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U.S. Army Environmental Center

FORT DIX REMEDIAL INVESTIGATION/FEASIBILITY STUDY FOR 13 SITES

FINAL TECHNICAL PLAN
DATA ITEM A004

CONTRACT NO. DAAA15-91-D-0008
TASK ORDER 0006

U.S. Army Environmental Center
Aberdeen Proving Ground, Maryland

SEPTEMBER 1995

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1.0 INTRODUCTION

The United States Army has tasked ABB Environmental Services, Inc. (ABB-ES) to prepare project plans for conducting Remedial Investigations/Feasibility Studies (RIs/FSs) for 13 Sites at the Fort Dix Army Installation (Ft. Dix), located in central New Jersey (Figure 1). Work for this assignment will be performed under Contract No. DAAA15-91-D-0008, Task Order 6.

In accordance with the requirements of this task, a RI/FS Technical Plan, Quality Assurance Project Plan (QAPP), and a Health and Safety Plan (HASP) are included with this submittal. The work plans prepared for this task order are based on:

a. The objectives of preparing project plans for conduct of a RI/FS at the 13 Sites listed in Subsection 1.1;

b. Evaluation of background information on Ft. Dix provided by the United States Army Environmental Center (USAEC);

c. Verbal communications with USAEC and Ft. Dix personnel;

d. Results of a August 17 - August 19, 1993 site visit by ABB-ES; and

e. Information derived during a meeting with representatives of USAEC, Ft. Dix, U.S. Environmental Protection Agency (USEPA), and New Jersey Department of Environmental Protection (NJDEP) on September 28, 1993.

This Technical Plan summarizes existing data and background information currently available on the 13 Sites and provides a detailed discussion of the scope of investigative activities planned for the RIs at the 13 Sites as well as a discussion of the programs that will support the investigation (e.g., Quality Assurance/Quality Control [QA/QC], Health and Safety, Data Management). The following paragraphs address several issues which have shaped the development and structure of this Technical Plan.

This Technical Plan is structured similar to the Work Plan and Sampling Design Plan developed for the Ft. Dix Environmental Investigation/Alternatives Analysis (EI/AA) (ICF, 1993) and the Technical Plan developed for the Ft. Dix RI/FS for the MAG-1

Area (ABB-ES, 1994a). Data collected as a result of some sampling efforts conducted in the Ft. Dix EI/AA and MAG-1 Area RI will be used in the development of this RI including:

1. Background surface water, sediment, subsurface soil, and groundwater samples collected near Brindle Lake (additional background samples will be proposed as part of a base-wide Background Sampling Program).

2. Surface water and sediment samples collected from Dogwood Lake where this RI proposes additional work to characterize previously detected total petroleum hydrocarbon (TPH) contamination in groundwater in this area.

The investigations within this Technical Plan are being conducted under provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), with the USEPA as lead agency. Several different protocols/methodologies are presented in this RI to address fieldwork activities, laboratory sample analyses, data validation, and performance of risk assessments. This integration of different protocols/methodologies addresses issues and concerns raised by the USAEC, USEPA, and NJDEP. In general, the most conservative protocols/methodologies are utilized. The following is a list of agencies' protocols/methodologies to be followed:

1. drilling permits - NJDEP;

2. borehole advancement/abandonment - NJDEP;

3. drilling materials - USAEC;

4. decontamination - USEPA;

5. QA\QC sampling - USEPA frequencies;

6. laboratory methodologies - USAEC (where available, otherwise USEPA); at a minimum, the analysis will quantify Target Compound List (TCL) volatile and semivolatile compounds and Target Analyte List (TAL) metals and cyanide as appropriate;

7. data validation - USAEC or USEPA depending on the laboratory methodology used;

8. risk assessment - USEPA;

9. cleanup goals - USEPA risk based (NJDEP cleanup standards to be used as to be considered [TBC] guidance).

Within this Technical Plan the number of explorations, their depths and sampling frequencies are estimated for planning purposes. As this program utilizes extensive field screening methods, it should be recognized that field modifications to the estimated locations, depths, and sampling frequencies may need to be made as the screening data becomes available. This will enhance the quality and comprehensive nature of the RI.

This Technical Plan makes substantial use of field screening techniques to evaluate contamination in the various media at Ft. Dix. Field screening analyses are outlined in the QAPP including methodologies for VOCs, pesticides, petroleum hydrocarbons, herbicides, and explosives. The objectives of the screening program include the following:

- to provide real time on-site data to direct field investigations, select monitoring well screen placement, and to aid in selection of samples for off-site laboratory analysis;

- to provide USEPA Level II quantitative data on VOCs, pesticides, and TPH which will be used in conjunction with off-site laboratory results to evaluate contaminant distribution at the 13 sites;

- to provide data on the presence or absence of herbicides and explosives at a subset of sites; and

- to be used as support data during the development future planning documents including the RI and FS reports, No Further Action documents, and RODs.

Field screening allows for relatively rapid data collection and analyses, although the quality of the data is typically lower than that associated with laboratory analyses. In accordance with the NJDEP Field Analysis Manual (NJDEP, 1994), this Technical

Plan generally calls for at least 10 percent confirmatory split samples from each media type per site to be submitted for laboratory analyses. Selection of the confirmatory samples will, to the extent practicable, be based on field screening results and should include samples exhibiting site-related contamination. Some field screening samples exhibiting non-detect will be submitted as well. With the exception of VOC analyses, soil samples will be homogenized prior to split-sample collection. Soil samples submitted for field and analytical laboratory volatile organic compound (VOC) analyses will not be homogenized. This may result in substantially different field screening and laboratory analytical results for VOCs in soil. The selection of specific samples for laboratory analysis will be conducted on a daily basis upon reviewing the field screening results and geologic conditions encountered. The criteria typically used to select samples for laboratory analysis include:

- Samples exhibiting visual or olfactory evidence of contamination;
- Elevated PID or field screening results;
- Samples collected at the top/bottom of contamination;
- Samples collected at geologic boundaries;
- Samples having anomalous field screening results; and
- Samples collected in clean zones, or those having no detects

1.1 TASK OBJECTIVES

The primary objective of this task is to prepare project plans for conducting RI/FS activities for 13 Sites at Ft. Dix, New Jersey. These 13 Sites have previously been investigated and have been assigned designations Site 2 through Site 6 and Site 8 through Site 15. Site 1 (the MAG-1 Area) and Site 7 (the NPL Landfill) are being investigated under separate work efforts. The 13 Sites included in this work effort, along with their historical site numbers and site identification (ID) abbreviations, are as follows:

- Petroleum, Oil, Lubricants (POL) Area (Site 2, PL)
- Fire Training Tanks Area (Site 3, FT)

- Golf Course Leaking Tank Area (Site 4, GT)
- Transportation Motor Pool (Site 5, TP)
- Armament Research Development Center (ARDC) Test Site (Site 6, AR)
- Pesticide Control Shop (Site 8, PC)
- New Egypt Armory (Site 9, NE)
- Range Landfill (Site 10, RL)
- ANC-9 Landfill (Site 11, A9)
- ANC-2 Disposal Area (Site 12, A2)
- Boiler Blowdown Area (Site 13, BB)
- Area North of Dogwood Lake (Site 14, DL)
- Golf Course Pesticide Mixing and Storage Area (Site 15, GP)

Figure 2 shows the locations of the 13 Sites at Ft. Dix. The two character, alphanumeric Site ID abbreviations are explained in Section 17.0 of this Technical Plan.

1.2 SCOPE OF WORK

Field activities under this task to meet the objectives described above are summarized on a site-by-site basis in Table 1. The following is a summary of investigative activities:

- Geophysical Investigation. Geophysical surveys using ground penetrating radar (GPR) and magnetometer and terrain conductivity (TC) will be conducted at selected sites to establish the boundaries of disposal areas, and the need for and location of soil borings, test pits, and monitoring wells.

- Soils Investigation. Surface and subsurface soil samples will be collected to evaluate contamination of soils at select sites. Field screening of soils will be performed at select sites using field gas chromatography (GC), infrared spectroscopy (IR), atomic absorption (AA) and immunoassay test kits to evaluate potential contaminant distribution. A gamma ray scintillating detector and GM pancake probe will also be used for assessment of radiological parameters at select sites.

- Hydrogeologic Investigation. Field screening using screened hollow-stem augers (HSAs) or a Geoprobe system will be employed at select sites to evaluate the need for additional monitoring wells. Analysis of groundwater samples collected during field screening will be performed with a field GC, IR, AA, and immunoassay test kits.

  Groundwater samples for chemical analysis will be collected from newly installed and existing wells. Groundwater elevation measurements will be taken at new and existing monitoring wells to establish groundwater flow directions. Slug testing will be conducted at all newly installed wells to develop estimates of hydraulic conductivity. Aquifer testing will be performed at the Golf Course Leaking Tank Area to provide information for selection of potential remedial alternatives at the site. Production well pumping will be performed at the ARDC site (production well FTDIX-13) to assess hydraulic communication.

- Surface Water and Sediment Investigation. Surface water and sediment samples will be collected to evaluate impacts to drainage ditches and water courses near selected sites, as appropriate. In addition, staff gauges will be installed at select sites and measurements taken at these locations during groundwater level measurements.

All project activities will be performed in accordance with USAEC QA/QC, geotechnical, and data management protocols, as well as State of New Jersey and USEPA Region II requirements.

1.3 TECHNICAL PLAN ORGANIZATION

This Technical Plan has been organized into major sections as follows:

• Section 1.0	Introduction
• Section 2.0	Site Background
• Section 3.0	POL Area - Site 2 (PL)
• Section 4.0	Fire Training Tanks Area - Site 3 (FT)
• Section 5.0	Golf Course Leaking Tank Area - Site 4 (GT)
• Section 6.0	Transportation Motor Pool - Site 5 (TP)
• Section 7.0	ARDC Test Site - Site 6 (AR)
• Section 8.0	Pesticide Control Shop - Site 8 (PC)
• Section 9.0	New Egypt Armory - Site 9 (NE)
• Section 10.0	Range Landfill - Site 10 (RL)
• Section 11.0	ANC-9 Landfill - Site 11 (A9)
• Section 12.0	ANC-2 Disposal Area - Site 12 (A2)
• Section 13.0	Boiler Blowdown Area - Site 13 (BB)
• Section 14.0	Area North of Dogwood Lake - Site 14 (DL)
• Section 15.0	Golf Course Pesticide Mixing and Storage Area - Site 15 (GP)
• Section 16.0	Technical Approach for Field Investigation
• Section 17.0	Analytical Program

• Section 18.0	Quality Assurance/Quality Control
• Section 19.0	Data Management
• Section 20.0	Risk Assessment
• Section 21.0	Preliminary Identification of Potential Applicable or Relevant and Appropriate Requirements
• Section 22.0	Health and Safety
• Section 23.0	Remedial Investigation/Feasibility Study and Reporting

Sections 3.0 through 15.0 present previous investigations and the proposed scope of work for each of the 13 Sites, including rationale, and the location and number of environmental sampling points. Section 16.0 presents the technical approach for the field investigation at the 13 Sites. This section describes the details of the investigative techniques and analyses of the proposed field program for the 13 Sites, including geophysics, field screening, geotechnical investigations (soil sampling, borings, monitoring wells, surface water/sediment sample collection, and aquifer testing), surveying, and groundwater modeling.

Figures and tables are presented at the end of the text sections as indicated by the report tabs and are numbered sequentially through the Technical Plan. Not all locations of environmental samples collected during previous investigations are indicated on the figures; only sample collection points entered in to the USAEC's Installation Restoration Data Management Information System (IRDMIS) prior to October 1993 are indicated on the figures. Locations of other sample collection points can be found in the reports referenced in Sections 3.0 through 15.0, in the subsections entitled "Previous Investigations."

2.0 SITE BACKGROUND

2.1 SITE LOCATION AND HISTORY

Ft. Dix is located in Burlington and Ocean Counties, New Jersey, approximately 20 miles southeast of Trenton (Figure 1).

Ft. Dix is a permanent Class 1 Army installation, occupying approximately 31,110 acres. It consists of a Cantonment Area, a Training Area, and a Range and Impact Area. The Cantonment Area occupies approximately one-third of the installation (Figure 3). A much smaller area southeast of the Cantonment Area is designated the Training Area, while the installation's eastern two-thirds is designated the Range and Impact Area. McGuire Air Force Base is situated between the Cantonment Area and the Range and Impact Area.

Ft. Dix, initially called Camp Dix, was established on July 18, 1917, as a cantonment area and training post for World War I troops. After the war, the camp served as a demobilization center, and from 1922 to 1926 it was used as a training ground for Army, Army Reserve, and National Guard units. The camp was inactive from 1926 to 1933, but from 1933 to 1939 it served as a reception, discharge, and replacement center for the Civilian Conservation Corps. In 1939, the camp became a permanent Army installation, and its name was changed to Ft. Dix. The installation again served as a reception and training center during World War II, and after the war it was used as a separation center. In 1947, Ft. Dix was designated as a basic training center and is currently used for that purpose. In 1956, the post was officially designated the U.S. Army Training Center and Ft. Dix.

Prior to October 1992, Ft. Dix was a government-owned installation under the jurisdiction of the U.S. Army Training and Doctrine Command (TRADOC). Its mission was to conduct Basic Combat Training and Advanced Individual Training, and to provide Combat Support and support to Reserve and National Guard Units. In October 1992, the major command was shifted to Forces Command (FORSCOM).

2.2 PHYSICAL SETTING

2.2.1 Site Physiography and Topography

Ft. Dix is located in the northern portion of the Atlantic Coastal Plain Physiographic Province, which is characterized by flat-to-gently rolling topography. Elevations range from about 70 feet to slightly over 200 feet above mean sea level (MSL). The Training Area and the western 75 percent of the Range and Impact Area are flat, with elevations varying between 80 and 100 feet MSL. Taylor's Mountain, located in the northwestern corner of the Range and Impact Area, is an exception to the generally flat topography of this section of the installation, rising about 50 feet above the surrounding terrain. The flat central portion of the installation is bounded on the east by a strip of higher ground measuring between one and two miles wide. Average elevation of this area is approximately 170 feet MSL with a local peak of 208 feet MSL. In the west, elevations rise steadily to between 170 and 180 feet then fall back to 70 feet MSL along the western boundary.

2.2.2 Climatology

The Ft. Dix area is characterized by moderate temperatures, precipitation, and wind velocities. The average annual temperature in the area is 54 degrees Fahrenheit (°F), based on 43 years of data recorded at the nearby McGuire Air Force Base weather station. January is the coldest month (average temperature of 31°F) while July is the hottest month (average temperature of 76°F). According to the Air Force Weather Station Climatic Brief of January 1989, the coldest temperature recorded at the climate station was -8°F and the highest 102°F.

The average annual precipitation in the area is 44 inches. Precipitation is fairly well distributed throughout the year, with the average monthly precipitation ranging from 2.9 inches in February to 4.7 inches in August.

The prevailing wind direction is from the south during the summer months and from the west and northwest during winter. Wind speeds in the area average approximately 7 miles per hour (mph), but instantaneous speeds of up to 87 mph have been recorded.

2.2.3 Soils

At least six major soil associations are present at Ft. Dix. The three associations covering most of the areas of concern are the Freehold-Holmdel-Adelphi association, the Downer-Sassafras Woodstown association, and the Lakehurst Lakewood-Eversboro association. The first two associations consist of soils that are well-to-moderately well drained and have moderate-to-moderately slow permeabilities. The third association is somewhat poorly-to-excessively drained with permeabilities ranging from rapid to moderately rapid. Subsoils range from sandy clayey loam to sand.

2.2.4 Geology

Ft. Dix is located in the Atlantic Coastal Plain Physiographic Province, approximately 15 miles east of the Fall Line separating the Piedmont and Coastal Plain Physiographic Provinces. The wedge-shaped mass of sedimentary strata comprising the Coastal Plain rests unconformably on the eastward continuation of the crystalline rocks of the Piedmont Physiographic Province. Sedimentary strata and the surface with the crystalline basement dip to the southeast. The approximate depth to the crystalline basement in the Ft. Dix area is 1,000 feet. Figure 4 is the site geologic map. Generalized subsurface stratigraphy including hydrogeologic units is shown in Figure 5. The near-surface geologic setting as presented in the 1989 U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) Preliminary Assessment/Site Investigation (PA/SI), are described below.

Quaternary Deposits. The Quaternary Period began about a million years ago with the advance of the Pleistocene glaciers toward Burlington County. The last glacial front began to retreat less than 20,000 years ago, marking the close of the Pleistocene Epoch. Glaciers did not cover the Ft. Dix area, but they played a part in its geological history. Sand, gravel, and clay materials were supplied by the glacial - meltwaters and deposited in the stream valleys during the Quaternary Period. Deposits of Quaternary age overlie much of the older formations. These deposits include remnants of fluvial sand and gravel capping the higher hilltops and low, broad alluvial plains on which Holocene stream channel and floodplain deposits developed. Available information indicates that the western portion of the post, including a major portion of the Cantonment Area, has a thin Quaternary deposit from early and interglacial times. This unit, termed the Bridgeton Formation, is composed of gravel and sand, in part solidified by iron oxide, capping higher hills and divides. The thickness of the Bridgeton Formation is reported to range from 0 to

40 feet and is usually hydraulically connected to underlying Beacon Hill and Cohansey Formations (Rush, 1968).

2.2.4.1 Cohansey Formation. The Cohansey Formation of Pliocene/Miocene age underlies Quaternary deposits or crops out in all of the southeastern half of Burlington County, including portions of the Ft. Dix Cantonment and Range and Training areas. The outcrop/subcrop area in Burlington County is approximately 46 percent of the total county area. The Cohansey Formation is described by Minard and Owens (1962) from an outcrop in the Columbus Quadrangle (United States Geologic Survey [USGS] 7.5-minute series-topographic map) as being a light gray to yellowish brown, medium-coarse grained, ilmenitic, pebbly, quartz sand with local pink and white kaolinitic beds in the upper part of the formation. Ironstone is locally present, such as at Taylor's Mountain and Arneys Mount. A characteristic feature of the formation in outcrop is its common horizontal and cross-stratification.

The lithology of the formation is variable, ranging from clayey quartz silt to gravelly quartz sand. The thickness of the Cohansey Formation ranges from approximately 50 feet in the Ft. Dix area to 250 feet southeast and downdip of the Ft. Dix outcrop area. The average strike of this unit is N80E with a dip of 8 to 12 feet per mile (ft/mi) to the southeast. The lower two-thirds of the formation is composed of thick gravelly quartz sand beds and thinner silt beds. The upper third is mostly sandy silt. The Cohansey Formation unconformably overlies the Kirkwood Formation. Glauconite, which is indicative of a deeper marine depositional environment, is not present in the Cohansey Formation and it is generally assumed that the Cohansey Formation represents beach and near-shore marine deposits. The environment of deposition for the Cohansey Formation, however, is subject to various interpretations. Markewicz et al. (1958) interpret the Cohansey Formation as being a large alluvial fan deposit. This is supported by its common coarse texture, poor sorting and cross-bedding. Owens and Minard (1960) favor a beach depositional environment and discount the alluvial fan environment because of the widespread nature of the deposit.

2.2.4.2 Kirkwood Formation. The Kirkwood Formation was deposited during the Miocene Epoch of the Tertiary Period. This formation crops out in a thin belt along the western boundary of Ft. Dix and a larger, irregular shaped area in the Range and Training areas. The Kirkwood Formation underlies the Cohansey Formation in the Ft. Dix area. Minard and Owens (1962) described the Kirkwood Formation from an outcrop in the Columbus Quadrangle where they divided the formation into two units: a basal unit of brownish-black clayey silt to very fine-grained quartz sand, and a thicker upper unit of very light-gray to light yellow orange, very fine to fine grained, well-sorted quartz sand. Muscovite, ilmenite, and lignite are important, minor constituents of both units. Small amounts of glauconite have been found in the basal unit.

The Kirkwood Formation thickens downdip to form a wedge-shaped unit. The formation has an average strike of N75E and dips to the southeast at a rate of 11-25 feet per mile (ft/mi.). The thickness of the formation in the outcrop in the Columbus Quadrangle, as reported by Minard and Owens (1962), is as much as 50 feet, with the basal unit measuring as much as 15 feet. From boring logs in test wells drilled downdip, the Kirkwood Formation thickens to 250 feet southeast of the Ft. Dix area.

The Kirkwood Formation unconformably overlaps the Hornerstown, the Vincentown, and Manasquan Formations in Burlington County, and is unconformably overlain by the Cohansey Formation. Fossils and glauconite found in the Kirkwood Formation indicate it to be of marine origin.

2.2.4.3 Manasquan Formation. The Manasquan Formation was deposited during the Eocene Epoch of the Tertiary Period. This formation crops out in a thin belt along the western boundary of Ft. Dix and at a small area near Brindle Lake. The Manasquan Formation underlies the Kirkwood Formation and is described by Owens and Minard (1960) as being a clayey, quartz-glauconite sand. The Manasquan Formation thickens and dips to the southeast to form a wedge-shaped unit. The formation thickness at Browns Mills, New Jersey, varies from 10 to 15 feet along the southern Ft. Dix boundary and increases to a maximum of 270 feet downdip (Rush, 1968).

This formation is the least exposed unit in the Coastal Plain of New Jersey. The Manasquan Formation strikes in a N 60E direction and dips to the southeast at a rate of 15-31 ft/mi.

2.2.4.4 Vincentown Formation. The Vincentown Formation was deposited during the Paleocene Epoch of the Tertiary Period. This formation crops out in a thin belt between Juliustown and Lewistown in the southwest area of the Ft. Dix Military Reservation. Throughout the region, the Vincentown crops out generally in a one to two mile wide belt immediately southeast of the Hornerstown Formation outcrop area. The Vincentown Formation has been divided into two members. The upper member is a light brown to light gray calcarenite with abundant sand-size fragments of bryozoa, foraminifera, and corals. The lower member is a gray, glauconitic, slightly clayey, poorly sorted, medium-grained quartz sand with a small amount of mica.

This formation thickens downdip to form a wedge-shaped unit. Average strike is N 60E and the unit dips at a rate of 20-30 ft./mi. Thickness near Wrightstown (near the outcrop area) is reported to be 30 feet, whereas downdip the thickness increases to about 185 feet. The Manasquan Formation unconformably overlies the Vincentown Formation and the Hornerstown Formation unconformably underlies the Vincentown Formation. Fossils and glauconite found in the Vincentown Formation indicate that it is of marine origin (Rush, 1968).

2.2.4.5 Hornerstown Sand. The Hornerstown Sand was deposited during the Paleocene Epoch of the Tertiary Period. This formation outcrops in an irregularly shaped belt northwest of the Vincentown Formation. The Hornerstown Sand is characteristically a glauconitic sand with a dark green clay matrix. Fossils and the very high glauconite content indicate the Hornerstown Sand is of marine origin.

The Hornerstown Sand is approximately 29 feet thick at Wrightstown near the outcrop area and thickens downdip to the southeast. The Hornerstown Sand uncomformably overlies the Navesink Formation and Red Bank Sand Formations. The Hornerstown Formation underlies the Vincentown Formation.

2.2.4.6 Red Bank Sand. The Red Bank Sand Formation was deposited during the Cretaceous Period. This formation outcrops in an irregular area occupying one to two square miles in Burlington County. The Red Bank Sand is characteristically composed of two unnamed units. A lower unit is described as a thin glauconitic sandy clay containing minor amounts of pyrite, lignite, and mica. An upper unit is described as a thick quartz sand with small amounts of clay, glauconite, and mica. A typical sample of the Red Bank Sand from the outcrop area near Arneytown had 73 percent sand and 27 percent silt and clay.

The Red Bank Sand is approximately 50 feet thick at Cookstown. The Red Bank Sand comformably overlies the Navesink Formation and is uncomformably overlain by the Hornerstown Sand.

2.2.4.7 Navesink Formation. The Navesink Formation was deposited during the Cretaceous Period. This formation outcrops in an irregularly shaped belt located southeast of outcrops of the Mount Laurel Formation. The Navesink Formation is typically described as a clayey glauconitic sand to a glauconitic, micaceous, sandy clay. The clay and mica contents of this formation increase upward. Overall, the formation is very micaceous and has a very prominent shell bed at its base.

The Navesink Formation is approximately 37 to 40 feet thick and does not thicken appreciably downdip. The Navesink Formation comformably overlies the Mount Laurel Formation and comformably underlies the Red Bank Sand.

2.2.5 Hydrogeology

There are five major aquifers in the Coastal Plain: the Potomac-Raritan Magothy aquifer, Englishtown aquifer, Mt. Laurel-Wenonah aquifer, the lower "800-foot" sand aquifer of the Kirkwood Formation, and the Kirkwood-Cohansey aquifer. These aquifers are separated by relatively impermeable units that vary in thickness and in their ability to function as confining layers. Hydrogeologic units of concern at the installation are discussed below.

The wedge-shaped mass of sedimentary strata underlying Ft. Dix can be divided into two separate aquifer systems. The upper flow regime is the most active and extends to a depth of approximately 50 feet below the surface. The surficial aquifer in the Ft. Dix area that comprises this upper flow regime includes the Cohansey and Kirkwood Formations. The Cohansey Formation is a highly permeable sand deposit with thin, discontinuous sections of laminated clay. The Kirkwood Formation underlies the Cohansey Formation and can be divided into two units: a basal unit of brownish-black, clayey-silt to very fine-grained quartz sand with mica, and a thicker upper unit of very light gray to light clayey-silt to very fine-grained quartz sand with mica, and a thicker upper unit of very light gray to light yellow orange, very fine to fine-grained sand. Hydrologic continuity exists between the Cohansey Formation and the upper strata of the Kirkwood Formation. The basal unit of the Kirkwood and a group of formations including the Manasquan, Vincentown, Hornerstown, Red Bank, and Navesink Formations function as a composite confining layer and separate the upper Kirkwood-Cohansey Aquifer from the lower Wenonah-Mount Laurel Aquifer. A small percentage of groundwater that infiltrates through the upper flow system will enter the deeper flow system. Groundwater in the shallow regime follows local flow lines from areas of infiltration to areas of discharge. This discharge occurs where the water table intersects the surface of the ground, creating a surface water body.

The Cohansey Formation is an important aquifer in Burlington County because it is essentially untapped. Most of the formation is under water table conditions. The biggest drawback to use of water from this formation is that it is close to the surface, thereby increasing the potential for surface contamination. Published well data for the area indicates that the Cohansey Formation is not being used as a source of drinking water. The Cohansey Formation discharges into the Rancocas Creek and the Mullica, Wading, and Bass Rivers (Rush, 1968).

The Kirkwood Formation is of minor importance as a useful aquifer in Burlington County. It is tapped only by low-yield domestic wells only in the formation outcrop area. Ft. Dix production wells MW #9 through MW #12 are screened in the Kirkwood Formation and the water is chlorinated prior to use. Groundwater movement is toward lowland areas where water is discharged to Rancocas Creek and the Mullica and Bass Rivers (Rush, 1968).

The composite confining unit, which is 150 to 200 feet thick in the Ft. Dix area separates the Kirkwood-Cohansey Aquifer from the deeper aquifer system, consisting of the Mt. Laurel-Wenonah aquifer, a major water supply aquifer. Because of water supply pumping, the heads in the Mt. Laurel-Wenonah aquifer have been lowered and a resultant significant downward gradient exists across the aquitard units separating the Kirkwood-Cohansey aquifer from the Mt. Laurel-Wenonah aquifer. The Mt. Laurel-Wenonah aquifer is described as fine-to-coarse-grained sand of late Cretaceous age. The Mt. Laurel Formation overlies the Wenonah Formation and consists of coarser sand and therefore is the principal component of this aquifer.

The Englishtown, Magothy, and Raritan Formations, and the Potomac Group contain important aquifers below the Mt. Laurel-Wenonah aquifer. The Englishtown Formation is tapped for minor water supplies and is characterized as a light gray to white, micaceous, lignitic, fine-grained quartz sand. In 1968, only public water supply wells tapped this aquifer. Two wells at Marlton, New Jersey, yield about 100 gallons per minute (gpm) each with drawdowns of about 36 feet. Reported maximum thickness of the Englishtown is 220 feet. The Magothy-Raritan-Potomac sequence contains the most important and productive aquifers in Burlington County. Most industries adjacent to the Delaware River and most public water supplies throughout the county obtain groundwater from these deeper aquifers. Large diameter wells tapping this sequence yield in excess of 1,500 gallons per minute (gpm). This stratigraphic sequence consists chiefly of light gray to white, cross-stratified, medium-to-coarse-grained quartz sand, interbedded with white to red and white variegated clay. In the Wrightstown, New Jersey area, the deeper aquifers are developed extensively for water supplies to serve Ft. Dix, McGuire Air Force Base, and Wrightstown.

The Merchantville and Woodbury Formation form a major confining unit throughout most of the Coastal Plain of New Jersey. These units are of early-middle Cretaceous age and separate the Potomac-Raritan Magothy aquifer from that of the overlying Englishtown Formation. The Merchantville-Woodbury confining unit consists of gray and black, micaceous clay with some local areas of very fine-grained quartz and glauconitic sand. The maximum reported thickness for this confining unit is 325 feet. Recharge to the Raritan and Magothy Formations from the Englishtown Formation takes place as a result of vertical leakage through these formations.

The Marshalltown Formation overlies the Englishtown Formation in most of the Coastal Plain. This formation has a maximum reported thickness of 30 feet and consists of gray and black, very clayey, very fine-to-medium-grained quartz and glauconitic sand. Because of its limited thickness and some local, slightly to moderately permeable beds, its ability to function as a confining unit is locally reduced. The Marshalltown Formation separates the Englishtown aquifer from the Mt. Laurel-Wenonah aquifer. The Mt. Laurel-Wenonah aquifer is overlain by a dominantly confining sequence composed of several geologic units. This confining sequence consists of the Navesink, Red Bank, Tinton, Hornerstown, Vincentown, Manasquan, Shark River, and Piney Point Formations, and the basal clayey silt of the Kirkwood Formation. The maximum reported thickness is approximately 900 feet. These units consist of sandy material with varying amounts of clay. Some of these geologic units may contain water-bearing zones on a localized basis.

2.2.6 Surface Water Hydrology

The Ft. Dix installation is drained by several perennial and intermittent tributaries of Crosswicks Creek and the North Branch of Rancocas Creek. For Crosswicks Creek, these tributaries include Jumping Brook and North Run; for the North Branch of the Rancocas, tributaries include the Ong and Newbold Runs. The North Branch of Rancocas Creek is located immediately south of Ft. Dix and flows westward into the Delaware River. Crosswicks Creek is also a tributary to the Delaware River, but first flows northward from the northern boundary of Ft. Dix for a distance of about 6 miles before turning west toward the Delaware River. The total length of stream channels within the installation has been estimated to be 54 miles. Several streams are bordered by swamps along significant segments of their lengths, indicating relatively shallow depths to groundwater.

The Ft. Dix area is also characterized by several ponds and lakes ranging from General's Pond, which measures about 1 acre in surface area, to Brindle Lake, which has a surface area of about 40 acres. Figure 2 shows water resource features, including the major streams, ponds, and lakes within and around Ft. Dix.

2.3 ENVIRONMENTAL STUDIES AT FT. DIX

Numerous environmental studies have been published on various aspects of Ft. Dix. Eight of the more significant studies are discussed below in chronological order.

An Installation Assessment of Ft. Dix (Boeing Michigan Army Research Center [BOMARC] Site) was completed by USATHAMA in 1977. This document describes the results of a records search conducted on Ft. Dix to estimate possible contamination at the installation by chemical, biological, and radiological material and to assess the possibility of contaminant migration beyond the installation boundary. As a result of the assessment, USATHAMA concluded that a more definitive survey of the BOMARC site was necessary and that the records did not indicate that contaminants were migrating beyond Ft. Dix boundaries from the remainder of the installation (USATHAMA, 1977).

Two reports on pesticide distribution and monitoring at Ft. Dix were compiled by the U.S. Army Environmental Hygiene Agency (USAEHA) in 1975 and 1985. These reports examined the distribution of pesticide residues at various sites at Ft. Dix. The 1975 pesticide report identified several locations that exceeded the action level recommended by the National Pesticide Monitoring Program. The 1985 study further defined pesticide contamination at six sites at Ft. Dix (USAEHA, 1975, 1985).

A report was prepared by Iffland, Kavanaugh, Waterbury, P.C. (IKW) detailing the results and findings of groundwater testing at three locations at Ft. Dix. The three sites were the Golf Course Area, Transportation Motor Pool, and an area north of Dogwood Lake. The report presented the results of the sampling program and recommended remedial measures (IKW, 1986).

An Environmental Noise Assessment of Ft. Dix was completed in 1986 by USAEHA. This Installation Compatible Use Zones (ICUZ) Report suggests types and intensities of land uses that take into consideration noise exposure in the Ft. Dix area. The report did not consider the impact of noise from adjacent land uses, such as McGuire

Air Force Base, on Ft. Dix. The report indicates wide range of compatible land uses surrounding Ft. Dix; however, there were some incompatibilities (USAEHA, 1986).

EA Engineering, Science, and Technology, Inc. (EA), under contract to USATHAMA, prepared a PA/SI of environmental conditions at Ft. Dix. The report presents the results from soil and groundwater investigations at 16 sites and TC terrain conductivity surveys at four other sites. Recommendations were presented for additional investigative studies at nine sites (EA, 1989).

Dames and Moore, under contract to USATHAMA, performed a RI at Ft. Dix. The RI Phase I was conducted at 15 sites and the RI Phase II was conducted at nine sites. The purpose of the RI was to investigate the nature and extent of water, soil, and sediment contamination caused by past operations at the studied sites, to evaluate the potential for contaminant migration, and to assess risks to public health and the environment posed by contamination at the studied sites (Dames and Moore, 1991, 1992). The Final RI Report was published in 1993 (Dames and Moore, 1993).

R.F. Weston, Inc., under contract to USATHAMA, prepared an Enhanced PA in December 1991 that identified 42 areas at Ft. Dix requiring environmental evaluation. A review of readily available site environmental literature was conducted to evaluate releases of hazardous or potentially hazardous substances to the environment. Recommendations for additional work and conclusions on the 42 areas were presented (Weston, 1991).

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3.0 POL AREA (SITE 2)

The POL Area is located near the intersection of Rancocas Road and Lexington Avenue in the northwest part of the Cantonment Area (Figure 3). The POL Area has served as a warehouse and central supply facility for approximately 40 years. In 1988, the Ft. Dix Environmental Office removed five underground storage tanks (USTs) from the site; two of the removed USTs were reportedly leaking. This effort reportedly included removal of contaminated soils and soil sampling. The leaking USTs contained diesel fuel and Type II dry cleaning solvent. Type II dry cleaning solvent is 100 percent aliphatic naphtha. Aliphatic naphtha, like diesel fuel, has a density less than water and is therefore considered a light non-aqueous phase liquid (LNAPL).

3.1 PREVIOUS INVESTIGATIONS

Two previous investigations have been completed for USAEC at the POL Area and include a PA/SI (EA, 1989) and a Phase I and II RI (Dames and Moore, 1993).

As part of the PA/SI, four water table monitoring wells were installed (POL-5 through POL-8) and a groundwater sample was collected from each well in 1986 and analyzed for VOCs and semivolatile organic compounds (SVOCs) (Figure 6). Analytical results detected naphthalene (8 micrograms per liter [μg/L]) and fluorene (2 μg/L). The PA/SI indicated the likely source of these contaminants to be the leaking diesel fuel tank and dry cleaning solvent tanks. Dames and Moore, under contract to USATHAMA, conducted an RI at the POL Area (1993). Investigations included the installation of three additional groundwater monitoring wells (POL-48 through POL-50) (1988), sampling and analysis of new and existing wells for VOCs and SVOCs (1988), and water level elevation measurements in 1990 and 1991.

Groundwater at the POL has been interpreted to flow to the southwest. Surface water runoff from the site also flows southwesterly into an unnamed intermittent stream that eventually discharges into Dogwood Lake. VOCs (benzene, ethylbenzene, and xylene) and SVOCs (2-methylnaphthalene and acenaphthene) were detected in groundwater in 1988 at well POL-6. The Ft. Dix Environmental Division reported TPH concentrations in soil associated with the tank removal that ranged from below detection to 6,700 milligrams per kilogram (mg/kg).

Results of previous investigations at the POL Area indicate that groundwater contamination exists in the vicinity of POL-6, which appears to be located downgradient of the oil transfer point for the 420,000-gallon aboveground No. 2 fuel oil storage tank. Detected groundwater contamination as well as the historical storage of fuels at this site suggest that groundwater contamination consists of VOCs and SVOCs with densities less than water. As such, if there are substantial contaminant plumes underlying the locations of the former USTs, they may occur as either LNAPLs or as dissolved contaminants. LNAPLs have not been detected at this site to date while dissolved contaminants have. The scope of work outlined below is intended to further characterize the nature and distribution of subsurface soil and groundwater contamination at this site.

3.2 PROPOSED SCOPE OF WORK

The objectives of this RI for the POL site are to:

1. establish the locations of the removed USTs,
2. establish whether surface runoff from the POL Area has affected downgradient surface water/sediment quality,
3. establish whether a source of contamination exists in the area of the removed USTs,
4. assess the nature and distribution of contaminants associated with the former USTs,
5. establish whether contaminants are migrating from the site through groundwater,
6. assess the potential risks to human health and the environment associated with site-related contamination, and
7. provide adequate data for assessment of remedial alternatives.

Table 1 summarizes the proposed scope of work and planned investigations for the POL Area.

3.2.1 Site Topographic Base Map

To better evaluate existing conditions at the POL and facilitate any remediation of this site, an accurate base map will be prepared. The map should be prepared before conducting fieldwork at this site and will accurately portray all existing structures including roads, fences, buildings, utilities, manholes, storm sewers, drainage ditches, water courses, monitoring wells, fuel storage structures, tree lines, and so forth. In addition, the base map shall include ground surface topography with two-foot contour intervals (this may require new photogrammetry to be performed). The map shall extend from the POL Area to include the Golf Course Leaking Tank Area (see Subsection 5.2.1 of this Technical Plan. The map shall be presented in hardcopy and computer aided design (CAD) compatible computer disk file(s). The map shall use the Universal Transverse Mercator (UTM) system for horizontal grid markings with a 1-inch = 100-foot scale. The topographic contours shall be based on the National Geodetic Vertical Datum (NGVD) of 1929. This activity should be coordinated with the field checking of existing monitoring wells (see Subsection 3.2.4.1 of this Technical Plan).

3.2.2 Geophysics

To focus the field program at this site, approximate locations of the former USTs will be estimated using GPR techniques. See Subsection 16.1.1 of this Technical Plan and Subsection 2.4.2 of the QAPP for a detailed discussion of the GPR program. The area to be surveyed with GPR is shown in Figure 6. The GPR survey will be based on grid transects spaced at approximate 10 foot intervals over an area of approximately one half acre. The approximate limits of the UST excavation will be mapped and delineated in the field using wooden stakes. This information will be used to refine the location of the field screening and monitoring well installations.

3.2.3 Field Screening

Field screening at the POL will include soil sampling to assess any residual soil contamination at the location of the five former USTs, and groundwater sampling to assess groundwater quality impacts. Careful coordination with Ft. Dix personnel will be needed to locate the field screening explorations in areas where buried utilities are not present.

3.2.3.1 Soil Field Screening. Up to five soil borings (PLB-01 through PLB-05) will be located in the immediate vicinity of the five former USTs. Results of the GPR survey will be used locate the soil borings. The borings will be advanced with 4.25-inch HSAs to the water table (estimated depth 15 feet bgs). If LNAPL is encountered, the borings will be advanced to the bottom of the LNAPL.

Continuous soil samples will be collected in these borings and submitted for field screening of benzene, toluene, ethylbenzene, and xylene (BTEX) by gas chromatography (GC) and TPH by IR (see Table 3). Soil samples collected at or just above the water table, as well as just above confining layers, will also be submitted for ultraviolet (UV) screening. At least 10 percent of the samples will be submitted for confirmatory laboratory analysis of TCL VOCs, TCL SVOCs, TAL metals, total organic carbon (TOC), and TPH.

3.2.3.2 Groundwater Field Screening. A geoprobe/screened auger field screening program will be completed to establish the absence or presence of potential groundwater contamination extending from the POL. Site conditions will dictate which technique is most suitable for this site. Up to five borings (PLA-01 through PLA-05) will be completed to characterize the lateral and vertical extent of a potential groundwater plume. Results of the GPR survey will be used to locate the borings. It is anticipated that one boring will be located in the suspect source area. The remaining four borings will be positioned downgradient of the source area. Figure 6 highlights the general location of the downgradient borings. Water samples will be collected from the screened auger borings at 5-foot intervals beginning at the water table (estimated depth 15 feet bgs). Sampling will extend to approximately 35 feet bgs although this depth may be reduced if the first two borings indicate groundwater contamination is shallower.

Field screening samples will be analyzed for BTEX and TPH by GC and IR, respectively. These analyses are appropriate for the types of materials stored at this site and lend themselves well to field screening technologies. Approximately 10 percent of the field screened samples will be sent off-site for confirmatory laboratory analysis for TCL VOCs, TCL SVOCs, TAL metals (nonfiltered and filtered), total suspended solid (TSS) and TPH. Results from the field screening effort will be reviewed with the USEPA and NJDEP to determine the need to install additional monitoring wells.

3.2.4 Geotechnical Investigations

The following subsections describe additional geotechnical investigations and surface water/sediment sampling that will be completed at the POL.

3.2.4.1 Monitoring Well Groundwater Sampling. Prior to installing new monitoring wells at the POL Area, an existing well survey will be performed to confirm their site identification, location, and physical integrity. Existing monitoring wells will be checked for their label/Site ID and location as compared to that indicated on Figure 6. Monitoring wells will also be sounded for water depths and well bottoms. Sounding depths shall be compared to those presented in Table 2. Monitoring wells that are mislabeled and cannot be accurately located from the field checking shall be resurveyed by a New Jersey-licensed land surveyor. Subsection 16.6 addresses the criteria to be used in determining if monitoring well surveying is needed.

If the field screening program indicates that the former USTs have impacted groundwater at the POL and existing wells are not adequately positioned to detect and monitor this impact then up to five additional monitoring wells will be installed at the POL (PLG-01 through PLG-05). The additional wells would be positioned at and downgradient of the identified source area to characterize and assess groundwater quality impacts. It is anticipated that the monitoring wells will be screened across the water table to detect free floating and dissolved contaminants. However, the position of the wells will be based on the results of the field screening program. A soil sample from the well screen interval of each new monitoring well will be submitted for analysis of grain size distribution.

One round of groundwater samples will be collected from new and existing monitoring wells. The samples will be analyzed for TCL VOCs, TCL SVOCs and TAL metals (nonfiltered and filtered) and TSS (Table 1).

Concurrent with groundwater sampling, a complete round of groundwater level measurements will be taken from existing and new monitoring wells. In addition, in-situ hydraulic conductivity testing will be performed at the new monitoring wells. Data collected from these tests, when combined with the flow gradients and directions calculated from measured water levels, can be used to estimate groundwater flow velocities in the vicinity of the wells.

3.2.4.2 Surface Water/Sediment Samples. Existing storm sewer plans and discharge locations at the POL will be reviewed and verified with field observations. Up to five surface water and sediment samples (PLD/PLW-01 through PLD/PLW-05) will be collected at the observed POL storm sewer discharge locations and downgradient drainages (Figure 6). Final locations of the five samples will be selected after a complete review of storm sewers that potentially drain the POL Area. Currently, it is anticipated that one sample will be collected upstream of the POL Area and four samples will be collected at or downstream of the POL Area.

These samples will be submitted for laboratory analysis of TCL VOCs, TCL SVOCs, TAL metals, TOC (sediment samples only), alkalinity/hardness (surface water only), polychlorinated biphenyls (PCBs), and grain-size analyses (sediment only) (Table 4). To the extent practicable, these samples will be collected when surface water is present in the drainage ditches and or during a surface water runoff event. The laboratory analyses of these samples will assess whether the storm sewer flow or runoff from the POL are adversely impacting surface water and sediment quality in the downgradient drainage ditches and streams.

4.0 FIRE TRAINING TANK AREA (SITE 3)

The Fire Training Tank Area (FTTA) is situated in the northwestern part of the Cantonment Area, south of the Firehouse. The FTTA site contains two 30-foot diameter soil berms (Figure 7). One berm contains an open steel circular tank (approximately 15 to 20 feet in diameter and two feet high). This tank reportedly was used for fire training from the 1960s to the 1980s. The second berm contains a geotextile reinforced pit (approximately 15 to 20 feet in diameter and two feet high). This pit was reportedly never used for fire training as the geotextile fabric was too slippery to train on.

4.1 PREVIOUS INVESTIGATIONS

Several previous investigations have been conducted at the FTTA. These investigations are discussed below in chronological order.

EA, under contract to USATHAMA, prepared a PA/SI of environmental conditions at Ft. Dix, including the FTTA (EA, 1989). The PA/SI indicates that two groundwater monitoring wells were installed (FTT-13 and FTT-14). Two groundwater sampling events, October 1986 and April 1987, were performed on FTT-13 and FTT-14. Monitoring well PTS-19, located at the Paint Shop was used as a background well. The samples were analyzed for VOCs and SVOCs in 1986 and VOCs in 1987. The analytical results from these wells reveal concentrations of 1,1,1-trichloroethane (111TCE) at 9 and 13 $\mu g/L$ for FTT-13 and FTT-14 respectively for 1986 and below detection limits for SVOCs for both wells. Both FTT-13 and FTT-14 were below detection limits for VOCs in 1987. Monitoring well PTS-19 was below detection limits for VOCs and SVOCs in 1986 and VOCs in 1987.

Dames and Moore, under contract to USATHAMA, conducted an RI at the FTTA (Dames and Moore, 1993). Investigations conducted as part of the RI included the collection and analysis of eight soil samples from four soil borings (SC-124 through SC-127); installation of one groundwater monitoring well (FTT-51), collection and analysis of groundwater samples from monitoring wells FTT-13, FTT-14, and FTT-51; collection and analysis of two surface soil samples (SC-126 and SC-127); and collection and analysis of two surface water and four sediment samples (SW/SE-103, SW/SE-104, SE-111, and SE-112). Results of the soil boring samples indicate VOC, SVOC, and TPH contamination. The groundwater sampling results indicate that

VOCs were not detected and the surface soil samples indicate SVOC contamination. Results of the surface water and sediment samples indicate VOC contamination up to 37 parts per billion (ppb).

The U.S. Army Corps of Engineers, Waterways Experiment Station (USACOE-WES) was tasked by the USAEC to perform a Site Characterization and Analysis Penetrometer System (SCAPS) site investigation at a series of sites at Ft. Dix, including the FTTA. This work, published in 1993 (USACOE-WES, 1993), was designed to develop screening level data regarding subsurface contamination of petroleum, oil and lubricants. The SCAPS investigation did not detect significant trends that would suggest a substantial contaminant source attributable to the fire-training tanks at the FTTA.

4.2 PROPOSED SCOPE OF WORK

Results of previous investigations at the FTTA indicate soil and surface water and sediment contamination by VOCs, mainly chlorinated solvents and SVOCs. Groundwater VOC concentrations have been below detection limits since the first sampling event in 1986.

The objectives of the RI for this site are to:

1. further define the distribution of soil, groundwater, surface water, and sediment contamination, and

2. assess the potential risk to human health and the environment associated with contaminants.

The proposed scope of work is to be implemented in a phased approach. If the first phase field screening results indicate the FTTA is not the source area for contamination previously detected in this vicinity, the second phase will not be conducted. The first phase will include a monitoring well survey, collection of surface water and sediment samples, and the collection of subsurface soils for field screening to determine the presence of contamination. The implementation of the second phase investigation is contingent on contamination being detected during the first phase field screening of subsurface soils. A brief technical memorandum will be prepared at the conclusion of the first phase to outline the extent of the second phase.

The second phase investigation will consist of additional soil borings, and the installation of shallow and deep monitoring well clusters to establish the distribution of contamination. Two piezometers will also be installed to assess hydraulic communication between Dogwood Brook and the water table aquifer.

4.2.1 Field Screening

The first phase subsurface soil field screening program consists of the installation of two soil borings (FTB-01 and FTB-02); one boring will be located in the open steel tank and the other soil boring will be located in the bermed pit (Figure 7). The objective of the program is to establish if contamination exists at the source area. If no contamination is detected, the second phase investigation will not be implemented.

Prior to advancing the soil borings, the steel tank and bermed pit will be checked for a solid bottom by using a hand auger or shovel to excavate a two to three foot deep hole inside the tank/pit. If a solid bottom is encountered, the boring shall be relocated just outside the tank/pit. After this preliminary investigation, the soil borings will be drilled to the top of the first confining geologic unit, estimated to be 45 feet bgs, and samples will be collected continuously. For the purposes of this Technical Plan, it is assumed that a confining layer will be defined as five or more feet of fine-grained cohesive soils with a United Soil Classification System (USCS) classification of CH, CL, ML, and possibly SC. This definition may be revised based upon the geologic conditions encountered. Each soil sample will be field screened for BTEX and chlorinated solvents (111TCE) utilizing a field GC. Soil samples collected at or just above the water table, as well as just above confining layers, will also be submitted for UV screening. At least 10 percent of the samples will be submitted for laboratory analyses of TCL VOCs, TCL SVOCs, TAL metals, TOC, and explosives to verify the field results (Table 3).

The second phase subsurface field screening program consist of up to eight soil borings (FTB-03 through FTB-10) located between the open steel tank and Dogwood Brook; approximate locations are presented in Figure 7. The objective of the second phase borings is to determine the lateral and vertical distribution of contamination. The borings will be drilled and sampled in accordance with the first phase; however, locations and final depths will be based on the results of the first phase. Generally, the second phase borings will be drilled to the depths where contamination was detected in first phase borings.

4.2.2 Geotechnical Investigations

The following subsections discuss the rationale and approach of geotechnical investigations proposed for the FTTA. Except for the monitoring well survey, these investigations are part of the second phase and will be implemented only if required after the completion of the first phase.

4.2.2.1 Monitoring Wells/Groundwater Sampling. As part of the first phase field activities, an existing monitoring well survey will be performed to confirm their site identifications, locations, and physical integrities. Existing monitoring wells will be checked for their label/Site ID and location as compared to that indicated on Figure 7. Monitoring wells shall also be sounded for water depths and well bottoms. Sounding depths should be compared to those presented in Table 2. Monitoring wells that are mislabeled and cannot be accurately located from the field checking shall be resurveyed by a New Jersey-licensed land surveyor. Subsection 16.6 addresses the criteria to be used in determining if monitoring well surveying is needed.

If required, upon completion of the first phase, up to six monitoring wells are proposed to be installed in three nested pairs at the FTTA (FTG-01A/B, FTG-02A/B, and FTG-03A/B). The number and location of the wells will be based on the field screening analytical results and existing well locations. Each pair will have one water table well and one well screened above the first encountered confining unit. The deep wells will be installed using the mud rotary technique (see Subsection 16.3.3), while the shallow wells will be installed using 6.25-inch HSAs. The depths and screened intervals of the deep wells will be chosen based on the contaminants detected during the screening program. A soil sample from the well screen interval of each new monitoring well will be submitted for analysis of grain size distribution.

One round of groundwater samples will be collected from the three existing monitoring wells and six (proposed) new monitoring wells. Groundwater samples will be analyzed for TCL VOCs, TCL SVOCs, TAL metals (nonfiltered and filtered), TSS, and explosives (Table 2).

Concurrent with groundwater sampling, a complete round of groundwater level measurements will be taken from the new and existing monitoring wells and piezometers. In addition, in-situ hydraulic conductivity tests will be performed at the existing and new monitoring wells. Data collected from these tests, when combined with the flow gradients and directions calculated from measured water levels, can be used to estimate groundwater flow velocities in the vicinity of the wells.

4.2.2.2 Piezometers. Two piezometers (FTPIEZ1 and FTPIEZ2) are proposed to be installed to determine the nature of the hydrologic connection between Dogwood Brook and the groundwater. Piezometer locations are presented in Figure 7. The piezometers will be installed using 4.25-inch HSAs and will be screened across the water table estimated to be 3 feet bgs. These piezometers will not be sampled for laboratory analyses.

4.2.2.3 Surface Water/Sediment Investigations. A surface water/sediment sampling program will be conducted as part of the first phase investigation along the banks of Dogwood Brook southeast of the FTTA. This sampling program will be conducted to characterize both the FTTA and Transportation Motor Pool (TMP) (located upstream on Dogwood Brook and east of the FTTA [see Section 6.0]) impacts to the surface water and sediment of Dogwood Brook.

Five surface water/sediment samples will be collected for laboratory analyses (FTD/FTW-01 through FTD/FTW-05) (Figure 7). Two samples will be collected upstream of the FTTA, two will be collected adjacent to the FTTA, and one will be collected downstream of the FTTA. The two upgradient samples will provide data regarding potential contamination contributed by the TMP. The surface water/sediment samples will be analyzed for TCL VOCs, TCL SVOCs, TAL metals, TOC (sediment samples only), alkalinity/hardness (surface water only), PCBs, explosives, and grain-size analyses (sediment only) (Table 4). Two staff gauges (FTSTAFF1 and FTSTAFF2) will be installed and surveyed in Dogwood Brook adjacent to the piezometers, if necessary.

5.0 GOLF COURSE LEAKING TANK AREA (SITE 4)

The Golf Course Leaking Tank Area is located in the northwestern part of the Cantonment Area (Figure 2). Before its removal, the leaking UST was located near the golf cart storage area just inside the southwestern fence of the driving range (Figure 6).

5.1 PREVIOUS INVESTIGATIONS

Several previous investigations have been conducted at the Golf Course Leaking Tank Area. These investigations are discussed below in chronological order.

In 1984, Ft. Dix personnel observed an oily sheen on the surface of a pond south of the golf course clubhouse. The source of the observed contamination was determined to be a 1,000-gallon UST containing unleaded gasoline (see Figure 6). In October 1984, the UST was removed. During tank removal, soil around the tank, to the depth of the water table, was removed and disposed of.

IKW presented a report in 1985 detailing the findings of groundwater testing at the Golf Course Leaking Tank Area. Nine borings were each drilled to 20 feet bgs and groundwater samples were collected from the saturated zone. Laboratory analyses of groundwater samples collected from three of these borings (A1, B1, and C1), located within 10 feet of the former UST location, indicated concentrations of BTEX up to 48.6 milligrams per liter (mg/L).

EA, under contract to USATHAMA, prepared a PA/SI of environmental conditions at Ft. Dix, including the Golf Course Leaking Tank Area. The PA/SI Report indicates that three groundwater monitoring wells (GLF-15, through GLF-17) were installed and samples from these wells were analyzed for VOCs, SVOCs, and pesticides. Analytical results indicate concentrations of ethylbenzene up to 680 μg/L, total xylene up to 440 μg/L, and benzene up to 400 μg/L. No pesticides were detected in groundwater.

Dames and Moore, under contract to USATHAMA, conducted an RI at the Golf Course Leaking Tank Area (Dames and Moore, 1993). This investigation included a soil gas survey, collection and analysis of 32 soil samples from 11 borings (SC-243 through SC-251), installation of four groundwater monitoring wells (GLF-52, 53, 73, 74), collection and analysis of groundwater samples, and collection and analysis of four surface water/sediment samples (SW/SE-105 through SW/SE-108). The soil gas survey results indicated VOCs east of the golf course clubhouse. Results of soil sample analyses for TPH revealed concentrations up to 558 ppm (SC-244). Groundwater analyses indicated benzene at concentrations up to 3.96 ppm in well GLF-53. Sediment analyses indicated total SVOC concentrations up to 18.8 ppm.

5.2 PROPOSED SCOPE OF WORK

Results of previous investigations at the Golf Course Leaking Tank Area indicate groundwater contamination by gasoline constituents such as BTEX. Based on comparisons among 1987, 1988, and 1990 groundwater sampling results, contaminant concentrations appear to be decreasing with time in the vicinity of the former UST location. Concentrations appear to be increasing in a downgradient direction toward, and possibly beyond, GLF-74 (Dames and Moore, 1993).

The objectives of the RI for this site are to:

1. further define the extent of groundwater, surface water, and sediment contamination,

2. assess the risk to human health and the environment associated with contamination, and

3. provide adequate data for assessment of remedial alternatives.

The proposed scope of work presented in the following subsections is based upon these objectives, and the results of previous investigations.

5.2.1 Site Topographic Base Map

To better evaluate existing conditions at the Golf Course Leaking Tank Area and facilitate any remediation of this site, an accurate base map will be prepared. The map should be prepared before conducting fieldwork at the site to facilitate locating proposed explorations. This map will accurately portray all existing structures at the site including roads, buildings, utilities, fences, water courses, monitoring wells, fuel storage structures, tree lines, and so forth. In addition, the base map shall include ground surface topography with two-foot contour intervals. The mapped area shall extend to the POL Area (see Subsection 3.2.1 of this Technical Plan). The map shall be presented in hardcopy and CAD compatible computer disk file(s). The map shall use the UTM system for horizontal grid markings. The topographic contours shall be based on NGVD of 1929. This activity shall be coordinated with the field checking of existing monitoring wells (see Subsection 5.2.3.1 of this Technical Plan).

5.2.2 Field Screening

Geoprobe/screened auger sampling of groundwater and field screening for BTEX, pesticide, and lead is proposed for the Golf Course Leaking Tank Area. Geoprobe/ screened auger sampling and field screening will provide data for: (1) delineation of the horizontal and vertical distribution of BTEX, pesticide, and lead in groundwater, and (2) placement of new monitoring wells. Specific details of geoprobe/screened auger sampling procedures and field analytical operations are discussed in Sections 16.0 and 17.0, respectively, of this Technical Plan.

It is anticipated that up to three transects of geoprobe/screened auger sampling points may be required at the Golf Course Leaking Tank Area with up to 21 explorations (GTA-01 through GTA-21). The first transect includes a series of seven geoprobe/screened auger sampling locations, distributed uniformly in the shaded area indicated in Figure 6. Subsequent geoprobe/screened auger transects and the location of sampling points within transects will depend on the analytical results of the first transect. The proposed location of the second geoprobe/screened auger transect is also indicated in Figure 6. The second transect has been proposed for this location due to detection of BTEX in monitoring well GLF-52. Installation and location of the third transect will depend upon analytical results from the first and second transects. It is estimated that five groundwater samples will be collected from each geoprobe/screened auger exploration. The maximum depth of sampling is anticipated to be 25 feet bgs. Depth to groundwater in the vicinity of the Golf Course Leaking Tank Area is anticipated to be 5 to 10 feet bgs.

Field screening samples will be analyzed for BTEX, pesticides by a field GC. Samples will also be collected for laboratory analyses of lead (filtered and unfiltered) as well as TSS. At least 10 percent of the samples will be submitted for confirmatory laboratory analysis of TCL VOCs, TCL SVOCs, TPH, pesticides, and herbicides (Table 2).

5.2.3 Geotechnical Investigations

The following subsections discuss the rationale and approach of geotechnical investigations proposed for the Golf Course Leaking Tank Area.

5.2.3.1 Monitoring Wells/Groundwater Sampling. Prior to new monitoring well installation, an existing well survey will be performed to confirm site identification, location, and physical integrity. Existing monitoring wells shall be checked for their label/Site ID and location as compared to that indicated on Figure 6. Monitoring wells shall also be sounded for water depths and well bottoms. Sounding depths should be compared to those in Table 2. Monitoring wells that are mislabeled and cannot be accurately located from the field checking shall be resurveyed by a New Jersey-licensed land surveyor. Subsection 16.6 addresses the criteria to be used in determining if monitoring well surveying is needed.

Up to 12 monitoring wells will be installed at the Golf Course Leaking Tank Area. The number and location of wells will be based on field screening analytical results and existing well locations. Eight of the wells are proposed to be installed in four clusters (GTG-01A/B, GTG-02A/B, GTG-03A/B, GTG-04A/B). The purpose of these clusters is to assess vertical distribution of contaminants and vertical hydraulic gradients. Each pair will have one water table monitoring well and one monitoring well screened above the first encountered confining unit. The deep wells will be installed using the mud rotary technique, while the shallow (water table) wells will be installed using HSAs. A natural gamma and EM conductivity borehole logging survey will be conducted in each of the four deep wells, drilled with mud rotary techniques, to assist in defining the geologic setting.

The remaining four shallow (water table) wells will be installed at the site beyond the expected plume boundary to allow for sampling of uncontaminated groundwater (GTG-05 through GTG-08). The locations and numbers of these shallow wells will be based upon results of field screening (Subsection 5.2.2). A soil sample from the well screen interval of each new monitoring well will be submitted for analysis of grain size distribution.

One round of groundwater samples will be collected from the seven existing monitoring wells and 12 (proposed) new monitoring wells. Groundwater samples will be analyzed for TCL VOCs, TCL SVOCs, TAL inorganics (nonfiltered and filtered), TPH, pesticides, herbicides, five-day biochemical oxygen demand (BOD-5), chemical oxygen demand (COD), TSS, total dissolved solids (TDS), nitrate/nitrite, sulfate, phosphateand alkalinity/hardness (Table 2). Pesticide and herbicide analyses are proposed based on potential contamination associated with Site 15 - Golf Course Pesticide Mixing and Storage Area (see Section 15.0 of this Technical Plan). The BOD-5, COD, nitrate/nitrite, sulfate, phosphate and alkalinity/hardness are included to assist in development of the FS.

During groundwater sampling, a complete round of groundwater level measurements will be taken from all new and existing wells. In addition, surface water levels will be obtained from the three staff gauges (see Subsection 5.2.3).

5.2.3.2 Aquifer Testing. In-situ hydraulic conductivity testing (slug testing) will be conducted at the site on all newly installed wells to estimate the hydraulic conductivity of the aquifer. Data collected from these tests, when combined with flow gradients and directions calculated from measured water levels can be used to estimate groundwater flow velocities.

To develop estimates of aquifer parameters, an aquifer test will be conducted on one of the monitoring wells at the Golf Course Leaking Tank Area. This test will consist of a variable rate step test followed by a constant rate long term test. The procedures for this test, outlined below, have been prepared in general accordance with USEPA Suggested Operating Procedures for Aquifer Pumping Tests (USEPA, 1993). One of the new monitoring wells to be installed as part of this RI will be used as the pumping well. The pumping well will be located as far as practicable from the Golf Course Ponds (greater than 100 feet) to limit their influence on the pumping test. Care will be taken to avoid starting or stopping the tests during or immediately after precipitation events.

Background Monitoring. Prior to initiating the step drawdown test, background groundwater levels will be monitored (hourly) to assess water level trends for a one to two week period. This monitoring will be conducted in a background well (located away from the site but within a similar geologic setting), in the pumping well, and in a nearby well. Barometric pressure changes as well as precipitation events will also be monitored (these may be available from the McGuire AFB weather station).

Step Drawdown Tests. During the step drawdown test, the well to be used in the long term monitoring test, will be pumped at successively higher rates over three to five separate steps. During each step the water level drawdown in the pumping well will be measured with a pressure transducer and data logger. The time between measurements will increase logarithmically over the course of each step. The following are minimum data collection intervals to be used during the step test and long term test:

Elapsed Time (minutes)	Frequency of Measurement
0-1	15 seconds
1-5	30 seconds
5-10	1 minute
10-30	2 minutes
30-60	5 minutes
60-120	10 minutes
120-180	20 minutes
180-240	30 minutes
240-1440	1 hour
1440-end of test	4 hours

Each step will last from one to three hours, depending on water level response. At the final step, the well will be pumped at the maximum rate possible without threatening to expose the bowls of the pump. Given an expected specific capacity of up to two gallons per minute per foot of drawdown and a typical 15 foot water column in the monitoring wells at this site, it is expected that the maximum discharge rate available in the pumping well will be on the order of 25 to 30 gallons per minute.

At the conclusion of the step test, water level recovery in the pumping well will be monitored to within 95 percent of pretest levels (accounting for any trend correction). Results of the step test will be reviewed to select an optimum pumping rate for the long term test. Selecting a constant rate test will require striking a balance between maximizing stress to the aquifer and ensuring that adequate static head remains in the extraction well to enable pumping to continue if a negative boundary is encountered during the test. The long term test will not begin until complete recovery from the step test is achieved. It is expected that there will be a one to two week period between the step test and the long term test.

Long Term Aquifer Test. During the long term test, groundwater will be pumped at a constant rate for a period up to 72 hours. The pumping period may be shortened or extended if the water level data indicates steady state is reached in a shorter time frame, or if data at the conclusion of the test indicate delayed responses (delayed yield drainage or inadequately defined boundary conditions) are present.

Water levels will be measured in the pumping well and between 5 to 11 select monitoring wells, this includes a combination of existing monitoring wells GLF-15, GLF-16, GLF-17, GLF-52, GLF-53, GLF-73, GLF-74, and the new monitoring wells. Background monitoring of these wells will be conducted as appropriate to correlate to the background monitoring well. Specifications of the wells being monitored, including drilling technique, well diameter, screen length, and screen location within the site geologic setting will be developed. Water level monitoring frequencies will again be logarithmic as tabulated above.

At the conclusion of the long term test, water levels will again be monitored in the select wells until recovery has reached a minimum of 95 percent of the prepumping water levels (adjusted for background trend). Monitoring of the background water level will be continuous from approximately one week before the step test until completion of recovery from the long term test.

Discharge Water Management. Water generated during the step test and long term test will be stored on-site. This water will be treated with activated carbon to remove site related contaminants. To document the performance of the activated carbon system, up to three samples of treated groundwater will be sampled and analyzed for TCL VOCs, TCL SVOCs, TAL metals, and pesticides. Following receipt of the water quality analyses the treated groundwater will be disposed at the Fort Dix waste water treatment plant.

Aquifer Test Analyses. The aquifer test analyses will evaluate both drawdown and recovery data. The analyses will account for influences such as partial penetration, barometric efficiency, and background water level trends. Factors such as delayed yield (characteristic of unconfined aquifers), and leakage (possibly associated with recharge the Golf Course Ponds) will also be assessed. Analytical techniques will be based on the data obtained from the test and will likely include semi-log straight line analyses as well as log-log curve matching.

5.2.3.3 Surface Water/Sediment Investigations. A surface water/sediment assessment program will be conducted in the site vicinity to obtain a preliminary indication of contaminant impacts to these environments. The assessment program consists of the following components: (1) sampling and analysis of surface water/ sediment samples from nine locations in the ponds and upgradient stream, (2) establishing three staff gauges in the ponds to measure surface water levels, and (3) coring and permeameter testing of two sediment samples from the pond bottoms to be used in evaluating hydraulic connection of the ponds with the underlying aquifer. Locations of these investigations are indicated in Figure 6.

Nine surface water/sediment samples (GTD/GTW-01 through GTD/GTW-09) will be collected for laboratory analysis. Three samples will be collected upstream of the northernmost pond (Figure 6). These 3 samples will provide upgradient data for delineation of site-related impacts particularly for pesticides that are the contaminants of concern for Site 15 - Golf Course Pesticide Storage and Mixing Area (see Section 15.0). The remaining six samples will be collected from the ponds in the vicinity of the site (see Figure 6). All surface water and sediment samples will be analyzed for TCL VOCs, TCL SVOCs, TAL inorganics (nonfiltered), alkalinity/ hardness (surface water only), PCBs, pesticides, herbicides, TOC (sediment only), and grain-size analyses (sediment only) (Table 4).

Three staff gauges (GTSTAFF1 through GTSTAFF3) will be installed in the ponds to measure surface water levels (Figure 6). Measurements from these gauges will provide data for assessment of hydrologic and hydrogeologic interaction.

Two sediment core samples will be collected for laboratory permeameter testing. Permeameter tests will provide vertical permeability estimates for assessment of hydraulic connection between the ponds and the underlying aquifer.

5.2.4 Groundwater Modeling

The conceptual geologic and hydrogeologic model of subsurface conditions at the Golf Course Leaking Tank Area will be augmented through aquifer testing and development of a groundwater flow/particle tracking model and a contaminant transport model. This modeling effort is needed, as it is anticipated that groundwater remediation will be required. The groundwater flow model will consist of a mathematical numerical model coupled with a particle tracking package to simulate groundwater flow conditions at the site. The contaminant transport model will utilize the calculated head distribution from the groundwater flow model to generate groundwater flow velocities and fluxes in the solution of the solute transport equation. The modeling effort will be used as a tool in evaluating the groundwater flow system and provide a mathematical framework for describing contaminant distribution and migration at this site. Overall, this will assist in the development of an adequate understanding of the groundwater flow system for completion of a comprehensive RI/FS at the Golf Course Leaking Tank Area.

The overall modeling tasks include:

- Model Development and Calibration
- Simulation of Remedial Alternatives
- Evaluation of Results and Reporting (to be included in the RI and the FS Reports)

The USGS Modular Three-Dimensional Finite Difference Groundwater Flow Model (MODFLOW) code (McDonald and Harbaugh, 1988) and the USGS particle tracking program MODPATH (Pollock, 1989) will be used to numerically simulate groundwater flow and advective transport at the site. MODFLOW is currently the most widely used groundwater flow model in the modeling community. MODFLOW is a finite difference numerical model with the capability to simulate groundwater flow, advective transport, complex boundary conditions, and which can simultaneously evaluate various remedial alternatives to support the FS. MODPATH interfaces with MODFLOW, simulating flow lines by computing particle pathlines. MODPATH uses MODFLOW output to calculate changes in particle positions over time.

Conceptually, the numerical model will have closely spaced nodes at the Golf Course Leaking Tank Area to facilitate the evaluation of various remedial alternatives and allow for a more accurate model calibration. Outside the source area, the model will have a coarser node spacing. It is anticipated that the model will consist of two or more layers depending on an evaluation of hydrogeologic and contaminant distribution data, and incorporate appropriate constant-head or specified flux boundaries in the model. The U.S. Army understands that the use of MODFLOW intrinsically implies to the USEPA that any or all MODFLOW packages will be employed as necessary to this site. MODFLOW packages likely to be used as part of this effort include the Basic Package, the Block-Centered Flow Package, the Well Package, the Recharge Package, the River Package, and one or more solver packages. Aquifer test results will also serve to validate the model.

USEPA has requested that the contaminant transport model be constructed using the MT3D model code. MT3D, developed by C. Zheng of S.S. Papadopulos and Associates (S.S. Papadopulos, 1992), utilizes the calculated head distribution from a groundwater flow model (MT3D is specifically designed for compatibility with MODFLOW) to generate groundwater flow velocities and fluxes in the solution of the solute transport equation. MT3D uses a number of solution techniques, principally based on the method of characteristics (MOC). Depending on the Courant number, indicating the degree of dominance of advective transport, MT3D can use the MOC approach, a modified MOC (MMOC), or a hybrid of the two. MT3D allows the user to incorporate dispersion in three dimensions, retardation due to partitioning, and reaction of the solute in the modelled system. MT3D can be applied to steady-state or transient solutions of the flow and transport systems. The purpose of the transport model is to provide a numerical framework for describing contaminant distribution and migration at the site.

To adequately document the model application and results at the Golf Course Leaking Tank Area, the following outline, based upon QA procedures developed at the Holcomb Research Institute, is presented. The final report will be structured around this format with appropriate revisions.

- Purpose: state goals and objectives.

- Conceptual Model: present geologic and hydrogeologic environment with an emphasis on identifying the controlling parameters and boundary conditions for the hydrogeologic system.

- Data Collection: describe data collection and interpretation from boring logs, slug tests, available literature, and so forth.

- Model Description: document model codes applied at Golf Course Leaking Tank Area.

- Model Parameters: discuss initial conditions, boundary conditions as well as hydraulic parameters, as appropriate.

- Model Calibration: present procedures and results of calibration as related to targets.

- Sensitivity Analysis: discuss parameter sensitivity as related to model application and influence on model results.

- Model Validation: comparison of model results with observed field conditions. This will include sum of the squares of the residuals and scattergram plots of head differentials.

- Data Processing: document pre- and post-processing applied to data inputs and results.

- Model Prediction: presentation of predictive scenarios.

- Model Results: evaluate how model results verify the conceptual model (modified as necessary) and the quantification of the flow regime as it pertains to the predictive scenarios. This will include capture zone analysis.

- Model Records: supply records of model runs on hard copy or disk as requested.

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6.0 TRANSPORTATION MOTOR POOL (SITE 5)

The Transportation Motor Pool (TMP) is a paved, active, fuel dispensing, and vehicle parking facility located in the north central part of the Cantonment Area (Figure 3). The TMP is bordered by West First Street to the south, Delaware Avenue to the east, Pennsylvania Avenue to the west and Headquarters Street to the north.

6.1 PREVIOUS INVESTIGATIONS

In 1985, IKW (IKW, 1986) conducted an investigation at the TMP fuel-dispensing facility. The investigation consisted of four soil borings to depths of 20 feet with continuous sampling. The borings were located north of two fuel pump islands that included a former leaking pump. Soil samples from the borings were submitted for TPH analysis by water and Freon extraction. In addition, water samples were collected from each soil boring at the water table and the bottom of each boring and were analyzed for VOCs and TPH. Surface water samples were collected at four locations on a daily basis for seven consecutive days and analyzed for VOCs. Surface water samples were collected at: (1) the sump (catch basin), (2) the outlet of Dogwood Lake drainage ditch, (3) the outlet of the drainage ditch off Pennsylvania Avenue, and (4) the outlet of the drainage ditch between the pine tree nursery and the parking area off Delaware Avenue.

Results of the IKW investigation indicated that TPH were detected in soils in borings E-3, F-3, G-3, and H-3, with highest detections occurring in a surface soil sample from boring G-3 (3,800 mg/kg). Sporadic TPH detections were noted below the water table. No VOCs were detected in the groundwater, surface water, and sediment samples collected at the TMP.

A PA/SI (EA, 1989) was conducted at the TMP. Three wells were installed, sampled, and analyzed for VOCs and SVOCs at the TMP as part of this PA/SI. No contaminants were detected in monitoring well TMP-21. Chloroform (8 μg/L) was detected once in two rounds of sampling at well TMP-22. Fluorene (40 μg/L), phenanthrene (100 μg/L), and pyrene (20 μg/L) were detected in one sample from the flush-mount monitoring well TMP-23. The PA/SI indicated that contaminants detected at TMP-23 were likely the result of well TMP-23 being contaminated by paving operations. Monitoring well TMP-23 was abandoned by grouting and replaced with a new monitoring well (TMP-55) during the Phase I RI.

During the RI, three additional 25-foot deep wells (TMP-54 through TMP-56) were installed by Dames and Moore (1993) (Figure 7). The new and existing wells were sampled and analyzed for VOCs. In addition, two surface water and sediment samples were collected and analyzed for VOCs (Figure 7). Sediment samples were analyzed for TOC. Groundwater was interpreted to flow both northeast and southeast toward the storm sewer transecting the southern half of the TMP. Because the site is paved, runoff was determined to flow southward for collection by the storm sewer system.

Dames and Moore reported that chloroform was detected in groundwater at existing monitoring well TMP-22 (1.34 $\mu g/L$) and in new monitoring wells TMP-54 (2.06 $\mu g/L$) and TMP-56 (5.57 $\mu g/L$). Methylene chloride was also detected at TMP-56 (6.53 $\mu g/L$). Methylene chloride was associated with field blanks collected at this site. No VOCs were detected in the surface water samples. Acetone detected in two sediment samples was attributed to laboratory contamination. TOC found in the most downstream sediment sample was associated with TPH that had been found at the site. This sample also could have contained a large percentage of natural organic matter.

6.2 PROPOSED SCOPE OF WORK

Results of previous investigations at the TMP do not conclusively confirm or eliminate the potential that past practices have not impacted groundwater at the TMP. Sampling and analysis by IKW indicates that a source of petroleum-related contaminants was and still may be present at the TMP. Also, existing wells at the TMP may not be strategically located to intercept groundwater contamination caused by the potential source described by the IKW Report. A summary of the field activities to be conducted at this site are presented in Table 1.

The objectives for the RI for this site are to:

1. determine if groundwater contamination exists at the TMP,

2. characterize the extent and distribution of groundwater contamination if it exists, and

3. assess the risk to human health and the environment associated with this contamination.

6.2.1 Field Screening

The field screening program consists of the collection of both subsurface soils and groundwater samples to be field screened for BTEX and TPH. The objective of the field screening program is to determine if residual contamination identified in the IKW study still exists.

6.2.1.1 Soil Field Screening. Up to 10 soil borings (TMB-01 through TMB-10) will be drilled with 4.25-inch HSAs to depths of approximately 25 feet bgs. Samples will be collected continuously and will be field screened for BTEX by GC and TPH by IR (Table 3). Soil samples collected at or just above the water table, as well as just above confining layers, will also be submitted for UV screening. The soil borings will be located in the vicinity of previous borings E3, F3, G3, and H3 where sporadic TPH detections below the watertable were encountered (Figure 7). At least 10 percent of the samples will be submitted for laboratory analyses of TCL VOCs, TCL SVOCs, TAL metals, TPH, and TOC to verify the field results.

Up to three tests pits (TMS-01 through TMS-3) will be excavated adjacent to the buried storm sewer (Figure 7). The objective of these test pits is to determine if the storm sewer, which traverses the southern portion of the TMP area from west to east, is providing a preferential flow path for TMP-related contaminants. Up to two samples of pipe bedding material/soils from each test pit will be collected and field screened for BTEX and TPH (Table 3).

Approximately one sample from each test pit will be submitted for laboratory analyses of TCL VOCs, TCL SVOCs, TAL metals, TPH, and TOC to verify the field results.

6.2.1.2 Groundwater Field Screening. Up to ten screened auger/geoprobe borings (TMA-01 through TMA-10) will be installed to collect groundwater samples for field screening. Samples will be collected at five foot intervals beginning at the groundwater table and continuing to a maximum depth of approximately 25 feet bgs, and will be field screened for BTEX, chlorinated solvents (chloroform), and TPH. The borings will be located in the vicinity of previous borings E3, F3, G3, and H3 (Figure 7). Depth to groundwater in this area is anticipated to be 10 feet bgs. At least 10 percent of the samples collected for screening will be submitted for laboratory analyses of TCL VOCs, TCL SVOCs, TAL metals (nonfiltered and filtered), TPH, and TSS to verify the field results.

6.2.2 Geotechnical Investigations

The following subsections discuss the rationale and approach of geotechnical investigations proposed for the TMP. Monitoring wells will be installed only if the groundwater field screening program indicates contamination.

6.2.2.1 Monitoring Wells/Groundwater Sampling. Prior to new monitoring well installations, an existing survey should be performed to confirm site identification, location, and physical integrity. Existing monitoring wells shall be checked for their label/Site ID and location as compared to that shown on Figure 7. Monitoring wells will also be sounded for water depths and well bottoms. Sounding depths shall be compared to those presented in Table 2. Monitoring wells that are mislabeled and cannot be accurately located from the field checking shall be resurveyed by a New Jersey-licensed land surveyor. Subsection 16.6 addresses the criteria to be used in determining if monitoring well surveying is needed.

If required, upon completion of the field screening program, up to three groundwater monitoring water table wells (TMG-01 through TMG-03) are proposed to be installed at the TMP. The final number and location of the wells will be based on the field screening analytical results. The wells will be installed using 6.25-inch HSAs to a depth estimated to be 25 feet bgs, although if groundwater contamination is detected at the water table the new well screens will be positioned to intersect the water table. A soil sample from the well screen interval of each new monitoring well will be submitted for analysis of grain size distribution.

One round of groundwater samples will be collected from the five existing and three new, if installed, monitoring wells, and will be analyzed for TCL VOCs, TCL SVOCs, TAL metals (nonfiltered and filtered), TSS, and TPH (Table 2). Concurrent with groundwater sampling, a complete round of groundwater level measurements will be taken from existing and new monitoring wells. In addition, in-situ hydraulic conductivity testing will be performed at the new monitoring wells. Data collected from these tests, when combined with the flow gradients and directions calculated from measured water levels, can be used to estimate groundwater flow velocities in the vicinity of the wells.

6.2.2.2 Surface Water/Sediment Investigations. The surface water and sediment program for the TMP will be conducted as part of the FTTA investigation presented in Subsection 4.2.2.3 of this Technical Plan.

7.0 ARDC TEST SITE (SITE 6)

The Armament Research and Development Center (ARDC) Test Facility is located in the Range and Impact Area near the northern Ft. Dix boundary approximately 2,000 feet west of Brindle Lake (Figure 2). The site, including nine buildings, has been the location for testing and analysis of weapons at Ft. Dix. A wide variety of small arms (up to 40 millimeter [mm]) weapons have been tested at this facility. Testing generally evaluates the physical response of weapons and munitions to the extreme physical conditions to which they may be exposed. This includes such tests as: weapons firing at extreme temperatures, munition response to firing at high pressures, measuring tracer firings, and measuring the penetration of bullets into metal plates. The tests do not include mixing, storage, replacement, or disposal of chemicals or radioisotopes. The only processes that have reportedly discharged wastes at this site are the X-ray photographic processing laboratory and fuel storage area.

The photographic processing laboratory is located at the western end of the site (Figure 8). The laboratory is currently equipped with a silver recovery unit. Before the installation of this recovery unit, laboratory rinsewater from a microflash X-ray process was allowed to drain onto the ground. This occurred for a two-year period with typical discharges of 5 to 25 gallons per month. This area was investigated during the Preliminary Assessment/Site Investigation for Fort Dix (EA, 1989). The results of the PA/SI indicated this area was uncontaminated. As such, it is not considered part of this investigation.

The second potential contaminant source is a fuel storage area at the southeast end of the site, where a spill of approximately 25 gallons of diesel fuel occurred in 1984. The fuel storage area includes two aboveground gasoline tanks and four 55-gallon drums used to store waste oil. As part of a previous remedial measure, the first foot of soil was removed from this area and replaced with clean fill. However, staining of the ground surface was still visible during a site visit in September 1987, suggesting either incomplete removal or new spillage following the remedial action.

7.1 PREVIOUS INVESTIGATIONS

During the PA/SI, a series of seven surface soil grab samples and one surface soil composite sample were collected. Three grab samples were collected near the photoprocessing shop. The remaining four grab samples, including one duplicate and the composite sample, were collected near the fuel storage area. Samples from the photoprocessing shop were analyzed for VOCs, SVOCs and inorganics. No VOCs or SVOCs were detected in any of the samples. Selected metals were detected although all concentrations are below the NJDEP-proposed soil cleanup criteria. Soil samples from the fuel storage area were analyzed for TPH. These results indicated TPH concentrations from 140 to over 436 mg/kg. Based on these results, the Phase I and Phase II RI were developed.

The Phase I and Phase II RI focused on potential contamination associated with the fuel storage area. During the Phase I RI, soil samples were collected from zero, three and occasionally six feet bgs at 17 locations (SC-128 through SC-144) (Figure 8). All soil samples were analyzed for TPH and a few select samples were analyzed for VOCs and SVOCs to determine the distribution of soil contamination. During the Phase II field program, nine additional soil samples were collected at depths of 0 to 10 feet from three monitoring well borings (ARD-75 through ARD-77). These soil samples were analyzed for VOCs and TPH.

Three 20-foot deep shallow water table monitoring wells (ARD-75, ARD-76, and ARD-77) were installed and sampled during the Phase II RI field program. The potable water well (FTDIX-13), located in Building 9990 at the center of the site, was also sampled. In addition, three surface water and three sediment samples were collected to establish whether contaminants had impacted surface water. Samples were collected from three locations (SW/SE-114, SW/SE-115, and SW/SE-116) along the drainage ditch that directs surface water flow to the northeast, past the fuel spill area (see Figure 8).

Analytical results from the Phase I and Phase II soil sampling programs indicated substantial TPH contamination in the vicinity of the fuel storage area. The TPH concentrations ranged from 22.4 to 48,439 mg/kg. The concentration of TPH decreased with distance from the gas tanks, indicating that the source of petroleum hydrocarbons in these borings is most likely the gasoline tanks. Concentrations of TPH in these borings also decreased with depth, but levels as high as 15,289 mg/kg were detected 3 feet bgs in boring SC-141.

An area of high TPH concentration was also observed upgradient of the oil drums, indicating that a spill/leakage may have occurred in this area. The VOC and SVOC analyses of soil samples also indicate that concentrations of toluene, ethylbenzene, xylene, acetone, and 2-methylnaphthalene generally decrease with distance from the oil drums. This suggests that leaks/spills from the drums may have caused the contamination. The chlorinated solvents detected during the Phase I and Phase II soil sampling program include 1,2-dichloroethylene, 1,1,2,2-tetrachloroethane, tetrachloroethylene, trichloroethylene, and trichlorofluoromethane. The maximum concentration of these individual compounds was 0.2 mg/kg of tetrachloroethylene detected in soil samples from three and six feet bgs at SC-142, located approximately 40 feet downgradient (southeast) from the fuel storage (see Figure 8). The maximum concentration of the sum of these compounds was 0.341 mg/kg which was also detected in a soil sample from SC-142 (six feet bgs).

The chlorinated VOCs, were also detected in soil samples from three and six feet bgs at SC-143 and SC-144, located approximately 90 to 110 feet downgradient from the fuel storage area. The concentrations detected in SC-143 and SC-144 was slightly lower then those measured at SC-142.

Chlorinated VOCs were not detected in soil samples from SC-141, located adjacent to the fuel storage area.

Analytical results from the groundwater sampling program indicated the presence of TPH in monitoring well ARD-76 and FTDIX-13 (657 and 784 μg/L, respectively). TPH in ARD-76 may be due to dispersion from the spill area, which is approximately 50 feet to the northeast, or because a low groundwater gradient exists in the area and flow direction may change periodically with variation in recharge conditions. FTDIX-13 supplies ARDC with production water. This well is located approximately 150 feet northwest of the fuel storage area. Because FTDIX-13 is 240 feet deep and probably screened at depths well below the Kirkwood Formation, it is unlikely that the detected TPH originates from the fuel storage area, especially as the Kirkwood formation is believed to overlie the Manasquan Formation, a confining bed. VOCs detected in groundwater were limited to ARD-76.

Analytical results from the surface water/sediment sampling program indicated TPH concentrations were lowest in upstream sediment (SE-114 93.7 mg/kg) and increased in the two downstream locations (SE-115 104.6 mg/kg and SE-116 416 mg/kg). The closest sampling location to the spill area (SE-115) also exhibited xylene and trichloroethene. Xylene at 0.027 mg/kg was below the New Jersey Action Level (NJAL), while trichloroethene at 2.43 mg/kg exceeded the NJAL of 1 mg/kg. The only contaminant detected in surface water was trichloroethene (2.19 mg/kg) at the downstream location SW-116.

7.2 PROPOSED SCOPE OF WORK

Results of previous investigations indicated shallow surface soil contamination at the fuel storage area. In addition, there appears to be an impact on the nearby drainage ditch and possibly the surface water within the ditch. Groundwater impacts associated with the fuel storage area appear to be confined to monitoring well ARD-76 where TPH, ethylbenzene, and xylene were detected during the Phase II RI. In addition, the potable well FTDIX-13 has also shown detectable concentrations of TPH, although no other site-related contaminants were detected. A summary of field activities to be conducted at this site are presented in Table 1.

The objectives of this RI are to:

1. Define the nature and distribution of the surface soil impacts near the fuel storage area where substantial TPH concentrations have been detected in the past.

2. Assess the condition of the potable well FTDIX-13. This includes checking the physical condition of the well and pump, analytical sampling of the well, and pumping the well to evaluate it's ability to affect shallow groundwater flow in the site vicinity.

3. Assess impacts to groundwater from the reported septic leachfield associated with Building 9990 where FTDIX-13 is located.

4. Install a monitoring well cluster to assist with the delineation of the water table configuration and assess potential vertical distribution of impacts from the fuel storage area.

7.2.1 Site Topographic Base Map

To better evaluate existing conditions at the ARDC, and facilitate any remediation of this site, an accurate base map will be prepared. The map should be prepared before conducting fieldwork at the site to facilitate fieldwork at this site. This map will accurately portray all existing structures at the site including roads, buildings, utilities, fences, water courses, monitoring wells, fuel storage structures, tree lines, etc. In addition, the base map shall include ground surface topography with two-foot contour intervals (this may require new photogrammetry to be performed). The map shall be presented in hardcopy and CAD compatible computer disk file(s). The map shall use the UTM for horizontal grid markings with a 1-inch = 100-foot scale. The topographic contours shall be based on NGVD of 1929. This activity should be coordinated with the field checking of existing monitoring wells (see Subsection 7.2.4.3 of this Technical Plan).

7.2.2 Field Screening

The field screening program consists of the collection of groundwater samples to be field screened for BTEX and TPH. The objectives of this field screening program is to evaluate the potential impact to soil and groundwater from the septic leachfield associated with Building 9990, where FTDIX-13 is housed (Figure 8). It is anticipated that up to five geoprobe/screened auger borings (ARA-01 through ARA-05) will be completed in the vicinity of the leachfield to collect groundwater samples. At each boring, up to two groundwater samples will be collected at five-foot intervals beginning at the groundwater table (estimated to be five feet bgs). Estimated sampling depth with the geoprobe/screened auger will be 25 feet bgs. At each groundwater sampling interval samples will be collected for field screening of BTEX and TPH. At least 10 percent of the field screening samples will be submitted for confirmatory laboratory analyses of TCL VOCs, TCL SVOCs, TAL metals (nonfiltered and filtered), TSS, and TPH (Table 2).

7.2.3 Well FTDIX-13 Evaluation

Laboratory analyses of groundwater samples from potable well FTDIX-13 have shown detectable concentrations of TPH, up to 784 μg/L. This well is downgradient from the fuel storage area. However, since the well is reportedly 240 feet deep, it is unlikely that TPH contamination could migrate from the ground surface to this depth. Prior to conducting an extensive analysis of the well condition, duplicate samples will be collected from FTDIX-13 (FDIX1301 and FDIX1301D) and analyzed for TCL VOCs, TCL SVOCs, TAL Metals (nonfiltered), TSS and TPH. These samples will be collected from a spigot located as close as practicable to the well head, preferably before any pressure tank and/or filters. These samples will be collected concurrent with the source water sampling to expedite the analyses and determine if a more extensive sampling program is necessary. The following program (see Subsection 7.2.3.1) will further assist in defining the source of this contamination and will be undertaken if the initial samples verify the historical TPH concentrations at this well.

7.2.3.1 Pump Removal. To evaluate the potential for the existing FTDIX-13 pump to contaminate the samples, the pump shall be removed and the following activities completed:

1. inspect the pump for cracks, oil leaks, worn materials, if the pump is in disrepair and is replaced the typical sustained rate of the new pump will be noted;

2. check water level for comparison with shallow water table elevation (vertical survey of top of well casing required);

3. check for product;

4. sound the well bottom to verify reported well depth;

5. natural gamma logging of well to identify the presence and depth of confining layer(s);

6. installation of a stilling tube to allow water level measurements;

7. if no product is observed, FTDIX-13 will be purged of three to five well volumes and sampled for laboratory analysis of TCL VOCs, TCL SVOCs, TAL metals (nonfiltered and filtered), TSS, and TPH (Site ID FDIX1301).

7.2.3.2 Pumping Test. To assess hydraulic communication between FTDIX-13 and the shallow water table aquifer, a 12-to-24-hour aquifer test shall be conducted on FTDIX-13. The test shall consist of a constant rate discharge test with FTDIX-13 being pumped at its typical sustained rate. Care shall be taken to coordinate the test with Ft. Dix personnel to ensure the pumped water can be adequately handled and disposed.

During the test, the water level in FTDIX-13 and nearby monitoring wells shall be measured to enable evaluation of hydraulic communication. The monitoring shall be conducted in advance of the test to assess trends in water level fluctuation.

During the aquifer test time , groundwater samples (FDIX1302 through FDIX1310) will be collected from FTDIX-13 to assess changing TPH concentrations over time. Samples will be collected at the beginning of the test as well as at 0.5, 1, 2, 4, 8, 16, and 24 hours and at the end of the aquifer test. The samples shall be submitted for laboratory analysis of TPH. The initial, one hour and final sample shall also be submitted for laboratory analysis of TCL VOCs, TCL SVOCs, TAL metals (nonfiltered and filtered), TPH, and TSS. These samples will be collected at the spigot nearest the pump to avoid sampling of water after it has passed through filters or pressure tanks. If the analytical results from the pumping test and activities associated with pump removal suggest the well casing is cracked, then additional efforts may be undertaken to assess the integrity of the casing (e.g., caliper and/or televiewer logging).

7.2.4 Geotechnical Investigations

7.2.4.1 Surface Soil Sampling. Up to 10 surface soil samples (ARS-01 through ARS-10) will be collected from the area near the fuel storage area to further delineate surficial contamination in this area. Proposed sample locations are presented in Figure 8. At each sampling location, a two to three feet deep hole shall be manually excavated and logged. One sample shall be collected from each excavation and submitted for laboratory analyses of TCL VOCs, TCL SVOCs, TAL metals, TOC, and TPH. The depth from which the sample is collected shall be based upon field observations, and to the extent practicable, be oriented toward sampling from contaminated soil horizons.

7.2.4.2 Soil Borings. Up to four additional soil borings (ARB-01 through ARB-04) shall be drilled with 4.25-inch HSAs to the water table at the ARDC. These borings are intended to assess the extent of shallow soil contamination above the water table and identify LNAPL that may be situated above the water table. The borings will be drilled to approximately 10 feet below the water table. The total soil boring depth is estimated to be 15 feet bgs. Proposed locations for these soil borings are presented in Figure 8, although their locations may be adjusted based on field observations of the shallow surface soil samples.

Soil samples will be collected continuously with a split spoon sampler. Up to three soil samples from each soil boring will be submitted for laboratory analyses. Samples selected for laboratory analyses will be based on field observations, such as elevated photoionization detector (PID) readings, sample discoloration, unusual odors, and so forth. However, if no significant field observations are noted, the samples will be collected from 10 feet bgs, the water table, and the bottom of the boring. Samples submitted for laboratory analyses shall be analyzed for TCL VOCs, TCL SVOCs, TAL metals, TOC, and TPH.

7.2.4.3 Monitoring Wells/Groundwater Sampling. Prior to new monitoring well installation, an existing well survey should be performed to confirm site identification, location, and physical integrity. Existing monitoring wells will be checked for label/ Site ID and their location as compared to that shown on Figure 8. Sounding depths shall be compared to those presented in Table 2. Monitoring wells that are mislabeled and cannot be accurately located from the field checking will be resurveyed by a New Jersey-licensed land surveyor. Subsection 16.6 addresses the criteria to be used in determining if monitoring well surveying is needed.

Efforts will be made to collect water level data to assess the level of influence that production well FTDIX-13 has on the shallow water table. This will be accomplished by collecting two separate rounds of water level data at this site. Prior to the first round, well FTDIX-13 will be shut down for one to five days (to the extent practicable). This will give an indication of the natural groundwater flow directions and gradients. The second round will be collected just prior to shutting down the aquifer test described in Subsection 7.2.3.2. This will give an indication of groundwater flow directions and gradients under impact from FTDIX-13.

Two additional monitoring wells, one shallow (ARG-01A) and one deep (ARG-01B), will be installed at the ARDC. The shallow monitoring well shall be installed to better define the orientation of the water table surface in this area. Previous investigations have indicated that shallow groundwater flow is toward the northwest. However, there are only three monitoring wells available to develop this interpreted flow direction. The proposed location for the shallow monitoring well is shown in Figure 8. This location may be adjusted slightly based on the results of the surface soil sampling and soil boring program. It is likely that the new monitoring well will be generally located between the fuel storage area and Building 9990 (where FTDIX-13 is located). The shallow monitoring well shall be drilled with 6.25-inch HSAs and shall be screened across the water table with an approximate 10-foot long well screen. A soil sample from the well screen interval of each new monitoring well will be submitted for analysis of grain size distribution.

The deep groundwater monitoring well will be installed if the FTDIX-13 well evaluation (Subsection 7.2.3 of this Technical Plan) indicates that TPH contamination originates at the fuel storage area. The proposed location for the deep monitoring well is between FTDIX-13 and the fuel storage area (Figure 8). The deep monitoring well shall be installed below the first confining unit, expected to be the base of the Kirkwood Formation and approximately 100 feet bgs. Because this well will be installed below a confining unit, the boring will be double-cased and drilled utilizing the mud rotary technique (see Subsection 16.3.3). Subsurface soil samples will be collected with a split-spoon sampler at five-foot intervals. A natural gamma and EM conductivity borehole logging survey will be conducted in the boring to assist in defining the geologic setting. The gamma logging produces better results if conducted in the borehole prior to the installation of casing. Therefore, the survey will be conducted in two phases, after completion of borehole to the confining unit but prior to the installation of casing and after the termination of the borehole and the installation of the monitoring well.

One round of groundwater samples will be collected from the three existing monitoring wells, the new monitoring well(s), and the production well FTDIX-13. Groundwater samples will be analyzed for TCL VOCs, TCL SVOCs, TAL metals (nonfiltered and filtered), TPH, and TSS (Table 2).

During groundwater sampling, a complete round of groundwater level measurements will be taken from new and existing monitoring wells. If access is available, the water level at FTDIX-13 will be measured. Surface water levels will be measured at the three staff gauges established on the drainage ditch south of the ARDC (see Subsection 7.2.4.4).

In addition, in-situ hydraulic conductivity testing will be performed at the new monitoring wells. Data collected from these tests, when combined with the flow gradients and directions calculated from measured water levels, can be used to estimate groundwater flow directions and velocities in the vicinity of the wells.

