CAFB 96

# DEPARTMENT OF THE AIR FORCE

HEADQUARTERS 27th FIGHTER WING (ACC)
CANNON AIR FORCE BASE, NEW MEXICO

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31 OCT 1996

Mr. Benito J. Garcia, Chief
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New Mexico Environment Department
2044 Galisteo Street
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Dear Mr. Garcia

Enclosed is the final RFI Workplan for Fire Training Area #4, SWMUs 109-112. Although, we have never received formal approval for the workplan, based on Mr. Steve Pullen's draft approval letter, we took the workplan final.

If you have any questions, please contact Mr. John Constantine at (505) 784-4348 or Mr. Sanford Hutsell at (505) 784-6378.

Sincerely

W. P. ARD, Colonel, USAF
Commander, 27th Support Group

Attachment:
Final RFI Workplan

cc:
NMED (B. Hoditschek)
NMED GW Bureau (J. Jacobs)
EPA Region VI (D. Neleigh)
HQ ACC CES/ESVW w/o atch (M. Calvert)

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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

September 1996

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. Department of the Army
Corps of Engineers, Omaha District
Omaha, Nebraska

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

September 1996

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

September 1996

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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 |
| 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 |
| TFW | Tactical Fighter Wing |

| | |
|---|---|
| TIC | Tentatively Identified Compound |
| TM | USACE Technical Manager |
| TRPH | Total Recoverable Petroleum Hydrocarbons |
| USACE | United States Army Corps of Engineers |
| USAF | United States Air Force |
| USDA | United States Department of Agriculture |
| USDA-SCS | United States Department of Agriculture - Soil Conservation Service Soil Classification System |
| USEPA | United States Environmental Protection Agency |
| USFWS | United States Fish and Wildlife Service |
| USGS | United States Geological Survey |
| VOC | Volatile Organic Compound |
| W-C | Woodward-Clyde Consultants |

# 1.0
# PROJECT DESCRIPTION

## 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 $2.0 \times 10^{-3}$ cm/sec. Calculations for water well 8 result in a hydraulic conductivity of $2.0 \times 10^{-2}$ 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 $1.0 \times 10^{-1}$ 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. 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. 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 $\mu$g/kg benzene; 1,300 to 56,200 $\mu$g/kg ethylbenzene; 2,870 to 64,000 $\mu$g/kg toluene; and 6,880 to 66,200 $\mu$g/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 $\mu$g/kg from a depth of 4 to 6 feet; xylenes between 6,700 and 290,000 $\mu$g/kg from depths of 4 to 12 feet; and TPH, between 46.7 and 13,600 $\mu$g/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 $\mu$g/kg from the upper 6 feet and between 203 and 215 $\mu$g/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 Risk Based Concentrations (RBCs) developed by USEPA, Region III. 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 |

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

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.

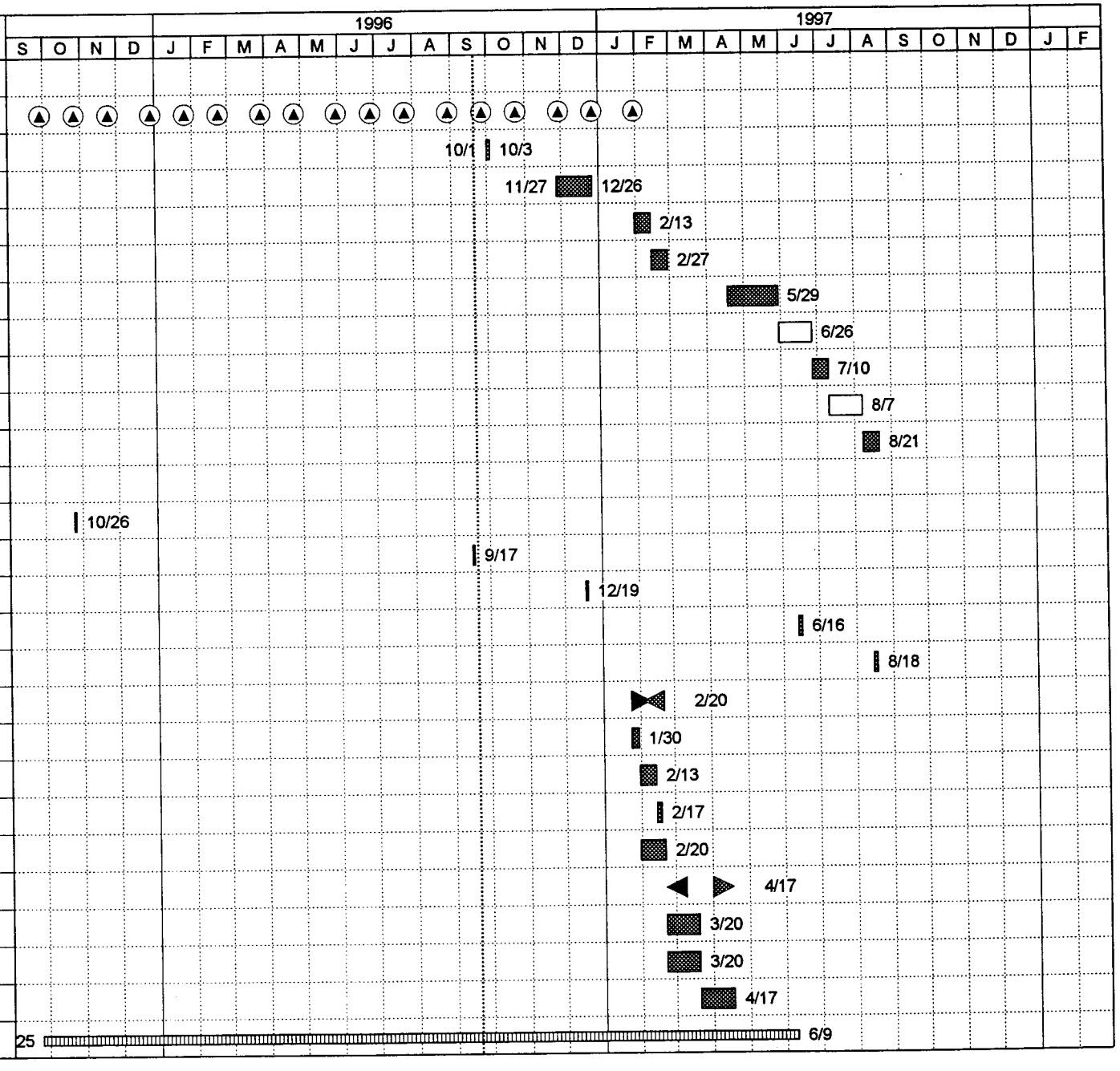
Source: Woodward-Clyde 1993.

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

| ID | Task Name | 1996 S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D | 1997 J | F | M | A | M | J | J | A | S | O | N | D | J | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **Notice to Proceed** | | 9/25 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | Project Work Plans | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | Pre-Draft | | | 11/14 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | USACE Review | | | | 12/27 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | Draft | | | | | 2/2 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | Regulatory Review | | | | | | | | | | | 6/25 | | | | | | | | | | | | | | | | | | | |
| 7 | Response to Comments | | | | | | | | | | | 7/19 | | | | | | | | | | | | | | | | | | | |
| 8 | Final | | | | | | | | | | | | 8/16 | | | | | | | | | | | | | | | | | | |
| 9 | Regulatory Review | | | | | | | | | | | | | 9/16 | | | | | | | | | | | | | | | | | |
| 10 | Approval | | | | | | | | | | | | | 9/16 | | | | | | | | | | | | | | | | | |
| 11 | Field Investigations | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | Passive Soil Gas Survey | | | | | | | | | | | | | | | 12/3 | | | | | | | | | | | | | | | |
| 13 | Obtain PSGS Modules | | | | | | | | | | | | | | 9/30 | | | | | | | | | | | | | | | | |
| 14 | Install PSGS Modules | | | | | | | | | | | | | | 10/3 | | | | | | | | | | | | | | | | |
| 15 | Retreive PSGS Modules | | | | | | | | | | | | | | 10/22 | | | | | | | | | | | | | | | | |
| 16 | Lab Analysis, PSGS | | | | | | | | | | | | | | 11/12 | | | | | | | | | | | | | | | | |
| 17 | Draft PSGS Report | | | | | | | | | | | | | | | 11/26 | | | | | | | | | | | | | | | |
| 18 | Finalize Boring Locations | | | | | | | | | | | | | | | 12/3 | | | | | | | | | | | | | | | |
| 19 | Soil Borings | | | | | | | | | | | | | | | | 2/13 | | | | | | | | | | | | | | |
| 20 | Mobilization | | | | | | | | | | | | | | | 11/26 | | | | | | | | | | | | | | | |
| 21 | Field Sampling & Drilling | | | | | | | | | | | | | | | 12/26 | | | | | | | | | | | | | | | |
| 22 | Lab Sample Analysis | | | | | | | | | | | | | | | | 1/23 | | | | | | | | | | | | | | |
| 23 | Field Documentation | | | | | | | | | | | | | | | | 1/2 | | | | | | | | | | | | | | |
| 24 | Data Validation | | | | | | | | | | | | | | | | | 2/13 | | | | | | | | | | | | | |
| 25 | Electronic Data Management | | | | | | | | | | | | | | | | | 2/13 | | | | | | | | | | | | | |

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

| ID | Task Name |
|---|---|
| 26 | Reporting |
| 27 | Monthly Progress Reports |
| 45 | Daily QC Reports |
| 46 | Daily QC Reports |
| 47 | Analytical Data |
| 48 | QC Summary Report |
| 49 | Pre-draft RFI Report |
| 50 | USACE Review |
| 51 | Draft RFI Report |
| 52 | Regulatory Review |
| 53 | Final RFI Report |
| 54 | Travel and Meetings |
| 55 | Site Visit |
| 56 | Field Mobilization Meeting |
| 57 | Demobilization Meeting |
| 58 | RFI Report Meeting 1 |
| 59 | RFI Report Meeting 2 |
| 60 | Screening Level Risk Evaluation |
| 61 | Initial Screening vs USEPA limits |
| 62 | Chem/Env. Data Evaluation |
| 63 | Ecological Site Visit |
| 64 | Identification of ARARS |
| 65 | Health/Env. Assessment |
| 66 | Exposure Assessment |
| 67 | Toxicity Assessment |
| 68 | Risk Characterization |
| 69 | Program & Project Management |



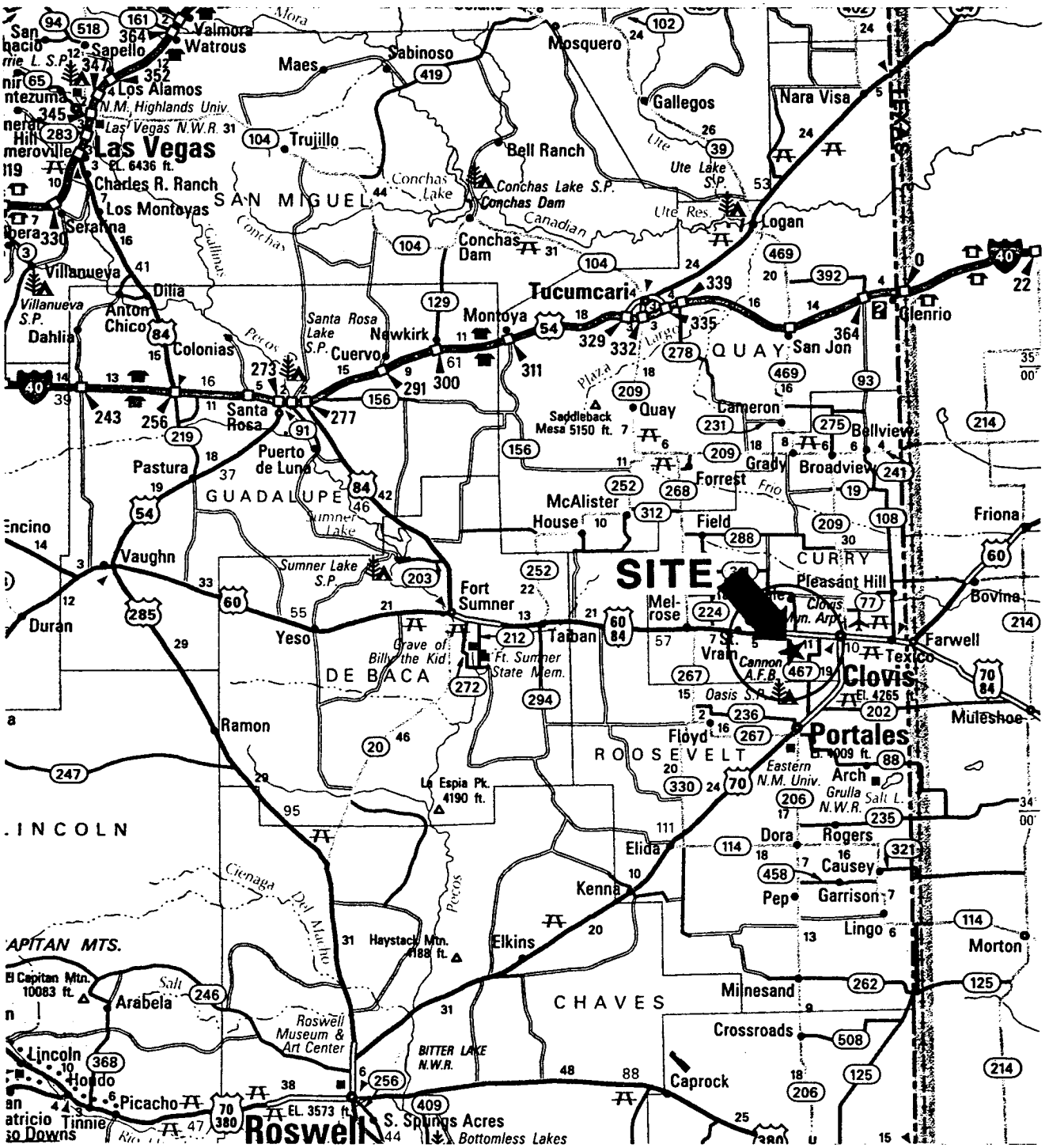



Figure 1-2
**VICINITY MAP**
CANNON AIR FORCE BASE
Clovis, New Mexico

HARZA *Consulting Engineers and Scientists*

c:\cdh\newmex\fig1-2.cdr

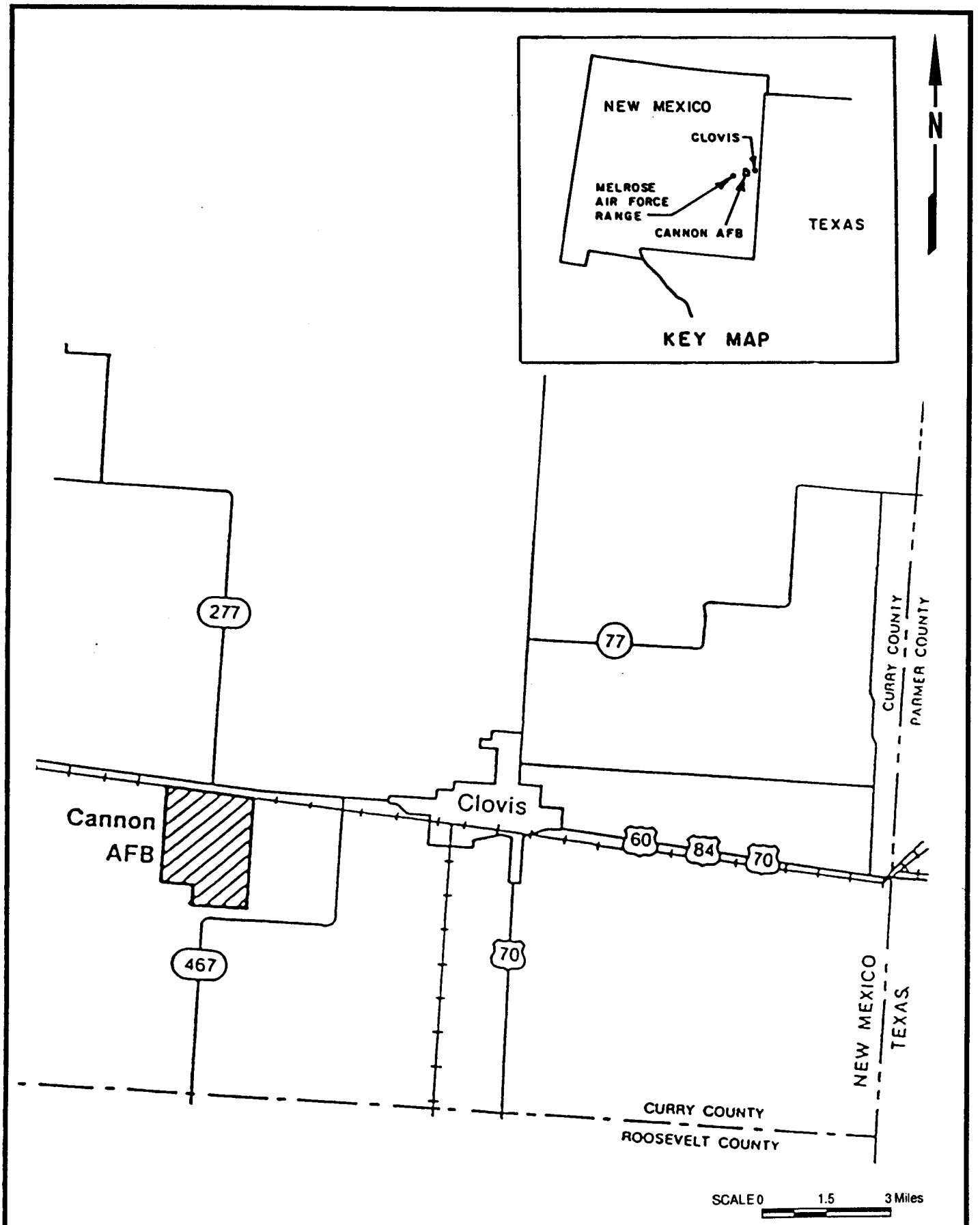



Figure 1-3
**SITE LOCATION MAP**
CANNON AIR FORCE BASE
Clovis, New Mexico

HARZA *Consulting Engineers and Scientists*

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

c:\cdr\nexmexfg1-4.cdr

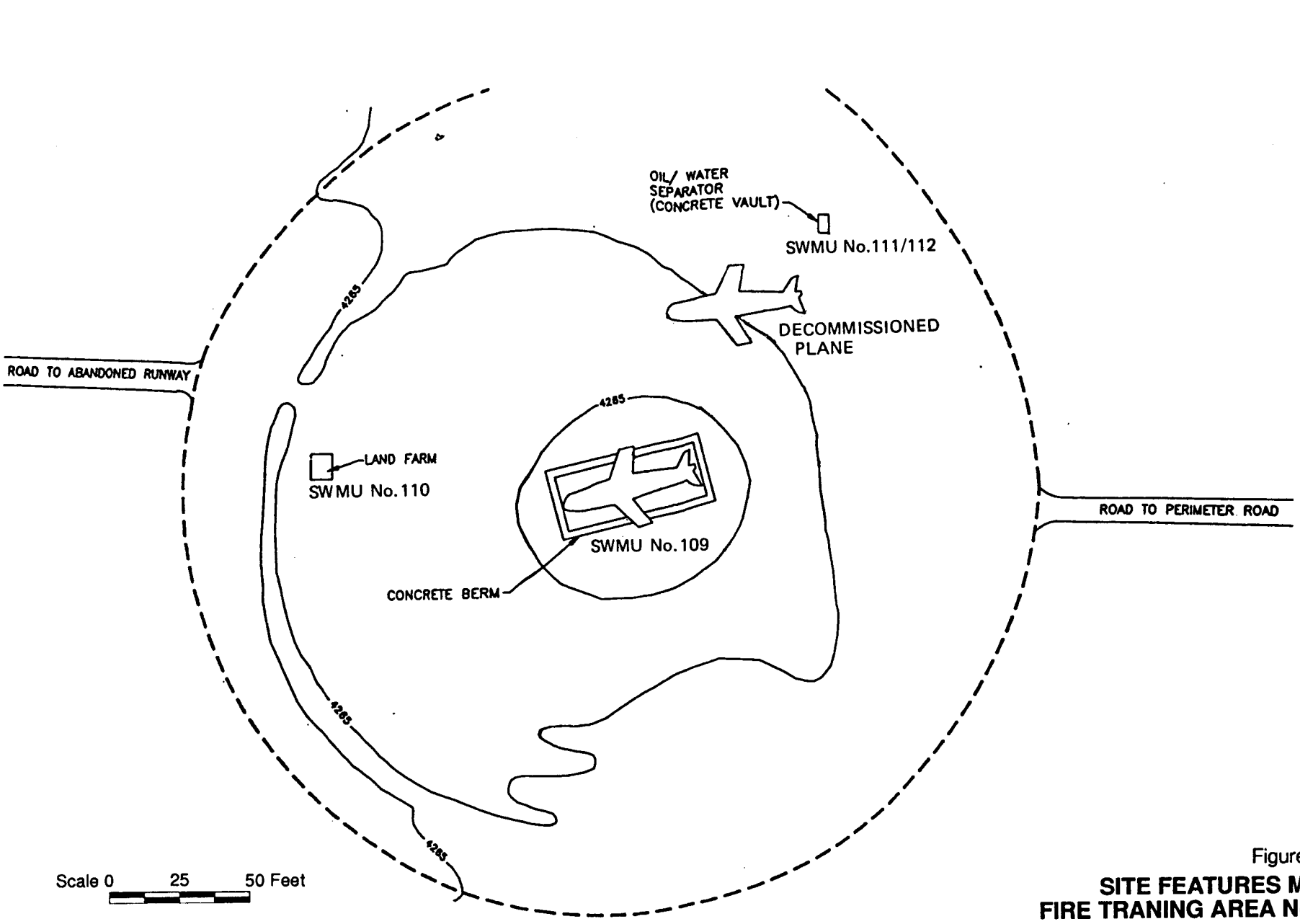



Figure 1-4

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

HARZA *Consulting Engineers and Scientists*

# 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

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*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<br>Derived in lab from: 01 (200 ml) | Client supplied |
| #04 - TCLP Extract for Metals<br>Derived in lab from: 01 (25 ml) | Client supplied |
| #05 - TCLP Extract for Metals<br>Derived in lab from: 01 (25 ml) | Client supplied |
| #07 - TCLP Extract for TVOA<br>Derived in lab from: 01 (25 ml) | Client supplied |
| #08 - TCLP Extract for TVOA<br>Derived in lab from: 01 (25 ml) | Client supplied |
| #06 - TCLP Extract for TABN<br>Derived in lab from: 01 (750 ml) | Client supplied |
| #09 - Mercury Digestion<br>Derived in lab from: 03 (50 ml) | |
| #10 - Mercury Digestion<br>Derived in lab from: 03 (50 ml) | |
| #11 - Mercury Digestion<br>Derived in lab from: 03 (50 ml) | |
| #12 - ICP Digestion<br>Derived in lab from: 03 (5 ml) | |
| #13 - ICP Digestion<br>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 | DDM |

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 |
| ayl 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 |
| ert-Butylbenzene | ND | ug/l | 0140 09/27/94 | 100 | EPA Method 8260 | DDM |

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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 | DDM |
| 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 |

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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 |
| TCLP 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 |
| TCLP 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) ($\mu$g/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
$\mu$g/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 | 8.0 | 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 | 10-15-91 | 1 | 2 | NA | 0 | 4265.24 | 100 | 10-27-91 |
| | HSA | F-10 | 6.5 | 0 to 22 | Continuous | 10-15-91 | 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 | 8.0 | 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 | 12-16-91 | 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.

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 |
| | | CAN109-1095-1265 | 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 |
| | | CAN109-1097-1265 | 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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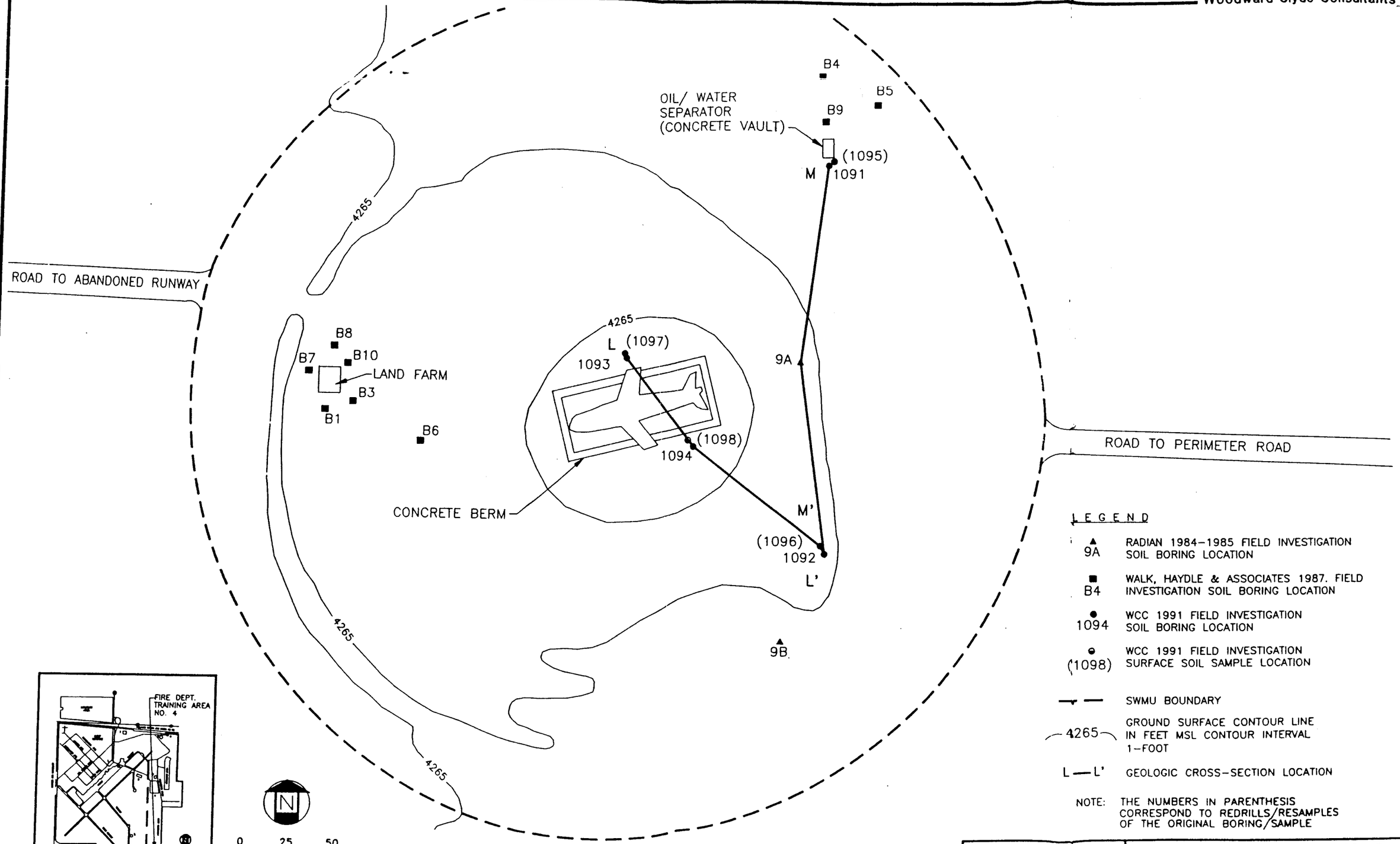


LEGEND

| | |
|---|---|
| ▲ 9A | RADIAN 1984–1985 FIELD INVESTIGATION SOIL BORING LOCATION |
| ■ B4 | WALK, HAYDLE & ASSOCIATES 1987. FIELD INVESTIGATION SOIL BORING LOCATION |
| ● 1094 | WCC 1991 FIELD INVESTIGATION SOIL BORING LOCATION |
| ◒ (1098) | WCC 1991 FIELD INVESTIGATION SURFACE SOIL SAMPLE LOCATION |
| —▾— | SWMU BOUNDARY |
| 4265 | GROUND SURFACE CONTOUR LINE IN FEET MSL CONTOUR INTERVAL 1-FOOT |
| L—L' | GEOLOGIC CROSS-SECTION LOCATION |

NOTE: THE NUMBERS IN PARENTHESIS CORRESPOND TO REDRILLS/RESAMPLES OF THE ORIGINAL BORING/SAMPLE

| | |
|---|---|
| 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)

## 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)

## 3.1 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.

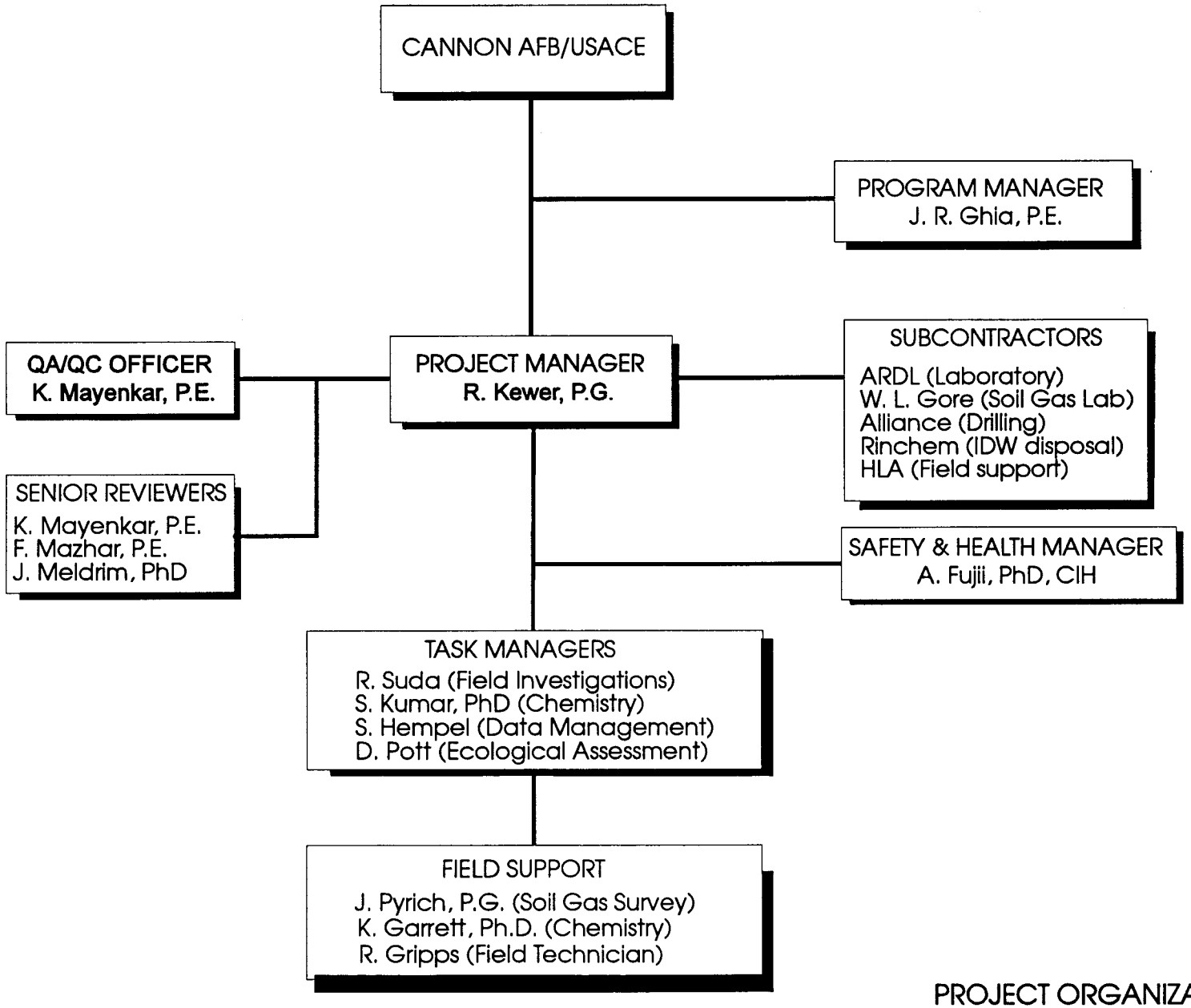


Figure 3-1
PROJECT ORGANIZATION CHART
Cannon Air Force Base
Clovis, New Mexico

# 4.0
# FIELD ACTIVITIES

## 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 RBC levels stipulated by U. S. EPA, Region III.

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 - 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)

**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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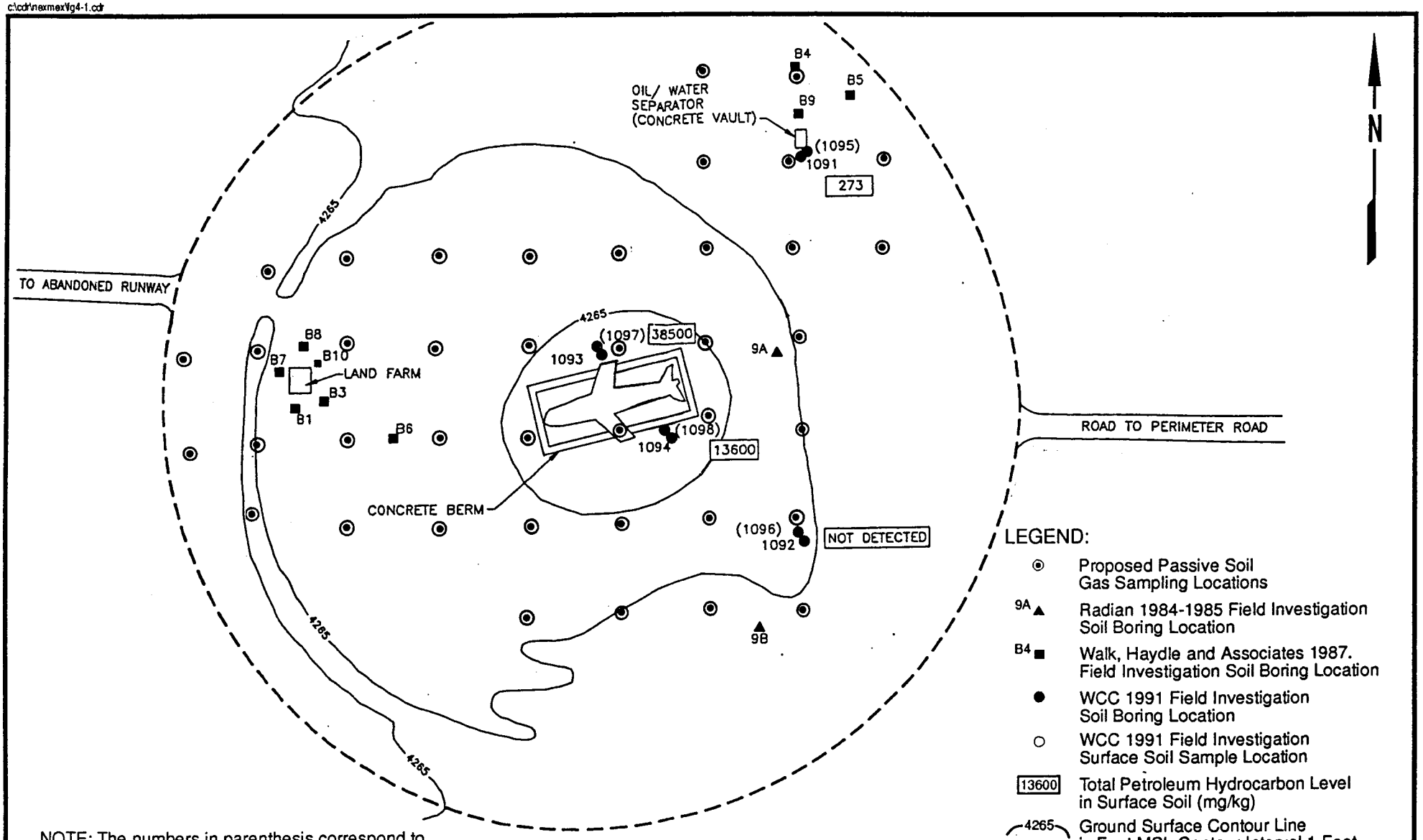


NOTE: The numbers in parenthesis correspond to redrills/resamples of the original boring/sample.

