INSTALLATION RESTORATION PROGRAM

OHIO AIR NATIONAL GUARD
TOLEDO EXPRESS AIRPORT, SWANTON, OHIO

SITE INVESTIGATION
WORK PLAN

FINAL

HAZWRAP SUPPORT CONTRACTOR OFFICE
Oak Ridge, Tennessee 37831
Operated by MARTIN MARIETTA ENERGY SYSTEMS, INC.
For the U.S. DEPARTMENT OF ENERGY under contract DE-AC05-840R21400

AIR NATIONAL GUARD
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SITE INVESTIGATION WORK PLAN

FINAL

Submitted to:

National Guard Bureau
Air National Guard Support Center
Andrews Air Force Base, Maryland 20331

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For the

U.S. Department of Energy
Under Contract No. DE-AC05-840R21400

SAIC Project No. 1-827-03-350-02

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LIST OF ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
ANG	Air National Guard
ANGB	Air National Guard Base
ANGSC	Air National Guard Support Center
ARARs	Applicable or Relevant and Appropriate Requirements
ASTM	American Society for Testing and Materials
AVGAS	Aviation Gasoline
BLS	Below Land Surface
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (1980)
CLP	Contract Laboratory Program
CWA	Clean Water Act
DOD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
DQOs	Data Quality Objectives
ECD	Electron Capture Detector
ELSA	Emergency Life Support Apparatus
EMT	Emergency Medical Technician
EPA	Environmental Protection Agency
ETG	Environmental Technology Group
FFS/RM	Focused Feasibility Study/Remedial Measures
FID	Flame Ionization Detector
FS	Feasibility Study
FTA	Fire Training Area
FWQC	Federal Water Quality Criteria
GC/MS	Gas Chromatography/Mass Spectrometry
gpm	Gallons Per Minute
HAZWRAP	Hazardous Waste Remedial Actions Program
HMTC	Hazardous Materials Technical Center
I.D.	Inside Diameter
IDLH	Immediately Dangerous to Life or Health
IRP	Installation Restoration Program
LOAEL	Lowest-Observable-Adverse-Effect Level

LIST OF ACRONYMS (Continued)

MCLs	Maximum Contaminant Levels
MCLGs	Maximum Contaminant Level Goals
MPRSA	Marine Protection, Research, and Sanctuaries Act
MSL	Mean Sea Level
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MUL	Maximum Use Limit
NBS	National Bureau of Standards
NGB	National Guard Bureau
NIOSH	National Institute for Occupational Safety and Health
NOAEL	No-Observable-Adverse-Effect Level
O.D.	Outside Diameter
OEPA	Ohio Environmental Protection Agency
OH ANG	Ohio Air National Guard
OSHA	Occupational Safety and Health Administration
OWS	Oil/Water Separator
PA	Preliminary Assessment
PAHs	Polynuclear Aromatic Hydrocarbons
PEL	Permissible Exposure Limit
PF	Protection Factor
PM	Project Manager
PMP	Project Management Plan
POL	Petroleum, Oil, and Lubricants
POTW	Publicly Owned Treatment Works
ppm	Parts Per Million
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RPD	Relative Percent Difference
SAIC	Science Applications International Corporation
SARA	Superfund Amendments and Reauthorization Act (1986)
SCBA	Self Contained Breathing Apparatus

LIST OF ACRONYMS (Continued)

SDWA	Safe Drinking Water Act
SHD	Safety and Health Director
SI	Site Investigation
SOW	Statement of Work
SPT	Standard Penetration Test
SSHC	Site Safety and Health Coordinator
TCA	Trichloroethane
TCE	Trichloroethene
TLV	Threshold Limit Value
TSCA	Toxic Substances Control Act
USAF	U.S. Air Force
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
UST	Underground Storage Tank
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound
WWTP	Wastewater Treatment Plant

1. INTRODUCTION

The U.S. Department of Defense (DOD) has initiated the Installation Restoration Program (IRP) to identify, evaluate, and remediate suspected environmental problems associated with past hazardous waste disposal and spill sites on DOD facilities. The Air National Guard (ANG), through a U.S. Air Force (USAF) interagency technical support agreement with the U.S. Department of Energy (DOE), uses Martin Marietta Energy Systems, Inc. (MMES) to provide technical assistance for implementation of the ANG IRP. Science Applications International Corporation (SAIC) has been retained by Martin Marietta Energy Systems under the Hazardous Waste Remedial Actions Program (HAZWRAP) to conduct an IRP Site Investigation (SI) at the Ohio Air National Guard (OH ANG) Base, located at the Toledo Express Airport in Swanton, Ohio, and at the Camp Perry ANG Station in Port Clinton, Ohio. This work plan presents SAIC's recommended technical approach for the SI activities.

A draft version of an IRP Preliminary Assessment (PA) (entitled "Phase I Records Search") was completed for the Base by the Hazardous Materials Technical Center (HMTC) in February 1989. The final version of the PA will be completed in the future. This investigation identified eight sites at Toledo ANG Base (ANGB) that potentially posed a threat to human health and the environment because of suspected contaminant migration from the sites. No sites were identified by the PA at Camp Perry Station; therefore, no further discussion of that facility is provided in this document.

In general, the available data for the sites of concern indicate that the Base activities conducted at these sites present a potential for the release of contaminants to the environment. This information, in conjunction with the shallow (2.5 to 3.0 feet below land surface [BLS]) groundwater table beneath the Base and the generally sandy soils (as evidenced from available boring logs), suggest that the hydrogeologic framework underlying the Base would be susceptible to the transport of contaminants released from a site. Therefore, an SI is necessary at the Toledo ANG sites to determine whether environmental contamination exists at the eight sites of concern, and if it does, to characterize the nature of any contamination identified.

Activities planned as part of this SI include data collection and evaluation, and reporting of the findings from the investigation. Technical procedures and details of these activities are described in this work plan. Data and findings generated by the SI will be used to evaluate the need for additional IRP investigative or response activities at sites where contamination is identified. The approach for evaluating this need and recommending additional IRP activities also is presented in this work plan. The SI will result in recommendations either to: 1) continue characterizing those sites where contamination was confirmed by conducting a Remedial Investigation (RI), 2) initiate a Focused Feasibility Study (FFS) to select a Remedial Measure (RM), 3) initiate immediate response actions, or 4) take no further action and complete decision documents.

The eight sites at Toledo ANGB identified as potential threats to human health and the environment by the PA were ranked as to the possible hazard they posed using the USAF Hazard Assessment Rating Methodology (HARM). The identified sites, and the HARM score they received, are:

- Site 1: Fire Training Area No. 1 (HARM score 73)
- Site 2: Fire Training Area No. 2 (HARM score 73)
- Site 3: Fire Training Area No. 3 (HARM score 63)
- Site 4: Fire Training Area No. 4 (HARM score 63)
- Site 5: POL Storage Area (HARM score 63)
- Site 6: Western Drainage Area (HARM score 63)
- Site 7: Eastern Drainage Area (HARM score 63)
- Site 8: Fire Training Area No. 5 (unranked).

Investigations at Sites 6 and 7 were expanded during the May 1989 project initiation meeting to include additional drainage areas at these sites and drainage swales near Sites 2 and 5. Since the May 1989 meeting, one underground storage tank (UST) was removed at the Base, and this site has been added to this SI. An addendum to this work plan will be prepared describing the technical approach of the SI at this site. IRP activities beyond the PA have not been conducted at Toledo ANGB.

Site descriptions, details of the SI program, and field program coordination are addressed in this section. A general overview of the SI approach is presented in Section 2. Details of the field program procedures are discussed in Section 3. Section 4 provides a schedule for the SI program. Details of the project organization, management, quality assurance/quality control (QA/QC), and health and safety are provided in project-specific companion documents (i.e., the Project Management Plan [PMP], Quality Assurance Project Plan [QAPP], and Health and Safety Plan).

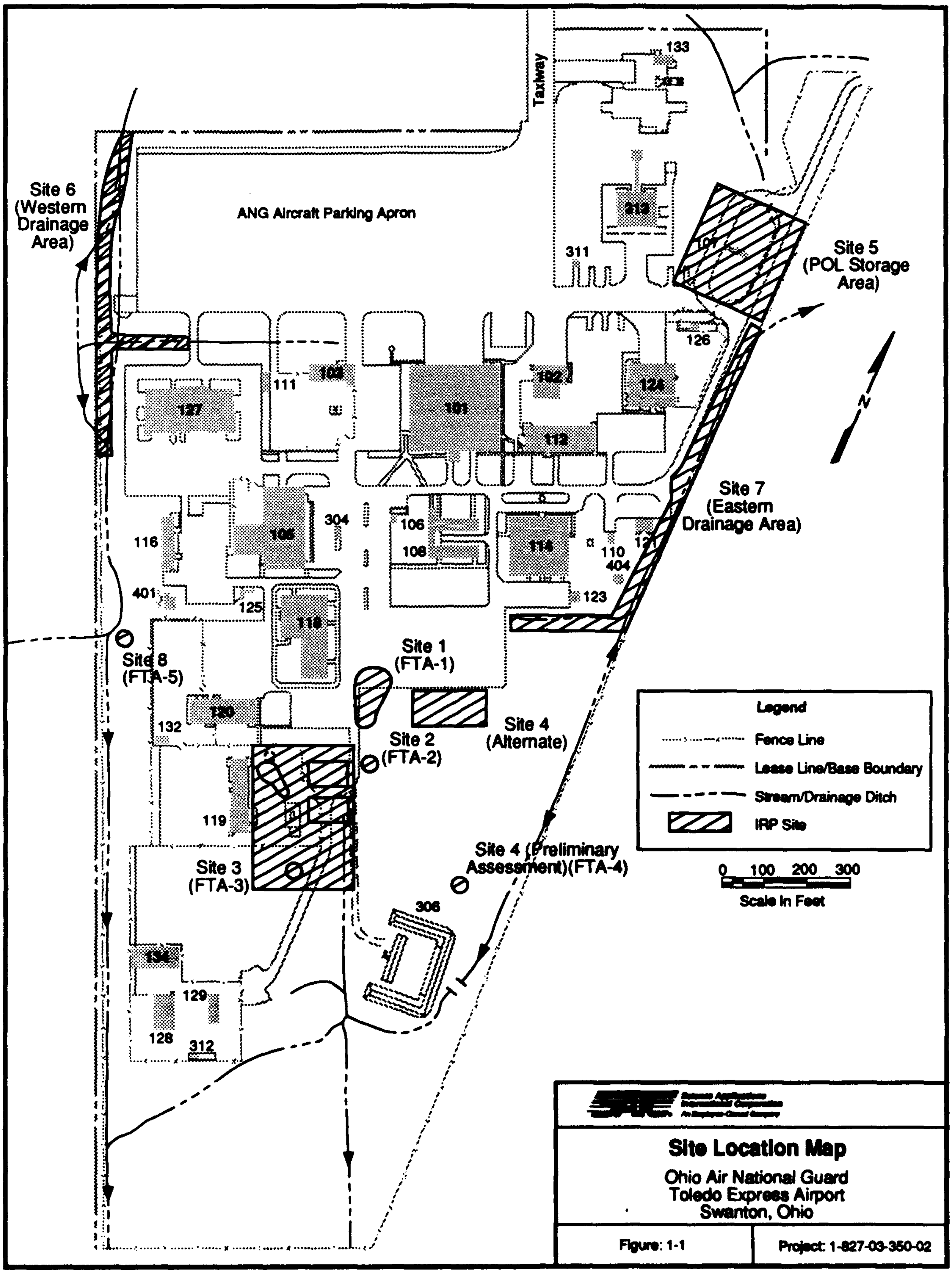
1.1 SITE DESCRIPTIONS

Narratives describing each site, and the history of Base activities conducted at that site, are presented in this section. These narratives are based on the findings of the draft PA (HMTC 1989), the initial project meeting held in May 1989, and subsequent data collection by SAIC in July 1989. The locations of the sites to be investigated under the SI are shown in Figure 1-1.

1.1.1 Site 1: Fire Training Area No. 1

Fire Training Area No. 1 (FTA-1) was located approximately 70 feet southeast of Building 118 in an open field. The location of this site was estimated by Base personnel for the PA and reportedly consisted of a 200-foot diameter, surficial circular berm. This construction method probably reflects the relatively shallow water table at the site. It is not known if the berm area contained an artificial fill bottom or if access notches were cut into the berm that may have allowed excess liquids to drain following the fire training exercises. The location of Site 1 was re-evaluated by Base personnel using aerial photographs from 1963, 1969, and 1972, and the area of concern, based on this re-evaluation, is shown in Figure 1-1.

Fire training exercises reportedly were conducted at this location an average of 18 times per year from the late 1950's until 1966, when use of FTA-1 was discontinued because of the construction of a parking lot immediately to the north of the site. Routine training procedures were to soak the ground in the FTA with water before igniting the flammable materials. Base personnel estimate that an average of 250 to 500 gallons of flammable


Taxiway
133
ANG Aircraft Parking Apron
Site 6
(Western
Drainage
Area)
212
311
Site 5
(POL Storage
Area)
126
103
111
102
124
127
101
112
Site 7
(Eastern
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304
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116
110
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Site 8
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306
134
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128
312
Legend
Fence Line
Lease Line/Base Boundary
Stream/Drainage Ditch
IRP Site
0 100 200 300
Scale In Feet
N
Science Applications
International Corporation
An Employee-Owned Company
Site Location Map
Ohio Air National Guard
Toledo Express Airport
Swanton, Ohio
Figure: 1-1
Project: 1-827-03-350-02

liquids were used per exercise. Assuming that 70 percent (HMTC estimate) of the flammable materials were consumed during fire training exercises, approximately 13,500 to 27,600 gallons of unconsumed flammable liquid may have seeped into the soils comprising the berm and subsequently into the subsurface soils and groundwater. The fate of the berm soils at the FTA is unknown. Before 1961, the most common liquid used for fire training was aviation gasoline (AVGAS). In addition, JP-4 and flammable liquids from Base shops, including waste oils, PD-680, and thinners, were burned at FTA-1 (HMTC 1989). Visual evidence of FTA-1 is not apparent at the location reported in the PA.

1.1.2 Site 2: Fire Training Area No. 2

Fire Training Area No. 2 (FTA-2) was used as the main location for Base fire training activities between 1966 and 1978. The site was precisely located during the onsite inspection (May 1989) using a 1975 aerial photograph of the Base, and visual evidence of the former berm area was observed at the site. FTA-2 was located 225 feet southeast of the southern edge of the existing parking lot, as measured along the unpaved access road to the target range. The center of the berm area was located approximately 30 feet to the east of the road, and the berm had a diameter of 50 feet. The aerial photograph suggests that the bottom of the berm area was artificially filled.

As with FTA-1, the berm area was flooded with water before each fire training exercise. Base personnel estimate that approximately 250 to 500 gallons of flammable liquid were used per exercise and that approximately 18 exercises were conducted per year. The majority of the fuel burned at this site was JP-4; however, small quantities of combustible liquid wastes (e.g., oils, solvents, and strippers) from the Base shops also were used in the FTA (HMTC 1989). Assuming that 70 percent (HMTC estimate) of the flammable materials were destroyed during fire training exercises, approximately 16,200 to 32,400 gallons of flammable liquid may have seeped into the berm soils and potentially into soils and groundwater beneath the berm area.

1.1.3 Site 3: Fire Training Area No. 3

According to Base personnel, Fire Training Area No. 3 (FTA-3) was located within a presently fenced area at the Base motor pool (Building 119). This area reportedly was used only once or twice in the early 1970's and then abandoned because of its proximity to planned construction sites and complaints from airport personnel about smoke blowing across the runway. The FTA-3 site was covered with asphalt in 1977. During the PA, it was estimated that a total of 500 gallons of JP-4 may have been used at FTA-3, with a potential release of approximately 150 gallons of fuel from FTA-3, assuming a 70 percent burn efficiency and no retention of unconsumed fuel by the berm materials.

Aerial photographs from 1963, 1969, and 1972 indicate that the general area of Site 3 included several bermed areas that may have been used for fire training exercises. The nature of the activities conducted within these areas is presently unknown; however, the bermed areas will be added to the SI as an expansion of the PA Site 3 boundary.

1.1.4 Site 4: Fire Training Area No. 4

Fire Training Area No. 4 (FTA-4) reportedly was located immediately north of the small arms firing range. This FTA was used for 6 months in the early 1970's immediately after fire training exercises were discontinued at FTA-3. The precise location, dimensions, construction method, and total number of exercises conducted at FTA-4 are unknown and the FTA could not be located by SAIC on aerial photographs from 1969, 1972, or 1975. Physical evidence of FTA-4 was not observed during the initial site meeting (May 1989) and no evidence of FTA-4 was observed on a 1975 aerial photograph of the Base. Base personnel indicate that FTA-4 may have been located east of FTA-1 based on the 1969 aerial photograph. This area will be investigated in addition to the location specified in the PA. A square, pad-like area observed on the 1975 aerial photograph immediately to the north of the firing range and approximately 100 feet to the west of the location of FTA-4 specified in the PA was identified by Base personnel as a former softball field. FTA-4 reportedly was abandoned because the sandy soil at the site would not retain water; thus, the fuel could not be floated before ignition. This suggests that the bottom of FTA-4 may have been composed of natural soils as opposed to artificial fill.

1.1.5 Site 5: POL Storage Area

Fuel storage and distribution at Toledo ANGB consists of a fenced yard housing four, 25,000-gallon capacity, unlined, steel USTs installed in 1959 with no cathodic protection. The tanks are housed beneath the Building 107 pump station. In 1985, the tanks were ultrasonically inspected (but not pressure tested) as part of a construction project; no leaks in the tank walls were detected at that time. However, some soil, possibly contaminated by refueling operations, was excavated from the area. During the PA, interviewees reported numerous small spills (200 to 300 gallons) in this area since the mid-1970's. These spills may be responsible for a patterned area of stressed vegetation immediately east of the POL extending across the Base access road. A trench excavated by a maintenance crew in the area to the east was reported to have produced a JP-4 odor. The source of inventory variances at the POL has not been positively identified, but is thought by Base personnel to be related to handling losses combined with accounting discrepancies and/or temperature variations. The possibility of tank leakage has not been definitively eliminated. A small drainage ditch between the POL Storage Area and the northern Base boundary has been included in Site 5 in the present SI (Figure 1-1).

1.1.6 Site 6: Western Drainage Area

The western drainage ditch runs parallel to the western Base boundary and receives storm drainage from the northwestern section of the Base property. The area of the ditch to be investigated will extend from the ditch area near the northern Base boundary to the area south of Building 127. Site 6 also will include a drainage swale located north of Building 127. This drainage includes effluent from the oil/water separators (OWSs) located on this part of the Base that are not connected to the sanitary sewer system.

The western drainage ditch shows physical signs of inorganic and organic contamination, possibly resulting from petroleum products in the effluent discharged from the OWSs. A sheen of oil on the water surface indicates possible organic contamination in the drainage area in front of Building 127, which was observed during the May 1989 site visit. Surface water in the drainage ditch appeared to be stagnant during the May 1989 onsite meeting.

1.1.7 Site 7: Eastern Drainage Area

The eastern drainage ditch runs parallel to the eastern Base boundary and receives storm drainage from the eastern portion of the Base. The site boundaries were extended to the south and east by the NGB to an area beyond where the water treatment plant backwash is discharged to the ditch. This ditch receives drainage from the POL facility as well as the OWSs on the eastern part of the Base that are not connected to the sanitary sewer system. During an inspection of this area, suspected organic contamination was observed in the northern portion of this ditch, possibly resulting from petroleum products in the effluent discharged from the OWSs (HMTC 1989). A reddish-brown discoloration also was observed in the southern portion of the ditch, possibly resulting from backwash effluent from the water treatment operations conducted at Building 110. Surface water in the drainage area appeared to be stagnant, with an occasional oily sheen on the water surface, during the May 1989 site meeting.

1.1.8 Site 8: Fire Training Area No. 5

Site 8 contains the rubbled remains of a curbed concrete burn pad that was used for fire extinguisher training exercises. After an exercise was completed, the remaining water, fuel, and extinguisher byproduct mixtures were released through a discharge valve to an adjacent drainage ditch. The amount of training activity or the quantity of releases were not estimated.

1.2 SUMMARY OF PROPOSED SITE INVESTIGATION PROGRAM

The primary objectives of the SI program are to acquire data to determine the presence of contaminants in the groundwater and soils at the sites of concern, and to assess the impacts and risks of confirmed contamination to the environment and surrounding populations. Secondary objectives of the SI program are to characterize the sources and nature of contamination and provide a preliminary evaluation of the extent, magnitude, and movement of confirmed contaminants at the sites. Full and complete characterization of the extent, magnitude, and movement of confirmed contamination may require additional field investigative efforts (RIs) at some sites, if contamination is determined to be extensive during the SI. Identification of possible receptors of potential contamination will be incorporated into the scope of the SI at the request of the NGB.

Rationale for site-specific tasks to study potential environmental contamination at the eight sites under investigation at Toledo ANGB are provided in the following paragraphs.

The project tasks to be conducted during the investigation will include: soil vapor/water sampling and analysis; soil boring, sampling, and chemical analysis; onsite gas chromatography (GC); monitoring well installation; sand point installation; surface water, sediment, and groundwater sampling and chemical analysis; field aquifer permeability testing; waste products management; and data analysis and preparation of project bid documents, plans, and reports. This work plan details a base level of effort for each site and includes optional field activities to be implemented in the event that additional or out-of-scope work items are necessary to complete the SI. Depending on the investigation findings in the field, SAIC will recommend additional investigation activities.

1.2.1 Site Investigation Objectives

Data requirements for the SI phase of an IRP project are, in general, less extensive than those necessary for an RI/FS phase. The objectives of the SI at Toledo ANGB require that sufficient data be obtained to:

- Determine the chemical nature and magnitude of identified constituents
- Evaluate the potential for contaminant release and migration
- Conduct a preliminary baseline risk assessment addressing applicable or relevant and appropriate requirements (ARARs) for remediating confirmed contamination at each site
- Prepare recommendations for broader investigation activities to determine the full extent of contamination (e.g., RI/FS phase), if necessary
- Evaluate the necessity for immediate response actions
- Support a definitive FFS/RM, if necessary
- Support no further action decisions and the completion of Decision Documents.

1.2.2 Data Quality Objectives

Analytical data are required from the Toledo ANGB SI to support site characterization, hazardous constituent characterization, evaluation of contaminant release potential, risk assessment, evaluation of immediate response alternatives, and recommendations for further investigations or actions. These data use requirements indicate that the minimum appropriate analytical level is HAZWRAP Level C (DOE 1988). The applicable analytical techniques will be U.S. Environmental Protection Agency (EPA) SW846 methods and procedures or other EPA-approved methods. The analytical methods used will be non-Contract Laboratory Program (CLP) methods. Recognized standards, such as American Society for Testing and Materials (ASTM) methods, will be used procedurally where appropriate. Specific data quality objectives (DQOs) for accuracy, precision, compatibility, representativeness, and completeness, and specific analytical methods to be used during the initial SI, are detailed in the QAPP. Specific sampling methods and protocols are detailed in this SI work plan. Implemented field procedures will be accomplished in accordance with HAZWRAP Quality Control Requirements for Field Methods (HAZWRAP 1989).

1.2.3 Work Plan Approach

SAIC's technical approach for conducting the SI at Toledo ANGB will include groundwater probe surveys, well drilling and installation, sand point installation, hydrologic testing, and multimedia sampling. Onsite GC equipment will be used for field screening of well/sand point development water and drill cuttings. These tasks are summarized below in the sequence in which they will be completed in the field and in Tables 1-1 and 1-2. The field investigation will be conducted so as to progress from preliminary field assessment activities (groundwater probes, sand points) to soil borings, well installation, and hydrologic testing. These activities are described in detail in the following paragraphs. All field activities will be conducted in compliance with the site health and safety, sampling, and quality assurance plans.

1.2.3.1 Groundwater Probe Survey

A groundwater probe survey (20 locations) will be conducted in the area of Site 5 (POL Storage Area) to delineate a JP-4 plume potentially emanating

TABLE 1-1. SUMMARY OF PROPOSED SITE INVESTIGATION ACTIVITIES AT OHIO AIR NATIONAL GUARD, TOLEDO EXPRESS AIRPORT, SWANTON, OHIO

CORE PROGRAM

Site Number	Site Name	Data Compilation	Sand Point Installations	Groundwater Probe Survey	Soil Borings No.	Soil Borings Footage	Monitoring Wells No.	Monitoring Wells Footage	Hydrologic Testing	Subsurface* Soil Samples	Chemical* Analyses Soils	Water Samples* Surface	Water Samples* GW	Sediment* Samples
1	Fire Training Area No. 1	X	0	10	3	46	1	15	1	28	10	0	1	0
2	Fire Training Area No. 2 (+ ditch)	X	0	0	3	46	1	15	1	28	10	2	1	2
3	Fire Training Area No. 3	X	1	15	7	100	2	30	3	60	22	0	2	0
4	Fire Training Area No. 4	X	1	20	4	76	1	15	2	41	14	0	1	0
5	POL Storage Area	X	0	20	2	38	3	45	3	38	12	1	3	1
6	Western Drainage Area	X	3	0	0	0	0	0	3	0	0	3	0	3
7	Eastern Drainage Area	X	3	0	0	0	0	0	3	0	0	4	0	4
8	Fire Training Area No. 5	X	0	0	2	38	1	15	1	24	8	1	1	1
	Nonsite-Specific	X	6	0	0	0	0	0	6	0	0	0	0	0
	Background Locations		0	0	2	60	0	0	0	26	6	0	0	0
	Site Supply Well	X										0	1	0
			14	65	23	404	9	135	23	245	82	11	10	11

* Does not include QA/QC samples.

TABLE 1-2. SUMMARY OF PROPOSED SITE INVESTIGATION ACTIVITIES AT OHIO AIR NATIONAL GUARD, TOLEDO EXPRESS AIRPORT, SWANTON, OHIO

OPTIONAL PROGRAM

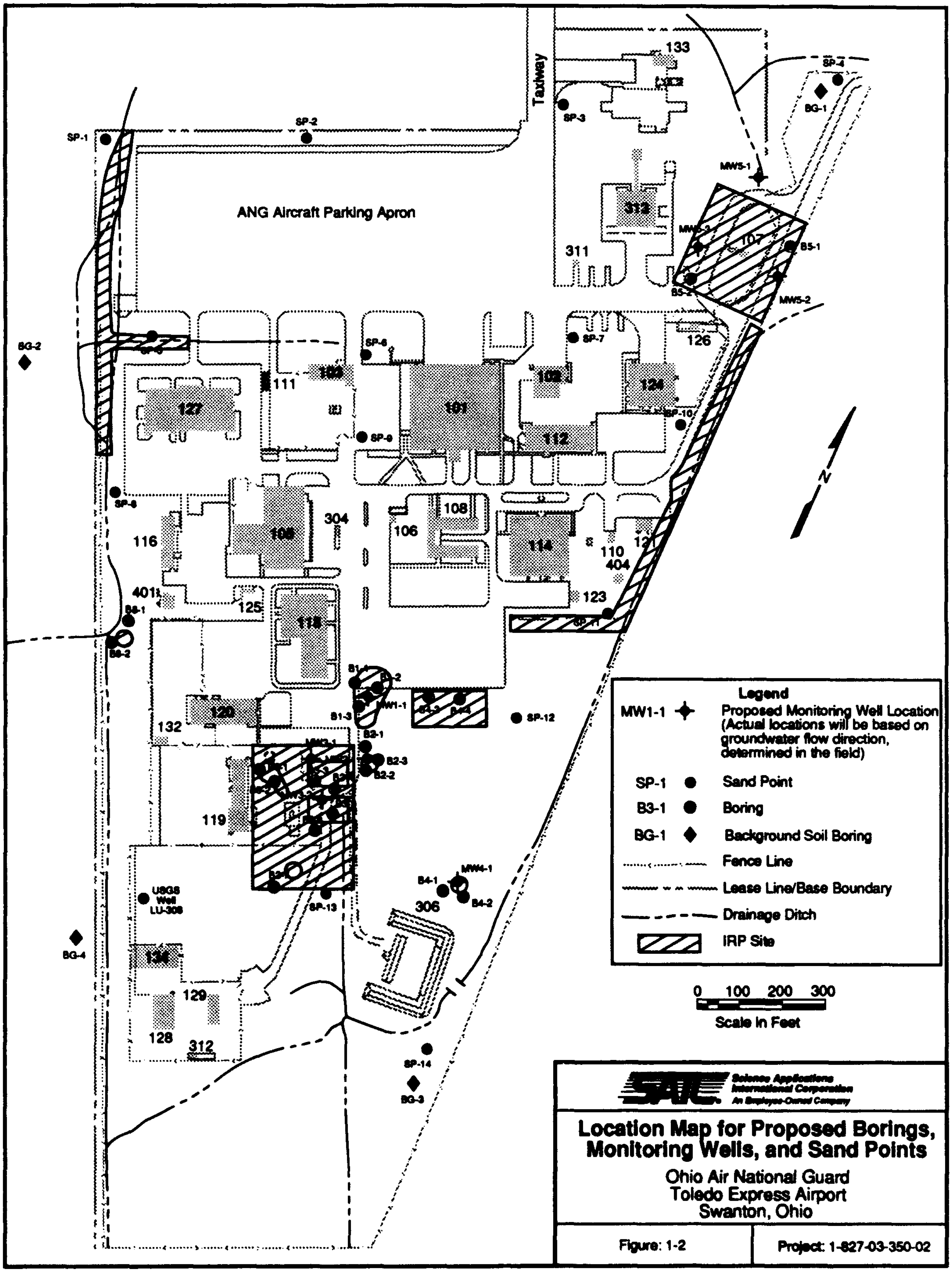
Site Number	Site Name	Sand Point Installations	Groundwater Probe Survey	Soil Borings		Monitoring Wells		Hydrologic Testing	Subsurface* Soil Samples	Chemical* Analyses Soils	Water Samples*		Sediment* Samples
				No.	Footage	No.	Footage				Surface	GW	
1	Fire Training Area No. 1	0	10	1	8	1	15	1	11	4	0	1	0
2	Fire Training Area No. 2 (+ ditch)	0	0	0	0	0	0	0	0	0	0	0	0
3	Fire Training Area No. 3	0	10	2	38	2	30	2	31	10	0	2	0
4	Fire Training Area No. 4	0	0	0	0	2	30	2	14	4	0	2	0
5	POL Storage Area	0	10	2	38	2	30	2	31	10	0	2	0
6	Western Drainage Area	0	0	0	0	0	0	0	0	0	2	0	2
7	Eastern Drainage Area	0	0	0	0	0	0	0	0	0	2	0	2
8	Fire Training Area No. 5	0	0	0	0	0	0	0	0	0	0	0	0
		0	30	5	84	7	105	7	87	28	4	7	4

* Does not include QA/QC samples.

from the site. The survey will be conducted over a rectangular area centered on the POL Storage Area and encompassing approximately 1.4 acres (250 feet x 300 feet). A grid on approximately 50-foot centers will be established over the area extending to the Base boundary to the east. Groundwater probe surveys will be conducted at Site 1 (10 locations), Site 3 (15 locations), and Site 4 (20 locations). The results of the surveys at Sites 3 and 4 will be used to pinpoint the locations of these sites (which was not possible from evaluation of air photographs or interviews with Base personnel). Analytes for the surveys will include total petroleum hydrocarbons, benzene, toluene, ethylbenzene, xylenes, bromochloromethane (BCM), 1,1,1-trichloroethane (1,1,1-TCA), carbon tetrachloride, trichloroethene (TCE), and tetrachloroethene (PPC). Duplicate samples will be collected at a rate of 10 percent of the environmental samples collected. Optional groundwater probes may be necessary at Site 1 (10 probes), Site 3 (10 probes), and Site 5 (10 probes) in the event that the base level of effort at these sites is determined to be insufficient to delineate contamination completely.

1.2.3.2 Soil Borings

Twenty-three soil borings will be drilled to investigate Sites 1, 2, 3, 4, 5, and 8: seven borings at Site 3, four borings at Site 4, three borings each at Sites 1 and 2, and two borings each at Sites 5 and 8. One boring from each site will be extended to a depth of approximately 30 feet BLS to provide site-specific stratigraphic information regarding the presence of a lower permeability clay layer beneath the site. The remaining borings at the sites will be drilled to 5 feet below the water table. Soil samples will be collected from the borings for physical and chemical analysis in the laboratory. The locations of the soil borings are shown in Figure 1-2. Two background soil borings will be drilled at locations to be determined in the field. Background borings will extend to approximately 30 feet BLS. The 23 soil borings constitute the base level of effort for the SI. A total of five optional borings at Sites 1, 3, and 5 may be drilled in the event that field conditions warrant additional borings in these areas.



Location Map for Proposed Borings, Monitoring Wells, and Sand Points

Ohio Air National Guard
Toledo Express Airport
Swanton, Ohio

Figure: 1-2 | Project: 1-827-03-350-02

1.2.3.3 Sand Point Installations

Fourteen 2-inch diameter sand points are proposed to be driven or augered into place at various locations across the Base. The shallow water table beneath the Base will make the installation of these sand points economically and technically advantageous. Hydrologic data, such as depth to groundwater, shape of the potentiometric surface, groundwater flow directions, and presence of floating product on the water table, can be collected from the sand points, and when used in conjunction with hydrogeologic data collected from the proposed monitoring wells (see Section 4.3.4), and the existing U.S. Geological Survey (USGS) well, will enable a more comprehensive hydrologic characterization of the Base area than would be attainable with fewer, more expensive monitoring wells.

The sand points will be installed before the proposed monitoring wells because these data are pertinent to selecting the final locations for those wells. Surveying of sand points for location and elevation will be initiated approximately one-third of the way into the installation program (i.e., after approximately five installations). A complete round of water level readings will be obtained from the sand points upon completion of the installation program and used in conjunction with the survey data to determine groundwater flow directions and gradients. No optional sand point installations are proposed at the Base.

1.2.3.4 Monitoring Well Installations

Nine monitoring wells are proposed to be installed at locations shown in Figure 1-2. Actual locations of these wells will be based on groundwater flow direction determined in the field. Locations will be selected so that almost all wells are situated downgradient of the site they monitor. One well will be installed at each of Sites 1, 2, 4, and 8, and the remaining five wells will be installed around Sites 3 and 5. The monitoring wells will be installed using nominal 4-inch PVC riser and screen extending 10 feet below the existing water table. The wells will be used to determine the hydrologic properties of the aquifer, groundwater flow directions, and for the chemical characterization of groundwater. A total of seven optional monitoring wells may be installed between Sites 1, 3, 4, and 5, in the event tha· field conditions warrant additional wells in these areas. Soil samples will be collected from the wells at 3.0-foot intervals during drilling. Two of the soil samples collected during the monitoring well installation will be sent to the laboratory for chemical analyses.

1.2.3.5 Background Soil Borings

Four soil borings will be drilled, two on-Base and two off-Base, that will attempt to represent background conditions in the Base area. Figure 1-2 presents tentative locations for the background borings. The information obtained from the background borings will be used for comparative purposes in determining significant health risks potentially associated with compounds detected at the sites of concern. Stratigraphic information obtained from these boreholes will be incorporated into the geologic and hydrogeologic characterization of the sites. Each boring will be drilled to the top of a silty clay layer that reportedly occurs at a depth of 20 to 25 feet. Two soil samples from each boring will be collected for chemical analysis in the laboratory. The exact locations of the background soil borings will be determined during the SI field program.

1.2.3.6 Hydrologic Testing

Hydrologic permeability testing of the proposed monitoring wells and sand points (23 total tests) will be conducted to determine the hydraulic conductivity of the aquifer. Tests will be conducted using rising or falling head slug testing methodology and appropriate analytical techniques for the confined or unconfined aquifer. Hydrologic testing will be conducted after all other site activities are completed through the multimedia sampling task. Before hydrologic testing is initiated, a full round of water level and well depth measurements will be obtained.

