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FORT WINGATE DEPOT ACTIVITY GALLUP, NM

FINAL RISK ASSESSMENT TECHNICAL MEMORANDUM OPEN BURNING/OPEN DETONATION AREAS

Prepared for:

U.S. ARMY CORPS OF ENGINEERS
FORT WORTH DISTRICT

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15 September 2000

TABLE OF CONTENTS

1.0 INTRODUCTION

This document, the Risk Assessment Technical Memorandum (RATM), presents the planned approach for the Human Health and Ecological Risk Assessments (HHRA and ERA, respectively) to be conducted for the Open Burning/Open Detonation (OB/OD) Areas at Fort Wingate Depot Activity (FWDA), Gallup, New Mexico. PMC Environmental [formerly ERM Program Management Company (ERM)] of Exton, Pennsylvania will produce the work elements described within this document. This RATM is being prepared under Purchase Order DACA63-98-P-1591 issued by the U.S. Army Corps of Engineers (USACE), Fort Worth District.

Prior to preparation of this RATM, FWDA conducted an environmental characterization and assessment at the OB/OD Areas. The overall objectives of the risk assessment are to:

- Provide the FWDA risk management team with an assessment of human risk posed by the OB/OD Areas;
- Provide the FWDA risk management team with a qualitative assessment of the cultural resources, habitat quality, and health of the ecological communities within the OB/OD Areas;
- Provide the FWDA risk management team with an assessment of whether or not the OB/OD Areas would require remediation to support future land uses;
- Provide the FWDA risk management team with an evaluation of the ecological effects of potential remedial measures;
- Identify FWDA-related risks, defined as any physical, chemical or biological factors that can induce an adverse human health or ecological effect; and
- Evaluate the likelihood that unacceptable risks exist at the OB/OD Areas or that adverse ecological effects are occurring or may occur as a result of exposure to one or more OB/OD Area-related risks.

2.0 *OB/OD AREA HISTORY AND SETTING*

2.1 *ENVIRONMENTAL SETTING AND CONTAMINANTS AT THE SITE*

The information included in this section was excerpted and summarized from the document titled, *Final Technical Plan for the Environmental Investigation at Fort Wingate Depot Activity, Gallup, New Mexico* (Metcalf & Eddy [M&E], 1992).

FWDA is an inactive United States Army depot under the administrative command of the Tooele Army Depot, Tooele, Utah. The former mission of FWDA included three primary functions: (1) to provide facilities for the storage of materiel, primarily ammunition components; (2) to handle shipping and receiving of materiel by rail or vehicular transport; and (3) to demilitarize and dispose of obsolete or deteriorated explosives and munitions. The active mission of FWDA ceased and the installation closed in January 1993. The installation is undergoing final environmental restoration prior to property transfer/reuse.

FWDA occupies approximately 34 square miles (22,120 acres) of land in northwestern New Mexico, in McKinley County. The installation is located 8 miles east of Gallup, and approximately 130 miles west of Albuquerque on U.S. Route 66 (Figure 2-1). The installation contains approximately 150 miles of internal roads.

The installation is almost entirely surrounded by federally owned or administered lands, including both national forests and tribal lands. North and west of FWDA are Navajo tribal trust and allotted lands. East of FWDA are Bureau of Indian Affairs (BIA) administered lands. Development north of FWDA includes Red Rock State Park, a Zuni railroad siding, an El Paso Natural Gas fractioning plant and housing area, the small Navajo community of Church Rock, and transportation corridors for Interstate 40, U.S. Route 66, and the Burlington, Northern, and Santa Fe Railroad. The town of Fort Wingate is located immediately to the east of FWDA on BIA administered land and was the original fort headquarters site. To the south and southeast is the largely undeveloped Cibola National Forest. The land to the west is primarily undeveloped and is tribal trust and allotment land that is administered by the BIA, the Navajo nation, and individual Native American allottees.

2.1.1 *Historical Land Use*

The installation can be divided into several areas based upon location and historical land use (Figure 2-2). These major land use areas include:

2.1.2 OB/OD Operations

Historic OB/OD activities at FWDA were conducted primarily within the OB/OD Areas. The Closed OB/OD Area was used from 1948 to 1955. After 1955, burning and detonation operations at the installation were performed within the Current OB/OD Area until installation closure in 1993.

2.1.2.1 Closed OB/OD Area

The Closed OB/OD Area includes the Old Burning Ground and Demolition Landfill Area and the Old Demolition Area (Figure 2-3). The Old Burning Ground and Demolition Landfill Area are located in Fenced Up Horse Valley and are approximately 26 acres in size. These areas were used from 1948 until the late 1950s to dispose of explosives contaminated waste from the TNT Washout Plant and old equipment from the TNT drying and flaking operations. In the mid-1950s, the area was permitted by the Army to open burn up to 30,000 pounds of explosives at a time. It was reported that debris was exposed by erosion in the arroyo at depths in excess of 10 feet. The debris reportedly included shell casings, metal strapping material, and other metal materials. The extent of landfilling in this area was not documented, but was known to be constrained on the northwest by bedrock exposures along the Hogback, and on the southeast by the arroyo in Fenced Up Horse Valley.

The Old Demolition Area consists of approximately 71 acres. The Army identified this area in 1981. Explosives from the holding tank of the TNT Washout Plant were transported to this area and burned in the open. The exact boundaries of this area are not well documented. However, three mounds were identified and were designated as potentially containing residue from the burning of white phosphorous rounds.

2.1.2.2 Current OB/OD Area

The Current OB/OD Area is located on the eastern side of the Hogback, south of Fenced-up Horse Valley (Figure 2-3). This area is approximately 38 acres in size and includes a number of former detonation craters and the Burning Ground Area. In addition, an arroyo bisects the area, traversing (downstream) from south to north. The Current OB/OD Area was actively utilized between 1955 and January 1993.

The Burning Ground Area is located in a valley immediately east of the main arroyo within the Current OB/OD Area and north of the former detonation craters. The Burning Ground Area is approximately 2 acres in size. From 1955 until 1993, it was used as a site to burn propellants and propellant-contaminated materials.

present grassland area would have contained sagebrush that was removed during the period of operation to prevent fires. There are also areas of Pinion Pine/Juniper woodland communities that appear to have been cleared of large vegetation to prevent fires. Regular activity consisting of burning and detonations would have greatly affected use of the area by wildlife.

The Current OB/OD Area habitat currently consists of a field/sagebrush community. Much of this area is located on the slopes of a hill that is covered by a Pinion Pine/Juniper woodland community and it appears that much of the natural vegetation was removed during OB/OD operations. This area was operated until January 1993, which explains why the habitat in this area is not as mature as the habitat present in the Closed OB/OD Area.

Environmental characterization was conducted in 1996 to define the extent of impacts to the OB/OD Areas. Trenches were excavated through waste areas to define the extent of visible debris/waste and are presented in Figure 2-5. No evidence of the migration of contaminants outside the boundaries of the area to be retained by the Army was identified. Detailed results of this investigation are presented in the *Final Open Burning/Open Detonation Area RCRA Interim Status Closure Plan Phase IA – Characterization and Assessment of Site Conditions for the Soils/Solid Matrix* (Phase IA Report) (PMC, 1999a) and the *Final Open Burning/Open Detonation Area RCRA Interim Status Closure Plan Phase IB – Characterization and Assessment of Site Conditions for the Ground Water Matrix* (Phase IB Report) (PMC, 1999b).

Data collected during the 1996 characterization were associated with debris/waste materials, or soils located immediately adjacent to these materials. This sampling was biased toward the most highly disturbed and contaminated materials; thus, the data are not considered representative of conditions throughout the OB/OD Areas, but represent the highest concentrations of contaminants present over a limited area. Based upon this sampling bias, use of these data in the screening level problem formulation and ecological effects evaluation discussed in Section 4 is considered very conservative.

Soil inorganic constituent concentrations for the Current and Closed OB/OD Areas will be separated into three potentially different populations based upon source rocks and the period of OB/OD operations. The three areas are the Current OB/OD Area, Closed OB/OD Area east of the Hogback, and Closed OB/OD Area west of the Hogback.

Source rock type, mineralogic composition, depositional environment, and weathering processes determine the chemical composition of soils

Volatilization of TNT and other explosives from surface soils should be relatively minor (Pennington, et al., 1992).

Photolysis is known to rapidly transform explosives in surface waters to other compounds (McGrath, 1995). This process should prevent explosives from persisting in surface waters; thus, exposure to explosives in surface water will not be considered further.

2.1.3.2 *Inorganics*

For inorganic constituents, the pH of the soil/sediment and the valence state of the metal will indicate whether migration occurs. Very low pH (acidic) soil/sediment may allow for the leaching of metals. However, slightly acidic, neutral, or high pH (basic) soils/sediments will generally not allow leaching to occur because of the tendency of metals to bind to soils. For inorganic constituents, the partitioning process is governed by complex electrochemical and physical interactions between the affected media and the constituent. These interactions involve the size and charge of the cation and the number of exchange sites on the individual particle surfaces. Migration of inorganics primarily takes place through the physical displacement of the particulates to which they are attached.

