DEPARTMENT OF THE AIR FORCE

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

0 9 OCT 1998

ENTERED

Col James A. Thomas III
Commander, 27th Support Group
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Cannon AFB NM 88103-5323

Mr. Benito J. Garcia, Chief
Hazardous and Radioactive Materials Bureau
New Mexico Environment Department
2044 Galisteo Street
P.O. Box 26110
Santa Fe NM 87502

OCT 1998 RECEIVED

Dear Mr. Garcia

On behalf of Colonel Thomas, 27th Support Group Commander, I am forwarding for your review and approval the attached Corrective Measures Study Work Plan for Installation Restoration Site SD-11, Solid Waste Management Units 86-90, at Cannon AFB. The prescribed field work is scheduled to be performed starting in October 1998.

If you have any question regarding this plan, please call Mr. John Pike at (505) 784-1092 or Mr. Sanford Hutsell at (505) 784-6378 of my environmental staff.

Sincerely

Jeffrey L. Parker

JEFFREY PARKER, Lt Col, USAF
Deputy Commander, 27th Support Group

Attachment:
Final Work Plan

cc:
NMED w/o attachment (C. Will)
NMED GW Bureau (J. Jacobs)
EPA Region VI (D. Neleigh)
EPA Region VI (B. Sturdivant)
HQ ACC/CEVRW (M. Patterson)

FINAL

WORK PLANS

- Corrective Measures Study Work Plan
- Field Sampling Plan
- Quality Assurance Project Plan Addendum
- Site Safety and Health Plan Addendum

SWMUs 86 - 90 (SITE SD-11)
CANNON AFB, NEW MEXICO

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

August 1998

These Work Plans are specifically for work associated with the Corrective Measures Study (CMS) being completed for SWMUs 86 - 90 (Site SD-11) at Cannon AFB, New Mexico. In support of the CMS, additional fieldwork is being completed.

This document is organized and tabbed as follows:

- CMS Work Plan
- Field Sampling Plan (FSP)
- Quality Assurance Project Plan (QAPP) Addendum
- Site Safety and Health Plan (SSHP) Addendum
- References
- Appendix A - Standard Operating Procedures
- Appendix B - EPA Region VI Media-Specific Screening Levels

The CMS Work Plan provides the Cannon AFB facility description, site background for SWMUs 86 - 90 and discusses the objectives and approach for completing the Corrective Measures Study. The FSP and associated QAPP Addendum, SSHP Addendum and SOPs provide directions for completing the fieldwork. Additional sampling and analysis is being completed to further define site contamination. EPA Region VI MSSLs are being used for human health evaluations following the Risk-Based Corrective Action (RBCA) process being used as discussed in the CMS Work Plan.

FINAL

CORRECTIVE MEASURES STUDY WORK PLAN AT SWMUs 86 - 90 (SITE SD-11) CANNON AFB, NEW MEXICO

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

August 1998

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Appendix A	Standard Operating Procedures
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ACC	Air Combat Command
AFB	Air Force Base
AGE	Aerospace Ground Equipment
ARAS	Applicable or Relevant and Appropriate Standard
bgs	below ground surface
B.P.	Before Present
BRA	Baseline Risk Assessment
BTEX	Benzene, toluene, ethylbenzene, and xylenes
CEC	Cation Exchange Capacities
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CMP	Corrugated Metal Pipe
CMS	Corrective Measures Study
CO_2	Carbon dioxide
COC	Chemicals of concern or chain of custody
CRQL	Contract Required Quantitation Limit
DQCR	Daily Quality Control Report
DQO	Data Quality Objectives
EPA	Environmental Protection Agency
EPFC	Exposure Pathway Flow Chart
ES	Engineering Science
FS	Feasibility Study
HQ	Hazard Quotient
HSA	Hollow-stem auger
HSWA	Hazardous and Solid Waste Management Act
ID	Inside Diameter
IRP	Installation Restoration Program
MCL	Maximum Contaminant Level
MCLGs	Maximum Contaminant Level Goals
MS	Matrix spike
MSD	Matrix spike duplicate
msl	Mean sea level
MW	Monitoring Well
NMED	New Mexico Environment Department
NPDES	National Pollutant Discharge Elimination System
NWR	National Wildlife Refuge
OD	Outside Diameter
OERA	Old Entomology Rinse Area
OVA	Organic Vapor Analyzer
OWS	Oil/water separator
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated Biphenyls
PVC	Polyvinyl Chloride
QA/QC	Quality assurance/quality control
QAPP	Quality Assurance Project Plan

QCSR	Quality Control Summary Report
RBC	Risk-based concentration
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RI	Remedial Investigation
RSI	Remediation Services Incorporated
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SMCLs	Secondary Maximum Contaminant Levels
SOP	Standard Operating procedure
SVOC	Semivolatile organic compound
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TBC	To Be Considered
TCL	Target Compound List
TDS	Total Dissolved Solids
T/E	Threatened/endangered
TFW	Tactical Fighter Wing
TIC	Tentatively Identified Compounds
TPH	Total petroleum hydrocarbons
TRPH	Total recoverable petroleum hydrocarbons
U.S.	United States
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USCS	Unified Soil Classification System
UST	Underground storage tank
UTL	Upper tolerance limit
VOC	Volatile organic compound
VSI	Visual Site Inspection
W-C	Woodward-Clyde
WHA	Walk-Haydel Associates

UNITARY ABBREVIATIONS

C	cesius
CFU/g	Colony Forming Units per gram
cm	centimeter
cm/sec	centimeters per second
cm/yr	centimeters per year
F	Fahrenheit
ft	feet
gal/ft	gallons per foot
gpm	gallons per minute

hr	hour
km/hr	kilometers per hour
kg	kilogram
L/min	liters per minute
m/yr	meters per year
mg	milligram
mg/kg	milligrams per kilograms
mg/L	milligrams per liter
m^3/m	cubic meters per meter
mm	miles per hour
NTUs	Nephlometric Turbidity Unit
ppm	parts per million
%R	percent recoveries
RfD	reference dose
µg/kg	micrograms per kilogram
yr or y	year

1.1 PURPOSE AND SCOPE

This Corrective Measures Study Work Plan (CMSWP) describes the activities to be completed at the Installation Restoration Program (IRP) Site SD-11 at Cannon Air Force Base (AFB) near Clovis, New Mexico. IRP Site SD -11 includes the Appendix I Solid Waste Management Units (SWMUs) 86 - 90. The purpose of the CMS is to develop and evaluate Corrective Measures Alternatives and to recommend the selected final Corrective Measure(s). A regional map showing the location of Cannon AFB is shown in Figure 1-1. A map of Cannon AFB and the location of SWMUs 86 - 90 (Site SD-11) are shown in Figure 1-2.

Section 2 of the CMSWP provides a facility description of Cannon AFB. Section 3 discusses the site background for SWMUs 86 - 90. Section 4 discusses the CMS objectives, approach, and decision process. In addition to the CMSWP, the documents required to complete the CMS include: the Field Sampling Plan (FSP), Quality Assurance Project Plan (QAPP) Addendum, and Site Safety and Health Plan (SSHP) Addendum. Appendix A contains the standard operating procedures (SOPs). The EPA Region VI Human Health Media-Specific Screening Levels are presented in Appendix B.

1.2 REGULATORY FRAMEWORK

SWMUs 86 - 90 are identified as Appendix I SWMUs in Cannon's RCRA permit. The CMSWP follows the general guidance/requirements listed in the RCRA permit.

1.3 SCHEDULE

The schedule for activities associated with the CMS to be completed at SWMUs 86 - 90 (Site SD-11) at Cannon AFB are presented in Figure 1-3.

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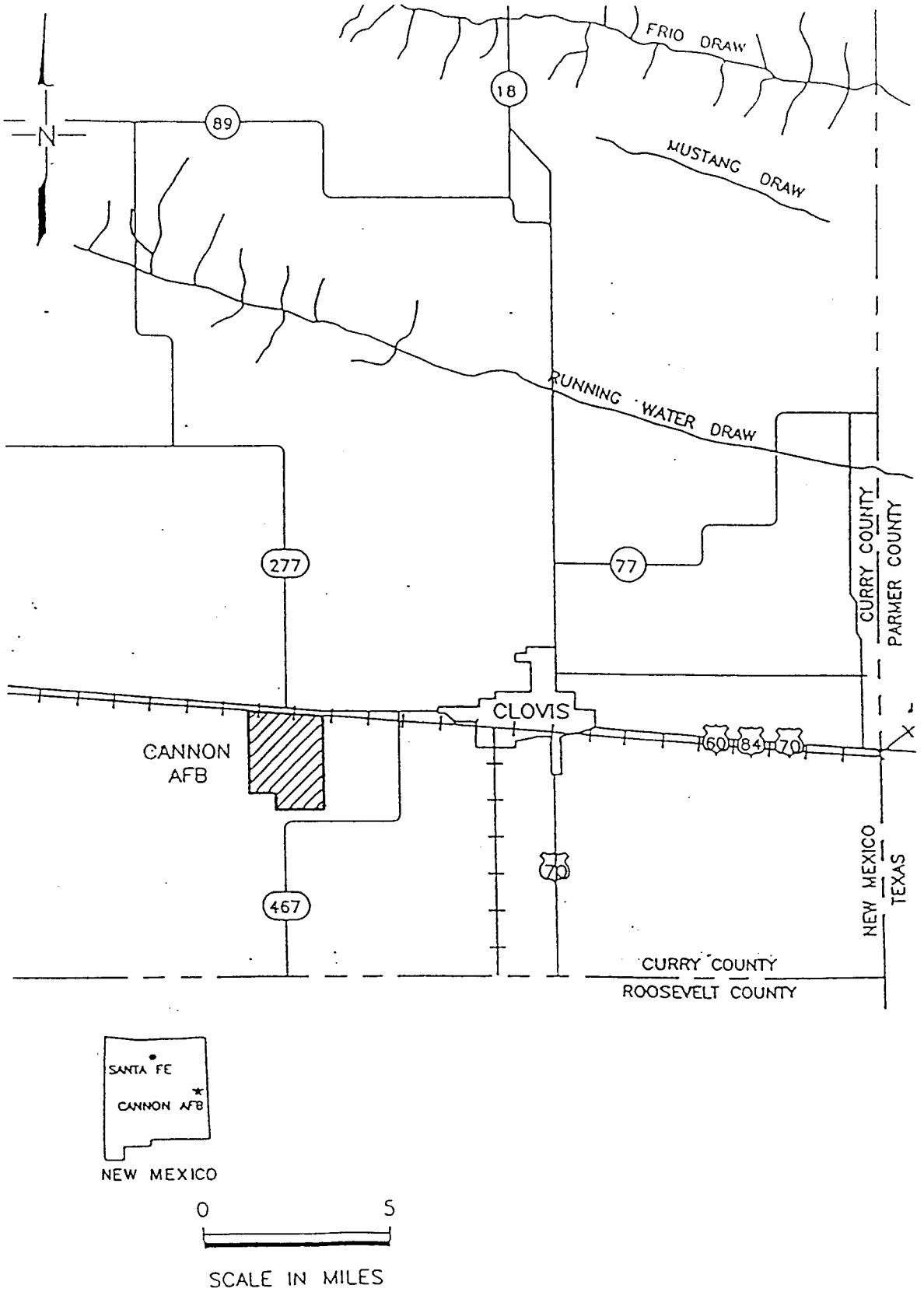

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DRN. BY: TSSM	DATE: 06/01/98	REGIONAL MAP CANNON AIR FORCE BASE NEW MEXICO	PROJECT No.	FIG. No.
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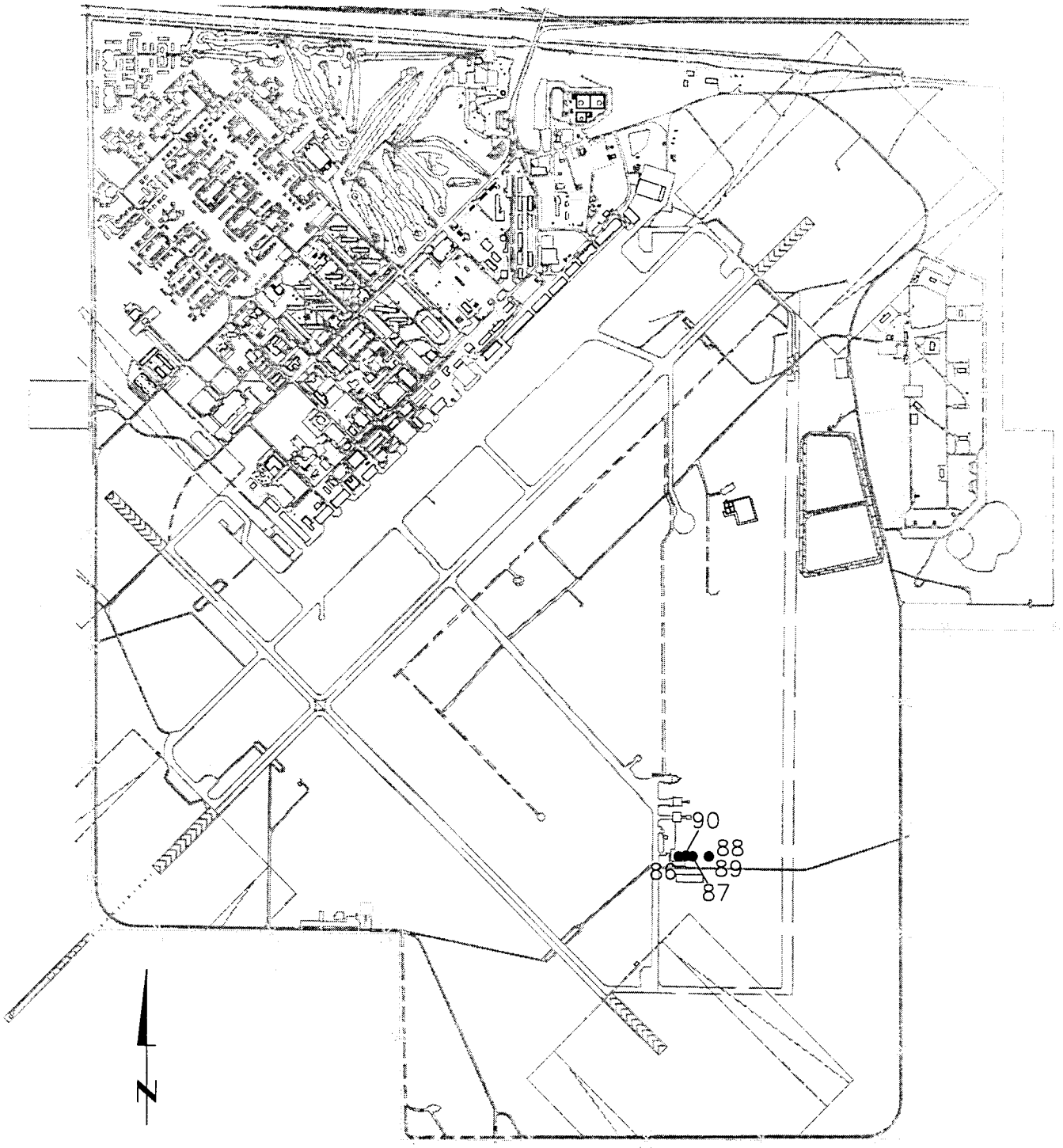
LEGEND

3 ● SOLID WASTE MANAGEMENT UNIT (SWMU) LOCATION AND NUMBER

SWMU No.	DESIGNATED AREA
86	SD-11 ENGINE TEST CELL
87	SD-11 FORMER OVERFLOW PIT
88	SD-11 FORMER LEACHING FIELD
89	SD-11 EVAPORATION POND
90	SD-11 OIL/WATER SEPARATOR No. 5114



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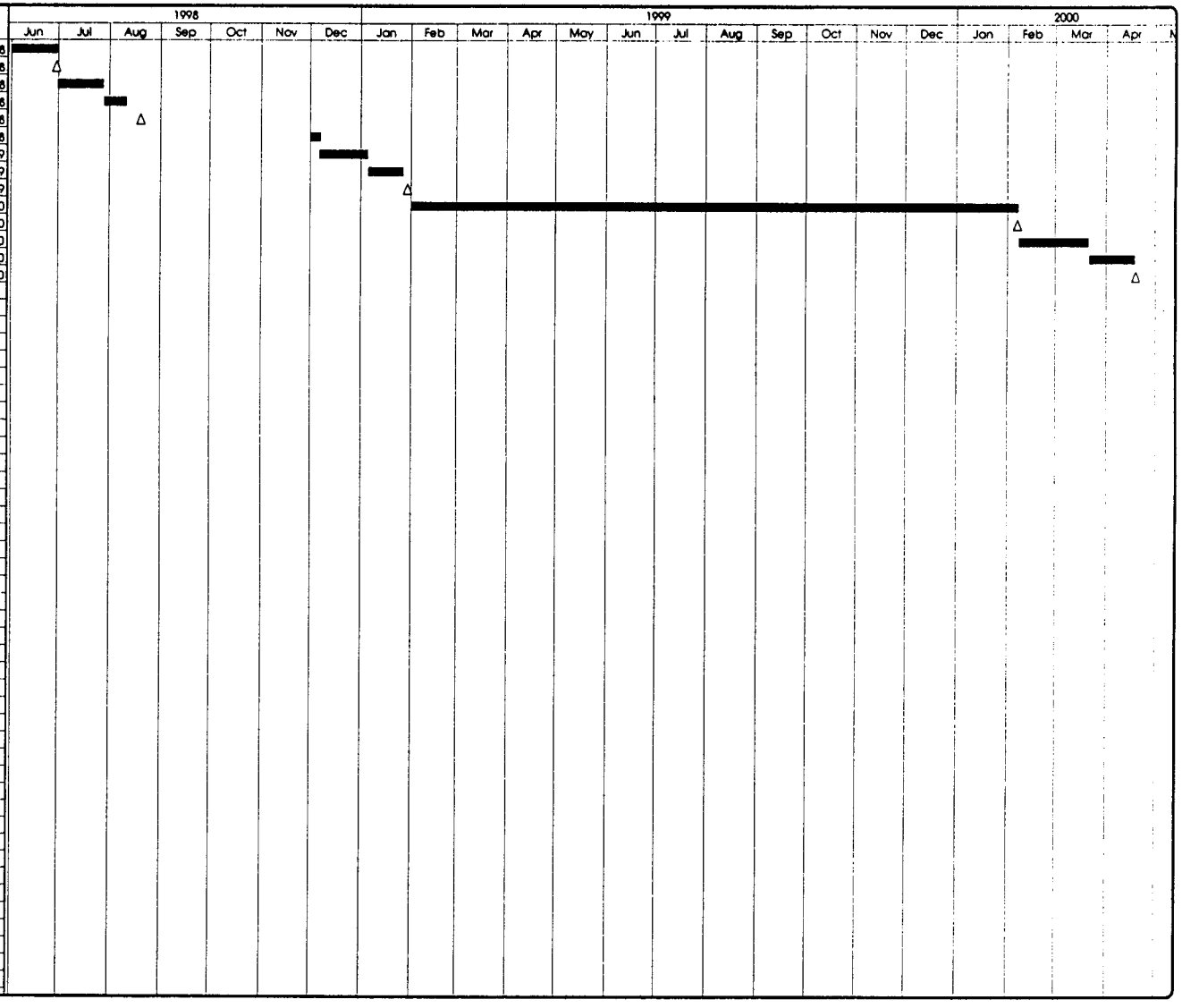
Drawing: T:\CANNON\M9602V\T3200\FIG1-2.DWG (TSM)
Xrefs: CAN-BASE.DWG

DRN. BY: TSSM	DATE: 08/20/98	APPENDIX 1 SWMUs 86-90 (SITE SD-11) LOCATION PLAN CANNON AIR FORCE BASE CLOVIS, NEW MEXICO	PROJECT NO.	FIG. NO.
CHK'D. BY:	REVISION: 0		M9602V	1-2

version 2.0 Fig 1-3

Figure 1-3 ESTIMATED SCHDULE
CORRECTIVE MEASURES STUDY
SWMUs 86-90 (SITE SD-11)

Task Name	Duration	Start	End
Project Planning	20.00 d	Jun/03/98	Jun/30/98
Issue Draft CMS Work Plans	0.00 d	Jun/30/98	Jun/30/98
Review and Comments	20.00 d	Jul/01/98	Jul/28/98
Revise Draft CMS Work Plans	10.00 d	Jul/29/98	Aug/11/98
Issue Final CMS Work Plans	0.00 d	Aug/20/98	Aug/20/98
Field Work	5.00 d	Dec/01/98	Dec/07/98
Chemical Analysis	20.00 d	Dec/07/98	Jan/05/99
Data Review and Validation	15.00 d	Jan/06/99	Jan/27/99
Issue QCSR	0.00 d	Jan/30/99	Jan/30/99
Report Preparation	260.00 d	Feb/01/99	Feb/07/00
Issue Draft CMS Report	0.00 d	Feb/07/00	Feb/07/00
Review and Comments	30.00 d	Feb/08/00	Mar/21/00
Revise Draft CMS Report	20.00 d	Mar/22/00	Apr/18/00
Issue Final CMS Report	0.00 d	Apr/19/00	Apr/19/00



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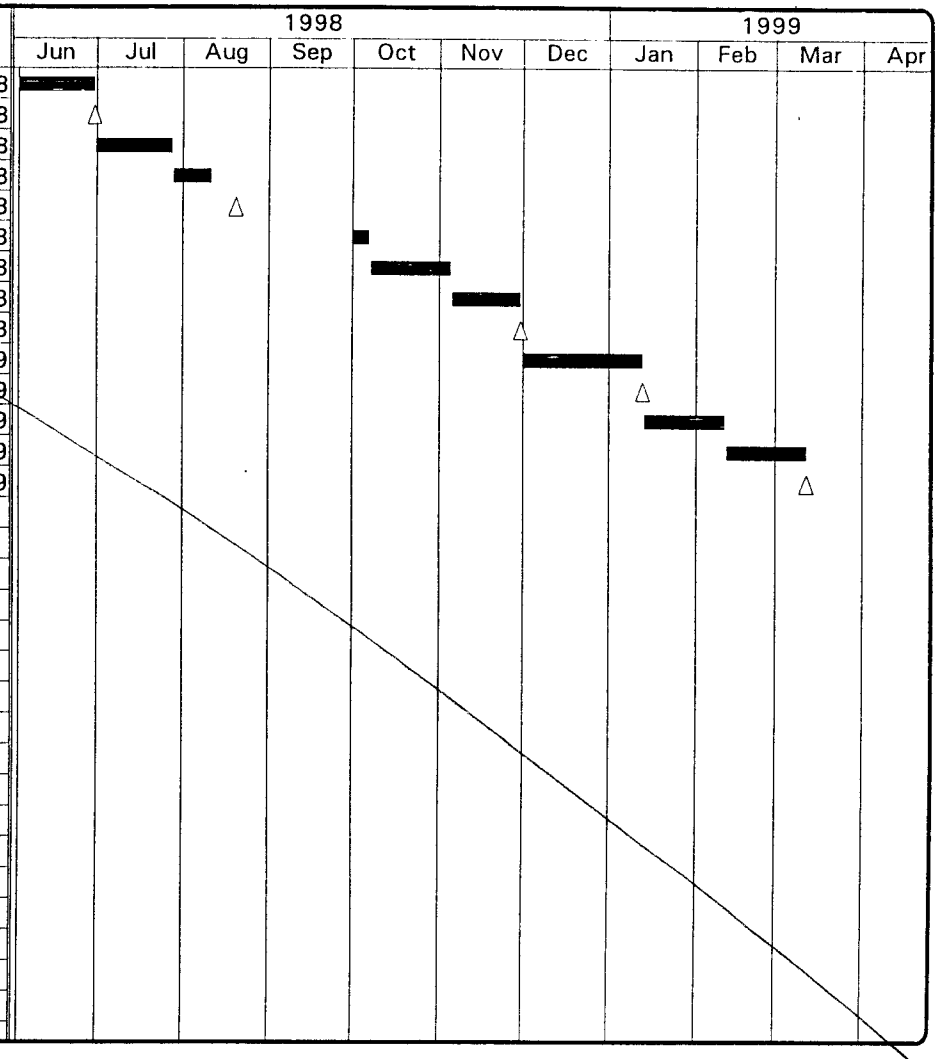
Page 1

Milestone Δ Summary ▬
Fixed Delay

version 1.0 Fig 1-3
replaced with 2.0 Fig 1-3

FIGURE 1-3 ESTIMATED SCHEDULE CORRECTIVE MEASURES STUDY SWMUs 86-90 (SITE SD-11)

Task Name	Duratio	Start	End
Project Planning	20.00 d	Jun/03/98	Jun/30/98
Issue Draft CMS Work Plans	0.00 d	Jun/30/98	Jun/30/98
Review and Comments	20.00 d	Jul/01/98	Jul/28/98
Revise Draft CMS Work Plans	10.00 d	Jul/29/98	Aug/11/98
Issue Final CMS Work Plans	0.00 d	Aug/20/98	Aug/20/98
Field Work	5.00 d	Oct/01/98	Oct/07/98
Chemical Analysis	20.00 d	Oct/08/98	Nov/05/98
Data Review and Validation	15.00 d	Nov/06/98	Nov/30/98
Issue Quality Control Summary Report	0.00 d	Nov/30/98	Nov/30/98
Report Preparation	30.00 d	Dec/01/98	Jan/13/99
Issue Draft CMS Report	0.00 d	Jan/13/99	Jan/13/99
Review and Comments	20.00 d	Jan/14/99	Feb/11/99
Revise Draft CMS Report	20.00 d	Feb/12/99	Mar/12/99
Issue Final CMS Report	0.00 d	Mar/12/99	Mar/12/99



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Milestone △ Summary ▬
Fixed Delay

2.1 SETTING - 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. Elevations in the eastern New Mexico portion of the Llano Estacado exceed 4,000 feet above mean sea level (msl). In the vicinity of Cannon AFB, elevations range from 4,250 feet to 4,350 feet above 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. These are second-order streams. Both streams are very straight, flow southeast, and have rectilinear drainage patterns with short laterals (W-C 1991).

2.2 DEMOGRAPHICS AND LAND USE NEAR CANNON AFB

Cannon AFB is located just south of U.S. Highway 60-84 in a farming and ranching area (Figure 1-1). 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 to be 4,650 in 1990 (W-C 1991).

2.3 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 12°C (39°F) to a July high of 26°C (78°F). Extreme daily temperatures range from -24°C (-11°F) to 41°C (106°F) (Lee Wan and Associates 1990). Average monthly precipitation ranges from 1 cm (0.4 inches) in winter to 6.9 cm (2.7 inches) in July. The maximum recorded 24-hour rainfall is 12.2 cm (4.8 inches), which occurred in August. Rainfall occurs on eight or more days

per month during the summer precipitation maximum. Mean annual precipitation is approximately 41 cm (16 inches). The mean annual evapotranspiration rate is 181.4 cm/yr (71.4 inches/yr) (Lee Wan and Associates 1990). Prevailing winds are from the west at an average of 5 km/hr (3.1 mph) during fall, winter, and spring. During the summer, winds are from the south at an average of 3.7 km/hr (2.3 mph).

The atmosphere around the area of 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 heat loss from the ground, producing surface-based temperature inversions. After sunrise, these inversions break up, and solar heating of the earth's surface causes vertical mixing in the atmosphere.

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 (average 5 km/hr) (W-C 1991).

2.4 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 as shown in Figure 2-1.

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 1990).

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. Paleo valleys in the post-Triassic unconformity are deep and trend dominantly east-west. Ogallala thickness may thus vary significantly over short north-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 (1990), data suggest that some Quaternary warping may have occurred; however, most of the structures are well to the northwest and southwest of Cannon AFB. No faults or buried structural lineaments are known 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 as 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 1990). As reported by Lee Wan and Associates (1990), five zones have been distinguished within the Ogallala of east central New Mexico on the basis of clay minerals. Smectites (montmorillonites) and attapulgite (with sepeotite) 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 throughout. A generalized geologic section at Cannon AFB is shown in Figure 2-1. 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 precipitates 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. As reported in Lee Wan and Associates (1990) radiocarbon dates for the upper "climax" caliche range from -27,000 yr. Before Present (B.P.) to -42,000 yr. B.P.

Caliche is relatively soluble in acidic water (pH < 7) or in waters containing dissolved CO_2. The top surface of the upper "climax" 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 (consisting of spherical concentrically laminated aggregates 1 to 10 mm in diameter, (Lee Wan and Associates 1990). The pisolites are thought to have formed as the caliche was repeatedly chemically-weathered and

brecciated during Pleistocene pluvials (wet climate episodes) and later recemented during drier intervals. This upper caliche crops out 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 may be thin or absent below playas (W-C 1991).

2.5 HYDROGEOLOGY

The lower portion of the Ogallala Formation is the primary regional aquifer for both potable and irrigation water. No deeper aquifers are utilized 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. The Ogallala is a water table, or unconfined, aquifer (Lee Wan and Associates 1990). The Ogallala aquifer has a southeasterly regional gradient of about 13 feet/mile. Well yields vary from less than one gallon per minute (gpm) in thin silts and sands, and up to 1,600 gpm in thick sands and gravels (Lee Wan and Associates 1990). Water quality is generally good, with hardness and fluorides being somewhat high (Lee Wan and Associates 1990).

At Cannon AFB, the depth to groundwater is greater than 200 feet, and the Ogallala aquifer has an average saturated thickness of 120 feet based on mid-1960s 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 7.5 feet/mile (Lee Wan and Associates 1990). Figure 2-2 shows water table elevation contours for 1984. 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 776 L/min (205 gpm) to 4,353 L/min (1150 gpm). Specific capacities range from 0.14 m^3/m (11.4 gal/ft) to 0.35 m^3/m (27.9 gal/ft) (Lee Wan and Associates 1990).

Very rough estimates of hydraulic conductivity were made from well pump tests in water wells 5 and 9 (Figure 2-3) 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 1990). 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 found to be approximately 2.0×10^{-3} cm/sec. Calculations for water well 8 resulted in a hydraulic conductivity of 2.0×10^{-2} cm/sec. In addition, slug testing of two monitoring wells (MW-O and MW-N) was done by Woodward-Clyde in February 1995 (W-C 1995a). The estimated hydraulic conductivities from these slug tests were both 3×10^{-3} cm/sec. These estimates appear to be low when compared to published hydraulic conductivity data for sands and gravels. As reported in Lee Wan and Associates (1990) a groundwater flow velocity of about 45 m/yr (150 ft/yr) has been estimated.

This calculates out to a hydraulic conductivity of approximately 1.0×10^{-1} cm/sec. Again, this appears to be low when compared with published data (Freeze and Cherry 1979).

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 1990) indicated that interstitial and interstratified clays are abundant in the Ogallala Formation.

Recharge to the Ogallala is primarily through precipitation. As reported in Lee Wan and Associates (1990), a recharge rate of 0.5 inches/year was calculated using the Theis equation. Lee Wan and Associates (1990) reported that the recharge rate may be as much as 1.0 inches/yr. Due to the high evapotranspiration rate and low precipitation, recharge probably 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 may allow deep percolation to the aquifer. The occurrence of this process is evidenced by the presence of clay deposits in, and thin or nonexistent caliche layers 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 of the formation. 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 the rate of recharge. Water levels in the Ogallala have declined steadily from the 1930s to the present. A decline of 50 to 100 feet has been observed in the area around Clovis, New Mexico for the period from the 1930s to 1980. Lee Wan and Associates (1990), states "the largest area of water level decline exceeding 100 feet occurs south of the Canadian River extending from Curry Co., New Mexico to Crosby Co., 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 of which provide only irrigation water (Figure 2-3).

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 (W-C 1991).

2.6 SOILS

Soils in the vicinity of Cannon AFB are classified as SM to SC under the Unified Classification Systems, and as aridisols (calciorthids) under the Soil Conservation Service Comprehensive Soil

Classification System. The following summary is based on the Soil Conservation Service Curry County Soil Survey as reported in Lee Wan and Associates (1990).

The most common soil type on the Base is the Amarillo fine sandy loam, 0- to 2-percent slope phase (map symbol Ab) (Figure 2-4). 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 Amarillo fine sandy loam is present on all relatively flat surfaces at the Base, but is also found on slopes associated with playas (map symbol Ac).

Clovis fine sandy loams, 0- to 2-percent slope phase (map symbol Cb) and 2- to 5-percent slope phase (map symbol Cc), are very similar to Amarillo fine sandy loams. 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 M6) are found. Mausker fine sandy loams have no B horizons and are very calcareous. The calcic C horizon is within 2 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 (Lee Wan and Associates 1990).

2.7 BACKGROUND METALS CONCENTRATIONS IN SOIL AND WATER QUALITY

The natural soils in the vicinity of Cannon AFB are alkaline and rich in metals in general. Typically high concentrations of aluminum, iron, magnesium, manganese, and potassium combine with elevated levels of many other metals in the natural soils. Calcium is naturally present in the soils at levels up to nearly 200,000 mg/kg. Tightly cemented layers of "caliche" are present in several horizons in the natural soils and the Ogallala aquifer below.

The background levels of inorganic compounds in surface and subsurface soil at Cannon AFB are presented in Table 2-1 in the form of a mean value and statistical information on the ranges encountered for each element. Table 2-1 has been adapted from a final report by Woodward-Clyde dated September 1997 entitled "Concentrations of Inorganics and Background Concentrations of Pesticides at Cannon Air Force Base, New Mexico". This report summarizes background data for soil from numerous past investigations in the vicinity.

The mean values and upper tolerance limits (UTLs) presented in Table 2-1 are the background levels used in the screening of soil chemical results for this RFI. In addition to comparison to the UTL of the Base-wide background data (which is necessarily from a limited data set), other

sources of naturally-occurring metals concentrations, such as USGS (1984), were considered when determining whether metals concentrations are within background levels.

The groundwater quality at Cannon AFB 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). The general water quality from the Ogallala aquifer over a broad region is presented in Table 2-2, and water quality data for samples from production wells and monitoring wells within the bounds of Cannon AFB are presented in Table 2-3.

2.8 BIOLOGICAL RESOURCES

Land adjacent to Cannon AFB is primarily used for agriculture, and there is little natural vegetation remaining in the area. The wildlife species that are common to agricultural areas throughout the region include bobwhite quail and pheasant. There are a few playa lakes in the area; these 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 (W-C 1991).

2.8.1 Plant Resources

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 (W-C 1991).

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 witmanii*), 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 be present on the Base (Lee Wan and Associates 1990).

2.8.2 Wildlife Resources

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 utilize 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 2-4.

Within Curry County, the only state-protected bird that is expected 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 that may occur within Curry County are the McCown's Longspur and Baird's Sparrow. These two species have not been sighted regularly in recent years. 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 (Source: Draft Environmental Impact Statement - Cannon AFB 1990).

TABLE 2-1

SUMMARY OF BACKGROUND ELEMENTAL CONCENTRATIONS[1] IN SOIL SAMPLES[2] AT CANNON AFB, NEW MEXICO

	Mean (x)		Standard Deviation (s)		95% Upper Tolerance Limit of Background Concentrations (UTLs)	
Element	Surface Soil	Subsurface Soil	Surface Soil	Subsurface Soil	Surface Soil	Subsurface Soil
Aluminum	5,508	5,932	1,964	2,183	8,950	12,214
Antimony	ND (3)	ND (3)	ND (3)	ND (3)	3.15 (3)	16 (3)
Arsenic	2.1	2.1 (4)	0.48	0.96 (4)	3.6	4.3 (4)
Barium	100	210	165	199	670	890
Beryllium	0.35 (4)	0.35 (4)	0.13 (4)	0.17 (4)	0.78 (4)	0.73 (4)
Cadmium	ND (3)	ND (3)	ND (3)	ND (3)	0.435 (3)	1.3 (3)
Calcium	5,645	89,410	11,366	64,611	44,800	237,498
Chromium (total)	7.1	5.6	1.3	2.33	10.5	13.3
Cobalt	2.9	2.6 (4)	1.0	1.4 (4)	6.6	4.7 (4)
Copper	6.8	3.8 (4)	4.6	1.97 (4)	18.3	8.3 (4)
Iron	6,458	5,148	1,349	2,262	10,100	13,148
Lead	6.8	4.7	1.6	1.7	12	8.7
Magnesium	1,066	4,260	390	3,856	1,930	19,300
Manganese	139	83	51	50	307	333
Mercury	0.025 (4)	ND (3)	0.016 (4)	ND (3)	0.056 (4)	0.019 (3)
Nickel	5.5	5.9 (4)	1.6	2.41 (4)	11	14.9 (4)
Potassium	1,345	1,222	413	417	2,691	2,512
Selenium	ND (3)	0.47 (4)	ND (3)	0.31 (4)	0.26 (3)	1.1 (4)
Silver	— (5)	ND (3)	— (5)	ND (3)	0.4 (5)	2.65 (3)
Sodium	91	351 (4)	10	253 (4)	102	1,227 (4)
Thallium	ND (3)	ND (3)	ND (3)	ND (3)	0.6 (3)	2.65 (3)
Vanadium	14.9	16	2.8	5.2	23.3	32.8
Zinc	15.4	12.1	5.2	4.8	32.2	30.6

(1) All concentrations are in milligrams per kilogram (mg/kg).
(2) From report entitled "Naturally Occurring Concentrations of Inorganics and Background Concentrations of Pesticides at Cannon Air Force Base, New Mexico" (W-C 1997).
(3) All analytical sample were nondetect; therefore, a mean and standard deviation was not calculated. One-half the highest reporting limit is used as the 95% UTL. The actual mean, standard deviation, and UTL may be less than these values.
(4) Values determined from a data set including one-half of the reporting limits for nondetects.
(5) Silver was detected in only one sample; therefore, a mean and standard deviation was not calculated. The single detected concentration is used as the 95% UTL.

TABLE 2-2

REGIONAL WATER QUALITY[1] - OGALLALA AQUIFER[2]

	Sherman Co. Nebraska	Laramie Co. Wyoming	Red Willow Co. Nebraska	Kit Carson Co. Colorado	Kiowa Co. Colorado	Stanton Co. Kansas	Meade Co. Kansas	Union Co. New Mexico	Roberts Co. Texas	Gaines Co. Texas	Gaines Co. Texas	Mean ()
Silica	63	28	58	36	22	20	23	38	27	58	64	40
Calcium	94	45	56	30	228	51	63	56	46	72	231	88
Magnesium	14	5.5	15	10	114	20	19	34	18	20	225	45
Sodium and Potassium	21	6.4	19	27	226	35	245	17	37	44	845	138
Bicarbonate	336	157	200	181	184	180	210	215	243	221	282	219
Sulfate	18	6.5	13	10	1,170[5]	8.1	94	49	32	104	1,351[5]	260
Chloride	18	2.8	3.9	3.0	143	30	350[5]	46	28	43	1,109[5]	162
Fluoride	---	0.4	0.8	1.8	4.0[5]	1.4	1.0	1.6	0.8	1.5	4.0[5]	1.6
Nitrate	7.6	7.0	---	7.6	3.9	12[5]	1.7	24[5]	3.9	5.6	4.2	7.0
Dissolved Solids	403	191	273	214	2,140[5]	339	900[5]	372	312	507[5]	3,970[5]	875
pH[3]	7.7	7.4	7.7	8.0	7.7	7.6	7.7	7.4	8.0	7.3	7.4	7.6
Specific Conductance[4]	605	281	420	325	2,630	555	1,650	628	507	675	5,350	1,240

1) Concentrations are in milligrams per liter (mg/L) unless otherwise indicated
2) Source: Krothe, et al. 1982
3) pH units
4) Micro mhos (:mhos)
5) Exceed U.S. Environmental Protection Agency Regulations (1976, 1977)

TABLE 2-3

WATER QUALITY SUMMARY[1] FOR CANNON AFB PRODUCTION WELLS AND MONITORING WELLS

	Minimum	Maximum	Mean	MCL
Antimony	0.06U	0.06U	0.06[5]	0.006[2]
Arsenic	0.005U	0.05U	0.02[5]	0.053
Barium	0.022	0.2	0.50[5]	2[2]
Beryllium	0.002U	0.002U	0.002[5]	0.004[2]
Cadmium	0.005U	0.01U	0.0008[5]	0.005[2]
Chloride	42	63.5	52.2	250
Chromium	0.01U	0.001	0.04[5]	0.1[2]
Cobalt	0.01U	0.01U	0.01[5]	*
Copper	0.001U	0.02U	0.012[5]	1.34
Cyanide	0.005U	0.005U	0.005[5]	0.2[2]
Fluoride	1.8	2.6	2.3	4[2]
Lead	0.005U	0.05U	0.015[5]	0.015[4]
Manganese	0.00	0.01U	0.0075[5]	*[5]
Mercury	0.0002U	0.003	0.001[5]	0.002[2]
Nickel	0.04U	0.032	0.04[5]	0.14[2]
Nitrate	0.9	6.6	1.8	10.0[2]
Selenium	0.01UJ	0.0049J	0 0.01501[5]	0.05[2]
Silver	0.01U	0.05U	0.02[5]	*
Sulfate	115	132	125	500[6]
Thallium	0.01U	0.01U	0.01[5]	0.002[2]
Tin	0.1U	0.1U	0.1[5]	*
Uranium	0.0036	0.0062	0.0046	5.0[6]
Vanadium	0.02	0.031	0.026	*
Zinc	0.0041J	0.09	0.05	*[5]
TDS	385	479	451	500[7]
pH (units)	7.5	7.95	7.78	6.5-8.5[7]

MCL = Maximum contaminant level (USEPA 1996)
UJ = Estimated as nondetect at the CRQL
J = Estimated value
U = Not detected
CRQL = Contract-Required Quantitation Limit
* = No primary or secondary MCL or proposed MCL as of March 1992

[1] All concentrations are in milligrams per liter (mg/L). Values calculated from historical data for Cannon AFB wells 1, 2, 3, 4, 7, 8, 113A, and 101E for period from 1966 through 1991.
[2] Final MCL
[3] MCL under review
[4] Action level
[5] Listed for regulation
[6] Proposed MCL
[7] Final secondary MCL
Detection limits (using one times the value) were also used to calculate means.

