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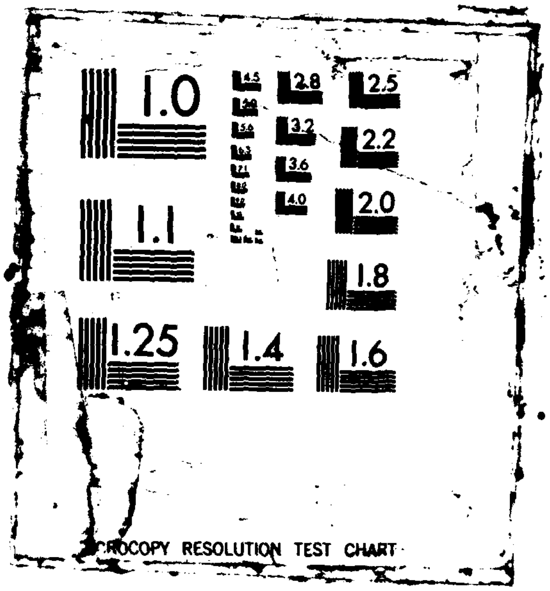
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INSTALLATION RESTORATION PROGRAM
PHASE II - CONFIRMATION/QUANTIFICATION
STAGE 1

VOLUME 1

AD-A175 451

CANNON AFB, NEW MEXICO 88103

RADIAN CORPORATION
8501 MO-PAC BLVD.
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AUSTIN, TEXAS 78766

September 1986

FINAL REPORT FOR PERIOD 9/84 - 4/85

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PREPARED FOR

HEADQUARTERS TACTICAL AIR COMMAND
COMMAND SURGEON'S OFFICE (HQ TAC/SGPB)
BIOENVIRONMENTAL ENGINEERING DIVISION
LANGLEY AFB, VIRGINIA 23665-5001

UNITED STATES AIR FORCE
OCCUPATIONAL & ENVIRONMENTAL HEALTH LABORATORY (USAFOEHL)
BROOKS AIR FORCE BASE, TEXAS 78235-5501

INSTALLATION RESTORATION PROGRAM
PHASE II - CONFIRMATION/QUANTIFICATION
STAGE 1

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FOR
CANNON AFB, NEW MEXICO

VOLUME 1. TEXT

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SEPTEMBER, 1986

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The Cannon AFB IRP Phase II Stage 1 program consisted of installation and sampling of four monitor wells and 41 soil borings at 15 locations on-base. The four monitor wells were located in a one-upgradient, three-downgradient configuration surrounding the active base landfill (Site No. 5).

Wells were drilled to about 15 feet below the top of the saturated zone of the Ogallala Formation. Each well was completed with a four-inch diameter PVC casing and 15-foot screen and equipped with a dedicated submersible pump.

Ground-water levels were measured to confirm the local ground-water flow direction and samples were collected for analysis of selected organic and inorganic parameters. Resulting data revealed no evidence of contamination by purgeable halocarbons or aromatics, oil and grease, pesticides, or metals.

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Soil samples were collected as cuttings or cores immediately above, five feet into, and immediately below the base of the caliche zone in each borehole at the 15 project sites. Some deep soil core samples were unobtainable due to the unconsolidated nature of the caliche. Analytical results confirm the presence of oil and grease components in the upper soil zone at several sites. Metals concentrations are generally low, except for some isolated species in samples from site Nos. 1 and 12. Elevated pesticide concentrations were detected in soil samples from Site No. 17.

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PREFACE

Radian Corporation is the contractor for the Installation Restoration Program (IRP) Phase II, Stage 1 investigation at Cannon AFB, New Mexico. The work was performed under USAF Contract No. F33615-84-D-4402, Delivery Order 0004.

The purpose of this report is to document the hydrogeological investigation conducted at several landfills, fire training areas, fuel handling and spill areas to determine if environmental contamination has resulted from waste disposal and materials handling operations at Cannon AFB. Ground-water monitor wells were installed in the Ogallala Aquifer. Soil samples were collected during shallow and deep boring operations and analyzed for a broad range of parameters. Water samples collected from the wells were analyzed for metals, organic indicator parameters, and purgeable organics.

Key Radian project personnel were:

Francis J. Smith, P.E. - Contract Administrator
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Tobin K. Walters - Project Director and Supervising Geologist
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Radian would like to acknowledge the cooperation of the Cannon AFB Bioenvironmental Engineering and Civil Engineering Staffs. In particular, Radian acknowledges the assistance of Lieutenant Eric Scott, Chief Bioenvironmental Engineer, Lieutenant Robert Walton and Mr. Jim Richards.

The work reported herein was accomplished between November 1984 and April 1985. Lieutenant Colonel Edward S. Barnes, Technical Services Division, USAF Occupational Environmental Health Laboratory, was the Technical Monitor.

Approved,

Francis J. Smith, P.E.
Senior Program Manager

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SUMMARY

Background and Purpose

The Department of Defense (DOD) is conducting a nation-wide program to identify and evaluate past hazardous material disposal and spill sites on DOD property and control the migration of hazardous contaminants resulting from these sites. This program, the Installation Restoration Program (IRP), consists of four phases: Phase I, Initial Assessment/Record Search; Phase II, Problem Confirmation/Quantification; Phase III, Technology Base Development; and Phase IV, Remedial Actions. The United States Air Force (USAF) has initiated an IRP investigation at Cannon Air Force Base near Clovis, New Mexico. Phase I was conducted from 1982 through 1983; Phase II (Stage 1) was conducted in 1984-1985. Radian Corporation has performed the Phase II (Stage 1) Field Investigation under USAF Contract No. F33615-84-D-4402, Delivery Order 0004.

The purpose of the Phase II (Stage 1) investigation was to determine if environmental contamination has resulted from waste disposal practices, fuel spills/leaks and fire training activities at Cannon AFB. In addition, the investigation included an estimate of the magnitude and extent of contamination, should contamination be found; the identification of potential environmental consequences of migrating pollutants; and the recommendation of any additional investigations necessary to identify the magnitude, extent and direction of movement of discovered contaminants.

Authorization to proceed on the Cannon AFB Phase II, Stage 1 program was given 25 September 1984. The field activities were conducted from November 1984 through April 1985. The field work consisted of the installation and sampling of four ground-water monitoring wells and the completion of forty-one soil borings at fifteen locations on the base.

Location and Site Descriptions

The Phase II, Stage 1 work at Cannon AFB focused on sixteen sites. These sites consist of landfills, fire training areas, spill sites and solvent disposal sites. Figure 1 shows the location of the Phase II, Stage 1 sites at Cannon AFB.

Site No. 1 - Landfill No. 1

Landfill No. 1 is an inactive landfill, approximately four acres in size. It was the original landfill on base and received domestic solid wastes and shop wastes including oils and solvents, paint strippers and thinners, outdated paint, pesticide containers, and various empty cans and drums from 1943 to 1946. Landfill operation included burning, then burying wastes. The former landfill is located under the base golf course, about 400 feet north of the hospital (Facility No. 1400).

Site No. 2 - Landfill No. 2

Landfill No. 2 is a former four-acre waste disposal site located in the northeast corner of the base, beyond the primary runway. It was operated during two periods in the past; from 1946 to 1947, and again from 1952 to 1959. The period of temporary inactivity from 1947 to 1952 was the time during which the base was on deactivated status. When in operation, Landfill No. 2 received domestic and industrial solid wastes including waste oils and solvents, paints, paint strippers and thinners, pesticide containers, and empty cans and drums. Wastes were deposited in trenches where they were burned and buried. In its present condition, the site appears as an open field covered by prairie grasses.

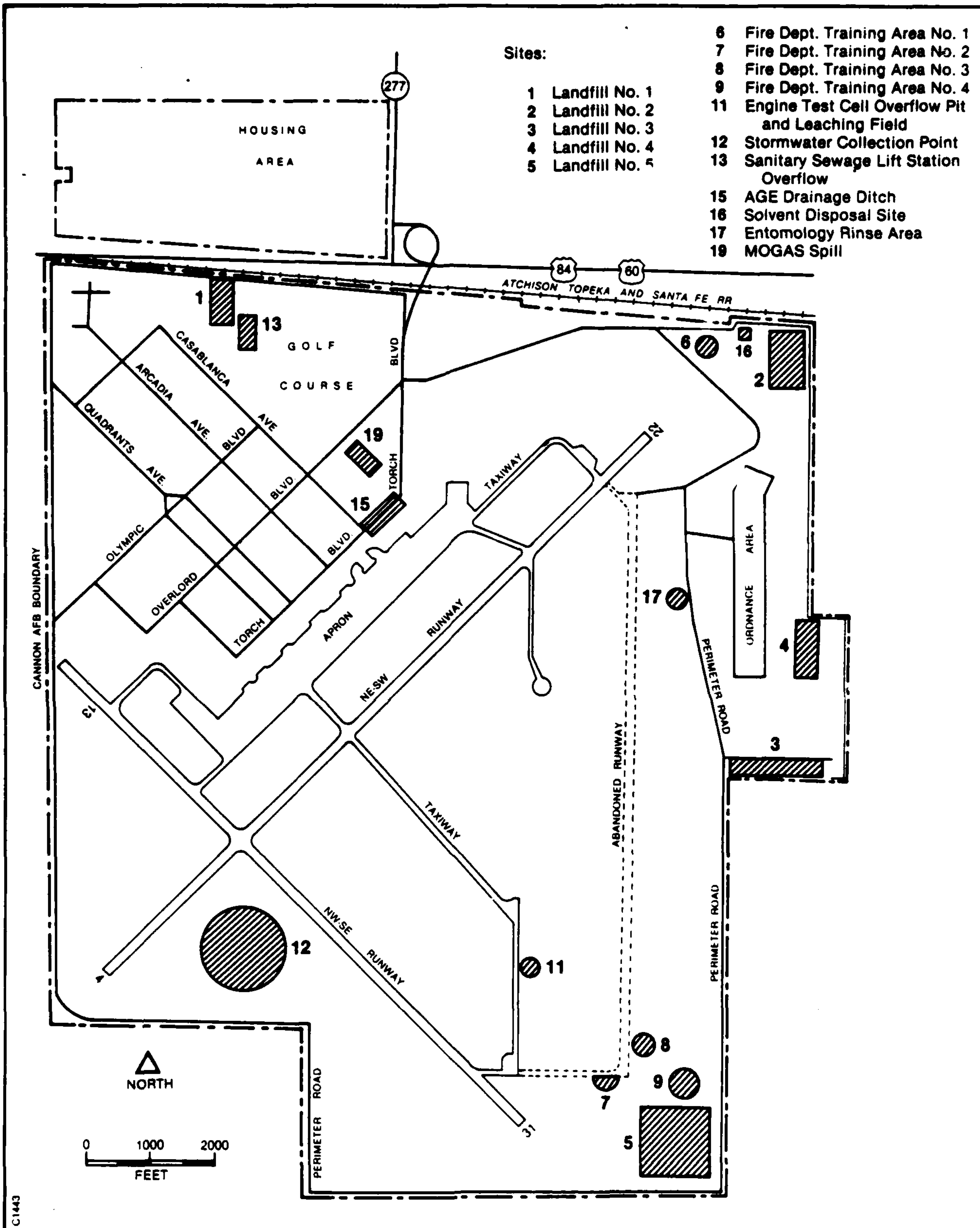

Figure 1. Areas of Investigation, IRP Phase II Stage 1, Cannon AFB, New Mexico

Site No. 3 - Landfill No. 3

Landfill No. 3 is an inactive waste disposal site. The landfill, which covers approximately nine acres on the east side of the base, south of the ordinance area (Figure 1), was operated from 1959 to 1967. During operation, domestic solid wastes, waste oils, solvents, paints, paint thinners and strippers, pesticide containers, and various empty cans and drums were burned in trenches and buried each following day. Currently, the inactive site appears as a rectangular open field covered by prairie grasses.

Site No. 4 - Landfill No. 4

Landfill No. 4 is an inactive waste disposal site covering approximately seven acres on the east side of the base between the ordinance area and the base boundary (Figure 1). During the years of operation, from 1967 to 1968, domestic solid-wastes, waste oils, solvents, paints, paint strippers and thinners, pesticide containers, and various empty cans and drums were deposited in trenches and burned. The residual wastes were buried in the trenches the day following each burning. Currently, this inactive site appears to be an open field covered by prairie grasses. Noticeable elongate areas of subsidence within the site suggest the locations of former trenches.

Site No. 5 - Landfill No. 5

The landfill was inactivated in October 1984, but had been in operation since 1968. Hazardous waste was disposed of until mid-1981 in the one cell in opertion during FY 81. Only this one cell is subject to RCRA requirements. The entire site covers approximately 30 acres in the southeast corner of the base.

Waste materials received at this landfill are similar to those received at the former base landfills: domestic solid waste; waste oils, solvents; paint, paint remover and thinners; pesticide containers and various empty cans and drums. Until mid-1981, approximately 5 to 10 drums per month of waste oils and solvents were disposed. Partially to completely full drums of material were generally deposited directly into trenches and crushed by a bulldozer. Currently, tree limbs and construction rubble are being disposed of in the landfill.

From 1968 to about 1972, the mode of operation at this landfill was burn and bury in trenches. Since 1972, unburned waste has been buried. An estimated eleven covered trenches exist at the site. A twelfth trench was opened and in use at the time of the Phase II investigation. The trench was excavated to about seven feet in depth, and bottomed in the caliche.

Site No. 6 - Fire Department Training Area No. 1

During the period of 1959 to 1968, this fire training area was operated on the northeast corner of the base. No evidence of recent use is apparent, although an approximately 100-foot-diameter previously disturbed area with sparse vegetation is recognizable. Waste oils, fuels, and solvents were burned on the ground to provide practical fire training experience. Prior to some of the exercises, the ground was soaked with water to minimize infiltration of any residual fuel.

Site No. 7 - Fire Department Training Area No. 2

Fire Training Area No. 2 was used from 1968 to 1974 to provide base personnel with practical experience in extinguishing fires. The site is located in the southeast corner of the base and is recognizable as a circular, sparsely vegetated area. Unused JP-4 was the only material burned at this site. Before each training exercise, the ground was pre-soaked with water to minimize infiltration of any residual fuel.

Site No. 8 - Fire Department Training Area No. 3

Fire Training Area No. 3 was used concurrently (1968 to 1974) with Fire Training Area No. 2, and is also located in the southeast corner of the base. The site is similar in appearance to Fire Training Area No. 2 (previously described) and no evidence of recent activity is apparent. Site exercises were conducted in the same manner (water-soaked soil) and with the same fuel (fresh JP-4) as at Site No. 7.

Site No. 9 - Fire Department Training Area No. 4

Fire Training Area No. 4 is the only active training site on-base. It has been used since 1974 and is located near former Fire Training Areas Nos. 2 and 3 in the southeast corner of the base.

This site was reportedly used from 1961 to 1974 as a fuel truck cleaning area in which residual fuels were drained onto the ground and the fuel tanks cleaned. This practice reportedly ended about 1974. From 1974 to 1975, commingled waste oils, solvents, and recovered JP-4 fuels were burned at the site. Since 1975 only recovered JP-4 has been burned in training.

Pre-soaking of the ground with water prior to conducting all fire department training exercises is standard practice; however, pre-soaking was not practiced prior to 1974, when fuel trucks were cleaned at the site.

The training site is a shallow unlined circular depression, approximately 400 feet in diameter. A simulated aircraft sits at the center of the burn pit. A 2,000-gallon underground tank installed in 1975 was used to store recovered JP-4 fuel for burning. Fuel is pumped from the storage tank to the simulated aircraft prior to practice burns. Runoff from the area was collected in an unlined pit adjacent to the site. Visual evidence of surface contamination at this site was reported during the Phase I survey. In 1985, this facility was rebuilt. A new lined facility with an oil/water separator was installed to handle collected runoff.

Site No. 11 - Engine Test Cell Overflow Pit and Leach Field

Site No. 11 is located in the southeast part of the base. It includes the leaching field for washdown from Engine Test Cell Facility No. 5114 and an overflow pit.

An oil/water separator (and leaching field) was installed during construction of the engine test cell and has been in operation since 1965.

The hydraulic capacity of the leaching field has been progressively reduced resulting in reduced capacity of the oil/water separator and hydraulic overloading of the unit. In 1982, a 6-8 foot diameter pit was excavated to relieve some of the overloading by receiving part of the wastewater from the engine test cell. At the time of the Phase I survey, the pit reportedly contained 5 to 6 feet of black liquid with a hydrocarbon odor. In 1985, a new oil/water separator was installed and a lined evaporation pond was constructed to handle water discharge.

Site No. 12 - Stormwater Collection Point

Since 1943, stormwater runoff from the flightline has been collected in a nine-acre playa lake located near the southwest corner of the base. The runoff is likely to contain small amounts of spilled fuels, oils and other POL materials as well as PD-680, a petroleum distillate used as a safety cleaning solvent. Reportedly no visual evidence of contamination was observed during the Phase I survey.

Site No. 13 - Sewage Lift Station Overflow

Site No. 13 is an overflow pit, approximately 100 feet x 600 feet, 2 to 3 feet deep, located on the golf course, north of the base hospital. It appears as a rectangular, grass-covered depression. The pit was designed specifically for emergency use. In February, 1983, such an emergency occurred when the pumps in Sanitary Lift Station No. 1402 malfunctioned and an estimated 100,000 to 150,000 gallons of raw sewage were bypassed to the pit. One week later, the pumps were repaired and the sewage was cycled back to the Lift Station. Initial sample results indicate that POL material (hazardous by ignitability criterion) may have been in the sewage diverted to the overflow pit.

Site No. 15 - AGE Drainage Ditch

Site No. 15 is a ditch which parallels Facilities Nos. 191, 192, and 193 and extends from the flightline side of the AGE building (No. 186) to near Argentia Avenue. The ditch was created by settling along the former trend of railroad tracks that were removed in the late 1960's. Spilled fuel and oil on the AGE maintenance pad are washed into the ditch during heavy rains. Contamination was observed during the Phase I survey as discolored black soil with a characteristic POL odor over 50 to 75 feet along the ditch bottom.

Site No. 16 - Solvent Disposal Site

Site No. 16 is located in the northeast corner of the base, between Fire Department Training Area No. 1 and Landfill No. 2 (Phase II Stage 1 Sites Nos. 6 and 2, respectively).

During the Phase I Survey, two empty 55-gallon drums labeled "Trichloroethylene" (TCE) were found on the ground, opened and positioned such that they would drain into a shallow pit. Each drum had rust holes in the top side, suggesting that they had been there for several years. A deteriorating black plastic liner was noted at the edge of the shallow pit. Approximately 4 to 6 inches of soil covered the rest of the liner, which had apparently been installed in the pit to prevent the volatile solvent from percolating into the ground. It is not known whether the drums were full at the time of disposal.

Site No. 17 - Entomology Rinse Area

The Entomology Rinse Area is located behind the former site of a pesticide storage building (No. 2160). Rinse water for decontaminating pesticide spraying equipment and empty containers drained from the building through a sink that discharged into a small 3' x 3' x 2' open pit in the rear.

Soil and gravel in the base of the pit prevent determination of the nature and condition of the bottom. It is not known whether pesticides which drained into the pit were contained or percolated into the ground. Real property records indicate a new facility (Bldg. 212) was constructed and occupied on 19 October, 1983. Building 2160 was abandoned at that time and demolished on 6 September, 1984. It is not known how long Building 2160 and the drain were in use.

Site No. 19 - MOGAS Spill

On two occasions in the early 1960's, fuel trucks overturned in a ditch along the southwest side of Argentia Avenue, across from the refueling area of Facility No. 379 (Vehicle Maintenance Shop). In each case, the trucks spilled an unknown quantity (estimated to have been between 2000 and 3000 gallons) of MOGAS into the ditch. Reportedly, the only response action taken after both accidents was a washdown of the area by the fire department.

In 1977, the construction of the gymnasium and associated pavements along Argentia Avenue modified the site. Currently, part of the ditch is apparently below pavement, while a portion exists only as a small depression. There is no evidence that contaminated soil was detected or removed during construction of the gym and associated pavements.

Base Water Supply Wells

Cannon AFB presently obtains water supplies from a system of nine on-base water wells. All base wells are completed in the Ogallala Aquifer and range from 357 to 415 feet in depth, with yields ranging from 50 to 820 gallons per minute (gpm). The wells incorporate multiple screens drawing water from the interbedded sands of the Ogallala Formation.

Sampling and Analytical Program

The sampling program at Cannon AFB consisted of the collection of soil and ground water samples. Soil samples were collected with a small hand auger at some sites and with a rig-mounted hydraulic-powered Shelby tube or split-spoon sampler during drilling activities at the remaining sites. All soil samples were placed individually in glass jars and frozen. Ground water samples were collected from the four monitor wells using dedicated permanently installed submersible pumps. All water samples were chilled to 4°C and shipped to Radian Analytical Services for analysis. The soil and ground-water samples from the various sites were analyzed for the presence of contaminants. The analyses can be divided into several types, as follows:

- Volatile aromatic compounds (EPA Method 8020 and 602)
- Volatile halocarbon compounds (EPA Method 8010 and 601)
- Oil and Grease
- Total Organic Carbon
- Metals
- General Ions
- Pesticides and Herbicides

The Schedule of Analyses is summarized in Table 1.

TABLE 1. ANALYTICAL SCHEDULE FOR SOIL AND WATER SAMPLES
CANNON AFB, PHASE II STAGE 1

Purgeable Halcarbons
EPA Methods 601 and 8010

Bromodichloromethane
Bromoform
Bromomethane
Carbon tetrachloride
Chlorobenzene
Chloroethane
2-Chloroethyl vinyl ether
Chloroform
Chloromethane
Dibromochloromethane
1-2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
Dichlorodifluoromethane*
1,1-Dichloroethane
1,2-Dichloroethane
1,1-Dichloroethene
trans-1,2-Dichloroethene
1,2-Dichloropropane
cis-1,3-Dichloropropene
trans-1,3-Dichloropropene
Methylene chloride
1,1,2,2-Tetrachloroethane
Tetrachloroethene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethene
Trichlorofluoromethane
Vinyl chloride

Purgeable Aromatics
EPA Methods 602 and 8020

Benzene
Chlorobenzene
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
Ethyl benzene
Toluene

Oil and Grease
EPA Methods 413.2

IR Method using freon-extraction.
note: oil and grease, as reported, may include variable amounts of natural freon-extracted organics in addition to hydrocarbons.

Total Organic Halogen (TOX)
EPA Method 9020

Sum of total halogenated organic compounds.

(Continued)

*Dichlorodifluoromethane coelutes with vinyl chloride and is not quantified separately. Such quantification would require addition of charcoal to the instrument trap and would interfere with the vinyl chloride analysis. All vinyl chloride concentrations greater than 1.0 ug/L are confirmed with a second column.

TABLE 1. ANALYTICAL SCHEDULE FOR SOIL AND WATER SAMPLES
CANNON AFB, PHASE II STAGE 1 (Continued)

Parameter	Method
Pesticides and Herbicides	
Aldrin	Standard Method 509 A
DDT isomer	Standard Method 509 A
Dieldrin	Standard Method 509 A
Endrin	Standard Method 509 A
Heptachlor	Standard Method 509 A
Lindane	Standard Method 509 A
Methoxchlor	Standard Method 509 A
Diazinon	Standard Method 509 A
Malathion	Standard Method 509 A
Parathion	Standard Method 509 A
Toxaphene	Standard Method 509 A
2,4-D	Standard Method 509 B
2,4,5-T	Standard Method 509 B
2,4,5-TP (silvex)	Standard Method 509 B

Metals	Method	General Ions	Method
Arsenic	EPA 206.2 or 206.3	Calcium	EPA Method 200.7
Barium	EPA 208.2	Magnesium	EPA Method 200.7
Cadmium	EPA 213.2	Sodium	EPA Method 200.7
Copper	EPA 220.1	Potassium	EPA Method 200.7
Chromium	EPA 218.1	Manganese	EPA Method 200.7
Iron (total)	EPA 236.1	Chloride	EPA Method 325.2
Lead	EPA 239.2	Sulfate	EPA Method 375.3
Manganese	EPA 243.1	Phosphate (Total)	EPA Method 365.4
Mercury	EPA 245.1 and 245.5 (soils)	Nitrate	EPA Method 353.1
Nickel	EPA 249.1		
Selenium	EPA 270.3		
Silver	EPA 272.2		**General Water Quality**
Zinc	EPA 289.1		
			pH
			Total Dissolved Solids
			Conductivity

Field Program

The following describes the various field activities performed during the Cannon AFB Phase II, Stage 1 investigation. The field program included hollow-stem auger and mud rotary drilling, monitor well installation, hand augering, and soil and water sampling. Radian performed static water level measurements at the newly installed monitor wells and at two existing base wells to evaluate local ground-water flow directions and conditions.

Drilling Techniques

Radian's drilling contractor drilled the four monitor wells at Cannon AFB using mud-rotary methods and a Failing 1500 Truck Mounted Rig. Air rotary methods were not used due to depths (>350 feet) of the wells. Bentonite mud was used to stabilize the walls of the borehole in order to keep the cuttings circulating upward and to prevent the borehole from collapsing during advancement of the bit. The rig drilled the borehole to a depth of about 15 feet below the top of the saturated zone of the Ogallala Formation using an 8-inch Tricone Bit. Bentonite mud and a biodegradable gel (Vari-flow) were used to stabilize the walls of the borehole and to aid in lifting cuttings during drilling. Following completion of the drilling the monitor well installation proceeded. A four-inch diameter PVC monitor well with a 15-foot screen and a dedicated submersible pump was installed in the borehole. Clean, coarse sand was placed in the annular space until the level of the top of the gravel pack was at least two feet above the top of the screen. Bentonite pellets (Volclay) were added to form at least a 3-foot thick seal above the saturated zone. Neat cement (Type I) grout was emplaced from the top of the bentonite seal to land surface.

The deep soil borings were drilled using a Mobile B-61 hollow-stem auger with 60 feet of 6 1/2" OD flight augers. As each soil boring was drilled, samples were obtained at the top of the local caliche layer, five feet into the caliche, and at the final depth. The drilling and sampling of the soils was conducted dry; no fluids were introduced during drilling. Each sample was obtained using a split-spoon sampler with a sleeve (ASTM D-3550) or by a 3-inch OD Shelby tube (ASTM D-1587). Cuttings were placed in 55 gallon barrels for transportation by base personnel to a proper disposal area. Samples were individually placed in jars and frozen for transport to Radian Analytical Services and USAF OEHL. After reaching total depth, the soil boring was sealed to land surface using Type I Portland cement grout.

Two sites were drilled using a portable hand-held auger with 2 inch OD auger flights. Soil samples were collected and frozen for shipment to Radian Analytical Services and USAF OEHL.

Ground Water Sampling

Ground-water samples were collected for analysis from the four monitor wells installed during this program. Water level measurements taken to the nearest 0.01 foot were followed by collection of water samples. All water samples were analyzed in the field for specific conductivity, temperature and pH. Collected water samples were then shipped to Radian Analytical Services. All aspects of the sampling protocol were conducted in accordance with EPA-approved methodologies.

Soil Sampling

Soil samples were collected at all Phase II Stage 1 sites either as cuttings or as undisturbed cores. Those samples which were to be used only for geologic interpretation were collected as cuttings. Grab samples were composited over 5 foot or 2 foot intervals (monitor wells/deep borings, and shallow borings, respectively) and described. Lithologic logs of all soil samples were maintained by the Radian supervising geologist. The samples were stored in plastic bags or small jars with labels identifying the sampling site, borehole location, and depth. Soil samples will be held at Radian for reference throughout the course of the Phase II program at Cannon AFB.

Samples which were collected for chemical analysis were taken as undisturbed cores. Core samples from the deep soil borings were obtained by Shelby tube (ASTM D-1587), or split-spoon sampler (ASTM D-3550). Generally, the Shelby tube was used to obtain the shallower samples; however in some cases where the deep unconsolidated sand was difficult to recover, the split-spoon apparatus was substituted for the Shelby tube.

Core samples were taken, where subsurface conditions permitted, at three positions in each borehole: immediately above the top of the caliche; five feet into the caliche; and just below the base of the caliche. Soil samples were collected in one-quart Mason jars with Teflon-lined lids and/or 40 ml glass vials with Teflon septa and stored at -10°C prior to shipment to Radian Analytical Services in Austin.

Results of Analysis

The Phase II, Stage 1 investigation has documented the presence of oil and grease in the upper soil zone at several sites. Concentrations of metals are generally at background levels except for barium and selenium at Site No. 2 and Lead at Sites Nos. 9, 11, 15 and 19. No ground-water contaminants were found in the four monitor wells.

Site 1: Sampling at Landfill No. 1 found no purgeable halocarbons or aromatics. The total concentrations for metals fall within the normal soil ranges except for selenium which is moderately elevated. Oil and grease levels are elevated above background values in surface soil samples.

Site 2: The samples from Landfill No. 2 revealed no purgeable halocarbons or aromatics. No oil or grease concentrations were found. The metals concentrations were within the normal range for soils except for slightly elevated levels of barium and selenium. The barium results from natural weathering in the semi-arid soils. The selenium is found in the shallow soils and remains remote from ground water.

Site 3: Landfill No. 3 contained no purgeable halocarbons or aromatics. All metal concentrations fell within normal soil ranges except for Borehole 3E where samples contained somewhat higher levels of selenium and mercury. However, the concentrations determined in this single borehole do not justify further investigation of the site within the context of the IRP.

Site 4: Landfill No. 4 contained no purgeable halocarbons or aromatics. Total concentrations of metals were within normal soil ranges. Levels of oil and grease above background norms were detected in only 2 of the 22 soil borings analyzed.

Site 5: Samples from the four monitor wells installed adjacent to Landfill No. 5 contained no increased levels of purgeable halocarbons or aromatics, no oil and grease, and no increased metals.

Site 6: Fire Department Training Area No. 1 contained no purgeable halocarbons or aromatics. Higher concentrations of oil and grease occur in the upper soils but a well-developed caliche zone isolates the materials from deeper soils.

Site 7: Fire Department Training Area No. 2 contained no purgeable halocarbons or aromatics. Lead values were within the normal range for soils. Raised levels of oil and grease occur in the shallow soils but a greater then 300-foot thick caliche zone serves to isolate the materials from ground water.

Site 8: Fire Department Training Area No. 3 samples showed no purgeable halocarbons or aromatics present. Lead concentrations fall within the normal concentration range for soils. Elevated concentrations of oil and grease were detected in the mid-depth sample, but are not interpreted as posing a threat to the deep Ogalla Aquifer.

Site 9: Fire Department Training Area No. 4 contained no purgeable halocarbons or aromatics. Somewhat increased levels of lead were detected 5 feet into the caliche at borehole 9A (located about 36 feet downslope from the waste pit), but all other lead concentrations were within the normal range. Measured concentrations of oil and grease decreased down-gradient from the waste run-off pit.

Site 11: Engine Test Cell Overflow Pit and Leach Field. Samples from Site No. 11 contained no purgeable halocarbons or aromatics. Oil or grease was detected at <10 mg/kg in the samples and all lead concentrations were within the normal range for soils.

Site 12: The samples from the Stormwater Collection Point contained no purgeable halocarbons or aromatics. No significant levels of oil and grease or concentrations of metals were detected. However, an apparent, slightly increasing trend in heavy metals (especially lead) concentrations toward the center of the basin may merit further investigation.

Site 13: The Sewage Lift Station Overflow area yielded no purgeable halocarbons or aromatics. The total metals concentrations fell within normal soil ranges. Low levels of oil and grease occurred in all samples. Moderately elevated levels of barium and manganese were detected in middle samples from one hole, but are not considered environmentally significant.

Site 15: The AGE Drainage Ditch samples contained no purgeable halocarbons or aromatics. Only one measured oil and grease concentration occurred above the site background level (<10 mg/kg). Elevated levels of lead were detected in the shallow soil of the down-gradient test hole, but this isolated surficial occurrence is not considered of environmental concern.

Site 16: The Solvent Disposal Site was not investigated because no evidence remained of its location.

Site 17: Soils from the Entomology Rinse Area contained no detectable concentrations of purgeable halocarbons or aromatics. The metals concentrations for arsenic and mercury fell within normal soil ranges. The total organic carbon (TOC) was low and no organophosphate pesticides were detected. The topsoil in the Entomology Rinse Area contained elevated levels of EPA Method 608 pesticides. The pesticides included: Dieldrin; Toxaphene; 4,4-DDT; 4,4-DDE; and 4,4-DDD. The deepest sample from borehole 17C contained the herbicide 2,4-D at a concentration of 406 mg/kg as well as 8 ug/kg of 4-4 DDT. This sample was collected below the caliche. The accumulation of contaminants in the unconsolidated sand represents a major environmental concern.

Site 19: The samples from the MOGAS Spill included one sample with a 237 ug/kg concentration of 1,2-DCE. However, this compound was not detected in the duplicate split and is not a component of MOGAS. No other purgeable halocarbons or aromatics were detected by EPA Methods 8010 or 8020. No oil or grease above background levels was detected in any of the samples. Lead levels were within background range except for one surface sample collected downslope in the ditch.

Recommendations

Based on the findings of this study, Radian recommends the following actions for each of the Phase II Stage 1 sites. The recommendations are organized by category, as defined by the IRP:

Category I - Sites where no further action is required.
Category II - Sites requiring additional Phase II investigations to fully quantify conditions.
Category III - Sites which require remedial action and are sufficiently well known for Phase III/IV actions to begin.

All Stage 1 study areas are discussed below.

Category I Sites

No further actions will be required at 13 of the sites investigated in the Phase II Stage 1 study of Cannon AFB. These are:

- Site No. 1 Landfill No. 1;
- Site No. 2 Landfill No. 2;
- Site No. 3 Landfill No. 3;
- Site No. 4 Landfill No. 4;
- Site No. 5 Landfill No. 5;
- Site No. 6 Fire Department Training Area No. 1;
- Site No. 7 Fire Department Training Area No. 2;
- Site No. 8 Fire Department Training Area No. 3;
- Site No. 9 Fire Department Training Area No. 4;
- Site No. 13 Sanitary Sewage Lift Station Overflow Pit;
- Site No. 15 AGE Drainage Ditch;
- Site No. 16 Solvent Disposal Site; and
- Site No. 19 MOGAS Spill.

Category II Sites

Based on the results of the Stage 1 investigation, two Category II sites were identified. They are:

- Site No. 11 Engine Test Cell Overflow Pit and Leaching Field; and
- Site No. 12 Stormwater Collection Point.

Additional Phase II actions recommended by Radian for the Category II sites are summarized in Table 2.

Category III Sites

Site No. 17 - Entomology Rinse Area is currently undergoing Phase IV cleanup, directed by Headquarters Tactical Air Command (TAC) Civil Engineering.

TABLE 2. RECOMMENDATIONS FOR CATEGORY II SITES, CANNON AFB, NEW MEXICO

Site	Recommended Action(s)	Rationale
No. 11 Engine Test Cell Overflow Pit and Leach Field	Install three deep soil borings in the vicinity of the old oil/water separator and drainpipe. Collect soil samples from each borehole immediately above the caliche; five feet into the caliche; and immediately below the base of the caliche. Analyze all samples for porosity, pollutant metals, purgeable organics, and oil and grease. Also, analyze water samples from the evaporation pond for purgeable organics.	The oil/water separator sump at this site was not sampled for Priority Pollutant Analysis during the Phase II investigation. Available data, though all negative, provide insufficient basis to dismiss the site from further activities as the extent of potential contamination is not adequately defined.
No. 12 Stormwater Collection Point	Install three deep soil borings along the southern perimeter of the Stormwater Collection Point to a maximum depth of 200 feet. Collect soil samles at 10 foot intervals and analyze for priority pollutant metals using the EP Toxicity Test.	A large proportion of surface runoff originating on-base is routed to the Stormwater Collection Point. Sediment samples collected from the basin indicate elevated levels of heavy metals exist in the sediment. The water body in the basin could potentially drive these heavy metals deeper into substrate and aquifer below.

1.0 INTRODUCTION

The Department of Defense (DOD) is conducting a nation-wide program to evaluate past hazardous material disposal and spill sites and control the migration of hazardous contaminants from these sites. This program, the Installation Restoration Program (IRP), consists of four phases: Phase I, Initial Assessment/Record Search; Phase II, Problem Confirmation/Quantification; Phase III, Technology Base Development; and Phase IV, Remedial Actions. The United States Air Force (USAF) has initiated an IRP investigation at Cannon Air Force Base near Clovis, New Mexico. Phase I was conducted from 1982 through 1983; Phase II (Stage 1) was conducted in 1984-1985. Radian Corporation has performed the Phase II (Stage 1) Field Investigation under USAF Contract No. F33615-84-D-4402, Delivery Order 0004.

1.1 Purpose of the Investigation

The purpose of the Phase II (Stage 1) investigation was to determine if environmental contamination has resulted from waste disposal practices, fuel spills/leaks and fire training activities at Cannon AFB. In addition, the investigation included an estimate of the magnitude and extent of contamination, should contamination be found; the identification of potential environmental consequences of migrating pollutants; and the recommendation of any additional investigations necessary to identify the magnitude, extent and direction of movement of discovered contaminants.

1.2 Duration of the Program

Authorization to proceed on the Cannon AFB Phase II (Stage 1) program was given on 25 September 1984. Field activities were conducted from November 1984 through April 1985. The field work consisted of the installation and sampling of four ground-water monitoring wells, and completion of forty-six soil borings at fifteen locations at the base. Table 1-1 summarizes the field schedule for Cannon AFB.

TABLE 1-1. SCHEDULE FOR CANNON AFB IRP PHASE II, STAGE 1

Task	Date
PHASE I	December 1982-August 1983
PHASE II	
Project Initiation	25 September 1984
Start of Field Work	12 November 1984
Monitor Well Completion	20 January 1985
Soil Boring Completion	28 February 1985
First Water Level Measurements	20 January 1985
First Quarter Ground-Water Sampling	24 January 1985
Last Water Level Measurements	2 April 1985

1.3 History

The history of Cannon AFB dates to 1929, when it was a passenger terminal for early trans-continental flights. In 1942, the Army Air Corps took control of the airfield and used it as a training base for flying, bombing, and gunnery exercises during World War II. The types of aircraft stationed at Cannon AFB during this time included B-17, B-24, and B-29 heavy bombers.

The base was reassigned to the Tactical Air Command in 1951. In December 1965, the mission of base changed to that of a replacement training unit. Since 1971, the primary mission of Cannon AFB has been to develop and maintain an F-111D tactical fighter wing, capable of day, night, and all-weather combat operations and to provide replacement training of combat aircrews for tactical organizations worldwide. Currently, there are approximately 70 F-111D aircraft assigned to Cannon AFB.

1.4 Waste Disposal Practices

The Phase I report (CH2M Hill, 1983) has an account of the history of waste generation and disposal activities. The following paragraphs describing the waste disposal history come from the Phase I report.

Wastes have been generated and disposed of at Cannon AFB since the beginning of industrial operations in 1942. The major industrial operations include jet engine, pneudraulics and aerospace ground equipment (AGE) maintenance, corrosion control, vehicle maintenance shops, and the non-destructive inspection (NDI) lab. These industrial operations generate varying quantities of waste oils, recoverable fuels, and spent solvents and cleaners.

The total quantity of waste oils, recovered fuels, and spent solvents and cleaners generated ranges from 10,000 to 20,000 gallons per year. The above range of total waste quantities is believed to be representative for the period from the mid-1960s, when the mission changed to that of a replacement training unit, to the present.

Practicies for past and present industrial waste disposal practices are summarized below:

- 1943 to 1947 and 1952 to 1965: The majority of waste oils, spent solvents, and recovered fuels were burned during fire department training exercises or burned/buried at one of the base landfills. Since no program of waste segregation existed, most spent solvents and paint thinners were commingled with waste engine oils, lube oils, and hydraulic fluids. The waste oils, spent solvents, and recovered fuels were collected in 55-gallon drums and bowsers and transported by shop personnel to either the fire department training area (Site No. 6) or landfill (Sites No. 1, 2, and 3) in use at the time. Waste materials brought to the fire department training area in 55-gallon drums were stored at the area until needed to ignite a practice burn during training exercises. Waste materials brought to the landfills were burned prior to burial in trenches.

- 1965 to 1982: The majority of waste oils, spent solvents, and recovered fuels were burned during fire department training exercises; brought to the underground waste oil tank (Facility No. 4028) and removed by a contractor; or disposed of in one of the base landfills. Since no program of waste segregation existed, most spent solvents and paint thinners were commingled with waste oils. Waste materials were collected in 55-gallon drums and bowsers and transported to either a fire department training area (Sites No. 6 and 9), a landfill (Sites No. 3, 4, and 5), or the underground waste oil tank (Facility No. 4028). From approximately 1968 to 1974, waste materials were not burned at the fire department training areas. However, burning of waste materials at the fire department training areas was practiced between 1974 and 1975. Burning operations at the landfill ceased in 1972, after which materials were placed directly into landfill trenches. Waste materials brought to the 20,000-gallon underground waste oil tank (Facility No. 4028) were removed by a contractor. Some waste oils collected in the underground waste oil tank were transported by base personnel to the Melrose Bombing Range and used for road oiling to control dust on unimproved roads. Some recovered fuels generated during the cleaning of refueling trucks were drained onto the ground at Site No. 9.