7.2.4.4 Surface Water/Sediment Investigations. A surface water/sediment sampling program will be conducted to further define the impacts to these environments. Three surface water/sediment sample pairs (ARD/ARW-01 through ARD/ARW-03) will be collected south and east of the previously sampled locations (SW/SE113, SW/SE114, and SW/SE116) as shown on Figure 8. These three samples will be field screened for BTEX, 111TCE, and TPH as well as being submitted for the laboratory analyses listed below. If the field screening results indicate the presence of BTEX, 111TCE, or TPH at concentrations above the ARARs listed in Table 12, then up to five additional surface water/sediment sample pairs (ARD/W-04 through ARD/W-08) will be submitted for laboratory analyses. Laboratory analyses for surface water/sediment samples will include TCL VOCs, TCL SVOCs, TAL inorganics, pesticides, PCBs, alkalinity/hardness (surface water only), TOC (sediment only) and grain-size distribution (sediment only).

Surface water staff gauges (ARSTAFF1 through ARSTAFF3) will be installed adjacent to each surface water/sediment sample pair to enable measurement of surface water elevations. Water level measurements from these gauges will assist in defining the degree of surface water/groundwater interaction.

8.0 PESTICIDE CONTROL SHOP (SITE 8)

The Pesticide Control Shop (Building 5352) is located in the northeast part of the Cantonment Area, north of the fire house and east of Delaware Avenue (Figure 3). The site was used for pesticide storage and consists of a small wood frame building with two gravel areas adjacent to the northern side of the building. The remainder of the area is a paved parking lot. The site was identified during investigations in 1975 and 1985 as a potential concern because of reported pesticide in soil. Details of historic site operations are unknown. Locations of existing and proposed investigations are presented in Figure 7.

8.1 PREVIOUS INVESTIGATIONS

The Pesticide Control Shop Site was studied by the USAEHA in 1975; distribution of pesticides in selected media and receptors was evaluated. DDT, DDD, DDE, and chlordane were detected in soil and sediment samples; however, the exact locations of the sampling stations were not defined. In 1985, USAEHA conducted another study to identify pesticide residues associated with the Pest Management Program at Ft. Dix. The investigation included the collection and analysis of soil and sediment samples. The maximum detected concentration of a total pesticide residue was 47.45 mg/kg.

Based on the results of the previous investigations, soil and sediment samples were collected and analyzed for VOCs, SVOCs, and pesticides during the Phase I RI program (Dames and Moore, 1993). Eighteen soil samples were collected from six locations at depths of zero, 1.5, and 3.5 feet. One sediment sample was collected from the storm drain, which collects runoff from the Pesticide Control Shop parking lot.

Results of the Phase I RI program indicate VOCs detected at relatively low levels, and SVOCs detected at relatively higher levels near the Pesticide Control Shop. In general, pesticide concentrations were lower in the Phase I RI sampling than in the 1985 sampling. The exception to this trend was o,p'-DDD, for which maximum detected concentrations were 2 mg/kg in 1985 compared to 6.90 mg/kg in 1988. 2,4-dinitrotoluene (DNT) was detected at a concentration of 0.322 mg/kg in one soil sample at a depth of 1.5 feet. The source of the 2,4-DNT is not known.

8.2 PROPOSED SCOPE OF WORK

Results of the previous investigations at the Pesticide Control Shop indicate surface and subsurface soil pesticide contamination. Groundwater quality has not been evaluated at this site.

The objectives of the RI for this site are to:

1. further define the distribution of soil, groundwater, surface water, and sediment contamination; and

2. assess the potential risk to human health and the environment associated with contaminants.

The proposed scope of work is to be implemented in a phased approach. The first phase focuses on field screening of subsurface soils and groundwater at the gravel areas adjacent to the Pesticide Control Shop to determine the presence or absence of contaminants. Surface water and sediment samples will also be collected. The second phase will consist of additional soil borings and installation of groundwater monitoring wells, if needed. The implementation of the second phase is contingent on contaminants being detected during the field screening program. A brief technical memorandum will be prepared at the conclusion of the first phase. This memorandum will summarize the results of the field screening program and detail the extent of the second phase, if required. This technical memorandum will be submitted to the USEPA to develop a consensus for any second phase of sampling and analyses needed at this site.

8.2.1 Field Screening

8.2.1.1 Soil Field Screening. During the first phase of field screening one soil boring will be drilled in each gravel area (PCB-01 and PCB-02). The soil borings will be drilled with 4.25-inch HSAs to a depth of 25 feet bgs. Soil samples will be collected continuously and field screened for BTEX and pesticides using a field GC and herbicides utilizing immunoassay tests. Soil samples collected at or just above the water table, as well as just above confining layers, will also be submitted for UV screening. At least 10 percent of the samples collected will also be submitted for confirmatory laboratory analyses of TCL VOCs, TCL SVOCs, TAL inorganics, pesticides, herbicides, and explosives (Table 3).

If the first phase field screening data suggest soil contamination, then a second phase will be undertaken. Up to six additional soil borings (PCB-03 through PCB-08) will be drilled in the parking lot north of the gravel area and in adjacent nongravel areas near the pads (Figure 7). The sampling and analyses from these borings will be identical to the first phase.

8.2.1.2 Groundwater Field Screening. During the first phase of groundwater field screening one geoprobe /screened auger boring will be advanced in each gravel pit (PCA-01 and PCA-02). Groundwater samples will be collected at five-foot intervals beginning at the groundwater table and continuing to a maximum depth of approximately 25 feet bgs. The samples will be field screened for BTEX and pesticides by GC and herbicides by immunoassay. Depth to groundwater in the vicinity of the Pesticide Control Shop is anticipated to be 15 feet bgs.

At least 10 percent of the samples will be submitted for laboratory analyses of TCL VOCs, TCL SVOCs, TAL inorganics (nonfiltered and filtered), TSS, herbicides, pesticides, and explosives to verify the field results (Table 2).

If the first phase groundwater field screening suggests groundwater contamination then a second phase will be undertaken. Up to six additional geoprobe/screened auger borings will be advanced to provide upgradient and downgradient groundwater data (PCA-03 through PCA-08). Two boring locations are proposed to be located upgradient north of the gravel areas to provide background data and the remaining four locations are proposed to be south and southeast of the Pesticide Control Shop (Figure 7). These additional investigations will be performed as described in the first phase investigation.

8.2.2 Geotechnical Investigations

The following subsections discuss the rationale and approach of geotechnical investigations proposed for the Pesticide Control Shop. Except for surface water and sediment samples, these investigations will be implemented only if required after the completion of the field screening program.

8.2.2.1 Monitoring Wells/Groundwater Sampling. If required upon completion of the field screening program, up to four water table groundwater monitoring wells (PCG-01 through PCG-04) are proposed to be installed at the Pesticide Control Shop. The final number and location of the wells will be based on the field screening analytical results. The wells will be installed using 6.25-inch HSAs to a depth estimated to be 25 feet bgs. A soil sample from the well screen interval of each new monitoring well will be submitted for analysis of grain size distribution.

One round of groundwater samples will be collected from the monitoring wells and analyzed for TCL VOCs, TCL SVOCs, TAL inorganics (nonfiltered and filtered), herbicides, pesticides, explosives, and TSS (Table 2). Concurrent with groundwater sampling, a complete round of groundwater level measurements will be taken from the monitoring wells. In addition, in-situ hydraulic conductivity testing will be performed at the new monitoring wells. Data collected from these tests, when combined with the flow gradients and directions calculated from measured water levels, can be used to estimate groundwater flow directions and velocities in the vicinity of the wells.

8.2.2.2 Surface Water/Sediment Investigations. A surface water/sediment sampling program will be conducted to determine the potential impact that storm water discharge from the Pesticide Control Shop may have on the unnamed brook north of Airfield Road.

Three surface water/sediment samples will be collected for laboratory analyses (PCD/PCW-01 through PCD/PCW-03). Two samples will be collected from the unnamed brook upstream and downstream of the confluence of the storm water discharge and the unnamed brook (Figure 7). The third sample will be collected at the first depositional area downstream of the storm water discharge. The surface water/sediment samples will be analyzed for TCL VOCs, TCL SVOCs, TAL inorganics (nonfiltered), herbicides, pesticides, explosives, alkalinity/hardness (surface water only), TOC (sediments only), and grain-size analyses (sediments only).

9.0 NEW EGYPT ARMORY (SITE 9)

The New Egypt Armory (NEA) Site is located in the northeast corner of the Range Impact Area and is currently used for the maintenance and storage of National Guard vehicles, tanks, and artillery (Figure 2). Two USTs are located in the northwest corner of the site at the head of a steep slope. These USTs are inactive and will be removed in the future. Oil-stained soil was observed around the tanks' fill caps and at the bottom of the slope. A general schematic of the NEA is presented in Figure 9.

9.1 PREVIOUS INVESTIGATIONS

In September 1987, oil-saturated soil was observed around the tanks and at the bottom of the slope. Based on this observation, Dames and Moore (1993) conducted a sampling and analysis program of the NEA Site in 1988. The investigation was part of the Phase I RI program; no additional sampling was conducted during the Phase II RI program. The investigation included soil samples collected from twelve locations at depths of 0 and 2.5 feet bgs, and from three locations at depths of zero, three, and six feet bgs. All soil samples were analyzed for TPH; samples collected from the 3- and 6-foot depths were analyzed for VOCs and SVOCs. Three monitoring wells were installed and sampled during the Phase I RI program. Groundwater samples were analyzed for TPHs, VOCs, and SVOCs.

Results of the soil sampling indicate that generally high levels of TPHs were detected at the NEA Site. TPHs were detected in all 15 soil borings at multiple depths, the maximum occurred at SC-158, located farthest away from the oil tanks (7,112 mg/kg). In general, TPH concentrations decreased with depth; however, they did not decrease with distance from the USTs. In two of the three deep soil borings, acetone was the only organic compound detected. It appears these sample results may reflect oil/grease spillage from parked vehicles in the sampling area rather than contamination from the two USTs.

Soil samples from the monitoring well soil boring log NEA-57 reports a "seam of 3black (oil?) sand" at a depth of approximately three to four feet bgs. This boring was located near the USTs. The boring logs contain no other observations suggesting leakage from the USTs.

Groundwater samples were collected from monitoring wells NEA-57 (background well) NEA-58, and NEA-59. Acetone was detected in well NEA-58 and chloromethane was detected in well NEA-57. No SVOCs or TPHs were detected. According to Dames and Moore (1993), TPH contamination in soil has not migrated to groundwater.

9.2 PROPOSED SCOPE OF WORK

Results of previous investigations at this site indicate limited surface and shallow subsurface soil contamination associated with the parking area north of the USTs as well as the potential for subsurface contamination adjacent to the UST. Laboratory analyses of groundwater samples from the existing wells do not suggest substantial groundwater impact although the location of the wells, relative to the groundwater flow direction is not optimum. Given these conditions the objectives of this RI are to:

1. Assess the nature of the contents of the USTs.
2. Evaluate the nature and extent of soil contamination adjacent to the USTs to enable appropriate planning for the eventual removal of the USTs.
3. Evaluate the nature and extent of the surface and shallow subsurface soil impacts associated with the parking area adjacent to the USTs.
4. Collect and analyze surface water and sediment samples from drainages leading from this site to evaluate the nature and extent of impacts to these media.
5. Collect and analyze groundwater samples to evaluate the nature and extent of groundwater impacts associated with this site.

The proposed scope of work is to be implemented in a phased approach. The first phase will include preparation of a site topographic map, collection of samples from the USTs, conduct of soil field screening work and survey of existing monitoring wells. This will be followed by a second phase which will include installation of up to 5 screened auger/geoprobe borings and up to three additional monitoring wells, if needed and collection and analysis of 13 surface soil samples (3 from drainageways and 10 from the parking area) and 3 surface water/sediment sample pairs. The extent of sampling and analyses to be conducted in the second phase will be dependent on results of the first phase.

9.2.1 Site Topographic Base Map

To better evaluate existing conditions at the New Egypt Armory, an accurate base map will be prepared. The map should be prepared before conducting fieldwork at the site to facilitate locating proposed explorations. This map will accurately portray all existing structures at the site including roads, buildings, utilities, fences, water courses, monitoring wells, fuel storage structures, tree lines, drainageways and so forth. In addition, the base map shall include ground surface topography with 2 to 5 foot contour intervals. The map shall be presented in hardcopy and CAD compatible computer disk file(s). The map shall use the UTM system for horizontal grid markings. The topographic contours shall be based on NGVD of 1929. This activity should be coordinated with the field checking of existing monitoring wells (see Subsection 9.2.4.1 of this Technical Plan).

9.2.2 UST Sampling

To aid in understanding the nature of the two USTs at this site, each UST will be sampled to assess contents. The sampling will estimate the thickness of aqueous and nonaqueous phase liquids as well as gather samples for laboratory analyses of TCL VOCs, TCL SVOCs, TAL inorganics, TPH, herbicides, pesticides and PCBs. Samples will be collected using a disposable, clear Teflon or polyethylene bailer. Thickness of product will be measured using an oil/water interface probe. If pure product is encountered, the only preservation required for the samples is cooling to 4°C. This sampling should be conducted prior to initiating soil borings at this site. This may allow for a more focused field screening effort than is currently proposed. In addition, the analyses may assist in evaluating disposal options during the UST removal.

9.2.3 Field Screening

9.2.3.1 Soil Field Screening. The soil field screening program consists of the collection of subsurface soil samples for screening of BTEX, chlorinated solvents (specific field screening analytes will be based on results of UST sample analyses), and TPH. It is anticipated that up to nine soil borings/geoprobes will be utilized in this program.

Five soil borings (NEB-01 through NEB-05) will be advanced around the USTs to assess any leakage associated with the USTs. The borings will be located around the perimeter of the UST and be as close as practicable. Due to the steep break in slope just north of the USTs it may be necessary to off-set one or more of the borings into the parking area adjacent to the USTs. These borings will be advanced with 4.25-inch HSAs to the water table (approximately 55 feet bgs). Soil samples will be collected continuously to 15 feet bgs or the bottom of contamination, whichever is deeper and at five foot intervals thereafter to the bottom of the boring.

Four soil borings (NEB-06 thorough NEB-09) will be advanced in the parking area to assess the vertical extent of TPH contamination associated with leakage from vehicle parking in this area. Given that the contamination in this area is associated with parked vehicles, these borings will be advanced with 4.25-inch HSAs to the bottom of contamination, estimated to be 10 feet bgs. Soil samples will be collected continuously to the bottom of contamination.

Soil samples from the nine soil borings will be field screened for BTEX, chlorinated solvents (specific field screening analytes will be based on results of UST sample analyses), and TPH. Soil samples collected at or just above the water table, as well as just above confining layers, will also be submitted for UV screening. At least 10 percent of the samples will be submitted for laboratory analyses of TCL VOCs, TCL SVOCs, TAL metals, TOC, and TPH.

9.2.3.2 Groundwater Field Screening. If, following the soil field screening, it appears that groundwater contamination is likely, then up to five screened auger/geoprobe explorations will be conducted. This will provide data for (1) delineating the horizontal and vertical distribution BTEX, chlorinated solvents (specific analytes will be based on UST sample analyses), and TPH in groundwater, and (2) locating additional monitoring wells.

It is anticipated that up to five screened auger/geoprobe explorations could be needed at the New Egypt Armory (NEA-01 through NEA-05). Locations of the explorations will be dictated by the results of the soil boring program, but it is assumed that these explorations will be situated in two transects near the vicinity of the USTs. Samples will be collected at five foot intervals beginning at the groundwater table and extending to a maximum depth of 85 feet bgs. The samples will be field screened for compounds detected during the soil field screening (BTEX, 111TCE, and/or TPH). At least 10 percent of the samples will be submitted for laboratory analyses of TCL VOCs, TCL SVOCs, TAL metals (filtered and nonfiltered metals), TPH, and TSS.

9.2.4 Geotechnical Investigations

The following subsections discuss the rationale and approach of geotechnical investigations proposed for the New Egypt Armory. New monitoring well installation and sampling will be conducted only if required after reviewing the results of the soil and/or groundwater field screening efforts.

9.2.4.1 Surface Soil Sampling. To generate adequate data to perform a risk assessment on surface soils at the New Egypt Armory a series of 10 surface soil samples (NES-01 through NES-10) will be collected for laboratory analyses. Because the USTs will be removed from this site, the surface soil sampling will be confined to the parking lot area north of the USTs. Sample locations are approximated on Figure 9. Generally the samples are located in areas where earlier sampling detected TPH. conducted in this area. The samples will be submitted for laboratory analyses of TCL VOCs, TCL SVOCs, TAL metals, TOC, and TPH.

9.2.4.2 Monitoring Wells/Groundwater Sampling. Prior to new monitoring well installation, an existing well survey should be performed to confirm site identification, location, and physical integrity. Existing monitoring wells will be checked for label/Site ID and their location as compared to that shown on Figure 9. Sounding depths shall be compared to those presented in Table 2. Monitoring wells that are mislabeled and cannot be accurately located from the field checking shall be resurveyed by a New Jersey licensed land surveyor. Subsection 16.6 addresses the criteria to be used in determining if monitoring well surveying is needed.

If required, upon completion of the field screening effort up to three additional monitoring wells (NEG-01 through NEG-03) will be installed at the New Egypt Armory. The final number and location of the wells will be based on the field screening results. The wells would be installed with 6.25-inch HSAs to an estimated depth of 72 feet bgs. Soil samples will be collected at 5 foot intervals during advancement of the soil boring monitoring wells (unless soil samples were collected from an adjacent boring). One soil sample, collected from the well screen interval, will be submitted for analysis of grain size distribution.

One round of groundwater samples will be collected from the new and existing monitoring wells (total of six). The samples will be analyzed for TCL VOCs, TCL SVOCs, TAL metals, (filtered and nonfiltered), TSS, and TPH.

Concurrent with groundwater sampling, a complete round of groundwater level measurements will be taken from the existing and new monitoring wells. In-situ hydraulic conductivity tests will be performed on new monitoring wells. Data from these test(s), when combined with groundwater level measurements, can be used to estimate groundwater flow directions and velocities in the vicinity of the wells.

9.2.4.3 Surface Water/Sediment Investigations. A surface water/sediment sampling program will be conducted to determine the potential impact to drainageways and streams in the site vicinity. Up to three sediment samples (NED-04 through NED-06) will be collected from the ditches or drainageways leading from the site area. Samples will be collected from areas where sedimentation may occur within the ditches or drainageway. Given the substantial depth to the water table at this site, it is unlikely the surface water will be available for sampling in these ditches/ drainageways adjacent to the site. These sediment samples will be submitted for laboratory analyses of TCL VOCs, TCL SVOCs, PCBs, TAL metals, TOC, TPH, and grain size analyses.

In addition, up to three surface water/sediment sample pairs (NED/NEW-01 through NED/NEW-03) will be collected from the stream located north of the site. These samples will be located such that one sample pair is located upstream from the New Egypt Armory, one sample pair is located in the vicinity of where the drainageway discharges to the stream, and the third sample pair is located approximately 100 to 200 feet downstream from New Egypt Armory.

The surface water/sediment samples will be analyzed for TCL VOCs, TCL SVOCs, PCBs, TAL metals, TOC (sediment only), TPH, TSS (surface water only), alkalinity/ hardness (surface water only), and grain size distribution (sediment only).

10.0 RANGE LANDFILL (SITE 10)

The Range Landfill is located in the northwestern part of the Range and Impact Area at Ft. Dix and southeast of the former BOMARC site. The Range Landfill is a 21-acre site that has been used for the disposal of waste materials from the Range and Impact Area from 1940 to approximately 1975. Wastes at the site reportedly include rubble, refuse, old storage tanks, and metals. Other wastes may be present because access to the site is not limited by fences or gates. The Range Landfill was considered to be downwind of the BOMARC site when a major fire, at the BOMARC site in 1960, was reported to have released radioisotopes into the atmosphere.

10.1 PREVIOUS INVESTIGATIONS

Two previous investigations have been completed at the Range Landfill by EA and Dames and Moore (EA, 1989; Dames and Moore, 1993). These previous investigations are briefly discussed in chronological order.

EA prepared a PA/SI of potential environmental impacts at Ft. Dix, including the Range Landfill. This investigation consisted of installing, sampling, and analyzing samples from four monitoring wells (RLF-27 through RLF-30). A schematic of the location of these wells is shown in Figure 10. The wells were sampled twice in 1987, and the results from the first round indicated the presence of lead, chromium, and nickel at concentrations up to 15, 1,350 and 6,600 μg/L, respectively, in well RLF-30. The second round of sampling indicated the presence of the same analytes at generally lower concentrations (4.2 μg/L, 14 μg/L, and below detection limit) than detected in the first round in well RLF-27. Additional analytes detected in RLF-27 in the second round included arsenic, cadmium, and copper at concentrations of 29.9, 19.0, and 36.0 respectively.

Dames and Moore, under contract to USATHAMA, conducted an RI of the Range Landfill. The RI consisted of sampling and analysis of RLF-30 in the fall of 1988 and resampling and analysis of RLF-27, RLF-29, and RLF-30. In addition, potable wells FTDIX-11 and FTDIX-12, approximately 3,000 feet northwest and 3,000 feet southwest of the Range Landfill, respectively, were sampled and analyzed. The groundwater data collected as part of the Dames and Moore RI indicate that groundwater moves toward the northwest. Analysis of collected groundwater samples indicate that the high concentrations of arsenic, cadmium, copper, chromium, and nickel detected in 1987 have not been detected in subsequent sampling rounds by Dames and Moore as part of the RI, with the exception of 16.59 ppm lead and 605 ppm copper in FTDIX-12.

Based on a field visit to this site on August 18, 1993, the location of the monitoring wells shown on Figure 10 appear suspect. The proposed scope of work will address this issue (see Subsection 10.2.5.1).

10.2 PROPOSED SCOPE OF WORK

The reason for the variability in the groundwater analytical results is not clear. Additional work is being proposed to more adequately define and characterize the nature and distribution of potential surficial soil and groundwater contamination at the Range Landfill. In addition, the flow direction of shallow groundwater in the Range Landfill area will be studied and confirmed.

10.2.1 Site Topographic Base Map

To better evaluate existing conditions at the Range Landfill and facilitate any remediation/closure of this site, an accurate base map will be prepared. The map should be prepared before conducting field work at the site to facilitate locating proposed explorations. This map will accurately portray all existing structures including roads, buildings, utilities, fences, water courses, monitoring wells, tree lines, and so forth. In addition, the base map shall include ground surface topography with two-foot contour intervals (this may require new photogrammetry). The map shall be presented in hardcopy and CAD compatible computer disk file(s). The map shall use the UTM for horizontal grid markings and shall be prepared at a maximum scale of 1 inch = 100 feet. The topographic contours shall be based on NGVD of 1929. This activity should be coordinated with the field checking of existing monitoring wells (see Subsection 10.2.5.1 of this Technical Plan).

10.2.2 Gross Radiation/Unexploded Ordnance Survey

In order to determine if radiation above background levels is present in surface soils and assess the presence of unexploded ordnance (UXO) at this site, a gross radiation and UXO surveys will be completed at the 20 acre Range Landfill. The radiological survey will be conducted to evaluate the exposure hazard to gamma radiation. Gross alpha and beta radiation are not evaluated during such a survey because these types of radiations do not penetrate through soil as far as gamma radiation. Therefore, it is difficult to evaluate the hazards from gross alpha and beta radiation with hand-held instruments.

The results of the survey will determine if there are any radioactive sources present in the surface soil that create gamma radiation levels above the background as determined from the measurements of the survey instrument. A detailed procedure for this survey is presented in Section 2.4.10 of the QAPP.

The UXO survey will be conducted by a qualified UXO subcontractor.

10.2.3 Geophysics

A geophysics program will be completed to determine the approximate fill limits of the Range Landfill. The geophysical survey program will be based on grid transects spaced at approximate 60 foot intervals over an area of approximately 20 acres. Readings will be collected at 20 foot intervals along the transects. See Subsection 16.1 of this Technical Plan and Subsection 2.4.2 of the QAPP for a detailed discussion of the geophysical survey program. The approximate landfill limits will be established using a combination of GPR, EM, and magnetometer surveys. The geophysical survey program will be conducted in a manner which optimizes the delineation of the landfill limits. The EM and magnetometer surveys will be conducted first and the GPR will be utilized to further define anomalous areas. If after conducting the first 10 transects, no evidence of the landfill limits are detected then the program will be reviewed to assess its adequacy. GPR will be useful to determine the limits of filled and disturbed soils as well as potentially characterizing the depth of buried waste. EM will be useful in assessing the potential presence of conductive, nonmetallic wastes. Magnetometry will be useful to establish the location of buried metal objects.

10.2.4 Field Screening

10.2.4.1 Groundwater Field Screening. Up to seven screened auger/geoprobe borings (RLA-01 through RLA-07) will be made at the Range Landfill. One of the screened auger borings will be upgradient and the remaining six will be downgradient (Figure 10). To minimize the possibility of inappropriate boring locations, the monitoring well survey presented in Subsection 10.2.5 of this Technical Plan along with groundwater elevation measurements should be conducted to reassess groundwater flow direction before proceeding with the boring program downgradient of the Range Landfill. The borings will extend approximately 30 feet below the groundwater table and samples will be collected at 10 foot intervals. Up to three groundwater samples will be collected from each boring for field analysis of BTEX by GC, TSS (laboratory analyses), explosives by immunoassay and alpha/beta/gamma radiation by GM pancake probe and gamma scintillation. These samples will also be submitted for laboratory analyses of TAL metals (filtered and nonfiltered) and TSS as well as being analyzed with a turbidity meter. At least 10 percent of the collected samples will be submitted for confirmatory laboratory analyses. These samples will be analyzed for TCL VOCs, TCL SVOCs, explosives, TSS, and gross alpha, beta, and gamma radiation (Table 2). Results of the field screening will be used to determine the need and most effective location for additional monitoring wells.

10.2.5 Geotechnical Program

10.2.5.1 Monitoring Wells/Groundwater Sampling. Prior to new monitoring well installation, an existing well survey should be performed to confirm site identification, location, and physical integrity. Existing monitoring wells shall be checked for their label/Site ID and location as compared to that indicated on Figure 10. Sounding depths shall be compared to those presented in Table 2. Monitoring wells which are mislabeled and cannot be accurately located from the field checking shall be resurveyed by a New Jersey licensed land surveyor. Subsection 16.6 addresses criteria to be used in determining if monitoring well surveying is needed.

Depending on field screening results, up to five additional shallow monitoring wells (RLG-01 through RLG-05) may be installed with 6.25-inch HSAs at the Range Landfill. To determine lithology, soil samples will be collected at five foot intervals as each boring is advanced. A soil sample from the well screen interval of each new monitoring well will be positioned to intersect the water table. The purpose of additional monitoring wells will be to further characterize groundwater quality if groundwater is determined to have been impacted by landfill activities. The new wells will also be used to further refine groundwater flow directions and conditions at the Range Landfill.

The new and existing wells will be sampled and analyzed for TCL VOCs, TCL SVOCs, TAL metals (nonfiltered and filtered), explosives, TSS, and gross alpha, beta, and gamma radiation (Table 2). In addition, in-situ hydraulic conductivity testing will be performed on the new monitoring wells. Data collected from these tests, when combined with the flow gradients and directions calculated from measured water levels, can be used to estimate groundwater flow directions and velocities in the vicinity of the wells.

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11.0 ANC-9 LANDFILL (SITE 11)

The ANC-9 Landfill is located in the south-central part of the Cantonment Area, southeast of the intersection of Pemberton-Pointville Road and Browns Mills-Lewiston Road (Figure 3). Currently the site is covered with vegetation 30 to 40 years old. Linear ground features provide evidence of four trenches 10 to 12 feet apart and 50 to 60 feet long. This site was identified as a possible fill area based on interpretation of aerial photographs dated 1940. However, it should be noted that recent excavations at similar pits/trenches in this area indicates they were used for trench warfare training. Given that many of the trenches at ANC-9 are still apparent at the ground surface, it appears likely that these trenches may have been utilized for training activities and do not reflect past waste disposal practices.

11.1 PREVIOUS INVESTIGATIONS

Three monitoring wells were sampled during the PA/SI program in 1987. Wells WES-3 and AN9-39 were sampled in February 1987, and wells AN9-38 and AN9-39 were sampled in April 1987. No organics or explosives were detected in the samples. However, several metals were detected including arsenic, beryllium, cadmium, copper, chromium (total), lead, mercury, and zinc.

Based on these results, AN9-38 was resampled for dissolved metals and VOCs during the Phase I RI field program. The Phase II RI program included sampling AN9-38, AN9-39, and FTDIX-4 and analyzing for nonfiltered and filtered metals. No contamination was detected in AN9-38 during the Phase I RI investigation, and only elevated levels of iron were detected in AN9-38 and FTDIX-4 during Phase II investigations.

11.2 PROPOSED SCOPE OF WORK

Results of previous investigations at the ANC-9 Landfill indicated a limited potential for groundwater contamination from inorganics. The objectives of the RI at the ANC-9 Landfill are to:

1. determine if the site is actually a landfill;

2. assess the potential risk to human health and the environment associated with contaminants; and

3. if the data warrants, gather adequate data to support a "No Further Action" decision at this site.

The proposed scope of work includes a geophysical survey of the area, excavation and sampling of test pits in existing trenches and anomalous areas identified during the geophysical survey, and the analysis of seeps/overland flow channels for surface water drainage. Based on historical information, site reconnaissance, and communications with Ft. Dix personnel, it is believed that the ANC-9 area was utilized as a training area not as a landfill. The geophysical survey and subsequent test pitting (Subsection 11.2.2) will determine if landfill activities have occurred.

11.2.1 Geophysical Investigations

A geophysical survey of the ANC-9 area will be conducted utilizing a magnetometer and TC to determine the presence and distribution of disposal material. The survey will be conducted over approximately two acres using an approximate 50 foot grid spacing (Figure 11). See Subsection 16.1 of this Technical Plan and Subsection 2.4.2 of the QAPP for a detailed discussion of the geophysical survey program. Anomalous areas will be flagged for further investigation. During this survey, the ground surface will be inspected to document the absence of seeps or surface water drainage from ANC-9.

11.2.2 Geotechnical Investigations

The following subsections discuss the rationale and approach of geotechnical investigations proposed at the ANC-9 Landfill.

11.2.2.1 Monitoring Wells/Groundwater Sampling. An existing monitoring well survey will be performed to confirm site identification, location, and physical integrity. Existing monitoring wells shall be checked for their label/site ID and location as compared to that indicated on Figure 11. Monitoring wells shall also be sounded for water depths and well bottoms. Sounding depths shall be compared to those in Table 2. Monitoring wells that are mislabeled and cannot be accurately located from the field checking shall be resurveyed by a New Jersey-licensed land surveyor. Subsection 16.6 addresses criteria to be used in determining if monitoring well surveying is needed.

One round of groundwater samples will be collected from the three existing monitoring wells (WES-3, AN9-38, and AN9-39). Groundwater samples will be analyzed for TCL VOCs, TCL SVOCs, TAL metals (nonfiltered and filtered) TSS, and explosives (Table 2).

Concurrent with groundwater sampling, groundwater level measurements will be taken from the existing wells.

11.2.2.2 Test Pits. Up to five test pits (A9S-01 through A9S-05) are proposed to be excavated to investigate existing trenches and anomalous areas identified during the geophysical survey. The test pits will be excavated to a maximum depth of approximately six feet bgs. The test pits will be carefully logged to document the presence or absence of landfilling activities. One soil sample will be collected from each test pit as discrete grab samples. Sample selection will be based on visual observations and PID readings. The samples will be submitted for laboratory analysis of TCL VOCs, TCL SVOCs, and TAL metals, TOC and explosives.

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12.0 ANC-2 DISPOSAL AREA (SITE 12)

The ANC-2 Disposal Area is located in the northwest Cantonment Area, north of Juliustown Road and west of Bordentown Road (Figure 3). The history of the site area is unknown except that it was a sand and gravel excavation that has been backfilled.

12.1 PREVIOUS INVESTIGATIONS

Three existing wells were sampled and analyzed in February 1987 during the PA/SI investigation. Groundwater was analyzed for VOCs, SVOCs, total inorganics, and explosives. No organics or explosives were detected, but nickel was detected at 70 μg/L in well AN2-40. This well was resampled in April 1987, and results for total inorganics indicate that nickel was not detected above the detection limit of 65 μg/L. Arsenic was also detected at 6 μg/L.

The Phase I RI investigation was limited to resampling and analyzing AN2-41 for dissolved metals and recording water level measurements. Phase II water level measurements were conducted in November 1990 and April 1991. Lead was the only contaminant detected during the 1988 sampling of AN2-41. Dames and Moore reported that the arsenic and lead, and the one-time detection of nickel are not contaminants of concern, and could potentially be representative of Ft. Dix area background groundwater concentrations.

12.2 PROPOSED SCOPE OF WORK

Results of the previous investigation at the ANC-2 Disposal Area indicated limited potential for contamination of the groundwater with inorganic compounds. The objectives of the RI for this site are to:

1. further define the distribution of contaminants in the groundwater;

2. address the potential risk to human health and the environment associated with the contaminants;

3. if data warrants, gather adequate data to support a "No Further Action" decision at this site.

The proposed scope of work includes the field screening of groundwater for inorganics and the potential installation and sampling of groundwater monitoring wells based on field screening results.

12.2.1 Site Topographic Base Map

To better evaluate existing conditions at the ANC-2 Disposal Area and facilitate any potential remediation/closure of this site, an accurate base map will be prepared. The map should be prepared before conducting fieldwork at the site to facilitate field work at this site. This map will accurately portray all existing structures including roads, buildings, utilities, fences, water courses, monitoring wells, fuel storage structures, tree lines, and so forth. In addition, the base map shall include ground surface topography with two-foot contour intervals (this may require new photogrammetry at this site). The map shall be presented in hardcopy and CAD compatible computer disk file(s). The map shall use the UTM for horizontal grid markings (this map shall be prepared at a 1 inch = 100 feet scale). The topographic contours shall be based on the NGVD of 1929. This activity should be coordinated with the field checking of existing monitoring wells (see Subsection 7.2.4.3 of this Technical Plan).

12.2.2 Field Screening

Six screened auger/geoprobe borings (A2A-01 through A2A-06) are proposed for the ANC-2 Disposal Area (Figure 12). The objective of the boring investigation is to determine the distribution of inorganic contamination in the groundwater and the need for additional monitoring wells. The borings will be sampled at ten foot intervals starting at the water table and continuing to approximately 30 feet below the water table (approximately four samples per boring). The water table is estimated to be approximately 25 feet bgs. Groundwater samples will be collected and submitted for laboratory analyses of nickel (nonfiltered and filtered) and TSS. Samples will also be qualitatively screened for gross alpha, beta, and gamma radiation using a GM pancake probe and gamma scintillator. At least 10 percent of the samples will be submitted for laboratory analysis for TCL VOCs, TCL SVOCs, TAL metals (nonfiltered and filtered), TSS, TDS, BOD-5, COD, alkalinity, hardness, and gross alpha, beta, and gamma radiation (Table 2).

12.2.3 Geotechnical Investigations

The following subsections discuss the rationale and approach of geotechnical investigations proposed for the ANC-2 Disposal Area.

12.2.3.1 Monitoring Wells/Groundwater Sampling. Prior to new monitoring well installation, an existing well survey will be performed to confirm site identification, location, and physical integrity. Existing monitoring wells shall be checked for their label/site ID and location as compared to that indicated on Figure 12. Monitoring wells shall also be sounded for water depths and well bottoms. Sounding depths shall be compared to those in Table 2. Monitoring wells that are mislabeled and cannot be accurately located from the field checking shall be resurveyed by a New Jersey-licensed land surveyor. Subsection 16.6 addresses criteria to be used in determining if a monitoring well survey is needed.

Up to four new monitoring wells (A2G-01 through A2G-04) are proposed to be installed, contingent on field screening results indicating contamination. One monitoring well will be installed in an upgradient location, and the remaining three will be installed downgradient of the ANC-2 Disposal Area. The number and location of the wells will be based on field screening analytical results and existing well locations. The monitoring wells will be installed using 6.25-inch HSAs and screened at the water table. Groundwater is estimated to be approximately 25 feet bgs. A soil sample from the well screen interval of each new monitoring well will be submitted for analysis of grain size distribution.

One round of groundwater samples will be collected from the three existing monitoring wells and four (proposed) new monitoring wells. Groundwater samples will be analyzed for TCL VOCs, TCL SVOCs, TAL metals (nonfiltered and filtered) TSS, TDS, BOD-5, COD, alkalinity, hardness, and gross alpha, beta and gamma radiation (Table 2).

Concurrent with groundwater sampling, groundwater level measurements will be taken from new and existing wells. In addition, in-situ hydraulic conductivity testing will be performed at the existing and new monitoring wells. Data collected from these tests, when combined with the flow gradients and directions calculated from measured water levels, will be used to estimate groundwater flow velocities in the vicinity of the wells.

12.2.3.2 Surface Water/Sediment Investigations. A surface water/sediment sampling program will be performed to determine the potential impact that the ANC-2 Disposal Area may have on Bakers Brook.

Three surface water/sediment samples (A2D/A2W-01 through A2D/A2W-03) will be collected for laboratory analysis from Bakers Brook, located north of the ANC-2 Disposal Area (Figure 12). One sample will be collected from an upstream location and one sample will be collected from a downstream location relative to the landfill. The third sample will be collected from a location on Bakers Brook approximately adjacent to the landfill. The surface water/sediment samples will be analyzed for TCL VOCs, TCL SVOCs, TAL metals, TOC (sediment only), alkalinity/hardness (surface water only), PCBs, and grain-size analyses (sediment only).

13.0 BOILER BLOWDOWN AREA (SITE 13)

The Boiler Blowdown Area is located approximately one-third mile east of the Ft. Dix Boiler Plant Building 5426, in the northeast Cantonment Area (Figure 3). Boiler blowdown was discharged to the storm sewer until about 1979; since then it has been discharged to the sanitary sewer. On occasion, blowdown enters the sanitary sewer at such high pressure and temperature that a discharge is released to a swale located adjacent to a stream that flows from Willow Pond.

13.1 PREVIOUS INVESTIGATIONS

One shallow soil sample was collected at the Boiler Blowdown Area during the PA/SI conducted at Ft. Dix. No organic contaminants were detected; however, lead was detected at concentrations up to 100 mg/kg. Other detected metals included arsenic, chromium, copper, nickel, selenium, silver, and zinc. Based on the results of the PA/SI, the Phase I RI program (Dames and Moore, 1991) consisted of the collection of three shallow soil samples (Figure 13). The samples were collected from the surface soil (0 to 6 inches) at low points in the swale and analyzed for the presence of metals. No additional sampling was conducted during the Phase II RI program.

Results of the soil sampling show detected levels of arsenic, barium, chromium, copper, lead, nickel, selenium, silver, thallium, and zinc in samples taken from the swale. Lead was detected in SC-156 at 142 mg/kg, and thallium was detected in two samples, SC-154 and SC-155 at 23 mg/kg and 22.8 mg/kg, respectively. Lead concentrations were within the typical background range for the eastern United States.

During the Environmental Investigation at Fort Dix two sites, the 4300 and 4400 Motor Pools, located adjacent to the Boiler Blowdown Area were investigated (ICF, 1994). These investigations included sampling and analyses of the surface water and sediment from the stream discharge associated with Willow Pond as well as subsurface soil and groundwater sampling. A series of six monitoring wells, three geoprobe soil explorations, six SCAPS probes, and three soil borings have been conducted in this area. Approximate locations of these explorations are presented on Figure 13.

The analyses of inorganics conducted on select samples from these explorations has not detected the presence of thallium. The results of these explorations will be incorporated into the RI report for this site including the presentation of geologic cross sections.

13.2 PROPOSED SCOPE OF WORK

Results of previous investigations at this site indicate isolated presence of thallium in surface soil samples. The scope of work included in this effort is intended to assess if these detects represent isolated occurrences of thallium or if elevated thallium is common in this drainage way. Results from ongoing work at the 4300 and 4400 motor pools, adjacent to the site, will be incorporated into the RI report presentation this site.

13.2.1 Geotechnical Investigations

The following subsections discuss the rationale and approach of geotechnical investigations proposed for the Boiler Blowdown Area.

13.2.1.1 Surface Soil Sampling. To assess whether the existing site data reflects isolated occurrences of thallium or a more widespread elevated condition, series of 11 surface soil samples (BBS-01 through BBS-11) will be collected from surface soils on the stream bank adjacent to the drainageway. The approximate sample locations are presented on Figure 13. One sample will be collected upstream from the SC-155/SC-156 sample location near the storm drain discharge point, the second sample will be collocated with the SC-155/SC-156 samples to confirm the concentration of thallium in the soils, the third sample will be collected on the south bank of the drainage way opposite from the SC-155/CS-156 sample location, and the remaining eight samples will be collected from a grid centered over the SC-155/SC-156 sample, spaced at approximately 50 foot intervals.

These samples will be submitted for laboratory analyses of TCL VOCs, TCL SVOCs, and TAL metals.

13.2.1.2 Surface Water/Sediment Investigations. A surface water/sediment sampling program will be conducted to assess the presence of elevated levels of thallium in surface water and sediment downstream from Willow Pond. The three surface water/sediment sample pairs (BBD/BBW-01 through BBD/BBW-03) will be collected from the stream. These samples will be located such that one sample pair is located upstream from the location of the outfall of the storm sewer , likely near the discharge point of Willow Pond, west of Texas Avenue. The second surface water/sediment sample pair will be located in the drainageway adjacent to the SC-155 and SC-156 surface soil sample locations. The third sample pair will be located approximately 200 feet downstream from the second sample pair.

The surface water and sediment samples will be submitted for laboratory analyses of TCL VOCs, TCL SVOCs, TAL metals, TOC (sediment only), alkalinity/hardness (surface water only), PCBs, and grain size distribution (sediment only).

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14.0 AREA NORTH OF DOGWOOD LAKE (SITE 14)

The Area North of Dogwood Lake is located in the northwestern Cantonment Area (Figure 3), and is currently an open field. Record drawings obtained from Ft. Dix dated 1917 indicate that 19 buildings, a water tank, railroad tracks, and three USTs previously existed at the site. The buildings included clothing stores, offices, a garage, and several storage sheds. A 1945 drawing indicates that the site was also used as a troop billeting area and contained 17 two-story, barracks-style buildings. The buildings were removed in the early 1960s (Dames and Moore, 1993).

14.1 PREVIOUS INVESTIGATIONS

Contamination was first discovered at this site in 1980 when the USAEHA installed well MW-17 as part of the study conducted to determine groundwater flow patterns at Ft. Dix. A groundwater sample collected from MW-17 indicated a petroleum-based compound at a concentration of approximately 2,000 μg/L (USAEHA, 1984).

The purpose of a 1984 investigation by the USAEHA was to locate the source and extent of potential groundwater contaminated by organic compounds in and around the Area North of Dogwood Lake (USAEHA, 1984). This 1984 USAEHA investigation included a geophysical survey as well as the drilling, installation, and sampling of 32 test wells. Samples were collected and analyzed for TPHs and xylenes. The results indicated TPH concentrations that ranged from 100 to 247,000 μg/L, forming a contaminant plume approximately 500 feet long by 200 feet wide at the site. Xylene concentrations in the groundwater ranged from 10 to 3,500 μg/L and formed a contaminant plume with a center about 50 feet downgradient of the center of the TPH plume. The study recommended additional investigations to locate the buried fuel tanks and determine the extent of petroleum hydrocarbon contamination at greater depth.

IKW (IKW, 1985) conducted another investigation at this site in 1985. Eleven soil borings were drilled to depths of 20 to 30 feet. Soil samples collected from the borings were analyzed for TPH. Concentrations of TPH ranged from less than 300 to 37,000 μg/L. The highest concentrations were generally detected in samples collected at a depth of 4 to 6 feet below the water table. The investigation concluded that the source of petroleum contamination was an old spill or leakage of petroleum products. The remaining hydrocarbon contaminants were believed to be firmly adhered to the soil, while mobile fractions appeared to have been flushed from the area by groundwater and surface water. The study recommended the installation of one monitoring well to be monitored at least once every six months.

In 1986, EA conducted a geophysical survey using TC over the Area North of Dogwood Lake. The purpose of the survey was to locate possible buried metal tanks (USTs) for excavation. The surveyed area boundaries were Maryland Avenue, the north shore of Dogwood Lake, Pennsylvania Avenue, and Airfield Road (EA, 1986). Several buried pipelines, areas of buried scrap metal, and sections of railroad tracks were detected during the survey. No USTs were located as a result of the survey. It is assumed that the USTs were excavated and removed, or that the 1917 drawings were inaccurate in depicting the number and/or location of USTs.

Dames and Moore conducted an RI in 1988 and 1991. Investigations performed included a soil gas survey, surface water/sediment sampling, soil borings, and installation/sampling of groundwater monitoring wells.

Soil gas samples were collected at 66 locations at the Area North of Dogwood Lake. These samples were analyzed for methyl tertiary butyl ether and BTEX to evaluate the presence of petroleum products. BTEX was detected in samples collected near monitoring wells NDL-78 and NDL-79 on the north shore of Dogwood Lake. Fifteen soil samples were collected at depths of 0 to 10 feet from two well borings (NDL-78 and NDL-79) and three soil borings (SC-252 through SC-254), and analyzed for VOCs and TPH (see Figure 7). TPHs were detected in soil samples from NDL-78 at concentrations up to 503 mg/kg. No contamination was detected in soil samples from the other borings.

Six groundwater monitoring wells were installed by Dames and Moore between 1988 and 1990: NDL-60 through NDL-63 and NDL-78 and NDL-79 (see Figure 7). Groundwater samples were collected from the six wells and analyzed for VOCs and TPH. TPHs were detected in groundwater at NDL-78 at a concentration of 2,450 μg/L. Petroleum-related compounds were not detected in any other groundwater samples.

Three surface water/sediment samples were collected from Dogwood Lake (Figure 7). These samples were analyzed for VOCs and TPH. TPHs were detected at SE-117, SE-118, and SE-119 at 81.89, 50.84, and 79.10 mg/kg, respectively, below regulatory standards. No contaminants were detected in the surface water samples.

Widespread TPH contamination was detected in soils and groundwater in 1984 and 1985. In 1988 and 1990, groundwater, soil, and soil gas sampling indicated elevated TPH concentrations near NDL-78, suggesting that some migration of the previously detected contaminant plume has occurred (Dames and Moore, 1993).

14.2 PROPOSED SCOPE OF WORK

Results of previous investigations at the Area North of Dogwood Lake indicate contamination of soil and groundwater by weathered fuel compounds. Contaminant distribution last identified in 1990 indicates groundwater contamination along the north shore of Dogwood Lake in the vicinity of monitoring well NDL-78.

The objectives of the RI for this site are to:

1. further assess the distribution of groundwater, surface water, and sediment contamination; and

2. assess the potential risk to human health and the environment associated with the contamination.

The proposed scope of work will be implemented in a phased approach. Groundwater field screening will be used to assess groundwater contamination and identify the need for, and location of, additional monitoring wells. Surface water and sediment data from samples collected by ICF Kaiser Engineers (1993) along the north shore of Dogwood Lake will be evaluated for fuel-related compound contamination. The proposed scope of work is presented in the following subsections in more detail.

14.2.1 Field Screening

Geoprobe/screened auger sampling of groundwater and field screening for BTEX and TPH will be performed at the Area North of Dogwood Lake. Geoprobe/ screened auger sampling and field screening will provide data for: (1) delineation of the horizontal and vertical distribution of BTEX in groundwater, and (2) placement of new monitoring wells.

It is anticipated that up to 3 transects of geoprobe/screened auger borings, with a total of 18 borings may be completed (Figure 7). It is anticipated that up to 3 groundwater samples will be collected from each boring: at the water table, and at 5 and 10 feet below the water table. These sampling depths are subject to change based upon the maximum attainable exploration depth and depth to groundwater. The maximum depth of borings is anticipated to be 25 feet bgs. Depth to groundwater is anticipated to be between 5 and 15 feet bgs.

The first transect includes a series of 8 borings (DLA-01 through DLA-08), distributed uniformly in the shaded area shown in Figure 7. The location of this transect was chosen based on the most recent groundwater data, which indicates that the only detects of fuel-related compounds were found in monitoring well NDL-78 (Dames and Moore, 1993). Subsequent transects, and the location of borings within transects, will depend on the analytical results of the first transect. The second transect will be located north of the first and will include up to 7 borings (DLA-09 through DLA-15). The third transect will be located north of the second transect and trending northwest/southeast and will include up to 3 borings (DLA-16 through DLA-18). The purpose of the third transect is to investigate groundwater quality in the area of TPH contamination identified by USAEHA in 1984 (USAEHA, 1984). The sequence of these transects is subject to change based on field screening results.

Groundwater samples from these explorations will be analyzed in the field for BTEX by GC, and for TPH by IR. At least 10 percent of the samples will be submitted for confirmatory laboratory analysis of TCL VOCs, TCL SVOCs, TAL metals (nonfiltered and filtered), TSS, and TPH (Table 2).

14.2.2 Geotechnical Investigations

The following subsections discuss the rationale and approach of geotechnical investigations proposed for the Area North of Dogwood Lake.

14.2.2.1 Monitoring Wells/Groundwater Sampling. Prior to new monitoring well installation, an existing monitoring well survey will be performed to confirm Site ID, location, and physical integrity. Specifically, each well shall be sounded for water level and well depth; this data will be checked against existing logs and depths presented on Table 2. Wells that cannot be accurately located shall be resurveyed by a licensed New Jersey land surveyor. Subsection 16.6 addresses criteria to be used in determining if a monitoring well survey is needed. In addition, water levels will be measured from all existing wells, including PTS-22, to evaluate groundwater flow direction prior to field screening activities.

Up to 4 new groundwater monitoring wells (DLG-01 through DLG-04) will be installed at the Area North of Dogwood Lake. The objective of these well installations is to provide future monitoring points for groundwater contamination that may be identified during the groundwater field screening activities. The number and location of wells will be based on field screening analytical results and existing well locations. To enhance evaluation of potential free product, new monitoring well borings will have continuous soil samples collected from approximately 10 feet above the water table to five feet below the water table. These soil samples will be field screened for BTEX and TPH. Soil samples collected at or just above the water table, as well as just above confining layers, will also be submitted for UV screening. At least 10 percent of the field screening soil samples will be submitted for confirmatory laboratory analysis. The confirmatory samples will be analyzed by the analytical laboratory for TCL VOCs, TCL SVOCs, TAL metals, and TPH.

These water table wells will be installed using HSAs. New monitoring well screens will be installed to span the water table. A soil sample for the well screen interval of each new monitoring well will be submitted for analysis of grain size distribution.

One round of groundwater samples will be collected from the six existing monitoring wells (including PTS-22) and 4 (proposed) new monitoring wells. Groundwater samples will be analyzed for TCL VOCs, TCL SVOCs, TAL metals (nonfiltered and filtered), TSS, and TPH (Table 2). During groundwater sampling, a complete round of groundwater level measurements will be taken from all new and existing wells. In addition, a surface water level measurement will be obtained from a staff gauge to be installed in Dogwood Lake.

In-situ hydraulic conductivity testing (slug testing) will be conducted at the site on all newly installed wells to establish the in-situ hydraulic conductivity of the aquifer. Data collected from these tests, when combined with groundwater flow gradients and directions calculated from measured water levels, can be used to estimate groundwater flow velocities. Slug testing procedures are discussed in Section 16.0.

14.2.2.2 Surface Water/Sediment Investigations. As part of an EI/AA being conducted by ICF-Kaiser Engineers for the USAEC, three surface water/sediment samples were collected in 1993 from the north shore of Dogwood Lake. At the time of preparation of this Technical Plan, the Site IDs for these samples are unknown, but will be available in the EI Report being prepared by ICF-Kaiser Engineers. These samples were analyzed for TCL VOCs, TCL SVOCs, TAL metals, TOC (sediment only) and grain-size analyses. To complement the ICF-Kaiser Engineers data, two additional surface water/sediment samples (DLD/DLW-01 and DLD/DLW-02) will be collected from the northwest corner of Dogwood Lake (Figure 7). These samples will be analyzed for TCL VOCs, TCL SVOCs, TAL metals, TPH, alkalinity/hardness (surface water only), PCBs, TOC (sediment only) and grain-size analyses (sediments only). Data from these surface water/sediment samples will be used to evaluate the potential impact to Dogwood Lake from the identified groundwater contaminant plume in the area north of the lake.

One staff gauge, designated DLSTAFF1, will be installed in Dogwood Lake to measure the surface water level. Measurements from this gauge will provide data for assessment of hydrologic and hydrogeologic interaction.

15.0 GOLF COURSE PESTICIDE MIXING AND STORAGE AREA (SITE 15)

The Golf Course Pesticide Mixing and Storage Area (Site 15) is located in the northern portion of the Cantonment Area within the Site 4 - Golf Course Leaking Tank Area (Figure 3). Site 15 includes Building 3150 - the Pesticide Storage Building, and Building 3151 - the Golf Course Herbicide Storage Building. Also, part of Site 15 is the pesticide mixing area located east of Building 3150 and southeast of Building 3151 (Figure 6). Historical practices and operations at the site are unknown; however, pesticide mixing operations reportedly occurred at the site as recently as 1985.

15.1 PREVIOUS INVESTIGATIONS

Several previous investigations have been conducted at the Golf Course Pesticide Mixing and Storage Area. These investigations are discussed below in chronological order.

The USAEHA conducted a study at Ft. Dix in 1975 to evaluate distribution of pesticides in selected media at Ft. Dix. The sites tested in 1975 included the Golf Course Area. Chlordane was detected in soil at the Golf Course at a concentration of 34.2 mg/kg. The study recommended review and revision of pesticide application procedures at Ft. Dix (USAEHA, 1978).

The USAEHA conducted another study in 1985 to identify pesticide residues associated with the Pest Management Program at Ft. Dix. The investigation was initiated as a result of concern that past use and disposal of pesticides at Ft. Dix might have resulted in pesticide residue accumulation in the environment in excess of amounts expected from normal use.

The investigation included the collection and analysis of soil and sediment samples within and around the Pesticide Control Shop (Building 5352), the Old Pesticide Storage Shop (Building 5317), and the Golf Course Herbicide Storage (Building 3151).

According to the report, data from years of monitoring by the USAEHA as well as other data from the National Pesticide Monitoring Program have shown that, as a general guideline, conditions at a site should be of concern when the total residual pesticide concentration in the soil equals or exceeds 5 mg/kg. In accordance with such a guideline, residual pesticide concentration detected in the Pesticide Control Shop in 1985 was of concern. The maximum total pesticide residue concentration detected in samples at the Golf Course Herbicide Storage Building Area was 5.41 mg/kg.

The study recommended further evaluation of the health and environmental hazards associated with pesticide management at Ft. Dix, especially with pesticide storage, mixing, and handling procedures.

EA, under contract to USATHAMA, prepared a PA/SI of environmental conditions at Ft. Dix (1989). This study was conducted in the adjacent Golf Course Leaking Tank Area (Site 4) as discussed in Section 5.0. No organics were detected in groundwater samples from monitoring well GLF-15 and pesticides were not detected in samples from wells GLF-15, GLF-16, or GLF-17 (Figure 6).

Dames and Moore, under contract to USATHAMA, conducted an RI at the Golf Course Pesticide Storage and Mixing Area (Dames and Moore, 1993). The investigation was conducted in two phases:

- Phase I involved collection and analysis of 3 surface soil samples SC151 through SC153.

- Phase II involved collection and analysis of soil samples from 3 borings (SC249 through SC251) each drilled to a depth of 10 feet bgs.

The locations of these sampling points are shown on Figure 6. Pesticides were detected only in soil sample SC-153, at a total concentration of approximately 1 ppm. SVOCs were detected in borings SC249 through 251 up to total concentration of 14 ppm.

15.2 PROPOSED SCOPE OF WORK

Results of previous investigations at the Golf Course Pesticide Storage and Mixing Area indicate limited soil contamination by pesticides, and some subsurface soil contamination by SVOCs that may not be related to pesticide storage and mixing activities.

The objectives of the RI for this site are to:

1. further define the extent of surface soil, subsurface soil, groundwater, surface water and sediment contamination by pesticides and herbicides;
2. assess the risk to human health and the environment associated with contamination; and
3. provide adequate data for assessment of remedial alternatives.

In addition to the field investigations described in the following subsections, existing data will be reassessed in light of revised Maximum Contaminant Levels (MCLs) and NJDEP soil cleanup criteria (last revised 2/3/94).

15.2.1 Geotechnical Investigations

The following subsections discuss the rationale and approach of geotechnical investigations proposed for the Golf Course Pesticide Mixing and Storage Area.

15.2.1.1 Surface Soil. The soil sampling program is summarized in Table 3. A grid pattern will be established at the identified pesticide mixing area (see Figure 6) for collection of twelve surface soil samples (GPS-01 through GPS-12). Soil samples will be collected in unpaved areas. These samples will be submitted for laboratory analyses of TCL VOCs, TCL SVOCs, TAL inorganics, pesticides, herbicides, and TOC. The analytical results from these samples will be used to determine contaminant distribution in surface soils as a result of post activities at the pesticide mixing area.

15.2.1.2 Soil Borings. Two soil borings (GPB-01 and GPB-02) will be drilled within the identified boundary of the former pesticide mixing area (Figure 6). The soil sampling program is summarized in Table 3. The borings will be drilled with 4.25-inch HSAs, and soil samples will be collected continuously from ground surface to the first significant fine-grained unit beneath the water table, estimated to be 30 feet bgs.

These soil samples will be field screened for selected pesticides and BTEX by GC and herbicides by immunoassay. Soil samples collected at or just above the water table, as well as just above confining layers, will also be submitted for UV screening.

At least 10 percent of the field screening samples will be submitted for confirmatory laboratory analysis. The confirmatory samples will be analyzed by the analytical laboratory for TCL VOCs, TCL SVOCs, TAL inorganics, pesticides, herbicides, and TOC.

15.2.1.3 Monitoring Wells/Groundwater Sampling. Groundwater sampling, conducted for the Golf Course Pesticide Mixing and Storage Area, is addressed in Subsection 5.2.3.1 of this Technical Plan.

15.2.1.4 Surface Water/Sediment. Surface water/sediment samples will be collected to assess impact to these media from pesticide mixing and storage. The surface water/sediment sampling program is summarized in Table 4.

Nine surface water/sediment samples (GTD/GTW-01 through GTD/GTW-09) will be collected from the nearby stream and ponds for analysis. These samples will be collected as part of Site 4 Golf Course Leaking Tank Area investigation and are discussed in Subsection 5.2.3.3 of this plan, and shown on Figure 6. The three samples to be collected upstream of the site are intended to provide data for delineation of site related affects, particularly for herbicides and pesticides in the Golf Course Area. This will allow an assessment of the impact from the pesticide mixing and storage area to the sediment/surface water in the immediate site vicinity.

Up to two additional surface water/sediment sample pairs (GPD/GPW-01 and GPD/GPW-02) will be collected from any observed surface drainageways from the identified former pesticide mixing area. It is anticipated that surface water may not be available for sampling at these locations. These sediment samples will be submitted for laboratory analyses of TCL VOCs, TCL SVOCs, TAL inorganics, pesticides, herbicides, TOC (sediment samples only), alkalinity/hardness (surface water only), PCBs, and grain size analyses (sediment only) (see Table 4).

16.0 TECHNICAL APPROACH FOR FIELD OPERATIONS

The objective of this task is to establish the nature and distribution of contamination at the 13 Sites at Ft. Dix identified in the USAEC task order. Data collected will be used to evaluate and recommend alternatives for site remediation and to produce final decision documents regarding remedial action at the site.

The field investigations will include soil borings and test pits to characterize contaminant distribution and the geologic setting; a field analytical program (using Geoprobe, screened augers and soil borings) to further characterize contaminant distribution; monitoring well and piezometer installation and sampling to more accurately characterize groundwater quality and hydrogeologic parameters; surficial geophysical surveys; surface and subsurface water and sediment sampling; surface soil sampling; and surveying of sampling locations.

Field sampling results will be used to characterize each site and further identify environmental contaminants, contaminant distribution, and contaminant migration pathways. The results will also be used in the risk assessment to determine the impact of the detected contaminants on human and ecological receptors, as well as in the FS to evaluate remedial alternatives.

The following subsections describe the elements of the proposed field program in the general order to be completed.

16.1 GEOPHYSICAL SURVEY

Geophysical surveys will be conducted using GPR, magnetometer, and TC at several sites to characterize the extent of landfill waste. GPR will also be used to clear locations where intrusive (subsurface) sampling techniques will be used.

16.1.1 GPR Survey Procedures

Before conducting the GPR survey, a grid system will be established to reference the survey results. The survey will then be conducted using a GSSI SIR System III GPR unit equipped with a 200 or 500 megahertz antenna. The survey will consist of a nonintrusive walkover along the established transects with the GPR antenna. The survey results will be printed in the field on a strip chart recorder for interpretation by a qualified geophysicist. This interpretation may redirect the survey transects to optimize the data generated during the survey.

Subsection 2.4.2.2 of the QAPP presents a more detailed discussion of the theory behind the GPR technique in addition to more specific procedures for conducting the survey and interpreting the results.

16.1.2 Magnetometer Survey Procedures

A magnetometer survey will be used to locate buried steel containers and define boundaries of pits or trenches with ferrous debris. The survey consists of a nonintrusive walkover and will be conducted utilizing a magnetic gradiometer consisting of a pair of total field magnetic sensors mounted on a survey pole. Data will be collected at pre-established grid nodes within the survey area, which will be marked in the field prior to the survey with wire-stake flagging. The data will be interpreted and anomalies marked in the field. This interpretation will be used to locate intrusive investigations.

Subsection 2.4.2.1 of the QAPP presents a more detailed discussion of the theory behind the magnetometer technique in addition to more specific procedures for conducting the survey and interpreting the data.

16.1.3 Terrain Conductivity Survey Procedures

A TC survey will be performed to complement the magnetometer survey and will be used to help map landfill boundaries and potential contaminant plumes in groundwater. The survey consists of a nonintrusive walkover and will be conducted utilizing a transmitter and receiver which produces and measures a magnetic field. Data will be collected continuously along survey lines established within the survey area prior to the survey. The data will be interpreted and anomalies marked in the field. This interpretation will be used to locate intrusive investigations.

Subsection 2.4.2.3 of the QAPP presents a more detailed discussion of the theory behind the terrain conductivity technique in addition to more specific procedures for conducting the survey and interpreting the data.

16.2 SOIL SAMPLING PROGRAM

The objectives of the soil sampling program are to characterize the geologic setting at each site and characterize the nature and distribution of contamination. Table 3 summarizes the soil exploration location rationale and analytical sampling for each site.

16.2.1 Soil Sampling

The characterization of the subsurface soils encountered at each site will be accomplished by careful logging and sampling of soils. A geologist will be present during drilling and soil sample collection activities to maintain descriptive logs and collect appropriate samples for chemical and physical analyses. Subsurface soil borings will be advanced using 4.25-inch HSAs, and soil samples will be collected with a 3-inch outside diameter (OD) split-spoon sampler. The sampler will be advanced using the standard penetration test technique (see Section 2.5.1 of the QAPP for a detailed description). Samples will be screened in the field using a PID for contaminant concentration and sample prioritization.

Analytical soil samples will be packed in appropriate sample bottles using a clean stainless steel spatula, and placed in a cooler maintained at 4 degrees Centigrade (°C). During the sampling phase, the VOC samples will be collected first and will be transferred such that air space is minimized in the sample bottle. Samples collected for SVOCs, metals, TOC, and TPH analyses will be homogenized using the "Coning and Quartering method".[1] Each sample bottle will contain a sample label, which will include the project number, sample number, analysis to be performed, time, date, and sampler's initials. Phthalate free gloves will be used during sampling activities and will be changed between each sample location. Soil sampling points will be located to map accuracy at the time of sample collection and locations will be marked or staked for future reference.

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[1] Coning and Quartering Method: Non-VOA samples should be homogenized using the following procedure: First remove rocks, twigs, leaves, and other debris, if they are not considered part of the sample. Then the soil/sediment should be removed from the sampling equipment and placed in a decontaminated stainless steel pan. The sample is then thoroughly mixed using a decontaminated stainless steel spoon. The soil/sediment in the pan should be scraped from the sides, corners, and bottom of the pan, rolled to the middle of the pan, and initially mixed. The sample should then be quartered and moved to the four corners of the pan. Each quarter of the pan should be mixed individually, and then rolled to the center of the container and the entire sample mixed again.

Geotechnical laboratory physical analysis of soil samples will be conducted on ten percent soil samples collected from each site where soil borings and monitoring wells are completed. The ten percent of samples will be calculated based on standard five-foot interval sampling. Each soil sample will be analyzed for moisture content (American Standards and Test Methods [ASTM] D 2216), grain-size distribution (ASTM D 422), and Atterberg limits (ASTM D 4318). Samples will be assigned a symbol and description.

The selection of soil samples for physical testing will be made by the geologist. Testing results will be used to assist in describing the subsurface soils, to verify the geologist field logs, and to develop site-specific values for soil porosity and hydrogeologic properties of the soils. Soil samples collected for physical testing will be placed in glass jars, labeled according to boring number and depth, and shipped to a geotechnical laboratory.

16.2.1.1 Surface Soil Sampling. Soil samples will be collected to determine the nature and extent of near-surface contamination. Surface soil samples will be collected from 0 to 6 inches bgs using a trowel, hand auger, tulip bulb planter, or stainless steel spoon and placed in a stainless steel bowl. After collection of the VOC sample, the remaining sample will be homogenized utilizing the coning and quartering technique. The soil samples will be placed in pre-labeled sample jars and sent for laboratory analysis. Remaining samples will be discarded into the 55-gallon Department of Transportation (DOT)-approved drums being used for collection of cuttings. Appropriate sample containers are described in Subsection 5.2 of the QAPP.

In the event it is necessary to remove asphalt to collect the sample, a pickaxe or jackhammer may be used. All sampling and asphalt-removal equipment will be decontaminated between sample collections as described in Subsections 16.5.1 and 16.5.3 of this Technical Plan.

16.2.1.2 Natural Gamma and EM Conductivity Borehole Logging. Natural gamma and EM conductivity borehole logging survey will be completed in several of the exploratory soil borings. The logging tools will be run the entire length of the borehole to assist in defining the geologic setting within the regional stratigraphic framework.

After logging is complete, the geologist will compare the log to other existing logs in conjunction with lithologic data. Subsection 2.4.2.4 of the QAPP describes how the gamma and EM conductivity logging will be completed.

16.2.2 Borehole Advancement

Drilling of soil borings at each site will proceed as follows:

a. Boring/well drilling permits and regulations, as required by the NJDEP, will be secured and/or complied with, and clearance of underground utilities will be arranged with appropriate plant personnel and local utility companies.

b. Water used for auger and drilling equipment decontamination will be obtained from the Ft. Dix water supply source and tested prior to use.

c. Filter pack material and bentonite to be used in the drilling program will be approved by USAEC as specified in Subsection 2.4.4 of the QAPP.

d. Sampling and drilling will be performed under direct supervision of the assigned geologist.

Soil samples for chemical analysis will be collected using a decontaminated split-spoon sampler. A truck-mounted HSA or mud-rotary drilling rig will be used to drill the overburden soil borings. Subsection 2.4.5 of the QAPP describes the techniques for advancing the boreholes using both the HSA and mud-rotary technique. As the boreholes are advanced, split-spoon samples will be collected at the intervals specified in Tables 2 and 3 of this Technical Plan. Details of the monitoring well installation are provided in Subsection 16.3.6 of this Technical Plan.

16.2.3 Borehole Logging

During drilling of the soil borings, the geologist will describe activities in the field boring logs. Upon completion of each boring or monitoring well, information from the boring logs will be transferred to Field Drilling or Well Construction File forms, and original boring logs will be submitted to USAEC as soon as possible following completion of the boring or well. The following data will be recorded in the boring logs, in real-time, at the drill site:

a. Depths in feet and fractions thereof (tenths of feet). Measurements will be entered on the data entry forms.

b. Soil descriptions, in accordance with the USCS and prepared in the field by the geologist, which include the following information:

- Classification
- USCS symbol
- Secondary components and estimated percentage
- Color (using Munsell Soil Color Chart)
- Plasticity
- Consistency (cohesive soil) or density (noncohesive soil)
- Moisture content
- Texture/fabric/bedding
- Depositional environment

c. Cutting descriptions, including basic classification, secondary components, and other apparent parameters

d. Visual estimates of secondary soil constituents (if terms such as "trace," "some," or "several" are used, their quantitative meanings will be characterized in a general legend).

e. Length of sample recovered for each sample interval for driven (split-spoon) samples.

f. Blow counts, hammer weight, and length of fall for split-spoon samples.

g. Estimated interval for each sample.

h. Depth to water first encountered during drilling and the method of determination (any distinct water-bearing zones below the first zone also will be noted).

i. General description of the drilling equipment used, including the rod size, bit type, pump type, rig manufacturer, model, and drilling personnel.

j. Drilling sequence.

k. Unusual problems.

l. Start and completion dates of all borings, and a chronological time-sequence of all events.

m. Lithologic boundaries.

16.2.4 Borehole Abandonment

Once the completion depth for the soil borings has been reached and samples have been collected, the shallow borings (i.e., those less than 25 feet deep) will be backfilled with material removed from the hole in accordance with the NJDEP Sealing Requirements[2]. These shallow borings will be completed at the surface with topsoil, concrete, or asphalt material to level with the ground surface immediately adjacent to the borehole. Deep borings (those greater than 25 feet deep) will be abandoned by tremie grouting with a cement bentonite grout mixture to within one-foot of the ground surface. The last foot will be completed with topsoil, concrete or asphalt level with the ground surface immediately adjacent to the borehole. For deep soil borings (greater than 25 feet deep) and monitoring well borings, soil cuttings will be visually inspected and checked with a PID for contaminants and containerized in 55-gallon DOT-approved drums. These drums will be managed as discussed in Subsection 16.5.

16.2.5 Test Pits

Test pits will be excavated at several sites to better characterize the nature of the media and character of the shallow subsurface soils. The precise locations of the pits will be established in the field at each site based on aerial photographs, GPR results, and soil boring data. Test pits will be excavated to a maximum depth of 10 feet bgs at each site.

Logging of test pit soils will be consistent with the protocols presented in Subsection 16.2.3. In addition, photographs will be taken to record subsurface conditions encountered. Soil samples will be collected from each test pit for

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[2] According to NJDEPE procedures for drilling and sealing boring/probe holes, borings less than 25 feet in depth, regardless of whether the boring has reached the water table, may be sealed by backfilling. Borings exceeding 25 feet must be tremie grouted.

chemical analyses as listed in Table 3 of this Technical Plan. Samples will be selected based on PID readings and field observations.

Each test pit will be backfilled with the soil excavated from that pit. During excavation, the upper one to two feet of soil will be segregated from deeper soils. The upper soil will be replaced at the ground surface when backfilling the excavation. Decontamination of soil sampling and test pitting equipment as well as residuals management is specified in Subsection 16.5 of this Technical Plan.

16.3 HYDROGEOLOGIC INVESTIGATION

Hydrogeologic investigations will be conducted at several of the subject sites. The investigation at each of the sites will consist of either screened auger or geoprobe sampling and field screening, and/or monitoring well installations and sampling. The screened auger/geoprobe sampling and field screening component is intended to quickly and accurately characterize the extent of groundwater contamination while giving a good approximation of contaminant concentrations. This will provide focused monitoring well installations to better characterize the contaminant concentrations in the groundwater flow system at each site.

16.3.1 Screened Auger Sampling

The screened auger program will be completed to characterize the lateral and vertical and horizontal distribution of the groundwater contaminants. Table 2 summarizes the screened auger programs. Screened auger borings will be completed in a series of transects extending downgradient from the site.

Initial screened auger borings will have more frequent sampling (approximately five samples per boring). A minimum of three groundwater samples will be collected from each screened auger boring. Depths from which samples will be collected will be based on the analytical results from existing monitoring wells, the geologic data from the three soil borings, and previously installed screened auger borings.

Screened auger soil borings will be advanced using a 4.25-inch ID HSAs equipped with O-rings and a five-foot slotted lead auger. If necessary, the slotted auger section may be placed after the lead auger. The slotted auger shall be constructed with either laser-slotted openings or welded wire-wound well screen. In either case, the slot size shall not exceed 0.010 inches.

Borehole advancement will be similar to a typical HSA soil boring, although the cutter head of the auger will be equipped with a bottom plate; and therefore, no center plug will be needed. Given this arrangement, no soil samples will be collected.

Upon reaching the specified sampling interval, a pump apparatus including a decontaminated submersible pump, a packer assembly and associated tubing, and electrical wiring will be lowered into the borehole annulus and positioned at or below the screened auger section. The packer assembly will contain materials such as polyethylene and/or Teflon, which are known not to interfere with the determination of organic constituents. The packer will be situated above the pump to isolate the screened auger from the remainder of the auger flights.

After positioning the pump apparatus, the pump will be turned on to begin purging the casing. As the water level begins to fall in the borehole, the packer will be inflated to isolate the screened auger interval. Purging will continue until three to five volumes of the packered zone have been removed from the boring. Field parameters (pH, specific conductance, temperature, dissolved oxygen, and turbidity) will be monitored during the purging. If recovery is poor, it may be necessary to abandon the packer assembly and purge the annulus dry. In this case, it may not be possible to purge three to five screened auger volumes.

After purging is complete, groundwater samples will be collected from the pump outlet. In this case, the discharge rate will be reduced approximately 100 ml/minute to avoid unnecessary agitation of the sample water. Or, if the packer assembly is not utilized, the sampling will be completed with a bailer.

Decontamination procedures and residuals management for the screened auger borings are discussed in Subsection 16.5.

16.3.2 Groundwater Sample Collection with Geoprobe

The Geoprobe system will be used to collect groundwater field screening samples to assess horizontal and vertical distribution of contaminants in groundwater.

Groundwater field screening samples will be collected using the Geoprobe in the following manner:

A stainless steel water sample probe (either slotted or retractable) is placed on the end of a 1-inch diameter threaded rod and pushed or hammered to the required sampling depth (i.e., into the water table). The slotted probe is used to collect a water table sample, the retractable probe is used when sampling a discrete interval within the water bearing zone. The retractable probe will be pushed or hammered to the desired sampling depth within the saturated zone. When the desired depth is achieved, the point is retracted and opened to the groundwater. The groundwater samples are collected using a small diameter (Teflon or stainless steel) bailer, polyethylene tubing equipped with a check valve, or peristatic pump.

16.3.3 Monitoring/Piezometer Well Drilling

Monitoring well borings will be drilled with a 6.25-inch ID (10-inch OD) HSA with a retractable center plug. Subsection 2.4.5 of the QAPP presents a more detailed discussion of the HSA drilling technique. If excessive soil heaving is encountered in the intermediate or deep monitoring well borings, the boring may be drilled with the mud-rotary technique. Soil samples for lithologic characterization will be collected using a split-spoon sampler at five-foot intervals.

Lithologic samples will be described according to the procedures outlined in Subsection 16.2.3. A geotechnical sample from each borehole will be analyzed for grain size at a qualified geotechnical laboratory.

Piezometers to be completed for instrumenting of an aquifer test will be drilled with 4.25-inch ID HSAs. The screen interval will be positioned to intercept granular soil units. Subsection 2.4.7 of the QAPP presents additional details on piezometer construction.

Soil cuttings from every HSA monitoring well/piezometer boring will be containerized in 55-gallon DOT-approved drums, labeled, dated, and stored on-site at Ft. Dix. Disposition of containerized soil cuttings will be carried out in accordance with NJDEP and USAEC requirements.

When mud-rotary drilling methods are used to drill deep monitoring wells, the drilling fluid used in this process will consist of approved bentonite (see Subsection 2.4.4 of the QAPP for approval requirements) and approved source water.

The bentonite/water drilling fluid will promote borehole stability in the unconsolidated formations, control the problem of heaving sands typically encountered in these formations, and will allow for downhole sampling. Subsection 2.4.5 of the QAPP presents a more detailed discussion of mud-rotary drilling techniques.

Mud that circulates to the surface during drilling operations will be containerized in the steel mud pit. Cuttings that settle out during drilling and all drilling fluid removed from the boring will be containerized in 55-gallon DOT-approved drums, labeled, dated, and stored on-site at Ft. Dix. Disposition of containerized cuttings and drilling fluid will be carried out by Ft. Dix in accordance with NJDEP and USAEC requirements.

If a monitoring well is to be installed that fully penetrates a confining layer, the well will be double-cased to prevent the vertical migration of contaminants during drilling. The borehole will be installed utilizing a telescoping casing method advanced by the mud-rotary drilling technique. The boring will be advanced to the confining layer using 12-inch diameter mud-rotary drilling. An 8-inch inside diameter black steel casing will be permanently installed to inhibit vertical migration of contaminants. The boring will be continued to the desired depth below the confining layer using 8-inch outside diameter mud-rotary drilling. The drilling fluid will be changed after the setting of the permanent casing to prevent cross-contamination.

16.3.3.1 Natural Gamma and EM Conductivity Logging. A natural gamma and EM conductivity borehole logging survey will be completed in several monitoring well borings. The gamma logging tool will be run the entire length of the monitoring well boring prior to setting the monitoring well, to better position the monitoring well screen to assist in defining the location of the geologic setting within the regional stratigraphic framework.

When natural gamma logging a double-cased boring, a two-phased logging technique will be used to maximize the effectiveness of the logging. The first phase will occur prior to the setting of the upper permanent casing. The second phase will occur after the completion of the remaining portion of the boring but prior to the installation of the monitoring well.

The geologist will compare the gamma log to other existing logs in conjunction with lithologic data, and select the depth for the screened interval. Subsection 2.4.2.4 of the QAPP describes in detail how the gamma logging will be conducted.

16.3.4 Monitoring Well Abandonment

In the event that a well must be abandoned, procedures outlined in the USAEC geotechnical requirements will be followed. Once approval from USAEC is obtained, the boring in question will be abandoned by tremie grouting from the bottom of the boring to ground surface and a completed well abandonment form (DWR-020) will be submitted to the NJDEP.

16.3.5 Groundwater Monitoring Well Design and Construction

Upon completion of monitoring well borings, the monitoring well will be constructed in the borehole annulus. After the well is placed in the boring, sand filter pack and borehole sealing materials will be placed around the well as the drill casing is withdrawn. Subsection 2.4.6 of the QAPP provides additional details regarding monitoring well design and construction.

The following materials will be used in well construction:

a. Monitoring wells - flush-threaded polyvinyl chloride (PVC) Schedule 40 casing with 4-inch ID. No PVC solvents or glues will be used. The well screen will be factory slotted, with a slot width of 0.010 inch. Screens will be 10 feet long.

b. Grout, composed (by weight) of 20 parts Portland cement (type II or V) up to one part bentonite with a maximum of 8 gallons of approved source water per 94-pound bag of cement. Bentonite will be added after mixing the cement and water.

c. Commercially available bentonite pellets designed for well-sealing purposes, or in the case of the intermediate and deep wells, a thick bentonite slurry. Subsection 2.4.4 of the QAPP outlines the requirements of bentonite approval.

d. Sand material, used in the filter pack around the well screen, compatible with both the screen slot size and aquifer materials. Subsection 2.4.4 of the QAPP outlines the requirements for filter pack approval.

e. A six-inch protective steel casing installed over the top of the PVC riser. This will include a padlocked cap, which will prevent entry of water but will not be airtight. A ¼-inch diameter weep-hole will be installed, above the level of the internal mortar collar. Four steel cement filled pickets will be installed around each monitoring well/ piezometer. The protective casing and each picket shall be painted orange. A cement collar shall be placed around each monitoring well/ piezometer. Cement collars shall be sloped to permit runoff of water away from the well. Well designations including the NJDEP well permit numbers and Ft. Dix site identifications will be engraved and stenciled on the protective casing. No aerosol spray paints will be used.

Locks used to secure the monitoring wells will be brass and keyed alike. In addition, existing monitoring wells utilized in this RI/FS will have existing locks replaced with the same keyed alike brass lock.

If shallow monitoring wells are screened at a shallow water table, modifications to the USAEC geotechnical requirements may be necessary. Because of the anticipated shallow water table (5 to 10 feet below surface), and the required length of the filter pack overlap (at least 5 feet above the screen), the required length of the bentonite seal (5 feet) may be shortened so that the screened interval spans the water table. This modification will be made only after obtaining approval by the USAEC Project Geologist and Contracting Officer's Representative (COR).

16.3.6 Groundwater Monitoring Well Installation Procedures

When a monitoring well boring is completed, the geologist will visually inspect the hole. Plumbness will be obtained by careful leveling of the drill rig prior to the commencement of drilling. Well installations will begin within 48 hours of boring completion, and, if possible, will continue uninterrupted until completed.

The well screen will be carefully steam-cleaned and rinsed with source water before being installed in the hole. All well screens will have a solid bottom. Solid casing will extend from the screen to approximately 2.5 feet above ground surface.

After the monitoring well screen and casing have been placed in the borehole, filter pack material will be gradually placed around the well screen as the drill casing is slowly withdrawn. The top of the filter pack will be periodically sounded to assess the location of the filter pack within the borehole annulus. Upon completion, the filter pack material will extend to approximately five-feet above the top of the well screen.

In monitoring wells with less than 10 feet of water above the top of the filter pack, a five-foot thick bentonite pellet seal will be installed to isolate the well screen. Bentonite seals will not be less than two feet thick, if possible. Bentonite seals less than two feet thick will be necessary only in monitoring wells screened within five-feet of the ground surface. Bentonite pellet seals will be allowed to hydrate for a minimum of one hour before cement-bentonite grout is added to the borehole annulus.

In monitoring wells having more than 10-feet of water above the filter pack, a 10-foot thick bentonite slurry seal will be tremie pumped above the filter pack. In both instances (pellet or slurry seal) the drill casing will be slowly withdrawn as the seals are placed.

Above the bentonite seals a cement-bentonite grout will be tremie-pumped to within one-foot of the ground surface. Tremie pumping will ensure that all grouts and slurry seals do not contain voids. The grouting will be a continuous process conducted under the guidance of the geologist (see Subsection 2.4.6.2 of QAPP for additional details).

A six-inch diameter aboveground steel protective casing will be sealed in the cement concrete surface cover to secure the well against tampering. This casing will extend approximately 2.5 feet above ground surface and will be seated 2.5 feet into the well seal grout. After the grout seal has set (approximately 24 hours), it will be checked for settlement, and additional grout (of approved composition) will be added to fill any depressions. Protective posts will be installed around the aboveground finished well to prevent damage to the wells by vehicles.

A monitoring well construction diagram will be prepared for each monitoring well. This diagram will indicate the bottom of the boring, screen location, filter pack location, bentonite seals, cement-bentonite grout, height of riser above ground surface, and protective casing detail. The actual composition of the grout, seals, and granular backfill will also be recorded.

16.3.7 Monitoring Well Development

Development of groundwater monitoring wells will be recorded and submitted to the COR within three working days following completion. The following data will be recorded on Well Development-Field Data Records as specified in the geotechnical requirements:

a. Well designation;

b. Date of well installation;

c. Date of development;

d. Static water level before and 24 hours after development;

e. Quantity of water lost during drilling and fluid purging, if water is used;

f. Quantity of standing water in well and annulus (30 percent porosity assumed for calculation) prior to development;

g. Specific conductivity, temperature, and pH measurements taken and recorded at the start of development, twice during, and at the conclusion of development;

h. Depth from top of well casing to bottom of well;

i. Screen length;

j. Depth from top of well casing to top of sediment inside well, before and after development;

k. Physical character of removed water, including changes during development in clarity, color, particulates, and odor;

l. Type and size/capacity of pump and/or bailer used;

m. Description of surge technique, if used;

n. Height of well casing above or below ground surface; and

o. Quantity of water removed and removal time.

Wells will be developed by pumping the groundwater with an electric-powered submersible, positive displacement, or centrifugal pump until the water is clear and the well is sediment free to the fullest extent practical. If well yields cannot sustain the flow rate of the submersible pump, a bailer will be used to evacuate the well. Water will not be added to the well to aid in development, nor will any type of air-lift technique be used.

Well development will begin no sooner than 48 consecutive hours after completion of the mortar collar placement, but not longer than seven days. Development will proceed until the following conditions are met:

a. The well water is clear to the unaided eye;

b. Parameters including pH, conductivity, and temperature have stabilized;

c. The sediment thickness remaining in the well is less than five percent of the screen length;

d. At least five well volumes (including the saturated filter material in the annulus) plus the volume of water added during the drilling process have been removed from the well; and

e. The cap and all internal components of the well casing above the water table have been rinsed with well water to remove all traces of soil/sediment/cuttings. Washing will also be conducted before and/or during development.

If standard well development conditions cannot be met, the COR and USAEC Project Geologist will be contacted for guidance.

Decontamination of downhole development equipment and management of development water are addressed in Subsection 16.5.

16.3.8 Monitoring Well Sampling

Groundwater samples will be collected from new and existing monitoring wells. Table 2 lists well designations and analyses to be conducted. The following procedures will be followed on the day of sampling:

a. The depth to water will be measured accurate to 0.01 foot and total depth of the well will be measured accurate to 0.1 foot. Both measurements will be made from the top of the PVC casing. The water column height in the well will be calculated. Each monitoring well will be checked for the presence and thickness of immiscible phase liquids.

b. Sampling equipment will be placed on polyethylene sheeting to prevent contact with soil. Phthalate free gloves will be worn by all samplers to prevent possible contamination of the sample.

c. Five times the amount of water in the well casing and saturated filter pack annulus will be evacuated with a submersible pump attached to dedicated polyethylene tubing, or Teflon bailer. In the event of low-yielding wells and subsequent low recovery rates (due to the presence of fine-grained sediments), a decision to reduce the well purging to less than five volumes may be made. This decision will be subject to approval by the COR. The amount of water actually purged will be measured and recorded.

d. Conductivity, pH, and temperature will be measured at the start, during, and at the end of the well purging. These data will be forwarded to the COR at the completion of all sampling activities. Calibration standards on the pH, conductivity, and temperature meters will be run and recorded prior to and after each day of sampling.

e. Sampling will be accomplished using a bailer constructed of inert materials (Teflon or stainless steel) attached to a Teflon-coated stainless steel or polypropylene monofilament leader approximately five-feet long. Disposable nylon rope attached to this leader will not come into contact with the water. No glue will be used in the construction of these bailers.

To minimize adsorption of analytes on the PVC surface of the well casing, which could affect the apparent groundwater concentration of certain contaminants, each well will be sampled within three hours of purging (well recovery permitting).

f. Sample containers will be filled in order of decreasing analyte volatility. However, metal or inorganic samples may be filled first to minimize sample turbidity. Metal samples will be collected as both nonfiltered and filtered samples.

g. Purge water will be containerized, labeled, dated, and stored on-site for proper disposal. Based on the analysis of groundwater samples collected from the monitoring wells, the containerized purge water will likely be disposed at the Ft. Dix wastewater treatment plant.

Decontamination of sampling equipment and management of purge water will be conducted in accordance with Subsections 16.5.1, 16.5.2, and 16.5.4.

To ensure the effectiveness of decontamination procedures, periodic equipment rinse blanks will be taken by pouring analyte-free water over or through equipment after cleaning, collecting the rinsate, and submitting it for chemical analysis (see Subsection 5.4.1 for QA/QC sample schedule).

Pertinent information collected during purging and sampling activities will be recorded in Groundwater-Field Data Records. The following data will be collected if applicable: well number; date; time; static water level; depth of well; calculation of the five volume equivalent; number of bailers; pumping rate; time of pumping; drawn-down water level; on-site water quality measurements; fractions sampled and preservatives; weather conditions and/or miscellaneous observations; and signature of sampler and date.

Each sample will be carefully labeled so that it can be identified by laboratory personnel (see Subsection 17.1 of this Technical Plan for the sample identification system). The sample label will include the installation code, sample number, analytes/analysis requested, preservation/filtering information, time, date, and sampler's initials. All samples will be identified by completing, in non-water-soluble ink, a standard preprinted label at the time of collection. Information concerning preservation methods, matrix, and sample locations will be included on Analytical Request Forms to accompany the samples to the laboratory. Samples will be maintained at 4°C from time of sample collection until analysis. The analytical parameter coverage for the groundwater samples is presented in Subsection 17.3.4 of this Technical Plan. Sample preservation methods and filtering methods for metals samples are described in detail in Subsections 5.3 and 2.5.2, respectively of the QAPP.

16.3.9 Water Level Measurements

Water level measurements at existing and newly installed groundwater monitoring wells will be obtained using an electric water level sounding device. Using a calibrated sounder, this procedure is accurate to 0.01 foot. The tape will be rinsed with water from the approved source, cloth-wiped, and allowed to air dry between consecutive water level measurements. Measurements of the depth to groundwater will be referenced to a permanently marked reference point on the monitoring wells (highest point on the top rim of the PVC casing). To aid in documenting the presence or absence of nonaqueous phase liquid, monitoring wells will also be checked for the presence and thickness of immiscible phase liquids.

16.3.10 Aquifer Testing

16.3.10.1 In-Situ Hydraulic Conductivity Testing. Aquifer testing will be conducted to establish the in-situ hydraulic conductivity of the shallow aquifer. Data collected from these tests, when combined with the flow gradients and directions calculated from measured water levels, can be used to estimate groundwater flow velocities in the vicinity of the wells. These aquifer characteristics are important for evaluating the potential for contaminant migration. The method of Bouwer and Rice[3] will be used to evaluate slug test data.

The proposed rising-head test consists of lowering a cylindrical slug into the well below the water table and waiting for the water level to stabilize. The slug is then raised above the water table and the rate at which the water rises and stabilizes in the well is recorded. The test procedure for each well will be as follows (alternate procedures are presented in Section 2.4.9.2 of the QAPP):

- Record an initial static water level in the well.

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[3] Bouwer, H, and R.C. Rice, 1976. A slug test for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells. Vol. 12, No. 3, pp 423-428.

- Connect the Hermit data logger to a pressure transducer and place the transducer in the well, below the water table.

- Insert the slug below the water level and allow the water level to stabilize.

- Record stabilized water level on data logger.

- Remove the slug as rapidly as possible in an effort to obtain an instantaneous fall in water level.

- Record water level recovery until the water reaches a level equal to at least 98 percent of the initial static water level or for a maximum of two hours of recovery.

If a minimal response in water level occurs as a result of the removal of the slug, drawdown required for the rising-head test will be produced by pumping the well. If this occurs, the test procedure will be as follows:

- Record an initial static water level in the well.

- Lower a 2-foot submersible pump with PVC tubing and electrical wiring into the well.

- Connect Hermit data logger to a pressure transducer and place the transducer in the well, below the water table.

- Allow water level to stabilize.

- Record stabilized water level on data logger.

- Run pump until approximately five-feet of drawdown occurs.

- Record water level recovery until the water reaches a level equal to at least 98 percent of the initial static water level or for a maximum of two hours of recovery.

To minimize the potential for cross-contamination, all down-hole equipment including pressure transducers and slugs will be decontaminated according to the procedures outlined in Subsection 16.5.

16.3.10.2 Aquifer Tests. Aquifer tests will provide the hydrogeologic data required to develop remedial alternatives at sites as well as data to calibrate/validate the numerical groundwater flow model. Specific aquifer tests to be conducted will include step-drawdown and constant-discharge tests.

Aquifer testing will be monitored by a computerized data logging instrument and pressure transducers. Portable field printers and a laptop computer should be used to facilitate data collection and analysis during the tests. The following is a general overview of the aquifer tests to be conducted.

A step-drawdown test will be conducted at a well to establish well efficiency, specific capacity, and short-term well yields. Three extraction rates will be conducted for successive three-hour durations. A constant discharge test will be conducted at the well to calculate transmissivity, storage coefficients, aquifer parameters, and long-term pumping rates.

A storage tank and a portable granular activated carbon canister will be used to store and treat water before direct discharge or transport to the on-base treatment system.

16.4 SURFACE WATER/SEDIMENT ASSESSMENT PROGRAM

A surface water/sediment sampling program will be conducted at several sites to obtain a preliminary indication of contaminant impacts to these environments. The intention of these programs is to generate adequate data to assess whether further studies on the ecological communities are warranted, and if so, what type of studies should be conducted.

16.4.1 Surface Water and Sediment Sampling Procedures

At each sampling location, the surface water sample will be collected first to avoid unnecessary disturbance of the water column. Chemical analyses will be the same for the sediment and water samples collected from the same location to aid in comparison and evaluation. Surface water and sediment sampling will be conducted in accordance with USEPA Region II and NJDEP guidance.

16.4.1.1 Surface Water Sampling. Surface water sampling will be conducted in accordance with procedures outlined in Subsection 2.5.2.1 of the QAPP. Briefly, the sampler will wade out into the stream or brook, if sampling from the shore cannot be performed and the water column is clear enough to see underwater objects. The sampling location will be approached from the downstream direction, without entraining additional sediment into the surface water sample. The bottle will be held upside down, immersed several inches below the water and then turned upright to fill. The bottle will then be removed from the water, field measurements will be made (pH, conductivity, temperature), the proper preservative (if required) will be added, and the bottle will be capped, labeled, and placed in a cooler. Alternately, a long-handled dip sampler may be used where access to the sampling location is difficult or contact with water is not permitted by the Health and Safety Plan.

If multiple surface water samples are to be collected from a flowing stream, samples will be obtained from the furthest point downstream, moving upstream as the sampling progresses. Surface water sampling locations will be marked on a site map. A numbered stake will be placed above the visible high water mark on the bank closest to the sampling location. A description of the sampling site will be entered into the Surface Water Sediment-Field Sampling Record. This description will be adequate to allow the sampling station to be relocated at some future date.

16.4.1.2 Sediment Sampling. Sediment samples will be collected from the bottom of surface water bodies to evaluate the impacts of the various study sites on the sediment of these surface water bodies and drainage courses. Sediment sampling locations will coincide with surface water sampling locations. Because areas of greatest contamination occur in depositional areas in aquatic systems, depositional areas within the surface water bodies being investigated will be targeted for sampling locations. Sediment samples will be analyzed for TOC in addition to specified chemical parameters.

Sediment sampling will be conducted in accordance with Subsection 2.5.2.2 of the QAPP. Samples will be collected with stainless steel spoons or trowels if there is little or no water on top of the sediment at the particular sampling location. If the water velocity is low at sampling locations where the water above the sediment is a few feet deep or the water velocity is high, a stainless-steel corer or other device that eliminates sample washing will be used.

Sediment samples collected for all analyses except VOCs will be thoroughly mixed before being placed in sample containers. Rocks, twigs, and other debris will be removed from the sample prior to homogenization if they are not considered part of the sample. Samples for VOCs analyses will be collected as individual grab samples and will not be homogenized. The procedure for homogenization of samples (referred to as coning and quartering) is described below.

Following removal of rocks, twigs, leaves, and other debris, the sediment is removed from the sampling device and placed in a stainless-steel pan, then thoroughly mixed using a stainless steel spoon. The sediment in the pan is scraped from the sides, corners, and bottom of the pan, rolled to the middle of the pan, and initially mixed. The sample is then quartered and moved to the four quarters of the pan. Each quarter of the sample is mixed individually, and then rolled to the center of the container, and the entire sample is mixed again. Then, the appropriate amount of sample is delivered to the sample jar with the trowel or spoon. A description of sediment properties (i.e., color, texture, odor, organic content, grain size) is recorded in the Surface Water/Sediment-Field Sampling Record immediately after sample collection.

Sediment sample locations will be marked on a site map. A numbered stake will be placed above the visible high water mark on the bank closest to the sampling location. A description of the sampling site will be entered into the field logbook to allow the sampling station to be reoccupied at a future date.

16.4.1.3 Staff Gauges. Staff gauges will be installed at several sites so that the elevation of specific water bodies may be measured. The gauges will be immediately downstream of surface water/sediment sampling stations to minimize the potential for impacting the surface water/sediment sampling station during placement of the gauge. The gauge itself will consist of an approximately one-half to one-inch diameter steel pipe manually driven into the streambed. The top of the pipe will extend approximately three feet above the surface of the water. The elevation of the top of this steel pipe will be surveyed to the nearest 0.01 foot MSL by a licensed New Jersey land surveyor.

To maintain repeatability in measuring water levels at the stream gauges, an additional benchmark shall be established on a nearby large tree or other stationary object at each stream gauge. This benchmark will enable the stream gauge to be easily reconstructed should it be damaged or displaced. The benchmark will also be surveyed to the nearest 0.01 foot MSL by a licensed New Jersey land surveyor.

16.5 DECONTAMINATION PROCEDURES AND RESIDUALS MANAGEMENT

The following subsections outline the decontamination procedures for field investigation equipment and the management of residuals (investigation-derived wastes) generated during RI field programs. Decontamination procedures will be performed prior to the equipment's first use at the site and at the conclusion of its use at an investigation location. To ensure the effectiveness of decontamination procedures, periodic equipment rinse blanks will be collected and submitted for chemical analysis (see Subsection 17.3.2 of this Technical Plan for the QA sample schedule). To minimize the potential impact from trace constituents present in decontamination fluids, the following standards will be met: organic reagents (hexane and methanol) will be pesticide grade or better, nitric acid will be ultra pure, and deionized water will not contain analytes of interest at concentrations above the USAEC CRL.

16.5.1 Decontamination of Laboratory Analytical Sampling Equipment

Equipment used for the collection of laboratory analytical samples, including but not limited to split-spoon samplers, groundwater bailers, stainless steel spoons, spatulas, and bowls, as well as sediment core samplers, will be properly decontaminated using the following procedure:

- Wash and scrub with Alconox or equivalent (low phosphate detergent)
- Rinse with USAEC-approved water
- Rinse with 10 percent nitric acid (HNO3) solution for stainless steel equipment (HNO3 used for decontamination will be ultra-pure grade)
- Rinse with 1 percent HNO3 solutions for carbon steel equipment
- Rinse with USAEC-approved water
- Methanol followed by hexane rinse (methanol and hexane used for decontamination will be pesticide grade or better)
- Deionized water rinse (five times the volume of solvent used)
- Air dry or nitrogen blow dry
- Wrap in aluminum foil (shiny side out)

Surface water samples are collected using laboratory pre-cleaned sample containers and therefore do not require decontamination procedures.

