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CERTIFIED MAIL
RETURN RECEIPT REQUESTED

February 17, 1997

W.P. Ard, Colonel, USAF
Commander, 27th Support Group
100 S DL Ingram Blvd., Ste. 200
Cannon AFB, NM 88103-5217

Subject: Fire Training Area No. 4 - Approval of Revised RFI Workplan (Workplan)
SWMU Nos. 109, 110, 111, and 112
EPA ID No. NM7572124454

Dear Colonel Ard:

The Hazardous and Radioactive Materials Bureau (HRMB) has completed its review of the Workplan, dated September, 1996, for the above-referenced Solid Waste Management Units (SWMU's). Pursuant to its authority under the New Mexico Hazardous Waste Act, N.M.S.A. 74-4-1 et seq., and regulations promulgated pursuant thereto, and pursuant to Cannon Air Force Base's (CAFB's) Hazardous Waste Management Permit, HRMB approves the Workplan and authorizes CAFB to proceed with the RCRA Facility Investigation (RFI) in accordance with the terms of the Permit.

HRMB review incorporated the draft Workplan dated February, 1996, EPA comments dated June 13, 1996, HRMB comments dated December 19, 1996, and CAFB response to HRMB comments submitted by fax to HRMB on January 10, 1997.

HRMB approval of the Workplan is with the stipulation that the Screening Action Levels used for the RFI and RFI Report will be those stipulated in the U.S. Environmental Protection Agency (EPA) Region 6 "Media Specific Action Levels," rather than the Region 3 RBC's referenced in the Workplan. This modification was agreed to verbally by phone today by Sanford Hutsell of CAFB.

HRMB retains the authority to require modifications to soil boring locations for the RFI when those locations are proposed by CAFB. HRMB will review the separate Passive Soil Gas Survey Report with proposed boring locations when a complete copy of that report is received by HRMB.

Please call me or Carl Will of my staff, at 505-827-1561, if you have any questions.

Sincerely,

Robert S. ("Stu") Dinwiddie, Manager
RCRA Permits Management Program
Hazardous and Radioactive Materials Bureau

cc: Jerry Bober, HRMB
Carl Will, HRMB
Steve Pullen, HRMB
David Neleigh, EPA Region 6
Bob Sturdivant, EPA Region 6

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RFI WORKPLAN

PHASE II RCRA FACILITY INVESTIGATION
Fire Training Area No. 4
SWMU Nos. 109, 110, 111, 112
Cannon Air Force Base
Clovis, New Mexico

Prepared for:

U.S. ARMY CORPS OF ENGINEERS
Omaha District

February 1997

RFI WORK PLAN

PHASE II RCRA FACILITY INVESTIGATION
FIRE TRAINING AREA No. 4
SWMU Nos. 109, 110, 111, 112
CANNON AIR FORCE BASE
Clovis, New Mexico

Prepared for:
U. S. Department of the Army
Corps of Engineers, Omaha District
Omaha, Nebraska

Prepared by:
Harza Environmental Services, Inc.
Chicago, Illinois

February 1997

TITLE PAGE

RFI WORKPLAN

PHASE II RCRA FACILITY INVESTIGATION
FIRE TRAINING AREA No. 4
SWMU Nos. 109, 110, 111, 112
CANNON AIR FORCE BASE, CLOVIS, NEW MEXICO

USACE CONTRACT No. DACW45-94-D-0044
HARZA ENVIRONMENTAL SERVICES, INC.
DELIVERY ORDER No. 0006

February 1997

HARZA RESPONSE TO NMED COMMENTS ON DRAFT WORKPLAN PHASE II RFI, FIRE TRAINING AREA #4, CANNON AFB, CLOVIS, NEW MEXICO (SWMU No. 109, 110, 111, 112)

1. **Comment:** As a RCRA required document, and to make our shelves more usable, this document should primarily be a RFI workplan and secondarily a DCQAPP and SSHP. This is a simple reversal of the current format. The title should also include the phase number, and the SWMU numbers.

   Response: The cover inserts and title page have been modified to address these comments. Minor text revisions also have been made to reflect these changes.

2. **Comment:** CAFB is required to use the screening action levels (SALs) stipulated in the EPA Region 6 "Media Specific Action Levels" rather than the Subpart SALs referenced in the WP. Please alter the WP accordingly.

   Response: Region 6 SALs have been referenced in Sections 1.4 and 4.2.2.2 in response to this comment.

3. **Comment:** CAFB must delineate the extent of contamination in the horizontal direction to the appropriate SALs, and in the vertical direction until two consecutive samples have measured non-detect. Please alter the WP accordingly.

   Response: A sentence has been added to Section 4.2.2.2 to the effect that horizontal extent of contamination will be determined by comparison to SALs. Since this investigation has a maximum drilling footage, delineation of the horizontal extent of contamination will be addressed to the best extent possible within the current, programmed funding amount. Further actions may be required by CAFB if additional investigations are found to be needed.

4. **Comment:** NMED prefers that instead of a passive vapor survey, that CAFB perform an active survey using a vacuum applied to probe a minimum of five feet below the ground surface. If CAFB insists upon using a passive survey, NMED must require a data quality analysis of the resultant information. This will entail an in depth comparison of the vapor data to the in-situ soil sampling data and an identification of all data gaps.

   Response: Harza and USACE selected the passive soil gas survey, proposed originally, as more appropriate to this project because it has the potential to detect some of the heavier organic compounds which might be present and can be more location specific. Therefore, this activity has not been modified. We agree that an analysis of the soil gas results compared to soil samples is appropriate and have added a sentence to Section 4.2.1 requiring such an evaluation in the RFI report. We note that both active and

passive surveys are only screening tools and both can have problems resulting in poor correlation with actual soil and/or groundwater contamination. To this extent, such an analysis of the results would be appropriate to both methods. Also, in this investigation, the soil gas results will be used only to help finalize boring locations, which will be reviewed with NMED before proceeding. Only the actual soil analyses will be used for any decision-making.

5. **Comment:** Section 1.3.1 Description: The Oil/Water Separator # 2336 (SWMU 112) was used to collect unburned fuel runoff from SWMU 109. What was the disposition of the contents during operation? Describe any effluent discharge from this unit. Has removal of this Oil/Water Separator been considered.

   Response: Further information on this OWS was provided by CAFB and is summarized in this section of the work plan. During operation of the fire training area, the OWS was pumped out by an outside contractor for off-site disposal. Analysis of an effluent sample from the third chamber of the OWS was provided and described as generally characteristic. This analysis is provided in new Attachment 1-1 and shows detections of several volatile organics. The OWS was removed by CAFB as an interim corrective action in 1996.

6. **Comment:** Section 1.3.2. Potential Contaminants. Since there are 4 SWMUs in this area, expand the discussion on previous investigations to include maps of each SWMU, borehole locations, and concentration amounts from analytical results.

   Response: The existing discussion was taken from Woodward-Clyde's 1992 RI Report and summarizes most of the information currently available to Harza. The text has been modified to include additional information on contaminant concentrations. Tables from the RI Report showing results of previous analyses have been added as new Attachment 1-2 to Section 1.0, including a map showing the sample locations. Harza does not have separate maps showing the SWMUs individually. These SWMUs have not generally been differentiated in the past because they all are within the general limits of the fire training pit (SWMU No. 109).

7. **Comment:** Section 2.3 Performance and Systems Audits: A Field Activities Audit should also examine sample labels, Chain of Custody Records, and Field Notebooks for completeness and accuracy.

   Response: These requirements have been added to the work plan, as requested.

8. **Comment:** Table 4.2 Summary of Sampling: When samples are collected for Volatile Organics Analysis, a Trip Blank is required for each day that samples are collected.

Response: Other than the soil gas survey, the RFI at fire training area No. 4 calls for sampling of soils only. Trip blanks for VOAs are routine for water samples, but not normally required for soils because the sample matrix is very site specific and cannot be reliably duplicated. The trip blanks, therefore, do not react in the same manner as the sample and do not provide meaningful QA data. Pending further discussion regarding this comment, we have assumed that trip blanks will not be required for the soil samples and have not modified the Workplan in response to this comment.

9. **Comment:** Section 6.8 Data Reduction, Validation, and Documentation: Describe the procedure for identifying and reporting "outliers".

Response: This section of the Work Plan has been modified to include provision for identifying infrequently detected chemicals as "outliers" in accordance with *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)* (USEPA, 1989). For this investigation, a chemical may be identified as an "outlier" if it is detected in less than five percent (5%) of the soil samples, is not detected at high concentrations, and there is no reason to believe that it may be present based upon past operations at FTA #4.

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Appendix B

Laboratory Information (ARDL, Inc.)

Appendix C

Analytical Procedures and QA (Gore Laboratory)
(Passive Soil Gas Survey)

Appendix D

Resumes

%R	Percent recovery
AA	Atomic absorption
ACC	Air Combat Command
ARARS	Applicable and relevant or appropriate requirements
ARDL	Applied Research and Development Laboratory (contract laboratory)
ASTM	American Society of Testing Materials
B.P.	Before present
BFB	Bromofluorobenzene
bgs	Below ground surface
Cannon AFB	Cannon Air Force Base
CEC	Cation exchange capacities
CGI	Combustible Gas Indicator
CLP	Contract laboratory program
CMS	Corrective Measures Study
COC	Chain-of-custody
COI	Chemicals of interest
DCQAP	Data Collection Quality Assurance Plan
DFTPP	Decafluorotriphenylphosphine
DOT	Department of Transportation
DQO	Data Quality Objective
DQCR	Data Quality Control Report
EM	Electromagnetic
GC/MS	Gas Chromatography/Mass Spectrometry
GC	Gas chromatography
GFAA	Graphite furnace atomic absorption
gpm	Gallons per minute
HEA	Health and Environmental Assessment
HSM	Health and Safety Manager
IATA	International Air Transport Agency
ICP	Inductively coupled plasma
ICS	Interference check sample
IR	Infrared
IRP	Installation Restoration Program

IS	Internal Standard
LCS	Laboratory Control Samples
LIMS	Laboratory Information Management System
MDL	Method detection limit
MPs	Method procedures
MRD	Missouri River Division
MRDL	Missouri River Division Laboratory
MS/MSD	Matrix spike/matrix spike duplicate
MS	Mass spectrometry
msl	Mean sea level
NMED	New Mexico Environment Department
NWR	National Wildlife Refuge
OSWER	Office of Solid Waste and Emergency Response (U. S. EPA)
PA	Contract laboratory Program Administrator
PAH	Polynuclear Aromatic Hydrocarbon
PID	Photoionization detector
POL	Petroleum, Oil, and Lubricant
PQL	Practical Quantitation Limit
QA	Quality Assurance
QAO	Quality Assurance Objective
QC	Quality Control
RBC	Risk-Based Concentration (U. S. EPA, Region III)
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RPD	Relative percent difference
SAL	Screening Action Level
SCFS	Sample Collection Field Sheet
sc	Clayey sand
SDG	Sample Delivery Group
sm	Silty sand
SOP	Standard Operating Procedure
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
SVOC	Semi-Volatile Organic Compound
SWMU	Solid Waste Management Unit
TBC	To be considered

1.1 PURPOSE AND SCOPE

This RFI Workplan (Workplan) details the field and laboratory procedures to be used and quality assurance (QA) requirements for activities associated with the Phase II RCRA facility investigation (RFI) of potential hazardous waste releases from Fire Training Area No. 4, Solid Waste Management Unit (SWMU) Nos. 109, 110, 111 and 112, at Cannon Air Force Base (Cannon AFB), Curry County, New Mexico. The Workplan was prepared by Harza Environmental Services, Inc. (Harza) under Delivery Order No. 006 to Contract DACW-45-94-D-0044. The Workplan was modified from a Data Collection Quality Assurance Plan (DCQAP) prepared by Woodward-Clyde Consultants and provided to Harza by USACE for that purpose. Background information and other aspects of the Workplan are taken from that plan.

The Workplan presents the purpose, organization, and standard operating procedures (SOPs) necessary to conduct the RFI activities in a manner consistent with specific quality goals of precision, accuracy, completeness, representativeness, and comparability. Implementation of the procedures described in this Workplan are required for the acquisition of data of known and sufficient quality. The SOPs included in Appendix A describe the methodologies commonly used, such as sampling, sample handling, decontamination, etc..

Work by Harza on this phase of the Cannon AFB Fire Training Area No. 4 project began in September 1995 and is projected to continue until January 1997. A project schedule is provided in Figure 1-1.

1.2 INSTALLATION BACKGROUND

Background information presented herein, including referenced materials, was taken from the prior DCQAP prepared by Woodward-Clyde Consultants (W-C, 1992) and provided to Harza by the USACE.

1.2.1 History of Cannon AFB

Information on the history of Cannon AFB was obtained from the Installation Restoration Program Records Search document prepared by CH_2M Hill for the United States Air Force (CH_2M Hill, 1983) and from the Cannon AFB Area Joint Military Telephone Directory (American Publishers, 1991).

Cannon AFB is located on approximately 4,320 acres of land in Curry County, New Mexico, approximately 7 miles west of the City of Clovis (Figures 1-2 and 1-3). The Melrose Bombing Range is an off-base facility located approximately 25 miles southwest of Cannon AFB.

Cannon AFB dates from 1929, when Portair Field was established on the site. Portair Field was a civilian passenger terminal for early commercial transcontinental flights. In 1942, the Army Air Corps took control of the civilian airfield and it became known as the Clovis Army Air Base. In early 1945, the base was renamed Clovis Army Air Field. Flying, bombing, and gunnery classes continued through World War II. However, by mid-1946 the airfield was placed on a reduced operational status and flying activities decreased. The installation was deactivated in May 1947. The types of aircraft stationed at Cannon AFB from 1942 to 1947 included B-17, B-24, and B-29 heavy bombers.

The base was reassigned to the Tactical Air Command (TAC) in July 1951. The first unit, the 140th Fighter-Bomber Wing, arrived in October of that year. The airfield was formally reactivated in November 1951 as Clovis Air Force Base. Between 1952 and 1957, the 50th and 388th Fighter-Bomber Wings were activated, and, upon their transfer, were replaced by the 312th and 474th Groups. Predominant aircraft stationed at Cannon AFB from 1951 to 1957 included the P-51 "Mustang" fighter and the F-86 "Sabre" fighter jet.

In June 1957, the base became a permanent installation and was renamed Cannon Air Force Base in honor of the late General John K. Cannon, a former TAC commander. In October 1957, the 312th and 474th Fighter-Bomber Groups were redesignated tactical fighter wings and the 832nd Air Division was activated to oversee their activities.

In 1959, the 312th Tactical Fighter Wing (TFW) was deactivated and replaced at Cannon AFB by the 27th TFW. In December 1965, the base's mission changed to that of a replacement training unit and the 27th TFW became the largest such unit in the TAC. The predominant aircraft stationed at Cannon AFB from 1957 to 1965 was the F-100 "Super Sabre" fighter jet.

The 832nd Air Division was deactivated in July 1975, leaving the 27th TFW the principal Air Force unit at Cannon AFB. In early 1981, the 27th TFW was designated a Rapid Deployment Joint Task Force member.

The primary mission of Cannon AFB has remained relatively unchanged since 1965: to develop and maintain an F-111 tactical fighter wing capable of day, night, and all-weather combat operations and to provide replacement training of combat aircrews for tactical organizations worldwide. Aircraft stationed at Cannon AFB since 1965 include the F-100 "Super Sabre" fighter jet (1957-1969), the F-111A (1969), the F-111E (1969-1971) and the F-111D (1971-present).

Approximately 70 F-111D aircraft are assigned to Cannon AFB. The total work force on Cannon AFB is approximately 4,000, which includes 3,500 military and 450 civil service personnel.

In 1992 Cannon AFB became part of the Air Combat Command (ACC) as the result of the overall realignment of Air Force Commands and the ongoing downsizing of the U.S. Military.

1.2.2 Facility Characteristics

Physical Geography. Cannon AFB is situated in the Southern High Plains Physiographic Province in the Llano Estacado subprovince. The Llano Estacado is a nearly flat plain sloping gently (10 to 15 feet per mile) to the east and southeast. In the vicinity of Cannon AFB, ground elevations range from 4,250 feet to 4,350 feet above mean sea level (msl).

The most prominent geomorphic features in the vicinity of Cannon AFB are blowouts and broad, widely spaced valleys. Less common landforms are relict sand dunes located along the northern

side of the Portales Valley south of the base. Relict dunes are not found on or near Cannon AFB.

Blowouts are broad shallow depressions which form as the result of soil erosion by wind. Blowouts commonly collect surface runoff from small to moderate sized drainage areas. During periods of rainfall, runoff collects in blowouts to form ephemeral playa lakes. Playas have no external surface drainage. Water is lost by infiltration to the soil and evaporation; without recharge, playa lakes persist for only a few days or weeks. Three playas are located within the base, and several more are found to the north and east of the base.

Stream valleys tend to be fairly broad and widely spaced. Streams are ephemeral and drainages are poorly developed. No streams exist on or near Cannon AFB. Running Water Draw and Frio Draw, located about 10 and 20 miles, respectively, north of Cannon AFB, are the nearest streams.

Land Use Near Cannon AFB. Cannon AFB is located just south of U.S. Highway 60-84 in a farming and ranching area. The majority of the land surrounding Cannon AFB is productive irrigated farmland or grassland. The major crops are wheat, sorghum, sugar beets, corn, cotton, alfalfa, barley, and peanuts. The land is also used for cattle grazing, both beef and dairy; and Clovis is considered the "Cattle Capital of the Southwest." There were 32,767 people living in Clovis in 1990, while the Cannon AFB population was estimated as 4,650 in 1990 (USAF 1991).

Climatology. The climate of east-central New Mexico is classified as tropical semi-arid, with summer temperature and precipitation maxima. Average monthly temperatures range from a January low of 39°F to a July high of 79°F. Extreme daily temperatures range from -11°F to 106°F (Lee Wan and Associates 1990a). Average monthly precipitation ranges from 0.4 inches in winter to 2.7 inches in July (USAF 1990). The maximum recorded 24-hour rainfall is 4.7 inches, which occurred in August 1985 (Hale 1992). Rainfall occurs on eight or more days per month during the summer precipitation maximum. Mean annual precipitation is approximately 15 inches. The mean annual lake evaporation is 69 inches per year. Prevailing winds are from the west at an average of 8 mph during fall, winter, and spring (USAF 1990).

The atmosphere around Cannon AFB is generally well mixed. The seasonal and annual average mixing heights can vary from 400 meters in the morning to 4,000 meters in the afternoon. The afternoon mixing heights are typically greater during the spring and fall seasons. The morning mixing heights are usually low, due to nighttime ground heat loss producing surface-based temperature inversions. After sunrise, these inversions generally break up, and solar heating of the earth's surface causes vertical mixing in the atmosphere (USAF 1990).

Dust is frequently entrained into the atmosphere in this region of the country because of gusty winds and the semiarid climate. The Texas Panhandle-eastern New Mexico area is considered the worst area in the United States for windblown dust. Occasionally, this windblown dust is of sufficient quantity to restrict visibility. Most of the seasonal dust storms occur in March and April, when the wind speeds are typically high.

Geology. The near-surface stratigraphic units of interest at Cannon AFB are the Late Miocene-Late Pliocene age Ogallala Formation and the Early Triassic Dockum Group.

The Dockum Group consists of three formations. The stratigraphically lowest unit is the Santa Rosa Sandstone. Overlying the Santa Rosa Sandstone are the Chinle and Redonda Formations. The Chinle and Redonda Formations are composed mainly of red shales with lesser interbedded sands and are known locally as "redbeds." The top of the Dockum Group is marked by an erosional unconformity having relief of up to several hundred feet (Lee Wan and Associates 1990a).

Overlying the Dockum Group redbeds is the Ogallala Formation. The Ogallala Formation extends from eastern New Mexico and Colorado into Texas, Oklahoma, Kansas, Nebraska, and South Dakota. Drillers logs from Cannon AFB indicate that the Ogallala Formation varies from 360 feet to 415 feet in thickness. The incised upper surface of Triassic redbeds strongly influences Ogallala thickness. Stream valleys in the post-Triassic unconformity are deep and trend dominantly east to west. Ogallala thickness may thus vary significantly over short north to south distances.

The Ogallala is erosionally truncated to the south along the abandoned Portales Valley, to the west along the Pecos River Valley, and to the north in a series of ephemeral stream valleys.

The Ogallala Formation extends more than 125 miles to the east before terminating as an escarpment in Briscoe County, Texas. Springs and seeps are common along the erosional margins of the Ogallala.

The Ogallala dips gently and monoclinally to the southeast in the vicinity of Cannon AFB. As reported in Lee Wan and Associates (1990a), data suggest that some Quaternary warping may have occurred, but most of the structures recognized are well to the northwest and southwest of Cannon AFB. No faults or buried structural lineaments are known to exist in the vicinity of Cannon AFB.

The Ogallala Formation is composed of unconsolidated poorly sorted gravel, sand, silts, and clays. The base of the Ogallala is generally marked by a gravel, cobble, and boulder deposit. This basal member contains sediments derived from igneous and sedimentary rocks transported from the mountains to the west. The Ogallala Formation was laid down by stream and overbank deposits formed within coalescing alluvial fans. These fans form a broad pediment along the eastern flank of the Rocky Mountains. As is typical of alluvial deposits, Ogallala internal stratigraphy varies vertically and horizontally over short distances.

Except where strongly cemented by calcium carbonate (caliche), the sediments of the Ogallala are loose and friable. Authigenic and allogenic clays are found as a trace to abundant matrix mineral (Lee Wan and Associates 1990a). As reported by Lee Wan and Associates (1990a), five zones have been identified within the Ogallala of east central New Mexico on the basis of clay minerals. Smectites (montmorillonites) and attapulgite (with sepeolite) are the dominant clays throughout the Ogallala. Illite is a lesser, but persistent clay, as is kaolinite. Smectite is a swelling clay, causing deep cracks to form in dry surface soils. Smectite in particular and, to a lesser extent, attapulgite and illite, are clays with moderate to high cation exchange capacities (CEC). The formation as a whole should therefore have a relatively high CEC, which should inhibit the migration of charged contaminants, and especially ionic forms of metals.

Caliche is a major feature of the Ogallala Formation, occurring as nearly continuous to discontinuous layers. Caliche is hard, white to pale tan on fresh surfaces, weathering to gray, and has a chalky appearance. Caliche forms as calcium carbonate, leached from overlying sediments and precipitated in the pore space of the host sediments. Precipitation is caused by

the evaporation of downward percolating water. The caliche may thus mark the position of ancient vadose zones.

Caliche is relatively soluble in acidic water (pH<7) or in waters containing dissolved CO_2. The top surface of the upper caliche in fresh outcrop shows solution etching.

The Ogallala has numerous continuous to discontinuous caliche layers throughout its thickness. The uppermost caliche, termed the "climax" caliche, is pisolitic (Lee Wan and Associates 1990a). As reported in Lee Wan and Associates (1990a), radiocarbon dates for the upper "climax" caliche range from approximately 27,000 years before present (B.P.) to approximately 42,000 years B.P. The pisolites are thought to have formed as the caliche was repeatedly chemically-weathered and brecciated during Pleistocene pluvials and later recemented during drier intervals. This upper caliche outcrops around playas and the bounding escarpments of the Ogallala, and is locally termed "caprock." The "climax" caliche is typically 3 to 5 feet thick. Caliches which occur lower in the Ogallala are platy and harder. Caliche is likely thin or absent below playas.

Hydrogeology. The lower portion of the Ogallala Formation is the primary regional aquifer for both potable and irrigation water. No deeper aquifers are used in the vicinity of Cannon AFB. The Ogallala aquifer is part of the High Plains Aquifer which extends continuously from Wyoming and South Dakota into New Mexico and Texas. In east central New Mexico, the Ogallala aquifer rests on Dockum Group redbeds, which serve as the basal confining layer (aquaclude). The Ogallala is a water table, or unconfined aquifer (Weeks and Gutentag 1981). The Ogallala aquifer has a southeasterly regional gradient of about 13 ft/mile. Well yields vary from less than one gallon per minute (gpm) in thin silts and sands up to 1,600 gpm in thick sands and gravels. Water quality is generally good with dissolved solids ranging from 250 to 500 mg/L (Gutentag et al. 1984) and fluorides ranging from 2.2 to 2.7 mg/L (William Matotan and Associates Inc. 1985).

At Cannon AFB, the Ogallala aquifer has an average saturated thickness of 120 feet based on mid-1960's data. Saturated thickness ranges from 93 to 143 feet, and is influenced by the configuration of the erosional unconformity surface marking the top of the Dockum Group. The local groundwater gradient is southeasterly at 7 to 15 feet/mile (USAF 1990). Flow within the

saturated zone may be influenced by the configuration of the top of the Dockum Group. Yields in tests of Cannon AFB water wells have ranged from 205 gpm to 1,150 gpm. Specific capacities range from 11.4 gal/ft to 27.9 gal/ft (Lee Wan and Associates 1990b).

Very rough estimates of hydraulic conductivity were made from well pump tests in water wells 5 and 9 using the Theis equation. An estimate of hydraulic conductivity for water well 8 was based on water level recovery data using the Bouwer and Rice approach (Lee Wan and Associates 1990a). The data used in these calculations were obtained to evaluate pump rates, efficiency, and well yield, and were not intended for use in calculating aquifer properties. The results of these calculations should, therefore, be considered as first approximations.

Hydraulic conductivity values for water wells 5 and 9 were approximately 2.0×10^{-3} cm/sec. Calculations for water well 8 result in a hydraulic conductivity of 2.0×10^{-2} cm/sec. These estimates appear to be low when compared to published hydraulic conductivity data for sands and gravels (Freeze and Cherry 1979). As reported in Kearney (1987), a groundwater flow velocity of about 150 ft/yr has been estimated. This calculates out to a hydraulic conductivity of approximately 1.0×10^{-1} cm/sec.

The presence of interstitial clays may account for both the variability and low values of hydraulic conductivities. Boring logs from Cannon AFB IRP projects and published reports (Lee Wan and Associates 1990a) indicated that interstitial and interstratified clays are abundant in the Ogallala Formation.

Recharge to the Ogallala is primarily through precipitation. Kearney (1987) indicated that the recharge rate may be as much as 1.0 in/yr. Due to the high evapotranspiration rate and low precipitation, recharge occurs only during heavy rainfall events in which the infiltration capacity of the soil is exceeded and runoff occurs, or during cool months when precipitation exceeds evapotranspiration. Excess runoff flows to playas and the presence of water in playas allows deep percolation to the aquifer. The occurrence of this process is evidenced by the presence of clay deposits in playas and the possibility that caliche is thin or absent directly below playas. Caliche is soluble in acidic rain waters and is leached over time to form percolation pathways.

Discharge from the Ogallala occurs through well pumping and springs along the eroded margins. Spring discharge does not occur on or near Cannon AFB. Domestic and irrigation water wells are common on and around the base, however. The rate of discharge exceeds recharge. Water levels in the Ogallala have declined steadily from the 1930s to the present. From the 1930s to 1980, a decline of 50 to 100 feet has been observed in the area around Clovis, New Mexico. Luckey et al. (1981) states, "the largest area of water level decline exceeding 100 ft occurs south of the Canadian River extending from Curry County, New Mexico to Crosby County, Texas."

The dominant uses of groundwater in the Cannon AFB area are for potable and irrigation water. Numerous wells are found in the Cannon AFB area; most provide only irrigation water.

The Ogallala will continue to be used as the primary source of potable and irrigation water for eastern New Mexico. The New Mexico State Engineer designated Curry County as a Water Basin in 1989. This designation allows for regulation of water rights, usage, and well drilling.

Soils. Soils in the vicinity of Cannon AFB are classified as silty sand (SM) to clayey sand (SC) under the Unified Classification System, and as aridisols (calciorthids) under the United States Department of Agriculture - Soil Conservation Service Comprehensive Soil Classification System (USDA-SCS). The following summary is based on the Curry County Soil Survey (USDA 1958). Soil characteristics are briefly described in the following paragraphs.

The most common soil type on the base is the Amarillo fine sandy loam, 0 to 2 percent slope phase (map symbol Ab). This soil consists of a thin sandy A horizon, well defined clayey B_{1-3} horizons, with a calcic B_3 horizon at depths below 40 inches. The calcic B_3 horizon lies on a calcic C horizon, or on caliche. The color of the surface soil is brown (7.5 YR 5/5, dry) and subsurface soils are reddish-brown (5 YR 4/4, dry) to yellowish-red (15 YR 5/6, dry). The calcic C horizon underlying the Amarillo Fine Sandy loam is white in color. The Amarillo fine sandy loam soil type is present on all relatively flat surfaces at the base but is also found on slopes associated with playas (map symbol Ac). A small area of Amarillo loamy fine sandy 0 to 2 percent slope phase (map symbol Ag) is mapped in the southeast corner of the base.

Clovis fine sandy loams, 0-2 percent slope phase (map symbol Cb) and 2-5 percent slope phase (map symbol Cc), are similar to Amarillo fine sandy loams. Clovis soils are reddish-brown on

the surface and in the subsurface, with a white Calcic C horizon. In the Clovis soils, the depth to the calcic C horizon ranges from 28 to 56 inches. The depth to caliche exceeds 56 inches. Clovis and Amarillo fine sandy loams occur in close association.

In a few limited areas, particularly along the steeper slopes around playas, Mausker fine sandy loam, 0 to 2 percent slope phase (map symbol Ma), and 2 to 5 percent phase (map symbol Mb) are found. Mausker fine sandy loams have no B horizons and are very calcareous. Mausker fine sandy loam soils are brown (10 YR 5/3, dry) to light brown (7.15 YR 6/4, dry) at the surface with a pink to reddish-yellow (7.5 YR 7/5, dry) calcic C horizon. Associated with the Mausker fine sandy loam soils around the base Playa Lake are Potter fine sandy loam soils, 0 to 5 percent slope phase (map symbol Pa). This soil typically has a thin A horizon, grayish brown (10 YR 5/2, dry) in color, with no B horizon; similar to Mausker soils. Potter soils are shallow and strongly calcareous, and overlie hard consolidated caliche. The calcic C horizon is within two feet of the surface.

The A and B horizons of Amarillo and Clovis fine sandy loams are rapidly to moderately permeable. Mausker fine sandy loam A and Ac horizons are rapidly permeable. Permeabilities in calcic B and C horizons are moderate (USDA 1958).

Biological Resources. Land adjacent to Cannon AFB is primarily used for agriculture and little natural vegetation remains in the area. The wildlife species that are common to agricultural areas throughout the region include bobwhite quail and pheasant. The few playa lakes in the area are used by upland game for cover, by waterfowl for resting and feeding, and by wildlife in general for drinking. Nearby riverbeds also provide water sources during rainy seasons. During periods of low rainfall, the riverbeds are dry.

The climate of the Base area is considered to be semiarid. The thin layer of topsoil in the vicinity of Cannon AFB is sandy loam, which is highly susceptible to wind erosion. The undisturbed natural vegetation is mostly shortgrass prairie, including blue grama grassland and mixed grama grassland vegetation types, which have moderately fast recovery rates.

Much of the study area has been previously cleared for agricultural crops. The predominant land use of the region is rangeland, primarily for cattle grazing. In general, moderately grazed

rangeland areas of the types occurring in the project area are highly productive in terms of both forage quality and quantity. The rangeland in the vicinity may support up to 15 to 20 head of cattle per section, depending on the rainfall. Large trees do not uniformly exist in the vicinity of the range except where planted around buildings and other structures on the Base. Woodlands composed of large shrubs and small trees are confined to riparian areas and playa lakes in the vicinity.

The following plants are candidate species for the Federal List of Endangered and Threatened Wildlife and Plants and are found within a 50-mile radius of Cannon AFB: chatterbox orchid (*Epipactus gigantea*), spiny aster (*Aster harridus*), Whittmans milkvetch (*Asragalus witmanil*), dune unicorn plant (*Proboscidea sabulosa*), and the tall plains spruce (*Eupjorbia strictior*). The dune unicorn plant is also on the state endangered plant species list. No federally protected endangered plants are known to grow on the Base (CH_2M Hill 1982; USFWS 1987; USAF 1990).

The eastern New Mexico area contains many nongame wildlife species that are typical of the High Plains. Most of these species are distributed widely throughout the western United States. Species diversity is low in most habitats because of the low vegetation diversity. Most amphibian species are associated with riparian habitats and playa lakes. Reptiles are found in all terrestrial habitat types but are most abundant in scrub/grasslands. Nocturnal rodents are the most abundant members of the small mammal community.

Grasslands on the High Plains support a variety of seed-eating sparrows and other ground-dwelling birds, both as residents and migrants. Raptors (hawks and owls) are relatively abundant in all habitats in the region. Insectivorous and tree-nesting species are most abundant in riparian areas. Shorebirds and waterbirds and migratory waterfowl in general use the rivers, playa lakes, and reservoirs of the region.

Two National Wildlife Refuges (NWRs) are located on the periphery of the Base area. The Grulla and Muleshoe NWRs are within 30 miles of Cannon AFB. These areas provide high-quality habitat for migratory and breeding waterfowl.

Big-game species in the area include mule deer, white-tailed deer, pronghorn, and barbary sheep. Pronghorn are the most abundant game animal in the area. Several species of upland game such as quail, ring-necked pheasant, and turkey are common in the area. Reservoirs (Ute Lake, Conchas Lake, and Clayton Lake) and playa lakes are important waterfowl habitats in the region. Numerous species of native and introduced fish inhabit the rivers and perennial streams, and the reservoirs support recreational fishing of warm-water species such as walleye, crappie, channel catfish, largemouth bass, and bluegill.

As determined by the regional office of the U.S. Fish and Wildlife Service, two federally listed endangered animal species, the bald eagle and peregrine falcon, are known to inhabit the area within a 50-mile radius of Cannon AFB. The New Mexico Department of Game and Fish also indicated that the state endangered Mississippi kite, Baird's sparrow, and the black-footed ferret may also occur in the vicinity of the Base. The federal- and state-protected species are listed in Table 1-1.

Within Curry County, the state-protected bird that is most likely to occur is the Mississippi kite. In New Mexico, since the early 1960s, this kite summers regularly and breeds in the Clovis region. The birds frequent the golf course at Cannon AFB. Two other state-protected birds within Curry County that may occur, but not regularly in recent time, are the McCown's longspur and Baird's sparrow. No information is available on the McCown's longspur in New Mexico; however, Baird's sparrow occurs mainly in autumn during migration in the eastern plains and southern lowlands. Migrants appear as early as the first week of August and move further south by November. The species seems to have declined in abundance throughout its range in the Southwest due to the loss of shrubby shortgrass habitats.

State-protected birds known to occur infrequently are the bald eagle and the peregrine falcon. The bald eagle migrates and winters from the northern border of New Mexico to the Gila, lower Rio Grande, middle Pecos, and Canadian valleys. It is seen occasionally in summer and as a breeding bird, with nests reported in the extreme northern and western parts of the state. Winter and migrant populations appear to have increased with reservoir construction. The peregrine falcon is widely distributed but population numbers are low. The American subspecies breeds statewide in New Mexico, but mainly west of the eastern plains.

1.3 FIRE TRAINING AREA No. 4 (SWMU Nos. 109, 110, 111, 112)

1.3.1 Description

Fire Training Area No. 4 is located in the southeast corner of Cannon AFB (Figure 1-3). Site features are shown on Figure 1-4. Cannon AFB has removed the mock-up aircraft, the decommissioned aircraft and automobiles from the site in anticipation of the investigation. This unit was reportedly used as a fuel truck cleaning area between 1961 and 1974. In 1974, it was activated as a fire training area. The site has had configuration changes over time such that former integral parts are also listed as SWMUs for this RFI. These include:

- SWMU No. 109 - the Fire Training Area No. 4;
- SWMU No. 110 - the Underground Waste Oil Tank #2336;
- SWMU No. 111 - the Unlined Pit; and
- SWMU No. 112 - the Oil/Water Separator #2336.

Reportedly, fuel was introduced to the ground surface between 1961 and 1974. From 1974 to 1975, co-mingled waste oils, solvents, and recovered JP-4 were burned at the site. Between 1975 and 1995, only recovered JP-4 has reportedly been used as a fuel. During some, but not all training exercises, the ground was saturated with water. Runoff was initially directed to an unlined pit (SWMU No. 111) which was later replaced with the oil-water separator (SWMU No. 112) in approximately the same location.

The Fire Training Area (SWMU No. 109) encompasses the three other SWMUs comprising the investigation area and was active and frequently used until recently. The larger surface area that comprises the training area is circular in shape, about 400 feet in diameter and is unlined and ringed with a small berm and a security fence. A mock airplane was located roughly in the center of the area. Immediately below the mock airplane was a concrete "pan" which had internal drainage features such that excess fuel/water was drained to the oil-water separator (SWMU No. 112) in the northeast part of the area. The oil-water separator was activated in 1985, allegedly on the site of the former unlined pit (SWMU No. 111) in the northeast part of the area. During operation, the unlined pit had been used to collect runoff from the general area and JP-4 left after fires were extinguished in training exercises. After 1985, during operation

of the fire training area, the oil-water separator was pumped out as needed by an outside contractor for off-site disposal. A 1994 sample analysis of the effluent from the oil-water separator is provided in Attachment 1-1. The oil/water separator was removed by CAFB in 1996. A later addition to the site was a decommissioned airplane located about 100 feet northeast of the mock airplane. The underground waste oil tank (SWMU No. 110) on the west side of the area has been removed and soil from around the tank was being land farmed on a plot adjacent to the site access gate. To prevent downward migration of contaminants, the land farmed soil was placed on top of heavy gauge plastic. The underground waste oil tank #2336 was an underground 2,000 gallon storage tank used to store recovered JP-4 fuel prior to burning for fire training exercises.

1.3.2 Potential Contaminants

Information concerning potential contaminants at the Fire Training Area No. 4 was obtained from excerpted information provided by USACE. Previous boring and sample locations are shown on Figure 1-5. Attachment 1-2 provides copies of analytical summary tables contained in the previous RI Report. The previous investigations are summaried as follows:

- In 1985, Radian Corporation (Radian, 1986) completed two deep soil boreholes; No. 9A, about 50 feet east of the mock airplane area, and 9B, about 100 feet south of the mock airplane area. Sample results from 9A indicated the presence of oil and grease up to 280 mg/kg and lead between 4.1 and 39.0 mg/kg at a depth of 10.5 to 11.5 feet. Results from 9B indicated 37 mg/kg oil and grease at a depth of 43 to 45 feet. No purgable organic compounds were detected in these borings.

- In 1988, Walk, Haydel and Associates (Walk-Haydel, 1990) completed nine boreholes in the runoff (SWMU Nos. 111/112) and underground fuel storage (SWMU No. 110) areas, ranging in depth from 5 to 100 feet. Analytical results indicated the presence of JP-4 constituents ethylbenzene, benzene, toluene and xylene in soils from three borings (B-1, B-3 and B-10) near the underground tank. Concentrations above depths of 60 feet ranged from: 2,030 to 15,200 μg/kg benzene; 1,300 to 56,200 μg/kg ethylbenzene; 2,870 to 64,000 μg/kg toluene;

and 6,880 to 66,200 μg/kg xylene (total). Concentrations declined rapidly or were non-detect between 60 and 100 feet. No organics were detected in the runoff area. Arsenic, selenium, barium, cadmium and silver were detected in the site soils but only arsenic in two borings (B-7, B-8) near SWMU No. 110 and one (B-9) near SWMU Nos. 111/112 and cadmium in one boring (B-5) exceeded concentrations typically found in soils. Arsenic concentrations which exceeded those typical of soils ranged from 86 to 152.5 mg/kg. Cadmium concentrations exceeding typical levels were 11.2 and 12.7 mg/kg.

- In 1991, Woodward Clyde Consultants (Woodward-Clyde, 1992) collected four surface soil samples and completed four boreholes (Nos. 1091 through 1094). Analytical results indicated the presence of ethylbenzene and xylenes as well as total petroleum hydrocarbon (TPH) in the area of the mock airplane at SWMU No. 109. In boring 1094, just south of the pad, ethylbenzene was found at an estimated concentration of 19,000 μg/kg from a depth of 4 to 6 feet; xylenes between 6,700 and 290,000 μg/kg from depths of 4 to 12 feet; and TPH, between 46.7 and 13,600 μg/kg from the surface to depths of 22 feet. In boring 1093, just north of the pad, TPH was reported between 12,900 and 38,500 μg/kg from the upper 6 feet and between 203 and 215 μg/kg at a depth of 50 to 62 feet. No other organic detections were reported. One elevated lead level (estimated at 19.6 mg/kg from the surface sample) also was detected in boring 1093.

Based upon these results and historical uses of the area, potential contaminants may include constituents of JP-4, TPH and oil and grease, solvents and heavy metals.

1.4 ANALYTICAL PARAMETERS AND METHODS

Based on previous investigations and reported historical information, the chemicals of concern at Fire Training Area No. 4 fall into the general categories of fuels, solvents, and waste petroleum oil and lubricants (POL), specifically, the following:

- Inorganics
  - heavy metals, including lead and chromium
- Organics
  - benzene, ethylbenzene, toluene, xylenes (BTEX)
  - waste petroleum oil, lubricants (POL)
  - polynuclear aromatic hydrocarbons (PAHs)
  - trichlorethylene (TCE) and other volatile halogenated solvents

Historic usage records indicate no evidence that Cannon AFB was used for activities involving uncommon hazardous constituents or industrial formulation. Rather, the activities likely to use or generate hazardous constituents at Fire Training Area No. 4 were related to fire training utilizing JP-4 and other appropriate materials generated by routine maintenance tasks such as cleaning engines, painting and repainting activities, paint stripping, and aircraft maintenance. The historic records indicate that one would not expect a wide spectrum of wastes to have been released. Therefore, the RFI is focused on the constituents that are likely to have been used.

Based upon this information and assessment, samples collected under this Workplan, including ten (10) surface soil samples and one-hundred and twenty (120) subsurface soil samples from boreholes, will be analyzed for four categories of analytical parameters: (1) Volatile Organic Compounds, (2) Semi-volatile Organic Compounds, (3) Target Analyte List (TAL) Metals and Cyanide; and (4) total recoverable petroleum hydrocarbons (TRPH). Analytical methods to be used are as follows, with reference to USEPA-SW-846 (USEPA, 1994):

- Volatile Organics (Method 8260)
- Semi-Volatile Organics (Method 8270)
- TAL Metals and Cyanide (Methods 6010 and 7000)
- TRPH (Method 9071/418.1)

Parameter lists to be analyzed associated with these groupings are provided in Tables 2-1, 2-2, and 2-3. The method detection and quantitation limits for all target analytes have been compared to the examples of concentrations meeting screening action levels (SALs) stipulated in the USEPA Region 6 "Media Specific Action Levels. The target analyte method detection and quantitation limits in Tables 2-1 through 2-3 were found to be lower than the RBC values. Data

expected to be produced using these analytical methods is considered to be of both known and sufficient quality to characterize hazardous waste [including hazardous constituents] that is likely to have been released from Fire Training Area No. 4 and to evaluate whether such releases pose an unacceptable risk to either human health or the environment.

Geotechnical analyses for particle size and moisture content also be conducted in conformance with American Society of Testing Materials (ASTM) methods, as specified in Section 6.1.

1.5 DEFINITIONS

The following definitions apply to terms commonly used in the text of this document:

Accuracy	Nearness of a measurement or the mean ($\overline{x}$) of a set of measurements to the true value. Accuracy is evaluated by the percent recovery of sample spikes, analysis of laboratory control samples, and reference materials.
Analytical Batch	The analytical batch is defined as 20 or fewer samples which are prepared and/or analyzed together with the same method sequence and the same lots of reagents and with the manipulations common to each sample within the same time period or in continuous sequential time periods. Samples in each analytical batch should be of similar matrix (e.g., groundwater, surface water, soil, sediment, sludge, etc.).
Batch	Synonymous with Sample Delivery Group (SDG).
Calibration Blank	Usually an organic or aqueous solution that is as free of analyte as practical and prepared with the same volume of chemical reagents used in the preparation of the calibration standards and diluted to the appropriate volume with the same solvent (water or organic) used in the preparation of the calibration standard. The calibration blank is used to give the null reading for the instrument response versus concentration calibration curve.

Case	A finite, usually predetermined number of samples collected over a given time period from a particular site. For this Workplan, a Case will consist of all samples of similar matrix to be collected under this Workplan.
Comparability	A measure of the confidence with which one data set can be compared with another.
Decontamination Water	A sample of water used for decontaminating field equipment. The source of this water can be the tanks used by contractors to transport the water to a site or a hydrant.
Completeness	A measure of the amount of valid sample data obtained from the measurement system compared to the amount of sample data that are requested. Valid results are those results which meet or exceed quality control criteria and satisfy quality assurance objectives.
Duplicate	Duplicate samples are two samples taken and analyzed independently. In cases where homogenization would affect sample quality or representativeness, as in the case of volatiles, nonhomogenized samples must be taken for the duplicate analysis.
Environmental Samples	An environmental sample or field sample is a representative sample of any material (aqueous, nonaqueous, or multimedia) collected from any source for which evaluation of composition or contamination is requested or required.
Matrix Duplicate Sample	An aliquot of the homogenized sample which is prepared and analyzed identically to the original sample. Used in metals and cyanide analyses in place of the matrix spike duplicate to measure precision of laboratory preparation and analysis.

Matrix Spike (MS)	A matrix spike is employed to provide a measure of accuracy for the method used in a given matrix. A matrix spike analysis is performed by adding a predetermined quantity of stock solutions of certain analytes to a sample matrix prior to sample extraction/digestion and analysis.
Matrix Spike Duplicate (MSD)	A second matrix spike sample prepared identically to the matrix spike on a homogenized duplicate sample of the matrix. Used to measure precision of laboratory preparation and analysis.
MDL	The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte (40CFR136, Appendix B).
Method Blank	A sample matrix that is as free of analyte as practical and contains all the reagents in the same volume as used in the processing of the samples. The method blank must be carried throughout the complete sample preparation procedure and contains the same reagent concentrations in the final solution as in the sample solution used for analysis. The blank is used to monitor for possible contamination resulting from the preparation or processing of the sample.
Performance Evaluation Sample	A material of known composition that is analyzed concurrently with test samples during a measurement process. It is used to verify the performance of the analytical system.

Precision	Precision is the agreement between a set of replicate measurements without assumption or knowledge of the true value. Precision is evaluated as the relative percent difference or relative standard deviation for replicate or split samples.
Reporting Limit	The reporting limit is the lowest concentration that can be reliably measured within specified limits of precision and accuracy during routine laboratory operating conditions.
Representativeness	The degree to which a single measurement is indicative of the characteristics of a larger sample or area or the degree to which data represents field conditions.
RPD	Relative Percent Difference, calculated as $$\text{RPD (\%)} = \frac{\lvert S-D \rvert}{(S+D)/2} \times 100$$ where S = first sample value (original) D = second sample value (duplicate)
SDG	Sample Delivery Group, defined as a group of 20 or fewer samples of similar matrix collected in a period of 14 days or less.
SOW	Statement of Work

TABLE 1-1

FEDERAL- AND STATE-PROTECTED ANIMALS POTENTIALLY OCCURRING IN THE VICINITY OF CANNON AFB (CURRY COUNTY)

Common Name	Scientific Name	Federal Status	State Status
Birds			
Barid's sparrow	Ammodramus baridii		Endangered (group 2)
Bald eagle	Haliaeetus leucocephalus	Endangered	Endangered (group 2)
Peregrine falcon	Falco perigrinus	Endangered	Endangered (group 1)
Mammals			
Black-footed ferret	Mustela nigripes	Endangered	Possibly Extinct

Endangered (group 1): Species whose prospects of survival or recruitment within the state are in jeopardy.

Endangered (group 2): Species whose prospects of survival or recruitment within the state are likely to become jeopardized in the foreseeable future.

Possibly Extinct: Potentially no longer in existence in the state.

Source: Woodward-Clyde 1993.

FIGURE 1-1
ESTIMATED PROJECT SCHEDULE
CANNON AFB, FIRE TRAINING AREA #4

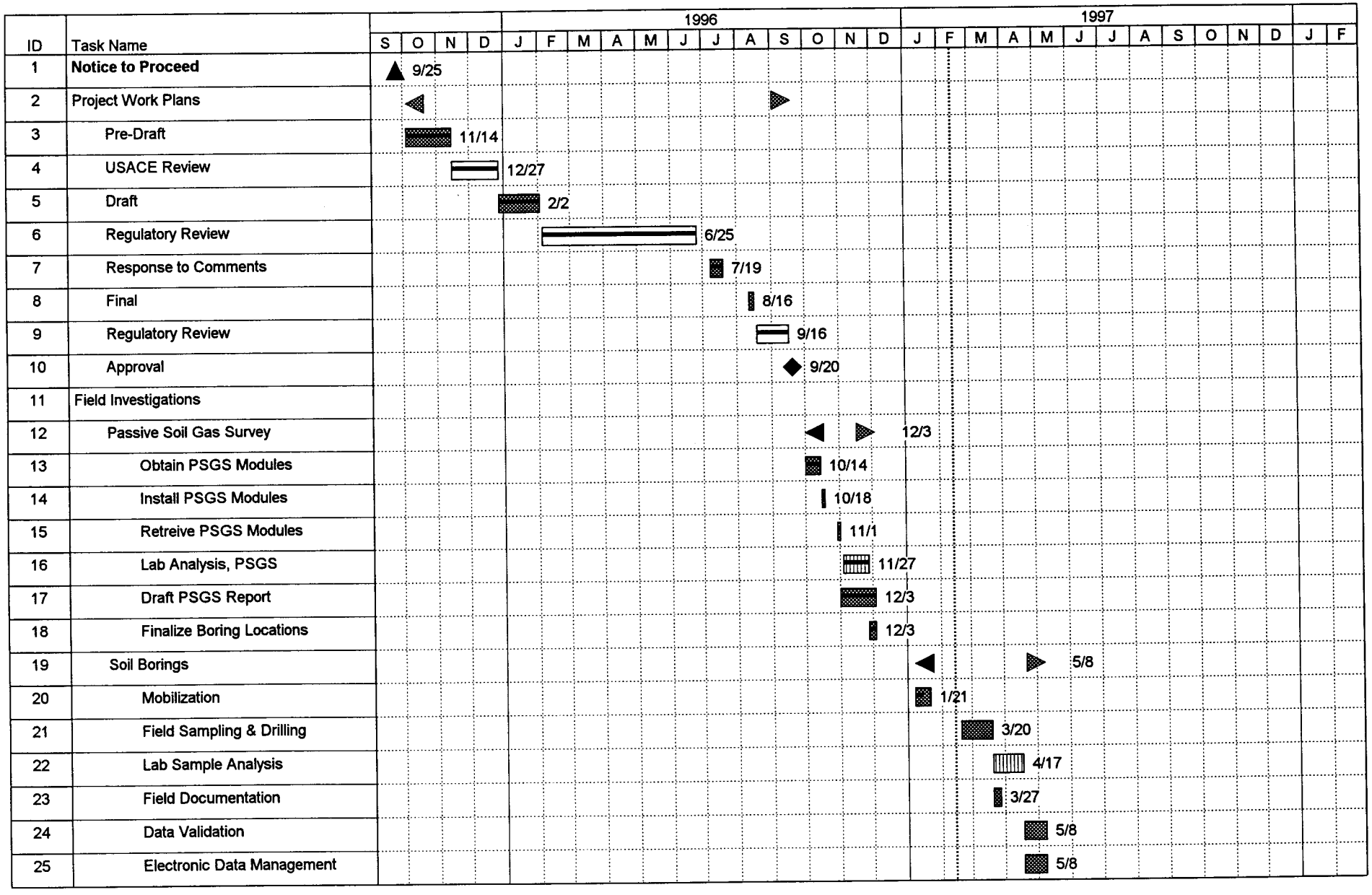
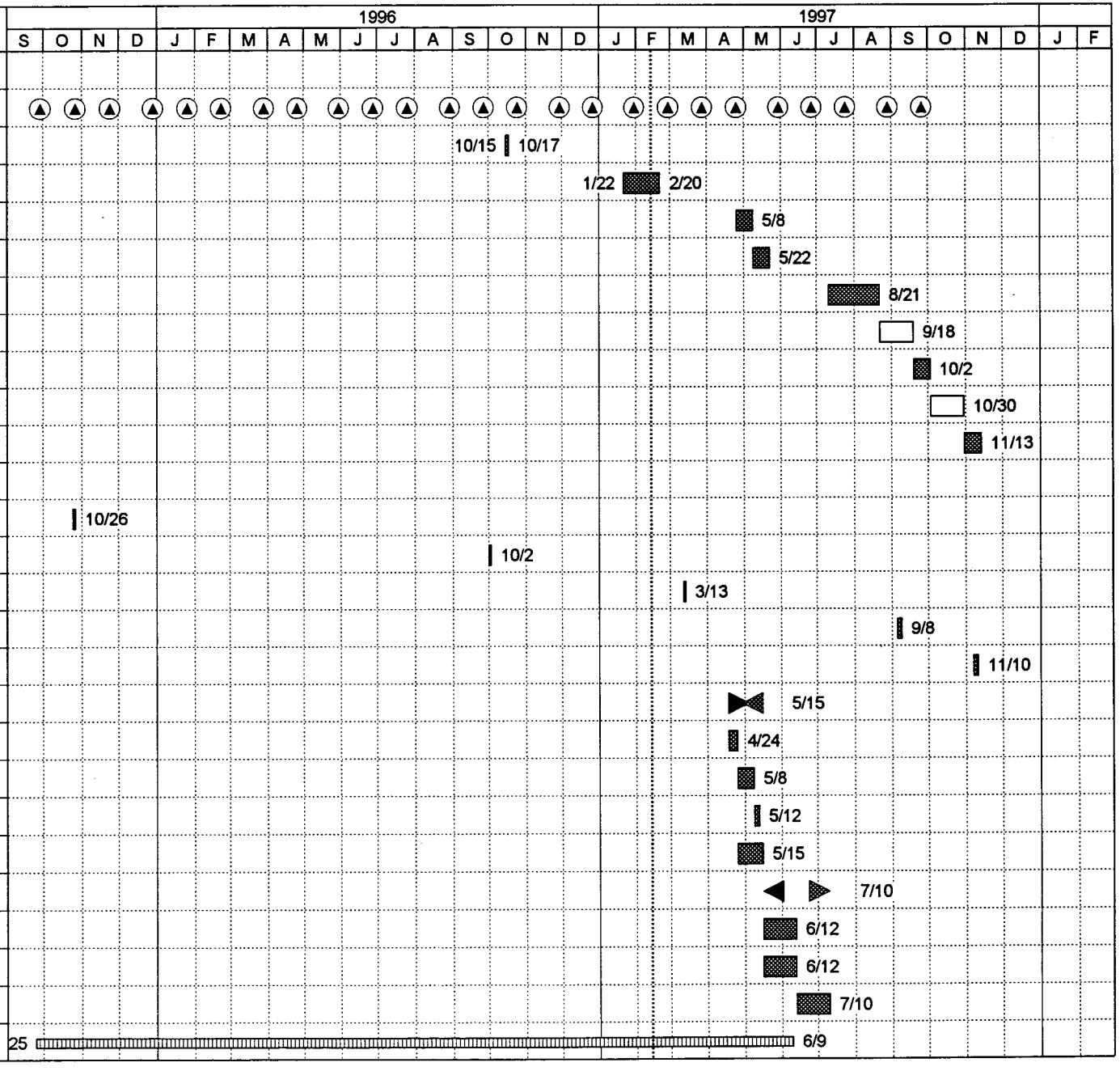


FIGURE 1-1
ESTIMATED PROJECT SCHEDULE
CANNON AFB, FIRE TRAINING AREA #4

ID	Task Name
26	Reporting
27	Monthly Progress Reports
53	Daily QC Reports
54	Daily QC Reports
55	Analytical Data
56	QC Summary Report
57	Pre-draft RFI Report
58	USACE Review
59	Draft RFI Report
60	Regulatory Review
61	Final RFI Report
62	Travel and Meetings
63	Site Visit
64	Field Mobilization Meeting
65	Demobilization Meeting
66	RFI Report Meeting 1
67	RFI Report Meeting 2
68	Screening Level Risk Evaluation
69	Initial Screening vs USEPA limits
70	Chem/Env. Data Evaluation
71	Ecological Site Visit
72	Identification of ARARS
73	Health/Env. Assessment
74	Exposure Assessment
75	Toxicity Assessment
76	Risk Characterization
77	Program & Project Management



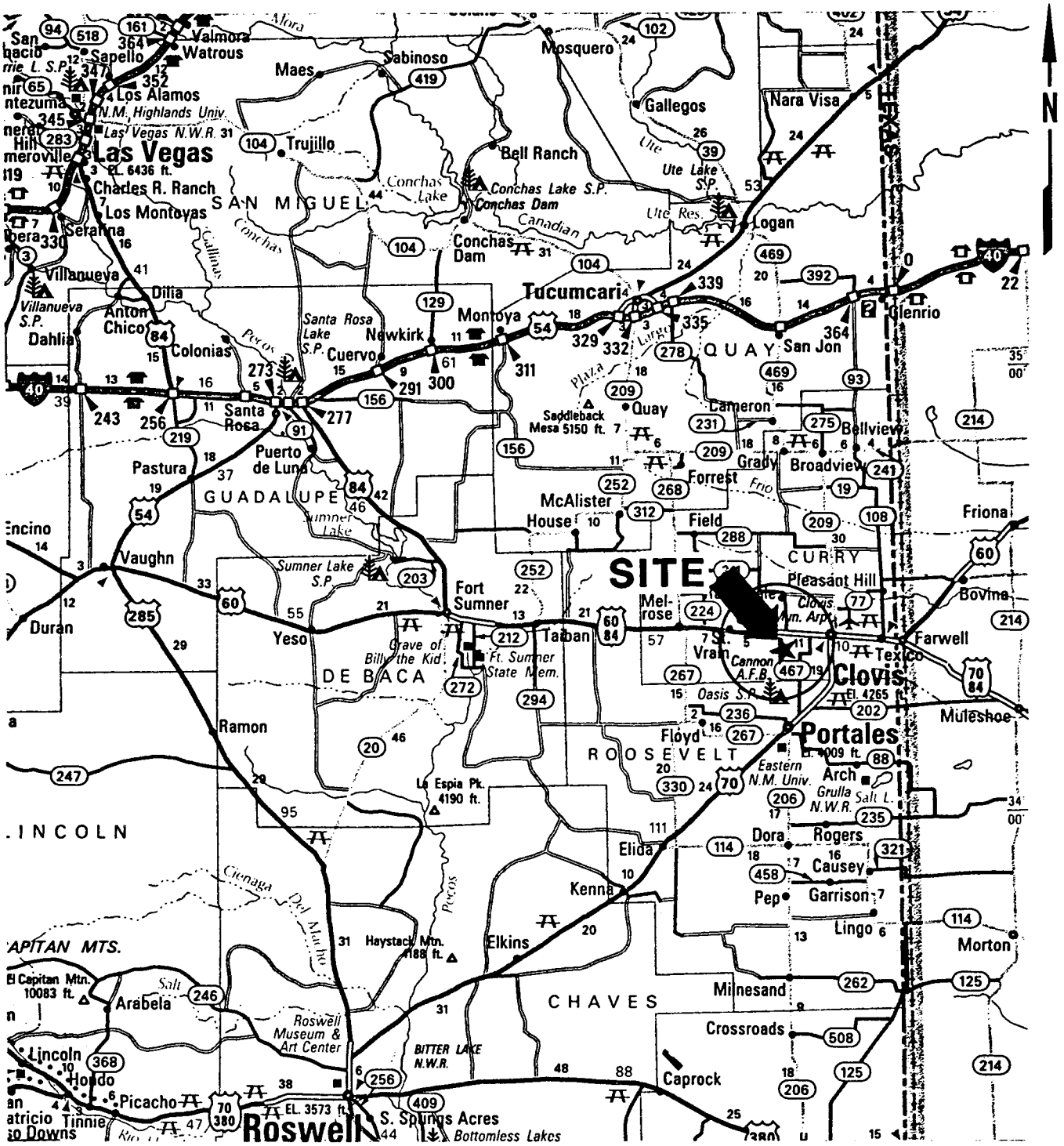


Figure 1-2
VICINITY MAP
CANNON AIR FORCE BASE
Clovis, New Mexico

HARZA *Consulting Engineers and Scientists*

c:\odrivewmeat\fig1-2.odt

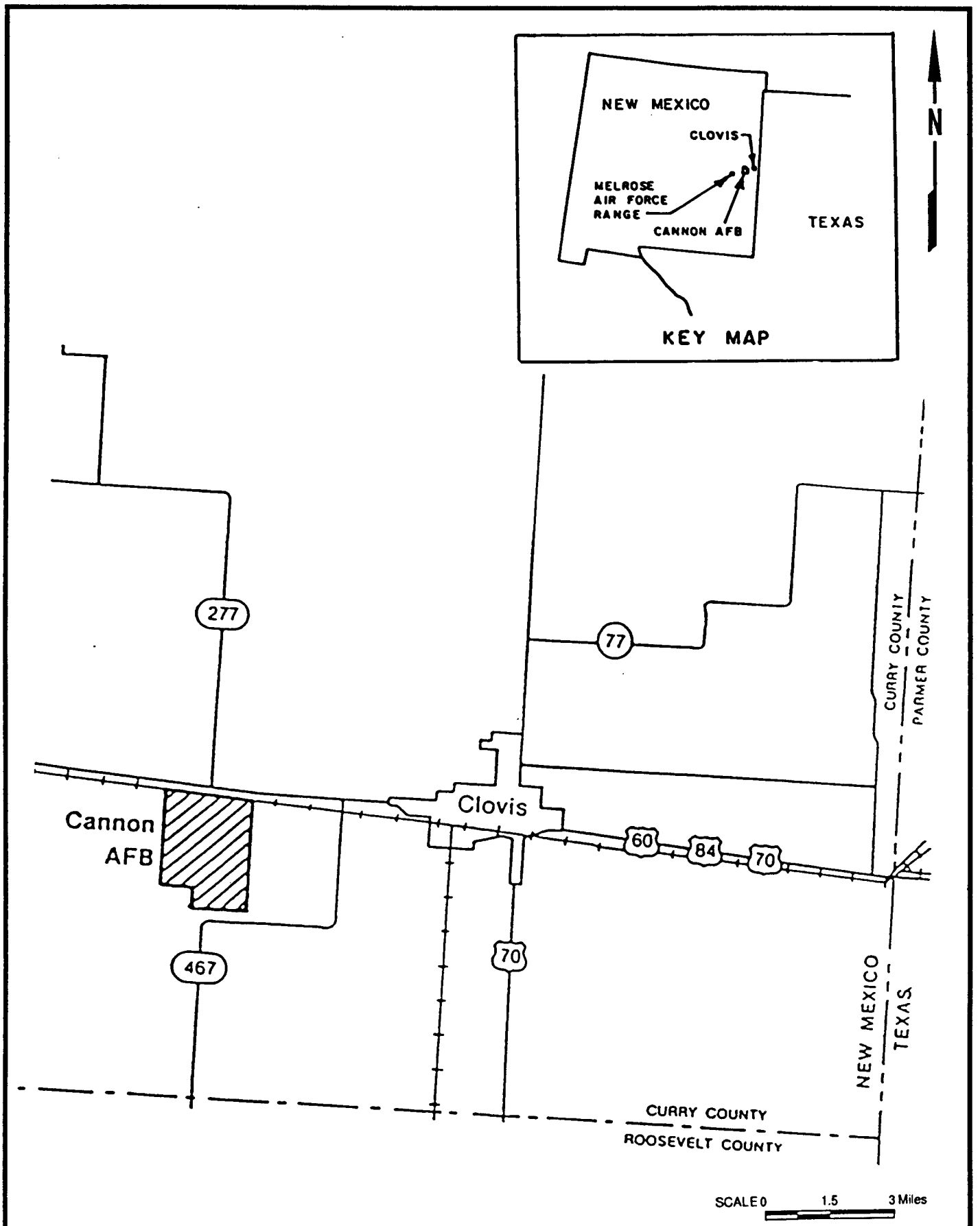


Figure 1-3
SITE LOCATION MAP
CANNON AIR FORCE BASE
Clovis, New Mexico

HARZA *Consulting Engineers and Scientists*

c:\cdr\newmex\fig1-3.cdr

c:\cdr\nexmex\fg1-4.cdr

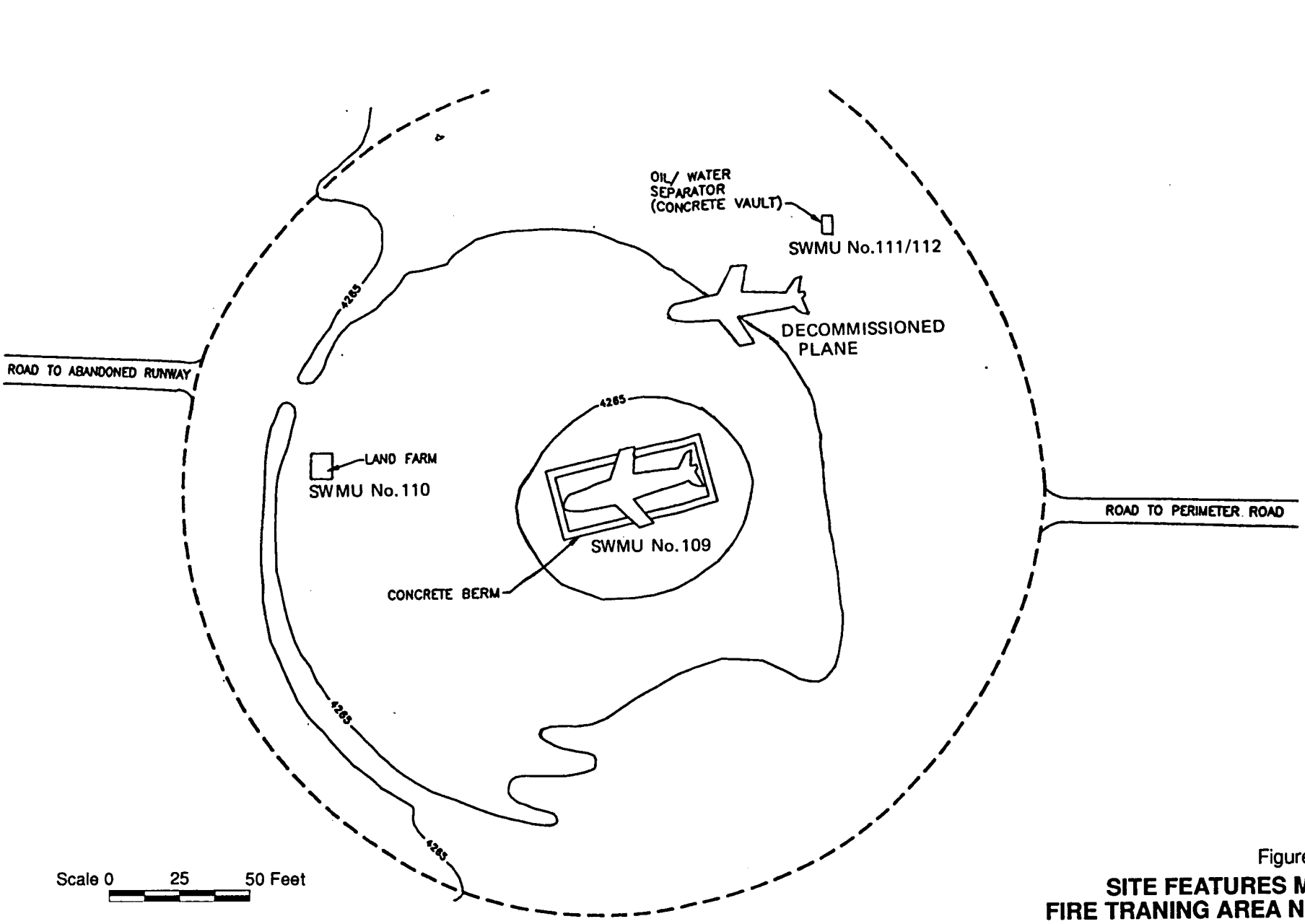


Figure 1-4

SITE FEATURES MAP
FIRE TRANING AREA No. 4
CANNON AIR FORCE BASE
Clovis, New Mexico

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ATTACHMENT 1-1

ANALYSIS OF OIL-WATER SEPARATOR (SWMU 112) EFFLUENT

P. O. BOX 9000 - KILGORE, TEXAS 75663-9000 - 903/984-0551 - FAX 903/984-5914

INA-LAB CORP.
THE COMPLETE SERVICE LAB

Analytical Chemistry • Utility Operations

TEST REPORT: 279291

27CES/CEV
111 Engineers Way
Contr: F2960594A0014
Cannon AFB, NM 88103-5136
Attention: Bill Hamilton

Sample Identification: Call #135 C
Collected By: DW
Date & Time Taken: 09/14/94 1440

Bottle Data:

#01 - Unpreserved Glass	Lot: 000141 Date: 09/13/94
#02 - Unpreserved Glass	Lot: 000141 Date: 09/13/94
#03 - TCLP Extract for Metals Derived in lab from: 01 (200 ml)	Client supplied
#04 - TCLP Extract for Metals Derived in lab from: 01 (25 ml)	Client supplied
#05 - TCLP Extract for Metals Derived in lab from: 01 (25 ml)	Client supplied
#07 - TCLP Extract for TVOA Derived in lab from: 01 (25 ml)	Client supplied
#08 - TCLP Extract for TVOA Derived in lab from: 01 (25 ml)	Client supplied
#06 - TCLP Extract for TABN Derived in lab from: 01 (750 ml)	Client supplied
#09 - Mercury Digestion Derived in lab from: 03 (50 ml)	
#10 - Mercury Digestion Derived in lab from: 03 (50 ml)	
#11 - Mercury Digestion Derived in lab from: 03 (50 ml)	
#12 - ICP Digestion Derived in lab from: 03 (5 ml)	
#13 - ICP Digestion Derived in lab from: 03 (5 ml)	

Sample Matrix: Aqueous Liquid
Report Date: 11/07/94 **Received:** 09/15/94 **Client:** CAFB

PARAMETER	RESULTS	UNITS	ANALYZED	EQL	METHOD	BY
Flash Point (Reg. Limit 140.0)	113	Degrees F	1430 09/19/94		EPA Method 1010	DSH
1,2-Dibromoethane	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
Bromochloromethane	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
1,2,3-Trichloropropane	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM

Continued

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11/07/94 279291 Continued

PARAMETER	RESULTS	UNITS	ANALYZED	EQL	METHOD	BY
Corrosivity (Reg. Limit 6.4)	ND	mmpy	1600 09/20/94	.1	SW-846 Ch. 7 7.2.2	DSH
Electrical Conductance	2600	Micromhos	2100 09/15/94		Soil Letro MHO-Meter	TEO
Reactivity with Water	Non-Reactive		1545 09/16/94			DSH
pH	7.2	SU	2300 09/15/94		EPA Method 9045A	WKC
Acrolein	ND	ug/l	0140 09/27/94	1000	EPA Method 8260	DDM
Acrylonitrile	ND	ug/l	0140 09/27/94	400	EPA Method 8260	DDM
Benzene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
Bromoform	ND	ug/l	0140 09/27/94	200	EPA Method 8260	DDM
Bromomethane	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
Carbon Tetrachloride	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
Chlorobenzene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
Chloroethane	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
2-Chloroethylvinyl ether	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
Chloroform	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
Chloromethane	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
Dibromochloromethane	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
Bromodichloromethane	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
1,1-Dichloroethane	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
1,2-Dichloroethane	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
1,1-Dichloroethene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
trans-1,2-Dichloroethene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
1,2-Dichloropropane	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
cis-1,3-Dichloropropene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	[illegible]

Continued

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11/07/94 279291 Continued

PARAMETER	RESULTS	UNITS	ANALYZED	EQL	METHOD	BY
Ethyl benzene	210	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
Methylene Chloride	ND	ug/l	0140 09/27/94	200	EPA Method 8260	DDM
1,2,4-Trimethylbenzene	270	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
1,1,2,2-Tetrachloroethane	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
Tetrachloroethene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
Toluene	880	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
1,1,1-Trichloroethane	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
1,1,2-Trichloroethane	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
Trichloroethene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
Trichlorofluoromethane	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
ıyl Chloride	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
trans-1,3-Dichloropropene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
1,1,1,2-Tetrachloroethane	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
2,2-Dichloropropane	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
1,1-Dichloropropene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
1,3-Dichloropropane	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
Styrene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
Isopropyl Benzene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
n-Propylbenzene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
Bromobenzene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
1,3,5-Trimethylbenzene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
2-Chlorotoluene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
4-Chlorotoluene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
rt-Butylbenzene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM

Continued

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11/07/94 279291 Continued

PARAMETER	RESULTS	UNITS	ANALYZED	EQL	METHOD	BY
sec-Butylbenzene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
p-Isopropyltoluene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
1,3-Dichlorobenzene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
n-Butylbenzene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
1,2-Dichlorobenzene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
1,2-Dibromo-3-chloropropane	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
1,2,4-Trichlorobenzene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
Hexachlorobutadiene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
Naphthalene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
1,2,3-Tichlorobenzene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
Methyl Isobutyl Ketone	ND	ug/l	0140 09/27/94	100	EPA Method 8260	
Methyl Ethyl Ketone	ND	ug/l	0140 09/27/94	1000	EPA Method 8260	DDM
1,4-Dichlorobenzene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
Xylenes	990	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
Dibromomethane	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
Cis-1,2-Dichloroethene	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
Dichlorodifluoromethane	ND	ug/l	0140 09/27/94	100	EPA Method 8260	DDM
TCLP Pyridine (Reg. Limit 5)	ND	mg/l	1230 09/28/94	0.1	EPA Method 8270-TCLP	DLS
Reactivity Cyanide (RL 250)	ND	mg/kg	1500 09/23/94	10	EPA Method 7.3.3	WMB
Reactivity Sulfide (RL 500)	ND	mg/kg	1530 09/23/94	100	EPA Method 9030	DSH
Reactivity	Non-reactive		1400 09/26/94		SW-846	SKL
TCLP Carbon Tetrachloride (.5)	ND	mg/l	0140 09/27/94	0.1	EPA Method 8260-TCLP	DDM
TCLP Chlorobenzene (Limit 100)	ND	mg/l	0140 09/27/94	0.1	EPA Method 8260-TCLP	DDM

Continued

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PARAMETER	RESULTS	UNITS	ANALYZED	EQL	METHOD	BY
TCLP Chloroform (Reg. Limit 6.0)	ND	mg/l	0140 09/27/94	0.1	EPA Method 8260-TCLP	DDM
TCLP 1,4 Dichlorobenzene: RL 7.5	ND	mg/l	1230 09/28/94	0.1	EPA Method 8270-TCLP	DLS
TCLP 1,2-Dichloroethane (RL .5)	ND	mg/l	0140 09/27/94	0.1	EPA Method 8260-TCLP	DDM
TCLP 1,1-Dichloroethene (.7)	ND	mg/l	0140 09/27/94	0.1	EPA Method 8260-TCLP	DDM
TCLP 2,4-Dinitrotoluene (.13)	ND	mg/l	1230 09/28/94	0.1	EPA Method 8270-TCLP	DLS
TCLP Hexachlorobenzene (.13)	ND	mg/l	1230 09/28/94	0.1	EPA Method 8270-TCLP	DLS
TCLP Hexachlorobutadiene (.5)	ND	mg/l	1230 09/28/94	0.1	EPA Method 8270-TCLP	DLS
TCLP Hexachlorethane (Limit 3)	ND	mg/l	1230 09/28/94	0.1	EPA Method 8270-TCLP	DLS
TCLP Nitrobenzene (Limit 2)	ND	mg/l	1230 09/28/94	0.1	EPA Method 8270-TCLP	DLS
TCLP Pentachlorophenol (100)	ND	mg/l	1230 09/28/94	0.5	EPA Method 8270-TCLP	DLS
LP Tetrachloroethylene (.7)	ND	mg/l	0140 09/27/94	0.1	EPA Method 8260-TCLP	DDM
TCLP Trichloroethylene (.5)	ND	mg/l	0140 09/27/94	0.1	EPA Method 8260-TCLP	DDM
TCLP 2,4,6-Trichlorophenol (2)	ND	mg/l	1230 09/28/94	0.1	EPA Method 8270-TCLP	DLS
TCLP Vinyl Chloride (.2)	ND	mg/l	0140 09/27/94	0.2	EPA Method 8260-TCLP	DDM
TCLP 2,4,5-Trichlorophenol (400)	ND	mg/l	1230 09/28/94	0.1	EPA Method 8270-TCLP	DLS
TCLP Total Cresols (Reg Lim 200)	ND	mg/l	1230 09/28/94	0.1	EPA Method 8270-TCLP	DLS
TCLP MEK (Reg. Limit 200)	ND	mg/l	0140 09/27/94	2.0	EPA Method 8260-TCLP	DDM
Total Petroleum Hydrocarbon	12	mg/l	0945 10/03/94	.7	EPA Method 418.1	WMB
TCLP Benzene (Reg. Limit 0.5)	ND	mg/l	0140 09/27/94	0.1	EPA Method 8260-TCLP	DDM
TCLP Silver (Reg. Limit 5.0)	ND	mg/l	0901 10/05/94	.1	EPA Method 6010	JDR
TCLP Arsenic (Reg. Limit 5.0)	ND	mg/l	0901 10/05/94	1	EPA Method 6010	JDR
TCLP Barium (Reg. Limit 100.0)	ND	mg/l	0901 10/05/94	1	EPA Method 6010	JDR
TCLP Cadmium (Reg. Limit 1.0)	ND	mg/l	0901 10/05/94	.1	EPA Method 6010	JDR
LP Chromium (Reg. Limit 5.0)	ND	mg/l	0901 10/05/94	.2	EPA Method 6010	JDR

Continued

ATTACHMENT 1-2

ANALYTICAL SUMMARY TABLES FROM PREVIOUS INVESTIGATIONS

TABLE 13-1

ANALYTICAL RESULTS OF SOIL SAMPLES COLLECTED BY
RADIAN AT FIRE DEPARTMENT TRAINING AREA NO. 4

SWMU NO. 109
CANNON AFB, NEW MEXICO

Sample Number	Sample Depth (Ft-BGS)	Oil and Grease (mg/kg)	Lead (mg/kg)	Purgeable Organic Compounds (EPA 8010/8020) (μg/kg)
9A-1	5.5-7.0	ND	4.1	ND
9A-2	10.5-11.5	110	39.0	ND
9A-2A[1]	10.5-11.5	280	5.3	ND
9B-1	4.0-5.5	ND	4.5	ND
9B-2	9.0-10.5	ND	3.7	ND
9B-3	43.0-45.0	37	1.3	ND

Ft-BGS = Feet below ground surface
mg/kg = Milligrams per kilogram
μg/kg = Micrograms per kilogram
ND = Not detected

[1] duplicate analysis of 9A-2

Source: Final Report, IRP Phase II (Radian 1986)

TABLE 13-2

VOLATILE ORGANIC COMPOUND CONCENTRATIONS[1] IN SOIL SAMPLES COLLECTED BY WALK, HAYDEL AND ASSOCIATES AT FIRE DEPARTMENT TRAINING AREA NO. 4

SWMU NO. 109
CANNON AFB, NEW MEXICO

Sample Depth (Ft-BGS)	Compound	Boring Number		
		B1	B3	B10
0-1.5	Benzene	NA	NS	1,060
	Toluene	NA	NS	762
	Total Xylene	NA	NS	6,940
2.5-4	Benzene	2,030	NS	2,140
	Ethylbenzene	1,790	NS	2,550
	Toluene	9,870	NS	14,600
	Xylene	10,900	NS	18,800
5-6.5	Benzene	4,560	NS	4,860
	Ethylbenzene	14,200	NS	2,020
	Toluene	2,870	NS	18,700
	Xylene	12,300	NS	10,400
7.5-9	Ethylbenzene	NSR	NS	2,150
	Toluene	NSR	NS	36,700
	Xylene	NSR	NS	6,880
10-11.5	Benzene	4,400	2,700	4,810
	Ethylbenzene	6,690	1,300	7,400
	Toluene	39,100	54,000	38,400
	Xylene	18,400	57,000	17,300
20-21.5	Benzene	15,200	NS	NS
	Ethylbenzene	6,220	NS	NS
	Toluene	64,000	NS	NS
	Xylene	12,500	NS	NS
25-26.5	Benzene	2,670	NS	NS
	Ethylbenzene	6,200	NS	NS
	Toluene	15,300	NS	NS
	Xylene	7,870	NS	NS

TABLE 13-2
(Concluded)

Sample Depth (Ft-BGS)	Compound	Boring Number		
		B1	B3	B10
30-31.5	Benzene	3,130	4,200	5,740
	Ethylbenzene	9,340	14,000	8,740
	Toluene	22,200	57,000	38,700
	Xylene	19,000	17,000	11,200
45-46.5	Benzene	NS	2,800	5,890
	Ethylbenzene	NS	11,000	24,400
	Toluene	NS	48,000	32,200
	Xylene	NS	10,000	66,200
55-56.5	Ethylbenzene	NS	NS	56,200
	Toluene	NS	NS	51,200
	Xylene	NS	NS	173,000
60-61.5	Benzene	NS	4,200	NS
	Ethylbenzene	NS	14,000	NS
	Toluene	NS	51,000	NS
	Xylene	NS	20,000	NS
85-86.5	Ethylbenzene	NS	620	NS
	Toluene	NS	310	NS
	Xylene	NS	1,700	NS
100-101.5	Toluene	NS	280	NS
	Xylene	NS	1,500	NS
Spent Mud	Benzene	NS	8,600	NS
	Ethylbenzene	NS	3,500	NS
	Toluene	NS	31,000	NS
	Total Xylene	NS	93,800	NS

Ft-BGS = Feet below ground surface
NS = Sample not collected/analyzed in accordance with Scope of Services/Sampling Plan
NA = Sample not analyzed by laboratory
NSR = No sample recovered from this interval. Split spoon contained only wood.