- 1975 to 1981: The practice of burning waste oils and spent solvents during fire department training exercises was stopped in 1975. The majority of waste oils were collected in 55-gallon drums and bowsers and transported to the underground waste oil tank (Facility No. 4028). Waste oils were removed by a contractor. The Defense Property Disposal Office (DPDO) assumed accountability and contracting responsibility for the contractor removal of waste oils in 1978. Some waste oils were disposed of in the base landfill (Site No. 5) during this period.

The majority of spent solvents and paint thinners were collected in 55-gallon drums and stored at the individual shops until contractor removal. DPDO arranged for contractor removal of spent solvents and paint thinners. Some waste paints and paint thinners were disposed of in the base landfill (Site No. 5).

The majority of recovered JP-4 fuel was burned during fire department training exercises or placed in the underground waste oil tank (Facility No. 4028) and removed by a contractor. Recovered JP-4 was collected in 55-gallon drums and bowsers and transported to the fire department training area (Site No. 9) and placed in a 2,000-gallon underground tank. The fuel was then pumped from the storage tank to the simulated aircraft when needed to ignite a burn. Other recovered JP-4 fuel was placed in the underground waste oil tank (Facility No. 4028) and removed by a contractor. Some recovered fuels were disposed of in the base landfill (Site No. 5).

- 1981 to present: Currently, waste materials are segregated and then accumulated and temporarily stored in marked 55-gallon drums and bowsers at designated waste accumulation points. Waste oils collected at the waste accumulation points are transported to the underground waste oil tank (Facility No. 4028) and are then removed by a contractor. Spent solvents and paint thinners collected at the waste accumulation points are turned over to DPDO for contractor removal and are stored at the base hazardous storage area. Recovered JP-4 fuel is transported to the fire department training area (Site No. 9) and placed in the 2,000-gallon underground tank or is collected in marked 55 gallon drums and turned over to DPDO for contractor removal.

1.5 Description of Sampling Sites

The Phase I report identified 19 potential contamination sites including fire training areas, landfills, fuel spills, and pesticide rinse areas. The Phase II, Stage 1 study evaluated a total of 16 sites (the Sludge Weathering Pit, blown capacitor site and JP-4 fuel spill identified in the Phase I study were not addressed in the Phase II study). Figure 1-1 shows the locations of these sites. Site No. 16 (Solvent Disposal Site) is shown in Figure 1-1 based on the Phase I report, but its exact location could not be determined in the field, and no evidence of the site could be found during the Phase II Stage 1 investigation. Table 1-2 provides priority ranking of sites using the Air Force Hazard Assessment Rating Methodology (HARM), and potential contaminant sources identified for each site. The following paragraphs provide brief descriptions of the locations and features of the Phase II sites. All of the information provided was obtained from the Installation Restoration Program Phase I record search report (CH2M Hill, 1983).

Site No. 1 - Landfill No. 1

Landfill No. 1 is an inactive landfill, approximately 4 acres in size. It was the original landfill on base and received domestic solid wastes and shop wastes including oils and solvents, paint strippers and thinners, outdated paint, pesticide containers, and various empty cans and drums from 1943 to 1946. Landfill operation included burning, then burying wastes. The former landfill is located under the base golf course, about 400 feet north of the hospital (Facility no. 1400).

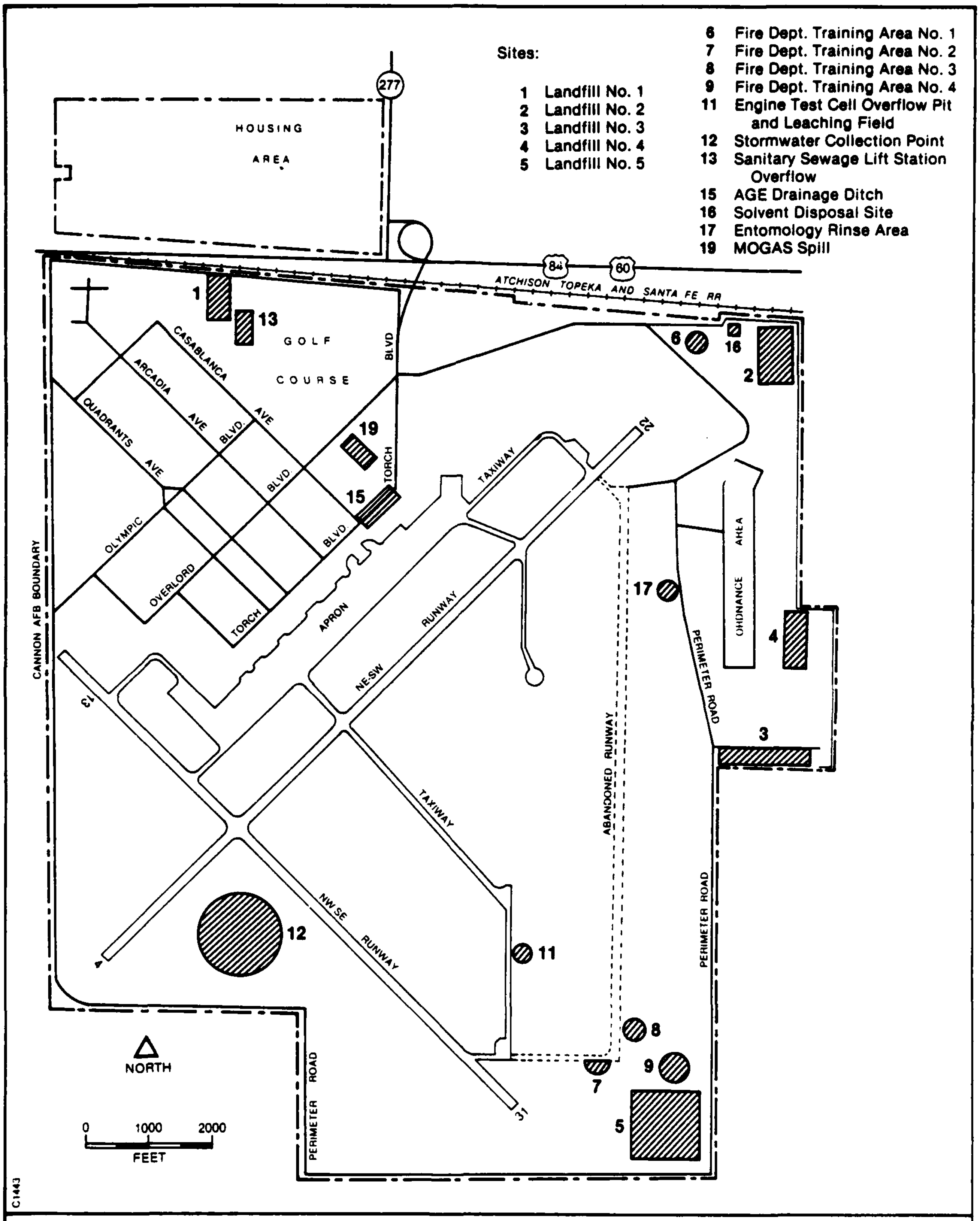

Figure 1-1. Areas of Investigation, IRP Phase II Stage 1, Cannon AFB, New Mexico

TABLE 1-2. PRIORITY RANKING OF SITES AND POTENTIAL CONTAMINANT SOURCES FROM IRP PHASE I, CANNON AFB (from Phase I report, 1982)

HARM RANK	HARM SCORE	SITE NO.	SITE NAME	PERIOD OF OPERATION OR OCCURRENCE	POTENTIAL CONTAMINANTS
1	66	9	Fire Department Training Area No. 4	1974 - present	JP-4 fuel, waste oil and solvents.
2	60	5	Landfill No. 5	1968 - present	Domestic solid wastes, waste oils, solvents, paints strippers and thinners and pesticide containers.
3	59	15	AGE Drainage Ditch	late 1960's - present	POL, runoff from maintenance pad.
4	57	6	Fire Department Training Area No. 1	1959 - 1968	JP-4 fuel, waste oil and solvents.
5	57	11	Engine Test Cell Overflow Pit and Leaching Field	1965 - present	Oil.
6	56	4	Landfill No. 4	1967 - 1968	Domestic solid wastes, waste oils, solvents, paint strippers and thinners and pesticide containers.
7	55	1	Landfill No. 1	1943 - 1946	Waste oils, solvents, paint strippers, thinners, pesticide containers.
8	54	3	Landfill No. 3	1959 - 1967	Domestic solid wastes, waste oils and solvents, paints, paint strippers, thinners and pesticide containers.
9	52	14	Sludge Weathering Pit	1960-1970	AVGAS and JP-4 sludge.

Continued--

TABLE 1-2. PRIORITY RANKING OF SITES AND POTENTIAL CONTAMINANT SOURCES FROM IRP PHASE I, CANNON AFB (from Phase I report, 1982) (Pg. 2)

HARM RANK	HARM SCORE	SITE NO.	SITE NAME	PERIOD OF OPERATION OR OCCURRENCE	POTENTIAL CONTAMINANTS
10	50	2	Landfill No. 2	1946 - 1959	Domestic solid wastes, solid wastes and shop wastes, solvents, paint strippers and thinners and pesticide containers.
11	50	16	Solvent Disposal Site	Unknown	Chlorinated solvents.
12	49	12	Stormwater Collection Point	1943 - present	PD-680 solvent, waste oils.
13	48	18	JP-4 Fuel Spill	1980	JP-4 fuel.
14	47	13	Sanitary Sewage Lift Station Overflow Site	February 1983	POL.
15	47	19	MOGAS Spill	1980	MOGAS.
16	47	17	Entomology Rinse Area	1981	Pesticides.
17	42	7	Fire Department Training Area No. 2	1968 - 1974	JP-4 fuel.
18	42	8	Fire Department Training Area No. 3	1968 - 1974	JP-4 fuel.
19	NR*	10	Blown Capacitor Site	-	PCB-contaminated oils.

*Not rated using HARM during Phase I Records Search.

Site No. 2 - Landfill No. 2

Landfill No. 2 is a former four acre waste disposal site located in the northeast corner of the base, beyond the primary runway. It was operated during two periods in the past; from 1946 to 1947, and again from 1952 to 1959. The period of temporary inactivity from 1947 to 1952 was the time during which the base was on deactivated status. When in operation, Landfill No. 2 received domestic and industrial solid wastes including waste oils and solvents, paints, paint strippers and thinners, pesticide containers, and empty cans and drums. Wastes were deposited in treaches where they were burned and buried. In its present condition, the site appears as an open field covered by prairie grasses.

Site No. 3 - Landfill No. 3

Landfill No. 3 is an inactive waste disposal site. The landfill, which coveres approximately nine acreas on the east side of the base, south of the ordinance area, was operated from 1959 to 1967. During operation, domestic solid wastes, waste oils, solvents, paints, paint thinners and strippers, pesticide containers, and various empty cans and drums were burned in trenches and buried each following day. Currently, the inactive site appears as a rectangular open field covered by prairie grasses.

Site No. 4 - Landfill No. 4

Landfill No. 4 is an inactive waste disposal site covering approximately seven acres on the east side of the base between the ordinance area and the base boundary. During the years of operation, from 1967 to 1968, domestic solid wastes, waste oils, solvents, paints, paint strippers and thinners, pesticide containers, and various empty cans and drums were deposited in trenches and burned. The residual wastes were buried in the trenches the day following each burning. Currently, this inactive site appears to be an open field covered by prairie grasses. The locations of the former trenches are still visible.

Site No. 5 - Landfill No. 5

Landfill No. 5 was inactivated in October 1984, for landfill operations, but had been in operation since 1968. Hazardous waste was disposed of until mid-1981 in the one cell in operation during FY 81. Only this one cell is subject to RCRA requirements. The entire site covers approximately 30 acres in the southeast corner of the base.

Waste materials received at this landfill are similar to those received at the former base landfills: doemstic solid waste; waste oils and solvents; paints, paint removers and thinners; pesticide containers; and various empty cans and drums. Until late 1981, approximately 5 to 10 drums per month of waste oils and solvents were disposed. Partially to completely full drums of material were generally deposited directly into trenches and crushed by a bulldozer. Currently, only tree limbs and construction rubble are being disposed of in the landfill.

From 1968 to about 1972, the mode of operation at this landfill was burn and bury in trenches. Since 1972, unburned waste has been buried. An estimated eleven covered trenches exist at the site. A twelfth trench was opened in use at the time of the Phase II investigation. The trench was excavated to about seven feet in depth, and bottomed in the caliche.

Site No. 6 - Fire Department Training Area No. 1

During the period of 1959 to 1968, this fire training area was operated on the northeast corner of the base. No evidence of recent use is apparent, although an approximately 100-foot-diameter previously disturbed area with sparse vegetation is recognizable. Waste oils, fuels, and solvents were burned on the ground to provide practical fire training experience. Prior to some of the exercises, reportedly the ground was pre-saturated with water.

However, some residual quantities of the waste liquids may have percolated into the subsurface.

Site No. 7 - Fire Department Training Area No. 2

Fire Training Area No. 2 was used from 1968 to 1974 to provide base personnel with practical experience in extinguishing fires. The site is located in the southeast corner of the base and is recognizable as a circular, sparsely vegetated area. Unused JP-4 was the only material burned at this site and before each training exercise, the ground was pre-soaked with water to minimize infiltration of any residual fuel.

Site No. 8 - Fire Department Training Area No. 3

Fire Training Area No. 3 was used concurrently (1968 to 1974) with Fire Training Area No. 2, and is also located in the southeast corner of the base. The site is similar in appearance to Fire Training Area No. 2 (previously described) and no evidence of recent activity is apparent. Site exercises were conducted in the same manner (water pre-saturated soil) and with the same fuel (fresh JP-4) as at Site No. 7.

Site No. 9 - Fire Department Training Area No. 4

Fire Training Area No. 4 is the only active training site on-base. It has been used since 1974 and is located near former Fire Training Areas Nos. 2 and 3 in the southeast corner of the base.

This site was reportedly used from 1961 to 1974 as a fuel truck cleaning area in which residual fuels were drained onto the ground and the fuel tanks cleaned. This practice reportedly ended about 1974. From 1974 to 1975, commingled waste oils, solvents, and recovered JP-4 fuels were burned at the site. Since 1975, only recovered JP-4 has been burned in training exercises.

Pre-saturation of the ground with water prior to conducting all fire department training exercises; however, pre-saturation was not practiced prior to 1974, when fuel trucks were cleaned at the site.

The training site is a shallow unlined circular depression, approximately 400 feet in diameter. A simulated aircraft sits at the center of the burn pit. A 2,000-gallon underground tank installed in 1975 is used to store recovered JP-4 fuel for burning. The fuel is pumped from the storage tank to the simulated aircraft prior to practice burns. Runoff from the area is collected in an unlined pit adjacent to the site. Visual evidence of surface contamination at this site was reported during the Phase I survey. In 1985, this facility was rebuilt. A new lined facility with an oil/water separator was installed to handle collected runoff.

Site No. 11 - Engine Test Cell Overflow Pit and Leach Field

Site No. 11 is located in the southeast part of the base. It includes the leaching field for washdown from Engine Test Cell Facility No. 5114 and an overflow pit.

An oil/water separator and leaching field were installed during construction of the engine test cell and have been in operation since 1965. However, the hydraulic capacity of the leaching field has been progressively reduced resulting in reduced capacity of the oil/water separator and hydraulic overloading of the unit. In 1982, a 6-8 foot diameter pit was excavated to relieve some of the overloading by receiving part of the wastewater from the engine test cell. At the time of the Phase I survey, the pit reportedly contained 5 to 6 feet of black liquid with a hydrocarbon odor. In 1985, a new oil/water separator was installed and a lined evaporation pond was constructed to handle water discharge.

Site No. 12 - Stormwater Collection Point

Since 1943, stormwater runoff from the flightline has been collected in a nine-acre playa located near the southwest corner of the base. The run-off is likely to contain small amounts of spilled fuels, oils and other POL materials as well as PD-680. Reportedly no visual evidence of contamination was observed during the Phase I survey.

Site No. 13 - Sewage Lift Station Overflow

Site No. 13 is an overflow pit, approximately 100' x 600' x 2 to 3 feet deep, located on the golf course, north of the base hospital. It appears as a rectangular, grass-covered depression. The pit was designed specifically for emergency use. In February, 1983, such an emergency occurred when the pumps in Sanitary Lift Station No. 1402 malfunctioned and an estimated 100,000 to 150,000 gallons of raw sewage were bypassed to the pit. One week later, the pumps were repaired and the sewage was cycled back to the lift station. Some evidence suggests that POL material (hazardous by ignitability criterion) may have been in the sewage diverted to the overflow pit.

Site No. 15 - AGE Drainage Ditch

Site No. 15 is a ditch which parallels Facilities Nos. 191, 192, and 193 and extends from the flightline side of the AGE building (No. 186) to near Argentina Avenue. The ditch was created by settling along the former line of railroad tracks that were removed in the late 1960's. Spilled fuel and oil on the AGE maintenance pad are washed into the ditch during heavy rains. Contamination was observed during the Phase I survey as discolored black soil with a characteristic POL odor along 50 to 75 feet of the ditch bottom.

Site No. 16 - Solvent Disposal Site

Site No. 16 is located in the northeast corner of the base, between Fire Department Training Area No. 1 and Landfill No. 2 (Phase II Stage 1 Sites Nos. 6 and 2, respectively).

During the Phase I Survey, two empty 55-gallon drums labeled "Trichloroethylene" (TCE) were found on the ground opened and positioned such that they would drain into a shallow surround pit. Each drum had rust holes in the top side, suggesting that they had been there for several years. A deteriorating black plastic liner was noted at the edge of the shallow pit. Approximately 4 to 6 inches of soil covered the rest of the liner, which had apparently been installed in the pit to prevent the volatile solvent from percolating into the ground. It is not known whether or not the drums were full at the time of disposal.

Site No. 17 - Entomology Rinse Area

The Entomology Rinse Area is located behind the former site of a pesticide storage building (No. 2160). Rinse water used in the decontamination of pesticide spraying equipment and empty containers drained from the building through a sink that discharges into a small 3' x 3' x 2' open pit in the rear. Building 2160 was abandoned when Building 212 opened 19 October 1983. Building 2160 was demolished 6 September 1984.

Soil and gravel in the base of the pit prevent determination of the nature and condition of the bottom. It is not known whether pesticides that drained into the pit were contained or percolated into the ground. Reportedly, the building and drain had been used since at least 1981, and possibly longer. It is not known how long Building 2160 and drain were in use.

Site No. 19 - MOGAS Spill

On two occasions in the early 1960's, fuel trucks overturned in a ditch along the southwest side of Argentia Avenue, across from the refueling area of Facility No. 379 (Vehicle Maintenance Shop). In each case, the trucks spilled an unknown quantity (estimated to have been between 2000 and 3000 gallons) of MOGAS into the ditch. Reportedly, the only response action taken after both accidents was a wash down of the area by the fire department.

In 1977, the construction of the gymnasium and associated pavements along Argentia Avenue modified the site. Currently, part of the ditch is apparently below pavement, while a portion exists only as a small depression along the roadside. There is no evidence that contaminated soil was detected or removed during construction of the gym and associated pavements.

1.6 Base Water Supply Wells

Cannon AFB presently obtains water supplies from a system of 9 on-base water wells. All Base wells are completed in the Ogallala Aquifer and range from 357 to 415 feet in depth, with yields ranging from 50 to 820 gallons per minute (gpm). The wells incorporate multiple screens deriving water from interbedded sands of the Ogalalla Formation. Table 1-3 shows the general specifications of the Base supply wells. A location map of the Base supply wells is shown in Figure 1-2.

1.7 Sampling and Analytical Program

Radian performed analyses of soil and ground-water samples from the various sites to determine the presence of contaminants. The analyses can be divided into several types, as follows:

- Volatile aromatic compounds (EPA Method 8020 and 602)
- Volatile halocarbon compounds (EPA Method 8010 and 601)
- Oil and Grease (EPA Method 413.2)
- Total Organic Carbon
- Metals
- General Ions
- Pesticides

Parameters detected by each analytical method used are in Table 1-4. Table 1-5 shows the analyses conducted at each site. In addition, each

TABLE 1-3. GENERALIZED SPECIFICATIONS OF CANNON AFB SUPPLY WELLS

Well Numbers	HP[1]/RPM[2]	GPM[3]	Pump Size	Static Level Original (ft.) yr.	Static Level Latest (ft.) yr.	Total Depth (ft.)
1	75/1760	460	10"	250/1942	289/1980	368
2	100/1770	540	8"	297/1977	300/1983	385
3	100/1770	820	8"	287/1978	291/1983	404
4	100/1770	510	8"	288/1978	300/1984	357
5	5	50	4"	273/1977	276/1980	345
6	25	250	6"	217/1964	243/1980	365
7	70/1770	600	6"	270/1967	300/1980	382
8	100/1770	770	6"	282/1969	294/1981	415
9	20	80	6"	241/1972	253/1980	382

HP[1] = horsepower
RPM[2] = revolutions per minute
GPM[3] = gallons per minute

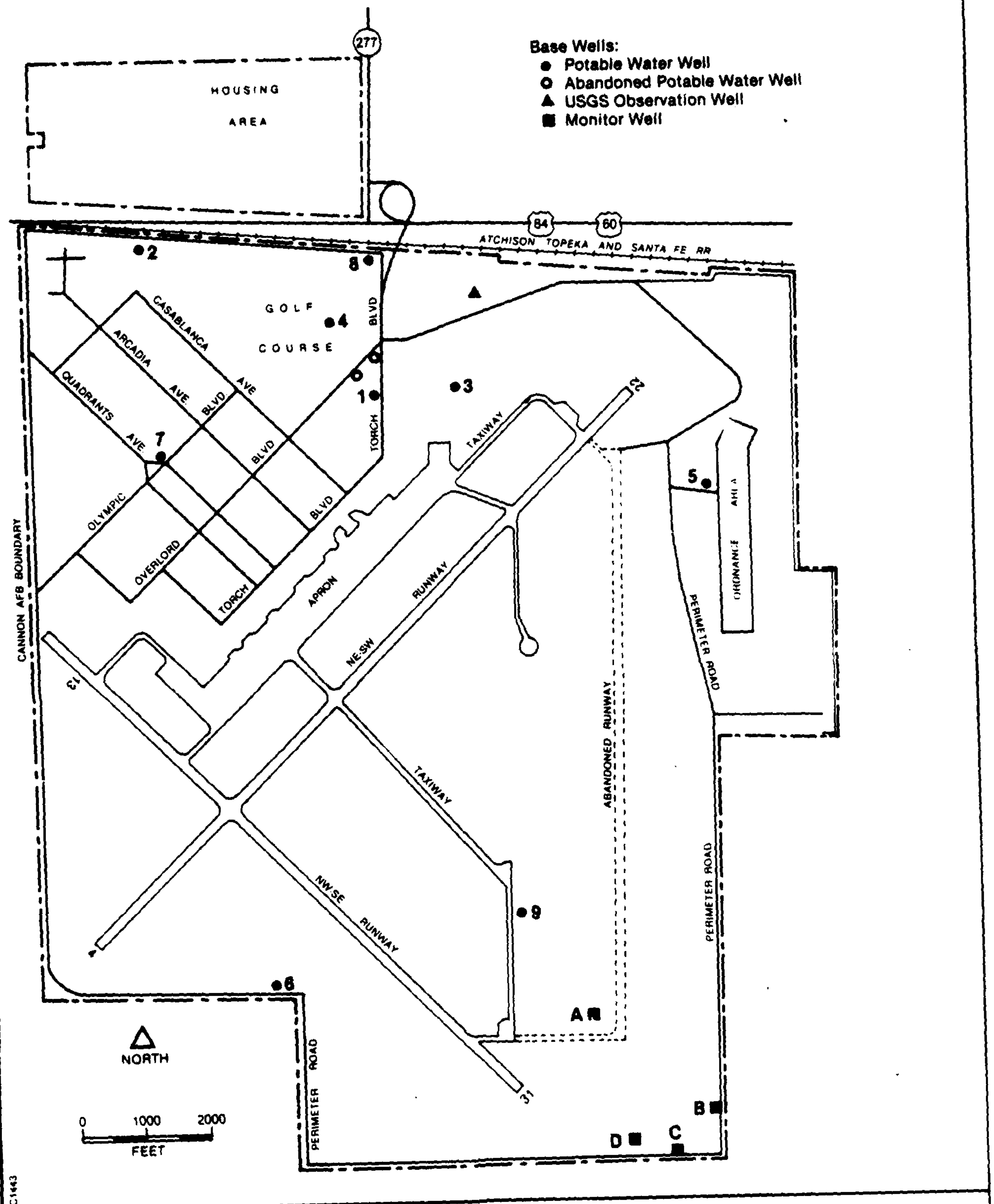

Figure 1-2. Locations of On-Base Water Wells, Cannon AFB, New Mexico

TABLE 1-4. ANALYTICAL PARAMETERS, BY METHOD, FOR SOIL AND WATER SAMPLES CANNON AFB, PHASE II STAGE 1

Purgeable Halcarbons EPA Methods 601 and 8010	Purgeable Aromatics EPA Methods 602 and 8020
Bromodichloromethane	Benzene
Bromoform	Chlorobenzene
Bromethane	1,2-Dichlorobenzene
Carbon tetrachloride	1,3-Dichlorobenzene
Chlorobenzene	1,4-Dichlorobenzene
Chloroethane	Ethylbenzene
2-Chloroethyl vinyl ether	Toluene
Chloroform	
Chloromethane	
Dibromochloromethane	Oil and Grease
1-2-Dichlorobenzene	EPA Method 413.2
1,3-Dichlorobenzene	
1,4-Dichlorobenzene	IR Method using freon-
Dichlorodifluoromethane*	extraction.
1,1-Dichloroethane	note: oil and grease as
1,2-Dichloroethane	reported, may include
1,1-Dichloroethene	variable amounts of
trans-1,2-Dichloroethene	natural freon-extractable
1,2-Dichloropropane	organics in addition to
cis-1,3-Dichloropropene	hydrocarbons. Data should
trans-1,3-Dichloropropene	be interpreted with caution,
Methylene chloride	as this method is a screen-
1,1,2,2-Tetrachloroethane	ing technique only.
Tetrachloroethene	
1,1,1-Trichloroethane	
1,1,2-Trichloroethane	
Trichloroethene	
Trichlorofluoromethane	
Vinyl chloride	

(Continued)

*Dichlorodifluoromethane coelutes with vinyl chloride and is not quantified separately. Such quantification would require addition of charcoal to the instrument trap and would interfere with the vinyl chloride analysis. All vinyl chloride concentrations greater than 1.0 ug/L are confirmed with a second column.

TABLE 1-4. ANALYTICAL PARAMETERS, BY METHOD, FOR SOIL AND WATER SAMPLES CANNON AFB, PHASE II STAGE 1 (Continued)

Metals	Method	General Ions	Method
Arsenic	EPA 206.2 or 206.3	Calcium	EPA Method 200.7
Barium	EPA 208.2	Magnesium	EPA Method 200.7
Cadmium	EPA 213.2	Sodium	EPA Method 200.7
Copper	EPA 220.1	Potassium	EPA Method 200.7
Chromium	EPA 218.1	Mangenese	EPA Method 200.7
Iron total	EPA 236.1	Chloride	EPA Method 325.2
Lead	EPA 239.2	Sulfate	EPA Method 375.3
Manganese	EPA 243.1	Phosphate (Total)	EPA Method 365.4
Mercury	EPA 245.1 and 245.5 (soils)	Nitrate (AS-N)	EPA Method 353.1
Nickel	EPA 249.1		
Selenium	EPA 270.3		
Silver	EPA 272.2	**General Water Quality**	
Zinc	EPA 289.1		
		pH	
		Total Dissolved Soilds	
		Conductivity	

Parameter	Method
Aldrin	Standard Method 509 A
DDT isomer	Standard Method 509 A
Dieldrin	Standard Method 509 A
Endrin	Standard Method 509 A
Heptachlor	Standard Method 509 A
Heptachlor epoxide	Standard Method 509 A
Lindane	Standard Method 509 A
Methoxychlor	Standard Method 509 A
Diazinon	Standard Method 509 A
Malathion	Standard Method 509 A
Parathion	Standard Method 509 A
Toxaphene	Standard Method 509 A
2,4-D	Standard Method 509 B
2,4,5-T	Standard Method 509 B
2,4,5-TP (silvex)	Standard Method 509 B

TABLE 1-5. ANALYTICAL SCHEDULE, CANNON AFB IRP PHASE II STAGE 1

SITES	OIL & GREASE	PURGEABLE ORGANICS (METH. 601,602)	LEAD	TOX	PESTICIDES	METALS	GENERAL IONS	GENERAL WATER QUALITY
9	S	S	S	-	-	-	W	W
5	-	W	W	W	-	W	-	-
15	S	S	S	-	-	-	-	-
6	S	S	S	-	-	-	-	-
11	S	S	S	-	-	-	-	-
4	S	S	S	-	-	S	-	-
1	S	S	S	-	-	S	-	-
3	S	S	S	-	-	S	-	-
2	S	S	S	-	-	S	-	-
19	S	-	S	-	-	-	-	-
17	-	-	-	-	S	S	-	-
7	S	S	S	-	-	-	-	-
8	S	S	S	-	-	-	-	-
12	S	S	S	-	-	S	-	-
13	S	S	S	-	-	S	-	-

W = Water; S = Soil

monitor well was tested for field conductivity (C), pH, depth to water, and temperature.

1.8 Investigative Personnel

Radian Corporation provided professional and experienced personnel to supervise the drilling operations and accomplish the soil and monitor well sampling. An experienced and qualified company (Jim Winnek) was selected as the drilling subcontractor. Key project personnel and their responsibilities are summarized in Table 1-6. Complete resumes are provided in Appendix E.

TABLE 1-6. PROJECT PERSONNEL FOR CANNON AFB PHASE II, STAGE I

Name	Degree	Years Experience	Responsibilities
T. W. Grimshaw	Ph.D.	12	Program Manager
T. K. Walters	B.S.	5	Project Director
W. L. Boettner	B.A.	11	Supervisory Geologist
D. L. Richmann	M.A.	10	Supervisory Geologist

2.0 ENVIRONMENTAL SETTING

The discussion of the Cannon AFB environmental setting was principally derived from the Installation Restoration Program Phase I Records Search report (CH2M Hill, 1983). Information developed from that report is supplemented by the literature and the general findings of this study. The following sections describe the environmental setting of Cannon AFB. Basic features and history of the sites investigated in this study are also discussed here.

2.1 General Geographic Setting and Land Use

Cannon AFB is located about 7 miles west of Clovis, (Curry County) New Mexico in the Southern High Plains section of the Great Plains physiographic province (Figure 2-1). The major land use in this part of Northeastern New Mexico is ranching and agriculture. The land surrounding Cannon AFB consists of irrigated crops and pasture land used in the cattle ranching and dairy business.

2.1.1 General Setting and Physical Geography

The Southern High Plains consist of an isolated plateau composed of Cretaceous, Tertiary, Pleistocene, and Holocene age sediments. The regional slope of the Southern High Plains is about 6 to 10 feet per mile and the area around Cannon AFB slopes about 10 to 15 feet per mile. Most of the plateau consists of sands, clays and gravels deposited by flowing water. All of these units comprise the Ogallala Formation. There are also minor amounts of wind blown and lake bottom sediments present. The surface of the plateau is formed by a resistant "caprock" of Pliocene age caliche. The caliche is composed of calcium carbonate and is a soil weathering product. The caliche is overlain in most places by Pleistocene age sands and thin, fine-grained lake deposits (Reeves, 1970).

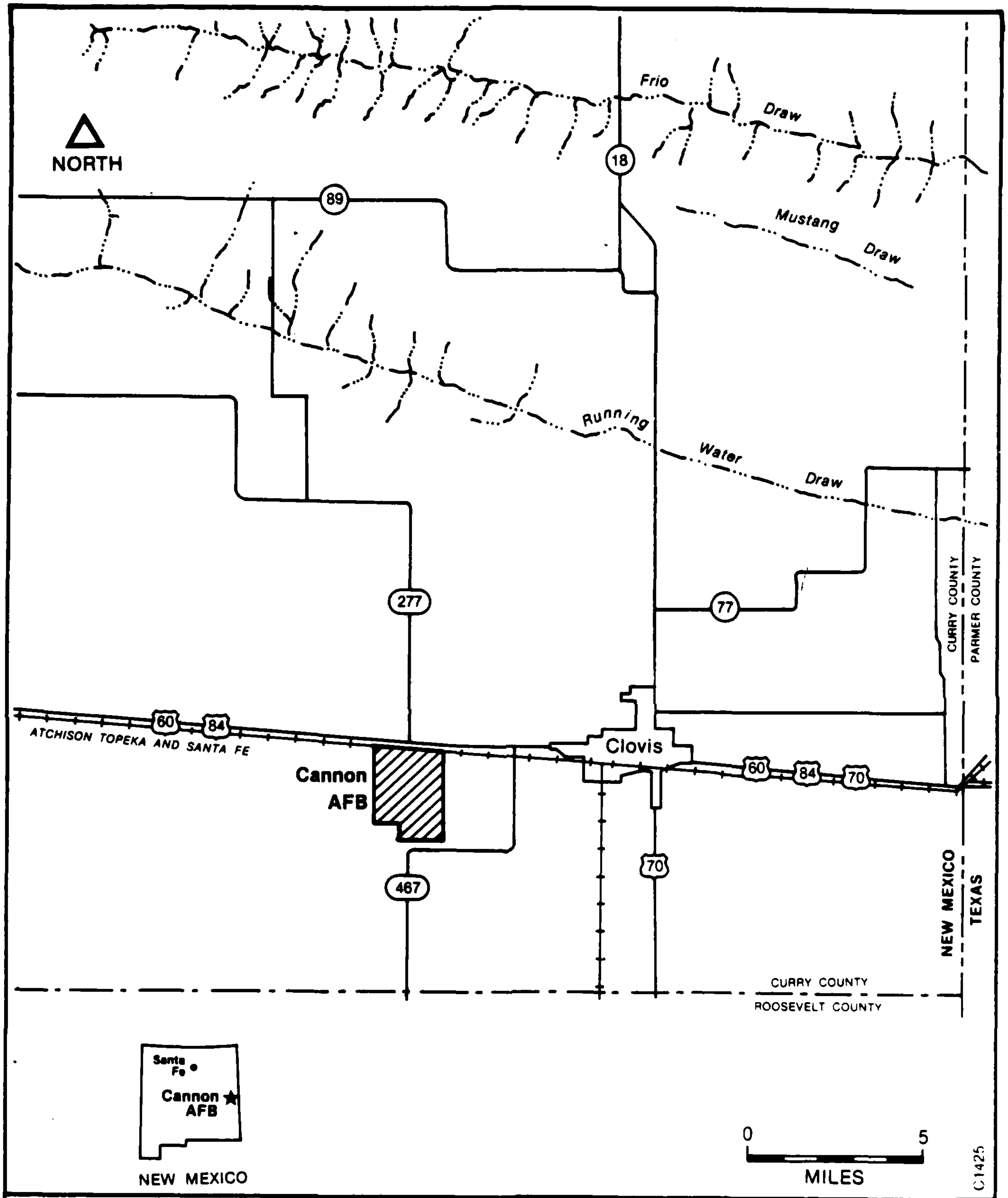

Figure 2-1. Location of Cannon AFB, New Mexico

The Southern High Plains are bounded on the north by the Canadian River which lies 60 miles to the north of Clovis. The eastern and western sides of the Southern High Plains are bounded by escarpments which rise as much as 300 feet above the surrounding area (CH2M Hill, 1983). Cannon AFB is located near the center of this plateau where the topography is typified by flat, featureless terrain having almost no relief. The High Plains surface is composed of flat, gently sloping surfaces that surround major drainage features and playa lakes. The land surface elevations at Cannon AFB range from 4,327 feet above mean sea level (MSL) at the northwest corner of the Base to about 4,260 feet above mean seal level at the southeast corner (CH2M Hill, 1983). The land surface of the Base generally slopes to the east and southeast, consistent with the regional slope. The dominant surface features in the area around Cannon AFB are small internally drained temporary lake basins known as playas. A large example of these temporary lakes is located on Cannon AFB and is known as Playa Lake. Playa Lake is used as a holding basin for treated effluent from the Base sewage treatment lagoons. Another large playa lake located near the intersection of the primary and the northwest-southeast runways is used as a stormwater retention pond.

Regional drainage in Curry County is predominantly to the southeast and the east. Stream drainage is poorly developed because of the low annual rainfall and the minimal relief. The drainage patterns consist of long shallow valleys, locally termed draws, that extend almost from the western edge of the Southern High Plains to the eastern boundary of the plateau. The valleys or draws eventually drain into one of three major river valleys; the Red, the Brazos or the Colorado. Although the draws extend to the river valleys as drainage systems, they seldom contribute actual flow to the rivers except during periods of unusually high rainfall. The bulk of the precipitation is lost to evapotranspiration and shallow infiltration before it has a chance to run off. In areas not drained by the draws, the playa lakes serve as low point collection areas for surface runoff. The playas have no surface outlet and any water that collects in the lakes is eventually lost to evapotranspiration or infiltration.

2.1.2 Geomorphology

The stream drainage in the area around Cannon AFB is very poorly developed and stream dissection is very light (Cronin, 1969). The stream valleys that do exist are long shallow valleys with little or no lateral drainage systems. The valleys are aligned with the slope of the land surface and occur at widely spaced intervals. The two major drainages in the Cannon AFB area are the Running Water Draw and the Frio Draw northeast of the base. The streams that occupy the valleys are intermittent streams that flow for only a short time after rainfall before the water is lost to infiltration and evapotranspiration. Runoff is generally channeled to the southeast away from the western escarpment of the High Plains along the regional slope.

2.1.3 Surficial Soils

The most common soil association at Cannon AFB is the Amarillo series as described in the Phase I report by CH2M Hill (1983). This soil type is derived from stream erosion coupled with extensive reworking of the sediments by wind action. The soil generally consists of a loamy sand overlying a hard calcium carbonate-enriched layer known as caliche. The caliche consists of friable to well indurated calcium carbonate-rich layers. The total thickness of the caliche layers varies from a few feet to more than 50 feet. The caliche probably began to form at the end of the period of deposition of the Ogallala Formation and continues to the present time (Brown, 1956). The U.S. Department of Agriculture Soil Conservation Service lists the Amarillo soils as being the most extensive soil group in Curry County. They formed on the medium to moderately coarse textured calcareous materials, most probably alluvium reworked by wind. The Amarillo soils have well developed profiles which are deeper over the calcium carbonate horizons. They frequently develop a stronger structure in the B Horizon than the other soil groups present in the area around Cannon AFB. The Amarillo soils in the area of Cannon AFB consists of three types. The Amarillo Loam, Amarillo Fine Sandy Loam and the Amarillo Loamy Fine Sand all overlie a white chalky zone of caliche that occurs at depths of three to six feet below the surface. The Phase II soil sampling program indicated that the caliche zone most often occurs at about four feet below the surface at Cannon AFB. The various soils within the Amarillo series exhibit different colors at the surface. The Amarillo Loam is brown to red brown, the Amarillo Loamy Sand and the Sandy Loam are brown to yellowish red. The subsoil colors are dark reddish brown in some areas of the Loam to yellowish red in the Loamy Sands and Sandy Loams.

There are several other soil associations at Cannon AFB which are not as extensive or important as the Amarillo series. These soils are commonly found near the playas and draws. The Clovis soils occur in small areas within the broader areas of the Amarillo soils. They usually occupy the upper margins of draws and playas. The Clovis soils are similar to the Amarillo soils but have a shallower caliche zone (16 to 36 inches) and often have a poorly developed soil profile. The Clovis soils consist of three types of soil: the Clovis Loam, the Clovis Fine Sandy Loam, and the Clovis Loamy Fine Sand (CH2M Hill, 1983). Two other soil groups are present in very limited areas at Cannon. The Mansker soils are strongly calcareous and occupy the slopes of draws and playas. The Mansker soils form where the higher horizons have been removed by erosion. The Potter soils are shallow and very calcareous soils which overlie hard, consolidated caliche (USADA-SCS, 1958). The areal distribution of these soils is shown in Figure 2-2.

