITE SUPERVISION/SAMPLING	PI	HRS	40	$62.00	1	$2,480.00		
PROJECT MANAGEMENT	PIII	HRS	5	$82.00	1	$410.00		
SENIOR REVIEW	PIV	HRS	2	$91.00	1	$182.00		
PROJECT ADMIN.	SII	HRS	5	$41.00	1	$205.00		
						TOTAL	$3,649.00	
EXPENSES/TRAVEL								
CAR RENTAL	HERTZ	DAY	4	$50.00	1.15	$230.00		
HOTEL/MEALS	ALLOCATION	DAILY	4	$75.00	1.15	$345.00		
AIRFARE	MESA	EACH	1	$160.00	1.15	$184.00		
						TOTAL	$759.00	
EQUIPMENT RENTAL								
PID	STOCK	DAY	3	$95.00	1	$285.00		
MAGNETOMETER	STOCK	DAY	3	$65.00	1	$195.00		
HAND AUGER	STOCK	DAY	3	$20.00	1	$60.00		
MISCELLANEOUS	ALLOCATION	ESTIMATE	3	$25.00	1	$75.00		
						TOTAL	$555.00	
SUBCONTRACTOR								
DRILLING	BEEMAN BRO.	QUOTE	4	$2,800.00	1	$11,200.00		
						TOTAL	$11,200.00	
							TOTAL TASK 2	**$16,163.00**

1. Assume drilling sampling will require 4 days to complete. No down time.
2. All work performed in level "D".

TASK 3: GROUNDWATER MONITORING WELL INSTALLATION								
OBJECT ACCOUNT	RESOURCE	UNITS	QTY	UNIT COST	COST FACTOR	BUDGET	OBJECT TOTALS	TASK TOTAL
DIRECT LABOR								
PREPARATION/TRAVEL	PI	HRS	5	$62.00	1	$310.00		
ONSITE SUPERVISION	PI	HRS	20	$62.00	1	$1,240.00		
DRILLING LOG	SII	HRS	6	$41.00	1	$246.00		
PROJECT MANAGEMENT	PIII	HRS	3	$82.00	1	$246.00		
SENIOR REVIEW	PIV	HRS	2	$91.00	1	$182.00		
PROJECT ADMIN.	SII	HRS	4	$41.00	1	$164.00		
						TOTAL	$2,388.00	
EXPENSES/TRAVEL								
CAR RENTAL	HERTZ	DAY	3	$50.00	1.15	$172.50		
HOTEL/MEALS	ALLOCATION	DAILY	2	$75.00	1.15	$172.50		
AIRFARE	MESA	EACH	1	$160.00	1.15	$184.00		
						TOTAL	$356.50	
EQUIPMENT RENTAL								
PID	STOCK	DAY	2	$95.00	1	$190.00		
EIP	STOCK	DAY	2	$50.00	1	$100.00		
MAGNETOMETER	STOCK	DAY	2	$65.00	1	$130.00		
HAND AUGER	STOCK	DAY	2	$20.00	1	$40.00		
MISCELLANEOUS	ALLOCATION	ESTIMATE	2	$25.00	1	$50.00		
						TOTAL	$470.00	
SUBCONTRACTORS								
DRILLING	BEEMAN BROS.	QUOTE	2	$2,800.00	1	$5,600.00		
MATERIALS (WELL CASING)	VENDOR	EACH	6	$1,000.00	1	$6,000.00		
MATERIALS (SAND, BENTONITE)	VENDOR	EACH	6	$500.00	1	$3,000.00		
ROAD BOXES/STANDPIPE	VENDOR	EACH	6	$250.00	1	$1,500.00		
						TOTAL	$16,100.00	
							TOTAL TASK 3	**$19,314.50**

1. Assumes drilling/well installation activities will require 2 days, and assumes all drilling can be performed with driven casing techniques.
2. All work performed in level "D".

TASK 4: GROUNDWATER SAMPLING(TWO EVENTS)

OBJECT ACCOUNT	RESOURCE	UNITS	QTY	UNIT COST	COST FACTOR	BUDGET	OBJECT TOTALS	TASK TOTAL
DIRECT LABOR								
PREPARATION/TRAVEL	SII	HRS	30	$41.00	1	$1,230.00		
GROUNDWATER SAMPLING	SII	HRS	80	$41.00	1	$3,280.00		
PROJECT MANAGEMENT	PIII	HRS	10	$82.00	1	$820.00		
PROJECT ADMIN.	SII	HRS	4	$41.00	1	$164.00		
						TOTAL	$5,494.00	
EXPENSES/TRAVEL								
MILEAGE	TRUCK	MILE	720	$0.60	1	$432.00		
HOTEL/MEALS	ALLOCATION	DAILY	4	$75.00	1.15	$345.00		
MISC.	ALLOCATION	DAILY	4	$25.00	1	$100.00		
						TOTAL	$877.00	
EQUIPMENT RENTAL								
EIP	STOCK	DAILY	4	$50.00	1	$200.00		
BAILER (DISPOSABLE)	STOCK	ALLOCATION	40	$10.00	1	$400.00		
pH/TEMP/COND METER	STOCK	DAILY	4	$35.00	1	$140.00		
BAILER (PVC)	STOCK	DAILY	6	$10.00	1	$60.00		
SUBMERSIBLE PUMP	STOCK	DAILY	4	$75.00	1	$300.00		
GENERATOR	STOCK	DAILY	6	$55.00	1	$330.00		
METALS FILTER KIT	STOCK	EACH SAMP.	48	$25.00	1	$1,200.00		
						TOTAL	$2,630.00	
							TOTAL TASK 4	**$9,001.00**

TASK 5: PROFESSIONAL SURVEY								
OBJECT ACCOUNT	RESOURCE	UNITS	QTY	UNIT COST	COST FACTOR	BUDGET	OBJECT TOTALS	TASK TOTAL
SUBCONTRACTORS								
PROFESSIONAL SURVEY	VENDOR	ESTIMATE	1	$3,300.00	1	$3,300.00		
						TOTAL	$3,300.00	
							TOTAL TASK 5	**$3,300.00**

1. Assume site survey will be conducted at the same time GTI is on site for groundwater sampling.

TASK 6: AQUIFER PUMP TEST

OBJECT ACCOUNT	RESOURCE	UNITS	QTY	UNIT COST	COST FACTOR	BUDGET	OBJECT TOTALS	TASK TOTAL
DIRECT LABOR								
DESIGN	PIV	HRS	10	$91.00	1	$910.00		
FIELD PREPARATION	PI	HRS	15	$62.00	1	$930.00		
PUMP TEST/TRAVEL	PI	HRS	57	$62.00	1	$3,534.00		
PUMP TEST/TRAVEL	PIII	HRS	50	$82.00	1	$4,100.00		
PROJECT MANAGEMENT	PIII	HRS	10	$82.00	1	$820.00		
PROJECT ADMIN.	SII	HRS	15	$41.00	1	$615.00		
						TOTAL	$10,909.00	
EXPENSES/TRAVEL								
MILEAGE	TRUCK	MILE	360	$0.60	1	$216.00		
HOTEL/MEALS	ALLOCATION	DAILY	5	$75.00	1.15	$431.25		
HOTEL/MEALS	ALLOCATION	DAILY	4	$75.00	1.15	$345.00		
EQUIPT SHIPPING	VENDOR	ALLOCATION	3	$250.00	1.15	$862.50		
MISC. PARTS	ALLOCATION	ESTIMATE	2	$100.00	1.15	$230.00		
AIRFARE	MESA	EACH	1	$160.00	1.15	$184.00		
CAR RENTAL	HERTZ	DAY	5	$50.00	1.15	$287.50		
						TOTAL	$2,556.25	
EQUIPMENT RENTAL								
WTDP	STOCK	WEEKLY	1	$532.00	1	$532.00		
DATA LOGGER	STOCK	WEEKLY	1	$300.00	1	$300.00		
PRESS. TRANDUCERS	STOCK	WEEKLY	8	$104.00	1	$832.00		
EIP	STOCK	WEEKLY	1	$200.00	1	$200.00		
						TOTAL	$1,864.00	
SUBCONTRACTORS								
DRILLING TEST/OBSERV. WELLS		ESTIMATE	1	$2,800.00	1	$2,800.00		
MATERIALS (FRE)		EACH	2	$1,000.00	1	$2,000.00		
MATERIALS (SAND, BENT.)	VENDOR	EACH	2	$500.00	1	$1,000.00		
ROADBOXES/STANDPIPE	VENDOR	EACH	2	$250.00	1	$500.00		
						TOTAL	$6,300.00	
							TOTAL TASK 6	**$21,629.25**

1. No costs included for waste disposal.
2. Assumes two additional piezometers will be installed in one day of drilling.

TASK 7: SOIL VAPOR EXTRACTION/AIR SPARGING PILOT TEST

OBJECT ACCOUNT	RESOURCE	UNITS	QTY	UNIT COST	COST FACTOR	BUDGET	OBJECT TOTALS	TASK TOTAL
DIRECT LABOR								
DESIGN	PIII	HRS	10	$82.00	1	$820.00		
FIELD PREPARATION	SII	HRS	15	$41.00	1	$615.00		
PILOT TEST/TRAVEL	SII	HRS	36	$41.00	1	$1,476.00		
PILOT TEST/TRAVEL	PI	HRS	52	$62.00	1	$3,224.00		
PROJECT MANAGEMENT	PIII	HRS	5	$82.00	1	$410.00		
PROJECT ADMIN.	SII	HRS	10	$41.00	1	$410.00		
						TOTAL	$6,955.00	
EXPENSES/TRAVEL								
MILEAGE	TRUCK	MILE	360	$0.60	1	$216.00		
HOTEL/MEALS	ALLOCATION	DAILY	4	$75.00	1.15	$345.00		
HOTEL/MEALS	ALLOCATION	DAILY	3	$75.00	1.15	$258.75		
EQUIPT SHIPPING	VENDOR	ALLOCATION	2	$200.00	1.15	$460.00		
MISC. PARTS	ALLOCATION	ESTIMATE	2	$100.00	1.15	$230.00		
AIRFARE	MESA	EACH	1	$160.00	1.15	$184.00		
CAR RENTAL	HERTZ	DAY	5	$50.00	1.15	$287.50		
						TOTAL	$1,981.25	
EQUIPMENT RENTAL								
SVES	STOCK	WEEKLY	1	$336.00	1	$336.00		
PID	STOCK	WEEKLY	1	$380.00	1	$380.00		
LEL/02 METER	STOCK	WEEKLY	1	$200.00	1	$200.00		
THERMAL ANEMOMETER	STOCK	WEEKLY	1	$120.00	1	$120.00		
AIR SAMPLING EQUIPMENT	STOCK	WEEKLY	1	$140.00	1	$140.00		
						TOTAL	$1,176.00	
SUBCONTRACTORS								
DRILLING PROBES	BEEMAN BRO.	ESTIMATE	2	$2,800.00	1	$5,600.00		
VAPOR CARBON - 200 LB.	VENDOR	UNITS	3	$1,000.00	1	$3,000.00		
MATERIALS (FRE)	VENDOR	EACH	11	$1,000.00	1	$11,000.00		
MATERIALS (SAND, BENT., ROADB.)	VENDOR	EACH	6	$750.00	1	$4,500.00		
						TOTAL	$24,100.00	
							TOTAL TASK 7	$34,212.25

1. Assume 5 nested additional SVE points and one air sparge point installed in 2 days of drilling.

TASK 8: SURFACE WATER SEDIMENT SAMPLING

OBJECT ACCOUNT	RESOURCE	UNITS	QTY	UNIT COST	COST FACTOR	BUDGET	OBJECT TOTALS	TASK TOTAL
DIRECT LABOR								
PREPARATION/TRAVEL	SII	HRS	10	$41.00	1	$410.00		
PREPARATION/TRAVEL	PI	HRS	10	$62.00	1	$620.00		
SURFACE WAT. SAMPLING	SII	HRS	16	$41.00	1	$656.00		
SURFACE WAT. SAMPLING	PI	HRS	16	$62.00	1	$992.00		
PROJECT MANAGEMENT	PIII	HRS	4	$82.00	1	$328.00		
PROJECT ADMINISTRATION	SII	HRS	2	$41.00	1	$82.00		
						TOTAL	$3,088.00	
EXPENSES/TRAVEL								
MILEAGE	TRUCK	MILES	360	$0.60	1	$216.00		
HOTEL/MEALS	ALLOCATION	DAILY	2	$75.00	1	$150.00		
HOTEL/MEALS	ALLOCATION	DAILY	2	$75.00	1	$150.00		
MISCELLANEOUS	ALLOCATION	EACH	2	$300.00	1	$600.00		
						TOTAL	$1,116.00	
EQUIPMENT RENTAL								
pH/TEMP/CONDUCTIVITY	STOCK	EACH	2	$25.00	1	$50.00		
METALS FILLER KIT	STOCK	EACH	14	$25.00	1	$350.00		
						TOTAL	$400.00	
							TOTAL	$4,604.00

FI REPORT PREPARATION

OBJECT ACCOUNT	RESOURCE	UNITS	QTY	UNIT COST	COST FACTOR	BUDGET	OBJECT TOTALS	TASK TOTAL
DIRECT LABOR								
ENVIRONMENTAL SETTING	PII	HRS	20	$73.00	1	$1,460.00		
SOURCE CHARACTERIZATION	PII	HRS	16	$73.00	1	$1,168.00		
CONTAMINANT CHARACTERIZATION	PII	HRS	20	$73.00	1	$1,460.00		
POTENTIAL RECEPTORS	PI	HRS	8	$62.00	1	$496.00		
POTENTIAL RECEPTORS	PIV	HRS	10	$91.00	1	$910.00		
PROTECTION STANDARDS	PV	HRS	16	$108.00	1	$1,728.00		
BORING/WELL LOGS/WTCs	PI	HRS	40	$62.00	1	$2,480.00		
PUMP TEST ANALYSIS	PIV	HRS	15	$91.00	1	$1,365.00		
SOIL VENT TEST ANALYSIS	PIII	HRS	10	$82.00	1	$820.00		
PRE-SCREENING TECHNOLOGIES	PIV	HRS	24	$91.00	1	$2,184.00		
SENIOR REVIEW	PIV	HRS	10	$91.00	1	$910.00		
ADMIN	SII	HRS	40	$41.00	1	$1,640.00		
DRAFTING	SIV	HRS	32	$54.00	1	$1,728.00		
						TOTAL	$18,349.00	
REBILLABLE EXPENSES								
OVERNITE COURIER	VENDOR	ALLOCATION	1	$100.00	1.15	$115.00		
MISCELLANEOUS	VENDOR	ALLOCATION	1	$150.00	1.15	$172.50		
						TOTAL	$287.50	
							TOTAL	$18,636.50

PROJECT MEETINGS/STATUS REPORTS/GENERAL PROJECT MANAGEMENT

OBJECT ACCOUNT	RESOURCE	UNITS	QTY	UNIT COST	COST FACTOR	BUDGET	OBJECT TOTALS	TASK TOTAL
DIRECT LABOR								
SITE KICKOFF MEETING	PII	HRS	10	$73.00	1	$730.00		
SITE KICKOFF MEETING	PIII	HRS	20	$82.00	1	$1,640.00		
UNSCHEDULED SITE MEETING	PIII	HRS	20	$82.00	1	$1,640.00		
MONTHLY STATUS REPORT	PIII	HRS	40	$82.00	1	$3,280.00		
GENERAL PROJECT MANAGEMENT	PIII	HRS	20	$82.00	1	$1,640.00		
						TOTAL	$8,930.00	
EXPENSES								
MILEAGE	TRUCK	MILE	360	$0.60	1	$216.00		
AIRFARE	VENDOR	TRIP	2	$160.00	1.15	$368.00		
HOTEL/MEALS	ALLOCATION	DAILY	4	$75.00	1.15	$345.00		
						TOTAL	$929.00	
							TOTAL	**$9,859.00**

