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**Installation Restoration Program
Phase II — Confirmation/Quantification
Stage 1**

AD-A150 158

Final Report
for
Hancock Field, New York
and
HQTAC, Langley AFB, VA

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Prepared for:
United States Air Force
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October 1984

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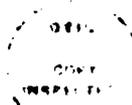
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1.0 INTRODUCTION

1.1 BACKGROUND

The United States Air Force has long been engaged in a variety of operations that involve the use of materials with toxic and hazardous properties. Hazardous wastes have been generated as a result of these operations. Federal, state, and local governments have developed strict regulations that require disposers of toxic and hazardous wastes to identify the location and content of waste disposal sites and to implement actions to eliminate any hazards to public health or the environment. The Department of Defense (DOD) has answered this challenge by issuing Defense Environmental Quality Program Policy Memorandum 81-5. This memorandum requires the identification and evaluation of past hazardous material disposal sites on DOD property, the control of hazardous contaminant migration, and the control of hazards to the public health and environment from past disposal activities. The program implemented by the Air Force (AF) under this memorandum is called the Installation Restoration Program (IRP). The IRP serves as the basis for response actions at AF installations under the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980.

The AF IRP has been developed as a four-phase program with distinct tasks and outputs from each phase. These phases are:

- Phase I - Installation Assessment (Records Search)
- Phase II - Confirmation/Quantification
- Phase III - Technology Base Development
- Phase IV - Operations/Remedial Actions

Phase I was completed at Hancock Field, New York, in July 1982. This study, conducted by Engineering-Science, Inc., identified and prioritized past disposal sites that could pose a threat to public health or the environment through contaminant migration. The Phase II (Stage 1) at Hancock Field consisted of a preliminary environmental survey to confirm the

presence of any environmental contamination that has resulted from waste disposal practices. This report presents the results of the Phase II (Stage 1) survey.

1.2 HANCOCK FIELD ORGANIZATION AND MISSION

The primary mission of Hancock Field is to provide support to the 21st NORAD Region/Air Division and other tenant organizations. The 4789th Air Base Group (ABG) acts as the host unit at Hancock Field and operates and maintains the installation. The support services provided by the 4789th ABG include the morale, welfare, and recreational needs of Hancock personnel, and acquisition and maintenance for all facilities and hardware.

Supply, accounting and finance, or contracting services are provided by the 416BMW, Griffiss AFB (SAC), New York, as arranged through Host-Tenant Agreements. The only flying mission at Hancock Field is conducted by the 174th Tactical Fighter Wing, New York Air National Guard (NYANG).

A current listing of Hancock Field units is provided in Table 1-1. A detailed discussion of the major base tenant missions is presented in the Phase I Report.

1.3 PHASE I

The IRP Phase I assessment at Hancock Field was conducted during 1982. The Phase I study was a record search identifying possible contaminant sites. Engineering-Science, Inc., performed the study at Hancock Field; the results of this effort are available from either:

- o AFESC/DEV
Tyndall AFB, Florida
- o HQ TAC/DEE
Langley AFB, Virginia.

The Phase I report describes installation, and environmental setting, and discusses past and present waste management and disposal activities.

TABLE 1-1

HANCOCK FIELD HOST AND TENANTS

HOST

4789th Air Base Group

TENANT AND OTHER INSTALLATION LOCATIONS

21st Air Division

21st Air Defense Squadron

3513th USAF Recruiting Group

Det 27, 12th Weather Squadron

Det 110, Air Force Office of Special Investigation

United States Army Communication Center - Northeast Telecommunications
Switching Center

OLME AFCEM/FCS Commissary

Civil Air Patrol

Det 2, 1913th Communications Group

Federal Aviation Administration (FAA)

Marine Corp Reserve Training Center

GUARD AND RESERVE UNITS

98th Division Aviation Support Facility 6 (U.S. Army Reserve)

174th Tactical Fighter Wing (NYANG)

138th Tactical Fighter Squadron

108th Tactical Control Flight

113th Tactical Control Flight

USAF Clinic Hancock

On the basis of interviews with past and present base personnel, file searches, and a site inspection, seven sites located on Hancock Field property were identified as containing potentially hazardous waste that could result in environmental contamination. The locations of these sites are shown in Figure 1-1. These sites were assessed using the Hazard Assessment Rating Methodology (HARM), which addresses factors such as site characteristics, waste characteristics, potential for contamination, and waste management practices. HARM rating scores for each of the seven sites are shown in Table 1-2 and provided in Appendix J. The conclusions developed in the Phase I effort for each site are as follows:

- o Fire Training Area - Fire Training Site FT-1 has a high potential for environmental contamination.
- o Disposal Sites - Disposal Sites D-1, D-3, and D-5 have a moderate potential for environmental contamination.
- o Hazardous Waste Storage Areas
 - The old transformer storage area (Site S-1) has a low potential for environmental contamination.
 - The entomology underground storage tank (Site S-3) has a low potential for environmental contamination.
- o Other sites are not considered to pose a significant hazard of environmental contamination.

1.4 PHASE II

On the basis of the Phase I findings, the Air Force OEHL developed the scope of work (refer to Appendix B) for the Phase II (Stage 1) - Confirmation/Quantification effort. The primary objectives of this program were to:

- o Determine the extent and magnitude of contamination resulting from previous waste disposal practices at Hancock Field
- o Recommend measures to mitigate adverse impacts at identified contaminated areas
- o Develop environmental monitoring program(s) to document environmental conditions resulting from past waste disposal practices.

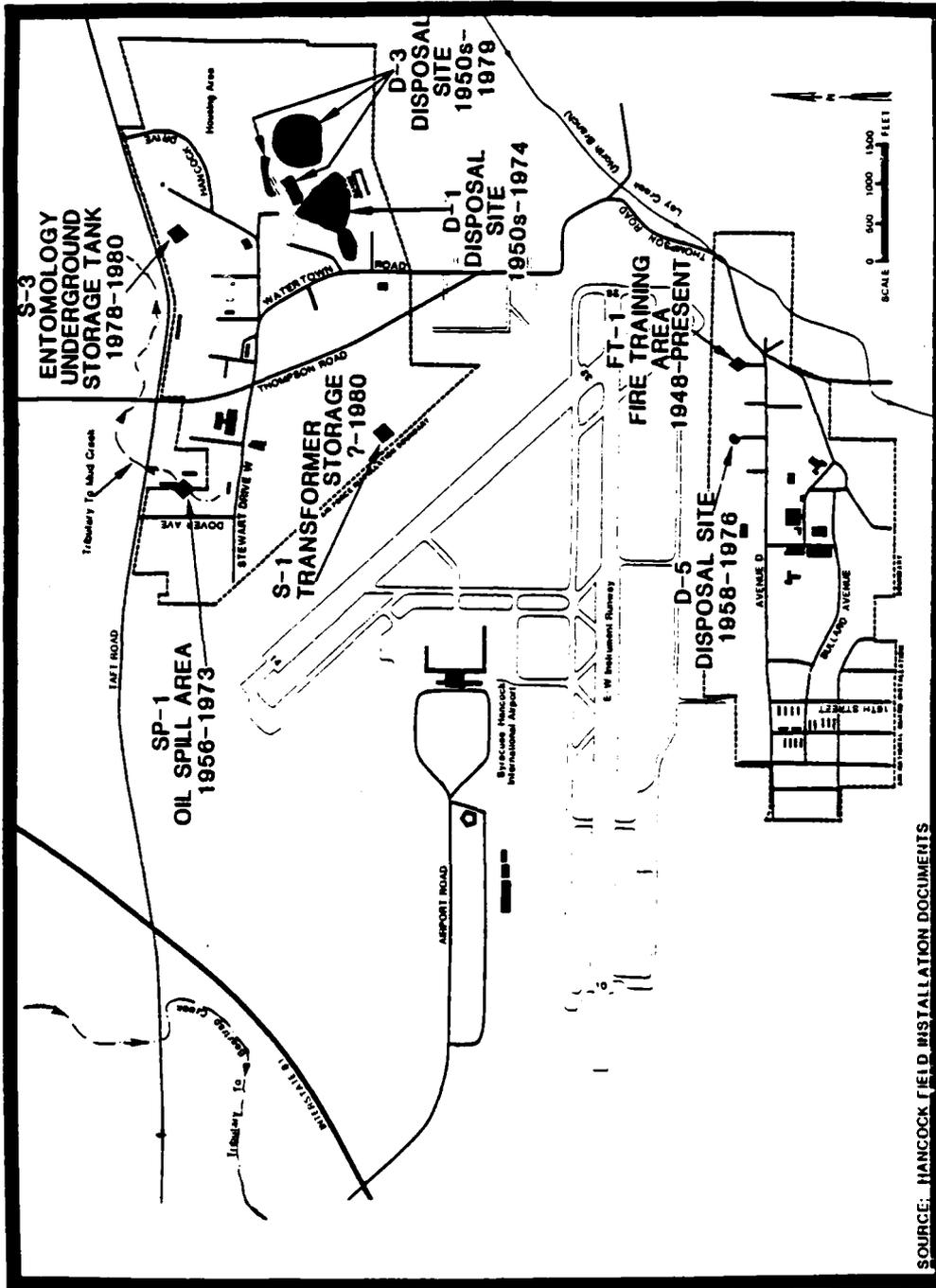


FIGURE 1-1. LOCATION OF SITES IDENTIFIED BY IRP, PHASE I.

TABLE 1-2
PRIORITY RANKING OF POTENTIAL CONTAMINATION SOURCES

Rank	Site Name	Score
1	FT-1 Fire Training Area	67
2	D-3 Disposal Site	57
3	D-1 Disposal Site	56
4	D-5 Disposal Site	56
5	S-1 Transformer Storage Area	54
6	S-3 Entomology Underground Storage Tank	51
7	Sp-1 Old Spill Area	6

Note: This ranking was performed according to the Hazard Assessment Rating Methodology (Refer to Appendix J).

To accomplish these objectives, the scope of work establish the following monitoring plan:

- o Zone 1: Fire Training Area (FT-1) and Disposal Site D-5
 - Groundwater: Four wells within the zone
 - Surface water: Five sampling sites along the runoff area north of the zone
 - Sediments: Six sampling sites along the runoff area north of the zone
- o Zone 2: Disposal Sites D-1 and D-3
 - Groundwater: Six wells within the zone
 - Surface water: Three sampling sites from the culvert adjacent to site D-3
 - Sediments: Three sampling sites from the culvert adjacent to site D-3.

Samples collected from the monitoring points listed above were to be analyzed for all or some of the following parameters:

- o Total organic carbon (TOC)
- o Total organic halogen (TOX)
- o Oil and grease
- o Volatile aromatics
- o Volatile halocarbons.

The remainder of the report is divided into five chapters, which are briefly described below:

- 2.0 Environmental Setting - An overview of regional and local geology and hydrology, including aquifer systems and disposal histories.
- 3.0 Field Program - the field activities and procedures associated with the monitoring well installation program, aquifer tests, and sampling procedures.
- 4.0 Discussion of Results and Significance of Findings - Field sampling results, extent of contamination, and evaluation of contamination.
- 5.0 Alternative Measures - The proposed options, by site, for future monitoring efforts or studies.
- 6.0 Recommendations - Conclusions of the study and recommendations for future IRP stages.

2.0 ENVIRONMENTAL SETTING

2.1 BACKGROUND

Hancock Field adjoins Syracuse International Airport and is located approximately 5 miles north-northwest of Syracuse, New York. Hancock Field and the surrounding area are within the Ontario-Mohawk Lowland Region of the Central Lowland Physiographic Province. This province extends from Albany to Buffalo and has a relatively flat topography with some areas of low topography. This low relief landscape was caused by glacial erosion and deposition during the Wisconsin Glacial Stage, which occurred 85,000 to 7,000 years ago. Flanking the lowland area to the northeast and southwest are the Tug Hill and Appalachian Upland Regions, respectively (Figure 2-1). These regions are dominated by hills and valleys that trend north-south.

These three physiographic regions make up the Eastern Oswego River Basin, which includes almost all of Onondaga County and large sections of surrounding counties. The Syracuse area lies in the approximate center of the basin and is the industrial and commercial center of this region of New York State.

The area within and around Hancock Field is typical of the Ontario-Mohawk Lowland Region. Dominant geomorphological features are not superficially obvious. Surrounding and within some areas of the base are naturally occurring swamps and poorly drained areas. The extent of these naturally occurring lowlands has been drastically altered because of on- and off-base construction activities. An obvious change to the original topography is the channelization of the Ley Creek tributary that flows north to south along the eastern edge of the base boundary (Figure 2-2). This tributary was created to provide additional surface water drainage from the swamp during construction activities associated with the airfield and base. Also, many of the natural lowlands and swampy areas were filled to provide sites for the construction of housing and other base facilities. Alterations to the land surface from 1938 to the present are illustrated in Figures 2-2 and 2-3. Figure 2-3 depicts the topography of Hancock Field in 1938, prior to base construction. Figure 2-2 shows Hancock Field as it appeared in a recent, photo revised, topographic quadrangle.

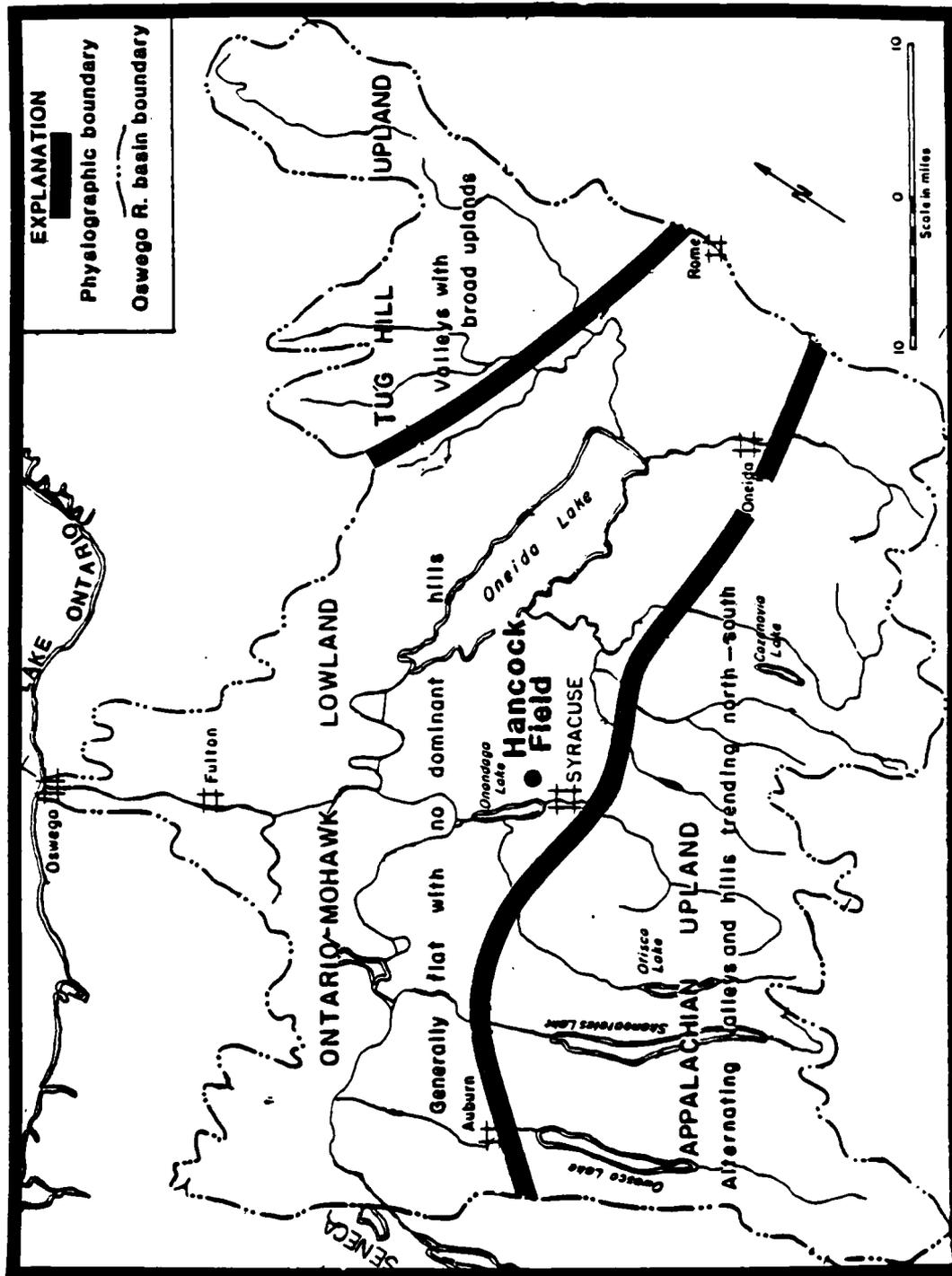


FIGURE 2-1. PHYSIOGRAPHIC LOCATION OF HANCOCK FIELD, NEW YORK

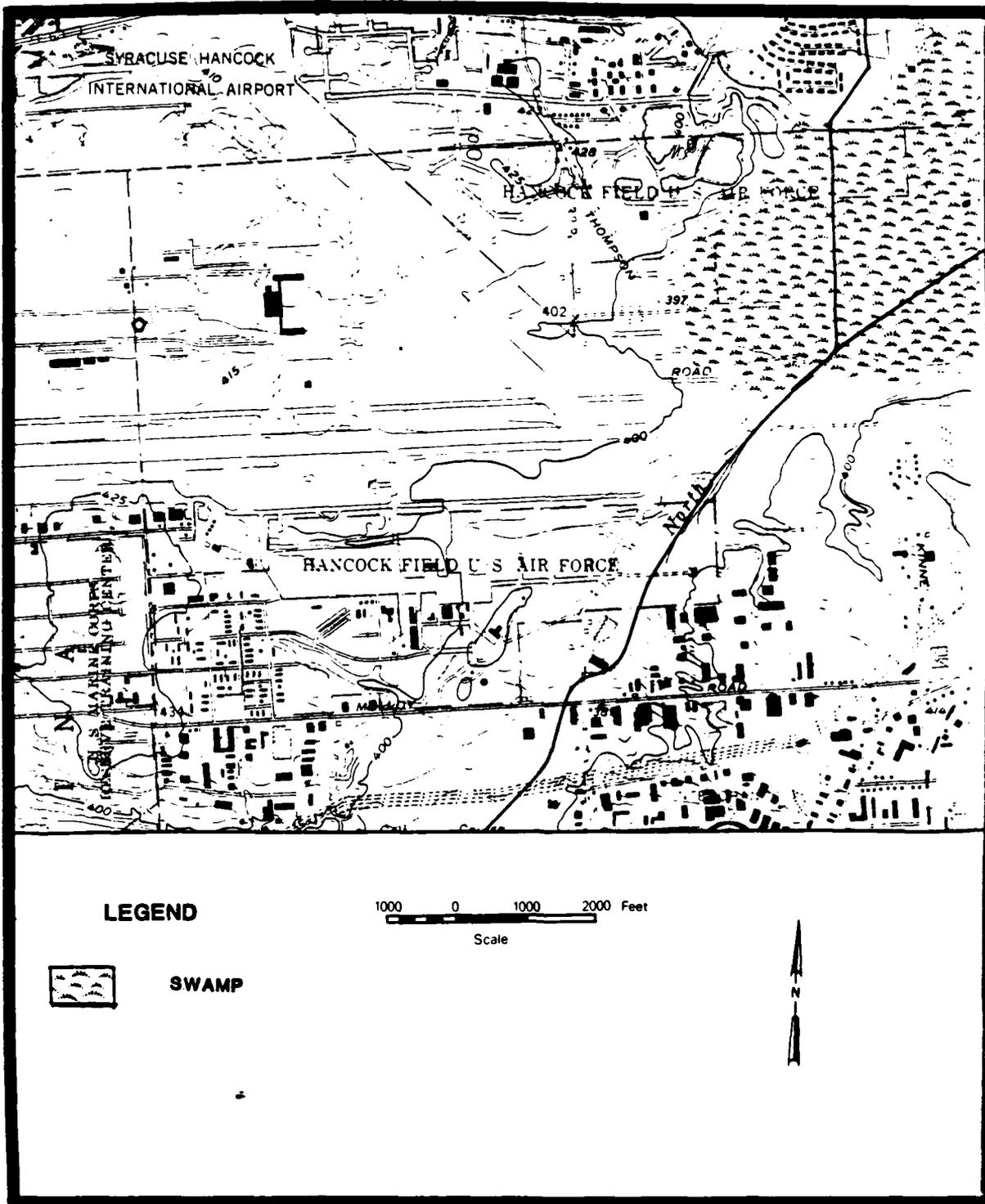


FIGURE 2-2. TOPOGRAPHY OF HANCOCK FIELD, 1978
(USGS, 1978)

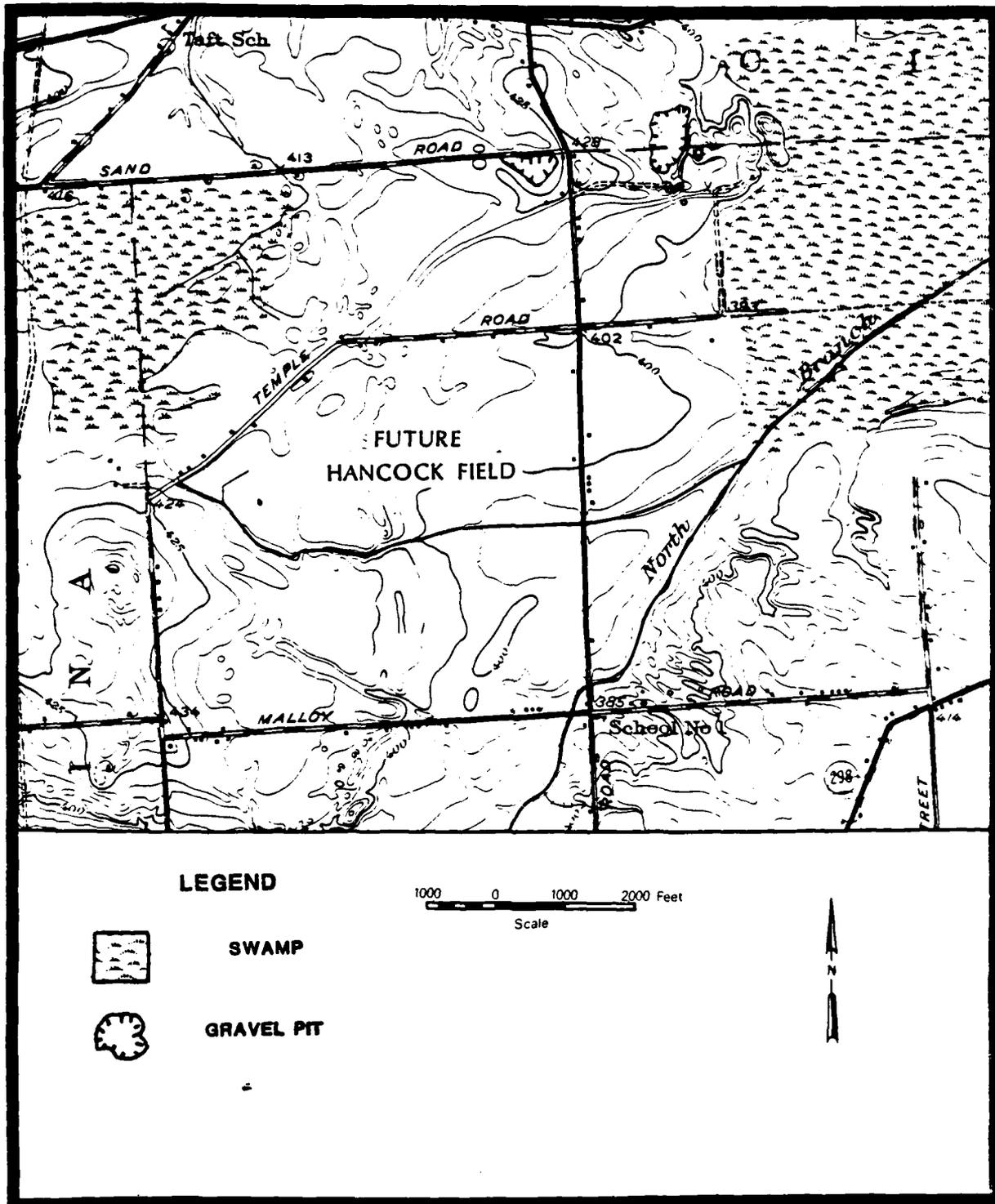


FIGURE 2-3. TOPOGRAPHY OF AREA PRIOR TO BASE CONSTRUCTION (USGS, 1938)

2.2 REGIONAL GEOLOGY AND HYDROLOGY

2.2.1 Geology

The geology of the Oswego River Basin has been investigated by numerous researchers including Dale (1950), Fisher (1957), and Richard and Fisher (1970). These reports discuss the geology of the Oswego River Basin with respect to depositional and structural influences. Based on these reports, two geologic units in the Hancock Field area are of primary importance to this study. These two units are the uppermost bedrock unit and the overlying, surficial, unconsolidated, glacial deposits. These two units are the main sources of groundwater in the area and are more susceptible to pollution by man's activities than other stratigraphically lower units.

The uppermost bedrock formation present at Hancock Field is the Vernon Formation of Silurian Age. This formation reportedly extends east-west from Rome, New York to Rochester, New York. The Vernon Formation attains a maximum thickness of about 600 feet near Vernon, New York.

The Vernon Formation is composed predominantly of red and green shales with thin occurrences of a shaley dolomite. These shales and dolomites are reported to be poorly cemented and crumbly. They have been shown to weather rapidly when exposed in a surface environment (Fisher, 1957).

The Vernon Formation, like the other major formations underlying the study area, dips gently to the south at a rate of approximately 50 feet per mile. Major faults have not been reported or mapped within the study area; however, localized fractures and enlarged joints and bedding planes are present within the shales.

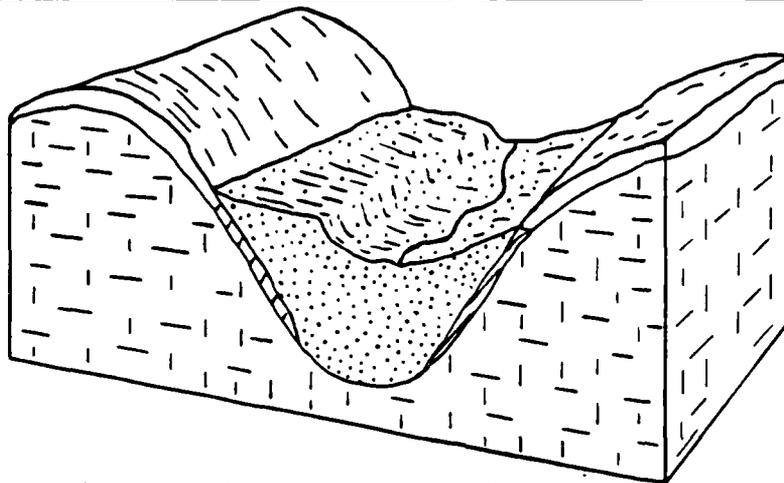
Overlying the majority of the Vernon Shale in the Eastern Oswego River Basin are unconsolidated deposits that are primarily glacial in origin. These deposits were laid down on the bedrock by the massive continental glaciers of the Wisconsin Glacial Stage. These unconsolidated deposits are

generally of two types: those deposited directly by the glacier without transport or sorting by water (i.e., till) and those deposited by glacier melt water (i.e., outwash). Typical depositional sequences are illustrated in Figure 2-4.

In the area studied, the deposits directly laid down by the glaciers without reworking by melt waters was till. The till generally consists of an unstratified, unsorted, unconsolidated to moderately consolidated, heterogeneous mixture of clay, sand, gravel, and boulders. Typically, a till layer of varying thickness directly overlies the Vernon Shale within the Basin. In the Ontario-Mohawk Lowlands, the till is about 30 feet thick (Kantorwitz, 1970). However, in some areas the till may be as much as 200 feet thick, or may be completely absent.

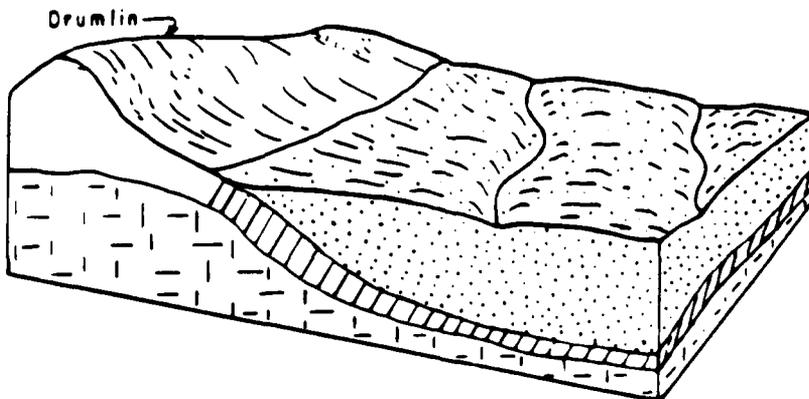
In many places, the till is overlain by glaciofluvial (i.e., water borne) deposits that were laid down as immense volumes of water melted during glacial stagnation or retreat. These melt waters carried material that was trapped in the glacier and formed large rivers and lakes. The outwash deposits laid down by the melt water are characteristically well-sorted and stratified, although poorly sorted, heterogeneous deposits also occur (Kantorwitz, 1970). In general, coarse grained materials (i.e., gravels and sands) were deposited in fast moving waters (i.e., fast moving water tends to keep small particles suspended) such as stream channels and the toes of a melting glacier (which may be at the edge of a lake environment). Finer grained materials (i.e., silts and clays) were generally deposited in the quiescent deeper waters of lakes and the slower moving stretches of streams.

Figure 2-5 illustrates the irregular surficial depositional patterns associated with the glacial deposits within the Eastern Oswego River Basin. This irregular pattern of deposits can be associated with the varied depositional activities occurring during glacial advance, stagnation, and retreat. From this figure, the most extensive glacial deposits in the study



Distribution of till and outwash in the Appalachian and Tug Hill Uplands

EXPLANATION	
 Water Bearing till	 Other unconsolidated deposits (outwash)
 Non-water bearing till	 Bedrock



Distribution of till and outwash in the Ontario-Mohawk Lowland

FIGURE 2-4. TYPICAL DEPOSITIONAL SEQUENCES OF GLACIAL MATERIAL IN THE EASTERN OSWEGO RIVER BASIN

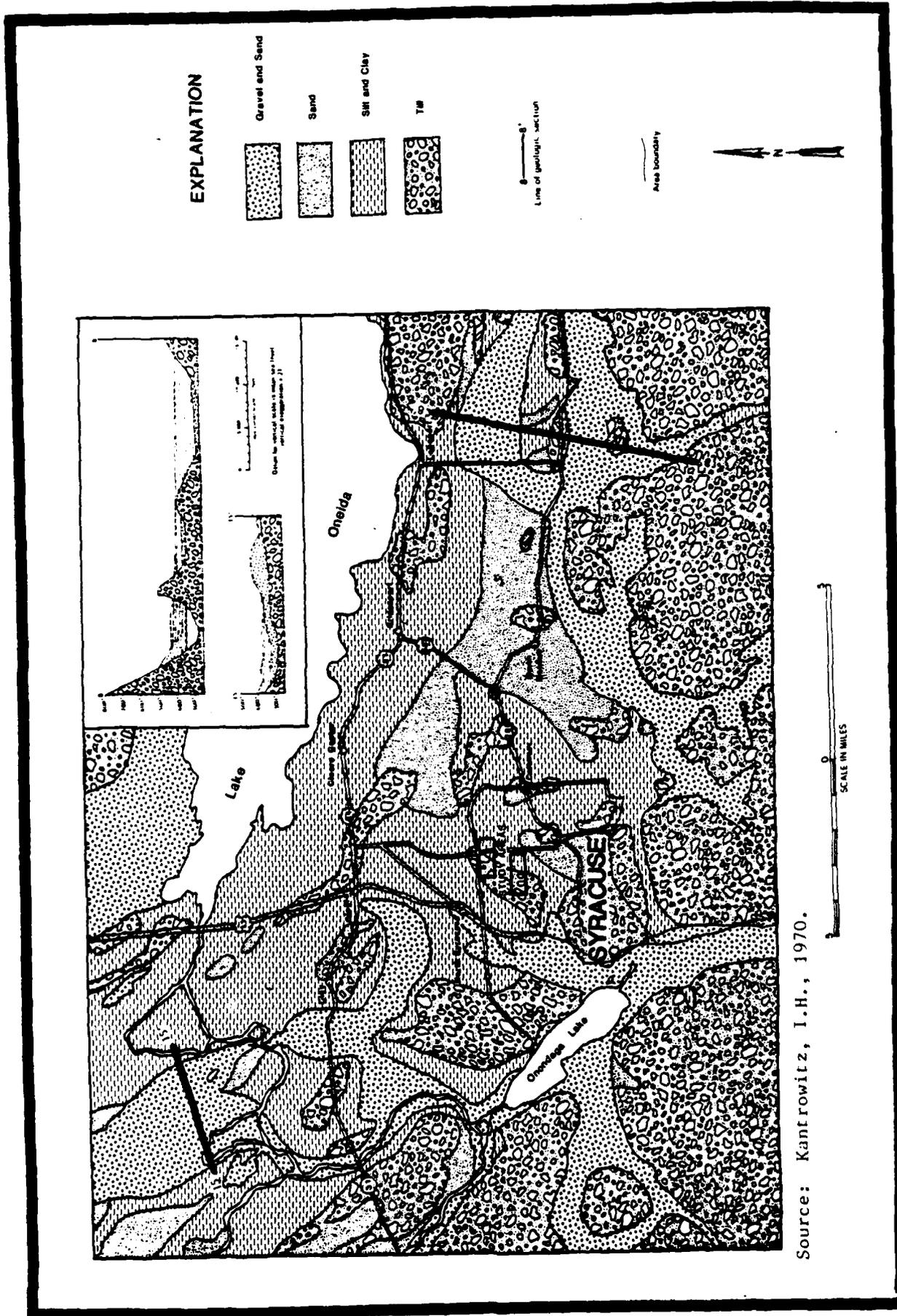


FIGURE 2-5, GEOLOGIC MAP AND CROSS-SECTIONS OF A PORTION OF THE EASTERN OSWEGO RIVER BASIN, NEW YORK (AFTER KANTROWITZ, 1970)

area are the tills, followed by silts and clays. Within these broad deposit classifications variations occur on a local scale and are not evident in Figure 2-5.

2.2.2 Hydrogeology

Hancock Field lies within the Glaciated Central Groundwater Region as described by Heath (1982). This region is characterized by thick glacial deposits over fractured sedimentary rock (i.e., Vernon Shale). Reported hydraulic conductivities of the dominant aquifers in the area range from 5 to 1000 ft/day and well yields for these aquifers range from 50 to 500 gal/min. The dominant aquifers in the Hancock Field area occur in the Vernon Shale where it is fractured or has enlarged joints and bedding planes, and the relatively well-sorted, homogeneous glacial deposits of sand and gravel.

Within the Vernon Shale the primary path of water movement and storage is through localized fractures and bedding planes. Additionally, openings have been enlarged by the solution of dolomite within the middle shale units of the Vernon Formation, which increases groundwater storage. Although these conditions result in a greater potential for groundwater production, the Vernon Shale is not usually considered a source of large supplies of groundwater. Rather, the Vernon Shale is mainly used for domestic or farm supplies. Investigations of wells within the Basin that penetrate the Vernon Shale show a wide variation in yield (Kantorwitz, 1970). These variations are probably caused by localized changes in the fracture patterns, varying degrees of solutioning, and the infilling of openings with fines.

Much of the groundwater that occurs in the Vernon Shale is present under confined conditions resulting in flowing artesian wells. Artesian conditions exist within the Vernon Shale because it is confined by overlying tills throughout much of the basin. Recharge of the Vernon Shale occurs either through the downward migration of groundwater from overlying glacial deposits or through direct infiltration at outcrops.

The only glacial deposits that contain significant amounts of groundwater are the well sorted, homogeneous sands and gravels. The other glacial deposits (i.e., till, silts, and clays) are not considered aquifers because they have low effective porosities, low hydraulic conductivities (i.e., less than 10^{-7} ft/day), and low specific yields. These deposits are generally capable of yielding only small quantities of groundwater, although quantities can be sufficient for individual domestic wells.

The relatively well-sorted sand and gravel, glaciofluvial deposits constitute the only significant source of groundwater in the unconsolidated deposits. Where these deposits are laterally extensive and receive sufficient recharge, large quantities of groundwater are available. Reported hydraulic conductivities of these deposits are relatively high, ranging from 1 to 100 ft/day for sand and gravel, respectively. Because the sand and gravel deposits are closely associated with the less permeable deposits (e.g., till, silts, and clays), groundwater in these deposits can occur under artesian conditions when overlying confining units are present.

As stated previously, the depositional pattern of the glacial deposits is highly complex within the Ontario-Mohawk Lowland (refer to Figure 2-5). Because of the complex depositional pattern of the glacial material, locating wells with sufficient yields can pose a problem. The general depositional patterns shown in Figure 2-5 allow for the isolation of depositional zones that may have a better potential for higher well yields than other depositional zones (i.e., till versus sand and gravel). However, within a delineated zone, large variations in well yields can occur because of localized variations in depositional patterns. For example, within the zones near Hancock Field delineated as till or silts and clays, gravel and sand deposits occur that probably contain significant volumes of groundwater.

The source of recharge for the glacial deposits is mainly from precipitation. Although the recharge may occur at some distance upgradient, this infiltrating water is the source of nearly all of the water that flows through the aquifer.

2.3 LOCAL GEOLOGY AND HYDROLOGY

2.3.1 Introduction

Section 2.2 provided a description of the regional geology and hydrology of the physiographic province in which Hancock Field is situated. This information is provided as background information so that correlations of site-specific information can be related to regional trends. The majority of the geologic and hydrologic conditions previously discussed are consistent with the information derived during the field investigations at Hancock Field. Identification of variations from regional trends are the result of site-specific data gathering that were not provided for in a regional investigation. This section provides site-specific descriptions of the waste disposal activities and the geologic and hydrologic conditions present at four sites investigated at Hancock Field.

2.3.2 Disposal Activities

Of the identified waste disposal and possibly environmentally deleterious areas evaluated by the Phase I contractor, four sites were identified that may pose a potential environmental threat at Hancock Field and were studied further under the Phase II (Stage 1) effort. These four sites are situated in two zones within the boundaries of the installation. These zones and sites are shown in Figures 2-6 and 2-7. Because the disposal sites are closely spaced within zones, the sites were investigated in the zone context, and the geology is similar, the geologic and hydrologic conditions of the zones will be discussed, rather than those of individual sites.