Scale 0 25 50 Feet

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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*

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

# CHAIN OF CUSTODY RECORD

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

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

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: Doug Mellema, 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: Ms. Margaret Calvert
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. |

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# SITE SAFETY AND HEALTH PLAN (SSHP)

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

September 1996

# SITE SAFETY AND HEALTH PLAN
# (SSHP)

## 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

September 1996

TITLE PAGE

# SITE SAFETY AND HEALTH PLAN

## 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

September 1996

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| | |
|---|---|
| AGE | Aerospace Ground Equipment |
| BETX | Benzene, Ethylbenzene, Toluene, Xylene |
| CAFB | Cannon Air Force Base |
| CGI | Combustable Gas Meter |
| CHSA | Corporate Health and Safety Administrator |
| CIH | Certified Industrial Hygienist |
| CHSO | Corporate Health and Safety Officer |
| CMHS | Hygiene/Chemical Safety Guidance |
| CMHS | Corporate Manager, Health and Safety |
| CRZ | Contamination Reduction Zone |
| ESDA | Emergency Service and Disaster Agency |
| EZ | Exclusion Zone |
| Harza | Harza Environmental Services, Inc. |
| HSM | Health and Safety Manager |
| HSP | Health and Safety Plans |
| HST | Health and Safety Technician |
| LEL | Lower Explosive Limit |
| MSD | Material Safety Data Sheet |
| NMED | New Mexico Environmental Department |
| OSHA | Occupational Safety and Health Administration |
| PID | Photoionization Detector |
| PM | Project Manager |
| PPE | Personal Protective Equipment |
| RFI | RCRA Facility Investigation |
| SCBA | Self-Contained Breathing Apparatus |
| SSHP | Site Safety and Health Plan |
| SSO | Site Safety Officers |
| SWMU | Solid Waste Management Unit |
| SZ | Support Zone |
| TPH | Total Petroleum Hydrocarbon |
| USACE | U. S. Army Corps of Engineers |
| USAF | U. S. Air Force |

# 1.0
# ADMINISTRATIVE INFORMATION

| | |
|---|---|
| Project Name: | Cannon Air Force Base, Fire Training Area #4 |
| Project Number: | 5644M |
| Project Manager: | Robert P. Kewer |
| Date of Issue: | September 20, 1996 |
| Effective Dates: | January 1, 1996 to July 19, 1996 |

Approvals:

| | |
|---|---|
| [signature] | 9-20-96 |
| Project Manager | Date |
| | |
| Health and Safety Manager | Date |

# 2.0
# INTRODUCTION

This Site Safety and Health Plan complies with Occupational Safety and Health Administration (OSHA) requirements contained in 29 CFR 1910.20. The Site Safety and Health Plan (SSHP) establishes guidelines and requirements for the health and safety of field personnel during field activities associated with U.S. Army Corps of Engineers Contract No. DACW-45-94-D-0044, Delivery Order No. 0006 at Cannon Air Force Base (CAFB) in Clovis, New Mexico. The specific activities addressed by this plan are defined in Section 6.0. All Harza on-site personnel and Harza subcontractors are required to read this plan and agree to abide by the provisions of this plan by signing the attached Employee Health and Safety Compliance Agreement provided in Appendix A. On-site personnel must also comply with the Harza written Health and Safety Program and the U.S Army Corps of Engineers, Safety and Health Requirements Manual EM 385-1-1. Copies of these manuals will be kept on site for reference by field personnel.

The health and safety guidelines and requirements presented are based on a review of available information and an evaluation of potential hazards. This plan outlines the health and safety procedures and equipment required for activities at this site to minimize the potential for exposures of field personnel. This plan may be modified by the Project Manager or the Health and Safety Manager (HSM) in response to additional information obtained regarding the potential hazards to field investigative personnel.

## 3.0
## STAFF ORGANIZATION, QUALIFICATIONS, AND RESPONSIBILITIES

Project personnel include the following:

| | | |
|---|---|---|
| USACE: | Technical Manager | Doug Mellema |
| CAFB: | CES/CEV | John Constantine |
| Harza: | Program Manager | Jitendra R. Ghia |
| | Project Manager | Robert P. Kewer |
| | Site Manager/Site Safety Officer | Robert W. Suda |
| | Health & Safety Manager (consulting) | Atsushi Fujii |

Responsibilities and qualifications of Harza health and safety positions are outlined below:

**Health and Safety Manager**. The HSM is a certified industrial hygienist (CIH) with experience in hazardous waste site operations. He is responsible for the development, implementation, oversight of the Health and Safety Program and the Site Safety and Health Plan and is available to the field team should problems arise in these areas.

**Site Safety Officer**. The Site Safety Officer (SSO) will implement and continually enforce the Health and Safety Program and specific plan elements on site. He has specific training, knowledge, experience necessary to implement the plan and verify compliance with applicable health and safety requirements. The SSO will give the initial site health and safety briefing prior to beginning site work and subsequent onsite health and safety briefings as necessary. The SSO has the authority to stop field activities if conditions become unsafe.

**Other Field Personnel**. Other field personnel will have received applicable health and safety training and will be responsible for observing requirements of the Site Safety and Health Plan while on site and assisting the HSM in enforcing the plan. The SSO may delegate the responsibility for monitoring or calibration of instruments to other field personnel. Other field personnel will be required to attend the initial health and safety briefing given by the SSO prior to beginning their site work.

## 4.1 Basic Off-Site Training

Forty hours of off-site training or equivalent is required for all field personnel including subcontractor personnel. Training meets the requirements of 29 CFR 1910.120 (e). Topics include:

- Safety, health, and other hazards associated with the site work.
- Bloodborn diseases.
- Use of personnel protective equipment, including necessary use of respirators.
- Work practices to minimize risk.
- Safe use of engineering controls and equipment.
- Medical surveillance requirements, including recognition of symptoms and signs indicating overexposure to hazards.
- Site control measures.
- Decontamination procedures.
- Emergency response plan and emergency equipment.
- Confined space entry procedures.

## 4.2 Field Training

Three days of actual field experience under the direct supervision of trained, experienced supervisor are required for all field personnel.

## 4.3 Refresher Training

Eight hours of annual refresher training are required for all field personnel. This training must occur within 12 months of the basic training course or the last refresher course.

## 4.4 Management Training

Eight hours of training is mandatory for onsite managers and supervisors who are directly responsible for employees engaged in hazardous waste operations.

As a minimum, the SSO will be currently certified in First Aid/CPR by American Red Cross or equivalent agency and will be present on site during site operations. All site personnel will attend a

health and safety briefing given by the SSO prior to beginning site work. The SSO has the authority to stop field activities if conditions become unsafe.

## 5.1 Overall Site

CAFB is located about 7 miles west of Clovis, New Mexico in Curry County, New Mexico (Figure 1). Since 1971, the primary mission of CAFB has been to develop and maintain an F111D tactical fighter wing, capable of day, night and all-weather combat operations and to provide replacement training of combat aircrews for tactical organizations worldwide. Currently, there are approximately 70 F111D aircraft assigned to CAFB (USAF, 1990).

## 5.2 Fire Training Area No. 4 (SWMU Nos. 109, 110, 111, 112)

Fire Training Area No. 4 is located in the southeast corner of CAFB, as shown on Figure 1. Site features are shown on Figure 2.

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 RCRA Facility Investigation (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 which was later replaced with the oil-water separator in approximately the same location.

The Fire Training Area (SWMU No. 109) encompasses the three other SWMUs comprising the investigation area and is active and frequently used. 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 is located roughly in the center of the area. Immediately below the mock airplane is a concrete "pan" which has internal drainage features such that excess fuel/water is drained to the oil-water separator (SWMU No. 112) in the northeast part of the area. A more recent

addition to the site is a decommissioned airplane located about 100 feet northeast of the mock airplane. 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. The unlined pit was used to collect runoff from the general area and JP-4 left after fires were extinguished in training exercises. 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.

Previous investigations have detected the presence of contaminants in site soils. Based on data reported by Woodward - Clyde Consultants, Inc. (W-C), contaminants have included the following:

- Inorganics
  - Heavy metals, including arsenic, barium, lead and chromium
- Organics
  - Benzene, ethylbenzene, toluene, xylene (BETX)
  - Total petroleum hydrocarbons (TPH)
  - Oil and grease

Highest concentrations reported from surface soil samples in the previous investigations included: benzene (1,060 $\mu$g/kg); toluene (762 $\mu$g/kg); total xylene (6,940 $\mu$g/kg); TPH (38,500 mg/kg); chromium (10 mg/kg); and lead (6.8 mg/kg). Highest concentrations reported from subsurface soil samples included: benzene (15,200 $\mu$g/kg); toluene (64,000 $\mu$g/kg); xylene (173,000 $\mu$g/kg); ethylbenzene (56,200 $\mu$g/kg); arsenic (152 mg/kg); cadmium (1,713.5 mg/kg); chromium (10.5 mg/kg); lead (39 mg/kg); and TPH (8,300 mg/kg).

Physical properties and health hazard characteristics of chemicals which may be encountered during the site investigations are provided in Table 1.

# 6.0
# SCOPE OF WORK

The generalized scope of work for the Fire Training Area No. 4 (SWMU Nos. 109, 110, 111, 112) RCRA Facility Investigation (RFI) includes:

- A 40 point passive soil gas survey - Harza personnel will bore 1 to 3 foot deep holes using a manually operated slide hammer. Soil gas collector devices provided by the supplier will be installed in the holes and left in place for 2 to 3 weeks, then retrieved manually by Harza and shipped to the laboratory.
- A drilling program consisting of approximately twelve 100-foot deep borings, drilled by subcontractor using Rotasonic methods. Harza activities during drilling will include collection of approximately 139 soil samples for chemical analysis from the retrieved cores, and headspace screening and immunoassay screening of soil samples.

The objective of the work is to identify and quantify contaminants which may be present in surface and subsurface soils within Fire Training Area No. 4 and the individual SWMUs included therein.

## 7.1 Chemical Hazards

Chemical hazards expected to be encountered at this site include co-mingled waste oils, solvents, and JP-4 fuel. Physical properties and health hazard characteristics of chemicals which may be encountered at the site are shown in Table 1. Abbreviations for Symptoms of Exposure and Target Organs is provided in Table 2. Material Safety Data Sheets for these materials are included in Appendix B.

The passive soil gas survey will require intrusive work to a depth of approximately 1 to 3 feet. A steel rod approximately 3/4" in diameter is driven into the ground and retracted to make a hole to place the soil gas sampler into. Soil is not removed from the hole. The potential routes of exposure to chemical hazards for this activity include inhalation, ingestion and dermal contact. The potential for exposure via all routes is expected to be low as the amount of contaminated soil exposed will be limited.

The greatest risk of chemical exposure is likely to occur during drilling activities. The potential routes of exposure include inhalation, dermal contact, and ingestion.

Compounds with a high vapor pressure may enter the borehole during drilling activities. However, in general the concentration of contaminants in air decreases quickly after exiting the borehole. Personnel should not be exposed to high concentrations of contaminants in their breathing zone. However, monitoring equipment will be used to protect personnel from these hazards. Without using monitoring equipment, the risk of chemical exposure via inhalation is expected to be moderate during drilling operations.

Some solvents and fuels can be absorbed through the skin. However, it is anticipated that personnel will not come into contact with significant amounts of contaminated materials due to the nature of the field activities to be conducted during drilling and sampling. The potential for exposure to chemicals of concern is expected to be low. There is a possibility that airborne particulates contaminated with residual surfactants may be generated during dusty conditions.

The potential for exposure to chemicals of concern by ingestion of contaminated materials is expected to be low. Personnel on site are expected to utilize good personal hygiene practices. In addition, specific procedures have been developed to prevent personnel from ingestion exposures.

## 7.2 Physical Hazards

### 7.2.1 Drilling

The hazards involved with the use of drill rigs are significant and include the hazards of pinch points; entrapment in machinery; impact from moving parts; fatigue; electrocution from lightning, overhead wires, or buried utilities; and improper operations. Use of hand tools, moving the rig, and conducting required repairs can increase physical risks. Excessive noise may be generated from drilling rigs. Working with and around a drill rig can involve a high risk of serious injury or death.

Work around heavy equipment can always be dangerous. Workers must be careful to communicate with heavy equipment operators regarding their location and should maintain a safe distance from operating equipment at all times.

### 7.2.2 Personal Protective Equipment

Personal protective equipment (PPE) which may be required for some activities places a physical strain on the wearer and may increase the risk of heat stress. In addition, PPE such as gloves and protective clothing limits manual dexterity and physical movement.

### 7.2.3 Noise Exposure

Work at this site will be conducted near drill rigs which may expose personnel to high noise levels. In addition, workers may be exposed to noise from jet engines on nearby taxiways.

### 7.2.4 Slips, Trips, and Falls

Some sampling may be completed in areas with steep slopes, muddy or slippery surfaces and uneven ground. Workers in these areas risk injury by slips, trips, and falls.

### 7.2.5 Heat Related Hazards

Work may be performed in periods of hot/humid weather. Working during hot and humid weather may cause heat exhaustion, heat stress or heat stroke.

### 7.2.6 Cold Related Hazards

Work may be performed in periods of cold weather. Working during cold weather may cause hypothermia or frost bite.

## 7.3 Biological Hazards

### 7.3.1 Insects

During field work at this site, personnel may encounter a wide variety of insects including bees, mosquitos, biting flies, ticks, and spiders. Field personnel are encouraged to use insect repellent when mosquitos or biting flies are present.

Stings of bees and wasps may cause serious allergic reactions in certain individuals. The SSO should identify all personnel with known insect allergies or sensitivities before field work begins.

Spider bites can be extremely serious, e.g., those of the black widow or brown recluse. Others are unpleasant or uncomfortable, resulting in rashes, itching, and possible infection. The possibility of allergies greatly increases the danger since people are not usually aware of such allergies until they have been bitten. Therefore, spiders should be regarded as potentially hazardous.

Ticks are parasites that feed on the blood of an animal/human host and can carry several severe diseases, the least bringing several days of fever and pain and the worst causing brain damage. This hazard is discussed in greater detail in Appendix C.

### 7.3.2 Other Animals

Chipmunks, ground squirrels, rats, and other mammals have been known to harbor fleas carrying bubonic plague. Their bites can also transmit rabies and other infections. Chipmunk-like animals pose a special problem because people tend to try to feed them or pet them, increasing contact and bringing greater possibility of danger. Wildlife should be avoided when possible.

Poisonous snakes may also be encountered on site. Personnel should check for snakes before walking through grassy or debris-strewn areas. Care should be taken when lifting possible habitats of snakes and spiders such as debris and cover.

## 8.1 Personnel Clearance

Harza employees must obtain health and safety clearances before beginning field work at the CAFB. Harza employees assigned to field operation must have (1) been certified by a Harza physician as being physically fit and able to perform their assigned field work, (2) successfully completed a 40-hour basic health and safety training course (Level C) for field personnel or the equivalent and subsequent 8-hour refresher courses, and (3) passed a respirator fit test with isoamyl acetate and/or irritant smoke as indicators. Site managers and supervisors must have successfully completed an 8-hour manager's health and safety course in addition to all other clearance requirements. The SSO must have current certification in CPR and First Aid in addition to requirements for field personnel.

Harza subcontractor employees must also provide documentation of similar medical, training, and respirator fit clearances and will be required to provide proof of clearance before beginning work.

## 8.2 Safety Briefings

Before field work begins, all field personnel must be briefed by the SSO on their work assignments and safety procedures contained in this document. Each person must be provided with and read a copy of this SSHP. At the end of the meeting, attendees should be informally quizzed to assess their understanding of the health and safety requirements, and should sign a safety compliance agreement form stating that they have read, understand, and agree to comply with the provisions of this plan. Individuals refusing to sign the agreement will be prohibited from conducting field work during this investigation.

## 8.3 Visitor Clearance

Visitors entering a contamination reduction zone and exclusion zone at Fire Training Area No. 4 will be required to read and verify compliance with the provisions of this SSHP. In addition, visitors will be expected to comply with relevant OSHA requirements such as medical monitoring and training. Visitors will also be expected to provide their own protective equipment. For government visitors, four extra sets of PPE (not including respirators, prescription safety glasses, or safety boots) shall be maintained on site.

In the event that a visitor does not adhere to the provisions of the SSHP, he/she will be requested to leave the work area. All non-conformance incidents will be recorded in the site log.

## 8.4 Distribution of Health and Safety Plan

Before field work begins, a copy of this SSHP must be provided to each Harza and subcontractor employee assigned to field work on the project as well as to an authorized representative of each firm contracted by Harza to perform work on site. The SSO is responsible for ensuring that a copy of the plan is available whenever work is in progress.

## 8.5 Accident/Incident Reporting

In the event of an accident or incident, the SSO will immediately notify the Harza Project Manager and HSM. Types of accidents or incidents that are considered reportable are:

- Illness resulting from chemical exposure or unknown causes,
- Physical injury, including an injury that does not require medical attention,
- Fire, explosions, and flashes resulting from activities performed by Harza and its subcontractors,
- Infractions of safety rules and requirements, or
- Unexpected chemical exposures.

Work will be suspended to correct the cause of the accident/incident and to modify this plan as necessary. Minor accidents/incidents will be noted on the Daily Safety Inspection Report. For a major accident/incident, an Accident Investigation Report (ENG FORM 3394, Appendix D) must be submitted to the USACE Technical Manager within two working days and to the PM and HSM.

## 8.6 Heat/Cold Stress Monitoring

The site is located in eastern New Mexico which is subject to severe cold and wind conditions in the winter and hot conditions in the spring, summer and fall. Field work is expected to take place in winter and spring. A field trailer provided with temperature control will be located near the site.

Cold stress monitoring will be implemented at any time the ambient temperature or the wind chill factor is $32^0$ F or less. A wind chill table (cooling power of wind on exposed flesh, expressed as equivalent temperatures) is provided in Table 3. Cold stress monitoring will include recognizing warning symptoms, such as reduced coordination, drowsiness, impaired judgement, fatigue, or numbing of toes and fingers. Frequent breaks will be taken in warm areas to relieve workers from the cold.

Heat stress monitoring will be implemented at any time temperatures are $70^0$ F, or above. The heat stress monitoring program will include recognizing warning symptoms such as rashes, cramps, discomfort and

drowsiness, and impaired functional ability. Frequent breaks will be taken in cool areas to relieve workers from heat and to provide them with liquids. The monitoring program will also include the following physiological measurements: heart rate; oral temperature; skin temperature; and if possible, body weight.

### 8.7 Safety Reports

The SSO will prepare Daily Safety Inspection Reports (Appendix E). The daily safety report will document health and safety-related matters. Information recorded will include weather conditions, monitoring instrument readings, records of initial and subsequent health and safety briefings, wind direction, levels of protection worn, upgrades/downgrades in level of protection, and records of site safety inspections by the HSM. The daily safety inspection report will be submitted to USACE as part of the Daily QC Reports for this project. Any significant deviations from the HSP or Harza health and safety policy will be reported by the SSO to the HSM. The SSO will also report any stop-work situations and incidents to the Harza project manager, the HSM and the USACE project manager.

### 8.8 Work Zones

Work zones will be required for drilling and soil-gas surveys. For these activities the following procedures are mandatory. Three work zones will be established around each sampling location: the exclusion zone (EZ), the contamination reduction zone (CRZ), and the support zone (SZ). An EZ is an area where contamination could or does occur. The EZ will be demarcated using orange cones and/or flagging. All Harza or subcontractor personnel who enter the EZ must be cleared by the SSO, have signed a safety compliance agreement form, and wear the level of protective equipment specified in Section 9.0 of this plan.

The CRZ is located immediately outside the exclusion zone. This zone is designed to limit the migration of contaminants from potentially contaminated areas to non-contaminated areas. Decontamination is conducted in this area near individual work locations.

The support zone is an uncontaminated area. Supporting equipment and facilities will be located in this area upwind of the EZ and CRZ.

## 8.9 Laboratory Considerations

Analysis of all samples collected during the investigation from the site will be handled by the contract laboratory. The laboratory director shall be informed that the samples may contain hazardous levels of contaminants that would require special handling procedures to prevent risks to the health and safety of laboratory personnel.

## 9.1 Personal Protective Equipment

Personnel on site must comply with the levels of protection outlined below and in Sections 9.1.1 and 9.1.2. Clothing and respirators must be stored properly to prevent damage or malfunction due to exposure to dust, moisture, sunlight, damaging chemicals, extreme temperatures, and impact. Prior to use, PPE clothing should be visually inspected for imperfect seams, non-uniform coatings and tears, malfunctioning closures, punctures or discoloration. Respirators should be checked before each use for cleanliness, deterioration, pliability, and distortion. Cartridges or canisters should be checked to insure that they have not been used previously, that they contain the proper sorbents, and that the expiration date has not passed. Face shields should be checked for cracks and fogginess. Attachment 1 provides information on field respirator pressure tests and general procedures for respiratory care and cleaning.

### 9.1.1 Hearing Protection

Noise levels in excess of 85 dBA, 8 hour time weighted average will require hearing protection. Such levels may be associated with drilling operations and overhead air traffic. Hearing protection is required during this investigation for exposures of greater than 90 dBA for any length of time. In the absence of instrumentation, an appropriate rule of thumb is that when normal conversation is difficult at a distance of two to three feet, hearing protection is required. Harza personnel and their subcontractors shall have hearing protection on site for use by their employees.

### 9.1.2 Personal Protection Levels

Levels of personal protection are as follows:

Level D:

- Hard Hat (when working around heavy equipment and when overhead hazards exist)
- Steel Toe and Shank Boots (when working around heavy equipment)
- Safety Glasses with side shields or goggles (as required by OSHA)
- Hearing Protection

Modified Level D:

- Uncoated Tyvek coveralls taped at ankles and wrists
- Hard Hat (when working around heavy equipment overhead hazards exist)
- Steel Toe and Shank Boots (when working around heavy equipment)
- Boot Covers
- Safety Glasses with side shields or goggles (as required by OSHA)
- Nitrile Gloves (when handling soils within the exclusion zone)
- Latex or Nitrile Inner Gloves (when handling soils within the EZ)
- Hearing Protection

Level C:

- Full face respirator with combination organic vapor/particulate filter cartridges
- Saranex coated Tyvek coveralls taped at ankles and wrists
- Hard Hat (when overhead hazards exist)
- Steel Toe and Shank Boots (when working around heavy equipment)
- Boot Covers (except for work in boats or on floating platforms)
- Safety Glasses with side shields or goggles (as required by OSHA)
- Nitrile Gloves (when handling soils within the exclusion zone)
- Latex or Nitrile Inner Gloves (when handling soils within the exclusion zone)
- Hearing Protection

### 9.1.3 Initial Levels of Protection

Level D will be the initial level of protection for the soil gas survey. Drilling and soil sampling will require level D Modified for personnel who will perform sampling and sampling equipment decontamination. Upgrades in the initial levels of protection for each activity will be made, if necessary, based on air monitoring results and/or field observations in accordance with Section 9.3 of this SSHP.

## 9.2 Air Monitoring Requirements

### 9.2.1 Exposure Monitoring/Air Sampling Program

Air monitoring will be conducted during all drilling and sampling procedures. Air monitoring will be accomplished with an HNu photoionization meter with an 11.7 eV probe at the beginning of each work

day, at each time a soil sample is recovered, at least hourly while work is underway, and at any other time the SSO deems necessary. If jet aircraft activity is taking place in close proximity to the work, the HNu will be used to monitor the presence of organics such as jet fuel. An MSA Model 360 $H_2S$/ Combustible Gas Meter with an oxygen alarm also will be used continuously during drilling activities in the alarm mode with readings taken hourly. Available site conditions do not indicate the need for personal exposure monitoring.

The HNu will be calibrated before field work begins each day. The Combustible Gas Meter will be calibrated at least weekly using calibration gases provided by the equipment manufacturer. Manuals for the HNu and Combustible Gas Meter will be available on site at all times for reference during calibration and maintenance. Model 360 $H_2S$ response to interferants and conversion factors for the HNu are provided in Attachment 2, along with calibration instructions.

#### 9.2.2 Recordkeeping

A summarization of daily monitoring results will be kept in the field log book and on the Daily Safety Inspection Reports.

### 9.3 Action Levels

Based on air monitoring and field observations, the following action levels are identified for the field investigations:

| MONITORING EQUIPMENT | SAMPLING RESULT | ACTION |
|---|---|---|
| PID | Any breathing zone readings over 5 ppm (sustained for 1 minute or more). | Upgrade to Level C PPE. Initiate monitoring at minimum 15 minute intervals. |
| PID | Any breathing zone readings over 25 ppm (sustained for 1 minute or more). | Stop work and Contact the HSM. |
| CGI | > 10 percent LEL | Initiate continuous monitoring. |

| | | |
|---|---|---|
| CGI | > 20 percent LEL | Stop work. Work may be resumed when concentrations drop to 10 percent LEL. Continuous monitoring required for the borehole. |
| Observation | Unusual odors are detected or symptoms of possible exposure occur in any individual while on the job (See MSD sheets in Appendix B for symptoms). | Stop work and Contact the HSM. |

If site conditions require a higher personal protection level than level C, then all persons must leave the site area. As discussed in Section 9.2.1, elevated levels of organic chemicals, such as jet fuel, may occur associated with nearby aircraft operations. The above action levels were developed with consideration of such possible occurrences and are based upon instrument readings in the worker's breathing zone whether due to contamination at the work site or ambient conditions.

## 9.4 Decontamination

### 9.4.1 Personnel Hygiene and Decontamination

All personnel, clothing, and samples leaving the Exclusion Zone must be decontaminated. Decontamination equipment shall be present on site. A temporary decontamination line will be set up at each boring location and decontamination conducted should personnel have contact with grossly contaminated material.

The temporary decontamination line should provide sufficient space to wash and rinse boots, gloves and all sampling equipment prior to placing equipment into a vehicle, as well as a place to discard of used disposable items such as gloves and tyvek. Personnel are advised to shower as soon as possible after leaving the site.

### 9.4.2 Equipment Decontamination

A temporary equipment decontamination pad will be set up on site at a location designated by CAFB personnel. Heavy equipment will be decontaminated with a steam or high pressure sprayer prior to leaving the site. Decontamination water will be contained or allowed to evaporate.

## 9.5 Work Practices

### 9.5.1 Personnel Precautions

- Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth transfer and ingestion of material is prohibited in the exclusion zone and the contamination reduction zone. The drinking of water, Gatorade, or equivalent fluids may occur in the CRZ at the discretion of the SSO after personnel have washed their hands and face.
- Smoking, carrying lighters and/or matches is prohibited in the exclusion zone and the contamination reduction zone.
- No jewelry may be worn by personnel engaged in field work, except for watches, which will be disposed of if they become contaminated.
- No facial hair which interferes with a satisfactory fit of the mask-to-face seal is allowed on personnel required to wear respirators or self-contained breathing apparatus (SCBAs).
- When respirators are worn, personnel will check the mask seal by positive and negative pressure tests daily. Respirator cartridges will be changed immediately upon odor breakthrough of airborne chemicals, or daily at a minimum. There will be no sharing of respirators between personnel.
- Contact lenses will be forbidden in Exclusion Zones and Support Zones.
- Medicine and alcohol can enhance the effects from exposure to toxic chemicals. Prescribed drugs should not be taken by personnel on operations where the potential for absorption, inhalation, or ingestion of toxic substances exists unless specifically approved by a qualified physician. Alcoholic beverage intake will not be allowed during working hours or breaks.
- No person will enter an exclusion zone alone.
- No one will approach or enter areas or spaces where toxic of explosive concentrations of gases or dust may exist without proper equipment available to enable safety entry.
- Entry into trenches or confined spaces will not be permitted.
- Field personnel should remain aware of wind direction during field activities. Equipment set-up and sampling efforts should be directed so that workers remain upwind of potential sources of exposure.
- No drilling activities will be permitted during periods of thunderstorms and lightning.
- Personnel will avoid areas where there is obvious discoloration of soil or water.
- All personnel must adhere to the information contained in the site Safety and Health Plan.

### 9.5.2 Drilling

Working with and around a drill rig can involve a high risk of serious injury or death. In order to reduce the risk, proper safety precautions must be observed at all times. Drill rig safety rules will be observed in accordance with the Contractor's Health and Safety Program. As a minimum, the following will apply:

- When working around a drill rig, personnel are required to wear hard hats. In addition, no loose fitting clothing is allowed in the vicinity of the drill rig as it may get tangled in augers, cathead and other equipment.
- All cables and ropes should be in good condition with no frays or damaged sections. All hooks used on ropes or cables should be moused or have protective doges to prevent them from jumping off the items which they are hoisting.
- All hoisting plugs shall be in good repair. Hoisting plugs with worn threads or damaged bearing shall not be used.
- Closed faced hoisting plates shall not be used when the drill rod does not extend at least 5 feet above the derrick.
- Personnel shall not be allowed to shovel cuttings away from the auger when it is spinning.
- All kill switches on the drill rig must be operable. To ensure operability, they should be checked daily.
- Drill rig personnel must be trained in the safe and effective operation of the drill rig and be familiar with its safety devices.
- No drill rig equipment should be allowed to operate within 15 feet of the overhead power lines as a potential for electricity arcing to the derrick exists.

### 9.5.3 Buddy System

The "buddy system" will be used during all field work requiring the use of disposable coveralls and/or work around drill rigs or other heavy equipment. At no time will an individual enter or leave an exclusion zone alone. Before entering an exclusion zone, each individual will identify his/her "buddy."

### 9.5.4 Confined Space Entry Procedures

No confined space entry will be required or permitted during these field activities.

### 9.5.5 Spill Containment Program

Due to the nature of the work at this site, a spill containment program will not be required.

### 9.5.6 Excavation Safety

No excavations will be required or permitted during these field activities.

### 9.5.7 Material Handling Procedures

All soils and decontamination water will be placed in 55-gallon drums and stored at the temporary drum storage area designated by appropriate CAFB personnel, until results of laboratory analysis have been completed. The 55-gallon drum will be marked identifying Fire Training Area No. 4, SWMU No. 109, the boring numbers, the date collected, contractor identification, and the telephone number for the 27 SG CEV office. The drums will also be labeled "contents waiting testing."

### 9.5.8 Machine Guarding

Machine guarding requirements are not required at this site.

### 9.5.9 Fall Protection

Work at elevated locations is not anticipated for this project, with the possible exception of repair work on a piece of drilling equipment. Any personnel conducting work at an elevated location will use fall protection as provided in 29 CFR 1926.104, with a lifeline or lanyard to prevent the worker from falling more than six feet.

### 9.5.10 Illumination

No night work will be allowed during this investigation.

### 9.5.11 Sanitation

Shower facilities will not be required during this investigation. Potable water and toilet facilities which comply with 29 CFR 1910.120(n) are located in the airport facilities that are available for worker use.

### 9.5.12 Communications

**9.5.12.1 On-Site Communications.** Due to the limited field work and number of personnel required for this project, on-site communications systems will not be utilized. The "buddy system" will be employed at this site, and personnel will be within site of the SSO during all field activities.

**9.5.12.2 Off-Site Communications.** The SSO will have access to a phone in the project vehicle during drilling activities.

## 10.1 Emergency Services

### 10.1.1 Emergency Phone Numbers

| | | |
|---|---|---|
| All Emergencies: | From a commercial phone: | 911 |
| | From a base phone: | 4117 |
| Security Police: | | 784-2667 |
| Fire Department: | | 784-3117 - Report Only |
| | | 784-4852 - All others |

Hospital:

Life threatening injury/illness
Cannon Air Force Base Hospital
Building 1400
784-4033 (Ambulance)
784-4852 (All others)

Non-life threatening injury/illness
Clovis High Plains Hospital
2100 N. Thomas
769-2141

| | | |
|---|---|---|
| Other: | Poison Control | (800)952-0123 |
| | ESDA (Emergency Service and Disaster) | (800)782-7862 |

### 10.1.2 Hospital Route

Hospital route maps are included as Figures 3 and 4. Hospitals were contacted by telephone for preparation of this SSHP. Both hospitals indicated the ability to accept potentially contaminated patients.

Cannon AFB Hospital. The base hospital is located in Building 1400 on Casablanca Avenue on the northwest corner of the base.

Clovis High Plains Hospital. Exit CAFB and turn left on 7th Street (at the 1st light) then turn north (left) on Thomas (at the second light). The hospital is on the west side of the road.

### 10.1.3 Harza Contacts

- Robert P. Kewer, Project Manager (312-831-3812)
- Atushi Fujii, Health and Safety Manager, (312-984-5055)

## 10.2 Emergency Response Procedures

The Site Manager, with assistance from the SSO, has responsibility and authority for coordinating all emergency response activities until proper authorities arrive and assume control.

### 10.2.1 Emergency Medical Treatment

If an employee working in a contaminated area is physically injured, Red Cross first aid procedures will be followed. Depending on the severity of the injury, emergency medical response may be sought. If the employee can be moved, he/she will be taken to the edge of the work area where contaminated clothing will be removed (if possible) and emergency first aid administered, and then they will be transported to the hospital.

**10.2.1.1 Emergency Medical Procedures.** For severe injuries, illnesses, or overexposures:

- Remove the injured or exposed person(s) from immediate danger.
- If possible, at least partial decontamination should be completed. Wash, rinse, and/or cut off protective clothing and equipment and redress the victim in clean coveralls.
- If decontamination cannot be done, wrap the victim in blankets or plastic sheeting to reduce contamination of other personnel.
- Render emergency first aid and call an ambulance for transport to local hospital immediately. Notify emergency personnel of contaminants on-site. This information, which is included in Appendix A and Section 4.0, should be sent with the victim to the hospital.
- Evacuate other personnel on site to a safe place until the SSO determines that it is safe to resume work.
- Report the accident to the PM and HSM immediately and complete an incident report.

For minor injuries or illnesses:

- Complete a full decontamination.
- Administer first aid. Minor injuries may be treated on site, but all injuries will be examined by trained medical personnel. Victims of serious bites or stings will be taken to a medical center.
- Notify the PM and HSM immediately.