[1] All concentrations are in micrograms per kilogram (ug/kg)

Source: Final Report, IRP Phase IV (Walk, Haydel and Associates Inc. 1990)

TABLE 13-3
ARSENIC CONCENTRATIONS[1] IN SOIL SAMPLES COLLECTED BY WALK, HAYDEL AND ASSOCIATES AT FIRE DEPARTMENT TRAINING AREA NO. 4
SWMU NO. 109
CANNON AFB, NEW MEXICO

Sample Depth (Ft-BGS)	Boring Number								
	B1	B3	B4	B5	B6	B7	B8	B9	B10
0-1.5	NA	NS					51.1		
2.5-4		NS			NS	NS	NS		
5-6.5		NS			NS	NS	NS		
7.5-9	NSR	NS			NS	NS	NS	(94.4)	
10-11.5		NS			NS	NS	NS	(86)	
15-16.5						(114.5)	(96.6)	50.7	
20-21.5		NS			NS	NS	NS	NS	NS
25-26.5		NS			NS	NS	NS	NS	NS
30-31.5						53.3	(88.1)	(152.5)	
45-46.5	NS		NS	NS		51.9	ISR	52.3	
55-56.5	NS	NS	NS	NS	NS	NS	NS	NS	
60-61.5	NS		NS	NS					AR
75-76.5	NS	ISR	NS	NS		ISR		NS	NS
85-86.5	NS		NS	NS	NS	NS	NS	NS	NS
90-91.5	NS	NS	NS	NS				NS	NS
100-101.5	NS	ISR	NS	NS				NS	NS

NS = No sample collected in accordance with Scope of Services/Sampling Plan
( ) = Above concentrations typical of soils
NA = Sample not analyzed by laboratory
NSR = No sample recovered from this interval. Split spoon contained only wood.
ISR = Insufficient sample recovered for analysis.
AR = Auger refusal prevented completion at 60 feet. Collected sample at 55 feet.
Ft-BGS = Feet below ground surface
[1] All concentrations are in milligrams per kilogram (mg/kg)
Source: Final Report, IRP Phase IV (Walk, Haydel and Associates Inc. 1990)

TABLE 13-4

BARIUM CONCENTRATIONS[1] IN SOIL SAMPLES COLLECTED BY WALK, HAYDEL AND ASSOCIATES AT FIRE DEPARTMENT TRAINING AREA NO. 4
SWMU NO. 109
CANNON AFB, NEW MEXICO

Sample Depth (Ft-BGS)	Boring Number								
	B1	B3	B4	B5	B6	B7	B8	B9	B10
0-1.5	NA								
2.5-4		NS		676.9	NS	NS	NS		
5-6.5		NS			NS	NS	NS	857.2	
7.5-9	NSR	NS			NS	NS	NS		
10-11.5		NS			NS	NS	NS		
15-16.5									
20-21.5		NS			NS	NS	NS	NS	NS
25-26.5		NS			NS	NS	NS	NS	NS
30-31.5									1713.5
45-46.5	NS		NS	NS		1074.4	ISR		
55-56.5	NS	NS	NS	NS	NS	NS	NS	NS	
60-61.5	NS		NS	NS					AR
75-76.5	NS	ISR	NS	NS		ISR		NS	NS
85-86.5	NS		NS	NS	NS	NS		NS	NS
90-91.5	NS	NS	NS	NS				NS	NS
100-101.5	NS	ISR	NS	NS				NS	NS

NS = No sample collected in accordance with Scope of Services/Sampling Plan
NA = Sample not analyzed by laboratory
NSR = No sample recovered from this interval. Split spoon contained only wood.
ISR = Insufficient sample recovered for analysis.
AR = Auger refusal prevented completion at 60 feet. Collected sample at 55 feet.
Ft-BGS = Feet below ground
[1] All concentrations are in milligrams per kilogram (mg/kg)
Source: Final Report, IRP Phase IV (Walk, Haydel and Associates Inc. 1990)

TABLE 13-5
CADMIUM CONCENTRATIONS[1] IN SOIL SAMPLES COLLECTED BY WALK, HAYDEL AND ASSOCIATES AT FIRE DEPARTMENT TRAINING AREA NO. 4
SWMU NO. 109
CANNON AFB, NEW MEXICO

Sample Depth (Ft-BGS)	Boring Number								
	B1	B3	B4	B5	B6	B7	B8	B9	B10
0-1.5	NA							9	
2.5-4	7.8	NS			NS	NS	NS		
5-6.5	8.2	NS		9.7	NS	NS	NS	9.1	
7.5-9	NSR	NS		(11.2)	NS	NS	NS		
10-11.5		NS	9	8.5	NS	NS	NS		
15-16.5	9.2	8.8	8.5	(12.7)					
20-21.5		NS		8	NS	NS	NS	NS	NS
25-26.5		NS		9.2	NS	NS	NS	NS	NS
30-31.5									1713.5
45-46.5	NS		NS	NS			ISR		
55-56.5	NS	NS	NS	NS	NS	NS	NS	NS	
60-61.5	NS		NS	NS					AR
75-76.5	NS	ISR	NS	NS		ISR		NS	NS
85-86.5	NS		NS	NS	NS	NS	NS	NS	NS
90-91.5	NS	NS	NS	NS				NS	NS
100-101.5	NS	ISR	NS	NS				NS	NS

NS = No sample collected in accordance with Scope of Services/Sampling Plan
( ) = Above concentrations typical of soils
NA = Sample not analyzed by laboratory
NSR = No sample recovered from this interval. Split spoon contained only wood.
ISR = Insufficient sample recovered for analysis.
AR = Auger refusal prevented completion at 60 feet. Collected sample at 55 feet.
Ft-BGS = Feet below ground surface
[1] All concentrations are in milligrams per kilogram (mg/kg)
Source: Final Report, IRP Phase IV (Walk, Haydel and Associates Inc. 1990)

TABLE 13-6
SELENIUM CONCENTRATIONS[1] IN SOIL SAMPLES COLLECTED BY WALK, HAYDEL AND ASSOCIATES AT FIRE DEPARTMENT TRAINING AREA NO. 4
SWMU NO. 109
CANNON AFB, NEW MEXICO

Sample Depth (Ft-BGS)	Boring Number								
	B1	B3	B4	B5	B6	B7	B8	B9	B10
0-1.5	NA	NS				85	67		
2.5-4		NS			NS	NS	NS		
5-6.5		NS			NS	NS	NS		
7.5-9	NSR	NS			NS	NS	NS	154.8	
10-11.5		NS			NS	NS	NS	134.6	
15-16.5						166.8	193.6	151.4	
20-21.5		NS			NS	NS	NS	NS	NS
25-26.5		NS			NS	NS	NS	NS	NS
30-31.5						104.9	112.3	198.4	
45-46.5	NS		NS	NS		85	ISR		
55-56.5	NS	NS	NS	NS	NS	NS	NS	NS	
60-61.5	NS		NS	NS		80.1	64.5		AR
75-76.5	NS	ISR	NS	NS		ISR	57.7	NS	NS
85-86.5	NS		NS	NS	NS	NS	NS	NS	NS
90-91.5	NS	NS	NS	NS			80.6	NS	NS
100-101.5	NS	ISR	NS	NS		57.1		NS	NS

NS = No sample collected in accordance with Scope of Services/Sampling Plan
NA = Sample not analyzed by laboratory
NSR = No sample recovered from this interval. Split spoon contained only wood.
ISR = Insufficient sample recovered for analysis.
AR = Auger refusal prevented completion at 60 feet. Collected sample at 55 feet.
Ft-BGS = Feet below ground surface
[1] All concentrations are in milligrams per kilogram (mg/kg)
Source: Final Report, IRP Phase IV (Walk, Haydel and Associates Inc. 1990)

TABLE 13-7
SILVER CONCENTRATIONS[1] IN SOIL SAMPLES COLLECTED BY WALK, HAYDEL AND ASSOCIATES AT FIRE DEPARTMENT TRAINING AREA NO. 4
SWMU NO. 109
CANNON AFB, NEW MEXICO

Sample Depth (Ft-BGS)	Boring Number								
	B1	B3	B4	B5	B6	B7	B8	B9	B10
0-1.5	NA	NS	5.4		18.7				7.3
2.5-4	6.7	NS	7.4	16.4	NS	NS	NS		
5-6.5	10.4	NS	20.7	17.4	NS	NS	NS		
7.5-9	NSR	NS	13.3	13.6	NS	NS	NS	154.8	
10-11.5	10.1	NS	15.4	9	NS	NS	NS	134.6	
15-16.5	6.2	8.6	6.2	13.5	13.4				5.2
20-21.5	15.5	NS	10.1	18.5	NS	NS	NS	NS	NS
25-26.5	16.1	NS	8.4	9.8	NS	NS	NS	NS	NS
30-31.5	7.4	12.3	19.2	10.1	4.3				6.0
45-46.5	NS	4.1	NS	NS	4.7		ISR		6.9
55-56.5	NS	NS	NS	NS	NS	NS	NS	NS	5.7
60-61.5	NS		NS	NS	5.1				AR
75-76.5	NS	ISR	NS	NS	5.1	ISR		NS	NS
85-86.5	NS		NS	NS	NS	NS	NS	NS	NS
90-91.5	NS	NS	NS	NS				NS	NS
100-101.5	NS	ISR	NS	NS	13.7			NS	NS

NS = No sample collected in accordance with Scope of Services/Sampling Plan
NA = Sample not analyzed by laboratory
NSR = No sample recovered from this interval. Split spoon contained only wood.
ISR = Insufficient sample recovered for analysis.
AR = Auger refusal prevented completion at 60 feet. Collected sample at 55 feet.
Ft-BGS = Feet below ground surface
[1] All concentrations are in milligrams per kilogram (mg/kg)
Source: Final Report, IRP Phase IV (Walk, Haydel and Associates, Inc. 1990)

TABLE 13-8

SUMMARY OF SURFACE SOIL SAMPLING, BOREHOLE DRILLING, AND BOREHOLE SAMPLING CONDUCTED BY WCC AT FIRE DEPARTMENT TRAINING AREA NO. 4, SWMU NO. 109 , CANNON AFB, NEW MEXICO

BORING NUMBER	DRILLING/ SAMPLING METHOD	DRILL RIG USED	BOREHOLE DIAMETER (in)	DRILLING/ SAMPLING DEPTH INTERVALS (Ft-BGS)	BOREHOLE SAMPLING FREQUENCY	DATE(S) DRILLED/ SAMPLED	NUMBER OF ANALYTICAL SOIL SAMPLES COLLECTED	NUMBER OF ANALYTICAL QA/QC SAMPLES COLLECTED	NUMBER OF SPT SOIL SAMPLES COLLECTED	NUMBER OF GRADATION ANALYSIS SAMPLES COLLECTED	GROUND ELEVATION (Ft-MSL)	TOTAL DEPTH OF BOREHOLE (Ft-BGS)	DATE BOREHOLE GROUTED
1091	HT	NA	NA	0 to 0.5	NA	10-08-91	1	1	NA	1	4265.46	61	10-09-91
	HSA	F-10	6.5	0 to 22	Continuous	10-08-91	3	2	13	0			
				22 to 61	5' Intervals	10-08-91 to 10-09-91	4	1	10	1			
(1095)*	HSA	CME-7	6.0	0 to 12	5' Intervals	12-09-91	1	0	2	0	4265.44	61	12-09-91
				12 to 61	10' Intervals	12-09-91	5	4	5	0			
1092	HT	NA	NA	0 to 0.5	NA	10-10-91	1	1	NA	0	4264.49	62	10-11-91
	HSA	F-10	6.5	0 to 22	Continuous	10-10-91	3	0	11	1			
				22 to 62	5' Intervals	10-10-91	4	1	8	1			
(1096)*	HT	NA	NA	0 to 0.5	NA	12-09-91	1	1	NA	0	4264.50	62	12-09-91
	HSA	B-61B	7.5	0 to 12	5' Intervals	12-09-91	2	0	2	0			
				12 to 62	10' Intervals	12-09-91	5	0	5	0			
1093	HT	NA	NA	0 to 0.5	NA	10-16-91	1	2	NA	0	4265.24	100	10-27-91
	HSA	F-10	6.5	0 to 22	Continuous	10-16-91	3	1	11	1			
				22 to 62	5' Intervals	10-16-91	4	0	8	1			
				62 to 82	5' Intervals	10-21-91 to 10-22-91	2	0	4	0			
				82 to 100	10' Intervals	10-22-91	2	0	3	1			
(1097)*	HT	NA	NA	0 to 0.5	NA	12-05-91	1	0	NA	0	4265.33	62	12-07-91
	HSA	CME-7	6.0	0 to 12	5' Intervals	12-05-91	2	2	2	0			
				12 to 62	10' Intervals	12-05-91 to 12-06-91	3	0	7	0			
1094	HT	NA	NA	0 to 0.5	NA	10-15-91	1	0	NA	0	4265.25	92	10-29-91
	HSA	F-10	6.5	0 to 22	Continuous	10-27-91 to 10-28-91	3	2	11	1			
				22 to 62	5' Intervals	10-28-91	4	0	8	1			
				62 to 92	10' Intervals	10-28-91 to 10-29-91	3	2	4	1			
(1098)*	HT	NA	NA	0 to 0.5	NA	12-18-91	1	0	NA	0	4265.07	0.5	NA

In	Inches	B-53	Mobile B-53 Auger Drill Rig with 6" OD / 3.75" ID Augers and 6.5" Bullet Bit
Ft-BGS	Feet Below Ground Surface	B-61A	Mobile B-61 Auger Drill Rig with 6" OD / 3.75" ID Augers and 6.5" or 6.25" Bullet Bit
Ft-MSL	Feet Mean Sea Level	B-61B	Mobile B-61 Auger Drill Rig with 7.25" OD / 4.25" ID Augers and 7.5" Bullet Bit
SPT	Standard Penetration Test	F-10	Failing F-10 Auger Drill Rig with 6.25" OD / 4.25" ID Augers and 6.5" Bullet Bit
HSA	Hollow Stem Auger	CME-75	Central Mine Equipment CME-75 Auger Drill Rig with 7.75" OD / 4.25" ID Augers and 8.0" Bullet Bit
HT	Hand Trowel, Surface Sample	OD	Outer Diameter
NA	Not Applicable, Surface Sample	ID	Inner Diameter
NS	Not Sampled		

( )* The borings that are shaded and in parentheses correspond to either a redrill or surface resample of the previous boring or surface sample due to laboratory missed holding times. These borings or surface resamples were drilled or collected approximately 1 to 5 feet away from the original boring or surface sample location.

22792A/89MC114W/R9T13-8.WK1 01-Oct-92/RPT/11

TABLE 13-9

SUMMARY OF SURFACE SOIL, SUBSURFACE SOIL, AND QA/QC SAMPLES COLLECTED BY WCC AT FIRE DEPARTMENT TRAINING AREA NO. 4, SWMU NO. 109, CANNON AFB, NEW MEXICO

BORING NUMBER	DEPTH INTERVAL (Ft-BGS)	SAMPLE IDENTIFICATION NUMBER	SAMPLE TYPE	QA/QC SAMPLES	SAMPLE MATRIX	DATE SAMPLED	TIME SAMPLED	OVA ON SAMPLE (ppm)	ANALYTICAL PARAMETERS
1091	0.25 to 0.5	CAN109-1091-0000	A		Soil	10-08-91	1500	0	VOC,TPH,Pb/Cr
		CAN109-1091-1201	A	MRD	Soil	10-08-91	1545	0	VOC,TPH,Pb/Cr
		CAN109-1091-4000	GA		Soil	10-08-91	1545	0	
	0.25 to 1.75	CAN109-1091-4000	SPT		Soil	10-08-91	1545		
	1.75 to 3.25	CAN109-1091-4001	SPT		Soil	10-08-91	1600		
	3.25 to 4.75	CAN109-1091-4003	SPT		Soil	10-08-91	1610		
	5 to 7	CAN109-1091-0005	A/SPT		Soil	10-08-91	1615	0	VOC,TPH,Pb/Cr
		CAN109-1091-1271	A	RB	Water	10-08-91	1635		VOC,TPH,Pb/Cr
	7 to 8.5	CAN109-1091-4007	SPT		Soil	10-08-91	1620		
	8.5 to 10	CAN109-1091-4008	SPT		Soil	10-08-91	1625		
	10 to 12	CAN109-1091-0010	A/SPT		Soil	10-08-91	1700	0	VOC,TPH,Pb/Cr,TOC
	12 to 13.5	CAN109-1091-4012	SPT		Soil	10-08-91	1705		
	13.5 to 15	CAN109-1091-4013	SPT		Soil	10-08-91	1710		
	15 to 17	CAN109-1091-4015	SPT		Soil	10-08-91	1715		
	17 to 18.5	CAN109-1091-4017	SPT		Soil	10-08-91	1720		
	18.5 to 20	CAN109-1091-4018	SPT		Soil	10-08-91	1730		
	20 to 22	CAN109-1091-0020	A/SPT	MS/MSD	Soil	10-08-91	1755	6	VOC,TPH,Pb/Cr,TOC
	23.5 to 25	CAN109-1091-4023	SPT		Soil	10-08-91	1815		
	28.5 to 30	CAN109-1091-4028	SPT/GA		Soil	10-09-91	0800		
	30 to 32	CAN109-1091-0030	A/SPT		Soil	10-09-91	0820	0	VOC,TPH,Pb/Cr,TOC
		CAN109-1091-1261	A	FD	Soil	10-09-91	0840	0	VOC,TPH,Pb/Cr,TOC
	33.5 to 35	CAN109-1091-4033	SPT		Soil	10-09-91	0845		
	38.5 to 40	CAN109-1091-4038	SPT		Soil	10-09-91	1050		
	40 to 41	CAN109-1091-0040	A/SPT		Soil	10-09-91	1115	22	VOC,TPH,Pb/Cr,TOC
	45 to 46.5	CAN109-1091-4045	SPT		Soil	10-09-91	1215		
	50 to 51.5	CAN109-1091-0050	A/SPT		Soil	10-09-91	1230	74	VOC,TPH,Pb/Cr,TOC
	55 to 56.5	CAN109-1091-4055	SPT		Soil	10-09-91	1305		
	60 to 61	CAN109-1091-0060	A/SPT		Soil	10-09-91	1400	0	VOC,TPH,Pb/Cr,TOC
(1096)*	5 to 7	CAN109-1095-4005	SPT		Soil	12-09-91	0855	0	
	10 to 12	CAN109-1095-0010	A/SPT		Soil	12-09-91	0915	0	TOC
	20 to 22	CAN109-1095-0020	A/SPT	MS/MSD	Soil	12-09-91	0935	0.5	TOC
	30 to 32	CAN109-1095-0030	A/SPT		Soil	12-09-91	1010	4.2	VOC,TOC
		CAN109-1095-1266	A	FD	Soil	12-09-91	1025	4.2	VOC,TOC
		CAN109-1095-1272	A	RB	Water	12-09-91	1040		VOC,TOC
	40 to 41	CAN109-1095-0040	A/SPT		Soil	12-09-91	1115	2.6	VOC,TOC
	50 to 51.5	CAN109-1095-0050	A/SPT		Soil	12-09-91	1155	1.8	VOC,TOC
		CAN109-1095-1282	A	DW	Water	12-09-91	1230		VOC
	60 to 61	CAN109-1095-0060	A/SPT		Soil	12-09-91	1240	0	VOC,TOC
1092	0 to 0.5	CAN109-1092-0000	A		Soil	10-10-91	1345	0	VOC,TPH,Pb/Cr
		CAN109-1092-1264	A	FD	Soil	10-10-91	1400	0	VOC,TPH,Pb/Cr
	0 to 2	CAN109-1092-4000	SPT		Soil	10-10-91	0930		
	2 to 4	CAN109-1092-4002	SPT/GA		Soil	10-10-91	0932		
	4 to 6	CAN109-1092-0004	A/SPT		Soil	10-10-91	1000	0	VOC,TPH,Pb/Cr
	6 to 8	CAN109-1092-4006	SPT		Soil	10-10-91	1005		
	8 to 10	CAN109-1092-4008	SPT		Soil	10-10-91	1010		
	10 to 12	CAN109-1092-0010	A/SPT		Soil	10-10-91	1015	0	VOC,TPH,Pb/Cr
	12 to 14	CAN109-1092-4012	SPT		Soil	10-10-91	1020		
	14 to 16	CAN109-1092-4014	SPT		Soil	10-10-91	1025		
	16 to 18	CAN109-1092-4016	SPT		Soil	10-10-91	1040		
	18 to 20	CAN109-1092-4018	SPT		Soil	10-10-91	1050		
	20 to 22	CAN109-1092-0020	A/SPT		Soil	10-10-91	1115	58	VOC,TPH,Pb/Cr
	25 to 26.5	CAN109-1092-4025	SPT		Soil	10-10-91	1130		
	30 to 32	CAN109-1092-0030	A/SPT		Soil	10-10-91	1200	0	VOC,TPH,Pb/Cr
	35 to 37	CAN109-1092-4035	SPT/GA		Soil	10-10-91	1230		
	40 to 41.5	CAN109-1092-0040	A/SPT		Soil	10-10-91	1315	58	VOC,TPH,Pb/Cr
	45 to 47	CAN109-1092-4045	SPT		Soil	10-10-91	1415		

TABLE 13-9

SUMMARY OF SURFACE SOIL, SUBSURFACE SOIL, AND QA/QC SAMPLES COLLECTED BY WCC AT FIRE DEPARTMENT TRAINING AREA NO. 4, SWMU NO. 109, CANNON AFB, NEW MEXICO

BORING NUMBER	DEPTH INTERVAL (Ft-BGS)	SAMPLE IDENTIFICATION NUMBER	SAMPLE TYPE	QA/QC SAMPLES	SAMPLE MATRIX	DATE SAMPLED	TIME SAMPLED	OVA ON SAMPLE (ppm)	ANALYTICAL PARAMETERS
1092	50 to 52	CAN109-1092-0050	A/SPT		Soil	10-10-91	1515	68	VOC,TPH,Pb/Cr
		CAN109-1092-1251	A	AB	Water	10-10-91	1525		VOC
	55 to 57	CAN109-1092-4055	SPT		Soil	10-10-91	1535		
	60 to 62	CAN109-1092-0060	A/SPT		Soil	10-10-91	1630	2.1	VOC,TPH,Pb/Cr
(1096)*	0 to 0.5	CAN109-1096-0000	A		Soil	11-23-91	1400	0	VOC
		CAN109-1096-1267	A	FD	Soil	11-23-91	1415	0	VOC
	4 to 6	CAN109-1096-0004	A/SPT		Soil	11-23-91	1450	0	VOC
	10 to 12	CAN109-1096-0010	A/SPT		Soil	11-23-91	1505	0	VOC
	20 to 22	CAN109-1096-0020	A/SPT		Soil	11-23-91	1530	20	VOC
	30 to 32	CAN109-1096-0030	A/SPT		Soil	11-23-91	1625	0	VOC
	40 to 41.5	CAN109-1096-0040	A/SPT		Soil	11-23-91	1715	10	VOC
	50 to 52	CAN109-1096-0050	A/SPT		Soil	11-24-91	0930	10	VOC
	60 to 62	CAN109-1096-0060	A/SPT		Soil	11-24-91	1110	0	VOC
1093	0 to 0.5	CAN109-1093-0000	A	MS/MSD	Soil	10-15-91	1150	35	VOC,TPH,Pb/Cr
		CAN109-1093-1202	A	MRD	Soil	10-15-91	1150	35	VOC,TPH,Pb/Cr
	0 to 2	CAN109-1093-4000	SPT		Soil	10-15-91	1700	35	
	2 to 4	CAN109-1093-4002	SPT		Soil	10-15-91	1710	14	
	4 to 6	CAN109-1093-0004	A/SPT		Soil	10-15-91	1745	10.5	VOC,TPH,Pb/Cr
		CAN109-1093-1262	A	FD	Soil	10-15-91	1800	10.5	VOC,TPH,Pb/Cr
	6 to 8	CAN109-1093-4006	SPT		Soil	10-15-91	1800	12	
	8 to 10	CAN109-1093-4008	SPT		Soil	10-15-91	1805	17	
	10 to 12	CAN109-1093-0010	A/SPT		Soil	10-15-91	1820	22	VOC,TPH,Pb/Cr
	12 to 14	CAN109-1093-4012	SPT/GA		Soil	10-15-91	1830	8	
	14 to 16	CAN109-1093-4014	SPT		Soil	10-15-91	1835	31	
	16 to 18	CAN109-1093-4016	SPT		Soil	10-15-91	1855	0.8	
	18 to 20	CAN109-1093-4018	SPT		Soil	10-15-91	1900	0.2	
	20 to 22	CAN109-1093-0020	A/SPT		Soil	10-15-91	1920	0	VOC,TPH,Pb/Cr
	25 to 27	CAN109-1093-4025	SPT		Soil	10-16-91	0725	0	
	30 to 32	CAN109-1093-0030	A/SPT		Soil	10-16-91	0755	0	VOC,TPH,Pb/Cr
	35 to 37	CAN109-1093-4035	SPT		Soil	10-16-91	0825	0	
	40 to 42	CAN109-1093-0040	A/SPT		Soil	10-16-91	0850	4.8	VOC,TPH,Pb/Cr
	45 to 47	CAN109-1093-4045	SPTGA		Soil	10-16-91	0915	0	
	50 to 52	CAN109-1093-0050	A/SPT		Soil	10-16-91	1000	1.1	VOC,TPH,Pb/Cr
	55 to 56.5	CAN109-1093-4055	SPT		Soil	10-16-91	1030	0	
	60 to 62	CAN109-1093-0060	A/SPT		Soil	10-16-91	1100	0.6	VOC,TPH,Pb/Cr
	65 to 66	CAN109-1093-4065	SPT		Soil	10-21-91	1625	7.1	
	70 to 72	CAN109-1093-0070	A/SPT		Soil	10-21-91	1710	11	VOC,TPH,Pb/Cr
	75 to 75.5	CAN109-1093-4075	SPT		Soil	10-22-91	0835	0.2	
	80 to 82	CAN109-1093-0080	A/SPT		Soil	10-22-91	0945	5.1	VOC,TPH,Pb/Cr
	90 to 92	CAN109-1093-0090	A/SPT		Soil	10-22-91	1220	1.1	VOC,TPH,Pb/Cr
		CAN109-1093-4090	SPT/GA		Soil	10-22-91	1220	1.1	
	98 to 100	CAN109-1093-0098	A/SPT		Soil	10-22-91	1320	0	VOC,TPH,Pb/Cr
(1097)*	0 to 0.5	CAN109-1097-0000	A		Soil	12-05-91	1130	30	TPH
	4 to 6	CAN109-1097-0004	A/SPT		Soil	12-05-91	1200	16	VOC
		CAN109-1097-1252	A	AB	Water	12-05-91	1210		VOC
	10 to 12	CAN109-1097-0010	A/SPT		Soil	12-05-91	1245	14	TPH
		CAN109-1097-1266	A	FD	Soil	12-05-91	1225	14	TPH
	20 to 22	CAN109-1097-0020	A/SPT		Soil	12-05-91	1345	0	TPH
	30 to 32	CAN109-1097-4030	SPT		Soil	12-06-91	1320	1.1	
	40 to 42	CAN109-1097-0040	A/SPT		Soil	12-06-91	1350	2.4	VOC
	50 to 52	CAN109-1097-4050	SPT		Soil	12-06-91	1455	8.2	
	60 to 62	CAN109-1097-4060	SPT		Soil	12-06-91	1540	2.4	
	70 to 72	CAN109-1097-4070	SPT		Soil	12-06-91	1625	17	
	80 to 82	CAN109-1097-0080	A/SPT		Soil	12-06-91	1710	11.2	VOC

TABLE 13-9

SUMMARY OF SURFACE SOIL, SUBSURFACE SOIL, AND QA/QC SAMPLES COLLECTED BY WCC AT FIRE DEPARTMENT TRAINING AREA NO. 4, SWMU NO. 109, CANNON AFB, NEW MEXICO

BORING NUMBER	DEPTH INTERVAL (Ft-BGS)	SAMPLE IDENTIFICATION NUMBER	SAMPLE TYPE	QA/QC SAMPLES	SAMPLE MATRIX	DATE SAMPLED	TIME SAMPLED	OVA ON SAMPLE (ppm)	ANALYTICAL PARAMETERS
1094	0 to 0.5	CAN109-1094-0000	A		Soil	10-15-91	1220	35	VOC,TPH,Pb/Cr
	0 to 2	CAN109-1094-4000	SPT		Soil	10-27-91	1545	20	
	2 to 4	CAN109-1094-4002	SPT		Soil	10-27-91	1555	70	
	4 to 6	CAN109-1094-0004	A/SPT		Soil	10-27-91	1605	36	VOC,TPH,Pb/Cr
	6 to 8	CAN109-1094-4006	SPT		Soil	10-27-91	1610	73	
	8 to 10	CAN109-1094-4008	SPT		Soil	10-27-91	1625	92	
	10 to 12	CAN109-1094-0010	A/SPT		Soil	10-27-91	1640	110	VOC,TPH,Pb/Cr
	12 to 14	CAN109-1094-4012	SPT		Soil	10-27-91	1650	32	
	14 to 16	CAN109-1094-4014	SPT		Soil	10-27-91	1655	24	
	16 to 18	CAN109-1094-4016	SPT		Soil	10-27-91	1710	3.6	
	18 to 20	CAN109-1094-4018	SPT/GA		Soil	10-27-91	1720	24	
	20 to 22	CAN109-1094-0020	A/SPT		Soil	10-28-91	0845	3.3	VOC,TPH,Pb/Cr
		CAN109-1094-1203	A	MRD	Soil	10-28-91	0845	3.3	VOC,TPH,Pb/Cr
		CAN109-1094-1263	A	FD	Soil	10-28-91	0915	3.3	VOC,TPH,Pb/Cr
	25 to 27	CAN109-1094-4025	SPT		Soil	10-28-91	0915	0.2	
	30 to 31	CAN109-1094-0030	A/SPT		Soil	10-28-91	0930	0.2	VOC,TPH,Pb/Cr
	35 to 37	CAN109-1094-4035	SPT		Soil	10-28-91	1005	0	
	40 to 41.5	CAN109-1094-0040	A/SPT		Soil	10-28-91	1040	0	VOC,TPH,Pb/Cr
	45 to 47	CAN109-1094-4045	SPT		Soil	10-28-91	1130	8	
	50 to 52	CAN109-1094-0050	A/SPT		Soil	10-28-91	1210	2.8	VOC,TPH,Pb/Cr
	55 to 57	CAN109-1094-4055	SPT/GA		Soil	10-28-91	1350	1.1	
	60 to 62	CAN109-1094-0060	A/SPT		Soil	10-28-91	1445	5.1	VOC,TPH,Pb/Cr
	70 to 72	CAN109-1094-0070	A/SPT		Soil	10-28-91	1525	6.2	VOC,TPH,Pb/Cr
	80 to 82	CAN109-1094-0080	A/SPT		Soil	10-28-91	1700	7.8	VOC,TPH,Pb/Cr
		CAN109-1094-1204	A	MRD	Soil	10-28-91	1700	7.8	VOC,TPH,Pb/Cr
		CAN109-1094-4080	GA		Soil	10-28-91	1700	7.8	
	90 to 92	CAN109-1094-0090	A/SPT		Soil	10-29-91	0845	0	VOC,TPH,Pb/Cr
		CAN109-1094-1281	A	DW	Water	10-30-91	1000		VOC
(1096)*	0 to 0.5	CAN109-1096-0000	A	MS/MSD	Soil	12-16-91	1100	21	VOC,TPH
		CAN109-1096-1201	A	MRD	Soil	12-16-91	1100	21	VOC,TPH
		CAN109-1096-1273	A	RB	Water	12-16-91	1115		VOC,TPH

Ft-BGS	Feet Below Ground Surface	FD	Field Duplicate	SV	Semi Volatile Organic Compounds
OVA	Organic Vapor Analyzer Reading	MRD	Missouri River Division Duplicate	M	Metals (TAL)
ppm	Parts per Million	AB	Ambient Blank	TPH	Total Petroleum Hydrocarbons
A	Analytical	RB	Rinsate Blank	BTEX	Benzene, Toluene, Ethylbenzene, Xylene
SPT	Standard Penetration Test	DW	Decontamination Water Blank	TOC	Total Organic Carbon
GA	Gradation Analysis	TB	Trip Blank	OL	Organic Lead
L	Lithology	VOC	Volatile Organic Compounds (TCL)	Pb/Cr	Lead / Chromium
MS/MSD	Matrix Spike / Matrix Spike Duplicate	PCB	Polychlorinated Biphenols, Pesticides	TAL	Target Analyte List
		TCL	Target Compound List		

( )* The borings that are shaded and in parentheses correspond to either a redrill or surface resample of the previous boring or surface sample due to laboratory missed holding times. These borings or surface resamples were drilled or collected approximately 1 to 5 feet away from the original boring or surface sample.

TABLE 13-10

TOTAL PETROLEUM HYDROCARBON, ETHYL BENZENE AND XYLENES CONCENTRATIONS IN SOIL SAMPLES COLLECTED BY WCC AT FIRE DEPARTMENT TRAINING AREA NO. 4

SWMU NO. 109
CANNON AFB, NEW MEXICO

Boring Number (Redrill Boring Number)	Sampling Depth (Ft-BGS)	TPH (mg/kg)	Xylenes (μg/kg)	Ethyl Benzene (μg/kg)
1091	0-0.5	27.3	2 J	11 UJ
(1095)	5-7	56.6	11 U	11 U
	10-12	45.1 U	11 U	11 U
	20-22	45.7 U	12 U	12 U
	30-32	44.5 U	(55 U)	(55 U)
	40-42	46.3 U	(57 U)	(57 U)
	50-52	43.9 U	(11 U)	(11 U)
	60-62	42.6 U	(11 U)	(11 U)
1092 (1096)	0-60	Not detected above CRQL	(Not detected above CRQL)	(Not detected above CRQL)
1093	0-0.5	(38500)	8J	19 U
(1097)	4-6	12900	(4100)	(1200 U)
	10-12	(45 U)	11 U	11 U
	20-22	(46.6 U)	12 U	12 U
	30-32	44 U	11 U	11 U
	40-42	45.6 U	(11 U)	(11 U)
	50-52	215	11 U	11 U
	60-62	203	10 U	10 U
	70-72	42.8 U	11 UJ	11 UJ
	80-82	41.8 U	(11 U)	(11 U)
	90-92	40.6 U	10 UJ	10 UJ
	98-100	41.2 U	10 UJ	10 UJ

TABLE 13-10
(Concluded)

Boring Number (Redrill Boring Number)	Sampling Depth (Ft-BGS)	TPH (mg/kg)	Xylenes (μg/kg)	Ethyl Benzene (μg/kg)
1094	0-0.5	(13600)	(11 U)	(11 U)
(1098)	4-6	8300	290,000	19,000 J
	10-12	1870	6,700 J	28,000 U
	20-22	46.7	12 U	12 U
	30-32	44 U	11 U	11 U
	40-42	44.1 U	11 U	11 U
	50-52	42.7 U	10 U	10 U
	60-62	43.2 U	10 U	10 U
	70-72	43 U	11 U	11 U
	80-82	42.2 U	11 U	11 U
	90-92	42.1 U	11 U	11 U

Ft-BGS = Feet below ground surface
mg/kg = Milligrams per kilogram
ug/kg = Micrograms per kilogram
U = Not detected
J = Estimated value
UJ = Estimated as non-detect at the CRQL
( ) = The values in parentheses are results from samples collected from the redrill borings due to laboratory missed holding times.

TABLE 13-11

CHROMIUM AND LEAD CONCENTRATIONS IN SOIL SAMPLES
COLLECTED BY WCC AT FIRE DEPARTMENT TRAINING AREA NO. 4

SWMU NO. 109
CANNON AFB, NEW MEXICO

Boring Number	Sample Depth (Ft-BGS)	Chromium (mg/kg)	Lead (mg/kg)
1091	0 - 0.5	10	6.4
	5	6.4	4.8
	10	4.5	4.2
	20	8.8	6.6
	30	7.8	3.7
	40	6.6	2.2
	50	3.6	2.5
	60	6.1	2.3
1092	0-0.5	9.3	6.8
	4	7.4	4.7
	10	7.5	4.7
	20	8.1	3.8
	30	7.7	3.0
	40	4.9	2.2
	50	4.5	2.3
	60	4.5	2.1
1093	0-0.5	6.5	19.6 J
	4	7.3	6.3
	10	6.8	5.0
	20	6.6	2.6
	30	5.5	3.1
	40	6.8	2.1
	50	3.3	2.4
	60	4.2	1.9
	70	1.4	0.9
	80	2.6	1.5
	90	1.4	0.9
	98	1.1 J	0.87

TABLE 13-11
(Concluded)

Boring Number	Sample Depth (Ft-BGS)	Chromium (mg/kg)	Lead (mg/kg)
1094	0 - 0.5	4.8	2.5
	4	5.8	6.5
	10	8.3	6.4
	20	10.5	5.3
	30	7.0	2.1
	40	7.4	2.4
	50	3.9	1.5
	60	4.1	1.6
	70	4.2	1.8
	80	9.1	2.1
	90	2.8	0.98

Ft-BGS = Feet below ground surface
mg/kg = Milligrams per kilogram
J = Estimated value

[1] Background range for chromium is 2.97 to 9.31 mg/kg (see Table 2-7).
[2] Background range for lead is 17.6 to 8.64 mg/kg (see Table 2-7).

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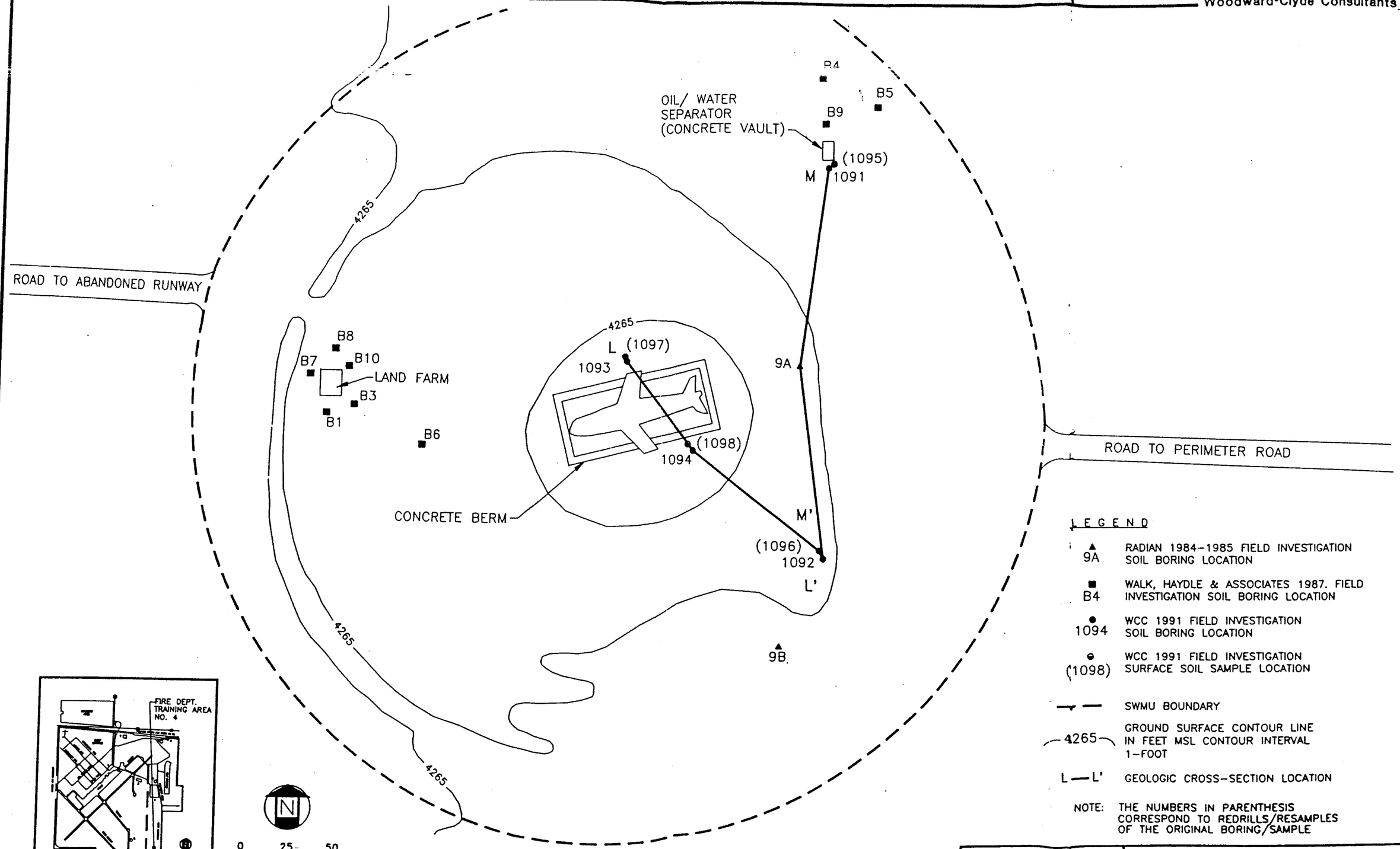

Job No. : 89MC114W	LOCATION OF SOIL BORINGS AT FIRE DEPARTMENT TRAINING AREA NO.4 SWMU NO. 109 CANNON AFB, NEW MEXICO
Prepared by : D.A.K.	
Date : 2/18/92	

C1140009

2.1 RESULTS OF DATA QUALITY OBJECTIVE PROCESS

The three-stage data quality objective process described in EPA guidance (USEPA 1987) was used to define the data objectives, specific task objectives, and quality assurance objectives for the RFI at Fire Training Area No. 4. This three-stage process includes identifying decision types (Stage 1), identifying data uses/needs (Stage 2), and designing the data collection program (Stage 3). Results of the data quality objective process are given below.

Overall RFI objectives at Fire Training Area No. 4 are to obtain data of sufficient quality, type and quantity to identify the contaminants of concern, delineate the extent of contamination, conduct Health and Environmental Assessments (HEA), and complete Corrective Measures Studies (CMS) at the SWMUs included. Specific Data Quality Objectives (DQOs) for RFI of Fire Training Area No. 4 at Cannon AFB are as follows:

- To sample and analyze soil gas and soils to determine which, if any, media have been impacted by contamination at the site.

- To sample and analyze soil gas and soils to identify the vertical and lateral extent of contamination, if any.

- To obtain a basic understanding of the geological framework of the site and to develop a conceptual model for the site using boring logs obtained in the field work.

- To identify potential contaminant migration pathways for use in risk assessment and corrective measures studies, if necessary.

The data quality requirements for risk assessment are more stringent than those for other potential data uses. Therefore, the use of data for risk assessment dictates the quality of

analytical data required. USEPA SW-846 (USEPA, 1986) analytical methods will be used for metals and cyanide, volatile and semivolatile organics, and TRPH, producing data of high quality which is suitable for use in risk assessment studies. These methods are characterized by rigorous QA/QC protocols and documentation providing qualitative and quantitative analytical data. This level of analytical laboratory analysis is acceptable for use in risk assessments (USEPA, 1987).

2.2 QA OBJECTIVES FOR MEASUREMENT OF DATA

2.2.1 General

The overall QA objective for this RFI is to develop and implement procedures for sampling, laboratory analyses, field measurements, reporting, and data review that will provide data of a quality consistent with the intended use. The sample set, chemical analysis results, and interpretations must be based on data that meet or exceed quality assurance objectives established for the project.

The data quality requirements for risk assessment data are more stringent than those for other uses of data governed by this Workplan. Since all project analytical data may be used for risk assessment, this use will determine the quality of analytical data required. The quality of analytical data generated by SW-846 methods, which will be used for all analyses, meet the QAOs and is suitable for use in risk assessment studies or any uses required by the RFI, as noted in Section 2.1. These methods are characterized by rigorous QA/QC protocols and documentation providing qualitative and quantitative analytical data. SW-846 methods will generate data of known quality using established methods. The addition of the full analytical data package (Section 6.8) required for this project will further enhance the documentation and data quality of the SW-846 analytical packages. Data from these analyses using standard EPA-approved procedures which meet quality assurance objectives are acceptable for use in risk assessments (USEPA 1987).

QAOs and procedures for field measurement systems are also important aspects of these investigations. The objectives and the quality assurance procedures for the acquisition of

nonchemical data are discussed in the appropriate SOPs. The following paragraphs discuss field and laboratory analytical measurements.

QAOs are usually expressed in terms of accuracy or bias, precision, completeness, representativeness, and comparability. Target ranges for these objectives are presented for analytical testing and field measurements. Variances from the quality assurance objectives will result in the implementation of appropriate corrective measures and an assessment of the impact on the useability of the data in the decision-making process.

2.2.2 Required Level of Analysis and Review

All analytical data to be collected will potentially be used in risk assessment modelling to meet RFI objectives. The data quality requirements for the risk assessment modelling are more stringent than those for other objectives for which these data will be used. In order to generate data of sufficient quality to be used in the risk assessment modelling, the following approach will be used:

- USEPA SW-846 methods will be used to analyze soil samples for metals and cyanide, volatile and semivolatile compounds, and TRPH. Analytical methods for each procedure are specified in Table 4-1 in Section 4.0.

- Internal quality control samples and procedures to be used by the laboratory for analysis are specified in Section 6.0.

- Full data documentation (including raw data) shall be obtained from the laboratories and shall be retained within the project files for a minimum of 10 years from the time of receipt from the laboratory.

- Either full data validation or a QC review, as defined in Section 6.0 and SOP #10, shall be completed on all data. As specified in Section 6.0, all samples defined as critical to the risk assessment or ten percent of samples, whichever is larger, will be subjected to a complete data validation. The remaining samples will be subject to the QC review process described in Section 6.0. Full analytical

data packages will be obtained from the laboratory, as noted above, and checked for completeness as part of the data validation and review process. Therefore, a complete data validation could be performed on these additional data packages if required in the future.

- Five percent of samples will be split and sent to the USACE Missouri River Division Laboratory (MRDL) for analysis.

2.2.3 QC Samples

Field duplicates will be collected and submitted to the analytical laboratory to provide a means to assess the quality of the data resulting from the field sampling program. Field duplicate samples will be analyzed to check for sampling and laboratory reproducibility. Laboratory control samples will be analyzed to measure the accuracy of the analytical method. Matrix Spike samples will be analyzed in order to determine the matrix-specific accuracy of the analysis. Laboratory duplicates for inorganic analysis and matrix spike duplicates for organic analytes will be analyzed to evaluate laboratory reproducibility or precision. Specific QC sample descriptions are given in Section 6.5, Internal Quality Control Checks. The specific level of field QC effort is summarized in Section 5.6.

2.2.4 QA Objectives - Quantitative Limits

Within this Workplan, quantitative limits are defined for reporting limits, accuracy, precision, and analytical completeness. Reporting limits are set by the analytical laboratory based on historical data and comparison to USEPA limits for CLP and other methods. Reporting limit requirements for this project are specified in Tables 2-1 through 2-3. Accuracy is defined as the degree of agreement of a measurement to an accepted reference or true value. Accuracy will be measured as the percent recovery (%R) of an analyte in a reference standard or spiked sample. The procedure for calculating percent recovery is specified in Section 6.7 . Precision is defined as the agreement between a set of replicate measurements without assumption or knowledge of the true value. The procedures for calculating precision are specified in Section 6.7 . Analytical completeness is defined as the percentage of analytical results requested, which

are determined as valid through validation and review. The procedure for calculating analytical completeness is specified in Section 6.7 .

2.2.4.1 Reporting Limits

Tables 2-1 through 2-3 list the project-required detection limits (reporting limits) for analyses to be conducted under this Workplan. These are the detection limits that the laboratory must be able to meet, based on analyses of matrix blanks using the analytical methods specified in Table 6-1. The detection limits for samples may be considerably higher depending on the sample matrix.

2.2.4.2 Accuracy Limits

Accuracy limits for matrix spike recoveries are specified in Table 2-5. Accuracy limits for surrogate spike recoveries are given in Tables 2-4. The limits specified in this table will be used during QC review or data validation as specified in Section 6.8.

2.2.4.3 Precision Limits

Precision limits for matrix spike recoveries are specified in Table 2-5. The limits specified in these tables will be used during QC review or data validation as specified in Section 6.8 .

2.2.4.4 Completeness

The overall analytical completeness goal for this project shall be 90 percent.

2.2.5 QA Objectives - Qualitative Limits

2.2.5.1 Representativeness

Representativeness is the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition.

Representativeness will be maintained during the sampling effort by performing all sampling in compliance with the procedures described in Section 5.0 of this document and the respective SOPs.

2.2.5.2 Comparability

Comparability expresses the confidence with which one data set can be compared to another. Comparability can be related to accuracy and precision as these quantities are measures of data reliability. Data are comparable if siting considerations, collection techniques, and measurement procedures, methods, and reporting are equivalent for the samples within a sample set. A qualitative assessment of data comparability will be made of applicable data sets.

2.3 PERFORMANCE AND SYSTEMS AUDITS

Performance and systems audits may be conducted to verify documentation on implementation of the QA program, assess the effectiveness of the Workplan, identify any nonconformances, and verify correction of identified deficiencies. For this project, audits will be combined with other laboratory and field QA activities. The laboratory participating in the Cannon AFB project has undergone a validation procedure by the USACE, Missouri River Division Laboratory, which includes performance evaluation, sample analysis and inspection. The Task Leader for field investigations will assure that field calibration of equipment are performed according to manufacturer's specifications and requirements of this Workplan and the SSHP. A field activities audit will examine sample labels, chain of custody records, and field notebooks for completeness and accuracy.

TABLE 2-1
Reporting Limits for Volatile Organics in Soil by GC/MS (Method 8260)

Compound	Reporting Limit (μg/kg)[1]	Compound	Reporting Limit (μg/kg)[1]
Acetone	100	1,3-Dichloropropane	5
Benzene	5	2,2-Dichloropropane	5
Bromobenzene	5	1,2-Dichloropropene	5
Bromochloromethane	5	Ethylbenzene	5
Bromodichloromethane	5	Hexachlorobutadiene	5
Bromoform	5	Isopropylbenzene	5
2-Butanone	100	p-Isopropyltoluene	5
Bromomethane	5	Methylene Chloride	5
n-Butylbenzene	5	4-Methyl-2-pentanone	20
Carbon Disulfide	10	Napthalene	5
sec-Butylbenzene	5	n-Propylbenzene	5
tert-Butylbenzene	5	Styrene	5
Carbon Tetrachloride	5	1,1,1,2-Tetrachloroethane	5
Chlorobenzene	5	1,1,2,2-Tetrachloroethane	5
Dibromochloromethane	5	Tetrachloroethene	5
Chloroethane	5	Toluene	5
Chloroform	5	1,2,3-Trichlorobenzene	5
Chloromethane	5	1,2,4-Trichlorobenzene	5
2-Chlofotoluene	5	1,1,1-Trichloroethane	5
4-Chlorotoluene	5	1,1,2-Trichloroethane	5
1,2-Dibromo-3-chloropropane	10	Trichloroethene	5
1,2-Dibromoethane	5	Trichlorofluoromethane	5
Dibromomethane	5	1,2,3-Trichloropropane	5
1,2-Dichlorobenzene	5	1,2,4-Trimethylbenzene	5
1,3-Dichlorobenzene	5	1,3,5-Trimethylbenzene	5
1,4-Dichlorobenzene	5	Vinyl Chloride	5
Dichlorodifluoromethane	5	o-Xylene	5
1,1-Dichloroethane	5	trans-1,3-Dichloropropene	5
1,2-Dichloroethane	5	m & p-Xylene	5
1,1-Dichloroethene	5	cis-1,3-Dichloropropene	5
cis-1,2-Dichloroethene	5	4-Bromofluorobenzene	1
2-Hexanone	20	Dibromofluoromethane	1
trans-1,2-Dichloroethene	5	Toluene-d8	1
1,2-Dichloropropane	5		

[1] Method Specific reporting limits provided by ARDL.

TABLE 2-2 (2 pages)
Reporting Limits for Semivolatile Organics in Soil by GC/MS[1] (Method 8270)[2]

Compound	Reporting Limit (µg/kg)	Compound	Reporting Limit (µg/kg)
Phenol	330	Diethylphthalate	330
bis(2-Chloroethyl)ether	330	4-Chlorophenylphenyl ether	330
2-Chlorophenol	330	Flourene	-
1,3-Dichlorobenzene	330	4-Nitroaniline	1600
1,4-Dichlorobenzene	330	4,6-Dinotro-2-methylphenol	1600
Benzyl alcohol	330	N-nitrosodiphenylamine	330
1,2-Dichlorobenzene	330	4-Bromophenylphenyl ether	330
2-Methylphenol	330	Hexachlorobenzene	330
bis(chloroisopropyl)ether	330	Pentachlorophenol	1600
3/4-Methylphenol	330	Phenanthrene	330
N-Nitroso-di-n-propylamine	330	Anthracene	330
Hexachloroethane	330	Di-n-Butylphthalate	330
Nitrobenzene	330	Flouranthene	330
Isophorone	330	Pyrene	330
2-Nitrophenol	330	Butylbenzylphthalate	330
2,4-Dimethylphenol	330	3,3-Dichlorobenzidine	660
bis(2-Chloroethoxy)methane	330	Benzo(a)anthracene	330
2,4-Dichlorophenol	330	Chrysene	330
1,2,4-Trichlorobenzene	330	bis(2-Ethylhexyl)phthalate	330
Naphthalene	330	Di-n-octylphthalate	330
4-Chloroaniline	330	Benzo(b)fluoranthene	330
Hexachlorobutadiene	330	Benzo(k)flouranthene	330
4-Chloro-3-methylphenol	330	Benzo(a)pyrene	330
2-Methylnaphthalene	330	Indeno(1,2,3-cd)pyrene	330
Hexachlorocyclopentadiene	330	Dibenz(a,h)anthrancene	330
2,4,6-Trichlorophenol	330	Benzo(g,h,i)perylene	330
2,4,5-Trichlorophenol	1600	Acetophenone	330
2-Chloronaphthalene	330	4-Aminobiphenyl	330
2-Nitroaniline	1600	Aniline	330
Dimethylphthalate	330	2,6-Dichlorophenol	330
Acenaphthylene	330	p-Dimethylaminoazobenzene	330
2,6-Dinitrotoluene	330	7,12-Dimethylbenz(a)anthracene	330
3-Nitroaniline	1600	a,a-Dimethylphenethylamine	330
Acenaphthene	330	Diphenylamine	330
2,4-Dinitrophenol	1600	Ethyl methanesulfonate	330
4-Nitrophenol	1600	3-Methylcholanthrene	330

TABLE 2-2 (2 pages)
Reporting Limits for Semivolatile Organics in Soil by GC/MS[1] (Method 8270)[2]

Compound	Reporting Limit (µg/kg)	Compound	Reporting Limit (µg/kg)
Dibenzofuran	330	Methyl methanesulfonate	330
2,4-Dinitrotoluene	330	1-Naphthylamine	330
2-Naphthylamine	330	1,4-Naphthoquinone	330
N-Nitroso-di-n-butylamine	330	N-Nitrosodiethylamine	330
N-Nitrosodimethylamine	330	N-Nitrosomethylethylamine	330
N-Nitrosopiperidine	330	N-Nitrosomorpholine	330
Pentachlorobenzene	330	N-Nitrosopyrrolidine	330
Pentachloronitrobenzene	1600	5-Nitro-o-toluidine	330
Phenacetin	330	Parathion	1600
2-Picoline	330	Pentachloroethane	330
Pronamide	330	Phorate	3300
1,2,4,5-Tetrachlorobenzene	330	Pyridine	660
2,3,4,6-Tetrachlorophenol	1600	Safrole	330
2-Acetylaminofluorence	3300	Sulfotepp	1600
Aramite	330	Thionazin	1600
2-sec-Butyl-4,6-dinitrophenyl	330	2-Toluidine	330
3,3'-Dimethylbenzidine	330	0,0,0-Triethylphosphorothioate	330
1,3-Dinitrobenzene	330	1,3,5-Trinitrobenzene	330
Disulfoton	1600	Dimethoate	330
Hexachloropropene	330	Famphur	330
Isosafrole	660	Hexachlorophene	330
Methapryrilene	330	4-Nitroquinoline-1-oxide	330
Methyl parathion	1600	4-Phenylenediamine	330

1. Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable. Quantitation limits listed for soil/sediment are based on wet weight.
2. SW-846, 3rd Edition, using a capillary column (Appendix IX compounds)

TABLE 2-3
Reporting Limits for Metals, Cyanide and TRPH in Soil[1]

Parameter	Method/ Technique	Reporting Limit (mg/kg)
Aluminum	6010 - ICP/AES	5.0
Antimony	6010 - ICP/AES	2.0
Arsenic	7061/Borohydride-AA	0.05 [2]
Barium	6010 - ICP/AES	1.0
Beryllium	6010 - ICP/AES	0.1
Cadmium	6010 - ICP/AES	0.5
Calcium	6010 - ICP/AES	10
Chromium	6010 - ICP/AES	0.5
Cobalt	6010 - ICP/AES	0.5
Copper	6010 - ICP/AES	0.5
Iron	6010 - ICP/AES	5.0
Lead	7421 - GFAA	0.1
Magnesium	6010 - ICP/AES	10
Manganese	6010 - ICP/AES	0.5
Mercury	7470 - CVAA	0.08
Nickel	6010 - ICP/AES	2.0
Potassium	6010 - ICP/AES	150
Selenium	7741 - Borohydride/AA	0.05
Silver	6010 - ICP/AES	0.5
Sodium	6010 - ICP/AES	40
Thallium	7841 - GFAA	0.1
Vanadium	6010 - ICP/AES	0.5
Zinc	6010 - ICP/AES	0.5
Cyanide	9012 - Colorimetric	0.5
TRPH	9071/418.1 - IR	10.0

1 Reporting limits are matrix dependant and may vary.
2 Assuming 100% Total Solids
* ICP/AES = Inductively Coupled Plasma/Atomic Emission Spectroscopy
GFAA = Graphite Furnace Atomic Absorption
CVAA = Cold Vapor Atomic Absorption
IR = Infrared Spectrometry

TABLE 2-4
QC Evaluation Criteria for Surrogates[1]

Fraction	Surrogate Compound	Percent Recovery
Volatiles[2]	1,2-Dichloroethane-d4	70-121
	Toluene-d8	84-138
	4-Bromofluorobenzene	59-113
	Dibromofluoroethane	80-120
Semivolatiles[1]	2-Fluorobiphenyl	30-115
	Phenol-d5	24-113
	2,4,6-Tribromophenol	19-122
	Nitrobenzene-d5	23-120
	p-Terphenyl	18-137
	2-Fluorophenol	25-121
Total Petroleum Hydrocarbons	Not Required	NA
Metals	Not Required	NA
Cyanide	Not Required	NA

NOTES:
1. From ARDL Standard Operating Procedures.
2. Based on interlaboratory study/Contract Laboratory Program protocol.

TABLE 2-5
QC Evaluation Criteria for Accuracy and Precision, Matrix Spikes and Matrix Spike Duplicates

Fraction/Parameter	Soil	
	Percent Recovery	Relative Percent Difference
Purgeable Volatiles[1]		
Benzene	66-142	21
Chlorobenzene	60-133	21
1,1-Dichloroethene	59-172	22
Toluene	59-139	21
Trichloroethene	62-137	24
Semivolatiles[1,2]		
1,4-Dichlorobenzene	28-104	27
Pyrene	52-115	25
1,2,4-Trichlorobenzene	44-142	23
2-Chlorophenol	25-102	29
Phenol	26-112	23
N-Nitroso-di-n-propylamine	41-126	38
4-chloro-3-methylphenol	26-103	33
Acenaphthene	47-137	19
4-nitrophenol	11-114	47
2,4-Dinitrotoluene	39-139	22
Pentachlorophenol	17-109	47
Metals [3]	75-125	20
Total Petroleum Hydrocarbons [2]	80-120	20
Cyanide [2]	75-125	20

1. Limits based on laboratory control samples and 25 mL purge.
2. Limits based on EPA CLP SOW criteria.
3. Limits based on laboratory established performance by ARDL.

TABLE 2-6
QC Evaluation Criteria for Laboratory Control Samples

Fraction/Parameter	Soil	
	Percent Recovery	Relative Percent Difference
Purgeable Volatiles	Not Applicable[1]	Not Applicable[1]
Semivolatiles	Not Applicable[1]	Not Applicable[1]
Metals	75-125	20
Total Petroleum Hydrocarbons	80-120	20
Cyanide	75-125	20

[1] LCSs are not required for these parameters according to methods specified in SW-846. LCS requirements discussed in National Functional Guidelines for Organics (USEPA, 1991 and 1994a) are not applicable to soil matrices.

FIGURE 2-1

NONCONFORMANCE AND CORRECTIVE ACTION REPORT (NCR)

DATE: _____

HARZA NCR NO: _____

SUBMITTAL

TO: Project Manager
QA/QC Officer

Description of Nonconformance and Cause: _____

_____

Proposed Corrective Action _____

_____

Submitted by _____ Location _____

Approved by _____ Date _____

CORRECTIVE ACTION (by Project Manager or Designee)

Implementation of Action Assigned to: _____

Actual Corrective Action: _____

_____

_____

Implementation verbally approved by QA Officer on _____

(Date)

Action implemented on _____

(Date)

_____

(Signature)

VERIFICATION (By QA/QC Officer or Designee)

Corrective Action implementation reviewed and work inspected by _____

on _____

Corrective Action verified by _____ on _____

(Use additional sheet or memo if needed)

3.0
PROJECT ORGANIZATION AND RESPONSIBILITIES

3.1 RESPONSIBILITIES OF KEY PERSONNEL

The organizational structure, defined below and in Figure 3-1, is designed to assure adequate project control and proper quality assurance for site investigative activities at Cannon AFB. Ultimate responsibility for the conduct of this RFI program at Cannon AFB rests with the installation commander (27 FW/CC). Daily management of RFI activities is vested in the 27 CSG/CEVR Branch of Civil Engineering. The U.S. Army Corps of Engineers (Omaha District) has been contracted to perform the RFI with Technical Management by Mr. Doug Mellema. The specific investigations described in this Workplan will be performed under contract with Harza.

The following key Harza project personnel are described below:

• Program Manager	J. R. Ghia, P.E.
• Project Manager	R. P. Kewer, P.G.
• QA/QC Officer	K. V. Mayenkar, P.E.
• Senior Technical Reviewers	F. M. Mazhar, P.E.
	J. Meldrim, Ph.D.
• Health and Safety Manager	A. Fujii, Ph.D., CIH
• Task Managers	R. W. Suda (Field Investigations)
	S. Kumar, Ph.D. (Chemistry)
	S. Hempel (Data Management)
	D. Pott (Ecological Assessment)
• Project Field Staff	J. J. Pyrich, P.G.
	K. E. Garrett, Ph.D.
	R. A. Grippa

Resumes of personnel planned to be involved in the project are provided in Appendix D.

3.1.1 Program Manager

The Program Manager has overall responsibility to the USACE, Omaha District, for activities on the project and monitoring the Project Manager's activities. The Program Manager has overall responsibility for monitoring the quality of the technical and managerial aspects of the project and, where necessary, corrective measures. Mr. Jitendra Ghia of Harza is Program Manager for the Omaha Contract.

3.1.2 Project Manager

Mr. Robert Kewer of Harza will serve as the Project Manager for this project. The Project Manager has primary responsibility for the completion of all required activities. He is responsible to the Program Manager and USACE for the day-to-day control of planning, scheduling, cost control, and implementation of the project, and for the development of technical reports and other project documents. The Project Manager monitors all project personnel in planning, coordinating, and controlling all technical aspects of the tasks.

3.1.3 QA/QC Officer

Harza's QA/QC Officer will be responsible for seeing that QA procedures and QC checks are conducted and documented in accordance with this Workplan. Working with the Project Manager, he will designate qualified personnel to perform the required procedures. For this project, Mr. Krishna V. Mayenkar will serve as QA/QC Officer. Mr. Mayenkar is Head of Harza's Industrial and Government Services Department and has 26 years of experience in chemical engineering, process design, hazardous waste remediation and site investigations.

3.1.4 Senior Technical Reviewers

Senior Technical Reviewers serve in a lead QA role, being responsible for review of deliverables and consultation regarding technical aspects of the work. Senior Technical Reviewers are selected from Harza staff based upon the needs of the project and report to the Project Manager. For Cannon AFB, Senior Technical Reviewers are: Mr. Krishna V. Mayenkar (Chemical Engineering and Hazardous Waste Remediation-see above); Dr. John Meldrim (Environmental

Science); and Mr. Farrukh M. Mazhar (Solid Waste Management). Other individuals would be identified if required by the needs of the project.

3.1.5 Health and Safety Manager

Dr. Atsushi Fujii will serve as the Health and Safety Manager (HSM), reporting to the Program Manager and working directly with the Site Manager and other project personnel. The HSM has the responsibility to monitor and verify that the work is performed in accordance with the site-specific HSP. The HSM will advise the Project manager regarding health and safety issues but will function independently of the Project Manager. The HSM will also designate and oversee the activities of the Site Health and Safety Officer.

3.1.6 Task Managers

The Task Managers are responsible to the Project Manager for planning, scheduling, cost control, and completion of the activities covered in this plan. The Task Managers also are responsible for implementing the QA/QC program related to assigned tasks at Cannon AFB. Task Leaders for the following RFI tasks are:

Robert Suda	-	Field Investigations
Surendra Kumar	-	Chemistry/Data Validation/Toxicology
Steven Hempel	-	Data Management
David Pott	-	Ecological Assessment

The Task Manager for Field Investigations also will serve as Site Safety and Health Officer (SSHO) as described in the Site Safety and Health Plan. The SSHO monitors all site activities and is responsible for the implementation of and compliance with the Project Health and Safety Plan. The SHSO reports directly to the Project Health and Safety Officer.

3.1.7 Project Field Staff

Field staff during soil gas sampling and soil boring tasks will be led by the Task Manager for Field Investigations. Additional project staff will be assigned as needed for each task. Each member of the project staff is responsible to the Task Leader and/or Project Manager for completion of assigned project activities. Members of the project staff are responsible for understanding and implementing the QA/QC program as it applies to their project activities. Field staff anticipated to be assigned to the project include: Janusz Pyrich, Kevin Garrett, and Robert Grippa

3.2 QUALIFICATIONS OF PERSONNEL

All personnel assigned to the project, including consultants, will be qualified to perform the tasks to which they are assigned. Appraisal of the qualifications of technical personnel assigned to the project will be made by the Project Manager. The appraisal will include the comparison of the requirements of the job assignment with the relevant experience and training of the prospective assignee; it will also include a determination whether further training is required and, if required, by what method. On-the-job training is an acceptable method, provided such training is provided by a person qualified to perform the trainee's assignment and the results of that training are documented. All documents concerning qualification appraisal will be stored in the project administrative files.

3.3 LABORATORY AND SUBCONTRACTOR ASSIGNMENT

The commercial laboratory for this investigation will be Applied Research and Development Laboratory (ARDL) or Mt. Vernon, Illinois. ARDL has been validated by the U.S. Army Corps of Engineers, Missouri River Division Laboratory. A description of the laboratory, its qualifications and organization and a list of laboratory personnel are provided in Appendix B. Soil gas samples also will be analyzed by W. L. Gore and Associates (Gore). Information pertaining to Gore and the QA procedures they will follow are provided in Appendix C. Other subcontractors to be used on this project are as follows:

Alliance Environmental	-	Rotasonic drilling & sampling
Rinchem	-	Hazardous waste disposal
HLA, Inc.	-	Field support

3.4 PROJECT FILES

A project file containing complete project documentation of all aspects of the activities associated with Cannon AFB site investigations will be maintained by the Project Manager. An outline of project file requirements follows:

- Communications
  - Internal
  - External
- Quality assurance/quality control
  - Procedures
  - Chain-of-custody
  - Audit reports
  - Laboratory quality control reports
  - Deviation notification forms
  - Nonconformance/corrective action reports
- Technical information
  - Analytical data
  - Field data
  - Field logbooks
  - Graphic resources
  - Calculations/evaluations
  - Regulatory compliance
- Management
  - Schedule
  - Budget
- Health and Safety
  - Plans/procedures
  - Records

- Documents
  - Plans
  - Reports
  - Relevant publications (e.g., USGS, USEPA, etc.)

Project documentation will be checked for completeness before being included in the file. Upon termination of the project, all records will be archived for at least 10 years from completion of work. The Project Manager will be responsible for ensuring that the quality assurance/quality control records are properly stored and retrievable.