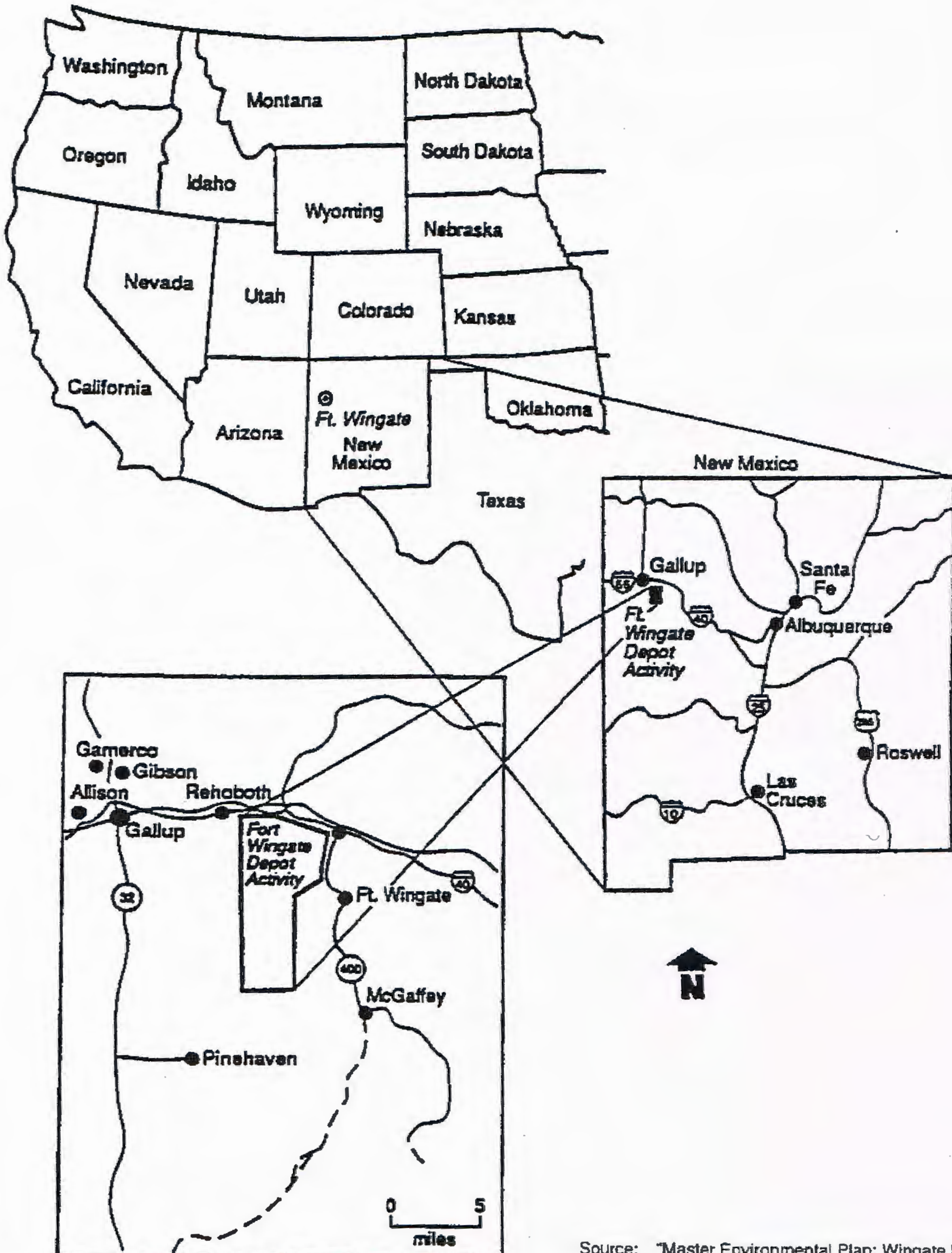
Inorganics are generally considered non-volatile, such that volatilization from soil, sediment or surface water is not generally considered a migration pathway. Additionally, chemically related processes such as biodegradation and photolysis are also not considered significant fate and transport mechanisms for inorganics. Thus, the important pathways for inorganics at FWDA would be primarily limited to wind (dust) transport and water transport.

Biotransformation and bioaccumulation are important processes in the fate of several metals that methylate, such as mercury and silver. Under certain conditions, these metals can be converted to a methyl form, which is soluble and mobile. Organisms are then exposed through their contact with and ingestion of water or soil.

2.1.3.3 *Contaminant Transport*

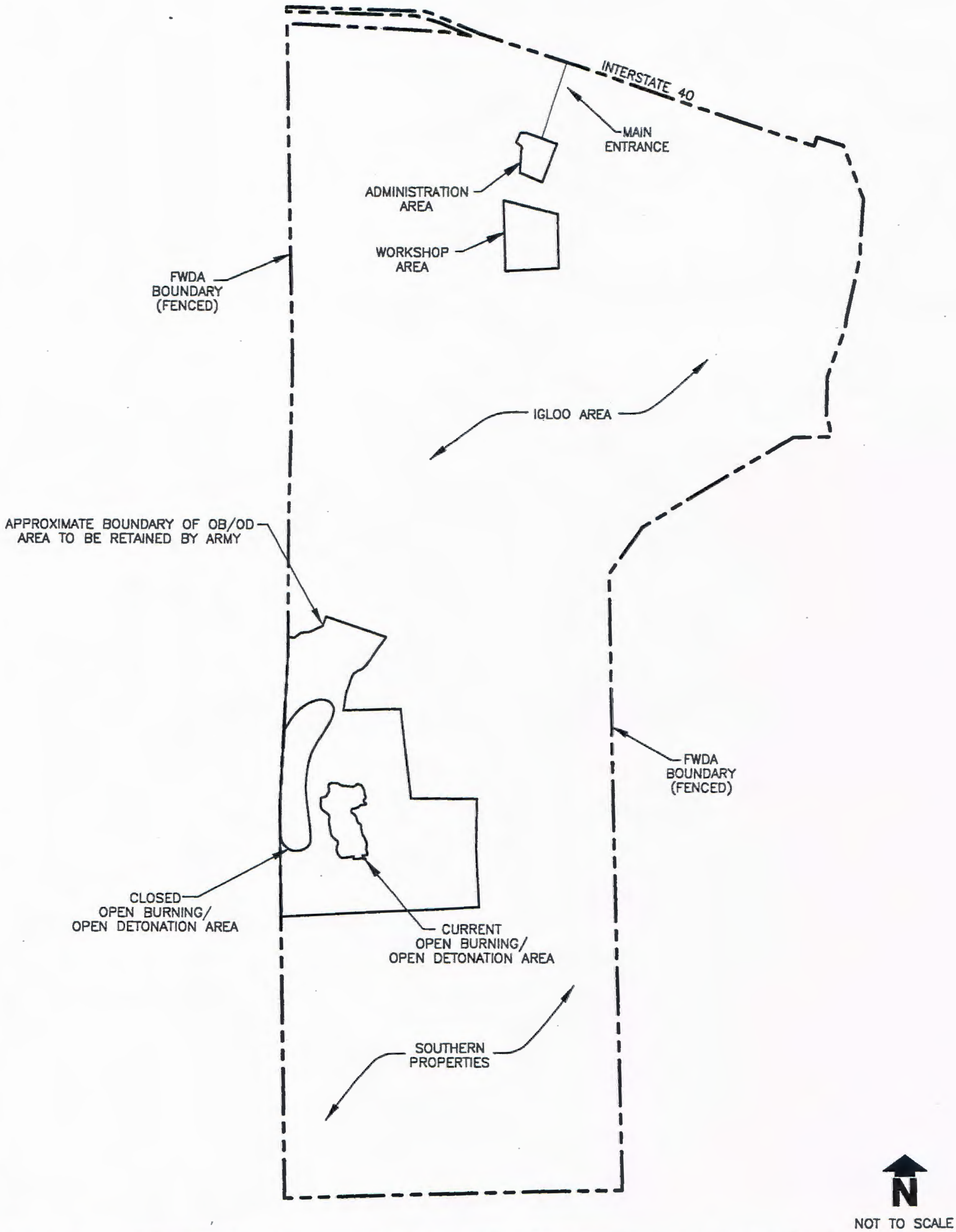
The physical transport of contaminants by surface water was assessed as part of the environmental characterization of the OB/OD Areas conducted in 1996. Leaching of explosives into ground water has been identified as the likely cause of contamination detected in monitoring wells located within and north of the Current OB/OD Area. Discharge of alluvial ground water into an arroyo and subsequent transport as surface water will not be considered because of the highly sporadic nature of the existence of surface water within the OB/OD Areas. Explosives and