LABORATORY COSTS

OBJECT ACCOUNT	RESOURCE	UNITS	QTY	UNIT COST	COST FACTOR	BUDGET	OBJECT TOTALS	TASK TOTAL
SOIL ANALYSES (SOIL BORINGS)								
EPA 8240	IML	EACH	20	$250.00	1	$5,000.00		
EPA 8270	IML	EACH	20	$425.00	1	$8,500.00		
EPA 418.1	IML	EACH	20	$75.00	1	$1,500.00		
EPA 6010/7000 SERIES	IML	EACH	20	$140.00	1	$2,800.00		
						TOTAL	$17,800.00	
PHYSICAL SOIL ANALYSES								
GRAIN SIZE	IML	EACH	4	$60.00	1	$240.00		
BULK DENSITY	IML	EACH	4	$30.00	1	$120.00		
TOC	IML	EACH	4	$10.00	1	$40.00		
MOISTURE CONTENT	IML	EACH	4	$5.00	1	$20.00		
ION EXCHANGE CAPACITY	IML	EACH	4	$72.00	1	$288.00		
POROSITY	IML	EACH	4	$60.00	1	$240.00		
HYDRAULIC CONDUCTIVITY	IML	EACH	4	$45.00	1	$180.00		
						TOTAL	$1,128.00	
WELL GW ANALYSES								
EPA 8240	IML	EACH	40	$250.00	1	$10,000.00		
EPA 8270	IML	EACH	40	$425.00	1	$17,000.00		
EPA 418.1	IML	EACH	12	$75.00	1	$900.00		
EPA 6010/7000 SERIES	IML	EACH	12	$140.00	1	$1,680.00		
						TOTAL	$29,580.00	
STREAM/DITCH ANALYSES (WATER)								
EPA 8240	IML	EACH	13	$250.00	1	$3,250.00		
EPA 8270	IML	EACH	13	$425.00	1	$5,525.00		
EPA 418.1	IML	EACH	13	$75.00	1	$975.00		
EPA 6010/7000 SERIES	IML	EACH	13	$140.00	1	$1,820.00		
						TOTAL	$11,570.00	

LABORATORY COSTS								
OBJECT ACCOUNT	RESOURCE	UNITS	QTY	UNIT COST	COST FACTOR	BUDGET	OBJECT TOTALS	TASK TOTAL
STREAM/DITCH ANALYSES (SEDIMENT)								
EPA 8240	IML	EACH	13	$250.00	1	$3,250.00		
EPA 8270	IML	EACH	13	$425.00	1	$5,525.00		
EPA 418.1	IML	EACH	13	$75.00	1	$975.00		
EPA 6010/7000 SERIES	IML	EACH	13	$140.00	1	$1,820.00		
						TOTAL	$11,570.00	
STREAM/DITCH ANALYSES (WATER)								
BOD (EPA 405.1)	IML	EACH	1	$15.00	1	$15.00		
COD(EPA 410.1)	IML	EACH	1	$25.00	1	$25.00		
TSS (EPA 160.3)	IML	EACH	1	$8.00	1	$8.00		
TDS (EPA 160.1)	IML	EACH	1	$8.00	1	$8.00		
TOC (EPA 415.1)	IML	EACH	1	$75.00	1	$75.00		
NUTRIENTS	IML	EACH	1	$71.00	1	$71.00		
						TOTAL	$202.00	
AIR ANALYSES								
TOTAL NONMETHANE (TO-12)	IML	EACH	6	$450.00	1	$2,700.00		
PURGEBALES (EPA 8010/8020)	IML	EACH	6	$210.00	1	$1,260.00		
GC-TCD	IML	EACH	6	$100.00	1	$600.00		
						TOTAL	$4,560.00	
QA/QC ANALYSES								
SOIL BORINGS								
EQUIPT (RII)	IML	EACH	3	$250.00	1	$750.00		
EQUIPT (RII)	IML	EACH	3	$425.00	1	$1,275.00		
EQUIPT (RII)	IML	EACH	3	$75.00	1	$225.00		
EQUIPT (RII)	IML	EACH	3	$140.00	1	$420.00		
						TOTAL	$2,670.00	

LABORATORY COSTS

OBJECT ACCOUNT	RESOURCE	UNITS	QTY	UNIT COST	COST FACTOR	BUDGET	OBJECT TOTALS	TASK TOTAL
GW SAMPLING								
TRIP BLANK	IML	EACH	4	$250.00	1	$1,000.00		
EQUIPT (RII)	IML	EACH	2	$250.00	1	$500.00		
EQUIPT (RII)	IML	EACH	2	$425.00	1	$850.00		
EQUIPT (RII)	IML	EACH	2	$75.00	1	$150.00		
EQUIPT (RII)	IML	EACH	2	$140.00	1	$280.00		
DUPLICATE	IML	EACH	2	$250.00	1	$500.00		
DUPLICATE	IML	EACH	2	$425.00	1	$850.00		
DUPLICATE	IML	EACH	2	$75.00	1	$150.00		
DUPLICATE	IML	EACH	2	$140.00	1	$280.00		
						TOTAL	$4,130.00	
SURFACE WATER								
TRIP BLANK	IML	EACH	2	$250.00	1	$500.00		
DUPLICATE	IML	EACH	1	$250.00	1	$250.00		
DUPLICATE	IML	EACH	1	$425.00	1	$425.00		
DUPLICATE	IML	EACH	1	$75.00	1	$75.00		
DUPLICATE	IML	EACH	1	$140.00	1	$140.00		
						TOTAL	$1,390.00	
						TOTAL	**$84,600.00**	
						PROJECT TOTAL		**$241,890.75**

APPENDIX D

INTER-MOUNTAIN LABORATORIES QUALITY ASSURANCE PROJECT PLAN

iml
Inter·Mountain
Laboratories, Inc.

2506 West Main Street
Farmington, New Mexico 87401
Tel. (505) 326-4737

GROUNDWATER TECHNOLOGY, INC.
BLOOMFIELD REFINERY RFI

QUALITY ASSURANCE PROJECT PLAN LABORATORY ANALYSES

INTER-MOUNTAIN LABORATORIES, INC.

March, 1993

Inter·Mountain Laboratories, Inc.

2506 W. Main Street
Farmington, New Mexico 87401

GROUNDWATER TECHNOLOGY, INC.
BLOOMFIELD REFINERY RFI

Quality Assurance Project Plan
Analytical Laboratory Services
March, 1993

Inter-Mountain Laboratories, Inc.
555 Absaraka
Sheridan, Wyoming 82801

2506 West Main Street
Farmington, New Mexico 87401

1160 Research Drive
Bozeman, Montana 59715

Version: GTI / BRC
03/93

Jay O. Stender
Vice President - IML Corporate

Date Submitted: __________

Inter·Mountain Laboratories, Inc.

2506 W. Main Street
Farmington, New Mexico 87401

BLOOMFIELD REFINERY RFI

TABLE OF CONTENTS

QUALITY ASSURANCE PROJECT PLAN

1.0 Title Page

2.0 Table of Contents

3.0 Project Description 1

4.0 Project Organization and Responsibilities 3

5.0 Quality Assurance Objectives and Criteria 7

6.0 Sampling Procedures 18

7.0 Chain-of-Custody 19

8.0 Calibration / QC Procedures 20

9.0 Analytical Procedures 25

10.0 Data Reduction, Validation, and Reporting 30

11.0 Internal Quality Control Checks 33

12.0 Performance and System Audits 35

13.0 Preventive Maintenance 37

14.0 Precision and Accuracy Determinations 38

15.0 Corrective Action 40

16.0 Quality Assurance Reporting Procedures 42

17.0 Method or Procedure References 43

Appendix A - Chain of Custody Document

Ver: 1.3

3.0 PROJECT DESCRIPTION

The project tasks will include the receipt, inventory, storage, analyses, and reporting of chemical analytes from environmental samples obtained from the Bloomfield Refinery Co. facility in New Mexico. The quality assurance objectives and requirements mandate documented control of sample and analytical data generated within the laboratory. Specifically, this project will have dedicated procedures and staff to receive, inventory, analyze and store samples to prevent any possible contamination or loss. Analytical procedures addressing the sample preparation will follow methods described in SW-846 "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", USEPA, 1986. The primary analytical instruments will be ICP, CVAA, IR, GC, and GC/MS.

Due to the confidential nature of this project, samples, raw data, finished data, and quality assurance reports will be secured for the client. IML will store, in a secured fashion, samples for 30 days following data package submission. At this time, samples will be returned to the client or a client representative or stored for an additional period by IML. Samples will not be transferred from IML unless directed by Groundwater Technology Inc. via letter.

Raw data, not submitted as part of the deliverables, will be stored by IML in a secure fashion for three (3) years from report. At this time, the client will be notified prior to disposal of records. The client will have the option to secure additional storage at IML or to archive records at a place of their choice. Deliverables are defined in section 11.0.

This QAPP follows and complies with project outlines suggested through negotiations with the client (Bloomfield Refinery Co.) and their authorized representative (Groundwater Technology Inc.). In addition, QA/QC checklist parameters provided by GTI with the QCPP are recognized and addressed under this document.

The analytical data submitted to GTI will be in Sample Data Batches of no more than 20 field samples. Quality control parameters dictated by USEPA will be included within respective sample data packages. Raw data, if requested by the client, will be available for additional validation purposes. Costs for documentation will be charged to the client.

3.0 PROJECT DESCRIPTION (Continued)

Project contact personnel are as follows:

Cymantha Diaz	GTI	Project Manager
Chris Hawley	BRC	BRC Project Manager
Cymantha Diaz	GTI	Project Quality Assurance
Jay Stender	IML	Project Administrator
Charles Ballek	IML	Laboratory Manager
Denise Bohemier	IML	Laboratory Quality Assurance

IML will submit detailed invoices against a specified identification number, to Cymantha Diaz at GTI unless otherwise notified.

4.0 PROJECT ORGANIZATION and RESPONSIBILITIES

Introduction:

Chart 4-1 identifies the analytical flow of responsibility throughout the laboratory. Responsible staff for each task are identified in table 10.1. Field Activities will not be covered under this document.

Project Administration: Jay Stender

Responsible for:

A. Review and compliance with contract conditions.

B. Verifying and reporting of analytical procedures.

C. Resolution of contract/QA/laboratory operations conflicts.

D. Final review of package for contract completeness.

Project QA/Technical Operations:

Mike Terry - Inorganic, Sheridan
Denise Bohemier - Organic, Farmington

Responsible for:

A. Maintaining and auditing laboratory activities for compliance with contract QC objectives.

B. Identifying and documenting any procedures that may 1) not be performed in accordance with contract requirements, or 2) are not being documented at a level indicated by the contract.

C. Coordinating and documenting any changes in activities associated with procedures for lab QC.

D. Maintaining records of all pertinent laboratory QC functions.

E. Issuing stop work orders if QC criteria are violated and issue CR.

4.0 PROJECT ORGANIZATION and RESPONSIBILITIES (Continued)

F. Report directly to laboratory project administrator and/or section leader any laboratory activities that may affect data.

G. Review data production to verify calculations, reporting units, and completeness.

Section Leader: Charles Ballek

Responsible for:

A. Schedule and monitor ongoing work in progress.

B. Organization and verification of preparation of samples, reagents, and method blanks for analysis.

C. Review and monitor bench level analytical procedures for compliance with methods and QC frequency.

D. Review and monitor all instrumental activities for compliance with procedures.

E. Presentation of data to QC for review and final reporting.

Sample Custodian: Fran Armenta

Responsible for:

A. Acceptance of samples from client.

B. Verification and confirmation of sample inventory, analytes, holding time requirements, and storage.

C. Notify section leaders and client of sample receipt for scheduling and QC.

D. Storage and organization of custody documents associated with the samples.

4.0 PROJECT ORGANIZATION and RESPONSIBILITIES (Continued)

The principal staff are dedicated to this project. IML reserves the right to utilize other equally qualified staff if needed. If any significant staff changes occur, IML will notify the project managers (GTI, BRC), in writing, of changes.

4.0 PROJECT ORGANIZATION and RESPONSIBILITIES (Continued)

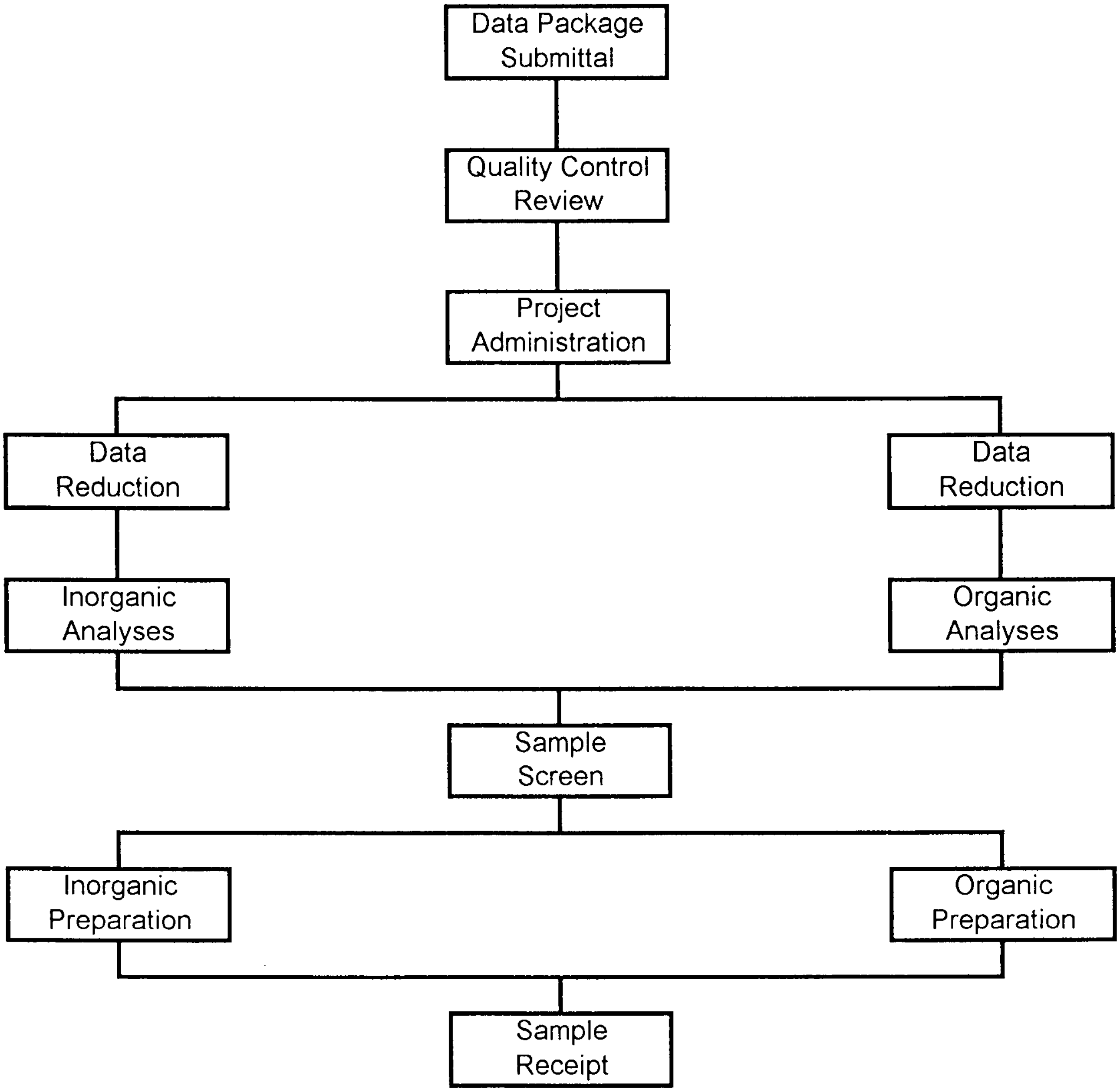


CHART 4 - 1: Project Flow

5.0 QUALITY ASSURANCE OBJECTIVES and CRITERIA

It is the objective of IML to analyze and report environmental samples in a consistent and reproducible manner. This objective is met by using standard procedures, effective documentation of the procedures, and peer review.

Quality control may be defined as those operations undertaken within the laboratory to assure that the data produced are generated within known probability limits of accuracy and precision.

Precision and accuracy are determined from the results of the laboratory QC samples. The audits consist of duplicates (or matrix spike duplicates), matrix spikes, and method blank standards. The quality assurance objectives for precision and accuracy are listed in Tables 5-1 through 5-3C.

To meet our precision and accuracy objective, five concepts are addressed.

1. Accuracy:

Accuracy is defined as the degree to which the analytical measurement reflects the true concentration level present. Accuracy will be measured as percent recovery for matrix spikes as the primary criteria.

$$\text{Percent Recovery} = \frac{SSR - SR}{SA} \times 100$$

SSR = Spikes sample result
SR = Sample result, 0 if < CRDL
SA = Spike added from known spike solution

Accuracy, or the measure of nearness to the actual value, is determined using spike recoveries. By tracking the recovery of known spiking concentrations on given samples one can chart the analytical method performance. The data quality objective of spike recoveries on soil matrix will match method-specific limits set by the EPA in SW-846. Analytical results not meeting these criteria will be reviewed by laboratory staff and evaluated for fitness. Data qualifiers "J" or "N" defined by the EPA in CLP SOW OLM01 or ILM01 may be used. Spike materials may be added prior to sample preparation to evaluate the digestion procedure. Post digestion spikes indicate accuracy of the analytical technique. If the sample concentration exceeds 4X the matrix spike recovery, the calculation may not be applicable for validation purposes.

