FINAL

PHASE II REMEDIAL INVESTIGATION WORK PLAN

STRATFORD ARMY ENGINE PLANT STRATFORD, CONNECTICUT

Prepared for
U.S. Department of the Army
Corps of Engineers, Omaha District
Omaha, Nebraska
November 1994

Woodward-Clyde

101 South 108 Avenue
Omaha, Nebraska 68[illegible]54
WC Project No. C3M11LL

Woodward-Clyde
Federal Services
Engineering & sciences applied to the earth & its environment

August 22, 1994
C3M11LL-1.1

U.S. Department of the Army
Corps of Engineers, Omaha District
CEMRO-ED-EA (Mr. John Barrett)
215 North 17th Street
Omaha, Nebraska 68102-4978

RE: Draft Phase II RI Work Plan
Stratford Army Engine Plant

Dear Mr. Barrett:

Attached to this letter, please find five copies of the Draft Phase II RI Work Plan for the Stratford Army Engine Plant in Stratford, Connecticut. Copies of this plan have also been mailed by Federal Express to those recipients listed below. This study was completed under Woodward-Clyde Consultants' Indefinite Delivery Contract No. DACW45-93-D-005.

We appreciate the opportunity to provide services for this project. If you have any questions concerning this project, please call.

Very truly yours,

Marion Craig

Marion Craig, P.G.
Project Manager

MC:cd

cc: P. Luedtke/ATCOM, AMSAT-EMC (2 copies)
H. Moglia/AVSCOM, SAVAI-F (1 copy)
D. Persett/DRPO-Textron Lycoming-RTAC (1 copy)
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LIST OF ACRONYMS AND ABBREVIATIONS

ADC	Average Daily Concentrations
ATCOM	U.S. Army Aviation and Troup Command
AVSCOM	U.S. Army Aviation Systems Command
CDAP	Chemical Data Acquisition Plan
CDEP	Connecticut Department of Environmental Protection
CPDWC	Connecticut Public Drinking Water Code
CWTP	chemical waste treatment plant
DQO	data quality objectives
EPA	U.S. Environmental Protection Agency
FSP	Field Sampling Plan
MCL	Maximum Contaminant Level
nd	not detected
NPDES	National Pollution Discharge Elimination System
OATP	Oil Abatement Treatment Plant
PAS	Preliminary Assessment Screening
PCB	polychlorinated biphenyl
ppm	parts per million
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
SAEP	Stratford Army Engine Plant
SAP	Sampling and Analysis Plan
SDWA	Safe Drinking Water Act
semi-VO	semi-volatile organic compound
SSHP	Site Safety and Health Plan
TL	Textron Lycoming Gas Turbine Division
TIC	total organic carbon
TPH	total petroleum hydrocarbons
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of the Army
USGS	United States Geological Survey
VO	volatile organic compound
W-C	Woodward-Clyde

1.0
INTRODUCTION

1.1 AUTHORITY

The Stratford Army Engine Plant (SAEP) is a government-owned, contractor-operated facility located in Stratford, Connecticut. The U.S. Department of the Army (USDA) owns the land, the buildings, and most of the production equipment at SAEP. The U.S. Army Aviation Systems and Troup Command (ATCOM, formerly AVSCOM) has responsibility for the jurisdiction, control, and accountability of SAEP. AlliedSignal Engines, a unit of AlliedSignal Aerospace, operates SAEP under a facilities contract with ATCOM. AlliedSignal manufactures and tests turbine engines at SAEP, primarily for the Department of the Army. AlliedSignal also produces turbine engines for the U.S. Navy, for foreign military sale, and for commercial use.

The USDA has adopted the position that it may sell a government-owned facility on the basis that it is "excess to ownership". A facility may be considered excess to ownership if it is not necessary for the government to own the facility, although the production capacity of the facility may be required. USDA is currently considering the lease or sale of government-owned property at SAEP. U.S. Army Regulation 200-1 (AR 200-1) requires that a Preliminary Assessment Screening (PAS) be completed for any real property for which a transaction is being proposed. In March, 1991 the U.S. Army Corps of Engineers (USACE), on behalf of ATCOM, contracted Woodward-Clyde (W-C) to complete a PAS for SAEP. Based on the results of the PAS, it was recommended to complete a Remedial Investigation as described in Chapter 9 of AR 200-1, Environmental Protection and Enhancement.

In April 1992 the USACE on behalf of ATCOM contracted W-C to conduct a Remedial Investigation. Field activities for this investigation were performed from May through November 1992. A report on the results of this work was issued in June 1993. Based on the results of this initial investigation, it was recommended that further investigations were needed to complete the Remedial Investigation

USACE has been tasked by AVSCOM to prepare a Phase II Remedial Investigation Work Plan for SAEP. The USACE has contracted the preparation of this plan to W-C under Indefinite Delivery Contract No. DACW45-93-D-0005. Any and all deviations from this work plan will be approved by USACE prior to implementation.

1.2 WORK PLAN ORGANIZATION

Section 1.0 of this Work Plan provides background information on the circumstances and regulations which have precipitated the upcoming investigation. Sections 2.0 and 3.0 provide background information on the site and conceptual models which form the basis of the rationale used to develop the Work Plan. Both of these sections are largely derived from the PAS, and more details can be found in that document. Section 4.0 describes the rationale that was used to develop the sampling and analysis scheme. Section 5.0 broadly outlines each of the tasks to be completed under the Phase II Remedial Investigation. Section 6.0 contains an estimated schedule of the time needed to complete the remedial investigation tasks. Section 7.0 provides references cited in the Work Plan. Appendix A is the Sampling and Analysis Plan (SAP).

The SAP is comprised of a Field Sampling Plan (FSP) and Chemical Data Acquisition Plan (CDAP). The FSP contains specific details on how and where samples will be collected, for what parameters they will be analyzed, and how and where field testing and monitoring will be done. The CDAP describes the procedures to be used to assure that high quality, defensible data are acquired. Appendix B contains a site specific Site Safety and Health Plan which establishes guidelines and requirements for the safety of personnel performing field activities during this investigation.

2.0
SITE BACKGROUND AND PHYSICAL SETTING

2.1 SITE DESCRIPTION

SAEP is an industrial facility which is mostly paved or covered by buildings. Surrounding land uses are mainly light industrial, commercial, and residential.

2.1.1 SITE LOCATION

SAEP is located in Stratford, Connecticut, on the Stratford Point peninsula in the southeast corner of Fairfield County. The plant lies on the borders of the Bridgeport and Milford United States Geological Survey (USGS) Quadrangles (Figure 2-1). Latitudinal and longitudinal coordinates of SAEP are approximately 41°10' North and 73°07' West. The property consists of about 126 acres including about 49 acres of riparian rights along the Housatonic River. Existing property features are shown in Figure 2-2.

2.1.2 SITE OWNERSHIP AND OPERATIONS HISTORY

The SAEP property was used for agriculture until 1929 when the first manufacturing facility was built on about 26 acres. The property has been used for development, manufacture, and assembly of aircraft or engines since 1929. The plant history has been categorized into the following periods:

- 1929 to 1939: Sikorsky Aero Engineering Corporation developed and manufactured sea planes at the Stratford plant from 1929 to 1939.

- 1939 to 1948: Chance Vought Aircraft located its operations at the Stratford plant in 1939, and the company became known as the Vought-Sikorsky Aircraft Division. Sikorsky developed the first helicopter, but left the plant in 1943 because of overcrowding. Chance Vought developed the "Corsair" for U.S. Navy, and mass produced Corsairs during World War II. Chance Vought vacated the Stratford plant in 1948.

- 1948 to 1951: The Stratford plant was idle.

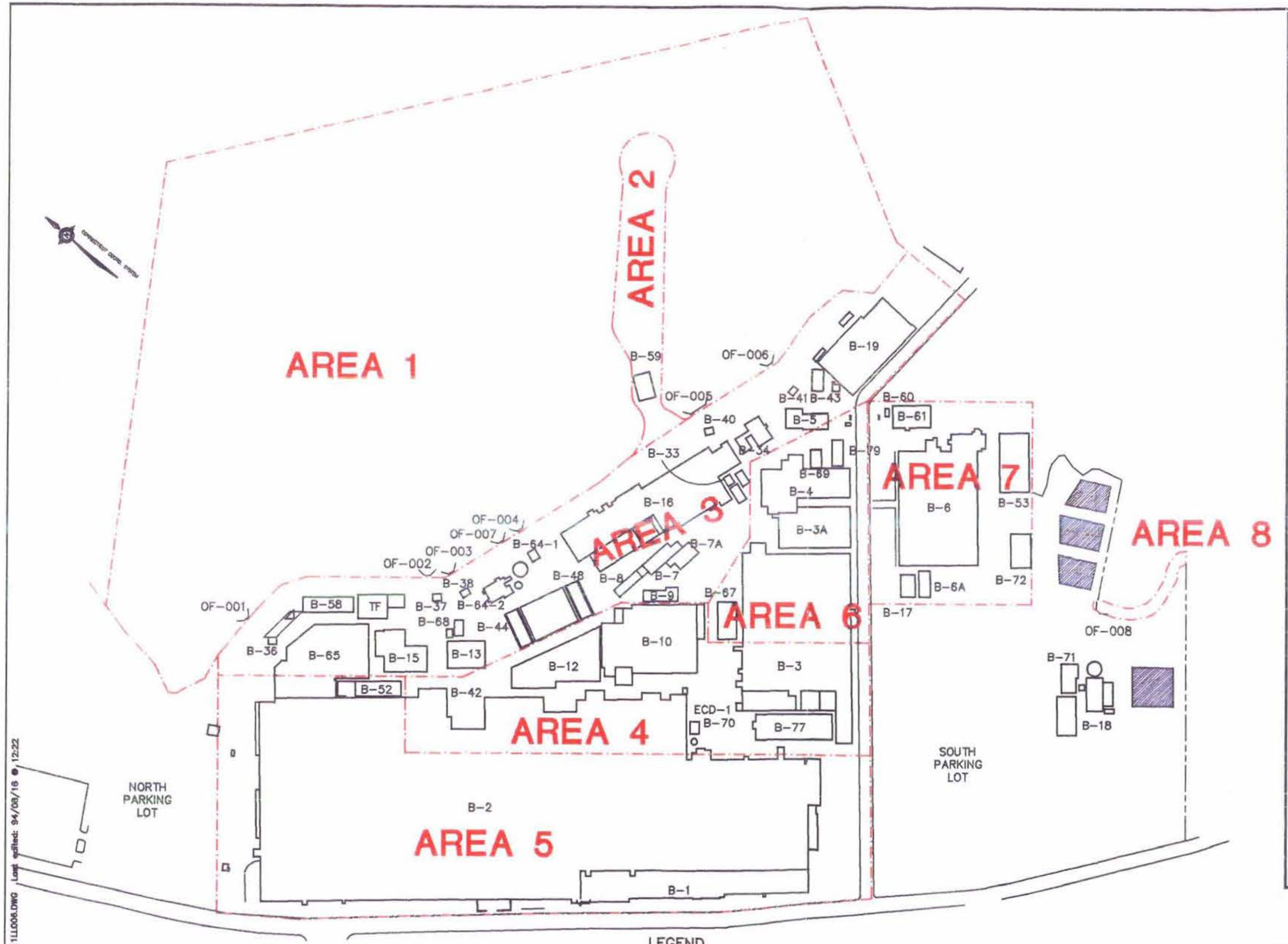
- 1951 to 1976: The U.S. Air Force procured the plant in 1951 and named it Air Force Plant No. 43. The Bridgeport Lycoming Division of the Avco Corporation was contracted by the Air Force to operate the plant. Avco developed and manufactured radial engines in the 1950s, and turbine engines in the 1960s and 1970s.

- 1976 to Present: The plant was transferred from the U.S. Air Force to the Army in 1976; at that time the plant was renamed the Stratford Army Engine Plant (SAEP). Avco was contracted by the Army to develop the AGT-1500 engine to power the Abrams tank. Avco also developed and manufactured marine and industrial engines. Avco merged with Textron in December 1985 and subsequently renamed the division Textron Lycoming. AlliedSignal Aerospace purchased Textron Lycoming in 1994. Today, turbine engines for military and commercial aircraft, as well as land vehicles, continue to be developed, manufactured, and tested at SAEP. Figure 2-2 shows the layout of the site, including building locations.

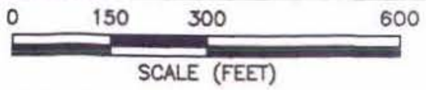
2.1.3 Physical Setting

2.1.3.1 Topography

The SAEP facility is located on the Stratford Point Peninsula, which is at the mouth of the Housatonic River and extends into Long Island Sound. The topography of the peninsula is relatively flat with a gentle slope towards the south. The ground elevations in the site area do not exceed 10 feet above mean sea level. A dike, approximately 10 feet high, was constructed along the edge of the Housatonic River at the eastern edge of the site for flood protection.



BUILDING NUMBER	BUILDING NAME
B-1	MAIN ADMINISTRATIVE & GOVERNMENT OFFICES
B-2	MANUFACTURING OPERATIONS
B-3	RESEARCH & DEVELOPMENT ENGINEERING
B-3A	ENGINEERING LABORATORIES
B-4	STORES AND AGT-1500 REPAIR
B-5	FUEL SYSTEM TEST
B-6	ENGINE ENVIRONMENTAL & COMPONENT TEST
B-6A	ENGINE MECHANICAL COMPONENT TEST
B-7	ENGINE FUEL SYSTEM TEST
B-7A	ENGINE FUEL SYSTEM TEST
B-8	VOLATILE STORAGE
B-9	AUTOMOTIVE MAINTENANCE
B-10	RECUPERATOR MANUFACTURE
B-12	MAINTENANCE DEPARTMENT
B-13	SCRAP & MATERIAL RECLAMATION
B-15	LUBRICATION STORAGE & FIRE HOUSE
B-16	PRODUCTION & DEVELOPMENTAL TEST CELLS
B-17	ENGINEERING TEST FACILITY
B-18	CHEMICAL WASTE TREATMENT PLANT (CWTP)
B-19	COMPONENT TEST FACILITY
B-33	COOLING TOWER PUMP STATION
B-34	FUEL PUMPING STATION
B-36	STORM DRAIN PUMPING STATION (OF-001)
B-37	STORM DRAIN PUMPING STATION (OF-002)
B-38	STORM DRAIN PUMPING STATION (OF-003)
B-40	STORM DRAIN PUMPING STATION (OF-004)
B-41	STORM DRAIN PUMPING STATION (OF-005)
B-42	SPRINKLER BOOST PUMP STATION (400K GAL.)
B-43	FUEL PUMPING STATION
B-44	STORES & CARPENTER SHOP
B-48	ENGINE CONTAINER REBUILD
B-52	STORES & ADJUNCT TO B-2
B-53	SURPLUS EQUIPMENT STORAGE
B-58	QUALITY & TESTING FACILITY
B-59	ENGINEERING STORAGE
B-60	HI-PRESSURE NATURAL GAS PUMPING STATION
B-61	REFRIGERATION PLANT
B-63	CWTP PUMPING STATION
B-64-1	OIL ABATEMENT PLANT PUMP HOUSE
B-64-2	OIL ABATEMENT TREATMENT PLANT (OATP)
B-65	STORAGE FACILITY
B-67	GENERAL STORES
B-68	EMERGENCY GENERATOR
B-69	USACE RESIDENT ENGINEER
B-70	CYANIDE DESTRUCTION FACILITY (CDF)
B-71	CWTP SOLIDS HANDLING
B-72	FUEL PUMPING STATION
B-77	OFFICE
B-79	SSE BUILDING



LEGEND

— - - —	PROPERTY LINE
—·—·—	OUTLINE OF AREA OF POTENTIAL ENVIRONMENTAL CONCERN
OF	OUTFALL
▨	LOCATION OF CLOSED LAGOONS
AREA 1	INTERTIDAL FLATS
AREA 2	CAUSEWAY
AREA 3	HYDRAULIC FILL AREA
AREA 4	PLATING AND MANUFACTURING
AREA 5	BUILDING 2
AREA 6	RESEARCH AND DEVELOPMENT
AREA 7	TESTING AREA
AREA 8	DRAINAGE DITCH

FACILITY BUILDINGS AND AREAS OF POTENTIAL ENVIRONMENTAL CONCERN
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

WOODWARD-CLYDE CONSULTANTS
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
OMAHA, NEBRASKA

DR. BY MVB	SCALE 1" = 300'	DWG. NO. 311LL006	PROJ. NO. C3M11LL
CK'D. BY MEC	DATE AUG 16, 1994	FIG. NO. 2-2	

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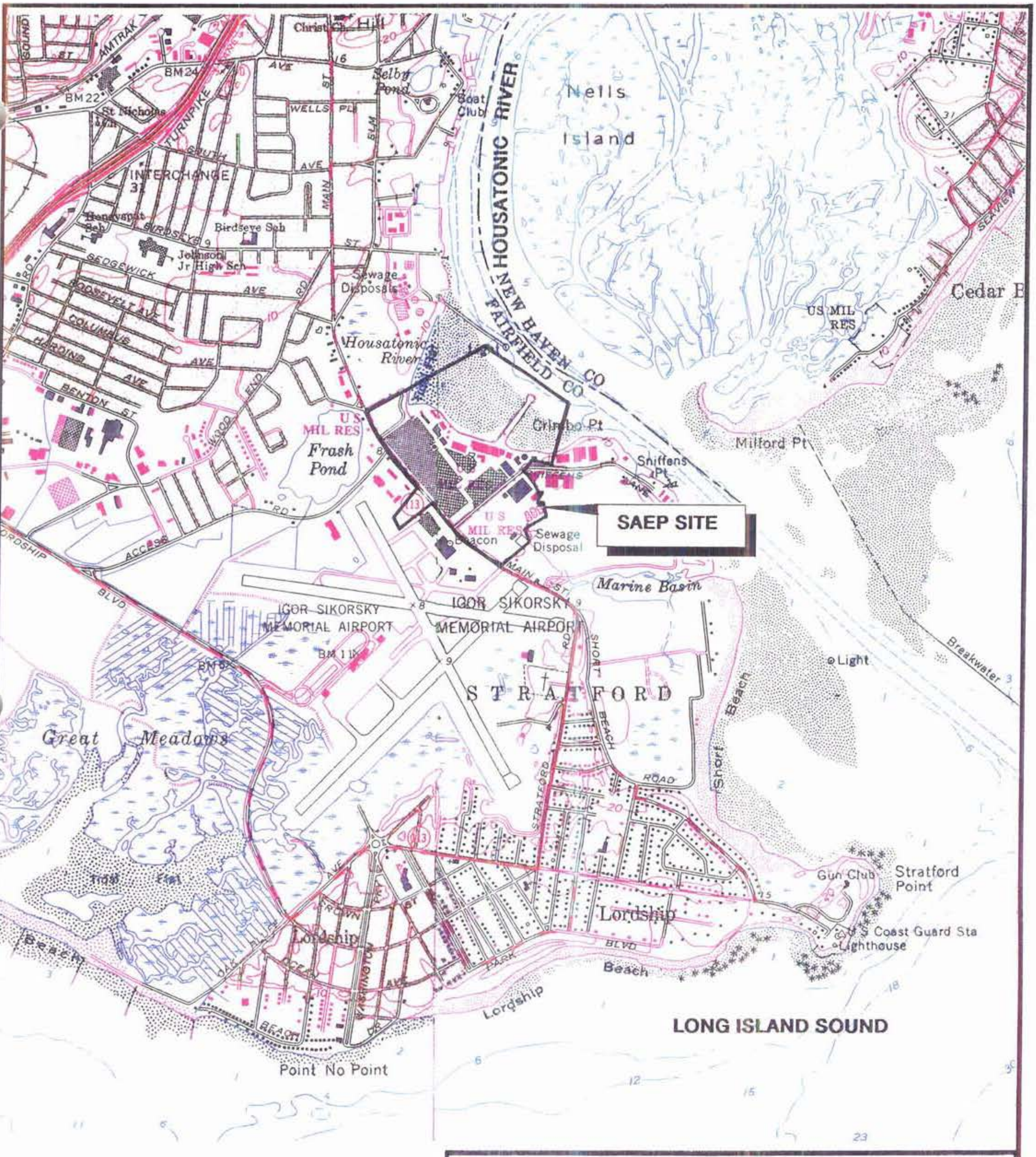


MAP SOURCE:
FROM BRIDGEPORT & MILFORD, CT. USGS QUADRANGLE MAP, 1970 & 1960, PHOTOREVISED 1984.

0 1000 2000 FT
SCALE

WOODWARD – CLYDE CONSULTANTS
ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

VICINITY MAP
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

DR. BY: FWD	DATE: JAN 1992	PROJ. NO:	FIGURE NO.:
CK'D BY: MEC	DATE: JAN 1992	89C114CC	2–1

2.1.3.2 Surface Hydrology

Several surface water bodies are located in the vicinity of SAEP: Long Island Sound, the Housatonic River, Frash Pond, Marine Basin and an associated drainage ditch, and scattered wetland areas (Figure 2-1). Each of these surface water bodies is described below.

Long Island Sound is located less than a mile south of the site. Water level differences between high tide and low tide are typically about 7 feet. Because of the numerous fresh water rivers that empty into the sound, the salinity of Long Island Sound water ranges from about 24 to 28 ‰ , which is less than the 35 to 37 ‰ salinity of oceanic water (Thomson, et al., 1978).

The Housatonic River is the dominant drainage system in the area. The river is located east of the site, flowing southward into Long Island Sound. In the vicinity of the site, the river is an estuary, with low and high tides that range from about 0.0 feet to 7.0 feet above mean sea level (National Oceanic and Atmospheric Administration, 1991). The salinity of the river decreases rapidly upstream, but in the area adjacent to SAEP the salinity ranges from about 17 to 22 ‰ (Connecticut Department of Environmental Protection, 1990).

Frash Pond, located less than 200 feet northwest of SAEP, drains southward via a man-made ditch into the Great Meadows Marsh (southwest of Sikorsky Memorial Airport). Tidal gates were constructed in the ditch to keep the flow unidirectional into the marsh. The gates, however, are reportedly leaking considerable amounts of brackish water back into the pond during high tide (Stratford, Connecticut, 1982). Consequently, the pond is subject to substantial tidal activity and is, therefore, classified as brackish (transitional between fresh water and sea water).

Marine Basin is an inland water body connected to the Housatonic River, and is located about 1,000 feet southeast of SAEP. A drainage system extends from the north into the basin, and one drainage ditch abuts the southeastern edge of the site. This drainage ditch is Area 8 (Figure 2-2). Outfall 008 drains directly into this ditch. Marine Basin and the associated drainage ditch are subject to tidal activity.

scouring the underlying bedrock as they advanced. Striations on local bedrock exposures indicate ice advancement directions between S30°E and S10°W (Flint,1968). Unconformable deposits of till and stratified sand/gravel were deposited as the glaciers retreated. These deposits are of variable thickness.

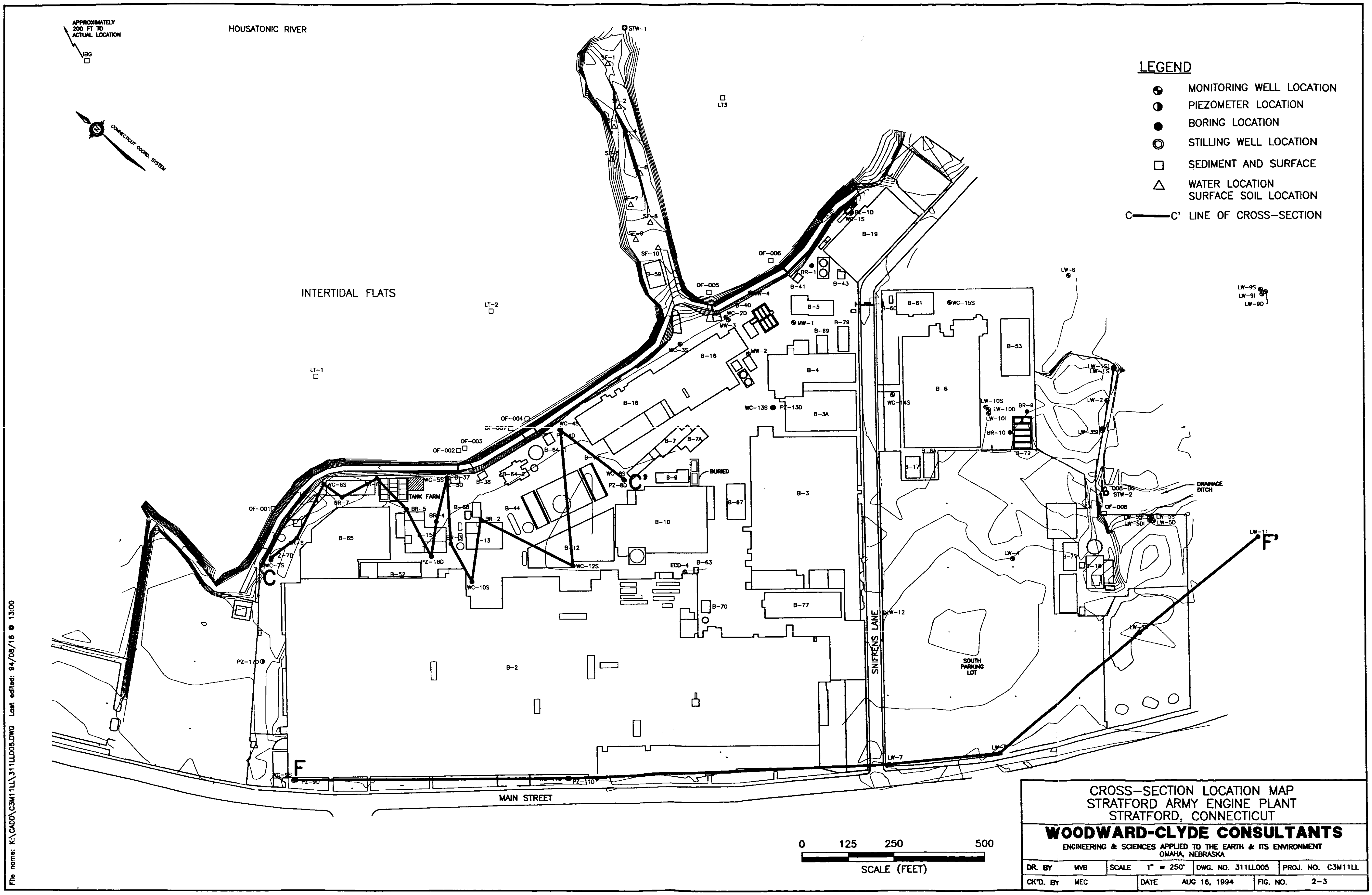
As the glaciers receded further, meltwater from the ice was locally impounded, creating a freshwater lake in what is today Long Island Sound. Glacial streams entering the lake left deltaic sand deposits along coastal Connecticut, including the site vicinity (Stone et al., 1985). Locally, the deltaic sand and gravel deposits are referred to as the Stratford Outwash sediments (Flint, 1968). The southern part of the outwash, in which a portion of the site lies, consists of sand with less than 25% gravel, most of it pebble size (Flint, 1968).

Currently, the glacial deposits are being dissected and locally affected by recent erosional and depositional processes. The Housatonic River has eroded much of the glacial sands from its channel while depositing recent alluvium and estuarine and tidal flat sediments. Locally the bedrock is also unconformably overlain by estuarine sediments. These gray silts, sands, clay, fine organic matter, bits of plants and broken shells comprise a mud with a maximum thickness to 60 ft (Flint, 1968). Area swamp deposits of muddy peat and peaty mud form crude wedge-shaped bodies that thicken seaward. These sediments are underlain by estuarine muds and glacial deposits in the seaward and landward directions, respectively (Flint, 1968). Beach sediments are also being locally deposited over the glacial sediments.

A large part of the area, including a portion of SAEP, consists of artificial fill deposited over all younger deposits (i.e. swamp, estuarine sediments, glacial deposits). Artificial fill of the area is said to include "railroad, road, building construction fill and large accumulations of trash."(Flint, 1968). Mapped artificial fill is typically at least 5 feet thick (Flint, 1968).

2.1.3.4 Site Geology

Based on the subsurface data collected during W-C's, as well as previous investigations (ESE, 1991; Haley and Aldrich, 1987; Metcalf and Eddy, 1987; and Zecco, Inc., 1990), at least five or six distinct stratigraphic units can be identified at the site. These units, from shallow to deep, are artificial fill, peat and silt alluvium, estuarine silt, glacial deposits, and



LEGEND

- ⊕ MONITORING WELL LOCATION
- ◐ PIEZOMETER LOCATION
- ● BORING LOCATION
- ◎ STILLING WELL LOCATION
- ☐ SEDIMENT AND SURFACE
- △ WATER LOCATION
  SURFACE SOIL LOCATION
- C——C' LINE OF CROSS-SECTION

CROSS-SECTION LOCATION MAP
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

WOODWARD-CLYDE CONSULTANTS

ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
OMAHA, NEBRASKA

DR. BY MVB	SCALE 1" = 250'	DWG. NO. 311LL005	PROJ. NO. C3M11LL
CK'D. BY MEC	DATE AUG 16, 1994	FIG. NO. 2-3	

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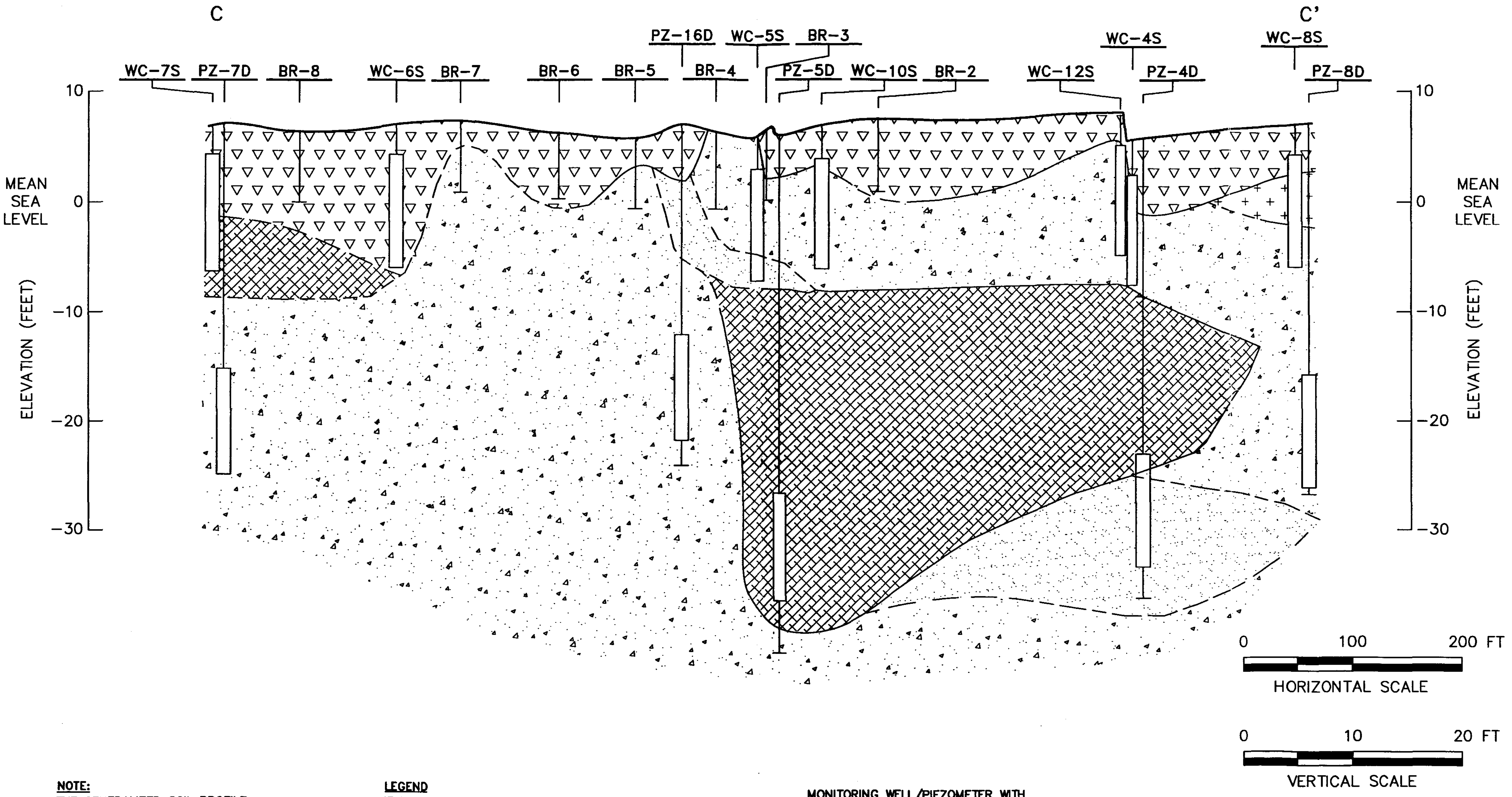

NOTE:
THE GENERALIZED SOIL PROFILE REPRESENTS AN INTERPRETATION OF BORINGS DONE BY WOODWARD-CLYDE CONSULTANTS (1992) AND BORINGS DONE BY OTHERS. ACTUAL SUB-SURFACE CONDITIONS MAY VARY.

LEGEND

▽ FILL

+ PEAT

▨ SILT

⬚ SAND AND SILTY SAND

△ SAND AND GRAVEL

BR-6 TEST BORING

MONITORING WELL/PIEZOMETER WITH SCREENED INTERVAL
WC-7S

LOCATION OF APPROXIMATE STRATIGRAPHIC BOUNDARY DASHED WHERE INFERRED

GEOLOGIC CROSS-SECTION C-C'
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

WOODWARD-CLYDE CONSULTANTS
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DR. BY MG/MVB	SCALE AS SHOWN	DWG. NO. 311LL004	PROJ. NO. C3M11LL
CK'D. BY MEC	DATE NOV 2, 1994	FIG. NO. 2-4	

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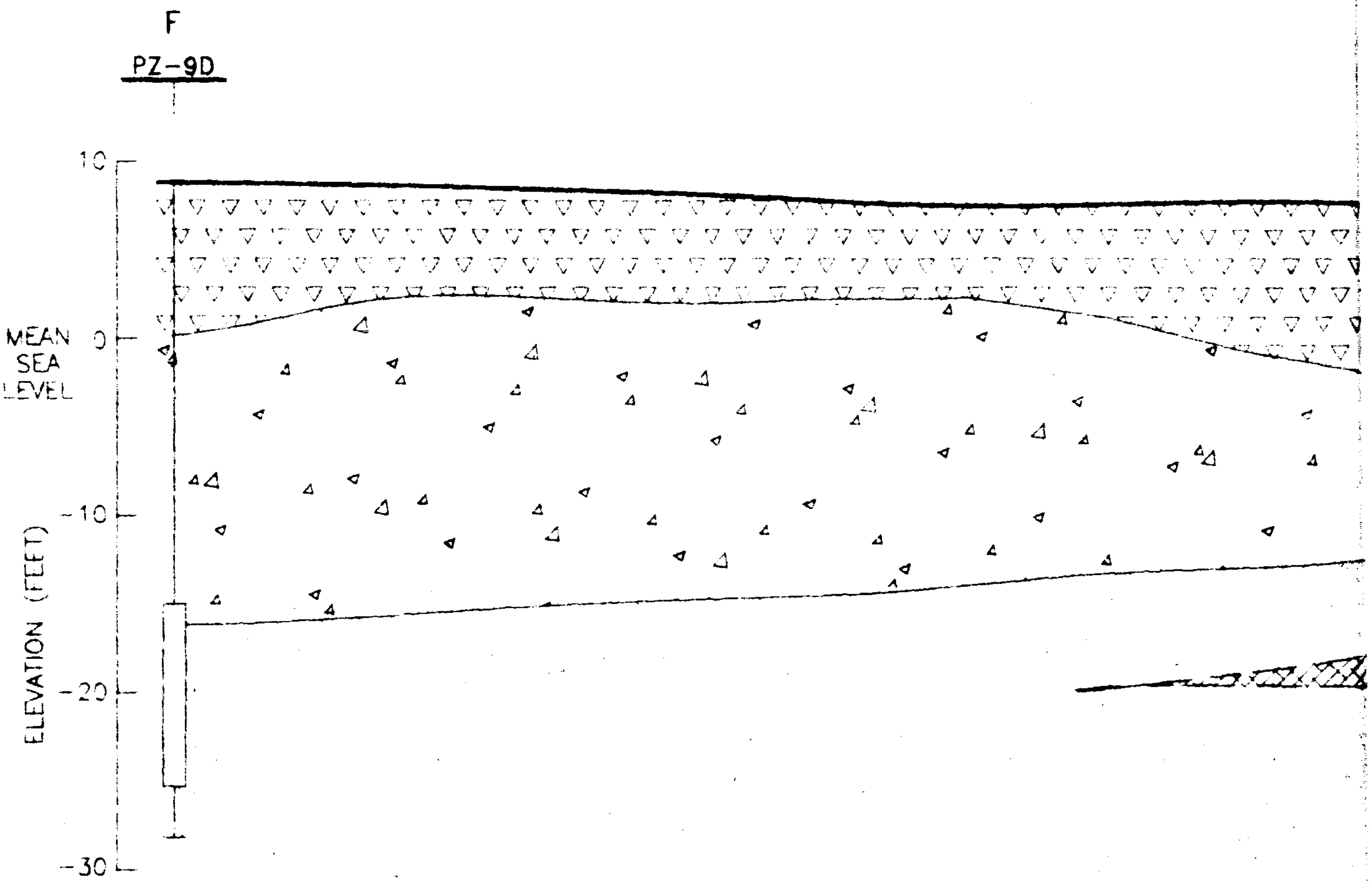