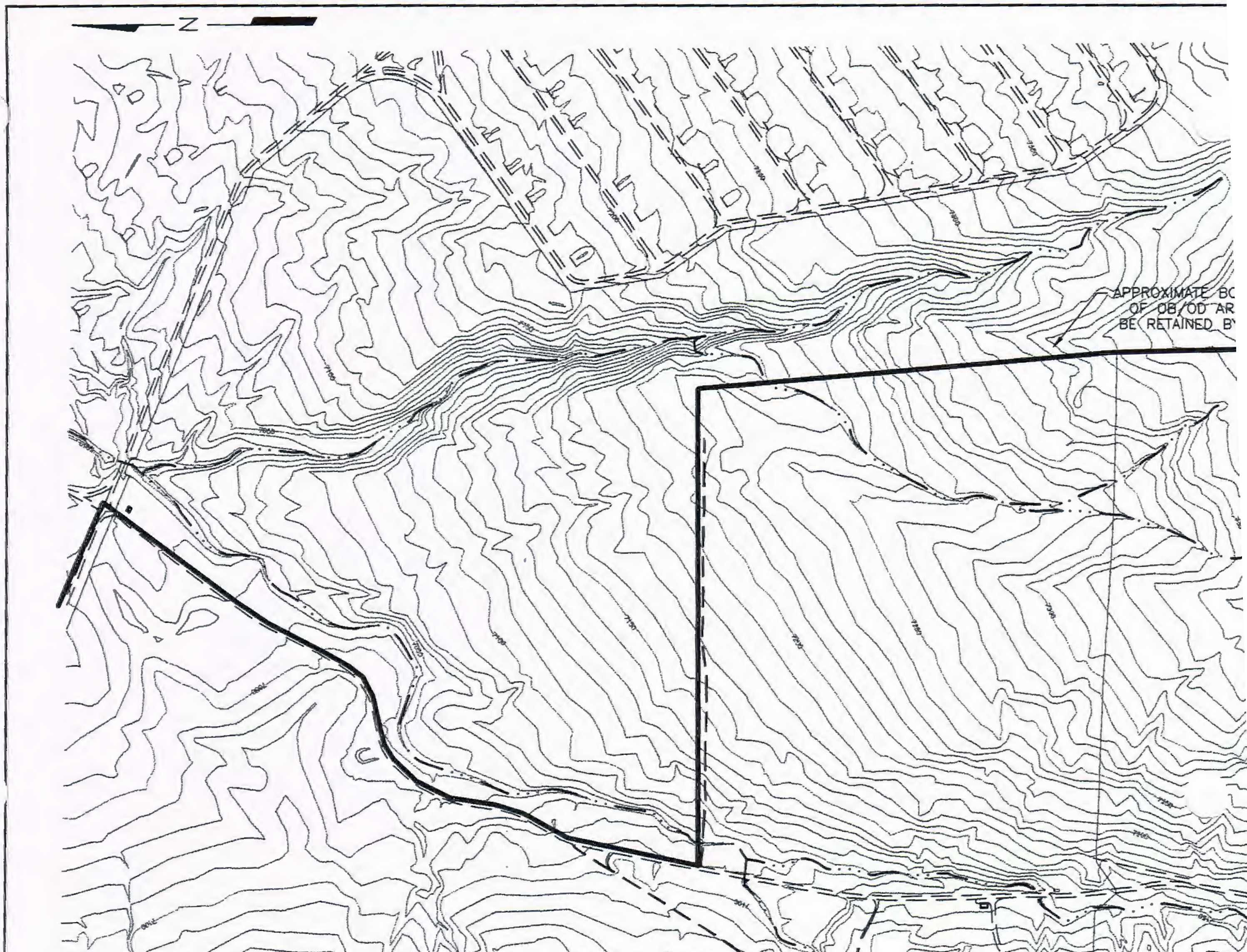
Figure 2-1
Installation Location
Fort Wingate Depot Activity
Gallup, New Mexico



Source: "Master Environmental Plan: Wingate Depot Activity, Gallup, New Mexico," December 1990.

Figure 2-2
Historical Land Use
Fort Wingate Depot Activity
Gallup, New Mexico

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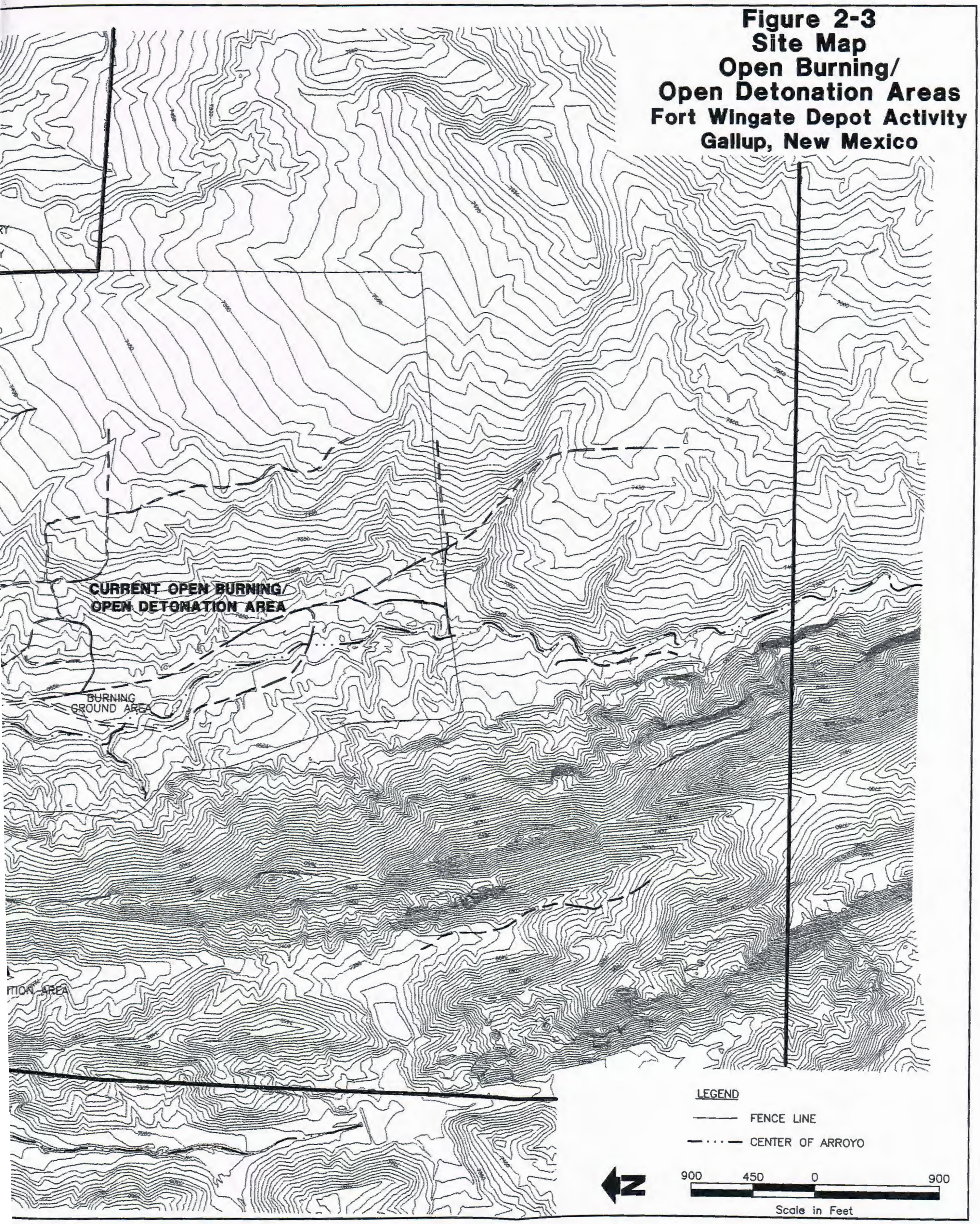
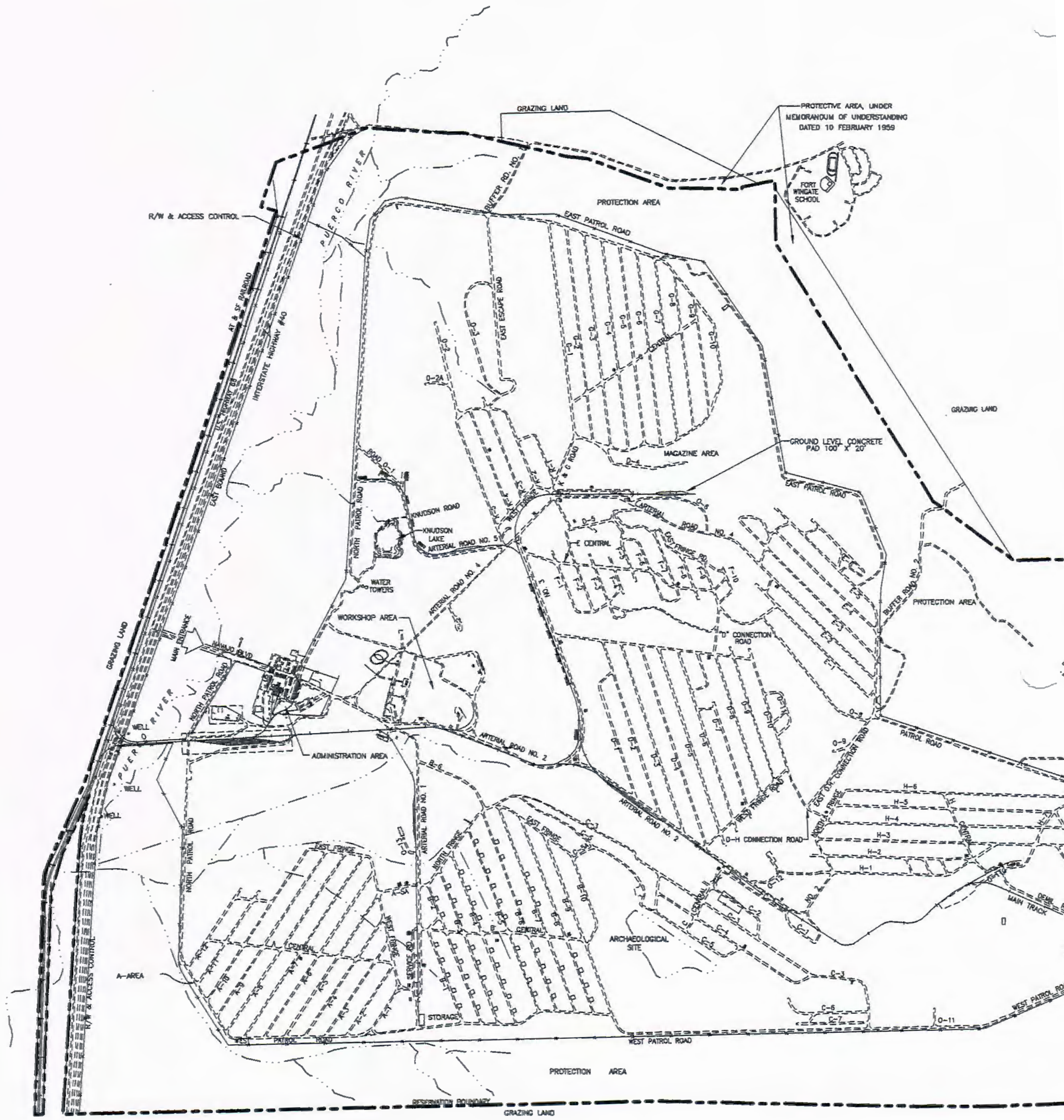
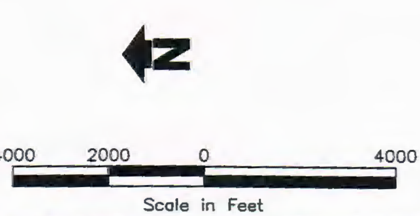
APPROXIMATE BO
OF OB/OD AR
BE RETAINED BY
OLD BURNING GROUND AND
DEMOLITION LANDFILL AREA
CLOSED OPEN BURN
OPEN DETONATION A
OLD D
BY PHOTOGRAMMETRIC METHODS FROM
AERIAL PHOTOGRAPHS TAKEN SEPTEMBER 28, 1995