1.2.3.7 Groundwater, Surface Water, and Sediment Sampling

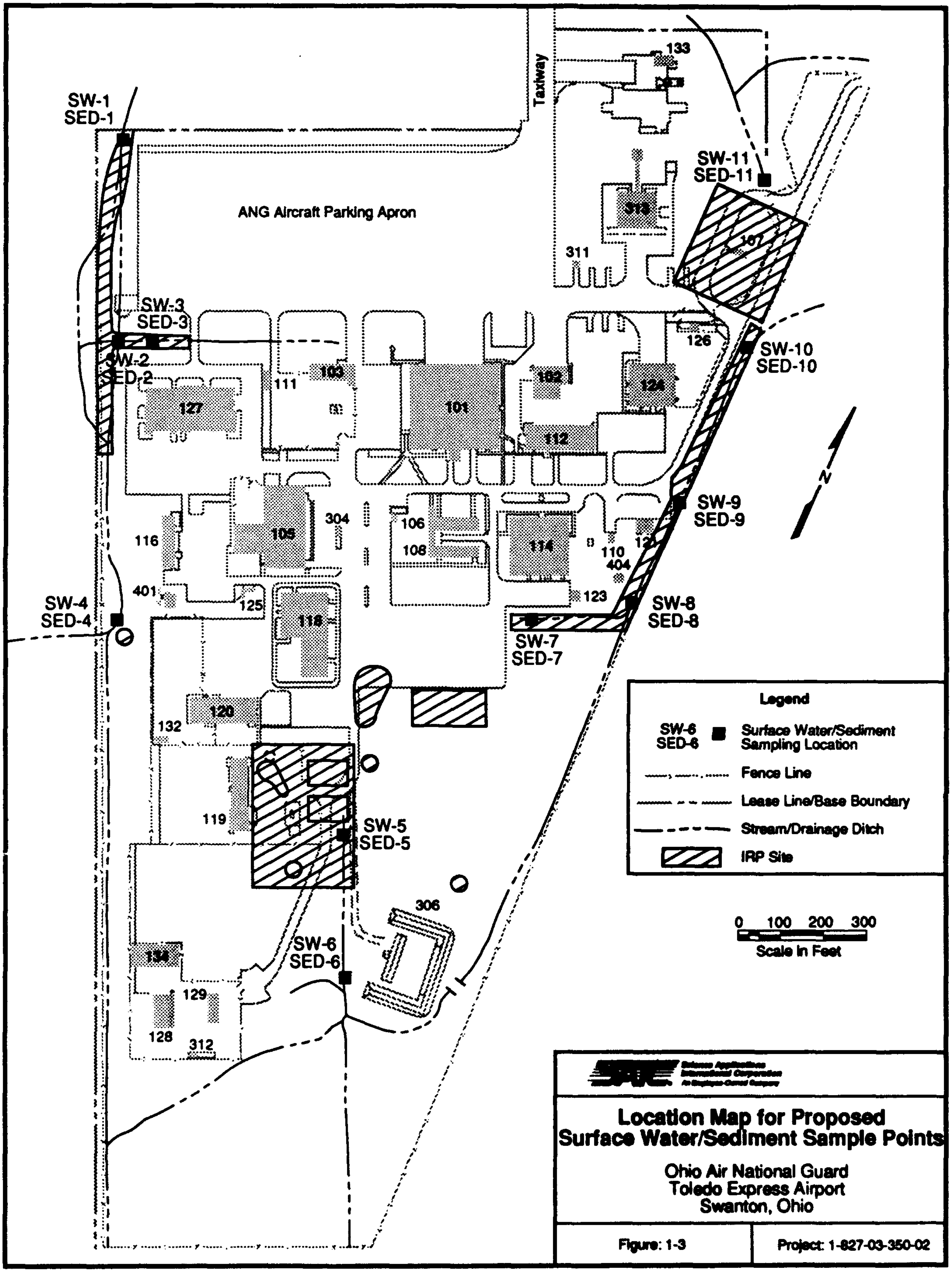
After all monitoring wells and sand points have been installed and developed, multimedia groundwater, surface water, and sediment samples will be collected from various sampling locations and submitted to the laboratory for analysis. Groundwater samples will be collected from the nine monitoring wells at Sites 1, 2, 3, 4, 5, and 8, but not from sand points (except for field screening samples to determine the disposition of the development water). Surface water and sediment samples will be collected from 11 locations within Sites 5, 6, and 7. The analytical results for these samples will allow the delineation of potential contaminant movement along the drainage ditches. Figure 1-3 shows the locations where surface water and sediment samples will be collected. One groundwater sample will be collected from the Base water supply well (before entering the Base treatment system) to assess the potential for contamination of bedrock underlying the Base. A full round of water level data will be collected from the monitoring well and sand point network before sampling activities begin.

1.2.3.8 Onsite GC Screening

During well development and groundwater sampling activities, a gas chromatograph will be onsite to screen the groundwater samples and the well and sand point development water generated. Samples of cuttings generated from the sand point installation, soil borings, and well borings also will be screened at this time. This screening will be used to determine the proper control of the drill cuttings and development water, and identify any contamination that may require immediate attention. Analytes to be screened for in the water and soil samples will include benzene, toluene, ethylbenzene, total volatile hydrocarbons, 1,1,1-trichloroethane, trichloroethene, tetrachloroethene, and carbon tetrachloride.

1.2.3.9 Optional Field Activities

The proposed Base level of effort described in this work plan is intended to provide sufficient characterization of physical and chemical conditions at the sites of concern based on presently available information. Identification or discovery of conditions or information that warrant further investigation may require that additional work be conducted under the SI, depending on the nature of the new information. Optional field activities that may be necessary for inclusion in the SI program include:


SW-1
SED-1
Taxiway
133
ANG Aircraft Parking Apron
SW-11
SED-11
313
311
107
SW-3
SED-3
SW-2
SED-2
126
SW-10
SED-10
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SED-9
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SW-4
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SW-8
SED-8
SW-7
SED-7
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SW-5
SED-5
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SW-6
SED-6
129
128
312
Legend
SW-6
SED-6
Surface Water/Sediment Sampling Location
Fence Line
Lease Line/Base Boundary
Stream/Drainage Ditch
IRP Site
N
0 100 200 300
Scale In Feet
Science Applications International Corporation
An Employee-Owned Company
Location Map for Proposed Surface Water/Sediment Sample Points
Ohio Air National Guard
Toledo Express Airport
Swanton, Ohio
Figure: 1-3
Project: 1-827-03-350-02

- Additional borings (5) and monitoring wells (7)
- Additional groundwater probes (30)
- Additional groundwater (7), surface water (4), and sediments (4) sampling round, and laboratory analyses.

The magnitude of the effort necessary to complete a site will be a determining factor toward either conducting additional SI work or recommending an RI. When it is determined that an optional activity is necessary to complete the SI at one of the sites, the procedures listed below will be followed:

- Notify the HAZWRAP Project Manager verbally of the need and present the reasons for implementing the options
- Provide a written justification supporting the execution of the option
- Maintain a record of all communications in the field log book.

Based on the information identified by SAIC as necessary for the completion of the SI, a determination will be made, in consultation with Martin Marietta Energy Systems, Inc. (Energy Systems) and the NGB, as to the course of action to be taken at the sites.

1.2.3.10 Data Analysis and Report Preparation

Data collected during each task of the SI will be tabulated into a coherent data base for inclusion in the SI report. Data analysis will be conducted using standard engineering and geologic practices and methods, and will in all cases cite references for specific analytical approaches used in the data evaluation. Interpretations arising from the data analysis will conform with standard engineering and geologic judgment. The SI report will include a summary of the completed work, data, interpretations of the task activities, the conclusions reached about each site by the investigation, and recommendations for any further work necessary at each site. Recommendations will be supported by a preliminary risk assessment. Details of possible recommendations under the IRP are presented in the following paragraphs.

1.2.3.11 Recommendations for Further Work

Based on the results of this SI, one of the following recommendations will be made for each site:

1. No further action - the site poses no threat to human health and the environment. Decision Documents supporting these conclusion should be prepared.

2. Continue investigating the site under an IRP RI - additional data are needed to determine completely the laterial and vertical extent of contamination identified. An RI is conducted to collect the data necessary for site and waste characterization. This information is used to evaluate the performance and cost of potential remedial action (RA) alternatives for the sites of concern. Activities conducted under the RI will supplement, and be based on, recommendations from the SI. Specific objectives of an RI (as outlined in the National Contingency Plan [NCP]) are:

   - Determine the horizontal and vertical extent and magnitude of groundwater and soils contamination identified during the SI

   - Provide data to determine the potential for future contaminant migration

   - Assess the risks to human health and the environment associated with identified contamination

   - Define geologic and physical properties at the problem sites to evaluate potential remedial action

   - Collect engineering data in support of an FS and for design of a remedial action alternative.

3. Conduct an FSS to identify RMs for the site. An FSS is conducted to identify and evaluate several options for RMs, select the most effective option, and provide documentation of the evaluation and selection process as quickly as possible. The FFS approach is similar to an FS in that evaluation and selection of remedial action alternatives are evaluated in detail (three to five alternatives) rather than the large number of technology options and alternatives typically evaluated in an FS, and an RM (which can be implemented immediately) rather than a remedial action alternative (which requires a remedial design step before implementation) is selected. An FFS is conducted when a timely control of contaminant migration is necessary to protect human health and the environment. The RM selected by an FFS can be modified or augmented with other remediation alternatives after a full FS is completed.

4. Implement remedial action alternatives.

1.3 FIELD PROGRAM COORDINATION

Before the start of field activities, a meeting will be held between SAIC field supervisory staff and Base personnel who will be involved in or will be impacted by any of the investigative field activities. This meeting will provide a forum in which to resolve potential questions, issues, or problems regarding the field activities. The following paragraphs present field provisions to be contributed by both the Base and SAIC to complete the field procedures outlined in this work plan, and a discussion of the disposition of cuttings and development water generated by the field activities.

1.3.1 Required Field Provisions

The following provisions in support of field activities have been made by the Base and SAIC for the duration of the investigation program:

- Verify that locations selected for sand point, monitoring well, or groundwater probes (as staked by SAIC) will not intercept underground structures and that the subsurface installations are well clear of known underground utilities.
- Provide a secure staging area within the Base perimeter for equipment storage (drilling rigs, augers) and well construction materials (casing, screens, bagged cement, sand). The area should be accessible during other than normal working hours.
- A wash rack for decontaminating the drilling equipment is not available on Base, so the drilling subcontractor will be tasked to construct a temporary decontamination facility. The facility will be located in an area designated by the Base, but accessible to a 110/115 electrical outlet for steam cleaner hookup, and constructed so that all decontamination wastes can be controlled and containerized.
- The on-Base potable water supply contains low levels of contaminants that make it unsuitable for the well drilling and decontamination requirements of this SI. However, an alternate source of potable water will be available through the city fire hydrant system for a nominal charge. The drilling subcontractor will be responsible for obtaining and transporting all potable water necessary to complete this SI.

- Provide a temporary storage and staging area for drummed materials from the investigated sites.

- Provide access to a secure, temporary office area of approximately 150 square feet, with a desk, chair, and access to a telephone.

- Provide access to sanitary facilities.

- Provide access to, or copies of, Base records regarding existing foundation engineering reports, grain size data, and soil boring logs.

- The USGS will be contacted by SAIC to gain access to the on-Base well for the purposes of sampling and obtaining water level measurements.

- It will not be possible for the Base to provide heavy equipment for field operations and/or drum handling. In the event heavy equipment is needed for these operations, it will be the responsibility of the drilling subcontractor to obtain the necessary equipment.

1.3.2 Disposition of Drill Cuttings and Development Water

At the direction of Ohio EPA (OEPA), if onsite GC analysis indicates drill (soil) cuttings or development and purging water to be comparable in quality to background samples, the soil/groundwater will be disposed of in any manner that the Base deems appropriate. If the soil/groundwater exhibit levels of contamination in excess of background, further discussions with the OEPA concerning disposal will be necessary.

Initially, cuttings from the borings and wells will be placed on plastic sheeting, covered, and left at the drilling site until a determination can be made as to the correct disposition of the material. If contamination is identified in onsite GC samples, the soil will be drummed and stored until the results of the laboratory analysis are available. When the laboratory results are available, discussion will be held with OEPA on the proper disposition of the cuttings.

Water generated during the development and purging of the wells also will be subjected to onsite GC analysis. Initially, the water will be containerized either in 55-gallon drums or site-specific tanks. If contamination is identified in GC samples, the water will not be discharged to the land surface and disposition will be based on the analytical results from the laboratory. For water that is only slightly contaminated (e.g., contamination greater than background, but below RCRA waste standards) permits will be sought for disposal through the Base's sanitary sewer treatment system.

2. SITE INVESTIGATION APPROACH

Based on the recommendations and data provided in the Toledo Air National Guard Base (ANGB) Preliminary Assessment (PA), the primary objectives of the Site Investigation (SI) activities are to acquire the necessary data to either confirm or deny the existence of suspected environmental contamination at each identified site and to provide a preliminary assessment of the potential risks to human health, welfare, and the environment. The SI will include identification of specific chemical contaminants and their concentrations in soils and groundwater, and will determine the potential for contaminant migration through site-specific hydrogeologic determinations. This section summarizes the methods that will be used at each site to meet these objectives.

2.1 REVIEW OF EXISTING DATA

Data that is obtained during the SI planning stages and during the course of the SI will be reviewed and incorporated into the final SI report. This information will be used to refine initial estimates made concerning the locations of the sites, groundwater flow paths, and receptor wells, and to define further the hydrogeologic conditions at Toledo ANGB. The data also will be used, in conjunction with information collected during the field program, to develop recommendations for further actions at the sites. A summary of the types of data for which Science Applications International Corporation (SAIC) plans to search is provided in Table 2-1, along with the intended use of the data. This information will be gathered as the initial step toward implementing the SI field program, although measures will be taken to locate the information during the planning stages of the SI. If any of the information that is obtained has substantial impact on the scheduled field program, SAIC will notify Martin Marietta Energy Systems, Inc. (Energy Systems) and the National Guard Bureau (NGB) immediately to resolve any schedule conflicts. Information needs that are not met will be reported to Energy Systems and NGB in the monthly progress reports.

TABLE 2-1. GENERAL DATA NEEDS FOR OHIO AIR NATIONAL GUARD, TOLEDO EXPRESS AIRPORT, SWANTON, OHIO

Data Category	Description	Planned Use	Source
Climatic Data	Records of daily precipitation, evaporation, evapotranspiration, freeze-free days	Define periodicity and magnitude of recharge	NOAA or NWS Toledo ANGB
Base Supply Well Pumping Data	Actual pumping rates and duration for Base well	Define potential receptor wells, flow paths, travel times, and sampling schedules	Toledo ANGB
Water Level Data	Water levels, both static and pumping, for Base well	Define static and pumping potentiometric surface, flow directions, and preliminary groundwater travel times	USGS
Drilling Logs/ Foundation Reports	Records of engineering investigations completed at the Toledo ANGB for building design	Hydrogeologic characterization	Toledo ANGB ODNR/DOW
Geology/Hydrogeology Literature Search	Reports, maps, and other relevent documents	Hydrogeologic characterization	USGS Ohio Geological Survey SCS
Site Location	Historic aerial photographs from the Base	Possibly more precise location of site boundaries	SCS

NOTES:
NOAA = National Oceanic and Atmospheric Administration
NWS = National Weather Service
SCS = Soil Conservation Service
Toledo ANGB = Toledo Air National Guard Base
USGS = U.S. Geological Survey

2.2 SITE INVESTIGATION FIELD PROGRAM

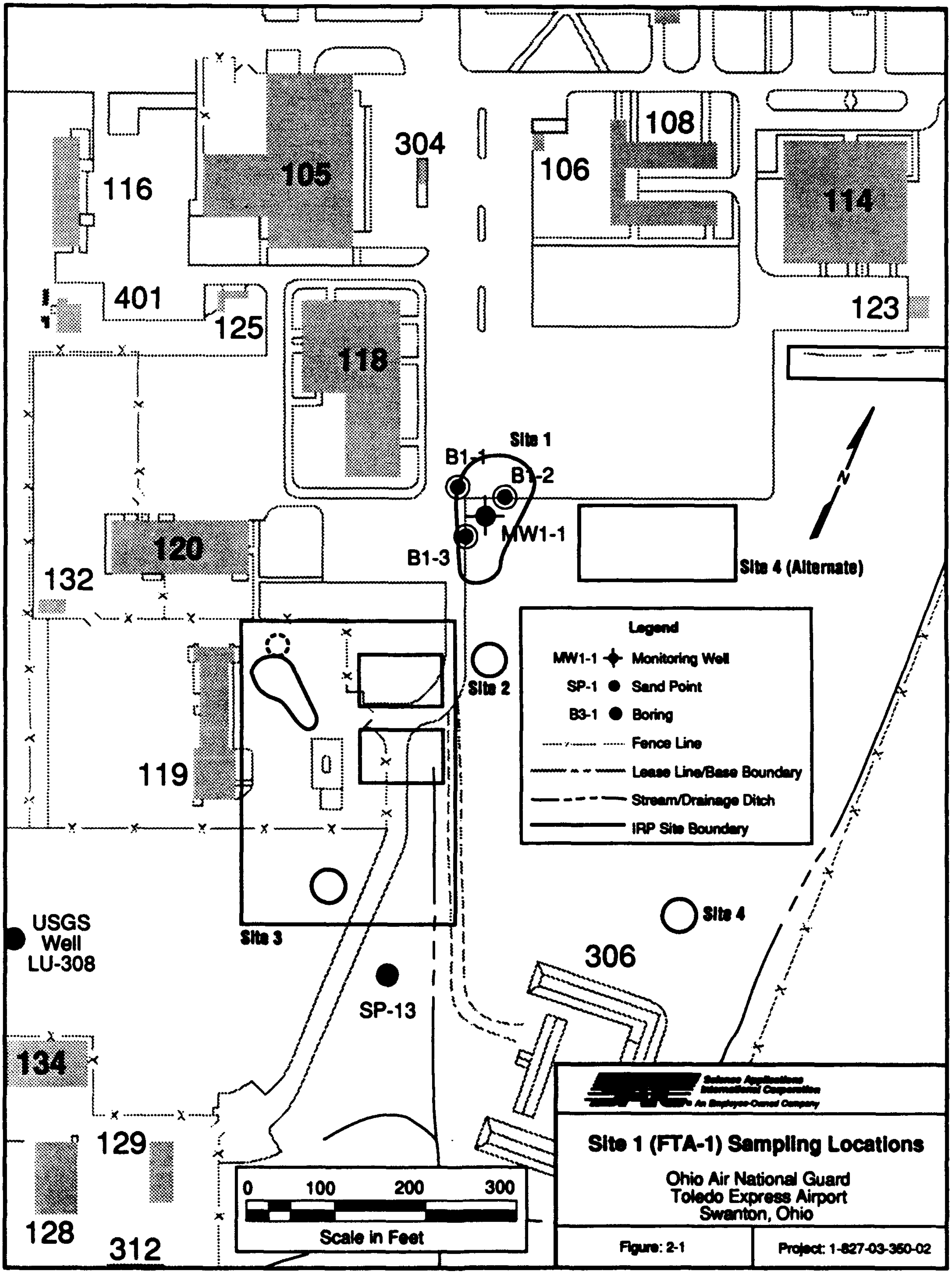
The SI field program developed by SAIC consists of a groundwater probe survey, soil borings, sand point and monitoring well drilling and installation, hydrologic testing, and groundwater and surface water/sediment sampling. Specific details on how the field activities will be conducted are presented in Section 3. Optional field activities that are determined to be within the scope of work for the SI will be recommended to Energy Systems for approval prior to implementation (see Section 1.2.3.9).

The preliminary monitoring well, soil boring, sand point, and sampling locations for the SI are presented in the following site descriptions. Final sample locations will be determined during the field program based on the presence of surface or subsurface obstructions or impediments.

2.2.1 Site 1: Fire Training Area No. 1

The concern for potential contamination at Site 1, formerly a Fire Training Area (FTA), results from the possibility of unconsumed flammable material seeping into underlying soils and groundwater. Figure 2-1 shows the location of the soil borings and monitoring wells that will aid in identifying subsurface contaminants. A 10-point groundwater probe survey will be conducted to provide reconnaissance of the site area regarding the presence and distribution of potential contaminants.

Three soil borings (B1-1, B1-2, and B1-3), two 8 feet deep and one 30 feet deep, will be augered to collect soil samples for laboratory analysis to determine if contamination is present in the soils beneath the site area. The two shallow borings will extend just below the water table (approximately 5 feet below land surface [BLS]) due to the concern for floating contaminants (i.e., hydrocarbons). The deep boring will provide site-specific stratigraphic information regarding the presence of a lower permeability clay layer beneath the site. Soil samples will be collected from the borings, and two samples from each shallow boring and four samples from the deeper boring will be sent to the laboratory for analysis.



304
116
105
108
106
114
401
125
123
118
Site 1
B1-1
B1-2
MW1-1
B1-3
Site 4 (Alternate)
120
132
Legend
MW1-1 Monitoring Well
SP-1 Sand Point
B3-1 Boring
Fence Line
Lease Line/Base Boundary
Stream/Drainage Ditch
IRP Site Boundary
Site 2
119
Site 4
USGS Well LU-308
Site 3
306
SP-13
134
129
128
312
0 100 200 300
Scale in Feet
Science Applications International Corporation
An Employee-Owned Company
Site 1 (FTA-1) Sampling Locations
Ohio Air National Guard
Toledo Express Airport
Swanton, Ohio
Figure: 2-1
Project: 1-827-03-350-02

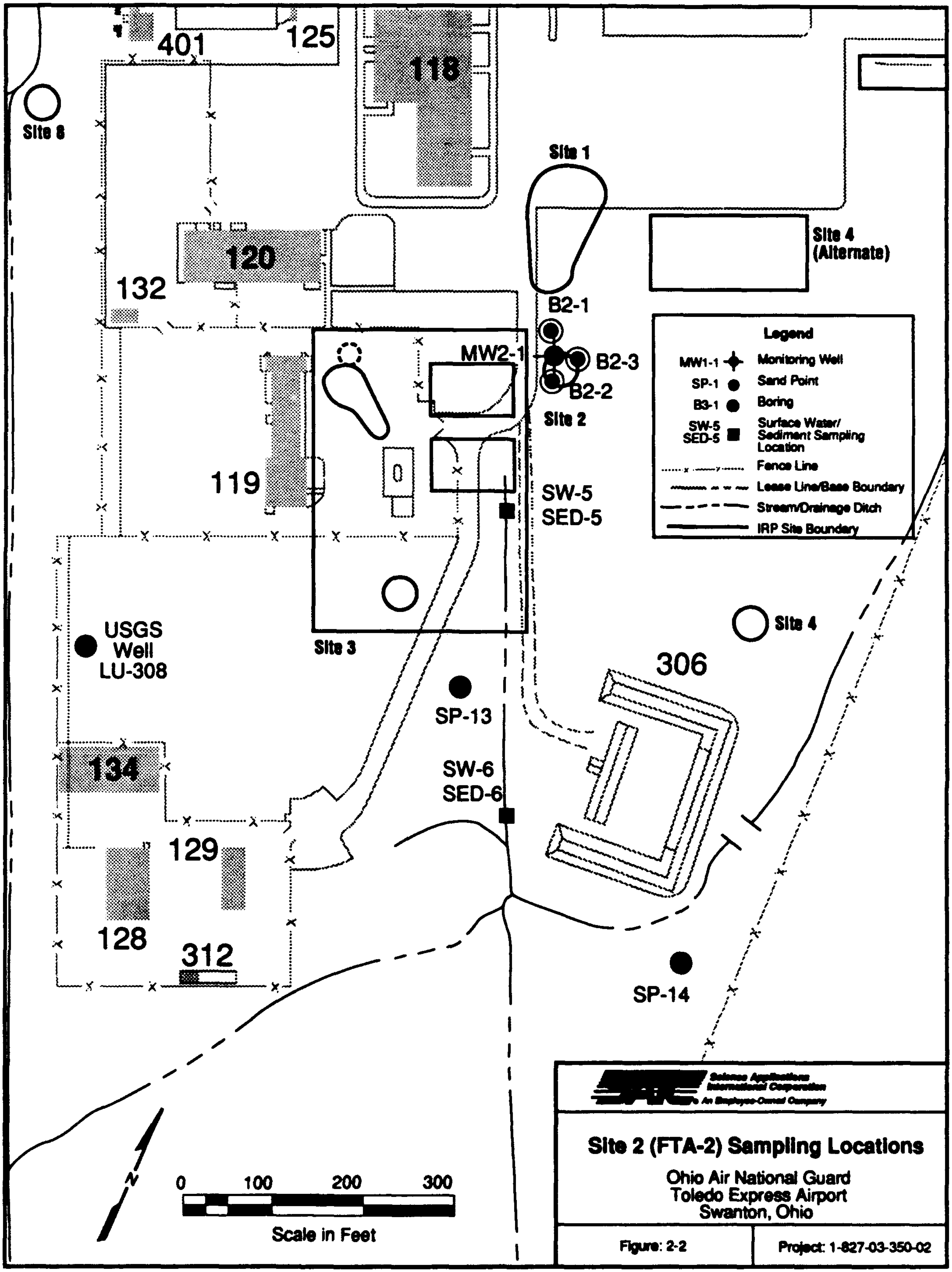
One monitoring well (MW1-1) will be installed at Site 1. The total depth of the well will extend 10 feet below the existing water table so as to be screened in a representative area of the subsurface and to obtain a nominal water column. Soil samples will be collected during drilling, and two samples will be sent to the laboratory for analysis. A groundwater sample will be collected from the well and screened for contamination using the onsite gas chromatograph (GC).

Installation of the well will provide both soil and groundwater samples to characterize contaminants from the area beneath the site. The Site 1 monitoring well also will provide a water level monitoring point. A hydrologic permeability test will be conducted in MW1-1 to provide aquifer hydraulic conductivity and transmissivity data at the site. An optional 10 groundwater probes and 1 soil boring may be installed at Site 1 if the extent of contamination warrants increasing the initial area of study.

2.2.2 Site 2: Fire Training Area No. 2

Fire Training Area No. 2 was used as the main location for Base fire training activities between 1966 and 1978. The primary focus at this site is soil and groundwater contamination resulting from unconsumed flammable material that may have seeped into the FTA berm and potentially into soils and groundwater beneath Site 2. Figure 2-2 shows the location of the soil borings, monitoring well, and surface water/sediment sampling locations that will help determine surface and subsurface contaminants.

Three soil borings (B2-1, B2-2, and B2-3), two 8 feet deep and one 30 feet deep, will be drilled at Site 2. Soil samples will be collected from the three borings. The two shallow borings will be sampled to characterize potential contaminants near the surface aquifer (approximately 5 feet BLS); the deeper boring will be sampled to provide stratigraphic information as to the presence of a lower permeability clay layer beneath Site 2. Two soil samples from each shallow boring and four samples from the deep boring will be sent to the laboratory for analysis. Additional samples may be sent if warranted.



401
125
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Site 8
Site 1
120
132
Site 4
(Alternate)
B2-1
MW2-1
B2-3
B2-2
Site 2
119
SW-5
SED-5
Legend
MW1-1 Monitoring Well
SP-1 Sand Point
B3-1 Boring
SW-5
SED-5 Surface Water/
Sediment Sampling
Location
Fence Line
Lease Line/Base Boundary
Stream/Drainage Ditch
IRP Site Boundary
USGS
Well
LU-308
Site 3
Site 4
306
SP-13
134
SW-6
SED-6
129
128
312
SP-14
N
0
100
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300
Scale in Feet
Science Applications International Corporation
An Employee-Owned Company
Site 2 (FTA-2) Sampling Locations
Ohio Air National Guard
Toledo Express Airport
Swanton, Ohio
Figure: 2-2
Project: 1-827-03-350-02

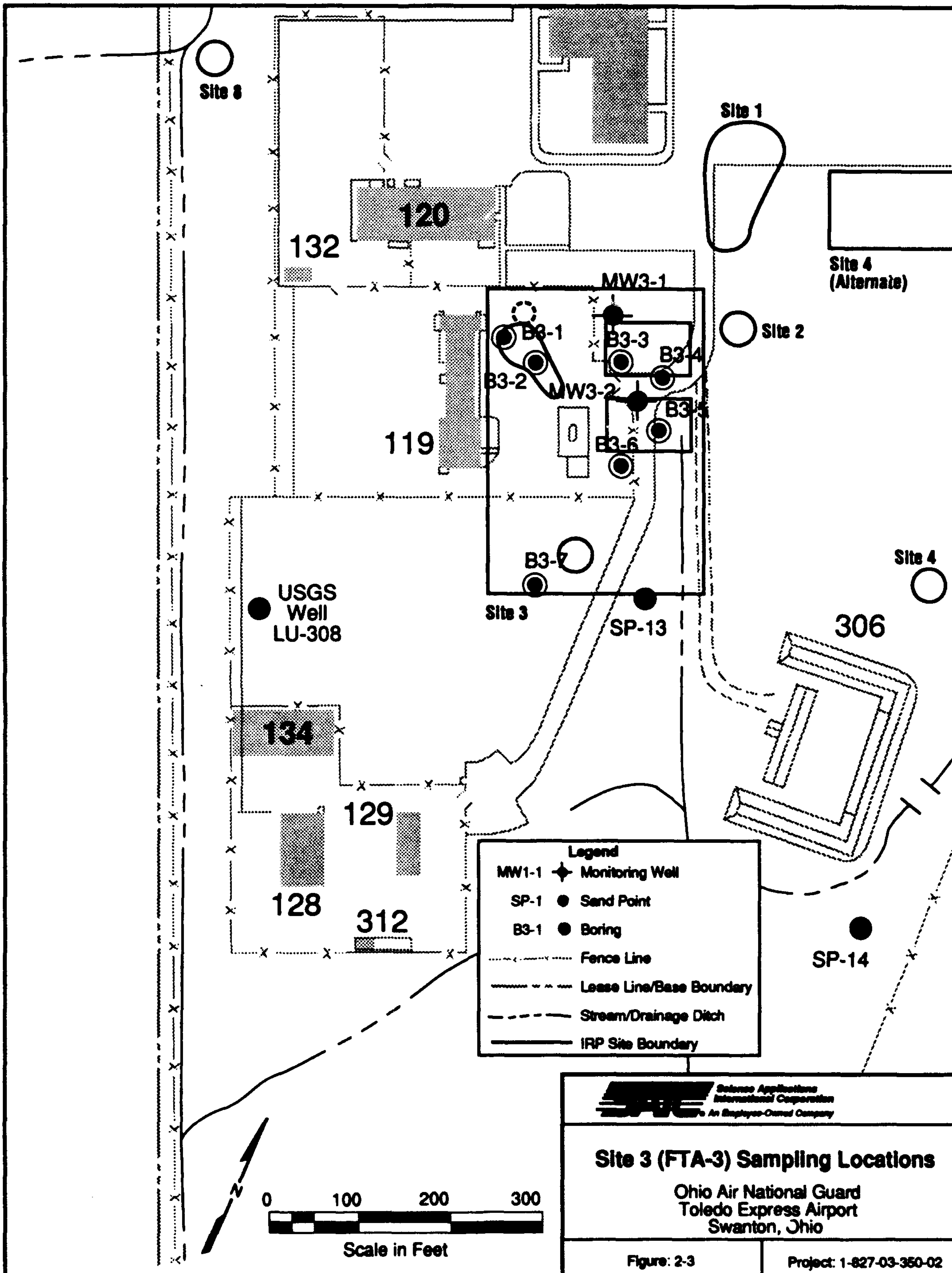
One monitoring well (MW2-1) will be installed at Site 2. Soil samples will be collected during drilling of the well, and two samples will be sent to the laboratory for analysis. The depth of the well will extend approximately 10 feet below the water table so that a representative water column screened in the surficial aquifer can be sampled for potential contaminants. A groundwater sample will be collected and screened for contamination. A hydrologic permeability test will be conducted in MW2-1 to provide aquifer hydraulic conductivity and transmissivity data at the site. The monitoring well also will provide a location to determine the water level beneath for site.

Surface water and sediment samples (two of each) will be collected in the drainage ditch adjacent to Site 2. These samples will assess the possibility of any surficial migration of contaminants at the site.

2.2.3 Site 3: Fire Training Area No. 3

According to Base personnel, Fire Training Area No. 3 was located within a presently fenced area at the Base motor pool (Building 119). Aerial photographs from 1963, 1969, and 1972 indicate that the general area of Site 3 included several bermed areas that may have been used for fire training exercises. Because of the larger aerial extent and the fact that activities conducted within these areas is presently unknown, more extensive drilling activities will be undertaken at this site than at FTA-1 and FTA-2. A 15-point groundwater probe survey will be conducted at Site 3 to provide hydrochemical reconnaissance of the site areas and to determine the extent of potential surficial aquifer contamination. Figure 2-3 shows the locations of the soil borings, sand points, and monitoring wells that will help identify potential contaminants.

Seven soil borings (B3-1 to B3-7), five 8 feet deep and two 30 feet deep, will be augered at points within the site at locations at which the aerial photographs indicated previous activities. Soil samples will be collected from the shallow borings and the deeper stratigraphic interpretation boring to determine if contamination is present. Two samples from each boring will be laboratory analyzed.



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Site 3 (FTA-3) Sampling Locations

Ohio Air National Guard
Toledo Express Airport
Swanton, Ohio

Figure: 2-3 | Project: 1-827-03-350-02

One sand point (SP-13) will be installed on the southern portion of Site 3 to provide both a water level monitoring point and an aquifer testing point. SP-13 also will provide data to help determine the overall groundwater flow directions at the Base.

Two groundwater monitoring wells (MW3-1 and MW3-2) will be installed at Site 3. These wells will provide groundwater sampling and water level measuring points. Soil samples will be collected at the two monitoring wells; two samples from each well will be laboratory analyzed. The groundwater sample from each well will be screened for contamination by the onsite GC.

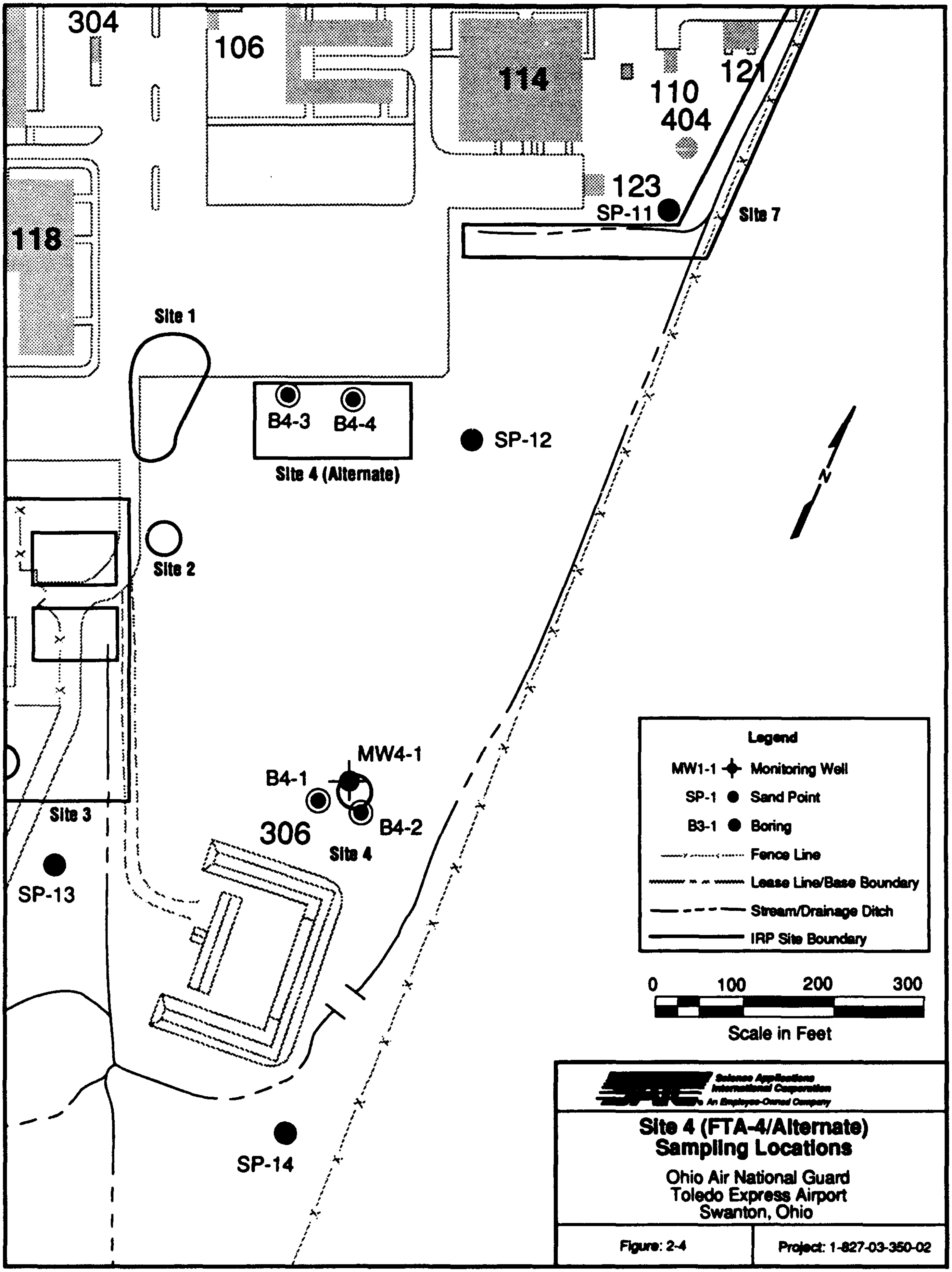
Hydrologic permeability tests will by performed in the sand point and both monitoring wells. These tests will provide data on the hydraulic conductivity and transmissivity of the underlying aquifer and materials at the site.