TABLE 2-4

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

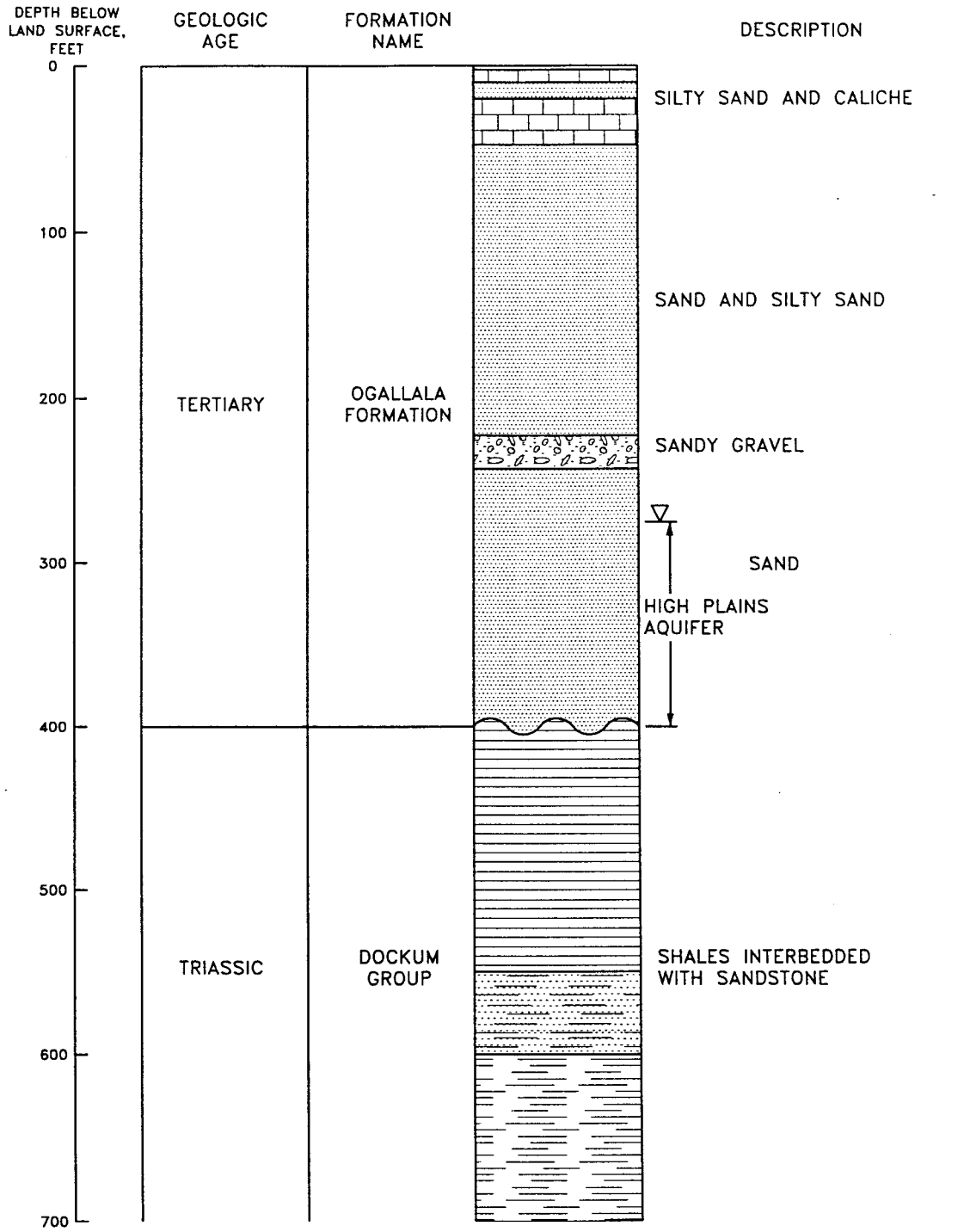
Common Name	Scientific Name	Federal Status	State Status
Birds			
Mississippi kite	*Ictinia mississippiensis*		Endangered (Group 2)
Barid's sparrow	*Ammodramus baridii*		Endangered (Group 2)
Bald eagle	*Haliaeetus leucocephalus*	Endangered	Endangered (Group 2)
Peregrine falcon	*Falco perigrinus*	Endangered	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: Lee Wan and Associates 1990



LEGEND

LITHOLOGIC CONTACT

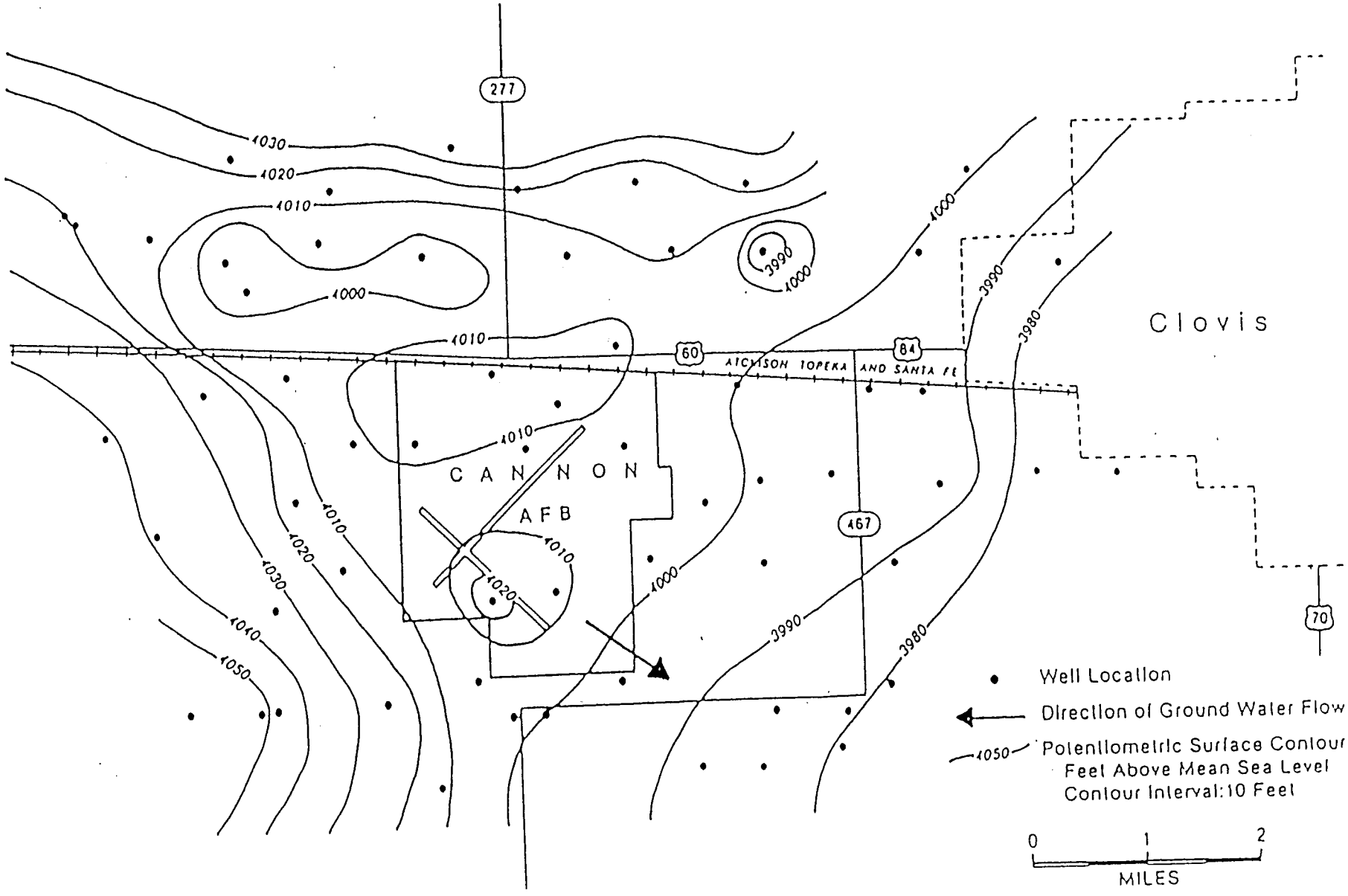
EROSINOAL UNCONFORMITY

WATER LEVEL

SOURCE: NODIFIED FROM GUTENTAG ET.AL., 1984

t:\cannon\m9602v\t3200\fig2-1.dgn

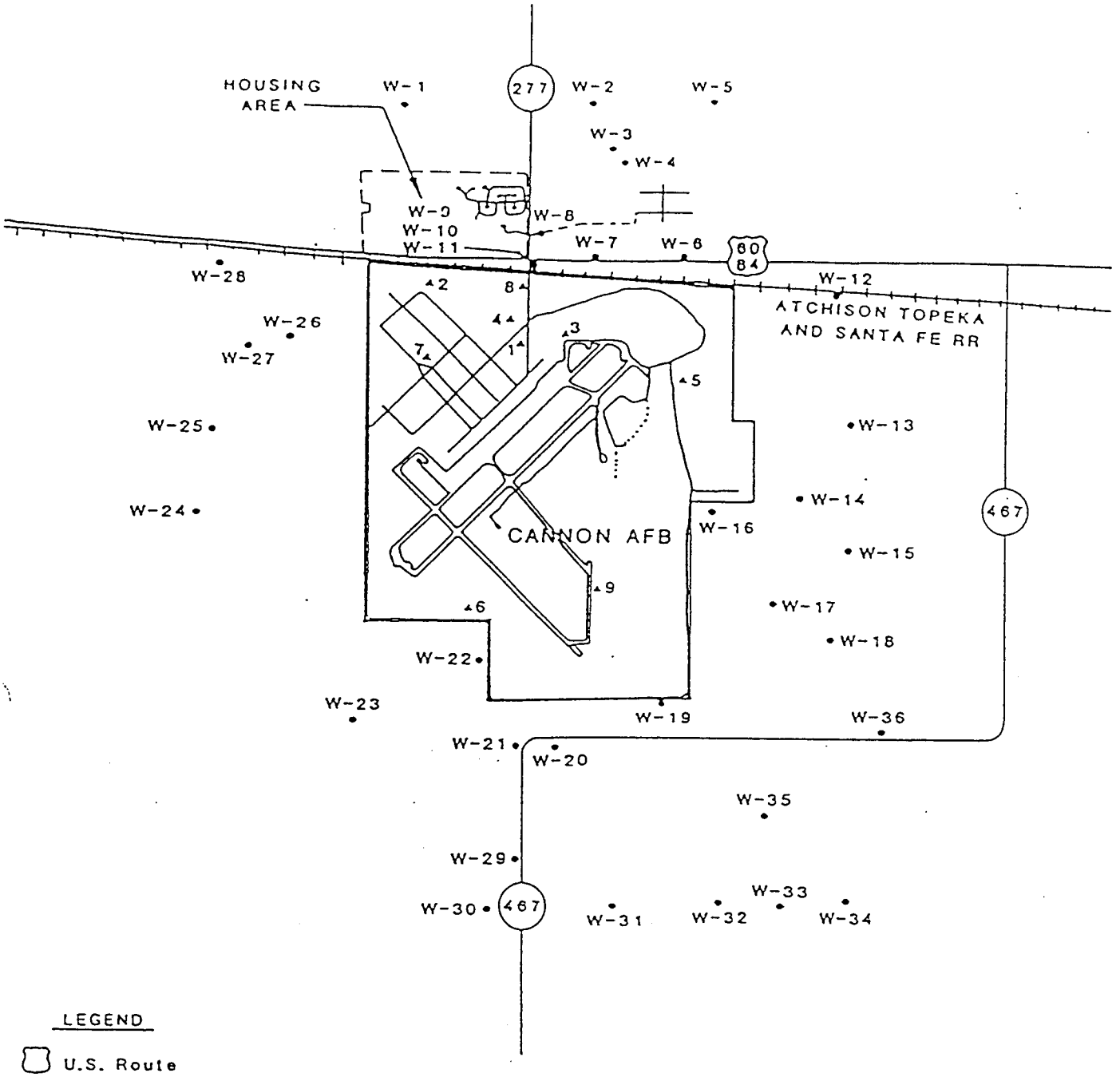
DRN BY TSSM	DATE 08/20/98	GENERALIZED GEOLOGIC STRATA AT CANNON AIR FORCE BASE NEW MEXICO	PROJECT NO. M9602V	FIG. No. 2-1
CHK'D BY	REVISION 0			



SOURCE: FINAL REPORT, IRP PHASE II

June 01, 1998 4:58:24 p.m.
Drawing: T:\TITLES\DY11X8.DWG (TSM)

DRN BY TSSM	DATE 06/01/98	POTENTIOMETRIC SURFACE CONTOUR MAP, VICINTY OF CANNON AIR FORCE BASE NEW MEXICO	PROJECT No.	FIG. No.
CHK'D BY	REVISIONS: 0		M9602V	2-2



LEGEND

- U.S. Route
- State Route
- Base Water Well
- Vicinity Water Well

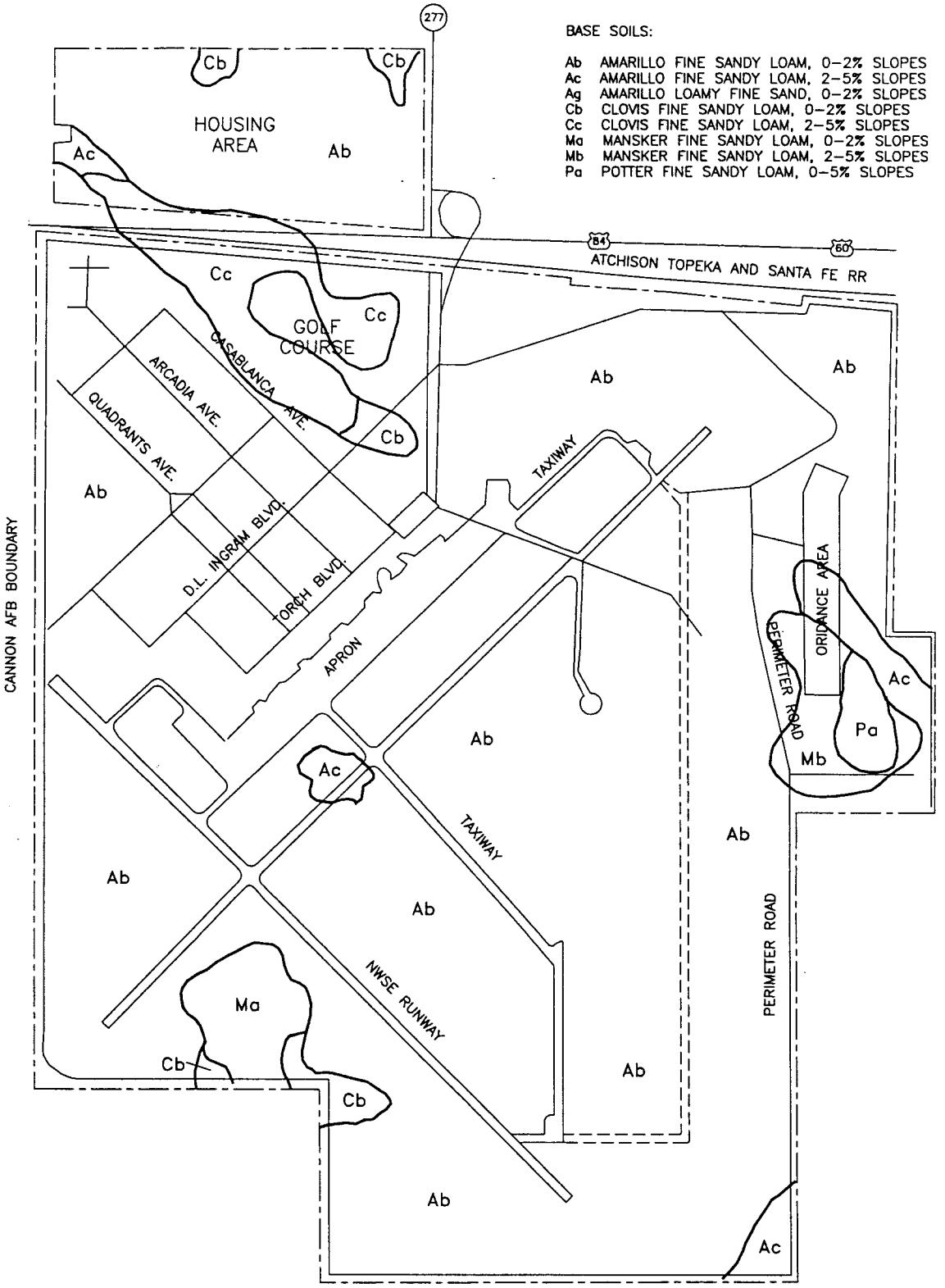
1 1/2 0 1 Mile

SCALE

BASE MAP ADAPTED FROM: FINAL REPORT, IRP PHASE II

June 01, 1998 4:50:01 p.m.
Drawing: T:\TITLES\DY8X11.DWG (TSM)

DRN. BY: TSSM	DATE: 06/01/98	WATER WELL LOCATIONS ON AND NEAR CANNON AIR FORCE BASE NEW MEXICO	PROJECT No.	FIG. No.
CHK'D. BY:	REVISIONS: 0		M9602V	2-3



SOURCE: USDA-S.C.S., SOIL SURVEY OF CURRY COUNTY N.M., 1958

August 20, 1998 11:07:43 a.m.
Drawing: T:\CANNON\M9602V\T3200\FIG2-4.DWG (TSM)

N

2000 1000 0 2000
SCALE IN FEET

DRN. BY: TSSM	DATE: 08/20/98	DISTRIBUTION OF SOILS, BY TYPE CANNON AIR FORCE BASE NEW MEXICO	PROJECT No.	FIG. No.
CHK'D. BY:	REVISIONS: 0		M9602V	2-4

3.1 SITE DESCRIPTION

Appendix I SWMUs 86-90 (Site SD-11) are located in the sparsely-populated southeast part of Cannon AFB, about 5,000 feet east and 2,000 feet south of the intersection of the two main runways (see Figure 1-1). The site consists of a former engine test cell (SWMU 86), former overflow pit (SWMU 87), former leach field (SWMU 88) which was later converted to an evaporation pond (SWMU 89), and former oil/water separator with associated 100-gallon collection tank (SWMU 90). A site plan of these SWMUs and surrounding area is shown in Figure 3-1.

The former test cell was enclosed by a 50-foot by 10-foot building resting on a concrete slab. In addition to the test cell structure, a small pumphouse building has been removed, leaving only a bare concrete slab. The oil/water separator system has also been removed. The concrete slab has been used periodically to conduct outdoor engine tests with portable equipment. Nearby buildings at the site include Building 2330 to the northwest, which is a support building for engine test activities, and a storage building directly south. Other site features include a wellhouse (Base Well No. 9), storage shed, water tank, and large sound suppressor buildings further to the north.

Most of the area around the former test cell is covered by asphalt. Topography is generally flat, near an elevation of 4268 ± 1 feet above mean sea level. Minimal vegetation exists in the area of SWMUs 86-90. Wind from engine tests conducted at the concrete slab appears to have created a depression, about 1 foot deep, directly east of the slab in the area of the former oil/water separator system. Sheepsfoot compactor marks are visible in the depression where backfill was placed for the removal of the oil/water separator vaults.

3.2 SITE HISTORY

Appendix I SWMUs 86-90 were active from 1965 to 1988. The separate areas at the site received potential contaminants from a single operation, the steam cleaning and testing of jet aircraft engines. It has also been reported that jet engines had water injected into the exhaust during testing to help muffle noise. Contaminants that may have been released at the site include lubricating and synthetic oils, residual JP-4 fuel, and possibly solvents.

During the life span of the facility, effluent was handled in several ways. Initially it was discharged only to an overflow pit (SWMU No. 87). Then the oil/water separator system (SWMU No. 90) was installed with discharge to a leach field (SWMU No. 88). Finally, the effluent was routed through the oil/water separator to an evaporation pond (SWMU No. 89). The evaporation pond was constructed in the area of the former leach field (SWMU 88).

3.3 PREVIOUS INVESTIGATIONS

Previous investigations, studies, or actions completed at Appendix I SWMUs 86 - 90 (Site SD-11) include the following

- 1983 Phase I IRP Records Search (CH_2M Hill 1983)
- 1984-1985 - Phase II IRP Investigation (Radian 1986)
- 1987 - RCRA Facility Assessment (A.T. Kearney 1987)
- 1989 - Remedial Investigation (WHA 1990)
- 1991 - 18 SWMUs RI (W-C 1992)
- 1994 - OWS Removal Action (RSI 1994)
- 1996 - Phase III RFI (W-C 1997)

1983 - Phase I IRP

A Phase I IRP Records Search was performed in 1983 by CH_2M Hill to identify and fully evaluate suspected problems associated with past hazardous material disposal sites and spill sites at Cannon AFB (CH_2M Hill 1983). During the records search, the existence and potential for migration of hazardous material contaminants was evaluated at the Engine Test Cell Area (SWMUs 86-90) by reviewing the existing information and conducting an analysis of installation records. Results of the Phase I IRP Records Search recommended that potable well 9 be analyzed for priority pollutants to determine if the groundwater had been impacted by activities at the site.

1984-1985 - Phase II IRP

During 1984-1985, a Phase II IRP investigation was conducted by Radian Corporation at the site. Two boreholes were drilled to depths of 35 and 50 feet, respectively (see Figure 3-2). One borehole (11B) was located within the leachfield, and another (11A) was located in a depression which had collected overflow from the oil/water separator. Five soil samples taken from the boreholes were analyzed for purgeable halocarbons and aromatics, oil and grease, and lead. Results of the samples collected during the Radian investigation indicated no soil contamination at the IRP/SWMU (Radian 1986). Based on the results of the Phase II (Stage I) investigation, additional soil sampling was recommended due to the limited number of borings drilled in the area.

1987 - RFA

In 1987, a Preliminary Review/Visual Site Inspection, RCRA Facility Assessment was conducted for the USEPA at Cannon AFB by A.T. Kearney, Inc. (A.T. Kearney 1987). The purpose of this investigation was to identify and evaluate Solid Waste Management Units to assess the potential for releases to the environment of hazardous wastes or constituents. Results of this investigation identified the site as a potential SWMU. The RCRA Facility Assessment also indicated that the

potential for releases to the soil was high due to the past disposal of hazardous wastes and the unlined nature of the IRP/SWMU site. The potential for releases to groundwater was considered to be lower due to the presence of caliche layers possibly inhibiting downward migration of hazardous constituents. Suggested further action was to conduct soil sampling to determine if contaminants had been released from the unit.

1989 - RI

In December 1989, five soil borings (Borings B1 through B5), shown in Figure 3-2, were drilled by Walk, Haydel and Associates and analyzed for volatile organic compounds (VOCs), xylene, base/neutral organics, and total metals (WHA 1990). Borehole 1 was drilled to a depth of 30 feet in the vicinity of the oil/water separator overflow pit. Boreholes 2, 3 and 4 were drilled to depths of 30 feet each immediately adjacent to the west, north, and east, respectively, of the existing evaporation pond. Borehole 5 was drilled to a depth of 60 feet immediately south. Analytical results indicated very low levels of phenol, 2,2'-methylene bis[6-1,1-(dimethylethyl)-4-ethyl-] (known as antioxidant 425) in boreholes B-1 and B-4. Silver was the only metal detected at levels exceeding background. However, the distribution of silver was considered by Lee Wan and Associates (1990) to be naturally occurring.

1991 - 18 SWMUs RI

In September 1991, Woodward-Clyde (W-C) investigated the site as part of the RI for 18 IRP/SWMU sites at Cannon AFB. The objective for sampling at the site during the investigation by W-C was to further evaluate the nature and extent of potential hazardous contaminants. Six soil borings (Borings 0861 through 0866) were drilled and surface and subsurface samples collected for chemical and geotechnical analysis. Additional borings (0867 through 08610) were drilled because of missed holding times or to get deeper samples. The soil borings were located near the Engine Test Pad and the old oil/water separator (see Figure 3-2). Surface samples were collected from 0 to 0.5 feet bgs at locations near each of the soil borings. Subsurface soil samples were collected at depths ranging from 2 to 23 feet bgs. All soil samples were analyzed for Target Compound List (TCL) volatile organic compounds (VOCs) and target analyte list (TAL) metals.

None of the target analyte list of volatile organic compounds, except acetone and toluene, were detected above the CRQL in surface and subsurface soil samples at the SWMUs. Toluene was present in surface sample 0865, at a concentration of 100 µg/kg. Acetone was detected above the CRQL in only one surface sample (i.e., sample 0864 at 17 µg/kg). Acetone was detected in nearly all subsurface samples at all five boring locations with concentrations ranging from 68 µg/kg to 5,700 µg/kg.

A variety of metals were detected in soil borings 0861 through 0865. Vanadium was detected at concentrations of 18-25 mg/kg, slightly higher than background levels. However, the distribution of vanadium was uniform throughout surface and subsurface samples and therefore, could be considered to be naturally occurring. Heavy metals detected at elevated levels are antimony,

barium, cadmium, chromium, cobalt, copper, lead, manganese, nickel, and zinc. Other metals, including iron, aluminum, potassium, and mercury were detected infrequently and at concentrations near or below site background or regional levels.

In August 1994, Remediation Services Incorporated (RSI) removed the oil/water separator system and excavated the petroleum contaminated soil surrounding the oil/water separator. An area originally estimated at 60 feet long by 30 feet wide by 25 feet deep was excavated (see Figure 3-2). Soil samples were taken from the excavated and stockpiled soil periodically and analyzed for TPH, volatiles, semivolatiles, and target analyte metals. Based on this sampling, approximately 186 tons of excavated soil was transported to an off-site facility. Because of concerns about residual contamination in the remaining stockpiled soil, the remaining soil was mixed with clean off-site soil and used to backfill the excavation.

RSI reported that the oil/water separator did not appear to be sealed along the bottom and at the edges and that petroleum contamination in site soils was visible after removing approximately 1 foot of soil.

1996 - Phase III RFI

During the removal action for the oil/water separator (OWS), contaminated soil was encountered which was not expected based on previous investigation results. A Phase III RFI was initiated to evaluate the nature and extent of contamination at these SWMUs. The Phase III RFI field investigation was completed during October 1995, and it consisted of sampling surface and subsurface soils, and sampling groundwater from a nearby Base well. Field immunoassay kits were used to determine sampling intervals and confirm completion of borings.

The Phase III field sampling program consisted of collecting 39 soil samples for chemical analysis from 9 borings completed in the area of the former OWS. Immunoassay testing of soil samples for petroleum hydrocarbons was conducted in the field to select intervals for chemical analysis and confirm completion of borings. Six and eight soil samples, respectively, were selected for microbiological and geotechnical analysis. A groundwater sample was also collected from Base Well No. 9 which is located about 300 feet northwest of the location of the former OWS.

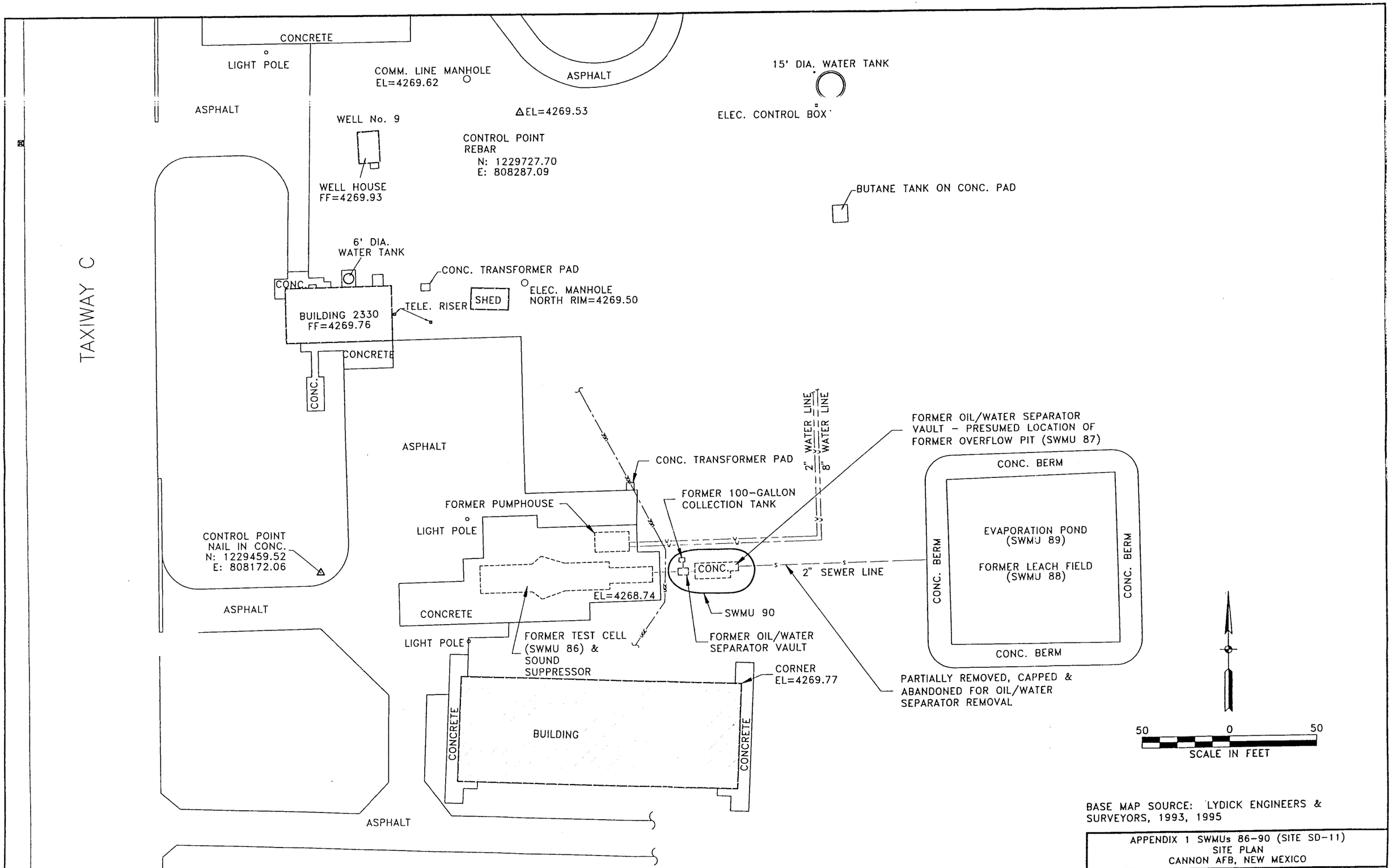
Low to moderate levels of TPH (< 1,000 mg/kg) were detected in surface soil and/or in backfill soil. Moderate to high concentrations of TPH (> 1,000 mg/kg) were detected in soils below the zone of backfill. Some VOCs and SVOCs were also detected below the zone of backfill. Below the zone of backfill, contaminant concentrations decreased with depth to non-detect levels. Maximum depth of detected contamination was 60 feet. Only low levels of metals, each considered to be within background, were detected in soil.

Corrective Measures Study

Comments from the New Mexico Environment Department on the Phase III RFI report indicated that contamination around the former leach field and evaporation pond has not been adequately characterized; and because of the elevated levels of TPH , a Corrective Measures Study was required. Consequently, a Corrective Measures Study will be completed that will include additional soil sampling around the former leach field and evaporation pond.

Sampling locations from previous investigations are shown on Figure 3-2.

REPORT PHASE: PHASE II RFI SITE SD-11



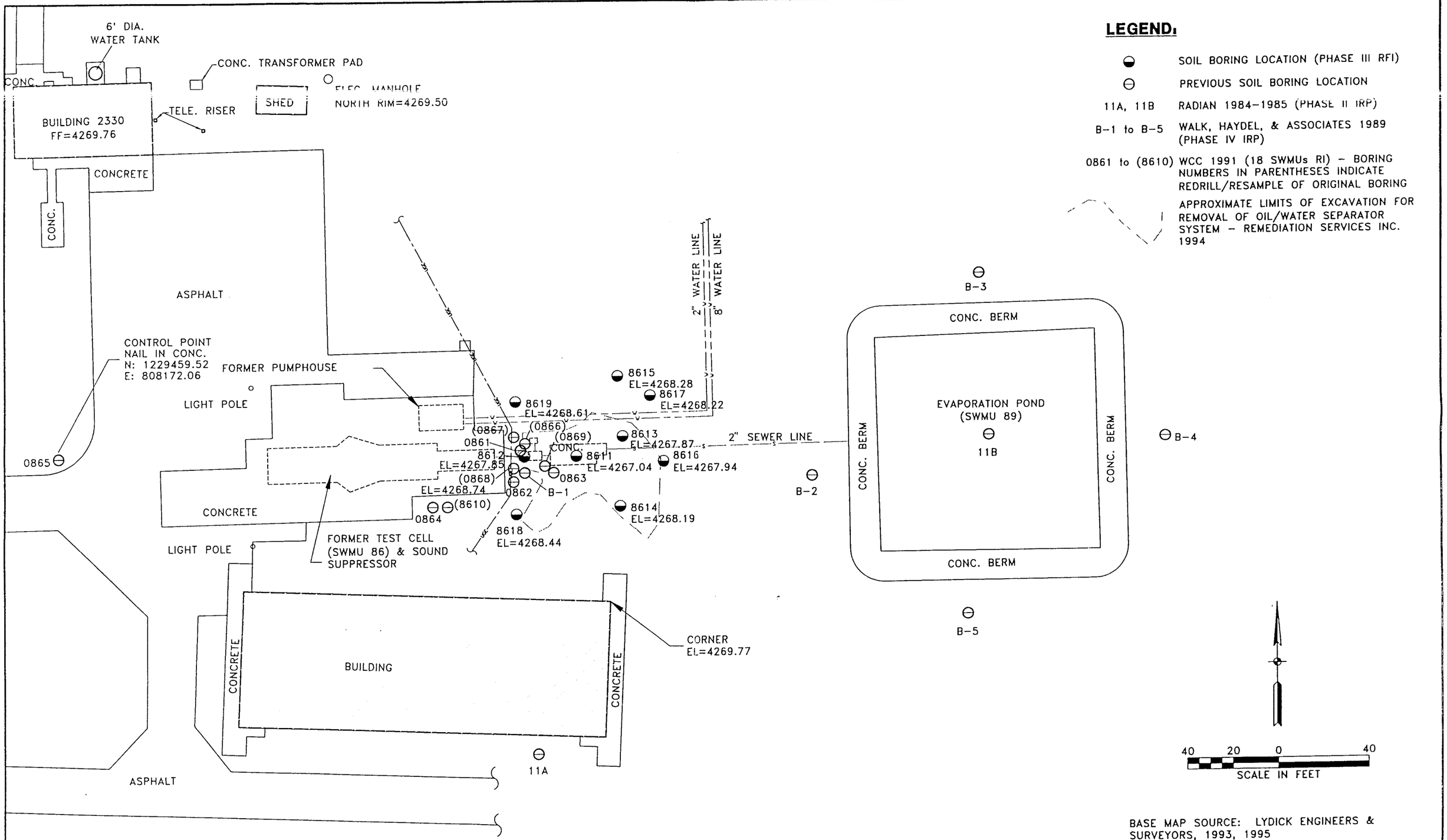
BASE MAP SOURCE: LYDICK ENGINEERS & SURVEYORS, 1993, 1995

NOTE: LOCATION OF UNDERGROUND UTILITY LINES SHOWN ARE APPROXIMATE.

June 01, 1998 4:35:22 p.m.
Drawing: T:\CANNON\M9602V\T3200\FIG3-1.DWG (TSM)

APPENDIX 1 SWMUs 86-90 (SITE SD-11) SITE PLAN CANNON AFB, NEW MEXICO			
DRN. BY: TSSM	DATE: 06/01/98	PROJECT NO. M9602V	FIG. NO 3-1
CHK'D. BY:	REVISION: 0		

REPORT PHASE: PHASE RFI SITE SD-11



LEGEND:

◒	SOIL BORING LOCATION (PHASE III RFI)
⊖	PREVIOUS SOIL BORING LOCATION
11A, 11B	RADIAN 1984-1985 (PHASE II IRP)
B-1 to B-5	WALK, HAYDEL, & ASSOCIATES 1989 (PHASE IV IRP)
0861 to (8610)	WCC 1991 (18 SWMUs RI) - BORING NUMBERS IN PARENTHESES INDICATE REDRILL/RESAMPLE OF ORIGINAL BORING
	APPROXIMATE LIMITS OF EXCAVATION FOR REMOVAL OF OIL/WATER SEPARATOR SYSTEM - REMEDIATION SERVICES INC. 1994

BASE MAP SOURCE: LYDICK ENGINEERS & SURVEYORS, 1993, 1995

NOTE: LOCATION OF UNDERGROUND UTILITY LINES SHOWN ARE APPROXIMATE.

APPENDIX 1 SWMUs 86-90 (SITE SD-11)
PREVIOUS SAMPLING LOCATION PLAN
CANNON AFB, NEW MEXICO

DRN. BY: TSSM	DATE: 06/04/98	PROJECT NO. M9602V	FIG. NO. 3-2
CHK'D. BY:	REVISION: 0		

June 01, 1998 4:48:58 p.m.
Drawing: T:\CANNON\M9602V\T3200\FIG3-2.DWG (TSM)

4.1 CORRECTIVE MEASURES STUDY OBJECTIVES

The overall purpose of a Corrective Measures Study is to develop and evaluate Corrective Measures Alternatives and to recommend the selected Final Corrective Measure(s) that is most cost-effective, most reliable, and easiest to implement.

The preliminary corrective action objective for SWMUs 86 -90 is to implement the Risk-Based Corrective Action (RBCA) process to streamline the decision process for corrective action that is protective of human health and the environment. RBCA is the integration of site assessment, remedial action selection, and monitoring with USEPA-recommended risk and exposure assessment practices. RBCA procedures for the assessment and response to a petroleum release are outlined in the American Society for Testing and Materials (ASTM) E1739-95[E1], *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites* (ASTM 1996).

The specific objectives for SWMUs 86 - 90 are to:

- Further define the extent and degree of contamination levels at this site, specifically in the area of the former evaporation pond (SWMU 89) and west of previous boring location 8612.
- Further assess the potential for contaminant migration in the surrounding environment.
- Further identify public health and environmental risks of contaminants relative to applicable regulatory standards.
- Based on the results of the RBCA process for the assessment and response to a petroleum release, evaluate and justify the "No Further Action" alternative or appropriate RBCA alternative.

4.2 CORRECTIVE MEASURES STUDY APPROACH

The following decision process has been used to assess the data needs and approach for the Corrective Measures Study at SWMUs 86 - 90 (Site SD-11). The Data Quality Objective (DQO) evaluation process is designed to provide data of sufficient quality and quantity to evaluate whether a release has occurred that could pose a risk to human health or the environment and to evaluate the need for further action, such as corrective measures implementation.