**10.2.1.2 First Aid - Chemical Injury.** If the injury to the worker is chemical in nature (e.g., overexposure), the following first aid procedures are to be instituted as soon as possible:

| | |
|---|---|
| Eye Exposure | If contaminated solid or liquid gets into the eyes, wash eyes immediately with sterile saline solution lifting the lower and upper lids occasionally. Continue eye wash for 15 minutes. Cover the eye with a dry pad and obtain medical attention immediately. (Contact lenses are not permitted in the exclusion zone.) |
| Skin Exposure | If contaminated solid or liquid gets on the skin, promptly wash contaminated skin for 15 minutes using soap or mild detergent and water. If solids or liquid penetrate through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. Obtain medical attention immediately if symptoms warrant. |

**10.2.1.3 First Aid - Physical Injury.**

| | |
|---|---|
| Animal Bites | Thoroughly wash the wound with soap and water. Flush the area with running water and apply a sterile dressing. Immobilize affected part until the victim has been attended by a physician. See that the animal is kept alive and in quarantine. Obtain name and address of the owner of the animal. Report all animal bites to Military Public Health at 784-4053. |
| Burns (minor) | Do not apply vaseline or grease of any kind. Apply cold water applications until pain subsides. Cover with a wet sterile gauze dressing. Do not break blisters or remove tissue. Seek medical attention. |
| Burns (severe) | Do not remove adhered particles of clothing. Do not apply ice or immerse in cold water. Do not apply ointment, grease or vaseline. Cover burns with thick sterile dressings. Keep burned feet or legs elevated. Seek medical attention immediately. |

| | |
|---|---|
| Cramps | Have the victim rest in a cool place. Give cool water or commercial sports drink. Lightly stretch the muscle and gently massage the area. |
| Cuts | Apply pressure with sterile gauze dressing, and elevate the area until bleeding stops. Apply a bandage and seek medical attention. |
| Eyes | Keep the victim from rubbing the eye. Flush the eye with (foreign objects) water. If flushing fails to remove the object, apply a dry, protective dressing and consult a physician. |
| Fainting | Keep the victim lying down with feet elevated. Loosen tight clothing. If victim vomits, roll him onto his side or turn his head to the side. If necessary wipe out his mouth. Maintain an open airway. Bathe his face gently with cool water. Unless recovery is prompt, seek medical attention. |
| Fracture | Deformity of an injured part usually means a fracture. If fracture is suspected, splint the part as it lies. Do not attempt to move the injured part of the person. Seek medical attention immediately. |
| Frostbite | The symptoms of frost bite include lack of feeling in the infected area and skin appears waxy and cold to the touch, or is discolored. Handle the area gently. Do not rub the area. Warm the area by soaking the affected part in water no warmer than $105^0$ F. Keep the frostbitten part in the water until it looks red and feels warm. Loosely bandage the area with dry, sterile dressing. Seek medical attention as soon as possible. |
| Heat exhaustion | Signals indicating heat exhaustion include cool, moist, pale or flushed skin, headache, nausea, dizziness, weakness, and exhaustion. Loosen any tight clothing, apply cool wet clothes, such as towels. If the victim is conscious, give cool water to drink. Let the victim rest in a comfortable position, and watch carefully for changes in his or her condition. The victim should not resume normal activities the same day. Refusing water, vomiting and changes in consciousness mean the victim's condition is getting worse. Seek medical attention immediately. |
| Heat stroke | It occurs most often when people ignore the symptoms of heat exhaustion. The signals of heat stroke include red, hot, dry skin; changes in consciousness; rapid weak pulse; and rapid shallow breathing. Immediate action must be taken to cool the body before serious injury and death occur. Seek medical attention immediately. |
| Hypothermia | Signals of hypothermia include shivering, numbness, glassy stare, apathy, and loss of consciousness. Remove any wet clothing and dry the victim. Warm the victim gradually by wrapping the body in blankets |

| | |
|---|---|
| | and moving him or her to a warm place. If the victim is alert give warm liquids to drink. |
| Snake Bites | Keep the bite area as low as possible. Transport the victim immediately to a medical facility. |
| Insect Bites | Remove "stinger" if present. Keep affected part down below the level of the heart. Apply ice bag. For minor bites and stings apply soothing lotions, such as calamine. |
| Puncture Wounds | If puncture wound is deeper than skin surface, seek medical attention. Serious infection can arise unless proper treatment is received. |
| Sprains | Elevate injured part and apply ice bag or cold packs. Do not soak in hot water. If pain and swelling persists, seek medical attention. |
| Unconsciousness | Never attempt to give anything by mouth. Keep victim flat, maintain an open airway. If victim is not breathing, provide artificial respiration by mouth to mouth breathing and call for an ambulance immediately. |

### 10.2.2 Fire/Explosion

In the event of a fire or explosion, the local fire department should be summoned immediately. Upon their arrival, the SSO or designated alternate will advise the fire commander of the location, nature, and identification of the hazardous materials on-site.

If it is safe to do so, site personnel may:

- Use fire fighting equipment available on site to control or extinguish the fire; and,
- Remove or isolate flammable or other hazardous materials which may contribute to the fire.

Otherwise, immediate evacuation of the area is indicated. In the event of an explosion, all personnel shall be evacuated and the fire department notified. No one shall re-enter the area until it has been cleared by explosives safety personnel.

### 10.2.3 Natural Disasters

Natural disasters may occur at the site due to weather. These include lightning and high winds.

- Lightning - Persons should not work in open areas, near trees or other equipment outside during lightning storms. Stop work until the storm passes. If possible, clear the site until the storm passes.

- High Winds - If high winds are forecast, then the site should be cleared before the winds become hazardous. Workers should be instructed to go to an appropriate shelter.
- In the event evacuation is necessary, account for all persons before leaving the site, proceed to the site access road and go to a pre-arranged meeting place. A car should be parked facing the access road as close as possible to sampling locations.
- Notify the PM of any work stoppage due to lightening and high winds.

### 10.3 Emergency Equipment and First Aid Requirements

This equipment will be stored at appropriate locations selected during site mobilization. Emergency response equipment may be moved from one location to another based on changing locations of construction activities. Emergency equipment and first aid supplies will be kept upwind of the work in the decontamination zone. The equipment will include drinking water, ice, portable telephone, whistle or horn, first aid kit, blanket, fire extinguisher and eyewash kit. Spill containment equipment such as absorbents and oil booms, if applicable, will also be kept upwind in the decontamination zone.

- Fire Extinguisher: At least one 20-lb-type ABC fire extinguisher will be located at the entrance to the exclusion zone.
- Emergency Eye Wash: A box containing 10 bottles (12 oz each) of sterile saline solution will be part of the first aid kit. Eyes will be flushed with sterile solution for 15 minutes. The bottles will be replaced if they have been used.
- First Aid Kit: At least one industrial first aid kit and stretcher will be provided and maintained fully stocked in the CRZ. First aid kit locations will be specially marked and provided with adequate water and other supplies necessary to cleanse and decontaminate burns, wounds, or lesions.
- Gatorade or the equivalent.
- Extra full set of PPE.

# 11.0
# REFERENCES

The American National Red Cross. 1993. American Red Cross Community First Aid & Safety.

Woodward - Clyde Consultants, Inc. 1995. Management Action Plan For Cannon Air Force Base, New Mexico. August.

Woodward - Clyde Consultants, Inc. 1992. Remedial Investigation. Cannon Air Force Base, New Mexico. October.

# TABLES

## TABLE 1
## Physical Properties and Health Hazard Characteristics of Chemicals Which May be Encountered at Cannon Air Force Base

| CHEMICAL | PHYSICAL PROPERTIES | | | PEL or TLV[4] (carc.[6]) | HEALTH HAZARDS | | |
|---|---|---|---|---|---|---|---|
| | IP[1] | LEL[2] | VP[3] | | SYMPTOMS | TARGET ORGANS | ROUTE OF ENTRY[6] |
| *Arsenic (inorganic compounds)* | NA | NA | 0 mm | 0.010 mg/m$^3$ (A) | Ulceration of nasal septum, derm, GI disturbances, perineur, resp irrit, hyperpig of skin' carc. (A1) | Liver, kidneys, skin, lungs, lymphatic sys. | Inh, abs, con, ing. |
| *Barium (soluble compounds)* | -- | NA | Low | 0.5 mg/m$^3$ (D) | Upper resp irrit; gastroenteritis; musc spasm; slow pulse; extra-systoles; hypokalemia; irrit eyes; skin; skin burns; carc (A2) | Heart, CNS, skin, resp sys, eyes | Inh, abs, con |
| *Cadmium* | NA | NA | 0 mm | 0.2 mg/m$^3$ (B1) | Pulm edma, dysp, cough, chest tight, subs pain; head; chills, musc aches; nau, vomit, diarr; anos, emphy, prot, mild anemia | Resp sys, kidneys, prostate, blood | Inh, ing |
| *Chromium VI* | NA | NA | 0 mm | 0.05 mg/m$^3$ (A) | Wheezing/coughing upon acute exposure, headache, nasal itch and soreness, liver injury, chronic exposure increases risk of lung cancer. | Resp sys | Inh, ing |
| *Lead* | NA | NA | 0 mm | 0.100 mg/m$^3$ (B2) | Weak, lass, insom; facial pallor; pal eye, anor, low wgt, malnut; constip, abdom pain, colic, anemia; gingiual lead line; tremor; irrit eyes; carc (A3) | GI tract, CNS, kidneys, blood, gingiual tissue | Inh, ing, con |

## TABLE 1
## Physical Properties and Health Hazard Characteristics of Chemicals Which May be Encountered at Cannon Air Force Base

| CHEMICAL | PHYSICAL PROPERTIES | | | PEL or TLV[4] (carc.[6]) | HEALTH HAZARDS | | |
|---|---|---|---|---|---|---|---|
| | IP[1] | LEL[2] | VP[3] | | SYMPTOMS | TARGET ORGANS | ROUTE OF ENTRY[6] |
| *Hexane (typ. Petroleum Hydrocarbon)* | 10.18 | 1.1 | 150 mm | 50 mg/m$^3$ (D) | Li-head; nau, head; numb extremities, musc weak; irrit eyes, nose; derm; chemical pneu; gidd | CNS, skin, resp sys | Inh, ing, con |
| *Cyclohexane (typ. Petroleum Hydrocarbon)* | 9.88 | 1.3 | 98 mm | 300mg/m$^3$ (D) | Irrit eyes, resp sys; drow; derm; narco, coma | Eyes, resp sys, skin, CNS | Inh, ing, con |
| *Benzene* | 9.24 | 1.3 | 75 mm | 0.1 ppm (A) | Upper resp irrit; gastroenteritis; musc spasm; slow pulse, extrasys-toles; hypokalemia; irrit eyes., skin; skin burns; suspected human carcinogen (A2). | Heart, CNS, skin, resp sys, eyes | Inh, abs, con |
| *Ethylbenzene* | 8.76 | 1.0 | 10 mm | 100 ppm (D) | Irrit eyes, muc meb; head; derm; narco, coma. | Eyes, upper resp sys, skin, CNS | Eye, Skin, Breath Swallow |
| *Toluene* | 8.82 | 1.2 | 20 mm | 100 ppm (D) | Ftg. weak; conf, euph, dizz, head; dilated pupils; lac; ner, musc ftg, insomnia, derm | CNS, liver, kidneys, skin | Inh, abs, ing, con |
| *Xylene o-* | 8.56 | 1.1 | 7 mm | 100 ppm (D) | Dizz, excitement, drow, inco, staggering gait; irrit eyes, nose, throat; corneal vacuolization, anor, nau, vomit, abdom pain; derm | CNS, eyes, GI tract, blood, liver, kidneys, skin | Inh, abs, ing, con |

## TABLE 1
## Physical Properties and Health Hazard Characteristics of Chemicals Which May be Encountered at Cannon Air Force Base

1. IP = Ionization Potential (eV), Guide to Chemical Hazards
2. LEL = Lower Explosive Limit in Air (% by volume at room temperature)
3. VP = Vapor pressure at 68°F (mg Hg)
4. PEL = Permissible Exposure Limit ($mg/m^3$). TLV = Threshold Limit Values ($mg/m^3$).
5. Inh = Inhalation; Abs = Skin absorption; Ing = Ingestion; Con = Skin and/or eye contact
6. (A) = Human carcinogen; (B1)(B2) = Probable human carcinogen; (C) = Possible human carcinogen; (D) = Not classifiable as human carcinogen.
   Sourcess: U. S. EPA, 1993, *Health Effects Summary Table*, EPA/540-R-93-058 and U. S. EPA, 1996, *On-line Integrated Risk Information System (IRIS)*, OSWER, Cincinnatti, OH.

-- = Not listed
NA = Not applicable

Table 2

# ABBREVIATIONS FOR SYMPTOMS OF EXPOSURE AND TARGET ORGANS

CANNON AIR FORCE BASE
Clovis, New Mexico

| Abbreviation | Symptom/organ | Abbreviation | Symptom/organ |
|---|---|---|---|
| abdom | Abdominal | convuls | Convulsions |
| album | Albuminuria | CVS | Cardiovascular system |
| anes | Anesthesia | cyan | Cyanosis |
| anor | Anorexia | depres | Depressant/depression |
| anos | Anosmia | derm | Dermatitis |
| appre | Apprehension | diarr | Diarrhea |
| arrhy | Arrhythmias | dist | Disturbance |
| asphy | Asphyxia | dizz | Dizziness |
| BP | Blood pressure | drow | Drowsiness |
| breath | Breathing | dysp | Dyspnea |
| bron | Bronchitis | emphy | Emphysema |
| broncopneu | Bronchopneumonia | eosin | Eosinophilia |
| bronspas | Bronchospasm | epis | Epistaxis |
| BUN | Blood urea nitrogen | equi | Equilibrium |
| [carc] | Carcinogen | eryt | Erythema |
| card | Cardiac | euph | Euphoria |
| chol | Cholinesterase | fail | Failure |
| cirr | Cirrhosis | fasc | Fasiculation |
| CNS | Central nervous system | FEV | Forced expiratory volume |
| conf | Confusion | fib | Fibrosis |
| conj | Conjunctivitis | fibrl | Fibrillation |
| constip | Constipation | ftg | Fatigue |
| constric | Constriction | func | Function |

| Abbreviation | Symptom/organ | Abbreviation | Symptom/organ |
|---|---|---|---|
| GI | Gastrointestinal | leupen | Leukopenia |
| gidd | Giddiness | li-head | Lightheadedness |
| halu | Hallucinations | low-wgt | Weight loss |
| head | Headache | mal | Malaise |
| hemato | Hematopoietic | malnut | Malnutrition |
| hemog | Hemoglobinuria | monocy | Monocytosis |
| hemorr | Hemorrhage | muc memb | Mucous membrane |
| hypox | Hypoxemia | musc | Muscle |
| incr | Increase(d) | narco | Narcosis |
| ict | Icterus | nau | Nausea |
| inco | Incoordination | nec | Necrosis |
| inflamm | Inflammation | neph | Nephritis |
| inj | Injury | ner | Nervousness |
| insom | Insomnia | numb | Numbness |
| irreg | Irregular | opac | Opacity |
| irrit | Irritation | palp | Palpitations |
| irrity | Irritability | para | Paralysis |
| jaun | Jaundice | pares | Paresthesia |
| kera | Keratitis | perf | Perforation |
| lac | Lacrimation | peri neur | Peripheral neuropathy |
| lar | Laryngeal | periorb | Periorbital |
| lass | Lassitude | phar | Pharyngeal |
| leucyt | Leukocytosis | photo | Photophobia |

| Abbreviation | Symptom/organ | Abbreviation | Symptom/organ |
|---|---|---|---|
| pig | Pigmentation | subs | Substernal |
| pneu | Pneumonia | sweat | Sweating |
| pneuitis | Pneumonitis | swell | Swelling |
| PNS | Peripheral nervous system | sys | System |
| polyneur | Polyneuropathy | tacar | Tachycardia |
| prot | Proteinuria | tend | Tenderness |
| pulm | Pulmonary | trachbronc | Tracheobronchitis |
| RBC | Red blood cell | venfib | Ventricular fibrillation |
| resp | Respiratory | verti | Vertigo |
| retster | Retrosternal | vesic | Vesiculation |
| rhin | Rhinorrhea | vis dist | Visual disturbance |
| salv | Salivation | vomit | Vomiting |
| sens | Sensitization | weak | Weakness |
| sez | Seizure | wheez | Wheezing |
| som | Somnolence | | |

REFERENCE: NIOSH Pocket Guide to Chemical Hazards, June 1990.

Table 3

# COOLING POWER OF WIND ON EXPOSED FLESH EXPRESSED AS EQUIVALENT TEMPERATURE (Under Calm Conditions)*

CANNON AIR FORCE BASE
Clovis, New Mexico

**Cooling Power of Wind on Exposed Flesh Expressed as Equivalent Temperature (under calm conditions)☆**

| Estimated Wind Speed (in mph) | Actual Temperature Reading (°F) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 50 | 40 | 30 | 20 | 10 | 0 | –10 | –20 | –30 | –40 | –50 | –60 |
| | Equivalent Chill Temperature (°F) | | | | | | | | | | | |
| calm | 50 | 40 | 30 | 20 | 10 | 0 | –10 | –20 | –30 | –40 | –50 | –60 |
| 5 | 48 | 37 | 27 | 16 | 6 | –5 | –15 | –26 | –36 | –47 | –57 | –68 |
| 10 | 40 | 28 | 16 | 4 | –9 | –24 | –33 | –46 | –58 | –70 | –83 | –95 |
| 15 | 36 | 22 | 9 | –5 | –18 | –32 | –45 | –58 | –72 | –85 | –99 | –112 |
| 20 | 32 | 18 | 4 | –10 | –25 | –39 | –53 | –67 | –82 | –96 | –110 | –121 |
| 25 | 30 | 16 | 0 | –15 | –29 | –44 | –59 | –74 | –88 | –104 | –118 | –133 |
| 30 | 28 | 13 | –2 | –18 | –33 | –48 | –63 | –79 | –94 | –109 | –125 | –140 |
| 35 | 27 | 11 | –4 | –20 | –35 | –51 | –67 | –82 | –98 | –113 | –129 | –145 |
| 40 | 26 | 10 | –6 | –21 | –37 | –53 | –69 | –85 | –100 | –116 | –132 | –148 |
| (Wind speeds greater than 40 mph have little additional effect.) | *LITTLE DANGER* In < hr with dry skin. Maximum danger of false sense of security | | | | *INCREASING DANGER* Danger from freezing of exposed flesh within one minute. | | | | *GREAT DANGER* Flesh may freeze within 30 seconds. | | | |
| | Trenchfoot and immersion foot may occur at any point on this chart. | | | | | | | | | | | |

* Developed by U.S. Army Research Institute of Environmental Medicine, Natick, MA.

☐ Equivalent chill temperature requiring dry clothing to maintain core body temperature above 36°C (96.8°F) per cold stress TLV.

# FIGURES

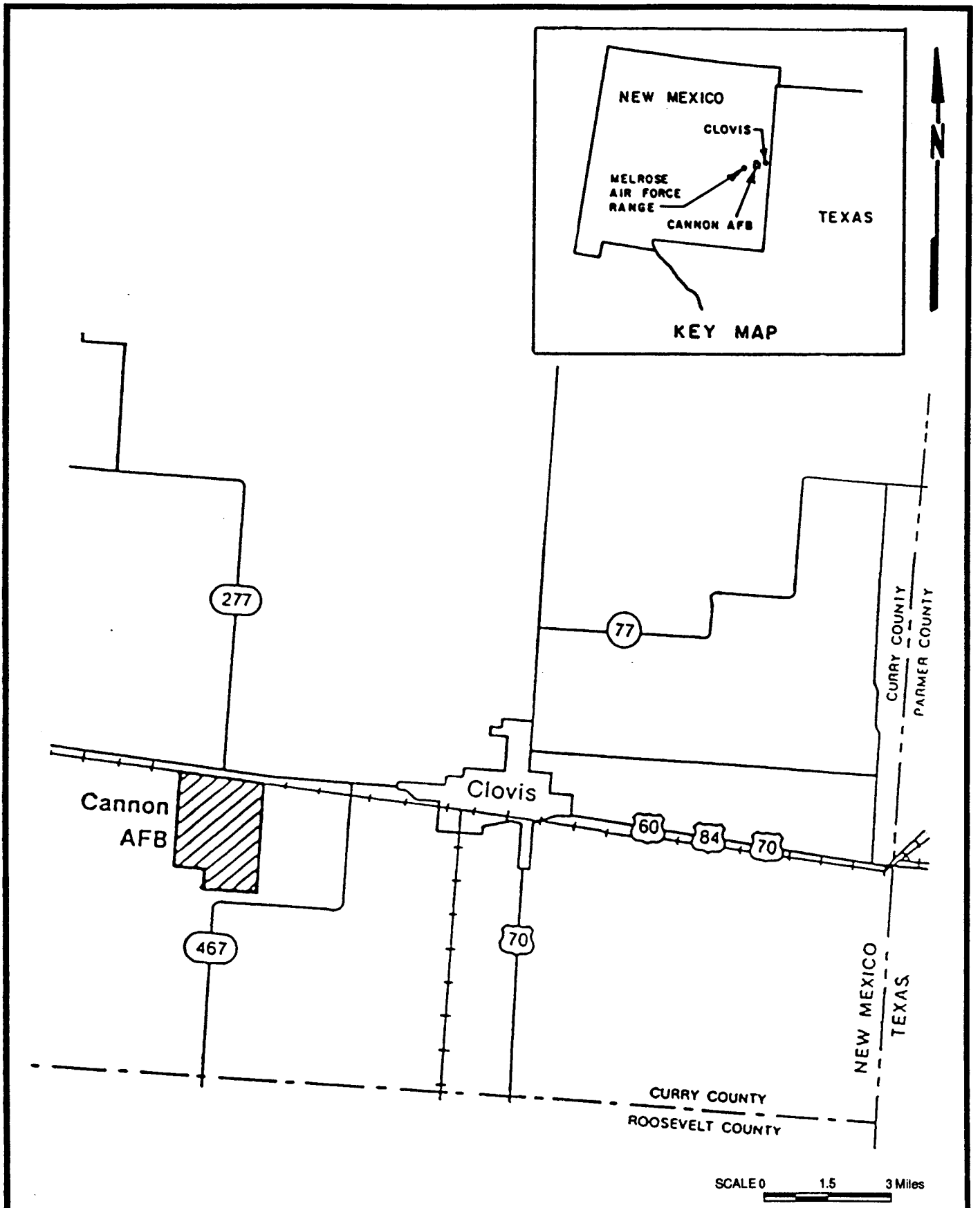


Figure 1
**SITE LOCATION MAP**
CANNON AIR FORCE BASE
Clovis, New Mexico

HARZA *Consulting Engineers and Scientists*

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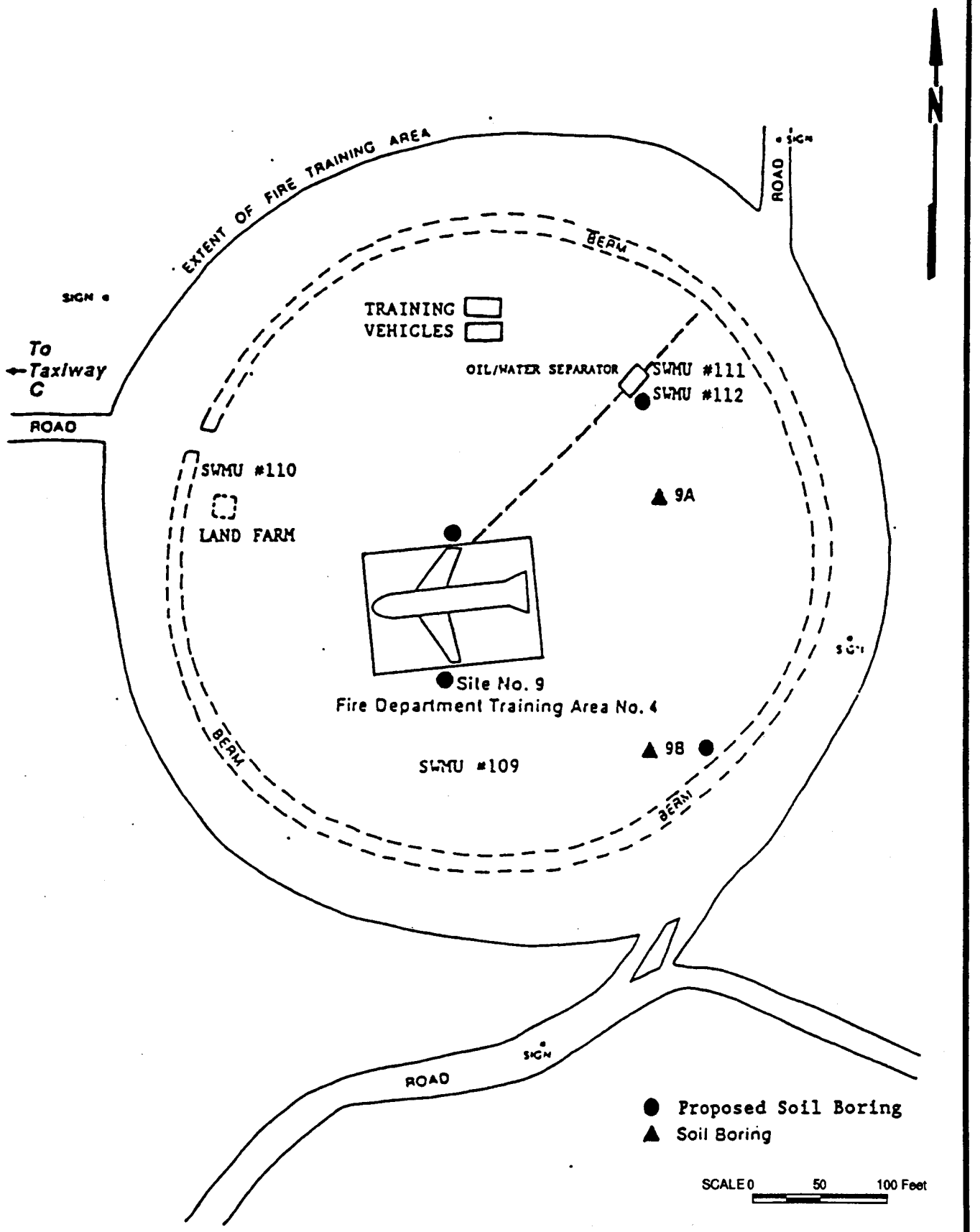


SOURCE: Cannon AFB

Figure 2
**SITE FEATURES MAP**
CANNON AIR FORCE BASE
Clovis, New Mexico

HARZA *Consulting Engineers and Scientists*

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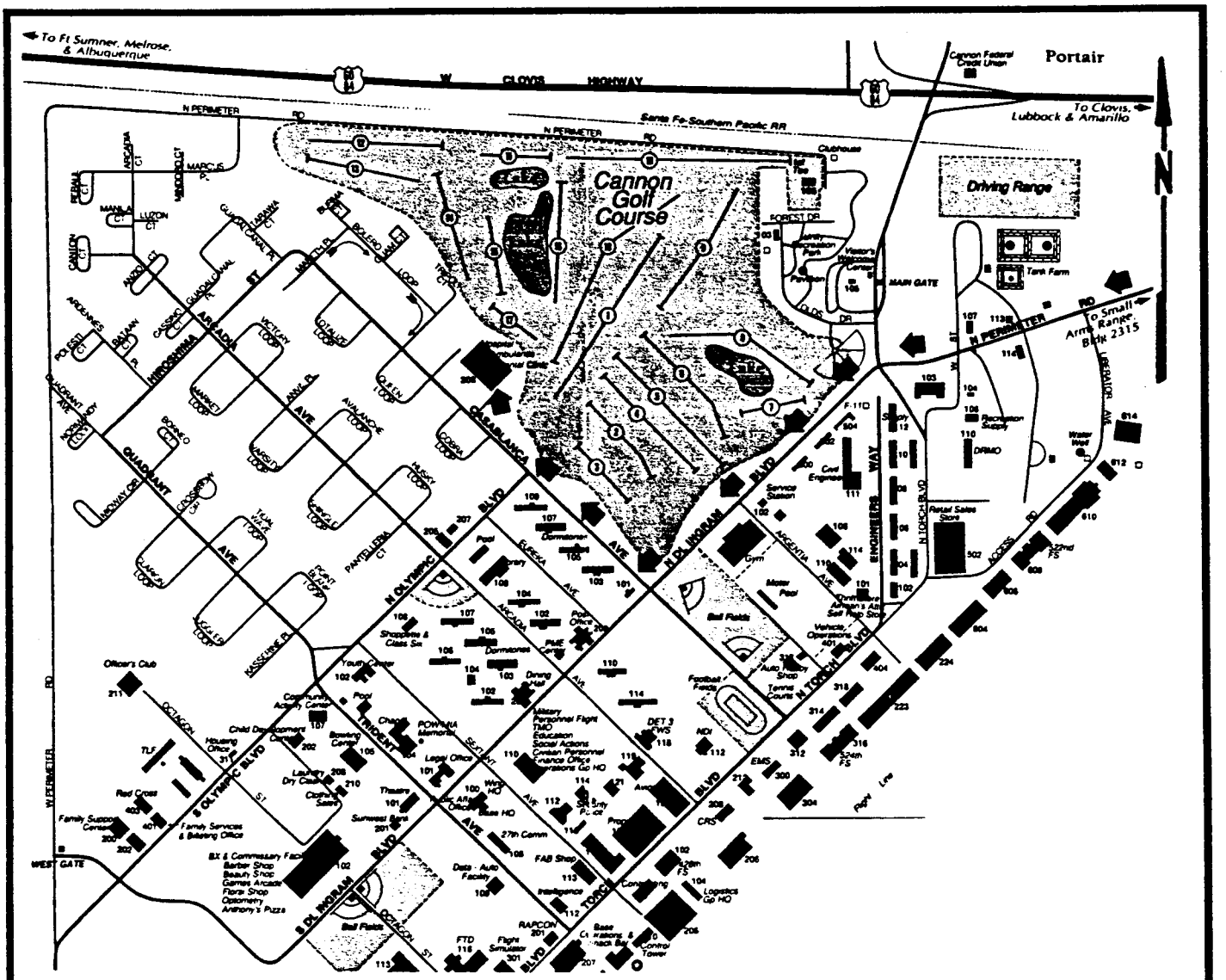


SCALE 0 400 800 1200 1600 Feet

SOURCE: Installation map published by MARCOA Publishing Incorporated

HARZA Consulting Engineers and Scientists

Figure 3

**CANNON AFB HOSPITAL ROUTE MAP**

CANNON AIR FORCE BASE
Clovis, New Mexico

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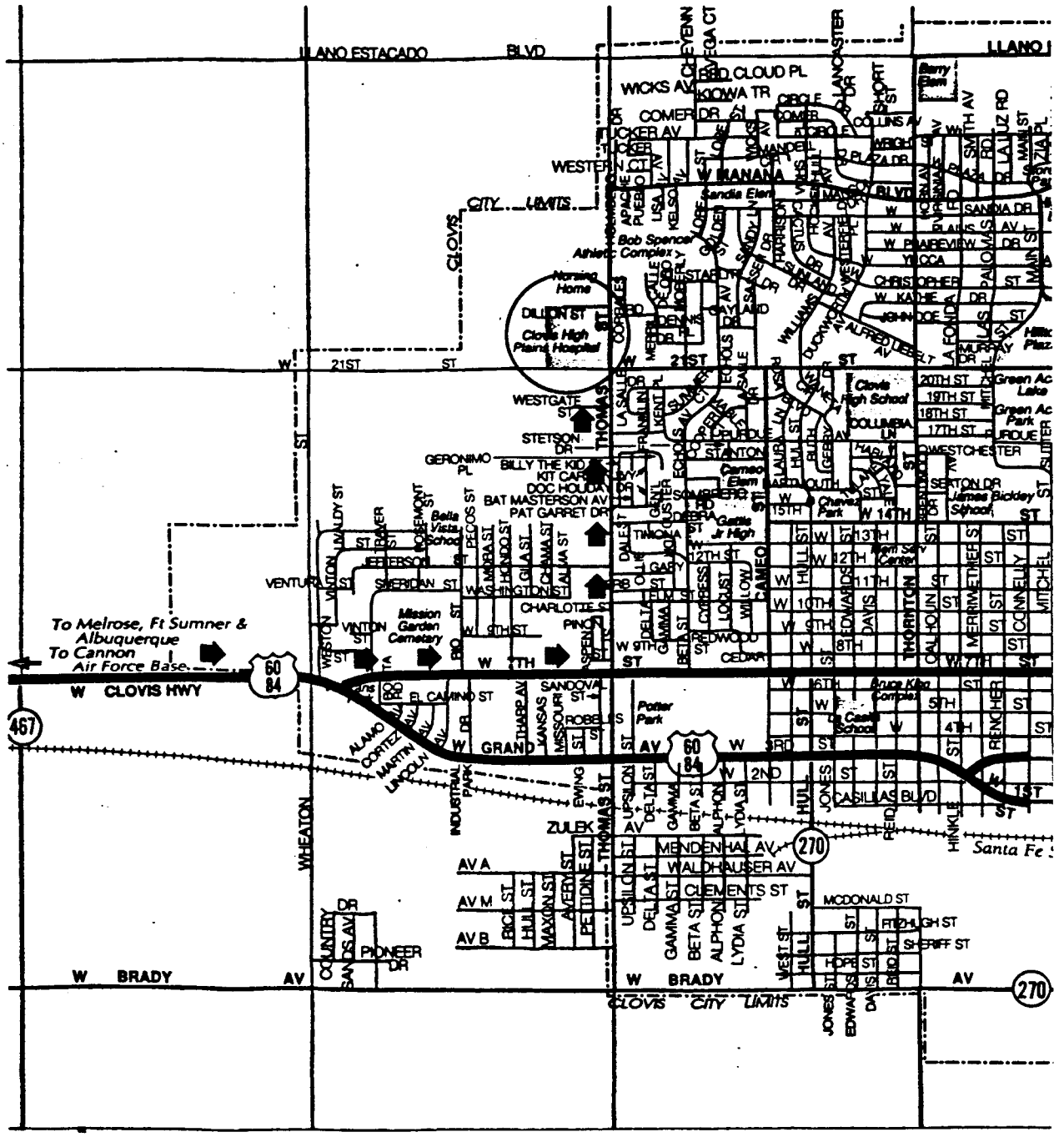


SOURCE: Installation map published by MARCOA Publishing Incorporated

Figure 4

**CLOVIS HIGH PLAINS HOSPITAL LOCATION MAP**

CANNON AIR FORCE BASE
Clovis, New Mexico

HARZA *Consulting Engineers and Scientists*

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# APPENDICES

# APPENDIX A
# EMPLOYEE HEALTH AND SAFETY COMPLIANCE AGREEMENT

# EMPLOYEE HEALTH AND SAFETY COMPLIANCE AGREEMENT

I, undersigned, have received a copy of the Site Safety and Health Plan identified below. I have read the plan, understand it, and agree to comply with all of the health and safety directives. I have attended a site briefing given by the Site Safety Officer or Health and Safety Officer. I understand that I may be prohibited from working on the project for violation any of the directives.

Project No. 5644H

Site Name Cannon Air Force Base, Fire Training Area #4

Employee Name _____

Firm _____

_____ _____

Signature Date

# APPENDIX B
# MATERIAL SAFETY DATA SHEETS

# OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR INORGANIC ARSENIC AND ITS COMPOUNDS (as As) POTENTIAL HUMAN CARCINOGEN

## INTRODUCTION

"Inorganic arsenic" is defined as elemental arsenic and all of its inorganic compounds except arsine (see guideline for arsine). This guideline summarizes pertinent information about inorganic arsenic for workers, employers, and occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments in these fields; therefore, readers are advised to regard these recommendations as general guidelines.

## SUBSTANCE IDENTIFICATION

Data in the following section are presented for elemental arsenic.

- **Formula:** As

- **Synonyms:** Arsenic black, arsenic-75, arsenic solid, arsenic metallic, arsenicals, grey arsenic

- **Identifiers:** CAS 7440-38-2; RTECS CG0525000; DOT 1558, label required: "Poison"

- **Appearance and odor:** Gray metal with an odor like garlic when heated

## CHEMICAL AND PHYSICAL PROPERTIES

Data in the following section are presented for elemental arsenic.

- **Physical data**

1. Molecular weight: 74.92
2. Boiling point (at 760 mmHg): 613°C (1,135°F), sublimes
3. Specific gravity (water = 1): 5.73
4. Vapor density (air = 1 at sublimation point of arsenic): 2.6
5. Melting point: Sublimes at 613°C (1,135°F)
6. Insoluble in water

- **Reactivity**

1. Incompatibilities: Oxidizing agents and heat
2. Hazardous decomposition products: Toxic gases and vapors or fumes (e.g., arsenic oxide fume) may be released in a fire involving arsenic.
3. Caution: Hydrogen gas can react with inorganic arsenic to form arsine.

- **Flammability**

1. Extinguishant: All firefighting agents, except soda-acid
2. Caution: Arsenic is combustible in powder form or by chemical reaction with powerful oxidizers such as bromates, chlorates, iodates, and peroxides.