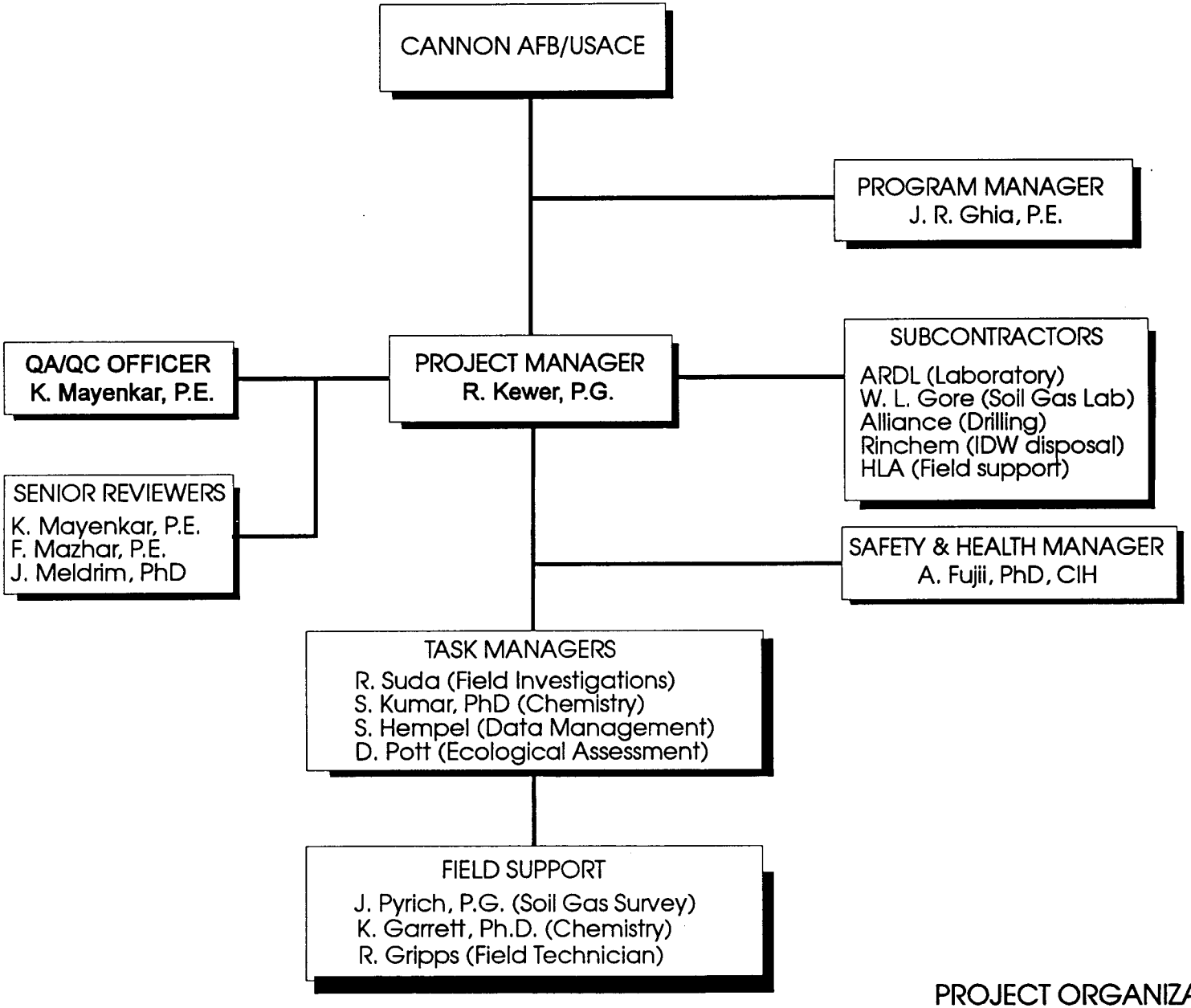

Figure 3-1
PROJECT ORGANIZATION CHART
Cannon Air Force Base
Clovis, New Mexico

HARZA ENVIRONMENTAL SERVICES, INC.

4.1 FIELD EQUIPMENT, CONTAINERS, AND SUPPLIES

Lists of field equipment, sample screening equipment, and supplies for sampling soil gas, screening surface and subsurface soil samples, and surface/subsurface soil sampling are included in the Standard Operating Procedures in Appendix A of this Workplan. Recommended containers for soil samples to be collected are listed in Table 4-1.

4.2 SAMPLING OBJECTIVES, FREQUENCY, AND LOCATIONS

The RFI field investigation for Fire Training Area No. 4 (SWMUs 109, 110, 111 and 112) will include two primary investigation activities:

- A passive soil gas survey to investigate areas of potential contamination by volatile and semi-volatile organic chemicals.

- A subsurface drilling and sampling program to investigate the presence or absence of possible contamination from the Fire Training Area into native soils underlying the site. This work will assess the level of contamination, if present, in the soils if their presence is confirmed.

4.2.1 Passive Soil Gas Survey

Harza will perform a passive soil gas survey in the area of SWMU Nos. 109, 110, 111 and 112 to determine the lateral extent of contamination. Forty (40) points will be sampled for identification of selected volatile and semivolatile organic chemicals. Results of the soil gas sampling will be reported in a preliminary report, which will include recommended boring locations. Results will be used to finalize locations of soil borings jointly with USACE, Cannon AFB, USEPA, and NMED, as appropriate. The final report of results will be included in the RFI Report. Specific activities are as follows:

A) **Location of Sampling Points.** Harza will establish a sampling grid on 50 foot spacings across the Fire Training Area using tape and compass methods and available site landmarks. The grid will be used to identify sample and data collection points for the soil gas survey. The grid and planned soil gas sampling points are shown on Figure 4-1. The grid will be established in the field in accordance with procedures in SOP No. 3 in Appendix A.

B) **Soil Gas Sampling.** Soil gas sampling will utilize the Gore-Sorber system in accordance with methods established by Gore. This system is designed to absorb a variety of volatile and semi-volatile organic contaminants. Gore-Sorber soil gas collection devices, free of contamination, will be provided to Harza by Gore prior to mobilization. Harza's field sampling team will install the collection devices at depths of approximately 3 feet at the required locations Hand augers and/or powered augers will be used for this purpose depending on site conditions. The devices will be field staked for identification purposes and left in place for 2 weeks. Harza's field sampling team then will remobilize and remove the devices, which will be shipped to the laboratory for analysis. Sampler installation and removal will be conducted in accordance with SOP No. 1 in Appendix A.

C. **Sample Analysis.** Soil gas samples will be analyzed by Gore for listed volatile and semi-volatile organic constituents (Table 4-3). Laboratory analytical and QC procedures to be used by Gore are provided in Appendix C.

D. **Reporting.** Results of the Passive Soil Gas Sampling program will be presented in a written report which will include, at a minimum, the following:

- field observations and discrepancies
- problems and corrective actions
- data interpretation
- isopleth maps and other appropriate graphics
- back-up information (i.e. raw laboratory data and field methods and procedures)
- documentation of field instrumentation and sample handling
- proposed soil boring locations

The report will be submitted in draft form and will be used as a basis for finalizing soil boring locations with USACE, Cannon AFB, USEPA and NMED. The final soil gas report, incorporating comments, will be included in the RFI Report, which also will include a data quality analysis comparing the soil gas sampling results with the results of laboratory analysis of soil samples and identify resultant data gaps, if any.

4.2.2 Soil Sampling

4.2.2.1 Sampling Objectives and Rationale

The soil gas survey results will be interpreted and used to identify suitable boring and soil sampling locations. Borings and sample locations will target identified soil gas anomalies and other areas of potential concern based upon historical usage of the four SWMUs. The objective of this drilling and sampling is to evaluate the presence of hazardous contaminants in the subsurface soils, help determine the vertical and lateral extent of possible downward migration of any contamination, and provide data to assist in determining the need for future corrective action. Data generated will be of a sufficient quality to support HEA activities undertaken for Fire Training Area No. 4.

Soil borings will be drilled with a truck-mounted drilling rig using Rotasonic equipment and methods. This method provides a continuous core sample of the soil which will be placed in plastic sleeves. The continuous soil samples will be screened using headspace and immunoassay screening methods. Screening results will be used to identify specific sampling intervals for laboratory chemical analysis.

All drilling and sampling operations will be performed in accordance with all applicable SOPs, including but not limited to:

- SOP No. 2, Headspace Screening of Soil Samples
- SOP No. 3, Identification and Description of Field Sampling Sites
- SOP No. 4, Equipment Decontamination
- SOP No. 5, Surface Soil Sampling
- SOP No. 6, Subsurface Drilling and Sampling

- SOP No. 7, Lithologic Description of Subsurface Samples
- SOP No. 9, Sample Handling, Documentation, and Analysis
- SOP No. 10, Data Validation and QC Review of Analytical Data Packages
- SOP No. 12, Immunoassay Screening of Soil Samples

4.2.2.2 Sample Locations and Frequencies

Soil boring and sampling locations and depths will be determined jointly with USACE based upon soil gas results and historical site data. Locations will be recommended by Harza in the Soil Gas Results Report, and finalized jointly with USACE, Cannon AFB, USEPA and NMED. Approximately 1,200 linear feet of drilling is planned. Each boring will be completed to the depth at which two consecutive non-detect results are obtained in the immuno-assay screenings. The number of borings will be dependent upon the depth at which this occurs. For planning purposes, it has been assumed that 12 borings will be completed to a depth of 100 feet, each. Horizontally, the extent of contamination will be based on comparison of soil sample analytical results to SALs stipulated in the U. S. EPA Region 6 "Media Specific Action Levels".

Soil borings will be continuously sampled and logged to their full depth, using the Rotasonic method. Samples obtained using this method will be extruded into plastic sleeves. Preliminary ("informal") headspace screening then will be performed at 1-foot intervals along the sample by inserting the PID probe through the plastic sleeve and recording readings on the boring log (column d), along with results of breathing zone screening. The 1-foot interval with the highest reading in each 10-foot interval will be selected for formal headspace screening and chemical analysis. Results of formal headspace screening will be recorded on the boring log (column h). All headspace screening will be conducted in accordance with SOP No. 2 in Appendix A.

An immuno-assay analysis for Total Petroleum Hydrocarbons (TPH) will be conducted on each sample interval selected for chemical analysis (total of 120). Procedures to be used in Immunoassay screening are provided in SOP No. 12. The immunoassay kit to be used is 70430 and uses Method 4030 approved by USEPA. The test has a minimum detection of 10 ppm for gasoline and 15 ppm for JP-4. Immunoassay screening results will be used to confirm that the planned bottom depth of each boring is not contaminated. The bottom depth of each soil boring will be defined as the depth at which two consecutive non-detect results for immunoassay

screening have been achieved. Immunoassay results will be recorded in the field notebook and on the boring log (column h).

A total of 139 chemical samples will be collected and submitted to the laboratory for chemical analysis. These will include:

- 12 surface samples (one at each boring location from the 0-2 foot depth interval beneath any pavement);
- 120 subsurface samples (one every 10-foot vertical interval); and
- 14 QC samples (including 7 submitted to MRDL).

The samples will be analyzed and reported for the Chemicals of Interest, discussed in Section 1.4.2 and shown in Tables 2-1 through 2-3.

A total of 14 QA/QC sample sets will be submitted for analysis, including 7 duplicate samples for analysis by USACE Missouri River Division Laboratory (MRDL). The type and frequency of field QA/QC samples is specified in Section 6.0. MRDL will be notified in advance if samples are to be delivered on a Saturday to insure that personnel will be available to receive the samples.

In addition to samples submitted for chemical analysis, a total of twelve (12) geotechnical samples will be submitted for grain size and moisture content analysis. Samples will be taken from the most highly contaminated interval of each boring and analyzed by ASTM procedures. During the drilling, a representative sample from each ten foot interval in the borings will be collected in appropriate containers and stored on-site until the drilling program is complete. At that time, based on the results of immuno-assay screening and headspace screening, the twelve samples to be tested will be selected to be representative of contaminated soil zones. A minimum of one sample will be selected for each of the various soil types encountered in the soil borings. These samples will be used to classify the various soils found underlying Fire Training Area No. 4 and to assist in site characterization and evaluation of potential corrective actions, if any.

4.2.2.3 Sampling and Preservation Procedures

Procedures for and equipment to be used in soil sampling at Cannon AFB are detailed in SOP No. 5 and other referenced SOPs. Table 4-1 summarizes required sample containers, preservation methods and holding times for samples. Observations made during sample collection in the soil borings will be recorded primarily on the soil boring log and, as required, in the field notebook and field data sheet as specified in Section 4.5.

4.2.2.4 Equipment Decontamination

Equipment decontamination procedures are provided in SOP No. 4, Equipment Decontamination. Sampling equipment shall be decontaminated prior to beginning sampling and between each sample. Fluids used for decontamination will be placed in drums and transported to the storage area at Landfill No. 5.

4.2.2.5 Instrument Calibration

Electronic equipment used during the drilling program will include air monitoring instruments such as the PID and CGI. All instruments will be calibrated in accordance with the Site Safety and Health Plan (SSHP) and the manufacturer's instructions provided therein. The sampler shall verify that all instruments are working properly and are properly calibrated before mobilizing to the field and prior to use every day. Pre- and post-use calibration times and readings, as appropriate, will be recorded in a notebook to be kept by the field sampler.

4.3 FIELD DOCUMENTATION

Thorough documentation in the field is required to ensure proper labeling and tracking of samples, to identify potential sources of error, and to maintain accountability of field personnel. Additional field documentation may be required for specific field activities as detailed in the appropriate SOPs.

4.3.1 Written Documentation

Requirements for written documentation of field activities includes the following primary elements:

- Soil Boring Log
- Field Logbook.
- A-E Daily Quality Control Report (DQCR)
- Sample Collection Field Sheet (SCFS)

Soil Boring Logs. The Soil Boring Log is the primary vehicle for documentation of data and observations obtained during drilling and sampling in soil borings, including results of headspace screening. Soil Boring Logs will be prepared in accordance with USACE requirements on pre-printed forms, as specified in SOP #7.

Field Logbook. The Field Logbook will be used to document observations and data acquired in the field, will provide information on the acquisition of samples, and will be a permanent record of field activities. The Field Logbook will be maintained and signed by field sampling personnel as described in SOP #9. Other field activities may have additional logbook requirements as described in the respective SOPs. Field personnel should be familiar with these requirements before start of field work.

A-E Daily Quality Control Report. The DQCR will be completed by the Site Manager in accordance with SOP #9, to supplement the field logbook. DQCRs will document daily field activities and note any nonconformances and corrective actions taken at every sampling location. An example of the DQCR is provided in SOP #9. Copies of the DQCR will be forwarded to Harza's Project Manager for review and submitted to the USACE Technical Manager on a weekly basis. A copy will be hand delivered to the Cannon AFB CEV Office on the morning after each reported work day. If problem situations occur, the DQCR will be faxed to the USACE Technical Manager on a daily basis, until the problems are corrected.

Sample Collection Field Sheet. The SCFS will be completed for each sample collected in the field investigation, as described in SOP #9.

4.3.2 Sample Designation

The sample numbering system to be used is detailed in SOP #9. The sample designation system for all field (analytical and geotechnical) and QA/QC samples is a unique identification for each sample. All sample location numbers correspond to the specific soil boring or surface soil location. The soil sample identifier will represent the approximate beginning depth at which the sample was collected. All QA/QC samples will be identified as to the location where they were collected and assigned a unique identification number.

4.4 FIELD PREVENTATIVE MAINTENANCE

To ensure that analytical data generated for the Cannon AFB site investigations are of sufficient quality to meet quality assurance objectives, all equipment and instruments will have a prescribed routine maintenance which will be performed and documented by qualified project personnel.

All field instrumentation, sampling equipment, and accessories will be maintained in accordance with the manufacturer's recommendations and specifications and established field practice. All maintenance will be performed by qualified project personnel and will be documented by the appointed equipment manager or designee under the direction of the equipment manager.

The Task Leader (Field Investigations), and Site Health and Safety Officer, if different, will review calibration and maintenance records on a regular basis to ensure that required maintenance is occurring. These activities will be recorded in the field logbook to document that established calibration and maintenance procedures have been followed. Field instruments will be checked and calibrated prior to their use on site, and batteries will be charged and checked daily where applicable. Non-operational field equipment will be removed from service and a replacement will be obtained. Field equipment will not be repaired in the field.

All field instruments will be properly protected against inclement weather conditions during the field investigation. Each instrument is specially designed to maintain its operating integrity during variable temperature ranges that are representative of ranges that will be encountered during cold-weather working conditions. At the end of each working day, all field equipment will be taken out of the field and placed in a cool, dry room for overnight storage.

4.5 FIELD INTERNAL QUALITY CONTROL CHECKS

Field quality control checks will include the review and approval of all field documentation by the Task Leader for field investigations or his/her designee. Signature or initial approval will indicate that the provisions outlined in the Workplan and SSHP have been appropriately implemented. Nonconformances will be corrected and immediately reported to the Project Manager and the USACE-TM orally, followed by a written memo for inclusion into the project file. In the event that a serious deficiency (nonconformance) is identified, the sampling team's prior work will also be reviewed.

The specific field QC samples to be collected for each sampling site are listed in Table 4-2.

Homogenized field duplicates will be submitted for analysis by all methods except volatile organics analysis. Non-homogenized collocated samples will be collected for volatile organics analysis. Field duplicate samples will be collected at a minimum frequency of 1 per 20 environmental samples. Seven sets of duplicate samples will be collected in this category.

For duplicate samples submitted to the USACE QA laboratory, homogenized duplicates will be prepared for soil samples to be analyzed for all methods except volatile organics analysis. Non-homogenized collocated samples will be collected for the volatile organics analysis. Seven sets of duplicate samples will be collected in this category.

Matrix spike/matrix duplicate (MS/MSD) (analysis for organics) and matrix spike/duplicate (MS/D) analytes (for inorganics) provide a measurement of long-term precision and accuracy of the analytical method on various matrices and demonstrate acceptable compound recovery by the laboratory on the site-specific matrix. For many analyses, extra sample volume must be collected in the field for the MS/MSD or MS/D analyses. MS/MSD and MS/D analyses will be analyzed at an overall frequency of 1 set per 20 or 5 percent of environmental samples for a total of 7 MS/MSD samples.

4.6 FIELD DATA REDUCTION

The field and technical (non-laboratory) data that will be collected at Cannon AFB can generally be characterized as either objective or subjective data. Objective data include all direct measurements such as field screening/analytical parameters and water level measurements. Subjective data include certain descriptions and observations.

4.6.1 Field and Technical Data Reduction

As appropriate, field data will be recorded by field personnel on standard USACE Soil Boring Log forms, in bound field logbooks and on other required standard forms described previously, including the DQCR and SCFS forms. The Soil Boring Log will be used to record descriptions of all soil materials encountered in soil borings and other pertinent information obtained during drilling such as staining, odors, field screening results, working conditions, water levels, geotechnical data, and sample data. Completed standard forms will be submitted to the Task Leader who will maintain field log files. At the completion of a work shift, copies of all Soil Boring Logs, notebook pages, and standard forms will be returned to the contractor's field office.

Upon completion of the field work, the validity of data in the field notes and on standard forms will be checked and designated project staff will reduce the data to tabular form, wherever possible, by entering the data in data files. Subjective data will be filed as hard copies for later review and for incorporation into technical reports, as appropriate.

4.6.2 Field and Technical Data Validation

Validation of objective field and technical data will be performed at two levels. On the first level, data will be validated at the time of collection by following standard procedures and quality control checks. At the second level, data will be validated by the Project Manager and/or designee, who will review the data to ensure that the correct information has been included. After data reduction into tables or arrays, the data sets will be reviewed for anomalous values. Any inconsistencies or anomalies will be resolved immediately, if possible, by seeking clarification from the field personnel responsible for collecting the data.

4.7 FIELD CORRECTIVE ACTION

The Task Leader for field investigations will review the procedures being implemented in the field for consistency with the established protocols. Sample collection, preservation, and labeling, etc., will be checked for completeness. Where procedures are not strictly in compliance with the established protocol, the deviation will be field documented and reported on the DQCRs. Any nonconformances with the established QC procedures will be expeditiously identified and controlled and immediately reported orally to the project manager and USACE-TM. No additional work which is dependent on the nonconforming activity will be performed until the identified nonconformance is corrected. Corrective actions will be defined by the Field Task Leader, Project Manager, and QA/QC Officer and documented as appropriate. Upon implementation of corrective action, the Field Task Leader will provide the Project Manager with a written memo documenting field implementation. The memo will become part of the project file.

The QA/QC Officer or designee will review the field and laboratory data generated for this project to ensure that all project QA objectives are met. If any nonconformances are found in the field procedures, sample collection procedures, or field documentation procedures, the impact of those nonconformances on the overall project QA objectives will be assessed. Appropriate actions, including resampling, reanalysis, etc., may be recommended so that the project objectives can be accomplished.

TABLE 4-1
Analytical Methods, Sample Containers, Preservation, and Holding Times

SW-846 Method	Parameter	Number of Containers/Sample	Minimum Sample Size	Preservation	Holding Time
8260[1]	Volatiles	2 - 4oz glass VOA jars with Teflon-lined lid	10g	4°C	14 days
8270	Semivolatiles	1 - 4oz wide-mouth glass jar with Teflon-lined lid	30g	4°C	Extract - 14 days Analyze - 40 days
9071/418.1	TRPH	1 - 16oz wide-mouth glass jar with Teflon-lined lid	30g	4°C	28 days
6010/ 7000 Series[3]	Metals		200g	4°C	120 days
9010	Cyanide		200g	4°C	28 days
4030	TPH Screening (immunoassay)	1 - 8oz wide-mouth glass jar with Teflon-lined lid	30g	4°C	14 days

[1] Method 8260 using capillary column.
[3] Includes Methods 7061 (arsenic), 7421 (lead), 7470 (mercury), 7741 (selenium) and 7841 (thallium)

TABLE 4-2
Summary of Analytical, Geotechnical and QA/QC Sampling

Matrix/ Parameter	No. Field Samples	No. A-E QC Samples				No. MRDL QA Samples			
		Dups/ Splits	Sampler rinsates	Trip Blanks	Total	Dups/ Splits	Sampler Rinsates	Trip Blanks	Total
SOIL									
Volatiles	132	7	0	0	139	7	0	0	7
Semi-Volatiles	132	7	0	0	139	7	0	0	7
TAL Metals/Cyanide	132	7	0	0	139	7	0	0	7
TRPH	132	7	0	0	139	7	0	0	7
TPH Innumoassay Screening [1]	40	4	0	0	44	0	0	0	0
Geotechnical [2]	12	0	0	0	12	0	0	0	0

1. Field screening procedure.
2. Geotechnical tests include sieve analysis and moisture content.

TABLE 4-3
GORE-SORBER® SCREENING SURVEY STANDARD COMPOUNDS

1. Methyl t-butyl ether
2. trans-1,2-Dichloroethene
3. 1,1-Dichloroethane
4. cis-1,2-Dichloroethene
5. Chloroform
6. 1,1,1-Trichloroethane
7. Benzene
8. Carbon tetrachloride
9. 1,2-Dichloroethane
10. Trichloroethylene
11. Toluene
12. Octane
13. Tetrachloroethene
14. Chlorobenzene
15. Ethylbenzene
16. m-Xylene
17. o-Xylene
18. 1,3,5-Trimethylbenzene
19. Phenol
20. 1,2,4-Trimethylbenzene
21. 1,4-Dichlorobenzene
22. 2-Methyl phenol
23. Undecane
24. Naphthalene
25. Tridecane
26. 2-Methyl naphthalene
27 Pendadecane

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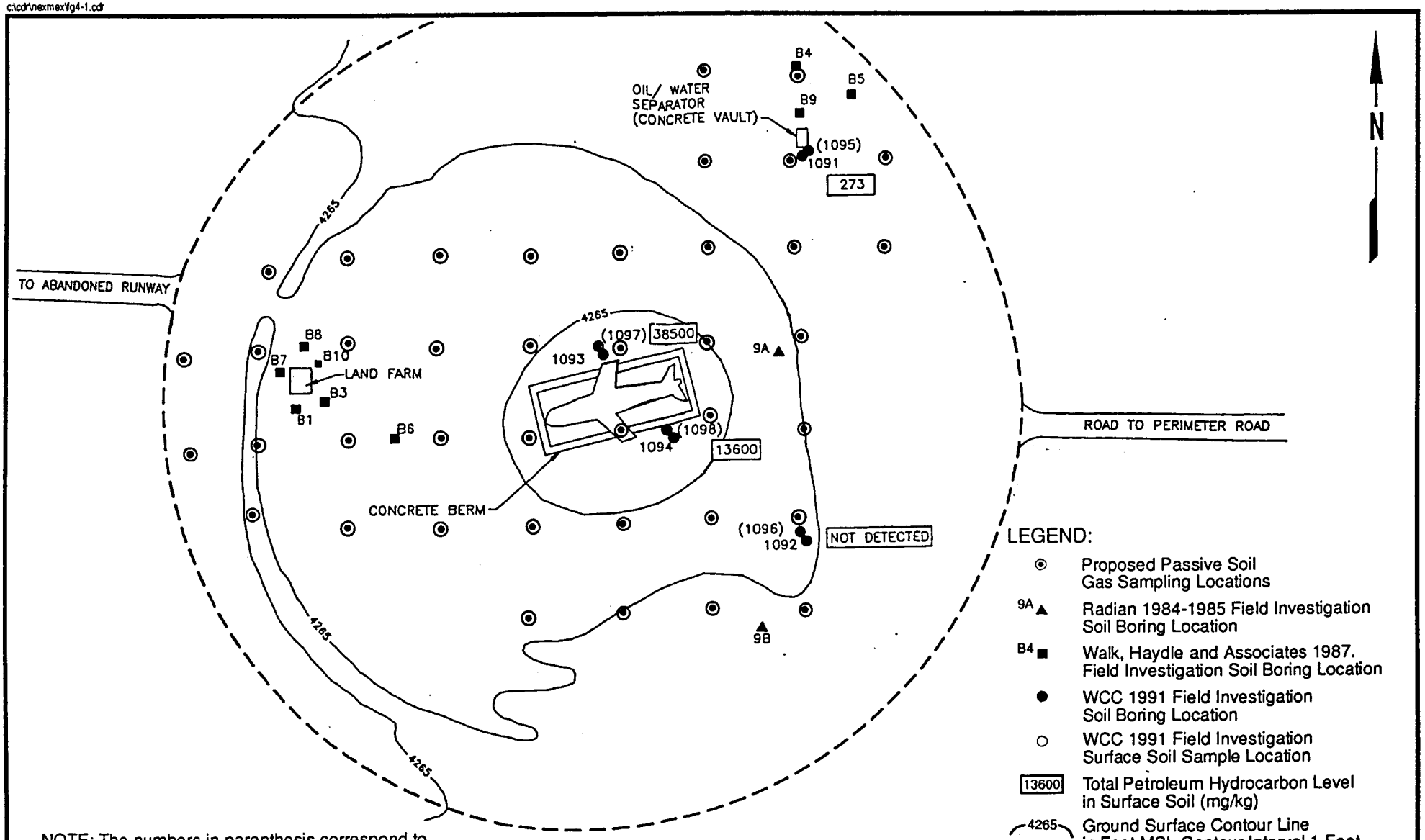

NOTE: The numbers in parenthesis correspond to redrills/resamples of the original boring/sample.

Scale 0 25 50 Feet

HARZA *Consulting Engineers and Scientists*

Figure 4-1

SAMPLING GRID FOR PASSIVE SOIL GAS SURVEY

CANNON AIR FORCE BASE
Clovis, New Mexico

5.0
SAMPLE CHAIN OF CUSTODY, PACKING, AND TRANSPORTATION

5.1 CHAIN-OF-CUSTODY PROTOCOL

5.1.1 Field Protocol

The field team members are responsible for the care and custody of collected samples until they are transferred to another party, dispatched to the laboratory, or disposed. The field team, under the direction of the Field Task Leader, is responsible for enforcing COC procedures during fieldwork.

Each cooler containing samples sent to the analytical laboratory will be accompanied by a chain-of-custody (COC) form, in accordance with SOP No. 9, Sample Handling, Documentation and Analysis. An example COC form is attached to SOP #9. The primary purpose of the COC procedures is to document the possession of the samples from collection through storage and analysis to reporting. COC forms will become the permanent records of all sample handling and shipment. The Field Task Leader or designee will be responsible to the Project Manager for monitoring compliance with COC procedures as delineated in SOP #9.

When transferring custody of the samples, the individual relinquishing custody of the samples will verify sample numbers and condition and will document the sample acquisition and transfer by signing and dating the COC. This process documents sample custody transfer from the sampler, usually through an express courier, to the analyst in the contracted analytical laboratory. A copy of each chain-of-custody form is retained by the sampling team for the project file and the original is sent with the samples. Bills of lading will also be retained as part of the documentation for the chain-of-custody records.

5.1.2 Laboratory Protocol

Upon receipt at the laboratory, the designated laboratory sample custodian shall sign the chain-of-custody form indicating receipt of the incoming field samples. The samples shall be checked

against the chain-of-custody form upon arrival at the laboratory. The receiving personnel will properly document the receipt of all arriving samples and note any problems or discrepancies between the sample and chain-of-custody forms and sample container and seal conditions and report them immediately to the field sampling coordinator. The samples shall be assigned a unique lab number for analysis or treatment which will be cross-referenced to the original field sample number, recorded in the laboratory notebook, and reported in the laboratory report. In conjunction with data reporting, a copy of the chain-of-custody form shall be returned to the Project Manager for inclusion in the central project file. The original shall be retained by the sample custodian.

5.2 SAMPLE LABELING

A sample numbering system will provide a tracking mechanism to allow retrieval of the sample and sample information and identification of the sampling locations. A unique sample number will be assigned to each sample. Procedures for this system are provided in Section 5.4.2 and in SOP No. 9.

5.3 SAMPLE HANDLING, PACKAGING, AND SHIPPING

Samples collected and shipped for analysis as part of the investigation at Cannon AFB will be shipped according to appropriate DOT or IATA regulations for environmental samples. SOP #9 provides information regarding the use of appropriate packaging materials, shipping containers, and shipping labels. SOP # 9 will be the guideline for shipment of samples collected during the investigation at Cannon AFB. If Saturday sample delivery to MRDL is required, advance notice will be provided to insure that personnel will be available to accept delivery.

HARZA ENVIRONMENTAL SERVICES, INC. *Consulting Engineers*

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CHAIN OF CUSTODY RECORD

SITE:						PARAMETERS	COOLER No.
SAMPLER: (Signature)					PROJECT No.	No. OF CONTAINERS	
FIELD SAMPLE NUMBER	DATE	TIME	COMP.	GRAB	STATION LOCATION		REMARKS

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)

Relinquished by: (Signature)	Date	Time	Received for Laboratory by: (Signature)	Date	Time	Remarks:

Figure 5-1

6.0
LABORATORY ANALYTICAL PROCEDURES

6.1 GEOTECHNICAL AND MATERIAL PROPERTY TESTING

Twelve soil samples will be submitted to a testing laboratory for selected geotechnical tests including particle size analysis (ASTM D421 and D422) and moisture content (ASTM D2216). Geotechnical tests will be performed in a geotechnical laboratory setting in accordance with appropriate ASTM test methods. The laboratory used for this work will be capable of handling contaminated samples safely.

6.2 ANALYTICAL LABORATORY PROCEDURES

The analytical laboratory procedures to be used for site investigations at Cannon AFB are specified in Table 4-1.

6.2.1 Volatile Organics

Volatile organics (VOCs) will be analyzed using SW-846 Method 8260, as listed in Table 4-1. VOCs include compounds among varying classes such as halogenated organics, nonhalogenated organics, and aromatic organics. The first two classes generally contain contaminants associated with solvents, such as TCE, MEK, acetone, etc. The third class includes compounds associated with fuels, such as benzene, toluene, ethylbenzene, and xylene (BTEX). Method 8260 employs mass spectrometry (MS) for detection. This method is indicated where the volatile contaminants are not well defined. The power of GC/MS lies in the capacity for positive identification at relatively low detection limits. Reporting limits for Method 8260 are listed in Table 2-1. QC Evaluation criteria for surrogate spike recoveries are specified in Table 2-4 and for matrix spike/matrix spike duplicates in Table 2-5.

6.2.2 Semivolatile Organics

Semi-volatile organics (SVOCs) will be analyzed using SW-846 Method 8270, as listed in Table 4-1. Method 8270 is a GC/MS method for determining extractable base/neutral and acid compounds in sample extracts. These procedures include the general classes of compounds, such as phenols, nitrosamines, polynuclear aromatic hydrocarbons (PAHs), phthalate esters, nitrotoluenes, etc.. Reporting limits for Method 8270 analyses are stated in Table 2-2. QC Evaluation criteria for surrogate spike recoveries are specified in Table 2-4 and for matrix spike/matrix spike duplicates in Table 2-5.

6.2.3 Cyanide

Total cyanide will be analyzed by USEPA Method 9012. This method employs a reflux-distillation operation, followed by colorimetric determination using a manual spectrophotometric unit. Reporting limits for Method 9012 analyses are stated in Table 2-3. QC Evaluation criteria for matrix spike/matrix spike duplicates are specified in Table 2-5 and for laboratory control samples in Table 2-6.

6.2.4 Metals

The methodology for metals analyses is provided in Table 2-3. Various factors influence the use of particular methods, including detection limits, interferences, and stability. Most metals, with a few exceptions, are detected at levels appropriate for Cannon AFB Task Objectives by inductively coupled plasma (ICP) emission spectroscopy. Atomic absorption (AA) methods, direct aspiration, will be used for mercury. Reporting limits for metals are stated in Table 2-3. Evaluation criteria for matrix spike/spike duplicates are specified in Table 2-5 and for laboratory control samples in Table 2-6.

6.2.5 Total Recoverable Petroleum Hydrocarbons (TRPH)

Petroleum hydrocarbon analysis is indicated where suspected or known releases or disposal of fuels, waste petroleum, oil, and lubricants (POL) have occurred. As specified in Table 4-1, samples for TRPH analysis will be extracted using oil and grease extraction method SW-846

9071A and analyzed using infrared spectrometric techniques by USEPA method 418.1. Reporting limits for TRPH are stated in Table 2-3. QC Evaluation criteria for matrix spike recoveries are specified in Table 2-5 and for laboratory control samples in Table 2-6.

6.3 PREVENTATIVE MAINTENANCE

The laboratory is responsible for the maintenance of its laboratory equipment. Preventive maintenance will be provided on a scheduled basis to minimize down time and the potential interruption of analytical work. All instruments will be maintained in accordance with manufacturer's recommendations and normal approved laboratory practice.

Designated laboratory personnel will be trained in routine maintenance procedures for all major instrumentation. When repairs become necessary, they will be performed by either trained staff or trained service engineers/technicians employed by the instrument manufacturer. The laboratory shall have multiple instruments which will serve as backup to minimize the potential for down time. All maintenance will be documented and kept in permanent logs. These logs will be available for review by auditing personnel.

Both scheduled maintenance and unscheduled maintenance required by operational failures will be recorded. The designated laboratory operations coordinator will review maintenance records on a regular basis to ensure that required maintenance is occurring.

6.4 INSTRUMENT CALIBRATION AND FREQUENCY

Calibration of all analytical instrumentation is required to ensure that the analytical system is operating correctly and functioning at the required sensitivity to meet project-specific data quality requirements. Each instrument will be calibrated with standard solutions appropriate to the instrument and analytical method in accordance with the methodology specified in the Functional Guidelines (USEPA, 1994a, b). The following paragraphs outline important concerns and provide specific information regarding calibration.

6.4.1 Standard/Reagent Preparation

A critical element in the generation of quality data is the purity/quality and traceability of the standard solutions and reagents used in the analytical operations. To ensure the highest purity possible, all primary reference standards and standard solutions will be obtained from the National Institute of Standards and Technology, the USACE, or other reliable commercial sources. All standards and standard solutions are logged into a data base that identifies the supplier, lot number, purity/ concentration, receipt/ preparation date, preparer's name, method of preparation, expiration date, and all other pertinent information.

Standard solutions are validated prior to use. Validation procedures can range from a check for chromatographic purity to verification of the concentration of the standard using a standard prepared at a different time or obtained from a different source. Stock and working standards are checked regularly for signs of deterioration, such as discoloration, formation of precipitates, or change of concentration. Care is exercised in the proper storage and handing of standard solutions, and all containers are labeled as to compound, concentration, solvent, expiration date, and preparation data (initials of preparer/date of preparation). Reagents are examined for purity by subjecting an aliquot or subsample to the corresponding analytical method, as well.

A data base is used to store essential information on specific standards or reagents. The system is designed to serve various functions (e.g., the system issues warnings on expiration dates and allows chemists to obtain a list of all working standard solutions prepared from the same stock solution). The program also facilitates the management and audit of reagents and standards.

6.4.2 Gas Chromatography (GC)

The field of gas chromatography involves a variety of instrumentation and detection systems. While calibration standards and acceptance criteria vary depending on the type of system and analytical methodology required for a specific analysis, the general principles of calibration apply uniformly. Each gas chromatographic system is calibrated prior to the performance of analyses. Initial calibration consists of determining the linear range, establishing limits of detection, establishing relative response factors, establishing calibration curves, and establishing retention time windows. The calibration is checked on the established frequency basis to ensure

that the system remains within specifications. The established criteria for initial and ongoing calibration of gas chromatography methods are based upon established USEPA methods or CLP Statements of Work.

6.4.3 Gas Chromatography/Mass Spectrometry (GC/MS)

Each day, prior to analysis of samples, the instrument is tuned with reagents such as bromofluorobenzene (BFB) for volatile compounds and decafluorotriphenylphosphine (DFTPP) for semivolatile compounds, and must meet the tuning criteria specified in the respective methods prior to conducting analyses.

The instrument is calibrated for all target compounds. An initial calibration curve is produced, and certain key calibration compounds and continuing calibration compounds are evaluated on a daily basis to ensure that the system is within calibration criteria.

6.4.4 Spectrophotometric Unit

Each spectrophotometric unit is calibrated prior to analyses being conducted. A calibration curve is prepared with a minimum of a calibration blank and five standards. The calibration is verified on an ongoing basis with a midpoint calibration standard to ensure that the instrument meets established acceptance criteria.

6.4.5 Metals

Metals analysis basically involves two types of analytical instrumentation: inductively coupled argon plasma emission spectroscopy (ICP), and atomic absorption spectroscopy (AA).

Each ICP unit is calibrated prior to the analyses being performed using criteria prescribed in the respective methods. The calibration is then verified using standards from an independent source. The linear range of the instrument is established using a linear range verification check standard. No values are reported above this upper concentration value without dilution.

A calibration curve is established daily by analyzing a minimum of two standards, one of which is a calibration blank. The calibration is monitored throughout the day by analyzing a continuing calibration blank and a continuing calibration verification standard. The standard must meet established criteria as described in the method.

An interelement check standard is analyzed at the beginning of each analytical run to verify that interelement (between analyte metals) and background correction factors have remained constant. Results outside of the established criteria trigger reanalysis of samples.

Each AA unit is calibrated prior to analyses being conducted. A calibration curve is prepared with a minimum of a calibration blank and two standards, and then verified with a standard that has been prepared from an independent source at a concentration near the middle of the calibration range. The calibration is verified on an ongoing basis with a midpoint calibration standard to ensure that the instrument meets established acceptance criteria. The method of standard additions is used when matrix interferences are present.

6.4.6 Documentation

Documentation of all calibration activities will be maintained by the laboratory and will also be submitted with the data packages. This information will become a part of the permanent project record and could be retrieved as necessary.

6.5 INTERNAL QUALITY CONTROL CHECKS

Two types of QA checks will be utilized to assess the production of analytical data of known and documented quality. These include:

- Program quality assurance
- Analytical method quality control

6.5.1 Program Quality Assurance

The stated objectives of the laboratory QA/QC Program are to:

- Ensure that all procedures are documented, including any changes in administrative and/or technical procedures
- Ensure that all analytical procedures are conducted according to sound scientific principles and have been validated
- Monitor the performance of the laboratory by a systematic inspection program and provide for corrective action as necessary
- Collaborate with other laboratories in establishing quality levels, as appropriate
- Ensure that all data are properly recorded and archived

All laboratory procedures are documented in writing as either SOPs or method procedures (MPs), which are edited and controlled. Internal quality control procedures for analytical services will be conducted by the laboratory in accordance with their corporate quality assurance plan and SOPs. These specifications include the types of audits required (sample spikes, surrogate spikes, reference samples, controls, blanks), the frequency of each audit, the compounds to be used for sample spikes and surrogate spikes, and the quality control acceptance criteria for these audits.

The laboratory will document, in each data package provided, that analytical QC functions have been met. Any samples analyzed in nonconformance with the QC criteria will be reanalyzed by the laboratory if the laboratory procedures were not in control as assessed by laboratory control samples and other data specific to the analysis, and if sufficient sample volume is available. It is expected that sufficient volume of samples will be collected for reanalysis.

6.5.2 Analytical Method Quality Control

The QC level of effort for analyses to be used for the Cannon AFB, Fire Training Area No. 4 investigation is summarized in Table 6-1.

Matrix Spike. A matrix spike (MS) is an environmental sample to which known concentrations of analytes have been added. The matrix spike is taken through the entire analytical procedure and the recovery of the analytes calculated. Results are expressed as percent recovery of the known amount spiked. The matrix spike is used to evaluate the effect of the sample matrix on the accuracy of the analysis. Matrix spike analysis will be designated on the chain-of-custody by field sampling personnel. Extra sample volume will be collected for this purpose if necessary. A determination will be made in the field concerning representative matrices.

Matrix Spike Duplicate. A matrix spike duplicate (MSD) is a split of the environmental sample utilized for the matrix spike which is spiked with known concentrations of analytes. The matrix spike and matrix spike duplicate are processed, separately but in identical fashion and the results compared to evaluate the precision and accuracy of the laboratory analysis. Results are expressed as percent recovery and as relative percent differences (RPD) between the MS and the MSD percent recoveries. MSD analysis will be designated on the chain of custody by field sampling personnel.

Laboratory (or Matrix) Duplicate. A laboratory duplicate is a split of an environmental sample, which is prepared and analyzed in a manner identical to that of the original sample. The results are utilized to evaluate the precision of the laboratory analyses. Results are expressed in Relative Percent Difference between analytical results for the split and the original sample.

Surrogate. A compound or compounds added to every blank, sample, matrix spike, matrix spike duplicate, and standard if specified in the analytical methodology. The results are utilized to evaluate the accuracy of analytical measurement on a sample-specific basis. Surrogates are generally brominated, fluorinated, or isotopically labeled compounds not expected to be detected in environmental media. Results are expressed in Percent Recovery of the surrogate spike.

Internal Standards. Internal standards performance criteria ensure that GC/MS sensitivity and response are stable during every analytical run. Internal standards are added to every blank, sample, and duplicate, and analyzed to verify that all retention times and IS areas are within the required criteria. Appropriate, method-required internal standards will be used to quantitate sample concentrations and to evaluate sensitivity and stability of the GC/MS system.

Method or Preparation Blank. A method blank consists of analyte-free deionized water or Ottawa sand for organic analysis of solids. The method blank is carried through each step of the analytical method. The method blank data will be used to evaluate the laboratory contamination during analysis.

Laboratory Control Samples (LCS). Laboratory control samples (LCS) are well-characterized, laboratory-generated samples used to monitor the laboratory's day-to-day performance of routine analytical methods. Certain LCS are used to monitor the precision and accuracy of the analytical process independent of matrix effects. Other LCS are used to identify any background interference or contamination of the analytical system which may lead to the reporting of elevated concentration levels or false positive data.

The results of the LCS are compared to well-defined laboratory acceptance criteria (see Section 3) to determine whether the laboratory system is "in control". Controlling lab operations with LCS (as opposed to MS/MSD samples) offers the advantage of being able to differentiate low recoveries due to procedural errors from those due to matrix effects. LCSs will be used for TRPH, metals and cyanide analyses.

6.6 LABORATORY CORRECTIVE ACTION

The laboratory QA/QC Officer or the officer's designee shall be responsible for initiating corrective action as necessary. Corrective action will be required if analyses of QC samples or laboratory conditions do not meet criteria specified in the respective methods, the laboratory quality assurance plan or the SOPs.

The project QA/QC Officer will review the field and laboratory data generated for this project to ensure that all project quality assurance objectives are met. If any nonconformances are found in the laboratory analytical and documentation procedures and data assessment and validation procedures, the impact of those nonconformances on the overall project QA objectives will be assessed. Appropriate actions, including resampling, reanalysis, etc., may be recommended to the Program Manager so that the project objectives can be accomplished.

6.7 DATA ASSESSMENT PROCEDURES

The reliability and credibility of analytical laboratory results are evaluated by the inclusion, as an integral part of any analytical procedure, of a program of randomly selected replicate analyses, and analysis of standards and spiked samples.

Precision of analytical results will be evaluated as the relative percent difference or relative standard deviation from the mean of replicate analyses. Accuracy is reported as the percent recovery of a parameter from a sample of known value with a given analytical procedure and analyst.

The procedures described herein are designed to ensure precise and accurate data for each analytical method and analyst. To ensure that reliable data continue to be produced, systematic checks must show that test results remain reproducible and that the methodology is actually measuring the quantity of analyte in each sample. Quality assurance must begin with sample collection and not end until the resulting data have been reported.

Data assessment and review will be accomplished by the joint efforts of the Project QA/QC Officer and the QA/QC Coordinator. The QA/QC Coordinator or his/her designee will review the analytical results for compliance with the established QC criteria as described below. Problems arising during sample collection, packing, shipping, or analysis will be taken into consideration in the data assessment.

The following procedures will be used to evaluate data precision, accuracy, and analytical completeness for the analyses conducted.

6.7.1 Accuracy

Accuracy will be expressed as percent recovery for laboratory control samples as follows:

$$\text{Percent Recovery} = \frac{x}{T} \times 100$$

where x = the observed value of measurement
T = "true" value

Recoveries will be compared with the applicable control limits (Section 3.0) and the data associated with outliers will be evaluated to determine its useability. The surrogate recoveries will also be calculated as above and compared against the limits shown in Section 3.0. If the surrogate percent recovery limits are exceeded, the data will be assessed to determine the potential effect of the poor surrogate recovery on the reported results.

In addition, the matrix spike and matrix spike duplicate sample results will be used to calculate the percent recovery.

$$\text{Percent Recovery (for matrix spikes)} = \frac{X-S}{T} \times 100$$

where X = observed value after spike
S = sample value
T = amount spiked

These matrix spike and matrix spike duplicate percent recoveries will be compared with the applicable control limits (Section 3.0) and the data associated with outliers will be assessed in conjunction with other QC data to determine if the sample matrix is potentially affecting the data adversely.

6.7.2 Precision

Precision will be expressed as RPD for duplicate environmental samples and for duplicate control samples, as follows:

$$\text{RPD (\%)} = \frac{|S-D|}{(S+D)/2} \times 100$$

where S = first sample value (original)
D = second sample value (duplicate)

The RPDs will be compared with the applicable control limits in Section 3.0, and the effect of inadequate precision on the associated sample data will be assessed.

6.7.3 Assessment Of Data For Completeness and Useability

Following validation of the data packages, assessment of the data with respect to fulfillment of quality assurance objectives and useability will be accomplished by the joint efforts of the Project QA/QC Officer and the Project Manager. This assessment will include sample collection, sample handling, field data, consideration of blank values and field duplicate values, and additional flagging of qualifying data for use at each site.

The analytical completeness will be calculated by the ratio of acceptable and estimated results to the total number of analytical results requested on samples submitted for analysis.

$$\text{\% Completeness} = \frac{\text{Accepted Analytical Results + Estimated Analytical Results}}{\text{Total Number of Analytical Results Requested}}$$

The percent completeness will be compared against the overall program goal of 90 percent, as stated in the sitewide Data Collection Quality Assurance Plan (Lee Wan and Associates, Inc. 1990c). If the goal is not met, the Project QA/QC Officer and the Project Manager will decide if the data are sufficient for the site characterization or other types of data uses. If it is judged that the data are inadequate, additional field samples will be collected to accomplish the project goals. Decisions to repeat sample collection and analysis may be made by the Project Manager

and the Project QA/QC Officer based on the extent of the deficiencies and their importance in the overall context of the project.

6.8 DATA REDUCTION, VALIDATION, AND DOCUMENTATION

The analytical data generated by the laboratory will be reviewed for accuracy, precision, completeness, representativeness, and comparability. The data validation process for this project will consist of data generation, reduction, and two levels of review, the first by the analytical laboratory and the second through an independent data review.

6.8.1 Analytical Laboratory Data Review and Reporting

The first level of review, which may contain multiple sublevels, will be conducted by the analytical laboratory Data Reviewer who has the initial responsibility for the correctness and completeness of the data. All data are generated and reduced in accordance with protocols specified in the analytical methodology. The laboratory Data Reviewer will evaluate the quality of the work based on an established set of laboratory guidelines and this Workplan. This person will review the data package to ensure that:

- Sample preparation information is correct and complete.
- Analysis information is correct and complete.
- Appropriate methods have been followed.
- Analytical results are correct and complete.
- QC samples are within appropriate QC limits.
- Special sample preparation and analytical requirements have been met.
- Documentation is complete (all anomalies in the preparation and analysis have been documented; out-of-control forms, if required, are complete; holding times are documented).

The laboratory will perform the in-house analytical data reduction and QA review under the direction of the laboratory Data Review Supervisor. The laboratory Program Administrator (PA) is responsible for assessing data quality and advising the Project Manager of any data which were rated "preliminary" or "unacceptable", or other notations which would caution the

data user of possible unreliability. Data reduction, QA review, and reporting by the laboratory will be conducted as follows:

- Raw data produced by the analyst is processed and reviewed for attainment of quality control criteria as outlined in this Workplan and/or established USEPA methods and for overall reasonableness.

- After entry into the Laboratory Information Management System (LIMS), a computerized report is generated and sent to the laboratory Data Reviewer.

- The Data Reviewer will decide whether any sample reanalysis is required.

- Upon acceptance of the preliminary reports by the Data Reviewer, final reports will be generated.

Laboratory data reduction procedures will be those specified in the respective USEPA SW-846 Methods, 3rd Edition, and those described in the laboratory SOPs.

The laboratory will prepare and retain full analytical and QC documentation. For SW-846 and other analytical methods, the following reporting requirements shall be met. The laboratory will report the data as a group of 20 samples or less, along with QC supporting data. The laboratory will provide the following hard copy information in each analytical data package submitted in accordance with QA objectives for Cannon AFB:

- Chain-of-custody forms

- Cover sheet listing the samples included in the report and narrative comments describing problems encountered in analysis

- Tabulated results of inorganic and organic compounds identified and quantified and reporting limits for all analytes

- Analytical results for QC sample spikes, sample duplicates, initial and continuing calibration verifications of standards and blanks, standard procedural blanks, laboratory control samples, and ICP interference check samples

- Tabulation of reporting limits related to the sample

- Raw data system printouts (or legible photocopies) identifying date of reported analysis, analyst, parameters analyzed, calibration curve, calibration verifications, method blanks, any reported sample dilutions, sample duplicates, spikes, and control samples; sample spiking levels, preparation/extraction logs and run logs

For organic analyses, the data packages will include matrix spikes, matrix spike duplicates, surrogate spike recoveries, chromatograms, GC/MS spectra, and computer printouts for reported analyses and associated QC data.

For the VOC and SVOC analyses, the data packages will include, at a minimum, the following:

- Analysis Data Sheet
- Confirmation Analysis Data Sheet if applicable
- Initial Calibration Response Factors
- Initial Calibration Ion Abundance Ratios
- Calibration Verification

The narrative accompanying the data package will include the identification of samples not meeting total QC criteria as specified in the analytical method and the laboratory data quality review SOPs.

The data reduction and the QC review steps will be documented, signed, and dated by the analyst.

Laboratory qualifiers will include:

- Concentration below required reporting limit
- Concentration of chemical also found in laboratory blank

The narrative accompanying the data package will include cautions regarding nonquantitative use or unuseability due to out-of-control QC results.

6.8.2 Independent Data Review Process

Harza will perform independent review and validation of the analytical data package in accordance with details provided in SOP #10 (Appendix A). All critical data or ten percent of sample data, whichever is larger, will be subjected to a complete data validation using guidance from USEPA functional guidelines for data validation. OSWER directive "Guidance for Data Useability in Risk Assessment" (USEPA 1990a) has been used in determining the level of independent data review required for sample analyses to be used in risk assessment modeling. In accordance with this OSWER directive, critical data are those data considered to be crucial for the purposes of the risk assessment. A minimum of one sample per source, per sample medium, per exposure pathway will be considered critical for those analytes to be used in the risk assessment.

Laboratory analytical data packages will receive a second level of review by a designee of the QA/QC Officer. Laboratory results will be reviewed and data qualified, if required. Sample data may be qualified as "J" (estimated), "UJ" (not detected - estimated), or may be rejected "R". The qualifier "U" is normally used for analytes not detected by the laboratory. Rejected data are not usable for any purpose. Infrequently detected chemicals may be identified as "outliers" in accordance with *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)* (USEPA, 1989). For this investigation, a chemical may be identified as an "outlier" if it is detected in less than five percent (5%) of the soil samples, is not detected at high concentrations, and there is no reason to believe that it may be present based upon past operations at FTA #4.

In addition, approximately five percent of all soil samples will be split and sent to a separate quality assurance laboratory for analysis. The QA laboratory for this project is the USACE MRD laboratory (MRDL). Comparison will be made between the analytical results for the samples split between the contract and USACE laboratories. These interlaboratory results will then be used in the Overall Assessment of Data for a Case for each of the analyte groupings.

TABLE 6-1
Quality Control Level of Effort for Analytical Testing

Parameter	QC Measure	Minimum Frequency
Metals and Cyanide	Calibration Blank	Each calibration, beginning and end of each run; 10% frequency
	Initial Calibration Verification	Daily for each instrument setup
	Continuing Calibration Verification	Beginning and end of each run; 10% frequency
	Preparation Blank	One per analytical batch
	Laboratory Duplicate	One per analytical batch
	Matrix Spike Analysis	One per analytical batch
	Laboratory Control Sample Analysis	One per analytical batch
	Analytical Spike (AA-Furnace)	Each sample (at least a single analytical spike will be performed to determine if the method of standard additions is required)
	Serial Dilution (ICP)	One per sample delivery group
	Interference Check Sample (ICP)	Beginning and end of each run
Volatiles, Semivolatiles, TRPH	Laboratory Blank	One per analytical batch
	Continuing Calibration	Daily for each instrument setup
	Laboratory Control Sample	One per analytical batch, where applicable
	Matrix Spike Analysis	One per analytical batch
	Matrix Spike Duplicate Analysis	One per analytical batch
	Surrogate Spike [1]	Each sample

1. Surrogate spikes not required for TRPH.

7.0
DELIVERABLES

Deliverables required for the field investigation at Cannon AFB are included in the Document Submittal Schedule on Table 7-1. Copies of deliverables to USEPA and NMED will be forwarded by Cannon AFB in accordance with Table 7-1. Deliverables include the following:

Daily Quality Control Report. The DQCR is described in Section 5.0. For any non-routine occurrences, the DQCR will identify problems identified, corrective actions, and verbal/written instructions for sampling or reanalysis.

Analytical Data Package. The analytical data package will be submitted to Harza by the contract laboratory in accordance with Section 6.8.1. The laboratory maintains detailed procedures for laboratory recordkeeping in order to support the validity of all analytical work. Each data set report submitted to Harza will contain the laboratory's written certification that the requested analytical method was run and that all analytical method QA/QC controls were within the established control limits. The laboratory QA Director will provide Harza with QA reports of external audits conducted by the EPA for the CLP program and by the USACE upon request.

The QA laboratory for this project is the USACE Missouri River Division Laboratory (MRDL). The shipping address for the laboratory is given at the end of this section. The QA laboratory will be notified approximately one week before any QA sample shipments are shipped to the laboratory. Advance notice also will be provided for any Saturday deliveries to MRDL to insure that personnel will be available to receive the samples. Analytical data results from the laboratory will be submitted to the MRDL for data validation and comparison purposes as soon as they are available. Harza will conduct an independent QC review of analytical data, as outlined in Section 6.8 of the Workplan and discussed in SOP No. 10. The submittals of analytical results to the MRDL will include all sample, blank, and internal quality control results such as spike and surrogate recoveries and agreement between replicate analyses. The data report to the QA laboratory shall include a tabular presentation matching contract laboratory sample identification numbers to laboratory sample identification numbers. Field duplicates and

field blanks shall be identified as such and matched with their corresponding field samples where applicable. Harza will submit copies of the original chain of custody forms from the contract laboratory to serve as cooler receipt forms. These chain of custody forms will document any problems in sample packing, chain of custody, and sample preservation.

Quality Control Summary Report. After the fieldwork has been completed and the final analyses are completed and checked, a draft quality control summary report (QCSR) will be prepared by Harza. The report will summarize the Daily Quality Control Reports and the quality assurance/quality control and audit information, indicating all data that have been compromised and the effect on data objectives, any corrective actions taken, and the overall results of Workplan compliance. The draft QCSR is scheduled to be submitted to the USACE Technical Manager within 30 days of the receipt of final laboratory deliverables.

Monthly Progress Reports and Schedule Updates. Harza's Project Manager will prepare monthly progress reports with attached confirmation notices and schedule updates for submission to the USACE TM, Cannon AFB personnel and ACC. The reports summarize work completed during the period and anticipated in the next period and provide explanation of deviations from the work plan or schedule.

Soil Gas Results Report. The Soil Gas Results Report will be submitted following completion of analysis of soil gas samples and will include recommended boring locations. Based upon the soil gas results and discussion with USACE and Cannon AFB personnel, the boring locations will be finalized.

RFI Report. Pre-draft, draft and final RFI Reports will be submitted following completion of the investigation and laboratory investigations. The RFI Report will present, summarize and document all methods and results of the investigations.

Meetings. Meetings to discuss the progress of the Cannon AFB site investigation will be held as requested in accordance with the USACE Scope of Services. Concerns which arise during the course of the work that may require changes to the scope of work or deviations from the established protocols specified in the approved project plans will be discussed and resolved at these meetings. Harza will prepare meeting minutes for distribution to attendees.

TABLE 7-1
DOCUMENT SUBMITTAL SCHEDULE

DOCUMENT	No. OF COPIES TO RECIPIENT[1]			
	A	B	C	D
Pre-Draft Work Plans	4	5	2	-
Draft Work Plans [3]	4	5	2	-
Final Work Plans [3]	5	5	2	1
Monthly Progress Reports	1	1	1	-
Daily Quality Control Reports	2	1	-	-
Quality Control Summary Reports	4	5	1	1
Soil Gas Results Report [3]	4	5	1	0
Pre-Draft RFI Report	4	5	2	-
Draft RFI Report [3]	4	5	2	1
Final RFI Report [3]	4	5	2	1
Field Well Construction Logs	2	1	-	-

1 Letter (A,B,C...) indicates addresses shown below.

2 Also, 1 set of IBM compatible 3.5 inch disk Word Perfect 5.1/5.2 files.

3 Copies submitted to U. S. EPA and NMED by Cannon AFB staff.

A. U.S. Army Corps of Engineers
Omaha District
Attn: Steve Peterson, CEMRO-ED-EC
215 North 17th Street
Omaha, Nebraska
68102-4978

B. Cannon Air Force Base
Attn: 27 CES/CEV (Mr. John Constantine)
111 Engineers Way, Bldg. 250
Cannon AFB, New Mexico 88103-5136

C. ACC CES/ESVW
Attn: Mr. Russ Shannon
129 Andrews Street, Suite 102
Langley AFB, Virginia 23665-2769

D. U.S. Army Corps of Engineers
Missouri River Division Laboratory
Department of the Army
Attn: CEMRD-EP-LC
420 South 18th Street
Omaha, NE 68102-2586
(For QA Sample Shipment, add "Attention: Sample Custodian")

8.0
PRELIMINARY ARARS

8.1 GENERAL

Preliminary identification of applicable and relevant and appropriate requirements (ARARS) pertaining to Fire Training Area No. 4 at Cannon AFB are outlined herein based upon those generated by Woodward-Clyde Consultants for the previous (1992) investigation work plan for Landfill No. 5. Information on the identified ARARs will be updated to reflect major regulatory changes and/or identify revisions when the investigation results are available, in support of health and environmental assessments. Included are preliminary chemical-specific and location-specific ARARs and "To be considered" requirements. Identification of action-specific ARARs can only be addressed once remedial alternatives are developed.

8.2 CHEMICAL-SPECIFIC ARARS

Chemical-specific ARARs and other criteria or guidelines to be considered are presented in Tables 8-1 and 8-2. Chemical-specific requirements are based on health or risk-based concentration limits of discharge limitations in environmental media (i.e., water, soil) for specific hazardous chemicals. These requirements may be used to set cleanup levels for the chemicals of concern in the designated media, or to set a safe level of discharge (e.g., water, air, etc.) that may occur as part of the remedial activity.

8.3 TO BE CONSIDERED MATERIALS

"To be considered" materials (TBCs) are nonpromulgated advisories, proposed rules, criteria, or guidance documents issued by federal or state governments that do not have the status of potential ARARs. However, these advisories and guidance are to be considered when determining protective cleanup levels where no ARARs exist, or where ARARs are not sufficiently protective of human health and the environment. In these circumstances, TBC values are used to establish cleanup targets. TBC screening values are provided Table 8-3.

8.4 LOCATION-SPECIFIC ARARs

Location-specific ARARs are restrictions placed on the types of activities that may occur in particular locations. Potential location-specific ARARs for Cannon AFB are presented in Table 8-4 with an explanation as to whether the regulation is applicable or relevant and appropriate and why. The location of a site may be an important characteristic in determining its impact on human health and the environment; thus, individual states may establish location-specific ARARs. These may restrict or preclude certain remedial actions or may apply only to certain portions of a site. Examples of location-specific ARARs include federal and state requirements for preservation of historic landmarks, endangered species and wetlands protection, and the restrictions on management of hazardous waste in floodplain areas.

TABLE 8-1

SUMMARY OF POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs
CANNON AFB - FIRE TRAINING AREA No. 4

Standard, Requirement, or Criteria	Description	Comment
FEDERAL		
Safe Drinking Water Act (40 USC Sect. 300)		
National Primary Drinking Water Standards [40 CFR Parts 141, 142, (1990, 1991)	Establishes maximum contaminant levels (MCLs) for specific contaminants which are health-based standards for public drinking water systems.	MCLs are applicable for drinking water at the tap. MCLs are relevant and appropriate for organic and inorganic contamination of groundwater that is or may be used for drinking.
National Secondary Drinking Water Standards (40 CFR Part 143)	Establishes secondary maximum contaminant levels (SMCLs) which are nonenforceable guidelines for public drinking water systems to protect the aesthetic quality of the water.	SMCLs may be "to be considered" if groundwater is used as a drinking water source.
Maximum Contaminants Level Goals (MCLGs) [PL No. 99-339, 100 Stat. 642 (1986), (1990, 1991); 40 CFR 141,142]	Establishes drinking water quality goals at a level at which no adverse health effects may occur with an adequate margin of safety.	MCLGs set above zero levels are relevant and appropriate for existing or potential sources of drinking water. MCLGs may be relevant and appropriate if the risk posed by multiple contaminants or pathways is in excess of 10^{-4}.
Resource, Conservation, and Recovery Act (RCRA)		
Releases from Solid Waste Management Units (40 CFR Part 264)	Subpart F (264.94) gives concentration limits in groundwater for hazardous constituents from a regulated unit.	Applicable if organic and inorganic contamination of groundwater is found at a RCRA regulated unit.
RCRA Facility Investigation Guidance (EPA, 1989)	Guidance levels for cleanup of contaminated soils based on EPA-derived chronic exposure assumptions; intended as screening levels at RCRA facilities to determine if a more detailed health-risk evaluation is warranted.	To be considered if contaminated soils are found.

TABLE 8-1
SUMMARY OF POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs
CANNON AFB, FIRE TRAINING AREA No. 4

Standard, Requirement, or Criteria	Description	Comment
Proposed RCRA Action Levels (55 FR 30798, 27 July 1990)	Risk-based action levels for contaminants in soil which, if exceeded, would trigger the need for a Corrective Measures Study.	To be considered if contaminated soils are found.
STATE		
New Mexico Water Quality Act, 1978		
New Mexico Drinking Water Regulations (4/16/91)(New Mexico Water Supply Regulations, Sections 202 to 203)	Establishes MCLs and standards for sources of drinking water.	State MCLs are applicable or relevant and appropriate to contaminated water if the state MCL is more stringent than federal requirements.
New Mexico Water Quality Regulations, amended through August 17, 1991 (WQCCR Part 3, Sections 100 through 103)	Establishes human health, domestic water supply, and irrigation use standards for ground water protection.	Applicable if remedial activities include discharges onto or below the surface of the ground.
New Mexico Water Quality Regulations, amended through August, 1991 (WQCCR Part1, Section 101.UU)	Establishes definition of toxic pollutant based on effects to human health and the environment. Requires a determination of health and environmental risk due to the presence of the contaminant.	Applicable if groundwater related to the source area contains any of the contaminants listed in the definition of toxic pollutants.
New Mexico Hazardous Waste Act 1978		
New Mexico Underground Storage Tank Regulations, amended through July 18, 1991, Section 1209	Sets cleanup levels for soils contaminated with benzene, aromatic hydrocarbons, or petroleum products.	May be "to be considered" if soils are contaminated with benzene, aromatic hydrocarbons, or petroleum products.

TABLE 8-1
SUMMARY OF POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs
CANNON AFB, FIRE TRAINING AREA No. 4

Standard, Requirement, or Criteria	Description	Comment
New Mexico Solid Waste Regulations		
New Mexico Special Waste Requirements Regulations, adopted effective January 30, 1992, Part VII	Sets disposal levels for soils contaminated with BTEX compounds and total petroleum hydrocarbons. Also sets disposal standards for asbestos waste.	May be "to be considered" if soils are contaminated with petroleum hydrocarbons and are removed and placed elsewhere.