Zone 2 (Figure 2-6) is situated on the northern part of the base and encompasses two separate disposal sites; D-1 and D-3. Site D-1 is located east of Watertown Road, south of Stewart Drive, and just north of the rifle range. Encompassing approximately 10 acres, this site was used for the disposal of general refuse and construction rubble from the early 1960's until 1979. Prior to disposal activities, this area was the location for

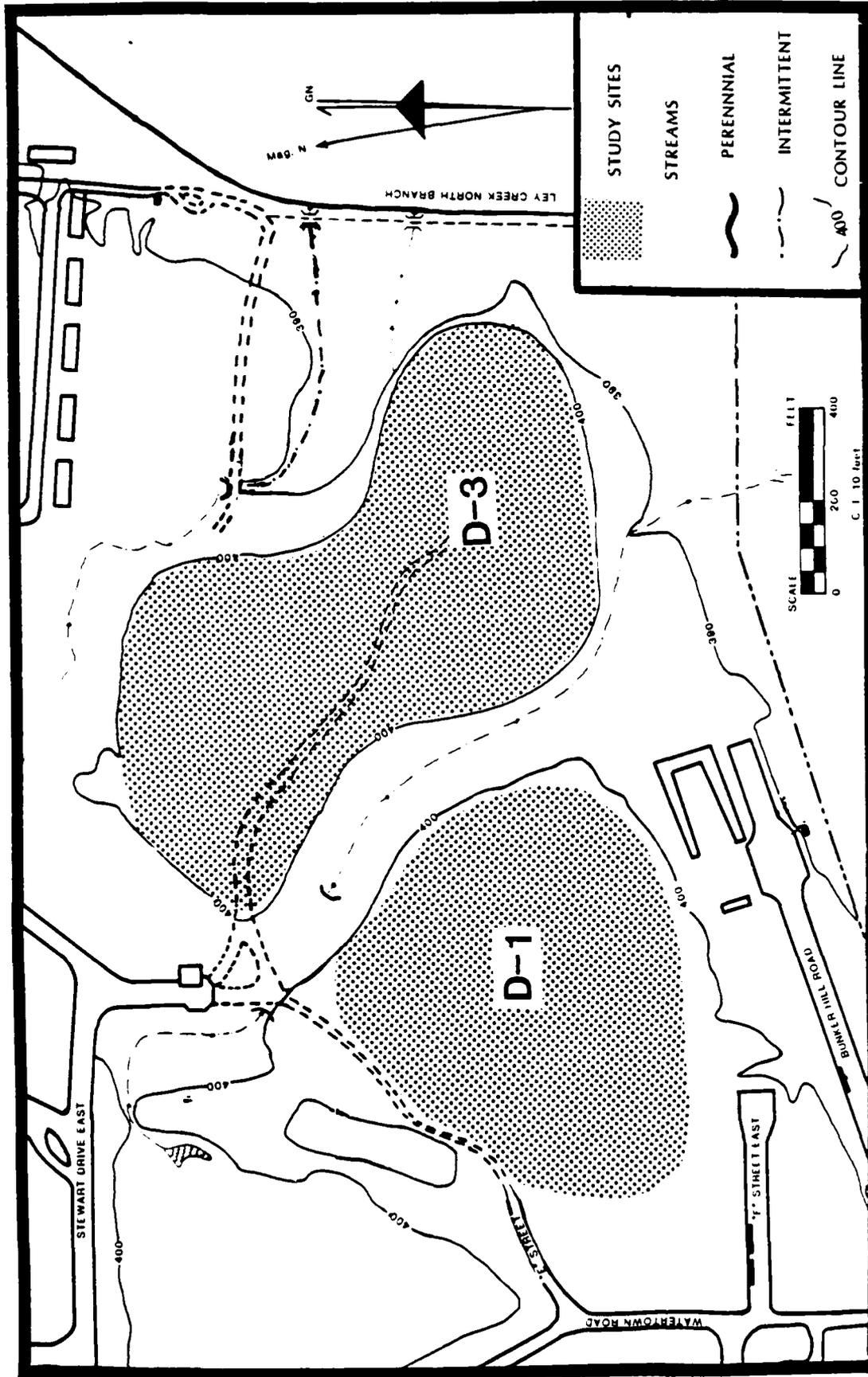


FIGURE 2-6. LOCATION OF SITES D-1 AND D-3 IN ZONE 2

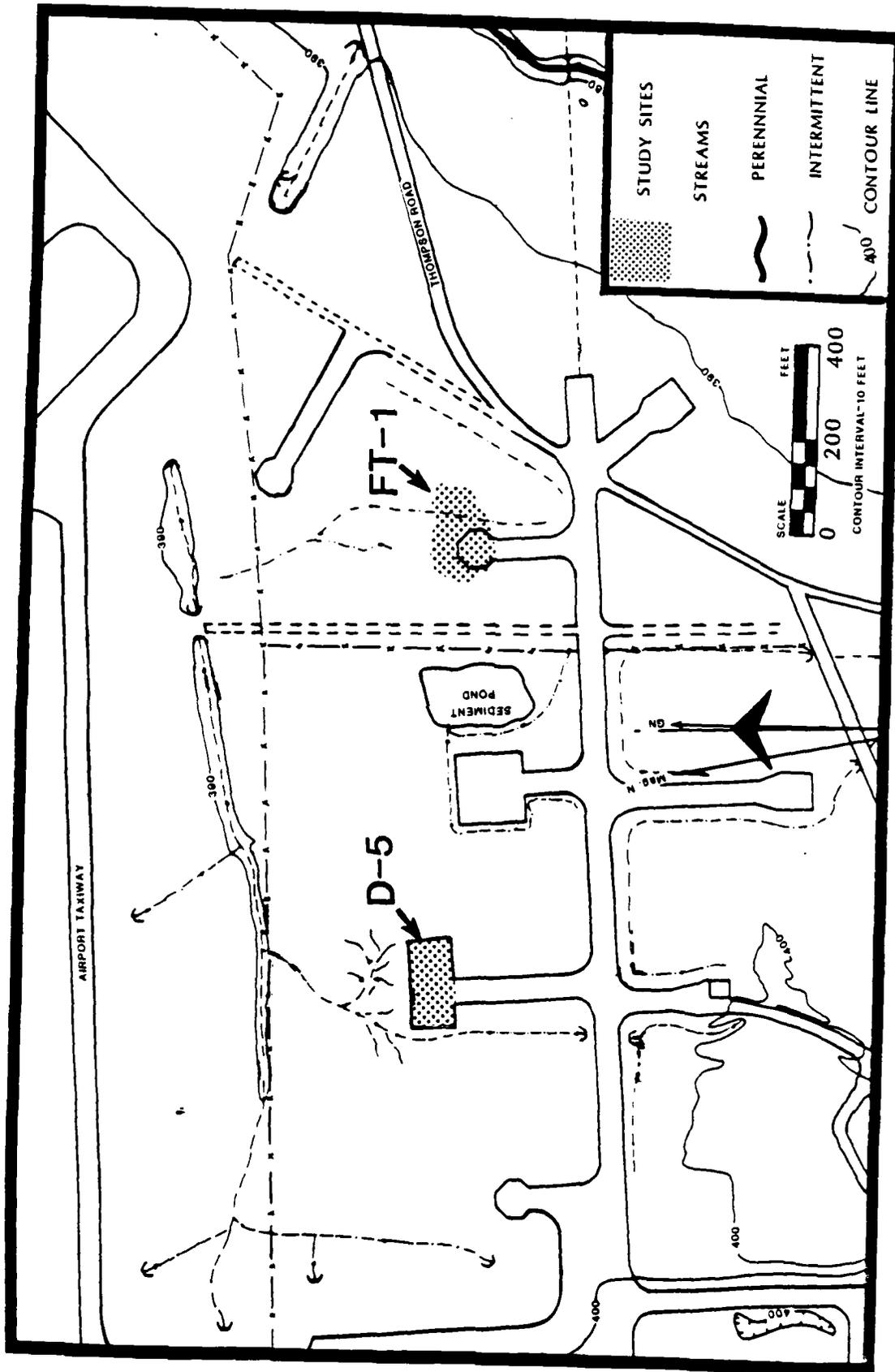


FIGURE 2-7. LOCATION OF SITES D-5 AND FT-1 IN ZONE 1

two domestic waste treatment lagoons. Records do not exist as to the disposition of sewage sludges after the closure of the treatment facility. This site is also believed to contain drums that contained chemical waste solvents and pesticides. Records do not indicate the quantities of the wastes disposed in this area; however, these quantities are believed to be minor (refer to Appendix J for Phase I discussion of waste disposal practices).

Site D-3 is actually three separate areas located east of site D-1 and west of the south-flowing tributary of Ley Creek. This site was utilized for disposal of waste materials such as slaked lime, construction rubble, general refuse, empty drums, and small quantities of liquid paint residues (Appendix J). This site is somewhat larger than D-1, which borders it to the west. Site D-3 flanks and possibly rests on part of the swampy area along the Ley Creek Tributary (Figure 2-6).

Zone 1 is located on the southern portion of the installation along the taxiway used by the New York Air National Guard (Figure 2-7). This zone also encompasses two waste sites of concern, D-5 and FT-1. Site D-5 is located at the end of an old aircraft hardstand which has been converted to a jet engine run-up area. This site is comparatively small (100 feet by 150 feet) and has been reported to contain construction rubble, empty ammunition boxes, empty drums, and drums containing various amounts of paint thinners and solvents. Detailed records of specific quantities or types of waste disposed at this site are not available, but wastes are most likely derived from the NYANG maintenance shops. The exact extent of this site is also difficult to determine because of earthmoving activities associated with modification of an aircraft hardstand.

Site FT-1 is a circular area about 150 to 200 feet in diameter (i.e., an abandoned hardstand). Drainage from this area is uncontrolled at the present time. This site has been used since 1948 by the NYANG and the Air Force for aircraft fire training simulations (Appendix J). Training occurs at the site on the average of once a month.

During fire training exercises, approximately 100 to 150 gallons of waste fuel are spilled on the hardstand. This material is then ignited and allowed to burn to maximum conditions simulating an aircraft fire. This burning material is then extinguished using water or Aqueous Film Forming Foam (AFFF). Chlorobromomethane (CB) or protein-based foams may also have been used in the early days of fire training operations. After the completion of fire training exercises, waste materials and residue are allowed to remain on the area. Because the area does not have controlled drainage, combustible materials, fire fighting agents, and residues used at the site can migrate from the hardstand to surrounding soil areas. Once these materials leave the concrete pad, they are free to either infiltrate into the ground or travel with surface runoff to the local receiving stream.

2.3.3 Geology

Ten wells were installed within the two zones to provide geohydrologic data for the four sites under investigation (refer to Section 3 for well details). Six wells were installed in Zone 2 around sites D-1 and D-3 and four wells were installed in Zone 1 around sites D-5 and FT-1.

As mentioned previously, geologic and hydrologic conditions will be described for each zone rather than each individual disposal site. Figure 2-8 illustrates the relative position of the wells installed in Zone 2 with respect to the two disposal sites D-1 and D-3 and other base facilities. These six wells range in depth from 30 to 42 feet below land surface (BLS). Well logs and "as-built" diagrams for these wells are included in Appendix D.

The variations in lithologies between the wells are indicative of conditions associated with the advance and retreat of the glacier during the Wisconsin Glacial Stage. Three distinct lithologies were encountered during drilling activities in Zone 2 (i.e., gravel, sand, and silt and clay). Using the well drilling data, a fence diagram (Figure 2-9) was constructed around Zone 2. This fence diagram is included to illustrate the stratigraphic relationships that possibly exist within this zone. The fence diagram is provided to show the possible three dimensional configuration of the geology within Zone 2.

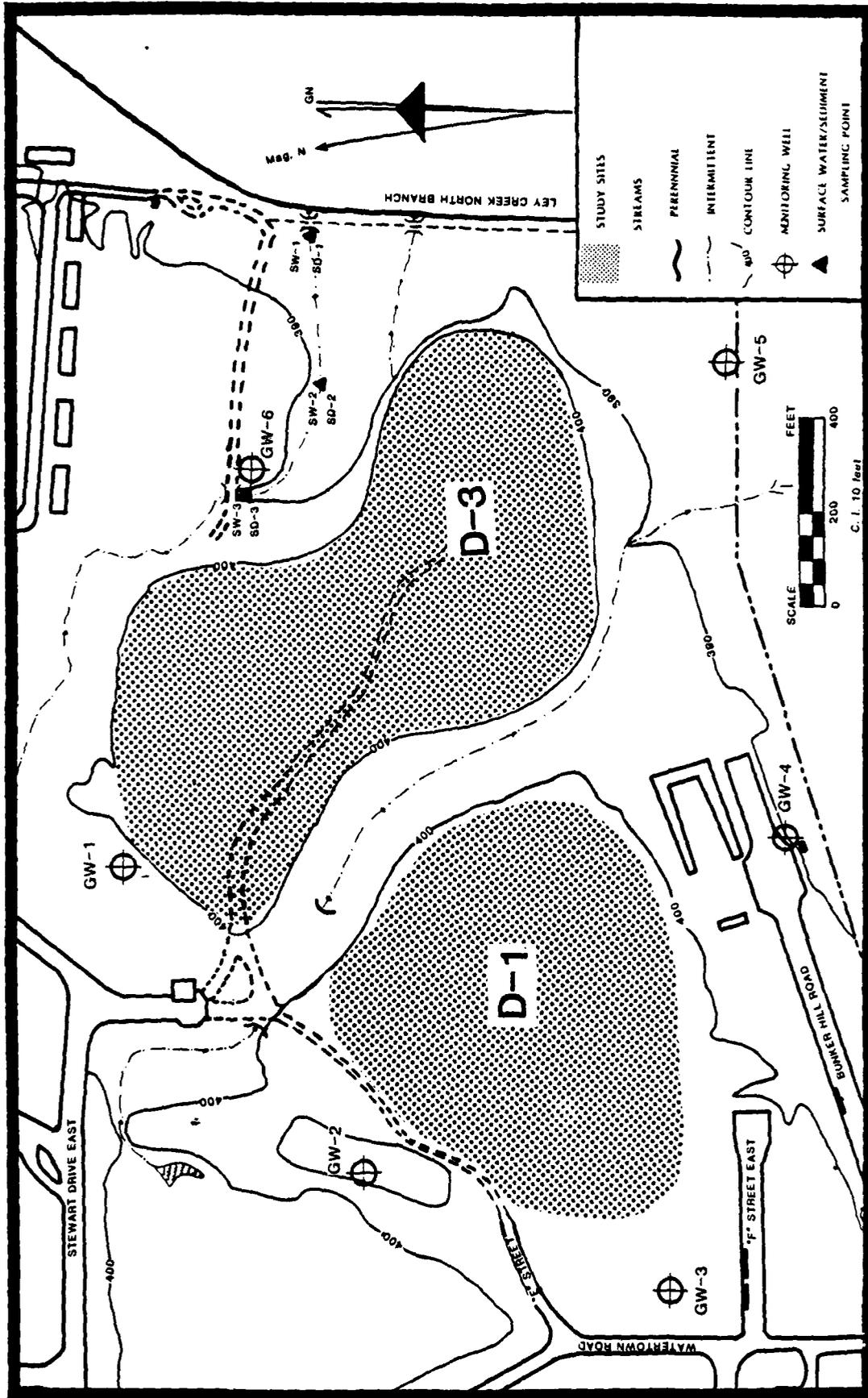


FIGURE 2-8. ZONE 2 SAMPLING POINT LOCATIONS

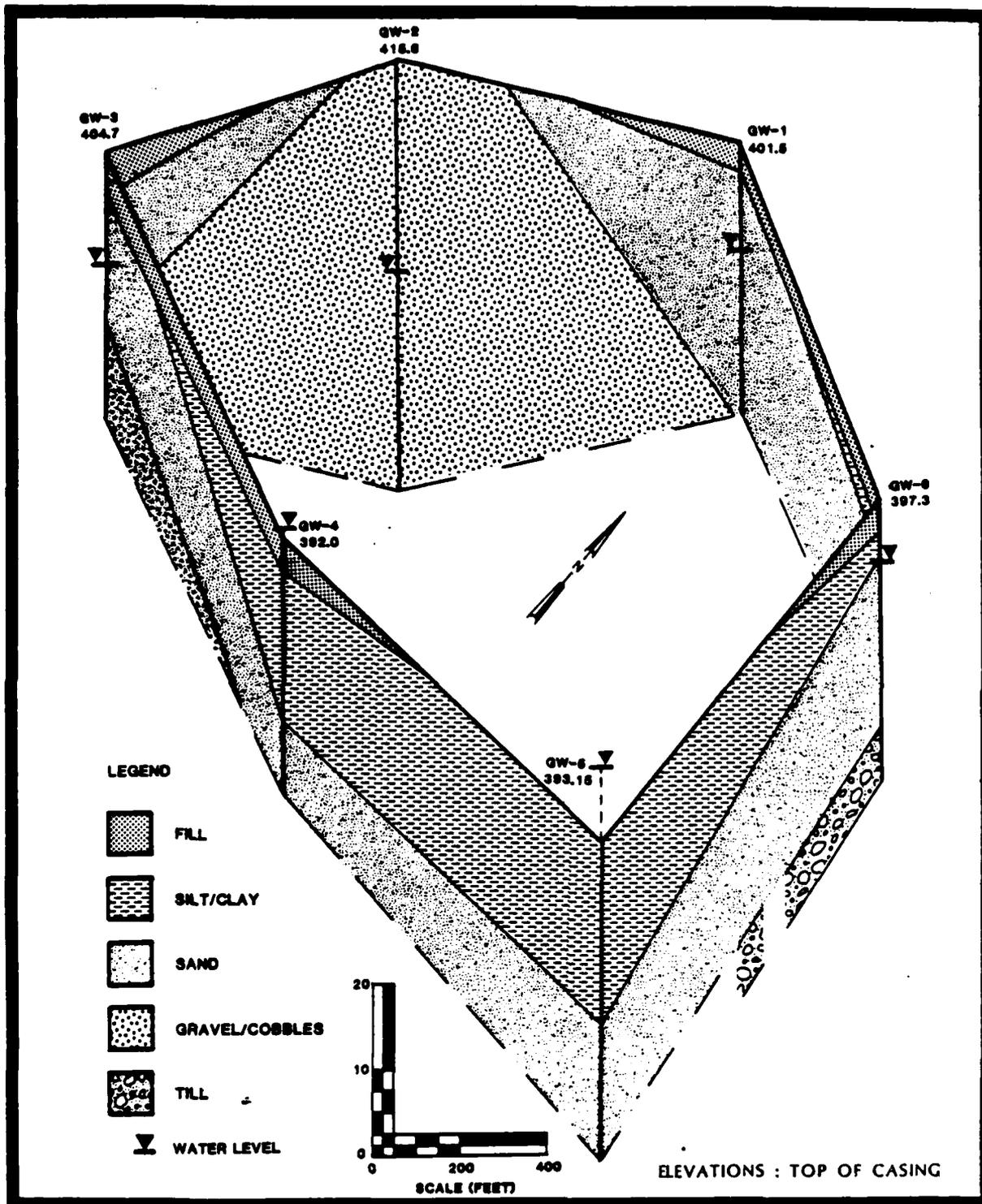


FIGURE 2-9. FENCE DIAGRAM ILLUSTRATING POTENTIAL STRATIGRAPHIC RELATIONSHIP BETWEEN DRILL HOLES IN ZONE 2

Well GW-1, situated along the northern edge of disposal area D-3, extends 30 feet BLS. Samples were taken at 5-foot intervals to a depth of 31.5 feet BLS. The drill logs and Figure 2-9 show material consistent for an area subjected to glaciation. The fine to very fine sand interlayered with alternating thin lenses of silts and clays indicate that this material was deposited in relatively quiescent water during glacial retreat. The thickness of the sandy layer is unknown since this well does not fully penetrate the unit.

Well GW-2 is located approximately 820 feet south-west of GW-1 and was drilled through material distinctly different than the material encountered in GW-1. Throughout the entire sampled interval of 50 feet, all material encountered was coarse in texture and varied in size from sands to boulders. Because this material is poorly sorted, of relatively large size, and located next to layered sands and silts, it may have been deposited at the edge of an ancient lake or during a stagnant phase of glacier retreat. The lack of any coarse material similar to this in well GW-1 indicates a gradational change in lithology or that the coarse zone extends below the sampled interval of GW-1.

The material in which well GW-3 was installed is similar to GW-2 in lithology, with lesser amounts of coarse fragments. However, the material is poorly sorted and extremely loose. Because the elevation of the bottom of well GW-2 is lower than the bottom of GW-3, the coarse material present in GW-2 probably extends further below GW-3 than the sampled interval or pinches out to the south.

Much of the upper material present at GW-3 may be fill material placed in natural, low lying areas during road construction activities on the air base. In addition, past records and maps (refer to Figures 2-2 and 2-3) indicate that several gravel pits existed in the area of GW-2 and GW-3. The areal extent of these gravel pits may be indicative of the surficial extent of the coarse material, but this does not accurately delineate areas where gravel was too far below the surface to be economically mined.

Wells GW-2 and GW-3 were not drilled deep enough to yield a true thickness of the gravel or to indicate whether or not the till layer that commonly overlies the bedrock is present. The fence diagram (Figure 2-9) shows that the gravel zone decreases in thickness toward the southeast. However, this does not indicate any aerial extent but merely indicates that the overlying sandy material increases in thickness.

The well logs of wells GW-4 and GW-5, located in the swampy area south and east of the disposal sites, show similar lithologies throughout their drilled depth. Wells GW-4 and GW-5 were drilled 30 and 35 feet BLS, respectively; and their logs do not indicate the presence of the underlying till or the gravel zones present in GW-2 and GW-3. Again, this does not preclude the presence of these units but only indicates that if they are present, they would exist below the depth drilled and sampled.

The primary difference between the stratigraphy observed at these two wells and the stratigraphy encountered at GW-1 is the presence of a fine textured, confining layer at the surface. This layer is predominantly silt and clay with interbedded fine sand stringers. The silty clay layer extends from the surface to approximately 7 feet BLS in GW-4 and 20 feet BLS in GW-5. This upper confining layer is probably responsible for the artesian conditions of these two wells.

Well GW-6 was drilled and sampled to a depth of 69.5 feet BLS. The upper 25 feet (0 to 25 feet BLS) of material is similar and correlates with that identified in wells GW-1, GW-4, and GW-5. However, below the 25-foot level, alternating layers of moist to wet till were encountered. The till layers ranged in thickness from 10 feet to less than 2 feet. The material between these till layers is a fine sand similar to that which overlies the till.

Correlations with other well logs (GW-4 and GW-5) do not show the presence of the till layers within the first 35 feet of material. The fence diagram (Figure 2-9) does not include the stratigraphy for the lower 38 feet

of GW-6. This portion was omitted from the diagram to avoid confusion, since other geologic data did not correlate with the till layers. However, the entire stratigraphic sequence for GW-6 is shown in Figure 2-10.

The fence diagram (Figure 2-9) depicts a possible stratigraphic correlation for Zone 2, showing the depositional sequence that may have occurred in the geologic past. Additional geologic data are necessary before accurate inferences can be made concerning the thickness of the sandy units encountered and the presence or continuity of the till layers overlying the shale bedrock.

Zone 1 is located on the southern end of Hancock Field within the area used by the NYANG (Figure 2-7). This zone contains the fire training area (FT-1) and the abandoned landfill site D-5. These areas are situated adjacent to the taxiways and have been extensively altered by previous construction activities associated with the air base and runway systems.

Four wells were installed in this zone to provide geohydrologic data for these two waste sites. The locations of these wells, and surface water and sediment sampling points, are indicated in Figure 2-11.

The logs of wells drilled in Zone 1 (Appendix D) show a consistent lithology except in the upper zones, which reflects surficial disturbances. An exception to this is the till layer encountered in GW-8 that was not encountered in the sampled intervals of the other wells. This till may be lenticular, not continuous, or dip below the sampled depths of the other wells. Additional stratigraphic data are necessary before the extent and thickness of the till can be determined. The stratigraphic relationships between the sampled intervals of wells within Zone 2 are illustrated in Figure 2-12. This figure shows a stratigraphic sequence typical of lacustrine deposition, fine sands overlain by the finer silty clays.

ELEVATION

395

385

375

365

355

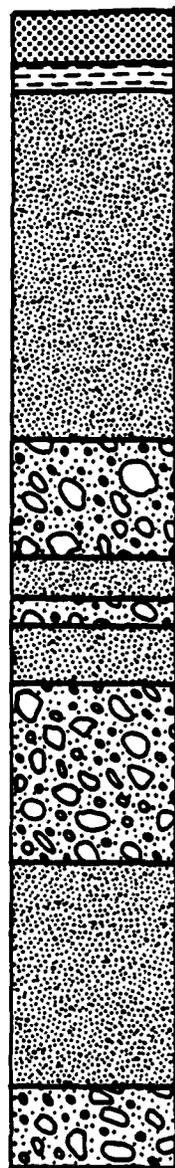
345

335

325

FEET

DATUM: MEAN SEA LEVEL



PORTION OF STRATIGRAPHIC COLUMN
NOT INCLUDED ON FENCE DIAGRAM

LEGEND

 FILL

 SILT/CLAY

 FINE SAND/SAND

 TILL

FIGURE 2-10. STRATIGRAPHIC COLUMN FOR GW-6

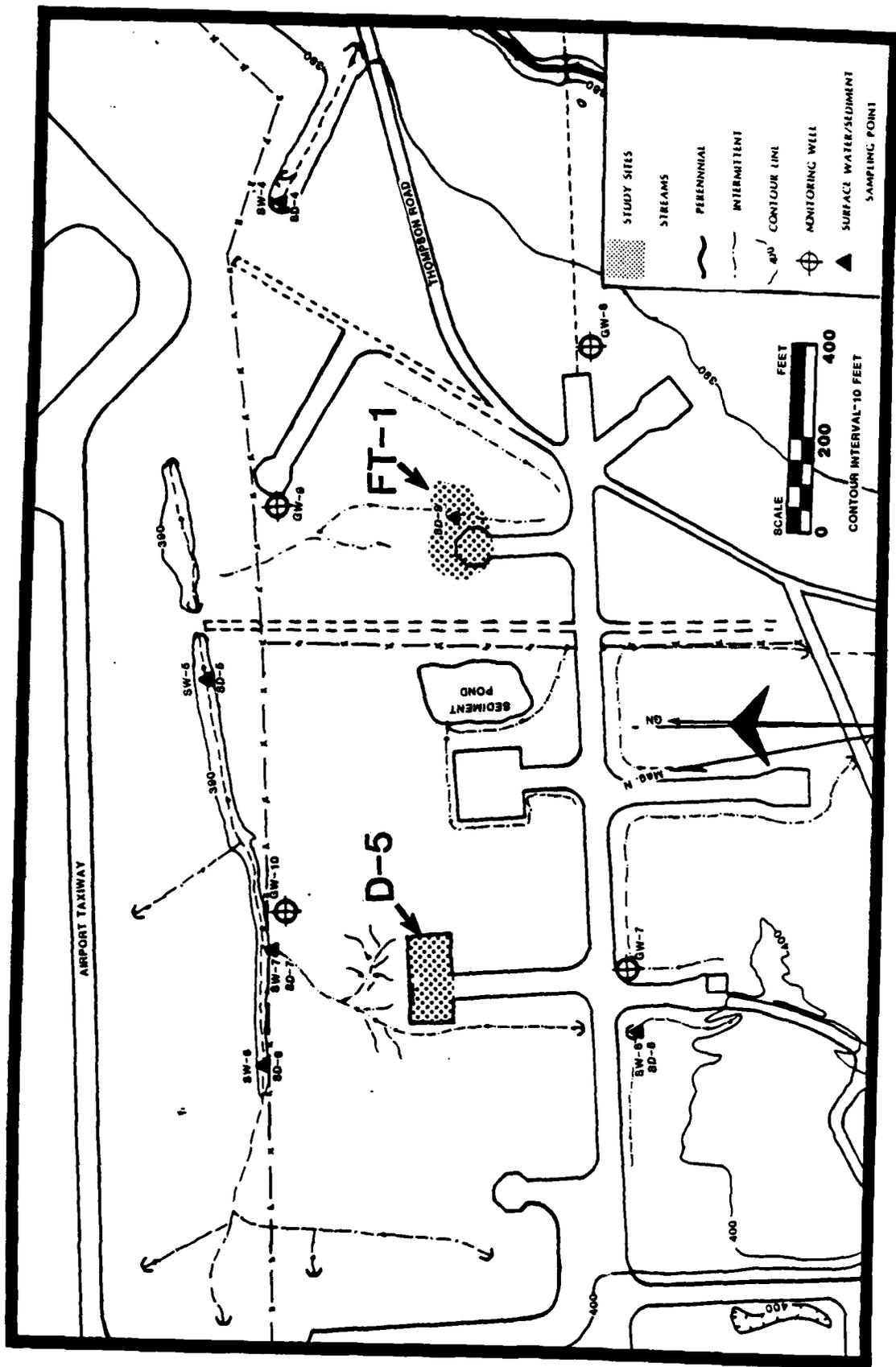


FIGURE 2-11. ZONE I - SAMPLING POINT LOCATIONS

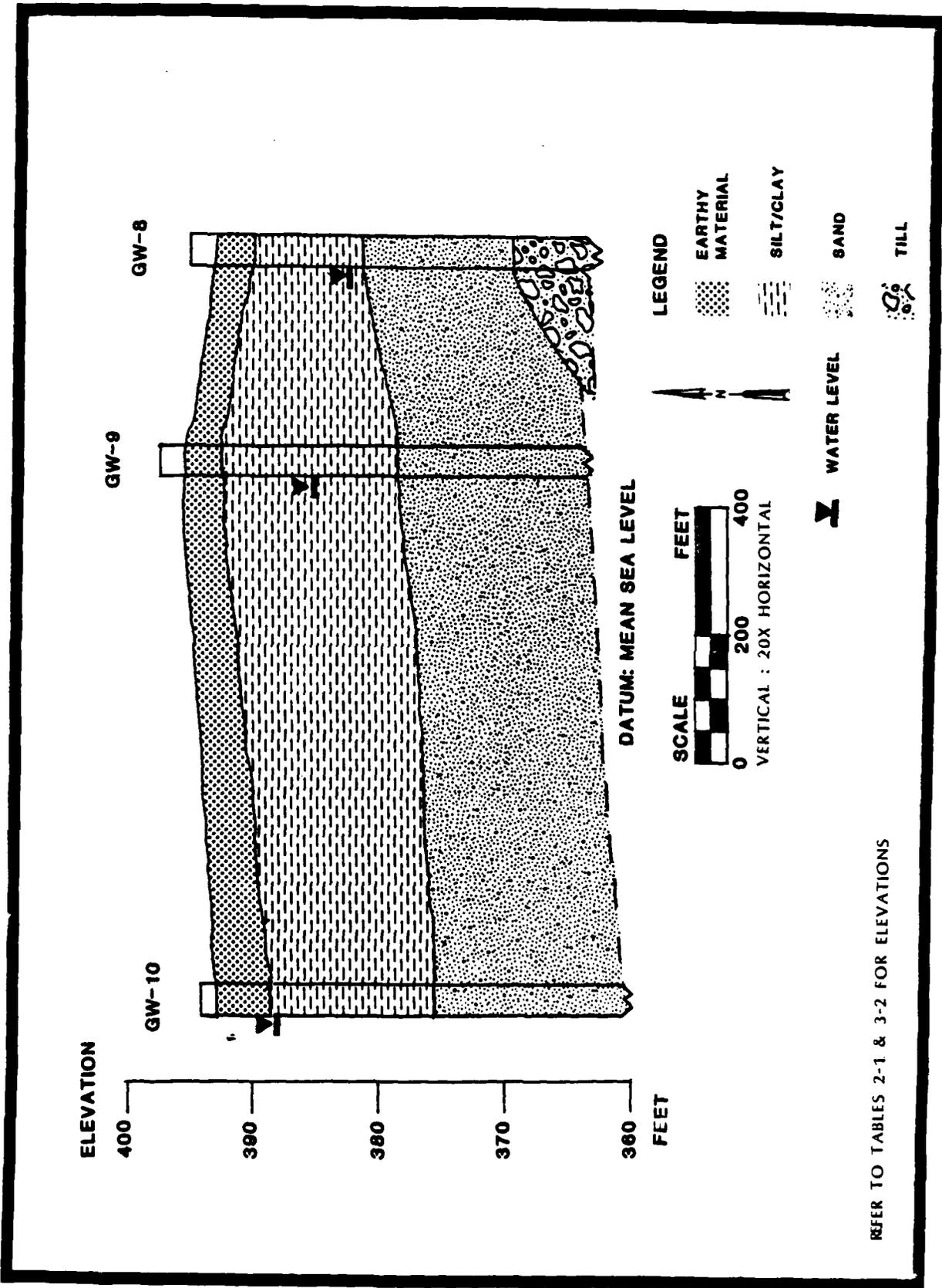


FIGURE 2-12. STRATIGRAPHIC RELATIONSHIPS BETWEEN THREE WELLS IN ZONE I

2.3.4 Groundwater Hydrology

In general, the first occurrence of groundwater in the Hancock Field area is within the glacial sand and gravel deposits overlying the bedrock. Within Zones 1 and 2, groundwater is present at very shallow depths (i.e., an average depth of less than 10 feet BLS). Groundwater in these glacial deposits is found under both water table and artesian conditions, depending on the presence or absence of overlying confining beds. Table 2-1 provides data obtained on groundwater levels during the two sampling efforts at Hancock Field.

At Zone 2, groundwater occurs in the fine sand and gravel glacial deposits. Groundwater at the site is present under both water table (GW-1, GW-2, GW-3, GW-6) and artesian (GW-4, GW-5) conditions. The artesian conditions existing in the area of GW-4 and GW-5 are caused by the presence of an overlying confining bed composed of silty clays. These silty clays appear to be alluvial in origin.

Within Zone 2, average groundwater levels in wells ranged from 4.99 feet above land surface in GW-5 to 21.43 feet below land surface in GW-2. This variation in water level is caused by differences in surficial topography rather than variations in the potentiometric surface. The average potentiometric surface of the aquifer within Zone 2 is shown in Figure 2-13. From this figure and Table 2-1, the maximum difference in head across the zone is 2.69 feet and occurs between wells GW-3 and GW-6. This yields a hydraulic gradient of approximately 0.14%.

The groundwater flow direction in the upper sands and gravels at Zone 2 is east-northeast as indicated by the potentiometric surface plot. Based on the limited available data for the site, the exact cause of this flow direction cannot be ascertained. Because flow directions are generally east-northeast across the zone, well GW-6 is the only well downgradient of the disposal sites. The other five wells are either upgradient of the disposal sites or are along parallel flow lines to the disposal sites.

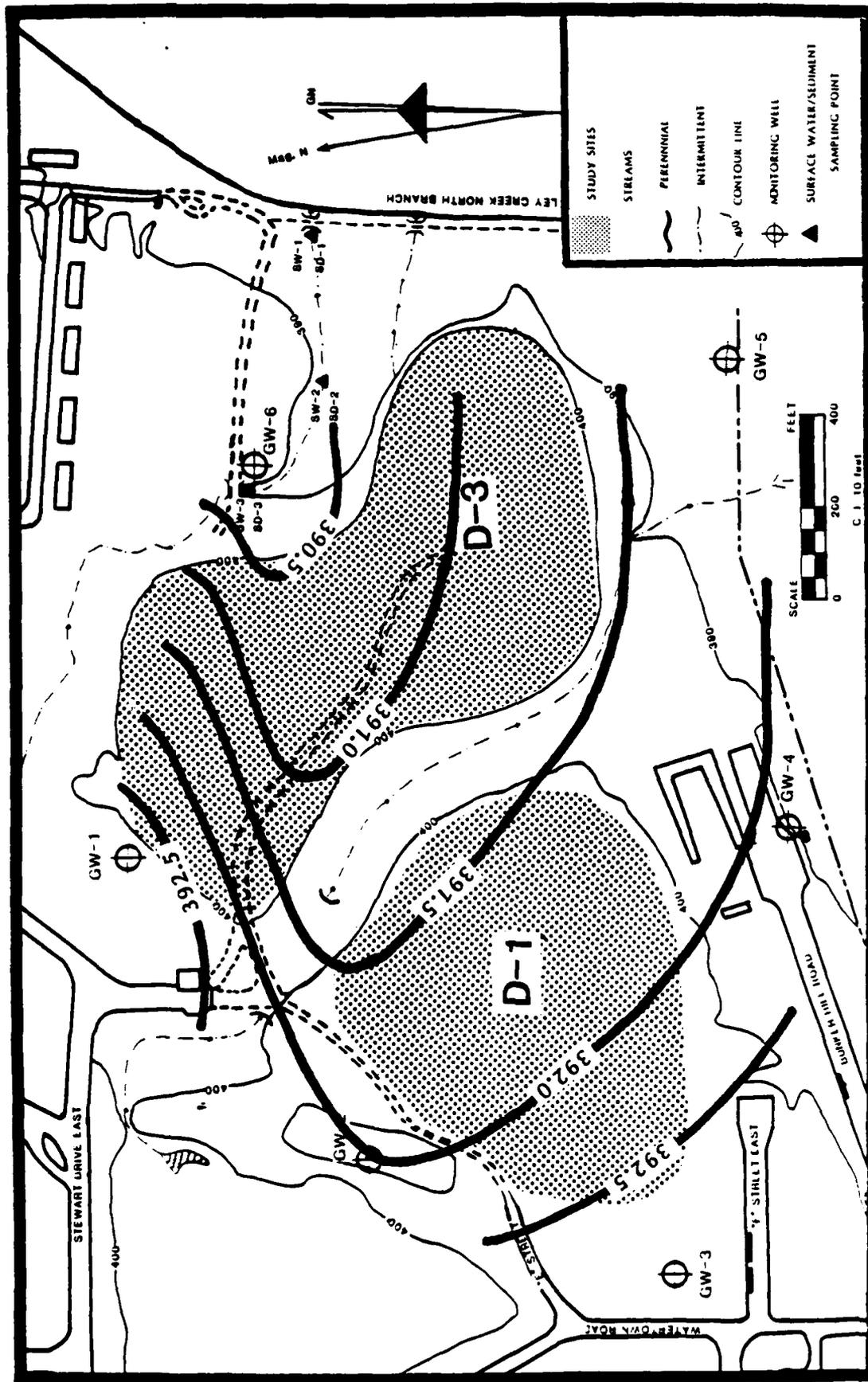


FIGURE 2-13. POTENTIOMETRIC SURFACE MAP OF ZONE 2

Table 2-1. Groundwater Levels at Hancock Field

Zone	Well No.	Water Levels (ft.)						
		26 Sept 1983		11 Jan 1984		Change	Average	Elevation (MSL)
		Depth BLS	Elevation (MSL)	Depth BLS	Elevation (MSL)			
2	GW-1	8.25	391.24	5.04	394.45	3.21	6.65	392.85
	GW-2	21.85	391.58	21.00	392.43	0.85	21.43	392.01
	GW-3	11.33	391.47	8.47	394.33	2.86	9.90	392.90
	GW-4	+ 0.58	390.64	+ 3.42	393.48	2.84	+ 2.00	392.06
	GW-5	+ 3.62	390.62	+ 6.35	393.18	2.73	+ 4.99	391.90
	GW-6	5.61	389.19	3.57	391.23	2.04	4.59	390.21
1	GW-7	8.48	388.87	5.59	391.76	2.89	7.04	390.32
	GW-8	9.11	383.89	5.85	387.15	3.26	7.48	385.52
	GW-9	9.45	386.20	5.84	389.81	3.61	7.65	388.01
	GW-10	1.84	390.46	+ 1.30	393.60	3.14	0.27	392.03

+ (positive sign) = level above ground surface; artesian well.

Aquifer tests were performed at Zone 2 using a slug test method developed by Hvorslev (1951) for partially penetrating wells under unconfined conditions. A complete description of the method used is presented in Appendix C and the field results are shown in Table 2-2.

The sandy material present within Zone 2 was found to have hydraulic conductivities ranging from 1.64×10^{-6} ft/sec (5.00×10^{-5} cm/sec) to 3.4×10^{-6} ft/sec (1.04×10^{-4} cm/sec). The hydraulic conductivity of the gravel material present in Zone 2 could not be determined, because the material was too permeable for testing using either a slug test or a pump test. During slug testing of the gravel aquifer, injected water could not be added quickly enough to maintain a head for the measurement of recovery. Pump tests performed using a centrifugal pump, pumping at a rate greater than 15 gallons per minute, also did not affect head levels within the wells. Although hydraulic conductivities could not be determined for the gravels, these values are probably in the order of 10^{-2} to 10^{-3} ft/sec (10^{-1} to 10^{-2} cm/sec). Calculated hydraulic conductivities for wells at Zones 1 and 2 are given in Table 2-2.

Using the hydraulic conductivities obtained through the aquifer tests and the hydraulic gradient from the potentiometric surface plots, the velocity of the groundwater movement in Zone 2 can be calculated using the following equation:

$$V = KI/n$$

Where V is groundwater velocity (ft/sec), K is hydraulic conductivity (ft/sec), I (dimensionless) is hydraulic gradient, and n (dimensionless) is effective porosity. Because effective porosity was not measured, the values were obtained from the literature; $n_{\text{sand}} = 35\%$ and $n_{\text{gravel}} = 30\%$. Using the above equation, the horizontal velocity of groundwater at Zone 2 ranges from a maximum of 126 ft/yr in the gravel to a minimum of 0.2 ft/yr in the sands.

Table 2-2. Slug Test Results

Zone	Well Number	Hydraulic Conductivities (K)	
		ft/sec	cm/sec
2	GW-1	$10^{-2} - 10^{-3}$ (1)	$10^{-2} - 10^{-2}$ (1)
	GW-2	$10^{-2} - 10^{-3}$ (1)	$10^{-2} - 10^{-2}$ (1)
	GW-3	$10^{-2} - 10^{-3}$ (1)	$10^{-2} - 10^{-2}$ (1)
	GW-4	1.64×10^{-6} (2)	5.0×10^{-5} (2)
	GW-5	(2)	(2)
	GW-6	3.4×10^{-6}	1.0×10^{-4}
1	GW-7	9.1×10^{-6}	2.8×10^{-4}
	GW-8	1.2×10^{-5}	3.7×10^{-4}
	GW-9	3.4×10^{-6}	1.0×10^{-4}
	GW-10	4.9×10^{-6}	1.5×10^{-4}

(1) Head declines were too rapid for measurements; K values were not in range of detection method; values given based on literature estimates.

(2) Groundwater under artesian conditions; test not applicable.

At Zone 1, groundwater occurs in the fine sand glacial outwash deposits. Groundwater within this zone is present under water table conditions. This area does not have a confining silty clay layer overlying the sands (as has Zone 2 within its swampy area). Average groundwater levels within Zone 1 range from 9.76 feet BLS to 0.27 feet BLS (Table 2-1). As in Zone 2, the topography dictates depth to groundwater rather than any significant potentiometric change across the site. Figure 2-14 shows the average potentiometric surface within Zone 1. From this figure and Table 2-1, the maximum difference in head across the site is 6.51 feet and occurs between wells GW-10 and GW-8. This head differential yields a hydraulic gradient of approximately 0.48%.

The groundwater flow direction in Zone 1 is east-southeast, as indicated by the potentiometric surface plot. This groundwater flow direction is essentially perpendicular to Ley Creek, which may be the controlling hydrologic feature in the area. Groundwater may be discharging to Ley Creek from the glacial deposits in the area. Based on the potentiometric surface plots, a well that is completely upgradient of the disposal sites was not drilled. Well GW-10 is the furthestmost upgradient well within the zone and probably can be used for background water quality samples since groundwater flow from disposal site D-5 does not occur in this direction. Monitoring well GW-8 is downgradient of both disposal sites and this will be the best well to use in judging water quality impacts caused by the disposal activities.