5.0 QUALITY ASSURANCE OBJECTIVE and CRITERIA (Continued)

2. Precision:

Precision is defined as the agreement among individual measurements of the same chemical constituent in a sample (duplicates) secured under the same analytical protocols. The calculated value addressing precision is "Relative Percent Difference (RPD)".

$$RPD = \frac{| SR - DR |}{((SR + DR) / 2)} \times 100$$

SR = Original sample result
DR = Duplicate sample result

Within each analytical run, a sample batch of twenty (20) samples or less, at least one duplicate analysis will be run.

Duplicate data qualifiers, for inorganic and organic parameters, will use the following criteria:

<u>Quantitation Value Qualifier</u>

$SR < 5 \times DL$	$\| SR - DR \| < CRDL$
$5 \times DL < SR < 10 \times DL$	$RPD < 35\%$
$SR > 10 \times DL$	$RPD < 20\%$

Where: DL = Method Detection Level for Soil Matrix and
CRDL = Contract Required Detection Level

If samples are less than 5 times the CRDL, the CRDL is the limit of the duplicate difference. Samples that are 5 to10 times the detection level will fall into the second criteria. Samples that are greater than 10 times the CRDL fall into the third criteria. Data qualifiers may be used as a result of laboratory duplicate analysis. Field duplicates will not be evaluated by RPD.

5.0 QUALITY ASSURANCE OBJECTIVES and CRITERIA (Continued)

3. Representativeness:

Representativeness should be considered an objective to be achieved rather than a characteristic which can be described in quantitive terms. Representativeness can be defined as the degree to which the data accurately and precisely represent actual sample matrix conditions. Representativeness is addressed by the use of a logical and thorough sampling and analysis project plan which is based on all available knowledge of the site.

4. Completeness:

Analytical completeness is the percentage of reported analytical data that is usable. IML achieves a high level of analytical completeness by assuring that the work is performed by well-trained analysts who know the program-specific objectives. IML has a detailed record keeping system that documents the details of each analysis. This assures that the analytical data will be defensible. IML's objective for completeness is 95%.

Completeness is calculated by:

$$\frac{\Sigma \text{ SM}}{\text{SA}} \times 100 = \% \text{ Completeness}$$

SM = samples analyzed that meet contract required QC parameters of 1) holding times, 2) duplicate recoveries, 3) spike recovery, and 4) method blanks

SM_1 = Holding Time
SM_2 = Duplicate
SM_3 = Spike Recovery
SM_4 = Method Blank

SA = Total number of samples received and analyzed

5.0 QUALITY ASSURANCE OBJECTIVES and CRITERIA (Continued)

5. Comparability:

Comparability is a measure of the confidence with which one data set can be compared to another. The following measures are taken to assure the comparability of the data:

- Appropriate selection of analytical procedures;
- Standardized written preparation and analysis procedures;
- Standard handling and shipping procedures used for all collected samples;
- Results reported in consistent formats and units.

In addition to the above techniques, the use of Laboratory Control Samples (LCS) prepared of similar analytes in a similar matrix allow the analysts to track, over a series of events, the effectiveness of the technique.

Method blanks, reagent and laboratory water samples that are prepared in a similar fashion to the samples will be analyzed at a frequency which satisfies data quality objectives (see Section 8.0). The method blanks will be used to verify consistent baseline response of the instrument and verify no carryover of analytes from one sample to another. Method blank results will be considered to confirm IDL and detection level performance of instruments. "B" qualifiers may be used within the inorganic analytical reports to denote positive analyte values on blanks.

Calibration Verification Standards (CVS's) are used within the laboratory to verify the linear response of the instrument's calibration curves. These materials are made a source different from the instrument calibration standards with analyte concentrations within the calibration range. CVS's for ICP are used every seven (7) analytical shots. CVS's for the IR are analyzed following every twenty (20) sample analyses. CVS's are used during calibration on GC/MS and GC.

5.0 QUALITY ASSURANCE OBJECTIVES and CRITERIA (Continued)

Data qualifiers that address calibration issues are "E" for results that are greater than the GC/MS calibration range, and/or "D" for samples that are diluted to bring analyte concentration into range.

TABLE 5-1 FOR INORGANICS
QUALITY ASSURANCE OBJECTIVES

PARAMETER	REFERENCE	CRITERIA/ CONTROL	UNITS
Calibration (ESS)	ICAL CCAL-ICP Hg	0.995 90-110 80-120	r %R %R
Blanks (ESS)	Prep blank	<CRDL	ug/L
Lab Control Samples	LCS	90-110%	%R
Duplicate (per batch)	Dup	± CRDL ± 35% ± 20%	(< 5X CRDL) (5X to 10X DL) (> 10X DL)
Matrix Spike (per batch)	MS	75-125%	%R

Matrix spike recoveries are pre-digestion spikes of aqueous samples.

Control levels apply to aqueous samples only.

r ≡ regression coefficient.

5.0 QUALITY ASSURANCE OBJECTIVES and CRITERIA (Continued)

TABLE 5-1A
HOLDING TIMES - SOIL

PARAMETER	REFERENCE	HOLDING TIME (days)	START OF TIMING
Metals *	RCRA 6010/7000	180	Sampling
Mercury	RCRA 7741	28	Sampling
Volatile Organics	RCRA 8240	14	Sampling
Semivolatile Organics	RCRA 8270	14 **	Sampling
TPH	EPA 418.1	14 **	Sampling
Grain Size	Handbook 60 / #42	N/A	N/A
Total/Effective Porosity	Handbook 60 / #40	N/A	N/A
Hydraulic Conductivity	RCRA 9100	28	Sampling
Specific Conductance	RCRA 9050	7	Sampling
Total Organic Carbon	RCRA 9060	N/A	N/A
Dry Bulk Density	EPA 600/2-78-054	N/A	N/A
Ion Exchange Capacity	Handbook 60 / #19	N/A	N/A
Moisture Content	Handbook 60 / #26	N/A	N/A
pH	RCRA 9045	14	Sampling

* Mercury is an exception to metal holding times.
** 14 days to extraction of soil, analysis performed within 40 days from extraction.
VTSR - Verified Time of Sample Receipt at laboratory
N/A - No holding time established

5.0 QUALITY ASSURANCE OBJECTIVES and CRITERIA (Continued)

TABLE 5-1B
HOLDING TIMES - WATER / SEDIMENT

PARAMETER	REFERENCE	HOLDING TIME (days)	START OF TIMING
Metals *	RCRA 6010/7000	180	Sampling
Mercury	RCRA 7741	28	Sampling
Volatile Organics	RCRA 8240	14	Sampling
Semivolatile Organics	RCRA 8270	7 **	Sampling
TPH	EPA 418.1	7 **	Sampling
pH	EPA 150.1	ASAP	VTSR
Conductivity	EPA 120.1	ASAP	VTSR
Dissolved Oxygen	EPA 360.1	ASAP	VTSR
Biological Oxygen Demand	EPA 405.1	2	VTSR
Chemical Oxygen Demand	EPA 410.1	28	Sampling
Total Suspended Solids	EPA 160.3	7	Sampling
Total Dissolved Solids	EPA 160.1	7	Sampling
Total Organic Carbon	EPA 415.1	28	Sampling
Nutrients	EPA 300 Series	14/28	Sampling

* Mercury is an exception to metal holding times.
** 7 days to extraction for water, analysis performed within 40 days from extraction.
VTSR - Verified Time of Sample Receipt at laboratory

5.0 QUALITY ASSURANCE OBJECTIVES and CRITERIA (Continued)

TABLE 5-2
QUALITY ASSURANCE OBJECTIVES
VOLATILE ORGANIC COMPOUNDS

PARAMETER	**CRITERIA/CONTROL**
Holding Time	10 days (preserved)
GC/MS Mass Calibration	BFB ion abundance ratios
GC/MS Initial Calibration	<30% RSD for SPCC and CCC RRF's
GC/MS Continuing Calibration	<25% RSD for CCC RRF's
Minimum RRF	SPCC RRF >0.30 and Bromoform >0.25
Internal Standard Responses	CCAL area response 50-200% of ICAL Sample area response 50-200% of CCAL
	CCAL within 0.5 minutes of ICAL
Internal Standard Retention Time	Sample within 0.5 minutes of CCAL
Internal Standard Retention Time	<CRDL
Method Blank	<CRDL
Extraction Blank	By matrix, see Table 2B
Surrogate Recoveries	By matrix, see Table 2C
Matrix Spike/Duplicate	

TABLE 5-2A
BFB ION ABUNDANCE CRITERIA

m/z	Ion Abundance Criteria
50	15-40% of mass 95
75	30-60% of mass 95
95	Base peak, 100% relative abundance
96	5-9% of mass 95
173	Less than 2% of mass 174
174	50-100% of mass 95
175	5-9% of mass 174
176	95-101% of mass 174
177	5-9% of mass 176

Source: SW-846

5.0 QUALITY ASSURANCE OBJECTIVES and CRITERIA (Continued)

TABLE 5-2B
SURROGATE RECOVERIES
VOLATILE ORGANIC COMPOUNDS

COMPOUND	Water	Soil
	% Recovery	% Recovery
1,2-Dichloroethane-d4	76-114	70-121
Toluene-d8	88-110	81-117
Bromofluorobenzene	86-115	74-121

TABLE 5-2C
MATRIX SPIKE / MATRIX DUPLICATE
VOLATILE ORGANIC COMPOUNDS

COMPOUND	Water		Soil	
	% Recovery	RPD	% Recovery	RPD
1,1-Dichloroethene	61-145	14	59-172	22
Trichloroethene	71-120	14	62-137	24
Benzene	76-127	11	66-142	21
Toluene	76-125	13	59-139	21
Chlorobenzene	75-130	13	60-133	21

Source: SW-846

5.0 QUALITY ASSURANCE OBJECTIVES and CRITERIA (Continued)

TABLE 5-3
QUALITY ASSURANCE OBJECTIVES
SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	CRITERIA/CONTROL
Holding Time	10 days - extraction of solid/sludge
GC/MS Mass Calibration	DFTPP ion abundance ratios, see Table 3A
	<30% RSD for CCC RRF's
GC/MS Initial Calibration	<30% RSD for CCC RRF's
GC/MS Continuing Calibration	0.05> for SPCC
Minimum RRF	Sample area response 50-200% of ICAL
Internal Standard Responses	Sample within 0.5 minutes of CCAL
	<CRDL
Internal Standard Retention Time	<CRDL
Method Blank	By matrix, see Table 3B
Extraction Blank	By matrix, see Table 3C
Surrogate Recoveries	
Matrix Spike/Duplicate	

TABLE 5-3A
DFTPP ION ABUNDANCE CRITERIA

m/z	Ion Abundance Criteria
51	30-60% of mass 198
68	Less than 2% of mass 69
69	Reference only
70	Less than 2% of mass 69
127	40-60% of mass 198
197	Less than 1% of mass 198
198	base peak, 100% relative abundance
	5-9% of mass 198
199	10-30% of mass 198
275	Greater than 1% of mass 198
365	0-100% of mass 443
441	40-100% of mass 198
442	17-23% of mass 442
443	

5.0 QUALITY ASSURANCE OBJECTIVES and CRITERIA (Continued)

TABLE 5-3B
SURROGATE RECOVERIES
SEMIVOLATILE ORGANIC COMPOUNDS

COMPOUND	Water	Soil
	% Recovery	% Recovery
2-Fluorophenol	21-100	25-121
Phenol-d5	10-94	24-113
Nitrobenzene-d5	35-114	23-120
2-Fluorobiphenyl	43-116	30-115
2,4,6-Tribromophenol	10-123	19-122
p-Terphenyl	33-141	18-137

TABLE 5-3C
MATRIX SPIKE/MATRIX SPIKE DUPLICATE
SEMIVOLATILE ORGANIC COMPOUNDS

COMPOUNDS	Water		Soil	
	% Recovery	RPD	% Recovery	RPD
Phenol	12-110	42	26-90	35
2-Chlorophenol	27-123	40	25-102	50
1,4-Dichlorobenzene	36- 97	28	28-104	27
n-Nitroso-di-n-propylamine	41-116	38	41-126	38
1,2,4-Trichlorobenzene	39- 98	28	38-107	23
4-Chloro-3-methylphenol	23- 97	42	26-103	33
Acenaphthene	46-118	31	31-137	19
4-Nitrophenol	10- 80	50	11-114	50
2,4-Dinitrotoluene	24- 96	38	28- 89	47
Pentachlorophenol	9-103	50	17-109	47
Pyrene	26-127	31	35-142	36

DEFINITIONS:

BFB	Bromofluorobenzene
DFTPP	Decafluorotriphenylphosphine
CCAL	Continuing Calibration
ICAL	Initial Calibration
CCC	Continuing Calibration Compounds
SPCC	System Performance Calibration Compounds
RRF	Relative Response Factor
RSD	Relative Standard Deviation
CRDL	Contract Required Detection Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate

6.0 SAMPLING PROCEDURES

IML will not be directly involved with sampling.

As part of our response to Groundwater Technology, Inc., IML will assist the contracted samplers by providing bottles, preservatives, packing, and shipping to meet EPA requirements. To enhance the analytical performance, it is essential to clearly identify sampling variables, to utilize proven field sampling techniques, and to document events. Validity of analytical data depends on good, consistent sampling.

7.0 CUSTODY DOCUMENTS

IML will provide sample Chain of Custody documents for the sampling team. The Chain of Custody form will require complete identification of sample location, time, and date. Sample data sets will utilize the form as the initial guiding information for holding time criteria and analytical parameters. The laboratory will keep the front, white, sheet with the samples. Any transfer of sample material will initiate a new Chain of Custody.

Sample custody will also be maintained and documented within the laboratory. At the time of sample receipt, a unique laboratory identification will be assigned to each sample. Each sample container will be labelled with this unique identification. Once the samples are inspected, logged in, and labelled, they will be stored in a secure area (locked refrigerator for samples requiring storage at 4°C). Transfer of samples from the secure areas will be accompanied by completion of an Internal Sample Custody form utilizing the laboratory identification.

Example Chain of Custody and Internal Sample Custody forms are found in Appendix A.

8.0 CALIBRATION / QC PROCEDURES

8.1 Laboratory Analysis:

Laboratory analysis of environmental samples is performed using state of the art instrumentation and by following standard methods. IML follows the procedural guidelines described by RCRA. The analytical methods are identified in Section 9.0. Under contract, IML can utilize modified methods to reach specific detection levels or to handle unusual matrix effects.

General calibration and QC procedures, based on type of analysis, are outlined in the following sections. Additional information can be provided by section leaders and project coordinators.

Inorganic Chemistry:

Inorganic parameters can be measured in water, soil, waste and air. Parameters include but are not limited to: pH, EC, temperature and color, and total metals.

General items of consideration under quality control include reagents, instruments, training, and reporting.

Ion-Selective Analysis:

Ion-Selective Electrodes are calibrated prior to analyses using freshly made or commercial solutions. Ion-selective probes are subject to maintenance regimes to insure correct response. EPA or commercial known solutions with acceptance criteria such as confidence intervals are used as QC parameters along with duplicates and method blanks.

Total Organic Carbon (TOC) Analysis:

The TOC analyzer is calibrated prior to analyses using a blank and a freshly made or commercial solution. Continuing calibration of the instrument is performed following every tenth sample. Four replicates are performed on each sample and the average is reported.

8.0 CALIBRATION PROCEDURES (Continued)

Atomic Absorption (AA) Spectroscopy:

IML will use Flame, Furnace and Cold Vapor Atomic Absorption Spectroscopy. QC parameters include the use of method blanks, 4 point-calibration, laboratory control samples for evaluation of matrix effect, and matrix spike analyses. IML's procedures satisfy USEPA quality control requirements.

Inductively Coupled Argon Plasma (ICP) Spectrometry:

The ICP allows versatile response to a variety of analytes due to extended linear response. QC parameters are similar to AA. Calibration checks are of a frequency that meet or exceed RCRA requirements.

To verify interelement and background correction factors, two NIST traceable ICP Interference Check Samples (ICS) will be analyzed. The ICS will be analyzed at the beginning and end of each analytical run or a minimum of twice per eight hour working shift. The results must fall within ±20% of the true value for each analyte in the ICS.