2.2 Geology

Cannon AFB is underlain by a thick package of unconsolidated gravel, sand, silts, clay and caliche which may extend to 400 feet below land surface. In areas where the sediments are saturated they form part of the High Plains Aquifer (Ogallala Aquifer). The base of the aquifer is considered to be the dominantly sandstone beds of the Triassic age Dockum Group. These beds are referred to as the "Red Beds" because their usual color is red to reddish brown. The Triassic age sediments are the deepest beds penetrated by wells in the Cannon AFB area. Generalized descriptions of the lithologies of the units

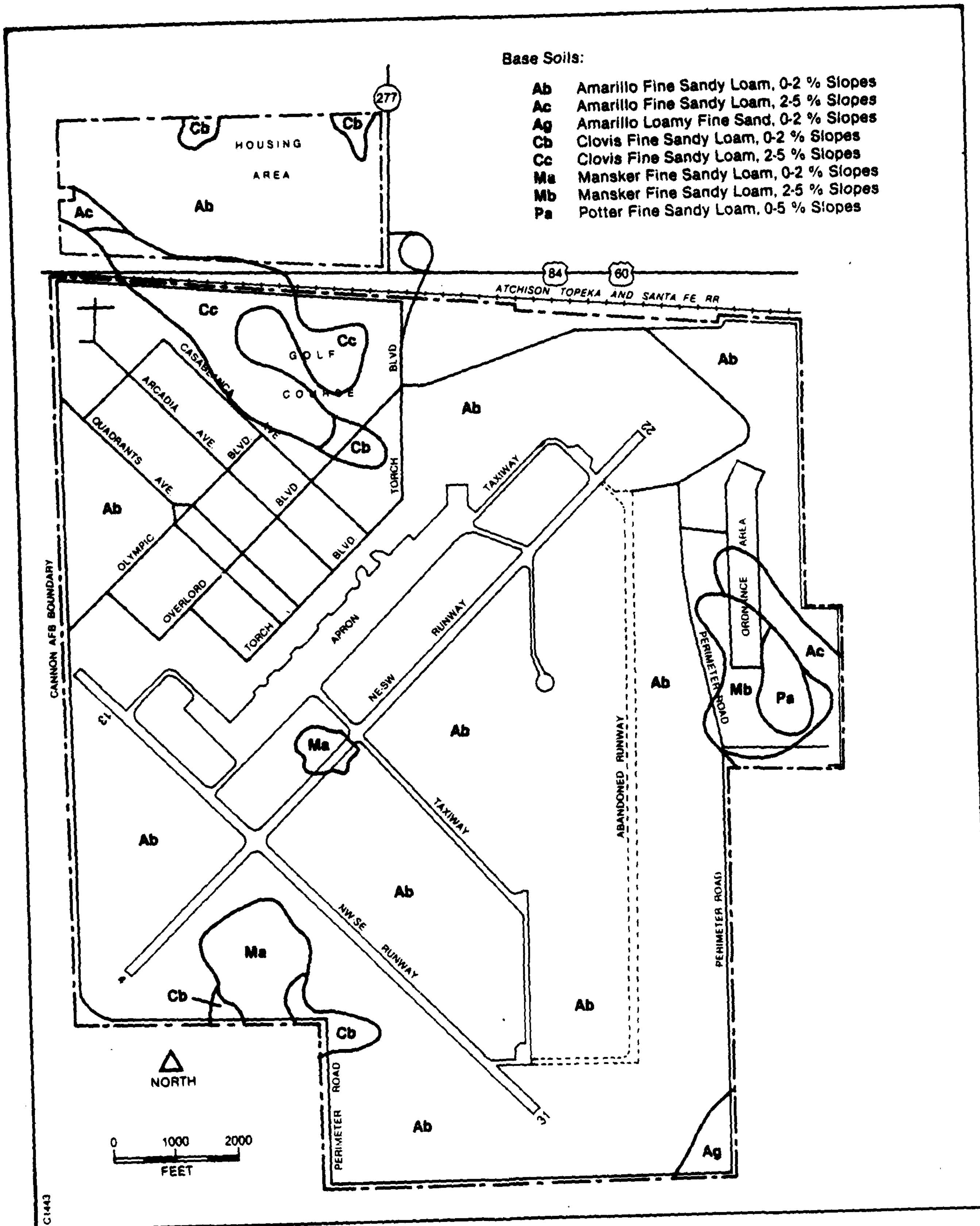

Figure 2-2. Distribution of Soils, by Type, Cannon AFB, New Mexico (from CH_2M-Hill, 1985)

underlying Cannon AFB are provided in Table 2-1. The areal distribution of these geologic units is shown in Figure 2-3, and a schematic vertical profile, showing the typical geologic column at Cannon AFB is provided in Figure 2-4. The sediments that compose the Dockum Group represent clastic deposits that range in composition from mudstone to conglomerate. These Triassic beds were deposited between 138 and 240 million years ago and were later eroded, establishing a base upon which the overlying unconsolidated sediments were deposited. The erosional surface that formed on the Triassic age Dockum Group sediments represented extensively dissected plains. Stream valleys and river channels developed as the erosion continued. The erosional processes created a highly irregular surface upon which the younger sediments were later deposited. The variability of this surface and the relationship of the younger sediments occurring in the abandoned valleys plays an important role in the hydrogeology of the High Plains Aquifer.

Overlying the Dockum Group, is the Ogallala Formation, which was deposited from the late Miocene into the Pliocene, or from about 10 million years ago to about 2 million years ago. The Ogallala Formation formed primarily as a product of many large and small streams that flowed to the east and southeast from the rising mountains to the west. During and after deposition, the sediments were extensively reworked by wind action. Periodically the sediment deposition was interrupted and soil formation processes took over. The alternating patterns of deposition and erosion created the characteristic hard cemented layers that occur in the Cannon AFB area subsurface deposits. The thickness of the Ogallala deposition was controlled mostly by the irregular pre-Ogallala erosion surface. The thickest packages of the Ogallala sediments accumulated along the axes of the stream valleys. These stream valleys were oriented in a northwest to southeast direction which corresponds to the present day regional gradient for the Ogallala aquifer in the Southern High Plains. The Ogallala fluvial systems deposited sediments into collapse basins formed in the Triassic age rocks as well as existing stream valleys (Seni, 1980). As the fluvial systems moved across the plains and periodically overflowed, areas on the flanks of the valleys received thinner and finer grained sediments. The texture of the Ogallala Formation ranges from coarse gravel

TABLE 2-1. GENERALIZED DESCRIPTION OF GEOLOGIC UNITS OCCURRING AT CANNON AFB, NEW MEXICO

SYSTEMS	SERIES	GEOLOGIC UNIT	THICKNESS IN FEET	PHYSICAL CHARACTER
Quaternary	Pleistocene	Blackwater Draw Formation	0 to 25	Stream-laid deposits of silt and sand, thinly bedded playa lake sediments, silt with lesser amounts of very fine sand and clay deposited as wind blown dust
Tertiary	Miocene-Pliocene	Ogallala Formation	50 to 400	Sand, silt, clay, gravel and caliche; sand, fine to coarse grained quartz, silty in part, caliche nodules locally, cemented locally by calcite and silica
Triassic	Upper Triassic	Dockum Group	200 to 2000	Shale, siltstone and sandstone, predominantly red sandstone in upper section

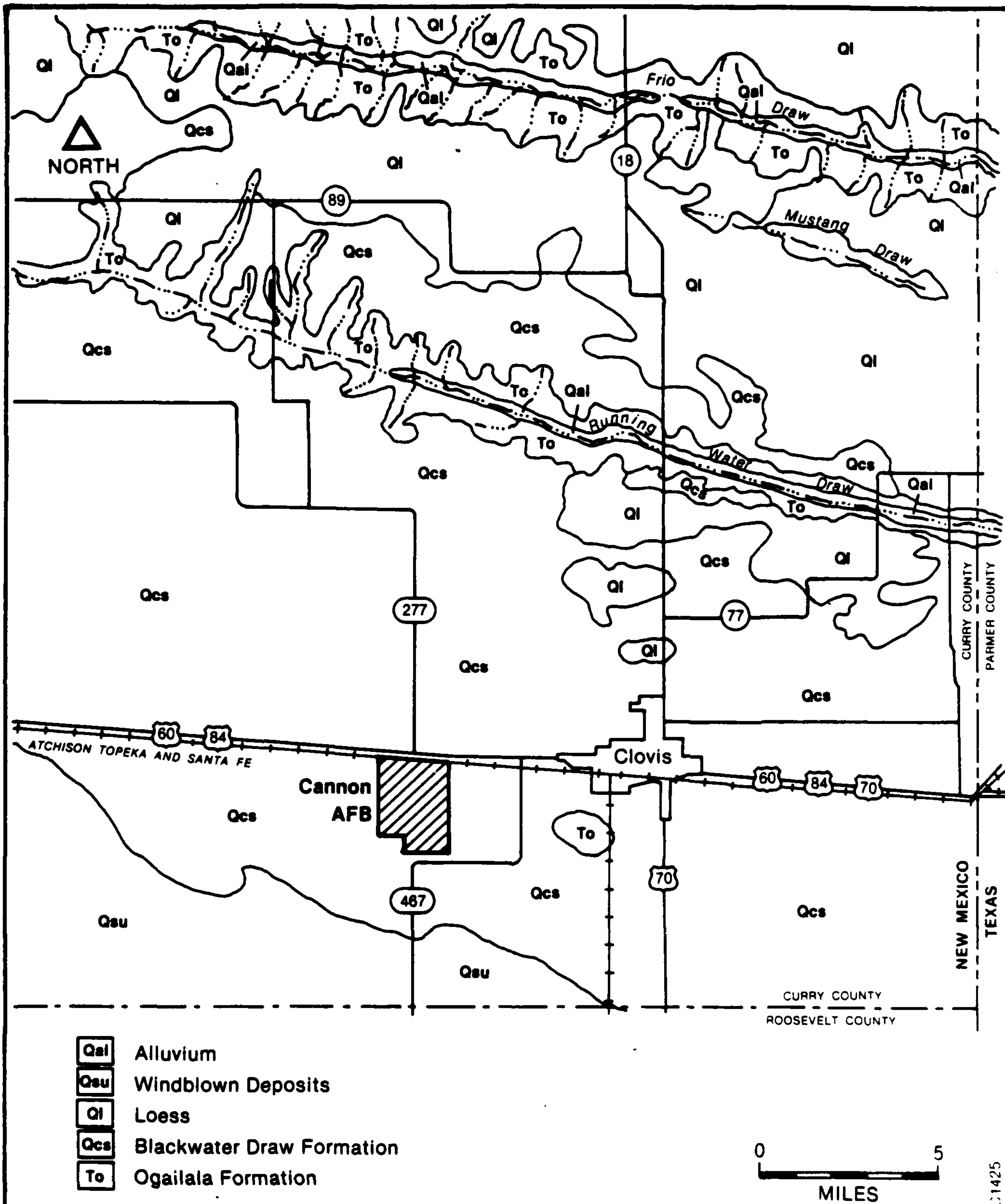

Figure 2-3. Geology of Cannon AFB, New Mexico

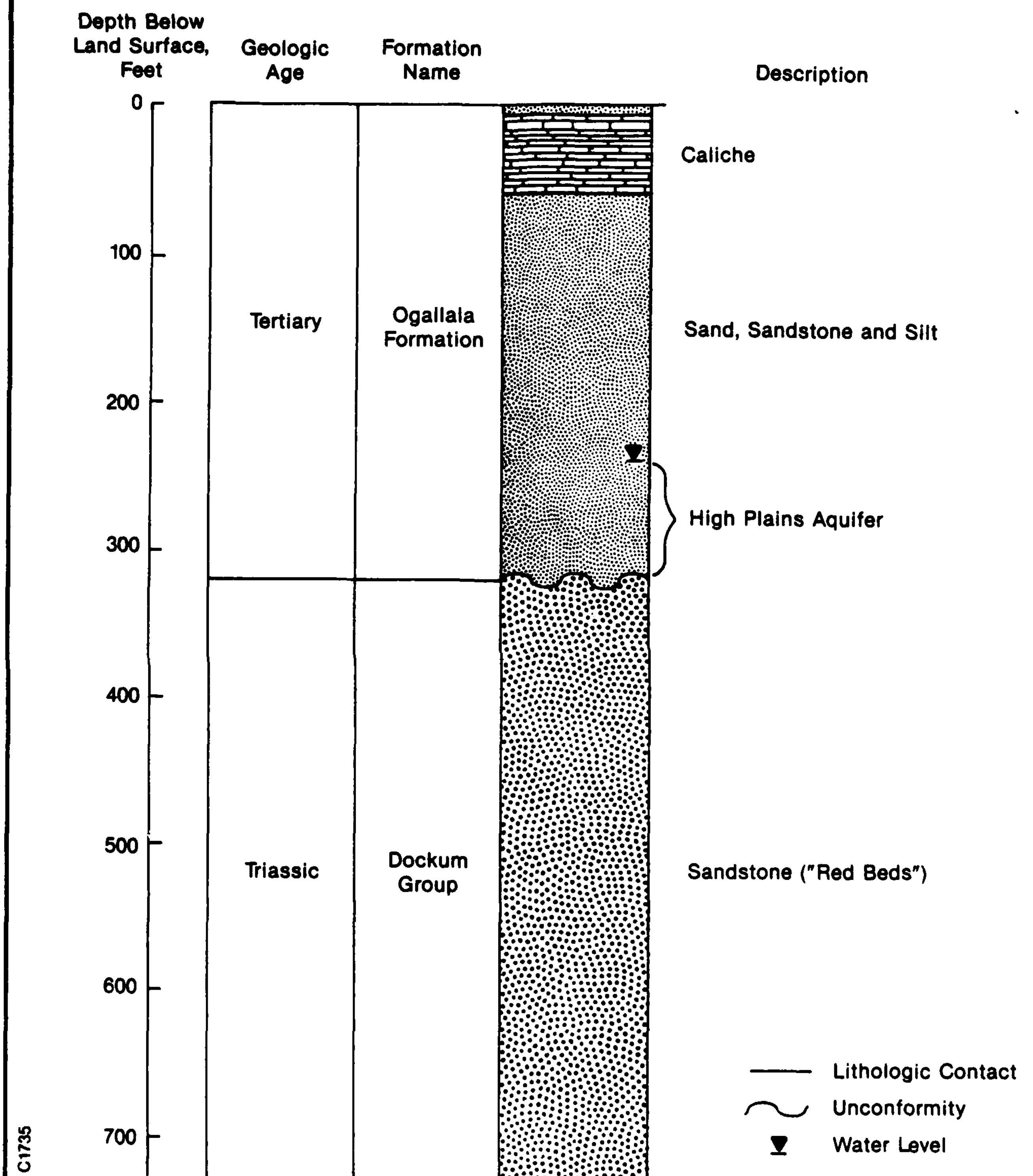

Figure 2-4. Generalized Geologic Column of Cannon AFB, New Mexico

and sand through sand and silt to marl and clay. It may be loose and friable to compact and locally cemented with calcium carbonate cement and silica (Seni, 1980). The thickness varies from very thin (less than a few feet) to more than 500 feet. The Ogallala Formation thins to the south and southeast in the direction of the regional gradient. The color of the formation may vary from white to light gray to tan, olive gray and red brown.

2.3 Hydrogeology

The hydrogeologic properties of the Ogallala aquifer are controlled by three major factors. These are the pre-Ogallala depositional topography, the alignment of the infilled former stream valleys, and the hydrologic barriers, particularly the buried soils that occur in the top half of the formation. The buried soils that exert the most control are the caliche horizons which limit the amount of recharge that may enter the aquifer.

2.3.1 Recharge

The major source of recharge to the Ogallala Formation in the Southern High Plains area is precipitation that falls on the land surface. The Ogallala Formation is isolated hydrologically by the boundary escarpments that lie to the east, west and southwest. The Canadian River valley acts to isolate the Ogallala aquifer to the north in the Southern High Plains. The hydrologic boundaries serve to restrict any inflow from subsurface sources and effectively limit the recharge to only precipitation falling on the land surface. The amount and rate of recharge to the aquifer depends upon the amount, distribution and intensity of rainfall over the area of the Southern High Plains.

The amount of surface recharge to the aquifer is quite low because of the low annual rainfall and the high rates of evapotranspiration. The surface recharge has been estimated to be between 0.8 and 0.10 inch per year over the entire extent of the Southern High Plains (Cronin, 1969).

2.3.2 Discharge

The ground water stored in the Ogallala aquifer is discharged by both natural and artificial means. The natural discharge of the Ogallala aquifer consists of springs and seeps that occur along the boundary escarpments and along the margins of the larger playa lakes (Cronin, 1969). Discharge also occurs through subsurface flow out of the area along the southern boundary of the plateau that makes up the Southern High Plains (Luckey, et.al, 1981).

The major artificial discharge from the aquifer consists of ground-water pumpage for private, municipal and agricultural supply. Many wells penetrate the aquifer in the area of the Southern High Plains and provide the largest demand on the ground-water system.

The amount of recharge to the Ogallala aquifer represents only a small portion of the withdrawals so that the system is a net losing system in the area of the Southern High Plains. Water level declines have occurred in wells that have been extensively pumped.

2.3.3 Well Yields

The well yields from the Ogallala aquifer in the area of the Southern High Plains are reported to yield from less than 100 gallons per minute to more than 1,000 gallons per minute (Cronin, 1969). The yields are the greatest in the areas where the thickness of saturated sediments is the greatest. The saturated thickness of the Ogallala aquifer in the Cannon AFB area ranges from less than 50 feet to as much as 150 feet and is controlled by the geometry of the pre-Ogallala sediments (ibid.). In the areas where there are buried stream valleys the thickness of the sediment package is greatly increased creating the greatest saturated thickness.

The value for the specific yield, the percentage of the water that is stored in the aquifer that may be released to wells, is given by Cronin (1969) as about 15 percent. This restricts the amount of water that may be pumped from the aquifer to only a percentage of the total water that may occur in the aquifer. Well yields at Cannon AFB average about 2 million gallons per day from nine wells that are on-base.

2.3.4 Water Levels

The depth to water in the part of Curry County where Cannon AFB area is greater than 300 feet. Four observation wells were drilled during the Phase II investigation which encountered water below 300 feet. The aquifer beneath Cannon AFB behaves as a semi-confined aquifer. Once water is encountered, it will rise in the well to about 250 feet, which is about 90 feet higher than the depth at which the water bearing zone is first penetrated.

2.3.5 Rate and Direction of Ground-Water Movement

The rate at which the ground water will move is controlled by the gradient of the water table and the permeability of the sediments. In the Cannon AFB area the ground water is reported to move at about 150 feet per year (Cronin, 1969). The direction of the gradient of the water table is to the east and southeast. This is the usual direction of ground water flow except where the flow is redirected by extensive withdrawals from irrigation wells in the vicinity.

3.0 FIELD PROGRAM

The field program at Cannon AFB included installation of ground-water monitoring wells in the Ogallala Aquifer using mud rotary drilling techniques; hollow-stem auger drilling of deep (approximately 60 feet) reconnaissance boreholes through the caliche caprock; and hand-augering of shallow (less than 10 feet) soil borings. Soil and ground-water samples were collected for chemical analysis, as specified in the Scope-of-Work (Appendix C). In addition, static water level measurements were taken at the newly installed monitor wells and at two existing base wells to evaluate local ground-water conditions and flow directions.

The number of monitor wells, deep, and shallow borings at each project site was specified in the Scope-of-Work. Less than the required number of samples were taken due to field conditions. The maximum drilled footage limits were adhered to. Descriptions of field techniques are provided in Section 3.1. Field activities and periods of performance at individual Phase II Stage 1 sites are presented in Section 3.2. Computer printouts, detailing analytical results, dates of collection and receipt by Radian Analytical Services (RAS), etc. are provided in Appendix A.

3.1 Field Techniques

The following paragraphs contain descriptions of the various field techniques used in the Cannon AFB Phase II Stage 1 investigation. These techniques included mud rotary drilling for monitor well installation, deep soil borings using a hollow-stem auger, shallow augering and ground-water sampling.

3.1.1 Drilling Techniques

Drilling of the four monitor wells at Cannon AFB was accomplished using the air and mud-rotary methods with a Failing 1500 truck mounted rig. Mud rotary methods were used to lift the drill cuttings from the borehole at depths of 100 feet or more. An 8 inch tricone bit was used to drill the borehole to a depth of about 15 feet below the saturated zone of the Ogallala Formation. Bentonite mud and a non-toxic, biodegradeable gel (Vari-flow brand) were used to stabilize the walls of the bore-hole and to allow circulation and lift of cuttings from the bottom of the borehole to land surface where they were discharged. Water encountered during drilling was noted with respect to depth of occurrence and rate of production. When formation water was suspected, the drilling was halted temporarily to check the static water level in the borehole. The driller was instructed to switch to air circulation to purge the borehole of all fluids introduced in the drilling process. After all fluids had been removed, the borehole was left open for several hours to allow time for the static water level to recover in the drilled portion of the borehole. These tests were conducted from 300 feet below land surface to the final depth of the borehole to accurately determine the depth to the top of the Ogallala Aquifer.

The deep soil borings were drilled using a Mobil drill B-61 hollow-stem auger with 60 feet of 6-1/2" OD flight augers. Site access and utility clearances for each site were provided by base personnel. Final augering locations were determined by Radian. Although the maximum depth anticipated was 60 feet for each boring the final depth was determined by the supervising Radian geologist in the field. Each soil boring was drilled using the hollow stem auger and samples were obtained at the top of the local caliche layer, five feet into the caliche, and at the final depth, anticipated to be 60 feet. Each sample was obtained using a split-spoon sampler with a sleeve (ASTM D-3550) or by a 3 inch OD Shelby tube (ASTM D-1587). No drilling fluids were allowed during drilling or sampling. After each sample was retrieved, the sample was sealed and shipped to Radian Analytical Services for analyses. Cuttings (non-hazardous) were temporarily placed into 55 gallon barrels for transportation by base personnel to a proper disposal area. Lithologic logs were kept of each boring and soil samples collected every 5 feet (Appendix E). Ambient air quality was continuously monitored with an organic vapor analyzer (OVA) during drilling operations and cuttings were screened with the OVA. However, no positive responses were noted. The general procedures for soil boring and abandonment were as follows:

- hollow-stem auger 6-1/2 inch -- test holes to a depth of approximately 60 feet;

- split-spoon samples of soil materials were taken above the top of the caliche; 5 feet into the caliche and just below the caliche at about 60 feet;

- after reaching total depth, the soil boring was sealed to land surface using cement as prescribed for the monitor wells. Grout (Type 1) was poured from land surface once the hollow-stem augers were withdrawn.

Two sites were drilled using a portable hand-held auger with 2 inch OD auger flights. Surficial soil samples were taken from one to five feet (top of caliche) maximum using the portable auger and saved for analyses at Radian. The shallow boreholes were backfilled with cuttings once completed.

3.1.2 Monitor Well Installation

Ground-water monitor wells were installed immediately upon completion of the drilling operations. Usually, the borehole was observed for a period of time, as necessary, to determine the approximate static water level. Monitor well construction specifications, summarized in Table 3-1, were consistent with the specifications provided in the Scope-of-Work. Appropriate changes in the final well depth were made on a site-by-site basis. Decisions regarding the setting of screen and casing, were made on the basis of the hydrogeology of the formation. If appropriate, the borehole was allowed to remain open overnight; there were no difficulties related to the integrity of the borehole or caving problems.

Monitor well installation followed a similar procedure at each well. Screen and casing sections were cleaned and assembled on the ground then lowered carefully into the borehole. As the string of screen and casing were

TABLE 3-1. MONITOR WELL CONSTRUCTION SPECIFICATIONS

- Casing: four-inch diameter, flush joint, threaded schedule 80 PVC, plugged at bottom with a permanent plug.
- Screen: four-inch diameter, flush joint, schedule 80 PVC, 0.010-inch mill slot, screen length = 15 feet.
- Sand Pack: 8-40 mesh silica, tremmied from bottom of hole to one foot above top of screen.
- Bentonite Seal: No. 50 Volclay brand bentonite tablets, to two feet above top of sand pack.
- Grout: neat cement (Type I Portland cement) grout tremmied from the top of the bentonite seal to the land surface.
- After each well was installed, it was developed for several hours by air development methods. Water was discharged by this process until the well produced no more fine material when surged and backwashed.
- Cuttings from well drilling activities were contained in 10' x 10' x 8' mud pits and covered. No hazardous or toxic forming materials were disposed of in the mud pits.
- All drill pipe and equipment was steam cleaned (under high pressure) before mobilizing to the next monitor well location.
- Surface Completion: The PVC casing was cut off to provide a two foot stick-up. A protective 5' steel guard pipe 6 inches in diameter with a locking cap was set in a 24" x 24" x 4" concrete pad over the PVC stickup. Each pipe extended about three feet above land surface.
- Guard Posts: Three 3" diameter steel posts 6' in length with a minimum of 2 feet below ground, were emplaced radially 4 feet from the well head, and set in concrete. The guard posts consisted of 2 sections of pipe, fitted together at land surface by keyed-alike locks, for easy removal for well and pump access.
- Pumps: each well was equipped with a submersible pumping apparatus, consisting of a Standard 1/2 HP pump (Model 20X4P 050 - 2.W. Type 20X4P). Each well pump contained a 600-TAX5 motor starter with a P-36-overload and lightning arrestor. Accessory items installed with pumps included a brass check valve, 1" schedule 80 threaded drop pipe, 12 x 2-2 conduction pump wire, 1/8" stainless steel safety cable, 1" stainless steel worm clamps, a three-prong electric plug, 1/4" cable clamps, #10 wire terminals 1 x 3/4" galvanized bushings, and a 3/4" brass hose connector.
- After all wells were in place, each was sampled for the chemical analyses specified in the Scope of Work.

lowered, additional sections of casing were added until the bottom of the screen reached the total depth of the borehole. Normally, enough casing was attached so as to leave a 2 foot stick-up at the ground surface. Clean, coarse sand was carefully tremmied down the annular space until the level of the top of the gravel pack was at least 2 feet above the top of the screen, as directed by the supervising geologist. (See individual well completion logs in Appendix E). Bentonite pellets (Volclay) were added to form a 2-foot thick seal above the saturated zone. Neat cement (Type I) grout was then prepared and tremmied from the top of the bentonite seal to the land surface. The grout was allowed to cure for at least 24 hours prior to well development.

As the borehole advanced, grab samples were taken of the cuttings at five-foot intervals or whenever a change in lithology occurred. Drilling conditions, such as relative rate and ease of penetration, were noted by the driller.

Selection of the screened interval in the monitor wells was governed in part by assessment of the likely zones of contaminant migration. In general, the uppermost occurrences of ground water are considered most likely to show the effects of contaminant infiltration from near surface sources. The method of introduction of contaminants is by dissolved constituents moving with downward migrating infiltration. Once these contaminants reach the ground-water body they are entrained in the flow and move with it. So long as no density effects operate, there will be no tendency for contaminants to plunge or sink in the ground-water system. Common causative agents of density effects, including concentrated brines or nearly pure streams of industrial chemicals denser than water (such as TCE) do not exist at Cannon AFB, so this phenomenon may safely be ignored.

Well Development

Development was done by the utilization of a single pipe air pumping system using the casing itself as the eductor line. The compressors, air lines, hoses, fittings, etc. were of adequate size to pump the well by the air lift principle at 1 1/2 to 2 times the design capacity of the well. The driller initially pumped the well with air until the well was developed to the point that it yielded clear, sand-free water. The driller then shut off the air and allowed water in the well to return to a near-static level. The driller reopened the valve and reintroduced air into the well then closed the air valve to allow water to drop back to a static condition. He repeated this lifting and dropping of the column of water until the water in the well became turbid. At this time, the well was continuously pumped with air until it again yielded clear sand-free water. The driller repeated the above operations until the well no longer produced fine material when surged and backwashed.

The bottom of the air line was placed at different levels in order to facilitate development of all intake areas along the screen length. The process was repeated until the well yielded water free of turbidity when surged and backwashed.

All down-hole equipment used during the purging of the monitor wells was carefully washed with a high pressure steam rinse to prevent cross-contamination.

Table 3-2 summarizes the elevations and depths of the monitor wells installed at Site No. 5 (Landfill No. 5). Water level elevations are presented in Appendix F.

TABLE 3-2. SPECIFICATIONS FOR LANDFILL NO. 5 MONITOR WELLS

Monitor Well	Measuring Point Elevation[1]	Measuring Height	Point Ground Level Elevation[2]	Screened Interval[3]	Screened Elevation[4]	Total Depth (ft.)
A	4,267.46	2.35	4,265.11	343 - 328	3922.11-393.11	343.00
B	4,266.04	2.80	4,263.24	362.3 - 347.3	3900.94-3915.94	362.3
C	4,267.90	2.96	4,264.94	362 - 347	3902.94-3917.94	362.0
D	4,265.90	2.67	4,263.23	356.75 - 341.75	3906.48-3921.48	356.75

[1] Top of protective guard post. Mean sea level elevations determined by Pettigrew and Associates, licensed surveyors.

[2] Ground level elevation above mean sea level taken from brass cap nearest to Well A

[3] Feet below ground level

[4] Feet MSL

3.1.3 Sampling Procedures

During Phase II Stage 1 field activities at Cannon AFB, soil and ground-water samples were collected by Radian project personnel. A total of 129 soil samples were collected for chemical analysis. In addition, grab samples from monitor well installation and the deep and shallow soil boreholes were collected at 5 foot or 2 foot (shallow borings) intervals. Soil grab samples were described lithologically to interpret the local hydrogeologic setting. Ground-water samples were collected from each of the four monitor wells installed at Landfill No. 5 (Site No. 5). Ground-water samples were collected using a dedicated submersible pump for each monitor well (4) as described in Table 3-1. The advantages of using submersible pumps were: 1) water entering the intake screen between the motor and bowl is discharged directly through the pump column onto the land surface thereby eliminating air contact with the water sample; and 2) the wells could be pumped at about 4 gpm continuously until sufficiently purged without introducing bailers or other less efficient equipment which could potentially volatilize the water column with air and slow down purging operations. Field sampling methodologies and equipment are described in the following sections.

3.1.3.1 Soil Sampling

Soil samples were collected at all Phase II Stage 1 sites either as cuttings or as undisturbed cores. Those samples which were to be used only for geologic interpretation were collected as cuttings. Grab samples were composited over 5 foot or 2 foot intervals (monitor wells/deep borings, and shallow borings, respectively) and described. Lithologic logs of all soil samples were maintained by the Radian supervising geologist. Cuttings for identification purposes were collected in sample bags or small jars with labels identifying the sampling site, borehole location, and depth. These cuttings were held at Radian for reference during the course of the Phase II program. They were not collected for chemical analysis.

Samples which were collected for chemical analysis were taken as undisturbed cores. Core samples from the deep soil borings were obtained by Shelby tube (ASTM D-1587), or split spoon sampler (ASTM D-3550). Generally, the Shelby tube was used to obtain the shallower samples; however in some cases where the deep unconsolidated sand was difficult to recover, the split spoon appratus was substituted for the Shelby tube. Both methods produce similar cores and representative samples suitable for analysis.

Prior to each use, the sampling apparatus was steam-cleaned, rinsed with acetone, and re-steamed. Samples were extruded onto a clean surface. Insofar as possible, the outside of the soil core which had been in contact with the core barrel was removed. If the core was competent, it was split longitudinally into duplicate fractions for the specified anlyses by Radian and OEHL. If the sample was unconsolidated, an attempt was made to physically homogenize it prior to sample splitting.

Core samples were taken, where subsurface conditions permitted, at three positions in each borehole: immediately above the top of the caliche; five feet into the caliche; and just below the base of the caliche. Initially, soil samples were collected in one-quart Mason jars with Teflon-lined lids and stored at -10°C prior to shipment to RAS in Austin, Texas. Later in the program, soil samples were split into additional fractions for volatile organics (EPA Methods 8010 and 8020) analysis. These soil samples were packed into 40 ml glass vials with Teflon septa, to minimize head space. Samples were maintained in a frozen state during storage, shipment, and handling. Analytical samples were packed with ice or dry ice and were shipped by overnight air freight. All were received within 24 hours in the frozen condition.

3.1.3.2 Ground-Water Sampling

Ground-water samples were collected for analysis from the four ground-water monitor wells installed under this program. Field sampling methodologies and equipment are detailed in the following sections. Specific conductivity meter and temperature were determined in the field using a conductivity and using a mercury-in-glass thermometer. The pH of the discharged water was measured with the use of a pH meter. Prior to each pH measurement, the instrument was calibrated against standard solutions for pH values of 7.0 and 4.0 or 10.0. Prior to exposure to discharge water, the probe was thoroughly washed with deionized water.

Water Level Determination

As the first step of ground-water sampling operations at each monitor well, water level measurements were taken using an electric water level probe (Actat Olympic brand). The probe and associated electrical line were washed with laboratory deionized water between each well to preclude the possibility of cross-contamination. Measurements were taken to the nearest 0.01 foot with respect to the top of the protective steel well casing. The elevation of the measuring points surveyed is discussed in Section 3.1.6. Water level measurements taken prior to each sampling operation are listed in Appendix F.

Sample Capture and Preservation

After each well was purged of five well volumes of water to ensure representative ground-water characteristics, including stabilized pH and conductivity, a sample was collected and split into the analytical aliquots required by the Statement of Work. The analytical schedule for ground-water samples is summarized on Table 3-3. Analytical results are discussed in Section 4.

All aspects of the sampling protocol were conducted in accordance with EPA-approved methodologies. A summary of sample collection and preservation techniques is provided in Table 3-4. Samples were cooled to 4°C on ice and shipped via overnight express to the analytical laboratory.

TABLE 3-3. SAMPLING SCHEDULE FOR GROUND-WATER SAMPLES, CANNON AFB

Parameter	First Round Sampling
Purgeable Halocarbons (EPA 601)	24-25 January 1985
Purgeable Aromatics (EPA (602)	4 April 1985*
TOC (Total Organic Carbon)	24-25 January 1985
Lead	24-25 January 1985
Metals	24-25 January 1985
Inorganic Species (non-metals)	24-25 January 1985

*Resampling effort for 602 compounds only

TABLE 3-4. SAMPLE COLLECTION SUMMARY, CANNON AFB, NM

Analyte	Sample Container	Preservative	Volume
Oil and Grease	wide mouth mason jar with Teflon lid liner	H_2SO_4 to pH<2, 4°C	750 ml
EPA 601	VOA-vial, Teflon lid	4°C	40 ml
EPA 602	VOA-vial, Teflon lid	4°C	40 ml
Phenols	amber glass	H_2SO_4 to pH<2, 4°C	1000 ml
TOC	amber glass	H_2SO_4 to pH<2, 4°C	1000 ml
Metals	plastic (LPE) bottle	HNO_3 pH<2, 4°C	500 ml
Inorganics (non-metals)	plastic	none, 4°C	1000 ml

3.1.4 Field QA/Procedures

In compliance with the Quality Assurance/Quality Control (QA/QC) protocols and procedures specified in the Scope-of-Work, a split of each analytical aliquot was forwarded to Brooks AFB, OEHL/SA. These samples were divided, preserved, and shipped via overnight air freight using the same procedures previously described (Section 3.1.3). A completed AF Form 2752 was submitted for each sample shipment to provide sample location/identification, description of sample purpose, and additional relevant information.

Approximately five percent of the soil samples were collected in duplicate as an internal check on the precision of routine analytical procedures and to verify sample representativeness. Water samples were collected in sufficient quantity (150% of amount required for a single analysis) to allow second column confirmation of any EPA Method 601 or 602 parameter(s) identified at concentrations exceeding specified levels on the first column run. Second column confirmation requires that the retention times in both columns match the established values before a positive identification can be demonstrated. If retention times from both columns do not match, the results are interpreted as an interference.

In addition to the AF Form 2752's that were submitted with the OEHL sample splits, Radian chain-of-custody forms were executed for all sample shipments. These forms insure accurate tracking of samples from the field to the laboratory system. Copies of chain-of-custody forms for all samples collected during Phase II Stage 1 activities at Cannon AFB are included in Appendix H.

3.1.5 Field Safety

Before the field work was initiated for Stage 1, a Field Safety Plan was prepared. This plan, developed from available data, anticipated likely field hazards and prescribed appropriate personal protective equipment for the field team. Drilling, core sampling and well installation within or in close proximity to the waste sites were expected to pose the most significant potential hazards. However, due to the nature of materials disposed, a relatively low level of personal protection was anticipated. Modified EPA Level D protection (impervious clothing, gloves, boots, and available half-face cartridge respirators) was required for drilling, well installation and groundwater sampling activities. The Safety Plan provided guidance for the complete field effort, and provided more than adequate protection for all situations encountered. The complete text of the Safety Plan utilized for this project is contained in Appendix M.

3.1.6 Surveying

After all wells were installed, wellhead elevations were determined to the nearest 0.01 foot, by surveying from the nearest benchmark, located near the southwest corner of the base. Pettigrew and Associates, a licensed and bonded survey company, accomplished this work. The report of the surveyors is contained in Appendix L. The locations of all deep and shallow soil borings were surveyed from known reference points by Radian Project team members. Horizontal distances and bearings to the site from the reference points were determined using the pace and compass method. Site locations were recorded and transfered onto project base maps at a scale of 1 inch = 400 feet.

3.2 Field Activities By Site

All drilling and sampling activities were conducted under the direct supervision of one of three degreed professional geologists assigned to this project: Tobin K. Walters, B.S. (Project Director), Debra L. Richmann, M.A., and William L. Boettner, B.A. All three geologists are Certified Professional Geological Scientists (CPGS) by the American Institute of Professional Geologists. The field schedule, activities conducted, and responsible Radian supervising geologists are summarized by project site in Table 3-5. Except for Borehole 4D, all soil borings and monitor wells at Landfill sites were located outside of waste disposal trenches.

TABLE 3-5. SUMMARY OF FIELD ACTIVITIES BY SITE, IRP PHASE II STAGE 1, CANNON AFB, NEW MEXICO

Site No.	Description	Radian Supervising Geologist	Period	No. Boreholes	No. Wells
1	Landfill No. 1	T.K. Walters (CPGS #7139)	2/24/85-2/25/86	5	-
2	Landfill No. 2	W.L. Boettner (CPGS #7129)	1/18/85-	5	-
3	Landfill No. 3	D.L. Richmann (CPGS #7071)	2/13/85-2/23/85	6	-
		T.K. Walters	2/22/85-2/23/85	3	-
4	Landfill No. 4	D.L. Richmann	2/8/85-2/11/85	7	-
5	Landfill No. 5	T.K. Walters/ W.L. Boettner	11/25/84-1/10/85	-	4
6	Fire Department Training Area No. 1	T.K. Walters	11/19/84-11/20/84	3	-
7	Fire Department Training Area No. 2	T.K. Walters	11/18/84	1	-
8	Fire Department Training Area No. 3		11/17/84		
9	Fire Department Training Area No. 4	W.L. Boettner	1/16/85-1/17/85	2	-
11	Engine Test Cell Overflow Pit and Leaching Field	T.K. Walters/ W.L. Boettner	1/14/85-1/15/85	2	-
15	AGE Drainage Ditch	W.L. Boettner	1/27/85-1/28/85	2	-
17	Entomology Rinse Area	W.L. Boettner/ T.K. Walters	11/27/84-	3	-
19	MOGAS Spill Area	T.K. Walters	12/18/84-12/19/84	2	-

4.0 DISCUSSION OF RESULTS AND SIGNIFICANCE OF FINDINGS

In this section, the hydrogeologic observations and chemical analyses are discussed on a site-by-site basis. Conclusions regarding subsurface conditions are made on the basis of available hydrogeologic data. Analytical chemistry data are discussed within the context of available regulatory standards and criteria. After an introduction section dealing with available standards and criteria, the discussion of results and significance of findings for each site are discussed in separate sections.

4.1 Regulatory and Human Health Criteria and Standards

In order to determine possible impacts on the ground water quality, the organic and inorganic compounds detected in the ground-water samples were compared to various criteria. These criteria were drawn from federal drinking water regulations, standards and guidelines. Table 4-1 shows parameters determined in Cannon AFB samples, along with the corresponding primary or secondary drinking water standard.

Table 4-2 lists EPA toxicity values and human health criteria which are available for most of the organic chemicals detected. Although these criteria do not have the force of standards, they do provide a valid means of assessing properties of chemicals of concern. Many of the compounds are proven or suspected animal carcinogens where zero consumption is recommended for the protection of human health. Many are also regulated as hazardous waste under RCRA (40 CFR Parts 262 and 263). For each site, parameters detected are evaluated in comparison with these standards and criteria. The use of human health criteria and standards in drinking water for comparison of ground-water contamination at Cannon AFB provides stringent evaluation. Cannon AFB is underlain by the regionally important Ogallala Aquifer at depths below 340 feet. If contaminants are recharged to that regional system, they would have direct human health implications. Since the formal assessment of environmental and human health risks associated with the occurrence of contaminants is

TABLE 4-1. REGULATORY STANDARDS OR CRITERIA FOR GROUND-WATER ANALYSES CONDUCTED AT CANNON AFB, NEW MEXICO

Parameter[1]	Federal Standard (mg/L)
Arsenic	0.05
Barium	1.0
Cadmium	0.010
Chromium	0.05
Lead	0.05
Mercury	0.002
Selenium	0.010
Silver	0.050
Endrin	0.0002
Lindane	0.004
Methoxychlor	0.1
Toxaphene	0.005
2,4-D	0.1
2,4,5-TP (Silvex)	0.01

[1] Reference: 40 CFR 141.