Figure 2-3
Site Map
Open Burning/ Open Detonation Areas
Fort Wingate Depot Activity
Gallup, New Mexico



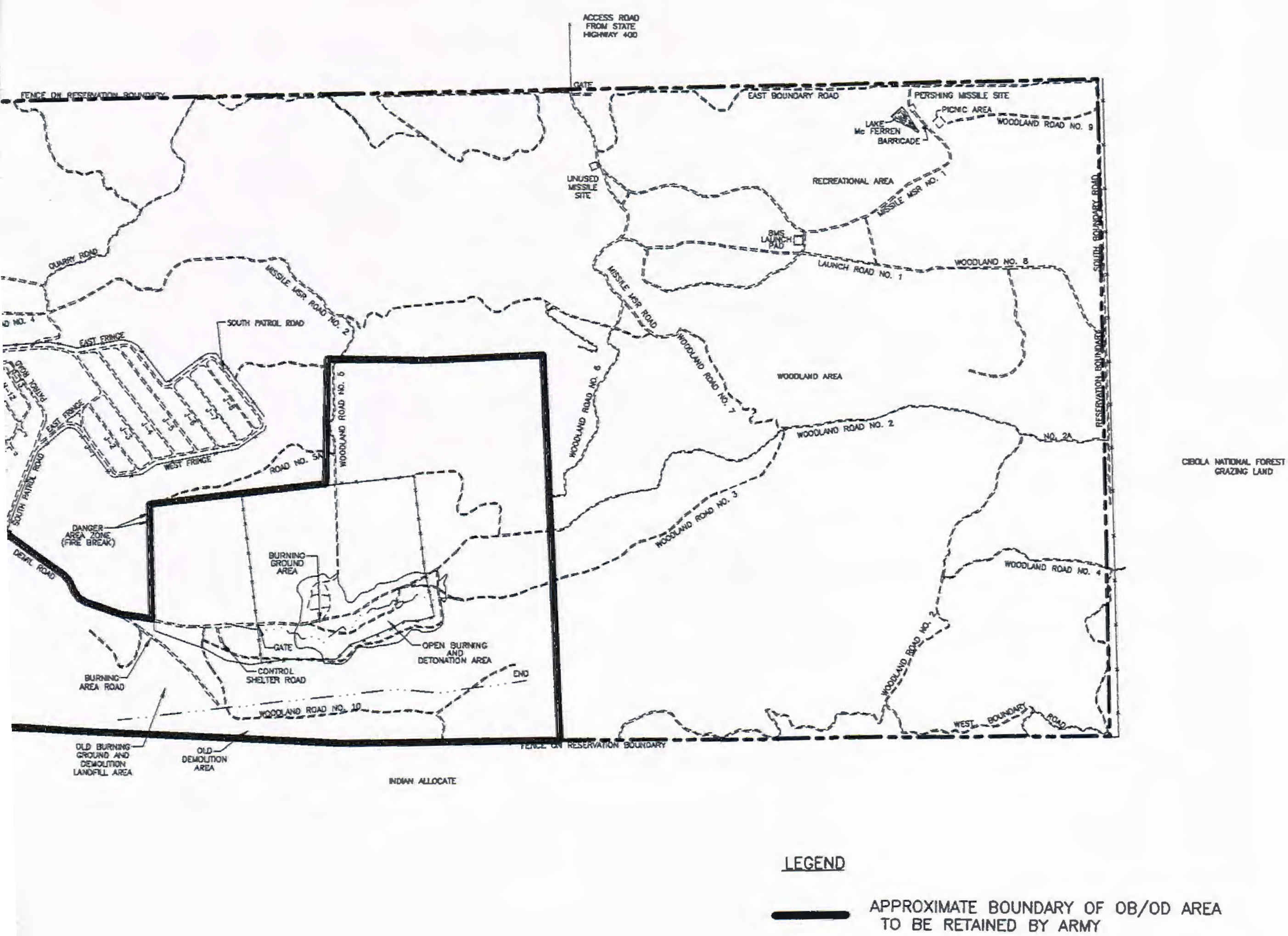


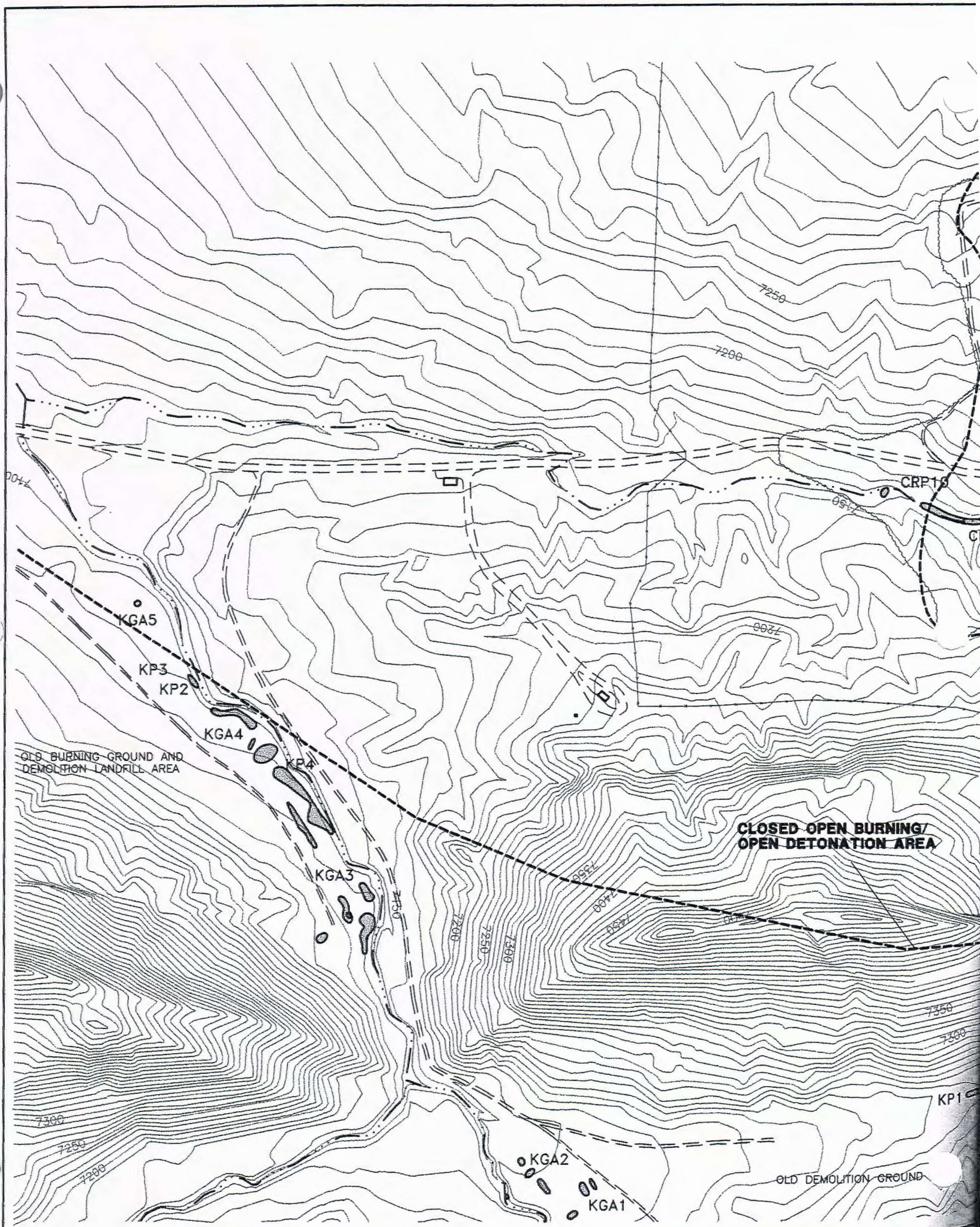
GRAZING LAND
PROTECTIVE AREA, UNDER MEMORANDUM OF UNDERSTANDING DATED 10 FEBRUARY 1959
FORT WINGATE SCHOOL
R/W & ACCESS CONTROL
PUERCO RIVER
BUFFER RD. NO.
PROTECTION AREA
EAST PATROL ROAD
EAST ESCAPE ROAD
AT & SF RAILROAD
INTERSTATE HIGHWAY #40
EAST BOUND
GRAZING LAND
MAGAZINE AREA
GROUND LEVEL CONCRETE PAD 100' X 20'
KNUDSON ROAD
KNUDSON LAKE
ARTERIAL ROAD NO. 5
NORTH PATROL ROAD
WATER TOWERS
ARTERIAL ROAD NO. 4
E CENTRAL
EAST FRINGE RD.
BUFFER ROAD NO. 2
PROTECTION AREA
WORKSHOP AREA
"D" CONNECTION ROAD
MAIN ENTRANCE
WELL
ADMINISTRATION AREA
ARTERIAL ROAD NO. 2
PATROL ROAD
EAST O-H CONNECTION ROAD
ARTERIAL ROAD NO. 1
O-H CONNECTION ROAD
EAST FRINGE
NORTH FRINGE
CENTRAL
ARCHAEOLOGICAL SITE
MAIN TRACK
A-AREA
STORAGE
WEST PATROL ROAD
PROTECTION AREA
RESERVATION BOUNDARY
GRAZING LAND