Techniques, not covered by usual methods, such as hydride generation on the ICP are available.

Infrared Spectrophotometry:

Initial calibration of the Infrared Spectrophotometer is performed at the beginning of each day using a solvent blank and nine standards from a certified source. Linearity standards are met prior to initiation of sample analyses. Method blanks, matrix spikes, spike duplicates, and matrix duplicates are performed on a frequency of one per ten analytical samples.

8.0 CALIBRATION PROCEDURES (Continued)

Gas Chromatography/Mass Spectrometry:

Tuning of GC/MS instruments using 4-Bromofluorobenzene (BFB) for systems used in analysis of volatile organic compounds and Decafluorotriphenylphosphine (DFTPP) for the semivolatile analysis systems will be performed at the beginning of each work shift and every twelve hours of operation following. Tuning results must meet requirements defined in the appropriate analytical methods (SW-846).

Initial calibration of the GC/MS instruments will be performed as described in each GC/MS analytical method in SW-846 utilizing a five point calibration curve. Relative standard deviations of Response Factors for the designated Calibration Check Compounds must be less than 30% and minimum average Response Factors will be achieved.

GC/MS continuing calibrations will be performed following successful completion of tuning and will follow procedures outlined in SW-846. Minimum Response Factor requirements will be met and the percent difference between initial and continuing Response Factors for the Calibration Check Compounds must meet the defined limits. Retention times of internal standards will be within 30 seconds of the last calibration and the peak areas will not vary by more than a factor of two (-50% to + 100%) from the previous calibration.

Gas Chromatography:

Initial Calibration of the GC instruments, using a 5 point calibration, will be performed as described in each GC analytical method in SW-846 to determine a calibration curve. Relative standard deviations of Response Factors for the target compounds must be less than 20%.

GC continuing calibrations will be performed at the beginning of each day and every 12 hours of operation following procedures outlined in SW-846. The difference between initial and continuing calibration Response Factors for all target compounds must be less than 15%.

8.0 CALIBRATION / QC PROCEDURES (Continued)

8.2 Quality control parameters used within the laboratory consist of the following:

Method Blanks:

This is type 1 laboratory-grade water or washed, baked sand that is subjected to the same preparation techniques as sample extracts. Results of method blanks are used to track any interferences introduced by reagent contamination or extract preparation procedures. Within spectroscopy, method blanks allow additional tracking of artifacts introduced to the system by highly concentrated samples. Method blanks may not be applicable to unprocessed samples.

Duplicate Analysis:

The duplicate analyses indicate the reproducibility of the analytical technique. Samples can be split prior to preparation or post-preparation. These variations allow the analyst and the project manager to determine the validity of the analytical run within the limits defined by sample homogeneity.

Spiked Analysis:

Samples have known aliquots of analyte added prior to preparation, or in the case of waste dilution, added after preparation. The resulting recovery allows determination of matrix effect on the known value. Spiking can be one of the best indicators of laboratory results for completeness.

8.0 CALIBRATION / QC PROCEDURES (Continued)

Spiked Duplicate:

This analysis is an evaluation of the duplicate and the spike response. It is most often used in trace organics, but may be applied to trace metal analysis.

Laboratory Control Sample:

A known matrix containing representative analytes at documented concentrations.

QC Parameter	Frequency
Method Blank	Each Sample Set / Each Calibration
Duplicate Analysis	Each Sample Set / Each Calibration
Matrix Spike	Each Sample Set / Each Calibration
Matrix Spike Duplicate	1 per calibration - Volatiles
Matrix Spike Duplicate	1 per calibration - Semivolatiles

*SDG = Batch of data from the field. A batch includes data produced from field samples and data generated through the quality control program.

9.0 ANALYTICAL PROCEDURES

List of EPA Approved Miscellaneous Test Procedures

Parameter and Method	SW-846[2]
Soil pH	9045
	EPA-600/4-79-020[3]
TPH - IR	418.1
	SW-846[2]
extraction for soil	3550

List of EPA Approved Inorganic Test Procedures

Parameter and Method	SW-846[2]
ICP Metals	6010
AA Metals	7000
Mercury cold vapor, manual	7471
Digestion, soil	3050
Digestion, surface/ground water	3010 / 3020

List of EPA Approved Organic Test Procedures

Compound Class[1]	SW-846[2]
Volatile Organics (sample prep included)	8240
Semivolatile Organics	8270
soil sample prep	3540

1. Analytes per compound class may not reflect common detection limits.
2. EPA. Test Methods for Evaluating Solid Waste, 3rd Edition. SW-846. November, 1986.
3. EPA. Methods for Chemical Analysis of Water and Waste. EPA-600/4-79-020, March 1983.

9.0 ANALYTICAL PROCEDURES (Continued)

EPA METHOD 8240
VOLATILE ORGANIC COMPOUNDS

Parameter	**Detection Limit** (Soil - ug/kg)	**Detection Limit** (Water - ug/L)
Acetone	10	10
Benzene	10	10
Bromodichloromethane	10	10
Bromoform	10	10
Bromomethane	10	10
2 - Butanone	10	10
Carbon disulfide	10	10
Carbon tetrachloride	10	10
Chlorobenzene	10	10
Chloroethane	10	10
Chloroform	10	10
Chloromethane	10	10
Dibromochloromethane	10	10
1,1-Dichloroethane	10	10
1,2-Dichloroethane	10	10
1,1-Dichloroethene	10	10
1,2-Dichloroethene (total)	10	10
1,2-Dichloropropane	10	10
cis-1,3-Dichloropropene	10	10
trans-1,3-Dichloropropene	10	10
Ethylbenzene	10	10
2-Hexanone (MEK)	10	10
Methylene chloride	10	10
4-Methyl-2-pentanone	10	10
Styrene	10	10
1,1,2,2-Tetrachloroethane	10	10
Tetrachloroethene	10	10
Toluene	10	10
1,1,1-Trichloroethane	10	10
1,1,2-Trichloroethane	10	10
Trichloroethene	10	10
Vinyl chloride	10	10
Xylenes (total)	10	10

Reference:

Method 8240, Gas Chromatography/Mass Spectrometry for Volatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States EPA, Third Edition, November 1986 and 1990.

9.0 ANALYTICAL PROCEDURES (Continued)

EPA METHOD 8270
SEMI-VOLATILE COMPOUNDS

Parameter	Detection Limit (Soil - mg/kg)	Detection Limit (Water - ug/L)
Acenaphthene	0.33	10
Acenaphthylene	0.33	10
Anthracene	0.33	10
Benzo(a)anthracene	0.33	10
Benzo(b)fluoranthene	0.33	10
Benzo(k)fluoranthene	0.33	10
Benzo(g,h,i)perylene	0.33	10
Benzo(a)pyrene	0.33	10
4-Bromophenyl phenyl ether	0.33	10
Butylbenzylphthalate	0.33	10
di-n-Butylphthalate	0.33	10
Carbazole	0.33	10
4-Chloroaniline	0.33	10
bis(2-Chloroethyl) ether	0.33	10
bis(2-Chloroethoxy) methane	0.33	10
bis(2-Chloroisopropyl) ether	0.33	10
4-Chloro-3-methylphenol	0.33	10
2-Chloronaphthalene	0.33	10
2-Chlorophenol	0.33	10
4-Chlorophenyl phenyl ether	0.33	10
Chrysene	0.33	10
Dibenzo(a,h)anthracene	0.33	10
Dibenzofuran	0.33	10
1,2-Dichlorobenzene	0.33	10
1,3-Dichlorobenzene	0.33	10
1,4-Dichlorobenzene	0.33	10
3,3'-Dichlorobenzidene	0.33	10
2,4-Dichlorophenol	0.33	10
Diethylphthalate	0.33	10
2,4-Dimethylphenol	0.33	10
Dimethylphthalate	0.33	10
4,6-Dinitro-2-methylphenol	0.8	25
2,4-Dinitrophenol	0.8	25
2,4-Dinitrotoluene	0.33	10
2,6-Dinitrotoluene	0.33	10
bis(2-Ethylhexyl)phthalate	0.33	10
Fluoranthene	0.33	10
Fluorene	0.33	10

9.0 ANALYTICAL PROCEDURES (Continued)

EPA METHOD 8270 (continued)
SEMI-VOLATILE COMPOUNDS

Parameter	**Detection Limit** (Soil - mg/kg)	**Detection Limit** (Water - ug/L)
Hexachlorobenzene	0.33	10
Hexachlorobutadiene	0.33	10
Hexachlorocylopentadiene	0.33	10
Hexachloroethane	0.33	10
Ideno(1,2,3-cd)pyrene	0.33	10
Isophorone	0.33	10
2-Methylnaphthalene	0.33	10
2-Methylphenol	0.33	10
4-Methylphenol	0.33	10
Naphthalene	0.33	10
2-Nitroaniline	0.8	25
3-Nitroaniline	0.8	25
4-Nitroaniline	0.8	25
Nitrobenzene	0.33	10
2-Nitrophenol	0.33	10
4-Nitrophenol	0.8	25
n-Nitrosodiphenylamine	0.33	10
n-Nitroso-di-n-propylamine	0.33	10
di-n-Octylphthalate	0.33	10
Pentachlorophenol	0.8	25
Phenanthrene	0.33	10
Phenol	0.33	10
Pyrene	0.33	10
1,2,4-Trichlorobenzene	0.33	10
2,4,5-Trichlorophenol	0.8	25
2,4,6-Trichlorophenol	0.33	10

Reference:

Method 8270, Gas Chromatography/Mass Spectrometry for Semi-Volatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States EPA, Third Edition, November, 1986.

9.0 ANALYTICAL PROCEDURES (Continued)

EPA METHODS 3050, 6010 AND 7000
PRIORITY POLLUTANT METALS

Parameter	Detection Limit (Soil - mg/kg)	Detection Limit (Water - ug/L)
Antimony	5	60
Arsenic	10	10
Beryllium	0.5	5
Cadmium	0.5	5
Chromium	5	10
Copper	5	25
Lead	10	3
Mercury	0.2	0.2
Nickel	1	40
Selenium	10	5
Silver	5	10
Thallium	10	10
Zinc	1	20

GENERAL PARAMETERS

Parameter	Detection Limit (Soil - mg/kg)	Detection Limit (Water - mg/L)
TPH	10	0.25
TOC	10	0.1
pH	± 0.1 s.u.	± 0.1 s.u
Nutrients		0.01
TDS		1
TSS		1

Note: Detection Limits may vary depending on matrix effects and interferences.

10.0 DATA REDUCTION / VALIDATION

Data reduction occurs in a multi-level system.

Initial level of data reduction occurs with the custodian and section leaders to verify, by comparison, the dates of sampling, the analytes, any sampling notes, and preparation notes from the raw log books with COC. Information should track chronologically and methodically. Results generated that are impacted by raw sample information, such as mixed matrix or samples with significant moisture are flagged.

Second level rests on the review of the analytical runs. The section leaders will review the runs, the methods used for compliance, and the frequency of quality control analyses. The section leaders and QA officer will review the data at this level to validate basic procedures, results, and QC. Rerun analysis for parameters will be initiated at this level.

The third level will start once the laboratory section leaders are confident of the overall fitness of the package in terms of raw data, supporting log books, operating conditions, and completeness. The report will be formatted within the client-requested formats, reviewed by the QA officer and submitted to the Project administrator for final signoff and delivery to the client.

The validation of the data will address all information from the sample receipt inventory to the finished product. Supporting documentation that follows sample chronology will be complete and verified.

A survey of validation information to be checked is as follows:

- Sample acceptability vs. Chain of Custody
- Holding times (interval between sample receipt and preparation/analysis)
- Instrument calibration and verification (calibration and control sample analysis)
- Statement of minimum detectable concentrations (detection limits)
- Verification of laboratory contamination control (blanks)

10.0 DATA REDUCTION / VALIDATION (Continued)

- Verification of analysis interference control - (inductively coupled plasma and GCMS) procedures.
- Verification of digestion and analysis control (reference standards) procedures.
- Verification of precision and accuracy of sample data (duplicate and spiked samples) generated.
- Verification of analysis control (duplicate injections and spike recoveries) within ICP and GC/MS runs.
- Table 10-1

10.0 DATA REDUCTION / VALIDATION (Continued)

TABLE 10-1
QUALITY CONTROL VALIDATION

Activity	First Tier	Second Tier
Receipt/Custody	Billie Perry	Fran Armenta
Inorganic Prep	Marlin Hopper	Mike Terry
Organic Prep	Jeff Poulson	Shawn Rettig
AA Spectroscopy	Bill Anderson	Laurel Main
IR Spectroscopy	Yvonne Imel	Denise Bohemier
GC Screen Lab	Rich Martoglio	Jack Felkey
GC/MS VOA	Scott Early	Wynn Sudtelgte
GC/MS/Semi-Vol	Ed Scruton	Tom Foubert
Data Control	Jack Felkey	Denise Bohemier
Package QC	Charles Ballek	Jay Stender

* If required, the above named individuals will be replaced with other similarly qualified individuals.

11.0 INTERNAL QUALITY CONTROL

A. Verify Parameter / Method with Chain of Custody and contract.

B. Verify instrumental calibrations by monitoring instrument conditions, wavelengths, and standards. Verify regression calculation for quantitation.

C. Perform method blank analysis by following the same procedure used for preparation of field samples.

D. Perform duplicate analysis of laboratory split sample. Relative percent difference will be calculated. Criteria for duplicates are given in Appendix B.

E. Perform matrix spike analysis of laboratory split sample to determine any matrix effect on known analyte spikes.

F. When appropriate, perform the analysis of a laboratory control sample with the analysis of each sample set and track recovery. IML uses USEPA or commercial grade control samples. The recovery of control samples are monitored using warning limits and control statistics as indicated by SW-846.

G. For IDL determinations, spiked blank solution will be analyzed a minimum of seven times on three non-consecutive run days.

H. Control charts of calibration materials to determine instrument changes by using control and warning statistics.

I. Daily calibration of analytical balances to NBS standards.

J. Mapping and rotation of reagents used within a project. Specific reagents for a project may be isolated to be used for the entire project. Records of reagents and dates are supplied by the laboratory section leaders and reviewed by the QC officer.

11.0 INTERNAL QUALITY CONTROL (Continued)

K. Develop and record instrument maintenance logs. Any changes in the parts or operation of an instrument are recorded and monitored.

L. Use laboratory record notebooks consistently and legibly.

Data deliverables will include:

1) Project narration

2) Quantitation Page
   a) Inorganic
   b) Organic - Volatiles
   c) Organic - Semivolatiles
   d) Organic - IR

3) Quality Control
   a) Method/preparation blanks
   b) Calibration controls - CCV for ICP, AA,
      CCAL for GC/MS,
      Calibration Curves for IR, ICP, AA
   c) Duplicate analyses
   d) Spike analysis - inorganic
   e) Spike and duplicate - organic
   f) Interference check - ICP

VOA quantitation report will include replicate analysis (3 results) if needed to verify detectable values. Any supporting data, such as replicate analysis, will be submitted as independent data in the QC report.

Analytical reports will be submitted as sample data batches. Estimated package turn, per Sample Delivery Group, will be 15 working days

12.0 PERFORMANCE AUDIT FOR LABORATORY ACTIVITIES

The QA/QC officer will perform system checks by the use of blind samples within the project.

IML participates in several Performance Evaluation Audits. Most specifically the WP and WS programs administered by Region VIII USEPA.

Audits by a variety of state and private concerns have occurred within the laboratory. In the last 12 months, the laboratory has been audited by USEPA, the State of Utah Department of Health, and the State of Washington Department of Ecology.

Ongoing certification projects with new states require submittal of QA manuals, the analysis of prepared evaluation samples, and on-site audits.

The data generated for this project will be Level IV, except for Level V parameters and methods which may be used to meet data quality objectives. Data detection levels will require some method modification that will impact validation procedures.

12.0 PERFORMANCE AUDIT (Continued)

Levels of data will include the following:

Analytical Level	TYPE OF ANALYSIS	LIMITATIONS	DATA QUALITY
Project Specific	Organics / Inorganics by GC/MS; IR; AA; ICP Low ppb detection limit	Tentative identification of non-HSL parameters Some time may be required for validation of packages	Goal is data of known quality Rigorous QA/QC

The data generated for this project will be level IV. Contract required detection levels may require some method modification that could impact validation procedures.

13.0 PREVENTATIVE MAINTENANCE:

This analytical project utilizes meters, auto analyzers, ion-chromatographs, atomic absorption spectrometers, inductively coupled plasma spectrometers, infrared spectrophotometers, gas chromatographs, and gas chromatographs/ mass spectrometers. Each instrument has a specific maintenance procedure. IML follows instrument manufacturer recommendations for maintenance.