16.5.2 Decontamination of Water Pumps and Monitoring Well Screen

Equipment that comes in contact with groundwater but is not used in the direct collection of an analytical sample, such as submersible pumps and associated hose, monofilament line for bailers, and PVC well screens, will be decontaminated by the following procedure:

- Wash with approved source water and Alconox or equivalent
- Rinse with approved source water (not applicable to screened auger sampling)
- Rinse with deionized water
- Wrap in clean polyethylene for transport

If disposable equipment, such as nylon rope or hose, are used on a one-time basis these will require decontamination if they are used in the direct collection of analytical samples. In this instance they will be prerinsed with soapy water and deionized water.

16.5.3 Decontamination of Drilling and Test Pitting Equipment

Drilling tools (i.e., augers, drill rods and test pitting equipment) will be decontaminated according to the following USAEC procedure:

- Hot water wash
- High pressure hot water rinse
- Air dry

Augers and drilling equipment will be placed on clean polyethylene sheeting during transport and will be placed on polyethylene sheeting at the drill site.

16.5.4 Field Instrumentation Probes

Field instrumentation probes (specific conductance, pH, temperature, D.O., and turbidity) will be rinsed with deionized water after each use.

16.5.5 Filters

Reusable field filters used to filter aqueous metals samples will be decontaminated according to the following procedures:

- 10 percent nitric acid wash
- analyte free deionized water rinse

16.5.6 Residuals Management

The management of residuals (investigation-derived wastes) produced during field activities (including but not limited to purge water, development water, decontamination fluids, soil cuttings [from soil borings with total depths greater than 25-feet bgs], excess grout, drilling fluids, field laboratory wastes, and personal protective equipment) will be containerized in appropriate DOT-approved containers. The drums will be labeled with date, contents, and source (e.g., boring number or monitoring well number) and staged according to contents to facilitate proper management. The containers will be disposed per decision of the NJDEP and the U.S. Army. RCRA requirements are considered ARARs for this RI investigation at Fort Dix. This includes the management of investigation derived waste during field activities. Off-site transport of materials may need to comply with Part 262 and 263 standards if the materials being transported are considered hazardous. The shipment of hazardous waste off-site to a treatment facility should be consistent with OSWER Off-Site Policy Directive Number 9834.11.

16.6 SURVEYING OF SAMPLING LOCATIONS AND TOPOGRAPHIC MAPPING

Soil borings and groundwater monitoring wells installed during this study will be surveyed by a professional land surveyor (licensed in the State of New Jersey), who will use a UTM and State Planar, latitude and longitude grid accurate to within ±1 foot to establish the well's/boring's map coordinates. Elevations for the natural ground surface at each well and the top of the PVC casing will be calculated to within ±0.01 feet using the NGVD of 1929. The remaining exploration locations (i.e., screened auger, Geoprobe, surface soil, surface water/sediment, staff gauges) will be horizontally located to latitude and longitude with a hand held global positioning system (GPS).

Topographic base mapping be conducted at several sites (POL, Golf Course Leaking Tank, ARDC Test Site, Range Landfill, and ANC-2 Disposal Area). Detailed descriptions of this mapping are presented within the individual sections for these sites in this Technical Plan. Mapping proposed for the remaining sites includes supplementing existing site maps with GPS location of additional explorations, significant land and cultural features, and surface water drainage pathways on the site. At sites not subject to detailed topographic mapping, general topography will be established using USGS 7.5 minute topographic maps.

Resurveying of existing monitoring wells will be determined based on the following criteria:

- Field observations do not agree with mapped locations in the Phase II Remedial Investigation Report, Fort Dix New Jersey, Draft Final, USATHAMA, 1992;
- Monitoring well survey data does not exist; and
- Monitoring wells exhibiting anomalous water level readings.

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17.0 ANALYTICAL PROGRAM

Field analytical services for this investigation will be provided by the Contractor and are presented in Subsection 17.2 of this Technical Plan. Laboratory analytical services in support of this investigation will be provided by the laboratory Subcontractor, which is validated by the USAEC MRD and certified by the State of New Jersey. Services to be provided for this investigation include: preparation and shipment of bottles cleaned according to USAEC specifications; sample tracking; analysis of samples by USEPA methodologies in accordance with USAEC QC requirements; laboratory QC; and data reporting, as required for the QC and data management functions. Details of the laboratory analytical program are presented in Subsection 17.3 of this Technical Plan.

The laboratory Subcontractor will analyze or subcontract, as necessary, selected samples for USEPA TCL VOCs; USEPA TCL SVOCs; USEPA TAL inorganics, pesticides/PCBs, explosives, TOC, BOD5, COD, TSS, TDS, alkalinity, herbicides, gross alpha, beta, and gamma radioactivity, and TPH. Tables 5 through 8 summarize the analytical efforts that will be performed to support this investigation, including the types and number of analyses to be conducted, the analytical method used to perform the analyses, and the approximate number of QC samples to be collected.

17.1 SAMPLE IDENTIFICATION AND LABELING

The sample identification system developed for this RI effort enables unique sample identification to be applied to each sample collected. The system has been developed to be consistent with the requirements of IRDMIS and, to the extent practicable, with the previous sampling efforts at Ft. Dix. Each exploration location will be assigned a unique identifier (the "Site ID"). However, as many explorations will have more than one analytical sample collected a unique identifier will also be assigned to each sample (the "field sample number"). The field sampling number will serve as the principal analytical data tracking identifier. The protocols for assigning Site IDs and field sampling numbers is described below.

17.1.1 Site ID

The following protocols are used for assigning Site IDs. Each Site ID consists of seven alpha-numeric characters and one hyphen (e.g., GTG-01A). The first two characters are letters that assign the Ft. Dix site designations as follows:

•	PL	Petroleum Oil Lubricant Area (POL), Site 2
•	FT	Fire Tank Training Area (FTTA), Site 3
•	GT	Golf Course Leaking Tank Area, Site 4
•	TM	Transportation Motor Pool Area (TMP), Site 5
•	AR	Armament Research Development Center (ARDC), Site 6
•	PC	Pesticide Control Shop, Site 8
•	NE	New Egypt Armory (NEA), Site 9
•	RL	Range Landfill (RL), Site 10
•	A9	ANC-9, Site 11
•	A2	ANC-2, Site 12
•	BB	Boiler Blowdown Area, Site 13
•	DL	Area North of Dogwood Lake, Site 14
•	GP	Golf Course Pesticide Mixing and Storage Area, Site 15

The third character specifies the type of exploration:

•	S	surface and subsurface soil samples from hand augers and test pits .
•	D	sediment sample from ditches, streams, ponds, etc.
•	W	surface water sample from ditches, streams, ponds, etc.
•	G	groundwater sample from monitoring wells
•	A	field screening groundwater sample from screened augers and Geoprobe
•	B	soil samples from soil borings.

The fourth character is a hyphen.

The fifth and sixth characters are numbers representing the specified exploration number (e.g., 02 indicates exploration number two and 10 indicates exploration number 10).

The seventh character is a letter which is used to distinguish between different monitoring wells in a given cluster (e.g., "A" denotes a shallow well, "B" denotes an intermediate well, "C" denotes a deep well, etc.).

17.1.2 Field Sampling Number

The field sampling number is a unique identifier individually assigned to each analytical sample. The field sampling number includes the Site ID information as well as sample depth and QA/QC information. The maximum number of alpha-numeric characters in the field sample number is eight (e.g., GTB0199X). The following protocols are utilized to assign field sampling numbers.

The first three characters in the field sampling numbers are assigned in the same fashion as the Site ID above.

In the fourth character the hyphen utilized in the Site ID is deleted. The fourth and fifth character are then utilized to assign numbers representing the specified exploration (e.g., 02 indicates exploration number two and 10 indicates exploration number 10).

The sixth and seventh characters are used to specify the sample depth. The only exception to this is in monitoring well samples where the letter designations presented in the Site ID are again applied. In this case, the unused sixth character is assigned an "X".

The eighth character may specify sample depth or a field duplicate or field screening confirmatory sample. If subsurface soil samples are collected from depths greater than 100 feet bgs this character will be used to indicate that (e.g., a Site ID ending in "125" would indicate a soil sample collected at 125 feet bgs). Field duplicates will be denoted with the letter "D". Field screening confirmatory samples will be denoted with the letter "C". Samples which are not collected from depths greater than 100 feet bgs and are not duplicates or field confirmation samples will be denoted with an "X". It is not anticipated that field duplicates will be collected from depths greater than 100 feet.

17.1.3 Sample Labels

Preprinted computer generated sample labels will be used. Labels will be covered with polyethylene tape to prevent the loss of the label during shipment. The sample label will include the following information:

- Site ID,
- Field sample number,
- Sample date,
- Sampling time,
- Preservative, if applicable,
- Analyte(s) and analytical method, and
- Samplers initials.

17.2 ANALYTICAL PROCEDURES FOR FIELD SCREENING SAMPLES

Samples will be analyzed for selected VOCs, metals, pesticides, herbicides, TPH, and UV using field analytical techniques. These field analyses will provide real-time data for use in decisions by on-site personnel. The following subsections generally describe the field analytical techniques selected for investigations at the 13 Sites. Detailed standard operating procedures and QA/QC programs are presented in Subsection 2.7 of the QAPP.

17.2.1 Volatile Organic Compounds

The field analytical protocol for VOCs in selected soil and groundwater samples is based on USEPA laboratory procedures, where a "purge-and-trap" sample concentration device is used to achieve detection limits in the 1 to 5 ppb range. The purge-and-trap process involves purging a measured amount of sample with helium, which strips VOCs from the sample and then traps them on a polymer trap. This trap is then heated rapidly, transferring the VOCs to the GC instrument for separation, identification, and quantitation.

17.2.2 Herbicides (2,4-D)

Selected soil samples will be analyzed for the herbicide 2,4-D in the field using enzyme-linked immuno-sorbent technology. This immunoassay procedure involves a sample tube coated with a material to which an antibody specific to 2,4-D residues has been linked. When the sample is introduced to this antibody-treated material, 2,4-D residues adhere to the antibody, forming an immune complex. A color developer is then added to the sample tube, and the resulting color is inversely proportional to 2,4-D concentration.

17.2.3 Pesticides

Selected soil samples will be analyzed in the field for pesticides. The analytical protocol was adapted from procedures developed by USEPA. An aliquot of the sample is placed in a test tube to which a small volume of hexane has been added. The test tube is capped and shaken on a vortex mixer to extract the pesticides from the sample into the hexane solvent. The extract is then injected into the GC instrument for separation, identification, and quantitation.

17.2.4 Total Petroleum Hydrocarbons

Selected soil and groundwater samples will be analyzed in the field for TPH by IR spectroscopy and assessment of non-aqueous phase liquids by ultraviolet screening. The field analytical procedure for TPH measures the sum of the hydrocarbons present, rather than the individual compounds. It is based on USEPA laboratory procedures, modified for field use and to encompass a wider range of compound classes. A microextraction is performed on a measured amount of sample using Freon-113 as a solvent. TPH is then measured in the Freon extract using an infrared spectrometer set to a wavelength of 2930 cm^{-1}. The UV procedure, presented in the QAPP, is similar.

17.2.5 Quality Control for Field Analytical Techniques

QC procedures are established prior to initiation of a field analytical program and implemented throughout sample collection and analysis to ensure that generated data are adequate for their intended uses. The QC program provides information to evaluate data quality and analytical system performance while not inhibiting the ability to generate daily analytical data, which is the primary goal of field analytical techniques.

The calibration curves for VOCs, pesticides, and TPH analyses are generated by analyzing the appropriate standards at a minimum of three concentrations. Concentrations of the compounds detected in field samples are then calculated from this calibration curve. A calibration check standard (a standard with a concentration in the mid-range of the calibration curve) is analyzed daily to ensure the instrument response does not drift. If the results for the calibration check standard are not acceptable, a new calibration curve is generated before any samples are analyzed.

Method blanks (laboratory pure water) are analyzed daily to show that the analytical system is free of contamination. Equipment blanks (water run through the sampling apparatus) are analyzed to show that cross-contamination is not occurring during sample collection. Cleaning blanks for the GC instruments are also analyzed after any highly contaminated sample to verify that instrument carryover of contamination is not occurring.

Spikes (chemicals added at a known concentration to a sample prior to analysis) are used to evaluate the accuracy of the analytical method. A surrogate, a compound that is chemically similar to those being analyzed, is added prior to sample analysis for VOCs and pesticides to assess recovery (accuracy). Matrix spikes are analyzed as part of the QC program for VOCs, pesticides, herbicides, and TPH. A sample is analyzed unspiked to get the baseline concentration. The sample is then spiked with the compounds being analyzed to evaluate their recovery in the actual sample matrix to provide information on potential matrix effects that could affect the analytical result.

These elements of a QC program allow for the evaluation of the quality and usability of field screening results. Blanks, surrogate spike, and matrix spike analyses provide information on the accuracy of the field screening methods. Duplicate analyses of field samples or of matrix spikes are incorporated into the program to provide information on method precision. These data can be used to show that the analytical system was operating within the required parameters and that the generated sample results are acceptable for use.

17.3 LABORATORY ANALYTICAL PROGRAM

Baseline analytical services supporting this investigation will be provided by a laboratory that is validated by USAEC MRD and certified by the State of New Jersey. Analytical services to be provided for this investigation include: preparation and shipment of bottles cleaned according to USAEC specifications; sample preservation; sample tracking; analysis of samples by USAEC methods and in accordance with USAEC QC requirements; laboratory QC; and data reporting, as required for QC and data management functions. Section 18.0 of this Technical Plan provides a discussion of QA/QC and Section 19.0 provides a discussion of data management, including sample tracking.

17.3.1 Sample Shipment/Chain-of-Custody

The attending Contractor site geologist or engineer will supervise and assist in all sampling activities. Samples will be labeled and preserved as described in the QAPP. Samples will be packed in plastic coolers with sufficient ice packs or double-bagged ice to maintain 4°C from the time of collection to receipt by the laboratory. If samples are collected on a Saturday or Sunday and held for shipment until Monday, their temperature will be maintained at 4°C to ensure sample integrity. If loose ice is to be used, it will be double-bagged to prevent contact of the meltwater with the samples. All samples will be checked for integrity and lid closure to prevent leakage.

Chain-of-Custody (COC) and Field Parameter Forms identifying all sample containers, analytical requirements, preservatives, and other field data required by the laboratory will accompany each cooler to the laboratory. The procedure for filling out these forms is provided in Subsection 5.5 of the QAPP. In addition, all coolers will be affixed with COC seals and will be shipped via overnight carrier for next-day delivery. The laboratory will be notified of the sample shipment and estimated time of arrival.

Samples will be shipped to the laboratory within 24 hours of collection. However, in select instances (e.g., samples collected late on Saturday afternoon) it may be necessary to hold the samples for an extra day. Under these circumstances, sample delivery to the laboratory will be coordinated to minimize the potential for exceeding sample hold times prior to laboratory analyses.

Upon arrival at the laboratory, the cooler will be opened by designated laboratory personnel who will verify the integrity of the custody seal, check the contents of the cooler against the COC, inspect and record the condition of each sample container, and sign the COC form. Any broken sample bottles or loosened sample jar lids at the time of laboratory receipt will be reported to the Contractor so that additional sampling may be conducted.

17.3.2 Quality Control Samples

QC samples to be collected during this investigation include field rinse (sample) blanks and trip blanks (Subsection 5.4.1 of the QAPP). The purpose of collecting these samples is to monitor and qualify contamination introduced during laboratory and/or field activities as well as monitor sampling and analytical precision. The following describes these QC samples:

- *Duplicate Sample.* A sample introduced into the train of environmental samples to monitor the analytical precision of the laboratory methodology and field sampling procedures and for verification of concentrations of an environmental sample.

- *Rinse Blank.* A sample collected from the decontaminated equipment used during sampling to monitor the integrity of decontamination and the potential for cross-contamination between sampling sites. Demonstrated analyte-free water will be used to prepare these blanks.

- *Trip Blank.* A sample containing demonstrated analyte-free water that is transported to the sampling site and returned to the laboratory, to ensure that no contamination has been introduced during shipment. The trip blanks will be pre-preserved in the laboratory with hydrochloric acid to $pH<2$.

17.3.3 Performance Demonstration and Data Review

Samples will be analyzed by the Subcontractor laboratory in accordance with USEPA analytical methods and USAEC QC requirements. The laboratory will be validated by the USAEC MRD for the analysis of baseline analytes of concern at the 13 Sites. The laboratory provides weekly QC submittals to USAEC validated in the form of QC charts. USAEC is responsible for reviewing the analytical data analyzed by USAEC validated methodology and evaluating the compliance of the data to the USAEC Guidelines for Implementation of ER 1110-1-263 (USATHAMA, 1990). The Subcontractor chemists are responsible for reviewing and determining potential limitations within available USEPA guidelines for analytical data analyzed by non-USAEC validated methodologies.

Methods that do not require USAEC validation include the following parameters: oil and grease, TPH, BOD5, COD, TSS, TDS, alkalinity, hardness, gross alpha, beta, and gamma radiation, and TOC. Data review and determination of limitations for these methodologies will be completed and encompass three fundamental elements:

- The analytical data will be evaluated against the method-specific requirements to ensure that the method requirements have been met;

- Limitations of the database will be established through relevant guidance documents; and

- Technical quality of the data will be assessed and any potential limitations to the database will be fully documented and cross-referenced to the associated raw data.

In assessing the method-specific requirements, the following data elements should be reviewed:

- Sample Collection Data: associated field screening results, sample collection field logs, COC forms, and shipping forms;

- Sample Analytical Data: nonconformance summary, sample preparation data, raw data from sample data acquisition, and instrument operating parameters;

- Associated Calibration Data: instrument tuning data, initial calibration data, continuing calibration data, instrument-specific detection limits, instrument operating parameters;

- QC requirements: surrogate recoveries, instrument and method blanks, field blanks, matrix spike recoveries and precision, laboratory and field duplicate precision, and laboratory control sample recoveries; and

- Quality Assurance (QA) requirements: performance evaluation samples.

Oil and grease, TPH, BOD5, COD, TSS, TDS, alkalinity, hardness, gross alpha, beta, and gamma radiation, and TOC data review will use the guidance of referenced methodology QA/QC requirements and/or laboratory QA/QC protocols. In addition, data evaluation procedures for non-metal inorganic parameters as given in Quality Assurance/Quality Control Guidance for Removal Activities: Sampling QA/QC Plan and Data Validation Procedures (USEPA/540/G-90/004) will be used.

The following items will be reviewed by ABB-ES to review and establish data use limitations:

- Sample Collection Data;
- Sample Holding Times and Methods of Preservation;
- Detection Limits Compliance;
- Documentation that the analytical results are in control and within the linear range of the analysis;
- Associated calibration data;
- Associated control checks to confirm that the daily analysis is in control;
- Documentation of analytical methodology and QC methodology;
- The potential presence of contamination from field sampling activities (field blanks); and
- The potential presence of interferences in analytical methods (laboratory blanks).

17.3.4 Chemical Analysis

USAEC-validated analytical procedures will be used for analysis of all samples, as applicable, to include the analytes from the USEPA TCL/TAL, herbicides, and miscellaneous wet chemistry procedures, as well as explosives. A Project Analyte List (PAL) is presented in Table 9. Methods that do not require validation include TPH, BOD5, COD, TSS, TDS, alkalinity, hardness, gross alpha, beta, and gamma radioactivity, and TOC.

Summaries of aqueous and solid samples to be collected for chemical analyses are presented in Tables 5 through 8. This subsection briefly describes the analytical methodologies to be used in the RI for the 13 Sites.

17.3.4.1 Volatile Organic Analyses. Volatiles will be analyzed in accordance with USAEC Class 1M protocols for gas chromatography/mass spectroscopy analysis (GC/MS). VOCs that will be analyzed at the 13 Sites are listed in Table 9.

17.3.4.2 Semivolatile Organic Analyses. Semivolatiles will be analyzed in accordance with USAEC Class 1M protocols for GC/MS analysis. SVOCs that will be analyzed at the 13 Sites are listed in Table 9.

Analysis for pesticide and PCB constituents and herbicides will be performed in accordance with USAEC CLASS 1P certified protocols for gas chromatography equipped with an electron capture detector (GC/ECD). Compounds that will be analyzed are listed in Table 9.

Analysis for explosives will be performed in accordance with USAEC Class 1 certified protocols using the methodology developed by the Cold Regions Research and Engineering Laboratory (CRREL). Compounds that will be analyzed are listed in Table 9.

Soil samples will be extracted for total oil and grease and TPH using USEPA 9071 Method 3540 and will be analyzed using USEPA 413.2 and Method 418.1, respectively.

17.3.4.3 Inorganics. TAL inorganics will be analyzed in accordance with USAEC Class 1 protocols. Groundwater samples will be analyzed for nonfiltered and filtered metals. The metal constituents will be analyzed using one of the following methodologies: inductively coupled argon emission plasma spectroscopy (ICAP), graphite furnace atomic absorption spectroscopy (GFAA), or cold vapor atomic absorption (CVAA). Cyanide will be analyzed by the spectrophotometric technique. Inorganics that will be analyzed are listed in Table 9.

17.3.4.4 Additional Analyses. TOC is measured by an instrument that converts the organic carbon in a sample to carbon dioxide (CO2) by wet chemical oxidation. The Lloyd Kahn Method will be used to analyze for TOC in sediment samples. BOD5 will be measured by field probe using USEPA method 405.1. COD will be measured by the titrimetric method using USEPA method 410.2. TSS and TDS will be measured gravimetrically using USEPA methods 160.2 and 160.1, respectively. Alkalinity and hardness will be measured titrimetrically using USEPA methods 310.1 and 130.2, respectively. Gross alpha and beta will be measured by USEPA SW846 method 9310, and gamma radiation will be measured by USEPA EMSL method 901.1.

18.0 QUALITY ASSURANCE/QUALITY CONTROL

USAEC has developed a leading QA/QC philosophy and specific QC implementation requirements over the past several years. Founded on the concept of project-wide procedures to determine and ensure the reliability, completeness, traceability, and comparability of data and conclusions, specific methodologies for controlling and documenting laboratory and sampling procedures have been developed. This project has been designed to follow the requirements contained in the ER 1110-1-263 (USATHAMA, 1990) to prepare and implement the internal QC Plan. Sections of the QAPP describe organizational responsibilities for data quality, specific procedures for collecting and analyzing data under controlled conditions, procedures for data review for NON-USAEC method data, procedures for preventing and correcting out-of-control situations, and other aspects of QA such as training, documentation, verification, reporting, and recordkeeping.

The Contractor will be committed to the precepts of this program:

a. Planning -- Organizing and developing procedures so that performance measures of systems are known, data quality objectives (DQOs) (i.e., the level of quality required to support each project objective) are established, and all personnel know what is required and what their individual responsibilities are.

b. Controlling -- Ongoing quality checks to confirm that all systems are performing as expected, and that personnel are operating the systems as planned and in a timely fashion.

c. Documenting -- Ensuring that data quality is validated and is traceable through all project stages from collection to archival.

d. Improving -- Developing more efficient and more exacting procedures for given DQOs.

Project deliverables are based on an understanding of the environmental situation at a site, which is derived from data collected during various task activities. The QC plan encompasses and integrates the various aspects of the project (geotechnical, sampling, analytical, testing, and assessment) by requiring data to be representative, precise, and accurate, within characterized limits. Documentation, prepared and maintained through a document/data control system, will provide the defensible evidence of traceability and adherence to prescribed protocols.

18.1 QUALITY CONTROL

When applied to sampling and chemical analysis, the QC Plan has the specific objectives of: (1) ensuring that the analytical results correspond to the environmental situation at the time a sample was collected; (2) estimating the level of quality of each analytical system sufficient for meeting DQOs; (3) assisting in the early recognition of deficiencies that might affect data quality; (4) enabling the laboratory to take actions to ensure data validity; and (5) enhancing the utility of data considered in the decision-making process, by requiring simultaneous expression of limitations on data quality.

The QAPP that accompanies this submittal has been designed to comply with the requirements of the ER 1110-1-263 (October, 1990). USAEC-validated analytical methods will be used for analyses, except for select cases where a USAEC-validated method is not required. Sample containers will be cleaned and samples preserved in accordance with USAEC and USEPA Region II procedures. Water and soil sample collection, shipment, and documentation will follow the guidance provided in Section 3 of the USAEC Guidelines for Implementation of ER 1110-1-263 for USAEC Projects (May 1993). Analyses will be monitored by the inclusion of QC samples, results from which will be used to evaluate data acceptability by linking each sample with controls. Results of analytical QC will characterize the criteria for the acceptance of data. Failure to meet these criteria, as monitored by the project QA personnel, will result in immediate cessation of analyses. Clarification and correction of the analytical difficulty may result in acceptance of the data, if justified, or reanalysis of all samples in the analytical lot.

Project activities will be characterized in written plans (work plans, methods, protocols) and will then be monitored and documented for compliance with these approved procedures. Documentation, including field data, laboratory data, methods, COC records, and logbooks will be maintained according to Section 10 of the QAPP. Data will be validated and archived prior to use in final assessments supporting USAEC decisions.

As mentioned above, USAEC monitors laboratories through its validation process. This means that all data, COC forms, QC checks, and internal reviews will be scrutinized by USAEC to ensure the highest quality of data possible. In doing so, USAEC will evaluate three-point moving average and single-day control charts for analytical compliance.

18.2 DATA REVIEW/VALIDATION

Data review and validation of sample results for USAEC-validated methods will be performed by Potomac Research, Inc. (PRI), a Contractor to USAEC. Before transmitting the information to permanent storage, the firm will inspect calibration data, control charts, and any other performance indicators. The evaluation of laboratory data will ensure the implementation of certification protocols and QC measures. The validation of the data will attest to the accuracy and precision of the analytical system.

Data review and validation of sample results for non-USAEC methods will be performed by the Contractor. The validation and review process is discussed in Subsection 6.3 of the QAPP.

Data review and determination of limitations of methodology not requiring USAEC validation will be performed by Contractor chemists. The review procedures for each parameter are outlined in the Subsection 6.3.2 in the QAPP.

18.3 DATA QUALITY OBJECTIVES

DQOs are qualitative and quantitative statements that specify the quality (i.e., level) of the data obtained from field activities that will be required to support decisions regarding remedial response activities. Development and use of DQOs is a USEPA requirement for conducting CERCLA projects and has been described by USEPA in their guidance document, DQOs for Remedial Response Activities (March 1987). The development of DQOs for remedial programs helps ensure that data obtained during remedial programs is of sufficient quality to support remedial response decisions, reduce overall costs of data sampling and analyses activities, and accelerate project planning and implementation. The following factors were considered in determining these DQOs:

a. The purpose of collecting data from the media associated with each field activity.

b. The data types required to meet analytical, chemical, and physical objectives.

c. A description of the sampling method being employed for each type of data.

d. The use for which data are being collected. This has been described by using general purpose categories that represent different data uses (e.g., site characterization, alternatives analysis, risk assessment).

e. The identification of an appropriate analytical level for the analysis (or measurement) being performed. Five such levels have been characterized by USEPA for chemical analyses -- these have been slightly modified to take into account physical measurements.

f. The analytical method that will be employed to analyze samples.

g. Evaluation of critical samples, those for which valid data must be obtained to satisfy the objectives of the sampling and analysis task.

h. The types and numbers of QC samples that will be collected in association with each sampling event/media.

Temperature, pH, and conductivity measurements will be performed to Level I screening. This provides the lowest data quality but the most rapid results. These data will be used primarily for initial site characterization. Health and safety monitoring conducted at the site will also be performed to Level I.

Geotechnical analyses conducted at the site (e.g., hydrologic testing) will be performed to Level II for field analyses. In addition, field analytical results for VOCs, pesticides, herbicides, and TPH will provide Level II data quality.

Laboratory chemical analyses performed for samples will be performed to Level IV equivalent. This includes soil, sediment, surface water, and groundwater samples. This level provides the highest level of data quality and produces data suitable for use in the risk assessment. All chemical analytical samples for the site will be sent to a laboratory certified by the State of New Jersey and validated by USAEC MRD.

Analytical data gathered during previous investigations for which USAEC methodologies at the site were followed, will be assumed to be Levels III and IV data that have had appropriate QA/QC verification. Unless data can be validated, all other previous site data will be assumed to be Level II.

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19.0 DATA MANAGEMENT

Proper data management during this investigation will enable and facilitate reliable and defensible conclusions. Experience in conducting environmental surveys and assessments has shown that organization plays a key role in ensuring that the large quantities of data collected in support of a particular project are put into a form that is easy to review and understand.

19.1 ORGANIZATION

The Task Manager is responsible for data management activities. The Contractor is responsible for initial data management of non-chemical field data. In addition to handling administration, coordination, and operations associated with the project, the Task Manager will periodically monitor the flow of data to ensure that schedule, technical quality, and resource requirements are met. The Task Manager will also be responsible for briefing technical personnel on the requirements of the project, and for identifying and resolving any technical problems concerning data management.

The Program Data Coordinator (PDC) will handle the day-to-day monitoring of data management activities by ensuring that the collected data are properly coded and entered into the IRDMIS. The PDC will also have the authority to enforce proper procedures, and to implement actions to ensure the accurate and timely flow of data.

The QA Supervisor will be responsible for auditing and secondary review of data records that have been coded and checked by the PDC to ensure they are accurate, complete, and supported by adequate documentation.

The Field Sampling Team, which will be directed by the Site Operations Leader (SOL), will be responsible for collecting and documenting the data on field parameter forms in the appropriate field logbooks (see the QAPP also included with this submittal). The SOL will ensure that the completed forms are checked for accuracy and presented to the PDC in a timely manner.

19.2 INSTALLATION RESTORATION DATA MANAGEMENT INFORMATION SYSTEM (IRDMIS)

19.2.1 System Description

The IRDMIS is an integrated system for the collection, validation, storage, retrieval, and presentation of Installation Restoration and Base Closures data. The IRDMIS PC Tool, a major component of IRDMIS, provides the ability to enter chemical, geotechnical, and map data in support of the USAEC Installation Restoration and Base Closure Programs. Each Contractor is supplied with appropriate microcomputer-based software to allow for record entry, error checking, and QC for chemical, geotechnical, and map data into IRDMIS. Records accepted by the local error checking program are then transmitted through a Bulletin Board System (BBS), AT&T Model 3B2 minicomputer, which is centrally located at the USAEC Edgewood, Maryland, facility. Subsequent processing (duplicate error check) at PRI results in an elevation of the accepted records to a higher file "level" and the eventual updating of installation-specific databases on a Pyramid System. It is understood that the Army is in the process of changing supporting hardware; however, it is expected that the procedures for data entry, validation, and archiving will remain the same.

19.2.2 Data Management

There are three levels of data recognized in the IRDMIS. Level 1 consists of files on the Contractor microcomputer that have been entered or generated by the error checking program. Once data have been entered in the IRDMIS, that data will be checked by both the PDC and the QA Supervisor. These data are then archived into a transfer file and transmitted via modem to PRI.

It is anticipated that error-free files will be transmitted weekly to the PRI local area network. The Contractor's computer terminal will be linked to the network using software supplied by USAEC and a Hayes modem. Terminal usage logs will be established and maintained as a permanent record of communications. If communications cannot be established and maintained, the Contractor will seek optional means, where needed, for forwarding the data to USAEC. Once the transfer file has been transmitted, the PDC will contact PRI by telephone to notify them of the transmittal. Each Monday, PRI will send a telefax to the Contractor listing the files received and the acceptance status. To verify acceptance, PRI will process each file through an error checking program identical to the one on the

Contractor's computer. Accepted files will then be sent to the UNISYS mainframe. Should any files fail this final error check, the Contractor will be notified and required to correct detected errors and retransmit the data.

Upon arrival at the UNISYS mainframe, the files will be classified as Level 2 files. Level 2 files will exist only until the data are loaded into the USAEC database, normally within 10 working days.

Data in the USAEC database are considered Level 3 data. They may be accessed by the Contractor using USAEC-supplied report programs and the appropriate read key; however, they are protected from changes by a write key.

Data management begins when USAEC and the Contractor transmit a request for analytical services to the laboratory, stating the number, type, sample numbers, methods for analysis, and any other information necessary for the laboratory to plan a particular job.

While in the process of collecting, documenting, packaging, and shipping samples to the laboratory, the field sampling team will record field parameter information in the appropriate logbook. Once the samples arrive at the laboratory, the site type/Site ID information will be combined with analytical results, by analytical lot, and the information entered into Level 1 data files in the IRDMIS. The laboratory will validate the data, perform error-checking and correction using the USAEC routines, and transmit the Level 1 files to USAEC, via the 3COM communications network. Hard-copy documentation will also be transferred from the laboratory to USAEC. The field sampling team will transmit location information from the field logbook to the PDC, who will input the data into map files for the site. The map files will be checked against the original field logbook entries.

Once the Level 1 files have been processed at USAEC, the PDC will transmit any required corrections, then generate a backup disk copy. This step will be completed within 50 days after the samples have been collected. The laboratory will archive copies of analytical data, including original instrument magnetic tapes, until approval for release is obtained from USAEC. Records will also be maintained, so that historical summaries of analyses may be generated. Figure 14 presents a summary diagram of how these data will be handled.

19.3 PROJECT DATA

Data for entry into the IRDMIS and generated during this project will consist of geotechnical data and sampling/analytical data. Data that are not entered into the IRDMIS will be logged into notebooks, then packaged with any hard-copy outputs (e.g., plots, charts), and sent to the PDC. Both the PDC and a secondary reviewer will review these data, referred to as field data, before the PDC archives the information for future reference. The types, origin, IRDMIS files, and handling of these data are described below.

19.3.1 Map File Data

A Geotechnical Map File (GMA), an IRDMIS geotechnical data file type, will be generated by the field team activities during the investigation at Ft. Dix. The GMA contains locational information about groundwater monitoring wells and soil samples. These files are generated from field logbooks, boring logs, and field parameter forms used by the Site Geologists and must precede all other data files for a particular site type and Site ID.

The map file is a listing of sample sites and corresponding location coordinates. Map files will be created from the sample site data, and input into the IRDMIS. Elevation and locational coordinates are obtained by surveying (wells) or from maps (other sampling points), and are submitted by the SOL to the PDC, who creates the map file. These data are entered into the computer by the PDC, and a computer printout of the file is checked and corrected by the SOL.

19.3.2 Field Drilling and Well Construction Files

During and after completion of well drilling activities, the Site Geologist enters field drilling data on USAEC's IRDMIS forms and submits them to the PDC. The information is entered into the data management system, and a computer printout is generated and returned to the Site Geologist for proofing. Corrections are noted on the sheet, and the sheet is returned to the PDC. After corrections have been made, the data are submitted to USAEC and loaded onto the USAEC data system in Level 1. Once the field drilling and well construction files are submitted to USAEC in Level 1, the data are checked with USAEC's GEOTEST program, which checks for correspondence between sites in the map and field drilling files, accurate entry of data, and completeness in the field drilling and well construction files.

Errors are printed out for correction in the Level 1 file. After the QA Supervisor has validated the field drilling and well map file, the data are elevated to Level 2.

19.3.3 Groundwater Stabilized File

The groundwater-stabilized file is a compilation of static water levels in the wells at the time of sampling. It is submitted by the Site Geologist after the sampling trip, along with the map file information. The groundwater-stabilized file is submitted on IRDMIS forms and undergoes the same entry, checking, and validation procedures as the field drilling and well construction files.

19.3.4 Sampling and Analytical Data

Field screening data from field analytical laboratory work will be kept in a separately bound logbook. In addition, during the field program, field screening data will be uploaded to electronic format for use in plotting to assess horizontal and vertical distribution of contaminants.

Data from analyses performed by the analytical laboratory are input into various chemical data files. The laboratory is also responsible for validation of the data for generation of error-free files. Data from sampling activities required by the laboratory will be submitted by the sampling team on field parameter forms, along with the samples. The sampling organization will also be responsible for generation of all map files, as described above. A description of sampling and analytical data generation and manipulation is provided below.

Subsection 17.1 of this Technical Plan specifies the Site ID and field sample number system. Sampling data will be collected in the field in a permanently bound logbook. Information will be recorded on two-part field parameter forms. Each logbook will be specific to the matrix being sampled. This information will include the site type, Site ID, sampling date and time, field sampling number, sample depth (if applicable), and the sampling technique. One copy of this form will accompany each sample to the laboratory so that the information can be encoded prior to sample analysis. In addition, each sample container will be annotated in waterproof ink with the installation name, sampling number, sampling date, analytes, and preservatives. A COC form will also be completed in the field and will accompany the samples to the laboratory, along with the field parameter form. One copy of the field parameter form is bound in the logbook for use in creating map files.

Collection of analytical data will begin when samples arrive at the laboratory. A laboratory technician will first verify that the samples noted on the COC form coincide with the sample containers being delivered. If any containers are broken or missing, the COC form will be annotated and the SOL will be notified immediately. Samples will then be logged into a project-specific notebook and the computerized laboratory data management system according to parameter code, site ID, field sample number, and laboratory sample number. The field parameter and COC forms will then be submitted to a laboratory data technician for later correlation with the analytical results.

Upon receipt of the sample log information, the laboratory Quality Assurance Coordinator (QAC) will assign analytical lot numbers to the samples in accordance with USAEC procedures. The first three letters of the six-character sample code will designate the analytical lot, while the remaining three digits will indicate the sample number within the lot (e.g., AAB006 indicates the sixth sample in lot AAB). All QC samples required for each analytical lot (e.g., method blank, control spike at two times the certified reporting limit (CRL), and two control spikes (at 10 times the CRL) will also receive USAEC sample numbers. The data technician will enter the sample information into the IRDMIS to generate partially completed data coding forms.

When the samples are taken from storage for analysis, the COC form will be signed by the Data Analyst to acknowledge receipt of the samples for processing. When analyses are complete, the Data Analyst will evaluate the data for QC samples to determine if the analyses were in control. The QC results will then be reviewed by the Laboratory Section Manager and forwarded to the QAC for verification. If the QAC agrees that the data are in control, the Data Analyst will be directed to proceed with data reduction for the samples. Concentrations of contaminants in extracts will be determined from instrumental responses of the extracts applied to the instrument calibration curve. The resulting concentration will then be modified by applying the appropriate dilution/concentration and sample weight or volume to obtain a final reportable concentration in the original matrix. Soil sample results will not be corrected for moisture, but percentage of moisture will be reported with the result. Aqueous samples will be reported in terms of μg/L and solid samples will be reported in mg/kg.

The data will contain no more than three significant digits and will be rounded to the appropriate number of significant digits, based on certification class and dilution, only after all calculations have been completed. When samples are diluted into a certified range, the reported concentration will contain one less significant digit than an undiluted sample. Values less than the CRL will be reported as "less than" the CRL. If a sample is diluted below the CRL, the value will be reported as "less than" the CRL multiplied by the dilution factor to more accurately reflect the observable limit. The dilution factor will be reported with the data. Method blank values will not normally be subtracted from sample results submitted to IRDMIS; however, method blank corrections may be made in accordance with the USATHAMA QA Program 1990 3rd ed., Subsection 11.3.1. It should be noted that data deletions as a result of qualifications from blank contamination will occur only during the risk assessment phase.

When data reduction has been completed for the samples, all data will be transmitted to USAEC. The correlation of the analytical and field data will be performed by PRI. Table 10 lists the information that is required for the IRDMIS.

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20.0 RISK ASSESSMENT

Baseline Human Health and Ecological Risk Assessments will be conducted for appropriate sites at Ft. Dix. The purpose of these assessments will be to establish the potential risks to human and ecological receptors. Based on the results of these baseline risk assessments (risks in the absence of remediation), one of the following recommendations will be made for the 13 Sites:

1) take no further action or initiate long-term monitoring
2) initiate an immediate removal or interim action, or
3) prepare an FS

The Human Health and Ecological Risk Assessments will be conducted in accordance with USEPA guidance for conducting risk assessments at Superfund sites. This includes Risk Assessment Guidance for Superfund (RAGs) Volume I, Human Health Evaluation Manual, and Volume II, Environmental Evaluation Manual. In addition, NJDEP's Guidance for Sediment Quality Evaluations (March 1991) will be followed. Additional guidance documents are presented in Task Order Number 0006.

20.1 HUMAN HEALTH RISK ASSESSMENT

The following subsections detail the approach to the Human Health Risk Assessment to be performed.

20.1.1 Identification of Chemicals of Potential Concern

The first step in the risk assessment will be the review of the validated analytical results from sampling completed during the RI, as well as other site-specific information, to identify chemicals of potential concern for detailed study in the risk assessment. Factors considered in selecting a chemical of potential concern include the chemical's relationship to the suspected source or to past activities at each site, and the relationship of the detected chemical concentration to site-specific background or upgradient levels of the chemical as outlined by USEPA (1989).

Before chemicals of concern are selected, the data collected during the RI will be summarized by environmental medium (e.g., groundwater, surface and subsurface soil, sediment, and surface water) for the 13 Sites. Each chemical detected within a given medium will be summarized by frequency of detection, arithmetic mean, mean sample size, range of detected concentrations, and range of background concentrations.

The shape of the data distribution represented by the field data will be evaluated by conducting a small number of "goodness of fit" tests to calculate the appropriate statistics to be used for generation of the arithmetic mean and confidence limits. The arithmetic mean will be calculated using detected values in addition to one-half the detection limit for non-detect values (excluding high detection limits in accordance with USEPA [1989a, guidance[4]). In addition, the 95 percent upper confidence limit (UCL) of the arithmetic mean will be determined and used for estimating exposure in the risk assessments.

For those environmental media with more than 20 organic chemicals, the Concentration-Toxicity Screening Procedure outlined in USEPA (1989a) may be used to select chemicals of potential concern. This procedure will focus the risk assessment on those chemicals contributing the most to potential impacts at each of the sites selected for evaluation. The screening procedure will be based on a chemical's toxicity and concentration, generally the two most important factors in establishing the risk or hazard posed by a chemical.

Inorganic chemicals at each of the sites at naturally occurring levels may be eliminated from the quantitative risk assessment based on comparison to background concentrations (USEPA 1989a). If there is a reasonable number of background samples (i.e., a minimum of three or four), a formal statistical analysis will be conducted to compare site-related and background chemical concentrations. Background samples will be collected for groundwater, soil, and surface water/ sediment as part of a base-wide Background Sampling Program. If analytical results for these background samples indicate they are not representative or appropriate to use as background, then background regional data could be used.

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[4] Note, however, that USEPA guidance indicates that this approach is only appropriate when the fraction of non-detects is less than 10 percent of the total. When a larger fraction of non-detects is present, alternate procedures are required. The budget estimate for this work plan assumes that none of the data sets to be evaluated in these studies contains more than 10 percent non-detects, and that alternative procedures will not be required.

If regional data must be used because of a lack of base-wide background data, and if adequate regional data are not available to conduct statistical analyses, the chemical concentrations in a site-affected medium may be compared to two times the maximum regional background sample concentration. A factor of two is considered conservative because background concentrations of naturally occurring chemicals can range over an order of magnitude. Inorganic chemicals that remain after the comparison to background will be selected and evaluated in the risk assessment.

20.1.2 Human Exposure Assessment

The next step in the risk assessment will be the exposure assessment. The purpose of the exposure assessment is to characterize (quantitatively or qualitatively) the route, frequency, duration, and magnitude of exposure to chemicals associated with the site. The exposure assessment will be conducted in a series of three steps: (1) receptor characterization; (2) exposure pathway identification; and (3) exposure quantification. Exposure will be evaluated assuming that land use does not change in the future and that all study areas will continue to support some type of Department of Defense (DOD) activity.

20.1.2.1 Receptor Characterization. As the first step of the exposure assessment, potentially exposed populations (receptors) are identified for each study area and described with respect to those characteristics that influence exposure. Factors such as activity patterns in the area, source characteristics, and routes of transport are considered when identifying potentially exposed populations. Again, for purposes of the risk assessment, it will be assumed that current and future land use will remain constant. For the human health assessment, it is anticipated that for most study areas, human receptors will be limited to installation personnel and other on-site workers. If the potential exists for Ft. Dix residents to be exposed to chemicals at the 13 Sites, they may be evaluated as potential receptors. In accordance with the U.S. Army and Ft. Dix, future residential development of the study areas will not occur, therefore related exposure scenarios will not be considered.

20.1.2.2 Identification of Exposure Pathways. The exposure pathways associated with each site are identified and are based on consideration of the sources, releases, types and locations of chemicals in each study area; the likely fate and transport of the chemicals; and the location and activity of receptor populations. Each exposure pathway includes: (1) a source and mechanism of release; (2) an environmental transport medium; (3) a point of potential exposure with the contaminated medium; and (4) a route of exposure (e.g., direct contact with soil, ingestion of groundwater) at the exposure point. Pathways that contain all these elements are considered complete and will be considered for quantitative evaluation in the risk characterization.

This exposure assessment will focus on those exposure pathways likely to result in the greatest exposure, which therefore are potentially associated with the greatest risks. This task will predict the potential magnitude, frequency, and duration of chemical exposures through the identified exposure pathways. A discussion will be provided in the risk assessment justifying the selection or exclusion of pathways from consideration. It is anticipated that, at minimum, the exposure pathways selected for quantitative evaluation will include incidental ingestion of soil and ingestion of groundwater. Other potential exposure pathways, such as direct contact or incidental ingestion of surface water and sediment, or inhalation of chemicals that may have volatilized from groundwater while showering, may also be evaluated, depending on whether the pathway would be considered complete. A discussion will be provided in the risk assessment justifying the inclusion or exclusion of pathways from evaluation.

20.1.2.3 Quantification of Exposure. For each exposure pathway selected for quantitative evaluation, concentrations at the exposure point will be using the RI data. The shape of the data distribution will be evaluated to determine the appropriate statistics to use in calculating the exposure point concentrations. In accordance with USEPA (1989a) guidance, the exposure point concentrations will be the 95 percent UCL of the arithmetic mean, or the maximum detected concentration in a given media and data grouping, whichever is less.

Exposures will be quantified for each receptor population and exposure pathway by calculating lifetime average daily doses (LADDs) for exposure to chemical carcinogens, and average daily doses (ADDs) for exposure to noncarcinogenic chemicals, following USEPA (1992) guidance. LADDs and ADDs will be based on the exposure point concentrations and assumptions regarding the frequency and duration of exposures, and the rate of media intake (e.g., amount of water or soil ingested per day). In accordance with USEPA (1989a) guidance, exposures will be quantified assuming a reasonable maximum exposure (RME) scenario.

20.1.3 Toxicity Assessment

Chemicals of potential concern will be characterized with respect to their toxic effects in humans. Where possible, relevant critical toxicity criteria will be identified for each chemical. Brief summaries of the toxicity of those chemicals that will be evaluated quantitatively in this assessment will be included. For the human health assessment, two types of toxicity values are used: USEPA-derived cancer slope factors (CSFs) and unit risks (URs) for potentially carcinogenic chemicals and reference doses (RfDs) and reference concentrations (RfCs) for chemicals exhibiting noncarcinogenic effects. For carcinogens, CSFs/URs and the chemicals' weight-of-evidence classifications for human carcinogenicity will be provided and discussed. For noncarcinogens, RfDs/RfCs and the uncertainty factors used in deriving them will be provided. The primary source of CSFs/URs and RfDs/RfCs will be USEPA's Integrated Risk Information System (IRIS) and Health Effects Assessment Summary Table (HEAST). The USEPA regional toxicologist and Environmental Criteria and Assessment Office (ECAO) may be contacted for toxicological information, as well as for guidance on the evaluation of chemicals that do not have USEPA-published toxicity values.

20.1.4 Risk Characterization

Potential human health impacts will be evaluated by comparing risk levels associated with estimated exposures to appropriate USEPA- and NJDEP-acceptable risk ranges. The results of the risk characterization will include estimates of the upper-bound individual cancer risk for potential carcinogens and a Hazard Index (HI) for noncarcinogens. The individual lifetime excess cancer risk for a chemical exhibiting carcinogenic effects will be calculated by multiplying the upper-bound CSF by the estimated LADD averaged over 70 years. For noncarcinogens, potential risks will be calculated as an HI, as recommended by USEPA (1989a). An HI greater than one may necessitate additional evaluation, in which HI for groups of chemicals affecting similar target organs will be calculated. If an HI exceeds one for a specific target organ, there may be concern for potential health effects (USEPA, 1989a). Risks will be calculated for each exposure pathway, and where applicable, will be summed across the exposure pathways to predict the combined impact for individuals who may be exposed via several pathways.

20.1.5 Uncertainty Analysis

The risk assessment process involves several steps (e.g., selection of chemicals of potential concern (CPCs), hazard identification, exposure assessment, and toxicity assessment). Each step contains assumptions and uncertainties. The uncertainties involved in risk assessment in general, and the risk assessment conducted for the study area, specifically, will be characterized. The impact of the uncertainties on the risk characterization, and risk management decisions will be discussed.

20.2 ECOLOGICAL RISK ASSESSMENT

The purpose of the Ecological Risk Assessment at the 13 Sites is to provide a baseline evaluation of actual and potential risks to ecological receptors posed by chemicals in environmental media. The Ecological Risk Assessment will consist of the following elements: Hazard Assessment; Ecological Characterization; Ecological Exposure Assessment; Ecological Effects Assessment; Ecological Risk Characterization; and an Uncertainty Analysis.

20.2.1 Hazard Assessment

This section will present an overview of the Ecological Chemicals of Potential Concern (COPCs) at the 13 Sites. The selection of COPCs is a screening process used to characterize the chemicals requiring evaluation in the Ecological Risk Assessment. Factors considered when selecting COPCs include: the validity of the data for ecological risk assessment; the classification of chemicals (e.g., inorganic, organic, pesticides); comparison of chemical concentrations with naturally occurring background concentrations; the physical and chemical properties of chemicals; the frequency of release and detection; and the inherent toxicity of exogenous chemicals.

20.2.2 Ecological Characterization

The ecological characterization will serve as the basis for identifying potential ecological receptors at the 13 Sites. It will describe the different biological habitats (aquatic and terrestrial) located at the sites as well as ecological receptors. The ecological characterization will qualitatively characterize the ecological communities associated with the 13 Sites.

This characterization will be based on a limited site reconnaissance. In addition, background information on the 13 Sites will be reviewed, including literature on the range and distribution of wildlife species, and interviews with local, state, and federal wildlife officials. Emphasis will be placed on the following: assessing habitat suitability for aquatic and terrestrial organisms; assessing the potential occurrence of rare, threatened, or endangered species; and identifying wetland or other aquatic areas that may be receptors of site-related contaminants. Additionally, plant communities at the 13 Sites will be described and observations of aquatic or terrestrial organisms will be recorded. The USEPA, NJDEP, U.S. Fish and Wildlife Service (USFWS), New Jersey Natural Heritage Program, and the Pinelands Commission will be contacted regarding the presence of potential receptors. The results of the receptor analysis will be used to further develop exposure scenarios for the Ecological Exposure Assessment.

Additionally, plant communities at the 13 Sites will be described and observations of aquatic or terrestrial organisms will be recorded. Wildlife and vegetative species encountered or expected to be present at the site will be listed in tabular format. The USEPA, NJDEP, U.S. Fish and Wildlife Service (USFWS), New Jersey Natural Heritage Program, and the Pinelands Commission will be contacted regarding the presence of potential receptors.

As part of the receptor identification, an informal Section 7 consultation also will be requested from the United States Fish and Wildlife Service (USFWS) to identify endangered or threatened species which may be associated with the site. The National Marine Fisheries Service (NMFS), often consulted for similar information on marine species, will not be notified because the installation is not located near any marine, coastal, or tidal systems, and therefore no threats to these systems are anticipated.

The New Jersey Natural Heritage Program also will be consulted for information regarding the potential presence of state-listed endangered, threatened, or rare species or communities. A Natural Diversity Inventory is being performed at Fort Dix by the New Jersey Natural Heritage Program which will be a useful tool in identifying species of special concern.

As part of the ecological characterization, any wetlands on or near a site that could potentially be affected by contamination and/or future remedial actions at a site will be identified and delineated. Delineated wetlands will be classified and depicted on a site map. Potentially affected wetlands will be delineated (and mitigated, if required) in accordance with the most stringent of either the U.S. Army Corps of Engineers (1987 Wetland Delineation Manual), the NJDEP Freshwater Wetlands Protection Act, or the New Jersey Pinelands Commission requirements. A functional assessment of the potentially affected wetlands will be conducted using the Corps of Engineers' Wetland Evaluation Technique (WET) or other appropriate functional assessment model.

20.2.3 Ecological Exposure Assessment

The Ecological Exposure Assessment will evaluate the potential for receptor exposure to chemical contaminants at the 13 Sites. This evaluation involves the identification of potential exposure routes and an evaluation of the magnitude of exposure of identified ecological receptors. Exposure concentrations and/or doses will be estimated for each exposure pathway. If appropriate, indicator species will be selected for ecological exposure modeling.

Exposure pathways describe how ecological receptors can come in contact with contaminated media and are based on identifying (1) the contaminant source, (2) the environmental transport medium, (3) the point of receptor contact, and (4) the exposure route (e.g., ingestion of prey items that have bioaccumulated chemicals in their tissues, drinking of contaminated surface water, incidental soil ingestion, or dermal absorption).

Ecological receptors at the 13 Sites could potentially be exposed through the following routes:

- Incidental ingestion of and direct contact with surface soil;
- Ingestion of contaminated food items (food chain exposure);
- Direct contact with or incidental ingestion of surface water and sediment; and
- Inhalation of particulate or vapor-phase chemicals.

Aquatic organisms potentially exposed to chemicals in surface water and sediment include freshwater aquatic invertebrates. Animal species most likely exposed to chemicals in sediment include macroinvertebrates living in the sediment or benthic-feeding organisms, as well as fish, amphibians, and certain reptiles. Plant species potentially exposed to surface water and sediment at the 13 Sites include various aquatic, emergent, and facultative wetlands species.

Terrestrial and semiterrestrial organisms that may be exposed to site-related environmental contamination include birds, mammals, reptiles, and amphibians. Potential exposures to terrestrial and semiterrestrial organisms are expected to vary considerably among species because of differences in feeding behavior, habitat preferences, and other factors affecting exposure. Because of this variability, indicator species will be selected as part of the exposure assessment to best represent the species of terrestrial and semiterrestrial and wildlife potentially exposed to site-related contamination.

Based on COPC concentration data, exposure concentrations will be estimated for aquatic, semiterrestrial, and terrestrial organisms identified as potential receptors. If sufficient information exists, integrated exposure analyses will be performed by modeling exposure information (e.g., populations exposed, duration and frequency of exposure, and routes of exposure) to calculate quantitative estimates of exposure concentrations for representative receptor species.

To evaluate exposure to aquatic organisms, the measured concentrations of site-related chemicals in surface water and sediment will serve as representative exposure point concentrations. Average and maximum values will be used to represent chronic and acute exposures, respectively.

The process of assessing terrestrial and semiterrestrial ecological exposure will involve estimating the likely dosage for each relevant route, and summing these estimates to derive an expected total body dosage for each receptor type. The amount of exposure will depend on various factors such as the type of food consumed, feeding rates, habitat preference, and home range. Indicator species will be chosen to best characterize the organisms and trophic levels potentially at risk due to selected exposure pathology (e.g., incidental ingestion of soil and consumption of contaminated prey). It is assumed that each species chosen will be representative of other species at a similar trophic position. The documentation of exposure parameters for each representative species will be presented in tabular form.

20.2.4 Ecological Effects Assessment

In the Ecological Effects Assessment, the hazards associated with the COPCs will be described, and the relationship between the concentration to which an organism is exposed and the potential for adverse effects will be evaluated. Toxicological effects will be evaluated using concentration-response data for acute and chronic toxic effects on aquatic biota and terrestrial wildlife. The concentration-response data will be used in conjunction with the exposure assessment information to develop Reference Toxicity Values (RTVs) for each COPC. RTVs represent threshold concentrations or doses for effects to aquatic and terrestrial organisms.

Toxicity to Terrestrial Receptors. Toxicity data for terrestrial receptors will be derived from acute and chronic ingestion studies. Based on these data, RTVs will be developed to represent threshold concentrations below which effects would not be expected. The most appropriate value for each representative species will be selected as the RTV.

Toxicity to Aquatic Receptors. Criteria available to evaluate the toxicity of COPCs in surface water include federal Ambient Water Quality Criteria (AWQC), NJDEP Surface Water Quality Standards (SWQS) laboratory-derived toxicity data, and threshold values developed using extrapolation techniques. These sources will be used to generate RTVs for the COPCs in surface water.

If AWQC are not available for certain chemicals, USEPA Lowest Observable Effect Levels (LOELs) will be used. The water quality standards of the Pinelands Comprehensive Management Plan will also be used, if appropriate.

For certain chemicals, toxicity data may be available only from acute studies. To develop a chronic RTV for these chemicals, a Quantitative Structure Activity Relationship (QSAR) model or other appropriate reference will be used to estimate an RTV.

Sediment Quality Criteria (SQC) will be used to evaluate the effects of sediment COPCs on aquatic life. The USEPA Interim Sediment Criteria Values for Nonpolar Hydrophobic Organic Contaminants (1988) and NJDEP's Guidance For Sediment Quality Evaluations (1991) will be sources of sediment criteria. Following the equilibrium-partitioning approach upon which these criteria are based, SQC values will be calculated taking into account the TOC content of the sediment.

If neither USEPA Interim Sediment Criteria Values nor NJDEP criteria are available for certain COPCs, the appropriateness of either the National Oceanographic and Atmospheric Administration (NOAA) Sediment Threshold Values and the New York State Department of Environmental Conservation (NYSDEC) SQC will be evaluated.

20.2.5 Ecological Risk Characterization

The purpose of the Ecological Risk Characterization will be to combine the results of the exposure and effects assessments to characterize the risks at the 13 Sites from environmental contamination. This section will identify ecological receptors that might be at risk from site-related contamination. Screening of risk will be done through the use of an HI approach.

The estimated doses or exposure concentrations will be compared to RTVs. Comparison of the average and maximum concentrations of chemicals detected in surface water and sediment with RTVs for aquatic organisms provides a means of evaluating the potential for adverse effects. Hazard Quotients (HQs) will be calculated by dividing exposure concentrations by RTVs. For terrestrial receptors, HQs will be calculated by dividing estimated body doses by RTVs. Cumulative HIs will be calculated by summing the HQs for individual chemicals. If the cumulative HI is greater than one, effects to organisms may be possible.

The Ecological Risk Characterization will include a discussion of visual observations of any ecosystem degradation or other symptoms of environmental stress observed during the site visit.

The findings of the Ecological Risk Characterization will be used to assess the need (if any) for additional biological work, such as tissue analyses, bioassays, or a benthic community ecology survey. This approach is consistent with both USEPA and NJDEP guidance that advocates a tiered process for evaluating ecological risks. For the 13 Sites, the need for additional biological investigations will be based largely on the results of the Ecological Risk Characterization.

20.2.6 Uncertainty Analysis

Because the prediction of ecological risks involves several assumptions, a discussion of uncertainties will be included in this section. This section will discuss both site-specific uncertainties at the 13 Sites and general uncertainties inherent in the risk assessment process.

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21.0 PRELIMINARY IDENTIFICATION OF POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

21.1 INTRODUCTION

In this section, Applicable, or Relevant and Appropriate, Requirements (ARARs) and other criteria or guidelines TBC are discussed. These criteria serve two purposes for the RI: (1) to aid in assessing the significance of the chemical results obtained in the RI, and (2) to aid in the selection of contaminants of concern for the Risk Assessment. In the FS, these criteria will be used to determine cleanup goals for remedial actions.

21.1.1 Definition of ARARs and Other Requirements to be Considered

Section 121 (d) of CERCLA, as amended by the Superfund Amendments and Reauthorization Act (SARA), requires that remedial actions comply with any standard, requirement, criterion, or limitation of federal or more stringent state environmental statutes. These standards, referred to as ARARs, include the statutory requirements of the National Primary and Secondary Drinking Water Regulation, Clean Air Act, Clean Water Act (CWA), Resource Conservation and Recovery Act (RCRA), Toxic Substances Control Act (TSCA) and the Solid Waste Disposal Act, among others. In accordance with the National Contingency Plan, a requirement may be either applicable, or relevant and appropriate, to a remedial action, but not both. These terms are discussed in the following paragraphs.

<u>Applicable Requirements</u> - Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a site. An example of an applicable requirement is the use of the Safe Drinking Water Act (SDWA) MCLs for a site where groundwater contamination has affected a public water supply.

<u>Relevant and Appropriate Requirements</u> - Relevant and appropriate requirements are federal and state standards, criteria, or limitations that are not legally applicable to a site, but which address problems or situations sufficiently similar that their application is appropriate. There is more discretion in this determination in that it is possible for only part of a requirement to be considered relevant and appropriate,

the rest being dismissed if judged not to be relevant and appropriate in a given case. Only those state standards identified by the state in a timely manner that are more stringent than the applicable federal standard may be relevant and appropriate. For example, MCLs for drinking water would be relevant and appropriate requirements at a site where groundwater contamination could affect a potential (rather than actual) drinking water source. Relevant and appropriate requirements have the same weight and consideration as applicable requirements.

Other Requirements to be Considered. Non-promulgated federal and state guidance documents or criteria do not have the status of potential ARARs. However, where specific ARARs do not exist for a chemical or situation, or where such ARARs are not protective of public health or the environment, guidance documents or advisories may be considered in determining the necessary level of cleanup for protection of health or environment.

In accordance with CERCLA guidance for conducting an RI/FS, ARARs will be identified and evaluated throughout the RI/FS process.

21.1.2 Types of ARARs

ARARs are generally classified as chemical-specific, location-specific, and action-specific as follows:

Chemical-specific ARARs - Chemical-specific requirements generally involve health- or risk-based numerical values or methodologies for site-specific hazardous substances in various environmental media. These requirements may provide site cleanup levels, or a basis for calculating cleanup levels, for chemicals of concern in designated media. Chemical-specific ARARs may also be used to develop an acceptable level of discharge, to determine treatment and disposal requirements for a particular remedial activity, and to assess the effectiveness of a remedial alternative.

Location-specific ARARs - Location-specific requirements set restrictions established for specific substances or activities based on site-specific characteristics or location. Potential remedial actions may be restricted based on proximity to wetlands or floodplains.

Action-specific ARARs - Action-specific requirements involve design, implementation, and performance requirements that are generally technology or activity-based. They are based on specific remedial activities that may be selected to accomplish cleanup objectives. After remedial alternatives are developed and screened, the alternatives retained for detailed analysis are evaluated relative to action-specific ARARs.

21.2 POTENTIAL CHEMICAL-SPECIFIC ARARS

In this subsection, an initial list is provided of potential chemical-specific ARARs and other TBCs for the environmental media that will be investigated in this task (groundwater, surface water, sediment, and soil).

ARARs for Groundwater at Ft. Dix. ARARs for groundwater applicable to the Ft. Dix RI/FS for 13 Sites include:

- Federal MCLs and maximum contaminant level goals (MCLGs) established under the SDWA
- New Jersey Drinking Water Regulations
- New Jersey Groundwater Quality Standards
- Other health advisories or criteria, as applicable
- Comprehensive Management Plan, issued by the Pinelands Commission

In New Jersey, groundwater cleanup standards are established to protect groundwater classifications set forth under the New Jersey Ground Water Quality Standards (N.J.A.C. 7:9-6). The NJDEP has established natural groundwater quality as the cleanup standard for all contaminants in Class IA and I-Pinelands (Preservation Area) groundwater, which includes all groundwater at Ft. Dix. The numerical criterion for any organic contaminant discovered at a contaminated site that is not the result of natural processes is zero. Because zero can only be measured with a certain degree of certainty, the Practical Quantitation Levels (PQLs) for groundwater have been selected for use in establishing whether organic contaminant concentrations observed in groundwater meet ARARs. Federal and state ARARs for groundwater are shown in Table 11.

For inorganics, "natural background" concentrations will be established for groundwater by means of analytical results obtained from "background" groundwater monitoring wells installed as part of the USAEC EI/AA being performed at Ft. Dix, the Background Sampling Program and from published regional background data. The range of values observed for inorganic constituents will be considered the natural range of concentrations expected for that constituent in groundwater. Analytical results greater than the average of the range for that constituent would be considered "above background."

ARARs and other Guidance TBC for Surface Water at Ft. Dix. For surface water, there are several ARARs:

- Federal AWQC established under the CWA
- New Jersey Surface Water Quality Standards
- Comprehensive Management Plan, issued by the Pinelands Commission

Table 12 reflects these ARARs for surface water.

New Jersey has its standard natural surface water quality for all surface water bodies in the Pinelands. The numerical criterion for any organic contaminant discovered at a contaminated site that is not the result of natural processes is zero. Because zero can only be measured with a certain degree of certainty, the PQLs for surface water have been selected for use in determining whether contaminant concentrations observed in surface water meet ARARs.

For inorganics, "natural background" concentrations will be established for surface water based on analytical results obtained from "background" surface water samples collected as part of the USAEC EI/AA, the MAG-1 Area RI, and the Background Sampling Program to be performed at Ft. Dix as well as published regional background data. The range of values observed for inorganic constituents in these samples and from published regional background data will be considered the natural range of concentrations expected for that constituent in surface water. Analytical results greater than the average of the range for that constituent would be considered "above background." These data will also be used in completion of Ecological Risk Assessments for the 13 Sites, as appropriate.

<u>ARARs and Other Guidance to be Considered for Sediment at Ft. Dix</u>. ARARs include:

- Comprehensive Management Plan, issued by the Pinelands Commission

The following additional guidance to be considered includes:

- Guidance for Sediment Quality Evaluations (March, 1991, New Jersey Department of Environmental Protection, Division of Hazardous Site Mitigation)

The Environmental Toxicology and Risk Assessment (ETRA) Section of NJDEP developed the Guidance for Sediment Quality Evaluations to promote a consistent methodology for determining contaminants of concern, current and potential ecological impacts, and appropriate remedial activities.

Within the NJDEP's hazardous waste program, a tiered process is used in which contaminant levels in sediment are initially compared against established screening level criteria. When levels of contaminants exceed screening criteria, subsequent evaluation is required to further characterize the magnitude of the threat posed by the particular sediment to ecological resources and, where appropriate, to human health (i.e., through shellfish/fish consumption). An exception to this policy can be made if there is a consensus that further work is not necessary. However, adequate justification must be presented to support the recommendation for no further action. It is the Army's intent to follow this tiered approach, by evaluating the chemical data collected from analysis of sediment samples first. Only if contaminant concentrations are found to exceed screening level criteria will further investigation (in the form of bioassays and/or community level bioassessment) be performed.

The guidance presents two established screening level criteria: SQC for selected organic compounds, and screening level values for inorganics, and certain pesticides and polynuclear aromatic hydrocarbon (PAHs).

The SQC for selected organic compounds is based on an equilibrium partitioning approach (USEPA 1988, 1989c). This theoretical model is based on the partitioning of nonpolar organic contaminants between sediments and interstitial waters. Distribution coefficients for individual contaminants are used to establish chemical concentrations in sediments that will yield concentrations in interstitial waters that are equivalent to AWQC for the protection of aquatic life. The partitioning between sediments and water depends on the organic content of the sediment. Criteria have been developed for both "fresh" and "saltwater." For this project, the "freshwater" criteria will be used.

Mean, lower, and upper confidence limits have been established for the SQC for each compound. The lower confidence limit represents a concentration below which no adverse impacts are expected (from a particular substance) with 95 percent certainty (USEPA, 1988). NJDEP suggests the use of the lower confidence limit in pristine or particularly sensitive environments. Given that the classification of surface water bodies under investigation is PL-Pinelands, this lower confidence limit will be used. Table 13 lists the SQC for selected organic compounds.

Screening level values for inorganics, certain pesticides, and PAHs are found in Table 14. These were taken from a summary document prepared by NOAA (1990): "The Potential for Biological Effects of Sediment-sorbed Contaminants Tested in the National Status and Trends Program." This report assembled and reviewed available information in which estimates of the sediment concentrations of chemicals associated with adverse biological effects have been established or could be derived.

The biological data for each compound were sorted in ascending order and two values were statistically calculated; an Effects Range-Low (ER-L), a concentration at the low end of the range in which effects had been observed and an Effects Range-Median (ER-M), a concentration approximately midway in the range of reported values associated with biological effects. In a very qualitative sense, the ER-L value can be taken as a concentration above which adverse effects may begin or are predicted among sensitive life stages and/or species. These criteria are general values used for screening and have been biased toward saltwater systems due to the nature of the data set used in the analysis.

In accordance with the NJDEP, the ERM value will be used in the sediment screening analysis.

In addition, for inorganics, "natural background" concentrations will be established for sediment based on analytical results obtained from "background" sediment samples collected as part of the Army's EI/AA, the MAG-1 Area RI, and the Background Sampling Program to be performed at Ft. Dix as well as from published regional background data. The range of values observed for inorganic constituents in these samples and from published regional background data will be considered the natural range of concentrations expected for that constituent in sediment. Analytical results greater than the average of the range for that constituent would be considered "above background." These data will also be used in completion of Ecological Risk Assessments for the 13 Sites as appropriate.

<u>ARARs and Other Guidance to be Considered for Soil at Fort Dix include</u>::

- Comprehensive Management Plan, issued by the Pinelands Commission

The following additional TBC guidance also exists: The NJDEP's February 3, 1992, proposed rule entitled <u>Cleanup Standards for Contaminated Sites</u>, N.J.A.C. 7:26D, presented in Table 15 with noted corrections based upon errors identified to the department during the comment period as well as new toxicological information obtained since the rule proposal. Ecological impacts and other site-specific factors including background conditions may result in site-specific cleanup criteria that differ from the criteria listed in the table. Note that in the table there are three soil cleanup criteria: residential direct contact, nonresidential direct contact, and impact to groundwater. Ft. Dix is classified as non-residential with a standard industrial classification of 9711. Therefore, the second and third criteria will be considered in the evaluation of soil chemical data. These cleanup standards will be used as screening criteria only, to be followed by a thorough risk assessment. If the risk assessment results in a cleanup standard which is greater than residential direct contact value, the NJDEP will require a Declaration of Environmental Restriction be placed on the subject site.

In addition, for inorganics, "natural background" concentrations will be established for soil based on analytical results obtained from "background" soil samples collected as part of the USAEC EI/AA and Background Sampling Program to be performed at Ft. Dix. The range of values observed for inorganic constituents in these samples and from published regional background data will be considered the natural range of concentrations expected for that constituent in soil. Analytical results greater than the average of the range for that constituent would be considered "above background." These data will also be used in completion of Ecological Risk Assessments for the 13 Sites, as appropriate.

21.3 POTENTIAL LOCATION-SPECIFIC AND ACTION-SPECIFIC ARARS

This subsection provides an overview of location- and action-specific ARARs that may have to be complied within the process of performing remedial activities. This list will be modified throughout the RI/FS process as new information becomes available regarding chemical data, site conditions, and potential remedial actions for the 13 Sites.

Location-specific ARARs that may limit the types of remedial actions that can be performed at a site include:

- CWA Section 404
- SDWA Section 1424(e), which confers a groundwater protective designation as the site is located within the boundaries of the New Jersey Coastal Plain Sole Source Aquifer
- New Jersey Wetlands Protection Act and Regulations
- Federal and State of New Jersey regulations concerning active fault areas and floodplains (Executive Order 11988, Floodplain Management); wilderness areas, wildlife refuges, and scenic rivers; historic sites and archaeological findings (National Historic Preservation Act 1966, as amended 16 USC 461 et seq.); and rare, threatened, or endangered species consistent with Section 7 of the Endangered Species Act of 1973 (amended 16 USC 1531)
- Protection of Wetlands Executive Order No. 11990; (40 CFR Part 6)

Action-specific ARARs are the standards or regulations associated with the remedial action selected. Examples of action-specific ARARs include surface water discharge and air emission limitations, permit requirements, and RCRA requirements on land disposal and off-site hazardous waste storage and treatment. Technology-specific ARARs will be identified as the appropriate remedial technologies for the site are identified and screened during the FS and are refined further during the Record of Decision and Proposed Plan of this investigation.

22.0 HEALTH AND SAFETY

All employees assigned to this project will receive sufficient training to recognize and evaluate hazards likely to be encountered during field activities. In addition, all site personnel who will be working at Ft. Dix will be medically monitored and receive basic health and safety training as specified under 29 CFR 1910.120 and in the Contractor Health and Safety Program Manual.

The Contractor has prepared a site-specific Health and Safety Plan, which has been approved by USAEC and the Contractor's Health and Safety Manager, to address foreseeable hazards associated with on-site investigations at Ft. Dix. This plan will be enforced by the Health and Safety Supervisor and Site Health and Safety Officer, and it includes:

a. General overview of the Contractor's Health and Safety Program;

b. Site-specific information, including proposed scope of work, site history, and site health and safety risks;

c. Identification of hazardous materials likely to be encountered at the site, their hazard potential, threshold, and other exposure limits;

d. Personal protective equipment requirements;

e. Monitoring equipment requirements;

f. Decontamination requirements and procedures; and

g. Emergency/contingency procedures in the event of a fire, medical emergency, or other mishap/accident.

All employee and Subcontractor injuries during field efforts will be reported as per Sequence No. A012, Accident/Incident Report, Data Item No. DI-A-12963. In addition, an Accident Report Form will be completed for any incident involving site personnel or Subcontractor employees.

The Contractor is not directly responsible for Subcontractor health and safety at the site. However, all Subcontractor personnel and operations will be required to abide by the requirements contained in the HASP, and the Contractor will monitor all on-site operations to ensure compliance with this plan. All Subcontractors will certify that their field personnel are medically monitored and trained in accordance with 29 CFR 1910.120. A copy of the HASP will be provided to all Subcontractors.

23.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY REPORTING

The environmental investigation process summarized in this Technical Plan is designed to gather information at the 13 Sites at Ft. Dix to establish the nature and extent of contamination, establish a Baseline Ecological Risk Assessment, and develop a Human Health Evaluation to determine potential risk to human and ecological receptors and the need for remedial action. Following the environmental investigation, an FS will be performed that will develop, screen, and evaluate remedial alternatives, and recommend a preferred alternative. The assessment of this information and the methods that will be employed for reporting them are described below.

23.1 REMEDIAL INVESTIGATION REPORT

This work element consists of the technical effort to prepare Draft, Draft Final, and Final versions of the RI Report for the 13 Sites at Ft. Dix. The Draft Report and the Draft Final Report will be subject to review by the U.S. Army and regulatory agencies. No review or comment period is currently anticipated for the Final RI Report. Report development consists of the drafting of text, compilation of data, tables, and figures from the data evaluation activities (i.e., modeling, geologic and hydrogeologic assessments, chemical analysis, Human Health Risk Assessment, and Ecological Risk Assessment). Also included is a description of the field and laboratory program, rationale/procedures, and assessment of data quality. Data from all investigations at the 13 Sites will be summarized as part of the RI Report.

The analytical data for all media must be submitted in a summary table as follows: Name of Contaminant, Location/Depth of Sampling, Date of Sampling, Date of Analysis, Analytical Method, Method Detection Limit/Practical Quantitation Limit, Result, Applicable Standard/Criteria (most stringent of all regulatory requirements), and Exceeds Standards/Criteria. For ease of comparison the soil and sediment analytical data should be reported with mg/kg until and the groundwater and surface water data should be reported with μg/L unit.

23.1.1 RI Report Organization

As indicated in the Task Order Request, the Draft, Draft Final, and Final RI Report will be developed and presented in accordance with the latest USEPA guidance, which was promulgated in interim final form in October 1988, as USEPA Office of Solid Waste and Energy Response (OSWER) Directive 9335.3-01. This guidance incorporates the requirements of the National Contingency Plan (NCP) as modified by SARA for the conduct of the overall RI/FS process. This guidance will be used for the 13 Sites at Ft. Dix.

At the conclusion of the RI, preliminary response objectives will be presented. These objectives will be based upon the contamination assessment, risk assessment, and ARARs. Summaries of these efforts are presented in this subsection. For the 13 Sites at Ft. Dix, one of the following recommendations will be developed in the preliminary response objectives.

1. No further action is required (including remedial action). The data for the site(s) is considered sufficient to rule out significant human health or ecological hazards.

2. Contamination exists but no apparent migration/exposure is occurring. Continue monitoring to ensure that future risks or violation of ARARs does not occur.

3. Remedial action is required due to contaminant(s) releases such that present or future public health risk or environmental impacts exist or would be predicted. Proceed with an FS including filling any data gaps as necessary (e.g., treatability, waste characterization) to select appropriate remedial technology response.

4. An immediate hazard exists due to releases from a site. Prepare an Action Memorandum, proceed directly to remedial design to contain/mitigate or remove the hazard.

23.1.2 Contamination Assessment

The purpose of the contamination assessment is to provide a characterization of the distribution of contamination, and the migration and fate of contaminants in the soil, sediment, and groundwater at the 13 Sites at Ft. Dix. The contamination assessment provides the interpretive link between the tabulated, validated chemical data, field observations, and the interpreted hydrogeological and physical environment. This information can be used to establish human health risks and environmental impacts. The major outputs of the contamination assessment are the spatial distribution of chemical contaminants in each of the environmental media and the identification and characterization of contaminant sources (qualitative and, to the extent possible, quantitative). To this end, two dimensional geologic cross-sections will be prepared for each site. These data will be used and reported in an assessment of contaminant migration potential.

According to USEPA's RAGs for Superfund (December 1989), sample data can be compared to background data to identify non-site-related chemicals and analytes found near the site. Wherever possible, background data collected at Ft. Dix or in New Jersey will be used. These data may be used in conjunction with literature and historical data and data collected by the ongoing EI/AA at Ft. Dix.

Appropriate statistical techniques will be used to establish whether significant site-related chemicals and analytes are present above background concentrations, especially such naturally occurring chemicals as nitrates/nitrites, sulfates, and metals. The particular statistical tests and methods will be chosen based upon the observed distributions of chemicals and concentrations. If the data are consistent with the assumptions requisite of the Gaussian (Normal) probability theory, standard techniques (e.g. ANOVA, t-Tests) will be used. Otherwise, non-parametric techniques may be required.

The historical chemical database that will be available for the contamination assessment includes the data contained in the previous investigations at the 13 Sites at Ft. Dix. These data will be reviewed, summarized, and utilized to identify the source(s) and to describe the distribution of contamination. Included as an appendix to the RI will be previous boring logs and well construction diagrams from the PA/SI and the Phase I and Phase II RIs.

The contamination assessment element will continue after the chemical analyses of soil, sediment, surface water, and groundwater samples. Groundwater samples for chemical analysis will be collected from existing monitoring wells and new monitoring wells. If additional samples are collected, the analyses will be included with the contamination assessment. The results of groundwater samples to be collected in the RI/FS will provide data for continued assessment of groundwater and possible source areas. Soil, surface water, and sediment analyses at the 13 Sites at Ft. Dix will provide data on current conditions contributing to groundwater contamination.

In the contamination assessment, chemical data will be utilized from the database and anomalies identified, evaluated, and described. Data outputs from this work element will include one or more of the following:

- Depth profile and areal concentration gradient figures and/or tables
- Maps of contaminant concentrations and mass
- Chemical profiles describing the characteristics of contaminants of concern

Accompanying these data will be narrative descriptions of the spatial/temporal distribution of chemicals at each site as well as qualification and interpretation of the data and anomalies.

23.1.3 Risk Assessment

The risk assessment will include Baseline Human Health and Ecological Risk Assessments. These assessments will establish the potential risks to human and ecological receptors. The following tasks will be performed in these assessments.

The Human Health and Ecological Risk Assessments will be conducted in accordance with USEPA guidance for conducting risk assessments at Superfund Sites (RAGs Volume I [Human Health Evaluation Manual] and Volume II [Environmental Evaluation Manual] and the Superfund Exposure Assessment Manual). These assessments will also be consistent with NJDEP guidance for risk evaluation.

23.1.3.1 Human Health Risk Assessment. The Human Health Risk Assessment will begin with an identification of COPCs based on validated analytical results, site history, background conditions, and frequency of detection. The toxicity of the COPCs will be assessed. This will be followed by a human exposure assessment. The exposure assessment will include characterization of the receptor, identification of the exposure pathway, and quantification of the exposure. Finally, the human health risk characterization will be developed.

23.1.3.2 Ecological Risk Assessment. The purpose of the Ecological Risk Assessment at the 13 Sites is to provide a baseline evaluation of actual and potential risks to ecological receptors posed by chemicals in environmental media. The

Ecological Risk Assessment will consist of the following elements: Hazard Assessment; Ecological Characterization; Ecological Exposure Assessment; Ecological Effects Assessment; Ecological Risk Characterization; and an Uncertainty Analysis.

23.1.4 ARARs

ARARs are federal and state public health and environmental requirements and guidelines that apply to hazardous waste site cleanup. Section 121 of CERCLA, amended by SARA and the NCP, require that CERCLA-mandated hazardous waste site remedial actions such as those in the RI program comply with federal ARARs. SARA also requires attainment of state ARARs if they are more stringent than federal ARARs, legally enforceable, and consistently enforced statewide. According to CERCLA Section 121, the SARA requirements are applicable to remedial actions at federal facilities where hazardous substances are present in the same manner that they are applicable to remedial actions at non-federal facilities.

As described in the NCP, ARARs may be characterized as chemical-specific, location-specific, or action-specific. Chemical-specific ARARs govern the extent of site cleanup and provide either actual cleanup levels or a basis for calculating such levels. Location-specific ARARs specific locations such as wetlands, floodplains, and sensitive ecosystems. Action-specific ARARs are usually technology- or activity-based limitations that control actions at CERCLA sites.

During the RI for the 13 Sites at Ft. Dix, both potential chemical- and location-specific ARARs will be identified. Chemical-specific ARARs will consist primarily of groundwater and surface water criteria and standards such as MCLs, AWQC, and New Jersey State Standards. These ARARs, in conjunction with the risk assessment, will be used to evaluate the extent of site cleanup.

Location-specific ARARs that may apply to the 13 Sites at Ft. Dix would include state and federal wetlands requirements and endangered species lists. These ARARs will provide a basis for assessing both existing site conditions and potential remedies.

Action-specific ARARs are generally identified in the FS during evaluation of the remedial alternatives.

23.1.5 Identification of Preliminary Remedial Action Objectives

At the conclusion of the RI, preliminary remedial action objectives will be identified. These preliminary objectives, which broadly characterize the likely extent of site cleanup, are based on the risk assessment and ARARs analyses. They provide the basis for determining the problems requiring remediation and limit the number of alternatives for consideration during the FS, when they will be developed into more detailed, target clean-up levels.

23.2 FEASIBILITY STUDY REPORT

The FS consists of three major components: development and screening of remedial alternatives, detailed evaluation of alternatives, and the FS Report.

Development and Screening of Remedial Alternatives. The FS Report will present potential federal and state public health and environmental requirements and guidelines (ARARs) used to: (1) evaluate the appropriate extent of site cleanup, (2) scope and formulate remedial action alternatives, and (3) govern the implementation and operation of the proposed action. Potential location-, chemical-, and action-specific ARARs will be listed and described in the report.

Remedial action objectives for the 13 Sites at Ft. Dix and the general response actions that may be undertaken to achieve these objectives will then be presented. Remedial action objectives are media-specific goals established to protect human health and the environment. Contaminant information from the RI Report, combined with risk assessment results and chemical-specific ARARs, will be used to develop media-specific Preliminary Remediation Goals (PRG) for each contaminant of concern.

Development and screening of remedial alternatives commences with the identification of remediation technologies capable of meeting the remedial action objectives developed as part of this work element. Identified technologies include containment, treatment, and disposal technologies capable of achieving the source control and groundwater remediation objectives. Technologies identified will include those potentially applicable to treat the historically identified site contaminants at the 13 Sites at Ft. Dix. The FS Report will contain a description of each applicable technology, technology process options, and potential site applicability. The technologies will be evaluated and screened based on waste characteristics and site conditions applicability criteria and ability to meet the PRGs. A list of screened technologies will be prepared.

Development and screening of alternatives will continue with the identification of alternatives formulated from the screened technologies. The FS will then identify and evaluate, from a technical and economic basis, the following alternatives for those sites where contamination has been identified:

- no action/minimal action conditions that will be used to compare with the containment, treatment, and disposal alternatives
- containment alternatives that will reduce the migration of surface and subsurface soil contamination to groundwater and surface water
- treatment alternatives for contaminated soil (surface and subsurface) utilizing in situ, on-site, and off-site treatment options
- disposal options for treated soil will be identified
- treatment alternatives for groundwater with and without barriers to prevent contaminated groundwater from leaving the Ft. Dix installation
- combinations of alternatives for source removal/containment/ treatment and groundwater treatment will be developed
- surface water and sediment remediation alternatives for contaminants identified in the unnamed tributary south of the 13 Sites at Ft. Dix

During the alternatives screening process, the FS will further refine the identified alternatives. The alternatives will be evaluated to determine their effectiveness (e.g., ability to meet regulatory requirements and response objectives), implementability (e.g., technical feasibility, for site-specific conditions, and equipment and service availability), and cost (e.g., capital and operation/maintenance). Based on this evaluation, a list of screened alternatives to be retained for detailed analysis will be prepared.

Detailed Evaluation of Alternatives. The remedial alternatives remaining after screening will be individually analyzed using USEPA guidance (October 1988a) against the following evaluation criteria:

- overall protection of human health and the environment
- compliance with ARARs
- long-term effectiveness and permanence
- reduction of toxicity, mobility, or volume
- short-term effectiveness
- implementability
- cost
- state acceptance
- community acceptance

Based on the detailed evaluation, the relative performance of the alternatives will be compared. Upon completion of the comparative evaluation of alternatives, a preferred alternative will be recommended for each site for the media of concern (i.e., soil, sediment, surface water, and groundwater).

FS Report. The FS report will be prepared in accordance with the USEPA RI/FS guidance (October 1988a). The FS report will contain a recommendation for a preferred alternative for each media evaluated. This assessment evaluates each alternative including the preferred alternatives according to impact/benefits of effects on land and soil quality, water quality, air quality, threatened and endangered species, cultural resources, land use, and so forth. The Draft FS Report will be submitted to USAEC for comments. The revised Draft Final FS Report will be prepared based on comments from USAEC and will be submitted to USEPA and NJDEP for review. A Final FS Report will be prepared based upon comments received. A summary of response to comments will be submitted to USAEC with the Draft Final and Final FS Reports.

23.3 PROPOSED PLAN AND RECORD OF DECISION

A Proposed Plan (PP) and Record of Decision (ROD) addressing the various media evaluated in the FS Report will be prepared for the 13 Sites at Ft. Dix.

The PP will summarize the remedial actions considered at the 13 Sites at Ft. Dix, and presents USAEC's preliminary recommendations for remedial action, based on the findings in the FS Report. The PP will: (1) identify the preferred alternative(s) and describes the rationale for selection, (2) educate the public about how they can participate in the remedy selection process, and (3) solicit public review and comment on the alternatives being considered.

The ROD will present the selected remedial action for the site, summarizing: (1) risks posed by the site, (2) the remedial alternatives evaluated in the FS, and (3) a comparative analysis of the alternatives against the evaluation criteria. The ROD also presents the selected remedy and provides the rationale for how the remedy satisfies the requirements of CERCLA and the NCP or waives those requirements.

The PP and ROD will be prepared in accordance with guidance in:

1. Interim Final Guidance on Preparing Superfund Decision Documents: The Proposed Plan and Record of Decision (OSWER Directive 9355.3-02);

2. the NCP (40 CFR 300.430, March, 1990); and

3. state and/or regional guidance.

Additional guidance and direction for preparing the PP and ROD documents will be obtained during information exchanges with USAEC and regulatory agencies. Draft, Draft Final, and Final versions of both the PP and ROD documents will be submitted to USAEC.

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GLOSSARY OF ACRONYMS AND ABBREVIATIONS

AA	atomic absorption
ABB-ES	ABB Environmental Services, Inc.
ADD	average daily dose
ARAR	Applicable or Relevant and Appropriate Requirement
ARDC	Armament Research Development Center
ASTM	American Standards and Test Methods
AWQC	Ambient Water Quality Criteria
BBS	Bulletin Board System
bgs	below ground surface
BOD5	five-day biochemical oxygen demand
BOMARC	Boeing Michigan Army Research Center
BTEX	benzene, toluene, ethylbenzene, and xylene
CAD	computer aided design
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CO2	carbon dioxide
COC	chain of custody
COD	chemical oxygen demand
COPC	chemicals of potential concern
COR	Contracting Officer's Representative
CRL	Certified Reporting Limit
CRREL	Cold Regions Research and Engineering Laboratory
CSF	cancer slope factor
CVAA	cold vapor atomic absorption
CWA	Clean Water Act
°F	degrees Fahrenheit
°C	degrees centigrade
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DOD	Department of Defense
DOT	Department of Transportation
DQO	Data Quality Objective
EA	Environmental Assessment
ECAO	Environmental Criteria and Assessment Office

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

EI/AA	Environmental Investigation/Alternatives Analysis
ER-L	effects range-low
ER-M	effects range-mid
ESE	Environmental Science and Engineering, Inc.
ETRA	Environmental Toxicology and Risk Assessment
FORSCOM	Forces Command
FS	feasibility study
Ft. Dix	Fort Dix U.S. Army Installation
ft/mi	feet per mile
FTTA	Fire Training Tank Area
GC	gas chromatography
GC/ECD	gas chromatography/electron capture detector
GC/MS	gas chromatography/mass spectroscopy
GFAA	graphite furnace atomic absorption spectroscopy
GGS	Geotechnical Groundwater Stabilized
GMA	Geotechnical Map File
gpm	gallons per minute
GPR	ground penetrating radar
HASP	Health and Safety Plan
HEAST	Health Effects Assessment Summary Table
HI	Hazard Index
HN03	nitric acid
HQ	Hazard Quotient
HSA	hollow-stem auger
ICAP	inductively coupled argon emission plasma spectroscopy
ICUZ	Installation Compatible Use Zones
ID	inside diameter
IKW	Iffland, Kavanaugh, Waterbury
IR	Infrared Spectroscopy
IRDMIS	Installation Restoration Data Management System
IRIS	Integrated Risk Information System
LADD	lifetime average daily dose
LNAPL	light nonaqueous phase liquids
LOE	level of effort

LOEL	Lowest Observable Effect Level
MCL	Maximum Contaminant Level
MCLG	maximum contaminant level goals
mg/kg	milligrams per kilogram (equivalent to parts per million)
mm	millimeter
MODFLOW	Modular Three-Dimensional Finite Difference Groundwater Flow Model
mph	miles per hour
MRD	Missouri River Division
MSL	mean sea level
MW	monitoring well
NCP	National Contingency Plan
NEA	New Egypt Armory Site
NGVD	National Geodetic Vertical Datum
NJAL	New Jersey Action Level
NJDEP	New Jersey Department of Environmental Protection
NOAA	National Oceanographic and Atmospheric Administration
NYSDEC	New York State Department of Environmental Conservation
OD	outside diameter
o,p'-DDD	2-(o-chlorophenyl)-2-(p-chlorophenyl)1,1,1-trichloroethane
OSWER	Office of Solid Waste and Energy Response
PA/SI	Preliminary Assessment/Site Investigation
PAH	polynuclear aromatic hydrocarbon
PAL	Project Analyte List
PCB	polychlorinated biphenyl
PDC	Program Data Coordinator
PID	photoionization detector
PL	Pinelands Commission
PP	Proposed Plan
ppb	parts per billion
POL	Petroleum, Oil, Lubricant Area
PQL	practical quantitation limit
PRG	Preliminary Remediation Goal
PRI	Potomac Research Institute
PVC	polyvinyl chloride

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

QA	quality assurance
QA/QC	quality assurance/quality control
QAC	Quality Assurance Coordinator
QAPP	Quality Assurance Project Plan
QSAR	Quantitative Structure Activity Relationship
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RfC	reference concentration
RfD	reference dose
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RME	reasonable maximum exposure
ROD	Record of Decision
RTV	Reference Toxicity Value
SARA	Superfund Amendments and Reauthorization Act
SC	soil boring
SCAPS	Site Characterization and Analysis Penetrometer System
SDWA	Safe Drinking Water Act
SE	sediment
SOL	Site Operations Leader
SQC	Sediment Quality Criteria
SVOC	semivolatile organic compound
SW	surface water
SWQS	Surface Water Quality Standards
TAL	target analyte list
TBC	to be considered
TC	Terrain Conductivity
TCL	target compound list
TDS	total dissolved solids
TMP	Transportation Motor Pool
TOC	total organic carbon
TP	test pit
TPH	total petroleum hydrocarbon
TRADOC	U.S. Army Training and Doctrine Command
TSCA	Toxic Substances Control Act
TSS	total suspended solids

UCL	upper confidence limit
$\mu g/L$	micrograms per liter
UR	unit risk
USACOE-WES	United States Army Corps of Engineers - Waterways Experiment Station
USAEC	United States Army Environmental Center
USAEHA	U.S. Army Environmental Hygiene Agency
USATHAMA	United States Army Toxic and Hazardous Materials Agency
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geologic Survey
UST	underground storage tank
UTM	Universal Transverse Mercator
UV	Ultraviolet
UXO	unexploded ordnance
VOC	volatile organic compound
111TCE	1,1,1-trichloroethane
2,4-D	2,4-dichlorophenoxyacetic acid
2,4-DNT	dinitrotoluene

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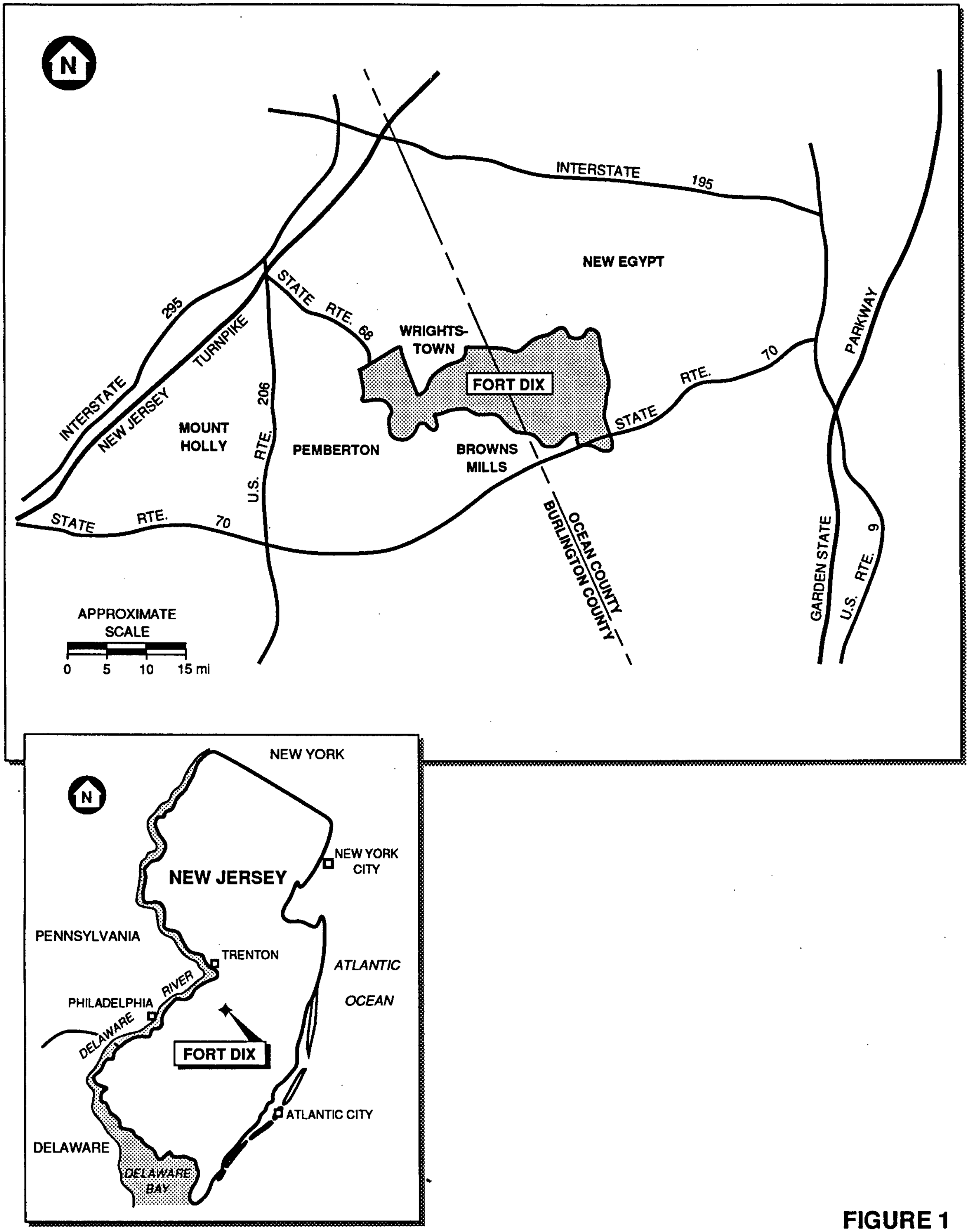
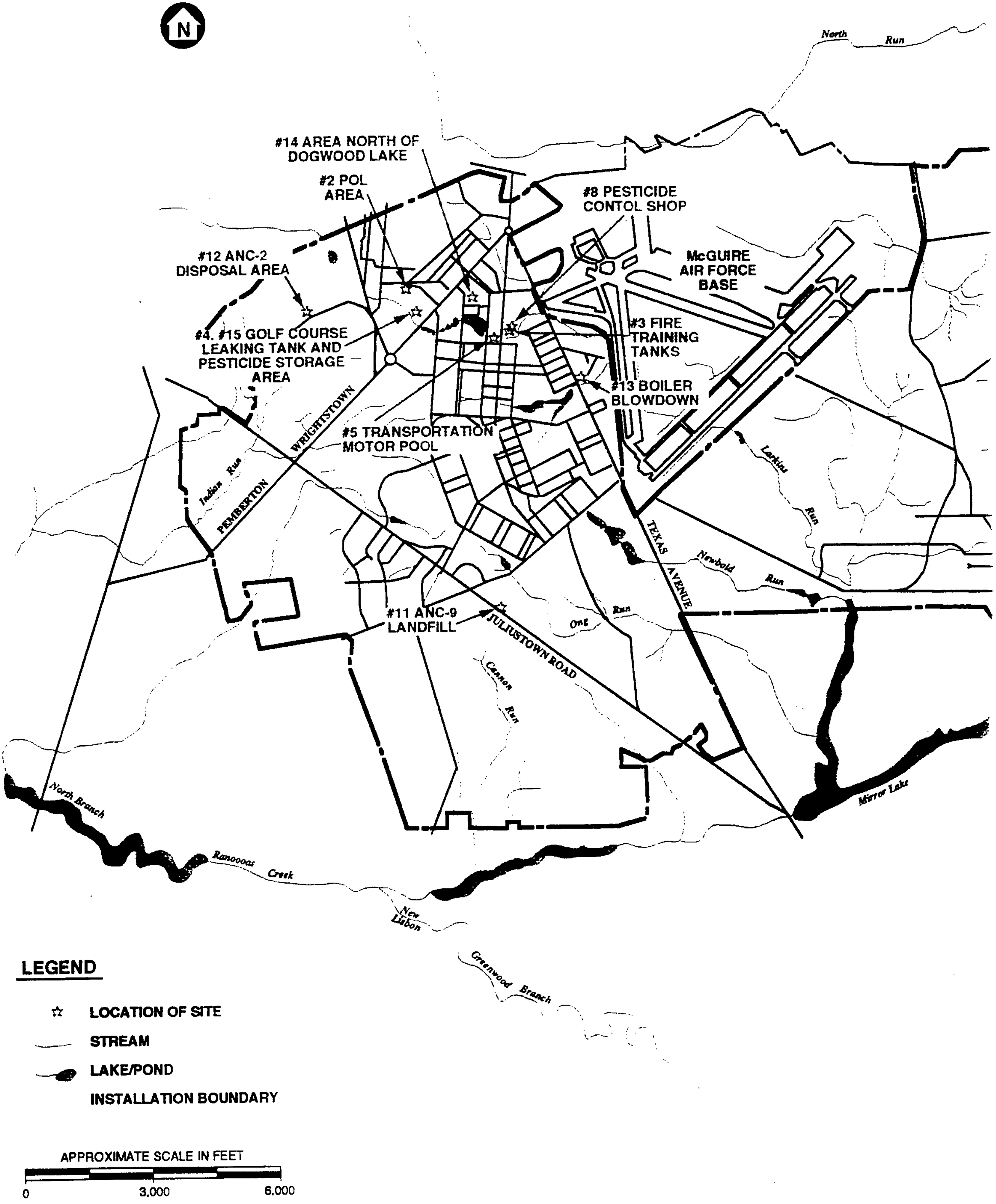
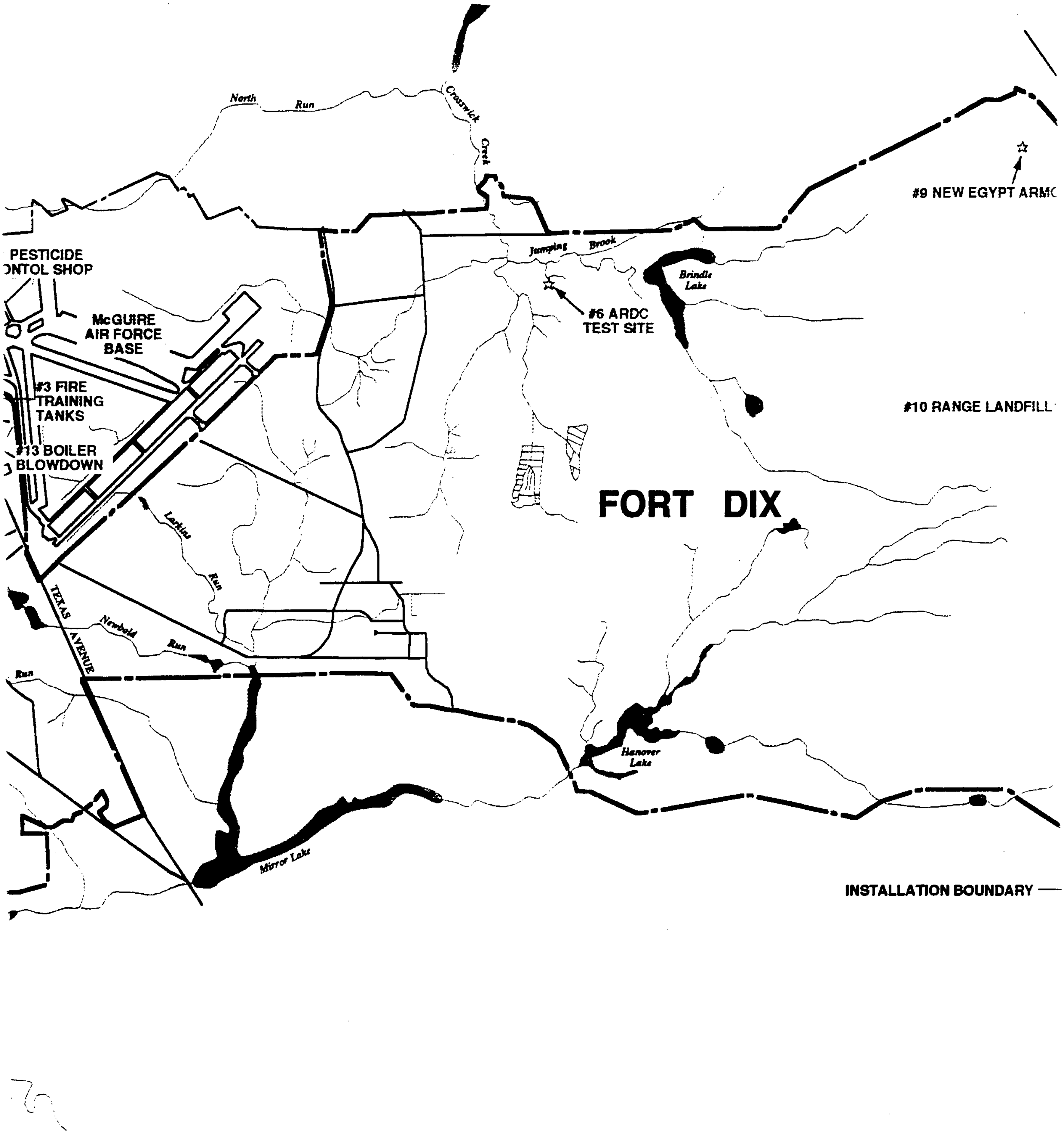


SOURCE: DAMES AND MOORE, 1993.