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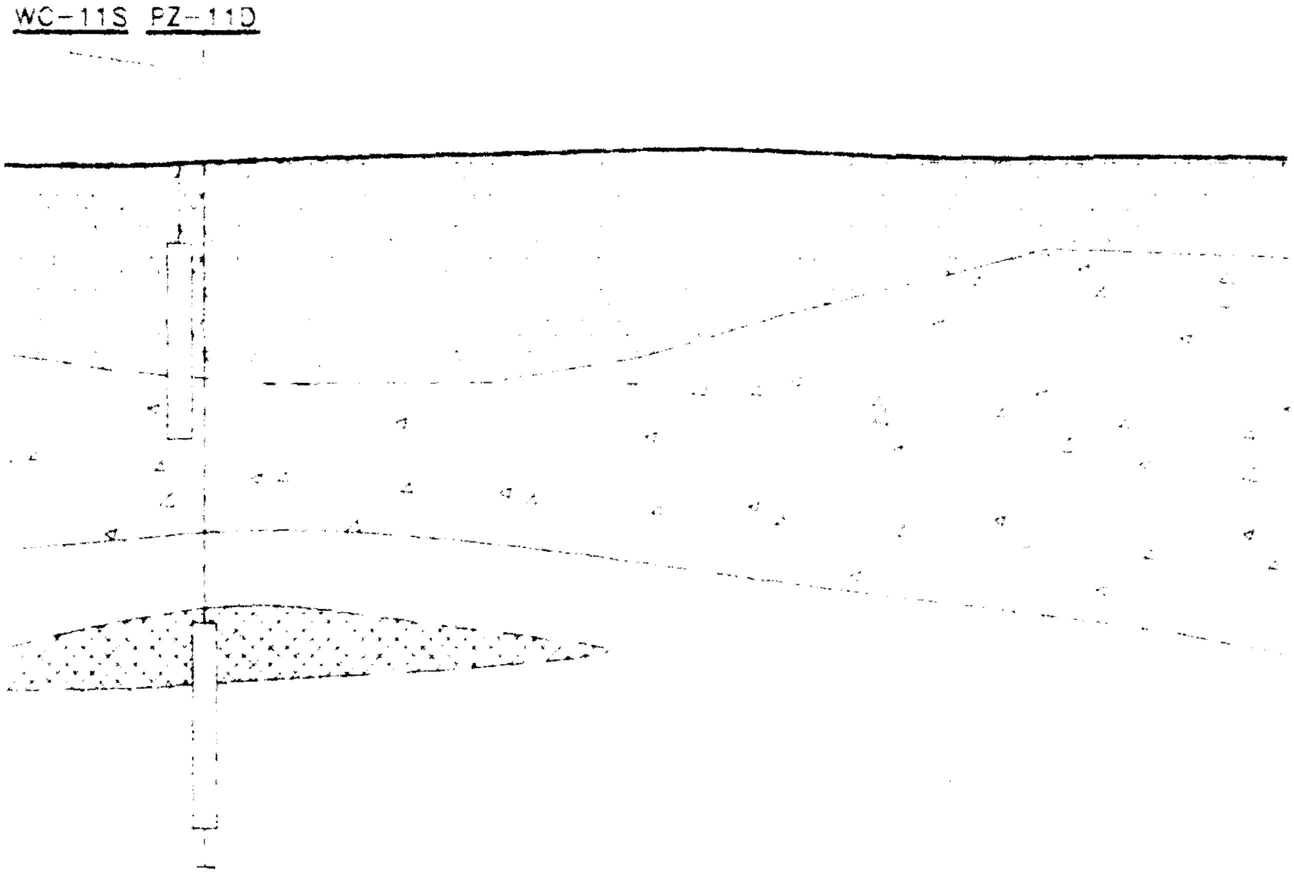
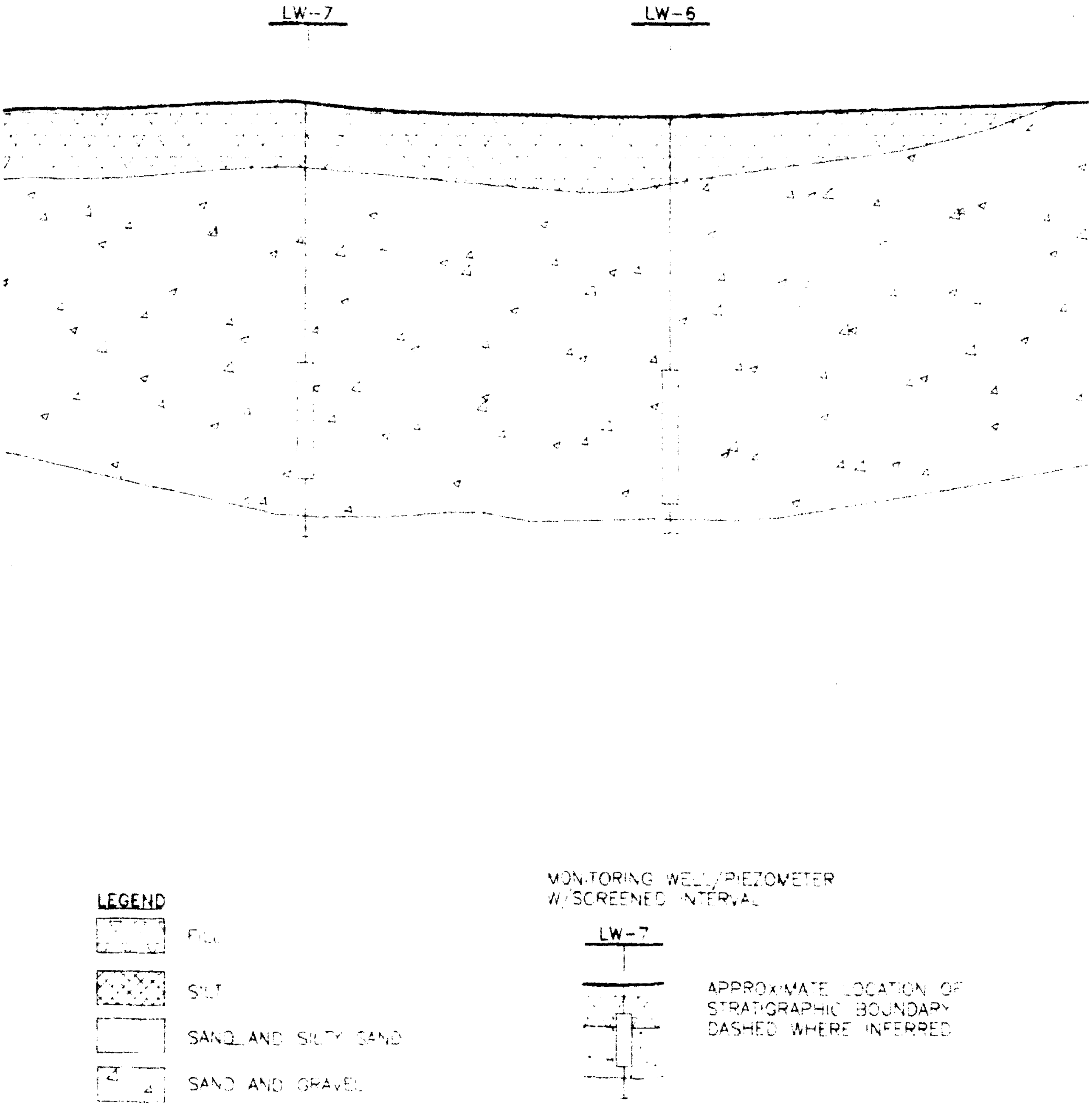
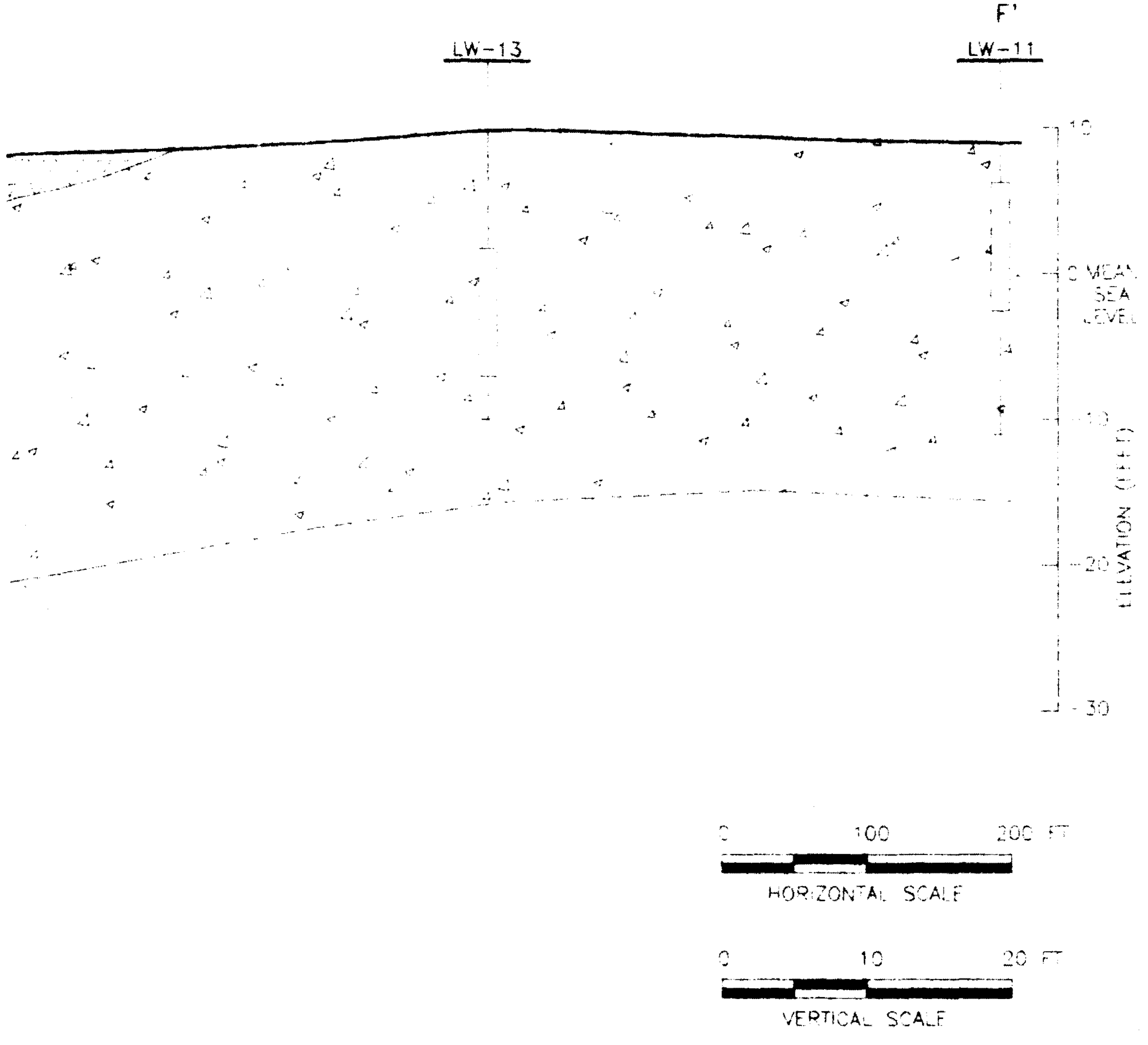


NOTE:
THE GENERALIZED SOIL PROFILE REPRESENTS AN INTERPRETATION OF BORINGS DONE BY WOODWARD-CLYDE CONSULTANTS (1992) AND BORINGS DONE BY OTHERS. ACTUAL SUB-SURFACE CONDITIONS MAY VARY.


LW-7
LW-6
LEGEND
FILL
SILT
SAND AND SILTY SAND
SAND AND GRAVEL
MONITORING WELL/PIEZOMETER
W/SCREENED INTERVAL
LW-7
APPROXIMATE LOCATION OF
STRATIGRAPHIC BOUNDARY
DASHED WHERE INFERRED



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GEOLOGIC CROSS-SECTION F-F'
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

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OMAHA, NEBRASKA

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CKD BY MEC	DATE NOV 2, 1994		FIG. NO. 2-5

Based on borings completed during this investigation, it is possible that a continuous deposit of silt stretches from PZ-7D to BR-1 at a depth of 1 to 9 ft below sea level, a thickness ranging from 2 to 30 ft and an inshore range of approximately 200 to 400 ft. Further borings would be required to confirm the range and continuity of the silt.

Glacial Sediments

Glacial deposits are the dominant sediments at the site. These deposits are reportedly up to 150-ft thick. They consist of uniform sands, silty sand, sands with varying amounts of gravel and boulders, and varved silt. The glacial silt unit has been reported to occur only locally in the vicinity of B-65 (Haley and Aldrich, 1987). A distinct gravel unit is located in the vicinity of PZ-13D and WC-2D.

The glacial sands are fine- to coarse-grained and range in color from gray and yellow to light brown. The glacial silt is distinguished from the estuarine silt by its lighter color and presence of thin laminations of sand or clay (varves).

Bedrock

A competent amphibole-mica schist bedrock was reported at locations LW-5D, LW-9D and LW-10D at depths of 163 ft, 151.5 ft, and 103 ft below grade, respectively (CA Rich Consultants, 1991). One foot of weathered bedrock (162 ft to 163 ft) was reported at LW-5.

A nineteenth century report of massive serpentinite consisting of antigorite with accessory magnetite and carbonate was reported on the site of SAEP (Crowley, 1968). No contemporary confirmation of this report exists.

If the locally N35°E trending trace of the Mixville Fault (Flint, 1968) is extrapolated to the southwest (Rodgers, 1985), across the Housatonic River, it would pass directly under the site, There is not, however, a confirmation of the existence of this fault southwest of its mapped terminus.

Surface Soil

Area 2 (Causeway) was the only area where surface soil samples were collected. samples (SF-1 through SF-10) were collected at a depth of 0 to 6 inches below gro surface. The majority of the causeway was covered with either asphalt, gravel, or de (primarily large pieces of concrete). Vegetation, consisting of various grasses and s small trees and shrubs, also covered much of the causeway.

The surface soil collected was comprised primarily of fine to coarse sands, with some and some gravel. The causeway is a man-made structure and, therefore, the surface located on the causeway is not indicative of surface soil in the site vicinity.

Surface soil was observed (but not sampled) at two additional locations on the facility. locations for monitoring wells WC-14S, WC-9S, and piezometer PZ-9D are within na grassed areas along Main Street and Sniffens Lane. The surface soil in these areas has likely been added or mixed during landscaping. The surface soil in these areas is also likely to be indicative of surface soil in the site vicinity.

The remainder of the facility is covered with asphalt, concrete, or buildings.

2.1.3.5 HYDROGEOLOGY

The data obtained from the hydrogeologic study activities described in W-C's Pha Remedial Investigation Report was used to characterize the groundwater regime at SA The results summarized below include discussions of high and low tide conditions, maxi tidal fluctuations, and vertical gradients.

High Tide

Groundwater flow along the shore line in the deep zone (greater than about 40 ft) o aquifer is generally from the north toward the south (i.e., inland) during high tide condit This phenomenon was observed typically within 500 ft of the shore. It does not appear he incoming tide significantly impacts groundwater levels further inland. Specifically, groundwater flow in the deep zone, near the southern end of the facility (i.e., near Main Street) is from the south toward the north during high tide conditions. These two flow regimes appear to converge near the central portion of the facility, where a relatively flat piezometric surface was observed regardless of the tidal conditions.

Groundwater flow in the shallow zone of the aquifer is generally from the south toward the north during high tide conditions. South of Sniffens Lane, groundwater flow is from the southwest toward the northeast. Groundwater flow in the shallow zone is fairly complex due to the presence of buried utilities, building foundations, and the dike.

Low Tide

Groundwater flow in the deep zone of the aquifer is generally from the south toward the north during low tide conditions. The groundwater surface is relatively flat throughout the majority of the facility. However, the groundwater surface steepens near the shore.

Groundwater flow in the shallow zone of the aquifer is generally from the south toward the north during low tide conditions. The groundwater surface is relatively flat throughout the majority of the facility. However, the groundwater surface steepens near the shore.

Groundwater level data from wells LW-10S and LW-3S were not included in the construction of the shallow groundwater elevation contour maps. There appears to be some local perching of the water table in this area due to the less permeable underlying peat layer.

Tidal Fluctuations

Groundwater levels in seven locations (WC-1S, WC-5S, WC-13S, PZ-1D, PZ-5D, PZ-13D, and PZ-17D) were monitored continuously for up to 79 hours using Aquistar® data loggers. Based on this data it was determined that the maximum change in head is directly related to the distance from the surface water body. The correlation is that the closer a well is to the shoreline, the greater the change in head and the further the well is from the shoreline, the

smaller the change in head. Head changes up to 1.0 ft were measured in the shallow we
Maximum head change in the deep wells was 1.2 ft.

At two well pairs (WC-1S/PZ-1D and WC-5S/PZ-5D) which are adjacent to the shore
(70 and 30 feet, respectively) the deeper well (piezometer) had a greater change in heac
compared to the shallower well of the pair. This indicates that the deeper well is exhibit
semi-confined to confined conditions. This occurs because a semi-confined or confi
aquifer will react faster and with a larger magnitude to a pressure change (tidal change) t
the shallow, unconfined aquifer.

Vertical Gradients

A downward gradient occurs when the head in the shallow well is higher than the head
the deep well. An upward gradient occurs when the head in the shallow well is lower tl
the head in the deep well. These two conditions were compared to determine the verti
gradients near the wells during the six measurement rounds.

Two well pairs adjacent to the river (WC-4S/PZ-4D and WC-5S/PZ-5D) displayed upw
gradients both at low tide and high tide. The WC-4S/PZ-4D pair showed a stronger gradi
at low tide, and the WC-5S/PZ-5D pair showed a stronger gradient during high tide.
upward gradient was measured in the well pair WC-1S/PZ-1D under high tide conditio
The gradient was not consistent during low tide conditions. Three well pairs (WC-8S/P
8D; WC-11S/PZ-11D; and WC-13S/PZ-13D) all have only very slight differences betwe
the shallow and deep wells resulting in very slight vertical gradients that fluctuated betwe
upward and downward. The WC-7S/PZ-7D well pair does not appear to have a clear patte
of gradient direction. The tendency appears to be a potential downward gradient at low ti
and potential upward gradient at high tide. Well pair WC-9S/PZ-9D has a very slig
downward vertical gradient during all measurement periods except during low tide
September 1, 1992. The lagoon well pair LW-9S/LW-9I has a downward vertical gradie
during both high and low tide. This pair had one strong upward vertical gradient duri
high tide B on November 16, 1992. The well pair LW-10S/LW-10I has a very stro
downward vertical gradient. The peat appears to be impeding the downward flow
groundwater and may be creating a perched water table condition.

Hydraulic Conductivities

As part of W-C's Phase I investigations slug tests were performed on 6 monitoring wells and 10 piezometers. Of the 26 tests performed, 19 were classified as valid and were used to produce graphic test plots and analyzed. The Bouwer and Rice solution (1976) from the AqteSolv® computer program was used for analysis of this data.

The geometric mean hydraulic conductivity for the wells tested was calculated to be 3.59 ft/day (1.3 x 10^{-3} cm/sec). Several wells (WC-1S, WC-9S, WC-11S, PZ-13D, and PZ-16D) reacted so quickly during the test that the hydraulic conductivities could not be determined.

In general, hydraulic conductivities were approximately one order of magnitude faster in the shallow wells than in the deep wells. These results appear consistent with observations made during the borehole drilling in that coarser, more permeable materials were encountered at shallower depths.

Salinity Measurements

As part of W-C's Phase I investigations salinity measurements of groundwater were obtained in the wells during the rounds of synoptic water level measurements. In general, salinity increases with depth (i.e., deeper wells had salinity values greater than the shallow and intermediate wells). The salinity values measured ranged from 0 to 5.0 ‰ in the shallow wells; 0 to 6.1 ‰ in the intermediate wells; and 5.0 to 24 ‰ in the deep wells.

The highest salinity values in shallow and intermediate wells were measured in those wells which are either in Area 3 (adjacent to the intertidal flats) or the lagoon wells surrounding the drainage ditch.

Intermediate wells (PZ-7D, PZ-9D, and PZ-17D) on the northwest side of the site had higher values than other intermediate wells. This indicates that brackish water occurs at a shallower depth at the northwest end of the site than at other locations.

All of the six deep wells are located in the southeast end of the site surrounding the dra ditch. The existence of brackish water at depth in this area is consistent with the gec and hydrogeologic conditions in the site vicinity. The deep wells are not screened belc feet outside of the lagoon/drainage ditch area. Therefore, a determination of the exte deep brackish water cannot be made for other areas of the site.

Salinity values in the wells did not change significantly between low and high tide read which indicates that tidal fluctuations most likely do not affect salinity in the shallow or aquifers.

2.2 PREVIOUS ENVIRONMENTAL INVESTIGATIONS

Several previous investigations at SAEP have involved sampling and chemical analys environmental media. In addition, analytical data collected in compliance with permit available. This section of the report briefly summarizes the results of the prev investigations and other analytical work.

2.2.1 National Pollution Discharge Elimination System Permit Monitoring

Water samples collected at Outfalls 007 and 008 (see Figure 2-2) have been analyze compliance with the facility National Pollution Discharge Elimination System (NPD permit. Water discharging from the Oil Abatement Treatment Plant (OATP) goes to Ou 007. Outfall 008 receives discharges from the Chemical Waste Treatment Plant (CW The permitted average daily concentrations (ADC) of certain analytes were exceede different times between 1980 and 1984. For Outfall 007, phenols, total suspended sol and oil and grease occasionally exceeded ADC limits of 0.1, 20, and 10 parts per mil (ppm), respectively. At Outfall 008, the following analytes occasionally exceeded indicated ADC limits: hexavalent chromium (0.1 ppm), total chromium (1.0 ppm), ni (1.0 ppm), cadmium (0.1 ppm), total suspended solids (10 ppm), and pH (maximum 8.75).

The NPDES permit issued in 1985 added outfalls 001, 002, 003, 004, 005, and 006, which discharge intermittent storm water. In addition, permit requirements included maximum daily and average monthly concentrations for various analytes. Textron followed the 1985 NPDES permit conditions while the draft 1990 NPDES permit was reviewed by CDEP. During calendar year 1990, several permit violations were noted (WCC, 1991): average daily flow limitations were exceeded at both outfalls, maximum daily concentration limitations were exceeded for nickel and cyanide, and the limitation for total toxic organics was exceeded.

The 1990 NPDES permit was approved July 10, 1991, and it added toxicity testing to the monitoring program. The first Aquatic Toxicity Monitoring Report (dated November 7, 1991) documented toxicity and analytical results which were within permitted limits.

2.2.2 Buildings B-10 and B-70

Greenish-blue groundwater was observed during construction activities at the cyanide destruction facility (building B-70, mid-1980s) and the recuperator manufacturing building (building B-10, late-1970s). A subsurface investigation was completed in 1986 to evaluate the soils in the area. East Coast Drilling, Inc. drilled ten test borings and collected soil samples for analysis by Environmental Monitoring Laboratory, Inc. Soil samples were collected above and below the water table, and were analyzed for the EP Toxicity metals. No metals were detected in five of the test borings. In the remaining borings, the following metals were detected in the indicated concentration ranges: total chromium (not detected (nd) to 0.64 ppm), hexavalent chromium (nd to 0.42 ppm), copper (nd to 0.34 ppm), and nickel (nd to 0.48 ppm). The maximum concentrations for total and hexavalent chromium were found at 18 to 20 feet below land surface. The highest concentrations of copper and nickel were found at a depth of 8 to 10 feet below land surface. All of the detectable metals occurred at or below the ground water table. Two of these borings were converted to monitoring wells (ECD-1 and ECD-4 on Figure 2-2). These wells were sampled, but results were not available at the time of the preparation of this report.

2.2.3 Discharge Toxicity Evaluation

IPC Corporation performed a discharge toxicity evaluation of Outfalls 007 and 008 in 19 The complete evaluation involved acute toxicity tests towards freshwater and ma organisms, chemical analysis of the effluents, and a dye dispersion study. Effluent sam were collected on three dates.

IPC's report states that the following analytes were detected in effluent samples from Out 007: copper (nd to 0.09 ppm), zinc (0.18 to 0.27 ppm), oil and grease (2 to 5 pp phenols (nd to 0.08 ppm), ammonia (nd to 1.17 ppm), and 1,1,1-trichloroethane (0.058 2.4 ppm). Toxicity testing was conducted with 100% effluent, using Daphnia pulex and fathead minnow as the test organisms (D. pulex is a type of crustacean commonly refer to as "water flea"). One of the three samples, the sample with the maximum obser concentration of 1,1,1-trichloroethane, showed toxicity to D. pulex,. No effects w observed in the test using the fathead minnow.

The following analytes were reported by IPC to be present in effluent samples from Out 008: ammonia (nd to 1.7 ppm), total chromium (nd to 0.40 ppm), hexavalent chromium to 0.05 ppm), copper (0.12 to 2.14 ppm), nickel (nd to 0.13 ppm), zinc (nd to 0.01 pp chloroform (0.007 ppm) and 1,1,1-trichloroethane (0.019 ppm). Toxicity was evalua using mysid shrimp and the sheepshead minnow. Some degree of toxicity was observed both of the organisms. The IPC report suggested that the toxic effects may have b associated with copper concentrations in the effluent. Since the time of the IPC Corporat report, toxicity testing has been added to Textron's NPDES permit monitoring requiremen The first Aquatic Toxicity Monitoring Report (dated November, 1991) documented toxic and analytical results which were within permitted limits.

2.2.4 Tank Farm Near Building B-34

Soil and groundwater conditions in the area near the tank farm at building B-34 (Figure 2-2) were evaluated in a subsurface investigation by Zecco, Inc. (1990). Seven test borings were drilled and soil samples were collected at 5-foot intervals. One soil sample from each boring was composited from all the depths sampled, and was analyzed for total petroleum hydrocarbons (TPH). Four of the borings were converted to monitoring wells, which were sampled and analyzed for volatile organic compounds and TPH.

Analytical results for the composite soil samples show that six of the seven borings contain measurable levels of TPH, ranging from 43 to 5500 ppm. The highest concentrations were in the borings adjacent to B-16 (MW-2 and MW-3 on Figure 2-2). Groundwater from MW-1 contained no detectable TPH or volatile organic compounds. The remaining three wells contained the indicated ranges of the following analytes: TPH (2.9 to 15.0 ppm), benzene (0.017 to 0.620 ppm), ethylbenzene (0.017 to 0.077 ppm), and xylenes (0.009 to 0.086 ppm). The overall highest concentrations of these analytes were in MW-2.

2.2.5 Groundwater Assessment Monitoring Program

Prior to 1989, four lagoons (one equalization lagoon and three sludge storage lagoons) existed on site (Figure 2-5) and were regulated under the Resource Conservation and Recovery Act (RCRA). Spent plating baths were discharged to the equalization lagoon. Wastewater from this lagoon was pumped to a chemical waste treatment plant, converted to a metal hydroxide sludge. The sludge was then pumped to the sludge storage lagoons. Groundwater monitoring wells were installed and sampled beginning in 1981, although changes in the requested analytical parameters resulted in the consideration of the 1983-1984 data as the "first year" of record (Metcalf and Eddy, Inc., 1987). The lagoons were closed in 1989, but the monitoring program continued as required under RCRA closure. Environmental Science and Engineering, Inc. (ESE) completed the most recent monitoring report, the "seventh year" annual summary for 1990. This section summarizes the conclusions of the two groundwater assessment monitoring reports: Metcalf and Eddy, Inc, 1987, and ESE 1991.

Metcalf and Eddy, Inc. (1987) reported that five monitoring wells were installed in 1 two were installed in 1983, and six were installed in 1985, for a total of thirteen monito wells in the lagoon area. The Connecticut Department of Environmental Protection (CD specified the following analytical parameters for the monitoring program: cadmi hexavalent chromium, total chromium, copper, mercury, nickel, zinc, amenable cyan total cyanide, pH, halogenated volatile organics, aromatic volatile organics, spe conductivity, total organic carbon, and total organic halogens. The "first year" res (1983-1984) indicated that Connecticut Public Drinking Water Code (CPDWC) stand were exceeded in samples from wells LW-1 through LW-5 for total chromium, hexava chromium, total cyanide, trichloroethylene, and tetrachloroethylene. In "second y samples (1984-1985), the CPDWC standards at these five wells were exceeded for t chromium and total cyanide. Metcalf and Eddy, Inc. installed six additional monito wells in 1985. The "third year" analytical results (1985-1986) showed that CPD standards were exceeded for total chromium, hexavalent chromium, total cyan trichloroethylene, and tetrachloroethylene at wells LW-1, LW-2, LW-3, and LW-5.

Lagoon closure was completed in 1989, and ESE (1991) presented results for the "sev year" of monitoring (1989-1990). In 1990, an upgradient well (LW-10 on Figure contained cadmium in exceedance of CPDWC standards. The following analytes were ab CPDWC standards in at least one of several wells (LW-1 through LW-5, LW-7, L through LW-10, and LW-12) in 1990, and have varied over the indicated concentrations the entire period of record: cadmium (4-70 ppb), vinyl chloride, 1,1-dichloroethene, trans-dichloroethene (2-6500 ppb), and trichloroethene (2-150 ppb). (Concentration ran for vinyl chloride and 1,1-dichloroethene were not reported.) ESE's statistical analysi the data indicated that the following analytes showed a statistically significant increase in downgradient wells (LW-1 through LW-5, and LW-13) as compared to the upgradient (LW-10): 1,2 trans-dichloroethene, tetrachloroethene, trichloroethene, total organic car (TOC), specific conductance, and pH. Note that these results assume that the source contamination was the closed lagoons. No further conclusions regarding alternative sou of contamination were made in either of the assessment monitoring reports.

2.2.6 Supplementary Hydrogeologic Investigation

CA Rich Consultants, Inc. (CA Rich), of Sea Cliff, NY, has been performing an ongoing hydrogeologic investigation of the lagoon wells in the southern portion of the facility. The latest report discussing this investigation is the Supplementary Hydrogeologic Investigation Report Textron/Lycoming, Stratford, Connecticut, December 1991. Information presented in this report is only for the wells located in Areas 7 and 8 and the South Parking Lot and cannot be extrapolated for the remainder of the site.

The CA Rich investigation was designed to determine hydrogeologic conditions based on the following objectives:

- determine whether there is a vertical contamination pathway across the peat layer;
- determine whether the organic peat layer is continuous using Ground Penetrating Radar and electrical resistivity profiling methods;
- determine the extent and magnitude of tidal influences on the upper glacial aquifer;
- determine the direction of shallow and deep groundwater flow and the horizontal and vertical gradients within each aquifer;
- determine the mean hydraulic conductivity of the upper and lower glacial aquifers; and
- calculate the average linear velocity of horizontal groundwater flow, and calculate the volume of seepage through the organic peat layer.

The results of this investigation are summarized below.

High levels of VOs were detected principally in the upper aquifer, above the peat lay Below the peat layer, the highest concentrations occur in the vicinity of LW-4 and LW-5 and LW-10D. The presence of VOs in the lower aquifer at LW-10D (with lo concentrations in the shallow (LW-10S) and intermediate (LW-10I) wells of the sa cluster), suggested a possible secondary upgradient (from north-northwest) source contamination which may not be associated with the RCRA lagoons. This data indicated t most of the VO contamination was located above the peat layer, but there were also eleva concentrations of VOs below the peat layer.

Due to interference caused by the salinity of the shallow groundwater, neither geophys method used generated adequate results. The thickness and extent of the peat layer estimated by determining vegetation changes from aerial photographs and using geolo boring information. The areal extent was estimated to be 10.5 acres with a maxim thickness of 15 ft.

The tidal influence was found to within 600 feet of the drainage ditch or Marine Basi both the shallow and deep aquifers. Tidal changes in the ditch were not sufficien overcome the natural hydraulic gradient in the adjacent upper aquifer, except during st tides. Therefore, tidal influences did not affect the overall direction and rate of groundw flow in the immediate area of the ditch.

The predominant direction of the shallow groundwater flow was toward the south. Flo the vicinity of former Lagoons 2, 3, and 4 (adjacent to wells LW-1, LW-2, and LW-3 the shallow aquifer was locally radial (toward the southeast, south and west). This are local radial flow generally coincides with the approximate extent of the peat layer. radial flow was considered, by CA Rich, to be a perched groundwater mound. geometric mean horizontal hydraulic gradient for the shallow aquifer was calculated to 0.0046 ft/ft.

The direction of groundwater flow in the aquifer beneath the organic peat layer (lo aquifer) was reported to be toward south-southeast. The horizontal hydraulic gradient in lower aquifer was calculated to be 0.00019 ft/ft.

In all cases the direction of vertical gradient through the organic peat layer was downward, from the upper aquifer down into the lower aquifer.

Slug test data was used to determine the hydraulic conductivity of all the lagoon wells. The slug test results on select wells indicated that the hydraulic conductivity of the upper aquifer ranged from 1.2 ft/day to 79.6 ft/day. The mean hydraulic conductivity of the upper aquifer was calculated to be 15.6 ft/day. The slug test data from selected wells in the lower aquifer indicated that the hydraulic conductivity of the lower aquifer ranged from 0.43 ft/day up to 13.03 ft/day. The geometric mean hydraulic conductivity of the lower aquifer was calculated to be 2.92 ft/day. The mean horizontal hydraulic conductivity of the peat was determined to be 3.1 ft/day.

The horizontal rate of groundwater flow through the upper and lower aquifers wss 0.25 and 0.002 ft/day, respectively. The rate of vertical flow between aquifers through the peat layer was approximately 0.096 ft/day. Consequently, the average rate of horizontal flow through the upper aquifer was approximately 2.6 times the rate of vertical flow through the peat, and 125 times the rate of deeper horizontal flow through the lower aquifer. The volume of seepage between the two aquifers, across the peat, was estimated by CA Rich to be 17,710 ft^3/day (0.0125 million gallons per day per acre).

2.2.7 Preliminary Assessment Screening

A Preliminary Assessment Screening (PAS) was conducted by W-C in 1991 (W-C, December 1991) to determine the potential for, or existence of, environmental contamination and the need for additional investigations. The PAS included a review of SAEP records, interviews with SAEP personnel, review of previous investigations, visual reconnaissance of the facility and surrounding area, and collection of information from other sources.

The PAS investigation identified the following eight areas of potential environmental concern at SAEP:

- Area 1 - Intertidal Flats
- Area 2 - Causeway

- Area 3 - Hydraulic Fill Area
- Area 4 - Plating and Manufacturing
- Area 5 - Building 2
- Area 6 - Research and Development
- Area 7 - Testing Area
- Area 8 - Drainage Ditch

These eight areas are presented on Figure 2-2 with facility buildings. A conceptual mo was developed for each of the eight areas based on information available at that time PAS was done. These models were developed to identify the types of information which w be needed to conduct a baseline risk assessment.

The conceptual models for the eight areas of environmental concern are summarized belo Background information used to develop the models was included in the PAS.

2.2.7.1 Conceptual Model - Area 1 - Intertidal Flats

The Intertidal Flats is an area that may have received hazardous compounds from p discharges and/or runoff from SAEP, as well as from upstream areas of the Housato River. Contaminants which may have been deposited in this area include heavy meta cyanide, polychlorinated biphenyls (PCBs), semi-volatile organic compounds (semi-VOs) a volatile organic compounds (VOs).

The primary potential pathways from the intertidal sediments to human and/or biota recepto are: a) when the flats are exposed during low tides there is a possibility that volatiles present) could be released to the atmosphere; and, b) dermal contact with the sediment humans and biota is possible. Another potential pathway is the ingestion of sediment a surface water by biota and the subsequent consumption of contaminated organisms. Oth potential pathways include direct contact with effluent air emissions from SAEPs discharg to the flats.

2.2.7.2 Conceptual Model - Area 2 - Causeway

The causeway was used for a fire training area and a landfill area. Contaminants of concern include asbestos and polynuclear aromatic hydrocarbons. Contaminated media would be limited to soils within the causeway. Potential pathways include contamination of surface water due to runoff and air releases of asbestos fibers and/or contaminated dust particles. Exposure routes to humans and biota would include ingestion, inhalation and dermal contact. Biota receptors would be limited to terrestrial animals and birds.

2.2.7.3 Conceptual Model - Area 3 - Hydraulic Fill Area

The hydraulic fill area has been used to store, treat, and dispose of materials used at SAEP including metals, fuels, oils and solvents. Contaminants of concern include heavy metals, PCBs, semi-VOs and VOs. Contaminated media would include soil and groundwater.

Because most of this area is paved or covered by buildings, potential pathways to human and/or biota receptors are limited. Groundwater may become a pathway if contaminants migrated into the groundwater which then discharged to sediments and surface water in the intertidal flats.

Potential human receptors would be limited to those involved in intrusive activities (eg. construction) in contaminated soil areas. Potential exposure routes would include inhalation, ingestion, and dermal contact. Potential biota receptors and exposure pathways associated with groundwater discharges would be the same as those described for Area 1 - Intertidal Flats.

2.2.7.4 Conceptual Model - Area 4 - Plating and Manufacturing Area

Area 4 has been used for plating, engine cleaning and manufacturing, and for storage of fuels, solvents and paints. Past disposal and/or uncontrolled releases are known to have contaminated soils and groundwater within this area. Contaminants of concern include heavy metals, cyanide, semi-VOs and VOs.

Because most of this area is paved or covered by buildings, potential pathways to huma and/or biota receptors are limited. Exposure pathways and potential receptors for Area are the same as those described for Area 3.

2.2.7.5 Conceptual Model - Area 5 - Building 2

This area includes most of B-2 (excluding the plating and heat treatment shops) which h been used for assembling aircraft and is presently used for manufacturing gas turbi engines. Past disposal practices and/or uncontrolled releases may have resulted in soil a groundwater contamination. Contaminants of concern include heavy metals, semi-VOs a VOs.

Because most of this area is paved or covered by buildings, potential pathways to huma and/or biota receptors are limited. Exposure pathways and potential receptors for Area are the same as those described for Area 3.

2.2.7.6 Conceptual Model - Area 6 - Research and Development Area

This area has been used for research and development for over 50 years. Metals, fuels, oi and solvents have been handled in the area. Contaminants of concern include heavy metal semi-VOs, and VOs.

Because most of this area is paved or covered by buildings, potential pathways to huma and/or biota receptors are limited. Exposure pathways and potential receptors for Area are the same as those described for Area 3.

2.2.7.7 Conceptual Model - Area 7 - Testing Area

This area contains the steam generating plant and has been used for experimental engi testing and for the storage of fuels. During excavation for lagoon closures, petroleu contaminated soils were reportedly observed within the southern portion of this are Contaminants of concern include heavy metals, semi-VOs, and VOs.

Because most of this area is paved or covered by buildings, potential pathways to human and/or biota receptors are limited. Exposure pathways and potential receptors for Area 7 are the same as those described for Area 3.

2.2.7.8 Conceptual Model - Area 8 - Drainage Ditch

This area includes a drainage ditch that originates at SAEP and flows into Marine Basin. No hazardous materials are handled or generated within this area, but it represents a potential depositional area for contamination from stormwater runoff and effluent from SAEP. Effluent from the CWTP discharges to the ditch under the facility NPDES permit. This discharge has occurred since 1958. Contaminants of concern would primarily include compounds in the CWTP waste stream and, to a lesser extent, chemicals that would be associated with site runoff. These chemicals include heavy metals, cyanide, PCBs, semi-VOs, and VOs.

Potential exposure pathways are direct contact with effluent, air emissions from effluent and/or contaminated sediment (during low tide) and surface water, and direct contact with contaminated sediment and surface water. Potential human receptors include people who may come in contact with effluent, sediment, or surface water in the drainage ditch. Potential biota receptors include organisms that live and/or feed within the ditch and associated riparian areas.

In summary, it was determined that additional data were needed to determine if complete exposure pathways for site-specific contaminants exist. The PAS recommended additional sampling for all eight areas of potential environmental concern.

2.2.8 Phase I Remedial Investigation

In July 1991, the USACE issued a Scope of Work for Work Plan for Remedial Investigation based on the PAS. W-C prepared a Remedial Investigation (RI) Work Plan, dated January 31, 1992, based on the Scope of Work issued by the USACE in July 1991, and implemented the work plan in 1992. The results of this work were presented in a report dated June 1993.

Phase I Remedial Investigation activities included the collection and analysis of physical chemical data at SAEP. Results of the physical characterization (i.e., site geolo hydrogeology, etc.) of the site based on Phase I data are summarized in Section 2.1 Results of the chemical characterization of the site based on Phase I data are summari below. Because no regulatory guidance has been provided regarding this site, and for m media standards do not exist, conclusions and recommendations described below are ba on professional judgement.

2.2.8.1 Phase I Soil Results

Volatile Organics in Soil

- The highest levels of VOs were detected in the vicinity of buildings B-13 B-15. The highest levels were below 10,000 μg/kg (10 mg/kg). At s levels these compounds are probably not of concern in terms of poten human contact or contact with groundwater.
- The types of volatile compounds detected are consistent with past and pres site activities.

Base Neutrals in Soil

- With minor exceptions, BNs were generally detected in total concentratio of less than 15,000 μg/kg (15 mg/kg). At such levels these compounds probably not of concern in terms of potential human contact or contact w groundwater.
- The PAH BNs detected are consistent with past and present site activiti The ubiquitous presence of phthalates is not consistent with site activities.

Acid Extractables in Soil

- The highest concentration of acid extractable compounds was about 6,000 μg/kg (6 mg/kg); most were below 100 μg/kg. At such levels these compounds are probably not of concern in terms of potential human contact or contact with groundwater.

- The source of AE compounds in SAEP soils is not known.

PCBs in Soil

- The levels of PCBs detected in SAEP soils are acceptable for industrial property site use.

- The source of PCBs in the northwest end of Area 3 is not known.

Cyanide in Soil

- Cyanide was not detected and is therefore not an issue for SAEP soils.

Metals in Soil

- Slightly elevated total metal concentrations in SAEP soils may not be of concern in terms of risk based on companion TCLP results. Lead concentrations in the area of buildings B-13 and B-15 will probably become an issue if this soil was to be excavated and disposed.

- Metals detected in SAEP soil appear to be consistent with past and present site activities with the possible exception of antimony.

2.2.8.2 Phase I Groundwater Results

Volatile Organics in Groundwater

- Shallow groundwater appears to have been impacted by releases of solve and/or waste solvents, primarily chlorinated hydrocarbons.

- The highest concentrations of chlorinated compounds are in areas adjacent solvent storage tanks and/or degreaser areas indicating these areas are or w possible sources of shallow groundwater contamination.

- The difference in the contaminants detected in deep wells WC-2D and PZ- suggests different sources of contamination. The very low ground wa gradients make it impossible to conclusively state that there is an off- source of the deep contamination in PZ-9D.

- WC-2D may be more contaminated than the adjacent shallow well becaus

    - the shallow water bearing zone is subject to "flushing" by tidal effe thus removing the residual sources; and/or
    - there may be an unidentified upgradient source from wh constituents have migrated downward into the deeper zone.

- There is, in most wells, a decrease in contaminant concentration fr Round 1 to Round 2. This could be a function of a higher groundwater le accessing the residual source in the soil to a larger extent in Round 1.

- There is also evidence that there has been a release(s) of gasoline or kerose (jet fuel). This is evidenced by the presence of BTEX compounds at number of locations.

Base Neutral/Acid Extractables in Groundwater

- BN/AE compounds have not significantly impacted groundwater quality in the shallow aquifer.

PCBs/Cyanide in Groundwater

- Neither PCBs nor Cyanide have impacted groundwater quality in the shallow aquifer.

Metals in Groundwater

- There is no pattern to the distribution of wells that have exceedances of one or more metals. Exceedances are randomly distributed across the site with the majority and highest exceedances occurring in wells in Area 3 adjacent to the tidal flats, and in Area 4 wells.

- The metals most frequently found in the groundwater are consistent with site activities (plating, manufacturing, etc.).

- The metals found in groundwater were consistent with those found in the soil (with the exception of antimony which was not found in exceedance of the Safe Drinking Water Act Maximum Contaminant Levels (MCLs) in groundwater).

2.2.8.3 Phase I Sediment Results

Volatile Organics in Sediment

- Volatile organic compounds have not significantly impacted sediment at the locations sampled except at the tidal flat outfall location 02 near the tank farm. Sediment at this location appears to have been impacted by release(s) of gasoline or kerosene (jet fuel) as evidenced by the presence of BTEX compounds. This location is also near the shallow monitoring wells where highest concentrations of VOs were detected in groundwater.

Base/Neutrals in Sediment

- Elevated levels of PAHs were detected in the sediment samples from most the tidal flat outfall locations, from the three tidal flat locations and from two Area 8 tidal drainage ditch locations. No PAHs were detected in intertidal background samples. Sediment at these locations appear to ha been impacted by a petroleum product related release(s). The vertical ext of PAH contamination was not defined at most sample locations evidenced the fact that PAHs were detected in the deep (12 to 24 inches) as well as shallow (0 to 12 inches) samples with some locations having higher deep PA concentrations than the shallow samples.