The uncertainty of previous practices at Site 3 may require optional activities to determine the full extent of potential contamination. Based on field decisions and onsite GC data, an additional 10-point groundwater probe survey, two soil borings, and two monitoring well installations may be warranted.

2.2.4 Site 4: Fire Training Area No. 4

The PA of the Base located FTA-4 immediately north of Building 306 on the southern portion of the Base (Figure 1-1). The precise location, dimensions, construction methods, and total number of exercises conducted at FTA-4 are unknown and the FTA could not be located on aerial photographs. Base personnel indicate that FTA-4 may have been located east of FTA-1 (Figure 1-1). Because of the uncertainty of the exact location of the FTA, both areas will be investigated.

A 20-point groundwater probe survey will be conducted for hydrochemical reconnaissance to determine the extent of potential surficial aquifer contamination at Site 4 and alternate Site 4. Figure 2-4 shows the location of the soil borings, sand point, and monitoring well that will be installed at these sites to identify potential contaminants.


304
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404
123
SP-11
Site 7
118
Site 1
B4-3
B4-4
Site 4 (Alternate)
SP-12
N
Site 2
MW4-1
B4-1
B4-2
306
Site 4
Site 3
SP-13
SP-14
Legend
MW1-1 Monitoring Well
SP-1 Sand Point
B3-1 Boring
Fence Line
Lease Line/Base Boundary
Stream/Drainage Ditch
IRP Site Boundary
0 100 200 300
Scale in Feet
Science Applications International Corporation
An Employee-Owned Company
Site 4 (FTA-4/Alternate)
Sampling Locations
Ohio Air National Guard
Toledo Express Airport
Swanton, Ohio
Figure: 2-4
Project: 1-827-03-350-02

Four soil borings (B4-1 to B4-4), two 8 feet deep and two 30 feet deep, will be drilled. One each of the shallow and deep borings will be drilled at Site 4 and alternate Site 4. The combination of the shallow and deep borings at each site will provide information on potential surficial contamination and site-specific stratigraphic information on the presence of a lower permeability clay layer, respectively. Soil samples will be collected from these borings, and a minimum of two samples from each will be sent to the laboratory for analysis.

One site-specific sand point (SP-12) will be installed east of alternate Site 4 to provide a groundwater elevation monitoring point and an aquifer testing location. This location was chosen because of the proximity of a nonsite-specific sand point (SP-14) located near Site 4. These sand points also will help to determine the groundwater flow direction in this area of the Base.

One monitoring well (MW4-1) will be installed, at the location of Site 4 determined by the PA. The depth of the well will extend approximately 10 feet below the water table at the site so that a representative waste column screened in the surficial aquifer can be sampled for potential contaminants. Soil samples will be collected during the drilling of MW4-1, two of which will be sent to the laboratory for analysis. A groundwater sample will be collected and screened for contamination using the onsite GC. Hydrologic permeability tests will be performed in SP-12 and MW4-1. These tests will provide hydraulic conductivity and transmissivity data for the site.

The uncertainty of the exact location and activities performed at Site 4 may necessitate the installation of an additional two monitoring wells. The location and necessity of these optional wells will be based on preliminary field and onsite GC sample data.

2.2.5 Site 5: POL Storage Area

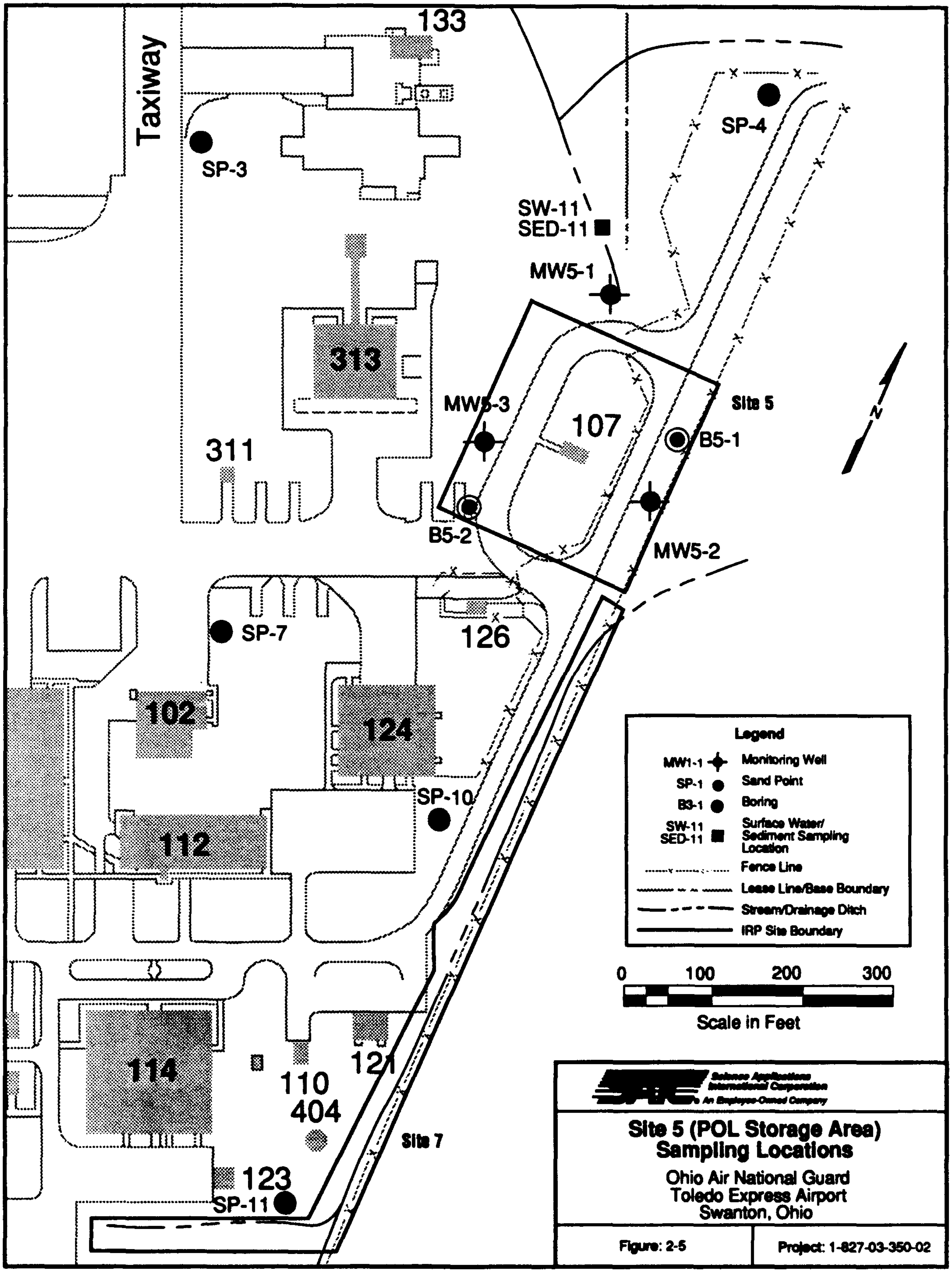
The primary concern at the POL Storage Area is groundwater and soils contamination. Numerous small fuel spills (200 to 300 gallons) have been reported in this area by the PA. These spills may be responsible for a patterned area of stressed vegetation immediately east of the POL extending across the Base access road. This visible evidence, fuel odors from nearby excavation, and POL inventory variances suggesting possible fuel leaks, created the need to investigate this site. A 20-point groundwater probe survey will be conducted to determine if spillage or leakage from the site has migrated to surrounding areas. This survey also will provide a preliminary determination of the extent and magnitude of contamination. Figure 2-5 shows the location of soil borings and a monitoring well that will help determine the presence of contaminants.

Two soil borings (B5-1 and B5-2), one on each side of the POL yard, will be augered to depths of 8 and 30 feet. These shallow and deep borings will provide soils contamination data near the surficial aquifer as well as stratigraphic information regarding the presence of a confining clay layer, respectively. Soil samples will be collected from these two borings, and two from each boring will be sent for laboratory analysis.

Three monitoring wells (MW5-1, MW5-2, and MW5-3) will be installed to a depth of 15 feet BLS. Installed in a radial pattern around Site 5, these wells will provide data on site water quality and potential soils contamination. Soil samples will be collected during drilling of the three wells, and a minimum of two samples from each well boring will be sent to the laboratory for analysis. A groundwater sample will be collected from each well and screened for potential contamination using the onsite GC. Hydrologic permeability tests will be conducted at each monitoring well to provide data for determining hydraulic conductivity and transmissivity for the aquifer underlying Site 5.

The presence of a nearby drainage ditch northwest of the site provides a location for surface water and sediment samples (one of each). These samples will be taken to determine potential surficial migration of contaminants, particularly from past fuel spills.

The potential for contamination at a fuel storage site is such that optional investigative activities may be warranted. Field data and onsite GC data may indicate the necessity for an additional 10-point groundwater probe survey as well as the drilling and installation of 2 additional soil borings and monitoring wells.


133
Taxiway
SP-3
SP-4
SW-11
SED-11
MW5-1
313
MW5-3
107
Site 5
B5-1
311
B5-2
MW5-2
SP-7
126
102
124
SP-10
112
Legend
MW1-1 Monitoring Well
SP-1 Sand Point
B3-1 Boring
SW-11 SED-11 Surface Water/ Sediment Sampling Location
Fence Line
Lease Line/Base Boundary
Stream/Drainage Ditch
IRP Site Boundary
0 100 200 300
Scale in Feet
114
110
404
121
Site 7
123
SP-11
Science Applications International Corporation
An Employee-Owned Company
Site 5 (POL Storage Area) Sampling Locations
Ohio Air National Guard
Toledo Express Airport
Swanton, Ohio
Figure: 2-5
Project: 1-827-03-350-02

2.2.6 Site 6: Western Drainage Area

The western drainage ditch runs parallel to the western Base boundary and receives storm drainage from the northwest section of the Base property. Concern for this area stems from the physical signs of inorganic and organic contamination in the drainage ditch, possibly resulting from petroleum products in the effluent discharged from oil/water separators (OWSs) that are included in the storm drainage. Installation of sand points and the sampling of surface water and sediments (Figure 2-6) will aid in identifying potential contaminants.

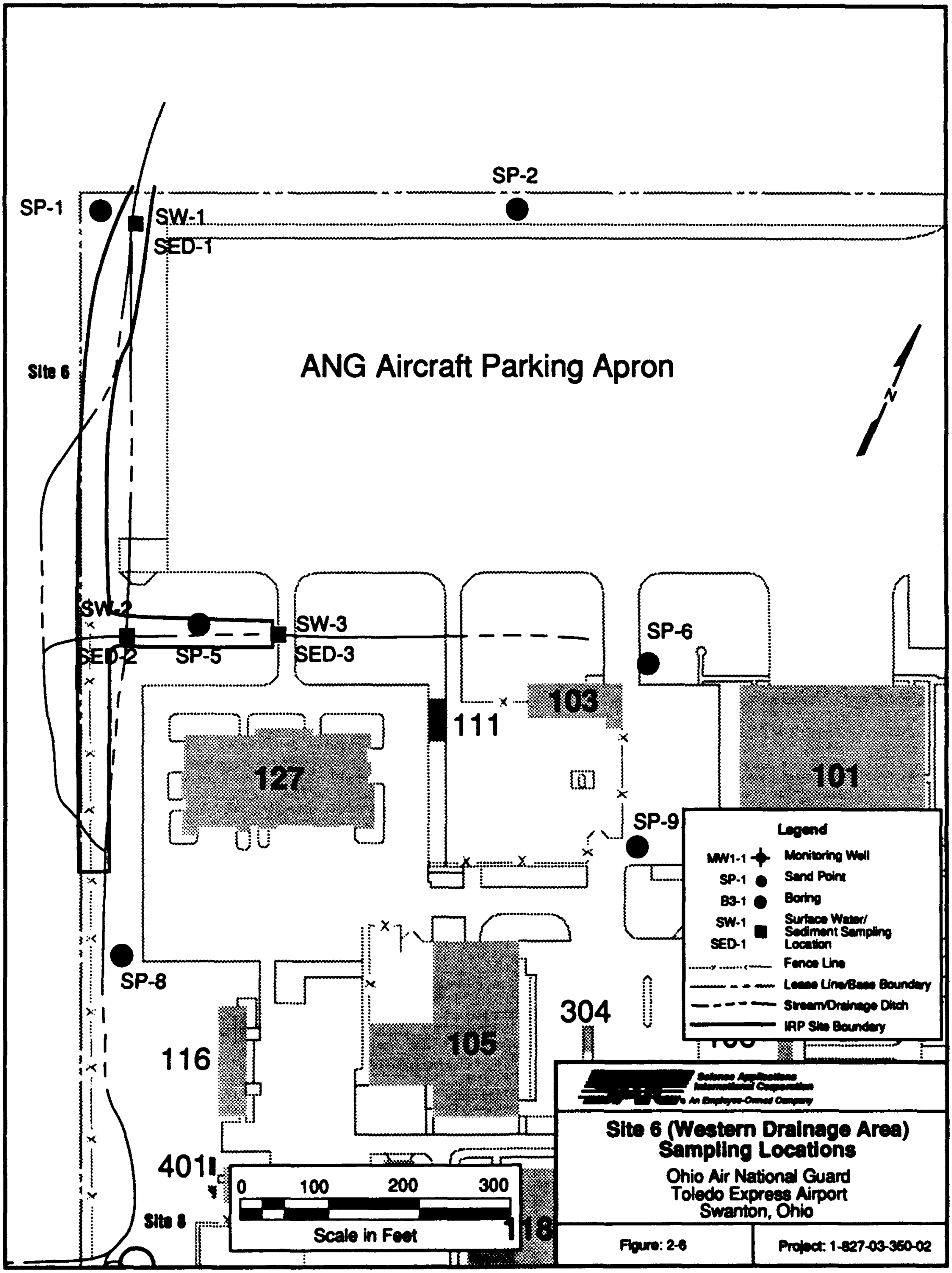
Three sand points (SP-1, SP-5, and SP-8) will be installed along the drainage ditch. These points will provide water quality and water level monitoring points along the alignment of Site 6. Hydrologic permeability tests will be conducted in each sand point to provide data on hydraulic conductivity and transmissivity characteristics at Site 6.

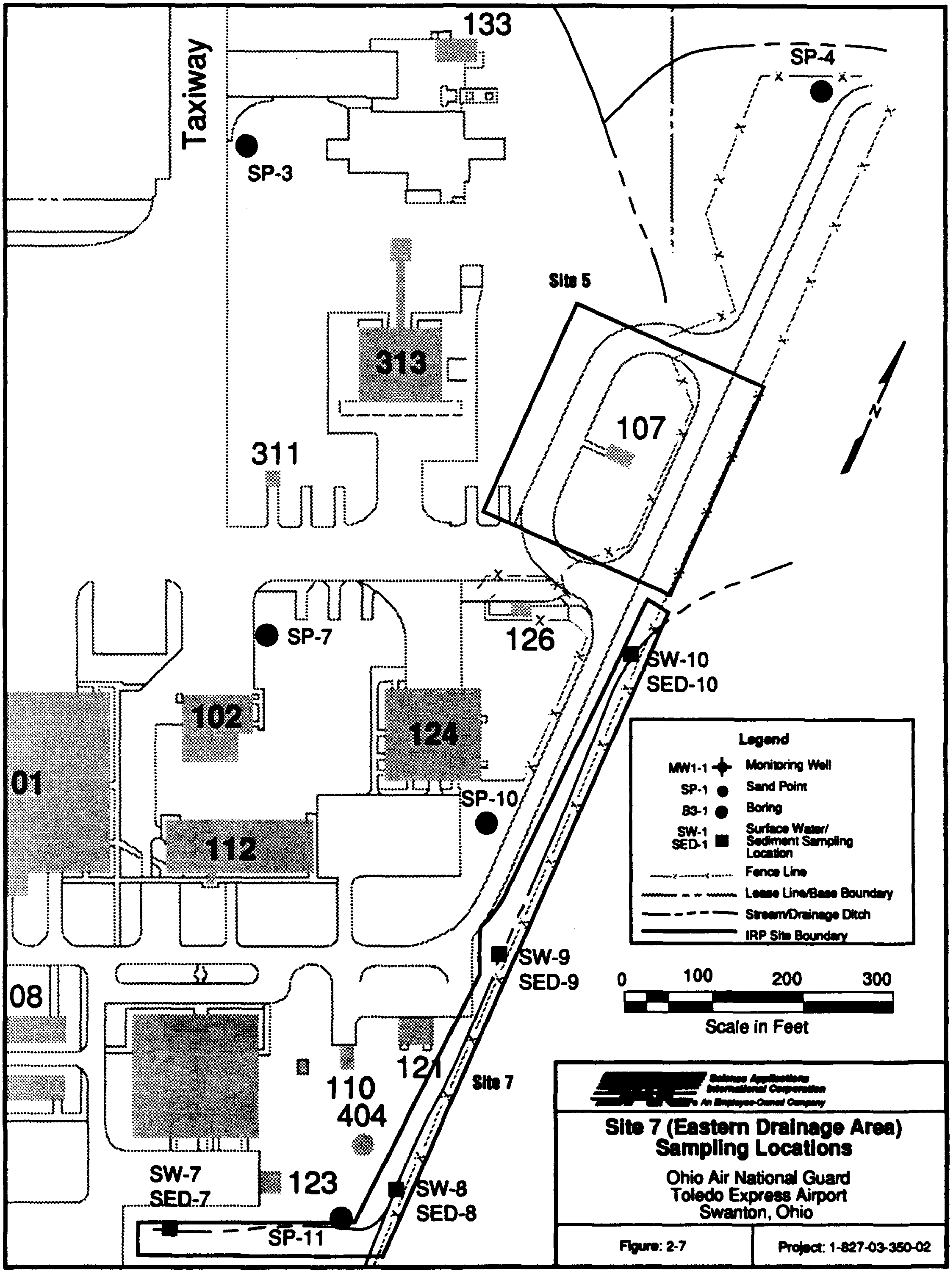
Surface water and sediment samples (three of each) will be taken along the drainage ditch. These samples will provide surface water quality data and chemical data for the sediments. If the field data indicate contamination extends beyond the proposed sampling area, an additional two surface water/sediment samples may be collected.

2.2.7 Site 7: Eastern Drainage Area

The eastern drainage ditch runs parallel to the eastern Base boundary and receives drainage from the POL facility as well as the OWSs on the eastern part of the Base that are not connected to the sanitary sewer system. Surface water and sediments are the primary focus at Site 7. Evidence of sediment discoloration and an oily sheen on surface waters indicates the need for surface water and sediment sampling. Installation of sand points also will aid in identifying potential contaminants (Figure 2-7).

Surface water and sediment samples (four of each) will be taken along the drainage ditch. These samples will provide surface water quality data and chemical data for sediments. If the extent of contamination is greater than anticipated, an additional two surface water and sediment samples may be necessary to define more fully the area of contamination.


SP-2
SP-1
SW-1
SED-1
Site 6
ANG Aircraft Parking Apron
N
SW-2
SED-2
SP-5
SW-3
SED-3
SP-6
103
111
127
101
SP-9
SP-8
304
116
105
401
Site 8
118
0 100 200 300
Scale in Feet
Legend
MW1-1 Monitoring Well
SP-1 Sand Point
B3-1 Boring
SW-1 SED-1 Surface Water/ Sediment Sampling Location
Fence Line
Lease Line/Base Boundary
Stream/Drainage Ditch
IRP Site Boundary
Science Applications International Corporation
An Employee-Owned Company
Site 6 (Western Drainage Area) Sampling Locations
Ohio Air National Guard
Toledo Express Airport
Swanton, Ohio
Figure: 2-6
Project: 1-827-03-350-02



133
Taxiway
SP-3
SP-4
Site 5
313
107
311
N
SP-7
126
SW-10
SED-10
102
124
01
SP-10
112
Legend
MW1-1 Monitoring Well
SP-1 Sand Point
B3-1 Boring
SW-1 SED-1 Surface Water/ Sediment Sampling Location
Fence Line
Lease Line/Base Boundary
Stream/Drainage Ditch
IRP Site Boundary
SW-9
SED-9
0 100 200 300
Scale in Feet
08
121
Site 7
110
404
SW-7
SED-7
123
SW-8
SED-8
SP-11
Science Applications International Corporation
An Employee-Owned Company
Site 7 (Eastern Drainage Area) Sampling Locations
Ohio Air National Guard
Toledo Express Airport
Swanton, Ohio
Figure: 2-7
Project: 1-827-03-350-02

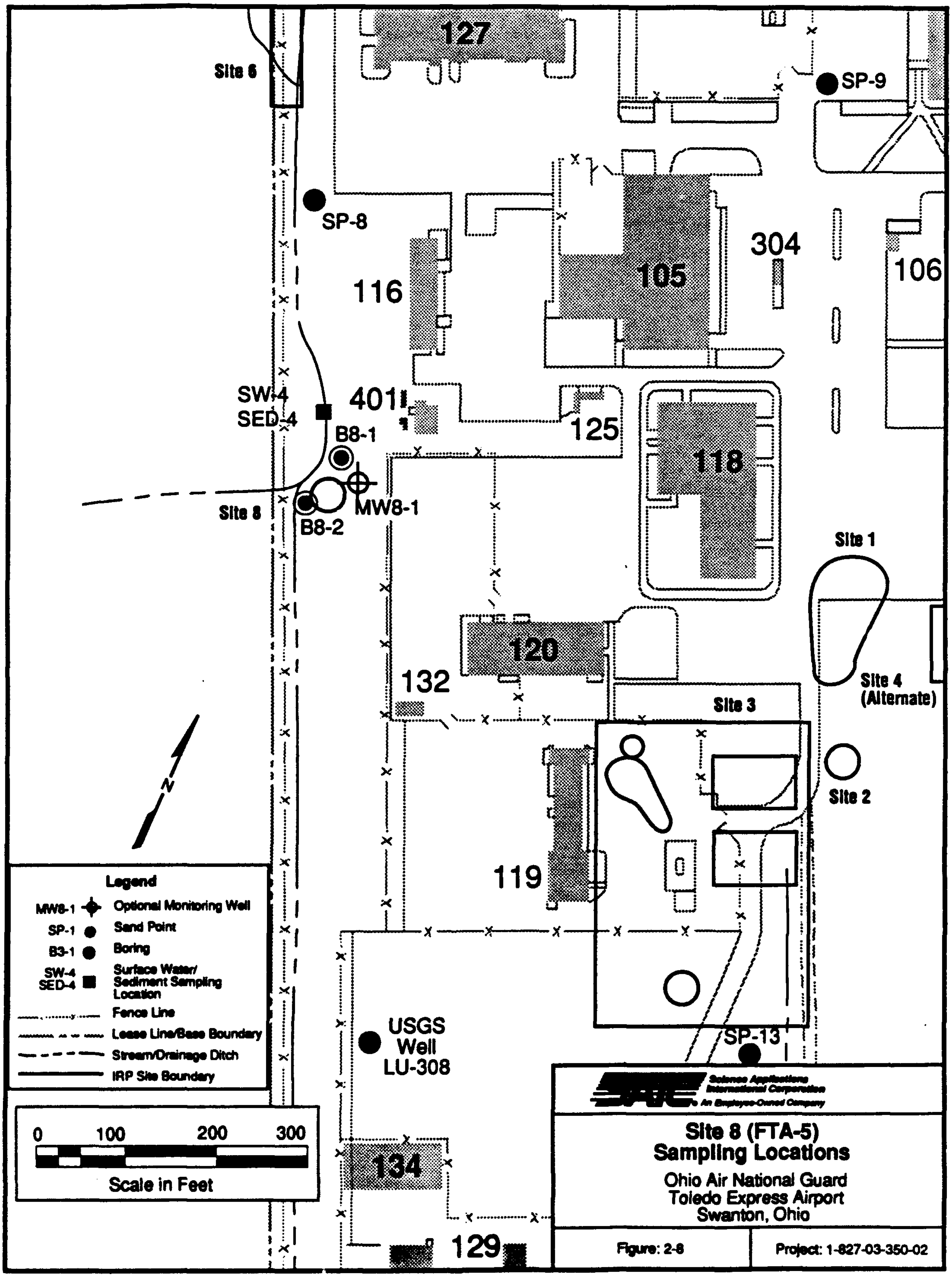
Three sand points (SP-4, SP-10, and SP-11) will be installed in an alignment along the ditch. The northernmost point is located above the POL yard to compare data with the two points located south of the POL, in the direction of surface water flow. These points will provide a vehicle for groundwater level and water quality monitoring. Hydrologic permeability tests will be conducted at the sand points to obtain hydraulic conductivity and transmissivity information for the site.

2.2.8 Site 8: Fire Training Area No. 5

Site 8 contains the rubbled remains of a curbed concrete burn pad that was used for fire extinguisher training exercises. The rubbled state of Site 8 creates difficulty in sampling of the soils and groundwater directly beneath the site. The soil borings and surface water/sediment sampling point shown in Figure 2-8 are located on the periphery of the previous site and will be used to determine potential contamination in the area.

Two soil borings (B8-1 and B8-2), on opposite sides of the site, will be augered to 8 and 30 feet deep. The 8-foot boring will provide data on the potential contamination near the surficial aquifer; the 30-foot boring will provide site-specific information on the presence of a confining clay layer beneath the site. Soil samples will be collected from the borings, two from each boring will be sent for laboratory analysis.

As an optional field activity, one monitoring well (MW8-1) will be installed at Site 8. The decision to install this well will depend on the results of the other field activities at this site. This optional well will provide water level measurements, hydrologic properties, and a groundwater sample to determine the presence of contaminants. The depth of the well will be approximately 10 feet below the water table so as to provide a representative water column for sampling. Soil samples will be collected during drilling of the well to help assess soil contamination and two will be sent for laboratory analysis. The groundwater sample will be screened for contamination using the onsite GC. A hydrologic permeability test will be conducted to provide hydraulic conductivity and transmissivity data for the aquifer.



127
Site 6
SP-9
SP-8
304
105
106
116
SW-4
SED-4
401
125
B8-1
118
Site 8
MW8-1
B8-2
Site 1
120
132
Site 4
(Alternate)
Site 3
Site 2
119
Legend
MW8-1 Optional Monitoring Well
SP-1 Sand Point
B3-1 Boring
SW-4 SED-4 Surface Water/ Sediment Sampling Location
Fence Line
Lease Line/Base Boundary
Stream/Drainage Ditch
IRP Site Boundary
USGS
Well
LU-308
SP-13
0 100 200 300
Scale in Feet
134
129
Science Applications International Corporation
An Employee-Owned Company
Site 8 (FTA-5)
Sampling Locations
Ohio Air National Guard
Toledo Express Airport
Swanton, Ohio
Figure: 2-8
Project: 1-827-03-350-02

One surface water and sediment sample will be collected in the drainage ditch adjacent to the site. This sample will help to assess the effects of potentially contaminated discharges on surface water quality and sediment contamination at this site.

2.2.9 Nonsite-Specific Activities

Various nonsite-specific activities will be implemented during the SI. These activities will aid in site-specific work as well as helping to characterize more fully the geologic and hydrogeologic conditions at the Base.

Four background soil borings, each 30 feet deep, will be drilled to collect soil samples for analysis. These analyses will determine the compounds present in local native soils. Analytical results will determine the local background conditions to be used comparatively against site-specific soil sample analysis. The depth of these borings will be that of the deepest site-specific boring so that comparisons can be made.

Twenty-six soil samples will be collected, and a minimum of two samples from each boring sent for laboratory analysis based on onsite GC results. The exact location of the borings will be determined during the SI field program based on groundwater flow directions and results of the groundwater probe investigation.

Six sand points (SP-2, SP-3, SP-6, SP-7, SP-9, and SP-14) will be installed near sites of concern. These points will provide water level measurement points to help establish groundwater flow directions. Water level measurements also will be taken from all monitoring wells and site-specific sand points. These data will help determine groundwater flow directions as well as the effects of the installation of monitoring wells and sand points. Hydrologic permeability tests also will be conducted on these sand points to provide hydraulic conductivity and transmisivity data for the aquifer.

During the soil boring phase, 10 samples, 1 from each site, will be collected for grain size analysis. Results will help determine the physical distribution of grain size at the sites, which will be used to select the well screen size.

Immediate analytical screening of water samples will be accomplished using an onsite GC. Results from this screening will provide nearly instantaneous data as to the extent of potential contamination in the samples. One sample from the Base drinking water well, collected before treatment, will assess the chemical quality of the drinking water source and the potential for migration of contaminants from the surficial aquifer to the bedrock aquifer.

A summary of the SI field program; the number of sampling points, samples, or tests; and the purpose of each activity is presented in Table 2-2. Chemical and physical parameters to be evaluated for in the surface water, groundwater, soil; and sediment samples collected in the field are listed in Table 2-3. The chemical parameters listed in Table 2-3 were selected based on the history of activities at the sites to be investigated. Ignitability and EP Toxicity tests are included for determining if the drilling waste generated is hazardous and will have to be manifested and disposed of at a special landfill. A full suite of metals analyses is proposed because potential contaminants used or disposed of at the sites under investigation may have contained dissolved metals and as such should be tested for.

2.3 DATA EVALUATION AND ASSESSMENT

Assessment of the field and laboratory data collected at Toledo ANGB will include an interpretation of the hydrogeologic framework underlying the sites of concern at the Base, a determination if contamination exists at the sites, and, if identified, a preliminary assessment as to the risks that contamination poses to human health and the environment. Based on this evaluation, whether immediate responses or interim remedial measures are necessary, and whether sufficient data are available to develop remedial alternatives for the sites of concern, will be assessed if necessary.

2.3.1 Data Evaluation

Following completion of the field and laboratory activities, all analytical data will be validated to determine compliance with approved quality assurance/quality control (QA/QC) methodologies and data quality objectives (DQOs), and evaluated using approved analytical procedures. The data evaluation will address each of the specific project objectives outlined previously.

TABLE 2-2. SUMMARY OF RECOMMENDED SITE INVESTIGATION FIELD ACTIVITIES AT THE OHIO AIR NATIONAL GUARD, TOLEDO EXPRESS AIRPORT, SWANTON, OHIO

Site	Activity	Number of Points, Samples, or Tests	Purpose of Activity
Site 1: Fire Training Area No. 1	• Groundwater Probes	• 10 probes	• Provide reconnaissance of site area with regard to presence and distribution of contaminants.
	• Soil Borings	• 3 soil borings (B1-1 to B1-3) 2 - 8 feet 1 - 30 feet	• Collect soil samples for laboratory analysis to determine if contamination is present in soils beneath site area.
		• 21 soil samples 8 samples (minimum) for laboratory analysis	• 2 Soil samples collected from each shallow boring and 4 samples from the deeper borings will be laboratory analyzed; remaining samples will be field screened using onsite GC and sent for analysis only if warranted.
	• Monitoring Well Installation	• 1 monitoring well (MW1-1) • 7 soil samples • 2 soil samples for analysis	• Provide groundwater sample beneath site. Provide soil samples beneath site at well.
	• Hydrologic Testing	• 1 permeability test in monitoring well	• Provide aquifer hydraulic conductivity and transmissivity data at site.
	• Groundwater Sampling	• 1 groundwater sample	• Provide information on potential groundwater contamination beneath site; provide water level monitoring point.
	• Options	• 10 groundwater probes • 1 soil boring	

TABLE 2-2. SUMMARY OF RECOMMENDED SITE INVESTIGATION FIELD ACTIVITIES AT THE OHIO AIR NATIONAL GUARD, TOLEDO EXPRESS AIRPORT, SWANTON, OHIO (Continued)

Site	Activity	Number of Points, Samples, or Tests	Purpose of Activity
Site 2: Fire Training Area No. 2	• Soil Borings	• 3 soil borings (B2-1 to B2-3) 2 - 8 feet 1 - 30 feet	• Collect soil samples for laboratory analysis to determine if contamination is present in soils beneath site area.
		• 21 soil samples 8 samples (minimum) for laboratory analysis	• Two soil samples from each shallow boring and four samples for each deep boring will be laboratory analyzed. Remaining samples will be field screened using onsite GC and sent for analysis only if warranted.
	• Monitoring Well Installation	• 1 monitoring well (MW2-1) • 7 soil samples • 2 soil samples for analysis	• Provide groundwater sample beneath site. Provide soil samples beneath site at well.
	• Hydrologic Testing	• 1 permeability test in monitoring well	• Provide aquifer hydraulic conductivity and transmissivity data at site.
	• Groundwater Sampling	• 1 groundwater sample	• Provide information on potential groundwater contamination beneath site; provide water level monitoring point.
	• Surface Water/Sediment Sampling	• 2 surface water samples 2 sediment samples	• Assess potential contamination in surface water and sediments in drainage ditch adjacent to site.
	• Options	• None	

TABLE 2-2. SUMMARY OF RECOMMENDED SITE INVESTIGATION FIELD ACTIVITIES AT THE OHIO AIR NATIONAL GUARD, TOLEDO EXPRESS AIRPORT, SWANTON, OHIO (Continued)

Site	Activity	Number of Points, Samples, or Tests	Purpose of Activity
Site 3: Fire Training Area No. 3	• Groundwater Probes	• 15 probes	• Hydrochemical reconnaissance of site areas
	• Soil Borings	• 7 soil borings (B3-1 to B3-7) 5 - 8 feet 2 - 30 feet	• Collect soil samples for laboratory analysis to determine if contamination exists beneath site.
		• 46 soil samples 18 samples for laboratory analysis	• Two soil samples from each shallow boring and four samples from each deep boring will be laboratory analyzed. Remaining samples will be field screened using on-site GC and sent for analysis only if warranted.
	• Sand Point Installation	• 1 sand point (SP-13)	• Provide water level monitoring and water quality screening point at site; also incorporate into determination of overall flow directions at Base.
	• Monitoring Well Installation	• 2 monitoring wells (MW3-1 to MW3-2) • 14 soil samples • 4 soil samples for analysis	• Provide groundwater sampling point beneath site.
	• Hydrologic Testing	• Permeability tests in each monitoring well and sand point	• Provide hydraulic conductivity and transmissivity of materials underlying site.
	• Groundwater Sampling	• 2 groundwater samples from monitoring wells at site	• Provide data on water quality at site.
	• Options	• 10 groundwater probes • 2 soil borings • 2 monitoring wells	

TABLE 2-2. SUMMARY OF RECOMMENDED SITE INVESTIGATION FIELD ACTIVITIES AT THE OHIO AIR NATIONAL GUARD, TOLEDO EXPRESS AIRPORT, SWANTON, OHIO (Continued)

Site	Activity	Number of Points, Samples, or Tests	Purpose of Activity
Site 4: Fire Training Area No. 4	• Groundwater Probes	• 20 probes	• Hydrochemical reconnaissance of Site 4 and alternative Site 4 locations.
	• Soil Borings	• 4 soil borings (B4-1 to B4-4) 2 - 8 feet 2 - 30 feet	• Determine if contamination underlies the site.
		• 34 soil samples 12 samples (minimum) to laboratory	
	• Sand Point Installation	• 1 sand point (SP-12)	• Provide groundwater elevation monitoring point and hydrochemical screening location.
	• Monitoring Well Installation	• 1 monitoring well (MW4-1) • 7 soil samples • 2 soil samples for analysis	• Provide water quality, water level, and hydrologic testing location at site.
	• Hydrologic Testing	• Permeability testing in each monitoring well and sand point	• Provide hydraulic conductivity and transmissivity data at site.
	• Groundwater Sampling	• 1 groundwater sample	• Provide water quality data beneath site.
	• Options	• 2 monitoring wells	

TABLE 2-2. SUMMARY OF RECOMMENDED SITE INVESTIGATION FIELD ACTIVITIES AT THE OHIO AIR NATIONAL GUARD, TOLEDO EXPRESS AIRPORT, SWANTON, OHIO (Continued)

Site	Activity	Number of Points, Samples, or Tests	Purpose of Activity
Site 5: POL Storage Area	• Groundwater Probes	• 20 probes	• Determine if spillage or leakage from site has migrated to areas surrounding site; preliminary determination of extent and magnitude of contamination.
	• Soil Borings	• 2 soil borings; (B5-1 to B5-2) 1 - 30 feet, 1 - 8 feet 17 samples; 6 samples for laboratory analysis	• Provide soils contamination data around site.
	• Monitoring Well Installation	• 3 monitoring wells (MW5-1 to MW5-3) to 15 feet • 21 soil samples 6 samples (minimum) to laboratory	• Provide data on potential soils contamination at Site 5.
	• Hydrologic Testing	• Permeability test in each monitoring well	• Provide hydraulic conductivity and transmissivity data for aquifer underlying Site 5.
	• Groundwater Sampling	• 3 groundwater samples	• Provide water quality information for Site 5.
	• Surface Water/Sediment Sampling	• 1 surface water sample • 1 sediment sample	• Access potential contamination in surface water and sediment in drainage ditch near site.
	• Options	• 2 monitoring wells • 2 soil borings • 10 groundwater probes	

TABLE 2-2. SUMMARY OF RECOMMENDED SITE INVESTIGATION FIELD ACTIVITIES AT THE OHIO AIR NATIONAL GUARD, TOLEDO EXPRESS AIRPORT, SWANTON, OHIO (Continued)

Site	Activity	Number of Points, Samples, or Tests	Purpose of Activity
Site 6: Western Drainage Area	• Sand Point Installation	• 3 sand points (SP-1, SP-5, SP-8)	• Provide water level monitoring points along alignment of Site 6 and for overall Base.
	• Hydrologic Testing	• Permeability tests in each sand point	• Provide hydraulic conductivity/transmissivity information for Site 6.
	• Surface Water/Sediment Sampling	• 3 surface water samples 3 sediment samples	• Provide surface water quality data and chemical data for sediments.
	• Options	• 2 surface water samples 2 sediment samples	
Site 7: Eastern Drainage Area	• Sand Point Installation	• 3 sand points (SP-4, SP-10, SP-11)	• Provide water level monitoring points along alignment of Site 7 and for overall Base.
	• Hydrologic Testing	• Permeability tests in each sand point	• Provide hydraulic conductivity/transmissivity information for Site 7.
	• Surface Water/Sediment Sampling	• 4 surface water samples 4 sediment samples	• Provide surface water quality data and chemical data for sediments.
	• Options	• 2 surface water samples 2 sediment samples	

TABLE 2-2. SUMMARY OF RECOMMENDED SITE INVESTIGATION FIELD ACTIVITIES AT THE OHIO AIR NATIONAL GUARD, TOLEDO EXPRESS AIRPORT, SWANTON, OHIO (Continued)

Site	Activity	Number of Points, Samples, or Tests	Purpose of Activity
Site 8: Fire Training Area No. 5	• Soil Borings	• 2 soil borings (B8-1 to B8-2) 1 - 8 feet 1 - 30 feet 17 samples; 6 for laboratory analysis	• Provide samples for laboratory analysis, stratigraphic information.
	• Surface Water/Sediment Sampling	• 1 surface water sample 1 sediment sample	• Assess surface water quality in drainage ditch adjacent to site.
	• Options	• 1 monitoring well (MW-8-1) • 7 samples 2 samples for laboratory analysis	• Provide shallow groundwater samples for analysis; provide water level measurement and hydrogeologic properties.
		• 1 permeability test in monitoring well	• Provide hydraulic conductivity and transmissivity data for shallow aquifer.