TABLE 8-2

POTENTIAL SITE-WIDE CHEMICAL-SPECIFIC ARARs/TBCs
GROUNDWATER QUALITY STANDARDS
CANNON AFB, FIRE TRAINING AREA No. 4

		FEDERAL STANDARDS			STATE STANDARDS NMWQCC Groundwater Quality Standards (g)			
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level Goal (a) ARARs/TBCs	RCRA Subpart F Concentration Limit (40 CFR 264.94) (b)	Community Water Supply System (h)	Human Health	Other Standards for Domestic Water Supply	Irrigation Use
pH	Field Parameter	6.5-8.5*					6.0-9.0	6.0-9.0
Total Dissolved Solids	Indicator	500,000 ug/l*					1,000,000 ug/l	1,000,000 ug/l
Carbonate	Anion							
Chloride	Anion	250,000 ug/l*					250,000 ug/l	250,000 ug/l
Fluoride	Anion	4,000 ug/l, 2,000 ug/l*	4,000 ug/l		4,000 ug/l	1,600 ug/l		1,600 ug/l
N as Nitrate	Anion	10,000 ug/l	10,000 ug/l(c)		10,000 ug/l	10,000 ug/l		10,000 ug/l
N as Nitrate+Nitrite	Anion	10,000 ug/l(c)	10,000 ug/l(c)					
N as Nitrite	Anion	1,000 ug/l(c)	1,000 ug/l(c)					
Potassium	Anion							
Sulfate	Anion	250,000 ug/l*					600,000 ug/l	600,000 ug/l
Aluminum	Metal	0.5 to 200 ug/l*(c)						5,000 ug/l
Antimony	Metal	6 ug/l(d)	6 ug/l(d)					
Arsenic	Metal	50 ug/l		50 ug/l	50 ug/l	100 ug/l		100 ug/l
Barium	Metal	2,000 ug/l(e)	2,000 ug/l(e)	1,000 ug/l	1,000 ug/l	1,000 ug/l		1,000 ug/l
Beryllium	Metal	4.0 ug/l(d)	4 ug/l(d)					
Boron	Metal							750 ug/l
Cadmium	Metal	5 ug/l(c)	5 ug/l(c)	10 ug/l	10 ug/l	10 ug/l		10 ug/l
Calcium	Metal							
Chromium	Metal	100 ug/l(c)	100 ug/l(c)	50 ug/l	50 ug/l	50 ug/l		50 ug/l
Cobalt	Metal							50 ug/l

TABLE 8-2
POTENTIAL SITE-WIDE CHEMICAL-SPECIFIC ARARs/TBCs
GROUNDWATER QUALITY STANDARDS
CANNON AFB, FIRE TRAINING AREA No. 4

		FEDERAL STANDARDS			STATE STANDARDS NMWQCC Groundwater Quality Standards (g)			
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level Goal (a) ARARs/TBCs	RCRA Subpart F Concentration Limit (40 CFR 264.94) (b)	Community Water Supply System (h)	Human Health	Other Standards for Domestic Water Supply	Irrigation Use
Copper	Metal	1,000 ug/l*	1,300 ug/l(f)				1,000 ug/l	1,000 ug/l
		1,300 ug/l***						
Cyanide	Metal	200 ug/l(d)	200 ug/l(d)			200 ug/l		200 ug/l
Iron	Metal	300 ug/l*					1,000 ug/l	1,000 ug/l
Lead	Metal	50 ug/l	0(f)	50 ug/l	50 ug/l	50 ug/l		50 ug/l
		15 ug/l***						
Magnesium	Metal							
Manganese	Metal	50 ug/l*					200 ug/l	200 ug/l
Mercury	Metal	2 ug/l	2 ug/l(c)	2 ug/l	2 ug/l	2 ug/l		2 ug/l
Molybdenum	Metal							1,000 ug/l
Nickel	Metal	100 ug/l(d)	100 ug/l(d)					200 ug/l
Selenium	Metal	50 ug/l(c)	50 ug/l(c)	10 ug/l	10 ug/l	50 ug/l		50 ug/l
Silver	Metal	100 ug/l*(c)		50 ug/l	50 ug/l	50 ug/l		50 ug/l
Sodium	Metal							
Thallium	Metal	2 ug/l(d)	0.5 ug/l(d)					
Tin	Metal							
Titanium	Metal							
Tungsten	Metal							
Vanadium	Metal							
Zinc	Metal	5,000 ug/l*					10,000 ug/l	10,000 ug/l
Gross Alpha	Radionuclide	15 pCi/l			15 pCi/l			

TABLE 8-2
POTENTIAL SITE-WIDE CHEMICAL-SPECIFIC ARARs/TBCs
GROUNDWATER QUALITY STANDARDS
CANNON AFB, FIRE TRAINING AREA No. 4

		FEDERAL STANDARDS			STATE STANDARDS NMWQCC Groundwater Quality Standards (g)			
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level Goal (a) ARARs/TBCs	RCRA Subpart F Concentration Limit (40 CFR 264.94) (b)	Community Water Supply System (h)	Human Health	Other Standards for Domestic Water Supply	Irrigation Use
Gross Beta	Radionuclide	4 mrem/yr						
Radium 226+228	Radionuclide	5 pCi/l			5 pCi/l	30 pCi/l		30 pCi/l
Strontium 90	Radionuclide	8 pCi/l			8 pCi/l			
Tritium	Radionuclide	20,000 pCi/l			20,000 pCi/l			
Uranium (total)	Radionuclide					5,000 ug/l		5,000 ug/l
1,1-Dichloroethane	Volatile					25 ug/l		25 ug/l
1,1-Dichloroethene	Volatile	7 ug/l	7 ug/l		7 ug/l	5 ug/l		5 ug/l
1,1,1-Trichloroethane	Volatile	200 ug/l	200 ug/l		200 ug/l	60 ug/l		60 ug/l
1,1,2,2-Tetrachloroethane	Volatile					10 ug/l		10 ug/l
1,1,2,2-Tetrachloroethene	Volatile					20 ug/l		20 ug/l
1,1,2-Trichloroethane	Volatile	5 ug/l(d)	3 ug/l(d)			10 ug/l		10 ug/l
1,1,2-Trichloroethene	Volatile					100 ug/l		100 ug/l
1,2-Dichloroethane	Volatile	5 ug/l	0 ug/l		5 ug/l	10 ug/l		10 ug/l
1,2-Dichloroethene	Volatile							
1,2-Dichloropropane	Volatile	5 ug/l(c)	0 ug/l(c)					
4-Methyl-2-pentanone	Volatile							
Acetone	Volatile							
Benzene	Volatile	5 ug/l	0 ug/l		5 ug/l	10 ug/l		10 ug/l
Bromodichloromethane	Volatile							
Bromoform	Volatile	Tot THM* <100 ug/l						

TABLE 8-2
POTENTIAL SITE-WIDE CHEMICAL-SPECIFIC ARARs/TBCs
GROUNDWATER QUALITY STANDARDS
CANNON AFB, FIRE TRAINING AREA No. 4

		FEDERAL STANDARDS			STATE STANDARDS NMWQCC Groundwater Quality Standards (g)			
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level Goal (a) ARARs/TBCs	RCRA Subpart F Concentration Limit (40 CFR 264.94) (b)	Community Water Supply System (h)	Human Health	Other Standards for Domestic Water Supply	Irrigation Use
Bromomethane	Volatile							
Carbon Tetrachloride	Volatile	5 ug/l	0 ug/l		5 ug/l	10 ug/l		10 ug/l
Chlorobenzene (mono)	Volatile	100 ug/l(c)	100 ug/l(c)					
Chlorobenzilate	Volatile							
Chloroethane	Volatile							
Chloroform	Volatile	Tot THM** <100 ug/l			Tot THM** 100 ug/l	100 ug/l		100 ug/l
Chloroprene	Volatile							
Chloromethane	Volatile							
Cis-1,2-Dichloroethene	Volatile	70 ug/l(c)	70 ug/l(c)					
Cis-1,3-Dichloropropene	Volatile							
Dibromochloromethane	Volatile	Tot THM** <100 ug/l						
Ethyl Benzene	Volatile	700 ug/l(c)	700 ug/l(c)			750 ug/l		750 ug/l
Methylene Chloride	Volatile	5 ug/l(d)	0 ug/l(d)			100 ug/l		100 ug/l
Styrene	Volatile	100 ug/l(c)	100 ug/l(c)					
Tetrachloroethanes	Volatile							
Tetrachloroethene	Volatile	5 ug/l(c)	0 ug/l(c)					
Toluene	Volatile	1,000 ug/l(c)	1,000 ug/l(c)			750 ug/l		
Total Trihalomethanes	Volatile	100 ug/l						
Total Xylenes	Volatile	10,000 ug/l(c)	10,000 ug/l(c)			620 ug/l		620 ug/l
Trans-1,2-Dichloroethene	Volatile	100 ug/l(c)	100 ug/l(c)					

TABLE 8-2
POTENTIAL SITE-WIDE CHEMICAL-SPECIFIC ARARs/TBCs
GROUNDWATER QUALITY STANDARDS
CANNON AFB, FIRE TRAINING AREA No. 4

		FEDERAL STANDARDS			STATE STANDARDS NMWQCC Groundwater Quality Standards (g)			
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level Goal (a) ARARs/TBCs	RCRA Subpart F Concentration Limit (40 CFR 264.94) (b)	Community Water Supply System (h)	Human Health	Other Standards for Domestic Water Supply	Irrigation Use
Trans-1,3-Dichloropropene	Volatile							
Trichloroethanes	Volatile							
Trichloroethene	Volatile	5 ug/l	0 ug/l		5 ug/l			
Vinyl Acetate	Volatile							
Vinyl Chloride	Volatile	2 ug/l	0 ug/l		2 ug/l	1ug/l		1 ug/l
1,2-Dichlorobenzene (ortho)	Semi-Volatile	600 ug/l(c)	600 ug/l(c)					
1,3-Dichlorobenzene (meta)	Semi-Volatile	600 ug/l	600 ug/l					
1,4-Dichlorobenzene (para)	Semi-Volatile	75 ug/l	75 ug/l		75 ug/l			
1,2,4-Trichlorobenzene	Semi-Volatile	70 ug/l(d)	70 ug/l(d)					
2-Chloronaphthalene	Semi-Volatile							
2-Chlorophenol	Semi-Volatile							
2-Methylnaphthalene	Semi-Volatile							
2-Nitroaniline	Semi-Volatile							
2-Nitrophenol	Semi-Volatile							
2,3,7,8-Tetrachlorodibenzo-p-dioxin	Semi-Volatile	$3x10^{-8}$(d)	0 ug/l(d)					
2,4-Dichlorophenol	Semi-Volatile							
2,4-Dichlorophenoxyacetic Acid (2,4-D)	Semi-Volatile (H)	70 ug/l(c)	70 ug/l(c)	100 ug/l	100 ug/l			
2,4-Dimethylphenol	Semi-Volatile							
2,4-Dinitrophenol	Semi-Volatile							
2,4-Dinitrotoluene	Semi-Volatile							

TABLE 8-2
POTENTIAL SITE-WIDE CHEMICAL-SPECIFIC ARARs/TBCs
GROUNDWATER QUALITY STANDARDS
CANNON AFB, FIRE TRAINING AREA No. 4

		FEDERAL STANDARDS			STATE STANDARDS NMWQCC Groundwater Quality Standards (g)			
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level Goal (a) ARARs/TBCs	RCRA Subpart F Concentration Limit (40 CFR 264.94) (b)	Community Water Supply System (h)	Human Health	Other Standards for Domestic Water Supply	Irrigation Use
2,4,5-TP Silvex	Semi-Volatile (H)	50 ug/l(c)	50 ug/l(c)	10 ug/l	10 ug/l			
2,4,6-Trichlorophenol	Semi-Volatile							
3-Nitroaniline	Semi-Volatile							
4-Bromophenyl Phenylether	Semi-Volatile							
4-Chloroaniline	Semi-Volatile							
4-Chlorophenyl Phenyl Ether	Semi-Volatile							
4-Chloro-3-methylphenol	Semi-Volatile							
4-Nitroaniline	Semi-Volatile							
4,6-Dinitro-2-methylphenol	Semi-Volatile							
Acenaphthalene	Semi-Volatile							
Acrylonitrile	Semi-Volatile							
Alachlor	Semi-Volatile	2 ug/l	0 ug/l					
Aldicarb	Semi-Volatile (P)	3 ug/l(e)	1 ug/l(e)					
Aldicarb Sulfone	Semi-Volatile (P)	2 ug/l	1 ug/l					
Aldicarb Sulfoxide	Semi-Volatile (P)	4 ug/l	1 ug/l					
Aldrin	Semi-Volatile (P)							
Aniline	Semi-Volatile							
Anthracene	Semi-Volatile							
Atrazine	Semi-Volatile	3 ug/l(c)	3 ug/l(c)					
Benzo(a)anthracene	Semi-Volatile							
Benzo(a)pyrene	Semi-Volatile	0.2 ug/l(d)	0 ug/l(d)			0.7 ug/l		0.7 ug/l

TABLE 8-2
POTENTIAL SITE-WIDE CHEMICAL-SPECIFIC ARARs/TBCs
GROUNDWATER QUALITY STANDARDS
CANNON AFB, FIRE TRAINING AREA No. 4

		FEDERAL STANDARDS			STATE STANDARDS NMWQCC Groundwater Quality Standards (g)			
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level Goal (a) ARARs/TBCs	RCRA Subpart F Concentration Limit (40 CFR 264.94) (b)	Community Water Supply System (h)	Human Health	Other Standards for Domestic Water Supply	Irrigation Use
Benzo(b)fluoranthene	Semi-Volatile							
Benzo(g,h,i)perylene	Semi-Volatile							
Benzo(k)fluoranthene	Semi-Volatile							
Benzyl Alcohol	Semi-Volatile							
Bis(2-Chloroethoxy)methane	Semi-Volatile							
Bis(2-Chloroethyl)ether	Semi-Volatile							
Bis(2-Chloroisopropyl)ether	Semi-Volatile							
Bis(2-Ethylhexyl)phthalate	Semi-Volatile							
Butyl Benzylphthalate	Semi-Volatile							
Carbofuran	Semi-Volatile (P)	40 ug/l(c)	40 ug/l(c)					
Carbon Disulfide	Semi-Volatile							
Chlordane	Semi-Volatile (P)	2 ug/l(c)	0 ug/l(c)					
Chlorophenol	Semi-Volatile							
DDT	Semi-Volatile (P)							
DDT metabolite (DDE)	Semi-Volatile (P)							
DDT metabolite (DDD)	Semi-Volatile (P)							
Dalapon	Semi-Volatile (P)	200 ug/l(d)	200 ug/l(d)					
Diallite	Semi-Volatile							
Dibenzofuran	Semi-Volatile							
Dibenz(a,h)anthracene	Semi-Volatile							
Dibromochloropropane	Semi-Volatile (P)	0.2 ug/l	0 ug/l					

TABLE 8-2
POTENTIAL SITE-WIDE CHEMICAL-SPECIFIC ARARs/TBCs
GROUNDWATER QUALITY STANDARDS
CANNON AFB, FIRE TRAINING AREA No. 4

		FEDERAL STANDARDS			STATE STANDARDS NMWQCC Groundwater Quality Standards (g)			
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level Goal (a) ARARs/TBCs	RCRA Subpart F Concentration Limit (40 CFR 264.94) (b)	Community Water Supply System (h)	Human Health	Other Standards for Domestic Water Supply	Irrigation Use
Dichlorobenzene	Semi-Volatile							
Dichlorobenzidine	Semi-Volatile							
Dieldrin	Semi-Volatile (P)							
Di(2-ethylhexyl)adipate	Semi-Volatile (P)	400 ug/l(d)	400 ug/l(d)					
Diethylphthalate	Semi-Volatile							
Di(2-ethylhexyl)phthalate	Semi-Volatile	6.0 ug/l(d)	0 ug/l(d)					
Dimethoate	Semi-Volatile							
Dimethylphthalate	Semi-Volatile							
Dinitrotoluene	Semi-Volatile							
Dinoseb	Semi-Volatile(H)	7 ug/l(d)	7 ug/l(d)					
Di-n-octylphthalate	Semi-Volatile							
Diquat	Semi-Volatile(P)	20 ug/l(d)	20 ug/l(d)					
Endosulfan I	Semi-Volatile (P)							
Endosulfan II	Semi-Volatile (P)							
Endosulfan Sulfate	Semi-Volatile (P)							
Endothall	Semi-Volatile (P)	100 ug/l	100 ug/l					
Endrin	Semi-Volatile (P)	2.0 ug/l(d)	2.0 ug/l(d)	0.2 ug/l	0.2 ug/l			
Ethylene Dibromide	Semi-Volatile	0.05 ug/l(c)	0 ug/l(c)			0.1 ug/l		0.1 ug/l
Fluoranthene	Semi-Volatile							
Fluorene	Semi-Volatile							
Glyphosate	Semi-Volatile(P)	700 ug/l(d)	700 ug/l(d)					

TABLE 8-2
POTENTIAL SITE-WIDE CHEMICAL-SPECIFIC ARARs/TBCs
GROUNDWATER QUALITY STANDARDS
CANNON AFB, FIRE TRAINING AREA No. 4

		FEDERAL STANDARDS			STATE STANDARDS NMWQCC Groundwater Quality Standards (g)			
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level Goal (a) ARARs/TBCs	RCRA Subpart F Concentration Limit (40 CFR 264.94) (b)	Community Water Supply System (h)	Human Health	Other Standards for Domestic Water Supply	Irrigation Use
Heptachlor	Semi-Volatile (P)	0.4 ug/l(c)	0 ug/l(c)					
Heptachlor Epoxide	Semi-Volatile (P)	0.2 ug/l(c)	0 ug/l(c)					
Hexachlorobenzene	Semi-Volatile	1.0 ug/l(d)	0 ug/l(d)					
Hexachlorobutadiene	Semi-Volatile							
Hexachlorocyclohexane, Alpha	Semi-Volatile (P)							
Hexachlorocyclohexane, Beta	Semi-Volatile (P)							
Hexachlorocyclohexane, (Lindane)	Semi-Volatile (P)	0.2 ug/l(c)	0.2 ug/l(c)	4 ug/l	4 ug/l			
Hexachlorocyclohexane, Technical	Semi-Volatile (P)							
Hexachlorocyclopentadiene	Semi-Volatile	50 ug/l(d)	50 ug/l(d)					
Hexachloroethane	Semi-Volatile							
Indeno(1,2,3-cd)pyrene	Semi-Volatile							
Methoxychlor	Semi-Volatile (P)	40 ug/l	40 ug/l(c)	100 ug/l	100 ug/l			
Naphthalene	Semi-Volatile							
Nitrobenzene	Semi-Volatile							
Nitrophenols	Semi-Volatile							
Nitrosodibutylamine	Semi-Volatile							
Nitrosodiethylamine	Semi-Volatile							
Nitrosodimethylamine	Semi-Volatile							
Nitrosopyrrolidine	Semi-Volatile							
N-Nitrosodiphenylamine	Semi-Volatile							

TABLE 8-2
POTENTIAL SITE-WIDE CHEMICAL-SPECIFIC ARARs/TBCs
GROUNDWATER QUALITY STANDARDS
CANNON AFB, FIRE TRAINING AREA No. 4

		FEDERAL STANDARDS			STATE STANDARDS NMWQCC Groundwater Quality Standards (g)			
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level Goal (a) ARARs/TBCs	RCRA Subpart F Concentration Limit (40 CFR 264.94) (b)	Community Water Supply System (h)	Human Health	Other Standards for Domestic Water Supply	Irrigation Use
N-Nitroso-di-n-dipropylamine	Semi-Volatile							
Oxamyl	Semi-Volatile(P)	200 ug/l(d)	200 ug/l(d)					
PCBs	PCBs	0.5 ug/l(c)	0 ug/l(c)			1 ug/l		1 ug/l
Pentachlorinated Ethanes	Semi-Volatile							
Pentachlorophenol	Semi-Volatile	1 ug/l(c)	0 ug/l(e)					
Phenanthrene	Semi-Volatile							
Phenol	Semi-Volatile				5 ug/l		5 ug/l	5 ug/l
Picloram	Semi-Volatile (H)	500 ug/l	500 ug/l					
Polynuclear Aromatic Hydrocarbons (total PAH)	Semi-Volatile				30 ug/l	30 ug/l		30 ug/l
Pyrene	Semi-Volatile							
Simazine	Semi-Volatile(P)	4 ug/l(d)	4 ug/l(d)					
Trans-1,2-Dichloroethene	Semi-Volatile	100 ug/l	100 ug/l					
Toxaphene	Semi-Volatile (P)	3 ug/l(c)	0 ug/l(c)	5 ug/l	5 ug/l			

TABLE 8-2
POTENTIAL SITE-WIDE CHEMICAL-SPECIFIC ARARs/TBCs
GROUNDWATER QUALITY STANDARDS
CANNON AFB, FIRE TRAINING AREA No. 4

EXPLANATION OF TABLE

(P) Pesticide (H) Herbicide

* = secondary maximum contaminant level (TBCs)
** = total trihalomethanes: chloroform, bromoform, bromodichloromethane, dibromochloromethane
*** = action levels in no more than 10% of tap samples, 56 FR 26460, 6/7/91, effective 12/7/92

NMWQCC = New Mexico Water Quality Control Commission
RCRA = Resource Conservation and Recovery Act
SDWA = Safe Drinking Water Act
(a) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR 141 and 40 CFR 143 (as of 5/1990)
(b) NCP, 40 CFR 300; NCP Preamble 55 FR 8764; CERCLA Compliance with Other Laws Manual EPA/540/G-89/006, August 1988
(c) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142, 143, Final Rule, Effective July 30, 1992 (56 Federal Register 3526; 1/30/91)
(d) EPA National Primary Drinking Water Regulations, 40 CFR 141 and 40 CFR 142, Final Rule (57FR 31776, 7/17/92); Effective date is January 17, 1994, (therefore TBCs) except for endrin, which is effective 8/17/92.
(e) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142, 143, Final Rule, Effective January 1, 1993 (56 FR 30266, 7/01/91)
(f) EPA Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper, 40 CFR 141 and 142; effective December 7, 1992 (56 FR 26460, 6/7/91)
(g) NM Water Quality Control Commission, NM Water Quality Regulations, Part 3, Section 3-103, 11/16/1967 amended through August 17, 1991
(h) New Mexico Drinking Water/Water Supply Regulations, adopted April 16, 1991

If no values are shown for a possible contaminant, there are no standards at this time.

TABLE 8-3

POTENTIAL SCREENING CONCENTRATIONS FOR INORGANIC COMPOUNDS IN SOIL (TO BE CONSIDERED) CANNON AFB, FIRE TRAINING AREA No. 4

Compound	RFI Guidance TBCs[a] (mg/kg)	Proposed RCRA Action Level Level TBCs[b] (mg/kg)	Proposed RCRA Action Level TBCs[c] (mg/kg)	Other TBCs[d] (mg/kg)	Average Background Concentration[e] (mg/kg)	Range of Background Concentrations[e,f] (mg/kg)
aluminum	-	-	-	-	5700	860 - 10,540
antimony	30	30	32	-	6.75	1.33 - 12.2
arsenic*	-	80	0.39	-	3.5	0 - 15.5
barium	4000	4000	5600		166	0 - 642
beryllium*	0.14	0.2	0.16		0.41	0.09 - 0.73
cadmium	-	40	80	-	1.1	0 - 2.9
calcium	-	-	-	-	69,200	0 - 186,400
chromium III	80000	(for CrVI) 400	80000	-	6.98	1.42 - 12.5
cobalt	-	-	-	-	2.5	0.5 - 4.5
copper	-	-	-	-	5.4	0 - 13.0
iron	-	-	-	-	4,780	840 - 8,720
lead	-	-	-	500 - 1000	7.12	0 - 25.8
magnesium	-	-	-	-	4,650	0 - 11,790
manganese	-	-	8000	-	72	0 - 164
mercury	-	20	24	-	0.11	0.9 - 0.13
nickel	2000	2000	1600		5.0	1.0 - 9.0
potassium	-	-	-	-	1360	148 - 2,572
selenium	-	-	400		8.23	0 - 56.6
silver	200	200	400		1.2	0.2 - 2.2
sodium	-	-	-	-	514	0 - 1,042
thallium**	30	6	5.6	-	0.50	0 - 1.2
vanadium	-	-	560	-	14.9	4.50 - 25.3

TABLE 8-3
POTENTIAL SCREENING CONCENTRATIONS FOR INORGANIC COMPOUNDS IN SOIL
(TO BE CONSIDERED)
CANNON AFB, FIRE TRAINING AREA No. 4

Compound	RFI Guidance TBCs[a] (mg/kg)	Proposed RCRA Action Level Level TBCs[b] (mg/kg)	Proposed RCRA Action Level TBCs[c] (mg/kg)	Other TBCs[d] (mg/kg)	Average Background Concentration[e] (mg/kg)	Range of Background Concentrations[e,f] (mg/kg)
zinc	-	-	16000	-	11.3	0.72 - 21.9

[a] RCRA Facility Investigation Guidance (EPA 1989a); human health-based criteria for systemic toxicants representing an estimate of the daily exposure an individual can experience without appreciable risk of health effects during a lifetime.
[b] Source: Corrective Action for SWMUs at Hazardous Waste Management Facilities (55 FR 30798, 27 July 1990). These risk-based levels trigger the need for a corrective action measure study.
[c] Human Health proposed action levels using calculations in 55 FR 30798. Sources of toxicity factors used in calculations include: (1) Integrated Risk Information System (IRIS) and (2) Health Effects Assessment Summary Tables (HEAST) FY1992.
[d] Source: Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites (USEPA, OSWER Directive 9355.4-02, 1990).
[e] Source: Woodward-Clyde Consultants, 1993.
[f] Average $\pm$ 2 standard deviations
* Carcinogen
** Values reported are for thallic oxide.

TABLE 8-4

SUMMARY OF POTENTIAL LOCATION-SPECIFIC ARARs
CANNON AFB, FIRE TRAINING AREA No. 4

Requirement	Potentially Applicable?	Potentially Relevant and Appropriate?	Comments
Resource Conservation and Recovery Act (RCRA)			
1. New facilities where treatment, storage or disposal of hazardous waste will be conducted is prohibited within 61 meters (200 feet) of a fault displaced in Holocene time [40 CFR 264.18(a)]*	No	No	Treatment, storage and disposal of waste will not be conducted within 61 meters of a fault displaced in Holocene time.
2. New facilities where treatment, storage or disposal of hazardous waste will be conducted is prohibited within the 100-year floodplain. [40 CFR 264.18(b)]*	No	No	Treatment, storage and disposal of waste will not be conducted within the 100-year floodplain of adjacent rivers.
3. Prohibits noncontainerized or bulk liquid hazardous waste placement in salt domes, salt bed formations, and underground mines or caves. [40 CFR 264.18(c)]*	No	No	No action which would place waste in a salt dome or salt bed formation, underground mine or cave is anticipated at this site.
E.O. 11988 Protection of Floodplains			
4. Limits activities in floodplain. Floodplain is defined as "the lowland and relatively flat areas adjoining inland and coastal waters including flood prone areas of off-shore islands, including at a minimum, that area subject to a one percent or greater chance of flooding in any given year." [40 CFR 6, Appendix A and 40 CRF 6.302]	No	No	Remedial activities will not be conducted within any floodplains.

*Adopted by the State of New Mexico and incorporated within Part V of the New Mexico Hazardous Waste Management Regulations.

TABLE 8-4
SUMMARY OF POTENTIAL LOCATION-SPECIFIC ARARs
CANNON AFB, FIRE TRAINING AREA No. 4

Requirement	Potentially Applicable?	Potentially Relevant and Appropriate?	Comments
E.O. 11990 Protection of Wetlands			
5. Minimizes impacts on areas designated as wetlands. [40 CRF 6, Appendix A]	No	No	Although playas are considered wetlands by the U.S. Fish and Wildlife Service, regulations are applicable only if the remedial activities impact the wetland areas. No impacts to the wetland areas are anticipated at this time.
Clean Water Act Section 404			
6. Action to prohibit discharge of dredged or fill material into waters of U.S. without permit. [33 USC 1251; 40 CFR 230; 33 CFR 320-330]	No	No	Dredge and fill permit requirements will not apply as no waters of the U.S. will be impacted by remedial activities on the site.
7. Requires Federal agencies to avoid, to the extent possible, adverse impacts associated with destruction or loss of wetlands	No	No	As described above, although wetlands are considered by the U.S. Fish and Wildlife Service to occur on the base in the form of playas, regulations are applicable only if the remedial activities impact the wetland area.

TABLE 8-4
SUMMARY OF POTENTIAL LOCATION-SPECIFIC ARARs
CANNON AFB, FIRE TRAINING AREA No. 4

Requirement	Potentially Applicable?	Potentially Relevant and Appropriate?	Comments
Endangered Species Act			
8. Protects endangered species and threatened species and preserves their habitat. [16 USC 1531 et sequence; 50 CFR 200, 50 CFR 402]	Yes	---	Although Walk, Haydel & Associates report in their Remedial Investigation that there are no critical habitats in the immediate vicinity of the site (according to the Wildlife Management Plan for the base), two federally listed endangered species are known to inhabit the area within a 50-mile radius of the site (Lee Wan & Associates, Inc., 6/90).
Bald Eagle Protection Act			
9. Protects all eagle species and restricts activities that may threaten or adversely affect their habitat (16 USC Section 688 et. seq)	Yes	---	If eagle species are found to occur on the base, special protection provisions will need to be coordinated with US Fish and Wildlife Service. Bald eagles are known to inhabit the area within a 50-mile radius of the site (Lee Wan & Associates, Inc., 6/90).
Migratory Bird Treaty Act			
10. Protects migratory, resident, or range habitat of migratory birds including raptors and waterfowl. (16 USC Section 703 et. seq).	Yes	--	Remedial actions cannot threaten or adversely affect the habitats of migratory waterfowl or raptors.

TABLE 8-4
SUMMARY OF POTENTIAL LOCATION-SPECIFIC ARARs
CANNON AFB, FIRE TRAINING AREA No. 4

Requirement	Potentially Applicable?	Potentially Relevant and Appropriate?	Comments
Wilderness Act			
11. Limits activities within an area designed as a wilderness area. [16 USC 1311 et seq.; 50CFR 53.1 et seq.]	No	No	The site is not within a federally-owned area designated as a wilderness area.
12. Limits the type of activities permitted in an area designated as a National Wildlife Refuge system [16 USC 668 et seq.; 50 CFR Part 27]	No	No	The site is not in an area designated as part of the National Wildlife Refuge System (the closest NWRS are over 25 miles from the site).
Fish and Wildlife Coordination Act			
13. Prohibits activities affecting/modifying streams or bodies of water if the activity has a negative impact on fish or wildlife. [16 USC 661 et seq.; 33 CFR Parts 320-330; 40 CFR 6.302]	No	No	As described above, no streams, rivers, or playas will be impacted by remedial activities.
Wild and Scenic Rivers Act			
14. Protects rivers that are designated as wild, scenic or recreational. [16 USC 1271; 40 CFR 6.302(e)]	No	No	No rivers designated as wild, scenic or recreational will be affected by remedial activities.

TABLE 8-4
SUMMARY OF POTENTIAL LOCATION-SPECIFIC ARARs
CANNON AFB, FIRE TRAINING AREA No. 4

Requirement	Potentially Applicable?	Potentially Relevant and Appropriate?	Comments
National Historic Preservation Act (NHPA)			
15. Requires the preservation of historic properties included in or eligible for the National Register of Historic Places and to minimize harm to National Historic Landmarks. [16 USC 470 et seq.; 7 CFR 650; 36 CFR Part 65, Part 800]	Yes	---	Pursuant to Section 106 of NHPA, proposed federal undertaking in any state shall take into consideration the effect of the undertaking on any site, building, structure, or object that is included or eligible for inclusion in the National Register; nothing has been placed on the register to date, but surveys are ongoing. Also applicable if historical sites are discovered during a remedial action or if known historical sites exist near a remedial action site.
The Historic and Archaeological Data Preservation Act of 1974			
16. Establishes procedures to provide for preservation of historical and archaeological data which might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity program (16 USC 469, 40 CFR 6.301(c))	Yes	---	May be available if remedial activities affect historical and/or undiscovered archaeological data of the site.
The Archaeological Resource Protection Act of 1979			
17. Requires a permit for any excavation or removal of archaeological resources form public or Indian lands (16 USC 470aa-47011)	Yes	---	May be applicable if any remedial activity involves removal of archaeological resources; substantive requirements need to be met.

TABLE 8-4
SUMMARY OF POTENTIAL LOCATION-SPECIFIC ARARs
CANNON AFB, FIRE TRAINING AREA No. 4

Requirement	Potentially Applicable?	Potentially Relevant and Appropriate?	Comments
Coastal Zone Management Act			
18. Limits activities affecting the coastal zone, including lands thereunder and adjacent shorelands. [16 USC Section 1451 et sequence]	No	No	The site is not located in the coastal zone management area.
State Regulations			
Endangered Species Act (New Mexico Regulation 682)			
19. Requires coordination with the Department of Game and Fish if activities impact on endangered/ threatened species or their habitat.	Yes	---	As stated above, although Walk, Haydel & Associates report in their Remedial Investigation that there are no significant habitats in the immediate vicinity of the site, state listed threatened/ endangered species have been identified at or near the base.
1978 New Mexico State Cultural Properties Act (Sections 18-6-1 through 18-6-17 NMSA 1978)			
20. Provides for the preservation, protection, and enhancement of structures, sites, and objects of historical significance within the State.	Yes	--	Although the Cannon AFB site, including its properties/buildings are not listed on the State Register of Historic Places, coordination with the State Historic Preservation Office is ongoing with respect to the historical and archaeological surveys that have been conducted at the base; State laws closely follow the federal laws.

9.0
REFERENCES

American Publishers, Inc. of Texas. 1991. Cannon AFB Area Joint Military Telephone Directory and Yellow Pages.

Chemical Publishing Company, Inc. 1987. Handbook of Industrial Toxicology.

CH_2M Hill. 1983. Installation Restoration Program Records Search for Cannon Air Force Base, New Mexico. Prepared for the Air Force Engineering and Services Center and the Tactical Air Command. Contract No. FO8637-80-G0010-0018. August.

Clayton and Clayton, Editors. 1981. Patty's Industrial Hygiene and Toxicology, Third Revision. Volume IIA.

Freeze, R.A., and J.A. Cherry. 1979. Groundwater. Prentice-Hall, Inc. Englewood Cliffs, N.J. p.29.

Genium Publishing Corporation. 1989. Material Safety Data Sheet No. 260, Osmium Tetroxide.

Gutentag, E.D., et al. 1984. Geohydrology of the High Plains Aquifer in Parts of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming. USGS Professional Paper 1400-B.

Hale, Bruce. 1992. Personal communication between Bruce Hale and Woodward-Clyde Consultants. May 11.

Kearney, A.T. 1987. Preliminary Review/VSI Report, RCRA Facility Assessment Cannon Air Force Base. U.S. Environmental Protection Agency, Region VI. A.T. Kearney, Inc., Chicago, Illinois.

Lee Wan & Associates, Inc. 1990a. (And references contained therein). RCRA Facility Investigation Program Management Plan. Cannon AFB, New Mexico. Prepared for 27 CSG/DEV Cannon AFB, New Mexico.

Lee Wan & Associates, Inc. 1990b. (And references contained therein). RCRA Facility Investigation Field Sampling Plan. Cannon AFB, New Mexico. Prepared for 27 CSG/DEV Cannon AFB, New Mexico.

Lee Wan & Associates, Inc. 1990c. RCRA Facility Investigation Sitewide Data Collection Quality Assurance Plan. Cannon AFB, New Mexico. Prepared for 27 CSG/DEV Cannon AFB, New Mexico.

Luckey, R.R., et al. 1981. Water-level and Saturated Thickness Changes, Predevelopment to 1980, in the High Plains Aquifer in Parts of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming. Hydrologic Investigation Atlas HA-652. U.S. Geological Survey.

U.S. Air Force (USAF). 1990. Final Environmental Impact Statement, Realignment of Cannon AFB, Curry County, New Mexico. May.

U.S. Department of Agriculture (USDA) Soil Conservation Service. 1958. Soil Survey of Curry County, New Mexico. Soil Survey Series 1953, No. 4. U.S. Government Printing Office.

United States Environmental Protection Agency (USEPA). 1983. Methods for Chemical Analysis of Water and Wastes. EPA/600/4-79/020.

United States Environmental Protection Agency (USEPA). 1986. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. SW-846, Third Edition (including Final Update I).

United States Environmental Protection Agency (USEPA). 1987. Data Quality Objectives for Remedial Response Activities. et. EPA/540/G-87/003. March.

United States Environmental Protection Agency (USEPA). 1988a. Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses. EPA Data Review Work Group. July.

United States Environmental Protection Agency (USEPA). 1988b. Statement of Work for Inorganics Analysis. SOW No. 788 Rev. 2/89 and 6/89.

United States Environmental Protection Agency (USEPA). 1990a. Guidance for Data Useability in Risk Assessment. OSWER Directive 9285.7-05. EPA 540/G-90/008. October.

U.S. Environmental Protection Agency (EPA). 1990b. SOP, Polychlorinated Dibenzodioxins/ Polychlorinated Dibenzofurans Data Review. October 1990.

United States Environmental Protection Agency (USEPA). 1991. Draft National Functional Guidelines for Organics Data Review. USEPA Contract Laboratory Program. December 1990. Rev. June 1991.

U. S. Environmental Protection Agency, 1995, *Risk-Based Concentration Table,* Office of RCRA Technical & Program Support Branch, USEPA Region III.

United States Fish and Wildlife Service (USFWS). 1987. Endangered and Threatened Species of Arizona and New Mexico.

Walk, Haydel & Associates, Inc. 1990. Final Installation Restoration Program Remedial Investigation. Cannon Air Force Base, New Mexico. Prepared under contract with Omaha District, Corps of Engineers, Omaha, Nebraska, for Headquarters, Tactical Air Command, HQ, TAC/DEEV, Langley Air Force Base, Virginia. 3 volumes.

Weeks, J.B., and E.D. Gutentag. 1981. Bedrock Geology, Altitude of Base and 1980 Saturated Thickness of the High Plains Aquifer in Parts of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, Wyoming: Hydrologic Investigation Atlas. HA-648, U.S. Geological Survey.

William Matotan and Associates Inc. 1985. Water Well Master Plan Survey. Prepared for Department of the Air Force, Cannon Air Force Base, New Mexico.

APPENDIX A
STANDARD OPERATING PROCEDURES

Standard Operating Procedure No. 1

PASSIVE SOIL GAS SURVEY

STANDARD OPERATING PROCEDURE No. 1

PASSIVE SOIL GAS SURVEY

CANNON AIR FORCE BASE, FIRE TRAINING AREA No. 4
RCRA FACILITY INVESTIGATION
CLOVIS, NEW MEXICO

USACE CONTRACT No. DACW45-94-D-0044
DELIVERY ORDER No. 0006
HARZA PROJECT No. 5644M

Approvals: Date

1-10-96

Robert P. Kewer, P.G.
Project Manager

1-30-96

Krishna V. Mayenkar, P.E.
Department Head

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ATTACHMENT:

Installation and Retrieval Information Sheet, Gore-Sorber® Screening Modules (W. L. Gore & Associates, June 4, 1993)

3.0
PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) defines the methods to be used for passive soil gas surveys at the Fire Training Area #4, Cannon Air Force Base, Clovis, New Mexico. Results will be used to identify target zones for soil borings and chemical sampling and laboratory analysis programs and to provide information on the extent of VOC and SVOC contamination. The procedure does not address requirements associated with laboratory analysis of samples. This SOP supplements and is intended to be used with the Data Collection Quality Assurance Plan (DCQAP) and other SOPs as referenced. Additional information on the procedures to be used also are provided by Gore and attached to this SOP.

4.0
RESPONSIBILITIES AND QUALIFICATIONS

Harza's Project Manager is responsible for assuring that passive soil gas survey is conducted according to this procedure. The Project Manager will designate qualified project staff, including a Task Leader, to complete this procedure and the required reviews.

Designated project staff are responsible for passive soil gas survey according to this procedure. They will report progress and any problems to the Task Leader or Project Manager. Staff members are responsible for understanding the activities assigned to them and the associated Quality Assurance (QA) requirements.

All personnel performing activities covered in this SOP shall be qualified to perform the activities assigned to them. The Project Manager will appraise the qualifications of prospective assignees based on their experience and training with respect to the job requirements. The Project Manager also will determine whether future training is required and, if so, by what method. On-the-job training is acceptable provided such training is received from a person qualified to perform the assignment and the results of training are documented.

5.1 GENERAL

The passive soil gas survey will employ patented Gore-Sorber® Screening Modules which can provide qualitative data on the concentrations of volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) in soil vapor at the time of screening. The passive soil gas survey will be performed to investigate areas of potential VOC and SVOC contamination within the boundaries of Fire Training Area #4. Installation and recovery of the Screening Modules shall be performed by Harza. Laboratory analysis of the samples will be performed by Gore. ***All personnel conducting passive soil gas surveys covered in this SOP are required to read and be familiar with additional information provided by Gore and attached to this SOP.***

5.2 EQUIPMENT AND MATERIALS

- Fluorescent orange spray paint, survey stakes, fluorescent survey ribbon, waterproof markers.
- Correctly scaled site map
- Pen, clipboard, field notebook, chain-of-custody form, and instruction sheet
- Measuring tape
- Slide hammer (obtained from Gore)
- Gore-Sorber® Screening Modules and Vials (provided by Gore)
- Electric masonry drill with ¾-inch bit and portable generator
- Corks with screw eyes (provided by Gore)
- Insertion rod (provided by Gore)
- Surgical gloves
- Paper towels and water (decon of an insertion rod)
- Knife, scissors, and a pair needle-nose pliers
- Cooler with adequate supply of chilled ice packs
- Cork screw
- Small shovel
- Camera and film

5.3 PROCEDURE

5.3.1 Field Deployment of Screening Modules

1. Locate and mark all sampling locations on the ground (see SOP #3).
2. Create a ¾-inch diameter hole approximately 3 feet deep, using the slide hammer and tile probe. If necessary, use the masonry drill/generator to penetrate any pavement.
3. Wearing surgical gloves, remove the Gore-Sorber® Screening Module from its sealed container and record its number on the site map and field logbook.
4. Insert the stainless steel insertion rod into the pocket in the bottom of the module, and lower the module into the hole.
5. When the module is completely inserted into the hole, press the insertion rod against the side of the hole. Twist the rod and pull it out.
6. Attach the end of the module to the screw eye in a cork.
7. Coil the access retrieval cord and push it with the metal label into the hole.
8. Cork the hole to prevent the intrusion of rain and atmospheric gases during exposure.
9. Decontaminate the insertion rod after each use (see SOP #4).
10. Demobilize from the site.

The Screening Modules will remain in place for approximately 2 weeks. This length of time is required to allow adsorption of SVOC compounds. When the required period is complete, the Screening Modules will be retreived by Harza, as described in the following section.

5.3.2 Retrieval of Screening Modules

1. Remove cork with cork screw.
2. Wearing surgical gloves, wrap retrieval cord once or twice around a hand.
3. Using slow, steady tension, pull the cord straight up out of the ground. Verify that the Module ID# is the same as on the site map and logbook.
4. Cut off the cork and discard.
5. Put the entire retrieval cord back into the correctly labeled vial, including the metal tag.
6. Tightly reseal the vial.
7. Using the vial racks, place vials into a cooler, label the cooler, and express ship the cooler with the exposed vials to: Screening Modules Laboratory, W. L. Gore &

Associates, Inc., 101 Lewisville Road, Elkton, Maryland 21921. Coolers are to be marked: "Attention: Notify Lab Immediately Upon Delivery!!"

All retreived samples will be handled and documented in accordance with applicable procedures in SOP #9. ***However, samplers shall read and be familiar with additional handling instructions and cautions for these samples provided by Gore and attached to this SOP.***

6.0
DOCUMENTATION

Documentation of the passive soil gas survey procedure will be recorded in a bound field logbook and, at a minimum, will included the following in addition to requirements delineated in SOP#9:

- Name and location of the site;
- Date and time of module installation/retrieval;
- Location of sampling points and depth of the installed modules;
- Sample location number;
- Observations of site conditions at the time of installation/retrieval;
- Physical description of the retrieved modules; and
- Name of persons performing the modules installation/retrieval;

A color photograph also will be taken of each module location after installation and before retrieval. Photographs will be taken and documented as described in SOP #3. The location of passive soil gas sampling points will be recorded on the site map and in the field logbook with reference to the site grid.

ATTACHMENT

INSTALLATION AND RETRIEVAL INFORMATION SHEET
GORE-SORBER SCREENING MODULES
June 4, 1993

W. L. GORE & ASSOCIATES
ENVIRONMENTAL PRODUCTS GROUP

INSTALLATION AND RETRIEVAL INFORMATION SHEET

GORE-SORBER® SCREENING MODULES

June 4, 1993

IF YOU HAVE ANY QUESTIONS AFTER YOU HAVE READ THESE INSTRUCTIONS, PLEASE CALL MARK WRIGLEY OR BARBARA KEAVENEY AT (410) 392-3300.

DESCRIPTION: GORE-SORBER Screening Modules are pollution detection sensors, utilizing Gore's patented sorbent containers and apparatus. The heart of our GORE-SORBER Screening Module is GORE-SORBER Passive Sorbent Collection Device ("sorber"), a container constructed of GORE-TEX® expanded polytetrafluoroethylene (ePTFE, similar to Teflon®) tubing. The sorbent mixture has been carefully selected to detect a broad range of volatile and semivolatile organic compounds. Replicate sorbers are housed in the bottom of an outer length of ePTFE tubing and sealed. The outer length of tubing serves as a sensor insertion and retrieval means.

CAUTION: GORE-SORBER Screening Modules are specially cleaned and stored after manufacturing. They must remain sealed in their shipping vials until deployment. Do not store or use them near cigarette smoke, gasoline, diesel fumes of exhaust, styrofoam peanuts, solvents, insect repellents, sunblocks, hand lotions or any other source of volatile organic compounds.

REQUIRED TOOLS: To date, most GORE-SORBER Screening Modules have been installed in 9/16" to 1" diameter holes, using a slide hammer and tile probe, or an electric rotary hammer auger. Installation depth is site dependent, but 3-4' is normally sufficient. Some of the recommended tools for a GORE-SORBER® Screening Survey are :

- Fluorescent spray paint, flags, or some other reliable means of location marking
- Correctly scaled site map
- Pen, clipboard, field notebook, chain-of-custody form, and this instruction sheet
- Measuring tapes, transit, or other distance measuring device
- Electric rotary hammer with 1" carbide tipped bit (31"- 36" long)
- Extension cords
- Electric power source (AC power outlet or generator)
- Slide hammer /Tile probe
- GORE-SORBER Screening Modules & Vials (supplied)
- Corks with screw eyes (supplied)
- Insertion rod (supplied)
- Surgical gloves
- Paper towels and water (de-con of the auger and insertion rod)
- Trash bag
- Knife, scissors, and a pair of needle-nose pliers.

GORE
Creative Technologies Worldwide

W. L. Gore & Associates
101 Lewisville Rd., P.O. Box 1100, Elkton, MD 21922-1100
Phone: 410-392-3300 Fax: 410-996-3325

GORE-TEX is a registered trademark of W. L. Gore & Associates
GORE-SORBER Screening Survey is a registered Service mark of W. L. Gore & Associates
GORE-SORBER is a registered trademark of W. L. Gore & Associates

Printed on Recycled Paper

FIELD DEPLOYMENT / INSTALLATION: Locate and mark all Screening Module locations on the ground using the spray paint and/or flags. Be sure to mark the locations well in order to ease retrieval. Create a narrow diameter hole, using a slide hammer and tile probe, or a rotary electric hammer auger. Wearing surgical gloves, remove the GORE-SORBER Screening Module from its sealed container. Note that each module has a unique serial number recorded on the top of the module and a metal tag attached to the module. Each vial is also individually numbered. **Record this number on the site map immediately!** Insert the stainless steel insertion rod into the pocket in the bottom of the module, and lower it into the hole. Be sure the module goes the entire way down the hole. If a large resistance is felt during insertion, remove the module and re-drill the hole. Re-insert the module. When the module is completely inserted into the hole, press the insertion rod against the side of the hole. Twist the rod and pull it out. Attach the end of the module to the screw eye in a cork. **Do not remove the metal ID tag!** Coil the excess retrieval cord and push it with the metal label into the hole. Cork the hole to prevent the intrusion of rain and atmospheric gasses during exposure. If the cork does not fit snugly into the hole, wrap a short length of the module retrieval cord around the cork and re-insert the cork into the hole. Decontaminate the auger and insertion rod after each use, using standard procedures (i.e. paper towels & clean water). If the surgical gloves become contaminated, replace them before handling any further modules.

GORE-SORBER MODULE RETRIEVAL: Some tools recommended for GORE-SORBER Module retrieval are:

- Cooler(s) with adequate supply of chilled ice packs, or water ice cubes **(required)**
- Original GORE-SORBER Module vials and racks **(required)**
- Site map with module locations **(required)**
- Distance measuring equipment
- Cork screw
- Knife, scissors, needle-nose pliers
- Small shovel
- Patching compound and equipment for concrete and asphalt holes (if required)
- Trash bag
- Surgical gloves.

Remove cork with cork screw. Wearing surgical gloves, wrap retrieval cord once or twice around your hand. Using a slow, steady tension, pull the cord straight up out of the ground. **Double check the Module ID# on the site map!** Cut off the cork and discard. **Put the entire retrieval cord back into the correctly labeled vial, including the metal tag.** Tightly reseal the vial. Using the vial racks and cooler, return the exposed vials and all supplies to the address below via Federal Express Overnight Service {(800) 238-5355}. **DO NOT** use Styrofoam "peanuts" or any other packing material which may contain volatiles or outgas and contaminate sorbers during shipment. Bubble packing is acceptable. Address the cooler to:

SCREENING MODULES LABORATORY
W. L. GORE & ASSOCIATES, INC.
101 LEWISVILLE ROAD
ELKTON, MD 21921
ATTN: NOTIFY LAB IMMEDIATELY UPON DELIVERY!!

GORE-SORBER Screening Module and GORE-TEX are registered trademarks of W. L. Gore & Associates
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Standard Operating Procedure No. 2

HEADSPACE SCREENING

STANDARD OPERATING PROCEDURE No. 2

HEADSPACE SCREENING

CANNON AIR FORCE BASE, FIRE TRAINING AREA No. 4
RCRA FACILITY INVESTIGATION
CLOVIS, NEW MEXICO

USACE CONTRACT No. DACW45-94-D-0044
DELIVERY ORDER No. 0006
HARZA PROJECT No. 5644M

Approvals: Date

1-9-96

Robert P. Kewer, P.G.
Project Manager

1-30-96

Krishna V. Mayenkar, P.E.
Department Head

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3.0
PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) defines the methods to be used for headspace screening of soil samples obtained from borings at Fire Training Area No. 4, Cannon Air Force Base, Clovis, New Mexico. Results of headspace screening will be used to provide qualitative data on the concentrations of volatile organic compounds (VOCs) in soil samples at the time of sample collection. Results will be used to identify target zones for immunoassay screening and for sampling and laboratory analysis programs and to provide information on the possible extent of VOC contamination. It is not applicable to inorganic constituents and is most effective in detecting compounds with boiling points less than 125°C. The procedure does not address sampling methods or additional requirements associated with laboratory analysis of samples. This SOP supplements and is intended to be used with the Data Collection Quality Assurance Plan (DCQAP) and other SOPs, as referenced.

4.0
RESPONSIBILITIES AND QUALIFICATIONS

Harza's Project Manager is responsible for assuring that headspace screening is conducted according to this procedure. The Project Manager will designate qualified project staff, including a Task Leader, to complete this procedure and the required reviews.

Designated project staff are responsible for headspace screening according to this procedure. They will report progress, and any problems, to the Task Leader or Project Manager. Staff members are responsible for understanding the activities assigned to them and the associated Quality Assurance (QA) requirements.

All personnel performing activities covered in this SOP shall be qualified to perform the activities assigned to them. The Project Manager will appraise the qualifications of prospective assignees based on their experience and training with respect to the job requirements. The Project Manager also will determine whether future training is required and, if so, by what method. On-the-job training is acceptable provided such training is received from a person qualified to perform the assignment and the results of training are documented.

5.1 GENERAL

Headspace screening shall be conducted during drilling of soil borings by Rotasonic methods at the site. An organic vapor analyzer equipped with a photo-ionization detector (PID) shall be used for this procedure. The ionization potential of the lamp for the PID shall be 11.7 eV, based upon the ionization potentials of the principal contaminants of concern. It is noted that detection limits that may be achieved and the consistency of results can vary widely among samples due to the large variability of physical and chemical properties of compounds and variability of sample matrices. Loss of VOCs during sample collection may also affect the detected concentration.

The Rotasonic drilling method will provide continuous soil "core" samples in approximately 10-foot lengths, which will be extruded into plastic sleeves. First, "informal" headspace screening will be performed to identify the 1-foot segment of the core with the greatest VOC concentrations. Based upon the results, "formal" headspace screening will be performed on the zone with the highest concentration.

5.2 EQUIPMENT AND MATERIALS

- Decontaminated glass jars (wide mouth, 8 oz minimum in size)
- Photo-ionization detector (PID) with extension probe (11.7eV probe)
- PID battery charger
- PID calibration gas with regulator
- Aluminum foil

5.3 PROCEDURE

Informal headspace screening will be conducted at 1-foot sample intervals along each 10-foot long recovered core segment. Informal headspace screening shall be performed as follows:

1. Calibrate the PID according to manufacturers specifications. The screening instrument should be calibrated using the appropriate span gas and shall be calibrated a minimum of once daily and before use after a long shut down period.
2. Immediately following extrusion of the 10-foot sample into the plastic sleeve, insert the PID extension probe into the plastic sleeve at 1-foot intervals along the full length of the sample to obtain informal headspace screening values.
3. Record the informal screening values in column "d" of the soil boring log.

The 1-foot interval with the highest PID reading shall be selected for formal headspace screening, as well as for collection of samples for chemical analysis and immunoassay screening (see SOP #12). The soil sample required for VOC analysis will be collected before the formal headspace screening. If the volume of sample recovered is insufficient for all analytical requirements, then the material used in the headspace readings can be used for any non-volatile sampling requirements. Formal headspace screening will be conducted as follows:

1. Place a representative portion of the sample from the selected interval (interval within the 10-foot sample segment with the highest informal PID reading) into a clean, wide-mouth, contaminant free, glass jar. The sample may be placed first in a new, clean, plastic sandwich bag and then inside the jar to minimize the number of new jars required. If this method is used, readings shall be taken from inside empty bags and recorded to ensure no external contamination is being introduced.
2. Seal each jar with at least one continuous sheet of aluminum foil, using the jar lid to secure the foil.
3. Vigorously agitate the sample jar for at least fifteen seconds and then allow a minimum of ten minutes (or as the environmental conditions dictate) for the sample to volatilize. During cold weather, the samples shall be warmed to near room temperature prior to taking the headspace measurement.
4. Re-shake the jar and then remove the jar lid. Quickly insert the PID sampling probe through the aluminum foil and record the maximum meter response (which should be within the first two to five seconds). Record the formal headspace screening data on column "h" of the soil boring log and on other documentation.
5. Generally, new sample jars will be used for formal headspace screening. However, if sample jars are to be re-used in the field, jars must be cleaned according to field

decontamination procedures detailed in SOP #4. If so, PID headspace readings must be taken from each cleaned jar to ensure that no residual organic vapors exist.

6.0
DOCUMENTATION

Headspace screening measurements will be recorded on the Soil Boring Logs, as discussed in Section 5.3, above. In the event that headspace screening is performed on surface soil samples which are not located at a soil boring, measurements will be recorded in the field logbook along with the following:

- Name and location of the site
- Date and time of measurement
- Sampling location, number, depth
- Name of person performing the reading
- Type of instrument used

Standard Operating Procedure No. 3

IDENTIFICATION AND DESCRIPTION OF FIELD SAMPLING SITES

STANDARD OPERATING PROCEDURE No. 3

IDENTIFICATION AND DESCRIPTION OF FIELD SAMPLING SITES

CANNON AIR FORCE BASE, FIRE TRAINING AREA No. 4
RCRA FACILITY INVESTIGATION
CLOVIS, NEW MEXICO

USACE CONTRACT No. DACW45-94-D-0044
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Robert P. Kewer, P.G.
Project Manager — 1-9-96

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3.0
PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) defines the method to be used for identification and description of field sampling sites. This SOP supplements and is intended to be used with the Quality Assurance Project Plan (QAPP) and the Field Sampling Plan (FSP), which describe the sampling sites which will be selected. The purpose of this procedure is to identify sampling site locations which are not identified by another structure, such as a man-hole, and to describe the site in such a manner that the site may be relocated for future investigative work at the site and/or for repetitive sampling.

4.0
RESPONSIBILITIES AND QUALIFICATIONS

Harza's Project Manager is responsible for assuring that sample sites are properly located, identified and documented according to this procedure. The Project Manager will designate qualified project staff to complete this procedure and the required reviews.

The designated project staff are responsible for the identification and description of sampling sites according to this procedure. They report their progress, and any problems, to the Task Leader or Project Manager. Staff members are responsible for understanding the activities assigned to them and the quality assurance requirements associated with the activities.

All personnel assigned to complete this procedure shall be qualified to perform the portions of the procedure assigned to them. The Project Manager will make the appraisal of qualifications and will document the qualifications in the project Quality Assurance files. The Project Manager's appraisal of qualifications will include a comparison of the requirements of the job assignment with the relevant experience and training of the prospective assignee; it will also include a determination whether future training is required, and, if required, by what method. On-the-job training is an acceptable method, provided such training is received from a person qualified to perform the trainee's assignment and the results of that training are documented.

5.1 EQUIPMENT LIST

- Fluorescent orange spray paint
- Survey stakes
- Fluorescent survey ribbon
- Metal spikes/pins
- Camera and film
- Field notebook
- Waterproof pens and markers
- 100 foot measuring tape (marked in tenths of feet)
- Surveying level and tripod
- Compass (Brunton or equivalent)

5.2 PROCEDURE

The location of soil gas survey locations, surface soil samples, and soil borings in this investigation will require documentation for future reference. Prior to sampling, a sampling grid on 50-ft spacings shall be established and referenced to permanent site features (i.e. fence posts, concrete pad, etc.) using a surveying level and measuring tape. The grid system will be marked with survey stakes with the grid coordinate location marked with permanent waterproof marker. The location of each sampling site will be determined using a measuring tape and compass described to the nearest tenth (0.1) foot relative to the established grid system or as directed by the QAPP. Each sampling site will be clearly marked with a survey stake (with fluorescent survey ribbon) on which the sampling site location as specified in the QAPP is identified. This information will be recorded in the field notebook.

Following sampling at a surface site, the sample site identification stake will be replaced and re-marked, as needed. For subsurface soil borings, which are grouted, a steel pin/spike will be placed "head up" in the center of the grout in addition to placing the sample site identification

stake next to the abandoned soil boring. Prior to leaving the sampling site, a photograph shall be taken showing identifiable permanent site features.

Following completion of sampling activities, all aboveground and, where possible, underground physical features shall be either verified from any maps provided in previous reports or determined by other means. All aboveground physical features will be located/verified to the nearest foot. The location of each sampling site shall be plotted on a map at a scale large enough to show their location with reference to permanent site features, site coordinates and other sampling sites. A tabulated list of the sampling sites, copies of all field books, and all computation sheets shall be prepared and maintained by Harza in the permanent project files. The tabulation shall consist of the designated number of the sampling sites and their respective X and Y coordinates.

6.0
DOCUMENTATION

The following information will be recorded in the field notebook:

- Sample site location identification
- Date of location installation
- Description of sample site location
- Type of sample site
- Description of installed marker
- Sample site location distance relative to/from permanent monument
- Location installer name

Photographs will be taken of each sample site location and recorded in the field notebook. Additional information concerning each photograph will include the following:

- Roll number
- Photo number
- Photo direction
- Sampling site location
- Points of intercept/scale in photograph

Standard Operating Procedure No. 4

EQUIPMENT DECONTAMINATION

STANDARD OPERATING PROCEDURE No. 4

EQUIPMENT DECONTAMINATION

CANNON AIR FORCE BASE, FIRE TRAINING AREA No. 4
RCRA FACILITY INVESTIGATION
CLOVIS, NEW MEXICO

USACE CONTRACT No. DACW-45-94-D-0044
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Krishna V. Mayenkar, P.E. Department Head	1-30-96

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3.0
INTRODUCTION

This Standard Operating Procedure (SOP) defines methods to be used for decontamination of equipment used in environmental sampling programs. This SOP supplements and is intended to be used with the Quality Assurance Project Plan (QAPP) and the Field Sampling Plan (FSP).

Extraneous contaminant materials can be introduced to a sampling location and/or into the medium of interest during the sampling process by use of equipment previously contaminated at another sampling site. Trace quantities of these materials can contaminate the sample leading to false positive analytical results and, ultimately, to an incorrect assessment of site conditions. Decontamination of sampling equipment (e.g., bailers, pumps, tubing, soil and sediment sampling equipment) and field support equipment (e.g., drill rigs, vehicles) is required to ensure that cross-contamination is prevented and that on-site contaminants are not carried off site.

4.0
RESPONSIBILITIES AND QUALIFICATIONS

Harza's Project Manager is responsible for assuring that equipment decontamination is conducted according to this procedure. The Project Manager will designate Harza's Site Manager and qualified project staff as appropriate to complete this procedure.

Harza's Site Manager, assisted by designated Project Staff, are responsible for implementing equipment decontamination activities in the field according to this procedure and for documenting and resolving problems. Progress, and any problems, are reported by them to Harza's Project Manager. All staff members are responsible for understanding the activities assigned to them and the quality assurance (QA) requirements associated with the activities.

All personnel assigned to complete this procedure shall be qualified to perform the portions of the procedure assigned to them. The Project Manager will make the appraisal of qualifications. The Project Manager's appraisal will include a comparison of the requirements of the job assignment with the individual's relevant experience and training and determination as to whether further training is required and, if so, by what method. On-the-job training is acceptable if such training is provided by a person qualified to perform the trainee's assignment.

5.1 EQUIPMENT LIST

- Brushes
- Wash tubs (minimum of 3) or
- 5-gallon buckets (minimum of 3)
- Scrapers
- Steam cleaner or high-pressure sprayer (portable)
- Large metal horse trough
- Disposal drums
- Sponges
- Paper towels
- Liquinox detergent (or equivalent)
- Potable tap water
- Deionized water
- Garden type water sprayers
- Nitric Acid (10% by volume)
- Plastic tubing for bailers
- Plastic trash bags
- Paint pens

5.2 DECONTAMINATION

5.2.1 Sampling Equipment

Steps to be used to decontaminate small sampling equipment (e.g. bailers, stainless steel trowels, stainless steel liners, plastic caps for liners, etc.) will be as follows:[1]

[1] Appropriate personnel protective equipment and procedures shall be used in all decontamination procedures in accordance with the Site Health and Safety Plan.

- Scrape gross contamination on equipment off at the sampling site.
- Place equipment that will not be damaged by water in a wash tub or bucket containing Liquiox or low-sudsing detergent along with potable water and scrub with a bristle brush or similar utensil. Then wash equipment with potable water followed by a potable water rinse. If high trace metal contamination is suspected, spray equipment with 0.1N nitric acid. Then double rinse equipment with deionized water.
- Equipment that may be damaged by water (such as the PID) will be carefully wiped clean when necessary using a sponge and detergent water and rinsed again with a sponge dipped in deionized water. Care will be taken to prevent damage to equipment.
- Rinse and detergent waters will be replaced with new solutions between borings or sample locations.
- Used rinse and detergent water will be contained in 55-gallon drums or holding tanks for evaporation or storage at the designated drum storage area until analytical results are received.

Decontaminated equipment will be stored in a clean area or in clean plastic trash bag until used.

5.2.2 Drilling and Heavy Equipment

Drilling and heavy equipment will be decontaminated before first use on the site, between each boring, and before demobilizing from the site. Decontamination of drilling equipment, including augers, drill rods, bits, etc., as applicable, will take place at a designated location which will be downslope from and a minimum of 50 feet away from sampling locations using a portable steam cleaner and plastic decontamination pad. The following steps will be used to decontaminate drilling and heavy equipment:[2]

- Gross contamination and/or drill cuttings caked on equipment will be scraped off with a flat-bladed scraper at the sampling site.

[2] Appropriate personnel protective equipment and procedures shall be used in all decontamination procedures in accordance with the Site Health and Safety Plan.

- The drill rig, augers, drill bits, shovels and similar equipment will be sprayed with detergent water by a high-pressure washer, then rinsed with potable water. Care should be taken to adequately clean the insides of the hollow-stem augers.
- Decontamination water generated during this process will be contained and pumped into drums for disposal at the central decontamination station. Soil cuttings generated during drilling will be contained in drums.
- Drums will be properly labeled with depth, location, date, boring numbers, the contractors identification, the phone number for the 27 SG CEV office, and the language "CONTENTS WAITING TESTING." Drum labeling will be done with permanent markers (paint pens) directly on the drums.

Following decontamination, drilling equipment will be placed on the clean drill rig and moved to a designated clean area at Landfill #5, adjacent to the site. If equipment such as augers and split-spoon samplers are not used immediately, they will be wrapped in plastic sheeting and stored at the designated clean area.

5.2.3 Equipment Leaving the Site

Vehicles used for nonconstruction activities shall be cleaned on an as-needed basis as determined by the Site Safety Officer. Vehicles will be cleaned using a soap and water wash on the outside and vacuuming the inside. Cleaning will be required for very dirty vehicles which will be leaving the area. The cleaning shall take place on site. On-site equipment such as drilling rigs will be pressure washed on site before the equipment is removed from the site.

5.2.4 Wastewater

Small volumes of used wash and rinse solutions will be containerized in labeled drums and transported to the central decontamination area at Landfill #5. The final determination of the disposal criteria for this wastewater will be made at the completion of the project.

5.2.5 Other Wastes

Solid wastes such as used personal protective equipment and drill cuttings will be placed in drums. The drums will be sealed when full and each drum will be labeled with its contents and the date using paint or other permanent marker. Drums will be stored in a designated area at Landfill #5 for later handling or disposal upon completion of the project.

6.0
DOCUMENTATION

Sampling personnel will document the decontamination of sampling and drilling equipment. The documentation will be recorded with waterproof ink in the sampler's field logbook in accordance with SOP #9. The information entered in the field book concerning decontamination should include the following:

- Decontamination personnel
- Date and start and end times
- Decontamination steps/observations
- Weather conditions
- Volumes of waste materials

Standard Operating Procedure No. 5

SURFACE AND NEAR-SURFACE SOIL SAMPLING

STANDARD OPERATING PROCEDURE No. 5

SURFACE AND NEAR-SURFACE SOIL SAMPLING

CANNON AIR FORCE BASE, FIRE TRAINING AREA No. 4
RCRA FACILITY INVESTIGATION
CLOVIS, NEW MEXICO

USACE CONTRACT No. DACW-45-94-D-0044
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Robert P. Kewer, P.G. Project Manager	1-9-96
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ATTACHMENT 1 SAMPLE COLLECTION FIELD SHEET

3.0
PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) defines equipment, field procedures, and QA/QC procedures to be used for collecting surface soil samples with a hand auger. Sample locations and frequency are specified in the Field Sampling Plan (FSP).

This SOP supplements and is intended to be used with the Quality Assurance Project Plan (QAPP) and the Field Sampling Plan (FSP) and several other SOPs. Sample identification, labeling, handling, and chain-of-custody procedures are described in SOP No. 9, which also lists sample containers, preservatives, and holding times. SOP No. 4 describes decontamination procedures.

4.0
RESPONSIBILITIES AND QUALIFICATIONS

Harza's Project Manager is responsible for assuring that these procedures are followed during field operations by reviewing field notebooks and analytical data when they are available. The Project Manager will designate qualified project staff, including a Task Leader, to complete this procedure and the required reviews.

Harza's Task Leader is responsible for assisting the Project Manager in completing activities covered by this procedure and in performing required QA functions.

Designated Project Staff are responsible for performing the activities required by this procedure and reporting progress and any problems to the Task Leader or Project Manager. Project staff are responsible for understanding the activities assigned to them and the associated quality assurance requirements.

All personnel assigned to complete this procedure shall be qualified to perform the portions of the procedure assigned to them. The Project Manager will make the appraisal of qualifications and will document the qualifications in the project Quality Assurance files. The Project Manager's appraisal of qualifications will include a comparison of the requirements of the job assignment with the experience and training of the candidate, a determination as to the need for training, and, if required, by what method. On-the-job training is acceptable provided such training is received from a person qualified to perform the trainee's assignment and the results of that training are documented.

5.1 EQUIPMENT LIST

Equipment to be used in surface soil sampling is as follows:

- Stainless steel or Teflon coated hand auger
- Ruler with 1/10-foot increments
- Field notebook
- Stainless steel knife
- Stainless steel spoons/trowels
- Stainless steel mixing bowl
- Sample containers supplied by analytical laboratory with labels
- Cooler with ice and vermiculite or equivalent
- Clear cellophane tape to cover labels
- Camera and film
- Waterproof marking pens
- Plastic sheeting
- Plastic bags
- Health and Safety Equipment as specified in the SSHP
- Decontamination equipment as specified in SOP #4

5.2 SAMPLING PROCEDURES

5.2.1 Sampling Locations and Numbers

Prior to sampling, sample locations will be identified and marked in accordance with SOP No. 3 and the DCQAP. Sample numbering will be in accordance with SOP No. 9.

5.2.2 Equipment Decontamination

Before any sampling, equipment must be decontaminated according to the procedures in SOP No. 4 and in the Site Safety and Health Plan (SSHP). Sampling equipment will be decontaminated between sampling stations and between collection of samples at different depths at the same location.

5.2.3 Obtaining Surface Soil Samples

Upon arrival at the sampling site, enter into the field notebook the sample location number, the general appearance of soil (i.e., noticeable stains etc.) and soil cover (e.g., grass, gravel, etc.), the time of sampling, and any unusual phenomena. Place a plastic sheet near the sampling station and place all sampling equipment on the sheet. Clear any existing vegetation and foreign matter from the surface at the sampling location.

Using the hand auger or a stainless steel spoon/trowel, depending on the sample depth and method to be used, collect samples from the appropriate depth (as determined prior to mobilization and/or as specified in the DCQAP). Perform headspace screening of the soil samples in accordance with SOP #2. Collect an appropriate amount of sample for the sample containers and analyses required. When the sample has been collected, remove any soil adhering to the side of the hand auger sampler using a stainless steel knife.

Samples will be collected in the following order: a) VOCs; b) SVOCs; c) TRPH; d) metals; and e) cyanide. Place the part of the recovered sample to be analyzed for volatile organics into the appropriate sample container first and as soon as possible after sample recovery and cap the sample container. Place the remainder of the recovered sample in the mixing bowl and homogenize with a decontaminated mixing instrument (e.g., a stainless steel spoon). Divide the homogenized soil in the bowl equally among the remaining sample containers in the order specified above and cap each container as it is filled. QA/QC sample containers should be filled from the same mixtures as the samples. Sample containers shall be labeled in accordance with SOP No. 9 in indelible ink and covered with clear cellophane tape.

5.2.4 Field QA/QC Procedures and Samples

QA/QC samples are used to help identify potential sources of sample contamination and evaluate potential error introduced by sample collection and handling. All QA/QC samples will be labeled with QA/QC identification numbers and submitted to the laboratory with other samples for analysis. Specific QA/QC samples that will be collected are to be determined prior to mobilization as described in the DCQAP and could include the following:

Duplicate Samples. Duplicate samples are used to help check for natural sample variance and the consistency of field techniques and laboratory analysis. For surface soil sampling, a duplicate sample will be collected from the homogenized sample. The initial sample containers for volatile organics will be filled first, then the duplicate sample containers and so on until all necessary sample containers for both the initial sample and the duplicate sample have been filled. The duplicate sample will be handled in the same manner as the initial sample. The duplicate sample will be assigned a QA/QC identification number, stored in an iced cooler, and shipped to the laboratory on the day it is collected.

Field Blanks. Field blanks are used to check for contamination of samples due to factors at the sampling site. Field blanks will be analyzed for the same parameters that are being analyzed in the surface soil samples. Empty sample bottles are taken to the field and filled at the site with organic-free deionized water at the time the soil sample is collected. The samples are assigned a QA/QC identification number, stored in an iced cooler, and shipped to the laboratory with the other samples.

Matrix Spikes/Matrix Spike Duplicates. Matrix spikes are used to determine long-term precision and accuracy of the analytical method on various matrices. Duplicate samples are collected in the field and spiked by the laboratory with method specified compounds. Samples are labeled as matrix spikes/matrix spike duplicate (MS/MSD) in the field.

5.3 SAMPLE HANDLING

Sample containers and preservatives are specified in SOP No. 9, Sample Handling, Documentation, and Analysis. Samples will be labeled and handled as described in SOP No. 9.

6.1 SOIL BORING LOG

If surface soil samples are collected at the location of a soil boring, the Soil Boring Log will be the primary vehicle for recording sample data and information. A Soil Boring Log form and procedures to be followed in completing the form are provided in SOP #7. In these cases, information to be recorded on the Soil Boring Log for each surface sample will include:

- Depth interval
- Field screening results
- Information on analytical samples collected, including geotechnical samples
- Soil type and description
- USCS group symbol
- Color, staining, odor or other observations

6.2 FIELD SAMPLING DATA SHEET

A Sample Collection Field Sheet (SCFS), will be completed at each sample location (Attachment 1). For surface soil samples not collected at a soil boring location and for which a Soil Boring Log is not available, the information on the data sheet includes the following:

- Sample location
- Date and time of sampling
- Person(s) performing sampling
- Type of sample
- Type of soil cover
- Depth interval
- Soil type (describe)

- USCS[1] Abbreviation
- Color, staining, or odor (describe)
- Sample identification number
- Number of samples taken
- Preservation of samples
- Record of any QC samples from site
- Any irregularities or problems which may have a bearing on sample quality.

In cases where the surface sample is collected at a soil boring location, the Soil Boring Log may be referenced in appropriate sections of the SCFS for the above information. In either case, items not applicable to the sampling will be labeled as not applicable (NA).

6.3 FIELD NOTES

The following information will be recorded in the bound field notebook using waterproof ink:

- Names of personnel
- Weather conditions
- Date and time of sampling
- Sample Location, depth and sample number
- Times that procedures and measurements are completed

[1] Unified Soil Classification System.

ATTACHMENT

SAMPLE COLLECTION FIELD SHEET

HARZA ENVIRONMENTAL SERVICES

SAMPLE COLLECTION FIELD SHEET (SOIL/SEDIMENT)

Project Name: CANNON AFB/FTA #4

Project No: 5644M

Sample Method:

Sample Depth (ft.):

Sample/Media Type: Soil (surface) Soil (subsurface) Sediment Sludge Other (describe)

Sample Split (circle one) Yes No

Field Duplicate (circle one) Yes No

Sampling Personnel:

Boring/Well No:

SAMPLE NO:

Date:

Time:

Split Sample No:

Duplicate Sample No:

Sample Container	Preservative	Analysis Requested				
		VOC	S-VOC	PEST/PCB	METALS	OTHER (List)

SAMPLE DESCRIPTION

Depth:	Description:

COMMENTS:

Standard Operating Procedure No. 6

SUBSURFACE DRILLING AND SAMPLING

STANDARD OPERATING PROCEDURE No. 6

SUBSURFACE DRILLING AND SAMPLING

CANNON AIR FORCE BASE, FIRE TRAINING AREA No. 4
RCRA FACILITY INVESTIGATION
CLOVIS, NEW MEXICO

USACE CONTRACT No. DACW45-94-D-0044
DELIVERY ORDER No. 0006
HARZA PROJECT No. 5644M

Approvals:	Date
Robert P. Kewer, P.G. Project Manager	1-9-96
Krishna V. Mayenkar, P.E. Department Head	1-30-96

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3.0
PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) provides technical guidance and methods for subsurface drilling and sampling at Cannon Air Force Base. Soil samples will be collected and submitted for chemical and geotechnical analysis. This SOP supplements the Quality Assurance Project Plan (QAPP) and is intended to be used with the QAPP and other SOPs, such as SOP No. 7, Lithologic Description of Subsurface Samples.

The step-by-step procedures described herein are sufficiently detailed to allow field personnel to properly perform subsurface drilling and sampling.

4.0
RESPONSIBILITIES AND QUALIFICATIONS

Harza's Project Manager is responsible for assuring that subsurface drilling and sampling are performed in accordance with this SOP. This Project Manager will designate qualified project staff to complete this procedure and the required reviews.

The designated project staff are responsible for performing subsurface drilling and sampling according to this procedure. They report their progress, and any problems, to the Task Leader or Project Manager. Staff members are responsible for understanding the activities assigned to them and the quality assurance requirements associated with the activities.

All personnel assigned to complete this procedure shall be qualified to perform the portions of the procedure assigned to them. The Project Manager will make the appraisal of qualifications and will document the qualifications in the project Quality Assurance files. The Project Manager's appraisal of qualifications will include a comparison of the requirements of the job assignment with the relevant experience and training of the prospective assignee; it will also include a determination whether future training is required, and, if required, by what method. On-the-job training is an acceptable method, provided such training is received from a person qualified to perform the trainee's assignment and the results of that training are documented.

5.1 EQUIPMENT LIST

The following is a list of soil sampling equipment:

- Stainless steel mixing bowl
- Stainless steel mixing devices
- Long-handled bristle brushes
- Wash/rinse tubs
- Liquinox detergent (or equivalent)
- Deionized water
- Electrical tape
- Weighted tape measure
- Water level probe
- Appropriate health and safety equipment
- Logbook
- Boring log forms
- Waterproof markers and labels
- Paper towels
- Baggies, ziplock bags
- Large plastic bags
- Plastic sheeting
- Decontamination equipment as specified in SOP #4

In addition, the drilling contractor will supply the following:

- Rotasonic drill rig and appurtenant equipment and materials
- Bentonite grout
- High-pressure steamer/sprayer
- Drums for containing cuttings

5.2 DRILLING METHOD

Borings will be drilled using a truck-mounted drilling rig utilizing the Rotasonic drilling method. Only potable water may be introduced during the advancement of the outer drill pipe, if necessary, to flush out cuttings in the annular space between the inner and outer drill pipe or to flush out cuttings at the bottom of the borehole after the sample is retrieved. No bentonite, barite, polymers, or other additives or viscosifying agents will be added to water introduced into the borehole or used during drilling. If lubrication is required on the drill pipe joints, only Teflon tape or vegetable oil are acceptable. The drill rig shall be free of leaks which could contaminate the borehole (i.e., hydraulic fluid, oil, gas, etc.).

Health and Safety equipment specified in the Site Health and Safety Plan (SSHP) will be donned before proceeding with subsurface drilling and soil sampling. The SSHP specifies action levels for various contaminants and the field monitoring required to measure ambient conditions.

All work areas around exploratory borings will be restored to a physical condition equivalent to that of pre-drilling, as near as practical. This will include drill cuttings removal and rut removal. Plastic sheeting will be placed under the drill rig as necessary to contain oil and hydraulic fluid leaks that may occur.

All drill cuttings will be containerized and moved to a central location at the nearby Landfill No. 5 for storage. Containers (drums) will be sealed, labeled, and recorded so that their contents can be identified as to material source and depth. Multiple drums from that same boring will have approximate depths labeled on each drum. The labeling will be such that it will be legible for the length of time that may transpire before final disposal of the drummed contents. Any water generated during drilling will be contained in labeled drums. The disposal of soil and water will be dependent on analytical laboratory results.

5.3 SOIL SAMPLING METHOD

Intact subsurface soil samples will be taken for physical description, and chemical and geotechnical analyses. Samples will be collected as outlined in Section 5.0 of the DCQAP, continuously from the ground surface to the terminal depth of each boring. Samples will be

collected inside of a core barrel in advance of the outer drill pipe to provide for minimal sample disturbance. Samples will be extruded from the core barrel and placed into a plastic sleeve which can be fitted to the end of the core barrel or alternatively extruded on to a stainless steel tray. Headspace screening will be performed on the recovered samples in accordance with SOP #2. Based on the results, sample intervals for chemical analysis and immunoassay screening (SOP #12) will be selected. Samples for analysis of volatile organic and semi-volatile organic compounds will be taken from the portion of the sample exhibiting the highest PID reading for the targeted interval. Sampling will be done immediately upon extruding the core sample, and shall be done as soon as possible once the core barrel is removed from the boring. Compositing of soil samples for Target Analyte List (TAL) metals, cyanide and total recoverable petroleum hydrocarbons (TRPH) shall be performed in a stainless steel bowl using stainless steel mixing devices.

Samples will be collected in the following order: a) VOCs; b) SVOCs; c) TRPH; d) metals; and e) cyanide. Place the part of the recovered sample to be analyzed for volatile organics into the appropriate sample container first and as soon as possible after sample recovery and cap the sample container. Place the remainder of the recovered sample in the mixing bowl and homogenize with a decontaminated mixing instrument (e.g., a stainless steel spoon). Divide the homogenized soil in the bowl equally among the remaining sample containers in the order specified above and cap each container as it is filled. QA/QC sample containers should be filled from the same mixtures as the samples. Sample containers shall be labeled in accordance with SOP No. 9 in indelible ink and covered with clear cellophane tape.

Soil samples that are to undergo chemical and geotechnical analyses (grain size distribution and moisture content) will be placed in glass jars with airtight, screw-type lids. Lids of jars for geotechnical samples shall be wrapped three times with electrical tape to preserve moisture content. A sample volume adequate for the analysis to be conducted will be collected. Minimum information on each sample container will include the project name, date, boring number, sample number, and depth of sample. All information that appears on the container will also appear on the boring log. Sample handling and documentation procedures are discussed in SOP No. 9.

5.4 ROCK CORING METHOD

Subsurface rock core samples will be taken for physical description and chemical analysis in depth intervals where unconsolidated sediments are not encountered (i.e., in expected caliche layer). Core samples will be collected using the same method used to collect samples of unconsolidated material. Core samples for chemical analysis will be obtained by subsampling the core run and will be placed in jars. Minimum information on each sample container will include the project name, date, boring number, sample number, and depth of sample. All information that appears on the container will also appear on the boring log. Sample handling and documentation are discussed in SOP #9.

All core, except that collected for chemical analysis, will be containerized and remain on site, stored at a location designated by Cannon AFB personnel. If the samples are not contaminated, disposition of these samples will be arranged by Cannon AFB. If the core is contaminated, it will be handled and disposed properly, depending upon the laboratory analytical results.

5.5 EQUIPMENT DECONTAMINATION

Equipment decontamination will be conducted in accordance with SOP #4.

- Drilling equipment decontamination (drill pipe and other downhole equipment) will be conducted prior to drilling and between each boring location and before any equipment is removed from the site.

- Sampling equipment decontamination (core barrels, stainless steel mixing devices, etc.) will be conducted between individual sampling points to minimize potential cross-contamination. Sampling equipment will be decontaminated between each sample.

6.1 FIELD BORING LOG

The Soil Boring Log will be the primary vehicle for recording data collected during drilling and sampling of soil borings. A Soil Boring Log form and procedures to be followed in completing the form are provided in SOP #7. The appropriate spaces for drilling method and equipment shall be completed prior to drilling.

6.2 SAMPLE COLLECTION FIELD SHEET

A Sample Collection Field Sheet (SCFS) will be completed for each sample collected from soil borings. A SCFS form is provided in Attachment 1. The information on the data sheet includes the following:

- Project Name and number
- Boring/Well and sample number
- Sampling method, depth and type
- Date and time of sampling
- Associated QC samples
- Sampling personnel
- Sample containers, preservatives, and analyses requested
- Sample description (reference Soil Boring Log, as appropriate)
- Any irregularities or observations which may have a bearing on sampling quality

Items not applicable to the sampling will be labeled as not applicable (NA).

6.3 FIELD LOGBOOK

Field notes will be kept during sampling activities. The following information will be recorded in the bound field notebook using waterproof ink:

- Names of personnel
- Date and time of sampling
- Location and sample station number
- Times that procedures and measurements are completed
- Weather conditions
- Decontamination times and procedures

ATTACHMENT 1

SAMPLE COLLECTION FIELD SHEET

HARZA ENVIRONMENTAL SERVICES

SAMPLE COLLECTION FIELD SHEET (SOIL/SEDIMENT)

Project Name: CANNON AFB/FTA #4

Project No: 5644M

Sample Method:

Sample Depth (ft.):

Sample/Media Type: Soil (surface) Soil (subsurface) Sediment Sludge Other (describe)

Sample Split (circle one) Yes No

Field Duplicate (circle one) Yes No

Sampling Personnel:

Boring/Well No:

SAMPLE NO:

Date:

Time:

Split Sample No:

Duplicate Sample No:

Sample Container	Preservative	Analysis Requested				
		VOC	S-VOC	PEST/PCB	METALS	OTHER (List)

SAMPLE DESCRIPTION

Depth: **Description:**

COMMENTS:

Standard Operating Procedure No. 7

LITHOLOGIC DESCRIPTION OF SUBSURFACE SAMPLES

STANDARD OPERATING PROCEDURE No. 7

LITHOLOGIC DESCRIPTION OF SUBSURFACE SAMPLES

CANNON AIR FORCE BASE, FIRE TRAINING AREA No. 4
RCRA FACILITY INVESTIGATION
CLOVIS, NEW MEXICO

USACE CONTRACT No. DACW-45-94-D-0044
DELIVERY ORDER No. 0006
HARZA PROJECT No. 5644M

Approvals: Date

Robert P. Kewer, P.G.
Project Manager — 1-9-96

Krishna V. Mayenkar, P.E.
Department Head — 1-30-96

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TABLE 1 LOG DESCRIPTORS FOR SOIL SAMPLES
TABLE 2 LOG DESCRIPTORS FOR ROCK CORE

ATTACHMENT 1 BORING LOG FORM

3.0
PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) provides technical guidance and methods for the lithologic logging of samples obtained from boreholes in soil or rock. This SOP supplements and is intended to be used with the Data Collection Quality Assurance Plan (DCQAP) and other SOPs, such as SOP No. 6, Subsurface Drilling and Soil Sampling.