N
4000 2000 0 4000
Scale in Feet

Figure 2-4
Approximate Area to be Retained by Army
Fort Wingate Depot Activity
Gallup, New Mexico




7250
7200
7100
CRP10
7150
KGA5
KP3
KP2
KGA4
OLD BURNING GROUND AND
DEMOLITION LANDFILL AREA
KP4
CLOSED OPEN BURNING/
OPEN DETONATION AREA
KGA3
7200
7250
7300
7400
7450
7350
7300
KP1
7300
7250
7200
KGA2
KGA1
OLD DEMOLITION GROUND

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3.0 HUMAN HEALTH RISK-BASED CLOSURE

This section describes the approach that will be taken to evaluate the data that were collected during environmental characterization activities conducted in 1996, 1997, 1998, 1999 and 2000. The chemical data will be assessed by comparison to select environmental quality benchmark values.

Chemical data from samples collected within the OB/OD Areas at FWDA during 1996, 1997, 1998, and 1999 will be sequentially screened against:

1. Area-specific background values,
2. Screening criteria including U.S. Environmental Protection Agency (USEPA) Region VI risk-based screening levels (RBLs), and
3. Closure Performance Standards (CPSs) developed for the OB/OD Areas.

Macronutrients will be excluded from the screening process for soil, sediment, surface water, and ground water samples. These constituents (calcium, magnesium, potassium, and sodium) and will be excluded because of the low toxicity associated with each of them.

3.1 BACKGROUND CONCENTRATIONS OF COCS

3.1.1 Ground Water

Separate background values were developed for both the Closed and Current OB/OD Areas because different geologic units are present in each area, resulting in different inorganic constituent concentrations in the ground water. As discussed in the Phase IB Report (PMC, 1999b), two samples were collected from the same well in the Closed OB/OD Area ground water system (KMW12), and three samples were collected from the same well in the Current OB/OD Area ground water system (CMW02). At that time, insufficient data were available to determine background values based upon a statistical distribution analysis. Background inorganic concentrations were determined for the Closed and Current OB/OD Areas based on the maximum concentration detected during these sampling rounds. This value was selected as the background concentration for that inorganic constituent for that area. For those constituents that were not detected in the background data set, the background screening values were set at zero to provide a conservative bias to this initial screening step. The data from each sampling event and

3.1.4 *Surface Water*

Surface water background levels were derived for the Closed and Current OB/OD Areas. The background screening levels were derived by selecting the maximum concentration detected in background surface water samples. There were two background sample locations (KSW01 and KSW03) in the Closed OB/OD Area and two background sample locations (CSW01 and CSW03) in the Current OB/OD Area. Data that were not detected or were rejected based upon blank qualification were not considered in the selection of a background value. The background surface water concentrations are presented in the Phase IB Report (PMC, 1999b).

3.2 *SCREENING CRITERIA*

3.2.1 *Ground Water*

3.2.1.1 *USEPA Region VI Risk-Based Screening Levels*

USEPA Region VI RBLs will be used to assess the data following the initial comparison to background. The RBLs are based on the 1 x 10^{-6} risk level or a hazard quotient of one, and residential land use (USEPA, 1999). The use of residential-based screening levels allows for a conservative bias during this stage of the data assessment process. The OB/OD Areas will remain under Army control; therefore, there will be no future use of ground water within the OB/OD Areas.

3.2.2 *Soil and Sediment*

USEPA Region VI RBLs will be used to assess soil and sediment data following the initial comparison to background. The RBLs are based on the 1 x 10^{-6} risk level or a hazard quotient of one and residential land use (USEPA, 1999). The use of residential-based screening levels allows for a conservative bias during this stage of the data assessment process. The OB/OD Areas are currently only accessed during sampling events and will remain under Army control; therefore, future use will be consistent with current use. For those constituents that do not have an RBL, site-specific values will be calculated using the same methodologies that generated the established Region VI RBLs.

3.2.3 *Surface Water*

Surface water samples were collected during sporadic storm events during which surface water was present for only a short period of time. Surface water screening levels are based upon perennial surface water flow conditions. Because no perennial surface water flow conditions exist

(USEPA, 1991). The equations, presented below, have been modified to account for site-specific dust generation conditions.

OFF-SITE FUGITIVE DUST EXPOSURE FOR CARCINOGENIC EFFECTS:

$$CPS_{soil} = \frac{TR \, x \, BW \, x \, AT \, x \, 365 \, {}^{days}\!/_{year}}{EF \, x \, ED \left[CPF_i \, x \, IR_{air} \, x \left(\frac{E_i \, x \, L \, x \, CF}{u \, x \, H} \right) \right]}$$

Where:

CPS_{soil}	=	Concentration of constituent in soil	(mg/kg)
TR	=	Target Risk	(unitless, $1E^{-6}$)
AT	=	Averaging Time	(70 years)
BW	=	Body Weight	(kg)
EF	=	Exposure Frequency	(days/year)
ED	=	Exposure Duration	(years)
CPF_i	=	Inhalation CPF	($(mg/kg\text{-}day)^{-1}$)
IR_{air}	=	Inhalation Rate	(m^3/day)
E_i	=	Dust Emission Rate - OB/OD Areas	($1x10^{-9}$ mg/m^2/sec)
L	=	Length of contaminated site perpendicular to wind (71.1 m based on the area of the debris/refuse piles)	
u	=	Mean annual wind speed	(4 m/sec (Ruffner, 1985))
H	=	Height of human inhalation	(m)

OFF-SITE FUGITIVE DUST EXPOSURE FOR NON-CARCINOGENIC EFFECTS:

$$CPS_{soil} = \frac{THI \, x \, BW \, x \, AT \, x \, 365 \, {}^{days}\!/_{year}}{EF x ED \left[{}^{1}\!/_{RfD_i} \, x \, IR_{air} \, x \left(\frac{E_i x \, L x CF}{u x H} \right) \right]}$$

Where:

THI	=	Target Hazard Index	(unitless, 1)
AT	=	Averaging Time	(years, AT=ED)
ED	=	Exposure Duration	(years)
RfDi	=	Inhalation Reference Dose	(mg/kg-day)

Table 3-1
Summary of Background Samples
and Background Determination
Closed OB/OD Area
Fort Wingate Depot Activity
Gallup, New Mexico