TABLE 2-2. SUMMARY OF RECOMMENDED SITE INVESTIGATION FIELD ACTIVITIES AT THE OHIO AIR NATIONAL GUARD, TOLEDO EXPRESS AIRPORT, SWANTON, OHIO (Continued)

Site	Activity	Number of Points, Samples, or Tests	Purpose of Activity
Nonsite-Specific Activities	• Water Level Monitoring	• 23 points from monitoring wells and sand points	• Determine groundwater flow directions.
	• Grain Size Analyses	• 10 samples	• Determine physical distribution of grain size and selection of well gravel and screen sizes.
	• Drinking Water Well Sampling (before treatment)	• 1 sample	• Determine chemical quality of drinking water source; assess potential for migration of contaminants from surficial aquifer to bedrock.
	• Onsite GC Analyses		• Provide onsite analysis of samples; provide quick turnaround data to support sample screening
	• Sand Point Installation	• 6 sand points (SP-2, SP-3, SP-6, SP-7, SP-9, SP-14)	• Provide water level monitoring point
	• Background Soil Borings	• 6 soil borings to 10 feet • 26 soil samples, 6 samples (minimum) for laboratory analysis	• Collect soil samples for laboratory analysis to determine compounds present in native soils (background conditions).
	• Hydrologic Testing	• Permeability test in each sand point	• Provide hydraulic conductivity and transmissivity data for shallow aquifer

TABLE 2-3. SITE-SPECIFIC SUMMARY OF CHEMICAL AND PHYSICAL PARAMETERS TO BE TESTED FOR IN SAMPLES FROM OHIO AIR NATIONAL GUARD BASE, TOLEDO EXPRESS AIRPORT, SWANTON, OHIO

Parameters	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Supply Well	Back-ground
GROUNDWATER, SURFACE WATER, SOIL, AND SEDIMENT CHARACTERIZATION										
Contaminant Characteristics:										
Total Petroleum Hydrocarbons (SW3550/E418.1)	X	X	X	X	X	X	X	X	X	X
Priority Pollutant Metals (SW3050/6010)	X	X	X	X	X	X	X	X	X	X
Volatiles (SW8240)	X	X	X	X	X	X	X	X	X	X
Semivolatiles (BNA) (SW3550/8270)	X	X			X	X	X		X	X
1,2-Dibromomethane (SW5030/502.2)	X	X			X				X	X
EP Tox[a] (metals, pesticides, and herbicides)	X	X	X	X	X			X		
Ignitability[a]	X	X	X	X	X			X		
Water Quality Parameters:										
pH	X	X	X	X	X	X	X	X	X	
Temperature	X	X	X	X	X	X	X	X	X	
Specific Conductance	X	X	X	X	X	X	X	X	X	
Alkalinity	X	X	X	X	X	X	X	X	X	
Iron (SW3005/6010)		X			X	X	X		X	
Manganese (SW3005/6010)		X			X	X	X		X	
Sulfate (A429)		X			X	X	X		X	
Chloride (A429)		X			X	X	X		X	
Magnesium (SW3005/6010)		X			X	X	X		X	
Sodium (SW3005/6010)		X			X	X	X		X	
Potassium (SW3005/6010)		X			X	X	X		X	
Calcium (SW3005/6010)		X			X	X	X		X	
Total Dissolved Solids (E160.1)		X			X	X	X		X	
Total Suspended Solids (E160.2)		X			X	X	X		X	
Nitrate - Nitrate (E353.1)		X			X	X	X		X	
Physical Characteristics:										
Soil Engineering Classification (D2488-84)	X	X	X	X	X	X	X	X		
Grain Size (D422-63)	X	X	X	X	X	X	X	X		
Permeability Tests (D2434)	X	X	X	X	X					
Consolidation Tests (D2435-80)	X	X	X	X	X					

Notes:

[a]EP Toxicity and Ignitability analyses are necessary to determine disposition of drilling wastes.

The evaluation of the hydrogeologic and analytical data, combined with the preliminary risk assessment results (approach to the preliminary risk assessment is presented in the following section), will be used to determine which of the following four recommendations should be made for each site:

- Take no further action and prepare a decision document
- Conduct a Focused Feasibility Study (FFS) and Remedial Measure (RM)
- Proceed to a Remedial Investigation (RI)
- Initiate preparation of engineering plans and specifications for removal of the contamination (response action).

The evaluation of the field and laboratory data, validated data, and results of the preliminary risk assessment will be presented in the SI report (described in Section 2.4). If remedial actions at Toledo ANGB are recommended, based on the observed magnitude of contamination and the risks associated with the contamination, SAIC will develop preliminary remedial response objectives. These objectives will be developed with respect to the contaminants of concern, the areas and volumes of contaminated media, existing or potential exposure routes, and receptors of concern.

2.3.2 Preliminary Risk Assessment

A critical component of the SI will be the preliminary risk assessment. The objective of the risk assessment is to evaluate the potential threat to human health and the environment in the absence of any remedial action. As a result, the assessment provides the basis for determining whether remedial actions, immediate response actions, or no further actions are necessary at the sites under consideration given the information available from the SI.

In general, the objectives of the preliminary risk assessment will be attained by identifying and characterizing, to the extent possible, the following:

- Toxicity and quantity of hazardous substances present in relevant media (e.g., groundwater, surface water, soil, and sediments)
- Potential exposure pathways and extent of actual or expected exposure
- Population(s) at risk

- Extent of expected harm and the likelihood of such harm occurring (i.e., risk characterization)
- Acceptable levels of exposure based on regulatory and toxicological information.

The preliminary risk assessment, conducted during the SI, is a screening level risk evaluation based upon the available SI data. This assessment differs from the baseline risk assessment, normally conducted as part of an RI, in that a comprehensive data set may not be available. The preliminary risk assessment may focus on hypothetical exposure of receptors to chemicals in order to derive a measure of the potential risk. The level of analysis will be more general than a baseline risk assessment and there may be no quantitative estimates of transport and fate available. The preliminary risk assessment will follow the basic standard procedures, but may only provide a preliminary measure of the potential for adverse affects. However, the process will assist in evaluating the need for a more comprehensive assessment (i.e., RI and full risk assessment).

The risk assessment process can be divided into the following four components:

- Contaminant identification
- Exposure assessment
- Toxicity or hazard assessment
- Risk characterization.

The following sections provide an overview of each component that will be included in the preliminary risk assessment for Toledo ANGB. Each component will be conducted, to the extent possible, given the data collected during the SI.

2.3.2.1 Contaminant Identification

The first step in the assessment process is to identify all potential contaminants of concern. From the full listing of all chemicals identified at Toledo ANGB, compounds will be selected as the subject of the risk evaluation. It is often impractical and unnecessary to evaluate all chemicals present at a waste site. Representative "highest risk" compounds may be selected on the basis of the quantities present at the site, the extent of environmental contamination or toxicity, and the mobility and persistence of the chemical in the environment. Guidance on the selection process is contained in the Superfund Public Health Evaluation Manual (EPA 1986) and in the Ohio Environmental Protection Agency (OEPA) water quality criteria included in Appendix A. According to U.S. Environmental Protection Agency (EPA) guidance, if less than 10 to 15 chemicals are actually identified at a waste site, it is not necessary to select indicator compounds, and all chemicals found will become the focus of the evaluation.

2.3.2.2 Exposure Assessment

The objectives of the exposure assessment are to identify actual or potential exposure pathways, characterize the potentially exposed populations, and determine the extent of the exposure. Critical to the exposure assessment is a quantification of the releases of contaminants of concern to each environmental medium (from all sources at the waste site). The results of these analyses provide data on the magnitude and extent of contamination.

In a public health risk assessment of hazardous waste sites, exposure pathways that may be identified include ingestion of contaminated groundwater, ingestion of soil or inhalation of contaminated soil particulates, dermal contact with soil and water, and inhalation of airborne particulate or volatile compounds. All of these pathways may be considered in the evaluation of release of chemicals from the Base. Dose estimates will be developed for each chemical of concern for the receptors at risk.

Once the baseline concentrations of indicator chemicals have been determined at exposure points, these levels will be compared to applicable or relevant and appropriate requirements (ARARs) established for Toledo ANGB. EPA considers drinking water maximum contaminant levels (MCLs), maximum contaminant level goals (MCLGs), Federal ambient water quality criteria (FWQC), and state environmental standards to be potential comparison values (ARARs) for ambient groundwater and surface water concentrations. The selection of ARARs for the Base will be made to correspond to the medium (e.g., water) for which the ARARs were developed. For example, the most appropriate comparison values for potential groundwater and surface water exposure via drinking water are the Safe Drinking Water Act (SDWA) MCLs and MCLGs. Ohio has not yet developed state groundwater quality standards. ARARs have not been developed for evaluating concentrations of indicator chemicals in soils. Soil samples will be collected from remote locations and the concentrations of indicator chemicals in these soils will be evaluated and may be considered representative of background conditions. Concentrations of indicator chemicals determined at the exposure points will then be compared to background levels.

2.3.2.3 Toxicity Assessment

The objectives of the toxicity assessment are to evaluate the inherent toxicity of the compounds under investigation, and to identify and select toxicological measures or endpoints to use in evaluating the significance of the exposure. In the development of these toxicological measures, available dose-response data are reviewed on the adverse effects to human and nonhuman receptors. Dose-response assessments for noncarcinogens provide an estimate of the no-observable-adverse-effect level (NOAEL) or lowest-observable-adverse-effect level (LOAEL). For carcinogenic compounds, the dose-response assessment yields estimates of probability or range of probabilities under which a carcinogenic effect will occur at a specified level of exposure.

2.3.2.4 Risk Characterization

The last step in the preliminary risk assessment for Toledo ANGB is risk characterization, which is the process of estimating the potential for adverse health or environmental effect under various scenarios of exposure derived in the exposure assessment. This objective is attained by integrating information developed during the exposure and toxicity assessments to characterize the potential or actual risk. It is common practice to consider risk characterization separately for carcinogenic and noncarcinogenic effects. This is due to a fundamental difference in the way organisms typically respond following exposure to carcinogenic or noncarcinogenic agents. For noncarcinogenic effects, toxicologists recognize the existence of a threshold of exposure below which there is only a very small likelihood of adverse health impacts in an exposed individual. Exposure to carcinogenic compounds, however, is not thought to be characterized by the existence of a threshold. Rather, all levels of exposure are considered to carry a risk of adverse effect (risk per unit dose).

In summary, the preliminary risk assessment will be performed to evaluate the potential threat to human health and the environment in the absence of remedial action. It will provide the basis for determining whether remedial actions are necessary or if additional investigations are required. The results of the preliminary risk assessment may indicate that the sites do not pose an actual or potential threat to human health or the environment. If additional investigations are required, a full risk assessment will be performed using all available SI and RI data.

2.4 REPORTING AND DOCUMENT REVIEW

At the completion of the SI activities, SAIC will prepare an internal draft SI report. The SI report will present study findings and interpretation and analysis of those findings. The report will include maps, figures, and tables, as appropriate, and will include analytical results, groundwater probe results, and all other pertinent information. The report also will include analyses, as appropriate, from the SI preliminary risk assessment. A preliminary outline of the SI report is presented in Table 2-4.

Four weeks after delivery of the internal draft SI report, SAIC will attend a review meeting at the Air National Guard Support Center (ANGSC) with Energy Systems, NGB, and Toledo ANGB personnel. SAIC will incorporate comments from the review meeting into a draft final SI report. This report will be submitted within 3 weeks of the date of the review meeting dependent upon the timeliness and nature of the review comments. SAIC will submit a draft SI report for review by Energy Systems, NGB, Toledo ANGB personnel, and regulatory (i.e., USEPA, OEPA) agency officials.

Following review of the draft SI report, SAIC will attend a meeting at Toledo ANGB, with Energy Systems, NGB, Toledo ANGB personnel, and the regulatory agency personnel to present the SI report and receive comments.

TABLE 2-4. PRELIMINARY SITE INVESTIGATION REPORT OUTLINE FOR OHIO AIR NATIONAL GUARD, TOLEDO EXPRESS AIRPORT, SWANTON, OHIO

EXECUTIVE SUMMARY

1. INTRODUCTION

   1.1 PURPOSE AND OBJECTIVES OF SITE INVESTIGATION
   1.2 SITE BACKGROUND

      1.2.1 Site Description
      1.2.2 Site History
      1.2.3 Previous Investigations

   1.3 SITE INVESTIGATION SUMMARY OF RESULTS
   1.4 REPORT ORGANIZATION

2. STUDY AREA CHARACTERIZATION

   2.1 SURFACE FEATURES (TOPOGRAPHY, MANMADE)
   2.2 GEOLOGY (REGIONAL HISTORY, NATURAL FEATURES)
   2.3 SOIL AND VADOSE ZONE (PHYSICAL, CHEMICAL)
   2.4 HYDROGEOLOGY
   2.5 ARARs AND EVALUATION CRITERIA (BACKGROUND CONCENTRATIONS)

3. NATURE AND EXTENT OF CONTAMINATION

   3.1 SITE 1 - FIRE TRAINING AREA NO. 1

      3.1.1 Soils Contamination
      3.1.2 Groundwater Contamination

   3.2 SITE 2 - FIRE TRAINING AREA NO. 2

      3.2.1 Soils Contamination
      3.2.2 Groundwater Contamination

   3.3 SITE 3 - FIRE TRAINING AREA NO. 3

      3.3.1 Soils Contamination
      3.3.2 Groundwater Contamination

   3.4 SITE 4 - FIRE TRAINING AREA NO. 4

      3.4.1 Soils Contamination
      3.4.2 Groundwater Contamination

   3.5 SITE 5 - POL STORAGE AREA

      3.5.1 Soils Contamination
      3.5.2 Groundwater Contamination

TABLE 2-4. PRELIMINARY SITE INVESTIGATION REPORT OUTLINE FOR OHIO AIR NATIONAL GUARD, TOLEDO EXPRESS AIRPORT, SWANTON, OHIO (Continued)

3.6 SITE 6 - WESTERN DRAINAGE AREA

3.6.1 Surface Water/Sediments Contamination
3.6.2 Groundwater Contamination

3.7 SITE 7 - EASTERN DRAINAGE AREA

3.7.1 Surface Water/Sediments Contamination
3.7.2 Groundwater Contamination

3.8 SITE 8 - FIRE TRAINING AREA NO. 5

3.8.1 Surface Water/Sediments Contamination
3.8.2 Groundwater Contamination

4. PRELIMINARY RISK ASSESSMENT

4.1 CONTAMINANT IDENTIFICATION
4.2 EXPOSURE ASSESSMENT
4.3 TOXICITY ASSESSMENT
4.4 RISK CHARACTERIZATION

5. SUMMARY

5.1 SUMMARY (CONTAMINATION EXTENT, RISK ASSESSMENT)
5.2 CONCLUSIONS (DATA LIMITATIONS)
5.3 RECOMMENDATIONS

ACRONYMS

REFERENCES

APPENDICES

This meeting will take place within 4 to 5 weeks of submittal of the draft SI report. SAIC will incorporate comments from the review meeting with the regulatory agencies into a final SI report to be submitted within 3 weeks of the conclusion of the review meeting and will address comments received from the regulatory agency officials.

The SI report will be a stand-alone document formatted in accordance with the EPA Draft Guidance on Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA 1988).

3. FIELD PROGRAM ACTIVITIES AND PROCEDURES

This section provides details on the methods and procedures that will be used during the Site Investigation (SI) field program at Toledo Air National Guard Base (ANGB). A summary of the field program and the purpose of each field activity is provided in Table 2-2.

3.1 GROUNDWATER PROBE PROCEDURES

A groundwater probe survey will be conducted at Sites 1, 3, 4, and 5 by a Science Applications International Corporation (SAIC) subcontractor. The groundwater probe survey is planned to help define the horizontal extent of groundwater contamination in and around Sites 1, 3, 4, and 5 and to provide information to optimize monitoring well locations. The strategy will be to sample groundwater on a regular pattern, beginning near the area of the known source of potential contamination and progressing in the general directions of contaminant detection toward points of no contaminant detection. However, if surface or subsurface conditions will not allow penetration of the probe to the water table, alternative sampling points will be attempted. Since no quantitative information is available regarding subsurface contamination at any of the sites of concern, the groundwater probes will be used to identify trends in any contaminant patterns around the site. Probe spacing will be adjusted as appropriate to delineate the areal extent of contamination.

Groundwater probe samples will be collected by hydraulically pushing a hollow steel probe below the water table (approximately 4 to 5 feet below land surface [BLS]) and evacuating groundwater with a vacuum pump. During the evacuation, samples will be collected by inserting a syringe needle through a silicone evacuation line that previously has been extended to groundwater through the steel probe. Ten milliliters of unfiltered sample will be collected for immediate analysis by direct injection into the gas chromatograph (GC). Turbid samples will be allowed to settle before analysis. The sample then will be subsampled (duplicate injections) in volumes ranging from 1 μL to 2 mL, depending on the volatile organic compound (VOC) concentration. High concentrations of VOCs will require sample dilution to minimize the impacts of column saturation. Following the collection of the sample, the probe will be extracted from the ground and stored away from clean probes for decontamination.

Sample concentrations will be quantified by comparison to compound-specific, premixed, aqueous chemical standards of known concentration. Based on the findings of the Preliminary Assessment (PA) and on SAIC's experience, the standards will be available for total petroleum hydrocarbons, total xylenes, benzene, toluene, and ethylbenzene.

Samples will be analyzed using a Varian 3300 GC and a Spectra-Physics SP270 computing integrator or equivalent. The detection limits for the analysis are a function of the injected sample volume as well as the detector sensitivity for individual compounds; thus, the detection limits will vary with the sample size, with a larger injected sample volume producing a lower detection limit. Chromatographic peaks for compounds of interest must be kept within the linear range of the integrator; therefore, compounds with high concentrations necessarily will use smaller injections to keep the equipment response within the linear range. This may result in higher detection limits for other compounds in the analyses (matrix effects). An electron capture detector (ECD) will be used to analyze halogenated compounds and a flame ionization detector (FID) will be used to analyze hydrocarbons.

Cross-contamination of samples will be prevented by purging syringes with ultrapure (deionized, double distilled, ASTM Type II) water before sampling and checking for contamination by injection into the GC. System blanks will be analyzed periodically to confirm that no contamination is present in the probes, adapters, or sampling syringes. Analytical instruments will be checked continually for calibration by the use of chemical standards prepared in water from commercially available pure chemicals. All chemical standards will be traceable to the National Bureau of Standards (NBS). Probes will be used only once during the course of a working day and then thoroughly cleaned by steam cleaning before use on the following day.

3.2 ONSITE GAS CHROMATOGRAPHY PROCEDURES

Laboratory-grade GC equipment will be used onsite during the groundwater probe survey and drilling program to screen groundwater probe samples, surface water and groundwater samples, decontamination water, drill cuttings, and discharge water produced during the aquifer testing and sampling activities. Water samples will be directly injected into and analyzed by the GC using the procedures outlined in Section 3.1. Drill cutting samples will be prepared by placing approximately 20 grams of each soil sample into a 40 mL VOC vial and then sealing the vial with a septum cap. The soil then will be shaken or gently heated for 1 minute before analysis and a volume of headspace gas will be obtained using a syringe. This headspace gas then will be injected and analyzed by the GC using the procedures outlined in Section 3.1.

Based on the compounds that reportedly were used at the sites, chemical standards will be available to quantify the concentration of the following compounds:

Site	Analytes
Site 5 - POL Storage Area	Total petroleum hydrocarbons, total xylenes, benzene, toluene, ethylbenzene
Sites 1, 2, 3, 4, 6, 7, and 8 - Fire Training Areas and Drainage Areas	Total petroleum hydrocarbons, total xylenes, benzene, toluene, PCE, TCE, carbon tetrachloride, bromochloromethanes, 1,1,1-TCA

3.3 DRILLING, MONITORING WELL, AND SAND POINT INSTALLATION PROCEDURES

The drilling, monitoring well, and sand point installation program at the Base will consist of three activities: 1) soil boring and abandonment, 2) monitoring well drilling and installation, and 3) sand point installation. Table 3-1 shows the general drilling, soil sampling, and well installation specifications for the field program. Figure 1-2 shows the proposed drilling locations. The specifications have been developed using available site information. Changes in the procedures may be necessary if site conditions are not favorable for allowing planned procedures to be implemented. SAIC will inform Martin Marietta Energy Systems, Inc. (Energy Systems) and the

TABLE 3-1. GENERAL DRILLING AND WELL INSTALLATION SPECIFICATIONS FOR THE SITE INVESTIGATION FIELD PROGRAM FOR OHIO AIR NATIONAL GUARD, TOLEDO EXPRESS AIRPORT, SWANTON, OHIO

Site/Boring Type	Soil Boring/Well Drilling Specifications				Well Installation Specification (if applicable)		
	Number of Borings/Wells	Location	Soil Sample Interval (feet)	Total Depth	Well Inside Diameter (inches)	Screen Length (feet)	Screen Depth Below Water Table (feet)
SITE1 1: FIRE TRAINING AREA NO. 1							
Soil Borings	3	See Figure 1-2.	3	One boring to 30 feet. Two borings to 8 feet BLS.	—	—	—
Monitoring Wells	1	See Figure 1-2.	3	Depth where two consecutive soil samples show no contamination based on onsite GC results or 10 feet below the water table (12.5 feet BLS), whichever is deeper.	4	10	(a)
SITE 2: FIRE TRAINING AREA NO. 2							
Soil Borings	3	See Figure 1-2.	3	One boring to 30 feet. Two borings to 8 feet BLS.	—	—	—
Monitoring Wells	1	See Figure 1-2.	3	Depth where two consecutive soil samples show no contamination based on onsite GC results or 10 feet below the water table (12.5 feet BLS), whichever is deeper.	4	10	(a)

TABLE 3-1. GENERAL DRILLING AND WELL INSTALLATION SPECIFICATIONS FOR THE SITE INVESTIGATION FIELD PROGRAM FOR OHIO AIR NATIONAL GUARD, TOLEDO EXPRESS AIRPORT SWANTON, OHIO (Continued)

	Soil Boring/Well Drilling Specifications				Well Installation Specification (if applicable)		
Site/Boring Type	Number of Borings/Wells	Location	Soil Sample Interval (feet)	Total Depth	Well Inside Diameter (inches)	Screen Length (feet)	Screen Depth Below Water Table (feet)
SITE 3: FIRE TRAINING AREA NO. 3							
Soil Borings	7	See Figure 1-2.	3	Two borings to 30 feet. Five borings to 8 feet BLS.	—	—	—
Sand Points	1	See Figure 1-2.		8 feet.	2	5	5
Monitoring Wells	2	See Figure 1-2.	3	Depth where two consecutive soil samples show no contamination based on onsite GC results or 10 feet below the water table (12.5 feet BLS), whichever is deeper.	4	10	(a)
SITE 4: FIRE TRAINING AREA NO. 4							
Soil Borings	4	Two borings at PA location for site. Two borings at alternative location for site.	3	Two borings to 30 feet BLS, one at each site; two borings to 8 feet BLS.	—	—	—
Monitoring Wells	1	Tentatively located at site from PA. To be relocated in field based on field data.	3	Depth where two consecutive soil samples show no contamination based on onsite GC results or 10 feet below the water table (12.5 feet BLS), whichever is deeper.	4	10	(a)
Sand Point	1	See Figure 1-2.		8 feet.	2	5	5

TABLE 3-1. GENERAL DRILLING AND WELL INSTALLATION SPECIFICATIONS FOR THE SITE INVESTIGATION FIELD PROGRAM FOR OHIO AIR NATIONAL GUARD, TOLEDO EXPRESS AIRPORT SWANTON, OHIO (Continued)

	Soil Boring/Well Drilling Specifications				Well Installation Specification (if applicable)		
Site/Boring Type	Number of Borings/Wells	Location	Soil Sample Interval (feet)	Total Depth	Well Inside Diameter (inches)	Screen Length (feet)	Screen Depth Below Water Table (feet)
SITE 5: POL STORAGE AREA							
Monitoring Wells	3	POL Storage Area.	3	3 wells to 15 feet BLS.	4	10	(a)
Soil Borings	2	See Figure 1-2.	3	1 boring to 30 feet; 1 boring to 8 feet.	—	—	—
SITES 6 AND 7: EASTERN AND WESTERN DRAINAGE AREAS							
Sand Points	6	Along ditch alignments.	—	8 feet.	2	5	5
SITE 8: FIRE TRAINING AREA NO. 5							
Soil Borings	2	See Figure 1-2.	3	1 boring to 30 feet. 3 borings to 8 feet.	—	—	—
Monitoring Wells	1 (optional)	See Figure 1-2.	3	15 feet.	4	10	(a)
NONSITE-SPECIFIC DRILLING							
Sand Points	6	See Figure 1-2.	—	8 feet.	2	5	5
Background Soil Borings	2	To be determined.	3	Two borings to 30 feet.	—	—	—

(a) Bottom of detected contamination based on onsite GC results.

National Guard Bureau (NGB) of any changes that may be warranted during the field activities. The drilling and well installation program will provide detailed geologic, hydrologic, and chemical data that will be used to characterize the nature, transport, and fate of the contaminants present.

3.3.1 <u>Soil Boring and Abandonment</u>

Soil borings will be completed at Sites 1, 2, 3, 4, 5 and 8. All boreholes for the Toledo ANGB investigation will be drilled using hollow stem augers. The sandy nature of the soils underlying the site indicates that a water head may need to be maintained in the augers to minimize the potential for "running sand" conditions in the borehole.

The hollow stem opening will be of sufficient size to permit soil sampling and, in the case of monitoring well boreholes, the installation of 4-inch inside diameter (I.D.) Schedule 40 PVC screen, riser pipe, and sand pack. Small diameter augers (6-1/4 inch outside diameter [O.D.]) will be specified for use in boreholes that will not be completed as wells to minimize the generation of drilling cuttings.

The soil borings will be sampled at 3-foot intervals beginning at the ground surface in order to characterize completely the lithology of the shallow subsurface. Soil sample spacing may be increased to 5-foot intervals, depending on the field conditions encountered. Samples also will be collected at changes in lithology. Specific soil sampling protocols are discussed in Section 3.5.1. Upon reaching completion depth, all soil borings not completed as wells will be abandoned by grouting using a cement/bentonite slurry.

Each operating drilling rig will be supervised by an experienced geologist for the logging of samples, monitoring of drilling operations, recording of soil and groundwater data, and monitoring and directing well installation procedures. Each geologist will be responsible for only one operating rig.

3.3.2 Monitoring Well Installation

Figure 3-1 is a typical as-built diagram for monitoring wells to be installed at the Base. Specific well construction parameters will be determined in the field based on groundwater levels observed during drilling and onsite GC results.

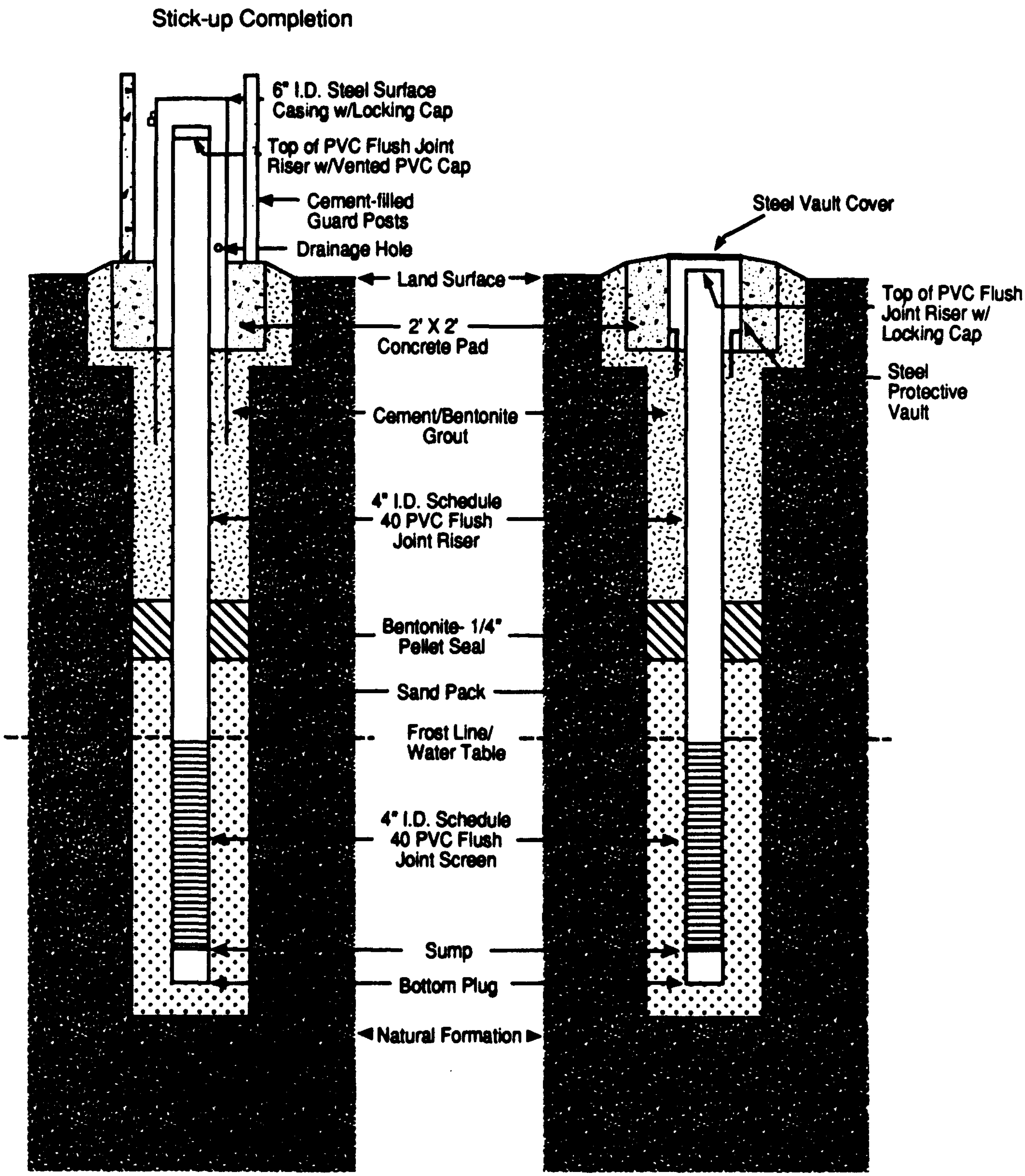
Procedures for monitoring well installation using hollow stem auger methods are described as follows:

- Once the borehole has been drilled to completion depth, the auger plug will be removed and an appropriate length (10-foot minimum) of PVC well screen and length of riser (4-inch I.D., PVC Schedule 40) will be installed. All screen and risers will be threaded flush joint. The well screen and casing will be steam cleaned before installation in the borehole. Screen slots will be sized so as to retain a minimum of 90 percent of the sandpack material. The screen interval (10 feet minimum) will extend from the existing water table to a depth 10 feet below the water table to allow for annual fluctuation in the groundwater table elevation and to allow any free-floating petroleum, oils, and lubricants to enter the well during purging. The top of the PVC casing will be completed either above ground, with a protective surface casing and guard posts, or flush with the land surface using a steel protective vault and manhole cover (see Figure 3-1).

- Upon installation of the well casing and screen, the augers will be raised in 2-foot increments and silica sand pack will be added. The grain size of the sand pack will be two times the 50 percent retained grain size of an aquifer sample. The grain size will be determined by studying previously collected aquifer grain size data that may be available from the Base or by running grain size analyses to determine the optimum well screen slot size for the formation. The sand pack should have a uniformity coefficient ranging from 2 to 3. With these grain size parameters as guidelines, the sand pack will be chosen from commercially available suppliers. The incremental lifting of the augers and emplacement of sand pack will be continued until the sand pack extends 2 feet above the top of the screen (this criteria may be changed if groundwater levels are shallow). Periodic sounding with a weighted tape during this process will ensure a continuous sand pack.