- **Warning properties**

Evaluation of warning properties for respirator selection: Warning properties are not considered in recommending respirators for use with carcinogens.

## EXPOSURE LIMITS

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for inorganic arsenic (except arsine) is 0.01 milligrams of arsenic per cubic meter of air (mg/m$^3$) as a time-weighted average (TWA) over an 8-hour workshift. The National Institute for Occupational Safety and Health (NIOSH) recommends that arsenic and all its inorganic compounds be controlled and handled as potential human carcinogens in the workplace and that exposure be minimized to the lowest feasible limit. The NIOSH recommended exposure limit (REL) for arsenic and all its inorganic compounds is 0.002 mg/m$^3$ as a ceiling concentration determined in any 15-minute sampling period. The American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV®) for soluble arsenic compounds is 0.2 mg/m$^3$ as a TWA for a normal 8-hour workday and a 40-hour workweek. The ACGIH has designated arsenic trioxide production as A2 (suspected human carcinogen) without having sufficient evidence to assign a TLV® (Table 1).

## HEALTH HAZARD INFORMATION

- **Routes of exposure**

Inorganic arsenic compounds may cause adverse health effects following exposure via inhalation, ingestion, or dermal or eye contact.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health
Division of Standards Development and Technology Transfer

**Table 1.—Occupational exposure limits for inorganic arsenic and its compounds (as As)**

| | Arsenic and its inorganic compounds | Arsenic compounds, soluble | Arsenic trioxide production |
|---|---|---|---|
| | mg/m³ | mg/m³ | mg/m³ |
| OSHA PEL TWA | 0.01 | — | — |
| NIOSH REL (Ca)* | | | |
| Ceiling (15 min) | 0.002 | — | — |
| ACGIH TLV® (TWA) | — | 0.2 | (A2)† |

* (Ca): NIOSH recommends treating as a potential human carcinogen.
† (A2): Suspected human carcinogen.

**• Summary of toxicology**

1. *Effects on animals:* Chronic ingestion or inhalation of inorganic arsenic by rats caused marked enlargement of the common bile duct and fatty degeneration of the liver. Injection of arsenic in pregnant rats, mice, and hamsters caused malformations of the offspring.
2. *Effects on humans:* Inhalation, ingestion, or dermal exposure of workers to inorganic arsenic has caused peripheral nerve inflammation (neuritis) and degeneration (neuropathy), reduced peripheral circulation, anemia, increased mortality due to cardiovascular failure, and cancers of the skin, lungs, and lymphatic system.

**• Signs and symptoms of exposure**

1. *Short-term (acute):* Exposure to inorganic arsenic can cause nausea, vomiting, diarrhea, weakness, loss of appetite, cough, chest pain, giddiness, headache, and breathing difficulty (dyspnea).
2. *Long-term (chronic):* Exposure to inorganic arsenic can cause weakness, nausea, vomiting, diarrhea, skin and eye irritation, hyperpigmentation, thickening of the palms and soles (hyperkeratosis), contact dermatitis, skin sensitization, warts, ulceration and perforation of the nasal septum, and numbness and weakness in the legs and feet.

## RECOMMENDED MEDICAL PRACTICES

**• Medical surveillance program**

Workers with potential exposures to chemical hazards should be monitored in a systematic program of medical surveillance intended to prevent or control occupational injury and disease. The program should include education of employers and workers about work-related hazards, placement of workers in jobs that do not jeopardize their safety and health, earliest possible detection of adverse health effects, and referral of workers for diagnostic confirmation and treatment. The occurrence of disease (a "sentinel health event," SHE) or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical surveillance program is intended to supplement, not replace, such measures.

A medical surveillance program should include systematic collection and epidemiologic analysis of relevent environmental and biologic monitoring, medical screening, morbidity, and mortality data. This analysis may provide information about the relatedness of adverse health effects and occupational exposure that cannot be discerned from results in individual workers. Sensitivity, specificity, and predictive values of biologic monitoring and medical screening tests should be evaluated on an industry-wide basis prior to application in any given worker group. Intrinsic to a surveillance program is the dissemination of summary data to those who need to know, including employers, occupational health professionals, potentially exposed workers, and regulatory and public health agencies.

**• Preplacement medical evaluation**

Prior to placing a worker in a job with a potential for exposure to inorganic arsenic, the physician should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic and laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the skin, peripheral nervous system, liver, lymphatic and hematopoietic (blood cell forming) systems, and respiratory tract. Medical surveillance for respiratory disease should be conducted by using the principles and methods recommended by NIOSH and the American Thoracic Society (ATS).

A preplacement medical evaluation is recommended in order to detect and assess preexisting or concurrent conditions which may be aggravated or result in increased risk when a worker is exposed to inorganic arsenic and its compounds at or below the NIOSH REL. The examining physician should consider the probable frequency, intensity, and duration of exposure, as well as the nature and degree of the condition, in placing such a worker. Such conditions, which should not be regarded as absolute contraindications to job placement, include concurrent dermatitis or peripheral neuropathy, a history and other findings consistent with chronic disease of the skin or nervous system, and significant breathing impairment due to preexisting chronic lung disease.

**• Periodic medical screening and/or biologic monitoring**

Occupational health interviews and physical examinations should be performed at regular intervals. Additional examinations may be necessary should a worker develop symptoms that may be attributed to exposure to inorganic arsenic. The interviews, examinations, and appropriate medical screening and/or biologic monitoring tests should be directed at identifying an excessive decrease or adverse trend in the physiologic function of the skin, blood, lymphatic system, peripheral nervous system, liver, and respiratory tract as compared to the baseline status of the individual worker or to expected values for a suitable reference population. The following tests should be used and interpreted according to standardized procedures and evaluation criteria recommended by NIOSH

and ATS: standardized questionnaires and tests of lung function.

• **Medical practices recommended at the time of job transfer or termination**

The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic or laboratory tests which were conducted at the time of placement should be repeated at the time of job transfer or termination. Any changes in the worker's health status should be compared to those expected for a suitable reference population. Because occupational exposure to inorganic arsenic and its compounds may cause diseases of prolonged induction-latency, the need for medical surveillance may extend well beyond termination of employment.

• **Sentinel health events**

Delayed-onset SHE's include: Inflammatory and toxic neuropathy, agranulocytosis or neutropenia (absense or a severe decrease in the number of certain white blood cells), and cancers of the liver and respiratory tract.

## MONITORING AND MEASUREMENT PROCEDURES

• **Ceiling concentration evaluation**

Measurements to determine worker exposure should be taken during periods of maximum expected airborne concentrations of inorganic arsenic. Each measurement to determine the NIOSH REL (ceiling exposure) in the worker's breathing zone (air that most nearly represents that inhaled by the worker) should consist of a 15-minute sample or a series of consecutive samples that total 15 minutes. A minimum of three measurements should be taken during one workshift, and the highest of all measurements taken is an estimate of the worker's exposure. If the periods of maximum exposure are not clearly defined, a statistical procedure which can be used as a peak exposure detection strategy is given in the *Occupational Exposure Sampling Strategy Manual.*

• **Method**

Sampling and analysis may be performed by collecting particulate inorganic arsenic with cellulose membrane filters followed by digestion with acid and analysis by atomic absorption with flame arsine generation. A detailed sampling and analytical method may be found in the *NIOSH Manual of Analytical Methods* (method number 7900).

## PERSONAL PROTECTIVE EQUIPMENT

Chemical protective clothing (CPC) should be selected after utilizing available performance data, consulting with the manufacturer, and then evaluating the clothing under actual use conditions.

Workers should be provided with and required to use CPC, gloves, and other appropriate protective clothing necessary to prevent skin contact with inorganic arsenic.

## SANITATION

Clothing which is contaminated with inorganic arsenic should be removed immediately and placed in sealed containers for storage until it can be discarded or until provision is made for the removal of inorganic arsenic from the clothing. If the clothing is to be laundered or cleaned, the person performing the operation should be informed of inorganic arsenic's hazardous properties. Reusable clothing and equipment should be checked for residual contamination before reuse or storage.

A change room with showers, washing facilities, and lockers that permit separation of street and work clothes should be provided.

Workers should be required to shower following a workshift and prior to putting on street clothes. Clean work clothes should be provided daily.

Skin that becomes contaminated with inorganic arsenic should be promptly washed with soap and water.

The storage, preparation, dispensing, or consumption of food or beverages, the storage or application of cosmetics, the storage or smoking of tobacco or other smoking materials, and the storage or use of products for chewing should be prohibited in work areas.

Workers who handle inorganic arsenic should wash their faces, hands, and forearms thoroughly with soap and water before eating, smoking, or using toilet facilities.

## COMMON OPERATIONS AND CONTROLS

Common operations in which exposure to inorganic arsenic may occur and control methods which may be effective in each case are listed in Table 2.

## EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, remove the victim from further exposure, send for medical assistance, and initiate emergency procedures.

• **Eye exposure**

Where there is any possibility of a worker's eyes being exposed to inorganic arsenic, an eyewash fountain should be provided within the immediate work area for emergency use.

If inorganic arsenic gets into the eyes, flush them immediately with large amounts of water for 15 minutes, lifting the lower and upper lids occasionally. Get medical attention as soon as possible. Contact lenses should not be worn when working with this chemical.

• **Skin exposure**

Where there is any possibility of a worker's body being exposed to inorganic arsenic, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

If inorganic arsenic gets on the skin, wash it immediately with soap and water. If inorganic arsenic penetrates the clothing, remove the clothing promptly and wash the skin with soap and water. Get medical attention promptly.

**Table 2.—Operations and methods of control for inorganic arsenic**

| Operations | Controls |
|---|---|
| During the manufacture of insecticides, weed killers and fungicides; during use as a wood preservative | Process enclosure, local exhaust ventilation, personal protective equipment |
| During use in the manufacture and handling of calcium arsenate; during use in the manufacture of electrical semiconductors, diodes, and solar batteries | Process enclosure, local exhaust ventilation, personal protective equipment |
| During use as a bronzing or decolorizing addition in glass manufacturing; during use in the production of opal glass and enamels | Process enclosure, local exhaust ventilation, personal protective equipment |
| During use as an addition to alloys to increase hardening and heat resistance | Process enclosure, local exhaust ventilation, personal protective equipment |
| During smelting of ores | Local exhaust ventilation, personal protective equipment |

• **Rescue**

If a worker has been incapacitated, move the affected worker from the hazardous exposure. Put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

## SPILLS AND LEAKS

Workers not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

If inorganic arsenic or its compounds are spilled, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill.
3. For small quantities of liquids containing inorganic arsenic, absorb on paper towels and place in an appropriate container.
4. Large quantities of liquids containing inorganic arsenic may be absorbed in vermiculite, dry sand, earth, or a similar material and placed in an appropriate container.
5. Inorganic arsenic dust may be collected by vacuuming with an appropriate high-efficiency fitration system. If a vacuum system is used, there should be no sources of ignition in the vicinity of the spill, and flashback prevention devices should be provided.

## WASTE REMOVAL AND DISPOSAL

U.S. Environmental Protection Agency, Department of Transportation, and/or state and local regulations shall be followed to assure that removal, transport, and disposal are in accordance with existing regulations.

## RESPIRATORY PROTECTION

It must be stressed that the use of respirators is the least preferred method of controlling worker exposure and should not normally be used as the only means of preventing or minimizing exposure during routine operations. However, there are some exceptions for which respirators may be used to control exposure: when engineering and work practice controls are not technically feasible, when engineering controls are in the process of being installed, or during emergencies and certain maintenance operations including those requiring confined-space entry (Table 3).

In addition to respirator selection, a complete respiratory protection program should be instituted which as a minimum complies with the requirements found in the OSHA Safety and Health Standards 29 CFR 1910.134. A respiratory protection program should include as a minimum an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, periodic environmental monitoring, maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program, including selection of the correct respirators, requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly.

Only respirators that have been approved by the Mine Safety and Health Administration (MSHA, formerly Mining Enforcement and Safety Administration) and by NIOSH should be used. **Remember! Air-purifying respirators will not protect from oxygen-deficient atmospheres.**

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## Table 3.—Respiratory protection for inorganic arsenic

| Condition | Minimum respiratory protection* |
|---|---|
| Any detectable concentration | Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode |
| | Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode |
| Planned or emergency entry into environments containing unknown or any detectable concentration | Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode |
| | Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode |
| Firefighting | Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode |
| Escape only | Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted acid gas canister having a high-efficiency particulate filter |
| | Any appropriate escape-type self-contained breathing apparatus |

* Only NIOSH/MSHA-approved equipment should be used.

# Occupational Health Guideline for Soluble Barium Compounds (as Barium)

## INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

## APPLICABILITY

The general guidelines contained in this document apply to all soluble barium compounds. Physical and chemical properties of several specific compounds are provided for illustrative purposes.

## SUBSTANCE IDENTIFICATION

### Barium nitrate

- Formula: $Ba(NO_3)_2$
- Synonyms: None
- Appearance and odor: Odorless white solid.

### Barium oxide

- Formula: BaO
- Synonyms: None
- Appearance and odor: Odorless white solid.

### Barium carbonate

- Formula: $BaCO_3$
- Synonyms: None
- Appearance and odor: Odorless white solid.

### Barium chloride

- Formula: $BaCl_2$
- Synonyms: None
- Appearance and odor: Odorless white solid.

## PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for soluble barium compounds is 0.5 milligram of soluble barium compounds per cubic meter of air ($mg/m^3$) averaged over an eight-hour work shift.

## HEALTH HAZARD INFORMATION

- **Routes of exposure**

Soluble barium compounds can affect the body if they are inhaled or if they come in contact with the eyes or skin. They can also affect the body if they are swallowed.

- **Effects of overexposure**

*1. Short-term Exposure:* Soluble barium compounds may cause local irritation of the eyes, nose, throat, bronchial tubes, and skin. Soluble barium compounds may also cause severe stomach pains, slow pulse rate, irregular heart beat, ringing of the ears, dizziness, convulsions, and muscle spasms. Death may occur.

*2. Long-term Exposure:* None known

*3. Reporting Signs and Symptoms:* A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to soluble barium compounds.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to soluble barium compounds at potentially hazardous levels:

*1. Initial Medical Examination:*

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the heart, lungs, and nervous system should be stressed. The skin should be examined for evidence of chronic disorders.

—14" x 17" chest roentgenogram: Soluble barium compounds cause human lung damage. Surveillance of the lungs is indicated.

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These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

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—FVC and FEV (1 sec): Soluble barium compounds are respiratory irritants. Persons with impaired pulmonary function may be at increased risk from exposure. Periodic surveillance is indicated.

—Electrocardiogram: Barium compounds may cause cardiac arrhythmias and may have a direct effect on the cardiac muscle. Periodic surveillance of the heart is indicated.

2. *Periodic Medical Examination:* The aforementioned medical examinations should be repeated on an annual basis, except that an x-ray is necessary only when indicated by the results of pulmonary function testing, or by signs and symptoms of respiratory disease.

• **Summary of toxicology**

Soluble barium salts cause severe gastroenteritis and systemic effects by ingestion. Intravenous injection of barium compounds in animals causes a strong, prolonged stimulation of muscle resulting in hyperperistalsis, bladder contraction, vasoconstriction, and irregular contraction of the heart followed by arrest in systole. Animals also exhibit stimulation of the central nervous system followed by paralysis. Ingestion of barium carbonate by humans causes gastroenteritis, muscular paralysis, slow pulse rate, extrasystoles, and hypokalemia. Heavy industrial exposure to dusts of barium sulfate or barium oxides may produce a benign pneumoconiosis, termed baritosis. It results in no impairment of ventilatory function, although signs of mild bronchial irritation may occur. Characteristic x-ray changes are those of small, dense, circumscribed nodules evenly distributed throughout the lung fields, reflecting the radio-opacity of the barium dust. Bronchial irritation has been reported from the inhalation of barium carbonate dust. Barium hydroxide and barium oxide are strongly alkaline in aqueous solution, causing severe burns of the eye and irritation of the skin.

## CHEMICAL AND PHYSICAL PROPERTIES

• **Physical data—Barium nitrate**

1. Molecular weight: 261.4
2. Boiling point (760 mm Hg): Greater than 592 C (greater than 1098 F) (decomposes)
3. Specific gravity (water = 1): 3.24
4. Vapor density (air = 1 at boiling point of barium nitrate): Not applicable
5. Melting point: 592 C (1098 F)
6. Vapor pressure at 20 C (68 F): Essentially zero
7. Solubility in water, g/100 g water at 20 C (68 F): 9.2
8. Evaporation rate (butyl acetate = 1): Not applicable

• **Physical data—Barium oxide**

1. Molecular weight: 153.3
2. Boiling point (760 mm Hg): 2000 C (3632 F)
3. Specific gravity (water = 1): 5.72
4. Vapor density (air = 1 at boiling point of barium oxide): Not applicable
5. Melting point: 1921 C (3490 F)
6. Vapor pressure at 20 C (68 F): Essentially zero
7. Solubility in water, g/100 g water at 20 C (68 F): Reacts
8. Evaporation rate (butyl acetate = 1): Not applicable

• **Physical data—Barium carbonate**

1. Molecular weight: 197.3
2. Boiling point (760 mm Hg): 1300 C (2372 F) (decomposes)
3. Specific gravity (water = 1): 4.25
4. Vapor density (air = 1 at boiling point of barium carbonate): Not applicable
5. Melting point: Decomposes at 1300 C (2372 F)
6. Vapor pressure at 20 C (68 F): Essentially zero
7. Solubility in water, g/100 g water at 20 C (68 F): 0.0022
8. Evaporation rate (butyl acetate = 1): Not applicable

• **Physical data—Barium chloride**

1. Molecular weight: 208.3
2. Boiling point (760 mm Hg): 1560 C (2840 F)
3. Specific gravity (water = 1): 3.86
4. Vapor density (air = 1 at boiling point of barium chloride): Not applicable
5. Melting point: 963 C (1765 F)
6. Vapor pressure at 20 C (68 F): Essentially zero
7. Solubility in water, g/100 g water at 20 C (68 F): 36
8. Evaporation rate (butyl acetate = 1): Not applicable

• **Reactivity**

1. Conditions contributing to instability: For barium nitrate, elevated temperatures may cause melting and decomposition; for the other compounds, none hazardous.
2. Incompatibilities: Contact of barium oxide with water, carbon dioxide, or hydrogen sulfide may cause fires and explosions. Contact of barium carbonate with acids causes formation of carbon dioxide gas that may cause suffocation in enclosed spaces. Contact of barium nitrate with organic matter and combustible materials may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as oxides of nitrogen and carbon monoxide) may be released in a fire involving barium nitrate.
4. Special precautions: None

• **Flammability**

1. Flash point: Not applicable
2. Autoignition temperature: For barium nitrate, data not available; for the the other compounds, not applicable.
3. Flammable limits in air, % by volume: Not applicable
4. Extinguishant: Large amounts of water should be used on adjacent fires.

• **Warning properties**

According to Grant, barium chloride causes "considerable iritis, which subsides in a few days" when "tested

in neutral 0.08 to 0.1 M solution on rabbit eyes by injection into the cornea or by dropping for 10 minutes on the eye after the corneal epithelium was removed to facilitate penetration." Grant states that "both the oxide and hydroxide are capable of causing severe alkali burns of the eye, similar to those produced by calcium hydroxide."

## MONITORING AND MEASUREMENT PROCEDURES

• **General**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

• **Method**

Sampling and analyses may be performed by collection on a cellulose membrane filter followed by leaching in hot water, solution of sample in acid, and analysis in an atomic absorption spectrophotometer. An analytical method for soluble barium compounds is in the *NIOSH Manual of Analytical Methods,* 2nd Ed., Vol. 3, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00261-4).

## RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

• In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

## PERSONAL PROTECTIVE EQUIPMENT

• Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with barium carbonate, barium chloride, barium nitrate, or liquids containing these compounds.

• Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent skin contact with barium oxide or liquids containing barium oxide, where skin contact may occur.

• If employees' clothing has had any possibility of being contaminated with barium carbonate, barium chloride, barium nitrate, barium oxide, or liquids containing these compounds, employees should change into uncontaminated clothing before leaving the work premises.

• Clothing contaminated with barium carbonate, barium chloride, barium nitrate, or barium oxide should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of contaminant from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the contaminant, the person performing the operation should be informed of contaminant's hazardous properties.

• Where exposure of an employee's body to barium oxide or liquids containing barium oxide may occur, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

• Non-impervious clothing which becomes contaminated with barium carbonate, barium chloride, barium nitrate, or barium oxide should be removed promptly and not reworn until the contaminant is removed from the clothing.

• Employees should be provided with and required to use dust- and splash-proof safety goggles where there is any possibility of barium oxide or liquids containing barium oxide contacting the eyes.

• Employees should be provided with and required to use dust- and splash-proof safety goggles where barium carbonate, barium chloride, barium nitrate, or liquids containing these compounds may contact the eyes.

• Where there is any possibility that employees' eyes may be exposed to barium oxide or liquids containing barium oxide, an eye-wash fountain should be provided within the immediate work area for emergency use.

## SANITATION

• Workers subject to skin contact with barium oxide or liquids containing barium oxide should wash any areas of the body which may have contacted barium oxide at the end of each work day.

• Skin that becomes contaminated with barium carbonate, barium chloride, or barium nitrate should be promptly washed or showered to remove any contaminant. In the case of barium carbonate, employees should use soap or mild detergent and water for washing purposes.

• Skin that becomes contaminated with barium oxide should be promptly washed or showered to remove any barium oxide from the skin after all obvious amounts of barium oxide have been removed by other means (e.g., by use of oil or vaseline). Employees who are being burned by barium oxide should immediately utilize quick drenching facilities without first removing barium oxide by other means.

• Eating and smoking should not be permitted in areas where solid barium carbonate, barium chloride, barium nitrate, or barium oxide, or liquids containing these compounds are handled, processed, or stored.

• Employees who handle barium carbonate, barium chloride, barium nitrate, barium oxide, or liquids containing these compounds should wash their hands thoroughly before eating, smoking, or using toilet facilities. In the case of barium carbonate, employees should use soap or mild detergent and water for washing purposes.

## COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to soluble barium compounds may occur and control methods which may be effective in each case:

| Operation | Controls |
|---|---|
| Manufacture and distribution of soluble barium compounds | Process enclosure; local exhaust ventilation |
| Use in manufacture of pressed and blown glasssware and flint and crown optical glass; manufacture of ceramic products; use in electronics industry in manufacture of magnets, vacuum tubes, cathodes, x-ray fluorescent screens, TV picture tubes, and dry cell depolarizers | Process enclosure; local exhaust ventilation |
| Use in manufacture of photographic papers, dyes, and chemicals | Process enclosure; local exhaust ventilation |
| Use as pesticides, rodenticides, and disinfectants; use in manufacture of explosives, matches, and pyrotechnics as igniter compositions and fireworks | Process enclosure; local exhaust ventilation |
| Use as an additive in manufacture of grease, and manufacture of lubricating oils; use in refining of vegetable and animal oils | Process enclosure; local exhaust ventilation |
| Use in case-hardening of steel in metallurgy; in welding aluminum; in electroplating; and in aluminum and sodium refining | Process enclosure; local exhaust ventilation |
| Use in water treatment and boiler compounds for softening water; use as catalysts, analytical reagents, and purifying agents | Process enclosure; local exhaust ventilation |
| Use for treatment of textiles, leather, and rubber; use in manufacture of paper and cellulose as a bleaching agent; use in manufacture of pigments, colors, and lakes | Process enclosure; local exhaust ventilation |
| Use as a depilatory in processing of hides; as a fire-proof and extinguishing agent; in embalming; in sugar refining; in gas and solvent drying; in marble substitutes; in valve manufacture; and as a smoke suppressant in diesel fuels | Process enclosure; local exhaust ventilation |
| Use in manufacture of pigments, paints, enamels, and printing inks | Process enclosure; local exhaust ventilation |

## EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• **Eye Exposure**

If solutions of barium compounds get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with these chemicals.

• **Skin Exposure**

If solutions of barium compounds get on the skin, immediately flush the contaminated skin with water. If solutions of barium compounds soak through the clothing, remove the clothing immediately and flush the skin with water. If irritation persists after washing, get medical attention.

• **Breathing**

If a person breathes in large amounts of soluble barium compounds, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• **Swallowing**

When soluble barium compounds have been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

• **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

## SPILL AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills until cleanup has been completed.

• If soluble barium compounds are spilled, the following steps should be taken:

1. Ventilate area of spill.
2. Collect spilled material in the most convenient and safe manner and deposit in sealed containers for reclamation or for disposal in a secured sanitary landfill. Liquids containing soluble barium compounds should be absorbed in vermiculite, dry sand, earth, or a similar material.

• Waste disposal method:

Soluble barium compounds may be disposed of in sealed containers in a secured sanitary landfill.

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## RESPIRATORY PROTECTION FOR SOLUBLE BARIUM COMPOUNDS (AS BARIUM)

| Condition | Minimum Respiratory Protection* Required Above 0.5 mg/m³ |
|---|---|
| Particulate Concentration | |
| 2.5 mg/m³ or less | Any dust and mist respirator, except single-use.** |
| 5 mg/m³ or less | Any dust and mist respirator, except single-use or quarter-mask respirator.<br>Any fume respirator or high efficiency particulate filter respirator.<br>Any supplied-air respirator.<br>Any self-contained breathing apparatus. |
| 25 mg/m³ or less | A high efficiency particulate filter respirator with a full facepiece.<br>Any supplied-air respirator with a full facepiece, helmet, or hood.<br>Any self-contained breathing apparatus with a full facepiece. |
| 250 mg/m³ or less | A Type C supplied-air respirator operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet, or hood operated in continuous-flow mode.<br>A powered air-purifying respirator with a high efficiency particulate filter. |
| Greater than 250 mg/m³ or entry and escape from unknown concentrations | Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.<br>A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode. |
| Fire Fighting | Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. |
| Escape | A high efficiency particulate filter respirator.<br>Any escape self-contained breathing apparatus. |

*Only NIOSH-approved or MSHA-approved equipment should be used.

**If eye irritation occurs, full-facepiece respiratory protective equipment should be used.

# OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR BENZENE

# POTENTIAL HUMAN CARCINOGEN

## INTRODUCTION

This guideline summarizes pertinent information about benzene for workers, employers, and occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments in these fields; therefore, readers are advised to regard these recommendations as general guidelines.

## SUBSTANCE IDENTIFICATION

- **Formula:** $C_6H_6$
- **Structure:**

- **Synonyms:** Benzol, benzole, benzolene, bicarburet of hydrogen, carbon oil, coal naphtha
- **Identifiers:** CAS 71-43-2; RTECS CY1400000; DOT 1114, label required: "Flammable Liquid"
- **Appearance and odor:** Colorless liquid with an aromatic odor

## CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 78.12
2. Boiling point (at 760 mmHg): 80.1°C (176°F)
3. Specific gravity (water = 1): 0.88
4. Vapor density (air = 1 at boiling point of benzene): 2.7
5. Melting point: 5.5°C (42°F)
6. Vapor pressure at 20°C (68°F): 75 mmHg
7. Solubility in water, g/100 g water at 20°C (68°F): 0.06
8. Evaporation rate (butyl acetate = 1): 5.1
9. Saturation concentration in air (approximate) at 25°C (77°F): 12.5% (125,000 ppm)
10. Ionization potential: 9.25 eV

- **Reactivity**

Incompatibilities: Benzene reacts with strong oxidizers including chlorine, oxygen, and bromine with iron.

2. Hazardous decomposition products: Toxic vapors and gases (e.g., carbon monoxide) may be released in a fire involving benzene.
3. Caution: Benzene will attack some forms of plastics, coatings, and rubber.

- **Flammability**

1. Flash point: -11.1°C (12°F) (closed cup)
2. Autoignition temperature: 498°C (928°F)
3. Flammable limits in air, % by volume: Lower, 1.4; upper, 7.1
4. Extinguishant: Alcohol foam, carbon dioxide, and dry chemical extinguishants are effective. Water may be an ineffective extinguishant but may be used to cool fire-exposed containers.
5. Class IB Flammable Liquid (29 CFR 1910.106), Flammability Rating 3 (NFPA)
6. Unusual fire and explosion hazards: Benzene liquid is flammable, and its vapors can easily form explosive mixtures. Flashbacks may occur along a vapor trail.

- **Warning properties**

1. Odor threshold: 12 ppm
2. Eye irritation levels: 3,000 ppm for 0.5-1 hour
3. Other information: 3,000 ppm may irritate nose and respiratory tract.
4. Evaluation of warning properties for respirator selection: Warning properties are not considered in recommending respirators for use with carcinogens.

## EXPOSURE LIMITS

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for benzene is 1 part of benzene per million parts of air (PPM) as a time-weighted average (TWA) concentration over an 8-hour workshift; the short-term exposure limit is 5 ppm in any 15-minute sampling period. The National Institute for Occupational Safety and Health (NIOSH) recommends that benzene be controlled and handled as a potential human carcinogen in the workplace and that exposure be reduced to the lowest feasible limit. The NIOSH recommended exposure limit (REL) is 0.1 ppm [0.32 milligrams of benzene per cubic meter of air ($mg/m^3$)] as an 8-hour TWA and 1 ppm (3.2 $mg/m^3$) as a ceiling in any 15-minute sampling period. The NIOSH REL is the lowest con-

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centration detectable by current NIOSH-validated sampling and analytical methods. The American Conference of Governmental Industrial Hygienists (ACGIH) has designated benzene as an A2 substance (suspected human carcinogen) having an assigned threshold limit value (TLV®) of 10 ppm (30 mg/m³) as a TWA for a normal 8-hour workday and a 40-hour workweek.

**Table 1.—Occupational exposure limits for benzene**

| | Exposure limits ppm | mg/m³ |
|---|---|---|
| OSHA PEL TWA | 1 | — |
| Short-term exposure limit (15 min) | 5 | — |
| NIOSH REL (Ca)* TWA | 0.1 | 0.32 |
| Ceiling (15 min) | 1 | 3.2 |
| ACGIH TLV® TWA (A2)† | 10 | 30 |

* (Ca): NIOSH recommends treating as a potential human carcinogen.
†(A2): Suspected human carcinogen.

## HEALTH HAZARD INFORMATION

**• Routes of exposure**

Benzene may cause adverse health effects following exposure via inhalation, ingestion, or dermal or eye contact.

**• Summary of toxicology**

1. *Effects on animals:* Acute inhalation of benzene by rats, mice, or rabbits caused narcosis, spontaneous heart contractions (ventricular fibrillation), and death due to respiratory paralysis. Subchronic inhalation of benzene by rats produced decreased white blood cell counts, decreased bone marrow cell activity, increased red blood cell activity, and cataracts. In rats, chronic inhalation or oral administration of benzene produced cancers of the liver, mouth, and Zymbal gland. Inhalation of benzene by pregnant rats caused retardation of fetal development and increased fetal mortality.

2. *Effects on humans:* Acute inhalation exposure of benzene has caused nerve inflammation (polyneuritis), central nervous system depression, and cardiac sensitization. Chronic exposure to benzene has produced anorexia and irreversible injury to the blood-forming organs; effects include aplastic anemia and leukemia.

**• Signs and symptoms of exposure**

1. *Short-term (acute):* Exposure to benzene can cause dizziness, euphoria, giddiness, headache, nausea, staggering gait, weakness, drowsiness, respiratory irritation, pulmonary edema and pneumonia, gastrointestinal irritation, convulsions, and paralysis. Benzene can also cause irritation to the skin, eyes, and mucous membranes.

2. *Long-term (chronic):* Exposure to benzene can cause fatigue, nervousness, irritability, blurred vision, and labored breathing. Repeated skin contact can cause redness, blistering, and dry, scaly dermatitis.

## RECOMMENDED MEDICAL PRACTICES

**• Medical surveillance program**

Workers with potential exposures to chemical hazards should be monitored in a systematic program of medical surveillance intended to prevent or control occupational injury and disease. The program should include education of employers and workers about work-related hazards, placement of workers in jobs that do not jeopardize their safety and health, earliest possible detection of adverse health effects, and referral of workers for diagnostic confirmation and treatment. The occurrence of disease (a "sentinel health event," SHE) or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical surveillance program is intended to supplement, not replace, such measures.

A medical surveillance program should include systematic collection and epidemiologic analysis of relevant environmental and biologic monitoring, medical screening, morbidity, and mortality data. This analysis may provide information about the relatedness of adverse health effects and occupational exposure that cannot be discerned from results in individual workers. Sensitivity, specificity, and predictive values of biologic monitoring and medical screening tests should be evaluated on an industry-wide basis prior to application in any given worker group. Intrinsic to a surveillance program is the dissemination of summary data to those who need to know, including employers, occupational health professionals, potentially exposed workers, and regulatory and public health agencies.

**• Preplacement medical evaluation**

Prior to placing a worker in a job with a potential for exposure to benzene, the physician should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic and laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the eyes, skin, liver, and respiratory, nervous, and hematopoietic (blood-cell-forming) systems. The physician should obtain baseline values for the complete blood count and a stained differential count of all blood cell types. Medical surveillance for respiratory disease should be conducted by using the principles and methods recommended by NIOSH and the American Thoracic Society (ATS).

A preplacement medical evaluation is recommended in order to detect and assess preexisting or concurrent conditions which may be aggravated or result in increased risk when a worker is exposed to benzene at or below the NIOSH REL. The examining physician should consider the probable frequency, intensity, and duration of exposure, as well as the nature and degree of the condition, in placing such a worker. Such conditions, which should not be regarded as absolute contraindi-

cations to job placement, include a history of chronic skin disease, concurrent dermatitis, or mild non-hemolytic anemia (e.g., mild iron-deficiency anemia).

• **Periodic medical screening and/or biologic monitoring**
Occupational health interviews and physical examinations should be performed at regular intervals. Additional examinations may be necessary should a worker report symptoms that may be attributed to exposure to benzene. The interviews, examinations, and appropriate medical screening and/or biologic monitoring tests should be directed at identifying an excessive decrease or adverse trend in the integrity and physiologic function of the skin, liver, and respiratory, nervous, and hematopoietic (blood-cell-forming) systems as compared to the baseline status of the individual worker or to expected values for a suitable reference population. The following tests should be used and interpreted according to standardized procedures and evaluation criteria recommended by NIOSH and the ATS: standardized questionnaires and tests of lung function.

• **Medical practices recommended at the time of job transfer or termination.**
The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic and laboratory tests which were conducted at the time of placement should be repeated at the time of job transfer or termination. Any changes in the worker's health status should be compared to those expected for a suitable reference population. Because occupational exposure to benzene may cause diseases of prolonged induction-latency, the need for medical surveillance may extend well beyond termination of employment.

• **Sentinel health events**
1. Acute SHE's include: Acute myeloid leukemia and contact and/or allergic dermatitis.
2. Delayed-onset SHE's include: Decrease in the number (neutropenia) or absence (agranulocytosis) of certain white blood cells in the peripheral circulation and/or in the bone marrow (aplastic anemia) and cancer of the red blood cells (erythroleukemia).

## MONITORING AND MEASUREMENT PROCEDURES

• **TWA exposure evaluation**
Measurements to determine worker exposure to benzene should be taken so that the TWA exposure is based on a single entire workshift sample or an appropriate number of consecutive samples collected during the entire workshift. Under certain conditions, it may be appropriate to collect several short-term interval samples (up to 30 minutes each) to determine the average exposure level. Air samples should be taken in the worker's breathing zone (air that most nearly represents that inhaled by the worker).

• **Ceiling concentration evaluation**
Measurements to determine worker exposure should be taken during periods of maximum expected airborne concentrations of benzene. Each measurement to determine the NIOSH REL (ceiling exposure) in the worker's breathing zone (air that most nearly represents that inhaled by the worker) should consist of a 15-minute sample. A minimum of three measurements should be taken during one workshift, and the highest of all measurements taken is an estimate of the worker's exposure. If the periods of maximum exposure are not clearly defined, a statistical procedure which can be used as a peak exposure detection strategy is given in the *Occupational Exposure Sampling Strategy Manual*.