FIGURE 1
FORT DIX LOCATION MAP
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES



SOURCE: ICF, 1994.



LOCATION OF 13 SITES AND

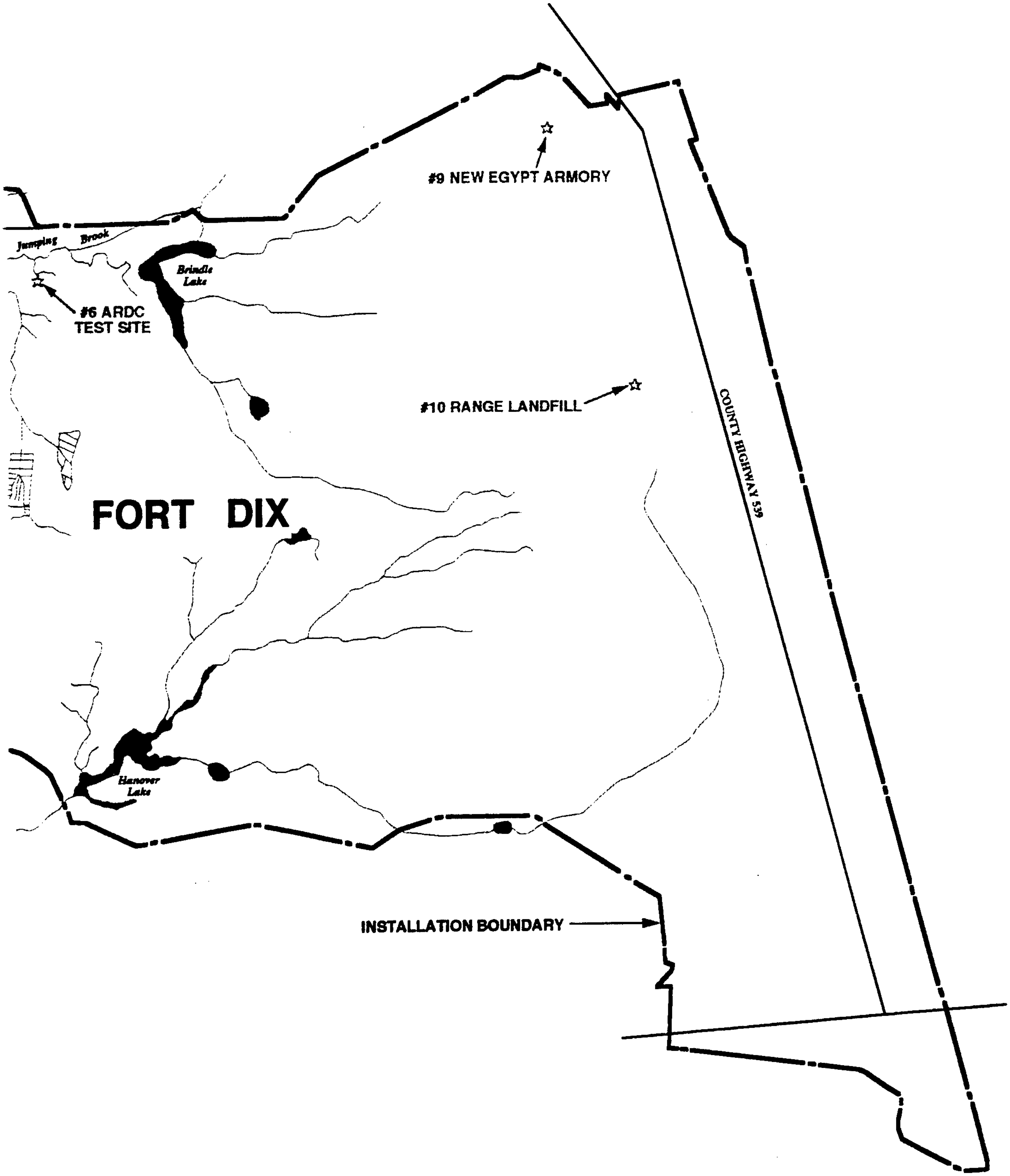
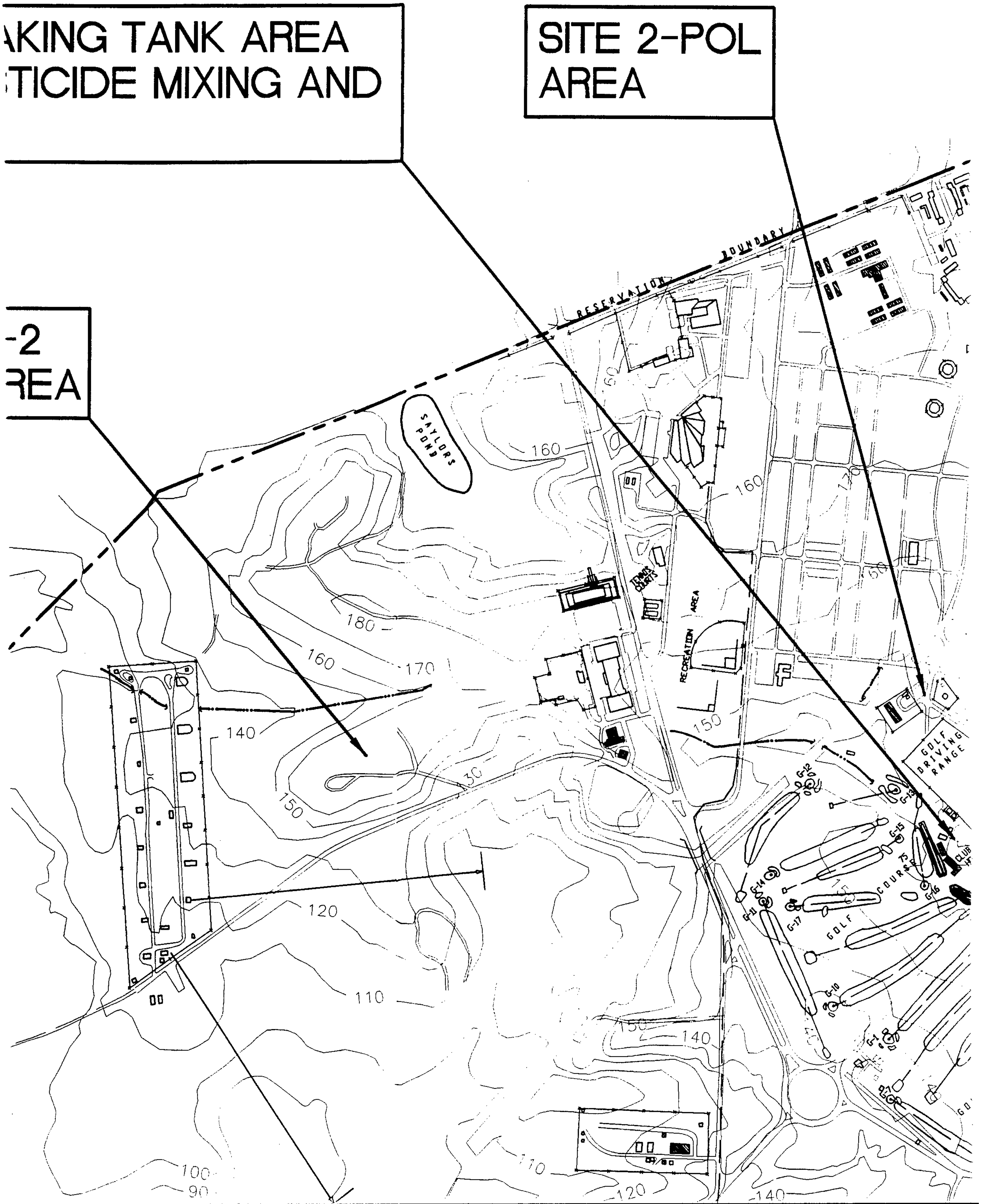


FIGURE 2
LOCATION OF 13 SITES AND WATER RESOURCE FEATURES
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

①

SITE 4 - GOLF COURSE LEAKING
SITE 15 - GOLF COURSE PESTICIDE
STORAGE AREA


SITE 12-ANC-2
DISPOSAL AREA

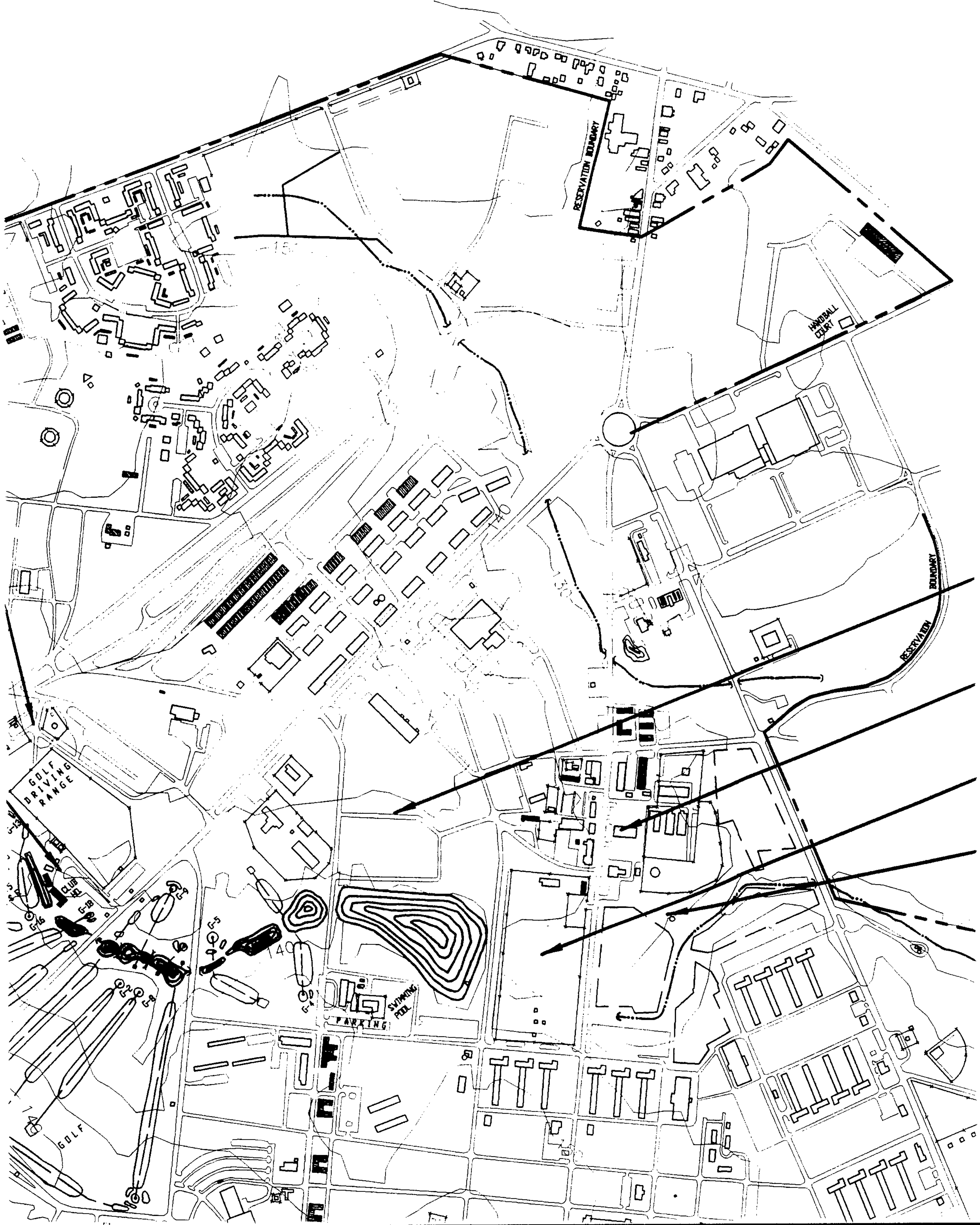


AKING TANK AREA
TICIDE MIXING AND

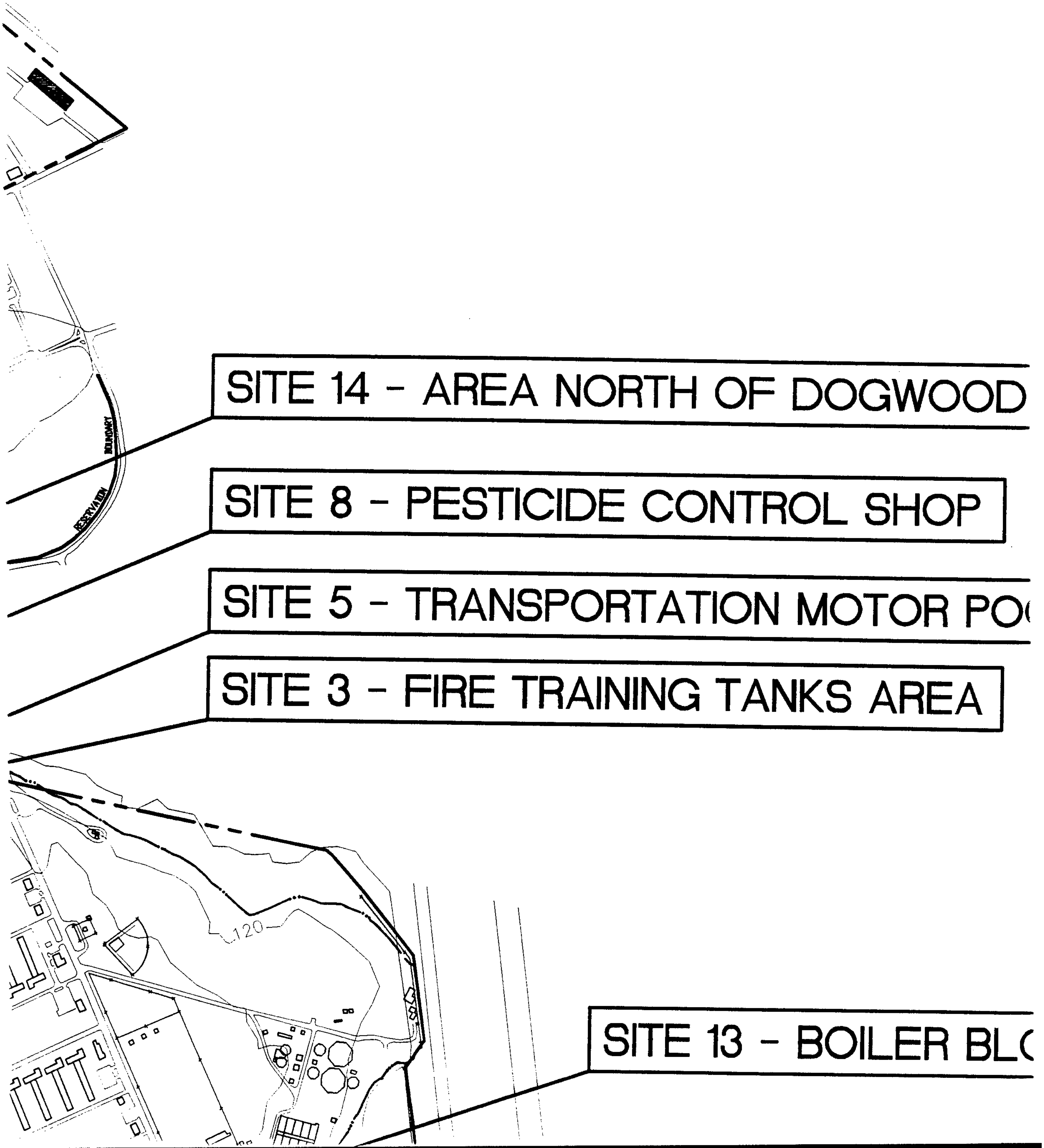
SITE 2-POL
AREA

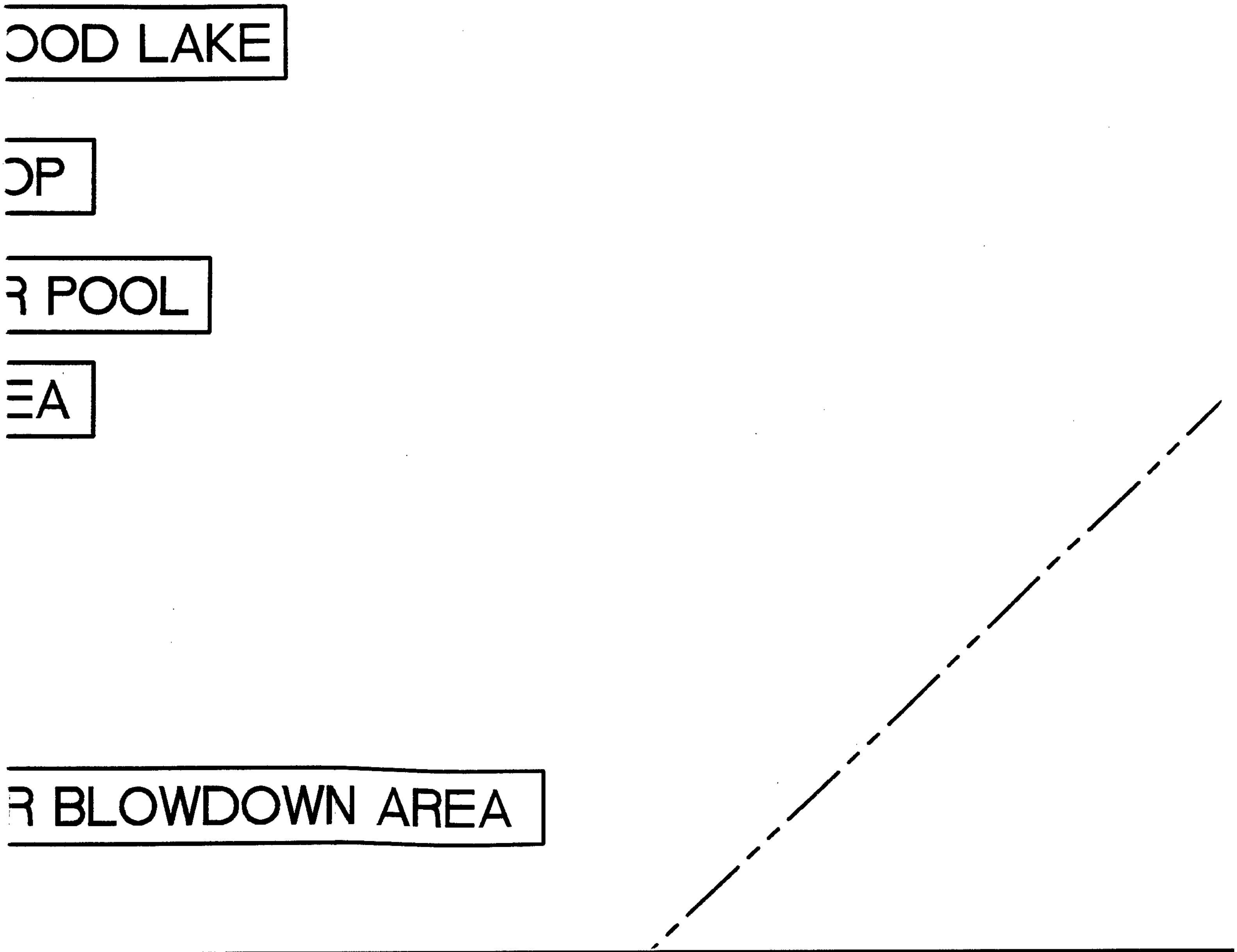
-2
REA

③

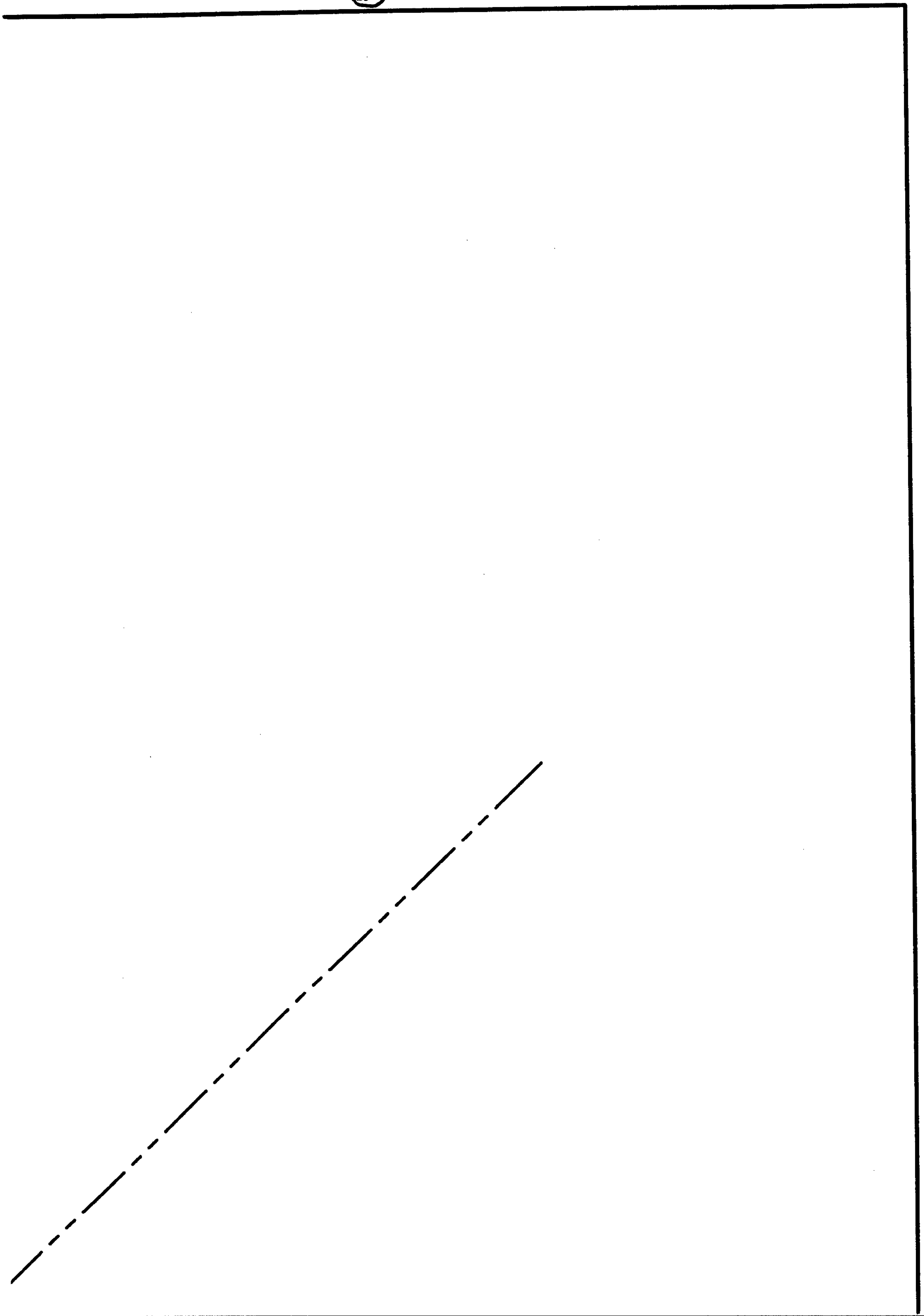

RESERVATION BOUNDARY
HANDBALL COURT
RESERVATION BOUNDARY
150
140
130
GOLF DRIVING RANGE
CLUB
G-13
G-18
G-16
G-9
G-5
G-2
G-8
G-1
140
SWIMMING POOL
PARKING
GOLF

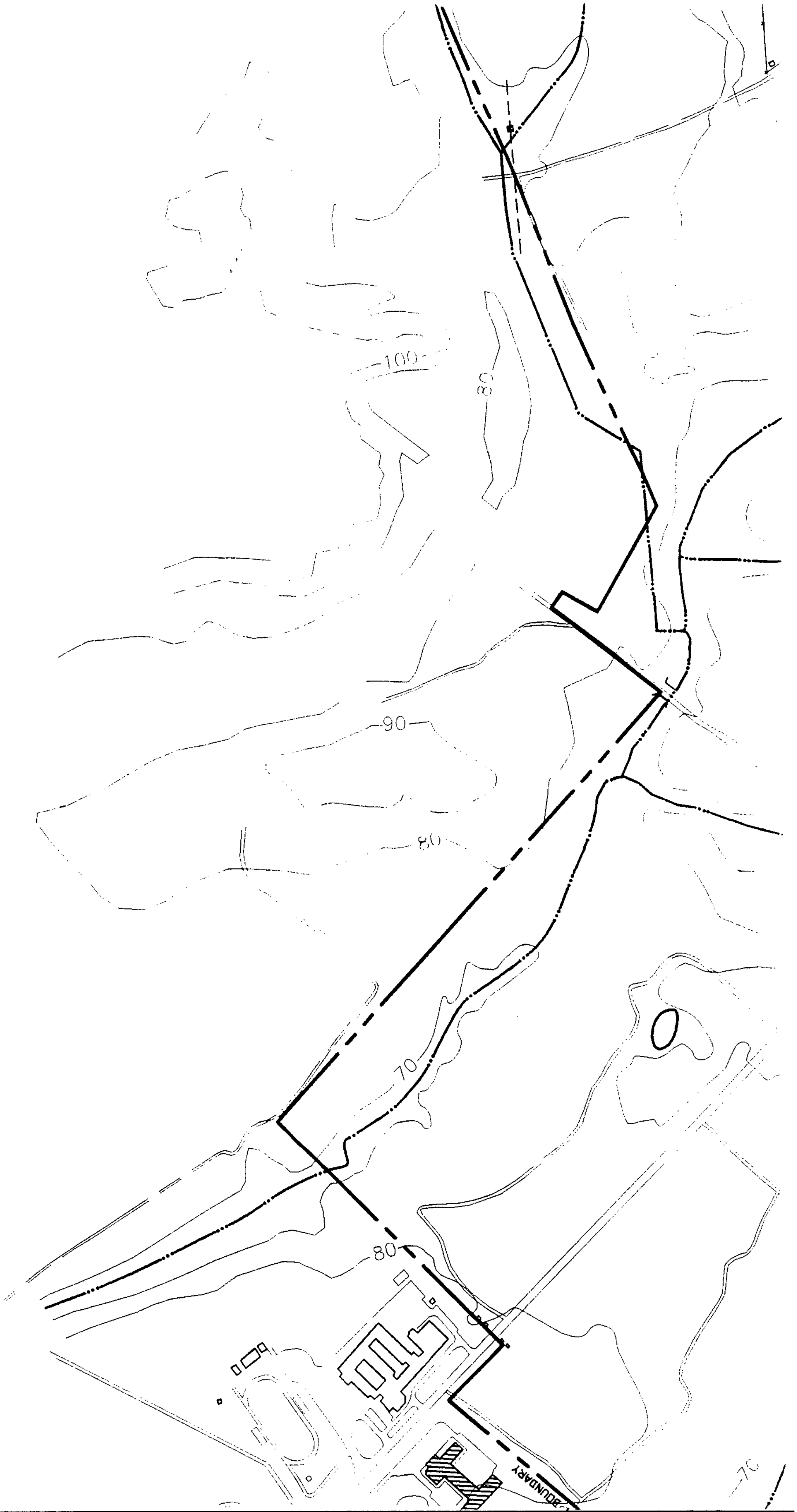
④


SITE 14 - AREA NORTH OF DOGWOOD
SITE 8 - PESTICIDE CONTROL SHOP
SITE 5 - TRANSPORTATION MOTOR PO
SITE 3 - FIRE TRAINING TANKS AREA
SITE 13 - BOILER BL
BOUNDARY
RESERVATION
120


OOD LAKE
OP
R POOL
EA
R BLOWDOWN AREA

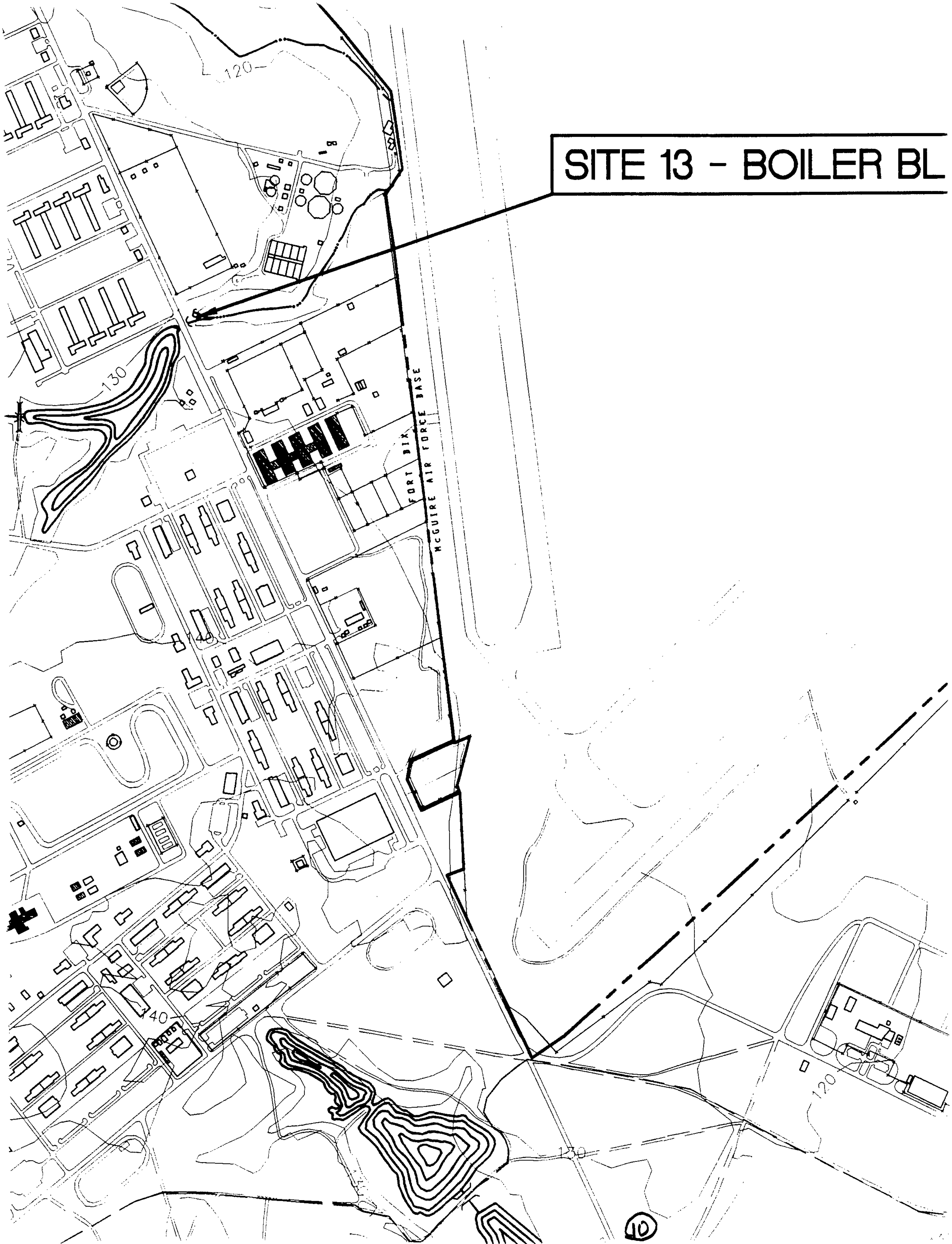
⑥




100
80
90
80
70
80
BOUNDARY
70

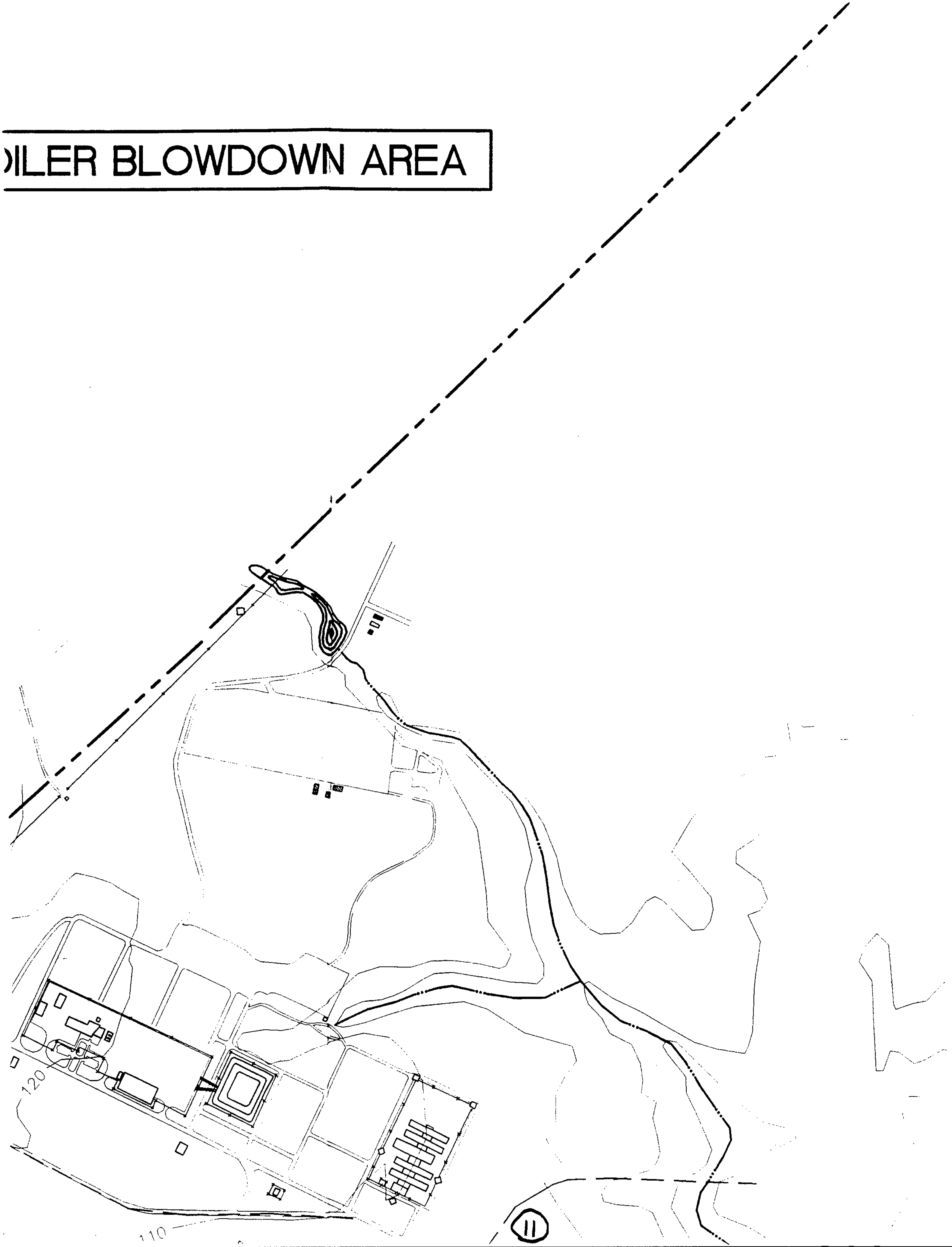
G-17
GOLF
G-10
G-1
GOLF
110
150
140
140
100
90
110
120
140
80
130
130
120
110
100
120
BASKETBALL COURT
100
110
90
130
140
150
160
80
70
8

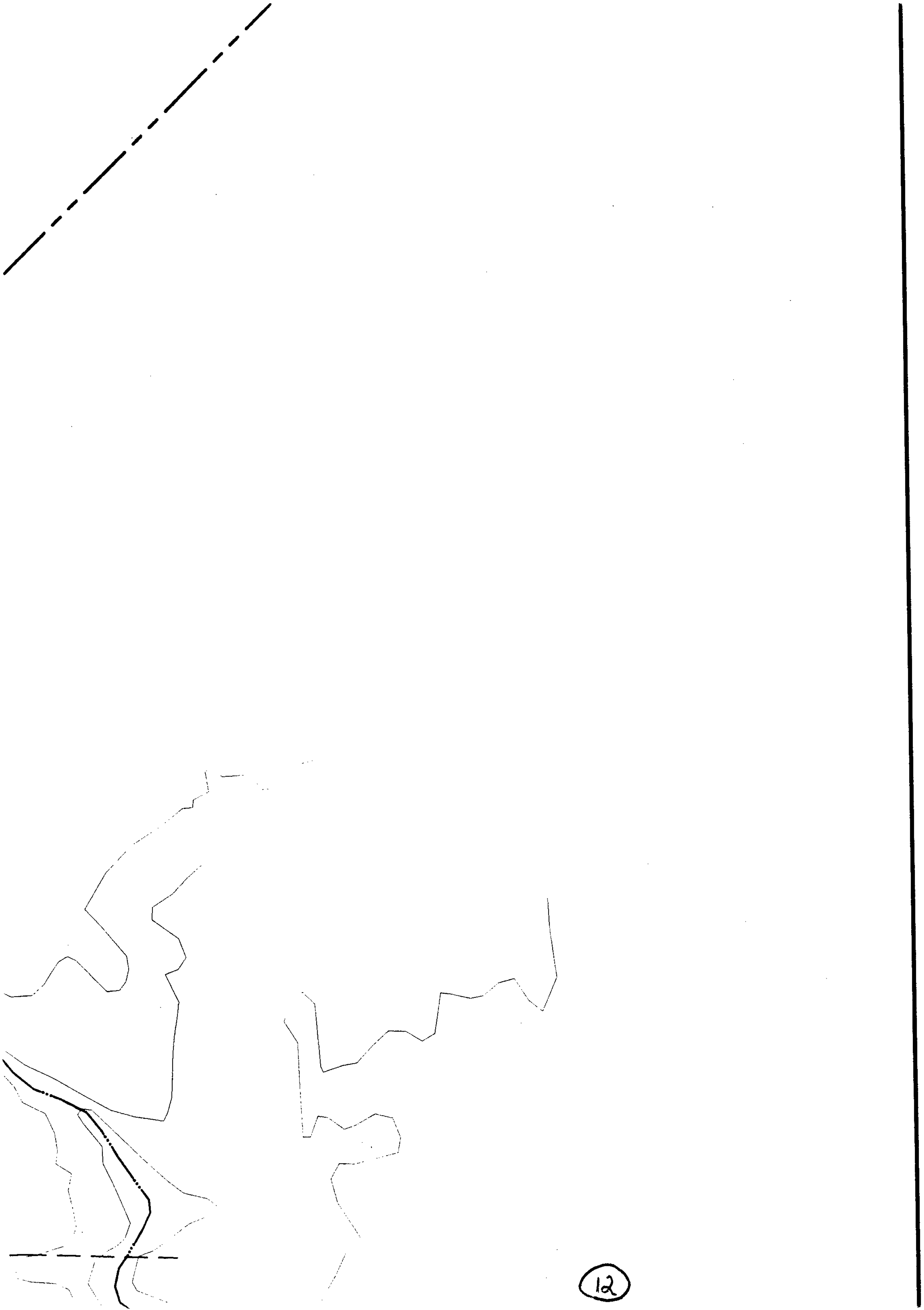
SWIMMING POOL
PARKING
GOLF
G-4
G-8
140
140
130
170
160
TENNIS COURTS
170
150
140
⑨

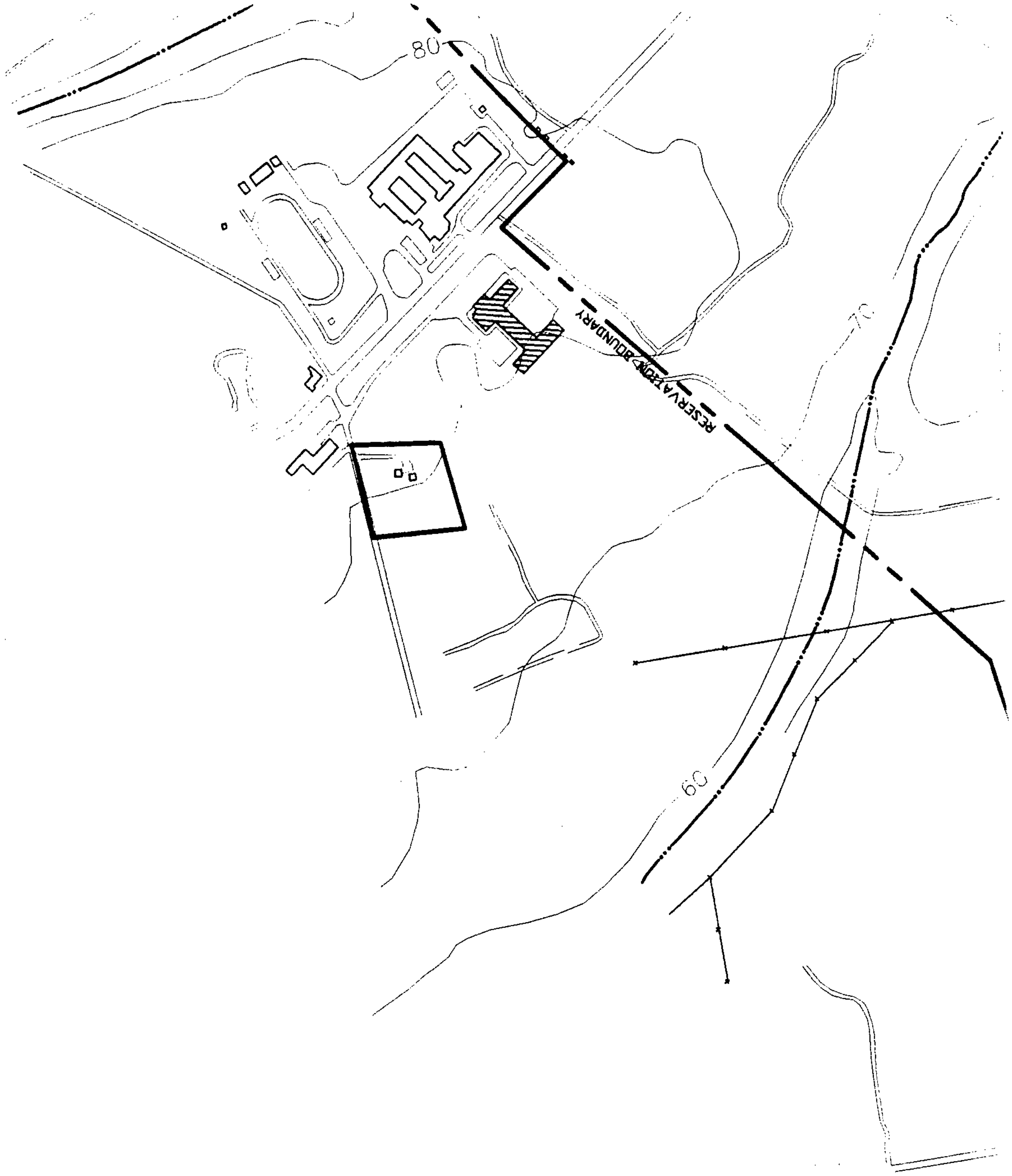

SITE 13 - BOILER BL
120
130
140
FORT DIX
McGUIRE AIR FORCE BASE
140
120
130

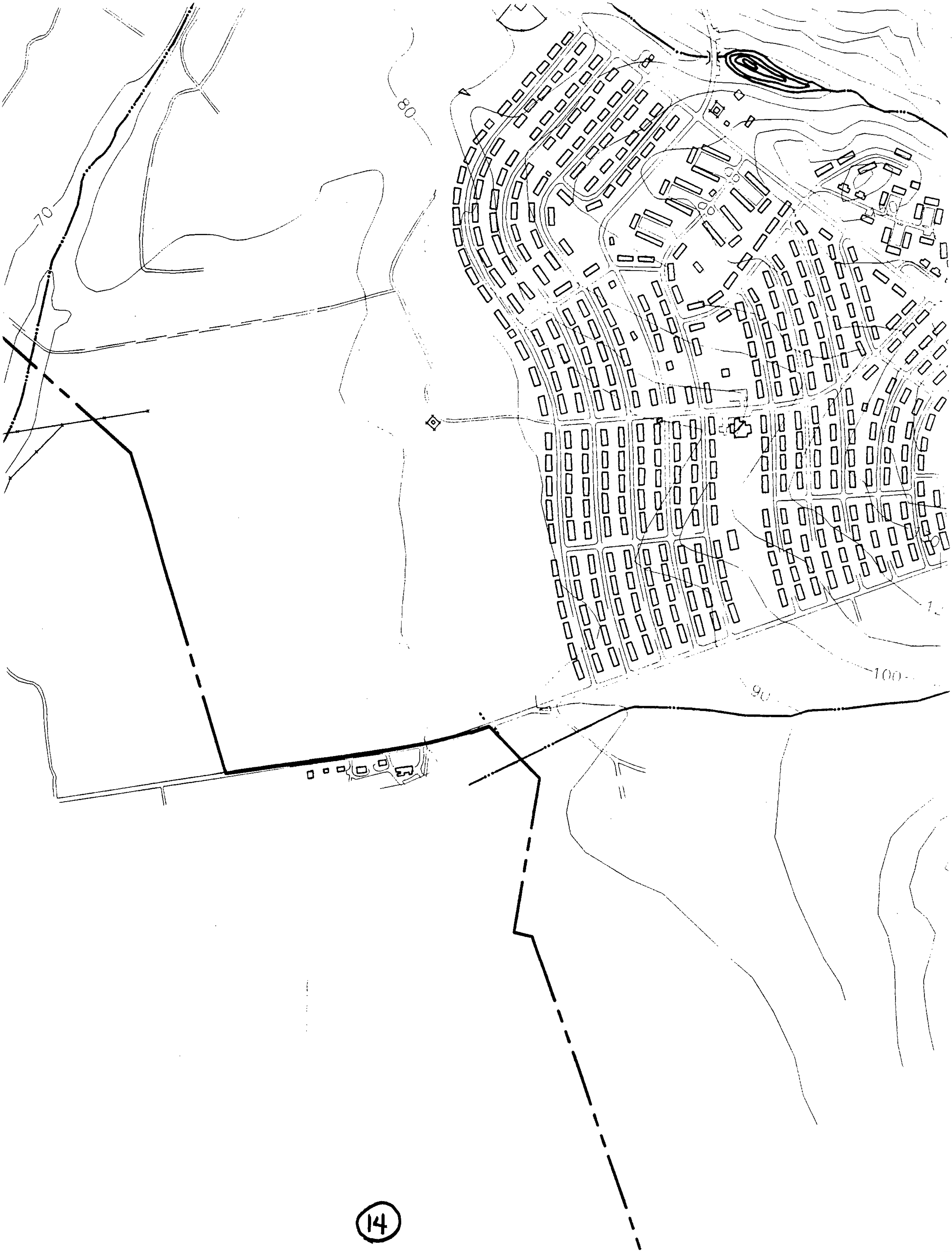
⑩

ILER BLOWDOWN AREA

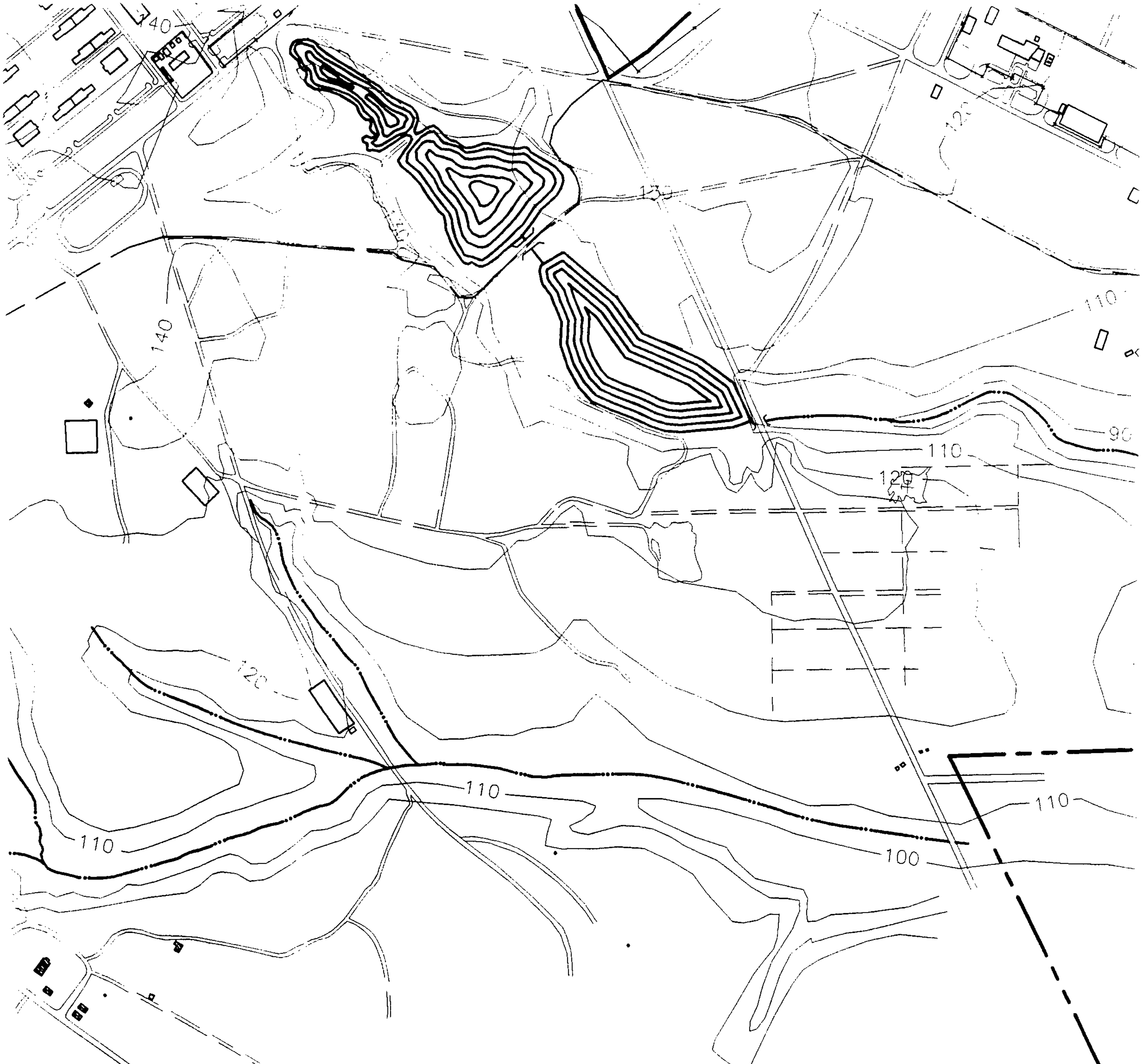


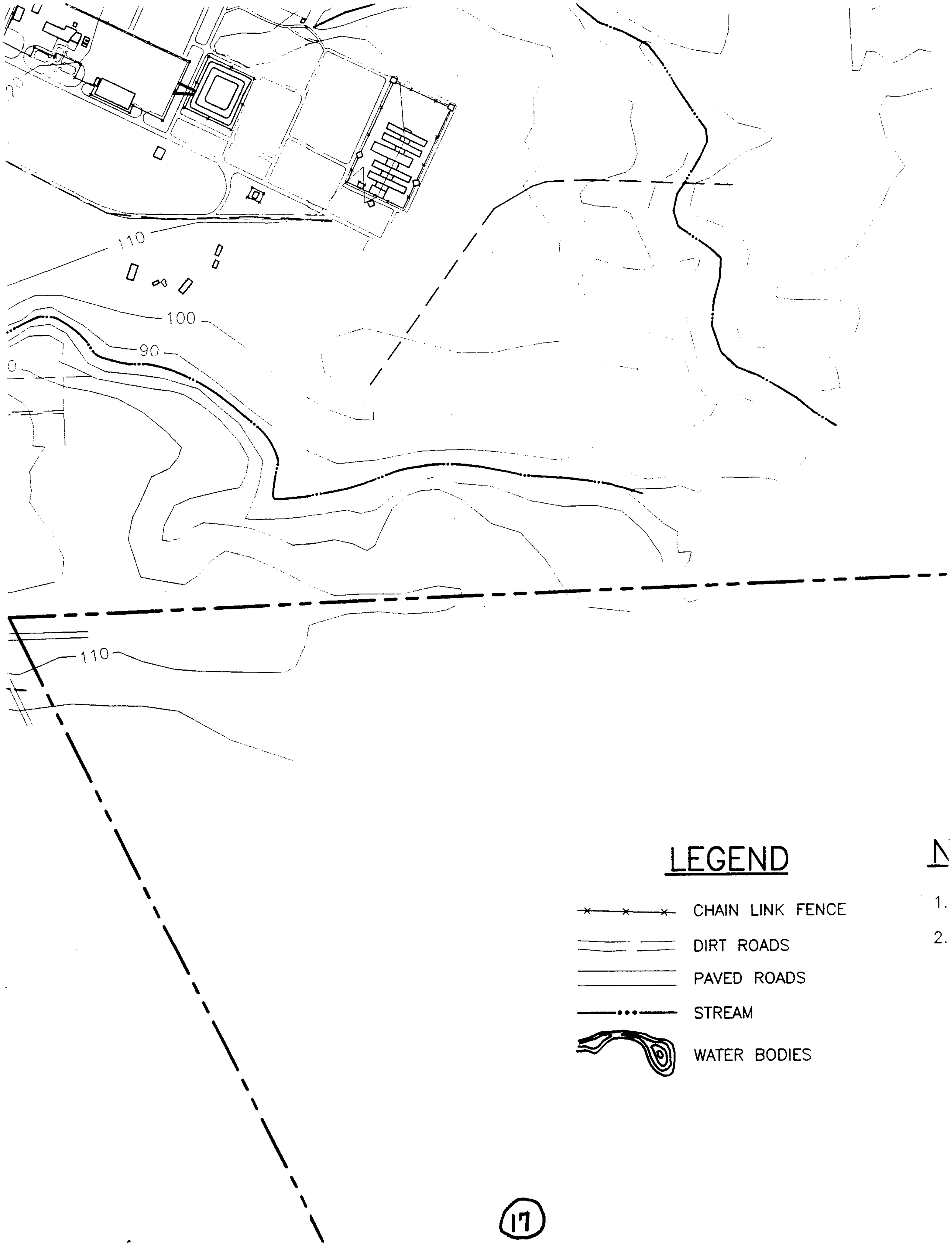



80
RESERVATION BOUNDARY
70
60


70
80
90
100

SITE 11-ANC-9 LANDFILL


140
120
130
140
110
90
110
120
120
110
110
110
100


110
100
90
0
110
LEGEND
CHAIN LINK FENCE
DIRT ROADS
PAVED ROADS
STREAM
WATER BODIES
N
1.
2.

LEGEND

—×—×— CHAIN LINK FENCE

═ ═ DIRT ROADS

═══ PAVED ROADS

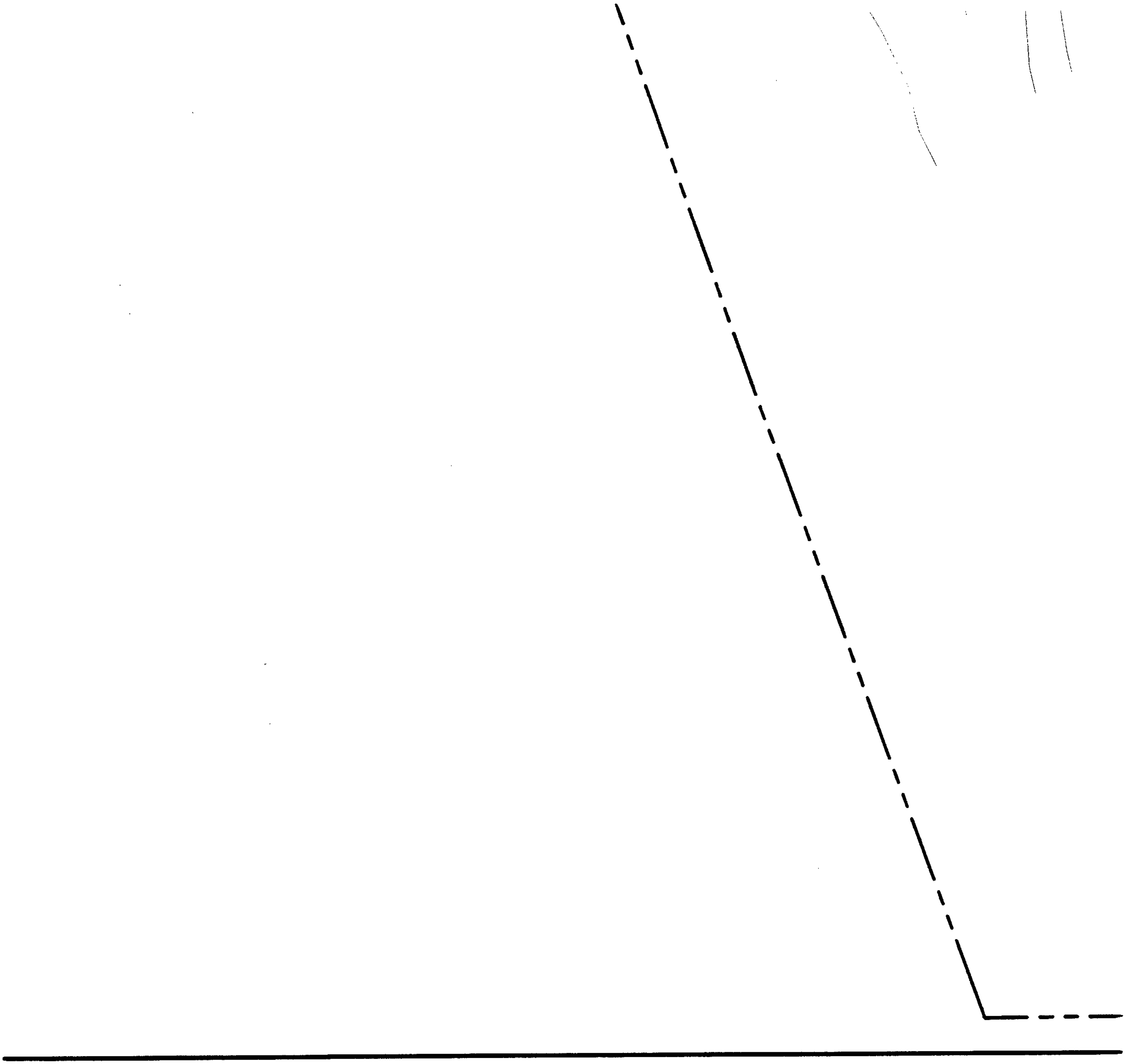
—•••— STREAM

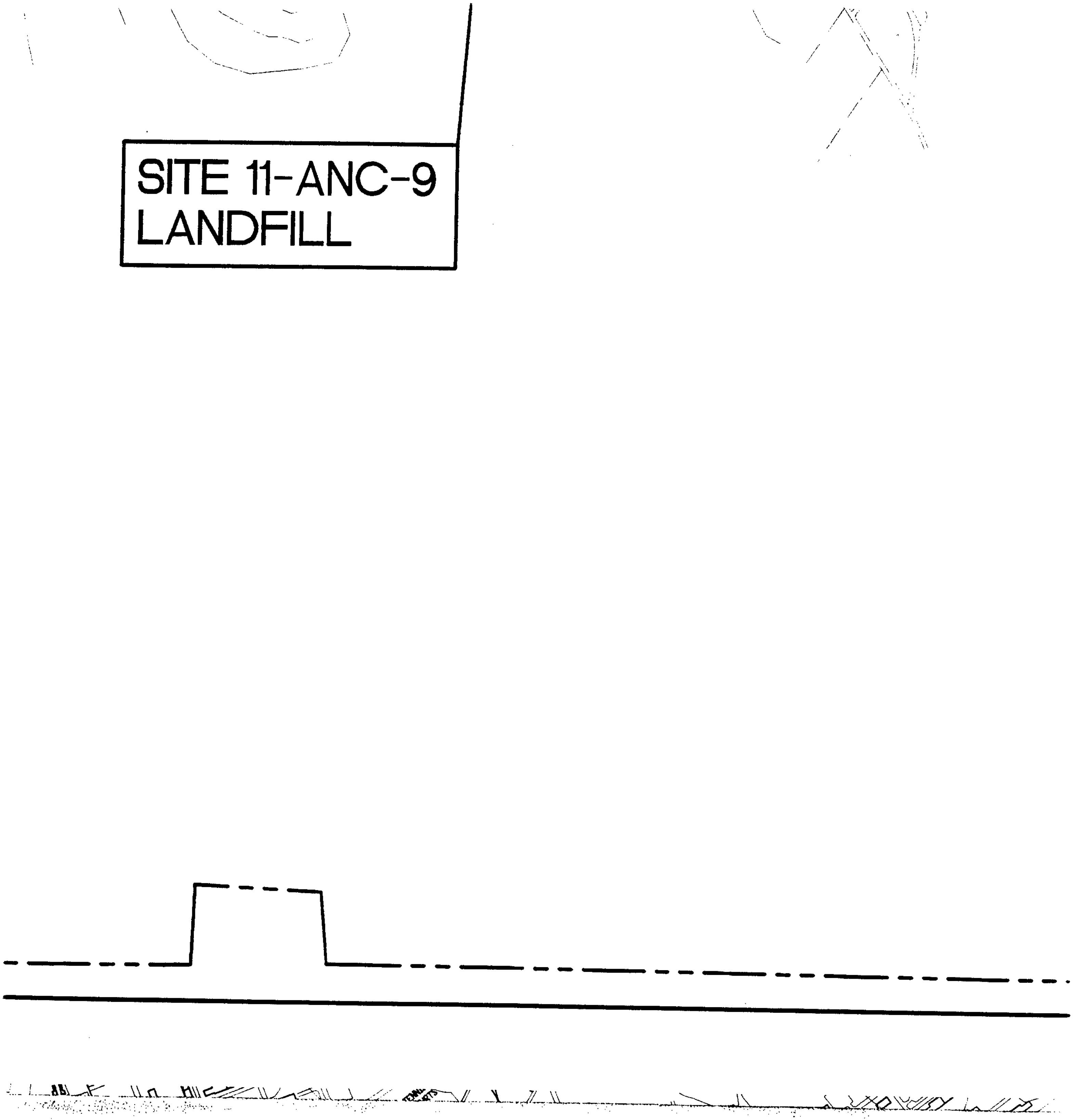
WATER BODIES

NOTES:

1. CAD BASE MAP SOURCE: FORT DIX
2. TOPOGRAPHIC CONTOURS DIGITIZED FROM USGS 7.5 MINUTE QUADRANGLES.

J:\7134-03\7134F010.DWG\ 11/10/93 1:15





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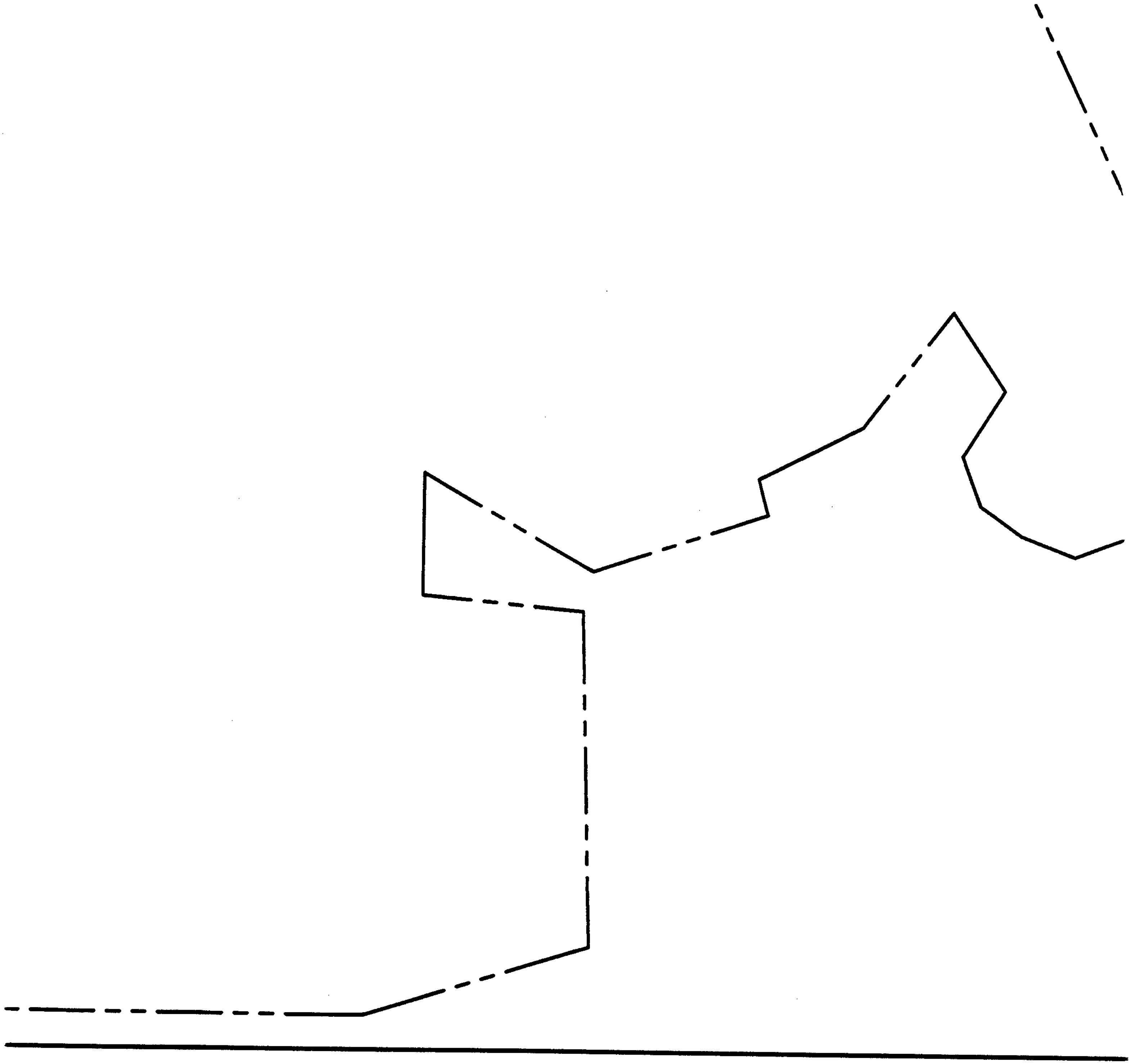
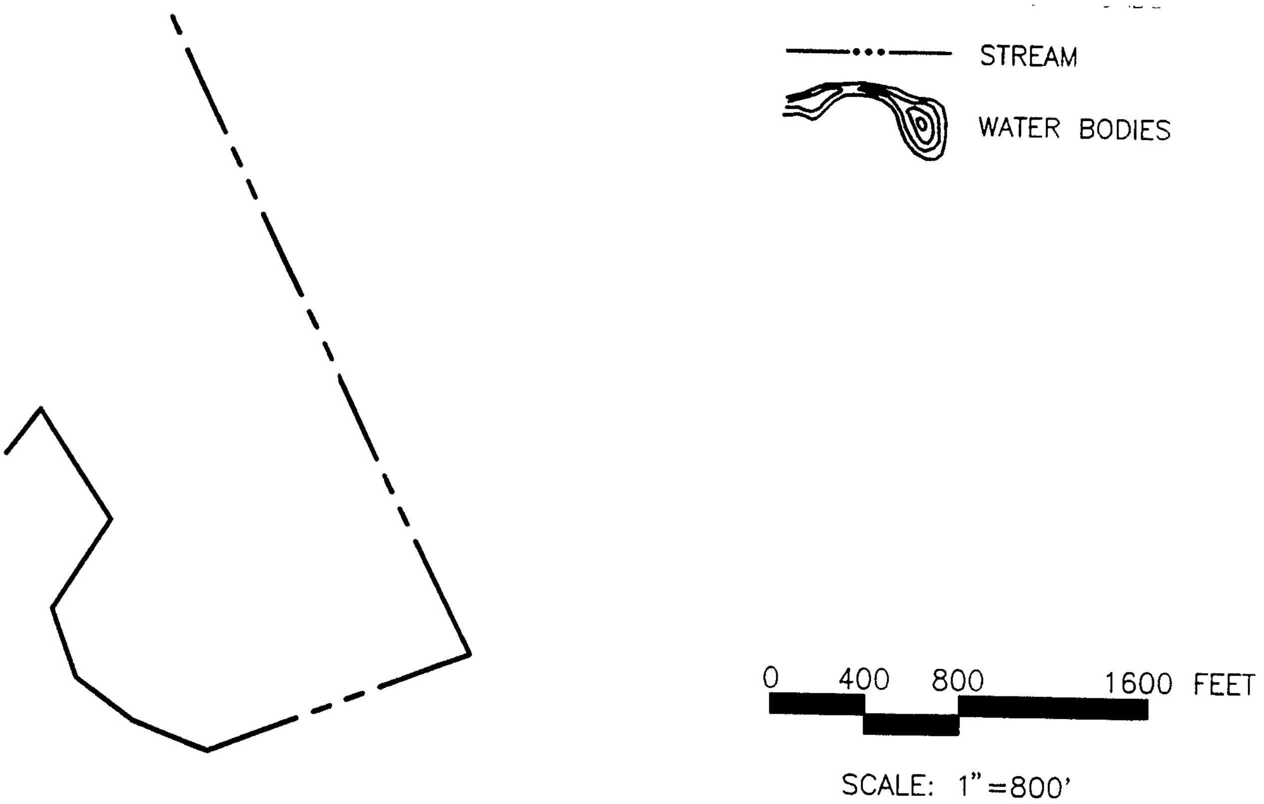
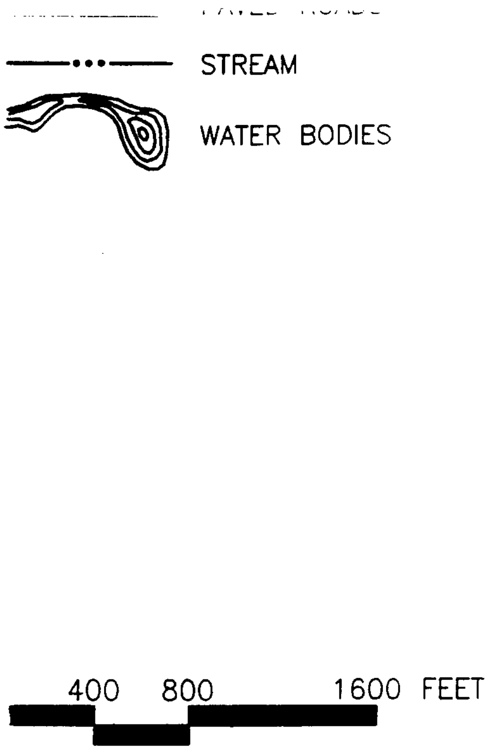




LOCATIONS
THE CANTON
FORT DIX RI/FS F
ABB Environment

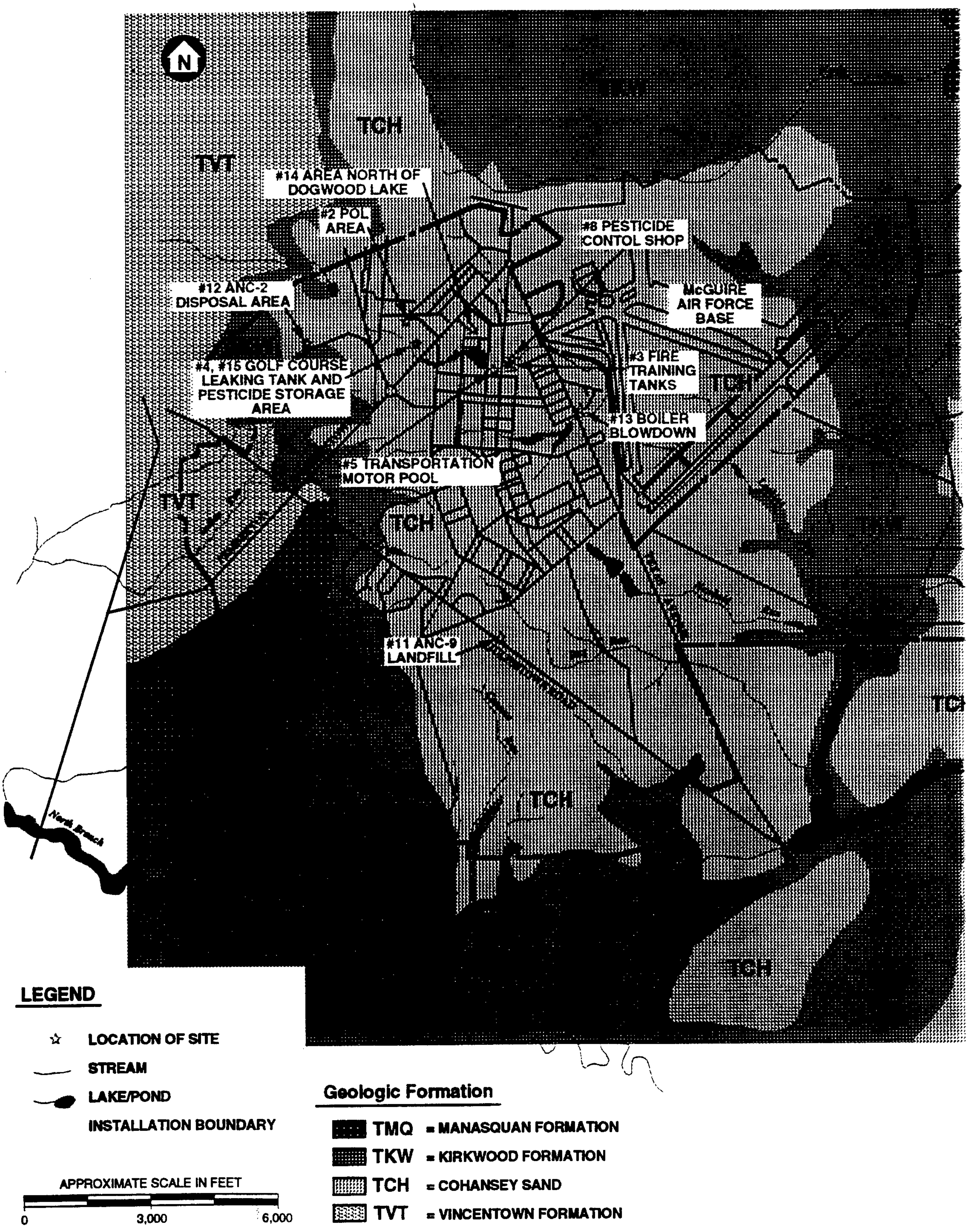
23



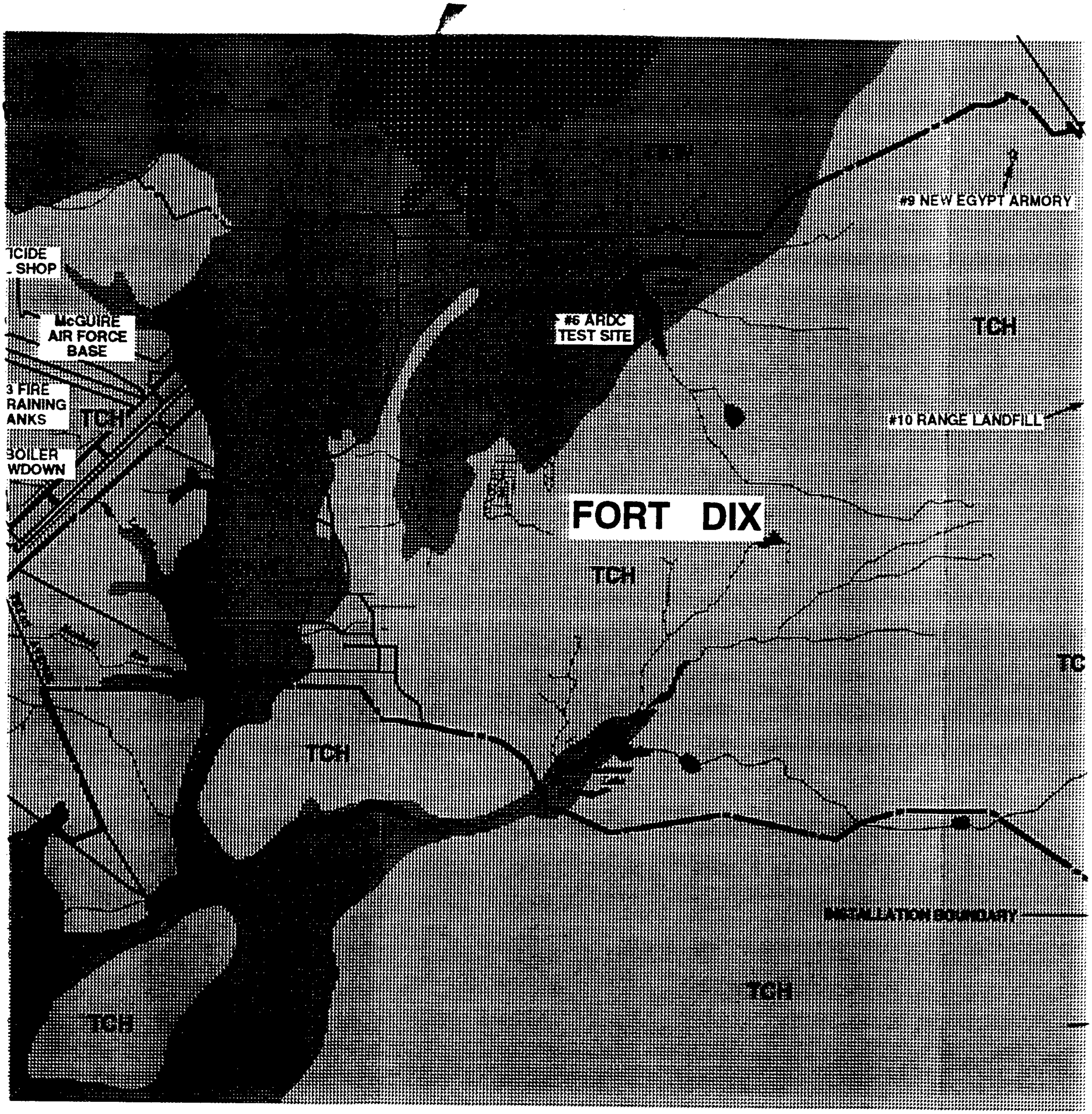
SCALE: 1"=800'

FIGURE 3
LOCATIONS OF SITES IN THE CANTONMENT AREA
FORT DIX RI/FS FOR 13 SITES

ABB Environmental Services, Inc.



SOURCE: ICF, 1994.


ICIDE
SHOP
McGUIRE AIR FORCE BASE
3 FIRE
RAINING
ANKS
BOILER
WDOWN
TCH
#6 ARDC TEST SITE
#9 NEW EGYPT ARMORY
TCH
#10 RANGE LANDFILL
FORT DIX
TCH
TC
TCH
INSTALLATION BOUNDARY
TCH
TCH

F

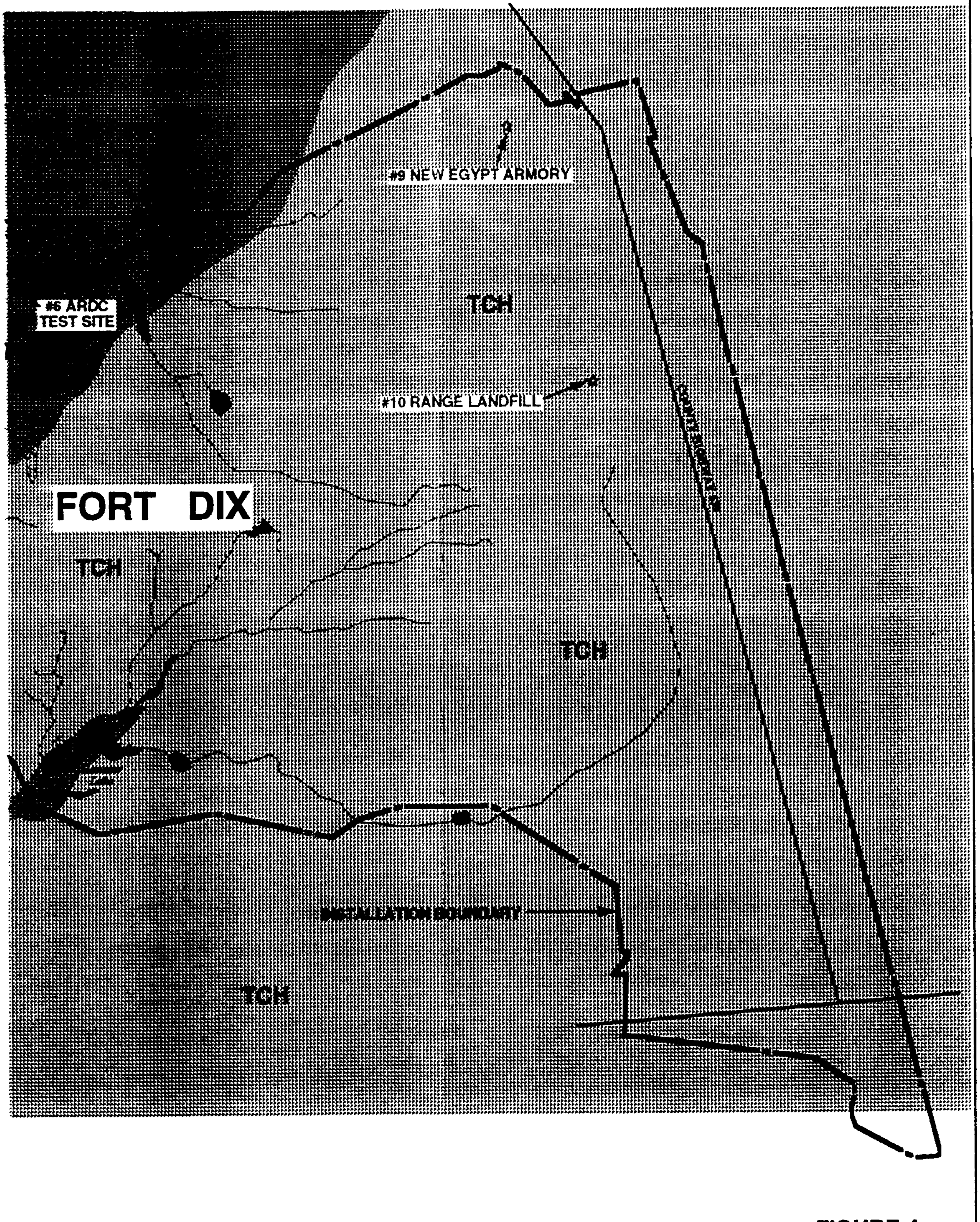
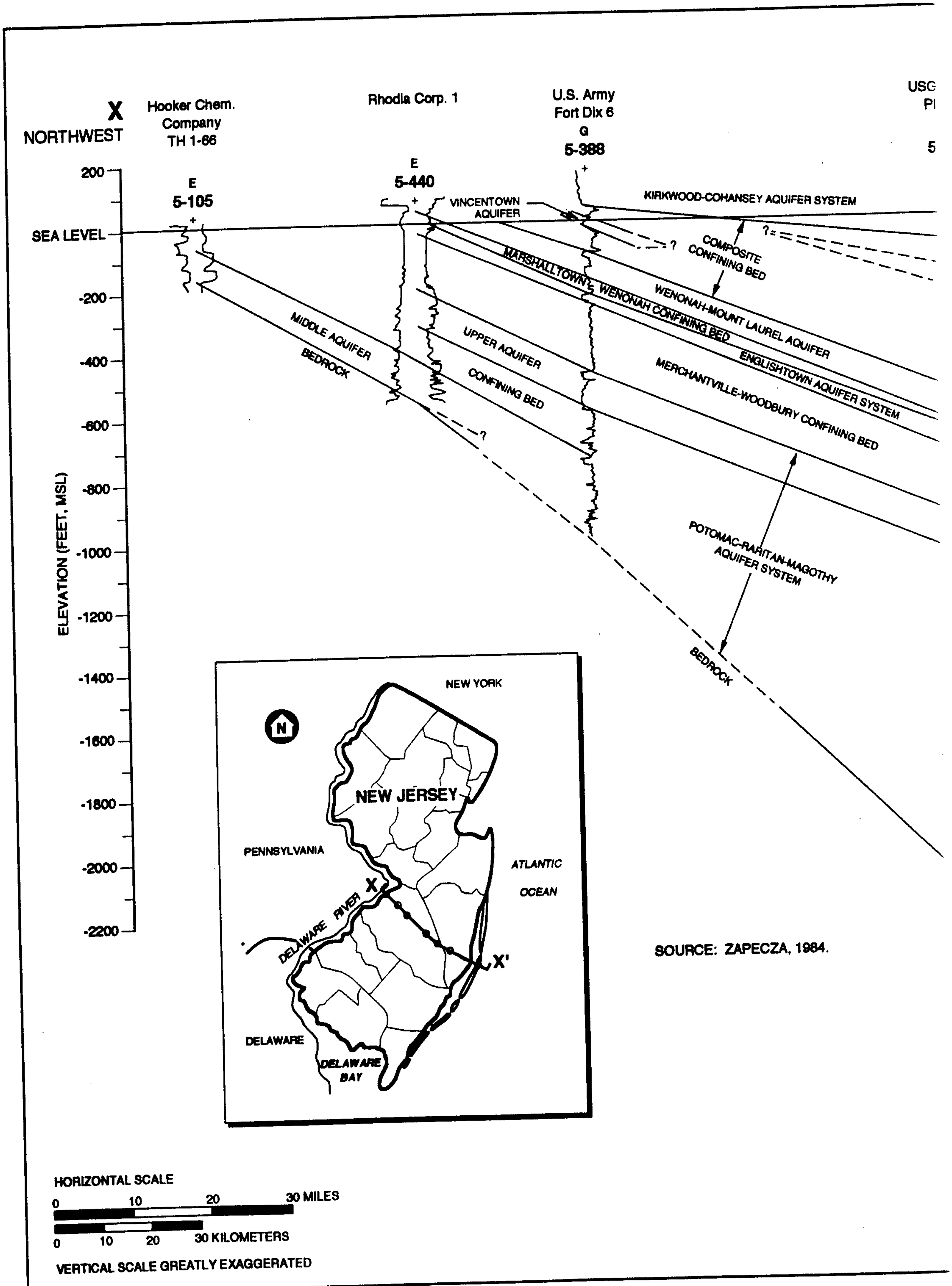
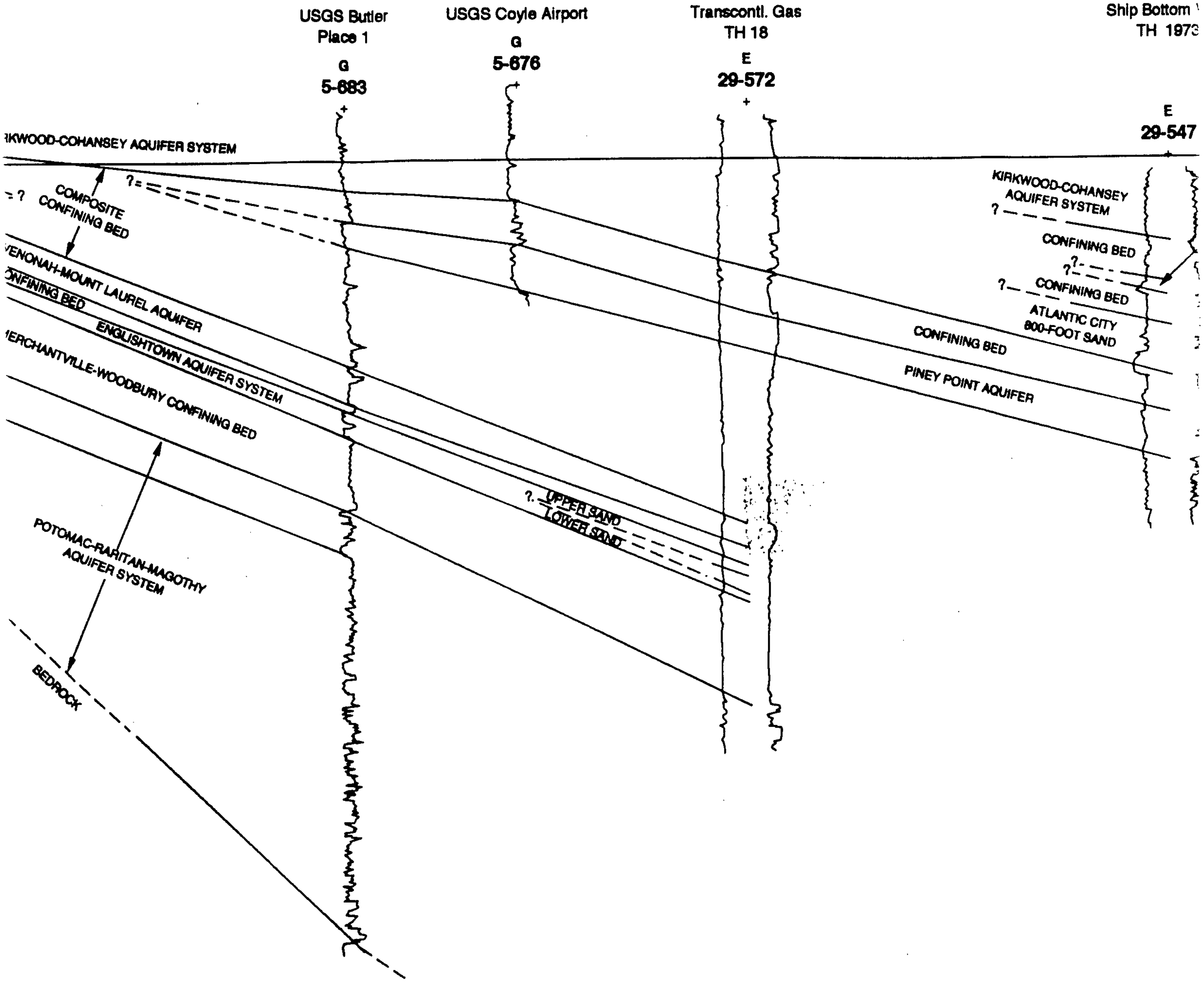


FIGURE 4
SITE GEOLOGIC MAP
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES



SOURCE: ZAPECZA, 1984.



URCE: ZAPECZA, 1984.