Spectroscopy:	The AA's and ICP are maintained through contracted service from the manufacturer. Annually, and sometimes more frequently, the instruments are updated by the factory to meet contract specifications.
Auto-analyzers/IC/IR:	These instruments come with manufacturer recommendations addressing the maintenance and upkeep. IML utilizes these outlines and meets the minimum requirements for the instrument.
Meters & Probes:	Analysts and laboratory staff check surfaces and calibrate daily. Instruments are cleaned monthly, and checked for operations.
Gas Chromatography:	Daily maintenance of columns as determined by method blank or chromatographic shift. Section leaders monitor RF responses weekly.
Gas Chromatography/ Mass Spectrometry:	Contracted maintenance with Hewlett Packard.

14.0 PROCEDURES FOR PRECISION AND ACCURACY

Precision within the analytical laboratory is defined as an agreement of results between similar samples for similar analytes. The calculated value addressing precision is "Relative Percent Difference."

Within each analytical run, a maximum of twenty (20) samples, at least one duplicate analysis will be run. Additional duplicate analysis will be performed if the matrix conditions change. Duplicate analysis RPD must be less than 35% for samples 5 times the Contract Reported Detection Level (CRDL). If sample concentrations are below 5 times the CRDL, the difference between the original and duplicate values must be less than the CRDL. Samples that are near or at the detection level will fall into the second criteria. Data qualifiers may be used as a result of duplicate analysis.

Accuracy, or the measure of nearness to the actual value, is determined using spike recoveries. By mapping the recovery of known spiking concentrations on given samples one can track, or chart, the analytical method performance. IML matrix spike results will fall within the EPA defined recovery range for the method. Samples outside of this recovery limit will be evaluated by the laboratory section leader. Spike solutions are added prior to sample preparation and evaluate the digestion and analysis procedures. Post digestion spikes monitor the accuracy of analytical instrumentation. If the sample concentration exceeds 4 times the matrix spike added, the recovery may not be applicable in terms of validation. When the analytical data is lower than the CRDL, the sample result is assumed to be 0 for the % recovery calculation. Data qualifiers may be used as the consequence of matrix spike recoveries.

The use of Laboratory Control Samples (LCS) prepared of similar analytes in similar matrices allow the analysts to track, over a series of events, the reproducibility of the technique.

14.0 PROCEDURES FOR PRECISION and ACCURACY (Continued)

Method Blanks, reagent and laboratory water samples that are prepared in a similar fashion to the samples, will be analyzed at a minimum of one per SDG. Some analyses, such as ICP metals, may have more method and calibration blanks. The method blanks will be used to verify consistent baseline response of the instrument and verify no carryover of analytes from samples. Method blanks will be analyzed to verify Instrument Detection Limits and detection level performance of the instruments.

Calibration Verification Standards are used within the laboratory to verify the linearity of the calibration curves. These materials are made from differing sources with analyte concentrations in the calibration range. CVS for ICP are used every seven (7) analytical shots.

15.0 CORRECTIVE ACTION

Corrective Action, or the ability to change procedures, instruments, or personnel can originate from either the section leader or QA officer. The corrective action will be recorded in the laboratory log books and tracked throughout the project.

15.1 Immediate and effective action will be taken when control data indicates non-standard method or instrument performance. Since the analyst records all observations and monitors QC analytical results, he or she should be the first to determine that an analysis is not in control. Therefore, primary responsibility for initiation of appropriate corrective action will belong to the analyst. The reviewer of the data may also begin procedures to correct the deficiency if evidence exists indicating conditions warrant action.

15.2 Quality Assurance activities will be monitored on an appropriate basis (run-to-run, daily, quarterly,...) to determine the need for initiation of corrective action.

1) Abnormal instrument performance or chromatographic output will result in initiation of corrective action.

2) Run-specific Quality Control data (surrogate recoveries, internal standard areas) which are found to exceed control limits on two or more successive analyses will result in corrective action steps being taken.

3) Daily Quality Control data (duplicate RPD, matrix spike percent recovery, continuing calibration percent difference,...) found to be outside control limits established will be cause for initiation of corrective action.

4) Corrective action steps will be initiated following notification of unacceptable results on performance evaluation audits.

5) Corrective action will begin upon notification of unacceptable results on inter- or intra-laboratory performance studies.

15.0 CORRECTIVE ACTION (Continued)

15.3 Corrective action will follow a defined series of steps to identify and correct the problem.

1) Calculations will be checked for mathematical errors. Extraction logs will be examined for non-standard procedures or observations of sample abnormalities. The log books documenting the preparation of calibration standards, surrogates, internal standards, and spikes will be reviewed for errors. Recalculations will be performed to confirm final results.

2) The sample(s) failing the Quality Control limits will be reanalyzed to check the repeatability of the analytical method. If the results differ from the original data and fall within the control limits, identify any changes in system settings or performance and reanalyze all potentially affected samples.

3) System performance will be reviewed to assure that all gas flows are consistent with standard operation, programmed instrument controls are unchanged, integrator/computer settings are within standard limits, and all other external inputs meet analytical specifications. Analysis of appropriate QC samples will monitor system performance. If an instrument malfunction is discovered, the problem will be corrected and all samples analyzed during the affected period will be reanalyzed.

4) The samples will be reextracted and reanalyzed to check the extraction methodology. If the results differ from the original data and fall within the control limits, identification of non-standard extraction protocol will be made and all potentially affected samples will be reextracted and reanalyzed.

5) If none of the steps listed above identify and solve the problem, the data will be flagged as "J -estimated concentration".

16.0 QUALITY ASSURANCE REPORTING PROCEDURES

The QA officer of the project will issue status reports addressing the sample data set, analytical method used, quality control tools and response throughout the project. A QA memo will begin with the receipt of samples and cover preparation analysis and data reduction.

Laboratory Section Leaders and the QC Officer will issue hard copy memos to the project file addressing any QC anomaly or corrective action.

Quality assurance reports will be addressed to the project administrator, client, and the project manager. Reports will cover, at the minimum:

1. Topic covered - method, sample, data set
2. When noted and why
3. Any further action noted
4. Any resolution to topic
5. Any conversation, etc., with GTI / BRC.

17.0 REFERENCES

Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analysis. February 1, 1988.

Handbook of Quality Assurance for the Analytical Chemistry Laboratory. 1990.

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd edition. June 1990.

Method 8240, Gas Chromatography/Mass Spectrometry for Volatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, 3rd edition, November 1986 and 1990.

Method 8270, Gas Chromatography/Mass Spectrometry for Semi-Volatile Organics, Test Methods for Evaluating Solid Wastes, SW-846, United States Environmental Protection Agency, 3rd edition, November, 1986.

Method 3050: Acid Digestion of Sediments, Sludges, and Soils, SW-846, November 1986.

Method 6010: Inductively Coupled Plasma Atomic Emission Spectroscopy, SW-846, November, 1986.

Method 7000: Atomic Absorption Methods, SW-846, November, 1986.

Method 7471: Mercury in Solid and Semisolid Waste (Manual Cold-Vapor Technique), SW-846, November, 1986.

Method 418.1: Total Recoverable Petroleum Hydrocarbons, EPA-600/4-79-020, March, 1983.

Diagnosis and Improvement of Saline and Alkali Soils, Handbook 60, United States Department of Agriculture, August, 1969.

Inter- Mountain
Laboratories, Inc.

CHAIN OF CUSTODY RECORD

Client/Project Name	**Project Location**	**ANALYSES / PARAMETERS**
Sampler: (Signature)	**Chain of Custody Tape No.**	

Sample No./ Identification	Date	Time	Lab Number	Matrix	No. of Containers					Remarks

Relinquished by: (Signature)	**Date**	**Time**	**Received by: (Signature)**	**Date**	**Time**
Relinquished by: (Signature)	**Date**	**Time**	**Received by: (Signature)**	**Date**	**Time**
Relinquished by: (Signature)	**Date**	**Time**	**Received by laboratory: (Signature)**	**Date**	**Time**

Inter-Mountain Laboratories, Inc.

☐ 1633 Terra Avenue
Sheridan, Wyoming 82801
Telephone (307) 672-8945

☐ 1714 Phillips Circle
Gillette, Wyoming 82716
Telephone (307) 682-8945

☐ 2506 West Main Street
Farmington, NM 87401
Telephone (505) 326-4737

☐ 1160 Research Dr.
Bozeman, Montana 59715
Telephone (406) 586-8450

☐ 11183 SH 30
College Station, TX 77845
Telephone (409) 776-8945

☐ 3304 Longmire Drive
College Station, TX 77845
Telephone (409) 774-4999

12202

INTER-MOUNTAIN LABORATORIES, INC.

INTERNAL SAMPLE CUSTODY

LABORATORY ID	DATE RECEIVED	DATE REMOVED	NEW LOCATION	REASON	INITIALS	DATE RETURNED	INITIALS
F931813	02/11/93	02/13/93	Metals	Digestion & Analysis		02/13/93	
F931814	02/11/93	02/14/93	Soils	% Moisture determination		02/14/93	
F931815							
F931816							
F931817							
F931818							
F931819							
F931820							
F931821							
F931822							
F931823							
F931824							
F931825							
F931826							
F931827							
F931828							
F931829							
F931830							
F931831							
F931832							
F931833							

APPENDIX E
EQUIPMENT CHECKLIST

EQUIPMENT CHECKLIST

The following equipment will be collected and inspected prior to going into the field to collect samples of environmental media for the facility RFI. General equipment is needed for every sampling event, with the additional equipment specified for each sample matrix.

1.0 GENERAL EQUIPMENT

Interface Probe
Bailers
Bailer Cord
Field Notebook and Writing Utensils
Permanent Waterproof Marking Pen
Work Gloves
Sample Gloves
Preservatives - HCl, H_2SO_4, HNO_3
Sample Containers
Decontamination Equipment
    a) 5 Gallon Buckets and Scrub Brushes
    b) 55 Gallon Drums for Waste
    c) Plastic Sheeting for Decon Area
    d) Non-detergent soap
    e) Distilled Water
    f) Chemicals - methanol, isopropyl alcohol, hexane
Sample Labels
Sample Seals
Field Documentation Forms
Chain-of-Custody Forms
Air Bills
Packaging
    a) coolers
    b) tape
    c) plastic bags
    d) bubble wrap or vermiculite
    e) ice
Tools, Spare Fittings, Fuses, Batteries, Etc.
Field Instruments (in proper working order)
Trip Blanks and Blank Water Obtained from the Lab
Safety Equipment - Cones, Caution Tape
Personal Protective Equipment
55 Gallon Drums
Drum Labels
Site Map
Site Safety Plan

2.0 SOIL SAMPLING (BORING/MONITORING WELL INSTALLATION)

Air Monitoring Instrument (PID) and Calibration Equipment
Field Screening Jars
Hand Auger
Stainless Steel Putty Knives
Tape Measure
Aluminum Foil

Shelby Tubes or Other Sampling Tubes
Split Spoons

3.0 GROUNDWATER SAMPLING (WELL DEVELOPMENT AND PURGING)

Conductivity Meter
pH/Temperature Meter
Calibration Standards
Submersible Pump
Teflon Tubing
Filtering Kit for Metals
Well Lock Keys
Spare Well Caps and Locks

4.0 SURFACE WATER SAMPLING

Conductivity Meter
pH/Temperature Meter
Calibration Standards
Filtering Kit for Metals

5.0 SEDIMENT SAMPLING

Stainless Steel Trowels
Shovel

6.0 PILOT TESTS

Aquifer Test
Pumping Equipment/Hose
Decon Equipment
Data Logger and Transducers
Flow Meter(s)
Interface Probe

Air Sparge/Soil Vapor Extraction
Tedlar Bags
Rotron Blower (SVE Test Kit)
PVC Fittings
Carbon Drums
PID and Calibration Equipment
LEL/O_2 Meter
Magnehelic Gauge(s)
Kurz (air flow) Meter

APPENDIX F
SOIL GAS SURVEY PROCEDURES

TRACER RESEARCH CORPORATION

3855 North Business Center Drive
Tucson, Arizona 85705

1555 Park Avenue, Suite E
Emeryville, California 94662

1100 NW Loop 410, Suite 700
San Antonio, Texas 78213

One Deerpark Road, Suite G
Manmouth Junction, New Jersey 08552

STEPHANIE SQUARE
Avenue Louise, 65 Box 11
1050 Brussels, Belgium

Soil Gas Sampling Procedures

and

Quality Assurance

and

Quality Control Procedures

Tracer Research Corporation
Typical Detection Limits

COMPOUND	SOIL GAS (ug/L)	DETECTOR
1,1-dichloroethene (1,1-DCE)	0.01	ECD
methylene chloride (CH_2Cl_2)	0.1	ECD
1,1,2-trichlorotrifluoroethane (F-113)	0.00005	ECD
trans-1,2-dichloroethene (trans-1,2-DCE)	0.02	ECD
1,1-dichloroethane (1,1-DCA)	0.02	ECD
cis-1,2-dichloroethene (cis-1,2-DCE)	0.01	ECD
chloroform ($CHCl_3$)	0.05	ECD
1,2-dichloroethane (1,2-DCA)	0.02	ECD
1,1,1-trichloroethane (TCA)	0.00005	ECD
carbon tetrachloride (CCL_4)	0.00004	ECD
trichloroethene (TCE)	0.0001	ECD
tetrachloroethene (PCE)	0.0001	ECD
vinyl chloride	0.1	FID
methylethylketone (MEK)	0.05	FID
benzene	0.05	FID
toluene	0.05	FID
ethylbenzene	0.05	FID
xylenes	0.05	FID
total volatile hydrocarbons (TVHC)	0.1	FID

These detection limits are subject to some fluctuation due to site specific conditions.

Table of Contents

SOIL GAS SAMPLING PROCEDURES 1

I. Probe Placement 1
II. Sample Extraction 1
III. Sample Collection 2
IV. Deactivation of Sampling Apparatus 2
V. Log Book and U. S. EPA Field Sheet Notations For Sampling (Figures 2A-2D) 2
VI. Other Recordkeeping 3
VII. Determination of Sampling Locations 3

ANALYTICAL PROCEDURES 4

I. Varian 3300 Gas Chromatograph or Hewlett Packard 5890 Series II 4
II. Two Spectra Physics SP4270 or two 3396 Hewlett Packard Computing Integrators. . .4
III. Chemical Standards from ChemServices, Inc. of Westchester, Pennsylvania. 4
IV. Analytical Supplies 5

QA/QC PROCEDURES 6

I. Standards 6
II. Syringe Blanks 7
III. System Blanks 8
IV. Ambient Air Samples 8
V. Samples 8
VI. Daily System Preparation (Figure 4). 9
VII. Sample Splits 9

APPENDIX 11

Figures

SOIL GAS SAMPLING PROCEDURES

I. Probe Placement

A) A clean probe (3/4 inch galvanized steel pipe) is removed from the "clean" storage tube on top of the van.

B) The soil gas probe is placed in the jaws of a hydraulic pusher/puller mechanism.

C) A sampling drive point is inserted into the bottom of the probe.

D) The hydraulic pushing mechanism is used to push the probe into the ground.

E) If the pusher mechanism will not push the probe into the ground to a sufficient depth for sampling, a 30 pound hydraulic hammer is used to pound the probe into the ground.

II. Sample Extraction

A) An adaptor (Figure 1) is attached to the top of the soil gas probe.

B) A vacuum pump is hooked onto the adaptor via polyethylene tubing.

C) The vacuum pump is turned on and used to evacuate soil gas.

D) Probe vacuums are evacuated before a sample is collected. Since the flow rate is dependent on resistances to flow, the evacuation time is adjusted to assume that the proper volume is extracted.

E) Gauges on the vacuum pump are checked for inches of mercury, which measures the resistance to flow.

   1) Gauge must read at least 2 inches of mercury less than maximum vacuum to be extracting sufficient soil gas to collect a valid sample.

III. Sample Collection

A) With vacuum pump running, a hypodermic syringe needle attached to a 10 mL glass syringe is inserted through the silicone rubber, which acts as a seal, and down into the metal tubing of adaptor (Figure 1). The adaptor (TRACERs special design) is designed to eliminate the possibility of exposing the sample stream to any part of the adaptor and associated tubing.

B) Gas samples only contact metal surfaces and never contact potentially sorbing materials (i.e., tubing, hose, pump diaphragm).

C) The syringe is purged with soil gas. Then, without removing the syringe needle from the adaptor, a 2 to 10 mL soil gas sample is collected.