A general decision diagram (Figure 4-1) was developed for the Cannon AFB CMS at SWMU 86 - 90 to present a logical decision process that will be used to evaluate the data resulting from the investigation and CMS to assure that objectives are met.

The decision process is designed to identify appropriate actions based on three alternative recommendations: no further action, further evaluation, or corrective measures implementation. The recommendation for the selection of alternative action will depend upon whether chemicals of potential concern (COPCs) are detected in soils at levels that may pose an unacceptable risk to

version 1.0 pg. 4-1
replaced with version 2.0
pg 4-1

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The specific objectives for SWMUs 86 - 90 are to:

- Further define the extent and degree of contamination levels at this site, specifically at the former evaporation pond (SWMU 89).
- Further assess the potential for contaminant migration in the surrounding environment.
- Further identify public health and environmental risks of contaminants relative to applicable regulatory standards.
- Based on the results of the RBCA process for the assessment and response to a petroleum release, evaluate and justify the "No Further Action" alternative or appropriate RBCA alternative.

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The decision process is designed to identify appropriate actions based on three alternative recommendations: no further action, further evaluation, or corrective measures implementation. The recommendation for the selection of alternative action will depend upon whether chemicals of potential concern (COPCs) are detected in soils at levels that may pose an unacceptable risk to

human health or the environment. This section provides a summary of the decision-making process that will be used.

The decision process will be implemented by first evaluating and summarizing existing historical information and analytical data. Historical information will be used to identify COPCs and to identify potential sites of chemical release.

Soil will be sampled and analyzed for COPCs. The analyte lists from which COPCs will be selected are discussed in the QAPP Addendum. Site-related COPCs will then be selected based on the results of the sampling program. Metals that do not exceed background levels, and chemicals which are attributable to field or laboratory contamination, will not be included as site-related COPCs. Organic chemicals that do not have EPA-established toxicity factors will not be evaluated quantitatively, but their potential contribution to site risks will be evaluated qualitatively.

The potential for site-related contaminants to impact groundwater will be assessed by evaluating the vertical distribution of contaminants in the soil column. If the concentrations of COPCs decrease significantly with depth, and the concentrations are below levels that are likely to migrate to groundwater (based on fate and transport properties of the contaminant and the vadose zone), the potential for transport to groundwater will be considered to be insignificant. If the concentrations do not decrease with depth, further investigation of the groundwater pathway will be recommended. If the concentrations are at levels that could potentially migrate to groundwater at concentrations of concern (based on comparison to EPA Region VI soil-screening levels), fate and transport modeling will be done to evaluate the potential for contaminant transport to groundwater.

Once extent and degree of contamination has been further defined, then corrective measures alternatives will be evaluated (see Section 4.3). The first CMS alternative to be evaluated will be "no further action". Concentrations of COPCs detected will be evaluated for potential human health and environmental risks by comparing maximum detected concentrations (which are higher than concentrations to which human and ecological receptors would routinely be exposed) to highly conservative (protective) human health risk-based concentrations (i.e., EPA Region VI Human Health Media-Specific Screening Levels [MSSLs]) and screening ecotoxicity values. This conservative screening approach permits identifying sites that pose no unacceptable risk under highly conservative exposure assumptions and, therefore, warrant no further evaluation or action. The approach also permits identification of sites that may warrant further evaluation based on exceedance of stringent risk-based concentrations. The methods used in the screening-level human health and ecological risk evaluations are presented in Sections 4.6 and 4.7, respectively.

After the risk evaluation has been completed, recommendations regarding the three alternatives stated above will be made on the following basis:

- If the vertical extent and lateral extent of contamination has been defined, no threat to human or ecological health exists based on comparison of maximum concentrations (excluding metals/pesticides below background, field/lab contaminants) to EPA Region VI MSSLs or ecotoxicity values, and no potential threat to the environment is apparent, then no further action will be recommended.
- If the extent has not been defined and there is a potential significant threat to human or ecological health based on exceedance of EPA Region VI MSSLs or ecotoxicity values, further evaluation will be recommended for the site.
- If there is an unacceptable threat to human health or the environment and the extent of contamination is defined, additional corrective measures alternatives will be reviewed, and the appropriate measure(s) recommended for implementation.

4.3 EVALUATION OF CORRECTIVE MEASURES ALTERNATIVE(S)

Once extent and degree of contamination has been defined, then corrective measures alternatives will be evaluated. Those alternatives include:

- No further action
- Excavation and removal
- Bioventing
- Soil vapor extraction

The corrective measures will be evaluated and the final measure(s) selected based on the following criteria.

1. Technical
    - Performance - corrective measure or measures which are most effective at performing their intended functions and maintaining the performance over extended periods of time will be given preference.
    - Reliability - corrective measure or measures which do not require frequent or complex operation and maintenance activities and have proven effective under waste and facility conditions similar to those anticipated will be given preference.
    - Implementability - corrective measure or measures which can be constructed and operated to reduce levels of contamination to attain or exceed applicable standards in the shortest period of time will be preferred.
    - Safety - corrective measure or measures which pose the least threat to the safety of nearby residents and environments as well as workers during implementation will be preferred.

2. Human Health

The corrective measure or measures must comply with existing U.S. EPA criteria, standards, or regulations for the protection of human health. Corrective measures which provide the minimum level of exposure to contaminants and the maximum reduction in exposure with time are preferred. Human health risk evaluations will be completed per the methodology described in Section 4.6.

3. Environmental

The corrective measure or measures posing the least adverse impact (or greatest improvement) on the environment over the shortest period of time will be favored. Ecological risk evaluations will be completed per the methodology described in Section 4.7.

4. Cost

The CMS report will justify and recommend a corrective measure alternative using technical, human health, environmental, and cost criteria. This will include summary tables which allow the alternative or alternatives to be understood easily. Trade-offs among health risks, environmental affects, cost, and other pertinent factors shall be highlighted.

4.4 PRELIMINARY DEVELOPMENT OF SITE CONCEPTUAL EXPOSURE MODELS (SCEMs)

The initial step in the evaluation of the site is the development of a Site Conceptual Exposure Model (SCEM), which provides a framework for evaluating potential risks associated with the site, aids in the identification of data needs, and assists in the identification of appropriate preliminary remediation goals targeted to significant exposure pathways. Upon completion of the field sampling program, the SCEM will be reviewed and modified (if necessary) in order to re-evaluate the site, taking into consideration the analytical results and fate and transport properties of site-related chemicals.

The SCEM presents chemical release sources and transport media, potential human receptors, and intake-mechanisms for each potential exposure pathway. An exposure pathway describes the means by which release, transport, and intake by receptor populations of site-related COPCs occurs. An exposure pathway consists of four necessary elements:

- A source and mechanism of chemical release to the environment
- An environmental transport medium for the released chemical (e.g., air, groundwater, or surface water)
- A point of potential human exposure to transported chemicals (e.g., a domestic drinking water well)
- A human intake mechanism (e.g., inhalation or ingestion) at the point of exposure

All four elements must be present for an exposure pathway to be complete and for chemical exposure to occur. In the SCEM, potentially significant pathways are denoted with solid lines, and pathways that are considered to be insignificant relative to other pathways are denoted with dashed lines.

Potential exposure pathways are evaluated with respect to potential chemical sources at the site. Exposure pathways are considered to be potentially complete if there are chemical release and transport mechanisms and identified exposure points and receptors for that exposure pathway. Incomplete exposure pathways do not result in actual exposure to human or environmental receptors and, therefore, do not pose a potential risk. Incomplete exposure pathways are not shown on the SCEM. Insignificant pathways are those that could conceivably be complete and result in an exposure, but the resulting exposure would undoubtedly be at levels that would not pose a significant risk.

The potential sources of chemical emissions from SWMUs 86 - 90 are presented in Figure 4-2. This site included an engine test cell, oil/water separator, and leach field which were potential sources for petroleum hydrocarbons and solvents. The primary source is generally waste (e.g., fuels, oils, and solvents) that may have leaked into subsurface soils or have been discharged or spilled on surface soil.

Chemicals from the primary source may be transported away from the primary source area, affecting other media that may in turn act as secondary sources. Percolation and leaching of the wastes to the subsurface soil are shown as primary chemical release mechanisms. Subsurface soils are an important secondary source of potential chemical release. Site-related chemicals in soils may infiltrate/percolate through the soil and be released to groundwater.

Other release mechanisms, such as direct contact (soil ingestion and dermal contact), surface runoff, wind erosion, or volatilization to the atmosphere, are also depicted in the SCEM. A portion of the site may be covered with clean soil or pavement; therefore, surface transport of chemicals by storm water runoff would be limited. Transport by storm runoff is not considered a significant pathway for human exposure at underground oil/water separators or underground storage tanks because the contamination at these areas is primarily in the subsurface. When the site is covered by pavement, soil exposures will only be considered potentially significant for future-use scenarios (i.e., if the pavement is removed).

4.5 EVALUATION OF BACKGROUND CONCENTRATIONS

A comparison of SWMUs 86 - 90 sample concentrations to background concentrations will be used to determine whether metals detected in soil samples are site related. The following sections describe the approaches used for each.

Soils are derived from parent geologic materials as a result of physical, chemical, and biological processes. The soil system is a highly heterogeneous matrix of inorganic and organic components. The relative proportions of these components are dependent upon factors influencing soil formations, such as topography, climate, depositional processes, and time (Sposito and Page 1984). Total concentrations of metals in soils may vary depending upon location; for example, at the surface, soils are influenced by leaching, runoff, atmospheric deposition, and biotic uptake, as well as anthropogenic activity. The ranges of naturally occurring or "background" concentrations of metals in soils is greatly varied due to the composition of parent material and, therefore, care must be taken in the interpretation of metals data generated during an investigation.

Metals concentrations in SWMUs 86 - 90 soils will be compared to background soils concentrations presented in "Naturally Occurring Concentrations of Inorganics and Background Concentrations of Pesticides at Cannon Air Force Base, New Mexico" (W-C 1997). The approach will compare the maximum concentrations detected at SWMUs 86 - 90 to the 95 percent upper tolerance limit (UTL) of the background concentrations. Using this technique, individual samples at the site with high concentrations relative to background levels (i.e., which could represent a site-related release) can be identified. In addition, concentrations detected in SWMUs 86 - 90 soils will be compared to regional soils metals concentrations reported in the literature.

4.6 HUMAN HEALTH RISK EVALUATION METHODOLOGY

This section provides a description of the approach that will be used in the health risk evaluation for SWMUs 86 - 90. The Risk-Based Corrective Action (RBCA) process will be used to identify human health risks at SWMUs 86 - 90. RBCA procedures that will be implemented in this report are outlined in the American Society for Testing and Materials (ASTM) E1739-95$^{E'}$, Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites (ASTM 1996).

4.6.1 RBCA Process

RBCA is the integration of site assessment, evaluation using USEPA-recommended risk and exposure assessment practices, and remedial action selection. The RBCA process is implemented in a tiered approach, involving increasingly sophisticated levels of data collection and analysis. The results and recommendations are reviewed after evaluation of each tier to decide whether more site-specific analysis is warranted. The RBCA process consists of the following steps:

1. Initial Site Assessment - Conduct a site investigation and complete a Tier 1 Summary Report to organize available site information regarding primary chemicals of concern, extent of affected environmental media, and potential migration pathways, and receptors
2. Site Classification and Initial Response Action

- Classify site according to specified scenarios and implement appropriate initial response action.
- Reclassify the site, if necessary, following initial response actions, interim remedial action, or additional data collection.

3. Tier 1 Evaluation

- Identify reasonable potential sources, transport pathways, and exposure pathways.
- Compare detected site soil concentrations (maximum detected concentrations or upper confidence levels if data permits) to risk-based screening levels (RBSLs) in the "look-up" table provided in ASTM E1739-95[E1]. EPA Region VI Media-Specific Screening Levels (MSSLs) will be used as the Tier 1 "look-up" table. The MSSLs are discussed in detail in Section 4.6.2 and are presented in Appendix A.
- If concentrations of chemicals of concern exceed the Region VI MSSLs at the point(s) of compliance, then either interim remedial action (e.g., "hot spot" removal), further tier evaluation (i.e., Tier 2 evaluation), or remediation to Tier 1 RBSLs may be warranted.
- If concentrations of chemicals of concern do not exceed the Region VI MSSLs, options include no further action or compliance monitoring.

4. Tier 2 Evaluation

- A Tier 2 evaluation is warranted if Tier 1 RBSLs are exceeded and interim removal action is not appropriate.
- Collect additional site data as needed.
- Identify indirect exposure scenarios to be addressed and the appropriate site-specific points of compliance.
- Nonsite-specific assumptions and point(s) of exposure used in Tier 1 will be replaced with site-specific data and information. Site-specific target levels (SSTLs) based on 10^{-6} to 10^{-4} risk levels will be calculated using the site-specific information and relatively simplistic mathematical models. The SSTLs calculated for the source area are generally not the same as the SSTLs calculated for the point(s) of compliance.
- Detected site soil concentrations (maximum detected concentrations or upper confidence levels if data permits) will be compared to SSTLs.
- If concentrations of chemicals of concern exceed the SSTLs at the point(s) of compliance, then interim remedial action (e.g., "hot spot" removal), further tier evaluation (i.e., Tier 3 evaluation), or remediation to Tier 2 SSTLs may be warranted.
- If concentrations of chemicals of concern do not exceed the SSTLs. options are no further action or compliance monitoring.

5. Basic Equation for RBSLs and SSTLs

- Risk = Concentration * Exposure * Toxicity

- RBSL = Target Risk / (Exposure * Toxicity)
- SSTL = Target Risk / (Exposure * Toxicity)

For these SWMUs, the RBSLs represent residential exposures. This is a conservative approach because the SWMUs are industrial sites which are not likely to become residential in the foreseeable future.

If the calculation of SSTLs is warranted, the exposure component of the equation will be modified to account for the industrial exposures that occur at the sites.

4.6.2 Derivation of EPA Region VI MSSLs

The MSSLs will be taken from the EPA Region VI table which is provided in Appendix B (EPA 1997b). The latest available version will be used. These MSSLs are based on 1×10^{-6} excess cancer risk or a hazard quotient equal to 1, assuming residential ingestion, dermal, and inhalation exposures. A maximum chemical concentration that exceeds a screening-level MSSLs does not mean that a health risk exists because the maximum concentration detected is not the concentration to which people would routinely be exposed, and the exposure assumptions used to derive the MSSLs are not site-specific.

For a carcinogen, the soil MSSLs is the concentration of a chemical in soil that is estimated to result in an excess cancer risk of 1×10^{-6})1 in 1,000,000) for Class A and B carcinogens or 1×10^{-5} for Class C carcinogens, assuming long-term (30-year) daily exposures. A range of 1×10^{-6} to 1×10^{-4} (1 in 1,000,000 to 1 in 10,000) is EPA's target excess cancer risk range for cleanup under Superfund and RCRA (EPA 1991). Therefore, MSSLs based on target risks of 1×10^{-6} and 1×10^{-5} are conservative (protective) values, and exceedances of these MSSLs do not necessarily mean that a health risk is present. Exceedance of the MSSLs may mean, however, that further evaluation of chemical concentrations, exposure assumptions, and carcinogenicity may be warranted.

For noncarcinogens, MSSLs are the concentrations in soil that are estimated to result in a "hazard quotient" (HQ) of 1.0. A hazard quotient is the ratio of the estimated daily dose from the assumed exposure to a reference dose (RfD), established by EPA, that is considered safe for a lifetime of daily exposure. A hazard quotient of 1 means that no toxic effects are likely to occur, even to sensitive individuals exposed for a lifetime. A hazard quotient above 1 does not mean that toxic effects will necessarily occur, but that further evaluation of exposures and chemical toxicity is required. It should be noted that the values for noncarcinogens do not account for chemical mixtures. If more than one noncarcinogen is expected, then the noncarcinogenic MSSL should be divided by 10.

EPA Region VI MSSLs for soil exposures are based on the ingestion, inhalation, and dermal exposure routes. Soil MSSLs are available for industrial and residential scenarios. SWMUs 86-90 are located in industrialized areas of the Base. For the Tier 1 assessment, residential MSSLs

will be used. If a Tier 2 assessment is required, the site-specific exposure parameters will be refined and industrial exposure SSTLs will be calculated. Maximum detected concentrations (or UCL, if there is adequate data) will then be compared to the site-specific industrial SSTLs.

It is important to note that MSSLs are not cleanup goals. Cleanup goals are determined on a site-specific basis. Rather, comparing soil concentrations to screening-level MSSLs is adopted as a means of screening whether the chemicals in soils could pose a threat to human health. If the screening-level MSSLs are not exceeded, no further action is recommended. If the screening-level MSSLs are exceeded, further evaluation of potential risks will be completed.

MSSLs for Lead in Soil

EPA withdrew the toxicity factor (i.e., the RfD) for lead in 1989, primarily due to the lack of a discernible threshold dose and because of the numerous sources of lead in the environment. However, EPA guidance (EPA 1994c) recommends an interim soil lead concentration of 400 mg/kg for residential scenarios at CERCLA and RCRA corrective action sites. This level is supported by EPA's Integrated Exposure Uptake Biokinetic (IEUBK) Model (EPA 1994c), which predicts that exposures of children ages 0 to 6 years to soils with approximately these levels will not result in blood lead levels that exceed a level of concern (10 μg/dL) established by the Centers for Disease Control. The interim soil lead concentration is the level above which there is sufficient concern that a site-specific study of risks should be conducted if exposure to children is expected at the site. Based on the residential soil-screening level for lead, EPA Region VI set the industrial soil MSSL for lead at 2,000.

4.7 SCREENING-LEVEL ECOLOGICAL RISK EVALUATION METHODOLOGY

The screening Ecological Risk Assessment (ERA) will follow Steps 1 and 2 as described in the EPA Superfund Screening Guidance (EPA 1997a). In this assessment, conservative assumptions are used throughout to evaluate worst-case scenarios. Steps 1 and 2 comprise Tier 1 USACE (1996) assessment. A Tier 2 assessment is conducted for those potential contaminants and exposure pathways indicated by the Tier 1 assessment to pose potential ecological risks. The Tier 2 screening assessment differs from the Tier 1 assessment in its use of more realistic exposure parameters and largely represents a second iteration of Step 2 in the Tier 1 assessment.

Step 1 has two components: a problem formulation process and an evaluation of ecological effects (EPA 1997a).

4.7.1 Tier 1 Screening Level Assessment: Step 1 - Problem Formulation

The purpose of the problem formulation process is to: 1) identify the environmental setting and known of suspected contaminants and their maximum concentrations (by medium) at the SWMU; 2) identify preliminary fate and transport mechanisms that may exist at the SWMU; 3) identify

will be used. If a Tier 2 assessment is required, the site-specific exposure parameters will be refined and industrial exposure SSTLs will be calculated. Maximum detected concentrations (or UCL, if there is adequate data) will then be compared to the site-specific industrial SSTLs.

It is important to note that MSSLs are not cleanup goals. Cleanup goals are determined on a site-specific basis. Rather, comparing soil concentrations to screening-level MSSLs is adopted as a means of screening whether the chemicals in soils could pose a threat to human health. If the screening-level MSSLs are not expected, no further action is recommended. If the screening-level MSSLs are exceeded, further evaluation of potential risks will be completed.

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EPA withdrew the toxicity factor (i.e., the RfD) for lead in 1989, primarily due to the lack of a discernible threshold dose and because of the numerous sources of lead in the environment. However, EPA guidance (EPA 1994c) recommends an interim soil lead concentration of 400 mg/kg for residential scenarios at CERCLA and RCRA corrective action sites. This level is supported by EPA's Integrated Exposure Uptake Biokinetic (IEUBK) Model (EPA 1994c), which predicts that exposures of children ages 0 to 6 years to soils with approximately these levels will not result in blood lead levels that exceed a level of concern (10 µg/dL) established by the Centers for Disease Control. The interim soil lead concentration is the level above which there is sufficient concern that a site-specific study of risks should be conducted if exposure to children is expected at the site. Based on the residential soil-screening level for lead, EPA Region VI set the industrial soil MSSL for lead at 2,000.

4.7 SCREENING-LEVEL ECOLOGICAL RISK EVALUATION METHODOLOGY

The screening Ecological Risk Assessment (ERA) will follow Steps 1 and 2 as described in the EPA Superfund Screening Guidance (EPA 1997a). In this assessment, conservative assumptions are used throughout to evaluate worst-case scenarios. Steps 1 and 2 comprise Tier 1 USACE (1996) assessment. A Tier 2 assessment is conducted for those potential contaminants and exposure pathways indicated by the Tier 1 assessment to pose potential ecological risks. The Tier 2 screening assessment differs from the Tier 1 assessment in its use of more realistic exposure parameters and largely represents a second iteration of Step 2 in the Tier 1 assessment.

Step 1 has two components: a problem formulation process and an evaluation of ecological effects (EPA 1997a).

4.7.1 Tier 1 Screening Level Assessment: Step 1 - Problem Formulation

The purpose of the problem formulation process is to: 1) identify the environmental setting and known of suspected contaminants and their maximum concentrations (by medium) at the SWMU; 2) identify preliminary fate and transport mechanisms that may exist at the SWMU; 3) identify

appropriate receptors); 4) identify mechanisms of ecotoxicology for the known or suspected contaminants; 5) identify complete exposure pathways linking contaminants with receptors; and 6) identify or develop ecotoxicity values equivalent to chronic no-observed-adverse-effects level (NOAEL) concentrations for each known or suspected contaminant.

4.7.1.1 Problem Formulation

Problem formulation will be performed as part of the screening ERA and will include a description of the approach, methodology, and data to be used to perform the screening ERA. The purpose of problem formulation is to document the decisions that need to be made and the type, quality, and quantity of data needed to support identified risk management goals and to protect valued environmental resources of this site. Problem formulation typically includes the following steps:

- Identify valued ecological resources
- Identify assessment endpoints that reflect federal, state or local agency ecosystem management goals
- Design an ecological conceptual site model and problem statements that describe key relationships between the principal contaminant stressors, the valued ecological resources to be protected; the appropriate spatial and temporal scale for the assessment; and the site and ecological study boundaries
- Perform a preliminary screening analysis
- Identify risk hypotheses (i.e., measurement endpoints).

As part of the screening assessment, each of these steps will be performed using a preliminary, conservative, largely qualitative approach. Problem formulation also includes the identification of potential data gaps to perform the Tier 1 screening ERA, or the Tier 2 ERA, if needed.

As part of problem formulation, existing studies, data, and reports will be reviewed. Relevant information and data pertinent to the site contaminant history as well as natural resources of the area will be assessed for the purposes of clarifying site and project management goals and objectives, and identifying potential data gaps. Problem formulation will include consideration of the realistic possibilities for near-term and long-term site management. Consideration of the site management goals will provide a focus for the Tier 1 ERA and provide specific clarification as to how the Tier 1 or Tier 2 ERA output will be used to support corrective action decision-making and the selection of appropriate alternatives.

4.7.1.2 Assessment and Measurement Endpoints

An assessment endpoint is an explicit expression of the valued ecological resources that are to be protected. By definition, an assessment endpoint includes both the resource (i.e., ecological

entity) and a specific attribute of that resource (EPA 1997a). EPA uses three principal criteria for selecting "useful" assessment endpoints: ecological relevance, susceptibility to the stressor; and management goals. Assessment endpoints may be selected for one or more levels of ecological organization (i.e., individual, population, community, ecosystem).

If no valued ecological resources are present that would be potentially exposed to contaminant release under the current or future land use scenarios, then no further assessment need take place. Whether individual organisms that are occasionally present constitute a valued ecological resource is a decision that would be made at this step using technical judgment and agency and stakeholder input.

Species which have been accorded official protection are commonly selected as assessment endpoints at the individual level and would be assessed in this case, because of the value society has placed on them, even though their importance in the structure and function of the ecosystem may be insignificant or not easily demonstrated. Game species, are a socially-valued ecological resource commonly assessed in ERAs. Game species are typically evaluated at the population rather than individual level of ecological organization because loss of an individual(s) will not affect the population. Assessment endpoints may also be more broadly defined in terms of general ecosystem values to be protected; e.g., biological diversity (biodiversity), functional integrity; and energy and nutrient dynamics (cycling and transport processes).

A general food web will be constructed to help identify valued ecological resources for the SWMU-related ecosystem and to help identity the principal functional components of the ecosystem and site-specific receptors. Food webs typically contain three basic trophic categories: producers (green plants), consumers (herbivores, carnivores, and omnivores) and decomposers (fungi and bacteria). Earthworms comprise a major functional component of many ecosystems and are therefore commonly assessed as receptors, not on an individual species or population basis, but rather on a functional basis because they provide a critical pathway for nutrient transfer in the terrestrial ecosystem. Woody plants and grasslands are an example of communities, rather than species, which are more commonly assessed on a functional or structural basis, because of their importance for energy and nutrient transfer to upper trophic levels and because of their importance as habitat for wildlife.

Screening level assessment endpoints are usually identified as any adverse effects on ecological receptors, with the receptors being on-site populations, communities, habitats, or sensitive environments (EPA 1997a). The screening ERA for this site will be performed using a generic surrogate receptor for the following functional categories:

- Vascular plants
- Soil invertebrates
- Mammalian and avian herbivores
- Mammalian and avian omnivores

- Mammalian and avian carnivores

Adverse effects on populations, the community, and the ecosystem, will be inferred from measurement endpoints related to impaired reproduction, growth, and survival for surrogate receptors within these functional categories (EPA 1997a). Depending on the conceptual site model, and type of contaminants present, receptors for each category may not necessarily need to be assessed. Upper trophic level categories would not need to be assessed, for example, if the contaminants are unlikely to biomagnify.

4.7.1.3 Environment Setting

A one-day site reconnaissance will be made to gain familiarity with the site setting. The purpose of the site reconnaissance will be to identify valued ecological resources of the area and delineate habitats that may be exposed to site-originated constituents. Specific activities will include the identification of ecological habitats on site, a qualitative assessment of the ecological condition of these habitats, a qualitative assessment of the wildlife associated with these habitats, and a description of the potentially valued ecological resources (i.e., assessment endpoints) for this area. An ecological SWMU characterization will be developed that includes the following:

- Description of current and historical information on the potential contaminant source and natural resources present.
- Map and description of potentially exposed ecological resources, habitats, and receptor groups.
- A discussion of potential ecological management issues.
- A discussion of natural resource management goals and objectives (site-specific and regional natural resource agency goals/objectives).
- A list and discussion of valued ecological resources to be protected.
- A list (if available) of common and observed species and their regulatory status (threatened and endangered species, game species, neotropical migratory birds, species of public interest).
- A general, SWMU-specific food web.

State and federal natural resource agencies as well as appropriate base personnel will be contacted with regard to providing an updated list of protected plant and wildlife species of the region and common and observed species for this SWMU.

4.7.1.4 Contaminants of Potential Ecological Concern

The contaminants of potential ecological concern (COPECs) evaluated in the screening level ERA may include both organic and inorganic chemicals. Identification of the COPECs for further evaluation in the screening level assessment will follow a two-part process. First, COPECs will be identified, by medium, using available data that are applicable to this SWMU. Data sources

may include, but will not be limited to, characterization data collected in support of past and ongoing RCRA and environmental monitoring activities at this SWMU and appropriate adjacent locations. Standard statistical parameters, including concentrations maximum, mean, and range, will be compiled for each COPEC.

Analytical results for the SWMU will be screened against five criteria. Chemicals that meet any one of the five criteria will be eliminated from further consideration. Chemicals that do not meet any of the criteria (or criteria are not available) will be retained as COPECs. The five screening criteria are:

- Non-detectable concentrations
- Laboratory or field contaminants
- Essential nutrient (e.g., calcium, magnesium, iron, potassium, and sodium)
- Below background concentrations
- Below toxicity-based soil screening values.

It is anticipated that the screening effort for the first four criteria will be performed as part of the human health risk assessment. The screening effort for COPECs will therefore largely consist of the toxicity-based screen. It is further anticipated that soil is the only medium of concern at this site. Therefore, maximum soil concentrations for the SWMU will be screening against the lowest available toxicity-based soil screening values that are protective of plants, soil microorganisms, soil invertebrates, and wildlife. Chemicals with exposure concentrations below the soil screening values will be considered to pose no hazard to the environment and will be eliminated as COPECs. Oak Ridge Laboratory's (ORNL's) toxicity-based soil screening values for plants (Will and Suter II, 1997), soil microorganisms and earthworms (Will and Suter II, 1994) and wildlife (Efroymson et al 1997) will be used, or equivalent values recommended by EPA Region VI or NMED.

4.7.1.5 Contaminant Fate and Transport

Potential ecological exposure pathways will be identified based on the environmental setting and available chemical and geophysical data for the site. Potential contaminant transport pathways will include pathways developed for the human health assessment (e.g., groundwater transport, surface water runoff). The identified transport pathways and mechanisms, together with contaminant fate, will be employed to develop the SWMU-specific ecological conceptual site model (ECSM).

The purpose of the ECSM is to provide a conceptual understanding of the potential for exposure to hazardous contaminants at the SWMU based on the source of contamination, the release mechanism, the complete exposure pathway, and the receptor.

4.7.1.6 Complete Exposure Pathways

Potential exposure pathways will be evaluated for completeness to ascertain whether the release mechanisms and transport pathways can be linked to the ecological receptors. Incomplete exposure pathways will be eliminated from further consideration. Similarly, only those COPECs and receptors for which complete exposure pathways are indicated will be carried forward in the screening level assessment.

Exposure in wildlife through inhalation and dermal contact pathways are generally not considered significant pathways for COPEC's in soil (Sample and Suter 1994). Such pathways will be qualitatively addressed in the screening assessment as to their importance with respect to remedial decision-making.

4.7.2 Perform Screening Analysis - Evaluation of Ecological Effects

The screening analyses includes a screening level exposure estimate and preliminary risk calculation. The risk estimate is based on the comparison of the maximum reported exposure concentration with the corresponding screening ecotoxicity value (EPA 1997a). The screening level exposure estimate employs simple, conservative exposure values. For example, the area-use factor, and bioavailability are initially set at 100 percent (i.e., equal to 1). Although the use of conservative assumptions is identified in the EPA guidance, the guidance calls for use of these assumptions only when site-specific information is absent or difficult to develop (EPA 1997a). Exposure estimates for wildlife will be developed using the allometric equations published by EPA (1993) in the *Wildlife Exposure Factors Handbook*.

4.8 CORRECTIVE MEASURES STUDY REPORT

At a minimum, the CMS report will include:

- Executive Summary
- Description of the Facility
- Summary of Previous Investigations
- Results of CMS Investigation, including Quality Control Summary Report
- Description of Nature and Extent of Contamination
- Description of Modeling Results, if applicable
- Description of the RBCA process
- Human Health and Ecological Risk Assessment Results (including methods and assumptions used to calculate the site-specific target clean-up goals)
- Evaluation of the RBCA decision

- Remedy selection, if applicable
- Justification of the RBCA decision or remedy selection, if applicable
- Remedy Cost Estimate, if applicable
- Remedy Schedule, if applicable

FIGURE 4-1

CANNON AFB
DECISION DIAGRAM FOR CORRECTIVE MEASURES STUDY AT SWMUS 86 - 90 (SITE SD-11)

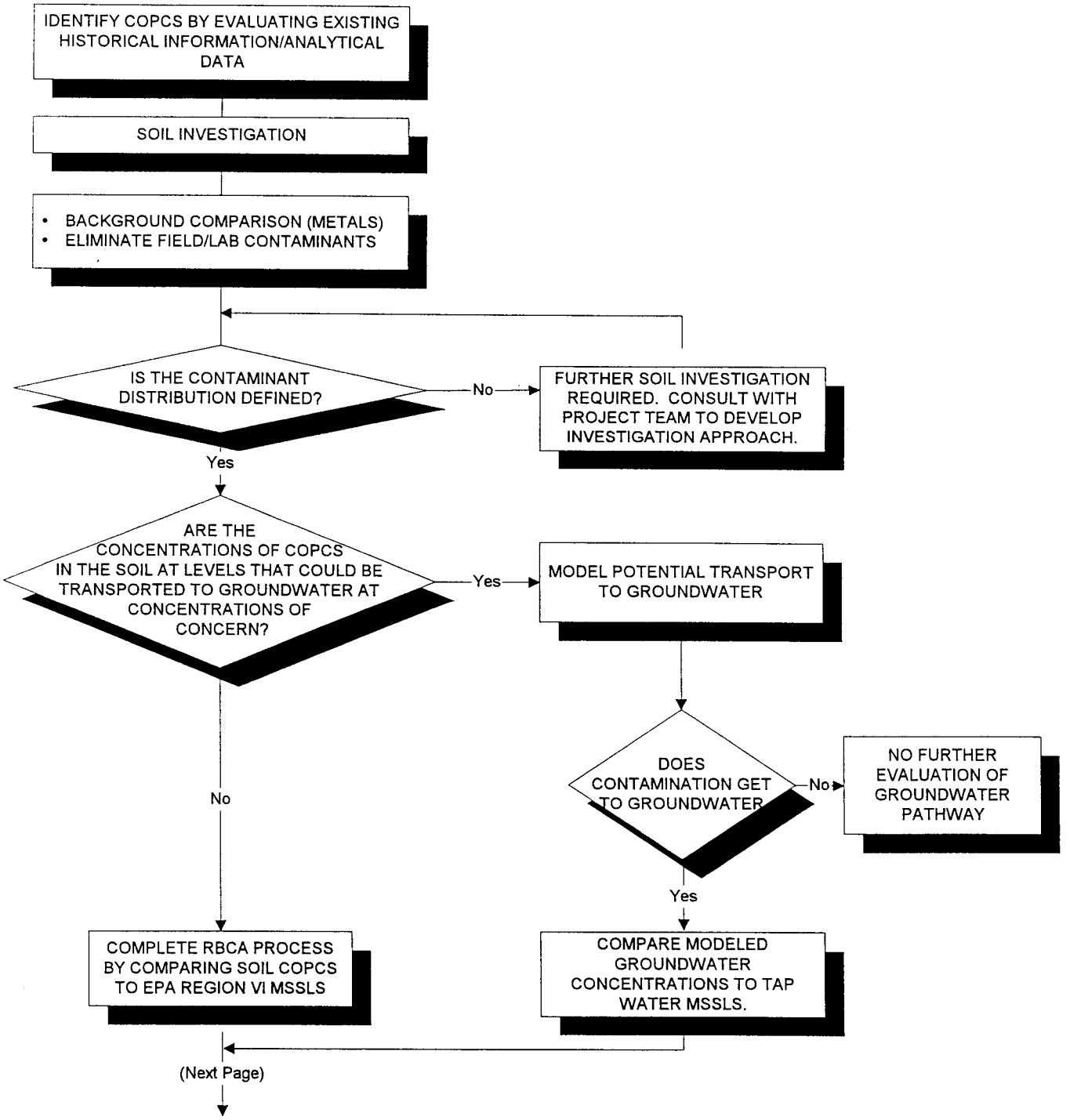
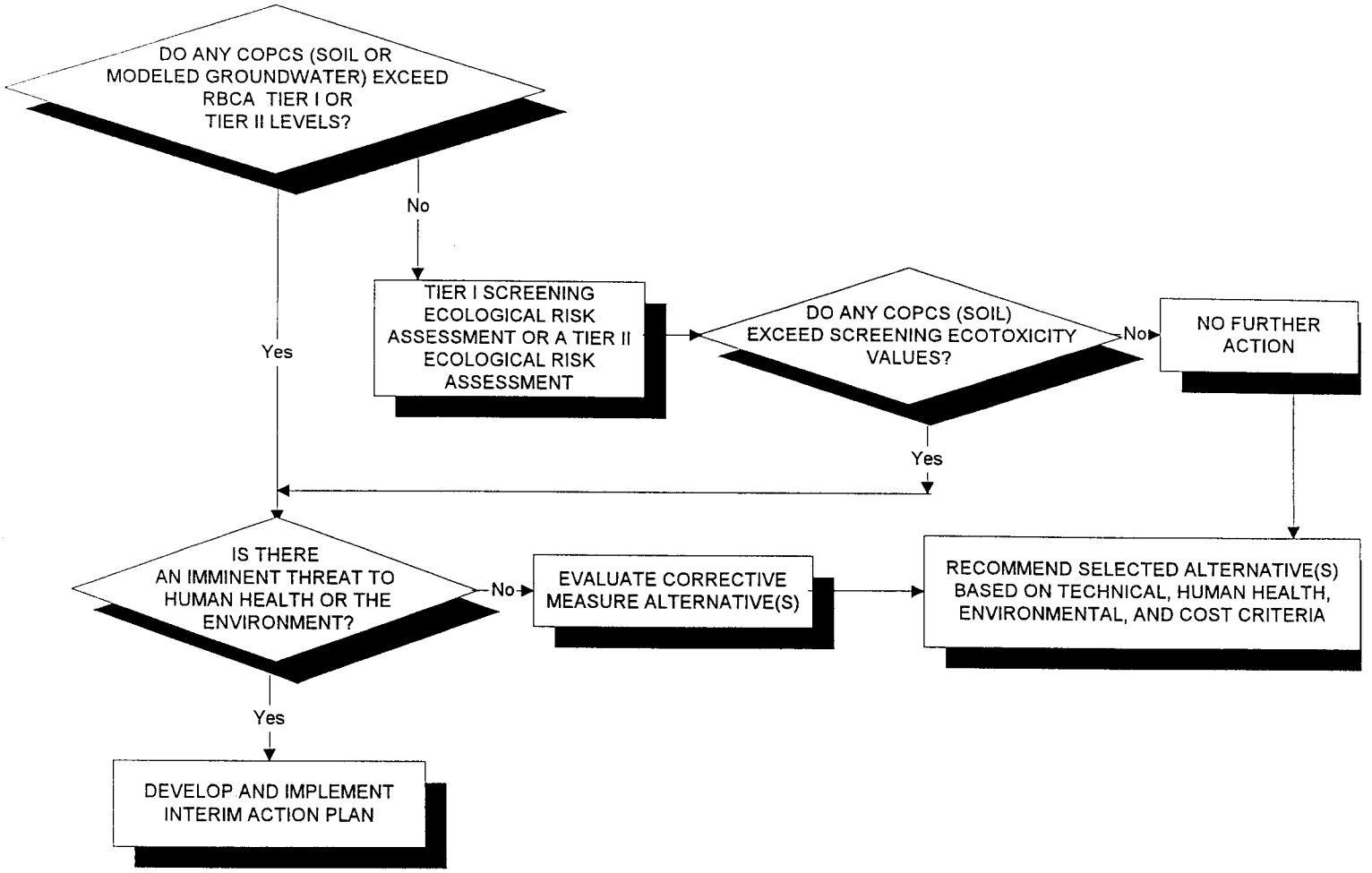
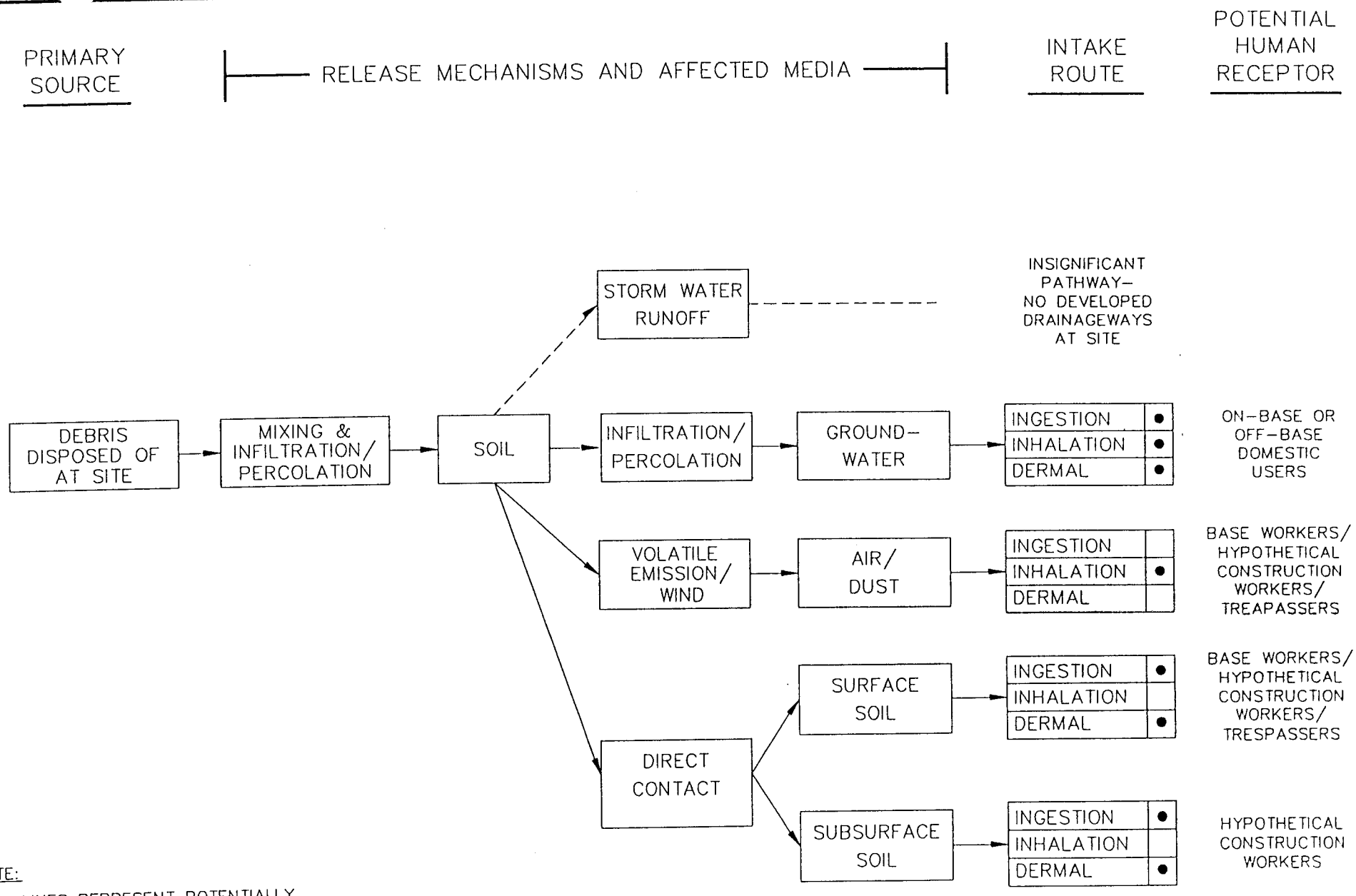


FIGURE 4-1

CANNON AFB
DECISION DIAGRAM FOR CORRECTIVE MEASURES STUDY AT SWMUS 86 - 90 (SITE SD-11)





NOTE:

SOLID LINES REPRESENT POTENTIALLY COMPLETE PATHWAYS

DASHED LINES REPRESENT INCOMPLETE OR INSIGNIFICANT PATHWAYS

June 01, 1998 12:20:55 p.m.
Drawing: T:\CANNON\M9602V\T3200\FIG4-2.DWG (TSM)

DRN BY TSSM	DATE 06/01/98	SITE CONCEPTUAL EXPOSURE MODEL SWMUs 86-90 HUMAN EXPOSURES CANNON AIR FORCE BASE NEW MEXICO	PROJECT NO.	FIG. NO
CHK'D BY .	REVISIONS: 0		M9602V	4-2

FINAL

FIELD SAMPLING PLAN FOR THE CORRECTIVE MEASURES STUDY AT SWMUs 86 - 90 (SITE SD-11) CANNON AFB, NEW MEXICO

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

August 1998

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Appendix A Standard Operating Procedures

Appendix B EPA Region VI Media-Specific Screening Levels

SECTIONONE Sampling Locations, Frequencies, and Analyses

This Field Sampling Plan (FSP) is for SWMUs 86 - 90 being investigated as part of the Corrective Measures Study (CMS) at Cannon AFB. The locations of the SWMUs are shown on Figure 1-2 of the CMS Work Plan. The FSP briefly discusses sampling objectives, and proposed sampling locations and frequencies. Sample designation, sampling equipment and procedures, and sample handling, documentation, and analysis are also presented in this section.