Slug tests (Hvorslev, 1951) were performed at each of the four wells within Zone 1 (i.e., wells GW-7 through GW-10). Hydraulic conductivities (Table 2-2) obtained ranged from 3.4×10^{-6} ft/sec to 1.2×10^{-5} ft/sec (1.0×10^{-4} to 3.7×10^{-4} cm/sec). Horizontal groundwater velocities obtained using the range of hydraulic conductivities are 1.5 ft/yr and 5.2 ft/yr, respectively.

2.3.5 Surface Water

Surface water flow in the two zones under study has been drastically altered by construction activities. Within Zone 2, water flows in all

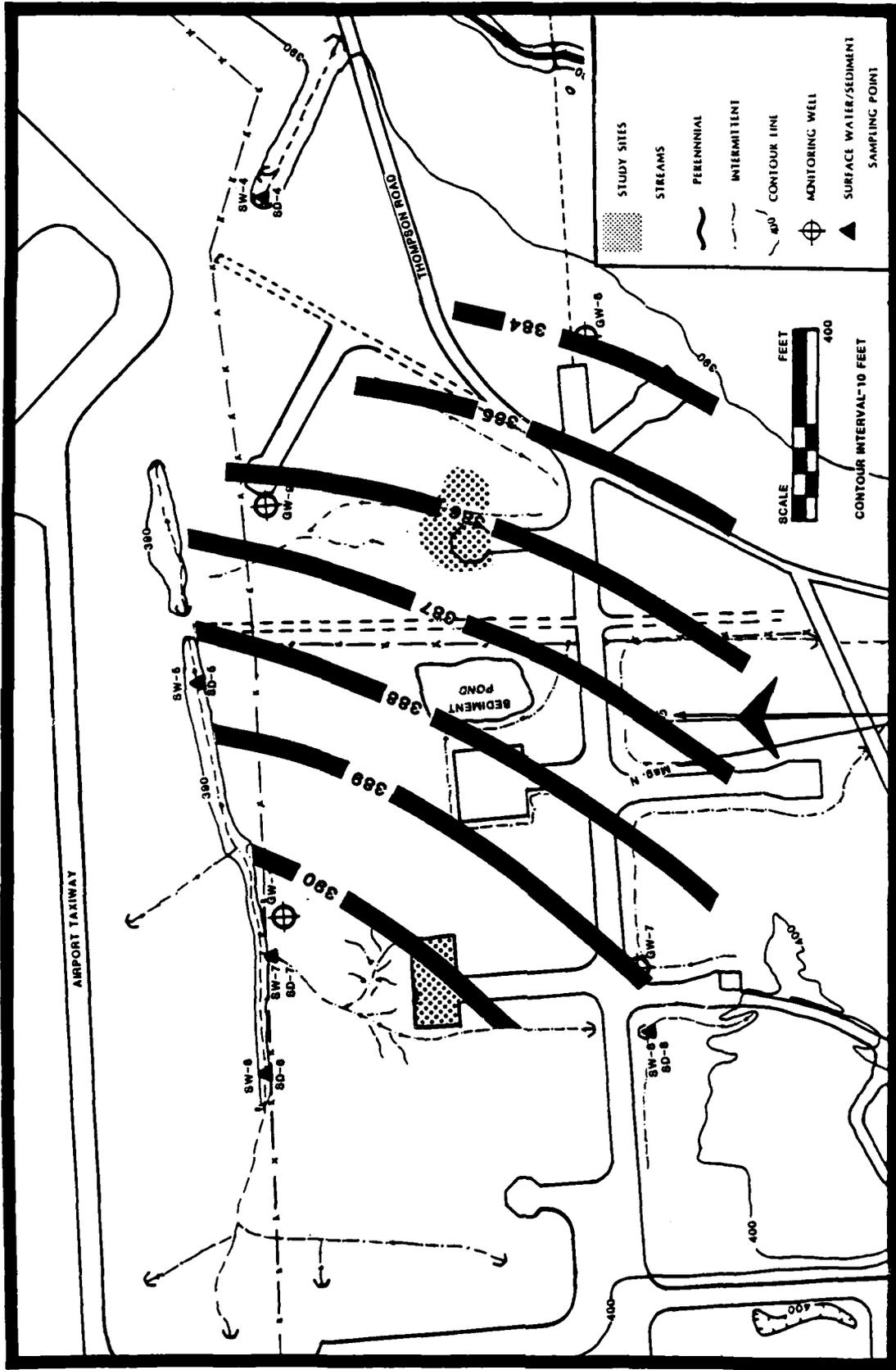


FIGURE 2-14. POTENTIOMETRIC SURFACE MAP OF ZONE 1

directions off of the disposal sites D-1 and D-3. Waters leaving these sites to the north and west are collected in drainage ditches. These ditches channel the water into the swampy area east and south of the site, where the water eventually flows into the channelized tributary of Ley Creek. Surface runoff leaving the disposal areas to the east and south runs directly into the swampy area. Surface water flow from sites D-1 and D-3 is illustrated in Figure 2-8.

Surface water within Zone 1 is controlled by drainage ditches. These ditches direct the flow of water north to the small drainage channel (Figure 2-7). This channel directs flow to the east into Ley Creek. Surface runoff from the airport is also partially collected by this drainage channel.

To evaluate the effects of surface runoff from the zones under investigation, surface water and sediment sampling points were established along the major drainage pathways. Sampling points were located above and below disposal sites to monitor the changes in surface water quality as it flowed past the sites. The locations of surface water sampling points for Zones 1 and 2 are shown in Figures 2-11 and 2-8, respectively.

2.3.6 Additional Information

Domestic or commercial water supply wells that obtain water from the glacial aquifer do not exist within three miles of the air base. Historically, this aquifer has been reported to provide adequate residential water supplies. However, naturally poor quality has resulted in residents switching to the municipal water system of Syracuse, New York.

3.0 FIELD PROGRAM

3.1 MONITORING PLAN DEVELOPMENT

Conception of the field program implemented at Hancock Field was based on the following: 1) review of the Phase I-Records Search performed by Engineering-Science Inc, 2) the scope of work supplied by the United States Air Force (Appendix B), and 3) a preliminary site visit by JRB personnel to acquire background material and familiarize themselves with the area. The initial site visit was conducted on 17 and 18 August 1983 by JRB's senior hydrologist and the project field supervisor, Dr. Edward W. Repa and Alfred Wickline, respectively (biographies of personnel assigned to the Phase II (Stage 1) effort are given in Appendix I). At this time a reconnaissance of the disposal sites was conducted and tentative locations for the groundwater monitoring wells and surface water and sediment sampling stations were chosen. In addition to walking the site, JRB personnel also reviewed aerial photographs of the base and interviewed key base personnel in order to determine the aerial extent of each of the four disposal sites.

3.1.1 Monitoring Well Placement

The scope of work specified that a maximum of five monitoring wells could be installed at Zone 1 and six at Zone 2; but the total number of wells installed could not exceed ten. Zone 1 consists of the fire training site (FT-1) and landfill disposal site D-5. Zone 2 comprises landfill disposal sites D-1 and D-3. Only the fire training site (FT-1) in Zone 1 and landfill site D-1 in Zone 2 have any ongoing activity. However, disposal activity at site D-1 is currently limited to small quantities of vegetative cuttings (i.e., tree slashings and lawn cuttings). The other two sites, D-3 and D-5, have been closed and are not receiving material. A description of each of the disposal areas is given in Table 3-1. Detailed descriptions of the disposal activities at the base are given in Appendix J.

TABLE 3-1
SUMMARY OF DISPOSAL SITES

Site No.	Site Name	Period of Operation	Approximate Area (Acres)	Suspected Types of Waste	Method of Operation	Closure Status	Surface Drainage	Geological Setting
D-1	Disposal Site	1950's-1974	10	General refuse, garbage, construction rubble, hardfill, empty containers, waste treatment sludge	Area Fill - 2'-5' lift depths - total fill depth 20'	Closed with several feet of local soils - grass cover	To Ley Creek	Fine sandy loam, loamy fine sand, high water table
D-3	Disposal Site	1950's-1979	12	General refuse, garbage, construction rubble, hardfill, empty containers, paint residues	Area Fill	Closed with several feet of local soils - grass cover	To Ley Creek	Loamy fine sand, fine sandy loam, high water table
D-5	Disposal Site	1958-1976	0.35	Construction rubble, ammunition boxes, sod, empty drums, drums partially containing solvents or thinners (unconfirmed)	Area Fill - 3'-4' depth	Closed with two feet of local soils, grass and wooded cover	To Ley Creek	Silty loam, high water table
FT-1	Fire Training Area	1948-Present	0.72	Oils, JP-4 and waste solvents	Spilled on hardstand and ignited	Operational	To Ley Creek	Silty loam, high water table

Source: Engineering-Science, Inc., 1982

The aerial extent of the sites within Zone 2 is much greater than that of Zone 1; therefore, the decision was made that in order to provide for adequate groundwater monitoring at both zones, six wells would be installed at Zone 2 and four wells at Zone 1. The exact direction of groundwater flow within each zone was unknown; however, the Phase I Report stated that groundwater in the area is typically controlled by surface topography. Utilizing this information and that collected during the site reconnaissance, the well locations were chosen within each zone.

The locations of the ten wells are shown in Figures 2-8 and 2-11. Logs of the wells are included in Appendix D. In Zone 2, monitoring wells GW-1, GW-2, and GW-3 were established as potential upgradient wells, while wells GW-4, GW-5, and GW-6 were potentially located downgradient. In Zone 1, the topography is nearly level and upgradient/downgradient well placement was difficult. Potentially, wells GW-8, GW-9 and GW-10 would be downgradient wells. Well GW-7 was established as the potential upgradient well.

3.1.2 Surface Water and Sediment

The location and number of surface water and sediment sampling stations were more rigidly established in the scope of work than for the monitoring wells. The scope of work called for establishing the following:

- o Zone 1: Five surface water sampling stations and six sediment sampling stations along the runoff area north of sites D-5 and FT-1
- o Zone 2: Three surface water and sediment sampling stations along the culvert adjacent to site D-3.

In addition to the specifications given in the scope of work for locating the sampling stations, surface water and sediment sampling stations were located above and below the drainage areas of the disposal sites whenever possible. This was done to provide information on the amount of change that occurred to the water and sediment quality as surface waters flowed past the sites.

Surface water and sediment sampling stations were located at the same points in both zones; i.e., surface water station SW-1 was also sediment station SD-1. The only exception was the location of the extra sediment sample in Zone 1. This sediment sample (SD-9) was located in the runoff area north of the fire training site that appeared to be saturated with oils.

The locations of the surface water and sediment sampling stations in Zones 1 and 2 are shown in Figures 2-8 and 2-11.

3.2 MONITORING PLAN INSTALLATION

3.2.1 Monitoring Wells

On 8 September 1983, JRB started drilling operations at Hancock Field. The drilling operation was conducted by Empire Soil Investigations, Inc., of Groton, New York. JRB personnel were on-site to supervise the drilling operation. As specified in the original scope of work, each well was to be screened throughout the entire saturated thickness of the soil aquifer (unconsolidated zone) and would be 30 feet deep on the average.

During the drilling of the first two wells, GW-2 and GW-5, the JRB field supervisor realized that the original well specifications could not be met at the site and still have the project remain within budget. This decision was based on the fact that wells GW-2 and GW-5 were drilled to depths of 50 feet and 70 feet respectively, without fully penetrating the unconsolidated soil aquifer.

Drilling operations were halted at the site and OEHL was informed of the situation. After conversations with members of the OEHL staff, the decision was made that the remaining eight wells should be drilled to the following specifications because of budget restrictions (OEHL, 1983):

- o Advance bore hole to 20 feet below the water table regardless of the depth encountered

- o Set screen throughout the entire saturated thickness of the bore hole (i.e., 20 feet of screen).

Well GW-6 was backfilled at this time to 20 feet below the water table and the well was installed. Well GW-2 was backfilled to 42 feet BLS and the well was installed. The new well specifications, however, will probably limit the detection of contaminants to those that are either miscible or floaters (i.e., floaters are immiscible and less dense than water). If heavy insoluble contaminants are present, they probably will not be detected, because they will sink to the bottom of the aquifer and not be drawn up into the monitoring well during purging.

The ten wells were drilled using hollow-stem auger methods. The augers had a 6-inch outside diameter and a 4-inch inside annulus. Wells were installed through the hollow stem augers using the auger flights as temporary casing to prevent hole collapse. The wells were constructed of 2-inch (ID) schedule 80 PVC pipe. Each well consisted of 20 feet of 10 slot per inch PVC screen threaded to a PVC riser. Wells extended approximately 2 feet above the land surface and were protected by 5 feet of 3-inch-diameter steel surface casing that extended 2.5 feet above and below the land surface. Protective casings have locking caps to prevent unauthorized access.

The following procedures were used in the installation of the wells and a typical "as-built" diagram for the wells is shown in Figure 3-1.

Drilling operations commenced with the advancement of the augers to 5 feet below land surface. At this point, a 1.5 to 2.0 foot split spoon sample was taken to obtain lithologic and pedologic descriptions of the strata to be drilled. Descriptions of the collected samples included:

- o Sample interval
- o Amount of soil recovered
- o Blow count per 6-inch travel interval

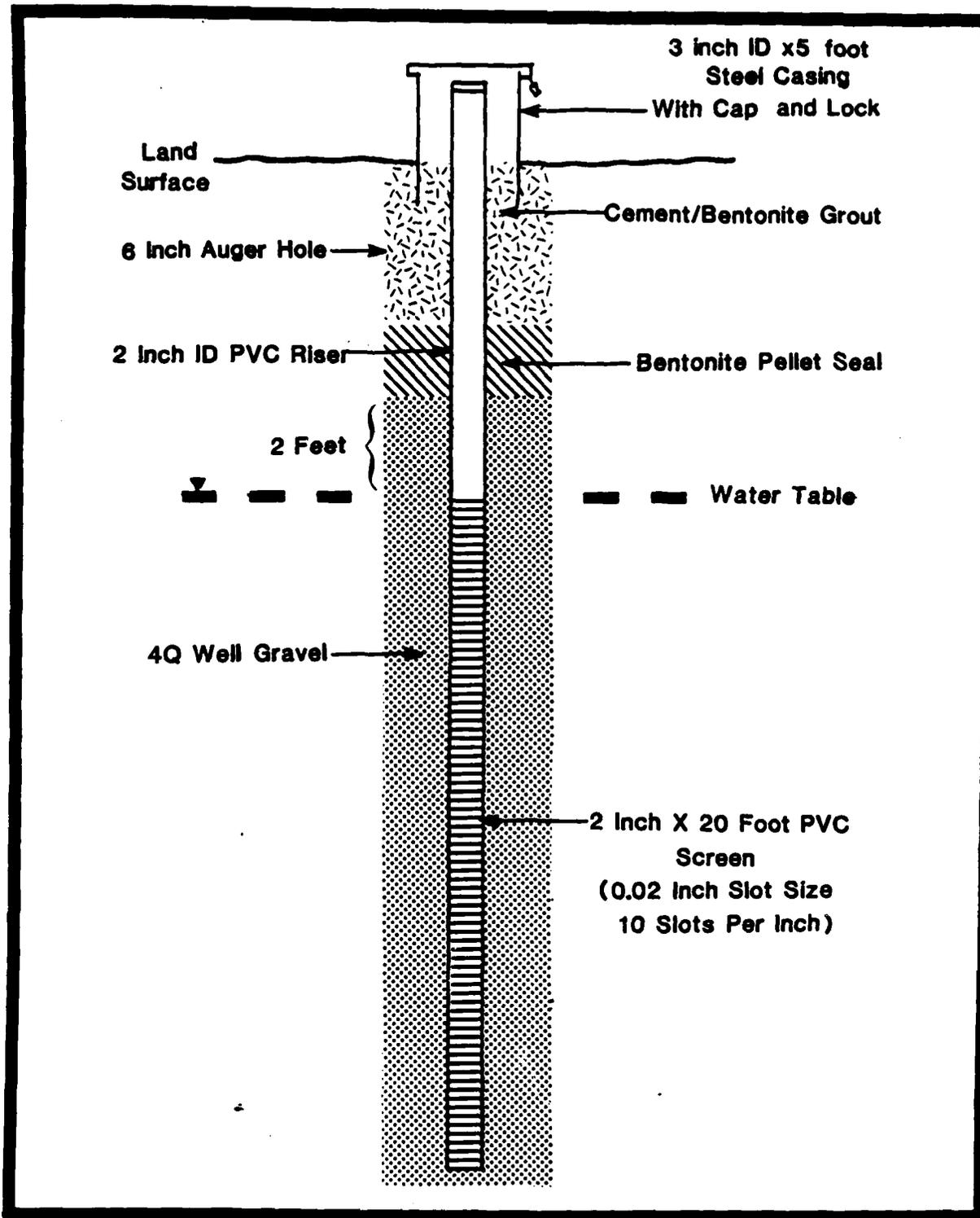


FIGURE 3-1. TYPICAL DIAGRAM FOR MONITORING WELLS
INSTALLED AT HANCOCK FIELD

- o Sample color using Munsell Soil Color Book
- o Texture
- o Moisture content
- o Density
- o Any unusual and distinguishing characteristics

Well logs are included in Appendix D. This augering and sampling sequence was repeated at 5-foot intervals until the hole had been advanced to 20 feet below the water table.

Augering methods were selected because they usually do not require the addition of extra water or drilling fluid. However, the fine saturated sands in the glaciofluvial material caused running conditions (i.e., saturated sand heaving into the annulus of the augers). To obtain the desired depths, water was added to the auger flights to maintain a positive head on the strata and prevent the sands from running into the augers. If the sands are allowed to run into the augers, heaving can occur which binds the augers and causes the loss of drilling equipment in the hole.

Once the augers were advanced to the desired depth, the auger plug was removed and the PVC well was threaded together as it was lowered down through the annulus of the augers. Adjustments to the well position were made as needed to ensure proper screen positioning. When the well was properly positioned, the augers were backed-off between 2 and 3 feet and a 4Q sand pack was added down the annulus to fill the void between the well screen and the borehole. This procedure of backing the augers out and adding the sand pack was continued until the sand pack extended at least 2 feet above the screen. After soundings were taken to ensure the correct location of the sand pack, bentonite pellets were added down the annulus to attain at least a 2-foot-thick seal on top of the sand pack. Once the seal was in place, a grout mixture was pumped through the auger stems as the auger flights were removed. The grout mixture consisted of a mixture of 5 gallons of water, 3 pounds of bentonite, and 94 pounds of Rochester Portland Cement.

Each well was developed using a centrifugal pump to remove at least five casing volumes of water. Six of the ten wells pumped dry after only a few minutes. These were allowed to recharge to ensure that the necessary volumes were removed.

Before drilling the first well, between each well drilling, and after drilling the final well, all drilling, measuring and sampling equipment (i.e., augers, drill steel, bits, samplers, wrenches, and other equipment) that contacted potentially contaminated soil or water were laid out and sprayed with clean water (i.e., base's domestic water source) to remove caked-on mud and dirt. These items were then washed using a high pressure steam sprayer to remove residual contaminants and then rinsed. In addition, the drill rigs were washed using the high pressure steam sprayer to remove mud and contaminants from the drill platform and adjacent areas.

During the development of the wells, the pump, hoses, and cables were washed with Alconox detergent and rinsed with water obtained from the base's domestic source. This was accomplished before, between, and after the development of each well.

At the completion of the drilling operations, all wells were surveyed for their horizontal and vertical locations. Surveying was performed via a subcontract with Rowell and Associates, P.C., of Syracuse, New York. Well locations were established by EDM (Electronic Distance Meter) measurements from known landmarks. Vertical control was established to the well top (PVC casing) by running levels from a known bench mark. Surveyed horizontal locations are shown in Figures 2-8 and 2-11. Table 3-2 lists the elevations of each well taken at the top of casing and at land surface.

3.2.2 Surface Water and Sediments

Surface water and sediment sampling stations were established in the field by the field team. Each sampling station was staked and flagged to facilitate resampling if required. The locations of the sampling points were mapped in the field based on existing features (e.g., culverts, bridges). The locations of surface water and sediment sampling stations are shown in Figures 2-8 and 2-11.

Table 3-2. Well Elevations

Well Number	Elevation (ft. MSL*)	
	Top of Casing	Land Surface
GW-1	401.5	399.5
GW-2	415.6	413.4
GW-3	404.7	402.8
GW-4	392.0	390.1
GW-5	390.0	387.0
GW-6	397.3	394.8
GW-7	399.6	397.4
GW-8	395.0	393.0
GW-9	397.7	395.7
GW-10	394.3	392.3

*MSL = mean sea level

3.3 SAMPLING PROCEDURES

3.3.1 Groundwater

Measurement of both head level and water quality were made at each well. Head levels were measured using the wetted tape method (USGS, 1980). In this method, a weighted graduated tape is marked with a water soluble ink and lowered to just below the groundwater level. The total distance lowered from the top of the casing is recorded and then the tape is extracted. Once the tape is removed, the length of the mark erased by the water is recorded. This length is then subtracted from the total length to obtain depth to groundwater.

Prior to collecting groundwater quality samples, each well was purged by pumping to ensure that a representative sample (i.e., not stagnant water) of the aquifer was collected. A 2-inch-diameter submersible pump was used to purge three to five times the calculated volume of standing water in each well (EPA, 1977). The pump and hosing were decontaminated between each well by scrubbing with an Alconox/water solution and then rinsing with distilled water (deVera et al., 1980). Sample collection took place within a 24-hour period after purging the well. Water quality samples were obtained by lowering a cleaned, point source, teflon bailer into the well. Samples were collected at the midpoint of the well screen (i.e., 10 feet from the bottom of the well). The bailer was cleaned between well samples with an Alconox/water solution and rinsed with sterile water. Water quality samples were obtained directly from the bailer using a special bottom emptying device to minimize the potential for sample agitation and contamination.

Samples were analyzed in the laboratory for total organic carbon (TOC), total organic halogens (TOX), oil and grease, volatile aromatics, and volatile halocarbons. Table 3-3 lists the sampling points and the type of analysis performed at each sampling location. Samples were preserved and

Table 3-3. Sample Analysis Plan

Sampling Location	TOC ¹⁾	TOX ²⁾	Oil and Grease	Volatile Aromatics	Volatile Halocarbons
GW-1	X	X	X	X	X
GW-2	X	X	X		
GW-3	X	X	X		
GW-4	X	X	X	X	X
GW-5	X	X	X	X	X
GW-6	X	X	X		
GW-7	X	X	X		
GW-8	X	X	X	X	X
GW-9	X	X	X	X	X
GW-10	X	X	X	X	X
Duplicate (GW-1)	X	X	X	X	X
SW-1	X	X	X	X	X
SW-2	X	X	X		
SW-3	X	X	X		
SW-4	X	X	X	X	X
SW-5	X	X	X		
SW-6	X	X	X		
SW-7	X	X	X		
SW-8	X	X	X		
Duplicate (SW-4)	X	X	X	X	X
SD-1		X	X	X	X
SD-2		X	X		
SD-3		X	X		
SD-4		X	X	X	X
SD-5		X	X		
SD-6		X	X	X	X
SD-7		X	X		
SD-8		X	X		
SD-9		X	X		

1) TOC - Total organic carbon

2) TOX - Total organic halogens

stored in containers according to methods prescribed by EPA (1979) in "Methods for Chemical Analysis of Water and Wastes" and JRB Laboratories. Table 3-4 lists the preservation method and sample container type used in the study.

During the sampling operations, collected laboratory samples were stored in ice chests to maintain a temperature of 4°C. At the end of a sampling day, collected samples were packaged in ice chests with "blue ice" to maintain the 4°C temperature, and shipped via overnight carrier to the laboratory. This ensured delivery of the samples to the laboratory within 24 hours of sample collection.

3.3.2 Surface Water and Sediments

Both surface water and sediment samples were taken at the same location on the stream. These points were staked and flagged for ease of identification and resampling if necessary. Parameters sampled at surface water points were TOC, TOX, oil and grease, and volatile aromatics and halocarbons. Methods of chemical analysis were the same as those performed for groundwater (Table 3-4).

Surface water quality samples were obtained using grab sampling techniques (USGS, 1977). In this method, sample bottles are used to directly collect samples from the surface water body. Sample bottles were filled with water by holding the container below the surface of the body of water. When obtaining samples in this manner, care was taken not to disturb the bottom sediments and incorporate them into the water sample. Typically this was achieved by sampling the furthest downstream point first and working upstream. When wading into the stream was necessary, samples were collected upstream from the disturbance made during wading.

Surface water quantity and quality samples were obtained only at those points that had flow during the sampling effort. Stagnant water, held in pools for example, was not sampled because this water would not be representative of contaminant concentrations migrating from the site.

Table 3-4. Sample Preservation and Storage*

Sample Type	Analysis	Container	Preservative	Special Instructions
Aqueous	TOX	125 ml glass amber	Cool to 4°C.	No air space.
	TOC	40 ml VOA bottle	0.1 ml HCl, cool to 4°C.	Fill container 90% full.
	Oil and Grease	1 liter glass	1.0 ml HCl, cool to 4°C.	Fill container 90-95% full.
Sediment	Volatile Aromatics	40 ml VOA bottle	Cool to 4°C.	No air space.
	Volatile Halocarbons	40 ml VOA bottle	Cool to 4°C.	No air space.
	TOX, and Oil and Grease	500 ml glass	Freeze.	Fill to 90% full.
	Volatile Aromatics	40 ml VOA bottle	Freeze.	Fill to 90% full.
	Volatile Halocarbons	40 ml VOA bottle	Freeze.	Fill to 90% full.

*As prescribed by JRB Laboratories.

Sediment samples were collected at each surface water monitoring station using a spade and analyzed for TOX, oil and greases, and volatile aromatics and halocarbons (Table 3-3). Samples were obtained from the top three inches of soil and deposited directly into sample containers. The spade used for sampling was thoroughly cleaned between samplings by scrubbing with an Alconox solution and rinsing with distilled water. This prevented cross-contamination between samples during collection.

3.3.3 Field QA/QC

During the field sampling of groundwater, surface water, and sediments numerous QA/QC procedures were enacted to ensure the quality and integrity of the effort. These procedures included the following:

- o Maintenance of chain of custody forms for all samples. Copies of these forms are contained in Appendix F.
- o Collection of the following QA samples for each day of sampling:
 - One field blank collected prior to the start of sampling. This sample consisted of pouring distilled water into sample containers and carrying these samples through the field. Field blanks are utilized to evaluate the field sampling procedures.
 - One replicate at a preselected monitoring point. This sample was collected at the same time and in the same manner as the normal laboratory sample. Results of the duplicate analysis are used to evaluate laboratory quality in reproducibility.

Copies of the results of these QA samples are given in Appendix G, and discussed in a following section.

- o Cleaning of all implements including drilling tools, sampling equipment, etc., between use (i.e., between monitoring wells or points) by washing them with an Alconox solution (i.e., low residue, biodegradable detergent) and rinsing with clean water. This method was utilized to ensure that contaminants were not transferred between monitoring points (EPA, 1977).

3.4 AQUIFER TESTING

In situ hydraulic conductivities were determined for wells within each disposal zone using a slug test as described by Hvorslev (1951) in Freeze and Cherry (1979). Hvorslev's (1951) method is applicable to point piezometers under water table conditions. This method assumes that the aquifer being tested is a homogeneous, isotropic, infinite medium in which both the soil and water are incompressible.

The slug test, as performed, is accomplished by rapidly adding water to the well to change the head level. The rate of recovery is monitored by measuring head level decline over time. The test is completed when the head level approaches the initial head which existed prior to the addition of water. Plots are then made of the head level changes versus time. From these plots, the hydraulic conductivity can be calculated. Appendix C contains a detailed description of this method and the results of field tests.

For the tests performed at Hancock, water was obtained from the base's domestic water source and rapidly added to wells by pouring it from containers (i.e., carboys) directly into wells. This method was chosen because the amount of water required to fill a 2-inch well to near capacity is approximately 2 gallons (i.e., 10 feet of well not containing water). The decline in head was monitored using a graduated line with attached float. Aquifer testing was not performed until groundwater quality and quantity tests had been completed. This ensured the collection of representative groundwater quality and quantity samples. The amount of water added to each well was in the order of 2 to 4 gallons. This should not adversely impact future samplings because this water will probably become mixed in the aquifer before the next sample round and if some remains near the well purging prior to sampling should remove part of it.

4.0 DISCUSSION OF RESULTS AND SIGNIFICANCE OF FINDINGS

For the assessment of contaminant migration resulting from past waste management activities at Hancock Field, samples of groundwater, surface water, and sediment were taken at four waste areas (Zone 1: sites D-5 and FT-1, and Zone 2: sites D-1 and D-3) identified during the Phase I - Records Search. These sites were indicated as having the highest potential for causing environmental contamination based in part on the Air Force Hazard Assessment Rating Methodology (HARM). Samples were analyzed for total organic carbon (TOC), total organic halogens (TOX), oil and grease, and volatile aromatics and halocarbons. A complete listing of the individual chemical constituents analyzed and the analytical results are provided in Appendix G. This section summarizes the analytical results of the sampling activities conducted in Zones 1 and 2, and evaluates the results and the significance of these findings.

4.1 QUALITY ASSURANCE/QUALITY CONTROL DATA

The laboratory analytical QA/QC results for the sampling activities conducted at Hancock Field are summarized in Tables 4-1 and 4-2. Overall, the analytical quality control was good. Method spike recovery levels exceeded 93%, indicating a good level of precision in the analytical procedures.

Extremely low levels of volatile halocarbons were detected in laboratory blanks for samples GW-1 and SD-4. These low contaminant levels are the result of background interferences inherent in laboratory procedures. Because the concentrations of the detected compounds are low, quantifiable impacts on sample results are not expected. In addition, the presence of these compounds was not detected in actual field samples. Correction for the blank was made by the laboratory for each sample.

Trace levels of toluene were detected in both field blanks (i.e., blanks prepared in the field prior to sampling using distilled water). The presence of toluene in the blanks may be attributable to 1) the use of

TABLE 4-1
QA/QC ANALYTICAL RESULTS - BLANKS AND DUPLICATES (ppm)

Sample No. JRB (ERG-1/)	TOC	Total Halogenated Organics			Oil and Grease	Volatile Aromatics	Volatile Halocarbons
		Cl	Br	I			
Field Blank (38)	< 2	0.05	ND	ND	ND	0.0035 Toluene	ND
Field Blank (58)	ND	ND	ND	ND	ND	0.02 Toluene	ND
Field Blank (38) Duplicate Lab Blank	1.27/1.23 2.3	-	-	-	-	-	-
GW-1 (39) Duplicate Lab Blank	-	0.04/ 0.04 ND	0.033/ 0.031 ND	0.11/ 0.11 ND	-	ND/ND 0.0015 Benzene	ND/ND 0.00092 Carbon Tetrachloride 0.00031 Chloroform 0.00095 1,1-Dichloroethane 0.00045 1,1-Dichloroethylene 0.0047 Methylene Chloride 0.000045 Tetrachloroethylene 0.000057 1,1,1-Trichloroethane 0.00011 Trichloroethylene 0.00029 Trans-1,2-dichloroethylene
GW-6 (45) Duplicate Lab Blank	42/42 2.3	-	-	-	-	-	-
GW-10 (49) Duplicate Lab Blank	12.57/8.8 2.3	-	-	-	-	-	-
SD-2 (68) Duplicate Lab Blank	-	-	-	-	315/343	-	-
SD-4 (70) Duplicate Lab Blank	-	-	-	-	-	ND/ND 0.0015 Benzene	ND/ND 0.00027 Carbon Tetrachloride 0.0034 Chloroform 0.00022 1,1-Dichloroethane 0.0012 1,1-Dichloroethylene 0.0053 Methylene Chloride 0.000046 Tetrachloroethylene 0.00013 1,1,1-Trichloroethane 0.00017 Trichloroethylene 0.00046 Trans-1,2-Dichloroethylene

1/ Sample numbers have 1008 prefix under ERG (laboratory) assignments

TABLE 4-2

QA/QC ANALYTICAL RESULTS - METHOD SPIKES

Sample No. JRB (ERG ^{1/})	Parameter	Spike Level	Recovery (%)	Analytical Results
GW-1 (39)	Haloscan: Cl	50 ppb	95	47.5 ppb
	Haloscan: Br	5.0 ppb	102	5.1 ppb
	Haloscan: I	-	-	-
GW-6 (45)	TOC	20 ppm	93	18.65 ppm

^{1/}Sample numbers have 1008 prefix under ERG laboratory assignment

distilled water with trace levels of contaminants, or 2) sample container contamination. Because toluene appears in the field blanks and the field blanks were taken on separate days, its presence is probably the result of using contaminated distilled water rather than sample bottle contamination. The presence of toluene in the blanks, however, does not interfere with the analytical results because toluene was not detected in any of the field samples.

In addition to the above QA/QC checks, significant differences in analytical results between duplicate field samples and actual field samples were not indicated. Consequently, the overall reproducibility of data from actual samples can be considered to be good and therefore, representative of actual site conditions.

4.2 INTERPRETATION OF CONTAMINANT LEVELS

The analysis performed on samples at Hancock Field included TOC, TOX, oil and grease, volatile aromatics, and volatile halocarbons. Analyses for TOC, TOX, and oil and grease are not compound specific and only provide estimates of concentrations of contaminants. As such, these analyses do not provide information on the toxicity or persistence of contaminants, the individual chemical species present, or the relative concentration of individual species. Therefore, use of this data is limited to indicating the relative level of a group of contaminants present and comparisons of these levels between monitoring sites.

Acceptable water quality standards (i.e., maximum acceptable levels) have not been established by Federal or state agencies for contaminant levels of TOC, TOX, or oil and grease. Concentrations of TOX up to 15 to 20 ppb (0.015 to 0.020 ppm) have been reported to occur naturally in the environment. This limit will be used throughout the report as a comparison point for determining the presence of halogenated organics in samples obtained at Hancock Field. However, because the TOX test is not compound specific, contaminant levels indicated as low may or may not be naturally

occurring halogenated organics. Detection limits for the TOX analysis were: TOX as Cl = 0.01 ppm TOX as Br = 0.002 ppm, and TOX as I = 0.002 ppm.

The detection limit of TOC was two parts per million (ppm) for the laboratory analytical method used (i.e., IR method). Concentration levels of TOC and oil and grease will be used only for comparison among stations points since limits have not been set for these parameters.

Analyses of volatile aromatics and halocarbons provide specific concentrations of the chemical species present, and water quality standards as well as toxicity levels have been established for many of these compounds. Although maximum acceptable levels for volatile aromatics and halocarbons have been established, analysis of samples taken during this study did not detect the presence of these compounds except for trace amounts of chloroform at monitoring station SW-4. Therefore, water quality standards are not relevant and are not included in this report.

4.3 RESULTS: ZONE 1

The analytical results for the Zone 1 sampling activities are summarized in Table 4-3. Locations of the sampling points are shown in Figure 2-11. Significant findings of the analyses from Zone 1 are discussed below.

4.3.1 Sediments

Elevated levels of oil and grease were detected in all of the sediment samples taken in Zone 1 (Table 4-3). The presence of the elevated concentrations of oil and grease at all sediment monitoring points upstream and downstream of disposal sites D-5 and FT-1 (SD-4 through SD-8) can not be explained with the presently available data. However, the oil and grease present may be the result of surface water runoff from the runway areas (i.e., residual oils and fuels from aircraft operation). Further sampling efforts would be required to support this hypothesis.

TABLE 4-3

ZONE 1 ANALYTICAL RESULTS ^{1/}

Sample No. JRB (ERC- ^{2/})	TOC	Total Halogenated Organics			Oil and Grease	Volatile Aromatics	Volatile Halocarbons
		Cl	Br	I			
<u>Groundwater</u>							
GW-7 (46) d	<2	ND	ND	0.023	ND	-	-
GW-8 (47) d	<2	ND	ND	0.01	ND	ND	ND
GW-9 (48) d	4	ND	ND	0.004	ND	ND	ND
GW-10 (49) u	11	ND	ND	0.053	2	ND	ND
<u>Surface Water</u>							
SW-4 (62)	6	0.27	0.004	0.008	<2	ND	0.00056 Chloroform
SW-4R (63)	5	ND	0.025	0.017	<2	ND	ND
SW-5 (64)	10	ND	0.006	ND	<2	-	-
SW-6 (65)	6	ND	0.005	0.005	<2	-	-
SW-7 (66)	20	0.01	0.20	0.002	<2	-	-
<u>Sediments</u>							
SD-4 (70)	-	ND	ND	ND	620	ND	ND
SD-5 (71)	-	1	ND	ND	300	-	-
SD-6 (72)	-	ND	ND	ND	130	ND	ND
SD-7 (73)	-	ND	ND	ND	190	-	-
SD-8 (74)	-	ND	ND	ND	350	-	-
SD-9 (75)	-	2.8	0.9	ND	390,000	-	-

^{1/} Data in ppm and are blank subtracted; ND=non-detected; - =not tested

^{2/} Sample numbers have 1008 prefix; ERG: Environmental Research Group (contract lab); u=upgradient; d=downgradient

Concentrations of oil and grease in the drainage ditch on the northern edge of Zone 1 steadily increase from the furthest upstream monitoring station, SD-6, to the downstream monitoring station, SD-4 (i.e., SD-6: 130 ppm, SD-5: 300 ppm, and SD-4: 620 ppm). The increase in the oil and grease concentrations between SD-6 and SD-5 does not appear to be related to landfill site D-5, which is situated between these two stations. A sediment sample (SD-7) taken in the runoff area from the landfill prior to its entering the drainage ditch shows oil and grease concentrations to be only slightly higher than the upstream monitoring station SD-6 (i.e., SD-7: 190 ppm and SD-6: 130 ppm). In addition, oil and grease concentrations in the small drainage channel that crosses through landfill site D-5 decrease from the upstream monitoring station SD-8 (i.e., SD-8: 350 ppm and SD-7: 190 ppm). Therefore, landfill site D-5 does not appear to be a source of oil and grease contamination in the sediments sampled. The increase in oil and grease concentration between sampling stations SD-6 and SD-5 (i.e., upstream and downstream of site D-5), however, may be attributable to runoff from the airport taxiways north of the drainage ditch that enters between these two stations (refer to Figure 2-11).

The increase in oil and grease concentrations between SD-5 and SD-4 is probably the direct result of contaminant runoff from the fire training area (FT-1). Analysis of a sediment sample (SD-9) taken in the drainage area north of the site showed very high concentrations of oil and grease (SD-9: 390,000 ppm). The contamination is most likely the result of fire training activities at the site. During fire training exercises, waste oils and other combustible liquids are spread on the water-soaked hardstand and ignited. The fire is typically extinguished before the oils are completely burned, resulting in a residue that is free to migrate from the site because runoff from the fire training area is not controlled. Because only one sample was obtained from this area, the extent (vertical and horizontal) of contamination could not be determined. Visual inspection did indicate that the contaminants have migrated at least 100 feet north of the hardstand.

In addition to the high concentrations of oil and grease in the sediment samples, TOX analysis indicated the presence, above background levels, of chlorinated or brominated organic compounds, or both, in sediment samples SD-5 and SD-9. A volatile fraction analysis was not performed on sediment samples SD-5 and SD-9. Monitoring station SD-5 had a total chlorinated organic concentration of 1 ppm, which is two orders of magnitude larger than the normal background water quality standard of 0.02 ppm (refer to Section 4.2). The presence of chlorinated organics in this sediment sample is probably related to the presence of oil and grease, although this trend does not hold for all sediment samples.

Monitoring point SD-9 has total chlorinated organic concentrations of 2.8 ppm and total brominated organic concentrations of 0.9 ppm. Both of these concentrations are considered indicative of the presence of contamination by halogenated organic compounds. Combustible materials ignited during the fire training exercises are probably the source of the organic contaminants. Material burned at the site include waste oils, contaminated fuels, and other combustible liquids (e.g., solvents, paint thinners). These materials can contain significant amounts of chlorinated and brominated organics. In addition, material used to extinguish fires, such as chlorobromomethane and protein based foams, may also be responsible for the elevated concentrations of chlorinated and brominated organics. The migration of these organic compounds from the fire training area could not adequately be assessed with the limited amount of available data. However, surface waters below the fire training area (SW-4) contained elevated levels of organic compounds, as measured by TOX, and this may be indicative of contaminant migration. The fire training site was still in use during the Phase II (Stage I) investigation and remains a source of contaminants.

4.3.2 Surface Water

Only very low levels of oil and grease, 1 to 2 ppm, were detected in the surface waters that drain from and through the zone. These low concentrations appear to indicate that oil and grease present during non-runoff

periods is probably caused by slow release from the sediments. The highest concentrations of oil and grease in surface waters probably occur during storm runoff periods, when the runways are rinsed of residual oils and greases.