CROSS-SECTION O

FORT

AB

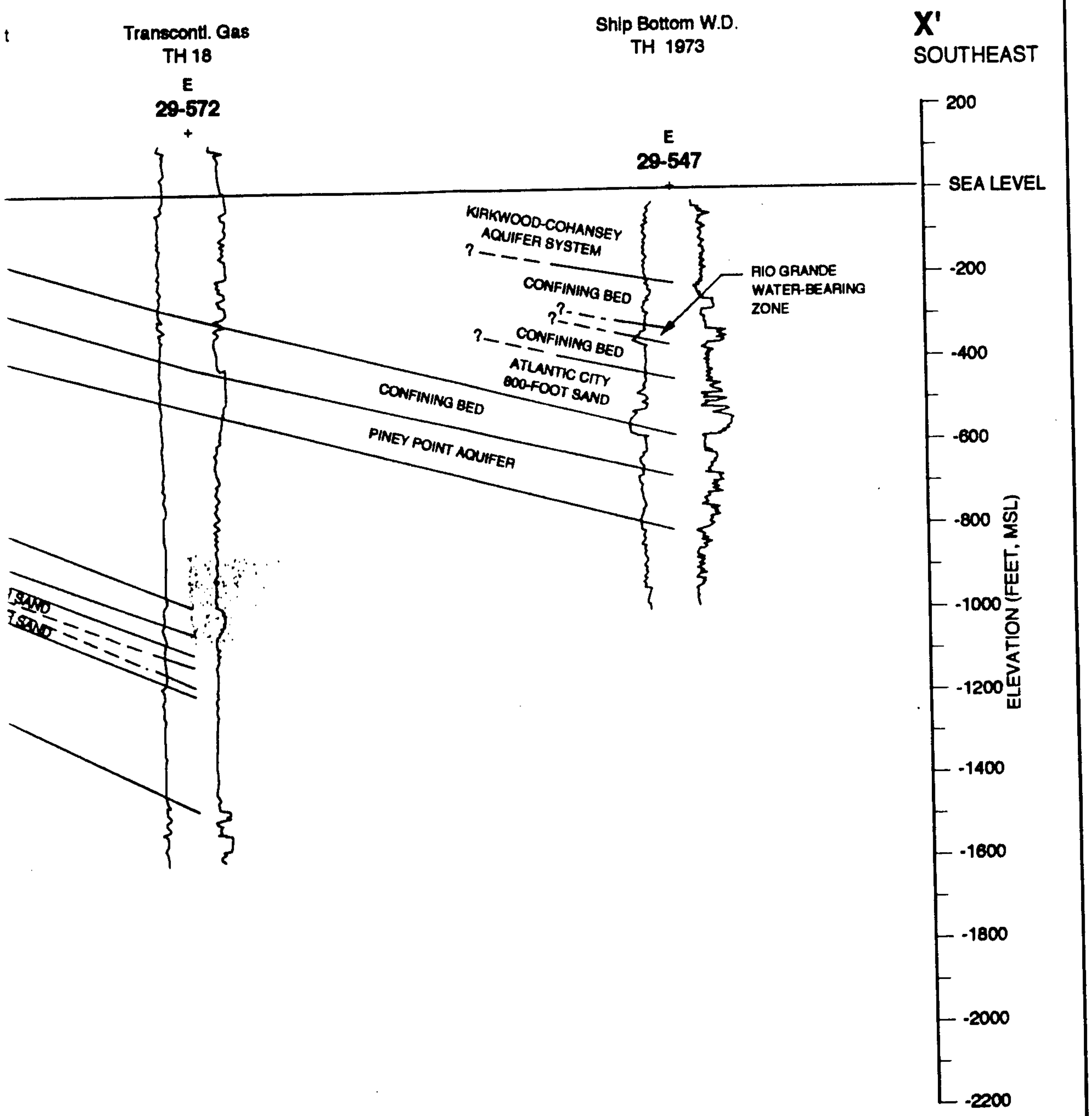
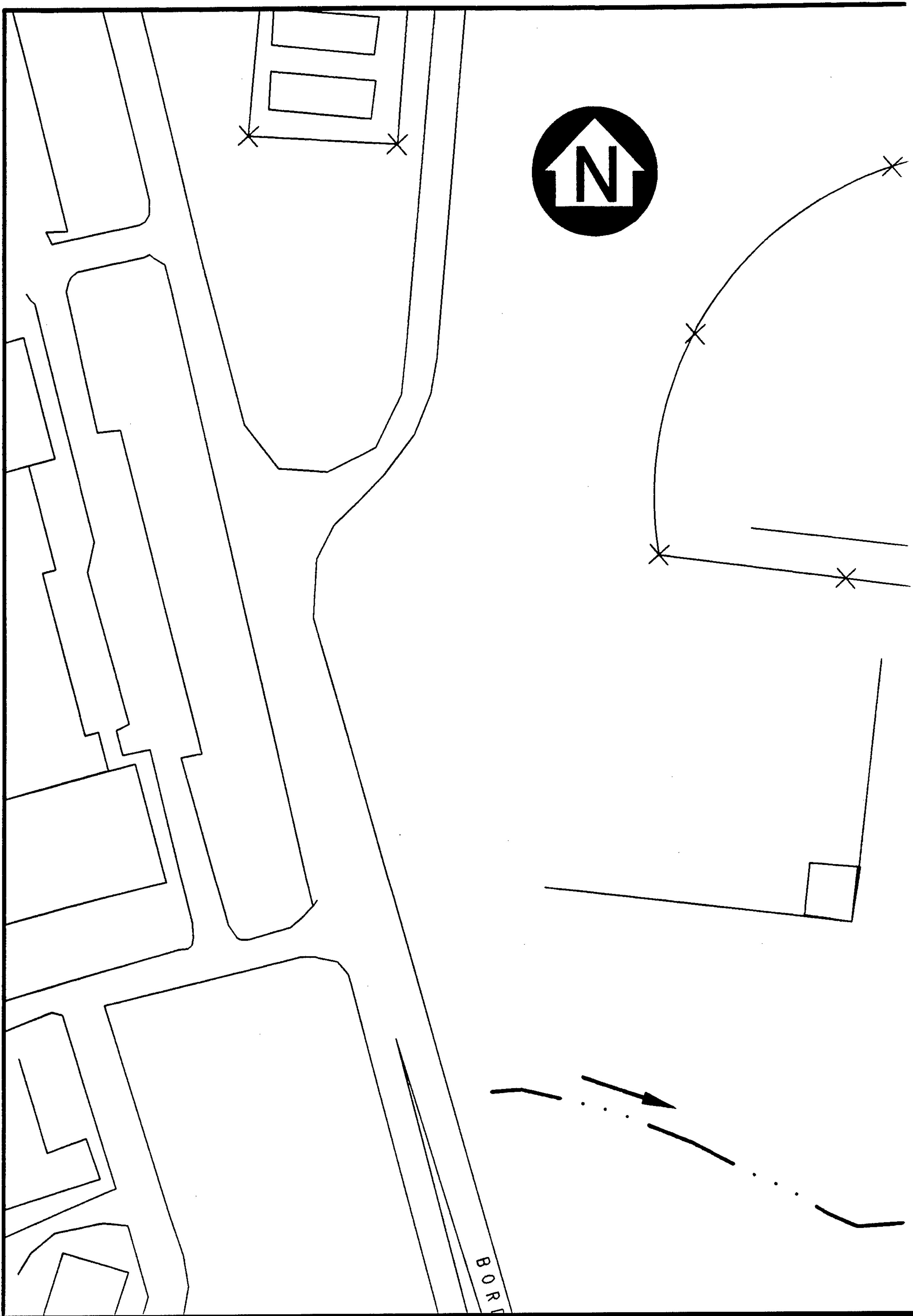


FIGURE 5
CROSS-SECTION OF REGIONAL GEOLOGY
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES
ABB Environmental Services, Inc.

①



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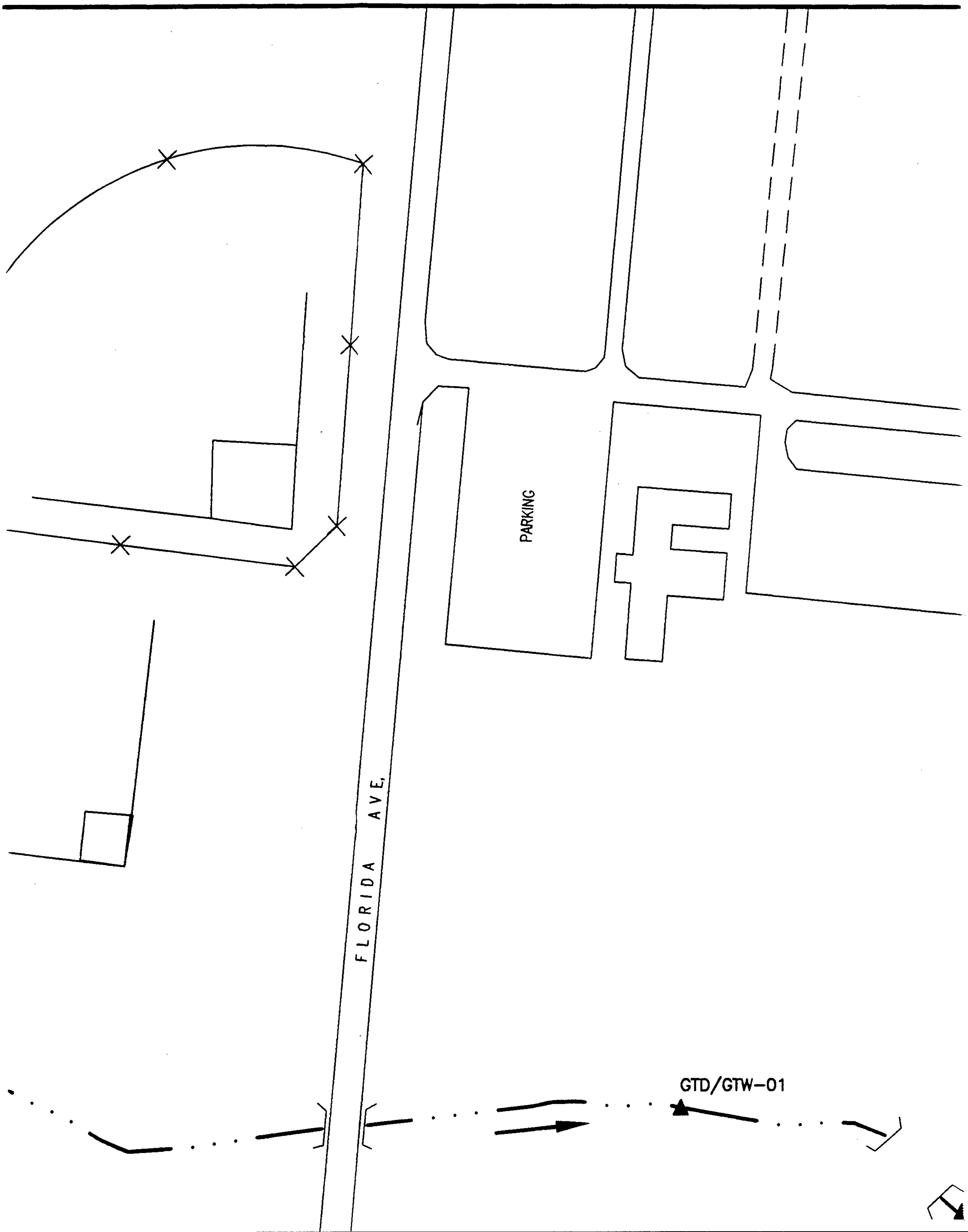

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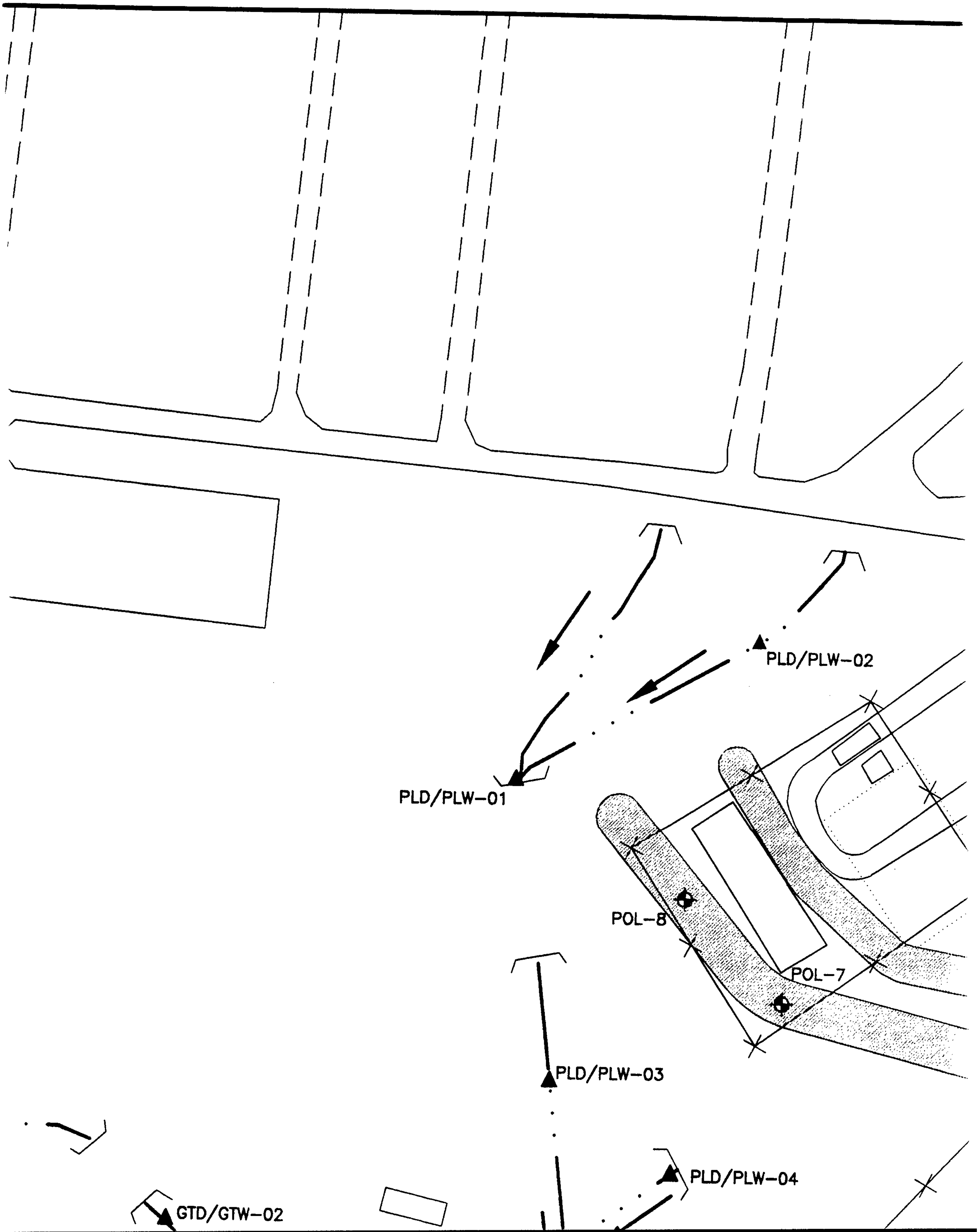
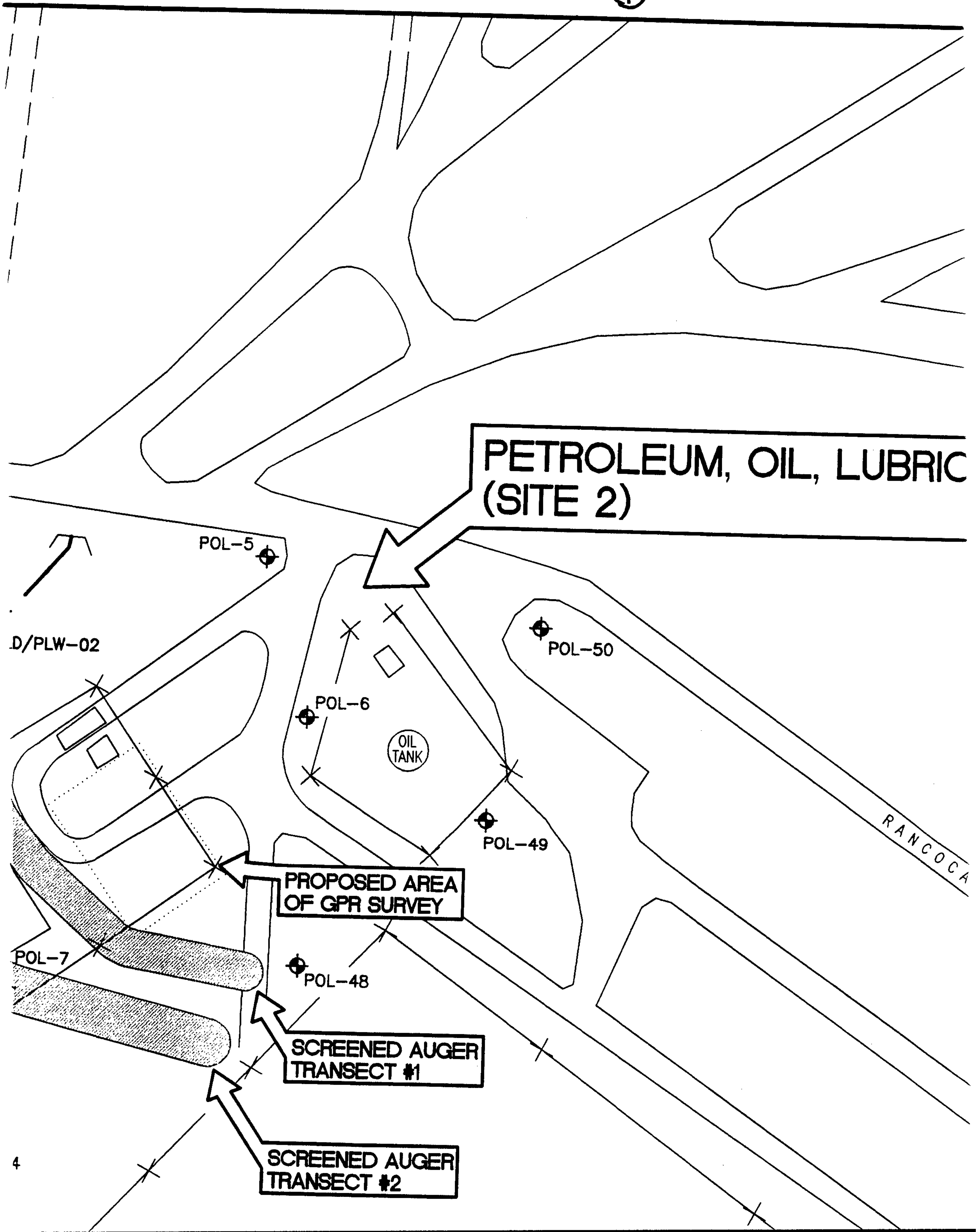
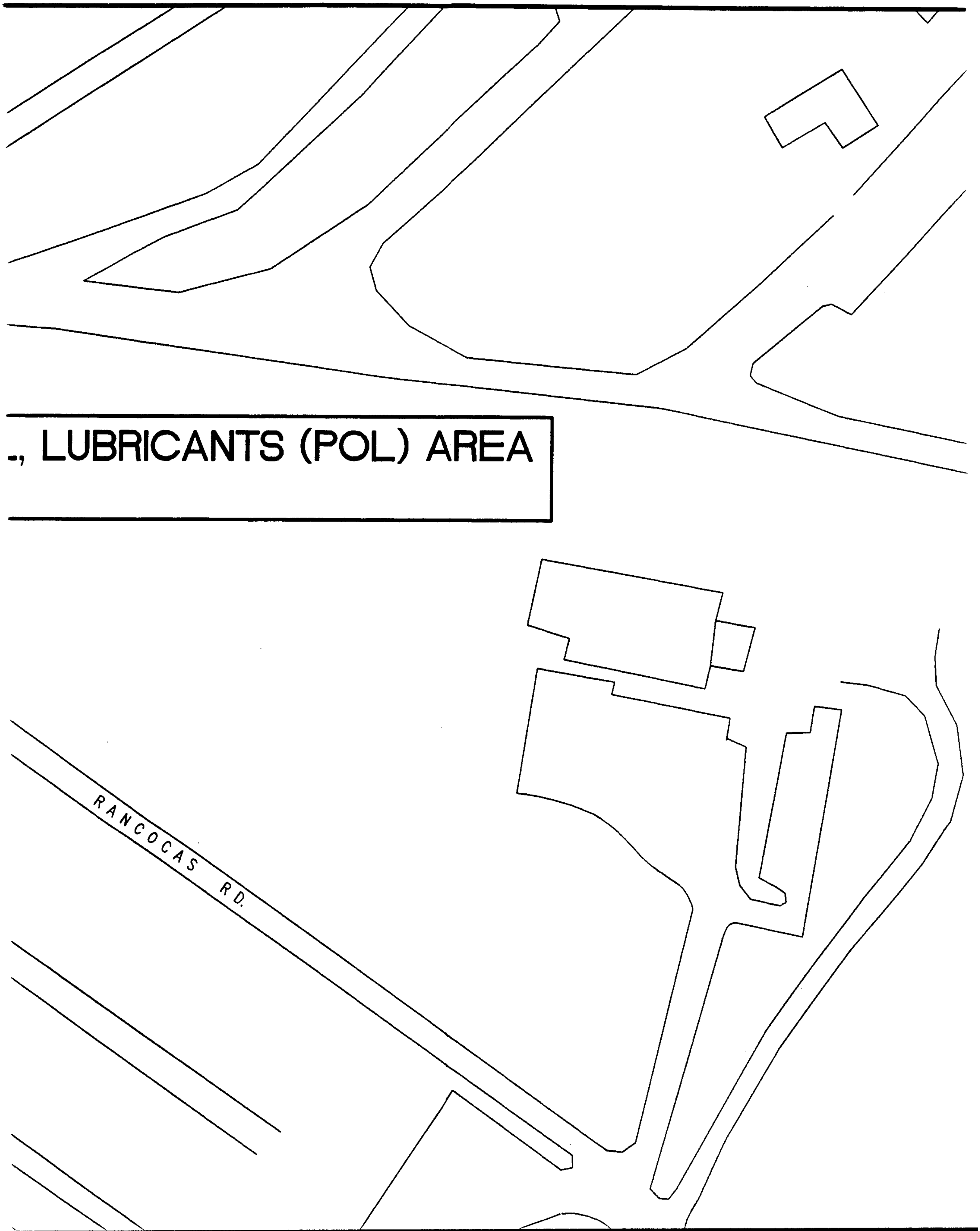


④

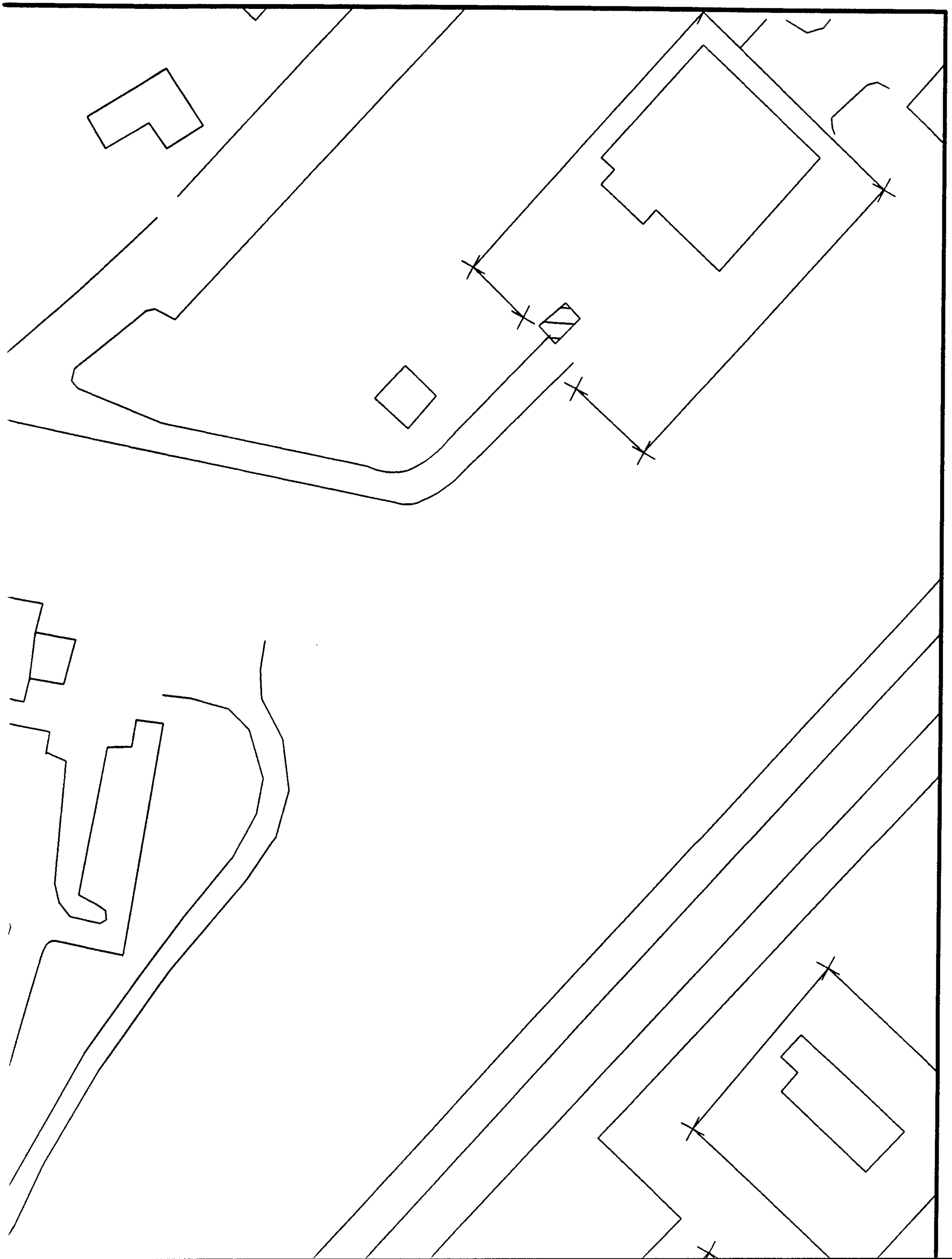

PETROLEUM, OIL, LUBRIC
(SITE 2)
POL-5
D/PLW-02
POL-50
POL-6
OIL TANK
POL-49
RANCOCA
PROPOSED AREA OF GPR SURVEY
POL-7
POL-48
SCREENED AUGER TRANSECT #1
SCREENED AUGER TRANSECT #2
4

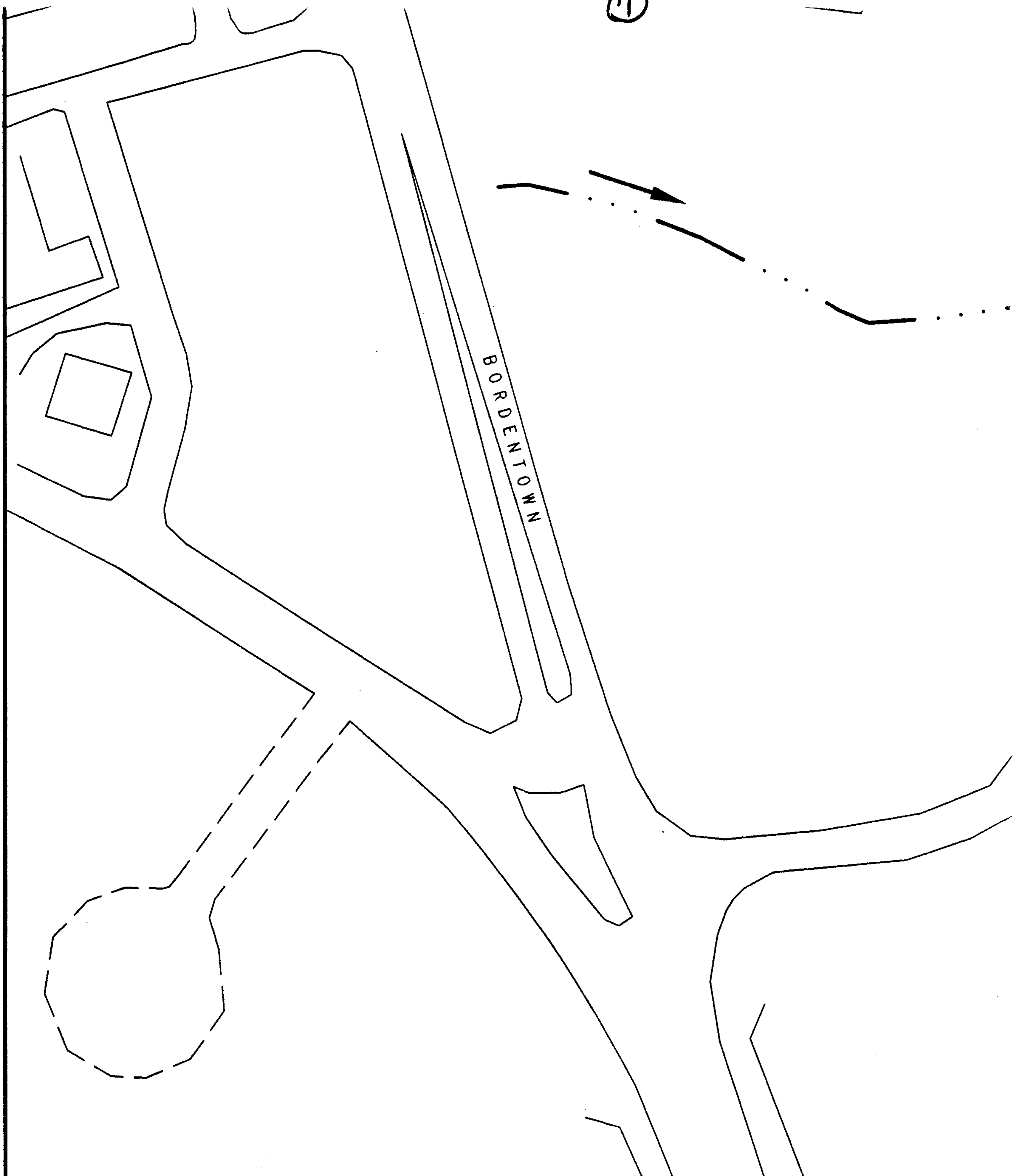
⑤



-, LUBRICANTS (POL) AREA

⑥

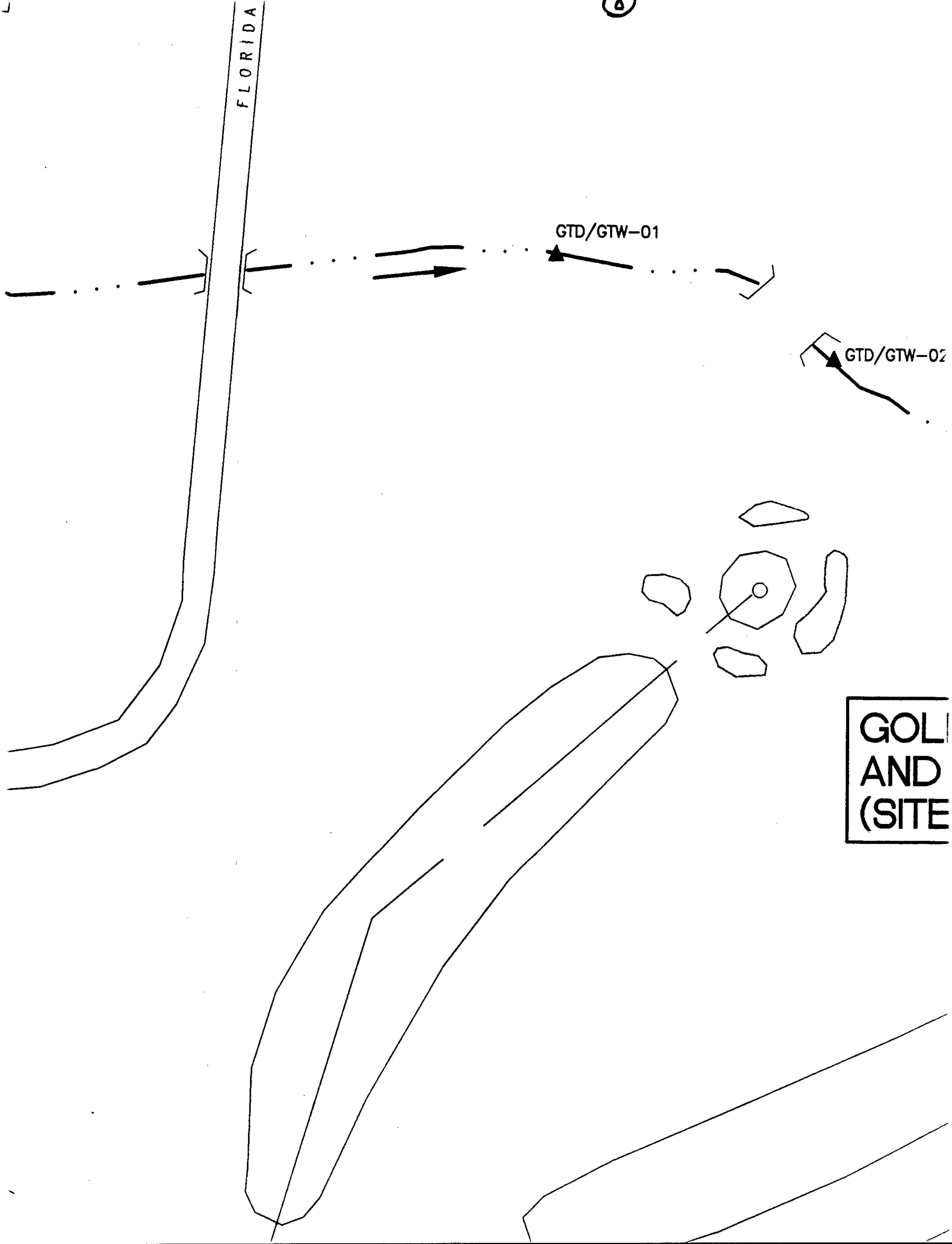




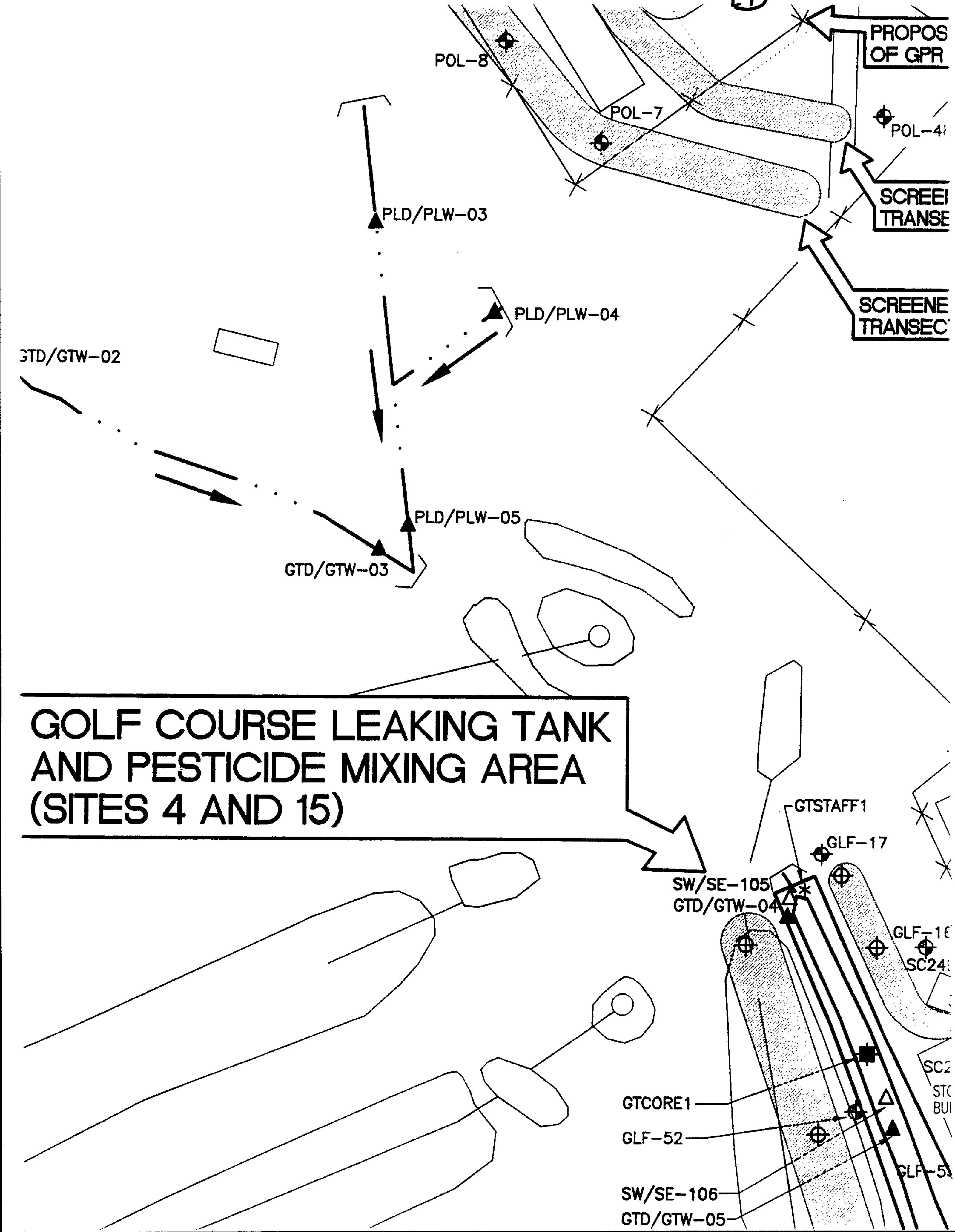
LEGEND

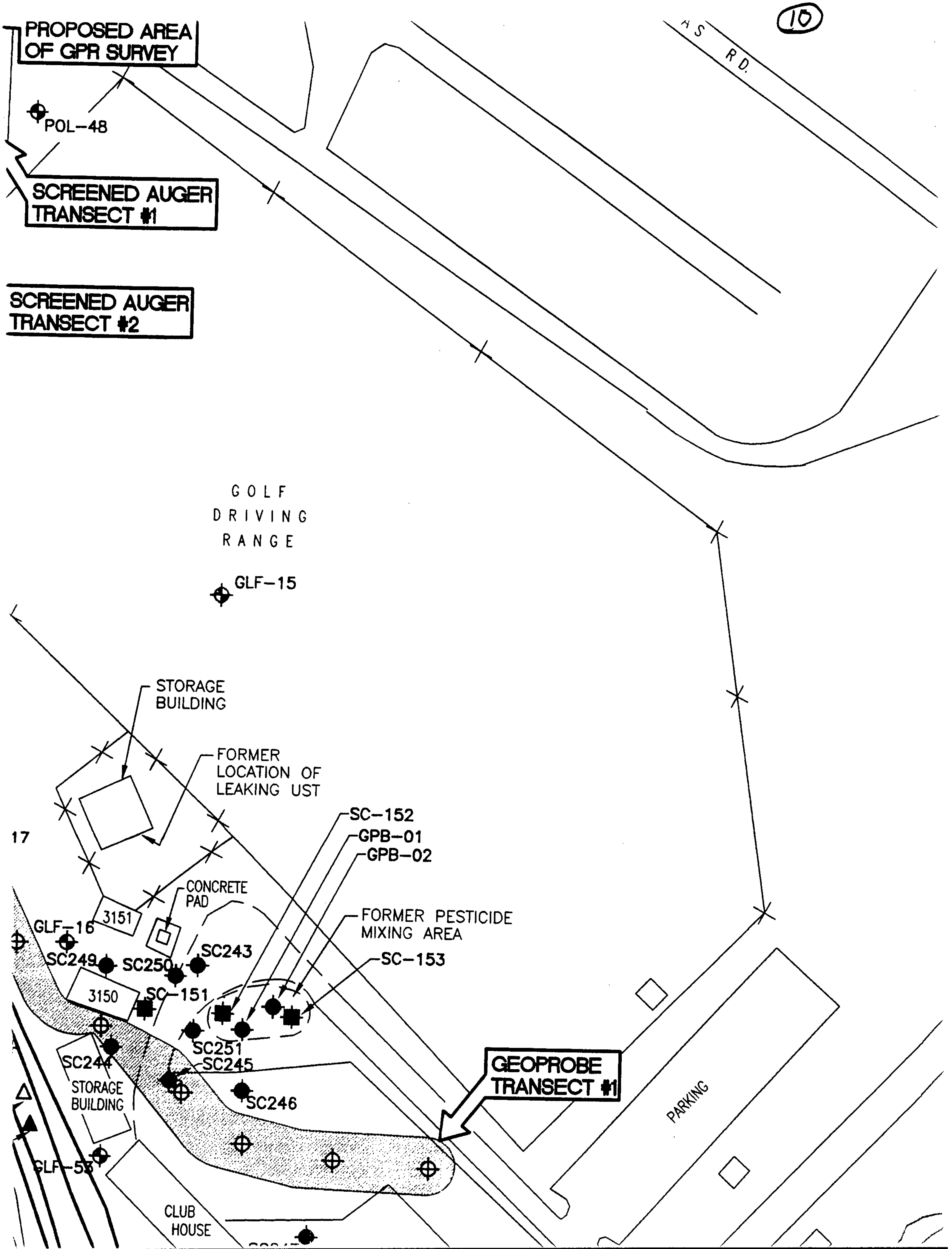
GTD/GTW-01 ▲	PROPOSED SURFACE WATER/SEDIMENT SAMPLE
GTCORE1 ■	PROPOSED SEDIMENT CORE LOCATION

⑧

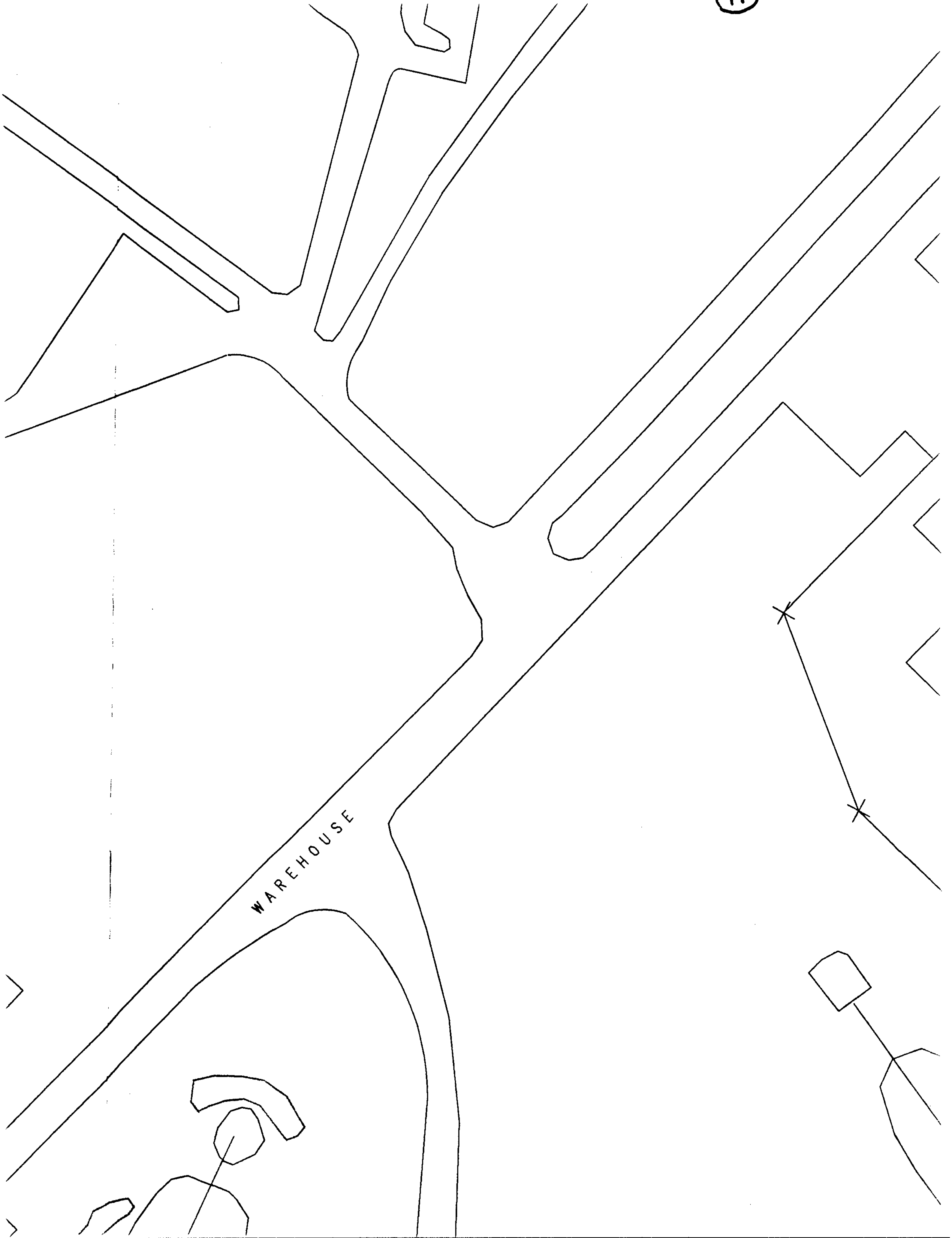


9

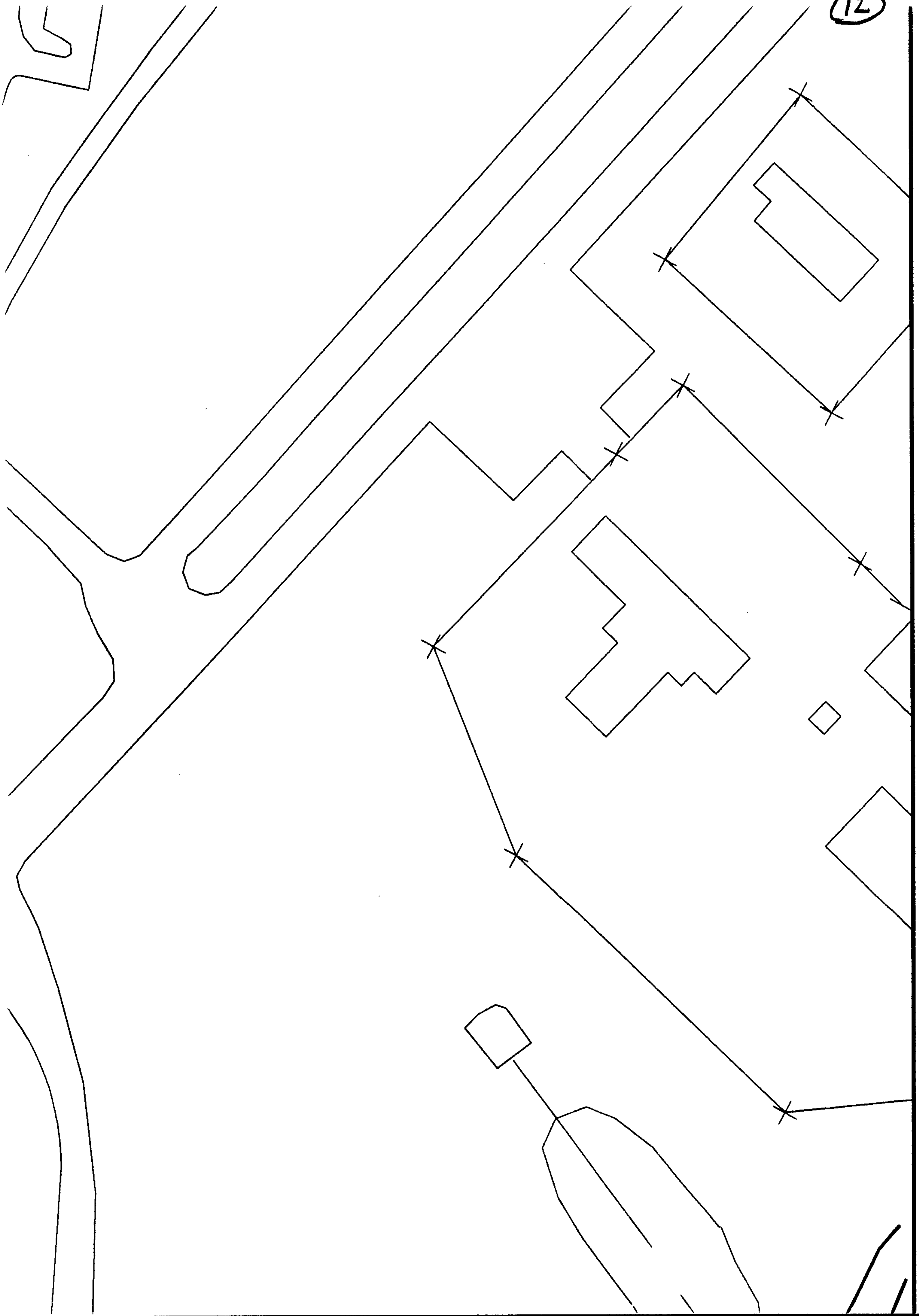

GOLF COURSE LEAKING TANK AND PESTICIDE MIXING AREA (SITES 4 AND 15)


PROPOSED AREA OF GPR SURVEY
A S RD.
POL-48
SCREENED AUGER TRANSECT #1
SCREENED AUGER TRANSECT #2
GOLF DRIVING RANGE
GLF-15
STORAGE BUILDING
FORMER LOCATION OF LEAKING UST
17
SC-152
GPB-01
GPB-02
CONCRETE PAD
3151
FORMER PESTICIDE MIXING AREA
GLF-16
SC243
SC249
SC250
SC-153
3150
SC-151
SC251
SC244
SC245
GEOPROBE TRANSECT #1
SC246
STORAGE BUILDING
PARKING
GLF-53
CLUB HOUSE

(11)



12



⑬

LEGEND

GTD/GTW-01	▲	PROPOSED SURFACE WATER/SEDIMENT SAMPLE
GTCORE1	■	PROPOSED SEDIMENT CORE LOCATION
GPB-01	●	PROPOSED SOIL BORING
	⊕	PROPOSED GEOPROBE EXPLORATION LOCATION
GTSTAFF1	*	PROPOSED STAFF GAUGE
SW/SE-108	△	EXISTING SURFACE WATER/SEDIMENT SAMPLE
SC-151	■	EXISTING SURFACE SOIL SAMPLE
SC248	●	EXISTING BORING
GLF-74	◐	EXISTING MONITORING WELL
	—×—×—×—×—	CHAIN LINK FENCE
	= = = = = =	DIRT ROADS
	═══════	PAVED ROADS
	——— · ‾ · ———	STREAM AND FLOW DIRECTION
	···························	GEOPHYSICAL SURVEY BOUNDARY

SITE 2 NOTES:

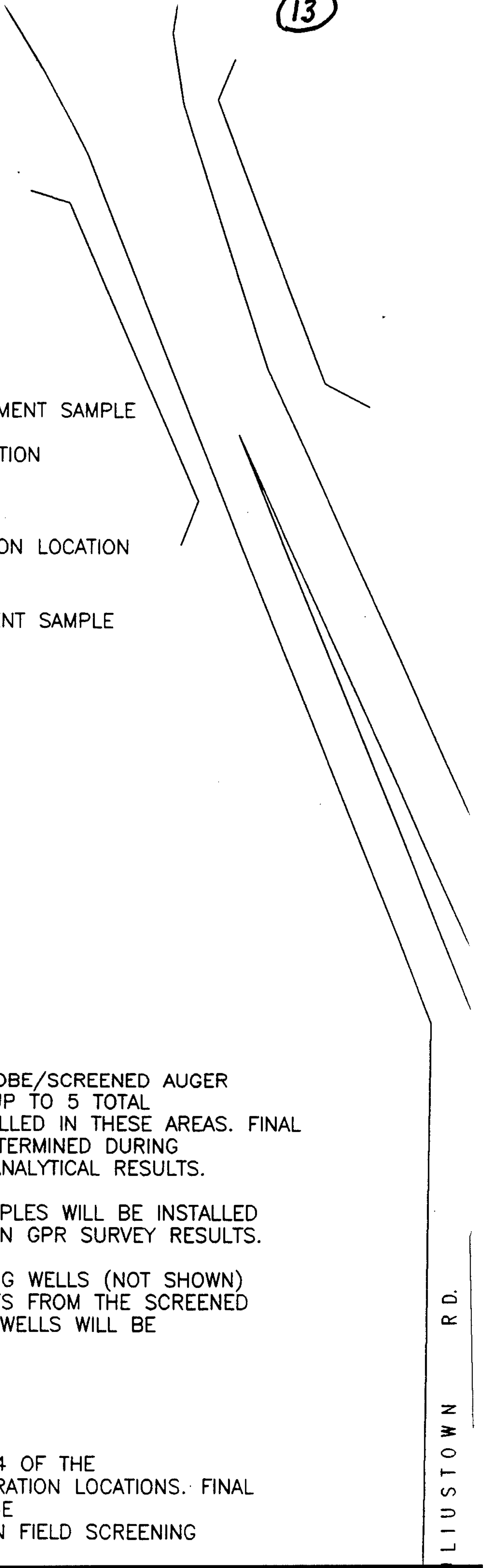
1. THIS FIGURE SHOWS THE LOCATION OF TWO GEOPROBE/SCREENED AUGER TRANSECTS FOR GROUNDWATER FIELD SCREENING. UP TO 5 TOTAL GEOPROBE/SCREENED AUGER BORINGS WILL BE DRILLED IN THESE AREAS. FINAL LOCATIONS AND NUMBERS OF BORINGS WILL BE DETERMINED DURING THE FIELD PROGRAM BASED ON FIELD SCREENING ANALYTICAL RESULTS.

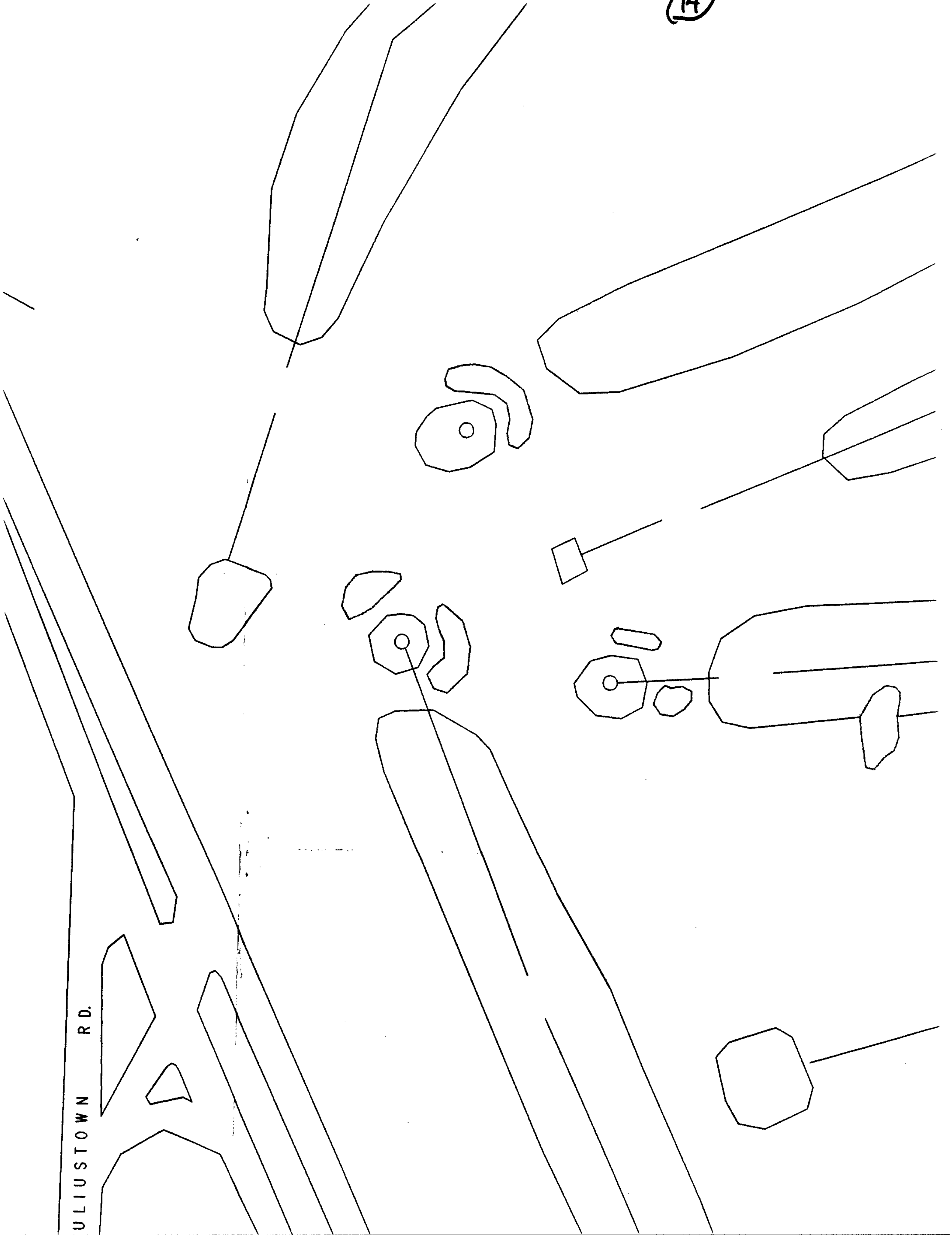
2. UP TO 5 FIELD SCREENING BORINGS FOR SOIL SAMPLES WILL BE INSTALLED IN THE PROPOSED AREA OF GPR SURVEY, BASED ON GPR SURVEY RESULTS.

3. LOCATIONS AND NUMBERS OF PROPOSED MONITORING WELLS (NOT SHOWN) WILL BE DETERMINED BASED ON ANALYTICAL RESULTS FROM THE SCREENED AUGER BORINGS. UP TO 5 ADDITIONAL MONITORING WELLS WILL BE INSTALLED.

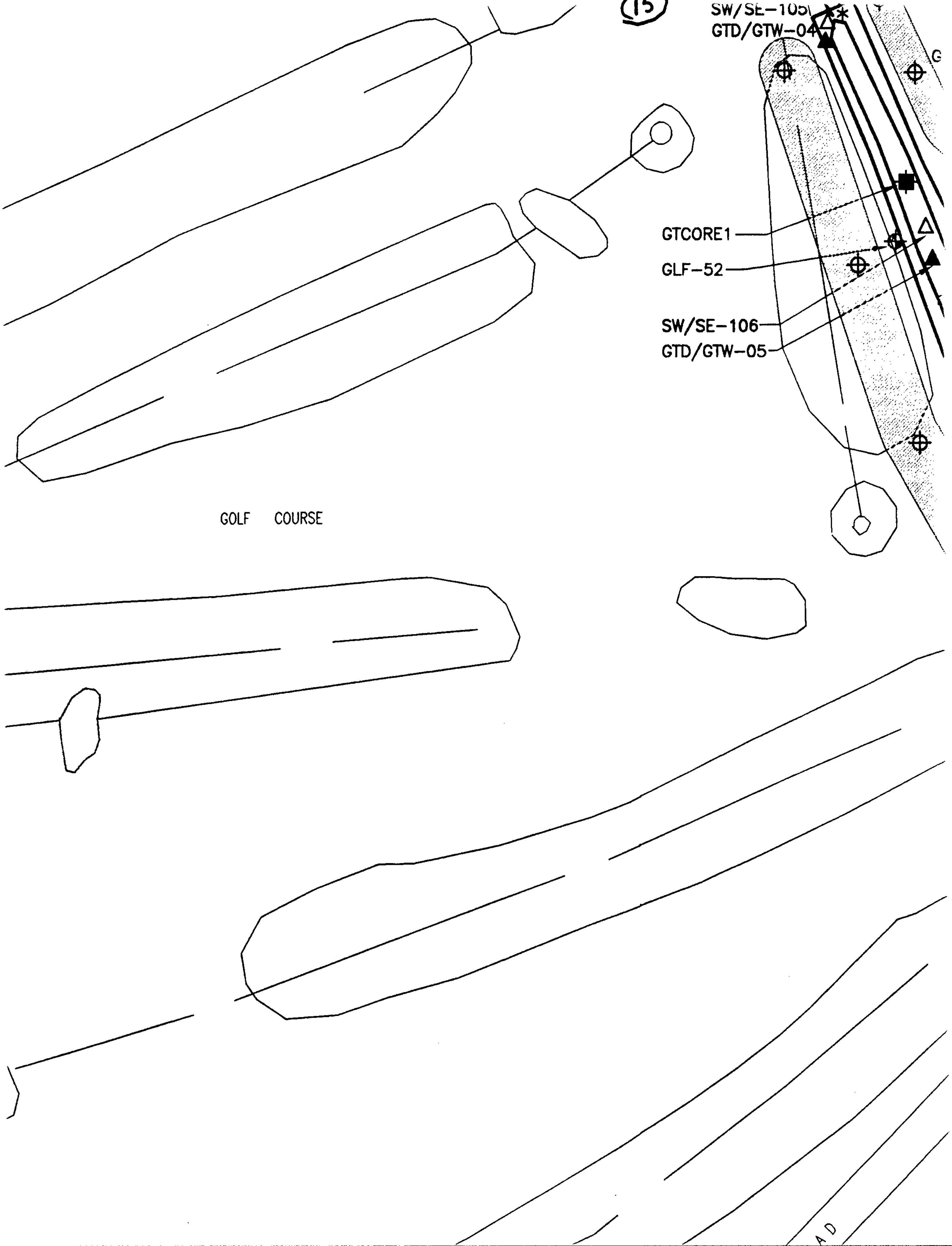
SITES 4 AND 15 NOTES:

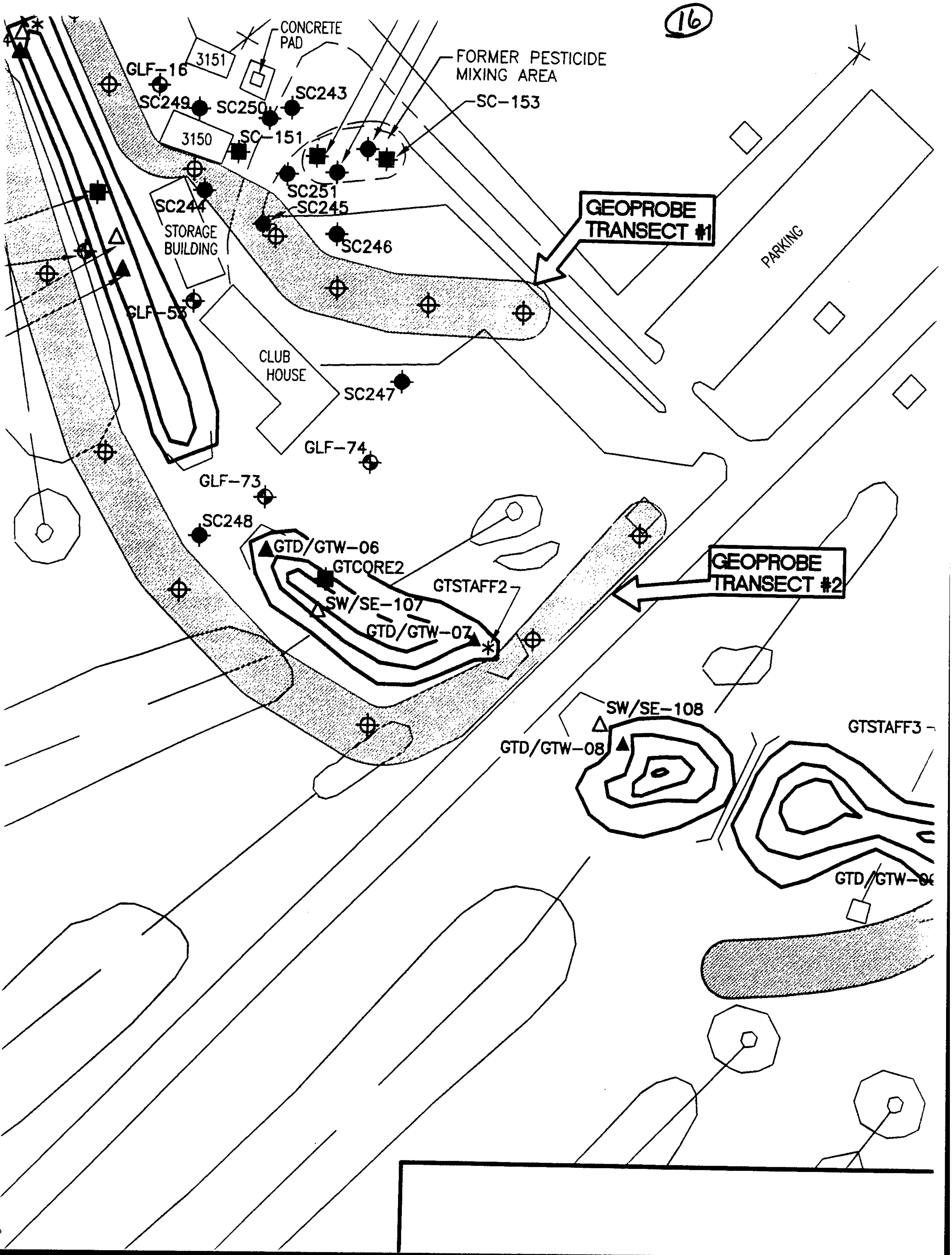
1. THIS FIGURE SHOWS APPROXIMATE LOCATIONS OF 14 OF THE PROPOSED 21 GEOPROBE/SCREENED AUGER EXPLORATION LOCATIONS. FINAL LOCATIONS AND NUMBERS OF EXPLORATIONS WILL BE DETERMINED DURING THE FIELD PROGRAM BASED ON FIELD SCREENING ANALYTICAL RESULTS.

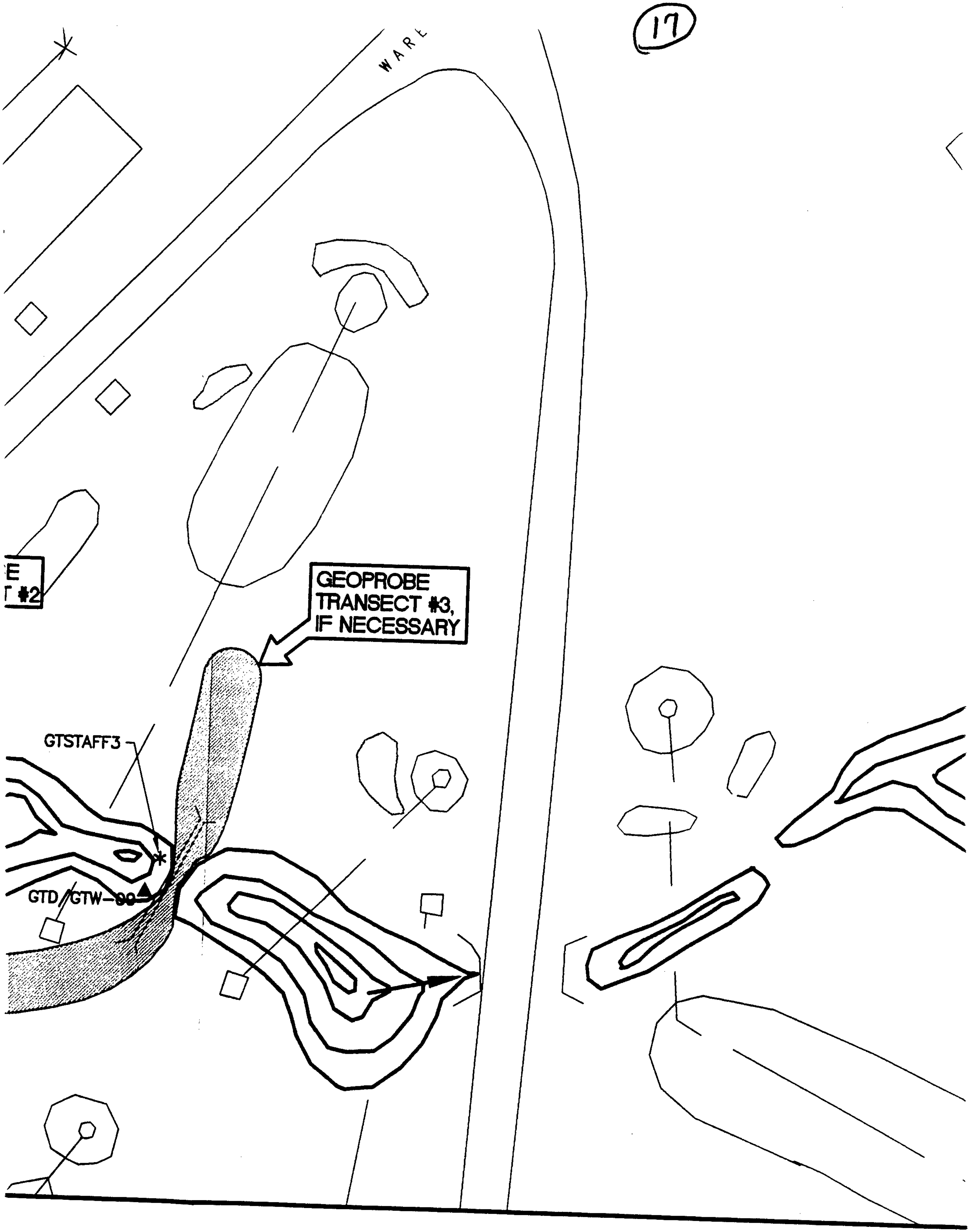


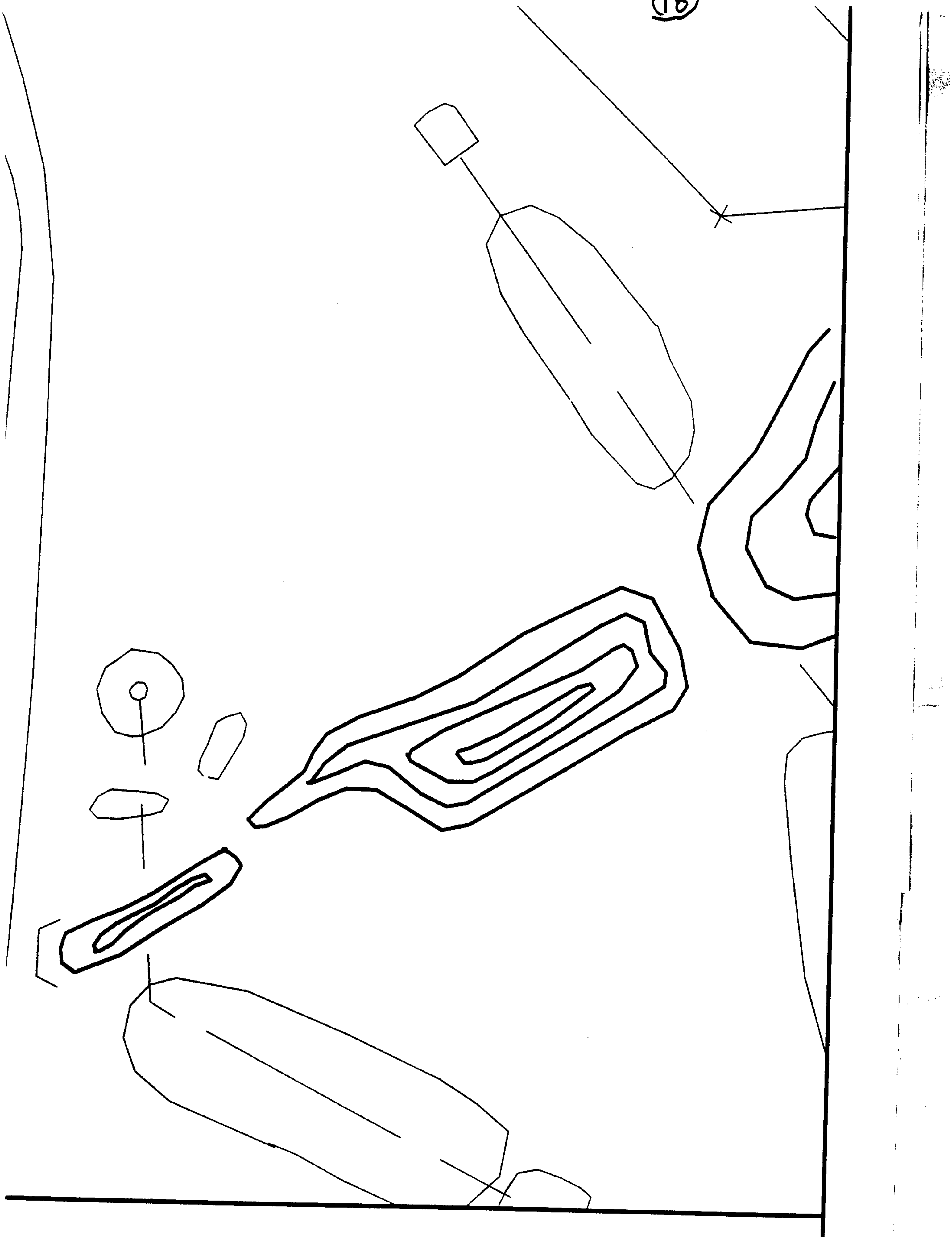

ULIUSTOWN RD.

⑮


SW/SE-105
GTD/GTW-04
G
GTCORE1
GLF-52
SW/SE-106
GTD/GTW-05
GOLF COURSE
AD


CONCRETE PAD
3151
GLF-16
FORMER PESTICIDE MIXING AREA
SC-153
SC243
SC249
SC250
3150
SC-151
SC251
SC244
SC245
STORAGE BUILDING
SC246
GEOPROBE TRANSECT #1
PARKING
GLF-53
CLUB HOUSE
SC247
GLF-74
GLF-73
SC248
GTD/GTW-06
GTCORE2
GTSTAFF2
SW/SE-107
GTD/GTW-07
GEOPROBE TRANSECT #2
SW/SE-108
GTD/GTW-08
GTSTAFF3
GTD/GTW-0


WARE
E
T #2
GEOPROBE TRANSECT #3, IF NECESSARY
GTSTAFF3
GTD/GTW-09



FIGURE

GEOPROBE/SCREENED AUGER BORINGS WILL BE DRILLED IN THESE AREAS. FINAL LOCATIONS AND NUMBERS OF BORINGS WILL BE DETERMINED DURING THE FIELD PROGRAM BASED ON FIELD SCREENING ANALYTICAL RESULTS.

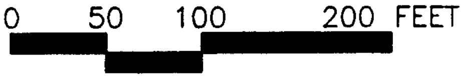
2. UP TO 5 FIELD SCREENING BORINGS FOR SOIL SAMPLES WILL BE INSTALLED IN THE PROPOSED AREA OF GPR SURVEY, BASED ON GPR SURVEY RESULTS.
3. LOCATIONS AND NUMBERS OF PROPOSED MONITORING WELLS (NOT SHOWN) WILL BE DETERMINED BASED ON ANALYTICAL RESULTS FROM THE SCREENED AUGER BORINGS. UP TO 5 ADDITIONAL MONITORING WELLS WILL BE INSTALLED.

SITES 4 AND 15 NOTES:

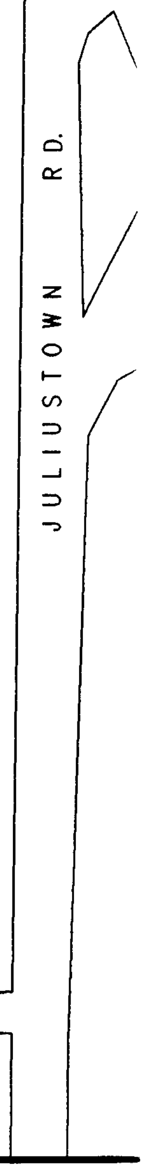
1. THIS FIGURE SHOWS APPROXIMATE LOCATIONS OF 14 OF THE PROPOSED 21 GEOPROBE/SCREENED AUGER EXPLORATION LOCATIONS. FINAL LOCATIONS AND NUMBERS OF EXPLORATIONS WILL BE DETERMINED DURING THE FIELD PROGRAM BASED ON FIELD SCREENING ANALYTICAL RESULTS.
2. LOCATIONS OF PROPOSED MONITORING WELLS (NOT SHOWN) WILL BE DETERMINED BASED ON FIELD SCREENING ANALYTICAL RESULTS FROM GEOPROBE EXPLORATIONS. 4 MONITORING WELL PAIRS (8 WELLS) AND UP TO 4 ADDITIONAL MONITORING WELLS ARE PROPOSED.

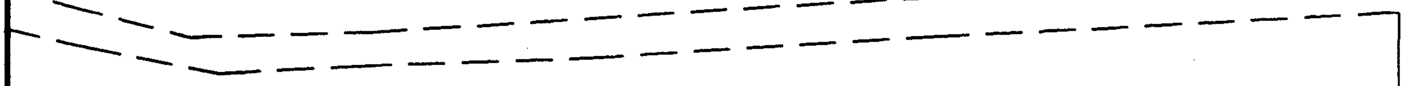
GENERAL NOTES:

1. LOCATIONS OF ALL PREVIOUS INVESTIGATIOINS ARE APPROXIMATE.
2. CAD BASE MAP SOURCE: FORT DIX



SCALE: 1"=100'





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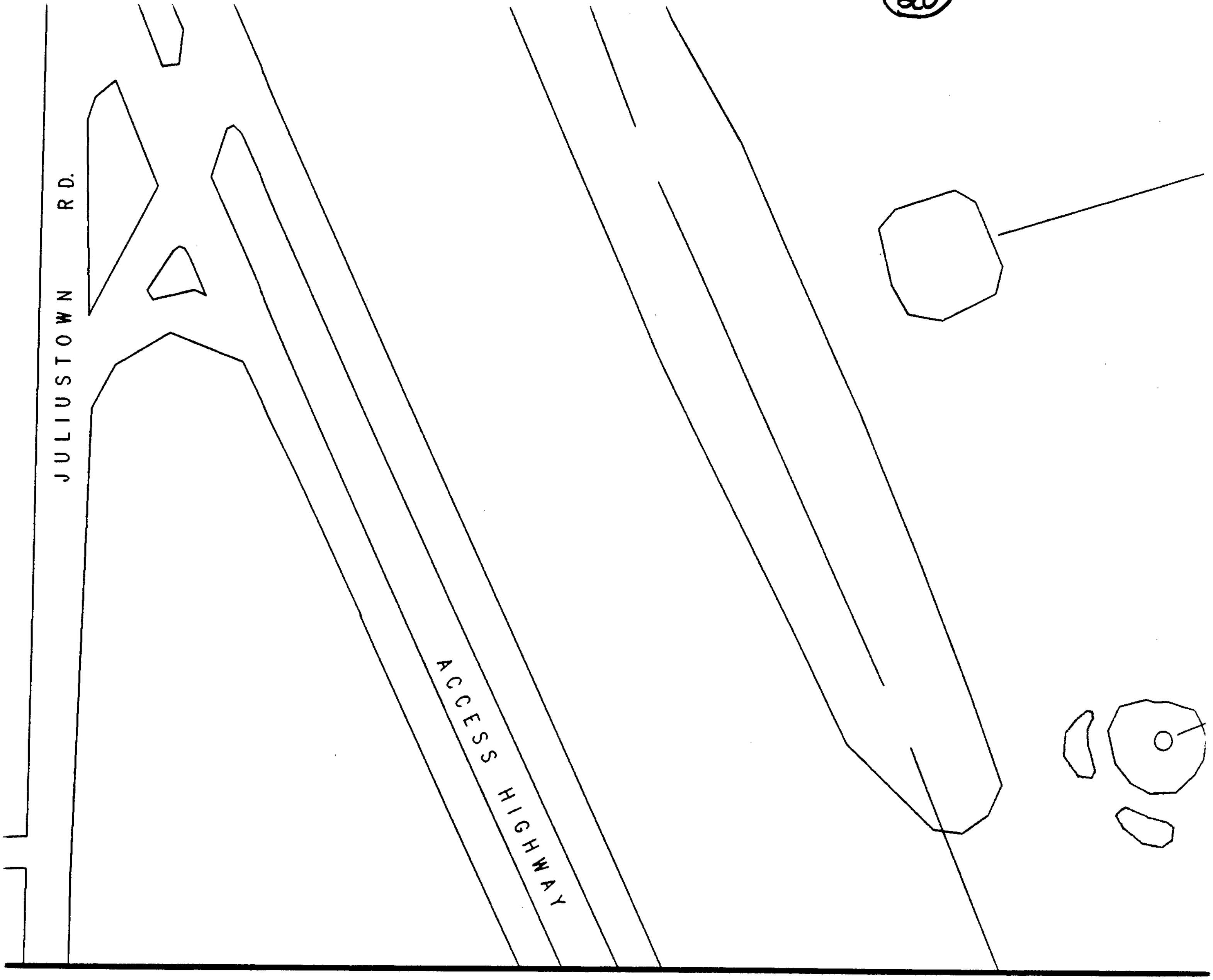
(20)



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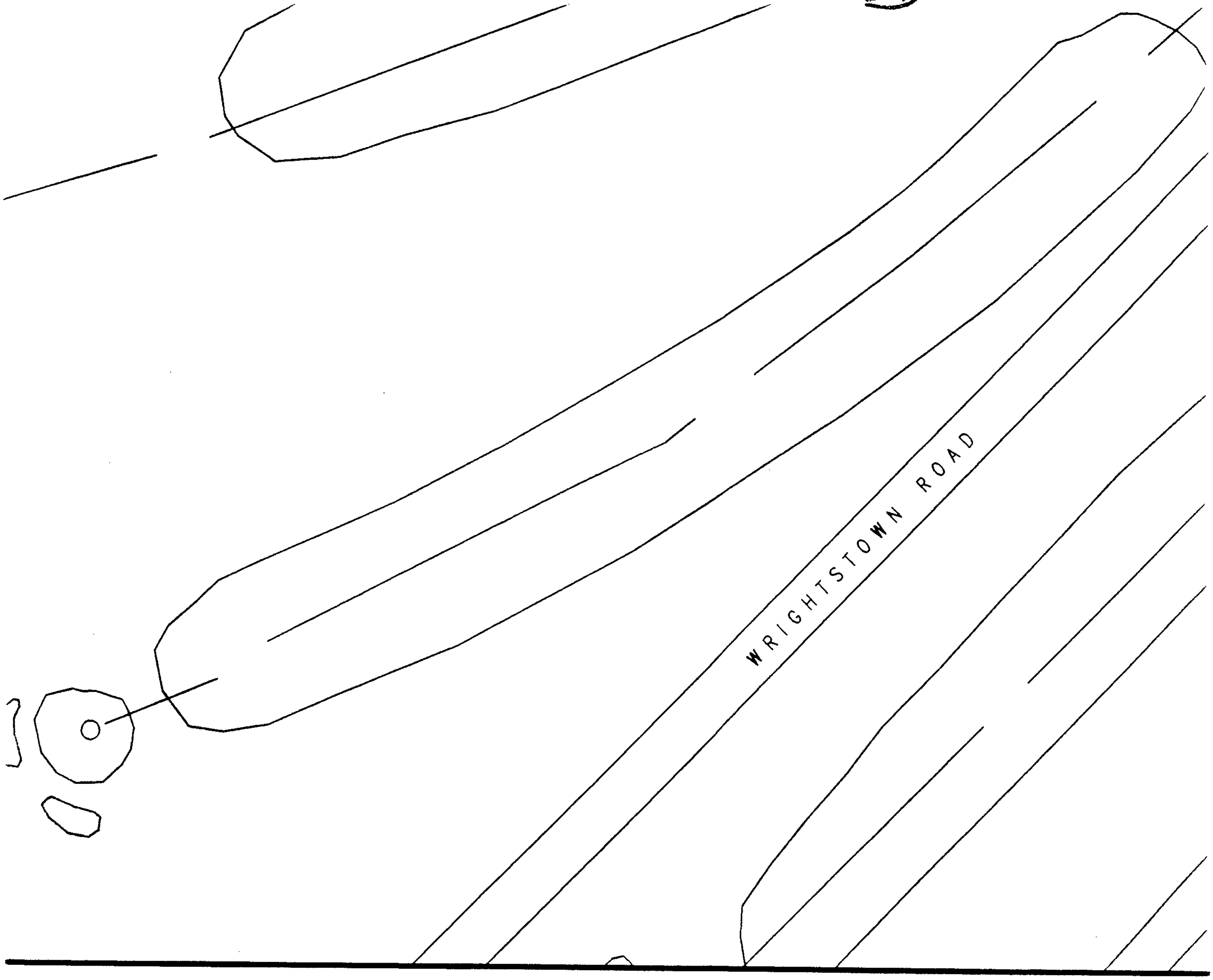
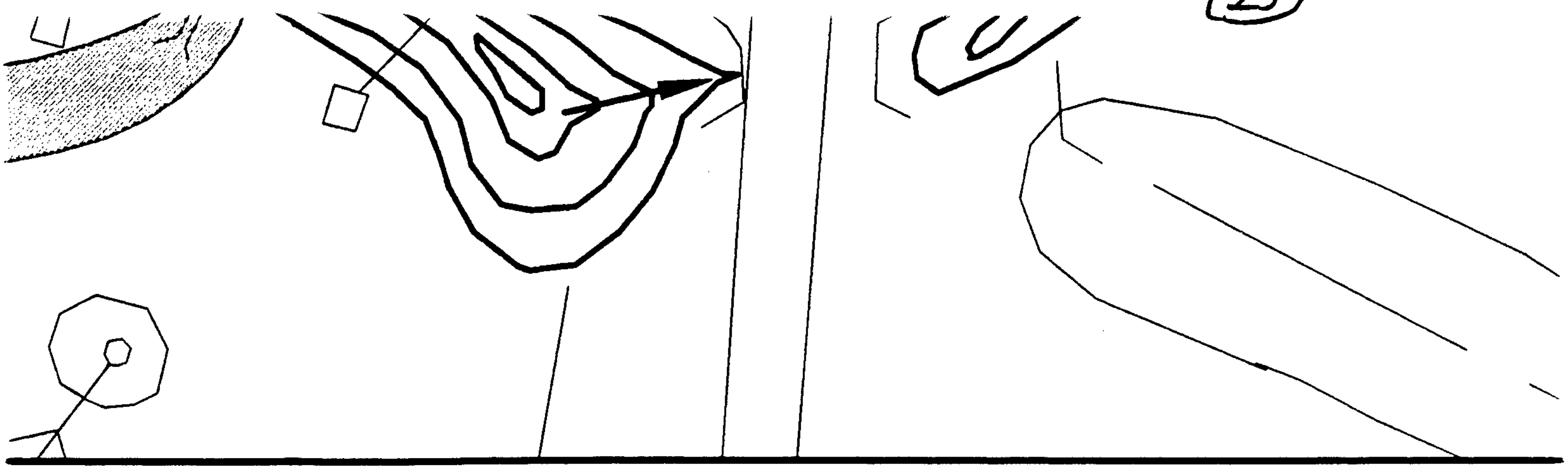

WRIGHTSTOWN ROAD

22

23



GOLF COURSE LEA
PESTICIDE
PETROLEUM, OIL, LUBRICA
F EXISTING AND PROPOSED INVES
FORT DIX RI/FS F

ABB Environmental

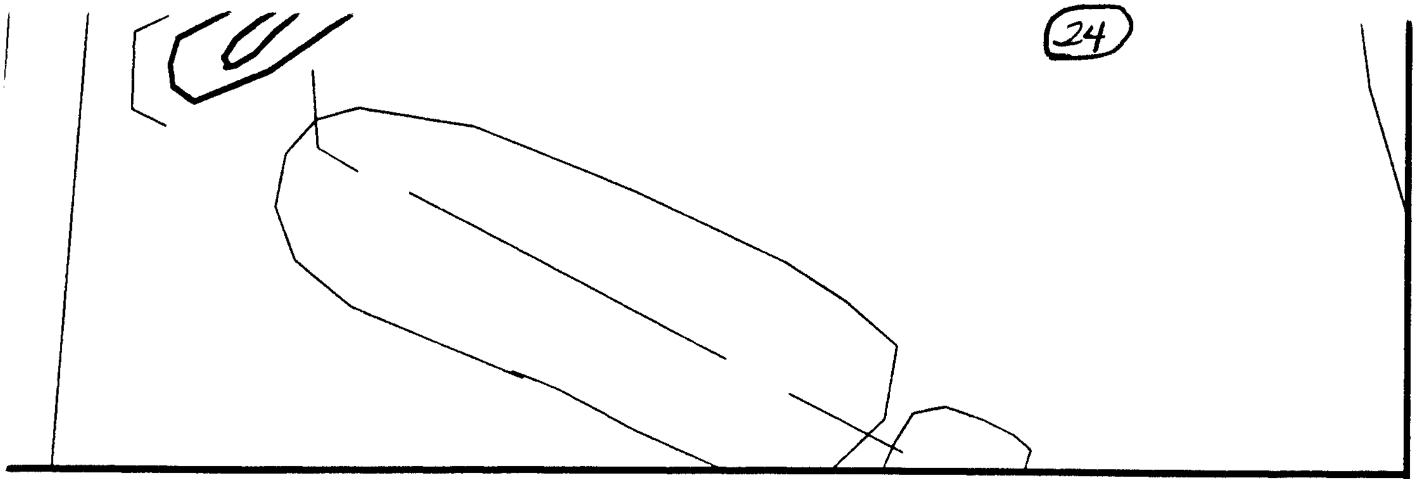
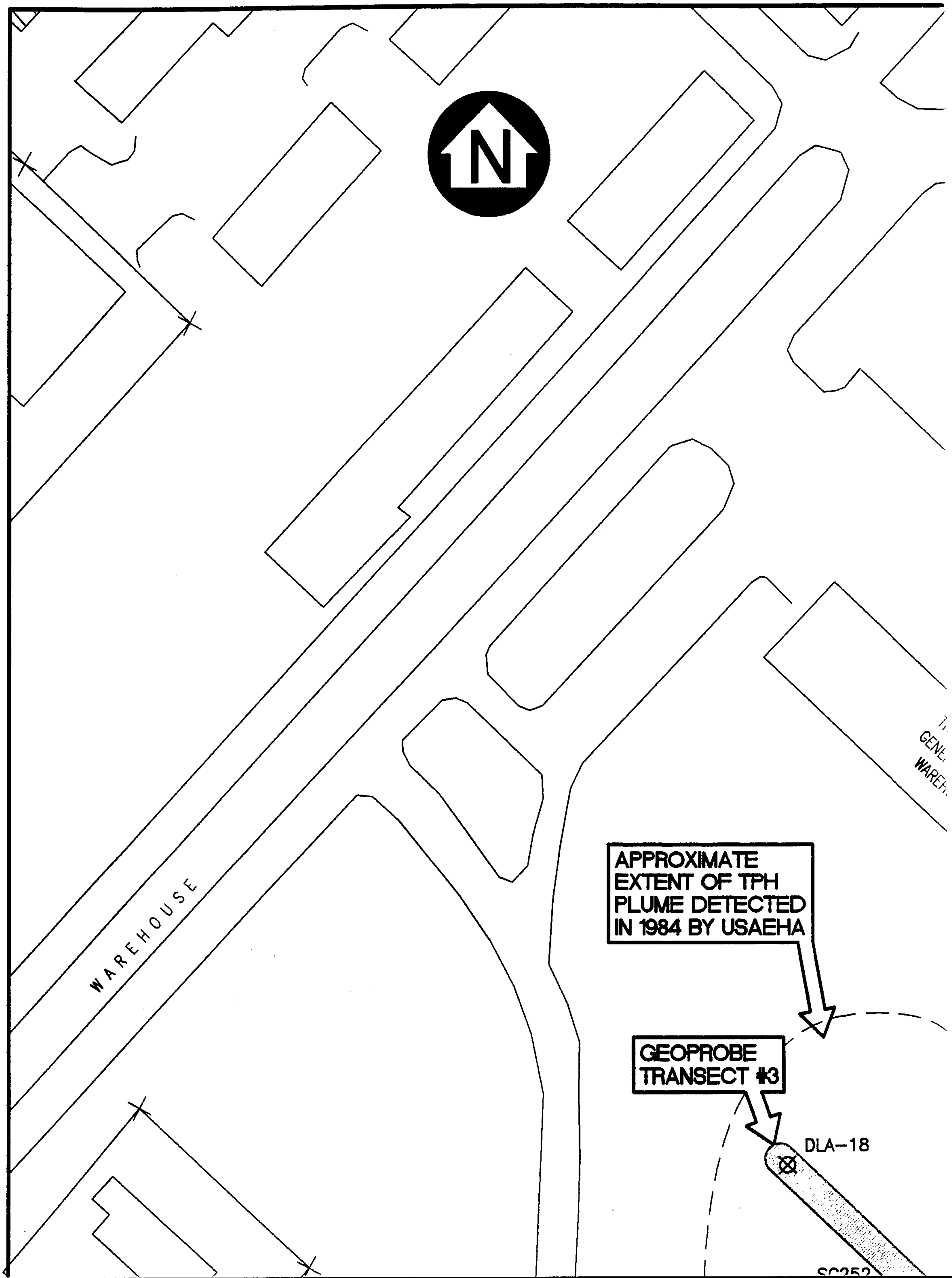
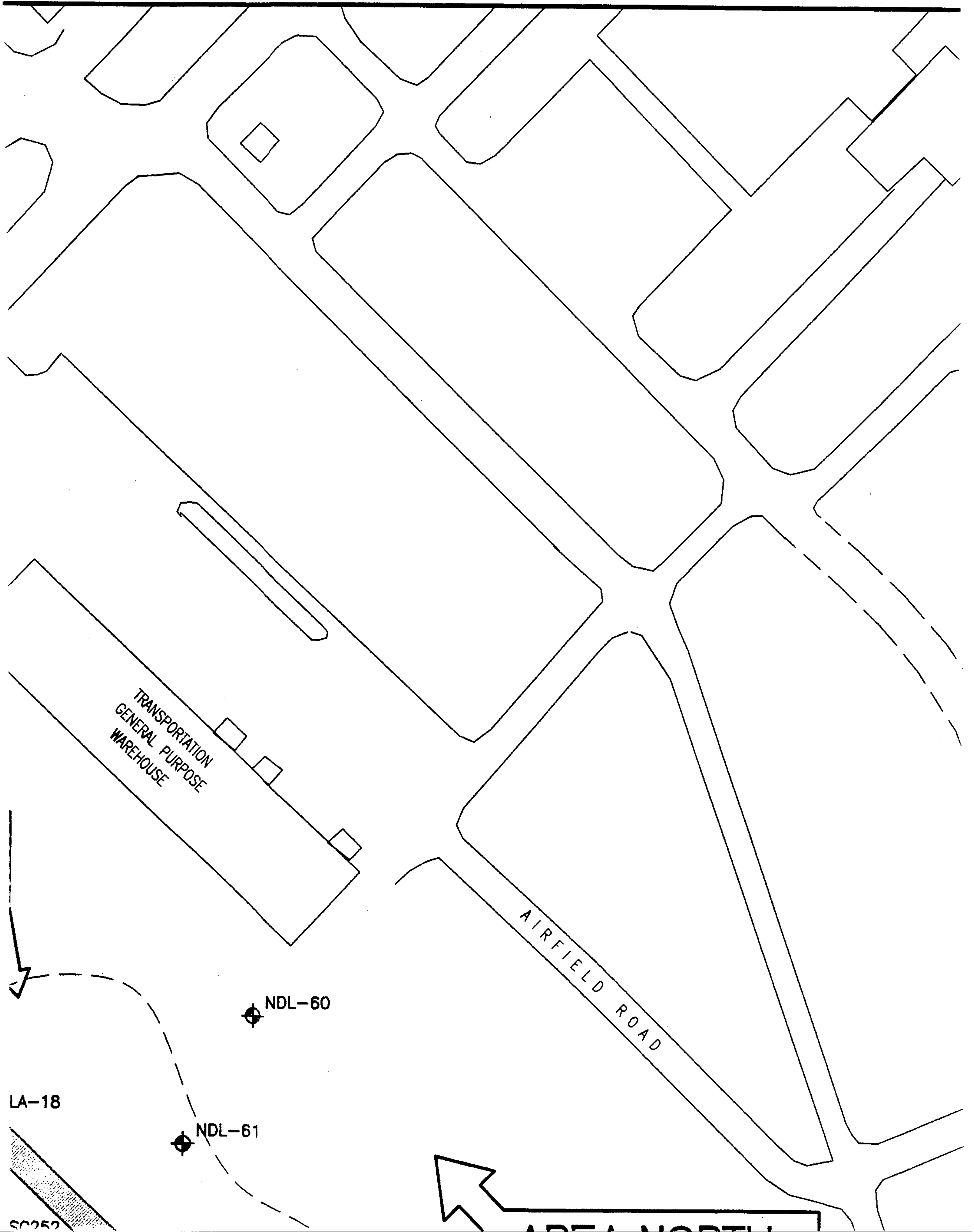


FIGURE 6
OLF COURSE LEAKING TANK, PESTICIDE MIXING AND UM, OIL, LUBRICANTS AREAS PROPOSED INVESTIGATIONS
FORT DIX RI/FS FOR 13 SITES

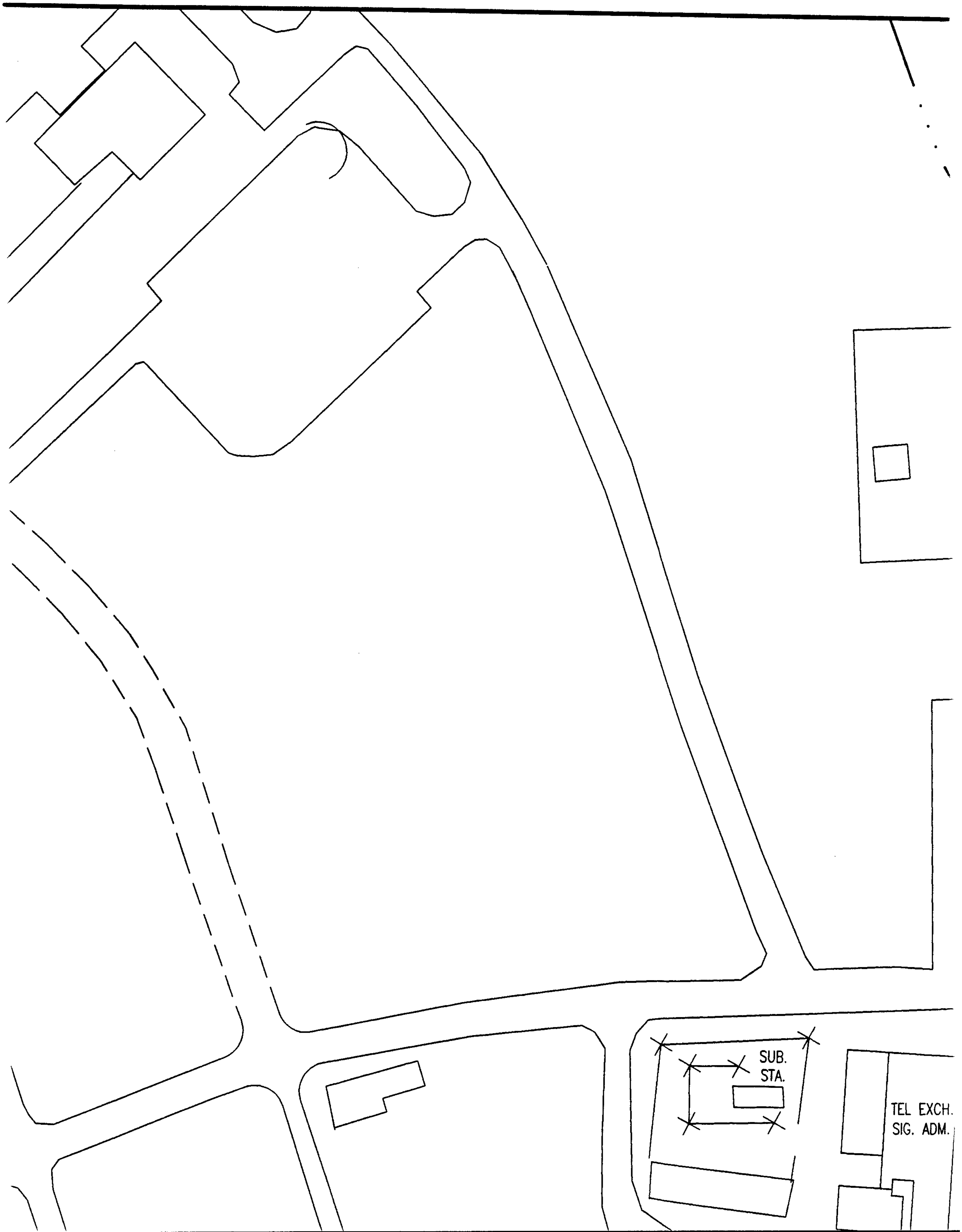
— ABB Environmental Services, Inc.