4.0
RESPONSIBILITIES AND QUALIFICATIONS

The Harza Project Manager is responsible for assuring that lithologic logging of boreholes is performed in accordance with this SOP. This Project Manager will designate qualified project staff to complete this procedure and the required reviews.

The designated project staff are responsible for logging boreholes according to this procedure. They report their progress, and any problems, to the Task Leader or Project Manager. Staff members are responsible for understanding the activities assigned to them and the quality assurance requirements associated with the activities.

A geologist or geotechnical engineer (logger) experienced in borehole drilling and soil sampling will be present at each operating drill rig. The logger will be responsible for logging samples, preparing samples for shipment to the laboratory for analyses, monitoring drilling operations, recording water losses or gains, obtaining groundwater data, and preparing boring logs.

All personnel assigned to complete this procedure shall be qualified to perform the portions of the procedure assigned to them. The Project Manager will make the appraisal of qualifications and will document the qualifications in the project Quality Assurance files. The Project Manager's appraisal of qualifications will include a comparison of the requirements of the job assignment with the relevant experience and training of the prospective assignee; it will also include a determination whether future training is required, and, if required, by what method. On-the-job training is an acceptable method, provided such training is received from a person qualified to perform the trainee's assignment and the results of that training are documented.

5.0
PROCEDURES FOR LITHOLOGIC LOGGING OF BOREHOLES

All boring logs will subscribe to the following requirements:

- The boring log will be the form presented in Attachment 1.
- Logs will be prepared in the field, as borings are drilled, and each log will be signed by the preparer.
- All log entries will be printed. Photo reproductions will be clear and legible. Copies will be submitted to USACE-PM within five days of completion of field work.
- Borehole depth information will be recorded to the nearest 0.1 foot.
- All relevant information blanks in the log heading and log body will be completed. Information not applicable will be noted as "NA". If surveyed horizontal control is not available at the time of drilling, location sketches referenced by measuring distances or prominent surface features shall be shown on or attached to the log.
- A scale of 1 inch on the log form equalling 1 foot of boring will be used.
- Each material type encountered will be described on the log form. Material types will be logged directly from samples and indirectly interpolated using professional judgement, drill cuttings, drill action, etc., between sampling intervals. The descriptions of intact soil samples will include the parameters listed in Table 1. Rock core will be described by the parameters listed in Table 2.
- Soil classifications will be in accordance with the Unified Soil Classification System (equivalent to ASTM D2487). Soil classifications will be made in the field at the time of sampling and are subject to change based on laboratory tests and subsequent review.
- For rock core, a scaled graphic sketch of the core breaks denoting the depth, location, and orientation will be drawn on the log. Bedrock coring information will be recorded in consecutively numbered runs and will include the start and stop time of each core run, the depth to top and bottom of each core run, the length of core recovered for each run, the size and type of coring bit and barrel,

and the measured depth to the bottom of the hole after the core is removed from each run. Breaks believed to be mechanically induced, or made to fit the core in the core box, will be so annotated. If fractures are too numerous to be shown graphically, they may be described in writing on the log. The intervals by depth of all lost core will also be noted. This information will be recorded at the time of core logging concurrent with drilling.

- In the field, visual estimates of the volume of secondary soil constituents can be reported by such terms as "trace" (1-10 percent), "little" (10-20 percent), "some" (20-35 percent), and "and" (35-50 percent) or by an estimated specific percentage. The quantitative range of each of the terms used is to be defined either within a general legend or on each log.
- When used to supplement other sampling techniques, auger-flight cutting samples will be described in terms of the appropriate soil or rock parameters, to the extent practical. "Classification" will be minimally described for these samples, along with a description of drill action and water losses/gains for the corresponding depth. Notations will be made on the log that these descriptions are based on observations of material other than samples, e.g., "from cuttings."
- The drilling equipment used will be described on each log. Information such as drill rod size, bit size and type, and rig manufacturer and model will be recorded.
- All special problems encountered during drilling and their resolution will be recorded on the log. This could include sudden tool drops, unrecovered tools in the borehole, and lost casings.
- The dates for the start and completion of borings will be recorded on the log. Changes in shift, day, driller, and site geologist will be noted at the depth they occur.
- Stratigraphic/lithologic changes will be identified on the boring log by a solid horizontal line at the appropriate scale depth on the log which corresponds to measured borehole depths at which changes occur, measured and recorded to the nearest 0.1 foot. Gradational transitions and changes identified from cuttings or methods other than direct observation and measurement will be identified by a horizontal dashed line at the appropriate scale depth based on the best judgement of the logger.

- Logs will clearly show the depth intervals from which all samples are retained. The sampler type, diameter, and length of sampled interval and length (or percent) of sample recovery will be recorded for each driven or cored sample.
- Logs will identify the depth at which water is first encountered, the depth of water at the completion of drilling, and the stabilized depth to water. The absence of water in borings will also be indicated. Stabilized water level data will include time allowed for levels to stabilize.
- Logs will show borehole and sample diameters and depths at which drilling or sampling methods or equipment change.
- Logs will show total depth of penetration and sampling. The bottom of the hole will be so identified on the log by solid double lines from margin to margin with the notation "bottom of hole."
- Logs will identify any drilling fluid (water) losses, including depths at which they occur, rate of loss and total volume lost.
- Refusal, if reached, will be noted, along with the reason.
- Logs will include all other information relevant to a particular investigation, but not limited to:
  - Odors
  - PID/OVA measurements or other field screening or test results
  - Any observed evidence of contamination in samples, cuttings, or drilling fluid
- Significant color changes in the drilling fluid return will be recorded, even when intact soil samples or rock core are being obtained. The color change (from and to), depth at which change occurred, and a lithologic description of the cuttings before and after the change will be recorded.
- Special abbreviations used on a log will be defined either in the log where used, or in a general legend.
- Readings of instruments used to detect organic vapors, toxic or explosive gases, and oxygen will be recorded on the log, if these instruments are used. This includes readings taken at the annulus of the borehole, of an individual sample, or at a certain depth within the borehole.

TABLE 1
LOG DESCRIPTORS FOR SOIL SAMPLES

Parameter	Examples
Depositional Environment and Formation, (if named and if known)	"glacial till" "Twin Cities Formation"
Unified Soil Classification System	"Sandy Clay"
Secondary Components and Estimated Quantities either by percentages or by descriptive percentage ranges (Note: terms used to indicate ranges should be described on the log or in a general legend)	"sand: fine, with trace med"
Color	"gray" "brown"
Consistency (cohesive soil)	very soft, soft, medium, stiff, very stiff, hard
Density (non-cohesive soil)	loose, medium, dense, very dense
Moisture Content[1]	dry, damp, moist, wet, saturated
Texture/Fabric/Bedding	"no apparent bedding, numerous vertical iron-stained tight fractures"
Grain Angularity (granular soils)	rounded, subrounded, subangular, angular
Sorting (sands)	well sorted, poorly sorted
Structure	"slickensides"
Grain or fragment size (sands)	very coarse, coarse, medium, fine, very fine
Note "Fill", "Top of Natural Ground", and "Top of Bedrock" where appropriate	

[1] *Use relative term. Do not express as a percent unless a value has been measured)*

TABLE 2
LOG DESCRIPTORS OF ROCK CORE

Parameter	Examples
Formation Name (if known)	"Raytown Formation"
Rock Type	limestone, sandstone, granite, etc.
Modifier denoting variety	Shaly, calcareous, siliceous, argillaceous, sandy, micaceous, etc.
Hardness	Very soft, soft, moderately hard, hard, very hard
Color	"Medium brown"
Bedding	"Parting band, thin bedded, medium bedded, thick bedded, massive"(provide thickness range of each in legend)
Texture	Very finely crystalline, finely crystalline, crystalline, coarsely crystalline, very coarsely crystalline porphyritic, glassy poorly cemented, well cemented, etc.
Voids in rock	Porous, pit, pitted, vug, vuggy, cavity, cavernous (Note: provide sizes of each in legend)
Structure and Orientation	Horizontal bedding, beds dipping "30°", highly fractured, open near vertical joints, healed 30 degree fractures, slickensides at 45 degree, fissile, etc.
Degree of Weathering	Unweathered, highly weathered, etc.
Core loss interval and reason for loss if known or "Unaccountable"	50-51', noncemented sandstone likely

ATTACHMENT 1

BORING LOG FORM

ATTACHMENT 1

HTW DRILLING LOG

		HOLE No.
1. COMPANY NAME	2. DRILLING SUBCONTRACTOR	SHEET 1 OF SHEETS
3. PROJECT	4. LOCATION	
5. NAME OF DRILLER	6. MANUFACTURER'S DESIGNATION OF DRILL	
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	8. HOLE LOCATION	
	9. SURFACE ELEVATION	
	10. DATE STARTED	11. DATE COMPLETED
12. OVERBURDEN THICKNESS	15. DEPTH GROUNDWATER ENCOUNTERED	
13. DEPTH DRILLED INTO ROCK	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX No. e	ANALYTICAL SAMPLE No. f	BLOW COUNTS g	REMARKS h

c:\cdr\misc\htw1.cdr

PROJECT | HOLE No.

HTW DRILLING LOG

HOLE No.

PROJECT

INSPECTOR

SHEET
OF SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX No. e	ANALYTICAL SAMPLE No. f	BLOW COUNTS g	REMARKS h

c:\cdr\misc\htw2.cdr

PROJECT

HOLE No.

Standard Operating Procedure No. 8

BOREHOLE ABANDONMENT

STANDARD OPERATING PROCEDURE No. 8

BOREHOLE ABANDONMENT

CANNON AIR FORCE BASE, FIRE TRAINING AREA No. 4
RCRA FACILITY INVESTIGATION
CLOVIS, NEW MEXICO

USACE CONTRACT No. DACW45-94-D-0044
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HARZA PROJECT No. 5644M

Approvals:	Date
Robert P. Kewer, P.G. Project Manager	1-10-96
Krishna V. Mayenkar, P.E. Department Head	1-30-96

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3.0
PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) defines the methods to be used for borehole abandonment during subsurface investigations at Fire Training Area No. 4, Cannon Air Force Base, Clovis, New Mexico. This SOP supplements and is intended to be used with the Data Collection Quality Assurance Plan (DCQAP) and other SOPs. The step-by-step procedures described herein are sufficiently detailed to allow field personnel to properly perform abandonment of boreholes.

4.0
RESPONSIBILITIES AND QUALIFICATIONS

Harza's Project Manager is responsible for assuring that borehole abandonment is performed in accordance with this Standard Operating Procedure. The Project Manager will designate qualified project staff to complete this procedure and the required reviews.

The designated project staff are responsible for performing borehole abandonment according to this procedure. They report their progress, and any problems, to the Task Leader or Project Manager. Staff members are responsible for understanding the activities assigned to them and the quality assurance requirements associated with the activities.

All personnel assigned to complete this procedure shall be qualified to perform the portions of the procedure assigned to them. The Project Manager will make the appraisal of qualifications and will document the qualifications in the project Quality Assurance files. The Project Manager's appraisal of qualifications will include a comparison of the requirements of the job assignment with the relevant experience and training of the prospective assignee; it will also include a determination whether future training is required, and, if required, by what method. On-the-job training is an acceptable method, provided such training is received from a person qualified to perform the trainee's assignment and the results of that training are documented.

5.0
PROCEDURE FOR BOREHOLE ABANDONMENT

Abandonment is the procedure by which any boring (or well) is permanently closed. Abandonment procedures should preclude any current or subsequent discharges from entering the abandoned boring or well and thereby terminate access to the subsurface environment through that borehole.

Upon completion of soil sampling and advancement of the boring to its predetermined depth, the soil boring will be abandoned immediately, unless saturated conditions have been encountered. For borings encountering saturated conditions, a 24-hour groundwater level will be measured before backfilling. Borings left open overnight will be covered to lessen the potential for injury to personnel and to minimize the potential for any surface drainage to enter the boring. Borehole abandonment will be performed as follows:

1. All boreholes greater than 3 feet in depth will be abandoned by grouting. Upon completion of drilling, the borings will be grouted subsequent to the removal of the drill string (hollow-stem augers, or other). Grouting will be accomplished by placing a tremie pipe to the bottom of the boring and pumping grout through this pipe until undiluted grout flows from the boring at ground surface. The grout mix will be in proportions of one sack (94 pounds) of Portland cement, 3-5 pounds of powdered bentonite, and a maximum of 7 gallons of water. The bentonite will be well mixed with the water prior to adding the cement. Alternatively, Hi-Solids bentonite hole plug may be used, mixed in accordance with the manufacturer's instructions. Twenty-four hours after grouting, the borehole will be checked for grout settlement and will be topped off to the ground surface with grout, if necessary.

2. Borings less than 3 feet deep will be backfilled with native materials available adjacent to the boring, unless otherwise instructed.

3. Upon completion of the boring, all downhole equipment will be scraped clean as it is withdrawn from the hole. Decontamination and cuttings disposal will be performed in

accordance with SOP No. 4, Equipment Decontamination and SOP No. 6, Subsurface Drilling and Soil Sampling.

6.0
DOCUMENTATION

For each abandoned boring, a record on the boring log as well as in the field logbook will be provided after the abandonment is completed. The record will include the data listed below with appurtanent information referenced (all depths should be measured from the ground surface):

- Project name and boring number.
- Location and location of any replacement boring.
- Open depth prior to grouting and depth to which grout pipe was placed.
- Copy of the boring log.
- Description and total quantity of grout used initially.
- Description and daily quantities of grout used to compensate for settlement.
- Dates of grouting.
- Water level prior to grouting and date measured.
- Personnel monitoring the grouting.

Standard Operating Procedure No. 9

SAMPLE HANDLING AND DOCUMENTATION

STANDARD OPERATING PROCEDURE No. 9

SAMPLE HANDLING AND DOCUMENTATION

CANNON AIR FORCE BASE, FIRE TRAINING AREA No. 4
RCRA FACILITY INVESTIGATION
CLOVIS, NEW MEXICO

USACE CONTRACT No. DACW45-94-D-0044
DELIVERY ORDER No. 0006
HARZA PROJECT No. 5644M

Approvals: Date

1-10-96

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1-30-96

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3.0
PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) defines the methods to be used for sample handling, documentation, and analysis. This SOP supplements and is intended to be used with the Data Collection Quality Assurance Plan (DCQAP) and other SOPs and is referenced in turn by all SOPs that apply to sampling.

4.0
RESPONSIBILITIES AND QUALIFICATIONS

Harza's Project Manager is responsible for assuring that samples are handled, documented, and analyzed according to this procedure. The Project Manager will designate qualified project staff, including a Task Leader, to complete this procedure and the required reviews.

Designated project staff are responsible for sample handling and documentation according to this procedure. They will report progress and any problems to the Task Leader or Project Manager. Staff members are responsible for understanding the activities assigned to them and the associated Quality Assurance (QA) requirements.

All personnel performing activities covered in this SOP shall be qualified to perform the activities assigned to them. The Project Manager will appraise the qualifications of prospective assignees based on their experience and training with respect to the job requirements. The Project Manager also will determine whether future training is required and, if so, by what method. On-the-job training is acceptable provided such training is received from a person qualified to perform the assignment and the results of training are documented.

5.1 SAMPLE LABELING

An example of a completed sample label is provided in Figure 1. All sample labels shall be filled out with waterproof ink and numbered. For samples (soil, groundwater, or other) collected in jars or sample bottles, labels should be completed and attached prior to sample collection. Soil samples collected in stainless steel liners (e.g. Shelby Tubes, or other), if any, will be capped and sealed immediately following collection and a completed label attached.

Labels may be partially completed prior to sample collection. The date, time, sampler's initials, and the sample identification number should not be completed until the time of sample collection. Each numbered label shall contain the following information:

- Project/Facility Name
- Type of sample (e.g. grab or composite)
- Sampler's company affiliation
- Date and time of sample collection
- Analyses required
- Preservation used
- Sampler's initials
- Whether filtered (if applicable)
- MRD LIMS No. (if collected for MRD Lab)
- Sample designation (see below)

5.2 SAMPLE DESIGNATIONS

The sample designation system for all field (analytical and geotechnical) and quality assurance/quality control (QA/QC) samples consists of a fifteen digit/letter identification which is unique for each sample (e.g. CANFTA4-YYYY-ZZZZ).

CANFTA4 is the facility identifier with "CAN" identifying Cannon AFB and FTA4 refering to Fire Training Area No. 4.

The next four digits/letters (YYYY) identify the specific sampled location. For the samples from Fire Training Area No. 4 at Cannon AFB, these include soil boring numbers and passive soil gas sample numbers identified as follows:

- SB01 for soil boring number 1
- SG01 for soil gas sample 1

The last four characters (ZZZZ) are the sample identifier. The first two digits correspond to the type of sample, as follows:

- 01 for soil (analytical)
- 02 for soil (geotechnical)
- 03 for soil gas
- 04 for soil for immunoassay screening

The last 2 numbers correspond to the beginning depth of the sample in feet below ground surface for all samples. The following is an example of an identification number for this field investigation:

Soil (Analytical)

CANFTA4 - SB01 - 0108

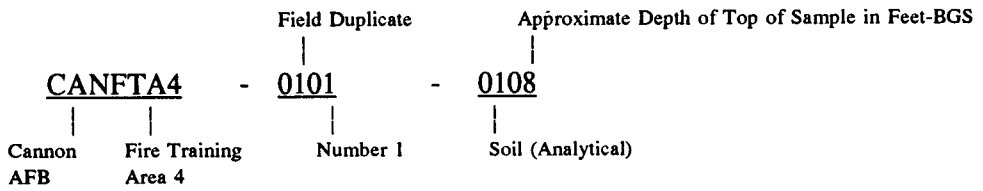
Cannon AFB | Fire Training Area 4 | Soil Boring #1 | Approximate Depth of top of Sample in Feet-BGS

Multiple soil samples will be collected from the same borehole. The last two digits differentiate among these multiple samples. The soil sample identifier will represent the approximate beginning depth at which the sample was collected.

All QA/QC samples will be identified as to the location where they were collected and assigned a unique identification number following the same procedure above except for the last eight digits (YYYY-ZZZZ). The first two numbers of the QA/QC sample identifier correspond to a particular type of QA/QC sample, as follows:

- "01" for Field Duplicate
- "02" for Missouri River Division Duplicate

The subsequent two characters correspond to the sequential sample number (e.g. 1,2, etc.). The final four characters (ZZZZ) designate the matrix and depth as described above. The following is an example of an identification number for a QA/QC Sample:



The only QA/QC sample type which is not identified as above is the Matrix Spike/Matrix Spike Duplicate. These are duplicate samples from a previously collected analytical sample which are spiked with the target analyte and reanalyzed for laboratory QA/QC control purposes. The samples which are chosen for MS/MSD analyses will be labeled in the field as MS/MSD samples and so noted on the Chain-of-Custody forms. The sample identifier consists of the regular sample number followed by "MS/MSD."

5.3 SAMPLE HANDLING

5.3.1 Sample Containers

Table 1 provides the required sample containers for the analyses to be performed at Fire Training Area No. 4. Certified, commercially clean sample containers shall be obtained from the contract analytical lab. If appropriate, the bottles shall be labeled by the lab to indicate the type of sample to be collected. Required preservatives (with the exception of sodium thiosulfate) shall be prepared and placed in the bottles for aqueous analyses at the laboratory prior to shipment to the site. Subsurface soil samples collected in stainless steel liners, if any, will be sealed by covering each end with a square of teflon tape and a plastic cap. Caps will be secured with electrical tape prior to affixing the sample label.

5.3.2 Sample Preservation

Required sample preservation is provided on Table 1. All samples will be stored on ice in an insulated cooler immediately following sample collection. Soil samples do not require additional preservation.

5.3.3 Sample Packing and Shipping

Sample containers will be placed in recloseable plastic storage bags and wrapped in protective packing material (if appropriate). Samples will then be placed in a cooler with ice (double bagged using plastic trash bags) for shipment to the laboratory. The drain on the cooler shall be taped shut. Samples collected in glass containers will be packed in foam liners and bubble packing or styrofoam peanuts to protect against breakage. Refer to SOP #1 for modified requirements for passive soil gas sample containers to be shipped to W. L. Gore and Associates. A completed chain-of-custody form will be placed in a ziplock bag and taped to the inside of each cooler lid. Coolers will be wrapped with strapping tape at two locations to secure the cooler lid. Numbered and signed custody seals shall be placed on the outside of each cooler. "Fragile" and "This Side Up" labels shall be placed on the outside of each cooler containing glass bottles. "This Side Up" labels should be placed on all four sides and "Fragile" labels on

at least two sides. Sampler's should ascertain that no cooler exceeds the weight limit set by the shipper.

Samples will be shipped by overnight express carrier for delivery to the analytical laboratory and to the MRD laboratory, as appropriate. Prior arrangements with the laboratory shall be made for any shipments expected to be received on Saturday, Sunday or other holiday. Sample pickup can be arranged between 2:00 and 4:00 pm at Building 250, Cannon AFB.

5.3.4 Holding Times and Analyses

'Holding time' is the maximum allowable time between sample collection and analysis and/or extraction, based on the analyte of interest, stability factors, and preservation methods. Chemical constituents which will be analyzed during the field investigation have been identified in the DCQAP and SOP No. 10. Allowable holding times are listed in Table 1. Samples should be sent by overnight courier service to the laboratory daily after collection to assure that holding times are not exceeded. If this is not possible due to the local pickup schedule, samples will be chilled and shipped as early as possible the next day.

5.4 SAMPLE DOCUMENTATION AND TRACKING

The Soil Boring Log as discussed in SOP #7 is the primary vehicle for recording geologic and sampling data collected during drilling and sampling in soil borings. Additional sample documentation and tracking requirements are described in the following sections.

5.4.1 Field Notebook

Documentation of observations and data acquired in the field will provide information on the acquisition of samples and also provide a permanent record of field activities. The observations and data will be recorded with waterproof ink in a permanently bound weatherproof field book with consecutively numbered pages and, if applicable, on field sampling data sheets.

The information in the field book will include the following as a minimum. Additional information is included in the specific SOPs regarding the appropriate data sheets.

- Project name
- Location of sample
- Sampler's signature
- Date and time of sample collection
- Sample identification numbers and sample depth (if applicable)
- Description of samples (matrix sampled), composite or grab sample
- Analysis to be performed
- Number and volume of samples
- Description of QA/QC samples (if collected)
- Sample methods or reference to the appropriate SOP
- Sample handling, including preservation, as appropriate for samples
- Field observations (if not provided on the Boring Log)
- Results of any field measurements (if not provided on the Boring Log)
- Personnel present

Changes or deletions in the field book should be lined out with a single strike mark, initialed and dated by the person making the change, taking care that entries remain legible. Sufficient information should be recorded to allow the sampling event to be reconstructed. Each page of the field book will be signed by the person making the entry. Anyone making entries in another person's field book will sign and date those entries.

5.4.2 A-E Daily Quality Control Report

As a supplement to the field notebook, Daily Quality Control Reports (DQCRs) will be maintained to document daily field activities and note any non-conformances and corrective actions taken at every sampling location. An example DQCR is provided in Attachment 1. DQCRs will be maintained by members of the field sampling team and cross-checked for completeness at the end of each day by the sampling team members and/or Site Manager. They will be signed and dated by individuals making entries and initialed by the reviewer upon completion. Copies of the DQCR will be forwarded to Harza's Project Manager, submitted to the USACE Technical Manager weekly, and hand delivered to Cannon AFB designated personnel the following morning. If problems arise, the relevant DQCRs will be faxed to the USACE Technical Manager daily until the problems are corrected.

5.4.3 Sample Chain-Of-Custody

During field sampling activities, traceability of the sample must be maintained from the time the samples are collected until laboratory data are issued. Information on the custody, transfer, handling, and shipping of samples will be recorded on a Chain-of-Custody (COC) form. An example COC form is shown on Figure 2. This form also will be used for samples hand delivered to Harza's field laboratory for TPH immunoassay screening.

The Sample Delivery Group (SDG) number will be designated by the field personnel and will be noted at the top of the COC. The analytical laboratory will assign this SDG number to the analysis and reporting of these samples.

The field sampling team will be responsible for initiating and filling out the COC form. The COC will be signed by the sampler when the sampler relinquishes the samples to anyone else. It is not necessary for the shipper (e.g. Federal Express, etc.) to sign the COC; however, the airbill shall be retained by the sample handler for tracking purposes and will become part of the sample documentation. A COC form will be completed for each set of samples collected daily, and will contain the following information:

- Sampler's signature and affiliation
- Project number
- Date and time of collection
- Sample identification number
- Sample type/matrix
- Grab or composite sample
- Preservative used
- Analyses requested
- Number of containers
- Signature of persons relinquishing custody, dates, and times
- Signature of persons accepting custody, dates, and times (laboratory)
- Method of shipment (i.e. Fed-X)

The person responsible for delivery of the samples to the air carrier will sign the COC form, retain the last copy of the three-part COC form, document the method of shipment, and send the original and the second copy of the COC form with the sample (taped in a ziplock bag to inner cooler lid). Upon receipt at the laboratory, the person receiving the samples will sign the COC form and return the second copy to the Harza Project Manager. Copies of the COC forms and all custody documentation will be received and kept in the central files. The original COC forms will remain with the samples until final disposition of the samples by the laboratory. The analytical laboratory will dispose of the samples in an appropriate manner 60 to 90 days after data reporting. After sample disposal, a copy of the original COC will be sent to the Harza Project Manager by the analytical laboratory to be incorporated into the central files.

TABLE 1
Analytical Methods, Sample Containers, Preservation, and Holding Times

SW-846 Method	Parameter	Number of Containers/Sample	Minimum Sample Size	Preservation	Holding Time
8260[1]	Volatiles	2 - 4oz glass VOA jars with Teflon-lined lid	10g	4°C	14 days
8270	Semivolatiles	1 - 4oz wide-mouth glass jar with Teflon-lined lid	30g	4°C	Extract - 14 days Analyze - 40 days
9071/418.1	TRPH	1 - 4oz wide-mouth glass jar with Teflon-lined lid	30g	4°C	28 days
6010/ 7000 Series[3]	Metals	1 - 8oz wide-mouth glass jar with Teflon-lined lid	200g	4°C	120 days
9010	Cyanide	1 - 8oz wide-mouth polyethylene jar	200g	4°C	28 days
4030	TPH Screening (immunoassay)	1 - 8oz wide-mouth glass jar with Teflon-lined lid	30g	4°C	14 days

[1] Method 8260 using capillary column.
[3] Includes Methods 7061 (arsenic), 7421 (lead), 7470 (mercury), 7741 (selenium) and 7841 (thallium)

FIGURE 1

EXAMPLE SAMPLE LABEL

Harza Environmental Services, Inc.
233 South Wacker Drive, Chicago, IL 60606
Client/Site: USACE / Cannon AFB FTA #4
Project No.: 5644M
Sample No.: CANFTA4-SB01-0108
Analysis: TRPH
Preservative: 4°C
Date: 02/12/96 **Time:** 1320 **By:** _____

HARZA ENVIRONMENTAL SERVICES, INC. *Consulting Engineers*

SEARS TOWER • 233 South Wacker Drive • Chicago, Illinois 60606-6392 Tel: (312) 831-3800 • Fax: (312) 831-3999 • Telex: 25-3540

№ 001061

CHAIN OF CUSTODY RECORD

SITE:

COOLER No.

SAMPLER: (Signature)

PROJECT No.

PARAMETERS

FIELD SAMPLE NUMBER	DATE	TIME	COMP.	GRAB	STATION LOCATION	No. OF CONTAINERS											REMARKS

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)

Relinquished by: (Signature)	Date	Time	Received for Laboratory by: (Signature)	Date	Time	Remarks:

Figure 2

ATTACHMENT 1

DAILY QUALITY CONTROL REPORT (DQCR) FORM

HARZA ENVIRONMENTAL SERVICES

DAILY QUALITY CONTROL REPORT

Sheet ___ of ___

--- USE SUPPLEMENTAL SHEET IF ADDITIONAL SPACE IS REQUIRED ---

Project Name:	CANNON AFB/FTA #4	**Report No:**	
Project Number:	5644N	**Date:**	
Contract No.:	DAC45-94-D-0044/006	**USACE TM:**	DOUG MELLEMA

DAY (circle one): Sun Mon Tue Wed Thu Fri Sat

Weather	Sunny	Clear	Overcast	Rain	Snow
Temp (°F)	< 32	32-50	50-70	70-85	> 85
Wind	Still	Moderate	High		
Humidity	Dry	Moderate	Humid		

1. Harza personnel on site:

2. Subcontractor personnel on site (name & affiliation):

3. Equipment on site:

4. Visitors (name & affiliation:

5(a). Work Performed:

5(b). Samples Collected (sample numbers):

6. QC Activities (including field calibrations):

7. Health & Safety Levels/Activities:

8. Problems Encountered/Corrective Actions Taken:

9. Remarks:

10. Planned Activities, Next Work Day:

Signature: _____ Title: _____

HARZA ENVIRONMENTAL SERVICES

DAILY QUALITY CONTROL REPORT

Sheet ___ of ___

--- USE SUPPLEMENTAL SHEET IF ADDITIONAL SPACE IS REQUIRED ---

Project Name: _____ Report No. _____ Date: _____

11. SUPPLEMENTAL INFORMATION (Explain and attach if additional space is required):

Signature: _____ Title: _____

Standard Operating Procedure No. 10

DATA VALIDATION AND QC REVIEW OF ANALYTICAL LABORATORY DATA PACKAGES

STANDARD OPERATING PROCEDURE No. 10

DATA VALIDATION AND QC REVIEW OF ANALYTICAL LABORATORY DATA PACKAGES

CANNON AIR FORCE BASE FIRE TRAINING AREA No. 4
RCRA FACILITY INVESTIGATION
CLOVIS, NEW MEXICO

USACE Contract No. DACW45-94-D-0044
Delivery Order No. 0006
HARZA Project No. 5644M

Approvals: Date

1-10-96

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1-30-96

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Department Head

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3.0
PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) defines the method by which laboratory chemical data will be validated and reviewed, checked, and qualified. This procedure applies to chemical data generated by any laboratory providing inorganic or organic chemical analyses of environmental or waste samples to Harza for the project. Any modifications to the SOP should be approved by the Project Manager and QA/QC Officer in advance. This SOP supplements and is intended to be used with the Data Collection Quality Assurance Plan (DCQAP), which describes QA requirements and activities for the project in compliance with the U.S. Environmental Protection Agency's (USEPA's) 16 required elements of a QA plan. This procedure specifically addresses elements 10 - Data Reduction, Validation and Reporting and 14 - Specific Routine Procedures to Assess Data Precision, Accuracy and Completeness.

4.0
RESPONSIBILITIES AND QUALIFICATIONS

The Harza Project Manager is responsible for initiating the data validation and review process according to this procedure for each analytical laboratory data package received. The Project Manager will designate qualified project staff to complete this procedure.

The Project QA Officer will be responsible for seeing that the data validation process is implemented in accordance with this plan. The designated project staff are responsible for completing the data validation and review and reporting progress according to this procedure. They report their progress, and any problems, to the Project QA Manager. Staff members are responsible for understanding the activities assigned to them and the quality assurance requirements associated with the activities.

All personnel assigned to complete portions of this procedure shall be qualified to perform the portions of the procedure assigned to them. The Project Manager will make the appraisal of qualifications, including comparison of the requirements of the job assignment with the relevant experience and training of the prospective assignee and a determination of whether future training is required, and, if required, by what method. On-the-job training is an acceptable method, provided such training is received from a person qualified to perform the trainee's assignment and the results of that training are documented.

5.1 DATA QUALIFIERS

Laboratory analytical data packages will receive an independent review by a designee of the Harza Project Manager. Laboratory results will be reviewed and data qualified, if required, as specified below. Sample data may be qualified as "J" (estimated), "UJ" (not detected above the instrument detection limit - estimated), or may be rejected ("R"). The qualifier "U" is normally used for analytes not detected by the laboratory. Rejected data are not usable for any purpose.

5.2 REQUIRED CONTENTS OF LABORATORY ANALYTICAL DATA PACKAGES

The laboratory will prepare and retain full analytical and QC documentation. For SW-846 and other analytical methods, the laboratory will report the data as a group of 20 samples or less, along with QC supporting data. The laboratory will provide the following hard copy information in each analytical data package submitted in accordance with QA objectives for the project:

- Completed chain of custody forms.
- Cover sheet listing the samples included in the report and narrative comments describing problems encountered in analysis.
- Tabulated results of inorganic and organic compounds identified and quantified and reporting limits for all analytes.
- Analytical results for QC sample spikes, sample duplicates, initial and continuous calibration verifications of standards and blanks, standard procedural blanks, laboratory control samples, and ICP interference check samples.
- Tabulation of reporting limits related to the sample.

- Raw data system printouts (or legible photocopies) identifying date of reported analysis, analyst, parameters analyzed, calibration curve, calibration verifications, method blanks, any reported sample dilutions, sample duplicates, spikes, and control samples; sample spiking levels, preparation/extraction logs and run logs.

For organic analyses, the data packages will include matrix spikes, matrix spike duplicates, surrogate spike recoveries, chromatograms, GC/MS spectra, and computer printouts for reported analyses and associated QC data. Laboratory qualifiers will include:

- Concentration reported as detected below required reporting limit
- Concentration of chemical also found in laboratory blank

The Case Narrative accompanying the data package will include the identification of samples not meeting laboratory QC criteria as specified in the QAPP and the laboratory QA Plan and cautions regarding nonquantitative use or unuseability due to out-of-control QC results.

5.3 DATA VALIDATION PROCEDURE

All critical data or ten percent of the sample data, whichever is less, will be subjected to complete data validation using guidance from USEPA functional guidelines for data validation. The OSWER directive *Guidance for Data Useability in Risk Assessment* (USEPA 1990a) will be used to determine the level of independent data review required for sample analyses to be used in risk assessment modeling. In accordance with this OSWER directive, critical data are those data considered to be crucial for the purposes of risk assessment.

5.3.1 Full Data Validation of Sample Data Packages

5.3.1.1 Volatile and Semivolatile Organic Analyses

Volatile and semivolatile organic analytical data for ten percent of the samples will undergo validation of all of the following requirements, using guidance from *National Functional Guidelines for Organic Data Review, Multi-Media, Multi-Concentration (OLM01.0) and Low Concentration Water (OLC01.0)* (USEPA, 1990), as appropriate to the analytical method:

- Holding times;
- GC/MS instrument performance check;
- Initial calibration;
- Continuing calibration;
- Blanks;
- Surrogate spikes;
- Matrix spikes/matrix spike duplicates;
- Internal standards;
- Target compound identification;
- Compound quantitation and reporting limits;
- Tentatively identified compounds (TICs);
- System performance;
- Field duplicates;
- Overall assessment of data; and
- Completeness of the data package.

Control criteria to be used for the validation will be taken from the appropriate tables in the DCQAP. Where data are reported outside the limits in the DCQAP, the validator will also reference the SW846 Method limits. Data reported outside both sets of control limits will be qualified by the validator as estimated or rejected based on guidance from the 1994 Organic Guidelines. Data reported outside only the DCQAP limits, based on laboratory historical data, will be evaluated by the validator and estimation or rejection of data will be based upon the professional judgment of the validator.

Holding Times. Analytical data will be reviewed for adherence to EPA-required holding times specified in Table 4-1 of the DCQAP and Table 1 of SOP #9. Data for samples analyzed beyond specified holding times will be qualified or rejected in accordance with the action criteria contained in the Organic Guidelines (USEPA, 1994a).

GC/MS Instrument Performance Check. GC/MS instrument performance checks are performed to ensure mass resolution, identification and sensitivity. The data reviewer will verify that the laboratory has used the proper check solutions at the beginning of each 12-hour period during which samples and standards were analyzed, in accordance with the Organic Guidelines (USEPA, 1994a). Raw data also will be reviewed for correct mass listing/mass assignment and to see that the mass is normalized to the specific ion abundance criteria (m/z). If possible, verification of generated spectra will be conducted using the appropriate background subtraction technique. The reviewer's professional judgement will be applied to determine the usability of the data.

Calibration. The initial calibration standard's relative response factors (RRFs) and percent relative standard deviation (%RSD) for all volatile target analytes and system monitoring compounds will be evaluated to verify that ranges are within USEPA's QC limits. Compliance requirements for satisfactory instrument calibration will be established to ensure that the instrument is capable of producing acceptable data, both quantitatively and qualitatively.

Blanks. Laboratory blank samples will be analyzed in accordance with the specifications contained in Section 6.0 of the DCQAP. Blank contamination will be evaluated and associated data validated in accordance with the action criteria contained in the Organic Guidelines (USEPA, 1994a).

Surrogate Recovery. Surrogate spikes will be added to all samples in accordance with the provisions of Section 6.0 of the DCQAP. Surrogate spike recoveries will be evaluated in accordance with the control limits tabulated and referenced in Section 2.0 of the DCQAP and the SW-846 method, and the data validated using guidance from the Organic Guidelines (USEPA, 1994a).

Matrix Spikes/Matrix Spike Duplicates. Matrix spikes and matrix spike duplicates will be analyzed at the frequency specified in Section 6.0 of the DCQAP. Spike recoveries and precision will be evaluated in accordance with the specifications tabulated and referenced in Section 2.0 of the DCQAP and the SW-846 method, and the data validated using guidance from the Organic Guidelines (USEPA, 1994a).

Internal Standards. Internal Standards (IS) performance criteria will be reviewed to evaluate the GC/MS sensitivity and response during each analysis. The evaluation process will include: a) checking raw data to verify the IS retention times and areas reported on the IS Area Summary; b) verifying all retention times and IS areas to be within criteria; and c) determining and reporting the best data set for two sets of analyses for a particular fraction. Additional guidance will be used as described by USEPA (1994a).

Target Compound Identification. All target compounds will be identified to minimize the number of erroneous identifications of compounds. The identification criteria can be applied more easily in detecting false positive than false negative results because more information is available due to the requirements for data supporting positive identifications. Additional guidance as provided by USEPA (1994a), will be used to identify other criteria, such as relative retention times.

Compound Quantitation and Reporting Limits. Compound quantitation results will be checked to verify that reporting limits are met and accurate. Raw data will be examined to verify the correct calculation of sample results reported by the laboratory. Other criteria provided by USEPA (1994a) will also be used to evaluate compound quantitation and reporting limits, if required.

Tentatively Identified Compounds (TICs). TICs will be checked to verify if they are listed. Chromatographic peaks that are not target analytes, system monitoring compounds, internal standards or surrogates are potential TICs. TICs will be qualitatively identified by mass spectral library search and reported as estimated values. Ions present in the sample spectrum but not in the reference spectrum will be reviewed for possible background contamination, interferences, or coelution of additional TIC or target compounds. In the case of uncertain identification, the TIC result may be reported as "unknown." Blank chromatograms will be examined to verify that TIC peaks present in samples are not found in blanks. Additionally, the data reviewer will use his/her judgement to determine sources of TICs, such as laboratory contaminants or artifacts.

System Performance. During the period following instrument performance checks (e.g. blanks, tuning, calibration), changes may occur in the system that degrade the quality of the

data. Indications of these occurrence which will be reviewed during system performance evaluation include: shifts in absolute retention times of IS; excessive baseline rise at elevated temperature; extraneous peaks; loss of resolution; and peak tailing or splitting that may result in inaccurate quantitation. There are no specific criteria for system performance and professional judgement should be applied.

Field Duplicates. The field duplicate data will be evaluated and validated in accordance with the criteria contained in the Organic Guidelines (USEPA, 1994a).

Overall Assessment of Data for a Case. The overall assessment of data for a case will be conducted in accordance with the criteria contained in the Organic Guidelines (USEPA, 1994a). Comparison of sample results to the analytical results for QA samples sent to the QA laboratory will be utilized, if available, in the overall assessment of data.

Completeness of Data Package. Analytical data packages will be checked for completeness of deliverables discussed in Section 5.2 of this SOP. If required elements are missing, the data validator will document the missing deliverables and request them, in writing, from the contract laboratory. If the laboratory fails to furnish the requested information, this will be noted in the Overall Assessment of Data and a second request will be made to the laboratory for the information.

5.3.1.2 Metals and Cyanide Analyses

Metals and total cyanide analytical data for critical samples will undergo validation of all of the following requirements, using guidance from *Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses* (USEPA 1994b), as appropriate to the analytical method:

- Holding times;
- Calibration;
- Blanks;
- ICP interference check sample (ICS);
- Laboratory control sample (LCS);
- Duplicate sample analysis;

- Matrix spike sample analysis;
- Sample result verification;
- Field duplicates;
- Completeness of data package; and
- Overall assessment of data for a case.

Control criteria to be used for the validation will be taken from the appropriate tables in the DCQAP. Where data are reported outside the limits in the DCQAP, the validator will also reference the SW846 Method limits. For the solid LCS sample, the control limits supplied by the manufacturer (based on an interlaboratory study) will be used since no limits are provided in the method. Data reported outside both sets of control limits will be qualified by the validator as estimated or rejected based on guidance from 1994 Inorganic Guidelines. Data reported outside of only the DCQAP limits, based on laboratory historical data, will be evaluated by the validator and an estimation or rejection of data will be based upon the professional judgment of the validator.

Holding Times. Analytical data will be reviewed for adherence to EPA-required holding times specified in Table 4-1 of the DCQAP and Table 1 of SOP #9. Data for samples analyzed beyond specified holding times will be qualified or rejected in accordance with the action criteria contained in "Functional Guidelines for Evaluating Inorganics Analyses" (USEPA, 1994b).

Calibration. Satisfactory instrument calibration will be establised by the laboratory to insure that the instruments are producing acceptable data in accordance with the required methods. Initial and continuing calibration data will be reviewed for inductively coupled plasma (ICP), graphite furnace atomic absorption (GFAA), and cold vapor atomic absorption (CFAA), as applicable.

Blanks. Laboratory blank samples will be analyzed in accordance with the specifications contained in Section 6.0 of the DCQAP. Blank contamination will be evaluated and associated data qualified, if required, in accordance with the action criteria contained in the Inorganic Guidelines (USEPA, 1994b).

ICP Interference Check Sample (ICS). The data reviewer will verify the raw data to see that the ICS was analyzed at the proper frequency and location during the analytical run. An ICS must be run at the beginning and end of each sample analysis run. ICS raw data will be evaluated to check the absolute value, ICS percent recovery, etc. Additional guidance as provided in the Inorganic Guidelines (USEPA, 1994b) will be followed.

Laboratory Control Samples (LCS). A laboratory control sample (LCS) will be analyzed with each sample delivery group and the data evaluated in accordance with the control limits tabulated and referenced in Section 2.0 of the DCQAP. Sample data associated with the LCS results will be qualified, if required, in accordance with the action criteria contained in the Inorganic Guidelines (USEPA, 1994b).

Duplicate Sample Analysis. Laboratory duplicate samples will be analyzed at the frequency specified in Section 6.0 of the DCQAP, the precision evaluated in accordance with the control limits tabulated and referenced in Section 2.0 of the DCQAP and the SW-846 method and the data qualified, if required, using guidance from the Inorganic Guidelines (USEPA, 1994b).

Matrix Spike Sample Analysis. Matrix spike samples will be analyzed at the frequency specified in Section 6.0 of the DCQAP; the recovery evaluated in accordance with the control limits tabulated and referenced in Section 2.0 of the DCQAP; and the data validated using guidance from the Inorganic Guidelines (USEPA, 1994b).

Field Duplicates. Field duplicate data will be evaluated and qualified, if required, in accordance with the criteria contained in the Inorganic Guidelines (USEPA, 1994b).

Sample Result Verification. Sample results will be checked to verify that the correct calculation of sample results was was reported by the laboratory. The data reviewer will: evaluate any technical problems not addressed by the laboratory; examine raw data for any anomolies such as baseline shifts, relative absorbance, etc.; check for transciptional errors; verify that results fall within the linear range of the ICP and within the calibrated range for the non-ICP parameters; and assess appropriate information to assist the data used in avoiding inappropriate use of the data.

Overall Assessment of Data for a Case. The overall assessment of data for a case will be conducted in accordance with the criteria contained in the Inorganic Guidelines (USEPA, 1994b). A case is a finite, usually predetermined number of samples collected over a given time period from a particular site. A case will consist of all samples of similar matrix to be collected under Section 5.0 of the DCQAP. Comparison of sample results to the analytical results from QA Sample splits sent to the QA laboratory will be utilized, if available, in the overall assessment of the data.

Completeness of Data Package. In addition, analytical data packages will be checked for completeness of the deliverables discussed in Section 5.2 of this SOP. If required elements are missing, the data validator will document the missing deliverables and request them, in writing, from the contract laboratory. If the laboratory fails to furnish the requested information, this will be noted in the Overall Assessment of Data for a Case and a second request will be made to the laboratory for the information.

5.3.2 QC Review of Sample Data Packages

5.3.2.1 Volatile and Semivolatile Organic Analyses

Volatile and semivolatile organic analytical data will undergo evaluation of:

- Holding Times;
- Blanks;
- Surrogate Recovery;
- Matrix Spike/Matrix Spike Duplicates;
- Field Duplicates;
- Overall Assessment of Data for a Case; and
- Completeness of Data Package;

Control criteria to be used for the validation will be taken from the appropriate tables in the DCQAP. Where data are reported outside the limits in the DCQAP, the validator will also reference the SW846 Method limits. Data reported outside both sets of control limits will be qualified by the validator as estimated or rejected based on guidance from the *National*

Functional Guidelines for Organic Data Review (USEPA, 1994a). Data reported outside only the DCQAP limits, based on laboratory historical data, will be evaluated by the validator and estimation or rejection of data will be based upon the professional judgment of the validator.

5.3.2.2 Metals and Cyanide Analyses

Metals and total cyanide analytical data will undergo evaluation of the following:

- Holding Times;
- Blanks;
- Laboratory Control Samples (LCS);
- Laboratory Duplicate Sample Analysis;
- Matrix Spike Sample Analysis;
- Field Duplicate Sample Analysis;
- Overall Assessment of Data for a Case; and
- Completeness of Data Package.

Control criteria to be used for the validation will be taken from the appropriate tables in the DCQAP. Where data are reported outside the limits in the DCQAP, the validator will also reference the SW846 Method limits. For the solid LCS sample, the control limits supplied by the manufacturer (based on an interlaboratory study) will be used since no limits are provided in the method. Data reported outside both sets of control limits will be qualified by the validator as estimated or rejected based on guidance from the Inorganic Guidelines. Data reported outside only the DCQAP limits, based on laboratory historical data, will be evaluated by the validator and estimation or rejection of data will be based upon the professional judgment of the validator.

5.3.2.3 Review of Other Analytical Data

Other analytical data, such as Total Recoverable Petroleum Hydrocarbons (TRPH), will undergo evaluation of:

- Holding times;
- Blank contamination;

- Spike recoveries (matrix spikes, and laboratory control sample spikes, if specified in the DCQAP);
- Duplicate analysis precision (field duplicates, laboratory duplicates, and matrix spike duplicates if specified in the DCQAP); and
- Overall Assessment of Data for a Case.

Validation of analytical data for other compounds to be analyzed under the RFI investigation for Cannon Air Force Base, New Mexico, are not covered by the Organics Guidelines or the Inorganics Guidelines. Analysis will be by standard EPA methods contained in either SW-846 (third edition, 1986) or from "Methods for Chemical Analysis of Water and Wastes" (EPA 600/4-79-020, 1983), as specified in the DCQAP. Control criteria to be used for the validation will be taken from the appropriate tables in the DCQAP. Review of analytical results for other analytes will consist of the following:

Holding Times. Analytical data will be reviewed to determine adherence to EPA-required holding times in Table 4-1 of the DCQAP and Table 1 of SOP #9. Results for samples analyzed beyond these holding times will be qualified as "J" (estimated), or "UJ" (not detected - estimated). Data will be rejected, "R," if, in the professional judgment of the data validator, the holding time infractions make the data unusable.

Blank Contamination. Blank contamination will be evaluated using guidance provided in the Guidelines for Organic Data Review (USEPA, 1994b). The purpose of blank analysis is to determine the existance and magnitude of contamination resulting from laboratory or field activities. The criteria for evaluation of blanks apply to any blanks associated with the samples (e.g. method blanks, trip blanks, equipment blanks, and others as appropriate). If problems with any blank exist, all associated data will be carefully evaluated to determine the usability of the data. The reviewer should note that the blank analyses may not involve the same weights, volumes, or dilution factors as the associated samples. These factors must be taken into consideration when applying the 5 x the blank concentration criterion, such that a comparison of the total contamination is actually made.

Spike Recoveries. Spike recoveries (matrix spikes, surrogate spikes, and laboratory control spikes if specified in the DCQAP) will be evaluated using criteria tabulated and

referenced in Section 2.0 of the DCQAP and the SW-846 methods. Data outside of the accuracy limits specified in the DCQAP will be compared to limits in the analytical method. Data outside method control limits will be qualified as "J" or "UJ." Data will be rejected, "R", if in the professional judgment of the validator, the data are unusable. If data are outside the DCQAP limits, but inside the method limits, professional judgment will be used in qualifying or rejecting the data.

Duplicate Analysis Precision. Duplicate analyses (field duplicates, laboratory duplicates, and matrix spike duplicates if specified in the DCQAP) will be evaluated using criteria tabulated and referenced in Section 2.0 of the DCQAP and the SW-846 methods. Data outside of the precision limits specified in the DCQAP will be compared to limits in the analytical method. Data outside method control limits will be qualified as "J" or "UJ." Data will be rejected, "R", if, in the professional judgment of the data validator, the data are unusable. If data are outside the DCQAP limits, but inside the method limits, professional judgment will be used in qualifying or rejecting the data.

Overall Assessment of Data for a Case. The overall assessment of data for a case will be conducted in accordance with the criteria contained in the Organic Guidelines (USEPA, 1994a). Comparison of sample results to the analytical results for QA samples sent to the QA laboratory will be utilized, if available, in the overall assessment of data.

5.3.3 Additional QA Data

In addition to the above specified quality control data and validation guidelines, approximately ten percent of all samples will be split and sent to a QA laboratory for analysis. The QA laboratory for this project is the USACE Missouri River Division Laboratory (MRD). Comparison will be made between the analytical results for the samples split between the two laboratories. These interlaboratory results will then be utilized in the Overall Assessment of Data for a Case for each of the analyte groupings.

6.1 QUALITY ASSURANCE OBJECTIVES

The quality of the data collected for the Cannon AFB RFI is directly dependent on the quality of the analytical results. This QC review procedure provides the primary method for independent assessment of the analytical data. Quality assurance objectives are expressed in terms of accuracy, precision, completeness, comparability, and representativeness. Accuracy and precision of the data are defined in the DCQAP in terms of acceptable ranges, control limits and RPDs. These items will be calculated or checked during this procedure. An overall assessment of data for a case will be prepared for each data package.

Analytical completeness is defined as the number of accepted and estimated analyses received compared to the number of analytical results requested. Analytical completeness, as defined in the DCQAP, will be calculated during this procedure. The overall goal for analytical completeness is 90 percent.

Comparability is the confidence with which one data set can be compared with another. Representativeness is the degree to which a set of data accurately represents the characteristics of the population. For this SOP, comparability and representativeness will be maintained by performing the validation process in accordance with this procedure.

6.2 NONCONFORMANCES AND CORRECTIVE ACTION

A nonconformance is defined as a deficiency or improper procedure which renders the quality of an item unacceptable or indeterminate. It is the responsibility of all project staff to produce quality results and to report potential nonconformances to the Task Leader or Project Manager. If any nonconformances are found in validation or QC review of analytical data packages, the impact of these nonconformances on the overall project QA objectives will be assessed. Appropriate corrective actions may be initiated by the QA/QC Officer so that the project objectives can be accomplished. If a nonconformance is determined to affect a critical sample,

the Project Manager will determine if resampling and analysis is required to meet project objectives.

7.0
REFERENCES

Applied Research and Development Laboratory. 1995. Analytical Services Quality Assurance Project Plan. March 1995.

U. S. Environmental Protection Agency (USEPA). 1994a. Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses. February 1.

U. S. Environmental Protection Agency 1994b. Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses. July 1.

U.S. Environmental Protection Agency (EPA). 1990a. Guidance for Data Usability in Risk Assessment. Interim Final. OSWER Directive 9285.7-05. EPA 540/G-90/008. October 1990.

U.S. Environmental Protection Agency (EPA). 1990b. National Functional Guidelines for Organic Data Review. December 1990. Revised June 1991.

Standard Operating Procedure No. 11

DATA MANAGEMENT

STANDARD OPERATING PROCEDURE No. 11

DATA MANAGEMENT

CANNON AIR FORCE BASE, FIRE TRAINING AREA No. 4
RCRA FACILITY INVESTIGATION, PHASE M
CLOVIS, NEW MEXICO

USACE CONTRACT NO. DACW-45-94-D-0044
DELIVERY ORDER NO. 0006
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Approvals:	Date
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FIGURE 1 DATA TRANSMITTAL FORM
FIGURE 2 DATA CORRECTION/CHANGE FORM

3.0
PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) details the procedures to be followed in data management to provide a validated database for the end user. This procedure is designed to eliminate errors in the database and to provide documentation that corrections have been completed. The primary purpose of the data management plan is to communicate to users and decision-makers how information will be entered, accessed, and reviewed. This data management plan addresses the following issues:

1. Sample Documentation
2. Data Deliverables
3. Sample Tracking
4. Data Entry
5. Data Proofing
6. Data Reporting

A data management system (DMS), including a sample tracking system and a database management program must be in place prior to initiation of field activities. The DMS will consist of two separate systems: a sample tracking system and a database management program. The sample tracking portion of the DMS will be a spreadsheet (Quattro Pro, or equivalent), capable of meeting the requirements in Section 7.0 of this SOP. The database management program required by ACC for this project will be the Installation Restoration Program Information Management System (IRPIMS). A replacement for IRPIMS is expected to be issued and will be used, if available.

This SOP supplements and is intended to be used in conjunction with the Data Collection Quality Assurance Plan (DCQAP) and other SOPs.

4.0
RESPONSIBILITIES AND QUALIFICATIONS

Harza's Project Manager is responsible for assuring that chemical data derived from studies at Cannon AFB are managed according to this procedure. The Project Manager will designate qualified project staff to complete this procedure and the required reviews.

The designated project staff are responsible for implementing and carrying out data management activities according to this procedure. They report their progress, and any problems, to the Task Leader or Project Manager. The Data Manager will be responsible for required data entry and checking. The QA Officer will be responsible for seeing that the data management program is implemented in accordance with this plan. All staff members contributing to data management will be responsible for understanding the activities assigned to them and the quality assurance requirements associated with the activities.

All personnel assigned to complete this procedure shall be qualified to perform the portions of the procedure assigned to them. The Project Manager will make the appraisal of qualifications. The Project Manager's appraisal of qualifications will include a comparison of the requirements of the job assignment with the relevant experience and training of the prospective assignee; it will also include a determination of whether future training is required, and, if required, by what method. On-the-job training is an acceptable method, provided such training is received from a person qualified to perform the trainee's assignment and the results of that training are documented.

Sample identification and documentation will be as described in SOP No. 9, Sample Handling, Documentation and Analysis. As discussed therein, the following are considered key elements in properly documenting and tracking samples for the purposes of data management:

Field logbooks. The field logbooks are used to document all samples collected for a project. For each sample taken, the field logbooks will contain, as a minimum, information on field sample ID, date and time of sampling, sampling location, sample description, sample depth, requested analyses (chemical or geotechnical), number of containers filled and associated QC samples taken.

Chain-of-Custody Forms. Chain of custody (COC) forms must be used to document the transport and receipt of samples from the field to the laboratory. For data management purposes, the major information needs in the COC are: Date and time the sample was taken; Field Sample Identification; Chemical analysis being requested; The number of containers sent to the lab for each sample set; any special instructions, including if samples are to be placed on hold; Air bill number (if applicable); and Sample delivery group (SDG) numbers. Following shipment of samples to the laboratory, the Site Manager or designee will transmit copies of the completed COC form(s) to the Project Manager.

A-E Daily Quality Control Reports. DQCRs will be prepared by field sampling personnel daily and submitted to the Project Manager, the USACE and Cannon AFB personnel. DQCRs will summarize all significant aspects of each days field activities, including sampling activities and associated QC efforts and will include information regarding any problems encountered in sampling and the steps taken to resolve the problems.

Field Sample Collection Sheets. A FSCS will be prepared by field sampling personnel for each sample collected and will summarize sampling and QC data pertaining to that sample.

6.0
DATA DELIVERABLES

Data deliverable requirements from the laboratory will be determined prior to the start of the field work. Electronic deliverables will be in a Harza-defined format compatible with the requirements of the IRPIMS system and and the laboratory will be notified that they will be held responsible for ensuring that electronic deliverables accurately reflect the data reported in hard copy format. The laboratory will be instructed to submit data deliverables to Harza's Project Manager, who will see that the sample tracking system is updated and forward data packages to the data reviewer for validation.

A major part of managing chemical data is knowing how many samples have been taken, analyses requested, and analysis due dates. In addition, some chemical data may be more urgently needed than others, requiring these data to be prioritized over the rest of the data.

Sample tracking and data management include all forms of data collection and documentation and may include printing sample labels, printing COC forms in the field, checking holding times, and tracking outstanding analyses. A sample tracking system (STS) should be in place prior to the initiation of field sampling activities and will consist of a simple spreadsheet, in Quattro Pro format, developed and reviewed prior to initiation of the project. The STS should, as a minimum, contain the field sample ID, the laboratory's sample ID, sample matrix, the analyses requested, the holding time limits for the analyses, date collected, sample preservation, laboratory performing analyses, assignment of QC samples (e.g., field replicates, rinsates, matrix spikes), and data fields for indicating the following data completion stages:

- Sample data receipt
- Data package completeness check
- Data validation/QC review completion per sample per analysis
- Data entry check completed
- Database proofed against validated data result sheets

The sample COC forms and the laboratory receipt confirmation listings serve as the initial data entry sheets for the STS providing the field sample ID numbers, laboratory IDs, analyses requested, date of collection, and laboratory performing the analyses.

Upon receipt of an analytical data package, the STS will be updated to indicate that the data were received for the samples contained in the data package. The data package then will be forwarded to the designated data reviewer for validation, accompanied by a Data Transmittal Form (Figure 1). If the data package is missing sample results for one or more samples, the laboratory will be notified of the discrepancy.

Following the initial check of the sample data received, the data package will be checked against the required data deliverables for completeness by the data reviewer. If the package is complete, the STS

will be updated to indicate that the SDG completeness check was performed. If any discrepancies are noted, the laboratory will be notified and redeliverables requested.

If the package is complete, or if the data present are sufficient for validation of the data, the data validation efforts will begin in accordance with procedures in SOP #10 and the DCQAP. Following validation of the data for the package and assignment of appropriate data qualifiers (if required), the STS will be updated to indicate that the data validation has been completed and qualifiers assigned.

Upon completion of the data validation, the validated sample results will be entered into the database and the entry checked by the Data Manager or designee as described in Section 8.0 of this SOP. Upon completion of the data entry, the STS will be updated to indicate that data entry has been completed and the data checked. The Data Transmittal Form will be updated.

The QA Officer or designee will check a minimum of one data package per project study to verify that the steps documented as complete were performed (e.g., sample data received, data package complete, data validation complete, data entered into database).

Analytical data will be entered in two ways: (1) manual entry of field data from the field logbooks and laboratory data sheets into the data system, and (2) downloading analytical data into the IRPIMS database from data disks supplied by the laboratory. Electronic deliverables are the preferred method for receipt and entry of laboratory data, making data entry more efficient.

Chemical data results and supporting QC data should be provided whenever possible in electronic format and accompanied by a printed hard copy. This will minimize data entry errors from manual input into the database.

Upon completion of data validation, the validated data sheets will be sent by the data reviewer to the Data Manager or designee for entry into the database. For sample data being entered by Harza personnel, all data should be manually entered from the validated data sheets followed by proofing by a second party to check for errors.

For data entered into the database from a data file provided by the laboratory, a minimum of 10 percent of the data will be proofed by the Project Manager or designee against the hard copy of the data supplied by the laboratory (i.e., lab result sheets). If errors or discrepancies are found, an additional 10 percent of the data will be proofed. If additional errors are found, all entered data will be proofed. The laboratory will be notified of any discrepancies found.

It is expected that changes or corrections may be required to the data entered into the STS or the database (e.g., cancellation of sample analyses, additions of qualifiers to non-validated data, field logbook errors). In those instances where changes are required to the database prior to the final QC review (Section 9.0), all changes must be accompanied by a Data Correction/Change form (Figure 2) that will detail the changes to be made, and document that the changes were completed.

Problems encountered in data management are typically due to inconsistencies or errors in the reporting of the data. The data in the database should be checked electronically and/or manually via database printouts. The data checks should include identifying:

1. Incorrect field sample numbers
2. Duplicate data and samples
3. Improper parameter names
4. Samples with missing data
5. Missing samples
6. Incorrect sample collection data
7. Incorrect units
8. Incorrect qualifiers
9. Missing detection limits, as applicable
10. Number of significant figures reported

It is important that data inconsistencies and errors be identified as soon as possible to allow for corrections of any problems prior to use of the data. All data received from a laboratory should be checked for inconsistencies such as those above.

9.1 DATA ENTRY QC PROCEDURE

The Site Manager or designee will be responsible for accurately completing required field documentation to identify sample IDs, collection dates, analyses requested, etc. and transmitting this documentation to the Project Manager or designee for entry into the STS. The initial sample data entry will be proofed as described in Section 8.0 of this SOP for electronic and single key entry. For sample results entered by Harza personnel, proofing of the entered data will be performed as described in Section 8.0 of this SOP. For all corrections, addition of data qualifiers, and other required changes to the database, all changes will be proofed by the Project Manager or designee for potential entry errors.

9.2 DATABASE QC PROCEDURE

The following data QC procedure should be followed for proofing the database to the validated data:

1. The database QC review will be completed on a data package basis. A hard copy of the data package will be checked by the Data Manager or designee against information in the data package as described below.

2. Clearly mark corrections to the hard copy report in red ink.

3. Using the data entry sheets and laboratory data sheets, check that the Harza sample IDs are correctly listed on the database hard copy, and that all samples for the package are reported on the database hard copy.

4. Using the validated and qualified laboratory data sheets, check that all the analyses requested for each sample are reported on the database hard copy.

5. Using the Lab Sheets, check that the units reported on the database hard copy are correctly reported (i.e., check that the analytical matrix is reported correctly), as liters (L) for aqueous samples, and kilograms (Kg) for solids, and that the power of the unit is correct for the analytical method (i.e., micrograms [μg] or milligrams [mg]).

6. Using the Lab Sheets, check that all qualifiers, results, units, and reporting limit changes are correctly reported on the database hard copy. All assigned validation qualifiers and all changes to the database will be checked for potential entry errors.

7. Using the Lab Sheets as a basis, check values (results and reporting limits) for all analytes for a given sample, at a frequency of approximately 10 percent of the samples for each package. For packages with results reported for more than 10 analytes for all samples, check the values and reporting limits for a minimum of one analyte per sample. If errors are found, an additional 10 percent of results and reporting limits will be checked for similar errors. If errors are found in the second 10 percent, then all results and reporting limits will be checked.

8. For each data package, note any questions concerning the reporting of the data and check with the Project Manager before returning the reviewed and edited database hard copy.

9. After completing the QC check of approximately 10 percent of the data packages, discuss the general findings of the review procedure with the QA Officer. Depending upon the review findings, appropriate modifications to the review procedure may be put into effect.

To make efficient use of the data to support decisions, it is important for the end user to know the status (i.e., preliminary or final) and quality (i.e., non-validated, validated) of the data in the database. Therefore, every data report generated will indicate the current status of the database. In addition, until the database is finalized (i.e., all data validated, reviewed, and the QC review completed), authorization for access to the database is limited to the Project Manager or designee(s). If there is a need for preliminary data by an end user, authorization must be obtained from the Project Manager.

10.1 PRELIMINARY DATABASE REPORTS

For reports generated from the database prior to the database being determined to be final by the Project Manager in consultation with the QA Officer and the Data Manager all data reports will include: (1) a header indicating that the database is '**PRELIMINARY**;' and (2) a status line per sample per analysis type (e.g., mercury, methyl mercury, ICP metals, fluoride, chloride, etc.) indicating the current status of the data for that sample. The status lines will indicate the following, as applicable:

- **Pre-QC** - The data entry has not been proofed. This may apply to manual entry of validated or non-validated results or entry of non-validated results from a data file supplied by the laboratory.

- **QC** - Sample data have been qualified in accordance with the validation/review and have been proofed in accordance with this SOP.

- **Validated** - Data have been validated, qualifiers assigned, and the validated data proofed.

For '**PRELIMINARY**' data reports, the reported sample results are subject to change and should be used with caution by the end user.

10.2 FINAL DATABASE REPORTS

When all sample data have been validated, the database QC completed for a given project study, and the database approved as final by the Project Manager in consultation with the QA Officer and Data Manager, the header on all data reports will indicate '**FINAL**.'

All persons receiving copies of 'FINAL' data report(s) for a given task or project will be listed on a distribution list for that report. Any changes required to the data in the 'FINAL' database version for a given project will be made in consultation with the Project Manager. If changes are approved and made to the database, then all individuals on the distribution list for that database report(s) will be sent a notice highlighting the revisions made and a copy of the revised 'FINAL' database report(s).

Figure 1
DATA TRANSMITTAL FORM

Data Transmitted

The attached laboratory data for Data Package Number _____ contains analytical data for the following analyses:

___ Volatile Organics
___ Semivolatile Organics
___ Pesticides/PCBs
___ Herbicides
___ ICP Metals
___ GFAA Metals
___ Mercury
___ TOC
___ TPH
___ Other - _____

The data are reported on a ***wet / dry*** weight basis (circle one)
The status of the attached data is:

___ Data Not Validated
___ Data Validated

Data Reviewer _____ Date _____

Data Entry

The status of data entry is as follows:

___ Data entered but entry not proofed
___ Data entered and entry proofed

Data Entry By _____ Date _____
Entry proofed by _____ Date _____

Figure 2

DATA CORRECTION/CHANGE FORM

The following changes and/or corrections to the database are required:

___ Data qualifiers have been assigned to the attached sample data for Data Package No. _____

___ The following sample analyses have been cancelled:

___ Other changes or corrections (describe below):

Changes Requested By _____ Date _____

Changes Made By _____ Date _____

Changes Checked By _____ Date _____

Standard Operating Procedure No. 12

SOIL SCREENING FOR PETROLEUM HYDROCARBONS BY IMMUNOASSAY

STANDARD OPERATING PROCEDURE No. 12

SOIL SCREENING FOR PETROLEUM HYDROCARBONS BY IMMUNOASSAY

CANNON AIR FORCE BASE, FIRE TRAINING AREA No. 4
RCRA FACILITY INVESTIGATION
CLOVIS, NEW MEXICO

USACE CONTRACT No. DACW45-94-D-0044
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3.0
PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) defines the methods to be used for field immunoassay screening of soil samples to determine the presence of total petroleum hydrocarbons (TPH) during subsurface investigations at Fire Training Area #4, Cannon Air Force Base, Clovis, New Mexico. Field screening by immunoassay methods will allow rapid and cost-effective identification of the presence of TPH residues in soil samples and will reduce the number of samples requiring more costly off-site laboratory analysis. Obtaining and evaluating data in real time also will allow field personnel to make maximum use of data as the work proceeds to direct and concentrate efforts. This procedure addresses interferences, apparatus and materials, reagents, sample extraction and preparation methods, and method requirements associated with sample screening. This SOP supplements and is intended to be used with the Data Collection Quality Assurance Plan (DCQAP) and other SOPs, and with the immunoassay kit User's Guide attached herein.

4.0
RESPONSIBILITIES AND QUALIFICATIONS

Harza's Project Manager is responsible for assuring that immunoassay based TPH screening is conducted according to this procedure. The Project Manager will designate qualified project staff, including a Task Leader, to complete this procedure and the required reviews.

Designated project staff are responsible for TPH screening according to this procedure. They will report progress and any problems to the Task Leader or Project Manager. Staff members are responsible for understanding the activities assigned to them and the associated Quality Assurance (QA) requirements.

All personnel performing activities covered in this SOP shall be qualified to perform the activities assigned to them. The Project Manager will appraise the qualifications of prospective assignees based on their experience and training with respect to the job requirements. The Project Manager also will determine whether future training is required and, if so, by what method. On-the-job training is acceptable provided such training is received from a person qualified to perform the assignment and the results of training are documented.

5.1 GENERAL

Immunoassay screening will be conducted in accordance with the "User's Guide" attached to this SOP and the procedures provided herein. The immunoassay screening method is performed using an extract derived from the soil sample. Filtered extracts may be stored cold, in the dark for up to 14 days. An aliquot of the extract and an enzyme-TPH conjugate reagent are added to immobilized TPH antibody. The enzyme-TPH conjugate "competes" with hydrocarbon present in the sample for binding to immobilized TPH antibody. The test is interpreted by comparing the response produced by the sample to the response produced by a reference reaction.

5.2 EQUIPMENT AND MATERIALS

Field lab facilities for the immunoassay screening will be established in the field trailer to be located near the investigation site. The field trailer will have electric power and a refrigerator. Distilled water for use in the procedure will be provided from outside. Following is a list of equipment and materials required for the screening:

- Immunoassay test kit: PETRO RISc® Soil Test (EnSys, Inc.) or equivalent
- Balance- Capable of accurately measuring 5.0 $\pm$ 0.1g
- Stopwatch or timer
- Micropipette - positive displacement tubes
- Photometer - Capable of reading differential optical density at 450 nm
- 20-place test tube rack
- Antibody coated test tubes
- Wooden Spatula
- Plastic weigh boats
- 30 mL extraction jars with stainless steel ball bearings
- filtration unit with plunger and barrel assembly

- Sample extract collection vials
- Laboratory wipes or equivalent absorbent material

5.3 PROCEDURE

This section summarizes the instructions provided in the User's Guide for the Ensys Petro Soil Sample Pro Rapid Detection kit (attached). Personnel responsible for conducting immunoassay screening in accordance with this procedure should read and be familiar with all information in the User's Guide before the work begins.

5.3.1 Interferences

The compounds that are chemically similar to petroleum hydrocarbons may cause a positive test (i.e. false positive) for TPH. The data for the lower limit of detection and possible interferants are provided in SW-846 Method 4030 (USEPA, 1995). Additionally, storage and use temperatures may modify the method performance. Therefore, kits should be stored at appropriate temperatures. The Petro Soil Pro Rapid Detection kit must be stored at 4° to 8°C when not in use. Storage at ambient temperature (18° to 25°C) is acceptable for up to one day during use. The shelf life for the kits is 16 months from the date of manufacture.

5.3.2 Sample Weighing and Extraction

Weigh out 10.0 $\pm$ 0.1 g soil into plastic weighing boat. Quantitatively transfer the sample to an appropriately labeled 30 mL extraction jar using wooden spatula. Wipe jar lid to remove loose soil or debris. Open methanol (extraction solvent) crimp top vial and pour entire contents into the extraction jar. Cap the jar tightly. Swirl or shake vigorously for one minute. Allow to settle suspension for one minute. Repeat steps for three samples to be tested with the batch.

5.3.3 Sample Preparation

Remove and discard the extraction jar cap. Disassemble filtration plunger from filtration barrel. Insert bulb pipette into top (liquid) layer in extraction jar and draw up sample. Transfer at least half (1/2) of the bulb capacity into filtration barrel. **(Do not use more than one full bulb).**

Press plunger firmly into the barrel until adequate filtered sample is available (place on a table and press if necessary). Repeat steps for each sample to be tested.

5.3.4 Sample Volumes, Containers, Preservation and Handling

Sample volumes, containers, and preservation requirements according to SW-846 Method 4030 for TPH screening by immunoassay are as follows:

Container:	1-8 oz glass wide mouth, with Teflon lid.
Minimum Sample Size:	30 g.
Preservation:	Cool to 4°C.
Analysis Holding Time:	14 Days.

Sampling handling methods will be as detailed in SOP No. 9, including Chain-of-Custody. Harza personnel conducting the sampling will be responsible for following these requirements during sampling. Samples will be transported to the on-site field laboratory and chain of custody forms will be appropriately filled out and signed by the appropriate personnel.

5.3.5 Immunoassay Screening

Allow all reagents and sample extracts to reach room temperature (approximately 45 minutes) before conducting the assay. Read and follow the instructions in the attached User's Guide for phase 2 dilution of samples and standards before proceeding with the test. Place the tubes in test tube racks so that they are held firmly.

Label the antibody coated tubes with sample identification and test level [H (high), L (low)] as described in phase 2 dilution of samples and standards. Set timer for ten (10) minutes. Working left to right in the work station: a) Fit all antibody coated tubes firmly on top of all corresponding conjugate tubes, b) Start timer and immediately invert all connected tube pairs so that the liquid is poured into the antibody coated tubes. Return the tube pairs to the appropriate work station row making sure the larger (antibody coated) tube is on the bottom. Invert all tube pairs several times making sure the pair is returned to the work station with the

larger (antibody coated) tube on the bottom. Disconnect and discard the smaller glass conjugate tubes.

Incubate all the tubes for 10 minutes and empty antibody coated tubes into liquid waste container. Wash antibody coated tubes thoroughly. Instructions for washing procedure are provided in the User's Guide. Tap antibody coated tubes upside down on paper towels to remove excess liquid. Residual foam in tubes will not interfere with the test results.

5.3.6 Color Development

Fully depress plunger button to dispense from the Stat-Matic Dispenser. Add solutions to tubes working from left to right in the work station using the Stat-Matics. Dispense Substrate A (yellow label) once in each tube. Set timer for 2.5 minutes. Start timer and dispense Substrate B (green label) once in each tube. *Solution will turn blue in some or all tubes.* Gently shake tubes. At 2.5 minutes, dipense Stop (red label) once in each tube. *Solution will turn yellow in some or all tubes.*

5.3.7 Measurement of Data

Standard preparation and selection. Open PETRO standard ampules and transfer solution to empty vial with bulb pipette. Label vial with current date. Standard is usable for two weeks. Always secure the cap tightly when finished using standards. Place the pair of Standard tubes for the lower test level in the photometer. Switch tubes until the photometer reading is negative or zero. Record readings. Remove and discard tube in the right well. The tube in the left well is the darker standard.

Measurement of data. Place the first sample tube for the lower test level in right well of photometer and record reading. If photometer reading is negative or zero, TPH is present. If photometer reading is positive, the concentration of TPH is less than the test level. Continue and read the remaining sample tubes for the lower level. Repeat the above process for the higher test level: Select the darker of the two Standards and measure the sample tubes for the higher test level. Record results on the data sheets as shown on Figure 1.

5.3.8 Quality Control

Follow the manufacturer's quality control/quality assurance (QC/QA) recommendations for screening test as presented in User's Guide (provided in Attachment).