TABLE 4-2. GUIDELINES FOR ORGANIC COMPOUNDS DETECTED IN GROUND WATER

Compound	EPA Toxicity[1,2] (ppb unless noted)
Vinyl Chloride	0(20)
Chloroethane	N.C.[3]
Methylene Chloride	0(1.9)
Trichlorofluoromethane	0(1.9)
1,1-Dichloroethene	0(0.33)
1,1-Dichloroethane	0(9.4)
1,1,1-Trichloroethane	18.4 ppm
1,4-Dichlorobenzene	400
1,1,2,2-Tetrachloroethane	0(1.7)
1,2-Dichloropropane	N.C.
Trichloroethene	0(27)
Tetrachloroethane	0(8)
Chlorobenzene	488
trans 1,2-Dichloroethane	N.C.
1,2-Dichlorobenzene	400
1,3-Dichlorobenzene	400
Benzene	0(6.6)
Ethyl Benzene	1.4 ppm
Toluene	14.3 ppm
Phenols	3.5 ppm

[1]EPA estimate of safe levels of toxicants in drinking water for human health effects (Federal Register, 28 November 1980).

[2]EPA has recommended human health effects criteria of zero (0) for carcinogens, but notes that this level may currently be infeasible. The Agency provides criteria for achieving various levels of protection on an interim basis. The levels which may result in a 10^{-5} incremental increase of cancer risk over a lifetime are presented in parentheses in ppb unless noted. These levels would permit one case of cancer per 100,000 people exposed.

[3]N.C. - denoted no criteria set for human health due to insufficient data.

beyond the scope of this program, the use of human health standards and criteria is both reasonable and prudent.

No similar guidelines exist concerning the metals content of soils. Table 4-3 lists the normal ranges of several heavy metal concentrations in soils, however, natural occurrences of metals can be far above and below the normal range, depending on local geologic conditions.

The individual and averaged metals concentrations of two samples collected from a hand-augered borehole located in an apparently undisturbed area near the base boundary are presented in Table 4-4. Most of these values lie within or very close to the normal ranges presented in Table 4-3. However, the concentrations of barium lie well below the normal range and are anomalously low when compared to the barium concentrations determined at the various IRP sites basewide. Barium is an alkaline earth metal occurring in nature as an insoluble salt. The presence of barium in the local soils is likely due to depositional/dessication cycles over time which formed evaporite brines (enriched in barium and other elements), and caliche soils, rather than to base activities. The low barium values determined in these soil samples may be the result of higher than normal variability associated with this particular geologic environment, or, more likely, that the samples are not representative of true background conditions.

Due to the natural variability in metals concentrations in soils and the uncertainty of the representativeness of the soil samples discussed above, apparent background levels were determined from analysis of soils at each site. Only order-of-magnitude excursions in metals concentrations above apparent local conditions or the normal range (Table 4-3) are considered significant.

TABLE 4-3. NORMAL RANGES OF HEAVY METAL CONCENTRATIONS FOUND IN SOILS

Metal	Normal Range (ppm)
Ba	100-500
Cr	10-50
Pb	2-20
As	5-10
Se	0.2-0.6
Ag	0.04-0.1

Source: Rose, A.W., H.E. Hawkes, and J.S. Webb, 1979, Geochemistry in Mineral Exploration: Academic Press, New York, 675 p.

TABLE 4-4. CONCENTRATIONS OF METALS IN SOIL SAMPLE FROM CANNON AFB PERIMETER

Parameter	Concentration (mg/kg)	
	Range*	Average
Ag	0.13-0.58	0.36
As	7.9-13	10.5
Ba	56-61	59
Cd	0.41-0.75	0.58
Cr	9.6-14	11.8
Cu	<0.08-7.8	3.9
Fe	8200-12000	10100
Hg	0.39-0.41	0.40
Ni	5.9-10	8.0
Pb	7.0-18	12.5
Se	0.61-0.68	0.65
Zn	23-29	26

*Concentrations were measured on two soil samples from a single borehole and were reported in mg/kg (equivalent to ppm).

4.2 Results and Significance of Findings of Phase II Stage 1 Investigation

Nineteen individual sites at Cannon AFB were identified during the Phase I investigation as possibly containing hazardous waste. The potential environmental consequence of each site was evaluated using the Air Force's HARM (Hazard Assessment Rating Methodology) system. This system took into account such factors as the site environmental setting, the nature of the wastes present, past waste management practices and the potential for contaminant migration.

Of the 19 individual sites identified in the Phase I investigation, 16 sites were selected for Phase II (Stage 1) studies. Three sites identified in Phase I were not recommended for Phase II studies: 1) Site 18, JP-4 Fuel Spill; 2) Site 14, Sludge Weathering Pit, and 3) Site 10, Blown Capacitor Site. Site 18 is the location of a JP-4 fuel spill which occurred southwest of Building No. 120 in 1980. It is estimated that 400 gallons of fuel was spilled. Because only a relatively small quantity of fuel was spilled at this site onto a concrete apron, the potential for ground-water contamination appears to be very low. Thus, the site was not recommeded for Phase II evaluation.

Phase I tests performed on soil obtained from the base of the sludge weathering pit (Site 14) indicate that only relatively low concentrations of hydrocarbons are present in the soil. Further analysis also found that no detectable quantities of lead are present. Since the site received only limited quantities of petroleum sludges, and since the soil analyses indicate only low concentrations of hydrocarbons in the soils, the site should not present a significant threat to ground-water resources. Thus no monitoring efforts were proposed for Site 14.

Site 10 is the site where several power capacitors ruptured and spilled small quantities of oil reportedly containing PCBs. Because the small quantity of oil that was spilled onto the ground at the site was removed along with the contaminated soil, the site should not pose a threat to water resources. Consequently, this site was not included in Phase II.

This section presents the results and significance of findings of geologic, hydrologic, and chemical data obtained during the Phase II Stage 1 investigation. The discussions are organized by site in numeric order, with appropriate references to trends or features common to more than one site. Figure 4-1 shows the areas of investigation for the Phase II Stage 1 investigation. Results from the work performed in each area are discussed in terms of the location, topography, geology, soil chemistry and water quality observed during the investigation. Significance of findings are presented separately for each site investigated. The following sections describe the results and significance of findings for the 16 Phase II Stage 1 sites identified on Cannon AFB.

4.2.1 Site No. 1 - Landfill No. 1

Landfill No. 1 is an inactive landfill, approximately four acres in size. It was the original landfill on the base and received domestic solid wastes and shop wastes including oils and solvents, paint strippers and thinners, outdated paint, pesticide containers, and various empty cans and drums from 1943 to 1946. Landfill operation included burning, then burying wastes. The former landfill is located under the base golf course, about 400 feet north of the hospital (Figure 4-2).

Landfill No. 1 was identified for Phase II Stage 1 investigation due to its proximity to the installation boundary and potable water well No. 2, and the known past disposal of small quantities of hazardous wastes. Five deep soil borings were placed within the landfill site to define the local hydrogeological setting and to evaluate the extent of contamination.

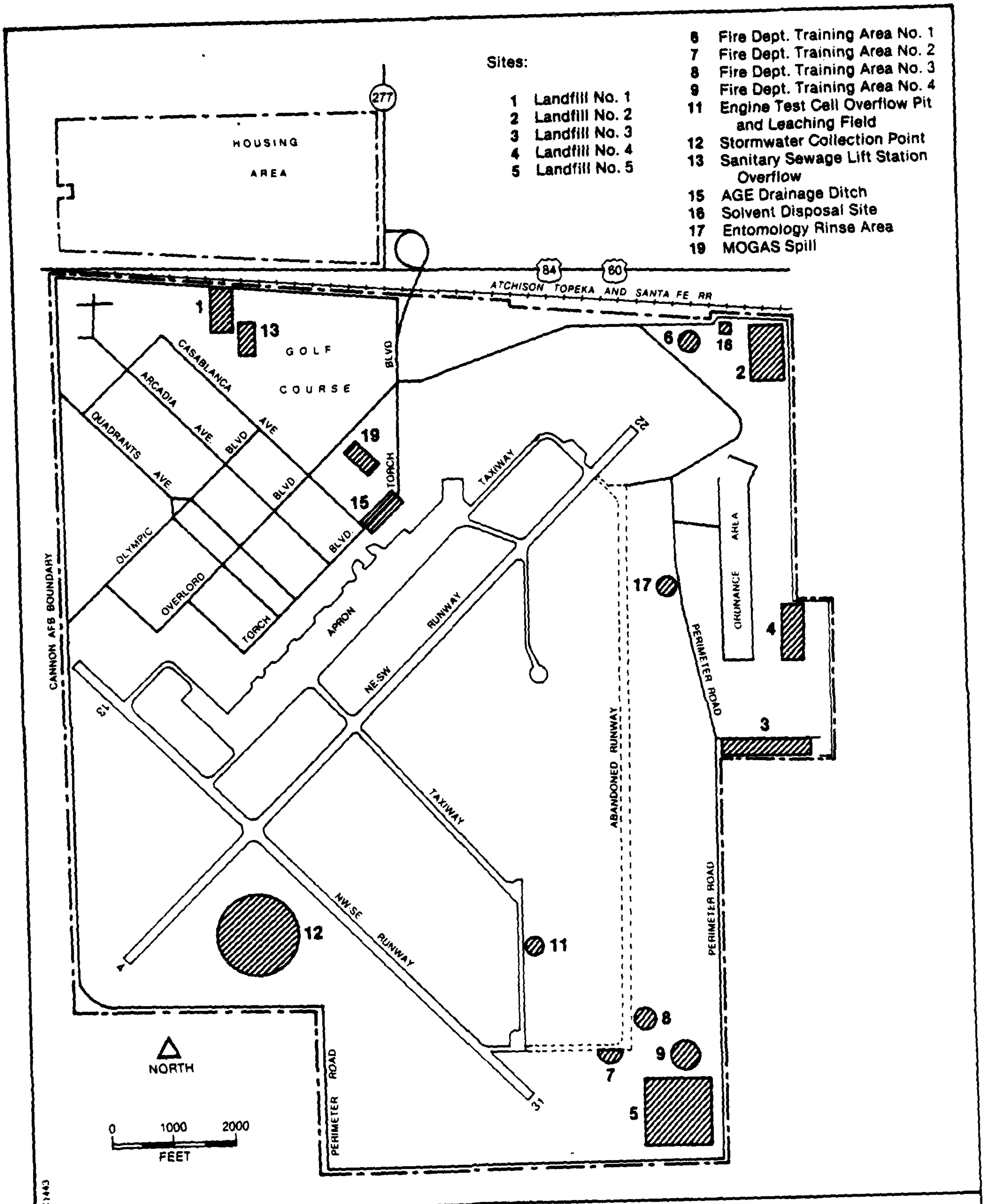

Figure 4-1. Areas of Investigation, IRP Phase II Stage 1, Cannon AFB, New Mexico

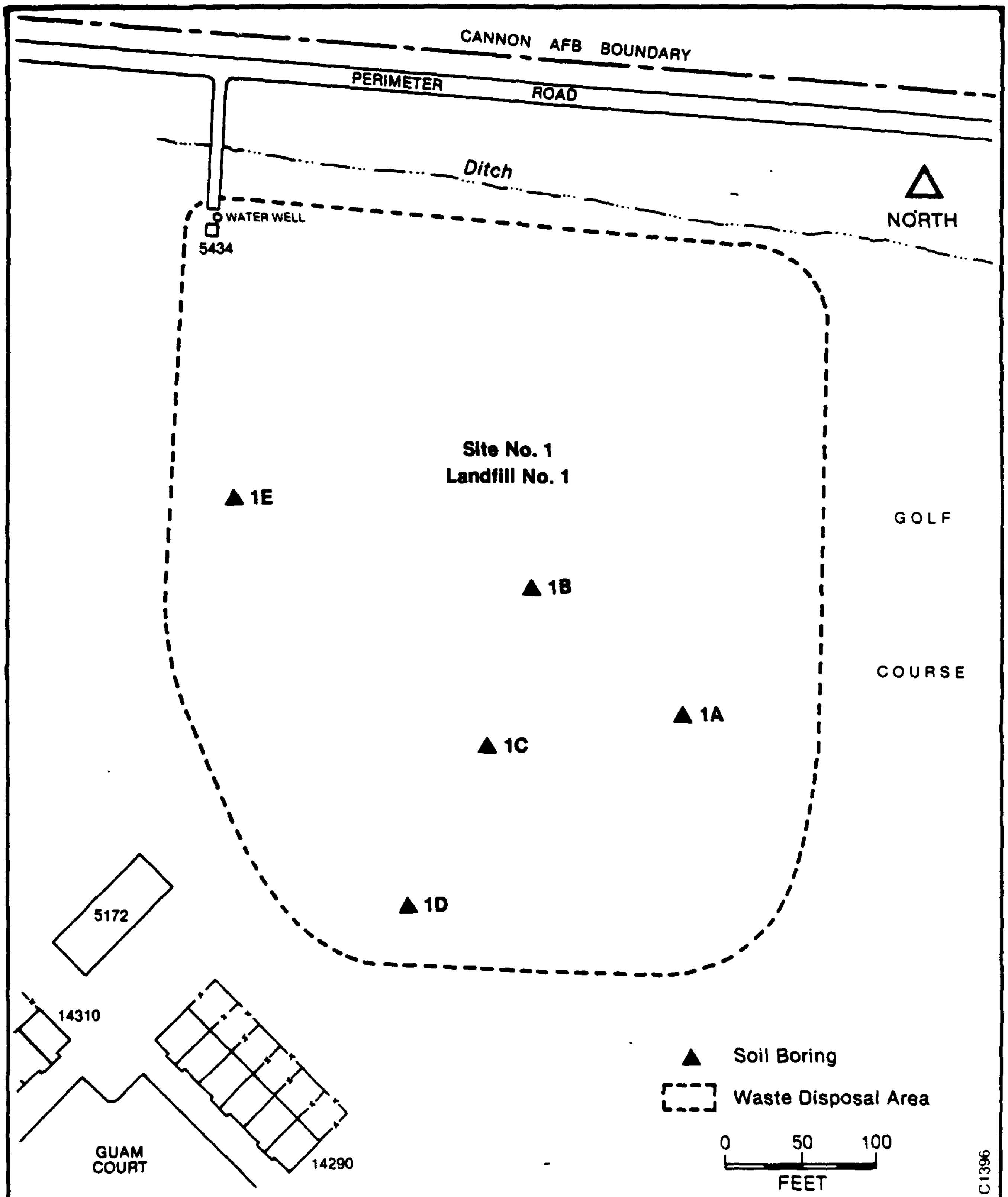

Figure 4-2. Soil Boring Locations, IRP Phase II Stage 1, Site No.1, Landfill No. 1, Cannon AFB, New Mexico

Topography

The topography of the landfill surface slopes gently to the northeast. Runoff from the landfill flows to the north and east and is carried by a small east-flowing interceptor ditch into a low depression east of the landfill. At the time of the field study the depression contained a standing body of water about 200 feet in diameter and less than one foot deep. Since the landfill is in close proximity to the depression (within 170 feet), and only a few feet higher in elevation, a portion of the landfill is subject to periodic submergence by surface waters that accumulate in the depression after significant rainfall events. However, no water was covering the site during the investigation. The only evidence of recent submergence was a debris line that extended into the area near soil boring 1A.

Geologic Features

Geologic data developed for Landfill No. 1 resulted from geologic sampling and observations made during drilling activities.

Topsoil in the landfill contains debris and metal fragments left from earlier disposal activities (since covered). Debris was encountered near an abandoned trench in soil boring 1C in the topsoil and again in the caliche profile at depths of 1 and 22 feet, respectively. Topsoil in the landfill ranges from 5 to 10 feet thick and is composed of sand and organic-rich clay.

A poorly developed caliche profile (caprock) (averaging about 20 feet thick) exists below the topsoil in the area. The caliche is generally buff-brown and silty, containing occasional hard lenses of cemented sand in the interval. No organic contaminants were observed or detected during drilling activities at the landfill. Any contaminants that may have been disposed of in the landfill would likely be contained within the topsoil and upper caliche profile.

Below the caliche profile is a red-brown, medium grained unconsolidated sand. The caliche/unconsolidated sand contact occurs throughout the landfill area at about 32 feet in depth. All deep soil borings were bottomed in this sand. Soil samples were collected and analyzed in accordance with the Scope-of-Work. Table 4-5 lists the depths of each soil samples collected from Site No. 1.

Soil Chemistry

Results of analysis of soil samples from Site No. 1 are summarized in Table 4-5. No purgeable organic compounds (EPA Methods 8010 and 8020) were detected in any of the samples analyzed. Total concentrations of most heavy metals are within the common range of soil concentrations (Table 4-3) or close to the average concentration of metals found in background samples (Table 4-4).

The highest selenium value on site (2.7 mg/kg) was found in the surface sample from borehole 1E, with the highest concentration at the top, next highest concentration at the bottom and least in the middle sample. Selenium concentrations in all three samples from borehole 1E are above the range of common soil values (Table 4-3) and are an order of magnitude greater than the average selenium concentration (below the detection limit of <.2 mg/kg) for Site No. 1.

Concentrations of arsenic, cadmium, iron, and lead exhibit no consistent depth-related trends. Copper, nickel, chromium and zinc show a general tendency to decrease with depth. With the exception of borehole 1D, silver and barium were found in highest concentrations in the samples collected five feet below the top of the caliche which generally occurs at depths below surface of 11 to 15 feet. Mercury concentrations tend to remain constant, both areally and with depth, except in boreholes 1D and 1E where they are somewhat higher relative to the remainder of the site. Oil and grease concentrations are elevated above an apparent background concentration of <10 mg/kg in the surface samples (duplicates) of borehole 1C, and to a lesser extent, in all deep samples from borehole 1E. The highest oil and grease

TABLE 4-5. RESULTS OF ANALYSIS OF SOIL SAMPLES, IRP PHASE II STAGE 1, SITE NO. 1, LANDFILL NO. 1, CANNON AFB, NEW MEXICO

Sample Number	Depth	Parameter: Ag[1]	As	Ba	Cd[1]	Cr	Cu	Fe	Hg	Ni	O/G	Pb	Se	Zn	Purgeable Organics** (EPA 8010/8020)
		(concentrations in mg/kg)													
1A-1	6.0-7.0'	0.38	1.7	63.0	0.40	7.4	4.6	6400	ND	5.8	ND	5.5	ND	43.0	ND
1A-2	11.5-11.75'	1.4	1.2	99.0	0.39	3.9	2.9	1800	0.06	3.4	ND	1.4	ND	1.4	ND
1A-3	42.5-43.5'	0.22	0.3	30.0	ND	2.0	1.3	2300	0.05	1.3	ND	1.4	ND	ND	ND
1B-1	4.0-6.0'	0.23	1.3	46.0	0.65	7.7	4.1	6500	0.05	6.3	ND	5.6	ND	21.0	ND
1B-2	15.0-16.0'	1.3	1.0	86.0	0.26	3.7	2.5	1800	ND	2.8	ND	1.3	ND	ND	ND
1B-3	42.5-44.5'	0.47	2.0	19.0	0.29	2.0	1.2	1900	0.05	1.3	ND	1.4	ND	1.9	ND
1C-1	4.0-6.0'	0.87	1.9	97.0	0.35	4.9	7.9	3600	0.12	3.9	130	6.2	ND	7.9	ND
1C-1a*	4.0-6.0'	0.71	2.0	110.0	0.44	6.1	5.9	5100	ND	4.6	100	8.2	ND	8.4	ND
1C-2	11.0-12.0'	1.3	1.2	200.0	0.30	3.7	2.1	2100	ND	3.2	ND	1.3	ND	1.6	ND
1C-3	42.5-43.5'	ND	ND	6.4	ND	0.80	0.38	1200	ND	0.61	ND	1.0	ND	ND	ND
1D-1	4.0-5.0'	2.9	3.5	160.0	0.27	4.0	2.9	1410	0.18	4.1	820	2.2	ND	9.2	ND
1D-2	12.0-12.5	1.5	8.2	110.0	0.37	5.0	3.5	3810	0.27	5.9	850	5.4	ND	15.0	ND
1D-3	42.5-43.0'	ND	1.2	7.2	ND	1.1	0.60	820	0.17	1.4	360	1.1	ND	5.4	ND
1E-1	4.0-5.0'	0.50	1.3	110.0	0.42	3.8	2.2	2600	0.14	2.6	50	3.6	2.7	20.0	ND
1E-2	12.0-12.5'	1.5	2.4	390.0	ND	3.1	1.6	840	0.13	2.4	56	0.61	2.1	1.2	ND
1E-3	52.5-53.0'	0.82	0.4	26.0	0.34	3.9	0.96	1500	0.16	0.63	55	1.1	2.3	2.6	ND

*duplicate analysis
**concentrations in ug/kg
ND = not detected, detection limits and analytical techniques are listed in Appendix A.

[1] Indicates a value less than 5 times the detection limit. Potential error for such low values ranges between 50 and 100%.

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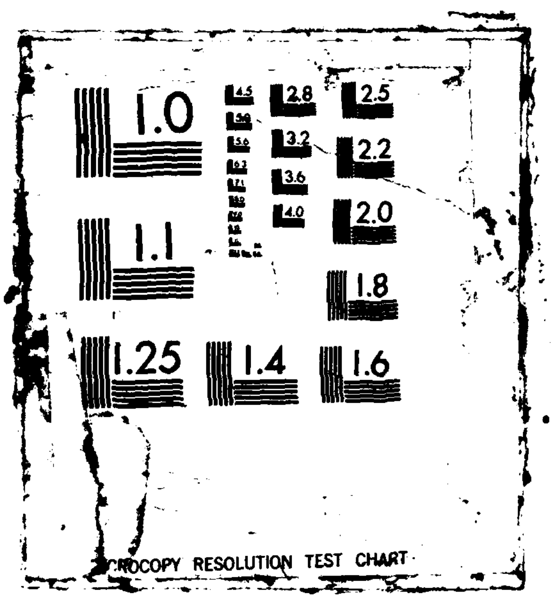
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values at this site were determined in the samples from borehole 1D.

Significance of Findings

Relatively high levels of oil and grease in samples from Borehole 1D and 1E appear to be inconsistent with other oil and grease data from this site. These concentrations of oil and grease may indicate contamination of deeper soil zones associated with past waste disposal activities, or accidental contamination of the sample during collection activities. The elevated oil and grease concentration determined in the shallow soil sample from borehole 1C is not considered significant. Only the shallowest sample taken immediately above the caliche is affected. Therefore, both the lateral and vertical extent of impacted soil is minimal and the local contamination is not interpreted to pose a threat to the ground water.

Potential soil contamination by selenium is suggested by order-of-magnitude elevated concentrations in all samples from borehole 1E. Somewhat elevated oil and grease concentrations were also found in these samples. Because only two boreholes showed the anomalously high selenium and oil and grease concentrations, a very limited areal extent of potential contamination is interpreted. However, since the elevated concentrations extend into the sand underlying the caliche, the vertical extent of contamination is unknown. Even so, the possibility of eventual impact on the local ground water is unlikely due to the great depth (>300 feet) to the water table.

4.2.2 Site No. 2 - Landfill No. 2

Landfill No. 2 is a former four-acre waste disposal site located in the northeast corner of the base, beyond the primary runway. It was operated during two periods in the past; from 1946 to 1947, and again from 1952 to 1959. The period of temporary inactivity from 1947 to 1952 was the time during which the base was on deactivated status. When in operation, Landfill No. 2 received domestic and industrial solid wastes including waste oils and solvents, paints, paint strippers and thinners, pesticide containers, and empty cans and drums. Wastes were deposited in trenches where they were burned and buried. In its present condition, the site appears as an open field covered by prairie grasses (Figure 4-3).

Landfill No. 2 was identified for Phase II Stage 1 study based primarily on its proximity to a base drinking water well and to the installation boundary, and on the known disposal of small quantities of hazardous wastes. Five deep soil borings were emplaced to define the local subsurface environment and to determine the potential impact of past waste disposal activities.

Topography

The topography of Landfill No. 2 is essentially flat with the exception of several small undulations and trenches in the landfill area. Shallow trenches and depressions were left during the regrading process of the landfill and act as catchment basins for precipitation. Surface water tends to drain internally into these shallow, north-south aligned trenches originally cut, then backfilled during the operation of the landfill.

A road berm borders the landfill to the north and east which restricts the flow of surface water runoff from the landfill. No surface water drainages exist near the landfill boundary that could impact, or be impacted by the landfill.

Geologic Features

Geologic data developed for Landfill No. 2 resulted from geologic sampling and observations made during drilling activities.

From reconnaissance boring information, the topsoil in Landfill No. 2 is composed primarily of sandy clay, ranging from 4 to 4.5 feet thick. The topsoil zone is fairly consistent throughout the landfill except in areas where the topsoil was removed or displaced by heavy equipment used during the

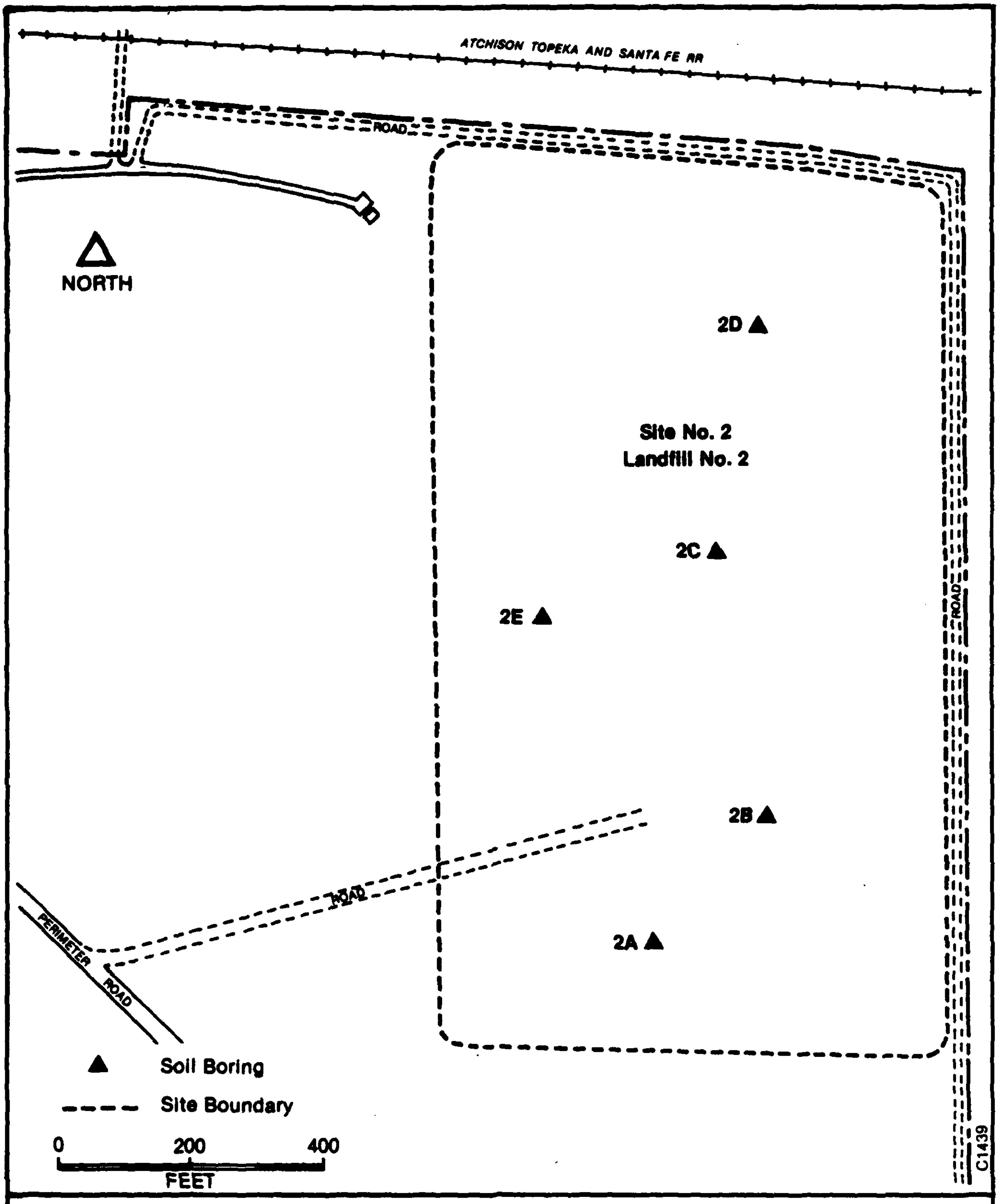


Figure 4-3. Soil Boring Locations, IRP Phase II Stage 1, Site No. 2, Landfill No. 2, Cannon AFB, New Mexico

operation of the landfill. In these areas, shallow depressions and undulations are present that contain intermixed debris, caliche and topsoil.

The contact with the underlying caliche is quite distinct as the topsoil is unconsolidated and the underlying caliche is characteristically very hard, consisting of a weathered bed of calcium carbonate (primarily) grading downward into a buff-brown, calcite-cemented sand with interbedded silt and sand in the lower part.

The caliche ranges in thickness from 30 to 40 feet in the landfill area, and is generally buff-brown, containing interbedded sands and silts in the lower portion of the profile. The sand units within the caliche are generally pink, quartzose, fine grained and loosely consolidated containing abundant calcite cement. The caliche and sand units tend to vary from extremely soft to well indurated, depending on the degree of cementation.

The total depth of the borings ranged from 36.5 to 60.0 feet deep in Landfill No. 2. All borings penetrated the caliche profile and were bottomed in a loose, unconsolidated sand immediately below the caliche profile. The sand unit below the caliche was not fully penetrated. In some cases the sand below the caliche was too unconsolidated to retrieve a split-spoon sample, allowing for the retrieval of only two samples, a shallow and intermediate sample from the borehole.

Soil Chemistry

Eleven soil samples, including one QA duplicate, were collected following the procedures detailed in Section 3.1.1. Deep soil borings were not obtained at borings 2A, 2B, 2C, and 2D due to the unconsolidated nature of the material. Each of the samples was analyzed for priority pollutant metals (total); total iron, nickel, and zinc; oil and grease; and purgeable halocarbons and aromatics.

Results of analysis of soil samples from Site No. 2 (Landfill No. 2), are summarized in Table 4-6. No purgeable organic compounds (EPA

TABLE 4-6. RESULTS OF ANALYSIS OF SOIL SAMPLES, IRP PHASE II STAGE 1, SITE NO. 2, CANNON AFB, NEW MEXICO

Sample Number	Depth	Ag	As	Ba	Cd	Cr	Cu	Fe	Hg	Ni	O/G	Pb	Se	Zn	Purgeable Organics** (EPA 8010/8020)
		Parameter (concentrations in mg/kg)													
2A-1	4.0-5.0'	1.0	1.6	89	0.50	9.5	5.3	9100	0.13	7.5	ND	7.4	ND	25.0	ND
2A-2	9.0-10.0'	ND	1.3	80	ND	7.1	4.0	6800	ND	4.7	ND	5.2	ND	16.0	ND
2B-1	4.0-5.0'	0.72	1.1	74	0.57	6.4	3.6	4500	0.08	4.1	ND	3.3	ND	38.0	ND
2B-2	9.0-10.0'	0.66	3.7	580	0.43	4.1	5.0	2500	0.21	3.3	ND	1.3	ND	36.0	ND
2C-1	4.0-5.0'	ND	4.0	79	0.27	7.9	5.8	8000	0.10	8.4	ND	6.4	1.6	68.0	ND
2C-2	9.0-10.0'	1.2	1.5	320	ND	5.8	2.4	4500	0.017	3.6	ND	3.7	ND	61.0	ND
2D-1	4.0-5.0'	0.58	1.5	100	0.34	8.3	6.3	7800	0.035	7.7	ND	7.0	ND	61.0	ND
2D-2	9.0-10.0'	.57	11.0	89	ND	3.5	0.79	2100	0.083	1.7	26	1.9	ND	19.0	ND
2E-1	4.0-5.0'	0.38	0.74	110	0.40	7.8	7.5	8700	0.068	5.8	ND	10.0	ND	57.0	ND
2E-2	9.0-10.0'	0.55	0.81	66	0.48	7.4	5.7	6900	0.13	7.7	ND	7.5	ND	190.0	ND
2E-3	52.5-53.5'	0.35	ND	45	0.39	3.1	0.81	2100	0.065	0.96	ND	0.90	ND	5.2	ND
2C-1a*	4.0-5.0'	ND	5.0	57	ND	4.7	4.5	5000	0.09	8.5	ND	2.6	1.8	16.0	ND

*duplicate analysis
**concentrations in ug/kg
ND = not detected, detection limits and analytical techniques are listed in Appendix A.

Methods 8010 and 8020) were detected in any of the samples analyzed. Likewise, none of the samples contained oil or grease in quantifiable amounts. Metals values are quite variable but lie generally within the normal range for soils (Table 4-3). Samples 2C-1 and the duplicate sample, 2C-1a contain selenium at levels above the apparent background concentration (<0.2 mg/kg), but the occurrence is isolated. Concentrations of iron, lead, nickel, cadmium, chromium, copper and zinc are generally higher in the topsoil layer than in the caliche profile. Iron has a definite pattern established, higher in the shallower zones of the site profile. The other metals, specifically silver, arsenic and mercury show no distinct increase or decrease in concentration with depth. No selenium was detected in the samples.

Significance of Findings

No purgeable halocarbons or aromatics or elevated levels of oil and grease were detected in samples from Landfill No. 2. Should these compounds exist in the soil in the landfill, the potential for downward migration of leachate through the caliche profile would be slight as the caliche averages about 40 feet thick and exhibits low natural permeability. The caliche is a desirable medium for a landfill location as it restricts the infiltration and movement of leachate and also retards the volumes of leachate produced. Natural attenuation of the leachate in the caliche may occur as the caliche and clays possess a high ion-exchange capacity which can remove metals from the leachate. Further, the volumes of leachate produced would be small, since the arid environment and low annual precipitation in the region are not sufficient to recharge the vadose zone or ground water below the site. Under these conditions, solid waste disposal within the landfill is not expected to result in ground-water contamination.

The measurable concentrations of selenium found in samples 2C-1 and 2C-1a are restricted to the shallowest sample. This isolated occurrence is probably the result of natural variability and is furthermore interpreted to pose no threat to the ground water because of the thick underling zone of low permeability caliche.

Two of the samples (2D-2 and 2B-2) contained arsenic and barium respectively, above the normal range for soils. However, these isolated anomalies are probably unrelated to past waste disposal activities and are not considered environmentally significant.

4.2.3 Site No. 3 - Landfill No. 3

Landfill No. 3 is an inactive waste disposal site. The landfill, which covers approximately nine acres on the east side of the base, south of the disposal lake (Figure 4-4), was operated from 1959 to 1967. During operation, domestic solid wastes, waste oils, solvents, paints, paint thinners and strippers, pesticide containers, and various empty cans and drums were burned in trenches and buried each following day. Currently, the inactive site appears as a rectangular open field covered by prairie grasses.

Landfill No. 3 was identified for Phase II Stage 1 investigation due to its proximity to the base boundary and to a disposal lake; the existence of base well No. 5 in the vicinity and the known past disposal of small volumes of hazardous wastes at this site. Nine deep soil borings were placed within the landfill site to define the local hydrogeological setting and to evaluate the potential extent of contaminant migration.

Topography

The topography in the Landfill No. 3 area is fairly flat with the exception of remnant trench depressions on the surface outlining areas of past excavation and subsequent backfilling. Generally, drainage in the area is to the north toward the disposal lake, although no defined drainage ways exist within the landfill boundary.

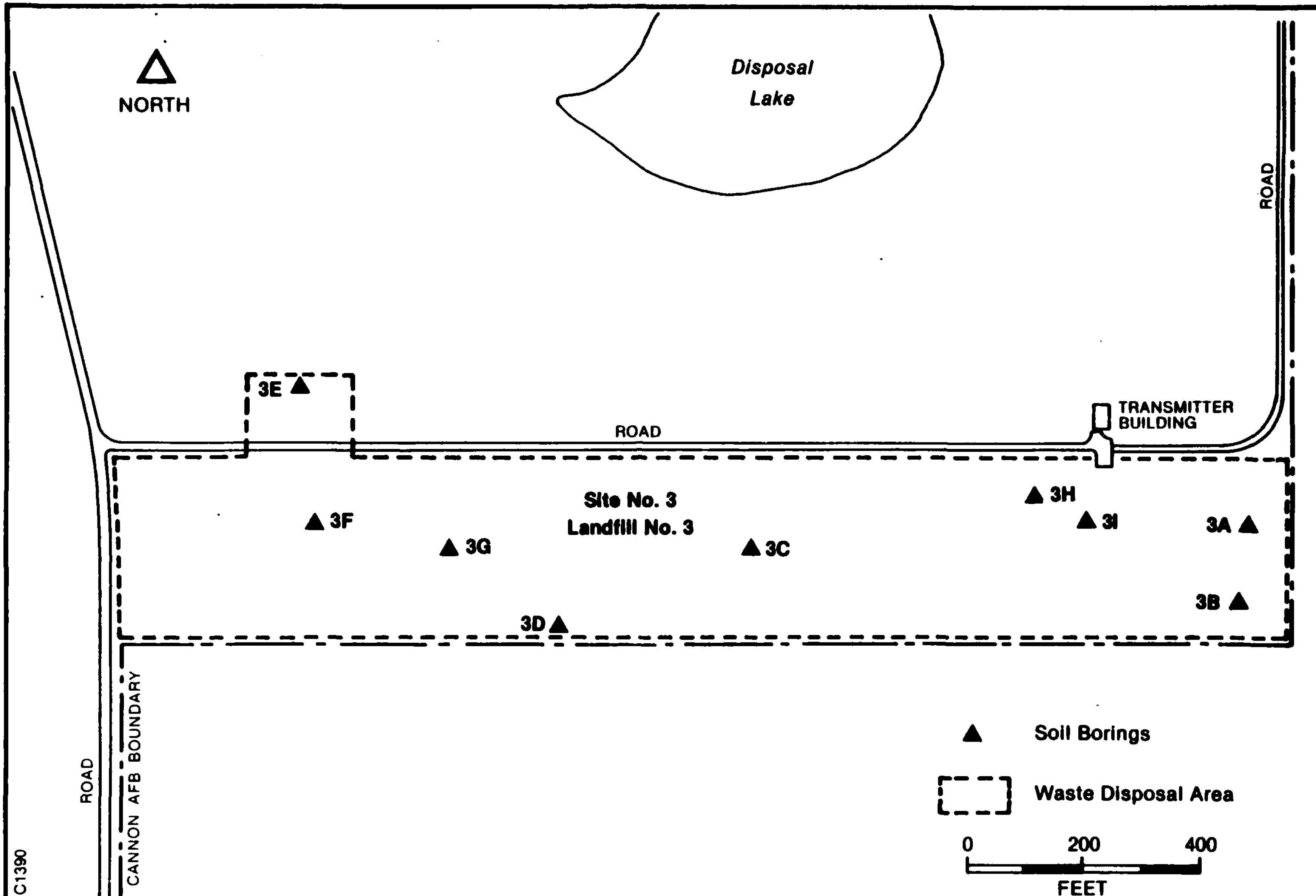


Figure 4-4. Soil Boring Locations, IRP Phase II Stage 1, Site No. 3, Landfill No. 3, Cannon AFB, New Mexico

Geologic Features

The Landfill No. 3 site is covered by surficial soils varying from about 4 to 5 feet in thickness. The uppermost soils are typically brown to red-brown, loamy sand, with or without minor calcite cement. The deeper soils may be similar to those described above, however in several borings they grade to a distinctive red-brown, fine grained, well sorted sand.

The caliche profile extends from the base of the topsoil to a depth in excess of 55 feet across the site. The caliche exhibits a variety of physical properties and ranges in character from soft, weakly consolidated, sparsely calcareous sand to extremely hard, completely indurated calcrete, with partial to extensive silicification occurring in localized zones. Texturally, the caliche varies from a massive and generally featureless form to laminated, honeycombed, and/or nodular varieties.

The unconsolidated sand at the base of the caliche profile is relatively consistent in physical appearance across the site. It is typically tan, fine to medium grained, moderately to well sorted and rounded, and composed dominantly of quartz grains. The sand appears to be laterally continuous across the site, however no determination of the thickness of the unconsolidated sand unit was made, since the unit was not fully penetrated.

Soil Chemistry

Twenty-seven soil samples, including one QA duplicate, were collected following the procedures detailed in Section 3.1.1. Each of the samples was analyzed for priority pollutant metals (total); total iron, nickel, and zinc; oil and grease; and purgeable halocarbons and aromatics.