Parameter	Units	Mean	Maximum	Standard Deviation	Selected Background	Basis for Background
Closed OB/OD Area						
Aluminum	µg/g	14,666	22,100	4,546	22,167	Normal: 95th percentile
Antimony	µg/g	-	-	-	0	All Less than DL
Arsenic	µg/g	7.69	8.85	0.98	9.30	Normal: 95th percentile
Barium	µg/g	93	156	40	159	Normal: 95th percentile
Beryllium	µg/g	0.67	1.01	0.21	1.02	Normal: 95th percentile
Cadmium	µg/g	-	-	-	0	18 Values less than DL; 2 outliers
Calcium	µg/g	13,157	36,300	11,529	37,204	Log Normal: 95th percentile
Chromium	µg/g	11.15	16.1	3.20	16.4	Normal: 95th percentile
Cobalt	µg/g	7.40	14.80	2.56	11.80	Log Normal: 95th percentile
Copper	µg/g	14.83	30.0	7.88	27.84	Normal: 95th percentile
Iron	µg/g	21,260	34,600	6,754	32,404	Normal: 95th percentile
Lead	µg/g	14.33	26.5	4.52	22.4	Log Normal: 95th percentile
Magnesium	µg/g	4,197	7,610	1,487	6,651	Normal: 95th percentile
Manganese	µg/g	226	463	101	392	Normal: 95th percentile
Mercury	µg/g	0.048	0.093	0.014	0.080	Log Normal: 95th percentile
Molybdenum	µg/g	-	-	-	0	18 Values less than DL; 2 reported below DL
Nickel	µg/g	11.59	20.1	3.67	18.4	Log Normal: 95th percentile
Phosphorus	µg/g	428	911	167	709	Log Normal: 95th percentile
Potassium	µg/g	2,818	3,990	694	3,963	Normal: 95th percentile
Selenium	µg/g	0.38	0.70	0.14	0.65	Log Normal: 95th percentile
Silver	µg/g	-	-	-	0	All Less than detection limit
Sodium	µg/g	95	137	22	136	Normal: 95th percentile (based on 10 detected values)
Thallium	µg/g	-	-	-	0	All Less than DL
Vanadium	µg/g	23.6	29.8	5.44	32.61	Normal: 95th percentile
Zinc	µg/g	50.5	78.0	16.20	77.3	Normal: 95th percentile

Table 3-3
Exposure Scenario Assumptions
Remediation Worker
Fort Wingate Depot Activity
Gallup, New Mexico

	Adult	Units
Where		
ED = exposure duration	1	year
EF = exposure frequency (1)	39.6	days
BW = Body weight (2)	70	kg
ATc = Averaging time, carcinogenic (2)	25550	days
ATnc = Averaging time, noncarcinogenic (2)	365	days
SSA = Skin to soil adherence (2)	1	mg/cm^2
SA = Skin surface area (3)	820	cm^2/day
ABS = absorption factor-organic (3)	0.1	%
ABS = absorption factor-inorganic (3)	1	%
PEF=Particulate emission factor (2)	1.32E+09	m^3/kg
IRsoil=Ingestion rate for soil	480	mg/day
IRair=Inhalation rate for air (2)	20	m^3/kg

(1) 8 hours per day for 120 days.
(2) USEPA, 1997b.
(3) USEPA, 1992. Dermal Exposure Assessment.

4.0 SCREENING-LEVEL PROBLEM FORMULATION AND ECOLOGICAL EFFECTS EVALUATION FOR A REPRESENTATIVE SMALL MAMMAL AND BIRD

4.1 SCREENING-LEVEL PROBLEM FORMULATION

4.1.1 *History of Ecological Investigations and Ecological Setting*

In addition to the general information presented in Section 2.0, this section provides information that is specific to the ecological site conditions and will be used in the screening-level problem formulation.

4.1.1.1 *Ecological Investigations*

1993 Site Visit

A site visit was conducted during 1993 to characterize habitat covertypes for the entire FWDA property. Information gathered during this field visit included the general type of habitat covertype, predominant species observed, anecdotal information regarding habitat quality, and whether threatened or endangered species could be expected.

1995 Ecological Survey

An ecological survey of the OB/OD Areas was conducted during the period of 24 through 31 July 1995. The objective of this survey was to generate baseline characterization information. This information will allow the Army to minimize the impact to potential wetlands located within the arroyo that drains the Current OB/OD Area, and to ensure the maintenance of existing habitat and species diversity within the Current and Closed OB/OD Areas throughout the performance of closure. A wetland characterization was completed by walking each upland area and arroyo, and physically marking any observed wetland-upland boundaries in the field. Results of the survey are presented in the following subsections.

4.1.1.2 *Ecological Setting*

The wildlife and habitat survey conducted in 1995 assessed the status of habitats within the OB/OD Areas. A second survey of the habitats present in the OB/OD Areas was conducted in 2000 to document potential changes and to augment the 1995 survey. These surveys identified actual and probable usage of ecological habitats by indigenous wildlife species. Special attention was paid to the actual or potential use of habitats by rare, threatened, or endangered species. Probable and observed exposure pathways and potential receptors were also characterized.

The Current OB/OD Area consists primarily of a field/sagebrush community, surrounded by a Pinyon Pine/Juniper woodland community (Figure 4-1). A deep arroyo bisects the Current OB/OD Area and creates a variety of favorable wildlife habitats, as well as providing an "edge" effect (i.e., where two habitat types come into contact), which is preferred by many species. Wet periods of the year may result in stream-like conditions in the arroyo; however, these periods appear to be temporary. A temporary pond was observed in the arroyo near the center of the Current OB/OD Area during 1993, but no evidence of surface water flow has been observed in this area since 1995. During dry weather, the bottom of the arroyo, although appearing dry, contains water close to the surface throughout most of its length within the Current OB/OD Area. During the 1995 survey, this water was observed in two areas containing small water holes that were heavily visited by wildlife as evidenced by the many tracks that were present. However, during geologic investigations spanning 1996 through 1999, water was not observed in these two water holes during dry weather.

The water present close to the ground surface also supports wetland vegetation in the majority of the arroyo (only the northern-most portion of the arroyo does not support these wetland plants). The wetland vegetation form two communities; a sedge meadow community and a coyote willow community (Figure 4-1). Both wetland communities are important to wildlife. The sedge meadows provide a food source for herbivores, and the willows, which form dense stands of low trees, provide shade and refuge areas as well as ambush sites for predators. In several areas the deer bone remains of mountain lion kills were observed as well as recent mountain lion tracks and coyote tracks.

Based on the preliminary site reconnaissance, the existence of an aquatic community is unlikely or limited to highly seasonal species. For the purpose of the RATM, aquatic ecosystems are defined as those developing in streams, lakes and perennial ponds. The Current OB/OD Area was identified as having plant species that are dependent on wet soils growing in the bottom of the arroyo as well as several small water holes. These water holes have been seen on several site visits but only at wet times of the year (during snowmelt and during the rainy season). Based upon their small size and the large evaporation rate, the observed water holes are believed to be completely dry during the arid portions of the year. Based on these observations, it has been assumed that there are no perennial aquatic ecosystems in the OB/OD Areas, and the existence of even a seasonal aquatic ecosystem is highly unlikely due to the extremely intermittent presence of water and water holes.

4.1.2 *Site Conceptual Model Development*

A site conceptual model has been developed that addresses COCs known to exist in the Current and Closed OB/OD Areas, and fate and transport mechanisms that affect the COCs. Mechanisms of ecotoxicity associated with the COCs; representative, highly exposed receptors; exposure assumptions; and endpoints to screen for ecological risk are presented below. Plant uptake models were not incorporated into this site conceptual model because available models are based on agricultural models and are not considered representative of the OB/OD Areas.

4.1.3 *Assessment Endpoints*

Assessment endpoints must "reflect the environmental values protected by law, provide critical resources, or provide an ecological function that would be significantly impaired...if the resource were altered" (USEPA, 1997). As presented in *Guidelines for Ecological Risk Assessment* (USEPA, 1998), three criteria are used to select the assessment endpoints used in a risk assessment:

- Receptors have relevance to the ecosystems present at the site;
- Receptors are potentially susceptible to adverse effects as a result of exposure to the COCs; and
- Receptors are significant with respect to ecosystem management goals.

Ecologically relevant species have been selected for the OB/OD Areas so that they define the assessment endpoints and have attributes that are potentially at risk and important to protect. Based on the feeding guilds present at the OB/OD Areas, the Army has selected the following assessment endpoints for this ecological assessment:

- Survival and reproduction of small mammals and birds.

The small mammal and bird were chosen as assessment endpoints because they can be expected to be the most highly exposed receptors because of their small home range and ingestion/body weight ratio. Based upon the general lack of bioaccumulation of the COCs present in the OB/OD Areas and greater exposure of small home range organisms, the assessment of the representative small mammal and bird is assumed to be protective of larger and wider ranging organisms.

4.1.4 *Measurement Endpoints*

Measurement endpoints are variables that can be measured, and the results mathematically linked to effects on assessment endpoints. USEPA

4.1.7 *Risk Estimation*

The following equations were adapted from the USEPA's *Wildlife Exposure Factors Handbook* (USEPA, 1996) and *Final Guidance for Ecological Risk Assessment* (USEPA, 1998):

$$Intake_{diet} = (EPC * DIR * SFD) + (C_{veg} * VFD * DIR/(1-w_{veg}))$$

where:

$Intake_{diet}$	=	Average daily oral exposure (mg/kg-d)
EPC	=	Dry weight 95th UCL concentration of the COC in soil (mg/kg)
DIR	=	Dietary ingestion rate (kg/kg-day)
SFD	=	Fraction of diet that is soil (%)
Cveg	=	Dry weight 95th UCL concentration of the COC in vegetation (mg/kg)
VFD	=	Fraction of diet that is vegetation (%)
w_{veg}	=	Portion of water in vegetation (%)

Hazard quotients will be calculated for each COC using the equation below:

$$HQ = Intake_{diet}/LOAEL$$

where:

HQ	=	Hazard quotient (unitless)
$Intake_{diet}$	=	Average daily oral exposure (mg/kg-d)
LOAEL	=	Chronic Lowest Observed Adverse Effect Level (mg/kg-d)

4.1.8 *Toxicological Benchmarks*

Chronic Lowest Observed Adverse Effect Levels (LOAELs) will be used as toxicological benchmarks in the risk calculations. The LOAELs and their sources are presented in Table 4-5. If calculations based on a LOAEL exceed an HQ of 1.0, then the possibility exists for adverse population risks (USEPA, 1997). The range of risks between the no observed adverse effects level (NOAEL) and the LOAEL-based HQ will be known as the "gray zone."