Soil sampling will be done using a truck-mounted drill rig and stainless-steel split-spoon samplers or stainless-steel hand augering equipment, where appropriate, according to the applicable SOPs in Appendix A.

The following site-specific activities will be completed to meet the objectives stated in the Corrective Measures Study Work Plan. The projected soil sampling breakdown is shown in Table 1.

Additional characterization in support of the CMS is required in the area of the former leach field and evaporation pond to ensure that the vertical and lateral extent of contamination has been determined. Three soil borings will be drilled to a depth of 40 feet. Five soil samples will be collected from each of these three boring locations. In addition, a fourth soil boring will be drilled west of the location of previous soil boring 8612 to further delineate the western extent of contamination. Exact depth and sampling intervals for this boring will be predetermined through discussions with NMED representatives. The proposed locations of the soil borings are presented in Figure 1. The concrete berm will be removed by the Base to facilitate entry of a drill rig. Soil samples will be collected at the following intervals:

- 0 to 2.0 feet below ground surface (bgs)
- 8.0 to 10.0 feet bgs
- 18.0 to 20.0 feet bgs
- 28.0 to 30.0 feet bgs
- 38.0 to 40.0 feet bgs

Surface soil samples will be collected from 0 to 24 inches for all parameters except VOCs. Samples collected for VOC analysis will be collected from 12 to 24 inches.

Immunoassay analysis will be performed for TPH following SW-846 Immunoassay Method 4030 at each of the sample intervals. Two detection limits may be used for each test. Each sample will be initially analyzed using the low-level analysis kit. If the initial TPH value does not exceed the minimum level of detection, the sample will be reported as nondetect at the minimum level of detection. If the initial value exceeds the lowest level of detection, the sample will be analyzed using a mid-level kit and the reporting limit of 10 times the minimum detection level will be used. The following table identifies the compounds which can be detected using the Immunoassay kits and their associated reporting limits:

version 1.0 pg 1-1
replaced with version 2.0 pg 1-1

SECTIONONE Sampling Locations, Frequencies, and Analyses

This Field Sampling Plan (FSP) is for SWMUs 86 - 90 being investigated as part of the Corrective Measures Study (CMS) at Cannon AFB. The locations of the SWMUs are shown on Figure 1-1 of the CMS Work Plan. The FSP briefly discusses sampling objectives, and proposed sampling locations and frequencies. Sample designation, sampling equipment and procedures, and sample handling, documentation, and analysis are also presented in this section.

Soil sampling will be done using a truck-mounted drill rig and stainless-steel split-spoon samplers or stainless-steel hand augering equipment, where appropriate, according to the applicable SOPs in Appendix A.

The following site-specific activities will be completed to meet the objectives stated in the Corrective Measures Study Work Plan. The projected soil sampling breakdown is shown in Table 1.

Additional characterization in support of the CMS is required in the area of the former leach field and evaporation pond to ensure that the vertical and lateral extent of contamination has been determined. A total of three soil borings will be drilled to a depth of 40 feet. Five soil samples will be collected from three boring locations. The proposed locations of the soil borings are presented in Figure 1. The concrete berm will be removed by the Base to facilitate entry of a drill rig. Soil samples will be collected at the following intervals:

- 0 to 2.0 feet below ground surface (bgs)
- 8.0 to 10.0 feet bgs
- 18.0 to 20.0 feet bgs
- 28.0 to 30.0 feet bgs
- 38.0 to 40.0 feet bgs

Surface soil samples will be collected from 0 to 24 inches for all parameters except VOCs. Samples collected for VOC analysis will be collected from 12 to 24 inches.

Immunoassay analysis will be performed for TPH following SW-846 Immunoassay Method 4030 at each of the sample intervals. Two detection limits may be used for each test. Each sample will be initially analyzed using the low-level analysis kit. If the initial TPH value does not exceed the minimum level of detection, the sample will be reported as nondetect at the minimum level of detection. If the initial value exceeds the lowest level of detection, the sample will be analyzed using a mid-level kit and the reporting limit of 10 times the minimum detection level will be used. The following table identifies the compounds which can be detected using the Immunoassay kits and their associated reporting limits:

version 2.0 pg 1-2

Compound	Low Level Detection Limit (ppm)	Mid-Level Detection Limit (ppm)
Gasoline	10	100
Diesel	15	150
#2 Fuel Oil	15	150
Kerosene	15	150
Jet Fuel A	15	150
Jet Fuel JP-4	15	150
#6 Fuel Oil	25	250
Mineral Spirits	25	250

If the field screening results for TPH indicate detections in either of the bottom two sample intervals from any boring, then the USACE Technical Manager will be immediately notified and before the field crew demobilizes from the site.

The soil samples will additionally be analyzed off site for the parameters listed below:

- TPH (DRO) by EPA method 8015B
- TRPH by EPA Method 9071/418.1
- VOCs by EPA Method 8260B
- SVOCs by EPA Method 3550B/8270C

Note: Although the soil samples from the fourth boring, located west of previous boring location 8612, will be analyzed for VOCs using EPA Method 8260B, the samples will be collected following EPA Method 5035 collection techniques.

Version 1.0 pg 1-2
replaced with version 2.0 pg 1-2

Compound	Low Level Detection Limit (ppm)	Mid-Level Detection Limit (ppm)
Gasoline	10	100
Diesel	15	150
#2 Fuel Oil	15	150
Kerosene	15	150
Jet Fuel A	15	150
Jet Fuel JP-4	15	150
#6 Fuel Oil	25	250
Mineral Spirits	25	250

If the field screening results for TPH indicate detections in either of the bottom two sample intervals from any boring, then the USACE Technical Manager will be immediately notified and before the field crew demobilizes from the site.

The soil samples will additionally be analyzed off site for the parameters listed below:

- TPH (DRO) by EPA method 8015B
- TRPH by EPA Method 9071/418.1
- VOCs by EPA Method 8260B
- SVOCs by EPA Method 3550B/8270C

The sample designation for field (analytical) and quality assurance/quality control (QA/QC) samples is a three letter and seven-digit/letter unique identification for each sample (CXX-YYYY-ZZZ). CXX is the facility and site identifier, with C for Cannon AFB, and XX representing the number identifying a specific SWMU. For example, the sample designation for SWMU 88 would start as C88-.

The next four digits (YYYY) identify the sampling method and specific sampled location. The first two characters will represent the method of sampling. The following codes will be used for the first two characters:

- HA - hand auger boring
- SB - soil boring
- SS - surface soil

The last two characters will identify the sample location. Samples from the second soil boring at SWMU 88 would be identified as C88-SB02- .

The last set of characters (ZZZ) are the sample identifier. The first number corresponds to the type of sample:

- 0 for soil (analytical)
- 1 for soil MS/MSD
- 2 for field duplicate
- 3 for Chemicals and Materials Quality Assurance Laboratory duplicate

The quality assurance (QA) samples sent to the Chemical and Materials Quality Assurance Laboratory will be labeled similar to the sample for which it is a duplicate. The seventh character of the QA split sample will be a "3", whereas the seventh character of the original sample will be a "0". The MS/MSD should also be labeled the same as the original sample, but should also have "MS/MSD Extra" written on the label.

The last two numbers correspond to the beginning depth of the sample in feet below ground surface (bgs) for all soil samples. The following is an example of an identification number:

Soil boring no.1 Approximate depth of top of sample in feet-bgs

C88 - SB01 - 018

Cannon AFB SWMU 88 Soil analytical sample

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

The anticipated sampling equipment and procedures that will be used to collect samples are described in the Standard Operating Procedures (SOPs) contained in Appendix A. These SOPs are consistent with procedures identified and described by the EPA (EPA 1987).

Before each sampling event, the Field Manager will meet with the assigned sampling personnel and review the purpose and objectives of the event. This meeting will provide clarification of the sampling event specifics. Topics of discussion and review will include:

- Sampling locations, equipment, and requirements
- Number and type of samples
- Sample identification
- Preservation requirements
- Analytical parameters
- Equipment decontamination procedures
- Chain-of-custody requirements

The procedures for collecting soil samples will be selected, as appropriate, from the SOPs. The Field Manager will be responsible for ensuring that samples are collected with properly decontaminated equipment and containerized as required by the site-specific sampling procedures.

Decontamination procedures shall be performed in a manner consistent with the most recent EPA guidelines, but as a minimum shall consist of steam cleaning and/or Liquinox, or equivalent wash, followed by a tap water rinse and a double deionized water rinse. Specific decontamination procedures are described in SOP No. 1 in Appendix A.

The projected sampling breakdown summaries for the site are presented in Table 1. The sample containers, preservation requirements, and holding times for soil are summarized in Table 2.

The labeling, preservation, handling, shipping, documentation, and tracking procedures for all samples collected at Cannon AFB are described in SOP No. 12, Sample Handling, Documentation, and Tracking.

All sample labels should be filled out with waterproof ink and numbered. Soil sample labels will be supplied by Woodward-Clyde. Sample containers will be placed in plastic storage bags (double bagged in zipper-lock bags) and wrapped in protective packing material (i.e., foam liners, bubble packing, Styrofoam peanuts). Samples will then be placed in a cooler with ice (double bagged using 1-gallon zipper-lock bags) for overnight express carrier shipment to the laboratory. A completed and signed Chain-of-Custody will be placed in each cooler being shipped.

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

To supplement the information in the field book, A-E daily quality control reports (DQCRs) will also be completed, forwarded to the USACE TM, and maintained in W-C records for every sample location.

Analyses to be done will be specified on the Chain-of-Custody.

TABLE 1

PROJECT SOIL SAMPLING BREAKDOWN

SWMUs 86 - 90 (SITE SD-11)

Method	Parameter	QUALITY CONTROL [2]					Total No. of W-C Samples[1]	QUALITY ASSURANCE [3]		
		No. of Field Samples [2]	No. of Field Duplicates	No. of Trip Blanks	No. of Field Blanks	No. of MS/MSD[1] Samples		No. of Field Splits	No. of Trip Blanks	Total No. of QA Samples
8260B	Volatile Organics	15	2	0	0	2	17	1	0	1
8270C	Semivolatile Organics	15	2	0	0	2	17	1	0	1
8015B	TPH (DRO)	15	2	0	0	2	17	1	0	1
418.1	TRPH	15	2	0	0	2	17	1	0	1

[1] Two extra 4-oz. VOA jars and two extra 8-oz. jars of soil will be provided from two samples at this AOC for MS/MSD testing by the laboratory. These samples shall be labeled the same as the soil sample they came from and include "MS/MSD - EXTRA". Total does not include MS/MSD samples.

[2] Samples sent to Laucks Testing Laboratory.

[3] Samples sent to USACE CMQAL

TABLE 2

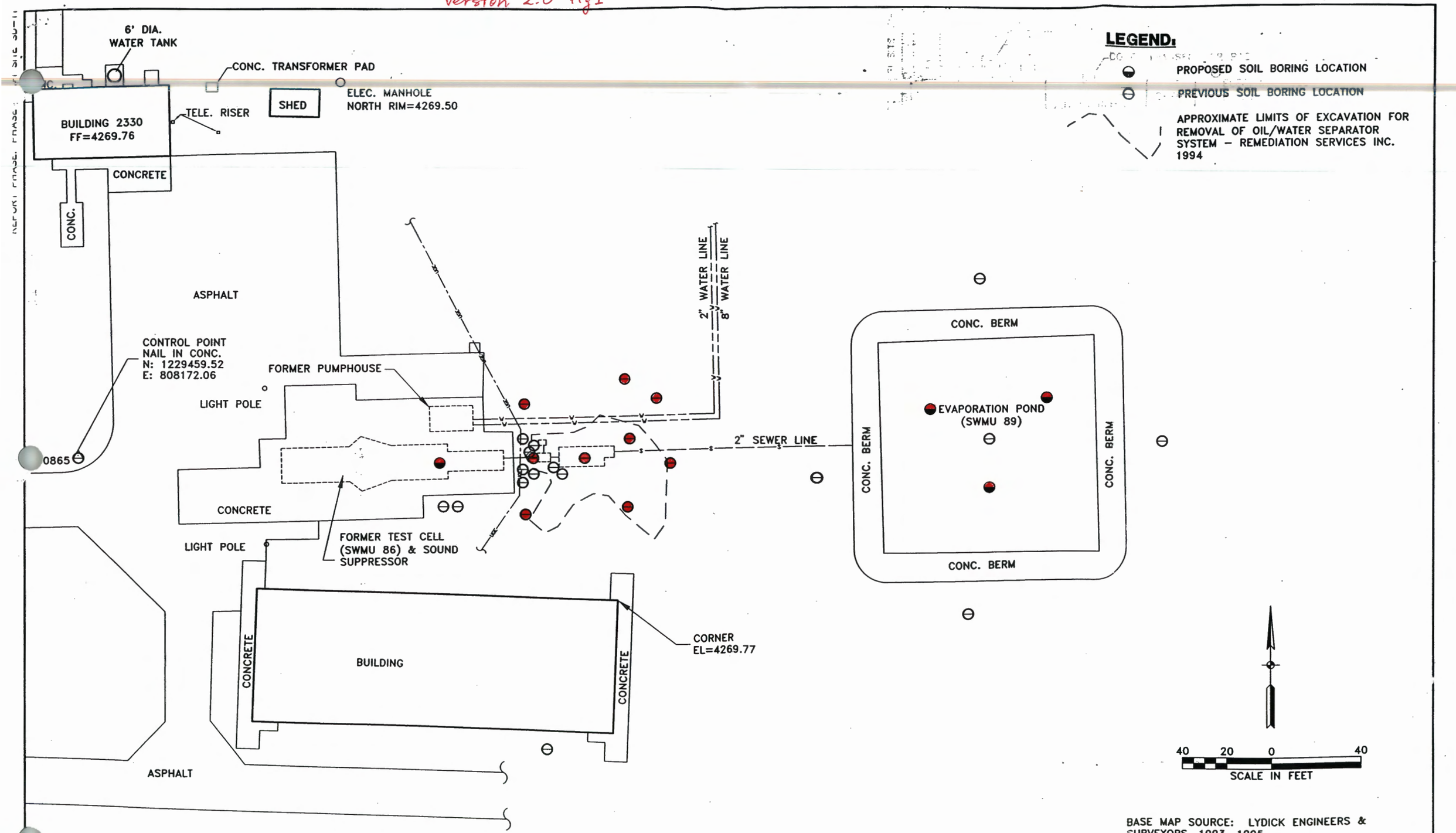
SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES FOR SOIL SAMPLES

Method	Parameter	No. of Containers / Sample	Minimum Sample Size	Preservation	Holding Time
8260B	Volatile Organics	2 - 4-oz. glass VOA jars with Teflon-lined septa	10 g	4°C	14 days
8270C	Semivolatile Organics	1 - 8-oz. wide-mouth glass jar with Teflon-lined lid [1]	30 g	4°C	Extract - 14 days Analyze - 40 days
8015B	Petroleum Hydrocarbons (DRO)	2 - 4-oz. glass VOA jars with Teflon-lined septa [1]	30 g	4°C	Extract - 14 days Analyze - 40 days
418.1	TRPH	1 - 8-oz. wide-mouth glass jar with Teflon-lined lid [1]	100 g	4°C	Analyze - 28 days

[1] 2 - 8-oz. jars are sufficient for Methods 8270A, 8015B, and 418.1.

Note: Sample containers will be double-bagged in zipper-lock bags. The bagged packing ice will be placed in double-bagged, 1-gallon, zipper-lock bags.

version 2.0 Fig1



BASE MAP SOURCE: LYDICK ENGINEERS & SURVEYORS, 1993, 1995

APPENDIX 1 SWMUs 86–90 (SITE SD–11)
PROPOSED SAMPLING LOCATIONS
CANNON AFB, NEW MEXICO

DRN. BY: TSSM	DATE: 06/04/98	PROJECT NO.	FIG. NO.
CHK'D. BY:	REVISION: 1	M9602V	1

January 12, 2000 11:30:13 a.m.
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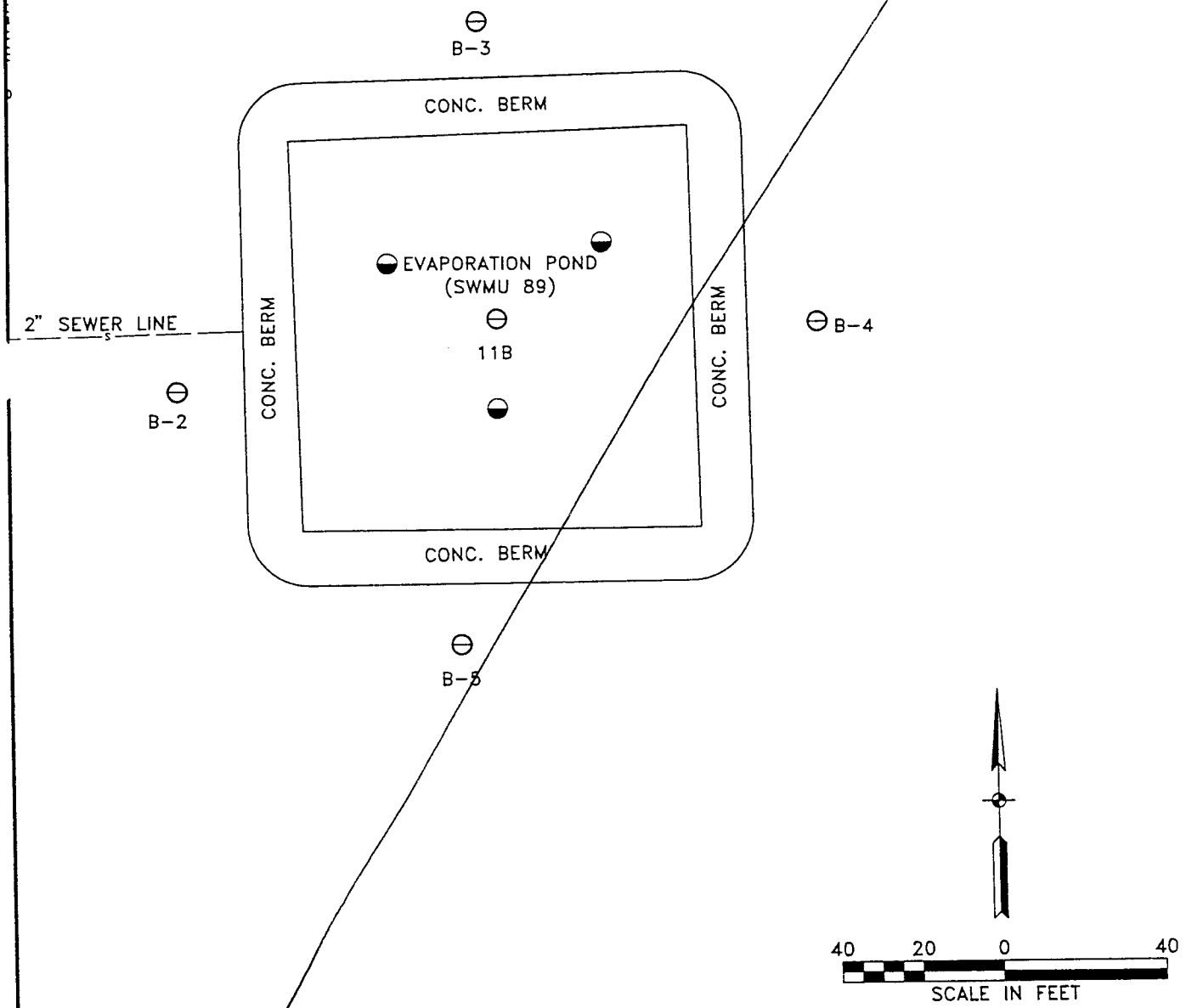
NOTE: LOCATION OF UNDERGROUND UTILITY LINES SHOWN ARE APPROXIMATE.

REPORT PHASE: PHASE I SITE SD-11

version 1.0 Fig 1 replaced with version 2.0 Fig 1

LEGEND:

◒	PROPOSED SOIL BORING LOCATION
⊖	PREVIOUS SOIL BORING LOCATION
11A, 11B	RADIAN 1984–1985 (PHASE II IRP)
B-1 to B-5	WALK, HAYDEL, & ASSOCIATES 1989 (PHASE IV IRP)



BASE MAP SOURCE: LYDICK ENGINEERS & SURVEYORS, 1993, 1995

NOTE: LOCATION OF UNDERGROUND UTILITY LINES SHOWN ARE APPROXIMATE.

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APPENDIX 1 SWMUs 86-90 (SITE SD-11)
PROPOSED SAMPLING LOCATIONS
CANNON AFB, NEW MEXICON

DRN. BY: TSSM	DATE: 04/29/98	PROJECT NO. C3M11MM	FIG. NO. 1
CHK'D. BY:	REVISION: 0		

FINAL

QUALITY ASSURANCE PROJECT PLAN ADDENDUM FOR THE CORRECTIVE MEASURES STUDY AT SWMUs 86 - 90 (SITE SD-11) CANNON AFB, NEW MEXICO

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

August 1998

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1.1 PURPOSE AND SCOPE

This Quality Assurance Project Plan (QAPP) Addendum is designed to provide specific guidance and quality assurance/quality control (QA/QC) requirements for the generation of environmental data of known quality. This Addendum addresses changes from the original QAPP (W-C 1993). This data will be used in making site-specific decisions for the Corrective Measures Study (CMS) for SWMUs 86-90 (Site SD-11) at Cannon Air Force Base (AFB), New Mexico.

This document provides discussion of project objectives, procedures, and specific measurements to be performed and evaluated in the assessment of data generated for the Cannon AFB CMS. As an appendix to the Work Plan (WP), specific Standard Operating Procedures (SOPs) are also provided as a means of maintaining consistency with respect to procedures commonly used in conjunction with data collection. The SOPs are located in Appendix A of the WP Addendum.

This QAPP Addendum has been prepared by Woodward-Clyde (W-C) under Indefinite Delivery Contract Number DACA45-96-D-0017 (Delivery Order 0022) with USACE, Omaha District, and in accordance with EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5; applicable elements of the USACE Engineering Regulation ER 1110-1-263; Engineering and Design Chemical Quality Management for Hazardous Waste Remedial Activities (USACE April 1996); and other applicable regulations and guidances. This QAPP Addendum is written to include the field activities associated with this investigation of SWMUs 86-90 (Site SD-11).

1.2 PLAN INTEGRATION

This QAPP Addendum is an integral part of a set of plans prepared to document site activities that are to be carried out at Cannon AFB. The other documents to be used in conjunction with the QAPP include the Work Plan/Field Sampling Plan Addendum and the Health and Safety Plan Addendum..

1.3 QAPP ADDENDUM ORGANIZATION

The following provides information on the outline of this Addendum and how it should be used in conjunction with the original QAPP.

Section 1.0	Introduction - Addendum
Section 2.0	Project Description - See Original QAPP
Section 3.0	Project Organization and Responsibility - See Original QAPP
Section 4.0	Quality Assurance Objectives - Addendum
Section 5.0	Sampling and Field Procedures - See Original QAPP
Section 6.0	Sample and Document Custody - See Original QAPP
Section 7.0	Calibration Procedures and Frequency - See Original QAPP
Section 8.0	Analytical Procedures - Addendum
Section 9.0	Analytical Data Reduction, Reporting, and Review Process - See

	Original QAPP
Section 10.0	Internal Quality Control Checks - See Original QAPP
Section 11.0	Performance and System Audits - See Original QAPP
Section 12.0	Preventative Maintenance - See Original QAPP
Section 13.0	Data Measurement Assessment Procedures - See Original QAPP
Section 14.0	Corrective Action - See Original QAPP
Section 15.0	Quality Assurance Reports to Management - See Original QAPP
Section 16.0	Data Management - See Original QAPP
Section 17.0	References - See Original QAPP

4.1 GENERAL

The overall QA philosophy for the CMS at Cannon AFB is to provide measurement tools so that data collected will be defensible and of known quality. As such, the environmental data generated must meet quality assurance objectives designed to support decisions to be made concerning the respective SWMUs. Quality assurance activities for field measurement systems are also an important aspect of this design. Activities for nonchemical data will be discussed in the appropriate SOPs. The following paragraphs discuss field and laboratory analytical measurements.

All laboratory procedures are documented in writing as either laboratory 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 Laboratory Quality Assurance Plan (LQAP) and SOPs (available upon request). These specifications include the types of QC samples required (sample spikes, surrogate spikes, reference samples, controls, blanks), the frequency of each, the compounds to be used for sample spikes and surrogate spikes, and the quality control acceptance criteria. The QC level of effort for analytical testing is summarized in Table 4-1.

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. If sufficient sample is not available or holding times would be compromised, it may be necessary to obtain replacement samples.

Quality assurance objectives for analytical data are usually expressed in terms of precision, accuracy, completeness, representativeness, comparability and sensitivity. 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 of corrective measures on the usability of the data in the decision-making process. The documentation acquired as a result of QC procedures will be included in the assessment of the usability of the analytical data.

The specific project objectives for the CMS and the data needs and uses are described in detail in the WP. In general, analytical data generated from the CMS will be used to:

- Further define the extent and degree of contamination levels at this site
- Further assess the potential for contaminant migration in the surrounding environment
- Further identify public health and environmental risks of contaminants relative to applicable regulatory standards

- Based on the results of the Risk-Based Corrective Action (RBCA) criteria for the assessment and response to a petroleum release, evaluate and justify the "No Further Action" alternative or appropriate RBCA alternative

Soil samples, along with designated QC samples, will be sent to an off-site analytical laboratory and analyzed for VOCs, SVOCs, total petroleum hydrocarbons (TPH), diesel range organics (DRO), and total recoverable petroleum hydrocarbons (TRPH)

Quality control samples and procedures to be utilized by the laboratory for each analysis are described in the LQAP (available upon request).

A data review of each sample delivery group shall be completed as described in Section 9.0 of the original QAPP. This review will be completed using EPA Functional Guidelines where appropriate. A minimum of 10 percent of the analytical data, as defined in Section 9.0 of the original QAPP, will undergo complete validation.

Data will be assessed for its usability to support SWMU-specific decisions.

As part of the USACE quality assurance program, designated duplicate/split samples will be sent to the Chemical and Materials Quality Assurance Laboratory (CMQAL) for analysis.

4.2 FIELD QA/QC SAMPLES

The following paragraphs describe the QA/QC samples anticipated for the Cannon AFB CMS.

4.2.1 Field Duplicates

Field duplicate samples for soil will be collected and submitted for analysis in conjunction with the field samples. Field duplicates will be sampled such that collocated samples will be obtained from the sampling device in a manner which minimizes loss due to volatilization (i.e., VOA samples will be collected first). Additionally, for soil, the material remaining in each half of the sampling device will be homogenized separately in stainless-steel bowls before the materials are collected for additional analyses.

Field duplicate results will provide estimates of overall precision of sample collection, field sample preparation, and laboratory analysis (total within-batch measurement variability). Subdividing one or both of the collocated samples just prior to analysis provides for an estimate of laboratory precision. Soil duplicates homogenized for nonvolatile analysis provide information on sampling precision as well as providing an estimate of representativeness in addition to laboratory precision. Additionally, samples will be split and analyzed by two different laboratories (the contracted analytical laboratory and CMQAL) which will help quantify the error associated with subsampling (i.e., split preparation) and laboratory bias or to estimate interlaboratory variability.

In general, field duplicates will represent 10 percent of the samples collected. While the location and number of duplicates have been specified in the WP, additional duplicates may be collected depending upon conditions encountered during field activities. These additional duplicate samples would be collected whenever such collection and analysis would be required for assessing the usability of the data. Evaluation criteria for field duplicates are discussed in Section 4.5.1.

4.2.2 Matrix Spike/Matrix Spike Duplicate Samples

Matrix spike and matrix spike duplicate (MS/MSD) samples specific to Cannon AFB AOC matrices will be submitted for organic analysis in conjunction with the field samples. Also, matrix spike and duplicate (MS/D) samples will be submitted for metals analysis. Results from MS/MSD or MS/D samples may be used to assess the potential for sample matrix interferences versus laboratory analytical errors, as well as to monitor the accuracy of the analysis.

In general, field MS/MSD or MS/D samples will represent 10 percent of the samples collected. While the location and number of duplicates have been specified in the WP, additional MS/MSD may be collected depending upon conditions encountered during field activities. These additional MS/MSD samples would be collected whenever such collection and analysis would be required for assessing the usability of the data. Evaluation criteria for field MS/MSD are available in Tables 4-2 through 4-4.

4.3 LABORATORY QA/QC SAMPLES

4.3.1 Method or Preparation Blank

A method blank consists of analyte-free deionized water or washed sea 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 contamination attributed to laboratory operations during analysis.

4.3.2 Laboratory Control Samples (LCS)

Laboratory control samples (LCS) are well-characterized, laboratory-generated samples and will be used to monitor the laboratory's day-to-day performance of analytical methods. LCS will be used to monitor the accuracy of the analytical process independent of matrix effects.

The results of the LCS will be compared to well-defined acceptance criteria (Tables 4-2 through 4-4) to determine whether the laboratory system is "in control". Controlling lab operations with LCS (rather than surrogates or MS/MSD) offers the advantage of being able to differentiate low recoveries due to procedural errors from those due to matrix effects.

4.3.3 Surrogate Spike

A compound or compounds are 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. QC evaluation criteria for surrogate spikes are presented in Table 4-5.

4.4 QUANTITATIVE QA/QC MEASUREMENTS

4.4.1 Precision

Precision is the measure of variability between individual sample measurements under prescribed conditions. Precision can be assessed by replicate measurements of known laboratory standards and analysis of duplicate environmental samples. Precision will typically be determined as relative percent difference (RPD) between duplicate sample results; however, replicate samples can be compared by calculating the sample standard deviation.

Duplicate environmental samples submitted from the field will comply with the criteria established in the WP. Precision acceptance criteria for MS/MSD samples to be achieved by the analytical laboratory for the parameters to be analyzed are provided in Tables 4-2 through 4-4.

4.4.2 Accuracy

Accuracy is the degree of agreement of a measurement to an accepted reference or true value. An evaluation of the accuracy of a measurement system provides an estimate of bias. The accuracy of an analytical method is evaluated by analyzing known reference standards. The percent recovery achieved by analysis of known reference standards or spiking compounds will be used to define the accuracy for the compounds of interest. One known reference standard is also analyzed for every batch of 20 samples. The percent recovery of an analyte is calculated by dividing the "true" value, T, into the observed value, X, and multiplying by 100.

The specific criteria ranges of accuracy for each measurement parameter are defined within the analytical test methods. Acceptable accuracy measures are also dependent on the sample matrix. Accuracy acceptance criteria (percent recovery) for the parameters to be analyzed are provided in Tables 4-2 through 4-5. The measurement of these data quality objectives are assessed for the laboratory control samples. Criteria for matrix spikes will be used to assess the potential for matrix interference.

4.4.3 Method/Project-Required Detection Limits

Reporting limits are defined as the lowest level of measurement that can be reliably achieved within specified limits of precision and accuracy under routine laboratory operating conditions. Tables 8-2 through 8-4 list the project-required reporting limits for analyses to be conducted under this QAPP Addendum. These are the reporting limits that the laboratory must be able to meet on pure water using the analytical methods specified in Table 8-1. The reporting limits for samples may be considerably higher depending upon the sample matrix.

The reporting limits desired for analyses at Cannon AFB are expected to meet requirements for risk-based decisions. However, when using EPA SW-846 methodologies that cover a broad range of compounds, there is a potential for certain analytes to exhibit elevated reporting limits. These occasions will be addressed as they arise and evaluated against the DQOs. When it can be anticipated that information on chemicals of concern is needed below reporting limits normally obtained by one methodology, another method may be utilized to provide supplemental information.

4.4.4 Analytical Completeness

The overall laboratory completeness goal for data for this project shall be 90 percent. If the completeness criterion of 90% is not achieved, W-C will evaluate the impact on the decisions and consult with USACE to determine appropriate actions.

4.5 QUALITATIVE QA/QC MEASUREMENTS

4.5.1 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.

Collocated duplicate samples will be collected and utilized as a means to assess field representativeness. Satisfactory representativeness will be assessed by the agreement between analytical results for collocated field duplicate samples. Satisfactory representativeness will be determined by the following criteria. The first level of evaluation will be to compare results to the evaluation criteria listed in Tables 4-2 through 4-5. Should these criteria be exceeded, further assessment with respect to project objectives will occur.

For analytes with both sample concentrations greater than 5x the reporting limit, the duplicate sample results should agree within 50 percent relative percent difference (RPD) for soil samples. For analytes with either or both sample concentrations less than 5x the reporting limit, duplicate sample results should agree within ± 2x the reporting limit for soil samples. Results for analytes

not meeting these criteria will be qualified as estimated in all associated samples during the review process.

Representativeness will be maintained during the sampling effort by completing all sampling in compliance with the procedures described in Section 5.0 of this document and in respective sections in the WP. A summary of the collocated duplicate samples to be collected is provided in the WP.

4.5.2 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.

TABLE 4-1

QC LEVEL OF EFFORT FOR ANALYTICAL TESTING

Parameters	QC Measure	Minimum Frequency
Volatile Organic Compounds, Semivolatile Organic Compounds, Total Petroleum Hydrocarbons (TPH), and Total Recoverable Petroleum Hydrocarbons (TRPH)	Initial Calibration	Initially
	Laboratory Blank	One per analytical batch
	Continuing Calibration	Daily for each instrument setup
	Laboratory Control Sample	One per analytical batch
	Matrix Spike Analysis	One per analytical batch[1]
	Matrix Spike Duplicate Analysis	One per analytical batch[1]
	Surrogate Spike	Each sample

[1] An analytical batch consists of 20 or fewer samples extracted/analyzed together.

TABLE 4-2

ACCURACY AND PRECISION FOR VOCS BY METHOD[1] 8260B

Analyte	LCS % Recovery	Matrix Spike % Recovery	MS/MSD RPD % Recovery
1,1-Dichloroethane	30-160	70-156	26
Benzene	63-141	66-130	16
Chlorobenzene	61-143	68-128	14
Toluene	62-148	52-139	35
Trichoroethene	65-146	63-136	22

[1] All samples will be analyzed by the referenced method as outlined in "Test Methods for Evaluating Solid Waste Physical/Chemical Methods," SW-846 Final Update.

LCS = Laboratory Control Sample
RPD = Relative Percent Difference

TABLE 4-3

ACCURACY AND PRECISION FOR SVOCS BY METHOD[1] 8270C

Analyte	LCS % Recovery	Matrix Spike % Recovery	MS/MSD RPD % Recovery
1,2,4-Trichlorobenzene	40-121	40-121	30
1,4-Dichlorobenzene	34-107	34-107	36
2,4-Dinitrotoluene	32-127	32-127	25
2-Chlorophenol	40-106	40-106	30
4-Chloro-3-methylphenol	55-120	55-120	22
4-Nitrophenol	23-143	23-143	37
n-Nitrosodi-n-propylamine	48-118	48-118	28
Pentachlorophenol	20-159	20-159	43
Phenol	41-109	41-109	28
Pyrene	25-141	25-141	50

[1] All samples will be analyzed by the referenced method as outlined in "Test Methods for Evaluating Solid Waste Physical/Chemical Methods," SW-846 Final Update.

LCS = Laboratory Control Sample
RPD = Relative Percent Difference

TABLE 4-4

ACCURACY AND PRECISION FOR PETROLEUM HYDROCARBONS BY METHOD 8015[1] AND 418.1[2]

Analyte	LCS % Recovery	Matrix Spike % Recovery	Matrix Duplicate % Recovery
Petroleum Hydrocarbons			
Diesel Range Organics	50-150	50-150	50
Total Recoverable Petroleum Hydrocarbons	51-122	51-122	26

[1] All samples will be analyzed by the referenced method as outlined in "Test Methods for Evaluating Solid Waste Physical/Chemical Methods," SW-846 Final Update.

[2] Sample will be analyzed for TRPH as outlined in "Methods for Chemical Analysis of Water and Waste".

LCS = Laboratory Control Sample
RPD = Relative Percent Difference

TABLE 4-5

SURROGATE RECOVERY CRITERIA

Parameter	Method[1]	Analyte	Accuracy
Volatile Organics	8260B	1,2-Dichloroethane	60-140
		Toluene-d_8	60-140
		Bromofluorobenzene	60-140
Semivolatile Organics	8270C	Nitrobenzene-d_5	24-102
		2-Fluorobiphenyl	32-99
		1,2-Dichlorobenzene	23-95
		Terphenyl-d_{14}	31-109
		Phenol-d_5	24-112
		2-Fluorophenol	25-108
		2,4,6-Tribromophenol	19-122
		2-Chlorophenol	29-111
TPH	8015B	2-Fluorobiphenyl (DRO)	50-150
		p-Terphenyl (DRO)	50-150

[1] All samples will be analyzed by the referenced method as outlined in "Test Methods for Evaluating Solid Waste Physical/Chemical Methods," SW-846 Final Update or Methods for Chemical Analysis of Water and Waste".