Analytical results for soil samples from Site No. 3 are presented in Table 4-7. No purgeable halocarbons or aromatic compounds were detected in

TABLE 4-7. RESULTS OF ANALYSIS OF SOIL SAMPLES, IRP PHASE II STAGE 1, SITE NO. 3, LANDFILL NO. 3, CANNON AFB, NEW MEXICO

Sample Number	Depth	Parameter (concentrations in mg/kg) Ag	As	Ba	Cd	Cr	Cu	Fe	Hg	Ni	O/G	Pb	Se	Zn	Purgeable Organics** (EPA 8010/8020)
3A-1	3.0-4.5'	0.50	0.89	48	0.37	5.6	1.8	5200	ND	3.9	ND	4.5	ND	19.0	ND
3A-2	9.5-11.0'	1.1	0.92	310	ND	2.4	ND	1500	ND	1.6	ND	1.7	ND	11.0	ND
3A-3	57.5-59.5'	ND	0.81	36	ND	3.4	ND	1900	ND	0.92	ND	1.7	ND	11.0	ND
3B-1	3.0-5.0'	0.23	1.2	40	ND	3.4	0.55	4200	ND	4.0	ND	4.2	ND	67.0	ND
3B-2	10.0-11.0'	0.44	0.93	140	ND	2.6	ND	1700	0.07	1.1	ND	6.0	ND	14.0	ND
3B-3	57.5-58.5'	0.39	0.62	140	ND	1.7	ND	1400	ND	0.50	ND	1.2	ND	4.4	ND
3C-1	3.0-4.0'	0.37	0.87	39	ND	5.8	ND	3400	0.07	3.3	ND	3.6	ND	17.0	ND
3C-2	9.0-10.0'	0.41	1.8	150	ND	3.5	ND	2000	ND	0.98	ND	2.4	ND	23.0	ND
3C-3	57.5-59.5'	0.26	ND	180	ND	15.0	ND	2700	ND	ND	24	14.0	ND	2.6	ND
3D-1	2.5-4.0'	0.65	0.80	33	0.33	4.2	1.3	4000	ND	4.0	ND	4.4	ND	7.3	ND
3D-1a	2.5-4.0'	0.63	0.80	70	0.35	4.6	1.9	4400	0.06	4.5	37	4.6	ND	14.0	ND
3D-2	9.0-11.0'	ND	0.88	260	ND	2.4	ND	2300	ND	1.6	ND	2.8	ND	11.0	ND
3D-3	57.5-59.5'	ND	ND	180	ND	0.86	14.0	1200	ND	ND	43	14.0	ND	500.0	ND
3E-1	2.0-4.0'	0.28	2.0	240	ND	4.4	1.7	3700	0.12	2.7	54	4.2	1.8	29.0	ND
3E-2	7.5-9.5'	1.1	2.5	150	0.91	6.0	4.5	120	0.14	9.2	83	3.2	1.6	20.0	ND
3E-3	57.5-58.5'	ND	ND	5.0	ND	ND	ND	570	0.13	ND	40	0.70	1.2	ND	ND
3F-1	3.5-5.0	0.80	0.58	49	0.27	3.7	1.3	3300	ND	4.0	16	4.1	ND	51.0	ND
3F-2	10.0-11.5'	0.45	0.94	190	ND	2.2	0.49	2100	ND	1.5	ND	3.1	ND	60.0	ND
3F-3	55.5-57.5'	ND	ND	60	ND	ND	0.50	1100	ND	ND	ND	1.1	ND	ND	ND
3G-1	3.0-4.5'	NO	0.51	69	ND	3.9	1.3	4700	ND	3.8	42	5.3	ND	110.0	ND
3G-2	9.5-10.5'	0.86	0.94	130	ND	3.3	0.50	2100	ND	2.2	26	3.1	ND	43.0	ND
3G-3	57.5-59.5'	0.77	ND	10	ND	1.1	0.47	930	0.08	0.29	25	0.94	ND	1.1	ND
3H-1	2.0-4.0'	0.76	1.3	110	0.23	4.5	0.57	3700	ND	2.6	10	5.0	ND	6.5	ND
3H-2	9.0-11.0'	0.23	0.66	540	ND	4.6	ND	4600	ND	7.0	20	6.1	ND	8.6	ND
3H-3	57.5-58.0'	0.40	ND	51	ND	ND	ND	600	ND	ND	25	0.78	ND	0.31	ND
3I-1	0-2'	87	ND	47	0.35	4.9	1.0	4500	ND	3.8	45	4.2	ND	6.1	ND
3I-2	7-9'	0.25	ND	54	ND	2.2	ND	2400	ND	1.6	35	2.9	ND	3.7	ND
3I-3	57.5-59.5'	ND	ND	18	ND	ND	ND	1100	ND	ND	ND	0.81	ND	ND	ND

*Duplicate sample
**concentratinos in ug/kg
ND = not detected, detection limits and analytical techniques are listed in Appendix A.

any of the soils. Metals values are variable, but generally well within the range of common soil concentrations (Table 4-3). Soil samples from all three depths in borehole 3E have higher levels of Se and Hg, relative to the other site samples. Oil and grease concentrations vary throughout the site from <10 mg/kg to 83 mg/kg in borehole 3E.

Significance of Findings

There is no evidence that past waste disposal activities associated with Landfill No. 3 have resulted in a threat to human health or the environment. The metals concentrations are generally within the normal range for soils. Also, the relatively low levels of oil and grease identified are unsupported by the purgeable organics data (all ND), and probably reflect the presence of natural organics. In general, the highest levels of parameters determined were associated with samples from borehole 3E, located beyond the suspected boundaries of the landfill. However, even these values are consistent with the range of concentrations common in soils.

Landfill No. 3 is underlain by approximately 55 feet of caliche. The caliche acts as a flow barrier between the landfill base and underlying Ogallala Aquifer (at about 340 feet). The maximum excavated depth of the landfill during its operation was about 20 feet at the lowest point, therefore any potential contaminants are resting on about 35 feet of caliche. The caliche exhibits low natural permeability thereby decreasing the potential for downward migration of leachate through the caliche profile. By restricting flow, it also retards the volumes of leachate produced. The potential for production of leachate to contaminate the ground water is also low because the amount of precipitation in the arid environment is not sufficient to saturate the vadose zone or recharge the Ogallala Aquifer below.

4.2.4 Site No. 4 - Landfill No. 4

Landfill No. 4 is an inactive waste disposal site covering approximately seven acres on the east side of the base between the ordnance area and the base boundary (Figure 4-5). During the years of operation, from 1967 to 1968, domestic solid wastes, waste oils, solvents, paints, paint strippers and thinners, pesticide containers, and various empty cans and drums were deposited in trenches and burned. The residual wastes were buried in the trenches the day following each burning. Currently, this inactive site appears to be an open field covered by prairie grasses. Noticeable elongate areas of subsidence within the site suggest the locations of former trenches.

Landfill No. 4 was identified for Phase II Stage 1 study based on its proximity to the base boundary and to a playa lake; the existence of a potable water well in the vicinity of the site; and the known past disposal of small volumes of hazardous wastes in the landfill trenches. Seven deep soil borings were made at Landfill No. 4 to define the local hydrogeologic setting and to evaluate the extent of potential contaminant migration.

Topography

The topography in the Landfill No. 4 area slopes to the southwest toward the disposal lake located near the southern boundary of the landfill. Undulations and ruts left from backfilled trenches are visible at land surface and trend roughly north-south in the landfill area. The ruts are approximately 250 feet in length. The low areas within the landfill act as catchment areas for precipitation, and are easily recognizable by the abundant vegetation present relative to the undisturbed areas.

Geology

The Landfill No. 4 site is covered by surficial soils which vary in thickness from approximately 2 to 4.5 feet. The soils are typically brown to red-brown, loamy sands. A few borings revealed calcite nodules near the basal contact of the topsoil and caliche.

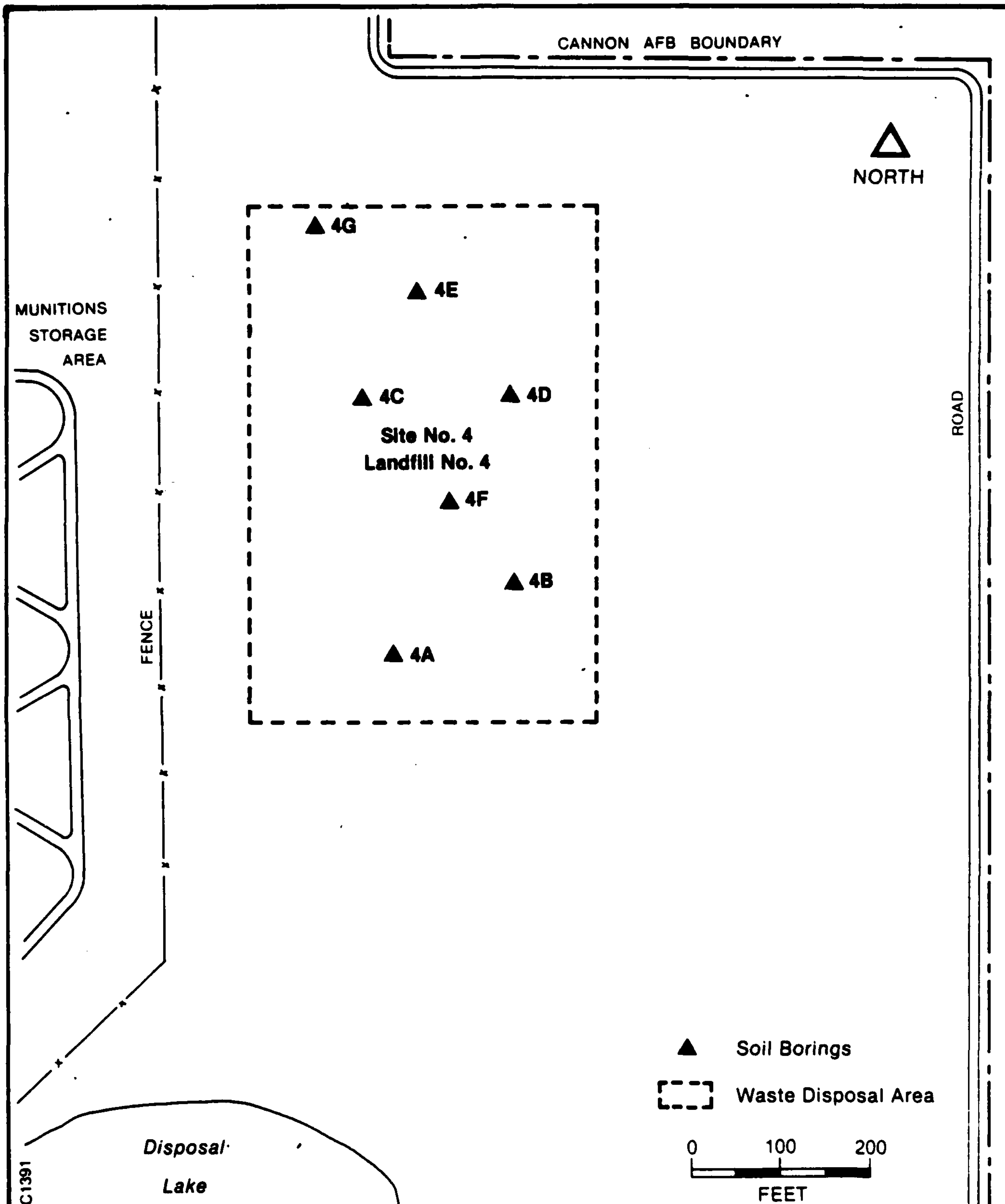


Figure 4-5. Soil Boring Locations, IRP Phase II Stage 1, Site No. 4, Landfill No. 4, Cannon AFB, New Mexico

The caliche profile across Landfill No. 4 extends from the base of the topsoil to a depth probably less than 60 feet. Borehole 4B was bottomed in caliche at 59.5 feet in hard "calcrete". The calcrete impeded progress and made the recovery of a deep core sample impossible. Most boreholes revealed sand at 50 to 60 feet in depth.

The physical properties of the caliche are highly variable and are similar to those described for the adjacent Landfill No. 3 site (see Section 4.2.3). However, a number of borings at Landfill No. 4 reveal weakly consolidated sand deposits between depths of about 15 to 25 feet. These may reflect the presence of a locally significant sand lens which could have a strong influence on the path of potential contaminant migration at the site.

The unconsolidated sand at the base of the caliche profile is similar to that described at Landfill No. 3 to the south (see Section 4.2.3). However, at Landfill No. 4 the caliche/sand contact is more gradational. The top of the unconsolidated basal sand was picked at depths varying from about 47 to greater than 60 feet across the site.

Borehole 4D was inadvertently located within one of the old landfill trenches. Since this boring was dry during drilling and was completely grouted after completion, no contaminant pathway was opened. The disruption caused by excavating and filling the trench has resulted in a local environment that is distinct from the natural hydrogeologic setting of the site, as interpreted from the other six deep soil borings.

A thin (1.5 foot thick) caliche layer was encountered at a depth of 3 feet. It is obviously a recent feature, deposited after the trench was inactivated. The shallow caliche is immediately underlain by fill material which includes domestic and construction-type wastes (e.g. wood, paper, and metal scrap). The fill extends to a depth of approximately 12.5 feet and is underlain by a largely unconsolidated 5 foot thick sand body. It is likely that any leachate migrating downward from the fill material would enter the sand and migrate laterally along this relatively permeable zone.

Within the underlying caliche profile, another sand-dominated unit is encountered between 22 and 27 feet. The remainder of the section consists of massive to nodular caliche to a depth of about 47 feet, where the unconsolidated basal sand occurs.

Soil Chemistry

Results of analysis of soil samples from Site No. 4 are summarized in Table 4-8. No purgeable halocarbons or aromatics were detected in any of the samples analyzed. Total concentrations of heavy metals are generally within the normal range for soils. Four samples contained oil and grease in quantities between 18 and 45 mg/kg. Anomalously low concentrations of iron were reported in soil samples 4E-2 and 4E-3. Generally values of iron are much higher in typical soils in this region. Samples from borehole 4D, immediately underlying a landfill cell, are not remarkably different from the other borings.

Significance of Findings

Samples from Landfill No. 4 contain concentrations of heavy metals that are generally consistent with the normal range of metals concentrations in soils and may represent native soil conditions. Four samples (4A-1, 4A-3, 4F-3 and 4G-2) did contain small quantities of oil and grease, but the low levels are not considered environmentally significant, especially since the IR analysis performed does not discriminate between naturally occurring organics and hydrocarbon compounds. Furthermore, a base-generated source of the oil and grease concentrations identified, is not supported by the negative purgeable organics data.

Below the abandoned landfill is a thick caliche layer which serves to isolate the landfill hydrologically from the underlying sediments and deeper Ogallala aquifer. As with the other landfills on-base, the potential for leachate migration through the caliche into underlying sediments is negligible, for several reasons; the caliche attenuates leachate migration due to

TABLE 4-8. RESULTS OF ANALYSIS OF SOIL SAMPLES, IRP PHASE II STAGE 1, SITE NO. 4, LANDFILL NO. 4, CANNON AFB, NEW MEXICO

Sample Number	Depth	Ag	As	Ba	Cd	Cr	Cu	Fe	Hg	Ni	O/G	Pb	Se	Zn	Purgeable Organics** (EPA 8010/8020)
		Parameter (concentrations in mg/kg)													
4A-1	1-2'	ND	0.96	75.0	ND	1.7	1.7	4900	ND	3.3	18	5.5	ND	94.0	ND
4A-2	7-9'	0.56	0.87	130.0	ND	4.8	ND	5200	ND	5.1	ND	4.5	ND	45.0	ND
4A-3	62.5-63.0'	1.1	ND	15.0	0.25	0.64	ND	200	ND	ND	34	0.54	ND	54.0	ND
4B-1	1-3'	0.43	1.1	57.0	ND	3.3	ND	2600	ND	5.3	ND	4.1	ND	29.0	ND
4B-2	8-10'	1.4	2.3	150.0	ND	4.6	ND	3400	ND	5.3	ND	5.1	ND	10.0	ND
4C-1	3.0-4.5'	1.1	0.82	54.0	0.52	4.9	1.7	880	ND	6.7	ND	4.2	ND	70.0	ND
4C-2	9.5-11.0'	0.92	ND	150.0	ND	3.7	ND	3100	0.11	4.5	ND	4.3	ND	26.0	ND
4C-3	52.5-54.0'	ND	0.81	23.0	ND	0.91	ND	1500	ND	ND	ND	0.74	ND	5.2	ND
4D-1	1.5-2.9'	0.72	1.2	210.0	0.30	5.0	1.6	4400	ND	3.4	ND	5.3	ND	14.0	ND
4D-2	15.0-17.0'	ND	1.2	38.0	ND	3.9	0.72	4600	ND	3.7	ND	5.0	ND	260.0	ND
4D-3	27.5-28.5'	0.57	1.1	240.0	ND	4.4	ND	3000	ND	1.6	ND	1.9	ND	7.5	ND
4D-4	47.5-49.0'	ND	0.81	320.0	ND	1.1	ND	2100	ND	.30	ND	1.0	ND	4.5	ND
4E-1	3.0-4.5'	ND	1.0	52.0	ND	5.4	2.5	6800	ND	5.4	ND	6.5	ND	85.0	ND
4E-1a*	3.0-4.5'	0.61	1.1	64.0	0.44	6.4	2.5	5400	0.07	6.0	ND	5.7	ND	120.0	ND
4E-2	9.5-11.0'	0.40	ND	160.0	ND	1.3	ND	25	ND	2.3	ND	3.1	ND	8.8	ND
4E-3	52.5-54.0'	0.46	ND	5.9	ND	ND	ND	14	ND	ND	ND	0.24	ND	31.0	ND
4F-1	2.0-3.5'	ND	1.3	78.0	ND	2.5	0.92	3100	ND	1.9	ND	3.9	ND	32.0	ND
4F-2	8.0-9.0'	1.0	0.71	290.0	0.23	4.1	0.58	3400	ND	3.7	ND	4.1	ND	15.0	ND
4F-3	57.5-6..5'	ND	0.65	9.2	ND	2.5	ND	1700	ND	ND	45	2.2	ND	190.0	ND
4G-1	2.0-4.0'	0.66	2.1	78.0	0.56	9.4	6.5	9100	ND	7.3	ND	5.8	ND	16.0	ND
4G-2	9.0-11.0'	1.2	1.4	200.0	0.29	4.7	3.1	3400	ND	3.8	45	2.5	ND	31.0	ND
4G-3	52.5-53.0'	0.20	0.5	30.0	0.11	3.0	1.4	2600	ND	1.6	ND	1.7	ND	9.9	ND

*duplicate analysis
**concentrations in ug/kg
ND = not detected, detection limits and analytical techniques are listed in Appendix A

naturally low permeability, and the chemical characteristics of caliche promotes ion-exchange of metals and adsorption of organics.

The saturated portion of the Ogallala Formation is about 340 feet below this site, and is not directly recharged in this area by precipitation and downward percolation of waters from the landfill or vicinity. Leachate produced in the landfill would not be expected to migrate below the uppermost topsoil and caliche layers as precipitation amounts are not sufficient to drive the leachate into deeper zones.

4.2.5. Site No. 5 - Landfill No. 5

The landfill was inactivated in October 1984. Hazardous waste was disposed of until mid-1981 in the one cell in operation during FY 81. The entire site covers approximately 30 acres in the southeast corner of the base (Figure 4-6).

Waste materials received at this landfill are similar to those received at the former base landfills: domestic solid waste; waste oils and solvents; paints, paint removers and thinners; pesticide containers; and various empty cans and drums. Until mid-1981, approximately 5 to 10 drums per month of waste oils and solvents were disposed. Partially to completely full drums of material were generally deposited directly into trenches and crushed by a bulldozer. Only tree limbs and construction rubble are currently being disposed of at Landfill No. 5.

From 1968 to about 1972, the mode of operation at this landfill was burn and bury in trenches. Since 1972, unburned waste has been buried. An estimated 11 covered trenches exist at the site. A twelfth trench was open and in use at the time of the Phase II investigation. The trench was excavated to about 10 feet in depth and bottomed in the caliche.

Landfill No. 5 was identified for Phase II Stage 1 investigation primarily because of the known disposal of large volumes of hazardous wastes

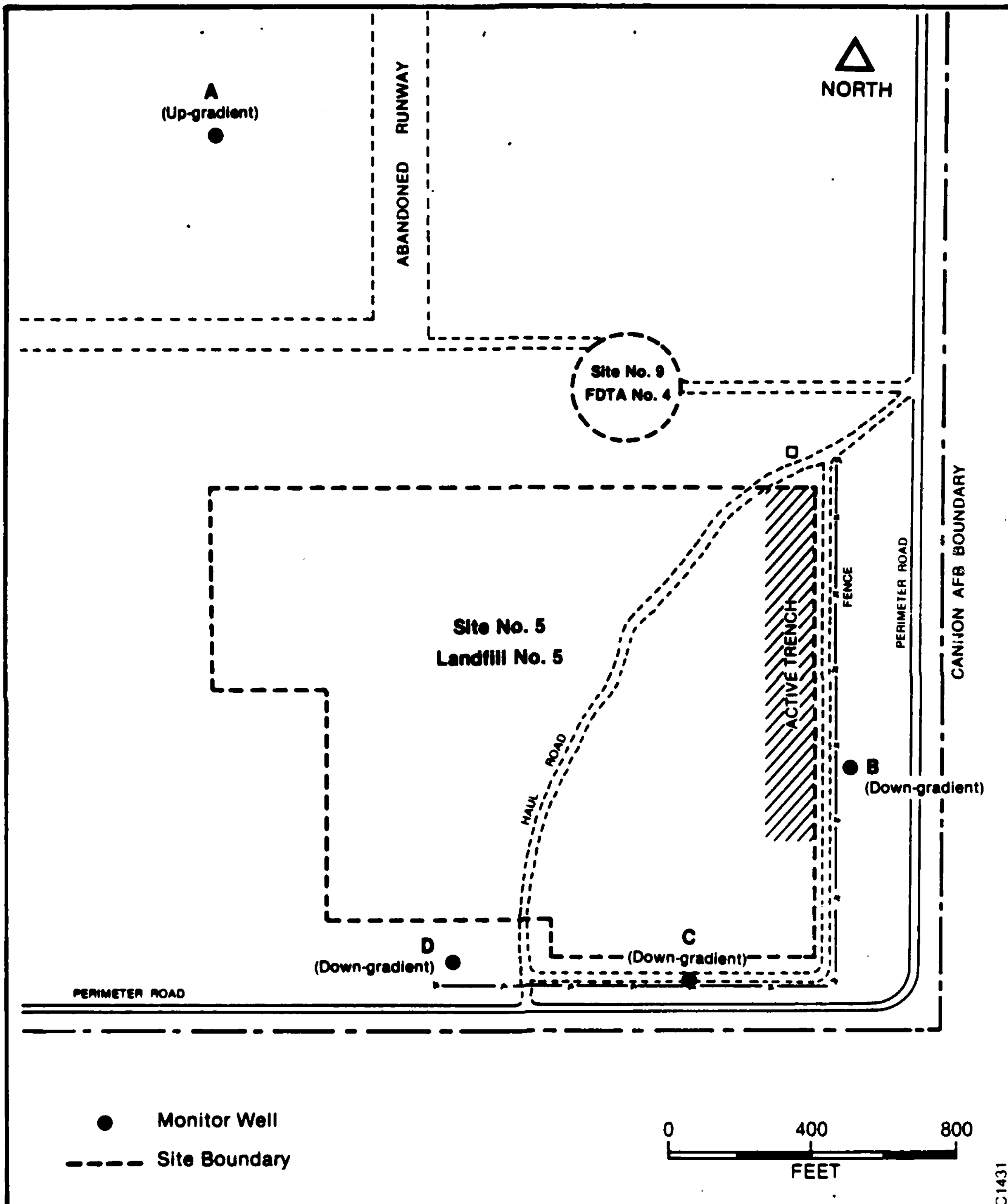


Figure 4-6. Monitor Well Locations, IRP Phase II Stage 1, Site No. 5, Landfill No. 5, Cannon AFB, New Mexico

in one former cell. In addition, the landfill is within 200 feet of the base boundary and within 200 to 300 feet of an off-site private irrigation well.

Monitor Well Installation

Four monitor wells were installed in Landfill No. 5 to assess the hydrogeologic conditions of the landfill and to determine if contaminants had migrated through the caliche caprock and underlying sediments into the Ogallala Aquifer.

The four monitor wells were positioned in a one up-gradient, three down-gradient configuration to serve two purposes. The primary objective was to provide determination as to the nature, extent and rate of migration of possible ground-water contaminants emanating from the site. The second objective was to potentially satisfy the requirements of the Resource Conservation and Recovery Act (RCRA) as it applies to active hazardous waste management facilities. The facility became inactive in 1980. Only one cell required RCRA monitoring (the 1980 cell).

The ground-water monitoring system was designed according to RCRA specifications. Monitor Well A was placed hydraulically up-gradient (i.e. in the direction of increasing static head) from the limit of Landfill No. 5 (Figure 4-6). The well location and depth was considered sufficient to yield ground-water samples representative of background conditions up-slope from Landfill No. 5.

Three monitor wells were installed hydraulically down-gradient from the landfill (Figure 4-6). The final well locations were determined partly with the assistance of base personnel who located specific disposal areas (particularly the 1980 Landfill No. 5 area), and by reviewing air photos and conducting field investigations of the landfill. Each down-gradient monitor well was placed within 200 feet of the landfill boundary to ensure that any hazardous waste constituents disposed of in the landfill would immediately be detected by the monitor wells screened in the uppermost portion of the

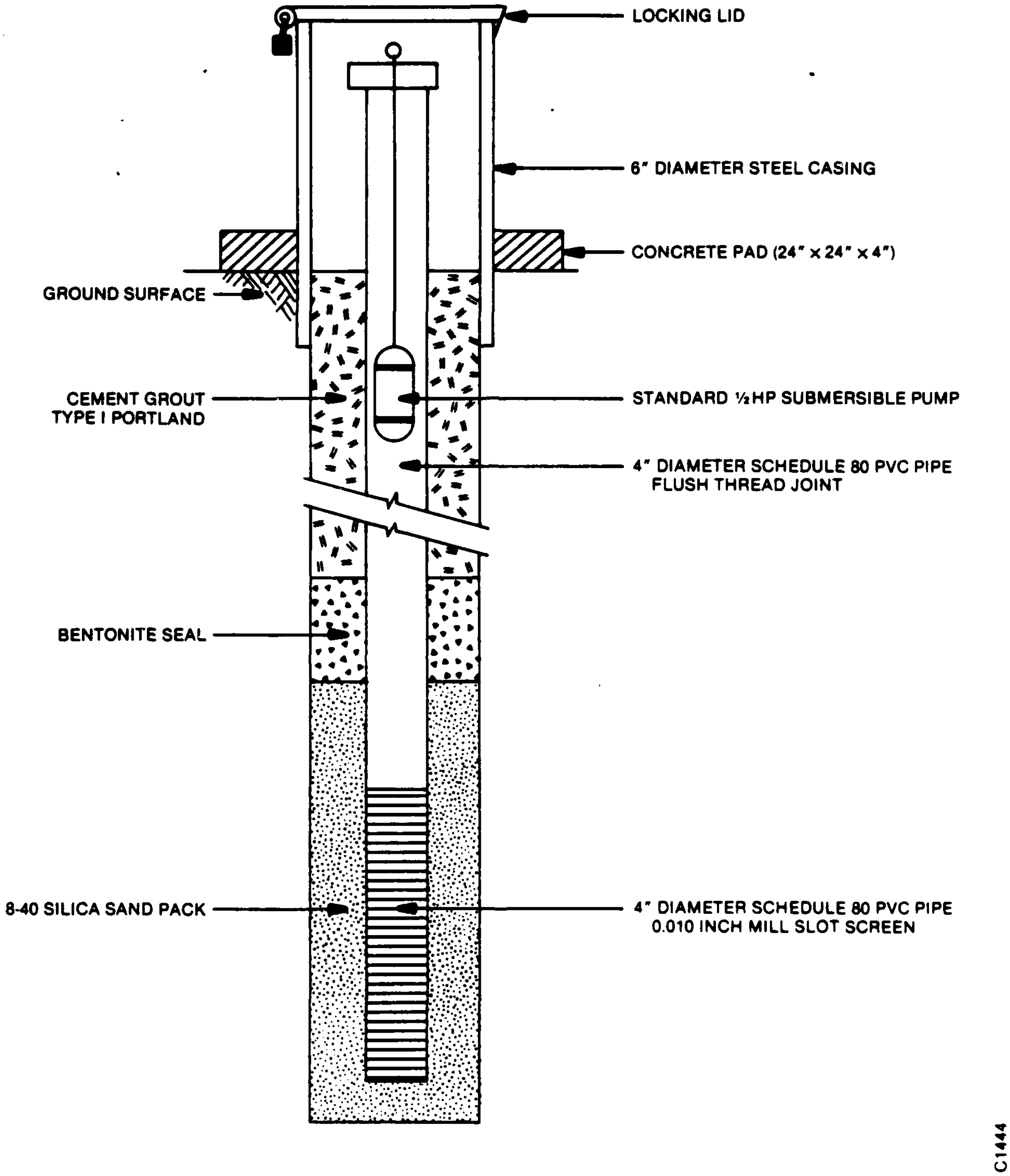


Figure 4-7. Schematic Diagram of a Ground-Water Monitoring Well, IRP Phase II Stage 1, Site No. 5, Landfill No. 5, Cannon AFB, New Mexico

Ogallala Aquifer. The well specifications of all the monitor wells are discussed in Section 3.1.2 of the report. A schematic diagram of the monitor wells is presented in Figure 4-7.

The following discussions regarding Landfill No. 5 are derived from geologic sampling information gathered during the installation of the four monitor wells. Monitor Well A was positioned up-gradient from the landfill, Monitor Wells B, C, and D were positioned down-gradient from the landfill boundary. The geologic discussion of Landfill No. 5 is divided into up-gradient and down-gradient conditions based on Monitor Well A and Monitor Wells B, C, and D respectively. Lithologic logs and well completion schematics of the four monitor wells are presented in Appendix E of the report.

Topography

The topography in the Landfill No. 5 area is fairly flat, sloping gently to the southeast which is consistent with the regional slope in the base area. The drainage system is dynamic as trenching and backfilling activities either intercept or redirect surface waters during rainfall events. A small playa lake located in the western portion of the landfill collects some surface water runoff from the landfill, although most runoff drains internally into trenches and other depressions created by landfill activities.

4.2.5.1 Monitor Well A (up-gradient)

Geologic Conditions

The soils underlying the area near Monitor Well A are the Amarillo Loam type. The Amarillo Loam is about 4 feet thick and consists chiefly of calcareous sands, silts and clay. The Amarillo Loam forms a distinct contact with the underlying caliche in the area at about 4 feet below the land surface. The caliche profile extends from 4 feet to approximately 60 feet in depth in this area and is characterized by interbedded silt and sand lenses throughout the interval. The sand units within the caliche are generally fine to medium grained, poorly sorted, unconsolidated with minor amounts of lithic fragments present. The sand is slightly calcareous, the calcite being derived principally from the caliche. Generally, silt is predominant in the upper portion of the caliche profile. Within the caliche profile are chert beds less than 1 foot thick and occasional nodules of "calcrete", extremely hard, rock-like concretions of calcite and sand.

Below 60 feet, the percentage of caliche decreases, and the sand becomes more coarse with depth. Also, occasional lenses of pebble sized gravel less than 1 foot thick are present within this zone. The sand is chiefly fine to medium grained, unconsolidated, and poorly sorted. From 195 feet to 225 feet in depth, the sediments are predominately sand and clay with minor amounts of gravel with reworked shales, and siltstone. From 225 feet to 325 feet, the sediments are mainly interbedded sands and gravel with minor amounts of clay.

From 325 feet to 343 feet (total depth), the sediments become more coarse grained, consisting primarily of unconsolidated sand and gravel interbedded with extremely well cemented conglomeratic lenses of sand and gravel. Silica and calcite are the dominant cementing agents that produce the sand and gravel conglomerate in this zone.

Occurrence of Water

Ground-water was first encountered in Monitor Well A at about 325 feet in depth. The borehole was advanced at least 15 feet into the upper portion of the Ogallala Aquifer as specified in the Scope-of-Work. The completion depth of Monitor Well A was 343 feet below land surface. After drilling was terminated, the borehole was allowed to stand open for 12 hours, to allow the water level to stabilize prior to setting the screen and casing. The static water level in the borehole rose to 260 feet below land surface indicating that the Ogallala Aquifer is semi-confined in the area. The well completion log of Monitor Well A are presented in Appendix F.

4.2.5.2 Monitor Wells B, C, D (down-gradient)

The following discussion of the area down-gradient of Landfill No. 5 is derived from geologic sampling and from reconnaissance information collected at the landfill. A geologic cross-section (A-A') including the three Phase II Stage 1 down-gradient wells is presented in Figure 4-8. The location of cross-section A-A' is shown in Figure 4-9.

Geologic Conditions

The topsoil in Landfill No. 5 is red-brown in color and composed of fine to medium grained unconsolidated sand. A poorly defined subsoil exists from 4 to 4.5 feet that contains slightly consolidated silt and sand. A sharp contact exists between the soil and caliche in this area at about 4.5 feet in depth.

The caliche profile in Landfill No. 5 is first encountered at about 4.5 feet below land surface and continues to about 65 feet in depth. Within the caliche profile are layers of silt and weakly cemented sand. The total thickness of the caliche is about 60 feet in the landfill. From 65 feet to about 185 feet in depth, sand grain size to coarsen downward and the amount of cementation between the grains decreases.

A distinctive 10 foot thick clay lens is present below the landfill between 190 and 195 feet in depth. The clay is brown, silty and exhibits low plasticity. Beneath the clay are thickly bedded, fine to coarse grained, unconsolidated sands, silts and gravels.

At approximately 340 feet an extremely hard, cemented sand and gravel conglomerate exists. Beneath the conglomerate are alternating beds of unconsolidated sand and gravel as well as interbedded sand and gravel conglomerates of similar lithologies. Water-bearing lenses are first encountered in the unconsolidated sediments below the conglomeratic zone at about 342 feet in depth. The water-bearing zones consist of sand and gravel with minor amounts of reworked shale and other lithic fragments.

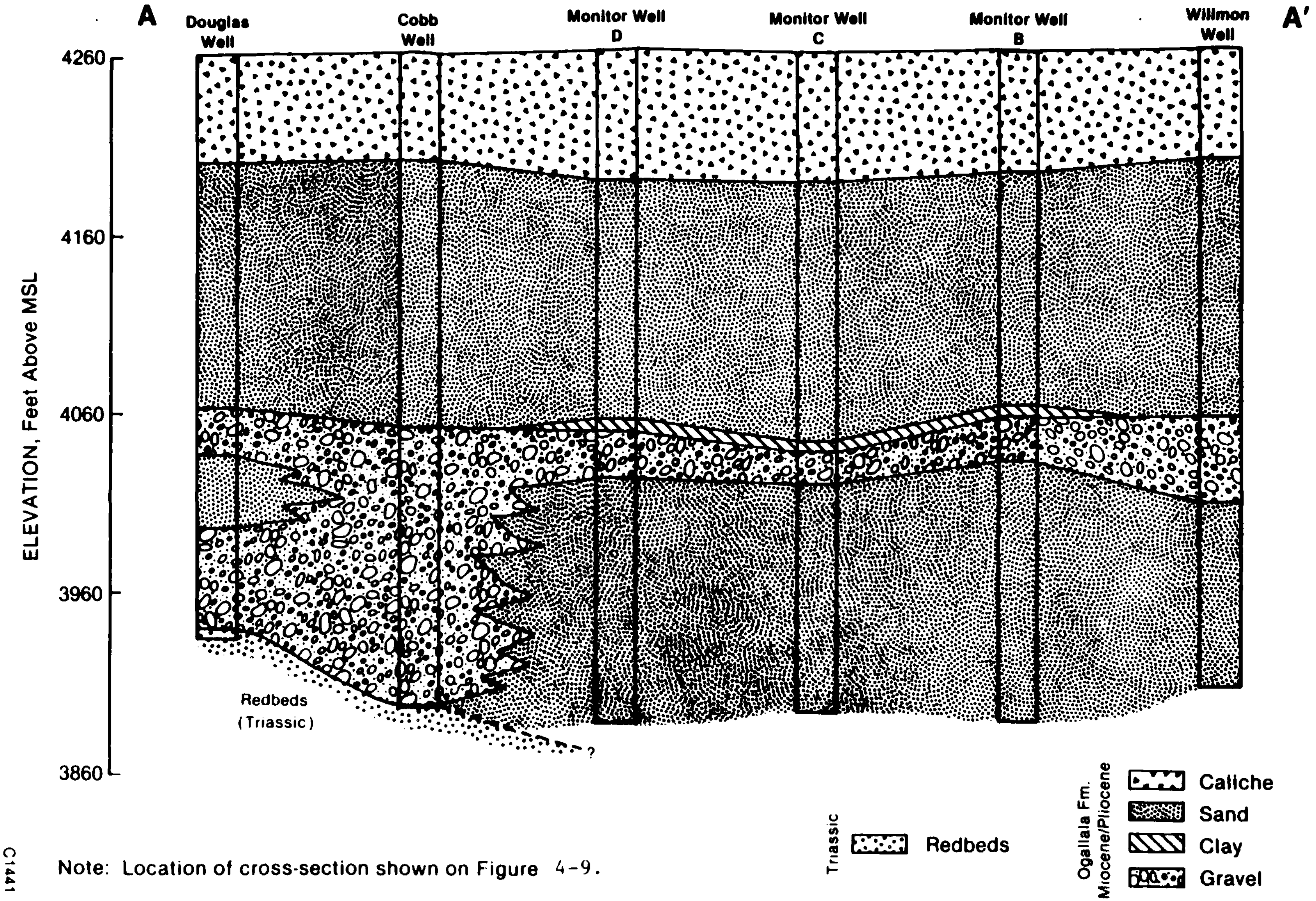
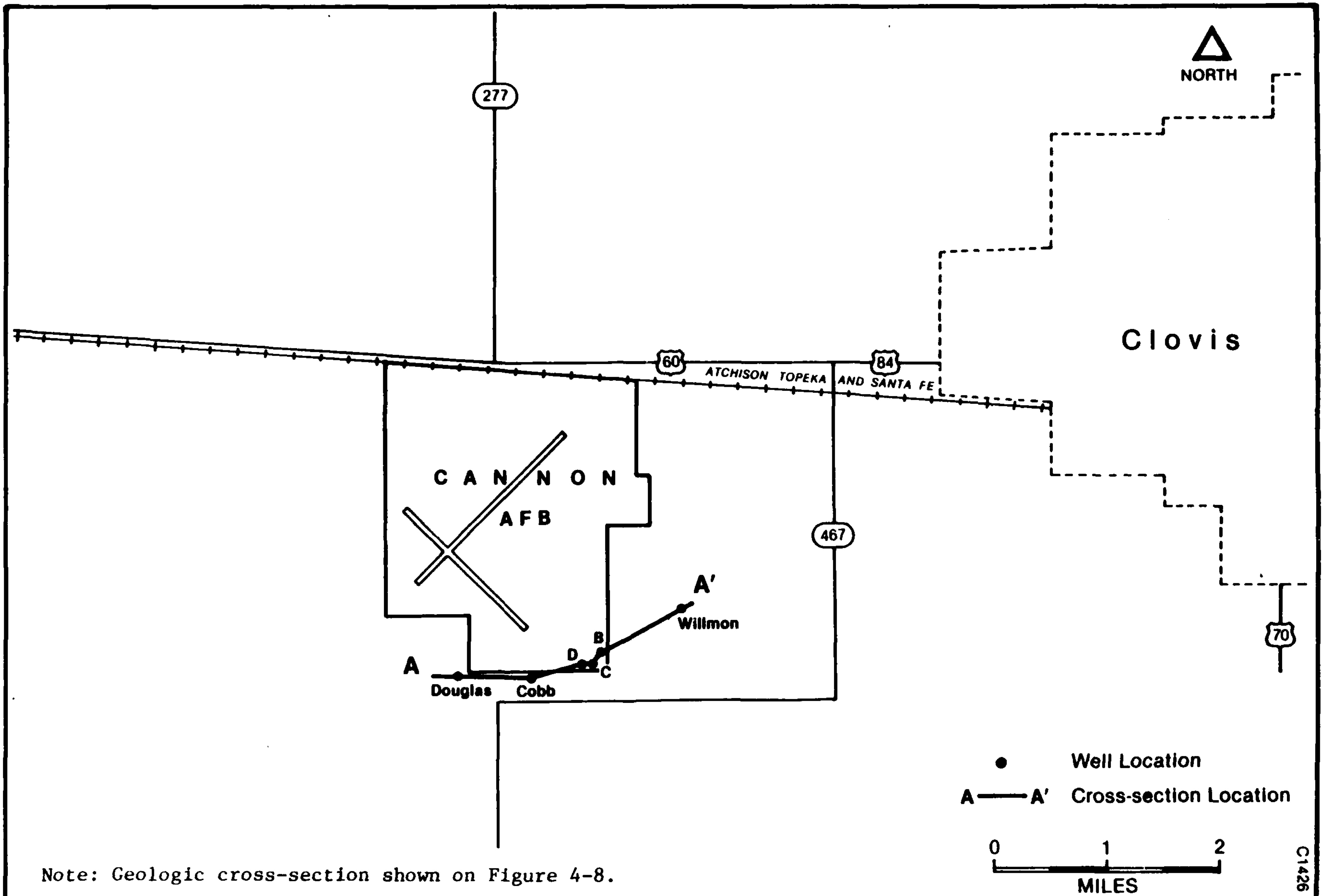


Figure 4-8. Generalized Geologic Cross-Section, A-A', IRP Phase II Stage 1, Cannon AFB, New Mexico



Note: Geologic cross-section shown on Figure 4-8.