- Phthalates were detected in both the on-site samples as well as in the interti background samples, and, therefore, may not be attributable to releases fr SAEP.

- The sediment at the locations sampled has not been significantly impacted halogenated hydrocarbons.

- Elevated levels of miscellaneous BNs were detected in the Area 8 ti drainage ditch sediment samples.

Acid Extractables in Sediment

- The sediment at the locations sampled has not been significantly impacted acid extractable compounds.

PCBs in Sediment

- PCBs were detected at more than half the sample locations with the shallow and deep samples from the tidal flat outfall location 02 having significantly higher (greater than an order of magnitude) concentrations than the other locations. The fact that no PCBs were detected in the intertidal background sample suggests that their occurrence may be related to past or present SAEP activities.

Cyanide in Sediment

- Elevated levels of cyanide were detected in samples from the two Area 8 tidal drainage ditch locations as well as from the tidal flat outfall locations 04 and 05.

Metals in Sediment

- Elevated levels of metals, relative to the intertidal background samples, were detected in most of the sediment samples from the site, with the concentrations of some metals being one to two orders of magnitude more than the intertidal background samples. The metals detected in elevated concentrations are consistent with past and present site activities.

2.2.8.4 Phase I Surface Water Results

Volatile Organics in Surface Water

- The low concentrations of halogenated aliphatics detected in surface water samples from the intertidal outfall locations 04 and 07 as well as from the two Area 8 tidal drainage ditch locations are probably associated with the effluent from outfalls 07 and 08. These outfalls were continuously discharging at the time of the sampling. These low concentrations may have little impact on the marine aquatic life in the adjacent waters because the effluent is diluted relatively quickly evidenced by the fact that these analytes were either detected, or detected at very low concentrations, at the tidal flat sam locations.

- The concentrations of the ketone 2-propanone in samples from the Are tidal drainage ditch are probably associated with the effluent from Outfall which was continuously discharging at the time the samples were collecte

- Monocyclic aromatic hydrocarbons have not impacted surface water qua in the vicinity of the SAEP.

Base/Neutrals in Surface Water

- PAHs were only detected at very low concentrations at two sample locati and have not impacted surface water quality.

Acid Extractables in Surface Water

- Acid extractables were only detected at very low concentrations at two sam locations and have not affected surface water quality.

Cyanide in Surface Water

- Cyanide was only detected in the sample from the tidal flat outfall location at a concentration which exceeds the EPA acute and chronic criteria for protection of marine aquatic life. Even though the concentration of cyan exceeds the criteria it may not impact marine aquatic life based the fact t USEPA developed the criteria on an acid soluble concentration basis and criteria may be overly protective.

Metals in Surface Water

- Elevated levels of some metals, relative to the intertidal background samples, were detected in more than half of the surface water samples from the tidal flat outfall locations and Area 8 tidal drainage ditch location 08-BG. The concentrations of some metals were an order of magnitude more than the intertidal background sample. The relatively high concentrations of some metals at these locations are probably associated with manufacturing processes at SAEP. The elevated concentrations of these metals appear to be diluted relatively quickly because the concentrations of these metals detected in the three tidal flat samples located a few hundred feet away were considerably lower than those detected in the tidal flat outfall location samples. Even though there were some exceedances of the USEPA acute and chronic criteria for copper, lead, mercury and zinc at some sample locations, marine aquatic life may not be impacted on the basis that the USEPA developed the criteria on an acid soluble concentration basis and the criteria may be overly protective.

2.2.8.5 Recommendations

Based on the findings summarized above, the following recommendations were made in the Phase I Remedial Investigation Report.

Soil Recommendations

Assuming that the site continues to be used for industrial purposes, concentrations of organics detected in unsaturated soils (i.e., above the groundwater table) in the areas investigated do not warrant further investigation or remediation. If soils in the area of B-13 and B-15 (Area 3) are exhumed, they should be further analyzed so that they can be disposed in accordance with appropriate regulations. This recommendation is based on the level of leachable lead in a sample from that area. Given that the soil is beneath a paved area and the lead exceedance occurred in only one sample, remediation is not recommended.

Groundwater Recommendations

Contamination of groundwater beneath the site has the potential to adversely affect environment in two ways: it could degrade the groundwater quality rendering it unus as a drinking water source; or it could degrade the quality of the surface water and sedin to which the groundwater discharges. Based on the Connecticut classification of groundw in this area, water beneath the site will not be used as a drinking water source. Theref the only potential adverse affect of contamination in groundwater beneath the site is degradation of sediment and surface water quality.

A comparison of constituents which may be of concern in groundwater, sediment and sur water suggests that the metals detected in sediments may be related to groundw discharges. Additional investigations (transport pathway analysis and/or modelling) w be required to determine whether metals in sediments were accumulated during histor outfall discharges, or are continually being deposited by current groundwater dischar Based on these results, a determination could be made regarding the need for groundw treatment.

In addition to the investigation described above, one anomalous finding warrants fur investigation. Elevated (greater than 10,000 ug/l) levels of halogenated aliphatics w detected in the first-round samples from piezometer PZ-9D. The source and extent of contamination in unknown. Further assessment of this contamination should be perfor by sampling other deep piezometers in the area downgradient of PZ-9D.

Sediment Recommendations

Additional sediment sampling is recommended to determine if PAHs and PCBs detecte sediment samples are adversely affecting the environment. Analyses should include chem analyses and toxicity testing, and tests required to normalize the data such as total orga carbon and grain size analysis. The goal of additional investigations should be to furt define the extent of contamination and determine its impact on the environment (i determine whether remediation is necessary).

Surface Water Recommendations

Concentrations of constituents detected in surface water samples suggest that this medium has not been significantly impacted by the site. No further actions or investigations are recommended for surface water.

3.0
WORK PLAN RATIONALE

3.1 FEDERAL, STATE, AND LOCAL ENVIRONMENTAL CRITERIA AND PERMITS

Federal, state, and local laws and statutes were reviewed for two purposes: 1) to determine if permits are required for the remedial investigation activities, and 2) to evaluate the environmental criteria against which analytical results will be compared. The review included documented telephone conversations with Connecticut Department of Environmental Protection (CDEP) employees and Town of Stratford employees. These conversations confirmed the contents of existing laws and statutes, and further clarified non-statutory policy pertaining to environmental criteria.

Permits are not required for three site investigation activities: 1) borings (based on a telephone conversation with Tony Bobowicz, CDEP, August 19, 1994); 2) monitoring well installation (based on same telephone conversation); and 3) sediment sampling in the intertidal flat area (based on a telephone conversation with Jeff Shamas, Stratford Conservation Officer, August 19, 1994). Because other investigation activities (sampling and testing) will take place within the property boundaries of SAEP, they will not require a permit. Collection of shellfish from the intertidal flats and Housatonic River will require a collection permit from the CDEP, Department of Agriculture, Aquaculture division.

Connecticut water quality standards and drinking water regulations were reviewed to determine if state environmental criteria are directly applicable to this investigation. Connecticut has promulgated a water quality classification system for ground water and surface waters. Groundwater beneath SAEP is classified as GB (phone conversation with CDEP and CDEP map of water quality classification): groundwater within highly urbanized areas or areas of intense industrial activity and where a public water supply is available; this water may not be suitable for human consumption. Based on this classification it may become necessary, though unlikely, to compare groundwater analytical results to Connecticut Health Department Drinking Water Standards.

As reported in the PAS, the coastal and marine surface waters in the vicinity of the faci are classified as SC/SB (Long Island Sound, Housatonic River, Marine Basin and drainage ditch). The SC/SB classification signifies that surface water quality is impair and that a goal of SB classification (wildlife habitat, suitable for recreation and indust uses) exists. Frash Pond is unclassified and therefore defaults to an SA classificat (wildlife habitat, suitable for shellfish harvesting and recreation). EPA water quality crite for acute and chronic effects on freshwater and saltwater aquatic life were published pursu to the Clean Water Act, and CDEP refers to these criteria. These criteria are guidelines a are not enforceable (phone conversation with T. Bobowicz, CDEP, 17 October 1991).

There are no regulatory criteria for contaminated soils in Connecticut, and CDEP person have stated that criteria are developed on a "case-by-case" basis. However, CDEP developed guidelines for the removal and disposal of soils contaminated with metals a cyanide which are related to the groundwater classification system. For metals in areas w a groundwater classification GB, soils are to be tested with the Toxicity Characteris Leaching Procedure (TCLP). The soil guidelines for metals and cyanide are multiples criteria from CPDWC (Table 3-1). For hydrocarbons and cyanide, soils are to be tes using the appropriate EPA SW-846 analytical method. Again, these are guidelines, a criteria for remedial activities are determined on a case-by-case basis by CDEP.

There are presently no promulgated federal or state regulatory clean-up criteria contaminated sediments. However, the CDEP considers three levels of contamination wh reviewing Long Island Sound dredged material disposal permits; low, medium, amd hig These levels come from the New England River Basin Commission's "Interim Plan for t Disposal of Dredged Material from Long Island Sound" (June 20, 1980), and are only list for nine metals (phone conversation with George Whisker, CDEP July 7, 1994). The thr levels of contamination for the selected metals are given in Table 3-2.

3.2 DATA QUALITY OBJECTIVES

Data quality objectives (DQOs) are established to ensure that the data collected are sufficie and of adequate quality for their intended uses. For SAEP, the data from the remedi investigation sampling described herein will be used to determine the extent of contaminati

TABLE 3-1

REGULATORY GUIDELINES FOR SOIL
STATE OF CONNECTICUT

Analyte	Connecticut Drinking Water Criteria	Soil Guidelines Using TCLP Results		
		Noncontaminated (Concentration = one to ten times drinking water criteria)	Contaminated (Concentration = ten to thirty times drinking water criteria)	Hazardous (Concentration > thirty times drinking water criteria)
Arsenic	0.05	0.05-0.50	0.50-1.5	>1.5
Barium	1	1.0-10	10.0-30.0	>30.0
Cadmium	0.01	0.01-0.10	0.1-0.3	>0.3
Chromium	0.05	0.05-0.50	0.50-1.5	>1.5
Cyanide	0.2	0.2-2.0	2.0-6	>6
Lead	0.02	0.02-0.20	0.20-0.6	>0.6
Mercury	0.002	0.002-0.02	0.02-0.06	>0.06
Selenium	0.01	0.01-0.10	0.10-0.30	>0.30
Silver	0.05	0.05-0.50	0.50-1.5	>1.5
Total Petroleum Hydrocarbons		See (3)	See (3)	See (3)

TE:

All concentrations in parts per million (ppm)

CTDEP determines cleanup levels for soil on a case-by-case basis. These guidelines are based on a groundwater classification of GB. The concentration ranges for each category above (noncontaminated, contaminated, and hazardous soil) are general guidelines only. Soils are to be tested using the Toxicity Characteristic Leaching Procedure (TCLP).

In areas with groundwater classification GB, soils with TPH greater than background must be excavated. If TPH is greater than 50 ppm, the soil is considered to be hazardous waste. Representative background samples must be approved by CTDEP.

TABLE 3-2

LONG ISLAND SOUND
DREDGED MATERIAL CONTAMINATION LEVELS

Analyte	**Level of Contamination**		
	Low	**Moderate**	**High**
Mercury	<0.5	0.5-1.5	>1.5
Lead	<100	100-200	>200
Zinc	<200	200-400	>400
Arsenic	<10	10-20	>20
Cadmium	<3	3-7	>7
Chromium	<100	100-300	>300
Copper	<200	200-400	>400
Nickel	<50	50-100	>100
Vanadium	<75	75-125	>125

NOTE: Concentrations of PCB's of 1.0 parts per million (ppm) will be considered as confirmation of high contamination.

in sediment, groundwater, soil, and potentially in biota. Extent of contaminants could be determined using field screening or field analytical techniques (EPA Analytical Support Levels I and II). However, in order for data to be defensible and confirmational, a higher level of precision and accuracy is needed. This higher level will allow the data to be used to augment any future investigations which may be needed for additional delineation; therefore, sample analysis will be conducted by an off-site laboratory using EPA-approved methodologies (EPA Analytical Support Level III). The methodologies used will be those presented in EPA SW-846.

CDEP determines cleanup levels for soil on a case-by-case basis. However, multiples of CPDWC criteria for inorganics are used as general guidelines for various excavation and disposal options (Table 3-1). These guidelines are based on TCLP analyses. Because the soil sampling to be conducted under this Phase of the RI is primarily off site, and not expected to result in excavation or disposal remediations, soil samples will be analyzed for total analyte content rather than by TCLP analyses.

Based on the history of compounds used at the site, nearly all samples will be analyzed for the presence of Target Compounds List (TCL) VOs and Priority Pollutant Metals. In some areas samples will also be analyzed for PAHs and the presence of PCBs.

Detection levels need to be sufficiently low to allow comparison of results to regulatory standards or guidance. Groundwater beneath the site is classified as potentially non-potable according to CDEPs classification system; however, it may be necessary to compare analytical results to Connecticut Health Department Drinking Water Standards. This list of standards is a combination of both Connecticut's numbers and EPA MCLs. Laboratory detection limits for compounds with Standards are lower than the Standards.

Risk assessment often requires a sample quantitation limit at or below the detection limit provided by routine analytical methods for many chemicals of toxicological concern. The sample quantitation limits vary according to sample medium. The qantitation limits for chemicals in water samples are often far lower than for the same chemicals in soils and sediments because of interferences caused by co-extractable components in the soil and sediments. These interferences are most problematic when chemicals are at concentrations near the detection limit. Analytical methods have been selected which should provide the required detection limits. The methods that will be used and their detection limits are discussed in the CDAP.

3.3 WORK PLAN APPROACH

3.3.1 Introduction

The primary objective of Phase I of this RI was to evaluate the presence or absence of contamination at the site. The primary objectives of Phase II of this RI are to delineate contamination and obtain the additional information needed for developing a Risk Assessment for the site. The overall approach to Phase II field sampling will be to evaluate the extent and biological effects of contamination which was identified in Phase I. The data from Phase I and Phase II will form part of the data set for the Baseline Risk Assessment.

As with the Phase I investigation, sampling will focus on the two major exposure pathways identified in the PAS:

- releases to sediment potentially resulting from discharge from outfalls in Areas 1 and 8 (see Figure 2-2); and,
- releases to subsurface soils from disposal, spills, or leaks with potential for leaching to groundwater and subsequent migration of groundwater to sediment in the Housatonic River (see Figure 2-2).

The environmental media of concern to be sampled are:

- sediment and biota in the intertidal flats and the Housatonic River and connected waterways adjacent to the site;
- groundwater beneath the site; and,
- subsurface soils in on-shore areas.

Environmental data from the Phase I and Phase II investigations will be used to develop a Baseline Risk Assessment (BRA). The Assesment will evaluate site-related risks to human health and biota.

The overall approachs to sampling each medium and to developing the Baseline Risk Assessment are summarized in the following sections. Specific details regarding sampling are contained in the Field Sampling Plan (FSP) and Chemical Data Aquisition Plan (CDAP).

3.3.1.1 Overall Approach to Sediment and Benthos Sampling

Sediment chemistry, toxicity testing, tissue analysis and benthic community analyses will be performed to evaluate sediment contamination in the vicinity of SAEP.

Sediment samples will be collected from four areas as follows: intertidal flats, drainage ditch, downstream and upstream of SAEP. The vertical extent of contamination will be determined by collecting samples at two depth intervals (0-6 inches and 2 to 4 feet) at each location. Sediment samples will be collected from the intertidal flats adjacent to the site along transects extending away from the potential sources of contamination (i.e. outfalls) to determine the lateral extent of contamination identified in Phase I investigations. Sediment samples will also be collected from drainageways in Area 8. Because of potential for sediment movement from tidal action, sediment samples will also be collected from one location downstream from SAEP, in the Housatonic River. Because of the potential for sediment contamination from upstream sources, sediment samples will be collected from two upstream locations which are presumed to be unaffected by SAEP activities.

Sediment samples will be analyzed for PAHs, PCBs, and Priority Pollutant Metals (Table 3-3). These parameters were selected based on the results of Phase I sediment analyses.

In order to determine the effects of sediment contamination on organisms living on or in the sediment, sediment will be tested for toxicological effects. Biota tissue will be analyzed for contaminant content, and the distribution of the benthic macroinvertebrate community will be studied.

TABLE 3-3
SAMPLING MEDIA AND CONTAMINANTS OF CONCERN

SAMPLE MEDIA	CONTAMINANTS OF CONCERN(1)
Sediment	PP Metals, PAHs, and PCBs
Soil	PP Metals and VOs
Groundwater	PP Metals and VOs
Biota	Mercury, Cadmium, Chromium, Nickel, Lead, PCBs

(1) PP Metals = Priority Pollutant List metals
PAHs = Polycyclic aromatic hydrocarbons
VOs = Volatile organic compounds
PCBs = Polychlorinated biphenyls

Sediment toxicity testing will be performed using the amphipod *Ampelisca abdita* following ASTM method E 1367-90. Using this protocol, the amphipods are directly exposed to the sediment, allowed to bury themselves and consume whatever foodstuffs are available. At the end of the testing period the organisms are assessed for any toxic response.

To determine whether organisms living adjacent to the site are accumulating site related contaminants in their tissues, biological tissues (if available) will be sampled and analyzed for mercury, cadmium, chromium, nickel, lead, PCBs, percent moisture and percent lipids. These parameters were selected based on their bioaccumulation potential, apparent relation to previous site activities, and detection in sediment samples during the Phase I investigation. Should they occur in sufficient numbers in the intertidal flats, sedentary species such as blue mussel (*Mytilus edulis*), hard clam (*Mercenaria mercenaria*), or Eastern oyster (*Crassostrea virginica*) will be collected for tissue analysis. Because these organisms are consumed by other aquatic organisms as well as humans, these data can be used in both the Human Health and Envrionmental Evaluation portions of the BRA.

To determine whether the sediments adjacent to SAEP are negatively affecting the resident benthic macroinvertebrate community, benthic sampling will be conducted at the same locations where samples for solid phase toxicity testing are collected, including the three background locations. The samples will be taken to the laboratory and sorted. The data will provide an estimation of density (number of individuals per unit area) and species richness (number of different types of organisms) at each location, which will be compared to the reference locations and any other available benthic invertebrate data for nearby areas (if any).

3.3.1.2 Overall Approach to Groundwater Sampling

Chemicals that have entered groundwater tend to travel horizontally away from the source in a downgradient direction. In the Phase I site investigations, groundwater monitoring wells were positioned downgradient of a number of potential sources to evaluate the effect of these individual sources on groundwater quality, and upgradient to monitor the quality of groundwater entering the area (background conditions). The results of the Phase I investigations indicated that shallow and deep groundwater at one of the presumed upgradient locations was contaminated. Phase II groundwater investigations will focus on delineating the contamination by installing and sampling additional wells in that area. In addition, The Phase II investigations will include a complete round of samples from all of the wells on site to confirm previous results and supply additional data for the BRA.

Samples from all monitoring wells will be analyzed for TCL VOs plus a 10 compound library search, and total metals. The library search is used to tentatively identify the 10 highest chromatogram peaks, other than those peaks for TCL compounds. The computer library used for the search contains approximately 50,000 compounds.

Shallow (water table) overburden, intermediate overburden, and deep overburden ground water monitoring wells will be installed. Shallow overburden wells will be installed so that their screened portions intersect the water table. Intermediate overburden wells will be screened at depths of approximately 40 to 50 feet. This depth corresponds to approximately the middle of the overburden materials. Deep overburden well will be screened in the 10-foot interval above the top of bedrock. The top of bedrock is expected to be encountered between 100 and 150 feet below ground surface.

All new monitoring wells will be surveyed for location and elevation. Slug testing and/or single-well pumping tests will be completed on all newly installed monitoring wells to estimate aquifer characteristics.

3.3.1.3 Overall Approach to Soil Sampling

Soil samples will be collected from pilot boreholes for the installation of monitoring wells for the purposes of chemical analysis, geotechnical analysis, and/or visual classification. Soil samples for chemical analysis will be obtained from a depth of 2 to 4 ft from one borehole at each new well cluster location. Soil samples for geotechnical analysis will be collected from screened intervals and as appropriate to characterize subsurface stratigraphic units. Soil samples for visual classification will be collected every 2.5 ft for the first 10 ft and every 5 ft for the remaining depth of each boring.

Soil samples will be obtained from split spoon samplers in borings advanced by a truck mounted drilling rig. Split spoon samplers to be used to collect samples for chemical analysis will be stainless steel. Other samples will be collected with non-stainless steel split spoon samplers or thin-wall sampler (Shelby tube) as appropriate.

Soil samples for chemical analysis will be analyzed for TCL VOs +10 and Priority Pollutant Metals (Table 3-3) These parameters were selected based on the types of contaminants detected in groundwater on site. Soil samples for geotechnical analysis will be analyzed for grain size distribution, Atterberg Limits, and moisture content.

3.3.1.4 Overall Approach to Baseline Risk Assessment (BRA)

A BRA will be conducted for this site to assess the potential risks to human health and the environment from exposures to chemicals of concern released from the site. The baseline risk assessment assesses risks for the present (baseline) conditions at the site (i.e., assuming no remedial action will be taken at the site). The results of the risk assessment will be used to:

- estimate the magnitude of potential human health and ecological risk associated with chemical releases at the site;
- identify the primary contributors to the risk from the site; and,
- help determine whether corrective action is warranted at the site and, if not, to support the no action alternative.

3.3.1.4.1 Conceptual Site Models. An important activity of the RI planning phase is the review of existing data and the development of conceptual site models. Information (including previous investigations) concerning waste sources, waste constituent release and transport mechanisms, and locations of potentially exposed individuals (receptors) is used to develop a conceptual understanding of the site in terms of potential human and ecological exposure pathways.

The conceptual site model is a schematic representation of the potential contaminant source areas, chemical release mechanisms, environmental transport media, potential intake routes and pathways, and potential human or ecological receptors. The conceptual site models developed in this Work Plan are extensions of the conceptual models developed in the PA for this site. The conceptual site model has three primary purposes:

- to assist in the development of the sampling plan (i.e., sampling locations, media to be sampled, and chemicals to be sampled) so that information regarding potential human health and environmental impacts from the site can be collected efficiently;
- to create a framework for the baseline risk assessment; and,
- to use as an aid in identifying effective cleanup measures, if necessary, that are targeted at significant contaminant sources and exposure pathways.

An exposure pathway includes four necessary elements:

- a source of chemicals and a mechanism of chemical release;
- an environmental transport medium (air, surface water, etc.);
- an exposure point; and,
- an intake route (inhalation, ingestion, dermal contact).

Each of these four elements must be present for an exposure pathway to be complete. Exposure pathways are considered to be complete if there are potential chemical release and transport mechanisms and identified receptors for that exposure pathway. An incomplete pathway means that one of these elements is missing and hence, exposure cannot occur. Only potentially complete pathways will be addressed in the risk assessment.

In the conceptual site models, potentially complete and significant exposure pathways are indicated with solid lines; incomplete or insignificant pathways are indicated with dashed lines. Exposure scenarios are developed based on current uses of the sites and on potential future uses. Future use of the SAEP is assumed to remain industrial as residential development is considered to be unlikely. If foreseeable future use excludes a receptor type, these receptors do not appear in the conceptual site models.

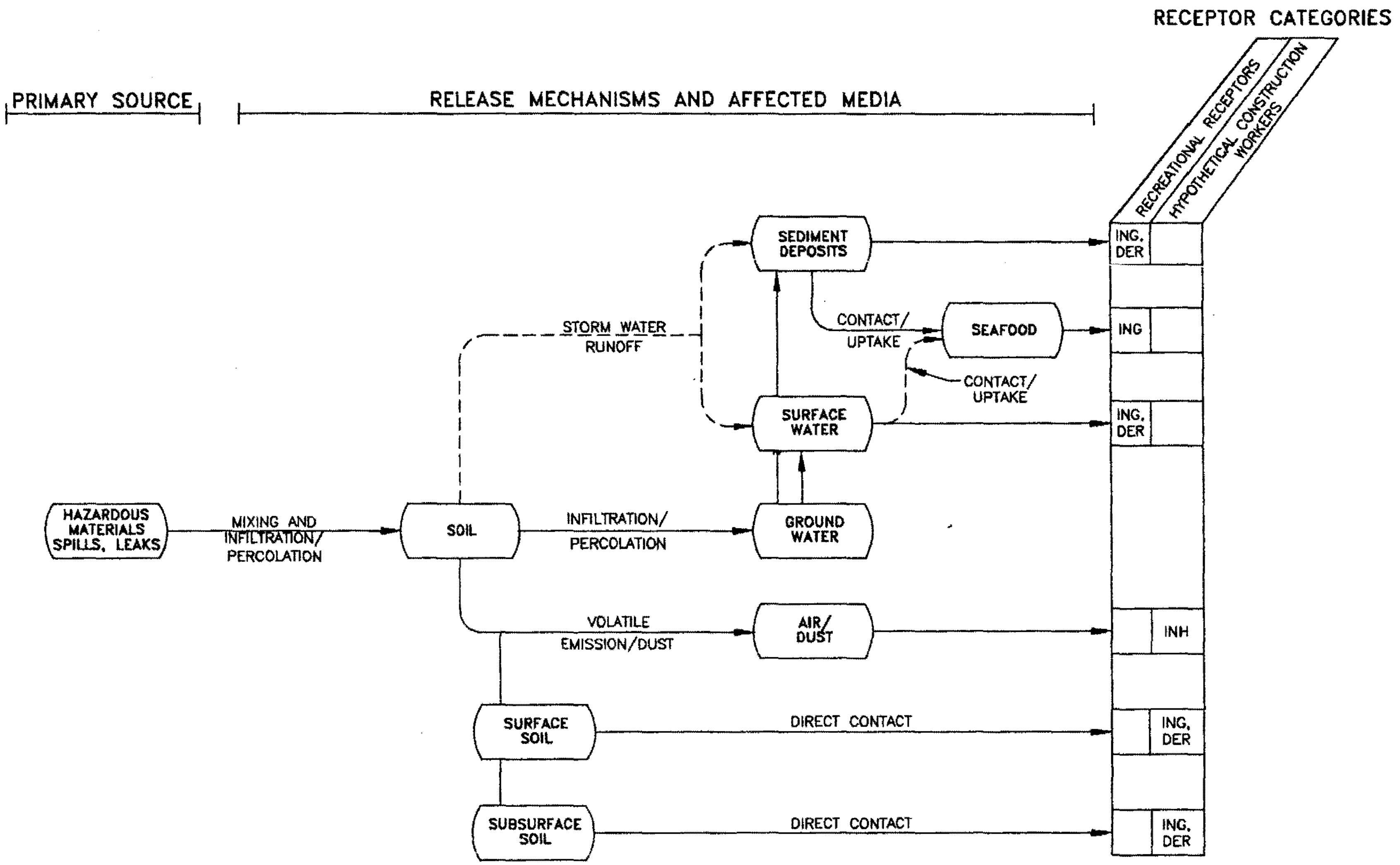
Figures 3-1 and 3-2 show the preliminary conceptual site models for human and ecological exposure pathways for the SAEP, respectively. These preliminary conceptual site models are subject to change, based on data which will be collected during the Phase II investigations.

Potential Human Exposures

The conceptual site model for potential human exposure pathways is shown in Figure 3-1. Hazardous materials spilled or leaked from various facilities at the SAEP to the ground and outfalls are the primary potential contaminant sources. Mixing of the spilled materials with soil, and direct releases of materials through the stormwater drainage system are shown as the primary chemical release mechanisms. Other potential primary release mechanisms, such as direct contact with spills, transport by storm runoff, wind erosion, or volatilization to the atmosphere, are not primary release mechanisms at this site because the spilled materials have been removed, have evaporated, or have infiltrated into the soil.

Soils are the secondary source of chemical release at the site. Once mixed with soils, the chemicals may be release to surface water by storm water transport, to groundwater by infiltration and percolation, to the atmosphere by volatilization or wind erosion of dust, and to receptors by direct contact.

Exposures to contaminants in surface soils is considered to be insignificant at this site because nearly all of the site is either paved or covered with buildings. Therefore, direct



NOTES:

SOLID LINES REPRESENT POTENTIALLY COMPLETE AND SIGNIFICANT PATHWAYS
DASHED LINES REPRESENT INCOMPLETE OR INSIGNIFICANT PATHWAYS

KEY TO EXPOSURE ROUTES

ING– INGESTION
INH– INHALATION
DER– DERMAL CONTACT

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PRELIMINARY CONCEPTUAL SITE MODEL FOR
HUMAN RECEPTORS
STRATFORD ARMY ENGINEERING PLANT
STRATFORD, CONNECTICUT

WOODWARD-CLYDE CONSULTANTS

ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

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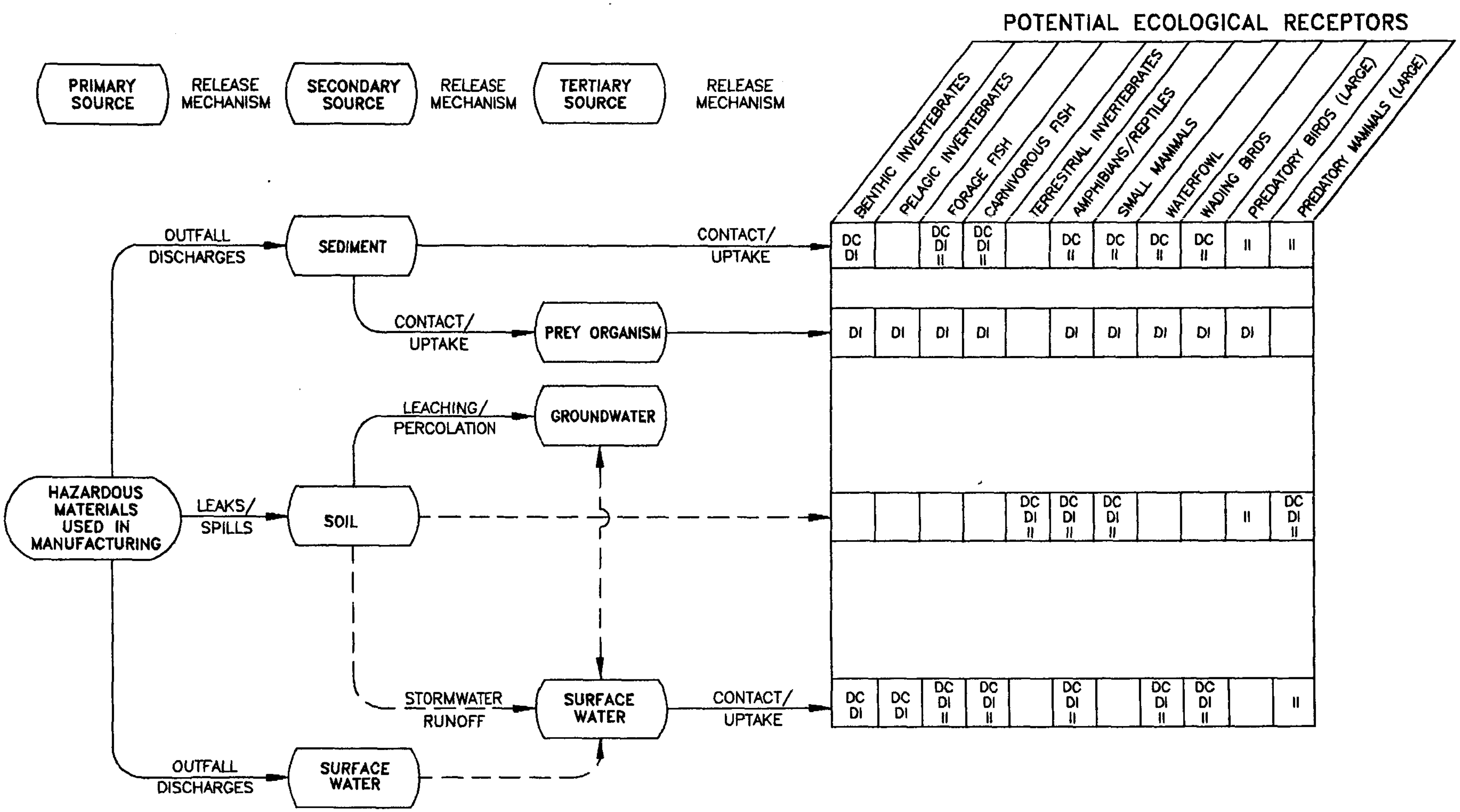

	BENTHIC INVERTEBRATES	PELAGIC INVERTEBRATES	FORAGE FISH	CARNIVOROUS FISH	TERRESTRIAL INVERTEBRATES	AMPHIBIANS/REPTILES	SMALL MAMMALS	WATERFOWL	WADING BIRDS	PREDATORY BIRDS (LARGE)	PREDATORY MAMMALS (LARGE)
SEDIMENT	DC DI		DC DI II	DC DI II		DC II	DC II	DC II	DC II	II	II
PREY ORGANISM	DI	DI	DI	DI		DI	DI	DI	DI	DI	
GROUNDWATER											
SOIL					DC DI II	DC DI II	DC DI II			II	DC DI II
SURFACE WATER	DC DI	DC DI	DC DI II	DC DI II		DC DI II		DC DI II	DC DI II		II

NOTES:

DASHED LINES REPRESENTS
INSIGNIFICANT PATHWAYS

KEY TO EXPOSURE ROUTES

DC – DIRECT CONTACT
DI – DIRECT INGESTION
II – INDIRECT INGESTION
(i.e. SECONDARY, TERTIARY CONSUMPTION)

PRELIMINARY CONCEPTUAL SITE MODEL
ECOLOGICAL RECEPTORS
STRATFORD ARMY ENGINEERING PLANT
STRATFORD, CONNECTICUT

WOODWARD-CLYDE CONSULTANTS

ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

DR.BY	FWD	SCALE	AS SHOWN	DWG.NO.	4N003011	PROJ.	C3M11LL
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contact by workers, surface water runoff, or volatilization and dust production are not significant pathways from surface soil for site workers. However, surface soil may present a significant pathway for hypothetical future construction workers who may be involved in excavation of the soils.

Groundwater is not a complete exposure pathway because there is no domestic use of groundwater at or downgradient of the site. However, groundwater may migrate from the site to surface water, (i.e., the Housatonic River). If contaminants are transported via groundwater to the river, exposure to recreational receptors could occur via exposures to surface water and sediments, and ingestion of contaminated sea food. Potentially significant exposures to surface water and sediment for recreational receptors include dermal contact and incidental ingestion of these media during sea food harvesting. For purposes of evaluating potential impacts to public health via the groundwater/surface water pathway, fate and transport modeling will be conducted to determine if there is a potential for contaminants detected in groundwater at the site to reach surface waters at concentrations of potential concern.

Air, contaminated either by contaminants volatilized from soil or by contaminated airborne particulate matter, represents a potentially complete inhalation pathway to hypothetical future construction workers involved in excavation of contaminated soils. Direct contact with contaminated soils by hypothetical construction workers represents a potentially complete ingestion and dermal contact pathway.

In summary, potentially complete and significant human exposure pathways are:

- Site workers
    - no significant exposures are expected because nearly all of the site is paved
- Hypothetical future construction workers
    - incidental ingestion of soil

  - dermal contact with soil
  - inhalation of volatile emissions and airborne particulates from soils

- Recreational receptors

  - incidental ingestion of sediments during seafood harvesting
  - dermal contact with sediments during seafood harvesting
  - incidental ingestion of sediments during seafood harvesting
  - dermal contact with sediments during seafood harvesting
  - ingestion of seafood.

Potential Ecological Exposures

The conceptual site model for potential ecological exposure pathways is shown in Figure 3-2. The primary sources of contaminants are hazardous materials used at the site which have leaked or been spilled onto site soils, or dischaged directly via outfalls to surface water bodies or sediment. Once in contact with the soil, the chemicals may percolate or leach through the soil to the groundwater. Groundwater discharge represents a tertiary source of contaminant release to the intertidal sediments adjacent to the site.

Small mammals or birds, such as white-footed mice or the American robin, are typical receptors to contaminated soil. These receptors may be exposed through direct contact, direct ingestion, and indirect ingestion of the soil. Predatory birds or mammals, such as the red-tailed hawk or raccoon, may also be exposed to soils through indirect ingestion.

At SAEP, ecological exposure to contaminants in the soil is considered an insignificant pathway at this site due to the site paving and development. Given the existing site conditions, populations of terrestrial mammals and predatory birds are expected to be very small to non-existent.

Sediments which have been contaminated by groundwater discharge or outfall discharges represent a likely media for ecological exposure. Receptors which may be effected by contaminated sediments include benthic invertebrates, forage fish, carnivorous fish, waterfowl, and wading birds, as depicted in Figure 3-2.

Surface water may also represent a contaminant source at the site. Results of fatre and transport modeling will abe used to determine whether contaminants have the potential to reach the surface water in concentrations trhat would pose a threat to ecological receptors such as fish.

In summary, potentially complete and significant ecological exposure pathways are likely to include the following:

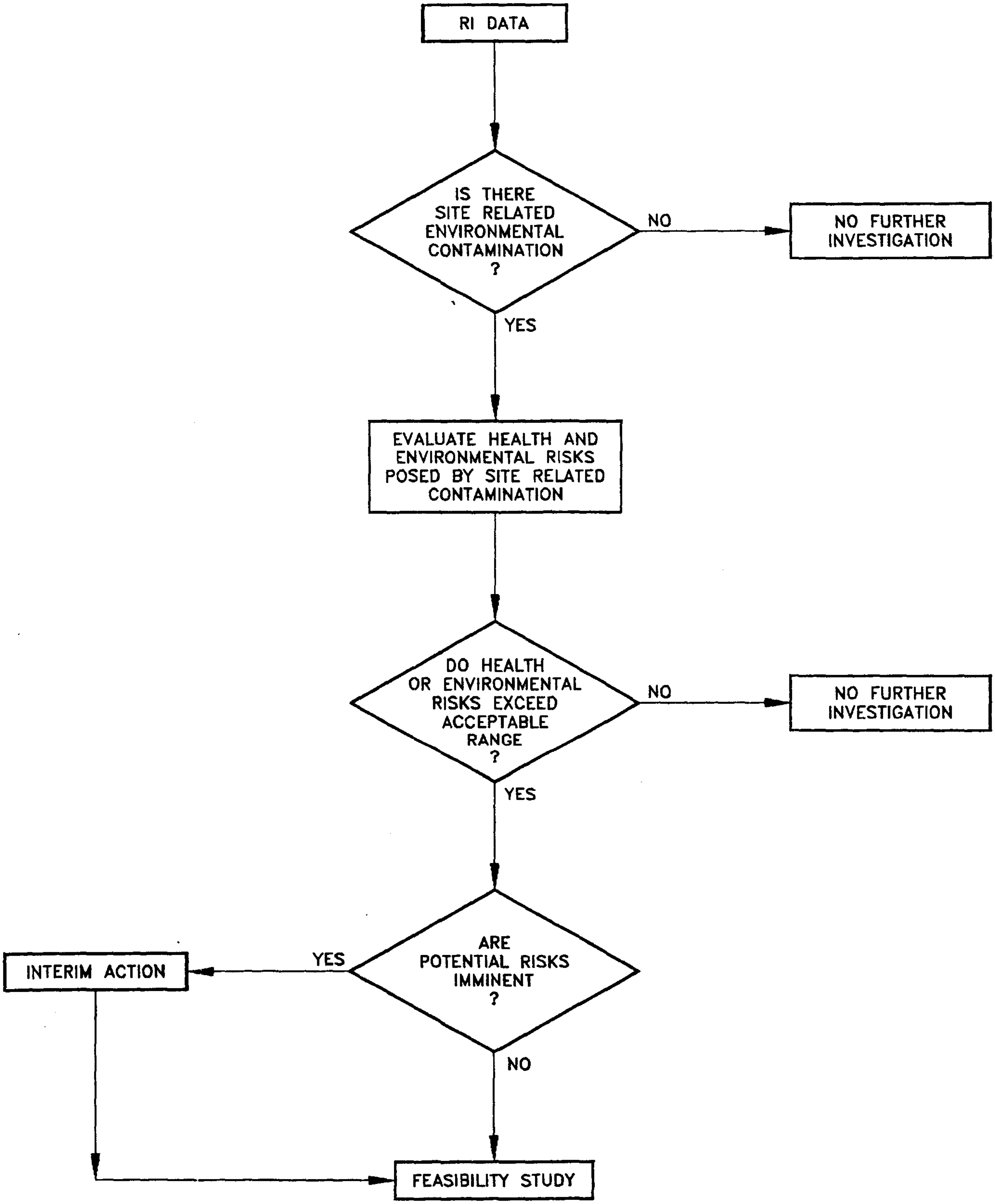
- Direct contact of benthos with contaminated sediments
- Ingestion of contaminated benthos by birds
- Ingestion of contaminated benthos by fish

Surface water scenarios may also be included depending on the outcome of the fate and transport modeling.

3.3.1.4.2 **Human Health Risk Assessment.** This section describes the approaches that will be used to complete the baseline human health risk assessment. The health risk assessment will estimate the level of health risks associated with potential exposures to site-related chemicals of concern in environmental media at the site. Existing data from the site and additional soils, sediment, groundwater, and surface water data obtained during the field investigations, and modeled results will be used to evaluate potential health risks.