- After the sand pack has been emplaced and measurements have been taken to ensure its proper location, 2 feet of bentonite pellets will be placed as a seal on top of the sand pack (this criteria may be changed if groundwater levels are shallow).

- After the bentonite seal is in place and has been allowed to hydrate, cement and bentonite grout will be placed from the top of the seal to the land surface. Cement and bentonite grout mixtures will consist of potable water, bentonite, and Type I or II Portland cement with 94 pounds of cement and 5 pounds of bentonite per 6.5 gallons of water.



Monitoring Well Detail Ohio Air National Guard Toledo Express Airport Swanton, Ohio	
Figure: 3-1	Project: 1-827-03-350-02

- A protective surface casing capable of being locked to prevent unauthorized entry will be installed within 72 hours of well installation. A concrete pad having a minimum depth of 2 feet BLS will be built around the casing and sloped to drain away from the well and will extend below the frost line. All wells will be fitted with keyed-alike locks.

- Each well will be developed by surging and/or pumping until well water is relatively turbidity free and acceptable in clarity and specific conductivity to the SAIC Supervisory Geologist (i.e., where clarity and conductivity have stabilized and show no further improvement or reduction with continued development). The total volume of removed water will be estimated and recorded. Wells will not be developed within 12 hours of the placement of grout seals. Wells and sand points will be developed between 12 and 48 hours after the placement of the grout seals.

- A blank pump, with an O.D. of 3-7/8 inches, will be lowered into the well, and will pass unobstructed throughout the entire well depth, and be removed from the well before well acceptance.

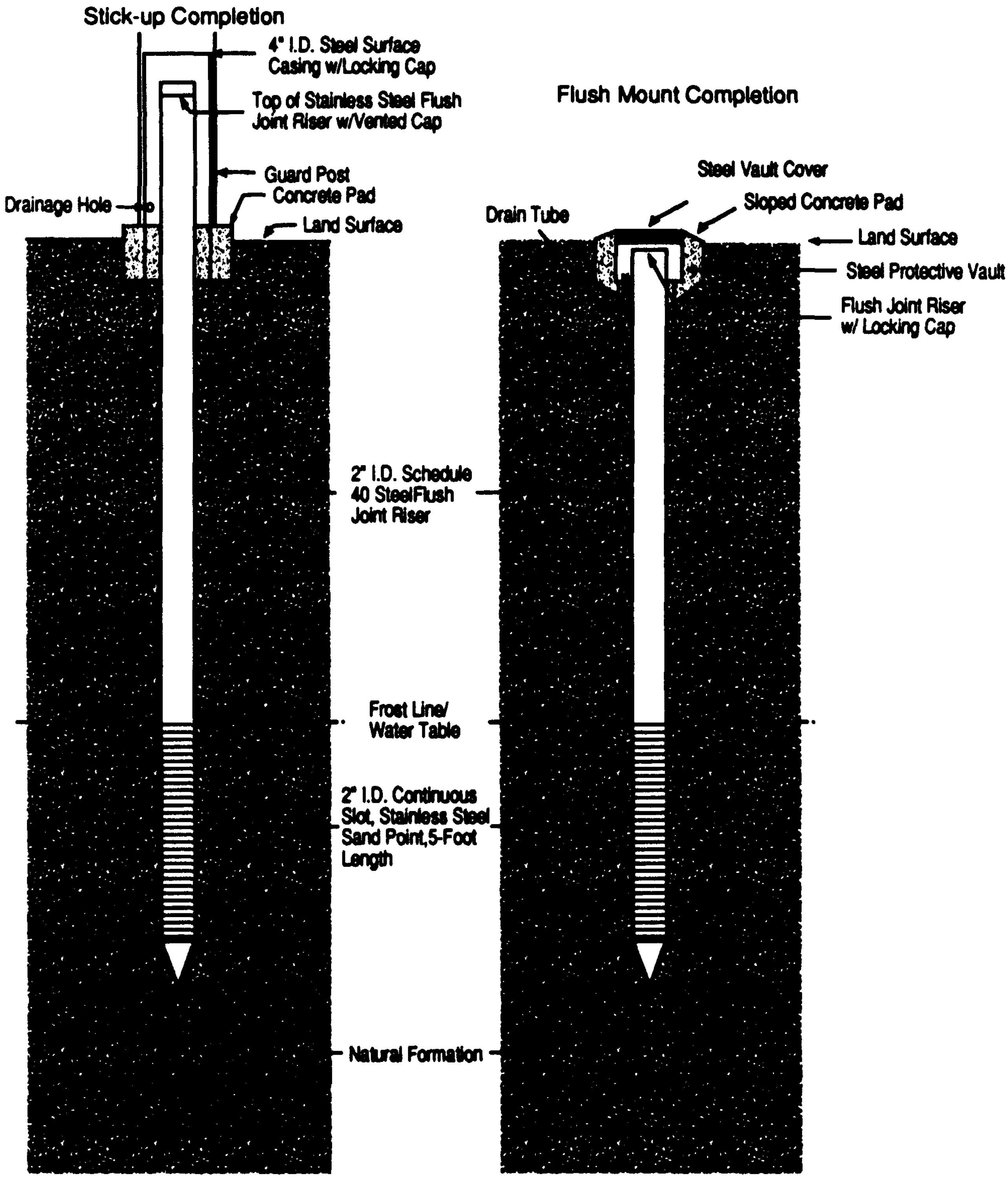
- An identification number will be steel-tagged on the protective casing. The wells will be permanently marked before subcontractor demobilization from the site.

- At each site, soil cuttings from drilling the borings and wells will be placed on a plastic tarp and covered until samples of the soil have been screened using the onsite GC. If the onsite GC analysis determines the soil to be comparable in quality to the background samples, the soil will be disposed of in any manner that the Base deems appropriate. If contamination is identified, the soil will be drummed and stored until the results are available. When the laboratory results are available, discussion will be held with the Ohio Environmental Protection Agency (OEPA) on the proper disposition of the cuttings.

3.3.3 Sand Point Installation

Fourteen shallow sand points will be installed at Toledo ANGB at locations shown in Figure 1-2. Sand point construction will consist of a 5-foot long, 2-inch I.D., continuous slot, wire-wound stainless steel well point coupled to 2-inch I.D., Schedule 40, PVC riser pipe. Details of this construction are presented in Figure 3-2.

At the request of the Base, nearly all sand points will be installed flush mount, except those located in areas not in full public view. All screens and risers will be set into augered bore holes of the same diameter as the riser pipe. For nonflush-mount sand points, a steel surface protective



Science Applications International Corporation
An Employee-Owned Company

Sand Point Detail

Ohio Air National Guard
Toledo Express Airport
Swanton, Ohio

Figure: 3-2	Project: 1-827-03-350-02

casing and cement-filled guard posts will be set around the riser pipe after it is installed, and a sloped concrete pad placed around the protective casing. For flush-mount completion, the riser will be cut off to the appropriate depth before installing the sand point in the bore hole, and a protective casing and vault with a man-hole type cover will be set around the riser pipe in a sloped concrete pad. Concrete pads for both types of installation will extend the frost line. Once the concrete pads have hardened, the sand points will be developed by pumping or bailing until the produced water is of acceptable clarity and specific conductance.

All sand points will be secured with locking, keyed-alike caps. Stamped steel tags will be used to identify each sand point. Details of both stick-up and flush mount sand point construction is shown in Figure 3-2. Sand points will be surveyed for location and elevation when a sufficient number are in place to warrant mobilization of the surveying crew.

The technical merits, waste minimization benefits, and feasibility of this type of installation will provide greater flexibility to the SI at Toledo ANGB. Technically, the installations will allow broader definition of hydrogeologic conditions impacting the sites of concern by providing a greater number of monitoring locations. The shallow (2.5-foot BLS) groundwater table beneath the Base and the generally sandy aquifer provide ideal conditions for sand point usage. Generation, handling, storage, testing, and disposal of waste products associated with driven sand point installations are minimal as compared to drilled in place installations.

3.4 SAMPLING PROCEDURES

The following sections discuss the various multimedia sampling procedures that will be used during the SI at Toledo ANGB.

3.4.1 Subsurface Soils Sampling Procedures

Subsurface soil sampling refers to split spoon samples collected during soil boring and monitoring well drilling activities. Samples will be collected at Sites 1 through 5 and Site 8. Samples will be collected using either standard 2-inch O.D., 18-inch long split spoons, or 18-inch California-type Ring samplers. Both types of samplers will be equipped with sand catchers to minimize loss of sample. The standard split spoon samples will be for lithologic descriptions only, and the ring samples will be collected both for laboratory analysis and for lithologic descriptions. Shelby tube samples also will be collected for geotechnical analysis.

California ring samplers are 3-inch O.D. split spoons lined with metal sleeves. As the sampler is driven into the ground to collect the sample, the sample material fills the sleeves. Both brass and stainless steel rings are used in the ring samplers to allow sampling for both organic and metals analyses. Samples collected in brass sleeves are used for the VOC analytical fraction, and samples collected in stainless steel are for metals analysis When the sampler is open, the rings are separated using a stainless steel knife and the brass ring containing the VOC fraction is sealed immediately and submitted to the laboratory for analysis. The remaining rings are either capped and submitted for analysis (as the VOA ring is capped), or the sample material is extruded, homogenized, and aliquoted to appropriate sampling containers. By collecting the VOC sample fraction in a ring, excess volatilization of the sample is reduced. In addition, this method also can reduce the number of sample containers required.

The drilling equipment will be capable of performing standard penetration tests in accordance with American Society for Testing and Materials (ASTM) D-1586 and undisturbed (Shelby tube) sampling in accordance with ASTM D-1587. California-type ring-lined barrel sampling will be in accordance with ASTM D-3550.

All soil boring samples will be examined for the following characteristics:

- Headspace organic vapor concentrations (using an HNu or OVA meter)
- Recovery
- Lithology (special emphasis on contaminated horizons)
- Grain size (visual)

- Color (Munsell)
- Consistency and texture
- Relative density (based on blow counts, noncohesive materials)
- Moisture (visual)
- Fabric/bedding
- Standard penetration test (SPT) values (blow count recorded for every 6 inches of penetration [ASTM D1586])
- Other distinctive features.

Two soil samples from the vadose (unsaturated) zone will be sent to the laboratory from each shallow soil boring or monitoring well borehole and four soil samples will be sent to the laboratory from each deep soil boring. Samples will be selected for laboratory analysis based on the results of the HNu or OVA screening. If OVA or HNu screening does not indicate that any of the samples contain greater amounts of contamination, the sample collected at the water table, and an additional sample from the vadose zone, will be submitted.

Grain size analyses (ASTM-D422) will be conducted on 10 samples from the site areas. Since wells will not be completed in the clay layer that is anticipated to be encountered beneath the Base, five undisturbed (Shelby tube) samples will be tested for laboratory permeability (ASTM D-2434) and for consolidation characteristics (ASTM D-2435).

3.4.2 Monitoring Well and Sand Point Sampling

3.4.2.1 Purging

Before purging and sample collection, static water level measurements will be taken in each well using an electric water level indicator or an interface probe. If a layer of petroleum product exists on the water table, it also will be measured by taking a water table sample with a decontaminated, bottom-filling, transparent bailer. Depths to groundwater will be used to calculate the volume of standing water in each well, and therefore, will determine the volume of water to be purged from each well before sampling according to the equation $\Pi r^2 \times h \times 3$, where r = well radius (in feet), and h = standing column of water in well (in feet). The equation indicates that a minimum of three times the standing well/sand point water volume will be purged.

Before samples are collected from the monitoring wells, three to five casing volumes of water will be purged from each well using a submersible pump, centrifugal pump, or bailer. Field measurements for temperature, pH, and specific conductivity will be monitored during purging to ensure that these parameters have stabilized. Well purging will ensure that a representative sample of the aquifer water (i.e., not stagnant well water) will be collected.

Before well purging operations begin, between wells, and after purging has been completed, the pump and/or hose will be washed with a laboratory-grade detergent (e.g., Liqui-Nox/Alconox) and rinsed with potable water. A sample of the potable water will be screened for volatile organics during the groundwater probe survey with the available onsite GC. The potable water will be collected from a hydrant.

3.4.2.2 Groundwater Sampling

Groundwater samples at each well will be collected within 3 hours of purging that monitoring well. Groundwater samples will be collected from nine monitoring wells and one Base supply well. Samples will be retrieved using a point-source, bottom-filling, Teflon® bailer and dispensed directly into an appropriate prelabeled sample bottle containing the necessary preservative (if any is required) for the analytical method. The samples collected for metals analysis will not be filtered and laboratory analyses will be for total concentrations. The results of the initial sampling will determine if subsequent sampling for metal analysis employing filtering is necessary. Field measurements for temperature, pH, and specific conductivity will be taken at each well. Field calibration of measurement instruments will be performed at the start of each day. Quality assurance/quality control (QA/QC) sample collection is detailed in the project Quality Assurance Project Plan (QAPP).

3.4.3 Equipment Decontamination

Before sampling activities begin, between sampling intervals, and after sampling activities at a location have been completed, all sampling equipment (e.g., split-spoon samplers, bailers) will be decontaminated. The equipment will be scrubbed with laboratory-grade detergent (e.g., Liqui-Nox, Alconox), rinsed with distilled water, rinsed with pesticide-grade methanol, air dried, rinsed with hexane, air dried, and final rinsed with ASTM Type II water. Lines used to lower bailers into the wells will be replaced between wells. Water level monitoring devices and measuring tapes will be scrubbed with laboratory-grade detergent and rinsed with distilled water.

Drilling equipment (including rods, bits, and tools) will be cleaned at the decontamination area with a steam cleaner, laboratory-grade detergent (e.g., Liqui-Nox, Alconox), and a potable water rinse before, between, and after drilling locations. The decontamination area will be cleaned after each use.

3.5 HYDROLOGIC TESTING

SAIC will conduct hydrologic aquifer permeability tests on all monitoring wells and sand points installed at Toledo ANGB. Permeability tests will involve the injection (falling head test) or removal (rising head test) of a volume of water at a well or sand point, and the subsequent recording of the water level response in the well as it recovers to equilibrium. The permeability testing will be conducted to determine the hydraulic conductivity of the natural formations and materials surrounding each well.

A Hermit Environmental Data Logger Model SE1000B (In-Situ, Inc.) will be used to collect the data from each well digitally by recording water levels at selected time intervals translated from a pressure transducer set in the well. Before the start of each test, the date, internal clock, test number, and sampling rate (timed intervals) and initial static recorder reading will be checked and adjusted if necessary. The transducer parameters will be set after the well is ready for testing to ensure that the reference level is set at well equilibrium. After approximately 10 minutes, the data will be reviewed, and the tests stopped after the water level has recovered to at least 90 to 100 percent of the initial drawdown. The data will be downloaded directly to a field computer for review and analysis to ensure data quality.

Before the start of a rising head test, the transducer and a pump or hose will be lowered into the well and the water level will be allowed to return to equilibrium. Once the well reaches equilibrium, the test will be started by turning on the pump. The data logger will be turned on immediately upon reaching maximum drawdown with the pump (i.e., turning off the pump). The pump or hoses will be fitted with a check valve to prevent water backflow into the well from the pump or pump hose. A 1-inch diameter submersible pump or a centrifugal pump will be used to produce drawdown in the well. The transducer will be set below the predetermined drawdown level. Water will be prevented from exposing the transducer during drawdown by monitoring the transducer responses on the data logger with respect to the initial reference level. Alternatively, a vacuum may be applied to the well head to raise the water level in the well (falling head test) and to allow instantaneous "injection" of a water slug into the well. This method is advantageous in that ground-water is not produced from the well, eliminating the generation of waste product. The test method to be implemented will be dependent on the subsurface conditions at each test location.

The recorded time-drawdown data will be processed using analytical solutions developed by Hvorslev (1951) and Bouwer and Rice (1976) for unconfined, partially penetrating wells.

3.6 SURVEYING OF MONITORING WELLS

After the wells and sand points have been installed at the Base, they will be surveyed for the vertical elevation of the top of the well casing and for the horizontal location of the well. The U.S. Geological Survey (USGS) well in the vicinity of Site 6 also will be tied to this survey. The surveys will be performed under subcontract by a land surveyor licensed in the State of Ohio. The surveys will be completed to a vertical accuracy of 0.01 feet and a horizontal accuracy of 1 foot. All surveys will be tied to U.S. Geodetic Survey vertical datum (N.G.V.D.) and the Ohio State Coordinate System.

3.7 FIELD DOCUMENTATION PROCEDURES

Bound, water-resistant field books and water-proof ink pens will be used to document the methodology, procedures, and events pertaining to sample and data acquisition. The log books will be considered as formal documents representing complete and organized records of all field activities. The entries will include, but not be limited to:

- Personnel present (including visitors)
- Date
- Time
- Work location
- Description of work
- Environmental conditions

  Previous 24-hour and present weather conditions
  Amount and date of last precipitation
  Any other conditions or activities that would affect samples

- Soil sample descriptions

  Organic vapor monitoring results (HNu)
  Recovery
  Lithology (special emphasis on contaminated horizons)
  Grain size (visual)
  Color (Munsell)
  Consistency and texture
  Moisture (visual)
  Relative density (based on blow counts, noncohesive materials)
  Fabric/bedding
  Standard penetration test values (blow count)
  Other distinctive features

- Water sample descriptions

  pH
  Specific conductivity
  Temperature
  Appearance

- Sample numbers
- Field QA/QC data.

A copy of these field books can be provided to Martin Marietta Energy Systems, Inc. on request at the completion of the field program.

3.8 WASTE MATERIALS HANDLING

Waste materials, including drill cutting, development and purge water, and decontamination water generated as a result of the SI program, will be handled as follows:

- Cuttings will be retained on plastic tarps at the well site and liquids will be drummed until they can be tested using the onsite GC
- If the onsite GC screening indicates the cuttings are comparable to background soils and/or the liquids contain no detectable contamination, they will be disposed of as the Base personnel see fit
- If the onsite GC screening shows above background levels of contaminants in the cuttings or liquids, they will be drummed and the results of the laboratory analysis will be used to determine their final disposition.

After all data are available, the disposition of the cuttings will be discussed with the State prior to the final disposal.

Containerized waste materials will be transported from the drilling site to a staging area designated by Toledo ANGB personnel for storage. SAIC will assist Energy Systems, NGB, and Toledo ANGB in contracting for waste disposal services, preparing forms and manifests, and testing waste containers. Toledo ANGB will maintain signature authority over waste manifests.

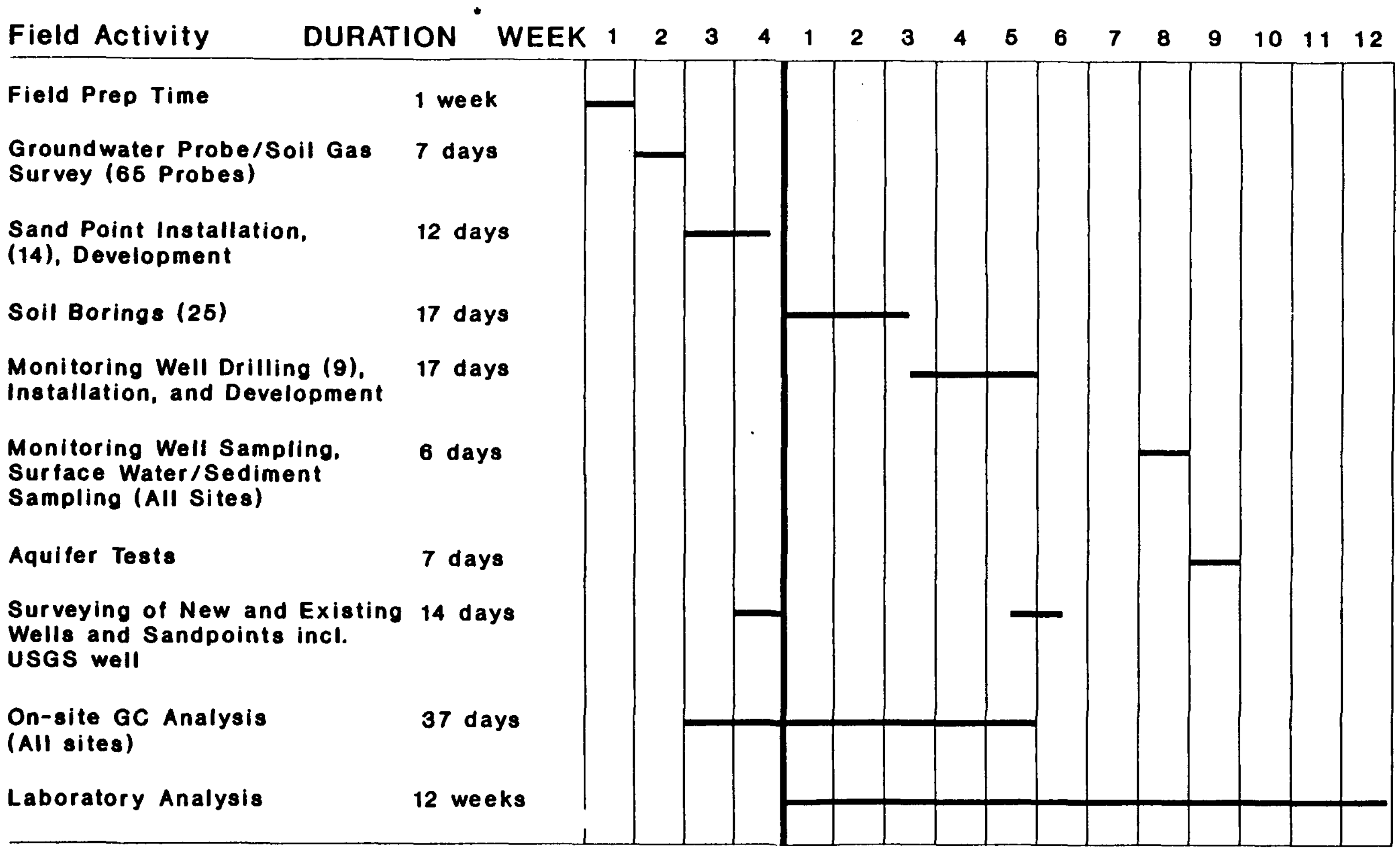
4. PROJECT SCHEDULE AND DELIVERABLES

4.1 PRELIMINARY PROJECT SCHEDULE

The Site Investigation (SI) schedule, shown in Figures 4-1 and 4-2, provides an approximate timetable for project tasks, including the field investigative effort and coordination of document deliverables and review periods. The SI as planned is estimated to require approximately 47 weeks. However, this time period does not include a substantial break in field activities between fall 1989 and spring 1990 (approximately 18 weeks) in the event that winter weather conditions require demobilization of the field work and remobilization in the spring. The schedules were estimated based on general assumptions regarding the time required to prepare subcontractor statements of work (SOWs), evaluate and select subcontractors, and receive approval from Martin Marietta Energy Systems, Inc. (Energy Systems) on subcontractors, the duration of the field investigative efforts, and the duration of review periods and regulatory agency interaction. The schedule does not include any optional SI field activities that may be required and implemented as a result of field conditions determined during the SI. These schedules are subject to modification, as appropriate, based on actual times required to complete the program.

4.2 PROJECT DELIVERABLES

All project deliverables will be submitted to the Energy Systems Project Manager, National Guard Bureau (NGB), and the Toledo Air National Guard Bureau (ANGB) Environmental Coordinator. All deliverables will be submitted on or before the dates indicated on Table 4-1. Submission dates are based on the projected schedules (Section 4.1) and may be modified as required by schedule changes. Table 4-2 provides the distribution list for deliverables.



* Assumes 7-day work week, Does not include optional field activities

Figure 4-1. Preliminary Schedule for the Site Investigation Field Program for Ohio Air National Guard, Toledo Express Airport, Swanton, Ohio

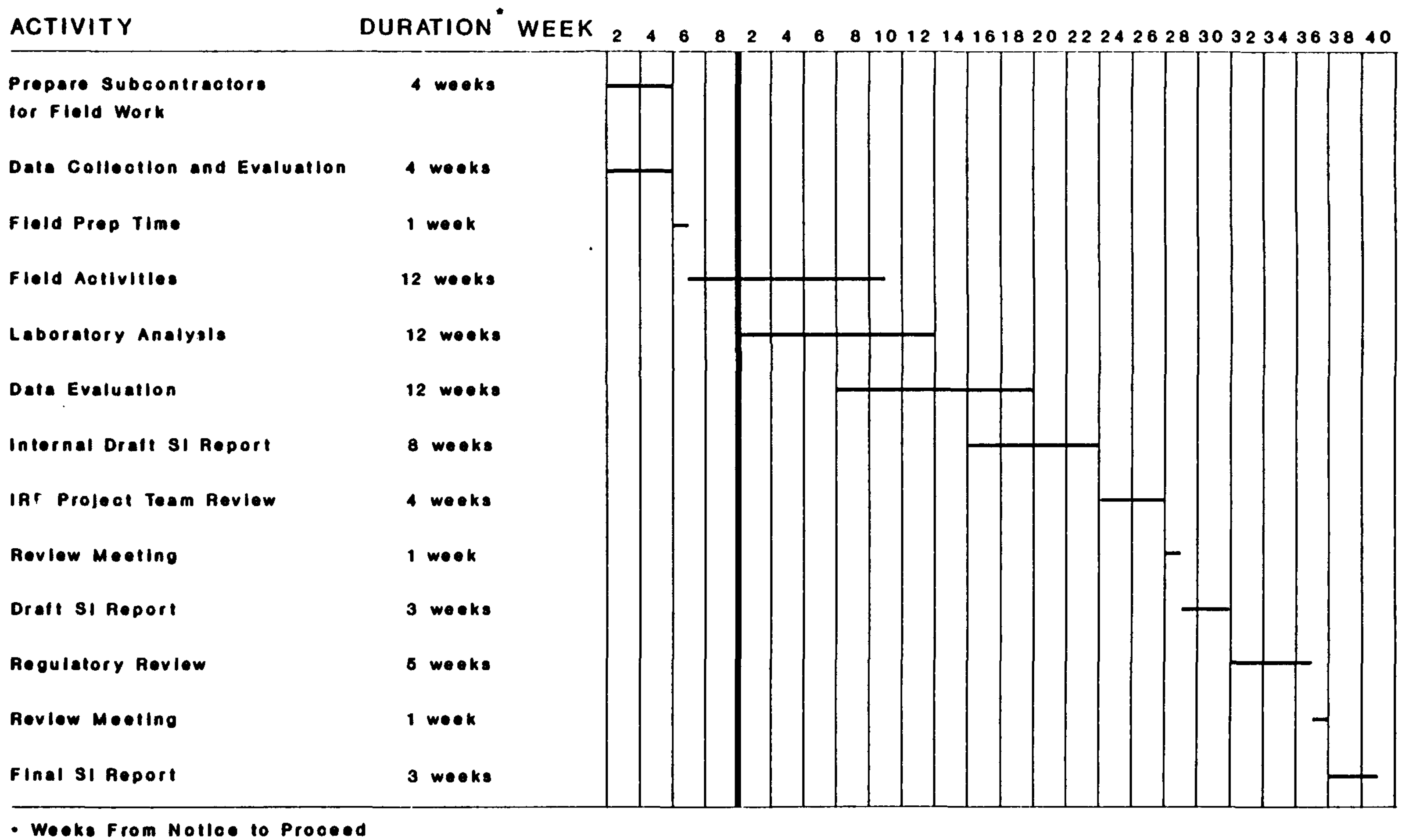


Figure 4-2. Preliminary Schedule for the Site Investigation for Ohio Air National Guard, Swanton, Ohio

TABLE 4-1. APPROXIMATE DELIVERY DATES FOR SITE INVESTIGATION REPORTS FOR OHIO AIR NATIONAL GUARD, TOLEDO EXPRESS AIRPORT, SWANTON, OHIO

Deliverable	Due Date*
Internal Draft SI Report	22 weeks from Remobilization
Draft SI Report	30 weeks from Remobilization
Final SI Report	39 weeks from Remobilization

*Weeks from Spring remobilization of field activities.

TABLE 4-2 DISTRIBUTION OF SITE INVESTIGATION DELIVERABLES FOR OHIO AIR NATIONAL GUARD, TOLEDO EXPRESS AIRPORT, SWANTON, OHIO

Recipient	Internal Draft	Draft	Final
Martin Marietta Energy Systems	3	3	5
National Guard Bureau	5	5	20
Ohio Air National Guard (Toledo Express Airport)	5	15	25

5. REFERENCES

Bouwer, H. and Rice, R.C. 1976. "A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells." Water Resources Research Vol. 12 p. 423.

Hazardous Materials Technical Center (HMTC). 1989. Draft Installation Restoration Program, Preliminary Assessment for 180th Tactical Fighter Group, Ohio Air National Guard, Toledo Express Airport, Swanton, Ohio. February 1989.

HAZWRAP Support Contractor Office. 1989. Statement of Work for Site Investigation, Remedial Investigation, Feasibility Study, and Remedial Design for Ohio Air National Guard Base at Toledo Express Airport, Swanton, Ohio. February 1989.

Hvorslev, M.J. 1951. Time Lag and Soil Permeability in Groundwater Observations. U.S. Army Corp of Engineers, Waterways Experiment Station Bulletin 36, Vicksburg, Mississippi.

U.S. Environmental Protection Agency. 1986. Superfund Public Health Evaluation Manual.

U.S. Environmental Protection Agency. 1988. Draft Guidance on Conducting Remedial Investigations and Feasibility Studies Under CERCLA.

APPENDIX A

STANDARD OPERATING PROCEDURES

SAIC STANDARD OPERATING PROCEDURE NO. 100
MOBILIZATION FOR FIELD ACTIVITIES

1. OBJECTIVE

To establish basic guidelines for planning the initiation of field activities. Additional requirements will be specified for each site. These requirements will be recognized through foresight and preparation. The checklists provided are not intended to be a substitute for good judgment.

2. BACKGROUND

Mobilization for field activities is the most important first step in the initiation of a remedial investigation. If required supplies and equipment are not available in the field upon arrival of work crews, valuable time and money can be wasted. Coordinated efforts and schedules are necessary to mobilize efficiently prior to a field activity.

3. PERSONNEL REQUIRED AND RESPONSIBILITIES

Field Manager: The Field Manager is responsible for ensuring the availability of all equipment and supplies necessary to mobilize for a field activity. Additional responsibilities include thorough planning for contingencies and coordination with appropriate personnel acting as points of contact at sites and facilities where work is being conducted.

Field Geologist: The Field Geologist is responsible for collecting all equipment and supplies required to conduct a field activity prior to commencement of the activity.

4. EQUIPMENT REQUIRED

Equipment that may be required for mobilization and during field operations is listed in Table 1.

5. PROCEDURE

1. Review the field equipment checklist provided in Table 1. Identify and acquire those items required for the field activities to be performed.

2. Verify that all equipment to be used has been calibrated and is operational.

6. REFERENCES

None.

TABLE 1. FIELD EQUIPMENT CHECKLIST

General

___ 1. Investigation Work Plan
___ 2. Sampling and Analysis Plan (includes Quality Assurance Project Plan and Field Sampling Plan)
___ 3. Health and Safety Plan
___ 4. Site base map
___ 5. Hand calculator
___ 6. Brunton compass
___ 7. Personal clothing and equipment

Safety Equipment

___ 1. Work gloves
___ 2. Barrier rope
___ 3. Plastic Flagging tape
___ 4. Drinking water container
___ 5. Gatorade (or equivalent)
___ 6. First-aid kit
___ 7. Eyewash kit

Personal Protective Equipment

___ 1. Long cotton underwear
___ 2. Coveralls, cotton
___ 3. Coveralls, Tyvek®, Polyvinylchloride (PVC), as required
___ 4. Surgical gloves
___ 5. Protective gloves (polypropylene/nitrile/viton®)
___ 6. Protective boots, rubber, neophrene steel toe/shank
___ 7. Hard hat
___ 8. Face shield
___ 9. Safety glasses
___ 10. Air-purifying respirator
___ 11. Respirator spectacle kit
___ 12. Respirator cleaning kit/equipment

Environmental Monitoring Equipment

___ 1. Shovels
___ 2. Keys to well caps
___ 3. pH meter (with calibrating solutions)
___ 4. pH paper
___ 5. Thermometer (calibrated to NIST)
___ 6. Conductivity meter (with calibrating solution)
___ 7. Organic vapor analyzer or photoionization detector w/calibration gas
___ 8. Explosimeter (LEL/O_2 meters)
___ 9. Oxygen meter

TABLE 1. FIELD EQUIPMENT CHECKLIST (Continued)

Sampling Equipment

___ 1. Tool box with assorted tools (pipe wrenches, screwdrivers, socket set and driver, open and box end wrenches, hacksaw, hammer, vice grips)
___ 2. Geologic hammer
___ 3. Trowel--stainless steel or Teflon®
___ 4. Stainless steel and/or Teflon® spatula
___ 5. Hand auger--(stainless steel)
___ 6. Engineer's tape marked in feet and tenths of feet
___ 7. Steel tape marked in feet and tenths of feet
___ 8. Water level sounder
___ 9. Petroleum interface probe
___ 10. Batteries
___ 11. Bailers (Teflon®, stainless steel, acrylic, PVC)
___ 12. Slug test water displacement tube
___ 13. Electric vacuum pump
___ 14. Displacement hand pump
___ 15. Mechanical pump (centrifugal, submersible, bladder)
___ 16. Portable generator
___ 17. Gasoline for generator
___ 18. Hose
___ 19. Calibrated buckets
___ 20. Stop watch
___ 21. Orifice plate or equivalent flow meter
___ 22. Data logger and pressure tranducers
___ 23. Strip chart recorders
___ 24. Sample bottles
___ 25. 0.45-micron filters (prepackaged in holders)
___ 26. Sample preservatives (nitric, hydrochloric, sulfuric acid/sodium hydroxide)
___ 27. Heavy-duty aluminum foil
___ 28. Coolers
___ 29. Ice (not reusable ice packs such as "Blue Ice")
___ 30. Large self-closing freezer bags
___ 31. Miscellaneous garbage bags
___ 32. Duct tape
___ 33. Strapping tape
___ 34. Paper towels
___ 35. Packaging material (bubble pack)
___ 36. Vermiculite

Decontamination Equipment

___ 1. Alconox®, Liquinox®, or equivalent
___ 2. Methanol, pesticide-grade
___ 3. Hexane, pesticide-grade
___ 4. ASTM Type II water with analytical certification for equipment blank preparation
___ 5. HPLG grade water for equipment decontamination washes

TABLE 1. FIELD EQUIPMENT CHECKLIST (Continued)

___ 6. Teflon® squeeze bottles
___ 7. Stainless steel garden sprayers
___ 8. Buckets and containers for decontamination fluids (stainless steel/Teflon®)
___ 9. Scrub and bottle brushes
___ 10. Waste containers (plastic trash cans/55-gallon hazardous waste containment drums)
___ 11. Steam cleaner (when not supplied by subcontractor)

Documentation Supplies

___ 1. Field logbook
___ 2. Daily Drilling Report forms
___ 3. Borehole Log forms
___ 4. Monitoring Well Installation Log forms
___ 5. Well Development forms
___ 6. Ground Water Sampling forms
___ 7. Aquifer Test forms
___ 8. Chain-of-Custody forms
___ 9. Custody seals
___ 10. Cooler labels ("This Side Up," "Hazardous Material," "Fragile")
___ 11. Federal Express/labels
___ 12. Communication Record forms
___ 13. Documentation of Change forms
___ 14. Camera and film
___ 15. Paper
___ 16. Pens/pencils
___ 17. Felt tip markers (indelible ink)
___ 18. Corrective Action forms
___ 19. Sample labels

SAIC STANDARD OPERATING PROCEDURE NO. 250
MONITORING OF HOLLOW-STEM AUGER DRILLING ACTIVITIES

1. OBJECTIVE

To establish standard guidelines for recording field observations critical to the documentation of drilling activities. The purpose of the daily log is to maintain a record of contract items. The drilling contractor should be instructed that the daily log is the basis for invoicing.