Figure 4-9. Location of Geologic Cross-Section A-A', Cannon AFB and Vicinity, New Mexico

Occurrence of Water

Ground water was first encountered beneath Landfill No. 5 at about 342 feet. Above 342 feet, cementation of the sand and gravel is sufficient to fill the pore spaces of the grains creating a conglomerate of low permeability that acts as a partial barrier to ground-water flow. Below the conglomerate are thin unconsolidated water-bearing sands and gravels. The three down-gradient monitor wells in Landfill No. 5 were advanced at least 15 feet into the saturated portion of the Ogallala Aquifer as specified in the Scope-of-Work, and completed.

4.2.5.3 Water Level Maps

Figure 4-10 shows the altitude of water levels in the area around Cannon AFB for the period of January-February 1982. The map is based on a round of water level measurements made on a selection of observation wells by the U.S. Geological Survey and the State Engineer's Office. The period of January-February 1982 represents the last time a sufficiently large number of wells were sampled to allow a realistic construction of a water level map. Figure 4-11 represents a water level elevation map constructed using most recent available data extrapolated forward to January-February 1984 (based on average annual water level declines calculated by area).

Both the 1982 and the 1984 maps indicate that the direction of ground-water flow is generally to the east and southeast. Exceptions occur in those areas where increased ground-water withdrawals impose localized flow patterns on the water surface. This effect is shown northwest of Cannon AFB where extensive ground-water pumping for agriculture is lowering the water levels locally.

The slope of the water table is to the east and southeast at 7 to 15 feet per mile. This inclination corresponds with the southeast regional dip of the Ogallala Formation which is 10 to 15 feet per mile in the area around Cannon AFB.

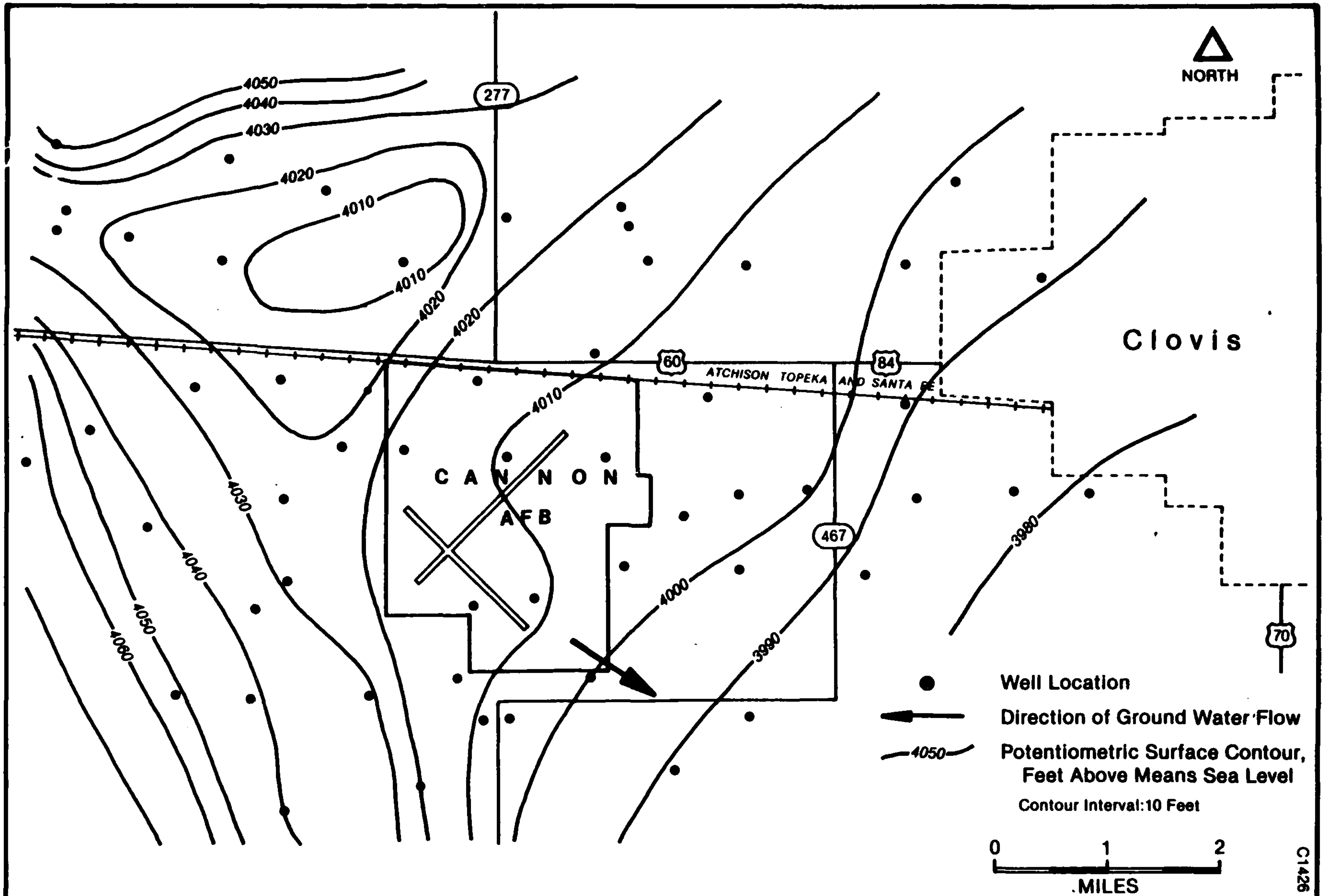


Figure 4-10. Ground-Water Elevation in the Vicinity of Cannon AFB, New Mexico - January - February 1982

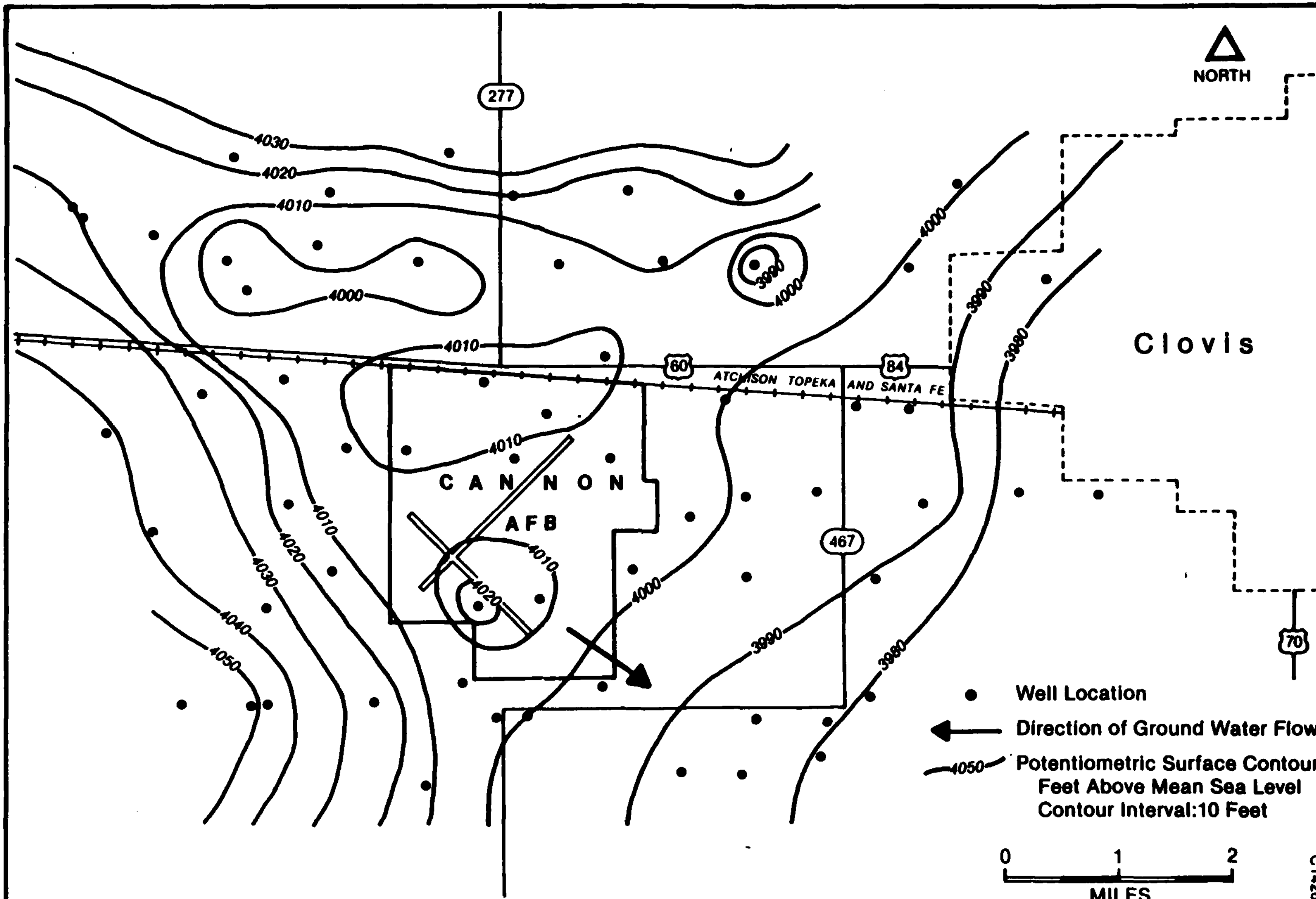


Figure 4-11. Estimated Ground-Water Elevations in the Vicinity of Cannon AFB, New Mexico - Data Extrapolated to 1984

Beneath Cannon AFB, the water level slope is flatter than in the remainder of the area around Cannon. Although very localized depressions in the water level surface occur adjacent to large extraction wells, the elevation of the water surface falls between 4000 and 4010 feet above mean sea level and averages 4003 feet above MSL.

4.2.5.4 Ground-Water Quality

Ground-water samples were collected from each of the four monitor wells installed at Landfill No. 5. The sampling and analytical schedules are included in Tables 3-2 and 1-7, respectively. Analytical parameters were specified in the Statement-of-Work to respond, in part, to the RCRA ground-water monitoring requirements, and to provide appropriate indicator parameters of potential landfill-generated contamination.

The results of ground-water analyses from all monitor well samples are summarized in Table 4-9. Analytical data reporting forms are included in Appendix A.

A review of these data indicates that ground-water conditions up-gradient and down-gradient of Landfill No. 5 are very similar. None of the samples collected exceed current drinking water standards for any of the parameters tested. Trichlorofluoromethane at a concentration of 2.1 ug/L, was identified in the water sample from up-gradient Monitoring Well A but was not detected in any of the down-gradient samples. No other volatile aromatic or halocarbon compounds were detected in any of the samples.

Significance of Findings

The four monitoring wells were installed in a one up-gradient, three down-gradient configuration in accordance with RCRA (264,265). Water level elevations recorded throughout the field investigation show that the flow gradient trends to the southeast from up-gradient monitor well A to down-gradient monitor wells B, C, and D. A water level map, constructed from information

TABLE 4-9. RESULTS OF WATER SAMPLES, IRP PHASE II STAGE 1, SITE NO. 5 MONITOR WELLS A-D, CANNON AFB, NEW MEXICO

Parameter	Well A*	Well B	Well C	Well D
Ag	ND	ND	ND	ND
As	0.0060	ND	0.0004	0.0005
Ba	0.074	0.320	0.079	0.150
Ca	37.0	55.0	44.0	45.0
Cd	ND	0.003	0.002	ND
Cl	53.0	50.0	50.0	51.0
Cr	0.001	0.002	ND	0.004
Cu	ND	ND	ND	0.002
Fe	0.020	0.34	0.020	0.047
F	2.6	2.7	2.6	2.4
Hg	0.0004	0.0006	0.0004	0.0006
K	3.7	4.7	3.7	4.1
Mg	37.0	38.0	40.0	36.0
Mn	0.021	0.760	0.330	0.520
Na	60.0	62.0	57.0	53.0
Ni	0.032	0.035	0.035	0.030
NO_3	0.81	0.81	0.82	0.88
Pb	ND	ND	ND	ND
Phenol	ND	0.041	ND	ND
Se	ND	ND	ND	ND
SO_4	120.0	130.0	120.0	110.0
TDS	490.0	440.0	450.0	430.0
TOC	ND	2.0	1.0	ND
TOX	ND	ND	ND	ND
TPO_4	0.06	0.05	0.04	0.05
Zn	0.015	0.010	0.010	ND
601**	2.1	ND	ND	ND
602***	ND	ND	ND	ND
Cond.	740/750/750/750*	810	740	720
pH	7.6/7.5/7.4/7.4*	7.6	7.2	8.2

(all units mg/L (equivalent to ug/ml default values in Appendix A) except pH, which is expressed in pH units, and conductivity (Cond.), which is in umhos, and 601/602 results which are reported in ug/L)

*Quadruplicate analyses for up-gradient well only
**601 = purgeable halocarbons (Trichlorofluoromethane)
***602 = purgeable aromatics
ND = not detected, detection limits and analytical techniques are listed in Appendix A.

obtained April 4, 1985 during the first quarter samples of the four wells, is presented in Figure 4-12.

The chemical analyses of water samples from the single up-gradient and the three down-gradient monitoring wells indicate that no ground-water contamination attributable to past or ongoing activities at Landfill No. 5 exists at this time. The thick (>60 ft.) caliche caprock, the local semi-confined aquifer conditions, and the deep occurrence of ground water combine to make landfill leachate migration into the ground water unlikely.

The relatively low permeability of the caliche, clay, and conglomeratic units overlying the water-bearing strata of the Ogallala Formation would impede downward percolation of potential leachate. Furthermore, the thick accumulation of over 300 feet of overlying unsaturated sediments afford a potential mechanism for adsorption and attenuation of any contaminants which might be migrating downward through the section.

The trichlorofluoromethane identified in the water sample from Monitor Well A is not attributable to Landfill No. 5, since the well is located up-gradient of the disposal site. Trichlorofluoromethane is commonly laboratory interference compound acquired during sample processing. Trichlorofluoromethane (freon) also shows up in samples due to refrigeration in the laboratory. Due to its highly volatile nature, it has occasionally been found at trace concentrations in sample blanks and in otherwise uncontaminated samples. Scheduled future RCRA sampling of the landfill monitor wells should alleviate the uncertainty concerning the source of this compound.

4.2.6 Site No. 6 - Fire Department Training Area No. 1

During the period of 1959 to 1968, this fire training area was operated on the northeast corner of the base. No evidence of recent use is apparent, although an approximately 100-foot-diameter previously disturbed area with sparse vegetation is recognizable. Waste oils, fuels, and solvents were

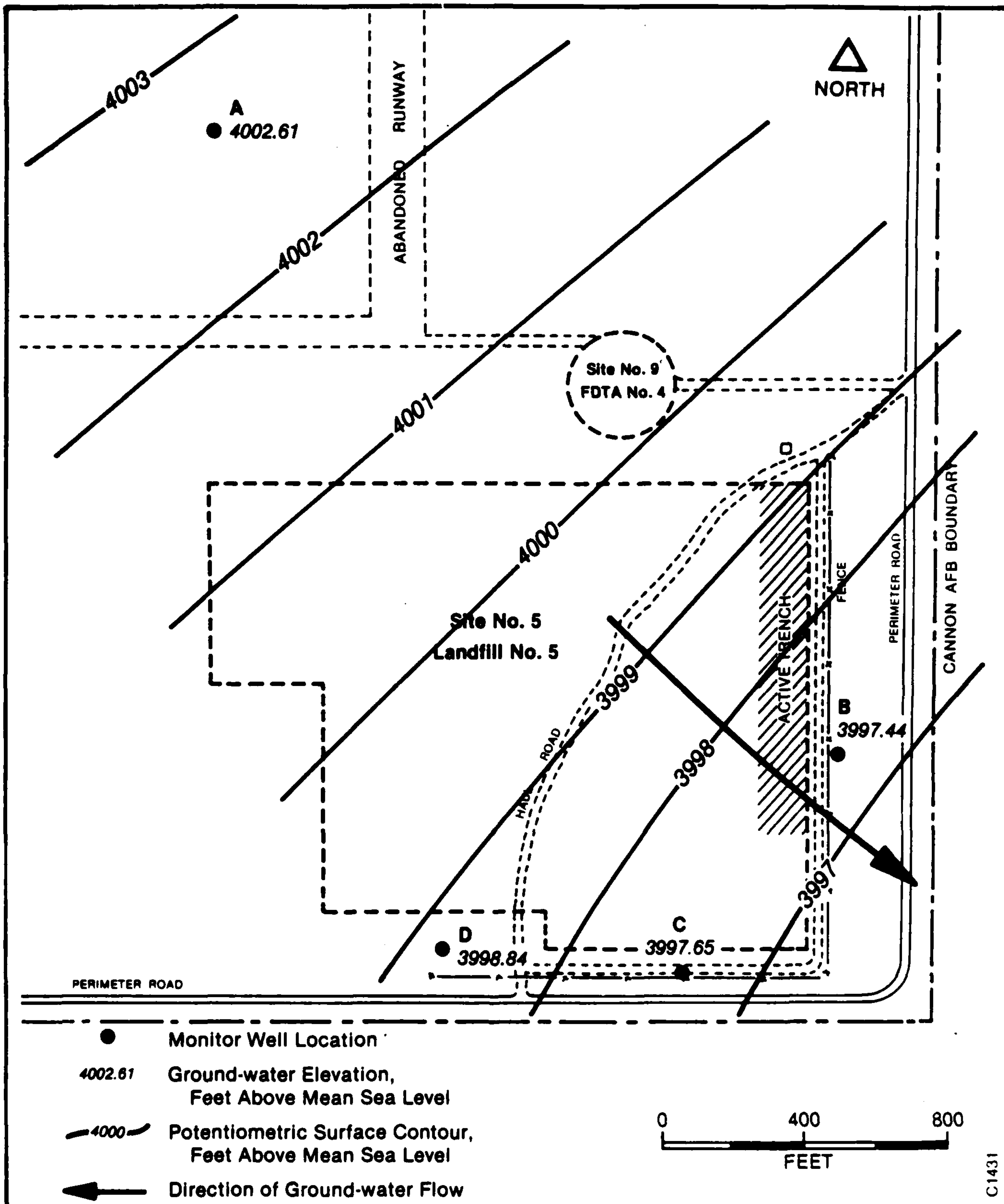


Figure 4-12. Water Level Elevation Map of Landfill No. 5, IRP Phase II Stage 1, Cannon AFB, New Mexico (Measured 4 April 1985)

burned on the ground to provide practical fire training experience. Prior to some of the exercises, reportedly the ground was pre-saturated with water. However, some residual quantities of the waste liquids may have percolated into the subsurface.

Fire Training Area No. 1 was included in the Phase II Stage 1 study because of the known disposal of hazardous wastes and proximity to the installation boundary. A potable water well (No. 5) is also located approximately 2800 feet from the site. Two deep soil borings were drilled at Site No. 6 to evaluate the extent of potential environmental contamination associated with past fire training exercises and to define subsurface conditions. Figure 4-13 shows the locations of borings at Site No. 6.

Topography

The topography at Site No. 6 is flat and partially barren due to previous training activities, and metal debris is exposed on the land surface. No berms or depressions exist to capture or route surface waters from the site, and no drainages are present in the vicinity of the fire training area.

Geologic Description

The topsoil below the site is sandy with roots and other organic matter. The total thickness of the topsoil is 4 feet thick.

Caliche is first encountered at 4 feet and continues to 45 feet. The caliche is composed of interbedded calcite nodules and silt layers less than 2 feet thick. At several depths, the caliche is extremely well indurated forming hard zones of "calcrete". The total thickness of the caliche at Site No. 6 is about 15 feet.

The two soil borings were advanced below the caliche and into a soft, unconsolidated sand where samples were taken. The total depths of boreholes 6A and 6B were 48.5 feet and 47.5 feet, respectively.

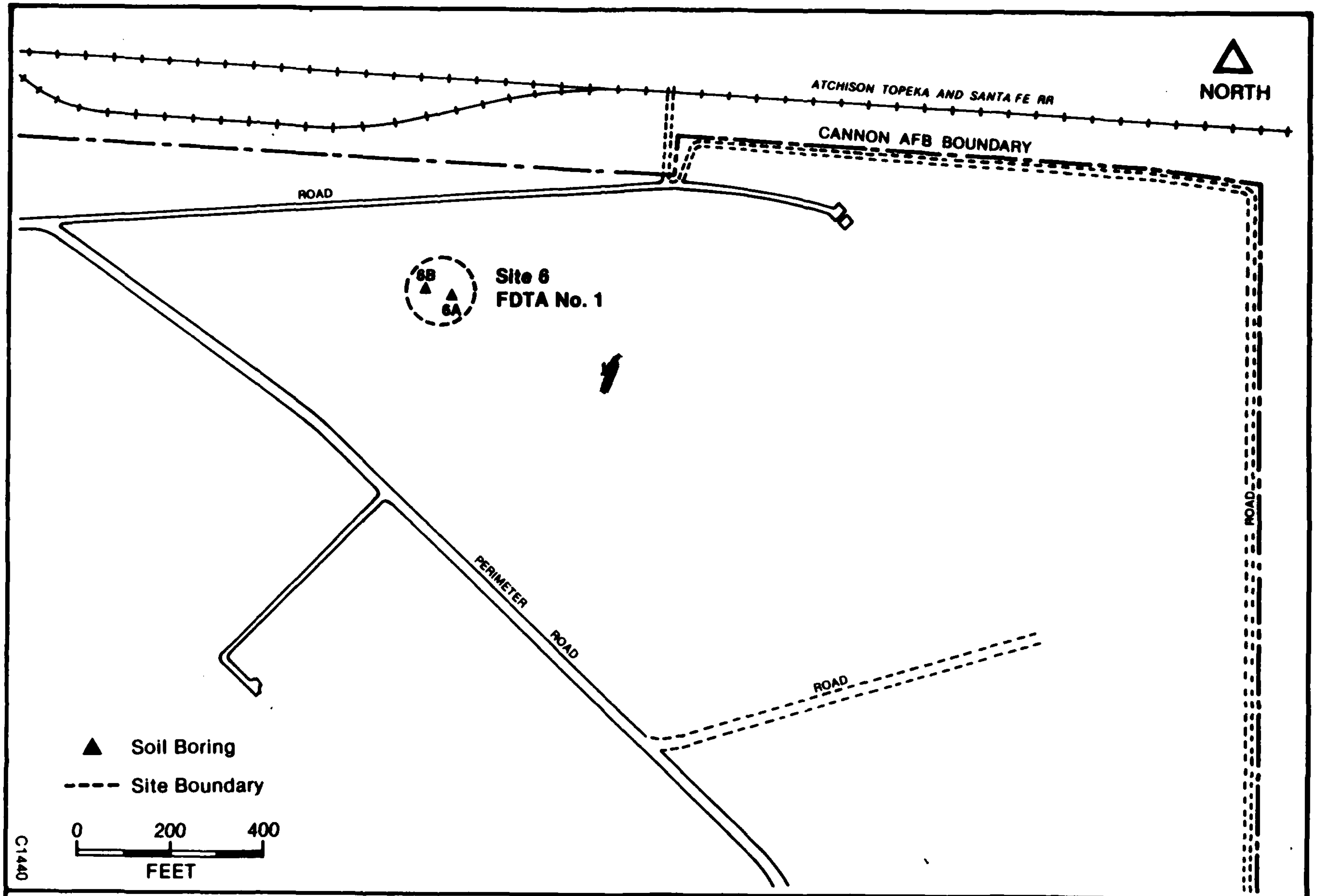


Figure 4-13. Soil Boring Locations, IRP Phase II Stage 1, Site No. 6, Fire Department Training Area No. 1, Cannon AFB, New Mexico

Soil Chemistry

Three types of analyses were run on the soil samples collected: oil and grease; lead; and purgeable halocarbons (EPA Method 8010) and purgeable aromatics (EPA Method 8020). Resulting data are summarized in Table 4-10. It is noteworthy that these samples were analyzed for oil and grease by the gravimetric method, rather than the IR method.

No purgeable halocarbon or aromatic compounds were found in the soil samples collected. Lead was detected in concentrations between 3.2 and 28 mg/kg in soil boring 6A and 1.8 to 23 mg/kg in soil boring 6B. Oil and grease was found in quantities ranging from 1700 to 2800 mg/kg in soil boring 6A and between 140 mg/kg and 520 mg/kg in soil boring 6B.

Significance of Findings

Oil and grease concentrations were higher in soil boring 6A than in soil samples from the other sites on-base where oil and grease were analyzed. However, as indicated, these analyses were performed by the gravimetric method which tends to yield generally higher values than IR. Thus, these values are not directly comparable with oil and grease concentration determined at other sites by IR.The deepest sample retrieved from soil boring 6A contained the least amount of oil and grease, as expected. A likely explanation for the lower oil and grease values with depth could be the caliche underlying the site which forms a barrier between the shallow, more contaminated zones and underlying sand first encountered at about 47 feet.

The elevated levels of oil and grease do not pose a significant threat to the ground water, as the Ogallala Aquifer is isolated hydraulically 340 feet below the area and is not recharged from downward percolation from this portion of the base. Since there are no surface drainages in the vicinity of the site, no impacts are expected to surface water quality.

4.2.7 Site No. 7 - Fire Department Training Area No. 2

Fire Training Area No. 2 was used from 1968 to 1974 to provide base personnel with practical experience in extinguishing fires. The site is located in the southeast corner of the base and is recognizable as a circular, sparsely vegetated area. Unused JP-4 was the only material burned at this

TABLE 4-10. RESULTS OF ANALYSIS OF SOIL SAMPLES, IRP PHASE II STAGE 1, SITE NO. 6, FIRE DEPARTMENT TRAINING AREA NO. 1 CANNON AFB, NEW MEXICO

Sample #	Depth	O&G*	Pb*	Purgeable Organic Compounds** (EPA 8010/8020)
6A-1	3.8-4.8'	2000	4.5	ND
6A-2	9.6-10.6'	2800	3.2	ND
6A-3	47.5-48.6'	1700	28	ND
6B-1	3.5-4.5'	520	3.8	ND
6B-2	9.5-10.5'	140	23	ND
6B-3	47.5-48.0'	310	1.8	ND

*concentrations in mg/kg
**concentrations in ug/kg
ND = not detected, detection limits and analytical techniques are listed in Appendix A.

site. Before each training exercise, the ground was pre-soaked with water to minimize infiltration of any residual fuel. The potential for significant environmental contamination at this site is considered low. Thus, only one deep boring was placed to determine the impact on this site (Figure 4-14).

Topography

The land surface at Site 7 slopes south from the abandoned runway into two small depressions. Soil boring 7 was placed at the lowest point of the larger of the two depressions as this was the most likely area for hydrocarbons to accumulate. The depression where soil boring 7 was located contains a one-foot berm around the perimeter of the fire training area. All

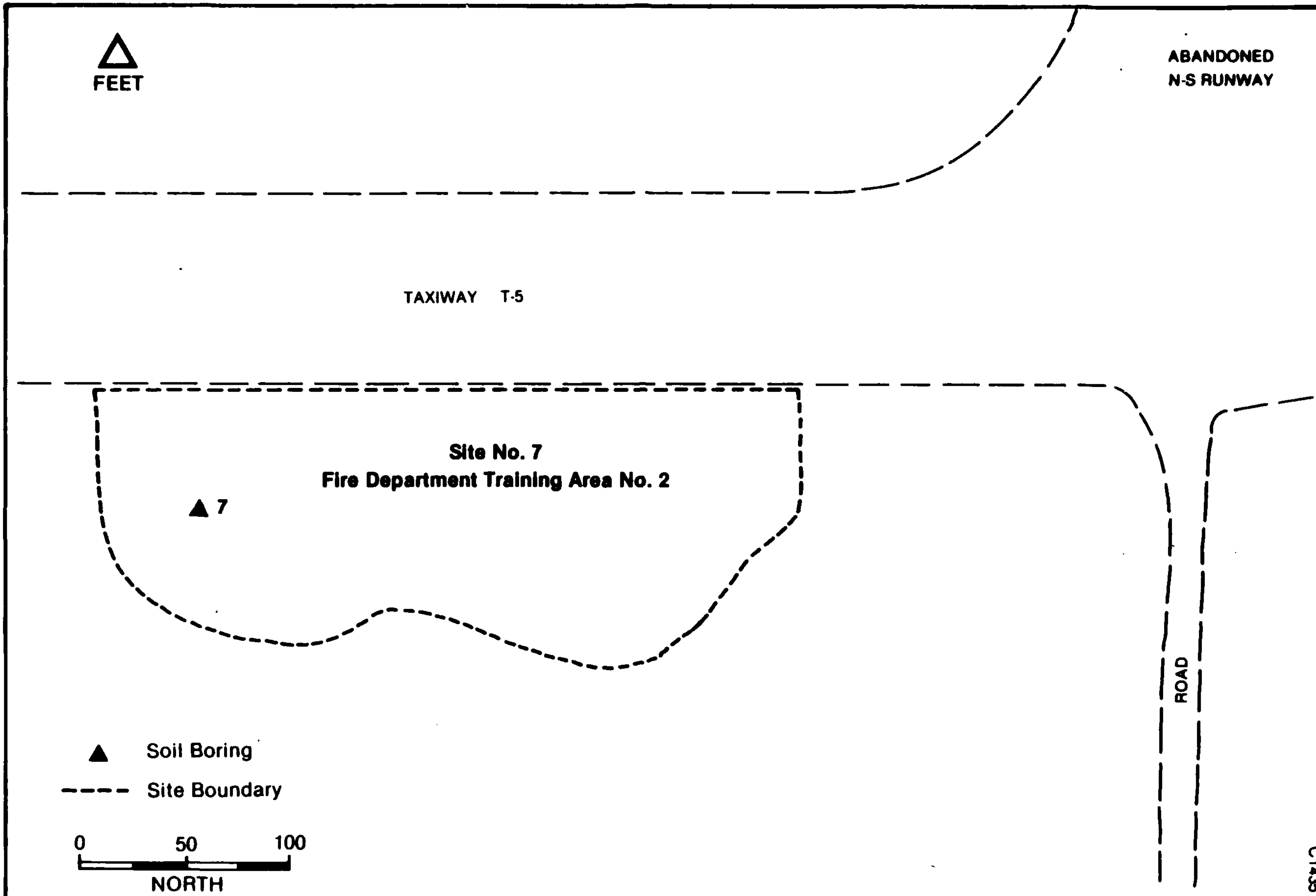


Figure 4-14. Soil Boring Locations, IRP Phase II Stage 1, Site No. 7, Fire Department Training Area No. 2, Cannon AFB, New Mexico

drainage is internal within the site. There are no surface water drainages in the vicinity of the fire training area.

Geologic Description

The topsoil in Site No. 7 averages about one-foot thick in the area and is composed of fine silty sand. The caliche below the site first occurs at two feet, with the upper contact characterized by a hard zone about 8 inches thick. Caliche with interbedded silt is present from two feet to about 47 feet in depth. The total thickness of the caliche is 45 feet. Within the caliche profile are clay lenses which exhibits poor plasticity and contain about 20 percent silt. From 47.0 feet to the final depth of 58.3 feet, the sediments are silty sand consisting of medium grained beds with occasional hard caliche clasts throughout. Soil samples were obtained from 1.0-2.5 feet, 5.0-6.0 feet, and from 57.3 to 58.3 feet. Lithologic descriptions of the samples are contained in Appendix E.

Soil Chemistry

Three samples were collected from Fire Training Area No. 2. The samples were analyzed for oil and grease, lead, and purgeable halocarbons and aromatics. The data are summarized in Table 4-11.

Oil and grease analyses were performed by gravimetric methods for samples collected at Fire Department Training Area No. 2. One sample, 7-3, was not analyzed for purgeable organic compounds (EPA Method 8010/8020) as the sample was discarded after duplicate analysis for oil and grease. Sample, 7-3, was rerun for oil and grease using the Infra Red (IR) method which yielded a significantly lower oil and grease than the gravimetric concentration method. The detection limits for oil and grease using gravimetric and IR methods vary greatly which likely resulted in two dissimilar values for the same sample. Using gravimetric techniques, the detection limit for oil and grease is 200 mg/kg. Using IR methods the detection limit is 10 mg/kg. The oil and grease results from the analyses of 7-3 using these two methods (8600 mg/kg and 80 mg/kg respectively) represent the sensitivity differences in the two techniques. Since the gravimetric method is a less precise method quantitatively (based upon the detection limit), it is reasoned that the rerun value of 80 mg/kg for sample 7-3 (using IR) is more realistic of the levels found at that depth.

Samples from two other sites, Site 6 (FDTA No. 1) and Site 8 (FDTA No.3) were analyzed for oil and grease using gravimetric methods. All other soil and groundwater samples at the base were analyzed using IR methods for oil and grease as required.

Lead concentrations from all three samples are consistently low and within the common range for soils. The two oil and grease results from sample 7-3 vary by more than two orders-of-magnitude and are thus considered anomalous. Oil and grease concentration in the two shallower samples range from 1000 to 3400 mg/kg.

TABLE 4-11. RESULTS OF ANALYSIS OF SOIL SAMPLES, IRP PHASE II STAGE 1, SITE NO. 7, FIRE DEPARTMENT TRAINING AREA NO. 2, CANNON AFB, NEW MEXICO

Sample #	Depth	O&G*	Pb*	Purgeable Organic Compounds** (EPA 8010/8020)
7-1	1.0-2.5'	1000	3.1	ND
7-2	5.0-6.0'	3400	3.9	ND
7-3	57.4-58.0'	8600 (80)	3.9	NA

*concentrations in mg/kg
**concentrations in ug/kg
( ) re-analysis using infrared methods
ND - not detected, detection limits and analytical techniques are listed in Appendix A
NA - not analyzed, sample discarded

Significance of Findings

Oil and grease is the only parameter of potential concern at Site No. 7. However, due to the anomalous oil and grease results for sample 7-3, no trends in oil and grease concentration with depth can be identified. It is expected that sample inhomogeneity and naturally occurring organics may account for some part of the observed concentrations as determined by gravimetric methods. The variability in results using the two methods, gravimetric and IR for oil and grease from sample 7-3 is apparent. However, it is reasoned that the value of 80 mg/kg oil and grease are more precise and representattive of the concentration of oil and grease at that depth.

Site No. 7 is small and bordered on the south side by a berm, and there are no drainages near the site. The Ogallala Aquifer is about 340 feet below the site. It is not recharged by precipitation in this area as the arid environment does not produce sufficient amounts of rainfall to saturate the vadose zone above the Ogallala Aquifer. Therefore, based on available data, Fire Training Area No. 2 does not pose a threat to surface or ground water in the vicinity.

4.2.8 Site No. 8 - Fire Department Training Area No. 3

Fire Training Area No. 3, used concurrently from 1968 to 1974 with Fire Training Area No. 2, is also located in the southeast corner of the base (Figure 4-15). The site is similar in appearance to Fire Training Area No. 2 (previously described) and no evidence of recent activity is apparent. Site exercises were conducted in the same manner (water pre-soaked soil) and with the same fuel (fresh JP-4) as at Site No. 7. Using the same rationale as applied to Site No. 7, a single deep boring was made at Fire Training Area No. 3.

Topography

The topography of Site No. 8 (Fire Training Area No. 3) is fairly flat, sloping gently to the east across the site. Soil boring 8 was emplaced

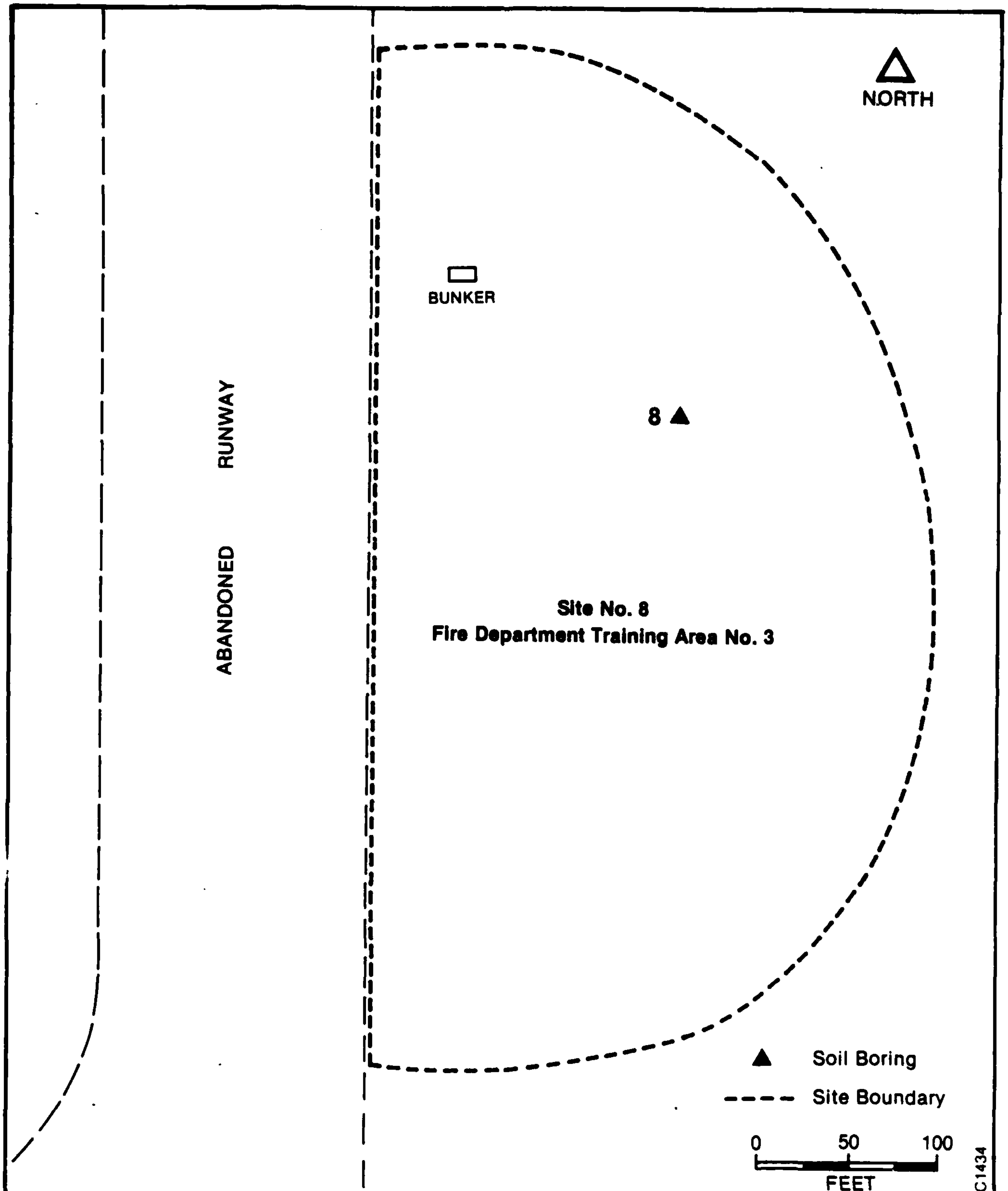


Figure 4-15. Soil Boring Location, IRP Phase II Stage 1, Site No. 8, Fire Department Training Area No. 3, Cannon AFB, New Mexico

in the lowest portion of the site where the greatest amount of contaminants were expected to accumulate. A low berm (less than one foot high) encircles the site and forms the site boundary for the fire training area. Drainage in the site is to the southeast, and is achieved through overland flow. There are no defined drainages in the vicinity.

Geologic Description

The topsoil in Fire Training Area No. 3 is about 4 feet thick in the area and composed primarily of red-brown silty sand. The topsoil/caliche contact occurs at 4.0 feet and is characterized by a hard, white caliche layer in the upper portion of the profile from four to five feet below the surface. Caliche and silt stringers are common throughout the interval from 5.0 feet to about 50 feet below the site. No contaminants were observed during the drilling process. The soil boring was bottomed at 61.5 feet in soft, silty sand below the caliche profile. Soil samples were retrieved and analyzed at 2.5 feet, 9.5 feet, and 61.5 feet. The geologic log of Fire Training Area No. 3 are presented in Appendix E.