The objectives of the baseline health risk assessments are to identify health risks specific to chemicals released from the site and, if a potential hazard to human health exists, to determine site-specific concentrations that will not be harmful to public health. Results of the risk assessment will be used to help determine whether no further investigation is needed at the site, if interim action is needed, or if the site should be carried forward in a Feasibility

FIGURE 3-3
RISK ASSESSMENT APPROACH
DECISION DIAGRAM



Study. Figure 3-3 illustrates the approach taken for the risk assessment. Methodologies for the risk assessment are described in the following sections.

3.3.1.4.2.1 Human Health Risk Assessment Approach. The health risk assessment will follow the guidance provided by EPA for evaluation of public health risks for Superfund. Specific EPA guidance to be followed for this human health risk assessment includes: Risk Assessment Guidance for Superfund Volume I - Human Health Evaluation Manual (EPA 1989b), Exposure Factors Handbook (EPA 1989a), Human Health Evaluation Manual Supplemental Guidance: "Standard Default Exposure Factors" (EPA 1991b), Superfund Exposure Assessment Manual (EPA 1988b), Dermal Exposure Assessment: Principles and Applications (EPA 1992a) and Data Usability in Risk Assessment (EPA 1990a). The health risk assessment consists of six components:

- Site Background and Demographics
- Identification of Chemicals of Concern
- Toxicity Assessment
- Exposure Assessment
- Risk Characterization
- Uncertainties and Limitations

3.3.1.4.2.2 Site Background and Demographics. The objective of this portion of the risk assessment is to characterize the exposure setting with respect to the general physical characteristics of the site and the populations on and near the site. Site characteristics such as climate, vegetation, and the presence and location of surface water are identified in this step. Receptor populations are also identified and are described with respect to those characteristics that influence exposure, such as location relative to the site, activity patterns, and the presence of sensitive subpopulations.

3.3.1.4.2.3 Identification of Chemicals of Concern. A large number of individual chemicals are associated with hazardous materials that may have been released at SAEP. Chemicals of concern in environmental samples (e.g., soil, sediment, surface water, groundwater) are expected to be constituents of certain potentially hazardous materials that are known or suspected to have been discharged. The selection of chemicals of concern is important and fundamental to the risk assessment process and will be done as recommended in EPA guidance. It is anticipated that the list would include all chemicals related to SAEP activities detected in environmental media above background levels. Chemicals that have documented EPA toxicity criteria (Reference Doses [RfDs] for noncarcinogens and cancer slope factors [SF] for carcinogens) will be evaluated quantitatively in the risk assessment. Chemicals without such criteria will be evaluated qualitatively in terms of their potential contribution to risk or compared to other standards such as MCLs. The chemicals of concern would not include chemicals that are identified as attributable to laboratory or field contamination in accordance with criteria from EPA's Functional Guidelines (EPA 1988a; 1991c) as specified in the QAPP or that do not exceed background concentrations.

3.3.1.4.2.4 Toxicity Assessment. Toxicological information for hazardous chemicals most often released to the environment from hazardous waste sites is generally well documented in the scientific literature. This risk assessment will follow the EPA recommended hierarchy of sources for determining critical toxicity criteria (RfDs and SFs). The first source in this hierarchy is IRIS (Integrated Risk Information System) and is the primary source of toxicological information for this risk assessment. The current Health Effects Assessment Summary Table (HEAST; EPA 1993 or later) will also be consulted for toxicity criteria where needed. For chemicals that have no published EPA toxicity criteria, but that could be significant contributors to risk, EPA's Environmental Criteria and Assessment office may be contacted for additional information. In addition, pertinent literature may be reviewed in order to summarize individual chemical toxicities relevant to site- and receptor-specific parameters.

3.3.1.4.2.5 Exposure Assessment. The conceptual site models presented in Section 3.3.1.4.1 of this Work Plan provide the basis for the exposure assessment. Exposure pathways identified in the conceptual site models define the migration pathways that chemicals might take from the chemical source area to the human receptor populations. The exposure pathway analysis will evaluate the chemical release mechanisms and transport in the environmental media and define the exposure points for human receptors. Construction (excavation) exposures will be considered at the site. Recreational exposures will be considered in the diversion ditches for exposure to sediment, surface water, and seafood based on modeled concentrations. Since the site is completely paved, occupational exposures are considered insignificant.

The identified exposure points are those locations where humans may be exposed to chemicals of concern. Exposure point concentrations in soils, sediments, and surface water will be estimated from the chemical analytical data. Both the average (mean) and Reasonable Maximum Exposure (RME) concentrations will be used in the exposure assessment. The RME concentration will be either the 95 percent upper confidence limit on the arithmetic mean or the maximum detected concentration, in accordance with EPA guidance. Potential exposure point concentrations of chemicals of concern in air will be estimated by air emissions modeling. Because groundwater is not used at or downgradient of the site, exposure point concentrations for chemicals of concern in groundwater will be calculated by modeling potential migration of chemicals of concern to sediment and surface water bodies (i.e., the Housatonic River).

3.3.1.4.2.6 **Human Health Risk Characterization.** Human health risks will be evaluated for long-term (chronic) exposures, and where appropriate, short-term (subchronic) exposures. The potential health risks from the various exposure routes (inhalation, ingestion, and dermal contact) to contaminated media will be included in the risk characterization.

The potential for noncarcinogenic human health effects is characterized by dividing the estimated daily chemical intakes by the respective RfDs. The resulting ratios are chemical- and pathway-specific hazard quotients. The sum of the hazard quotients is a pathway-specific hazard index for noncarcinogenic health effects. Carcinogenic risks are calculated by multiplying the daily average lifetime intakes by the chemical-specific cancer slope factors, which results in an estimate of the excess lifetime probability of developing cancer from the exposure. Hazard indexes and cancer risks are summed for all chemicals and exposure pathways to calculate the total hazard index and cancer risk for each exposed population.

3.3.1.4.2.7 **Uncertainties and Limitations.** Conservative assumptions are used in the risk assessment to avoid underestimation of potential health risks and to enhance confidence in the results and conclusions. Nevertheless, uncertainties are inherent in the risk assessment process. The RI report will include a discussion of the major sources of uncertainty in the risk assessment and identify factors that may result in either overestimation or underestimation of potential risk.

3.3.1.4.2.8 **Evaluation of Background Concentrations.** Soils are derived from parent geologic materials as a result of physical, chemical and biological processes. The soil system is a highly heterogeneous matrix of inorganic and organic components. The relative proportions of these components are dependent upon factors influencing soil formations, such as topography, climate, depositional processes, and time (Sposito and Page, 1984). Total concentrations of metals in soils may vary depending upon location. For example, at the surface, soils are influenced by leaching, runoff, atmospheric deposition, and biotic uptake, as well as anthropogenic activity. The ranges of naturally occurring or "background" concentrations of metals in soils is greatly varied due to the composition of parent material, and therefore, care must be taken in the interpretation of metals data generated during a site investigation.

For the RI, concentrations of metals in site soils will be compared to background soils concentrations using a statistical approach. The maximum concentrations detected at the site will be compared to the 95th upper tolerance limit of the background concentrations. Using this technique, individual samples at the site with high concentrations can be identified. For metals whose maximum detected concentration exceeds the 95% UTL of the background, the site and background populations (e.g., means or medians) will be compared. Finally, concentrations detected in site soils will be compared to regional soils concentrations reported in the literature.

3.3.1.4.3 Environmental Evaluation

3.3.1.4.3.1 **Environmental Evaluation Approach.** Section B-10, Part c, of Appendix B to US Army Regulation 200-1 (AR 200-1) describes the four elements of an ecological risk assessment to be: hazard identification, exposure assessment, ecological disruption assessment and risk characterization. Appendix B also refers to standard EPA guidance used in risk assessment. The scope of work described below for the Environmental Evaluation

(EE) of the SAP has been developed based upon the Scope of Work for the site, Part c and the following USEPA guidance for the conduct of ecological risk assessments:

- Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual (Part A)(USEPA 1989) and EcoUpdates; and,
- Framework for Ecological Risk Assessment (USEPA 1992).

The objective of the EE portion of the BRA for the SAEP is to use environmental and ecological data collected as part of the Phase I and Phase II Remedial Investigations conducted for the site to assess potential aquatic ecological impacts attributable to the presence of site related contaminants in environmental media. Data sets will include sediment chemistry, biological tissue chemistry, solid phase toxicity testing and benthic macroinvertebrate communities.

In the following sections, each of the major elements of the EE will be described.

3.3.1.4.3.2 Description of Site and Surrounding Area. The description of the site setting will include aquatic resources and, to a limited degree, terrestrial ecological resources in the immediate vicinity of the Plant using existing available information. Terrestrial resources will be evaluated only to the extent that certain terrestrial forms may use the aquatic habitat for foraging. Information sources will include the New York State Department of Environmental Conservation (NYSDEC), US Geological Survey (USGS), US Fish and Wildlife Service (USF&WS), National Oceanographic and Atmospheric Administration (NOAA), CTDEP Marine Fisheries Division, CTDEP Western District Wildlife, CT Department of Agriculture - Aquaculture Division. As requested in the Scope of Work, the description will include commercial, residential, recreational, and aesthetic uses of natural resources which could potentially be affected by site-related contaminants. A description of the following natural resources will also be compiled:

- sensitive habitats or populations of organisms (eg., tidal wetlands);
- potentially impacted flora and fauna; and,

- critical habitats and species (eg., endangered and threatened species).

The purpose of this description is to characterize potentially exposed ecosystems through development of an aquatic food web, so that biological populations which represent potential receptors can be identified and incorporated into the conceptual site model for the site. A brief description of significant natural features such as physiography, regional hydrogeology and surface water hydrology which may directly or indirectly influence the site ecology will also be presented as appropriate.

3.3.1.4.3.3 **Identification of Chemicals of Concern.** Based on the Phase I data, chemicals of concern will be identified for sediments only for the purposes of this EE. The selection of ecological chemicals of concern for sediments will be based on a systematic evaluation to identify what site-related chemicals are the most prevalent and toxic, and hence represent the greatest threat or hazard, to ecological receptors. Prevalence, concentration and toxicity information for the chemicals identified will be evaluated to ensure that the list represents chemicals posing the greatest ecological threat. The following five criteria will be used to screen sediment data to select ecological chemicals of concern :

- detection in at least one matrix sample above the method or instrument detection limit;
- presence of chemicals in blanks or known laboratory contaminants;
- frequency of detection and maximum concentration level;
- persistence and potential for chemical to transfer through food chains and bioaccumulate; and,
- exceedance of environmental "benchmarks".

The ecological chemicals of concern will include all site-related contaminants which fail the screening process. Surrogate compounds representing the greatest ecological threat will be selected from the list to undergo the exposure assessment.

3.3.1.4.3.4 **Toxicity Assessment.** Toxicity profiles for each of the chemicals of concern will also be presented. Toxicity profiles will include published data on chemistry, environmental fate, residues in environmental media and ecotoxicity for each of the chemicals of concern.

3.3.1.4.3.5 **Exposure Assessment.** The exposure assessment characterizes exposure of potential ecological receptors to chemicals of concern. The objective of the exposure assessment is to examine the potential threat from the chemicals of concern to pre-selected principle receptors of concern. For the aquatic habitat, the "weight of evidence" approach using exceedance of existing ecological benchmarks, biological tissue analyses, comparison to literature toxicity values, evaluation of site-specific solid phase toxicity testing data and assessment of indigenous benthic communities, will be used to assess whether or not the aquatic habitat has been impacted or poses a risk to aquatic biota which use the habitat.

A semi-quantitative evaluation will be used to evaluate the exposure of potential aquatic and terrestrial receptors to bioaccumulative chemicals in sediment and food. Concentrations in food items will be based upon site-specific biological tissue data. Information on food web pathways and bioaccumulation factors (BAFs; the ratio of the concentration of a contaminant in an organism to the concentration in the abiotic media) for chemicals and receptors of concern will be obtained from the published literature. Calculated receptor tissue levels, and actual concentrations measured in biological tissues collected in the field, will be compared to values in the published literature.

In the event that birds and semiaquatic mammals or terrestrial receptors are potentially exposed to nonbioaccumulative site related chemicals, an "Ecotoxicological Quotient" Method similar to the Hazard Index for human health assessments, will be used to evaluate exposure from direct ingestion of sediment and food items derived from the exposed aquatic habitat.

3.3.1.4.3.6 **Risk or Threat Characterization.** As part of the risk characterization, data collected will be used to identify what general areas of the site, if any, pose a threat to wildlife using the site. Chemical data will be evaluated concurrently with available ecological data to identify areas which may pose a threat.

Characterization of impacts to semiaquatic receptors will be based on the results of ecological hazard and ecological quotient indices if warranted. Resultant indices will provide a screening of the potential for risk under the various exposure scenarios.

3.3.1.4.3.7 **Uncertainty Analysis**. EPA guidance for performing ecological risk assessment cannot provide a systematic, reproducible approach to evaluating ecological risks and impacts to all receptors, at all sites, for all chemicals. Owing to the multitude of variables, and the level of professional judgement which must be exercised in ecological risk assessment, numerous uncertainties and limitations are inherent in the process, and can effect the final outcome of the evaluation. The following sources of uncertainty and data gaps will be addressed in the report as appropriate: data quality; data availability; exposure assessment assumptions; toxicity assessment; and risk characterization.

4.0
REMEDIAL INVESTIGATION TASKS

4.1 FIELD INVESTIGATION

This task involves all efforts related to fieldwork required to implement this Work Plan. This task will begin when the Work Plan is approved and end when field activities are completed. Elements of this task are outlined below and described in detail in Appendix A (Part 1).

- procurement of subcontracts
- mobilization
- media sampling
- hydrogeological investigation
- monitoring well and sampling location survey (vertical and horizontal)

4.2 DATA REVIEW AND QUALITY CONTROL SUMMARY REPORT

This task includes all efforts related to laboratory analysis of samples and data review. Analysis begins when the samples are received by the laboratory and ends when the laboratory reports have been reviewed and found to be acceptable. Elements of this task are outlined below and described in detail in the CDAP (Appendix A, Part 2).

- procurement of subcontracts
- laboratory analysis
- laboratory data validation
- data reduction and tabulation
- data usability evaluation
- evaluation of data gaps
- preparation of Quality Control Summary Report (QCSR)

4.3 BASELINE RISK ASSESSMENT

This task includes the preparation of a Baseline Risk Assessment (BRA) for the site including a human health evaluation and environmental evaluation. Data from previous investigations and data collected as part of theis phase of the RI will be used in the BRA. Elements of this task are outlined below and described in detail in Section 3 of this Work Plan.

- exposure setting characterization
- chemicals of concern identification
- toxicity assessment
- exposure pathways assessment
- risk characterization

As a subtask to exposure pathway assessment, hydrogeologic modeling will be used to model the fate and transport of contaminants in the groundwater pathway. The modeling effort will include the following:

- additional analyses of groundwater flow properties including determining the variablility of the directions and rates of groundwater flow and hydraulic gradient of different parts of the site, and the interaction of surface watyer and groundwater which includes estimating the discharge volumes of groundwater into the surface water;

- calculation of the impact to groundwater of constituesnts detected in soil (but not in groundwater) using representative subsurface soil concentration data; and,

- calculation of the concentrations of contaminants when they enter the surface water based on dilution calculation.

4.4 REMEDIAL INVESTIGATION REPORT

This task includes all efforts related to the presentation of findings once the data has been evaluated. Preliminary work on this task will begin when the field effort is completed. The task will end when the report is submitted to the concerned parties as defined in the USACEs Document Submittal List. Elements of the task are outlined below.

- data presentation
- draft report preparation
- internal WCC peer review
- draft report distribution
- review meeting
- report revisions
- final report distribution

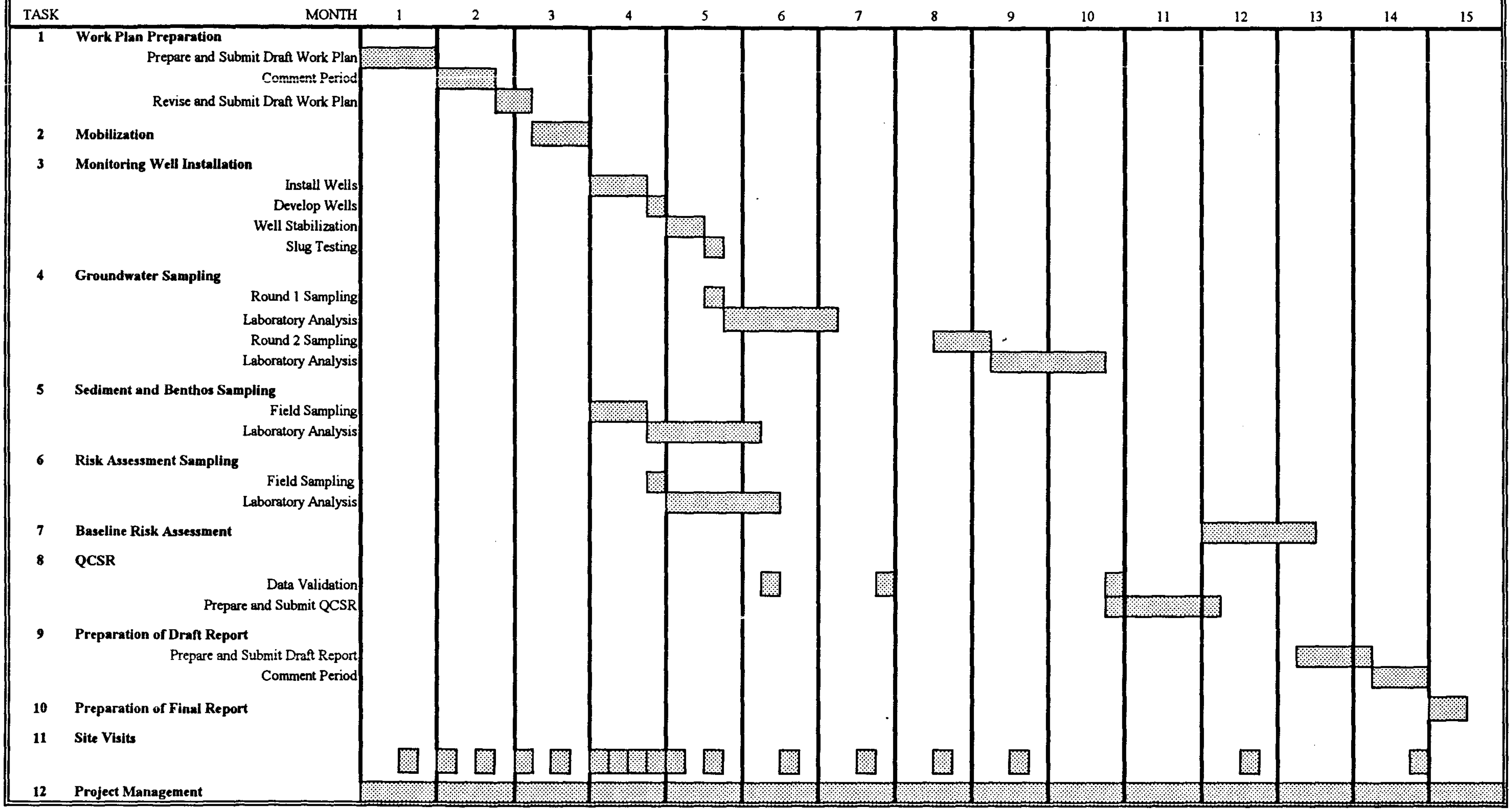
5.0

SCHEDULE

It is estimated that it will take approximately 15 months to complete all of the Phase II Remedial Investigation tasks. A detailed graphical schedule is provided in Figure 5-1.

Figure 5-1

PHASE II REMEDIAL INVESTIGATION
STRATFORD ARMEY ENGINE PLANT
STRATFORD, CONNECTICUT



6.0
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FINAL

APPENDIX A

SAMPLING AND ANALYSIS PLAN

PART 1 - FIELD SAMPLING PLAN

PHASE II REMEDIAL INVESTIGATION WORK PLAN

STRATFORD ARMY ENGINE PLANT STRATFORD, CONNECTICUT

Prepared for
U.S. Department of the Army
Corps of Engineers, Omaha District
Omaha, Nebraska
November 1994

Woodward-Clyde

101 South 108 Avenue
Omaha, Nebraska 68154
WC Project No. C3M11LL

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1.0
SITE BACKGROUND

A description of the SAEP site and the purpose of this investigation are contained in Sections 1.0 and 2.0 of the Phase II RI Work Plan.

2.0
SAMPLING OBJECTIVES

The sampling described in this Field Sampling Plan (FSP) is designed to determine the extent of contamination identified in sediment and groundwater in the Phase I Remedial Investigation, and the effects of the contamination on biota in the intertidal flats and the Housatonic River and connected waterways adjacent to the site. Information regarding the nature and extent of contamination and physical conditions at SAEP will be used to develop a Baseline Risk Assessment (BRA). The BRA will evaluate site-related risks to human health and biota.

3.0
SAMPLE LOCATION AND FREQUENCY

This section describes the contamination assessment sampling and biota sampling to be conducted, and the hydrogeologic investigation plan. Because of name duplication, some of the existing wells were renamed for the purposes of this Remedial Investigation. Wells which were installed for lagoon monitoring are identified with the letters LW (Lagoon Well) followed by the number originally assigned to them. One well which was installed in the area of building B-70 is identified with the letters ECD (East Coast Drilling) followed by its original number (-4).

3.1 SEDIMENT SAMPLING FOR CONTAMINATION DELINEATION AND PHYSICAL PARAMETERS

Sediment will be sampled at 30 locations in the intertidal flats area and drainage ditch/ Marine Basin area (Outfall 008) for chemical analysis as shown on Figure 3-1. Three additional locations will be sampled to represent "background/reference" sediment conditions: on the north side of the jetty separating the intertidal flats from the Housatonic River; a drainageway within Nells Island on the east side of the Housatonic River; and one location downstream from the site.

Two sediment samples will be collected at each location using a push core sampler. One sediment sample will be collected from 0 to 6 inches below the sediment surface and the second at a depth of 24 to 48 inches below the sediment surface.

All of the sediment samples will be analyzed for Target Compound List (TCL) polyaromatic hydrocarbons (PAHs), Priority Pollutant Metals, polychlorinated biphenyls (PCBs), and total organic carbon (loss on ignition). Sampling techniques and analytical methods are described in the Chemical Data Acquisition Plan (CDAP) (SOPs 6, 7, 10, and 11).

Geotechnical analysis for grain size, and percent moisture will also be conducted for all surficial (0 to 6 inches) sediment samples. Grain size analysis will be conducted using a conducted using a modified ASTM method D 422-63. This method involves modification to the mesh sizes of the sieves used for this analysis. W-C proposes to use the U.S. Standard mesh sizes 10, 18, 35, 60, 120, and 230. This will allow comparisons with data on fine-grained sediments contained in the literature. Percent moisture will be analyzed using ASTM method D 2216.

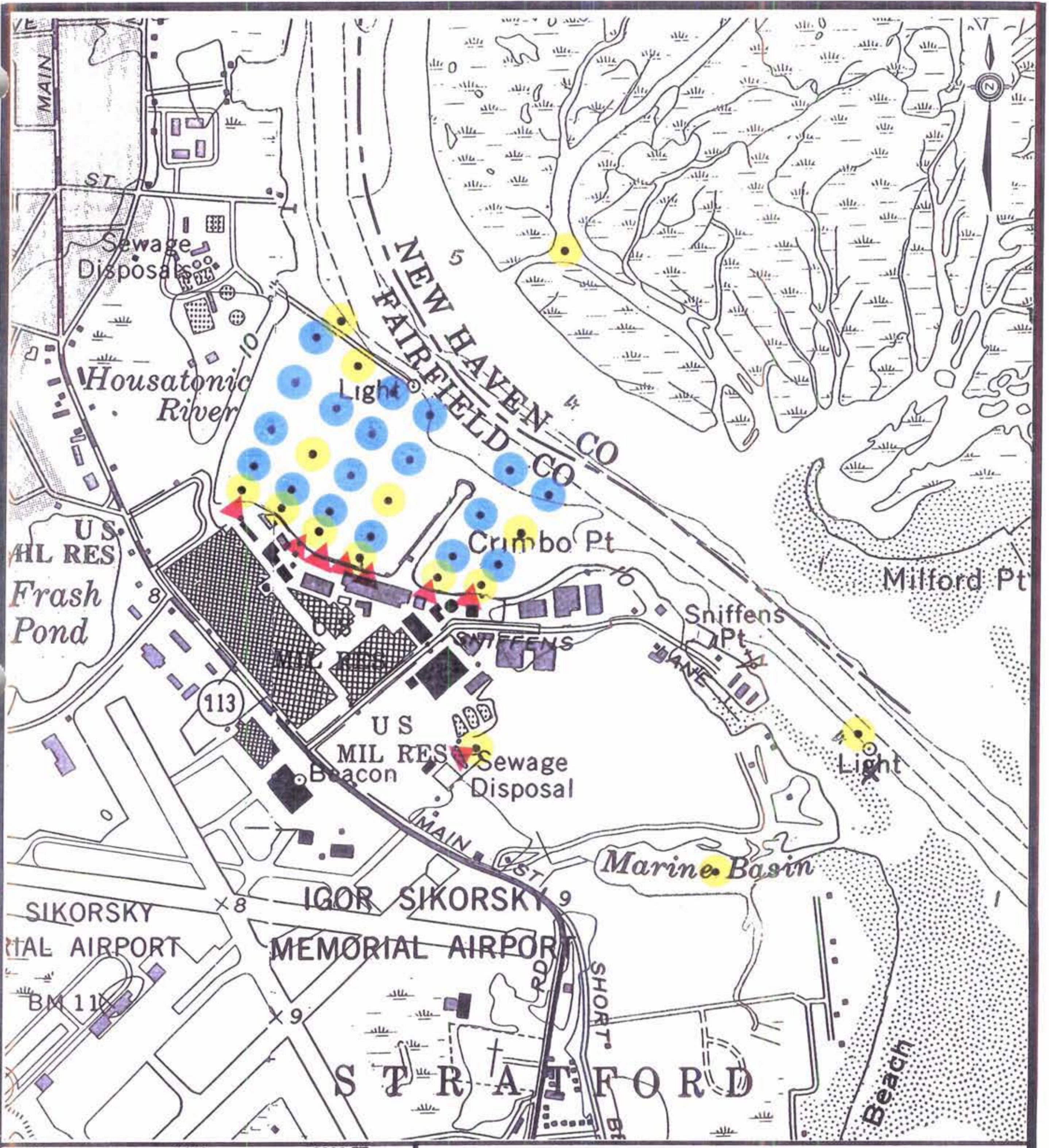
3.2 SEDIMENT TOXICITY SAMPLING AND BENTHIC COMMUNITY CHARACTERIZATION

3.2.1 Samples for Sediment Toxicity Tests

Surficial sediment (0 to 6 inches) will be collected at selected sediment locations for use in solid phase sediment toxicity tests. Locations for collection of sediment for toxicity tests will correspond to locations sampled for analytical sediment chemistry (described in Section 3.1) which appear to have site-related contamination, as well as several areas which appear to be out of the influence of site-related contaminants. Sediment toxicity tests will also be performed on the three off-site background sediments, as well as a laboratory reference and a grain-size reference sample. The solid phase sediment toxicity tests will be performed using the amphipod *Ampelisca abdita*, following ASTM method E 1367-90, "Standard Guide for Conducting Solid Phase 10-day Static Sediment Toxicity Tests with Marine and Estuarine Amphipods". Using this protocol, the amphipods are directly exposed and allowed to bury themselves in the sediment and consume whatever foodstuffs are available. At the end of the testing period the amphipods are assessed for any toxic response (acute effects, i.e death; or chronic effects, i.e. reduced growth compared to a control population).

3.2.2 Benthic Macroinvertebrate Community Sampling

To determine whether the sediments adjacent to SAEP are negatively affecting the resident benthic macroinvertebrate community, benthic sampling will be conducted at the same locations where samples for solid phase toxicity testing are collected (described in Section 3.2.1), including the three background locations. Three replicate surficial sediment grabs will be collected at each location using a standard Ponar grab sampler. The samples will be



0 1000 2000 FT

SCALE

LEGEND:

▲ APPROXIMATE LOCATION OF EXISTING OUTFALL

● SEDIMENT CHEMISTRY SAMPLING LOCATION

● TOXICITY, BENTHOS AND SEDIMENT CHEMISTRY SAMPLING LOCATION

MAP SOURCE:
USGS 7.5 MINUTE SERIES TOPOGRAPHIC MAPS, BRIDGEPORT & MILFORD, CT, QUADRANGLES, DATED 1970 & 1960, RESPECTIVELY, (PHOTOREVISED 1984).

SEDIMENT SAMPLING LOCATIONS
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

WOODWARD – CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS
WAYNE, NEW JERSEY

DR. BY:	KJFH	SCALE:	AS SHOWN	PROJ. NO.:	P3M11LL
CK'D BY:	MEC	DATE:	AUG. 16, 1994	FIG. NO.:	3–1

on the sieve will be preserved in a 10% buffered formalin solution. Each replicate will be preserved and analyzed separately.

The samples will be taken to the laboratory where they will be washed of formalin and the macroinvertebrates will be sorted from any sediment/detritus under a magnified illuminator and/or a dissecting microscope. The macroinvertebrates will be identified to the lowest practical taxon, counted, and preserved in 70% isopropyl alcohol.

This data will provide an estimation of density (number of individual macroinvertebrates per unit area) and species richness (number of different types of macroinvertebrates) at each location, which can be compared to the reference locations and any other benthic invertebrate data which may exist for nearby areas. The benthic data will be compared with the sediment toxicity testing and sediment analytical chemistry results in the environmental evaluation to assist in determining impacts of sediment contaminants.

3.2.3 Water Quality Parameters

At each ecological sampling location (those where sediment for toxicity testing and benthic community analysis are collected) the following water quality parameters will be measured in-situ using field instruments: dissolved oxygen, pH, temperature, salinity, and conductivity.

3.3 TISSUE SAMPLING

In order to determine whether organisms which live in the sediments of the intertidal mudflat or attached to the SAEP causeway are accumulating site-related contaminants in their tissues biological samples will be collected. The tissues from these organisms will be analyzed for selected metals (mercury, cadmium, chromium, nickel, and lead), PCBs, percent moisture, and percent lipids. These chemical parameters were selected based on their bioaccumulation potential, apparent relation to previous site activities, and detection in sediment samples during the Phase I investigation.

Owing to their sedentary existence, a mollusc species which lives in or is in close association with the substrate, such the blue mussel (*Mytilus edulis*), hard clam (*Mercenaria mercenaria*), or Eastern oyster (*Crassostrea virginica*) makes an ideal choice for biological tissue sampling. Since these organisms are consumed by other aquatic organisms as well as humans, the data generated from these data will be used in both the Human Health and Ecological portions of the BRA.

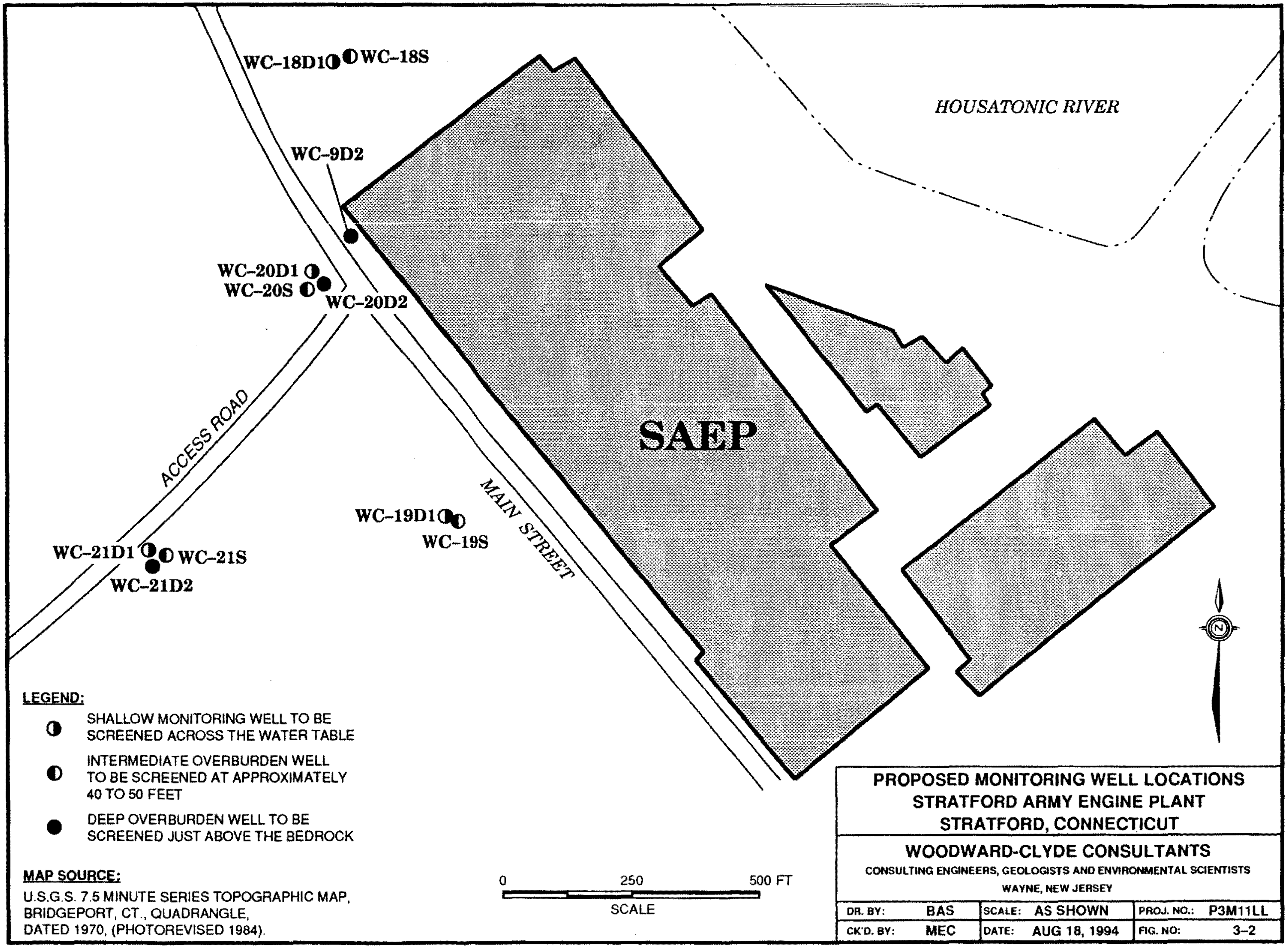
In order to determine whether quantities sufficient for providing tissue samples of either of these species occur on or near the intertidal flats or SAEP causeway, a site reconnaissance would be required prior to planning any biological tissue sampling. If sufficient populations of any one of these bivalves occur in the sampling area, W-C proposes to collect three replicate samples from six locations (including an upstream or background sample location), for a total of 18 biological tissue samples.

3.4 SOIL SAMPLING

One soil sample will be collected from one of the pilot borings in each of the five new well cluster locations. Each sample will be collected from 24 to 48 inches below the ground surface. The five soil samples will be analyzed for TCL VOs, and Priority Pollutant Metals. Soil sampling techniques and laboratory analytical methods are described in the CDAP (SOPs 1, 6, and 7).

3.5 GROUNDWATER SAMPLING

Eleven groundwater monitoring wells (WC-9D2, WC-18S, WC-18D1, WC-19S, WC-19D1, WC-20S, WC-20D1, WC-20D2, WC-21S, WC-21D1, WC-21D2) will be installed west of Building 2 to monitor the quality of groundwater entering the site from the presumed upgradient direction. The proposed locations of these wells are shown on Figure 3-2. The shallow wells will be screened (using 10-foot screen sections) to intersect the water table in order to detect floating product, if present. Intermediate depth wells (D1) will be screened at depths of approximately 30 to 50 feet below ground surface. Deep overburden wells (D2)



LEGEND:

◑ SHALLOW MONITORING WELL TO BE SCREENED ACROSS THE WATER TABLE

◐ INTERMEDIATE OVERBURDEN WELL TO BE SCREENED AT APPROXIMATELY 40 TO 50 FEET

● DEEP OVERBURDEN WELL TO BE SCREENED JUST ABOVE THE BEDROCK

MAP SOURCE:

U.S.G.S. 7.5 MINUTE SERIES TOPOGRAPHIC MAP,
BRIDGEPORT, CT., QUADRANGLE,
DATED 1970, (PHOTOREVISED 1984).

PROPOSED MONITORING WELL LOCATIONS STRATFORD ARMY ENGINE PLANT STRATFORD, CONNECTICUT

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CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS
WAYNE, NEW JERSEY

DR. BY: BAS	SCALE: AS SHOWN	PROJ. NO.: P3M11LL
CK'D. BY: MEC	DATE: AUG 18, 1994	FIG. NO: 3-2

will be screened just above bedrock at depths of approximately 90 to 110 feet below ground surface. Actual screened intervals will determined in the field by the geologist.

Two rounds of groundwater samples will be collected from each of the newly installed wells described above. The rounds of sampling will be conducted at least three months apart to monitor for seasonal variations. Groundwater samples from these wells will be analyzed for the presence of TCL VOs, and total Priority Pollutant Metals. During the second sampling event, 45 existing monitoring wells will also be sampled and analyzed for the same parameters (Table 3-1).

Well installation, sampling techniques and analytical methods will be as described in Section 5 of this FSP and in the CDAP (SOPs 2, 3, 6, and 7).

3.6 HYDROGEOLOGIC STUDY

Aquifer testing will be used to assess the hydrogeologic conditions in areas where new wells are installed. Each of the new wells will be slug tested. Permeability data derived from these tests combined with the hydraulic gradient and porosities will be used to estimate the rates of groundwater flow. Testing and data reduction will be performed as described in the CDAP.

Porosities of screened strata in new monitoring wells will be determined using geotechnical testing methods. Fine grained components will be analyzed using the Atterberg Limits test. Coarse grained components will be subjected to sieve analysis. All geotechnical samples will be analyzed for moisture content. Samples for geotechnical analysis will be collected from the interval to be screened and additional strata as needed to characterize subsurface conditions.

TABLE 3-1
LIST OF WELLS FOR GROUNDWATER SAMPLE COLLECTION

EXISTING WELLS

WELL IDENTIFICATION NUMBER	SCREENED INTERVAL (ft)	WELL IDENTIFICATION NUMBER	SCREENED INTERVAL (ft)
WC-1S	4-14	LW-1S	0-10
WC-2D	24.5-34.5	LW-1SI	6-16
WC-3S	3-13	LW-2	6-16
WC-4S	3-13	LW-3S	0-10
WC-5S	3-13	LW-3SI	8-18
WC-6S	3-13	LW-4	24-34
WC-7S	3-13	LW-5S	0-10
WC-8S	3-13	LW-5SI	17-27
WC-9S	3-13	LW-5D	90-110
WC-10S	3-13	LW-5DI	38-48
WC-11S	3-13	LW-6	19-29
WC-12S	3-13	LW-7	19-29
WC-13S	3-13	LW-8	0-10
WC-14S	3-13	LW-9S	3-13
WC-15S	3-13	LW-9I	38-48
PZ-9D	24-34	LW-9D	80-100
PZ-16D	21-31	LW-10S	4-14
PZ-17D	29-39	LW-10I	38-48
MW-1	2-15	LW-10D	71-86
MW-2	2-15	LW-11	2-12
MW-3	2-15	LW-12	3-13
MW-4	2-15	LW-13	6-16
ECD-4	8-18		
45 WELLS TOTAL			

NEW WELLS TO BE INSTALLED IN PHASE II

WELL IDENTIFICATION NUMBER	SCREENED INTERVAL (ft)	WELL IDENTIFICATION NUMBER	SCREENED INTERVAL (ft)
WC-9D2	90-110	WC-20D1	30-50
WC-18S	5-15	WC-20D2	90-110
WC-18D1	30-50	WC-21S	5-15
WC-19S	5-15	WC-21D1	30-50
WC-19D1	30-50	WC-21D2	90-110
WC-20S	5-15		
11 WELLS TOTAL			

NOTES:
Screened intervals are in feet below ground surface.
Estimated screened intervals are indicated for new wells. A 10-foot section of screen will be installed within the depth interval indicated.

4.0
SAMPLE DESIGNATION

Sample designations have been pre-assigned and are listed in Table 4-1. The designations were developed to allow logical correlation with sampling locations. The sample designation scheme is explained in SOP 6 of the CDAP.