2. BACKGROUND

Written field observations are critical to the success of a drilling program, and are required as part of the SAIC document control program. The daily log will provide a logical reconstruction of events as they occurred in the field in the event discrepancies are encountered in the production of the final report. The Field Geologist is responsible for monitoring and documenting the drilling activities.

3. PERSONNEL REQUIRED AND RESPONSIBILITIES

Field Manager: The Field Manager is responsible for ensuring that field personnel have been trained in the use of this procedure, for verifying that auger drilling activities are being performed in compliance with this procedure, and for ensuring that data collected meet the requirements of the QAPP.

Field Geologist: The Field Geologist is responsible for monitoring drilling activities and documenting observations made during drilling activities in a bound field notebook. Documentation of drilling activities requires an understanding of pertinent drilling contract specifications. The Field Geologist will ensure that all specified terms of the drilling subcontract are met, and pertinent information regarding the borehole/well location, depth, screen placement, and other necessary data will be provided in the subcontract documents and by the Field Geologist to the driller. The driller is responsible for proper installation of the borehole/well in accordance with the specifications for drilling.

4. EQUIPMENT REQUIRED

- Field log book
- Drilling subcontract
- Daily drilling report forms
- Field borehole log forms.

5. PROCEDURE

The following are general instructions that will be used as a minimum during hollow-stem auger drilling operations:

1. Prior to arriving at the site, the Field Geologist will confer with the Field Manager regarding the pertinent aspects of the drilling contract related to daily drilling activities.

2. A field log book will be kept by each Field Geologist and will be used to record at least the following information:

   - Date
   - Location
   - Weather
   - Drilling company
   - Drill crew names and telephone numbers
   - Descriptions of the material being drilled.

   The Field Geologist will record, at a minimum, the following observations:

   - Start and stop time of all drilling activities, including:
     - Mobilization
     - Drilling/reaming/augering
     - Sampling
     - Drill rig decontamination
     - Cementing
     - Geophysical well logging
     - Any other relevant events
   - Footage for the above activities
   - Type and quantity of drilling equipment (especially auger flights and drill stems)
   - Condition of drilling equipment. Should ensure that it is clean and no leaks in the system that would input the boring or well
   - Problems causing delays during drilling activities

3. A Daily Drilling Report (Attachment 1) will be completed at the conclusion of drilling activities for the day. This report is required to document work conducted by the subcontractor and will be filled out as follows:

   - Assign unique number to form

   - Enter unique code assigned to the borehole in the upper right-hand corner of the form in the space provided for boring ID.

   - Enter descriptive name of the project and the SAIC project number in the space provided.

   - Enter current date in the space provided.

   - Enter type of equipment used for drilling operation.

   - Enter diameter of the borehole in the space provided.

   - Enter names of the SAIC Field Manager and Geologist monitoring the drilling in the space provided.

   - Enter name of the drilling subcontractor in the space provided.

   - Check the box applicable to the activities accomplished during the day in the space provided for daily activities.

   - Circle the method(s) used (drilled/augered/cored or reamed) for the type of work accomplished and enter the start and stop depths (below surface level) in the blanks provided in the section titled "Footage."

   - Enter the size in inches of bit(s) used in the space provided.

   - Describe the type(s) of sample taken and the method(s) used; enter the quantity either in feet, volume, or number of samples logged in the space provided.

   - Enter number of hours to the nearest tenth of an hour in the applicable box or boxes (standby time is normally a delay caused by SAIC or the client; down time is a delay caused by the drilling subcontractor) in the space provided. Comments should include, as a minimum, the following:

     - Reason and start and stop times for standby or down time
     - Explanation of "other" time
     - Explanation of large deviations from planned progress
     - Clear, concise comments relevant to any justification of work stoppage.

   - Enter amount of material actually used by the subcontractor; comments include any necessary explanations for the amount entered in the space provided.

- Have driller verify the identified activities and sign the form in the space provided; the driller receives a copy of the form daily.

- Enter the start and stop footage below the land surface in the space provided for well construction information.

- Enter casing material under "Casing Type"; enter "Casing Size" in inches (specify O.D. or I.D.); check "Drain Hole" and "Stamped ID," in the space provided for well casing information.

- Sign and date (Field Geologist) the form in the space provided for verification of activities.

- Payment for standby hours and well acceptance must be approved by the SAIC Field Manager or his designee. Sign and date (Field Manager) in the space provided. This signature is required for payment of standby hours and well approval.

- Distribute copies of the Daily Drilling Report to individuals designated by the Field Manager.

6. REFERENCES

Campbell, Michael D. and Jay H. Lehr. 1973. Water Well Technology, National Water Well Association, Worthington, Ohio.

Canter, Larry, W. and Robert C. Knox. 1985. Ground Water Pollution Control, Lewis Publishers, Chelsea, Michigan.

Driscoll, Fletcher G. 1986. Ground Water and Wells, 2nd Edition, Johnson Division, St. Paul, Minnesota.

U.S. Environmental Protection Agency. Manual of Water Well Construction Practices, Office of Water Supply, U.S. EPA, Washington, D.C., EPA 570/9-75-001.

SAIC Science Applications International Corporation

DAILY DRILLING REPORT

Boring ID: ____________

Project: ______________________________ Date: ____________

Drilling Method: ____________________ Borehole Diameter: ____________

Supervisor/Geologist: ____________________ Driller: ____________

Drilling Company: ____________________ Helper: ____________

DAILY ACTIVITIES:

- ☐ Mobilization
- ☐ Decontamination
- ☐ Set-up
- ☐ Drilling/Augering/Coring
- ☐ E-logging (standby)
- ☐ Reaming
- ☐ Setting Surface Casing
- ☐ Well Installation
- ☐ Well Development
- ☐ Clean-up
- ☐ Std. Penetration Test
- ☐ Other: ____________

Footage:

Drilled/Augered/Cored: ______ **ft to** ______ **ft; Reamed:** ______ **ft to** ______ **ft**

Bit Sizes: ____________ ____________

Sample Type: ____________ **Quantity:** ________ **S.P. Tests (qty):** ________

Time: **Drill/Rig:** ________ **hr.** **Well Development:** ________ **hr.**

Decon.: ________ **hr.** **Down Time:** ________ **hr.**

Standby: ________ **hr.** **Other:** ________ **hr.**

Comments: ______________________________

Material Used: Bentonite: ________ bags Bentonite: ________ buckets

Cement: ________ bags ________ : ________

Sand: ________ bags Comments: ________

Verification of Activities: ______________________ Date: ____________
(Driller Signature)

WELL CONSTRUCTION:

Screen Setting: ________ ft to ________ ft BLS Surface Casing:

Blank Casing Setting: ________ ft to ________ ft BLS Casing Type: ________

Sand Pack Setting: ________ ft to ________ ft BLS Casing Size: ________

Seal Setting: ________ ft to ________ ft BLS Drain Hole: ☐ Yes ☐ No

Grout Setting: ________ ft to ________ ft BLS Stamped ID: ☐ Yes ☐ No

Comments: ______________________________

Development Method(s): ______________________________

Verification of Activities: ______________________ Date: ____________
(Supervisory Geologist Signature)

Approved for Payment: ________ Standby Hours. Well Accepted: ☐ Yes ☐ No

______________________ Date: ____________
(Field Supervisor Signature)

WHITE Copy - Field Supervisor
YELLOW Copy - Driller
PINK Copy - Geologist

Attachment 1

DAILY DRILLING REPORT

SAIC STANDARD OPERATING PROCEDURE NO. 275
BOREHOLE LOGGING

1. OBJECTIVE

To establish guidelines for consistently recording and describing borehole data.

2. BACKGROUND

During hazardous waste site investigations, most boreholes are drilled using hollow-stem augers and are sampled using split-spoon samplers. Use of these tools allows the Field Geologist to observe the geologic materials brought to the surface as cuttings carried up the auger flights or moderately disturbed split-spoon samples for detailed visual examination and logging.

In addition, the Field Geologist must observe the action of the drill and augers as they are advanced into the soil to obtain information on the nature of the materials being penetrated. For instance, smooth drilling generally indicates that fine-grained materials are being penetrated, while rough turning and grinding sounds indicate gravel, cobble, or fracture zones.

3. PERSONNEL REQUIRED AND RESPONSIBILITIES

Field Manager: The Field Manager is responsible for ensuring that field personnel have been trained in the use of this procedure, for verifying that monitoring well installation activities are performed in compliance with this procedure, and to ensure consistency in logging between Field Geologists.

Field Geologist: The Field Geologist is responsible for on-site monitoring of drilling and soil sampling operations, for recording (logging) pertinent information regarding the geologic materials penetrated during the operations, and that the well and sample numbering system follows that described in the Quality Assurance Project Plan (QAPP).

4. EQUIPMENT REQUIRED

- Field Log Book
- Field Borehole Log forms
- Clipboard and indelible ink pens
- Folding rule
- Hand lense
- Various charts and gauges
- Munsell color book.

5. PROCEDURE

Record observations of the drilling activities on the Field Log Book and a Field Borehole Log Sheet (Attachment 1), as detailed in Steps 1 through 32.

1. Borehole Number: Enter the unique number assigned to the borehole in the upper right-hand corner of the form. The borehole number identifies the investigation site and the sequential number of the borehole. For example, the second borehole at Fire Training Area No. 1 would be identified as F1B-2 and the third well at the Base Landfill would be identified as LFW-3.

   NOTE: Boreholes that are redrilled or extended to greater depths retain the same borehole number; however, a new logsheet will be used, which will start at the depth from which the original logged borehole ended. The logsheet will indicate that the hole was redrilled.

2. Project Number: Enter the unique SAIC number assigned to the project. A typical SAIC project number is "1-817-07-667-00."

3. Project Name: Enter the SAIC project name.

4. Location: Enter the physical location of the drilling site (site name, etc.).

5. Drilling Company: Enter the name of the drilling subcontractor.

6. Rig Type and Number: Enter the type of drill rig (for instance, "Mobil B-61") and the drilling company vehicle number, if one is assigned.

7. Drilling Method: Enter the method used to advance the borehole, for example, "8-inch Hollow-Stem Auger" or "12-inch Tricone Bit on 6-inch Drill Pipe."

8. Weather: Enter the weather conditions, including, but not limited to, estimated wind speed and direction, cloud conditions, and precipitation.

9. Geolog' .: Identify the SAIC Field Geologist(s) logging the borehole and other SAIC personnel on-site assisting with drilling activities.

10. Date Begun: Enter the date the borehole was begun.

11. Date Completed: Enter the date the borehole drilling is completed. This date may be different from the date a monitoring well is completed in the borehole.

12. Field Book No.: Enter the number of the assigned project field book used by the Field Geologist to record pertinent project information.

13. Total Depth: Enter the total depth reached during drilling of the borehole; that is, the deepest point reached when advancing the augers or other drill string, or the bottom depth of the last sample taken, whichever is deeper.

14. Sheet __ of __: Enter the consecutive number of the Field Borehole Log Sheet and the total number of sheets used (i.e., "Sheet 2 of 4").

15. Groundwater Table Depth: Enter the depth (below ground surface) at which groundwater is encountered and indicate whether it was measured while drilling ("WD") or after the borehole was completed ("AB"). Multiple measurements may be taken.

16. Groundwater Table Time: Enter the time the groundwater level measurement was taken.

17. Groundwater Table Date: Enter the date the groundwater level measurement was taken.

18. Location Diagram: Sketch a generalized plan-view diagram indicating the location of the borehole on the investigation site and add appropriate notes that will identify the location of the borehole. Include a north arrow, a scale, and an indication of the ground slope on all sketches.

19. Sampling Method: Enter the appropriate code from the Sampling Method Code on Attachment 2.

20. Sample No.: Enter the consecutive sample number starting with the uppermost sample designated as Sample No. 1. Boreholes that are extended to greater depths will continue the consecutive numbering initiated on the original borehole log.

21. Blow Count: Enter the number of hammer blows per 6-inch interval. For most hazardous waste site work, blow counts are not necessary as they are primarily used for geotechnical design calculations. Specific instructions are provided in the applicable ASTM method.

22. Sample Interval: Indicate the interval sampled using a line or an arrow extending from the top depth of the interval to the bottom.

23. Recovery: Indicate the amount of material recovered in the sampler using a line or an arrow of the appropriate length extending down from the top depth interval. Provide measurement in feet and tenths of feet.

24. Depth in Feet: Indicate the depth interval of the portion of the borehole that is recorded on the particular log sheet. For example, the second log sheet would typically start at 20 feet and extend to 40 feet.

25. Moisture: Indicate the estimated moisture content of the sample or lithologic stratum using the codes provided in Attachment 2.

26. Consistency: Indicate the estimated relative density of the sample or lithologic stratum using the codes provided in Attachment 2.

27. Organic Vapor: Enter the reading measured on the organic vapor detector or photoionization detector. If the reading is "zero," enter "0" in the space. Do not leave the space blank. Note background vapor concentrations.

28. Description: Use this section to record a written description of the lithologic materials encountered. Information to be recorded includes soil or rock classification, grain size and shape, bedding, color, relative density, estimated moisture content, and Unified Soil Classification Code.

    - Classify soil using the Unified Soil Classification System (Asphalt Institute, 1969). Use the percentages on Attachment 2 as a guide; for example, 65-percent gravel, 25-percent sand, 10-percent silt = GRAVEL w/Some Sand, Trace Silt; 55-percent sand, 35-percent silt, 8-percent gravel, 2-percent clay = Silty SAND w/Trace Gravel. Classify particle sizes in accordance with the guide provided in Attachment 2.

    - Classify bedrock in accordance with a standardized naming system such as used in the Manual of Field Geology (Compton 1962). The classification system to be used will be appropriately referenced in the Work Plan for the project. Reference the bedrock strata to common local formation names, if possible. At a minimum, identify the rock type and the degree of weathering, hardness, jointing, bedding, and foliation spacing. Attachment 3 provides a guide for the description of rock properties.

    - Describe the grain shape of coarse-grained soils (gravel and sand) in terms of roundness and sphericity, ranging from very angular to well-rounded and from discoidal to prismoidal. A pictorial guide is provided on Attachment 4 for making this classification.

    - Record bedding features observed in the soil column on the log sheet. Pay particular attention to changes in lithology within the soil column, as changes from fine-grained soils to coarse-grained soils affect the speed with which contaminants can move through the soil mass.

- Determine color using the Munsell Soil Color Charts or the Rock Color Charts. Carefully note changes in coloration and mottling.

- Determine the relative density of soils in accordance with the guide presented in Attachment 2.

- Use the Unified Soil Classification System for soils (Attachment 5) to code the soil type.

- Record any other characteristics of significance in the description section of the Field Borehole Log Sheet.

29. Time: Record the time of commencement of drilling on a borehole, sampling events, air quality measurements, standby start and stop times, borehole drilling completion, and other times and/or dates of importance in this column.

30. Complete the Field Borehole Log Sheet by signing and dating the log at the end of each shift.

6. REFERENCES

American Geological Institute. 1982. AGI Data Sheets for Geology in the Field, Laboratory, and Office, 2nd Edition, Falls Church, Virginia.

Asphalt Institute. 1969. Manual Series No. 10, Soils Manual for Design of Asphalt Pavement Structures, 2nd Edition, 3rd Printing.

Compton, 1962. Manual of Field Geology, John Wiley & Sons, New York, New York.

Munsell Color. 1975. Munsell Soil Color Chart, Kollmorgen Corporation, Baltimore, Maryland.

SAIC

FIELD BOREHOLE LOG

BOREHOLE NUMBER:

PROJECT NUMBER ____________________

PROJECT NAME ____________________

LOCATION ____________________

DRILLING COMPANY ____________________

RIG TYPE & NUMBER ____________________

DRILLING METHOD ____________________

WEATHER ____________________

FIELD PARTY ____________________

GEOLOGIST ____________________

DATE BEGUN ____________ DATE COMPLETED ____________

FIELD BOOK NO. ____________

TOTAL DEPTH ____________

SHEET ______ OF ______

GROUNDWATER TABLE			
WD=While Drilling		AB=After Boring	
Depth (ft)			
Time			
Date			

Sampling Method	Sampling: Sample No.	Sampling: Blow Count	Sampling: Loc. Sampled	Sampling: Recovery	Depth in Feet	Soil Graph	Moisture	Consistency	Organic Vapor	Location Diagram:

Description:	Time:

Attachment 1

SAMPLE FIELD BOREHOLE LOG

Attachment 2

SAMPLING METHOD

Ss - 1.4 S.S. w/140 lb.	Ts - Shelby Tube (state size)
Sz - 1.4 S.S. w/340 lb.	Tm - Mod. Shelby (state size)
Sd - 1.4 S.S. - pushed	Pb - Pitcher Barrel (state size)
Sl - 2.5 S.S. w/140 lb.	Db - Dennison Sampler (state size)
Sh - 2.5 S.S. w/340 lb.	Cs - Single Tube Core Barrel (state size)
Sp - 2.5 S.S. - pushed	Cd - Double Tube Core Barrel (state size)
Hs - 1.4 S.S. - Air Hammer	Ct - Triple Tube Core Barrel (state size)
Hl - 2.5 S.S. - Air Hammer	A - Auger cuttings, air rotary cuttings
	Bs - Bulk Samples (100 lb. +)

MOISTURE CONTENT

Very Wet (VW)	40%
Wet (W)	30 - 40
Very Moist (VM)	20 - 30
Slightly Moist (SM)	10 - 15
Dry (D)	10%

SOIL CLASSIFICATION

No Callout:	<5%
With Trace:	5% - 12%
With Some:	13% - 30%
With:	>30%

CONSISTENCY (RELATIVE DENSITY)

Cohesionless Soils

Loose (L)	0 - 10 BPF
Med. Dense (MD)	0 - 30 BPF
Dense (D)	30 - 60 BPF
Very Dense (VD)	60 BPF

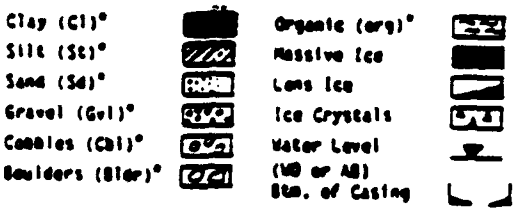
Cohesive Soils - Thumbnail Test

Hard (H)	- Difficult to indent
Stiff (ST)	- Readily indented
Firm (F)	- Penetrated by mod. pressure
Soft (S)	- Penetrated easily - can be remolded w/light finger pressure.

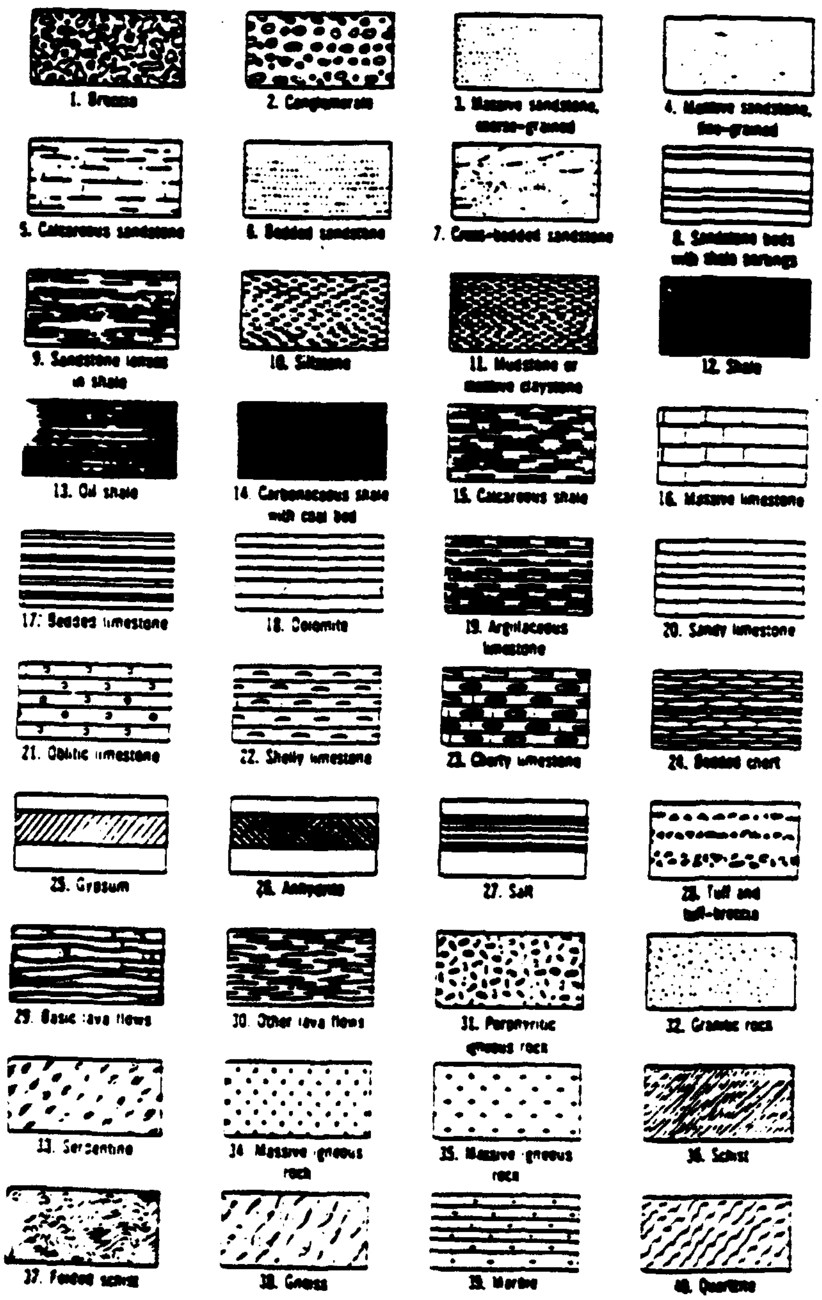
PARTICLE SIZE

	Inches	(mm)
Sand		
Fine	.003 - .02	0.74 - .42
Medium	.02 - .08	.42 - 2.0
Coarse	.08 - .2	2.0 - 4.8
Gravel		
Fine	.2 - 7.5	4.8 - 19.1
Coarse	.75 - 3	
Cobbles	3 - 12	
Boulders	12 - 16	

LITHOLOGIC SOIL SYMBOLS

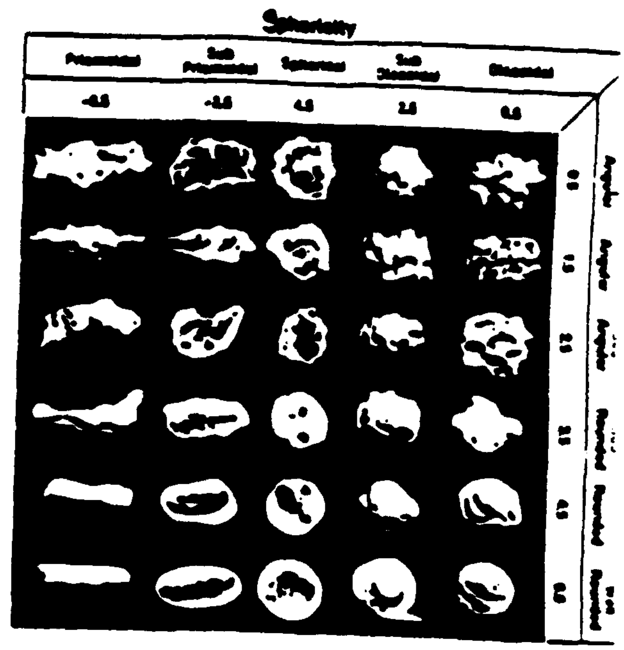


LITHOLOGIC ROCK SYMBOLS



Source: Compton, 1962

ROUNDNESS AND SPHERICITY



Source: AGI, 1982

Attachment 3

LITHOLOGIC ROCK AND SOIL SYMBOLS

Attachment 4

DESCRIPTION OF ROCK PROPERTIES

(a) Weathering

Fresh	Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer if crystalline.
V[illegible]y slight	Rock generally fresh, joints stained, some joints may show thin clay coatings, crystals in broken face show bright. Rock rings under hammer if crystalline.
Slight	Rock generally fresh, joints stained, and discoloration extends into rock up to 1 in. Joints may contain clay. In granitoid rocks some occasional feldspar crystals are dull and discolored. Crystalline rocks ring under hammer.
Moderate	Significant portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored; some show clayey. Rock has dull sound under hammer and shows significant loss of strength as compared with fresh rock.
Moderately severe	All rock except quartz discolored or stained. In granitoid rocks, all feldspars dull and discolored and majority show kaolinization. Rock shows severe loss of strength and can be excavated with geologist's pick. Rock goes "clunk" when struck.
Severe	All rock except quartz discolored or stained. Rock "fabric" clear and evident, but reduced in strength to strong soil. In granitoid rocks, all feldspars kaolinized to some extent. Some fragments of strong rock usually left.
Very severe	All rock except quartz discolored or stained. Rock "fabric" discernible, but mass effectively reduced to "soil" with only fragments of strong rock remaining.
Complete	Rock reduced to "soil." Rock "fabric" not discernible or discernible only in small scattered locations. Quartz may be present as dikes or stringers.

(b) Hardness (for engineering description of rock—not to be confused with Moh's scale for minerals)

Very hard	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist's pick.
Hard	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.
Moderately hard	Can be scratched with knife or pick. Gouges or grooves to 1/4 in. deep can be excavated by hard blow of point of a geologist's pick. Hand specimens can be detached by moderate blow.
Medium	Can be grooved or gouged 1/16 in. deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1-in. maximum size by hard blows of the point of a geologist's pick.
Soft	Can be gouged or grooved readily wi[illegible] pick point. Can be excavated in chips to pieces se[illegible]s in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.
Very soft	Can be carved with knife. Can be excavated readily with point of pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.

(c) Joint Bedding and Foliation Spacing in Rock[b]

Spacing	Joints	Bedding and foliation (3)
Less than 2 in.	Very close	Very thin
2 in.–1 ft	Close	Thin
1 ft–3 ft	Moderately close	Medium
3 ft–10 ft	Wide	Thick
More than 10 ft	Very wide	Very thick

(d) Rock Quality Designator (RQD)[c] (4)

RQD, as a percentage	Diagnostic description
Exceeding 90	Excellent
90–75	Good
75–50	Fair
50–25	Poor
Less than 25	Very poor

[a] For specific projects involving only a limited number of rock types, subdivision of major groupings may be desirable. Numerical or alphabetical subscripts may be used to identify such subdivisions.

[b] Joint spacing refers to the distance normal to the plane of the joints of a single system or "set" of joints that are parallel to each other or nearly so. The spacing of each "set" should be described, if possible to establish.

[c] RQD should always be given as a percentage. Diagnostic description is intended primarily for evaluating problems with tunnels or excavations in rock. RQD = 100 (length of core in pieces 4 in. and longer/length of run) (1 in. = 25.4 mm; 1 ft = 0.305 m).

Table VI-1—Unified Soil Classification (Including Identification and Description)

Major Divisions			Group Symbols	Typical Names	Field Identification Procedures (Excluding particles larger than 3 inches and basing fractions on estimated weights)			Information Required for Describing Soils
1	2		3	4	5			6
More than half of material is larger than No. 200 sieve size. The No. 200 sieve size is about the smallest particle visible to the naked eye.	Gravels More than half of coarse fraction is larger than No. 4 sieve size. (For visual classification, the ¼-in. size may be used as equivalent to the No. 4 sieve size)	Clean Gravels (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.			For undisturbed soils add inform on stratification, degree of com ness, cementation, moisture cond and drainage characteristics.
			GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.			
		Gravels with Fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures.	Nonplastic fines or fines with low plasticity. (for identification procedures see ML below)			
			GC	Clayey gravels, gravel-sand-clay mixtures.	Plastic fines (for identification procedures see CL below).			Give typical name; indicate app mate percentages of sand and gr max. size; angularity, surface c tion, and hardness of the co grains; local or geologic name other pertinent descriptive info tion; and symbol in parenthese
	Sands More than half of coarse fraction is smaller than No. 4 sieve size.	Clean Sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines.	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.			
			SP	Poorly-graded sands, gravelly sands, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.			Example: Silty sand, gravelly; about 20% h angular gravel particles ½ maximum size; rounded and angular sand grains coarse to f about 15% nonplastic fines with dry strength; well compacted moist in place; alluvial sa (SM).
		Sands with Fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures.	Nonplastic fines or fines with low plasticity. (for identification procedures see ML below)			
			SC	Clayey sands, sand-clay mixtures.	Plastic fines (for identification procedures see CL below).			
					Identification Procedures on Fraction Smaller than No. 40 Sieve Size			
					Dry Strength (Crushing characteristics)	Dilatancy (Reaction to shaking)	Toughness (Consistency near PL)	
More than half of material is smaller than No. 200 sieve size.	Silts and Clays Liquid limit less than 50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.	None to slight	Quick to slow	None	Give typical name, indicate degree character of plasticity, amount maximum size of coarse grains, co in wet condition, odor if any, local geologic name, and other pertin descriptive information; and sym in parentheses.
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Medium to high	None to very slow	Medium	
			OL	Organic silts and organic silty clays of low plasticity.	Slight to medium	Slow	Slight	
	Silts and Clays Liquid limit greater than 50		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	Slight to medium	Slow to none	Slight to medium	For undisturbed soils and inform tion on structure, stratificatio consistency in undisturbed and molded states, moisture and dra age conditions.
			CH	Inorganic clays of high plasticity, fat clays.	High to very high	None	High	
			OH	Organic clays of medium to high plasticity, organic silts.	Medium to high	None to very slow	Slight to medium	Example: Clayey silt, brown, slightly plas small percentage of fine san numerous vertical root holes, fi and dry in place, loess, (ML).
Highly Organic Soils			Pt	Peat and other highly organic soils.	Readily identified by color, odor, spongy feel and frequently by fibrous texture.			

Boundary classifications: Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW-GC, well-graded gravel-sand mixture

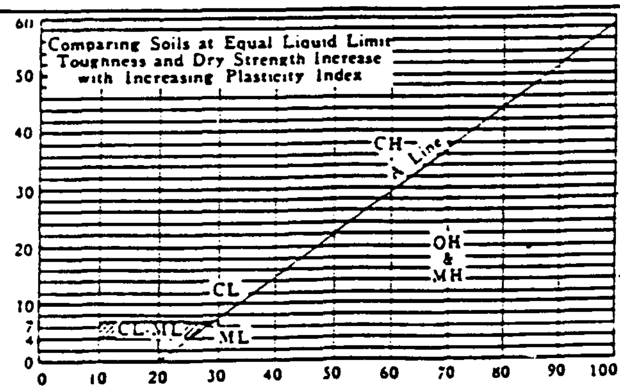
Source: Asphalt Institute, 1969

Table VI-1—Unified Soil Classification (Including Identification and Description)

Adopted by Corps of Engineers and Bureau of Reclamation, January 1952

	Field Identification Procedures (Excluding particles larger than 3 inches and basing fractions on estimated weights)	Information Required for Describing Soils		Laboratory Classification Criteria	
	5	6		7	
l-sand mix-	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.	For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics.	Use grain-size curve in identifying the fractions as given under field identification. Determine percentages of gravel and sand from grain size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size) coarse grained soils are classified as follows: Less than 5% GW, GP, SW, SP. More than 12% GM, GC, SM, SC. 5% to 12% Borderline cases requiring use of dual symbols.	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between one and 3	(See note, far right)
-l-sand mix-	Predominantly one size or a range of sizes with some intermediate sizes missing.			Not meeting all gradation requirements for GW	
t mixtures.	Nonplastic fines or fines with low plasticity. (for identification procedures see ML below)	Give typical name; indicate approximate percentages of sand and gravel, max. size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbol in parentheses.		Atterberg limits below "A" line or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols.
-clay mix-	Plastic fines (for identification procedures see CL below).			Atterberg limits above "A" line with PI greater than 7	
sands, little	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.			$C_u = \frac{D_{60}}{D_{10}}$ Greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between one and 3	(See note, far right)
lly sands,	Predominantly one size or a range of sizes with some intermediate sizes missing.	Example: Silty sand, gravelly; about 20% hard, angular gravel particles ½-in. maximum size; rounded and subangular sand grains coarse to fine; about 15% nonplastic fines with low dry strength; well compacted and moist in place; alluvial sand; (SM).		Not meeting all gradation requirements for SW	
s.	Nonplastic fines or fines with low plasticity. (for identification procedures see ML below)			Atterberg limits below "A" line or PI less than 4	Limits plotting in hatched zone with PI between 4 and 7 are borderline cases requiring use of dual symbols.
tures.	Plastic fines (for identification procedures see CL below).			Atterberg limits above "A" line with PI greater than 7	

	Identification Procedures on Fraction Smaller than No. 40 Sieve Size			
	Dry Strength (Crushing characteristics)	Dilatancy (Reaction to shaking)	Toughness (Consistency near PL)	
ands, rock sands or icity.	None to slight	Quick to slow	None	Give typical name, indicate degree and character of plasticity, amount and maximum size of coarse grains, color in wet condition, odor if any, local or geologic name, and other pertinent descriptive information; and symbol in parentheses.
ium plas- ty clays,	Medium to high	None to very slow	Medium	
clays of	Slight to medium	Slow	Slight	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remolded states, moisture and drainage conditions.
diatoma- s, elastic	Slight to medium	Slow to none	Slight to medium	
city, fat	High to very high	None	High	
ia plas-	Medium to high	None to very slow	Slight to medium	Example: Clayey silt, brown, slightly plastic, small percentage of fine sand, numerous vertical root holes, firm and dry in place, loess, (ML).
soils.	Readily identified by color, odor, spongy feel and frequently by fibrous texture.			



LIQUID LIMIT PLASTICITY CHART

For laboratory classification of fine-grained soils

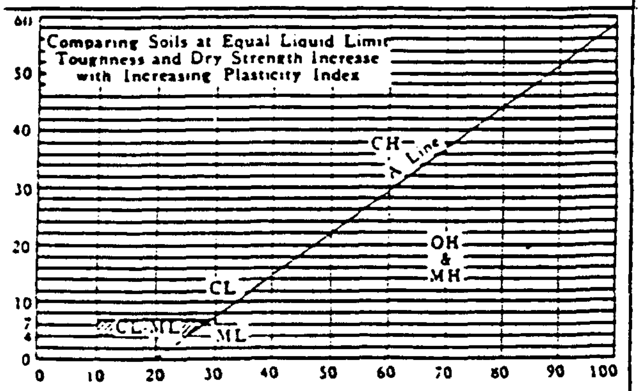
esignated by combinations of group symbols. For example GW-GC, well-graded gravel-sand mixture with clay binder. (2) All sieve sizes on this chart are U. S. standard.

2

Adopted by Corps of Engineers and Bureau of Reclamation, January 1952

Laboratory Classification Criteria	
7	
$Cu = \frac{D_{60}}{D_{10}}$ Greater than 4 $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between one and 3	(See note, far right)
Not meeting all gradation requirements for GW	
Atterberg limits below "A" line or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols.
Atterberg limits above "A" line with PI greater than 7	
$Cu = \frac{D_{60}}{D_{10}}$ Greater than 6 $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between one and 3	(See note, far right)
Not meeting all gradation requirements for SW	
Atterberg limits below "A" line or PI less than 4	Limits plotting in hatched zone with PI between 4 and 7 are borderline cases requiring use of dual symbols.
Atterberg limits above "A" line with PI greater than 7	

... 200 sieve size) coarse grained soils are classified as follows:
Less than 5% GW, GP, SW, SP.
More than 12% GM, GC, SM, SC.
5% to 12% Borderline cases requiring use of dual symbols.



LIQUID LIMIT PLASTICITY CHART

For laboratory classification of fine-grained soils

...r. (2) All sieve sizes on this chart are U. S. standard.

FIELD IDENTIFICATION PROCEDURES FOR FINE-GRAINED SOILS OR FRACTIONS

These procedures are to be performed on the minus No. 40 sieve size particles, approximately 1/64 in. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Dilatancy (Reaction to shaking)

After removing particles larger than No. 40 sieve size, prepare a pat of moist soil with a volume of about one-half cubic inch. Add enough water if necessary to make the soil soft but not sticky. Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens, and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.

Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

Dry Strength (Crushing characteristics)

After removing particles larger than No. 40 sieve size, mold a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun, or air drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.