6.0
DOCUMENTATION

Field laboratory personnel performing the analyses will record test data on the Data Sheets provided in Figure 1. In addition, sampling and field laboratory personnel will maintain bound field/lab logbooks as described in SOP No. 9. Information to be recorded in the logbooks whall include the following:

- Name and location of the site
- Date and time of sampling/analysis
- Location of sampling
- Sample number (boring number and sample depth)
- Name of person performing the reading
- Physical description of the sample (boring log)
- Type of instrument used
- Sample results

Data Sheet for PETRO RISC® SamplePro Test

Operator: _____ Date: _____ Location: _____

	Low Test Level			High Test Level			
Sample ID	ΔOD	OD sample	Interpretation	ΔOD	OD sample	Interpretation	Comments
	Standards	_____ ppm		Standards	_____ ppm		

Figure 1

ATTACHMENT 1

ENSYS USER'S GUIDE

ENSYS INC.
ENVIRONMENTAL PRODUCTS

PETRO SOIL SamplePro

RAPID DETECTION KIT

User's Guide

Important Notice

This method correctly identifies 95% of samples that are petroleum fuels-free and those containing petroleum fuels at or above the selected test level. A sample that develops color, less than or equal to the standard is interpreted as positive. It contains petroleum fuels. A sample that develops more color than the standard is interpreted as negative. It contains petroleum fuel at less than the selected test level. The most sensitive SamplePro PETRO test level is 10 ppm for gasoline and 15 ppm for diesel and other petroleum fuels.

This test system should be used only under the supervision of a technically qualified individual who is capable of understanding any potential health and environmental risks of this product as identified in the product literature. The components must only be used for the analysis of soil samples for the presence of petroleum hydrocarbons. After use, the kits must be disposed of in accordance with applicable federal and local regulations.

FOUR PHASES OF PETRO SamplePro

The PETRO SamplePro Rapid Detection Kit is divided into four phases.

PHASE I - Extraction and Preparation of the Samples

Petroleum fuels are extracted from a 10 gram soil sample with methanol. The soil extract containing petroleum fuels is then filtered.

PHASE II - Dilution of Sample and Standards

Different test levels require different dilution procedures. Each test level has a designated SamplePro program number. PETRO Standards corresponding to the desired test level are provided in the kit and are diluted in the same way as the samples.

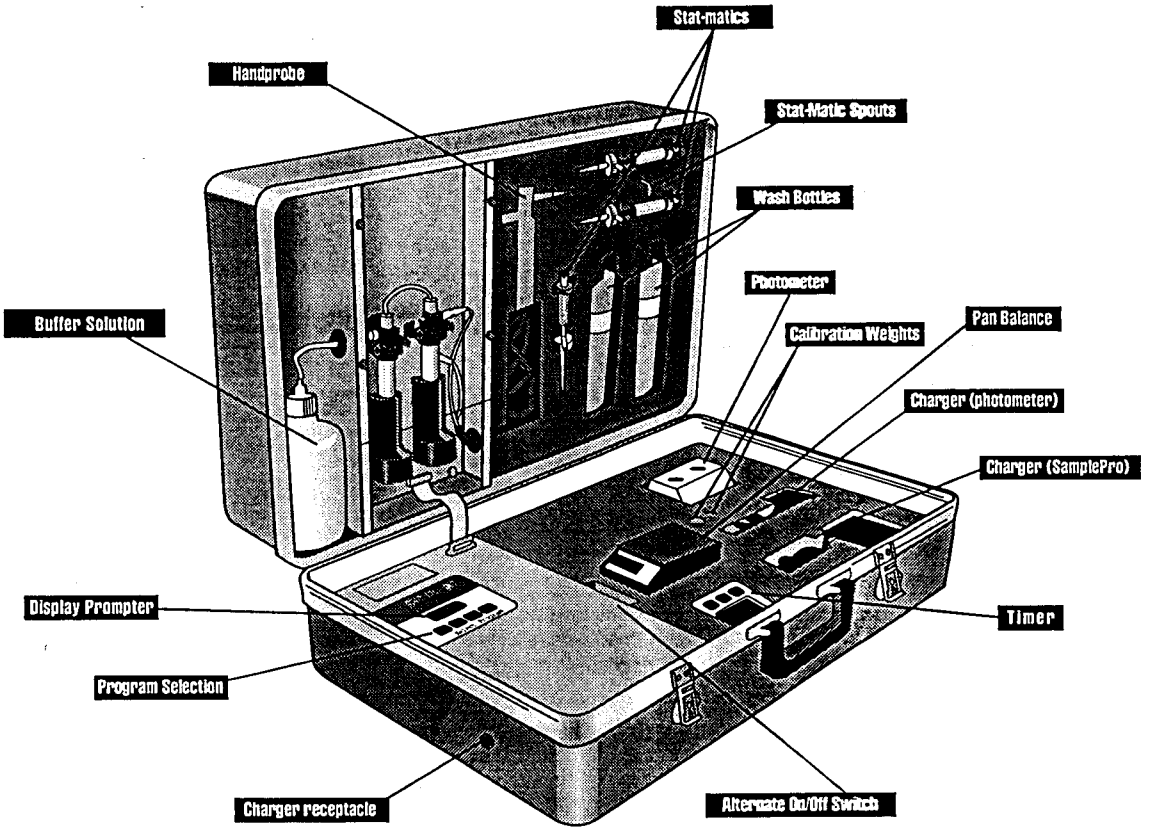
PHASE III - The Immunoassay

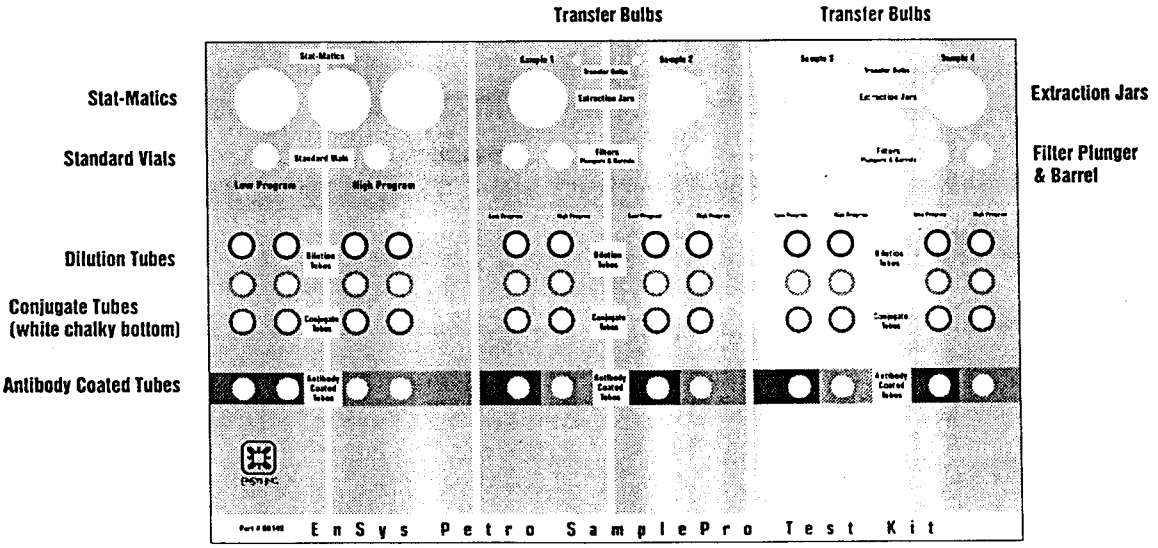
The PETRO samples and standards are diluted into the enzyme conjugate and then added to the antibody coated tubes. The petroleum hydrocarbons are allowed to bind to antibody binding sites for 10 minutes. During this incubation, the petroleum hydrocarbons in the sample and the enzyme conjugate are "competing" for antibody binding sites. Next, washing the antibody coated tubes removes any unbound petroleum hydrocarbons or enzyme conjugate. The addition of substrate solutions causes a colorimetric reaction.

PHASE IV - Interpretation of Results

The intensity of the color in the tube is inversely proportional to the concentration of the petroleum hydrocarbons in the sample. The analysis of two standards provides a quality control check. Using the differential photometer the sample tubes are compared to the standard tube in order to make a greater than or less than interpretation for each test level.

SamplePro ACCESSORY KIT





SamplePro Petro Laminated Overlay for recognition and placement of your test components shown above.

MATERIALS

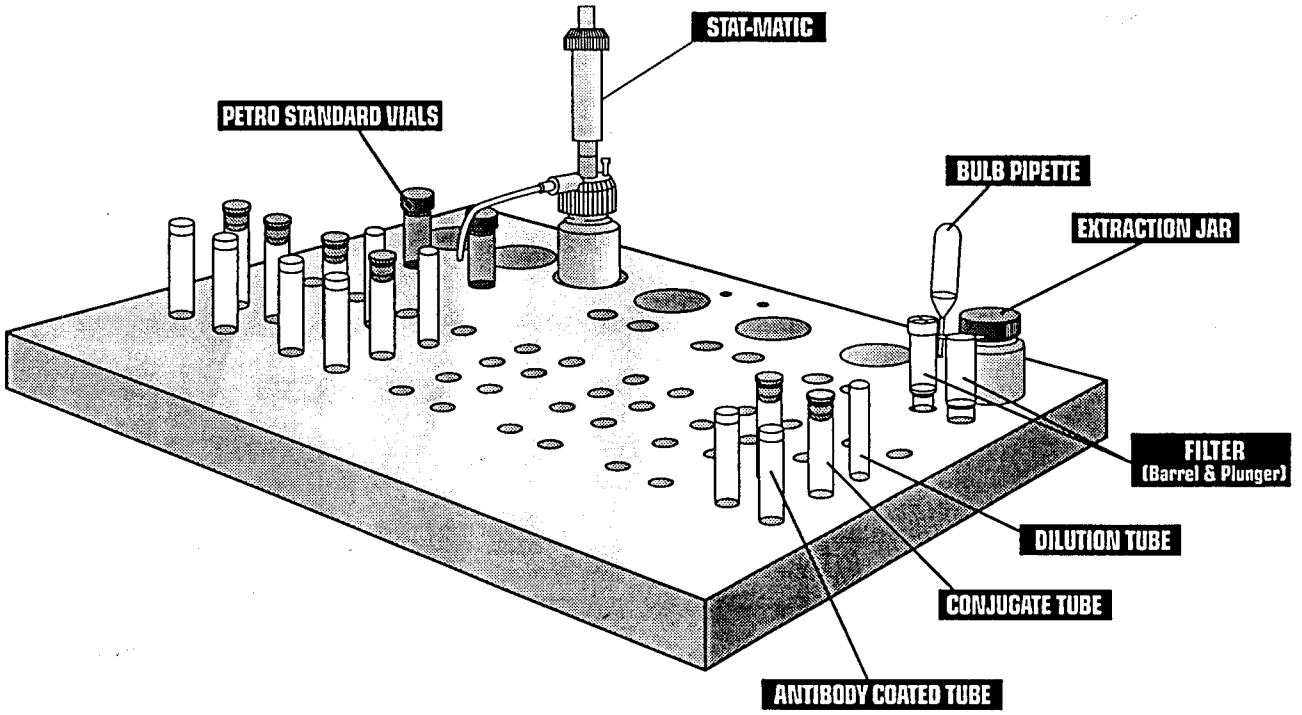
MATERIALS PROVIDED IN PETRO SamplePro DETECTION KIT

Test Preparation
3 PETRO Standards/Test level
6 Empty Vials
6 Transfer bulbs
1 10x Wash Concentrate
1 Ampule Cracker
1 Bottle of Buffer Solution
1 Bottle of Substrate A
1 Bottle of Substrate B
1 Bottle of Stop Solution

Phase I
24 Weigh Boats
24 Wooden Spatulas
24 Extraction Jars
24 Filtration Plungers and Barrels
24 Bulb Pipettes
24 Methanol Crimp Top Vials

Phase II
1 Box of Dilution tubes
1 Box of Handprobe tips

Phase III
6 Bags of Antibody Coated Tubes
72 Conjugate Tubes



ASSAY PERFORMANCE TIPS

READ ALL INSTRUCTIONS BEFORE PROCEEDING WITH THE TEST

WASH STEP

Lack of vigorous washing may result in false positives or negatives depending on whether the wash error was committed on standard or sample tubes. Make sure to wash four times vigorously. Also make sure to wash the whole set of 12 tubes at once.

MIXING

Lack of thorough mixing, when instructed, can cause inconsistent results. Observe the times in the instructions and mix with sufficient force to ensure that the liquid is mixed.

TIMING

It is important to follow the timing steps in the instructions carefully. The incubation step in the antibody tubes can vary a bit without harm to the tests as long as all samples and standards within a run are incubated identically. The color development step timing is critical and should be no less than 2 minutes and no greater than 3 minutes.

WIPING TUBES

Antibody coated tubes should be wiped before they are read in the photometer because smudges and fingerprints on the tubes can give potentially false negative readings.

MIXING LOT #'S

Never mix lots! Each kit's components are matched for optimal performance and may give inaccurate results with the components from other kits with different lot #'s. Also, NEVER mix components from different types of kits (ex: Petro kit buffer can not be used with a PCB kit).

STORAGE OF ACCESSORY KIT

Never close unit and store without removing Buffer Bottle and flushing unit with DI water. Buffer Bottle may leak and flood electrical system.

STORAGE AND OPERATING TEMPERATURES FOR TEST KIT

Temperature requirements are very important and should be strictly adhered to. This information can be found in the kit User's Guide.

SHELF-LIFE

Each kit label contains the kit expiration date. To achieve accurate results, kits must be used prior to expiration.

SAMPLEPRO QUICK TIPS AND REMINDERS

READ ALL INSTRUCTIONS BEFORE PROCEEDING WITH THE TEST

TEST PREPARATION

1) Plug in **SamplePro** overnight before first use and after each day of use. Do not store the unit with a dead battery. Charge before storage.
2) Peel the label from the standard ampule and transfer it to the screw cap vial.
3) Label the antibody coated tubes with sample identification and test level.
4) Save the caps from substrate bottles. If you need to pack up the *Stat-Matic* substrate dispensers, first disassemble and purge the remaining fluid back into the appropriate bottle. Then recap bottles and flush the *Stat-Matic* dispensers with water.

RUNNING THE TEST

1) Before running each phase of the test procedure, make sure you have all the necessary components set up and ready. For example; Assemble and prime the *Stat-Matic* substrate dispensers; Pre-dilute the wash concentrate with distilled water, etc.
2) ***Do not rest the handprobe tip on the bottom of the container as the sample/standard is being picked up.***
3) **"Look"** to see that the sample has been picked up.
4) When a mistake in dilution has been made, discard the dilution tubes and start the dilution over. Reset the **SamplePro** by pressing **CHANGE PROGRAM**. followed by **ENTER**. - Now ready for sample pickup. Plenty of extra dilution tubes are supplied.
5) Change handprobe tips between samples and standards.
6) ***Keep handprobe tip fully inserted in the dilution tube until the beep sounds.***
7) Prime the *Stat-Matic* with 8-10 pumps when it is assembled. Also, before each set of tubes is developed, remove any air bubbles visible in the *Stat-Matic.*
8) Push *Stat-Matic* substrate dispenser button all the way down to deliver the appropriate amount of substrate.
9) You must run 4 samples at once to acheive 24 sample tests per kit.
10) Accomplished users may refer to page 17 of the User's Guide for the Abbreviated Procedure.

FLUSHING

Flush SamplePro unit after each day's use to avoid salt crystallization in moving parts. Also, flush unit several times with DI water before using unit on a different kit format.

TEST PREPARATION

SamplePro Unit must be;

1. Charged overnight for 8 - 10 hours of normal use or operated from line voltage with charger attached.
2. To conserve battery, turn off SamplePro during long breaks.

MATERIALS NOT PROVIDED IN THIS KIT

Distilled Water
Paper towels
Liquid waste container
Permanent marking pen
Disposable gloves

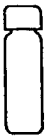
STANDARD PREPARATION

- Open PETRO Standard ampules by slipping ampule cracker over top, and then breaking tip at scored neck. Transfer solution to empty vial with Bulb Pipettes.
- Label vial with current date. Standard is usable for 2 weeks. Always cap tightly when finished using Standard.
- A new PETRO Standard should be opened for every 8 samples (Two test runs).

PETRO Standard Ampule

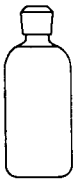
Ampule Cracker

Bulb Pipette


PETRO Standard vial

WASH PREPARATION

1. Measure 50ml of 10X Wash Concentrate into measuring cup.
2. Pour into an empty Wash Bottle and fill to top with distilled water.

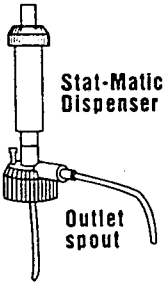

10x Wash Bottle

Measuring Cup

Wash Bottle

SUBSTRATE PREPARATION

Attach outlet spout to each *Stat-Matic.* Label the caps of the Substrate jars with "A", "B" & "Stop" and save the caps for reclosure. Attach Stat-Matic dispenser tops to Substrate A, Substrate B, and Stop Solution. Prime dispensers by pumping 8-10 times into a waste container.



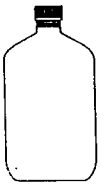
Substrate A

Substrate B

Stop Solution

SamplePro SET-UP

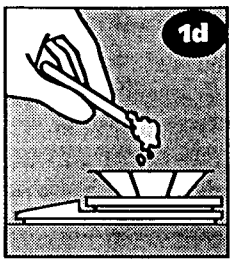
1. Attach the bottle of Buffer Solution to the cap assembly.
2. Switch unit on. **SamplePro prompt: Flush**
3. Aiming handprobe into liquid waste container press white button to flush line. BEEP will sound to indicate flush is complete.


Buffer Solution

PHASE 1 EXTRACTION & PREPARATION OF THE SAMPLE

READ ALL INSTRUCTIONS BEFORE PROCEEDING WITH THE TEST

WEIGH SAMPLE



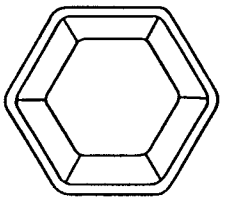
1a Open methanol crimp top vial and pour the entire contents into the extraction jar.

1b Place unused weigh boat on pan balance.

1c Press ON/MEMORY button on pan balance. Balance will beep and display 0.0.

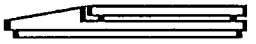
1d Weigh out 10 ⁄ 0.1 grams of soil.

1e If balance turns off prior to completing weighing, use empty weigh boat to retare, then continue.

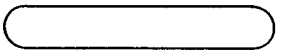


Weigh Boat

Methanol Crimp Top Vial



Pan balance



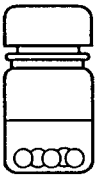
Wooden spatula

EXTRACT PETROLEUM HYDROCARBONS

2a Using wooden spatula, transfer 10 grams of soil from weigh boat into extraction jar.

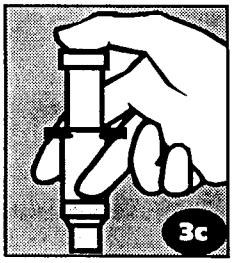
2b Recap extraction jar tightly and shake **vigorously** for one minute.

2c Allow to settle for one minute. Repeat steps 1a - 2c for remaining three samples to be tested.



Extraction jar

FILTER SAMPLE



3a Disassemble filtration plunger from filtration barrel.

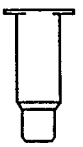
3b Insert bulb pipette into top (liquid) layer in extraction jar and draw up sample. Transfer **at least** ½ bulb capacity into filtration barrel. **Do not use more than one full bulb.**

3c Press plunger firmly into barrel until adequate filtered sample is available (place on table and press if necessary).

Repeat steps 3a - 3c for each sample to be tested.

Filtration plunger

Bulb pipette



Filtration barrel

PHASE 2 DILUTION OF SAMPLES AND STANDARDS

READ ALL INSTRUCTIONS BEFORE PROCEEDING WITH THE TEST

READ BEFORE PROCEEDING

The samples and standards are now in methanol. It is necessary to dilute the samples and standards in buffer. SamplePro picks up the sample and dilutes it with a set amount of buffer. One to three dilutions are necessary depending on the desired test concentration of petroleum hydrocarbons . Higher test concentrations require more dilutions. If one dilution is needed, conjugate tubes will be set-up only in red row. If two dilutions are needed then conjugate tubes are set-up in red row with empty dilution tubes set-up in the blue row. Three dilutions require conjugate tubes in red row, and empty dilution tubes in the blue and black rows.

PETRO SamplePro Test Levels (ppm)

Find the test levels in the chart and set up necessary dilution tubes in Black & Blue rows. Set up conjugate tubes in the red row. Place tubes for lowest test level in the Purple column and tubes for the highest test level in the Green column.

Program	Gasoline	Diesel #2 Fuel Oil Kerosene Jet A JP-4	# 6 Fuel Oil	Mineral Spirits	
11	10	15	25	40	USE — Conjugate tubes in RED Row
12	20	30	50	80	
13	33	50	83	133	
13	40	60	100	160	
13	50	75	125	200	
14	67	100	167	267	
15	100	150	250	400	
16	200	300	500	800	USE — Conjugate tubes in RED Row Dilution tubes in BLUE Row
17	333	500	833	1,333	
17	400	600	1,000	1,600	
17	500	750	1,250	2,000	
18	667	1,000	1,667	2,667	
19	1,000	1,500	2,500	4,000	
20	2,000	3,000	5,000	8,000	
21	3,333	5,000	8,333	13,333	USE — Conjugate tubes in RED Row Dilution tubes in BLACK,BLUE Rows
21	4,000	6,000	10,000	16,000	
21	5,000	7,500	12,500	20,000	
22	6,667	10,000	16,667	26,667	
23	10,000	15,000	25,000	40,000	

PHASE 2 DILUTION OF SAMPLES AND STANDARDS

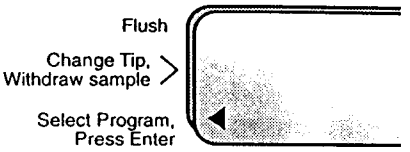
READ ALL INSTRUCTIONS BEFORE PROCEEDING WITH THE TEST

LOWER LEVEL TEST

1. Refer to chart to determine Program number for lower test level.

SamplePro prompt: Select Program, Press Enter

2. Use the + and - Arrow keys to set the SamplePro Program number. Press **ENTER.**
3. Working from left to right in workstation prepare conjugate and dilution tubes in all purple columns for all samples and lower level Standard using appropriate instructions on the following page.



HIGHER LEVEL TEST

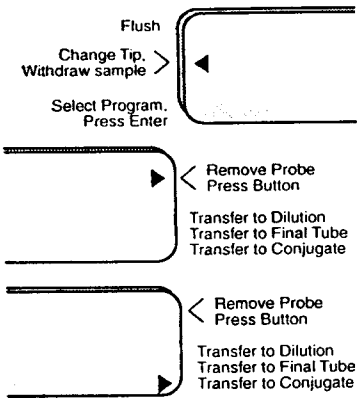
1. Refer to chart to determine Program number for higher test level.
2. **Press Change Program.** Use the + **and** - Arrow keys to set the SamplePro Program number. Press **ENTER.**
3. Working from left to right in workstation prepare conjugate and dilution tubes in all green columns for all samples and higher level Standard using appropriate instructions on the following page.

PHASE 2 DILUTION OF SAMPLES AND STANDARDS CONT'D

READ ALL INSTRUCTIONS BEFORE PROCEEDING WITH THE TEST

STEP D in each Dilution procedure must be completed **immediately** following STEP C within 1-2 seconds. **Remove tip from liquid** & press button a second time to avoid losing sample extract.

TO PREPARE RED CONJUGATE TUBES



SamplePro prompt: Change Tip, Withdraw sample.

A. **Firmly** install tip on handprobe.

B. Place tip below liquid level of sample, but not touching bottom of container.

C. Press and release handprobe button once to withdraw sample. ***SHORT BEEP***

SamplePro prompt: Remove Probe, Press Button.

D. Remove handprobe from tube and press handprobe button again. ***SHORT BEEP***

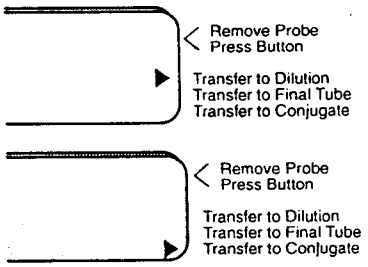
SamplePro prompt: Transfer to Conjugate

E. Fully insert tip into conjugate tube in RED row and press handprobe button to release diluted sample. ***SHORT BEEP, LONG BEEP***

F. Eject tip into waste container.

G. Repeat steps A-F for each sample and Standard.

TO PREPARE BLUE DILUTION AND RED CONJUGATE TUBES



SamplPro prompt: Change tip, Withdraw sample

A. **Firmly** install tip on handprobe.

B. Place tip below liquid level of sample, but not touching bottom of container.

C. Press and release handprobe button once to withdraw sample. ***SHORT BEEP***

SamplePro prompt: Remove probe, Press Button.

D. Remove handprobe from tube and press handprobe button again.

SamplePro prompt: Transfer to Dilution

E. Fully insert tip into dilution tube in BLUE row and press handprobe button. Do not remove tip before ***SHORT BEEP.***

SamplePro prompt: Transfer to Conjugate

F. Fully insert tip into conjugate tube in RED row and press handprobe button. ***SHORT BEEP, LONG BEEP.***

G. Eject tip into waste container.

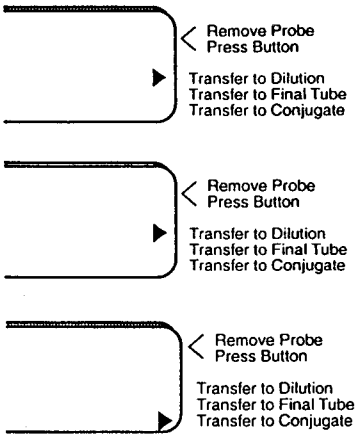
H. Repeat steps A-G for each sample and Standard.

PHASE 2 DILUTION OF SAMPLES AND STANDARDS CONT'D

READ ALL INSTRUCTIONS BEFORE PROCEEDING WITH THE TEST

STEP D in each Dilution procedure must be completed **immediately** following STEP C within 1-2 seconds. **Remove tip from liquid** & press button a second time to avoid losing sample extract.

TO PREPARE BLACK & BLUE DILUTION TUBES & RED CONJUGATE TUBES



SamplePro prompt: Change Tip, Withdraw sample.

A. **Firmly** install tip on handprobe.

B. Place tip below liquid level of sample, but not touching bottom of container.

C. Press and release handprobe button once to withdraw sample.

SamplePro prompt: Remove probe, Press Button.

D. Remove handprobe from tube and press handprobe button again. ***SHORT BEEP.***

SamplePro prompt: Transfer to Dilution

E. Fully insert tip into dilution tube in BLACK row and press handprobe button. Do not remove tip before ***SHORT BEEP.***

SamplePro prompt: Transfer to Dilution

F. Fully insert tip into dilution tube in BLUE row and press handprobe button. Do not remove tip before ***SHORT BEEP.***

SamplePro prompt: Transfer to Conjugate

G. Fully insert tip into conjugate tube in RED row and press handprobe button. ***SHORT BEEP, LONG BEEP.***

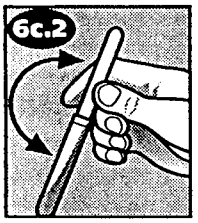
H. Eject tip into waste container.

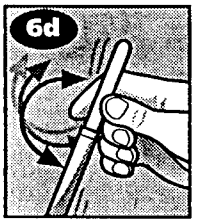
I. Repeat steps A - H for each sample and Standard.

PHASE 3 THE IMMUNOASSAY

READ ALL INSTRUCTIONS BEFORE PROCEEDING WITH THE TEST

TRANSFER FROM CONJUGATE TUBE TO ANTIBODY COATED TUBE





6a. Label the antibody coated tubes with sample identification and test level [H(High), L(Low)]

6b. Set timer for 10 minutes.

6c. Working left to right in the workstation:

1. Fit all antibody coated tubes firmly on top of all corresponding conjugate tubes.
2. **Start timer and immediately** invert **all** connected tube pairs so that the liquid is poured into the antibody coated tubes. Return the tube pairs to the appropriate workstation row making sure the larger (antibody coated) tube is on the bottom.

6d. Invert all tube pairs several more times making sure the pair is returned to the workstation with the larger (antibody coated) tube on the bottom.

6e. Disconnect and discard the smaller glass conjugate tubes. [It is not important to worry about drops of liquid adhering to lips of tubes].

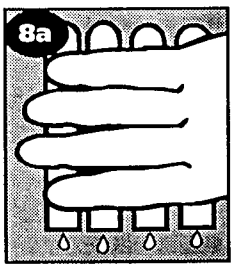
PHASE 3 THE IMMUNOASSAY

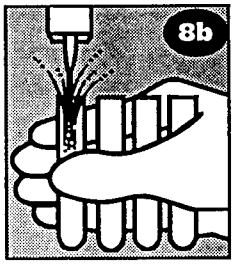
READ ALL INSTRUCTIONS BEFORE PROCEEDING WITH THE TEST

READ BEFORE PROCEEDING/ WASH PROCEDURE

- An accurate test requires a vigorous wash accomplished by directing a strong stream into the antibody coated tubes.
- The wash solution is a mild, dilute solution of detergent.
- Wash all 12 tubes at once.

WASH





8a After the 10 minute incubation, empty antibody coated tubes into liquid waste container.

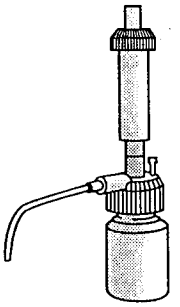
8b Wash antibody coated tubes by vigorously filling and emptying a total of 4 times.

8c Tap antibody coated tubes upside down on paper towels to remove excess liquid. Residual foam in the tubes will not interfere with test results.

COLOR DEVELOPMENT

- **Fully depress plunger button to dispense from *Stat-Matic* Dispenser.**
- **Add Solutions to tubes working from left to right in the workstation using the Stat-Matics.**

9a. Dispense Substrate A (yellow label) once in each tube.
9b. Set timer for 2 1/2 minutes.
9c. Start timer and dispense Substrate B (green label) once in each tube. *Solution will turn blue in some or all tubes.*
9d. Gently shake tubes.
9e. At 2 1/2 minutes, dispense Stop (red label) once in each tube. *Solution will turn yellow in some or all tubes.*



Stat-Matic

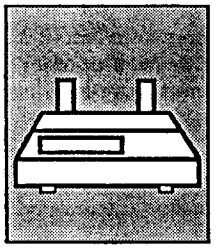
PHASE 4 INTERPRETATION OF RESULTS

READ ALL INSTRUCTIONS BEFORE PROCEEDING WITH THE TEST

PERFORM THESE FUNCTIONS FOR EACH TEST LEVEL

- Wipe outside of all antibody coated tubes before placing them in the photometer.

SELECT STANDARD

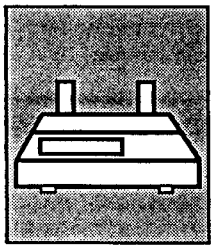


10a. Place the pair of Standard tubes for the lower test level in photometer.

10b. Switch tubes until the photometer reading is negative or zero. Record reading.
If reading is greater than - 0.3 in magnitude, results are outside QC limits. Retest the sample(s).

10c. Remove and discard tube in right well. The tube in the left well is the darker Standard.

MEASURE SAMPLE



11. Place first sample tube for the lower test level in right well of photometer and record reading.

If photometer reading is **negative** or zero, petroleum hydrocarbons are present.

If photometer reading is **positive**, concentration of petroleum hydrocarbons is less than the test level.

Continue and read the remaining sample tubes for the lower level.

Repeat the above process for the higher test level:
Select the darker of the two Standards and **measure** the sample tubes for the higher test level.

QUALITY CONTROL

READ ALL INSTRUCTIONS BEFORE PROCEEDING WITH THE TEST

System Description

Each PETRO SamplePro System contains enough material to perform 24 complete tests, each at two test levels.

The PETRO SamplePro System is divided into four phases. The instructions and notes should be reviewed before proceeding with each phase.

Hotline Assistance

If you need assistance or are missing necessary Test System materials, call toll free: 1-800-242-RISC (7472).

Validation and Warranty Information

Product claims are based on validation studies carried out under controlled conditions. Data has been collected in accordance with valid statistical methods and the product has undergone quality control tests of each manufactured lot.

Petroleum fuels-free soil and soil containing petroleum fuels at or above the test level were tested with the EnSys PETRO SamplePro analytical method. The method correctly identified 95% of these samples. A sample that has developed less color than the standard is interpreted as positive. It contains fuel. A sample that has developed more color than the standard is interpreted as negative. It contains fuel at less than the selected test level.

The company does not guarantee that the results with the PETRO SamplePro Soil Test System will always agree with instrument-based analytical laboratory methods. All analytical methods, both field and laboratory, need to be subject to the appropriate quality control procedures.

EnSys, Inc. warrants that this product conforms to the descriptions contained herein. No other warranties, whether expressed or implied, including warranties of merchantability and of fitness for a particular purpose shall apply to this product.

EnSys, Inc. neither assumes nor authorizes any representative or other person to assume for it any obligation or liability other than such as is expressly set forth herein.

Under no circumstances shall EnSys, Inc. be liable for incidental or consequential damages resulting from the use or handling of this product.

How It Works

Standards, Samples, and color-change reagents are added to test tubes, coated with a chemical specific to petroleum fuels. The concentration of petroleum fuel in an unknown **Sample** is determined by comparing its color intensity with that of a **Standard**.

Note: Petroleum fuel concentration is inversely proportional to color intensity; the lighter the color development of the sample, the higher the concentration of petroleum fuel.

Quality Control

Standard precautions for maintaining quality control:

- Do not use reagents or test tubes from one Kit with reagents or test tubes from another Kit.
- Do not use the Test System kit after its expiration date.
- Do not attempt the test using more than 12 antibody coated tubes (4 of which are **Standards**) at the same time.
- Do not exceed incubation periods prescribed by the specific steps.
- Always wash the number of times indicated in this guide.
- Use a method which is appropriate for your specific regulatory situation to confirm results.

Storage and Handling Precautions

- Wear protective gloves and eyewear.
- Store kit at room temperature and out of direct sunlight (less than 80°F).
- Keep aluminized pouch (containing unused antibody coated tubes) sealed when not in use.
- If Stop Solution, PETRO Standard or liquid from the extraction jar comes into contact with eyes, wash thoroughly with cold water and seek immediate medical attention.
- Operate test at temperatures between 15°C/60°F and 39°C/100°F.

ON-SITE QUALITY CONTROL/QUALITY ASSURANCE RECOMMENDATIONS
EnSys RIS$^{\underline{c}}$® TEST SYSTEM

Please read the following before proceeding with field testing.

SAMPLING

The result of your screening test is only as valid as the sample that was analyzed. Samples should be homogenized thoroughly to ensure that the 10 grams you remove for field testing is representative of the sample as a whole. All other applicable sample handling procedures should be followed as well.

PRIOR TO TESTING SAMPLES

Carefully follow the instructions in the User's Guide included with every test kit. This is the key element in obtaining accurate results. In addition, store your unused test kits at room temperature and do not use them past their expiration date (see label on each test kit).

INTERNAL TEST QC

Two standards are analyzed with each sample to provide internal test system quality control. With both standards inserted in the photometer, a valid test is indicated when the magnitude of the displayed number (irrespective of the sign, + or -) is less than the value given in the User's Guide. Test runs resulting in a greater number should be repeated to ensure valid conclusions.

QA/QC

The validity of field test results can be substantially enhanced by employing a modest, but effective QA/QC plan. EnSys recommends that you structure your QA/QC plan with the elements detailed below. These have been developed based on the data quality principles established by the U.S. Environmental Protection Agency.

A. **Sample Documentation**
   1. Location, depth
   2. Time and date of collection and field analysis

B. **Field analysis documentation** - provide raw data, calibration, any calculations, and final results of field analysis for all samples screened (including QC samples)

C. **Method calibration** - this is an integral part of EnSys RIS$^{\underline{c}}$® immunoassay tests; a duplicate calibration is performed for each set of samples tested (see the instructions in the User's Guide)

D. **Method blank** - analyze methanol from the extraction jar.

E. **Site-specific matrix background field analysis** - collect and field analyze uncontaminated sample from site matrix to document matrix effect

F. **Duplicate sample field analysis** - field analyze duplicate sample to document method repeatability; at least one of every 20 samples should be analyzed in duplicate

G. **Confirmation of field analysis** - provide confirmation of the quantitation of the analyte via an EPA-approved method different from the field method on at least 10% of the samples; choose at least two representative samples testing above the action level; provide chain of custody and documentation such as gas chromatograms, mass spectra, etc.

H. **Performance evaluation sample field analysis (optional, but strongly recommended)** - field analyze performance evaluation sample daily to document method/operator performance

I. **Matrix spike field analysis (optional)** - field analyze matrix spike to document matrix effect on analyte measurement

FURTHER QUESTIONS?

EnSys technical support personnel are always prepared to discuss your quality needs to help you meet your data quality objectives.

PETRO *SamplePro* - Abbreviated Procedure

STEP	P R O C E D U R E
1	Prepare PETRO standards, wash, substrates and extraction jars. Attach buffer to SamplePro, turn unit on, and flush.
2	Weigh out 10 grams of sample and transfer it to extraction jar. Shake extraction jar for 1 minute. Filter the extracted sample.
3	Set up the workstation and label tubes. Select your LOW program. Dilute all samples and standards in the purple columns.
4	Select your HIGH program. Dilute all samples and standards in the green columns.
5	Set timer for 10 minutes. Fit antibody coated tubes (AbCT) on corresponding final tubes (red row). Working from left to right, invert all tube pairs and return to workstation. Invert each pair several more times.
6	After 10 minutes, IMMEDIATELY: Wash AbCT vigorously 4 times.
7	Working left to right, dispense Sub A (yellow) once in each AbCT. Set timer for 2 1/2 minutes. Start timer and dispense B (green) once in each AbCT, shake. After 2 1/2 minutes, dispense Stop (red) once in each AbCT.
8	Read tubes in photometer.

Data Sheet for PETRO RISC® SamplePro Test

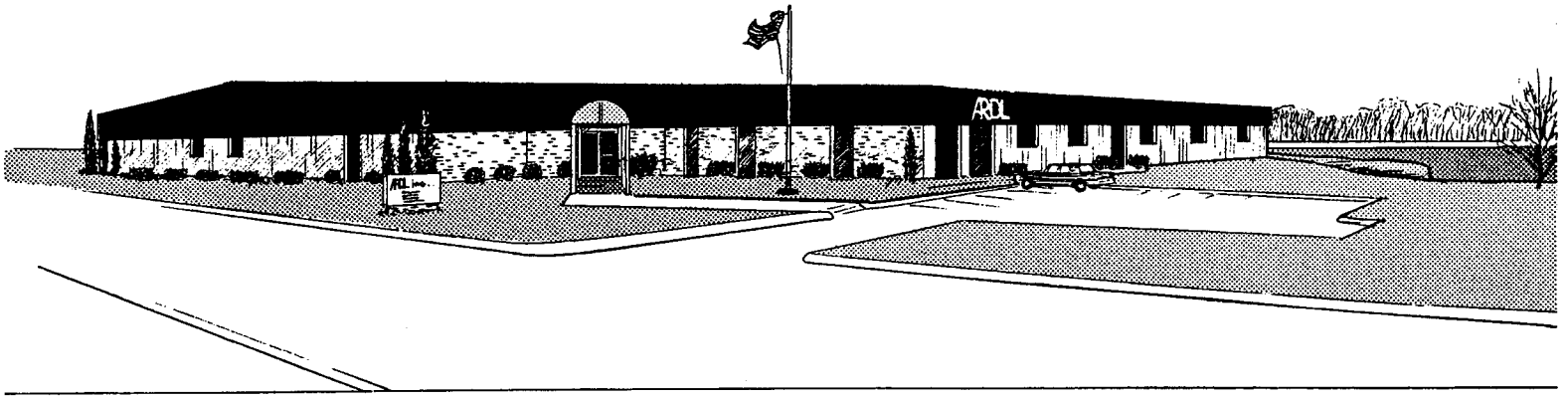
Operator: _____ Date: _____ Location: _____

	Low Test Level			High Test Level			
Sample ID	ΔOD	OD sample	Interpretation	ΔOD	OD sample	Interpretation	Comments
	Standards	_____ ppm		Standards	_____ ppm		

APPENDIX B
LABORATORY INFORMATION (ARDL, INC.)

ARDL Inc. applied research & development laboratory

CHEMISTRY · BIOLOGY · PHYSIOLOGY
ENGINEERING · ENVIRONMENTAL ANALYSIS



ARDL PROFILE

Established in Mt. Vernon, Illinois, in 1971 by Dr. L.V. Gibbons, ARDL has grown to include a staff of highly trained scientists, engineers, and technical specialists, providing a wide variety of services in the fields of analytical chemistry, engineering, the environmental sciences, industrial hygiene, safety training and petroleum technology. ARDL is a certified drinking water laboratory in the State of Illinois, and a certified analytical laboratory in the State of Oklahoma. Further, the laboratory is certified by the U.S. Corps of Engineers and is an active participant in the Contract Laboratory Programs of the Environmental Agencies of both the State of Illinois and the State of Indiana.

Given the demonstated strength of its technical and management staff and its highly sophisticated instrumentation inventory, ARDL can provide its clients with a focused, cost effective response to their need for assistance in the sciences and engineering, drawing upon more than 20-years of successful operational history to assure successful project completion. No project is too large or too small. ARDL's services range from the analysis of a single sample to the management and execution of large multi-year, multi-dollar programs requiring a complex, multi-disciplinary team approach.

The Company prides itself on furnishing each and every client with a quality service at a highly competitive price.

ARDL Inc. applied research & development laboratory

CHEMISTRY • BIOLOGY • PHYSIOLOGY
ENGINEERING • ENVIRONMENTAL ANALYSIS

ARDL HIGHLIGHTS

- **24 years experience:** Established in 1971
- **Experienced Staff:** 72 full and part-time
- **Location:** Central Mid-west, Mt. Vernon, Illinois
- **Adequate Facilities:** 25,000 ft^2 plus
- **State-of-the-Art Equipment:** Major equipment redundancy in all areas of sampling and analysis.

Small Business Status: Considered Small Business Under SIC 8734, Laboratory Testing.

- **Project Experience:**

  Superfund and Non-NPL Site Sample Analysis
  RCRA Closures
  UST/LUST Work - Investigations and Corrective Action Oversight
  Site Assessment and Remediation

- **Contract Laboratory Experience:**

  Illinois EPA SRAPL - since 1986
  Illinois EPA CERCLA (USEPA Region V approval) - since 1988
  Corps of Engineers - Rock Island, IL - 1987 - 1992
  Corps of Engineers - Portland, OR - since 1988
  Indiana DEM - 1989 - 1992
  Corps of Engineers - Dallas, TX - since 1991
  Corps of Engineers - Buffalo, NY - 1991-1994
  USEPA CLP-SMO - since 1991
  Corps of Engineers - St. Louis, MO - since 1992
  CDM Federal Programs Corp. - 1992-1994
  Rocky Mountain Arsenal - since 1992

- **Successful Performance Evaluation Audits and Certifications**

  Corps of Engineers - Missouri River Division
  Illinois EPA - CLP (State and USEPA Approved Contractor)
  Illinois EPA - Drinking Water Certification
  Indiana DEM - CLP
  USEPA - CLP
  USEPA - WS and WP Studies
  Oklahoma Water Resources Board
  Alaska DEMC - Drinking Water Certification
  Statement of Tennessee -Drinking Water Certification
  Illinois Power Company

Financial Status: Excellent - Dunn & Bradstreet rated.

P.O. Box 1566 • Mt. Vernon Airport, Route 15 East • Mt. Vernon, Illinois 62864 • (618) 244-3235 • FAX (618) 244-1149

1.0 ORGANIZATION AND RESPONSIBILITY

ARDL is organized along conventional lines as indicated by Figure 1. Dr. L.V. Gibbons is President and Laboratory Director and all personnel in the laboratory engaged in analytical work either report directly to him or through the Manager of Technical Services. As shown in Figure 1, the General Laboratory Manager acts independently as the administrator of ARDL's quality control program. The duties of key personnel involved in analytical work are summarized below.

1.1 General Laboratory Manager

Responsible to the Laboratory Director for efficiency and productivity in all aspects of technical operations in the laboratory. Activities that impinge directly on ARDL's analytical efforts are as follows:

- Review of project status to insure that requirements are being met and that the responses to customer needs are timely.

- Assess modifications in standard analytical methodologies and/or customer needs which may occur from time to time and identify, approve and coordinate changes in operating procedures, staff or equipment needed to meet those new requirements.

- Evaluate laboratory facilities and capabilities and assess recommendations for improvements which may enhance responses to customer needs.

- Monitor manpower loadings to insure adequate staffing of the analytical effort and correct deficiencies which may occur by approval of personnel reassignments from other laboratory duties or hiring of new staff.

1.2 Technical Services Manager

Responsible to the Laboratory Director for safe, efficient and timely operations in the analytical laboratory. Some of the specific tasks involved in that effort are:

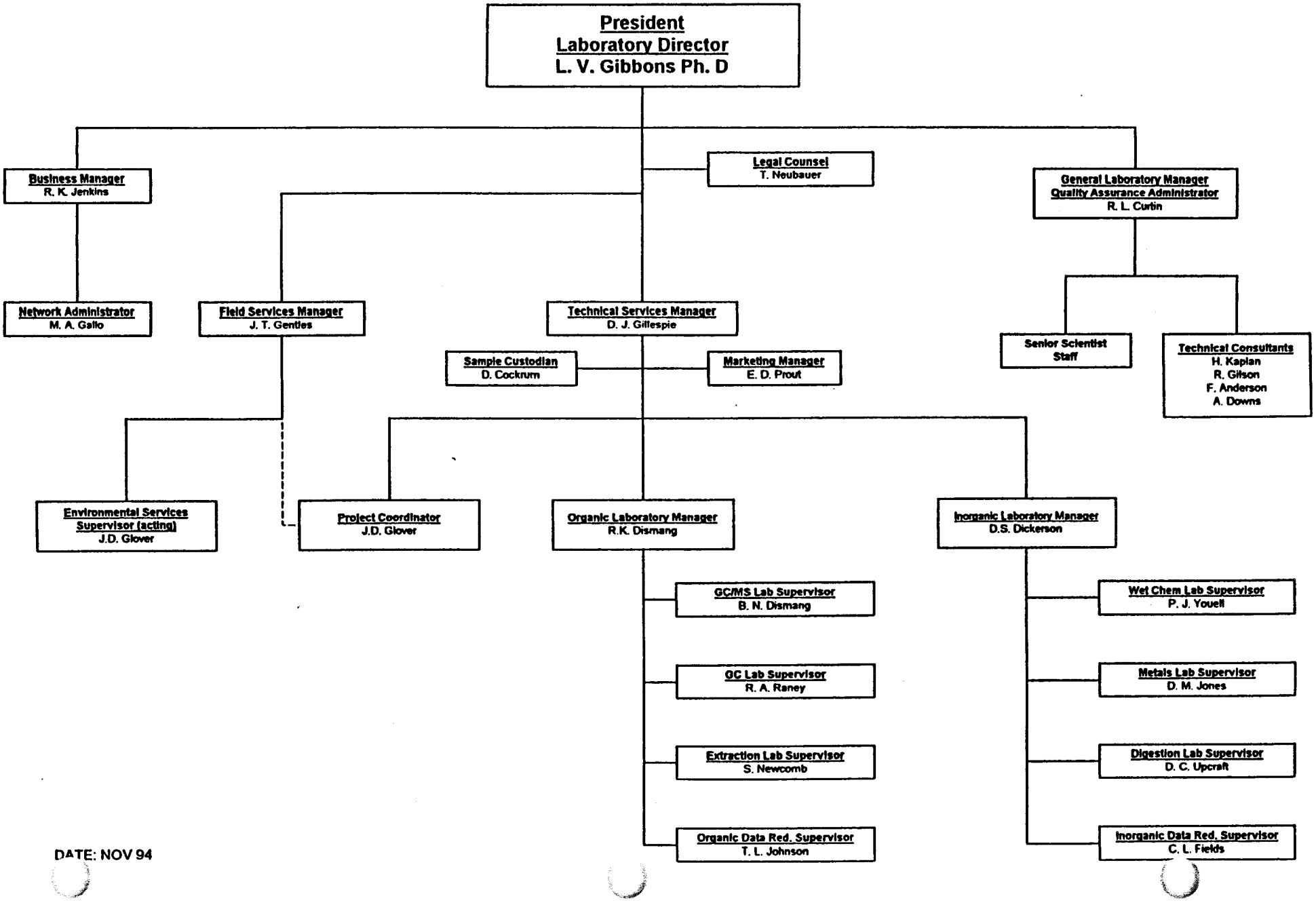
- Monitor work progress on a daily basis to insure that samples are being handled in accordance with customer requirements in a timely fashion.

- Coordinate efforts of the Inorganic and Organic Laboratory Managers to insure adequate staffing and efficient scheduling to meet customer needs.

- Monitor laboratory facilities and capabilities and make recommendations for improvements which may enhance response to customer requirements.

FIGURE 1

ARDL, INC. OPERATING ORGANIZATIONAL CHART



DATE: NOV 94

- Evaluate changes in requirements which may result from modifications in standard analytical methodologies or new needs of customers and make recommendations for changes in staff, equipment or procedures which may be needed to meet those new requirements.

- Coordinate with the Inorganic Laboratory Manager, Organic Laboratory Manager and Quality Assurance Administrator relative to adherence to provisions of the Quality Assurance Program Plan (QAPP).

- Approval of finished data for release to the customer.

1.3 Inorganic Laboratory Manager

Responsible to the Technical Services Manager for the safe, efficient operation of laboratory facilities engaged in sample analysis for metals, anions, BOD/COD, solids, certain organic moieties and other parameters associated with water/waste water quality. Specific activities relative to that effort are as follows:

- Daily supervision of analyst activities including review of results for completeness and accuracy, analysis scheduling, analyst assignments, consultation with analysts regarding special problems, etc.

- Monitor analyst adherence to QC requirements.

- Coordinate with the Technical Services Manager and Quality Assurance Administrator regarding overall adherence to provisions of the QAPP and identify corrective actions where required.

- Approve requisitions for materials.

- Supervise training of personnel in analytical procedures.

- Prepare laboratory reports for approval by the Technical Services Manager.

- Review preventative maintenance logbooks and coordinate service work on instruments as required.

1.4 Organic Laboratory Manager

Responsible to the Technical Services Manager for the safe, efficient operation of laboratory facilities involved in gas and liquid chromatographic analyses. Specific activities relative to that effort are as follows:

- Daily supervision of analyst activities including review of results for completeness and accuracy, sample preparation and analysis scheduling,

consultation with analysts relative to special problems, analyst assignments, etc.

- Monitor analyst adherence to QC procedures.

- Coordinate with the Technical Services Manager and Quality Assurance Administrator regarding overall adherence to provisions of the QAPP and identify corrective actions where required.

- Approve requisitions for materials.

- Supervise training of personnel in analytical procedures.

- Operate or supervise operation of the GC/MS system on a daily basis and monitor the results obtained to insure adequate function.

- Prepare laboratory reports for approval by the Technical Services Manager.

- Review preventative maintenance logbooks and coordinate service work on instruments as required.

1.5 Quality Assurance Administrator

Responsible to the Laboratory Director for administration of the QAPP. Specific activities relating to that effort are as follows:

- Review of analyses in progress to identify the pertinent requirements necessary to fulfill the specifications and guidelines to the QAPP.

- Review of analytical results obtained on QC samples.

- Advise the Inorganic and Organic Laboratory Managers relative to the acceptability of QC data and coordinate with those individuals in cases where QC data is outside acceptable limits so that appropriate corrective actions may be taken.

- Supervise maintenance of QC logbooks and records on a continuous basis.

- Report to the Laboratory Director regarding QAPP status on a regular and frequent basis.

1.6 Analysts

Responsible to either the Inorganic or Organic Laboratory Managers, as appropriate, for safe, efficient performance of analytical procedures. Specific activities relating to those efforts include:

- Performance of assigned analytical procedures in the prescribed manner.

- Performance of the required QC procedures and analyses.

- Maintenance of laboratory notebooks and log books.
- Preparation of requisitions for materials.

- Performance of preventative maintenance on instruments and equipment associated with assigned analyses.

APPENDIX C
ANALYTICAL PROCEDURES AND QA (GORE LABORATORY)

W. L. GORE & ASSOCIATES, INC.

101 LEWISVILLE ROAD • P.O. BOX 1100 • ELKTON, MARYLAND 21922-1100 PHONE: 410/392-3300
FAX: 410/996-3325 • TELEX 467637 GORE FB ELKT
ENVIRONMENTAL PRODUCTS GROUP

DESCRIPTION OF SERVICE

Screening Survey Applications

GORE-SORBER® Screening Surveys employing GORE-SORBER® Screening Modules (patented passive soil vapor sampling devices) have been used successfully at many sites for determining subsurface areas impacted by VOCs and SVOCs. Previous screening surveys have successfully detected a broad range of organic compounds, including fluorinated and chlorinated solvents, phenols, and phthalates. A wide range of petroleum hydrocarbons have been detected, including short-chain alkanes, gasoline, mineral spirits, naphthalenes, heating oils, creosotes, and coal tars. They have been used to detect soil vapor analytes in soil, dissolved in ground water plumes, and above ground water flowing through bedrock fractures. Non-aqueous phase liquids (NAPLs) have also been located.

Description Of GORE-SORBER Screening Modules

A typical GORE-SORBER Screening Module consists of three (3) separate GORE-SORBER® Passive Sorbent Collection Devices (sorbers). A typical sorber is 40 millimeters (mm) long, with a 3 mm inside diameter (ID), and contains 40 milligrams (mg) of a suitable granular adsorbent material depending on the specific compounds to be detected. Typically, Tenax-TA® resin is used for it's affinity for a broad range of VOCs and SVOCs. The three sorbers are sheathed in the bottom of a four (4) foot length of vapor-permeable insertion and retrieval cord. This construction is termed a GORE-SORBER Screening Module. Both the retrieval cord and sorbent container are constructed solely of inert, hydrophobic, microporous GORE-TEX® expanded polytetrafluoroethylene (ePTFE, similar to Teflon®). Figure 1, Attachment 1 shows a typical screening module.

A unique feature of ePTFE membranes are that they are hydrophobic and exclude liquid water, yet they do not retard vapor transfer, thus allowing VOC and SVOC vapors to freely penetrate the module and collect on the adsorbent material. This ability to protect the sorbent media from contact with ground and soil pore water without retarding soil vapor diffusion facilitates the application of GORE's soil vapor screening methods to saturated and very low permeability, poorly drained soils.

Quality Assurance (QA) Measures

As standard practice, all modules are individually numbered and tracked throughout the entire manufacturing, field deployment, and analytical process. Completed modules are subjected to a 16-hour "bake-out" under a nitrogen blanket in a vacuum oven at 150 °C prior to shipment to the customer. Finally, each module is sealed into a clean glass vial with a Teflon liner. All modules are transported to and from the customer's site in sealed glass vials packed inside of coolers supplied by GORE. Five to ten percent additional trip blanks will accompany the modules to and from the site. Associated manufacturing blanks and trip blanks are always tested with each job as controls. Full details of GORE's QA measures are documented in our Quality Assurance Manual, QAM-1.06/01/94, dated June 1, 1994.

Screening Survey Installation And Retrieval Procedures

Installation of the modules is performed by the customer. A slam bar or electric rotary hammer-drill is used to auger a 3/4 to 1-inch diameter pilot hole for the deployment of the modules to an average depth of three (3) feet below grade.

After the pilot hole is completed, modules are inserted into the completed boreholes, using the stainless steel insertion rod supplied by GORE. The top of each cord is typically fastened to a cork, which is tamped flush with the ground surface to assist in retrieval of the module, and to seal the annulus of the boring.

Module retrieval requires that field personnel locate the module, remove the cork, grasp the retrieval cord and manually pull the module from each location. Corks are separated from the module and discarded. The exposed modules are resealed in their respective designated shipping vials and placed immediately on ice in the supplied coolers. In addition,

GORE-TEX and GORE-SORBER are trademarks of W. L. Gore & Associates, Inc.
GORE-SORBER Screening Survey is a registered service mark of W. L. Gore & Associates, Inc.

trip blanks and water temperature control blanks (provided by GORE) are also returned. Coolers are returned along with the Chain-of-Custody (COC) form to GORE's laboratory in Elkton, MD via overnight carrier.

Screening Module Exposure Time

GORE's suggested module exposure times are two weeks for VOC detection, and two to three weeks for SVOCs and PAHs.

Analytical Procedures

On receipt of the modules at the GORE laboratory, each cooler is opened, the temperature of the water temperature control blank is recorded, the samples are logged, and the COC is inspected. Samples are then transferred to a laboratory freezer which is maintained at minus (-)15 °C until analysis.

Analytical instrumentation consists of Hewlett-Packard 5890 gas chromatographs and 5971A mass selective detectors, as well as Perkin-Elmer ATD-400 automated thermal desorption units. Sample preparation simply involves cutting the tip off the bottom of the sample module and transferring an exposed sorbent container (sorber) to a thermal desorption tube for analysis. Sorbers remain clean and protected from dirt, soil, and groundwater by the insertion/retrieval cord, and require no further sample preparation. Samples remain frozen until analysis and unanalyzed sorbers are retained in freezer storage until discarded (up to 1 month after data reporting). We currently offer two levels of laboratory QC as follows:

Level 1 Screening Method Quality Assurance:

This is our standard analytical screening method. Before each run sequence, two instrument blanks, a sorber containing 5µg BFB (Bromofluorobenzene), and a method blank are analyzed. The BFB mass spectra must meet the criteria set forth in Statement of Work (SOW) for Organic Analysis Multi-Media Multi-Concentration (SOW OLM 010.0 and revisions) before samples can be analyzed. A BFB containing sorber is also analyzed after every 30 samples and/or trip blanks, as is a method blank. Standards containing target compounds (see Attachment 1) at a single calibration level of 5µg are analyzed at the beginning of each run, after every 10 samples and/or trip blanks, and at the end of the run sequence. The %RSD criterion for all target compounds is less than 35% RSD. If this criterion is not met for any target compound, outlier values are removed until the criterion is met. and analyst's judgment. No second-source reference standard is analyzed and no surrogates are added. Compound identification is based on target ion, retention time versus the reference standard,, and chemist's judgment. A laboratory data deliverables package is not provided as part of the report deliverables. This data can be provided at an additional charge.

Level 2 Screening Method Quality Assurance:

As in the Level 1 Screening Method, two instrument blanks, a sorber containing 5µg BFB, and a method blank are analyzed at the beginning of each run sequence. The BFB mass spectra must meet the same criteria as above as well. A BFB containing sorber is also analyzed after every 30 samples and/or trip blanks, as is a method blank. Standards containing our target compounds at three calibration levels of 5, 20, and 50µg are analyzed at the beginning of each run. The %RSD criterion for all target compounds is less than 35% RSD. If this criterion is not met for any target compound, the analyst has the option of generating second- or third-order standard curves, as appropriate. A second-source reference standard, at a level of 20µg per target compound, is analyzed after every ten samples and/or trip blanks, and at the end of the run sequence. No surrogates are added. Positive identification of target compounds is determined by the presence of the target ion and at least two secondary ions, retention time versus reference standard, and the analyst's judgment. A laboratory data deliverables package, including all analytical results for samples, standards and blanks, sample chromatograms, and mass spectra comparisons with standards for all detects, is provided for Level 2.

Interpretation of Screening Survey Data

In general, the detection of VOCs and SVOCs in field-exposed modules indicates that potential sources (i.e. soil adsorbed-, dissolved- and separate-phase organics) of the detected compound(s) vapors may exist in proximity to the module location. The module will adsorb migrating soil vapors present in the adjacent soil column. The processes that govern the movement of soil vapors in the subsurface are complex, involving interactions between the soil, soil moisture, pore gasses, ground

water, and the volatile contaminant. Chemical and microbiological processes can further influence the presence of soil gases, by reacting with or metabolizing the compounds.

Vapor pressure, water solubility, molecular weight, and the Henry's Law partitioning coefficient, are all important chemical parameters to consider when interpreting soil vapor data. The Henry's Law coefficient reflects a compound's behavior when partitioned into air and water, which aids in understanding an organic chemical's likely state in the subsurface.

Absolute levels of detected ions are determined by the ionization efficiency of the target compound. These efficiencies vary by a factor of twenty for the GORE's target soil vapor analytes, and make comparison of ion count data difficult. Furthermore, detected ion levels can change from tune to tune of the MS and are dependent on such variables as the cleanliness of the MS source, and the ages of the GC column and ATD cold trap. For this reason, GORE always includes analyses of sorbers injected with reference standard solution, and generally reports target data as a mass of analyte, in micrograms (µg) per sorber.

Contour Maps Of Soil Vapor Analytes
Graphic presentation of the data extracted from GORE-SORBER Screening Modules is normally presented by overlaying the contamination patterns detected during analysis onto CAD maps supplied by the customer. Either minimum surface curvature or kriging models (GEOSOFT® Mapping Software) are employed. "B-sized" (11" x 17") color contour plots are standard, however "E-size" (24" x 36") plots are available, if requested. The site plan base map(s) provided by the customer must include a scaled drawing with relevant site features, and an overlay containing the sample locations for the Screening Survey.

Unresolved Hydrocarbon Envelopes
Inspection of the total ion chromatograms for each module frequently reveals the presence of unresolved hydrocarbon envelopes (UHEs) at some sample locations. Some of these hydrocarbon envelopes are indicative of naturally occurring hydrocarbons, such as terpenes. However, other hydrocarbon envelopes are indicative of commercial fuels such as gasoline, mineral spirits, diesel, #2 heating oil, kerosene, and jet A fuel.

Tentative identifications of the UHEs may be provided through comparison to GORE's mass spectra library of commercial fluids.

Tentatively Identified Compounds (TICs)
Some of the modules may contain non target analytes (compounds not on GORE's standard list). GORE can provide tentative identification of prominent non-target compound peaks (TICs). These compounds can include non-target soil vapor analytes, and contaminants introduced during sample transport and installation/retrieval activities.

Reporting of Results
The results of the GORE-SORBER Screening Survey will be summarized in a brief report which will include the chain of custody, laboratory analytical data summary tables, and color contour maps. A laboratory analytical data deliverables package incorporating results of samples, standards and blanks, chromatograms, and mass spectra compared to standards for all detects can be optionally provided for the GORE Level 1 QC package.

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GORE-SORBER® Screening Survey

STANDARD COMPOUNDS

1. Methyl t-butyl ether
2. trans-1,2-Dichloroethene
3. 1,1-Dichloroethane
4. cis-1,2-Dichloroethene
5. Chloroform
6. 1,1,1-Trichloroethane
7. Benzene
8. Carbon tetrachloride
9. 1,2-Dichloroethane
10. Trichloroethylene
11. Toluene
12. Octane
13. Tetrachloroethene
14. Chlorobenzene
15. Ethylbenzene
16. m-Xylene
17. o-Xylene
18. 1,3,5-Trimethylbenzene
19. Phenol
20. 1,2,4-Trimethylbenzene
21. 1,4-Dichlorobenzene
22. 2-Methyl phenol
23. Undecane
24. Naphthalene
25. Tridecane
26. 2-Methyl naphthalene
27. Pentadecane

GORE
Creative Technologies Worldwide

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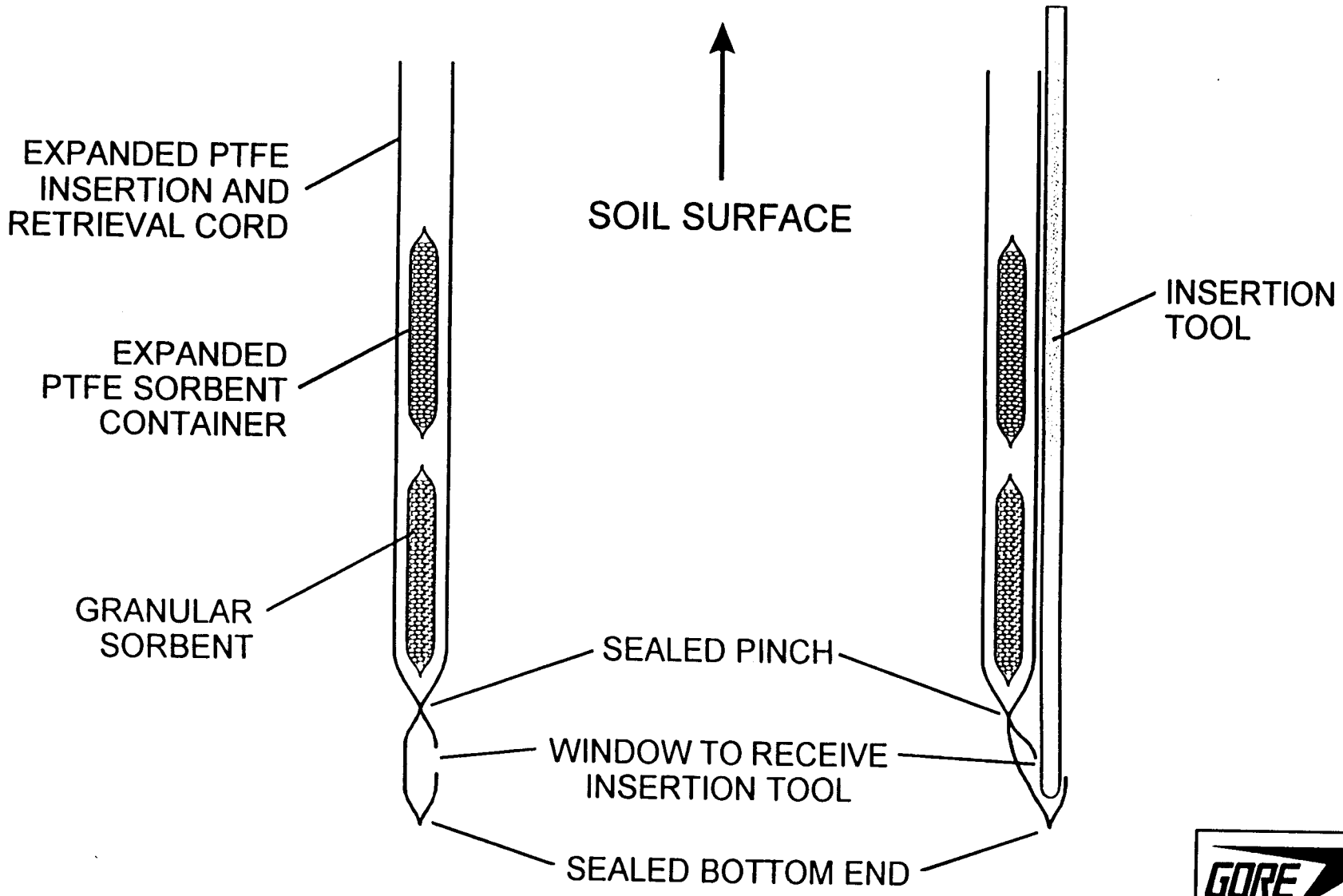
GORE-SORBER® Screening Module



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W. L. GORE & ASSOCIATES, INC.

101 LEWISVILLE ROAD • P.O. BOX 1100 • ELKTON, MARYLAND 21922-1100 PHONE: 410/392-3300
FAX: 410/996-3325 • TELEX 467637 GORE FB ELKT
ENVIRONMENTAL PRODUCTS GROUP

GORE-SORBER® SCREENING SURVEY CAD MAP INSTRUCTIONS

Thank you for your recent purchase of a GORE-SORBER Screening Survey. It is our goal to make certain that you are happy with our service for this project, so please do not hesitate to contact us with any questions at (410)996-3402.

To help insure that we deliver results on time, please comply with our specifications for the supply of a CAD map of your site to Gore:

Upon installation of the GORE-SORBER® Screening Modules, a simplified CAD map showing the Module locations identified with the Gore Module serial number should be generated and forwarded to Gore as soon as possible (in advance of the return shipment of exposed Modules).

The site drawing should include:

- A minimum number of layers with no additional hidden or frozen layers.
- Only necessary location entities - such as buildings, streets, property lines, etc...
- The Module locations clearly marked and labeled with the Gore serial number.
- **A simple graphical scale**; map scaled for the desired map size (typically B size).
- Allow room for a color bar.
- Be drawn in decimal ground units (i.e. feet as opposed to plot inches or architectural units).
- Colored layers, text, entities, etc... should be changed to white.
- Exploded blocks.
- Hard copy to be sent with diskette. (General example attached)
- Include any special font or other files used to generate the drawing.
- If possible, the drawing should be generated using AutoCAD® version 12 or earlier, or by a compatible CAD program.

Thank you, again, for your business. Your attention to these requests will insure prompt processing of your GORE-SORBER Screening Survey results. Please call with any questions, (410) 392-3402.

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AutoCAD is a trademark of Autodesk, Inc.

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17 miles

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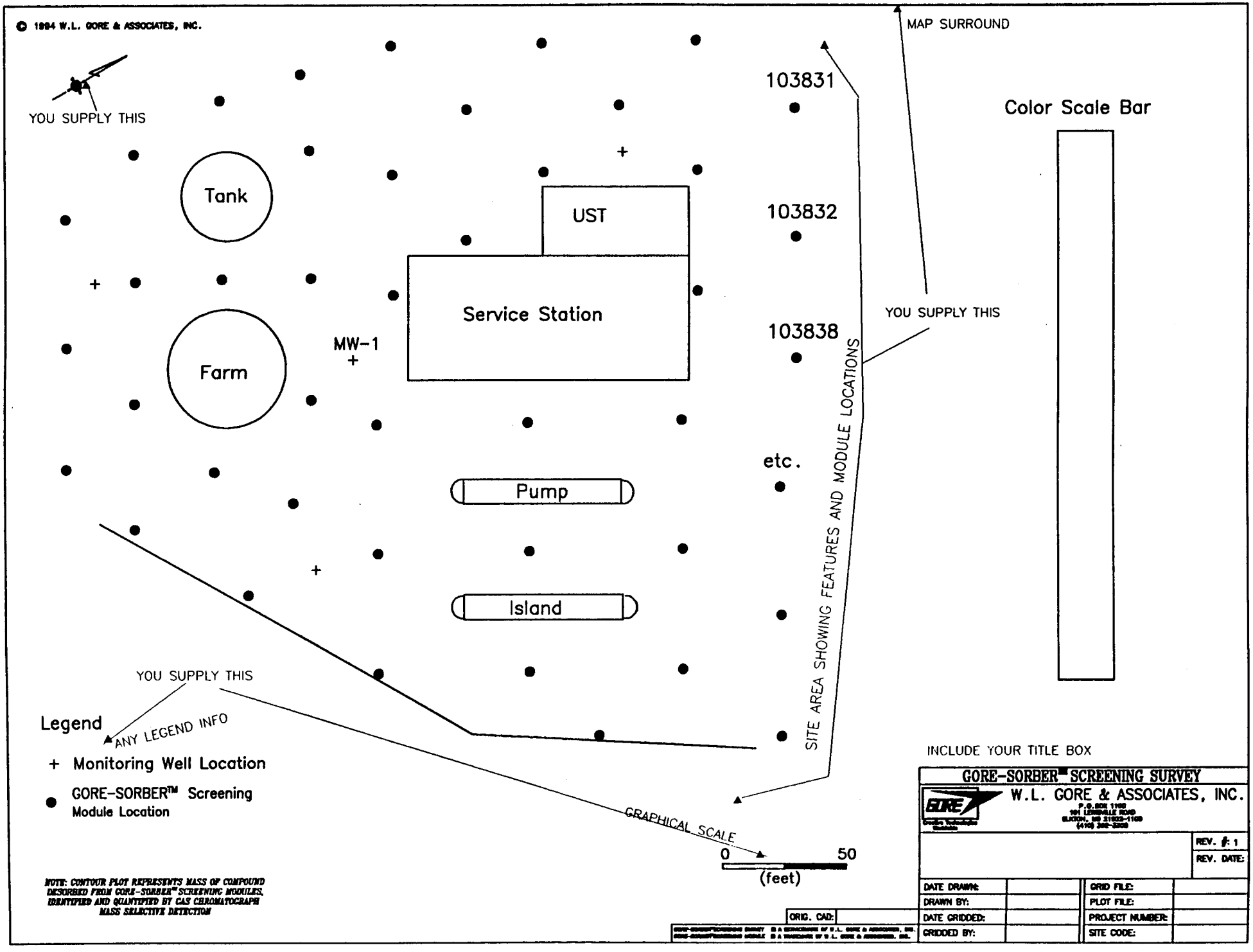

NOTE: CONTOUR PLOT REPRESENTS MASS OF COMPOUND DESORBED FROM GORE-SORBER™ SCREENING MODULES, IDENTIFIED AND QUANTIFIED BY GAS CHROMATOGRAPH MASS SELECTIVE DETECTION

INSTALLATION AND RETRIEVAL INFORMATION SHEET

GORE-SORBER® SCREENING MODULES

June 4, 1993

IF YOU HAVE ANY QUESTIONS AFTER YOU HAVE READ THESE INSTRUCTIONS, PLEASE CALL MARK WRIGLEY OR BARBARA KEAVENEY AT (410) 392-3300.

DESCRIPTION: GORE-SORBER Screening Modules are pollution detection sensors, utilizing Gore's patented sorbent containers and apparatus. The heart of our GORE-SORBER Screening Module is GORE-SORBER Passive Sorbent Collection Device ("sorber"), a container constructed of GORE-TEX® expanded polytetrafluoroethylene (ePTFE, similar to Teflon®) tubing. The sorbent mixture has been carefully selected to detect a broad range of volatile and semivolatile organic compounds. Replicate sorbers are housed in the bottom of an outer length of ePTFE tubing and sealed. The outer length of tubing serves as a sensor insertion and retrieval means.

CAUTION: GORE-SORBER Screening Modules are specially cleaned and stored after manufacturing. They must remain sealed in their shipping vials until deployment. **Do not store** or **use** them near cigarette smoke, gasoline, diesel fumes of exhaust, styrofoam peanuts, solvents, insect repellents, sunblocks, hand lotions or any other source of volatile organic compounds.

REQUIRED TOOLS: To date, most GORE-SORBER Screening Modules have been installed in 9/16" to 1" diameter holes, using a slide hammer and tile probe, or an electric rotary hammer auger. Installation depth is site dependent, but 3-4' is normally sufficient. Some of the recommended tools for a GORE-SORBER® Screening Survey are :

- Fluorescent spray paint, flags, or some other reliable means of location marking
- Correctly scaled site map
- Pen, clipboard, field notebook, chain-of-custody form, and this instruction sheet
- Measuring tapes, transit, or other distance measuring device
- Electric rotary hammer with 1" carbide tipped bit (31"- 36" long)
- Extension cords
- Electric power source (AC power outlet or generator)
- Slide hammer /Tile probe
- GORE-SORBER Screening Modules & Vials (supplied)
- Corks with screw eyes (supplied)
- Insertion rod (supplied)
- Surgical gloves
- Paper towels and water (de-con of the auger and insertion rod)
- Trash bag
- Knife, scissors, and a pair of needle-nose pliers.