Soil Chemistry

Soil samples were analyzed for oil and grease, lead, and purgeable halocarbons and aromatics. Resulting data are presented in Table 4-12. The oil and grease analysis was done by the gravimetric method.

TABLE 4-12. RESULTS OF ANALYSIS OF SOIL SAMPLES, IRP PHASE II STAGE 1, SITE NO. 8, FIRE DEPARTMENT TRAINING AREA NO. 3, CANNON AFB, NEW MEXICO

Sample #	Depth	O&G*	Pb*	Purgeable Organic Compounds (EPA 8010/8020) (ug/kg)
8-1	1.5-2.0'	1700	3.7	ND
8-2	7.5-9.5'	3800	2.9	ND
8-3	59.8-61.5'	2600	1.7	ND

*all values in mg/kg except where noted
ND = not detected, detection limits and analytical techniques are listed in Appendix A

None of the soil samples contained purgeable halocarbons or aromatic compounds in detectable quantities. Lead values in the soil are well within the normal range. Oil and grease was detected in all three soil samples. The values ranged from 1700 mg/kg to 3800 mg/kg, by the gravimetric method. Soil sample 8-2, collected between 7.5 feet and 9.5 feet, contained the greatest concentration of oil and grease. The shallowest sample, 8-1, collected between 1.5 and 2.0 feet contained the lowest concentration of oil and grease.

Significance of Findings

No trend can be defined based on three samples. However the surface sample contained the least oil and grease of the three. Fire training activities at the site would tend to initially saturate the surficial soils to a greater degree than the underlying caliche. It is likely that combustible materials in the shallowest zone would be more completely consumed than those that percolated to slightly greater depth. This would account for the observed increase in oil and grease between the shallowest and intermediate samples and decrease from the intermediate to deepest sample, beyond the likely range of downward migration.

The site is not considered a potential threat to surface water or ground-water quality in the base or vicinity since the site is fairly small (about one acre) and is not connected hydraulically with the underlying Ogallala Aquifer (see Site No. 5 discussion, Section 4.2.5).

4.2.9 Site No. 9 - Fire Department Training Area No. 4

Fire Training Area No. 4 is the only active training site on-base. It has been used since 1974 and is located near former Fire Training Areas Nos. 2 and 3 in the southeast corner of the base (Figure 4-16).

This site was reportedly used from 1961 to 1974 as a fuel truck cleaning area in which residual fuels were drained onto the ground and the fuel tanks cleaned. This practice reportedly ended about 1974. From 1974 to

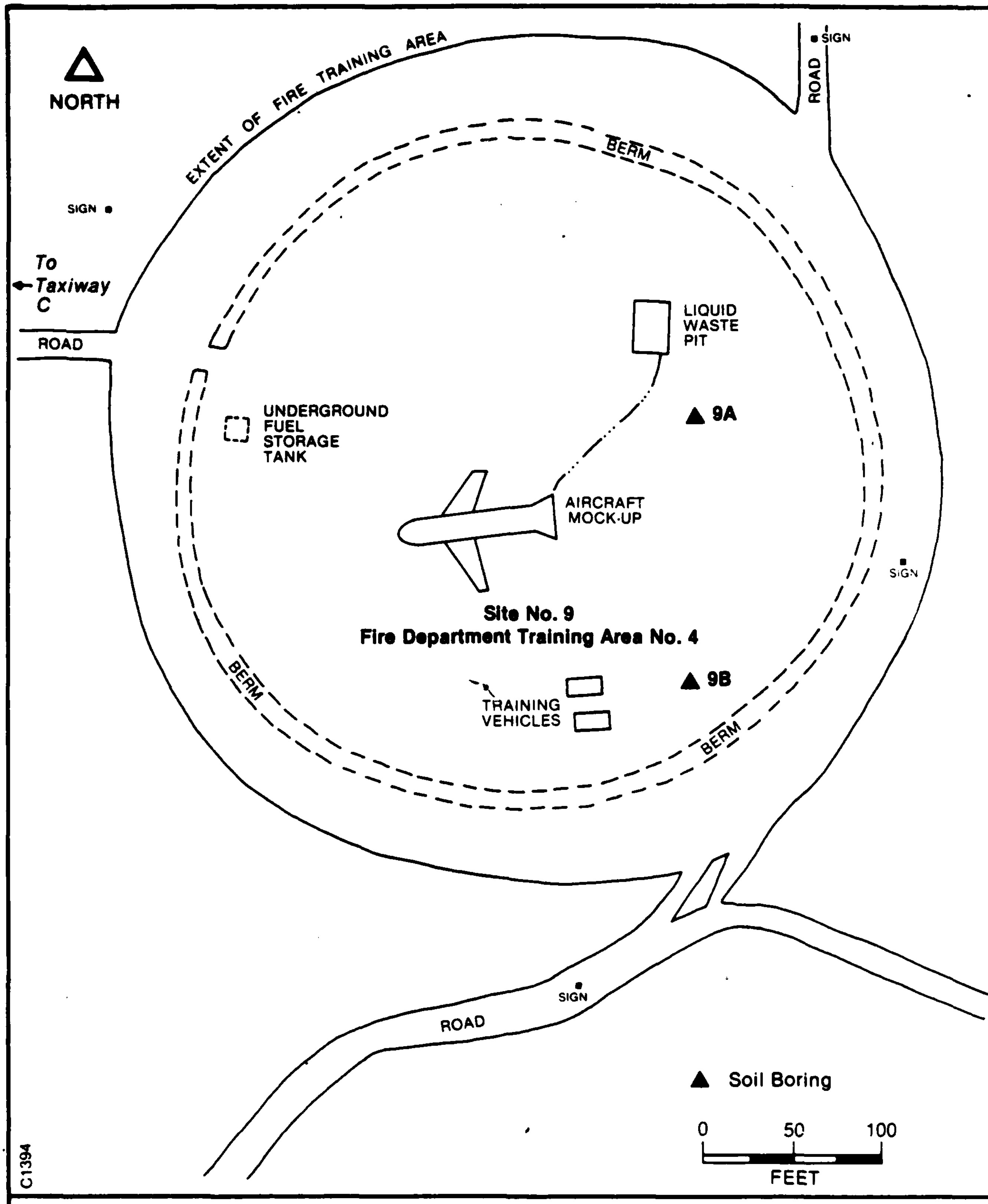


Figure 4-16. Soil Boring Locations, IRP Phase II Stage 1, Site No. 9, Fire Department Training Area No. 4, Cannon AFB, New Mexico

1975, commingled waste oils, solvents, and recovered JP-4 fuels were burned at the site. Since 1975, only recovered JP-4 has been burned in training exercises.

Prior to all fire department training exercises, the ground is presoaked with water. This practice was not in effect before 1974 when fuel trucks were cleaned at the site.

The training site is a shallow unlined circular depression, approximately 400 feet in diameter. A simulated aircraft sits at the center of the burn pit. A 2,000-gallon underground tank installed in 1975 is used to store recovered JP-4 fuel for burning. The fuel is pumped from the storage tank to the simulated aircraft prior to practice burns. Runoff from the area is collected in an unlined pit adjacent to the site. Visual evidence of surface contamination at this site was reported during the Phase I survey. In 1985, this facility was rebuilt. A new lined facility with an oil/water separator was installed to handle collected runoff.

Fire Training Area No. 4 was identified for Phase II Stage 1 investigation because of the known past disposal of a moderate quantity of a hazardous material before and during the site's use as a fire training area and visual observations of fuel on the ground. Two deep soil borings were drilled at this site to evaluate the impact of past and ongoing activities and to define the site-specific hydrogeologic conditions.

Topography

Fire Training Area No. 4 is enclosed by a low berm approximately one-foot high. The berm was used to define the site boundary for the study. The site slopes gently to the northeast. A small interceptor ditch drains water and JP-4 fuel away from the mock-up aircraft into a small unlined waste pit. No other drainages exist in the fire training area. Soil boring 9B was located northeast of the pit area, due to local topography. This area was a local depression which would have tended to contain contaminated runoff and concentrate residual contaminants in the surface soils.

Geologic Description

Since JP-4 fuel is used to ignite the mock-up aircraft for fire training exercises, the greatest amount of fuel contamination was expected to be near the surface, near the craft and the small unlined pit adjacent to the craft. Both soil borings were drilled in these areas where hydrocarbons were expected to accumulate.

The topsoil in the fire training area is about 4.5 feet thick and consists of silty sand. The topsoil/caliche contact occurs at about 4.5 feet below land surface. The caliche below the site is about 45 feet thick and contains abundant sand and silt layers between 2 and 5 feet thick. Near the bottom of the two borings (47 feet), the percentage of calcite in the profile increases, effectively cementing the sand units in the profile. At about 47 feet a well-indurated cemented sand was encountered which prohibited further penetration by the auger. Organic vapor measurements of the cuttings did not reveal hydrocarbons when tested.

Soil Chemistry

Five soil samples were collected from Fire Training Area No. 4 and analyzed for the following: oil and grease, lead, and purgeable halocarbons and aromatics. The data are summarized in Table 4-13. None of the samples contained purgeable aromatics or halocarbons in detectable quantities when tested. Lead values ranged from 1.3 mg/kg to 39 ug/g. The highest lead concentration was found in soil boring 9A-2, collected 5 feet into the caliche layer, however, the duplicate sample (9A-2A) contained only site background levels of lead. The lowest value was from the deepest sample (9B-3) collected below the caliche profile.

Three samples (9A-2, 9A-2A and 9B-3) contained oil and grease in quantifiable amounts. The variations in oil and grease concentrations determined in the duplicate samples (9A-2 and 9A-2A) probably reflect sample inhomogeneity, meaning that a portion of the split sample contained a greater concentration of oil and grease, producing the much higher oil and grease value when analyzed, thus, the discrepency in oil and grease concentrations between the two.

Significance of Findings

Fire Training Area No. 4 received the highest HARM rating of all the sites listed in the Phase I records search. During the drilling of the two deep soil borings, no organic vapors were detected, and none of the soil samples contained detectable quantities of purgeable halocarbons or aromatics when analyzed.

At the time of the drilling activities, the waste pit at the site contained about 450 gallons of fuel-saturated water from recent fire training exercises. Soil boring 9A was installed 36 feet down-slope from the liquid waste pit. Lead was detected at a concentration of 39.0 ug/g in this location. This value is only slightly higher than the normal range for lead in soil (2-20 ug/g; Table 4-3) and is not considered environmentally significant. The other samples taken in the fire training area contained lead concentrations within the normal range for soils.

TABLE 4-13. RESULTS OF ANALYSIS OF SOIL SAMPLES, IRP PHASE II STAGE 1, SITE NO. 9, FIRE DEPARTMENT TRAINING AREA NO. 4 CANNON AFB, NEW MEXICO

Sample #	Depth	O&G*	Pb*	Purgeable Organic Compounds (EPA 8010/8020) (ug/kg)
9A-2A**	10.5-11.5'	280	5.3	ND
9A-1	5.5-7.0'	ND	4.1	ND
9A-2	10.5-11.5'	110	39.0	ND
9B-1	4.0-5.5'	ND	4.5	ND
9B-2	9.0-10.5'	ND	3.7	ND
9B-3	43.0-45.0'	37	1.3	ND

*all values in mg/kg, except as noted
**duplicate analysis
ND = not detected, detection limits and analytical techniques are listed in Appendix A

Soil boring 9B was drilled regionally downgradient from both the mock-up aircraft and waste pit. Soil sample 9B-3 contained the lowest concentration of lead (1.3 mg/kg) of the six samples collected from the site. If a contaminant plume were migrating downgradient from the waste pit and aircraft, it is anticipated that soil boring 9A would intercept the plume. Since all reported values for soil boring 9B are low (in relation to 9A), it is rationalized that the geologic setting of the fire training area is such that the caliche is confining liquids to the waste pit area, effectively preventing horizontal and vertical movement of potential contaminants from the waste pit and mock-up aircraft to the adjacent soils downgradient from these two structures.

4.2.10 Site No. 11 - Engine Test Cell Overflow Pit and Leaching Field

Site No. 11 is located in the southeast part of the base. It includes the leaching field for washdown from Engine Test Cell Facility No. 5114 and an overflow pit (Figure 4-17).

An oil/water separator and leaching field was installed during construction of the engine test cell and has been in operation since 1965. However, the hydraulic capacity of the leaching field has been progressively reduced resulting in reduced capacity of the oil/water separator and hydraulic overloading of the unit. In 1982, a 6-8 foot diameter pit was excavated to relieve some of the overloading by receiving part of the wastewater from the engine test cell. At the time of the Phase I survey, the pit reportedly contained 5 to 6 feet of black liquid with a hydrocarbon odor. In 1985, a new oil/water separator was installed and a lined evaporation pond was installed to handle water discharge.

Site No. 11 was identified for Phase II Stage 1 investigation due to the known disposal of hazardous material, the observed contamination in the overflow pit, and the site location, within 300 feet of potable water well No. 9. Two deep soil borings were installed to evaluate the environmental impact of this site.

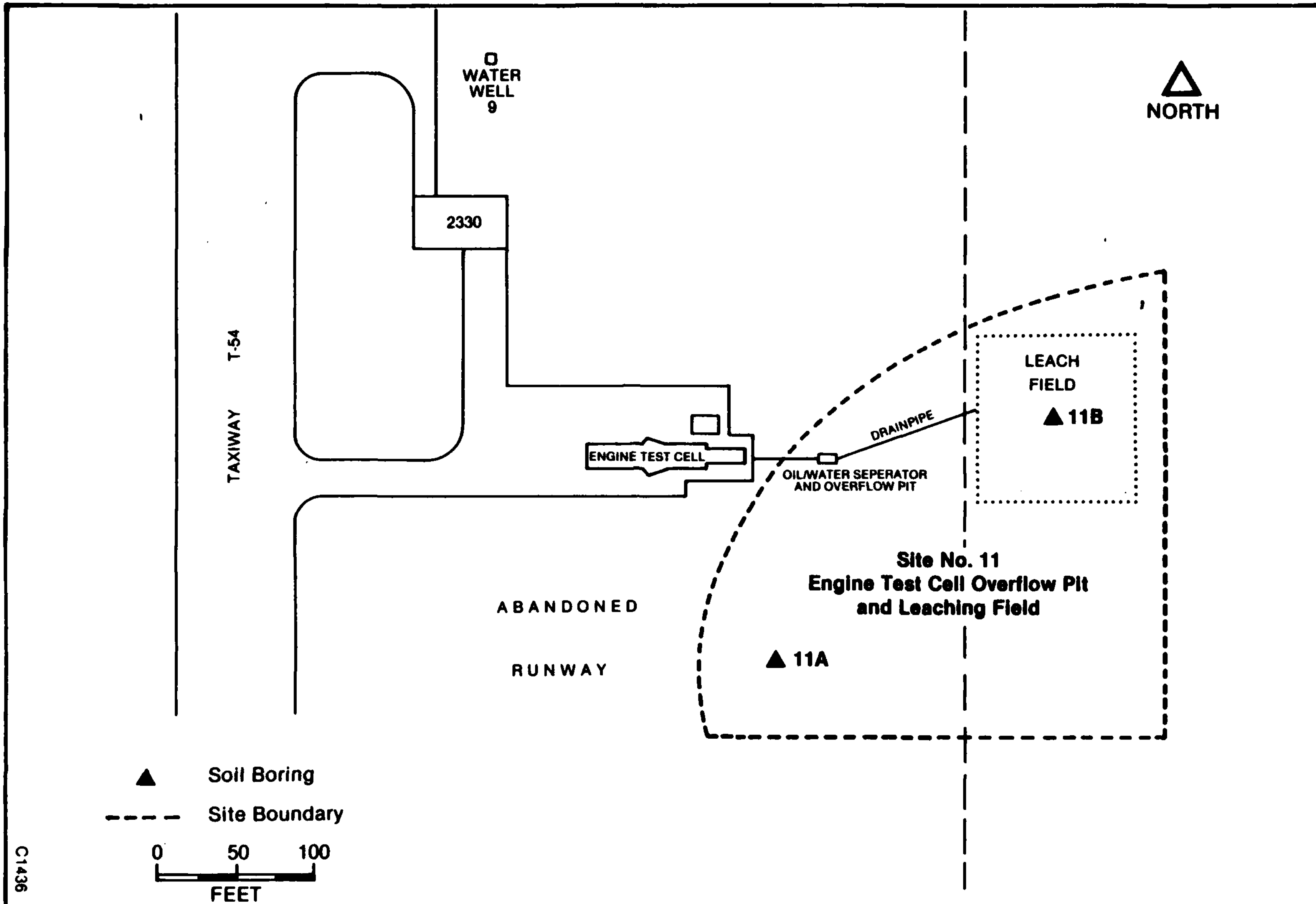


Figure 4-17. Soil Boring Locations, IRP Phase II Stage 1, Site No. 11, Engine Test Cell Overflow Pit and Leaching Field, Cannon AFB, New Mexico

Topography

The topography of Site No. 11 is essentially flat or sloping gently to the south in the vicinity of soil boring 11A and east in the vicinity of soil boring 11B. Drainage is typically to the southeast with surface water accumulating in low catchment areas. The low areas containing the greatest water accumulations were chosen as drilling locations.

Soil boring 11A was drilled 132 feet south of the Engine Test Cell Overflow Pit in a low catchment area about 100 feet in diameter and 0.5 feet deep. Any past spillage from the overflow pit would have accumulated in this area, therefore this location was chosen to determine if contaminants had migrated downward through the caliche profile into underlying soil layers.

Soil boring 11B was placed near the center of the leach field about 153 feet east of the Engine Test Cell Overflow Pit. The leach field occupies an area approximately one acre in size and is fed by a drain pipe leading from the overflow pit. At the time of the inspection, the leach field was wet and the ground was muddy from discharged water/oil from the engine test cell.

Geologic Description

As drilling progressed through the topsoil layer, no visible contaminants were observed. Shelby tube samples were collected at depths of 1 foot and again at 5 feet to capture any suspected contamination that might have accumulated above the caliche or migrated into the caliche zone.

The topsoil/caliche contact occurred at about 2 feet below the surface. Caliche intermixed with silt is present from 2 to 50 feet (the total depth of the borehole) for sample 11A and up to 50 feet for sample 11B.

The caliche profile in both soil borings is extremely well developed and contains one-inch calcareous nodules throughout the interval. At the completion depth of the boreholes (35 feet) the caliche and sand are well cemented preventing the auger rig from penetrating beyond this depth. It was decided by the supervisory geologist to complete the boreholes in the cemented zone, as the possibility of contaminant migration below this depth was highly unlikely.

Soil Chemistry

Five samples were collected following the procedures detailed in Section 3.1.1. Each of the samples was analyzed for purgeable halocarbons and aromatics, lead, and oil and grease.

Results of analyses of soil samples from Site No. 11 (Engine Test Cell and Overflow Pit) are summarized in Table 4-14. No purgeable aromatics or halocarbons were detected in any of the samples. Likewise none of the samples contained oil and grease in quantifiable amounts. The normal range for lead in soils is between 2-20 mg/kg. All soil samples retrieved from this site contained lead concentrations within this normal range.

Significance of Findings

No soil contamination is suggested by the available analytical data. However, information provided from only two boreholes is not considered adequate to evaluate the potential environmental impacts associated with the site as a whole.

TABLE 4-14. RESULTS OF ANALYSIS OF SOIL SAMPLES, IRP PHASE II STAGE 1, SITE NO. 11, ENGINE TEST CELL OVERFLOW PIT AND LEACHING FIELD, CANNON AFB, NEW MEXICO

Sample #	Depth	O&G*	Pb*	Purgeable Organic Compounds** (EPA 8010/8020)
11A-1	1.0-2.0'	ND	1.5	ND
11A-2	5.0-7.0'	ND	4.0	ND
11B-1	2.0-4.0'	ND	4.8	ND
11B-2	5.5-7.0'	ND	2.0	ND
11B-3	46.5-47.5'	ND	2.0	ND
QA-1***	5.0-7.0'	ND	4.3	ND

*all values in mg/kg
**concentrations in ug/kg
***duplicate of 11A-2
ND = not detected, detection limits and analytical techniques are listed in Appendix A

4.2.11 Site No. 12 - Stormwater Collection Point

Since 1943, stormwater runoff from the flightline has been collected in a nine-acre playa located near the southwest corner of the base. The runoff is likely to contain small amounts of spilled fuels, oils and other POL materials as well as PD-680, a petroleum distillate used as a safety cleaning solvent. Reportedly no visual evidence of contamination was observed during the Phase I survey.

This site was included for study in the Phase II Stage 1 program primarily because of the suspected disposal of small amounts of hazardous materials and the existence of a drinking water well (No. 6) within 800 feet (Figure 4-18). Three shallow (5 ft) hand-augered boreholes were made at Site No. 12. Samples were collected at a depth of one foot and five feet, and analyzed to determine whether environmental contamination has occurred. Two sites were positioned near the center of the basin. Another site was located near the inlet to the Stormwater Collection basin. The soil, debris and clay in the catchment basin was completely saturated with water forming a type of

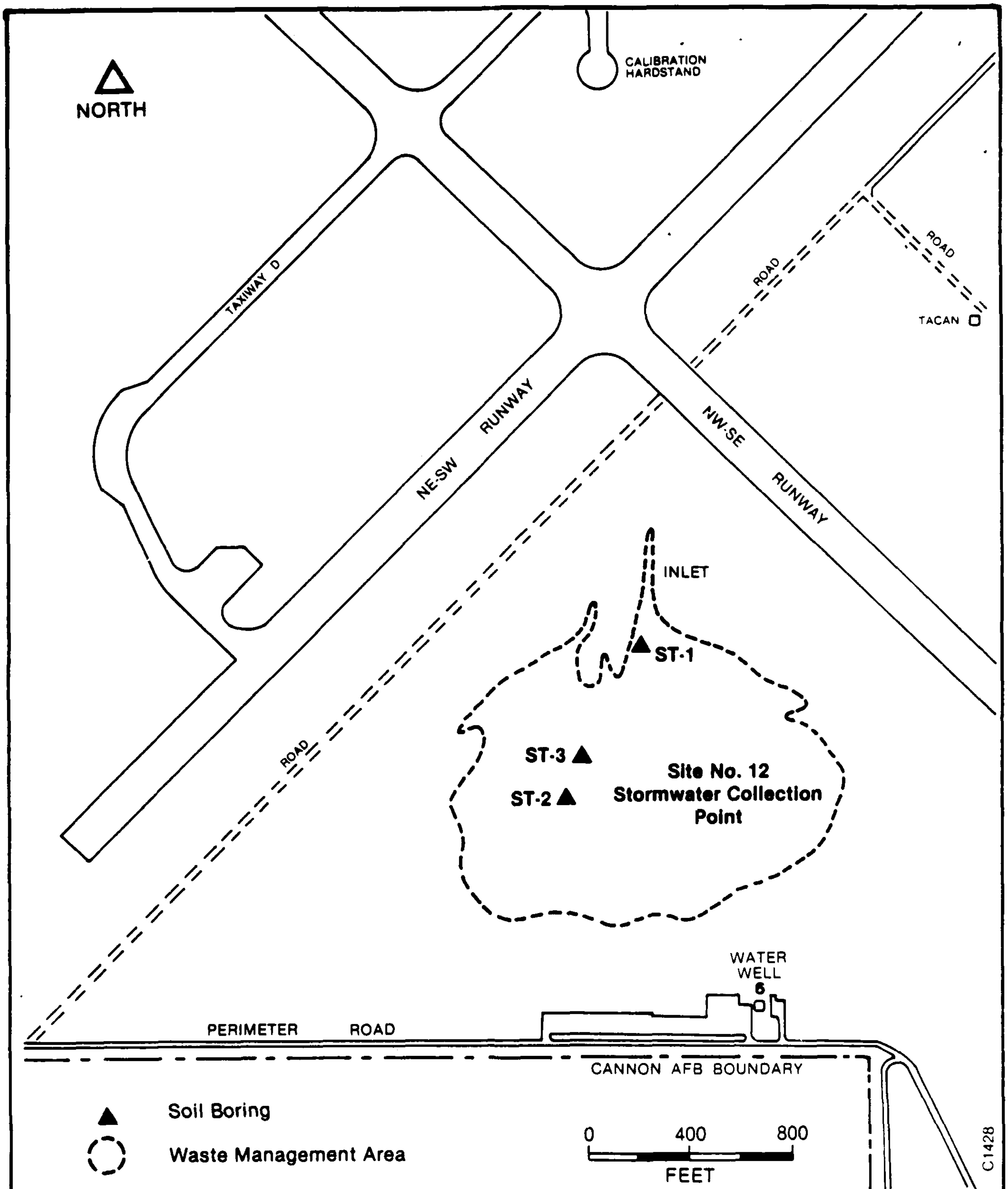


Figure 4-18. Soil Boring Locations, IRP Phase II Stage 1, Site No. 12, Stormwater Collection Point, Cannon AFB, New Mexico

"quicksand" at about 4 feet in depth. Saturated conditions prevented the retrieval of any samples beyond 4 feet in depth, therefore, only one sample per shallow auger hole was retrieved for analysis.

Topography

The Stormwater Collection Point (Site No. 12) is a playa lake approximately nine acres in size. The depth of the playa is about 15 feet in the lowest part. The playa receives water from the flightline area at an inlet ditch located south of the two runway intersections. Since the playa has no outlet, the surface waters flow to the center of the basin and either evaporate, or percolate into the soil.

Geologic Description

The basin of the Stormwater Collection Point is composed of extremely fine grained silt and clay with organic debris. The thickness of the clay and organic debris is unknown as the unit was not fully penetrated.

Soil Chemistry

Four soil samples, including one QA duplicate, were collected following the procedures detailed in Section 3.1.1. Each of the samples was analyzed for priority pollutant metals (total); total iron, nickel, and zinc; oil and grease; and purgeable halocarbons and aromatics.

Results of analysis of soil samples from Site No. 12 are summarized in Table 4-15. No purgeable halocarbons or aromatic compounds (EPA 8010 and 8020) were detected in any of the samples analyzed. Only sample ST-3 contained measurable amounts of oil and grease. Metals values are quite variable but generally within the range common to soils (Table 4-3). Soil boring ST-3, collected in the deepest portion of the basin, contained the greatest concentration of metals with the exception of three elements: selenium, arsenic and silver.

TABLE 4-15. RESULTS OF ANALYSIS OF SOIL SAMPLES, IRP PHASE II STAGE 1, SITE NO. 12 STORMWATER COLLECTION POINT, CANNON AFB, NEW MEXICO

Sample Number	Depth	Ag	As	Ba	Cd	Cr	Cu	Fe	Hg	Ni	O/G	Pb	Se	Zn	Purgeable Organics** (EPA 8010/8020)
								Parameter (concentrations in mg/kg)							
ST-1	3.0-4.0'	0.40	1.6	48	0.28	5.5	3.5	5500	0.17	3.3	ND	5.3	ND	9.9	ND
ST-2	3.0-4.0'	ND	1.8	70	1.2	18.0	7.7	6900	0.20	4.4	ND	33.0	ND	46.0	ND
ST-3	3.0-4.0'	ND	1.5	110	2.3	28.0	12.0	7700	0.21	6.1	40	74.0	ND	57.0	ND
ST-1a	3.0-4.0'	ND	3.1	48	ND	3.4	4.2	3900	0.17	3.2	ND	5.3	1.3	9.0	ND

*duplicate analysis
**concentrations in ug/kg
ND = not detected, detection limits and analytical techniques are listed in Appendix A

Significance of Findings

Variable metals concentrations were found in the three samples collected at Site No. 12. The concentration of heavy metals, especially lead, appears to increase toward the center of the basin. The environmental significance of this trend cannot be fully evaluated based on existing data. The vertical extent of the clay- debris layer on the basin bottom could not be determined, therefore, it is unclear where the first confining caliche or sand layer lies. Further investigation for lead may be required for this site.

4.2.12 Site No. 13 - Sewage Lift Station Overflow

Site No. 13 is an overflow pit, approximately 100 feet x 600 feet 2 to 3 feet deep, located on the golf course, north of the base hospital. It appears as a rectangular, grass-covered depression (Figure 4-19). The pit was designed specifically for emergency use. In February, 1983, such an emergency occurred when the pumps in Sanitary Lift Station No. 1402 malfunctioned and an estimated 100,000 to 150,000 gallons of raw sewage were bypassed to the pit. One week later, the pumps were repaired and the sewage was cycled back to the lift station. Initial sample results reflected that material (hazardous by EPA ignitability criterion) may have been in the sewage diverted to the Overflow Pit.

The Overflow Pit was identified for Phase II Stage 1 study primarily because of the proximity of potential receptors (greater than 100 people are located within 1000 feet of the site). A potable water well is also located within 800 feet and the site is only 400 feet from the installation boundary. Two shallow boreholes were made at this site to identify potential contamination from the Overflow Pit.

Topography

The topography in the area of Site No. 13 slopes inward forming a closed basin 2 to 3 feet deep at the lowest point. To the east of the basin

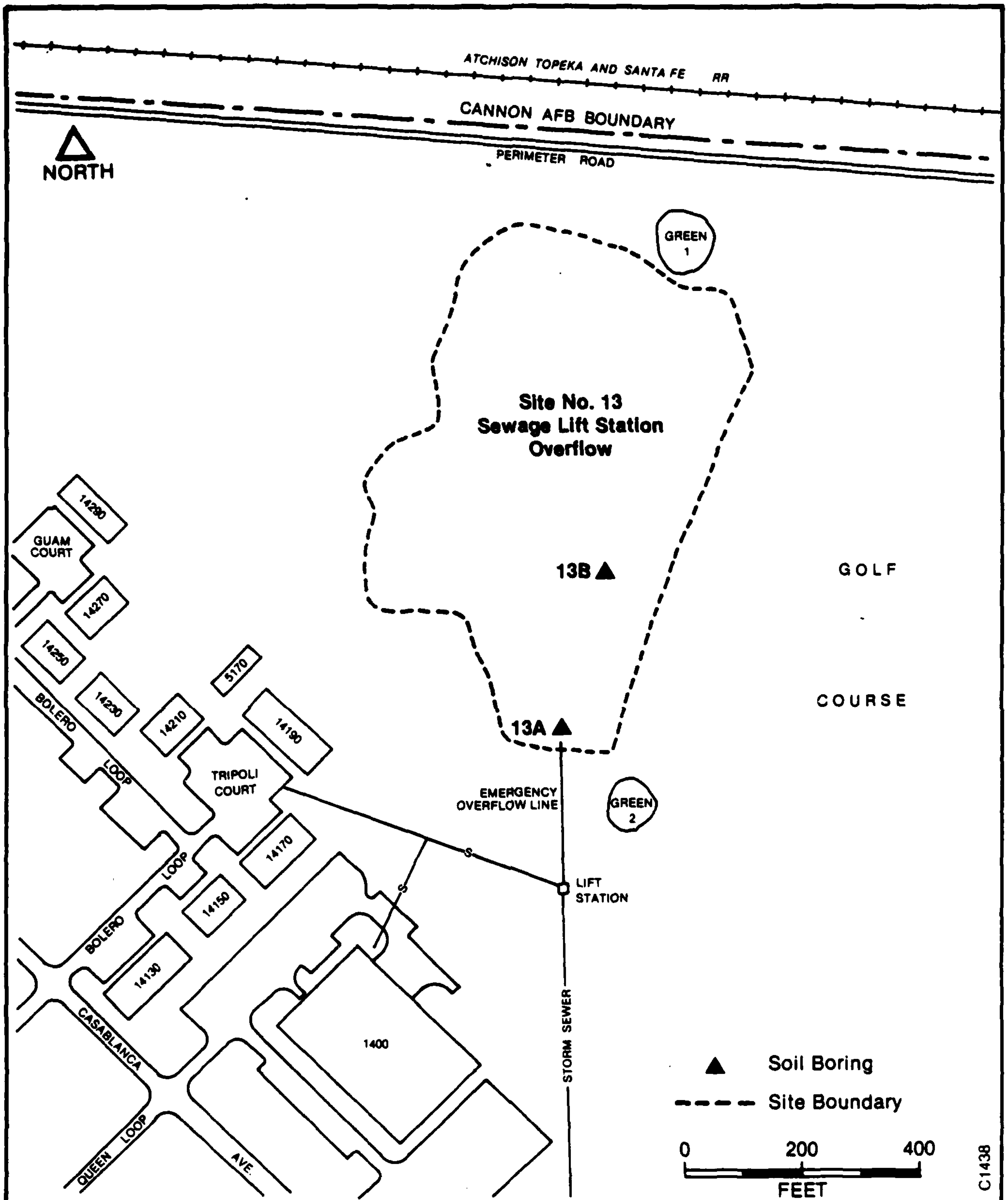


Figure 4-19. Soil Boring Locations, IRP Phase II Stage 1, Site No. 13, Sewage Lift Station Overflow, Cannon AFB, New Mexico

lies the golf course. The golf course is several feet higher in elevation, and forms the eastern boundary of the site. Site No. 13 is bounded to the north by Golf Course Green 1 and the base Perimeter Road. The western boundary of the site is a low berm, 2 to 3 feet high, which separates the site from another internally drained depression near Landfill No. 1.

Geologic Description

Two shallow hand-augered borings were installed in Site No. 13 (the Sanitary Sewage Lift Overflow Pit). Samples were collected at 1.0 foot and 4.0 foot intervals below the surface. The total depth of each borehole was 5.0 feet. A field survey of the pit floor near the site chosen for soil boring 13A revealed debris, paper and other waste materials left from the January 1983 discharge. Borehole 13B was located near the lowest point of the basin where the greatest accumulations of wastes were suspected.

No organic compounds were recorded by the Organic Vapor Analyzer during the investigation activities at Site No. 13. Analyses of soil samples revealed mostly moist to wet, dark clay and organic debris, approximately 4.0 feet thick, underlain by caliche (thickness unknown).

Soil Chemistry

Five total samples, including one QA duplicate, were collected following the procedures outlined in Section 3.1.1. Each of the samples was analyzed for the priority pollutant metals (total); total iron, nickel, and zinc; oil and grease; and purgeable aromatics and halocarbons.

Analytical results for the soil samples from Site No. 13 are presented in Table 4-16. No volatile organics (EPA 8010 and 8020) were detected in any of the samples collected. Metals values are variable but generally within the normal range for soils (Table 4-3). Somewhat higher levels of barium and manganese were found in soil boring 13B, relative to the other samples. Oil and grease was found in all samples at relatively low levels ranging from 26 mg/kg to 67 mg/kg.

TABLE 4-16. RESULTS OF ANALYSIS OF SOIL SAMPLES, IRP PHASE II STAGE 1, SITE NO. 13 SEWAGE LIFT STATION OVERFLOW, CANNON AFB, NEW MEXICO

	Parameter (concentrations in ug/g)												
	Ag	As	Ba	Cd	Cr	Cu	Hg	Mn	O/G	Pb	Se	Zn	Purgeable Organics** EPA(8010/8020)
13A-1	1.6	2.6	98	0.20	5.3	9.1	0.38	2.5	65	9.6	1.3	23	ND
13A-2	1.4	1.6	87	ND	5.5	7.1	0.24	120	26	7.6	1.5	24	ND
13B-1	ND	2.6	100	0.22	7.5	7.5	0.14	330	55	9.9	1.3	20	ND
13B-2	0.54	2.1	130	0.34	7.4	7.4	0.12	550	28	2.0	1.2	18	ND
13B-2a*	0.70	3.1	140	0.59	9.7	9.5	0.16	210	67	7.2	2.2	25	NA

*duplicate analysis
**concentrations in ug/kg
ND = not detected
NA = not analyzed, detection limits and analytical techniques are listed in Appendix A

Significance of Findings

There does not appear to be a significant environmental threat from activities at the Sewage Lift Overflow Station (Site No. 13). Oil and grease were detected in small quantities, but volatile organic compounds, which were the primary concern based on the Phase I investigation, were not detected. The relatively low levels of oil and grease may be attributable to naturally occurring organics and may be unrelated to base activities.

Geologically, the site is underlain by caliche, as is Landfill No. 1 to the west of Site No. 13. The caliche profile was first encountered at 4 feet below land surface.

The caliche is fairly continuous and likely restricts the downward migration of surface waters in this area. The total thickness of the caliche profile was not penetrated, but it is assumed to be about 20 feet, based on boreholes drilled at Landfill No. 1 (located west of the Stormwater Collection Point).

4.2.13 Site No. 15 - AGE Drainage Ditch

Site No. 15 is a ditch which parallels Facilities Nos. 191, 192, and 193 and extends from the flightline side of the AGE building (No. 186) to near Argentia Avenue (Figure 4-20). The ditch was created by settling along the former trend of railroad tracks that were removed in the late 1960's. Spilled fuel and oil on the AGE maintenance pad are washed into the ditch during heavy rains. Contamination was observed during the Phase I survey as discolored black soil with a characteristic hydrocarbon odor over 50 to 75 feet along the ditch bottom.

The AGE Drainage Ditch was identified for Phase II Stage 1 action because of the known disposal of hazardous waste and presence of observable contamination. In addition, the ditch is located within 1600 feet of the installation boundary. Two deep soil borings were made along the Drainage Ditch

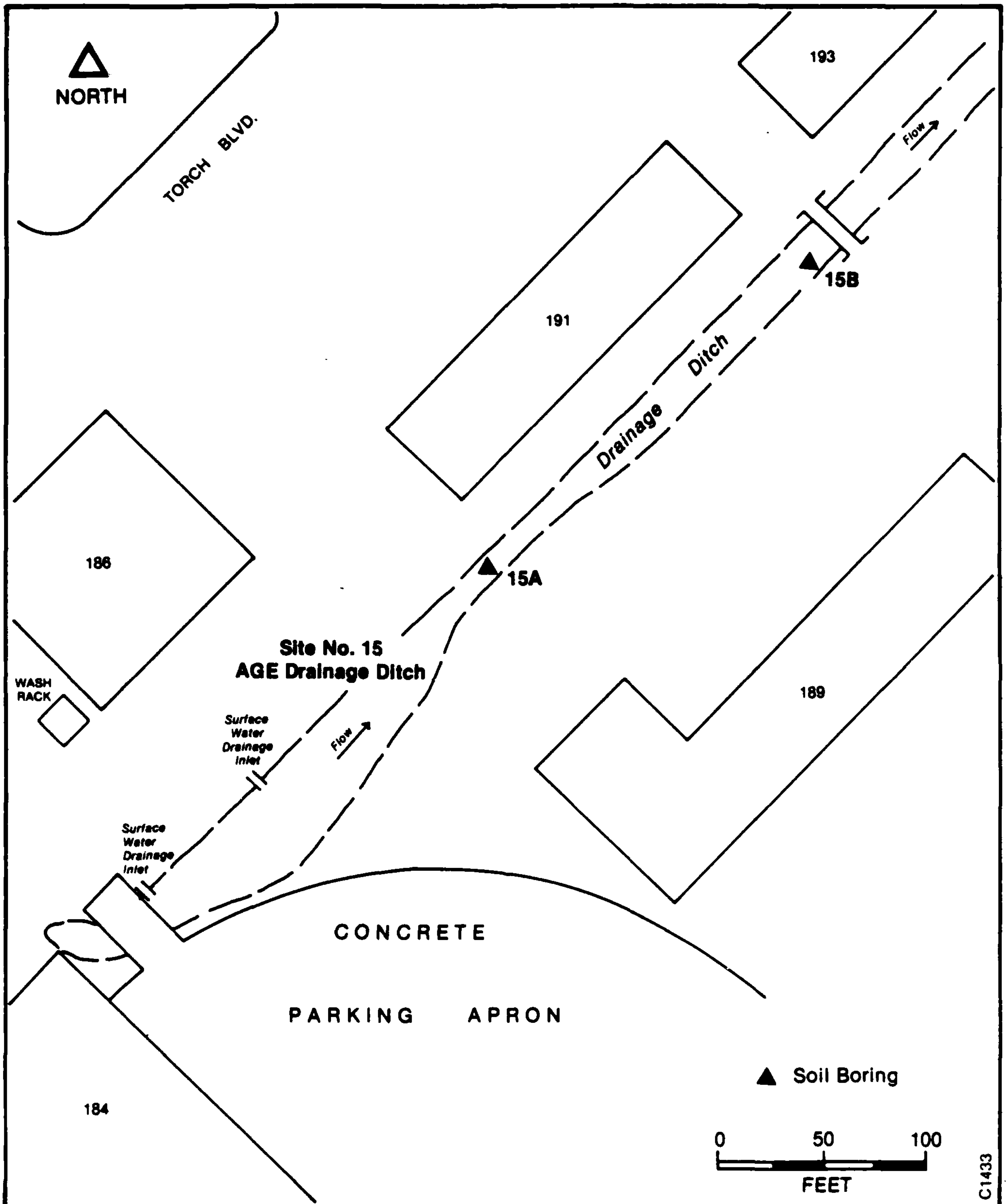


Figure 4-20. Soil Boring Locations, IRP Phase II Stage 1, Site No. 15, AGE Drainage Ditch, Cannon AFB, New Mexico

to define the local hydrogeologic setting and to evaluate the extent of potential contamination. Boreholes 15A and 15B are located approximately 225 ft. and 440 ft. downgradient (northeast) of the surface water drainage inlet adjacent to the parking apron, respectively. The soil borings would also serve in selected areas where suspected contamination would accumulate.