High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

Toughness (Consistency near plastic limit)

After removing particles larger than the No. 40 sieve size, a specimen of soil about one-half inch cube in size is molded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about one-eighth inch in diameter. The thread is then folded and rerolled repeatedly. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.

After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles.

The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line.

Highly organic clays have a very weak and spongy feel at the plastic limit.

Note

(Laboratory Classification)

Cu = uniformity coefficient
Cc = coefficient of curvature
D_{60} = grain diameter at 60% passin...
D_{30} = grain diameter at 30% passin...
D_{10} = grain diameter at 10% passin...

The grain-size distributions of w... graded materials generally plot ... smooth and regular concave cu... with no sizes lacking or no excess material in any size range. The u... formity coefficient (Cu) of w... graded gravels is greater than 4, ... of well-graded sands is greater than ...

The coefficient of curvature (C... insures that the grading curve w... have a concave curvature within re... tively narrow limits for a given ... and D_{10} combination. All gradatio... not meeting the foregoing criteria ... classed as poorly graded.

3

SAIC STANDARD OPERATING PROCEDURE NO. 350
MONITORING WELL INSTALLATION

1. OBJECTIVE

To establish acceptable design and construction methods for monitoring well emplacement.

2. BACKGROUND

Monitoring wells provide a means for measuring piezometric data, collecting representative groundwater samples, and detecting and collecting light- and dense-phase organics. Monitoring wells generally are constructed following more rigorous protocols than piezometers.

Selection of well casing and screen materials will be made with consideration for the geochemistry, anticipated lifetime of the monitoring program, well depth, chemical parameters to be monitored, and other site-specific factors. For example, steel casings and screens deteriorate in corrosive environments; PVC deteriorates in contact with ketones, esters, and aromatic hydrocarbons; polyethylene deteriorates in contact with aromatic and halogenated hydrocarbons; and polypropylene deteriorates in contact with oxidizing acids, aliphatic hydrocarbons, and aromatic hydrocarbons. In addition, steel, PVC, polyethylene, and polypropylene may absorb and leach chemical constituents that may affect the chemical quality of groundwater samples.

In some applications, a composite well may be appropriate. For instance, stainless steel riser pipe in the saturated zone may be combined with PVC riser pipe in the unsaturated zone.

The screened intake of the monitoring well will be constructed to allow sufficient groundwater flow to enter the well for sampling, minimize the passage of fine-grained formation materials into the well, and ensure sufficient structural integrity to prevent collapse of the intake structure. Screen size will be determined based on sieve analysis at both packed and upacked wells.

Seals will be installed in the annular space to prevent the migration of contaminants to the sampling zone from the surface and intermediate zones, and to prevent cross-contamination between strata.

3. PERSONNEL REQUIRED AND RESPONSIBILITIES

Project Manager: The Project Manager is responsible for selecting the well casing and screen materials, the screen length and placement, and the filter pack and seal materials to be used for each monitoring well. The Project Managers should work in cooperation with the Field Manager to ensure that all contract items are fulfilled and that the project is executed in a scientifically sound manner. It is the responsibility of the Project Manager to notify the TPO of changes in project scope.

Field Manager: The Field Manager is responsible for ensuring that field personnel have been trained in the use of this procedure and for verifying that monitoring well installation activities are performed in compliance with the contract. The Field Manager will obtain the information necessary for the Project Manager to select screen size and well packing material and siting well installation locations.

Field Geologist: The Field Geologist is responsible for ensuring the well is installed according to the contract specifications. If notification of the driller does not result in corrective action, the Field Geologist will thoroughly document the driller's failure to follow procedures and notify the Field Manager as soon as possible.

4. EQUIPMENT REQUIRED

- Field Logbook
- Monitoring Well Installation (MWI) form
- Clipboard and indelible ink pens
- Folding ruler
- Weighted tape.

5. PROCEDURE

5.1 DEPTH MEASUREMENT

1. After the borehole has been completed to the desired depth and reamed out, an accurate measurement of the total depth will be made. Record the depth on the MWI form and in the Field Logbook.

5.2 SCREEN AND RISER PIPE INSTALLATION

2. Determine the length and placement of the well screen. The placement of the well screen in relation to the aquifer will be stated in the work plan and QAPP for the project. The length and placement of well screens often will vary throughout the course of a project based on site locations, expected hydrogeologic conditions, and the contaminants of concern. In general, if light-phase contaminants are to be sampled and analyzed, set the top of the screen at 1 to 2 feet above the top of the seasonally high static water level to allow free-floating materials to enter the well. If dense-phase contaminants are to be sampled and analyzed, set the bottom of the well screen at the bottom of the aquifer.

3. Use only commercially manufactured screens or slotted casings. Field slotting of casing is not permitted.

4. Steam clean the well screen and casing prior to installation in the borehole. Inspect the casing and casing connectors for grease, dirt, and cracks.

5. Attach a sump consisting of a nominal 1-foot or longer blank riser pipe equipped with a bottom plug to the bottom of the well screen.

   NOTE: The sump will collect fine-grained sediments that enter the well and will help to prolong the operating life of the well screen. In addition, the sump can capture intermittent dense-phase contaminants, which can be sampled by lowering a sampling device into the sump.

6. Install lengths of PVC (or other material) riser pipe and well screen using centralizers to ensure that each well is as straight as possible.

   NOTE: All well screen and riser pipe will be threaded and flush-jointed. Flush-joint pipe reduces the chance of equipment hanging up inside the well casing and the well annulus and backfill materials are less likely to be caught in the annulus between the well casing and borehole wall. If steel casing and screen is used, blank end sections may be welded together using appropriate procedures. The appropriate safety precautions will be taken when welding over an open borehole. Do Not Use Glues and/or Solvents in monitoring well installations.

7. Determine the depth to the top of the screen and record it on the MWI form.

5.3 PLACEMENT OF FILTER PACK AND ANNULAR SEAL

8. Place the sand filter pack by slowly pouring filter pack material directly or with a tremie pipe into the annulus between well screen and the open borehole wall. Alternately, if the borehole will not stand open, gradually pull back the auger string in small increments (2 feet at a time) and slowly pour filter pack material directly or using a tremie pipe into the annulus between the auger wall and the well casing and screen.

   NOTE: The filter pack material will be chemically inert (e.g., clean quartz sand, silica, or glass beads) with particles that are well-rounded. Fabric filters are not permitted.

9. Care will be taken to prevent filter pack material from bridging between the borehole wall or augers and the well screen and riser pipe. This can be accomplished by using a tamping device to ensure that the material passes through the augers or annulus. In some instances, it will help to shake the well pipe inside the borehole or augers.

10. The filter pack material will be placed from the bottom of the well to a nominal 2 feet above the top of the screen. The depth to the top of the sand pack will be recorded on the MWI form. Note the number of bags of sand used. Charts are available for determining the number of bags of sand to fill a specific annulus.

11. Place a nominal 2 feet of bentonite pellets or other acceptable seal material on the top of the filter material pack for an annular seal. Install bentonite pellets in the same manner as described for filter pack material installation; however, do not shake the well pipe to aid in installation, as it tends to cause the pellets to break up and this may cause bridging. Allow approximately 30-45 minutes for pellets to hydrate. Record the depth to the top of the bentonite seal and the number of buckets of bentonite used on the MWI form.
    NOTE: The annular seal material must be chemically compatible with the well materials and contaminants and chemically inert so it does not affect the quality of groundwater samples. The permeability of annular seals will be one to two orders of magnitude less than the surrounding formation.

12. Tremie cement-bentonite or other acceptable grout above the bentonite seal by pouring grout into the annular space or, preferably, by pumping it through a tremie pipe (with its bottom opening set at the top of the well seal), and allow the grout to rise in the borehole annulus to the bottom of the frost line.
    NOTE: Cement-bentonite grout typically consists of one 94-pound sack of Portland cement and 3 to 5 pounds of powdered bentonite with 6.5 gallons of water. Mix the bentonite and water first, and then add the cement (Driscoll 1986). The final density of grout will range

from 11 to 13 pounds per gallon and will be verified using a mud balance onsite for each well.

13. From the frost line to the surface, place concrete so that it blends into a minimum 4-inch thick surface seal. The specification for surface completions should be coordinated with the client.

5.4 WELL COMPLETION

14. Notch the north side of the well casing with a hacksaw or file. The notch will be the point from which surveys and subsequent water level measurements will be measured. Ensure no filings or PVC shavings enter the well.

15. For wells that have surface stickup, install a protective casing equipped with a hinged, loose-fitting cap that can be locked to prevent unauthorized entry. Sufficient space must be allowed between the protective casing lid and the top of the well riser pipe for a well cap. The minimum size for 2-inch well is 6-inch protective casing.

16. Construct a concrete pad around the protective casing within 24 hours of well installation.
17. Drill a hole into the side of the protective casing near the top of the concrete pad to permit drainage.

18. Stamp or mark a permanent identification number on the top and side of the protective casing and the inner casing.

19. If deemed necessary by the contract, install three 3-inch diameter by 5-foot long, concrete-filled, steel guard posts radially around the concrete pad.

20. For wells that are completed flush with the land surface, install a well vault over the PVC well riser pipe. The vault will be water-tight and equipped with a locking mechanism to prevent unauthorized entry. A system for drainage also should be installed.

5.5 DOCUMENTATION

21. Document all aspects of the design and construction of the well on a Monitoring Well Installation Form, an example of which is included as Attachment 1.

6. REFERENCES

Driscoll, Fletcher G. 1986. Groundwater and Wells, 2nd Edition, Johnson Division, St. Paul, Minnesota.

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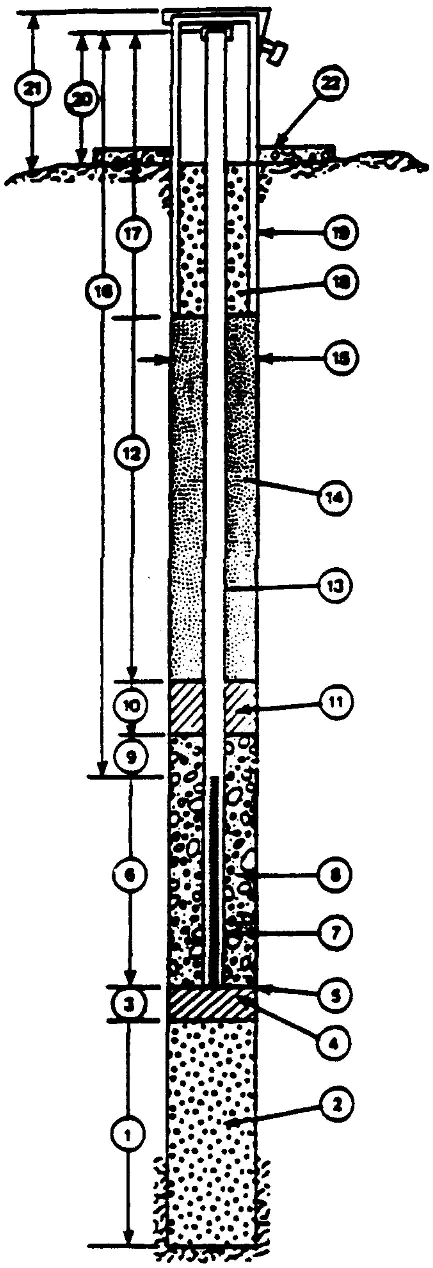
MONITORING WELL INSTALLATION LOG

BOREHOLE/WELL NUMBER: ____________

PROJECT NUMBER ____________
PROJECT NAME ____________
INSTALLATION TEAM ____________

GROUND SURFACE ELEVATION ____________
TOP OF WELL CASING ELEVATION ____________
START DATE ____________ TIME ____________
END DATE ____________ TIME ____________



1. ELEV/DEPTH OF BOREHOLE ________ FEET.
2. TYPE OF LOWER BACKFILL ________ FEET.
3. ELEV/DEPTH OF BOTTOM OF BOTTOM SEAL (IF INSTALLED) ________ FEET.
4. TYPE OF BOTTOM SEAL ________.
5. ELEV/DEPTH TO TOP OF BOTTOM SEAL ________ FEET.
6. ELEV/BOTTOM DEPTH OF WELL SCREEN ________ FEET.
7. TYPE OF SCREEN MATERIAL ________. DIAMETER OF SCREEN ________. SLOT SIZE OF SCREEN ________.
8. TYPE OF PACK AROUND WELL POINT OR SCREEN ________.
9. ELEV/DEPTH TO TOP OF WELL POINT OR SCREEN ________ FEET.
10. ELEV/DEPTH TO BOTTOM OF TOP OF SEAL (IF INSTALLED) ________ FEET.
11. TYPE OF UPPER SEAL ________.
12. ELEV/DEPTH TO TOP OF TOP SEAL (IF INSTALLED) ________ FEET.
13. TYPE OF RISER PIPE MATERIAL ________. DIAMETER OF RISER PIPE ________.
14. TYPE OF UPPER BACKFILL ________.
15. BOREHOLE DIAMETER ________ FEET.
16. TOTAL LENGTH OF RISER PIPE ________.
17. ELEV/DEPTH TO BOTTOM OF UPPER SEAL/PROTECTIVE CASING ________.
18. TYPE OF UPPER SEAL ________.
19. TYPE OF WELL COVER ________. DIAMETER OF WELL COVER ________.
20. ELEV/HEIGHT OF WELL CASING ABOVE GROUND ________ FEET.
21. PROTECTIVE CASING? YES NO (CIRCLE ONE)
    ELEV/HEIGHT ABOVE GROUND ________ FEET.
    LOCKING CAP? YES NO (CIRCLE ONE)
22. CONCRETE CAP? YES NO (CIRCLE ONE)

Data Verified ____________ Date ____________
Data Reviewed by ____________ Date ____________

Attachment 1

SAMPLE MONITORING WELL INSTALLATION LOG

SAIC STANDARD OPERATING PROCEDURE NO. 355
MONITORING WELL DEVELOPMENT

1. OBJECTIVE

To establish accepted procedures for the restoration of monitoring wells following drilling activities to yield minimally disturbed water samples and pump test results.

2. BACKGROUND

Following installation of a well (see SOP No. 350), it is necessary to restore, to the extent possible, the natural hydraulic conductivity of the formation by removing drilling fluids and sediments from the disturbed zone around the well. A variety of techniques is available for developing the well to ensure turbidity-free groundwater samples. The actual well development method will be chosen in the field based on the specific information most currently available.

The primary requirement of an effective development technique is to provide reversals or surges in flow to prevent bridging by formation particles, a common problem when flow is always in one direction. Reversals or surges can be created using surge blocks, bailers, pumps, jetting tools, or a combination of devices.

Use of air for development shall not be used when samples are to be collected for volatile organic compound analyses, as air surging tends to strip volatiles from the water. In general, formation water should be used for development, although if low-yielding, water-bearing formations are being developed, it may be necessary to introduce water from an outside source. The introduced water must be tested for chemical properties to evaluate its potential impact on the in situ water quality (EPA 1986).

3. PERSONNEL REQUIRED AND RESPONSIBILITIES

Field Manager: The Field Manager is responsible for ensuring that field personnel have been trained in the use of this procedure and for verifying that monitoring well development activities are performed in compliance with this procedure.

Field Geologist: The Field Geologist is responsible for complying with this procedure, including well development, containerization of extracted water, and documentation of all development activities.

4. EQUIPMENT REQUIRED

- Surge block, bottom-filling bailer, air surging, or pumping device
- pH meter
- Conductivity/temperature probe
- Turbidity meter (when applicable)
- Well Development Data form
- Clipboard and indelible ink pens
- 55-gallon drums for containerization of extracted water, if required.

5. PROCEDURE

1. After installation of a monitoring well and prior to purging and ground water sampling (see SOP No. 600), use a surge block, bottom-filling bailer, air surging, or pumping device to develop the well by drawing water through the screen and forcing it back through the screen repeatedly.

2. Containerize any extracted water, or if permitted, discharge the water to the ground surface away from the well in a manner that minimizes erosion and the impact of recharge to the well.

   NOTE: Containerization is usually necessary at wells where drill cuttings were containerized due to the suspected presence of contaminants.

3. Develop the well until deviations between sample measurements of pH, temperature, specific conductance, color, and odor are stabilized using the following criteria:

   - pH: 0.1 standard units
   - Temperature: 0.5C
   - Specific conductance: 10 umhos/cm
   - Color: no visually discernible difference
   - Odor: no nasally discernible difference.

4. Record all observations during purging on the Well Development Data Sheet, an example of which is shown in Attachment 1.

6. REFERENCES

Driscoll, Fletcher G. 1986. Groundwater and Wells, 2nd Edition, Johnson Division, St. Paul, Minnesota.

U.S. Environmental Protection Agency. 1986. OWER-9950.1, RCRA Ground-Water Monitoring Technical Enforcement Guidance Document (TEGD), Office of Solid Waste and Emergency Response.

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WELL DEVELOPMENT DATA

BOREHOLE/WELL NUMBER:

PROJECT NUMBER ____________ START DATE ____________ TIME ________
PROJECT NAME ____________ END DATE ____________ TIME ________
DEVELOPMENT TEAM ____________ TOTAL WELL DEPTH (BTC*) ____________
WELL INSTALLATION COMPLETION DATE ____________ WELL DIAMETER ____________
Note: 1 gal = 0.1337 ft3 WELL VOLUME/FOOT ____________

Development Method	Time	Water Level (BTC) (Feet)	Total Volume Water Removed (Gallons)	Elec. Conductivity (µmhos/cm)	pH	Temperature (°C)				

* BTC = Below Top of Casing

Data Verified by ____________ Date ________
Data Reviewed by ____________ Date ________

SAIC STANDARD OPERATING PROCEDURE NO. 365
MONITORING WELL PURGING

1. OBJECTIVE

To establish accepted procedures for purging monitoring wells prior to sampling of groundwater to ensure that representative formation water is collected.

2. BACKGROUND

Following installation and development of a well (see SOP Nos. 350 and 355), it is necessary to remove stagnant water from within and near the well. In general, 3 to 10 borehole volumes of water must be removed from the well prior to sampling to provide a representative sample. The specific method of well purging will be decided upon in the field based on the most current available information.

3. PERSONNEL REQUIRED AND RESPONSIBILITIES

Field Manager: The Field Manager is responsible for ensuring that field personnel have been trained in the use of this procedure and for verifying that monitoring well purging activities are performed in compliance with this procedure.

Field Geologist: The Field Geologist is responsible for complying with this procedure, including purging of wells, containerization of extracted water, and documentation.

4. EQUIPMENT REQUIRED

- Bottom-filling bailer, suction-lift pump, air-lift pump, gas-operated (bladder) pump, submersible pump, or other pumping device
- pH meter
- Conductivity/temperature probe
- Well Development Data form
- Clipboard and indelible ink pens
- 55-gallon drums for containerization of extracted water, if required.

5. PROCEDURE

1. After completion of monitoring well installation and development and prior to groundwater sampling, use a bottom-filling bailer or pumping device to purge well of 3 to 10 times its borehole volume of standing water. Purging will be conducted at a rate such that cavatation will not occur.

2. Containerize extracted water, or if permitted, discharge the water to the ground surface away from the well in a manner that minimizes erosion and the impact of recharge to the well.

   NOTE: Containerization is usually necessary at wells where drill cuttings were containerized due to the suspected presence of contaminants.

3. Purge the well until the deviations between sample measurements of pH, temperature, specific conductance, color, and odor are stabilized using the following criteria:

   - pH: 0.1 standard units
   - Temperature: 0.5C
   - Specific conductance: 10 umhos/cm
   - Color: no visually discernible difference
   - Odor: no nasally discernible difference.

4. Record all observations during purging on the Well Development Data Sheet, an example of which is shown in Attachment 1.

5. Sampling must be performed within 24 hours of purging, and preferably as soon as possible afterward.

6. REFERENCES

Driscoll, Fletcher G. 1986. Groundwater and Wells, 2nd Edition, Johnson Division, St. Paul, Minnesota.

U.S. Environmental Protection Agency. 1986. OWER-9950.1, RCRA Ground-Water Monitoring Technical Enforcement Guidance Document (TEGD), Office of Solid Waste and Emergency Response.

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WELL DEVELOPMENT DATA

BOREHOLE/WELL NUMBER:

PROJECT NUMBER ____________ START DATE ____________ TIME ____________
PROJECT NAME ____________ END DATE ____________ TIME ____________
DEVELOPMENT TEAM ____________ TOTAL WELL DEPTH (BTC*) ____________
WELL INSTALLATION COMPLETION DATE ____________ WELL DIAMETER ____________
Note: 1 gal = 0.1337 ft3 WELL VOLUME/FOOT ____________

Development Method	Time	Water Level (BTC) (Feet)	Total Volume Water Removed (Gallons)	Elec. Conduc-tivity (μmhos/cm)	pH	Tempera-ture (°C)				

* BTC = Below Top of Casing

Data Verified by ____________ Date ____________
Data Reviewed by ____________ Date ____________

SAIC STANDARD OPERATING PROCEDURE NO. 375
SLUG TESTING

1. OBJECTIVE

To provide approved methods for measuring hydraulic conductivity using a slug test.

2. BACKGROUND

An estimated measurement of the hydraulic conductivity (permeability) of a formation in the immediate vicinity of a well can be made using either a falling or rising head slug test. This test provides a relatively inexpensive and rapid technique to obtain order-of-magnitude permeability values for groundwater studies. Data interpretation will be accomplished using the techniques of Bouwer and Rice (1976); Cooper, Bredehoeft, and Papadopulos (1967); or others, as appropriate to the conditions found.

3. PERSONNEL REQUIRED AND RESPONSIBILITIES

Field Manager: The Field Manager is responsible for ensuring that field personnel have been trained in the use of this procedure and for verifying that the slug testing method(s) are performed in compliance with this procedure.

Field Geologist: The Field Geologist is responsible for complying with this procedure, including proper collection of data and documentation.

4. EQUIPMENT REQUIRED

- Groundwater level measurement device
- Measuring tape (engineering scale)
- Timer with precision to 0.1 second
- Bailer or slug test water displacement tube
- Decontamination equipment
- Aquifer Test Data form

- Two colors of adhesive tape and permanent markers
- Hermit Data Logger and pressure transducers
- Monofilament nylon line (100-lb test)
- Interpretation supplies (3-cycle by 70 division semilog paper, pencils).

5. PROCEDURE

Field Method I - The following method describes a suitable approach for two persons to obtain data using an electric water level sounder:

1. Decontaminate all required equipment.
2. Open the well.
3. Prepare the Aquifer Test Data form, Attachment 1, with entries for:
   - Borehole/well number
   - Project number
   - Project name
   - Aquifer testing team
   - Distance from pumping well (if appropriate)
   - Ground surface elevation
   - Top of well casing elevation
   - Measuring equipment being used
   - Page number
   - Static water level
   - Date
   - Time intervals (0, 1, 3, 5, 7, 9, 10, and 12 minutes and every 3 minutes thereafter through 60 elapsed minutes, then in 10-minute intervals for the next hour, and in 30-minute intervals for the next 3 hours.)
4. Prepare the electric well sounder by placing a piece of adhesive tape lengthwise along the sounder wire. The tape should extend a calculated amount above and/or below the top of the surface casing.

Those lengths will depend on whether a falling or rising head test is used, and how much drawdown or displacement of water level is anticipated. Place a second piece of tape adhesive side down, over the opposite side of the sounder wire and onto the adhesive surface of the first piece of tape.

5. Lower the sounder into the well to the top of the static water level.

6. A rising head slug test is conducted by withdrawing a quantity of water as rapidly as possible. This is accomplished by using a bailer or pump to quickly remove a volume of water. Alternatively, a volume of water can be removed from the well with a displacement tube by lowering in a water displacement tube, allowing static water levels to be re-established, and then withdrawing the tube. (Water displacement tubes are constructed from sections of pipe that have both ends sealed and which will fit inside the well. One cap is pre-drilled and an eye bolt is secured to it so that a nylon line can be attached. The pipe may require weights inside to overcome bouyancy.)

7. Immediately after the slug test is initiated by withdrawing a quantity of water or by using the water displacement tube, mark off water levels directly on the tape on the sounder wire at the pre-established time intervals. Use the top of the surface casing as the reference point. One person will call out the times for measurements and one person will measure water levels and mark the tape. Continue measuring and marking the tape until the well water returns to its initial level.

8. Remove the sounder wire from the well, measure off the head elevations with a measuring tape, and record the measurements at the appropriate time increments on the log.

9. Plot the values on semilog paper as follows:

   - Logarithmic scale: time
   - Arithmetic scale: ratio of H/H_o = [depth to measured head/depth to initial (static) head].

10. Use the methods referenced below or other appropriate methods to reduce the data and determine permeabilities.

Field Method II - The following method describes a suitable approach for obtaining data using a Hermit Data Logger and pressure transducer to measure and record water levels during slug testing:

1. Decontaminate all required equipment.

2. Open the well.

3. Measure the static water-level depth in the well using an electric well sounder or other appropriate method.

4. Place an appropriate transducer (see SOP No. 850) into the well and allow the displaced water to return to its static level. Select a bailer or water displacement tube that has a diameter that allows removal from the well without displacing the transducer.

5. Initiate recording of data by the logger and withdraw or displace a quantity of water as described above in Method I.

   NOTE: Proper operation of the In-Situ, Inc., Hermit Data Logger is ensured by use of the manufacturer's operating instructions.

6. When the water level has returned to its static level, stop data recording, remove the transducer from the well, and download the data from the logger onto a computer for analysis (In-Situ, Inc. 1985).

6. REFERENCES

Bouwer, H. and R.C. Rice. 1976. A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers With Completely or Partially Penetrating Wells, Water Resources Research, Vol. 12, No.3.

Cooper, Hilton H., Jr., John D. Bredehoeft, and Stavros S. Papadopulos. 1967. Response of a Finite-Diameter Well to an Instantaneous Charge of Water, Water Resources Research, Vol 3. No.1.

In-Situ, Inc. 1985. Hermit Environmental Data Logger Model SE1000B Owner's Manual, Laramie, Wyoming.

Papadopulos, Stavros S., John D. Bredehoeft, and Hilton H. Cooper, Jr. 1967. On the Analysis of 'Slug Test' Data, Water Resources Research, Vol 9, No.4.

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AQUIFER TEST DATA

BOREHOLE/WELL NUMBER: ______

PROJECT NUMBER ______
PROJECT NAME ______
AQUIFER TESTING TEAM ______
DISTANCE FROM PUMPING WELL ______

GROUND SURFACE ELEVATION ______
TOP OF WELL CASING ELEVATION ______
MEASURING EQUIPMENT ______
PAGE ______ OF ______

Time Data
Pump on: Date ___ Time ___ (t)
Pump off: Date ___ Time ___ (t')
Duration of aquifer test:
Pumping ____ Recovery ____

Water Level Data
Static Water Level ______

Discharge Data
Depth of pump/air line ______
Previous pumping? Yes ___ No ___

Comments on factors affecting test data

Date	Clock time	Time since pump started t	Time since pump stopped t'	t/t'		Water level measurement (BTC*)	Correction or Conversion	Adjusted water level	Water level change (s or s')		Discharge measurement (Units: ____)	Rate (Units: ____)		

* BTC = Below Top of Casing

Attachment 1

AQUIFER TEST DATA FORM

SAIC STANDARD OPERATING PROCEDURE NO. 395
BOREHOLE AND MONITORING WELL ABANDONMENT

1. OBJECTIVE

To establish proper procedures for well and borehole closure and abandonment.

2. BACKGROUND

Because wells are a direct conduit to subsurface formations, proper abandonment is necessary to minimize surface and groundwater contamination from hazardous materials encountered on the ground surface or in the subsurface, preserve the hydrostatic pressure of individual aquifers, and prevent groundwater quality degradation due to introduction of water of unknown quality. In addition, improperly abandoned boreholes pose a potential risk to humans and animals.

3. PERSONNEL REQUIRED AND RESPONSIBILITIES

Field Manager: The Field Manager is responsible for becoming familiar with the laws and regulations of local, state, and Federal agencies regarding well abandonment; ensuring that field personnel have been trained in the use of this procedure; and verifying that monitoring well abandonment activities are performed in accordance with the applicable laws and regulations and this procedure.

Field Geologist: The Field Geologist is responsible for complying with this procedure, including ensuring compliance with all applicable laws and regulations of local, state, and Federal agencies.

4. EQUIPMENT REQUIRED

- Drill rig equipped with appropriate drilling tools and crew
- Cement, sand, bentonite powder, bentonite pellets, and commercial hole-sealing products.

5. PROCEDURE

1. Remove any casing, well screen, or other downhole materials or obstructions that could interfere with abandonment procedures by pulling or drilling them out of the borehole, if possible. If the casing is not pulled, it must be perforated at intervals to be sealed and must be cut off at least 10 feet below the ground surface (ADEC 1983, CADWR 1981).

2. Backfill the borehole from the bottom to 10 feet below the top using appropriate materials as discussed below in steps 3 and 4.

3. Boreholes not encountering groundwater or those completed in unconfined aquifers can be backfilled with clay (bentonite pellets or grout), neat cement, sand-cement grout, concrete, or commercial hole-sealing products.

   NOTE: Drilling fluids and cuttings are specifically prohibited for use as backfilling materials.

4. The following sections describe the types of borehole sealants and the methods of placing them:

   Dry bentonite pellets can be poured into shallow boreholes (less than about 25 feet) from the surface. Care must be taken to pour the pellets at a sufficiently slow rate to prevent bridging in the borehole, which would preclude completely filling the hole.

   Bentonite slurries, prepared by mixing dry bentonite powder with water, can be pumped down a tremie pipe or a hollow drill stem. If fractured or highly permeable strata are to be sealed or if the annular space around a casing is to be sealed through perforations in a casing, the grout must be emplaced under pressure to provide a more effective seal.

   Neat cement (prepared by mixing cement with water) and sand-cement (prepared by mixing sand, cement, and water) grouts can be installed in the same manner as used for bentonite slurries. Neat cement and sand-cement seals must be emplaced in one continuous operation, unless shorter segments are installed and allowed to set or partially set to form a base for the remaining sealants.

5. Sealing materials must be thoroughly mixed and prepared according to manufacturer's recommendations and must meet the following standards:

   - Bentonite products used must be specifically designed for plugging and abandoning boreholes and must be nontoxic. Bentonite slurry must have a Marsh funnel viscosity of 50 seconds minimum.

   - Sand-cement grout must be composed of not more than two parts by weight of sand and one part cement.

   - All additives to bentonite and cement grouts must be nontoxic and nondegradable so deterioration of groundwater quality does not result from contact with the sealing materials.

   - Addition of bentonite to a cement slurry must not exceed 5 percent of the volume of cement; curing additives such as calcium chloride or hydrated lime must not exceed 10 percent of the volume of cement (API 1984).

6. Backfill the borehole from the top of the grout (at 10 feet or more below the ground surface) to the surface with cement grout (ADEC 1983, CADWR 1984).

6. REFERENCES

Alaska Department of Environmental Conservation. 1983. General Management Order No. 2035, Field Office Directive, Well-Exploration Drill Hole and Excavation: State of Alaska, Juneau, Alaska

American Petroleum Institute. 1984. Standard Procedure for Field Testing Drilling Fluids, Tenth Edition: American Petroleum Institute, Dallas, Texas, 44 p.

California Department of Water Resources. 1981. Bulletin 74-81, Water Well Standards: State of California, Sacramento, California, 92 p.

Colorado Division of Water Resources. 1984. Rules and Regulations and Colorado Statutes Governing Construction of Water Wells and the Installation of Pumping Equipment: State of Colorado, Denver, Colorado, 20 p.

SAIC STANDARD OPERATING PROCEDURE NO. 400
EQUIPMENT DECONTAMINATION

1. OBJECTIVE

To establish safe, standardized methods for decontaminating equipment during field activities at hazardous material sites for the purpose of minimizing the potential of cross-contamination, off-site contaminant migration, and personnel exposure to potentially hazardous substances. The effectiveness of the procedures used at any particular site will be assessed by the evaluation of the laboratory data obtained from the analysis of trip blanks, field blanks, and equipment washes.

2. BACKGROUND

Equipment decontamination minimizes the risk of exposure to hazardous substances and ensures the collection of representative samples. Boundaries beyond which contaminated equipment is restricted, or decontamination lines, are site-specific. These boundaries are dependent upon the types of contamination and the type of work activities onsite. The Health and Safety Plan for each project will contain specific information regarding establishing the following zones for personnel and equipment at each site:

- Exclusion Zone -- to minimize the number of people in the area where active drilling and sampling activities will be undertaken (zone of maximum hazard)
- Contamination Reduction Zone -- to allow decontamination of personnel and equipment after working in the exclusion zone
- Support Zone: to provide an area with minimal hazards from physical activities and chemical contaminants.

3. PERSONNEL REQUIRED AND RESPONSIBILITIES

Field Manager: The Field Manager is responsible for ensuring that field personnel have been trained in the use of this procedure and for verifying that equipment decontamination is performed in compliance with this procedure. The Field Manager is also responsible for approving the placement of the restrictive zones at each site.

Field Geologist: The Field Geologist is responsible for complying with this procedure and ensuring that site staff understand the philosophy behind the equipment decontamination procedures and conduct each step correctly.

4 EQUIPMENT REQUIRED

- Plastic drop cloths
- Scrub brushes
- Potable water
- ASTM Type-II reagent-grade or HPLC-grade water
- Methanol, reagent-grade
- Hexane, pesticide-grade
- Nitric acid, reagent-grade
- Containers of various sizes (including wash tubs and/or window boxes equipped with a bottom grate to hold equipment out of soil washed from samplers)
- Glass, Teflon®, or stainless steel squeeze bottles and sprayers
- Steam cleaner with laboratory-grade detergent.

5. PROCEDURE

Use only glass, Teflon®, or stainless steel dispensing devices to dispense water, alcohol, acid, and solvent rinses. Plastic dispensing devices are prohibited. Do not clean rubber or plastic surfaces with hexane or methanol. Waste fluids must be collected in suitable containers and treated as hazardous waste, unless otherwise directed.

5.1 SOIL, SEDIMENT, AND SLUDGE SAMPLING EQUIPMENT DECONTAMINATION PROCEDURES

1. Decontaminate soil, sediment, and sludge sampling equipment before use, between samples, and upon completion of sampling operations.
2. Decontaminate equipment used during drilling operations at the "hot line" of the Exclusion Zone prior to transport to the Support Zone.
3. If the steam cleaning location is in an area outside of the Exclusion Zone, remove loose soil on the drill rig, augers, drill pipe and rods, and other large equipment at the drill site, then move the equipment directly to the steam cleaning decontamination area for more thorough cleaning.

4. To decontaminate a drill rig, pressure wash it with a steam cleaner using a laboratory-grade detergent (e.g., Alconox, Liquinox, or equivalent)/water solution and potable water rinse upon mobilization, between drilling locations, and upon demobilization.

5. To decontaminate an auger, drill rods, and other downhole tools, pressure wash with a steam cleaner using a laboratory-grade detergent/water solution and potable water rinse upon mobilization, between drilling locations, and upon demobilization.

6. To decontaminate a split spoon, Shelby tube, Dennison, wireline core barrels, scoops, gravity corers, Poner grabs, or other samplers, pressure wash with a steam cleaner using a laboratory-grade detergent/potable water solution upon mobilization, between sampling locations, and demobilization. In addition, wash using a laboratory-grade detergent/water solution, rinse with ASTM Type II reagent-grade water, rinse with pesticide-grade methanol, rinse with hexane, and allow to air dry before sampling and between samples.

7. To decontaminate wash buckets, pressure wash with a steam cleaner using a laboratory-grade detergent/water solution and potable water rinse upon mobilization, between drilling locations, upon demobilization, or as needed during sampling operations.

5.2 SURFACEWATER AND GROUNDWATER SAMPLING EQUIPMENT DECONTAMINATION PROCEDURES

8. Decontaminate surfacewater and groundwater sampling equipment before use, between sampling locations, and upon completion of sampling operations.

9. Decontaminate water sampling equipment used inside the Exclusion Zone at the "hot line" prior to transport to the Support Zone.

10. If the steam cleaning location is in an area outside of the Exclusion Zone, drain water from the equipment to the extent possible and then move the equipment directly to the steam cleaning decontamination area for more thorough cleaning.