TOC levels in surface water samples were relatively low, ranging from 5 to 20 ppm. TOC concentrations measured at the upstream monitoring station SW-6 were 6 ppm. This level increased to 10 ppm at the midpoint monitoring station SW-5. This increase is probably attributable to flow originating from the swampy area north of disposal site D-5, which had TOC levels of 20 ppm (monitoring station SW-7). Surface water flow was not occurring at monitoring station SW-8; therefore, comparisons between surface water quality above and below site D-5 on this drainage channel was not possible. TOC levels decreased between the mid-point monitoring station and the downstream station (SW-4: 6 ppm).

The organic compounds detected in the surface water at Zone 1, as measured by TOC, are probably attributable to naturally occurring organics resulting from the decomposition of organic matter rather than the introduction of contaminants. This hypothesis is supported by the following observations:

- o Measured concentrations of TOX, oil and grease, and volatile aromatics and halocarbons are low, and correlations between TOC and these parameters do not exist.
- o The area surrounding the drainage ditch in Zone 1 is swampy and contains large amounts of decaying plant matter.
- o Organics originating from natural sources would not be evident in the analysis of the other parameters.

Based on the above discussion and available data, the fire training site FT-1 and landfill site D-5 do not appear to be the major sources of the TOC concentrations detected in the surface water. The actual source of the measured TOC concentrations is probably naturally occurring organic carbon.

Total organic halogens were detected in all surface water samples to some degree. Elevated concentrations of chlorinated organics were detected only at surface water monitoring station SW-4 (0.27 ppm), the downstream station. Chlorinated organics were found at the detection limit (0.01 ppm) at monitoring station SW-7. Because the concentrations detected were below background levels and at the detection limits of the test, they are not considered to be indicative of environmental contamination. Chlorinated organics were not detected in samples SW-4R and SW-6.

A discrepancy occurs in the data for the measured levels of chlorinated organics in samples SW-4 and SW-4R (i.e., SW-4: 0.27 ppm and SW-4R: none detected). Because these samples were taken from the same monitoring station at the same time, contaminant levels are expected to be very similar. This discrepancy in measured levels also occurs for the brominated and iodinated organics. An explanation for the differences in measured values is not apparent.

Elevated concentrations (i.e., above expected background levels: TOX \geq 0.02ppm) of brominated organics were measured at two surface water monitoring stations in Zone 1. The highest concentrations were measured at stations SW-7 (0.20 ppm), followed by SW-4R (0.025 ppm). Brominated organic concentrations at SW-4, SW-5, and SW-6 were only slightly higher than the test's detection limit (0.004 to 0.006 ppm) and an order of magnitude lower than expected background levels.

Elevated concentrations (i.e., \geq 0.02 ppm) of iodinated organics were not measured at sampling stations SW-4 (0.008 ppm), SW-4R (0.017 ppm), and SW-6 (0.005 ppm). Levels observed at all stations were at or below the detection limit and are not considered to be an indicator of environmental contamination.

Because elevated concentrations (i.e., above the expected background levels) of chlorinated, brominated, or iodinated organics were present at surface water monitoring stations SW-4 and SW-7, the occurrence of

environmental contamination is indicated in Zone 1. The organic compounds are probably non-volatile as indicated by the absence of detectable volatile halocarbons and aromatics. The source of the halogenated organics in surface waters at Zone 1 is not apparent because trends in the data do not occur (i.e., relative concentrations of Cl, Br, and I organics within a sample and between samples as surface water flows through the site do not show perceivable trends). In addition, trends between surface water contamination and groundwater or sediment contamination within Zone 1 are not apparent.

4.3.3 Groundwater

As with surface water and sediment samples, groundwater samples did not contain detectable levels of volatile aromatics or halocarbons. The presence of oil and grease was not detected in three of the four monitoring wells installed in Zone 1 (GW-7, GW-8, and GW-9). Only low concentrations of oil and grease (2 ppm) were detected in the upgradient well GW-10 north of the landfill site D-5. The presence of low levels of oil and grease in this well could be caused by either surface contamination during well installation or groundwater recharge from surface waters flowing north of the well's position.

TOC levels in all wells were low, ranging in concentrations from 2 to 11 ppm. These TOC levels are probably indicative of naturally occurring organic carbon rather than of environmental contamination, because of the low measured concentrations of oil and grease, TOX, and volatiles. The higher concentration of TOC in well GW-10 may be attributable to surface contamination during drilling or groundwater recharge as indicated by the surface water sample taken at SW-7, upgradient of the well.

Total organic halogen (TOX) analysis of groundwater samples showed that only iodinated organic compounds were present. Concentrations ranged from 0.004 at GW-9 to 0.053 at GW-10. Measured concentrations of iodinated organics at wells GW-7 (0.023 ppm) and GW-10 (0.053) are elevated above

expect background levels (i.e., 0.015 to 0.020 ppm). These levels may be indicative of environmental contamination. However, iodinated compound usage at Air Force installations is limited and the levels reported may in reality be from some other source.

The highest concentrations of iodinated organics were measured in the upgradient well (upgradient of the disposal area) GW-10 (0.053 ppm). Concentrations decreased directly downgradient (downgradient of disposal areas) of well GW-10 to 0.01 ppm at well GW-8. Wells GW-7 and GW-9 are situated so that groundwater flow at these wells does not pass through the disposal site. Concentrations of TOX as iodine in these wells were less than that of the upgradient well.

Based solely on these data, disposal site D-5 and the fire training area FT-1 are not responsible for contamination of groundwater. However, the hydraulic gradient of the groundwater in Zone 1 is extremely slight (0.48%), causing groundwater velocities in the underlying sands to range from 1.5 to 5.2 ft/yr in a southeasterly direction (refer to Section 2.0 for details). Using these calculated groundwater velocities, a worst-case scenario can be developed to predict the distance (extent) that a plume would travel downgradient if contamination was originating from a waste disposal site. The fire training site FT-1 has been used for this calculation because it is located further downgradient.

Worst-case calculation of a plume's extent is based upon Darcy's Law as follows:

$$d = t (KI/n) = t(V)$$

Where d (ft) is maximum plume limit, t (yrs) is time since release, K (ft/yr) is hydraulic conductivity, I (dimensionless) is hydraulic gradient, n (dimensionless) is effective porosity, and V (ft/yr) is groundwater velocity. The above equation also assumes that attenuation or degradation of chemical species does not occur. The fire training site has been in operation for 36 years and this value was used in the calculations.

The maximum distance that a contaminant plume emanating from the site could travel since its opening would be approximately 187 feet ($d = 36 \text{ yrs} \times 5.2 \text{ ft/yr}$). If the fire training site is contaminating groundwater in the area, the contamination would not be detected in the downgradient well GW-8 because it is located approximately 400 feet from the site. Therefore, because of the prevailing groundwater conditions in the zone, the location of monitoring wells in relation to disposal areas, and the lack of contaminant concentrations over background levels (upgradient levels), the levels of indicated compounds in the wells may not provide a reliable base for use in evaluating the impacts of waste disposal practices on groundwater contamination. However, if a plume does exist at the site, its limits are probably small and still somewhat isolated.

4.4 RESULTS: ZONE 2

The analytical results for sampling activities conducted in Zone 2 are summarized in Table 4-4. The location of monitoring stations is shown in Figure 2-8. A detailed discussion of the analytical results for Zone 2 follows.

4.4.1 Sediments

Volatile aromatics, volatile halocarbons, and halogenated organic compounds were not detected in sediment samples collected from Zone 2. However, elevated concentrations of oil and grease were detected in all sediment samples. Oil and grease concentrations ranged from 330 ppm at SD-2 to 570 ppm at SD-1.

The presence of oil and grease at these sites is probably the result of surface runoff from old taxiways and hardstands, and from roads upstream of the waste sites, rather than the result of leaching of oil and grease from the disposal sites. This assumption is supported by the lack of detectable quantities of oil and grease in either the surface water or groundwater samples. The oil and grease present in the sediments is probably residue resulting from storm water runoff sorbed to sediments.

TABLE 4-4

ZONE 2 ANALYTICAL RESULTS^{1/}

Sample No. JRB (ERG ^{2/})	TOC	Total Halogenated Organics			Oil and Grease	Volatile Aromatics	Volatile Halocarbons
		Cl	Br	I			
<u>Ground Water</u>							
GW-1 (39) u	31	0.04	0.033	0.11	ND	ND	ND
GW-1R (40) u	31	0.04	0.031	0.11	<2	ND	ND
GW-2 (41) u	13	1.6	ND	0.02	ND	-	-
GW-3 (42) u	6	ND	ND	0.002	ND	-	-
GW-4 (43)	2	0.03	ND	0.02	ND	ND	ND
GW-5 (44)	<2	0.64	ND	ND	ND	-	-
GW-6 (45) d	<2	0.71	ND	0.005	<2	ND	ND
<u>Surface Water</u>							
SW-1 (59)	ND	ND	0.006	0.002	ND	ND	ND
SW-2 (60)	4	0.03	0.005	0.002	ND	-	-
SW-3 (61)	18	0.07	0.011	0.002	ND	-	-
<u>Sediments</u>							
SD-1 (67)	-	ND	ND	ND	570	ND	ND
SD-2 (68)	-	ND	ND	ND	330	-	-
SD-3 (69)	-	ND	ND	ND	350	-	-

^{1/} Data in ppm and are blank subtracted; ND=non-detected; - =not tested

^{2/} Sample numbers have 1008 prefix; ERG=Environmental Research Group (contract lab); u=upgradient; d=downgradient

4.4.2 Surface Water

Oil and grease, volatile aromatics, and volatile halocarbons were not detected in any of the surface water samples taken. Total organic carbon (TOC) concentrations in these samples was low and ranged from none detected in SW-1 (downstream station) to 18 ppm at SW-3 (upstream station). The concentration of TOC decreased from the upstream monitoring station to the downstream stations. A similar trend is exhibited by the TOX results. This decrease is probably attributable to dilution.

The TOC levels measured at surface water monitoring stations are probably attributable to naturally occurring organics, rather than being indicative of environmental contamination. This assumption is supported by 1) the low levels of TOC in the groundwater that is discharging and maintaining stream flows (i.e., GW-5 and GW-6 2 ppm), and 2) the presence of a considerable amount of decomposed plant matter in this swampy area.

Elevated levels of halogenated organic compounds (TOX) were detected in surface water samples SW-2 and SW-3 (i.e., 0.037 ppm and 0.083 ppm, respectively). Because of the absence of volatile components, the detected halogenated organics probably belong to a non-volatile fraction (acid extractable, base/neutral extractable, pesticides and PCB's). Concentrations of iodinated organics were 0.002 ppm for the three surface water samples. This concentration is at the detection limit of the testing procedure and probably indicates that iodinated organics are present at very low concentrations. These concentrations may be attributable to naturally occurring compounds.

Brominated organics were detected in all surface water samples. Concentrations of brominated organics were highest at the upstream monitoring station SW-3 (0.011 ppm) and decreased at the downstream stations (SW-2: 0.005 ppm, SW-1: 0.006 ppm). This reduction was small and may be attributable to dilution or the precision of the analytical method. Contaminants present may or may not be attributable to environmental contamination.

Elevated levels of chlorinated organics were detected in the upstream (SW-3) and midpoint (SW-2) monitoring stations (SW-3: 0.07 ppm, SW-2: 0.03 ppm). Chlorinated organics were not detected at the downstream station SW-1. A decreasing trend in the concentrations as surface waters flow through the site is evident. This pattern is similar to the decrease in brominated organics and may be attributable to the same causes. The contaminant levels found at surface water monitoring stations SW-2 and SW-3 are considered indicative of environmental contamination because these levels were higher than those expected to occur naturally (i.e., 20 ppm).

The source of halogenated organics in the surface water is not apparent. Based on the available data, it does not appear that the oil and grease trapped in the sediments is the source, because halogenated organics were not detected in any of these samples. If groundwater is recharging the stream, the stream's water quality should be similar to the groundwater quality. This is not apparent from the data; however, elevated concentrations of chlorinated organics are present at GW-6 (0.71 ppm) the downgradient well.

4.4.3 Groundwater

As with the surface water samples taken at Zone 2, oil and grease, volatile aromatics, and volatile halocarbons were not detected at elevated levels in the groundwater samples that would indicate environmental contamination. Concentrations of TOC ranged from a high of 31 ppm in the upgradient well GW-1 (samples GW-1 and GW-1R) to less than 2 ppm in wells GW-5 and GW-6 (i.e., well GW-6 is the downgradient well). The concentrations of TOC in the groundwater probably result from naturally occurring organic carbon rather than from environmental contamination. A relationship does not exist between TOC and the other measured parameters. Another explanation of the TOC concentrations measured in Zone 2 is that they are the residual effects of the old waste treatment sludge ponds that formerly occupied the site.

Halogenated organics were detected at all well locations. Chlorinated organics were detected in all wells except GW-3 (an upgradient well). Concentrations of chlorinated organics ranged from a high of 1.6 ppm at GW-2 (upgradient well) to 0.03 ppm at GW-4. Brominated organics were present in only one well GW-1 (upgradient) at an average concentration of 0.032 ppm. Brominated organics were not detected in the other wells. Iodinated organics were detected in all wells except GW-5. Concentrations of iodinated organics ranged from 0.11 ppm in well GW-1 (upgradient) to 0.002 ppm in well GW-3 (upgradient).

The source of the halogenated organics in the groundwater at Zone 2 is not apparent based on the available data. TOX analytical results indicate that elevated quantities of contaminants are present but do not indicate their origin. The highest concentrations of chlorinated organics occur at well GW-2 (1.6 ppm), while the highest concentrations of both brominated and iodinated organics occur in the upgradient well, GW-1 (TOX as Br: 0.032 ppm and TOX as I: 0.11 ppm). Well GW-6 (downgradient) has lower halogenated organic concentrations than the upgradient wells. Concentrations of halogenated organics are as large as two orders of magnitude higher than those expected to occur naturally.

An analysis of groundwater flow rates was conducted (refer to the previous section for a complete description) for Zone 2 to determine the extent of a plume if it originated from the disposal sites. The groundwater flow rates within Zone 2 vary according to the geologic material present, being 126 ft/yr for the gravels and 0.2 ft/yr for the sands. The landfill sites were first opened for operation in the 1950's, approximately 30 years ago. Assuming that a continuous gravel lens (channel) exists in the area, the maximum distance that a plume originating from site D-3 could extend would be 3,780 feet. However, because the glacial deposits in the area are highly variable, the actual extent of a plume would be expected to be less.

If flow is occurring through the sand deposits, the maximum distance that a plume could extend was calculated to be 6 feet from site D-3 (30 yrs

at 0.2 ft/yr). This range of 3,780 feet for gravel to 6 feet for sand is relatively wide and places the downgradient well GW-6 either within range of a potential plume's extension or too far away, since it is located approximately 200 feet downgradient from site D-3. Based on the well logs, the downgradient well penetrates sand deposits (gravel not present); therefore, the downgradient well is probably too far away from the disposal site to detect a plume if one exists.

The cause of the relatively high concentration levels of halogenated organics detected in upgradient wells GW-1 and GW-2 is not known. Two possible explanations are that 1) contaminants are migrating through Zone 2 from a source hydraulically upgradient of wells GW-1 and GW-2, or 2) a groundwater mound is present under Zone 2, causing contaminants from disposal sites D-1 and D-3 to flow outward to all wells. Neither of these explanations can be proven with the available data. Numerous potential sources for the elevated concentrations of halogenated organics in the groundwater exist in the area. These potential sources include:

- o Disposal sites D-1 and D-3 within Zone 2 that reportedly contain empty containers, paint residues, and waste treatment sludges
- o Disposal site D-2 located northwest of Zone 2 that reportedly contains demolition wastes, slaked lime, hardfill, and construction rubble
- o Disposal site D-4 located west of Zone 2 that reportedly contains hardfill and construction rubble, formerly a gravel pit.

Without identification of the specific halogenated organic constituents present and the inclusion of more wells located throughout the zone, the source of contamination cannot be determined.

4.5 SUMMARY OF RESULTS

The results of the sampling effort conducted at Hancock Field, within the two identified potential hazardous waste zones, did not provide sufficient data to conclusively confirm the occurrence of contaminant migration

from the disposal sites. However, the presence of halogenated organics were identified within both zones at concentrations that were elevated and indicative of environmental contamination.

In general, the following statements can be made about the data for Zones 1 and 2:

- o Volatile aromatics were not detected in any of the groundwater, surface water, and sediment samples taken.
- o Volatile halocarbons were not detected in any of the field samples analyzed, with the exception of SW-4, which had a very low concentration of chloroform (0.00056 ppm); this level was not repeated in the duplicate sample and is not considered to be a result of environmental contamination.
- o Elevated concentrations of total organic carbon (TOC) were detected in all tested samples and are probably the result of naturally occurring organics rather than an indication of environmental contamination.
- o Elevated levels of oil and grease were not detected in surface water and groundwater samples, only in sediments.
- o Elevated levels (i.e., greater than levels expected as background; 0.015-0.020) of halogenated organic compounds (TOX) were detected in samples taken from each zone, indicating environmental contamination; however, because TOX only scans for total halogenated species, the identity, as well as the toxicity and persistence of the indicated chemicals, cannot be determined.
- o Trends in the data, for the most part, did not exist between samples (e.g., upstream versus downstream, surface water versus sediment) or among parameters measured within a sample.

For Zone 1, which contains disposal site D-5 and fire training pit FT-1, the following statements can be made based on the available data:

- o Very high concentrations of oil and grease exist in the sediments at site FT-1; these sediments also contained the highest concentrations of chlorinated and brominated organics of all samples taken at either zone; leaching of these contaminants into the surface waters and sediments downstream of FT-1 appears to be occurring based on changes in surface water and sediment samples taken above and below the site, contamination of the groundwater is not apparent based on these data.

- o Environmental contamination originating from disposal site D-5 was not apparent; surface waters draining the area north of the site had high concentrations of chlorinated and brominated organics; groundwater monitored at an upgradient well near this same area had elevated concentrations of iodinated organics only; because relationships between surface water, groundwater, and sediments did not exist, the contamination present cannot be conclusively attributed to disposal site D-5.
- o Oil and grease in sediments (except at SD-9) and halogenated organics in surface water and groundwater appear throughout samples taken within Zone 1 and may not be the direct result of past disposal activities within Zone 1.

For Zone 2, which contains disposal sites D-1 and D-3, the following statements can be made based on the available data:

- o Oil and grease concentrations were elevated at all sediment monitoring stations; these contaminants are probably residues of surface runoff from the surrounding area.
- o Environmental contamination resulting directly from disposal site D-1 and D-3 was not apparent; an upgradient groundwater monitoring well contained the highest concentrations of halogenated organics and organic carbon; trends between surface water, groundwater, and sediment analyses were not indicated.
- o Oil and grease in sediments and halogenated organics in surface water and groundwater appear throughout samples taken within Zone 2 and may not be directly related to past disposal activities within the zone.

In general, the contaminant levels present in samples, for the most part, were not extremely high (indicating the presence of large concentration of compounds) or low; rather, they indicated the presence of environmental contamination within Zones 1 and 2 without identifying exact sources. The following sections discuss the options available for further identifying the types of contaminants in each zone and for determining their source or sources.

5.0 ALTERNATIVE MEASURES

This section describes the major possible monitoring options, by zone and site, for future Phase II efforts at Hancock Field. The proposed monitoring plans, monitoring methods, and durations are discussed. Only future monitoring efforts are addressed, because the results of the initial monitoring program indicated that organic contaminants are present in both zones but did not provide specific information about these organics or their source. Therefore, further monitoring is recommended so that the need for and the scope of future IRP work can be determined.

5.1 ZONE 1: FIRE TRAINING SITE FT-1 AND DISPOSAL SITE D-5

On the basis of the results of the initial monitoring performed in Zone 1, three shortcomings in the data are evident. These shortcomings are as follows (refer to Section 4.0 for detailed discussions of results):

- (1) Elevated concentrations of chlorinated, brominated, or iodinated organics were present in surface water, groundwater, or sediment samples. These chemicals appear throughout the zone and their source is not determinable with the available data.
- (2) Relatively high concentrations of oil and grease were present in the runoff area north of the fire training site FT-1. The vertical and horizontal extent of contamination is not known.
- (3) The locations of wells within Zone 1 are inappropriate for monitoring contaminant migration from the two disposal sites, because the direction and rate of groundwater flow are not as predicted from the Phase I effort (i.e., with topography).

The following monitoring options for Zone 1 have been developed for use in collecting the necessary information on which to base future IRP work.

5.1.1 Option 1 - Resample Existing Monitoring Stations

Because initial sampling of groundwater, surface water, and sediments within Zone 1 showed elevated levels of chlorinated, brominated, or iodinated organic compounds, or some combination of these compounds, all

monitoring stations should be resampled to determine the specific organic compounds present. Sample analysis should be performed using GC/MS (gas chromatography/mass spectrometry) methods in order to identify specific organic fractions (i.e., volatiles, base/neutral extractables, acid extractables, and pesticides and PCB's).

Once the chemical species are identified and their concentrations known, the level of toxicity and persistence in the environment can be evaluated. If the species present are not toxic or persistent further IRP work may not be warranted. However, if the organic species present are toxic and persistent, further Phase II efforts are probably warranted to determine the extent of contamination. This type of information would be required for the development of any remedial action plan.

The limitations of performing this alternative solely would be that the sources of contamination are not delineated, and if sites D-5 or FT-1 are causing environmental degradation, well placement is inadequate to detect this (i.e., downgradient wells are either absent or too far downgradient to detect a plume if it exists based on flow rates). Also, because the wells are screened only through the top 20 feet of the aquifer and the aquifer may be more than 70 feet thick, contaminants that are relatively insoluble and denser than water would probably not be detected by monitoring the existing wells.

5.1.2 Option 2 - Soil Sampling at Site FT-1

To accurately delineate the vertical and horizontal extent of contamination caused by the fire training exercises conducted at site FT-1, additional soil (sediment) samples will have to be obtained from the areas surrounding the site. The method proposed for delineating the extent of contamination consists of establishing a sampling grid around the site and obtaining soil samples at incremental depths.

Once the grid is established, a detailed visual inspection of the site for signs of visible oil and grease contamination should be made and plotted on the grid (i.e., this was done in Phase II (Stage 1), but will have to be redone to establish contaminant extent on the grid). Once the contaminated area has been determined, sampling transect lines radiating outward from the hardstand should be established at 45° intervals around the site (Figure 5-1). Soil sampling stations should be established along these transect lines at 100-foot intervals throughout the contaminated area, and should extend at least 100 feet beyond the furthest visible sign of contamination.

Soil samples should be taken at these stations using a bucket auger. The first sample should be taken at the surface and additional samples should be acquired at interval depths of one foot. Sampling depth should extend to at least one foot beyond any obvious signs of contamination (i.e., sight and smell) or to a depth equal to the water table.

Samples obtained should be sealed in individual containers and appropriately labeled to ensure sample integrity. Care should also be taken to ensure that samples are not cross-contaminated during collection. Samples should be analyzed for oil and grease and TOX. Selected samples should have a full analysis performed (i.e., GC/MS).

Data provided by this program would yield the horizontal and vertical extent of contamination in the site soils above the groundwater table. If the contaminants are found to extend into the water table, additional monitoring of the groundwater system will be required. The scope of this monitoring program cannot be evaluated at this time. The data provided from this effort would be required for the planning of remedial actions at the site (e.g., volume of soil to be removed by excavation).

This option could be implemented alone or in conjunction with the other options. This option should be implemented regardless of other option choices because of the environmental contamination present at the site.

5.1.3 Option 3 - Additional Groundwater Monitoring Wells

Well placement in the initial Phase II (Stage 1) effort was based on available data pertaining to the site as presented in the Phase I report. Unfortunately, the well locations chosen did not yield the data necessary to properly monitor sites FT-1 and D-5, because these wells were either placed too far downgradient to intercept a plume or were located so that they are neither upgradient nor downgradient of the waste sites.

To properly monitor the groundwater within Zone 1 at sites FT-1 and D-5, an additional four well pairs should be installed in the zone. These well pairs should be located so that each waste disposal site has a new upgradient and downgradient well pair. Figure 5-2 shows the locations of these well pairs. The new well pairs are located close to the waste sites because groundwater flow rates are very slow (i.e., approximately 5 ft/yr) and any plume originating from the site will not have migrated very far.

As used in this report, a well pair is defined as two separate wells installed side by side with their screens located at different depths. Figure 5-3 shows a typical well pair installation. Well pairs are suggested for new well installations because the aquifer thickness within Zone 1 may be more than 70 feet. Well pairs used in this type of situation allow for effective monitoring of both miscible and immiscible contaminants which may float or sink and for maintaining the integrity of the well so that bore hole collapse does not occur (i.e., rather than screening 70 feet of aquifer).

The exact depth of the well pair cannot be determined because the existing wells do not fully penetrate the water table aquifer. The deep well of the well pair should be drilled to bedrock and screened over the bottom 20-foot section. During drilling a well log should be developed by obtaining split spoon samples at 5-foot intervals. The shallow well of the well pair should be drilled to 20 feet below the water table (i.e., identical to previous wells) and screened throughout this interval.

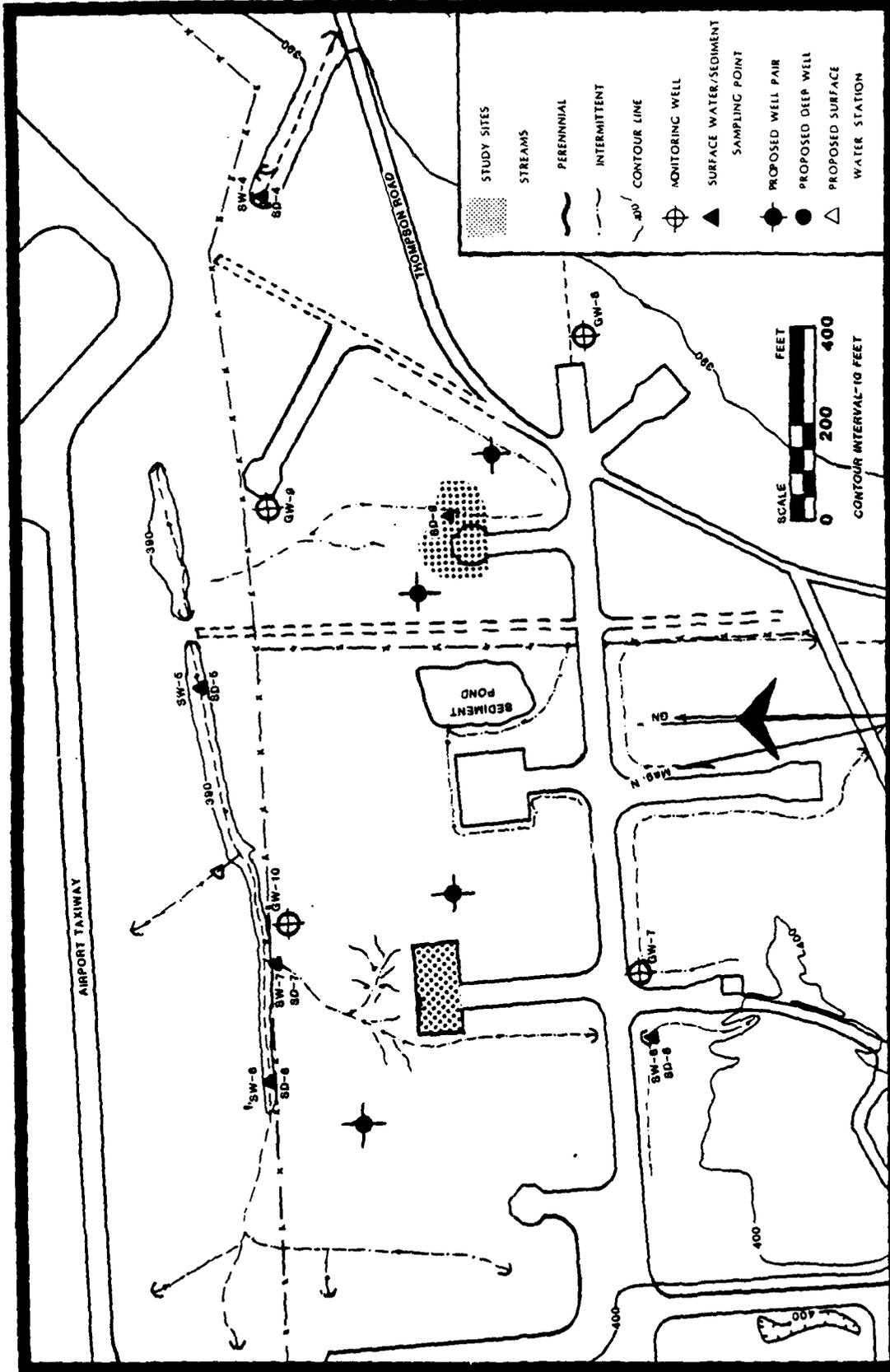


FIGURE 5-2. EXISTING AND PROPOSED LOCATIONS OF SAMPLING STATIONS AT ZONE 1

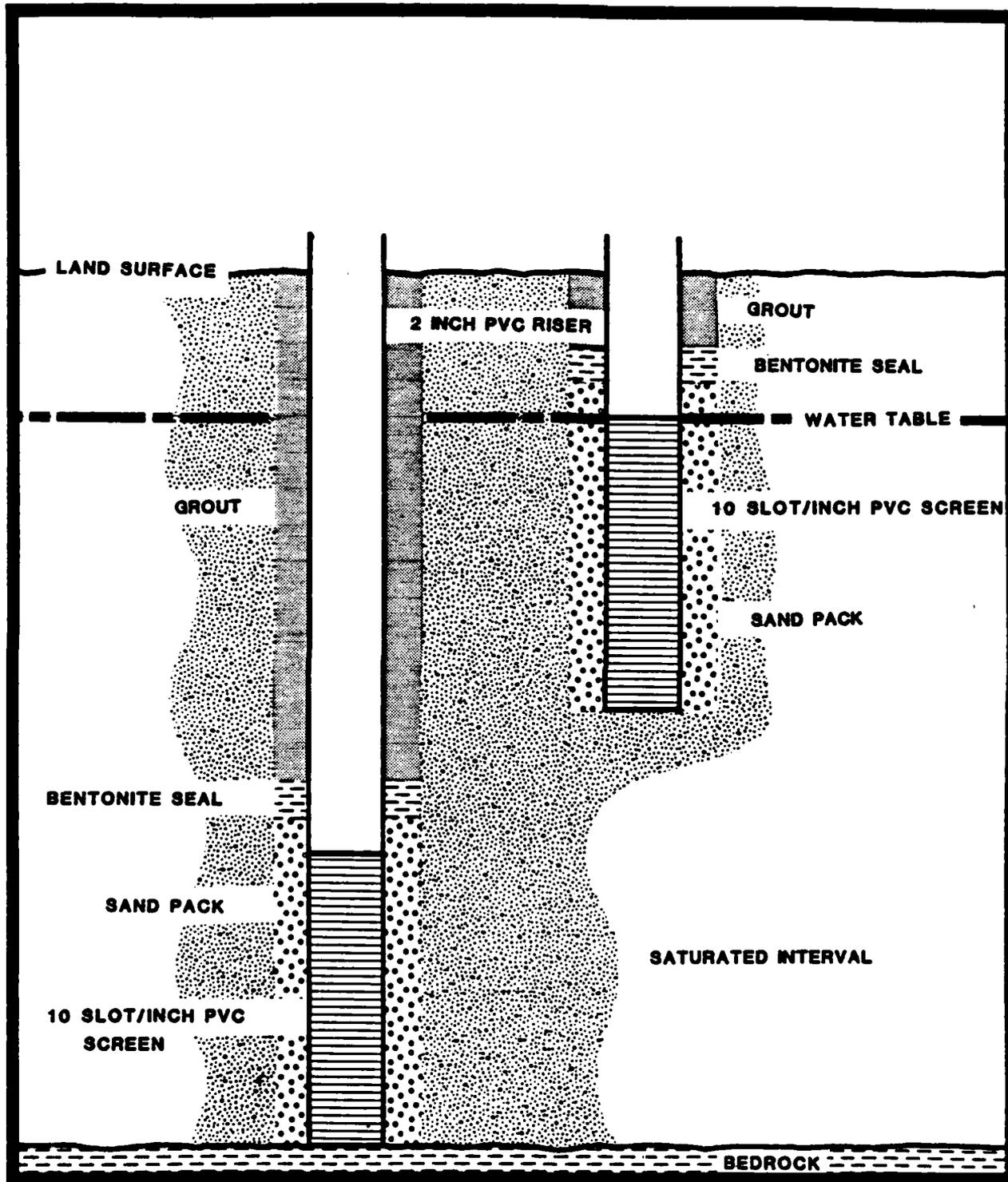


FIGURE 5-3. TYPICAL WELL PAIR INSTALLATION

Sampling during drilling would not be required since this was performed for the other member of the pair. Well construction material, screens, gravel packs, and guard pipes should have the same specifications as previously installed wells (i.e., refer to Section 3.0 and Appendix D).

Water quality samples and head level measurements should be collected from these wells using the procedures used on the existing wells (i.e., refer to Section 3.0). Samples should be analyzed for all organic fractions using GC/MS methods (i.e., volatiles, acid extractables, base/neutral extractables, and pesticides and PCB's). Water levels and quality samples should be obtained from the wells previously installed within the zone at the same time that new wells are sampled.

This groundwater monitoring program has the following advantages:

- o Allows for detection of both miscible and immiscible, floating and sinking organic contaminants
- o Allows for differentiation of organic chemical species
- o Provides both upgradient and downgradient monitoring within the potential extent of a plume.

This type of information is required to properly evaluate the environmental hazards posed by the two sites within Zone 1 and to plan any future IRP efforts.

Numerous sub-options of this option can be developed to provide a less intensive monitoring effort, but each will sacrifice some data requirement needed to properly evaluate the site. These sub-options could include the following:

- o Shallow downgradient wells
- o Paired downgradient wells
- o Shallow upgradient and downgradient wells
- o Shallow upgradient and paired downgradient wells
- o Analysis for TOX or some partial analysis of organics.

Each of the above options will decrease the cost of future monitoring but will sacrifice data.

5.1.4 Option 4 - Additional Surface Water Monitoring Station

This option would establish one additional surface water sampling station on the drainage channel north of Zone 1. This station should be located on the drainage ditch from the airport runway area. Location of this additional monitoring station is shown in Figure 5-2 (i.e., monitoring station SW-9).

This proposed option would be implemented in conjunction with Option 1 and this station would be monitored as part of that overall program. The data obtained would aid in determining potential sources of contaminants occurring within the zone and determine if the airport runways are contributing to the environmental problems associated with the site.

5.2 ZONE 2: DISPOSAL SITES D-1 AND D-3

The two disposal sites located within Zone 2 (D-1 and D-3) were investigated simultaneously during the Phase II (Stage 1) study. Because the direction and rate of groundwater flow were unknown, wells were positioned so that they encircled the site. This was done so that an upgradient and downgradient well would presumably be established.

Analysis of samples of surface water, groundwater, and sediments showed that chlorinated, brominated, or iodinated organics were present in the surface water and groundwater systems at significant levels. Upon evaluating the data from the Phase II (Stage 1) effort, several shortcomings were evident. These shortcomings in the data are:

- (1) Elevated concentrations of halogenated organics are present in the surface water and groundwater systems at Zone 2. These chemicals appear throughout the zone. Based on the data the specific organic compounds are not known and their source cannot be determined.

- (2) Well placement indicates that only one downgradient well exists at the site (GW-6). This may not provide adequate coverage to detect contaminant migration from the site because of the aerial extent of the disposal site. Also, this well may be outside the potential extent of the plume migration because of the very slow flow rates (i.e., minimum rates 0.2 ft/yr).
- (3) Wells installed within Zone 2 are screened only in the top 20 feet of the water table aquifer which is probably more than 70 feet thick. Monitoring wells constructed in such a manner are not likely to detect immiscible, sinking contaminants if they are present.

The following proposed monitoring options would provide data to meet these data shortcomings.

5.2.1 Option 1 - Resampling

Because initial sampling of groundwater and surface water within Zone 2 showed elevated levels of either chlorinated, brominated, or iodinated organic compounds, or some combination of these compounds, a resampling of all surface water and groundwater monitoring stations should be performed to determine the specific organic compounds present. Sample analysis should be performed using GC/MS methods to yield specific identification of organic fractions (i.e., volatiles, acid extractables, base/neutral extractables, and pesticides and PCB's).

Once the chemical species are identified and their concentration known, the toxicity level and persistence in the environment can be evaluated. If the compounds present are not toxic or persistent, further IRP work may not be warranted. However, if the organic compounds are toxic and persistent, further Phase II efforts are probably warranted to determine the extent of, contamination. This type of information would be required for the development of any remedial action plan.

The limitations of performing this alternative solely would be that well locations and depths may be inadequate to detect the existence of a plume or contaminants if they are present (i.e., downgradient well may be beyond the extent of plume migration) and wells are probably not capable of monitoring immiscible sinking contaminants.

Sampling should be performed using the same methods applied in the Phase II (Stage 1) study. A description of these methods is given in Section 3.0.

5.2.2 Option 2 - Installation of New Monitoring Wells

Because of the close proximity of the two waste disposal sites and the limited number of wells installed during the Phase II (Stage 1) effort, identification of the source of halogenated organics present at the site was not possible. In addition, groundwater flow may not be as represented by the potentiometric surface plots (Figure 2-13). Rather, a mound may be present under the waste disposal sites, resulting in all the presently installed wells being downgradient. Groundwater mounding under waste disposal sites is not uncommon because they are typically more permeable than the surrounding soils.

To separate the two sites from each other and provide for adequate monitoring of any contaminants present, additional wells should be installed within the zone. The proposed monitoring program would include the installation of two well pairs and one deep well. One well pair would be located downgradient of site D-3 close to its perimeter. The other well pair would be situated between waste disposal sites D-1 and D-3. An additional deep well would be installed next to upgradient well GW-3. The locations of these wells are shown in Figure 5-4.

As previously described, well pairs are two separate wells installed side by side at different depths in the aquifer. One of the well pairs is drilled to bedrock and screened 20 feet above this interface. The other well is installed 20 feet below the groundwater table and screened throughout the saturated thickness. Figure 5-3 shows a typical well pair installation. The additional deep well at GW-3 will be drilled in a similar manner to the deep wells of the well pair, potentially resulting in a deep upgradient well at the site.

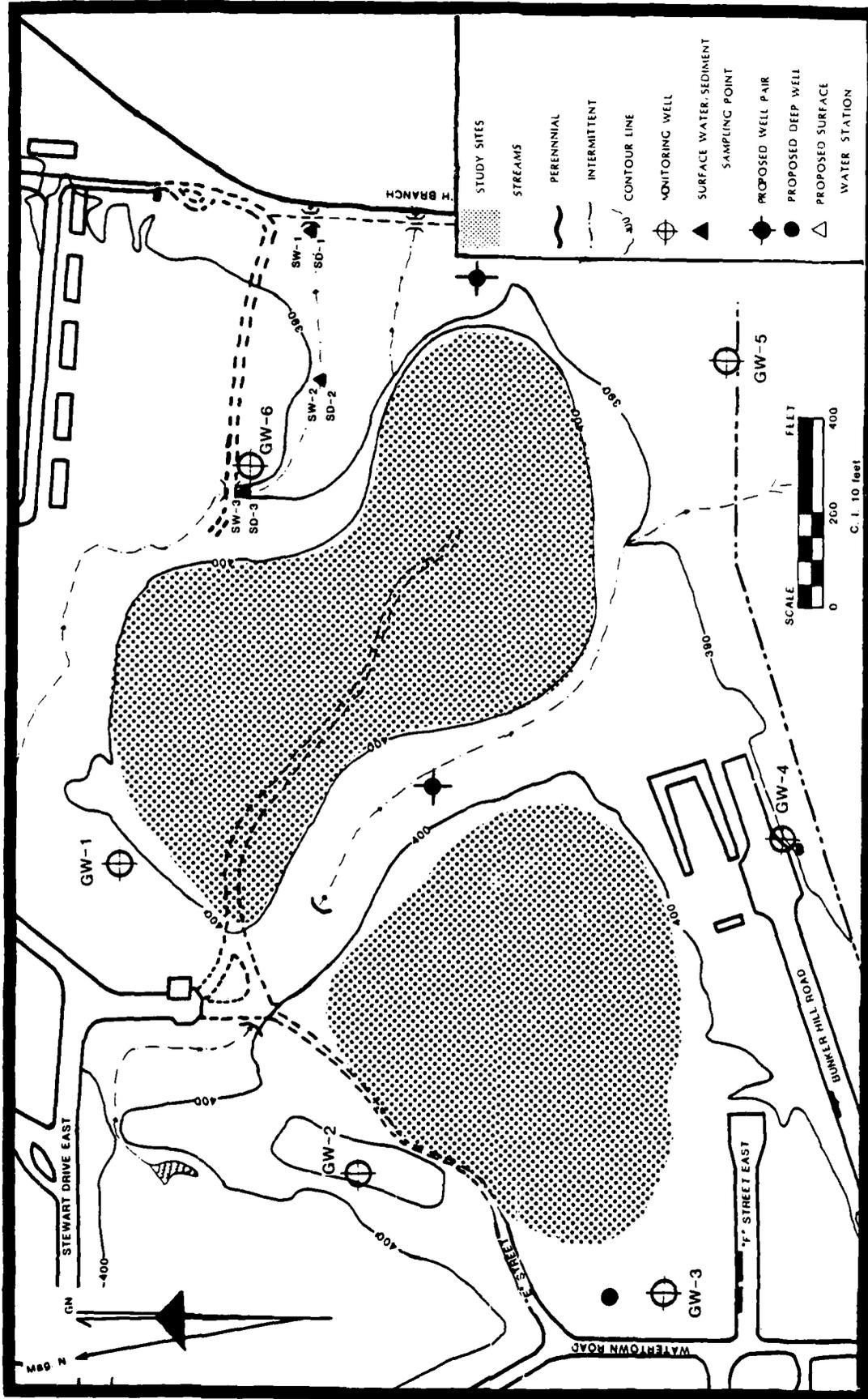


FIGURE 5-4. EXISTING AND PROPOSED LOCATIONS OF SAMPLING STATIONS AT ZONE 2

A well log should be developed for each of the three new deep wells by collecting split spoon samples at 5-foot intervals throughout its total depth. Detailed logs are not necessary for the shallow wells because of their close proximity to the deep wells. Construction methods and well specifications should be the same as those used for the previously drilled wells (i.e., refer to Section 3.0 and Appendix D).