TABLE 4-1
SAMPLE DESIGNATIONS

AREA	LOCATION	MEDIA	METHOD	DEPTH	DESIGNATION	PARAMETERS
Intertidal Flats	Transect A, Location 1	Sediment	Core	0-6"	TA1-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture, Toxicity
	Transect A, Location 1	Sediment	Core	24-48"	TA1-24-48	PAHs, Metals, PCBs, TOC
	Transect A, Location 2	Sediment	Core	0-6"	TA2-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture
	Transect A, Location 2	Sediment	Core	24-48"	TA2-24-48	PAHs, Metals, PCBs, TOC
	Transect A, Location 3	Sediment	Core	0-6"	TA3-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture
	Transect A, Location 3	Sediment	Core	24-48"	TA3-24-48	PAHs, Metals, PCBs, TOC
	Transect A, Location 4	Sediment	Core	0-6"	TA4-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture
	Transect A, Location 4	Sediment	Core	24-48"	TA4-24-48	PAHs, Metals, PCBs, TOC
	Transect A, Location 5	Sediment	Core	0-6"	TA5-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture
	Transect A, Location 5	Sediment	Core	24-48"	TA5-24-48	PAHs, Metals, PCBs, TOC
	Transect B, Location 1	Sediment	Core	0-6"	TB1-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture, Toxicity
	Transect B, Location 1	Sediment	Core	24-48"	TB1-24-48	PAHs, Metals, PCBs, TOC
	Transect B, Location 2	Sediment	Core	0-6"	TB2-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture
	Transect B, Location 2	Sediment	Core	24-48"	TB2-24-48	PAHs, Metals, PCBs, TOC
	Transect B, Location 3	Sediment	Core	0-6"	TB3-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture, Toxicity
	Transect B, Location 3	Sediment	Core	24-48"	TB3-24-48	PAHs, Metals, PCBs, TOC
	Transect B, Location 4	Sediment	Core	0-6"	TB4-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture
	Transect B, Location 4	Sediment	Core	24-48"	TB4-24-48	PAHs, Metals, PCBs, TOC
	Transect B, Location 5	Sediment	Core	0-6"	TB5-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture, Toxicity
	Transect B, Location 5	Sediment	Core	24-48"	TB5-24-48	PAHs, Metals, PCBs, TOC
	Transect C, Location 1	Sediment	Core	0-6"	TC1-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture, Toxicity
	Transect C, Location 1	Sediment	Core	24-48"	TC1-24-48	PAHs, Metals, PCBs, TOC
	Transect C, Location 2	Sediment	Core	0-6"	TC2-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture
	Transect C, Location 2	Sediment	Core	24-48"	TC2-24-48	PAHs, Metals, PCBs, TOC
	Transect C, Location 3	Sediment	Core	0-6"	TC3-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture
	Transect C, Location 3	Sediment	Core	24-48"	TC3-24-48	PAHs, Metals, PCBs, TOC
	Transect C, Location 4	Sediment	Core	0-6"	TC4-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture
	Transect C, Location 4	Sediment	Core	24-48"	TC4-24-48	PAHs, Metals, PCBs, TOC
	Transect C, Location 5	Sediment	Core	0-6"	TC5-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture
	Transect C, Location 5	Sediment	Core	24-48"	TC5-24-48	PAHs, Metals, PCBs, TOC
	Transect D, Location 1	Sediment	Core	0-6"	TD1-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture, Toxicity
	Transect D, Location 1	Sediment	Core	24-48"	TD1-24-48	PAHs, Metals, PCBs, TOC
	Transect D, Location 2	Sediment	Core	0-6"	TD2-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture
	Transect D, Location 2	Sediment	Core	24-48"	TD2-24-48	PAHs, Metals, PCBs, TOC
	Transect D, Location 3	Sediment	Core	0-6"	TD3-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture, Toxicity
	Transect D, Location 3	Sediment	Core	24-48"	TD3-24-48	PAHs, Metals, PCBs, TOC
	Transect D, Location 4	Sediment	Core	0-6"	TD4-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture
	Transect D, Location 4	Sediment	Core	24-48"	TD4-24-48	PAHs, Metals, PCBs, TOC
	Transect D, Location 5	Sediment	Core	0-6"	TD5-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture
	Transect D, Location 5	Sediment	Core	24-48"	TD5-24-48	PAHs, Metals, PCBs, TOC
	Transect E, Location 1	Sediment	Core	0-6"	TE1-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture, Toxicity
	Transect E, Location 1	Sediment	Core	24-48"	TE1-24-48	PAHs, Metals, PCBs, TOC
	Transect E, Location 2	Sediment	Core	0-6"	TE2-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture
	Transect E, Location 2	Sediment	Core	24-48"	TE2-24-48	PAHs, Metals, PCBs, TOC
	Transect E, Location 3	Sediment	Core	0-6"	TE3-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture
	Transect E, Location 3	Sediment	Core	24-48"	TE3-24-48	PAHs, Metals, PCBs, TOC
	Transect E, Location 4	Sediment	Core	0-6"	TE4-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture
	Transect E, Location 4	Sediment	Core	24-48"	TE4-24-48	PAHs, Metals, PCBs, TOC
	Transect F, Location 1	Sediment	Core	0-6"	TF1-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture, Toxicity
	Transect F, Location 1	Sediment	Core	24-48"	TF1-24-48	PAHs, Metals, PCBs, TOC
	Transect F, Location 2	Sediment	Core	0-6"	TF2-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture
	Transect F, Location 2	Sediment	Core	24-48"	TF2-24-48	PAHs, Metals, PCBs, TOC
	Transect F, Location 3	Sediment	Core	0-6"	TF3-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture, Toxicity
	Transect F, Location 3	Sediment	Core	24-48"	TF3-24-48	PAHs, Metals, PCBs, TOC
	Transect F, Location 4	Sediment	Core	0-6"	TF4-0-6	PAHs, Metals, PCBs, Grain size, TOC, % moisture
	Transect F, Location 4	Sediment	Core	24-48"	TF4-24-48	PAHs, Metals, PCBs, TOC
SUBTOTAL	28 locations	Sediment		2 depths	56 samples	

TABLE 4-1
SAMPLE DESIGNATIONS

AREA	LOCATION	MEDIA	METHOD	DEPTH	DESIGNATION	PARAMETERS
Existing Monitoring Wells	WC-1S	Groundwater	Bailer	Screened Interval	WC-1S	VOs, Metals
	WC-2D	Groundwater	Bailer	Screened Interval	WC-2D	VOs, Metals
	WC-3S	Groundwater	Bailer	Screened Interval	WC-3S	VOs, Metals
	WC-4S	Groundwater	Bailer	Screened Interval	WC-4S	VOs, Metals
	WC-5S	Groundwater	Bailer	Screened Interval	WC-5S	VOs, Metals
	WC-6S	Groundwater	Bailer	Screened Interval	WC-6S	VOs, Metals
	WC-7S	Groundwater	Bailer	Screened Interval	WC-7S	VOs, Metals
	WC-8S	Groundwater	Bailer	Screened Interval	WC-8S	VOs, Metals
	WC-9S	Groundwater	Bailer	Screened Interval	WC-9S	VOs, Metals
	WC-10S	Groundwater	Bailer	Screened Interval	WC-10S	VOs, Metals
	WC-11S	Groundwater	Bailer	Screened Interval	WC-11S	VOs, Metals
	WC-12S	Groundwater	Bailer	Screened Interval	WC-12S	VOs, Metals
	WC-13S	Groundwater	Bailer	Screened Interval	WC-13S	VOs, Metals
	WC-14S	Groundwater	Bailer	Screened Interval	WC-14S	VOs, Metals
	WC-15S	Groundwater	Bailer	Screened Interval	WC-15S	VOs, Metals
	PZ-9D	Groundwater	Bailer	Screened Interval	PZ-9D	VOs, Metals
	PZ-16D	Groundwater	Bailer	Screened Interval	PZ-16D	VOs, Metals
	PZ-17D	Groundwater	Bailer	Screened Interval	PZ-17D	VOs, Metals
	MW-1	Groundwater	Bailer	Screened Interval	MW-1	VOs, Metals
	MW-2	Groundwater	Bailer	Screened Interval	MW-2	VOs, Metals
	MW-3	Groundwater	Bailer	Screened Interval	MW-3	VOs, Metals
	MW-4	Groundwater	Bailer	Screened Interval	MW-4	VOs, Metals
	ECD-4	Groundwater	Bailer	Screened Interval	ECD-4	VOs, Metals
	LW-1S	Groundwater	Bailer	Screened Interval	LW-1S	VOs, Metals
	LW-1SI	Groundwater	Bailer	Screened Interval	LW-1SI	VOs, Metals
	LW-2	Groundwater	Bailer	Screened Interval	LW-2	VOs, Metals
	LW-3S	Groundwater	Bailer	Screened Interval	LW-3S	VOs, Metals
	LW-3SI	Groundwater	Bailer	Screened Interval	LW-3SI	VOs, Metals
	LW-4	Groundwater	Bailer	Screened Interval	LW-4	VOs, Metals
	LW-5S	Groundwater	Bailer	Screened Interval	LW-5S	VOs, Metals
	LW-5SI	Groundwater	Bailer	Screened Interval	LW-5SI	VOs, Metals
	LW-5D	Groundwater	Bailer	Screened Interval	LW-5D	VOs, Metals
	LW-5DI	Groundwater	Bailer	Screened Interval	LW-5DI	VOs, Metals
	LW-6	Groundwater	Bailer	Screened Interval	LW-6	VOs, Metals
	LW-7	Groundwater	Bailer	Screened Interval	LW-7	VOs, Metals
	LW-8	Groundwater	Bailer	Screened Interval	LW-8	VOs, Metals
	LW-9S	Groundwater	Bailer	Screened Interval	LW-9S	VOs, Metals
	LW-9I	Groundwater	Bailer	Screened Interval	LW-9I	VOs, Metals
	LW-9D	Groundwater	Bailer	Screened Interval	LW-9D	VOs, Metals
	LW-10S	Groundwater	Bailer	Screened Interval	LW-10S	VOs, Metals
	LW-10I	Groundwater	Bailer	Screened Interval	LW-10I	VOs, Metals
	LW-10D	Groundwater	Bailer	Screened Interval	LW-10D	VOs, Metals
	LW-11	Groundwater	Bailer	Screened Interval	LW-11	VOs, Metals
	LW-12	Groundwater	Bailer	Screened Interval	LW-12	VOs, Metals
	LW-13	Groundwater	Bailer	Screened Interval	LW-13	VOs, Metals
SUBTOTAL	45 wells	Groundwater		Screended Interval	45 samples	1 round of sampling per well
TOTAL	**56 wells**	**Groundwater**			**67 samples**	

NOTES: Metals = Priority Pollutant List Metals

VOs = Target Compound List Volatile Organics

PCBs = Polychlorinated Biphenyls

PAHs = Target Compound List Polycyclic Aromatic Hydrocarbons

TOC = Total Organic Carbon

TBD = To Be Determined

"a-b" code at end of soil sample designations indicates that the depth interval will be determined in the field.

Totals do not include QA/QC samples.

5.0
MONITORING WELL INSTALLATION

5.1 REGULATORY REQUIREMENTS

There are no federal, state or local requirements for the installation of monitoring wells.

5.2 UTILITY CLEARANCES AND PERMITS

W-C will coordinate all utility clearances prior to drilling. If it is necessary to move a boring location in order to avoid utilities, a new location which satisfies the intent of the original location will be selected. W-C will take all reasonable precautions to protect persons and property near the drilling site. No local, state or federal permits are required for the installlation of monitoring wells in Connecticut.

5.3 DRILLING METHODS AND DECONTAMINATION

Pilot boreholes for monitoring wells will be drilled using hollow stem auger methods. The boring diameter (6-inches) will be sufficient to allow a 2-inch anular space between the boring wall and the sides of the riser and screen.

Where deep piezometers or wells are to be installed, a working casing will be installed to prevent cross-contamination during drilling. The casing will be installed to two feet below the water table. The remainder of the boring will then be drilled with clean augers.

All sampling equipment will be decontaminated according to Section 2.2 of SOP 7 in the CDAP. All drill pipe, drilling tools, etc. will be free of potentially contaminating materials and will be steam cleaned prior to use at each well location. The drilling rig will be free of leaks that could contaminate the bore holes. If needed, non-petroleum based grease will be used on drill pipe joints.

5.4 GEOTECHNICAL AND LITHOLOGIC SAMPLING

Sampling for geotechnical analysis will be performed using a split spoon sampler or thin wall sampler according to ASTM D-1586 and ASTM D-1587. Soil samples for lithologic logging will be collected every 2.5 feet for the first ten feet and every five feet for the remaining depth of each boring. Soil samples will be visually classified in the field using the Unified Soil Classification System (ASTM D-2488). Samples representative of materials at the site will be retained for laboratory geotechnical testing. This testing will consist of grain size analysis (ASTM D-421 and -422), Atterberg Limits (ASTM D 4318), and moisture content (ASTM D-2216).

5.5 BORING LOGS

Logs will be prepared in the field as borings are drilled, by a qualified, experienced geologist or geotechnical engineer who will sign the log. Log entries will be preinted. One copy of each log will be sent to the USACE within five day of completion of field work. Borehole depth information recorde on the log will be from direct measurements accurate to one-tenth of a foot. Logs shall be prepared on HTW Drilling Log forms (SOP 1). The log scale will be 1 inch equals 1 foot. Each material type encountered will be described in column c of the log form. Unconsolidated materials will be described as follows:

- decsriptive USCS classification in accordance with ASTRM D-2488 - 84;
- consistency of cohesive materials or apparent density of non-cohesive materials;
- moisture content assessment;
- color;
- other descriptive features; and
- depositional type.

Stratigraphic changes will be identified in column c of the log by a solid horizontal line at the appropriate scale depth on the log which corresponds to measured borehole depths at which the changes occur. Gradational transitions, or other changes identified through non-direct observations will be denoted with a horizontal ashed line at the appropriate depth based on the judgement of the logger.

The depth intervals from which samples are retained will be identified in columns e and f of the log.

5.6 WELL DESIGN AND INSTALLATION

5.6.1 Well Screen

Well screens will be steam cleaned prior to installation. The well screens will consist of new 2-inch OD factory slotted Schedule 40 PVC. The slot size of the screens will be determined in the field in consultation with the USACE. A bottom cap will be installed at the base of the screen.

5.6.2 Filter Pack

The annular space around the well screens will be backfilled with a clean, washed, well-rounded silica sand. The grain size of the filter pack will be selected based on the characteristics of the formation being screened and the well screen. A grain size distriburtion curve for each type of filter pack used will be included in the final report. The filter pack will be tremied into place. The filter pack will extend approximately 1 foot below, and 2 feet above the well screen.

5.6.3 Well Riser

Well risers will be steam cleaned prior to installation. The well risers will consist of 2-inch OD PVC. PVC pipe will be new threaded, flush joint Schedule 40. Riser sections will be joined by threaded fllush-joint couplings.

5.6.4 Well Plumbness and Alignment

A 10-foot section of steam-cleaned pipe, one-half inch less in diameter than the inner diameter of the well riser, will be passed through the entire length of the well to check alignment. The results of the test will be recorded on the Daily Quality Control Reports and the installation diagram.

5.6.5 Bentonite Seal

A 2-foot thick bentonite seal will be tremied into place in the annular space above the well screen and filter pack sand. The seal will be composed of sodium bentonite pellets (less than 1/2-inch diameter) or granules. The seal will be allowed to hydrate for at least 4 hours before the remaining annulus is grouted. If the seal is above the water table, granular bentonite will be added in 6-inch lifts with each lift hydrated with potable water for 30 minutes between lifts. After the final lift is in place, the seal will be allowed to hydrate for 2 hours before grouting.

5.6.6 Annular Seal

Cement grout will be placed above the bentonite seal to the ground surface. The grout will consist of a mixture of Portland Cement and water in the proportions of not more than 7 gallons of potable water per 94 pound bag of cement plus 3 percent by weight of sodium bentonite powder. Grout will be placed by pumping through a side discharging tremie pipe with the lower end within 3 feet of the top of the bentonite seal.

5.6.7 Protection of Well

At all times during the intstallation of the wells, precautions will be taken to prevent tampering with the well, and the introduction of foreign materials and run-off. Upon completion, each well will be equippped with a water-tight cap and lock, and protected by a flush-mounted curb box.

5.6.8 Well Installation Diagrams

Diagrams presenting the as-built configuration of each monitoring well well be prepared for inclusion in the Final Report. Two copies of the field well installation diagram will be completed and sent to the USACE within five days of completion of each well. The diagrams will include the following information:

- project and site name, well number and total well depth;
- depth of grouting or sealing, and the amount of cement and/or bentonite used, and the total boring depth;
- depth and type of well casing;
- static water level upong completion of the well, and after development;
- installation date, name of driller, name and signature of geologist;
- construction details
- description of sufrace completion
- description of difficulties encountered
- surveyed coordinates and elevation of top of ground an top of well riser (on final well installation diagram); and,
- a brief stratigraphic log.

5.6.9 Temporary Capping

Any well that is to be temporarily left incomplete for any reason will be capped with a watertight cap and equipped with a vandal proof protection.

5.6.10 Identification of Wells

A permanent corrosion resistant tag will be affixed to the protective casing of each well to identify the well number, depth, date of instllation, the USACE, Omaha district, and the top casing elevation. The wells will be clearly identified as groundwater monitoring wells.

5.6.11 Well Development

Within one week after each well has been constructed, but no sooner than 48 hours after grouting is completed, the wells will be developed. Development will consist of mechanical surging and bailing for a minimum of 2 hours or until little or no sediment enters the well. No water will be introduced to the wells during development. The wells will then be continuously pumped using an electric submersible, or pneumatic drive positive displacement or bladder pump. Temperature, pH, specific conductivity, and turbidity will be monitored at the rate of 1 reading per well volume pumped. Pumping will continue until these parameters have stabilized (less than 0.2 pH units or a 10 percent change for the other parameters between four consecutive readings). If these parameters have not stabilized after 4 hours of continuous pumping, then the USACE will be contacted for further direction.

After development is complete, a sample of the last water withdrawn from the well will be collected in a clear glass jar. The jar will be immediately labeled and photographed. The photograph will be attached to the well installation diagram. After the photograph is taken, the nephelometric turbidity of the water will be determined in accordance with ASTM D-1889 and recorded on the well installation diagram.

5.6.11.1 Well Development Records

A well development form will be prepared and completed for each monitoring well installed. The forms will include the following:

- name of project and site, well number, dates of development;
- date, time and elevation of the static water level and bottom of well before develpment;
- development method and equipment;
- development duration by method, including pumping rates, if appropriate;
- volume and character of water removed;
- estimated volume and charater of sediment removed;
- clarity of water at various stages of development;

- total depth of well and water level immediately after, and 24 hours after development;
- pH, conductivity, temperature and turvbidity readings;
- names and job titles of develpers;
- disposition of water removed from wells.

5.6.12 In-situ Permeability Testing

After development of the monitoring wells, each new well will be slug tested. Only rising head tests will be performed in wells which are screened across the water table.

5.6.13 Water Source

A municipal water source will be used for drilling, steam cleaning and other necessary field activities. A sample of this water will be collected at the source and from the support vehicle used to transport water. These samples will be analyzed for the same parameters as the groundwater samples.

5.6.14 Monitoring Well Log Book

A log book will be maintained to record all personnel who access the monitoring wells, and to record lock-out tag numbers. The book will also provide a detailed description of the decontamination procedures required for any equipment that enters the well.

5.6.15 Site Restoration

The site will be restored to its condition prior to field work within 5 days of the completion of the site investigation. Drums will be moved to a pre-determined area specified by Textron for temporary storage. Drums will be placed on wooden pallets.

6.0
GROUNDWATER SAMPLING

6.1 WATER LEVEL/NAPL MEASUREMENT

Immediately prior to purging monitoring wells a complete round of groundwater elevation and non-aqueous phase liquid (NAPL) thickness measurements from all newly installed and existing wells will be performed. The water level, NAPL thickness, date and time of measurement, well depth, and weather conditions at the time of measurement will be recorded. The measurements will be made as quickly as possible within a 24 hour period.

6.2 WELL PURGING

After development, all wells will be allowed to stabilize for a minimum 2-week period prior to sampling. Volumes to be purged will be determined by measureing the depth to water and total well depth using an electronic water level meter. Prior to purging, the presence of NAPLs at the top and bottom of the water column in each well will be determined. If NAPLs are present, the USACE-TM will be contacted for further instructions. The well will be pumped or bailed with clean equipment to remove at least three well volumes of water. Specific conductivity, pH, temperature, and turbidity will be measured at the start of purging and twice per casing volume removed. Purging will continue beyond three well volumes until these parameters have stabilized (less than 0.2 pH units or +/- 10 percent for other parameters between four consecutive readings). If the well does not recharge fast enough to permit removing three well volumes, the well will be pumped or bailed dry and sampled as soon as sufficient recharge has occurred.

6.3 SAMPLE COLLECTION

Samples will be collected within 2 hours of purging each well. Samples will be collected with disposable bailers as described in the CDAP (SOP 3).

7.0
SOIL SAMPLING

7.1 SAMPLE COLLECTION

Soil samples for chemical analysis will be collected using a stainless steel split spoon sampler. Samples will be collected immediately upon opening the split spoon, and as soon as possible after the split spoon is taken from the boring. If the sample volume is not adequate, another sample will be collected from immmediately below the previous sample. A clean stainless steel spoon will be used to transfer soil from the split spoon to the laboratory container. Samples for volatile organic analysis will be collected first, followed by samples for metals analysis.

7.2 HEADSPACE SCREENING

Headspace screening is not required in the site specific section of the Scope of Services for this project. Soil samples for chemical analysis are to be collected from a specified depth, not based on headspace screening.

8.0

SEDIMENT SAMPLING

Sediment for chemical and physical analyses will be collected using cellulose acetate butyrate (CAB) core tubes. The core tubes will be pushed into the sediment to the specified depth by hand. If sediment from the specified depth can not be obtained using the hand-push method, a vibratory motor collar will be attached to the core tube and the sample will be collected by vibracoring. Sediment for laboratory analysis from each depth increment will be transferred to separate stainless steel bowls. Additional cores will be collected, if necessary, to provide a sufficient quantity of sediment from each depth increment for chemical and physical analyses. The sediment from each depth increment will be homogenized (separately) before being transferred to jars with a stainless-steel spoon.

Sediment for toxicity testing and benthic community characterization will be collected using a standard Ponar grab sampler. The sediment collected for toxicity testing will be transferred to a stainless-steel bowl before being transferred to laboratory-supplied plastic jars. Sediment for benthic community analysis will be transferred to a 500 micron mesh sieve, and will be sieved to remove fine sediment. Any organisms, detritus, or sediment which remains on the sieve after sieving will be placed into plastic collection jars and preserved with a 10% formalin solution.

9.0
SAMPLE HANDLING AND ANALYSIS

A sample numbering system will provide a tracking mechanism to allow retrieval of each sample, and information concerning the sample location and description. A unique sample identification number is assigned to each sample as presented on Table 4-1. Chain-of-custody (COC) forms will be used to document the possession of the samples from collection by the field sampling team through shipping, storage and analysis, to data reporting by the laboratory.

Appropriate procedures and safeguards shall be used for all sample packaging and shipping activities. Sample analyses will be performed by a certified laboratory approved by the USACE and the State of Connecticut. The laboratory will comply with all appropriate quality assurance/quality control requirements of the USACE. Laboratory procedural details will be submitted and samples will be analyzed using the EPA SW-846 methodologies.

The CDAP and the SOPs present detailed information concerning the sample handling and analysis procedures and requirements.

10.0
GENERAL PROCEDURES

10.1 INVESTIGATION DERIVED WASTES

Groundwater generated during well development and purging, and drill cuttings generated during boring installation will be stored in appropriate drums on site. The disposition of the drums will be determined based on analytical results. Composite samples will be collected from drums of like material (i.e. water or soil) within each area of concern. These samples will be analyzed for waste classification using Toxicity Characteristic Leaching Procedure (TCLP). W-C will handle all aspects of the disposal of contaminated materials, except for selecting the disposal company and signing manifests.

10.2 SURVEYING

Well locations will be located vertically and horizontally by a licensed surveyor. Ground elevations will be measured to the nearest 0.1 ft and well casings to the nearest of 0.01 ft. The locations and elevations will be plotted on existing site plans at a scale of 1 inch represents 100 ft.

FINAL

APPENDIX A

SAMPLING AND ANALYSIS PLAN

PART 2 - CHEMICAL DATA ACQUISITION PLAN

PHASE II REMEDIAL INVESTIGATION WORK PLAN

STRATFORD ARMY ENGINE PLANT STRATFORD, CONNECTICUT

Prepared for
U.S. Department of the Army
Corps of Engineers, Omaha District
Omaha, Nebraska
November 1994

Woodward-Clyde

101 South 108 Avenue
Omaha, Nebraska 68154
WC Project No. C3M11LL

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LIST OF TABLES

NOTE: The figures listed below are located at the end of each appropriate section.

LIST OF FIGURES

LIST OF ATTACHMENTS

Batch	Synonymous with Sample Delivery Group.
Calibration Blank	Usually an organic or aqueous solution that is as free of analyte as possible and prepared with the same volume of chemical reagents used in the preparation of the calibration standards, and diluted to the appropriate volume with the same solvent (water or organic) used in the preparation of the calibration standard. The calibration blank is used to give the null reading for the instrument response versus the concentration calibration curve.
CDAP	Chemical Data Acquisition Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	U.S. Environmental Protection Agency Contract Laboratory Program.
Co-located Samples	Two or more separate samples taken from the same location, but not homogenized.
Comparability	A measure of the confidence with which one data set can be compared with another.
Completeness	A measure of the amount of valid sample data obtained

	from the measurement system compared to the amount of sample data that are analyzed. Valid results are those results which meet or exceed quality control criteria and satisfy quality assurance objectives.
Duplicate	Duplicate samples are two samples taken and analyzed independently. In cases where aliquoting is impossible, as in the case of volatiles, co-located samples must be taken for the duplicate analysis.
Environmental Samples	An environmental sample or field sample is a representative sample of any material (aqueous, nonaqueous, or multimedia) collected from any source for which determination of composition or contamination is requested or required.
Field Rinsate Sample	Reagent water or other equivalent analyte-free material is transported to the site, opened in the field, and poured over or through the sample collection device, collected in a sample container, and returned to the laboratory. This serves as a check on sampling device cleanliness and potential cross-contamination.
Matrix Spike (MS)	A matrix spike is employed to provide a measure of accuracy for the method used in a given matrix. A matrix spike analysis consists of adding a predetermined quantity of stock solutions of certain analytes to a sample matrix prior to sample extraction/digestion and analysis. The concentration of the spike should be at the regulatory

	standard level, or the reporting limit for the method if the sample is free of the analyte.
Matrix Spike Duplicate	A second matrix spike sample prepared identically to the matrix spike on a duplicate sample of the matrix.
MDL	The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.
Method Blank	A sample matrix that is as free of analyte as possible, and contains all the reagents in the same volume as used in the processing of the samples. The method blank must be carried throughout the complete sample preparation procedure, and contain the same reagent concentrations in the final solution as in the sample solution used for analysis. The reagent blank is used to monitor for possible contamination resulting from the preparation or processing of the sample.
PCBs	Polychlorinated biphenyls
Performance Evaluation Sample	A material of known composition that is analyzed concurrently with test samples during a measurement process. It is used to verify the performance of the analytical

	system. These samples are provided by the USACE during the laboratory validation process.
Precision	Precision is the agreement between a set of replicate measurements without assumption or knowledge of the true value. Precision is evaluated as the relative percent difference or relative standard deviation for replicate or split samples.
QA	Quality Assurance
QAPP	Quality Assurance Program Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
Replicate Samples	Replicate samples are two or more samples collected separately at the same location.
Reporting Limit	The reporting limit is the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions as defined by laboratory QA procedures.
Representativeness	The degree to which a single measurement is indicative of the characteristics of a larger sample or area, or the degree to which data represents field conditions.

RPD	Relative Percent Difference, calculated as $RPD\ (\%) = \frac{\mid S-D \mid}{(S+D)/2} \times 100$ where S = first sample value (original) D = second sample value (duplicate)
SAEP	Stratford Army Engine Plant
SAS	CLP Special Analytical Services
SVO	Semi-volatile organic compounds
SOP	Standard operating procedure
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TLS	Textron Lycoming, Stratford Operations
Trip Blank	A sample of reagent water that is as free of organic analyte as possible and is transported to the sampling site and returned to the laboratory without being opened. This serves as a check on sample contamination originating from the container or sample transport.
USACE	US Army Corps of Engineers
USDA	US Department of the Army

USEPA	US Environmental Protection Agency
VOC	Volatile organic compounds
WC	Woodward-Clyde

1.0
INTRODUCTION

1.1 PROJECT BACKGROUND

Project background information for SAEP and the Phase II Remedial Investigation (RI) is contained in Sections 1.0 and 2.0 of the Phase II RI Work Plan.

1.2 CHEMICAL DATA ACQUISITION PLAN (CDAP) DESCRIPTION

This CDAP has been prepared based on the requirements presented in the Scope of Work for Phase II Remedial Investigation, June 1994 issued by USACE for Delivery Order Number 32 under Contract Number DACW45-93-D-0005 and the USACE guidance document entitled Engineering and Design-Chemical Data Quality Management for Hazardous Waste Remedial Activities, October 1, 1990 ER-1110-1-263.

Many of the procedures for conducting the field activities for the RI are described in the Standard Operating Procedures (SOPs) presented in Attachment A of this CDAP.

This CDAP, the Work Plan, and the Field Sampling Plan (FSP) have been prepared with the intention of being interdependent. The three documents should be used in conjunction with each other in order to perform and complete the RI activities. The purpose of the Work Plan is to present the project background, scope of work, descriptions of SAEP and summarizing the results of the 1992 Remedial Investigation. The FSP identifies and describes the field sampling program for this RI. This CDAP presents the specific methodology to be used to conduct the field sampling program activities. The procedures for monitoring and obtaining high quality data are also presented in this CDAP.

The proposed laboratory for conducting chemical analyses is Nytest Environmental, Inc. (NEI), Port Washington, New York. NEI was approved and validated by the USACE for the 1992 Remedial Investigation activities. Copies of the NEI Laboratory QA/QC Manual will be sent to USACE and MRD upon request.

1.3 SITE DESCRIPTION AND HISTORY

A description of the site conditions and a history of activities and investigations at SAEP is presented in the Work Plan. A physiographic description of SAEP and the surrounding area is also presented in the Work Plan.

1.4 WORK PLAN SCHEDULE

The proposed schedule for the Phase II RI activities is presented in Figure 5-1 of the Work Plan. This schedule is based on the date of authorization by USACE to proceed with the RI activities. Anticipated milestones in the schedule such as deliverables, documents, and the initiation or completion of major project activities are identified.

Mobilization for site investigation activities should commence upon receipt of authorization to proceed by the USACE. Investigation and analysis activities are expected to extend for about ten months. The entire RI is estimated to be completed within 15 months.

The proposed schedule represents an aggressive approach to meet overall project objectives. Attainment of the project schedule goals is partially dependent upon expedited regulatory review and USACE review.

2.0
DATA QUALITY OBJECTIVES

2.1 REMEDIAL INVESTIGATION OBJECTIVES

The primary objective of Phase II of the Remedial Investigation (RI) at SAEP is to determine the extent of contamination identified in sediment and groundwater in Phase I of the RI, and the effects of contamination on biota. This information will be used to develop a Baseline Risk Assessment for the site.

Specific objectives of this Remedial Investigation include the following:

- Determine pertinent parameters of any contamination found (type, concentration, location).
- Characterize the physical properties of the soil and sediment material sampled.
- Study the hydrogeological conditions in new areas of groundwater investigation.

2.2 DEVELOPMENT OF DATA QUALITY OBJECTIVES

Data quality objectives (DQOs) are defined as qualitative and quantitative statements which specify the quality of the data required to support decisions regarding remedial investigation activities. DQOs are determined based on the end uses of the data to be collected and, therefore, vary with each intended use.

Data will be generated and collected to provide information concerning the biota, soil, sediment, and groundwater characteristics at the facility. The following data needs are identified for this RI:

- evaluate characteristics of soil and sediment, including chemical and physical properties, and contaminant concentrations, if any;

- identify depth to groundwater, selected aquifer characteristics, groundwater flow direction, and chemical contamination of groundwater, if any; and,

- identify contaminants in biota, if any.

2.2.1 General Data Quality Needs

Factors involved in assessing the level of chemical data quality include appropriate analytical levels, contaminants of concern, and concentrations expected or appropriate detection limits, and samples designated as critical. The following sections describe the intended level of data quality determined as appropriate for the SAEP RI. The contaminants of concern and the concentrations expected are discussed in the Work Plan.

2.2.1.1 Analytical Level

The following are the general analytical levels, as defined by the EPA, with respect to data quality.

- Level I - Samples are field screened or analyzed using portable instruments. Results are often not compound specific and not quantitative, but are available in real-time, and provide initial screening information. These results are also used in modifying health and safety procedures. Field screening is the least costly of the analytical options.

- Level II - Samples are analyzed in the field using more sophisticated portable analytical instruments; in some cases, the instruments may be set up in a mobile laboratory on site. There is a wide range in the quality of data that can be generated. The quality of the data depends on the use of suitable calibration standards, reference materials, sample preparation equipment, detection limits, interference factors, and training of the operator. Results are available in real-time or within several hours.

- Level III - Samples are analyzed in an off-site analytical laboratory. Level III analyses may or may not use Contract Laboratory Program (CLP) procedures; but, although QA/QC may be rigorous, Level III analyses do not usually use the validation or documentation procedures required of Level IV (CLP) analysis. Generally, USEPA SW-846 methodologies with specified QA/QC protocols fall into this level.

- Level IV - CLP Routine Analytical Services (RAS). All samples are analyzed in an off-site CLP analytical laboratory following CLP protocols. Level IV is characterized by rigorous QA/QC protocols and documentation.

- Level V - Analysis by nonstandard methods. Samples are analyzed in an off-site analytical laboratory which may or may not be a CLP laboratory. Method development or method modification may be required for specific constituents or detection limits. CLP Special Analytical Services (SAS) are Level V.

Table 2-1 presents a typical characterization of these levels. In general, for the Phase II RI, Level I is to be used for field screening of samples, and for health and safety purposes. Level II is appropriate for some field geotechnical analyses and some field screening procedures. Level III is appropriate for all samples sent off site for chemical analysis. Levels IV and V will not be used for the activities proposed in this Work Plan for the RI. Further details of the analytical levels selected for site investigation activities are discussed in Section 4.0.

2.2.1.2 Detection Limit Requirements

The primary data for this RI will be from Level III analysis. The detection limits required for Level III analysis are determined by the analytical method and on a site-specific basis dependent upon the contaminants of concern, and the applicable or relevant and appropriate requirements (ARARs). Details of method and site-specific detection limits are addressed in Section 6.0.

2.3. QUALITY ASSURANCE OBJECTIVES

The overall QA objective for the RI at SAEP is to develop and implement procedures for sampling, laboratory analyses, field measurements, and reporting that provide data to a degree of quality consistent with their intended use. The sample set, chemical analysis results, and interpretations must be based on data that meet or exceed quality assurance objectives established for the project. Quality assurance objectives for field measurement systems are also an important aspect of these investigations. These objectives for non-chemical data are discussed in the appropriate SOPs. The following sections discuss field and laboratory analytical measurements.

Quality assurance objectives are usually expressed in terms of accuracy, precision, completeness, representativeness, and comparability. Target ranges for these objectives are presented for analytical testing and field measurements. Variances from the quality assurance objectives result in the implementation of appropriate corrective measures and an assessment of the impact of corrective measures on the usability of the data in the decision-making process.

2.3.1 Level of Effort

2.3.1.1 QC Effort

Field duplicates and field blank samples will be collected and submitted to the analytical laboratory to provide a means to assess the quality of the data resulting from the field sampling program. Field duplicate samples will be analyzed to check for sampling and laboratory reproducibility. Field blank samples will be analyzed to check for procedural contamination and cross-contamination. Matrix spike (MS), matrix spike duplicate (MSD), and laboratory control samples will be analyzed to assess whether recoveries falling outside acceptance criteria are attributable to sample matrix interferences and not to laboratory analytical errors, as well as to measure the precision of the analysis. The general level of this QC effort for the SAEP RI will be a minimum of one field duplicate collected for every 20 investigative soil, sediment, and groundwater sample collected and analyzed for chemical parameters. The actual frequency may be higher and will be determined in accordance with site-specific objectives. At least one field rinsate blank sample will be collected for each media sampled. One matrix spike and one matrix spike duplicate sample will be analyzed for each matrix per analytical batch, which is usually set at a maximum of 20 samples per batch.

The level of QC effort provided by the laboratory will be equivalent to the level of QC effort specified in USEPA SW-846, Third Edition. The level of laboratory QC effort required for specific analytical parameters is summarized in Table 2-2.

The QC level of effort for the field measurement of pH consists of premeasurement calibration and postmeasurement verification using a standard reference solution at least once per day or one in 20 samples. The QC effort for field conductivity and salinity measurements will include daily calibration of the instrument, using standard solutions of known conductivity and salinity as specified in SOP No. 3.

2.3.1.2 QA Effort

Field duplicates and replicates may be collected for specific parameters and submitted to an independent government quality assurance laboratory. The USACE has chosen the Missouri River Division (MRD) Laboratory for this project. QA samples shall be collected and submitted as directed by the USACE MRD project manager.

2.3.2 Measurement of Data Quality Objectives

2.3.2.1 Accuracy

Accuracy is the degree of agreement of a measurement to an accepted reference or true value. An evaluation of the accuracy of a measurement system provides an estimate of bias. Sources of error which affect accuracy are the sampling process, field contamination, sample handling, sample matrix, sample preparation and analysis techniques.

Analytical Accuracy

The accuracy of an analytical method is evaluated by analyzing known reference standards, and is reported as the percent recovery of an analyte which has been added to the environmental sample at a known concentration before analysis. Analytical accuracy may be assessed through the use of QC sample (laboratory control samples and surrogates) and matrix samples. The percent recovery achieved by analysis of known reference standards, laboratory control, or spiking compounds will be used to define the accuracy for the compounds of interest. One known reference standard is analyzed for every batch of 20 samples.

The estimated ranges of accuracy for each measurement parameter are defined within the analytical test methods. Acceptable accuracy measures are also dependent on the sample matrix. Accuracy criteria (percent recovery) for the parameters to be analyzed by the analytical laboratory are provided in the NEI Laboratory QA/QC Manual.

Accuracy will be expressed as percent recovery for laboratory control samples and surrogates as follows:

$$\text{Percent Recovery} = \frac{X}{T} \times 100$$

where X = the observed value of measurement

T = "true" value

These recoveries will be compared with the method and laboratory control limits and the outliers will be assessed in conformance with other QC data. If the surrogate percent recovery limits are exceeded, the data will be assessed.

The matrix spike and matrix spike duplicate sample results will be used to calculate the percent recovery as an indicator of matrix effects as follows.

$$\text{Percent Recovery (for matrix spikes)} = \frac{X-S}{T} \times 100$$

where X = observed value after spike
S = sample value
T = amount spiked

The matrix spike and matrix spike duplicate percent recoveries will be compared against the methods and laboratory limits.

Sample Collection Accuracy

Sampling accuracy can be assessed by evaluating the results of trip and rinsate blanks. These blank samples would be included in sample batches to ensure that all samples represent the particular site from which they were sampled and to assess any cross-contamination that may have occurred.

Trip Blank A trip blank is a pre-cleaned and pre-certified, 40 ml VOC sample vial filled with contaminant-free water at the laboratory. The trip blank is shipped to and from the field with the sample containers. It is not opened in the field and therefore provides a test for contamination from sample preservation, site conditions and transport as well as sample storage, preparation and analysis. A trip blank is normally only analyzed for

VOC. A trip blank will be submitted at a frequency of one per sample cooler which contains samples for volatile organic compounds analysis for the laboratory.

Rinsate Blank A rinsate blank is prepared in the field by pouring "clean" deionized, distilled or High Performance Liquid Chromatograph (HPLC) grade water over or through sample collection devices or equipment. A rinsate blank is sometimes referred to as an equipment blank, field blank, or wash blank. A rinsate blank will be prepared at a frequency of one per media sampled and is analyzed for the analytes being sampled for by the sampling equipment.

The accuracy of field measurements such as pH will be assessed through premeasurement calibrations and postmeasurement verifications, using at least two standard buffer solutions. The two measurements must each be within 0.1 standard unit of buffer solution values.

2.3.2.2 Precision

Precision is the measure of variability between individual sample measurements under prescribed conditions. Precision can be assessed by replicate measurements of known standards and analysis of duplicate environmental samples. Replicate samples are compared by calculating the sample standard deviation, while the precision of duplicate samples is expressed as relative percent difference (RPD).

Replicate measurements of known standards (laboratory control samples) are routinely monitored by the laboratory by comparing the RPD with control limits established at plus three standard deviations from the mean RPD of historical data.

Precision will be expressed as relative percent difference (RPD) for duplicate environmental samples and for duplicate control samples, as follows:

$$\text{RPD (\%)} = \frac{|S-D|}{(S+D)/2} \times 100$$

where S = first sample value (original)
D = second sample value (duplicate)

The RPDs will be compared against the limits in the NEI Laboratory QA/QC Manual and data assessment will be conducted as specified in Section 7.0.

Analytical Precision

Analytical precision is much easier to control and quantify than sampling precision. Analytical precision will be determined through the use of matrix spikes and matrix spike duplicates for the analytical work performed. Precision of analytical results will be evaluated as the relative percent difference or relative standard deviation from the mean of replicate analyses.

<u>Matrix Spike</u> A matrix spike (MS) is an environmental sample to which known concentrations of analytes have been added. The MS is taken through the entire analytical procedure and the recovery of the analytes is calculated. Results are expressed as percent recovery of the known amount spiked. The MS is used to evaluate the effect of the sample matrix on the accuracy of the analysis. In addition matrix spike duplicates (MSD) will be obtained. In order to verify that poor recoveries (recoveries out of control limits) are due to matrix effect and not lab error for either the MS or the MSD the laboratory will be required to run a blank (deionized water) spiked at the same level as the MS. WC will not require that this analysis be reported, but the lab must be able to prove that poor spike recoveries are not a result of lab error. To ensure that MS samples adequately represent all matrices sampled, MS analysis will be conducted at a rate of one per matrix per batch of 20 samples. The analysis will be designated on the chain-of-custody by field sampling personnel. The lab will plot MS data with control charts. Extra sample volume will be collected for MS samples. A determination will be made in the field concerning representative matrices to ensure that MS samples adequately represent all matrices sampled.