11. To decontaminate well casings, pressure wash with a steam cleaner using a laboratory-grade detergent (e.g., Alconox, Liquinox, or equivalent)/water solution and rinse with potable water prior to installation.

12. To decontaminate well development and purging apparatus, pressure wash with a steam cleaner using a laboratory-grade detergent/water solution, rinse with ASTM Type II reagent-grade water, rinse with pesticide-grade methanol, rinse with hexane, and allow to air dry upon mobilization, between wells, and upon demobilization.

13. To decontaminate bailers and pumps, wash using a laboratory-grade detergent/water solution, rinse with potable water, ASTM Type II reagent-grade water, pesticide grade methanol, hexane, in that order, and allow to air dry upon mobilization, between uses, and upon demobilization.

14. To decontaminate water level measurement devices, wash using a laboratory-grade detergent/water solution, tap water, ASTM Type II reagent-grade water, and allow to air dry upon mobilization, between uses, and upon demobilization.

15. To decontaminate hand-held tools, wash using a laboratory-grade detergent/water solution, rinse with tap water, ASTM Type II Reagent-grade water, pesticide-grade methanol and hexane, in that order, and allow to air dry upon mobilization, between samples, and upon demobilization.

6. REFERENCES

U.S. EPA, 1984, Standard Operating Safety Guides, Office of Emergency and Remedial Response.

SAIC STANDARD OPERATING PROCEDURE NO. 460
PERSONNEL DECONTAMINATION - LEVEL C

1. OBJECTIVE

To provide approved methods for personnel decontamination and minimize the risk of exposure to hazardous substances at hazardous waste sites requiring Level C protection.

2. BACKGROUND

Decontamination lines are site-specific, since they are dependent on the types of contamination and the type of work activities on-site. The Health and Safety Plan for each project will contain specific information regarding establishing three zones for Level C work activities at each site:

- Exclusion Zone: To minimize the number of people in the area where active drilling and sampling activities will be undertaken (zone of maximum hazard).
- Contamination Reduction Zone: Consisting of areas set up for decontamination of personnel and equipment after working in the Exclusion Zone.
- Support Zone: Outside of the decontamination zones (zone of no hazard).

3. PERSONNEL REQUIRED AND RESPONSIBILITIES

Field Manager: The Field Manager is responsible for ensuring that field personnel have been trained in the use of this procedure and for verifying that the field activities are performed in compliance with the requirements of this procedure.

Field Geologist: The Field Geologist is responsible for his own health and safety and for complying with this procedure. He is also responsible for requesting any additional information necessary to perform field duties in a safe and healthful manner.

4. EQUIPMENT REQUIRED

Equipment required to perform maximum decontamination measures is listed in Attachment 1. Equipment required to perform minimum decontamination measures is listed in Attachment 2.

5. PROCEDURE

1. The maximum decontamination procedure consists of specific activities, as shown in Attachment 1.

2. Decontamination procedures may be reduced from the maximum requirements if the situation warrants, at the discretion of the Field Manager.

   NOTE: The minimum decontamination procedure is shown in Attachment 2.

3. When the Field Manager determines that the decontamination line is no longer required, contaminated wash and rinse solutions will either be containerized or, if evidence of contamination was detected during drilling activities through visual observations or air monitoring, discharged to the ground surface. Contaminated decontamination materials will be containerized or disposed of in waste receptacles if no evidence of contamination was detected during drilling activities.

4. Any containerized waste materials will be disposed of in accordance with the requirements for the highest level of wastes encountered on the site.

6. REFERENCES

U.S. EPA. 1984. Standard Operating Safety Guides, Office of Emergency and Remedial Response.

ATTACHMENT 1. MAXIMUM MEASURES FOR LEVEL C DECONTAMINATION
(adapted from NIOSH 1985)

	ACTIVITY	PROCEDURE	EQUIPMENT NEEDED (See Key)
1.	Equipment Drop	To reduce possibility of cross-contamination, deposit equipment (tools, instruments, etc.) on drop cloth or in containers (possible cool-down location)	A,B,C
2.	Boot Cover and Glove Wash/Rinse	Scrub with decon solution, rinse with potable water; may use high-pressure spray	A,D,E,F,I
3.	Tape Removal	Dispose of tape from boots and gloves	A,B
4.	Boot Cover and Glove Removal	Remove boot cover then outer glove; place in container with plastic liner	A,B,H
		HOTLINE	
5.	Splash, Safety Boot, Inner Glove Wash/Rinse	Scrub items with decontamination solution and scrub brush; rinse with water; may use high-pressure spray	A,D,E,F,I
6.	Canister or Mask Change	Exchange the mask or canister, replace and tape on boot covers and outer gloves, and return to duty	G,J
7.	Safety Boot, Splash Suit Removal	First remove boots, and then, with assistance, remove splash suit; place each in container with plastic liner	A,B,H,K
8.	Inner Glove Wash/Rinse	Scrub with decontamination solution, rinse with water	A,D,E,F,K

ATTACHMENT 1. MAXIMUM MEASURES FOR LEVEL C DECONTAMINATION
(Continued)

	ACTIVITY	PROCEDURE	EQUIPMENT NEEDED (See Key)
9.	Face Piece Removal	Remove face piece, deposit in container with plastic liner; avoid touching with fingers	A,B
10.	Inner Glove Removal	Remove inner glove, deposit in lined container	A,B
11.	Inner Clothing Removal	Remove inner clothing, deposit in lined container	A,B
	CONTAMINATION CONTROL LINE - SUPPORT ZONE		
12.	Field Wash, Redress	Shower if highly toxic materials are suspected; wash hands and face if shower is not available; trailer may be needed in inclement weather; put on clean clothes	A,C,D,E,H, K,L

Key:

A. Container (e.g., 20-30 gal plastic garbage can
B. Liners (plastic bags)
C. Plastic drop cloths
D. Detergent/water solution
E. Potable water
F. Brushes
G. Cartridges mask or canister
H. Stool or chair
I. High-pressure spray unit
J. Tape, boot covers, gloves
K. Rack or table
L. Towels

ATTACHMENT 2. MINIMUM MEASURES FOR LEVEL C DECONTAMINATION
(adapted from NIOSH 1985)

	ACTIVITY	PROCEDURE	EQUIPMENT NEEDED (See key)
1.	Equipment Drop	Deposit equipment (tools, instruments, etc.) on drop cloths or in containers to reduce probability of cross-contamination (possible cool-down location)	A,B,C
2.	Outer Garments, Boot Cover and Glove Wash/Rinse	Scrub with decontamination solution, with water; may use high-pressure spray	A,D,E,F,I
		HOTLINE	
3.	Boot Cover and Glove Removal	Remove items; place in lined container	G,J
4.	Canister or Mask Change	Exchange the mask or canister, replace and retape gloves and boot covers, and return to duty	A,B
5.	Outer Safety Boots, Gloves, and Splash Suit Removal	Remove and deposit in separate lined containers	A,B
6.	Face Piece Removal	Remove and deposit on plastic sheet; avoid touching with fingers	A,B,C
		CONTAMINATION CONTROL LINE	
7.	Field Wash, Redress	Wash hands and face thoroughly; redress; shower as soon as possible	A,D,E,F,L

Key:

A. Container (e.g., 20-30 gal plastic garbage can)
B. Liners (plastic bags)
C. Plastic drop cloths

ATTACHMENT 2. MINIMUM MEASURES FOR LEVEL C DECONTAMINATION
(Continued)

D. Detergent/water solution
E. Potable water
F. Brushes
G. Cartridges mask or canister
H. Stool or chair
I. High-pressure spray unit
J. Tape, boot covers, gloves
K. Rack or table
L. Towels

SAIC STANDARD OPERATING PROCEDURE NO. 550
SEDIMENT/SLUDGE SAMPLING

1. OBJECTIVE

To provide accepted guidelines for sediment/sludge sampling and collection.

2. BACKGROUND

Several techniques may be used to obtain sediment/sludge samples. The techniques employed depend on the consistency of the materials to be sampled, the depth from which the sample is to be collected, and the specific location to be sampled. The most common techniques for collection of sediment/sludge samples are use of a stainless steel trowel, stainless steel spoon, or Teflon® scoop to excavate the sample, or, if sampling more than 4 or 5 inches below the surface, use of a hand-operated, stainless steel bucket auger.

3. PERSONNEL REQUIRED AND RESPONSIBILITIES

Field Manager: The Field Manager is responsible for ensuring that field personnel have been trained in the proper technique for collecting sediment/sludge samples.

Field Geologist: The Field Geologist is responsible for collecting sediment/sludge samples in accordance with this procedure.

4. EQUIPMENT REQUIRED

- Stainless steel trowel or spoon or Teflon® scoop
- Sample containers and cooler chests with ice (not reusable ice packs ["Blue Ice"])
- Field Log book or Field Borehole Log form
- Stainless steel mixing bowl or Teflon® sheet.

5. PROCEDURE

1. Insert scoop or trowel into material and remove sample or rotate auger into the ground and remove sample (see SOP No. 526).

2. Place sample in mixing bowl or on Teflon® sheet.

3. Samples for volatile organic compound (VOC) analysis will be collected from the sampling device or from unmixed soil placed into a stainless steel bowl or onto a Teflon® sheet.

4. The remaining sample containers will be filled after the soil sample is stirred to provide a homogenous mass for sampling. Sample material to be composited will be placed into a mixing bowl or onto a Teflon® board and thoroughly stirred to provide a homogeneous mass for sampling prior to extracting material to fill sample containers.

5. Place the sample containers on ice in a cooler chest and maintain at 4°C.

6. Note the sample identification, sample location (provide sketch), sampling time, and sample personnel in the Field Log book or on a Field Borehole Log form.

7. Decontaminate the field equipment.

6. REFERENCES

None.

SAIC STANDARD OPERATING PROCEDURE NO. 600
GROUNDWATER SAMPLING USING A BAILER

1. OBJECTIVE

To provide an accepted method for the collection of groundwater samples.

2. BACKGROUND

A variety of sampling techniques are available for the collection of groundwater samples. These techniques include using bailers, air lift samplers, submersible pumps, gas-driven piston pumps, and peristaltic pumps. Many of these techniques are not suitable when volatile samples are being collected. The most common method of groundwater sampling is using a bailer.

3. PERSONNEL REQUIRED AND RESPONSIBILITIES

Field Manager: The Field Manager is responsible for ensuring that field personnel have been trained in the use of this procedure and for verifying that groundwater sampling activities are performed in accordance with this procedure.

Field Geologist: The Field Geologist is responsible for complying with this procedure, including collection of samples, containerization of samples, and documentation.

4. EQUIPMENT REQUIRED

- Teflon® bailer
- Bottom Emptying Device (BED)
- Monofilament nylon line (100-lb test)
- Groundwater Sampling Log form
- Sample containers
- Decontamination materials
- Bottle brush.

5. PROCEDURE

1. Decontaminate the bailer as described in SOP No. 400.

2. Secure the nylon line to the bailer. Ensure that there is sufficient length to allow the sample to be collected from the appropriate depth.

   NOTE: Each well will have a dedicated nylon line. Lines used in one well will not be used in any other well.

3. Tape a horizontal distance from the well equal to the depth from which the sample is to be taken and mark the location on the ground.

4. Place the bailer inside the top of the well and have your partner hold it in place.

5. Slowly walk back to the mark on the ground while holding the monofilament line, being careful not to let the line touch the ground.

6. Stop at the mark and have your partner release the bailer.

7. Slowly walk toward the well and pause a few seconds after the bailer enters the water to ensure that the bailer is full.

8. Slowly walk back to the mark.

9. Keeping the line taut to keep it off the ground, have your partner fill the sample bottles (using the BED to minimize agitation), starting with 40 mL VOC vials.

   NOTE: It is imperative that the vials containing samples for VOC analyses have no trapped air bubbles. To ensure this, turn the vials upside down and strike them against your hand. Check to ensure that air bubbles are not released. If no air bubbles are present, proceed with filling the rest of the sample containers. If air bubbles are present, empty the vial and refill it, repeating the process until no trapped air bubbles are found. Most other sample bottles need not be filled to the top.

10. Repeat Steps 4 through 9 until all bottles are full.

11. Secure the well lid and lock on the well. Dispose of gloves and nylon line to prevent cross-contamination.

12. Place sample containers on ice in a cooler chest to maintain sample temperatures at 4°C.

13. Collect spilled material after sampling and dispose of in accordance with the client's wishes and local, state, and Federal requirements.

14. Decontaminate the bailer as described in SOP No. 400.

15. Complete the Groundwater Sampling Log form (Attachment 1) as follows:

- Enter the sampling point number in the upper righthand corner under "Borehole/Well Number."
- Enter the project number assigned.
- Enter the descriptive project name.
- Enter the name(s) of all field crew members sampling this point in the "sampling team" block.
- Enter the well installation completion date from the Monitoring Well Installation Log form (see SOP No. 350).
- Enter total well depth from top of casing.
- Enter well diameter from Monitoring Well Installation Log form.
- Determine well volume per foot from the well diameter and enter in the appropriate block.
- Enter date and time for each sample in the proper column.
- Measure water level from the top of the casing and determine standing water column by subtracting from total well depth. Determine the volume of this column by multiplying the standing water column by the quantity entered for "Well Volume per Foot."
- If a bailer is used, enter "Teflon® (or other material) Bailer" in the column marked "Sampling System." If a pump is used, enter the type in the column marked "Pumping System."
- Enter the analyte being sampled for in the space above the "Required/Collected" columns; enter the number of samples required and the number collected for each analyte in its respective column.
- Enter verification signature and date by the Field Geologist.
- Enter review signature and date by the Field Manager.

6. REFERENCES

Scalf, M.R., J.F. McNabb, W.J. Dunlap, R.L. Cosby, and J. S. Fryberger. 1981. Manual of Ground Water Quality Sampling Procedures, National Water Well Association, Worthington, Ohio.

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GROUNDWATER SAMPLING LOG

BOREHOLE/WELL NUMBER:

PROJECT NUMBER ____________ PROJECT NAME ____________
SAMPLING TEAM ____________ WELL INSTALLATION COMPLETION DATE ____________
TOTAL WELL DEPTH (BTC*) ____________ WELL DIAMETER ____________ WELL VOLUME/FOOT ____________

Note: 1 gal = 0.1337 ft^3

Date	Time	Water Level (BTC) (Feet)	Standing Water Column (Feet)	Standing Water Volume (Gallons)	Water Volume Removed (Gallons)	Pumping System	Sampling System	Required	Collected	Required	Collected	Required	Collected	Required	Collected	Required	Collected	Required	Collected

* BTC = Below Top of Casing

Data Verified by ____________ Date ____________
Data Reviewed by ____________ Date ____________

Attachment 1

GROUNDWATER SAMPLING LOG

SAIC STANDARD OPERATING PROCEDURE NO. 625
SAMPLE CUSTODY/SHIPPING

1. OBJECTIVE

To establish chain-of-custody procedures for sample processing from collection through shipping.

2. BACKGROUND

Sample custody procedures include inventory and documentation during sample collection, shipment, and laboratory processing. A sample is considered in one's possession if the sample is:

- In the physical possession or view of the responsible party, or
- Secured to prevent tampering, or
- Placed in a restricted area by the responsible party.

Chain-of-custody in the field is established by unique identification of samples using sample labels, followed by recording of sample disposition data on chain-of-custody forms. The transfer of samples from the field to the laboratory and through the testing process is documented using chain-of-custody procedures.

3. PERSONNEL REQUIRED AND RESPONSIBILITIES

Field Manager: The Field Manager is responsible for ensuring that field personnel have been trained in the use of this procedure and for verifying that sample custody procedures are in accordance with this procedure.

Field Geologist: The Field Geologist is responsible for the custody of samples collected by him or her until they have been properly transferred to the Field Manager, a courier, or directly to the laboratory.

4. EQUIPMENT REQUIRED

- Sample labels
- Indelible ink pens
- Sample Chain-of-Custody Log forms

- Master Sample Log form
- Sample Shipping Log form.

5. PROCEDURE

Sample Numbers

1. Assign a unique sample number to each sample collected in the field. The sample number will identify the sampling location, installation type, sequential sample number (aqueous) or sample depth (non-aqueous), and the matrix (air, water, or soil) sampled.

2. The sample will be identified as follows unless otherwise noted in the Field Sampling Plan:

Location Designator	Installation Type	Sequential Installation No.	Sequential Sample No.	Depth (ft)	Media
Will vary depending on site	V - monitoring well B - soil boring P - piezometer S - surface sample (soil/sediment/sludge/surface water)	00-99	00-99	000.0-999.9	S - soil W - water

3. For example, a subsurface soil sample collected from the second soil boring at Fire Training Area No. 1 from a depth of 35 feet will be identified as "F1B-02-035.0S". The third water sample collected from the first well completed at the Base Landfill will be identified as "LFW-01-03W".
4. Record the sample number on the sample label and Sample Chain-of-Custody Log and on the Master Sample Log.

Sample Labels

5. Attach a sample label (Attachment 1) to all sample containers at the time of sample collection and mark the liquid meniscus level on the outside of the sample bottle (unless the bottle is filled to the top).
6. Complete the label in indelible ink and include at least the following information:

   - Date and time collected
   - Purpose of the sample (analyte and sample group)
   - Sample number
   - Source location and location of sample

- Volume collected
- Preservative used (if any)
- Collector's initials.

Sample Chain-of-Custody Log

The Sample Chain-of-Custody Log represents the official documentation for all transfers of sample custody until the samples have arrived at the laboratory. Sample Chain-of-Custody Logs are used to document the integrity of samples.

7. Fill out a Sample Chain-of-Custody Log (Attachment 2) for each sample set at each sampling location to maintain a record of sample collection, transfer between personnel, and receipt by the laboratory.

8. When relinquishing custody of samples, sign the Sample Chain-of-Custody Log and fill in the date and time of transfer. The individual receiving the samples will do the same.

9. If shipping samples to the laboratory, complete the Sample Chain-of-Custody Log prior to shipment and note the date and time of shipment. Inspect the form for completeness and accuracy.

10. If a change is made on the Sample Chain-of-Custody Log, the person making the change will place his initials by the change.

11. The Sample Chain-of-Custody Log will contain the following information:

    - Sample number (for each sample in the shipment)
    - Collection date (for each sample in shipment)
    - Time shipment was packed
    - Number of containers of each sample
    - Sample description (environmental matrix)
    - Analyses required for each sample
    - Shipment number
    - Shipping address of the laboratory
    - Date, time, and method of shipment
    - Signatures as custody is transferred from one individual to another.

12. The completed Sample Chain-of-Custody Log will be placed in a sealed plastic bag and taped inside the lid of the cooler containing the samples logged on that record.

13. If quality assurance samples are to be provided to another laboratory facility or government agency, a separate Sample Chain-of-Custody Log will be prepared for those samples.

14. The Log will indicate with whom the samples have been split or duplicated and will be appropriately signed and dated with the time of transfer of the splits or duplicates.

Master Sample Log

15. Each project will have a Master Sample Log (Attachment 3) to track the collection of samples for that project. The log identifies:

- Master Log Sample Number
- Sampling location
- Sample number, depth, type, and date and time of sampling
- Chemical analyses collected
- Sample containers collected
- Sample collector's initials

Sample Shipment

16. Samples will be carried directly to the laboratory or, in most cases, transferred to a forwarding company (DHL, Federal Express, or the equivalent) for overnight delivery to the laboratory. All sample shipments will be tracked using a Sample Shipping Log (Attachment 4). The Log will contain:

- Analytical laboratory address
- Sample shipping container number
- Shipment number
- Custody seal number(s)
- Shipping method
- Date shipped
- Sample shipper's initials.

6. REFERENCES

None.

Date: ______	I.D. Number: ______	Depth: ______
Project Number: ______	Collected By: ______	Time: ______

Type: ☐ Soil/Sediment/Sludge ☐ Water ☐ Waste ☐ Other: ______

Preservatives: ______

Required Analysis: ______

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Attachment 1

SAMPLE LABEL

SAIC Science Applications International Corporation	SAMPLE CHAIN OF CUSTODY LOG	Shipment No. ______
Project:	Reason for Transfer:	

	Sampling Date	Start Time	Sample Location	Sample ID	R-Rep B-Blk S-Sam	Matrix/ Media	# Items or Containers	Comments
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
Column Total:								

Signature & Affiliation PLEASE				
	Relinquished by/Affiliation:	Received by/Affiliation:	Date/Time:	Condition:
	Relinquished by/Affiliation:	Received by/Affiliation:	Date/Time:	Condition:
	Relinquished by/Affiliation:	Received by/Affiliation:	Date/Time:	Condition:
	Relinquished by/Affiliation:	Received by/Affiliation:	Date/Time:	Condition:

Page ______ of ______

White - Return to Original Sampler (above address)
Yellow - Laboratory Record
Pink - Retained by Original Sampler

Attachment 2

SAMPLE CHAIN OF CUSTODY FORM

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Project No. ______
Project Name ______
Project Location ______
Client Name ______

MASTER SAMPLE LOG

Master Log Sample Number	Sampling Location	Sample Number	Sample Depth	Sample Type	Sample Date	Sampling Time	Chemical Analyses Collected	Sample Bottles Collected	Sample Collector	Comments

Attachment 3

MASTER SAMPLE LOG

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SAMPLE SHIPPING LOG

Project No. ______________________

Project Name ______________________

Project Location ______________________

Client Name ______________________

Master Log Sample Number	Sampling Location	Sample Number	Sample Depth	Sample Type	Sample Bottles Shipped	Shipping Container Number	Chain-of Custody Number	Container Custody Seal No.	Date Shipped	Sample Shipping Method	Sample Shipper	Comments

Attachment 4

SAMPLE SHIPPING LOG

SAIC STANDARD OPERATING PROCEDURE NO. 650
SAMPLE PREPARATION/PACKAGING

1. OBJECTIVE

To provide accepted methods for sample preparation prior to shipping.

2. BACKGROUND

The testing laboratory will typically provide all sample containers, preservatives, and packaging for transportation of soil and water samples to be tested by the laboratory. Proper preparation of sample containers for shipment to the laboratory is essential to prevent breakage of containers and spillage of potentially hazardous materials.

3. PERSONNEL REQUIRED AND RESPONSIBILITIES

Field Manager: The Field Manager is responsible for ensuring that field personnel have been trained in the use of this procedure and for verifying that sample preparation and packaging activities are being performed in accordance with this procedure.

Field Geologist: The Field Geologist is responsible for compliance with this procedure, including sample container preparation, marking and labeling, and sample packaging.

4. EQUIPMENT REQUIRED

- Paper towels
- Coolers with ice (not reuseable ice packs ["Blue Ice"])
- Plastic insulating material ("bubble wrap")
- Strapping tape and friction tape
- Styrofoam and absorbent packing material
- 1-gallon (or other appropriate size) sealable plastic bags
- Large plastic garbage bags

- Custody seals
- Address, "This Side Up," "Fragile," "Hazardous Materials," and other labels as appropriate or required
- Master Sample Log form.

5. PROCEDURE

Sample Container Preparation

1. After sampling activities are completed, clean the outer surfaces of all sample containers with potable water and disposable towels.

2. Identify and document sample collection points, depth increments, and sampling devices.

3. Complete log book entries, sample tags, chain-of-custody forms, and field record data forms with sample identification points, date, time, and names or initials of all persons handling the sample in the field.

4. Wrap tape around the neck and cap of each container to help prevent leakage.

5. Place samples into an ice chest or other appropriate container with ice.

Sample Packaging

6. Wrap glass sample containers with plastic insulating material ("bubble wrap") to prevent contact with other sample containers or the inner walls of the cooler.

7. Place samples in thermally insulated, rigid ice chests which contain ice and absorbent packing for liquids or styrofoam packing for solids in accordance with U.S. Department of Transportation specifications contained in 49 CFR 171, 172, 173. Line the chest with a large plastic bag which will contain all of the sample containers and will be sealed over the top of the containers.

8. Pack samples to be analyzed for organic and inorganic compounds in separate coolers.

9. When an ice chest is filled, complete a chain-of-custody form and seal it inside a plastic bag. Tape the plastic bag inside the top cover of the ice chest.

   NOTE: Instructions for completing chain-of-custody forms are provided in SOP No. 625, "Sample Custody/Shipping."

10. Place a thermometer into the ice chest, close the lid, and allow the temperature to stabilize for approximately 15 minutes. Record the temperature of the inside of the ice chest.

11. Clean the outer surface of the ice chest.

12. Tape the ice chest shut with strapping tape, seal the drain opening with friction tape, and place custody seals over the lid opening in such a fashion that the tape must be broken to open the lid.

13. Place an address label on top of the cooler. Place a "This Side Up" sticker on all four sides and "Fragile" labels on two sides and the top.

14. Classify samples and mark the ice chests according to the requirements of Title 49 CFR 171, 172, and 173. In most cases, the shipment will be classified as "Environmental Samples" and will not require special marking or labeling.

6. REFERENCES

49 CFR 171, 172, 173.

SAIC STANDARD OPERATING PROCEDURE NO. 685
WATER SAMPLE FILTRATION

1. OBJECTIVE

To establish uniform guidelines for filtering water samples in the field.

2. BACKGROUND

The filtration of water samples collected in the field is required for several analytical parameters including dissolved metals, orthophosphate, and chemical oxygen demand.

3. PERSONNEL REQUIRED AND RESPONSIBILITIES

Field Operations Manager: The Field Operations Manager is responsible for ensuring that field personnel have been trained in the use of this procedure and for verification that water sample filtration has been performed in compliance with this procedure.

Field Geologist: The Field Geologist is responsible for compliance with this procedure and filtration of samples in a timely manner.

4. EQUIPMENT REQUIRED

- Vacuum pump
- Filter holder and filters or prepackaged disposable in-line filters in holders (0.45 micron)
- Teflon tubing
- Vacuum tubing (Tygon)
- Two-hole rubber stopper
- Glass or stainless steel tubes to fit holes in stopper
- Sample bottles.

5. PROCEDURE

1. Decontaminate the rubber stopper and tubes. Insert the tubes through holes in the stopper. Set one tube with the lower end near the bottom of the rubber stopper (outlet tube). Set the other tube with the

lower end approximately one inch below the bottom of the stopper (inlet tube).

2. Place the rubber stopper in a sample container. The fit between the sample container and rubber stopper must be tight enough to maintain a vacuum while filtering.

3. Connect the vacuum tubing to the outlet of the aspirator and the inlet of the vacuum pump.

4. Connect Teflon® tubing to the inlet tube and to the outlet of the in-line filter. Connect another length of Teflon® tubing to the inlet of the filter and place the free-end in the unfiltered sample.

5. Turn on the vacuum pump and draw the sample through the filter. Monitor the water level in the unfiltered sample to avoid drawing air into the in-line filter.

6. When the sample container is filled, cap the sample bottle or transfer the filtered water to other sample containers.

7. Disassemble the vacuum apparatus and properly dispose of the in-line filter and Teflon tubing.

8. Place the samples on ice in a cooler to maintain their temperature at 4°C.

6.0 REFERENCES

None.

SAIC STANDARD OPERATING PROCEDURE NO. 770
MINE SAFETY APPLIANCES MODEL 2A COMBUSTIBLE GAS INDICATOR

1. OBJECTIVE

To provide field operating instructions for the MSA Combustible Gas Indicator.

2. BACKGROUND

Measurement of combustibility of various types of atmospheres encountered at hazardous waste investigation sites is a requirement for protection of the health and safety of workers. In addition, it can be an indicator of the presence of contaminants at a site. Incorrect readings may be indicated in oxygen deficient atmospheres.

3. EQUIPMENT REQUIRED

- MSA Model 2A Combustible Gas Indicator
- MSA Calibration Test System.

4. CALIBRATION

The following procedure describes the steps for calibration of the MSA Model 2A Combustible Gas Indicator:

1. With the "ON-OFF" bar in the off position, set the meter pointer to zero on the scale.
2. Turn the indicator on by lifting the end of the "ON-OFF" bar on the rheostat knob and rotating the bar and knob clockwise 1/4 turn.
3. Flush the instrument with fresh air by squeezing and releasing the aspirator bulb five or more times.
4. Rotate the rheostat knob until the meter needle rests at zero. (Avoid large clockwise rotations of the rheostat knob, as they send large electric currents through the filament that can shorten the instrument life.)
5. Connect the hose adapter in the calibration kit to the sample inlet fitting on the instrument.
6. Assemble the rubber tube and balloon to the plastic cup as shown in the calibration kit instructions and eliminate air in the balloon by rolling the balloon up toward the cup.

7. While keeping the balloon rolled up, attach the opening in the balloon to the outlet of the calibration gas can and inflate the balloon with the calibration gas. It is not necessary to pressurize the balloon.

8. Close the rubber tube between the calibration gas can and the balloon with the pinch clamp and remove the rubber tube from the can outlet.

9. Attach the rubber tube to the hose adapter on the instrument to be tested and remove the pinch clamp.

10. Draw gas from the balloon through the instrument by operating the aspirator bulb and note the maximum meter reading.

11. Using the calibration curves provided in the calibration kit, determine if the meter reading falls within the proper range.

12. If the reading is outside the range, check the test setup and rerun the check. If the meter reading is again outside the range, replace the detector unit. If this does not eliminate the problem, return the indicator to the manufacturer for repair.

5. USE

The following procedure describes the steps for use of the MSA Model 2A Combustible Gas Indicator:

1. Assemble the hose and probe and attach to the instrument.

2. Attach the aspirator bulb assembly to the instrument.

3. With the "ON-OFF" bar in the off position, set the meter pointer to zero on the scale.

4. Turn the indicator on by lifting the end of the "ON-OFF" bar on the rheostat knob and rotating the bar and knob clockwise 1/4 turn.

5. Flush the instrument with fresh air by squeezing and releasing the aspirator bulb five or more times.

6. Rotate the rheostat knob until the meter needle rests at zero. (Avoid large clockwise rotations of the rheostat knob, as they send large electric currents through the filament that can shorten the instrument life.)

7. Insert the probe assembly into the atmosphere to be measured and operate the aspirator bulb five or more times to draw sample into the instrument.

8. Observe the meter needle deflection while operating the aspirator bulb. The highest reading is the lower explosive limit (LEL) of the atmosphere being measured.

6. PREVENTIVE MAINTENANCE

Each time the MSA Combustible Gas Indicator is used, the battery will be recharged and the sample inlet filter will be examined for cleanliness. If the filter element appears to be coated with dirt or dust, it will be washed, dried, and reinserted or a new element will be substituted. A new filter O-ring will be installed with each new element. The inlet seal O-ring in the inlet filter cap will be checked to ensure that it is properly seated. If the O-ring is damaged or missing, it must be replaced before the instrument is used again.

7. REFERENCES

Mine Safety Appliances Model 2A Combustible Gas Indicator Instruction Manual.

SAIC STANDARD OPERATING PROCEDURE NO. 850
HERMIT DATA LOGGER WITH PRESSURE TRANSDUCER

1. OBJECTIVE

To provide field instructions for operation of the Hermit Data Logger.

2. BACKGROUND

Aquifer tests may be conducted using a variety of equipment and techniques. Techniques frequently used include slug tests and pump tests. Pump tests involve measuring the water level drawdown in observation wells over an extended period of time. Slug tests measure the recovery of the water level in a well following the rapid removal or addition of a quantity of water. In either case, data may be collected using a Hermit Data Logger and a pressure transducer.

The person performing the slug test should be familiar with the operation of the Hermit Data Logger and should have a copy of the instruction manual at hand. The procedure outlined below assumes no instrument operational problems or programming errors will occur, although these are common. This procedure is not intended as a detailed description of the operation of the Hermit Data Logger. The instruction manual is mandatory if one is to properly operate the instrument.

3. EQUIPMENT REQUIRED

- Hermit Data Logger Model SE1000B w/Instruction Manual
- Pressure transducer.

4. CALIBRATION

No field calibration can be accomplished (see Page 2, Section 6).

5. USE

1. Check and reset the clock, if necessary.

2. Enter the test definition parameters:

   - Select test: 0
   - Select sampling mode: LOG
   - Select active input: 1
   - Select type of input: LEVEL.

3. Enter the transducer parameters:

   - REF.: skip this parameter for now
   - SCALE: set to value marked on transducer
   - OFFS.: set to zero or as marked on transducer
   - DSP.: select top of casing mode and English or metric units
   - HI AL: set off
   - LO AL: set off.

4. Connect the transducer(s) to the unit and set the transducer(s) into the well at the desired depth. The transducer(s) must be set below the lowest anticipated drawdown, although it is not necessary that it be set at the bottom of the well.

5. Use the XD key to display the transducer(s) depth and to verify that all connections have been made properly.

6. Go back and enter the reference level of the water. This can be the initial level of the water with respect to the top of the casing or zero if only changes in level are important.

7. Use the START function to begin collecting data, synchronizing this with the onset of pumping.

8. After one minute, stop the pump and simultaneously press the STOP function on the keyboard. Immediately after pressing the STOP function, press the START function again. This will begin the collection of recovery data. The data collection time depends on the type of aquifer test.

9. Use the STOP function to end data collection. The final data may be viewed, output to a computer, or another test may be run by selecting a new test number.

6. PREVENTIVE MAINTENANCE

The Hermit Data Logger Model SE1000B is not user serviceable and will require no calibration or maintenance in the field.

7. REFERENCES

Hermit Environmental Data Logger Model SE1000B Owner's Manual, April 1985, In-situ, Inc.

SAIC STANDARD OPERATING PROCEDURE NO. 860
CORNING MODEL 103 HANDHELD PH METER

1. OBJECTIVE

To provide field operating instructions for the Corning pH meter.

2. BACKGROUND

pH is an important environmental parameter that is routinely measured during waste management investigations to provide information on the extent of contamination at a site. In addition, pH measurements are taken on purge waters from monitoring wells to aid in assessing when sufficient water has been removed from the well to ensure that formation water samples will be collected.

3. EQUIPMENT REQUIRED

- Corning Model 103 Handheld pH Meter and probe
- Calibration solutions.

4. CALIBRATION

The following procedure describes the steps for calibration of the Corning Model 103 pH Meter:

1. Connect the pH probe to the pH meter and rinse the probe in deionized water.

2. Ensure that the temperatures of all buffers are approximately equal and are approximately the same as the temperatures of the solutions to be measured.
3. Set the "TEMPERATURE" knob to the temperature of a pH 7.00 buffer solution and immerse the pH probe in the solution.

4. When the digital reading stabilizes, adjust the "CALIBRATE" knob to set the reading to 7.00, remove the probe from the solution, and rinse the probe with deionized water.

5. Set the "TEMPERATURE" knob to the temperature of a pH buffer solution of higher or lower pH (generally pH 4.00 or pH 10.00) and immerse the pH probe in the solution.

6. When the reading stabilizes, adjust the display to the value of the second buffer solution by turning the "CAL 2 DELTA %" control on the bottom of the meter, using the slope adjustment tool, to complete the calibration.

5. USE

1. Set the temperature dial to the temperature of the sample to be tested.

2. Rinse the probe thoroughly with distilled water to prevent any cross-contamination.

3. Immerse the probe in the test sample and take the reading. Allow at least 30 seconds for the reading to stabilize.

6. PREVENTIVE MAINTENANCE

Preventive maintenance for the pH meter consists primarily of battery replacement when required, checking the cable between the pH probe and the instrument for wear, and reconditioning the pH electrode as required. The pH electrode can be reconditioned using the following procedures:

1. Immerse the electrode tip in 0.1N hydrochloric acid followed by immersion in 0.1 N sodium hydroxide and again in 0.1 N hydrochloric acid, each for a two-minute period.

2. Rinse with demineralized water and soak in pH 7.00 buffer solution for 30 minutes.

3. If the electrode is slow to respond or if readings are unstable and the condition cannot be remedied with normal cleaning, then the reference junction may be clogged.

4. Prepare a saturated potassium chloride solution and dilute it to about 1:10 with water.

5. Bring the solution to a boil and place the electrode tip in the solution for about 10 minutes.

6. Remove heat and allow the electrode to cool while immersed in the solution.

7. Rinse the electrode with distilled water and soak in pH 7.00 solution before testing again.

If these steps fail to improve electrode response, replace the electrode. If the pH bulb becomes contaminated or dries out, it may be reconditioned by following the cleaning procedure above.

7. REFERENCES

Corning Glass Works Model 103 Hand Held pH Meter Instruction Manual, 1983.