D) The syringe and needle are removed from the adaptor and the end of the needle is plugged.

E) If necessary, a second 10 mL sample is collected using the same procedure.

IV. Deactivation of Sampling Apparatus

A) The vacuum pump is turned off and unhooked from the adaptor.

B) The adaptor is removed and stored.

C) Using the hydraulic puller mechanism, the probe is removed from the ground.

D) The probe is stored in the "dirty" probe tube on top of the van.

E) The probe hole is backfilled and capped, if required.

V. Log Book and U. S. EPA Field Sheet Notations For Sampling (Figures 2A-2D)

A) Time (military notation)

B) Sample number (use client's numbering system)

C) Location (approximate description - i.e., street names)

D) Sampling depth

E) Evacuation time before sampling

F) Inches of mercury on vacuum pump gauge

G) Probe and adaptor numbers

H) Number of sampling points used

I) Observations (i.e., ground conditions, concrete, asphalt, soil appearance, surface water, odors, vegetation, etc.)

J) Backfill procedure and materials, if used.

VI. Other Recordkeeping

A) Client-provided data sheets are filled out, if required

B) Sample location is marked on the site map

VII. Determination of Sampling Locations

A) Initial sample locations are determined by client (perhaps after consultation with TRACER personnel) prior to start of job.

B) Remaining sample locations may be determined by:

- 1) Client
    - a) Entire job sampling locations set up on grid system.
    - b) Client decides location of remaining sample locations based on results of initial study, or
- 2) Client and TRACER Personnel
    - a) Client and TRACER personnel decide location of remaining sample locations based on results of initial sample locations.

I. Varian 3300 Gas Chromatograph or Hewlett Packard 5890 Series II

A) Equipped with an Electron Capture Detector (ECD), a Flame Ionization Detector (FID), a Photo Ionization Detector (PID), and/or a Thermal Conductivity (TCD) Detector.

B) The chromatographic column used by TRACER for the analysis of halocarbons is a 1/8" diameter packed column containing Alltech OV-101. This nicely separates most of the tri-chloro and tetra-chloro compounds that are typically encountered during soil gas investigations. The di-chloro compounds tend to elute ahead of the tri-chloro and tetra-chloro compounds, thus creating no interference. In the event that assurance of the identity of a compound in any particular sample is required, it will be analyzed on a SP-1000 column after the OV-101 analysis.

II. Two Spectra Physics SP4270 or two 3396 Hewlett Packard Computing Integrators.

A) The integrators are used to plot the chromatogram and measure the size of the chromatographic peaks. The integrators compute and record the area of each peak. The peak areas are used directly to calculate contaminant concentrations.

III. Chemical Standards from ChemServices, Inc. of Westchester, Pennsylvania.

A) TRACER uses analytical standards that are pre-analyzed, of certified purities, and lot numbered for quality control assurance. Each vial is marked with an expiration date. All analytical standards are the highest grade available. Certified purities are typically 99 percent.

B) The Quality Assurance procedures used by ChemService were described by the Laboratory Supervisor, Dr. Lyle Phipher.

1) The primary measurement equipment at ChemServices, the analytical balance, is serviced by the Mettler Balance Company on an annual basis and recalibrated with NBS traceable weights.
2) All chemicals purchased for use in making the standards are checked for purity by means of gas chromatography using a thermal conductivity detector. Their chemicals are purified as needed.
3) The information on the purification and analysis of the standards is made available upon request for any item they ship when the item is identified by lot number. All standards and chemicals are shipped with their lot numbers printed on them. The standards used by TRACER are made up in a two-step dilution of the pure chemical furnished by ChemServices.

IV. Analytical Supplies

A) Sufficient 2cc and 10 cc glass Hamilton syringes so that none have to be reused without first being cleaned.

B) Disposable lab supplies, where appropriate.

C) Glassware to prepare aqueous standards.

D) Miscellaneous laboratory supplies.

I. Standards

A) A fresh aqueous standard is prepared each day. The standards are made by serial dilution.

1) First, a stock solution containing the standard in methanol is prepared at TRACERs Tucson office. The stock solution is prepared by pipetting the pure chemical into 250 mL of methanol in a volumetric flask at room temperature. The absolute mass is determined from the product of volume and density calculated at room temperature. Hamilton microliter syringes, with a manufacturer's stated accuracy of plus or minus 1 percent, are used for pipetting. Information on density is obtained from the CRC Handbook of Physics and Chemistry. Once the stock solution is prepared, typically in concentration range of 50-4000 mg/L, a working standard is prepared in water each day. The solute in the stock solution has a strong affinity to remain in methanol so there is no need to refrigerate the stock solution. Additionally, the solute tends not to biodegrade or volatilize out of the stock solution.

2) The working standards are prepared in 40 mL VOA septum vials by diluting the appropriate µg/L quantity of the standard solution into 40 mL of water.

B) The standard water purity is verified each day before using it to prepare the aqueous standard.

C) The aqueous standard is prepared in a clean vial using a dedicated syringe each day.

D) Final dilution of the calibration standards are made in water in a VOA vial having a Teflon coated septum cap instead of a volumetric flask in order to have the standard in a container with no air exposure. The VOA bottle permits mixing of the standard solution and subsequent syringe sampling all day long without opening the bottle or exposing the standard to air. The measurement uncertainty inherent in the use of a VOA bottle instead of a volumetric flask is approximately plus or minus 1 percent.

E) The aqueous standard will contain the compounds of interest in the range of 5 to 400 µg/L depending on the detectability of the individual components. The standard will be analyzed at least three times at the beginning of each day to determine the mean response factor (RF) for each component (Figure 3). The standard will be injected again after every fifth sample to check detector response and chromatographic performance of the instrument throughout the day.

F) The RF allows conversion of peak areas into concentrations for the contaminants of interest. The RF used is changed if the standard response varies 25 percent. If the standard injections vary by more than 25 percent, the standard injections are repeated. If the mean of the two standard injections represents greater than 25 percent difference then a third standard is injected and a new RF is calculated from the three standard injections. A new calibration is started with the new RF's and calibration data.

$$\% \text{ of difference} = \frac{A \text{ area} - B \text{ area}}{A \text{ area}}$$

A = mean peak area of standard injection first calibration

B = peak area of subsequent standard injection

G) The low µg/L aqueous standards that are made fresh daily need not be refrigerated during the day because they do not change significantly in a 24-hour period. On numerous occasions, the unrefrigerated 24-hour old standards have been compared with fresh standards and no measurable difference has been affected.

If the standards were made at high ppm levels in water, the problem of volatilization would probably be more pronounced in the absence of refrigeration.

H) Primary standards are kept in the vans and replaced every six months.

I) A client may provide analytical standards for additional calibration and verification.

II. Syringe Blanks

A) Each uL syringe is blanked before use.

B) 2 cc (glass) syringes are blanked if ambient air concentrations are elevated (greater than or equal to 0.01 µg/L) for components of interest.

C) If ambient air concentrations are µg/L for components of interest, a representative sample of at least two syringes are blanked at the beginning of each day. If representative syringes have no detectable contamination remaining syringes need not be blanked. If any of representative syringes show contamination, all 2 cc syringes must be blanked prior to use.

D) Syringe blanks are run with air or nitrogen.

E) If it is necessary for any syringe to be used again before cleaning, it is blanked prior to its second use.

III. System Blanks

A) System blanks are ambient air drawn through the probe and complete sampling apparatus (probe adaptor and 10 cc syringe) and analyzed by the same procedure as a soil gas sample. The probe is above the ground.

B) One system blank is run at the beginning of each day and compared to a concurrently sampled air analyses.

C) A system blank is run before reusing any sampling system component.

IV. Ambient Air Samples

A) Ambient air samples are collected and analyzed a minimum of two times daily to monitor safety of the work environment and to establish site background concentrations, if any, for contaminants of interest.

B) All ambient air samples are documented (Figure 3).

V. Samples

A) All unknown samples are analyzed at least twice when injection times are less than 12 minutes.

B) More unknown samples are run until reproducibility is within 25 percent, computed as follows:

$$\text{Difference} = \frac{A - B}{(A + B) / 2}$$

WHERE:

A is the first measurement result

B is second measurement result

If the difference is greater than .25, a subsequent sample will be run until two measurements are made that have a difference of .25 or less. Those two measurements are used in the final calculation for that sample.

C) The injection volume is adjusted so that mass of analyte is as near as possible to that which is contained in the standard, at least within a factor of ten.

D) Whenever possible, the attenuation for unknown samples is kept constant through the day (so as to provide a visual check of integrations).

E) A water plug is used as a gas seal in uL syringes.

F) A seal is established between syringes when subsampling.

G) At very high concentrations air dilutions are acceptable once concentration of contaminants in air have been established.

H) All sample analysis are documented (Figure 3).

I) Separate data sheets are used if chromatographic conditions change.

J) Everything is labeled in µg/L, mg/L, etc. PPM and PPB notations are to be avoided.

VI. Daily System Preparation (Figure 4).

A) Integrator parameters are initialized
  1) Peak threshold
  2) Attenuation
  3) Peak markers
  4) Auto zero
  5) Baseline offset (min. 10% of full scale)

B) The baseline is checked for drift, noise, etc.

C) System parameters are set.
  1) Gas flows (Note: N_2, air, H_2 tank pressure on Page 1 of chromatograms).
  2) Temperatures
    a) Injector
    b) Column
    c) Detector

D) After the last analysis of the day, used septa are rotated out of the injection ports and replaced with fresh septa.

E) Column and injector temperatures are increased to bake out residual contamination.

F) Syringes are cleaned each day
  1) 2 and 10 cc syringes are cleaned with Alconox or equivalent detergent and brush.
  2) uL syringes are cleaned daily with IPA or MeOH and purged with N_2. Syringe Kleen is used to remove metal deposits in the barrel.
  3) Syringes are baked out overnight in the oven of the gas chromatograph at a minimum temperature of 60°C.

VII. Sample Splits

If desired, TRACER,s clients, or any party with the approval of TRACER,s client, may use sample splits to verify TRACER,s soil gas or groundwater sampling results.

A) Sample splits may be collected in two-valve, flow-through-type, all-glass or internally electroplated stainless steel containers for analysis within 10 days of collection.

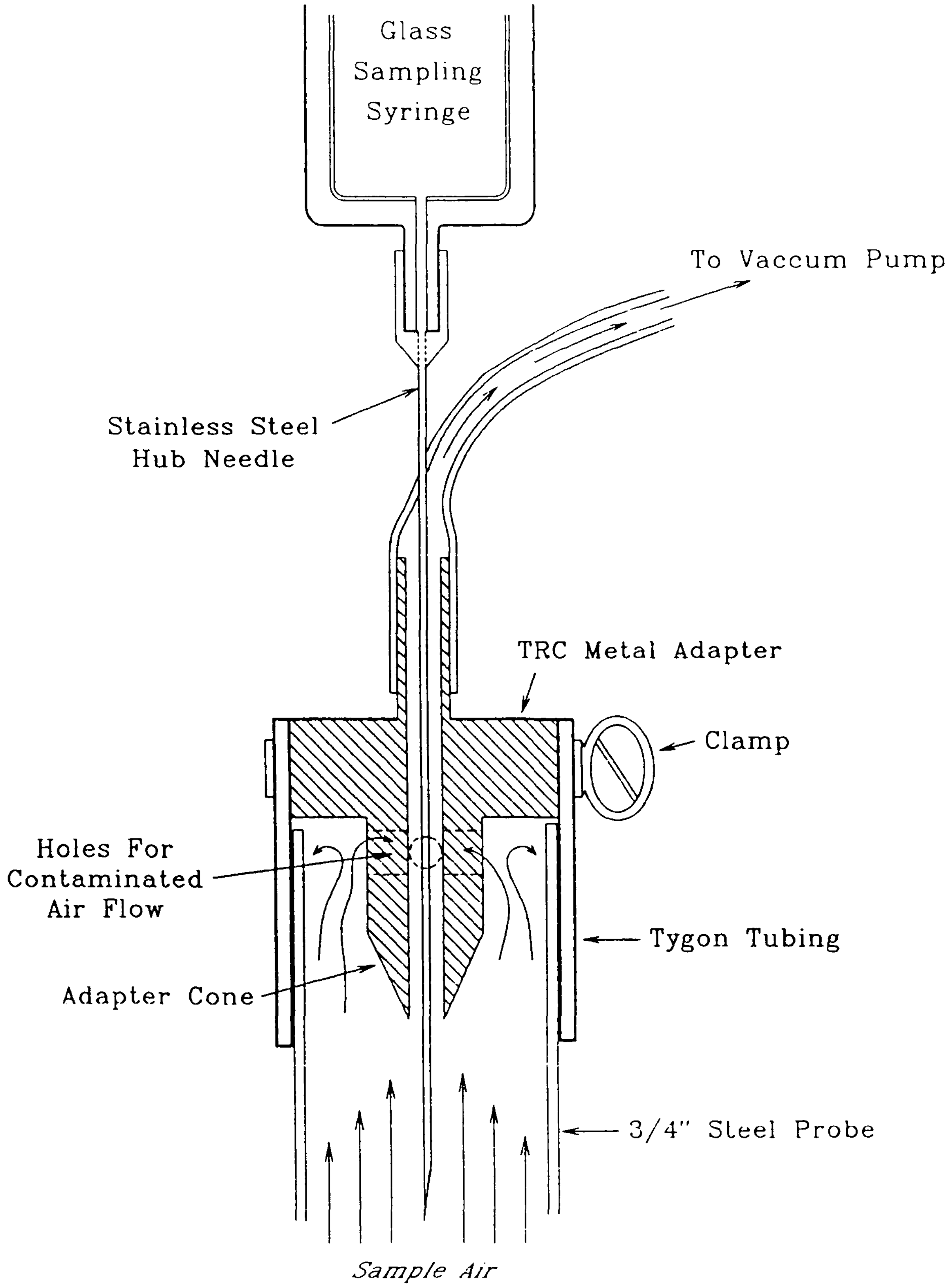
  1) Flow through sample collection bottles are cleaned by purging with nitrogen at 100°C for at least 30 minutes. Once clean, the bottles should be stored filled with nitrogen at ambient pressure.
  2) Sample bottles are filled by placing them in the sample stream between the probe and the vacuum pump. Five sample bottle volumes are drawn through the container before the final sample is collected. The sample should be at ambient pressure.

B) Sample splits can be provided in 10 cc glass syringes for immediate analysis in the field by the party requesting the sample splits.

C) Splits of the aqueous standards or the methanol standards used by TRACER for instrument calibration may be analyzed by the party requesting sample splits.

APPENDIX

Figures



SCHEMATIC CROSS SECTION OF THE NEW TRC PROBE ADAPTER

SOIL GAS INVESTIGATION BACKGROUND INFORMATION

Job Number: 1-41-178-S

Van Number: 1

Plate Number: 4GY OWL

Site Name: Davidson Chemical

Location: 14600 West Avenue N., Leatham, South Dakota

Dates Of Investigation: 2/16-18/89

Client Name and Address:
Brandenburg Environmental
602 Harpoon Rd
Wheresinthel, SD 19667

Phone Number: (783) 172-1003

Field Representative(s) For Client: Joe Pandelket

Person To Whom Report And Questions Should Be Directed: Sarah Whendel

Phone Number: (783) 172-1003

Fax Number: [illegible]72-1000

CREW:

Crew Leader: S. Chuller

Field Ass[illegible] H[illegible]ni

Report To Include (CHECK ONE):

☑ QA/QC - Procedures - Data Only

☐ Full Report With Contour Maps and Interpr[illegible]

Additional infor[illegible]included in report at client's [illegible]

[illegible] & QA/QC data

Purpose Of Investigation:

Determine extent [illegible]ination from storage tank spill.

Target VOC's: [illegible]

Client's signature of target voc's verification: Sarah Whendel

Groundwater Information [illegible]

Depth To Water: 12-16'

Direction of flow: NE

Sources Of Contamination:

Company used solvents in photo-etching process in manufacture of electronic circuit boards.

Storage tank cracked and leaked from approx. 1977-1982 when company shut down. Source was removed in 1982.

Geologic Setting (e.g. soil type, subsurface geology, etc.):

Loess & glacial till (to 10'); Fractured basement below 10'.