Matrix Spike Duplicate A matrix spike duplicate (MSD) is another aliquot of the same environmental sample as the MS which is spiked with known concentrations of analytes. The two spiked aliquots are prepared and analyzed separately and the results compared to evaluate the effects of the matrix on the precision and accuracy of the analysis. Results are expressed as relative percent differences (RPD) between the duplicate samples analyzed and percent recovery. MSD's will be analyzed at a rate of one per batch of 20 samples. The analysis will be designated on the chain-of-custody by field sampling personnel. Extra sample volume will be collected for MSD samples.

Sample Collection Precision

Sampling precision may be determined by collecting and analyzing collocated or field duplicate or replicate samples and then creating and analyzing laboratory replicates for one or more of the field samples. During the collection of field instruments, precision will be checked by reporting several measurements taken at one location during the same sampling event and comparing the results.

Field Duplicate A field duplicate is an environmental sample which is divided into two separate aliquots. The aliquots are processed separately and the results are compared to evaluate the effects of the matrix on the precision of the analysis. Results are expressed as RPD between the duplicate aliquots analyzed. Duplicate field samples will be obtained at a rate of one per twenty environmental samples or one per batch of samples submitted to the lab, whichever is greater. Field duplicates will not be designated on the chain-of-custody by field sampling personnel but will be submitted to the laboratory blind (the laboratory will not know the corresponding field sample for the duplicate).

Precision of field measurements such as pH will be assessed through replicate measurements. The electrode will be withdrawn, rinsed with deionized water, and reimmersed between each replicate measurement. The instrument used will be capable of providing measurement to 0.1 standard unit, however, a pH change of up to 0.5 pH units between replicates is possible due to potentially rapid equilibration of the sample with atmospheric carbon dioxide. A replicate measurement will be taken at least once per day or one in 20 samples.

2.3.2.3 Completeness

Completeness is a measure of the amount of data from a given measurement system that is considered valid based on the prescribed data quality objectives. The completeness goal is to generate a sufficient amount of valid data to support the RI objectives.

The data set must contain all QC analyses verifying precision and accuracy for the analytical protocol. In addition, all data are reviewed in terms of stated goals in order to assess the sufficiency of the data base.

The analytical completeness will be calculated by the ratio of the sum of the acceptable and estimated analytical results to the total number of analytical results requested on samples submitted for analysis.

$$\%\ \text{Completeness} = \frac{\text{Accepted Analytical Results} + \text{Estimated Analytical Results}}{\text{Total Number of Analytical Results Requested}}$$

The goal for all measurement systems is 100% completeness, that is, all the data should be valid. This is not always the case. The acceptability of less than 100% complete data will be reviewed on a case-by-case basis. The acceptability will be based largely on the significance of a particular measurement system to the project goals.

2.3.2.4 Representativeness

Representativeness is the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is a qualitative parameter which is most concerned with the proper design of the sampling program. The representativeness criteria may also be satisfied by making certain the sampling locations are selected properly and that a sufficient number of samples are collected. The rationale used to select sampling locations is described in the Work Plan and the Field Sampling Plan.

Duplicate or co-located samples will be collected and used as a means to assess field representativeness. By definition, duplicate samples are representative of a given point in space and time. Representativeness will also be maintained during the sampling effort by sampling in compliance with the procedures described in the Field Sampling Plan and SOPs in Attachment A to this CDAP.

2.3.2.5 Comparability

Comparability expresses the confidence with which one data set can be compared to another. Comparability can be related to accuracy and precision as these quantities are measures of data reliability. Data are comparable if siting considerations, collection techniques, and measurement procedures, methods, and reporting are equivalent for the samples within a sample set. A qualitative assessment of data comparability will be made of applicable data sets.

TABLE 2-1
SUMMARY OF ANALYTICAL LEVELS APPROPRIATE TO DATA USES

DATA USES	ANALYTICAL LEVEL	TYPE OF ANALYSIS	LIMITATIONS	DATA QUALITY
Site Characterization, Monitoring during Implementation	Level I	- Total organic/inorganic vapor detection using portable instruments	- Instruments respond to naturally-occurring compounds	- If instruments calibrated and data interpreted correctly, can provide indication of contamination
Site Characterization, Evaluation of Alternatives, Engineering Design, Monitoring during Implementation	Level II	- Variety of organics by GC; inorganics by AA; XRF - Tentative ID; analyte-specific - Detection limits vary from low ppm to low ppb	- Tentative ID - Techniques/instruments limited mostly to volatiles, metals	- Dependent on QA/QC steps employed - Data typically reported in concentration ranges
Risk Assessment, PRP Determination, Site Characterization, Evaluation of Alternatives, Engineering Design, Monitoring during Implementation	Level III	- Organics/inorganics using EPA procedures other than CLP can be analyte-specific - RCRA characteristic tests	- Tentative ID in some cases - Can provide data of same quality as Levels IV, V	- Similar detection limits to CLP - Less-rigorous QA/QC
Risk Assessment, PRP Determination, Evaluation of Alternatives, Engineering Design	Level IV	- HSL organics/inorganics by GC/MS; AA; ICP - Low ppb detection limit	- Tentative identification of non-HSL parameters - Some time may be required for validation of packages	- Goal is data of known quality - Rigorous QA/QC
Risk Assessment, PRP Determination	Level V	- Nonconventional parameters - Method-specific detection limits - Existing methods modification - Appendix 8 parameters	- May require method development/modifications - Mechanism to obtain services requires special lead time	- Method-specific

Source: EPA Data Quality Objectives for Remedial Response Activities; EPA/540/G-87/003, March 1987

TABLE 2-2

QUALITY CONTROL LEVEL OF EFFORT FOR ANALYTICAL TESTING

PARAMETERS	QUALITY CONTROL MEASURE	FREQUENCY
Metals	Calibration Blank (ICP and AA)	Each calibration, beginning and end of each run, 10% frequency
	Initial Calibration Verification (ICP and AA)	Daily for each instrument setup
	Continuing Calibration Verification (ICP and AA)	Beginning and end of each run; 10% frequency or every 2 hours
	Preparation Blank (ICP and AA)	One per analytical batch[1]
	Matrix Spike Analysis (ICP and AA)	One per 20 samples of each matrix
	Matrix Spike Duplicate	One per 20 samples of each matrix
	Duplicate or Replicate Sample Analysis (ICP and AA)	One per 20 samples
	Laboratory Control Sample Analysis (ICP and AA)	One per analytical batch[1]
	Analytical Spike (AA-Furnace)	Each sample (at least a single analytical spike will be performed to determine if the method of standard addition is required for quantitation)
	Serial Dilution (ICP)	One per sample delivery group
	Interference Check Sample (ICP)	Beginning and end of each run or twice per 8-hr shift, whichever is more frequent
Volatile Organic Compounds, Semivolatile Organic Compounds, and Polychlorinated Biphenyls (PCBs)	Laboratory Blank	One per analytical batch[1]
	Continuing Calibration	Daily and each instrument setup
	Laboratory Control Sample	One per analytical batch[1]
	Second Column Confirmation	Gas chromatography methods, where appropriate (i.e., pesticides)
	Matrix Spike Analysis	One per matrix per batch (20 samples)
	Matrix Spike Duplicate Analysis	One per matrix per batch (20 samples)
	Surrogate Spike	Each sample, where appropriate (e.g., semivolatiles)

[1] An analytical batch consists of 20 samples or less, prepared or analyzed together with a common QC sample.

3.0
PROJECT ORGANIZATION AND RESPONSIBILITY

The project organization identifies the responsibilities of individuals involved in this Remedial Investigation project. The project organizational structure and personnel responsibilities are designed to provide adequate project coordination and control and proper quality assurance for the Remedial Investigation activities at SAEP. The responsibilities of key personnel are described below. The organizational structure is shown on Figure 3-1. Individual personnel assignments to the project organization may be changed at the discretion of the W-C Program Manager and W-C Project Manager. Upon request, resumes of key personnel will be submitted to USACE for review and approval. The analytical laboratory internal organizational structure will be provided in the NEI Laboratory QA/QC Manual submitted under separate cover.

3.1 RESPONSIBILITIES OF KEY PERSONNEL

The responsibilities of key W-C personnel are described in the following sections.

3.1.1 Program Manager/Responsible Professional

The Program Manager has overall responsibility for all activities on the project and reporting of project status and progress to the USACE. The Program Manager monitors progress of the project work and provides supervision and support to the Project Manager. The Program Manager has overall responsibility for the development of the Work Plan, for monitoring the quality of the technical and managerial aspects of the project, and, where necessary, for implementing corrective measures.

3.1.2 Project Manager

The Project Manager (PM) has primary responsibility for the coordination, implementation, and completion of the scope of work and all activities on the project. The Project Manager is responsible to the Program Manager and the USACE for day-today control of planning, scheduling, cost control, and implementation of the project. The Project Manager also supervises the timely development and delivery of the technical reports, and other project documents. The Project Manager assigns and monitors all project personnel in planning, coordinating, and controlling all technical aspects of the tasks, and is responsible for maintaining the quality of the work product, schedule and budget control, and communications with USACE Project Manager and other key staff personnel.

3.1.3 Project QA/QC Officer

The Project QA/QC Officer reports to the Program Manager and works directly with the Project Manager and other project personnel. Overall responsibility of the QA/QC Officer is to implement the quality assurance program, and monitor and verify that the work is done in accordance with the Field Sampling Plan, the CDAP, the Standard Operating Procedures, and other applicable procedures. The QA/QC Officer also has the following responsibilities: to assess the effectiveness of the QA/QC program; to recommend modifications to the program when applicable; for verifying that personnel assigned to the project are trained and indoctrinated relative to the requirements of the QA/QC Program; for reviewing and verifying the disposition of nonconformance and corrective action reports; and for periodic quality assurance audits.

The QA/QC Officer advises the Project Manager on implementation of the QA/QC program, but the QA/QC functions of the QA/QC Officer are independent of the Project Manager. The QA/QC Officer is responsible for coordination of QA sample collection and delivery and data submittal to the Government Quality Assurance Laboratory (USACE Missouri River Division Laboratory). The QA/AC Officer will also designate and oversee the activities of the QA/QC Coordinator.

3.1.4 Project Safety and Health Officer

The Project Safety and Health Officer (PSHO) reports to the Program Manager and works directly with the Project Manager and other project personnel. The PSHO has the responsibility to monitor and verify, by conducting periodic audits and reports from the Site Safety and Health Officer (SSHO), that the field activities are conducted in accordance with the Site Safety and Health Plan (SSHP) written for this remedial investigation. The PSHO will advise the Project Manager regarding health and safety issues, but will function independently of the Project Manager. The PSHO will also designate and oversee the activities of the SSHO.

3.1.5 QA/QC Coordinator

A QA/QC Coordinator will be appointed by the QA/QC Officer, with approval by the Program Manager, to review, monitor, and report on the conformance to QA/QC program requirements for specific project activities or tasks. A QA/QC Coordinator may audit activities and will report audit findings to the QA/QC Officer. As QA/QC Coordinator, the designated staff member may also do project-related work, but may not do quality-monitoring on his or her own work. As a QA/QC Coordinator, the designated staff member may also advise the field personnel on QA/QC methods and practices, and conduct field audits of project activities. The QA/QC Coordinator will maintain a record of quality-monitoring activities and will inform the QA/QC Officer of these monitoring activities.

3.1.6 Site Safety and Health Officer

The Site Safety and Health Officer (SSHO) monitors all site activities and is responsible for the implementation of the Site Safety and Health Plan (SSHP). The SSHO reports directly to the Project Health and Safety Officer (PHSO), and works with the Project Manager and Task Leaders to ensure overall compliance with the SSHP. A detailed description of the PSHO and SSHO responsibilities is presented in the SSHP.

3.1.7 Technical Task Leaders

Technical Task Leaders will be chosen by the Project Manager with approval by the Program Manager and will be assigned to work on various tasks as deemed necessary by the Project Manager. Each Task Leader is responsible to the Project Manager for planning, scheduling, cost control, and completion of assigned project tasks. The Task Leader is responsible for implementing the QA/QC program as it relates to assigned tasks for the project.

3.1.8 Field Manager

The Field Manager (FM) will be appointed by the Project Manager with approval by the Program Manager, and will be responsible for coordinating all field activities. The Field Manager will work with the Technical Task Leaders, and will schedule field activities with the project staff assigned by the Project Manager. The Field Manager will also work with the Site Safety and Health Officer and the QA/QC Coordinator to accomplish the objectives of all aspects of the work plan, including this CDAP, as they pertain to field activities.

3.1.9 Project Staff

Project staff members are chosen by the Project Manager. Each member of the project staff is responsible to the Field Manager or Project Manager for completion of assigned project activities. Members of the project staff are responsible for understanding and implementing the QA/QC program as it applies to their project activities.

3.1.10 Data Reviewers

Data Reviewers are chosen by the Project Manager and the Project QA/QC Officer and report directly to the Project QA/QC Officer. Responsibilities of the Data Reviewers include, but are not necessarily limited to:

- verifying measurement system calibration;
- auditing quality control activities;
- screening data sets for outliers;
- auditing field sample data records and chain-of-custody forms; and

- checking calculations.

The primary task of the Data Reviewers is to quantitatively and qualitatively assess chemical data reported by the laboratory.

Data quality review of laboratory analytical data will be accomplished by the Data Reviewers. Data quality review of non-laboratory data will be accomplished by a professional qualified for that task (i.e., geologic data will be reviewed by a geologist). The appropriate data reviewer will review the data results and data collection procedures for compliance with established quality control criteria. The data quality reviewers will report to the Project Manager and Project QA/QC Officer.

3.2 SUBCONTRACTORS

Implementation of the Work Plan and the RI activities will require subcontractors for providing additional project support for services such as:

- Laboratory chemical analysis of soil, sediment, biological, and groundwater samples;
- Classification of soil samples;
- Drilling borings and monitoring well installation and development; and,
- Surveying of sample and monitoring well locations and elevations.

Training and qualifications of subcontractor personnel is assumed through certifications and licenses which are issued by regulatory agencies. Equipment, including related health and safety items, required for field activities performed by subcontractors, will be supplied by the subcontractors.

Nytest Environmental Inc. (NEI) of Port Washington, New York has been selected as the subcontract laboratory for chemical analysis of samples. The procurement of the other subcontractors will occur during the mobilization phase of this project. Selection of subcontractors will be made based on the responses submitted for the bids prepared for various project activities. The names of the subcontractors selected will be submitted to the USACE Project Manager, if requested.

The QA/QC Coordinator and Field Manager will be responsible for compliance to the Work Plan, the CDAP, and QA/QC requirements by the field subcontractors. The Project QA/QC Officer will be responsible for verifying laboratory compliance to the QA/QC program for this project. Laboratory personnel which have primary responsibility of ensuring adherence to the QA/QC of the project and the laboratory QA/QC program are identified in the laboratory Quality Management Plan.

3.3 QUALIFICATIONS OF PERSONNEL

All personnel assigned to the project, including subcontractors, will be qualified for the task to which they are assigned. Appraisal of the qualification of technical personnel assigned to the project will be made by the Project Manager. The appraisal will include comparison of the requirements of the task assignment with the relevant experience and training of the prospective personnel. All documents concerning qualification appraisal will be stored in the project administrative files.

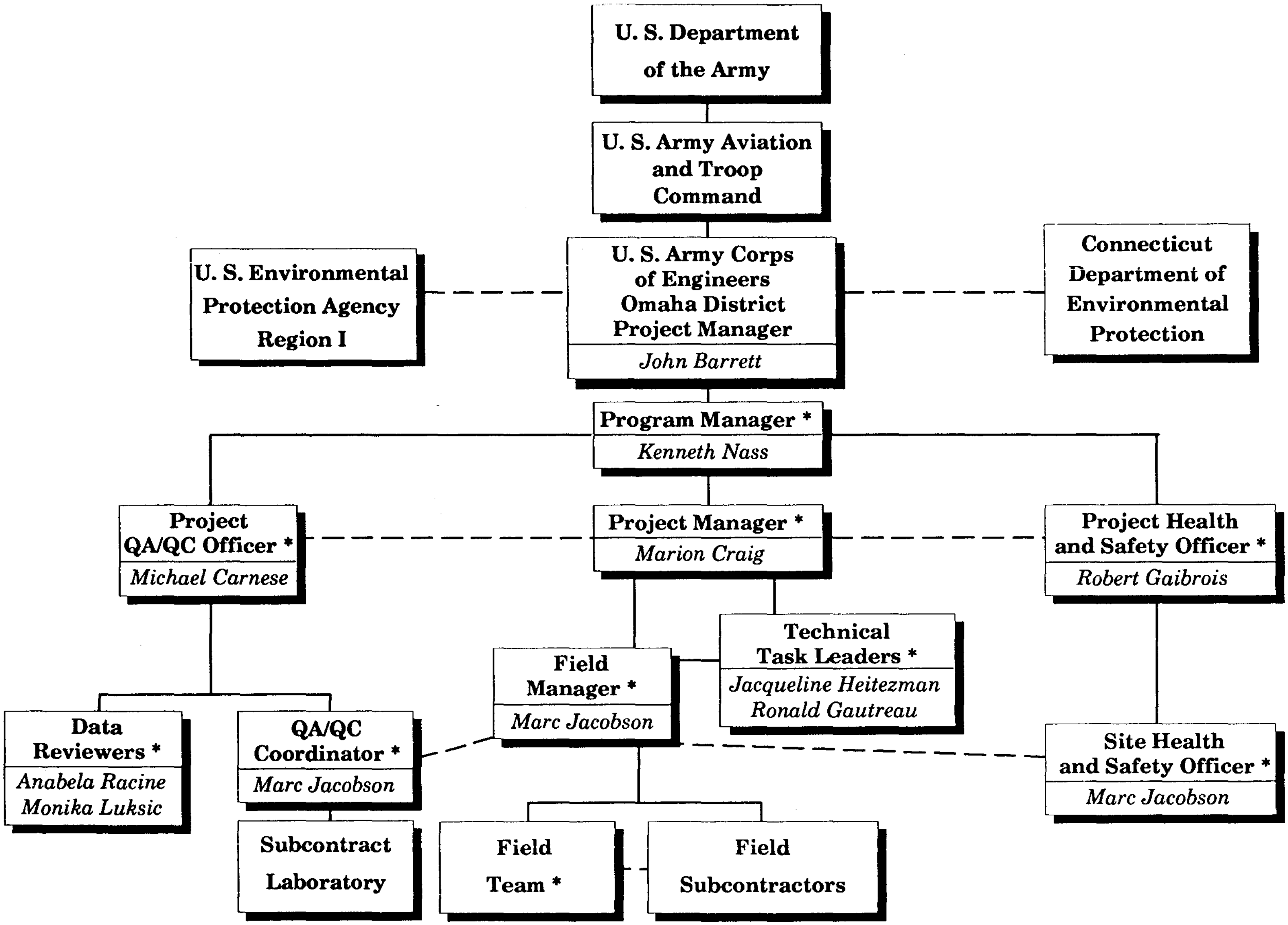


Figure 3–1

PROJECT ORGANIZATION CHART
PHASE II REMEDIAL INVESTIGATION
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

Key:
* Woodward–Clyde Personnel

C:\CSM11LL\FIG 3-1

4.1 SAMPLING OBJECTIVES

The sampling activities described in this section are designed to determine the extent of contamination identified in sediment and groundwater in the Phase I Remedial Investigation, and the effects of the contamination on biota in the intertidal flats and the Housatonic River and connected waterways adjacent to the site. In addition to determining contamination, the investigation will include a study of the site hydrogeology. Details on the sampling activities are provided in the Field Sampling Plan (FSP). If unforeseen circumstances necessitate major deviations from the procedures described below and in the FSP, the USACE TM will be notified. Changes and modifications will be subject to USACE approval and documented in writing.

The USACE TM and MRD laboratory will be notified one week in advance of all sample collection activities.

All field personnel conducting sample collection activities are required to conform to the health and safety procedures and requirements described in the Site Safety and Health Plan (SSHP).

Specifications and detailed procedures for sampling and associated field activities are described in the Standard Operating Procedures (SOPs) that are presented in Attachment A. Analytical requirements are presented in Section 6.0 of this CDAP.

4.2 SAMPLE LOCATION AND FREQUENCY

All sample locations are presented on Figures 3-1 and 3-2 of the FSP. The projected numbers of samples to be collected for each media, including QC samples, are presented in Tables 4-1, 4-2, 4-3, 4-4, 4-5, and 4-6.

4.3 SAMPLING EQUIPMENT AND PROCEDURES

General descriptions of sampling equipment and procedures for collecting samples are described in Section 5 of the FSP; details of the same are provided in the SOPs in Attachment A to this CDAP.

4.4 SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES

It is expected that the laboratory will supply sample containers precleaned and packaged according to EPA specifications. Precautions will be taken to avoid sample container contamination.

The general requirements for sampling containers, preservation and holding times, along with site-specific requirements, are shown in Table 4-7 and are detailed in Appendix D of ER 1110-1-263.

4.5 DECONTAMINATION

All sampling equipment will be decontaminated to prevent cross-contamination of samples. The equipment will be decontaminated before entering the sampling location, between intrusive activities, and before equipment is removed from the site. All decontaminated equipment will be inspected prior to use by WCC personnel. Decontamination of personnel and equipment will be performed at specified decontamination areas as determined by the Field Manager and Site Safety and Health Officer. Specific procedures for decontamination are provided in SOP No. 7. Personnel decontamination procedures are outlined in the Site Safety and Health Plan (SSHP). Personnel decontamination will occur to comply with the SSHP and to prevent cross-contamination of samples.

4.6 FIELD DOCUMENTATION

Various types of documentation will be produced during the RI, with a majority being field documentation from field activities. The primary documentation is described in the following sections. Other documentation may be produced as necessary during the RI and will be consistent with the standards and requirements presented within this CDAP and associated SOPs.

4.6.1 Field Logbook

Details of field documentation are provided in SOP No. 6. Bound hardcover field logbooks will be used to record all pertinent field data and observations made during the field activities. The pages of the notebook will be consecutively numbered and will not be removed. Documentation in the field logbook will be of sufficient detail to reconstruct pertinent sampling activities of a later date. Entries into the field logbook will include, but are not necessarily limited to, the following information:

- Project name and number
- Task or activity description
- Date and time
- Sample location
- Sample identification number
- Sample depth
- Number of aliquots
- Media type
- Sampling personnel present
- Field measurement data
- Type of health and safety clothing/equipment used
- Analyses requested
- Time of sample collection
- Sample preservation, field observations, to include soil description (if relative)

- Weather conditions
- Photographic information
- Other project-specific information

In addition, field sketches will be made in the field logbooks, when appropriate, and will be referenced to existing permanent structures in the area (i.e., trees, fence posts, buildings).

All entries will be made in blue or black ink and no erasures will be allowed. If an incorrect or unreadable entry is made, the information will be crossed out with a single strike mark and the change initialed and dated by the team member performing the change.

Each page in the field logbook will be signed and dated in the top margin by all persons making entries on that page.

Field logbooks will be identified by a project-specific number (i.e., Logbook No. 1 for Project Number C3M11LL, etc.), and will be stored in the field project files when not in use. At the completion of the field activities, the logbooks will be maintained in the permanent project file. A photocopy of all field notebooks, logs, etc., will be provided to the USACE upon request.

4.6.2 Boring Logs

Boring logs will be completed for each boring by qualified personnel. An example boring log and the information to be included on each boring log is located in SOP No. 1, in Attachment A.

4.6.3 Monitoring Well Construction Log

A log documenting well construction will be completed for each monitoring well installed on the site. An example log and a summary of the information to be included on each log can be found in SOP No. 2, in Attachment A.

4.6.4 Well Development Log

A well development log will be completed to document the well development procedures followed for each monitoring well installed. An example well development log and a list of information to be included on these logs can be found in SOP No. 2, in Attachment A.

4.6.5 Water Level Data Sheet

All water level measurements will be recorded on a water level data sheet. These sheets will include all pertinent information concerning water levels, field measurements, and monitoring wells. An example data sheet can be found in SOP No. 5.

4.6.6 Photographic Documentation

Pertinent field activities and sample locations will be documented with representative photographs. The picture number and roll number will be logged in the field logbook to identify the area and activity depicted in the photograph. A separate photographic documentation logbook will be maintained by the Field Manager in charge of the site investigation. The film roll number will be identified by taking a photograph on an information sign as the first frame of the roll. The project and film roll numbers and date will be shown on this sign. The picture number, roll number, and a description of the picture will be logged in the photographic documentation logbook as well as the Daily Quality Control Report (DQCR), if appropriate. All photographs will be stored in the project file.

Videotape recording cameras may also be used during some field activities to provide an additional type of documentation. Videotapes will be labelled with pertinent project information and stored in the project file.

The use of all photographic equipment will be subject to approval by Alliedsignal.

4.7 FIELD SURVEY

An elevational and horizontal control survey will be extended to all sample locations, including sediment sampling locations and monitoring wells. Permanent survey points will be established at the site for future reference. The accuracies established for the surveys will be ±0.1 foot (vertical control) and ±1.0 foot (horizontal control) for all sample locations and ground surface measurements at monitoring wells. The well casings will be surveyed with an accuracy of 0.01 foot (vertical control). Vertical and horizontal locations will be referenced to permanent survey points.

4.8 FIELD INSTRUMENT PREVENTATIVE MAINTENANCE AND CALIBRATION

All field instrumentation, equipment, and accessories will be maintained in accordance with the manufacturer's recommendations and specifications, and established field practice. Table 4-8 summarizes field equipment calibration procedures.

The calibration and general maintenance of field instrumentation will be the responsibility of the field team member, under the direction of the Field Manager and Site Safety and Health Officer. All documentation pertinent to the calibration and/or maintenance of field equipment will be maintained in a field logbook. Entries made into the logbook regarding the status of any field equipment will contain, but are not necessarily limited to, the following information:

- Date and time of calibration

- Name of person doing calibration; type of equipment being serviced, and identification number (such as serial number)
- Reference standard used for calibration (such as pH of buffer solutions);
- Calibration and/or maintenance procedure used
- Other pertinent information

Equipment that fails calibration and/or becomes otherwise inoperable during the field investigation will be removed from service and segregated to prevent use. Such equipment will be properly tagged to indicate that it should not be used until the nature of the problem can be determined. Failed equipment will be repaired or recalibrated and may be used after approved for use by the Field Manager or Site Safety and Health Officer prior to placement back into service. Equipment that cannot be repaired or recalibrated with minimum delay will be replaced.

TABLE 4-1

PROJECTED TOTAL NUMBER OF SAMPLES FOR CHEMICAL ANALYSIS AND TESTING

TYPE OF SAMPLE (MATRIX)	NUMBER OF FIELD SAMPLES	QUALITY CONTROL SAMPLES				QUALITY ASSURANCE SAMPLES		TOTAL NUMBER OF SAMPLES
		No. of Field Duplicates	No. of Field Rinsate Blanks	No. of Trip Blanks	No. of MS/MSD Samples	No. of Splits	No. of Trip Blanks	
SOIL	5	1	1	3	2	1	1	**14**
GROUNDWATER	67	6	1	20	3	6	6	**109**
SEDIMENT								
Chemical	66	6	1	0	3	6	0	**82**
Physical	66	0	0	0	0	0	0	**66**
Toxicity Testing	15	0	0	0	0	0	0	**15**
BIOLOGICAL	18	0	0	0	2	0	0	**20**
SOURCE WATER	2	0	0	0	0	0	0	**2**
TOTALS	**239**	**13**	**3**	**23**	**10**	**13**	**7**	**308**

NOTES:
MS/MSD = Matrix Spike / Matrix Spike Duplicate (number shown is sets of two samples).
The number of samples are estimated; actual numbers of field samples will be dependent on the field conditions.
Actual total numbers of trip blanks will be dependent on the number of days required for sample collection.
Analyses for all samples (except trip blanks):
Trip blanks samples will be analyzed for TCL Volatile Organic Compounds only.
The number and type of Quality Assurance samples (collocated split or replicate samples) proposed to be collected were requested by USACE.

TABLE 4-2
PROJECTED TOTAL NUMBER OF CHEMICAL ANALYSES FOR MONITORING WELL SOIL SAMPLES

MONITORING WELL SAMPLE LOCATIONS	ANALYTICAL PARAMETERS		TOTAL NUMBER OF ANALYSES
	TCL Volatile Organics	Priority Pollutant Metals	
Northwest Corner of Facility			
1 well	1	1	2
Access Road			
6 wells	2	2	4
North Parking Lot			
2 wells	1	1	2
West Parking Lot			
2 wells	1	1	2
FIELD SAMPLE TOTALS	**5**	**5**	**10**
QA/QC SAMPLES			
Field Duplicates	1	1	2
Field Rinsate Blanks	1	1	2
Trip Blanks	3	NA	3
Matrix Spike	1	1	2
Matrix Spike Duplicate	1	1	2
Splits	1	1	2
QA Trip Blanks	1	NA	1
QA/QC SAMPLE TOTALS	**9**	**5**	**14**
TOTAL OF ALL SAMPLES	**14**	**10**	**24**

NOTES:

One soil sample will be collected from each well cluster.

The number of samples are estimated; actual numbers of field samples will be dependent on the field conditions.

Actual total numbers of trip blanks will be dependent on the number of days required for sample collection.

NA = not applicable

TABLE 4-3
PROJECTED TOTAL NUMBER OF CHEMICAL ANALYSES FOR GROUNDWATER SAMPLES

MONITORING WELL SAMPLE LOCATIONS	ANALYTICAL PARAMETERS		TOTAL NUMBER OF ANALYSES
	TCL Volatile Organics	Priority Pollutant Metals (total)	
NEW WELLS *			
Northwest Corner of Facility			
1 well	2	2	4
Access Road			
6 wells	12	12	24
North Parking Lot			
2 wells	4	4	8
West Parking Lot			
2 wells	4	4	8
EXISTING WELLS			
45 wells	45	45	90
FIELD SAMPLE TOTALS	**67**	**67**	**134**
QA/QC SAMPLES			
Field Duplicates	6	6	12
Field Rinsate Blanks	1	1	2
Trip Blanks	20	NA	20
Matrix Spike	4	4	8
Matrix Spike Duplicate	4	4	8
Splits	6	5	11
QA Trip Blanks	6	NA	6
QA/QC SAMPLE TOTALS	**47**	**20**	**67**
TOTAL OF ALL SAMPLES	**114**	**87**	**201**

NOTES:
The number of samples are estimated; actual numbers of field samples will be dependent on the field conditions.
Actual total numbers of trip blanks will be dependent on the number of days required for sample collection.

* Two rounds of groundwater samples will be collected form the new wells.
The number indicated on the table is for both rounds

NA = not applicable

TABLE 4-4
PROJECTED TOTAL NUMBER OF CHEMICAL ANALYSES FOR SEDIMENT SAMPLES

SEDIMENT SAMPLE LOCATIONS	ANALYTICAL PARAMETERS			TOTAL NUMBER OF ANALYSES
	PAHs Semivolatile Organics	Polychlorinated Biphenyls (PCBs)	Priority Pollutant Metals (total)	
Intertidal Flats / Housatonic River				
30 locations	60	60	60	180
Upstream / Upgradient				
2 locations	4	4	4	12
Downstream / Downgradient				
1 location	2	2	2	6
FIELD SAMPLE TOTALS	**66**	**66**	**66**	**198**
QA/QC SAMPLES				
Field Duplicates	6	6	6	18
Field Rinsate Blanks	1	1	1	3
Trip Blanks	0	NA	NA	0
Matrix Spike	4	4	4	12
Matrix Spike Duplicate	4	4	4	12
Splits	6	6	6	18
QA Trip Blanks	0	NA	NA	0
QA/QC SAMPLE TOTALS	**21**	**21**	**21**	**63**
TOTAL OF ALL SAMPLES	**87**	**87**	**87**	**261**

NOTES:

Sediment samples will be collected from two depths at each location.

The number of samples are estimated; actual numbers of field samples will be dependent on the field conditions.

Actual total numbers of trip blanks will be dependent on the number of days required for sample collection.

TABLE 4-5
PROJECTED TOTAL NUMBER OF TESTS FOR SEDIMENT SAMPLES

SEDIMENT SAMPLE LOCATIONS	TEST PARAMETERS				
	PHYSICAL			TOXICITY	BIOLOGICAL
	Grain Size	Percent Moisture	Total Organic Matter		Macroinvertebrates
Intertidal Flats / Housatonic River					
30 locations	60	60	60	12	12
Upstream / Upgradient					
2 locations	4	4	4	2	2
Downstream / Downgradient					
1 location	2	2	2	1	1
FIELD SAMPLE TOTALS	**66**	**66**	**66**	**15**	**15**
QA/QC SAMPLES					
Field Duplicates	NA	NA	NA	NA	NA
Field Rinsate Blanks	NA	NA	NA	NA	NA
Trip Blanks	NA	NA	NA	NA	NA
Matrix Spike	NA	NA	NA	NA	NA
Matrix Spike Duplicate	NA	NA	NA	NA	NA
Splits	NR	NR	NR	NR	NR
QA Trip Blanks	NR	NR	NR	NR	NR
QA/QC SAMPLE TOTALS	**0**	**0**	**0**	**0**	**0**
TOTAL OF ALL SAMPLES	**66**	**66**	**66**	**15**	**15**

NOTES:

The number of samples are estimated; actual numbers of field samples will be dependent on the field conditions.

Actual total numbers of trip blanks will be dependent on the number of days required for sample collection.

Sediment samples will be collected from two depths at each location.

NA = Not Applicable; NR = Not Requested

TABLE 4-6
PROJECTED TOTAL NUMBER OF CHEMICAL ANALYSES FOR BIOLOGICAL SAMPLES

SAMPLE LOCATIONS	ANALYTICAL PARAMETERS		TOTAL NUMBER OF ANALYSES
	Polychlorinated Biphenyls (PCBs)	Priority Pollutant Metals (selected)	
Intertidal Flats / Housatonic River			
5 locations	15	15	30
Upstream / Upgradient			
1 location	3	3	6
FIELD SAMPLE TOTALS	**18**	**18**	**36**
QA/QC SAMPLES			
Field Duplicates	0	0	0
Field Rinsate Blanks	0	0	0
Trip Blanks	NA	NA	0
Matrix Spike	1	1	2
Matrix Spike Duplicate	1	1	2
Splits	NR	NR	0
QA Trip Blanks	NA	NA	0
QA/QC SAMPLE TOTALS	**2**	**2**	**4**
TOTAL OF ALL SAMPLES	**20**	**20**	**40**

NOTES:

NA = Not applicable NR = Not requested

The number of samples are estimated; actual numbers of field samples will be dependent on the field conditions.

Three replicate samples will be collected from each field location.

Selected metals are: cadmium, chromium, nickel, lead, and mercury.

TABLE 4-7
SAMPLE CONTAINER, PRESERVATION, AND HOLDING TIME REQUIREMENTS FOR CHEMICAL ANALYSES OF SAMPLES

ANALYTICAL PARAMETER	ANALYTICAL METHOD	NUMBER, VOLUME, AND TYPE OF CONTAINERS PER SAMPLE	PRESERVATION	MAXIMUM HOLDING TIME	
				Extraction	Analysis
GROUNDWATER					
TCL Volatile Organics	8240	(2) - 40 milliliter glass vials with Teflon-lined septa lid	4 degrees Celsius and 4 drops HCL to pH <2	NA	14 days
Priority Pollutant Metals (unfiltered)	6010 [7060, 7421, 7470, 7740, 7841] *	(1) - one quart plastic or (1) - one liter plastic	Nitric acid to pH <2	NA	6 months
SOIL / SEDIMENT					
TCL Volatile Organics	8240	(2) - 40 milliliter glass vials with Teflon-lined septa lid	4 degrees Celsius	NA	14 days
Priority Pollutant Metals	6010 [7060, 7421, 7471, 7740, 7841] *	(1) - 8 ounce wide-mouth glass bottle with Teflon-lined lid	4 degrees Celsius	NA	6 months [mercury = 28 days]
Polycyclic Aromatic Hydrocarbons (semivolatile)	3540 8270		4 degrees Celsius	14 days	40 days
Polychlorinated Biphenyls (PCBs)	3550 8080		4 degrees Celsius	14 days	40 days
BIOLOGICAL					
Cadmium, chromium, nickel, lead, and mercury	6010 7421, 7471	(1) - 4 ounce wide-mouth glass bottle with Teflon-lined lid or wrap in two layers of aluminum foil and place in a reclosable plastic bag	< 0 degrees Celsius	NA	6 months [mercury = 28 days]
Polychlorinated Biphenyls (PCBs)	3550 8080		< 0 degrees Celsius	14 days	40 days

NOTES:

TCL = Target Compound List	NA = Not Applicable	HCL = Hydrochloric acid

Analytical methods are from USEPA SW-846, "Test Methods for Evaluating Solid Waste, 3rd Edition, Update I, July 1992.

Priority Pollutant Metals are antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc.

* The method numbers listed in brackets are for arsenic, lead, mercury, selenium, and thallium respectively.

Methods listed for metals are for analysis only; Table 6-1 list all extraction / digestion and analytical methods.

Extraction holding times are elapsed days from the date of sample collection to the date of extraction. Analysis holding times are elapsed days from the date of extraction to the date of analysis.

The holding time for mercury is 28 days.

Plastic indicates high density polyethylene.

TABLE 4-8
SUMMARY OF FIELD EQUIPMENT CALIBRATION AND MAINTENANCE REQUIREMENTS

EQUIPMENT		TASK	FREQUENCY[1]	MAINTENANCE
OVA	1.	Make sure hydrogen tank is full and allow instrument to warm up for 15 min. after turning on.	Before each day's use	Charge battery daily
	2.	Perform calibration check by introducing a known methane standard and adjusting instrument to correspond to calibration standard.	Before each day's use	
	3.	Zero the instrument	Periodically during use	
HNu	1.	Perform internal calibration.	Weekly	Charge battery daily
	2.	Introduce a known isobutylene standard and adjust instrument to correspond to calibration standard.	Before each day's use	
	3.	Zero instrument.	Periodically during use	
Salinity - Specific Conductivity - Temperature Meter	1.	Obtain correction factor by checking observed reading against 3-point known standard solutions.	Prior to each sampling event	Check batteries daily
	2.	Zero check.	Periodically during use	
pH Meter	1.	Immerse electrodes in buffer solution at pH 7 and adjust meter to proper reading. Rinse electrodes and immerse in buffer solution at pH 4 and pH 10 and adjust meter to proper reading.	Before each day's use	Check batteries daily
	2.	Repeat above procedures until readings are within 0.05 pH units of the buffer solution values. All buffer solutions and rinses should be at the same temperature.	Before each day's use and periodically during use	

---

[1] Site specific conditions may warrant a higher frequency

NOTE: Additional equipment may be required during field activities. Calibration and maintenance will be performed as specified in manufacturer's manual or in guidance documents.

5.0
SAMPLE IDENTIFICATION, HANDLING, AND DOCUMENTATION

5.1 SAMPLE IDENTIFICATION AND LABELING

A sample numbering system will provide a tracking mechanism to allow retrieval of each sample, and information concerning the sample location and description. A unique sample identification number will be assigned to each sample, and this number will be recorded on the sample label and all documentation associated with the sample. Procedures for this sample numbering system are provided in SOP No. 6.

5.2 SAMPLE CHAIN-OF-CUSTODY PROTOCOL

5.2.1 Field

The primary purpose of the chain-of-custody (COC) procedures is to document the possession of the samples from collection by the field sampling team through shipping storage and analysis. COC forms will become the permanent records of all sample handling and shipment. The Field Manager or designee will be responsible to the Project Manager for monitoring compliance with COC procedures. These procedures are described in detail in SOP No. 6.

5.2.2 Laboratory

Procedures for laboratory chain-of-custody, sample storage, and dispersement for analysis and associated documentation to be performed by laboratory personnel will be provided in the NEI Laboratory QA/QC Manual.

5.3 PACKAGING AND SHIPPING

Appropriate procedures and safeguards shall be used for all sample packaging and shipping activities. These procedures, described in SOP No. 6, shall be followed to ensure the integrity of all samples shipped for laboratory analysis.

6.1 LABORATORY ANALYTICAL PROCEDURES

The general laboratory procedures anticipated for the remedial investigation at SAEP are summarized in Tables 6-1 and 6-2. The specific analyses for sampling locations are defined in Section 4.0 and in the FSP. Included in these procedures are method-specific data quality objectives that would be applicable whenever a particular method is specified in Section 4.0. Specific laboratory practices for the methods listed below, including sample preparation, sample tracking, and documentation will be provided in the NEI Laboratory QA/QC Manual.