- Run representative species model using the 95th UCL from the background data sets. If background concentrations generate HQs greater than 1.0, then the OB/OD areas are similar to background;

- Contamination is historical;

- Sampling was biased toward worst case conditions; and

- Presence of a thriving ecosystem.

4.2 *ALTERNATIVE LINES OF EVIDENCE*

4.2.1 *U.S. Army Environmental Center Survey*

A survey of the habitat and archaeological resources of the OB/OD areas was conducted by personnel from the U.S. Army Environmental Center (USAEC). The results of this survey will provide the risk management team with additional evidence regarding the current condition of the OB/OD Areas. The following information will be collected and evaluated.

- Results of the USAEC survey will be discussed regarding good/bad habitat quality

- Qualitative field observations including discussion of spatial scale and size of the OB/OD in relation to receptor home range

- Discussion of habitats surrounding the OB/OD Areas. Does OB/OD Area provide best habitat on the installation? Is surrounding biota equivalent to OB/OD biota?

- Discussion noting that the contamination at the site is historical, and how observation of receptors at the site carry considerable weight regarding the overall site health; (An HQ above 1.0 does not necessarily equate with risk, and the presence of receptors such as small rodents that are reproducing successfully and have had many generations since the site was closed can be discussed as good evidence of lack of impact)

4.3 *SUMMARY*

The results of the HHRA and ecological effects evaluation will be summarized to provide the risk management team with a weight of evidence to support the selected remedial option.

Table 4-1
95th UCL Concentrations
Current OB/OD Area Soils/Wastes
Fort Wingate Depot Activity
Gallup, New Mexico

Parameters	95th UCL (mg/kg)
1,3,5-Trinotribenzene	0.672
1,3-Dinitrobenzene	0.264
2,4,6-Trinitrotoluene	4.74
2,4-Dinitrotoluene	0.328
2-Amino-4,6-dinitrotoluene	0.754
3-Nitrotoluene	0.503
4-Amino-2,6-dinitrotoluene	0.573
4-Nitrotoluene	1.00
Aluminum	30,365
Antimony	6.73
Arsenic	2.55
Barium	356
Beryllium	13
Cadmium	0.738
Chromium	21.8
Cobalt	6.10
Copper	364
HMX	2
Lead	48
Manganese	458
Mercury	0.183
Molybdemum	4.92
Nickel	18
RDX	4
Selenium	0.367
Silver	1.45
Tetryl	0.584
Thallium	0.917
Vanadium	29.6
Zinc	195

Samples were collected at depths ranging from 0-5 feet.
UCL - Upper confidence limit.

Table 4-3
95th UCL Concentrations
Closed OB/OD Area West of Hogback Soils/Wastes
Fort Wingate Depot Activity
Gallup, New Mexico

Parameters	95th UCL (mg/kg)
1,3,5-Trinitrobenzene	0.188
2,4,6-Trinitrotoluene	1.84
3-Nitrotoluene	0.388
Aluminum	20,627
Antimony	5.59
Arsenic	12.9
Barium	305
Beryllium	1.07
Cadmium	0.659
Chromium	20
Cobalt	9.14
Copper	70.0
Lead	25.9
Manganese	399
Mercury	0.083
Molybdenum	5.39
Nickel	16.0
Phosphorus	392
Silver	1.22
Thallium	1.41
Vanadium	36.8
Zinc	567

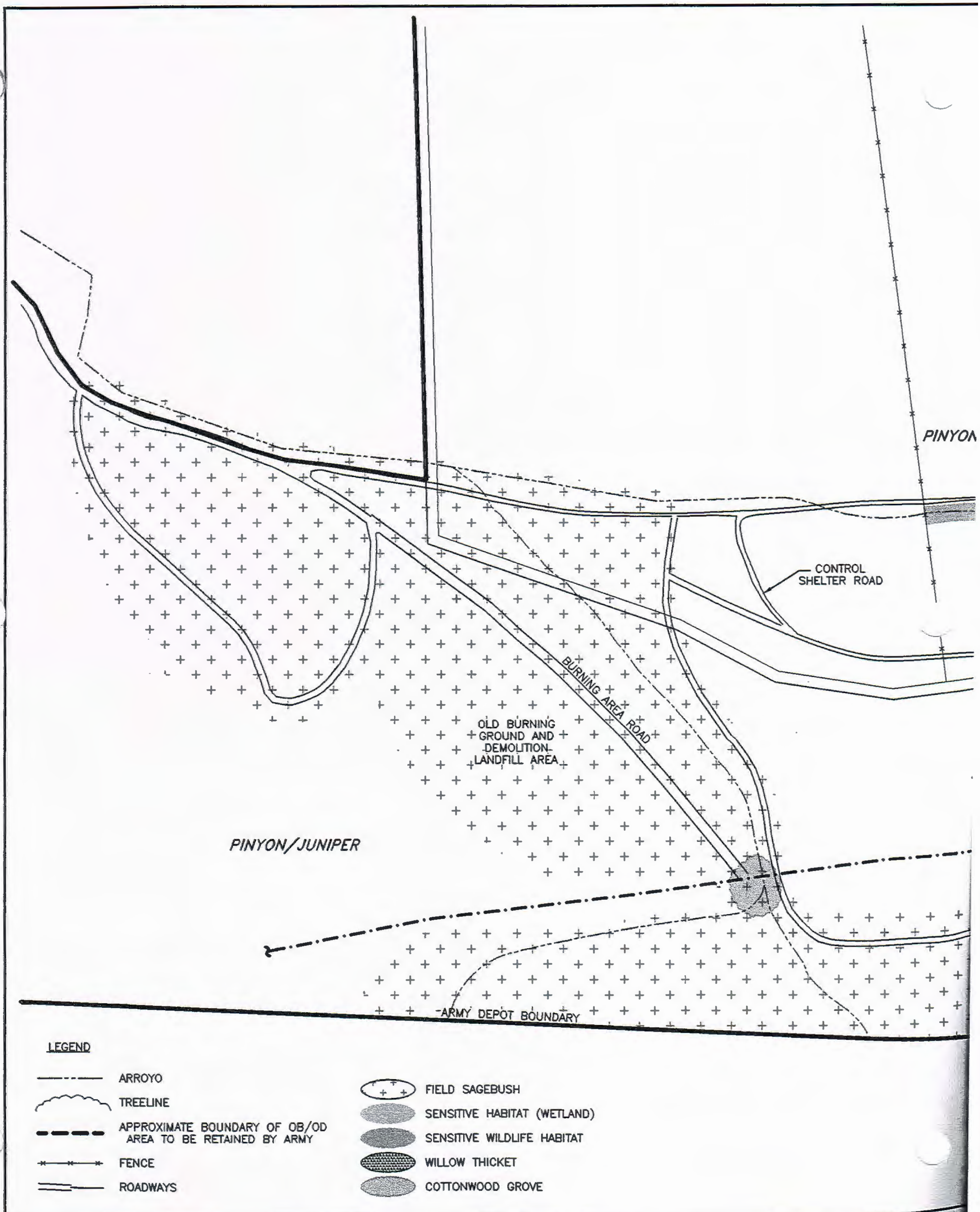
Samples were collected at depths ranging from 0-5 feet.
UCL - Upper confidence limit.

Table 4-5
Toxicity Reference Values
Current and Closed OB/OD Areas
Fort Wingate Depot Activity
Gallup, New Mexico

Constituent of Concern	Species	LOAEL (mg/kg bw/d)	Study Description	Reference
1,3,5-Trinitrobenzene	White footed mouse	108		Reddy et al., 1994
2,4,6-Trinitrotoluene	White footed mouse	330	Increased kidney, liver, spleen weights; presence of hemosiderin in spleen; chromaturia; increased extramedullary hematopoiesis in spleen	McCain, 1998
2,4-Dinitrotoluene	Rat	5.0	NOAEL/LOAEL for 2 yr study. Mortality, liver and kidney pathology, decreased spermatogenesis,anemia, and neuromuscular effects.	Lee et al., 1985
Aluminum	Rat, mouse	67.45	Normal diet contained up to 180 ppm Al (use as NOAEL). At 355 ppm, growth decreased in mice exposed 40 days (LOEL). Convert with mean DIR for deer mouse of 0.19 g/g/d (EPA, 1993).	Ondreicka et al., 1966
Aluminum	Ring dove	NA	1000 ppm in diet had no effect on reproduction or growth over 4 month period when Ca and P levels in diet normal. Convert with mean of 0.963 g/g/d for robin, marsh wren from EPA, 1993.	Carriere et al., 1986
Antimony		1.35		Sample, 1996
Arsenic	Rat	22.5	NOAEL (LOAEL was 22.5 mg/kg bw/day for growth, liver lesions)	Schroeder et al., 1968
Arsenic	Mallard	42	NOAEL @ 100 ppm in diet for behavior (LOAEL was 300 ppm for behavior and growth). Converted with 0.14 kg diet/kg bw from Camardese et al., 1990.	Camardese et al., 1990; Whitworth et al., 1991
Barium	Rat	19.8	Barium chloride mortality in rats.	Borzelleca et al. 1988
Barium	Chicken	194	NOAEL is 1000 ppm diet. Slight growth depression at 2,000-4,000 ppm. Converted with 0.097 kg/kg bw/d from Wiseman (1987).	Johnson et al., 1960