SAMPLING DATA

Date: 2-16-89

Job Number 1-99-178-S

Location: 14600 West Avenue N., Leathorn, South Dakota

Client: Davidson Chemical

List Rental or Extra Equipment use on this Date:

TIME	SAMPLE NUMBER	DEPTH FT	PROBE #	PROBE PUSH/ POUND	VACUUM (in Hg)	EVAC TIME (s)	SAMPLE VOL (cc)	POINTS USED	NOTES/ADD'L DATA REQUESTED BY CLIENT This includes, but is not limited to: description of sampling location and general area, ground conditions, asphalt, concrete, soil appearance, odors, [illegible], backfill procedures and materials, etc.
0845	System Blank	N/A	16	N/A	3	30S	8	N/A	
0900	SG-01	6'	27	Push-5 Ham-6	3		[illegible]	1	ICE [illegible] ' NE of sampling point [illegible] of [illegible] dock, from [illegible] [illegible] and [illegible] loading bay is 50' E.
0915	SG-02	6'	301	Push-1 1/2 Ham-6	5	30S	7 1/2	1	[illegible] asphalt is degraded to tar consistency. Soft and [illegible] like in appearance & feels as used to drill, probe [illegible] through easily; patched when done.
0941	SG-40	5 1/2'	45	Push-1 1/2 Ham-6	[illegible]	[illegible]	[illegible]	1	More tar-puddle asphalt; client has indicated that patch won't be necessary.

DAILY SUMMARY

DATE: 2-16-89	CLIENT: Brandenburg Environmental	JOB NUMBER: 1-99-178-S

WEATHER: 12 degrees F., snow squalls, cold & breezy

FIELD HOURS

Time on Site:	0730	Lunch Hours	1
Time off Site:	1730	Downtime Hours[1]	0
		Standby Hours[2]	0

Client's signature verifying time on and off site: Sarah Whend[illegible]

Billable Hours *(office use only)*:

NOTE: REPORT TIME TO NEAREST O.[illegible]RS

DECONTA[illegible]TION

Probe Decontam[illegible]	Sy[illegible]ontamination
Total Hours: 4	[illegible]ta[illegible]s: 1/2
Signature of verification by GC Operato[illegible] S[illegible]	Signature of verification by Field Assistant: M. Ferraroni

SA[illegible]LING AND ANALYSIS

Calibratio[illegible]	[illegible]Sampling	Analysis
Time Start: 0[illegible]30	[illegible]acuum used (Check one): ☐ Diaphram ☑ Transducer	Total System Blanks: 1
Time End: 0830	Max Vacuum: 23 (in Hg)	Total Ambient Air Samples: 3
Total Hours: 1	Probes Used: 18	Total Analytical Blanks: 1
	Points Used: 20	Total Reagent Blanks: 1
	Soil Gas Samples Collected: 18	Water Samples Collected: 0

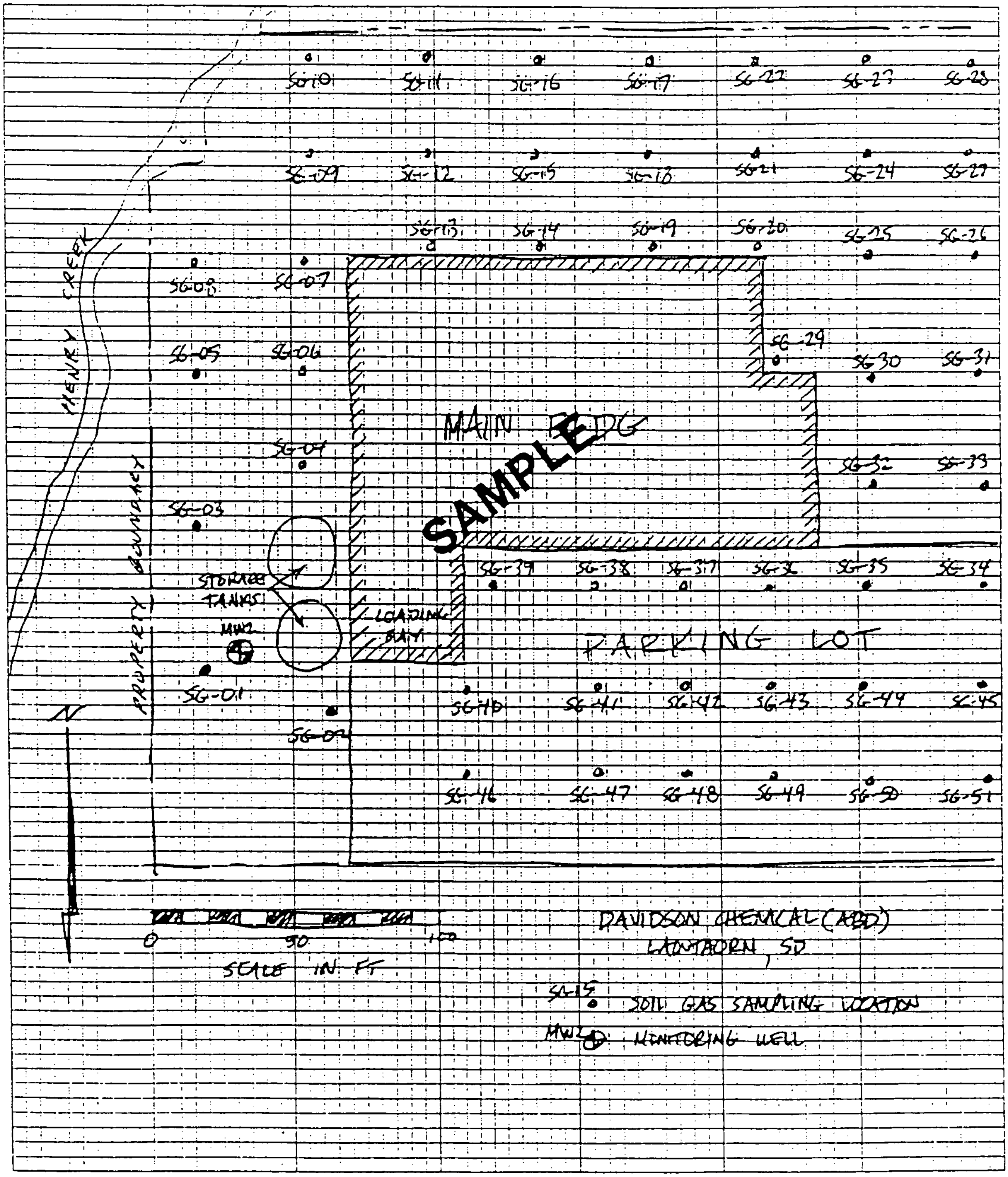
---

[1] - Downtime includes time spent repairing sampling & analytical equipment; note times and explanation on following field data pages

[2] - Standby includes time available for sampling but waiting for client; note times and explanation on following field data pages

Tracer Research Corporation

SITE MAP



SITE MAPS TO INCLUDE: SITE NAME, SCALE, NORTH ARROW, SOIL GAS LOCATIONS & NUMBERS, CULTURAL AND NATURAL FEATURES TO IDENTIFY SITE

SITE MAPS

DRAW SITE MAPS TO SCALE and include:

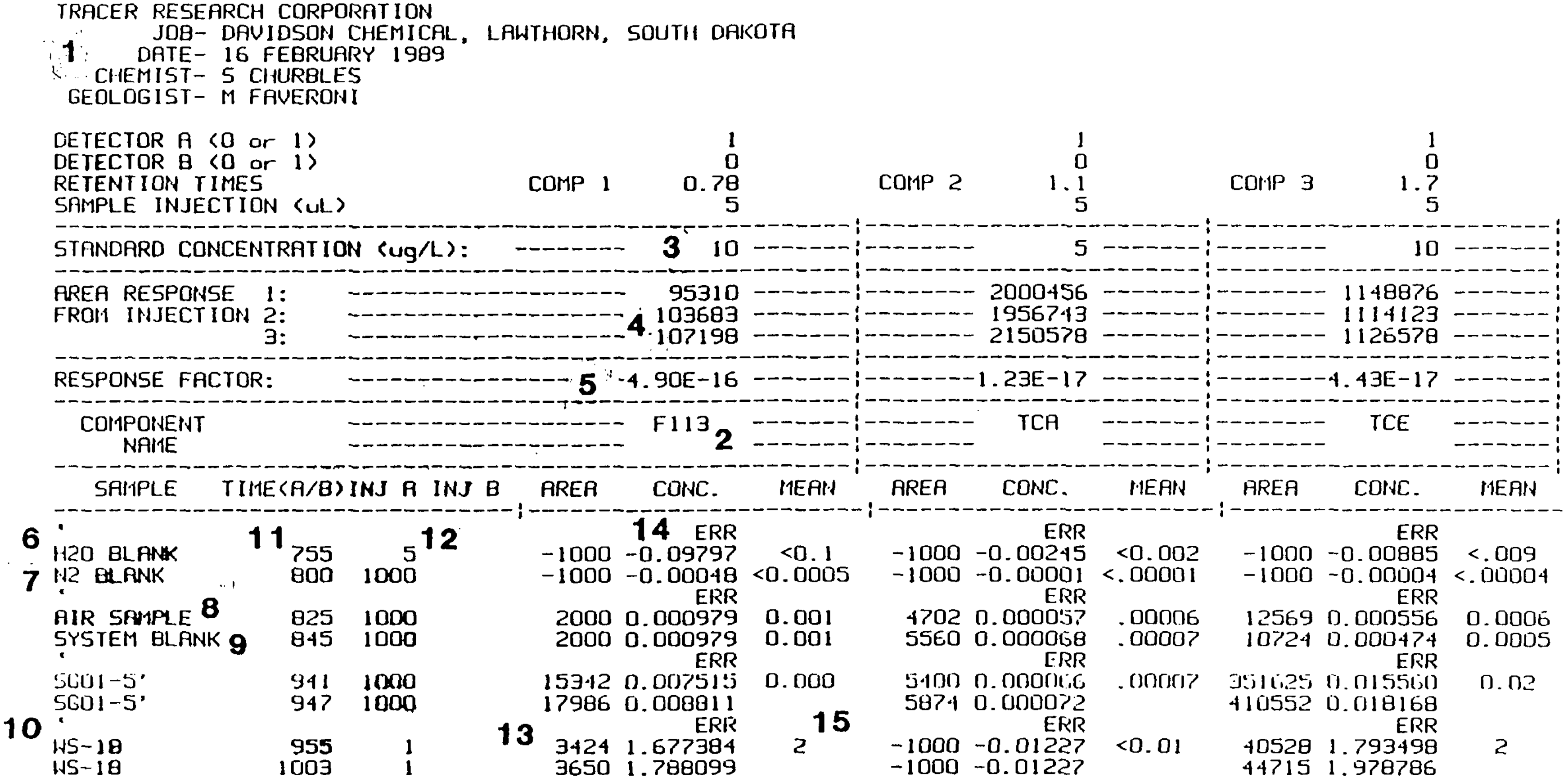
- Job number
- Client
- Site name and location
- Scale, both bar and inch equivalent
- North arrow (approximate)
- Soil gas locations and numbers
- Cultural and natural features to identify the site

IF MAPS ARE SUPPLED BY CLIENT, CHECK FOR ACCURACY AND CLARITY AND ENCLOSE.

MAP (S) HAVE BEEN CHECKED FOR COMPLETENESS AND ACCURACY:

M. Faveroni

Signature of Field Assistant



```
TRACER RESEARCH CORPORATION
      JOB- DAVIDSON CHEMICAL, LAWTHORN, SOUTH DAKOTA
     DATE- 16 FEBRUARY 1989
  CHEMIST- S CHURBLES
 GEOLOGIST- M FAVERONI

DETECTOR A (0 or 1)                              1                 1                  1
DETECTOR B (0 or 1)                              0                 0                  0
RETENTION TIMES                   COMP 1      0.78     COMP 2    1.1     COMP 3     1.7
SAMPLE INJECTION (uL)                            5                 5                  5
----------------------------------------------------------------------------------------
STANDARD CONCENTRATION (ug/L):  --------        10 ------|--------    5 ------|--------   10 ------|
----------------------------------------------------------------------------------------
AREA RESPONSE  1:   -------------------      95310 ------|-------- 2000456 ------|-------- 1148876 ------|
FROM INJECTION 2:   -------------------     103683 ------|-------- 1956743 ------|-------- 1114123 ------|
               3:   -------------------     107198 ------|-------- 2150578 ------|-------- 1126578 ------|
----------------------------------------------------------------------------------------
RESPONSE FACTOR:    -------------------  4.90E-16 ------|--------1.23E-17 ------|--------4.43E-17 ------|
----------------------------------------------------------------------------------------
 COMPONENT          -------------------       F113 ------|--------   TCA   ------|--------   TCE   ------|
   NAME             -------------------            ------|--------         ------|--------         ------|
----------------------------------------------------------------------------------------
  SAMPLE    TIME(A/B)INJ A INJ B   AREA    CONC.    MEAN    AREA    CONC.    MEAN     AREA    CONC.    MEAN
---------------------------------|-----------------------|-----------------------|----------------------
'                                                ERR                     ERR                      ERR
H20 BLANK         755     5         -1000 -0.09797   <0.1   -1000 -0.00245  <0.002   -1000 -0.00885  <.009
N2 BLANK          800  1000         -1000 -0.00048 <0.0005  -1000 -0.00001 <.00001   -1000 -0.00004 <.00004
'                                                ERR                     ERR                      ERR
AIR SAMPLE        825  1000          2000 0.000979  0.001    4702 0.000057  .00006   12569 0.000556 0.0006
SYSTEM BLANK      845  1000          2000 0.000979  0.001    5560 0.000068  .00007   10724 0.000474 0.0005
'                                                ERR                     ERR                      ERR
SG01-5'           941  1000         15342 0.007515  0.000    5400 0.000066  .00007  351625 0.015560   0.02
SG01-5'           947  1000         17986 0.008811           5874 0.000072          410552 0.018168
'                                                ERR                     ERR                      ERR
WS-18             955     1          3424 1.677384    2     -1000 -0.01227   <0.01   40528 1.793498     2
WS-18            1003     1          3650 1.788099          -1000 -0.01227           44715 1.978786
```

FIGURE 3.
EXPLANATION OF FIELD DATA SHEET

1. Site and staff information.
2. Name of compound.
3. Concentration of analyte in calibration standard.
4. Peak areas obtained from standard injections during calibration.
5. Response factor (RF) for compound obtained from three calibration runs. The RFs are used for calculation of actual concentrations and are included on each data sheet.
6. Water blank verifies purity of standard water and cleanliness of injection system.
7. Nitrogen blank verifies decontamination of syringes and analytical equip.
8. Air sample gives ambient concentrations for comparison with system blank.
9. System blank verifies decontamination of sampling equipment.
10. Sample ID number; SG01-5' (soil gas sample 1 taken 5' below grade), WS-18 (water sample).
11. Time of analysis identifies the chromatogram from which the data was taken.
12. Amount of sample injection - used for concentration calculation.
13. Peak area - raw data produced by the computing integrator that is proportional to the mass of analyte in the sample.
14. Actual concentration present in the sample rounded to 1 significant figure.
15. Mean concentration of duplicate injections.

APPENDIX G
FIELD INSTRUMENT CALIBRATION

1.0 Calibration of MicroTip® MP-100 Air Monitor

The MicroTip MP-100 field screening instrument will be calibrated on a daily basis prior to use. Calibration results will be recorded in a field notebook and documented on the Instrument Calibration form shown in Figure [ ] of Appendix [ ]. The documentation includes recording the date of calibration, person who performed calibration, instrument ID number, calibration results, and span gas type and concentration. Clean ambient air will be used as zero air and isobutylene at 100 ppm will be used as span gas.

The instrument calibration procedure is outlined below:

1. Connect the supplied gas regulator to the span gas cylinder.

2. Open the valve of the Tedlar® bag (gas bag) and connect the bag valve to the gas regulator using the supplied adapter and tubing.

3. Turn the regulator knob counterclockwise about half a turn to start the flow of gas.

4. Fill the gas bag about half full and then turn off the flow of gas. Disconnect the bag from the adaptor and empty it. Flush the bag a few times with span gas and then fill it. Close the gas bag by turning the valve clockwise.

5. Press CAL and enter the response factor, which is 1 since a specific compound is not being measured.

6. Expose the instrument to zero air and press ENTER.

7. Enter the known span gas concentration (100 ppm) as requested by the instrument.

8. Connect the span gas bag adaptor to the instrument inlet and open the bag valve so that span gas is flowing into the instrument.

9. Press ENTER and the sensitivity of the instrument will be set.

10. When the MicroTIP® display reverts to normal, the instrument is calibrated and ready for use. Remove the span gas from the inlet.