①


N
WAREHOUSE
GENE
WAREH
APPROXIMATE EXTENT OF TPH PLUME DETECTED IN 1984 BY USAEHA
GEOPROBE TRANSECT #3
DLA-18
SC252


TRANSPORTATION
GENERAL PURPOSE
WAREHOUSE
AIRFIELD ROAD
NDL-60
NDL-61
LA-18
SC252
AREA NORTH

③



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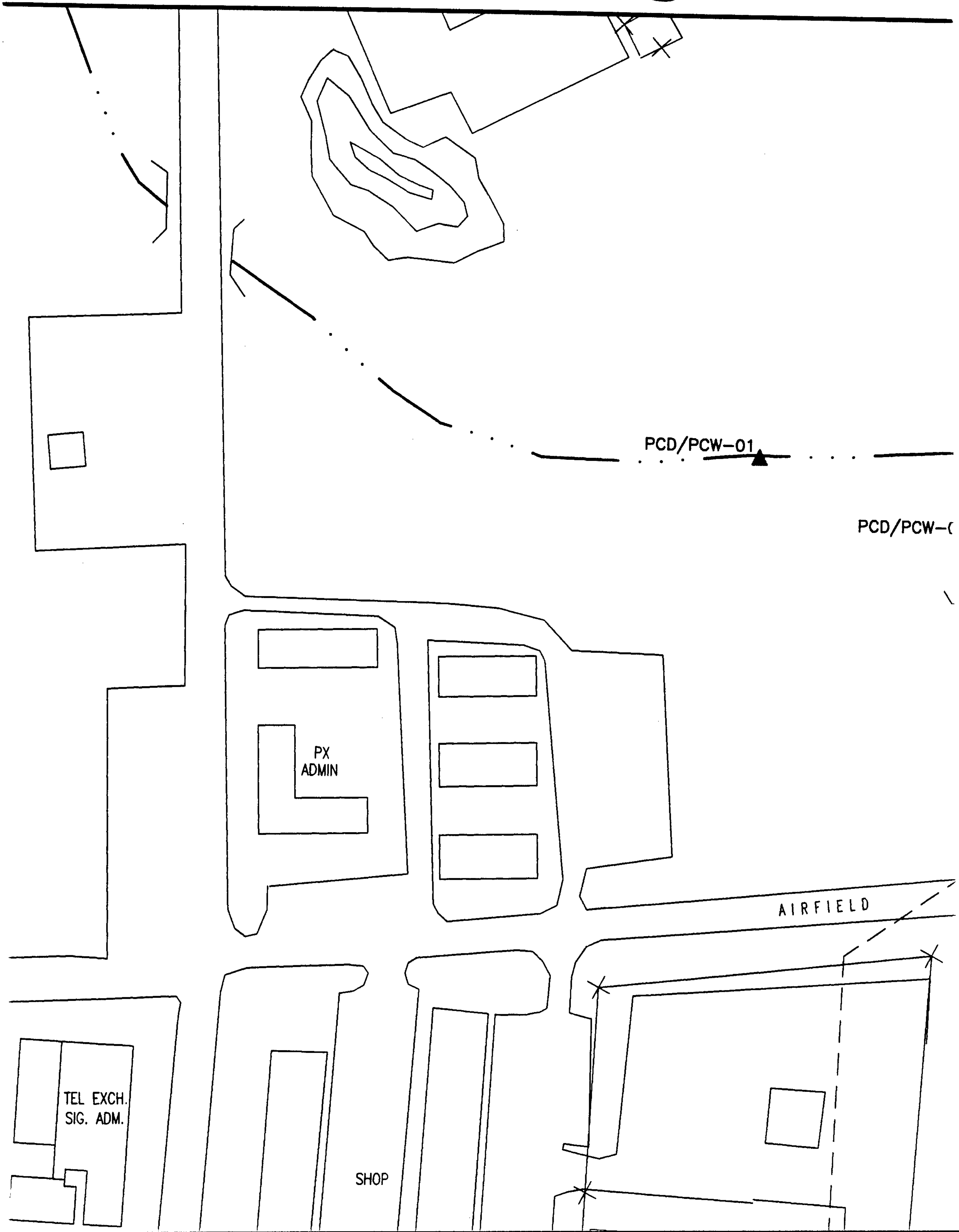
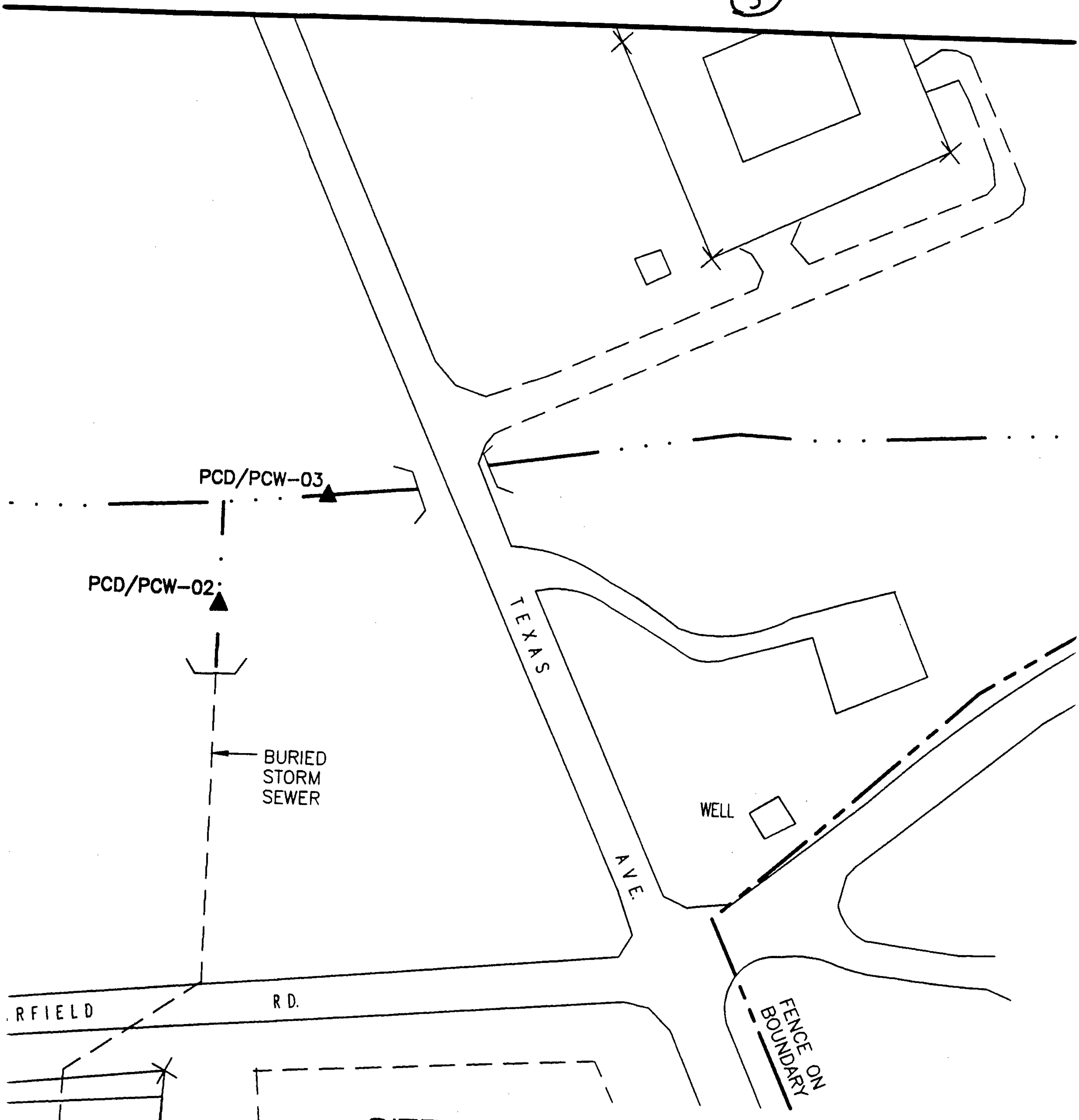


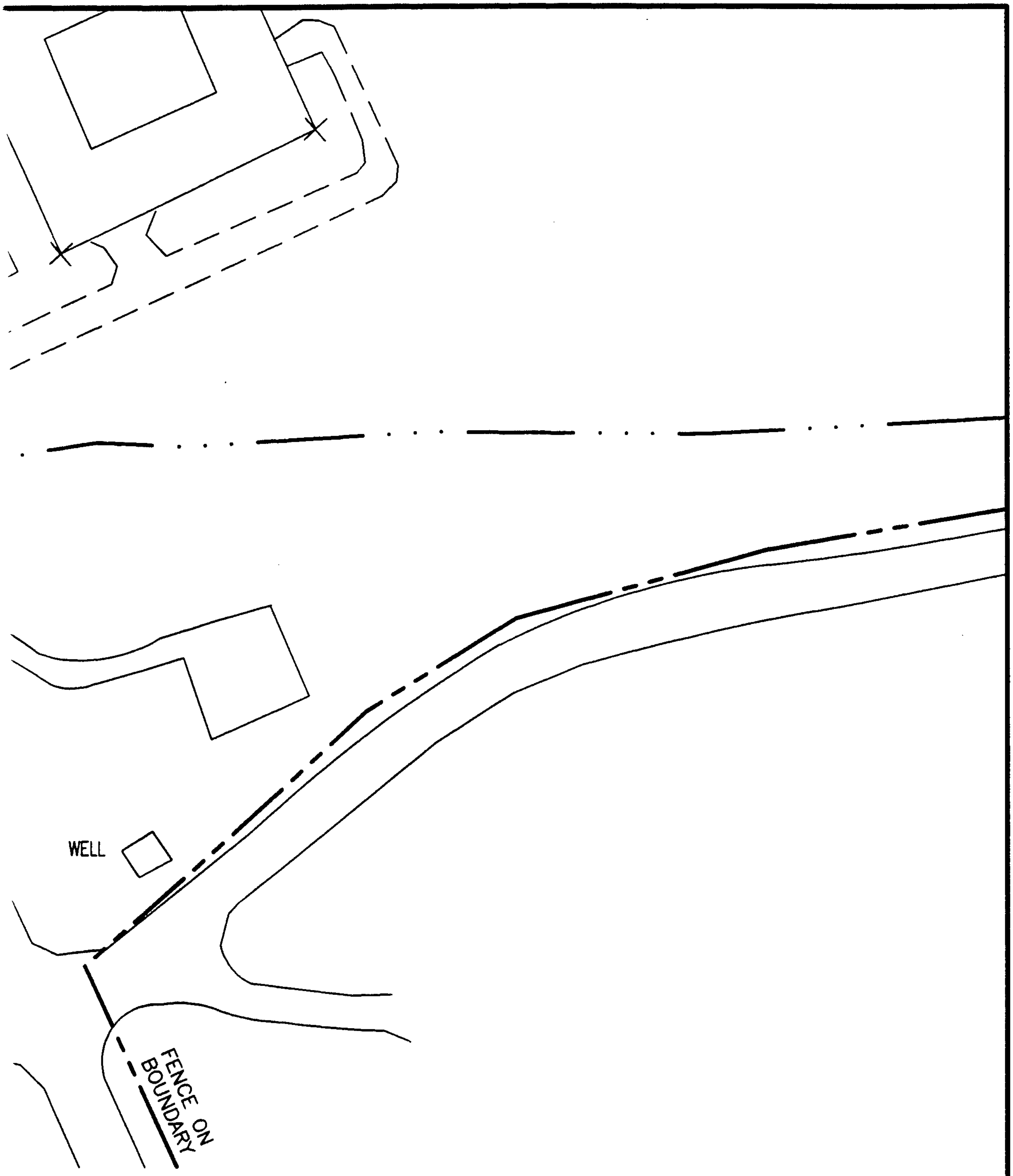
⑤



SITE 3 NOTES:

1. LOCATIONS OF FIELD SCREENING SOIL BORINGS ARE APPROXIMATE AND ON FIELD SCREENING ANALYTICAL RESULTS.
2. LOCATIONS AND NUMBER OF PROPOSED MONITORING WELLS (NOT SHOW BASED ON SOIL BORING FIELD SCREENING ANALYTICAL RESULTS. UP TO WELLS WILL BE INSTALLED IF NECESSARY.

SITE 5 NOTES:

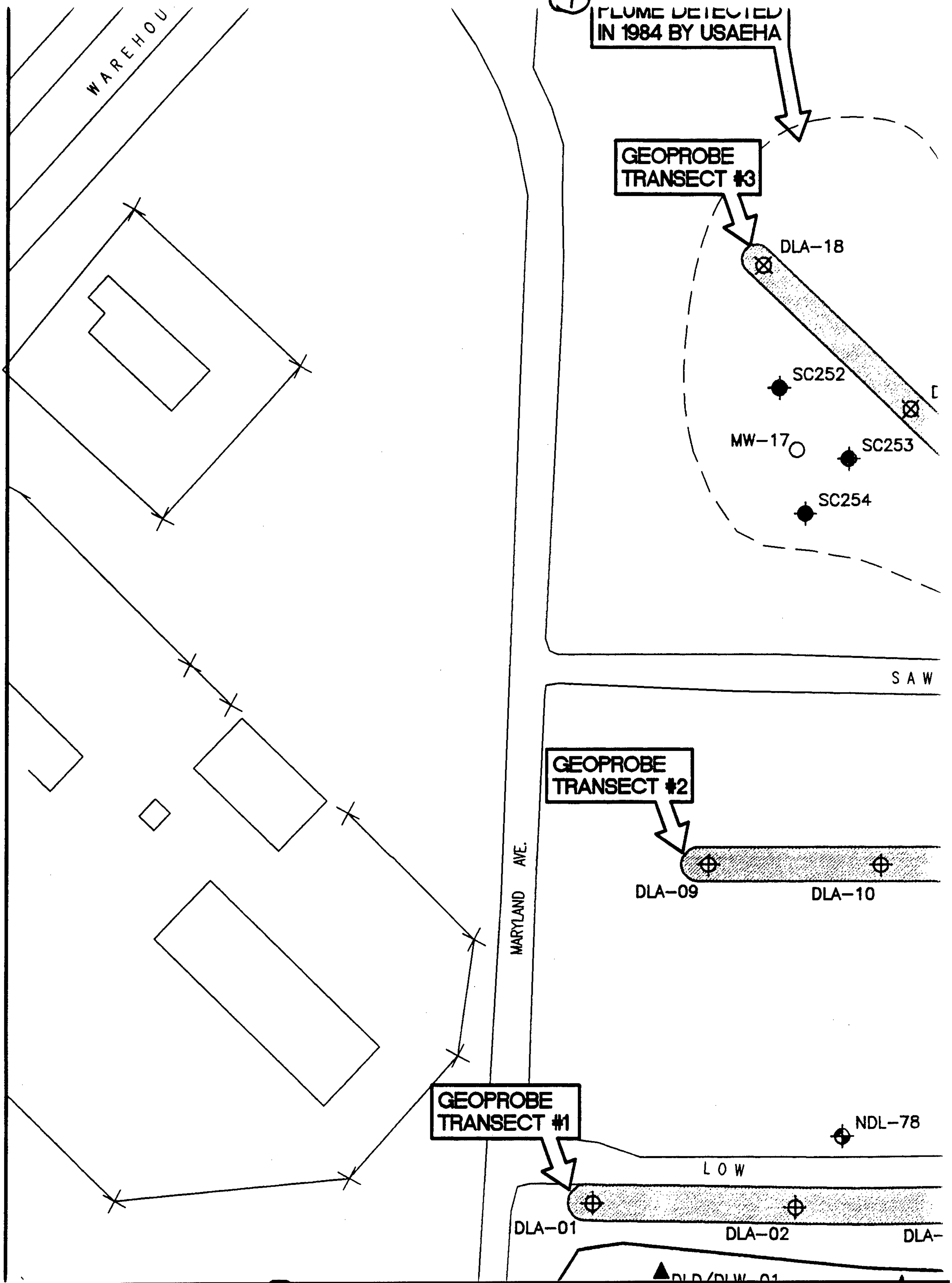


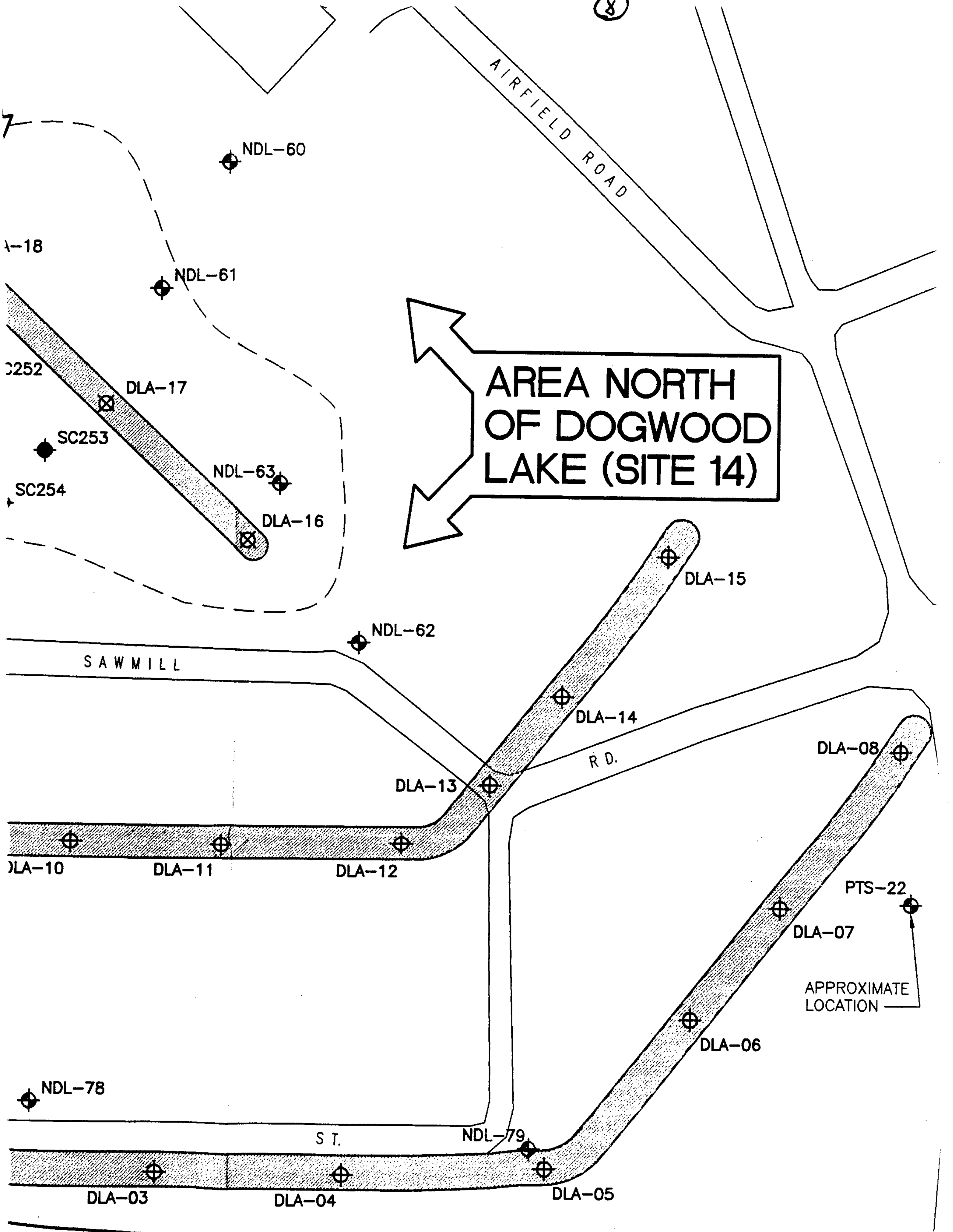
EENING SOIL BORINGS ARE APPROXIMATE AND WILL BE ADJUSTED BASED
ALYTICAL RESULTS.

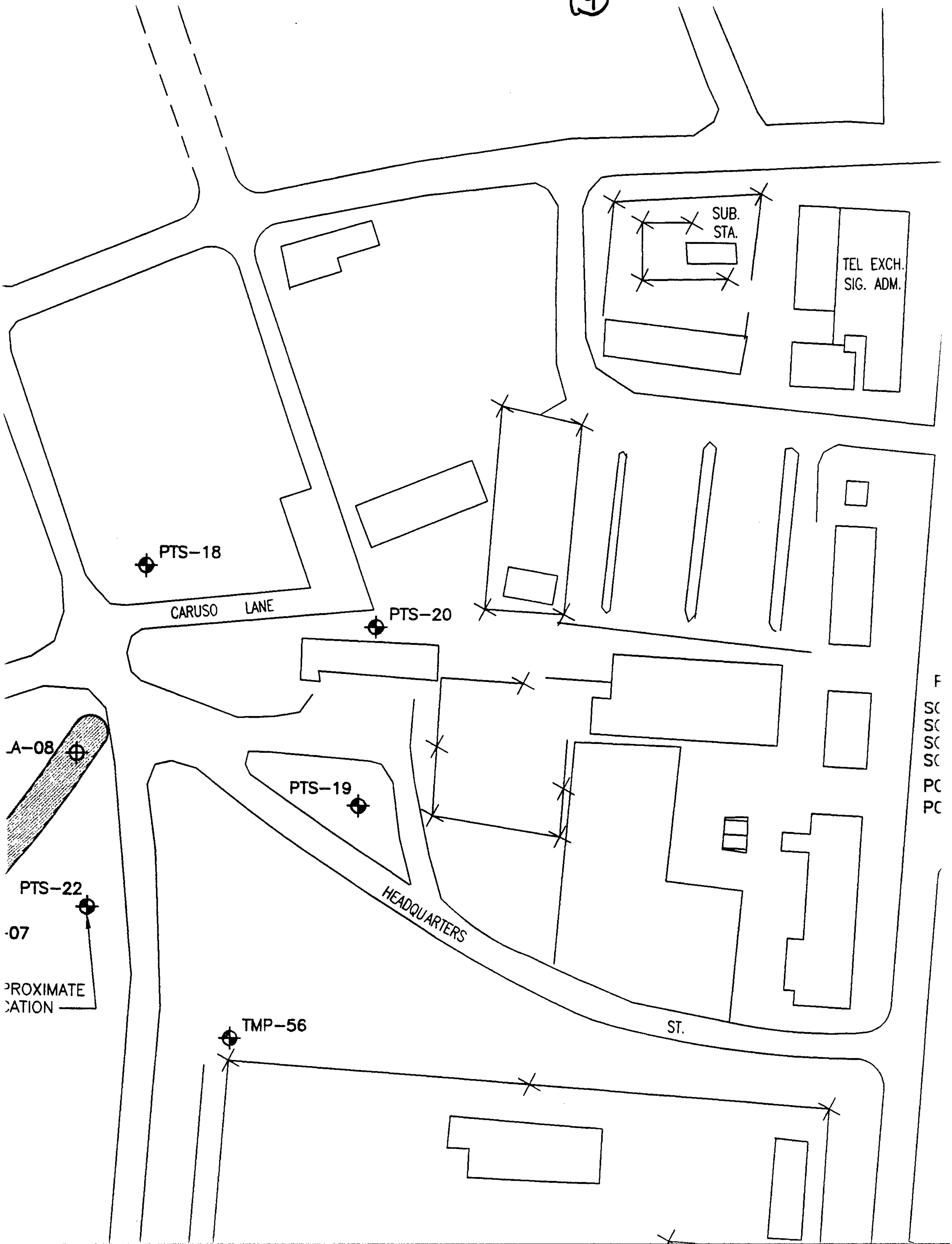
OF PROPOSED MONITORING WELLS (NOT SHOWN) WILL BE DETERMINED
FIELD SCREENING ANALYTICAL RESULTS. UP TO 6 ADDITIONAL MONITORING
) IF NECESSARY.

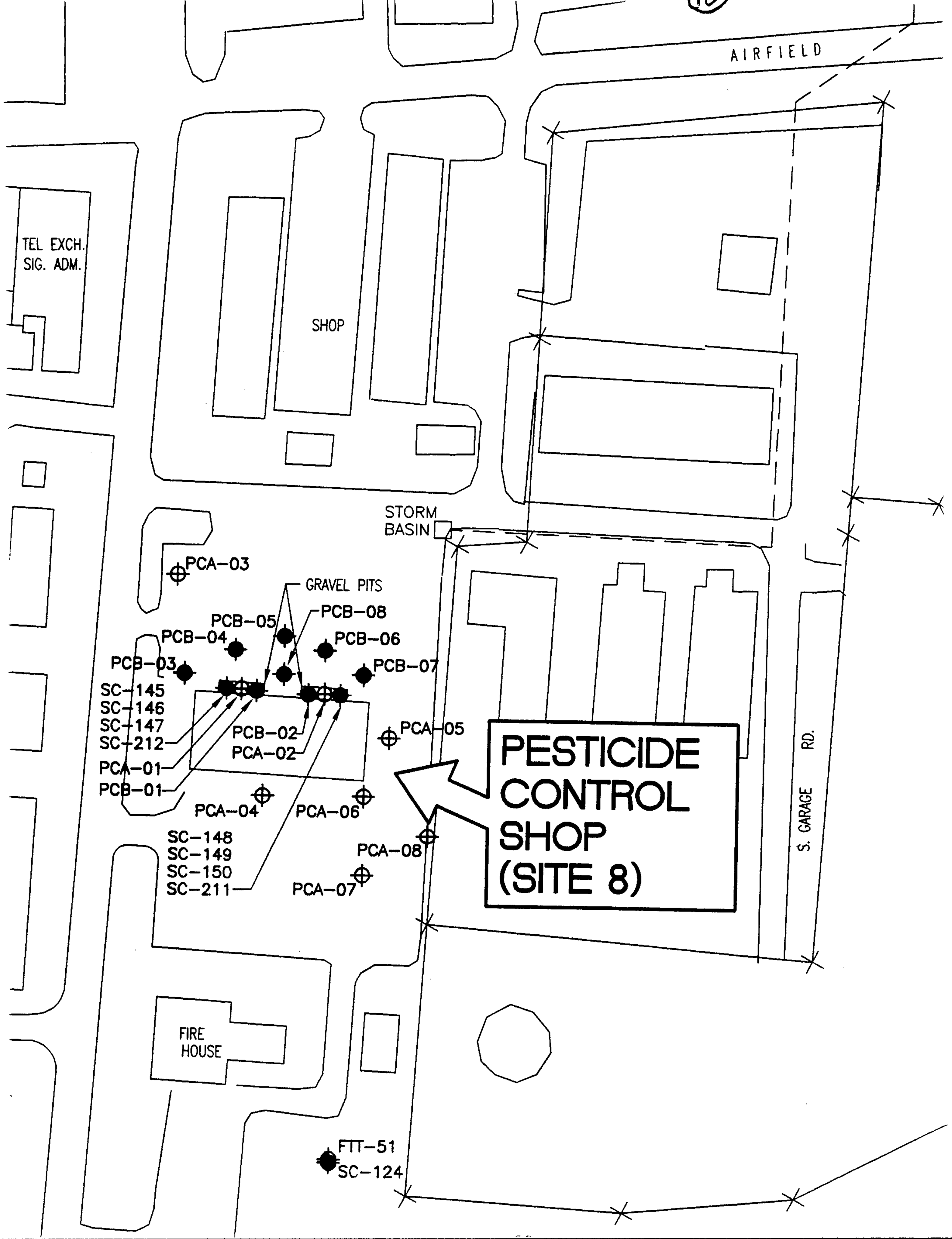
ATIONS WILL CONSIST OF 10 GEOPROBE/SCREENED AUGER EXPLORATIONS FOR GROUNDWATER

⑦

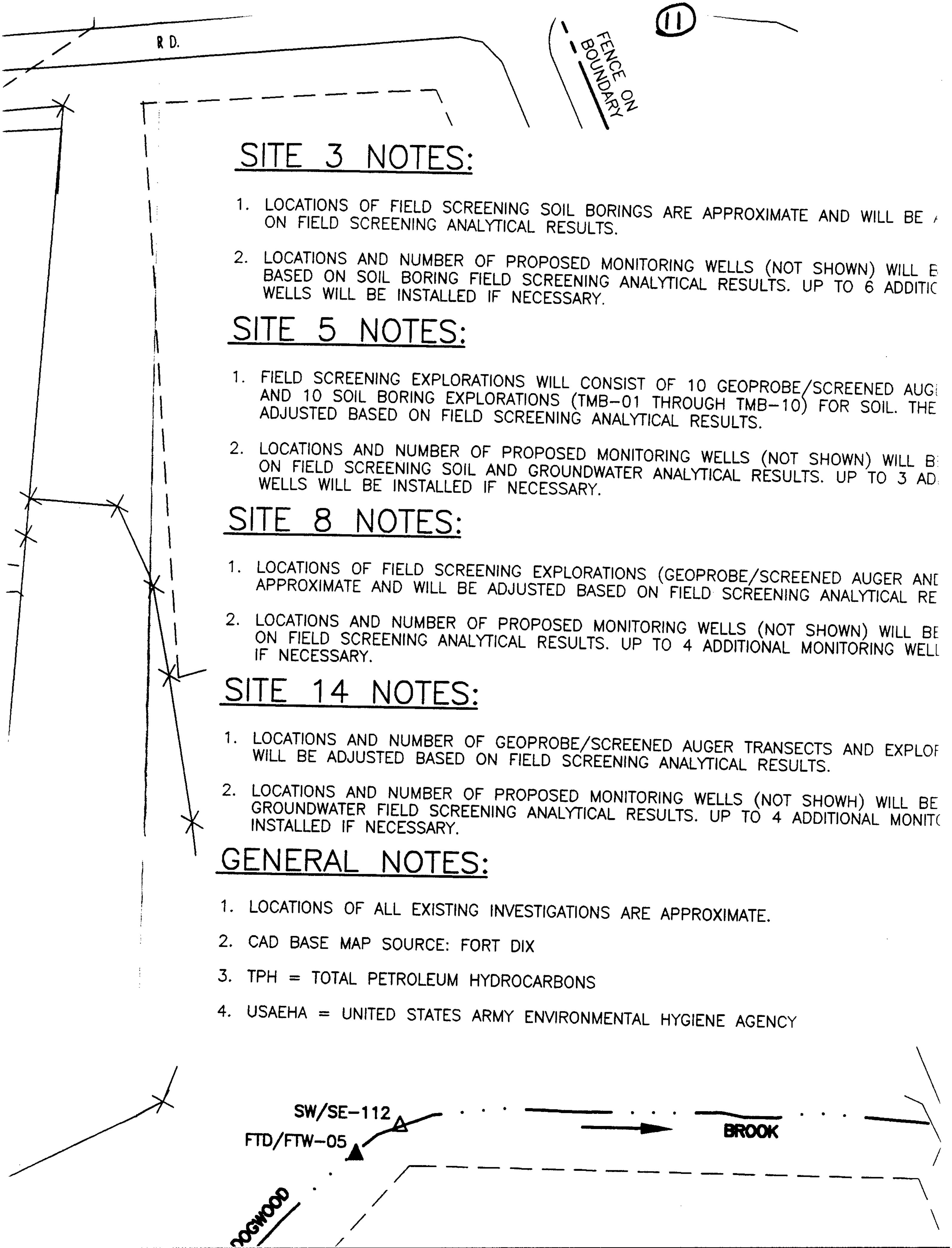

PLUME DETECTED
IN 1984 BY USAEHA
WAREHOU
GEOPROBE TRANSECT #3
DLA-18
SC252
MW-17
SC253
SC254
SAW
GEOPROBE TRANSECT #2
DLA-09
DLA-10
MARYLAND AVE.
GEOPROBE TRANSECT #1
NDL-78
LOW
DLA-01
DLA-02
DLA-
DLD/DLW-01


7
AIRFIELD ROAD
NDL-60
-18
NDL-61
252
DLA-17
SC253
NDL-63
SC254
DLA-16
AREA NORTH OF DOGWOOD LAKE (SITE 14)
DLA-15
NDL-62
SAWMILL RD.
DLA-14
DLA-08
DLA-13
LA-10
DLA-11
DLA-12
PTS-22
DLA-07
APPROXIMATE LOCATION
DLA-06
NDL-78
ST.
NDL-79
DLA-03
DLA-04
DLA-05


SUB.
STA.
TEL EXCH.
SIG. ADM.
PTS-18
CARUSO LANE
PTS-20
A-08
PTS-19
PTS-22
-07
PROXIMATE
CATION
HEADQUARTERS
ST.
TMP-56


AIRFIELD
TEL EXCH.
SIG. ADM.
SHOP
STORM
BASIN
PCA-03
GRAVEL PITS
PCB-05
PCB-08
PCB-04
PCB-06
PCB-03
PCB-07
SC-145
SC-146
SC-147
SC-212
PCA-01
PCB-01
PCB-02
PCA-02
PCA-05
PCA-04
PCA-06
SC-148
SC-149
SC-150
SC-211
PCA-08
PCA-07
PESTICIDE
CONTROL
SHOP
(SITE 8)
S. GARAGE RD.
FIRE
HOUSE
FTT-51
SC-124

⑪



SITE 3 NOTES:

1. LOCATIONS OF FIELD SCREENING SOIL BORINGS ARE APPROXIMATE AND WILL BE ON FIELD SCREENING ANALYTICAL RESULTS.
2. LOCATIONS AND NUMBER OF PROPOSED MONITORING WELLS (NOT SHOWN) WILL BASED ON SOIL BORING FIELD SCREENING ANALYTICAL RESULTS. UP TO 6 ADDITI WELLS WILL BE INSTALLED IF NECESSARY.

SITE 5 NOTES:

1. FIELD SCREENING EXPLORATIONS WILL CONSIST OF 10 GEOPROBE/SCREENED AUG AND 10 SOIL BORING EXPLORATIONS (TMB-01 THROUGH TMB-10) FOR SOIL. THE ADJUSTED BASED ON FIELD SCREENING ANALYTICAL RESULTS.
2. LOCATIONS AND NUMBER OF PROPOSED MONITORING WELLS (NOT SHOWN) WILL B ON FIELD SCREENING SOIL AND GROUNDWATER ANALYTICAL RESULTS. UP TO 3 AD WELLS WILL BE INSTALLED IF NECESSARY.

SITE 8 NOTES:

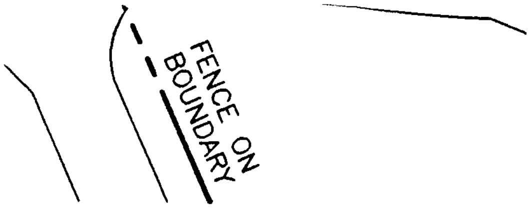
1. LOCATIONS OF FIELD SCREENING EXPLORATIONS (GEOPROBE/SCREENED AUGER AN APPROXIMATE AND WILL BE ADJUSTED BASED ON FIELD SCREENING ANALYTICAL RE
2. LOCATIONS AND NUMBER OF PROPOSED MONITORING WELLS (NOT SHOWN) WILL BE ON FIELD SCREENING ANALYTICAL RESULTS. UP TO 4 ADDITIONAL MONITORING WELL IF NECESSARY.

SITE 14 NOTES:

1. LOCATIONS AND NUMBER OF GEOPROBE/SCREENED AUGER TRANSECTS AND EXPLO WILL BE ADJUSTED BASED ON FIELD SCREENING ANALYTICAL RESULTS.
2. LOCATIONS AND NUMBER OF PROPOSED MONITORING WELLS (NOT SHOWH) WILL BE GROUNDWATER FIELD SCREENING ANALYTICAL RESULTS. UP TO 4 ADDITIONAL MONIT INSTALLED IF NECESSARY.

GENERAL NOTES:

1. LOCATIONS OF ALL EXISTING INVESTIGATIONS ARE APPROXIMATE.
2. CAD BASE MAP SOURCE: FORT DIX
3. TPH = TOTAL PETROLEUM HYDROCARBONS
4. USAEHA = UNITED STATES ARMY ENVIRONMENTAL HYGIENE AGENCY



ENING SOIL BORINGS ARE APPROXIMATE AND WILL BE ADJUSTED BASED
YTICAL RESULTS.

F PROPOSED MONITORING WELLS (NOT SHOWN) WILL BE DETERMINED
ELD SCREENING ANALYTICAL RESULTS. UP TO 6 ADDITIONAL MONITORING
IF NECESSARY.

TIONS WILL CONSIST OF 10 GEOPROBE/SCREENED AUGER EXPLORATIONS FOR GROUNDWATER
ORATIONS (TMB-01 THROUGH TMB-10) FOR SOIL. THE NUMBER OF EXPLORATIONS WILL BE
SCREENING ANALYTICAL RESULTS.

PROPOSED MONITORING WELLS (NOT SHOWN) WILL BE DETERMINED BASED
AND GROUNDWATER ANALYTICAL RESULTS. UP TO 3 ADDITIONAL MONITORING
IF NECESSARY.

NING EXPLORATIONS (GEOPROBE/SCREENED AUGER AND SOIL BORING) ARE
ADJUSTED BASED ON FIELD SCREENING ANALYTICAL RESULTS.

PROPOSED MONITORING WELLS (NOT SHOWN) WILL BE DETERMINED BASED
TICAL RESULTS. UP TO 4 ADDITIONAL MONITORING WELLS WILL BE INSTALLED

GEOPROBE/SCREENED AUGER TRANSECTS AND EXPLORATIONS ARE APPROXIMATE AND
)N FIELD SCREENING ANALYTICAL RESULTS.

PROPOSED MONITORING WELLS (NOT SHOWH) WILL BE DETERMINED BASED ON
NING ANALYTICAL RESULTS. UP TO 4 ADDITIONAL MONITORING WELLS WILL BE

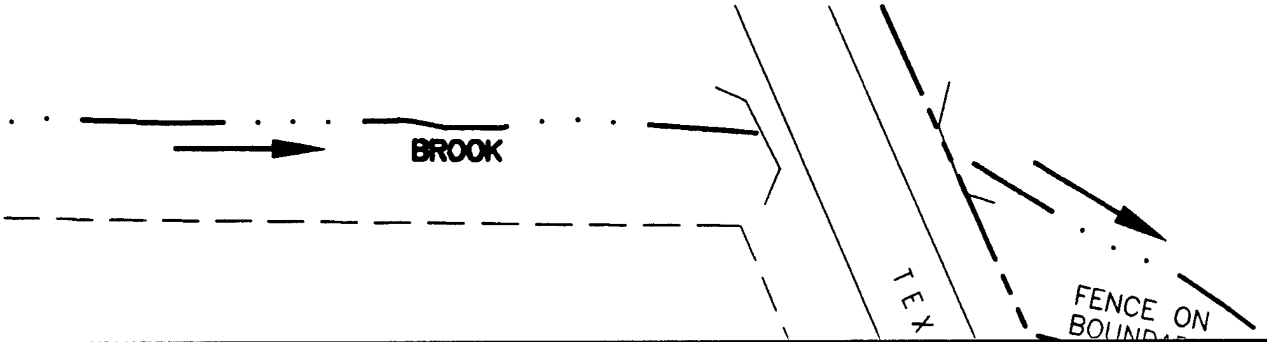
:

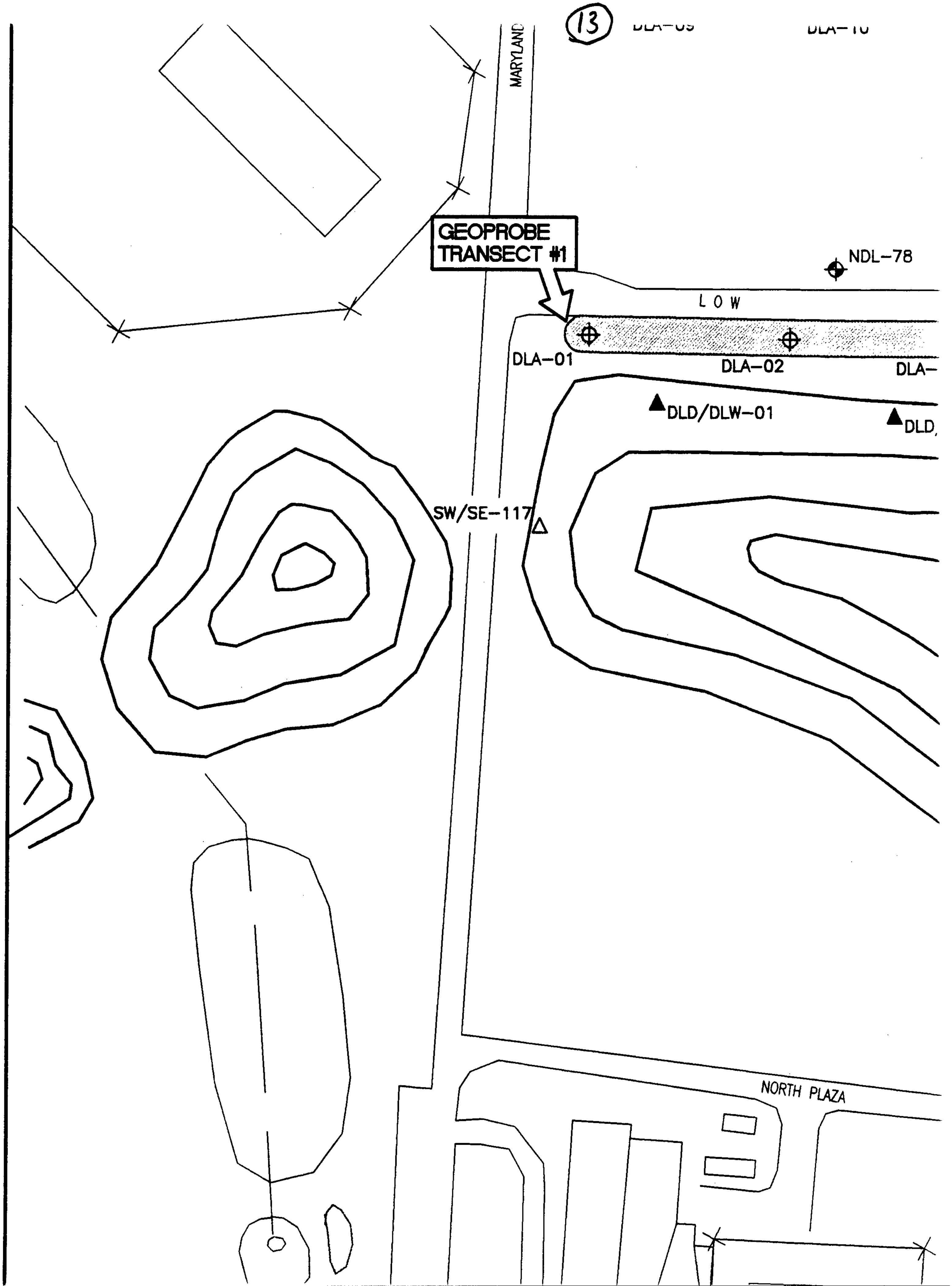
INVESTIGATIONS ARE APPROXIMATE.

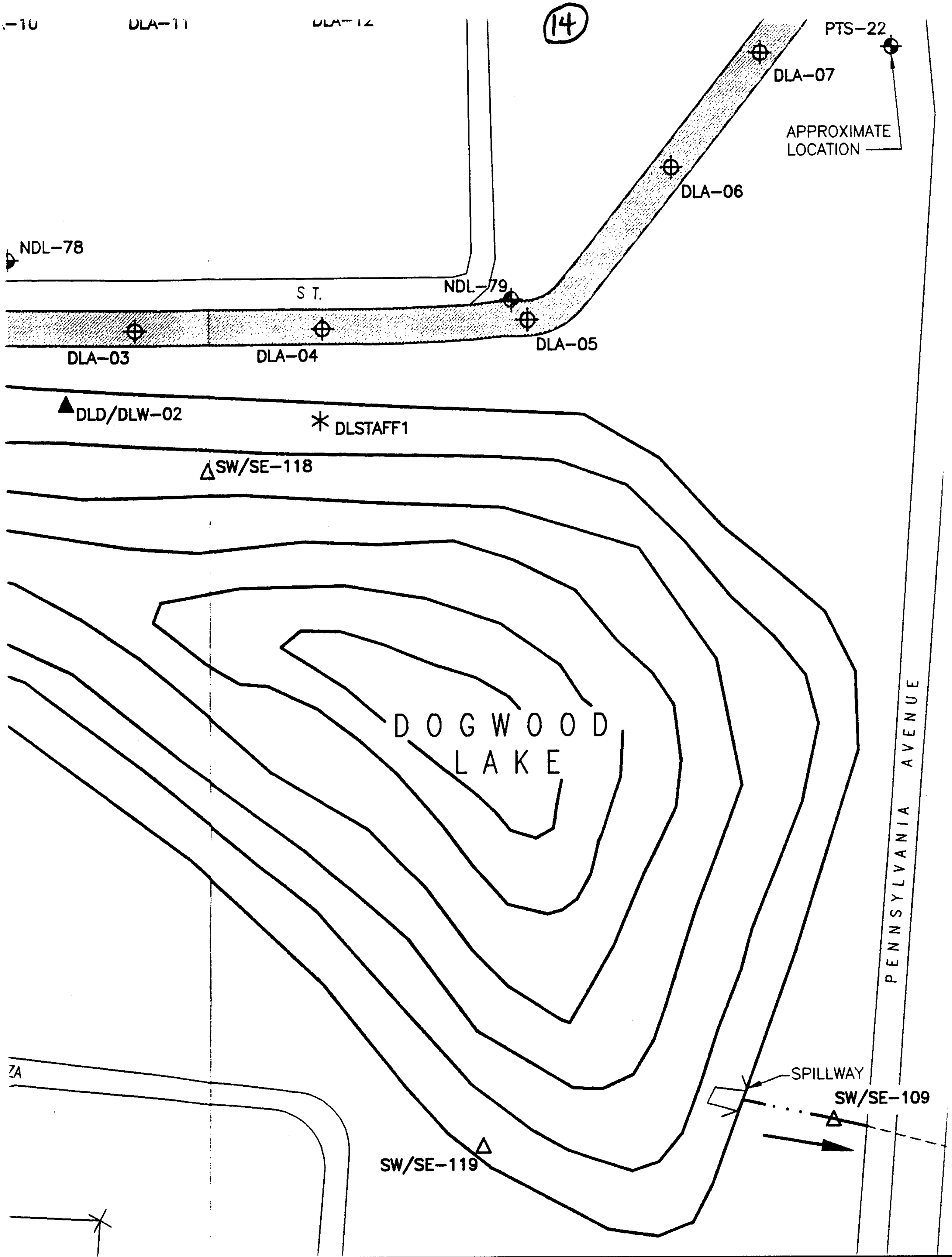
RT DIX

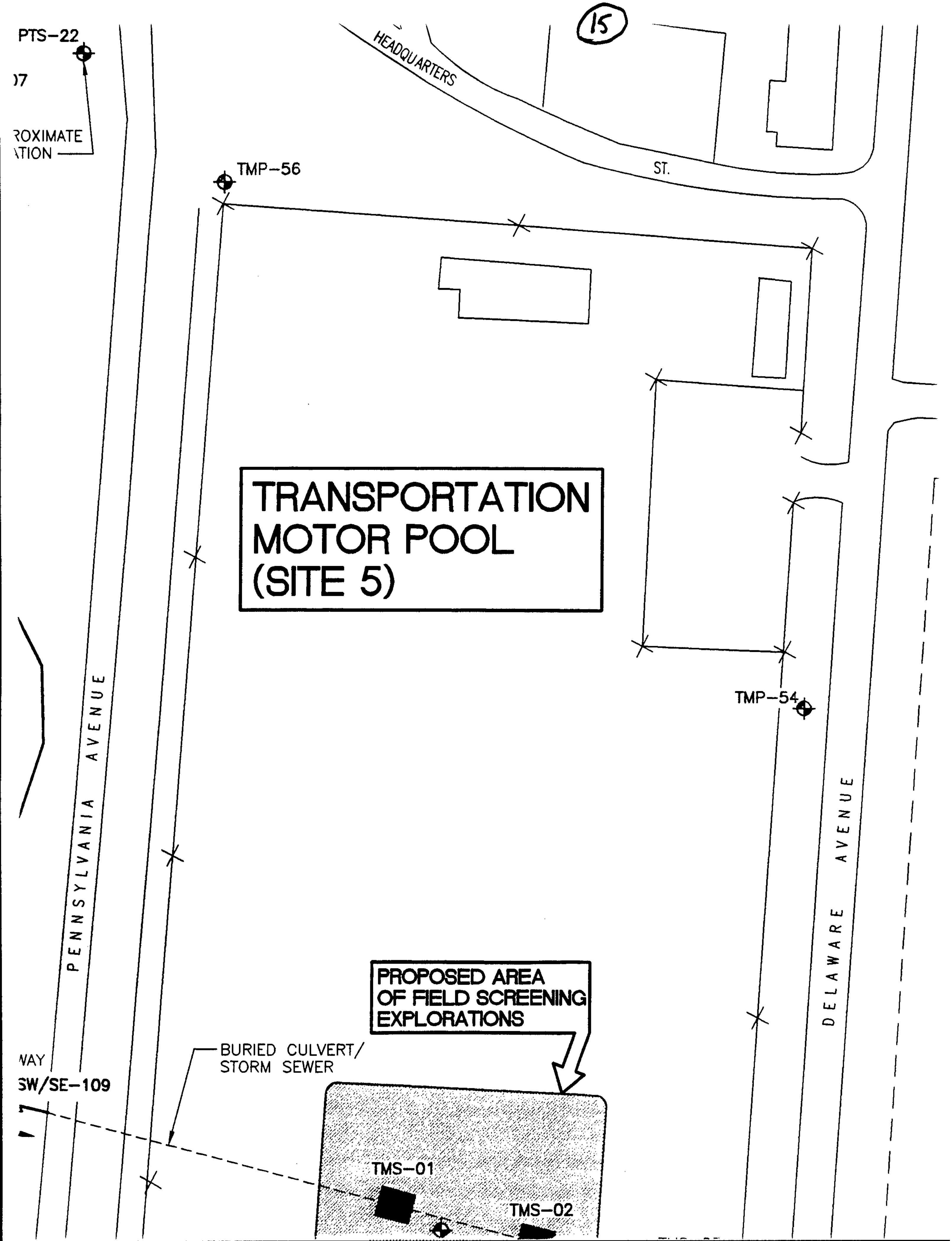
YDROCARBONS

RMY ENVIRONMENTAL HYGIENE AGENCY

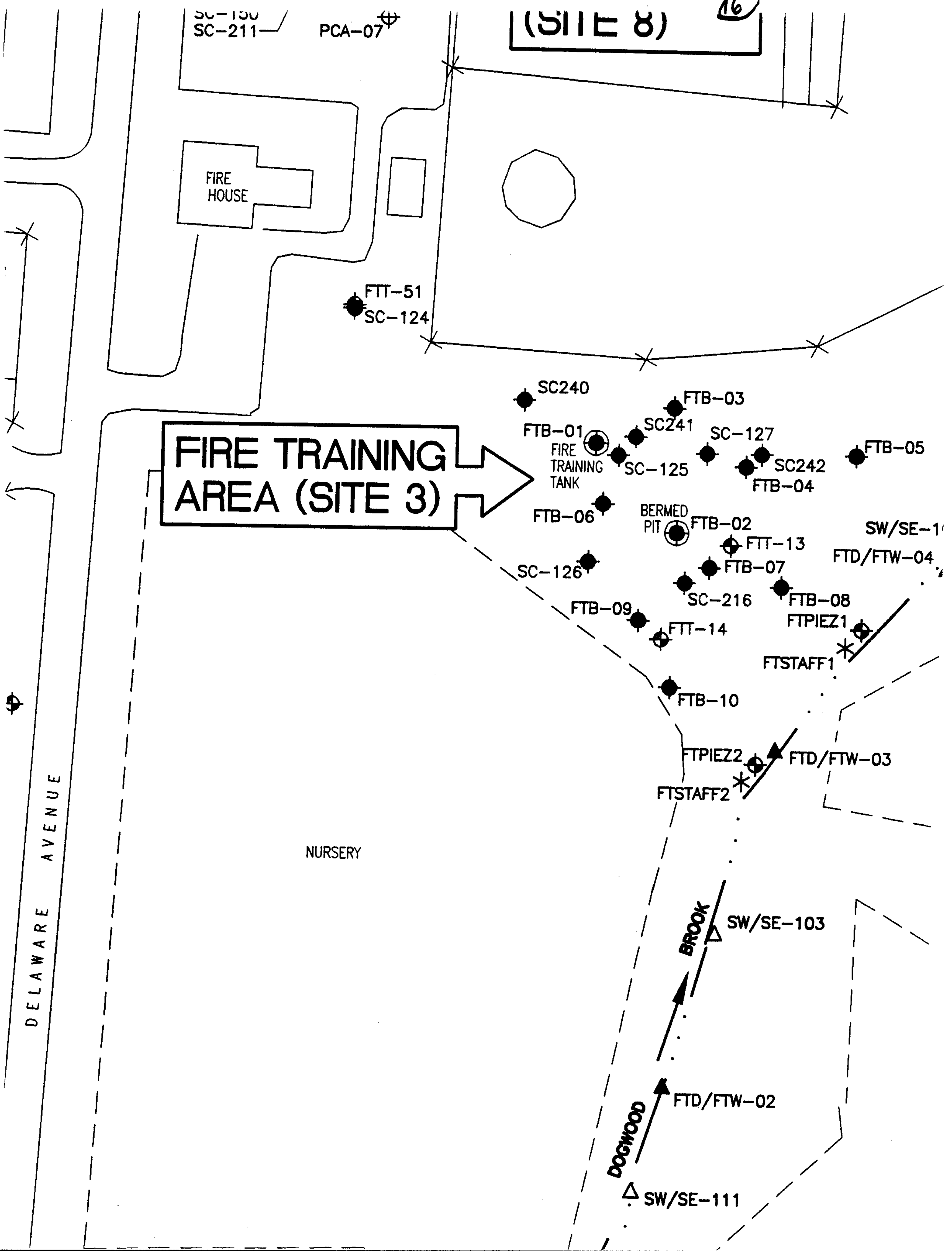



MARYLAND
GEOPROBE TRANSECT #1
NDL-78
LOW
DLA-01
DLA-02
DLA-
DLD/DLW-01
DLD
SW/SE-117
NORTH PLAZA


DLA-11
DLA-12
PTS-22
DLA-07
APPROXIMATE LOCATION
DLA-06
NDL-78
S T.
NDL-79
DLA-03
DLA-04
DLA-05
DLD/DLW-02
DLSTAFF1
SW/SE-118
DOGWOOD LAKE
PENNSYLVANIA AVENUE
SPILLWAY
SW/SE-109
SW/SE-119

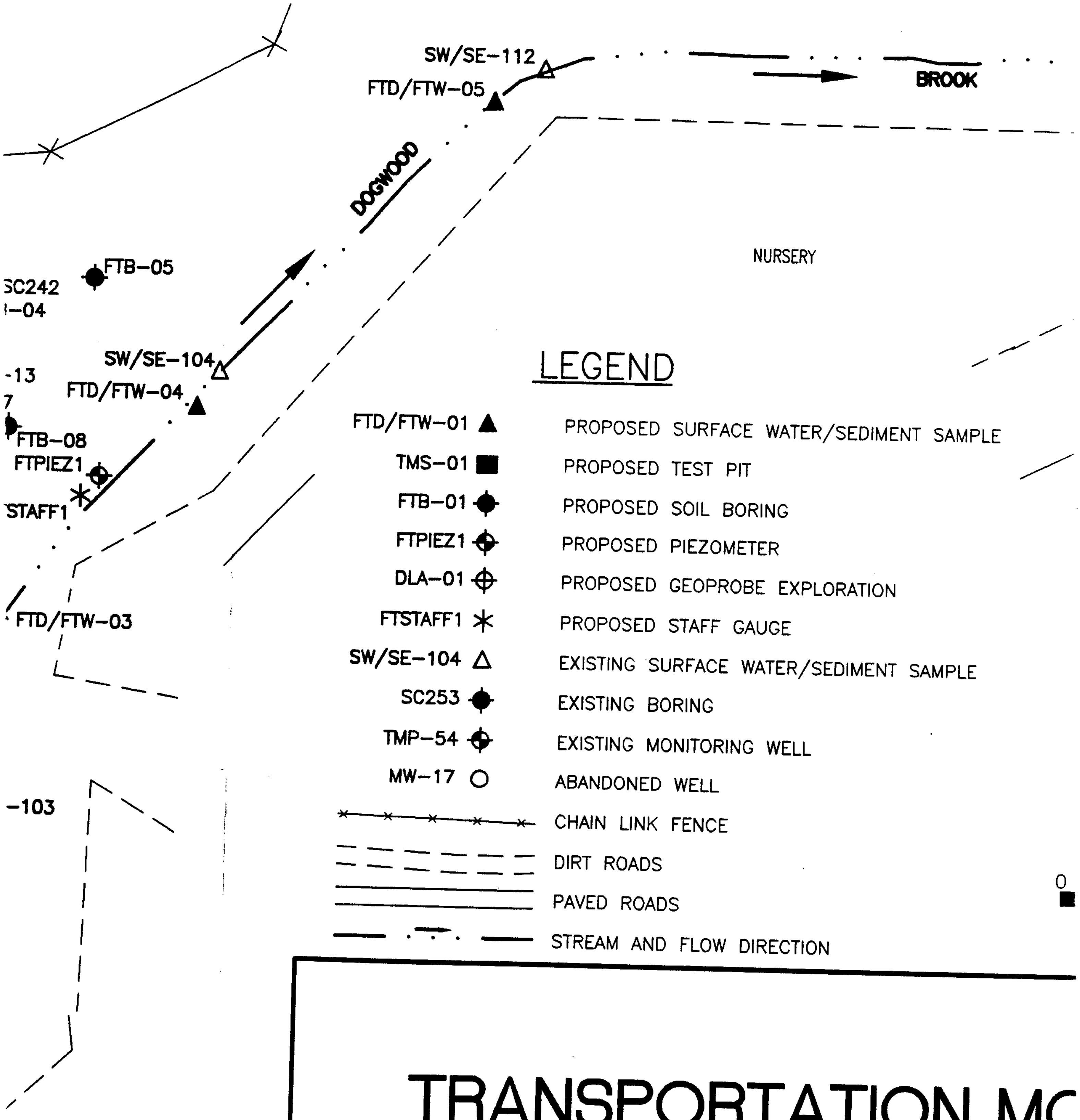

PTS-22
)7
ROXIMATE
ATION
HEADQUARTERS
ST.
TMP-56
TRANSPORTATION MOTOR POOL (SITE 5)
PENNSYLVANIA AVENUE
DELAWARE AVENUE
TMP-54
PROPOSED AREA OF FIELD SCREENING EXPLORATIONS
BURIED CULVERT/ STORM SEWER
WAY
SW/SE-109
TMS-01
TMS-02

⑯


SC-150
SC-211
PCA-07
(SITE 8)
FIRE HOUSE
FTT-51
SC-124
SC240
FTB-03
FTB-01
SC241
SC-127
FTB-05
FIRE TRAINING TANK
SC-125
SC242
FTB-04
FIRE TRAINING AREA (SITE 3)
FTB-06
BERMED PIT
FTB-02
SW/SE-1
FTT-13
FTD/FTW-04
SC-126
FTB-07
SC-216
FTB-08
FTB-09
FTT-14
FTPIEZ1
FTSTAFF1
FTB-10
FTPIEZ2
FTD/FTW-03
FTSTAFF2
DELAWARE AVENUE
NURSERY
BROOK
SW/SE-103
FTD/FTW-02
DOGWOOD
SW/SE-111

⑰

1. LOCATIONS OF ALL EXISTING INVESTIGATIONS ARE APPROXIMATE.
2. CAD BASE MAP SOURCE: FORT DIX
3. TPH = TOTAL PETROLEUM HYDROCARBONS
4. USAEHA = UNITED STATES ARMY ENVIRONMENTAL HYGIENE AGENCY



LEGEND

FTD/FTW-01 ▲	PROPOSED SURFACE WATER/SEDIMENT SAMPLE
TMS-01 ■	PROPOSED TEST PIT
FTB-01 ●	PROPOSED SOIL BORING
FTPIEZ1 ⊕	PROPOSED PIEZOMETER
DLA-01 ⊕	PROPOSED GEOPROBE EXPLORATION
FTSTAFF1 ✳	PROPOSED STAFF GAUGE
SW/SE-104 △	EXISTING SURFACE WATER/SEDIMENT SAMPLE
SC253 ●	EXISTING BORING
TMP-54 ⊕	EXISTING MONITORING WELL
MW-17 ○	ABANDONED WELL
–×–×–×–×–	CHAIN LINK FENCE
– – – – –	DIRT ROADS
———	PAVED ROADS
— .→. —	STREAM AND FLOW DIRECTION

TRANSPORTATION MC

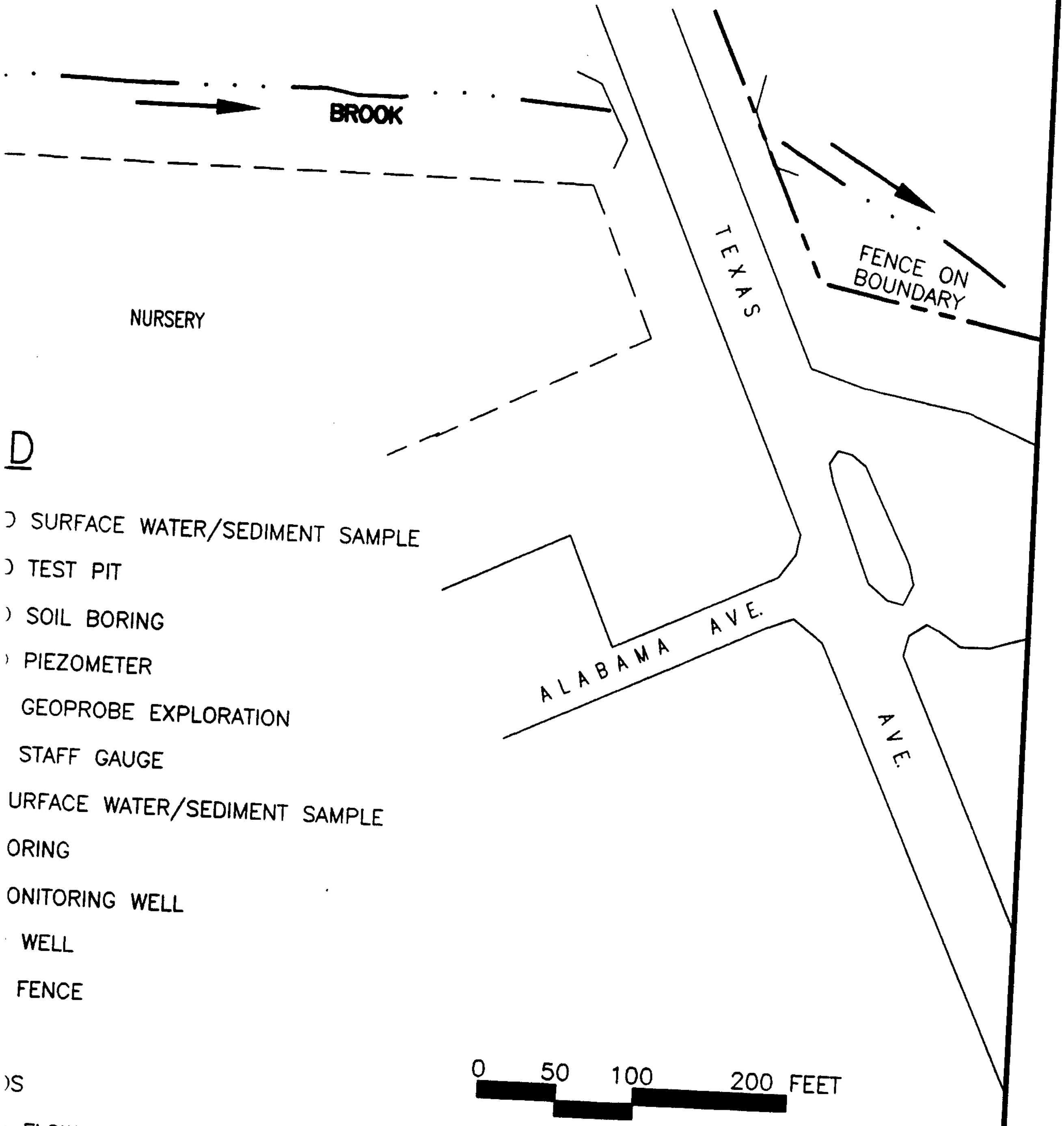
—

; INVESTIGATIONS ARE APPROXIMATE.

)RT DIX

IYDROCARBONS

ARMY ENVIRONMENTAL HYGIENE AGENCY



SCALE: 1"=100'

D

) SURFACE WATER/SEDIMENT SAMPLE

) TEST PIT

) SOIL BORING

) PIEZOMETER

GEOPROBE EXPLORATION

STAFF GAUGE

URFACE WATER/SEDIMENT SAMPLE

ORING

ONITORING WELL

WELL

FENCE

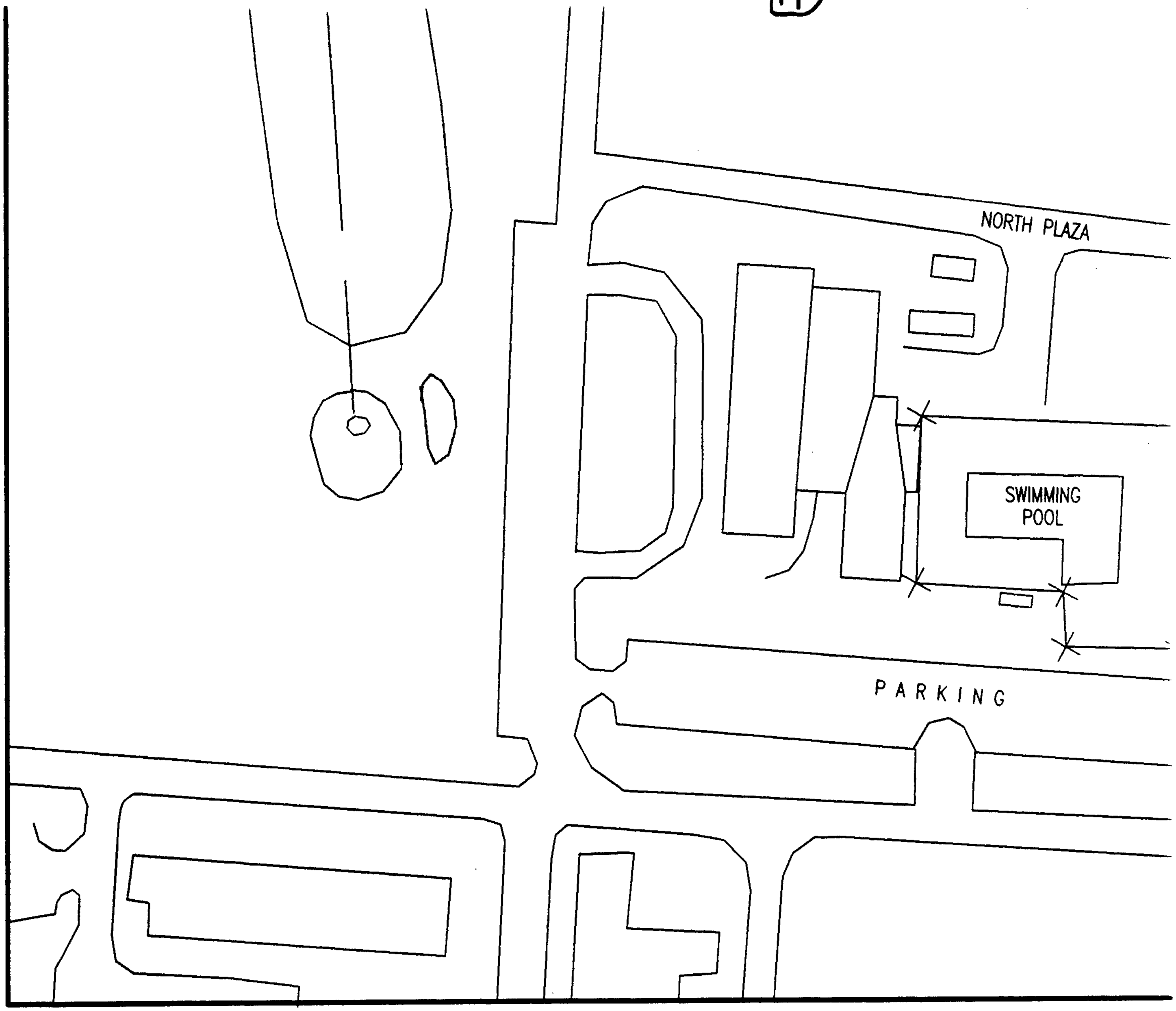
)S

FLOW DIRECTION

FIGURE 7

)RTATION MOTOR POOL,

⑲



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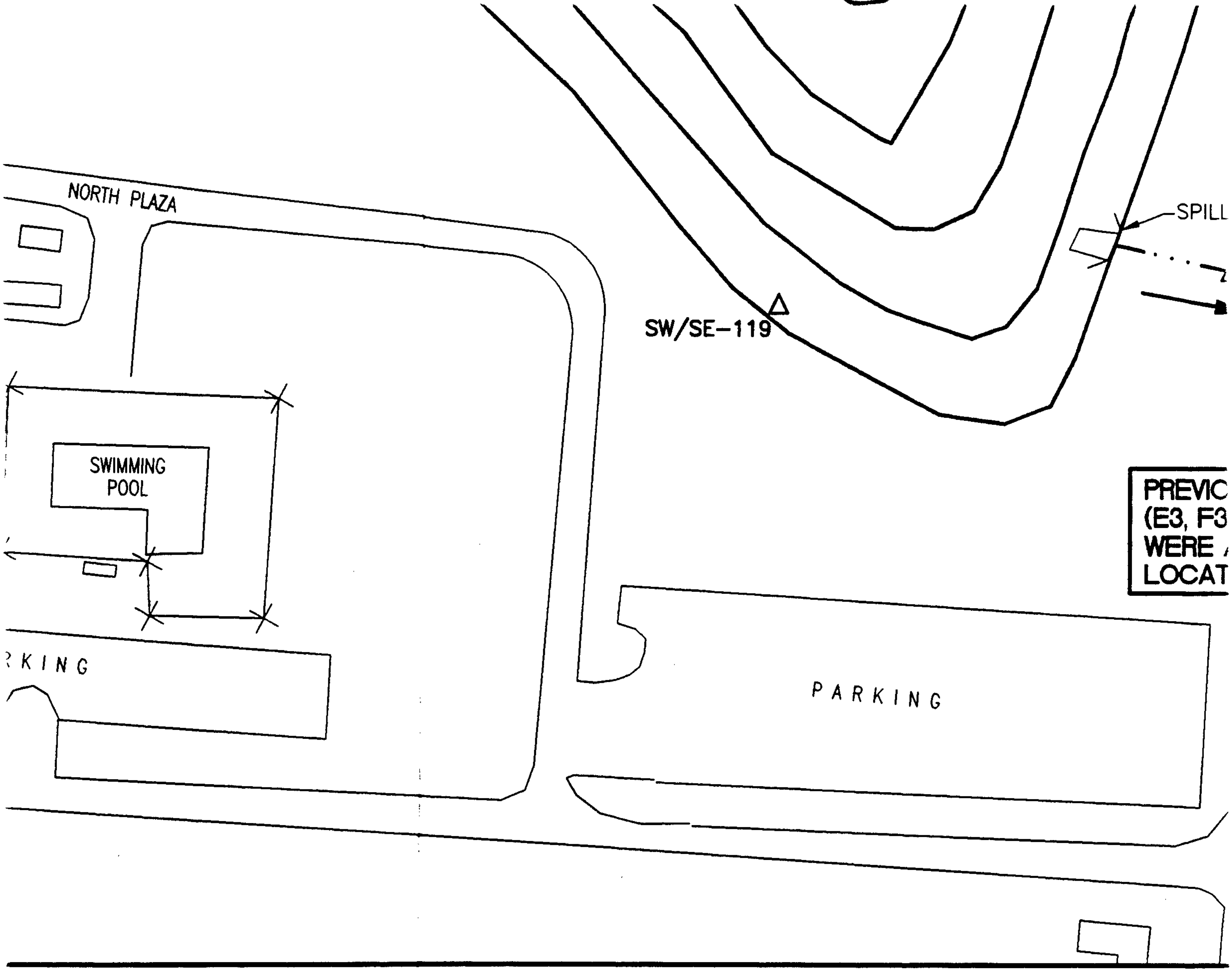
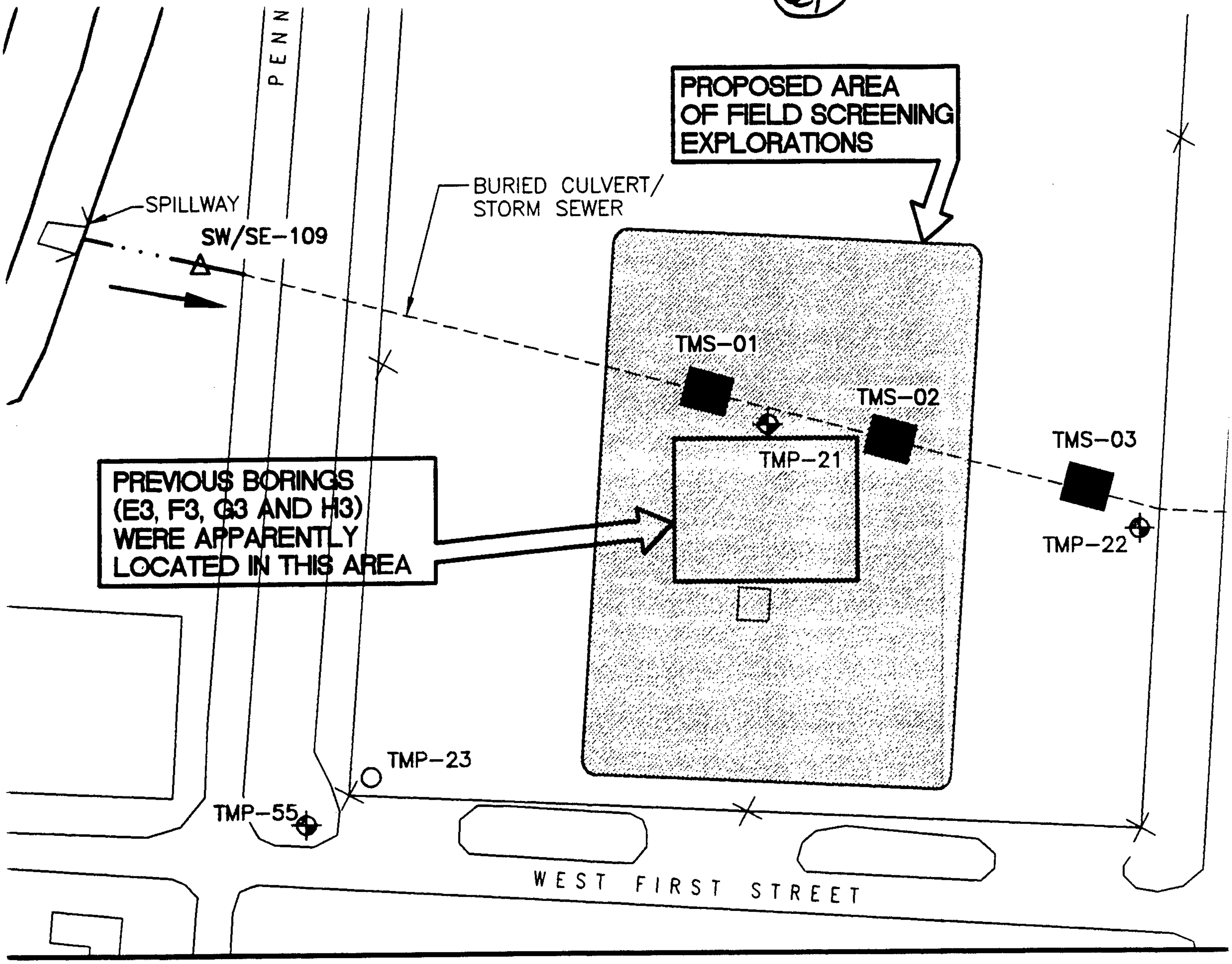
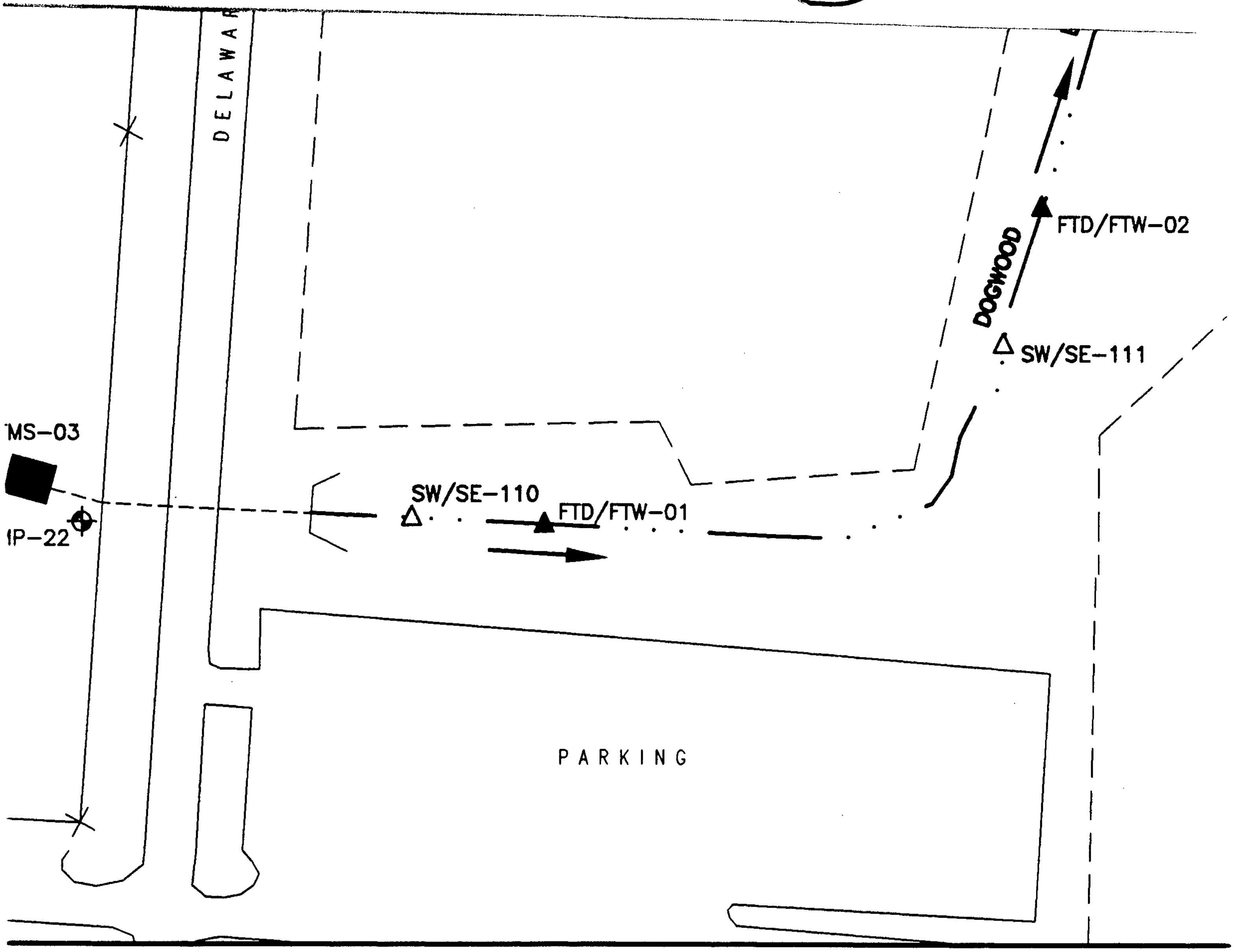
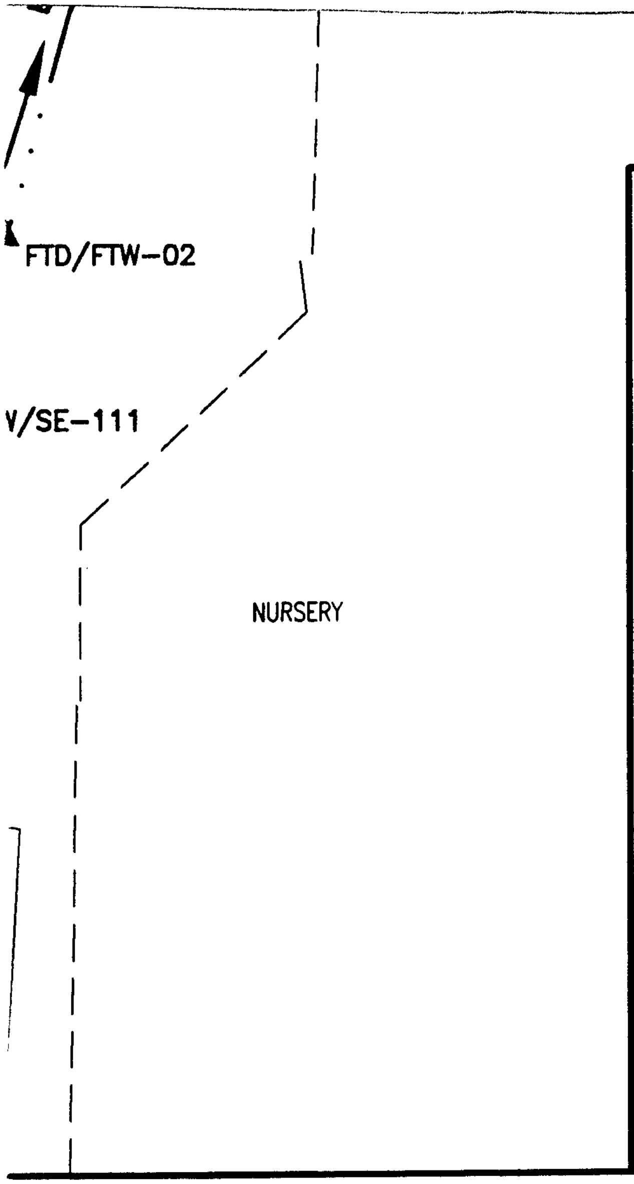

NORTH PLAZA
SPILL
SW/SE-119
SWIMMING POOL
PREVIC
(E3, F3
WERE
LOCAT
KING
PARKING


PENN
PROPOSED AREA OF FIELD SCREENING EXPLORATIONS
BURIED CULVERT/ STORM SEWER
SPILLWAY
SW/SE-109
TMS-01
TMS-02
TMS-03
TMP-21
TMP-22
TMP-23
TMP-55
PREVIOUS BORINGS (E3, F3, G3 AND H3) WERE APPARENTLY LOCATED IN THIS AREA
WEST FIRST STREET


DELAWAR
MS-03
P-22
SW/SE-110
FTD/FTW-01
DOGWOOD
FTD/FTW-02
SW/SE-111
PARKING



TRANSPORTATIO
PESTICIDE (
FIRE TRAINING
AREA NORTH OF D
LOCATIONS OF
PROPOSED
FORT DIX RI/

ABB Environ

PAVED ROADS

STREAM AND FLOW DIRECTION

SCALE: 1"=100'

FIGURE 7

NSPORTATION MOTOR POOL,
PESTICIDE CONTROL SHOP,
E TRAINING TANK AREA AND
NORTH OF DOGWOOD LAKE
CATIONS OF EXISTING AND
PROPOSED INVESTIGATIONS
ORT DIX RI/FS FOR 13 SITES

ABB Environmental Services, Inc.

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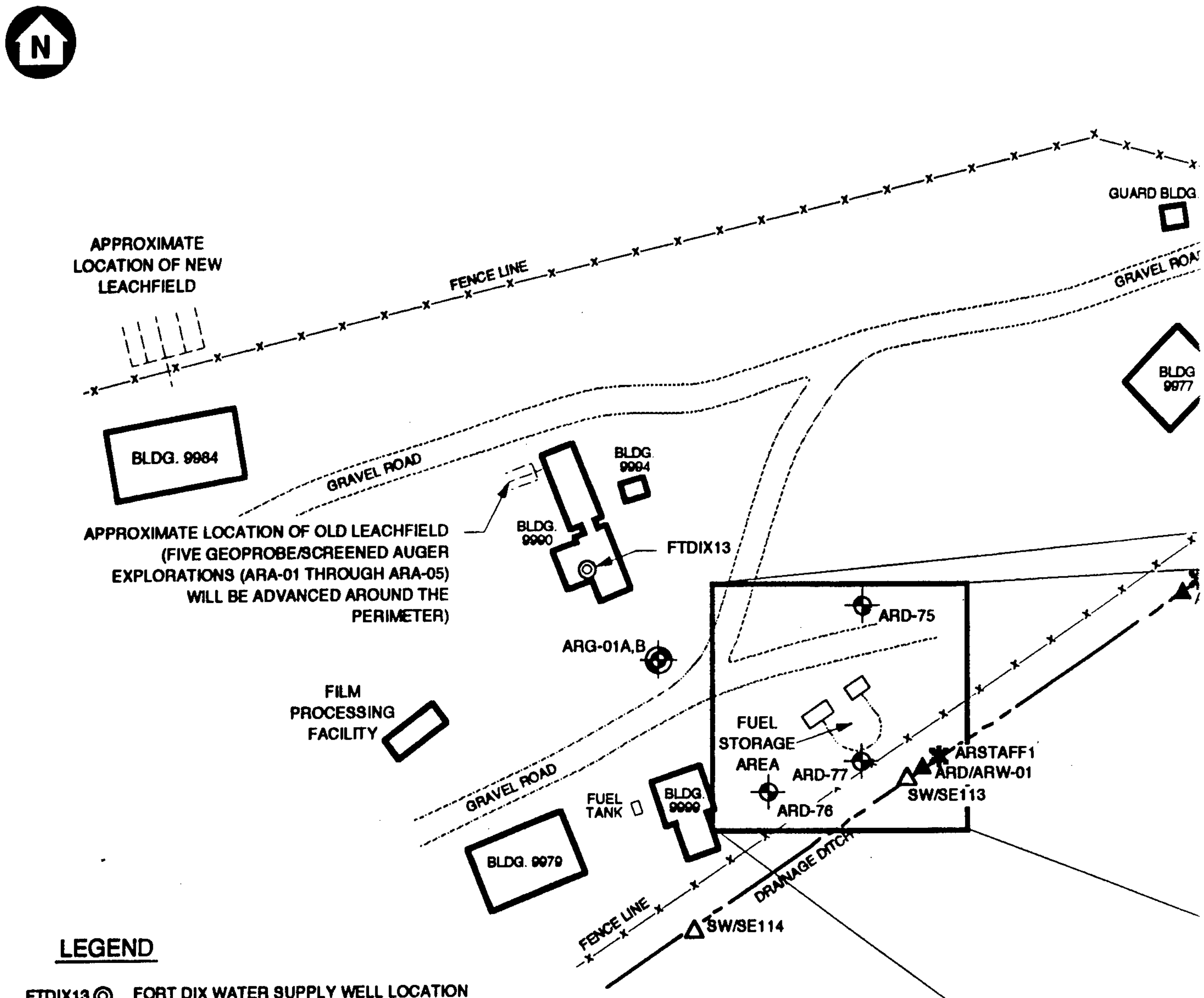


LEGEND

FTDIX13 ◎	FORT DIX WATER SUPPLY WELL LOCATION
ARD-75 ⊕	EXISTING MONITORING WELL LOCATION
SC-130 ⊕	EXISTING SOIL BORING SAMPLE LOCATION
SW/SE-113 △	EXISTING SURFACE WATER/SEDIMENT SAMPLE LOCATION
ARG-01A,B ⊕	PROPOSED MONITORING WELL NEST LOCATION
ARB-01 ⊕	PROPOSED SOIL BORING SAMPLE LOCATION
ARS-07 ■	PROPOSED SURFACE SOIL SAMPLE LOCATION
ARD/ARW-01 ▲	PROPOSED SURFACE WATER/SEDIMENT SAMPLE LOCATION
ARSTAFF2 ✱	PROPOSED SURFACE WATER STAFF GAUGE

NOTES: 1. OPTIONAL SURFACE WATER/SEDIMENT SAMPLE PAIRS ARD/ARW-04 THROUGH ARD/ARW-08 WILL BE LOCATED AS NEEDED, BASED ON FIELD SCREENING RESULTS FROM ARD/ARW-01 THROUGH ARD/ARW-03.

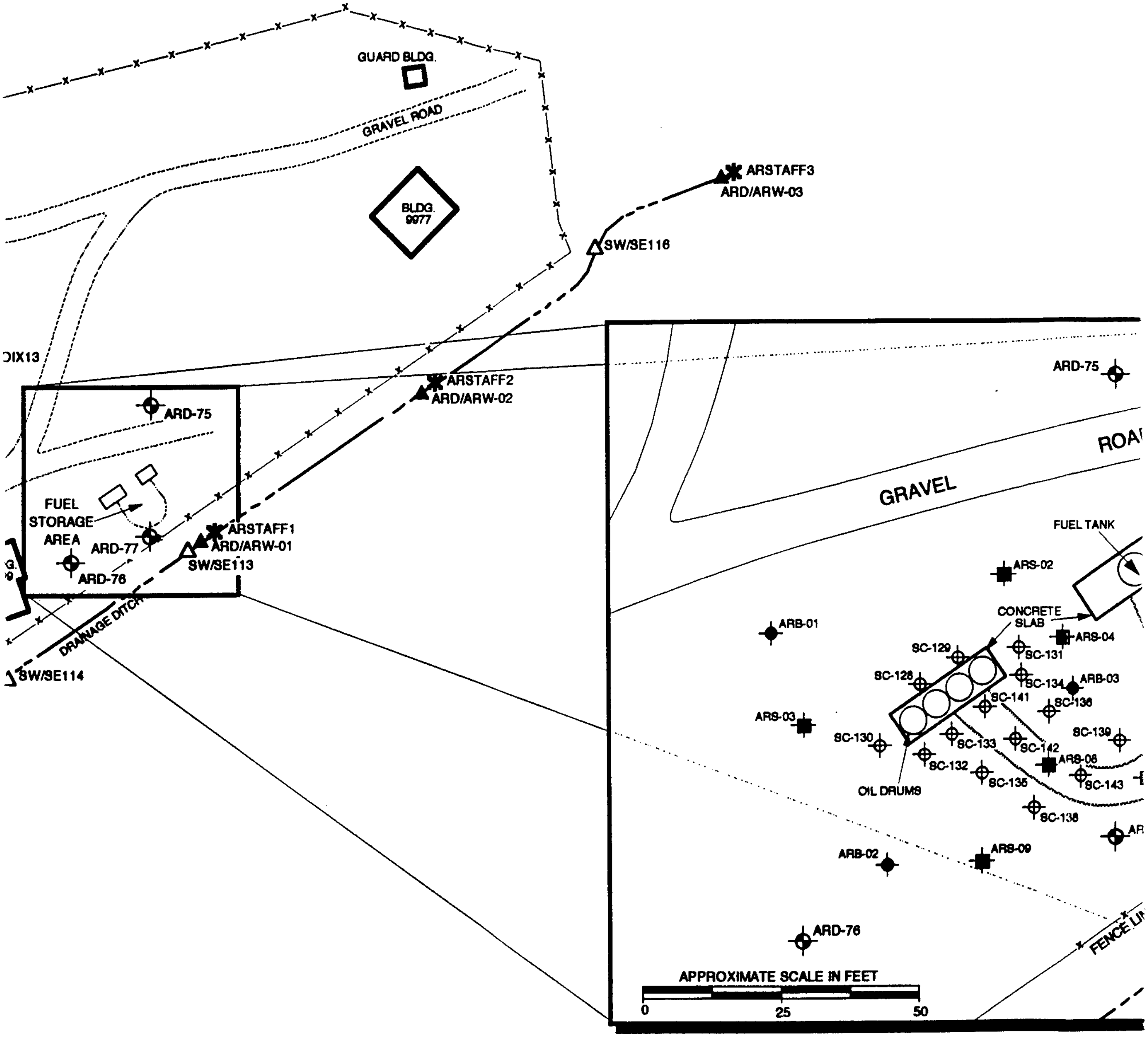
2. LOCATIONS OF EXPLORATIONS ARE APPROXIMATE AND MAY BE ADJUSTED BASED ON FIELD CONDITIONS.

APPROXIMATE SCALE IN FEET

0 100 200

SOURCE: DAMES & MOORE, 1993.