6.1.1 Volatile Organics

Volatile organics include compounds among varying classes such as halogenated organics, nonhalogenated organics, and aromatic organics. The first two classes generally contain contaminants associated with solvents, such as TCE, MEK, acetone, etc. The third class includes compounds associated with fuels, such as benzene, ethylbenzene, toluene, and xylene (BETX). The volatile organic method (SW-846 8240) listed in Table 6-1 employs mass spectrometry (MS) for detection. This method is indicated where the volatile contaminants are not known. The GC/MS has the capacity for positive identification at relatively low detection limits. This methodology is also indicated where its capability for tentative identification of nonlisted compounds is desired. Compounds generally analyzed by GC/MS are presented with associated reporting limits in the NEI Laboratory QA/QC Manual.

6.1.2 Semivolatile Organics

Method 8270 (SW846) is a GC/MS method for determining extractable base/neutral and acid compounds in sample extracts that have been extracted by Methods SW846-3510-3520 for aqueous or by Methods SW846-3540/3550 for solid samples. This procedure will include the general classes of compounds of polynuclear aromatic hydrocarbons (PAHs). These compounds are generally less volatile, with Method 8270 applicable for detection. The list of analytes and reporting limits are presented with the NEI Laboratory QA/QC Manual.

6.1.3 PCBs

The highly chlorinated arochlors (PCBs) are persistent in the environment and, therefore, more available for exposure or bioaccumulation. SW846 Method 8080, with the associated sample extraction (SW-846 3540/3550 for solid samples) is indicated for potential areas contaminated with PCBs.

Method 8080 is a gas chromatographic method employing an electron capture detector or an electrolytic conductivity detector. The general analyte list and associated reporting limits for soil and water are provided in the NEI Laboratory QA/QC Manual.

6.1.4 Metals

The metals analyses for the RI at SAEP shall include the Priority Pollutant list specified in Table 6-1. Interpretation of metals data can be complex, particularly when background and/or naturally occurring levels complicate the analysis.

The methodology for metals analyses is provided in Table 6-1. Factors which influence the use of particular methods are detection limits, interference, and stability.

Most metals, with a few exceptions (see Table 6-1), are detected at levels appropriate for DQOs by inductively coupled plasma emission spectroscopy (ICP). Method 6010 (SW846) is indicated for water and soil (after appropriate sample digestion, see Table 6-1) for ICP analysis. Atomic absorption (AA) methods for arsenic, lead, mercury, selenium, and thallium are indicated to achieve the lower detection limits. The reporting limits for the various ICP and AA methods are presented in the NEI Laboratory QA/QC Manual.

The methods of choice for arsenic, lead, selenium, and thallium are non-ICP due to inherent analytical interferences which, consequently, elevate instrument detection limits.

Non-ICP methods for these metals are indicated for regulatory purposes, particularly in groundwater.

6.1.5 Additional Analyses

The soil, sediment, and biological tissue samples will also be analyzed for percent moisture in accordance with the appropriate analytical method procedures for each analysis.

The laboratory shall also calculate and report percent lipids for all biological tissue samples. The procedure developed by the laboratory for calculating the percent lipids shall be based on one or more of the following reference documents:

- USEPA, March 1989, Second Printing, Methods for Analysis of Water and Wastes, 600/4-79-020, "Method 413.1, Oil and Grease Total Recoverable".
- USEPA, July 1992 Update, Test Methods for Evaluating Solid Waste, Physical/Chemical Mehtods, SW-846, 3rd Edition, "Method 9071, Oil and Grease Extraction Method for Sludge Samples".
- NOAA, Technical Memorandum NOSORCA 76, "Sampling and Analytical Methods of the National Status", Fren Program National Benthic Surveillance and Manual Watch Project, 1984-1992, Volume VI.
- Randall, 1991, "Evaluation of Selected Lipid Methods for Normalizing Pollutant Bioaccumulation", Environmental Toxicology and Chemistry, Volume 110. Issue 11, pp. 1431-1436.

6.2 LABORATORY INSTRUMENT CALIBRATION AND PREVENTATIVE MAINTENANCE

The laboratory will follow the method-specific procedures for calibration, preventative or unscheduled maintenance, and corrective action related to instruments and equipment used for chemical analysis. This section identifies the general issues which must be addressed by the laboratory to meet the minimum requirements of the project. The Laboratory QA/QC Manual also includes information relevant to calibration and preventative maintenance.

6.2.1 Calibration and Frequency

The majority of laboratory chemical analyses of samples use the following instruments and equipment:

GC (Gas Chromatography),
GC/MS (Gas Chromatography/Mass Spectrometry),
HPLC (High Performance Liquid Chromatography),
ICP-AE (Inductively Coupled Plasma-Atomic Emission Spectroscopy),
GFAA (Graphite Furnace Atomic Absorption Spectroscopy),
CVAA (Cold-Vapor Atomic Absorption Spectroscopy),

Each instrument is calibrated prior to the analyses being performed using criteria prescribed in the appropriate laboratory SOP or method. The calibration is then verified using standards from an independent source. The linear range of the instrument is established using a linear range verification check standard and the instrument detection limit (IDL) will be determined using USEPA-approved methods. No values are reported above this upper concentration value without dilution and values between the required detection limit and the instrument detection limit will be noted with the appropriate qualifiers. Both the linear range studies and the instrument detection studies will be documented and readily available for auditor review. For ICP-AE methods, interference check standards (interelement check standards) shall be run at the beginning of each analytical run. Any results outside of established criteria shall result in re-analysis.

6.2.2 Preventative Maintenance

The laboratory is responsible for the maintenance of its laboratory equipment. Preventive maintenance will be provided on a scheduled basis to minimize down time and the potential interruption of analytical work. All instruments will be maintained in accordance with manufacturer's recommendations and good laboratory practice.

Designated laboratory personnel will be trained in routine maintenance procedures for all major instrumentation. When repairs become necessary, they will be made by either trained staff or trained service engineers/technicians employed by the instrument manufacturer. The laboratory shall have multiple instruments that will serve as backup to minimize the potential for down time. All maintenance and analytical runs will be documented and kept in permanent logs. These logs will be available for review by auditing personnel.

Both scheduled maintenance and unscheduled maintenance required by operational failures will be recorded. The designated laboratory operations coordinator will review maintenance records on a regular basis to ensure that required maintenance is occurring.

TABLE 6-1

SUMMARY OF ANALYTICAL METHODS FOR CHEMICAL ANALYSES OF SAMPLES

ANALYTICAL PARAMETER	ANALYTICAL TECHNIQUE	EXTRACTION AND ANALYSIS METHOD		
		Groundwater	Soil / Sediment	Biological Tissue
TCL Volatile Organics	GC/MS	8240	8240	NA
Priority Pollutant Metals	ICP	3005, 3010 / 6010	3050 / 6010	3050 / 6010
Arsenic	GFAA	3020 / 7060	3050 / 7060	3050 / 7060
Lead	GFAA	3020 / 7421	3050 / 7421	3050 / 7421
Mercury	CV	7470	7471	7471
Selenium	GFAA	3020 / 7740	3050 / 7740	3050 / 7740
Thallium	GFAA	3020 / 7841	3020 / 7841	3020 / 7841
Polycyclic Aromatic Hydrocarbons (semivolatile)	GC/MS	NA	3540 or 3550 8270	NA
Polychlorinated Biphenyls (PCBs)	GC	NA	3540 or 3550 8080	3540 or 3550 8080

NOTES:
NA = Not applicable; the media is not being analyzed for that analytical parameter.
TCL = Target Compound List
GC/MS = gas chromatography / mass spectrometry
GC = gas chromatography
ICP = inductively coupled plasma
GFAA = graphite furnace atomic absorption
CV = cold vapor
Analytical methods are from USEPA SW-846, "Test Methods for Evaluating Solid Waste, 3rd Edition, Update I, July 1992.
Biological methods are modified from the SW-846 methods.
Where two method numbers are indicated, the extraction/digestion method is listed first.
Soil, sediment, and biological tissue samples will also be analyzed for percent moisture.
Priority Pollutant Metals are antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc.
The biological tissue samples will also be analyzed for percent lipids using a procedure based on one or more the references listed in Section 6.1.5.

TABLE 6-2
SUMMARY OF TEST METHODS FOR SEDIMENT SAMPLES

TEST	METHOD OR TECHNIQUE
PHYSICAL	
Grain Size	ASTM Method D 422
Percent Moisture	
Total Organic Matter	ASTM Method D 2974-87
TOXICITY	ASTM Method E 1367-90
BIOLOGICAL	
Macroinvertebrates	From USEPA documents: 1) EPA/600/4-90/030, November 1990; "Macroinverterbrate Field and Laboratory Methods for Evaluating the Biological Intergrity of Surface Water." and 2) EPA-670/4-73-001, July 1993; "Biological Field and Laboratory Methods for Measuring the Quality of Surface Waters and Effluents."

NOTES:

Biological method is sieving, washing, sorting, counting, and preserving the macroinvertabrates

7.0
DATA MANAGEMENT, REDUCTION, VALIDATION, AND REPORTING

7.1 DATA MANAGEMENT

During the Remedial Investigation (RI), large amounts of various types of data will be generated. At a minimum, data gathered as a part of the RI will consist of field observations, field data sheets, field log books, boring logs, results of geotechnical soil testing, chemical data from analysis of soil, sediment, and groundwater, field parameter measurements, maps, drawings, and documents. Procedures that will be used to physically manage and present project related data and information are described below.

7.1.1 Sampling Data Management

The intent of these sampling data management procedures is to maintain accurate records of all samples taken and to follow the disposition of the samples and analytical results, while minimizing the duplication of record keeping activities and the possibilities for errors.

The tabulation and flow of all sample data management information can be broken down into the following activities:

- assignment of sample numbers, sample label preparation, and initiation of permanent record keeping;
- labeling of sample bottles;
- sampling and in-the-field record keeping;
- sample receiving and preparation for shipping; and
- completion of sample record book.

7.1.2 Record Keeping During Sampling

Prior to collecting samples, the Task Leader or Field Manager will assign a sample number and a description to all samples to be collected. Sample numbers will be assigned according to the procedures presented in SOP No. 6. The sample number and corresponding description will be entered into a permanent sample record book. The information in the record book will then be written onto the appropriate sample label.

The labels for samples and a copy of the record book pages that include these numbers will be given to the sampler. This individual is responsible for completing all labels on the appropriate types of bottles. A copy of the record book pages that include information about the samples will also be given to the person collecting the samples in order to provide a list of samples to check off during the sampling activity.

The individual(s) performing the sampling is (are) responsible for verifying that each sample is put in the appropriate sample bottle. At the time of sampling this person must complete the sample label. By the end of the sampling day, the sampler must return all samples to the Task Leader or Field Manager, who will oversee preparation of the samples for shipment (i.e., review chain-of-custody (COC) forms, inspect packaging, etc.).

The person responsible for shipping the full sample bottles will compare the sample bottles with the appropriate sample record book pages. This person will then prepare the samples for shipping. All samples sent to laboratories will be recorded on a COC form; the originals must accompany the samples, and copies will be sent to the Field Manager to include in the appropriate project files.

When the samples are ready to be shipped to the laboratory, the Field Manager or Task Leader will examine the samples and note their condition. Information including the date sampled, time sampled, and method of preservation, for each sample will be entered in the sample record book.

At the time the samples are shipped, the Task Leader will have a copy of the pages in the sample record book that include information on the sample numbers and the corresponding information on the date sampled, time sampled, and the date shipped. Detailed procedures for sample handling and shipping are presented in SOP No. 6.

7.1.3 Document Control

The project file will be maintained in the office and will contain the following types of items:

- hard copies of original data;
- computer diskette copies of data;
- engineering calculations;
- data summaries;
- reports;
- original figures and maps;
- memoranda;
- telephone conversation records;
- correspondence; and
- supporting documents, when appropriate.

If a document is removed from the project file, a sign-out card will be inserted in its place. The card will identify the item removed, person removing it, and date of removal.

Original documents and correspondence will be date stamped upon arrival and will be stored in the appropriate dedicated document file. Those materials will be circulated to the appropriate personnel as determined by the Project Manager.

In all cases, the original paper copies of documents, analytical reports, and other information generated during the RI will be stored in the project files. Original, unaltered copies will be maintained independent of any working copies or later generations of the data.

Results of previous investigations and background information or documents that will be used to support the RI will also be stored in the project file.

All graphics generated through use of computer software will be accompanied by a tabular representation of the data which may or may not be included in its entirety in the reports. However, all file copies of graphics will be accompanied by a complete table of data.

All data files stored on electronic media will be backed up periodically and copies of original or master files will be stored in separate locations in the office.

Oversight of data management activities will be carried out by Project Manager.

7.2 DATA REDUCTION

Data will be reported according to accepted practices of quality assurance and data validation. However, replicate measurements, outlier values and results below the method detection limit will require explanations beyond what is presented in the table, graph or map. Non-reduced data will be available for inspection by the USACE.

Outlying values (numbers that lie outside the "expected" range of values) will not be omitted from the raw data report. Outlying values will be corrected (if possible) if the cause is related to inconsistent sampling or analytical chemical methodology or errors in the transcription of data values or decimal points. Documentation and validation of the cause of outliers will accompany any attempt to correct or delete data values.

The reduction of field-generated data may require adjustments because of baseline or background conditions. Adjustments will not be made on raw data tables or field documents.

7.3 DATA REVIEW

Data review serves the three main purposes listed below.

1) Data review qualifies field and analytical data for further use and ensures that data are not inappropriately reported or used.

2) Data review serves as a check on a laboratory to ensure that they are meeting contractual deliverables and regulatory requirements.

3) Data review establishes due diligence and allows errors to be addressed earlier in a program therefore the impact will be less than if the errors were detected later.

7.3.1 Field Data

Review of objective field and technical data will be performed at two different levels. The first level of data review will be performed at the time of collection by following standard operating procedures and quality control checks. The second level of data review will be completed by the Field Manager who will review the data to ensure that the correct codes and units have been included. After data reduction into tables or files, the Field Manager will review data sets for anomalous values. Any inconsistencies or anomalies discovered by the Field Manager will be resolved immediately, if possible, by seeking clarification from the field personnel responsible for collecting the data. Subjective field and technical data will be validated by the Project Manager who will review field reports for reasonableness and completeness. In addition, random checks of sampling and field conditions will be made by the Field Manager and QA/QC Coordinator who will check recorded data to confirm the recorded observations.

7.3.2 Laboratory Data

The data review process of chemical data produced by the analytical laboratory for this project will consist of data generation, reduction, and four possible levels of review.

The first level of review, which may contain multiple sublevels, will be made by the analytical laboratory data reviewer who has the initial responsibility for the correctness and completeness of the data. All data are generated and reduced following protocols specified in the NEI Laboratory QA/QC Manual and analytical methodology. The laboratory data reviewer will evaluate the quality of the work based on an established set of laboratory guidelines. This person will review the data package to verify the following items:

- Sample preparation information is correct and complete
- Analysis information is correct and complete
- The appropriate SOPs have been followed
- Analytical results are correct and complete
- QC samples are within established control limits
- Blank anomalies have been identified
- Special sample preparation and analytical requirements have been met
- Documentation is complete (all anomalies in the preparation and analysis have been documented; Non-conformance forms, if required, are complete; holding times are documented)

The laboratory will perform the in-house analytical data reduction and QA review under the direction of the laboratory QA Director. The laboratory QA Director is responsible for assessing data quality and advising the Project Manager of any data which were rated "preliminary" or "unacceptable", or other notations which would caution the data user of possible unreliability. Data reduction, QA review, and reporting by the laboratory will proceed as follows:

- Raw data produced by the analyst is processed and reviewed for attainment of quality control criteria as outlined in the laboratory QA/QC Manual and/or established EPA methods and for overall reasonableness.

- After entry into a laboratory management system, a computerized report is generated and sent to the laboratory data reviewer.

- The data reviewer will verify that corrective measures such as sample re-extraction or reanalysis have been performed.

- Upon acceptance of the preliminary reports by the data reviewer, final reports will be generated. This documentation will be retained as hard (paper) copy on file for 3 years. In addition, GC/MS files will be retained on magnetic tape (computerized) for 5 years.

Data reduction procedures will be based on those specified in EPA SW-846, 3rd Edition.

The laboratory will prepare and retain full analytical and QC documentation. As needed, the laboratory will supply hard copies of the retained information.

The laboratory will report the data, as a delivery group of 20 samples or less, in the order of assigned laboratory identification number, along with QC supporting data. The laboratory will provide the hard copy information, listed below, in each analytical data package:

- Cover sheet listing the samples included in the report and narrative comments describing problems encountered in analysis

- Tabulated results of compounds identified and quantified

- Analytical results for QC sample spikes, sample duplicates, method blanks, and laboratory control samples

- Tabulation of reporting limits related to the sample

The data reduction and validation steps are documented, signed, and dated by the analyst.

The second level of review will be performed by a program administrator at the laboratory to verify that the project data quality objectives were met. This review does not include review of calibration data, qualitative identifications, or quantitative results.

These items are reviewed by the data reviewer in the laboratory, who provides an independent review of all calculations and QC relevant to the report. An independent audit is performed on 5% of all projects analyzed by the laboratory by the laboratory QA director or designated staff.

The third level of review will be provided by the Project Data Reviewers, whose function is to independently review the data package. The review is intended to verify that:

- QC samples are within established guidelines;
- Qualitative identification of sample components is correct;
- Quantitative results are correct;
- Documentation is complete and correct (all anomalies in the preparation and analysis have been documented; Out-of-Control forms, if required, are complete; holding times are documented);
- The data is ready for incorporation into the final report; and
- The data package is complete.

Criteria for review of data are modelled from Functional Guidelines for Evaluating Organics Analyses, USEPA, February 1, 1998, (EPA/68-01-6699) and Functional Guidelines for Evaluating Inorganics Analyses, USEPA, July 1, 1988, or their updated versions.

Laboratory results will be reviewed and data qualified, if required. Sample data may be qualified as "J" (estimated), "UJ" (not detected-estimated) or may be rejected by "R". The qualifier "U" is normally used for analytes not detected by the laboratory.

The reviewer will identify any out-of-control data points and data omissions and interact with the laboratory to correct data deficiencies. Decisions to repeat sample collection and analysis may be made by the Project Manager based on the extent of the deficiencies and their importance in the overall context of the project. This data review will also be documented and the signature of the reviewer and the date of the review recorded.

A summary of the elements to be checked in the review process is presented in the following sections.

Review of Volatile and Semivolatile Organic Analyses

Volatile and semivolatile organic analytical data for all samples will undergo review of the following requirements, in accordance with SW-846 Chapter 1 (USEPA, 1986) and the appropriate method requirements. The data review will include the following:

- Data Package Completeness Check;
- Holding times;
- Field and Laboratory Blanks;
- Surrogate recovery;
- MS/MSD;
- Laboratory control sample;
- Compound quantitation and reported quantitation limits;
- Tentatively identified compounds (TICs);
- Field Duplicates; and
- Overall assessment of data for a case.

The precision of duplicate samples will be compared as a measure of how representative the analytical result is of the matrix sampled.

Review of Pesticides, PCBs, and Herbicides Analyses

Pesticides, PCBs, and Herbicides analytical data for samples will undergo review in accordance with SW-846 (USEPA, 1986) and Methods 8080 and 8150, respectively. The data review will consist of the following requirements:

- Data Package Completeness Check;
- Holding times;
- Calibration information;
- Blanks;
- Surrogate recovery;
- MS/MSD;
- Field duplicates;
- Compound quantitation and reported detection limits; and
- Overall assessment of data for a case.

Duplicate analysis precision will be assessed based on field duplicate and MS/MSD assessment.

Review of Metals Analyses

Metals analytical data will undergo a data review of the following requirements, in accordance with SW-846 (USEPA 1986) and the appropriate method. This review will consist of:

- Data Package Completeness Check;
- Holding times;
- Blanks - field, rinsate, lab;
- Laboratory control sample (LCS);
- Duplicate sample analysis;
- Matrix spike (MS) sample analysis;
- Field and lab duplicates; and
- Overall assessment of data for a case.

Inorganics Data Review

Inorganic data other than metals produced from the Project will undergo a data review according to SW-846 (USEPA 1986) or MCAWW (USEPA 1983) and the requirements of the applicable method. The data review will include the following:

- Data Package Completeness Check;
- Hold Times;
- Calibration information;
- Field and Laboratory Blanks;
- Laboratory Control Samples;
- Matrix spike/Matrix spike duplicates (MS/MSD);
- Lab Duplicate analysis result;
- Field Duplicate; and
- Overall assessment of data for a case.

The project may also require that the analytical laboratory submit additional data to the USACE as the fourth level of review for data validation and comparison purposes. Each data submittal will include all sample, blank, and internal quality control results such as spike and surrogate recoveries and agreement between replicate analyses. Interim data reports may be requested if the project warrants.

7.4 DATA REPORTING

The data reporting process begins with the recording of information and data during field activities. This information and data from observations or measurements are documented using various types of reporting formats. These document formats include field log books, boring logs, monitoring well construction logs, test pit logs, well development logs, and photographic documentation. These reporting formats are discussed below and described in Section 4.7 and associated SOPs.

The following are minimum data reporting requirements for the laboratory data submittals:

1) Sample ID Numbers: The laboratory, in conjunction with the Project Manager, will prepare a tabular presentation which matches laboratory sample numbers to QA laboratory sample numbers. This table will identify all field duplicates and field blanks as such and match with their corresponding field samples where applicable.

2) Sample Receipt: The laboratory will verify that the samples were received in good condition. The Cooler Receipt Form will be used to note the condition of sample shipments. Problems such as broken sample containers, broken custody seals, improper sample preservation (including temperature), and incomplete sample documentation will be immediately communicated with the Field Manager or QA/QC Coordinator.

3) General Organic and Inorganic Reporting: For each analytical method run, the laboratory will report all analytes for each sample as a detected concentration or as less than the specific limits of quantitation. Generally, all samples with out-of-control spike recoveries resulting from matrix interferences shall be designated as such. All soil samples shall be reported on a dry-weight basis with percent moisture also reported. The laboratory shall also report the date of extraction (if applicable) and date of analysis for each sample.

4) Internal Quality Control Reporting: At a minimum, internal quality control samples shall be analyzed at rates specified in the specific methods or higher rates if required to meet project specific Data Quality Objectives:

a) Laboratory Blanks (Method Blanks and Instrument Blanks): All analytes shall be reported for each laboratory blank. All non-blank sample results shall be designated as corresponding to a particular laboratory blank in terms of analytical batch processing.

b) Surrogate Spikes: Surrogate spike percent recoveries shall be reported with all organic method reports, where appropriate. The report will also specify the control limits for surrogate spike results as well as the spiking concentrations.

c) Matrix Spikes: Matrix spike recoveries (including Matrix Spike Duplicates) shall be reported for all organic and inorganic analyses. All general sample results shall be designated as corresponding to a particular matrix spike sample. The report shall indicate what field sample was spiked. The report shall also indicate the amount of analyte spiked for each matrix spike, the percent recovered, and relative percent difference.

d) Laboratory Duplicates and/or Matrix Spike Duplicate Pairs: Relative percent difference shall be reported for all duplicate pairs as well as analyte/matrix specific control limits.

Data generated during the RI will be presented in a clear and logical format in the RI Report. Tabular, graphical and other appropriate visual aids such as site plans, isopleth plots and groundwater contour maps will be used to organize and display data generated from the investigation. The overall data presentation format described herein will be designed to not only present data but aid and support conclusions drawn from the review of the data.

7.4.1 Laboratory Reporting

The laboratory will report the data as a group of 20 samples or less, along with supporting QC data. The laboratory will provide the following hard copy information in each analytical data package submitted in accordance with QA objectives for the project:

- Chains of custody;
- Cover sheets listing the samples included in the report and narrative comments describing problems encountered in analysis;
- Tabulated results of inorganic an organic compounds identified and quantified with appropriate qualifiers;
- Tabulation of reporting limits related to the sample analytes;
- Data Summary Tables of all samples by matrix an analysis type (i.e., 8240 VOC, 8270 SVOC, etc); and

- Analytical results for QC sample spikes, blank spikes, sample duplicates, blanks, standard procedural blanks, and laboratory control samples, including surrogate recoveries for organic analyses.

Laboratory qualifiers will include (at minimum):

- U = Concentration below required reporting limit;
- J = Estimated concentration due to poor spike recovery; and
- B = Concentration of chemical also found in laboratory blank.

The narrative accompanying the data package will include cautions on quantitative use, and usability of results from out-of-control QC method modification deviations.

7.4.2 Tabular Presentation of Data

Tabular presentations of both raw and sorted data will be used as a means of data presentation. Descriptions are provided in the following sections.

Raw Data

Presentation of raw data will be used as a means of introducing other presentation formats. At a minimum, these lists provide sample validation and verify that the proper sample handling and QA/QC protocol were followed. Each data record will provide the following information:

- unique sample identification;
- sample date, location and sample type;
- laboratory analytical identification number;
- parameter measured;
- analytical results and reporting units;
- detection limits for parameters not detected; and
- standard analytical data qualifiers.

In addition to the analytical data, tabulated field logs describing pertinent information gathered during the investigation, such as water level measurements, will be included. Information contained in the logs may include the following:

- name of sampler;
- date, time and purpose of sampling;
- sample media;
- sample volume or weight;
- sampling method;
- sample location and identification number;
- sample depth;
- number of samples;
- strata sampled;
- readings from field instruments;
- amount of purged groundwater;
- climatic conditions; and
- signature of person responsible for observations.

Significant events of unexpected conditions which result in a deviation from the Work Plan will be detailed.

Sorted Data

Data sorted according to specific categories provide a simple means of displaying trends, comparing sample results to one another and to regulatory guidelines and standards. Examples of categories depend upon the purpose of the table; however, they may include the following:

- sample identification number;
- sample type;
- parameter measured and concentration;
- sampling date;
- sampling location;
- depth to groundwater;
- elevation of groundwater;
- time of measurements;
- regulatory concentration guidelines and standards;
- data reductions for statistical analyses;
- summary data;
- sorted data by strata; and
- results for each constituent in each medium.

7.4.3 Graphical Presentations of Data

Graphical presentations of data will be used to help visualize trends, ranges and patterns. The following information will be presented in graphical formats:

- sampling locations and sample grids;
- boundaries of sampling areas and areas where more data is required;
- geographical position of contamination; and
- constituent concentrations at each sampling location.

Graphical formats may include bar graphs, line graphs, areal maps and contour maps. Descriptions of these graphical methods of data presentation are provided in the following sections.

Bar Graphs and Line Graphs

Bar graphs and line graphs can be used to display changes in groundwater contaminant concentrations with respect to time. Line graphs are typically more practical when there is a large volume of data points to be displayed. This will allow a more accurate and continuous line to be drawn. Different symbols, colors and textures will be used to distinguish each line or bar.

Areal Maps

The presence and distribution of contamination will be represented by superimposing contaminant concentrations over a plan of the site. Depending upon the distribution, individual measurements or contour plots will be presented.

Areal maps displaying individual measurements are practical when a small number of sampling locations are shown or the concentrations of only one parameter are being displayed. Conversely, contaminant contour maps generally require a large number of sampling locations, spaced across the study area. Contaminant contour maps can be drawn in order to display the configuration of a contamination plume.

Vertical Profiles or Cross-Sections

Vertical profiles can be used to display the distribution of a contaminant release throughout the various substrata. Cross-section diagrams will be drawn based upon stratigraphic observations made during the installation of monitoring wells, soil borings, and background or reference data.

8.0
INTERNAL QUALITY CONTROL

8.1 QUALITY CONTROL ASSESSMENT PROCEDURES

The reliability and validity of analytical laboratory results are evaluated by the inclusion, as an integral part of any analytical procedure, of a program of replicate and spiked sample analyses and the analysis of standards and trip and blank samples.

Field duplicates, trip blanks, equipment blanks, matrix spikes (MS) and matrix spike duplicates (MSD), will be collected and submitted to the analytical laboratory to provide a means to assess the internal quality of the data obtained from the field sampling program. In addition, the laboratory will produce internal samples consisting of laboratory control samples, laboratory duplicates and method blanks to assess the quality of data resulting from laboratory procedures.

Field duplicate samples will be analyzed to check for sampling and laboratory reproductibility. Trip blank samples will be analyzed to check for procedural contamination, cross-contamination, and laboratory contamination during shipment and storage of aqueous samples. Equipment blanks will be used as a measure of contamination of samples from the sampling equipment. The MS, MSD, and laboratory control samples will be analyzed to assess if recoveries falling outside acceptance windows are attributable to sample matrix interferences and not to laboratory analytical errors, as well as to measure the accuracy of the analysis. Laboratory duplicates for inorganic analysis and matrix spike duplicates for organic analytes will be analyzed to evaluate laboratory reproducibility or precision. Specific QC sample descriptions and minimum frequency of collection requirements are presented in Sections 2.0 and 4.0. Laboratory quality control procedures are presented in the Laboratory QA/QC Manual. The specific level of field QC effort is summarized in Sections 2.0 and 4.0. A description of the various types of QC samples and procedures are provided below.

8.2 FIELD QUALITY CONTROL

Field quality control will be accomplished through the review of field documentation, and the preparation and analysis of equipment rinsate blank, trip blank, and duplicate samples. These controls will check that the collection of data and field samples are representative of site conditions and are valid, in accordance with this CDAP and the project objectives.

8.2.1 Documentation

One type of field quality control will include the review and approval of all field documentation by the Field Manager or designee. Signature or initial approval will indicate that the provisions outlined in the CDAP and Site Safety and Health Plan (SSHP) have been appropriately implemented. In addition, the Field Manager will perform random spot checks on the field team daily. Documentation and procedures will be checked. Nonconformances and field corrective action will be documented as required in Section 10.0.

Field quality control activities will also include the use of calibration standards and blanks (in accordance with manufacturer's instructions) for various equipment or parameters such as pH, temperature, specific conductance, and organic vapor measurements.

Additional information and requirements for documentation preparation and review are presented in Sections 4.7 and 5.0 and SOP No. 6.

8.2.2 Rinsate Blank

Rinsate blank samples will be collected as field QC check samples which monitor contamination associated with the collection of the sample. Rinsate blank samples will also be collected to verify that materials used during the investigation, including sample collection devices and equipment will not result in the introduction of contamination to the samples. The rinsate blank samples will consist of laboratory-supplied, analyte-free deionized water (or distilled) which is poured over or through a decontaminated sample collection device or equipment. The rinsate blank samples will be analyzed for the same parameters as the associated field samples being collected at that time. One rinsate blank sample per media sampled will be collected.

If contaminants in rinsate blanks are reported above the method detection limit for any analytical procedure, the possible source of contamination will be investigated. If a problem is found, it will be corrected and samples rerun, if necessary. If no analytical problems are identified, the data will be flagged accordingly. Decontamination techniques for subsequent sampling events shall also be adjusted in the field prior to collection of additional samples.

8.2.3 Trip Blanks

Each trip bank will consist of two 40 ml glass vials with septum-lined lids which are filled by the laboratory with analyte-free laboratory water. The filled vials will be packed and shipped with the empty sample containers and subsequently returned to the laboratory with the filled sample containers. Trip blanks will be analyzed at the rate of one trip blank per shipment or cooler samples sent to the laboratory for volatile organics analysis. Trip banks will be analyzed for the same volatile organic compounds as the samples which they accompany.

Results from trip blank analyses will be used to determine whether contaminants may have been introduced during sample shipment, from sample containers, or from laboratory water and associated sample storage, preparation and analysis. The total number of trip blanks submitted and analyzed is dependent upon the type of samples, number of coolers, and associated analytical parameters collected on a daily basis.

8.2.4 Duplicate Samples

Field duplicate samples (duplicates) will be prepared by field personnel and will consist of an individual environmental sample divided into two separate aliquots and placed into two identical sets of sample containers. Duplicates will be analyzed for the same parameters as the samples which they represent.

Results of the analysis of duplicates will provide an independent evaluation of laboratory performance and analytical precision by comparing analytical results of two samples from the same location to determine the relative percent difference between the two samples. Duplicate samples will be collected and submitted for analysis at the rate of one duplicate for every 20 environmental samples collected. The duplicate samples will be submitted to the laboratory blind (i.e. the laboratory will not know which field samples are associated with the duplicates).

8.3 LABORATORY QUALITY CONTROL

Two types of QA/QC checks will be used to assess the production of analytical data of known and documented quality. These include:

- Program quality assurance; and
- Analytical method quality control.

8.3.1 Program Quality Assurance

The objectives of the laboratory QA/QC Program are to:

- Verify that all procedures are documented, including any changes in administrative and/or technical procedures;

- Document that all procedures comply with applicable analytical protocol;

- Monitor the performance of the laboratory by a systematic inspection program and provide for corrective action as necessary; and

- Verify that all data are properly recorded and archived.

All laboratory procedures are documented in writing as either Standard Operating Procedures (SOPs) or Method Procedures (MPs), which are edited and controlled. Internal quality control procedures for analytical services will comply with the laboratory QA Plan and SOPs. These specifications include the types and frequency of audits required (sample spikes, method spikes, reference samples, controls, blanks, MDL studies), the frequency of QC samples, the compounds to be used for sample spikes, and the quality control acceptance criteria for these audits.

In each data package provided, the laboratory will document, that analytical QC functions have been met. Any samples analyzed that are in nonconformance with the QC criteria will be reanalyzed by the laboratory, if the laboratory procedures were not in control as assessed by laboratory controls samples and other data specific to the analysis. Reanalysis will also be dependent on availability of sufficient sample volume. QC check samples (method blanks, MS, MSD, etc.) will be analyzed concurrently with the sample batch (maximum of 20 environmental samples) to which they are assigned. Any deviation from or modifications to the published EPA procedures or SOPs must be documented and clearly noted in the case narrative of the data package.

8.3.2 Analytical Method Quality Control

The following sections describe the types of QC samples analyzed by the laboratory in accordance with the analytical method specifications.

8.3.2.1 Method Blank

A method blank consists of analyte-free deionized reagent water or equivalent neutral reference material. The method blank is carried through each step of the analytical method and the results are used to evaluate the possible influence of analytical methods on sample analytical results. Method blanks will be analyzed at a rate of one per batch of 20 environmental samples analyzed.

8.3.2.2 Matrix Spike and Matrix Spike Duplicate

A matrix spike (MS) is an environmental sample to which known concentrations of analytes have been added. The matrix spike is taken through the entire analytical procedure and the percentage of recovery of the analytes is calculated. Results are expressed as percent recovery of the known amount spiked. The matrix spike is used to evaluate the effect of the sample matrix on the accuracy of the analysis.

A matrix spike duplicate (MSD) is the same environmental sample as the MS which is spiked with the same known concentrations of analytes. The two spiked aliquots are processed separately and the results compared to evaluate the effects of the matrix on the precision and accuracy of the analysis. Results are expressed as relative percent differences (RPD) between the duplicate samples analyzed and as percent recovery.

In order to verify that poor recoveries (recoveries out of control limits) are due to matrix effect and not lab error for either MS or the MSD the laboratory will be required to run a blank (deionized water) spiked at the same level as the MS. The reporting of this spike blank analysis is not requested; however, the laboratory must be able to prove that poor spike recoveries are not a result of laboratory error.

Matrix spike and matrix spike duplicates will be analyzed at a rate of one per matrix per analytical batch (20 samples), and will be designated on the chain-of-custody by field sampling personnel. The laboratory may request that extra sample volume be collected for MS and MSD samples.

8.3.2.3 Reagent Blank Sample

A reagent blank sample is an aliquot of analyte-free water or solvent which is analyzed concurrently with an analytical batch. It is used to prove that preparations and analyses procedures did not introduce cross-contamination during the analysis procedure.

8.3.2.4 Surrogate Spike Sample

Surrogate spike samples are used to monitor both the performance of an analytical system and the effectiveness of an analytical method. Each blank, standard, and environmental sample (including MS/MSD samples) are spiked with surrogates prior to purging or extracting according to the appropriate analytical methods. Surrogate spike recoveries shall fall within the control limits set by the laboratory (in accordance with the procedures specified in the analytical method or within ±20%) for undiluted samples. Dilution of the samples to bring the analyte concentration into the linear range of calibration may dilute the surrogates below the quantification limit. Evaluation of analytical quality will then rely on the quality control embodied in the check, spiked and duplicate spiked samples.

8.3.2.5 Check Sample

Each analytical batch shall contain a check sample. The analytes employed shall be a representative subset of the analytes to be determined. The concentrations of these analytes shall approach the estimated quantification limit in the matrix of the check sample. In particular, check samples for metallic analytes shall be matched to field samples in phase and in general matrix composition.

8.3.2.6 Clean-up

The quality control procedures described here are intended for adsorbent chromatography and back extractions applied to organic extracts. All batches of adsorbents (florisil, alumina, silica gel, etc.) prepared for use shall be checked for analyte recovery by running the elution pattern with standards as a column check. The elution pattern shall be optimized for maximum recovery of analytes and maximum rejection of contaminants.

8.3.2.7 Instrument Adjustments, Calibrations and Standards

Instrument Adjustment (Tuning, Alignment, etc.)

Requirements and procedures are instrument and method specific. Analytical instrumentation shall be tuned and aligned in accordance with requirements which are specific to the instrumentation procedures employed. Individual determinative procedures shall be consulted. Criteria for initial conditions and for continuing confirmation conditions are found in the appropriate procedures of the analytical method.

Calibration

Analytical instrumentation shall be calibrated in accordance with requirements which are specific to the instrumentation and procedures employed. Introductory Methods 7000 and 8000 in Test Methods for Evaluating Solid Wastes (EPA/SW-846) and the procedures specified in the individual methods shall be consulted for criteria for initial and continuing calibration.

Standards

The U.S. Environmental Protection Agency does not supply analytical reference standards either for direct analytical measurements or for the purpose of traceability. All contact laboratories are required to prepare from neat materials or purchase from private chemical supply houses, those standards necessary to successfully and accurately perform the analyses required for this project. The laboratory should obtain the highest purity possible when purchasing neat chemical standards. Standards purchased at less than 97% purity must be documented as to why a higher purity could not be obtained.

8.4 QUALITY REVIEW OF REPORTS

Quality control during preparation of reports relies on documentation of data and peer review of conclusions drawn from the assembled database. Peer reviews will be conducted to provide assurance that the quality of services is in accordance with the standards of the profession, the objectives of the services, and the terms of the SOW or Delivery Order. Peer reviews will be completed prior to submission of the results of work or technical recommendations to USACE. Upon completion of a peer review, the Peer Reviewer will discuss his/her comments with the author/originator and any significant issues concerning the quality of the work reviewed will be resolved. Peer reviews are documented by the reviewer by completing a Peer Review Documentation Form (see Figure 8-1) that is retained in the project file.

PEER REVIEW DOCUMENTATION FORM

SHEET 1

Project Name ______________________ Project Number ____________

Document Title ______________________ DocumentControlNo. ____________

Project Manager ______________________ Date Transmitted to Client ____________

Responsible Professional ______________ Peer Reviewer ______________

Document Author(s) ______________________

REVIEW REQUIREMENT

Part A) Document does not require Full Peer Review for the following reason: ______________________

(REMINDER: Deliverable containing judgements, opinions, recommendations or conclusions **must be peer reviewed.**)

Approved by: ______________________ Review Date ____________
Responsible Professional

Part B) Document requires Full Peer Review.

SCOPE OF PEER REVIEW

____ Preliminary ____ Letter ____ Proposal Restricted to the following Section(s):

____ Draft ____ Report ____ Contract ______________________

____ Final ____ Design ____ ____ ______________________

Part C) External Peer Review Conducted by: ______________________ Date ____________

(Documentation Attached) Comments: ______________________

REVIEW DOCUMENTATION

PROJECT MANAGER -- I have performed a review of all elements of this deliverable described on the *PEER REVIEW DOCUMENTATION WORKSHEET*, except those I have marked as NOT APPLICABLE. I believe that this deliverable will meet the needs of the Client and that the deliverable and its supporting files are complete.

Project Manager ______________________ Review Date ____________
Signature

PEER REVIEWER -- I have reviewed the assigned Items/Sections noted for the above deliverable related to my discipline and believe them to be in accordance with the standards and care of the profession. My comments have been discussed with the author(s) and all issues have been resolved to my satisfaction. I further state that I am qualified to perform this review.

Peer Reviewer ______________________ Review Date ____________
Signature

RESPONSIBLE PROFESSIONAL -- I have discussed the deliverable and review requirements with the Project Manager and Peer Reviewer(s) and believe that this review is complete and that the deliverable will meet the needs of the Client.

Responsible Professional ______________________ Review Date ____________
Signature

☐ Entered into tracking system.

WCFS1292.prd-Rev.2 - 3/5/93

FIGURE 8-1
PEER REVIEW DOCUMENTATION FORM

PHASE II REMEDIAL INVESTIGATION
STRATFORD ARMY ENGINE PLANT
STARTFORD, CONNECTICUT

PERFORMANCE AND SYSTEMS AUDITS

Performance and system audits will be performed as appropriate throughout the duration of the remedial investigation. The objectives of the performance and system audits are:

- to ensure that the quality assurance program developed for this project is being implemented according to the specified requirements;
- to assess the effectiveness of the quality assurance program;
- to identify nonconformances; and
- to verify correction of identified deficiencies or nonconformances.

If any significant deviations from the CDAP are documented, corrective action measures will be implemented and documented as detailed in Section 10.0. Reports to be prepared at the completion of an audit are described in Section 11.0.

The QA/QC Officer will be responsible for initiating audits, selecting the audit team, and overseeing audit implementation. The QA/QC Officer will also report to the Project Manager the results of audits, and corrective action measures taken, if any.

The laboratories participating in this project may also undergo a validation or certification audit procedure by the USACE which includes performance evaluation sample analysis and a laboratory facility inspection. This validation is implemented at the discretion of USACE.