• **Method**
Sampling and analysis may be performed by collecting benzene vapors with charcoal tubes followed by desorption with carbon disulfide and analysis by gas chromatography. Direct-reading devices calibrated to measure benzene may also be used if available. A detailed sampling and analytical method for benzene may be found in the *NIOSH Manual of Analytical Methods* (method number 1500).

## PERSONAL PROTECTIVE EQUIPMENT

Chemical protective clothing (CPC) should be selected after utilizing available performance data, consulting with the manufacturer, and then evaluating the clothing under actual use conditions.

Workers should be provided with and required to use CPC, gloves, and other appropriate protective clothing necessary to prevent skin contact with benzene.

## SANITATION

Clothing which is contaminated with benzene should be removed immediately and placed in sealed containers for storage until it can be discarded or until provision is made for the removal of benzene from the clothing. If the clothing is to be laundered or cleaned, the person performing the operation should be informed of benzene's hazardous properties. Reusable clothing and equipment should be checked for residual contamination before reuse or storage.

A change room with showers, washing facilities, and lockers that permit separation of street and work clothes should be provided.

Workers should be required to shower following a workshift and prior to putting on street clothes. Clean work clothes should be provided daily.

Skin that becomes contaminated with benzene should be promptly washed with soap and water.

Workers who handle benzene should wash their faces, hands, and forearms thoroughly with soap and water before eating, smoking, or using toilet facilities.

The storage, preparation, dispensing, or consumption of food or beverages, the storage or application of cosmetics, the storage or use of smoking materials, or the storage or use of products for chewing should be prohibited in work areas.

## COMMON OPERATIONS AND CONTROLS

Common operations in which exposure to benzene may occur and control methods which may be effective in each case are listed in Table 2.

**Table 2.—Operations and methods of control for benzene**

| Operations | Controls |
|---|---|
| During the manufacture and processing of benzene; during use as a raw material in the production of aromatic compounds and derivatives | Process enclosure, local exhaust ventilation, personal protective equipment |
| During the use of chemicals in which benzene may be an impurity (e.g., naphthas, toluene, xylene) | Process enclosure, local exhaust ventilation, personal protective equipment |
| During the manufacture and use of motor fuel blends in which benzene is used as an ingredient; during use as an extracting solvent | Process enclosure (when possible), local exhaust ventilation, personal protective equipment, material substitution |
| During the preparation and use of paint and varnish removers, rubber cements, and lacquers | Process enclosure (when possible), local exhaust ventilation, personal protective equipment, material substitution |

## EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, remove the victim from further exposure, send for medical assistance, and initiate emergency procedures.

- **Eye exposure**

Where there is any possibility of a worker's eyes being exposed to benzene, an eye-wash fountain should be provided within the immediate work area for emergency use.

If benzene gets into the eyes, flush them immediately with large amounts of water for 15 minutes, lifting the lower and upper lids occasionally. Get medical attention as soon as possible. Contact lenses should not be worn when working with this chemical.

- **Skin exposure**

Where there is any possibility of a worker's body being exposed to benzene, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

If benzene gets on the skin, wash it immediately with soap and water. If benzene penetrates the clothing, remove the clothing immediately and wash the skin with soap and water. Get medical attention promptly.

- **Rescue**

If a worker has been incapacitated, move the affected worker from the hazardous exposure. Put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

## SPILLS AND LEAKS

Workers not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

If benzene is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. For small quantities of liquids containing benzene, absorb on paper towels and place in an appropriate container.
4. Large quantities of liquids containing benzene may be absorbed in vermiculite, dry sand, earth, or a similar material and placed in an appropriate container.
5. Liquids containing benzene may be collected by vacuuming with an appropriate system. If a vacuum system is used, there should be no sources of ignition in the vicinity of the spill, and flashback prevention devices should be provided.

## WASTE REMOVAL AND DISPOSAL

U.S. Environmental Protection Agency, Department of Transportation, and/or state and local regulations shall be followed to assure that removal, transport, and disposal are in accordance with existing regulations.

## RESPIRATORY PROTECTION

It must be stressed that the use of respirators is the least preferred method of controlling worker exposure and should not normally be used as the only means of preventing or minimizing exposure during routine operations. However, there are some exceptions for which respirators may be used to control exposure: when engineering and work practice controls are not technically feasible, when engineering controls are in the process of being installed, or during emergencies and certain maintenance operations including those requiring confined-space entry (Table 3).

In addition to respirator selection, a complete respiratory protection program should be instituted which as a minimum complies with the requirements found in the OSHA Safety and Health Standards, 29 CFR 1910.134. A respiratory protection program should include as a minimum an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, periodic environmental monitoring, maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program, including selection of the correct respirators, requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly.

Only respirators that have been approved by the Mine Safety and Health Administration (MSHA, formerly Mining Enforcement and Safety Administration) and by NIOSH should be used. **Remember! Air-purifying respirators will not protect from oxygen-deficient atmospheres.**

# BENZENE

**BNZ**

| Common Synonyms | Watery liquid | Colorless | Gasoline-like odor |
|---|---|---|---|
| Benzol<br>Benzole | Floats on water. Flammable, irritating vapor is produced. Freezing point is 42°F. | | |

Avoid contact with liquid and vapor. Keep people away.
Wear goggles and self-contained breathing apparatus.
Shut off ignition sources and call fire department.
Stop discharge if possible.
Stay upwind and use water spray to "knock down" vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

## Fire

FLAMMABLE.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.

Wear goggles and self-contained breathing apparatus.
Extinguish with dry chemical, foam, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

## Exposure

CALL FOR MEDICAL AID.
**VAPOR**
Irritating to eyes, nose and throat.
If inhaled, will cause headache, difficult breathing, or loss of consciousness.

Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.
**LIQUID**
Irritating to skin and eyes.
Harmful if swallowed.

Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.

## Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

## 1. RESPONSE TO DISCHARGE

**(See Response Methods Handbook)**
Issue warning-high flammability
Restrict access

## 2. LABEL

2.1 **Category:** Flammable liquid
2.2 **Class:** 3

## 3. CHEMICAL DESIGNATIONS

3.1 **CG Compatibility Class:** Aromatic Hydrocarbon
3.2 **Formula:** $C_6H_6$
3.3 **IMO/UN Designation:** 3.2/1114
3.4 **DOT ID No.:** 1114
3.5 **CAS Registry No.:** 71-43-2

## 4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid
4.2 **Color:** Colorless
4.3 **Odor:** Aromatic; rather pleasant aromatic odor; characteristic odor

## 5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Hydrocarbon vapor canister, supplied air or a hose mask; hydrocarbon-insoluble rubber or plastic gloves; chemical goggles or face splash shield; hydrocarbon-insoluble apron such as neoprene.
5.2 **Symptoms Following Exposure:** Dizziness, excitation, pallor, followed by flushing, weakness, headache, breathlessness, chest constriction. Coma and possible death.
5.3 **Treatment of Exposure:** SKIN: flush with water followed by soap and water; remove contaminated clothing and wash skin. EYES: flush with plenty of water until irritation subsides. INHALATION: remove from exposure immediately. Call a physician. IF breathing is irregular or stopped, start resuscitation, administer oxygen.
5.4 **Threshold Limit Value:** 10 ppm
5.5 **Short Term Inhalation Limits:** 75 ppm for 30 min.
5.6 **Toxicity by Ingestion:** Grade 3; $LD_{50}$ = 50 to 500 mg/kg
5.7 **Late Toxicity:** Leukemia
5.8 **Vapor (Gas) Irritant Characteristics:** If present in high concentrations, vapors may cause irritation of eyes or respiratory system. The effect is temporary.
5.9 **Liquid or Solid Irritant Characteristics:** Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 **Odor Threshold:** 4.68 ppm
5.11 **IDLH Value:** 2,000 ppm

## 6. FIRE HAZARDS

6.1 **Flash Point:** 12°F C.C.
6.2 **Flammable Limits in Air:** 1.3%-7.9%
6.3 **Fire Extinguishing Agents:** Dry chemical, foam, or carbon dioxide
6.4 **Fire Extinguishing Agents Not to be Used:** Water may be ineffective
6.5 **Special Hazards of Combustion Products:** Not pertinent
6.6 **Behavior in Fire:** Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back
6.7 **Ignition Temperature:** 1097°F
6.8 **Electrical Hazard:** Class I, Group D
6.9 **Burning Rate:** 6.0 mm/min.
6.10 **Adiabatic Flame Temperature:** Data not available
6.11 **Stoichiometric Air to Fuel Ratio:** Data not available
6.12 **Flame Temperature:** Data not available

## 7. CHEMICAL REACTIVITY

7.1 **Reactivity With Water:** No reaction
7.2 **Reactivity with Common Materials:** No reaction
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent
7.7 **Molar Ratio (Reactant to Product):** Data not available
7.8 **Reactivity Group:** 32

## 8. WATER POLLUTION

8.1 **Aquatic Toxicity:**
5 ppm/6 hr/minnow/lethal/distilled water
20 ppm/24 hr/sunfish/$TL_m$/tap water
8.2 **Waterfowl Toxicity:** Data not available
8.3 **Biological Oxygen Demand (BOD):** 1.2 lb/lb, 10 days
8.4 **Food Chain Concentration Potential:** None

## 9. SHIPPING INFORMATION

9.1 **Grades of Purity:**
Industrial pure .....99+%
Thiophene-free .....99+%
Nitration .....99+%
Industrial 90% .....85+%
Reagent ..... 99+%
9.2 **Storage Temperature:** Open
9.3 **Inert Atmosphere:** No requirement
9.4 **Venting:** Pressure-vacuum

## 10. HAZARD ASSESSMENT CODE

**(See Hazard Assessment Handbook)**
**A-T-U-V-W**

## 11. HAZARD CLASSIFICATIONS

11.1 **Code of Federal Regulations:** Flammable liquid
11.2 **NAS Hazard Rating for Bulk Water Transportation:**

| Category | Rating |
|---|---|
| Fire | 3 |
| Health | |
| Vapor Irritant | 1 |
| Liquid or Solid Irritant | 1 |
| Poisons | 3 |
| Water Pollution | |
| Human Toxicity | 3 |
| Aquatic Toxicity | 1 |
| Aesthetic Effect | 3 |
| Reactivity | |
| Other Chemicals | 2 |
| Water | 1 |
| Self Reaction | 0 |

11.3 **NFPA Hazard Classification:**

| Category | Classification |
|---|---|
| Health Hazard (Blue) | 2 |
| Flammability (Red) | 3 |
| Reactivity (Yellow) | 0 |

## 12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm:** Liquid
12.2 **Molecular Weight:** 78.11
12.3 **Boiling Point at 1 atm:** 176°F = 80.1°C = 353.3°K
12.4 **Freezing Point:** 42.0°F = 5.5°C = 278.7°K
12.5 **Critical Temperature:** 552.0°F = 288.9°C = 562.1°K
12.6 **Critical Pressure:** 710 psia = 48.3 atm = 4.89 $MN/m^2$
12.7 **Specific Gravity:** 0.879 at 20°C (liquid)
12.8 **Liquid Surface Tension:** 28.9 dynes/cm = 0.0289 N/m at 20°C
12.9 **Liquid Water Interfacial Tension:** 35.0 dynes/cm = 0.035 N/m at 20°C
12.10 **Vapor (Gas) Specific Gravity:** 2.7
12.11 **Ratio of Specific Heats of Vapor (Gas):** 1.061
12.12 **Latent Heat of Vaporization:** 169 Btu/lb = 94.1 cal/g = $3.94 \times 10^5$ J/kg
12.13 **Heat of Combustion:** —17,460 Btu/lb = —9698 cal/g = —$406.0 \times 10^5$ J/kg
12.14 **Heat of Decomposition:** Not pertinent
12.15 **Heat of Solution:** Not pertinent
12.16 **Heat of Polymerization:** Not pertinent
12.25 **Heat of Fusion:** 30.45 cal/g
12.26 **Limiting Value:** Data not available
12.27 **Reid Vapor Pressure:** 3.22 psia

**NOTES**

| BNZ | BENZENE |
|---|---|

| 12.17 SATURATED LIQUID DENSITY | |
|---|---|
| Temperature (degrees F) | Pounds per cubic foot |
| 55 | 55.330 |
| 60 | 55.140 |
| 65 | 54.960 |
| 70 | 54.770 |
| 75 | 54.580 |
| 80 | 54.400 |
| 85 | 54.210 |
| 90 | 54.030 |
| 95 | 53.840 |
| 100 | 53.660 |
| 105 | 53.470 |
| 110 | 53.290 |
| 115 | 53.100 |
| 120 | 52.920 |
| 125 | 52.730 |
| 130 | 52.540 |
| 135 | 52.360 |
| 140 | 52.170 |
| 145 | 51.990 |
| 150 | 51.800 |
| 155 | 51.620 |
| 160 | 51.430 |
| 165 | 51.250 |
| 170 | 51.060 |
| 175 | 50.870 |

| 12.18 LIQUID HEAT CAPACITY | |
|---|---|
| Temperature (degrees F) | British thermal unit per pound-F |
| 45 | .394 |
| 50 | .396 |
| 55 | .398 |
| 60 | .400 |
| 65 | .403 |
| 70 | .405 |
| 75 | .407 |
| 80 | .409 |
| 85 | .411 |
| 90 | .414 |
| 95 | .416 |
| 100 | .418 |

| 12.19 LIQUID THERMAL CONDUCTIVITY | |
|---|---|
| Temperature (degrees F) | British thermal unit-inch per hour-square foot-F |
| 75 | .988 |
| 80 | .981 |
| 85 | .975 |
| 90 | .969 |
| 95 | .962 |
| 100 | .956 |
| 105 | .950 |
| 110 | .944 |
| 115 | .937 |
| 120 | .931 |
| 125 | .925 |
| 130 | .919 |
| 135 | .912 |
| 140 | .906 |
| 145 | .900 |
| 150 | .893 |
| 155 | .887 |
| 160 | .881 |
| 165 | .875 |
| 170 | .868 |

| 12.20 LIQUID VISCOSITY | |
|---|---|
| Temperature (degrees F) | Centipoise |
| 55 | .724 |
| 60 | .693 |
| 65 | .665 |
| 70 | .638 |
| 75 | .612 |
| 80 | .588 |
| 85 | .566 |
| 90 | .544 |
| 95 | .524 |
| 100 | .505 |
| 105 | .487 |
| 110 | .470 |
| 115 | .453 |
| 120 | .438 |

| 12.21 SOLUBILITY IN WATER | |
|---|---|
| Temperature (degrees F) | Pounds per 100 pounds of water |
| 77.02 | .180 |

| 12.22 SATURATED VAPOR PRESSURE | |
|---|---|
| Temperature (degrees F) | Pounds per square inch |
| 50 | .881 |
| 60 | 1.171 |
| 70 | 1.535 |
| 80 | 1.989 |
| 90 | 2.547 |
| 100 | 3.227 |
| 110 | 4.049 |
| 120 | 5.033 |
| 130 | 6.201 |
| 140 | 7.577 |
| 150 | 9.187 |
| 160 | 11.060 |
| 170 | 13.220 |
| 180 | 15.700 |
| 190 | 18.520 |
| 200 | 21.740 |
| 210 | 25.360 |

| 12.23 SATURATED VAPOR DENSITY | |
|---|---|
| Temperature (degrees F) | Pounds per cubic foot |
| 50 | .01258 |
| 60 | .01639 |
| 70 | .02109 |
| 80 | .02681 |
| 90 | .03371 |
| 100 | .04196 |
| 110 | .05172 |
| 120 | .06317 |
| 130 | .07652 |
| 140 | .09194 |
| 150 | .10960 |
| 160 | .12980 |
| 170 | .15270 |
| 180 | .17850 |
| 190 | .20750 |
| 200 | .23970 |
| 210 | .27560 |

| 12.24 IDEAL GAS HEAT CAPACITY | |
|---|---|
| Temperature (degrees F) | British thermal unit per pound-F |
| 0 | .204 |
| 25 | .219 |
| 50 | .234 |
| 75 | .248 |
| 100 | .261 |
| 125 | .275 |
| 150 | .288 |
| 175 | .301 |
| 200 | .313 |
| 225 | .325 |
| 250 | .337 |
| 275 | .349 |
| 300 | .360 |
| 325 | .371 |
| 350 | .381 |
| 375 | .392 |
| 400 | .402 |
| 425 | .412 |
| 450 | .421 |
| 475 | .431 |
| 500 | .440 |
| 525 | .449 |
| 550 | .457 |
| 575 | .465 |
| 600 | .474 |

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## Table 3.—Respiratory protection for benzene

| Condition | Minimum respiratory protection* |
|---|---|
| Any detectable concentration | Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode |
| | Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode |
| Planned or emergency entry into environments containing unknown or any detectable concentration | Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode |
| | Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode |
| Firefighting | Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode |
| Escape only | Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic canister |
| | Any appropriate escape-type self-contained breathing apparatus |

* Only NIOSH/MSHA-approved equipment should be used.

# Occupational Health Guideline for Ethyl Benzene

## INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

## SUBSTANCE IDENTIFICATION

- Formula: $C_2H_5C_6H_5$
- Synonyms: Phenylethane; ethylbenzol
- Appearance and odor: Colorless liquid with an aromatic odor.

## PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for ethyl benzene is 100 parts of ethyl benzene per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 435 milligrams of ethyl benzene per cubic meter of air ($mg/m^3$).

## HEALTH HAZARD INFORMATION

- **Routes of exposure**

Ethyl benzene can affect the body if it is inhaled, is swallowed, or comes in contact with the eyes or skin.

- **Effects of overexposure**

*1. Short-term Exposure:* Ethyl benzene causes irritation of the eyes, nose, throat, and skin. With exposure to high concentrations, irritating effects are more pronounced, and a person may begin to feel weak, dizzy, drowsy, and become unconscious.

*2. Long-term Exposure:* Prolonged or repeated ethyl benzene exposure of the skin may casue skin rash.

*3. Reporting Signs and Symptoms:* A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to ethyl benzene.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to ethyl benzene at potentially hazardous levels:

*1. Initial Medical Screening:* Employees should be screened for history of certain medical conditions (listed below) which might place the employee at increased risk from ethyl benzene exposure.

—Chronic respiratory disease: In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of ethyl benzene might cause exacerbation of symptoms due to its irritant properties or psychic reflex bronchospasm.

—Kidney disease: Although ethyl benzene is not known as a kidney toxin in humans, the importance of this organ in the elimination of toxic substances justifies special consideration in those with possible impairment of renal function.

—Liver disease: Although ethyl benzene is not known as a liver toxin in humans, the importance of this organ in the biotransformation and detoxification of foreign substances should be considered before exposing persons with impaired liver function.

—Skin disease: Ethyl benzene is a defatting agent and can cause dermatitis on prolonged exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent.

*2. Periodic Medical Examination:* Any employee developing the above-listed conditions should be referred for further medical examination.

- **Summary of toxicology**

Ethyl benzene is primarily an irritant of skin and, to some degree, of eyes and upper respiratory tract. Systemic absorption causes depression of the central nervous system with narcosis at very high concentrations. Aspiration of small amounts causes extensive edema and hemorrhage of lung tissue. It is readily metabolized and excreted chiefly as mandelic acid in the urine.

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These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

**U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES**
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

**U.S. DEPARTMENT OF LABOR**
Occupational Safety and Health Administration

## CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 106
2. Boiling point (760 mm Hg): 136 C (277 F)
3. Specific gravity (water = 1): 0.865
4. Vapor density (air = 1 at boiling point of ethyl benzene): 3.66
5. Melting point: −95 C (−139 F)
6. Vapor pressure at 20 C (68 F): 7.1 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 0.015
8. Evaporation rate (butyl acetate = 1): Less than 1

- **Reactivity**

1. Conditions contributing to instability: Heat
2. Incompatibilities: Contact with strong oxidizing agents may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide) may be released in a fire involving ethyl benzene.
4. Special precautions: None

- **Flammability**

1. Flash point: 15 C (59 F) (closed cup)
2. Autoignition temperature: 432 C (810 F)
3. Flammable limits in air, % by volume: Lower: 1.0; Upper: 6.7
4. Extinguishant: Dry chemical, foam, or carbon dioxide

- **Warning properties**

1. Odor Threshold: According to the Department of Transportation's *CHRIS Hazardous Chemical Data*,, ethyl benzene has an odor threshold of 140 ppm.
2. Eye Irritation Level: According to the AIHA *Hygienic Guide*, "the vapor caused a noticeable eye irritation in humans at concentrations of 200 ppm."
3. Evaluation of Warning Properties: Through its odor and irritant effects, ethyl benzene can be detected at a concentration less than twice the permissible exposure limit. Therefore, for the purposes of this guideline, ethyl benzene is treated as a material with adequate warning properties.

## MONITORING AND MEASUREMENT PROCEDURES

- **General**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

- **Method**

Sampling and analyses may be performed by collection of ethyl benzene vapors using an adsorption tube with subsequent desorption with carbon disulfide and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure ethyl benzene may be used. An analytical method for ethyl benzene is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 2, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00260-6).

## RESPIRATORS

- Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.
- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

## PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquid ethyl benzene.
- Clothing wet with liquid ethyl benzene should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of ethyl benzene from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the ethyl benzene, the person performing the operation should be informed of ethyl benzene's hazardous properties.
- Non-impervious clothing which becomes contaminated with liquid ethyl benzene should be removed promptly and not reworn until the ethyl benzene is removed from the clothing.
- Any clothing which becomes wet with liquid ethyl benzene should be removed immediately and not reworn until the ethyl benzene is removed from the clothing.
- Employees should be provided with and required to use splash-proof safety goggles where liquid ethyl benzene may contact the eyes.

## SANITATION

• Skin that becomes contaminated with liquid ethyl benzene should be promptly washed or showered with soap or mild detergent and water to remove any ethyl benzene.

## COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to ethyl benzene may occur and control methods which may be effective in each case:

| Operation | Controls |
|---|---|
| Liberation during manufacture of styrene monomer | Local exhaust ventilation |
| Use during spray application of vinyl resin surface coating | Local exhaust ventilation; personal protective equipment |
| Liberation during manufacture of paints, varnishes, and other surface coatings | Local exhaust ventilation; general dilution ventilation |
| Use in manufacture and application of rubber adhesives | General dilution ventilation; local exhaust ventilation; personal protective equipment |
| Use during electroplating of aluminum on copper or steel | Local exhaust ventilation for open-surface tanks |
| Liberation during oven baking and drying of surface coatings | Local exhaust ventilation for ovens |
| Liberation during application of surface coatings by dipping, flow coatings, and roller coating | Local exhaust ventilation |
| Liberation during use as an intermediate in dye manufacture | General dilution ventilation |
| Use as a heat-transfer medium; use as a dielectric | General dilution ventilation; personal protective equipment |
| Liberation during production of acetophenone by oxidation of ethyl benzene | General dilution ventilation |

## EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• **Eye Exposure**

If ethyl benzene gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention as soon as possible. Contact lenses should not be worn when working with this chemical.

• **Skin Exposure**

If ethyl benzene gets on the skin, promptly flush the contaminated skin with water. If ethyl benzene soaks through the clothing, remove the clothing immediately and flush the skin with water. When there is skin irritation, get medical attention.

• **Breathing**

If a person breathes in large amounts of ethyl benzene, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• **Swallowing**

If ethyl benzene has been swallowed, do not induce vomiting. Get medical attention immediately.

• **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

## SPILL, LEAK, AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

• If ethyl benzene is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. For small quantities, absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for evaporating vapors to completely clear the hood ductwork. Burn the paper in a suitable location away from combustible materials. Large quantities can be collected and atomized in a suitable combustion chamber. Combustion may be improved by mixing with a more flammable liquid. Ethyl benzene should not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion.

• Waste disposal methods:

Ethyl benzene may be disposed of:

1. By absorbing it in vermiculite, dry sand, earth or a similar material and disposing in a secured sanitary landfill.

2. By atomizing in a suitable combustion chamber. Combustion may be improved by mixing with a more flammable liquid.

## REFERENCES


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### RESPIRATORY PROTECTION FOR ETHYL BENZENE

| Condition | Minimum Respiratory Protection* Required Above 100 ppm |
|---|---|
| Vapor Concentration | |
| 1000 ppm or less | A chemical cartridge respirator with a full facepiece and an organic vapor cartridge(s). |
| 2000 ppm or less | A gas mask with a chin-style or a front- or back-mounted organic vapor canister.<br>Any supplied-air respirator with a full facepiece, helmet, or hood.<br>Any self-contained breathing apparatus with a full facepiece. |
| Greater than 2000 ppm or entry and escape from unknown concentrations | Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.<br>A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode. |
| Fire Fighting | Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. |
| Escape | Any gas mask providing protection against organic vapors.<br>Any escape self-contained breathing apparatus. |

*Only NIOSH-approved or MSHA-approved equipment should be used.

# ETHYLBENZENE

**ETB**

| Common Synonyms | Liquid | Colorless | Sweet, gasoline-like odor |
|---|---|---|---|
| Phenylethane<br>EB | Floats on water. Flammable, irritating vapor is produced. | | |

Avoid contact with liquid and vapor. Keep people away.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves).
Shut off ignition sources and call fire department.
Stop discharge if possible.
Stay upwind and use water spray to "knock down" vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

**Fire**

FLAMMABLE.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves).
Extinguish with dry chemical, foam, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

**Exposure**

CALL FOR MEDICAL AID.

**VAPOR**
Irritating to eyes, nose and throat.
If inhaled, will cause dizziness or difficult breathing.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

**LIQUID**
Will burn skin and eyes.
Harmful if swallowed.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
DO NOT INDUCE VOMITING.

**Water Pollution**

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
Fouling to shoreline.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

## 1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Mechanical containment
Should be removed
Chemical and physical treatment

## 2. LABEL

2.1 **Category:** Flammable liquid
2.2 **Class:** 3

## 3. CHEMICAL DESIGNATIONS

3.1 **CG Compatibility Class:** Aromatic hydrocarbon
3.2 **Formula:** $C_6H_5CH_2CH_3$
3.3 **IMO/UN Designation:** 3.3/1175
3.4 **DOT ID No.:** 1175
3.5 **CAS Registry No.:** 100-41-4

## 4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid
4.2 **Color:** Colorless
4.3 **Odor:** Aromatic

## 5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Self-contained breathing apparatus; safety goggles.
5.2 **Symptoms Following Exposure:** Inhalation may cause irritation of nose, dizziness, depression. Moderate irritation of eye with corneal injury possible. Irritates skin and may cause blisters.
5.3 **Treatment of Exposure:** INHALATION: if ill effects occur, remove victim to fresh air, keep him warm and quiet, and get medical help promptly; if breathing stops, give artificial respiration. INGESTION: induce vomiting only upon physician's approval; material in lung may cause chemical pneumonitis. SKIN AND EYES: promptly flush with plenty of water (15 min. for eyes) and get medical attention; remove and wash contaminated clothing before reuse.
5.4 **Threshold Limit Value:** 100 ppm
5.5 **Short Term Inhalation Limits:** 200 ppm for 30 min.
5.6 **Toxicity by Ingestion:** Grade 2; $LD_{50}$ = 0.5 to 5 g/kg (rat)
5.7 **Late Toxicity:** Data not available
5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause moderate irritation such that personnel will find high concentrations unpleasant. The effect is temporary.
5.9 **Liquid or Solid Irritant Characteristics:** Causes smarting of the skin and first-degree burns on short exposure; may cause secondary burns on long exposure.
5.10 **Odor Threshold:** 140 ppm
5.11 **IDLH Value:** 2,000 ppm

## 6. FIRE HAZARDS

6.1 **Flash Point:** 80°F O.C.; 59°F C.C.
6.2 **Flammable Limits in Air:** 1.0%-6.7%
6.3 **Fire Extinguishing Agents:** Foam (most effective), water fog, carbon dioxide or dry chemical.
6.4 **Fire Extinguishing Agents Not to be Used:** Not pertinent
6.5 **Special Hazards of Combustion Products:** Irritating vapors are generated when heated.
6.6 **Behavior in Fire:** Vapor is heavier than air and may travel considerable distance to the source of ignition and flash back.
6.7 **Ignition Temperature:** 860°F
6.8 **Electrical Hazard:** Not pertinent
6.9 **Burning Rate:** 5.8 mm/min.
6.10 **Adiabatic Flame Temperature:** Data Not Available

*(Continued)*

## 7. CHEMICAL REACTIVITY

7.1 **Reactivity With Water:** No reaction
7.2 **Reactivity with Common Materials:** No reaction
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent
7.7 **Molar Ratio (Reactant to Product):** Data Not Available
7.8 **Reactivity Group:** 32

## 8. WATER POLLUTION

8.1 **Aquatic Toxicity:** 29 ppm/96 hr/bluegill/$TL_m$/fresh water
8.2 **Waterfowl Toxicity:** Data not available
8.3 **Biological Oxygen Demand (BOD):** 2.8% (theor.), 5 days
8.4 **Food Chain Concentration Potential:** None

## 9. SHIPPING INFORMATION

9.1 **Grades of Purity:** Research grade: 99.96%; pure grade: 99.5%; technical grade: 99.0%
9.2 **Storage Temperature:** Ambient
9.3 **Inert Atmosphere:** No requirement
9.4 **Venting:** Open (flame arrester) or pressure-vacuum

## 10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

**A-T-U**

## 11. HAZARD CLASSIFICATIONS

11.1 **Code of Federal Regulations:** Flammable liquid
11.2 **NAS Hazard Rating for Bulk Water Transportation:**

| Category | Rating |
|---|---|
| Fire | 3 |
| Health | |
| Vapor Irritant | 2 |
| Liquid or Solid Irritant | 2 |
| Poisons | 2 |
| Water Pollution | |
| Human Toxicity | 1 |
| Aquatic Toxicity | 3 |
| Aesthetic Effect | 2 |
| Reactivity | |
| Other Chemicals | 1 |
| Water | 0 |
| Self Reaction | 0 |

11.3 **NFPA Hazard Classification:**

| Category | Classification |
|---|---|
| Health Hazard (Blue) | 2 |
| Flammability (Red) | 3 |
| Reactivity (Yellow) | 0 |

## 12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm:** Liquid
12.2 **Molecular Weight:** 106.17
12.3 **Boiling Point at 1 atm:** 277.2°F = 136.2°C = 409.4°K
12.4 **Freezing Point:** −139°F = −95°C = 178°K
12.5 **Critical Temperature:** 651.0°F = 343.9°C = 617.1°K
12.6 **Critical Pressure:** 523 psia = 35.6 atm = 3.61 $MN/m^2$
12.7 **Specific Gravity:** 0.867 at 20°C (liquid)
12.8 **Liquid Surface Tension:** 29.2 dynes/cm = 0.0292 N/m at 20°C
12.9 **Liquid Water Interfacial Tension:** 35.48 dynes/cm = 0.03548 N/m at 20°C
12.10 **Vapor (Gas) Specific Gravity:** Not pertinent
12.11 **Ratio of Specific Heats of Vapor (Gas):** 1.071
12.12 **Latent Heat of Vaporization:** 144 Btu/lb = 80.1 cal/g = $3.35 \times 10^5$ J/kg
12.13 **Heat of Combustion:** −17,780 Btu/lb = −9877 cal/g = $-413.5 \times 10^5$ J/kg
12.14 **Heat of Decomposition:** Not pertinent
12.15 **Heat of Solution:** Not pertinent
12.16 **Heat of Polymerization:** Not pertinent
12.25 **Heat of Fusion:** Data Not Available
12.26 **Limiting Value:** Data Not Available
12.27 **Reid Vapor Pressure:** 0.4 psia

## 6. FIRE HAZARDS (Continued)

6.11 **Stoichiometric Air to Fuel Ratio:** Data Not Available
6.12 **Flame Temperature:** Data Not Available

| ETB | ETHYLBENZENE |
|---|---|

| 12.17 SATURATED LIQUID DENSITY | |
|---|---|
| Temperature (degrees F) | Pounds per cubic foot |
| 40 | 54.990 |
| 50 | 54.680 |
| 60 | 54.370 |
| 70 | 54.060 |
| 80 | 53.750 |
| 90 | 53.430 |
| 100 | 53.120 |
| 110 | 52.810 |
| 120 | 52.500 |
| 130 | 52.190 |
| 140 | 51.870 |
| 150 | 51.560 |
| 160 | 51.250 |
| 170 | 50.940 |
| 180 | 50.620 |
| 190 | 50.310 |
| 200 | 50.000 |
| 210 | 49.690 |

| 12.18 LIQUID HEAT CAPACITY | |
|---|---|
| Temperature (degrees F) | British thermal unit per pound-F |
| 40 | .402 |
| 50 | .404 |
| 60 | .407 |
| 70 | .409 |
| 80 | .412 |
| 90 | .414 |
| 100 | .417 |
| 110 | .419 |
| 120 | .421 |
| 130 | .424 |
| 140 | .426 |
| 150 | .429 |
| 160 | .431 |
| 170 | .434 |
| 180 | .436 |
| 190 | .439 |
| 200 | .441 |
| 210 | .443 |

| 12.19 LIQUID THERMAL CONDUCTIVITY | |
|---|---|
| Temperature (degrees F) | British thermal unit-inch per hour-square foot-F |
| —90 | 1.065 |
| —80 | 1.056 |
| —70 | 1.047 |
| —60 | 1.037 |
| —50 | 1.028 |
| —40 | 1.018 |
| —30 | 1.009 |
| —20 | 1.000 |
| —10 | .990 |
| 0 | .981 |
| 10 | .971 |
| 20 | .962 |
| 30 | .953 |
| 40 | .943 |
| 50 | .934 |
| 60 | .924 |
| 70 | .915 |
| 80 | .906 |
| 90 | .896 |
| 100 | .887 |
| 110 | .877 |
| 120 | .868 |
| 130 | .859 |
| 140 | .849 |
| 150 | .840 |
| 160 | .830 |

| 12.20 LIQUID VISCOSITY | |
|---|---|
| Temperature (degrees F) | Centipoise |
| 40 | .835 |
| 50 | .774 |
| 60 | .719 |
| 70 | .670 |
| 80 | .626 |
| 90 | .586 |
| 100 | .550 |
| 110 | .518 |
| 120 | .488 |
| 130 | .461 |
| 140 | .436 |
| 150 | .414 |
| 160 | .393 |
| 170 | .374 |
| 180 | .356 |
| 190 | .340 |
| 200 | .325 |
| 210 | .311 |

| 12.21 SOLUBILITY IN WATER | |
|---|---|
| Temperature (degrees F) | Pounds per 100 pounds of water |
| 68.02 | .020 |

| 12.22 SATURATED VAPOR PRESSURE | |
|---|---|
| Temperature (degrees F) | Pounds per square inch |
| 80 | .202 |
| 100 | .370 |
| 120 | .644 |
| 140 | 1.071 |
| 160 | 1.713 |
| 180 | 2.643 |
| 200 | 3.953 |
| 220 | 5.747 |
| 240 | 8.147 |
| 260 | 11.290 |
| 280 | 15.320 |
| 300 | 20.410 |
| 320 | 26.730 |
| 340 | 34.460 |
| 360 | 43.800 |
| 380 | 54.950 |

| 12.23 SATURATED VAPOR DENSITY | |
|---|---|
| Temperature (degrees F) | Pounds per cubic foot |
| 80 | .00370 |
| 100 | .00654 |
| 120 | .01099 |
| 140 | .01767 |
| 160 | .02734 |
| 180 | .04087 |
| 200 | .05926 |
| 220 | .08363 |
| 240 | .11520 |
| 260 | .15510 |
| 280 | .20490 |
| 300 | .26570 |
| 320 | .33910 |
| 340 | .42620 |
| 360 | .52850 |
| 380 | .64720 |

| 12.24 IDEAL GAS HEAT CAPACITY | |
|---|---|
| Temperature (degrees F) | British thermal unit per pound-F |
| —400 | —.007 |
| —350 | .026 |
| —300 | .060 |
| —250 | .093 |
| —200 | .125 |
| —150 | .157 |
| —100 | .187 |
| —50 | .217 |
| 0 | .246 |
| 50 | .274 |
| 100 | .301 |
| 150 | .327 |
| 200 | .353 |
| 250 | .377 |
| 300 | .401 |
| 350 | .424 |
| 400 | .446 |
| 450 | .467 |
| 500 | .487 |
| 550 | .507 |
| 600 | .525 |

# Occupational Health Guideline for Petroleum Distillates (Naphtha)

## INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

## SUBSTANCE IDENTIFICATION

- Formula: $C_6H_{14}$ – $C_7H_{16}$ – $C_8H_{18}$
- Synonyms: Petroleum naphtha; aliphatic petroleum naphtha; petroleum ether (95 to 115 C); naphtha, petroleum
- Appearance and odor: Colorless liquid with an odor like gasoline and kerosene.

## PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for petroleum distillates is 500 parts of petroleum distillates per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 2000 milligrams of petroleum distillates per cubic meter of air (mg/m³). NIOSH has recommended that the permissible exposure limit be reduced to 350 mg/m³ averaged over a work shift of up to 10 hours per day, 40 hours per week.

## HEALTH HAZARD INFORMATION

- **Routes of exposure**

Petroleum distillates can affect the body if they are inhaled, come in contact with the eyes or skin, or are swallowed.

- **Effects of overexposure**

*1. Short-term Exposure:* Overexposure to petroleum distillates may cause dizziness, drowsiness, headache, and nausea. They may also cause irritation of the eyes, throat, and skin.

*2. Long-term Exposure:* Prolonged overexposure may cause drying and cracking of the skin.

*3. Reporting Signs and Symptoms:* A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to petroleum distillates.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to petroleum distillates at potentially hazardous levels:

*1. Initial Medical Screening:* Employees should be screened for history of certain medical conditions (listed below) which might place the employee at increased risk from petroleum distillates exposure.

—Skin disease: Petroleum distillates are skin defatting agents and can cause dermatitis on prolonged exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of these agents.

—Chronic respiratory disease: In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of petroleum distillates might cause exacerbation of symptoms due to their irritant properties.

—Liver disease: Although petroleum distillates are not known as liver toxins in humans, the importance of this organ in the biotransformation and detoxification of foreign substances should be considered before exposing persons with impaired liver function.

—Kidney disease: Although petroleum distillates are not known as kidney toxins in humans, the importance of this organ in the elimination of toxic substances justifies special consideration in those with impaired renal function.

*2. Periodic Medical Examination:* Any employee developing the above-listed conditions should be referred for further medical examination.

- **Summary of toxicology**

The vapors of petroleum distillates are mild narcotics and mucous membrane irritants. There have been few toxicologic studies, either on animals or man. While 4000 to 7000 ppm are tolerated for 1 hour by human subjects, symptoms of narcosis, such as dizziness and drowsiness, occur at those concentrations. Continuing

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These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

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exposure may produce signs of inebriation, followed by headache or nausea. Exposure at 10,000 to 20,000 ppm is regarded as immediately hazardous to life. The higher boiling fractions may produce irritation of the eyes, nose, and throat in addition to symptoms of mild narcosis. The liquid is a defatting agent, and repeated or prolonged skin contact results in drying and cracking of the skin. No chronic systemic effects have been reported from widespread industrial use. If benzene is present in the distillate, however, the hazard of both acute and chronic poisoning is increased; the presence of elevated phenol in the urine is indicative of benzene exposure.

## CHEMICAL AND PHYSICAL PROPERTIES

• **Physical data**

1. Molecular weight: 100 (approximately)
2. Boiling point (760 mm Hg): 30 to 127 C (86 to 260 F)
3. Specific gravity (water = 1): 0.74
4. Vapor density (air = 1 at boiling point of petroleum distillates): 3.4 (approximately)
5. Melting point: Data not available
6. Vapor pressure at 20 C (68 F): 40 mm Hg (approximately)
7. Solubility in water, g/100 g water at 20 C (68 F): 0.04 (approximately)
8. Evaporation rate (butyl acetate = 1): 10 (approximately)

• **Reactivity**

1. Conditions contributing to instability: Heat
2. Incompatibilities: Contact with strong oxidizing agents may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide) may be released in a fire involving petroleum distillates.
4. Special precautions: Petroleum distillates will attack some forms of plastics, rubber, and coatings.

• **Flammability**

1. Flash point: −40 to 20 C (−40 to 68 F) (closed cup)
2. Autoignition temperature: 232 to 260 C (450 to 500 F)
3. Flammable limits in air, % by volume: Lower: 1; Upper: 6
4. Extinguishant: Foam, carbon dioxide, dry chemical

• **Warning properties**

1. Odor Threshold: The odor thresholds of the main constituents of petroleum naphtha (i. e., heptane, octane, pentane, etc.) are below the individual permissible exposure limits.
2. Eye Irritation Level: According to Gafafer, the naphthas irritate the conjunctiva. The American Petroleum Institute states that irritation of the conjunctiva may occur "when the eyes are exposed to high vapor concentrations (of petroleum naphtha) in air. The irritation is mild and transitory." No quantitative information is available concerning the threshold of eye irritation, however.
3. Evaluation of Warning Properties: Since the odor of each of the main constituents of petroleum naphtha is detectable at concentrations below the respective permissible exposure limits, petroleum naphtha is treated as a material with adequate warning properties.

## MONITORING AND MEASUREMENT PROCEDURES

• **General**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

• **Method**

Sampling and analyses may be performed by collection of petroleum distillates vapors using an adsorption tube with subsequent desorption with carbon disulfide and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure petroleum distillates may be used. An analytical method for petroleum distillates is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 3, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00261-4).

## RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

• In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

## PERSONAL PROTECTIVE EQUIPMENT

• Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch

minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquid petroleum distillates.

• Clothing wet with liquid petroleum distillates should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of petroleum distillates from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the petroleum distillates, the person performing the operation should be informed of petroleum distillates' hazardous properties.

• Any clothing which becomes wet with liquid petroleum distillates should be removed immediately and not reworn until the petroleum distillates are removed from the clothing.

• Employees should be provided with and required to use splash-proof safety goggles where liquid petroleum distillates may contact the eyes.

## SANITATION

• Skin that becomes wet with liquid petroleum distillates should be promptly washed or showered with soap or mild detergent and water to remove any petroleum distillates.

## COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to petroleum distillates may occur and control methods which may be effective in each case:

| Operation | Controls |
|---|---|
| Liberation during degreasing operations | General dilution ventilation; local exhaust ventilation; personal protective equipment |
| Use as solvents in rubber industry during manufacture of waterproof cloth, shoe adhesives, and rubber tires | General dilution ventilation; local exhaust ventilation; personal protective equipment |
| Use as extractants; use in preparation of paint, varnish, and lacquer as solvents, diluents, or thinners; use as solvents in pesticides | General dilution ventilation; local exhaust ventilation; personal protective equipment |
| Use during dry cleaning operations | General dilution ventilation; local exhaust ventilation; personal protective equipment |

## EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• **Eye Exposure**

If petroleum distillates get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation persists after washing, get medical attention. Contact lenses should not be worn when working with these chemicals.

• **Skin Exposure**

If petroleum distillates get on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If petroleum distillates soak through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.

• **Breathing**

If a person breathes in large amounts of petroleum distillates, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• **Swallowing**

If petroleum distillates have been swallowed, do not induce vomiting. Get medical attention immediately.

• **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

## SPILL, LEAK, AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

• If petroleum distillates are spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. For small quantities, absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for evaporating vapors to completely clear the hood ductwork. Burn the paper in a suitable location away from combustible materials. Large quantities can be collected and atomized in a suitable combustion chamber. Petroleum distillates should not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion.

• Waste disposal method:

Petroleum distillates may be disposed of by atomizing in a suitable combustion chamber.

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### RESPIRATORY PROTECTION FOR PETROLEUM DISTILLATES (NAPHTHA)

| Condition | Minimum Respiratory Protection* Required Above 500 ppm |
|---|---|
| Vapor Concentration | |
| 1000 ppm or less | A chemical cartridge respirator with a full facepiece and an organic vapor cartridge(s). |
| 5000 ppm or less | A gas mask with a chin-style organic vapor canister. |
| 10,000 ppm or less | A gas mask with a front- or back-mounted organic vapor canister.<br>Any supplied-air respirator with a full facepiece, helmet, or hood.<br>Any self-contained breathing apparatus with a full facepiece. |
| Greater than 10,000 ppm or entry and escape from unknown concentrations | Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.<br>A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode. |
| Fire Fighting | Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. |
| Escape | Any gas mask providing protection against organic vapors.<br>Any escape self-contained breathing apparatus. |

*Only NIOSH-approved or MSHA-approved equipment should be used.

# Occupational Health Guideline for Toluene

## INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

## SUBSTANCE IDENTIFICATION

- Formula: $C_6H_5CH_3$
- Synonyms: Toluol; phenylmethane; methylbenzene
- Appearance and odor: Colorless liquid with an aromatic odor, like benzene.

## PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for toluene is 200 parts of toluene per million parts of air (ppm) averaged over an eight-hour work shift, and during any such work shift, 300 ppm toluene may not be exceeded except that a peak of 500 ppm toluene is permitted for 10 minutes during the eight-hour work shift. NIOSH has recommended that the permissible exposure limit be reduced to 100 ppm toluene averaged over an eight-hour work shift with a ceiling level of 200 ppm averaged over a ten-minute period. The NIOSH Criteria Document for Toluene should be consulted for more detailed information.

## HEALTH HAZARD INFORMATION

- **Routes of exposure**

Toluene can affect the body if it is inhaled, if it comes in contact with the eyes or skin, or if it is swallowed. It may enter the body through the skin.

- **Effects of overexposure**

*1. Short-term Exposure:* Toluene may cause irritation of the eyes, respiratory tract, and skin. It may also cause fatigue, weakness, confusion, headache, dizziness, and drowsiness. Peculiar skin sensation may be produced such as a "pins and needles feeling" or numbness. Very high concentrations may cause unconsciousness and death. The liquid splashed in the eye may cause irritation and temporary damage. Inhalation may also cause difficulty in seeing in bright light. If liquid toluene is splashed in the eyes, it will cause temporary irritation.

*2. Long-term Exposure:* Repeated or prolonged exposure to liquid toluene may cause drying and cracking of the skin.

*3. Reporting Signs and Symptoms:* A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to toluene.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to toluene at potentially hazardous levels:

*1. Initial Medical Examination:*

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the central nervous system, liver and kidneys should be stressed. The skin should be examined for evidence of chronic disorders.

—Urinalysis: Since proper kidney function is necessary for biologic monitoring, a urinalysis should be obtained to include at a minimum specific gravity, albumin, glucose, and a microscopic on centrifuged sediment. The urine should be analyzed for hippuric acid to obtain a background level.

*2. Periodic Medical Examination:* The aforementioned medical examinations should be repeated on an annual basis. Hippuric acid level in urine may be an indicator of the level of toluene exposure.

- **Summary of toxicology**

Toluene vapor causes narcosis. Controlled exposure of human subjects to 200 ppm for 8 hours produced mild fatigue, weakness, confusion, lacrimation, and paresthesia; at 600 ppm for 8 hours there were also euphoria, headache, dizziness, dilated pupils and nausea; at 800

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These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

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ppm for 8 hours, symptoms were more pronounced, and after-effects included nervousness, muscular fatigue, and insomnia persisting for several days. Severe but reversible liver and kidney injury occurred in a person who was a glue-sniffer for 3 years; the chief component of the inhaled solvent was toluene (80% V/V); other ingredients were not listed. In workers exposed for many years to concentrations in the range of 80 to 300 ppm, there was no clinical or laboratory evidence of altered liver function. Toluene exposure does not result in the hematopoietic effects caused by benzene; the myelotoxic effects previously attributed to toluene are judged by more recent investigations to be the result of concurrent exposure to benzene present as a contaminant in the commercial toluene used. Most of the toluene absorbed from inhalation is metabolized to benzoic acid, conjugated with glycine in the liver to form hippuric acid, and excreted in the urine; the average amount of hippuric acid excreted in the urine by individuals not exposed to toluene is approximately 0.7 to 1.0 g/l of urine. The liquid splashed in the eyes of two workers caused transient corneal damage and conjunctival irritation; complete recovery occurred within 48 hours. Repeated or prolonged skin contact with liquid toluene has a defatting action, causing drying, fissuring, and dermatitis.

## CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**
  1. Molecular weight: 92.1
  2. Boiling point (760 mm Hg): 111 C (231 F)
  3. Specific gravity (water = 1): 0.86
  4. Vapor density (air = 1 at boiling point of toluene): 3.14
  5. Melting point: −95 C (−139 F)
  6. Vapor pressure at 20 C (68 F): 22 mm Hg
  7. Solubility in water, g/100 g water at 20 C (68 F): 0.05
  8. Evaporation rate (butyl acetate = 1): 2.24
- **Reactivity**
  1. Conditions contributing to instability: Containers may burst at elevated temperatures.
  2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions.
  3. Hazardous decomposition products: Toxic gases and vapors (such as carbon dioxide and carbon monoxide) may be released in a fire involving toluene.
  4. Special precautions: Toluene will attack some forms of plastics, rubber, and coatings.
- **Flammability**
  1. Flash point: 4 C (40 F) (closed cup)
  2. Autoignition temperature: 480 C (896 F)
  3. Flammable limits in air, % by volume: Lower: 1.27; Upper: 7.1
  4. Extinguishant: Carbon dioxide, dry chemical, foam
- **Warning properties**
  1. Odor Threshold: The American National Standards Institute (ANSI) states that "the odor of toluene is detectable by most people at concentrations in the range of 10 to 15 ppm. The odor has little value as a warning property."

Patty points out that olfactory fatigue occurs rapidly upon exposure to toluene.

2. Eye Irritation Level: Grant states that "the vapors of toluene cause noticeable sensation of irritation to human eyes at 300 to 400 ppm in air, but even at 800 ppm irritation is slight."

ANSI reports that "irritation of eyes, mucous membranes, and upper respiratory tract may occur while workers are exposed to low concentrations of toluene. There is a considerable range of variation (100 to 500 ppm) between individuals, some finding any concentration of toluene objectionable. Commercial grades of toluene vary in irritant properties."

3. Evaluation of Warning Properties: Because of its irritant effects, toluene is judged to have good warning properties.

## MONITORING AND MEASUREMENT PROCEDURES

- **Eight-Hour Exposure Evaluation**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

- **Ceiling Evaluation**

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of toluene. Each measurement should consist of a ten (10) minute sample or series of consecutive samples totalling ten (10) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

- **Peak Above Ceiling Evaluation**

Measurements to determine employee peak exposure should be taken during periods of maximum expected airborne concentration of toluene. Each measurement should consist of a 10-minute sample or a series of consecutive samples totalling 10 minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

- **Method**

Sampling and analyses may be performed by collection of vapors using an adsorption tube with a subsequent desorption of toluene with carbon disulfide and gas

chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure toluene may be used. An analytical method for toluene is in the *NIOSH Manual of Analytical Methods,* 2nd Ed., Vol. 3, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00261-4).

Methods for Set V" (order number PB 262 524).

## RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

• In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

## PERSONAL PROTECTIVE EQUIPMENT

• Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquid toluene.

• Any clothing which becomes wet with liquid toluene should be removed immediately and not reworn until the toluene is removed from the clothing.

• Clothing wet with toluene should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of toluene from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the toluene, the person performing the operation should be informed of toluene's hazardous properties.

• Employees should be provided with and required to use splash-proof safety goggles where liquid toluene may contact the eyes.

• Where there is any possibility that employees' eyes may be exposed to toluene, an eye-wash fountain should be provided within the immediate work area for emergency use.

## SANITATION

• Skin that becomes wet with liquid toluene should be promptly washed or showered with soap or mild detergent and water to remove any toluene.

• Employees who handle liquid toluene should wash their hands thoroughly with soap or mild detergent and water before eating or smoking.

## COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to toluene may occur and control methods which may be effective in each case:

| Operation | Controls |
|---|---|
| Use as a solvent in pharmaceutical, chemical, rubber, and plastics industries; as a thinner for paints, lacquer, coatings, and dyes; as a paint remover; insecticides | Process enclosure; general dilution ventilation; local exhaust ventilation; personal protective equipment |
| Use as starting material and intermediate in organic chemical and chemical synthesis industries | Process enclosure; general dilution ventilation; local exhaust ventilation; personal protective equipment |
| Use in manufacture of artificial leather; fabric and paper coatings; photogravure ink production; spray surface coating; as a diluent (cellulose ester lacquers) | Process enclosure; general dilution ventilation; local exhaust ventilation; personal protective equipment |
| Use as constituent in formulation of automotive and aviation fuels | Process enclosure; general dilution ventilation; local exhaust ventilation; personal protective equipment |

## EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• **Eye Exposure**

If liquid toluene gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Contact lenses should not be worn when working with this chemical.

• **Skin Exposure**

If liquid toluene gets on the skin, promptly wash the contaminated skin using soap or mild detergent and

water. If liquid toluene soaks through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.

• **Breathing**

If a person breathes in large amounts of toluene, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• **Swallowing**

When toluene has been swallowed, get medical attention immediately. Do not attempt to make the exposed person vomit.

• **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

## SPILL, LEAK, AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

• If toluene is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. For small quantities, absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for evaporating vapors to completely clear the hood ductwork. Burn the paper in a suitable location away from combustible materials. Large quantities can be reclaimed or collected and atomized in a suitable combustion chamber. Toluene should not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion. Sewers designed to preclude the formation of explosive concentrations of toluene vapors are permitted.

• Waste disposal method:

Toluene may be disposed of by atomizing in a suitable combustion chamber.

## ADDITIONAL INFORMATION

To find additional information on toluene, look up toluene in the following documents:

• Medical Surveillance for Chemical Hazards
• Respiratory Protection for Chemical Hazards
• Personal Protection and Sanitation for Chemical Hazards
• NIOSH Criteria Document for Toluene (July 1973)

These documents are available through the NIOSH Division of Technical Services, 4676 Columbia Parkway, Cincinnati, Ohio 45226.

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• Union Carbide Corporation, Industrial Medicine and Toxicology Department: *Toxicology Studies – Toluene*, New York, 1970.

## RESPIRATORY PROTECTION FOR TOLUENE

| Condition | Minimum Respiratory Protection* Required Above 200 ppm |
|---|---|
| Vapor Concentration | |
| 500 ppm or less | Any chemical cartridge respirator with an organic vapor cartridge(s).<br>Any supplied-air respirator.<br>Any self-contained breathing apparatus. |
| 1000 ppm or less | A chemical cartridge respirator with a full facepiece and an organic vapor cartridge(s). |
| 2000 ppm or less | A gas mask with a chin-style or a front- or back-mounted organic vapor canister.<br>Any supplied-air respirator with a full facepiece, helmet, or hood.<br>Any self-contained breathing apparatus with a full facepiece. |
| Greater than 2000 ppm or entry and escape from unknown concentrations | Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.<br>A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode. |
| Fire Fighting | Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. |
| Escape | Any gas mask providing protection against organic vapors.<br>Any escape self-contained breathing apparatus. |

*Only NIOSH-approved or MSHA-approved equipment should be used.

# Occupational Health Guideline for Xylene

## INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

## SUBSTANCE IDENTIFICATION

- Formula: $C_6H_4(CH_3)_2$
- Synonyms: Commercial xylene (xylol) is a mixture, mostly the meta-isomer. 1) O-xylene, ortho-xylene, 1,2-dimethylbenzene; 2) m-xylene, meta-xylene, 1,3-dimethylbenzene; 3) p-xylene, para-xylene, 1,4-dimethylbenzene
- Appearance and odor: Colorless liquids with aromatic odors (pure p-xylene is a solid below 12.7 C (55 F)).

## PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for xylene is 100 parts of xylene per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 435 milligrams of xylene per cubic meter of air (mg/m$^3$). NIOSH has recommended that the permissible exposure limit be changed to 100 ppm averaged over a work shift of up to ten hours per day, forty hours per week, with an acceptable ceiling level of 200 ppm averaged over a 10-minute period. The NIOSH Criteria Document for Xylene should be consulted for more detailed information.

## HEALTH HAZARD INFORMATION

- **Routes of exposure**

Xylene can affect the body if it is inhaled, if it comes in contact with the eyes or skin, or if it is swallowed. It may enter the body through the skin.

- **Effects of overexposure**

*1. Short-term Exposure:* Xylene vapor may cause irritation of the eyes, nose, and throat. At high concentrations, xylene vapor may cause severe breathing difficulties which may be delayed in onset. At high concentrations, it may also cause dizziness, staggering, drowsiness, and unconsciousness. In addition, breathing high concentrations may cause loss of appetite, nausea, vomiting, and abdominal pain. Liquid xylene may be irritating to the eyes and skin. Exposure to high concentrations of xylene vapor may cause reversible damage to the kidneys and liver.

*2. Long-term Exposure:* Repeated or prolonged exposure to xylene may cause a skin rash. Repeated exposure of the eyes to high concentrations of xylene vapor may cause reversible eye damage.

*3. Reporting Signs and Symptoms:* A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to xylene.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to xylene at potentially hazardous levels:

*1. Initial Medical Examination:*

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the central nervous system, eyes, gastrointestinal tract, blood, liver, and kidneys should be stressed. The skin should be examined for evidence of chronic disorders.

—A complete blood count: Xylene has been shown to cause reversible hematopoietic depression in animals. A complete blood count should be performed, including a red cell count, a white cell count, a differential count of a stained smear, as well as hemoglobin and hematocrit.

—Liver function tests: Since liver damage has been observed in humans exposed to xylene, a profile of liver

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These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

**U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES**
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

**U.S. DEPARTMENT OF LABOR**
Occupational Safety and Health Administration

function should be obtained by using a medically acceptable array of biochemical tests.

—Urinalysis: Since kidney damage has been observed in humans exposed to xylene, a urinalysis should be obtained to include at a minimum specific gravity, albumin, glucose, and a microscopic on centrifuged sediment.

*2. Periodic Medical Examination:* The aforementioned medical examinations should be repeated on a biannual basis.

• **Summary of toxicology**

Xylene vapor irritates the eyes, mucous membranes, and skin; at high concentrations it causes narcosis. In animals, xylene causes blood changes reflecting mild toxicity to the hematopoietic system. Repeated exposure of rabbits to 1150 ppm of a mixture of isomers of xylene for 40 to 55 days caused a reversible decrease in red and white cell count and an increase in thrombocytes; exposure to 690 ppm for the same time period caused only a slight decrease in the white cell count. Three painters working in a confined space of a fuel tank were overcome by xylene vapors estimated to be 10,000 ppm; they were not found until 18.5 hours after entering the tank, and one died from pulmonary edema shortly thereafter; the other two recovered completely in 2 days; both had temporary hepatic impairment (inferred from elevated serum transaminase levels) and one of them had evidence of temporary renal impairment (increased blood urea and reduced creatinine clearance). In humans, exposure to undetermined but high concentrations caused dizziness, excitement, drowsiness, incoordination and a staggering gait. Workers exposed to concentrations above 200 ppm complain of anorexia, nausea, vomiting, and abdominal pain. Brief exposure of humans to 200 ppm caused irritation of the eyes, nose, and throat. There are reports of reversible corneal vacuolation in workers exposed to xylene, or to xylene plus other volatile solvents. The liquid is a skin irritant and causes erythema, dryness, and defatting; prolonged contact may cause the formation of vesicles.

## CHEMICAL AND PHYSICAL PROPERTIES

Data in the following section are presented for xylene's three isomers: 1) ortho, 2) meta, and 3) para.

• **Physical data**

1. Molecular weight: 106.2
2. Boiling point (760 mm Hg): 1) 144.4 C (292 F); 2) 138.9 C (282 F); 3) 138.3 C (281 F)
3. Specific gravity (water = 1): 1) 0.88; 2) 0.86; 3) 0.86
4. Vapor density (air = 1 at boiling point of xylene): 3.7
5. Melting point: 1) −25 C (−12 F); 2) −48 C (−54 F); 3) 13 C (55 F)
6. Vapor pressure at 20 C (68 F): 1) 7 mm Hg; 2) 9 mm Hg; 3) 9 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 1) 0.00003; 2) 0.00003; 3) 0.00003
8. Evaporation rate (butyl acetate = 1): 1) 0.7; 2) 0.7; 3) 0.7

• **Reactivity**

1. Conditions contributing to instability: Elevated temperatures may cause containers to burst.
2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide) may be released in a fire involving xylene.
4. Special precautions: Xylene will attack some forms of plastics, rubber, and coatings.

• **Flammability**

1. Flash point: 1) 32 C (90 F) (closed cup); 2) 28.9 C (84 F); 3) 27.2 C (81 F)
2. Autoignition temperature: 1) 465 C (869 F); 2) 530 C (986 F); 3) 530 C (986 F)
3. Flammable limits in air, % by volume: Lower: 1) 1.0; 2) 1.1; 3) 1.1; Upper: 1) 6.0; 2) 7.0; 3) 7.0
4. Extinguishant: Foam, carbon dioxide, dry chemical

• **Warning properties**

1. Odor Threshold: Patty states that "the initial odor of 200 ppm has an intensity of approximately 3 and an irritation value of 1. As in most other instances, olfactory fatigue occurs rapidly and the odor is no longer detected at this concentration."
2. Eye Irritation Level: The AIHA *Hygienic Guide* states that "exposure to vapors at 200 ppm caused eye irritation in most of the persons tested. Lesions in the form of fine vacuoles in the cornea of cats exposed to commercial xylene vapors have been observed."
3. Other Information: The *Handbook of Industrial Organic Chemicals* states that xylene "may be irritating to eyes, nose and throat as exposure exceeds threshold limit." The *Hygienic Guide* notes that 200 ppm causes irritation of the nose and throat.
4. Evaluation of Warning Properties: Through its irritant effects, xylene can be detected within three times the permissible exposure limit. For the purposes of this guideline, therefore, xylene is treated as a material with good warning properties.

## MONITORING AND MEASUREMENT PROCEDURES

• **Eight-Hour Exposure Evaluation**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

• **Ceiling Evaluation**

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of xylene. Each measurement

should consist of a ten (10) minute sample or series of consecutive samples totalling ten (10) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

• **Method**

Sampling and analyses may be performed by collection of vapors using an adsorption tube with subsequent desorption with carbon disulfide and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure xylene may be used. An analytical method for xylene is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 3, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00261-4).

## RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

• In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

## PERSONAL PROTECTIVE EQUIPMENT

• Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquid or solid xylene.

• Clothing contaminated with xylene should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of xylene from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the xylene, the person performing the operation should be informed of xylene's hazardous properties.

• Any clothing which becomes wet with liquid xylene should be removed immediately and non-impervious clothing which becomes contaminated with xylene should be removed promptly and not reworn until the xylene is removed from the clothing.

• Employees should be provided with and required to use splash-proof safety goggles where liquid or solid xylene may contact the eyes.

## SANITATION

• Skin that becomes contaminated with xylene should be promptly washed or showered with soap or mild detergent and water to remove any xylene.

• Employees who handle liquid or solid xylene should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

## COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to xylene may occur and control methods which may be effective in each case:

| Operation | Controls |
|---|---|
| Use as an intermediate during manufacture of plastics, synthetic fibers, and mixed/pure isomers | Process enclosure; local exhaust ventilation; general mechanical ventilation; personal protective equipment |
| Use as diluent or solvent in surface coatings, printing operations, and manufacture of rubber; degreasing agent in plastics and electronics manufacture; in organic synthesis reactions and manufacture of epoxy resins | Process enclosure; local exhaust ventilation; general mechanical ventilation; personal protective equipment |
| Use in formulation of insecticides | Process enclosure; local exhaust ventilation; general mechanical ventilation; personal protective equipment |
| Use in manufacture of xylene-formaldehyde resins; pharmaceuticals, vitamins, leather; and as a sterilizing agent for cat-gut and in microscopy | Process enclosure; local exhaust ventilation; general mechanical ventilation; personal protective equipment |

| Operation | Controls |
| --- | --- |
| Use during blending of motor and aviation fuels | Process enclosure; local exhaust ventilation; general mechanical ventilation; personal protective equipment |

## EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• **Eye Exposure**

If liquid or solid xylene gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

• **Skin Exposure**

If liquid or solid xylene gets on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If liquid or solid xylene penetrates through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. If irritation is present after washing, get medical attention.

• **Breathing**

If a person breathes in large amounts of xylene, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• **Swallowing**

When xylene has been swallowed, do not induce vomiting. Get medical attention immediately.

• **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

## SPILL, LEAK, AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

• If xylene is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. For small quantities, absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for evaporating vapors to completely clear the hood ductwork. Burn the paper in a suitable location away from combustible materials. Large quantities can be reclaimed or collected and atomized in a suitable combustion chamber. Xylene should not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion. Sewers designed to preclude the formation of explosive concentrations of xylene vapors are permitted.
4. If the solid form, allow to melt and treat as in (3) above.

• Waste disposal method:

Xylene may be disposed of by atomizing in a suitable combustion chamber.

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## RESPIRATORY PROTECTION FOR XYLENE (XYLOL)

| Condition | Minimum Respiratory Protection* Required Above 100 ppm |
|---|---|
| Vapor Concentration | |
| 1000 ppm or less | A chemical cartridge respirator with a full facepiece and an organic vapor cartridge(s). |
| 5000 ppm or less | A gas mask with a chin-style or a front- or back-mounted organic vapor canister.<br>Any supplied-air respirator with a full facepiece, helmet, or hood.<br>Any self-contained breathing apparatus with a full facepiece. |
| 10,000 ppm or less | A Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet, or hood operated in continuous-flow mode. |
| Greater than 10,000 ppm or entry and escape from unknown concentrations | Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.<br>A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode. |
| Fire Fighting | Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. |
| Escape | Any gas mask providing protection against organic vapors.<br>Any escape self-contained breathing apparatus. |

*Only NIOSH-approved or MSHA-approved equipment should be used.

# APPENDIX C
# TICK HAZARD

## TICKS AND TICK-BORNE DISEASES

Field personnel should be aware of an increased occurrence of tick-borne Lyme disease in the United States. All field personnel should take proper precautions to limit exposure to ticks and tick-borne diseases. These include:

- Cinching and taping clothing at the ankles and wrists, especially the ankles. Ticks lie low on grass blades and shrubs. They encounter your feet, ankles or lower legs and then crawl upward;

- Wear light-colored clothing to facilitate spotting the ticks, and check your clothing periodically. Be especially careful in terrain with tall grass, bushes or woods;

- Use a tick repellant on skin or clothing. Always read the labels before using. Clothing repellents should never be used on the skin; and

- Recognize the signs of a bite or an infection. It takes several hours for a tick to attach and feed; removing it promptly lessens the chance of being infected.

Pregnant women should be particularly careful since the effects of Lyme disease upon the fetus is unknown.

If a tick is discovered on the skin, it is important to remove the entire insect as soon as possible. The most effective method is to grasp the tick as close as possible to the mouth with tweezers or thin, curved forceps. Then, without jerking, pull it upward steadily (a small amount of skin may be removed in the process).

After removing the tick, disinfect the bite with rubbing alcohol plus Adolph's Meat Tenderizer (meat protein, not artificial) or povidone iodine (Betadine). Do not handle the tick; spirochetes could enter the body through breaks in the skin. Dispose of it in alcohol or flush it down the drain. And check the bite occasionally for at least 3 weeks to see if a rash forms. If it does, you have been infected and should seek medical treatment promptly.

The rash generally appears at the bite location from about 2 days to 2 weeks after the bite. It usually starts as a small red spot that expands as the spirochetes spread beyond the bite. Most commonly,

the rash develops into a reddish circle or oval about 2 to 3 inches in diameter. It fades with or without treatment after a few weeks.

Much larger rashes - anywhere from 6 to 20 inches in diameter also occur, especially on the back. Despite their size, large rashes may be easy to miss because they are often very faint.

Other variants include a rash with a red perimeter and a clear center and the so-called bull's-eye rash, which consists of several concentric red rings. Rashes may vary in shape, depending on where they occur on the body. Frequent sites are the thigh, groin, and armpits. People often develop a rash in more than one place.

Early symptoms may include profound fatigue, a stiff neck, and flu-like symptoms such as headache, chills, fever, and muscle aches. Since tick bites do not always produce a rash, those symptoms alone may warrant a medical check for possible Lyme infection - especially if they occur in summer and you live or work in an area that is endemic for Lyme disease.

Without treatment, the spirochetes usually multiply and the disease progressively worsens. The second stage, occurring within weeks to months of the bite, may affect the heart and nervous system. The third state is the chronic arthritic stage, which begins up to a year or more after the bite.