②



LOCATIONS OF EXISTING

③

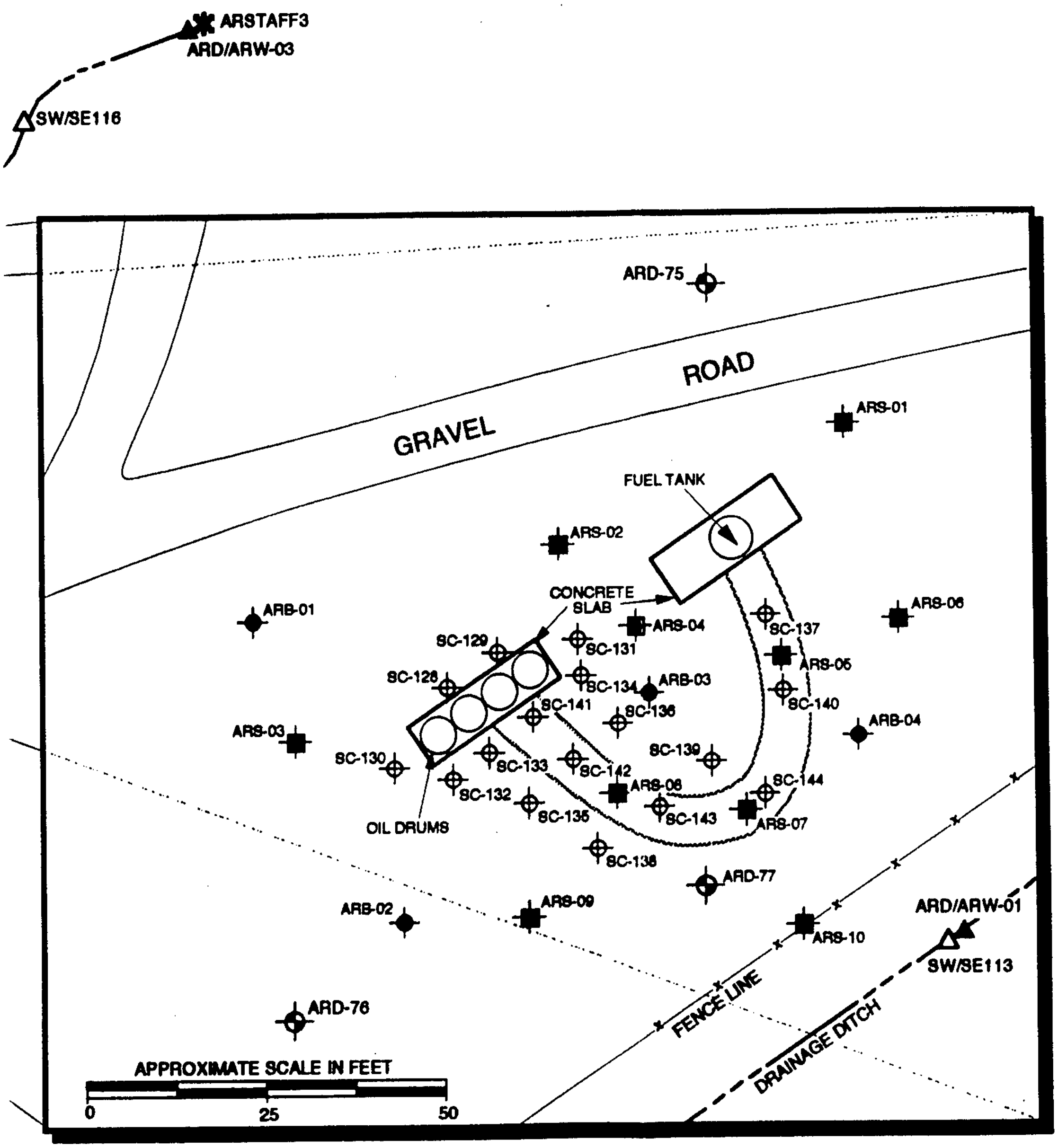


FIGURE 8
ARDC TEST FACILITY
LOCATIONS OF EXISTING AND PROPOSED INVESTIGATIONS
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

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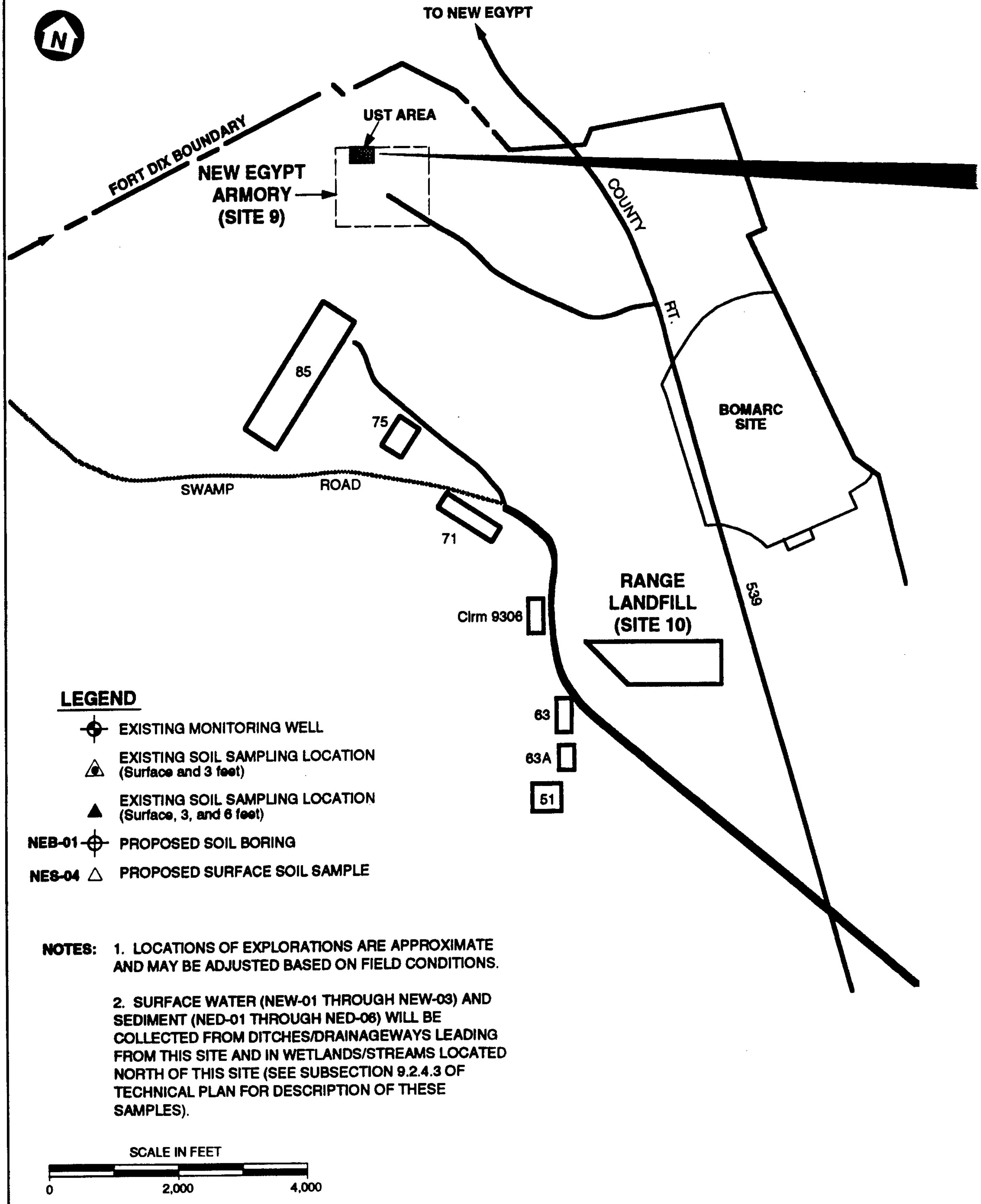

LEGEND

- EXISTING MONITORING WELL
- EXISTING SOIL SAMPLING LOCATION (Surface and 3 feet)
- ▲ EXISTING SOIL SAMPLING LOCATION (Surface, 3, and 6 feet)
- NEB-01 PROPOSED SOIL BORING
- NES-04 △ PROPOSED SURFACE SOIL SAMPLE

NOTES: 1. LOCATIONS OF EXPLORATIONS ARE APPROXIMATE AND MAY BE ADJUSTED BASED ON FIELD CONDITIONS.

2. SURFACE WATER (NEW-01 THROUGH NEW-03) AND SEDIMENT (NED-01 THROUGH NED-06) WILL BE COLLECTED FROM DITCHES/DRAINAGEWAYS LEADING FROM THIS SITE AND IN WETLANDS/STREAMS LOCATED NORTH OF THIS SITE (SEE SUBSECTION 9.2.4.3 OF TECHNICAL PLAN FOR DESCRIPTION OF THESE SAMPLES).

SOURCE: Dames & Moore, 1993.

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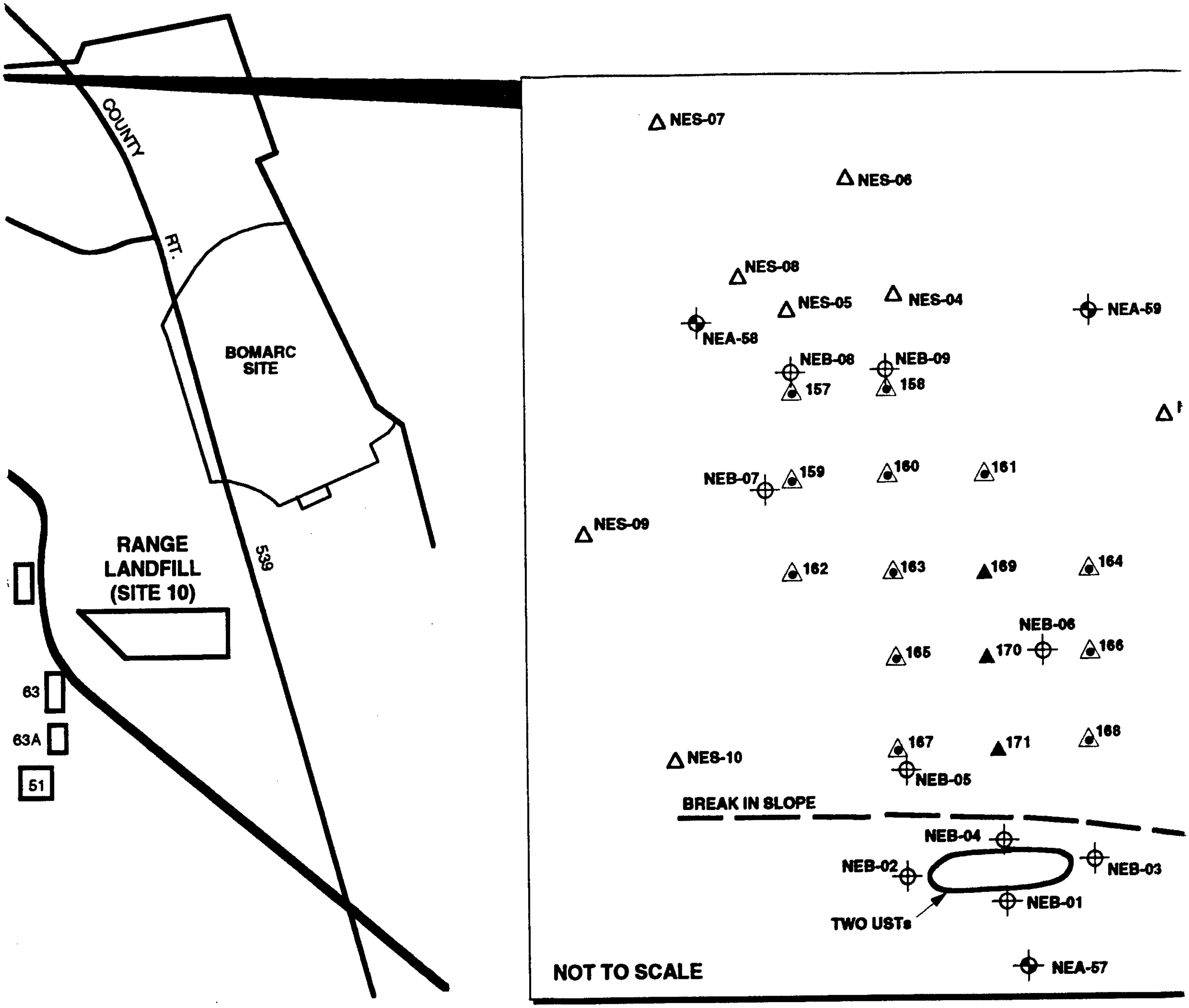

LOCATIONS OF EXISTI

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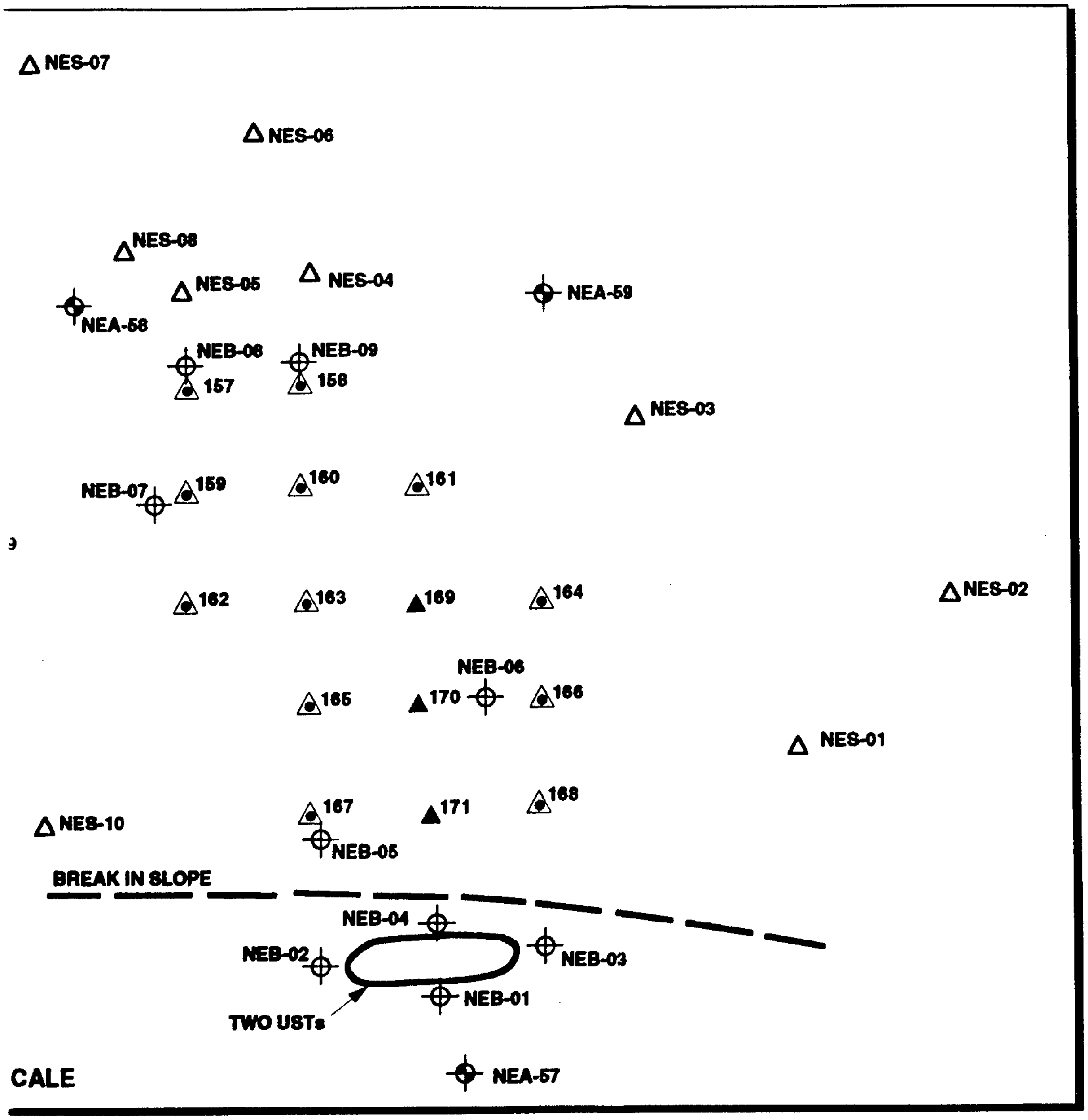
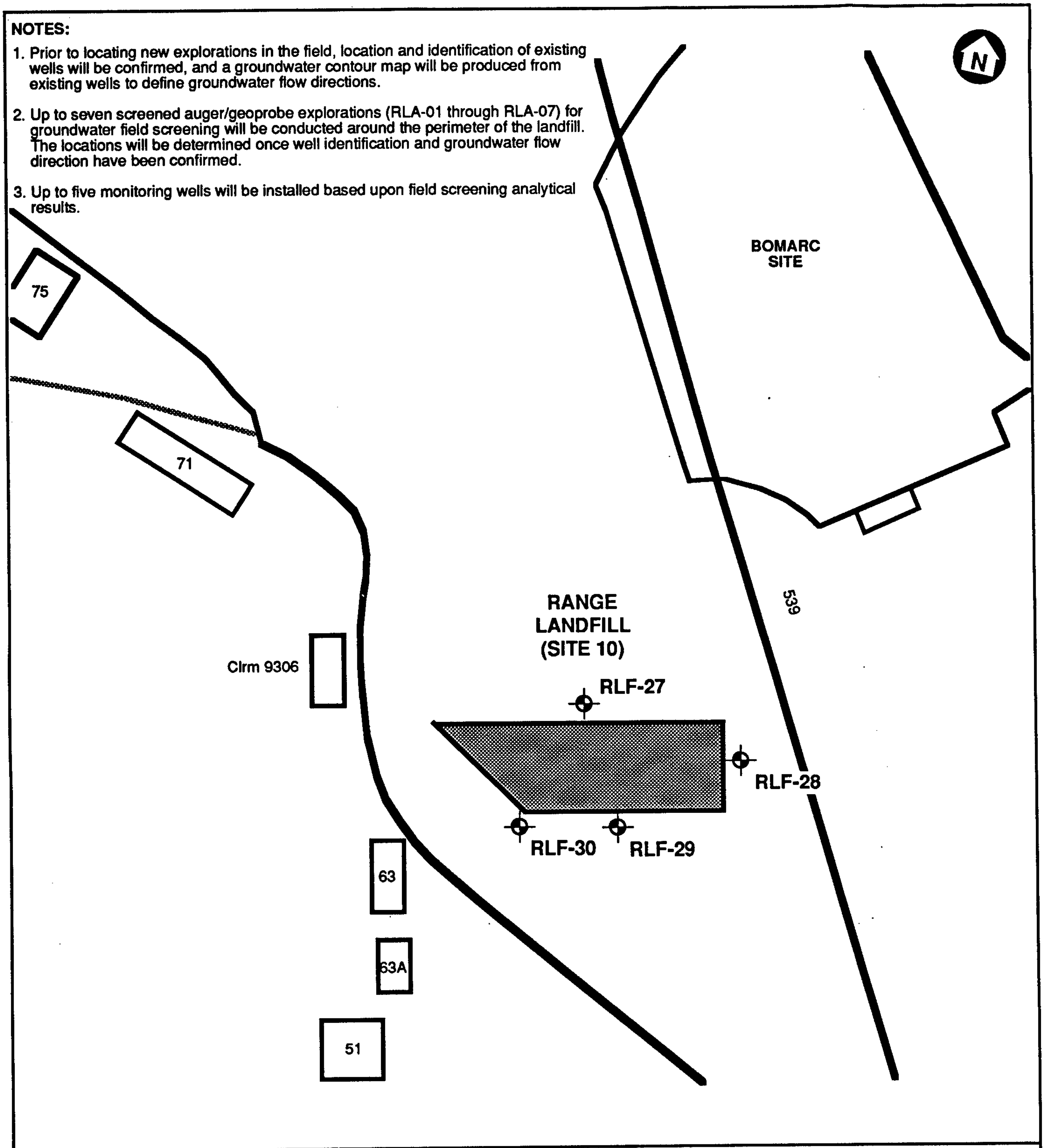


FIGURE 9
NEW EGYPT ARMORY
LOCATIONS OF EXISTING AND PROPOSED INVESTIGATIONS
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ABB Environmental Services, Inc.

NOTES:

1. Prior to locating new explorations in the field, location and identification of existing wells will be confirmed, and a groundwater contour map will be produced from existing wells to define groundwater flow directions.
2. Up to seven screened auger/geoprobe explorations (RLA-01 through RLA-07) for groundwater field screening will be conducted around the perimeter of the landfill. The locations will be determined once well identification and groundwater flow direction have been confirmed.
3. Up to five monitoring wells will be installed based upon field screening analytical results.



LEGEND

RLF-30 ⌖ EXISTING MONITORING WELL

APPROXIMATE SCALE IN FEET

0 1,000 2,000

SOURCE: Dames & Moore, 1993.

FIGURE 10
RANGE LANDFILL
LOCATIONS OF EXISTING AND PROPOSED INVESTIGATIONS
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ABB Environmental Services, Inc.

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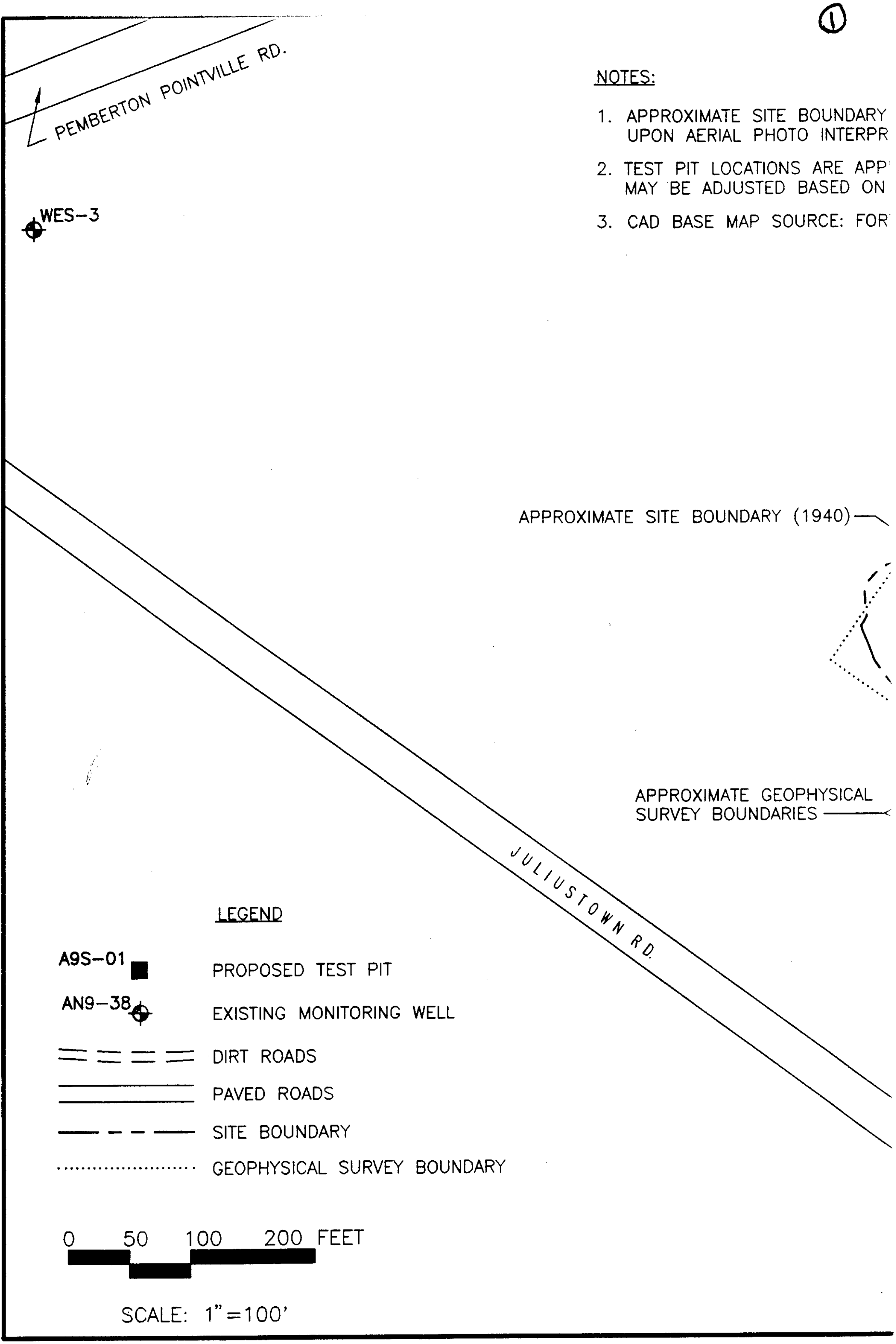

NOTES:

1. APPROXIMATE SITE BOUNDARY UPON AERIAL PHOTO INTERPR
2. TEST PIT LOCATIONS ARE APP MAY BE ADJUSTED BASED ON
3. CAD BASE MAP SOURCE: FOR

LEGEND

A9S-01 ■	PROPOSED TEST PIT
AN9-38 ⊕	EXISTING MONITORING WELL
═ ═ ═ ═	DIRT ROADS
═══════	PAVED ROADS
—— – – ——	SITE BOUNDARY
···············	GEOPHYSICAL SURVEY BOUNDARY

0 50 100 200 FEET

SCALE: 1"=100'

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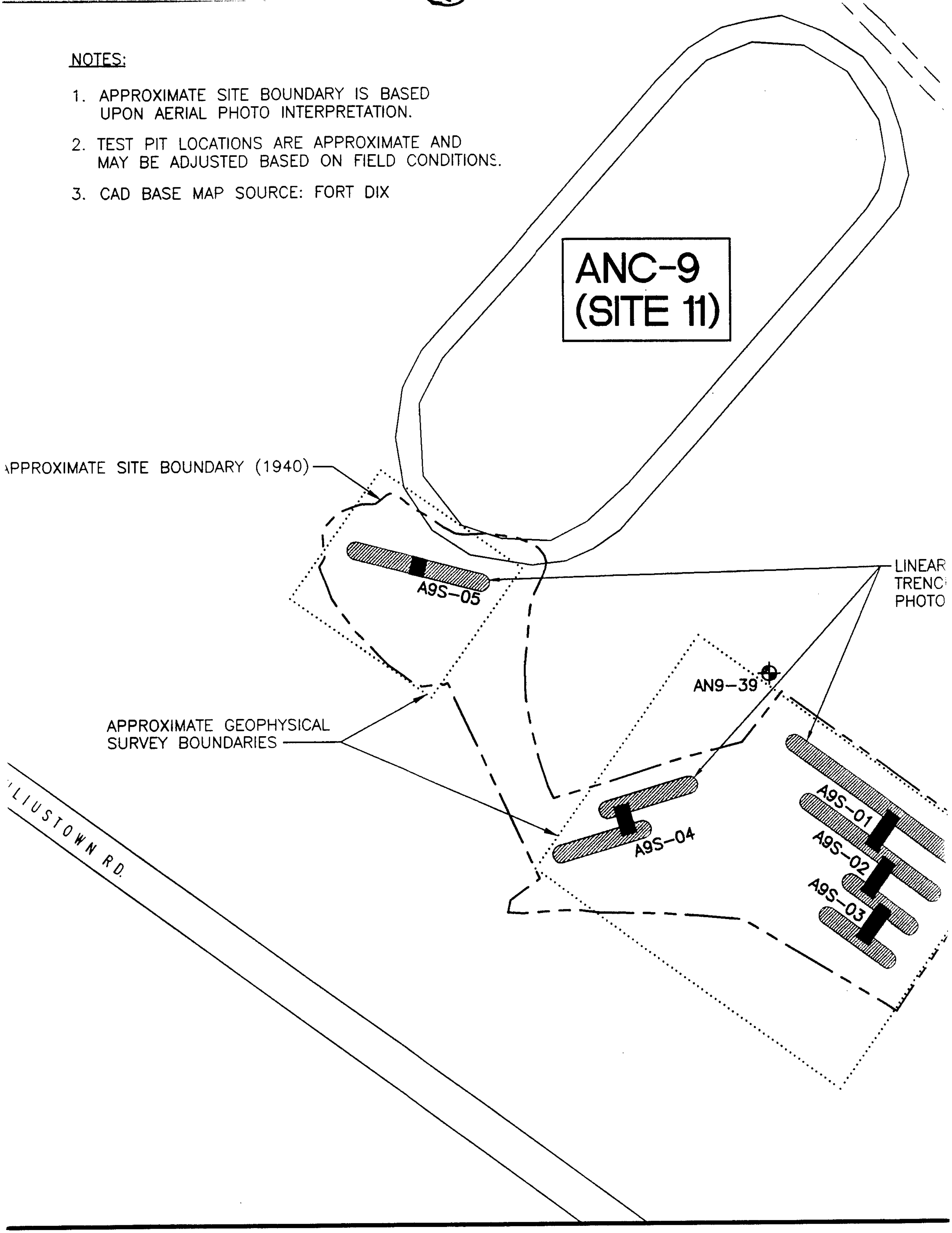
NOTES:

1. APPROXIMATE SITE BOUNDARY IS BASED UPON AERIAL PHOTO INTERPRETATION.
2. TEST PIT LOCATIONS ARE APPROXIMATE AND MAY BE ADJUSTED BASED ON FIELD CONDITIONS.
3. CAD BASE MAP SOURCE: FORT DIX



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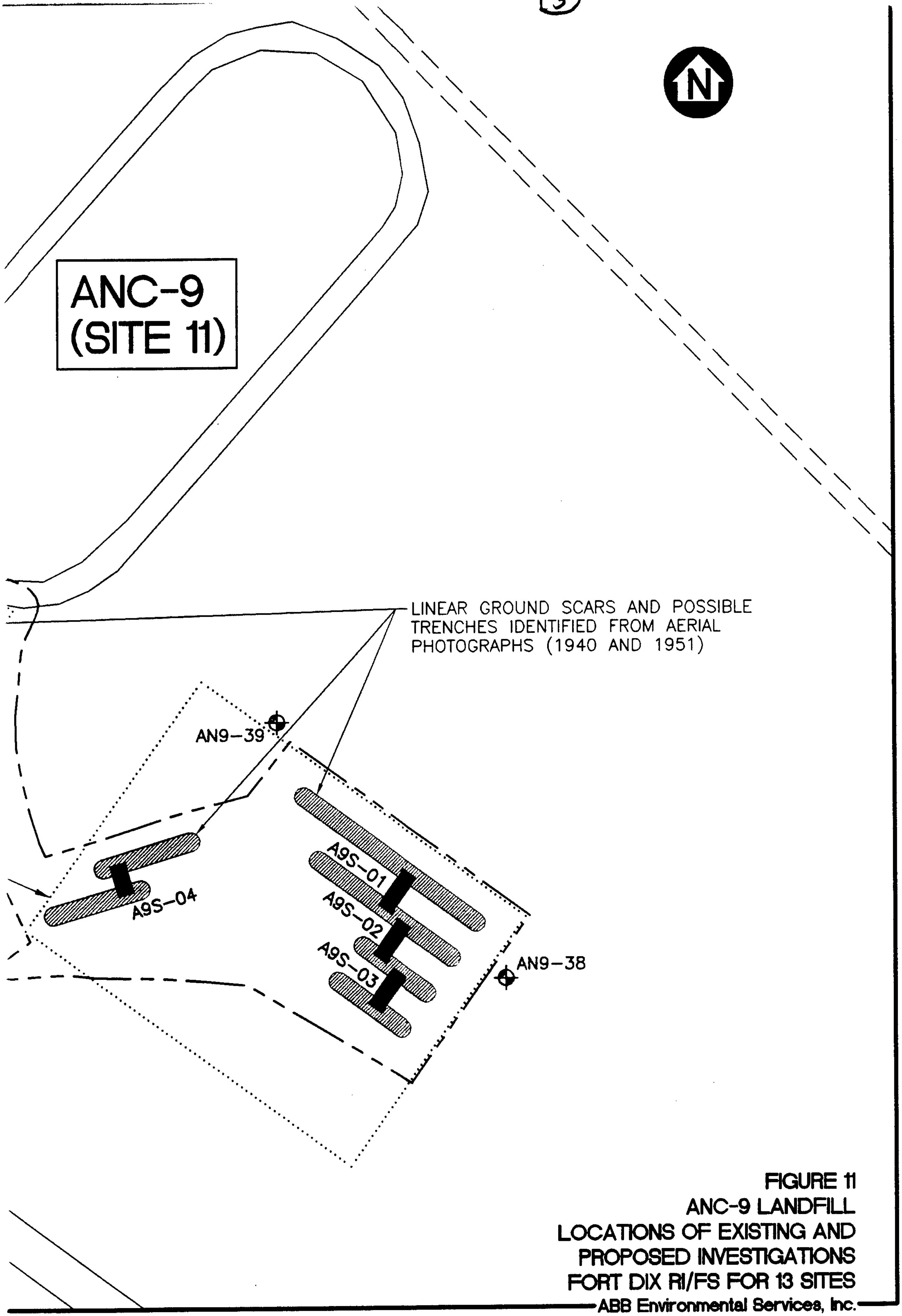

FIGURE 11
ANC-9 LANDFILL
LOCATIONS OF EXISTING AND PROPOSED INVESTIGATIONS
FORT DIX RI/FS FOR 13 SITES

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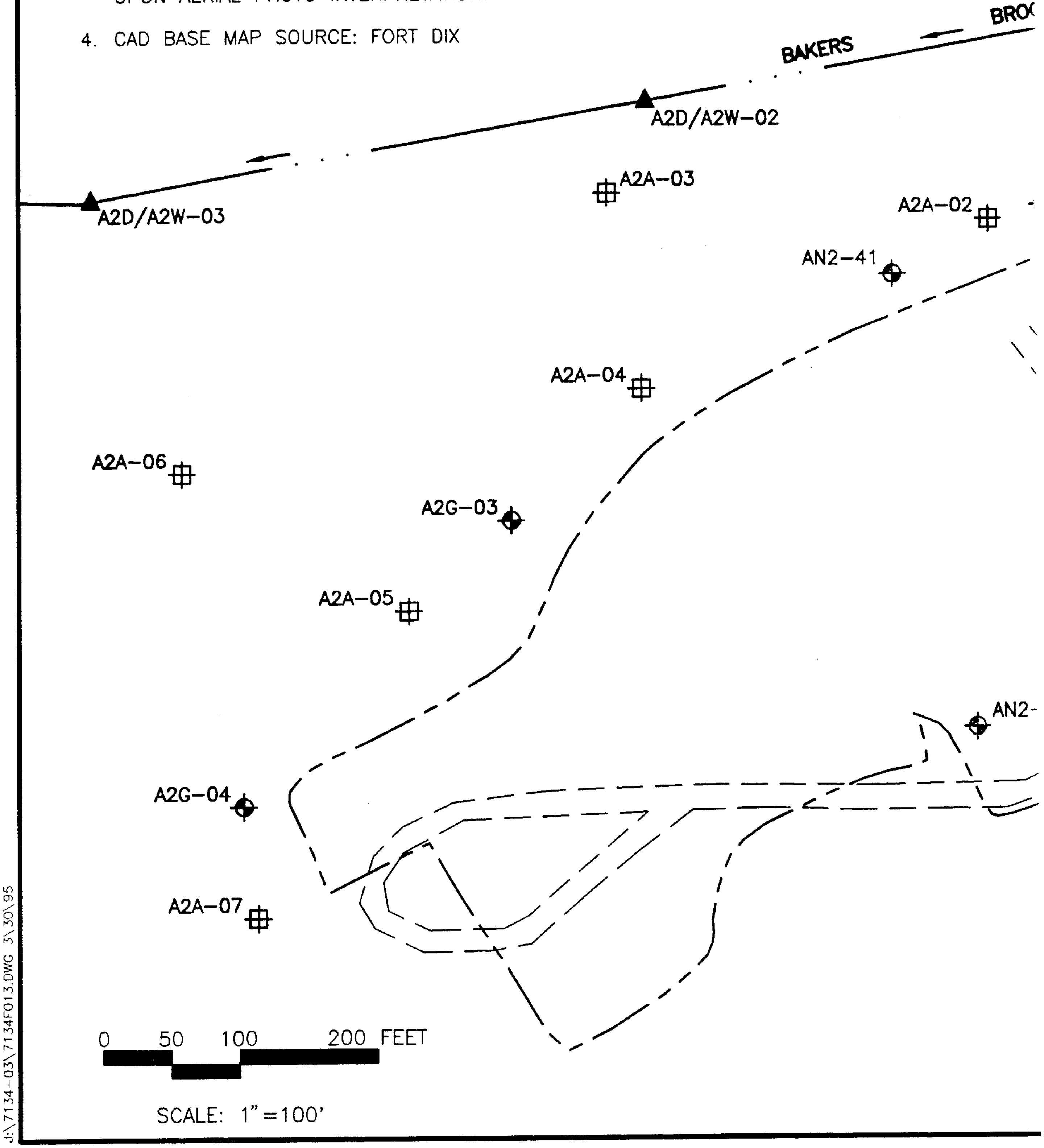
NOTES:

1. LOCATIONS OF SCREENED AUGER BORINGS ARE APPROXIMATE AND SUBJECT TO CHANGE BASED ON DRILL RIG ACCESS AND FIELD SCREENING ANAYLTICAL RESULTS.
2. PROPOSED EXPLORATION LOCATIONS ARE APPROXIMATE; FINAL LOCATIONS AND NUMBERS WILL BE DETERMINED BASED ON FIELD SCREENING ANALYTICAL RESULTS.
3. APPROXIMATE SITE BOUNDARY IS BASED UPON AERIAL PHOTO INTERPRETATION.
4. CAD BASE MAP SOURCE: FORT DIX



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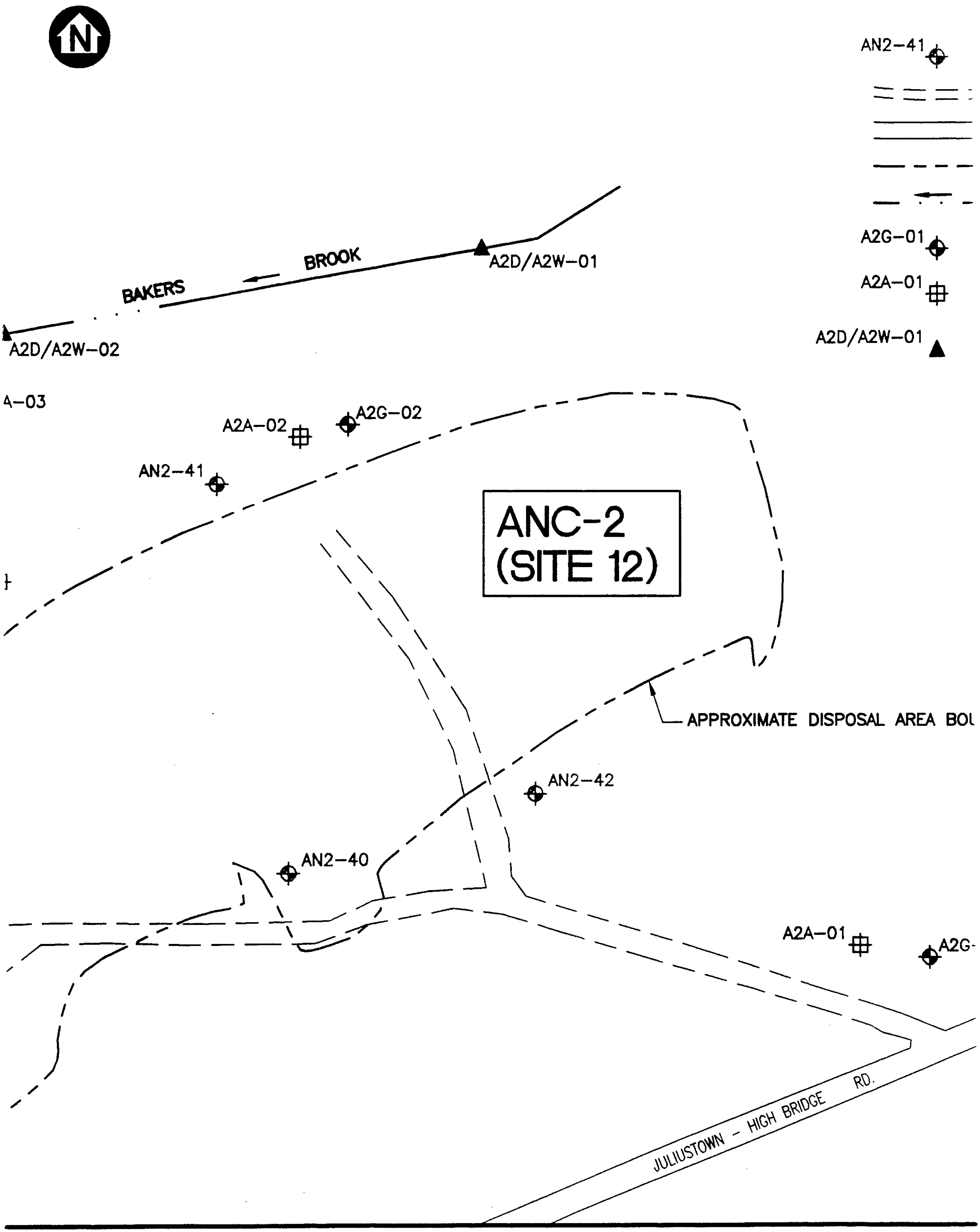
AN2-41
A2G-01
A2A-01
A2D/A2W-01
BAKERS
BROOK
A2D/A2W-01
A2D/A2W-02
A-03
A2A-02
A2G-02
AN2-41
ANC-2
(SITE 12)
APPROXIMATE DISPOSAL AREA BOU
AN2-42
AN2-40
A2A-01
A2G-
JULIUSTOWN - HIGH BRIDGE RD.

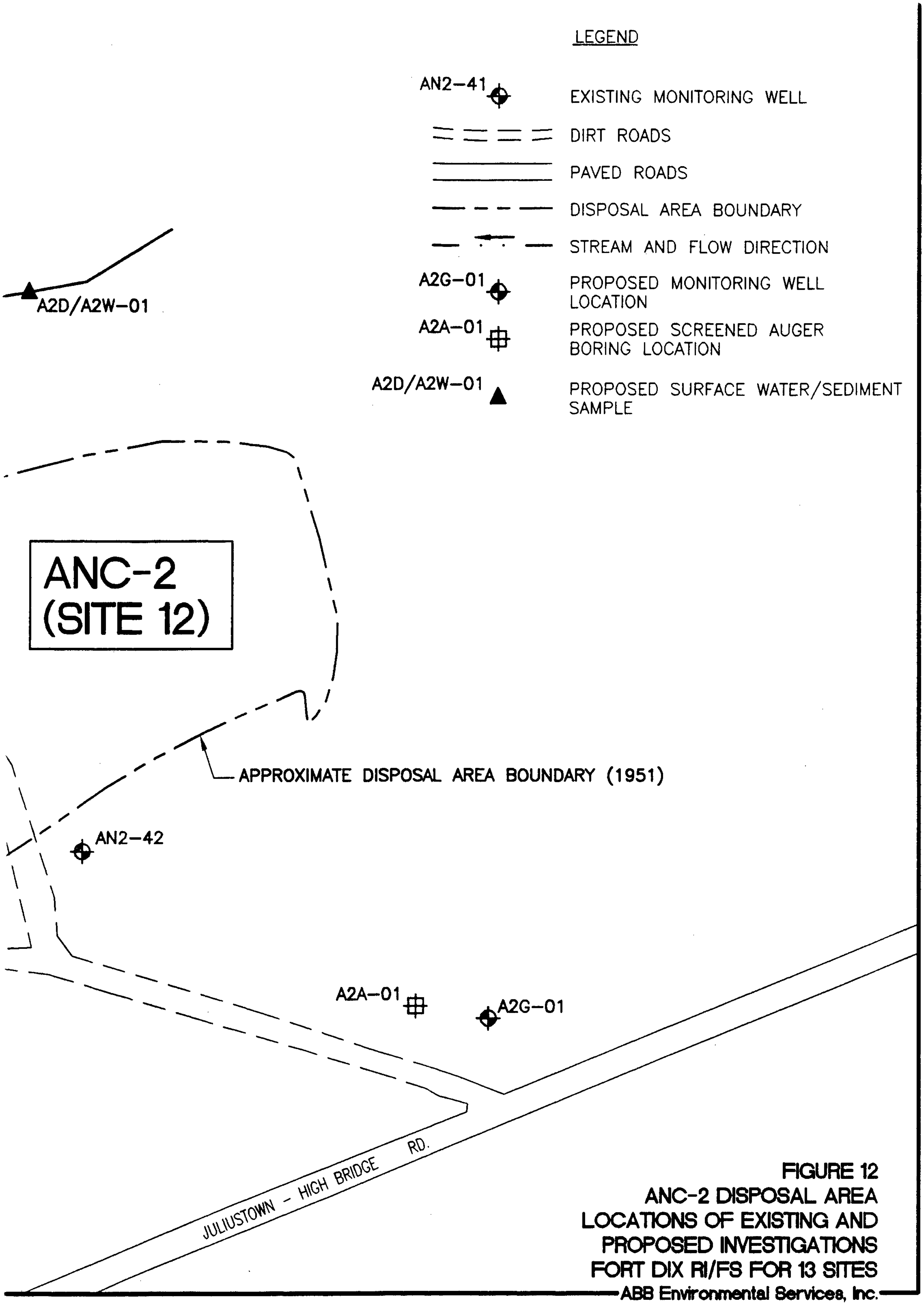

FIGURE 12
ANC-2 DISPOSAL AREA
LOCATIONS OF EXISTING AND
PROPOSED INVESTIGATIONS
FORT DIX RI/FS FOR 13 SITES
ABB Environmental Services, Inc.

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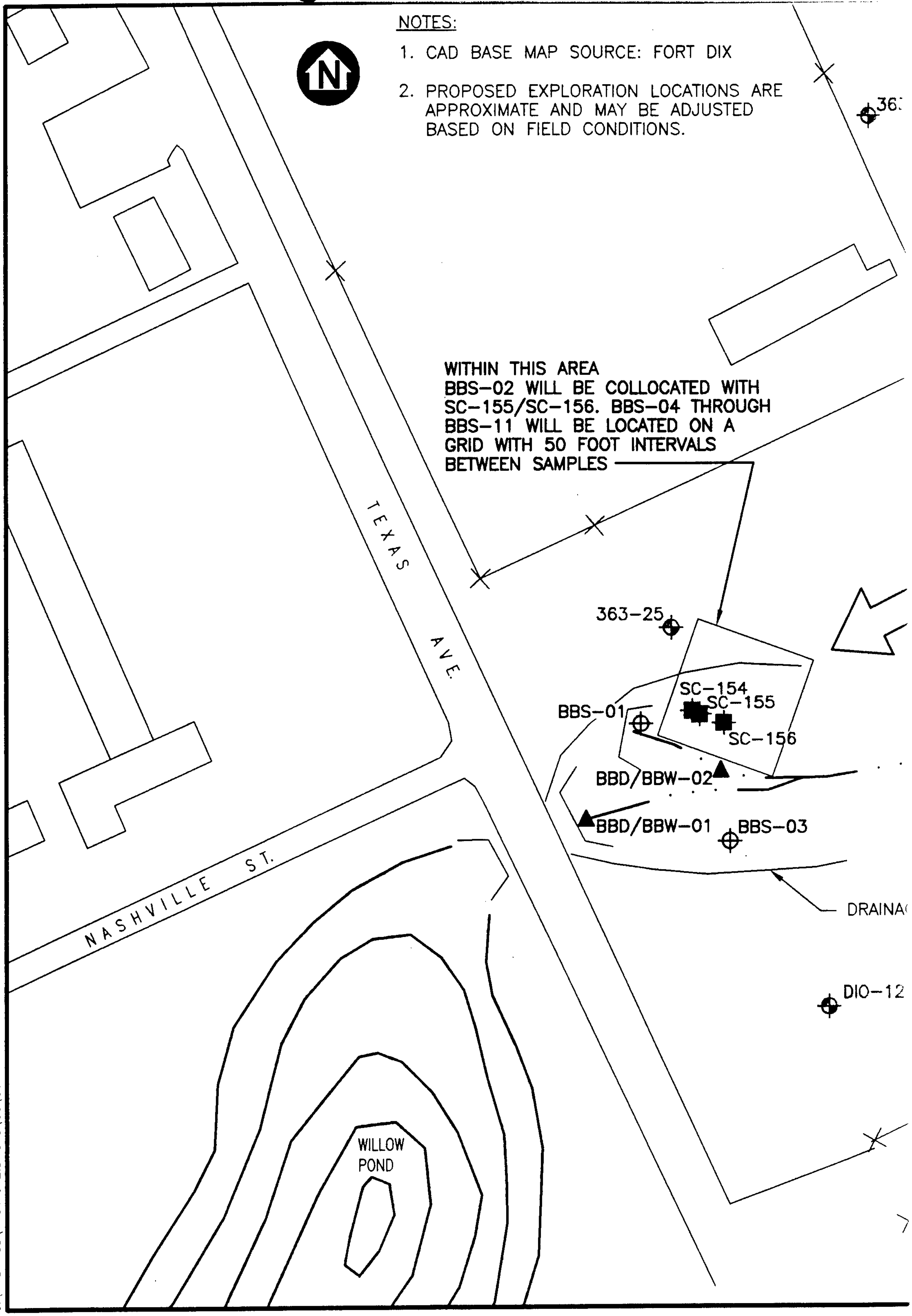

NOTES:

1. CAD BASE MAP SOURCE: FORT DIX
2. PROPOSED EXPLORATION LOCATIONS ARE APPROXIMATE AND MAY BE ADJUSTED BASED ON FIELD CONDITIONS.

WITHIN THIS AREA BBS-02 WILL BE COLLOCATED WITH SC-155/SC-156. BBS-04 THROUGH BBS-11 WILL BE LOCATED ON A GRID WITH 50 FOOT INTERVALS BETWEEN SAMPLES

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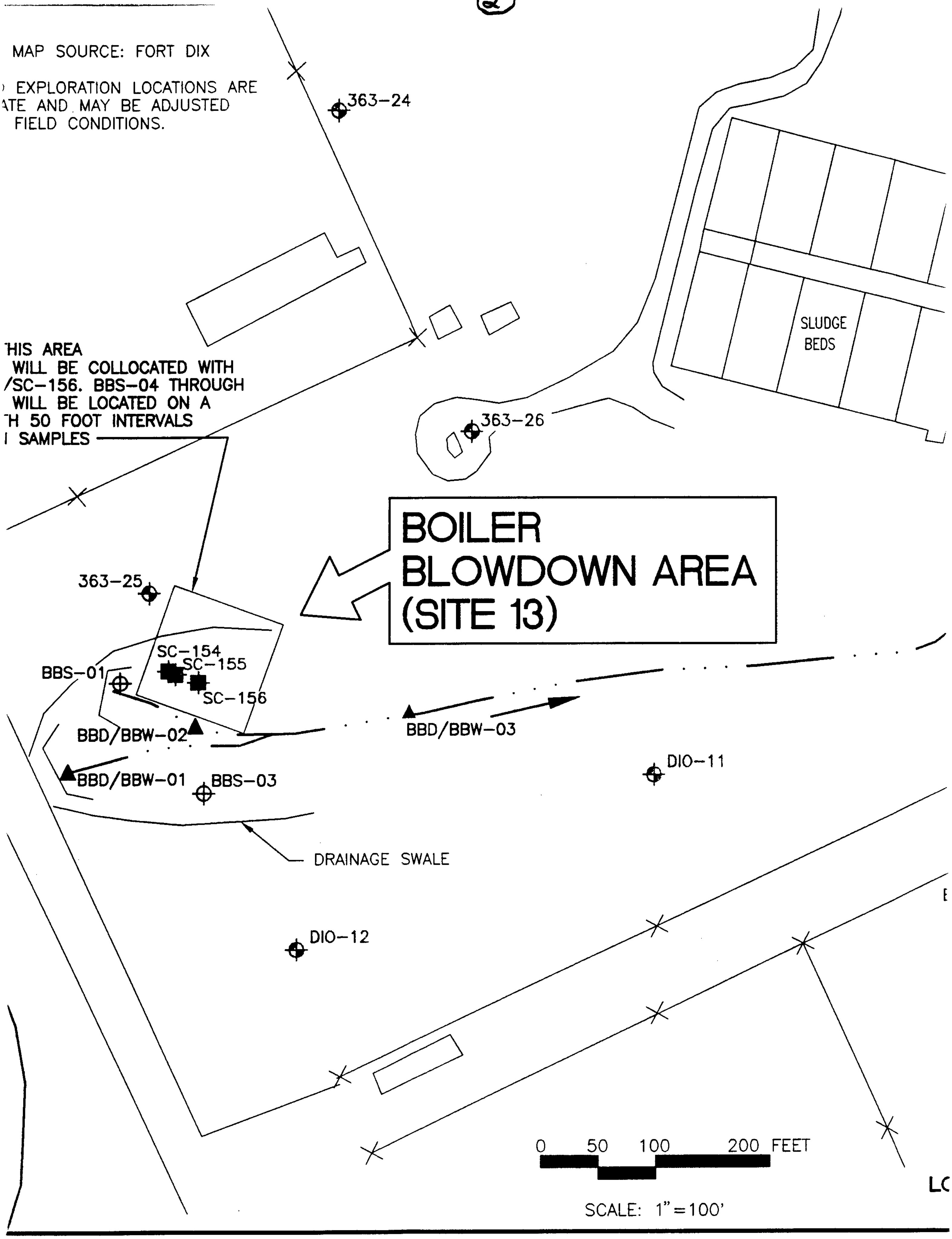
MAP SOURCE: FORT DIX

EXPLORATION LOCATIONS ARE
ATE AND MAY BE ADJUSTED
FIELD CONDITIONS.

HIS AREA
WILL BE COLLOCATED WITH
/SC-156. BBS-04 THROUGH
WILL BE LOCATED ON A
H 50 FOOT INTERVALS
SAMPLES

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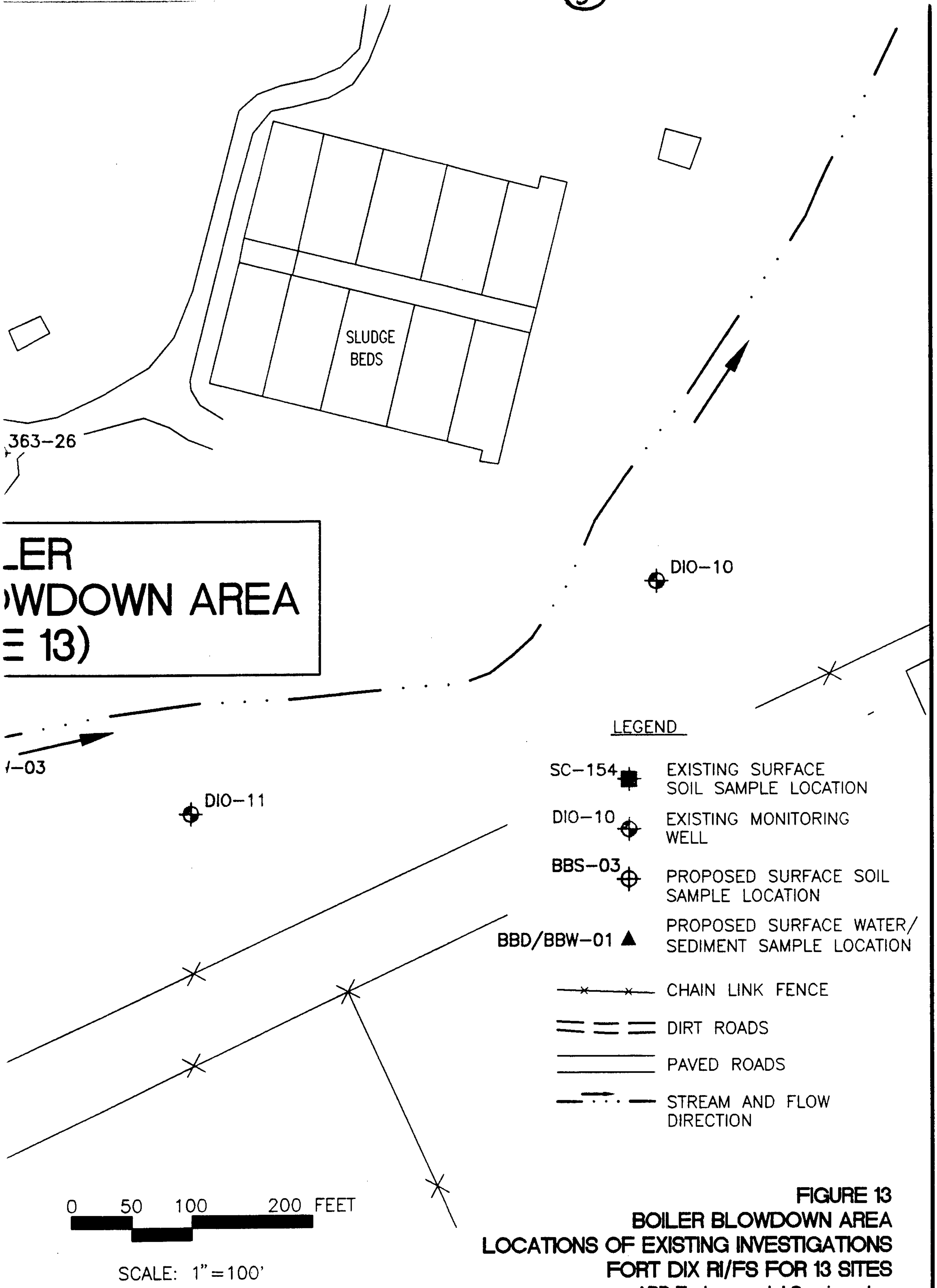
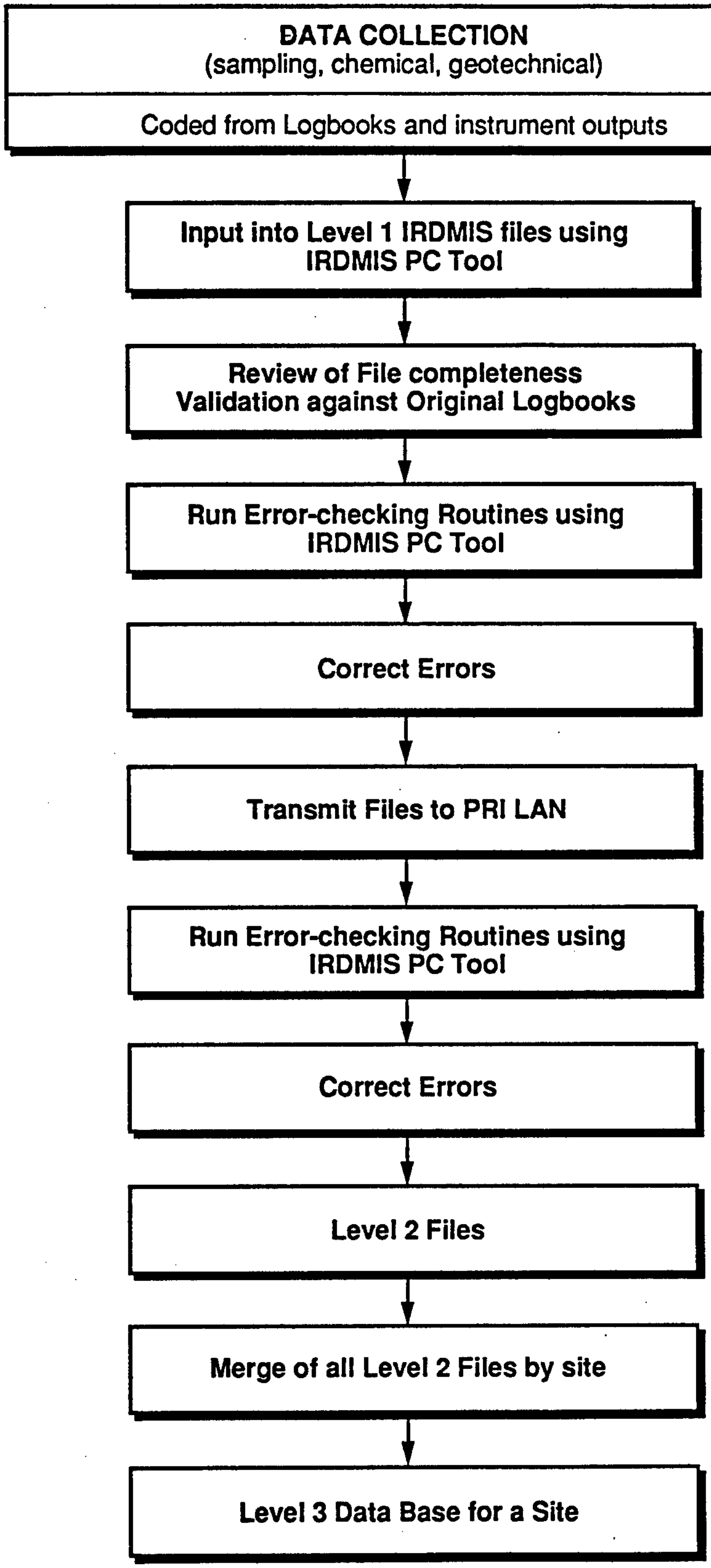


FIGURE 13
BOILER BLOWDOWN AREA
LOCATIONS OF EXISTING INVESTIGATIONS
FORT DIX RI/FS FOR 13 SITES

ABB Environmental Services, Inc.



SOURCE: ICF KAISER ENGINEERS, 1993.

FIGURE 14
DATA MANAGEMENT SCHEME
TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

TABLE 1
SUMMARY OF FIELD INVESTIGATION ACTIVITIES

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SITE NUMBER	SITE NAME	INVESTIGATIVE APPROACH
2	POL Area	• Perform geophysical survey to approximate locations of former USTs. • Resurvey selected monitoring wells to better define locations. • Survey site area for 2 foot contours. • Drill 5 soil borings to evaluate residual soil. • Sample storm sewer discharge points. • Conduct field screening program for groundwater. • If needed, install, develop, and slug test additional monitoring wells • Sample existing and/or new monitoring wells.
3	Fire Tank Training Area	• Two phased approach. • Confirm locations and integrity of monitoring wells. • Collect surface water/sediment samples from Dogwood Brook. • Install 2 soil borings, one in the fire tank and one in bermed area, and analyze using field screening. • If contaminant concentrations exceed levels of concern then: • Install additional soil borings and perform field screening. • Install 2 piezometers and 2 staff gauges adjacent to Dogwood Brook. • Install, develop, sample, and slug test new monitoring wells. • Sample new and/or existing monitoring wells.
4	Golf Course Leaking Tank Area	• Survey site area for 2 foot contours. • Confirm locations and integrity of monitoring wells. • Conduct groundwater field screening program. • Install, develop, sample, and slug test monitoring wells. • Install stream gauges. • Collect core sample of sediments from pond bottoms. • Collect 9 surface water/sediment samples. • Conduct aquifer test. • Develop groundwater flow and contaminant transport models.
5	Transportation Motor Pool	• Confirm locations and integrity of monitoring wells. • Survey location of underground conduit from Dogwood Lake. • Establish approximate locations of previous boring E3, F3, G3, H3. • Install soil borings, and perform field screening. • Install, develop, sample, and slug test monitoring wells. • Test pit adjacent to conduit. • Evaluate surface water/sediment media based on Fire Tank Training Area samples.

TABLE 1
SUMMARY OF FIELD INVESTIGATION ACTIVITIES

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SITE NUMBER	SITE NAME	INVESTIGATIVE APPROACH
6	ARDC Test Facility	• Sample FTDIX-13 to assess accuracy of previous sampling. • Confirm locations and integrity of monitoring wells. • Collect surface and subsurface soil samples. • Collect surface water/sediment samples. • Install, develop, sample, and slug test monitoring well. • Pump FTDIX-13 and monitor monitoring well water levels, if necessary. • Sample new and existing monitoring wells, including FTDIX-13.
8	Pesticide Control Shop	• Conduct monitoring well survey. • Perform phased field screening program for soils and groundwater. • Surface water/sediment sample program. • Pending results of field screening, install soil borings and or monitoring wells, collect and analyze samples. • Slug test new monitoring wells.
9	New Egypt Armory	• Produce base map with cultural and topographic features. • Sample and analyze contents of USTs. • Confirm location and integrity of monitoring wells. • Perform phased field screening program for soils and groundwater. • Collect and analyze surface water/sediment samples. • Install, develop, sample and slug test new monitoring wells, also sample existing monitoring wells.
10	Range Landfill	• Produce base map with cultural and topographic features. • Confirm location and integrity of monitoring wells. • Perform geophysical survey. • Perform gross radiation survey. • Define regional hydrogeologic conditions. • Perform field screening of groundwater. • Install, develop, sample, and slug test additional monitoring wells.
11	ANC-9 Landfill	• Review EI/AA Report by ICF for groundwater flow and chemical data. • Perform surface geophysical survey. • Excavate test pits in areas in observed trenches. • Sample soils from test pits.

TABLE 1
SUMMARY OF FIELD INVESTIGATION ACTIVITIES

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SITE NUMBER	SITE NAME	INVESTIGATIVE APPROACH
12	ANC-2 Disposal Area	• Survey excavation boundary and produce topographic contours (2 foot interval). • Confirm location and integrity of monitoring wells. • Collect and analyze surface water/sediment samples. • Perform groundwater field screening program. • Install, develop, sample, and slug test monitoring wells. • Sample existing monitoring wells.
13	Boiler Blowdown Area	• Review ongoing efforts at 4400 Motor Pool for relevant data. • Collect and analyze surface soils of samples. • Collect and analyze surface water/sediment samples.
14	Area North of Dogwood Lake	• Confirm location and integrity of monitoring wells. • Determine groundwater flow direction utilizing existing wells. • Review EI/AA Report by ICF for additional surface water/sediment information. • Collect surface water and sediment samples. • Perform groundwater field screening program. • Install, develop, sample, and slug test monitoring wells.
15	Golf Course Pesticide Mixing and Storage Area	• Survey site area for 2 foot contours. • Conduct soil borings with field screening. • Collect sediment samples. • Collect surface soil samples.

PROPOSED HYD

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SITE	MONITORING WELL PIEZOMETER SITE I.D.	TOP OF PVC/GROUND ELEVATION	DEPTH OF WELL FROM TOC PVC (feet)	SCREEN INTERVAL (bgs)	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL
Site 2 POL Area	**EXISTING MONITORING WELLS**					
	POL-5	156.16/153.84	37.2	25-35	16.2-17.2	4" PVC
	POL-6	156.48/154.54	27.0	15-25	16.7-17.5	
	POL-7	150.87/148.93	26.0	14-24	11.8-12.8	
	POL-8	152.78/150.93	26.9	15-25	13.5-14.5	
	POL-48	153.19/151.00	27.2	10-25	13.7-14.7	
	POL-49	156.29/153.70	30.0	12.5-27.5	16.5-17.3	
	POL-50	158.57/156.10	30.0	12.5-27.5	18.4-19.2	
	PROPOSED EXPLORATIONS					
	Field Screening					
	PLA-01		N/A	N/A	15 Feet	N/A
	PLA-02					
	PLA-03					
	PLA-04					
	PLA-05					
	Monitoring Wells					
	PLG-01 (Optional)		Shallow	Water Table	15 Feet	4" PVC
	PLG-02 (Optional)					
	PLG-03 (Optional)					
	PLG-04 (Optional)					
	PLG-05 (Optional)					
Site 3 Fire Training Tank Area	**EXISTING MONITORING WELLS**					
	FTT-13	127.27/125.57	26.7	15-25	2.9-3.3	4" PVC
	FTT-14	126.34/124.34	20.0	8-18	2.4-2.8	
	FTT-51	138.95/136.7	32.2	20-30	12.0-13.0	
	PROPOSED EXPLORATIONS					
	Monitoring Wells					
	FTG-01A (Optional)		Shallow	Water Table	10 Feet	4" PVC
	FTG-01B (Optional)		Deep	TFCU		
	FTG-02A (Optional)		Shallow	Water Table		
	FTG-02B (Optional)		Deep	TFCU		
	FTG-03A (Optional)		Shallow	Water Table		
	FTG-03B (Optional)		Deep	TFCU		
	Piezometers					
	FTPIEZ-1		Shallow	Water Table		2" PVC
	FTPIEZ-2		Shallow	Water Table		2" PVC

TABLE 2
PROPOSED HYDROGEOLOGIC INVESTIGATION ACTIVITIES

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

EEN RVAL gs)	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL	DRILLING METHOD	EST. EXPLORATION DEPTH AND SAMPLE INTERVAL	FIELD SCREENING ANALYSES	ANALYTICAL LABORATORY ANALYSES
-35	16.2–17.2	4" PVC	Rotary	5' intervals	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), and TSS.
-25	16.7–17.5					
-24	11.8–12.8					
-25	13.5–14.5					
-25	13.7–14.7					
-27.5	16.5–17.3			Continuous		
-27.5	18.4–19.2					
/A	15 Feet	N/A	Geoprobe/ Screened Augers	Water samples at 5' intervals from water table surface to max. 35 ft. bgs	BTEX, TPH	10% confirmatory analyse for TCL VOCs, TCL SVOCs, TAL metals (filtere and unfiltered), TPH, and TSS.
able	15 Feet	4" PVC	HSA	Soil samples at 5' intervals to approximately 25 ft. bgs	N/A	TCL VOCs, TCL SVOCs, TAL metals, and TSS (grai size analysis from screen interval).
25	2.9–3.3	4" PVC	Rotary	Soil samples at 5' intervals	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), explosives, and TSS.
18	2.4–2.8			Soil samples at 5' intervals		
30	12.0–13.0			Soil samples continous to 10', at 5' intervals below 10'		
Table	10 Feet	4" PVC	HSA	Soil samples at 5' intervals. Shallow wells estimated to be 20 ft. deep, deep wells estimated to be 45 ft. deep.	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), explosives, and TSS (grain size analysis fro well screen interval).
U			Rotary			
Table			HSA			
U			Rotary			
Table			HSA			
U			Rotary			
Table		2" PVC	HSA	N/A	N/A	N/A
able		2" PVC	HSA	N/A	N/A	N/A

TION ACTIVITIES

ES

EXPLORATION EPTH AND SAMPLE INTERVAL	FIELD SCREENING ANALYSES	ANALYTICAL LABORATORY ANALYSES	NOTES
5' intervals	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), and TSS.	One round of samples collected from existing wells.
Continuous			
ples at 5' intervals table surface to max.	BTEX, TPH	10% confirmatory analyses for TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), TPH, and TSS.	Field screening will terminate upon two consecutive samples below detection limits. Estimated to be 35 ft. bgs.
es at 5' intervals mately 25 ft. bgs	N/A	TCL VOCs, TCL SVOCs, TAL metals, and TSS (grain size analysis from screen interval).	Wells installed only if existing wells are improperly located to characterize contaminant plumes. One round of samples will be collected.
es at 5' intervals es at 5' intervals es continous to 10', als below 10'	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), explosives, and TSS.	One round of samples will be collected.
es at 5' intervals. ells estimated to be , deep wells to be 45 ft. deep.	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), explosives, and TSS (grain size analysis from well screen interval).	Shallow wells installed if tank area screening indicates contamination, deep wells installed if tank area screening detects TCA. One round of samples will be collected.
N/A N/A	N/A N/A	N/A N/A	Installed if tank area screening detects contamination. Determine hydraulic connection to surface water.

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PROPOSED HYD

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SITE	MONITORING WELL PIEZOMETER SITE I.D.	TOP OF PVC/GROUND ELEVATION	DEPTH OF WELL FROM TOC PVC (feet)	SCREEN INTERVAL (bgs)	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL
Site 4 Golf Course Leaking Tank Area	**EXISTING MONITORING WELLS**					
	GLF-15		26.9	15-25	11.3-12.3	4" PVC
	GLF-16	146.27/144.52	24.1	12-22	8.8-9.6	
	GLF-17	142.04/140.25	26.0	14-24	5.1-5.7	
	GLF-52	136.67/NA	25.0 (bgs)	15-25	0.9-1.4	
	GLF-53	138.48/NA	25.0 (bgs)	15-25	2.4-2.9	
	GLF-73	139.32/139.75	20.0	10-20	3.1-3.6	
	GLF-74	138.96/139.22	20.0	10-20	2.8-3.4	
	PROPOSED EXPLORATIONS					
	Field Screening					
	GTA-01		N/A	N/A	5 Feet	N/A
	GTA-02					
	GTA-03					
	GTA-04					
	GTA-05					
	GTA-06					
	GTA-07					
	GTA-08					
	GTA-09					
	GTA-10					
	GTA-11					
	GTA-12					
	GTA-13					
	GTA-14					
	GTA-15					
	GTA-16					
	GTA-17					
	GTA-18					
	GTA-19					
	GTA-20					
	GTA-21					
	Monitoring Wells					
	GTG-01A		Shallow	Water Table	5 Feet	4" PVC
	GTG-01B		Deep	TFCU		
	GTG-02A		Shallow	Water Table		
	GTG-02B		Deep	TFCU		
	GTG-03A		Shallow	Water Table		
	GTG-03B		Deep	TFCU		
	GTG-04A		Shallow	Water Table		
	GTG-04B		Deep	TFCU		4" PVC
	GTG-05		Shallow	Water Table		
	GTG-06					
	GTG-07					
	GTG-08					

TABLE 2
PROPOSED HYDROGEOLOGIC INVESTIGATION ACTIVITIES

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

CREEN TERVAL (bgs)	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL	DRILLING METHOD	EST. EXPLORATION DEPTH AND SAMPLE INTERVAL	FIELD SCREENING ANALYSES	ANALYTIC LABORATO ANALYSE
15–25	11.3–12.3	4" PVC	Mud Rotary	Soil samples at 5' intervals	N/A	TCL VOCs, TCL SVOC TAL inorganics (filtere unfiltered), TSS, TDS, pesticides and herbici BOD5, COD, hardnes and Alkalinity.
12–22	8.8–9.6					
14–24	5.1–5.7					
15–25	0.9–1.4		Water Rotary	Soil samples continuous to 10', 5' intervals below 10', soil samples continuous to 12', 5' intervals below 12'		
15–25	2.4–2.9					
10–20	3.1–3.6					
10–20	2.8–3.4					
N/A	5 Feet	N/A	Geoprobe/ Screened Auger	Groundwater samples collected at 5' intervals from water table surface to approximately depth of 25 ft. bgs.	BTEX and pesticides (see analytical laboratory for lead.)	Samples will also be submitted for laborato analyses of lead (filter andunfiltered) and TS confirmatory analyses VOCs, TCL SVOCs, T pesticides and herbici
ter Table	5 Feet	4" PVC	HSA	Soil samples at 5' intervals; shallow wells estimated to be 15 ft. deep. Deep wells estimated to be 30 ft.	N/A	TCL VOCs, TCL SVOC TAL inorganics, TSS, pesticides, herbicides BOD5, COD, hardnes and alkalinity (grain si analysis from well scr interval).
TFCU			Mud Rotary			
ter Table			HSA			
TFCU			Mud Rotary			
ter Table			HSA			
TFCU			Mud Rotary			
ter Table			HSA			
TFCU		4" PVC	Mud Rotary		N/A	
ter Table			HSA			

ƷATION ACTIVITIES

ITES

ƷT. EXPLORATION DEPTH AND SAMPLE INTERVAL	FIELD SCREENING ANALYSES	ANALYTICAL LABORATORY ANALYSES	NOTES
npies at 5' intervals npIes continuous to 10', ɂals below 10', soil s continuous to 12', ɂals below 12'	N/A	TCL VOCs, TCL SVOCs, TAL inorganics (filtered and unfiltered), TSS, TDS, pesticides and herbicides, BOD5, COD, hardness, and Alkalinity.	One round of samples will be collected from existing wells.
ıwater samples collected tervals from water ırface to approximately ›f 25 ft. bgs.	BTEX and pesticides (see analytical laboratory for lead.)	Samples will also be submitted for laboratory analyses of lead (filtered andunfiltered) and TSS. 10% confirmatory analyses for TCL VOCs, TCL SVOCs, TPH, pesticides and herbicides.	Field screening will terminate at approximately 25' bgs.
npies at 5' intervals; wells estimated to . deep. Deep wells ɜd to be 30 ft.	N/A N/A	TCL VOCs, TCL SVOCs, TAL inorganics, TSS, TDS, pesticides, herbicides, BOD5, COD, hardness, and alkalinity (grain size analysis from well screen interval).	Paired well nests, based on field screening results located on either side of pond to assess vertical gradients. Single wells based on field screening results to verify field screening. One round of samples will be collected from wells.

PROPOSED HYDR

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SITE	MONITORING WELL PIEZOMETER SITE I.D.	TOP OF PVC/GROUND ELEVATION	DEPTH OF WELL FROM TOC PVC (feet)	SCREEN INTERVAL (bgs)	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL	
Site 5 Transportation Motor Pool	**EXISTING WELLS**						
	TMP-21	131.39/131.48	17.9	8-18	4.0-4.3	4" PVC	
	TMP-22	134.23/132.36	26.9	15-25	7.6-8.0		
	TMP-54	137.22/135.20	27.0	15-25	8.7-9.5		
	TMP-55	143.81/141.50	29.8	17.5-27.5	12.3-12.7		
	TMP-56	144.68/142.50	29.7	17.5-27.5	11.9-13.2		
	PROPOSED EXPLORATIONS						
	Field Screening						
	TMA-01		N/A	N/A	10 Feet	N/A	
	TMA-02						S
	TMA-03						
	TMA-04						
	TMA-05						
	TMA-06						
	TMA-07						
	TMA-08						
	TMA-09						
	TMA-10						
	Monitoring Wells						
	TMG-01 (Optional)		Shallow	Water Table	10 Feet	4" PVC	
	TMG-02 (Optional)						
	TMG-03 (Optional)						
Site 6 ARDC Test Facility	**EXISTING MONITORING WELLS**						
	FDIX-13						
	ARD-75	87.21/84.80	22.4	10-20	5.5-6.3	4" PVC	
	ARD-76	86.61/84.20	22.4	10-20	4.6-5.0		
	ARD-77	84.25/83.60	20.7	10-20	4.3-4.7		
	PROPOSED EXPLORATIONS						
	Field Screening						
	ARA-01		N/A	N/A	5 Feet	N/A	
	ARA-02						S
	ARA-03						
	ARA-04						
	ARA-05						
	Monitoring Wells						
	ARG-01A (Optional)		Shallow	Water Table	5 Feet	4" PVC	
	ARG-01B (Optional)		Deep	TFCU			

TABLE 2
PROPOSED HYDROGEOLOGIC INVESTIGATION ACTIVITIES

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SCREEN INTERVAL (bgs)	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL	DRILLING METHOD	EST. EXPLORATION DEPTH AND SAMPLE INTERVAL	FIELD SCREENING ANALYSES	ANALYTI LABORAT ANALYS
8−18 15−25 15−25 17.5−27.5 17.5−27.5	4.0−4.3 7.6−8.0 8.7−9.5 12.3−12.7 11.9−13.2	4" PVC	Mud Rotary Water Rotary	Soil samples at 5' intervals. Soil samples continuous to 10 ft. bgs, 5' intervals to end.	N/A	TCL VOCs, TCL SVC TAL metals (filtered unfiltered), TPH, anc
N/A	10 Feet	N/A	Geoprobe/ Screened Augers	Groundwater samples collected at 5' intervals starting at water table surface, and terminating at 25 ft. bgs.	Chlorinated Solvents, BTEX, and TPH	10% confirmatory an for TCL VOCs, TCL SVOCs, TAL metals and unfiltered), TPH,
Vater Table	10 Feet	4" PVC	HSA	Soil samples at 5' intervals; wells estimated to be approximately 20 ft. deep.	N/A	TCL VOCs, TCL SVO TAL metals (filtered unfiltered), TPH, and (grain size analysis fr screen interval).
10−20 10−20 10−20	5.5−6.3 4.6−5.0 4.3−4.7	4" PVC	N/A	Soil samples continuous to 12' ft. bgs, 5' intervals to end of boring.	N/A	TCL VOCs, TCL SVO TAL metals (filtered a unfiltered), TSS, TPH pesticides.
N/A	5 Feet	N/A	Geoprobe/ Screened Augers	Groundwater samples collected at 5' intervals starting at water table and terminating at 25' ft. bgs.	BTEX, TPH	10% confirmatory an for TCL VOCs, TCL SVOCs, TAL metals (and unfiltered), TSS,
/ater Table TFCU	5 Feet	4" PVC	HSA Rotary	Soil samples at 5' intervals Shallow wells estimated to be 15 ft. deep. Deep wells estimated to be 45 ft. deep.	N/A	TCL VOCs, TCL SVO TAL metals, (filtered unfiltered) TSS, and (grain size analyses from well screen inter

TION ACTIVITIES

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EXPLORATION ƆEPTH AND SAMPLE INTERVAL	FIELD SCREENING ANALYSES	ANALYTICAL LABORATORY ANALYSES	NOTES
les at 5' intervals. les continuous to 5' intervals to	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), TPH, and TSS.	One round of samples will be collected from existing wells.
ıter samples ɜt 5' intervals water table nd terminating ȷs.	Chlorinated Solvents, BTEX, and TPH	10% confirmatory analyses for TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), TPH, and TSS.	Field screening will terminate at 25 ft. bgs.
ıes at 5' intervals; ɿated to be ıtely 20 ft. deep.	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), TPH, and TSS (grain size analysis from well screen interval).	One round of samples will be collected.
ıes continuous to 12' ntervals to end of	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), TSS, TPH, and pesticides.	See Technical Plan for sampling of Fort Dix-13. One round of samples will be collected from existing monitoring wells.
ıter samples collected als starting at ɜ and terminating ȷs.	BTEX, TPH	10% confirmatory analyses for TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), TSS, and TPH.	Field screening will terminate at 25' bgs.
es at 5' intervals ells estimated to be 15 Ɔeep wells estimated deep.	N/A	TCL VOCs, TCL SVOCs, TAL metals, (filtered and unfiltered) TSS, and TPH (grain size analyses from well screen interval).	One round of samples will be collected.

PROPOSED HYDRO

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SITE	MONITORING WELL PIEZOMETER SITE I.D.	TOP OF PVC/GROUND ELEVATION	DEPTH OF WELL FROM TOC PVC (feet)	SCREEN INTERVAL (bgs)	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL	I
Site 8 Pesticide Control Shop	**EXISTING MONITORING WELLS**						
	N/A	N/A	N/A	N/A	N/A	N/A	
	PROPOSED EXPLORATIONS						
	Field Screening						
	PCA-01		N/A	N/A	15 Feet	N/A	
	PCA-02						Sc
	PCA-03						
	PCA-04						
	PCA-05						
	PCA-06						
	PCA-07						
	PCA-08						
	Monitoring Wells						
	PCG-01 (Optional)			Water Table	15 Feet	4" PVC	
	PCG-02 (Optional)						
	PCG-03 (Optional)						
	PCG-04 (Optional)						
Site 9 New Egypt Armory	**EXISTING MONITORING WELLS**						
	NEA 57	178.53/176.6	70	47.5-67.5	57.2-57.6	4" PVC	
	NEA 58	161.10/159.0	57	35-55	40.3-40.6		
	NEA 59	162.79/160.9	62	37.5-57.5	41.7-43.0		
	PROPOSED EXPLORATIONS						
	Field Screening						
	NEA-01 (Optional)		N/A	N/A	40-60	N/A	
	NEA-02 (Optional)						Scr
	NEA-03 (Optional)						
	NEA-04 (Optional)						
	NEA-05 (Optional)						
	MONITORING WELLS						
	NEG-01 (Optional)		50-60	Water Table	40-50	4" PVC	I
	NEG-02 (Optional)						
	NEG-03 (Optional)						

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TABLE 2
PROPOSED HYDROGEOLOGIC INVESTIGATION ACTIVITIES

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

REEN ERVAL ɔgs)	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL	DRILLING METHOD	EST. EXPLORATION DEPTH AND SAMPLE INTERVAL	FIELD SCREENING ANALYSES	ANALYTICAL LABORATORY ANALYSES
·|/A	N/A	N/A	N/A	N/A	N/A	N/A
·|/A	15 Feet	N/A	Geoprobe/ Screened Auger	Groundwater samples at 5' intervals, starting at water table and ending at 25' ft. bgs.	BTEX, herbicides, and pesticides.	10% confirmatory analys for TCL VOCs, TCL SVOC TAL inorganics (filtered a unfiltered),TSS, pesticide herbicides, and explosive
r Table	15 Feet	4" PVC	HSA	Soil samples at 5' intervals. Wells estimated to be 25 ft. deep.	N/A	TCL VOCs, TCL SVOCs, TAL inorganics (filtered a unfiltered), TSS, pesticide herbicides, and explosive (grain size analyses from screen interval).
–67.5	57.2–57.6	4" PVC	Rotary	Soil samples at five–foot intervals.	N/A	TCL VOCs, TCL SVOCs, Metals (filtered and unfilte TSS, and TPH.
–55	40.3–40.6					
–57.5	41.7–43.0					
'/A	40–60	N/A	Geoprobe/ Screened Augers	Groundwater samples at five–foot intervals starting at the water table and extending 30 feet below the water table.	Chlorinated Solvent, BTEX, and TPH.	10% confirmatory analyse TCL VOCs, TCL SVOCs, Metals (filtered and unfilte TPH, and TSS.
· Table	40–50	4" PVC	Rotary/HSA	Soil samples at five–foot intervals. Wells established to be 50–60 feet bgs.	N/A	TCL VOCs, TCL SVOCs, Metals (filtered and unfilte TPH, and TSS.

ATION ACTIVITIES

ES

. EXPLORATION DEPTH AND SAMPLE INTERVAL	FIELD SCREENING ANALYSES	ANALYTICAL LABORATORY ANALYSES	NOTES
N/A	N/A	N/A	No existing monitoring wells present.
ater samples vals, starting at le and ending at 3.	BTEX, herbicides, and pesticides.	10% confirmatory analyses for TCL VOCs, TCL SVOCs, TAL inorganics (filtered and unfiltered),TSS, pesticides, herbicides, and explosives.	Field screening will terminate at 25 ft. bgs.
oles at 5' intervals. imated to be 25	N/A	TCL VOCs, TCL SVOCs, TAL inorganics (filtered and unfiltered), TSS, pesticides, herbicides, and explosives (grain size analyses from well screen interval).	Installed only if field screening indicates groundwater contamination. One round of samples will be collected.
oles at intervals.	N/A	TCL VOCs, TCL SVOCs, TAL Metals (filtered and unfiltered), TSS, and TPH.	One round of samples will be collected from existing wells.
ater samples at intervals starting at the le and extending 30 feet water table.	Chlorinated Solvent, BTEX, and TPH.	10% confirmatory analyses for TCL VOCs, TCL SVOCs, TAL Metals (filtered and unfiltered), TPH, and TSS.	Field screening performed if soil borings suggest groundwater contamination. Field screening to terminate at 30 feet into water table.
oles at five–foot Wells established to be et bgs.	N/A	TCL VOCs, TCL SVOCs, TAL Metals (filtered and unfiltered), TPH, and TSS.	Monitoring wells installed if data from screened augers detect groundwater contamination and if existing wells are not positioned properly.

PROPOSED HYDRC

FOR

SITE	MONITORING WELL PIEZOMETER SITE I.D.	TOP OF PVC/GROUND ELEVATION	DEPTH OF WELL FROM TOC PVC (feet)	SCREEN INTERVAL (bgs)	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL	
Site 10 Range Landfill	**EXISTING MONITORING WELLS**						
	RLF-27	171.56/169.95	49.6	28-48	43.5-44.8	4" PVC	
	RLF-28	174.65/172.56	70.1	48-68	45.90		
	RLF-29	178.46/176.52	68.0	48-68	40.9-41.3		
	RLF-30	180.55-178.68	74.8	53-73	49.8-50.0		
	PROPOSED EXPLORATIONS						
	Field Screening						
	RLA-01		N/A	N/A	45 Feet	N/A	Sc
	RLA-02						
	RLA-03						
	RLA-04						
	RLA-05						
	RLA-06						
	RLA-07						
	Monitoring Wells						
	RLG-01		Shallow	Water Table	45 Feet	4" PVC	
	RLG-02						
	RLG-03						
	RLG-04						
	RLG-05						
Site 11 ANC-9 Landfill	**EXISTING MONITORING WELLS**						
	AN9-38	161.48/159.48	50.0	28-48	40.33	4" PVC	
	AN9-39	160.36/158.47	57.0	35-55	38.67		
	WES-3	N/A	46.0	N/A	43.90		
	PROPOSED EXPLORATIONS						
	N/A	N/A	N/A	N/A	N/A	N/A	
Site 12 ANC-2 Disposal Area	**EXISTING MONITORING WELLS**						
	AN2-40	143.10/141.50	41.6	20-40	23.4	4" PVC	
	AN2-41	145.85/144.11	41.7		24.3		
	AN2-42	146.69/143.69	41.2		23.5		
	PROPOSED EXPLORATIONS						
	Field Screening						
	A2A-01		N/A	N/A	25 Feet	N/A	Sc
	A2A-02						
	A2A-03						
	A2A-04						
	A2A-05						
	A2A-06						

TABLE 2
PROPOSED HYDROGEOLOGIC INVESTIGATION ACTIVITIES

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

REEN ERVAL gs)	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL	DRILLING METHOD	EST. EXPLORATION DEPTH AND SAMPLE INTERVAL	FIELD SCREENING ANALYSES	ANALYTICAL LABORATORY ANALYSES
3–48 3–68 3–68 3–73	43.5–44.8 45.90 40.9–41.3 49.8–50.0	4" PVC	Rotary	Soil samples at 5' intervals.	N/A	TCL VOCs, TCL SVOCs, explosives, TAL metals (f and unfiltered), TSS, gro alpha, beta, gamma.
N/A	45 Feet	N/A	Screened Augers	Groundwater samples at 10' intervals, starting at the water table and ending 30' ft. below water table.	BTEX, radiation, and explosives (see analytical laboratory for metals.)	Sample will also be subm for laboratory analyses o metals (nonfiltered and filtered) and TSS. 10% confirmatory analyses fo VOCs, TCL SVOCs, gros alpha, beta, and gamma, explosives.
Table	45 Feet	4" PVC	HSA	Soil samples at 5' intervals. Wells estimated to be 55 ft. deep.	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), TSS, gross al beta, and gamma, and explosives.
–48 –55 /A	40.33 38.67 43.90	4" PVC	Rotary N/A	Soil samples at 5' intervals. N/A	N/A	TCL VOCs, TCL SVOCs, Metals (filtered and unfilte TSS, and explosives.
/A	N/A	N/A	N/A	N/A	N/A	
–40	23.4 24.3 23.5	4" PVC	Rotary	Soil samples at 5' intervals.		TCL VOCs, TCL SVOCs, TAL metals, TSS, BOD5, COD, TDS, alkalinity, har gross alpha, beta and ga
/A	25 Feet	N/A	Screened Auger/ Geoprobe	Groundwater samples at 10' intervals, to 30' ft. below water table.	Radiation (see analytical laboratory for nickel.)	Samples will also be sub for laboratory analyses of (nonfiltered and filtered) a 10 %confirmatory analyse VOCs, TCL SVOCs, TAL n (filtered and unfiltered), T BOD5, COD,TDS, hardne alkalinity, gross alpha, be gamma.

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I ACTIVITIES

LORATION H AND MPLE ERVAL	FIELD SCREENING ANALYSES	ANALYTICAL LABORATORY ANALYSES	NOTES
5' intervals.	N/A	TCL VOCs, TCL SVOCs, explosives, TAL metals (filtered and unfiltered), TSS, gross alpha, beta, gamma.	One round of samples will be collected from existing wells.
amples starting at and ending ter table.	BTEX, radiation, and explosives (see analytical laboratory for metals.)	Sample will also be submitted for laboratory analyses of TAL metals (nonfiltered and filtered) and TSS. 10% confirmatory analyses for TCL VOCs, TCL SVOCs, gross alpha, beta, and gamma, and explosives.	Field screening to terminate approximately 30 feet into water table.
5' intervals. 1 to be 55 ft.	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), TSS, gross alpha, beta, and gamma, and explosives.	Installed if metals data from screened augers indicates contamination. Depths will be contingent on metals data.
5' intervals. I/A	N/A	TCL VOCs, TCL SVOCs, TAL Metals (filtered and unfiltered), TSS, and explosives.	One round of groundwater sampling from existing wells.
I/A	N/A		No groundwater explorations proposed.
5' intervals.		TCL VOCs, TCL SVOCs, TAL metals, TSS, BOD5, COD, TDS, alkalinity, hardness, gross alpha, beta and gamma.	One round of samples will be collected from existing wells.
amples at 30' ft. below	Radiation (see analytical laboratory for nickel.)	Samples will also be submitted for laboratory analyses of nickel (nonfiltered and filtered) and TSS. 10 %confirmatory analyses for TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), TSS, BOD5, COD,TDS, hardness, alkalinity, gross alpha, beta and gamma.	Field screening to terminate 30 feet into the water table.

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PROPOSED HYD

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SITE	MONITORING WELL PIEZOMETER SITE I.D.	TOP OF PVC/GROUND ELEVATION	DEPTH OF WELL FROM TOC PVC (feet)	SCREEN INTERVAL (bgs)	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL
Site 12 (cont.)	Monitoring Wells					
	A2G-01 (Optional)		Shallow	Shallow	25 Feet	4" PVC
	A2G-02 (Optional)					
	A2G-03 (Optional)					
	A2G-04 (Optional)					
Site 13 Boiler Blowdown Area	N/A	N/A	N/A	N/A	N/A	N/A
Site 14	**EXISTING MONITORING WELLS**					
	PTS-22	N/A	39.0	28.3-38.5	13.5	
Area North of Dogwood Lake	NDL-60	156.14/154.00	27.0	10-25	19.2-20.6	4" PVC
	NDL-61	157.73/155.70	29.5	12.5-27.5	20.9-30.0	
	NDL-62	149.25/147.20	27.0	10-25	13.4-14.4	
	NDL-63	151.79/149.90	27.0	10-25	15.6-16.3	
	NDL-78	144.38/141.80	19.6	7-17	7.9-9.6	
	NDL-79	141.79/139.10	19.7	7-17	7.4-8.3	
	PROPOSED EXPLORATIONS					
	Field Screening					
	DLA-01		N/A	N/A	5 to 15 Feet	N/A
	DLA-02					
	DLA-03					
	DLA-04					
	DLA-05					
	DLA-06					
	DLA-07					
	DLA-08					
	DLA-09					
	DLA-10					
	DLA-11					
	DLA-12					
	DLA-13					
	DLA-14					
	DLA-15					
	DLA-16					
	DLA-17					
	DLA-18					

TABLE 2
PROPOSED HYDROGEOLOGIC INVESTIGATION ACTIVITIES

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

OF ROM VC)	SCREEN INTERVAL (bgs)	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL	DRILLING METHOD	EST. EXPLORATION DEPTH AND SAMPLE INTERVAL	FIELD SCREENING ANALYSES	A LA /
w	Shallow	25 Feet	4" PVC	HSA	Soil samples at 5' intervals to approximately 35 ft. bgs.	N/A	TCL VOCs TAL metal unfiltered), COD, TDS, gross alph (grain size screen inte
	N/A	N/A	N/A	N/A	N/A	N/A	
	28.3–38.5 10–25 12.5–27.5 10–25 10–25 7–17 7–17	13.5 19.2–20.6 20.9–30.0 13.4–14.4 15.6–16.3 7.9–9.6 7.4–8.3	4" PVC	Rotary	Soil samples continuous to 10' ft. bgs and 5' intervals to end of boring.	N/A	TCL VOCs, TAL metals unfiltered),
	N/A	5 to 15 Feet	N/A	Geoprobe	Groundwater samples collected at 5' intervals starting at water table (estimated three samples per boring). Maximum depth will be 25' ft. bgs.	BTEX, TPH	10% confir for TCL VO TPH, TAL m unfiltered),

TIGATION ACTIVITIES

N
3 SITES

EST. EXPLORATION DEPTH AND SAMPLE INTERVAL	FIELD SCREENING ANALYSES	ANALYTICAL LABORATORY ANALYSES	NOTES
il samples at 5' intervals approximately 35 ft. bgs.	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), TSS, BOD5, COD, TDS, hardness, Alkalinity, gross alpha, beta and gamma (grain size analyses from well screen interval).	Wells will be installed if metals data from screened auger indicates contamination. Depths will be contingent on metals data
N/A	N/A	N/A	No groundwater exploration proposed at this site.
l samples continuous to 10' gs and 5' intervals to l of boring.	N/A	TCL VOCs, TCL SVOCs, TAL metals (filtered and unfiltered), TPH, and TSS.	One round of samples will be collected from existing wells.
undwater samples ected at 5' intervals ting at water table imated three samples per ng). Maximum depth will be ft. bgs.	BTEX, TPH	10% confirmatory analyses for TCL VOCs, TCL SVOCs, TPH, TAL metals (filtered and unfiltered), and TSS.	Field screening will terminate at 25 ft. bgs.