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W. L. Gore & Associates
101 Lewisville Rd., P.O. Box 1100, Elkton, MD 21922-1100
Phone: 410-392-3300 Fax: 410-996-3325

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Printed on Recycled Paper

FIELD DEPLOYMENT / INSTALLATION: Locate and mark all Screening Module locations on the ground using the spray paint and/or flags. Be sure to mark the locations well in order to ease retrieval. Create a narrow diameter hole, using a slide hammer and tile probe, or a rotary electric hammer auger. Wearing surgical gloves, remove the GORE-SORBER Screening Module from its sealed container. Note that each module has a unique serial number recorded on the top of the module and a metal tag attached to the module. Each vial is also individually numbered. **Record this number on the site map immediately!** Insert the stainless steel insertion rod into the pocket in the bottom of the module, and lower it into the hole. Be sure the module goes the entire way down the hole. If a large resistance is felt during insertion, remove the module and re-drill the hole. Re-insert the module. When the module is completely inserted into the hole, press the insertion rod against the side of the hole. Twist the rod and pull it out. Attach the end of the module to the screw eye in a cork. **Do not remove the metal ID tag!** Coil the excess retrieval cord and push it with the metal label into the hole. Cork the hole to prevent the intrusion of rain and atmospheric gasses during exposure. If the cork does not fit snugly into the hole, wrap a short length of the module retrieval cord around the cork and re-insert the cork into the hole. Decontaminate the auger and insertion rod after each use, using standard procedures (i.e. paper towels & clean water). If the surgical gloves become contaminated, replace them before handling any further modules.

GORE-SORBER MODULE RETRIEVAL: Some tools recommended for GORE-SORBER Module retrieval are:

- Cooler(s) with adequate supply of chilled ice packs, or water ice cubes **(required)**
- Original GORE-SORBER Module vials and racks **(required)**
- Site map with module locations **(required)**
- Distance measuring equipment
- Cork screw
- Knife, scissors, needle-nose pliers
- Small shovel
- Patching compound and equipment for concrete and asphalt holes (if required)
- Trash bag
- Surgical gloves.

Remove cork with cork screw. Wearing surgical gloves, wrap retrieval cord once or twice around your hand. Using a slow, steady tension, pull the cord straight up out of the ground. **Double check the Module ID# on the site map!** Cut off the cork and discard. **Put the entire retrieval cord back into the correctly labeled vial, including the metal tag.** Tightly reseal the vial. Using the vial racks and cooler, return the exposed vials and all supplies to the address below via Federal Express Overnight Service {(800) 238-5355}. **DO NOT** use Styrofoam "peanuts" or any other packing material which may contain volatiles or outgas and contaminate sorbers during shipment. Bubble packing is acceptable. Address the cooler to:

SCREENING MODULES LABORATORY
W. L. GORE & ASSOCIATES, INC.
101 LEWISVILLE ROAD
ELKTON, MD 21921
ATTN: NOTIFY LAB IMMEDIATELY UPON DELIVERY!!

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APPENDIX D
RESUMES

Kevin E. Garrett, Ph.D.
Staff Chemist II

Experience

Dr. Garrett has two years of experience in environmental chemistry. His responsibilities include evaluating and reporting analytical data. Dr. Garrett is familiar with the techniques, methods, and quality assurance/quality control (QA/QC) procedures applied in environmental analytical chemistry. He has evaluated analytical data for volatile organic, semivolatile organic, pesticide, herbicide, dioxins and furans, metal, and general inorganic contaminants from a variety of media. In addition, he is experienced in designing treatability study programs and is also experienced in chemical research and has performed analytical method development.

Training

Occupational Safety and Health Administration (OSHA) 40-hour hazardous materials/waste health and safety training course
OSHA 8-hour supervisory hazardous materials/waste health and safety training course

Education

Ph.D., Chemistry, The Pennsylvania State University, University Park, 1990
B.S., Chemistry, Colorado State University, Fort Collins, 1986

Representative Projects

Landfill remedial investigation/feasibility study, Ebey Island, Washington - As a staff chemist, assisted in a Superfund remedial investigation and feasibility study. Prepared laboratory scope of work and work authorizations, and generated field chain of custodies. Coordinated laboratory and sampling activities. Coordinated and performed data validation and data management activities. Client: Confidential

Rocky Mountain Arsenal (RMA), Denver, Colorado - As a staff chemist, assisted in a treatability study. Designed a treatability study program to evaluate the removal of contaminants from groundwater. Prepared the proposal and experimental design for the study. Client: U.S. Department of the Army (Army)

Fort Benjamin Harrison, Marion County, Indiana - As a staff chemist, assisting in an Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI). Technical supervisor in a soil-gas survey conducted by a subcontractor. Ensured that the soil-gas subcontractor met the contractual and QA/QC requirements of the project. Client: U.S. Army Environmental Center (USAEC)

RMA, Denver, Colorado - As a staff chemist, assisted in the evaluation of groundwater analytical data. Identified potentially flawed and inconsistent data using a variety of statistical approaches. Client: Army

Fort Ord, Monterey, California - As a staff chemist, assisted in the validation of a variety of U.S. Environmental Protection Agency (EPA) Level IV

organic and inorganic analytical data in accordance with U.S. Department of Defense and EPA Region IX guidelines. Prepared data validation summary reports. Client: Army

Petroleum refining company, Ponca City, Oklahoma - As a staff chemist, assisted in an RFI and corrective measures study of 25 solid waste management units with potential impacts on soil, groundwater, and surface-water quality. Validated a variety of EPA Level III analytical data and prepared data validation summaries. Client: Confidential

Industrial solvents reclaiming site, Winnebago County, Illinois - As a staff chemist, assisted in the validation of a variety of organic and inorganic analytical data and prepared data validation summary reports. Client: Acme Solvents Technical Committee

Sierra Army Depot, Lassen County, California - Staff chemist assisting in validation of EPA Level II (i.e., soil gas and screening) analytical data and preparing data validation summary reports. Client: USAEC

Research associate in organometallic, inorganic, and catalytic chemistry - Studied the interaction of metal clusters on metal oxide supports. Developed new methodology for the synthesis of mixed metal transition metal clusters on metal oxide supports. Studied these supported metal clusters by a wide variety of instrumental and analytical techniques.

Graduate student researcher in organometallic and inorganic chemistry - Studied the interaction of a variety of organic compounds with highly reactive transition metal complexes. Demonstrated the use of tungsten complexes as substrates in the synthesis of organic compounds such as naphthols. Studied the mechanisms by which the organic products are formed. Studied organic, organometallic, and inorganic compounds by a wide variety of instrumental and analytical techniques.

Memberships

American Chemical Society

Representative Publications and Presentations

1990. Further studies of the synthesis of 1-naphthols and 4-hydroxy-5,6-dimethylbenzothiophene by protonation of $Cp(CO)_2WCTol$ and $Cp(CO)_2WC(2\text{-}C_4H_3S)$ in the presence of alkynes and CO. *J. Organomet. Chem.*, 394, 251 (with W. C. Feng, H. Matsuzaka, G. L. Geoffroy, and A. L. Rheingold).

1990. The synthesis and characterization of size selective Pt-Ir clusters on metal oxide surfaces. Annual Research Review, Center for Catalytic Science and Technology, University of Delaware, October (with B. C. Gates, and A. L. Rheingold).

1989. Transient generation of the reactive carbene complex $[Cp(CO)_2W{=}CH(Tol)]^+$ and its reactions with alkynes to form vinylcarbene, allyl, naphthol, diene, and metallafuran complexes. *J. Am. Chem. Soc.*, 111, 8383 (with J. B. Sheridan, D. B. Pourreau, W. C. Feng, G. L. Geoffroy, D. L. Staley, and A. L. Rheingold).

1989. In-situ generation of the benzylidene complex $[Cp(CO)_2W{=}CH(Tol)]^+$ and its reaction with alkynes. *Advances in Metal Carbene Chemistry*, Schubert U. Ed.: Kluwer Academic Publishers: Dordrecht, 1989; p. 189 (with G. L. Geoffroy, J. B. Sheridan, and D. B. Pourreau).

1989. Cycloaddition of imines and $Bu^tN{=}O$ with the carbyne complexes $[Cp(CO)_2MCTol]^+$ (M=Mn, Re). *Organometallics*, 9, 1562 (with B. M. Handwerker, K. L. Nagle, G. L. Geoffroy, and A. L. Rheingold).

1989. New types of metallacycles formed by cycloaddition of imines and $Bu^tN{=}O$ with Mn and Re carbyne complexes. *J. Am. Chem. Soc.*, 111, 369 (with B. M. Handwerker, G. L. Geoffroy, and A. L. Rheingold).

1989. Transient generation of the reactive carbene complex $[Cp(CO)_2W{=}CH(Tol)]^+$ and its reactions with alkynes to form vinylcarbene, allyl, naphthol, and metallafuran complexes. Presented at 23rd Middle Atlantic Regional Meeting of the American Chemical Society, May (with J. B. Sheridan, D. B. Pourreau, G. L. Geoffroy, and A. L. Rheingold).

1988. Preparation and structural characterization of $[\{Cp(CO)_2W\}_2(\mu\text{-}TolCC(OH)CTol)][BF_4]\ CH_2Cl_3$. *Inorg. Chem.*, 27, 3248 (with J. B. Sheridan, G. L. Geoffroy, and A. L. Rheingold).

1988. Reaction of $[Cp(CO_2MCTol]^+$ (M=Mn, Re) with imines and hydrazones. *Third Chemical Congress of North America*, June (with B. M. Handwerker, G. L. Geoffroy, and A. L. Rheingold).

Robert A. Grippa
Field Services Supervisor

Experience

Mr. Grippa has eight years of experience in coordinating, scheduling, and conducting field services for several large groundwater sampling programs. He is responsible for scheduling field staff to meet the needs of the HLA-Denver office field-related project tasks; training technicians and staff-level geologists/engineers regarding field operations and activities; and performing field audits and inventory/maintenance in maintaining HLA field sampling equipment, trucks, and supplies. Mr. Grippa also assists project and task managers in costing, setup, staffing, logistics, and field procedures to efficiently complete project field work. He has conducted field operations in Levels B, C, and D personal protective equipment.

Registration and Certification

Certified in ensys immunoassay field testing

Training

Occupational Safety and Health Administration (OSHA) 40-hour hazardous materials/waste health and safety training course
OSHA 8-hour supervisory hazardous materials/waste health and safety training course
OSHA 8-hour hazardous materials/waste health and safety training refresher course (annual)
Certified in adult cardiopulmonary resuscitation (CPR) and standard first aid
Certified in radiation safety-operation of nuclear density gauge
Certified forklift operator instructor
Eight-hour confined space training
Air transportation of dangerous goods - Federal Express

Education

B.A., Business Administration, Mesa College of Grand Junction, Colorado, 1982
A.A., Mesa Community College, Mesa, Arizona, 1980

Representative Projects

Groundwater Sampling

Rocky Mountain Arsenal (RMA), Denver, Colorado - As field supervisor of a large-scale sampling program, responsible for all groundwater-related field activities requiring an understanding of all aspects of groundwater sampling, equipment inventory, operation and maintenance, scheduling and efficient assignment of daily work activities, document review and chain-of-custody, sample handling and shipment, field audits, and communication with HLA project managers and clients regarding program status. Mr. Grippa was directly responsible for training all field personnel on correct sampling protocol. In this capacity, interacted with regulatory agency personnel in field situations. Chemicals of concern included volatile organic compounds, U.S. Department of the Army (Army) chemical agents, organosulfur and organophosphorus compounds,

phosphonates, organochlorine pesticides, and heavy metals.
Client: Army c/o R. L. Stollar & Associates

RMA, Denver, Colorado - Hydrazine blending and storage facility (HBSF) operation of treatment plant, inventory control of Army property, and decommissioning of plant. Managed field services support of the hydrazine rinsewater transfer (350,000 gallons) from HBSF to Pond A. Implemented and trained field personnel to ensure that rinsewater was transferred safely and successfully. Received a letter of outstanding performance from the Army's post commander, Col. Bishop, for contributing to the success of an installationwide emergency response spill exercise. Received an additional commendation for initiating an emergency response action to repair a pipeline leaking from a 200,000-gallon storage tank. Client: Army

RMA, Denver, Colorado - Provide technical support and assistance to tasks awarded to the HLA-Denver office. The tasks include waste management, solvent extraction pilot treatability, soil vapor extraction (SVE) treatability, and groundwater monitoring. Performed a long-term aquifer pumping test (10 days), as well as slug and packer testing associated with treatability studies to compare extraction wells versus subsurface drains. Client: Army

Lowry Landfill, Arapahoe County, Colorado - Field supervisor for the groundwater sampling portion of the remedial investigation/feasibility study (RI/FS) of this Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site. Also, responsible for operations of a large drum storage pad. Duties included inspecting numerous inventoried 55-gallon steel drums for any signs of leaking or corrosion; overpacking of suspect drums; transfer, storage, and sampling of liquid collected from sumps; organization and acceptance of contractor's drums; and maintenance and snow removal during winter months. The drum storage pad was kept in compliance with RCRA storage standards. The landfill, in which up to 150 million gallons of industrial waste were codisposed with municipal waste, was contaminated with organic solvents, heavy metals, and radionuclides. Client: The Lowry Coalition

Phase I and II environmental site assessments (ESAs), Colorado - Conducted monitoring well installation, groundwater sampling, and well abandonment in conjunction with Phase I and II ESAs for subsequent property transactions. Client: Confidential

Astronautic manufacturing facility, Jefferson County, Colorado - Performed Resource Conservation and Recovery Act (RCRA) groundwater sampling, surface-water sampling, storm water sampling, and hazardous waste sampling programs. Certified in Ensys immunoassay field testing for polychlorinated biphenyls (PCBs). Client: Confidential

Chemical formulation, blending, and repackaging facility, Salt Lake City, Utah - Conducted groundwater, surface-water monitoring, soil sampling, pipeline installation, and excavation activities. Chemicals detected at the site included volatile organic compounds (primarily solvents), herbicides, pesticides, and semivolatiles. Client: Confidential

Radium site, Denver, Colorado - Performed monthly groundwater sampling of 10 monitoring wells for a one-year period, in addition to monthly

water-level monitoring of new and existing monitoring wells. Also, conducted aquifer testing using slugs and dataloggers.
Client: Confidential

Electronics manufacturing facility, Colorado - Performed quarterly groundwater sampling and water-level monitoring. Client: Confidential

Information storage device manufacturer, Denver, Colorado - Performed groundwater sampling, water-level monitoring, well installation, development of new monitoring wells, and disposal of investigation-derived waste. Client: Confidential

Remedial Investigation and Feasibility Study

Mobile laboratory, Sidney, Montana - Setup and operated mobile laboratory for performing immunoassay analyses for total petroleum hydrocarbons, specifically for detection diesel in both the soil and groundwater. Required accurate laboratory procedures to make critical field decisions on "plume closing" at the site. Costed Phase III field investigations for program. Client: Anchor Drilling Fluids USA, Inc.

Reclamation site, Denver area, Jefferson County, Colorado - For a soil and groundwater investigation, conducted soil sampling and installed, developed, and sampled monitoring wells. Client: Confidential

Various landfills (RPS, Fountain, 48th and Holly, Marshall/Boulder), Colorado - Performed RI/FS groundwater sampling, surface-water sampling, diel sampling, nuclear density testing, and disposal of investigation-derived wastes. Initiated sampling of influent and effluent water from newly constructed groundwater treatment plant for compliance requirements and permits. Also, conducted aquifer testing using slugs. Primary chemicals of concern at this CERCLA site include volatile organic compounds (solvents) and trace metals. Recently involved in the installation and testing of dedicated sampling equipment for the initiation of a newly developed sampling method known as micro-purging.
Client: Confidential

Pesticide manufacturing facility, CERCLA, Commerce City, Colorado - Conducted RI/FS soil and groundwater sampling. Client: Confidential

Aircraft component manufacturing facility, Denver, Colorado - Assisted in maintaining and operating a full-scale groundwater extraction and non-aqueous-phase liquid (NAPL) recovery system. Responsible for recovering NAPL, via skimmers, from monitoring and extraction wells. Provided daily oversight of an onsite groundwater remediation treatment plant. Directly involved with installation and operation of five new extraction wells. Collected biweekly water-level measurements for plant performance monitoring. Also, performed waste handling and drum sampling, and coordinated waste disposal at an offsite hazardous Subtitle C landfill. Responsible for monitoring groundwater seeps. Constructed decontamination pad. Client: Confidential

Oversight

Petroleum refinery company, Ponca City, Oklahoma - Provided internal quality assurance/quality control for field audit on HLA personnel

performing groundwater sampling and RCRA monitoring program. Client: Confidential

Aircraft component manufacturing facility, Denver, Colorado - Provide oversight of subcontractor for acidizing and rehabilitating existing extraction wells, pump installation, and startup. Client: Confidential

HARZA

ATSUSHI FUJII

Health and Safety Officer

Harza Environmental Services, Inc., Health and Safety Officer, 1991 to Present; Technology Management Associates, Inc., Environmental Chemistry and Chemical Safety Consultant, 1985 to Present. University of Illinois Medical Center School of Public Health, Assistant Professor (Adjunct) of Environmental and Occupational Health Sciences, 1982-89. Peoria Disposal Companies and PDC Laboratory, Inc., Technical and Laboratory Director, 1982-85. Self-Employed Environmental Chemistry and Chemical Safety Consultant, 1979-82. National College of Chiropractic Department of Chemistry and Nutrition, Associate Professor, 1973-79. Hodag Chemical Corp., Research and Development Group Leader, 1970-72.
Degrees: Doctor of Philosophy in Organic Chemistry, Illinois Institute of Technology, 1970. Master of Science in Industrial Hygiene, University of Illinois Medical Center, 1982. Bachelor of Science in Chemistry, International Christian University, Tokyo, 1965.
Professional Certification and License: Asbestos Inspector and Management Planner, Illinois; Certified Industrial Hygienist; Certified Hazard Control Manager.
Professional Societies: National Asbestos Council, American Academy of Industrial Hygiene, American Board of Industrial Hygiene, American Industrial Hygiene Association, American Council of Governmental Industrial Hygienists, American Chemical Society, American Association for Advancement of Science.
Continuing Education: Groundwater Monitoring at Hazardous Waste Sites (EPA Center for Environmental Research Information). Quality and Pollution of Groundwater, 1987 (International Groundwater Modeling Center, Butler University). Environmental Chemistry of Groundwater, 1986 (American Chemical Society). Basic Statistics for the Analytical Chemist, 1985 (American Chemical Society). Priority Pollutants Analysis, 1984 (American Chemical Society). A Guide to Voluntary Compliance, 1980 (OSHA Training Center).

As a certified industrial hygienist, Dr. Fujii has undertaken exposure monitoring and control projects of asbestos, chemical and physical agents of industrial hygiene significance. He has also instructed safety training courses for workers in radioactive site cleanup and asbestos abatement projects.

As a specialist in environmental chemistry and safety, he has served as a project manager and a project scientist in the areas of environmental audit, hazardous waste management, groundwater monitoring programs, and groundwater/soil contamination assessment.

Dr. Fujii has served as Department Chairman of Chemistry and Nutrition at the National College of Chiropractic, and he has also presented a graduate-level class and several seminars on industrial hygiene and hazardous waste management topics.

Among Mr. Fujii's professional appointments was the Asbestos Abatement Task Force organized by the Illinois Attorney General. He contributed to the group's Survey Protocol and the Abatement Process/Transportation, Storage and Disposal committees.

EXPERIENCE HIGHLIGHTS

Asbestos

- Developed and performed building inspection and bulk sampling protocol for hospital, residential, school, and industrial buildings.
- Submitted reports and recommendations on prioritized need of abatement activities, training program for operation and maintenance personnel, monitoring exposure, and air quality.
- Provided an evaluation and interpretation report of air monitoring results as a technical defense material in an asbestos-labor dispute.
- Established project specifications, contractor qualifications, and air quality/exposure monitoring program.
- Performed, as a third-party expert, a quality-control audit of abatement work, which included independent air quality/exposure monitoring.

Hazardous Waste Management

- Recommended safety and health protection measures for each waste stream destined to disposal at the PDC Hazardous Waste Landfill and Waste Water Treatment Facility.
- Recommended acceptability of each prospective industrial waste stream based on chemical compatibility and possible impact to leachate, groundwater, landfill liner, and landfill employee safety.
- Implemented waste quality control and analysis procedures to establish identity of each incoming waste for disposal acceptance.

ATSUSHI FUJII
Health and Safety Officer

• Designed a site-specific groundwater sampling and analysis plan to meet RCRA parts A and B requirements. Recommended a statistical procedure to evaluate groundwater quality of non-RCRA monitoring wells on a landfill.

• Recommended an alternate concentration level of 1,2-dichloroethane as an acceptable groundwater quality criterion.

• Submitted groundwater/soil contamination assessment programs and application requirements.

• Developed a groundwater monitoring program for RCRA Part B permit application, which was accepted with minor alternations.

Environmental Audit

• Managed Phase 1 of environmental projects, which consisted of commercial, business, and industrial properties.

• Managed site investigation projects of soil/groundwater contamination resulting from underground storage tanks (chemical solvents, gasoline, and fuel oils) and hazardous material spills.

• Conducted environmental audit seminars for financial institutions.

Industrial Hygiene

• Conducted indoor air quality surveys of offices with "sick building" syndrome.

• Performed OSHA compliance survey on workers' exposure to respirable dusts, fumes, and organic vapors in various industrial plants and manufacturing facilities.

• Surveyed and evaluated ventilation efficiency of laboratory hoods in medical laboratories to recommend proper usage for safer work environment in handling biological, chemical, and radioactive agents.

• Evaluated noise emission and characteristics in a data processing room to recommend effective noise reduction.

• Conducted a comprehensive industrial hygiene survey at a foundry, with emphasis on exposure to metal fumes, silicates, carbon monoxide, noise, and vibration.

• Made a walk-through industrial hygiene and safety survey in a railroad engine and car repair facility as preparation to establishing a medical survey program, including a substance abuse program.

• Served as an expert witness in an occupational health damage claim stemming from the improper use of degreasing material.

HARZA

STEPHEN P. HEMPEL
Environmental Engineer

Harza Environmental Services, Inc.: Environmental Engineer, 1995 to Present. ATC Environmental, Inc., Livonia, MI: Industrial Hygiene Technician and Laboratory Analyst, 1994. William Beaumont Hospital, Royal Oak, MI: Customer Relations Representative, 1992.
Degrees: Bachelor of Science in Civil & Environmental Engineering, *cum laude*, University of Michigan, 1994.
Professional Engineer: E.I.T.
Continuing Education:
- Water Environment Federation two-day course in Industrial Wastewater Pretreatment and Regulatory Compliance (1995).
- Purdue University Industrial Waste Conference (1995).
- OSHA 40-Hour Hazardous Waste Training (1995).
- NIOSH 582 Asbestos/Lead air monitoring (1994).

Languages: English, Spanish.

Mr. Hempel is an environmental engineer who specializes in industrial processes and treatment. Mr. Hempel's experiences include environmental auditing, wastewater treatment, air monitoring, soil and groundwater investigation, and remediation. His varied field experiences have equipped him with a practical approach and understanding for each project.

EXPERIENCE HIGHLIGHTS

Industrial Processes and Pollution Prevention
- Developed and presented a week-long training course in pollution prevention and industrial waste auditing for a United States Agency for International Development-funded project. Training course participants represented government offices and private industry from the country of Jordan (1995).
- Assisted in preparation of pollution prevention/waste minimization and water conservation audit reports for a thermal electric power plant and a petroleum refinery. The audits were conducted for the Industrial Wastewater Discharge Prevention Program in Amman, Jordan (1995).
- Staff engineer for performing a pollution prevention feasibility study for a petroleum refinery. The study involved technical, economic and environmental evaluation of various wastewater recycling options within the plant. Systems were developed for treating and reusing wastewater as boiler feed and cooling tower makeup water in order to reduce wastewater discharge and conserve water. The feasibility study was conducted for the Industrial Wastewater Discharge Prevention Program in Amman, Jordan (1995).
- Staff engineer for performing a pollution prevention feasibility study for a vegetable oil refinery. The study involved technical, economic and environmental evaluation of various state-of-the-art systems for optimizing industrial water treatment prior to use as boiler feed water. The feasibility study was conducted for the Industrial Wastewater Discharge Prevention Program in Amman, Jordan (1995).
- Performed combustion residue sampling for waste stream characterizations at the Chicago Northwest Waste-to-Energy Facility. The sampling was conducted following USEPA guidelines (1995).
- As industrial hygiene technician and laboratory analyst, collected and analyzed air samples to determine regulatory compliance; enforced EPA and OSHA regulations; and received project supervisor certification by NIOSH and the Michigan Department of Public Health (1994).

Wastewater Treatment
- Project engineer for performing a feasibility study for upgrading a 40,000 gpd wastewater treatment facility at Commonwealth Edison's Dresden Nuclear Power Station in Morris, Illinois. Responsibilities included coordination and oversight of the sampling program, data and process analyses, development of improvement alternatives, technical, economic and regulatory evaluations of each alternative, and report writing (1995).
- Staff engineer for performing an environmental feasibility study for a yeast manufacturing plant. The study involved technical, economic and environmental evaluation of wastewater treatment options. Various systems were developed for providing anaerobic wastewater treatment in conjunction with land treatment for final polishing in order to reduce wastewater discharge and preserve the local groundwater quality. The feasibility study was conducted for the Industrial Wastewater Discharge Prevention Program in Amman, Jordan (1995).

Soil and Groundwater
- Assisted in subsurface investigations as part of a comprehensive environmental audit of the Chicago Northwest Waste-to-Energy Facility. The results of the investigations were used to obtain permits for modernizing the facility and to identify concerns related to construction. Duties included oversight of monitoring well installation and soil and groundwater sampling for environmental and geotechnical analyses (1995).
- Installed and operated a Soil Vapor Extraction pilot system as part of remedial site investigation for the USACE. The system was designed to test the feasibility

of removing volatile organic carbons from a fire training pit at the Iowa Army Ammunition Plant in Middletown, Iowa. Contamination was a result of organic solvents and fuels. Responsibilities included: air sampling and monitoring of vapor pressures, oxygen levels, and total volatile organic carbons; sampling of monitoring wells, and monitoring of the effectiveness of the activated carbon treatment system (1995).

- Designed pump-and-treat remediation system for TCE-contaminated groundwater; modeled aquifer using MODFLOW software (1994).
- Isolated and characterized PAH-degrading microorganisms, and applied results to bioremediation feasibility study (1994).

Customer Relations

- As customer relations representative, coordinated customer service activities; developed inventory system utilizing computer database; and prepared and presented monthly reports on program success (1992).

HONORS AND AWARDS

Chi Epsilon, National Civil Engineering Honor Society

James B. Angell Scholar Award, University of Michigan

HARZA

JITENDRA R. GHIA

President

Harza Environmental Services, Inc.: President, 1990 to Present. Harza Engineering Company: Hazardous Waste Program, Manager, 1981-86; Project Manager, 1979-86; Senior Environmental/Sanitary Engineer, 1976-79. Roy F. Weston, Inc.: Senior Project Engineer, 1973-76. Weston Ghia and Company, Environmental Engineering Consultants, Rajkot, India: Partner and Principal Engineer, 1964-73. Roy F. Weston, Inc.: Associate Engineer, 1961-64. Fenner-Brey Engineering Company: Sanitary Engineer, 1960-61.
Special Corporate Assignments: Secretary, Research and Development Committee, 1982-84. Member, Proposal Review Committee, 1982.
Degrees: Master of Science in Civil Engineering (Environmental), University of Wisconsin, 1961. Bachelor of Engineering (Civil), Gujarat University, 1958.
Languages: Hindi, Gujarati, English
Professional Engineer: Pennsylvania
Professional Societies: American Academy of Environmental Engineers (Diplomate), Hazardous Waste Action Coalition, Society of American Military Engineers.
Continuing Education: Groundwater Flow and Contamination Control, 1982 (University of Illinois, Chicago Geotechnical Series). Hazardous Waste Disposal, 1981 (Hazardous Materials Control Research Institute, Baltimore). Use of Soil Materials for Wastewater Treatment, 1977 (University of Wisconsin, Madison). Process Design in Water Quality Engineering - New Concepts and Developments, 1977 (Vanderbilt University, Nashville). Short Course on Water Supply Engineering: Quality Treatment, Management, 1977 (University of North Carolina, Chapel Hill). Certificate - Value Engineering Workshop, 1976 (Consulting Engineers Council).

Jitendra R. Ghia has served as project manager and/or project engineer for more than 200 projects, including industrial wastewater treatment, hazardous waste management/remediation, sewage treatment, and water supply. He supervises engineers and drafters preparing reports, designs, plans and specifications, cost estimates, treatability studies, and field investigations.

EXPERIENCE HIGHLIGHTS

Hazardous Waste Management/ Remediation Projects

- Technical supervision and/or project manager for remedial investigation/design or new facility design in numerous projects involving underground storage tanks and/or above ground storage tanks:
  - Nine gas stations in Chicago for Amoco;
  - Amoco Asphalt Terminal;
  - CECO Chicago Central Headquarters;
  - Chemical plant above ground and underground chemical storage tanks;
  - Elmendorf AFB-29 underground fuel storage tanks of 50,000-gallon capacity each;
  - Elmendorf AFB-One 300,000-gallon underground storage tank;
  - Motel & Abandoned Gas Station, Joliet, IL;
  - Nome Area/Seward Peninsula Project;
  - Northbrook UST removal;
  - Park Ridge UST removal;
  - Resin Coating Plant;
  - TNT-Holland Express Terminal;
  - Peoria Disposal Company - aboveground chemical storage tanks design; and
  - SCA - aboveground hazardous waste storage tanks design.
- Project manager on Illinois EPA project that included furnishing oversight and technical assistance services at about 120 state-funded or voluntary cleanup sites. The types of services included: oversight of remedial action, immediate removal actions, remedial investigations, remedial design, cost estimating, cost recovery, UST removal, constructibility review, and community relations. Soil removal and incineration, review of PRP work plans, enforcement of health and safety and sampling protocols, oversight on field investigations, sample collection, air monitoring, environmental assessment, and evaluation of contract bids were included (1986 to present).
- Technical supervision for remedial design of Sand Creek Superfund Site with soils contaminated with pesticides. Soil washing and low temperature thermal desorption technology are used as the main remedial technologies. A soil washing pilot test for treatability study was designed and implemented (1992 to present).
- Technical supervision of property assessment, RCRA closure activities, and investigation of TCE release at a General Electric plant in Illinois (1991 to present).
- Project manager for the Nome Area - Seward Peninsula RI/FS. The project involved assessment of 13 former military facilities in northwestern Alaska and development of a detailed work plan including RI Sampling Plan, HSP, QA/QC Plan, and Logistic Plan. Harza collected over 800 samples from multimedia such as drums, transformers, soil, sediment, and surface water in a 2.5-month weather

window from 13 remote sites. Supervised all of Harza's activities, including Confirmation Studies, Environmental Assessment, Remedial Site Investigations, UST investigations, hazard evaluation, engineering feasibility studies, remedial design, checking construction documents, and cost estimating for these 13 sites. Participated in the community relations program. The challenge was to select proper Remedial Actions that would protect sensitive environment during the construction activities and meet the cost restraints (1988-1991).

• Harza's project manager on Elmendorf Air Force Base DERP, involving RI/FS and RD at five on-base sites. The sites included a waste area containing several hundred drums, a base landfill, 29 underground fuel storage tanks, a fire training pit, and a 500,000-gallon waste tank. Project followed USACE protocols and required logistical support for two field seasons (1988-90).

• Whitestown Landfill RI/FS, NY: Technical supervision in development of RI work plans, potential remedial technologies report, and a solid waste management plan. Directed and reviewed results of multimedia field investigations, including ambient air and soil gas surveys, test pits, drilling and monitoring well installations, sampling, and analysis. Prepared Phase I of the RI report (1988-89).

• Project manager on four USACE NIKE sites in Anchorage and Fairbanks, AK. Project involved remedial investigation, feasibility study, and remedial design. Investigations included sampling of soil, groundwater, water, and USTs (1985-86).

• Technical supervision for closure of the City of Ann Arbor Phase II Landfill. Project tasks include engineering design, construction specifications and construction oversight (1990 to present).

• Technical supervision for remedial action plan for the City of Ann Arbor Phase I Landfill. Project tasks include performing a site-specific risk assessment select remedial alternatives for the media of concern identified in the risk assessment, and preparing a remedial action plan design report (1990 to present).

• Project manager for composite liner system design, gas management system design and operation, slurry wall de- sign, operation plan, and final cover system design, Ann Arbor Landfill, Phase III, MI (1989 to present).

• Technical supervision for RI/FS at the Behn Drum SRAPL site, IL. Work includes installation of monitoring wells; sampling of soils, sediment, surface water, and groundwater; and Risk Assessment (1991-92).

• Technical supervision for soil investigation of aboveground fuel storage facility, Vigo County, IN. Approximately 12,000 yd^3 of fuel-oil-contaminated soils were known to be present, and additional contamination from off site was possible. Six monitoring wells were installed to identify groundwater flow patterns. Soil and groundwater samples were collected to identify contamination elsewhere. Site and area data were compiled for submission to IDEM. On-site soil treatment technologies were examined and preliminary cost estimates prepared (1990).

• Project manager of design of new hazardous waste disposal site for Peoria Disposal Company, IL. This multiassignment project involved development of a conceptual/preliminary design of a commercial hazardous waste disposal facility, including drum storage, waste solidification, leachate treatment, and landfill. It also involved technical input into preparation of RCRA Part B Application. Subsequent assignments included:

Liner compatibility;
Compliance for minimum technology;
Exposure assessment;
Groundwater monitoring;
Groundwater assessment; and
Contaminant movement modeling (1983 to present).

• Project manager of detailed design of landfill cells for Peoria Disposal Company, IL, including liner selection and specifications, leachate collection system, leak detection system, closure plan, run-on and runoff control measures, foundation design, development of operation plans, and estimates of landfill capacity (1984 to present).

• Project manager of two projects for Peoria Disposal Company, IL, on remedial investigation and remedial design for controlling migration of leachate or contaminated groundwater at old landfill and old pond areas. The former project included design of a cutoff wall, a leachate collection system, and removal of sand lenses. In the old pond project, the remedial action alternatives considered included pump-out wells, capping, *in situ* treatment, and removal (1984 to present).

• Project manager of an industrial site contamination assessment and remedial design project, IN. The project involved discovery and confirmation studies, remedial investigations and feasibility study, and remedial design for the removal and controlling of migration of organic contaminants that have leaked into the subsoil over several years. Among several remedial alternatives considered were included a pump and beat, *in-situ* bioreclamation, and containment system. A pump-out well system was designed and installed. Additional remedial actions may involve interceptor french drains and trenches, cutoff walls, or removal (1984 to present).

• Project manager of a site assessment study at Torrington Company, South Bend, IN. The study involved review of past practices, developing sampling program, sampling of soil and groundwater, and assessing potential for contaminants release (1986).

• Project manager of development of groundwater monitoring program, IN, for a surface impoundment, a solids disposal facility, and tank farms. A hydrogeologic study, including subsoil investigations, was completed as part of this project (1985-86).

• Project manager of site contamination study at Fascura facility for Acme Solvents, IL. The study involved soil

and groundwater analyses, subsurface explorations, and assessment for contamination release potentials from underground storage tanks and other plant operations (1985).

• Project manager of a contamination assessment study at a site in Indiana, for an industrial client. The scope included soil sampling and analyses to determine the extent of soil contamination with PCBs and other organic priority pollutants (1984).

• Project manager of a contamination assessment study at a site in Texas, for a transportation company. The study included soil sampling and analyses and determination of the extent of surface and subsurface soil contamination. Samples were analyzed for PCBs and other organic priority pollutants (1984).

• Project manager of assessment of potential for release into surface waters and/or groundwaters of toxic contaminants from a metal finishing facility in Indiana, Anderson and Company (1983).

• Project manager of groundwater quality impact assessment due to energy development activities in the United States for Argonne National Laboratory, IL (1981).

• Project engineer for evaluation of treatment alternatives for leachate from Gratiot County, MI, landfill site contaminated with polybrominated biphenyls (PBB) dumping (1978).

Steam Electric Power Station Wastewater Treatment Projects

• Supervised preparation of operations and maintenance manual section III for wastewater treatment facilities at Will County, Kincaid, and Ridgeland stations for Commonwealth Edison Company, IL (1978).

• Project manager of the design work and services during construction of wastewater treatment facilities at Zion, Quad Cities, and Dresden stations for Commonwealth Edison Company, IL (1976-78).

• Supervised preparation of process design for wastewater treatment facilities at LaSalle, Byron, and Braidwood stations for Commonwealth Edison Company, IL (1976).

Wastewater Projects in the Chemical Industry

• Project engineer for process design of wastewater treatment facilities for Stepan Chemical Company, NJ (1974); Rainbow Texdyes Corporation, India (1965); and Atlas Chemical Company, PA (1964).

• Project engineer for Evaluation of Pollution Control Projects at three Celanese Corporation plants, VA and NJ (1961-62). Aspects of air, wastewater, and solids were reviewed (1963-64).

• Project engineer for wastewater treatability studies for Goodrich Gulf petrochemical complex, WV (1963).

Textile Wastewater Treatment Facilities

• Project engineer for wastewater treatability studies for Futura Fabrics, NJ (1976).

• Project manager/engineer of process design for wastewater treatment facilities for the Dinesh Woolen Mills, India, and Bharat Vijay Mills, India (1967-68).

• Project engineer for treatability studies and process design of wastewater treatment facilities for Fibre Industries, Inc., PA (1964).

• Project engineer for treatability studies and process design of upgrading and expansion of wastewater treatment facilities for Oxford Textile Finishing Company, NY (1962).

Wastewater Treatment Facilities in Food and Dairy Industries

• Project engineer for wastewater treatment alternatives evaluation study for Great Lakes Canning Company, OH. Alternatives considered included Carver Greenfield, vapor compression evaporation, and biological treatment (1976).

• Project engineer for treatability studies, process design, detailed design, and construction supervision of wastewater treatment facilities for Wawa Dairy, PA (1963-64).

• Project engineer for treatability studies and process design for wastewater treatment facilities for Braddox Frosted Food, NJ (1963).

• Project engineer for treatability studies and process design of wastewater treatment facilities for Gorman Dairy and Weldron and Sons Dairy, NJ (1961-62).

Pulp and Paper Wastewater Treatment Plants

• Project engineer for process design of wastewater treatment facilities for Owens Illinois Company, VA (1974).

• Project engineer for process design and detailed engineering design of wastewater treatment plant for Daring Paper Company, PA (1963).

• Conducted operation surveillance of wastewater treatment facilities for Taylor Fibre Company, PA (1961).

Aircraft Maintenance Wastewater Treatment Projects

• Directed technical work for conceptual design plans and performance-type specifications for pretreatment facilities at two aircraft maintenance bases in Saudi Arabia (1978-79).

Oil Refinery Wastewater Treatment Project

• Project engineer for process design of a wastewater treatment facility for Caltex Oil Refinery, Germany (1964).

Development Document for Effluent Guidelines of Eight Industries

• Technical project manager of development documents preparation for the U.S. Environmental Protection Agency, Washington, DC, of eight industries, including

pharmaceuticals, pesticides, and agricultural chemicals; explosives, adhesives, and sealants; gum and wood chemicals; carbon black; photographic chemicals; and hospitals (1974-75).

Water Supply and Treatment Projects

- Technical advisor on feasibility study and preliminary engineering design for water supply projects for Choluteca, Danli, and San Marcos de Colon, Honduras (1976-77).
- Project engineer for evaluation of alternative water supplies for the City of Alexandria, VA (1975).
- Project engineer for preliminary engineering design of an addition to the water supply system for Longwood Gardens Kennett Square, PA (1975).
- Project manager and technical supervisor of preparation of design, plans, and specifications for water supply systems in three townships in Baroda, Rajkot, and Keshod, India (1964-70).
- Project manager and technical supervisor of preparation of design, plans, and specifications for water supply system in Mandvi, India, with design population of 30,000 (1969).
- Project engineer for preparation of prefeasibility-level design and cost estimates for 41-mgd water treatment plant for Yarmouk-Amman Water Carrier Project, Jordan (1978).
- Project engineer for preparation of preliminary design and cost estimates for turnkey bids on two water filtration plants at Gondal (2.5 mgd) and Gandhinagar (4.5 mgd), India (1965-71).

Sewage Collection and Treatment Projects

- Assistant supervisor of preparation of design, plans, and specifications of 30-mgd sewage treatment facilities for the City of De Pere, WI (1974).
- Project engineer for preparation of preliminary design, equipment selection, and cost estimates for turnkey bids on activated sludge sewage treatment plants - a 72-mgd Pirana plant and 14-mgd Vasna plant, both for Ahmedabad, India (1964).
- Project engineer for treatability studies, process design, and engineering design for expansion of a sewage treatment plant for Telford Borough, NJ (1963).
- Project engineer for preparation of conceptual engineering report for activated sludge plants in Phillipsburg, NJ, and Bordentown Township, NJ (1962).
- Project manager and technical supervisor of survey and preparation of preliminary design and detailed engineering design for sanitary sewers, pumping stations, oxidation-pond-type treatment facilities, and agricultural application of effluent for Sidhpur, India, with design population of 65,000 (1971-73); and for Bagasara, India, with design population of 35,000 (1972-73).
- Project manager and technical supervisor of survey and preparation of preliminary design and detailed engineering design for 150 miles of sanitary sewers, 12 pumping stations, 12-mgd activated sludge treatment plant, and agricultural application of effluent for Rajkot, India, with design population of 450,000 (1968-71).
- Project manager/engineer of survey and preparation of detailed design for sewer system, a pumping station, and oxidation-pond-type treatment facilities for the Village of Clyman, WI (1960).

Stormwater Projects

- Supervised preliminary engineering design for stormwater collection system for a subdivision in Highland Park, IL (1978).
- Project manager and technical supervisor of detailed engineering design of stormwater collection system for Gujarat State Fertilizer Township, India (1964); Jawahar Cooperative Industrial Estate, India (1968); and Union Carbide (India) Ltd. (1973).

Sludge Disposal Projects

- Project manager of sludge management plan for Barrington Sewage Treatment Plant, IL. Alternatives included landfill, composting, and liquid or dry land application (1981).
- Project manager/engineer of Economic Evaluation of Sludge Disposal Alternatives, including landfilling, land application, and incineration for Rockford, IL, Sanitary District's sewage treatment plant (1977).

Additional Projects

- Project manager/engineer of feasibility study, preliminary engineering design, and preparation of performance-type specifications for remote monitoring of alarm conditions at sewage treatment plant, Barrington, IL (1982).
- Project manager of development of industrial pretreatment program for Downers Grove, IL, Sanitary District (1982).
- Project manager/engineer of preparation of design, plans, and specifications for wastewater collection and treatment project for Odhav Industrial Park, India (1973).
- Project engineer for process design of a wastewater treatment plant, Paoli Industrial Park, PA (1964).
- Project manager/engineer of process design, detailed design, and construction supervision of wastewater treatment plant for New Bolten Veterinary Center, PA (1963).

TECHNICAL PAPERS AND ARTICLES

"Contaminant Transport Modeling for a Proposed Hazardous Waste Site," presented at the Sixth National Symposium and Exposition on Aquifer Restoration and Ground-

water Monitoring, Columbus, OH, 1986 (C.B. Burke, A.J. Frano, J.R. Ghia, and D.I. Leib, co-authors).

"Selection of Synthetic Liners for a Hazardous Waste Landfill Facility," presented at the Working Together to Manage Waste Conference, Chicago, IL, 1984 (J.R. Ghia and K.V. Mayenkar, co-authors).

"Nonradioactive Wastewater Treatment at the Zion Nuclear Station - Design, Start-Up and Troubleshooting," presented at the American Power Conference, Chicago, IL, 1980 (J.R. Ghia, L. Rafner, and D. Hardwick, co-authors).

"Cost Comparison of Sewage Treatment Plants," Master's thesis, University of Wisconsin, 1961.

HARZA

ROBERT P. KEWER

Senior Associate, and Head - Geology/Hydrogeology Section

Harza Environmental Services, Inc.: Senior Associate, 1995 to Present; Associate, 1990-95; Geology/Hydrogeology Section, Head, 1986 to Present.
Harza Engineering Company: Senior Hydrogeologist, 1984-86; Senior Engineering Geologist, 1981-84; Engineering Geologist, 1974-81; Field Geologist, 1971-72.
Degrees: Master of Science in Geology, Rutgers University, 1973. Bachelor of Science in Geology, Tufts University, 1970.
Languages: English, Spanish.
Professional Engineering Geologist: Oregon.
Certified Geologist: Indiana.
Professional Societies: Association of Engineering Geologists, National Ground Water Association.
Continuing Education: Seminar on Site Characteristics for Subsurface Remediations, 1989 (U.S. EPA). Groundwater Pollution and Protection, 1988 (Association of Engineering Geologists). CHMM Review Course, 1988 (Illinois Institute of Technology). Subsurface Monitoring Technology, 1983 (University of Wisconsin). Groundwater Analysis and the Design of Dewatering Systems, 1976 (University of Missouri). 40-Hour General Site Worker Program, 1989, and refresher (University of Illinois).

As Head of the Geology/Hydrogeology Section, Robert P. Kewer is responsible for planning, implementation, and review of all groundwater studies at HES and supervision of staff hydrogeologists.

Mr. Kewer has served as project manager on many assignments. His experience and capabilities cover all aspects of hydrogeology, including groundwater resource evaluations, environmental property assessments, soil and groundwater contamination investigations, evaluation of waste disposal sites, groundwater monitoring, remedial investigations, and groundwater remediation.

EXPERIENCE HIGHLIGHTS

Remedial Investigations/Feasibility Studies

- Deputy Program Manager for $20-million Omaha District Corps of Engineers HTRW IDC. Assignments have included: Investigation of TCE groundwater contamination and evaluation of the Funnel & Gate *in-situ* technology at the Duluth International Airport, MN; investigation of two dumps at the Buckley Field Arctic Training Center FUDS site, CO; Engineering Evaluation/Cost Analysis (EE/CA) for a burn pit at the Iowa Army Ammunition Plant; RFIs for Landfill 5 and Fire Training Pit Area 4 at Cannon AFB, NM; and others (1994 to present).
- Project Manager for City of Chicago environmental assessment IDC. Assignments have included: Modernization of the Northwest Waste-to-Energy Refuse Combustion Facility, including environmental, residue handling, and air compliance issues; Phase I Environmental Baseline Survey (EBS) for O'Hare International Airport Air Reserve Forces Facility; soil sampling and reporting for UST removal at O'Hare Airport; technical support for the Dutch Boy Paint Site, Paxton I and II Landfills, and others (1994 to present).
- Provided technical support to Fuller-O'Brien Paint Company for groundwater contamination at South Bend, IN plant, including interaction with Indiana Department of Environmental Management (1995).
- Provided senior review for investigation and RI/FS workplans for the Inland Metals site, Chicago, for Illinois EPA and directed field activities (1994-95).
- Project manager for General Electric plant in Bloomington, IL. Prepared plans and directed oversight of a RCRA drum storage pad closure. Planned and directed investigation for TCE spill and evaluated soil vapor extraction options. Directed two Phase I ESAs and a Phase II ESA for divestitures (1991 to present).
- Project manager for multiphase RCRA Facility Investigation and corrective action at a chemical plant in Indiana. Assisted in Part B permitting and directed five phases of investigation, including borings, monitoring wells, aquifer tests, geophysical surveys, sampling, groundwater modeling, and bench testing of *in-situ* bioremediation. Corrective actions included recovery pumping well system, seepage collection system and slurry wall cutoff. Consulted on underground process storage tanks, prepared quarterly groundwater monitoring reports, and participated in discussions with IDEM and U.S. EPA (1984 to present).
- Directed groundwater investigations at a chemical plant in Indiana, including methylene chloride release from process USTs and consulted on management of water supply pumping system and development of flow and transport models (1986-93).
- Project manager for groundwater modeling of TCE and litigation support to Kirkland & Ellis, Tucson, AZ (1990-92).

ROBERT P. KEWER
Senior Associate, and Head-Geology/Hydrogeology Section

• Participated in RCRA corrective action planning at DuPont chemical plant, WV, including groundwater containment and collection (1991).

• Project manager for RI at Commonwealth Edison's Behn Drum SRAPL Site, IL. Directed soil, sediment and groundwater investigations and prepared RI report for IEPA (1991-92)

• Project manager for above-ground fuel storage facility, Vigo County, IN containing about 12,000 yd^3 of contaminated soil. Investigated soil and groundwater to identify contamination elsewhere. Prepared site data package for IDEM, examined on-site soil treatment technologies and prepared preliminary cost estimates (1990).

• Planned and directed Illinois EPA's Refinery Products Site RI, Schiller Park, IL, including sampling of soil and groundwater (1989).

• Lead hydrogeologist for Whitestown Landfill RI/FS, NY. Assisted in Work Plans and discussions with NYDEC and review of potential remedial technologies report and solid waste management plan. Investigations included ambient air and soil gas surveys, test pits, borings, monitoring wells and sampling. Prepared RI report (1988-89).

• Lead hydrogeologist for RI at five sites on the Elmendorf AFB, AK. Assisted in planning and directing drilling and well installation at a base landfill, underground fuel tank farm, fire training pit, asphalt drum storage area and underground waste oil tank. Sampling included soils, groundwater, drums, tanks, and wastes (1988).

• Hydrogeologist for evaluation of PBB contamination of glacial aquifers from the Gratiot County Landfill, MI. Study recommended remedial treatments implemented by MDNR (1978).

• As resident hydrogeologist, evaluated alluvial aquifer contamination at an Olin Chemical plant, KY, including remedial treatments, aquifer protection, and augmented water supply (1975).

Solid and Hazardous Waste Disposal

• Project manager for Commonwealth Edison's Joliet/Lincoln Quarry Landfill used for ash from coal-fired power stations. In 1976, prepared initial permit application. In 1993-94, directed investigations and prepared significant modification application under Subtitle D. In 1995, supported petition for site-specific standards to the Illinois Pollution Control Board (1976, 1994 to present).

• Project manager for review of siting criteria for Low Level Radioactive Waste Disposal facilities for Commonwealth Edison (1994).

• Senior groundwater reviewer for Ann Arbor, MI Phase I Landfill RI and Phase II Landfill closure, including site monitoring (1993-94).

• Project manager for technical assistance and expert witness testimony to the City of Chicago for the Paxton I/II Landfills. Directed groundwater sampling to identify contamination, and reviewed the owner's closure plans (1989-94).

• Provided technical review of application for expansion of the Countryside Landfill, IL for adjoining land owners (1994).

• Lead hydrogeologist for Peoria Disposal Company RCRA facility, IL. Included soil and groundwater investigations, Part B permitting, groundwater quality assessments, RFI Work Plan for off-site landfill, RCRA monitoring system, negotiations with U.S. EPA and Illinois EPA, and installation of leachate recovery wells. Site received one of the first Part B permits to be issued (1984-91).

• Prepared draft monitoring plans for underground tank farms, impoundments and solid waste disposal units at a chemical plant in Indiana. Subsequently designed RCRA monitoring system consisting of four, 3-well clusters at an incinerator ash landfill (1985-89).

• Lead hydrogeologist for investigation of the Arlington Heights Landfill, IL. Investigations defined soil and groundwater conditions, identified landfill gas, installed groundwater monitoring system, and assessed adjacent underground utilities (1988).

• Lead hydrogeologist for proposed Lake County, IL Landfill. Directed investigations, prepared groundwater sections of IEPA permit application, designed monitoring system and provided expert witness testimony at public siting hearings (1987).

Environmental Site Assessments/Underground Storage Tanks

• Project manager for more than 30 Phase I and II Environmental Site Assessments (ESAs), including undeveloped lands, residential properties and commercial/-industrial sites. Clients include City of Chicago, Eli Lilly, Amoco Oil Company, Northern Indiana Public Service, Commonwealth Edison, John Buck Company, Baker & McKenzie, Northern Trust Bank, and others (1977 to present).

• Managed Phase I/II ESAs at a GM-Electromotive plant, IL, proposed for the Metropolitan Water Reclamation District TARP system (1993).

• Managed Phase I/II ESAs at a GR Group, Inc. metal fabrication plant in Marsaille, IL. Phase II included soil and paint sampling (1992-93).

• Managed Phase II soil and groundwater investigation at a planned Commonwealth Edison substation (1991).

• Managed Phase II ESA at an equipment manufacturing plant in DeKalb, IL, including preliminary remedial cost estimates (1990).

• Project Manager for LUST investigations, removals and reporting. Clients included TNT-Holland Motor Express, Northbrook, IL, Park Ridge, IL, the City of Chicago, Glenview, IL and others (1977 to present).

• Directed removal of four fuel tanks, one waste oil tank and 1,200 yds^3 of contaminated soil for the City of Park

Ridge, IL. Included 66 confirmation samples, corrective action plans and reports to IEPA, and LUST reimbursement documents (1993-94).

Groundwater Resource/Flow Evaluation

• Directed groundwater flow analyses and evaluation of alternatives to provide water supply to a planned golf course in New Lennox, IL (1994).

• Co-authored study plans for developing water supplies for construction of the Yucca Mountain High Level Radioactive Waste Facility, NV. Reviewed study plans by others in areas of saturated and unsaturated zone flow (1990-91).

• Estimated groundwater inflows to a Vulcan Materials dolomite quarry expansion, McHenry County, IL. Determined bulk rock mass permeability and hydraulic heads from packer tests in coreholes. Developed cost estimates for pumping at various pit stages (1990)

• Estimated seepage losses from a stream proposed for water distribution by the City of Decatur, IL. Included review of test data and site characteristics, and installation of observation wells to analyze flow to the stream (1989).

• Designed and conducted 24-hour pumping test in St. John, IN and estimated sustained yield from existing and new wells (1989).

• Assisted in design of a new water supply well for the DuPage County Department of Public Works, IL. Performed field investigations to assess potential contaminant sources (1988).

• For the Ak Chin groundwater study, AZ, supervised and analyzed results of extensive exploration program, including deep boreholes, 12-inch observation wells, and 24-inch-high capacity (up to 4,400 gpm) production wells (1982).

• Resident hydrogeologist for water supply exploration drilling in northern Haiti. Directed completion and testing of 7-inch test wells (1980).

• Resident hydrogeologist for groundwater supply studies at the Copper Mountain Uranium Tailings project, WY. Installed deep test well in the Madison Limestone and directed related exploration to assess groundwater flow (1979).

Engineering Geology Projects

• With Harza Engineering Company, participated in planning, design, and construction of hydroelectric and water supply dams, pumped-storage hydroelectric projects, tunnels and shafts, and foundations. Selected projects include

Colorado Front Range Study, CO (1984);
Two Forks Dam and Alternatives, CO (1982-83);
Pehuenche Hydroelectric Project, Chile (1981-82);
Uribante Dam, Venezuela (1980);
Tunnel and Reservoir Plan, Chicago, IL (1980);
Itapeuara Dam, Brazil (1978);
Kootenai Falls Hydroelectric Project, MT (1977);
El Nispero/El Remolino dams, Honduras (1977);
Bath County Pumped-Storage Project, VA (1977-80);
Guri Hydroelectric Project, Venezuela (1976);
Argonne Laboratory CAES/UPHS Project (1976);
Montezuma Pumped-Storage Project, AZ (1975);
Northern Illinois UPHS Project, IL (1975);
Lock and Dam No. 1 Restoration, MN (1974); and
Stony Creek Pumped-Storage Project, PA (1971-72).

TECHNICAL ARTICLES

"Groundwater Monitoring for Remedial Investigations in the Oriskany-Whitestown Sand Plains, Oneida County, New York," Sixth National Outdoor Action Conference, NGWA, Las Vegas, NV, 1992, (R.P. Kewer and E. Birckhead).

"The Importance of Geologic Observation in Environmental Site Assessments: A Case Study," *The National Environmental Journal,* vol.1, no. 2, 1991 (R.P. Kewer and S. Anderson).

"Use of Water Pressure Testing to Estimate Potential Groundwater Inflows for Expansion of a Dolomite Quarry in North-Central Illinois," Geological Society of America, North-Central Section, 1991; abstracts with programs, Toledo, OH, 1991 (R.P. Kewer, A. Shapiro, A. Curley, D. Barden, and D. Walker).

William P. Rogers and Robert M. Kirkham, editors, "Regional Fault Study, Central Front Range, and Tectonics-A, 1986 Update," Col. Geol. Survey Special Publication 28, 1986 (P.A. Dickson, R.P. Kewer, and J.E. Wright).

HARZA

SURENDRA N. KUMAR
Environmental Chemist/Toxicologist

Harza Environmental Services, Inc.: Environmental Chemist/Toxicologist, 1990 to present. Northeast Analytical, Inc., Staff Chemist/Toxicologist, 1989-90. Industrial Toxicology Research Centre, India, Pesticide Toxicologist, 1983-89. University of Allhabad, India, Chemistry Department, Scientific Pool Officer, 1982-83. Dioxin Laboratory, Wadsworth Center for Labs and Research, Research Scientist, 1981-82. SUNY at Albany, Department of Chemistry, Post-Doctoral Fellow, 1979-81. Howard University, Department of Chemistry, Graduate Research Assistant; Fellow and Teaching Fellow, 1973-79.
Degrees: Doctor of Philosophy in Chemistry, Howard University, 1979. Master of Science in Analytical Chemistry, Howard University, 1975. Bachelor of Science in Chemistry, Bihar University, Muzzaffarpur, India, 1969.
Languages: Hindi, English, French.
Professional Societies: The American Chemical Society, National Geographic Society.

Dr. Surendra N. Kumar has worked extensively in the areas of analytical chemistry and chemical toxicology. He has actively participated in numerous experimental and monitoring programs, including the monitoring program for sanitary and stormwater characterization at the Great Lakes Naval Training Center, Great Lakes, Illinois. He was actively involved with the soil/sediment monitoring program, Hudson River, New York. He has performed validation and interpretation of chemical data for various projects.

Dr. Kumar has worked extensively on the safety evaluation of various pesticides/chemical mixtures, and has generated considerable amounts of toxicity data used for human health and ecological risk assessment. Many of his technical publications have been cited by the Agency for Toxic Substances and Disease Registry (ATSDR) for generating toxicological profiles.

Additionally, he has performed evaluations of various remedial technologies and has developed risk-based cleanup objectives for sites with contaminated soil and groundwater.

Dr. Kumar has vast experience with various EPA regulations, including the Toxic Substances Control Act, Resources Conservation and Recovery Acts, and their successors - the Hazardous Solid Waste Amendments, and Comprehensive Environmental Response Compensation and Liability Act. He has hands-on experience with National Pollutants Discharge and Elimination System (NPDES) permitting.

EXPERIENCE HIGHLIGHTS

Field Data Collection/and Monitoring

- Analyzed soil data collected from Elgin Salvage and Supply for Aroclor Source identification, using statistical analysis and fingerprinting technique (1994).
- Participated in sanitary and stormwater characterization at the Great Lakes Naval Training Center, IL (1991-92).
- Participated in Phase III sampling at Sand Creek Superfund site in Commerce City, CO (1992).
- Participated in field sampling, review of chemical analyses data, and report preparation on I-287 Thruway Hazardous Studies for the New York Department of Transportation (1990).
- Participated in remedial investigation of an underground storage tank site for a confidential client, predicting fate and transport of organic compounds in groundwater (1990).
- Developed extraction, cleanup, and chromatographic methodologies for PCBs and organochlorine insecticides in industrial waste streams in environmental samples (1989-90).
- Monitored PCBs and organochlorine insecticides in soils/sediments, water, and aquatic animal samples for confidential client (1989-90).
- Performed continuous monitoring of environmental oils before their safe disposal (1989-90).
- Developed extraction, cleanup, and column chromatographic methodologies for the determination of organochlorine pesticides in edible oils and oil seeds (1983-90).
- Monitored organochlorine insecticides and 1-Naphthol in sources of drinking water (1983-89).
- Monitored dioxins and dibenzofurans in environmental samples by high-pressure liquid chromatography and capillary GC (1981-82).
- Monitored 2,3,7,8-TCDD in spent carbons of Love Canal, NY, water treatment systems (1981-82).
- Monitored 2,3,7,8-TCDD and 2,3,7,8-TCDF in Binghamton State Office Building due to transformer fire containing PCBs (1981-82).

SURENDRA N. KUMAR
Environmental Chemist/Toxicologist

Analytical Data Validation

- Performed analytical data validation on aquatic samples collected from Texas condo site, U.S. Army Corps of Engineers, North Pacific Division Laboratory, Troutdale, OR (1994).
- Performed analytical data validation on aquatic and soil samples collected from Anchorage Harbor Site, U.S. Army Corps of Engineers, North Pacific Division Laboratory, Troutdale, OR (1994).
- Performed analytical data validation on soils obtained from landfill slurry-wall construction area, City of Ann Arbor, MI (1993).
- Performed analytical data validation on underground storage tank removal activity for the Village of Northbrook, Northbrook, IL (1993).
- Performed analytical data validation and developed preliminary Health Risk Assessment for GE Bloomington, IL (1992).
- Performed analytical data validation for Commonwealth Edison, Behn Drum SRAPL site in Marengo, IL (1992).
- Performed analytical data validation on PCBs and lead removal action for Elliot's Auto Parts (CERCLIS ID #ARD981058829) site in Little Rock, AR (1992).
- Performed analytical data validation for Remedial Investigation at an Illinois EPA immediate removal site in Chicago. Critically reviewed the laboratory quality control and analytical data to identify any data limitations (1991).
- Participated in preparation of report on Whitestown Remedial Investigation Phase I, NY. Interpreted data on soil, groundwater, and surface water samples and toxicologic properties of chemicals present in environmental media (1990).

Risk Assessment/Safety Evaluation

- Performed risk assessment for hazardous air pollutants emitting from a municipal waste combuster, confidential client (1995).
- Performed risk assessment for the Skokie Rail Vehicle Shop, Chicago Transit Authority, Skokie, IL (1994).
- Performed risk assessment for inactive Lincoln Park Gun Club, Chicago Park District, IL (1993).
- Evaluated magnitude of residual risk and overall protectiveness for each remedial alternative. Determined how specific alternatives achieve protection over time and how site risks are reduced (1991).
- Performed risk assessment for a sanitary landfill in Michigan to evaluate the likelihood of risks arising from the contaminants detected in on-site and off-site groundwater, surface water, soil, and sediment. Assisted in feasibility study to determine the most effective remedial action based on risk management approach (1991).
- Developed methodologies on the estimation of risks associated with the presence of carcinogens and noncarcinogens in environmental media for a confidential client (1990).
- Performed safety evaluation of pesticides and industrial chemicals in various species of animals (1983-89).
- Studied toxicity of organo-phosphorus insecticides with heavy metals, such as mercury, cadmium, and zinc, organochlorines, organo-phosphorus insecticides, hexachlorocyclohexane and endosulfan in animals (1983-89).

Evaluation of Remedial Technologies

- Performed technology evaluation for groundwater contaminated with boron, Joliet, IL (1994).
- Developed cleanup objective and remediation technology for any inactive Gun Club contaminated with lead and PAHs (1993).
- Performed technology evaluations for a Superfund site contaminated with organochlorine insecticides in Commerce City, Colorado (1993).
- Field supervision for PCB cleanup at an IEPA site in Chicago using Mobile Rotary Klin Incinerator (1992).
- Participated in pilot-scale soil washing demonstration at Sand Creek Superfund site in Commerce City, CO (1992).
- Participated in pilot-scale soil washing report, 50% design and evaluation of soil washing vendor. Report for Sand Creek Superfund site in Commerce City, CO (1992).

Research Studies

- Evaluation of on-line monitoring for cyanide discharge from plating industries (1994 to present).
- Generated baseline data on low-level radio active waste siting criteria for the State of Illinois (1993).
- Synthesized bio-inorganic model compounds and performed spectral characterization, X-ray, crystallography, and electrochemical studies of metal enzymes for biodegradation studies (1979-81).
- Studied biodegradation of toxicants using synthetic metal enzymes (1979-81).

TECHNICAL PAPERS, ARTICLES, AND PRESENTATIONS

"Risk Assessment Approach for Management of Soils Containing PNAs and Inoganic Lead," (International Congress on Hazardous Waste: Impact on Human and Ecological Health, Atlanta, Georgia).

"A Systematic Twenty-Two-Step Data Validation Procedure for Risk Assessment," (Second Symposium on Superfund Risk Assessment in Soil Contamination Studies: Volume 2, ASTM STP 1264, 1995).

"Risk Assessment for Fast Track Remediation of Contaminated Sites." (Presented at the Water Environment Federation, 1994, Chicago, IL).

"Innovative Technologies for Cleanup of Soils Contaminated with Pesticides." Presented at the Enviro-Pro Expo, Mexico City, Mexico (1993).

"Soil Washing Pilot Test for Removal of Pesticides from Soils," (S.R. Niaki, S.N. Kumar, P.A. Smith, co-authors). HASMAT West Conference (1993).

"Risks Due to Exposure to Lead and PAHs at the Lincoln Park Gun Club," Chicago, IL. Presented at the SETAC Conference 1993 (B.K. Shephard, D.B. Pott, S.N. Kumar, S.R. Niaki and E. Uhlar, co-authors).

"Residues of Poly Aromatic Hydrocarbons (PAHS) in Coal Fly Ash Samples Obtained from Thermal Power Plants," *Bulletin of Environmental Contamination and Toxicology*, 1991 (J.L. Kaw, S.N. Kumar, A.K. Khanna, M. Waseem, R.B. Raizada, and T.S.S. Dikshith, co-authors).

"Interaction of Malathion and Cadmium Chloride in Male Albino Rats," *National Academy of Science Letters*, 1990 (T.S.S. Dikshith, S.N. Kumar, R.B. Raizada, and M.K. Srivastava, co-authors).

"Residues of DDT and HCH in Major Sources of Drinking Water in Bhopal, India," *Bulletin of Environmental Contamination and Toxicology*, 45:389-393, 1990 (T.S.S. Dikshith, R.B. Raizada, S.N. Kumar, M.K. Srivastava, S.K. Kulshrestha, and U.N. Udholia, co-authors).

"Residues of 1-Naphthol in Soil and Water Samples in and Around Bhopal, India," *Bulletin of Environmental Contamination and Toxicology*, 44:87-91, 1990 (T.S.S. Dikshith, S.N. Kumar, R.B. Raizada, M.K. Srivastava, and P.K. Ray, co-authors).

"Presence of Organochlorine Insecticides in Edible Oil Seeds in India," *National Academy of Science Letters*, 1990 (T.S.S. Dikshith, S.N. Kumar, M.K. Srivastava, R.B. Raizada, and P.K. Ray, co-authors).

"Residues of Organochlorine Pesticides in Cattle Feed in India," *Bulletin of Environmental Contamination and Toxicology*, 43:691-696, 1989 (T.S.S. Dikshith, S.N. Kumar, R.B. Raizada, and M.K. Srivastava, co-authors).

"Impact of Hexachlorocyclohexane (HCH) Insecticide on Erythrocyte Membranes of Rats," *Biochemical Archives*, 5:193-200, 1989 (G.S. Tandon, R.K. Upreti, S.N. Kumar, R.B. Raizada, T.S.S. Dikshith, and A.M. Kidwai, co-authors).

"Dissipation of Organochlorine Pesticides from Drinking Water at Boiling Temperature," CSIR (Council of Scientific and Industrial Research) Report, New Delhi, India, 1989 (T.S.S. Dikshith, S.N. Kumar, M.K. Srivastava, R.B. Raizada, and P.K. Ray, co-authors).

"Determination of Organochlorine Insecticides in Milk and Milk Products," ICMR (Indian Council of Medical Research) Report, New Delhi, India, 1989 (T.S.S. Dikshith, S.N. Kumar, R.B. Raizada, M.K. Srivastava, and P.K. Ray, co-authors).

"Residues of Organochlorine Insecticides in Betel Leaves," *National Academy of Science Letters*, 12:129-132, 1989 (T.S.S. Dikshith, S.N. Kumar, R.B. Raizada, S.C. Saxena, and B.R. Subrahmanyan, co-authors).

"Pesticide Residues in Edible Oils and Oil Seeds," *Bulletin of Environmental Contamination and Toxicology*, 42:5056, 1989 (T.S.S. Dikshith, S.N. Kumar, G.S. Tandon, R.B. Raizada, and P.K. Ray, co-authors).

"Dermal Absorption of Hexachlorocyclohexane (HCH) in Male Rabbits," *Indian Journal of Experimental Biology*, 27:252-257, 1989 (T.S.S. Dikshith, R.B. Raizada, M.K. Srivastava, S.N. Kumar, R.P. Singh, R.A. Kaushal, K.P. Gupta, and H. Srilakshmi, co-authors).

"Acute Toxicity of Hexachlorocyclohexane (HCH) in Mice, Rats, Rabbits, Pigeons, and Freshwater Fish," *Veterinary and Human Toxicology*, 31:113-116, 1989 (T.S.S. Dikshith, R.B. Raizada, R.P. Singh, S.N. Kumar, K.P. Gupta, and R.A. Kaushal, co-authors).

"Effect of Repeated Dermal Application of Endosulfan to Rats," *Veterinary and Human Toxicology*, 30:219-230, 1988 (T.S.S. Dikshith, R.B. Raizada, S.N. Kumar, M.K. Srivastava, R.A. Kaushal, R.P. Singh, and K.P. Gupta, co-authors).

"Interaction of Hexachlorocyclohexane and Malathion in Male Guinea Pigs After Repeated Dermal Application," *Veterinary and Human Toxicology*, 29:138-143, 1987 (T.S.S. Dikshith, M.K. Srivastava, R.B. Raizada, and S.N. Kumar, co-authors).

"Interaction of Malathion and Mercury Chloride in Albino Rats," *National Academy of Science Letters*, 9:287-291, 1986 (T.S.S. Dikshith, S.N. Kumar, R.B. Paizada, and M.K. Srivastava, co-authors).

"Relative Toxicity of 2,3,7,8-TCDD and 2,3,7,8-TCDF Using Different Vehicles in Female Guinea Pigs," *Journal of Recent Advancement in Applied Science*, 1:17-21, 1986 (S.N. Kumar, A. Srivastava, and M.K. Srivastava, co-authors).

"Polarographic Investigation of Thioureido-Type Compounds with HG(II) Ion in Acidic Aqueous Solution," *Na-*

tional Academy of Science Letters, 9:73-74, 1986 (S.N. Kumar and J.B. Morris, co-authors).

"Effect of Processing on the Removal of Malathion from Treated Cabbage," *Journal of Recent Advancement in Applied Science*, 1:42-54, 1985 (M.K. Srivastava, G. Nath, and S.N. Kumar, co-authors).

"Stationary Electrode Polarography of Some Thioureido Compounds and Their Mercury Complexes at the Hanging Mercury Drop Electrode," *National Academy of Science Letters*, 9:31-33, 1985 (S.N. Kumar and J.B. Morris, co-authors).

"Chronoamperometry of Some Thioureido Compounds and Their Mercury Complexes at the Hanging Mercury Drop Electrode," *National Academy of Science Letters*, 8:379-380, 1985 (S.N. Kumar and J.B. Morris, co-authors).

"Potentiometric Investigation of 2-Immidazolidine-thion and 2-Thiazadinethon and Their Mercury Complexes," *National Academy of Science Letters*, 8:213-215, 1985 (S.N. Kumar and J.B. Morris, co-authors).

"Human and Environmental Risks of Chlorinated Dioxins and Related Compounds," *Environmental Science Research*, 26:73-94, 1983 (R.M. Smith, D.R. Hilker, P.W. O'Keefe, C.M. Meyer, S.N. Kumar, and B.M. Jelus-Tyror, co-authors).

Inorganic Chemistry, 21:908-916, 1982 (C. Pickett, S.N. Kumar, P.A. Vella, and J.A. Zubieta, co-authors).

Journal of Chemical Society "Chemical Communications", 9:411-412, 1981 (P.L. Dahlstrom, S.N. Kumar, and J.A. Zubieta, co-authors).

HONORS AND AWARDS

Bachelor of Science with Honors in Chemistry, teaching assistantship, teaching fellowship, and postdoctoral fellowship.

HARZA

KRISHNA V. MAYENKAR
Director and Vice President

Harza Environmental Services, Inc.: Director, 1994 to Present; Vice President and Head, Industrial/Government Services Department, 1993 to Present. Emcon Associates, Vice President and Director, Technical Services Division, 1986-93. Harza Engineering Company, 1975-85. Roy F. Weston, Inc., 1971-75.
Degrees: Master of Science in Chemical Engineering, University of Louisville, 1970. Bachelor of Technology in Chemical Engineering, Indian Institute of Technology, 1966.
Professional Registration: Professional Engineer, California, No. CH4608. Professional Engineer, Wisconsin, No. 15110. Diplomate, American Academy of Environmental Engineers. Registered Environmental Assessor, State of California, No. 00823.
Professional Societies: American Academy of Environmental Engineers, American Institute of Chemical Engineers, National Society of Professional Engineers, California Society of Professional Engineers.

Krishna V. Mayenkar has more than 20 years of experience in hazardous waste treatment and disposal, groundwater and soil cleanup, and industrial wastewater treatment.

Mr. Mayenkar was responsible for the development of two patented processes (one of which is in the name of the company that funded the studies): removal of toxic metals from water and wastewaters using iron filings, and generating potable water from oily ballast water.

Mr. Mayenkar has provided expert witness testimony in legal proceedings related to groundwater remediation.

EXPERIENCE HIGHLIGHTS

Harzardous Waste Management

- Managed and directed Superfund site cleanup efforts, including hydrological investigations, bench and pilot studies, process optimization, engineering design, facility construction, startup, preparation of operations and maintenance manual, quality assurance project plan, field sampling plan, health and safety plan, and providing ongoing operations and maintenance (1989 to present).
- Provided technical direction for designing and implementing numerous petroleum-contaminated soil remediation projects involving aeration, *in-situ* soil vapor extraction, *in-situ* air sparging and extraction, and aquifer dewatering and vapor extraction (1989-94).
- Participated and provided technical direction in several contaminant transport/risk assessment studies to determine extent of remediation required (1987 to present).
- Provided direction for several design and construction projects involving remediation of water contaminated with petroleum hydrocarbons, chlorinated solvents, pesticides, metals, and pentachlorophenols (1986-93).
- Provided technical direction for numerous feasibility level studies for remediation of soil and groundwater contaminated with solvents, petroleum hydrocarbons, metals, PCBs, and pesticides (1986 to present).
- Responsible for designing and implementing bioremediation projects for soil containing oil and grease, diesel, gasoline, ketones, and cyclohexanones (1987-93).
- Provided technical direction to extensive bench and pilot scale research, funded primarily by DuPont, it was determined that the degradation of chlorinated volatile organics contained in water, by ultraviolet light and strong oxidants like ozone and hydrogen peroxide, strongly depends upon the Reynold's Number and also pH, when the water has relatively high alkalinity (1989 to present).
- Provided technical direction for numerous Phase I and Phase II property assessments (1989 to present).
- Provided technical direction and review for a Risk Management Prevention Program for a hydrazine handling operation in southern California (1988-89).

Solid Waste Management

- Provided overall project direction to the 1600-TPD Waste-To-Energy Modernization Project for the City of Chicago. Also was responsible for providing technical guidance for regulatory compliance issues, including water, air, solid and other wastes and other work (1994 to Present).
- At three Class III landfills, technical direction for implementing groundwater remediation systems (1991-92).
- Managed, designed, and implemented leachate treatment program for a Class III landfill. Also assisted the client in operating the facility (1991-92).
- Provided technical direction preparing an air quality assessment report containing transport modeling and risk assessment, to determine the environmental impact of the proposed landfill expansion (1990-91).
- Directed and developed a solidification and stabilization process for hazardous sludge from Class I Landfill containing petroleum hydrocarbons, PCBS, metals, pesticides, phenols, and floating oils. The process was devel-

KRISHNA V. MAYENKAR
Vice President

oped based on strength, leachability, and free liquid content criteria. Participated in developing treatment process for leachate generating from sludge pond (1988-89).