The additional new wells should be sampled (i.e., head levels and water quality) in conjunction with the existing wells within zone. Sampling methods should be the same as those used previously (refer to Section 3.0). Laboratory analysis should consist of GC/MS analysis for all organic extractables (i.e., volatiles, acid extractables, base/neutral extractables, and pesticides and PCB's).

Installation of these additional monitoring wells and sampling of these wells in conjunction with existing wells should provide the data necessary to evaluate the following:

- o The presence of miscible and immiscible contaminants if present at the site
- o The direction of groundwater flow within the zone; i.e., either easterly flow or radial flow as indicated by present data from a groundwater mound
- o The source of contamination if it is either disposal site D-1 or D-3
- o The specific organic species present and their concentrations.

The above program will probably provide for the complete evaluation of any contaminant migration from the sites and zone. However, numerous sub-options of this option exist that provide for a less intensive program. These sub-options could include the following:

- o Installation of one shallow well between the sites
- o Installation of both shallow wells

- o Installation of a shallow well between sites and a well pair downgradient
- o Installation of two well pairs (downgradient and between sites).

5.2.3 Option 3 - Additional Surface Water Monitoring Stations

Two additional surface water monitoring stations should be established on Ley Creek North Branch. These stations should be above monitoring point SW-1 and below the southern boundary of the disposal area. The locations of these surface water monitoring stations are shown in Figure 5-4.

Data from the analysis of samples taken at these two points would aid in evaluating the overall effect contaminants are having on the surface water regime. This option should be implemented in conjunction with Option 1 for the results to be useful. Sampling procedures and analyses should be identical to those performed for Option 1 and Phase II (Stage 1).

6.0 RECOMMENDATIONS

This section contains the recommendations for further monitoring at Hancock Field to completely assess the presence of contaminants originating from the four waste sites evaluated in the study. The monitoring program recommended in this section is intended to:

- o Identify the specific organic compounds present within each zone so that their toxicity and persistence in the environment can be determined
- o Isolate the source of contamination if it is originating from one of the four waste disposal sites studied in the Phase II (Stage 1) effort
- o Provide for the monitoring of both miscible and immiscible contaminants that may be present in the water table aquifer
- o Increase the hydrogeologic data base on which future IRP work will be based.

6.1 ZONE 1: FIRE TRAINING SITE FT-1 AND WASTE DISPOSAL SITE D-5

Zone 1 contains the fire training area (FT-1), which is currently in use, and waste disposal site D-5, which is now abandoned. Elevated concentrations of halogenated organic compounds are present throughout the surface water and groundwater regimes in this zone. In addition, very high concentrations of oil and grease are present in the soils surrounding the fire training area. Halogenated organics were also detected in high concentrations in the soil samples obtained from the fire training area.

Hydrogeologic data collected during the Phase II (Stage 1) effort indicated that several shortcomings were present in the monitoring program as established. These shortcomings are as follows:

- o Monitoring well locations do not provide for an upgradient well and the downgradient well is potentially too far downgradient of the closest waste site to detect contaminants if they are present (i.e., based on calculated flow rates to predict the extent of plume migration)

- o Monitoring wells were installed to a depth of 20 feet below the water table in an aquifer that is probably over 70 feet thick. Wells placed in such a manner will probably not detect immiscible sinking contaminants if they are present.

On the basis of the information obtained from Zone 1 during the Phase II (Stage 1) effort, an expanded monitoring program should be implemented at the two sites to determine whether environmental degradation has occurred because of past or ongoing waste material handling. This program includes the following:

- (1) Installation of four new well pairs within the zone (Option 5.1.3)
- (2) Establishment of an additional surface water monitoring station on the drainage ditch that drains the runway areas (Option 5.1.4)
- (3) Sampling of all surface water and groundwater monitoring stations (i.e., existing and new) and analysis of collected samples for specific organic compounds that may be present (Option 5.1.1)
- (4) Delineation and sampling of contaminated soils associated with the fire training site. Analysis would consist of oil and grease determinations and organic compound analysis of select samples (Option 5.1.2).

6.1.1 Installation of Well Pairs

Four new well pairs should be installed within Zone 1, one well pair upgradient and one well pair downgradient of each site (Figure 5-2). The downgradient well pairs should be located within 150 feet of the waste sites so that if a plume exists it will be detected (i.e., maximum calculated plume extent was 187 feet). Upgradient wells should be placed at least 200 feet from the site to ensure that samples are representative of the background water quality.

Because of the thickness of the water table aquifer at Zone 1 (i.e., greater than 70 feet), paired wells should be installed so that monitoring will effectively detect both immiscible and miscible contaminants. Paired wells are two individual wells drilled close to each other with their screens set at different depths (Figure 5-3). For Zone 1, the well pairs

will consist of one deep well drilled to bedrock and screened over the 20-foot interval directly above the bedrock, and a shallow well drilled to a depth of 20 feet below the elevation of the encountered water table and screened throughout the 20 feet of saturated aquifer.

A detailed well log should be developed during the installation of the deep well by collecting geologic samples at 5-foot intervals using split spoon sampling methods. Samples obtained should be completely described (i.e., color, texture, sign of contamination) so that a detailed geologic description can be developed of the unconsolidated glacial deposits present. Well construction specifications should be identical to those used for wells installed during the initial Phase II (Stage 1) effort (i.e., 2-inch ID, PVC well; 20 feet of 10 slot/inch PVC screen; 4Q gravel pack around screen; bentonite pellet seal above well pack; cement/bentonite backfill; 3-inch by 5-foot protective cap). Wells should be developed by pumping at least five casing volumes of water from the well.

Hydraulic conductivities should be determined for all four well pairs using a slug test method. This will provide information on the uniformity of the aquifer to transport contaminants and provide data needed to calculate the extent of a potential plume's migration.

6.1.2 Additional Surface Water Monitoring Station

An additional surface water monitoring station should be established on the drainage ditch that drains the airport runways north of the main drainage channel. Figure 5-4 shows the proposed location of this monitoring station. This station should be established so that any contaminants originating from the runway area can be evaluated and accounted for in surface water quality changes that occur as this water flows past and through Zone 1.

This additional surface water monitoring station should be established in the same manner as those established during the Phase II (Stage 1) effort (staked and marked). This will allow easy identification of the monitoring station if future sampling efforts are required.

6.1.3 Groundwater and Surface Water Sampling

Groundwater and surface water should be resampled within Zone 1 to determine whether contaminants are present and environmental degradation is occurring. All existing surface water and groundwater monitoring stations, the four new well pairs, and the new surface water monitoring station should be sampled in the effort.

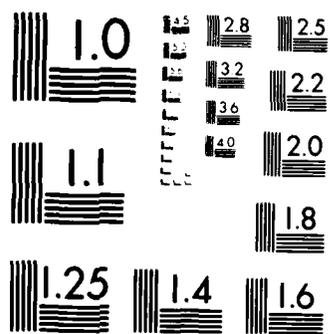
Groundwater samples should be collected using a point source teflon bailer after the well has been purged of 3 to 5 casing volumes of water (i.e., removes stagnant water and ensures a representative sample). Surface water samples should be collected directly from the drainage channel using the sample collection bottles. Care should be taken not to disturb sediments in the collection process. Sampling equipment should be decontaminated between monitoring points using an Alconox wash and rinsing with distilled water.

QA/QC samples should be collected during the effort and would consist of the following samples:

- o One surface water replicate
- o One groundwater replicate
- o One bailer wash
- o One field blank taken at the start of sampling day.

These samples should be analyzed for the same parameters as normally collected samples. The results of this analysis will provide checks on the adequacy of the decontamination procedures, reproducibility of sample results, and the presence of introduced compounds.

Sample analysis for the collected surface water and groundwater samples should consist of field pH, conductivity, and temperature, and laboratory analysis for specific organic compounds using GC/MS methods. The organic compounds analyzed should include the following extraction groups:



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

volatiles, acids, base/neutral, and pesticides and PCB's. These groups were selected for analysis based on the results of the Phase II (Stage 1) sampling effort. The only contaminants present in elevated quantities in the groundwater and surface water were the halogenated organics. Oil and grease and total organic carbon were not present in elevated levels in water samples. Sediments not associated with the fire training site (i.e., discussed in the next section) were not heavily contaminated to warrant further analysis.

Sampling of surface water and groundwater within Zone 1 should be performed only once, initially, to determine whether a problem exists and to define the magnitude of the problem. Results of the resampling effort will serve as a basis for the decision to conduct future IRP efforts at the site.

6.1.4 Fire Training Site: FT-1

6.1.4.1 Additional Monitoring

The fire training site presents a unique set of problems that warrant special sampling beyond the water quality testing previously described. Past and present activities at the site have allowed unburned waste oil, fuels, and ignitables to contaminate the soils surrounding the site. The extent of environmental contamination is not known, but Phase II (Stage 1) visual observations and sampling suggest that a large surficial area around the site may be contaminated with high levels of oil and grease and halogenated organics. The sampling program described below should provide information on the vertical and horizontal extent of contamination and the concentrations at which this contamination occurs.

To determine the extent (i.e., vertical and horizontal) and concentration of the existing contamination at site FT-1, a soil sampling program should be instituted. This program should be based on a grid system radiating outward from the site. The surficial extent of contamination should be plotted on the grid system through visual observations of the presence of oil and grease in the surface soils. Once the surficial extent

of contamination is determined, soil sampling transect lines should be established at 45° angles around the site (Figure 5-1). Soil sampling stations should be established at 100-foot intervals on the transect lines and should extend at least 100 feet past the last visible sign of contamination.

Soil samples should be taken with a hand auger at 1-foot intervals starting at the surface. Sampling should be continued until obvious signs of contamination no longer exist or until the water table is encountered. Collected soil samples should be sealed in air-tight containers and numbered according to monitoring location and depth. Boreholes should be backfilled with bentonite to preclude future migration pathways.

All soil samples should be analyzed for oil and grease and TOX. Selected samples should be analyzed for specific organic compounds using GC/MS methods. At a minimum, organic analysis should be performed on the first and last soil samples taken at each sampling station.

The results of this study should provide information about the vertical and horizontal extent of contamination at the site, the concentrations and types of contaminants present, and an indication of whether or not contaminants have reached the groundwater table. This information will be necessary in conducting future IRP efforts.

6.1.4.2 Site Improvements

In addition to the sampling program, the fire training site should be contained to prevent further environmental contamination. Containment can be accomplished by installing a durable berm around the hardstand. This berm should channel unburned ignitables to a collection sump. This sump should be lined with an impervious barrier and be large enough to hold the volume of waste typically generated during a fire training exercise. This containment system is shown diagrammatically in Figure 6-1. The sump should be emptied when full and the contents either reignited or properly disposed.

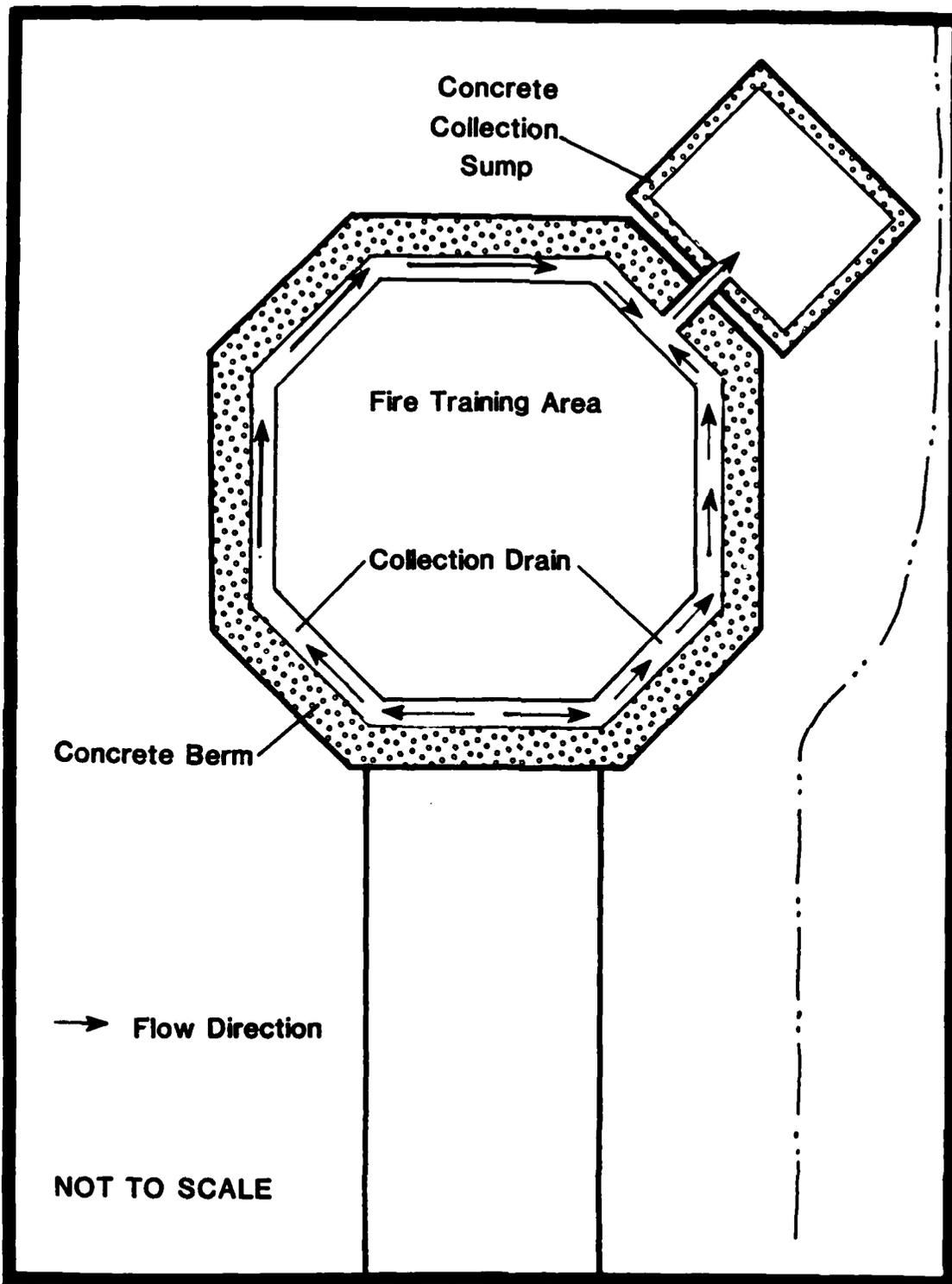


FIGURE 6-1. COLLECTION SYSTEM FOR RECOVERY OF UNBURNED IGNITABLES

6.2 ZONE 2: WASTE DISPOSAL SITES D-1 AND D-3

The two waste disposal sites within Zone 2 were evaluated as a unit in the Phase II (Stage 1) study because the number of monitoring wells was limited in the scope of work. Wells were placed around the perimeter of the zone and drilled to a depth that allowed only for monitoring of the upper portion of the water table aquifer. Significant concentrations of halogenated organics were detected in both surface water and groundwater at Zone 2. The halogenated organics in the groundwater and surface water appear, from the performed analysis, to be the only contaminants present in significant quantities within the zone.

Hydrogeologic information collected during the Phase II (Stage 1) effort indicated that several shortcomings were present in the monitoring program as established at the zone. These shortcomings are as follows:

- o Monitoring well locations provide for only one downgradient monitoring station. The disposal area that this one well must monitor is large and probably cannot be adequately monitored by a single well.
- o Monitoring wells were installed to a depth of 20 feet below the water table in an aquifer that is at least 70 feet thick. The water table aquifer at Zone 2 appears to be heterogeneous, containing gravel, sand, and silt/clay layers. Wells installed in such a manner will probably not be adequate to detect all types of contaminants that may be originating from the site.
- o The upgradient monitoring well contained the highest concentrations (i.e., based on available data) of halogenated organic compounds. This suggests two possible explanations: contaminants are originating from another source, or a groundwater mound is present under the disposal areas and the contaminants originated from site D-1.

On the basis of information obtained from Zone 2 during the Phase II (Stage 1) effort, an expanded monitoring program should be implemented at the two waste disposal sites to determine whether environmental degradation

has occurred because of past disposal activities and which site is the source of any found contamination. The recommended monitoring program includes the following items:

- 1) Installation of two well pairs and one additional deep well within Zone 2 (Option 5.2.2)
- 2) Establishment of two additional surface water monitoring stations on Ley Creek North Branch (Option 5.2.3)
- 3) Sampling of all surface water and groundwater monitoring stations and analysis of collected samples for specific organic compounds present (Option 5.2.1).

6.2.1 Installation of Wells

Two new well pairs and an additional deep well should be installed within Zone 2. One of the well pairs should be installed downgradient of waste disposal site D-3 near its southeast corner. This well should be installed within 150 feet of the edge of the visible disposal area so that if a plume exists, the possibility of detecting it is increased. Figure 5-4 shows the locations of these wells.

The other well pair should be installed between the disposal sites in the drainage swale. Data from the well pair will provide information on the possible existence of a groundwater mound at the zone and aid in determining the source of contaminants if they are present. The location of the well pair is shown in Figure 5-4.

The additional deep well should be installed next to existing shallow well GW-3, making this monitoring station a well pair. This well will serve as an upgradient well to monitor the lower portion of the water table aquifer. If a groundwater mound exists at the site, the additional deep well will provide additional downgradient monitoring in the lower section of the aquifer.

Installation of the additional wells at Zone 2 will provide for the monitoring of both miscible and immiscible contaminants that may be leaching from the disposal sites, aid in determining the source of contaminants if

present, and provide information on the hydrogeology of the area and how the aquifer may be transporting contaminants. Well installation should follow the same specifications described in Section 6.1.1 for the installation of paired wells in Zone 1. Detailed well logs should be developed during the drilling of the deep wells by obtaining and describing geologic samples. Samples should be collected at 5-foot intervals using split spoon methods.

Hydraulic conductivities should be determined for the new wells, if possible, using a slug test method. This information will provide data about the uniformity of aquifer which is expected to be layered, and allow for determining plume migration rates.

6.2.2 Additional Surface Water Monitoring Stations

Two additional surface water monitoring stations should be established on Ley Creek North Branch. These stations should be located above the inflows from the zone and below the southern drainage area of the zone. The locations of these two additional surface water monitoring stations are shown in Figure 5-4.

Data collected from the new monitoring station will be used to evaluate any changes that occur in surface water quality that may be attributable to waste disposal activities at sites D-1 and D-3, since base flow appears to be the result of groundwater discharge in the area. Sampling methods should be the same as those used in the Phase II (Stage 1) effort (as described in Section 6.1.2).

6.2.3 Groundwater and Surface Water Sampling

Groundwater and surface water should be resampled within Zone 2 to determine whether contaminants are present and environmental degradation is occurring. All existing surface water and groundwater monitoring stations, new wells, and new surface water monitoring stations should be sampled in the effort.

Groundwater samples should be collected using a point source teflon bailer after the well has been purged of 3 to 5 casing volumes of water (i.e., removes stagnant water and ensures a representative sample). Surface water samples should be collected directly from the drainage channel using the sample collection bottles. Care should be taken not to disturb sediments in the collection process. Sampling equipment should be decontaminated between monitoring points using an Alconox wash and rinsing with distilled water.

QA/QC samples should be collected during the effort and would consist of the following samples:

- o One surface water replicate
- o One groundwater replicate
- o One bailer wash
- o One field blank taken at the start of the sampling day.

These samples should be analyzed for the same parameters as normally collected samples. The results of this analysis will provide checks on the adequacy of the decontamination procedures, reproducibility of sample results, and the presence of introduced compounds.

Sample analysis for the collected surface water and groundwater samples should consist of field pH, conductivity, and temperature, and laboratory analysis for specific organic compounds using GC/MS methods. The organic compounds analyzed should include the following extraction groups: volatiles, acids, base/neutral, and pesticides and PCB's. These groups were selected for analysis based on the results of the Phase II (Stage 1) sampling effort. The only contaminants present in significant quantities in the groundwater and surface water were the halogenated organics. Oil and grease and total organic carbon were not present in significant levels in water samples.

Sampling of surface water and groundwater within Zone 2 should be performed only once, initially, to determine whether a problem exists and to define the magnitude of the problem. Results of the sampling effort will dictate any future IRP efforts at the sites.

6.3 SUMMARY OF RECOMMENDATIONS

Additional surface water and groundwater monitoring is required at both Zones 1 and 2 in order to determine the presence and magnitude of any environmental degradation that resulted from past disposal activities within these zones. The recommended monitoring program for both zones includes the installation of new wells, the establishment of additional surface water monitoring points, and the sampling and analysis of all surface water and groundwater monitoring stations. In addition, the fire training area (site FT-1) requires additional soil sampling. Table 6-1 summarizes the monitoring program as described in the previous sections.

TABLE 6-1

SUMMARY OF SUGGESTED FUTURE MONITORING AT HANCOCK

Zone/Site	Ground Water	Surface Water	Analysis	Special Sampling
Zone 1	<ul style="list-style-type: none"> o Resample existing monitoring wells (4 wells) 	<ul style="list-style-type: none"> o Resample existing surface water stations (5 stations) 	<ul style="list-style-type: none"> o Field: pH, conductivity, temperature, flow rate, head level 	
D-5	<ul style="list-style-type: none"> o Install and sample 2 new well pairs (up and down-gradient) 	<ul style="list-style-type: none"> o Establish and sample new surface water station on drainage from runway area 	<ul style="list-style-type: none"> o Field: pH, conductivity, temperature, flow rate, head level o Laboratory: GC/MS scan for organic constituents 	<ul style="list-style-type: none"> o Slug test new wells to determine hydraulic conductivity
FT-1	<ul style="list-style-type: none"> o Install and sample 2 new well pairs (up and down-gradient) 		<ul style="list-style-type: none"> o Field: pH, conductivity, temperature, head level o Laboratory: GC/MS scan for organic constituents 	<ul style="list-style-type: none"> o Perform soil sample in drainage area surrounding site to determine vertical and horizontal extent of contamination o Test samples of oil and grease and selected samples for organic constituents (GC/MS scan)
Zone 2	<ul style="list-style-type: none"> o Resample existing monitoring wells (6 wells) o Install and sample 2 new well pairs (1 downgradient site D-3, 1 between sites D-1 and D-3) o Install and sample 1 new deep well near GW-3 	<ul style="list-style-type: none"> o Resample existing surface water stations (3 stations) o Establish and sample 2 new surface water monitoring stations (above and below sites on Ley Creek North Branch) 	<ul style="list-style-type: none"> o Field: pH, conductivity, temperature, flow rate, head level o Laboratory, GC/MS scan for organic constituents 	<ul style="list-style-type: none"> o Slug test new wells to determine hydraulic conductivity

APPENDIX A

GLOSSARY OF TERMINOLOGY AND ABBREVIATIONS

TABLE A-1

LIST OF ABBREVIATIONS

DOD	Department of Defense
AF	Air Force
IRP	Installation Restoration Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
NORAD	North American Aerospace Defense Command
AFB	Air Force Base
SAC	Strategic Air Command
NYANG	New York Air National Guard
HARM	Hazard Assessment Rating Methodology
TOC	Total Organic Carbon
TOX	Total Organic Halogens
OPHL	Occupational and Environmental Health Laboratory
ft/day	feet per day
gal/min	gallon per minute
AFFF	Aqueous Film Forming Foam
CB	Chlorobromomethane
BLS	Below Land Surface
ft/sec	feet per second
cm/sec	centimeter per second
ATV	All Terrain Vehicle
ID	Inside Diameter
PVC	Polyvinyl Chloride

EDM	Electronic Distance Meter
Cl	Chlorine
Br	Bromine
I	Iodine
ppm	part per million (also equivalent to milligrams per liter;- mg/l)
TAC	Tactical Air Command

TABLE A-2

LIST OF DEFINITIONS*

Alluvium	A general term for all detrital material deposited permanently or in transit by streams. It includes gravel, sand, silt, and clay, and all variations and mixtures of these.
Aqueoglacial	Resulting from or pertaining to the combined action of ice and water; as, many glacial deposits.
Aquiclude	A formation which, although porous and capable of absorbing water slowly, will not transmit it fast enough to furnish an appreciable supply for a well or spring.
Aquifer	A geologic formation or structure that transmits water in sufficient quantity to supply pumping wells or springs.
Artesian	Pertaining to underground water that is confined by impervious material under pressure sufficient to raise it above the upper level of the saturated material in which it lies if this is penetrated by wells or natural fissures.
Bed	Any tabular body of rock lying in a position essentially parallel to the surface or surfaces on or against which it was formed, whether these be a surface of weathering and erosion, plans of stratification, or inclined fractures.
Bedding	The arrangement of rock in layers, strata, or beds.
Bedrock	The more or less solid, undisturbed rock in place either at the surface or beneath superficial deposits of gravel, sand, or soil.
Bentonite	A rock composed of any of the montmorillonite-beidellite group of clay minerals.
Boulder	A large detached rock fragment, somewhat rounded or otherwise modified in shape by transport. A boulder is larger than a cobble, ten inches (256 mm.) having been suggested as a convenient lower limit for the diameter.

Calcareous	Consisting of or containing calcium carbonate.
Clay	A fine-grained aggregate consisting wholly or dominantly of microscopic and submicroscopic mineral particles, derived from the chemical decomposition of rocks, which is plastic when wet and hard when dry. The distinctive physical properties are due to the presence of clay minerals, which are hydrous aluminum silicates that break down into colloidal, exceedingly minute shreds or flaky particles.
Cobble	A rock fragment between 64 and 256 mm. diameter, thus larger than a pebble and smaller than a boulder, rounded or otherwise abraded in the course of transport by water, wind, or ice.
Cross-Section	A geologic diagram or actual field exposure showing the geologic formations and structures transected by a given plane.
Dip	The angle at which a stratum or any planar feature is inclined from the horizontal.
Effective Porosity	The portion of pore space in saturated permeable material in which movement of water takes place.
End Moraine	A ridgelike accumulation of drift built chiefly along the terminal margin of a valley glacier or the margin of an ice sheet. It has a surface form of its own and is the result chiefly of deposition by the ice, or deformation by ice thrust, or both.
Glaciation	The geologic work accomplished by ice, including erosion and deposition and the resulting effects of these processes on the surface.
Glacier	A body of ice consisting of recrystallized snow, lying wholly or largely on land, and showing evidence of present or former flow.
Gravel	Loose or unconsolidated coarse granular material, larger than sand grains, resulting from erosion of rock by natural agencies.
Groundwater	Subsurface water in a zone of saturation; phreatic water.

Hazardous Waste	A solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical or infectious characteristics may cause or significantly contribute to a increase in mortality or an increase in serious, irreverisble, or incapacitating reversible illness; or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.
Hydraulic Conductivity	The capacity of a rock or soil for transmitting water under pressure.
Lithology	The study of stones or rocks.
Moraine	An accumulation of drift with an initial topographic expression of its own, built within a glaciated region chiefly by the direct action of glacier ice.
Outwash	Detrital material removed from a glacier by meltwater and laid down by streams beyond the glacier itself.
Permeability	The property or state of being permeable, of allowing fluids and gases to pass through.
Piezometric Surface	An imaginary surface that everywhere coincides with the static level of the water in the aquifer.
Porosity	The property of a rock of containing interstices without regard to size, shape, interconnection, or arrangement of openings.
Shale	A general term for lithified muds, clays, and silts that are fissile and break along planes parallel to the original bedding.
Silt	Unconsolidated material finer than sand and coarser than clay.
Silt Loam	A type of soil having over half of the particles of the size called silt. The amount of material of sand or clay size is relatively small.

Solid Waste:	Any garbage, refuse, or sludge from a waste treatment plant, water supply treatment, or air pollution control facility and other discarded material, including solid, liquid, semi-solid, or contained gaseous material resulting from industrial, commercial, mining, or agricultural operations and from community activities, but does not include solid or dissolved materials in domestic sewage; solid or dissolved materials in irrigation return flows; industrial discharges which are point source subject to permits under Section 402 of the Federal Water Pollution Control Act, as amended (86 USC 880); or source, special nuclear, or by-product material as defined by the Atomic Energy Act of 1954 (68 USC 923).
Stratigraphy	The branch of geology that deals with the definition and interpretation of the stratified rocks, the conditions of sequence, age, distribution, and especially their correlation by the use of fossils and other means.
Strike	The direction or bearing of the outcrop of an inclined bed or structure on a level surface. It is perpendicular to the direction of the dip.
Swell-and-Swale	The type of topography characteristic of the ground moraine of a continental glacier.
Till	That part of glacial drift deposited directly by ice, without transportation or sorting by water, consisting generally of an unstratified, unsorted, unconsolidated to moderately consolidated, heterogeneous mixture of clay, sand, gravel, and boulders.
Topographic Map	A topographic map is a representation on paper that is designed to portray certain selected features of a section of the earth's surface plotted on some form of projection and to a certain scale; that primarily depicts the relief of the country mapped by shows also its drainage and cultural features; and that delineates all features in true latitude and longitude and therefore all parts in a rigidly correct relative position.

Water Table

A water table is the upper surface of a zone of saturation except where that surface is formed by an impermeable body.

Well Log

A systematic and sequential record of geologic data obtained from a well.

* Stokes, W.L. and D.J. Varnes, 1955.

APPENDIX B
SCOPE OF WORK

INSTALLATION RESTORATION PROGRAM

Phase IIB Field Evaluation

Hancock Field, New York

I. Description of Work:

The purpose of this task is to determine if environmental contamination has resulted from waste disposal practices at Hancock Field; to provide estimates of the magnitude and extent of contamination, should contamination be found; to identify any additional investigations and their attendant costs necessary to properly evaluate the magnitude, extent and direction of movement of discovered contaminants.

The Phase I IRP report (mailed under separate cover) incorporated background and description of the sites for this task. To accomplish the survey effort, the contractor shall take the following steps:

Ambient air monitoring of hazardous and/or toxic material and Air Force personnel shall be accomplished when necessary, especially during the drilling operation.

A. General

1. The contractor shall visit Hancock Field to acquire the necessary background material and to become familiar with the sites being investigated.
2. The contractor shall review the Phase I Records Search Report (mailed under separate cover) for Hancock Field to obtain an understanding of the problems being investigated.
3. Determine the areal extent of each site by reviewing available aerial photos of the base, both historical and the most recent panchromatic and infrared.
4. Locations where surface water samples are collected shall be marked with a permanent marker, and the location recorded on a project map for the zone.
5. Water sampling shall be accomplished only once at each location.
6. All water samples shall be analyzed on site by the contractor for pH, temperature and specific conductance. Sampling, maximum holding time and preservation of samples shall strictly comply with the following references: Examination of Water and Wastewater, 15th Ed. (1980), pp. 35-42; ASTM, Part 31, pp. 72-82, (1976), Method D-3370; and Methods for Chemical Analysis of Waters and Wastes, EPA Manual 600/4-79-020, pp. xiii to xix (1979).
7. Aquifer testing shall be conducted within each of the zones listed in "B" below to estimate the direction and rate of groundwater movement.

8. Field data collected for each zone shall be plotted and mapped. The nature of contamination and the magnitude and potential for contaminant flow within each zone to receiving streams and groundwaters shall be determined or estimated. Upon completion of the sampling and analysis, the data shall be tabulated in the next R&D Status Report as specified in Item VI below.

9. Wells shall be of sufficient depth to collect samples representative of aquifer quality and to intercept contaminants if they are present in the surface aquifer. The average depth of each well is anticipated to be 30 feet and shall be screened throughout the entire saturated thickness of the soil aquifer.

B. Conduct the following specific actions at sites identified at Hancock Field.

1. Zone 2. Disposal Sites D-3 and D-1

a. Install a maximum of six groundwater monitoring wells within this zone.

b. Collect one groundwater sample from each well.

c. Each groundwater sample shall be analyzed for total organic carbon, total organic halogen (ASTM Sec II Vol 11.02) and oils and greases using IR Method. The required limits of detection for the above analyses is given in attachment 1. Three of the groundwater samples collected shall be analyzed by the contractor for volatile aromatic and volatile halocarbon compounds using GC techniques.

d. Collect three surface water samples from the culvert adjacent to Site D-3. Analyze the surface water samples collected for total organic carbon, total organic halogen (ASTM Sec II Vol 11.02) and oil and grease using IR Method. The required limits of detection for the above analyses is given in attachment 1. One surface water sampling location (the most downstream sampling location) shall also be analyzed for volatile aromatics and volatile halocarbon compounds using GC techniques.

e. Collect a maximum of three sediment samples from the culvert adjacent to Site D-3. Analyze each sediment sample collected for oils and greases using IR Method and total organic halogen (ASTM Sec II Vol 11.02). The required limits of detection for the above analyses is given in attachment 1. One sediment sample shall be analyzed for volatile aromatic and volatile halocarbon compounds using GC techniques.

2. Zone 1. Fire Training Area (Site FT-1) and Disposal Site (D-5)

a. Install a maximum of five groundwater monitoring wells within this zone.

b. Collect one groundwater sample from each well.

c. Each groundwater sample shall be analyzed for total organic carbon, total organic halogen (ASTM Sec II Vol 11.02) and oil and grease using IR Method. The required limits of detection for the above analyses is given in attachment 1. Three of the groundwater samples collected shall be analyzed by the contractor for volatile aromatic and volatile halocarbon compounds using GC techniques.

d. Collect a maximum of six sediment samples from the runoff area along the northern perimeter of the zone. Each sediment sample shall be analyzed for oil and grease using IR Method and total organic halogen (ASTM Sec II Vol 11.02). The required limits of detection for the above analyses is given in attachment 1. Two sediment samples shall be analyzed for volatile aromatic and volatile halocarbon compounds using GC techniques.

e. Collect five surface water samples from the runoff area north of sites FT-1 and D-5. Each surface water sample shall be analyzed for total organic carbon, total organic halogen (ASTM Sec II Vol 11.02) and oil and grease using IR Method. The required limits of detection for the above analyses is given in attachment 1. One surface water sample (the most downstream sampling location) shall also be analyzed for volatile aromatics and volatile halocarbons using GC techniques.

C. A combined maximum of ten groundwater monitoring wells shall be installed in zones 1 and 2.

D: Well Installation and Cleanup

Well installations shall be cleaned up following the completion of the well. Drill cuttings shall be removed and the general area cleaned. The exact location of wells in each zone shall be determined in the field.

E. Data Review

Results of sampling and analysis shall be tabulated and incorporated as they become available in the R&D Status Reports and forwarded to the USAF OEHL for review as specified in Item VI below.

F. Reporting

1. A draft report delineating all findings of this field investigation shall be prepared and forwarded to the USAF OEHL as specified in Item VI below for Air Force review and comment. This report shall include a discussion of the regional hydrogeology, well logs of all project wells, data from water level surveys, aquifer test results and conclusions, water quality analysis results, available geohydrologic cross sections, groundwater surface and gradient vector maps, vertical and horizontal flow vectors and laboratory quality assurance information. The report shall follow the USAF OEHL supplied format (mailed under separate cover).

2. Estimates shall be made of the magnitude, extent and direction of movement of contaminants discovered. Potential environmental consequences of discovered contamination shall be identified or estimated.

3. Specific requirements, if any, for future groundwater and surface water monitoring must be identified.

G. Quality Assurance

The quality assurance specified in Section H, para (xxi) of the contract is applicable to this order.

II. Site Location and Dates:

Hancock Field NY
(Syracuse-Hancock International Airport)
USAF Clinic/SGPAE
Dates to be Established

III. Base Support: None

IV. Government Furnished Property: None

V. Government Points of Contact:

- | | |
|---|---|
| 1. Capt Robert Bauer
USAF OEHL/CVT
Brooks AFB TX 78235
(512) 536-2158
AV 240-2158 | 2. Col Jerry Dougherty
HQ TAC/SGPAE
Langley AFB VA 23665
(804) 764-2180
AV 432-2180 |
| 3. USAF Clinic Hancock
Hancock AFB NY
(315) 458-5500, Ext 3566
AV 587-9566 | |

VI. In addition to sequence numbers 1, 5 and 11 listed in Atch 1 to the contract, which are applicable to all orders, the sequence number listed below are applicable to this order. Also shown are data applicable to this order.

Sequence Nr	Block 10	Block 11	Block 12	Block 13	Block 14
4	ONE/R	6 MAC	6 MAC	9 MAC	*

*Contractor shall supply the USAF OEHL with 15 copies of the draft report and 50 copies plus the original camera ready copy of the final report.

REQUIRED LIMITS OF DETECTION
FOR ANALYSES

Total Organic Carbon - 1 milligram/l

Oils and Grease (IR Method) - 0.10 milligram/l (waters)

- 100 micrograms/gram (sediment or soil)

Total Organic Halogen (TOX) - 5 microgram/l

Volatile Aromatic and Volatile Halocarbons - Detection limits as specified
for compounds listed in EPA Methods 601 and 602.

APPENDIX C

PUMP TESTS

A plot of field recovery data, $H - h$ versus t , should therefore show an exponential decline in recovery rate with time. If, as shown on Figure 8.20(b), the recovery is normalized to $H - H_0$ and plotted on a logarithmic scale, a straight-line plot results. Note that for $H - h/H - H_0 = 0.37$, $\ln(H - h/H - H_0) = -1$, and from Eq. (8.33), $T_0 = t$. The basic time lag, T_0 , can be defined by this relation; or if a more physical definition is desired, it can be seen, by multiplying both top and bottom of Eq. (8.32) by $H - H_0$, that T_0 is the time that would be required for the complete equalization of the head difference if the original rate of inflow were maintained. That is, $T_0 = V/q_0$, where V is the volume of water removed or added.

To interpret a set of field recovery data, the data are plotted in the form of Figure 8.20(b). The value of T_0 is measured graphically, and K is determined from Eq. (8.32). For a piezometer intake of length L and radius R [Figure 8.20(a)], with $L/R > 8$, Hvorslev (1951) has evaluated the shape factor, F . The resulting expression for K is

$$K = \frac{r^2 \ln(L/R)}{2LT_0} \quad (8.34)$$

Pump Test Data and Analysis

Well No.: GW-4

H: 35.64 ft.

H_o: 27 ft.

	$H-h_z/H-H_o$	t (sec)
h ₁	.13	1797
h ₂	.19	984
h ₃	.31	445
h ₄	.42	189
h ₅	.54	87
h ₆	.65	44
h ₇	.77	21
h ₈	.88	9
h ₉	1.00	0
h ₁₀		
h ₁₁		
h ₁₂		
h ₁₃		
h ₁₄		
h ₁₅		
h ₁₆		
h ₁₇		
h ₁₈		
h ₁₉		
h ₂₀		

Regression Analysis

Correlation: -.9276

Slope : -.0011

Intercept : -.3745

T_o : 582.4

$K=(r^2) \ln(LR) / 2LT_o$: 1.64×10^{-6} ft/sec

Pump Test Data and Analysis

Well No.: GW-6

H: 24.89 ft.

H_o: 32.0 ft.

	$H-h_z / H-H_o$	t (sec)
h ₁	0.859	8.9
h ₂	0.719	26.6
h ₃	0.578	49.6
h ₄	0.437	97.6
h ₅	0.297	205.6
h ₆	0.156	774.6
h ₇		
h ₈		
h ₈		
h ₉		
h ₁₀		
h ₁₁		
h ₁₂		
h ₁₃		
h ₁₄		
h ₁₅		
h ₁₆		
h ₁₇		
h ₁₈		
h ₁₉		
h ₂₀		

Regression Analysis

Correlation: -0.9201

Slope : -0.002

Intercept : -0.438

T_o : 280.9

$K=(r^2) \ln(LR) / 2LT_o$: 3.4×10^{-6} ft/sec

Pump Test Data and Analysis

Well No.: GW-7

H: 21.02 ft.

H_o: 30.72 ft.