TPH = Total Petroleum Hydrocarbons
GRO = Gasoline Range Organics
DRO = Diesel Range Organics

8.1 LABORATORY PROCEDURES

The general laboratory procedures anticipated for the CMS of SD-11 at Cannon AFB are summarized in Table 8-1 and include EPA SW-846 and other appropriate EPA methodologies. The specific analyses planned for each SWMU are defined in the FSP. Specific laboratory practices for the methods listed below, including sample preparation, sample tracking, and documentation controls, are provided in the LQAP (available upon request).

8.1.1 Volatile Organic Compounds (VOCs)

Volatile organic compounds (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. The third class includes compounds associated with petroleum hydrocarbons such as BTEX.

Method 8260B is a purge-and-trap gas chromatographic (GC) method appropriate for analysis of suspected VOCs and employs mass spectrometry (MS) for detection. The power of GC/MS lies in the capacity for positive identification at project-required quantitation limits. Volatile organic compounds to be analyzed by GC/MS at Cannon AFB are listed in Table 8-2 with associated reporting limits.

8.1.2 Semivolatile Organic Compounds (SVOCs)

Method 8270C is a GC/MS method appropriate for determining SVOCs (base/neutral and acid extractable). This procedure will include analysis to detect the general classes of compounds such as phenols, nitrosamines, polyaromatic hydrocarbons (PAHs), and other less volatile compounds of concern. The list of SVOC analytes and reporting limits are provided in Table 8-3.

8.1.3 Petroleum Hydrocarbons

Samples will be analyzed for total petroleum hydrocarbons by Modified Method 8015. The laboratory will report data as DRO. This method utilizes fingerprinting by gas chromatography using a flame ionization detector (FID) for identification. Samples will also be analyzed for total recoverable hydrocarbons (TRPH) by Method 418.1 Reporting limits are provided in Table 8-4.

TABLE 8-1

ANALYTICAL PROCEDURES FOR CANNON AFB SITE INSPECTIONS

Parameter	Technique[1]	Extraction and Analysis Method Soil
Volatile Organics	GC/MS	5030/8260B
Semivolatile Organics	GC/MS	3550/8270C
Total Petroleum Hydrocarbons (Diesel Range)	GC/FID	3550/8015B
Total Recoverable Petroleum Hydrocarbons (TRPH)	IR	9071/418.1 (1640)

[1] GC/MS = gas chromatography/mass spectrometry, FID = flame ionization detector. The 3000-9000 methods are from the 3rd Edition, SW-846.

TABLE 8-2

REPORTING LIMITS FOR VOLATILE ORGANICS BY METHOD 8260B

	Laboratory MDL (µg/kg)	PQL Soil (µg/kg)
Volatile Organics		
1,1,1-Trichloroethane	0.22	3
1,1,2,2-Tetrachloroethane	0.34	3
1,1,2-Trichloroethane	0.31	3
1,1-Dichloroethane	0.34	3
1,1-Dichloroethene	0.43	3
1,2-Dichloroethane	0.24	3
1,2-Dichloropropane	0.22	3
2-Butanone	0.54	5
2-Hexanone	0.38	5
4-Methyl-2-pentanone	0.28	5
Acetone	1.6	5
Benzene	0.36	3
Bromodichloromethane	0.18	3
Bromoform	0.27	3
Bromomethane	0.29	3
Carbon disulfide	0.3	3
Carbon tetrachloride	0.57	3
Chlorobenzene	0.29	3
Chloroethane	0.55	3
Chloroform	0.38	3
Chloromethane	0.55	3
cis-1,2-Dichloroethene	0.26	3
cis-1,3-Dichloropropene	0.33	3
Dibromochloromethane	0.1	3
Dichlorodifluoromethane	0.85	3
Ethylbenzene	0.3	3
Methylene chloride	0.22	3
Styrene	0.39	3
Tetrachloroethene	0.43	3
Toluene	0.32	3

TABLE 8-2

REPORTING LIMITS FOR VOLATILE ORGANICS BY METHOD 8260B (Continued)

	Laboratory MDL (µg/kg)	PQL Soil (µg/kg)
Volatile Organics		
trans-1,2-Dichloroethene	0.43	3
trans-1,3-Dichloropropene	0.2	3
Trichloroethene	0.55	3
Trichlorofluoromethane	NA	3
Vinyl chloride	0.69	3
m,p-Xylenes	0.94	3
o-Xylene	0.37	3

MDL = Method Detection Limit
PQL = Practical Quantitation Limit

Note: The laboratory will report values less than the PQL and greater than the MDL. These values will be reported as estimated "J".

TABLE 8-3

REPORTING LIMITS FOR SEMIVOLATILE ORGANICS BY METHOD 8270C

	Laboratory MDL (µg/kg)	PQL Soil (µg/kg)
Semivolatile Organics		
1,2,4-Trichlorobenzene	43.2	333
1,2-Dichlorobenzene	45.3	333
1,3-Dichlorobenzene	32.8	333
1,4-Dichlorobenzene	53	333
2,4,5-Trichlorophenol	39.7	333
2,4,6-Trichlorophenol	32.9	333
2,4-Dichlorophenol	65.3	333
2,4-Dimethylphenol	21.3	333
2,4-Dinitrophenol	26.4	333
2,4-Dinitrotoluene	23.1	333
2,6-Dinitrotoluene	42	333
2-Chloronaphthalene	41.3	333
2-Chlorophenol	29.3	333
2-Methylnaphthalene	37.9	333
2-Methylphenol(8)	32.9	333
2-Nitroaniline	75.8	333
2-Nitrophenol	29	333
3,3'-Dichlorobenzidine	54.8	333
3-Nitroaniline	30.6	333
4,6-Dinitro-2-methylphenol	33.9	333
4-Bromophenyl phenyl ether	55.5	333
4-Chloro-3-methylphenol	30.6	333
4-Chloroaniline	11.1	333
4-Chlorophenyl phenyl ether	15.7	333
4-Methylphenol	50.8	333
4-Nitroaniline	69.3	333
4-Nitrophenol	58.6	333
Acenaphthene	35.7	333
Acenaphthylene	41.5	333
Aniline	6	333
Anthracene	44.9	333
Benzo(a)anthracene	40	333
Benzo(a)pyrene	54	333
Benzo(b)fluoranthene	50.7	333
Benzo(g,h,i)perylene	20.08	333
Benzo(k)fluoranthene	57.8	333
Benzoic Acid	30.4	333

TABLE 8-3

REPORTING LIMITS FOR SEMIVOLATILE ORGANICS BY METHOD 8270C (Continued)

	Laboratory MDL (µg/kg)	PQL Soil (µg/kg)
Semivolatile Organics		
Benzyl alcohol	36.3	333
Bis(2-chloroethoxy)methane	34.9	333
Bis(2-chloroethyl)ether	23.1	333
Bis(2-chloroisopropyl)ether	29.2	333
Bis(2-ethylhexyl)phthalate	46.3	333
Butyl benzyl phthalate	42.1	333
Carbazole	47.8	333
Chrysene	50.1	333
Di-n-butyl phthalate	56	333
Di-n-octyl phthalate	74.6	333
Dibenzo(a,h)anthracene	37.8	333
Dibenzofuran	20.5	333
Diethyl phthalate	45.7	333
Dimethyl phthalate	27	333
Fluoranthene	38.1	333
Fluorene	34.3	333
Hexachlorobenzene	43.5	333
Hexachlorobutadiene	27.1	333
Hexachlorocyclopentadiene	22.8	333
Hexachloroethane	60.5	333
Indeno(1,2,3-cd)pyrene	47.6	333
Isophorone	35.5	333
Nitrobenzene	38.3	333
n-Nitrosodiphenylamine	38.1	333
n-Nitrosodi-n-propylamine	48.4	333
Naphthalene	38.6	333
Pentachlorophenol	28.6	333
Phenanthrene	37.5	333
Phenol	44.2	333
Pyrene	38	333

MDL = Method Detection Limit
PQL = Practical Quantitation Limit

TABLE 8-4

REPORTING LIMITS FOR PETROLEUM HYDROCARBONS BY METHOD 8015B AND 418.1

	Laboratory MDL (mg/kg)	PQL Soil (mg/kg)
TPH (Method 8015B)		
Diesel Range Organics	1.2	25
TRPH (Method 418.1)		
Total Recoverable Hydrocarbons	9.3	20

MDL = Method Detection
PQL = Practical Quantitation Limit

FINAL

SITE SAFETY AND HEALTH PLAN ADDENDUM FOR THE CORRECTIVE MEASURES STUDY AT SWMUs 86 - 90 (SITE SD-11) CANNON AFB, NEW MEXICO

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

August 1998

Project Name Cannon AFB SD-11 Investigation **Project #** M9602V **Location** Cannon AFB, New Mexico

Project Manager Steve Cox **Effective Dates** 6-1-98 through 12-31-98 **Prepared By** Jeff Hopkins

( ) New Plan (X) Amendment to Existing Approved HSP RCRA Facility Investigations Appendix III SWMUs, September 1993

Description of Activities

Preliminary Assessment	( )	Cleanup	( )	Active	(X)	Landfill	( )	Unknown	( )
Initial Investigation "Walk Through"	( )	Oversight	( )	Inactive	( )	Uncontrolled	( )	Jet Engine Test Stand	( )
Initial Investigation "Sampling"	(X)	Long-term monitoring	( )	Secure	(X)	Industrial	( )		
Site Characterization	( )	Background Sampling	( )	Unsecure	( )	Recovery	( )		
				Enclosed Space	( )	Well Field	( )		

Scope of Work:

The overall intent of this investigation is to provide additional site characterization in the area of the former evaporation pond at Site SD-11, and to ensure that the lateral and vertical extent of contamination has been determined. Three soil borings will be drilled within the boundaries of the evaporation pond. Five soil samples will be collected from each boring and analyzed for a variety of organic compounds.

Surrounding Area: ( ) Residential ( ) Industrial ( ) Commercial ( ) Rural ( ) Urban (X) Other:: (Military Installation)

Site Location and Description:

Site SD-11 includes five Solid Waste Management Units (SWMUs 86 through 90) located in the sparsely populated southeast part of Cannon AFB, about 5,000 feet east and 2,000 feet south of the intersection of the two main runways (see Figure 1-2 of the Corrective Measures Study Work Plan). The site consists of a former engine test cell (SWMU 86), former overflow pit (SWMU 87), former leach field (SWMU 88) which was later converted to an evaporation pond (SWMU 89), and a former oil/water separator with associated 100-gallon collection tank (SWMU 90).

Site History:

The history of Cannon AFB is described in Section 2.1 of the QAPP. The area surrounding the sampling locations for this investigation are generally undeveloped with the exception of roadways and perimeter fences.

Previous Investigations and Reports:

Numerous environmental investigations have been completed at Cannon AFB. Reports generated by Woodward-Clyde include:

- Remedial Investigation - Appendix I SWMUs (W-C 1992-1993)
- RFI (Phase I) - Landfills 1 and 2 (W-C 1992-1993)
- RFI (Phase I) - Appendix III SWMUs (W-C 1993)
- RFI (Phase II) - Appendix II SWMUs (W-C 1994-1995)
- RFI (Phase II) - Appendix III SWMUs (W-C 1994-1995)
- RFI (Phase III) - Appendix I SWMUs (W-C 1996)

Previous Monitoring Results:

Low levels of VOCs and SVOCs were detected in soil samples collected from Site SD-11 during the RFI Phase III completed in 1996. During the drilling activities of this investigation, a PID was used to monitor organic compound concentrations in the breathing zone of site workers. The recorded concentrations were all less than 1 ppm.

Known or Suspected Releases at the Site:

Site operations that may have generated contaminants include the cleaning and testing of jet aircraft engines.

Chemical Hazards

Chemical hazards that may be encountered at this site include ethylbenzene, toluene, xylene, and several PAHs.

Physical Hazards

Physical hazards may include slips, trips, and falls, and heat or cold stress. A detailed description of these hazards and hazards associated with drilling are in the attached SOPs.

Working around heavy equipment presents a risk of physical injury and noise exposure.

Biological Hazards - Field personnel are at risk of exposure to insect bites, bee stings, and poisonous plants and snakes.

Hazard Assessment

(X) Heat Stress (attach guidelines)
( ) Cold Stress (attach guidelines)
( ) Explosion/Flammable
( ) Oxygen Deficient
( ) Radiological
(X) Biological

(X) Inorganic Chemicals
(X) Organic Chemicals
(X) Buried/Overhead Utilities
(X Other (Noise)

Overall Hazard Evaluation ( ) High ( ) Medium (X) Low ( ) Unknown

Explanation:

The protocol for workspace monitoring should provide warning if potentially dangerous chemicals are encountered.

Good work practices and the use of appropriate PPE should minimize the risk to physical, chemical, and biological hazards.

Field Investigation Activities Covered Under This Plan

Task Description/Specific Technique-Standard Operating Procedures/Site Location	Type	Primary	Contingency	Schedule/Notes
1. Soil Borings	Intrusive	D	Stop Work	

Site Access and Establishment of Work Zones:

An exclusion zone will be established at least 10 feet around each sampling location. Decontamination will be done at the edge of the exclusion zone or at a centralized location.

General Safety Procedures:

Personnel will use the buddy system

A safety briefing will be held at the beginning of field activities

No eating, drinking, smoking, or other hand-to-mouth activities in the established exclusion zone.

All health and safety incidents are to be reported following W-C Operating Procedure No. HS-102 (attached). In addition, an Accident Investigation Report (USACE ENG. Form 3394, Sep 89) shall also be submitted in the event of any accident resulting from activities specified in the Health and Safety Plan. A copy of ENG Form 3394 is attached in this plan.

Protective Equipment: (Specify by task. Indicate type and/or material, as necessary.)

Tasks: 1

Level: D

[X] **Primary**

Respiratory

- [X] Not Needed
- [ ] SCBA, Airline:
- [ ] APR:
- [ ] Cartridge:
- [ ] Escape Mask:
- [ ] Other:

Head and Eye

- [ ] Not Needed
- [X] Safety Glasses:
- [ ] Face Shield:
- [ ] Goggles:
- [X] Hard Hat: when working with drill rig
- [ ] Other:

Boots

- [ ] Not Needed
- [X] Boots: Steel toe work boots
- [ ] Overboots:

Protective Clothing

- [X] Not Needed
- [ ] Tyvek Coverall:
- [ ] Polycoat Coverall
- [ ] Saranex Coverall
- [ ] Coverall
- [ ] Other:

Gloves

- [ ] Not Needed
- [ ] Undergloves:
- [X] Gloves: Nitrile or Latex (when handling soil)

Other (specify below)

Hearing protection when noise levels are expected to exceed 85 dBA

Monitoring Equipment:

Instrument	Tasks	Action Guidelines	Comments
PID	1	10 ppm in breathing zone; contact HSO.	Calibrate to benzene equivalent with 100 ppm isobutylene.

Emergency Contacts	Name	Telephone	Emergency Contacts	Name	Telephone
Health and Safety Officer	Jeff Hopkins	402/334-8181			
Corporate Health and Safety Officer	Charles Self Phil Jones	318/478-5532 215/542-8300			
On-Site/Client Representative	Sanford Hutsell	505/784/2739			
Fire Department	Cannon AFB	505/784-3117			
Police Department	Cannon AFB	505/784-2667			

Medical Emergency		Directions to Hospital
Cannon AFB Hospital Building 1400 Cannon AFB, New Mexico	505/784-4033	Cannon AFB (Figure 1) The Base hospital is located in Building 1400 on Casablanca Avenue on the northwest corner of the Base. The Site Safety Officer is responsible for making sure all personnel have been shown the location of the hospital.

Attach Map With Route To Hospital

Site Health and Safety Plan Approvals

PM Signature: [signature] Date: 5/21/98

BUHSO Signature: Jeffrey S. Hopkins Date: 5/20/98

CHSO Signature: Charles W. Self Date: 5/20/98

Attachments:

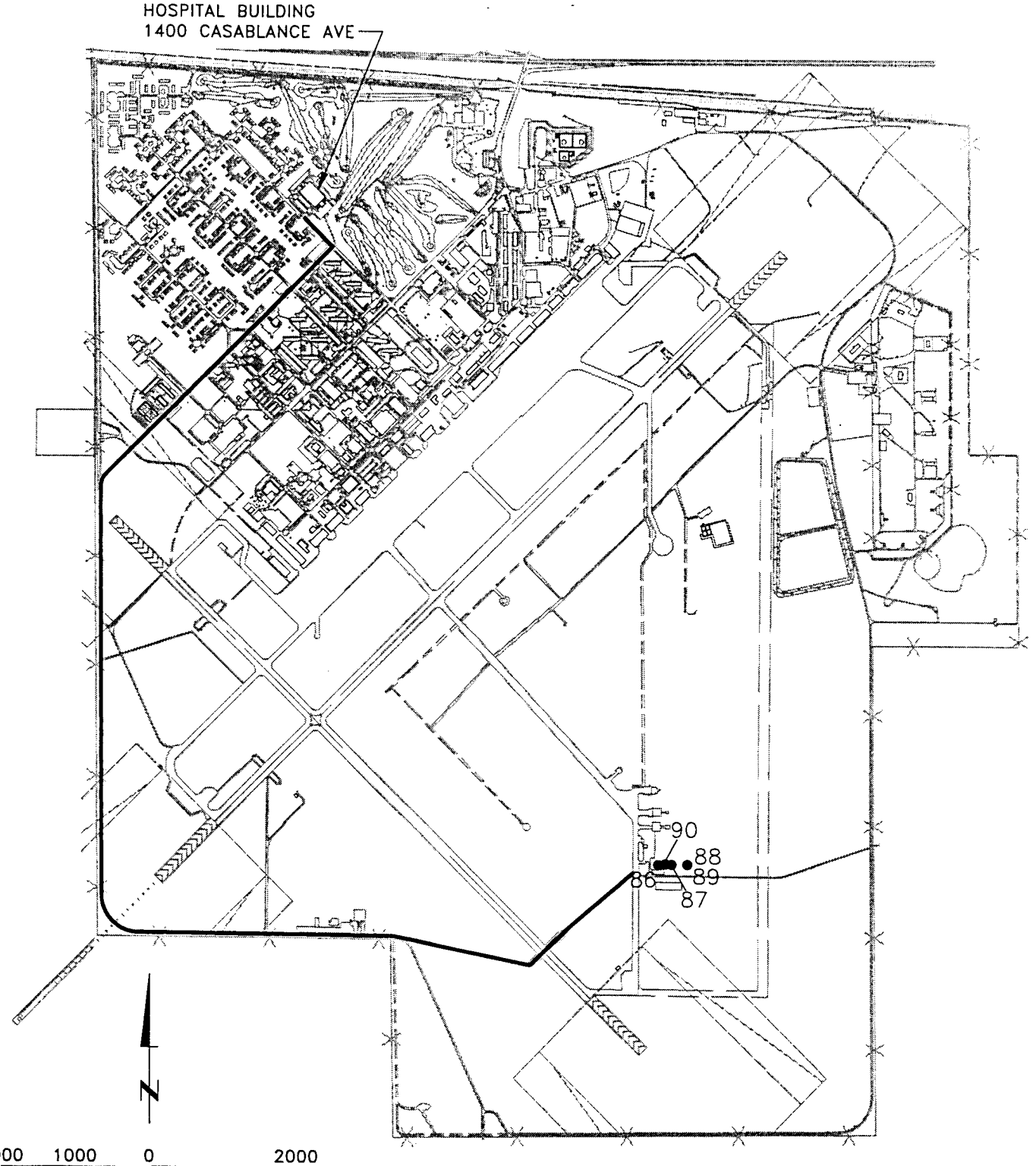
(X) Heat Stress (HS-201)
(X) Incident/Accident Reporting (HS-102)

REPORT PHASE: PHASE 2SR SITE SD-11

LEGEND

3 ● SOILD WASTE MANAGEMENT UNIT (SWMU) LOCATION AND NUMBER

SWMU No.	DESIGNATED AREA
86	SD-11 ENGINE TEST CELL
87	SD-11 FORMER OVERFLOW PIT
88	SD-11 FORMER LEACHING FIELD
89	SD-11 EVAPORATION POND
90	SD-11 OIL/WATER SEPARATOR No. 5114



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SCALE IN FEET

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Drawing: T:\CANNON\M9602V\T3200\FIG1.DWG (TSM)
Xrefs: CAN-BASE.DWG

DRN. BY: TSSM	DATE: 07/17/98	ROUTE TO HOSPITAL CANNON AIR FORCE BASE CLOVIS, NEW MEXICO	PROJECT NO.	FIG. NO.
CHK'D. BY:	REVISION: 0		M9602V	1

OPERATING PROCEDURE NO. HS-102

102.0 INCIDENT REPORTS

102.1 PURPOSE

All health and safety incidents shall be reported to Woodward-Clyde (W-C) management and health and safety staff. The prompt investigation and reporting of incidents will reduce the risk of future incidents, better protect W-C employees, and reduce W-C liability.

102.2 DEFINITIONS

A health and safety incident is any event listed below:

- Illness resulting from chemical exposure or suspected chemical exposure.
- Physical injury, including both those that do and do not require medical attention to W-C employees or W-C subcontractors.
- Fire, explosions, and flashes resulting from activities performed by W-C and its subcontractors.
- Property damage resulting from activities performed by W-C and its subcontractors.
- Vehicular accidents occurring on-site, while traveling to and from client locations, or with any company-owned vehicle.
- Infractions of safety rules and requirements.
- Unexpected chemical exposures.
- Complaints from the public regarding W-C field operations.

102.3 REPORTING PROCEDURES

Reporting Format

Incident reports shall be prepared by completing Form HS-102. This form may be obtained from any W-C Health and Safety Officer (HSO) and is attached to this operating procedure.

Responsible Party

Reports of incidents occurring in the field shall be prepared by the Site Safety Officer or, in the absence of the site safety officer, the supervising field engineer, witness, or injured/exposed individual.

Filing

A report must be submitted to the Health and Safety Officer of the Operating Unit to which the Project Manager belongs within 24 hours of each incident involving medical treatment. In turn, the Health and Safety Officer must distribute copies of the report to the Corporate Health and Safety Manager and the Corporate Health and Safety Officer. When an injury or illness is reported, the Health and Safety Officer must deliver a copy of the report to the individual in charge of Human Resources so that a Worker's Compensation Insurance Report can be filed if necessary. Reports must be received by Human Resources within 48 hours of each qualifying incident.

Major Incidents

Incidents that include fatalities, hospitalization of employees or subcontractors, or involve injury/illness of the public shall be reported to the HSO and Project Manager as soon as possible. Any contact with the media should be referred to the Project Manager and Operating Unit Manager.

FORM HS-102
W-C HEALTH AND SAFETY INCIDENT REPORT

Project Name: _____

Project Number: _____

Date of Incident: _____

Time of Incident: _____

Location: _____

_____

TYPE OF INCIDENT (Check all applicable items)

☐ Illness ☐ Fire, explosion, flash

☐ Injury ☐ Unexpected exposure

☐ Property Damage Vehicular Accident

☐ Health & Safety Infraction

☐ Other (describe) _____

DESCRIPTION OF INCIDENT (Describe what happened and possible cause. Identify individual involved, witnesses, and their affiliations; and describe emergency or corrective action taken. Attach additional sheets, drawings, or photographs as needed.)

_____

_____

_____

_____

_____

_____

Reporter: _____ _____ _____

Print Name Signature Date

Reporter must deliver this report to the Operating Unit Health & Safety Officer within 24 hours of the reported incident for medical treatment cases and within five days for other incidents.

Reviewed by: _____ _____

Operating Unit Health & Safety Officer Date

Distribution by HSO:

- WCGI Corporate Health and Safety Manager
- Corporate Health and Safety Officer
- Project Manager
- Personnel Office (medical treatment cases only)

OPERATING PROCEDURES NO. HS-201

201.0 HEAT STRESS

201.1 PURPOSE

The purpose of this Operating Procedure is to provide general information on heat stress and the methods that can be utilized to prevent or minimize the occurrence of heat stress.

Adverse climatic conditions are important considerations in planning and conducting site operations. Ambient temperature effects can include physical discomfort, reduced efficiency, personal injury, and increased accident probability. Heat stress is of particular concern while wearing impermeable protective garments, since these garments inhibit evaporative body cooling.

201.2 TYPES OF HEAT STRESS

Heat stress is the combination of environmental and physical work factors that constitute the total heat load imposed on the body. The environmental factors of heat stress are the air temperature, radiant heat exchange, air movement, and water vapor pressure. Physical work contributes to the total heat stress of the job by producing metabolic heat in the body in proportion to the intensity of the work. The amount and type of clothing also affects heat stress.

Heat strain is the series of physiological responses to heat stress. When the strain is excessive for the exposed individual, a feeling of discomfort or distress may result, and, finally, a heat disorder may ensue. The severity of strain will depend not only on the magnitude of the prevailing stress, but also on the age, physical fitness, degree of acclimatization, and dehydration of the worker.

Heat disorder is a general term used to describe one or more of the heat-related disabilities or illnesses shown in Table 201-1.

201.3 METHODS OF CONTROLLING HEAT STRESS

As many of the following control measures, as appropriate, should be utilized to aid in controlling heat stress:

- Provide for adequate liquids to replace lost body fluids. Encourage personnel to drink more than the amount required to satisfy thirst. Thirst satisfaction is not an accurate indicator of adequate salt and fluid replacement.

- Replace body fluids primarily with water, with commercial mixes such as Gatorade or Quick Kick used only as a portion of the replacement fluids. Avoid excessive use of caffeine drinks such as coffee, colas or tea.

- Establish a work regimen that will provide adequate rest periods for cooling down. The heat exposure Threshold Limit Values (TLV) may be used for guidelines.
- Provide shaded work areas, if possible.
- Wear cooling devices such as vortex tubes or cooling vests.
- Consider adjusting work hours to avoid the worst heat of the day.
- Take breaks in a cool rest area.
- Remove any impermeable protective garments during rest periods.
- Do not assign other tasks to personnel during rest periods.
- Inform personnel of the importance of adequate rest, acclimation, and proper diet in the prevention of heat stress.

201.4 MONITORING

201.4.1 Temperature

The environmental heat stress of an area can be monitored by the Wet Bulb Globe Temperature Index (WBGT) technique. When heat stress is a possibility, a heat stress monitoring device, such as the Wibget Heat Stress Monitor (Reuter Stokes) can be utilized.

The WBGT shall be compared to the TLV outlined by the American Conference of Governmental Industrial Hygienists (ACGIH) TLV guides, and a work-rest regiment can be established in accordance with the WBGT. Note that approximately 5°C must be subtracted from the TLVs listed for heat stress to compensate for the wearing of impermeable protective clothing.

201.4.2 Medical

In addition to the provisions of the Woodward-Clyde (W-C) medical surveillance program, on-site medical monitoring of personnel should be performed for projects where heat stress is a significant concern. Blood pressure, pulse, body temperature (oral), and body weight loss may be utilized.

Heart Rate: Count the radial pulse during a 30-second period as early as possible in the rest period. If the heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third. If the heart rate still exceeds 110 beats per minute at the next rest cycle, shorten the following work cycle by one-third.

Oral Temperature: Use a clinical thermometer or similar device to measure the oral temperature at the end of the work period (before drinking liquids). If the oral temperature exceeds 99.6°F (37.6°C), shorten the next work cycle by one-third without changing the rest period. If the oral temperature still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, shorten the following work cycle by one-third.

Do not permit a worker to wear a semipermeable or impermeable garment if his/her oral temperature exceeds 100.6°F (38.1°C).

Body Water Loss: Measure body weight on a scale accurate to ±0.25 pounds at the beginning and end of each work day (also at lunch break, if possible) to see if enough fluids are being taken to prevent dehydration. Weights should be taken while the employee wears similar clothing or, ideally, nude. The body water loss should not exceed 1.5 percent total body weight loss in a work day.

Physiological Monitoring: Initially, the frequency of physiological monitoring depends on the air temperature adjusted for solar radiation and the level of physical work. The length of the work cycle will be governed by the frequency of the required physiological monitoring.

201.5 REFERENCES

American Conference of Governmental Industrial Hygienists, Threshold Limit Values for Chemical Substances and Physical Agents, 1992-1993.

EPA, Standard Operating Safety Guides, 1992, Pages 91-93.

National Institute for Occupational Safety and Health, Criteria for a Recommended Standard: Occupational Exposure to Hot Environments, 1986.

TABLE 201-1
Classification, Medical Aspects, and Prevention of Heat Illness

Category and Clinical Features	Predisposing Factors	Underlying Physiological Disturbances	Treatment	Prevention
Temperature Regulation Heatstroke Heatstroke (1) Hot, dry skin; usually red, mottled, or cyanotic; (2) rectal temperature 40.5°C (104°F) and over; (3) confusion, loss of consciousness, convulsions, rectal temperature continues to rise; fatal if treatment is delayed	(1) Sustained exertion in heat by unacclimatized workers; (2) lack of physical fitness and obesity; (3) recent alcohol intake; (4) dehydration; (5) individual susceptibility; and (6) chronic cardiovascular disease	Failure of the central drive for sweating (cause unknown) leading to loss of evaporative cooling and an uncontrolled accelerating rise in temperature; there may be partial rather then complete failure of sweating	Immediate and rapid cooling by immersion in chilled water with massage or by wrapping in wet sheet with vigorous fanning with cool dry air; avoid overcooling; treat shock if present	Medical screening of workers, selection based on health and physical fitness; acclimatization for 5-7 days by graded work and heat exposure; monitoring workers during sustained work in severe heat
Circulatory Hypostasis Heat Syncope Fainting while standing erect and immobile in heat	Lack of acclimatization	Pooling of blood in dilated vessels of skin and lower parts of body	Remove to cooler area; rest in recumbent position; recovery prompt and complete	Acclimatization; intermittent activity to assist venous return to heat
Water and or Salt Depletion (a) Heat Exhaustion (1) Fatigue, nausea, headache, giddiness; (2) skin clammy and moist; complexion pale, muddy, or hectic flush; (3) may faint on standing with rapid thready pulse and low blood pressure; (4) oral temperature normal or low, but rectal temperature usually elevated (37.5-38.5°C or 99.5-101.3°F); water restriction type: urine volume small, highly concentrated; salt restriction type; urine less concentrated chlorides less than 3 g/L	(1) Sustained exertion in heat; (2) lack of acclimatization; and (3) failure to replace water lost in sweat	(1) Dehydration from deficiency of water; (2) depletion of circulating blood volume; (3) circulatory strain from competing demands for blood flow to skin and to active muscles	Remove to cooler environment; rest in recumbent position; administer fluids by mouth; keep at rest until urine volume indicates that water balances have been restored	Acclimatize workers using a breaking-in schedule for 5-7 days; supplement dietary salt only during acclimatization; ample drinking water to be available at all times and to be taken frequently during work day
(b) Heat Cramps Painful spasms of muscles used during work (arms, legs, or abdominal); onset during or after work hours	(1) Heavy sweating during hot work; (2) drinking large volumes of water without replacing salt loss	Loss of body salt in sweat, water intake dilutes electrolytes; water enters muscles, causing spasm	Salted liquids by mouth or more prompt relief by IV infusion	Adequate salt intake with meals; for unacclimatized workers, supplement salt intake at meals.

TABLE 201-1 (continued)
Classification, Medical Aspects, and Prevention of Heat Illness

Category and Clinical Features	Predisposing Factors	Underlying Physiological Disturbances	Treatment	Prevention
Skin Eruptions				
(a) Heat Rash (miliaria rubra, or "prickly heat")				
Profuse tiny raised red vesicles (blisterlike) on affected areas; prickling sensations during heat exposure	Unrelieved exposure to humid heat with skin continuously wet from unevaporated sweat	Plugging of sweat gland ducts with sweat retention and inflammatory reaction	Mild drying lotions; skin cleanliness to prevent infection	Cool sleeping quarters to allow skin to dry between heat exposures
(b) Anhidrotic Heat Exhaustion (miliaria profunda)				
Extensive areas of skin which do not sweat on heat exposure, but present gooseflesh appearance, which subsides with cool environments; associated with incapacitation in heat	Weeks or months of constant exposure to climatic heat with previous history of extensive heat rash and sunburn	Skin trauma (heat rash; sunburn) causes sweat retention deep in skin; reduced evaporative cooling causes heat intolerance	No effective treatment available for anhidrotic areas of skin; recovery of sweating occurs gradually on return to cooler climate	Treat heat rash and avoid further skin trauma by sunburn; provide periodic relief from sustained heat
Behavioral Disorders				
(a) Heat Fatigue - Transient				
Impaired performance of skilled sensorimotor, mental, or vigilance tasks, in heat	Performance decrement greater in unacclimatized and unskilled worker	Discomfort and physiologic strain	Not indicated unless accompanied by other heat illness	Acclimatization and training for work in the heat
(b) Heat Fatigue - Chronic				
Reduced performance capacity; lowering of self-imposed standards of social behavior (e.g., alcoholic over-indulgence); Inability to concentrate, etc.	Workers at risk come from temperature climates for long residence in tropical latitudes	Psychosocial stresses probably as important as heat stress; may involve hormonal imbalance but no positive evidence	Medical treatment for serious causes; speedy relief of symptoms on returning home	Orientation on life in hot regions (customs, climate, living conditions, etc.)

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APPENDIX A - CONTENTS

Standard Operating Procedure No. 1	-	Equipment Decontamination
Standard Operating Procedure No. 2	-	(not used)
Standard Operating Procedure No. 3	-	(not used)
Standard Operating Procedure No. 4	-	(not used)
Standard Operating Procedure No. 5	-	(not used)
Standard Operating Procedure No. 6	-	(not used)
Standard Operating Procedure No. 7	-	Subsurface Drilling and Sampling
Standard Operating Procedure No. 8	-	Lithologic Description of Subsurface Samples
Standard Operating Procedure No. 9	-	Borehole Abandonment
Standard Operating Procedure No. 10	-	(not used)
Standard Operating Procedure No. 11	-	(not used)
Standard Operating Procedure No. 12	-	Sample Handling, Documentation, and Tracking
Standard Operating Procedure No. 13	-	(not used)
Standard Operating Procedure No. 14	-	Headspace Analysis
Standard Operating Procedure No. 15	-	Investigation-Derived Wastes
Standard Operating Procedure No. 16	-	Detection of Petroleum Hydrocarbons Using Immunoassay

STANDARD OPERATING PROCEDURE NO. 1
EQUIPMENT DECONTAMINATION

CANNON AIR FORCE BASE
SITE INSPECTIONS
CANNON AFB, NEW MEXICO

USACE CONTRACT NO. DACW-45-96-D-0017

W-C PROJECT NUMBER M9602V

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2.0
INTRODUCTION

The purpose of this document is to define the standard procedure for equipment decontamination for the Cannon Air Force Base project. This Standard Operating Procedure (SOP) serves as a supplement to the Quality Assurance Project Plan (QAPP) and the Work Plan (WP). This procedure is intended to be used with the WP and the other SOPs.

The overall objective of multimedia sampling programs is to obtain samples which accurately depict the chemical, physical, and/or biological conditions at the sampling site. Extraneous contaminant materials can be brought to a sampling location and/or introduced into the medium of interest during the sampling program (e.g., by bailing or pumping of groundwater with equipment previously contaminated at another sampling site). Trace quantities of these materials can contaminate the sample and lead to false positive analytical results and, ultimately, to an incorrect assessment of the conditions associated with the site. Decontamination of sampling equipment (e.g., soil sampling equipment) and field support equipment (e.g., drill rigs, vehicles) is required at Cannon Air Force Base to ensure that sampling cross-contamination is prevented, and that on-site contaminants are not carried off site.

3.0
RESPONSIBILITIES AND QUALIFICATIONS

The Woodward-Clyde (W-C) Cannon AFB Project Manager is responsible for assuring that equipment decontamination is conducted according to this procedure. The Project Manager will designate qualified project staff to complete this procedure.

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

The W-C Project QA/QC Officer or designee will be responsible for periodically reviewing decontamination activities to assure that they are completed according to this procedure. Problems related to equipment decontamination are also the responsibility of the W-C Task Leader.

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

4.1 EQUIPMENT LIST

The following is a list of equipment that may be needed to perform decontamination:

- Brushes
- Wash tubs (minimum of three) or
- 5-gallon buckets (minimum of three)
- Scrapers
- Steam cleaner or high-pressure sprayer (portable)
- Large metal horse trough
- Disposal drums
- Paper towels
- Liquinox detergent (or equivalent)
- Potable tap water
- Deionized water
- Garden-type water sprayers
- Plastic tubing for bailers
- Plastic trash bags

4.2 DECONTAMINATION

4.2.1 Personnel

A temporary personnel decontamination line will be set up around each exclusion zone. If contamination is not encountered, a dry decontamination station may be established which consists of discarding of disposable PPE.

If real-time monitoring instruments indicate that contamination has been encountered (i.e., action levels are exceeded requiring an upgrade from initial PPE levels), or if the initial PPE is B or C, a complete personnel decontamination station will be established.

The temporary decontamination line should provide space to wash and rinse boots, gloves, and all sampling or measuring equipment prior to placing the equipment into a vehicle, and a container to dispose of used disposable items such as gloves, tape, or tyvek (if used).

The decontamination procedure for field personnel shall include:

1. Glove and boot wash in a Liquinox solution
2. Glove and boot rinse
3. Duct tape removal
4. Outer glove removal
5. Coverall removal
6. Respirator removal (if used)
7. Inner glove removal

4.2.2 Sampling Equipment

The following steps will be used to decontaminate small sampling equipment, such as stainless steel trowels, stainless steel bowls, etc.:

- Personnel will dress in suitable safety equipment to reduce personal exposure.

- Gross contamination on equipment will be scraped off at the sampling site.

- Equipment that will not be damaged by water will be either pressure-washed and/or placed in a wash tub or bucket containing Liquinox or low-sudsing detergent along with potable water and scrubbed with a bristle brush or similar utensil. Equipment will be rinsed with tap water in a second wash tub or bucket followed by a double deionized water rinse applied with pump sprayers.

- The water level indicator will be decontaminated using the equipment decontamination procedure described in the third bulleted item. Care will be taken to prevent damage to equipment.

- Rinse and detergent waters will be replaced with new solutions between borings or sample locations.

- Used rinse and detergent water will be contained in 55-gallon drums or holding tanks for storage at Landfill 5 or area designated by Cannon AFB.

Following decontamination, equipment will be placed in a clean area or in clean plastic.

4.2.3 Drilling and Heavy Equipment

Prior to moving onto each area of concern (SWMU), drilling and heavy equipment will be decontaminated at the decontamination area (Landfill 5). Between each boring, augers will be decontaminated downslope and a minimum of 50 feet away from sampling locations using a portable steam cleaner and large metal trough. The following steps will be used to decontaminate drilling and heavy equipment:

- Personnel will dress in suitable safety equipment to reduce personal exposure.

- Equipment showing gross contamination or having drill cuttings caked on will be scraped off with a flat-bladed scraper at the sampling site.

- Drill rig, augers, drill bits, and shovels will be sprayed with detergent water (heated to at least 160°F) by a high-pressure washer, then rinsed with potable water. Care should be taken to adequately clean the insides of the hollow-stem augers.

- Decontamination water generated at each SWMU will be contained in the trough and pumped into drums for storage at the central decontamination station. Soil cuttings generated during drilling will be contained in drums.

- Drums will be labeled with matrix, depth, location, date, SWMU and boring numbers, drum I.D. number, geologists' initials, and the Base contact, including phone number.

The designated clean area at Landfill 5 will be protected from potential contamination by several techniques: setting up exclusion zones; setting up temporary decontamination lines around each exclusion zone as needed; scraping gross contamination off equipment at the sampling site; containing used rinse and detergent water in 55-gallon drums or nonleaking holding tanks; containing any soil cuttings in 55-gallon drums; and following decontamination, placing all equipment in clean plastic or designated clean area.

Following decontamination, drilling equipment will be placed on the clean drill rig and moved to the clean area at Landfill 5. If the equipment is not used immediately, it should be stored at the designated clean area at Landfill 5.