• Managed $1.2-million program of air SWAT testing and reporting for 45 landfills (1988-89).

• Participated in preparing water SWAT reports for Tier I, II, and III landfills (1987-89).

• Developed a treatment scheme for leachate generated at a hazardous waste disposal facility; devised a solidification process for hazardous liquid and solid wastes; conducted a liner compatibility testing program; selected liner material for containment of the landfill, and designed a container storage facility. Also developed run-on, runoff, and spill control plan in support of the Part B Permit application (1980-84).

Industrial Waste Management

• Developed patented process to convert oily ballast water into potable water (1983-85).

• Hands-on experience in biological processes: filtration (single, dual, and multimedia; micro, and ultra), reverse osmosis, carbon adsorption, ion exchange, air and steam stripping, froth floatation, cementation, ozonation, hydroxide/sulfide precipitation and ultraviolet-light-catalyzed oxidation. Also experienced in dewatering processes including coil filter, belt filter, ditomaceous-earth-coated filter, sludge beds, and centrifuge (1972-85).

• Developed patented process for removal of toxic metals from water and wastewaters (1984).

• Prepared operations and maintenance manuals 1979-80).

• Through extensive field sampling, testing, and operation monitoring, combined with bench and pilot scale studies, developed overall industrial waste management systems incorporating water reuse and recycle (1973-80).

• Improved sludge dewatering processes through sludge blending, polymer use, and improved technologies using bench and pilot-scale studies, which resulted in volume and disposal cost reduction.

• Improved efficiency of operating waste treatment systems by analyzing processes and operating practices (1972).

PUBLICATIONS AND PRESENTATIONS

"Fundamentals of Wastewater Treatment and Source Control," presented at Wastewater Pretreatment Seminar, Peninsula Industrial and Business Association, California, November 1993.

"Optimizing Treatment Design by Performing Treatability Studies. Comparing UV Systems," presented at HAZMCON '91, Santa Clara, CA, April 1991.

"Set-Up and Performance of Treatability Studies for VOC-contaminated Ground-Water," presented at the NWWA Petroleum Hydrocarbons Conference, Houston, TX, November 1990.
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"Effective Ground-Water Remediation Using Transient and Steady State Flow Modelling" presented at HAZMAT West '90 Conference, Los Angeles, CA, November 1990.

"Leaking Underground Fuel Tanks: Costly Projects," presented at the Industrial and Hazardous Waste Information Exposition, Oakland, CA, June 1988.

"Restoration of Aquifer Contaminated with Diesel Fuel," presented at the Second National Outdoor Action Conference on Aquifer Remediation, Las Vegas, NV, May 1,-988.

"Innovative Process for Removing Heavy Metals from Wastewater," presented at 59th Annual Meeting of Central States Water Pollution Control Association, May 1986.

"Selection of a Synthetic Liner for a Hazardous Waste Landfill Facility," presented at the Hazardous and Toxic Waste Management: Working Together to Manage Wastes Conference, Chicago, IL, May 1984.

"Removal of Chelated Nickel from Wastewaters," presented at the 38th Annual Purdue Industrial Waste Conference, Purdue University, IN, May 1984.

"Quick Way To Determine Scaling or Corrosive Tendencies of Water", *Chemical Engineering*, Vol 90, May 1982.

"Commonwealth Edison's Wastewater Management Program for the Fossil-Fuel Generating Station at Will County, Illinois," presented at the 52nd Water Pollution Control Federation Conference, Houston, TX, October 1979.

"Pollution Abatement Regulations for Nuclear Power Stations and Their Economic Impact," presented at the American Power Conference, Chicago, IL, April 1977.

"Cost-Effective Treatment Methods for Power Plants To Meet NPDES Requirements," presented at the American Power Conference, Chicago, IL, April 1976.

HONORS AND AWARDS

Who's Who in the West, 23rd Edition, Marquis Publications.

Who's Who in Engineering, American Association of Engineering Societies.

KRISHNA V. MAYENKAR
Vice President

PATENT

Received Patent No. 4,565,633 for development of process for removing toxic metals from water and waste-water.

HARZA

FARRUKH M. MAZHAR
Vice President

Harza Environmental Services, Inc.: Vice President, 1995 to Present; Senior Associate, 1991-95; Associate, 1990; Solid Waste/Geotechnical Engineering Section, Head, 1986 to Present. Harza Engineering Company: Senior Geotechnical Engineer, 1980-86; Geotechnical Engineer, 1974-80. Government of North East State, Nigeria: Resident Engineer, 1970-73. Development Construction Corporation, Karachi, Pakistan: Senior Engineer, 1969-70. Asian Institute of Technology, Thailand: Laboratory Assistant, 1967-69. Asbestos Cement Industries, Karachi, Pakistan: Civil Engineer, 1966-67. Water and Power Development Authority, Pakistan: Junior Engineer, 1965-66.
Degrees: Master of Engineering in Soil Engineering, Asian Institute of Technology, Thailand, 1969. Bachelor of Engineering in Civil Engineering, Karachi University, Pakistan, 1965.
Languages: English, Urdu.
Professional Engineer: Illinois, Indiana, Wisconsin.
Professional Societies: American Society of Civil Engineers; International Society of Soil Mechanics and Foundation Engineering; U.S. Committee on Large Dams; Southeast Asian Society of Soil Engineering; Institute of .0Engineers, Pakistan.
Continuing Education: Landfill Design, 1988 (University of Wisconsin). Geotechnical Aspects and Reclamation of Tailings Impoundments, 1984 (University of Arizona). Cold Regions Geotechnical Engineering, 1982 (University of Illinois). Seismic Design and Analysis of Earth- and Rockfill Dams, 1982 (University of Missouri). Embankment Dams, 1975 (University of Missouri).

As Head of the Solid Waste/Geotechnical Engineering Section, Farrukh M. Mazhar is involved in all geotechnical and solid and hazardous waste management projects undertaken by HES. He provides direction and supervises a staff of engineers, technicians, and drafters in the preparation of siting studies, conceptual and preliminary design of disposal facilities, remedial action plans and construction oversight. He also supervises the preparation of detailed design studies and analysis, design and/or construction drawings, specifications, design reports, and contract documents for projects. This includes interfacing with client's technical staff, permitting/regulatory agencies, and contractors.

Mr. Mazhar has participated in all phases of solid waste/geotechnical work required for planning, design, and construction of various types of projects. He has worked on site investigations, field and laboratory testing, design and analysis of embankment dam and solid and hazardous waste disposal sites, foundations analysis, geosynthetic materials, stability of slopes, slurry walls, leachate collection and removal systems, and landfill covers. He has served as project manager on a variety of projects, made presentations to boards of consultants, and provided expert witness testimony.

EXPERIENCE HIGHLIGHTS

Project Management
- Project manager on numerous flood control and landfill design assignments, including the indefinite-delivery contract for geotechnical design and field investigations with USACE, Omaha District and the multisite indefinite-delivery contract with the Illinois Environmental Protection Agency. Responsibilities include client liaison, contractual and technical performance of the project team, coordination of activities within different engineering disciplines, and monitoring of budget and schedule (1986 to present).

Design and Analysis Assignments
- Oversees, reviews, and performs design studies and analyses for a variety of projects. Has prepared design and construction drawings, specifications, and design and construction control memoranda.

Multi-Purpose Hydro Projects
- Conducted underseepage study; reviewed and analyzed design studies for cutoff wall, wave height, riprap, and free board; reviewed construction drawings; and incorporated revisions, Yacyreta Project, Argentina/Paraguay (1982-86).
- Evaluated and interpreted field exploration and testing results, post-earthquake stability and liquefaction analyses, threshold earthquake for Santee North Dam. Evaluated various methods to improve seismic stability of Pinopolis West Dam, Santee Cooper Project, SC (1982--83).
- Performed additional instrumentation and selection of piezometers and stability analysis of spillway headworks, Bath County Pumped-Storage Project, VA (1981-82).
- Studied surface runoff and spring treatment on left abutment for river closure and cofferdam; responsible for slurry wall design and instrumentation evaluation and report during reservoir filling, 15 de Septiembre (formerly San Lorenzo) Project, El Salvador (1981).
- Evaluated construction materials for 16-m (53-foot) raising of existing 94-m-high (308-foot) dam, analyzed

instrumentation data, and evaluated the behavior of the existing dam, King Talal Dam, Jordan (1981).

• Performed stability, settlement, transient seepage, and construction pore pressure analyses; prepared brief design report, Guri Hydroelectric Project, Venezuela (1977).

• Performed analysis of soil test data; design criteria for three earth and earth/rock dams; design of water conveyance canal; and prepared contract documents and construction drawings, Lake Yojoa-Rio Lindo Project, Honduras (1974-75).

Water Supply/Flood Control Projects

• In charge of design of about 6,500-foot-long earthen levee and concrete wall along east side of Salt Creek, and design of dry-bottom, 136-acre-foot, off-channel reservoir to store flood water. Included stability analysis of levee and reservoir, design of slurry wall around detention basin, permitting assistance, preparation of construction drawings and specifications, and assistance during bidding and construction. Elmhurst Flood Mitigation Project, IL (1988 to present).

• Responsible for two contracts for design of flood protection berms and walls, permitting assistance, preparation of contract documents, design modifications during construction, and preparation of record drawings for City of Park Ridge, IL (1988-90).

• Responsible for layout and design of wet-bottom reservoir to store stormwater, evaluation of groundwater system, and seepage analysis to determine need for liner and underdrainage to maintain minimum pool. Provided characterization of excavation material for use in developing surrounding area into recreational facility and as capping material for existing landfill; prepared construction drawings and specifications; provided assistance during construction. McDonald Creek Project, IL (1986-90).

• Prepared field investigation program; supervised laboratory testing; evaluated strength parameters, static stability, and liquefaction potential analyses of the 12.5-mile-long main cooling reservoir embankment and its foundation; and provided instrumentation monitoring, underseepage evaluation, and recommendations for remedial works, South Texas Nuclear Power Plant Project, TX (1984-86).

Soil and Rock Tunnels

• Supervised planning of geotechnical investigation and testing, evaluated subsurface conditions, estimated surface settlements, analyzed tunnel support system, established loading criteria for connecting structures, drop structures, and 150-foot-deep shaft in overburden and rock, reviewed geotechnical design report and contract documents, continued geotechnical support during construction, Weller Creek Combined-Sewer Relief Project, IL (1991-95).

• Supervised preparation of investigation program and evaluation of subsurface conditions for soft-ground tunneling for 9-foot-diameter deep sewer for Basins S06 and S13; foundations analysis and geotechnical design parameters for connecting structures and drop shafts; and review of construction contract specifications and drawings; review of geotechnical design report; support during construction. Flood Relief Project, Evanston, IL (1990-91).

• Responsible for planning and geotechnical design of approximately 4,000 feet of 60- and 120-inch-diameter pipe jacked/tunneled combined-sewer in soft to very soft clays, connecting and outfall structure, and 215-foot-deep dropshaft in overburden and rock, with a live connection to an existing TARP System tunnel; reviewed geotechnical investigation program and evaluation of site conditions; established geotechnical design criteria; reviewed design analysis, permanent support system in soil and rock, and contract drawings and specifications; continued geotechnical support during construction, Evanston Flood Relief Project - Phase II, IL (1991-94).

• Supervised geotechnical investigation, planning and design studies for soft ground tunnel, connecting structures, and drop shaft with a live connection to TARP Tunnel System (1991).

• Supervised geotechnical investigation and testing program, geotechnical evaluations, analyses and design for approximately 6,300 feet of 108-inch-diameter tunnel and about 2,700 feet of 72-inch-diameter jacked pipe sewer, including shallow drop structures, and air vent shafts; technical specifications; continued support during construction, Evanston Flood Relief Project - Phase III, IL (1992-95).

• Responsible for geotechnical investigation program and design of 6,500 feet of 78- and 108-inch-diameter tunneled sewer including drop structures and a connection to the TARP System. Similar services also provided for another phase, which included 3,300 feet of tunneled sewer of 78-inch-diameter, Evanston Flood Relief Project - Phase IV and V, IL (1993 to present).

• Selected cross section for 150-m-high (492-foot) dam; evaluated geotechnical properties of construction materials; performed foundation evaluation and treatment, settlement analysis, stability and tunnel deformation analyses, filter and slope protection design, and spillway foundation analysis and design; diversion tunnel analysis and design of temporary and permanent support system; and prepared contract documents and specifications, Al Wehdah (formerly Maqarin) Dam, Jordan (1979-80).

• Evaluated rock excavation slopes; performed foundation evaluation and treatment of a shear zone, wedge-type stability analysis; diversion tunnel temporary and permanent support system and prepared contract documents and specifications, Strontia Springs Project, CO (1976).

Solid/Hazardous Waste Management Projects

• Provided expert witness testimony on Remedial Action Plan and implementation costs for remediation of on-site and off-site groundwater contamination associated with the City of Ann Arbor landfills, Ann Arbor, MI (1995).

• Reviewed siting permit application and provided an expert witness testimony on the design and operation of a proposed vertical and horizontal expansion of an existing landfill in Lake County, IL (1994).

• Project manager for evaluating the seismic stability of the landfill cap and its foundation at Hamilton Air Force Base, Novato, CA (1992-93).

• Project manager for closure of the City of Ann Arbor Phase II Landfill. Developed alternatives for multimedia cover including a geomembrane and a geocomposite liner and identified a technically acceptable and cost-effective option. Tasks include preparation of engineering design report, construction specifications and drawings, gas management plan, odor control plan, and construction quality assurance plan. Also provided construction oversight, construction certification, and complete construction documentation of site closure (1990-93).

• Project manager for remedial action plan for City of Ann Arbor Phase I Landfill. Tasks include performing site-specific risk assessment addressing groundwater, soil, sediment, surface water, air, and landfilled wastes; conducting feasibility study to develop and select remedial alternatives for media of concern identified in risk assessment, and preparing remedial action plan design report that included detailed conceptual design sketches for selected alternatives and performance specifications for selected process options. Review of field investigation for slurry wall, mix design studies in compatibility testing, slurry wall design, and construction contract document. Provide general oversight audits during construction (1990 to present).

• Project manager for Removal Action at metal reclamation facility near Little Rock, AR. Remedial plans including decontamination of site debris, removal and off-site disposal of PCB-contaminated soil, and stabilization of lead-contaminated soil and its disposal off site. Required preparation of detailed work plans, remedial design, plans and specifications, field oversight, and interaction with USEPA and auto parts site (1991-93).

• Project manager for review of construction schedule, cost estimates, construction and permitting programs, and contractor's progress payments for development of solid waste landfill in Illinois permitted under 1990 Subtitle G Regulations for Northern Trust Company (1992-93).

• Developed and evaluated alternatives, including cost estimates, for the Lincoln Quarry Disposal Facility to comply with Illinois Subtitle G Regulation for Commonwealth Edison, Joliet, IL (1993).

• Responsible for composite liner system design, gas management system design and operation, slurry wall design, operation plan, and a composite final cover system design, Ann Arbor Landfill, Phase III, MI. Reviewed existing design and provided recommendations for modifications (1989-90).

• Evaluated strength parameters, stability, and liquefaction potential analyses for existing tailings impoundment and future raising; performed planning studies for new disposal facility, Chino Mines Company, NM (1983-84).

• Responsible for detailed closure plan, design computations and drawings, specification and contract documents, QAPP, and construction audit and certification of a composite liner cap over an existing incinerator ash (hazardous) landfill, IN (1989-90).

• Reviewed and provided comments to Illinois Environmental Protection Agency on the work plan, conceptual, preliminary, and final design of leachate collection system, and specifications for remedial action prepared by the engineering consultant for the city, Danville/H&L No. 1 Landfill, IL (1988-90).

• Provided expert witness testimony for the City of Chicago on the geotechnical design of a proposed vertical expansion on top of an existing landfill, Paxton Landfill Expansion, Zoning Hearing, IL (1989 to present).

• Prepared closure plan for landfill, which accommodated about 1 million yd^3 of material excavated from flood control detention basin project. Assisted in preparation of environmental assessment report for landfill for intended end use as golf course. Certified landfill closure and successfully assisted the Village in obtaining post-closure application approved by IEPA, Arlington Heights Landfill, IL (1987-89).

• Evaluated subsurface conditions in part of hazardous waste disposal landfill; designed leachate containment and collection systems and surface water detention facility; and reviewed RCRA Part B permit application, Peoria Disposal Company, IL (1983-88).

• Prepared subsurface exploration and testing program and evaluation of test data; developed design concepts and criteria; designed computations for stability of excavation slopes, settlement, and leachate quantity; and prepared design of liner and leachate collection system, site development drawings, and operation plan leading to submittal of permit application for development of solid waste landfill, Lake County Landfill, IL (1986).

Site Investigations, Field and Laboratory Testing Assignments

Developed and reviewed site investigation programs, including field and laboratory testing for the following:

• Field investigation and soil testing programs for numerous solid/hazardous waste disposal sites (1986 to present).

• Static and dynamic stability analyses of Chino Mines Tailings Impoundment, NM (1983).

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Vice President

• Seismic evaluation and remedial measures of Santee Cooper Project, SC (1982).
• Field assignment to evaluate construction methods and recommend appropriate earthwork quality control tests for crushed sandstone for the Uribante-Doradas Project, Venezuela (1980).
• Field assignment to explore naturally occurring filter material for the Guri Hydroelectric Project, Venezuela (1980).
• Resident geotechnical engineering services for the investigation and field laboratory testing of construction material sources for Al Wehdah (formerly Maqarin) Dam, Jordan (1978-79).

Additional Experience
• Performed investigation and quality control testing and supervised field laboratory and construction activities for road construction project, Nigeria (1970-73).
• Performed investigations, analyses, and design for foundations of structures. Supervised construction of cast-in-place piles and *in situ* plate-bearing and pile-load tests; prepared reports on foundation designs. Resident engineer on a pile foundation contract for bridges in southwest Iran (1969-70).
• Student assistant in soil mechanics laboratory performing engineering properties tests, including triaxial tests for a research project (1967-69).
• Supervised pressure pipeline installation for water supply and designed steel and timber trusses for asbestos cement sheet roofing (1966-67).
• Surveyed excavation sections and supervised construction of tubewell house foundation and superstructures (1965-66).

TECHNICAL PAPERS AND ARTICLES

"The McDonald Creek Flood Control Project, Arlington Heights, Illinois: A Model Community Flood Mitigation Project," Association of Floodplains and Stormwater Management, 18th Annual Conference, 1994 (C.D. Smith, F.M. Mazhar, and D. Bowe).

"Geotechnical Aspects of Strontia Springs Arch Dam," proceedings of Session on Hydropower Recent Development, ASCE Spring Convention, Denver, CO, May 1985 (N.R. Hopton and F.M. Mazhar, co-authors).

"Effect of Methods of Preparation on Index Properties of Lateritic Soils," proceedings of Session on Lateritic Soils, Seventh International Conference on Soil Mechanics and Foundation Engineering, Mexico City, Mexico, 1969 (Z.C. Moh and F.M. Mazhar, co-authors).

HARZA

JOHN W. MELDRIM

Chief Environmental Scientist, Senior Associate and Head, Environmental Sciences Department

Harza Engineering Company: Chief Environmental Scientist, 1993 to Present; Senior Associate, 1992 to Present; Environmental Sciences Department, Head, 1991 to Present; Associate, 1990-92; Aquatic Resources and Fisheries Section, Head, 1986-91; Environmental Sciences Section, Acting Head, 1985-86; Senior Aquatic Biologist, 1984 to Present. Ichthyological Associates, Inc.: Vice President, 1978-84; Technical Director of Experimental Studies, 1976-84; Senior Research Biologist, 1968-76. University of Washington: Research Assistant, 1964-68.
Degrees: Doctor of Philosophy in Fisheries Biology, University of Washington, 1968. Bachelor of Science in Biology, Occidental College, 1963.
Languages: English, German.
Registration: Certified Fisheries Biologist (American Fisheries Society).
Professional Societies: American Fisheries Society: National Water Quality Committee, 1975-77; Associate Editor *Transactions of the American Fisheries Society's*, 1981-83; Board of Professional Certification, 1986-88. American Fisheries Society Water Quality Section: Secretary-Treasurer, 1977 to Present. North Central Division, American Fisheries Society. Illinois Chapter, American Fisheries Society. Estuarine Research Federation. Society of Sigma Xi. Water Environment Federation.
Continuing Education: USFWS Fish Passage Course, 1989. USFWS Certified Habitat Evaluation Procedures (HEP) Course, 1988.

As Head of the Environmental Sciences Department, Dr. John W. Meldrim supervises a staff of environmental professionals, including aquatic and terrestrial ecologists, ecotoxicologists, reclamation specialists, landscape architects, and regulatory permitting specialists. He is responsible for departmental staffing, budgeting, and final technical review of work. As Chief Environmental Scientist, he monitors and reviews environmental aspects of Harza projects.

Dr. Meldrim serves as lead scientist on numerous projects and is responsible for the management of environmental scientists at Harza on a wide variety of projects. Additionally, he provides expertise on all forms of water quality and fisheries problems associated with water resource development projects, including hydropower, water supply and flood control facilities.

Prior to joining Harza, as a consulting biologist for 15 years, Dr. Meldrim conducted and supervised research to evaluate the biological effects of industrial (thermal and chemical) discharges, and to evaluate fish impingement and entrainment at power plants and other water intake structures in the mid-Atlantic states. His experience includes evaluation of those effects in freshwater, estuarine, and marine environments.

EXPERIENCE HIGHLIGHTS

Hydropower and Water Supply

- Team leader and lead aquatic scientist for Upper Indravati Hydroelectric and Irrigation Project Environmental Assessment, India. Responsible for multinational team of 20 scientists preparing environmental assessment in accordance with World Bank Guidelines (1994 to present).
- Lead scientist for Upper Indravati Hydroelectric and Irrigation Project, India. Based on on-site evaluation and document review, prepared aquatic portion of Terms of Reference for Project Environmental Assessment, in accordance with World Bank Guidelines (1993-94).
- Lead scientist for the Parsa Pumped-Storage Project, Israel. Responsible for assisting client in scoping and evaluating environmental studies, and in permitting (1992-93).
- Project manager for fish entrainment study at Scott Worldwide Park Mill Hydroelectric Station, Marinette, WI. Designed and managed year-long fish sampling effort, and assisted client in mitigation negotiations (1989 to present).
- Lead scientist for environmental assessment study at Northfield Mountain Pumped-Storage Project, MA. Designed and supervised initial studies (1990).
- Lead aquatic scientist in studies to obtain environmental permits for proposed Orange County Water Supply Project on the Dwaar Kill in southeastern New York State. Designed and conducted fisheries and water quality surveys of the Dwaar Kill and prepared aquatic portions of the Draft Environmental Impact Statement submitted in accordance with New York State's Environmental Quality Review Act (1989-1990).
- Lead scientist for the Pickens County Pumped-Storage Hydroelectric Project, GA. Conducted environmental assessments of three potential project locations as part of site selection process. Evaluated aquatic baseline stud-

ies and potential project impacts, planned mitigation (including minimum flow studies for water diversions), coordinated public hearings and agency consultation, and helped select site using multi-criteria analysis (1985-89).

• Lead scientist for the Moose River Hydroelectric Project, NY. Designed, supervised, and participated in three fisheries and water quality surveys of the river. Conducted biological portion of IFIM study to determine minimum flows. Prepared the fisheries, wildlife, and botanical sections of Exhibit E for the FERC License Application (1984-88).

• Lead scientist for Bakers Falls Hydroelectric Project, Hudson River, NY. Designed, supervised, and participated in fisheries surveys at the site. Prepared the aquatic section of Exhibit E for the FERC License Application (1985-87).

• Lead scientist for South Glens Falls Hydroelectric Project, Hudson River, NY. Prepared aquatic section of Exhibit E for the FERC License Application (1985-87).

• Lead scientist for Mechanicville/Lock 2 and North-Lumberland/Lock 5 Hydroelectric Projects, Hudson River, NY. Responsible for aquatic sections of Exhibit E of the FERC License Applications (1985-87).

• Lead scientist for the Felts Mills Hydroelectric Project, Black River, NY. Designed, supervised, and participated in a fisheries and water quality survey of the river. Conducted biological evaluation to determine minimum flows. Prepared the fisheries, wildlife, and botanical sections of the Exhibit E report and provided an environmental assessment of alternative sites and facilities designs for the FERC License Application (1984-87).

• Lead scientist for Hawkinsville Multipurpose Project, Black River, NY. Designed, supervised, and participated in fisheries surveys at the project site. Prepared environmental assessment for State Environmental Quality Review (SEQR) evaluation (1985-86).

• Lead scientist for Christine Falls Hydroelectric Project, Sacandaga River, NY, and Philadelphia Hydroelectric Project, Indian River, NY. Designed, supervised, and conducted fisheries and water quality surveys at all locations and prepared environmental reports for all projects as a condition of the FERC License Application (1984).

• Designed, supervised, and conducted a fisheries reconnaissance survey of the Wisconsin River for the Grandfather Falls Hydroelectric Project, WI. Prepared the environmental report that was the basis of the fisheries, wildlife, and botanical section of Exhibit E for the FERC License Application (1984).

• Assisted in preparation of the fisheries, wildlife, and botanical sections of Exhibit E for the FERC License Applications for the Cannonsville, Rondout, and Croton hydroelectric projects, NY (1984).

• Assisted in the FERC License Application process for the Susitna Hydroelectric Project, AK. Documented aquatic issues of concern to regulatory agencies and in response to environmental concerns of the public (1984).

Fish Passage

• Provided biological recommendations for upstream and downstream fish passage facility designs for lake sturgeon and Pacific salmon at Menominee and Park Mill Dams, Menominee River, WI (1992).

• Lead scientist for downstream fish passage studies on American shad and blueback herring at Hadley Falls Station and the Holyoke Canal, Connecticut River, MA (1990).

• Participated in preparing a review of fish protection alternatives for the Northfield Mountain Pumped Storage Project, MA (1990).

• Evaluated feasibility and environmental benefits of fish passage for American shad and river herring at Fairfax County Water Authority Occoquan River Projects, VA (1989).

• Provided biological evaluations for fish ladder design and construction for the State of Maryland (1989).

• Designed and managed the study of American shad upstream and downstream routes of passage around Lowell and Essex Hydroelectric Projects, Merrimack River, MA, using radiotelemetry and hydroacoustic methods (1988-89).

• Lead scientist for Walker's Dam Rehabilitation Project, Chickahominy River, VA. Assessed environment, recommended upstream and downstream fish passage facilities for American shad, blueback herring, alewife and striped bass, and negotiated with regulatory agencies (1985-88).

• Lead scientist for Lower Saranac Hydroelectric Project, Saranac River, NY. Responsibilities included environmental assessments of and recommendations for upstream and downstream fish passage facilities for Atlantic salmon and steelhead, and negotiations with regulatory agencies (1985-86).

• Provided environmental assessments of, and recommendations for, upstream and downstream fish passage facilities for Atlantic salmon at the Laxa Hydroelectric Project (Laxa River) and around two waterfalls (Thjorsa River) in Iceland (1984).

Water Quality and Estuarine Ecology

• Lead estuarine ecologist for studies to assist the Mississippi Department of Environmental Quality in selecting an approach for establishing minimum flows in the tidal freshwater portion of the Pascagoula River. Assisting in establishing biological criteria for evaluating estuarine impacts due to changes in salinity intrusion resulting from freshwater withdrawals (1993 to present).

• Lead scientist for Calgon Carbon Corporation thermal discharge monitoring program. Designed and established the program to monitor the thermal discharge of Calgon

Carbon's Pearl River Plant into Mulatto Bayou, a tidal section of the Pearl River, MS (1991-93).

• Lead scientist for evaluation of environmental program to assess riverine and estuarine impacts of sedimentation and water quality changes due to mining, Papau New Guinea. Task included on-site assessment of facilities, procedures, and data evaluation (1989-90).

• As Senior Research Biologist for Ichthyological Associates, Inc., performed duties which included: Experimental study of effects of light and salinity on the temperature preferences and avoidances of the fishes of the Delaware River estuary; experimental study of acute toxicity and behavioral reactions of estuarine fishes to pure organic compounds, to chlorine, and to gas supersaturated; analysis of data obtained in ecological study of Delaware River estuary; and preparation of client reports (1969-76).

• As Senior Research Biologist for Ichthyological Associates, Inc., performed duties which included curatorial duties of fishes collected in the Delaware River Ecological Study, analyses of data obtained in ecological study; life history studies of *Fundulus*; Assisted in design and conduct of sampling program for ecological study of Delaware River estuary; and preparation of client reports (1968-69).

Ecological Risk Assessment and Monitoring

• Lead scientist for Ecological Risk Assessment of Krejci Dumpsite, Cuyahoga Valley National Recreation Area, Ohio. Responsible for preparation of Ecological Risk Assessment and assisting Bureau of Reclamation in preparation of Ecological Assessment documents presented to Ohio EPA (1995 to present).

• Project manager for Fort Edward PCB remnant site containment environmental monitoring program, Hudson River, NY (1989-92).

• Designed and conducted a study of environmental fate and flow of PCBs in the tidal Hudson River (New York City to Troy), New York Harbor, and Long Island Sound, NY (1988-91).

• Designed, negotiated with agencies, and established water quality and biological (periphyton, macroinvertebrate, and fish) monitoring of containment of Hudson River PCB remnant sites, Fort Edward, NY (1989).

Oil Refinery

• Evaluated the biological effects of oil spills at Exxon Bayway Refinery, NJ (1982, 1980).

• Designed and supervised on-site studies to determine optimum biocidal (chlorine) effectiveness program at Exxon Bayway Refinery, NJ (1977-78).

• Researched and evaluated the biological effects of thermal discharges from Exxon Bayway Refinery, NJ (1975-77).

Steam Electric Generation

• Designed and conducted experimental studies to evaluate various types of water intake screening for effectiveness in reducing fish impingement, DE (1982-83).

• Designed and conducted on-site studies evaluating the effects of impingement and entrainment at Salem Nuclear Generating Station, NJ (1977-83).

• Supervised research to evaluate the biological effects resulting from the use of ozone versus chlorine as a biocide for steam electric generating stations, NJ (1978-80).

• Designed and conducted experimental studies on responses of aquatic fauna and evaluated biological effects from thermal discharges at numerous steam electric generating stations throughout the mid-Atlantic states, DE (1969-79).

• Designed and implemented the research programs to evaluate the effects of impingement, entrainment and thermal and chemical discharges at numerous mid-Atlantic steam electric generating stations, and to supervise such programs at five Ichthyological Associates, Inc., Experimental laboratories located in Delaware, Pennsylvania and New Jersey (1978).

• Designed and conducted experimental studies evaluating the biological effects of chlorinated discharges from steam electric generating stations in the mid-Atlantic states, DE (1970-77).

• Designed and conducted experimental studies of fish swimming speeds to determine appropriate intake velocities for mid-Atlantic steam generating stations, DE (1971-74).

• Designed and conducted experimental behavioral response and acute toxicity studies on organic chemicals and industrial effluents using mid-Atlantic fishes and macroinvertebrates, DE (1969-73).

• Designed and conducted experimental studies evaluating the effects of gas-supersaturated thermal discharges from the Waukegan Generating Station, IL (1970-71).

Expert Witness

• Testified before New York State Administrative Law Judge (direct and cross-examination) in hearing on New York State Department of Environmental Conservation application for dredging permit to remove PCBs from the Hudson River, NY (1987).

• Provided sworn affidavit on behalf of Exxon Company, U.S.A., for U.S. Coast Guard hearing on effect of five oil spills at Exxon Bayway Refinery, Linden, NJ (1983).

• Testified before the Hearing Officer, United States Coast Guard, Governors Island, NY, on the *deminimis* effect of three oil spills at the Exxon Bayway Refinery, Linden, NJ (1981).

• Testified before the New Jersey Department of Environmental Protection, Trenton, NJ, on proposed revisions to the New Jersey State Water Quality Standards (1980).

JOHN W. MELDRIM
Senior Associate and Head, Environmental Sciences Department

Special Assignments

• Served as technical examiner for oral examinations by New York State Department of Civil Service for Chief, Division of Environmental Protection, New York State Department of Environmental Conservation (1989).

• Served as expert respondent for GPU - Jersey Central Power & Light 316 a&b demonstration agency questions (1988).

• Evaluated capital worth of Ichthyological Associates, Inc., Brigantine, NJ, Marine Experimental Laboratory (1985).

TECHNICAL PAPERS AND ARTICLES

"Fisheries Concerns at Small Hydropower Facilities in Four Regions of the U.S.A," Proceedings of the AFS Symposium on Small Hydropower and Fisheries, Aurora, CO, 1985 (D.B. Pott, J.W. Meldrim, and J.J. Pizzimenti, co-authors).

"Comparison of Acute Toxicity and Avoidance Responses of Atlantic Silverside and White Perch to Chlorinated Estuarine Water," *In: R. Jolley, et al, editors, Proceedings of the Fifth Conference on Water Chlorination: Environmental Impacts and Health Effects,* Volume 5, Lewis Publishers, MI, 1985, (J.A. Fava and J.W. Meldrim, co-authors).

"A Comparative Evaluation of the Effects of Ozonated and Chlorinated Condenser Discharges on the White Perch, *Morone Americana,*" *Ozone: Science and Engineering,* 3(3): 155-168, 1981 (J.W. Meldrim, E.R. Holmstrom, G.E. Balog, and R. Sugam, co-authors).

"*Novumbra hubbsi* Schultz, Olympic Mudminnow," In: D. Lee, et al, editors, *Atlas of Freshwater Fishes of North America,* Publication #1980-12 of the North Carolina Biological Survey, North Carolina State Museum of National History. (J.W. Meldrim), 1980 (J.W. Meldrim, author).

"Comparative Evaluation of Effects of Ozonated and Chlorinated Thermal Discharges on Estuarine and Freshwater Organisms," Final Report to U.S. Department of Energy 1980, (C.R. Guerra, R. Sugam, J.W. Meldrim, E.R. Holmstrom, and G.E. Balog, co-authors).

"Chlorine," pages 67-75, *Review of the EPA Red Book: Quality Criteria for Water,* Water Quality Section, American Fisheries Society, 1979 (Coordinator G.M. DeGraeve, W.J. Blogoslawski, W.A. Brungs, J.A. Fava, B.J. Finlayson, T.P. Frost, T.M. Krischan, J.W. Meldrim, D.T. Michaud, R.E. Nakatani, and G.L. Seegert, co-authors).

"Effects of Thermal Discharges on Freshwater Fishes," pages 132-136, K.C. Flynn and W.T. Mason, editors, *The Freshwater Potomac: Aquatic Communities and Environmental Stresses,* Interstate Commission on the Potomac River Basin, 1978 (J.W. Meldrim and S.E. Peterson, co-authors).

"Behavioral Avoidance Responses of Estuarine Fishes to Chlorine," *Chesapeake Science,* 18(1):154-57, 1977 (J.W. Meldrim and J.A. Fava, co-authors).

"The Effect of Temperature and Chemical Pollutants on the Behavior of Several Estuarine Organisms," Final Report to Office of Water Research and Technology, U.S. Department of Interior Bulletin 11 of Ichthyological Associates, Inc., 1974, (J.W. Meldrim, and J.J. Gift, B.R. Petrosky, co-authors).

"Temperature Preference, Avoidance, and Shock Experiments with Estuarine Fishes," Bulletin 7 of Ichthyological Associates, Inc., 1971 (J.W. Meldrim, and J.J. Gift, co-authors).

"Responses of Several Freshwater Fishes to Waters Containing Various Levels of Gas Supersaturation," Miscellaneous Reports of Ichthyological Associates, Inc., 34 pp., 1971 (J.W. Meldrim, J.J. Gift, B.R. Petrosky, co-authors).

"An Experimental Study of the Behavior of Estuarine Fishes to a Proposed Thermal Effluent," Proceedings of the Fourth Mid-Atlantic Industrial Waste Conference, Newark, DE, November 1970 (J.W. Meldrim, author).

"Holotype of Fishes Described by A.W.C.T. Herre Transferred to the U.S. National Museum from the University of Washington," *Copeia* 4:872-873, 1968 (J.W. Meldrim and G.W. Wadley, co-authors).

HONORS, AWARDS AND PEER RECOGNITION

Awarded Distinguished Service Award, American Fisheries Society Water Quality Section (1993).

Listed in *Who's Who in the Midwest,* 1989.

Listed in *American Men and Women of Science,* 1978.

Crown-Zellerbach Foundation Scholarship Award, 1964.

HARZA

DAVID B. POTT
Senior Aquatic Ecologist

Harza Engineering Company, Environmental Sciences Department, Aquatic Resources & Fisheries Section, Senior Aquatic Ecologist, 1991 to Present; Aquatic Ecologist, 1983-90. Savannah River Ecology Laboratory, Graduate Research Fellow, 1982-83. Clemson University, Research Assistant, 1981-82. U.S. Peace Corps/Philippines, Mariculturist, 1979-80.
Degrees: Master of Science in Environmental Systems Engineering, Clemson University, 1982. Bachelor of Science in Chemistry and Biology, Appalachian State University, 1979.
Languages: English, Tagalog.
Professional Societies: North American Lake Management Society, American Society of Limnology and Oceanography, Asian Fisheries Society, International Humic Substances Society, Water Environment Federation.
Specialty Training: Ecological Risk Assessment (1993). Health and Safety Training Course for Hazardous Waste Site Workers (1988).

Since joining Harza, David B. Pott has been involved in a variety of water development projects. His primary responsibilities are in the study and analysis of aquatic ecosystems. Mr. Pott's areas of expertise include aquaculture, environmental chemistry, aquatic ecology, and acid precipitation.

EXPERIENCE HIGHLIGHTS

Water and Sediment Quality Projects

- Project manager for Lincoln Park Gun Club Site Restoration. Led experimental design, field sampling, and data analysis for soil, groundwater, sediment, and lake water investigations of lead and PNA contamination in Lake Michigan. Studies included TCLP, supernatant, bulk chemistry, sediment microbial toxicity assessments, risk assessment, feasibility studies, remedial design, health and safety plan, permitting, and services during construction (1992 to present).
- Project manager for Lake Barrington Water Quality Restoration Study. Designed and implemented two-year water and sediment quality monitoring study, bioassays of 2,4-D, sediment phosphorus speciation, and restoration feasibility and design studies. Lake aeration system design, bid evaluation, and inspection. Alum dose tests performed (1991 to present).
- Performed sediment supernatant tests for design services on dredging two lakes in Illinois. Led 404 and 401-permitting tasks (1989-92).
- Designed one-year program for monthly monitoring of thermal discharge in Mulatto Bayou, MS (1992).
- Dissolved oxygen modeling of Skokomish River (WA) using Streeter-Phelps equation (1993).
- Lead environmental scientist for Sylvan Lake Enhancement Project, IN, for water and sediment quality monitoring, preparation of one-dimensional dynamic water quality model, and public presentations (1990-92).
- Lead environmental scientist assessing sediment contamination in Salt Creek, IL. Techniques utilized bulk and TCLP analysis of priority pollutants (1990-92).
- Field scientist collecting sediment cores for PCB analysis using both gravity corers and vibracorers, Hudson River, NY (1991).
- Geochemist for the assessment of hazardous organic solvent contamination at an industrial site, IN. Directed soil and groundwater sampling programs to determine the areal and vertical extent of contamination (1985-86).
- Lead ecologist, Stream Survey, IL. Designed and led a one-year investigation to assess the chemical and biological effects of mine effluents on five streams (1986).
- Geochemist, Abandoned Mine Lands Project #11, WY. Conducted feasibility study for clarifying ponds containing high levels of suspended colloids (1985).
- Consulting limnologist for prediction of leaching and bioaccumulation of heavy metals from inundated soils in two proposed reservoirs of the Susitna Hydroelectric Project, AK (1983-85).
- Aquatic ecologist on Abandoned Mine Lands Project, AK. Performed aquatic environmental assessments and assisted in preparation of reclamation plans for six abandoned coal mine sites in south central Alaska (1984).
- Performed research on geochemical neutralization mechanisms of acid precipitation and aluminum binding capacity of humic and fulric acids (1982-83).
- Conducted functional group and acidity analyses of aquatic humic acids under coal ash program (1982).
- Participated in a major research project on acid precipitation in the Southeast. Duties included surface water and groundwater sampling, flow measurements, and water quality analyses (1981-82).

DAVID B. POTT
Senior Aquatic Ecologist

Limnological Projects

• Project manager, Guntersville Reservoir Aquatic Plant Master Plan, AL. Directed Geographic Information System preparation and public participation process including four public meetings; and prepared NEPA documents (1990-92).

• Project manager for three "T by 2000" lake enhancement feasibility studies in northern Indiana. Led all technical and public participation aspects of the projects, designed water quality programs, prepared computer models of nonpoint source pollution, and designed wetlands for water quality control (1988 to present).

• Project manager for feasibility study of two public swim lakes, suburban Chicago, IL (1989-90).

• Project manager for nonpoint source pollution treatment feasibility study on Big and Little Turkey Lakes' watershed, IN. Led development of models estimating nonpoint source sediment and phosphorus loadings to lakes and assessment of eight large constructed wetlands to remediate these loadings, including construction cost, effectiveness, environmental compatibility, and permit requirements (1989-90).

• Water quality scientist assessing quality of planned recreational impoundment near Las Vegas, NV (1988).

Hydroelectric Projects

• Lead environmental scientist for licensing five hydroelectric projects on Otter Tail River, MN. Led agency consultation, managed field studies, and prepared Exhibit E and Schedule A for FERC License Application. Issues included instream flow, recreation use, and water quality (1987 to present).

• Environmental scientist on two hydroelectric projects on Brazos River, TX. Consulted with agencies and conducted studies in support of FERC License Applications. Responsible for data collection and analysis using Instream Flow Incremental Methodology (1983-87).

• Aquatic ecologist for two small hydropower projects on the upper Hudson River, NY. Assisted in fisheries surveys, sediment studies, and preparation of FERC License Applications (1985-86).

• Lead environmental scientist, Heron Dam Hydroelectric Project, NM. Directed feasibility studies and contacted agencies for small hydropower retrofit (1985).

• Aquatic ecologist, Southern Ute Hydropower Project, CO. Assisted in prefeasibility-level study and identified environmental problems for detailed study (1984).

• Environmental scientist for a siting study of pumped-storage hydropower on Illinois River, IL. Interfaced with civil engineers in evaluating feasibility of pumped-storage development (1983-84).

Flood Control Projects

• Lead scientist, Judy Creek Flood Control Study, IN. Directed environmental assessment and mitigation design of flood control project. Led field studies that discovered Indiana's only known self-sustaining brown trout population. Developed conceptual design of mitigation measures, including artificial wetland (1986).

• Lead environmental scientist for Maumee River Flood Control Feasibility Study, IN. Designed and directed studies to evaluate ecological and social effects of channel modifications. Mitigation planning included conceptual design of a large artificial wetland (1985-86).

• Aquatic ecologist, Hawkinsville Multi-Purpose Reservoir, Black River, NY. Assisted fisheries field surveys and preparation of environmental impact statement (1985).

Aquatic Habitat Improvement

• Lead scientist for restoration of trout habitat in Piscasaw Creek, McHenry County, IL. Duties included hydrological, chemical, and biological assessments of the stream system, site selection design, and installation of habitat enhancement structures (1983 to present).

• Aquatic ecologist, Dragon Lake, IL. Directed water quality studies to determine feasibility of recreational lake in forest preserve. Designed structures to enhance fish production and directed artificial wetland design (1986).

• Resident engineer, Back Creek Habitat Improvements, VA. Designed and managed construction of $350,000 stream improvement project (1985-86).

Additional Experience

• Environmental Team Leader, Spring Lake Expansion Project, western Illinois. Led interdisciplinary team addressing environmental, socioeconomic and regulatory issues for construction of a new dam as a water supply reservoir for the City of Macomb on Spring Creek (1994 to present).

• Lead environmental scientist for long-range water supply planning in Kentucky River basin. Work included prefeasibility-level environmental assessments of 5 pipelines, 14 new reservoirs, and 7 raised dams (1990-92).

• Permitting for rehabilitation of three dams in South Dakota. Section 106 and endangered species determinations procured and timely section 404 permits issued for each project (1993).

International Development Projects

• Aquaculture specialist, Upper Indravati Project Orissa, India. Prepared aquaculture development plan and fishery resource assessment for project's environmental impact assessment (1994).

• Environmental specialist on FAO Preparation Mission for Maldives' Fisheries III Project. Assessed effects of proposed fish harbors, fishing operations, and tuna processing plants on environmental resources; proposed mitigation measures; and prepared environment sector review and Terms of References (1990).

• Fisheries development specialist on FAO Preparation Mission for Bangladesh Fisheries Sector Credit Project. Estimated existing national carp spawn and fingerling production capacity and cost to increase capacity to meet project requirements. Prepared environmental assessment of proposed project (1988-89).

• Fisheries advisor, Gujarat Fisheries Project, India. Special fisheries advisor in planning study for development of inland fisheries production programs for reservoirs and irrigation systems. Major Indian carps and exotic species were assessed for production potential and economic benefits; hatcheries were planned, including cost estimates (1988).

• Aquaculture specialist, catfish facility, USSR. Assisted in design of closed-system channel catfish facility producing 500 tons per year. All water was reconditioned and recycled; ammonia removal was accomplished by clinoptilolite filters. Biological production and water quality were modeled using spreadsheet software (1988).

• Aquacultural engineer, Integrated Prawn Project, Philippines. Lead scientist for feasibility study of *Penaeus mododon* hatchery, grow-out farm, feed mill, processing plant, and marketing plan. Duties included planning, design, cost estimating, and economic and financing analyses for both stand-alone and integrated components of large prawn development. Hatchery capacity 96 million PL per year; 100-ha farm will eventually produce 950 tons per year. PC-based estimating, economic, and financial models were developed for all components (1987-88).

• Fisheries biologist on National Water Plan Project, Bangladesh. Planned use of water for fisheries sector in relation to existing and expected national needs. Provided near- to medium-term aquaculture prospectus for entire nation. Developed framework for training national biologists and engineers in environmental mitigation planning of water development projects (1984).

• Aquaculture specialist in master plan formulation, agricultural development, Lower Casamance Basin, Senegal. Performed feasibility-level studies recommending fish/sh.imp production alternatives and planning/design of pilot penaeid shrimp culture project (1983-84).

• Mariculturist for managing a Philippine government-sponsored research sea farm. Conducted research on culture of various bivalves, fin fishes, and marine algae. Led local seminars on new mariculture technologies, performed hydrobiological surveys of Bamban Bay, and designed and installed two artificial reef projects. Extended expertise to area milkfish and prawn farmers (1979-80).

PUBLICATIONS, PAPERS, AND PRESENTATIONS

"Lake Michigan Sediment Contamination from 73 Years of Trap and Skeet Shooting," *Proceedings*, First International Conference on Contaminated Aquatic Sediments: Historical Records, Environmental Impact, and Remediation, Milwaukee, WI, June 1993 (D.B. Pott, B.K. Shepard, and A. Modi, co-authors).

"Other Environmental Factors," Chapter 10 in *Guidelines for the Design of Intakes for Hydroelectric Plants*, American Society of Civil Engineers, 1993 (C.E. Bohac, D.B. Pott, and S.E. Boltz, co-authors).

"Applications of GIS to Lake Management Planning," presented to Illinois Lake Management Association, 1992.

"Guntersville Reservoir Aquatic Plant Management Master Plan," presented at 11th International Symposium, North American Lake Management Society, November 1991 (D.B Pott, A.L. Bates, and J. Morrison, co-authors).

"Mercury in Fish and Water of New Impoundments," *Proceedings*, Waterpower '91, Denver, CO, 1991.

"Planning Wetlands for Flood Control in Indiana," *Proceedings*, 11th Annual Conference of the Association of State Floodplain Managers, Seattle, WA, 1987 (D.B. Pott, C.B. Burke, and R.K. Suttle, co-authors).

"Reversal of Habitat Degradation in a Northern Illinois Trout Stream," *Proceedings*, Fifth Trout Stream Habitat Improvement Workshop, Lock Haven, PA, 1986 (D.B. Pott, J.T. Huiting, and J. Pizzimenti, co-authors).

"Feasibility Study and Environmental Assessment of a Flood Control Project for the Maumee River in Allen County, Indiana," *Proceedings*, Seventh Annual Indiana Water Resources Symposium, Angola, IN, 1986 (C.B. Burke, D.B. Pott, and J.C. Bradley, co-authors).

"Water Quality of Abandoned Mine Runoff: A Case Study of Alaskan Sites," *Proceedings*, Cold Regions Hydrology Symposium, Fairbanks, AK, 1986 (D.B. Pott, R.E. Lindsay, and N. Pansic, co-authors).

"Rehabilitation of a Trout Stream," *Public Works* 117(6): 90-93, 1986 (D.B. Pott and D. Schellhaass, co-authors).

"Fisheries Concerns at Small Hydropower Facilities in Four Regions of the USA," *Proceedings*, Symposium on Small Hydropower and Fisheries, Aurora, CO, 1985 (D.B. Pott, J.W. Meldrim, and J. Pizzimenti, co-authors).

"The Influence of pH on the Binding Capacity and Conditional Stability Constants of Aluminum and Naturally Occurring Organic Matter," *Chemical Geology* 48:293-304 (D.B. Pott, J.J. Alberts, and A.W. Elzerman, co-authors).

DAVID B. POTT
Senior Aquatic Ecologist

"Interactions Between Aluminum and Dissolved Organic Matter in Natural Aqueous Systems," University Microfilms International, Ann Arbor, MI, 1983.

"Initial Screening of Heavy Metals in Potential South Carolina Mariculture Areas," report to South Carolina Sea Grant Consortium, 1981 (D.B. Pott, A.W. Elzerman, and M.M. Sviatyla, co-authors).

HONORS AND AWARDS

Graduate Laboratory Fellowship, Savannah River Ecology Laboratory, 1982.

National Science Foundation Research Assistantship, Department of Environmental Systems Engineering, Clemson University, 1981-82.

A.R. Smith Scholarship, Appalachian State University, 1978-79.

Belle Ledbetter Biology Scholarship, Appalachian State University, 1978-79.

HARZA

JANUSZ PYRICH

Senior Hydrogeologist

Harza Environmental Services, Inc., Geology/ Hydrogeology Section, Senior Hydrogeologist, 1987 to Present. State Environmental Protection Agency, Landshut, Germany, Hydrogeologist, 1985-87. State Hydrogeological Office, Cracow, Poland, Group Leader, 1974-85. Harza Engineering Company, Chicago, IL, Planning Department, Designer, 1973-74. State Hydrogeological Office, Cracow, Poland, Project Manager, 1967-73.
Degrees: Master of Science in Geology, Academy of Mining and Metallurgy, Cracow, Poland, 1967. Diploma in Hydrogeology, Academy of Mining and Metallurgy, Cracow, Poland, 1973.
Languages: English, Polish, German, Russian.
Professional Certified Geologist: Indiana #1022, Kentucky, #1506.
Professional Hydrogeologist: Poland #050693.
Professional Engineering Geologist: Poland #060233.
Professional Society: Association of Groundwater Scientists and Engineers, Association of Engineering Geologists.
Continuing Education: Eight-Hour Supervisory Program, 1993 (University of Illinois, Institute of Labor and Industrial Relations). 40-Hour General Site Worker Program, 1988 (University of Illinois, Institute of Labor and Industrial Relations). Regional Hydrogeology, Water Supply for Metropolitan Areas, 1972 (Academy of Mining and Metallurgy, Cracow).

As a senior hydrogeologist at Harza Environmental Services (HES), Janusz Pyrich is responsible for all aspects of groundwater assessments, remediation, monitoring, and report generation. Mr. Pyrich has served as a project manager/lead hydrogeologist on many hydrogeologic projects.

Mr. Pyrich's experience includes aquifer contamination investigations, groundwater resources evaluation, groundwater supply studies, and environmental impact assessment in Poland, West Germany, and the United States. As an engineering geologist, he performed geological investigations for dams, reservoirs, and industrial facilities.

EXPERIENCE HIGHLIGHTS

Groundwater Resources Projects

• As project manager, planned and reviewed works related to water resources evaluation in the recreational areas of the Dunajec River Valley (1985), the Raba River Valley (1984), and in the heavily industrialized areas of the Cracow Metropolitan Area (1982) and Silesia Region (1979). Researched data and evaluated regional groundwater characteristics and water supply development, created hydrogeological model for computer, and estimated regional groundwater resources based on field investigations and data obtained from 50 years of groundwater monitoring.

Water Supply Studies

• Lead hydrogeologist for groundwater resources evaluation and water supply study for proposed golf course at New Lenox, IL (1994).

• Performed feasibility study for water supply infiltration gallery projects on Mississippi River, WI; and Potomac River, VA (1992).

• Provided geological, hydrogeological, and chemical data collection, and analyzed aquifer tests to evaluate potential well field for:
AMAX Coal Industries, IN (1990);
Decatur, IL (1989);
Valparaiso, IN (1988); and
St. John, IN (1988).

• As a member of an interdisciplinary team, performed water supply feasibility study for City of Cracow, Poland (Rudawa, Pradnik Bialy, Czerwony, Dlubnia, Biezanow). Study included evaluation of hydrogeologic properties of sand and limestone aquifers, groundwater resources estimation, and water production prognosis using a computer code (1984).

• Performed and supervised water supply project for City of Cracow (Biezanow-Niepolomice). Project included groundwater resources evaluation of existing water wells and field investigations, implemented with drilling and pumping tests performed for four additional deep production (600 feet) wells, in extensive sandy Miocene formation (1983).

• Performed studies for water supply wells, evaluated boring logs, analyzed pump tests in uniform and nonuniform aquifers, studied groundwater quality, evaluated groundwater resources, and assessed hydrogeological conditions for 10 and 20 years of pumping. Projects included:
City of Cracow, Poland, 10 mgd (1984);
Cracow steel mill, 24 mgd (1980);
City of Tarnow, Poland, 10 mgd (1976); and
Przeworsk railroad station, Poland (1968).

Aquifer Protection/Contamination/Monitoring Studies

• As a senior hydrogeologist, participated in Environmental Site Assessment, Phase I and Phase II, for City of

JANUSZ PYRICH
Senior Hydrogeologist

Chicago (IL) multisite project. Scope of services included records review, site inspection, interviews and report (Phase I), and monitoring wells and soil borings drilling, soil and water sampling (Phase II), as a full-scale contamination investigation conducted to determine the extent of contamination (1994).

• Performed field investigations and prepared hydrogeologic conditions and geologic setup descriptions of CTA site, Skokie, IL, as a part of environmental site assessment (1994).

• Participated in geologic investigation and supervised drilling for the McCook Reservoir Project (1993).

• Performed a groundwater flow and solute transport modeling study for a chemical manufacturing plant in Indiana. The study was conducted using the finite-element models GWFLOW and GWTRAN, developed at Colorado State University (1993).

• Participated in Lincoln/Joliet Ash Landfill groundwater study. Project included extensive field investigation and evaluation of hydrogeological conditions of the existing limestone quarry (1993).

• Developed engineering services proposals for an oil terminal in Vilnius, Lithuania; and a shale oil power plant in Narva, Estonia. The sites are severely contaminated by hydrocarbons from leaking aboveground and underground tanks (Vilnius) and shale oil waste (Narva). Reviewed and evaluated existing data; developed conceptual site models; and outlined recommended investigations (1992).

• Lead hydrogeologist for Environmental Assessment of the soil on the football field, St. Rita High School, Chicago, IL. Client was concerned that past surface water runoff from an adjacent wood-treating facility, no longer used for that purpose, may have impacted a portion of the football field. A field sampling and laboratory testing program was developed and conducted. Evaluated test results. Submitted results, conclusions, and recommendations to the client (1992).

• Participated in a groundwater flow study of the Platte River basin, NE. Analyzed the interaction between groundwater and surface water, including natural drainage features, irrigation canals, and power generation facilities (1992).

• Hydrogeologist for field and office studies to assess soil and groundwater contamination at a chemical plant in Indiana. Tasks have included:

Monitoring well field design and construction, including geologic core logging, log interpretation, well development, and aquifer testing;
Design and construction of recovery well system;
Preparing contract documents for subcontracted activities;
Performing data reduction;
Presenting results and assisting with report preparation;
Assisting with preparation of quarterly groundwater monitoring reports to USEPA;
Supervising drilling program for geotechnical evaluation of soil at new facilities; and
Collecting soil samples and evaluating analytical results (1989 to present).

• Participated in groundwater modeling project in Arizona. Project involved groundwater flow and solute transport simulations of a TCE plume. Used the USGS models MODFLOW and MODPATH to simulate groundwater flow and advective transport of contaminants (1991).

• Project hydrogeologist for hydrogeological investigation of groundwater system design for

City of Ann Arbor, MI (1990-91); and
Tazewell Service Company, Pekin, IL (1990).

• Lead hydrogeologist for Environmental Assessment of two GE landfills at Fort Edward, NY. Tasks included:

Designing investigative protocol to evaluate extent of contamination, time of travel, and plume configuration; and
Designing vadose and groundwater monitoring system (1990).

• Participated in developing unsaturated zone and groundwater monitoring systems for several Amoco stations in Illinois (1990).

• Project hydrogeologist on remedial investigation project for refinery products site, Schiller Park, IL. Activities included:

Collection of existing geological, hydrogeological, and chemical data;
Preparation of work plan and design of groundwater monitoring system;
On-site data collection and supervision of monitoring wells construction; and
Data reduction and report preparation (1987-89).

• Participated in planning and work plan preparation for Remedial Investigation of the Whitestown Landfill, NY (1989).

• Project hydrogeologist for Environmental Assessments at the Northbrook Sports Club, Hainesville, IL. Soil at shooting zone is a target for approximately 50,000 to 60,000 lbs. of lead per year. Scope of services was developed, and four sets of soil samples were collected during two years (1989).

• Underground Storage Tank Removal Project at Shorewood, IL; developed the soil-sampling program, collected samples after tank removal, and evaluated analytical data (1988).

• Hydrogeologist for investigation of the Arlington Heights Landfill, IL. Tasks included:

Monitoring well system design;
Directing field activities, including sampling of water and soil, and pumping tests;
Analyzing testing results; and
Assisting with preparation of report (1988).

• Supervised drilling, construction, and sampling of monitoring wells at several landfills and hazardous waste sites, including:

Midvale, UT (1991);

Peoria, IL (1988);
Clinton, IL (1988); and
Lake County, IL (1987).

• As senior hydrogeologist, reviewed hydrogeological data collected by others, including:

Site Assessment Report - Capsule Environmental Engineering, Rocky Mount, NC (1990);
Study Plan - Gaseous phase in unsaturated zone, Yucca Mountain, NV (1989);
Site Assessment Report - Wabash DataTech, Huntley, IL (1988); and
Site Assessment Report - AT&T site, Skokie, IL (1988).

• Project manager for field and office study to estimate Landshut-area groundwater contamination, West Germany. Prepared water protection, water pollution, and hydrogeological maps and performed field evaluation of groundwater pollution. In the field, analyzed contaminant hydrogeology and the physical and chemical behavior of subsurface contaminants. Evaluated amount of strontium and cesium in groundwater after disaster at Chernobyl, Soviet Union (1986).

• As project manager, conducted study to evaluate environmental impact of coal mine sludge pond in Silesia Region, Poland. Estimated hydrogeological conditions, studied change of contaminant concentration, traced paths of pollutant using environmental isotope method, and evaluated extent of polluted groundwater (1984).

• Conducted field and office study for design of groundwater-monitoring system at municipal waste disposal site in Cracow, Poland. Site is located in fractured limestone. Monitoring wells were constructed to assess pollution degree and area of influence (1982).

• Designed field investigations for groundwater contamination caused by water from lead mine at Olkusz, Poland, where field investigation area is located on karstic dolomite, and polluted water endangers groundwater catchment for Silesia (1981).

• Designed water pollution and protection maps for the most-polluted area in southern Poland, the Silesia-Cracow Region (1979).

Hydroelectric Projects

• Lead geologist for Sobel Pumped-Storage Project, Poland. Performed engineering geology for the upper and lower reservoirs, diversion tunnel, and dam in the Carpathian Region (1981).

• Performed geological investigations and managed works for Krosno Reservoir, Poland, in complex geological conditions. Conducted geophysical surveys to trace fractures and joints in limestone and sandstone (1974).

Other Hydrogeology Projects

• Evaluated aquifer properties at Amoco Water Treatment Plant, Granger, IN (1990).

• Project hydrogeologist to evaluate water supply for a mined geologic disposal system at Yucca Mountain, NV. Part of a multidisciplinary team evaluating the site for a highly radioactive nuclear waste repository (1989).

• Performed hydrogeological characterization of aquifers for DuPage River reservoirs, DuPage County, IL (1989), and Clear Lake, IL (1989), to assess their suitability as recreation sites.

• Designed artificial recharge of water-bearing formation for chemical plant at Oswiecim, Poland. The plant, situated in the Vistula River Valley, needed more water than regional groundwater resources provided. Designed a system to transport water from the Vistula to several fish ponds, so that it would then flow into aquifers through about 400 injection wells (1984).

• Evaluated riverbank filtration along the Raba River in Poland. The evaluation included physical aquifer characteristics, the effects of river water infiltration on groundwater quality, and infiltration rate. Due to a wastewater plant outlet to the river, river water was slightly polluted. Bank filtration removed about 75% of the dissolved organics present in the river water (1983).

• Designed groundwater recharge project for the cities of Cracow and Tarnow, Poland. System designs were based on two methods: recharging with surface water by basin spreading and by well injection. The project included physical and chemical characteristics of the environmental setting of an aquifer (transmissivity, porosity, and type of aquifer); infiltration rate; water quality (turbidity, suspended solids, algae types, and chemistry); and pollution potential from recharge operations (1982-83).

• Analyzed dewatering for part of city of Omaha, NE. Groundwater levels in Omaha are higher than bottom of septic tanks, resulting in groundwater pollution (1974).

• Participated in hydrogeological studies related to Stony Creek Pumped-Storage Project, PA. Designed and drafted hydrogeological maps, and geological and hydrogeological cross sections (1973).

Storm Sewer Project

• Design engineer for stormwater project for City of Evanston, IL. Duties included design layout of storm sewers and relocated utilities, and layout of construction details (1991-92).

TECHNICAL PAPERS AND ARTICLES

"Water for Cracow," presented at Meeting of Polish Geological Society, Karniowice, Poland, May 1985.

"Water Pollution Map for South Poland," presented at National Hydrogeological Meeting, Tuczno, Poland, September 1983.

"Map of Pollution and Protection of Water," *Technika Poszukiwan Geologicznych*, vol. 45-46, 1973.

HARZA

ROBERT WILLIAM SUDA
Environmental Geologist

Harza Environmental Services: Geology/Hydrogeology, Environmental Geologist, 1993 to Present.
Fugro-McClelland Environmental, Inc., Division of Fugro-McClelland Midwest: Staff Geologist, 1990-93.
Degrees: Master of Science, Environmental Studies, Southern Illinois University, 1992. Bachelor of Science, Geology, University of Illinois, 1989.
Continuing Education: Hazardous Waste Worker Training, (40-hour), Environmental Training Institute, 1990. Hazardous Waste Worker Refresher Training (8-hour), University of Illinois, Champaign, IL (1991 to present). Candidate, Master of Science in Environmental Engineering, Illinois Institute of Technology, 1995 to Present.

Robert Suda is responsible for providing technical assistance in planning and implementing geologic and hydrogeologic investigations and providing assistance in aspects of environmental engineering.

Mr. Suda has extensive experience in conducting soil and groundwater assessments and providing design assistance for groundwater recovery and treatment systems. His general duties include proposal development, regulatory interaction, work plan preparation, report preparation, project administration and field operation activities.

EXPERIENCE HIGHLIGHTS

Environmental Engineering

• Resident engineer for construction of a 9600 linear foot soil-bentonite slurry wall at the city of Ann Arbor, Michigan closed landfill. The slurry wall is being constructed as part of a remedial action to address contaminated groundwater associated with the landfill. Responsibilities included implementing the construction quality assurance plan and administering the contract. Performed Quality Assurance testing of bentonite slurry and trench backfill material, and reviewed QC testing reports for conformance with the specifications (1995).

• Site Manager for a Remedial Site Investigation/Engineering Feasibility Study for the Illinois Environmental Protection Agency at the Inland Metals site. The five acre site was formerly used to process ore by-products to extract metals such as tin, zinc, copper and lead. Objectives of the investigations were to determine the nature of contaminated in site soils, sediment, surface water and groundwater, characterize the slag wastes with respect to possible metals recovery and identify and evaluate innovative remedial technologies applicable to the site.

Provided oversight of field investigations including; drilling and installation of four groundwater monitoring wells and seven soil borings; chemical sampling and analysis of soils, groundwater, surface water and sediment, and survey of current site conditions. Based upon the investigation results, a preliminary Site Investigation Report was prepared.

Based upon the findings of the Site Investigation, performed a focussed assessment to identify innovative remedial technologies that may apply to the site. Used site investigation data to quantify the volume of contaminated media, performed a background literature search to obtain information on innovative technologies and potential developers with equipment for recovery of metals. Prepared a final report which included the results of the RI and provided a description of the technologies identified and alternatives developed, and their technical and cost evaluation including limitations reliability and environmental regulatory acceptance (1994-current).

• Project engineer for a Pollution Prevention/Waste Minimization program for petroleum refining, thermal electric power generating and phosphate mining industries in Jordan. Through audits, feasibility studies, and demonstration programs, Harza is assisting various industries in assessing pollution problems and identifying alternative solutions/technologies to achieve pollution prevention, water conservation, and wastewater treatment. Specific responsibilities included development and review of water balance schematics, development and review of process flow diagrams, development and review of proposed water use schematics for conservation, and editorial and technical review of final audit reports (1994 to present).

• General experience in development and implementation of corrective action plans for remediation of contaminated soil and groundwater. Select methods, techniques, and equipment required for additional site characterization. Provide oversight for implementation of field activities to document and verify that the work was performed in accordance with the work plan (1990 to present).

• Project engineer for a groundwater remediation project in St. Louis, MO. Assisted in conceptual and preliminary design for a recovery and treatment system in response to a gasoline spill. Work included preparation of a proposed process flow diagram, preparation of a conceptual site layout drawing, and compilation of groundwater characteristics and estimated discharge characteristics. Preliminary design tasks included preparation of facility

plans and equipment layouts, development of major equipment lists, identification and selection of qualified vendors, and preparation of preliminary cost estimates. A carbon adsorption system was designed and installed to treat impacted groundwater at a rate of 25 gpm to reduce contaminant levels below method detection limits (1990).

• Resident engineer for installation of a groundwater recovery and treatment system in St. Charles, MO. The treatment system included the installation of a free-product recovery trench, four groundwater recovery wells, and a tray stripping unit for treatment of dissolved gasoline components. Work included construction observation and documentation (i.e. daily logs), coordination of equipment deliveries, subcontractor supervision, resolution of problems encountered during construction, and status reporting to project manager. Separate phase hydrocarbons were removed from total fluid flow and dissolved hydrocarbons were removed to levels required by the regulatory agency (1992).

• Resident engineer for construction of a low-permeability, multi-layer, landfill cover system at an Illinois Superfund site. Previous on-site remedial activities included high-temperature incineration of hazardous waste, including PCBs, volatile and semi-volatile organic compounds, and heavy metal. Work was conducted to obtain site closure by installation of the cover over the incinerator ash. Responsibilities included construction observation and documentation, review of QA/QC material test report and field testing to verify conformance with specifications, processing progress payment requests, change order preparation, safety assurance, and report of work progress to the project engineer. Worked with contractor to interpret drawings and contract specification, and provide general technical assistance as required. In excess of 100,000 yd^3 of material were placed to construct the cover system (1993-94).

• Project manager for more than 30 soil remediation projects in Illinois and Missouri. Work included excavation and transportation of excavated material to a permitted disposal facility. Provided direction for excavation using field screening techniques to aid in determining extent of contamination. Other activities included waste disposal permitting and manifesting, collection of samples required for site closure and conducted project scheduling and coordination with excavation contractor and disposal facility (1990 to present).

• Project engineer for soil vapor extraction remedial action for rail yard located near Los Angeles, CA. Site characterization identified approximately 15,000 yd^3 of impacted soil containing several chlorinated volatile organic compounds. Responsibilities included preparation of remedial design report, including plans and specifications for additional site assessment and pilot scale testing, permit requirements, system operations, monitoring and maintenance measures, and a health and safety plan. Also assisted in preparation of the bidding document for installation and operation of the vapor extraction system (1992).

Geology/Hydrogeology

• Project Geologist for 3-year, $20 million indefinite delivery contract with the US Army Corps of Engineers for A-E services at HTRW sites throughout the continental U.S. Assignments have included investigation of TCE plume in groundwater and evaluation of Funnel & Gate *in-situ* technology at Duluth International Airport, Minnesota, and RCRA Facility Investigation activities at Cannon AFB, New Mexico. Responsibilities have included site investigation activities, preparation of Project Work Plans and Standard Operating Procedures (SOPs), and preparation of Health and Safety Plans (1995-current).

• Project Geologist for an Environmental Site Assessment of the City of Chicago, Northwest Waste-to-Energy Facility. The ESA was conducted to obtain information to define site hydrogeology, investigate the current extent of impacted soil and groundwater and confirm previous measurements of the geotechnical properties of subsurface soils. Responsibilities included oversight of drilling soils borings, installation of groundwater monitoring wells, collection of soil and groundwater samples and evaluation of the investigation results. Prepared a Site Investigation Summary Report which detailed the analytical results by area for soil and groundwater, and discussed site geology and hydrogeology which included reference to prepared cross-sections (1995).

• Project Geologist for the removal and investigation of seven underground storage tanks at the Village of Glenview Public Works Garage. Responsibilities included field oversight for the drilling of 14 soil borings and the collection of samples for chemical analysis. Prepared a Site Investigation Report which summarized the results of the investigations and included recommendations and potential options for site remediation. Prepared preliminary cost estimates for feasible options considering the time constraints and budget to complete the project (1995).

• General experience in aquifer testing to determine site-specific performance characteristics for groundwater recovery systems at sites located in Illinois, Kentucky, and Missouri. Experience includes performing pumping tests and *in-situ* permeability tests in low- to high-range permeability zones. Evaluated the test data by analytical and computer models to resolve data to evaluate aquifer properties (1990-93).

• Develop and implement assessment work plans to characterize site geologic and hydrogeologic conditions, and delineate contaminant plumes, for more than 50 sites in Illinois and Missouri. Plans include sampling and decontamination procedures, monitoring well construction standards, waste disposal and management methods, analytical procedures, and site health and safety. Investi-

gations are conducted at gasoline service stations, chemical and general manufacturing facilities, and industrial facilities (1990 to present).

• Project geologist for pre-remedial investigation at chemical manufacturing facility in Louisville, KY. Performed oversight for installation of more than 100 monitoring wells. Provided oversight of drilling contractor to assure proper well construction based upon geology. Developed and sampled each well, using submersible pumps and block-and-surge techniques. Conducted field pumping tests utilizing facility water supply wells and more than 40 observation wells. Performed preliminary interpretation of field data to determine adequacy of data. Analytical and pumping test data was interpreted to determine locations and pumping rates required to prevent off-site contaminant migration (1991-92).

• Project geologist for a pre-remedial investigation at a chemical manufacturing facility in western Kentucky. Activities included planning and supervision of drilling and sampling of more than 50 soil borings, and the installation of a groundwater monitoring well at each location. Field classified soil samples and prepared stratigraphic logs. Maintained field notes and descriptions of work activities. Provided oversight for development of each monitoring well. Served as on-site client contact, and coordinated drilling and sampling activities around ongoing construction activities throughout the plant (1991).

• Project geologist for groundwater compliance sampling at several RCRA-permitted facilities. Groundwater samples were collected on a quarterly basis, and statistical analysis of data was performed. Reports were prepared and submitted to the Illinois Environmental Protection Agency, documenting the laboratory and statistical analytical results. Rate and extent determinations were conducted for statistically significant concentrations of detected compounds (1990-93).

• Project manager for a voluntary cleanup of PCB-impacted soil and removal of excavated soil at manufacturing facility located in Decatur, IL. Work included determination of extent of impacted soil, permitting of waste material for off-site disposal, and oversight of removal of excavated soil. Samples were collected to verify completion of excavation, clean fill material was used to backfill the excavation, and a report documenting field activities was issued to the client (1993).

• Project geologist for an RCRA clean closure for a food additives company located in south St. Louis, MO. Work included oversight for drilling of 12 shallow soil borings, for soil sample collection for chemical analysis. Used analytical data to identify areas that exceeded allowable levels. Utilized computer programs to prepare isopach maps to illustrate vertical and horizontal extent of impacted soil. Prepared estimates of volume of soil requiring removal (1993).

• Conducted soil vapor surveys at various locations in Illinois and Missouri. Analyzed soil vapor samples using a portable gas chromatograph. Determined extent of hydrocarbon-impacted soil, and recommended locations for additional investigations based upon findings (1991-92).

• Project geologist for study of siting criteria for low-level radioactive waste disposal facilities. Reviewed geologic and hydrogeologic criteria used for evaluating site suitability. Evaluated technical basis for criteria and prepared recommendations for modification to existing criteria, which may provide additional sites for consideration. Evaluated potential implications of using alternative criteria (1994).

• Project geologist for investigation of various sites using cone penetrometer testing. Provided oversight of piezometric cone penetration testing and interpretation of data. Data was collected to detect hydrocarbon contamination, describe stratigraphy/lithology, determine the surface, and define aquifer characteristics (1992-93).

Engineering Geology

• Conducted extensive geologic investigation for proposed airport location in southeastern Missouri. Work included compilation and preparation of general description of local and regional geology and field investigation to characterize site geologic conditions. Provided oversight of drilling and sampling of 40 shallow soil borings, and collection of soil samples for geotechnical testing. Provided oversight for the drilling and logging of 20 rock cores. Geologic logs were prepared from soil and rock descriptions. Site geology was used as the primary factor to determine site suitability due to predominance of subsurface mining in the area. Field investigations were conducted to describe the quality of bedrock and determine thickness of overlying soils for cut-and-fill determinations (1991).

• Project geologist for a geological investigation for a proposed water treatment facility in Carbondale, IL. Field work included drilling and sampling of 14 soil borings and collection of soil samples for testing. Worked with project engineer to select representative samples for testing based upon proposed facility layout. Soil samples were classified for soil type, moisture content, and Modified Proctor (1992).

• Project geologist for geological investigation to evaluate stability of rock walls of a quarry proposed for use as a temporary reservoir, and to determine proper alignment for 35-foot-diameter tunnels that will feed into the quarry. Field mapping involved detailed observations of locations, attitudes and characteristics of major joints, bedding planes, formation contacts and other discontinuities, lithologies, rock conditions, and sources of water seepage. Data gathered during field investigation was used to eval-

uate rock wall stability under a variety of future reservoir conditions (1994).

Phase I Site Assessments

• Project manager for site assessments for property transfer purposes at various locations in Missouri. Projects included industrial manufacturing facilities, service stations, retail sales buildings, office buildings, and apartment complexes. Activities included historical title review, site walk-through, environmental regulatory compliance, and aerial photography review (1990-91).

Site Safety Coordinator

• Site safety officer for site investigation and remediation projects. Implemented more than 30 site safety plans for underground storage tank removals, hazardous waste site investigations and remediation projects. Calibrated and operated field screening and safety survey equipment such as FID, PID, GC, Draeger tubes, explosimeter, oxygen meter, and ph meter. Responsible for the selection and proper use of personal protective equipment. Developed site-specific health and safety plans (1990 to present).