Topography

The topography of Site No. 15 is extremely flat as most of the area adjacent to the AGE Drainage Ditch is an asphalt-paved parking lot. Runoff from the building complex to the northwest is intercepted by the AGE Drainage Ditch which flows to the northeast. The ditch is about 10 feet wide and 2 feet deep. The banks and bottom of the ditch were vegetated with grass when inspected.

Geologic Description

The topsoil in the AGE Drainage Ditch is between 3 to 4 feet thick and is composed primarily of red-brown sandy loam with minor amounts of caliche present. The topsoil was considered to be the most likely zone of contamination from base activities.

Below the topsoil layer is soft, white-to-gray caliche. Soil boring 15A revealed this gray caliche from 14 feet to about 30 feet in depth. No organic vapors were detected in the cuttings which were screened by the OVA. Soil boring 15A was drilled closer to the suspected area of contamination. Soil Boring 15B was drilled approximately 200 feet downstream from 15A. No discoloration of the caliche was noted in soil boring 15B.

The caliche in Site No. 15 ranges between 45 and 50 feet thick in the area, and contains interbedded sands and silts throughout the interval. Both borings penetrated the sand zone beneath the caliche at about 50 feet. Soil samples were collected from this zone and saved for analysis.

Soil Chemistry

Seven samples including one QA duplicate were collected from Site No. 15 and retained for analysis. The collection procedures are outlined in Section 3.1.1 of this report. Samples were analyzed for the following parameters: oil and grease; lead; and purgeable halocarbons and aromatics. The analytical results are summarized in Table 4-17.

No purgeable aromatics or halocarbons were detected in any of the soil samples. No elevated concentrations of oil and grease were found with the exception of sample 15B-1 which contained 99 mg/kg oil and grease. However, the duplicate sample 15B-1a did not contain oil and grease in detectable quantities which leads to the interpretation that the higher oil and grease value may actually represent interference from natural organics. Elevated levels of lead relative to the site average were found in soil sample 15B-1 (35 mg/kg) and in the duplicate sample, 15B-1a (69 mg/kg). Sample 15B-1 was collected in the topsoil above the caliche where suspected contamination would be expected to accumulate.

Significance of Findings

Based on the information obtained from the two deep soil borings, the potential for environmental contamination by the AGE Drainage Ditch does not appear to be significant. Only one sample, 15B-1 (and its duplicate) contained relatively elevated levels of lead. It is likely that the lead concentrations are restricted to the AGE Drainage Ditch only.

Geologically, the caliche contains interbedded silt and sand units within the interval between 4 and 45 feet. The sand units are generally fairly permeable as compared to the caliche, and could potentially transport contaminants laterally along bedding planes. However, the sand units are laterally discontinuous and are not in contact with any local water sources. The potential for migration of contaminants into deeper water-bearing zones is

TABLE 4-17. RESULTS OF ANALYSIS OF SOIL SAMPLES, IRP PHASE II STAGE 1, SITE NO. 15, AGE DRAINAGE DITCH, CANNON AFB, NEW MEXICO

Sample #	Depth	O&G*	Pb*	Purgeable Organic Compounds (EPA 8010/8020) (ug/kg)
15A-1	3.0-4.1'	<10	5.8	ND
15A-2	8.5-9.5'	<10	2.4	ND
15A-3	47.5-50.0'	<10	0.93	ND
15B-1	4.0-5.5'	99	35	ND
15B-2	9.0-10.5'	<10	2.7	ND
15B-3	52.5-54.0'	<10	1.2	ND
15B-1a**	4.0-5.5'	<10	69	ND

*concentrations in mg/kg, except as indicated
**duplicate analysis
ND = not detected, detection limits and analytical techniques are listed in Appendix A

highly unlikely due to the low natural permeability of the caliche and depth to water in the area (about 340 feet).

4.2.14 Site No. 16 - Solvent Disposal Site

Site No. 16 is located in the northeast corner of the base, between Fire Department Training Area No. 1 and Landfill No. 2 (Phase II Stage 1 Site Nos. 6 and 2, respectively.

Two empty 55-gallon drums labeled "Trichloroethylene" (TCE) were found on the ground during the Phase I Survey. They were open and positioned such that they would drain into a shallow surrounding pit. Each drum had rust holes in the top side, suggesting that they had been there for several years. A deteriorating black plastic liner was noted at the edge of the shallow pit. Approximately 4 to 6 inches of soil covered the rest of the liner, which had apparently been installed in the pit to prevent the volatile solvent from percolating into the ground. It is not known whether or not the drums were full at the time of disposal.

The Solvent Disposal Site was selected for Phase II Stage 1 study due to the suspected disposal of a small quantity of hazardous waste and the existence of a potable water well within about 2900 feet.

According to the Phase I report, Site No. 16 was located near the base boundary between Site No. 6 and Site No. 2, about 100 feet north of the base perimeter road intersection. Several attempts to locate the site were made by the supervisory geologist with the assistance of the Base Bioenvironmental Engineering Section. Metal detection equipment was used in an attempt to locate sub-surface metal (barrels) at the site, although none was found. After this extensive search for Site No. 16, it was suspected that the barrels and other debris had been picked up and disposed of by the Roads and Maintenance Department some time before the Phase II Stage 1 field study began. After discussions with base personnel and follow-up field inspections, it was concluded that the plastic liner had been removed and that no barrels or other physical evidence of the site were left. No further investigations were made of this site, since all barrels suspected of containing chlorinated solvents had been removed and no physical evidence of the site remained to warrant a shallow borehole.

4.2.15 Site No. 17 - Entomology Rinse Area

The Entomology Rinse Area is located behind a pesticide storage building (No. 2160) (Figure 4-21). Rinse water from decontaminating pesticide spraying equipment and empty containers drained from the building through a sink that discharged into a small 3′ x 3′ x 2′ open pit in the rear. The pit was within 5 feet of Building 2160.

Soil and gravel in the base of the pit prevented determination of the nature and condition of the bottom. It is not known whether pesticides that drain into the pit are contained or percolate into the ground. Cannon AFB Real Property records indicate a new facility (Building 212) was constructed and occupied 19 October 1983. It is not known how long Building 2160 or its drain were in use. Building 2160 was demolished on 6 September 1984.

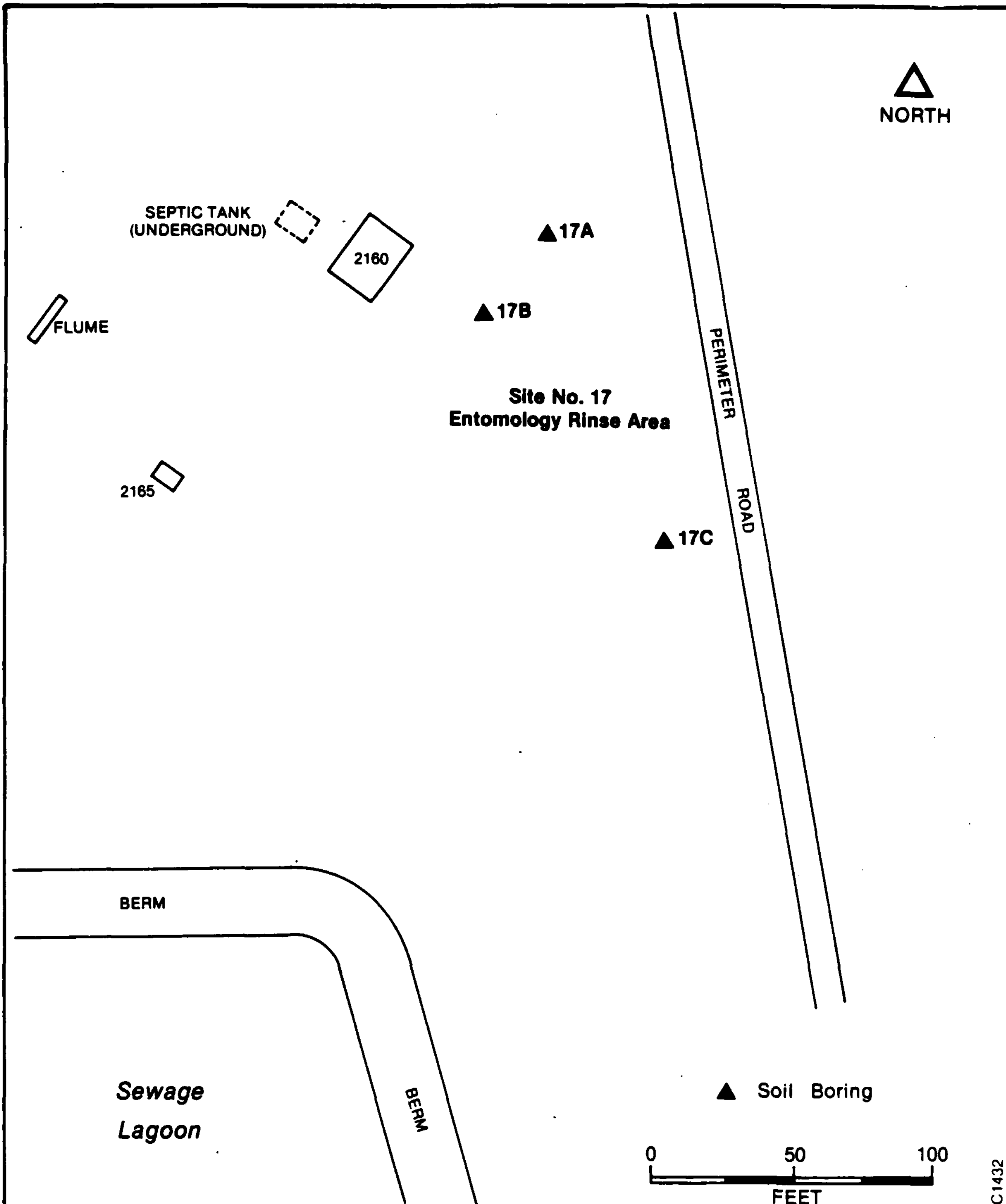


Figure 4-21. Soil Boring Locations, IRP Phase II Stage 1, Site No. 17, Entomology Rinse Area, Cannon AFB, New Mexico

The Entomology Rinse Area was included in the Phase II Stage 1 investigation due to the potential for percolation of pesticide wastes into the ground and the existence of potable water well No. 5 within 1200 feet of the site.

Topography

Site No. 17 is located in a relatively flat portion of the base. Drainage is to the southeast in the Entomology Rinse Area toward the perimeter road. A small ditch runs parallel to the road which intercepts surface runoff from the site.

Three deep soil borings were drilled in the Entomology Rinse Area. Soil borings 17A and 17B were drilled 30 feet south of the rinse pad. Soil boring 17C was drilled southeast of Building 2160 down-gradient from the Entomology Rinse Area.

Geologic Description

Topsoil in the Entomology Rinse Area is between four and five feet thick and consists of unconsolidated brown loamy soil. The topsoil/caliche contact occurs at about 5 feet in the area and the caliche extends to approximately 40 feet below land surface. Within the caliche are sand and silt lenses less than five feet thick. The percentage of unconsolidated silty sands increases within the caliche profile from 40 to 60 feet in depth.

Samples were collected from each borehole in zones above the caliche, about 5 feet into the caliche, and at the bottom of the borehole below the last significant caliche profile. No organic contaminants were detected by the Organic Vapor Analyzer during field activities.

Soil Chemistry

Ten samples including one QA duplicate were collected from Site No. 17 following the procedures outlined in Section 3.1.1. Samples were analyzed for the following: arsenic, mercury, herbicides, pesticides, and purgeable halocarbons and aromatics. Analytical results are summarized in Table 4-18. None of the samples contained purgeable halocarbons or aromatics in detectable quantities when tested. Also, none of the samples from Site No. 17 contained detectable levels of organophosphate pesticides.

Arsenic and mercury concentrations measured are generally low and within the range of common soils and apparent background.

The herbicide compound, 2,4-D was detected in four soil samples. The values were; 0.059 mg/kg (17A-3); 0.283 mg/kg (17A-2); 3.41 mg/kg (17A-4); and 0.406 mg/kg (17C-3). No herbicides were found in the shallow topsoil layer. Herbicides tended to be concentrated within the caliche profile and in the deep unconsolidated sands below the caliche. The greatest concentration (3.41 mg/kg) of 2,4-D at Site No. 17 was found in sample 17A-4 in an unconsolidated, permeable sand unit below the caliche profile.

Pesticides were detected at trace to ppm-level concentrations in several samples. Soil sample 17A-1 contained dieldrin (0.002 mg/kg) and toxaphene (0.221 mg/kg). Sample 17C-1 contained three pesticide compounds; 4,4 DDT (29 ug/g); 4,4 DDE (25 mg/kg); and 4,4 DDD (7ug/kg). Soil sample 17C-3 contained one pesticide compound, 4,4 DDT (8.0 ug/kg). All first run analyses that indicated concentrations >10 mg/kg were confirmed by second column. Soil boring 17B did not reveal pesticides when tested. The greatest proportion of pesticides appears to be contained in the area of soil boring 17C. Generally, the pesticides are restricted to the surficial soil layers above the caliche, with the exception of one sample, 17C-3. The pesticide compound, 4,4 DDT was found in the unconsolidated and permeable sands below the caliche profile at a depth of 58 feet below land surface.

TABLE 4-18. RESULTS OF SOIL SAMPLES, IRP PHASE II STAGE 1 SITE NO. 17, ENTOMOLOGY RINSE AREA, CANNON AFB, NEW MEXICO

Sample Number	Depth	As[1]	Hg[1]	Herbicides[1]	Organo-Phosphate Pesticides[3]	EPA 608 Pesticides[3]	Purgeable Organics (EPA 8010/8020)[2]
17A-1	2.0-4.0'	4.1	0.09	ND	ND	dieldrin=.002 toxaphene=.221	ND
17A-2	5.0-6.0'	2.3	0.10	2,4-D=.283	ND	ND	ND
17A-3	7.5-9.6'	1.4	0.10	2,4-D=.059	ND	ND	ND
17A-4	62.5-63.0	ND	0.04	2,4-D= 3.41	ND	ND	ND
17B-1	4.0-5.5'	1.8	0.08	ND	ND	ND	ND
17B-2	9.5-10.5'	5.6	0.24	ND	ND	ND	ND
17C-1	2.0-4.0'	1.6	0.07	ND	ND	4,4-DDT=29 4,4-DDE=25 4,4-DDD=7	ND
17C-2	9.5-10.5'	1.2	0.08	ND	ND	ND	ND
17C-3	61.5-62.0'	2.0	0.10	2,4-D=0.406	ND	4,4-DDT=8	ND
17B-2a	9.5-10.5'	2.0	0.10	ND	ND	ND	ND

[1]concentrations in mg/kg
[2]concentrations in ug/kg
[3]concentrations in ug/kg (corresponding to default units of ug/L reported in Appendix A)
ND = not detected, detection limits and analytical techniques are listed in Appendix A

Significance of Findings

The topsoil in the Entomology Rinse Area (Site No. 17) contains elevated levels of pesticides in the area of 17A and 17C.

It is of potential concern that soil boring 17C contains measurable amounts of pesticides and herbicides at 62 feet (below the caliche profile). The geologic description of this zone as described by the supervisory geologist is "silty sand, unconsolidated, poorly sorted and fine to medium grained". This indicates that pesticides and herbicides in measurable amounts have accumulated in the underlying unconsolidated silty sands below the caliche profile.

A potential source for deeper zone contamination of 17C besides entomology rinse operations could be the Sewage Treatment Lagoon (about 200 feet southwest of 17C). The Sewage Treatment Lagoon was not evaluated in this study. It is likely that the potential for contaminant migration as seepage into the entomology rinse area is fairly low since 17C is upgradient from the lagoon. However, there exists a nearly constant standing body of water, which could drive wastewater downward through the unsaturated sands and caliches downgradient from the Entomology Rinse Area.

4.2.16 Site No. 19 - MOGAS Spill

On two occasions in the early 1960's, fuel trucks overturned in a ditch along the southwest side of Argentia Avenue, across from the refueling area of Facility No. 379 (Vehicle Maintenance Shop). In each case, the trucks spilled an unknown quantity (estimated to have been between 2000 and 3000 gallons) of MOGAS into the ditch. Reportedly, the only response action taken after both accidents was a wash down of the area by the fire department.

In 1977, the construction of the gymnasium and associated pavements along Argentia Avenue modified the site. Currently, part of the ditch is apparently below pavement, while a portion exists only as a small depression along the roadside. There is no evidence that contaminated soil was detected or removed during construction of the gym and associated pavements.

Two deep soil borings were made at this site to define the local hydrogeologic setting and to evaluate the environmental impact of the MOGAS spills (Figure 4-22).

Topography

The general slope of Site No. 19 is to the north. Runoff from Argentia Avenue and the MOGAS spill area is routed to the southeast by a small ditch. Soil boring 19A was placed in the center of the ditch, soil boring 19B was located on a grassy area 60 feet northwest of 19A, and about two feet higher in elevation.

Geological Description

Topsoil in the area ranges between four and five feet thick and consists of buff-brown silty sandy loam with some caliche present in the subsoil layers. The topsoil in the area of 19A appears to be discolored from organic contaminants although organic vapor measurements of the topsoil did not reveal hydrocarbons.

The caliche in the two boreholes ranges between 42 and 45 feet thick, and is composed of cemented caliche and silt, with occasional hard cemented sands. The degree of cementation appears to increase with depth, making it difficult to penetrate certain zones with the auger rig.

An unconsolidated to well-cemented, poorly sorted sand, exists below the caliche profile at 47 feet in both borings. Within the sand are caliche nodules approximately one inch in diameter. Soil boring 19B was bottomed in an unconsolidated sand at 59.5 feet. Soil boring 19A was bottomed in a hard, cemented sand and chert unit at 47.5.

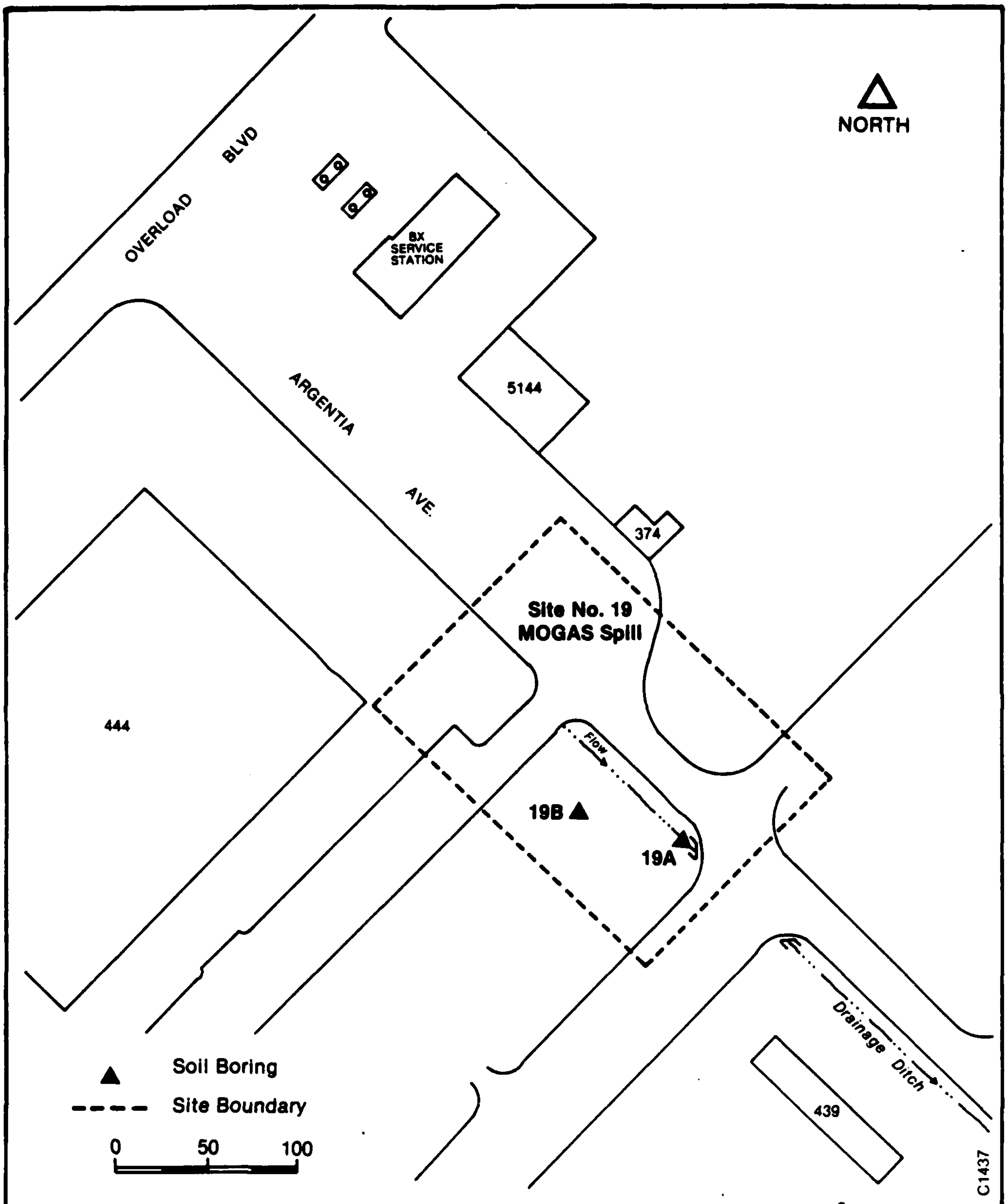


Figure 4-22. Soil Boring Locations, IRP Phase II Stage 1, Site No. 19, MOGAS Spill, Cannon AFB, New Mexico

Soil Chemistry

Seven samples including one QA duplicate were collected from Site No. 19 following the procedures outlined in Section 3.1.1. Samples were analyzed for the following; oil and grease, lead, and purgeable aromatics and halocarbons. The analytical results are summarized in Table 4-19.

None of the soil samples contained oil or grease above background levels. All but one sample, 19B-1, contained lead concentrations within the common range for soils (Table 4-3) and at similar, low (<3 mg/kg) levels. A lead concentration of 35 mg/kg was detected in the topsoil at soil boring 19B.

One sample, 19A-1a, the duplicate sample for 19A, contained 1,2-dichloroethane at a concentration of 237 ug/kg. No other purgeable halocarbons or purgeable aromatics were detected by EPA Methods 8010 and 8020.

Significance of Findings

Based on the present topography of the area, it was determined that MOGAS fuel would likely accumulate in the area of soil boring 19A. Visual inspections of the site prior to drilling revealed a dark substance on the land surface which may have been residue left from earlier spills. Therefore, it is unusual that one halogenated halocarbon, 1,2-DCE (a solvent) was found in the topsoil at soil boring 19A-1a. The compound 1,2-DCE is not present below this depth, however, and was not found in the other soil boring, 19B or the original sample (9A-1). Its presence at the reported concentration was, however, verified by second column confirmation.

The horizontal and vertical extent of contamination is quite small at Site No. 19 and likely restricted to the uppermost topsoil bounded by the drainage ditch. Since runoff currently enters the ditch from Argentia Avenue, it is difficult to trace contamination in the drainage ditch to the MOGAS

TABLE 4-19. RESULTS OF ANALYSIS OF SOIL SAMPLES, IRP PHASE II STAGE 1
SITE NO. 19, MOGAS SPILL, CANNON AFB, NEW MEXICO

Sample #	Depth	O&G*	Pb*	Purgeable Organic Compounds (EPA 8010/8020) (ug/kg)
19A-1	3.0-4.0'	ND	1.50	ND
19A-2	8.0-9.0'	ND	2.30	ND
19A-3	45.0-47.0'	ND	1.10	ND
19B-1	0.0-1.0'	ND	35.00	ND
19B-2	9.0-10.'	ND	0.95	ND
19B-3	57.5-59.5'	ND	0.99	ND
19A-1A**	3.0-4.0'	ND	2.30	1,2-DCE=237

*all concentrations in mg/kg, except as indicated
**duplicate analysis of 19A-1
ND = not detected, detection limits and analytical techniques are listed in Appendix A

spill which occurred 20 years ago. The solvent 1,2-DCE would not be contained in MOGAS. Therefore, the origin of the 1,2-DCE is unknown based on the analytical results. Even though sample 19A-1 did not contain 1,2-DCE, the confirmed elevated concentration of 1,2-DCE in sample 19A-1a is considered significant because of the potential implications for human health.

5.0 ALTERNATIVE MEASURES

In this section, Phase II Stage 1 project sites are categorized on the basis of the adequacy of existing data for assessment of environmental impact, and conclusions are drawn from those data. Category I includes those sites where no further action (including remedial action) is required. Data for these sites are considered sufficient to rule out unacceptable health or environmental risks. Category II sites are those requiring additional monitoring or work to quantify or further assess the extent of current or future contamination. Category III sites are sites that require remedial actions and are ready for IRP Phase IV actions.

5.1 Category I Sites

It is Radian's opinion that the majority of sites investigated in the Phase II Stage 1 study at Cannon AFB belong in Category I. Therefore, alternative measures are not considered for these sites. Table 5-1 is a list of these sites.

Site No. 1 - Landfill No. 1

No purgeable organic compound (8010/8020) were detected in any samples from this site. Although potential soil contamination by selenium is suggested by order-of-magnitude elevated concentrations, relative to site background, in borehole 1E, selenium is not associated with base activities. Further more, only two boreholes revealed relatively higher selenium and oil and grease concentrations. Thus, a very limited areal extent of potential contamination is interpreted. In addition, groundwater exists at about 340 feet below land surface and should not be affected. The site does not require further investigation.

TABLE 5-1. CATEGORY I SITES REQUIRING NO FURTHER ACTION FROM PHASE II STAGE 1 INVESTIGATION

Site No.	Site Name
1	Landfill No. 1
2	Landfill No. 2
3	Landfill No. 3
4	Landfill No. 4
5	Landfill No. 5
6	Fire Department Training Area No. 1
7	Fire Department Training Area No. 2
8	Fire Department Training Area No. 3
9	Fire Department Training Area No. 4
13	Sanitary Sewage Lift Station Overflow Site
15	AGE Drainage Ditch
16	Solvent Disposal Site
19	MOGAS Spill

Site No. 2 - Landfill No. 2

Landfill No. 2 contained no purgeable halocarbons or aromatics. Oil and grease levels were within the normal range found in soils. Isolated occurrences of somewhat elevated metals concentrations were not considered environmentaly significant. The potential for downward migration of leachate is reduced because of the thick (up to 40 feet), low permeability caliche zone. The potential for downward migration of leachate is further diminished by the low annual precipitation and the arid environment.

Site No. 3 - Landfill No. 3

No purgeable halocarbon or aromatic compounds were detected in any of the soil samples analyzed. Metals, and oil and grease concentrations, though somewhat variable, were generally low. Landfill No. 3 is also underlain by approximately 55 feet of caliche which acts as a flow barrier between the landfill base and underlying Ogallala Aquifer (at about 340 feet). The caliche exhibits low natural permeability thereby inhibiting downward migration of any potential leachate through the caliche profile. Based on the available chemical analyses and the local geologic setting, no further activities are recommended for this site.

Site No. 4 - Landfill No. 4

The low levels of metals found in Landfill No. 4 are not environmentally significant. Slightly elevated levels of oil and grease occurred but they are considered representative of background levels in the area. The landfill is separated from the ground water by an underlying caliche layer. The low permeability caliche layer attenuates the potential migration of leachate.

Site No. 5 - Landfill No. 5

Knowledge of the geology and ground-water flow gradient at Landfill No. 5 is adequate to define the hydrogeologic environment at the site, and thus predict the potential movement of any contaminants from the landfill. The placing of the four monitor wells in a 1 up-gradient, 3 down-gradient configuration was accomplished in accordance with the requirements of the Resource Conservation and Recovery Act (RCRA 264 and 265) as it applies to the ground-water monitoring of waste disposal facilities. No contaminants were found in any of the monitor wells beneath the site. Although Site No. 5 requires further ground-water monitoring and sampling as a RCRA landfill, this activity is not funded nor considered appropriate under the IRP program.

Site No. 6 - Fire Department Training Area No. 1

Although higher levels of oil and grease were detected at the site, the concentrations are not considered potentially hazardous. The affected area is very small and the caliche zone attenuates and isolates the oil and grease from infiltrating far enough into the subsurface to affect the ground water about 340 feet below. The low rainfall and lack of surface drainage in the vicinity further reduces the probability of adverse impacts upon the ground-water system.

Site No. 7 - Fire Department Training Area No. 2

The apparently elevated oil and grease concentrations observed at this site are interpreted as reflecting some degree of naturally occurring organics, as well as potentially some hydrocarbon contamination. Fire Training Area No. 2 is considered to be a very low potential impact site because of the fire department's practice of soaking the soil before conducting fire training exercises. The saturated soil reduces the capacity of the soil to permit infiltration of any residual hydrocarbon contaminants into the subsurface. Furthermore, a more than 300 foot thick caliche layer separates the zone of potential hydrocarbon contamination from the ground water.

Site No. 8 - Fire Department Training Area No. 3

Fire Training Area No. 3 (Site 8) exhibited high oil and grease levels between the shallow and intermediate samples. The existence of a well developed caliche zone and the depth to ground water (340') serves to isolate the contaminants from the ground water and reduce the potential for interaction between surface contaminants and the ground water system.

Site No. 9 - Fire Department Training Area No. 4

The area around Fire Department Training Area No. 4 (Site 9) is considered to have a low potential for ground water contamination. The extensive, thick caliche layer beneath the site effectively limits downward percolation of any contaminant materials that may be present in the surface soils.

Site No. 13 - Sanitary Sewage Lift Station Overflow

The area around the Sewage Lift Overflow Station (Site 13) presents a minimal risk to the ground-water system. The lack of significant concentrations of volatile halocarbons and aromatics, low levels of oil and grease and a well developed, thick caliche layer characterize a site with a low potential for ground-water contamination.

Site No. 15 - AGE Drainage Ditch

The AGE Drainage Ditch (Site 15) contained no purgeable halocarbons or aromatics. Oil and grease was found in sample 15B-1 and duplicate samples (15B-1 and 15B-1a) contained somewhat elevated concentrations of lead. However the low level of potential contaminants, the limited areal occurrence, and the intrinsically low permeability of the underlying sediments create a low potential for ground-water contamination.

Site No. 16 - Solvent Disposal Site

The Solvent Disposal Site (Site 16) was identified as no longer presenting a potential for ground water contamination. The originally small area could not be located, as the area had been cleaned up and barrels removed before the start of the Phase II, Stage 1 project. No evidence of the site remained to warrant installing a shallow borehole.

Site No. 19 - MOGAS Spill

The horizontal and vertical extent of apparent contamination is small. Although the presence of 1,2-DCE was confirmed in a single soil sample, this compound is not a constituent of MOGAS. Therefore, while this isolated occurrence may merit further investigation for its human health implications, it is not associated with the MOGAS spill, and further assessment under the IRP is inappropriate.

5.2 Category II and III Sites

This section presents a discussion of the alternate measures that may be applied to the remaining sites that were investigated as part of the Phase II Stage 1 work at Cannon AFB. The alternate measures presented in this section are based on the hydrogeologic, and analytical findings discussed in Section 4.0.

The following paragraphs describe the major possible options for dealing with each site. Generally speaking, there are two classes of options (excluding clean up or other remedial actions) that are available at each site. These options include: no further action, appropriate in the case where available evidence is considered adequate and does not suggest the potential for environmental impairment; and further monitoring, appropriate for sites where possible problems have been incompletely identified.

It is Radian's opinion that two sites investigated in the Phase II Stage 1 study at Cannon AFB be classified as Category II (No. 11- Engine Test Cell Overflow Pit and Leach Field; and No. 12 - Stormwater Collection Point). Consideration of additional alternative IRP Phase II activities is necessary for these sites. Only one site (No. 17 - Entomology Rinse Area) has been assigned to Category III on the basis of existing data.

5.2.1 Site 11 - Engine Test Cell Overflow Pit and Leaching Field

Site No. 11 includes the leaching field for washdown from engine Test Cell Facility No. 5114 and an overflow pit. Progressive overloading of the original oil/water separator, installed in 1965, resulted in excavation of an overflow pit in 1982. In 1985, a new oil/water separator and lined evaporation pond were constructed. The site is located within 300 ft. of potable water well No. 9.

To date, all available analyses indicate that environmental degradation resulting from past site activities has not occurred. However, these data are from only two soil borings. Water samples from the evaporation pond were not collected. Also, the original wastewater control system was abandoned at the sites and could result in future environmental impacts. In view of the limited available data and remaining uncertainties, the alternatives are:

- Install three additional soil borings in the vicinity of the old oil/water separator and drainpipe. Collect soil samples from each borehole at three positions: immediately above the caliche; five feet into the caliche; and immediately below the base of the caliche. Analyze all soil samples for priority pollutant metals, purgeable organics and oil and grease. Collect water samples from the evaporation pond and analyze for purgeable organics.

- No further action.

Site No. 11 was assigned to Category II because the oil water separator sump was not sampled for priority pollutants during the Phase II investigation. The amount of information regarding the previous operation and construction is insufficient to dismiss the site from further activities, as is the extent of contamination from the oil water separator and leach field. Additional soils analyses from the proposed borings would more clearly define potential environmental impacts associated with the site in its entirety.

5.2.2 Site 12 - Stormwater Collection Point

The Stormwater Collection Point is a large receptor of runoff from the flightline area. It was observed that there is generally a year-round body of water in the topographically down-gradient stormwater basin. Base activities also contribute effluent to the stormwater basin.

The potential for ground-water recharge to the Ogallala Formation is greatest from the Stormwater Collection Point. The metals values obtained from the Stormwater Collection Point are generally elevated for the sediments with respect to the soils in the local area. Potable water well No. 6 is located approximately 800 feet southeast in a down-gradient position from the site. (See Figure 4-18). To date, no analyses of samples from Well No. 6 have been identified to assess potential impacts associated with the Stormwater Collection Point, if any. The thickness and saturated depth of the sediments containing metals at these levels has not been precisely quantified due to the limited shallow sampling done at the site. The following alternatives are considered:

- o Conduct another sampling program of the Stormwater Collection Point to identify the soil chemistry of the deeper soil and caliche units below the site. The soil borings could be drilled by hollow-stem auger on the southeast corner of the site to approximately 200 feet in depth, and samples retrieved at 10 foot intervals. Samples could be analyzed for the priority pollutant metals using the EP Toxicity Test.

- o No further action.

The installation of a deep soil boring to a depth of 200 feet would potentially serve two purposes. By retrieving and analyzing soil samples at 10 foot intervals for heavy metals and oil and grease, the vertical extent of metals enrichment may be determined. The deep soil borings would also serve to delineate the geologic setting of the site in greater detail and would be relatively inexpensive.

If no further actions are taken at Site No. 12, the data presented in the Phase II Stage 1 report shall be considered sufficient documentation of the environmental setting of the site. Although the extent of vertical contamination of the site will not be fully documented, the hydraulic isolation of the site above the aquifer (340 feet) could warrant re-ranking this site to Category 1 (Table 5-1).

5.2.3 Site No. 17 - Entomology Rinse Area

Site No. 17, the Entomology Rinse Area, contained high levels of herbicides and pesticides in the subsurface. Most significantly, soil boring 17C-3 contained the herbicide compound 2,4-D at high levels (406 mg/kg) below the caliche profile at a depth of 62 feet. Since the existence of organic contamination has been documented, but a clear determination of the vertical and lateral extent of pesticide and herbicide contamination could not be fully assessed from the Phase II Stage 1 investigation, the following alternative measures are considered:

- Install three deep soil borings radially 100 feet from Site No. 17C (maximum depth 200 feet) using a hollow-stem auger and collect soil samples at 10 foot intervals beginning from land surface. The soil samples would be analyzed for pesticides and herbicides.

- Initiate clean-up activities (Phase IV) in the areas of demonstrated soil contamination. Concurrently monitor the effectiveness and completeness of the selected remedial actions by analyzing soil samples for pesticides and herbicides.

- No further action.

The Air Force supports assignment of Site No. 17 to Category III based on the soil contamination documented in the Phase II study. Tactical Air Command (TAC) Civil Engineering is currently directing Phase IV clean-up activities at the site.

6.0 RECOMMENDATIONS

This section contains the Phase II Stage 1 IRP recommendations for further actions at Cannon AFB. According to Air force criteria, each site has been assigned to one of the following categories:

Category I - sites where no further action is required,

Category II - sites requiring additional monitoring or work to assess the extent of current or future contamination, and

Category III - sites that require and are ready for remedial action.

6.1 Category I Sites

Most sites investigated during the Stage 1 program fall into Category I where no further action is required. The sites listed as Category I, are: Landfills 1, 2, 3, 4 and 5; Fire Department Training Areas 1, 2, 3 and 4; Sanitary Sewage Lift Station Overflow Site, AGE Drainage Ditch; MOGAS Spill; and Solvent Disposal Site.

6.1.1 Landfills Nos. 1, 2, 3 and 4

The chemical data and geologic information obtained during the Stage 1 activities are adequate to demonstrate that these sites pose no threat to the environment and therefore do not warrant further investigation.

6.1.2 Landfill No. 5

Results of the first round of ground-water sampling and analysis at Landfill No. 5 do not indicate ground-water contamination exists beneath the site. Base monitoring will continue however, under the guidance of RCRA.

This monitoring will be accomplished under the direction of EPA's state representative, The Environmental Improvement Division in Santa Fe, New Mexico. Further IRP action or involvement at this site is unwarranted.

6.1.3 Fire Department Training Areas 1, 2, 3 and 4

The absence of volatile halocarbons and aromatics (commonly associated with fuel and fuel derivatives) combined with other information obtained during the Stage 1 investigation is considered sufficient basis to eliminate these sites from further IRP studies. No further actions are required.

6.1.4 Sanitary Sewage Lift Station Overflow Site

No volatile organic compounds were detected. Oil and grease concentrations were generally low, and the site is underlain by a well developed caliche layer. Therefore, there is little threat to the Ogallala aquifer and the site requires no further action.

6.1.5 AGE Drainage Ditch

The information obtained from the two soil borings at the site did not reveal elevated levels of potentially hazardous materials when tested, except for lead. This information combined with other data obtained during the Stage 1 investigation is considered sufficient to demonstrate that the site does not warrant further documentation.

6.1.6 MOGAS Spill

The information gathered from this study indicates that this site probably poses no threat to human health or the environment. The 1,2-DCE detected in one soil sample is not a component of MOGAS. Therefore any further investigation of this site is beyond the responsibility of the IRP.

6.1.7 Solvent Disposal Site

No indication of this location was found. It is probable that, as previously reported, the materials had been removed. No further actions are required at this site.

6.2 Category II Sites

Category II sites are defined as sites requiring additional monitoring work or work to quantify or further assess the extent of contamination. The sites listed in Category II are the Engine Test Well Overflow Pit and Leach Field, and the Stormwater Collection Point.

6.2.1 Engine Test Cell Overflow Pit and Leach Field

No available analyses to date provide evidence of soil contamination related to past site activities. However, the data are very limited and were obtained from only two borehole locations across the site. To more completely assess potential environmental impacts, Radian recommends:

- Installation of three additional soil borings in the vicinity of the former oil/water separator and drainpipe. Collect soil samples from each borehole at three positions: immediately above the caliche; five feet into the caliche; and immediately below the base of the caliche. Analyze all soil samples for priority pollutant metals, purgeable organics, and oil and grease. Also, collect water samples from the evaporation pond and analyze for purgeable organics.

6.2.2 Stormwater Collection Point

A large proportion of surface runoff originating on base is routed into the Stormwater Collection Point. Sediment samples collected from the basin indicate elevated levels of heavy metals exist in the sediment. The water body in the basin could potentially drive these heavy metals deeper into substrate and aquifer below. Base supply Well No. 6 is located approximately 800 feet southeast and down-gradient from the Stormwater Collection Point. Radian recommends the following actions:

- Install three deep soil borings along the southern perimeter of the Stormwater Collection Point to a maximum depth of 200 feet. Collect soil samples at 10 foot intervals and analyze for priority pollutant metals using the EP Toxicity Test.

6.3 Category III Sites

Tactical Air Command (TAC) Civil Engineering has already begun clean-up activities at Site No. 17 - Entomology Rinse Area.

6.3.1 Entomology Rinse Area

Samples from soil borings 17A and 17C contained pesticides and herbicides. The geology of the site appears to be well documented, but the areal and vertical extent of contamination is not defined. Radian recommends that further soil sampling and analysis be conducted in conjunction with the Phase IV effort to confirm the effectiveness and completness of the ongoing remedial activities.

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