2.0 Calibration of the Cole-Parmer Model 5985-80 DigiSense pH Meter

The Digi-Sense® pH meter will be calibrated on a daily basis prior to use. Calibration results will be recorded in a field notebook and documented on the Conductivity/Temperature/pH Meter Calibration and Results Log shown in Figure [ ] of Appendix [ ]. The documentation includes recording the date of calibration, analyst who performed calibration, and calibration results. The calibration procedure is as follows:

1. Place the electrode in a pH 7.00 buffer solution. Wait approximately 30 seconds for the sensor to stabilize and then press CAL.

2. The exact pH value will appear on the display in accordance with pH and temperature charts. If this is not the case, use a fresh buffer solution.

3. Wait 30 seconds and then push CON to accept the buffer value.

4. Take the electrode out of the pH 7.00 solution, rinse it with distilled water, and dip it into a pH 4.01 or pH 10.01 solution. Use pH 4.01 solution for measurements between 0 and 7 pH and pH 10.01 solution for measurements between 7 and 14 pH. The value of the chosen buffer will appear on the display. Wait 30 seconds and press CON. The instrument is now calibrated.

3.0 Calibration of the YSI 33 S-C-T Meter

The YSI 33 S-C-T meter will be calibrated on a daily basis prior to use. Calibration results will be recorded in a field notebook and documented on the Conductivity/Temperature/pH Meter Calibration and Results Log shown in Figure [ ] of Appendix [ ]. The documentation includes recording the date of calibration, analyst who performed calibration, and calibration results. The calibration procedure is as follows:

1. Adjust the zero, if necessary, by turning the screw on the meter face until the meter needle coincides with the zero on the conductivity scale.

2. Calibrate the meter by turning the MODE control to REDLINE and adjusting the REDLINE control so that the meter needle lines up with the redline on the meter face.

APPENDIX H
FIELD DOCUMENTATION FORMS

PID CALIBRATION LOG

INSTRUMENT ID NO.________________________

DATE OF CALIBRATION	USER	CALIBRATION GAS	LAMP eV	VERIFICATION READING

PID MAINTENANCE LOG

INSTRUMENT ID NO.__________________________

DATE OF MAINTENANCE	PERSONNEL PERFORMING MAINTENANCE	MAINTENANCE PERFORMED	NOTES

GROUNDWATER TECHNOLOGY

FIELD SCREENING FORM

DATE:
PROJECT NAME:
CALIBRATION VERIFICATION:
CALIBRATION GAS:
BACKGROUND READING:
ANALYST:
INSTRUMENT ID NO.:

Sample ID	Approximate Sample Depth (feet)	Sample Collection Time	Sample Measurement Time	Total Ionizable Vapors (ppmv)

GROUNDWATER
TECHNOLOGY

WELL DEVELOPMENT FORM

PROJECT:__________________________
PROJECT NO.____________________________
FIELD PERSONNEL:______________________

WELL ID	DATE	AMOUNT OF PURGED WATER	PURGING METHOD	DESCRIPTION OF WATER

GROUNDWATER
TECHNOLOGY

SEDIMENT/SURFACE WATER SAMPLING FIELD LOG

SITE INFORMATION

CLIENT:____________________ DATE:____________________

SITE:____________________ WEATHER:____________________

PROJECT NO.:____________________ SAMPLER NAMES:____________________

SOURCE INFORMATION

NAME OF WATER BODY____________________

LOCATION (MEASURE AND SKETCH)

SAMPLING INFORMATION

EQUIPMENT USED____________________

COLLECTION METHOD____________________

DECONTAMINATION PROCEDURES____________________

SAMPLE ID, LOCATIONS, AND TYPE____________________

____

____

DATA COLLECTED

____

____

____

LABORATORY:

ANALYSIS REQUESTED____________________

GROUNDWATER TECHNOLOGY, INC.

Test Boring ______

Drilling Log

Project ______ Owner ______
Location ______ Project Number ______
Date Drilled ______ Total Depth of Hole ______ Diameter ______
Surface Elevation ______ Water Level Initial ______ 24-hour ______
Screen: Dia. ______ Length ______ Slot Size ______
Casing: Dia. ______ Length ______ Type ______
Drilling Company ______ Drilling Method ______
Driller ______ Log by ______
Geologist / Engineer ______ License No. ______

Sketch Map

Notes:

Depth (Feet)	Well Construction	PID (ppm)	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
0					
2					
4					
6					
8					
10					
12					
14					
16					
18					
20					
22					
24					

OCTOBER 13th, 1988 – REV. F

GROUNDWATER
TECHNOLOGY, INC.

Monitoring Well ______

Drilling Log

Project ______ Owner ______
Location ______ Project Number ______
Date Drilled ______ Total Depth of Hole ______ Diameter ______
Surface Elevation ______ Water Level Initial ______ 24–hour ______
Screen: Dia. ______ Length ______ Slot Size ______
Casing: Dia. ______ Length ______ Type ______
Drilling Company ______ Drilling Method ______
Driller ______ Log by ______
Geologist / Engineer ______ License No. ______

Sketch Map

Notes:

Depth (Feet)	Well Construction	PID (ppm)	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
0					
2					
4					
6					
8					
10					
12					
14					
16					
18					
20					
22					
24					

OCTOBER 13th, 1988 – REV. F

Page 1 of ___

GROUNDWATER
TECHNOLOGY, INC.

Recovery Well ______ Drilling Log

Project ______ Owner ______
Location ______ Project Number ______
Date Drilled ______ Total Depth of Hole ______ Diameter ______
Surface Elevation ______ Water Level Initial ______ 24-hour ______
Screen: Dia. ______ Length ______ Slot Size ______
Casing: Dia. ______ Length ______ Type ______
Drilling Company ______ Drilling Method ______
Driller ______ Log by ______
Geologist / Engineer ______ License No. ______

Sketch Map

Notes:

Depth (Feet)	Well Construction	PID (ppm)	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
0					
2					
4					
6					
8					
10					
12					
14					
16					
18					
20					
22					
24					

OCTOBER 13th, 1986 – REV. F

GROUNDWATER
TECHNOLOGY, INC.

Vapor Point ____

Drilling Log

Project ____ Owner ____
Location ____ Project Number ____
Date Drilled ____ Total Depth of Hole ____ Diameter ____
Surface Elevation ____ Water Level Initial ____ 24–hour ____
Screen: Dia. ____ Length ____ Slot Size ____
Casing: Dia. ____ Length ____ Type ____
Drilling Company ____ Drilling Method ____
Driller ____ Log by ____
Geologist / Engineer ____ License No. ____

Sketch Map

Notes:

Depth (Feet)	Well Construction	PID (ppm)	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
0					
2					
4					
6					
8					
10					
12					
14					
16					
18					
20					
22					
24					

OCTOBER 13th, 1988 – REV. F

Page 1 of ____

WELL GAUGING DATA FORM

[illegible]ENT :

SITE :

PROJECT NO. :

DATE :

RECORDED BY :

INTERFACE PROBE NO. :

INTERFACE PROBE CORRECTION : FT.

WEATHER :

WELL NUMBER	WELL DIAMETER (INCH)	WELL DEPTH (FEET)	TIME OF READING (HH:MM)	DEPTH OF WELL FROM TOP OF CASING (FEET)	DEPTH TO WATER FROM TOP OF CASING (FEET)	DEPTH TO PRODUCT FROM TOP OF CASING (FEET)	PRODUCT THICKNESS (FEET)	GALLONS OF PRODUCT BAILED	COMMENTS (WATER IN MANHOLE/ LOCK OR CAP MISSING)
							TOTAL GALLONS BAILED		

REMARKS:

CONDUCTIVITY / TEMPERATURE / pH METER
CALIBRATION AND RESULTS LOG

CLIENT :

DATE :

SITE :

ANALYST'S NAME :

PROJECT NO. :

WEATHER :

pH CALIBRATION

TIME CALIBRATION STARTED :

BUFFER TEMPERATURE :

TIME CALIBRATION COMPLETED :

pH	METER READINGS					COMMENTS
BUFFER	ADJUSTED	ADJUSTED	ADJUSTED	ADJUSTED	FINAL	
7.0						
4.0						
10.0						
7.0					▨	

SAMPLE RESULTS

SAMPLE ID	TIME	TEMPERATURE (F)	CONDUCTIVITY (uMHOS/CM) DISPLAY X MULTIPLIER = VALUE	pH (S. U.)	COMMENTS
			X =		
			X =		
			X =		
			X =		
			X =		
			X =		
			X =		
			X =		
			X =		
			X =		
			X =		
			X =		
			X =		
			X =		
			X =		

PRIOR TO EACH USE THE INSTRUMENT MUST BE CALIBRATED AS FOLLOWS :

1. RECORD THE TIME CALIBRATION WAS STARTED.

2. RINSE THE INSIDE OF THE SAMPLE CUP WITH DISTILLED WATER AND FILL IT 2/3 FULL WITH ONE OF THE BUFFER SOLUTIONS.

SLIDE THE FUNCTION SWITCH TO "TEMP", PUSH THE "READ" BUTTON, AND RECORD THE TEMPERATURE OF THE BUFFER.

4. ADJUST THE TEMPERATURE COMPENSATION KNOBS FOR CONDUCTIVITY AND pH TO THE TEMPERATURE OF THE BUFFER.

5. RINSE THE pH ELECTRODE WITH DISTILLED WATER AND WIPE DRY.

6. SLIDE THE FUNCTION SWITCH TO "pH".

7. PLACE THE pH ELECTRODE IN THE 7.0 BUFFER SOLUTION, PRESS THE "READ" BUTTON, AND ADJUST THE "ZERO" KNOB UNTIL THE DIGITAL DISPLAY INDICATES "7.00". ENTER THE VALUE (7.00) IN THE LOG AS THE "ADJUSTED" VALUE.

8. RINSE THE pH ELECTRODE WITH DISTILLED WATER AND WIPE DRY.

9. PLACE THE pH ELECTRODE IN THE 4.0 BUFFER SOLUTION, PRESS THE "READ" BUTTON, AND ADJUST THE "SLOPE" KNOB (NOT THE "ZERO" KNOB) UNTIL THE DIGITAL DISPLAY INDICATES "4.00". ENTER THE VALUE (4.00) IN THE LOG AS THE "ADJUSTED" VALUE.

10. RINSE THE pH ELECTRODE WITH DISTILLED WATER AND WIPE DRY.

11. PLACE THE pH ELECTRODE IN THE 10.0 BUFFER SOLUTION, PRESS THE "READ" BUTTON, AND ADJUST THE "SLOPE" KNOB (NOT THE "ZERO" KNOB) UNTIL THE DIGITAL DISPLAY INDICATES "10.00". ENTER THE VALUE (10.00) IN THE LOG AS THE "ADJUSTED" VALUE.

12. RINSE THE pH ELECTRODE WITH DISTILLED WATER AND WIPE DRY.

13. PLACE THE pH ELECTRODE IN THE 7.0 BUFFER AGAIN AND PUSH THE "READ" BUTTON.

    A. IF THE DIGITAL DISPLAY DOES NOT INDICATE "7.00", THEN ENTER THE VALUE OBTAINED AND REPEAT THE ABOVE PROCESS BEGINNING WITH STEP 5.

    B. IF THE DIGITAL DISPLAY DOES INDICATE "7.00", THEN RECORD 7.00 AS THE "FINAL" VALUE FOR THE 7.0 BUFFER AND TAKE "FINAL" READINGS FOR THE 4.0 AND 10.0 BUFFERS ALSO.

14. RECORD THE TIME CALIBRATION WAS COMPLETED.

AFTER THE pH ELECTRODE HAS BEEN CALIBRATED THE INSTRUMENT IS READY FOR USE AS FOLLOWS :

1. RECORD THE TIME OF ANALYSES.

2. RINSE THE INSIDE OF THE SAMPLE CUP WITH THE WATER TO BE ANALYZED AND THEN FILL IT 2/3 FULL.

3. SLIDE THE FUNCTION SWITCH TO "TEMP" AND PUSH THE "READ" BUTTON. IF THE READING IS NOT STABLE, EMPTY AND REFILL THE CUP SEVERAL TIMES TO BRING THE CUP AND SAMPLE TO THE SAME TEMPERATURE.

4. ADJUST THE TEMPERATURE COMPENSATION KNOBS FOR CONDUCTIVITY AND pH TO THE TEMPERATURE OF THE SAMPLE.

5. FOR THE CONDUCTIVITY OF A SAMPLE, SLIDE THE FUNCTION SWITCH TO "COND" AND PUSH THE "READ" BUTTON.

    A. IF A SINGLE "1" APPEARS ON THE LEFT SIDE OF THE DISPLAY, THEN THE SAMPLE CONDUCTIVITY IS HIGHER THAN THE SELECTED RANGE. SLIDE THE CONDUCTIVITY SELECTOR RANGE TO THE RIGHT UNTIL A 3 OR 4 DIGIT DISPLAY APPEARS (IE. 5.72).

    B. IF A NUMBER LESS THAN 1.00 APPEARS (IE. 0.27), THE CONDUCTIVITY IS LOWER THAN THE SELECTED RANGE. SLIDE THE CONDUCTIVITY SELECTOR TO THE LEFT UNTIL A NUMBER GREATER THAN 1.00 APPEARS.

    C. RECORD THE DISPLAY (IE. 2.57), THE MULTIPLIER (IE. X 100), AND THE VALUE (IE. 257) IN THE LOG.

6. FOR THE pH OF A SAMPLE, SLIDE THE FUNCTION SWITCH TO "pH"

    A. RINSE THE pH ELECTRODE WITH DISTILLED WATER AND WIPE DRY.

    B. PLACE THE pH ELECTRODE IN THE SAMPLE CUP OR ANY NON-METALLIC SAMPLE CONTAINER, PUSH THE "READ" BUTTON, AND RECORD THE VALUE IN THE LOG.

WELL SAMPLING FIELD LOG

SITE INFORMATION

CLIENT:

SITE:

PROJECT NO.:

DATE:

WEATHER:

SAMPLERS:

WELL INFORMATION

WELL NO.:

WELL DEPTH:

DEPTH TO WATER:

FEET OF WATER IN WELL:

WELL DIAMETER:

GALLONS OF WATER PER FOOT IN WELL:

GALLONS OF WATER IN WELL:

GALLONS OF WATER TO BE PURGED:

PURGING/SAMPLING INFORMATION

PURGE METHOD:

TIME PURGING STARTED:

TIME PURGING STOPPED:

TOTAL GALLONS PURGED:

SAMPLE METHOD:

TIME OF SAMPLING:

SAMPLE TEMPERATURE:

SAMPLE pH:

SAMPLE CONDUCTIVITY:

DATA COLLECTED DURING PURGING

TIME	FLOW RATE	TOTAL FLOW	TEMPERATURE	pH	CONDUCTIVITY

COMMENTS

GROUNDWATER TECHNOLOGY, INC.

WELL SAMPLING CHART

CLIENT:

LOCATION:

PROJECT #:

DATE:

SAMPLED BY:

PAGE: OF

Well #	(A) Well Diameter (in.)	(B) Depth to Water (ft)	(C) Well Depth (ft)	(D) Ft. of of water in well (C-B)	(E) Gallons of Water in Well (D x Factor for A)	(F) Gallons of Water to be Purged (E x 3)	Purging Equipment		(I) Gallons of Water Per Bail (H x Factor for G)	# of Bails to purge three volumes (F+I)	Time Sampled	Remarks
							(G) Diameter(in.)	(H) Length(ft.)				

Pipe Diameter (in.)	Factor
1	0.04
2	0.16
3	0.37
4	0.65
6	1.47

Date:
Measured by:

Test Well:

Time	Elapsed Time (min.)	Vacuum at Test Well (ins. H2O)	Pre/Post Vacuum at Blower (ins. H2O)	Pre-Blower Anemom. Reading (ft/min.)	Pre Blower Temp (oF)	Post Blower Temp (oF)	Vapor Concentration (Eff)			Vacuum at Observation Wells (ins. H2O)						
							PID (ppmv)	FID (ppmv)	LEL Meter (%LEL)	Distance from MN-04						
										35ft	24ft	67ft	102ft	96ft	31ft	243ft

GROUNDWATER
TECHNOLOGY
CONSULTING GROUNDWATER GEOLOGISTS

CLIENT: ________________

LOCATION: ________________

DATE: ________________

RECORDED: ________________

WELL DESIGNATION: __________

PUMP & SETTING: __________

DATA GATHERED DURING PUMP TEST

TIME	ELAPSED TIME (MINUTES)	DISCHARGE (GPM)	DTW (FEET)	DTP (FEET)	PT (FEET)	DRAWDOWN (FEET)	S.C. GPM/FT