	$H-h_z/H-H_o$	t (sec)
h ₁	-.1087	8.4
h ₂	-.2306	17.8
h ₃	-.3696	29.7
h ₄	-.5310	44.4
h ₅	-.7346	64.4
h ₆	-.9649	88.4
h ₇	-1.2801	126.4
h ₈	-1.7429	185.4
h ₉	-2.6311	329.9
h ₁₀		
h ₁₁		
h ₁₂		
h ₁₃		
h ₁₄		
h ₁₅		
h ₁₆		
h ₁₇		
h ₁₈		
h ₁₉		
h ₂₀		

Regression Analysis

Correlation: -.9924

Slope : -.0078

Intercept : -.1725

T_o : 104.59

$K=(r^2) \ln(LR)/2LT_o$: 9.1×10^{-6} ft/sec

Pump Test Data and Analysis

Well No.: GW-8

H: 19.1 ft.

H_o: 29.3 ft.

	$H-h_z/H-H_o$	t (sec)
h_1	0.902	1
h_2	0.804	8
h_3	0.706	14
h_4	0.608	25
h_5	0.510	38
h_6	0.412	55
h_7	0.314	78
h_8	0.216	115
h_9	0.118	178
h_{10}	0.020	520
h_{11}		
h_{12}		
h_{13}		
h_{14}		
h_{15}		
h_{16}		
h_{17}		
h_{18}		
h_{19}		
h_{20}		

Regression Analysis

Correlation: -.976

Slope : -.007

Intercept : -.401

T_o : 82.10

$K=(r^2) \ln(LR)/2LT_o$: 1.2×10^{-5} ft/sec

Pump Test Data and Analysis

Well No.: GW-9

H: 20.6 ft.

H_o: 31.1 ft.

	$H-h_z / H-H_o$	t (sec)
h ₁	0.915	12
h ₂	0.871	24
h ₃	0.822	39
h ₄	0.757	61
h ₅	0.681	90
h ₆	0.605	122
h ₇	0.539	154
h ₈	0.457	204
h ₉	0.408	242
h ₁₀	0.360	279
h ₁₁	0.307	328
h ₁₂	0.257	384
h ₁₃	0.197	478
h ₁₄	0.150	576
h ₁₅	0.109	691
h ₁₆	0.065	892
h ₁₇		
h ₁₈		
h ₁₉		
h ₂₀		

Regression Analysis

Correlation: -0.998

Slope : -0.003

Intercept : -0.124

T_o : 285.79

$K=(r^2) \ln(LR) / 2LT_o$: 3.4×10^{-6} ft/sec

Pump Test Data and Analysis

Well No.: GW-10

H: 27.87 ft.

H_o: 30.68 ft.

	$H-h_z/H-H_o$	t (sec)
h ₁	0.644	70
h ₂	0.466	129.5
h ₃	0.288	241
h ₄	0.110	519.4
h ₅		
h ₆		
h ₇		
h ₈		
h ₉		
h ₁₀		
h ₁₁		
h ₁₂		
h ₁₃		
h ₁₄		
h ₁₅		
h ₁₆		
h ₁₇		
h ₁₈		
h ₁₉		
h ₂₀		

Regression Analysis

Correlation: -0.997
 Slope : -0.004
 Intercept : -0.2398
 T_o : 195.9

$K=(r^2) \ln(LR)/2LT_o$: 4.89×10^{-6} ft/sec

APPENDIX D

WELL LOGS

JRB ASSOCIATES

A Company of Science Applications, Inc.
8400 Westpark Drive, McLean, Virginia 22102

WELL CONSTRUCTION SUMMARY

Project: Hancock Field Owner: U.S Air Force Well No.: GW-5

Drilling Summary:

Total Depth: 36.5' BLS Drillers: Empire Soil
 Borehole Diameter(s): _____ (R. Bush) _____
 _____ 6" Rig Type: CME-45
 Elevation: Land Surface: 393.7' Bit(s): Auger
 Top of Casing: 390.0' Drilling Fluid Type: water
 Supervisory Geologist: A. Lapins Amount Use: _____
 Log Book No. 1 pp. 25-31 Water Level: 390.6'

Well Design:

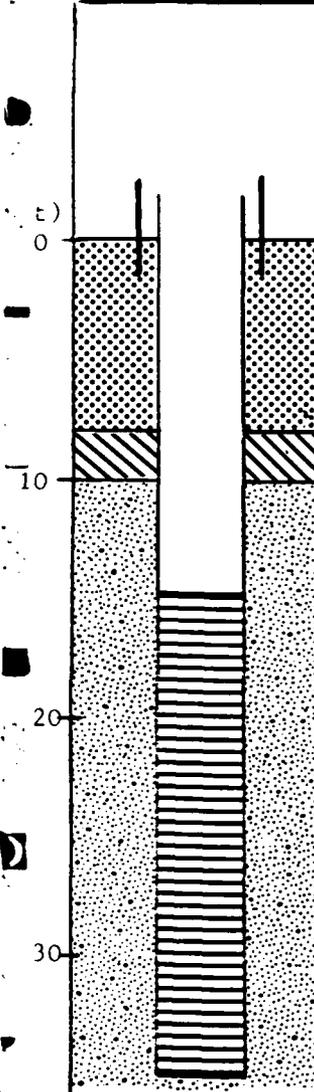
Casing: Material: PVC Screen: Material: PVC
 Diameter: 2" ID- 2 1/4" OD Diameter: 2"
 Length: 18' Slot: .02" slot
 Filter: Material: 4 Q sand Setting: 15'-35' BLS
 Setting: 10'-36.5' BLS Seals: Type: Bentonite/clay
 Grout: Type: #1 Portland Cement Setting: 8'-10' BLS/5'-8' BLS
 Setting: LS-5' BLS Surface Casing: PVC/steel
 Other: 3' of clay seal on top of bentonite to help stop anular flow

Time Log:

	Started	Completed
Drilling:	<u>9/10/83 0938 hr</u>	<u>9/10/83 1118 hr</u>
Installation:	<u>9/10/83 1328 hr</u>	<u>9/12/83</u>
Water Level Reading:	<u>6' BLS</u>	<u>3.1' ALS</u>
Development :	<u>9/12/83 1139 hr</u>	<u>9/12/83 1227 hr</u>

Well Development:

Method/Equipment: pump/drill rig pump
 Static Depth to Water: 3.1' ALS - Artesian
 Pumping Depth to Water: _____
 Pumping Rate: 10 gpm
 Volume Pumped: 480 gal.

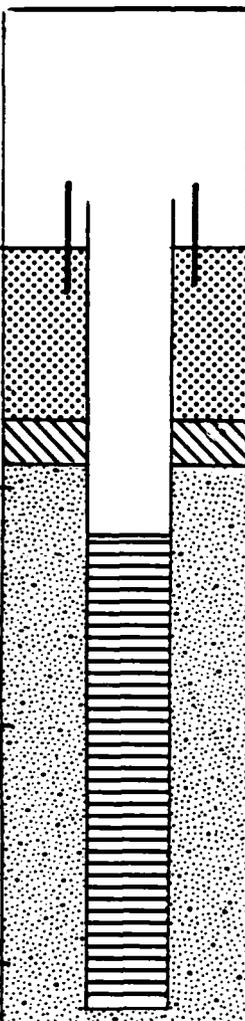


Depth (feet)	Graphic Log	Sample type and Number	Blow Count (N)	DESCRIPTION
10		SS#2	1	plastic.
			1	
			1	
15		SS#3		S.I. 14.5-16.5' BLS Rec. 1.8'
		WOH		1.8' soft gray clay (10 YR 5/1); very fine sand and clay laminations; wet; plastic; weight of hammer drove splitspoon 2' (WOH)
		"		
		"		
		"		
20		SS#4		S.I. 19.5-21.5' BLS Rec. 1.9'
		WOH		1.9' soft clay, some silt and very fine sand, grayish brown (2.5 Y 5/2); saturated; slightly plastic; weight of hammer drove split spoon 2'.
		"		
		"		
		"		
25		SS#5		S.I. 24.5-26.5' BLS Rec. 2'
		WOH		1.55' very fine sand and clay; grayish brown

Depth (feet)	Graphic Log	Sample type and Number	Blow Count (N)	DESCRIPTION
25		SS#5	1	(10 YR 5/2); wet.
			1	.3' fine sand, some clay; dark reddish brown
			2	(2.5 YR 3/4); wet.
				.15' very fine sand, trace clay; very dark grayish brown (2.5 Y 3/2); wet.
30		SS#6		S.I. 29.5-31.5' BLS Rec. 2.0'
			3	.55' cave in material: fine gray and reddish brown sand and
			4	clay (mixed).
			4	1.45' medium sand and gravel grading to fine sand: dark gray
			5	(10 YR 4/1); large pebbles in gravel @
				.05' diam.; .005' reddish brown laminae through center; wet
35		SS#7		S.I. 34.5-36.5' BLS Rec. 2.0'
			2	1.05' cave in material; fine gray and reddish
			3	brown sand and clay (mixed); wet.
			4	.75' fine to medium sand, trace clay; very
			5	dark gray (10 YR 3/1); wet.
				.2' very fine to fine sand, trace clay; dark gray (10 YR 4/1); wet.

WELL CONSTRUCTION SUMMARY

Project: Hancock Field Owner: U.S. Air Force Well No.: GW-4



Drilling Summary:

Total Depth: 35' BLS Drillers: Empire
 Borehole Diameter(s): 6" (R. Bush)
 Rig Type: CME-55
 Elevation: Land Surface: 390.1' Bit(s): Auger
 Top of Casing: 392.0' Drilling Fluid Type: water
 Supervisory Geologist: A. Wickline Amount Use: _____
 Log Book No. 2 pp. 17-21 Water Level: 390.6'

Well Design:

Casing: Material: PVC Screen: Material: PVC
 Diameter: 2" ID 2 1/4" OD Diameter: 2"
 Length: 15' Slot: .02"
 Filter: Material: 4 Q sand Setting: 13'-33' BLS
 Setting: 10'-35' BLS Seals: Type: Bentonite
 Grout: Type: #1 Portland Cement Setting: 8'-10' BLS
 Setting: LS-8' BLS Surface Casing: pvc/steel
 Other: _____

Time Log:

	Started	Completed
Drilling:	9/10/83 1028 hr	9/10/83 1259 hr
Installation:	9/10/83 1318 hr	9/12/83 0853 hr
Water Level Reading:	12.5' BLS	.06' ALS
Development :	8/15/83 1120 hr	8/15/83 1415 hr

Well Development:

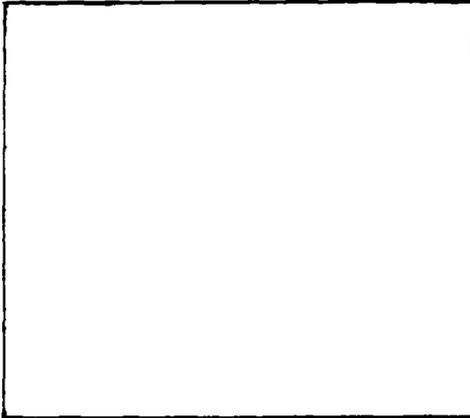
Method/Equipment: pump on drill rig
 Static Depth to Water: .06' ALS
 Pumping Depth to Water: 15.4 BLS
 Pumping Rate: 2 gpm
 Volume Pumped: 310 gal.

JRB ASSOCIATES

A Company of Science Applications, Inc.
8400 Westpark Drive, McLean, Virginia 22102

DRILLING LOG

Project: Hancock Field Owner: U.S. Air Force Well No.: GW-4



Site Sketch

Location: _____ Field Book No.: 2 pp 17-21
 _____ Log By: A. Wickline
 _____ Driller: Empire (R. Bush)
 _____ Rig Type: CME-55
 Reference Point: _____ Total Depth: Auger

Reference Point Elevation: _____ Date Time
 Drilling Started: 9/10/83 1028hr
 Drilling Completed: 9/10/83 1259hr
 Water Level: 390.6'

Depth (feet)	Graphic Log	Sample Type and Number	Blow Count (N)	Legend	DESCRIPTION
				S.I. Sampling Interval Rec. Recovery Grain Size and 50 to 40% some 40 to 10% trace 10% or less	
0					
					Cuttings: dark brown silt and fine sand
5		SS#1		S.I. 5-6.5' BLS Rec. 1.5'	
		2		.35' fine sand and silt with clay and	
		3		silt laminations; dark brown	
		5		(10 YR 3/3); dry.	
				1.15' clay, some silt, trace fine sand;	
				dark brown (10 YR 3/3); dry; some	
				mottling; increased density.	
10		SS#2		S.I. 10-11.5' BLS Rec. 1.3'	

JRB ASSOCIATES

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WELL CONSTRUCTION SUMMARY

Project: Hancock Field Owner: U.S. Air Force Well No.: CW-6

Drilling Summary:

Total Depth: 70.3' BLS Drillers: Empire Soil
 Borehole Diameter(s): 6" (R. Bush)
 Rig Type: CME-45
 Elevation: Land Surface: 394.8' Bit(s): Auger
 Top of Casing: 397.3' Drilling Fluid Type: water
 Supervisory Geologist: A. Lapins Amount Use: _____
 Log Book No. 1 pp. 1-14 Water Level: 389.2'

Well Design:

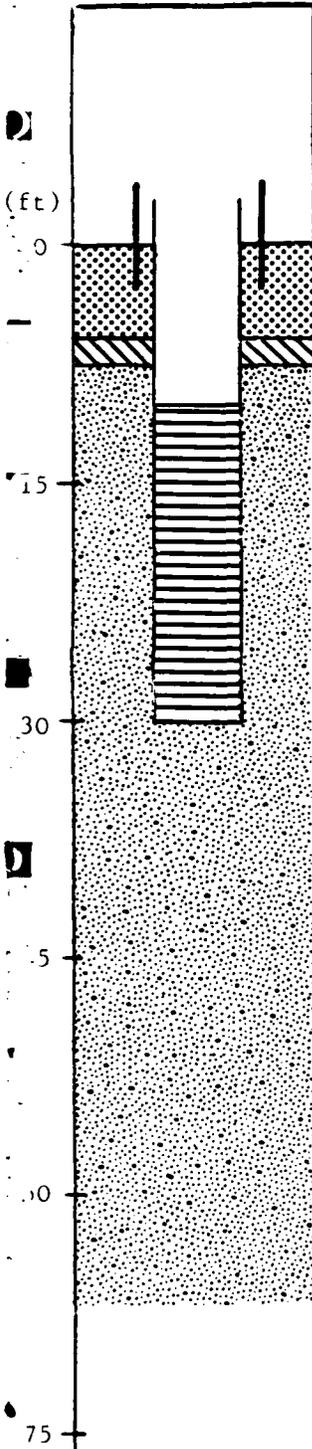
Casing: Material: PVC Screen: Material: PVC
 Diameter: 2" ID-2 1/4" OD Diameter: 2"
 Length: 12.2' Slot: 10/inch, .02" slot
 Filter: Material: 4 Q sand Setting: 10'-30' BLS
 Setting: 7'-70.3' BLS Seals: Type: Bentonite
 Grout: Type: #1 Portland Cement Setting: 5'-7' BLS
 Setting: LS-5' BLS Surface Casing: PVC/steel
 Other: _____

Time Log:

	Started	Completed
Drilling:	<u>9/7/83 1435 hr</u>	<u>9/8/83 1629 hr</u>
Installation:	<u>9/9/83 1045 hr</u>	<u>9/10/83 0746 hr</u>
Water Level Reading:	<u>6' BLS</u>	<u>5.6' BLS</u>
Development:	<u>9/12/83 1546 hr</u>	<u>9/12/83 1624 hr</u>

Well Development:

Method/Equipment: pump/homelite 111521A centrif. pump
 Static Depth to Water: 5.6' BLS
 Pumping Depth to Water: 29.5' BLS
 Pumping Rate: 2.8 gpm
 Volume Pumped: 112 gals.



DRILLING LOG

GW-6 (cont'd)

Depth (feet)	Graphic Log	Sample Type and Number	Blow Count (N)	DESCRIPTION
0		SS#2	1	(10 YR 4/2 saturated).
			2	
			1	
		SS#3		S.I. 14.5-16.5' BLS Rec. 0.7'
			1	0.7' very fine sand; loose; dark grayish
			1	brown (10 YR 4/2 saturated).
			2	
		SS#4		S.I. 19.5-21.5' BLS Rec. 0.8'
			2	0.8' very fine sand grading to medium sand; loose;
			3	dark gray to dark grayish brown (10 YR 4/1;
			4	4/2 saturated).
		SS#5		S.I. 24.5-26.5' BLS Rec. 1.9'
5			4	1.3' very fine sand grading to coarse sand

Depth (feet)	Graphic Log	Sample type and Number	Blow Count (N)	DESCRIPTION
25			3	and gravel; dark grayish brown (10 YR 4/2, saturated); loose
			3	.6' very dark grayish brown till (10 YR 3/2,
			4	wet); very fine to coarse sand and silt
				trace clay with large (.05' diam.) subangular cobbles; dense; stiff.
		SS#6		S.I. 29.5-31.5' BLS Rec. 1.9'
30			7	.8' very dark grayish brown till (10 YR 3/2 moist);
			11	very fine to coarse sand and silt, some gravel,
			15	trace clay; subangular pebbles; dense; stiff.
			17	Note: sample included cave-in material of very fine to coarse sand and gravel.
		SS#7		S.I. 32.5-34.5' BLS Rec. 1.9'
			3	.6' very dark grayish brown till (10 YR 3/2 moist);
			3	very fine to coarse sand and silt, some gravel,
			3	trace clay, subangular pebbles; dense.
			6	1.3' very fine sand some silt; dark grayish brown (10 YR 4/2 saturated); loose.
35				
				Driller reports change in lithology 35.5' BLS, "harder layer"
				Driller reports change in lithology at 37' BLS "softer layer" cuttings: coarse sand some silt.
		SS#8		S.I. 39.5-41.5 BLS Rec. 2.0'
40			9	1.12' medium to coarse sand and silt some

DRILLING LOG

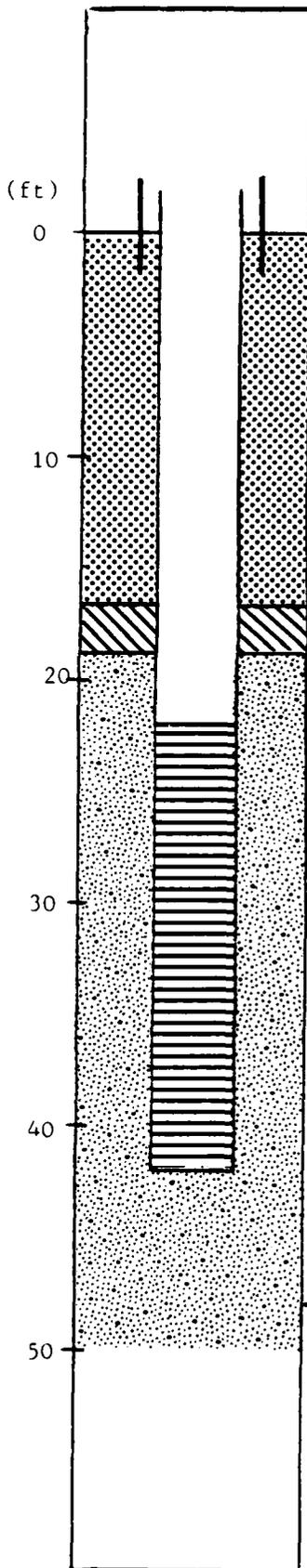
GW-6 (cont'd)

Depth (feet)	Graphic Log	Sample type and Number	Blow Count (N)	DESCRIPTION
		SS#8	10	gravel, trace clay, dark gray (5 YR 4/1, saturated);
			9	loose.
			9	.88' weak red till (2.5 YR 5/2, wet); very fine to coarse sand and silt, some gravel, trace clay; slightly plastic.
		SS#9		S.I. 44.5-46.5' BLS Rec. 1.8'
			3	.85' dark gray till (5 YR 4/1, moist); very fine to coarse
			5	sand and silt, some gravel, trace clay; with
			5	several subangular pebbles (.05' diam.);
			8	dense; stiff.
				.95' reddish brown till (5 YR 4/3 wet); very
				fine to coarse sand and silt, some clay and
				gravel; subangular pebbles (.05' diam.);
				medium soft, slightly plastic.
			SS#10	
			8	1.2' reddish brown till (5 YR 4/3, moist to wet);
			11	very fine to coarse sand and silt, some clay and
			15	gravel; subangular to angular pebbles; medium soft, slightly plastic.
		SS#11		S.I. 54.5-56.5' BLS REc. 1.55'
			1	1.55' very fine sand and silt, trace clay; reddish

Depth (feet)	Graphic Log	Sample type and Number	Blow Count (N)	DESCRIPTION
55		SS#11	1	brown (5 YR 4/3, wet); slightly plastic;
			1	medium stiff.
			3	
		SS#12		S.I. 59.5-61.5' BLS Rec. 1.8'
			19	1.1' very fine sand, some silt; reddish brown
60			27	(5 YR 4/3, wet).
			35	.17' coarse sand and gravel, trace silt; reddish brown (5 YR 4/3, wet), loose.
				.10' very fine sand, some silt; reddish brown (5 YR 4/3, wet).
				.10' coarse sand and gravel, trace silt; reddish brown (5 YR 4/3, wet); loose.
				.02' very fine sand, some silt; reddish
		SS#13		brown (5 YR 4/3, wet).
			15	.31' coarse sand and gravel, trace silt; reddish
65			40	brown (5 YR 4/3, wet); loose.
			49	
			72	S.I. 64.5-66.5' BLS Rec. 2.0'
				.73' very fine to fine sand, some silt; reddish brown (5 YR 4/3, wet).
				1.26' dark gray till (5 YR 4/1, moist); very fine to coarse sand and silt, some gravel, trace clay; subangular pebbles; dense, stiff.
		SS#14		S.I. 69.5-70.3' Rec. .8'
70			91	.8' dark reddish gray till (5 YR 4/2, moist to

WELL CONSTRUCTION SUMMARY

Project: Hancock Field Owner: U.S. Air Force Well No.: GW-2



Drilling Summary:

Total Depth: 50' BLS Drillers: Empire Soil
 Borehole Diameter(s): 6" (R. Bush)
 Rig Type: CME-55
 Elevation: Land Surface: 413.4' Bit(s): Auger
 Top of Casing: 415.6' Drilling Fluid Type: Water
 Supervisory Geologist: A. Wickline Amount Use: _____
 Log Book No. 2 pp. 3-11 Water Level: 391.6

Well Design:

Casing: Material: PVC Screen: Material: PVC
 Diameter: 2" ID- 2 1/4" OD Diameter: 2"
 Length: 24' Slot: .02"
 Filter: Material: 4 Q sand Setting: 22'-42' BLS
 Setting: 19'-50' BLS Seals: Type: Bentonite
 Grout: Type: #1 Portland Cement Setting: 17'-19' BLS
 Setting: LS-17' BLS Surface Casing: PVC/steel
 Other: _____

Time Log:

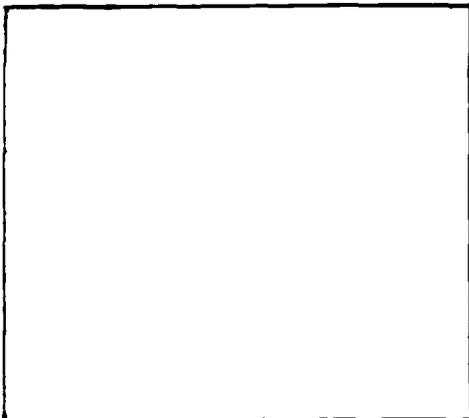
	Started	Completed
Drilling:	<u>9/8/83 1811 hr</u>	<u>9/9/83 1641 hr</u>
Installation:	<u>9/9/83 1100 hr</u>	<u>9/10/83 0854 hr</u>
Water Level Reading:	<u>20.6' BLS</u>	<u>21.9' BLS</u>
Development :	<u>9/15/83 1001 hr</u>	<u>9/15/83 1110 hr</u>

Well Development:

Method/Equipment: Pump on drill rig
 Static Depth to Water: 21.9' BLS
 Pumping Depth to Water: 22.5' BLS
 Pumping Rate: varied
 Volume Pumped: 120 gal.

DRILLING LOG

Project: Hancock Field Owner: U.S Air Force Well No.: GW-2



Site Sketch

Location: _____ Field Book No.: 2 pp 3-11

Log By: A. Wickline

Driller: Empire (R. Bush)

Rig Type: CME-55

Reference Point: _____ Total Depth: 50' BLS

Reference Point _____ Date _____ Time _____

Elevation: _____ Drilling Started: 9/8/83 0811 hr

Drilling Completed: 9/9/83 1641 hr

Water Level: 391.6'

Depth (feet)	Graphic Log	Sample Type and Number	Blow Count (N)	Legend	DESCRIPTION
				S.I. Sampling Interval Rec. Recovery Grain Size and 50 to 40% some 40 to 10% trace 10% or less	
0					Surface material: brown silt, sand and gravel; large cobbles.
5		SS#1		S.I. 5.0-6.5' BLS	Rec. 1.4'
			13		1.4' fine to coarse sand and gravel,
			34		some silt, some clay; many large
			104		cobbles (diam. > 1"); dark brown
					(10 YR 3/4); dry.
10		SS#2		S.I. 10-11.1' BLS	Rec. 0.9'

Depth (feet)	Graphic Log	Sample type and Number	Blow Count (N)	DESCRIPTION
10			16	.9' Gravel, some sand and silt; yellowish
			66	brown (10 YR 5/4); dry.
			100/.1	
				12'-13' BLS - large boulder
15		SS#3		S.I. 15' Rec. 0
			100/.2	Large boulder
20		SS#4		S.I. 20-21.5' BLS Rec. 0.8'
			17	.8' Gravel, some sand and silt; large
			20	cobbles (>2" diam.); light olive brown
			14	(2.5Y 5/4); moist
25		SS#5		S.I. 25-26.5' BLS Rec. 0.8'

Depth (feet)	Graphic Log	Sample type and Number	Blow Count (N)	DESCRIPTION
40			27	1.3' same as above
			30	
			32	
		SS#9		S.I. 45-46.5' BLS Rec. 1.4'
45			33	1.4' gravel, some sand and silt, trace
			36	clay; dark gray (5Y 4/1); wet.
			73	
		SS#10		S.I. 50-51.5' BLS Rec. 1.3'
50			41	1.3' same as above
			67	
			43	
55				

WELL CONSTRUCTION SUMMARY

Project: Hancock Field Owner: U.S. Air Force Well No.: GW-3

Drilling Summary:

Total Depth: 32' BLS Drillers: Empire Soil
 Borehole Diameter(s): 6" (R. Bush)
6" Rig Type: CME-55
 Elevation: Land Surface: 402.8' Bit(s): Auger
 Top of Casing: 404.7' Drilling Fluid Type: Water
 Supervisory Geologist: A. Wickline Amount Use: _____
 Log Book No. 2 pp. 26-30 Water Level: 391.5'

Well Design:

Casing: Material: PVC Screen: Material: PVC
 Diameter: 2" ID 2 1/4"OD Diameter: 2"
 Length: 13.9' Slot: .02"
 Filter: Material: 4 Q sand Setting: 12'-32' BLS
 Setting: 9'-32' BLS Seals: Type: Bentonite
 Grout: Type: #1 Portland Cement Setting: 7'-9' BLS
 Setting: LS-7' BLS Surface Casing: PVC/Steel
 Other: _____

Time Log:

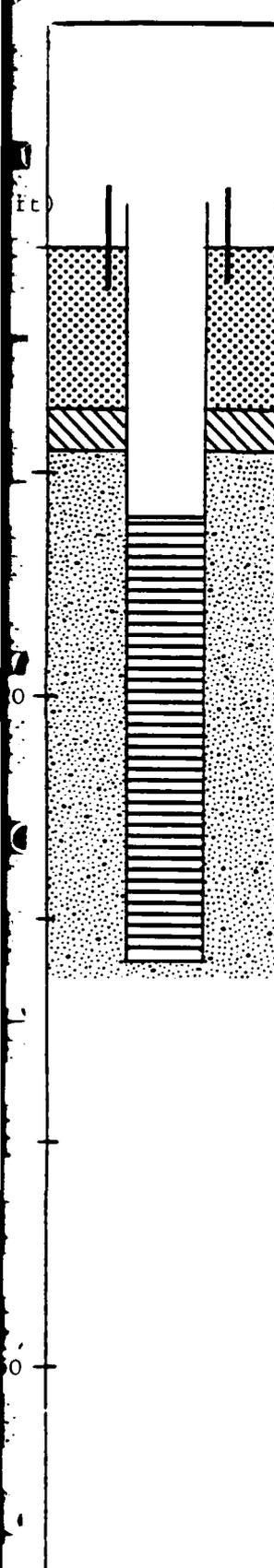
Started

Completed

	Started	Completed
Drilling:	<u>9/12/83 1252 hr</u>	<u>9/12/83 1403 hr</u>
Installation:	<u>9/12/83 1445 hr</u>	<u>9/13/83 0801 hr</u>
Water Level Reading:	<u>11. BLS</u>	<u>11.3' BLS</u>
Development :	<u>9/15/83 1430 hr</u>	<u>9/15/83 1510 hr</u>

Well Development:

Method/Equipment: pump on drill rig
 Static Depth to Water: 11.3' BLS
 Pumping Depth to Water: 11.9' BLS
 Pumping Rate: 7 gpm
 Volume Pumped: 280 gal.

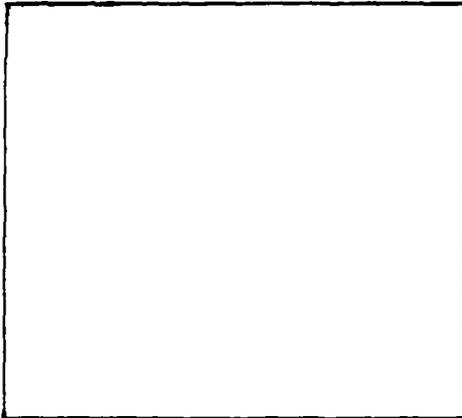


JRB ASSOCIATES

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DRILLING LOG

Project: Hancock Field Owner: U.S. Air Force Well No.: GW-3



Site Sketch

Location: _____ Field Book No.: 2 pp26-31
 _____ Log By: A. Wickline
 _____ Driller: Empire (R. Bush)
 _____ Rig Type: Auger

Reference Point: _____ Total Depth: 32' BLS

Reference Point Elevation: _____ Date Time Drilling Started: 9/12/83 1252hr

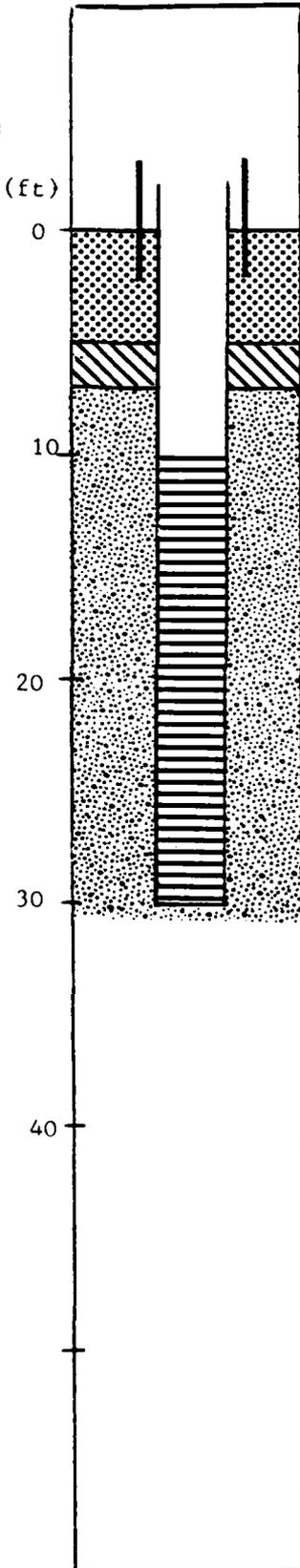
Drilling Completed: 9/12/83 1412hr

Water Level: 391.5'

Depth (feet)	Graphic Log	Sample Type and Number	Blow Count (N)	Legend	
				S.I. Sampling Interval	DESCRIPTION
0				Rec. Recovery	
				Grain Size	
				and 50 to 40%	
				some 40 to 10%	
				trace 10% or less	
5		SS#1		S.I. 5-6.5' BLS	Rec. 1.25'
		6		1.25' fine sand, some sand and clay;	
		6		dark brown (10 YR 4/3); moist;	
		10		semi-plastic	
10		SS#2		S.I. 10-11.5' BLS	Rec. 1.2'

WELL CONSTRUCTION SUMMARY

Project: Hancock Field Owner: U.S. Air Force Well No.: GW-10



Drilling Summary:

Total Depth: 30' BLS Drillers: Empire Soil
 Borehole Diameter(s): 6" (R. Bush)
 Rig Type: CME-45
 Elevation: Land Surface: 392.3' Bit(s): Auger
 Top of Casing: 394.3' Drilling Fluid Type: water
 Supervisory Geologist: A. Lapins Amount Use: _____
 Log Book No. 1 pp. 51-54 Water Level: 390.5'

Well Design:

Casing: Material: PVC Screen: Material: PVC
 Diameter: 2" ID 2 1/4" OD Diameter: 2"
 Length: 12' Slot: .02"
 Filter: Material: 4Q sand Setting: 10'-30' BLS
 Setting: 7'-30' BLS Seals: Type: Bentonite
 Grout: Type: #1 Portland Cement Setting: 5'-7' BLS
 Setting: LS-5' BLS Surface Casing: PVC/steel
 Other: _____

Time Log:

	Started	Completed
Drilling:	<u>9/14/83 0925 hr</u>	<u>9/14/83 1010 hr</u>
Installation:	<u>9/14/83 1024 hr</u>	<u>9/14/83 1255 hr</u>
Water Level Reading:	<u>6' BLS</u>	<u>1.8' BLS</u>
Development:	<u>9/14/83 1435 hr</u>	<u>9/14/83 1718 hr</u>

Well Development:

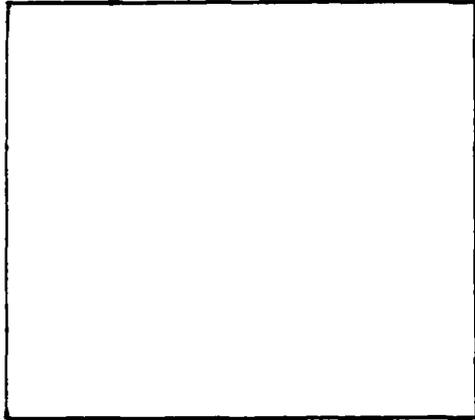
Method/Equipment: pump/homelite 11152 1A centrif. pump
 Static Depth to Water: 1.8' BLS
 Pumping Depth to Water: 8.0' BLS
 Pumping Rate: varied
 Volume Pumped: 100 gal.

JRJB ASSOCIATES

A Company of Science Applications, Inc.
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DRILLING LOG

Project: Hancock Field Owner: U.S. Air Force Well No.: GW-10



Site Sketch

Location: _____ Field Book No.: 1 PP 51-54

Log By: A. Lapins

Driller: Empire (R. Bush)

Rig Type: CME-45

Reference Point: _____ Total Depth: 30' BLS

Reference Point Elevation: _____ Date Time

Drilling Started: 9/14/83 0925 hr

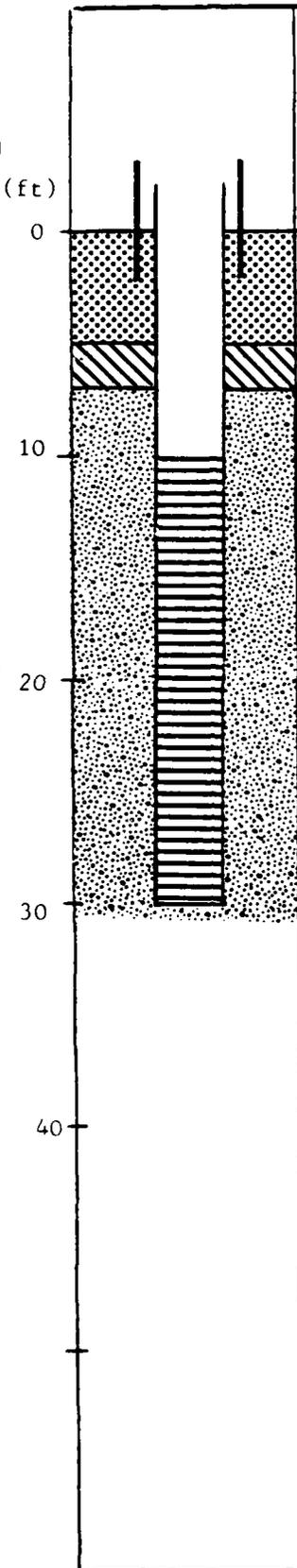
Drilling Completed: 9/14/83 1010

Water Level: 390.5'

Depth (feet)	Graphic Log	Sample Type and Number	Blow Count (N)	Legend	DESCRIPTION
				S.I. Sampling Interval Rec. Recovery Grain Size and 50 to 40% some 40 to 10% trace 10% or less	
0					
		SS#1		S.I. 4.5-6.5' BLS Rec. 1.9'	
5			5	1.9' clay, some silt, trace very fine sand;	
			4	dark grayish brown (2.5Y 4/2); moist;	
			3	plastic; grading to clay; dark gray (5Y 4/1);	
			3	wet; plastic. Olive green and yellow brown to brown mottling 0-1.3'.	
		SS#2		S.I. 9.5-11.5' BLS Rec. 1.2'	
10			1	1.2' clay; dark grayish brown (2.5Y 4/2);	

WELL CONSTRUCTION SUMMARY

Project: Hancock Field Owner: U.S. Air Force Well No.: GW-9



Drilling Summary:

Total Depth: 30' BLS Drillers: Empire Soil
 Borehole Diameter(s): 6" (R. Bush)
 Rig Type: CME 55
 Elevation: Land Surface: 395.7' Bit(s): Auger
 Top of Casing: 397.7' Drilling Fluid Type: water
 Supervisory Geologist: A. Wickline Amount Use: _____
 Log Book No. 2 pp. 43-45 Water Level: 386.2'

Well Design:

Casing: Material: PVC Screen: Material: PVC
 Diameter: 2" ID 2 1/4" OD Diameter: 2"
 Length: _____ Slot: .02"
 Filter: Material: 40 sand Setting: 10.6-29.9' BLS
 Setting: 7-29.9' BLS Seals: Type: Bentonite
 Grout: Type: #1 Portland Cement Setting: 5-7' BLS
 Setting: LS-5' BLS Surface Casing: PVC/steel
 Other: _____

Time Log:

	Started	Completed
Drilling:	<u>9/14/83 1455</u>	<u>9/14/83 1553</u>
Installation:	<u>9/14/83 1604</u>	<u>9/15/83 0845</u>
Water Level Reading:	<u>6.5' BLS</u>	<u>9.5' BLS</u>
Development :	<u>9/15/83 1224</u>	<u>9/15/83 1607</u>

Well Development:

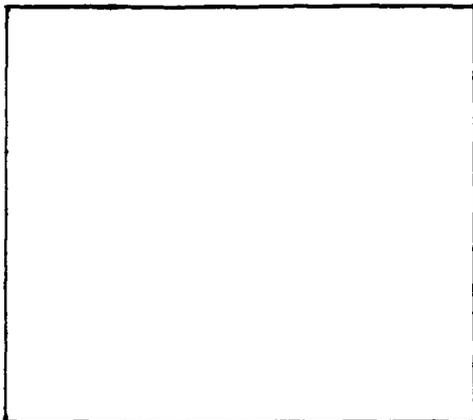
Method/Equipment: pump on drill rig
 Static Depth to Water: 9.5' BLS
 Pumping Depth to Water: 30.0' BLS
 Pumping Rate: 1 gpm
 Volume Pumped: 90 gal

JRB ASSOCIATES

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DRILLING LOG

Project: Hancock Field Owner: U.S. Air Force Well No.: CW 9



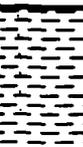
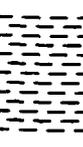
Site Sketch

Location: _____ Field Book No.: 2 pp 43-45
 _____ Log By: A. Wickline
 _____ Driller: Empire (R. Bush)
 _____ Rig Type: Auger

Reference Point: _____ Total Depth: 30' BLS

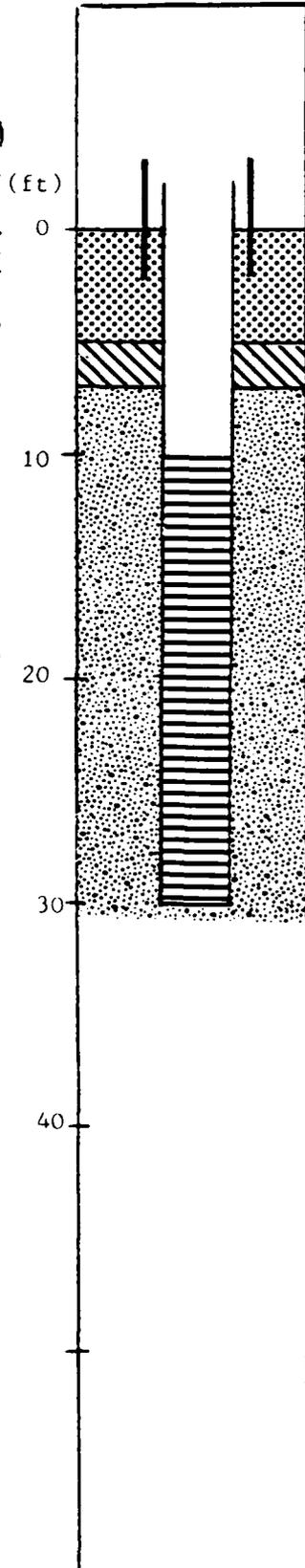
Reference Point Elevation: _____ Date Time
 Drilling Started: 9/14/93 1455
 Drilling Completed: 9/14/83 1553
 Water Level: 386.2'

Depth (feet)	Graphic Log	Sample Type and Number	Blow Count (N)	Legend	DESCRIPTION
				S.I. Sampling Interval Rec. Recovery Grain Size and 50 to 40% some 40 to 10% trace 10% or less	
0					
5		SS#1		S.I. 5-6.5' BLS	Rec. 1.4'
		3		1.4' silt and clay; grayish brown	
		3		(10 YR 5/2) with common yellowish	
		3		brown (10 YR 6/4) mottles; plastic;	
				moist	
				Note: Encountered water at \approx 10' BLS	
10		SS#2		S.I. 10-11.5' BLS	Rec. 1.5'

Depth (feet)	Graphic Log	Sample type and Number	Blow Count (N)	DESCRIPTION	
10			2	.6' same as above	
			2	.9' silt and clay; gray (10 YR 6/1);	
			3	plastic; wet.	
					