4.2.4 Equipment Leaving the Site

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

4.2.5 Wastewater

It will be necessary to contain small volumes of used wash and rinse solutions and transport them to the central decontamination area (Landfill 5). This wastewater will be containerized in labeled drums and stored in a secured area at Landfill 5. The SOP on Investigation-Derived Waste (No. 15) will govern the final disposal of this wastewater.

4.2.6 Other Wastes

Solid wastes such as used personal protective equipment will be collected in drums. When drums are full, they will be sealed. Each drum will be labeled with its contents and the date, using paint or other permanent marker. Drums will be stored in a secured area at Landfill 5 and managed according to SOP No. 15 - Investigation-Derived Wastes.

4.3 DOCUMENTATION

Sampling personnel will be responsible for documenting the decontamination of sampling and drilling equipment. The documentation will be recorded with waterproof ink in the sampler's field notebook with consecutively numbered pages. The information entered in the field book concerning decontamination should include the following:

- Decontamination personnel
- Date and start and end times
- Decontamination steps/observations
- Weather conditions
- Waste drum(s) generated and I.D. numbers

1.0
TITLE PAGE

STANDARD OPERATING PROCEDURE NO. 7
SUBSURFACE DRILLING AND SAMPLING

CANNON AIR FORCE BASE
SITE INSPECTIONS
CANNON AFB, NEW MEXICO

USACE CONTRACT NO. DACW-45-96-D-0017

W-C PROJECT NUMBER M9602V

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2.0
PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) provides technical guidance and methods for subsurface drilling and sampling at Cannon Air Force Base. Soil samples will be collected for field screening (i.e., headspace and visual analysis) and identifying the soil types and submitted for chemical analysis.

This SOP serves as a supplement to the Quality Assurance Project Plan (QAPP) and the Work Plan (WP). This SOP is intended to be used with the WP and other SOPs, such as SOP No. 8, Lithologic Description of Subsurface Samples and SOP No. 14, Headspace Analysis.

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

3.0
RESPONSIBILITIES AND QUALIFICATIONS

The Woodward-Clyde (W-C) Cannon AFB Project Manager is responsible for assuring that subsurface drilling and sampling are performed in accordance with this Standard Operating Procedure. This Project Manager will designate qualified project staff to complete this procedure and the required reviews.

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

The W-C Project QA/QC Officer or designee will be responsible for periodically reviewing the activities associated with this procedure to assure that subsurface drilling and sampling are being completed according to this procedure.

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

4.1 EQUIPMENT LIST

The following is a list of soil sampling equipment:

- Split-spoon sampler, 3-inch O.D. (stainless steel)
- Cement for grouting (portland cement, Type II or V)
- Stainless steel mixing bowl
- Stainless steel stirring devices
- High-pressure steamer/sprayer (provided by drilling contractor)
- Long-handled bristle brushes
- Wash/rinse tubs
- Liquinox detergent
- Auger rig with appropriate equipment for drilling and sampling
- Weighted tape measure
- Water level probe
- Drums for containment of cuttings
- Appropriate health and safety equipment
- Logbook
- Boring log forms
- Tape (electrical and Teflon)
- Waterproof markers and labels
- Paper towels
- Baggies, ziploc bags
- Large plastic bags

4.2 DRILLING METHOD

Borings will be drilled using a truck-mounted drilling rig utilizing hollow-stem augers. No water may be introduced into the boreholes. No bentonite, barite, polymers, or other additives or viscosifying agents will be introduced into the borehole or used during drilling.

If lubrication is required on the drill pipe joints, Teflon tape or vegetable oil is acceptable. The rig shall be free of leaks which could contaminate the boreholes (i.e., hydraulic fluid, oil, gas, etc.).

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

All work areas around exploratory borings will be restored to a physical condition equivalent to that of predrilling, as near as practical. This will include drill cuttings removal and rut removal.

All drill cuttings will be containerized and moved to a central secured location for storage. Containers (drums) will be sealed, labeled with a paint pen, and recorded so that their contents can be identified as to material, source, and depth. Multiple drums from that same boring will have approximate depths labeled on each drum. The labeling will be such that it will be legible for the length of time that may transpire before final disposal of the drummed contents. The disposal of soil will be dependent on laboratory analytical results.

4.3 SOIL SAMPLING METHOD

Intact subsurface soil samples will be taken for physical description and chemical analyses. Samples will be collected as outlined in the WP. Sampling will be done in advance of the lead auger to minimize potential cross-contamination. Samples will be collected with a stainless steel split-spoon sampler. The sampler will be driven with a 140-pound hammer and 30-inch drop for a total of 2 feet. Standard blow counts will be recorded for driving the sampler 6, 12, 18, and 24 inches, according to ASTM Method D 1586-84 with the N-value being the sum of the second and third 0.5-foot interval. Provisions will be made to use other sample collection methods if this method results in poor sample recovery in some depth intervals. Soil grab samples for volatile organic analyses will be obtained by subsampling the material retrieved in the split spoon. Subsampling will be done immediately upon opening the split spoon, and shall be done as soon as possible once the split-spoon sample is taken from the boring. The portion of the split-spoon sample which represents slough will

not be sampled. A sample for VOC analysis will be collected at each sampling interval. The VOC samples will be placed into the proper sample container, marked with the boring number and depth, and placed in an iced sample cooler. After completion of the boring, the depth intervals selected for chemical analysis will be retained while the unused intervals will be discarded into the cuttings drum. The soil remaining in the split spoon after VOC sampling at each depth interval will be placed into a new 1-gallon Ziploc bag. After completion of the boring and selection of the depth intervals for chemical analysis, the soil will be removed from the bag and composited. Compositing of soil samples for nonvolatile chemical analyses shall be performed in a stainless steel bowl using stainless steel stirring devices. Soil from intervals not selected for analysis will be placed in the cuttings drum.

Soil samples from split-spoon samplers that are to undergo chemical and geotechnical analyses will be placed in glass or plastic jars with airtight, screw-type lids. A sample volume adequate for the analysis to be conducted will be collected. Minimum information on each sample container will include the project name, date, boring number, sample number, and depth of sample. The CMQAL LMS number will be included on all QA samples. All information that appears on the container will also appear on the boring log. Sample handling, documentation, and analysis procedures are more fully discussed in SOP No. 12.

4.4 DOCUMENTATION

4.4.1 Field Boring Log

A copy of the USACE Omaha District HTW field boring log is shown as Figure 1 in SOP No. 8. The appropriate spaces for drilling method and equipment shall be completed prior to drilling.

4.4.2 Field Sampling Data Sheet

In addition to recording the field sampling data on the HTW boring log, a field sampling data sheet will also be completed at each sample location (Figure 1). Items not applicable to the sampling will be labeled as not applicable (NA). The information on the data sheet includes the following:

- Sampling location
- Date and time of sampling
- Person performing sampling
- Soil type (describe), USCS Abbreviation
- Color (describe), staining (describe), odor (describe)
- Sample identification number
- Number of samples taken
- Preservation of samples
- Type of sample
- Type of soil cover
- Depth interval
- Record of any QC samples from site
- Any irregularities or problems which may have a bearing on sampling quality.

4.4.3 Field Notes

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

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

5.0
EQUIPMENT DECONTAMINATION PROCEDURES

Specific equipment decontamination procedures are described in the following paragraphs. Equipment decontamination will include:

- Drilling equipment decontamination (augers, drill stems, drill bits, other downhole equipment) will be conducted prior to drilling and between each boring location. Before any equipment is removed from the site, it will be decontaminated according to the procedure for decontamination of drilling and heavy equipment described in SOP No. 1.

- Sampling equipment decontamination (stainless steel split-spoon samplers, stainless steel stirring devices, etc.) will be conducted between individual sampling points to minimize potential cross-contamination. Soil sampling will require one clean stainless steel split-spoon sampler per sample. Sampling equipment will be decontaminated between each sample according to the procedure for decontamination of sampling equipment described in SOP No. 1.

5.1 DRILLING EQUIPMENT DECONTAMINATION PROCEDURES

Augers will be scraped off as they are withdrawn from a boring. The cuttings will be disposed of as outlined in Section 4.2. The following step in accordance with SOP No. 1, will be used to decontaminate drilling and heavy equipment:

- Personnel will dress in suitable safety equipment to reduce personal exposure.

- Equipment showing gross contamination or having drilling cuttings caked on will be scraped off with a flat-bladed scraper. The scrapings will be containerized. Drill cuttings should not be washed down the drain.

- Equipment that will not be damaged by water, such as drill rigs, augers, drill bits, and tools will be sprayed with detergent water by a high-pressure steamer,

then rinsed with clear potable water. This water will be obtained at an approved source.

- Decontamination will continue until all equipment is devoid, both inside and out, of any asphaltic, bituminous, or other encrusting or coating materials, such as grease, gravel, and soil.

Following decontamination, drilling equipment will be placed on the clean drill rig and moved to a clean area. If the equipment is not used immediately, it should be stored in a designated secure, clean area and covered with plastic sheeting.

Drilling equipment will be decontaminated prior to drilling, between each boring, and prior to leaving the site. Decontamination will occur at the designated decontamination area.

5.2 SAMPLING EQUIPMENT DECONTAMINATION PROCEDURES

The following steps in accordance with SOP No. 1, will be used to decontaminate sampling equipment:

- Personnel will dress in suitable safety equipment to reduce personal exposure.

- Equipment showing gross contamination will be placed in a wash tub and the gross contamination will be scraped off with a flat-bladed scraper. The scrapings will be containerized.

- Equipment that will not be damaged by water will be placed in a wash tub containing Liquinox (or low-sudsing detergent) along with potable water and scrubbed with a bristle brush or similar utensil. Equipment will be rinsed with clear potable water, in a second wash tub or bucket, followed by a double deionized water rinse.

- When sampling for organic volatiles, semivolatiles, or pesticides/PCB, the potable water rinse of the equipment will be followed by a double distilled or deionized water rinse.

- Equipment that may be damaged by water, such as an HNu or OVA, will be carefully wiped clean using a sponge and detergent water, and rinsed with deionized water. Oily or tarry contamination will be removed by sparing use of a solvent followed by a sponge and deionized water wipe-off. Care will be taken to prevent any equipment damage.

- Detergent waters will be replaced between borings. Rinse waters will be contained in pump sprayers to prevent used rinse water from contaminating subsequent samples.

Following decontamination, sampling equipment will be placed in a clean area on clean plastic sheeting to prevent contact with contaminated soil. If the equipment is not used immediately, it will be covered or wrapped in plastic sheeting to minimize potential airborne contamination.

Decontamination of all soil sampling equipment that will contact the sample will occur between samples.

5.3 DECONTAMINATION PROCEDURE DOCUMENTATION

Sampling personnel will be responsible for documenting the decontamination of sampling and drilling equipment. The documentation will be recorded with waterproof ink in the sampler's field notebook with consecutively numbered pages. The information entered in the field book concerning decontamination should include the following:

- Decontamination personnel
- Date and start and end times
- Decontamination steps/observations
- Weather conditions

FIGURE 1

Field Sampling Data Sheet for Soil (Surface or Subsurface) Samples

Location Identification: _____ Date: _____

Samplers' Signature: _____ Time: _____

Type of Sample: Surface: _____ Subsurface: _____

Type of Soil Cover: _____

Depth Interval: _____

Sample Identification: _____

Soil type (i.e. sand silt clay) _____

USCS Abbreviation _____

Color _____

Staining _____

Odor _____

Containers	Number	Preservatives

QA/QC Samples Collected: _____

Comments: _____

1.0
TITLE PAGE

STANDARD OPERATING PROCEDURE NO. 8
BORING LOG COMPLETION AND
LITHOLOGIC DESCRIPTION OF SUBSURFACE SAMPLES

CANNON AIR FORCE BASE SITE INSPECTIONS
CANNON AFB, NEW MEXICO

USACE CONTRACT NO. DACW-45-96-D-0017

W-C PROJECT NUMBER M9602V

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3.0
PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) provides technical guidance and methods for the lithologic logging of boreholes at Cannon Air Force Base. This SOP serves as a supplement to the Quality Assurance Project Plan (QAPP). This SOP is intended to be used with the QAPP and other SOPs, such as SOP No. 7, Subsurface Drilling and Soil Sampling.

The step-by-step procedures described herein are sufficiently detailed to allow field personnel to properly log boreholes.

4.0
RESPONSIBILITIES AND QUALIFICATIONS

The Woodward-Clyde (W-C) Cannon AFB Project Manager is responsible for assuring that lithologic logging of boreholes is performed in accordance with this Standard Operating Procedure. This Project Manager will designate qualified project staff to complete this procedure and the required reviews.

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

The W-C Project QA/QC Officer or designee will be responsible for periodically reviewing the activities associated with this procedure to assure that borehole logging is being completed according to this procedure.

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

5.0
PROCEDURES FOR LITHOLOGIC LOGGING OF BOREHOLES

5.1 HAZARDOUS AND TOXIC WASTE (HTW) BORING LOG COMPLETION

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

5.2 EQUIPMENT NEEDS

- HTW Drilling Log Forms
- Indelible Pens
- Straight Edge
- Fiberglass Tape Measure

5.3 PROCEDURES

Logs will be prepared on the HTW Drilling Log form that accompanies this SOP. A blank HTW boring is provided at the end of this SOP (Figure 1). Logs will be prepared in the field by a qualified, experienced geologist or geotechnical engineer as borings are drilled. Each log will be signed by the preparer.

All log entries will be printed. Photo reproductions will be clear and legible. Illegible or incomplete logs are not acceptable. Survey coordinates will be completed at a later date and will be included on the final computer-drafted copies of the boring log. One legible copy of each field log will be completed and sent/mailed with DQCRs on a weekly basis.

Borehole depths and sample intervals will be measured to 0.1 foot.

All relevant information blanks in the log heading and log body will be completed. If surveyed horizontal control is not available at the time of drilling, location sketches, referenced by measured distances from prominent surface features, will be shown on the first page of the log.

Logs will identify the depth at which water is first encountered and the depth to water prior to grouting the boring. The absence of water in borings also shall be indicated. The time between encountering the groundwater and the last measurement of the depth to groundwater will be noted on the log.

Column b

Log scale will be 1 inch = 1 foot.

Column c

Every material type encountered will be described in column "c" of the log form. Unconsolidated materials will be described as outlined below and in the sequence:

1. Descriptive USCS classification
2. Consistency of cohesive materials or apparent density of non-cohesive materials
3. Plasticity
4. Cementation
5. Moisture content assessment; e.g., moist, wet, saturated, etc.
6. Color
7. Grain size
8. Grain shape
9. Other descriptive features (bedding characteristics, organic materials, macrostructure of fine-grained soils; e.g., root holes, fractures, etc.)
10. Depositional type (alluvium, till, loess, etc.)

Stratigraphic/lithologic changes will be identified in column "c" by a solid horizontal line at the appropriate scale depth on the log which corresponds to the measured borehole depths at

which changes occur. Stratigraphic/lithologic changes will be measured to the nearest 0.1 foot. Gradational transitions will be identified by a horizontal dashed line at the appropriate scale depth based on the best judgment of the logger. All lines will be drawn with a straight edge, not free hand.

Column d

The calibration information for the PID will be written at the top of the column on the first page, along with the background level in parts per million (ppm). For each sample interval, the following information will be provided in column "d":

1. Breathing Zone reading in ppm
2. Headspace Screen reading in ppm

Columns e and f

Logs will clearly show, in columns "e" and "f", the depth intervals from which all samples for off-site analysis were obtained, including depth intervals for duplicate samples. Soil sampling intervals will be shown in column "e", including depths from which attempts were made and length of sample recovered from each attempt.

Column g

The blow counts for each 0.5-foot interval will be recorded at the appropriate depth in column "g". A line drawn with a straight edge will extend across column "g" to indicate each 0.5-foot interval.

Column h

Soil sample information with the split-spoon samplers will be recorded in column "h" and will include the following:

1. N value -- the sum of the blow counts from the second and third half-foot intervals in column "g"

2. Recovery -- in feet
3. Time of sample collection

Soil sample information with the continuous soil core barrel will be recorded in consecutively numbered runs in column "h" and will include the following:

1. Start and stop time of each sample run
2. Depth to top and bottom of each sample run
3. Length of sample recovered from each run
4. Measured depth to the bottom of the hole after sample is removed from each run

Logs will include all other information relevant to a particular investigation in column "h", including, but not limited to:

1. Odors
2. Staining
3. Drilling difficulties and how resolved
4. PID/FID measurements or other field screening or test results
5. Any other observed evidence of contamination in samples

Logs will show the total depth of penetration and sampling. The bottom of the hole will be clearly identified on the log with a continuous double line across the width of the log and with the notation "Bottom of Hole = XXX feet".

Logs will identify any intervals of hole instability, and will show depths and types of any temporary casing used. Any drilling or sampling problems will be recorded on logs, including descriptions of problem resolution.

Boring logs will be included as appendices to the Draft Project Report and Final Project Report and will be computer generated.

In the field, visual estimates of the volume of secondary soil constituents can be reported by such terms as "trace" (1-10 percent), "little" (10-20 percent), "some (20-35 percent), and "and"

(35-50 percent) or by an estimated specific percentage. The quantitative range of each of the terms used is to be defined either within a general legend or on each log.

When used to supplement other sampling techniques, auger-flight cutting samples will be described in terms of the appropriate soil parameters, to the extent practical. "Classification" will be minimally described for these samples, along with a description of drill action and water losses/gains for the corresponding depth. Notations will be made on the log that these descriptions are based on observations of material other than samples; e.g., "from cuttings".

The drilling equipment used will be described on each log. Information such as drill rod size, bit size and type, and rig manufacturer and model will be recorded.

All special problems encountered during drilling and their resolution will be recorded on the log. This would include sudden tool drops, unrecovered tools in the borehole, and lost casings.

The dates for the start and completion of borings will be recorded on the boring log. Changes in shift, day, driller, and site geologist will also be noted on the boring log.

Logs will identify any drilling fluid (water) losses, including depths at which they occur, rate of loss and total volume lost.

Logs will show blow counts, hammer type and weight, and length of hammer fall for driven samplers. Blow counts will be recorded in half-foot increments when a standard penetration test is performed. For penetration less than a half-foot, the count will be annotated with the distance over which the count was taken. Refusal, if reached, will be noted.

Significant color changes in the drilling fluid return will be recorded, even when intact soil samples or rock core are being obtained. The color change (from and to), depth at which change occurred, and a lithologic description of the cuttings before and after the change will be recorded.

Special abbreviations used on a log will be defined either in the log where used, or in a general legend.

6.0
LITHOLOGIC DESCRIPTION OF SURFACE AND SUBSURFACE SOIL SAMPLES

6.1 EQUIPMENT NEEDS

- Drill rig and related equipment (see SOP 7)
- Stainless steel 3-inch split spoon
- Stainless steel 5-foot continuous soil core barrel
- Pocket knife or small spatula
- Hand lens
- Camera and film
- Field forms
- Field logbook
- Indelible pens

6.2 PROCEDURES

Soil samples will be classified according to the Unified Soil Classification System (USCS), following methods outlined in ASTM D 2488 (Standard Practice for Description and Identification of Soils, Visual-Manual Procedure) and the Standard Nomenclature for Description of Soils of the U.S. Army Corps of Engineers, Omaha District.

The field geologist will describe and classify soil materials based on field observations using methods discussed above and will enter the lithologic classifications into the HTW boring log. Final boring logs will be prepared using observations of the field geologist an the driller. Laboratory analyses will not be used to confirm or modify the visual-manual classifications.

The field geologist will subdivide materials into stratigraphic units of practical thickness based on significant lithologic changes, measure depth intervals to the nearest 0.1 foot, and record the readings on the boring log. Very thin intervals may be described as lenses, laminae, or beds within a larger stratigraphic unit, with the depth intervals noted.

Field soil classifications will be based on estimated grain-size distribution in reference to ASTM flow charts for identifying fine-grained and coarse-grained soils. The order of descriptive terminology on the boring log generally will follow the USACE Standard Nomenclature for Description of Soils. The orders is as follows:

1. USCS Classification -- determined from flow charts in ASTM D 2488; e.g., silty sand (SM), lean clay (CL), etc.
2. Density -- for dominantly coarse-grained materials (silt, sand, gravel), based on blow counts in Standard Penetration Tests (Sats) in ASTM D 1586.
3. Consistency -- for dominantly fine-grained materials, based on blow counts in Sats in ASTMD 1586.
4. Plasticity -- described as non-plastic, low, medium, or high, based on field test described in ASTM D 2488.
5. Cementation -- described as high, moderate, or weak, according to field test in ASTM D 2488.
6. Moisture -- generally described as dry, moist, wet, or saturated.
7. Color -- for moist samples, determined by visual description such as brown, gray, olive, etc.
8. Grain Size -- estimated percentages of grain size categories; e.g., 10% silt, 50% fine sand, 40% medium sand.
9. Grain Shape -- for coarse-grained materials, generally described as angular, subangular, subrounded, or rounded.
10. Other features -- includes any other notable identifying characteristics, such as fractures, structures, bedding, fossil content, nature of contents with overlying or underlying strata, etc.
11. Depositional Type -- e.g., alluvium, outwash, till, etc., if it can be determined.

The blow counts from each 0.5-foot interval will be recorded in column "g" and will be used to determine the density/consistency of the soil in that interval. The N value (see table) will be entered in column h. The following table permits adjustment for different split-spoon samplers:

Standard Penetration Test (SPT)

Standard Penetration Tests are made by driving a standard split-spoon sampler with a 140-pound hammer falling 30 inches and counting the number of blows required to advance the sampler a distance of 12 inches (blows per foot). The N value is the sum of the blow counts for the second and third 0.5-foot intervals.

Density (Sand and Gravel)				Consistency (Silt and Clay)			
Spoon Diameter (I.D.) -- Inches				Spoon Diameter (I.D.) -- Inches			
Description	1.4	2.0	2.5	Description	1.4	2.0	2.5
Very Loose	0-4	0-5	0-7	Very Soft	0-2	0-2	0-2
Loose	4-10	5-12	7-18	Soft	2-4	2-4	2-4
Medium Dense	10-29	12-37	18-51	Medium Stiff	4-8	4-9	4-0
Dense	29-47	37-60	51-86	Stiff	8-15	9-17	9-18
Very Dense	>48	>60	>86	Very Stiff	15-30	17-39	18-42
				Hard	30-60	39-78	42-85
				Very Hard	>60	>78	>85

FIGURE 1

HTRW DRILLING LOG

DISTRICT		HOLE NUMBER
1. COMPANY NAME	2. DRILLING SUBCONTRACTOR	SHEET OF SHEETS
3. PROJECT	4. LOCATION	
5. NAME OF DRILLER	6. MANUFACTURE'S DESIGNATION OF DRILL	
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	8. HOLE LOCATION	
	9. SURFACE ELEVATION	
	10. DATE STARTED	11. DATE COMPLETED
12. OVERBURDEN THICKNESS	15. DEPTH GROUNDWATER ENCOUNTERED	
13. DEPTH DRILLED INTO ROCK	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING	
14. TOTAL DEPTH OF HOLE	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

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

20. SAMPLES FOR CHEMICAL	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR		

LOCATION SKETCH/COMMENTS SCALE:

PROJECT	HOLE NO.

ENG FORM 5056-R, AUG 94 (Proponent: CECW-EG)

HTW DRILLING LOG

HOLE NO	
PROJECT	INSPECTOR
SHEET	OF SHEETS

ELEV	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO e	ANALYTICAL SAMPLE NO f	BLOW COUNTS g	REMARKS h
	1.0						
	2.0						
	3.0						
	4.0						
	5.0						
	6.0						
	7.0						
	8.0						
	9.0						

PROJECT

HOLE NO.

HTW DRILLING LOG

HOLE NO	
PROJECT	INSPECTOR
SHEET	OF SHEETS

ELEV	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO e	ANALYTICAL SAMPLE NO f	BLOW COUNTS g	REMARKS h
	11.0						
	12.0						
	13.0						
	14.0						
	15.0						
	16.0						
	17.0						
	18.0						
	19.0						

1.0
TITLE PAGE

STANDARD OPERATING PROCEDURE NO. 9
BOREHOLE ABANDONMENT

CANNON AIR FORCE BASE SITE INSPECTIONS
CANNON AFB, NEW MEXICO

USACE CONTRACT NO. DACW-45-96-D-0017

W-C PROJECT NUMBER M9602V

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3.0
PURPOSE AND SCOPE

The purpose of this document is to define the Standard Operating Procedure (SOP) for borehole abandonment at Cannon Air Force Base.

This SOP serves as a supplement to the Quality Assurance Project Plan (QAPP) and the Work Plan (WP). This SOP is intended to be used with the WP and other SOPs.

The step-by-step procedures described herein are sufficiently detailed to allow field personnel to properly perform abandonment.

4.0
RESPONSIBILITIES AND QUALIFICATIONS

The Woodward-Clyde (W-C) Cannon AFB Project Manager is responsible for assuring that borehole abandonment is performed in accordance with this Standard Operating Procedure. This Project Manager will designate qualified project staff to complete this procedure and the required reviews.

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

The W-C Project QA/QC Officer or designee will be responsible for periodically reviewing the activities associated with this procedure to assure that borehole abandonment is being completed according to this procedure.

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

5.0
PROCEDURE FOR BOREHOLE ABANDONMENT

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

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

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

2. Upon completion of the boring, all downhole equipment will be scraped clean as it is withdrawn from the hole. Decontamination and cuttings disposal will be performed in accordance with SOP No. 1, Equipment Decontamination and SOP No. 7, Subsurface Drilling and Soil Sampling.

3. Where borings penetrate surface pavements, walkways, or sidewalks, it will be necessary to patch the pavement surface following backfilling. Concrete pavements should be filled with low slump (less than 4 inches) concrete mix. Asphaltic concrete

pavements should be filled with asphaltic concrete patch mix and thoroughly compacted by ramming. The surface of any patch should be screeded level upon completion. In freezing weather, the concrete mix must be protected from freezing for 48 hours after placement.

4. For each abandoned boring, a record on the boring log as well as in the field log book will be provided after the abandonment is completed. The record will include the data listed below; all depths should be measured from the ground surface.

   a. Project name and boring designation

   b. Location with respect to any replacement boring

   c. Open depth prior to grouting and depth to which grout pipe was placed

   d. Copy of the boring log

   e. Description and total quantity of grout used initially

   f. Description and daily quantities of grout used to compensate for settlement

   g. Dates of grouting

   h. Water level prior to grouting and date measured

STANDARD OPERATING PROCEDURE NO. 12
SAMPLE HANDLING, DOCUMENTATION, AND TRACKING

CANNON AIR FORCE BASE
REMEDIAL INVESTIGATION
CANNON AFB, NEW MEXICO

USACE CONTRACT NO. DACW-45-96-D-0017

W-C PROJECT NUMBER M9602V

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FIGURE 1 COMPLETED SAMPLE LABEL
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FIGURE 3 EXAMPLE CHAIN-OF-CUSTODY FORM

2.0
PURPOSE AND SCOPE

The purpose of this document is to define the standard procedures for sample handling, documentation, and analysis for the Cannon Air Force Base project. This Standard Operating Procedure (SOP) serves as a supplement to the Quality Assurance Project Plan (QAPP) and the Field Sampling Plan (FSP). This procedure is intended to be used together with the FSP and other SOPs and is referenced in all SOPs that apply to sampling.

3.0
RESPONSIBILITIES AND QUALIFICATIONS

The Woodward-Clyde (W-C) Cannon AFB Project Manager is responsible for assuring that samples are handled, documented, and analyzed according to this procedure. The Project Manager will designate qualified project staff to complete this procedure and the required reviews.

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

The W-C Project QA/QC Officer or designee will be responsible for periodically reviewing sample handling and tracking activities to assure that they are being completed according to this procedure. The W-C Field Task Leader will be designated to assist in this process.

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

4.0
PROCEDURES FOR SAMPLE HANDLING, DOCUMENTATION, AND ANALYSIS

4.1 SAMPLE LABELING

All sample labels should be filled out with waterproof ink and numbered. Soil samples collected in stainless steel liners will be capped immediately following collection and a completed label attached. For soil samples collected in jars and sample bottles for groundwater analyses, sample labels should be completed and attached prior to sample collection. A typical sample label is shown as Figure 1.

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

- Project/Facility (Cannon)
- Grab or composite sample
- Sampler's company affiliation
- Date and time of sample collection
- Analyses required
- Preservation used
- Sampler's initials
- Filtered (if applicable)
- CMQAL LIMS No. identified if sample is collected for USACE CMQAL
- Sample identification (see below)

The sample designation for field (analytical) and quality assurance/quality control (QA/QC) samples is a three letter and seven-digit/letter unique identification for each sample (CXX-YYYY-ZZZ). CXX is the facility and site identifier, with C for Cannon AFB, and XX representing the number identifying a specific SWMU. For example, the sample designation for SWMU 88 would start as C88-.

The next four digits (YYYY) identify the sampling method and specific sample location. The first two characters will represent the method of sampling. The following codes will be used for the first two characters:

- HA - hand auger boring
- SB - soil boring
- SS - surface soil

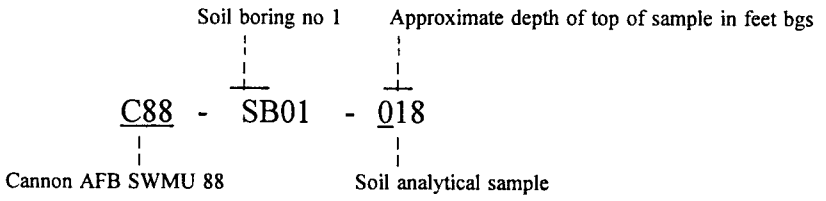
The last two characters will identify the sample location. Samples from the second soil boring at SWMU 88 would be identified as C88-SB02-.

The last set of characters (ZZZ) are the sample identifier. The first number corresponds to the type of sample:

- 0 for soil (analytical)
- 1 for soil MS/MSD
- 2 for field duplicate
- 3 for Missouri River lab duplicate

The quality assurance (QA) samples sent to the Chemical and Materials Quality Assurance Laboratory will be labeled exactly as the sample for which it is a duplicate. The MS/MSD should also be labeled the same as the original sample, but should also have "MS/MSD Extra" written on the label.

The last two numbers correspond to the beginning depth of the sample in feet below ground surface (bgs) for all soil samples. The following is an example of an identification numbers:



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

4.2 SAMPLE HANDLING

This section discusses proper sample containers, preservatives, and handling and shipping procedures. Tables 1 and 2 summarize the information contained in this section.

4.2.1 Sampling Containers

Certified, commercially clean sample containers shall be obtained from the contract analytical lab. If appropriate, the bottles shall be labeled by the lab to indicate the type of sample to be collected. Required preservatives (with the exception of sodium thiosulfate) shall be prepared and placed in the bottles for aqueous analyses at the laboratory prior to shipment to the site.

4.2.2 Sample Preservation

All samples will be stored on ice in an insulated cooler immediately following sample collection. Soil samples do not require additional preservation. As noted above, sample containers for aqueous samples will be sent by the laboratory containing the appropriate preservatives.

4.3 SAMPLE HANDLING AND SHIPPING

Sample containers will be placed in plastic storage bags (double bagged in zipper-lock bags) and wrapped in protective packing material (if appropriate). Samples will then be placed in a cooler with ice (double bagged using 1-gallon zipper-lock bags) for shipment to the laboratory. Samples collected in glass containers will be placed on the bottom of the cooler, and the ice will be placed on top of the jars. The drain on the cooler shall be taped shut. The glass containers will be packed in foam liners and bubble packing or styrofoam peanuts to ensure that no breakage occurs during shipment. Samples will be shipped by overnight

express carrier for delivery to the analytical laboratory and to the CMQAL laboratory. Custody seals on the cooler will be covered with clear plastic tape.

A completed chain-of-custody form for each cooler will be placed in a zipper-lock bag and taped to the inside of the cooler lid. Coolers will be wrapped with strapping tape at two locations to secure lids. Numbered and signed custody seals shall be placed on the outside of each cooler. In addition, "Fragile" labels and "This Side Up" labels shall be placed on the outside of each cooler containing glass bottles. Put "This Side Up" labels on all four sides and "Fragile" labels on at least two sides. Note that each cooler cannot exceed the weight limit set by the shipper.

4.3.1 Holding Times and Analyses

The holding time is specified as the maximum allowable time between sample collection and analysis and/or extraction, based on the analyte of interest, stability factors, and preservation methods. Samples should be sent by overnight courier service to the laboratory daily after collection.

Chemical constituents which will be analyzed during the field investigation have been identified by SWMU in the FSP.

4.4 SAMPLE DOCUMENTATION AND TRACKING

This section describes documentation required in the field notes, Daily Quality Control Reports, and sample Chain-of-Custody requirements.

4.4.1 Field Notes

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

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

- Project name
- Location of sample
- Sampler's signature
- Date and time of sample collection
- Sample identification numbers and sample depth (if applicable)
- Description of samples (matrix sampled), composite or grab sample
- Analysis to be performed
- Number and volume of samples
- Description of QA/QC samples (if collected)
- Sample methods or reference to the appropriate SOP
- Sample handling, including filtration and preservation, as appropriate for samples
- Field observations
- Results of any field measurements, such as depth to water, pH, temperature, conductivity and chlorine test results
- Personnel present

Changes or deletions in the field book should be lined out with a single strike mark, initialed and dated by person making change, and remain legible. Sufficient information should be recorded to allow the sampling event to be reconstructed without relying on the collector's memory.

Each page of the field book will be signed by the person making the entry. Anyone making entries in another person's field book will sign and date those entries.

4.4.2 A-E Daily Quality Control Report

To supplement the information recorded in the field book, A-E daily quality control reports (DQCRs) will also be maintained at every sampling location. An example of the DQCR is shown as Figure 2. DQCRs will be maintained by members of the field sampling team and cross-checked for completeness at the end of each day by the sampling team members and/or

Field Manager. They will be signed and dated by individuals making entries and initialed by the reviewer upon completion. Copies of the DQCR will be forwarded to the Quality Assurance Officer for review and submitted to the USACE Project Manager within 5 days of completion of sampling. If there are any problems, the DQCR will be faxed to the USACE Project Manager on the following morning.

4.4.3 Sample Chain-Of-Custody

During field sampling activities, traceability of the sample must be maintained from the time the samples are collected until laboratory data are issued. Information on the custody, transfer, handling, and shipping of samples will be recorded on a Chain-of-Custody (COC) form. An example COC form is shown as Figure 3.

The sample handler will be responsible for initiating and filling out the COC form. The COC will be signed by the sampler when the sampler relinquishes the samples to anyone else. It is not necessary for the shipping company to sign COC; however, the airbill shall be retained by the sample handler for tracking purposes. A COC form will be completed for each set of samples collected daily, and will contain the following information:

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

The person responsible for delivery of the samples to the shipping company will sign the COC form, retain the last copy of the three-part COC form, document the method shipment,

and send the original and the second copy of the COC form with the sample (taped in a ziploc bag to inner cooler lid). Upon receipt at the laboratory, the person receiving the samples will sign the COC form and return the second copy to the Project manager. Copies of the COC forms and all custody documentation will be received and kept in the central files. The original COC forms will remain with the samples until final disposition of the samples by the laboratory. The analytical laboratory will dispose of the samples in an appropriate manner 60 to 90 days after data reporting. After sample disposal, a copy of the original COC will be sent to the Project manager by the analytical laboratory to be incorporated into the central files. Sample tracking will be done by using W-C's Sample Information Management System (SIMSII) as described in the Data Management Plan.

FIGURE 1
EXAMPLE SAMPLE CONTAINER LABEL

CANNON AFB

Project: SD-11
Sample ID: CAN089-0891-0015
Analysis: 8260 VOC's
Preservative: HCl, 4°C
Collect Date: 4.20.98 Time: 1200
Sampler(s): JH CJ

Project _____ Report No. _____
Project No. _____ Date _____

FIGURE 2

Date

_____

W-C DAILY QUALITY CONTROL REPORT

Day	S	M	T	W	TH	F	S

Weather	Bright Sun	Clear	Overcast	Rain	Snow
Temp	To 32	32-50	50-70	70-85	85 up
Wind	Still	Moderate	High	Report No.	
Humidity	Dry	Moderate	Humid		

COE Project Manager _____
Project _____
Project No. _____
Contract No. _____

Subcontractors on Site:
Equipment on Site:
Visitors on Site:
W-C Personnel on Site:
Work Performed (including sampling):

DQCR.frm /dal

Sheet ___ of ___

Quality Control Activities (including field calibrations):
Health and Safety Levels and Activities:
Problems Encountered/Corrective Actions Taken:
Downtime/Standby:
Special Notes:

By _____ Title _____

Woodward de
101 South 108 Avenue, Omaha, NE 68154 (402) 334-8181 Fax (402) 334-1984

CHAIN OF C ODY RECORD

Project Name	Project No.
Project Location	Project Manager
Sampler(s)	

Sample		Type		Sample Identification	Matrix	Containers		Analytical Parameters										Remarks
Date	Time	Comp.	Grab			No.	Type											

Signatures	Date	Time	Shipping Details	Special Instructions
Relinquished by:			Method of Shipment	
Received by:			Airbill No.	
Relinquished by:			Lab Address	
Received for Laboratory by:				

Custody.frm/jdg 3-09-92

White copy - Laboratory Yellow copy - Laboratory Pink copy - WCC

№ 113090

STANDARD OPERATING PROCEDURE NO. 14
HEADSPACE ANALYSIS

CANNON AIR FORCE BASE
SITE INSPECTIONS
CANNON AFB, NEW MEXICO

USACE CONTRACT NO. DACW-45-96-D-0017

W-C PROJECT NUMBER M9602V

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2.0
PURPOSE AND SCOPE

This document defines the standard procedures for performing headspace analysis of soil and water samples in the field at Cannon Air Force Base (AFB). This Standard Operating Procedure (SOP) serves as a supplement to the Quality Assurance Project Plan (QAPP) and the Work Plan (WP) and gives the description of equipment and procedures for field screening of soil and water samples. Samples locations and frequency of collection are specified in WP. This procedure is intended to be used together with the WP and other SOPs.

Applicable SOPs are listed below:

- SOP No. 4 - Groundwater Sampling
- SOP No. 7 - Subsurface Drilling and Sampling
- SOP No. 12 - Sample Handling, Documentation, and Tracking

3.0
RESPONSIBILITIES AND QUALIFICATIONS

The Woodward-Clyde (W-C) Cannon AFB Project Manager is responsible for assuring that headspace analysis is conducted according to this procedure. The Project Manager will designate qualified project staff to complete this procedure.

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

The W-C Project QA/QC Officer or designee will be responsible for periodically reviewing headspace analysis to assure that they are completed according to this procedure. Problems related to headspace analysis are also the responsibility of the W-C Task Leader.

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

4.1 EQUIPMENT LIST

The following equipment is required for headspace analysis:

- Clean glass sample containers
- Paper towels
- Aluminum foil
- Organic vapor analyzer equipped with a photoionization detector (PID) or flame ionization detector (FID)
- Field book
- Waterproof and permanent marking pens
- Daily quality Control Report form (DQCR)

4.2 FIELD SCREENING PROCEDURES

A portion of each soil or water sample will be placed in the appropriate glass container. The container should be filled approximately three-fourths full for water and one-half full for soil. The mouth of the container will be covered with aluminum foil, tightly capped, and the samples will be allowed to equilibrate for 30 minutes. Care must be taken in the selection of soils with respect to consistency and sample placement in the container in order to achieve comparability and consistency. The disposition of the sample in the container will be recorded in the field logbook. All headspace material will be containerized as specified in SOP No. 15 after analysis.

The sample headspace in the container shall be analyzed with an organic vapor analyzer by removing the lid and inserting the instrument probe through the foil liner. Care must be taken in the selection of appropriate foil, placement of the foil on the container, and removal of the lid so as not to compromise the integrity of the seal. If the seal has been compromised, this will be recorded appropriately or a new sample taken if possible.

4.3 ORGANIC VAPOR ANALYZER SELECTION

The selection of the appropriate organic vapor analyzer equipped with either a PID or an FID shall be based on contaminants of concern and/or ambient conditions at the respective site. The lamp selected for the PID, where applicable, will be based on the relative ionization potentials of the expected volatile contaminants. The selected instrument and rationale for use will be recorded on the DQCR and in the field logbook.