# APPENDIX D
# ACCIDENT INVESTIGATION REPORT

| (For Safety Staff only) | REPORT NO | EROC CODE | UNITED STATES ARMY CORPS OF ENGINEERS<br>ACCIDENT INVESTIGATION REPORT<br>(For Use of this Form See Attached Instructions and USACE Suppl to AR 385-40) | REQUIREMENT CONTROL SYMBOL: CEEC-S-8(R2) |
|---|---|---|---|---|

**1. ACCIDENT CLASSIFICATION**

| PERSONNEL CLASSIFICATION | INJURY/ILLNESS/FATAL | PROPERTY DAMAGE | MOTOR VEHICLE INVOLVED | DIVING |
|---|---|---|---|---|
| GOVERNMENT ☐ CIVILIAN ☐ MILITARY | ☐ | ☐ FIRE INVOLVED ☐ OTHER | ☐ | ☐ |
| ☐ CONTRACTOR | ☐ | ☐ FIRE INVOLVED ☐ OTHER | ☐ | ☐ |
| ☐ PUBLIC | ☐ FATAL ☐ OTHER | | ☐ | |

**2. PERSONAL DATA**

a. NAME (Last,First,MI)

b. AGE

c. SEX ☐ MALE ☐ FEMALE

d. SOCIAL SECURITY NUMBER ___ ___ ___ / ___ ___ / ___ ___ ___ ___

e. GRADE

f. JOB SERIES/TITLE

g. DUTY STATUS AT TIME OF ACCIDENT
☐ ON DUTY ☐ TDY
☐ OFF DUTY

h. EMPLOYMENT STATUS AT TIME OF ACCIDENT
☐ ARMY ACTIVE ☐ ARMY RESERVE ☐ VOLUNTEER
☐ PERMANENT ☐ FOREIGN NATIONAL ☐ SEASONAL
☐ TEMPORARY ☐ STUDENT
☐ OTHER (Specify) _____

**3. GENERAL INFORMATION**

a. DATE OF ACCIDENT (month/day/year) / /

b. TIME OF ACCIDENT (Military time))

c. EXACT LOCATION OF ACCIDENT

d. CONTRACTOR'S NAME
(1) PRIME
(2) SUBCONTRACTOR:

e. CONTRACT NUMBER _____
☐ CIVIL WORKS ☐ MILITARY
☐ OTHER (Specify) _____

f. TYPE OF CONTRACT
☐ CONSTRUCTION ☐ SERVICE
☐ A/E ☐ DREDGE
☐ OTHER (Specify) _____

g. HAZARDOUS/TOXIC WASTE ACTIVITY
☐ SUPERFUND ☐ DERP
☐ IRP ☐ OTHER (Specify) _____

**4. CONSTRUCTION ACTIVITIES ONLY** (Fill in line and corresponding code number in box from list - see instructions)

a. CONSTRUCTION ACTIVITY _____ (CODE) ☐

b. TYPE OF CONSTRUCTION EQUIPMENT _____ (CODE) ☐

**5. INJURY / ILLNESS INFORMATION** (Include name on line and corresponding code number in box for items e, f & g - see instructions)

a. SEVERITY OF ILLNESS / INJURY _____ (CODE) ☐

b. ESTIMATED DAYS LOST

c. ESTIMATED DAYS HOSPITALIZED

d. ESTIMATED DAYS RESTRICTED DUTY

e. BODY PART AFFECTED
PRIMARY _____ (CODE) ☐
SECONDARY _____ (CODE) ☐

f. NATURE OF ILLNESS / INJURY _____ (CODE) ☐

g. TYPE AND SOURCE OF INJURY/ILLNESS
TYPE _____ (CODE) ☐
SOURCE _____ (CODE) ☐

**6. PUBLIC FATALITY** (Fill in line and corresponding code number in box - see instructions)

a. ACTIVITY AT TIME OF ACCIDENT _____ (CODE) ☐

b. PERSONAL FLOATATION DEVICE USED? ☐ YES ☐ NO ☐ N/A

**7. MOTOR VEHICLE ACCIDENT**

a. TYPE OF VEHICLE
☐☐ PICKUP/VAN ☐☐ AUTOMOBILE
☐☐ TRUCK ☐☐ OTHER (Specify) _____

b. TYPE OF COLLISION
☐ SIDE SWIPE ☐ HEAD ON ☐ REAR END
☐ BROADSIDE ☐ ROLL OVER ☐ BACKING
☐ OTHER (Specify) _____

| c. SEAT BELTS | USED | NOT USED | NOT AVAILABLE |
|---|---|---|---|
| (1) FRONT SEAT | | | |
| (2) REAR SEAT | | | |

**8. PROPERTY/MATERIAL INVOLVED**

| a. NAME OF ITEM | b. OWNERSHIP | c. $ AMOUNT OF DAMAGE |
|---|---|---|
| (1) | | |
| (2) | | |
| (3) | | |

**9. VESSEL / FLOATING PLANT ACCIDENT** (Fill in line and corresponding code number in box from list - see instructions)

a. TYPE OF VESSEL/FLOATING PLANT _____ (CODE) ☐

b. TYPE OF COLLISON/MISHAP _____ (CODE) ☐

**10. ACCIDENT DESCRIPTION** (Use additional paper if necessary)

## 11. CAUSAL FACTOR(S) *(Read Instruction Before Completing)*

a. *(Explain YES answers in item 13)*

| | YES | NO |
|---|---|---|
| DESIGN: Was design of facility, workplace or equipment a factor? | ☐ | ☐ |
| INSPECTION/MAINTENANCE. Were inspection & maintenance procedures a factor? | ☐ | ☐ |
| PERSON'S PHYSICAL CONDITION. In your opinion, was the physical condition of the person a factor? | ☐ | ☐ |
| OPERATING PROCEDURES. Were operating procedures a factor? | ☐ | ☐ |
| JOB PRACTICES. Were any job safety/health practices not followed when the accident occurred? | ☐ | ☐ |
| HUMAN FACTORS. Did any human factors such as, size or strength of person, etc., contribute to accident? | ☐ | ☐ |
| ENVIRONMENTAL FACTORS. Did heat, cold, dust, sun, glare, etc., contribute to the accident? | ☐ | ☐ |

a. *(CONTINUED)*

| | YES | NO |
|---|---|---|
| CHEMICAL AND PHYSICAL AGENT FACTORS. Did exposure to chemical agents, such as dust, fumes, mists, vapors or physical agents, such as, noise, radiation, etc., contribute to accident? | ☐ | ☐ |
| OFFICE FACTORS. Did office setting such as, lifting office furniture, carrying, stooping, etc., contribute to the accident? | ☐ | ☐ |
| SUPPORT FACTORS. Were inappropriate tools/resources provided to properly perform the activity/task? | ☐ | ☐ |
| PERSONAL PROTECTIVE EQUIPMENT. Did the improper selection, use or maintenance of personal protective equipment contribute to the accident? | ☐ | ☐ |
| DRUGS/ALCOHOL. In your opinion, was drugs or alcohol a factor to the accident? | ☐ | ☐ |

b. WAS A WRITTEN JOB/ACTIVITY HAZARD ANALYSIS COMPLETED FOR TASK BEING PERFORMED AT TIME OF ACCIDENT?

☐ YES *(If yes, attach a copy.)* ☐ NO

## 12. TRAINING

a. WAS PERSON TRAINED TO PERFORM ACTIVITY/TASK? ☐ YES ☐ NO

b. TYPE OF TRAINING. ☐ CLASSROOM ☐ ON JOB

c. DATE OF MOST RECENT FORMAL TRAINING. / / *(Month) (Day) (Year)*

## 13. FULLY EXPLAIN WHAT ALLOWED OR CAUSED THE ACCIDENT. INCLUDE DIRECT AND INDIRECT CAUSES *(See instruction for definition of direct and indirect causes.) (Use additional paper if necessary)*

a. DIRECT CAUSE

b. INDIRECT CAUSE(S)

## 14. ACTION(S) TAKEN ANTICIPATED OR RECOMMENDED TO ELIMINATE CAUSE(S).

DESCRIBE FULLY:

## 15. DATES FOR ACTIONS IDENTIFIED IN BLOCK 14.

a. BEGINNING *(Month/Day/Year)* / /

b. ANTICIPATED COMPLETION *(Month/Day/Year)* / /

c. SIGNATURE AND TITLE OF SUPERVISOR COMPLETING REPORT

CORPS _____

CONTRACTOR _____

d. DATE *(Mo/Da/Yr)* ___ / ___ / ___ ___ / ___ / ___

e. ORGANIZATION IDENTIFIER *(Div, Br, Sect)*

f. OFFICE SYMBOL

## 16. MANAGEMENT REVIEW *(1st)*.

a. ☐ CONCUR b. ☐ NON CONCUR c. COMMENTS

| SIGNATURE | TITLE | DATE |
|---|---|---|
| | | |

## 17. MANAGEMENT REVIEW *(2nd - Chief Operations, Construction, Engineering, etc.)*

a. ☐ CONCUR b. ☐ NON CONCUR c. COMMENTS

| SIGNATURE | TITLE | DATE |
|---|---|---|
| | | |

## 18. SAFETY AND OCCUPATIONAL HEALTH OFFICE REVIEW

a. ☐ CONCUR b. ☐ NON CONCUR c. ADDITIONAL ACTIONS/COMMENTS.

| SIGNATURE | TITLE | DATE |
|---|---|---|
| | | |

## 19. COMMAND APPROVAL

COMMENTS

| COMMANDER SIGNATURE | DATE |
|---|---|
| | |



☆ U.S.G.P.O. 1988- 626-113

**GENERAL.** Complete a separate report for each person who was *injured, caused,* or *contributed* to the accident (excluding uninjured personnel and witnesses). Use of this form for reporting USACE employee first-aid type injuries not submitted to the Office of Workers' Compensation Programs (OWCP) shall be at the descretion of the FOA commander. Please type or print legibly. Appropriate items shall be marked with an "X" in box(es). If additional space is needed, provide the information on a separate sheet and attach to the completed form. Ensure that these instructions are forwarded with the completed report to the designated management reviewers indicated in sections 16. and 17.

## INSTRUCTIONS FOR SECTION 1 – ACCIDENT CLASSIFICATION. *(Mark All Boxes That Are Applicable.)*

a. GOVERNMENT. Mark "CIVILIAN" box if accident involved government civilian employee; mark "MILITARY" box if accident involved U.S. military personnel.

(1) INJURY/ILLNESS/FATALITY – Mark if accident resulted in any government civilian employee injury, illness, or fatality that requires the submission of OWCP Forms CA-1 (injury), CA-2 (illness), or CA-6 (fatality) to OWCP; mark if accident resulted in military personnel lost-time or fatal injury or illness.

(2) PROPERTY DAMAGE – Mark the appropriate box if accident resulted in any damage of $1000 or more to government property (including motor vehicles).

(3) VEHICLE INVOLVED – Mark if accident involved a motor vehicle, *regardless* of whether "INJURY/ILLNESS/FATALITY" or "PROPERTY DAMAGE" are marked.

(4) DIVING ACTIVITY – Mark if the accident involved an in-house USACE diving activity.

b. CONTRACTOR.

(1) INJURY/ILLNESS/FATALITY – Mark if accident resulted in any contractor lost-time injury/illness or fatality.

(2) PROPERTY DAMAGE – Mark the appropriate box if accident resulted in any damage of $1000 or more to contractor property (including motor vehicles).

(3) VEHICLE INVOLVED – Mark if accident involved a motor vehicle, *regardless* of whether "INJURY/ILLNESS/FATALITY" or "PROPERTY DAMAGE" are marked.

(4) DIVING ACTIVITY – Mark if the accident involved a USACE Contractor diving activity.

c. PUBLIC.

(1) INJURY/ILLNESS/FATALITY – Mark if accident resulted in public fatality or permanent total disability. (The "OTHER" box will be marked when requested by the FOA to report an unusual non-fatal public accident that could result in claims against the government or as otherwise directed by the FOA Commander).

(2) VOID SPACE – Make no entry.

(3) VEHICLE INVOLVED – Mark if accident resulted in a fatality to a member of the public and involved a motor vehicle, *regardless* of whether "INJURY/ILLNESS/FATALITY" is marked.

(4) VOID SPACE – Make no entry.

## INSTRUCTIONS FOR SECTION 2 – PERSONAL DATA

a. NAME – (MANDATORY FOR GOVERNMENT ACCIDENTS. OPTIONAL AT THE DISCRETION OF THE FOA COMMANDER FOR CONTRACTOR AND PUBLIC ACCIDENTS). Enter last name, first name, middle initial of person involved.

b. AGE – Enter age.

c. SEX – Mark appropriate box.

d. SOCIAL SECURITY NUMBER – (FOR GOVERNMENT PERSONNEL ONLY) Enter the social security number (or other personal identification number if no social security number issued).

e. GRADE – (FOR GOVERNMENT PERSONNEL ONLY) Enter pay grade. Example: O-6; E-7; WG-8; WS-12; GS-11; etc.

f. JOB SERIES/TITLE – For *government civilian employees* enter the pay plan, full series number, and job title, e.g. GS-0810/Civil Engineer. For *military personnel* enter the primary military occupational specialty (PMOS), e.g., 15A30 or 11G50. For *contractor employees* enter the job title assigned to the injured person, e.g. carpenter, laborer, surveyor, etc..

g. DUTY STATUS – Mark the appropriate box.

(1) ON DUTY – Person was at duty station during duty hours or person was away from duty station during duty hours but on official business at time of the accident.

(2) TDY - Person was on official business, away from the duty station and with travel orders at time of accident. Line-of-duty investigation required.

(3) OFF DUTY - Person was not on official business at time of accident

h. EMPLOYMENT STATUS – (FOR GOVERNMENT PERSONNEL ONLY) Mark the most appropriate box. If "OTHER" is marked, specify the employment status of the person.

## INSTRUCTION FOR SECTION 3 – GENERAL INFORMATION

a. DATE OF ACCIDENT – Enter the month, day, and year of accident.

b. TIME OF ACCIDENT – Enter the local time of accident in military time. Example: 1430 hrs (not 2:30 p.m.).

c. EXACT LOCATION OF ACCIDENT – Enter facts needed to locate the accident scene. (installation/project name, building number, street, direction and distance from closest landmark, etc.,).

d. CONTRACTOR NAME

(1) PRIME – Enter the exact name (title of firm) of the prime contractor.

(2) SUBCONTRACTOR – Enter the name of any subcontractor involved in the accident.

e. CONTRACT NUMBER – Mark the appropriate box to identify if contract is civil works, military, or other: if "OTHER" is marked, specify contract appropriation on line provided. Enter complete contract number of prime contract, e.g., DACW 09-85-C-0100.

f. TYPE OF CONTRACT – Mark appropriate box. A/E means architect/engineer. If "OTHER" is marked, specify type of contract on line provided.

g. HAZARDOUS/TOXIC WASTE ACTIVITY (HTW) – Mark the box to identify the HTW activity being performed at the time of the accident. For Superfund, DERP, and Installation Restoration Program (IRP) HTW activities include accidents that occurred during inventory, predesign, design, and construction. For the purpose of accident reporting, DERP Formerly Used DoD Site (FUDS) activities and IRP activities will be treated separately. For Civil Works O&M HTW activities mark the "OTHER" box.

## INSTRUCTIONS FOR SECTION 4 – CONSTRUCTION ACTIVITIES

a. CONSTRUCTION ACTIVITY – Select the *most appropriate* construction activity being performed at time of accident from the list below. Enter the activity name and place the corresponding code number identified in the box.

CONSTRUCTION ACTIVITY LIST

1. MOBILIZATION
2. SITE PREPARATION
3. EXCAVATION/TRENCHING
4. GRADING (EARTHWORK)
5. PIPING/UTILITIES
6. FOUNDATION
7. FORMING
8. CONCRETE PLACEMENT
9. STEEL ERECTION
10. ROOFING
11. FRAMING
12. MASONRY
13. CARPENTRY
14. ELECTRICAL
15. SCAFFOLDING/ACCESS
16. MECHANICAL
17. PAINTING
18. EQUIPMENT/MAINTENANCE
19. TUNNELING
20. WAREHOUSING/STORAGE
21. PAVING
22. FENCING
23. SIGNING
24. LANDSCAPING/IRRIGATION
25. INSULATION
26. DEMOLITION

b. TYPE OF CONSTRUCTION EQUIPMENT – Select the equipment involved in the accident from the list below. Enter the name and place the corresponding code number identified in the box. If equipment is not included below, use code 24, "OTHER", and write in specific type of equipment.

CONSTRUCTION EQUIPMENT

1. GRADER
2. DRAGLINE
3. CRANE (ON VESSEL/BARGE)
4. CRANE (TRACKED)
5. CRANE (RUBBER TIRE)
6. CRANE (VEHICLE MOUNTED)
7. CRANE (TOWER)
8. SHOVEL
9. SCRAPER
10. PUMP TRUCK (CONCRETE)
11. TRUCK (CONCRETE/TRANSIT MIXER)
12. DUMP TRUCK (HIGHWAY)
13. DUMP TRUCK (OFF HIGHWAY)
14. TRUCK (OTHER)
15. FORKLIFT
16. BACKHOE
17. FRONT-END LOADER
18. PILE DRIVER
19. TRACTOR (UTILITY)
20. MANLIFT
21. DOZER
22. DRILL RIG
23. COMPACTOR/VIBRATORY ROLLER
24. OTHER

## INSTRUCTIONS FOR SECTION 5 – INJURY/ILLNESS INFORMATION

a. SEVERITY OF INJURY / ILLNESS - Reference para 2-10 of USACE Suppl 1 to AR 385-40 and enter code and description from list below.

NOI NO INJURY
FAT FATALITY
PTL PERMANENT TOTAL DISABILITY
PPR PERMANENT PARTIAL DISABILITY
LWD LOST WORKDAY CASE INVOLVING DAYS AWAY FROM WORK
NLW RECORDABLE CASE WITHOUT LOST WORKDAYS
RFA RECORDABLE FIRST AID CASE
NRI NON-RECORDABLE INJURY

b. ESTIMATED DAYS LOST – Enter the estimated number of workdays the person will lose from work.

c. ESTIMATED DAYS HOSPITALIZED – Enter the estimated number of workdays the person will be hospitalized.

d. ESTIMATED DAYS RESTRICTED DUTY – Enter the estimated number of workdays the person, as a result of the accident, will not be able to perform all of their regular duties.

e. BODY PART AFFECTED – Select the most appropriate primary and when applicable, secondary body part affected from the list below. Enter body part name on line and place the corresponding code letters identifying that body part in the box.

| GENERAL BODY AREA | CODE | BODY PART NAME |
|---|---|---|
| ARM/WRIST | AB | ARM AND WRIST |
| | AS | ARM OR WRIST |
| TRUNK, EXTERNAL MUSCULATURE | B1 | SINGLE BREAST |
| | B2 | BOTH BREASTS |
| | B3 | SINGLE TESTICLE |
| | B4 | BOTH TESTICLES |
| | BA | ABDOMEN |
| | BC | CHEST |
| | BL | LOWER BACK |
| | BP | PENIS |
| | BS | SIDE |
| | BU | UPPER BACK |
| | BW | WAIST |
| | BZ | TRUNK OTHER |
| HEAD, INTERNAL | C1 | SINGLE EAR INTERNAL |
| | C2 | BOTH EARS INTERNAL |
| | C3 | SINGLE EYE INTERNAL |
| | C4 | BOTH EYES INTERNAL |
| | CB | BRAIN |
| | CC | CRANIAL BONES |
| | CD | TEETH |
| | CJ | JAW |
| | CL | THROAT, LARYNX |
| | CM | MOUTH |
| | CN | NOSE |
| | CR | THROAT, OTHER |
| | CT | TONGUE |
| | CZ | HEAD OTHER INTERNAL |
| ELBOW | EB | BOTH ELBOWS |
| | ES | SINGLE ELBOW |
| FINGER | F1 | FIRST FINGER |
| | F2 | BOTH FIRST FINGERS |
| | F3 | SECOND FINGER |
| | F4 | BOTH SECOND FINGERS |
| | F5 | THIRD FINGER |
| | F6 | BOTH THIRD FINGERS |
| | F7 | FOURTH FINGER |
| | F8 | BOTH FOURTH FINGERS |
| TOE | G1 | GREAT TOE |
| | G2 | BOTH GREAT TOES |
| | G3 | TOE OTHER |
| | G4 | TOES OTHER |
| HEAD, EXTERNAL | H1 | EYE EXTERNAL |
| | H2 | BOTH EYES EXTERNAL |
| | H3 | EAR EXTERNAL |
| | H4 | BOTH EARS EXTERNAL |
| | HC | CHIN |
| | HF | FACE |
| | HK | NECK/THROAT |
| | HM | MOUTH/LIPS |
| | HN | NOSE |
| | HS | SCALP |
| KNEE | KB | BOTH KNEES |
| | KS | KNEE |
| LEG, HIP, ANKLE, BUTTOCK | LB | BOTH LEGS/HIPS/ ANKLES/BUTTOCKS |
| | LS | SINGLE LEG/HIP ANKLE/BUTTOCK |
| HAND | MB | BOTH HANDS |
| | MS | SINGLE HAND |
| FOOT | PB | BOTH FEET |
| | PS | SINGLE FOOT |
| TRUNK, BONES | R1 | SINGLE COLLAR BONE |
| | R2 | BOTH COLLAR BONES |
| | R3 | SHOULDER BLADE |
| | R4 | BOTH SHOULDER BLADES |
| | RB | RIB |
| | RS | STERNUM (BREAST BONE) |
| | RV | VERTEBRAE (SPINE: DISC) |
| | RZ | TRUNK BONES OTHER |
| SHOULDER | SB | BOTH SHOULDERS |
| | SS | SINGLE SHOULDER |
| THUMB | TB | BOTH THUMBS |
| | TS | SINGLE THUMB |
| TRUNK, INTERNAL ORGANS | V1 | LUNG, SINGLE |
| | V2 | LUNGS, BOTH |
| | V3 | KIDNEY, SINGLE |
| | V4 | KIDNEYS, BOTH |
| | VH | HEART |
| | VL | LIVER |
| | VR | REPRODUCTIVE ORGANS |
| | VS | STOMACH |
| | VV | INTESTINES |
| | VZ | TRUNK, INTERNAL; OTHER |

f. NATURE OF INJURY/ILLNESS - Select the most appropriate nature of injury / illness from the list below. This nature of injury / illness shall correspond to the primary body part selected in 5e, above. Enter the nature of injury / illness name on the line and place the corresponding CODE letters in the box provided.

* The injury or condition selected below must be caused by a specific incident or event which occurred during a single work day or shift.

| GENERAL NATURE CATEGORY | CODE | NATURE OF INJURY NAME |
|---|---|---|
| TRAUMATIC INJURY OR DISABILITY | TA | AMPUTATION |
| | TB | BACK STRAIN. |
| | TC | CONTUSION: BRUISE. ABRASION |
| | TD | DISLOCATION |
| | TF | FRACTURE |
| | TH | HERNIA |
| | TK | CONCUSSION |
| | TL | LACERATION, CUT |
| | TP | PUNCTURE |
| | TS | STRAIN, MULTIPLE |
| | TU | BURN, SCALD, SUNBURN |
| | TI | TRAUMATIC SKIN DISEASES/ CONDITIONS INCLUDING DERMATITIS |
| | TR | TRAUMATIC RESPIRATORY DISEASE |
| | TQ | TRAUMATIC FOOD POISONING |
| | TW | TRAUMATIC TUBERCULOSIS |
| | TX | TRAUMATIC VIROLOGICAL/ INFECTIVE/PARASITIC DISEASE |
| | T1 | TRAUMATIC CEREBRAL VASCULAR CONDITION/STROKE |
| | T2 | TRAUMATIC HEARING LOSS |
| | T3 | TRAUMATIC HEART CONDITION |
| | T4 | TRAUMATIC MENTAL DISORDER: STRESS; NERVOUS CONDITION |
| | T8 | TRAUMATIC INJURY – OTHER (EXCEPT DISEASE, ILLNESS) |

** A nontraumatic physiological harm or loss of capacity produced by systemic infection; continued or repeated stress or strain; exposure to toxins, poisons, fumes, etc.; or other continued and repeated exposures to conditions of the work environment over a long period of time. For practical purposes, an occupational illness/disease or disability is any reported condition which doses not meet the definition of traumatic injury or disability as described above.

| GENERAL NATURE CATEGORY | CODE | NATURE OF INJURY NAME |
|---|---|---|
| **NON-TRAUMATIC ILLNESS/DISEASE OR DISABILITY | | |
| RESPIRATORY DISEASE | RA | ASBESTOSIS |
| | RB | BRONCHITIS |
| | RE | EMPHYSEMA |
| | RP | PNEUMOCONIOSIS |
| | RS | SILICOSIS |
| | R9 | RESPIRATORY DISEASE, OTHER |
| VIROLOGICAL, INFECTIVE & PARASITIC DISEASES | VB | BRUCELLOSIS |
| | VC | COCCIDIOMYCOSIS |
| | VF | FOOD POISONING |
| | VH | HEPATITIS |
| | VM | MALARIA |
| | VS | STAPHYLOCOCCUS |
| | VT | TUBERCULOSIS |
| | V9 | VIROLOGICAL/INFECTIVE/ PARASITIC – OTHER |
| DISABILITY, OCCUPATIONAL | DA | ARTHRITIS, BURSITIS |
| | DB | BACK STRAIN, BACK SPRAIN |
| | DC | CEREBRAL VASCULAR CONDITION; STROKE |
| | DD | ENDEMIC DISEASE (OTHER THAN CODE TYPES R&S) |
| | DE | EFFECT OF ENVIRONMENTAL CONDITION |
| | DH | HEARING LOSS |
| | DK | HEART CONDITION |
| | DM | MENTAL DISORDER, EMOTIONAL STRESS NERVOUS CONDITION |
| | DR | RADIATION |
| | DS | STRAIN, MULTIPLE |
| | DU | ULCER |
| | DV | OTHER VASCULAR CONDITIONS |
| | D9 | DISABILITY, OTHER |
| SKIN DISEASE OR CONDITION | S8 | BIOLOGICAL |
| | SC | CHEMICAL |
| | S9 | DERMATITIS, UNCLASSIFIED |

g. TYPE AND SOURCE OF INJURY/ILLNESS (CAUSE) - Type and Source Codes are used to describe what caused the incident. The Type Code stands for an ACTION and the Source Code for an OBJECT or SUBSTANCE. Together, they form a brief description of how the incident occurred. Where there are two different sources, code the initiating source of the incident (see example 1, below). Examples:

(1) An employee tripped on carpet and struck his head on a desk.
TYPE: 210 (fell on same level) SOURCE: 0110 (walking/working surface)

NOTE. This example would NOT be coded 120 (struck against) and 0140 (furniture).

(2) A Park Ranger contracted dermatitis from contact with poison ivy/ oak.
TYPE: 510 (contact) SOURCE: 0920 (plant)

(3) A lock and dam mechanic punctured his finger with a metal sliver while grinding a turbine blade.
TYPE: 410 (punctured by) SOURCE: 0830 (metal)

(4) An employee was driving a government vehicle when it was struck by another vehicle..
TYPE: 800 (traveling in) SOURCE: 0421 (government-owned vehicle, as driver)

NOTE. The Type Code 800, "Traveling in" is different from the other type codes in that its function is not to identify factors contributing to the injury or fatality, but rather to collect data on the type of vehicle the employee was operating or traveling in at the time of the incident.

Select the most appropriate TYPE and SOURCE identifier from the list below and enter the name on the line and the corresponding code in the appropriate box.

| CODE | TYPE OF INJURY NAME |
|---|---|
| | STRUCK |
| 0110 | STRUCK BY |
| 0111 | STRUCK BY FALLING OBJECT |
| 0120 | STRUCK AGAINST |
| | FELL, SLIPPED, TRIPPED |
| 0210 | FELL ON SAME LEVEL |
| 0220 | FELL ON DIFFERENT LEVEL |
| 0230 | SLIPPED, TRIPPED (NO FALL) |
| | CAUGHT |
| 0310 | CAUGHT ON |
| 0320 | CAUGHT IN |
| 0330 | CAUGHT BETWEEN |
| | PUNCTURED, LACERATED |
| 0410 | PUNCTURED BY |
| 0420 | CUT BY |
| 0430 | STUNG BY |
| 0440 | BITTEN BY |
| | CONTACTED |
| 0510 | CONTACTED WITH (INJURED PERSON MOVING) |
| 0520 | CONTACTED BY (OBJECT WAS MOVING) |
| | EXERTED |
| 0610 | LIFTED, STRAINED BY (SINGLE ACTION) |
| 0620 | STRESSED BY (REPEATED ACTION) |
| | EXPOSED |
| 0710 | INHALED |
| 0720 | INGESTED |
| 0730 | ABSORBED |
| 0740 | EXPOSED TO |
| 0800 | TRAVELING IN |

| CODE | SOURCE OF INJURY NAME |
|---|---|
| 0100 | BUILDING OR WORKING AREA |
| 0110 | WALKING/WORKING SURFACE (FLOOR, STREET, SIDEWALKS, ETC) |
| 0120 | STAIRS, STEPS |
| 0130 | LADDER |
| 0140 | FURNITURE, FURNISHINGS, OFFICE EQUIPMENT |
| 0150 | BOILER, PRESSURE VESSEL |
| 0160 | EQUIPMENT LAYOUT (ERGONOMIC) |
| 0170 | WINDOWS, DOORS |
| 0180 | ELECTRICITY |

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| CODE | SOURCE OF INJURY NAME |
|---|---|
| 0200 | ENVIRONMENTAL CONDITION |
| 0210 | TEMPERATURE EXTREME (INDOOR) |
| 0220 | WEATHER (ICE, RAIN, HEAT, ETC.) |
| 0230 | FIRE, FLAME, SMOKE (NOT TOBACCO) |
| 0240 | NOISE |
| 0250 | RADIATION |
| 0260 | LIGHT |
| 0270 | VENTILATION |
| 0271 | TOBACCO SMOKE |
| 0280 | STRESS (EMOTIONAL) |
| 0290 | CONFINED SPACE |
| 0300 | MACHINE OR TOOL |
| 0310 | HAND TOOL (POWERED: SAW, GRINDER, ETC.) |
| 0320 | HAND TOOL (NONPOWERED) |
| 0330 | MECHANICAL POWER TRANSMISSION APPARATUS |
| 0340 | GUARD, SHIELD (FIXED, MOVEABLE, INTERLOCK) |
| 0350 | VIDEO DISPLAY TERMINAL |
| 0360 | PUMP, COMPRESSOR, AIR PRESSURE TOOL |
| 0370 | HEATING EQUIPMENT |
| 0380 | WELDING EQUIPMENT |
| 0400 | VEHICLE |
| 0411 | AS DRIVER OF PRIVATELY OWNED/RENTAL VEHICLE |
| 0412 | AS PASSENGER OF PRIVATELY OWNED/RENTAL VEHICLE |
| 0421 | DRIVER OF GOVERNMENT VEHICLE |
| 0422 | PASSENGER OF GOVERNMENT VEHICLE |
| 0430 | COMMON CARRIER (AIRLINE, BUS, ETC.) |
| 0440 | AIRCRAFT (NOT COMMERCIAL) |
| 0450 | BOAT, SHIP, BARGE |
| 0500 | MATERIAL HANDLING EQUIPMENT |
| 0510 | EARTHMOVER (TRACTOR, BACKHOE, ETC.) |
| 0520 | CONVEYOR (FOR MATERIAL AND EQUIPMENT) |
| 0530 | ELEVATOR, ESCALATOR, PERSONNEL HOIST |
| 0540 | HOIST, SLING CHAIN, JACK |
| 0550 | CRANE |
| 0551 | FORKLIFT |
| 0560 | HANDTRUCK, DOLLY |
| 0600 | DUST, VAPOR, ETC. |
| 0610 | DUST (SILICA, COAL, ETC.) |
| 0620 | FIBERS |
| 0621 | ASBESTOS |
| 0630 | GASES |
| 0631 | CARBON MONOXIDE |
| 0640 | MIST, STEAM, VAPOR, FUME |
| 0641 | WELDING FUMES |
| 0650 | PARTICLES (UNIDENTIFIED) |
| 0700 | CHEMICAL, PLASTIC, ETC. |
| 0711 | DRY CHEMICAL—CORROSIVE |
| 0712 | DRY CHEMICAL—TOXIC |
| 0713 | DRY CHEMICAL—EXPLOSIVE |
| 0714 | DRY CHEMICAL—FLAMMABLE |
| 0721 | LIQUID CHEMICAL—CORROSIVE |
| 0722 | LIQUID CHEMICAL—TOXIC |
| 0723 | LIQUID CHEMICAL—EXPLOSIVE |
| 0724 | LIQUID CHEMICAL—FLAMMABLE |
| 0730 | PLASTIC |
| 0740 | WATER |
| 0750 | MEDICINE |
| 0800 | INANIMATE OBJECT |
| 0810 | BOX, BARREL, ETC. |
| 0820 | PAPER |
| 0830 | METAL ITEM, MINERAL |
| 0831 | NEEDLE |
| 0840 | GLASS |
| 0850 | SCRAP, TRASH |
| 0860 | WOOD |
| 0870 | FOOD |
| 0880 | CLOTHING, APPAREL, SHOES |
| 0900 | ANIMATE OBJECT |
| 0911 | DOG |
| 0912 | OTHER ANIMAL |
| 0920 | PLANT |
| 0930 | INSECT |
| 0940 | HUMAN (VIOLENCE) |
| 0950 | HUMAN (COMMUNICABLE DISEASE) |
| 0960 | BACTERIA, VIRUS (NOT HUMAN CONTACT) |

| CODE | SOURCE OF INJURY NAME |
|---|---|
| 1000 | PERSONAL PROTECTIVE EQUIPMENT |
| 1010 | PROTECTIVE CLOTHING, SHOES, GLASSES, GOGGLES |
| 1020 | RESPIRATOR, MASK |
| 1021 | DIVING EQUIPMENT |
| 1030 | SAFETY BELT, HARNESS |
| 1040 | PARACHUTE |

## INSTRUCTIONS FOR SECTION 6 — PUBLIC FATALITY

a. ACTIVITY AT TIME OF ACCIDENT—Select the activity being performed at the time of the accident from the list below. Enter the activity name on the line and the corresponding number in the box. If the activity performed is not identified on the list, select from the *most* appropriate primary activity area (water related, non-water related or other activity), the code number for "Other", and write in the activity being performed at the time of the accident.

WATER RELATED RECREATION

1. Sailing
2. Boating—powered
3. Boating—unpowered
4. Water skiing
5. Fishing from boat
6. Fishing from bank dock or pier
7. Fishing while wading
8. Swimming/supervised area
9. Swimming/designated area
10. Swimming/other area
11. Underwater activities (skin diving, scuba, etc.)
12. Wading
13. Attempted rescue
14. Hunting from boat
15. Other

NON-WATER RELATED RECREATION

16. Hiking and walking
17. Climbing (general)
18. Camping/picnicking authorized area
19. Camping/picnicking unauthorized area
20. Guided tours
21. Hunting
22. Playground equipment
23. Sports/summer (baseball, football, etc.)
24. Sports/winter (skiing, sledding, snowmobiling etc.)
25. Cycling (bicycle, motorcycle, scooter)
26. Gliding
27. Parachuting
28. Other non-water related

OTHER ACTIVITIES

29. Unlawful acts (fights, riots, vandalism, etc.)
30. Food preparation/serving
31. Food consumption
32. Housekeeping
33. Sleeping
34. Pedestrian struck by vehicle
35. Pedestrian other acts
36. Suicide
37. "Other" activities

b. PERSONAL FLOTATION DEVICE USED—If fatality was water-related was the victim wearing a person flotation device? Mark the appropriate box.

## INSTRUCTIONS FOR SECTION 7—MOTOR VEHICLE ACCIDENT

a. TYPE OF VEHICLE—Mark appropriate box for each vehicle involved. If more than one vehicle of the same type is involved, mark both halves of the appropriate box. USACE vehicle(s) involved shall be marked in left half of appropriate box.

b. TYPE OF COLLISION—Mark appropriate box.

c. SEAT BELT—Mark appropriate box.

## INSTRUCTIONS FOR SECTION 8—PROPERTY/ MATERIAL INVOLVED

a. NAME OF ITEM—Describe all property involved in accident. Property/material involved means material which is damaged or whose use or misuse contributed to the accident. Include the name, type, model; also include the National Stock Number (NSN) whenever applicable.

b. OWNERSHIP—Enter ownership for each item listed. (Enter one of the following: *USACE; OTHER GOVERNMENT; CONTRACTOR; PRIVATE*)

c. $ AMOUNT OF DAMAGE—Enter the total estimated dollar amount of damage (parts and labor), if any.

## INSTRUCTIONS FOR SECTION 9 — VESSEL/ FLOATING PLANT ACCIDENT

a. TYPE OF VESSEL/FLOATING PLANT — Select the most appropriate vessel/floating plant from list below. Enter name and place corresponding number in box. If item is not listed below, enter item number for "OTHER" and write in specific type of vessel/ floating plant.

VESSEL/FLOATING PLANTS

1. ROW BOAT
2. SAIL BOAT
3. MOTOR BOAT
4. BARGE
5. DREDGE/HOPPER
6. DREDGE/SIDE CASTING
7. DREDGE/DIPPER
8. DREDGE/CLAMSHELL BUCKET
9. DREDGE/PIPE LINE
10. DREDGE/DUST PAN
11. TUG BOAT
12. OTHER

b. COLLISION/MISHAP — Select from the list below the object(s) that contributed to the accident or were damaged in the accident.

COLLISION/MISHAP

1. COLLISION W/OTHER VESSEL
2. UPPER GUIDE WALL
3. UPPER LOCK GATES
4. LOCK WALL
5. LOWER LOCK GATES
6. LOWER GUIDE WALL
7. HAULAGE UNIT
8. BREAKING TOW
9. TOW BREAKING UP
10. SWEPT DOWN ON DAM
11. BUOY/DOLPHIN/CELL
12. WHARF OR DOCK
13. OTHER

## INSTRUCTIONS FOR SECTION 10 — ACCIDENT DESCRIPTION

DESCRIBE ACCIDENT — Fully describe the accident. Give the sequence of events that describe what happened leading up to and including the accident. Fully identify personnel and equipment involved and their role(s) in the accident. Ensure that relationships between personnel and equipment are clearly specified. Continue on blank sheets if necessary and attach to this report.