5				SS#3 S.I. 15-16.5' Rec. 1.2'	
			2	1.2' same as above with a slight	
			2	increase in silt near bottom of	
		2	sample		
					
20				SS#4 S.I. 20-21.5' BLS Rec. 1.3'	
			2	1.3' fine sand, trace silt; dark brown	
			2	(7.5 YR 4/2); non-plastic; wet.	
		2			
					
25				SS#5 S.I. 25-26.5' BLS Rec. 1.1'	

WELL CONSTRUCTION SUMMARY

Project: Hancock Field Owner: U.S. Air Force Well No.: GW-8



Drilling Summary:

Total Depth: 29.5 Drillers: Empire Soil
 Borehole Diameter(s): 6" (R. Bush)
 Rig Type: CME-55
 Elevation: Land Surface: 393.0' Bit(s): Auger
 Top of Casing: 395.0' Drilling Fluid Type: water
 Supervisory Geologist: A. Wickline Amount Use: _____
 Log Book No. 2 pp. 38-41 Water Level: 383.9'

Well Design:

Casing: Material: PVC Screen: Material: PVC
 Diameter: 2" ID 2 1/4" OD Diameter: 2"
 Length: 10' Slot: .02"
 Filter: Material: 40 sand Setting: 8'-28' BLS
 Setting: 5'-28' BLS Seals: Type: Bentonite
 Grout: Type: #1 Portland Cement Setting: 4'-5' BLS
 Setting: LS-4' BLS Surface Casing: PVC/ steel
 Other: _____

Time Log:

	Started	Completed
Drilling:	<u>9/14/83 0753</u>	<u>9/14/83 0928</u>
Installation:	<u>9/14/83 1024</u>	<u>9/14/83 1241</u>
Water Level Reading:		<u>9.1' BLS</u>
Development :	<u>9/15/83 0752</u>	<u>9/15/83 1005</u>

Well Development:

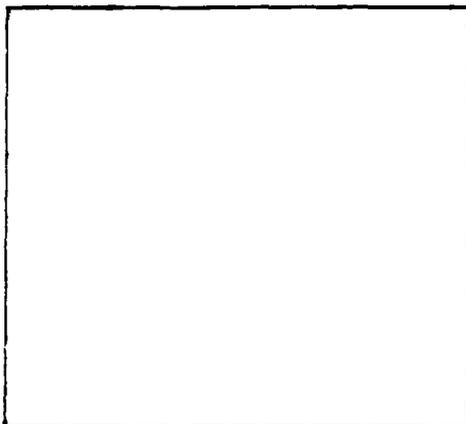
Method/Equipment: pump on drill rig
 Static Depth to Water: 9.1' BLS
 Pumping Depth to Water: 11.3' BLS
 Pumping Rate: varied
 Volume Pumped: 107 gals

JRIB ASSOCIATES

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DRILLING LOG

Project: Hancock Field Owner: U.S. Air Force Well No.: GW-8



Site Sketch

Location: _____ Field Book No.: 2 pp38-41

Log By: A. Wicline

Driller: Empire (R. Bush)

Rig Type: Auger

Reference Point: _____ Total Depth: 29.5' BLS

Reference Point _____ Date _____ Time _____

Elevation: _____ Drilling Started: 9/14/83 0753

Drilling Completed: 9/14/83 0928

Water Level: 383.9'

Depth (feet)	Graphic Log	Sample Type and Number	Blow Count (N)	Legend	
				S.I. Sampling Interval	DESCRIPTION
0					
5		SS#1		S.I. 5-6.5'	Rec. 1.5'
		1		1.5' silt with some fine sand; brown	
		1		(7.5 YR 5/4); slightly plastic; moist.	
		1			
10		SS#2		S.I. 10-11.5' BLS	Rec. 1.4'

DRILLING LOG

GW-8 (cont'd)

Depth (feet)	Graphic Log	Sample type and Number	Blow Count (N)	DESCRIPTION
10			1	0.5' same as above
			4	0.9' fine sand and silt, trace clay;
			5	dark brown (10 YR 4/3); non-plastic;
				wet.
5				SS#3 S.I. 15-16.5' BLS Rec. 1.3'
			2	.65' same as above
			2	.65' fine sand, some silt; dark
			4	brown (7.5 YR 4/2); non-plastic;
				wet.
				Note: encountered a cobble at 17' BLS
20				SS#4 S.I. 20-21.5' BLS Rec. 1.5'
			4	1.2' same as above - slight color change
			3	0.3' silt and clay; dark grayish brown
			2	(10 YR 4/2); plastic; wet.
				Note: encountered till at 23.5' BLS
5				SS#5 S.I. 25-26.5' BLS Rec. 0.6'

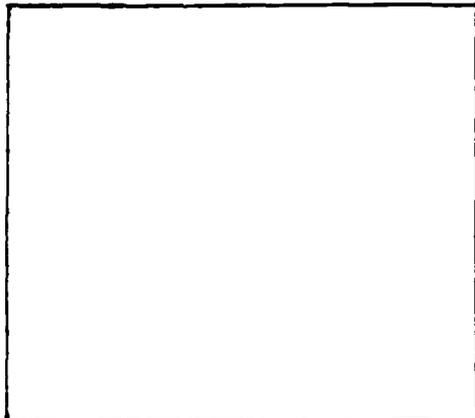
WELL CONSTRUCTION SUMMARY

Project: Hancock Field Owner: U.S. Air Force Well No.: GW-7

	Drilling Summary:	
	Total Depth: <u>30' BLS</u>	Drillers: <u>Empire Soil</u>
	Borehole Diameter(s): <u>6"</u>	(R. Bush)
	Elevation: Land Surface: <u>397.4'</u>	Bit(s): <u>Auger</u>
	Top of Casing: <u>399.6'</u>	Drilling Fluid Type: <u>water</u>
	Supervisory Geologist: <u>A. Wickline</u>	Amount Use: _____
	Log Book No. <u>2</u> pp. <u>33-36</u>	Water Level: <u>388.8'</u>
	Well Design:	
	Casing: Material: <u>PVC</u>	Screen: Material: <u>PVC</u>
	Diameter: <u>2"</u> ID <u>2 1/4" OD</u>	Diameter: <u>2"</u>
	Length: <u>12.2'</u>	Slot: <u>.02"</u>
	Filter: Material: <u>4Q sand</u>	Setting: <u>10'-30' BLS</u>
	Setting: <u>7'-30' BLS</u>	Seals: Type: <u>Bentonite</u>
	Grout: Type: <u>#1 Portland Cement</u>	Setting: <u>5'-7' BLS</u>
	Setting: <u>LS-5' BLS</u>	Surface Casing: <u>PVC/steel</u>
	Other: _____	
	Time Log:	
	Started	Completed
	Drilling: <u>9/13/83 1030</u>	<u>9/13/83 1147</u>
	Installation: <u>9/13/83 1321</u>	<u>9/13/83 1500</u>
	Water Level Reading: <u>8.5' BLS</u>	<u>8.5' BLS</u>
	Development: <u>9/15/83 1023</u>	<u>9/15/83 1308</u>
	Well Development:	
	Method/Equipment: <u>pump on drill rig</u>	
	Static Depth to Water: <u>8.5' BLS</u>	
	Pumping Depth to Water: <u>12.9' BLS</u>	
	Pumping Rate: <u>varied</u>	
	Volume Pumped: <u>121 gal</u>	

DRILLING LOG

Project: Hancock Field Owner: U.S. Air Force Well No.: GW-7



Site Sketch

Location: _____ Field Book No.: 2 pp 33-36

Log By: A. Wickline

Driller: Empire (R. Bush)

Rig Type: Auger

Reference Point: _____ Total Depth: 30' BLS

Reference Point Elevation: _____ Date Time Drilling Started: 9/13/83 1030

Drilling Completed: 9/13/83 1137

Water Level: 388.8'

Depth (feet)	Graphic Log	Sample Type and Number	Blow Count (N)	Legend S.I. Sampling Interval Rec. Recovery Grain Size and 50 to 40% some 40 to 10% trace 10% or less	DESCRIPTION
0					
					Note: Encountered water table at = 6' BLS
5		SS#1		S.I. 5-6.5' BLS	Rec. 1.4'
		2		.2' silt, some sand, trace clay; dark brown	
		2		(10 YR 4/3); slightly plastic; moist.	
		3		1.2' silt, some clay, trace fine sand; brown	
				(10 YR 5/3); slightly plastic; wet in lower	
				.2'.	
10		SS#2		S.I. 10-11.5' BLS	Rec. 1.4'

WELL CONSTRUCTION SUMMARY

Project: Hancock Field Owner: U.S. Air Force Well No.: GW-1

Drilling Summary:

Total Depth: 30' BLS Drillers: Empire Soil
 Borehole Diameter(s): 6" (R. Bush)
 Rig Type: CME-45
 Elevation: Land Surface: 399.5' Bit(s): Auger
 Top of Casing: 401.5' Drilling Fluid Type: water
 Supervisory Geologist: A. Lapins Amount Use: _____
 Log Book No. 1 pp. 43-47 Water Level: 391.2'

Well Design:

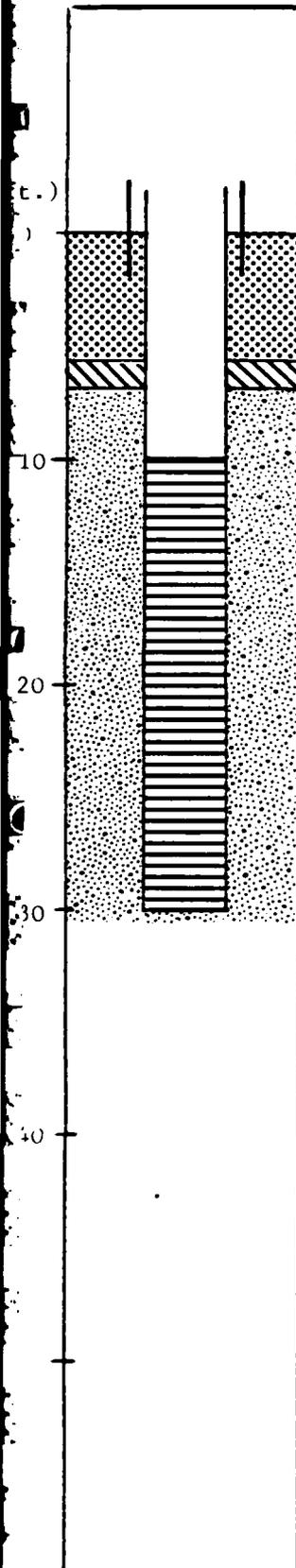
Casing: Material: PVC Screen: Material: PVC
 Diameter: 2" ID- 2 1/4"OD Diameter: 2"
 Length: 12' Slot: .02"
 Filter: Material: 4Q sand Setting: 10-30' BLS
 Setting: 7'-30' BLS Seals: Type: Bentonite
 Grout: Type: #1 Portland Cement Setting: 6'-7' BLS
 Setting: LS-6' BLS Surface Casing: PVC/steel
 Other: _____

Time Log:

	Started	Completed
Drilling:	<u>9/13/83 0748 hr</u>	<u>9/13/83 0921</u>
Installation:	<u>9/13/83 1012 hr</u>	<u>9/13/83 1335</u>
Water Level Reading:	<u>6' BLS</u>	<u>8.3' BLS</u>
Development :	<u>9/15/83 1520 hr</u>	<u>9/15/83 1605 hr</u>

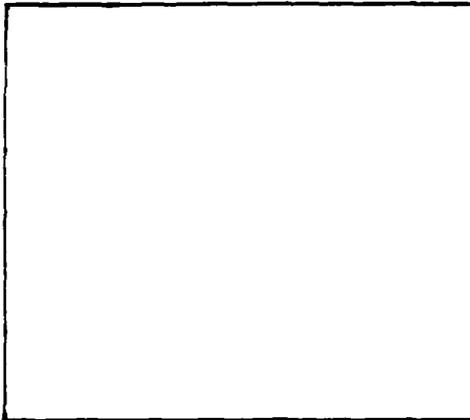
Well Development:

Method/Equipment: pump/rig mounted pump
 Static Depth to Water: 8.3' BLS
 Pumping Depth to Water: 9.0' BLS
 Pumping Rate: 8 gpm
 Volume Pumped: 350 gal.



DRILLING LOG

Project: Hancock Field Owner: U.S. Air Force Well No.: GW-1



Site Sketch

Location: _____ Field Book No.: 1 pp 43-47
 _____ Log By: A. Lapins
 _____ Driller: Empire (R. Bush)
 _____ Rig Type: CME 45
 Reference Point: _____ Total Depth: 30' BLS

Reference Point Elevation: _____ Date Time
 Drilling Started: 9/13/83 0748hr
 Drilling Completed: 9/13/83 0921hr
 Water Level: 391.2'

Depth (feet)	Graphic Log	Sample Type and Number	Blow Count (N)	Legend	DESCRIPTION
				S.I. Sampling Interval Rec. Recovery Grain Size and 50 to 40% some 40 to 10% trace 10% or less	
0					
					2' BLS; cuttings: dark brown very fine sand and silt.
		SS#1		S.I. 4.5-6.5' BLS Rec. 1.6'	
5			4	.9' fine sand, trace silt; light brownish	
			6	gray (10 YR 6/2); moist; loose.	
			5	.7' fine sand, trace silt; dark gray (10 YR 4/1);	
			4	wet, loose	
		SS#2		S.I. 9.5-11.5' BLS Rec. 0.9'	
10			1	.9' fine sand, trace silt; dark brown to brown	

Depth (feet)	Graphic Log	Sample type and Number	Blow Count (N)	DESCRIPTION
25		SS#5	7	(10 YR 4/1); wet.
			12	
			13	
		SS#6		S.I. 29.5-31.5' BLS Rec. 2.0'
			12	2.0' same as above
			12	
			14	
			15	

APPENDIX E

FIELD DATA

TABLE E-1

FIELD ANALYTICAL DATA FOR GROUNDWATER SAMPLING
(20 September 1983)

Monitoring Station	pH (std units)	Conductivity (umhos/cm)	Temperature (C°)
GW-1	6.30/6.30	460/470	14/13
GW-2	7.15/7.19/7.14	380/340/275	14/14/14
GW-3	6.25/5.40	340/340	15/15
GW-4	5.60/5.90	300/280	14/14
GW-5*			
GW-6	6.80/5.80	260/245	15/15
GW-7	7.26/7.40	330/210	15/15
GW-8	7.40/7.50	275/290	14/14
GW-9	7.40/7.60	290/240	14/11
GW-10	7.60/7.90	160/152	15/13

* Instruments not functioning - wet from rain

TABLE E-2

FIELD ANALYTICAL RESULTS FOR GROUNDWATER SAMPLING
(27 September 1983)

Monitoring Station	pH* (std units)	Conductivity (umhos/cm)	Temperature (C ^o)
GW-1		450	14
GW-2		370	13
GW-3		325	13
GW-4		300	14
GW-5		250	12
GW-6		240	12
GW-7		235	14
GW-8		260	12
GW-9		255	12
GW-10		172	13

*pH meter not functioning - wet from rain

TABLE E-3

FIELD ANALYTICAL DATA FOR GROUNDWATER SAMPLES
(10 January 1984)

Monitoring Station	pH ^{1/} (std units)	Conductivity (umhos/cm)	Temperature ^{2/} (C°)
GW-1	6.0	515	
GW-2	6.0	250	
GW-3	6.0	110	
GW-4	6.0	275	
GW-5	6.0	190	
GW-6	6.0	155	
GW-7	6.0	215	
GW-8	6.0	206	
GW-9	-	-	
GW-10	6.0	175	

^{1/} pH obtained using litmus paper - temperature too low for pH meter operation

^{2/} Temperature too low for accurate reading

TABLE E-4

STREAMFLOW MEASUREMENTS TAKEN AT TIME OF SAMPLING

(22 September 1983)

Monitoring Station	Flow (cfs)
SW-1	0.01
SW-2	0.01
SW-3	0.08
SW-4	3.20
SW-5	0.24
SW-6	0.16
SW-7	>0.01
SW-8	-

APPENDIX F

QA/QC

ERG CHAIN OF CUSTODY RECORD

PROJ NO	PROJECT NAME	NO OF CON-TAINERS	REMARKS
503	Hancock Field		
551-91			
RECEIVED BY: <i>Robert M. McKelvey</i> DATE: 11/18/84 TIME: 1:48 PM			
STATION NO <th>DATE</th> <th>TIME</th> <th>STATION LOCATION</th>	DATE	TIME	STATION LOCATION
Field 2A	11/18/84	5:25	Field Station - Hancock Field
Field 2B	11/18/84	5:35	
Field 2C	11/18/84	5:45	
Field 2D	11/18/84	5:55	
Field 2E	11/18/84	6:05	
Field 2F	11/18/84	6:15	
Field 2G	11/18/84	6:25	
Field 2H	11/18/84	6:35	
Field 2I	11/18/84	6:45	
Field 2J	11/18/84	6:55	
Field 2K	11/18/84	7:05	
Field 2L	11/18/84	7:15	
Field 2M	11/18/84	7:25	
Field 2N	11/18/84	7:35	
Field 2O	11/18/84	7:45	
Field 2P	11/18/84	7:55	
Field 2Q	11/18/84	8:05	
Field 2R	11/18/84	8:15	
Field 2S	11/18/84	8:25	
Field 2T	11/18/84	8:35	
Field 2U	11/18/84	8:45	
Field 2V	11/18/84	8:55	
Field 2W	11/18/84	9:05	
Field 2X	11/18/84	9:15	
Field 2Y	11/18/84	9:25	
Field 2Z	11/18/84	9:35	
Field 2AA	11/18/84	9:45	
Field 2AB	11/18/84	9:55	
Field 2AC	11/18/84	10:05	
Field 2AD	11/18/84	10:15	
Field 2AE	11/18/84	10:25	
Field 2AF	11/18/84	10:35	
Field 2AG	11/18/84	10:45	
Field 2AH	11/18/84	10:55	
Field 2AI	11/18/84	11:05	
Field 2AJ	11/18/84	11:15	
Field 2AK	11/18/84	11:25	
Field 2AL	11/18/84	11:35	
Field 2AM	11/18/84	11:45	
Field 2AN	11/18/84	11:55	
Field 2AO	11/18/84	12:05	
Field 2AP	11/18/84	12:15	
Field 2AQ	11/18/84	12:25	
Field 2AR	11/18/84	12:35	
Field 2AS	11/18/84	12:45	
Field 2AT	11/18/84	12:55	
Field 2AU	11/18/84	1:05	
Field 2AV	11/18/84	1:15	
Field 2AW	11/18/84	1:25	
Field 2AX	11/18/84	1:35	
Field 2AY	11/18/84	1:45	
Field 2AZ	11/18/84	1:55	
Field 2BA	11/18/84	2:05	
Field 2BB	11/18/84	2:15	
Field 2BC	11/18/84	2:25	
Field 2BD	11/18/84	2:35	
Field 2BE	11/18/84	2:45	
Field 2BF	11/18/84	2:55	
Field 2BG	11/18/84	3:05	
Field 2BH	11/18/84	3:15	
Field 2BI	11/18/84	3:25	
Field 2BJ	11/18/84	3:35	
Field 2BK	11/18/84	3:45	
Field 2BL	11/18/84	3:55	
Field 2BM	11/18/84	4:05	
Field 2BN	11/18/84	4:15	
Field 2BO	11/18/84	4:25	
Field 2BP	11/18/84	4:35	
Field 2BQ	11/18/84	4:45	
Field 2BR	11/18/84	4:55	
Field 2BS	11/18/84	5:05	
Field 2BT	11/18/84	5:15	
Field 2BU	11/18/84	5:25	
Field 2BV	11/18/84	5:35	
Field 2BW	11/18/84	5:45	
Field 2BX	11/18/84	5:55	
Field 2BY	11/18/84	6:05	
Field 2BZ	11/18/84	6:15	
Field 2CA	11/18/84	6:25	
Field 2CB	11/18/84	6:35	
Field 2CC	11/18/84	6:45	
Field 2CD	11/18/84	6:55	
Field 2CE	11/18/84	7:05	
Field 2CF	11/18/84	7:15	
Field 2CG	11/18/84	7:25	
Field 2CH	11/18/84	7:35	
Field 2CI	11/18/84	7:45	
Field 2CJ	11/18/84	7:55	
Field 2CK	11/18/84	8:05	
Field 2CL	11/18/84	8:15	
Field 2CM	11/18/84	8:25	
Field 2CN	11/18/84	8:35	
Field 2CO	11/18/84	8:45	
Field 2CP	11/18/84	8:55	
Field 2CQ	11/18/84	9:05	
Field 2CR	11/18/84	9:15	
Field 2CS	11/18/84	9:25	
Field 2CT	11/18/84	9:35	
Field 2CU	11/18/84	9:45	
Field 2CV	11/18/84	9:55	
Field 2CW	11/18/84	10:05	
Field 2CX	11/18/84	10:15	
Field 2CY	11/18/84	10:25	
Field 2CZ	11/18/84	10:35	
Field 2DA	11/18/84	10:45	
Field 2DB	11/18/84	10:55	
Field 2DC	11/18/84	11:05	
Field 2DD	11/18/84	11:15	
Field 2DE	11/18/84	11:25	
Field 2DF	11/18/84	11:35	
Field 2DG	11/18/84	11:45	
Field 2DH	11/18/84	11:55	
Field 2DI	11/18/84	12:05	
Field 2DJ	11/18/84	12:15	
Field 2DK	11/18/84	12:25	
Field 2DL	11/18/84	12:35	
Field 2DM	11/18/84	12:45	
Field 2DN	11/18/84	12:55	
Field 2DO	11/18/84	1:05	
Field 2DP	11/18/84	1:15	
Field 2DQ	11/18/84	1:25	
Field 2DR	11/18/84	1:35	
Field 2DS	11/18/84	1:45	
Field 2DT	11/18/84	1:55	
Field 2DU	11/18/84	2:05	
Field 2DV	11/18/84	2:15	
Field 2DW	11/18/84	2:25	
Field 2DX	11/18/84	2:35	
Field 2DY	11/18/84	2:45	
Field 2DZ	11/18/84	2:55	
Field 2EA	11/18/84	3:05	
Field 2EB	11/18/84	3:15	
Field 2EC	11/18/84	3:25	
Field 2ED	11/18/84	3:35	
Field 2EE	11/18/84	3:45	
Field 2EF	11/18/84	3:55	
Field 2EG	11/18/84	4:05	
Field 2EH	11/18/84	4:15	
Field 2EI	11/18/84	4:25	
Field 2EJ	11/18/84	4:35	
Field 2EK	11/18/84	4:45	
Field 2EL	11/18/84	4:55	
Field 2EM	11/18/84	5:05	
Field 2EN	11/18/84	5:15	
Field 2EO	11/18/84	5:25	
Field 2EP	11/18/84	5:35	
Field 2EQ	11/18/84	5:45	
Field 2ER	11/18/84	5:55	
Field 2ES	11/18/84	6:05	
Field 2ET	11/18/84	6:15	
Field 2EU	11/18/84	6:25	
Field 2EV	11/18/84	6:35	
Field 2EW	11/18/84	6:45	
Field 2EX	11/18/84	6:55	
Field 2EY	11/18/84	7:05	
Field 2EZ	11/18/84	7:15	
Field 2FA	11/18/84	7:25	
Field 2FB	11/18/84	7:35	
Field 2FC	11/18/84	7:45	
Field 2FD	11/18/84	7:55	
Field 2FE	11/18/84	8:05	
Field 2FF	11/18/84	8:15	
Field 2FG	11/18/84	8:25	
Field 2FH	11/18/84	8:35	
Field 2FI	11/18/84	8:45	
Field 2FJ	11/18/84	8:55	
Field 2FK	11/18/84	9:05	
Field 2FL	11/18/84	9:15	
Field 2FM	11/18/84	9:25	
Field 2FN	11/18/84	9:35	
Field 2FO	11/18/84	9:45	
Field 2FP	11/18/84	9:55	
Field 2FQ	11/18/84	10:05	
Field 2FR	11/18/84	10:15	
Field 2FS	11/18/84	10:25	
Field 2FT	11/18/84	10:35	
Field 2FU	11/18/84	10:45	
Field 2FV	11/18/84	10:55	
Field 2FW	11/18/84	11:05	
Field 2FX	11/18/84	11:15	
Field 2FY	11/18/84	11:25	
Field 2FZ	11/18/84	11:35	
Field 2GA	11/18/84	11:45	
Field 2GB	11/18/84	11:55	
Field 2GC	11/18/84	12:05	
Field 2GD	11/18/84	12:15	
Field 2GE	11/18/84	12:25	
Field 2GF	11/18/84	12:35	
Field 2GG	11/18/84	12:45	
Field 2GH	11/18/84	12:55	
Field 2GI	11/18/84	1:05	
Field 2GJ	11/18/84	1:15	
Field 2GK	11/18/84	1:25	
Field 2GL	11/18/84	1:35	
Field 2GM	11/18/84	1:45	
Field 2GN	11/18/84	1:55	
Field 2GO	11/18/84	2:05	
Field 2GP	11/18/84	2:15	
Field 2GQ	11/18/84	2:25	
Field 2GR	11/18/84	2:35	
Field 2GS	11/18/84	2:45	
Field 2GT	11/18/84	2:55	
Field 2GU	11/18/84	3:05	
Field 2GV	11/18/84	3:15	
Field 2GW	11/18/84	3:25	
Field 2GX	11/18/84	3:35	
Field 2GY	11/18/84	3:45	
Field 2GZ	11/18/84	3:55	
Field 2HA	11/18/84	4:05	
Field 2HB	11/18/84	4:15	
Field 2HC	11/18/84	4:25	
Field 2HD	11/18/84	4:35	
Field 2HE	11/18/84	4:45	
Field 2HF	11/18/84	4:55	
Field 2HG	11/18/84	5:05	
Field 2HH	11/18/84	5:15	
Field 2HI	11/18/84	5:25	
Field 2HJ	11/18/84	5:35	
Field 2HK	11/18/84	5:45	
Field 2HL	11/18/84	5:55	
Field 2HM	11/18/84	6:05	
Field 2HN	11/18/84	6:15	
Field 2HO	11/18/84	6:25	
Field 2HP	11/18/84	6:35	
Field 2HQ	11/18/84	6:45	
Field 2HR	11/18/84	6:55	
Field 2HS	11/18/84	7:05	
Field 2HT	11/18/84	7:15	
Field 2HU	11/18/84	7:25	
Field 2HV	11/18/84	7:35	
Field 2HW	11/18/84	7:45	
Field 2HX	11/18/84	7:55	
Field 2HY	11/18/84	8:05	
Field 2HZ	11/18/84	8:15	
Field 2IA	11/18/84	8:25	
Field 2IB	11/18/84	8:35	
Field 2IC	11/18/84	8:45	
Field 2ID	11/18/84	8:55	
Field 2IE	11/18/84	9:05	
Field 2IF	11/18/84	9:15	
Field 2IG	11/18/84	9:25	
Field 2IH	11/18/84	9:35	
Field 2II	11/18/84	9:45	
Field 2IJ	11/18/84	9:55	
Field 2IK	11/18/84	10:05	
Field 2IL	11/18/84	10:15	
Field 2IM	11/18/84	10:25	
Field 2IN	11/18/84	10:35	
Field 2IO	11/18/84	10:45	
Field 2IP	11/18/84	10:55	
Field 2IQ	11/18/84	11:05	
Field 2IR	11/18/84	11:15	
Field 2IS	11/18/84	11:25	
Field 2IT	11/18/84	11:35	
Field 2IU	11/18/84	11:45	
Field 2IV	11/18/84	11:55	
Field 2IU	11/18/84	12:05	
Field 2IV	11/18/84	12:15	
Field 2IU	11/18/84	12:25	
Field 2IV	11/18/84		

149.4 m 4

ERG CHAIN OF CUSTODY RECORD

PROJ NO.	PROJECT NAME	NO OF CON. TAINERS	STATION LOCATION	REMARKS
6635141	Haverk Field			
SAMPLERS: (Signature) <i>[Signature]</i>				
SIA NO	DATE	TIME	STATION LOCATION	REMARKS
S21	11/18/84	1455	Sediment #7	Sediment #7. Top 20cm of core OK
S22	11/18/84	1455	↓	to truck - both types OK with OK
S23	11/18/84	1455	Sediment sample #7	Top bottle and resealed OK
S24	11/18/84	1455	↓	OK
S25	11/18/84	1522	Water sample #6	OK
S26	11/18/84	1522	↓	OK
S27	11/18/84	1522	Sediment #6	OK
S28	11/18/84	1522	↓	OK
S29	11/18/84	1522	Sediment #5	OK
S30	11/18/84	1522	↓	OK
S31	11/18/84	1522	Sediment #5	OK
S32	11/18/84	1522	↓	OK
S33	11/18/84	1522	Sediment #5	OK
S34	11/18/84	1522	↓	OK
S35	11/18/84	1522	Sediment #5	OK
S36	11/18/84	1522	↓	OK
S37	11/18/84	1522	Sediment #5	OK
S38	11/18/84	1522	↓	OK
S39	11/18/84	1522	Sediment #5	OK
S40	11/18/84	1522	↓	OK
S41	11/18/84	1522	Sediment #5	OK
S42	11/18/84	1522	↓	OK
S43	11/18/84	1522	Sediment #5	OK
S44	11/18/84	1522	↓	OK
S45	11/18/84	1522	Sediment #5	OK
S46	11/18/84	1522	↓	OK
S47	11/18/84	1522	Sediment #5	OK
S48	11/18/84	1522	↓	OK
S49	11/18/84	1522	Sediment #5	OK
S50	11/18/84	1522	↓	OK
S51	11/18/84	1522	Sediment #5	OK
S52	11/18/84	1522	↓	OK
S53	11/18/84	1522	Sediment #5	OK
S54	11/18/84	1522	↓	OK
S55	11/18/84	1522	Sediment #5	OK
S56	11/18/84	1522	↓	OK
S57	11/18/84	1522	Sediment #5	OK
S58	11/18/84	1522	↓	OK
S59	11/18/84	1522	Sediment #5	OK
S60	11/18/84	1522	↓	OK
S61	11/18/84	1522	Sediment #5	OK
S62	11/18/84	1522	↓	OK
S63	11/18/84	1522	Sediment #5	OK
S64	11/18/84	1522	↓	OK
S65	11/18/84	1522	Sediment #5	OK
S66	11/18/84	1522	↓	OK
S67	11/18/84	1522	Sediment #5	OK
S68	11/18/84	1522	↓	OK
S69	11/18/84	1522	Sediment #5	OK
S70	11/18/84	1522	↓	OK
S71	11/18/84	1522	Sediment #5	OK
S72	11/18/84	1522	↓	OK
S73	11/18/84	1522	Sediment #5	OK
S74	11/18/84	1522	↓	OK
S75	11/18/84	1522	Sediment #5	OK
S76	11/18/84	1522	↓	OK
S77	11/18/84	1522	Sediment #5	OK
S78	11/18/84	1522	↓	OK
S79	11/18/84	1522	Sediment #5	OK
S80	11/18/84	1522	↓	OK
S81	11/18/84	1522	Sediment #5	OK
S82	11/18/84	1522	↓	OK
S83	11/18/84	1522	Sediment #5	OK
S84	11/18/84	1522	↓	OK
S85	11/18/84	1522	Sediment #5	OK
S86	11/18/84	1522	↓	OK
S87	11/18/84	1522	Sediment #5	OK
S88	11/18/84	1522	↓	OK
S89	11/18/84	1522	Sediment #5	OK
S90	11/18/84	1522	↓	OK
S91	11/18/84	1522	Sediment #5	OK
S92	11/18/84	1522	↓	OK
S93	11/18/84	1522	Sediment #5	OK
S94	11/18/84	1522	↓	OK
S95	11/18/84	1522	Sediment #5	OK
S96	11/18/84	1522	↓	OK
S97	11/18/84	1522	Sediment #5	OK
S98	11/18/84	1522	↓	OK
S99	11/18/84	1522	Sediment #5	OK
S100	11/18/84	1522	↓	OK

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Date / Time
<i>[Signature]</i>	11/18/84 7:05	<i>[Signature]</i>	
<i>[Signature]</i>	11/18/84 11:25 AM	<i>[Signature]</i>	
<i>[Signature]</i>	11/18/84 1:15 PM	<i>[Signature]</i>	

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Date / Time
<i>[Signature]</i>	11/18/84 11:50 AM	<i>[Signature]</i>	

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Date / Time
<i>[Signature]</i>	11/18/84 1:15 PM	<i>[Signature]</i>	

Distribution: Original Accompanies Shipment, Copy to Coordinator Field Files

ERG CHAIN OF CUSTODY RECORD

PROJ NO		PROJECT NAME		NO OF CONTAINERS	REMARKS
SAMPLERS: (Signature)		STATION LOCATION			
263	CL 35141	Hansen Field			
SAMPLERS: (Signature)		Station Location			
STA NO	DATE	TIME	TIME		
SW-1	1/19/84	12:55	12:55	1	
SW-1	1/19/84	12:55	12:55	2	
SW-1	1/19/84	12:55	12:55	3	
SW-1	1/19/84	12:55	12:55	1	
SW-1R	1/19/84	12:55	12:55	1	
SW-1R	1/19/84	12:55	12:55	1	
SW-1R	1/19/84	12:55	12:55	2	
SW-1R	1/19/84	12:55	12:55	2	
SW-1R	1/19/84	12:10	12:10	1	
SW-1R	1/19/84	12:10	12:10	1	
SW-1R	1/19/84	12:10	12:10	1	
SW-2	1/19/84	12:35	12:35	1	
SW-3	1/19/84	12:35	12:35	1	
SW-3	1/19/84	12:35	12:35	1	
SW-4	1/19/84	13:00	13:00	1	
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Date / Time	Relinquished by: (Signature)	Date / Time
Robert M. Albrecht	1/19/84 12:35	RAY	1/11/84 11:50 AM		
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Date / Time	Relinquished by: (Signature)	Date / Time
(EMERY DELVAYMAN)	1/11/84 11:50 AM	Ray Kayspeck	1/11/84 1:00 PM		
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Date / Time	Relinquished by: (Signature)	Date / Time
Ray Kayspeck	1/11/84 1:00 PM	Robert K Wood	1/11/84 1:00 PM		

Instructions: Original Accompanies Shipment, Copy to Coordinator Field Files

By 211 at 4

ERG CHAIN OF CUSTODY RECORD

PROJ NO		PROJECT NAME		NO OF CON. TAINERS	REMARKS
26 351 41		Hancock Field			
SAMPLERS (Signature)				STATION LOCATION	NO OF CON. TAINERS
[Signature]					
SIA NO	DATE	TIME	STATION LOCATION		
SP10	11/19/83	1445	gumland to well #10	1	will 5 tubes - had to be shipped.
SP10	11/19/83	1445	↓	1	thought to sample. Some small in
SP10	11/19/83	1445	↓	2	chips in sample - small hole
SP10	11/19/83	1445	↓	3	trapped in. If by factory in
SP10	11/19/83	1530	gumland to well #10	1	sample to H&B to be sample sent to
SP10	11/19/83	1530	↓	1	tube
SP10	11/19/83	1530	↓	1	

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Date / Time
[Signature]	11/19/83 1605	[Signature]	
(EMERY DELIVERYMAN)	11/19/83 11:50 AM	[Signature]	
STR 26597	11/19/83 1:00 PM	[Signature]	

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Date / Time
[Signature]	11/18/84 1:00 PM	[Signature]	

APPENDIX G
ANALYTICAL DATA

ENVIRONMENTAL RESEARCH GROUP, INC.



117 N. First Ann Arbor, Michigan 48104 (313) 662-3104

Submitted To:

JRB Associates, Inc.
8400 Westpark Drive
McLean, VA 22102

Attn: Claudia Wiegand

Project Number: A1396.1 **Reference:** JRB-Hancock

Date Samples Received: January 12, 1984

Date Samples Extracted: No extraction - all purgeables

Date Samples Analyzed: January 18, 1984

Methodology Employed: Halocarbon Purgeables EPA Method 601
Aromatic Purgeables EPA Method 602
Halides by Haloscan Interim EPA Method 9022

Sample Quality Control: ERG's QA/AC requires a duplicate, method spike and blank with each group of samples or with every 10 samples, whichever is larger.