4.4 CALIBRATION

The instrument(s) selected for use in accordance with data quality objectives and site requirements shall be calibrated according to the manufacturers recommendations and specifications. These procedures will be attached to this SOP where applicable.

4.5 DOCUMENTATION

All procedures and field conditions shall be recorded on the DQCR and in the field logbook. The record shall include a description of the material being screened as well as site conditions such as humidity and the equilibration time and temperature. The headspace screening results shall be recorded on the HTW boring log.

1.0
TITLE PAGE

STANDARD OPERATING PROCEDURE NO. 15
INVESTIGATION-DERIVED WASTES

CANNON AIR FORCE BASE
SITE INSPECTIONS
CANNON AFB, NEW MEXICO

USACE CONTRACT NO. DACW-45-96-D-0017

W-C PROJECT NUMBER M9602V

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2.0
PURPOSE AND SCOPE

This document defines the standard procedures for handling and final disposition of Investigation-Derived Wastes (IDW) at Cannon Air Force Base (AFB). This Standard Operating Procedure (SOP) serves as a supplement to the Quality Assurance Project Plan (QAPP) and the Work Plan (WP).

3.0
RESPONSIBILITIES AND QUALIFICATIONS

The Woodward-Clyde (W-C) Cannon AFB Project Manager is responsible for assuring that management of investigation-derived waste (IDW) is conducted according to this procedure. The Project Manager will designate qualified project staff to complete this procedure.

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

The W-C Project QA/QC Officer or designee will be responsible for periodically reviewing IDW activities to assure that they are completed according to this procedure. Problems related to equipment decontamination are also the responsibility of the W-C Task Leader.

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

4.0
INVESTIGATION DERIVED WASTES

The fieldwork planned at Cannon AFB during the Site Investigation (SI) will produce investigation-derived wastes (IDW). These will consist of the soil from the drilling of soil borings and headspace analysis, the well development/purge water from the monitoring well, and the potable water used to decontaminate the drilling and sampling equipment and personnel, and the used Personnel Protective Equipment (PPE).

5.0
SOIL CUTTINGS

The soil cuttings generated by the drilling and sampling of all soil borings and monitoring wells will be placed into DOT rated 55-gallon drums. Mixing of the cuttings from several borings is permissible in order to fill the drums as full as possible. However, only cuttings from individual SWMUs can be mixed, and the splitting of cuttings from one boring into several drums should be avoided. The drums will be sealed and labeled with permanent markings indicating the SWMU number, the boring(s) number, the matrix, date, drum ID number, geologist's initials, and the base contact, including phone number. If cuttings from an individual boring must be split, the depths of the cuttings will also be included on the drums. The drums will then be moved to a temporary storage facility designated by Cannon AFB and placed on wooden pallets. Drums from individual SWMUs will be segregated from each other as much as possible. Composite samples from the drums will be collected and analyzed and will be used in conjunction with specific sample data to profile the IDW. IDW will be categorized as either nonhazardous and disposed of on site, nonhazardous and disposed of off site, or hazardous. It has been assumed that all IDW will fall in the first two categories. W-C will complete and submit all appropriate paperwork and will arrange for the disposal of all nonhazardous IDW. If the soil is hazardous, the appropriate method of disposal will be discussed and agreed upon by Cannon AFB, USACE, and W-C personnel.

6.0
DECONTAMINATION WATER

During the field activities, equipment used for the various sampling methods will be decontaminated before and after use according to the procedures in SOP No. 1. This water will be containerized and placed into a DOT-rated drum and transported to the temporary storage facility.

It is anticipated that this decontamination water will not have any significant levels of contaminants since it is originally potable water. A headspace analysis will be performed to determine if any significant volatile organic compounds (VOCs) are present. Noncontaminated water will either be discharged onto the ground or into a wastewater lagoon on Cannon AFB as directed by Cannon AFB and USACE personnel. If the decontamination water is not acceptable, it will be characterized further to determine if it is necessary to ship to a licensed hazardous waste facility.

7.0
USED PERSONNEL PROTECTIVE EQUIPMENT

Any personnel protective equipment (i.e., gloves, duct tape, Tyvek, etc.) used during field activities will be placed into 55-gallon drums, sealed, and labeled with the appropriate information. **No mixing of wastes will be allowed (i.e., soil with PPE trash).** PPE from individual SWMUs does not need to be segregated. If the drum is not full after the work has been completed at one SWMU, PPE from the next SWMU may be placed into it.

STANDARD OPERATING PROCEDURE NO. 16
DETECTION OF PETROLEUM HYDROCARBONS USING IMMUNOASSAY

CANNON AIR FORCE BASE
REMEDIAL INVESTIGATION
CANNON AFB, NEW MEXICO

USACE CONTRACT NO. DACW-45-96-D-0017

W-C PROJECT NUMBER M9602V

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2.0
INTRODUCTION

The purpose of this document is to define the standard procedure for detection of petroleum hydrocarbons using immunoassay for the Cannon Air Force Base project. This Standard Operating Procedure (SOP) serves as a supplement to the Quality Assurance Project Plan (QAPP) and the Field Sampling Plan (FSP). This procedure is intended to be used with the SAP and the other SOPs.

Total petroleum hydrocarbons will be analyzed for by SW-846 Immunoassay Method 4030. Method 4030 is a procedure for screening soils to determine whether they contain petroleum products. This method will be used to semi-quantitatively evaluate the presence of gasoline, jet-A fuel, JP-4, diesel fuel No. 2, kerosene, fuel oil #2, fuel oil #6, and mineral spirits. The method is useful in situations where other analytical methods (lab testing, etc.) are not practical or effective and timely information is required. At CAFB, the method will be used as a semi-quantitative screening method for the detection of residual petroleum components in soil samples.

The overall objective of the sampling program is to obtain samples which accurately depict the chemical, physical, and/or biological conditions at the sampling site. Extraneous contaminant materials can be brought to a sampling location and/or introduced into the medium of interest during the sampling program (e.g., by bailing or pumping of groundwater with equipment previously contaminated at another sampling site). Trace quantities of these materials can contaminate the sample and lead to false positive analytical results and, ultimately, to an incorrect assessment of the conditions associated with the site. Decontamination of sampling equipment (e.g., bailers, pumps, tubing, soil, and sediment sampling equipment) and field support equipment (e.g., drill rigs, vehicles) is required at Cannon Air Force Base to ensure that sampling cross-contamination is prevented, and that on-site contaminants are not carried off site.

3.0
RESPONSIBILITIES AND QUALIFICATIONS

The Woodward-Clyde (W-C) Cannon AFB Project Manager is responsible for assuring that immunoassay testing is conducted according to this procedure. The Project Manager will designate qualified project staff to complete this procedure.

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

The W-C Project QA/QC Officer or designee will be responsible for periodically reviewing immunoassay testing activities to assure that they are completed according to this procedure. Problems related to immunoassay testing are also the responsibility of the W-C Task Leader.

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

4.1 EQUIPMENT LIST

The following is an equipment list for conducting immunoassay detection tests.

- Spectrophotometer
- Ensys Petro risct test kit
- Permanent marking pen
- Paper towels
- Liquid waste container
- Disposable gloves

4.2 IMMUNOASSAY TEST PROCEDURES

The procedures which will be used to detect petroleum hydrocarbons in the soils using immunoassay are as follows. These instructions were taken from and are also contained in Ensy's User's Guide which is provided with the test kit. Reference that document for further definition and illustrations:

READ ALL INSTRUCTIONS BEFORE PROCEEDING WITH THE TEST

1) Set up work station in accordance with the diagram found on the Ensys instruction sheet.

2) Collect a split spoon sample of the soil material from the specified interval in the boring.

3) Observe the soil material as described in Section 5.0 of SOP No. 8. Make sure the soil type is adequately described on the boring log.

PHASE ONE

Weigh Sample

4) Open methanol crimp top vial and pour the entire contents into the extraction jar.

5) Press ON/MEMORY button on pan balance. Balance will beep and display. 0.0

6) Crush a portion of the sample, if cemented, with a hammer or crucible to obtain a 10 g sample. Weigh out 10.0 g (±0.1 g) of pulverized sample. The rest of the samples may be chosen for the 10 percent confirmation analysis. Send 10 percent of the samples to be analyzed by 418.1 according to procedures described in the FSP.

7) If balance turns off prior to completing weighing, use empty weight boat to retare, then continue.

Extract Petroleum Hydrocarbons

8) Using wooden spatula, transfer 10 g of soil (or a quantity of soil appropriate for the detection level required) from weight boat into extraction jar.

9) Recap extraction jar tightly and shake vigorously for one minute.

10) Allow to settle for one minute.

11) Repeat step 4 - 10 for each sample to be tested.

Filter Sample

12) Disassemble filtration plunger from filtration barrel.

13) Insert bulb pipette into top (liquid) layer in extraction jar and draw up sample. Transfer a least ½ bulb capacity into filtration barrel. Do not use more than one full bulb.

14) Press plunger firmly into barrel until adequate filtered sample is available (Place on table and press if necessary).

15) Repeat steps 12 - 14 for each sample to be test.

PHASE TWO

16) Label the conjugate and antibody-coated tubes with a permanent marking pen.

17) Open dilution sample by slipping ampule cracker over top, and then breaking top at scored neck.

18) Uncap enough blue buffer, conjugate and antibody-coated tubes for samples and standards.

19) Empty a blue buffer tube into each conjugate tube.

20) Assemble new tip onto mechanical pipette.

21) Withdraw 60 μL of sample from filter unit using mechanical pipette and dispense below the liquid level in 15 ppm conjugate tube. Wipe mechanical pipette tip.

22) Withdraw 60 μL of filtered sample from the filter unit and dispense below the liquid level in the 1,000 ppm dilution ampule. Shake (thoroughly mix the contents with special care not to spill or splash) ampule for 5 seconds.

23) Withdraw 60 μL of diluted sample from 1,000 ppm dilution ampule and dispense below the liquid level in 1,000 ppm dilution ampule.

24) Withdraw μL from 1,000 ppm dilution ampule and dispense below the liquid level in 1,000 ppm conjugate tube. Discard mechanical pipette tip.

Buffer Standards

25) Assemble new tip onto mechanical pipette.

26) Open PETRO standard ampule.

27) Withdraw 60 μL of PETRO standard and dispense below the liquid level in standard conjugate tube. Wipe mechanical pipette.

28) Repeat step 27 for the second standard.

29) Shake all conjugate tubes for 5 seconds.

PHASE THREE

This phase requires critical timing and care in handling the antibody-coated tubes.

30) Set timer for exactly 10 minutes.

31) Start timing and immediately pour solution from each conjugate tube into appropriate antibody-coated tube.

32) Shake carefully, taking care not to splash or spill, all tubes for 5 seconds.

33) Let tubes stand for exactly 10 minutes.

34) After the 10-minute incubation, empty antibody-coated tubes into liquid waste container.

35) Wash antibody-coated tubes vigorously and with force. Place nozzle just above antibody-coated tube, squeeze bottle to fill each tube with a vigorous stream, and empty into liquid waste container. (The wash solution is a harmless, dilute solution of detergent. Do not hesitate to wash vigorously even if the solution contacts gloved hands.) Wash by filling and emptying a total of 4 times.

36) Tap antibody-coated tubes upside down on paper towels to remove excess liquid. Residual foam in the tubes will not interfere with test results.

Color Development

37) Add 5 drops of Substrate A (yellow cap) to each antibody-coated tube.

38) Set timer for exactly 2 minutes.

39) Start timer and immediately add 5 drops of Substrate B (green cap) to each antibody-coated tube.

40) Shake all tubes for 5 seconds. Solution will turn blue in some or all antibody-coated tubes.

41) Stop reaction at end of 2 minutes by adding 5 drops of Stop Solution (red cap). Blue solution will turn yellow when Stop Solution is added.

PHASE FOUR

Select Darker Standard

42) Wipe outside of antibody-coated tubes.

43) Place both standard tubes in the photometer.

44) Switch tubes until the photometer reading is negative or zero. Record reading. If reading is greater than 0.2 in magnitude (+ or -), results are outside of QC limits. Retest the sample(s).

45) Remove and discard tube in right well. The tube in the left well is the darker standard.

Interpret Results

46) Place 15 ppm tube in right well of photometer and record reading.

47) If photometer reading is negative or zero, petroleum hydrocarbons are present. If photometer reading is positive, concentration of petroleum hydrocarbons is less than 15 ppm.

48) Place 1,000 ppm tube in right well of photometer and record reading shown on display.

49) If photometer reading is negative or zero, petroleum hydrocarbons are present. If photometer reading is positive, concentration of gasoline or petroleum fuel is less than 1,000 ppm.

4.3 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

In addition to following procedures recommended by the manufacturer, the level of QA/QC proposed for the immunoassay-based field testing is consistent with the QA2 level of QA/QC defined for the Superfund program by Ryti and Neptune (1991) and consists of the following elements:

A. **Sample Documentation** - Each sample must be documented with the location, depth, time, and date of collection.

B. **Field Analysis Documentation** - Record raw data, including any calculations and final results of field analysis for all samples screened (including all QC samples).

C. **Method Calibration** - Standards will be obtained from the manufacturer and analyzed in duplicate. The difference in optical density (OD, photometer display) of the duplicate standards will be recorded. A valid test is indicated when the magnitude of the displayed numbers absolute value is 0.20 or less. Test runs resulting in a greater number will be repeated to ensure valid conclusions. Standards will be analyzed at the beginning and end of each day and at a rate of 1 in 20 during the testing period. Each analysis must include two standards, with no more than a total of 12 antibody-coated tubes.

D. **Method Blank** - The method blank will consist of the extraction solvent supplied by the manufacturer. This blank will be analyzed at a rate of at least 1 in 10 to evaluate cross-contamination and document baseline conditions.

E. **Confirmation of Field Analysis** - To confirm the quantitation of the analyte, at least 10 percent of the samples will be sent off site and analyzed by EPA Method 418.1.

F. **Site-Specific Matrix Background Field Analysis** - A sample of uncontaminated material from the same matrix will be analyzed to evaluate potential matrix effects.

EPA Region 6

Human Health

Media-Specific Screening Levels

U.S. Environmental Protection Agency
Region 6
1445 Ross Avenue
Dallas, Texas 75202

Screening Levels
Uses and Limitations

- A consultation with a Risk Assessor should take place before making a final decision in the corrective/remedial action process.

- The screening levels should only used in the preliminary stages of the investigations, i.e., screen.

- All values are risk-based with exceptions and their respective basis for the calculations/values noted.

- Risk-based concentrations for carcinogens were calculated at the following risk levels: Class A or B = 10^{-6}, Class C = 10^{-5}, "Blank" = 10^{-6}.

- The screening levels only address human health protection.

- Values do not account for chemical mixtures. If more than one non-carcinogen is expected, than the non-carcinogenic chemical screening level should be divided by 10.

- Exceedance of a screening level does not indicate a required action.

- Unrestricted land use, i.e., residential values should be considered in the initial screening of sites for which future residential land use cannot be definitively ruled out.

- The selection of constituents of potential concern (COPC's) can be conducted against these values once the screening levels for the non-carcinogenic compounds are divided by a factor of 10 to account for chemical mixtures.

- Sources used to compile the screening levels were:

  Region IX Preliminary Remediation Goals (PRGs)
  - Tap Water Values, Direct soil exposure values.

  EPA Region III Risk-Based Concentration Table
  - Tap Water and Soil Values labeled "I", Ambient Air Values, Fish Values, Soil Screening Levels

  EPA's *Draft Soil Screening Level Guidance*
  - Soil screening levels. . .

  EPA Region 6 Current and Proposed National Primary and Secondary Drinking Water Regulations Table
  - Drinking values labeled MCL's.

  Risk Assessment Guidance for Superfund (RAGS), Health Effects Assessment Summary Tables (HEAST), Agency for Toxic Substances and Disease Registry Toxicological Profiles, and *EPA Provisional Guidance*
  - Technical reference documents.

  Region 6 Draft Supplemental Guidance to RAGS
  - Technical reference documents.

  OSWER Directives
  - Policy documents, e.g., residential soil lead screening level.

  Elemental Composition of Surficial Materials in the Conterminous United States and *OSWER Regional Toxics Coordinators Memorandum* titled "Background Metals in Soil" dated March 14, 1989.
  - Soil regional background values.

1. conc. at 10^{-7}

EPA Region 6
Human Health
Media-Specific Screening Levels

Legend: MCL = Maximum Contaminant Level
SAT = risk-based value above expected saturation point
max = maximum concentration
PEST = Pesticide Herb = Herbicide
VOC = Volatile Organic Compound
SVOC = Semi-Volatile Organic Compound
"Blank" = Missing data for generation of value.

Basis: C= carcinogenic effects N = non-carcinogenic effects
E = EPA draft Soil Screening Level S = soil saturation concentration
M' = EPA MCL I = Ingestion route only

Contaminant	Chemical Group Name	Cancer Class Risk Level: A/B= 10^{-4} C= 10^{-5} Blank= 10^{-4}	Soil Regional Background Conc/Range (mg/kg)	Drinking Water (MCL's)	Risk-Based Screening Levels: Tap Water (Residential Scenario: Ingestion, & Inhalation)	Ambient Air (Residential Scenario)	Fish (Recreational Fishing Scenario)	Soil (Ingestion, Inhalation, and Dermal Exposure Routes): Residential	Soil: Industrial	Soil Screening Level Transfers from Soil to: Air	Soil Screening Level Transfers from Soil to: Ground Water
				µg/L	µg/L	µg/m3	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Acephate	PEST	C			77 C	7.2 C	3.6 C	510 C	2200 C		
Acetaldehyde					94N I	0.81 C					
Acetochlor	PEST				730 N	73N	27 N	1300 N	14000 N		
Acetone	VOC				610 N	370 N	140 N	2000 N	8400 N	62000 E	8 E
Acetone cyanohydrin					2600 N	150 N	95 N	4600 N	48000 N		
Acetonitrile	VOC				220 N	52 N	8.1 N	390 N	4100 N		
Acetophenone	SVOC				0.04 N	0.021 N	140 N	5600 N	45000N		
Acifluorfen	PEST				470 N	47 N	18 N	850 N	8900 N		
Acrolein	PEST				730 N	0.021 N	27 N	1300N	12000N		
Acrylamide		B2			0.015 C	0.0014 C	0.0007 C	0.098 C	0.41 C		
Acrylic acid					18000 N	1 N	680 N	32000N	SAT		
Acrylonitrile	VOC	B1			0.12 C I	0.026 C	0.0058 C	0.13 C	0.30 C		
Alachlor	PEST			2	0.8 C	0.078 C	0.039 C	5.5 C	24 C		
Alar	PEST				5500 N	550 N	200 N	9800 N	SAT		
Aldicarb	PEST			7	37 N	3.7 N	1.4 N	65 N	680 N	570 S	0.036 M'
Aldicarb sulfone				7	37 N	3.7 N	1.4 N	65N	680 N		
Aldrin	PEST	B2			0.004 C	0.00037 C	0.00019 C	0.026C	0.11 C	0.5 E	0.005 E
Ally					9100 N	910 N	340 N	16000N	SAT		

EPA Region 6
Human Health
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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-6} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc./Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Allyl alcohol	VOC				180 N	18 N	6.8 N	330 N	3400 N		
Allyl chloride	VOC				1800 N	1 N	68 N	3300 N	34000N		
Aluminum			45,000		37000 N	3700 N	1400 N	77000 N	SAT		
Aluminum phosphide	PEST				15 N	1.5 N	0.54 N	31N	680 N		
Amdro	PEST				11 N	1.1 N	0.41 N	21N	200 N		
Ametryn	PEST				330 N	33 N	12 N	590 N	6100 N		
m-Aminophenol					2600 N	260 N	95 N	4600 N	48000N		
4-Aminopyridine	PEST				0.73 N	0.073 N	0.027 N	1.3N	14 N		
Amitraz	PEST				91 N	9.1 N	3.4 N	160 N	1700 N		
Ammonia					1000 N I	100 N					
Ammonium sulfamate	PEST				7300 N	730 N	270 N	13000 N	SAT		
Aniline	SVOC	B2			11 N	1 N	0.55 C	19 C	200 C	45 N	0.031 N
Antimony and compounds				6	15 N	1.5 N	0.54 N	31 N	680 N		
Antimony pentoxide					18 N	1.8 N	0.68 N	38 N	850 N		
Antimony potassium tartrate					33 N	3.3 N	1.2 N	69 N	1500 N		
Antimony tetroxide					15 N	1.5 N	0.54 N	31 N	680 N		
Antimony trioxide					15 N	1.5 N	0.54 N	31 N	680 N		
Apollo	PEST				470 N	47 N	18 N	850 N	8900 N		

6

EPA Region 6
Human Health
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				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Aramite Arsenic (noncancer) Arsenic (as carcinogen)	PEST	B2 A	1.1-16.7	50	2.7 C 23 N I 0.04 C	0.25 C 1.1 N 0.00041 C	0.13 C 0.41 N 0.0021 C	18 C 22 N 0.32 C	76 C 610 N I 2.0 C	380 E 380 E	15 E 15 E
Arsine Assure Asulam	PEST PEST				0.52 N I 330 N 1800 N	0.052 N 33 N 180 N	12 N 68 N	590 N 3300 N	6100 N 34000 N		
Atrazine Avermectin B1 Azobenzene	PEST PEST	B2		3	0.3 C 15 N 0.61 C	0.028 C 1.5 N 0.058 C	0.014 C 0.54 N 0.029 C	2.0 C 26 N 4.0 C	8.6 C 270 N 17 C		
Barium and compounds Baygon Bayleton	PEST PEST		430	2000	2600 N 150 N 1100 N	0.52 N 15 N 110 N	95 N 5.4 N 41 N	5300 N 260 N 2000 N	SAT 2700N 20000N	SAT	32 E
Baythroid Benefin Benomyl	PEST PEST PEST				910 N 11000 N 1800 N	91 N 1100 N 180 N	34 N 410 N 68 N	1600 N 20000 N 3300 N	17000 N SAT 34000 N		
Bentazon Benzaldehyde Benzene	PEST VOC			5	91 N 610 N I 0.4 C	9.1 N 370 N 0.22 C	3.4 N 140 N 0.11 C	160 N 6500 N 1.4 C	1700 N 68000 N 3.2 C	0.5 E	0.02 E

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				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Benzenethiol					0.37 N I	0.037 N	0.014 N	0.78 N I	20 N I		
Benzidine	SVOC	A			0.0003 C	0.00003 C	0.00001 C	0.002 C	0.008 C	1.3 C	1.1E-06 C
Benzoic acid	SVOC				150000 N	15000 N	5400 N	SAT	SAT	320 S	280 E
Benzotrichloride		B2			0.0052 C	0.00048 C	0.00024 C	0.034 C	0.150 C	0.012 C	0.000073 C
Benzyl alcohol	SVOC				11000 N	1100 N	410 N	20000 N	SAT		
Benzyl chloride		B2			0.066 C	0.037 C	0.019 C	1.4 C	3.9 C	0.5 C	0.00036 C
Beryllium and compounds		B2	0.5-2	4	0.02 C	0.00075 C	0.00073 C	0.14 C	1.10 C	690 E	180 E
Bidrin					3.7 N	0.37 N	0.14 N	6.5 N	68 N		
Biphenthrin (Talstar)	PEST				550 N	55 N	20 N	980 N	10000 N		
1,1-Biphenyl					1800 N	180 N	68 N	3300 N	34000 N	9000 S	110 N
Bis(2-chloroethyl)ether		B2			0.0098 C	0.0054 C	0.0029 C	0.07 C	0.17 C	0.3 E	0.0003 E
Bis(2-chloroisopropyl)ether	SVOC				0.27 C	0.18 C	0.045 C	3.9 C	12 C		
Bis(chloromethyl)ether		A			0.00005 C	0.00003 C	0.00001 C	0.0001 C	0.0003 C	0.00004 C	1.0E-07 C
Bis(2-chloro-1-methylethyl)ether					0.96 C	0.089 C	0.045 C	6.3 C	27 C		
Bis(2-ethylhexyl)phthalate (DEHP)	SVOC				4.8 C	0.45 C	0.23 C	32 C	140 C	210 E	11 E
Bisphenol A					1800 N	180 N	68 N	3300 N	34000 N		
Boron (and borates)			2-100		3300 N	21 N	120 N	5900 N	61000 N		
Boron trifluoride					7.3 N I	0.73 N					

EPA Region 6
Human Health
Media-Specific Screening Levels

Legend: MCL = Maximum Contaminant Level
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max = maximum concentration
PEST = Pesticide Herb = Herbicide
VOC = Volatile Organic Compound
SVOC = Semi-Volatile Organic Compound
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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-6} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc/Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Bromodichloromethane	VOC	D			0.18 C	0.1 C	0.051 C	1.4 C	3.4 C	1800E	0.3 E
Bromoethene (vinyl bromide)					0.1 C	0.057 C		0.45 C	1.0 C		
Bromoform (tribromomethane)	VOC	B2			2.4 C I	1.6 C	0.4 C	56 C	240 C	46 E	0.5 E
Bromomethane	VOC				8.7 N I	5.2 N	1.9 N	15 N	57 N	2 E	0.1 E
4-Bromophenyl phenyl ether	SVOC				2100 N I	210 N	78 N	4500 N I	120000 N I		
Bromophos					180 N	18 N	6.8 N	330 N	3400 N		
Bromoxynil	PEST				180 N	73 N	27 N	1300 N	14000 N		
Bromoxynil octanoate	PEST				730 N	73 N	27 N	1300 N	14000 N		
1,3-Butadiene		B2			0.011 C	0.0064 C		0.009 C	0.02 N	0.0013 C	0.000072 c
1-Butanol	VOC				3700 N	370 N	140 N	6500 N	68000 N	9700 E	8 E
Butyl benzyl phthalate					7300 N	730 N	270 N	13000 N	SAT	530 E	68 E
Butylate					1800 N	180 N	68 N	3300 N	34000 N		
sec-Butylbenzene	VOC				61 N I	37 N	14 N	780 N I	20000 N I	80 S	0.27 M'
tert-Butylbenzene	VOC				61 N I	37 N	14 N	780 N I	20000 N I		0.27 M'
Butylphthalyl butylglycolate					37000 N	3700 N	1400 N	65000 N	SAT		
Cacodylic acid	PEST				110 N	11 N	4.1 N	200 N	2000 N		
Cadmium and compounds			0.01-1.0	5	18 N	0.00099 C	0.68 N	38 N	850 N	920 E	6 E
Caprolactam					18000 N	1800 N	680 N	33000 N	SAT		

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-6} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc/Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Captafol	PEST				7.8 C	0.73 C	0.37 C	52 N	220 C		
Captan	PEST				19 C	1.8 C	0.9 C	130 C	550 C		
Carbaryl	PEST				3700 N	370 N	140 N	6500 N	68000 N	0.34 S	23 N
Carbofuran	SVOC			40	180 N	18 N	6.8 N	330 N	3400 N		
Carbon disulfide					21 N	730 N	140 N	16 N	52 N	11 E	14 E
Carbon tetrachloride				5	0.2 C	0.12 C	0.024 C	0.47 C	1.1 C	0.2 E	0.03 E
Carbosulfan	PEST				370 N	37 N	14 N	650 N	6800 N		
Carboxin	PEST				3700 N	370 N	140 N	6500 N	68000 N		
Chloral					73 N	7.3 N	2.7 N	130 N	1400 N		
Chloramben	PEST				550 N	55 N	20 N	980 N	10000 N		
Chloranil					0.17 C	0.016 C	0.0078 C	1.1 C	4.7 C		
Chlordane	PEST			2	0.05 C	0.0049 C	0.0024 C	0.34 C	1.5 C	10 E	2 E
Chlorimuron-ethyl					730 N	73 N	27 N	1300 N	14000 N		
Chlorine					3700 N	370 N	140 N	7700 N	SAT		
Chlorine dioxide	PEST				2.1 N I	0.21 N					
Chloroacetaldehyde					250 N I	25 N	9.3 N	540 N I	14000 N I		
Chloroacetic acid					73 N	7.3 N	2.7 N	130 N	1400 N		
2-Chloroacetophenone					0.05 N	0.031 N		0.07 N	0.27 N		

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-4} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc/Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
4-Chloroaniline Chlorobenzene Chlorobenzilate	SVOC VOC PEST				150 N 39 N 0.25 C	15 N 21 N 0.023 C	5.4 N 27 N 0.012 C	260 N 160 N 1.6 C	2700 N 570 N 7.1 C	1200 S 94 E	0.3 E 0.6 E
p-Chlorobenzoic acid 4-Chlorobenzotrifluoride 2-Chloro-1,3-butadiene					7300 N 730 N 14 N	730 N 73 N 7.3 N	270 N 27 N 27 N	13000 N 1300 N 6.3 N	SAT 14000 N 21 N	86 N	7.5 N
1-Chlorobutane Chlorodibromomethane 1-Chloro-1,1-difluoroethane	VOC VOC				2400 N 0.13 C I 87000 N	1500 N 0.075 C 52000 N	540 N 0.038 C	810 S 7.6 C I	810 S 68 C I	1900 E	0.2 E
Chlorodifluoromethane Chloroethane 2-Chloroethyl vinyl ether	VOC VOC VOC				87000 N 8600 N 150 N I	52000 N 10000 N 91 N	540 N 34 N	350 S 31000 N I 2000 N I	350 S SAT 51000 N I	2600 S	33 N
Chloroform Chloromethane 4-Chloro-2,2-methylaniline hydrochloride	VOC VOC	B2			0.16 C 1.5 C 0.15 C	0.078 C 0.99 C 0.014 C	0.52 C 0.24 C 0.0069 C	0.53 C 2.0 C 0.77 C	1.1 C 4.3 C 3.3 C	0.2 E 0.063 C	0.3 E 0.0066 C
4-Chloro-2-methylaniline beta-Chloronaphthalene o-Chloronitrobenzene	SVOC				0.12 C 2900 N 0.42 C I	0.011 C 290 N 0.25 C	0.0054 C 110 N 0.13 C	0.97 C 5200 N 18 C	4.1 C 55000 N 76 C	2.8 S	140 N

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-4} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc/Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
p-Chloronitrobenzene 2-Chlorophenol 2-Chloropropane	SVOC				0.59 C I 180 N 170 N	0.35 C 18 N 100 N	0.18 C 6.8 N	25 C 330 N 350 N	110 C 3400 N 1300 N	53000 E 22 N	2 E 0.64 N
Chlorothalonil o-Chlorotoluene Chlorpropham	PEST PEST				6.1 C 120 N 7300 N	0.57 C 73 N 730 N	0.29 C 27 N 270 N	41 C 340 N 13000 N	170 C 1600 S SAT	1200 N	5.6 N
Chlorpyrifos Chlorpyrifos-methyl Chlorsulfuron	PEST PEST PEST				110 N 370 N 1800 N	11 N 37 N 180 N	4.1 N 14 N 68 N	200 N 650 N 3300 N	2000 N 6800 N 34000 N		
Chlorthiophos Total Chromium (1/6 ratio Cr VI/Cr III) Chromium VI and compounds		A	38	100	29 N 37000 N I 180 N	2.9 N 0.0021 N 0.00015 C	1.1 N 1400 N 6.8 C	52 N 210 N 31 C	550 N 1600 N 230 C	140 E	19 E
Coal tar Cobalt Coke Oven Emissions	PEST	A	8		2200 N I	0.0028 C 220 N 0.0029 C	81 N	4700 N I	SAT		
Copper and compounds Crotonaldehyde Cumene		C	20		1400 N 0.006 C 19 N	150 N 0.033 C 9.4 N	54 N 0.017 C 54 N	2800 N 0.1 C 49 N	63000 N 0.3 C 160 N	81 N	65 N

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level:* *A/B= 10^{-6}* *C= 10^{-5}* *Blank= 10^{-4}*	*Soil Regional Background Conc/Range (mg/kg)*		*Risk-Based Screening Levels*					*Soil Screening Level Transfers from Soil to:*	
				Drinking Water (MCL's)	*Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)*			
								Residential	*Industrial*	*Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Cyanides: Barium cyanide Calcium cyanide					3700 N 1500 N	370 N 150 N	140 N 54 N	7700 N 3100 N	SAT 68000 N		
Copper cyanide Cyanazine Cyanogen	PEST				180 N 0.08 C 1500 N	18 N 0.0075 C 150 N	6.8 N 0.0038 C 54 N	380 N 130 C 2600 N	8500 N 2.3 C 27000 N		
Cyanogen bromide Cyanogen chloride Free cyanide					3300 N 1800 N 730 N	330 N 180 N 73 N	120 N 68 N 27 N	5900 N 3300 N 1300 N	SAT 34000 N 14000 N		
Hydrogen cyanide Potassium cyanide Potassium silver cyanide					6.2 N 1800 N 7300 N	3.1N 180 N 730 N	27 N 68 N 270 N	1600 N I 3300 N 13000 N	41000 N I 34000 N SAT		
Silver cyanide Sodium cyanide Thiocyanate					3700 N 1500 N 730 N I	370 N 150 N 73 N	140 N 54 N 27 N	6500 N 2600 N 1600 N I	SAT 27000 N 41000 N I		
Zinc cyanide Cyclohexanone Cyclohexlamine					1800 N 180000 N 7300 N	180 N 18000 N 730 N	68 N 6800 N 270 N	3300 N SAT 13000 N	34000 N SAT SAT		

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-4} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc/Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Cyhalothrin/Karate	PEST				180 N	18 N	6.8 N	330 N	3400 N		
Cypermethrin	PEST				370 N	37 N	14 N	650 N	6800 N		
Cyromazine					270 N	27 N	10 N	490 N	5100 N		
Dacthal	PEST				370 N I	37 N	14 N	33000 N	SAT		
Dalapon	HERB			200	1100 N	110 N	41 N	2000 N	20000 N		
Danitol					18 N	91 N	34 N	33 N	340 N		
DDD	PEST	B2			0.28 C	0.026 C	0.013 C	1.9 C	7.9 C	37 S	0.7 E
DDE	PEST	B2			0.2 C	0.018 C	0.0093 C	1.3 C	5.6 C	10 S	0.5 E
DDT	PEST	B2			0.2 C	0.018 C	0.0093 C	1.3 C	5.6 C	80 E	1 E
Decabromodiphenyl ether					61 N I	37 N	14 N	650 N	6800 N		
Demeton	PEST				1.5 N	0.15 N	0.054 N	2.6 N	27 N		
Diallate	PEST				0.17 C I	0.1 C	0.052 C	7.3 C	31 C		
Diazinon	PEST				33 N	3.3 N	1.2 N	59 N	610 N	5400 S	2.8 N
Dibenzofuran	SVOC				150 N	15 N	5.4 N	260 N	2700 N	120 S	120 S
1,4-Dibromobenzene					61 N I	37 N	14 N	650 N	6800 N		
1,2-Dibromo-3-chloropropane	VOC				0.048 C	0.21 N	0.0023 C	0.32 C	1.4 C	1.9 N	0.00061 M'
1,2-Dibromoethane	VOC	B2			0.00076 C	0.0081 C	0.00004 C	0.005 C	0.02 C	0.0058 C	0.00018 M'
Dibutyl phthalate					3700 N	370 N	140 N	6500 N	68000 N	100 E	120 E

EPA Region 6
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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-4} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc/Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels: Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)*		*Soil Screening Level Transfers from Soil to:*	
								Residential	*Industrial*	*Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Dicamba	PEST				1100 N	110 N	41 N	2000 N	20000 N		
1,2-Dichlorobenzene	VOC				270 N I	150 N	120 N	2300 S	2300 S	300 E	6 E
1,3-Dichlorobenzene	VOC			600	540 N	320 N	120 N	2800 S	2800 S		
1,4-Dichlorobenzene	VOC			75	0.5 C	0.26 C	0.13 C	7.4 C	21 C	7700 E	1 E
3,3'-Dichlorobenzidine	SVOC	B2			0.15 C	0.014 C	0.007 C	0.99 C	4.2 C	52 S	0.01 E
1,4-Dichloro-2-butene					0.0012 C	0.00067 C		0.007 C	0.02 C		
Dichlorodifluoromethane	VOC				390 N	210 N	270 N	110 N	350 S	37 N	7.5 N
1,1-Dichloroethane	VOC				810 N	520 N	140 N	840 N	3900 S	980 E	11 E
1,2-Dichloroethane (EDC)	VOC	B2		5	0.12 C	0.069 C	0.035 C	0.44 C	0.98 C	0.3 E	0.01 E
1,1-Dichloroethylene	VOC	C		7	0.5 C	0.36 C	0.053 C	0.4 C	0.8 C	0.04 E	0.03 E
1,2-Dichloroethylene (cis)	VOC			70	61 N	37 N	14 N	59 N	200 N	1500 E	0.2 E
1,2-Dichloroethylene (trans)	VOC			100	120 N	73 N	27 N	170 N	600 N	3600 E	0.3 E
1,2-Dichloroethylene (mixture)	VOC				55 N	33 N	12 N	75 N	270 N		
2,4-Dichlorophenol	SVOC				110 N	11 N	4.1 N	200 N	2000 N	4800 S	0.5 E
2,4-Dichlorophenoxyacetic Acid (2,4-D)	HERB			70	370 N	37 N	14 N	650 N	6800 N	7000 S	1.7 M'
4-(2,4-Dichlorophenoxy)butyric Acid (2,4-DB)	HERB				290 N	29 N	11 N	520 N	5500 N		
1,2-Dichloropropane	VOC			5	0.16 C	0.092 C	0.046 C	0.7 C	1.5 C	11 E	0.02 E
2,3-Dichloropropanol	VOC				110 N	11 N	4.1 N	200 N	2000 N		

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-6} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc/Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
1,3-Dichloropropene	PEST	B2			0.081 C	0.048 C	0.018 C	0.51 C	1.2 C	0.1 E	0.001 E
Dichlorvos	PEST	B2			0.23 C	0.022 C	0.011 C	1.5 C	6.6 C	3.5 C	0.00072 C
Dicofol	PEST				0.15 C	0.014 C	0.0072 C	1.0 C	4.3 C		
Dicyclopentadiene					0.42 N	0.21 N	41 N	2300 N I	61000 N I		
Dieldrin	PEST	B2			0.0042 C	0.00039 C	0.0002 C	0.03 C	0.12 C	2 E	0.001 E
Diesel emissions					52 N I	5.2 N					
Diethyl phthalate	SVOC				29000 N	2900 N	1100 N	52000 N	SAT	520 E	110 E
Diethylene glycol, monobutyl ether					210 N	21 N		370 N	3900 N		
Diethylene glycol, monoethyl ether					73000 N	7300 N	2700 N	SAT	SAT		
Diethylformamide					400 N	40 N	15 N	720 N	7500 N		
Di(2-ethylhexyl)adipate				400	56 N	5.2 C	2.6 C	370 C	1600 C		
Diethylstilbestrol					0.00001 C	1.3E-06 C	7.0E-07 C	9.5E-05 C	4.1E-04 C		
Difenzoquat (Avenge)	PEST				2900 N	290 N	110 N	5200 N	55000 N		
Diflubenzuron	PEST				730 N	73 N	27 N	1300 N	14000 N		
1,1-Difluoroethane					69000 N	42000 N					
Diisopropyl methylphosphonate (DIMP)					2900 N	290 N	110 N	5200 N	55000 N		
Dimethipin	PEST				730 N	73 N	27 N	1300 N	14000 N		
Dimethoate	PEST				7.3 N	0.73 N	0.27 N	13 N	140 N		

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-6} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc/Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
3,3'-Dimethoxybenzidine	SVOC				4.8 C	0.45 C	0.23 C	32 C	140 C		
Dimethylamine	PEST				0.04 N	0.021 N		0.062 N	0.23 N		
2,4-Dimethylaniline hydrochloride					0.12 C	0.011 C	0.0054 C	0.8 C	3.3 C		
2,4-Dimethylaniline					0.09 C	0.0083 C	0.0042 C	0.6 C	2.5 C		
N-N-Dimethylaniline					73 N	7.3 N	2.7 N	130 N	1400 N		
3,3'-Dimethylbenzidine	SVOC				0.0073 C	0.00068 C	0.00034 C	0.05 C	0.21 C	29 C	0.00039 C
N,N-Dimethylformamide					3700 N	31 N	140 N	6500 N	68000 N		
1,1-Dimethylhydrazine					0.026 C	0.0018 C	0.0012 C	0.17 C	0.73 C		
1,2-Dimethylhydrazine					0.0018 C	0.00017 C	0.00009 C	0.01 C	0.05 C		
2,4-Dimethylphenol	SVOC				730 N	73 N	27 N	1300 N	14000 N	5400 S	3 E
2,6-Dimethylphenol					22 N	2.2 N	0.81 N	39 N	410 N		
3,4-Dimethylphenol					37 N	3.7 N	1.4 N	65 N	680 N		
Dimethyl phthalate	SVOC				370000 N	37000 N	14000 N	SAT	SAT	1600 E	1200 E
Dimethyl terephthalate					3700 N	370 N	140 N	6500 N	68000 N		
1,2-Dinitrobenzene	SVOC				15 N	1.5 N	0.54 N	26 N	270 N		
1,3-Dinitrobenzene	SVOC				3.7 N	0.37 N	0.14 N	6.5 N	68 N		
1,4-Dinitrobenzene	SVOC				15 N	1.5 N	0.54 N	26 N	270 N		
4,6-Dinitro-o-cyclohexyl phenol					73 N	7.3 N	2.7 N	130 N	1400 N		