PROPOSED HYDRC

FOR

SITE	MONITORING WELL PIEZOMETER SITE I.D.	TOP OF PVC/GROUND ELEVATION	DEPTH OF WELL FROM TOC PVC (feet)	SCREEN INTERVAL (bgs)	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL
Site 14 (cont.)	Monitoring Wells DLG-01 (Optional) DLG-02 (Optional) DLG-03 (Optional) DLG-04 (Optional)		Shallow	Water Table		4" PVC
Site 15 Golf Course	**EXISTING MONITORING WELLS**					
	See Site 4	See Site 4	See Site 4	See Site 4	See Site 4	See Site 4
	PROPOSED EXPLORATIONS					
	N/A		N/A	N/A	N/A	N/A

NOTES:

Elevations from EA 1989 and Dames and Moore 1993.
Laboratory analyses for metals will be for total and dissolved.
TCL VOCs = USEPA Target Compound List of Volatile Organic Compounds
TCL SVOCs = USEPA Target Compound List of Semivolatile Organic Compounds
TAL inorganics = USEPA Target Analyte List of metals and cyanide
TAL metals = USEPA Target Analyte List of metals
PVC = Polyvinyl Chloride
BOD5 = Biological Oxygen Demand

TSS = Total Suspended Solids
N/A = Not Applicable
bgs = below ground surface
TPH = Total Petroleum Hydrocarbons
TFCU = Top of First Confining Unit
TOC = Total Organic Carbon as a labor

TABLE 2
PROPOSED HYDROGEOLOGIC INVESTIGATION ACTIVITIES

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

N AL	APPROXIMATE DEPTH TO WATER (from TOC)	WELL MATERIAL	DRILLING METHOD	EST. EXPLORATION DEPTH AND SAMPLE INTERVAL	FIELD SCREENING ANALYSES	ANALYTICAL LABORATORY ANALYSES
ɔle		4" PVC	HSA	Soil samples at 5' intervals to approximately 25 ft. bgs.	N/A	TCL VOCs, TCL SVOCs, TPH, TAL metals, and TSS.
4	See Site 4	See Site 4	See Site 4	See Site 4	See Site 4	See Site 4
	N/A	N/A	N/A	N/A	N/A	N/A

TSS = Total Suspended Solids
N/A = Not Applicable
bgs = below ground surface
TPH = Total Petroleum Hydrocarbons
TFCU = Top of First Confining Unit
TOC = Total Organic Carbon as a laboratory analysis and top of casing as a well survey

ACTIVITIES

LORATION TH AND MPLE ERVAL	FIELD SCREENING ANALYSES	ANALYTICAL LABORATORY ANALYSES	NOTES
t 5' intervals to 25 ft. bgs.	N/A	TCL VOCs, TCL SVOCs, TPH, TAL metals, and TSS.	Monitoring wells will be installed if field screening results detect contamination and existing wells are not properly positioned based on field screening results.
Site 4	See Site 4	See Site 4	See Site 4
/A	N/A	N/A	Groundwater explorations are proposed under Site 4.

s a well survey

TABLE 3
SOIL SAMPLING PROGRAM

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SITE	SITE IDs	NUMBER OF LABORATORY ANALYTICAL SAMPLES	SAMPLE DEPTHS ANALYSIS	LOCATION	RATIONALE	DRILLING/ SAMPLING METHOD
Site 2 POL Area	Borings PLB-01 PLB-02 PLB-03 PLB-04 PLB-05	5 1 per boring	• Continuous samples to water table field screened for BTEX and TPH. • At least 10% confirmatory samples analyzed for TCL VOCs, TCL SVOCs, TAL metals, TOC, and TPH.	Borings will be located near previously removed USTs.	To document any residual soil contamination from USTs.	HSA/Split-spoon
Site 3 Fire Training Tank Area	Phase I Borings FTB-01 FTB-02	6 3 per boring Field Screening (23 per boring) 6 Lab Analytical (3 per boring)	• Continuous samples to TFCU field screened for BTEX and chlorinated solvents. • At least 10% confirmatory samples analyzed for TCL VOCs, TCL SVOCs, TAL metals, TOC, and explosives.	One boring will be installed in the Fire Training Tank Location and one in the bermed pit. Anticipated depth of each boring is 45 feet.	To determine the presence or absence of contaminants at levels of concern in soils. If none are present then no further action is necessary; if present, continue investigation.	HSA/Split-spoon
	Phase II Borings (if necessary) FTB-03 FTB-04 FTB-05 FTB-06 FTB-07 FTB-08 FTB-09 FTB-10	24 3 per boring 184 Field Screening (23 per Boring) 24 Lab Analytical (3 per boring)	• Continuous samples to TFCU field screened for BTEX and chlorinated solvents. • Select at least 10% field screening samples for laboratory confirmation for TCL VOCs, TCL SVOCs, TAL metals, TOC, and explosives.	Borings will be located down gradient from the fire tanks toward Dogwood Brook. Location selection will utilize screening data from Phase 1 borings.	To determine the distribution of contaminants.	HSA/Split-spoon
Site 4 Golf Course Leaking Tank Area	N/A	N/A	N/A	N/A	N/A	N/A

TABLE 3
SOIL SAMPLING PROGRAM

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SITE	SITE IDs	NUMBER OF LABORATORY ANALYTICAL SAMPLES	SAMPLE DEPTHS ANALYSIS	LOCATION	RATIONALE	DRILLING/ SAMPLING METHOD
Site 5 Transportation Motor Pool Area	Borings TMB-01 TMB-02 TMB-03 TMB-04 TMB-05 TMB-06 TMB-07 TMB-08 TMB-09 TMB-10	20 2 per boring	• Continuous samples to 25 ft. bgs field screened for BTEX, TPH. • Select at least 10% field screening samples for laboratory confirmation for TCL VOCs, TCL SVOCs, TAL metals, TPH, and TOC.	Borings will be located in vicinity of previous borings E3, F3, G3, and H3 drilled in 1985 (IKW, 1985).	To determine the presence or absence of contaminants at levels of concern in soils in area of previous tank removal action.	HSA/split-spoon
	Test Pits TMS-01 TMS-02 TMS-03	3 1 per test pit	• 2 samples from each test pit field screened for BTEX, TPH. • 1 sample from each test pit submitted for laboratory confirmation for TCL VOCs, TCL SVOCs, TAL metals, TPH, and TOC.	Test pits located along buried culvert.	To determine presence or absence of contaminants at levels of concern in soils. Contaminants may be moving preferentially along outside of buried culvert.	Backhoe/ Grab
Site 6 ARDC Test Facility	Surface Soil ARS-01 ARS-02 ARS-03 ARS-04 ARS-05 ARS-06 ARS-07 ARS-08 ARS-09 ARS-10	10 1 per surface soil sample site	• Surface soil samples will be analyzed for TCL VOCs, TCL SVOCs, TAL metals, TPH, and TOC.	Boring and surface soil samples will be collected at fuel storage area.	To determine the presence or absence of contaminants at levels of concern in soils. If present, to help determine distribution of contamination.	Grab

TABLE 3
SOIL SAMPLING PROGRAM

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SITE	SITE IDs	NUMBER OF LABORATORY ANALYTICAL SAMPLES	SAMPLE DEPTHS ANALYSIS	LOCATION	RATIONALE	DRILLING/ SAMPLING METHOD
Site 6 ARDC Test Facility (continued)	Soil Borings ARB-01 ARB-02 ARB-03 ARB-04	12 3 per boring	• Collect samples from borings continuously to the water table. Up to 3 samples per boring will be submitted for laboratory analyses. • Boring soil samples will be analyzed for TCL VOCs, TCL SVOCs, TAL Metals, TPH, and TOC.			HSA/split-spoon
Site 8 Pesticide Control Shop	Phase I Borings PCB-01 PCB-02	4 2 per boring	• Continuous sampling to 25 ft. bgs, field screened for BTEX, pesticides, and herbicides. • Select at least 10% field screening samples for laboratory confirmation for TCL VOCs, TCL SVOCs, TAL inorganics, herbicides, pesticides, and explosives.	One boring in each of two gravel areas adjacent to north side of building.	To determine the presence or absence of contamination at levels of concern in soils and ground-water.	HSA/split-spoon
	Phase II Borings PCB-03 PCB-04 PCB-05 PCB-06 PCB-07 PCB-08	12 2 per boring	• Continuous sampling to 25 ft. bgs, field screened for BTEX, pesticides, and herbicides. • Select at least 10% field screening samples for laboratory confirmation for TCL VOCs, TCL SVOCs, TAL inorganics, herbicides, pesticides, and explosives.	Adjacent to the gravel areas.	If contamination detected in gravel area, drill borings to define distribution of soil contamination.	HSA/split-spoon

TABLE 3
SOIL SAMPLING PROGRAM

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SITE	SITE IDs	NUMBER OF LABORATORY ANALYTICAL SAMPLES	SAMPLE DEPTHS ANALYSIS	LOCATION	RATIONALE	DRILLING/ SAMPLING METHOD
Site 9 New Egypt Armory	<u>Soil Borings</u> NEB-01 NEB-02 NEB-03 NEB-04 NEB-05 NEB-06 NEB-07 NEB-08 NEB-09	14 1 to 2 per boring	• NEB-01 through NEB-05 collect samples continuous to 15 feet bgs or bottom of contamination than at 5-foot intervals to the watertable. • NEB-06 through NEB-09 collect samples continuous to 10 feet bgs or bottom of contamination. • Field screening for BTEX, chlorinated solvents, and TPH. Select at least 10% field screening samples for laboratory confirmation for TCL VOCs, TCL SVOCs, TAL Inorganics, TOC, and TPH.	NEB-01 through NEB-05 located near USTs. NEB-06 through NEB-09 and surface soil samples located in vehicle parking area.	To determine presence or absence of contamination at levels of concern in soils. If present, to help determine distribution of chemicals.	HSA/split-spoon
Site 9 New Egypt Armory (continued)	<u>Surface Soils</u> NES-01 NES-02 NES-03 NES-04 NES-05 NES-06 NES-07 NES-08 NES-09 NES-10	10 1 per surface soil sample site	• Boring and surface soil samples submitted for TCL VOCs, TCL SVOCs, and TAL inorganics.			
Site 10 Range Landfill	N/A	N/A	N/A	N/A	N/A	N/A
Site 11 ANC-9 Landfill	<u>Test Pits</u> A9S-01 A9S-02 A9S-03 A9S-04 A9S-05	5 1 per test pit	Grab soil samples from test pits analyze for TCL VOCs, TCL SVOCs, TAL metals, explosives, and TOC.	In areas of trenches observed in review of historical aerial photographs and during field visits.	To investigate nature of material observed in trenches.	Test Pit/ Grab

TABLE 3
SOIL SAMPLING PROGRAM

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SITE	SITE IDs	NUMBER OF LABORATORY ANALYTICAL SAMPLES	SAMPLE DEPTHS ANALYSIS	LOCATION	RATIONALE	DRILLING/ SAMPLING METHOD
Site 12 ANC-2 Disposal Area	N/A	N/A	N/A	N/A	N/A	N/A
Site 13 Boiler Blowdown Area	Surface Soils BBS-01 BBS-02 BBS-03 BBS-04 BBS-05 BBS-06 BBS-07 BBS-08 BBS-09 BBS-10 BBS-11	11 1 per surface soil sample site	• Samples collected from 0 to 0.5 feet bgs along stream bank. • Samples analyzed for TCL VOCs, TCL SVOCs, and TAL inorganics.	Located near previous surface soil samples where thallium was detected.	To determine the presence or absence of contamination at levels of concern in surface soils. If present, to help determine distribution of chemicals.	Grab
Site 14 Area North of Dogwood Lake	Well Boring DLG-01(optional) DLG-02(optional DLG-03(optional) DLG-04(optional)	8 2 per boring	• Continuous soil samples from 10 feet above watertable to 5 feet below water table, field screen samples for BTEX and TPH. • Select at least 10 percent field screening samples for laboratory confirmation for TCL VOCs, TCL SVOCs, TAL Metals, and TPH.	Wells to be located north of Dogwood Lake in area of groundwater contamination, if detected in geoprobe program.	To enhance evaluation of potential free product.	HSA/split-spoon
Site 15 Golf Course Pesticide Mixing and Storage Area	Soil Borings GPB-01 GPB-02	4 2 per boring	• Continuous samples to water table, field screened samples for BTEX, pesticides, and herbicides. • Select at least 10% field screening samples for laboratory confirmation for TCL VOCs, TCL SVOCs, TAL inorganics, pesticides, herbicides, and TOC.	Borings located within mapped boundary of mixing area. Analytical confirmatory samples collected from ground surface, water table, and top of first major fine grained soil unit.	To determine the presence or absence of contaminants at levels of concern in soils. If present, to help determine distribution of contamination.	HSA/split-spoon

TABLE 3
SOIL SAMPLING PROGRAM

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SITE	SITE IDs	NUMBER OF LABORATORY ANALYTICAL SAMPLES	SAMPLE DEPTHS ANALYSIS	LOCATION	RATIONALE	DRILLING/ SAMPLING METHOD
Site 15 Golf Course Pesticide Mixing and Storage Area (continued)	Surface Soil GPS-01 GPS-02 GPS-03 GPS-04 GPS-05 GPS-06 GPS-07 GPS-08 GPS-09 GPS-10 GPS-11 GPS-12	12 1 per surface soil sample site	• Analyze three samples for TCL VOCs, TCL SVOCs, pesticides, herbicides, TAL inorganics, and TOC.	Collect samples in grid pattern in unpaved areas of the Pesticide Mixing Area.	To determine the presence or absence of contaminants at levels of concern in soils. If present, to help determine distribution of contamination.	Grab

Notes:

BTEX = Benzene, toluene, ethylbenzene, and xylene
111TCE = 1,1,1-Trichloroethane
TCL VOCs = USEPA Target Compound List of Volatile Organic Compounds
TCL SVOCs = USEPA Target Compound List of Semivolatile Organic Compounds
TAL Metals = USEPA Target Analyte List of Metals
TAL Inorganics = USEPA Target Analyte List Metals and Cyanide
TOC = Total Organic Carbon
TPH = Total Petroleum Hydrocarbons

TABLE 4
SURFACE WATER/SEDIMENT ASSESSMENT PROGRAM

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SITE	SITE ID	MEDIA	CHEMICAL ANALYSES	LOCATION	RATIONALE
Site 2 POL Area	PLD/PLW-01 PLD/PLW-02 PLD/PLW-03 PLD/PLW-04 PLD/PLW-05	Storm Sewer Water and Sediment	TCL VOCs, TCL SVOCs, TAL Metals, PCBs, TOC (sediment), Alkalinity/hardness (surface water), Grain Size Analyses	Sample discharge points of storm sewers and downgradient drainage	Water flow may be potentially derived from shallow groundwater and may be a transport mechanism.
Site 3 Fire Training Tank Area	FTD/FTW-01 FTD/FTW-02 FTD/FTW-03 FTD/FTW-04 FTD/FTW-05	Surface Water Sediment	TCL VOCs, TCL SVOCs, TAL Metals, PCBs, Explosives, TOC (sediment), Alkalinity/hardness (surface water), Grain Size Analyses	5 locations along Dogwood Brook: 2 upstream, 2 at site, 1 downstream.	Stream flow is potentially derived from shallow groundwater. All five locations will be used for Fire Training Tank Area (Site 3) and Transportation Motor Pool Area (Site 5).
Site 4 Golf Course Leaking Tank Area	GTD/GTW-01 GTD/GTW-02 GTD/GTW-03 GTD/GTW-04 GTD/GTW-05 GTD/GTW-06 GTD/GTW-07 GTD/GTW-08 GTD/GTW-09	Surface Water Sediment	TCL VOCs, TCL SVOCs, TAL Inorganics, PCBs, Pesticides, Herbicides, TOC (sediment), Alkalinity/hardness (surface water), Grain Size Analyses	Ponds and stream.	Ponded water is potentially in connection with shallow groundwater flow. Pesticide/herbicide analysis is associated with Site 15 Golf Course Pesticide Mixing and Storage Area.
Site 5 Transportation Motor Pool	See Site 3 above	See Site 3 above	See Site 3 above	See Site 3 above	See rationale for Site 3 Fire Training Tank Area.
Site 6 ARDC Test Facility	ARD/ARW-01 ARD/ARW-02 ARD/ARW-03 ARD/ARW-04 ARD/ARW-05 ARD/ARW-06 ARD/ARW-07 ARD/ARW-08	Surface Water Sediment	TCL VOCs, TCL SVOCs, TAL Metals, PCBs, Pesticides, TOC (sediment), Alkalinity/hardness (surface water), Grain Size Analyses	At three locations along drainage ditch south of ARDC.	To assess impacts from ARDC on drainage ditch and confirm previous sampling. ARD/ARW-04 through ARD/ARW-08 are optional and dependent on detecting contamination in field screening (BTEX, TCE and TPH) on ARD/ARW-01 through ARD/ARW-03.

TABLE 4
SURFACE WATER/SEDIMENT ASSESSMENT PROGRAM

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SITE	SITE ID	MEDIA	CHEMICAL ANALYSES	LOCATION	RATIONALE
Site 8 Pesticide Control Shop	PCD/PCW-01 PCD/PCW-02 PCD/PCW-03	Surface Water Sediment	TCL VOCs, TCL SVOCs, TAL Inorganics, PCBs, Herbicides, Pesticides, Explosives, TOC (sediment), Alkalinity/hardness (surface water), Grain Size Analyses	Collect 3 samples from storm sewer/surface drainage ditch: upstream of site, first depositional area downstream of site, and downstream of second sample.	Previous data suggest potential contaminant transport via storm sewer, surface water.
Site 9 New Egypt Armory	NED/W-01 NED/W-02 NED/W-03	Surface Water Sediment	TCL VOCs, TCL SVOCs, TAL Inorganics, PCBs, TOCs (sediment), TPH, Alkalinity/hardness (surface water), Grain Size Analyses	Collect samples in stream assocaited with New Egypt Armory located north of the site.	To assess impacts from surface water runoff and groundwater discharge associated with New Egypt Armory.
Site 10 Range Landfill	N/A	N/A	N/A	N/A	N/A
Site 11 ANC-9 Landfill	N/A	N/A	N/A	N/A	N/A
Site 12 ANC-2 Disposal Area	A2D/A2W-01 A2D/A2W-02 A2D/A2W-03	Surface Water Sediment	TCL VOCs, TCL SVOCs, TAL Metals, PCBs, TOC (sediment), Alkalinity/hardness (surface water), Grain Size Analyses	Collect 3 samples from Bakers Brook	To evaluate potential contamination from landfill material.

TABLE 4
SURFACE WATER/SEDIMENT ASSESSMENT PROGRAM

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

SITE	SITE ID	MEDIA	CHEMICAL ANALYSES	LOCATION	RATIONALE
Site 13 Boiler Blowdown Area	BBD/W-01 BBD/W-02 BBD/W-03	Surface Water Sediment	TCL VOCs, TCL, SVOCs, TAL inorganics, PCBs, Alkalinity/hardness (surface water), Grain Size Analyses	Collect one sample at outlet of Willow Pond, one sample adjacent to SC-155/156, and one sample approximately 200 feet downstream.	To assess presence/absence of thallium in stream near SC-155/156.
Site 14 Area North of Dogwood Lake	DLD/DLW-01 DLD/DLW-02	Surface Water Sediment	TCL VOCs, TCL SVOCs, TAL Metals, PCBs, TOC (sediment), Alkalinity/hardness (surface water), Grain Size Analyses	Collect two samples from northwest corner of Dogwood Lake	To evaluate potential impact to these media from an identified groundwater plume in the area north of the lake. Data from these two samples will be complemented by SW/SED data from three samples collected for the EI/AA being performed at Fort Dix (ICF-KE, 1993).
Site 15 Golf Course Pesticide Mixing and Storage Area	GPD-01 GPD-02	Sediment	TCL VOCs, TCL SVOCs, TAL Inorganics, PCBs, Herbicides, Pesticides, Explosives, TOC (sediment), Alkalinity/hardness (surface water), Grain Size Analyses	Collect two sediment samples from surface drainage from Mixing Area.	To determine if sediments in potential surface water drainage have been impacted by site activities. Surface water/sediment samples for nearby ponds and stream are included in Site 4 Golf Course Leaking Tank Area.

Notes:

TCL VOCs = USEPA Target Compound List of Volatile Organic Compounds
TCL SVOCs = USEPA Target Compound List of Semivolatile Organic Compounds
TAL Metals = USEPA Target Analyte List of Metals
TAL Inorganics = USEPA Target Analyte List of Metals and Cyanide
TOC = Total Organic Carbon

[3] Five percent of samples will be collected as duplicates.

[4] The number of rinse blanks given represent the anticipated number. Rinse blanks will be collected at a rate of one per type of decontaminated equipment per decontamination event. This rate under the requirements given shall not exceed one rinse blank per day. Rinse blanks will be collected and analyzed for associated parameters. The rinse blank will be collected at the beginning of the day and will accompany the associated samples which are collected during the day.

[5] ICAP analytes are: aluminum, iron, magnesium, manganese, nickel, potassium, silver, sodium, barium, beryllium, cadmium, chromium, cobalt, copper, vanadium, zinc, calcium. GFAA analytes are: arsenic, lead, thallium, silver, selenium. CVAA analyte is Mercury. SPEC analyte is cyanide.

Source: ICF-KE, 1993

TABLE 5
SUMMARY OF FIELD SCREENING CHEMICAL ANALYSES FOR GROUNDWATER SAMPLES

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE	METHOD[2]	SITE DESIGNATION/SITE NO. NUMBER OF SAMPLES[1]															NUMBER OF QC SAMPLES		TOTAL SAMPLES
		PL 2	FT 3	GT 4	TM 5	AR[6] 6	PC 8	NE[6] 9	RL 10	A9 11	A2 12	BB 13	DL 14	GP 15	SOURCE H_2O	SUBTOTAL	FIELD DUPLICATES[3]	RINSE BLANKS[4]	
FIELD SCREENING																			
BTEX	GC	25		105	40	25	24	35	21				54			329	16		345
Chlor. Sol.	GC				40			35								75	4		79
TPH	IR	25			40	25		35					54			179	9		188
Explosives	Immunoassay								21							21	1		22
Pesticides	GC/ECD			105			24									129	6		135
Herbicides	Immunoassay						24									24	1		25
Radiation	Gamma scintillator								21		24					45	2		47
LABORATORY ANALYTICAL																			
TCL VOCs	GC/MS	17	9	43	18	21	12	13	16	3	13		29		2	196	10	135	341
TCL SVOCs	GC/MS	17	9	43	18	21	12	13	16	3	13		29		2	196	10	35	241
Pesticides/ PCBs	GC/ECD			43			12	2							2	59	3	10	72
Herbicides	GC/ECD			40			12	2							2	56	3	14	73
TAL Inorganics[5]	ICAP, GFAA, CVAA, SPEC			41			24	22							2	89	4	43	136
TAL Metals[5]	ICAP, GFAA, CVAA	34	18		36	31			60	6	26		58			269	13	42	324
Lead	GFAA			210												210	11	5	226
Nickel	GFAA										48					48	3	3	54
Total Alpha and Beta Emission	USEPA: SW–846, Method 9310 (GFPC)								16		13				2	31	2		33
Gamma Radiation	USEPA EMSL 901.1								16		13				2	31	2		33
TPH	USEPA: MCAWW 418.1 (IR)	5		40	18	21		13					29		2	128	6	27	161
BOD5	USEPA: MCAWW 405.1			19							13					32	2		34
COD	USEPA: MCAWW 410.2			19							13					32	2		34

TABLE 5
SUMMARY OF FIELD SCREENING CHEMICAL ANALYSES FOR GROUNDWATER SAMPLES

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

		SITE DESIGNATION/SITE NO. NUMBER OF SAMPLES[1]															NUMBER OF QC SAMPLES		
ANALYTE	METHOD[2]	PL 2	FT 3	GT 4	TM 5	AR[6] 6	PC 8	NE[6] 9	RL 10	A9 11	A2 12	BB 13	DL 14	GP 15	SOURCE H_2O	SUBTOTAL	FIELD DUPLICATES[3]	RINSE BLANKS[4]	TOTAL SAMPLES
LABORATORY ANALYTICAL (cont.)																			
TSS	USEPA: MCAWW 160.2	17	9	124	18	21	12	11	30	3	13		29			287	14		301
TDS	USEPA: MCAWW 160.1			19							13					32	2		34
Alkalinity	USEPA: MCAWW 310.1			19							13					32	2		34
Hardness	USEPA: MCAWW 130.2			19							13					32	2		34
Explosives	HPLC		9				12		16	3					2	42	2	17	61
Nitrate/ Nitrite	USEPA: 353.2			19												19	1		20
Phosphate	USEPA: 365.4			19												19	1		20
Sulfate	USEPA: 375.4			19												19	1		20

NOTES:
TCL VOCs = USEPA Target Compound List of Volatile Organic Compounds
TCL SVOCs = USEPA Target Compound List of Semivolatile Organic Compounds
TCL Pesticides = USEPA Target Compound List of pesticides
TAL Inorganics = USEPA Target Analyte List (metals and cyanide)
TAL Metals = USEPA Target Analyte List (metals only)
ICAP = Inductively Coupled Argon Plasma
CVAA = Cold Vapor Atomic Absorption
GFAA = Graphite Furnace Atomic Absorption
TPH = Total Petroleum Hydrocarbons
SM = Standard Methods for the Examination of Water and Wastewater
MCAWW = Methods for Chemical Analysis of Water and Wastewater
MCAWW = Methods for Chemical Analysis of Water and Wastewater
SW-846 = Test Methods for Evaluating Solid Waste
GC/MS = Gas Chromatography/Mass Spectrometry
HPLC = High Pressure Liquid Chromatography
GFPC = Gas Flow Proportional Counter
GC/ECD = Gas Chromatography/Electron Capture Detector
IR = Infrared Spectrophotometry
SPEC = Spectrophotometric (cyanide analysis)
CHLOR SOL = Chlorinated Solvents including TCE, 1,1,1-TCA, 1,2-DCE, 1,2-DCA, 1,1-DCE, vinyl chrloride, tetrachloroethene, chloroform, and carbon tetrachloride.

[1] Number of samples includes 10% confirmatory analyses for field screening samples, plus analyses of 1 round of samples from existing and proposed monitoring wells.

[2] Methods used will be those of a USAEC-certified laboratory, unless otherwise noted.

[3] Five percent of samples will be collected as duplicates.

[4] The number of rinse blanks given represent the anticipated number. Rinse blanks will be collected at a rate of one per type of decontaminated equipment per decontamination event. This rate under the requirements given shall not exceed one rinse blank per day. Rinse blanks will be collected and analyzed for associated parameters. The rinse blank will be collected at the beginning of the day and will accompany the associated samples which are collected during the day. One trip blank (prepared by laboratory) will be sent with each cooler container aqueous samples for VOC analysis. It is estimated that 50 trip blanks will be required for the field program.

[5] TAL Metals and Inorganics are for both nonfiltered and filtered analyses. ICAP analytes are: aluminum, iron, magnesium, manganese, nickel, potassium, silver, sodium, barium, beryllium, cadmium, chromium, cobalt, copper, vanadium, zinc, calcium. GFAA analytes are: arsenic, lead, thallium, silver, selenium. CVAA analyte is mercury. SPEC analyte is cyanide.

[6] This table includes samples FTDIX-13 production well and UST samples at New Egypt Armory.

TABLE 6
SUMMARY OF FIELD SCREENING AND CHEMICAL AND PHYSICAL ANALYSES FOR SOIL SAMPLES

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

		SITE DESIGNATION/SITE NO. NUMBER OF SAMPLES														NUMBER OF QC SAMPLES[2]		
ANALYTE	METHOD[1]	PL 2	FT 3	GT 4	TM 5	AR 6	PC 8	NE 9	RL 10	A9 11	A2 12	BB 13	DL 14	GP 15	SUBTOTAL	FIELD DUPLICATES[3]	RINSE BLANKS[4]	TOTAL SAMPLES
FIELD ANALYTICAL																		
BTEX		40	230		136		96	100					40	30	672	34		706
Chlor. Sol.			230					100							330	23		353
TPH		40			136			100					40		316	9		325
Explosives																		0
Pesticides							96							30	126	6		132
Herbicides							96							30	126	6		132
Radiation															0			0
LABORATORY ANALYTICAL																		
TCL VOCs	GC/MS	5	30		23	22	16	24		5		11	4	16	156	9	90	255
TCL SVOCs	GC/MS	5	30		23	22	16	24		5		11	4	16	156	9	45	210
Pesticides/ PCBs	GC/ECD						16							16	32	3	13	48
Herbicides	GC/ECD						16							16	32	3	5	40
TAL Inorganics[5]	ICAP, GFAA, CVAA, SPEC						16							16	32	4	33	69
TAL Metals[5]	ICAP, GFAA, CVAA	5	30		23	22		24		5		11	4		124	6	25	155
Total Alpha and Beta Emission	USEPA: SW-846, Method 9310 (GFPC)														0	2		2
Gamma Radiation	USEPA EMSL 901.1														0	2		2
TPH	USEPA: MCAWW 418.1 (IR)	5			23	22		24					4		78	6	33	117
Explosives	HPLC		30				16			5					51	4	13	68
TOC	USEPA: Llyod Kahn	5	30		23	22		24		5				16	125	8	25	158
Grain Size[6]	ASTM D-422	5	5	12	3	2	4	3		1			4		39	N/A	N/A	39

NOTES:

TCL VOCs = USEPA Target Compound List of Volatile Organic Compounds
TCL SVOCs = USEPA Target Compound List of Semivolatile Organic Compounds
TCL Pesticides = USEPA Target Compound List of pesticides
TAL Inorganics = USEPA Target Analyte List (metals and cyanide)
TAL Metals = USEPA Target Analyte List (metals only)
ICAP = Inductively Coupled Argon Plasma
CVAA = Cold Vapor Atomic Absorption
GFAA = Graphite Furnace Atomic Absorption
TPH = Total Petroleum Hydrocarbons
SM = Standard Methods for the Examination of Water and Wastewater
MCAWW = Methods for Chemical Analysis of Water and Wastewater
SW-846 = Test Methods for Evaluating Solid Waste
GC/MS = Gas Chromatography/Mass Spectrometry
HPLC = High Pressure Liquid Chromatography
GFPC = Gas Flow Proportional Counter
GC/ECD = Gas Chromatography/Electron Capture Detector
IR = Infrared Spectrophotometry
SPEC = Spectrophotometric (cyanide analysis)
CHLOR SOL = Chlorinated Solvents including TCE, 1,1,1-TCA, 1,2-DCE, 1,2-DCA, 1,1-DCE, vinyl chrloride, tetrachloroethene, chloroform, and carbon tetrachloride.

[1] Methods used will be those of a USAEC-certified laboratory, unless otherwise noted.

[2] One trip blank (prepared by laboratory) will be sent with each cooler containing aqueous samples for VOC analysis. Trip blanks will be analzyed for VOCs.

[3] Five percent of samples will be collected as duplicates.

[4] The number of rinse blanks given represent the anticipated number. Rinse blanks will be collected at a rate of one per type of decontaminated equipment per decontamination event. This rate under the requirements given shall not exceed one rinse blank per day. Rinse blanks will be collected and analyzed for associated parameters. The rinse blank will be collected at the beginning of the day and will accompany the associated samples which are collected during the day.

[5] ICAP analytes are: aluminum, iron, magnesium, manganese, nickel, potassium, silver, sodium, barium, beryllium, cadmium, chromium, cobalt, copper, vanadium, zinc, calcium. GFAA analytes are: arsenic, lead, thallium, silver, selenium. CVAA analyte is mercury. SPEC analyte is cyanide.

[6] The number of grain size samples is estimated. One soil sample from the well screen interval of each new monitoring well will be analyzed for grain size.

TABLE 7
SUMMARY OF FIELD SCREENING CHEMICAL ANALYSES FOR SURFACE WATER SAMPLES

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

		SITE DESIGNATION/SITE NO. NUMBER OF SAMPLES														NUMBER OF QC SAMPLES[2]		
ANALYTE	METHOD[1]	PL 2	FT 3	GT 4	TM 5	AR 6	PC 8	NE 9	RL 10	A9 11	A2 12	BB 13	DL 14	GP 15	SUBTOTAL	FIELD DUPLICATES[3]	RINSE BLANKS[4]	TOTAL SAMPLES
FIELD ANALYTICAL																		
BTEX						3									3	1		4
Chlor. Sol.						3									3	1		4
TPH						3									3	1		4
Explosives															0			0
Pesticides															0			0
Herbicides															0			0
Radiation															0			0
LABORATORY ANALYTICAL																		
TCL VOCs	GC/MS	5	5	9		8	3	3			3	3	2	2	43	3	15	61
TCL SVOCs	GC/MS	5	5	9		8	3	3			3	3	2	2	43	3	15	61
Pesticides/ PCBs	GC/ECD	5	5	9		8	3	3			3	3	2	2	43	3	10	56
Herbicides	GC/ECD			9			3							2	14	1	6	21
TAL Inorganics[5]	ICAP, GFAA, CVAA, SPEC			9			3							2	14	1	7	22
TAL Metals[5]	ICAP, GFAA, CVAA	5	5			8		3			3	3	2		29	2	8	39
Total Alpha and Beta Emission	USEPA: SW-846, Method 9310 (GFPC)														0			0
Gamma Radiation	USEPA EMSL 901.1														0			0
TPH	USEPA: MCAWW 418.1 (IR)					8		3							11	1	3	15
Explosives	HPLC		5				3								8	1	3	12
Alkalinity/ Hardness	USEPA MCAWW 310.1 & 130.2	5	5	9		8	3	3			3	3	2	2	43	3	15	61
TSS	USEPA MCAWW 160.2							3										

NOTES:
TCL VOCs = USEPA Target Compound List of Volatile Organic Compounds
TCL SVOCs = USEPA Target Compound List of Semivolatile Organic Compounds
TCL Pesticides = USEPA Target Compound List of pesticides
TAL Inorganics = USEPA Target Analyte List (metals and cyanide)
TAL Metals = USEPA Target Analyte List (metals only)
SW-846 = Test Methods for Evaluating Solid Waste
GC/MS = Gas Chromatography/Mass Spectrometry
ICAP = Inductively Coupled Argon Plasma
CVAA = Cold Vapor Atomic Absorption
GFAA = Graphite Furnace Atomic Absorption
TPH = Total Petroleum Hydrocarbons
SM = Standard Methods for the Examination of Water and Wastewater
MCAWW = Methods for Chemical Analysis of Water and Wastewater
HPLC = High Pressure Liquid Chromatography
GFPC = Gas Flow Proportional Counter
GC/ECD = Gas Chromatography/Electron Capture Detector
IR = Infrared Spectrophotometry
SPEC = Spectrophotometric (cyanide analysis)
CHLOR SOL = Chlorinated Solvents including TCE, 1,1,1-TCA, 1,2-DCE, 1,2-DCA, 1,1-DCE, vinyl chrloride, tetrachloroethene, chloroform, and carbon tetrachloride.

[1] Methods used will be those of a USAEC-certified laboratory, unless otherwise noted.

[2] One trip blank (prepared by laboratory) will be sent with each cooler containing aqueous samples for VOC analysis. Trip blanks will be analzyed for VOCs.

[3] Five percent of samples will be collected as duplicates.

[4] Rinse blanks are included in Table 8.

[5] TAL Metals and Inorganics are for total analyses only. No dissolved analyses will be conducted on these samples. ICAP analytes are: aluminum, iron, magnesium, manganese, nickel, potassium, silver, sodium, barium, beryllium, cadmium, chromium, cobalt, copper, vanadium, zinc, calcium. GFAA analytes are: arsenic, lead, thallium, silver, selenium. CVAA analyte is mercury. SPEC analyte is cyanide.

TABLE 8
SUMMARY OF FIELD SCREENING CHEMICAL AND PHYSICAL ANALYSES FOR SEDIMENT SAMPLES

QUALITY ASSURANCE PROJECT PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE	METHOD[1]	SITE DESIGNATION/SITE NO. NUMBER OF SAMPLES														NUMBER OF QC SAMPLES		TOTAL SAMPLES
		PL 2	FT 3	GT 4	TM 5	AR 6	PC 8	NE 9	RL 10	A9 11	A2 12	BB 13	DL 14	GP 15	SUBTOTAL	FIELD DUPLICATES[2]	RINSE BLANKS[3]	
FIELD ANALYTICAL																		
BTEX						3									3	1	0	4
Chlor. Sol.						3									3	1	0	4
TPH						3									3	1	0	4
LABORATORY ANALYTICAL																		
TCL VOCs	GC/MS	5	5	9		8	3	6			3	3	2	2	46	3	30	79
TCL SVOCs	GC/MS	5	5	9		8	3	6			3	3	2	2	46	3	15	64
Pesticides / PCBs	GC/ECD	5	5	9		8	3	6			3	3	2	2	46	2	7	55
Herbicides	GC/ECD			9			3							2	14	1	7	22
TAL Inorganics[5]	ICAP, GFAA, CVAA, SPEC			9			3							2	14	1	7	22
TAL Metals[5]	ICAP, GFAA, CVAA	5	5			8		6			3	3	2		32	2	15	49
Total Alpha and Beta Emission	USEPA: SW−846, Method 9310 (GFPC)														0	1	0	1
Gamma Radiation	USEPA EMSL 901.1														0	1	0	1
TPH	USEPA: MCAWW 418.1 (IR)					8		6					2		16	2	7	25
Explosives	HPLC		5				3								8	1	7	16
TOC	USEPA: Lloyd Kahn	5	5	9		8	3	6			3	3	2	2	46	3	15	64
Grain Size[6]	ASTM D−422	5	5	9		8	3	6			3	3	2	2	46	3	3	52

NOTES:

TCL VOCs = USEPA Target Compound List of Volatile Organic Compounds
TCL SVOCs = USEPA Target Compound List of Semivolatile Organic Compounds
TCL Pesticides = USEPA Target Compound List of pesticides
TAL Inorganics = USEPA Target Analyte List (metals and cyanide)
TAL Metals = USEPA Target Analyte List (metals only)
ICAP = Inductively Coupled Argon Plasma
CVAA = Cold Vapor Atomic Absorption
GFAA = Graphite Furnace Atomic Absorption
TPH = Total Petroleum Hydrocarbons
Chlor Sol =

MCAWW = Methods for Chemical Analysis of Water and Wastewater
SW−846 = Test Methods for Evaluating Solid Waste
GC/MS = Gas Chromatography/Mass Spectrometry
HPLC = High Pressure Liquid Chromatography
GFPC = Gas Flow Proportional Counter
GC/ECD = Gas Chromatography/Electron Capture Detector
IR = Infrared Spectrophotometry
SPEC = Spectrophotometric (cyanide analysis)
SM = Standard Methods for the Examination of Water and Wastewater
CHLOR SOL = Chlorinated Solvents including TCE, 1,1,1−TCA, 1,2−DCE, 1,2−DCA, 1,1−DCE, vinyl chrloride, tetrachloroethene, chloroform, and carbon tetrachloride.

[1] Methods used will be those of a USAEC−certified laboratory, unless otherwise noted.

[2] One trip blank (prepared by laboratory) will be sent with each cooler containing aqueous samples for VOC analysis. Trip blanks will be analzyed for VOCs.

[3] Five percent of samples will be collected as duplicates.

[4] The number of rinse blanks given represent the anticipated number. Rinse blanks will be collected at a rate of one per type of decontaminated equipment per decontamination event. This rate under the requirements given shall not exceed one rinse blank per day. Rinse blanks will be collected and analyzed for associated parameters. The rinse blank will be collected at the beginning of the day and will accompany the associated samples which are collected during the day.

[5] ICAP analytes are: aluminum, iron, magnesium, manganese, nickel, potassium, silver, sodium, barium, beryllium; cadmium, chromium, cobalt, copper, vanadium, zinc, calcium. GFAA analytes are: arsenic, lead, thallium, silver, selenium. CVAA analyte is mercury. SPEC analyte is cyanide.

[6] Grain size analyses will be performed on sediment samples.

TABLE 9
PROJECT ANALYTE LIST

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE GROUP	ANALYTICAL METHOD	ANALYTE	TCL/TAL ANALYTE
VOCs	GC/MS	1,2-Dichloroethenes/1,2-Dichloroethylenes (cis and trans isomers)	✓
		trans-1,3-Dichloropropene	✓
		Ethylbenzene	✓
		Styrene/Ethenylbenzene/Styrol/Styrolene/ Cinnamene/Cinnamol/Phenylethylene/Vinylbenzene	✓
		1,2-Dichloroethane	✓
		Methyl isobutyl ketone/Isopropylacetone/ 4-Methyl-2-pentanone	✓
		Toluene	✓
		Chlorobenzene/Monochlorobenzene	✓
		cis-1,3-Dichloropropene/cis-1,3-Dichloropropylene	✓
		Xylenes	✓
		Dibromochloromethane/Chlorodibromomethane	✓
		Tetrachloroethene/Tetrachloroethylene/ Perchloroethylene/Ethylene tetrachloride/Nema/ Tetracap/Tetropil	✓
		Carbon tetrachloride	✓
		Acetone	✓
		Chloroform	✓
		Benzene	✓
		1,1,1-Trichloroethane	✓
		Bromomethane	✓
		Chloromethane	✓
		Chloroethane	✓
		Chloroethene/Vinyl chloride	✓
		Methylene chloride/Dichloromethane	✓
		Carbon disulfide	✓

TABLE 9
PROJECT ANALYTE LIST

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE GROUP	ANALYTICAL METHOD	ANALYTE	TCL/TAL ANALYTE
VOCs (cont.)	GC/MS	Bromoform	✓
		Bromodichloromethane	✓
		1,1-Dichloroethene/1,1-Dichloroethylene	✓
		1,1-Dichloroethane	✓
		1,2-Dichloropropane	✓
		2-Butanone/Methyl ethyl ketone	✓
		1,1,2-Trichloroethane	✓
		Trichloroethene/Trichloroethylene/Ethinyl trichloride/Tri-Clene/Trielene/Trilene	✓
		1,1,2,2-Tetrachloroethane/Tetrachloroethane/Acetylene tetrachloride/Cellon/Bonoform	✓
		2-Hexanone/Methyl n-butyl ketone	✓
SVOCs	GC/MS	4-Bromophenyl phenyl ether	✓
		4-Chlorophenyl phenyl ether	✓
		4-Nitroaniline	✓
		4-Nitrophenol	✓
		2,4-Dimethylphenol	✓
		Benzo[b]fluoranthene/3,4-Benzofluoranthene	✓
		2,6-Dinitrotoluene	✓
		Fluoranthene	✓
		4-Cresol/4-Methylphenol/p-Cresol	✓
		1,4-Dichlorobenzene	✓
		4-Chloroaniline	✓
		Benzo[k]fluoranthene	✓
		Bis(2-chloroisopropyl) ether/2,2'-oxybis(1-chloropropane)	✓
		Phenol/Carbolic acid/Phenic acid/Phenylic acid/ Phenyl hydroxide/Hydroxybenzene/Oxybenzene	✓

TABLE 9
PROJECT ANALYTE LIST

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE GROUP	ANALYTICAL METHOD	ANALYTE	TCL/TAL ANALYTE
SVOCs (cont.)	GC/MS	Acenaphthylene	✓
		Bis(2-chloroethyl) ether	✓
		Bis(2-chloroethoxy) methane	✓
		Bis(2-ethylhexyl) phthalate	✓
		Di-n-octyl phthalate	✓
		Chrysene	✓
		Hexachlorobenzene	✓
		Anthracene	✓
		1,2,4-Trichlorobenzene	✓
		2,4-Dichlorophenol	✓
		2,4-Dinitrotoluene	✓
		N-Nitrosodi-n-propylamine	✓
		Pyrene/Benzo[def]phenanthrene	✓
		Dimethyl phthalate	✓
		Dibenzofuran	✓
		2-Methyl-4,6-dinitrophenol/4,6-Dinitro-2-methylphenol	✓
		1,3-Dichlorobenzene	✓
		Benzo[a]pyrene	✓
		2,4-Dinitrophenol	✓
		Dibenz[ah]anthracene/1,2:5,6-Dibenzanthracene	✓
		Benzo[a]anthracene	✓
		3-Methyl-4-chlorophenol/4-Chloro-3-cresol/ 4-Chloro-3-methylphenol/4-Chloro-m-cresol	✓
		Hexachloroethane	✓
		Hexachlorocyclopentadiene	✓
		Isophorone	✓
		Acenaphthene	✓

TABLE 9
PROJECT ANALYTE LIST

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE GROUP	ANALYTICAL METHOD	ANALYTE	TCL/TAL ANALYTE
SVOCs (cont.)	GC/MS	Diethyl phthalate	✓
		Di-n-butyl phthalate	✓
		Phenanthrene	✓
		Butylbenzyl phthalate	✓
		N-Nitrosodiphenylamine	✓
		Fluorene/9H-Fluorene	✓
		9H-Carbazole/Carbazole	✓
		Hexachloro-1,3-butadiene/Hexachlorobutadiene	✓
		Pentachlorophenol	✓
		2,4,6-Trichlorophenol	✓
		2-Nitroaniline	✓
		2-Nitrophenol	✓
		Naphthalene/Tar camphor	✓
		Benzo[ghi]perylene	✓
		2-Methylnaphthalene	✓
		2-Chloronaphthalene	✓
		3,3'-Dichlorobenzidine	✓
		Indeno[1,2,3-C,D]pyrene	✓
		2-Cresol/2-Methylphenol/o-Cresol	✓
		1,2-Dichlorobenzene	✓
		2-Chlorophenol	✓
		2,4,5-Trichlorophenol	✓
		Nitrobenzene/Essence of mirbane/Oil of mirbane	✓
		3-Nitroaniline	✓

TABLE 9
PROJECT ANALYTE LIST

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE GROUP	ANALYTICAL METHOD	ANALYTE	TCL/TAL ANALYTE
PESTICIDES	GC/ECD	Toxaphene/Chlorinated camphene/Camphechlor/ Alltox/Genephene/Motox/Penphene/Phenacide/ Phenatox/	✓
		alpha-Chlordane	✓
		Aldrin	✓
		beta-Endosulfan/Endosulfan II	✓
		alpha-Benzenehexachloride/ alpha-Hexachlorocyclohexane	✓
		beta-Benzenehexachloride/ beta-Hexachlorocyclohexane	✓
		delta-Benzenehexachloride/ delta-Hexachlorocyclohexane	✓
		Endrin aldehyde	✓
		Heptachlor epoxide	✓
		Endosulfan sulfate	✓
		2,2-Bis(p-chlorophenyl)-1,1,1-trichloroethane (4,4'-DDT)	✓
		gamma-Benzenehexachloride/gamma-Hexachlorocyclohexane/Lindane	✓
		alpha-Endosulfan/Endosulfan I	✓
		Dieldrin	✓
		gamma-Chlordane	✓
		Endrin	✓
		Methoxychlor/Methoxy-DDT/1,1'-(2,2,2-Trichloroethylidene)-bis[4-methoxybenzene]	✓
		1,1-Dichloro-2,2-bis(p-chlorophenyl)ethane/Rhothane/ TDE/ppDDD/1,1'-(2,2-Dichloroethylidene)bis[4-chlorobenzene]	✓
		2,2-Bis(p-chlorophenyl)-1,1-dichloroethene (4,4'-DDE)	✓
		Heptachlor/1H-1,4,5,6,7,8,8-Heptachloro-3a,4,7,	✓
		Endrin ketone	✓

TABLE 9
PROJECT ANALYTE LIST

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE GROUP	ANALYTICAL METHOD	ANALYTE	TCL/TAL ANALYTE
HERBICIDES	GC/ECD	2,4-D	
		2,4-DB	
		2,4,5-T	
		2,4,5-TP	
		Dalapon	
		Dicamba	
		Dichloroprop	
		Dinoseb	
		MCPA	
		MCPP	
EXPLOSIVES	HPLC	2,6-Dinitrotoluene	✓
		2,4,6-Trinitrotoluene/alpha-Trinitrotoluene	
		2,4-Dinitrotoluene	✓
		RDX/Cyclonite/Hexahydro-1,3,5-trinitro-1,3,5-triaz Hexogen	
		Nitroglycerine/1,2,3-Propanetriol trinitrate	
		PETN/Pentaerythritol tetranitrate/2,2-Bis[(nitroox methyl]-1,3-propanediol dinitrate (ester)	
		Tetryl/N-Methyl-N,2,4,6-tetranitroaniline/Nitramine	
		HMX/Cyclotetramethylenetetranitramine	
		Nitrobenzene/Essence of mirbane/Oil of mirbane	✓
		1,3,5-Trinitrobenzene	
		1,3-Dinitrobenzene	
INORGANICS	CVAA	Mercury	✓
	GFAA	Selenium	✓
	GFAA	Lead	✓
	GFAA	Arsenic	✓

TABLE 9
PROJECT ANALYTE LIST

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE GROUP	ANALYTICAL METHOD	ANALYTE	TCL/TAL ANALYTE
INORGANICS (Cont.)	GFAA	Thallium	✓
	GFAA	Antimony	✓
	ICAP	Aluminum	✓
		Iron	✓
	ICAP	Magnesium	✓
		Manganese	✓
		Nickel	✓
		Potassium	✓
		Silver	✓
		Sodium	✓
		Barium	✓
		Beryllium	✓
		Cadmium	✓
		Chromium	✓
		Cobalt	✓
		Copper	✓
		Vanadium	✓
		Zinc	✓
		Calcium	✓
	Spectrophotometric	Cyanide	✓
OIL & GREASE	Infrared	Oil & Grease	
TPH	Infrared	Total Petroleum Hydrocarbons	
TOC	Combustion	Total Organic Carbon	
BOD5	Probe	Biochemical Oxygen Demand	
COD	Titrimetric	Chemical Oxygen Demand	
TSS	Gravimetric	Total Suspended Solids	

TABLE 9
PROJECT ANALYTE LIST

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE GROUP	ANALYTICAL METHOD	ANALYTE	TCL/TAL ANALYTE
TDS	Gravimetric	Total Dissolved Solids	
ALKALINITY	Titrimetric	Alkalinity	
HARDNESS	Titrimetric	Hardness	
GROSS ALPHA	Scintillation Counter	Gross Alpha Radiation	
GROSS BETA	Scintillation Counter	Gross Beta Radiation	
GAMMA RADIATION	Gamma Spectrometer	Gamma Radiation	

Notes:

TCL = Target Compound List
TAL = Target Analyte List
VOC = volatile organic compound
SVOC = semivolatile organic compound
GC/MS = Gas Chromatography/Mass Spectrometry
GC/ECD = Gas Chromatography/Electron Capture Detector
HPLC = High Pressure Liquid Chromatography
CVAA = Cold Vapor Atomic Absorption
GFAA = Graphite Furnace Atomic Absorption
ICAP = Inductively Coupled Argon Plasma

TABLE 10
INFORMATION REQUIRED FOR GEOTECHNICAL AND CHEMICAL DATA ENTRY INTO IRDMIS

QUALITY ASSURANCE PROJECT PLAN
FORT DIX RI/FS FOR 13 SITES

IRDMIS DATA ENTRY ELEMENTS	GEOTECHNICAL DATA ENTRY	CHEMICAL DATA ENTRY
Installation	X	X
Laboratory		X
Sample		X
Test Method		X
Measurement Units		X
Analyst		X
Sample Number		X
File Name	X	X
File Site Type	X	X
Site ID	X	X
Field Sampler Number	X	X
Sample Date	X	X
Sample Program	X	
Sample Depth (cm)	X	
Sample Technique	X	
Lab Analysis Number		X
Sample Preparation Date		X
Analysis Date		X
Test Name		X
Measurement Boolean		X
Uncorrected Measurement Value		X
Dilution Factor		X
Percent Moisture		X
Internal Standard Code		X
QC Test		X
QC Spike Value		X

Source: ICF Kaiser Engineers, 1993b

TABLE 11
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) AND OTHER GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN: GROUNDWATER (μG/L)

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

CHEMICAL	FEDERAL MAXIMUM CONTAMINANT LEVELS (μG/L)	OTHER FEDERAL GUIDANCE (μG/L)			NEW JERSEY GROUNDWATER STANDARDS (A) CLASS I-PINELANDS GROUNDWATER	LOC (μG/L)	USAEC GROUNDWATER	
		MAXIMUM CONTAMINANT LEVEL GOALS	DRINKING WATER HEALTH ADVISORY FOR LIFETIME EXPOSURE	SECONDARY MAXIMUM CONTAMINANT LEVELS			CRL (μG/L)	COD (μG/L)
ORGANICS								
Benzene	5 (f)	0 (f)	-	-	Zero	1	0.5	0.25
bis(2-Chloroisopropyl)ether	-	-	300 (bb)	-	Zero	14.8	5.3	2.65
Bromoform	100 (f,k)	-	-	-	Zero	0.8	2.6	1.3
Bromomethane	-	-	10 (bb)	-	Zero	-	5.8	2.9
Carbon tetrachloride	5 (f)	0 (f)	-	-	Zero	2	0.58	0.29
Carcinogenic PAHs [benzo(a)pyrene]	0.2 (b,c)	0 (b,c)	-	-	Zero	15.5	4.7	2.35
Chlordane	2 (d)	0 (d)	-	-	Zero	0.5	0.265	0.13
Chlorobenzene	100 (d)	100 (d)	300 (j)	-	Zero	2	0.5	0.25
Chloroform	100 (f,k)	-	-	-	Zero	1	0.5	0.25
Chloromethane	-	-	3 (bb)	-	Zero	-	3.2	1.6
cis-1,2-Dichloroethene	70 (d)	70 (d)	70 (bb)	-	Zero	2	0.5	0.25

Table 11
Applicable or Relevant and Appropriate Requirements (ARARs) and other Guidance for Chemicals of Potential Concern: Groundwater (μg/L)

Technical Plan
Fort Dix RI/FS For 13 Sites

Chemical	Federal Maximum Contaminant Levels (μg/L)	Other Federal Guidance (μg/L)			New Jersey Groundwater Standards (A) Class I-Pinelands Groundwater	LOC (μg/L)	USAEC Groundwater	
		Maximum Contaminant Level Goals	Drinking Water Health Advisory for Lifetime Exposure	Secondary Maximum Contaminant Levels			CRL (μg/L)	COD (μg/L)
1,2-Dichlorobenzene	600 (d)	600 (d)	620 (j)	10 (b,r)	Zero	5	1.7	0.85
1,3-Dichlorobenzene	-	-	620 (j)	-	Zero	5	1.7	0.85
1,4-Dichlorobenzene	75 (f)	75 (f)	75 (j)	5 (b,r)	Zero	5	1.7	0.85
1,2-Dichloroethane	5 (f)	0 (f)	-	-	Zero	2	0.50	0.25
1,1-Dichloroethene	7 (f)	7 (f)	7 (bb)	-	Zero	2	0.50	0.25
Dichloromethane	5	0	-	-	Zero	5	2.3	1.15
1,2-Dichloropropane	5 (d)	0 (d)	-	-	Zero	1	0.50	0.25
Diethylhexylphthalate	6 (c)	0 (c)	-	-	Zero	0.04	4.8	2.4
Endrin	0.2 (f), 2 (b,c)	2 (b,c)	2 (bb)	-	Zero	5	0.0238	0.119
Ethylbenzene	700 (d)	700 (d)	700 (bb)	30 (b,r)	Zero	0.4	0.5	0.25
Gamma-BHC (Lindane)	0.2 (d)	0.2 (d)	0.2 (bb)	-	Zero	0.2	0.0507	0.025
Heptachlor	0.4 (d)	0 (d)	-	-	Zero	5	0.0423	0.021

TABLE 11
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) AND OTHER GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN: GROUNDWATER (μG/L)

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

CHEMICAL	FEDERAL MAXIMUM CONTAMINANT LEVELS (μG/L)	OTHER FEDERAL GUIDANCE (μG/L)			NEW JERSEY GROUNDWATER STANDARDS (A) CLASS I-PINELANDS GROUNDWATER	LOC (μG/L)	USAEC GROUNDWATER	
		MAXIMUM CONTAMINANT LEVEL GOALS	DRINKING WATER HEALTH ADVISORY FOR LIFETIME EXPOSURE	SECONDARY MAXIMUM CONTAMINANT LEVELS			CRL (μG/L)	COD (μG/L)
Heptachlor epoxide	0.2 (d)	0 (d)	-	-	Zero	0.2	0.245	0.12
Hexachlorobenzene	1 (b,c)	0 (b,c)	-	-	Zero	10	1.6	0.8
Hexachlorobutadiene	-	-	0.1 (bb)	-	Zero	1	3.4	1.7
Hexachlorocyclopentadiene (HEX)	50 (b,c)	50 (b,c)	-	8 (b,c)	Zero	10	8.6	4.3
Methoxychlor	40 (d)	40 (d)	40 (bb)	-	Zero	10	0.057	0.029
Methylene chloride (dichloromethane)	5 (b,c)	0 (b,c)	-	-	Zero	2	2.3	1.15
Naphthalene	-	-	20 (t)	-	Zero	20	0.5	0.25
Pentachlorophenol	1 (i)	0 (i)	-	-	Zero	1	1.19	0.59
Polychlorinated Biphenyls (PCBs)	0.5 (d)	0 (d)	-	-	Zero	0.5	0.16	0.08
Styrene	100 (d)	100 (d)	100 (bb)	-	Zero	5	0.5	0.25
Tetrachloroethene	5 (d)	0 (d)	-	-	Zero	1	1.6	0.8

TABLE 11
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) AND OTHER GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN: GROUNDWATER (μG/L)

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

CHEMICAL	FEDERAL MAXIMUM CONTAMINANT LEVELS (μG/L)	OTHER FEDERAL GUIDANCE (μG/L)			NEW JERSEY GROUNDWATER STANDARDS (A) CLASS I-PINELANDS GROUNDWATER	LOC (μG/L)	USAEC GROUNDWATER	
		MAXIMUM CONTAMINANT LEVEL GOALS	DRINKING WATER HEALTH ADVISORY FOR LIFETIME EXPOSURE	SECONDARY MAXIMUM CONTAMINANT LEVELS			CRL (μG/L)	COD (μG/L)
Toluene	1,000 (d)	1,000 (d)	1,000 (bb)	-	Zero	5	0.5	0.25
Toxaphene	3 (d)	0 (d)	-	-	Zero	3	1.35	0.68
trans-1,2-Dichloroethene	100 (d)	100 (d)	-	-	Zero	2	0.5	0.25
1,2,4-Trichlorobenzene	70 (b,c)	70 (b,c)	70 (bb)	-	Zero	1	1.8	0.9
1,1,1-Trichloroethane	200 (f)	200 (f)	200 (bb)	-	Zero	1	0.5	0.25
1,1,2-Trichloroethane	5 (c)	3 (c)	3 (bb)	-	Zero	2	1.2	0.6
Trichloroethene	5 (f)	0 (f)	-	-	Zero	1	0.5	0.25
Vinyl chloride	2 (f)	0 (f)	-	-	Zero	5	2.6	1.3
Xylenes	10,000 (d)	10,000 (d)	10,000 (bb)	-	Zero	2	0.84	0.42
INORGANICS								
Aluminum	-	-	-	50-200 (d)	Background	200	141.0	70.5
Antimony	6 (b,c,e)	6 (b,c)	3 (bb)	-	Background	20	3.03	1.575

Table 11
Applicable or Relevant and Appropriate Requirements (ARARs) and other Guidance for Chemicals of Potential Concern: Groundwater (µg/L)

Technical Plan
Fort Dix RI/FS For 13 Sites

Chemical	Federal Maximum Contaminant Levels (µg/L)	Other Federal Guidance (µg/L)			New Jersey Groundwater Standards (a) Class I-Pinelands Groundwater	LOC (µg/L)	USAEC Groundwater	
		Maximum Contaminant Level Goals	Drinking Water Health Advisory for Lifetime Exposure	Secondary Maximum Contaminant Levels			CRL (µg/L)	COD (µg/L)
Arsenic	50 (f)	-	-	-	Background	8	2.54	1.27
Barium	2,000 (i,h)	2,000(i)	2,000 (bb)	-	Background	200	5.0	2.5
Beryllium	(4,c)	(4,c)	-	-	Background	20	5.0	2.5
Cadmium	5 (d)	5 (d)	5 (bb)	-	Background	2	4.01	2.00
Chromium	100 (d)	100 (d)	120 (bb)	-	Background	10	6.02	3.01
Copper	1,300 (o,p)	1,300 (p)	-	1,000 (q)	Background	1,000	8.09	4.04
Cyanide	200 (b,c)	200 (b,c)	200 (bb)	-	Background	40	2.5	1.25
Iron	-	-	-	300 (bb)	Background	100	38.8	19.4
Lead	15 (o,p)	0 (p)	-	-	Background	10	1.26	0.63
Manganese	-	200 (bb)	-	50 (bb)	Background	6	2.75	1.38
Mercury	2 (d)	2 (d)	2 (bb)	-	Background	1	0.243	0.12
Nickel	100 (b,c)	100 (b,c)	100 (bb)	-	Background	10	34.3	17.15

Table 11
Applicable or Relevant and Appropriate Requirements (ARARs) and Other Guidance for Chemicals of Potential Concern: Groundwater (μG/L)

Technical Plan
Fort Dix RI/FS For 13 Sites

Chemical	Federal Maximum Contaminant Levels (μG/L)	Other Federal Guidance (μG/L)			New Jersey Groundwater Standards (a) Class I-Pinelands Groundwater	LOC (μG/L)	USAEC Groundwater	
		Maximum Contaminant Level Goals	Drinking Water Health Advisory for Lifetime Exposure	Secondary Maximum Contaminant Levels			CRL (μG/L)	COD (μG/L)
Selenium	50 (d)	50 (d)	-	-	Background	10	3.02	1.51
Silver	-	-	-	100 (bb)	Background	2	0.25	0.125
Thallium	2 (c,x)	0.5 (b,c)	0.4 (bb)	-	Background	10	6.99	3.49
Zinc	-	-	2,000 (bb)	5,000 (bb)	Background	30	21.1	10.55

Notes:

- = Standard not developed for this chemical.
CRL = USAEC Certified Reporting Limit
COD = USAEC Criteria of Detection, extended detection limits = 0.5*CRL
LOC = Level of Concern. Defined as NJDEP GW-1 PQL, unless otherwise noted. Groundwater Quality Standards (NJDEPE, 1993 N.J.A.C. 7:9-6.

(a) For Class 1 - Pinelands (Protection Area) groundwater, the groundwater cleanup for a contaminant shall be the background groundwater concentration of that contaminant (24 New Jersey Register 389, February 3, 1992).
(b) Proposed.
(c) Environmental Protection Agency (EPA). 1990. National Primary and Secondary Drinking Water Regulations; Synthetic Organic Chemicals and Inorganic Chemicals. Proposed Rule. Federal Register. Vol. 53, No. 143, Wednesday, July 25, 1990.
(d) Environmental Protection Agency (EPA), 1991. National Primary Drinking Water Regulations; Final Rule. Federal Register. Vol. 56, No. 20, Wednesday, January 30, 1991. 3526-3597.
(e) EPA proposes MCLs of 10 μg/l and 5 μg/l for antimony based on proposed practical quantitation levels (PQLs).
(f) 40 CFR, Part 141-National Primary Drinking Water Regulations, 559-563, 620-621.

Table 11 Notes

(g) Environmental Protection Agency (EPA), 1985. National Primary Drinking Regulations. Synthetic Organic Chemicals, Inorganic Chemicals and Microorganisms. Proposed Rule. Federal Register, Vol. 50, No. 219, Wednesday, November 13, 1985. 46935-47025.

(h) The MCL for barium of 1,000 μg/l shall remain effective until January 1, 1993 when the MCL of 2,000 μg/l will take its place.

(i) Environmental Protection Agency (EPA), 1991. National Primary Drinking Water Regulations - Monitoring for Volatile Organic Chemicals; MCLGs and MCLs for Aldicarb, Aldicarb Sulfoxide, Aldicarb Sulfone, Pentachlorophenol, and Barium; Final Rule. Federal Register. Vol. 56, No. 126, Monday, July 1, 1991. 30266-30281.

(j) Environmental Protection Agency (EPA), 1987. Health Advisories, Office of Drinking Water, Washington, D.C. March 31, 1987.

(k) The value of 100 μg/liter is for total trihalomethanes (i.e., the sum of chloroform, bromochloromethane, and bromoform).

(l) Environmental Protection Agency (EPA), 1989. Health Advisory of Bromomethane. Office of Drinking Water, Washington, D.C. September, 1989.

(m) Environmental Protection Agency (EPA), 1989. Health Advisory for bis(2-Chloroisopropyl)ether, Office of Drinking Water, Washington, D.C. September, 1989.

(n) Environmental Protection Agency (EPA), 1989. Health Advisory for Chloromethane, Office of Drinking Water, Washington, D.C. October, 1989.

(o) Action Level; exceeded if the level of concentration in more than 10 percent of the targeted tap samples is greater than the specified value (90th percentile).

(p) Standards effective December 7, 1992. Environmental Protection Agency (EPA), 1991, Drinking Water Regulations; Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper; Final Rule. Federal Register, Vol. 56, No. 110, 26460-26564, Friday, June 7, 1991.

(q) 40 CFR, Part 143-National Secondary Drinking Water Regulations. 674.

(r) Environmental Protection Agency (EPA), 1989. National Primary and Secondary Drinking Water Regulations; Proposed Rule. Federal Register. Vol. 54, No. 97, Monday, May 22, 1989. 22062-22160.

(s) Environmental Protection Agency (EPA), 1989. Health Advisory for Hexachlorobutadiene, Office of Drinking Water, Washington D.C., September 1989.

(t) Environmental Protection Agency (EPA), 1990. Health Advisory for Naphthalene, Office of Drinking Water. Washington, D.C. March, 1990.

(x) EPA proposes MCLs of 2 μg/l and 1 μg/l for thallium based on proposed practical quantitation levels (PQLs).

(aa) The MCL for lead is in effect until December 7, 1992, when the Action Level will take its place.

(bb) Environmental Protection Agency (EPA), 1992. Drinking Water Regulations and Health Advisories. Office of Water, Washington D.C.

(cc) CRL/COD listed applies specifically to benzo(a)pyrene.

TABLE 12
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) AND OTHER GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN: SURFACE WATER (μG/L)

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE	FEDERAL SURFACE WATER QUALITY CRITERIA (μG/L)				PROPOSED STATE SURFACE WATER QUALITY CRITERIA FOR FW2 WATERS	LOC (μG/L)	USAEC[a] SURFACE WATER	
	FRESHWATER ACUTE CRITERIA	FRESHWATER CHRONIC CRITERIA	WATER AND FISH INGESTION	FISH CONSUMPTION ONLY			CRL (μG/L)	COD (μG/L)
Acenaphthene	*1,700	*520	NC	NC	NC	10	1.7	0.85
Acenaphthylene	NC	NC	NC	NC	0.0028 (hc)	10	0.5	0.25
Aldrin	3.0	NC	0.074x10^{-3}	0.079x10^{-3}	3.0 (a); 0.000135 (hc)	0.04	0.092	0.046
Anthracene	NC	NC	NC	NC	9.570 (h)	10	0.5	0.25
Benzo[a]anthracene[d]	NC	NC	2.8x10^{-3}	31.1x10^{-3}	0.0028 (hc)	10	1.6	0.80
Benzene	5,300	NC	**0.66	**40.0	13.5 (h)	7	0.5	0.25
Benzo[a]pyrene[d]	NC	NC	2.8x10^{-3}	31.1x10^{-3}	0.0028 (hc)	20	4.7	2.35
Benzo[b]fluoranthene[d]	NC	NC	2.8x10^{-3}	31.1x10^{-3}	0.0028 (hc)	10	5.4	2.7
Benzo[g,h,i]perylene[d]	NC	NC	2.8x10^{-3}	31.1x10^{-3}	0.0028 (hc)	20	0.61	0.305
Benzo[k]fluoranthene[d]	NC	NC	2.8x10^{-3}	31.1x10^{-3}	0.0028 (hc)	20	0.87	0.435
alpha-BHC	*100	NC	NC	NC	0.00391 (hc)	NC	0.0385	0.019
beta-BHC	NC	NC	NC	NC	0.137 (hcc)	NC	0.024	0.012
Bis(2-chloroethyl)ether	NC	NC	**0.03	*1.36	0.0311 (hc)	10	1.9	0.95
Bis(2-chloroisopropyl)ether	NC	NC	34.7	4.36x10^{3}	1,250 (h)	10	5.3	2.65

TABLE 12
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs) AND OTHER GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN: SURFACE WATER (μG/L)

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE	FEDERAL SURFACE WATER QUALITY CRITERIA (μG/L)				PROPOSED STATE SURFACE WATER QUALITY CRITERIA FOR FW2 WATERS	LOC (μG/L)	USAEC[a] SURFACE WATER	
	FRESHWATER ACUTE CRITERIA	FRESHWATER CHRONIC CRITERIA	WATER AND FISH INGESTION	FISH CONSUMPTION ONLY			CRL (μG/L)	COD (μG/L)
Bis(2-ethylhexyl)phthalate	NC	NC	NC	NC	1.76 (hc)	30	4.8	2.4
Bromodichloromethane	NC	NC	NC	NC	0.266 (hc)	5	0.59	0.295
Bromoform	NC	NC	NC	NC	4.38 (hc)	8	2.6	1.3
Bromomethane	NC	NC	NC	NC	NC	9	5.8	2.9
Butylbenzylphthalate	NC	NC	NC	NC	239 (h)	NC	3.4	1.7
Carbon tetrachloride	*35,200	NC	**0.4	**6.94	0.363 (hc)	6	0.58	0.29
Chlordane	2.4	0.0043	0.46×10^{-3}	0.48×10^{-3}	2.4 (a); 0.0043 (c); 0.277×10^{-3} (hc)	0.2	0.246	0.123
Chlorobenzene	*250	*50	NC	NC	22.0 (h)	6	0.5	0.25
Chloroform	*28,900	*1,240	0.19	15.7	5.67 (hc)	5	0.5	0.25
Chloromethane	NC	NC	NC	NC	NC	10	3.2	1.6
2-Chloronaphthalene[c]	*1,600	NC	NC	NC	NC	NA	0.5	0.25
2-Chlorophenol	*4,380	*2,000	NC	NC	NC	20	0.99	0.495
Chrysene[d]	NC	NC	2.8×10^{-3}	31.1×10^{-3}	0.0028 (hc)	20	2.4	1.2
cis-1,3-Dichloropropene	*6,000	*244	87	14.1×10^{3}	0.193 (hc)	5	0.58	0.29

TABLE 12
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) AND OTHER GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN: SURFACE WATER (μG/L)

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

ANALYTE	FEDERAL SURFACE WATER QUALITY CRITERIA (μG/L)				PROPOSED STATE SURFACE WATER QUALITY CRITERIA FOR FW2 WATERS	LOC (μG/L)	USAEC[c] SURFACE WATER	
	FRESHWATER ACUTE CRITERIA	FRESHWATER CHRONIC CRITERIA	WATER AND FISH INGESTION	FISH CONSUMPTION ONLY			CRL (μG/L)	COD (μG/L)
4,4'-DDD	NC	NC	NC	NC	.000832 (hc)	0.04	0.019	0.0095
4,4'-DDE	*1.050	NC	NC	NC	0.588×10^{-3} (hc)	0.04	0.025	0.0125
4,4'-DDT	1.1	0.001	0.024×10^{-3}	0.024×10^{-3}	1.1 (a); 0.001 (c); 0.588×10^{-3} (hc)	0.06	0.034	0.017
Di-n-butylphthalate	NC	NC	NC	NC	3,530 (h)	20	3.7	1.85
Dibenzo[a,h]anthracene[d]	NC	NC	2.8×10^{-3}	31.1×10^{-3}	0.0028 (hc)	20	6.5	3.25
Dibromochloromethane	NC	NC	NC	NC	72.6 (h)	6	0.67	0.335
1,2-Dichlorobenzene	*1,120	*763	400	2,600	2,520 (h)	9	1.7	0.85
1,3-Dichlorobenzene[a]	*1,120	*763	400	2,600	2,620 (h)	9	1.7	0.85
1,4-Dichlorobenzene[a]	*1,120	*763	400	2,600	343 (h)	20	1.7	0.85
3,3-Dichlorobenzidine	NC	NC	**0.01	**0.02	0.0386 (hc)	60	12	6.0
1,2-Dichloroethane	*118,000	*20,000	0.94	243	0.291 (hc)	3	0.50	0.25
1,1-Dichloroethene	*11,800	NC	0.033	1.85	4.81 (hc)	6	0.50	0.25
1,2-Dichloroethene (total)	*11,800	NC	0.033	1.85	4.81 (hc)	4 (trans)	2.3	1.15
2,4-Dichlorophenol	*2,020	*365	3.09×10^{3}	NA	92.7 (h)	10	2.9	1.45

Table 12
Applicable or Relevant and Appropriate Requirements (ARARs) and Other Guidance for Chemicals of Potential Concern: Surface Water (μg/L)

Technical Plan
Fort Dix RI/FS For 13 Sites

Analyte	Federal Surface Water Quality Criteria (μg/L)				Proposed State Surface Water Quality Criteria for FW2 Waters	LOC (μg/L)	USAEC^{A} Surface Water	
	Freshwater Acute Criteria	Freshwater Chronic Criteria	Water and Fish Ingestion	Fish Consumption Only			CRL (μg/L)	COD (μg/L)
1,2-Dichloropropane	*23,000	*5,700	NC	NC	NC	NA	0.50	0.25
Dieldrin	2.5	0.0019	0.071×10^{-3}	0.078×10^{-3}	2.5 (a); 0.0019 (c); 0.135×10^{-3} (hc)	0.03	0.018	0.009
Diethylphthalate	NC	NC	350×10^{3}	1.8×10^{6}	21,200 (h)	10	2.0	1.0
2,4-Dimethylphenol	*2,120	NC	NC	NC	NC	NA	5.8	2.9
Dimethylphthalate	*2,120	NC	NC	NC	313,000 (h)	10	1.5	0.75
Di-n-octyl phthalate	NC	NC	NC	NC	NC	NA	15	7.5
2,4-Dinitrotoluene	NC	NC	**0.11	**9.1	0.11 (hc)	10	4.5	2.25
2,6-Dinitrotoluene	NC	NC	70	14.3×10^{3}	NC	NA	0.79	0.395
Endosulfan I	0.22	0.056	74	159	0.22 (a); 0.056 (c); 0.932 (h)	NC	0.023	0.012
Endosulfan II	0.22	0.056	74	159	0.22 (a); 0.056 (c); 0.932 (h)	NC	0.023	0.012
Endosulfan sulfate	NC	NC	NC	NC	0.93 (h)	NC	0.0786	0.039
Endrin	0.18	0.0023	1	NC	0.18 (a); 0.0023 (c); 0.629 (h)	0.04	0.018	0.009

Table 12
Applicable or Relevant and Appropriate Requirements (ARARs) and Other Guidance for Chemicals of Potential Concern: Surface Water (μg/L)

Technical Plan
Fort Dix RI/FS For 13 Sites

Analyte	Federal Surface Water Quality Criteria (μg/L)				Proposed State Surface Water Quality Criteria for FW2 Waters	LOC (μg/L)	USAEC[a] Surface Water	
	Freshwater Acute Criteria	Freshwater Chronic Criteria	Water and Fish Ingestion	Fish Consumption Only			CRL (μg/L)	COD (μg/L)
Ethylbenzene	*32,000	NC	1.4×10^3	3.28×10^3	3.030 (h)	6	0.5	0.25
Fluoranthene	*3,980	NC	42	54	310 (h)	10	3.3	1.65
Fluorene	NC	NC	NC	NC	1,340 (h)	10	3.7	1.85
gamma-BHC (lindane)	NC	NC	NC	NC	2.0 (a); 0.08 (c); 0.0180 (hc)	0.03	0.051	0.0255
Heptachlor	0.52	0.0038	0.28×10^{-3}	0.28×10^{-3}	0.52 (a); 0.0038 (c); 0.000208 (hc)	0.02	0.042	0.021
Heptachlor epoxide	NC	NC	NC	NC	0.52 (a); 0.0038 (c); 0.000208 (hc)	0.4	0.024	0.012
Hexachlorobenzene	NC	NC	0.72×10^{-3}	0.71×10^3	0.000748 (hc)	10	1.6	0.8
Hexachlorobutadiene	*90	*9.3	**0.45	**50	6.94 (h)	10	3.4	1.7
Hexachlorocyclopentadiene	*7	*5.2	206	NC	245 (h)	10	8.6	4.3
Hexachloroethane	*980	*540	1.9	8.74	2.73 (h)	10	1.5	0.75
Indeno(1,2,3-cd)pyrene[d]	NC	NC	2.8×10^{-3}	31.1×10^{-3}	0.0028 (hc)	20	8.6	4.3
Isophorone	*117,000	NC	5.2×10^3	520×10^3	552 (h)	10	4.8	2.4
Methoxychlor	NC	0.03	100	NC	0.03 (c); 40 (h)	0.2	0.057	0.0285

Table 12
Applicable or Relevant and Appropriate Requirements (ARARs) and Other Guidance for Chemicals of Potential Concern: Surface Water (μg/L)

Technical Plan
Fort Dix RI/FS For 13 Sites

Analyte	Federal Surface Water Quality Criteria (μg/L)				Proposed State Surface Water Quality Criteria for FW2 Waters	LOC (μg/L)	USAEC^a Surface Water	
	Freshwater Acute Criteria	Freshwater Chronic Criteria	Water and Fish Ingestion	Fish Consumption Only			CRL (μg/L)	COD (μg/L)
N-Nitrosodiphenylamine	NC	NC	**4.9	**16.1	4.95 (hc)	20	3.0	1.5
Naphthalene	*2,300	*620	NC	NC	NC	NA	0.5	0.25
Nitrobenzene	*27,000	NC	19.8×10^{3}	NC	16.0 (h)	10	0.5	0.25
2-Nitrophenol[b]	*230	*150	NC	NC	NC	NA	3.7	1.85
Pentachlorophenol	***20	***13	1.01×10^{3}	NC	0.282 (hc)	30	18.0	9.0
Phenanthrene	NC	NC	2.8×10^{-3}	31.1×10^{-3}	0.0028 (hc)	10	0.5	0.25
Phenol	*10,200	*2,560	3.5×10^{3}	NC	20,900 (h)	10	9.2	4.6
Pyrene	NC	NC	NC	NC	797 (h)	20	2.8	1.4
1,1,2,2-Tetrachloroethane	NC	*2,400	**0.17	**10.7	1.72 (hcc)	10	0.51	0.255
Tetrachloroethene	*5,280	*940	**0.8	**8.86	0.388 (hc)	9	1.6	0.8
Toluene	*17,500	NC	14.3×10^{3}	424×10^{3}	7,440 (h)	6	0.5	0.25
Toxaphene	0.73	0.0002	0.71×10^{-3}	0.73×10^{-3}	0.73 (a); 0.0002 (c); 0.73×10^{-3} (hc)	1	1.35	0.675
trans-1,3-Dichloropropene	*6,000	*244	87	14.1×10^{3}	0.193 (hc)	7	0.70	0.35
1,2,4-Trichlorobenzene	NC	NC	NC	NC	30.6 (h)	10	1.8	0.9

TABLE 12
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) AND OTHER GUIDANCE FOR CHEMICALS OF POTENTIAL CONCERN: SURFACE WATER (μG/L)

TECHNICAL PLAN
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ANALYTE	FEDERAL SURFACE WATER QUALITY CRITERIA (μG/L)				PROPOSED STATE SURFACE WATER QUALITY CRITERIA FOR FW2 WATERS	LOC (μG/L)	USAEC[A] SURFACE WATER	
	FRESHWATER ACUTE CRITERIA	FRESHWATER CHRONIC CRITERIA	WATER AND FISH INGESTION	FISH CONSUMPTION ONLY			CRL (μG/L)	COD (μG/L)
1,1,1-Trichloroethane	NC	NC	$18.4\text{x}10^3$	$1.0\text{x}10^6$	127 (h)	6	0.5	0.25
1,1,2-Trichloroethane	NC	*9,400	**0.6	**41.8	13.5 (h)	6	1.2	0.6
Trichloroethene	*46,000	*21,800	**2.7	**80.7	1.09 (hc)	5	0.5	0.25
2,4,5-Trichlorophenol	NC	NC	2,800	NC	NC	10	5.2	2.6
2,4,6-Trichlorophenol	NC	*970	**1.2	**3.6	2.14 (hc)	20	4.2	2.1
Vinyl chloride	NC	NC	**2	*525	0.0830 (hc)	10	2.6	1.3
Inorganics								
Aluminum	NC	NC	NC	NC	750 (a); 87 (c)	200	141	70.5
Antimony	*9,000	*1,600	146	45,000	12.2 (h)	20	3.03	1.52
Arsenic	NC	NC	0.0022	0.0175	50 (h)	8	2.54	1.27
Barium	NC	NC	1,000	NC	1,000 (h)	20	5.0	2.5
Beryllium	*130	*5.3	0.0068	0.117	0.00767 (hc)	20	5.0	2.5
Cadmium	+3.9	+1.1	43	9.3	10 (h)	4	4.01	2.00
Chromium	+1,700	+210	170,000	$3,433\text{x}10^3$	16 (a); 11 (c); 160 (h)	10	6.02	3.01

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Technical Plan
Fort Dix RI/FS For 13 Sites

Analyte	Federal Surface Water Quality Criteria (μg/L)				Proposed State Surface Water Quality Criteria for FW2 Waters	LOC (μg/L)	USAEC[A] Surface Water	
	Freshwater Acute Criteria	Freshwater Chronic Criteria	Water and Fish Ingestion	Fish Consumption Only			CRL (μg/L)	COD (μg/L)
Copper	+18	+12	NC	NC	$e^{(0.9422(\ln(H)-1.464)}$ (a) $e^{(0.8545(\ln(H)-1.465)}$ (c)	10	8.09	4.04
Cyanide	22	5.2	200	NC	22 (a); 5.2 (c); 768 (h)	40	2.5	4.04
Iron	NC	1,000	300	NC	1,000 (c)	100	38.8	19.9
Lead	+82	+3.2	NC	60	see (A)	10	1.26	0.63
Manganese	NC	NC	50	100	100 (h)	6	2.75	1.37
Mercury	2.4	0.012	0.144	0.146	2.4 (a); 0.012 (c); 0.144 (h)	1	0.243	0.121
Nickel	+1,400	+160	13.4	100	see (B)	10	34.3	17.1
Selenium	280	35	10	NC	20 (a); 5.0 (c); 179 (h)	10	3.02	1.51
Silver	+4.1	0.12	50	NC	164 (h); see (C)	2	0.25	0.125
Sodium	NC	NC	NC	NC	NC	400	500	250
Thallium	*1.400	*40	13	48	1.70 (h)	10	6.99	3.50
Zinc	+120	+110	NC	NC	see (D)	30.09	21.1	10.6

Notes:

+ = Hardness Dependent Criteria (100 mg/L used)

* = Insufficient Data to Develop Criteria Value presented is the harvest Observed Effect Level (LOEL)

** = Human Health Criteria for Carcinogens Reported for Three Risk Levels Value Presented is 10^{-6} Risk Level

*** = pH Dependent Criteria (7.8 pH used)

LOC = Level of Concern. Defined as the NJDEPE Surface Water PQL, unless otherwise noted. NJDEPE Surface Water PQLs from N.J.A.C. 7:9-4, New Jersey's Surface Water Quality Standards, NJDEPE, October 1992. For inorganics, the "natural background" concentrations will also be considered for LOCs. "Natural inorganic background" concentrations will be established from analytical results from background samples and published regional background data.

PQL = Practical Quantitation Level

NC = No Criterion

NA = Not Available

(a) = aquatic protection based criteria

(h) = criteria based upon human health information

a+ = criteria developed after review of both human health information and aquatic protection data. The basis for the criterion adopted (human health or aquatic protection) is indicated by the letter preceding the *.

h+ = criteria developed after review of both human health information and aquatic protection data. The basis for the criterion adopted (human health or aquatic protection) is indicated by the letter preceding the *.

see p. 56 of NJ SW reg for hc and hcc "H" represents hardness in mg/L as calcium carbonate in water quality criteria formulas for metals.

Except as noted, aquatic life criteria followed by an (a) represent acute aquatic life protection criteria as a one-hour average, aquatic life criteria followed by (c) represent chronic aquatic life protection criteria as a four-day average. No exceedance of aquatic life criteria shall be permitted at or above the design flows specified in section N.J.A.C. 7:9B-1.5(c)2. Criteria followed by an (h) are noncarcinogenic effect-based human health criteria as a 30-day average with no frequency of exceedance at or above the design flows specified in section N.J.A.C. 7:9B-1.5(c)2. Criteria followed by (hc) are carcinogenic effect-based human health criteria as a 70-year average with no frequency of exceedance at or above the design flows specified in section N.J.A.C. 7:9B01.5(c)2 and are based on a risk level of one-in-one-million. Criteria followed by (hcc) are for toxic substances considered to be possible human carcinogens and are based on a risk level of one-in-one hundred thousand. These criteria, (hc) and (hcc), are carcinogenic effect-based human health criteria as a 70-year average with no frequency of exceedance at or above the design flows specified in section N.J.A.C. 7:9B-1.5(c)2. Criteria followed by an (OL) are organoleptic effect-based criteria and are maximum concentrations. "H" represents hardness, in mg/L as calcium carbonate, in water quality criteria formulas for metals.

(a)	Federal criteria are for total dichlorobenzenes
(b)	Federal criteria are for nitrophenols
(c)	Federal criteria are for chlorinated naphthalenes
(d)	Federal criteria are for total carcinogenic PAHs
(e)	Federal and State criteria are for total PCBs
(A)	$e^{(1.273(\ln H)-1.460)}$ (a), $e^{(1.273(\ln H)-4.705)}$ (c); 5(h)
(B)	$e^{(0.8460(\ln H)+3.3612)}$ (a); $e^{0.8460(\ln H)+1.1645)}$ (c); 516(h)
(C)	$e^{(1.72(\ln H)-6.52)}$ (a)
(D)	$e^{0.8473(\ln H)+0.8604)}$ (a); $e^{(0.8473(\ln H)+0.7614)}$ (c)

TABLE 13
SEDIMENT QUALITY CRITERIA FOR SELECTED ORGANIC COMPOUNDS

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

COMPOUND	SEDIMENT CRITERION (μg/g CARBON) (TOP # FW CRITERION, BOTTOM # SW CRITERION)		
	95% CONFIDENCE INTERVAL		
	MEAN	LOWER	UPPER
Acenaphthene	730 NA	180 NA	3,030 NA
Anilene	0.0662 0.248	0.0169 0.0635	0.262 0.984
Chlorpyrifos	3.22 0.44	0.831 0.114	12.7 1.73
DDT	0.828 0.828	0.183 0.183	3.80 3.80
Dieldrin	0.130 0.130	0.00976 0.00976	1.79 1.79
Endrin	0.0532 0.0532	0.00654 0.00654	0.443 0.443
Ethyl Parathion	0.0810 NA	0.0160 NA	0.416 NA
Heptachlor	0.110 0.104	0.0148 0.014	0.840 0.796
Lindane	0.157 NA	0.0394 NA	0.636 NA
Phenanthrene	139 102	32.6 23.8	605 442

Notes:

* should be used as a surrogate for PCBs in general
FW = fresh water
SW = salt water
NA = not available

The sediment quality criteria are reference numbers used to identify the presence of contamination exceeding levels potentially harmful to aquatic life. Specific cleanup objectives are to be developed on a case-by-case basis.

TABLE 14
SCREENING LEVEL VALUES FOR INORGANICS, PESTICIDES, AND PAHS IN SEDIMENT

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

CHEMICAL ANALYTE	ER-L CONCENTRATION	ER-M CONCENTRATION	SUBJECTIVE DEGREE OF CONFIDENCE IN ER-L/ER-M VALUES
Trace Elements (ppm)			
Antimony	2	25	Moderate/moderate
Arsenic	33	85	Low/moderate
Cadmium	5	9	High/high
Chromium	80	145	Moderate/moderate
Copper	70	390	High/high
Lead	35	110	Moderate/high
Mercury	0.15	1.3	Moderate/high
Nickel	30	50	Moderate/moderate
Silver	1	2.2	Moderate/moderate
Zinc	120	270	High/high
Pesticides (ppb)			
Chlordane	0.5	6	Low/low
Polynuclear Aromatic Hydrocarbons (ppb)			
Acenaphthene	150	650	Low/low
Anthracene	85	960	Low/moderate
Benzo(a)anthracene	230	1,600	Low/moderate
Benzo(a)pyrene	400	2,500	Moderate/moderate
Chrysene	400	2,800	Moderate/moderate
Dibenz(a,h)anthracene	60	260	Moderate/moderate
Fluoranthene	600	3,600	High/high
2-methylnaphthalene	65	670	Low/moderate
Naphthalene	340	2,100	Moderate/high
Phenanthrene	225	1,380	Moderate/moderate
Pyrene	350	2,200	Moderate/moderate
Total PAH	4,000	35,000	Low/low

Notes:

The ER-L and ER-M are reference numbers used to identify the presence of contamination exceeding levels potentially harmful to aquatic life. Specific cleanup objectives are to be developed on a case-by-case basis.

Source: NOAA 1990

TABLE 15
PROPOSED SOIL CLEANUP CRITERIA

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

Contaminant	CASRN	RESIDENTIAL DIRECT CONTACT SOIL CLEANUP CRITERIA (a)(b) (mg/kg)	NON RESIDENTIAL DIRECT CONTACT SOIL CLEANUP CRITERIA (a)(b) (mg/kg)	IMPACT TO GROUNDWATER SOIL CLEANUP CRITERIA(b) (mg/kg)
Acenaphthene	83-32-9	3,400	10,000(c)	100
Acetone	67-64-1	1,000(d)	1,000(d)	100(i)
Acrylonitrile	107-13-1	1	5	1(i)
Aldrin	309-00-2	0.040	0.17	50
Anthracene	120-12-7	10,000(c)	10,000(c)	100(i)
Antimony	7440-36-0	14	340	(h)
Arsenic	7440-38-2	20(e)	20(e)	(h)
Barium	7440-39-3	700	47,000(n)	(h)
Benzene	71-43-2	3	13	1
3,4-Benzofluoranthene- (Benzo(b)fluoranthene)	205-99-2	0.9	4	50(i)
Benzo(a)anthracene	56-55-3	0.9	4	500
Benzo(a)pyrene (BaP)	50-32-8	0.66(f)	0.66(f)	100
Benzo(k)fluoranthene	207-08-9	0.9	4	500
Benzyl Alcohol	100-51-6	10,000(c)	10,000(c)	50
Beryllium	7440-41-7	1(f)	1(f)	(h)
Bis(2-chloroethyl)ether	111-44-4	0.66(f)(i)	3	10(j)
Bis(2-chloroisopropyl)ether	39638-32-9	2,300	10,000(c)	10
Bis(2-ethylhexyl)phthalate	117-81-7	49	210	100
Bromodichloromethane (Dichlorobromomethane)	75-27-4	11(g)	46(g)	1
Bromoform	75-25-2	86	370	1
Bromomethane	74-83-9	79	1,000(d)	1
2-Butanone (MEK)	78-93-3	1,000(d)	1,000(d)	50
Butylbenzyl phthalate(j)	85-68-7	1,100	10,000(c)	100
Cadmium	7440-43-9	1	100	(h)
Carbon tetrachloride	56-23-5	2(k)	4(k)	(r)
4-Chloroaniline	106-47-8	230	4,200	(h)
Chlorobenzene	108-90-7	37	680	1
Chloroform	67-66-3	19(k)	28(k)	1

TABLE 15
PROPOSED SOIL CLEANUP CRITERIA

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

Contaminant	CASRN	RESIDENTIAL DIRECT CONTACT SOIL CLEANUP CRITERIA (a)(b) (mg/kg)	NON RESIDENTIAL DIRECT CONTACT SOIL CLEANUP CRITERIA (a)(b) (mg/kg)	IMPACT TO GROUNDWATER SOIL CLEANUP CRITERIA(b) (mg/kg)
4-Chloro-3-methyl phenol (p-Chloro-m-cresol)	59-50-7	10,000(c)	10,000(c)	100
Chloromethane	74-87-3	520	1,000(d)	10
2-Chlorophenol	95-57-8	280	5,200	10(j)
Chrysene	218-01-9	9	40	500
Copper	7440-50-8	600(m)	600(m)	(h)
Cyanide	57-12-5	1,100	21,000(o)	(h)
4,4'DDD (p,p'-TDE)	72-54-8	3	12	50(i)
4,4'-DDE	72-55-9	2	9	50(i)
4,4'-DDT	50-29-3	2	9	500(i)
Dibenz(a,h)anthracene	53-70-3	0.66(f)	0.66(f)	100(j)
Dibromochloromethane (Chlorodibromomethane)	124-48-1	110	1,000(d)	1
Di-n-butyl phthalate	84-74-2	5,700	10,000(c)	100
Di-n-octyl phthalate	117-84-0	1,100	10,000(c)	100
1,2-Dichlorobenzene	95-50-1	5,100	10,000(c)	50
1,3-Dichlorobenzene	541-73-1	5,100	10,000(c)	100
1,4-Dichlorobenzene	106-46-7	570	10,000(c)	100
3,3'-Dichlorobenzidine	91-94-1	2	6	100
1,1-Dichloroethane	75-34-3	570	1,000(d)	10(i)
1,2-Dichloroethane	107-06-2	6	24	1
1,1-Dichloroethene	75-35-4	8	150	10
1,2-Dichloroethene (trans)	156-60-5	1,000(d)	1,000(d)	50
1,2-Dichloroethene (cis)	156-59-2	79	1,000(d)	1(i)
2,4-Dichlorophenol	120-83-2	170	3,100	10
1,2-Dichloropropane	78-87-5	10	43	(r)
1,3-Dichloropropene (cis and trans)	542-75-6	4	5(k)	1
Dieldrin	60-57-1	0.042	0.18	50
Diethyl phthalate	84-66-2	10,000(c)	10,000(c)	50

TABLE 15
PROPOSED SOIL CLEANUP CRITERIA

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

Contaminant	CASRN	RESIDENTIAL DIRECT CONTACT SOIL CLEANUP CRITERIA (a)(b) (mg/kg)	NON RESIDENTIAL DIRECT CONTACT SOIL CLEANUP CRITERIA (a)(b) (mg/kg)	IMPACT TO GROUNDWATER SOIL CLEANUP CRITERIA(b) (mg/kg)
2,4-Dimethyl phenol	105-67-9	1,100	10,000(c)	10
Dimethyl phthalate	131-11-3	10,000(c)	10,000(c)	50
Dinitrotoluene (2,4-/2,6-mixture)	25321-14-6	1(l)	4(l)	10(l)
2,4-Dinitrophenol	51-28-5	110	2,100	10
Endosulfan	115-29-7	340(g)	6200(g)	50
Endrin	72-20-8	17	310	50
Ethylbenzene	100-41-4	1,000(d)	1,000(d)	100
Fluoranthene	206-44-0	2,300	10,000(c)	100(i)
Fluorene	86-73-7	2,300	10,000(c)	100
Heptachlor	76-44-8	0.15	0.65	50(j)
Hexachlorobenzene	118-74-1	0.66(f)	2	100(i)
Hexachlorobutadiene	87-68-3	1(g)	21(g)	100(g)
Hexachlorocyclopentadiene	77-47-4	400	7,300	100
Hexachlorethane	67-72-1	6	100	100
Indeno(1,2,3-cd)pyrene	193-39-5	0.9	4	500
Isophorone	78-59-1	1,100	10,000(c)	50(j)
Lead	7439-92-1	100(p)	600(q)	(h)
Lindane	58-89-9	0.52	2.2	50(j)
2-Methylphenol	95-48-7	2,800	10,000(c)	(r)
4-Methylphenol	106-44-5	2,800	10,000(c)	(r)
Methoxychlor	72-43-5	280	5,200	50(i)
Mercury	7439-97-6	14	270	(h)
4-Methyl-2-pentanone (MIBK)	108-10-1	1,000(d)	1,000(d)	50
Methylene chloride	75-09-2	49	210	1(j)
Naphthalene(j)	91-20-3	230	4,200	100
Nickel	7440-02-0	250	2,400(k)(n)	(h)
Nitrobenzene	98-95-3	28	520	10(i)
N-Nitrosodiphenylamine	86-30-6	140	600	100

TABLE 15
PROPOSED SOIL CLEANUP CRITERIA

TECHNICAL PLAN
FORT DIX RI/FS FOR 13 SITES

Contaminant	CASRN	RESIDENTIAL DIRECT CONTACT SOIL CLEANUP CRITERIA (a)(b) (mg/kg)	NON RESIDENTIAL DIRECT CONTACT SOIL CLEANUP CRITERIA (a)(b) (mg/kg)	IMPACT TO GROUNDWATER SOIL CLEANUP CRITERIA(b) (mg/kg)
N-Nitrosodi-n-propylamine	621-64-7	0.66(f)	0.66(f)	10(j)
PCBs (Polychlorinated biphenyls)	1336-36-3	0.49(i)	2	50(i)
Pentachlorophenol	87-86-5	6	24	100
Phenol	103-95-2	10,000(c)	10,000(c)	50
Pyrene	129-00-0	1,700	10,000(c)	100(j)
Selenium	7782-49-2	63	3,100(n)	(h)
Silver	7440-22-4	110(g)	4,100(n)	(h)
Styrene	100-42-5	23	97	100
1,1,1,2-Tetrachloroethane	630-20-6	170	310	1
1,1,2,2-Tetrachloroethane	78-34-5	34	70(k)	1
Tetrachloroethylene	127-18-4	4(k)	6(k)	1
Thallium	7440-28-0	2(f)	2(f)	(h)
Toluene	108-88-3	1,000(d)	1,000(d)	500
Toxaphene	8001-35-2	0.10(k)	0.2(k)	50(i)
1,2,4-Trichlorobenzene	120-82-1	68	1,200	100
1,1,1-Trichloroethane	71-53-6	210	1,000(d)	50
1,1,2-Trichloroethane	79-00-5	22	420	1
Trichloroethene (TCE)	79-01-6	23	54(k)	1
2,4,5-Trichlorophenol	95-95-4	5,600	10,000(c)	50
2,4,6-Trichlorophenol	88-06-2	62	270	10(i)
Vanadium	7440-62-2	370	7,100(h)	(h)
Vinyl chloride	75-01-4	2	7	10(i)
Xylenes (Total)	1330-29-7	410	1,000(d)	10
Zinc	7440-66-6	1,500(m)	1,500(m)	(h)

Notes:

Source: NJDEPE Soil Cleanup Criteria (Last Revised 2/3/94)

(a) Criteria are health based using an incidental ingestion exposure pathway except where noted below.
(b) Criteria are subject to change based on site specific factors (e.g., aquifer classification, soil type, natural background, environmental impacts, etc.
(c) Health based criterion exceeds the 10,000 mg/kg maximum for total organic contaminants.
(d) Health based criterion exceeds the 1,000 mg/kg maximum for total volatile organic contaminants.

(e) Cleanup standard proposal was based on natural background.
(f) Health based criterion is lower than analytical limits; cleanup criterion based on practical quantitation level.
(g) Criterion has been recalculated based on new toxicological data.
(h) The impact to groundwater values for inorganics will be developed based upon site-specific chemical and physical parameters.
(i) Original criterion was incorrectly calculated; new criterion recalculated using original toxicological data.
(j) Typographical error.
(k) Criterion based on inhalation exposure pathway which yielded a more stringent criterion than the incidental ingestion exposure pathway.
(l) Criterion derived in the basis and background document but inadvertently omitted from Table 3-1 for the residential standard and Table 7-1 for the non-residential standard as found in the proposed rule.
(m) Criterion based on ecological (phytotoxicity) effects.
(n) Level of the human health based criterion is such that evaluation for potential environmental impacts on a site-by-site basis is recommended.
(o) Level of the criterion is such that evaluation for potential acute exposure hazard is recommended.
(p) Criterion based on the goal that children should be exposed to the minimal amount of lead that is practicable and is reflective of natural background as altered by diffuse anthropogenic pollution. Criterion corresponds to both a median value for urban land which has not been impacted by any local point source of lead and a 90th percentile value for similar suburban land.
(q) Criteria were derived from a model developed by the Society for Environmental Geochemistry and Health (SEGH) and was designed to be protective for adults in the workplace.
(r) Insufficient information available to calculate impact to groundwater criteria.