Table 4-5
Toxicity Reference Values
Current and Closed OB/OD Areas
Fort Wingate Depot Activity
Gallup, New Mexico

Constituent of Concern	Species	LOAEL (mg/kg bw/d)	Study Description	Reference
Lead	Kestral	43.5	NOAEL (for survival, growth) from diet of 50 ppm (25 mg/kg bw/d) converted with 0.29 kg diet/kg bw (kestrel)(EPA, 1993b). A NOAEL of 14.5 mg/kg for survival, histopathology and reproduction also reported.	Franson et al., 1983; Pattee, 1984; Hoffman et al., 1985a,b
Manganese	Rat, mouse	615	NOAEL for mortality for chronic exposure; 615 the LOAEL for mortality. NOAEL for mice 160-200.	NTP, 1993
Manganese (oxide)	Bird	977	Aggressive behavior	Laskey and Edens 1985
Mercury	Mouse	3.9	Increased morbidity. Converted from 15 ppm in diet with 0.26 kg diet/kg bw/d (EPA, 1993).	Mitsumori et al., 1981
Mercury	Chicken	12.5	NOAEL for growth; 12.5 the LOAEL (convert with 0.097 kg diet/kg bw/day (Wiseman, 1987)). 12.5 mg/kg bw/d affects quail reproduction. 1.1 NEL for starling.	Thaxton et al., 1975; Thaxton and Parkhurst, 1973; Nicholson and Osborn, 1984
Nickel	Mallard	107	Reduced growth and mortality in Mallard duckings	Cain and Pafford, 1981
Nickel (noncarnivore)	Rat	158	TDlo for multigeneration study for effects on embryo or fetus.	RTECs, 1997
RDX	Rat	12.5	Acute oral gavage study of motor activity at doses of 0, 12.5, 25 and 50 mg/kg bw. The lowest dose reduced activity by >50%, with some decrease even 24 h after dosing Behavior trial 2 hr after dosing.	MacPhail et al., 1985
Selenium	Mouse	0.57	LOAEL for reproductive effects	Opresko et al., 1993
Selenium	Chicken	1.3	NOAEL for egg production and egg weight, although slight decrease in hatchability.	Ort and Latshaw, 1978


PINYON
CONTROL SHELTER ROAD
BURNING AREA ROAD
OLD BURNING GROUND AND DEMOLITION LANDFILL AREA
PINYON/JUNIPER
ARMY DEPOT BOUNDARY
LEGEND
ARROYO
TREELINE
APPROXIMATE BOUNDARY OF OB/OD AREA TO BE RETAINED BY ARMY
FENCE
ROADWAYS
FIELD SAGEBUSH
SENSITIVE HABITAT (WETLAND)
SENSITIVE WILDLIFE HABITAT
WILLOW THICKET
COTTONWOOD GROVE

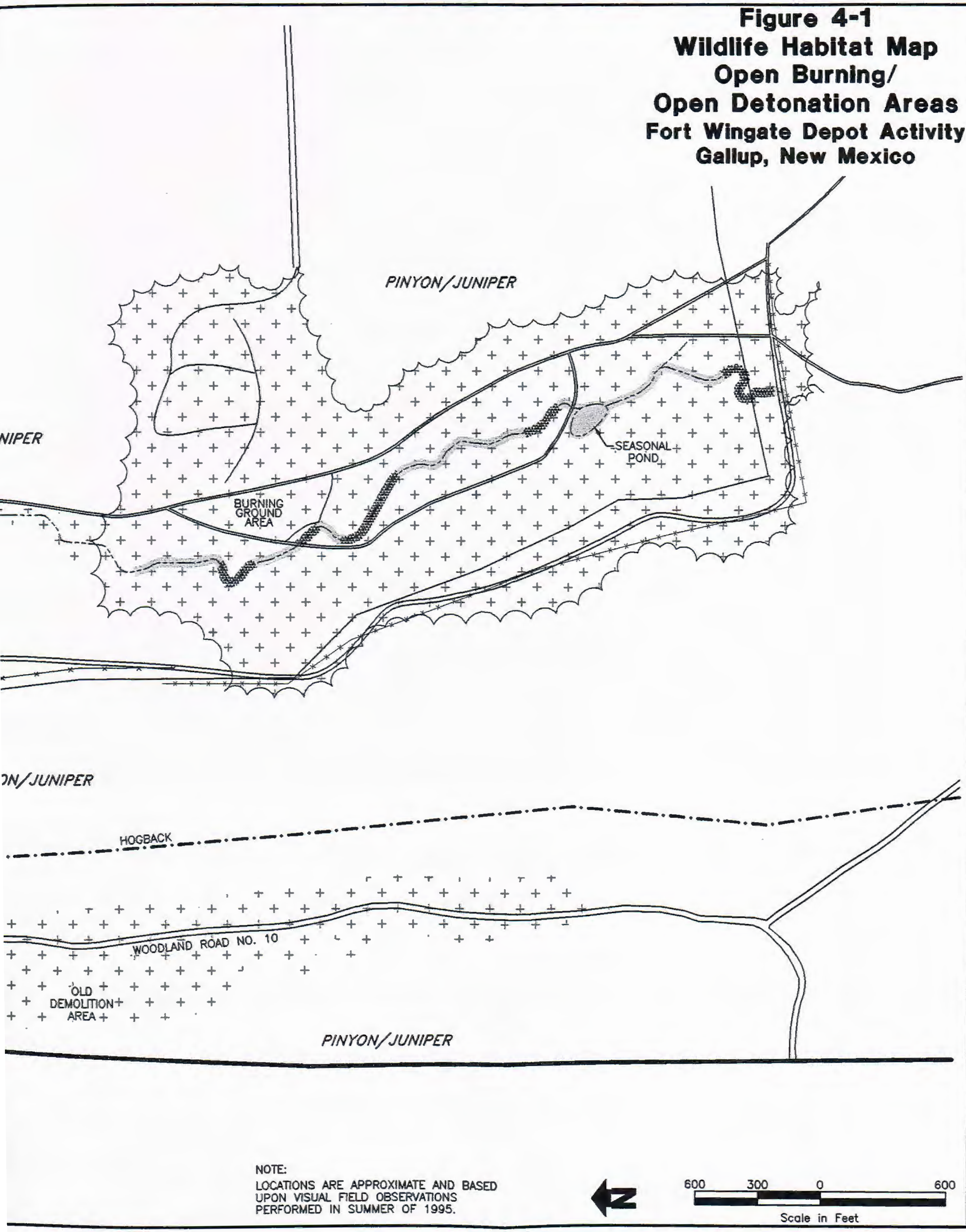


Figure 4-1
Wildlife Habitat Map
Open Burning/
Open Detonation Areas
Fort Wingate Depot Activity
Gallup, New Mexico

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5.0 *REFERENCES*

Brannon, J. M. and Myers, T. E., 1997. Review of Fate and Transport Processes of Explosives. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS. Technical Report IRRP-97-2. March 1997.

ERM Program Management Company, 1996. Final OB/OD Area Closure Field Program – Field Sampling Plan and Contaminated Materials Handling Plan, Fort Wingate Depot Activity, Gallup, New Mexico.

McGrath, C. J., 1995. Review of Formulations for Processes Affecting the Subsurface Transport of Explosives. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS. Technical Report IRRP-95-2.

Metcalf & Eddy, 1992. Final Technical Plan for the Environmental Investigation at Fort Wingate Depot Activity, Gallup, New Mexico.

Pennington, J. C., Hayes, C. A., Price, C. B., and McCormick, E., 1992. Effects of Wet and Dry Cycles on TNT Losses From Soils. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS. Technical Report EL-92-37.

Price, C. B., Brannon, J. M., and Hayes, C. A., 1995. Transformation of 2,4,6-Trinitrotuluene Under Controlled Eh/pH Conditions. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS. Technical Report IRRP-95-5.

PMC Environmental (PMC), 1999a. Final Open Burning/Open Detonation Area RCRA Interim Status Closure Plan Phase IA – Characterization and Assessment of Site Conditions for the Soils/Solid Matrix.

PMC, 1999b. Final Open Burning/Open Detonation Area RCRA Interim Status Closure Plan Phase IB – Characterization and Assessment of Site Conditions for the Ground Water Matrix.

Ruffner, J. A., Editor, 1995. Climates of the States, Volume I. Gale Research Company, Detroit, Michigan.

U.S. Army Corps of Engineers (USACE), 1987. U.S. Army Corps of Engineers Wetland Delineation Manual. January 1987

U.S. Environmental Protection Agency (USEPA), 1991. Risk Assessment Guidance for Superfund: Volume 1 – Human Health Evaluation Manual