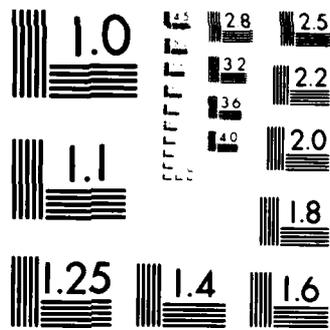
SUMMARY OF QUALITY CONTROL ANALYSIS

<u>ERG Sample Number</u>	<u>Parameter</u>	<u>Description</u>	<u>Spike Level</u>	<u>Recovery (%)</u>	<u>Analytical Results ug/L*</u>
100839	Cis-1,3-dichloro-propene	Duplicate	-----	-----	ND(0.50)/ND(0.50)
100839	Cis-1,3-dichloro-propene	Blank	-----	-----	ND(0.50)
100870	Cis-1,3-dichloro-propene	Duplicate	-----	-----	ND(5.0)/ND(5.0)
100870	Cis-1,3-dichloro-propene	Blank	-----	-----	ND(5.0)
100839	Chloroethyl-vinyl Ether, 2-	Duplicate	-----	-----	ND(0.50)/ND(0.50)
100839	Chloroethyl-vinyl Ether, 2-	Blank	-----	-----	ND(0.50)
100870	Chloroethyl-vinyl Ether, 2-	Duplicate	-----	-----	ND(5.0)/ND(5.0)
100870	Chloroethyl-vinyl Ether, 2-	Blank	-----	-----	ND(5.0)

*NOTE: All Analytical Results are blank subtracted

<u>ERG Sample Number</u>	<u>Parameter</u>	<u>Description</u>	<u>Spike Level</u>	<u>Recovery (%)</u>	<u>Analytical Results ug/L</u>
100870	Dichlorobenzene, 1,4	Duplicate	-----	-----	ND(20)/ND(20)
100870	Dichlorobenzene, 1,4	Blank	-----	-----	ND(20)
100839	Benzene	Duplicate	-----	-----	ND(2.0)/ND(2.0)
100839	Benzene	Blank	-----	-----	1.5
100870	Benzene	Duplicate	-----	-----	ND(20)/ND(20)
100870	Benzene	Blank	-----	-----	1.5
100839	Toluene	Duplicate	-----	-----	ND(1.0)/ND(1.0)
100839	Toluene	Blank	-----	-----	ND(1.0)
100870	Toluene	Duplicate	-----	-----	ND(10)/ND(10)
100870	Toluene	Blank	-----	-----	ND(10)
100839	Ethyl Benzene	Duplicate	-----	-----	ND(1.0)/ND(1.0)
100839	Ethyl Benzene	Blank	-----	-----	ND(1.0)
100870	Ethyl Benzene	Duplicate	-----	-----	ND(10)/ND(10)
100870	Ethyl Benzene	Blank	-----	-----	ND(10)
100839	Haloscan: Cl	Duplicate	-----	-----	0.04/0.04 mg/L
100839	Haloscan: Cl	Blank	-----	-----	ND
100839	Haloscan: Cl	Method Spike	50 ug	95	47.5 ppb
100839	Haloscan: Br	Duplicate	-----	-----	0.033/0.031 mg/L
100839	Haloscan: Br	Blank	-----	-----	ND
100839	Haloscan: Br	Method Spike	5.0 ug	102	5.1 ppb
100839	Haloscan: I	Duplicate	-----	-----	0.11/0.11 mg/L
100839	Haloscan: I	Blank	-----	-----	ND
100839	Haloscan: I	Method Spike	-----	-----	-----
100838	TOC	Duplicate	-----	-----	1.27/1.23 mg/L
100838	TOC	Blank	-----	-----	2.3 mg/L
100845	TOC	Duplicate	-----	-----	<2/<2 mg/L
100845	TOC	Blank	-----	-----	2.3 mg/L
100845	TOC	Method Spike	20 ppm	93	18.55 mg/L
100849	TOC	Duplicate	-----	-----	12.57/8.8 mg/L
100849	TOC	Blank	-----	-----	2.3 mg/L

<u>ERG Sample Number</u>	<u>Parameter</u>	<u>Description</u>	<u>Spike Level</u>	<u>Recovery (%)</u>	<u>Analytical Results ug/L</u>
100839	Methylene Chloride	Duplicate	-----	-----	ND(10)/ND(10)
100839	Methylene Chloride	Blank	-----	-----	4.7
100870	Methylene Chloride	Duplicate	-----	-----	ND(100)/ND(100)
100870	Methylene Chloride	Blank	-----	-----	5.3
100839	Trichlorofluoro-methane	Duplicate	-----	-----	ND(0.50)/ND(0.50)
100839	Trichlorofluoro-methane	Blank	-----	-----	ND(0.50)
100870	Trichlorofluoro-methane	Duplicate	-----	-----	ND(5.0)/ND(5.0)
100870	Trichlorofluoro-methane	Blank	-----	-----	ND(5.0)
100839	Dichloroethylene, 1,1	Duplicate	-----	-----	ND(0.50)/ND(0.50)
100839	Dichloroethylene, 1,1	Blank	-----	-----	0.45
100870	Dichloroethylene, 1,1	Duplicate	-----	-----	ND(5.0)/ND(5.0)
100870	Dichloroethylene, 1,1	Blank	-----	-----	1.2
100839	Trans-1,2-dichloroethylene	Duplicate	-----	-----	ND(0.50)/ND(0.50)
100839	Trans-1,2-dichloroethylene	Blank	-----	-----	0.29
100870	Trans-1,2-dichloroethylene	Duplicate	-----	-----	ND(5.0)/ND(5.0)
100870	Trans-1,2-dichloroethylene	Blank	-----	-----	0.46
100839	Chloroform	Duplicate	-----	-----	ND(0.50)/ND(0.50)
100839	Chloroform	Blank	-----	-----	0.31
100870	Chloroform	Duplicate	-----	-----	ND(5.0)/ND(5.0)
100870	Chloroform	Blank	-----	-----	0.34
100839	Dichloroethane, 1,2-	Duplicate	-----	-----	ND(0.50)/ND(0.50)
100839	Dichloroethane, 1,2-	Blank	-----	-----	ND(0.50)
100870	Dichloroethane, 1,2-	Duplicate	-----	-----	ND(5.0)/ND(5.0)
100870	Dichloroethane, 1,2-	Blank	-----	-----	ND(5.0)



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

<u>ERG Sample Number</u>	<u>Parameter</u>	<u>Description</u>	<u>Spike Level</u>	<u>Recovery (%)</u>	<u>Analytical Results ug/L</u>
100839	Dibromochloromethane	Duplicate	-----	-----	ND(0.50)/ND(0.50)
100839	Dibromochloromethane	Blank	-----	-----	ND(0.50)
100870	Dibromochloromethane	Duplicate	-----	-----	ND(5.0)/ND(5.0)
100870	Dibromochloromethane	Blank	-----	-----	ND(5.0)
100839	Trichloroethane, 1,1,2	Duplicate	-----	-----	ND(0.50)/ND(0.50)
100839	Trichloroethane, 1,1,2	Blank	-----	-----	ND(0.50)
100870	Trichloroethane, 1,1,2	Duplicate	-----	-----	ND(5.0)/ND(5.0)
100870	Trichloroethane, 1,1,2	Blank	-----	-----	ND(5.0)
100839	Dichloroethane, 1,1	Duplicate	-----	-----	ND(0.50)/ND(0.50)
100839	Dichloroethane, 1,1	Blank	-----	-----	0.095
100870	Dichloroethane, 1,1	Duplicate	-----	-----	ND(5.0)/ND(5.0)
100870	Dichloroethane, 1,1	Blank	-----	-----	0.22
100868	Oil & Grease I.R.	Duplicate	-----	-----	315/343
100868	Oil & Grease I.R.	Blank	-----	-----	-----
100839	Chloromethane	Duplicate	-----	-----	ND(0.50)/ND(0.50)
100839	Chloromethane	Blank	-----	-----	ND(0.50)
100870	Chloromethane	Duplicate	-----	-----	ND(0.50)/ND(0.50)
100870	Chloromethane	Blank	-----	-----	ND(0.50)
100839	Bromomethane	Duplicate	-----	-----	ND(0.50)/ND(0.50)
100839	Bromomethane	Blank	-----	-----	ND(0.50)
100870	Bromomethane	Duplicate	-----	-----	ND(0.50)/ND(0.50)
100870	Bromomethane	Blank	-----	-----	ND(0.50)
100839	Dichlorodifluoromethane	Duplicate	-----	-----	ND(0.50)/ND(0.50)
100839	Dichlorodifluoromethane	Blank	-----	-----	ND(0.50)
100870	Dichlorodifluoromethane	Duplicate	-----	-----	ND(0.50)/ND(0.50)
100870	Dichlorodifluoromethane	Blank	-----	-----	ND(0.50)
100839	Vinyl Chloride	Duplicate	-----	-----	ND(0.50)/ND(0.50)

<u>ERG Sample Number</u>	<u>Parameter</u>	<u>Description</u>	<u>Spike Level</u>	<u>Recovery (%)</u>	<u>Analytical Results ug/L</u>
100839	Vinyl Chloride	Blank	-----	-----	ND(0.50)
100870	Vinyl Chloride	Duplicate	-----	-----	ND(0.50)/ND(0.50)
100870	Vinyl Chloride	Blank	-----	-----	ND(0.50)
100839	Chloroethane	Duplicate	-----	-----	ND(0.50)/ND(0.50)
100839	Chloroethane	Blank	-----	-----	ND(0.50)
100870	Chloroethane	Duplicate	-----	-----	ND(0.50)/ND(0.50)
100870	Chloroethane	Blank	-----	-----	ND(0.50)

APPENDIX H

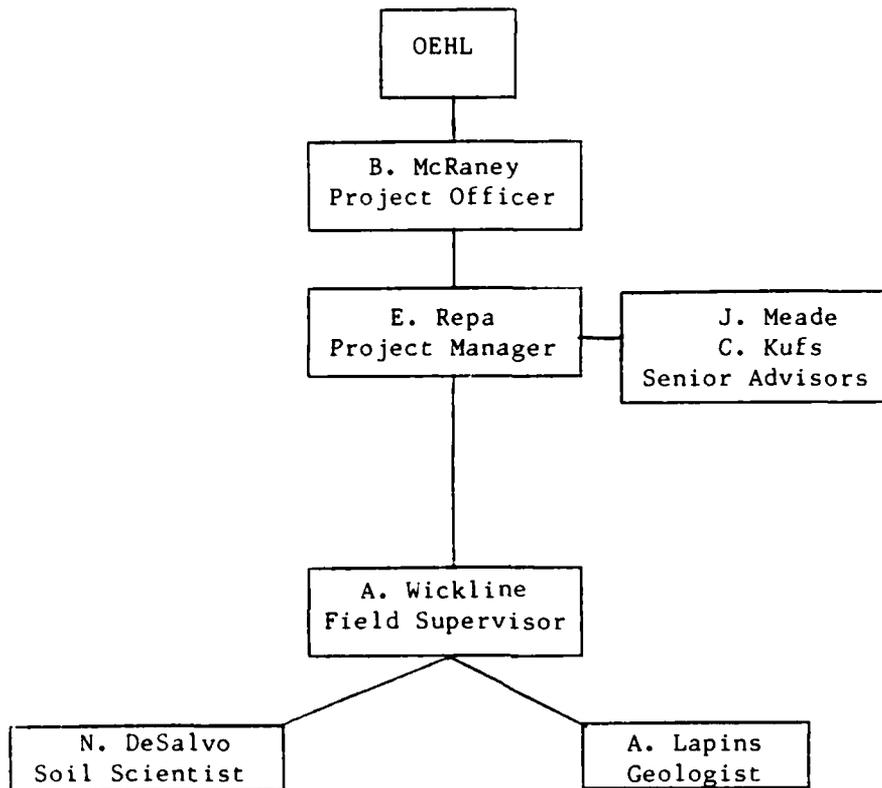
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APPENDIX I

RESUMES



Project Management Structure

NICHOLAS J. DeSALVO

EDUCATION

West Virginia University: M.S. Agronomy (1981)
West Virginia University: B.S.A. Plant and Soil Science (1977)

EXPERIENCE

Mr. DeSalvo is a soil scientist with JRB's Geotechnical Assessment Group. Recently he supervised the installation of groundwater monitoring wells to detect the presence of organic contaminants at an army munitions plant in Tennessee. The wells ranged in depth from 50 to 250 feet deep and both auger and hydraulic rotary drill rigs were used. After installation he participated in development, purging and sampling procedures which were carried out under strict quality control/quality assurance standards to insure accurate data. Mr. DeSalvo also participated in a project that involved collecting five foot continuous cores from TNT washout lagoons at an army munitions depot in Illinois. The presence of ignitable and potentially explosive agents dictated the use of innovative sampling protocols which stressed worker health and safety. Both of these projects were completed as part of the U.S. Army Installation Restoration Program. Participation required a working knowledge of EPA and United States Army Toxic and Hazardous Material Agency quality control/quality assurance and chain-of-custody procedures.

Presently Mr. DeSalvo is working on a section which addresses the options of on-site containment of drums for a technical handbook entitled, "Drum Handling Practices at Hazardous Waste Sites." He also has been involved in the Chemical Countermeasures Program for EPA Edison Laboratories. These projects deal with the uses of chemical countermeasures for in-situ treatment of large volumes of contaminated soils surrounding uncontrolled hazardous waste sites and treatment of chemical spills to relatively quiescent bodies of water.

Prior to joining JRB, Mr. DeSalvo was employed as a Soil Scientist with UTD Corporation's Natural Resources Division. Duties included: developing site specific reports on overburden and minesoils; soil sampling and classification; physical and chemical data interpretation; making recommendations for alternative topsoiling materials and fertilizer application rates to insure successful revegetation. Other responsibilities included water sample collection, aquatic biology sampling, survey of stream cross-sections, and performance of routine water quality laboratory analyses. He has participated in hydrologic assessments for the states of West Virginia and Virginia and numerous independent coal companies.

While attending graduate school at West Virginia University, Mr. DeSalvo was a Research Assistant in the University's Division of Plant and Soil Science. Experience was gained in sampling coal overburdens by core drills, rock chips from air blast drills, and rock chips from highwalls. Laboratory experience in acid-base accounting and characterization of overburden and mine soil was

Verified for accuracy by: Nicholas J. DeSalvo Date: 4/11/53

NICHOLAS J. DeSALVO
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gained while working in the Minesoils Potential Laboratory. Research conducted at the University dealt with revegetation of abandoned minelands and was presented in a thesis entitled, "The Effects of Phosphorus on the Revegetation of Abandoned Minelands."

ASSOCIATIONS

West Virginia Association of Professional Soil Scientists

PUBLICATIONS

Prediction of the Probable Hydrologic Consequences of Mining by Copen Coal, Inc., WV SOAP 055 and 058, 1981. Division of Reclamation, Department of Natural Resources, State of West Virginia.

Prediction of the Probable Hydrologic Consequences of Mining by Mogasco and Galloway, WV SOAP 102, 103, 105, and 123, 1981. Division of Reclamation, Department of Natural Resources, State of West Virginia.

Prediction of the Probable Hydrologic Consequences of Mining by Marson Coal Company, WV SOAP 050, 1981. Division of Reclamation, Department of Natural Resources, State of West Virginia.

Prediction of the Probable Hydrologic Consequences of Mining by Black Mountain Coal Company, WV SOAP 062, 1981. Division of Reclamation, Department of Natural Resources, State of West Virginia.

The Effects of Phosphorus on the Revegetation of Abandoned Minelands. 1981. Thesis, West Virginia University.

Verified for accuracy by: Nicholas J. DeSalvo Date: 9/11/83

CHARLES T. KUFS

EDUCATION

Ohio University: M.S., Geology (1978)
Franklin and Marshall College: B.A., Geology (1976)

WORK SUMMARY

Mr. Kufs is the manager of JRB's Geotechnical Assessment Program Area. In this capacity, he directs a multidisciplinary staff of hydrologists, geologists, engineers, and environmental scientists. Mr. Kufs specializes in the transport, fate, and effects of hazardous materials from waste disposal facilities and in site remediation, and has served as an expert witness.

PROFESSIONAL EXPERIENCE

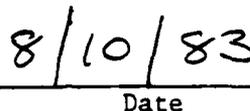
Mr. Kufs is currently directing a project for EPA's Municipal Environmental Research Laboratory on proven and developing procedures and technologies for controlling the migration of hazardous waste leachate plumes. The objective of this project is to examine and prepare a reference handbook on plume dynamics and delineation; plume management technologies including groundwater pumping, subsurface drains, impermeable barriers, and in-situ treatment and other innovative technologies; and technology selection procedures. The handbook will be used by Federal and state Superfund coordinators and contractors in planning and implementing remedial actions at hazardous waste release sites.

Mr. Kufs was the Assistant Project Manager and a supervisory geologist on JRB's groundwater monitoring study of Love Canal. In this role, he assisted in project staffing and coordinating JRB's activities with EPA, New York State, and several other contractors. He also supervised the installation of monitoring wells and the hydrologic testing of the bedrock underlying the Canal area, and coordinated the interpretation of data from the 178-well monitoring system and the production of the final report.

Mr. Kufs led the development of a simple system of rating the hazard potential of waste disposal sites. He also participated in field testing the system at 31 hazardous waste sites in New Jersey. This rating methodology was used by EPA to set its site enforcement priorities, and is the forerunner to systems currently being used by EPA, the U.S. Air Force, and several states. He has also participated as a senior scientist in a variety of technical and policy-related studies in the area of environmental protection including:

Verified for accuracy by:


Charles T. Kufs


Date

CHARLES T. KUFS

page 2 of 5

- Sampling and analysis programs to determine the impact of industrial waste disposal on the groundwater, surface water, and soils of Henderson, NV; and Nitro, WV.
- A study concerning environmentally safe techniques for land disposal of a wide variety of hazardous wastes--including low-level radioactive wastes--which focused on identifying potential contaminant transport routes and on developing strategies for controlling leachate migration from disposal sites.
- An investigation of the best available treatment, storage and disposal techniques for selected ignitable, reactive, and volatile wastestreams in the petroleum refining industry.
- A review of the environmental fates of TCDD, phenoxy herbicides, and several other toxicants.
- RCRA compliance inspections of 9 waste generators in Florida and landfills in Louisville, KY; Quantico, VA; and Crane, ID.
- A review of the use of remote sensing techniques for assessing environmental problems in wetlands.
- An evaluation of the use of "Blacklisting" for enforcing provisions of the Clean Water Act.
- The development of a framework for tracking and evaluating the progress of EPA's research projects on toxic pollutants including the preparation of a simplified user's guide for the Office of Research and Development Information System (ORDIS/PTS).
- Several data base development projects on the chemicals designated by EPA as priority pollutants and on wastewater loadings and treatment costs for EPA's secondary industries.

As a specialist in waste disposal site hydrogeology and aquifer restoration, Mr. Kufs has served as a Senior Technical reviewer on a number of projects including:

- Phase II Installation Restoration Program studies of the Naval Air Development Center in Warminster, PA; the Savanna Army Depot Activity in Savanna, IL; Hill Air Force Base in Salt Lake City, UT; and the Milan Army Ammunitions Plant in Milan, IN.

Verified for accuracy by:

Charles Kufs
Charles T. Kufs

8/10/83
Date

CHARLES T. KUFS

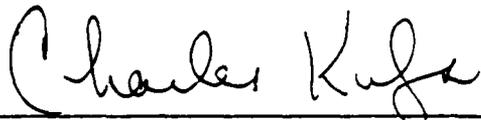
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- Groundwater, surface water, and soil monitoring studies of hazardous waste disposal sites in Lincoln, RI; Southington, CN; Waukegan, IL; and Solley, MD.
- A field research study of the long-term effectiveness of remedial measures implemented at the Lipari waste disposal site in Pittman, NJ.
- A field demonstration study of the block displacement waste site isolation technique in Whitehouse, FL.
- An evaluation of the potential effectiveness of a geophysical investigation of the S-Area hazardous waste dump in Niagara Falls, NY.
- An investigation of design, construction, and operation parameters for zone-of-saturation landfills in Wisconsin.

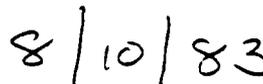
Mr. Kufs has also helped to develop and present a series of training seminars for EPA and state personnel on procedures for investigating hazardous waste disposal sites. He presented sessions on investigating known sites, on evaluating the hazard potential of sites, and on discovering additional sites. In addition, he contributed to the sections of the seminar training manual that dealt with these topics and with collecting background information, sampling, and selecting and evaluation locations for proposed facilities.

Prior to joining JRB, Mr. Kufs participated in a study of nitrate contamination of groundwater in Lancaster County, PA. His responsibilities included: sampling groundwater throughout the county; mapping areas of high nitrate concentrations; determining pollutant migration patterns; and assessing the relative influence of land use, geology, well construction, precipitation, and waste disposal techniques on nitrogen distribution. He has investigated the hydrologic effects of surface coal mining in Harlan County, KY. This work considered soil erosion, slope stability, water quality, and flooding in the light of high level of surface disturbance in the area. Mr. Kufs' responsibilities on this project included project planning, soil and water sampling, mapping, analysis, and documentation. He also conducted a statistical analysis of the characteristics of landslides near Athens, OH. This study required using advanced statistical techniques to relate the size of rotational slumps to geologic, hydrologic, and topographic features which can be observed prior to movement to determine if it is possible to predict the size of potential landslides.

Verified for accuracy by:



Charles T. Kufs



Date

CHARLES T. KUFUS

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PROFESSIONAL AFFILIATIONS

National Water Well Association, Technology Division
American Geophysical Union, Hydrology Division
American Society of Photogrammetry
International Association for Mathematical Geology
Mathematical Geologists of the United States

PUBLICATIONS

Kufs, C., "Leachate Plume Management: A General Discussion." Presentation to be given at the National Solid Waste Management Association's 12th Annual Conference on Waste Technology, Memphis, TN, October 18-20, 1983.

Kufs, C., et al., Leachate Plume Migration Control, a five-volume JRB report prepared for EPA's Municipal Environmental Research Laboratory, EPA contract No. 68-01-3113-Task 38-1, (in preparation, publication expected October 1983).

Kufs, C., "Analysis of Covariance," Chapter 5 in Computer Packages and Research Design, Athens, OH: Ohio University Press, (in press, publication expected October 1983).

Kufs, C., et al., "Procedures and techniques for controlling the migration of leachate plumes" in Proceedings of the Ninth Annual EPA SHWRD Research Symposium, Cincinnati, OH: EPA Municipal Environmental Research Laboratory, 1983.

Kufs, C., et al. "Alternatives to Groundwater Pumping for Controlling Hazardous Waste Leachates," in Management of Uncontrolled Hazardous Waste Sites, Silver Spring, MD: Hazardous Material Control Research Institute, Washington, D.C. 477 pp. 1982.

Kufs, C., et al. "The groundwater monitoring program at Love Canal," JRB report prepared for EPA's Office of Research and Development in conjunction with GCA Corporation, EPA contract number 68-02-3186-TSA3-26, 1981.

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Spooner, P., and Kufs, C., Groundwater Contamination Study of a Site in Nitro, WV. JRB Report prepared for EPA's Office of Water Enforcement, EPA contract No. 68-01-5052-DOW 40-Case 4, 1981.

Verified for accuracy by:

Charles Kufs
Charles T. Kufs

8/10/83

Date

CHARLES T. KUFS

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Kufs, C., et al. "Rating the hazard potential of waste disposal facilities," pp. 30-41 in Management of Uncontrolled Hazardous Waste Sites; Silver Spring, MD: Hazardous Materials Control Research Institute, 285 pp, 1980.

Forman, E., Collins, P., Kufs, C., Boutwell, S., Dickerson, D., Campbell, K., Clear, J., Peters, R., Epstein, P., and Nork, W. "Henderson Industrial Complex Hazardous Waste Site Investigation." JRB Report prepared for EPA's Office of Water Enforcement in Conjunction with ERG, Inc., EPA contract No. 68-01-5052-DOW 23, 1980.

Kufs, C., et al. "Methodology for rating the hazard potential of waste disposal sites," JRB report prepared for EPA's Office of Research and Development, EPA contract No. 68-01-4839, Task 15, 1980.

Kufs, C., et al. "Cleaning up hazardous landfills," Geotimes, vol. 25, no. 9, p. 18, 1980.

Kufs, C. "DAF float from the petroleum refining industry," in Evaluation of Treatment, Storage, and Disposal Techniques for Ignitable, Reactive, and Volatile Wastes, JRB report prepared for EPA's Office of Solid Waste, EPA contract No. 68-01-5160, 1980.

Kufs, C. "Another view of the use of factor analysis in geology," J. Math. Geol., vol. 11, no. 6, p. 207, 1979.

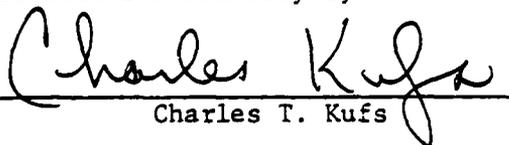
Kufs, C. "Simplified ORDIS/PTS user's guide for assessing projects in the toxic-wastewater control program," JRB report prepared for EPA's Office of Research and Development, EPA contract No. 68-01-4839, Task 10, 1979.

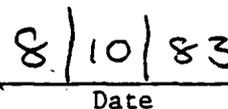
Saltzberg, E., Kufs, C., Kuhlthau, R., and Landesman, J. "A Framework to Track ORD's Research Projects on Toxic Pollutants in Wastewater," JRB report prepared for EPA's Office of Research and Development, EPA contract No. 68-01-4839, Task 10, 1979.

Slimak, K., Arons, A., and Kufs, C. "Assessment of low-level radioactive waste and hazardous waste disposal," JRB report prepared for the Los Alamos Scientific Laboratory, Los Alamos, NM, LASL order number LP8-9760-F-1, 1979.

McGlinchy, D., Bartlett, J., Holzinger, P., Kufs, C., Suzko, P., Griffiths, L., Shaskan, S., Taub, K., and Stanton, S. "Factors influencing nitrate contamination in the groundwater of Lancaster County, PA," National Science Foundation Grant No. SMI-76-08414, 1976.

Verified for accuracy by:


Charles T. Kufs


Date

ANDRIS LAPINS

EDUCATION

University of Pennsylvania: M.R.P., Regional Planning (1980)
University of Pennsylvania: Coursework toward M.S., Geology
Franklin and Marshall College: B.A., Geology (1978)

EXPERIENCE

Mr. Lapins is an environmental scientist with JRB's Waste Management Department. His project involvement has included: coordinating and conducting field investigations at controlled and uncontrolled hazardous waste sites including, supervising the installation of groundwater monitoring wells and groundwater, soil and sediment sampling; data analysis; contaminant transport assessment; hydrogeologic and geomechanical evaluation; and alternative site remediation analysis.

Presently, Mr. Lapins is managing a task for EPA's Emergency Response Division involving updating EPA's "Acceptance List" for dispersants and other chemical countermeasures for oil spills, and reformatting technical test data for each product, which will be included in Subpart H of the National Contingency Plan as Appendix C of 40 CFR 300. The "Acceptance List" and reformatted technical product test data will serve to facilitate an expeditious selection of appropriate chemical countermeasures by On-scene Coordinators in EPA Regional offices and U.S. Coast Guard Districts in the event of a spill.

Mr. Lapins has had considerable experience supervising the drilling and installation of groundwater monitoring wells, and with conducting groundwater sampling and soil/sediment sampling. Collectively, he has played a supervisory role in projects which involved the installation of more than 40 monitoring wells, employing both hydraulic rotary and hollow stem auger drilling methods, and has performed groundwater sampling of more than 70 wells for county and federal clients.

For the U.S. Army, Mr. Lapins investigated and evaluated soil, sediment, and groundwater contamination resulting from munitions manufacturing activities at two Army depots in Illinois and Tennessee as part of the Army's Installation Restoration Program. His involvement in these projects included: developing novel sampling and health and safety procedures for sampling reactive wastes, coordinating field sampling activities with laboratory activities in accordance with the analytical requirements of samples to insure accurate analytical results, supervising the drilling and installation of groundwater monitoring wells, obtaining core and grab samples of sediments containing high concentrations of explosives, groundwater sampling, geotechnical and hydrogeologic data analysis remedial action evaluation, and final report preparation. Mr. Lapins also supervised the installation of groundwater monitoring wells at Hancock Field, New York, for the U.S. Air Force as part of their Installation Restoration Program.

Verified for accuracy by:



Date:

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ANDRIS LAPINS

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For the EPA, Mr. Lapins supervised the drilling and installation of groundwater monitoring wells at the Lipari Superfund Site in New Jersey. His responsibilities included overseeing well drilling and installation operations, enforcement of health and safety protocol (Level A Protection), collection and characterization of core samples and the maintenance of daily logs. Mr. Lapins also participated in a study of groundwater contamination from an active hazardous waste disposal site in Anne Arundel County, Maryland, where he performed groundwater sampling and data analysis. His involvement with groundwater sampling and monitor well installation has given him a working knowledge of EPA and U.S. Army Toxic and Hazardous Materials Agency quality control/quality assurance and chain of custody procedures.

Recently, Mr. Lapins has taken part in an EPA project to evaluate the validity and accuracy of statistical test procedures specified in 40 CFR 265.93 of RCRA for monitoring groundwater quality at Interim Status facilities. His role in this project included: reviewing site information and groundwater analytical data for facilities throughout the country, providing hydrogeologic evaluations, and data coding for computer analysis.

For the EPA's Office of Solid Waste, Mr. Lapins has taken part in the development of a large computerized data base for characterizing wastes and assessing waste management practices within several segments of the Organic Chemical Manufacturing Industry. The data base which characterizes and tracks manufacturing processes, residual streams, and waste management practices will provide technical support to EPA for the development of industry specific guidelines (RCRA Phase III regulations) for hazardous waste management. Mr. Lapins' role in the project has included reviewing RCRA 3007 Questionnaires and sampling and analysis data, and coding manufacturing processes, process products, residual streams, and waste management practices for chlorinated organic, industrial organic, dye and pigment, and plastic and resin manufacturing industries. Mr. Lapins also aided in the establishment of a computerized status matrix for the EPA to track the progress of RCRA delisting petitions through regulatory review. His responsibilities in this project included petition review and data coding for computer input.

Prior to joining JRB, Mr. Lapins was employed as an environmental scientist by Ecolsciences, Inc., where he managed task assignments and prepared report elements for EIS's and environmental assessments specializing in the inventory, analysis, and evaluation of geologic, topographic, soil, and hydrologic conditions with special emphasis on groundwater impact assessments. A large segment of his responsibilities included performing siting and site suitability/feasibility analysis for municipal wastewater treatment facilities, deep well wastewater injection and land application of municipal wastewater and sludge at sites in Pennsylvania, Maryland, and Delaware. In addition, Mr. Lapins participated in the development of environmentally sensitive growth management plans for Stafford Township, Ocean County, New Jersey, where he inventoried and evaluated the geology, soils, hydrology, vegetation and wildlife of the region and delineated areas most suitable for commercial, industrial, residential and recreational land uses.

Verified for accuracy by:

Andris Lapins

Date:

11/83

ANDRIS LAPINS

Page 3 of 3

PUBLICATIONS

Draft Environmental Impact Statement, Currituck County, North Carolina Outer Banks Access, March, 1981. Department of Transportation, Raleigh, North Carolina.

Environmental Assessment of Construction Grants Projects, January, 1979. U.S. Environmental Protection Agency, Office of Water Program Operations, Washington, D.C. (revisions).

Draft Environmental Impact Statement, Little Patuxent Water Quality Management Center (Savage Plant), Howard County, Maryland, October 1981. U.S. Environmental Protection Agency, Philadelphia, Pennsylvania.

Draft Environmental Impact Statement, Leola Sewer Authority Facilities Plan, Upper Leacock Township, Pennsylvania, October 1981. U.S. Environmental Protection Agency, Philadelphia, Pennsylvania.

Draft Environmental Impact Statement, Wastewater Management Facilities, City of Rehoboth Beach, Sussex County, Delaware, January 1982. U.S. Environmental Protection Agency, Philadelphia, Pennsylvania.

Draft Environmental Impact Statement, Wastewater Management Facilities, City of Lewes, Sussex County, Delaware, October 1981. U.S. Environmental Protection Agency, Philadelphia, Pennsylvania.

Verified for accuracy by:

Andris Lapins

Date:

11/19/83

JOHN P. MEADE

EDUCATION

Manhattan College: B.C.E., Civil Sanitary Engineering (1955)

SUMMARY

Mr. Meade has 25 years of experience in sanitary, industrial hygiene, and bioenvironmental engineering, and is certified as an Associate Public Health Engineer in the State of New York. He is a Senior Project Manager at JRB, working as a senior technical reviewer for a multi-task contract for remedial actions on uncontrolled hazardous waste sites. He joined JRB as the Project Manager of two Department of Labor (DOL) contracts to provide OSHA with on-site consultation services to assist small businesses in Pennsylvania. Prior to joining JRB, Mr. Meade spent 24 years on active duty in the U.S. Air Force (USAF). His last post there was Vice Commander of the USAF Occupational and Environmental Health Laboratory (OEHL). In that position, he assisted the Commander in the direction and monitoring of OEHL's daily efforts and was also involved in the preparation of an annual budget in excess of \$4 million for OEHL operation. His other Air Force experience includes serving as Chief of the Consultant Services Division, USAF OEHL, and as Director for Categorical Programs for the Department of Defense. This last position included serving as the DOD representative on the Federal Task Force for Hazardous Materials Management.

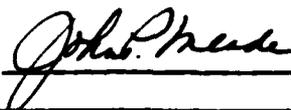
EXPERIENCE

December 1980 to present: JRB Associates

Mr. Meade, under the terms of an EPA contract addressing the investigation of remedial actions of uncontrolled hazardous waste sites, has functioned as one of JRB's senior technical reviewers. One of his assigned tasks is to review the majority of twenty detailed case study analyses selected from an inventory of nationwide remedial action sites. The sites were selected based upon their overall priority and the remedial actions were evaluated from both their effectiveness in meeting the objectives of the site action and also from a cost standpoint.

Mr. Meade joined JRB as Project Manager in charge of the Job Safety and Occupational Health Program for the State of Pennsylvania. At the time of the award, Mr. Meade immediately established a program office in Pennsylvania and assembled a staff of senior experienced professionals. Because of his extensive managerial experience, the consultation program in Pennsylvania has continued with no interruption of service to small businesses located in the State. The technical reports produced have been of the highest quality and the cost per consultation has been reduced to less than one-half that of the previous consultant. This has resulted in net savings to DOL, as well as

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continued excellent services. In addition, the end of the year saw three times as many consultations performed using one-half as many professionals; another cost-avoidance for DOL.

April 1978 to December 1980: U.S. Air Force Occupational and Environmental Health Laboratory

As Vice Commander of the USAF OEHL, Mr. Meade directed and monitored the daily efforts of 150 professional and support personnel, including assisting the AIMA-certified laboratory to ensure compliance with applicable Federal, state, and local standards. He was also responsible for preparing portions of an annual budget in excess of \$4 million for the operation of the USAF OEHL. In this effort, he was assisted by four Division Chiefs.

For 2 years, Mr. Meade was the Chief of the Consultant Services Division of the OEHL. In this position, he managed and supervised 60 professionals, including 12 industrial hygienists, 7 air and 8 water pollution abatement engineers and scientists, with a budget of \$913,000. He had responsibility for managing almost fifty environmental projects within the Division. The Division had integrated conventional safety, hazards monitoring, and safety and health control functions. Mr. Meade also provided technical, industrial hygiene, and engineering oversight and direction of U.S. Air Force hazard abatement efforts, conducted occupational safety and health training of managers and employees, and developed programs to monitor and control exposure of employees to occupational safety and health hazards inherent in Air Force Operations. He was responsible for developing a computerized industrial hygiene information system that will be part of an overall occupational health information system and will be used Air Force wide. He also administered four requirements, with a 3-year program of more than \$16 million.

July 1973 to April 1978: U.S. Department of Defense

For the U.S. Department of Defense (DOD), office of the Assistant Secretary for Energy, Environment, and Safety, Mr. Meade was the Director of Categorical Programs for 5 years. In this position, he provided special technical expertise to the Deputy Assistant Secretary of Defense in the areas of hearing conservation and noise abatement, management of toxic and hazardous materials, and military construction programs to comply with applicable Environmental Protection Agency (EPA) and DOL legislative mandates. During this time, he also represented DOD on the Federal Task Force for Hazardous Materials Management and the Executive Steering Committee sponsored by EPA Region IX. As the DOD representative, he was responsible for conducting a regional inventory of DOD hazardous wastes; exploring, developing, and recommending courses of action to safely manage DOD hazardous materials; identifying, developing, and disseminating recommended plans of action for environmentally safe management (transportation, storage, resale, recycling, reuse, modification, and ultimate disposal) of these materials; coordinating interagency actions relating to hazardous waste management; coordinating final disposition actions relating

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to hazardous waste management; and coordinating final disposition actions with appropriate state agencies. The primary objective of the Task Force was to provide a mechanism for technology and information transfer to all regional agencies concerned with hazardous waste management. Additionally, he served as the DOD focal point for the control of PCBs. He was lead member on several DOD-EPA working groups to develop guidelines for the appropriate disposal methodology for PCBs and to identify a safe transition to the use of less toxic materials. He also served as a key DOD member in the disposal actions of both DDT and Herbicide Orange. From 1975-1977, Mr. Meade was the DOD subcommittee Chairman for the management of hazardous wastes for the Inter-agency Committee on Resource Recovery.

Mr. Meade's other accomplishments included coordinating more than \$1 billion for air and water pollution abatement programs in 4 years; developing policy for the control of toxic substances; initiating an expanded safety and occupational health program, including new procedures to implement the Occupational Safety and Health (OSH) Act; developing plans for occupational health and industrial hygiene programs; initiating procedures and mechanisms for early review and evaluation of proposed National Institute for Occupational Safety and Health (NIOSH) criteria documents and proposed Department of Labor Standards; recommending goals for the occupational health program, and coordinating budget requests to allocate resources within fiscal constraints.

July 1968 to July 1973: U.S. Air Force

Previously, Mr. Meade was a staff bioenvironmental engineer in the Life Sciences Division of the U.S. Air Force Inspection and Safety Center. He applied bioenvironmental engineering principles in formulating health and safety policies and programs in flight, ground, explosive, and missile and space operations; reviewed accident and incident reports to identify environmental deficiencies and recommend corrective actions; and prepared studies and special reports on safety and OSHA problems for dissemination to Air Force agencies. He also evaluated several new weapons systems (Airborne Test Bed and Gas-Dynamic Laser) to determine whether the program, which might affect personnel or the environment, had timely Environmental Impact Statements; he conducted studies concerning ground egress of air crews and passengers involved in survivable crashes; and he served as Air Force representative on all projects involving cockpit/cabin flammability.

PROFESSIONAL AFFILIATIONS

American Industrial Hygiene Association
American Conference of Governmental Industrial Hygienists
Aerospace Medical Association
Conference of Federal Environmental Engineers

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4/7/83

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EDWARD W. REPA

EDUCATION

West Virginia University, Ph.D. Hydrology (1981)
West Virginia University, M.S.F. Hydrology (1977)
Baldwin-Wallace College, B.S. Biology (1975)

EXPERIENCE

Dr. Repa is a senior hydrologist with JRB's Waste Management Department. He has a wide range of experience involving surface and ground water assessments and hydrologic modeling. He is presently managing and acting as principal investigator for a research project that is assessing the performance of remedial actions (i.e., slurry wall and cap) at a hazardous waste site. This project included developing a monitoring plan to determine the effectiveness of the remedial actions, installing groundwater monitoring wells, and collecting hydrologic data over the long term to provide a data base. The project is very unique in that little long term monitoring of the effectiveness of slurry walls has been performed. Projects recently completed by Dr. Repa include developing a manual for the use of groundwater pumping techniques in contaminant plume containment and a report on the availability and applicability to groundwater transport models for hazardous waste facilities.

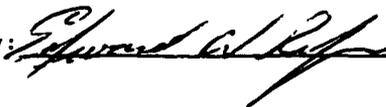
Prior to joining JRB, Dr. Repa was Manager of UTD Corporation's Natural Resources Division. His principal duties with UTD concerned management of hydrologic projects for coal mines, refuse areas and preparation plants including work funded by OSM's Small Operators Assistance Program (SOAP). These projects included predictions of surface and groundwater contamination potential with the use of models. While with UTD, he was also responsible for the establishment and management of a water quality testing laboratory which met OSM standards for certification and West Virginia Department of Natural Resources certification. He has done hydrologic assessments for the states of West Virginia and Virginia and numerous independent coal companies including the Pittston Coal Group, Slab Fork Coal Company and Jewell Ridge Coal Corporation.

While a doctoral candidate at West Virginia University, Dr. Repa was a Research Assistant in the University's Division of Forestry. Duties at the University included hydrologic research, teaching and laboratory supervision.

PUBLICATIONS

Alternatives to Ground Water Pumping for Controlling Hazardous Waste Leachates, 1982, National Conference on Management of Uncontrolled Hazardous Waste Sites, Washington, D.C., p. 146-149.

Verified for accuracy by:



Date:



Procedures and Techniques for Controlling the Migration of Leachate Plumes, 1983, Ninth Annual Research Symposium, Land Disposal, Incineration and Treatment of Hazardous Waste, USEPA, Cincinnati, May 2-4, 1983.

The Establishment of Guidelines for Modeling Groundwater Contamination from Hazardous Waste Facilities, 1982, EPA-OSW, Washington, D.C.

Prediction of the Probable Hydrologic Consequences of Mining by the Demotto Peerless Coal Company, WV SOAP #001, 1981, Division of Reclamation, Department of Natural Resources, State of West Virginia.

Prediction of the Probable Hydrologic Consequences of Mining by the Lehigh Corporation, WV SOAP 020, 1981, Division of Reclamation, Department of Natural Resources, State of West Virginia.

Prediction of the Probable Hydrologic Consequences of Mining by the Winsor Pittman Coal Company, WV SOAP 012, 1981, Division of Reclamation, Department of Natural Resources, State of West Virginia.

Prediction of the Probable Hydrologic Consequences of Mining by Copen Coal, Inc., WV SOAP 055 and 058, 1981, Division of Reclamation, Department of Natural Resources, State of West Virginia.

Prediction of the Probable Hydrologic Consequences of Mining by Asco Coal Inc., WV SOAP 027, 1981, Division of Reclamation, Department of Natural Resources, State of West Virginia.

Prediction of the Probable Hydrologic Consequences of Mining at the Double D. Enterprises, Inc. Mine, 1981, Division of Mine Land Reclamation, Department of Conservation and Economic Development, State of Virginia.*

Rainfall Catch Errors Associated with Circumambient Obstructions, 1981, Dissertation, West Virginia University.

Rainfall Additaments to Subsurface Water in a Young Pine Plantation, 1978, Water Resource Bulletin 15(2): 381-6.

Normal Precipitation in West Virginia, 1977, West Virginia Agriculture and Forestry 7(2):12-8.

The Effect of Circular Obstructions on Rainfall Catch, 1977, Thesis, West Virginia University.

*Numerous other hydrologic assessments performed; full listing available upon request.

Verified for accuracy by: Edward W. Ruff Date: 10 April 83

ALFRED N. WICKLINE

EDUCATION

West Virginia University: M.S., Agronomy/Soil Science (1978)

West Virginia University: B.S., Agriculture (Animal Science) (1975)

EXPERIENCE

Mr. Wickline is a senior soil scientist with JRB's Waste Management Department. He has over six years experience in dealing with disturbed lands, with emphasis on surface and underground mining operations and drilling, coring, and logging procedures. Mr. Wickline also has experience in the installation of wells for monitoring water potentially contaminated with hazardous materials. Mr. Wickline recently completed field supervision of the installation of over 20 wells for monitoring the movement of hazardous materials in the groundwater.

Prior to transferring into JRB's Waste Management Department, Mr. Wickline was managing the geologic/hydrologic and soils evaluation for over 150 mining operations in four appalachian coal producing states. These evaluations and studies were concerned with all aspects of mining from pre-mine planning, overburden analysis, and recommendations concerning reclamation and revegetation to remedial actions for the control and/or abatement of acid mine discharge.

Mr. Wickline also served as a supervisory geologist for the installation of wells in an extensive groundwater monitoring project at Love Canal in Niagara Falls, New York. Mr. Wickline has also been involved in coring and logging operations for oil and gas development for the Department of Energy, Seneca Nation of Indiana and various private industry clients.

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Alfred N. Wickline

Date: 5/19/83

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