## INSTRUCTIONS FOR SECTION 11 — CAUSAL FACTORS

a. Review thoroughly. Answer each question by marking the appropriate block. If any answer is yes, explain in item 13 below. Consider, as a minimum, the following:

( 1) DESIGN — Did inadequacies associated with the building or work site play a role? Would an improved design or layout of the equipment or facilities reduce the likelihood of similar accidents? Were the tools or other equipment designed and intended for the task at hand?

( 2) INSPECTION/MAINTENANCE — Did inadequately or improperly maintained equipment, tools, workplace, etc. create or worsen any hazards that contributed to the accident? Would better equipment, facility, work site or work activity inspections have helped avoid the accident?

( 3) PERSON'S PHYSICAL CONDITION — Do you feel that the accident would probably not have occurred if the employee was in "good" physical condition? If the person involved in the accident had been in better physical condition, would the accident have been less severe or avoided altogether? Was over exertion a factor?

( 4) OPERATING PROCEDURES — Did a lack of or inadequacy within established operating procedures contribute to the accident? Did any aspect of the procedures introduce any hazard to, or increase the risk associated with the work process? Would establishment or improvement of operating procedures reduce the likelihood of similar accidents?

( 5) JOB PRACTICES — Were any of the provisions of the Safety and Health Requirements Manual (EM 385-1-1) violated? Was the task being accomplished in a manner which was not in compliance with an established job hazard analysis or activity hazard analysis? Did any established job practice (including EM 385-1-1) fail to adequately address the task or work process? Would better job practices improve the safety of the task?

( 6) HUMAN FACTORS — Was the person under undue stress (either internal or external to the job)? Did the task tend toward overloading the capabilities of the person; i.e., did the job require tracking and reacting to many external inputs such as displays, alarms, or signals? Did the arrangement of the workplace tend to interfere with efficient task performance? Did the task require reach, strength, endurance, agility, etc., at or beyond the capabilities of the employee? Was the work environment ill-adapted to the person? Did the person need more training, experience, or practice in doing the task? Was the person inadequately rested to perform safely?

( 7) ENVIRONMENTAL FACTORS — Did any factors such as moisture, humidity, rain, snow, sleet, hail, ice, fog, cold, heat, sun, temperature changes, wind, tides, floods, currents, dust, mud, glare, pressure changes, lightning, etc., play a part in the accident?

( 8) CHEMICAL AND PHYSICAL AGENT FACTORS — Did exposure to chemical agents (either single shift exposure or long-term exposure) such as dusts, fibers (asbestos, etc.), silica, gases (carbon monoxide, chlorine, etc.,), mists, steam, vapors, fumes, smoke, other particulates, liquid or dry chemicals that are corrosive, toxic, explosive or flammable, by-products of combustion or physical agents such as noise, ionizing radiation, non-ionizing radiation (UV radiation created during welding, etc.) contribute to the accident/incident?

( 9) OFFICE FACTORS — Did the fact that the accident occurred in an office setting or to an office worker have a bearing on its cause? For example, office workers tend to have less experience and training in performing tasks such as lifting office furniture. Did physical hazards within the office environment contribute to the hazard?

(10) SUPPORT FACTORS — Was the person using an improper tool for the job? Was inadequate time available or utilized to safely accomplish the task? Were less than adequate personnel resources (in terms of employee skills, number of workers, and adequate supervision) available to get the job done properly? Was funding available, utilized, and adequate to provide proper tools, equipment, personnel, site preparation, etc?

(11) PERSONAL PROTECTIVE EQUIPMENT — Did the person fail to use appropriate personal protective equipment (gloves, eye protection, hard-toed shoes, respirator, etc.) for the task or environment? Did protective equipment provided or worn fail to provide adequate protection from the hazard(s)? Did lack of or inadequate maintenance of protective gear contribute to the accident?

(12) DRUGS/ALCOHOL — Is there any reason to believe the person's mental or physical capabilities, judgement, etc., were impaired or altered by the use of drugs or alcohol? Consider the effects of prescription medicine and over the counter medications as well as illicit drug use. Consider the effect of drug or alcohol induced "hangovers".

b. WRITTEN JOB/ACTIVITY HAZARD ANALYSIS — Was a written Job/Activity Hazard Analysis completed for the task being performed at the time of the accident? Mark the appropriate box. *If one was performed, attach a copy of the analysis to the report.*

## INSTRUCTIONS FOR SECTION 12 — TRAINING

a. WAS PERSON TRAINED TO PERFORM ACTIVITY/TASK? — For the purpose of this section "trained" means the person has been provided the necessary information (either formal and/or on-the-job (OJT) training) to competently perform the activity/task in a safe and healthful manner.

b. TYPE OF TRAINING — Mark the appropriate box that best indicates the type of training; (classroom or on-the-job) that the injured person received before the accident happened.

c. DATE OF MOST RECENT TRAINING — Enter the month, day, and year of the last *formal* training completed that covered the activity-task being performed at the time of the accident.

## INSTRUCTIONS FOR SECTION 13 — CAUSES

a. DIRECT CAUSES — The direct cause is that single factor which most directly lead to the accident. See examples below.

b. INDIRECT CAUSES — Indirect causes are those factors which contributed to but did not directly initiate the occurrence of the accident.

Examples for section 13:

a. Employee was dismantling scaffold and fell 12 feet from unguarded opening.
*Direct cause:* failure to provide fall protection at elevation.
*Indirect causes:* failure to enforce USACE safety requirements; improper training/motivation of employee (possibility that employee was not knowledgeable of USACE fall protection requirements or was lax in his attitude towards safety); failure to ensure provision of positive fall protection whenever elevated; failure to address fall protection during scaffold dismantling in phase hazard analysis.

b. Private citizen had stopped his vehicle at intersection for red light when vehicle was struck in rear by USACE vehicle. (note USACE vehicle was in proper/safe working condition).
*Direct cause:* failure of USACE driver to maintain control of and stop USACE vehicle within safe distance.
*Indirect cause:* Failure of employee to pay attention to driving (defensive driving).

## INSTRUCTIONS FOR SECTION 14 — ACTION TO ELIMINATE CAUSE(S)

DESCRIPTION — Fully describe all the actions taken, anticipated, and recommended to eliminate the cause(s) and prevent reoccurrence of similar accidents/illnesses. Continue on blank sheets of paper if necessary to fully explain and attach to the completed report form.

## INSTRUCTIONS FOR SECTION 15 — DATES FOR ACTION

a. BEGIN DATE — Enter the date when the corrective action(s) identified in Section 14 will begin.

b. COMPLETE DATE — Enter the date when the corrective action(s) identified in Section 14 will be completed.

c. TITLE AND SIGNATURE — Enter the title and signature of supervisor completing the accident report. For a GOVERNMENT employee accident/illness the immediate supervisor will complete and sign the report. For PUBLIC accidents the USACE Project Manager/Area Engineer responsible for the USACE property where the accident happened shall complete and sign the report. For CONTRACTOR accidents the Contractor's project manager shall complete and sign the report and provide to the USACE supervisor responsible for oversight of that contractor activity. This USACE Supervisor shall also sign the report. Upon entering the information required in 15.d, 15.e and 15.f below, the responsible USACE supervisor shall forward the report for management review as indicated in Section 16.

d. DATE SIGNED — Enter the month, day, and year that the report was signed by the responsible supervisor.

e. ORGANIZATION NAME — For GOVERNMENT employee accidents enter the USACE organization name (Division, Branch, Section, etc.) of the injured employee. For PUBLIC accidents enter the USACE organization name for the person identified in block 15.c. For CONTRACTOR accidents enter the USACE organization name for the USACE office responsible for providing contract administration oversight.

f. OFFICE SYMBOL — Enter the latest complete USACE Office Symbol for the USACE organization identified in block 15.e

## INSTRUCTIONS FOR SECTION 16 — MANAGEMENT REVIEW (1st)

1ST REVIEW — Each USACE FOA shall determine who will provide 1st management review. The responsible USACE supervisor in section 15.c shall forward the completed report to the USACE office designated as the 1st Reviewer by the FOA. Upon receipt, the Chief of the Office shall review the completed report, mark the appropriate box, provide substantive comments, sign, date, and forward to the FOA Staff Chief (2nd review) for review and comment.

## INSTRUCTIONS FOR SECTION 17 — MANAGEMENT REVIEW (2nd)

2ND REVIEW — The FOA Staff Chief (i.e., FOA Chief of Construction, Operations, Engineering, Planning, etc.) shall mark the appropriate box, review the completed report, provide substantive comments, sign, date, and return to the FOA Safety and Occupational Health Office.

## INSTRUCTIONS FOR SECTION 18 — SAFETY AND OCCUPATIONAL HEALTH REVIEW

3RD REVIEW — The FOA Safety and Occupational Health Office shall review the completed report, mark the appropriate box, ensure that any inadequacies, discrepancies, etc. are rectified by the responsible supervisor and management reviewers, provide substantive comments, sign, date and forward to the FOA Commander for review, comment, and signature.

## INSTRUCTION FOR SECTION 19 — COMMAND APPROVAL

4TH REVIEW — The FOA Commander shall (to include the person designated Acting Commander in his absence) review the completed report, comment if required, sign, date, and forward the report to the FOA Safety and Occupational Health Office. Signature authority shall not be delegated.

# APPENDIX E
# DAILY SAFETY INSPECTION REPORT

HARZA *Consulting Engineers and Scientists*

Sears Tower
Fax: (312) 831-3999

233 South Wacker Drive
Telephone: (312) 831-3800

Chicago, Illinois 60606-6392 U.S.A.
Telex: 25-3540 HARZENG CGO

# DAILY SAFETY INSPECTION REPORT

**PROJECT No.:** 5644L
**PROJECT:** CANNON AFB, FIRE TRAINING AREA # 4
**CLIENT:** USACE
**DATE:** :
**REPORT No.:**

| | | | | | |
|---|---|---|---|---|---|
| Weather | Sunny | Clear | Overcast | Rain | Snow |
| Temp | to 32°F | 32-50°F | 50-70°F | 70-85°F | Other_____ |
| Wind | Calm | Moderate | High | | |
| Humidity | Low | Moderate | Humid | | |

**DAILY HEALTH AND SAFETY BRIEFING(S):**

**MONITORING INSTRUMENT READINGS:**

**LEVEL(S) OF PROTECTION:**

**SITE SAFETY INSPECTIONS:**

**OTHER:**

**NAME:** **SIGNATURE:** **TITLE:** SITE HSO

# ATTACHMENTS

# ATTACHMENT 1
# FIELD RESPIRATOR PRESSURE TESTS AND GENERAL PROCEDURES FOR RESPIRATOR CARE AND CLEANING

# FIELD RESPIRATOR PRESSURE TESTS AND GENERAL PROCEDURES FOR RESPIRATOR CARE AND CLEANING

# FIELD RESPIRATOR PRESSURE TESTS AND GENERAL PROCEDURES FOR RESPIRATOR CARE AND CLEANING

## 1. FITTING

Place the respirator over the face and draw the straps securely. The mask should not be so tight as to cause discomfort or a headache. Secure bottom straps first.

## 2. NEGATIVE PRESSURE TEST

This test (and the positive pressure test) should be used only as a very gross determination of fit. The wearer should use this test just before entering the hazardous atmosphere. In this test, the user closes off the inlet of the canister, cartridge(s), or filter(s) by covering with the palm(s) or squeezing the breathing tube so that it does not pass air; inhales gently so that the facepiece collapses slightly; and holds breath for about 10 seconds.

If the facepiece remains slightly collapsed and no inward leakage is detected, the respirator is probably tight enough. This test, of course, can only be used on respirators with tight-fitting facepieces.

Although this test is simple, it has severe drawbacks; primarily that the wearer must handle the respirator after it has supposedly been positioned on his face. This handling can modify the facepiece seal.

## 3. POSITIVE PRESSURE TEST

This test, similar to the negative pressure test, is conducted by closing off the exhalation valve and exhaling gently into the facepiece. The fit is considered satisfactory if slight positive pressure can be built up inside the facepiece without any evidence of outward leakage. For some respirators, this method requires that the wearer remove the exhalation valve cover; this often disturbs the respirator fit even more than does the negative pressure test. Therefore, this test should be used sparingly if it requires removing and replacing a valve cover. The test is easy for respirators whose valve cover has a single small port that can be closed by the palm or a finger.

## 4. INSPECTION

On air-purifying respirators, thoroughly check all connections for gaskets and "O" rings and for proper tightness. Check the condition of the facepiece and all its parts, connecting air tube, and headbands. Inspect rubber elastomer parts for pliability and sign of deterioration.

Maintain a record for each respirator inspection, including date, inspectors, and any unusual conditions or findings.

## 5. CLEANING AND DISINFECTION

- Remove all cartridges, canisters, and filters, plus gaskets or seals not affixed to their seats.

- Remove elastic headbands.
- Remove exhalation cover.
- Remove speaking diaphragm or speaking diaphragm-exhalation valve assembly.
- Remove inhalation valves.
- Wash facepiece and breathing tube in cleaner/sanitizer powder mixed with warm water, preferably at 120° to 140°F. Wash components separately from the facemask, as necessary. Remove heavy soil from surfaces with a hand brush.
- Remove all parts from the wash water and rinse twice in clean warm water.
- Air dry parts in a designated clean area.
- Wipe facepieces, valves, and seats with a damp lint-free cloth to remove any remaining soap or other foreign materials.

NOTE: Most respirator manufacturers market their own cleaners/sanitizers as dry mixtures of a bactericidal agent and a mild detergent. One-ounce packets for individual use and bulk packages for quantity use are usually available.

## 6. REPAIRS

Only a trained person with proper tools and replacement parts should work on respirators. No one should ever attempt to replace components or to make adjustments or repairs beyond the manufacturer's recommendations. It may be necessary to send high-pressure-side components of SCBA's to an authorized facility for repairs.

Make repairs as follows:

- Replace all faulty or questionable parts or assemblies. Use parts only specifically designed for the particular respirator.
- Reassemble the entire respirator and visually inspect the completed assembly.
- Insert new filters, cartridges, or canisters, as required. Make sure that gaskets or seals are in place and tightly sealed.

## 7. STORAGE

Follow manufacturers' storage instructions, which are always furnished with new respirators or affixed to the lid of the carrying case. In addition, these general instructions may be helpful:

- After respirators have been inspected, cleaned, and repaired, store them so to protect against dust, excessive moisture, damaging chemicals, extreme temperatures and direct sunlight.

- Do not store respirators in clothes lockers, bench drawers, or tool boxes. Place them in wall compartments at work stations or in a work area designated for emergency equipment. Store them in the original carton or carrying case.

- Draw clean respirators from storage for each use. Each unit can be sealed in a plastic bag, placed in a separate box, and tagged for immediate use.

**LIMITATIONS**

Following is a partial list of gaseous materials for which chemical cartridge respirators should not be used for respiratory protection regardless of concentration or time of exposure; this far-from-complete list is offered only as a guide to proper evaluation of the many contaminants found in industry. Contact MSA for further information on other specific materials.

| | | |
|---|---|---|
| Acrolein | Hydrogen Sulfide | Ozone |
| Aniline | Methanol | Phosgene |
| Arsine | Methyl Bromide | Phosphine |
| Bromine | Methyl Chloride | Phosphorous |
| Carbon Monoxide | Methylene Chloride | Trichloride |
| Dimethylaniline | Nickel Carbonyl | Stibine |
| Dimethyl Sulfate | Nitro Compounds: | Sulfur Chloride |
| Hydrogen Cyanide | Nitrobenzene | Toluene |
| Hydrogen Fluoride | Nitrogen Oxides | Diisocyanate |
| Hydrogen Selenide | Nitroglycerin | Vinyl Chloride |
| | Nitormethane | |

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*Reference:* *8-Hour Refresher Program for Hazardous Waste Site Personnel, Version II, Student Handbook, Midwest Consortium for Hazardous Waste Worker Training, June 1989.*

# ATTACHMENT 2
# AIR MONITORING INSTRUMENT INFORMATION AND INSTRUCTIONS

# AIR MONITORING INSTRUMENT INFORMATION AND INSTRUCTIONS

# CALIBRATION

## 3.1 INTRODUCTION

The PI 101 Analyzer is designed for trace gas analysis in ambient air and is calibrated at HNU with certified standards of benzene, vinyl chloride and isobutylene. Other optional calibrations are available (e.g., ammonia, ethylene oxide, H2S, etc.). Calibration data is given in the data sheet. If a special calibration has been done, the data is given in the Application Data Sheet, which notes the sample source, type of calibration (see Section 8, Appendix), and other pertinent information.

Good instrumentation practice calls for calibration on the species to be measured in the concentration range to be used. This procedure assures the operator that the analyzer is operating properly and will generate reliable data.

Some general points to consider when calibrating the PI 101 are that the analyzer is designed for operation at ambient conditions and therefore the gas standards used for calibration should be delivered to the analyzer at ambient temperatures and pressure and at the proper flow rates.

---

WARNING:

---

The PI 101 is a non-destructive analyzer; calibrations using toxic or hazardous gases must be done in a hood.

The frequency of calibration should be dictated by the usage of the analyzer and the toxicity of the species measured. If the analyzer has been serviced or repaired, calibration should be done to verify operation and performance. It is recommended that calibration be checked frequently at first (daily or every other day) and then regularly based on the confidence level developed.

The normal meter scaleplate is 0 to 20. If the scaleplate is different, refer to the Application Data Sheet. If there are questions, consult the HNU representative before proceeding with calibration check.

An accurate and reliable method of calibration check is to use an analyzed gas cylinder in a test setup as shown in Figure 3-1 and described below. Additional material on calibration is given in Section 8, Appendix.

## 3.2 ANALYZED GAS CYLINDER

a. Concentration - The calibration gas cylinder is to contain the species of interest made up in an air matrix at or near the concentration to be analyzed. If the component is unstable in air, another matrix is to be used. The final calibration mixture should be similar to the sample the PI 101 will analyze. If the expected concentration is not known then a concentration should be chosen that will cause a scale displacement of 50 to 80% on the X10 range. Calibration on X10 range will provide accurate values on the X1 range as well.

For use on the 0-2000 range, a two-standard calibration is preferred: one at 70 to 85% of the linear range and the other at 25 to 35% of the linear range. With the linear range of approximately 600 ppm for most compounds these points would lie between 420 to 510 ppm and 150 to 210 ppm, respectively.

b. Stability - The calibration gas must be stable within the cylinder during the period of use. If the calibration is required in the field, then use of a small cylinder is recommended. In addition, the choice of cylinder material in contact with the gas must be considered (steel, aluminum or teflon). If there are any questions, the operator should request stability and usage information from the gas supplier.

---
WARNING
---

Extreme care must be taken in the handling of gas cylinders. Contents are under high pressure. In some cases, the contents may be hazardous. Many gas suppliers will provide data sheets for the mixtures upon request.

c. Delivery - The cylinder containing the calibration mixture must be connected to a proper regulator.

---
WARNING
---

Never open the valve on a gas cylinder container without a regulator attached.

Leak test all tank/regulator connections as well as the main cylinder valve to prevent toxic or hazardous materials from leaking into the work area. Care must be taken that the materials of construction of the regulator will not interact with the calibration gas.

One method of sampling the calibration gas is illustrated in Figure 3-1. Connect the cylinder to one leg of the tee, a flow meter to the opposite leg, and the probe to the third leg. The flow meter does not require a valve. If there is a valve, it must be left wide open. the flowmeter is only to indicate excess flow. Adjust the flow from the regulator such that only a little excess flow is registered at the flowmeter.

This insures that the PI 101 sees the calibration gas at atmospheric pressure and ambient temperature.

d. Usage - Generally, a gas cylinder should not be used below 200-300 psi as pressure effects could cause concentration variations. The cylinder should not be used past the recommended age of the contents as indicated by the manufacturer. In case of difficulty, verify the contents and concentration of the gas cylinder.

e. Alternate means of calibration are possible. For more information, contact the HNU Service Department.

## 3.3 PROBE

a. Identify the probe by the lamp label. If a question exists, disassemble the probe and inspect the lamp. The energy of the lamp is etched into the glass envelope.

b. Connect the probe to the readout assembly, making sure the red interlock switch is depressed by the ring on the connector.

c. Set the SPAN pot to the proper value for the probe being calibrated. Refer to the calibration memo accompanying the probe.

d. Check the Ionization Potential (IP) of the calibration gas to be used. The IP of the calibration gas must be at or below the IP of the lamp.

e. Proceed with the calibration as described in Section 3.4. Check the calibration memo for specific data. If any questions develop, call the HNU representative.

f. NOTE: The 11.7eV lamp has a special cleaning compound. Do not use water or any other cleaning compound with the 11.7 eV lamp. Do not interchange ion chambers, amplifier boards or lamps between probes. (See Section 5.2).

## 3.4 PROCEDURE

a. Battery check - Turn the function switch to BATT. The needle should be in the green region. If not, recharge the battery.

b. Zero set - Turn the function switch to STANDBY. In this position the lamp is OFF and no signal is generated. Set the zero point with the ZERO set control. The zero can also be set with the function switch on the X1 position and using a "Hydrocarbon-free" air. In this case "negative" readings are possible if the analyzer measures a cleaner sample when in service.

c. 0-20 or 0-200 range - For calibrating on the 0-20 or 0-200 range only one gas standard is required. Turn the function switch to the range position and note the meter reading. Adjust the SPAN control setting as required to read the ppm concentration of the standard. Recheck the zero setting (step b.). If readjustment is needed, repeat step c. This gives a two-point calibration; zero and the gas standard point. Additional calibration points can be generated by dilution of the standard with zero air if desired (see Section 8).

d. 0-2000 range - For calibrating on the 0-2000 range, use of two standards is recommended as cited in Section 3.2a. First calibrate with the higher standard using the SPAN control for setting. Then calibrate with the lower standard using the ZERO adjustment. Repeat these several times to ensure that a good calibration is obtained. The analyzer will be appoximately linear to better than 600 ppm, (see Figure 3-2). If the analyzer is subsequently to be used on the 0-20 or 0-200 range, it must be recalibrated as described in steps b. and c. above.

e. Lamp cleaning - If the span setting resulting from calibration is 0.0 or if calibration cannot be achieved, then the lamp must be cleaned (see Section 5.2).

f. Lamp replacement - If the lamp output is too low or if the lamp has failed, it must be replaced (see Section 5.3).

## 3.5 CALIBRATION CHECKING

Rapid calibration checking in the field can be accomplished by use of a small disposable cylinder containing isobutylene. Immediately after a calibration has been completed, a reading is taken on a special isobutylene standard. This provides a reference concentration measurement for later checking in the field. This can be done at any time with a portable cylinder containing this same special standard, using this reference reading as a check, and making adjustments to the analyzer if necessary. In effect, this is an indirect method of calibration, one maintaining the calibration to give direct readings for the original gas mixture, but using the portable isobutylene cylinder. Details are given in Section 8.2 of the Appendix.

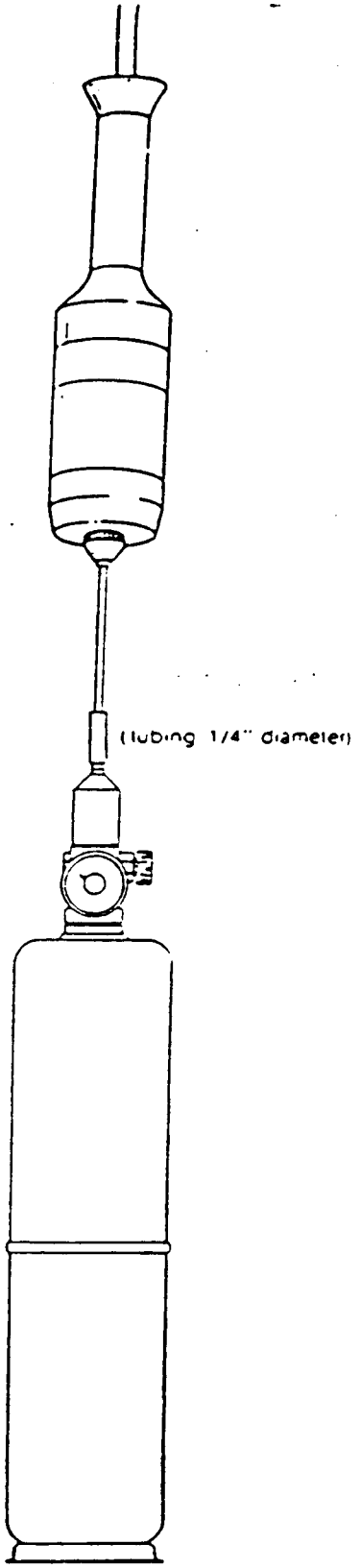
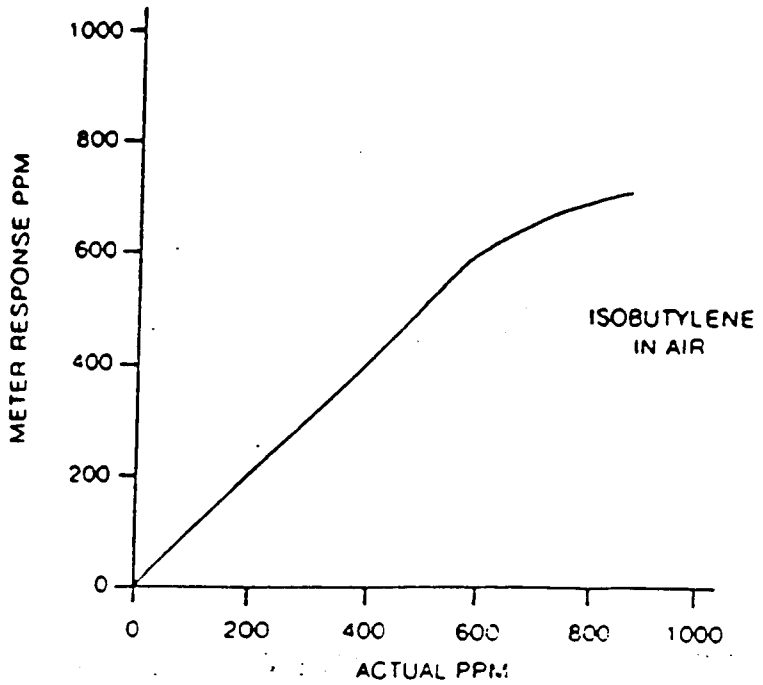



**FIGURE 3-1**
**CALIBRATION TEST SET UP**



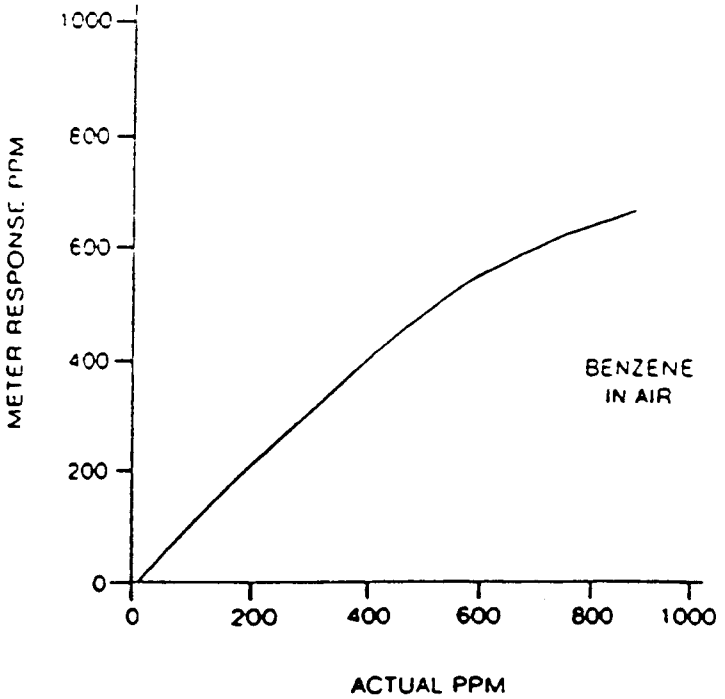




FIGURE 3-2
TYPICAL CALIBRATION CURVES (10.2 eV)

MSA MODEL 361

HYDROGEN SULFIDE, COMBUSTIBLE GAS, AND OXYGEN ALARM

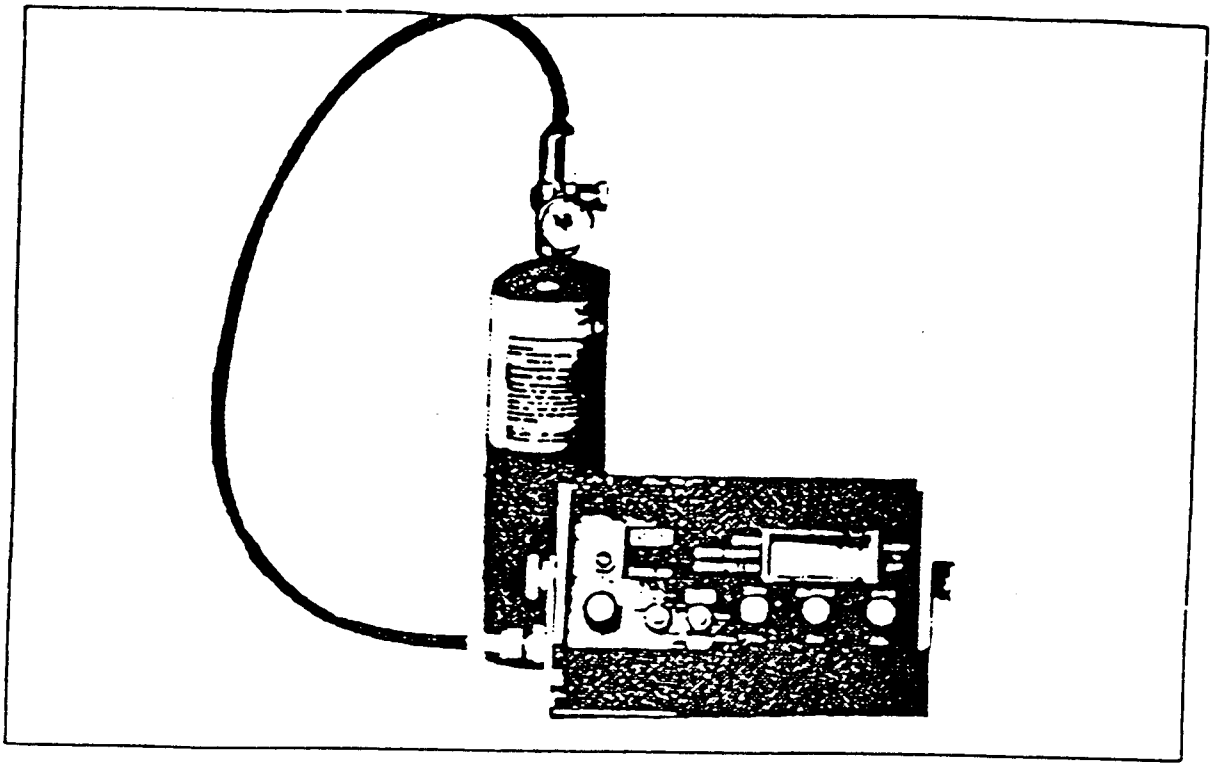


Figure 11. Model 360 or 361 with Calibration Equipment

11. Connect the adapter-hose fitting to the inlet of the instrument; after approximately 2 minutes, the TOX readout should stabilize and indicate between 275 and 325 ppm. If the indication is not in the correct range, remove the right end of the indicator and adjust the TOX SPAN control to obtain 300ppm.

12. Disconnect the adapter-hose fitting from the instrument.

13. Close the flow control valve.

14. Remove the adapter-hose from the flow control.

15. Remove the flow control from the calibration gas tank.

MODEL 361 CALIBRATION
(USING MODEL RP CALIBRATION CHECK KIT, FIGURE 11)

1. Attach the flow control to the .75% pentane/15% oxygen calibration gas tank.

2. Connect the adapter-hose to the flow control.

3. Open the flow control valve.

4. Connect the adapter-hose fitting to the inlet of the instrument; within 30 seconds, the LEL meter should stabilize and indicate between 47 and 55%. If the indication is not in the correct range, remove the right end of the indicator and adjust the LEL SPAN control to obtain 50%

5. Verify the oxygen reading; it should be between 13 and 17%.

6. Disconnect the adapter-hose fitting from the instrument.

7. Close the flow control valve.

8. Remove the flow control from the calibration gas tank.

9. Attach the flow control to the 10 ppm hydrogen sulfide calibration gas tank (40 ppm gas may be used; the choice of $H_2S$ calibration gas will depend upon concentrations anticipated in the workplace).

10. Open the flow control valve.

11. Connect the adapter-hose fitting to the inlet of the instrument; after approximately 1 minute, the TOX readout should stabilize and indicate between 7 to 13 ppm (35 to 45 ppm for 40 ppm $H_2S$). If the indication is not in the correct range, remove the right end of the indicator and adjust the TOX SPAN control to obtain 10 ppm (40 ppm for 40 ppm $H_2S$).

12. Disconnect the adapter-hose fitting from the instrument.

13. Close the flow control valve.

14. Remove the adapter-hose from the flow control.

15. Remove the flow control from the calibration gas tank.

CAUTION

Calibration gas tank contents are under pressure. Do not use oil, grease or flammable solvents on the flow control or the calibration gas tank. Do not store calibration gas tank near heat or fire, nor in rooms used for habitation. Do not throw in fire, incinerate or puncture. Keep out of the reach of children. It is illegal and hazardous to refill this tank. Do not attach any gas tank other than MSA calibration tanks to the flow control.

# MODEL 361 $H_2S$ RESPONSE TO INTERFERANTS

| Interferant | Interferant Concentration (PPM) | Sensor Response (PPM) |
|---|---|---|
| Ammonia | 100 | 0 |
| Benzene | 17.7 | 0 |
| Carbon Dioxide | 5000 | 0 |
| Carbon Disulfide | 14.5 | 0 |
| Carbon Monoxide | 100 | 0 |
| Chlorine | 5 | 0 |
| Dimethyl Sulfide | 4.5 | 0 |
| Ethylene | 50 | 0 |
| Freon 12 | 1000 | 0 |
| Hexane | 500 | 0 |
| Hydrogen | 500 | 1 |
| Hydrogen Cyanide | 42 | 0 |
| Hydrogen Sulfide | 40 | 40 |
| Isopropanol | 50 | 0 |
| Mercaptan | | |
| Ethyl | 44 | 3 |
| Methyl | 5 | 5 |
| Methane | 50,000 | 0 |
| Methanol | 50 | 0 |
| Nitric Oxide | 100 | 2 |
| Nitrogen Dioxide | 100 | -8 |
| Sulfur Dioxide | 150 | 5 |

# CONVERSION FACTORS

| Chemical | Conversion Factor |
|---|---|
| Acetone | 1.0 |
| Acetylene | 0.8 |
| Benzene | 1.1 |
| Iso-Butane | 1.0 |
| n-Butane | 1.0 |
| Butadiene | 0.8 |
| Butene-1 | 1.0 |
| Carbon Monoxide | 0.6 |
| Ethane | 0.7 |
| Ethyl Acetate | 1.1 |
| Ethyl Alcohol | 1.0 |
| Ethylene | 0.8 |
| Ethylene Oxide | 0.9 |
| Ethyl Ether | 1.1 |
| Gasoline | 1.0 |
| Heptane | 1.1 |
| Hexane | 1.3 |
| Hydrogen | 0.6 |
| Methane | 0.6 |
| Methyl Alcohol | 0.7 |
| Methyl Ethyl Ketone | 1.6 |
| Pentane | 1.0 |
| Propane | 0.9 |
| Propylene | 1.0 |
| Propylene Oxide | 1.0 |
| Iso Propyl Alcohol | 1.1 |
| Tetrahydrofuran | 0.8 |
| Toluene | 1.2 |

***EXAMPLE:***

*When a Model 360 or Model 361, calibrated on Pentane, is used to test for propane, the conversion factor is 0.9. If the meter reads 50% LEL, the true propane concentration is:*

*(50% x 0.9) or 45% LEL*