EPA Region 6
Human Health
Media-Specific Screening Levels

Legend: MCL = Maximum Contaminant Level SAT = risk-based value above expected saturation point max = maximum concentration PEST = Pesticide Herb = Herbicide VOC = Volatile Organic Compound SVOC = Semi-Volatile Organic Compound *"Blank" = Missing data for generation of value.*					*Basis: C= carcinogenic effects N = non-carcinogenic effects* *E = EPA draft Soil Screening Level S = soil saturation concentration* *M' = EPA MCL I = Ingestion route only*						
Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-6} C= 10^{-5} Blank= 10^{-6}*	*Soil Regional Background Conc./Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
2,4-Dinitrophenol Dinitrotoluene mixture 2,4-Dinitrotoluene	SVOC SVOC SVOC	B2			73 N 0.099 C 73 N	7.3 N 0.0092 C 7.3 N	2.7 N 0.0046 C 2.7 N	130 N 0.65 C 130 N	1400 N 2.8 C 1400 N	360 N 120 S	0.1 E 0.2 E
2,6-Dinitrotoluene Dinoseb di-n-Octyl phthalate	SVOC HERB SVOC			7	37 N 37 N 730 N	3.7 N 3.7 N 73 N	1.4 N 1.4 N 27 N	65 N 65 N 1300 N	680 N 680 N 14000 N	370 S SAT	0.1 E SAT
1,4-Dioxane Diphenamid Diphenylamine	VOC PEST SVOC	B2			1.0 C 1100 N 910 N	0.57 C 110 N 91 N	0.29 C 41 N 34 N	14 C 2000 N 1600 N	37 C 20000 N 17000 N		
1,2-Diphenylhydrazine Diquat Direct black 38	SVOC PEST	B2		20	0.084 C 80 N 0.0078 C	0.0081 C 8 N 0.00073 C	0.0039 C 3 N 0.00037 C	0.6 C 140 N 0.05 C	2.4 C 1500 N 0.2 C		
Direct blue 6 Direct brown 95 Disulfoton	 PEST				0.0083 C 0.0072 C 1.5 N	0.00077 C 0.00067 C 0.15 N	0.00039 C 0.00034 C 0.054 N	0.06 C 0.05 C 2.6 N	0.2 C 0.2 C 27 N		
1,4-Dithiane Diuron Dodine	 PEST PEST				370 N 73 N 150 N	37 N 7.3 N 15 N	14 N 2.7 N 5.4 N	650 N 130 N 260 N	6800 N 1400 N 2700 N		

EPA Region 6
Human Health
Media-Specific Screening Levels

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-6} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc/Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Endosulfan	PEST				1.8 N	22 N	8.1 N	3.3 N	34 N	1 S	3 E
Endothall	PEST			100	730 N	73 N	27 N	1300 N	14000 N		
Endrin	PEST			2	11 N	1.1 N	0.41 N	21 N	200 N	16 S	0.4 E
Epichlorohydrin	VOC	B2			2.0 N	1 C	0.32 C	8.6 C	31 C		
1,2-Epoxybutane					210 N	21 N		370 N	3900 N		
Ethephon (2-chloroethyl phosphonic acid)	PEST				180 N	18 N	6.8 N	330 N	3400 N		
Ethion	PEST				18 N	1.8 N	0.68 N	33 N	340 N		
2-Ethoxyethanol acetate					11000 N	1100 N	410 N	20000 N	SAT		
2-Ethoxyethanol					15000 N	210 N	540 N	26000 N	SAT		
Ethyl acrylate					0.23 C	0.13 C	0.066 C	0.5 C	1.0 C		
EPTC (S-Ethyl dipropylthiocarbamate)					910 N	91 N	34 N	1600 N	17000 N		
Ethyl acetate	VOC				33000 N	3300 N	1200 N	59000 N	SAT		
Ethylbenzene	VOC			70	1300 N	1000 N	140 N	2900 S	3100 S	260 E	5 E
Ethylene cyanohydrin					11000 N	1100 N	410 N	20000 N	SAT		
Ethylene diamine					730 N	73 N	27 N	1300 N	14000 N		
Ethylene glycol					73000 N	7300 N	2700 N	130000 N	SAT		
Ethylene glycol, monobutyl ether					210 N	21 N		370 C	3900 C		
Ethylene oxide	VOC				0.024 C	0.018 C	0.0031 C	0.12 C	0.3 C		

EPA Region 6
Human Health
Media-Specific Screening Levels

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-4} C= 10^{-5} Blank= 10^{-6}*	*Soil Regional Background Conc/Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Ethylene thiourea (ETU) Ethyl ether Ethyl methacrylate	VOC				0.11 C 1200 N 550 N	0.053 C 730 N 330 N	0.027 C 270 N 120 N	0.7 C 3800 S 340 S	3.2 C 3800 S 340 S		
Ethyl p-nitrophenyl phenylphosphorothioate Ethylnitrosourea Ethylphthalyl ethyl glycolate					0.37 N 0.00048 C I 110000 N	0.037 N 0.00005 C 11000 N	0.014 N 0.00002 C 4100 N	0.7 N 0.005 C I SAT	6.8 N 0.041 C I SAT		
Express Fenamiphos Fluometuron	PEST PEST PEST				290 N 9.1 N 470 N	29 N 0.91 N 47 N	11 N 0.34 N 18 N	520 N 16 N 850 N	5500 N 170 N 8900 N		
Fluoride Fluoridone Flurprimidol	PEST PEST			4000	2200 N 2900 N 730 N	220 N 290 N 73 N	81 N 110 N 27 N	3900 N 5200 N 1300 N	41000 N 55000 N 14000 N		
Flutolanil Fluvalinate Folpet	PEST PEST PEST	B2			2200 N 370 N 19 C	220 N 37 N 1.8 C	81 N 14 N 0.9 C	3900 N 650 N 130 C	41000 N 6800 N 550 C		
Fomesafen Fonofos Formaldehyde	PEST PEST	C			3.5 C 73 N 5500 N	0.33 C 7.3 N 0.14 C	0.17 C 2.7 N 270 N	23 C 130 N 9800 N	100 C 1400 N SAT		

EPA Region 6
Human Health
Media-Specific Screening Levels

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-6} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc/Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Formic Acid Fosetyl- Al Furan	PEST				73000 N 110000 N 37 N	7300 N 11000 N 3.7 N	2700 N 4100 N 1.4 N	SAT SAT 65 N	SAT SAT 680 N		
Furazolidone Furfural Furium	PEST				0.018 C 110 N 0.0013 C	0.0016 C 52 N 0.00013 C	0.00083 C 4.1 N 0.00006 C	0.12 C 200 N 0.009 C	0.5 C 2000 N 0.04 C		
Furmecyclox Glufosinate-ammonium Glycidaldehyde		B2			2.2 C 15 N 15 N	0.21 C 1.5 N 1 N	0.11 C 0.54 N 0.54 N	15 C 26 N 26 N	64 C 270 N 270 N		
Glyphosate Haloxyfop-methyl Harmony	PEST PEST			700	3700 N 1.8 N 470 N	370 N 0.18 N 47 N	140 N 0.068 N 18 N	6500 N 3.3 N 850 N	68000 N 34 N 8900 N		
HCH (alpha) HCH (beta) HCH (gamma) Lindane	PEST PEST PEST	B2 C		 0.2	0.011 C 0.37 C 0.05 C	0.00099 C 0.035 C 0.0048 C	0.0005 C 0.018 C 0.0024 C	0.07 C 3 C 0.34 C	0.3 C 11 C 1.5 C	0.9 E 16 E 4.2 C	0.0004 E 0.002 E 0.006 E
HCH-technical Heptachlor Heptachlor epoxide	PEST PEST PEST	B2 B2 B2		 0.1 0.2	0.037 C 0.2 C 0.007 C	0.0035 C 0.0014 C 0.00069 C	0.0018 C 0.0007 C 0.00035 C	0.3 C 0.1 C 0.05 C	1.1 C 0.4 C 0.2 C	 0.3 E 1 E	 0.06 E 0.03 E

EPA Region 6
Human Health
Media-Specific Screening Levels

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-6} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc/Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Hexabromobenzene					12 N I	7.3 N	2.7 N	130 N	1400 N		
Hexachlorobenzene	PEST	B2		1	0.04 C	0.0039 C	0.002 C	0.3 C	1.2 C	1 E	0.8 E
Hexachlorobutadiene	VOC	C			8.6 C	0.81 C	0.4 C	57 C	240 C	1 E	0.1 E
Hexachlorocyclopentadiene	PEST			50	260 N	0.073 N	9.5 N	450 N	4700 N	2 E	10 E
Hexachlorodibenzo-p-dioxin mixture		B2			0.00001 C	1.4E-06 C	5.0E-07 C	7.2E-05 C	3.1E-04 C		
Hexachloroethane	VOC	C			48 C	4.5 C	2.3 C	320 C	1400 C	49 E	0.2 E
Hexachlorophene	SVOC				11 N	1.1 N	0.41 N	20 N	200 N		
Hexahydro-1,3,5-trinitro-1,3,5-triazine		C			6.1 C	0.57 C	0.29 C	40 C	170 C		
1,6-Hexamethylene diisocyanate					0.1 N	0.01 N					
n-Hexanex					350 N I	210 N	81 N	4700 N I	SAT	32 N	13 N
Hexazinone	PEST				1200 N	120 N	45 N	2200 N	22000 N		
Hydrazine, hydrazine sulfate		B2			0.022 C	0.00037 C	0.0011 C	0.2 C	0.6 C		
Hydrogen chloride					210 N I	21 N					
Hydrogen sulfide					1.8 N	1 N	4.1 N	6100 N I	230 N I		
Hydroquinone					1500 N	150 N	54 N	2600 N	27000 N		
Imazalil	PEST				470 N	47 N	18 N	850 N	8900 N		
Imazaquin	PEST				9100 N	910 N	340 N	16000 N	SAT		
Iprodione	PEST				1500 N	150 N	54 N	2600 N	27000 N		

EPA Region 6
Human Health
Media-Specific Screening Levels

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SVOC = Semi-Volatile Organic Compound
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Basis: C= carcinogenic effects N = non-carcinogenic effects
E = EPA draft Soil Screening Level S = soil saturation concentration
M' = EPA MCL I = Ingestion route only

Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-6} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc/Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Iron					11000 N I	1100 N	410 N	23000 N I	SAT		
Isobutanol	VOC				1800 N I	1100 N	410 N	20000 N	SAT		
Isophorone	PEST	C			710 C	66 C	33 C	4700 C	20000 C	3400 E	0.2 E
Isopropalin	PEST				550 N	55 N	20 N	980 N	10000 N		
Isopropyl methyl phosphonic acid					3700 N	370 N	140 N	6500 N	68000 N		
Isoxaben					1800 N	180 N	68 N	3300 N	34000 N		
Lead			10-18		(Uptake	Biokinetic	Model)	400 N	2000 N		
Kepone	PEST				0.0037 C	0.00035 C	0.00018 C	0.03 C	0.1 C		
Lactofen	PEST				73 N	7.3 N	2.7 N	130 N	1400 N		
Linuron	PEST				73 N	7.3 N	2.7 N	130 N	1400 N		
Lithium					730 N	73 N	27 N	1500 N	34000 N		
Londax	PEST				7300 N	730 N	270 N	13000 N	SAT		
Malathion	PEST				730 N	73 N	27 N	1300 N	14000 N		
Maleic anhydride	SVOC				3700 N	370 N	140 N	6500 N	68000 N		
Maleic hydrazide	PEST				18000 N	1800 N	680 N	33000 N	SAT		
Malononitrile	VOC				0.73 N	0.073 N	0.027 N	1.3 N	14 N		
Mancozeb	PEST				1100 N	110 N	41 N	2000 N	20000 N		
Maneb	PEST				180 N	18 N	6.8 N	330 N	3400 N		
Manganese and compounds			389-850		180 N	0.052 N	6.8 N	380 N	8300 N		

0.3

EPA Region 6
Human Health
Media-Specific Screening Levels

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Basis: C= carcinogenic effects N = non-carcinogenic effects
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Contaminant	Chemical Group Name	Cancer Class Risk Level: A/B= 10^{-4} C= 10^{-5} Blank= 10^{-4}	Soil Regional Background Conc./Range (mg/kg)	Drinking Water (MCL's)	Risk-Based Screening Levels: Tap Water (Residential Scenario: Ingestion, & Inhalation)	Ambient Air (Residential Scenario)	Fish (Recreational Fishing Scenario)	Soil (Ingestion, Inhalation, and Dermal Exposure Routes): Residential	Industrial	Soil Screening Level Transfers from Soil to: Air	Ground Water
				µg/L	µg/L	µg/m3	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Mephosfolan	PEST				3.3 N I	0.33 N	0.12 N	5.9 N	180 N I		
Mepiquat chloride	PEST				1100 N I	110 N	41 N	2000 N	61000 N I		
Mercuric chloride					11 N I	1.1 N	0.41 N	23 N I	610 N I		
Mercury (inorganic)			0.10	2	11 N	0.31 N	0.41 N	23 N	510 N	7 E	3 E
Mercury (methyl)					3.7 N I	0.37 N	0.14 N	20 N	200 N I		
Merphos	PEST				1.1 N	0.11 N	0.041 N	2.0 N	21 N		
Merphos oxide	PEST				1.1 N	0.11 N	0.041 N	2.0 N	20 N		
Metalaxyl	PEST				2200 N	220 N	81 N	3900 N	41000 N		
Methacrylonitrile	VOC				1.0 N	0.73 N	0.14 N	1.3 N	5.1 N		
Methamidophos	PEST				1.8 N	0.18 N	0.068 N	3.3 N	34 N		
Methanol	VOC				18000 N	1800 N	680 N	33000 N	SAT		
Methidathion	PEST				37 N	3.7 N	1.4 N	65 N	680 N		
Methomyl	PEST				910 N	91 N	34 N	1600 N	17000 N		
Methoxychlor	PEST			40	180 N	18 N	6.8 N	330 N	3400 N	41 S	62 E
2-Methoxyethanol acetate					73 N	7.3 N	2.7 N	130 N	1400 N		
2-Methoxyethanol					37 N	21 N	1.4 N	65 N	680 N		
2-Methoxy-5-nitroaniline					1.5 C	0.14 C	0.069 C	9.7 C	41 C		
Methyl acetate					6100 N	3700 N	1400 N	20000 N	84000 N		

EPA Region 6
Human Health
Media-Specific Screening Levels

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Basis: C= carcinogenic effects N = non-carcinogenic effects
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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-6} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc/Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Methyl acrylate 2-Methylaniline hydrochloride 2-Methylaniline					1100 N I 0.37 C 0.28 C	110 N 0.035 C 0.026 C	41 N 0.018 C 0.013 C	150 N 2.5 C 1.9 C	520 N 11 C 7.9 C		
Methyl chlorocarbonate 4-(2-Methyl-4-chlorophenoxy) butyric acid 2-Methyl-4-chlorophenoxyacetic acid	HERB HERB				37000 N 370 N 18 N	3700 N 37 N 1.8 N	1400 N 14 N 0.68 N	65000 N 650 N 33 N	SAT 6800 N 340 N		
2-(2-Methyl-1,4-chlorophenoxy)propionic acid Methylcyclohexane Methylene bromide	HERB				37 N 31000 N 61 N I	3.7 N 3100 N 37 N	1.4 N 14 N	65 N 56000 N 650 N	680 N SAT 6800 N	60 S	1500 N
Methylene chloride 4,4'-Methylene bis(2-chloroaniline) 4,4'-Methylenebisbenzeneamine	VOC				4.3 C 0.52 C 0.27 C	3.8 C 0.048 C 0.025 C	0.42 C 0.024 C 0.013 C	11 C 3.4 C 1.8 C	25 C 15 C 7.6 C	7 E	0.01 E
4,4'-Methylene bis(N,N'-dimethyl)aniline 4,4'-Methylenediphenyl isocyanate Methyl ethyl ketone		B2			1.5 C 0.035 N I 1900 N	0.14 C 0.021 N 1000 N	0.069 C 810 N	9.7 C 0.37 N 8700 N	41 C 3.9 N 34000 N		
Methyl hydrazine Methyl isobutyl ketone Methyl methacrylate	VOC				0.061 C 2900 N 2900 N	0.0057 C 84 N 290 N	0.0029 C 110 N 110 N	0.4 C 5200 N 5200 N	1.7 C 55000 N 55000 N		

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-6} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc/Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
2-Methyl-5-nitroaniline	SVOC				2 C	0.19 C	0.096 C	13 C	58 C		0.041 N
Methyl parathion	SVOC				9.1 N	0.91 N	0.34 N	16 N	170 N	28 S	6 E
2-Methylphenol (o-cresol)					1800 N	180 N	68 N	3300 N	34000 N	12000 S	
3-Methylphenol (m-cresol)	SVOC				1800 N	180 N	68 N	3300 N	34000 N		
4-Methylphenol (p-cresol)	SVOC				180 N	18 N	6.8 N	330 N	3400 N		
Methyl styrene (mixture)					60 N	42 N	8.1 N	220 N	1200 N	100 N	1 N
Methyl styrene (alpha)					430 N	260 N	95 N	1800 N	8100 N	8.8 S	7.5 N
Methyl tertbutyl ether (MTBE)	VOC				180 N	3100 N	6.8 N	330 N	3400 N		
Metolaclor (Dual)	PEST				5500 N	550 N	200 N	9800 N	SAT		
Metribuzin	PEST				910 N	91 N	34 N	1600 N	17000 N		
Mirex	PEST				0.037 C	0.0035 C	0.0018 C	0.25 C	1.1 C		
Molinate	PEST				73 N	7.3 N	2.7 N	130 N	1400 N		
Molybdenum					180 N	18 N	6.8 N	380 N	8500 N		
Monochloramine					3700 N	370 N	140 N	6500 N	68000 N		
Naled	PEST				73 N	7.3 N	2.7 N	130 N	1400 N		
2-Naphthylamine	SVOC				0.00052 C I	0.00005 C	0.00002 C	0.005 C I	0.04 C I		
Napropamide	PEST				3700 N	370 N	140 N	6500 N	68000 N		
Nickel refinery dust		A				0.0075 C					

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VOC = Volatile Organic Compound
SVOC = Semi-Volatile Organic Compound
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Basis: C= carcinogenic effects N = non-carcinogenic effects
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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-6} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc/Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Nickel and compounds Nickel subsulfide Nitrapyrin	PEST	A	16	100	730 N 55 N	73 N 0.0037 C 5.5 N	27 N 2 N	1500 N 98 N	34000 N 39000 C 1000 N	6900 E	21 E
Nitrate Nitric Oxide Nitrite				10000 1000	58000 N 3700 N 3700 N	5800 N 370 N 370 N	2200 N 140 N 140 N	SAT 6500 N 6500 N	SAT SAT SAT		
2-Nitroaniline 3-Nitroaniline 4-Nitroaniline	SVOC SVOC SVOC				2.2 N 110 N I 110 N I	0.21 N 11 N 11 N	0.081 N 4.1 N 4.1 N	3.9 N 230 N I 230 N I	41 N 6100 N I 6100 N I		
Nitrobenzene Nitrofurantoin Nitrofurazone	VOC				3.4 N I 2600 N 0.045 C	2.1 N 260 N 0.00067 C	0.68 N 95 N 0.0021 C	33 N 4600 N 0.3 C	340 N 48000 N 1.3 C	110 E	0.09 E
Nitrogen dioxide Nitroguanidine 4-Nitrophenol					37000 N I 3700 N 2300 N I	3700 N 370 N 230 N	1400 N 140 N 84 N	SAT 6500 N 4800 N I	SAT 68000 N SAT		
2-Nitropropane N-Nitrosodi-n-butylamine N-Nitrosodiethanolamine	VOC VOC	B2 B2			35 C 0.012 C 0.024 C	0.00067 C 0.0011 C 0.0022 C	0.00058 C 0.0011 C	0.08 C 0.2 C	0.4 C 0.7 C		

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-6} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc/Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
N-Nitrosodiethylamine	SVOC	B2			0.00045 C	0.00004 C	0.00002 C	0.003 C	0.01 C		
N-Nitrosodimethylamine	SVOC	B2			0.0013 C	0.00013 C	0.00006 C	0.009 C	0.04 C		
N-Nitrosodiphenylamine	SVOC	B2			14 C	1.3 C	0.64 C	91 C	390 C	29 C	0.2 E
N-Nitroso di-n-propylamine	SVOC				0.0096 C	0.00089 C	0.00045 C	0.06 C	0.3 C	0.014 C	0.00002 E
N-Nitroso-N-methylethylamine		B2			0.0031 C	0.00028 C	0.00014 C	0.02 C	0.09 C		
N-Nitrosopyrrolidine		B2			0.032 C	0.0029 C	0.0015 C	0.2 C	0.9 C		
m-Nitrotoluene					61 N I	37 N	14 N	650 N	6800 N	460 S	0.42 N
o-Nitrotoluene					61 N I	37 N	14 N	780 N I	20000 N I	460 S	0.42 N
p-Nitrotoluene					61 N I	37 N	14 N	650 N	6800 N	460 S	0.42 N
Norflurazon	PEST				1500 N I	150 N	54 N	31000 N I			
NuStar	PEST				26 N	2.6 N	0.95 N	46 N	480 N		
Octabromodiphenyl ether					110 N	11 N	4.1 N	200 N	2000 N		
Octahydro-1357-tetranitro-1357-tetrazocine					1800 N	180 N	68 N	3300 N	34000 N		
Octamethylpyrophosphoramide	SVOC				73 N	7.3 N	2.7 N	130 N	1400 N		
Oryzalin	PEST				1800 N	180 N	68 N	3300 N	34000 N		
Oxadiazon	PEST				180 N	18 N	6.8 N	330 N	3400 N		
Oxamyl	PEST			200	910 N	91 N	34 N	1600 N	17000 N		
Oxyfluorfen	PEST				110 N	11 N	4.1 N	200 N	2000 N		

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-4} C= 10^{-6} Blank= 10^{-4}*	*Soil Regional Background Conc./Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Paclobutrazol Paraquat Parathion	PEST PEST PEST				470 N 160 N 220 N	47 N 16 N 22 N	18 N 6.1 N 8.1 N	850 N 290 N 390 N	8900 N 3100 N 4100 N	110 S	3.9 N
Pebulate Pendimethalin Pentabromo-6-chloro cyclohexane	PEST PEST				1800 N 1500 N 2.9 C	180 N 150 N 0.27 C	68 N 54 N 0.14 C	3300 N 2600 N 19 C	34000 N 27000 N 83 C		
Pentabromodiphenyl ether Pentachlorobenzene Pentachloronitrobenzene	 SVOC				73 N 4.9 N I 0.041 C I	7.3 N 2.9 N 0.024 C	2.7 N 1.1 N 0.012 C	130 N 52 N 1.7 C	1400 N 550 N 7.3 C	570 N	48 N
Pentachlorophenol Permethrin Phenmedipham	PEST PEST PEST			1	0.56 C 1800 N 9100 N	0.052 C 180 N 910 N	0.026 C 68 N 340 N	2.5 C 3300 N 16000 N	7.9 C 34000 N SAT	7.9 C	0.2 E
Phenol m-Phenylenediamine p-Phenylenediamine	SVOC SVOC SVOC				22000 N 220 N 6900 N	2200 N 22 N 690 N	810 N 8.1 N 260 N	39000 N 390 N 12000 N	SAT 4100 N SAT	21000 S	49 E
Phenylmercuric acetate 2-Phenylphenol Phorate	 PEST				2.9 N 35 C 7.3 N	0.29 N 3.2 C 0.73 N	0.11 N 1.6 C 0.27 N	5.2 N 230 C 13 N	55 N 980 C 140 N		

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level:* *A/B= 10^{-4}* *C= 10^{-5}* *Blank= 10^{-6}*	*Soil Regional Background Conc/Range (mg/kg)*		*Risk-Based Screening Levels*					*Soil Screening Level Transfers from Soil to:*	
				Drinking Water (MCL's)	*Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)*			
								Residential	*Industrial*	*Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Phosmet Phosphine Phosphoric acid	PEST				730 N 11 N 100 N I	73 N 0.31 N 10 N	27 N 0.41 N	1300 N 20 N	14000 N 200 N		
Phosphorus (white) p-Phthalic acid Phthalic anhydride	SVOC				0.73 N I 37000 N I 73000 N I	0.073 N 3700 N 130 N	0.027 N 1400 N 2700 N	1.6 N I SAT SAT	41 N I SAT SAT		
Picloram Pirimiphos-methyl Polybrominated biphenyls	PEST PEST				2600 N 370 N 0.0076 C	260 N 37 N 0.0007 C	95 N 14 N 0.00035 C	4600 N 650 N 0.05 C	48000 N 6800 N 0.2 C		
Polychlorinated biphenyls (PCBs) Aroclor 1016 Aroclor 1254	SVOC	B2		0.5	0.009 C 2.6 N 0.73 N	0.00081 C 0.26 N 0.073 N	0.00041 C 0.095 N 0.027 N	0.07 C 4.9 N 1.4 N	0.3 C 65 N 19 N		
Polychlorinated terphenyls (PCTs) Polynuclear aromatic hydrocarbons Acenaphthene	SVOC				0.015 C I 370 N	0.0014 C 220 N	0.0007 C 81 N	0.14 C I 360 S	1.3 C I 360 S	SAT 120 S	200 E
Anthracene Benz[a]anthracene Benzo[b]fluoranthene	SVOC SVOC SVOC	B2			1800 N 0.092 C 0.092 C	1100 N 0.01 C 0.01 C	410 N 0.0043 C 0.0043 C	19 S 0.6 C 0.6 C	19 S 2.6 C 2.6 C	6.8 S 27 S 23 S	4300 E 0.7 E 4 E

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-6} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc/Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Benzo[k]fluoranthene	SVOC	B2			0.92 C	0.1 C	0.043 C	6.1 C	26 C		4 E
Benzo[a]pyrene	SVOC	B2		0.2	0.0092 C	0.001 C	0.00043 C	0.06 C	0.3 C	11 S	4 E
Carbazole	SVOC				3.4 C I	0.31 C	0.16 C	32 C I	290 C I	11 S	0.5 E
Chrysene	SVOC				9.2 C	1 C	0.43 C	24 S	24 S	3.6 S	1 E
Dibenz[a,h]anthracene	SVOC				0.0092 C	0.001 C	0.00043 C	0.06 C	0.3 C	7.2 S	11 E
Fluoranthene	SVOC				1500 N	150 N	54 N	2600 N	27000 N	68 S	980 E
Fluorene	SVOC				240 N	150 N	54 N	300 S	300 S	89 S	160 E
Indeno[1,2,3-cd]pyrene	SVOC	B2			0.092 C	0.01 C	0.0043 C	0.6 C	2.6 C	280 S	35 E
Naphthalene	SVOC				240 N	150 N	54 N	800 S	800 S	180 S	30 E
Pyrene	SVOC				1100 N	110 N	41 N	2000 N	20000 N	56 S	1400 E
Prochloraz	PEST	C			4.5 C I	0.42 C	0.21 C	30 C	130 C		
Profluralin					220 N	22 N	8.1 N	390 N	4100 N		
Prometon	PEST				550 N	55 N	20 N	980 N	10000 N		
Prometryn	PEST				150 N	15 N	5.4 N	260 N	2700 N		
Pronamide	PEST				2700 N	270 N	100 N	4900 N	51000 N		
Propachlor	PEST				470 N	47 N	18 N	850 N	8900 N		
Propanil	PEST				180 N	18 N	6.8 N	330 N	3400 N		
Propargite	PEST				730 N	73 N	27 N	1300 N	14000 N		

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-4} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc/Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Propargyl alcohol	VOC				73 N	7.3 N	2.7 N	130 N	1400 N		
Propazine	PEST				730 N	73 N	27 N	1300 N	14000 N		
Propham	PEST				730 N	73 N	27 N	1300 N	14000 N		
Propiconazole	PEST				470 N	47 N	18 N	850 N	8900 N		
Propylene glycol					730000 N	73000 N	27000 N	SAT	SAT		
Propylene glycol, monoethyl ether					26000 N	2600 N	950 N	46000 N	SAT		
Propylene glycol, monomethyl ether					26000 N	2100 N	950 N	46000 N	SAT		
Propylene oxide		B2			0.22 C	0.49 C	0.013 C	2.7 C I	24 C I		
Pursuit	PEST				9100 N	910 N	340 N	16000 N	SAT		
Pydrin	PEST				910 N	91 N	34 N	1600 N	17000 N		
Pyridine	VOC				37 N	3.7 N	1.4 N	65 N	680 N		
Quinalphos	PEST				18 N	1.8 N	0.68 N	33 N	340 N		
Quinoline					0.0056 C	0.00052 C	0.00026 C	0.04 C	0.2 C		
Resmethrin	PEST				1100 N	110 N	41 N	2000 N	20000 N		
Ronnel	PEST				1800 N	180 N	68 N	3300 N	34000 N		
RDX (Cyclonite)		C			6.1 C	0.6 C		40 C	170 C		
Rotenone	PEST				150 N	15 N	5.4 N	260 N	2700 N		
Savey	PEST				910 N	91 N	34 N	1600 N	17000 N		
Selenious Acid					180 N	18 N	6.8 N	330 N	3400 N		

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-6} C= 10^{-5} Blank= 10^{-6}*	*Soil Regional Background Conc/Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Selenium			0.2	50	180 N	18 N	6.8 N	380 N	8500 N		3 E
Selenourea					180 N	18 N	6.8 N	330 N	3400 N		
Sethoxydim	PEST				3300 N	330 N	120 N	5900 N	61000 N		
Silver and compounds			0.01-5		180 N	18 N	6.8 N	380 N	8500 N		
Simazine	PEST			4	0.6 C	0.052 C	0.026 C	3.7 C	16 C		
Sodium azide					150 N	15 N	5.4 N	260 N	2700 N		
Sodium diethyldithiocarbamate					0.25 C	0.023 C	0.012 C	1.6 C	7.1 C		
Sodium fluoroacetate	PEST				0.73 N	0.073 N	0.027 N	1.3 N	14 N		
Sodium metavanadate					37 N	3.7 N	1.4 N	65 N	680 N		
Strontium, stable					22000 N	2200 N	810 N	46000 N	SAT		
Strychnine	PEST				11 N	1.1 N	0.41 N	20 N	200 N		
Styrene	VOC			100	1600 N	1000 N	270 N	2200 S	2200 S	1400 E	2 E
Systhane	PEST				910 N	91 N	34 N	1600 N	17000 N		
2,3,7,8-TCDD (dioxin)				3E-08	4.5E-07 C	5.4E-08 C		3.8E-06 C	2.4E-05 C		
Tebuthiuron	PEST				2600 N	260 N	95 N	4600 N	48000 N		
Temephos	PEST				730 N	73 N	27 N	1300 N	14000 N		
Terbacil	PEST				470 N	47 N	18 N	850 N	8900 N		
Terbufos	PEST				0.91 N	0.091 N	0.034 N	1.6 N	17 N		

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-4} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc/Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Terbutryn	PEST				37 N	3.7 N	1.4 N	65 N	680 N		
1,2,4,5-Tetrachlorobenzene	SVOC				11 N	11 N	0.41 N	20 N	200 N	91 N	0.69 N
1,1,1,2-Tetrachloroethane	VOC	C			4.3 C	2.4 C	1.2 C	48 C	120 C		
1,1,2,2-Tetrachloroethane	VOC	C			0.55 C	0.31 C	0.16 C	9 C	24 C	0.4 E	0.001 E
Tetrachloroethylene (PCE)	VOC			5	1.1 C	3.1 C	0.061 C	7 C	25 C	11 E	0.04 E
2,3,4,6-Tetrachlorophenol	SVOC				1100 N	110 N	41 N	2000 N	20000 N		
p,a,a,a-Tetrachlorotoluene					0.00053 C I	0.00031 C	0.00016 C	0.02 C	0.1 C		
Tetrachlorovinphos	PEST				2.8 C	0.26 C	0.13 C	19 C	79 C		
Tetraethyldithiopyrophosphate	PEST				18 N	1.8 N	0.68 N	33 N	340 N		
Tetraethyl lead					0.0037 N	0.00037 N	0.00014 N	0.006 NI	0.07 N	0.00068 N	0.000034 N
1,1,1,2-Tetrafluoroethane					140000 N I	84000 N					
Thallic oxide					2.6 N	0.26 N	0.095 N	5.4 N	120 N		
Thallium				20							0.4 E
Thallium acetate					3.3 N	0.33 N	0.12 N	6.9 N	150 N		
Thallium carbonate					2.9 N	0.29 N	0.11 N	6.1 N	140 N		
Thallium chloride					2.9 N	0.29 N	0.11 N	6.1 N	140 N		
Thallium nitrate					3.3 N	0.33 N	0.12 N	6.9 N	150 N		
Thallium selenite					3.3 N	0.33 N	0.12 N	6.9 N	150 N		

EPA Region 6
Human Health
Media-Specific Screening Levels

Legend: MCL = Maximum Contaminant Level
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max = maximum concentration
PEST = Pesticide Herb = Herbicide
VOC = Volatile Organic Compound
SVOC = Semi-Volatile Organic Compound
"Blank" = Missing data for generation of value.

Basis: C= carcinogenic effects N = non-carcinogenic effects
E = EPA draft Soil Screening Level S = soil saturation concentration
M' = EPA MCL I = Ingestion route only

Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-4} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc/Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Thallium sulfate					2.9 N	0.29 N	0.11 N	6.1 N	140 N		
Thiobencarb	PEST				370 N	37 N	14 N	650 N	6800 N		
2-(Thiocyanomethylthio)-benzothiazole					1100 N	110 N	41 N	2000 N	20000 N		
Thiofanox					11 N	1.1 N	0.41 N	20 N	200 N		
Thiophanate-methyl	PEST				2900 N	290 N	110 N	5200 N	55000 N		
Thiram	PEST				180 N	18 N	6.8 N	330 N	3400 N		
Tin and compounds			122		22000 N	2200 N	810 N	46000 N	SAT		
Toluene	VOC			1000	720 N	420 N	270 N	1900 N	2700 S	520 E	5 E
Toluene-2,4-diamine					0.021 C	0.002 C	0.00099 C	0.1 C	0.6 C		
Toluene-2,5-diamine					22000 N	2200 N	810 N	39000 N	SAT		
Toluene-2,6-diamine					7300 N	730 N	270 N	13000 N	SAT		
p-Toluidine					0.35 C	0.033 C	0.017 C	2.3 C	10 C		
Toxaphene	PEST	B2		3	0.061 C	0.0056 C	0.0029 C	0.4 C	1.7 C	5 E	0.04 E
Tralomethrin	PEST				270 N	27 N	10 N	490 N	5100 N		
Triallate	PEST				470 N	47 N	18 N	850 N	8900 N		
Triasulfuron	PEST				370 N	37 N	14 N	650 N	6800 N		
1,2,4-Tribromobenzene					30 N I	18 N	6.8 N	330 N	3400 N		
Tributyltin oxide (TBTO)	PEST				1.1 N	0.11 N	0.041 N	2 N	20 N		

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Human Health
Media-Specific Screening Levels

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-6} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc/Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
2,4,6-Trichloroaniline hydrochloride					2.3 C	0.22 C	0.11 C	15 C	66 C		
2,4,6-Trichloroaniline					2.0 C	0.18 C	0.093 C	13 C	56 C		
1,2,4-Trichlorobenzene	VOC			70	190 N	210 N	14 N	620 N	5900 N	240 E	2 E
1,1,1-Trichloroethane	VOC			200	1300 N	1000 N	120 N	3200 N	3000 S	980 E	0.9 E
1,1,2-Trichloroethane	VOC			5	0.2 C	0.11 C	0.055 C	1.4 C	3.3 C	0.8 E	0.01 E
Trichloroethylene (TCE)	VOC			5	1.6 C	1 C	0.29 C	7.1 C	17 C	3 E	0.02 E
Trichlorofluoromethane	VOC				1300 N	730 N	410 N	710 N	2400 N	790 N	13 N
2,4,5-Trichlorophenol	SVOC				3700 N	370 N	140 N	6500 N	68000 N	8200 S	120 E
2,4,6-Trichlorophenol	SVOC	B2			6.1 C	0.57 C	0.29 C	40 C	170 C	150 C	0.06 E
2,4,5-Trichlorophenoxyacetic acid	PEST				370 N	37 N	14 N	650 N	6800 N		
2-(2,4,5-Trichlorophenoxy)propionic acid	PEST				290 N	29 N	11 N	520 N	5500 N		
1,1,2-Trichloropropane					30 N	18 N	6.8 N	51 N	190 N	13 N	0.14 N
1,2,3-Trichloropropane					0.0015 C I	0.00089 C	0.00045 C	0.007 C	0.02 C	0.00003 C	6.0E-06 C
1,2,3-Trichloropropene					31 N	18 N	6.8 N	75 N	290 N		
1,1,2-Trichloro-1,2,2- trifluoroethane					59000 N	31000 N	41000 N	3600 S	3600 S	2400 S	3100 N
Tridiphane	PEST				110 N	11 N	4.1 N	200 N	2000 N		
Triethylamine					12 N	7.3 N		22 N	80 N		
Trifluralin	PEST	C			87 C	8.1 C	4.1 C	580 C	2500 C		

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-6} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc/Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
1,2,4-Trimethylbenzene	VOC				300 N I	180 N	68 N	3900 N I	SAT		
1,3,5-Trimethylbenzene	VOC				300 N I	180 N	68 N	3900 N I	SAT	98 S	0.26 M
Trimethyl phosphate					1.8 C	0.17 C	0.085 C	12 C	52 C		
1,3,5-Trinitrobenzene	SVOC				1.8 N	0.18 N	0.068 N	3.3 N	34 N		
Trinitrophenylmethylnitramine					370 N	37 N	14 N	650 N	6800 N		
2,4,6-Trinitrotoluene		C			22 C	2.1 C	1.1 C	480 C	640 C		
Uranium (soluble salts)					110 N	11 N	4.1 N	230 N	5100 N		
Vanadium			66		260 N	26 N	9.5 N	540 N	12000 N		
Vanadium pentoxide					330 N	33 N	12 N	690 N	15000 N		
Vanadium sulfate					730 N	73 N	27 N	1500 N	34000 N		
Vernam	PEST				37 N	3.7 N	1.4 N	65 N	680 N		
Vinclozolin	PEST				910 N	91 N	34 N	1600 N	17000 N		
Vinyl acetate	VOC				37000 N	210 N	1400 N	65000 N	SAT	370 E	84 E
Vinyl bromide					5.2 N I	3.1 N				2 N	0.018 N
Vinyl chloride	VOC			2	0.02 C	0.021 C	0.0017 C	0.005 C	0.01 C	0.002 E	0.01 E
Warfarin	PEST				11 N	1.1 N	0.41 N	20N	200 N	0.046 N	1800 N
m-Xylene	VOC				1400 N	730 N	2700 N	980 S	980 S	950 S	240 M
o-Xylene	VOC				1400 N	730 N	2700 N	980 S	980 S	730 S	150 M

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				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
p-Xylene Xylene (mixed) Zinc	VOC VOC		22-50	10000	520 N I 1400 N 11000 N	310 N 7300 N 1100 N	2700 N 410 N	980 S 980 S 23000 N	980 S 980 S SAT	1000 S 320 E	220 M 74 E 42000 E
Zinc phosphide Zineb	PEST PEST				11 N 1800 N	1.1 N 180 N	0.41 N 68 N	23 N 3300 N	510 N 34000 N		