9.1 PERFORMANCE AUDITS

Performance audits are usually conducted after data management systems are operational and data is being collected. Performance audits are used to quantitatively assess the accuracy of the data. Performance audits consist of two types: internal and external.

9.1.1 Field Performance Audit

Field performance audits may be conducted on an ongoing basis during the project as field data are generated, reduced, and analyzed. All numerical manipulations, including manual calculations, will be documented. All records of numerical analyses will be legible, of reproduction-quality, and sufficiently complete to permit logical reconstruction by a qualified individual other than the originator.

Internal performance audit check samples will be submitted to the subcontracted laboratory. These samples will consist of equipment rinsate blanks and duplicates as described in Section 8.0. Some duplicate samples may be used by the laboratory for matrix spike analysis. Analytical results from these internal performance audit samples will be used throughout the project to assess data from environmental samples for laboratory accuracy and precision and determine the ability of the field sample collection personnel to collect representative samples.

9.1.2 Laboratory Performance Audit

Laboratory performance audits are conducted on a routine basis and include items such as:

- Verification of written procedures and analyst(s) understanding;
- Verification and documentation of procedures;
- Verification of documents;
- Periodic unannounced inspection of the analytical process record keeping; and
- Review of a portion of all analytical data and calculations.

In addition, external performance audit check samples may be submitted by external regulatory agencies to assess whether a contracted laboratory is generating data within acceptable control limits. If external performance audit check samples are provided by USACE, the subcontracted laboratory will analyze these samples and provide analytical results along with results of the investigation samples.

Requirements for the performance audit check samples may be fulfilled as part of the contract laboratory validation procedures for USACE as outlined in Appendix C of ER 1110-1-263.

In addition, USACE may request that QA samples, usually in form of splits or replicates of field samples, be submitted to the USACE QA laboratory as described in Appendices B and E of ER 1110-1-263.

9.2 SYSTEMS AUDITS

Systems audits are conducted during the RI activities in order to verify that quality control measures/procedures specified in the CDAP are being used, documentation and project records are being completed and maintained, and that reviews of documents and reports are being conducted. These systems audits are a qualitative evaluation of the QA/QC program and its components. These audits include an evaluation of both field and laboratory quality control procedures and are conducted after the project systems are operational.

9.2.1 Field System Audit

A field system audit will be conducted by the QA/QC Officer or qualified designee during the initial sampling activities. The audit will include an on-site review of field operations, facilities, and activities, including sampling and equipment use and calibration. Documentation such as field notes, chain-of-custody forms, and equipment calibration forms will be checked for completeness and conformance to the CDAP requirements.

At the conclusion of the field audit, a post-audit conference will be held with the Field Manager and field personnel to discuss the audit results and initiate corrective action for critical items, if necessary.

The auditor will provide an oral report summarizing the results of the audit to the Project Manager within five working days of the audit. A written report will be prepared and signed by the QA/QC Officer. The report will include the following:

- Description of the audit scope;
- Identification of the audit team;
- Persons contacted during preaudit, audit, and postaudit activities;
- A summary of audit results, including an evaluation statement regarding the effectiveness of the CDAP elements which were audited;
- Details of findings and program deficiencies; and
- Recommendations for corrective action by the Project Manager or others, as appropriate.

This written report documenting all activities associated with the field system audit will be provided to the Project Manager within ten working days after completion of the audit. The report will document audit findings, on-site meetings, and program revisions, if necessary. The Project Manager will respond to the audit report within two working days of receipt. The response will clearly state the corrective action for each finding, including action to prevent recurrence and the date the corrective action will be completed.

A follow-up action will be conducted if the Project Manager deems it necessary.

Follow-up action shall be performed by the QA/QC Officer or designated representative to:

- Evaluate the adequacy of the Project Manager's response;
- Assess that corrective action is identified and scheduled for each finding; and
- Confirm that corrective action is accomplished as scheduled.

Follow-up action may be accomplished through written communications, reaudit or other appropriate means. When all corrective actions have been verified, a memorandum shall be sent to the Project Manager signifying the satisfactory close-out of the audit, with copies to the Program Manager and others as appropriate.

9.2.2 Laboratory System Audit

A technical systems audit of the laboratory is performed annually by WC. A laboratory systems audit may also be conducted by the QA/QC Officer or qualified designee during analysis of initial sample shipments sent to the laboratory. If a laboratory systems audit is conducted, the QA/QC Officer, in conjunction with the project manager representing the subcontracted laboratory, will review documentation used to verify that instrumentation required by the analytical program is being operated and that the instruments are functioning properly. This initial audit will also include a review of the analytical methods proposed for use and the laboratory SOPs prepared from these methods. The laboratory project manager, or designee, will make changes as necessary following the initial laboratory systems audits and confirm orally within five working days and in writing within ten working days to the Project Manager and/or QA/QC Officer or designee that the laboratory meets all requirements of the measurement system.

9.2.3 Office System Audit

Office system audits will be conducted as part of the overall Quality Assurance Program. The office audit consists of reviewing the project file and verifying that data collected is being presented, reviewed, and filed in accordance with this CDAP and an established QA Program. The QA/QC Officer or designee, will be responsible for conducting office system audits of this project. The QA/QC Officer will prepare a written audit report within ten working days of the audit. The QA/QC Officer will present the findings to the Project Manager if further action is required.

In addition, the QA/QC Officer will conduct a limited office audit immediately prior to the start of field activities. The audit will focus on review of the established project filing system and procedures and requirements for documentation. This audit will help ensure that the project file and documentation system are set-up in a manner which will facilitate information and data storage and retrieval during the project.

9.3 AUDIT RECORDS

Original records generated for all audits shall be retained within project files. Records shall include checklists completed by the auditor, audit reports, the record of the implementation and completion of corrective actions, and documents associated with the audits which support audit findings and corrective actions as appropriate.

10.0
NONCONFORMANCE AND CORRECTIVE ACTION

The ultimate responsibility for maintaining quality throughout the project rests with the Program Manager and the QA/QC Officer. The routine operation of the quality assurance program, however, falls upon the Project Manager, the QA/QC Coordinator, the technical staff, and the subcontracted laboratory's quality assurance officer and project manager.

Any member of the project staff who identifies a condition adversely affecting quality can initiate corrective action by notifying the Project Manager or QA/QC Officer verbally or in writing. A written communication identifying the condition and an explanation of how it may affect data quality or quantity is preferable for initiating the corrective action process.

10.1 NONCONFORMANCE

A nonconformance is an unauthorized deviation from documented procedures, practices or standards, or a defect in an item that is sufficient to render the quality of the item unacceptable or indeterminate, or any event which is beyond the expected conditions and limits such as those presented in this CDAP. Nonconformances may include (but are not limited to) the following:

- failure of an instrument to work properly;
- sample documentation not correct;
- improper sample collection method;
- sample holding time exceeded;
- sample storage conditions outside criteria;
- incorrect sample preparation/analysis procedures used;

- Quality Control sample data (replicate, duplicate, blind duplicate, etc.) outside limits;

- calibration requirements not met;

- documentation errors in data recording or transcription;

- data validation errors;

- a recovery or RPD result that is out of control limits (e.g., more than three standard deviations from the weighted mean);

- relative standard deviation for response factors greater than accepted limits; and/or

- any situation or result which might affect the quality of data.

Any identified nonconformances with the established quality control procedures will be expeditiously controlled or corrected. Additional work which is dependent on the nonconforming activity will not be performed until the identified nonconformance is corrected.

10.2 CORRECTIVE ACTION

A corrective action is an appropriate measure applied to correct a nonconformance and minimize the possibility of recurrence.

Corrective action may be necessary in the event that data is determined to be suspect following performance or system audits or when existing or potential conditions are identified which may have an adverse impact on data quality.

10.2.1 Field Corrective Action

The Project Manager will periodically review the procedures being implemented in the field and audit findings for verifying consistency with the established procedures and protocols. Documentation will be checked for completeness. Where procedures are not strictly in compliance with the established protocol, deviations will be documented and reported. Corrective actions will be defined by the Project Manager and QA/QC Officer and documented as appropriate. Upon implementation of the corrective action, the Project Manager will provide the Program Manager and QA/QC Officer with a written memo documenting field implementation. The memo will become part of the project file.

10.2.2 Laboratory Corrective Action

The laboratory's quality assurance officer and the project Data Validator(s) will review the analytical data generated to ensure that all quality control samples have been analyzed as specified in the protocol. Recoveries of spike samples will be checked for consistency with method accuracy and duplicate samples will be checked with method precision. Where sample results fall outside of the acceptable ranges, deficiencies will be reported to the Project Manager and QA/QC Officer. Corrective actions will be defined by the Project Manager in coordination with the laboratory project manager and documented as appropriate.

Laboratory personnel will be alerted that corrective actions may be necessary if:

- QC data are outside the warning or acceptable windows for precision and accuracy as established for matrix spikes and matrix spike duplicates in the analytical protocols.

- Blanks contain contaminants at concentrations above the required quantitation limit of any target compound.

- Undesirable trends are detected in matrix spike recoveries or coefficients of variation (CV) between matrix spike duplicates.

- There are unusual changes in detection limits.

- Deficiencies are detected during internal or external audits, or from the results of performance evaluation samples.

11.0
CHEMICAL DATA QUALITY MANAGEMENT (CDQM) DELIVERABLES

Various reports and documents will be prepared during the RI for presenting information about the Chemical Data Quality Management (CDQM) program. These reports are described in this section.

11.1 DAILY QUALITY CONTROL REPORTS (DQCR)

During the field investigation, the Field Manager will prepare Daily Quality Control Reports (DQCR) for the USACE. These reports will include the information presented in the USACE ER-1110-1-263. These reports will be compiled and sent to the USACE Project Manager once every week (along with the weekly confirmation notice package) in the event that no problems or deviations from the schedule arise. Should problems arise, the Field Manager or Project Manager will notify the USACE Project Manager immediately and send the DQCR by express mail or fax.

11.2 QUALITY CONTROL SUMMARY REPORT (QCSR)

A summary report of quality control activities will be submitted at the conclusion of the site investigation. The QCSR will contain, but not be limited to, the following information:

1) Project Description: This will include project organization and site description.

2) Laboratory QC Activities: This will include a summary of laboratory QC activities, a summary of any deviations from planned activities and a summary of the evaluation of the data quality for each analysis and matrix.

3) Field QC Activities: This will include a summary of field QC activities, a summary of any deviations from planned activities, and a summary of the evaluation of the quality of the sampling.

4) Data Presentation and Evaluation: This will include an assessment of sampling and analysis techniques, an evaluation of data quality of each matrix and parameter, and an evaluation of the usability of the data.

5) Lessons Learned: This will summarize any suggested changes to field or analytical procedures that could be made to better characterize chemical contamination in future work efforts.

6) DQCR Consolidation: All DQCR's will be consolidated and summarized.

7) Conclusions and recommendations.

11.3 NONCONFORMANCE AND CORRECTIVE ACTION

As presented in Section 10.0, a written report will be prepared and sent to the USACE Project Manager for all significant problems or non-routine occurrences which may arise. These reports will identify the nonconformance or problem and present the corrective action implemented. These reports will be sent to the USACE Project Manager within 48 hours after the corrective action is implemented.

11.4 ANALYTICAL DATA REPORTS

Analytical data will be presented in report format and will be transmitted to USACE for review. All laboratory analytical reports will follow the same format. Analyses will typically be grouped, for reporting purposes, by the date the sample was received by the laboratory and the batch it was analyzed with. In general, a typical analytical report will include:

1) General Discussion: This will include a description of sample types, tests performed, any problems encountered, and any general comments.

2) Analytical Data: Data are reported by sample or by test. All pertinent dates, information and reporting limits are also included.

3) QC Information: All pertinent QC information, including laboratory control samples, method blanks, matrix spikes, matrix spike duplicates, and duplicates will be included.

4) Methodology: Reference for analytical methodology used is cited.

5) Custom Services: Any requested special services are included.

11.5 SITE INVESTIGATION REPORT

A draft report summarizing the activities, data and findings which occurred or collected during the RI at the site will be prepared. The outline of information and elements to be included in this report will be determined at the end of field activities. At a minimum, the report will include the following elements:

- Information related to the implementation of the investigation;
- A description of field activities;
- Chemical analytical results for the media sampled;
- A discussion of the data and information collected during the RI and from previous investigations; and,
- Conclusions and recommendations.

Upon receipt of USACE comments, it is anticipated that a review meeting will be scheduled to discuss the comments and potential resolutions to any deficiencies identified. Following the review meeting, the resolved comments will be incorporated into the draft report and a final report prepared. This document will be transmitted to the appropriate federal, state, and local agencies.

ATTACHMENT A
STANDARD OPERATING PROCEDURES (SOP)

STANDARD OPERATING PROCEDURE NUMBER 1

SOIL SAMPLING

TABLE OF CONTENTS

LIST OF FIGURES

1.0
PURPOSE AND SCOPE

This document defines the standard procedure for collecting soil samples. This Standard Operating Procedure (SOP) serves as a supplement to the Chemical Data Acquisition Plan (CDAP). This procedure gives descriptions of equipment, field procedures, and QA/QC procedures necessary to collect soil samples. The sample locations and frequency of collection are specified in the FSP.

This SOP is intended to be used together with the CDAP and several other SOPs. Sample identification, handling, and documentation procedures are described in SOP No. 6. SOP No. 7 describes decontamination procedures which are also applicable to this SOP. Health and safety procedures and equipment that will be required during the investigation are detailed in the Site Safety and Health Plan (SSHP).

2.0
PROCEDURES FOR SOIL SAMPLING

Subsurface soil samples for chemical analysis will be collected using stainless steel 2-inch O.D. split-spoon samplers. Subsurface samples for geotechnical analysis will be collected using non-stainless steel 2-inch O.D. split-spoon samplers or Shelby tubes.

2.1 EQUIPMENT LIST

The following list of equipment will be needed to collect subsurface soil samples

- Drill rig with appropriate drilling and stainless steel 2-inch O.D. split spoon sampler (for chemical analytical sampling)
- Drill rig with appropriate drilling tools, 3-inch-diameter Shelby tubes, and non-stainless steel 2-inch O.D. split spoon sampler (for geotechnical sampling)
- Measuring tape - 150 feet
- Aluminum foil
- Field books/field sheets
- Stainless steel spoons
- Sample bottles provided by the laboratory
- Sample bottle labels
- Label tape (clear)
- Paper towels
- Camera and film
- Waterproof and permanent marking pens
- Plastic sheeting
- Plastic bags
- Appropriate health and safety equipment, as specified in the SSHP
- Appropriate decontamination supplies

2.2 DECONTAMINATION

- Decontaminate the drilling and sampling equipment according to SOP No. 7.

- Record the boring location on a site map and in the field log book.

- Select the appropriate sampler for boring and collect the soil samples using the drilling rig at the intervals stated in the FSP.

- Don a clean pair of surgical gloves.

- Open the split-spoon and measure the recovery, scrape off any soil smear zone from the recovered sample with a stainless steel spoon, and homogenize the retained sample from the depth interval to be sampled. Samples to be collected for VOC analysis should be collected prior to homogenizing the retained sample.

- Determine and identify the use of the recovered sample. This will always be for visual soil classification and stratigraphic logging and may be for chemical or geotechnical analysis.

- Individual bottles will be filled in the following order:

    - Volatile organic compounds (VOCs)
    - Metals

- Label, store, transport and document the samples (depending on the use of the sample) according to SOP No. 6.

- Record applicable information on the sample collection Field Sheet (Figure 1) and Chain-of-Custody (COC).

- Complete the lithologic description of the recovered sample according to the Unified Soil Classification System.

2.4.2 Duplicate Samples

Duplicate samples are samples collected as close as possible to each other in time and space to check for the natural sample variance and the consistency of field techniques and laboratory analysis. The duplicate samples will be collected at the same time as the primary samples. For example, primary sample bottles for the volatile analysis will be filled first, then the duplicate sample bottles for volatiles, and so on until all necessary sample bottles for both the primary sample and the duplicate sample have been filled. The duplicate sample will be handled in the same manner as the primary sample. The duplicate sample will be assigned a QA/QC identification number, stored in an iced cooler, and shipped to the laboratory on the day it is collected.

2.4.3 Matrix Spikes and Matrix Spike Duplicates

Matrix spikes are used to determine the long-term precision and accuracy of the laboratory analytical method on various matrices. For this procedure duplicate samples are collected with the field samples and spiking is done by the laboratory. Samples are labeled as matrix spikes for the laboratory. It is useful to collect enough additional sample for both the matrix spike and duplicate samples from the same location.

2.4.4 Blind Spikes and/or Blanks

The USACE may provide blind spikes and/or blanks for laboratory analysis to determine the accuracy of the laboratory analytical method. The samples will be assigned a QA/QC identification number, stored in an iced cooler, and shipped to the laboratory on the day received.

- Weather conditions
- Names and addresses of field contacts
- Names and responsibilities of field crew members
- Names and titles of any site visitors
- Location, description, and log of photographs (if taken)
- References for all maps and photographs
- Information concerning sampling changes, scheduling modifications, and change orders
- Summary of daily tasks and documentation on any cost or scope of work changes required by field conditions
- Signature and date by personnel responsible for observations

Field investigation situations vary widely. No general rules can include each type of information that must be entered in a logbook for a particular site. A site-specific logging procedure will be developed to include sufficient information so that the sampling activity can be reconstructed without relying on the memory of field personnel. The logbooks will be kept in the field team member's possession or in a secure place during the investigation. Following the investigation, the logbooks will become part of the final project file.

2.6.2 Boring Logs

Boring logs will be completed for each boring by qualified personnel (geologist, geological engineer, or geotechnical engineer). The boring log form is shown on Figure 2.

SAMPLE COLLECTION FIELD SHEET
REMEDIAL INVESTIGATION
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

SAMPLE NUMBER: ____________________

DATE and TIME OF COLLECTION: ____________________________

COLLECTED BY: __________________________________

SAMPLE MEDIA: Soil Water Sediment

SAMPLE DEPTH: ______________

SAMPLING EQUIPMENT: _____________________________________

SAMPLING METHOD: __________________________________

SAMPLE SPLIT? NO YES SPLIT SAMPLE NUMBER: ____________________________

QA/QC SAMPLES? NO YES QA/QC SAMPLE NUMBERS: ____________________________

Sample Container	Preservative	Analysis Requested

SAMPLE DESCRIPTION: ____

INSTRUMENT SCREENING: ____

COMMENTS: ____

Figure 1
Sample Collection Field Sheet

HTW DRILLING LOG

HOLE No. 0

1. COMPANY NAME

2. DRILLING SUBCONTRACTOR

SHEET 1
OF 0 SHEETS

3. PROJECT

4. LOCATION

[illegible]AME OF DRILLER

6. MANUFACTURER'S DESIGNATION OF DRILL

[illegible]IZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT

8. HOLE LOCATION

9. SURFACE ELEVATION
feet

10. DATE STARTED

11. DATE COMPLETED

12. OVERBURDEN THICKNESS

15. DEPTH GROUNDWATER ENCOUNTERED

13. DEPTH DRILLED INTO ROCK

16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED

14. TOTAL DEPTH OF HOLE

17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX No. e	ANALYTICAL SAMPLE No. f	BLOW COUNTS g	REMARKS h

Project

Hole No.

Phase II RI Work Plan
Stratford Army Engine Plant
Stratford, CT
s:P3M11LL\sop1fig2.xls

Figure 2
Boring Log Form

11/22/9410:54 AM

STANDARD OPERATING PROCEDURE NUMBER 2

MONITORING WELL INSTALLATION

TABLE OF CONTENTS

1.0
PURPOSE AND SCOPE

The purpose of this document is to define the standard operation procedures (SOP) for installation and development of groundwater wells. The procedures are sufficiently detailed to allow field personnel to properly install and develop wells. The well locations are defined in the Chemical Data Aquisition Plan (CDAP).

This SOP serves as a supplement to the CDAP and is intended to be used together with the CDAP and several other SOPs. SOP No. 7 describes the decontamination procedures applicable to well installation and development.

2.0
PROCEDURES FOR DRILLING AND MONITORING WELL INSTALLATION

2.1 DRILLING AND WELL INSTALLATION PROCEDURES

This section will describe the standard operating procedures for the installation of both shallow wells (total depth of approximately 15 ft) and deep wells (total depth of approximately 35 feet and 100 feet), the data recorded during the drilling of the well and the well installation procedures. These procedures are defined in keeping with the requirements of the USACE, as defined in Attachment B of the Scope of Work for Phase II Remedial Investigation at the Stratford Army Engine Plant, and the standard operating procedures of W-C.

2.1.1 Shallow Wells: Total Depth Approximately Fifteen Feet

The borings for shallow wells, i.e. wells screened from approximately five to fifteen feet below ground surface (bgs), will be advanced using a truck mounted hollow stem auger drill rig. The drill rig, augers and other drilling tools that will be used down the hole will be steam cleaned before beginning a new boring and before leaving the site. Borings which cannot be completed by the end of a working day will be covered to prevent contaminated material from entering the borehole and will be secured using available equipment.

During the advancement of the well boring, soil samples will be collected using a 2-inch outer diameter (OD) split spoon sampler advanced 24 inches using a 140 lb hammer dropped approximately 30 inches (ASTM D1586-84). The split spoons will be decontaminated according to methods outlined in Section 2.2.2 of SOP 7. Blow counts will be recorded by the W-C drilling inspector.

The working casing will be removed during the installation of the well (Section 2.2.5).

2.1.2.1 Variable Site Conditions

In the event of "running sands" W-C reserves the right to use standard industry techniques such as those described in Section 2.1.1.1.

2.2 STRATIGRAPHIC LOGGING

Soil samples will be collected using 2-inch OD split spoon samplers. Samples for lithologic logging will be collected every 2.5 feet for the first ten feet, and every five feet for the remaining depth of each boring.

Soil descriptions will be based on visual/manual observations of the soil in the split spoon samples, augmented by observations of soil cuttings from the auger flights. The typical sequence of describing a soil sample is as follows:

- Unified Soil Classification Symbol;
- consistency of cohesive materials or apparent density of non-cohesive materials;.
- moisture content assessment;
- color;
- other descriptive features;
- depositional type.

A legible, concise record of all significant information pertaining to drilling and sampling operations for each boring will be maintained concurrent with the advancement of the hole. This information will be recorded by the W-C drilling inspector on a boring log (Figure 1).

2.3.1 Variations on Standard Well Installation Procedures

W-C recognizes that field conditions and/or slight differences between shallow and deep well construction methods may cause variations on the well construction procedures outlined above. For example, it is anticipated that the deep wells will have the working casings removed before the well is tremie grouted to within three feet of ground surface. However, if the shallow portion of the well boring is unstable, W-C reserves the right to leave the working casing in place.

W-C reserves the right to install wells without using centralizers on the well screen and riser. Centralizers are not compatible with well installation using hollow stem augers and/or in areas where borehole stability is in question. If the hollow stem augers were removed before well installation the borehole may collapse at any elevation, thereby not allowing the well to be installed at the appropriate depth. To avoid this situation the wells will be installed through the annular space of the augers, removing the augers in a stepped fashion. If this method is used, centralizers cannot be used because they will not fit down the annular space of the augers.

W-C will consult with the USACE and obtain USACE approval on any variations from the procedures described in this SOP.

2.4 WELL INSTALLATION DOCUMENTATION

A well installation form will be completed for every completed well (Figures 3). The information included on the well installation form is:

- Well designation;
- Date and time well started;
- Date and time well completed;
- Surface elevation (to the nearest 0.1 ft);
- Casing elevation (to the nearest 0.01 ft);
- Elevation of top of grout in annular space;
- Elevation of top of bentonite seal;

3.0
WELL DEVELOPMENT PROCEDURE

Wells will be developed to improve the hydraulic communication between the formation and monitoring wells and to help assure that representative ground water samples will be collected. During the drilling process, the sides of the borehole may become smeared (commonly referred to as the "skin effect") which substantially retards the movement of water into the well. In addition, soil may enter the filter pack, or temporarily clog the well screen slots during the installation of the well materials.

Well development is the process of flushing the interface between the aquifer and the well. In addition, the filter pack and screen slots are cleaned, allowing ground water to flow into the well with a minimum of retardation. Development is required to (1) restore the natural permeability of the formation immediately adjacent to the borehole, (2) remove clay, silt and other fines from the filter pack and well screen, and (3) remove remnant drilling fluids and contaminants potentially introduced during drilling activities.

3.1 PROCEDURES

The development of a newly installed monitoring well will proceed only after the grout has been allowed to set for a minimum of 48 hours, but not more than one week after construction. Before development begins, the development equipment will be decontaminated according to the procedures defined in SOP 7.

Initial development of each well will be accomplished using a surge block or by bailing. A surge block is a round plunger with pliable edges that will not catch on the well screen. The surge block is moved forcefully up and down inside the well screen, causing the water to surge in and out of the well screen. The surge procedure or bailing will continue for a minimum of 2 hours.

Following surging, water will be evacuated by pumping. The choice of pumping method is dependent on the well depth and/or recharge rate. Temperature, pH, and specific conductivity and turbidity will be measured once per well volume pumped. The pumping

HTW DRILLING LOG

HOLE No. 0

1. COMPANY NAME	2. DRILLING SUBCONTRACTOR	SHEET 1 OF 0 SHEETS
3. PROJECT	4. LOCATION	
[illegible]AME OF DRILLER	6. MANUFACTURER'S DESIGNATION OF DRILL	
[illegible]ES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	8. HOLE LOCATION	
	9. SURFACE ELEVATION feet	
	10. DATE STARTED	11. DATE COMPLETED
12. OVERBURDEN THICKNESS	15. DEPTH GROUNDWATER ENCOUNTERED	
13. DEPTH DRILLED INTO ROCK	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR	

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX No. e	ANALYTICAL SAMPLE No. f	BLOW COUNTS g	REMARKS h

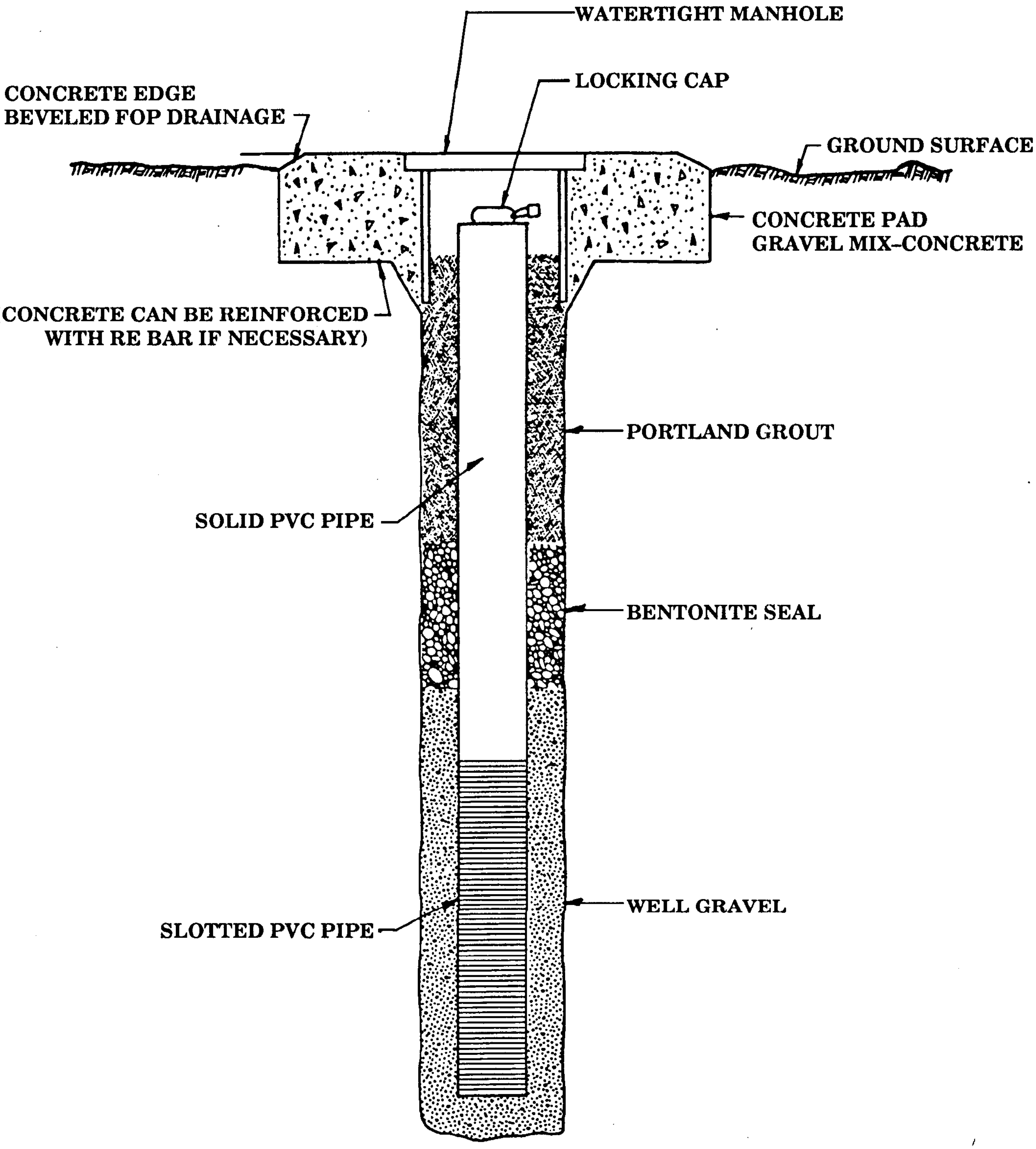
Project

Hole No.

Phase II RI Work Plan
Stratford Army Engine Plant
Stratford, CT
s:P3M11LL\sop2fig1.xls

Figure 1
Boring Log Form

11/22/9410:54 AM



Remedial Investigation Work Plan - SOP 2
Stratford Army Engine Plant
Stratford, CT
bas\C3Mill

TYPICAL FLUSH MOUNT MONITORING WELL
CONSTRUCTION
REMEDIAL INVESTIGATION
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS
WAYNE, NEW JERSEY

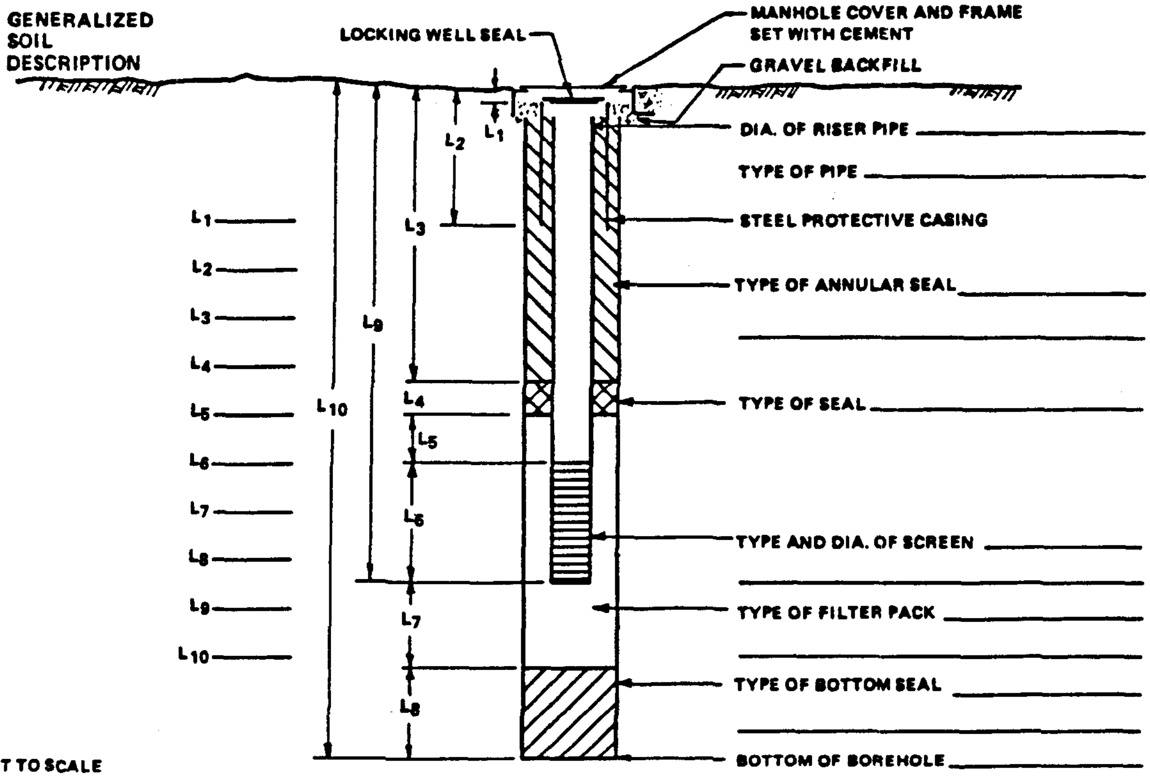
DR. BY:	BAS	SCALE:	AS SHOWN	PROJ. NO.:	C3MILL
CK'D. BY:	MEC	DATE:	22 NOV 1994	FIG. NO:	2

WOODWARD–CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

CONSTRUCTION OF FLUSHMOUNT MONITORING WELL NO. ________

PROJECT AND LOCATION	GROUND ELEV. AND DATUM	PROJECT NO.
DRILLING AGENCY	TOP OF RISER ELEV.	DATE FINISHED
METHOD OF DRILLING ________	TOP OF PROTECTIVE CASING ELEV.	INSPECTOR:
DIA. OF BOREHOLE ________ DEPTH OF BOREHOLE ________	GROUND WATER ELEV.	CHECKED BY:



L1 ________
L2 ________
L3 ________
L4 ________
L5 ________
L6 ________
L7 ________
L8 ________
L9 ________
L10 ________

NOT TO SCALE
(VALUES REPORTED IN FT)

REMARKS: ________

FIGURE–3
FLUSHMOUNT MONITORING WELL CONSTRUCTION LOG
REMEDIAL INVESTIGATION
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

MONITORING WELL DEVELOPMENT LOG

Well Number: ____________

Date Installed: ____________

Depth of Well (ft): ____________

Screened Interval: ____________

Casing Diameter: ____________

SURGE DATA

Pre-Surge Sample

Date and Time: ____________

DTW(ft):* ____________

DTB(ft):** ____________

Surge Date and Time: ____________

Depth (ft): ____________

Conductivity: ____________

Temperature: ____________

Turbidity (NTUs): ____________

pH: ____________

Surge Method: ____________

Post-Surge Sample

Date and Time: ____________

Comments: ____________

Depth (ft): ____________

Conductivity: ____________

Temperature: ____________

Turbidity (NTU's): ____________

pH:

PURGE DATA

Date and Time: ____________

DTW(ft): ____________

Height of Water Column (ft): ____________

Volume of Water in Casing (g): ____________

5 Casing Volumes (g): ____________

Purge Method: ____________

Time	Temperature	Conductivity	Turbidity (NTUs)	pH	Gallons Purged	Comments

DTW after purge: ____________

Total gallons purged: ____________

Inspector: ____________

*DTW: depth to water

**DTB: depth to bottom

Figure 4
Well Development Log

STANDARD OPERATING PROCEDURE NUMBER 3

GROUNDWATER SAMPLING

TABLE OF CONTENTS

LIST OF FIGURES

1.0
PURPOSE AND SCOPE

This document defines the standard procedure for collecting groundwater samples. This Standard Operating Procedure (SOP) serves as a supplement to the Chemical Data Acquisition Plan (CDAP). This procedure gives descriptions of equipment, field procedures, and QA/QC procedures necessary to collect groundwater samples. The sample locations and frequency of collection are specified in the CDAP.

This SOP is intended to be used together with the CDAP and several other SOPs. Sample identification, handling, and documentation procedures are described in SOP No. 6. SOP No. 7 describes decontamination procedures which are also applicable to this SOP. Health and safety procedures and equipment that will be required during the investigation are detailed in the Site Safety and Health Plan (SSHP).

2.0
GROUNDWATER SAMPLING PROCEDURES

2.1 EQUIPMENT LIST

Equipment used during well purging:

- Well keys
- Well lock-out tags
- Electronic water level probe
- Assorted tools (knife, screwdriver, etc.)
- Disposable bailer, or pump
- Nylon rope or twine
- Discharge hose
- Thermometer
- pH meter (with automatic temperature compensation)
- Conductivity meter
- Plastic squeeze bottle filled with deionized water
- Polyethylene or glass container (for field parameter measurements)
- Paper towels
- Calculator
- Field notebook
- Waterproof and permanent marker
- 55-gallon drum for storing purged water
- Appropriate health and safety equipment
- Well completion information sheet
- Organic free deionized water
- Appropriate decontamination equipment
- Organic vapor analyzer
- Appropriate Pump(s)

Equipment used during well sampling:

- Electronic water level measurement probe
- Disposable bailers
- Nylon rope
- Thermometer
- pH meter (with automatic temperature compensation)
- Conductivity meter
- Plastic squeeze bottle filled with organic free deionized water
- Cooler with ice
- Polyethylene or glass jar for measurement of field parameters
- Sample jars and labels. Sample bottles with preservatives added will be obtained from the analytical laboratory. Several extra sample bottles will be obtained in case of breakage or other problems.
- Paper Towels
- Field notebook
- Water sample collection form
- Waterproof and permanent marker
- Well completion information sheet
- Appropriate decontamination equipment
- Appropriate health and safety equipment

2.2 SAMPLING PROCEDURE

This section gives the step-by-step procedures for collecting groundwater samples in the field. Observations made during sample collection should be recorded in the field notebook and field data sheet as specified in Section 2.4 of this SOP.

2.2.1 Equipment Decontamination

Before any purging or sampling begins, all well probes, bailers, and other sampling devices shall be decontaminated. If dedicated equipment is used, it should be rinsed with distilled water. Mobile decontamination supplies will be provided so that

- The condition of the inner well cap and casing will be noted.

- HNu reading will be taken at well head.

- The depth of static water level and NAPL thickness will be measured to nearest 0.01 foot and recorded from the measuring point on the well casing.

- The total depth of well from the same measuring point on the casing will be measured and recorded.

- The volume of water in the well casing will be calculated in gallons based on feet of water and casing diameter. (See Section 2.4.3 for calculation of volumes.)

- From the above calculation, the three casing volumes to be evacuated will be calculated.

- When evacuating a well using a hand pump, the pump intake should be placed:

  - for low recovery wells (wells which can be pumped dry), the pump intake will be placed at the bottom of the screened interval

  - for high recovery wells (little drawdown with pumping) the pump will be placed at the top of the screened interval

- Specific conductivity, pH, temperature, and turbidity will be measured at the start of purging and twice per casing volume removed.

- Purging will continue beyond three well volumes until specific conductivity, pH, temperature and turbidity have stabilized (less than 0.2 pH units or +/- 10 percent ofr other parameters between four consecutive readings).

Turn the vial over and tap it to check for bubbles in the vial which indicate air space. If air bubbles are observed in the sample vial, discard the sample vial and repeat the procedure until no air bubbles appear. Care should be taken to not overfill sample vials. Measure pH in "dummy" sample containers to verify that appropriate amounts of preservatives have been added to the containers. Do not collect samples for laboratory analysis into containers used for preservative level testing.

6. Time of sampling will be recorded.

7. The well cap will be replaced and locked and tagged.

8. Field documentation will be completed, including the chain-of-custody.

2.2.5 Field Quality Assurance/Quality Control Procedures and Samples

The well sampling order will be dependent on expected levels of contamination in each well, if known, and will be determined prior to sampling. Sampling will progress from the least contaminated well to the most contaminated. Quality assurance/quality control (QA/QC) samples will be collected during groundwater sampling.

Field QA/QC samples are designed to help identify potential sources of sample contamination and evaluate potential error introduced by sample collection and handling. All QA/QC samples are labeled with QA/QC identification numbers and sent to the laboratory with the other samples for analyses.

Field Rinsate Samples

An equipment rinsate sample is intended to check for contamination may be contribute. For the well sampling operation, a rinsate sample will be collected from the sampling equipment (bailer) before it is used to obtain the sample. Organic free deionized water will be rinsed over the decontaminated sampling apparatus and transferred to the sample

2.4 DOCUMENTATION

2.4.1 Field Sampling Data Sheet

A sample collection field sheet for groundwater samples (Figure 1) will be completed at each sampling location. The data sheet will be completely filled in. If items on the sheet do not apply to a specific location, the item will be labeled as not applicable (NA). Well purging information will be recorded on the well purging and sampling form (Figure 2). The information on the data sheet includes the following:

- Well number
- Method of purging
- Type of pump and pumping rate (if applicable)
- Date and time of sampling
- Depth of sample collected
- Person performing sampling
- Type of sampling equipment
- Volume of water purged before sampling
- Conductivity, temperature, and pH during evacuation (note number of well volumes)
- Number of samples taken
- Sample identification number
- Preservation of samples
- Record of any QC samples from site
- Any irregularities or problems which may have a bearing on sampling quality

2.4.2 Field Notes

Field notes shall be kept in a bound field book. The following information will be recorded using waterproof ink:

3.0
CALIBRATION

3.1 pH METER

The pH meter must be calibrated each day before taking any readings of samples and must be recalibrated during the day if it has been turned off after the initial calibration. Calibration and operation of the pH meter will follow the manufacturer's specific instructions. In general, calibration is done by adjusting the meter with standard buffers that bracket the expected pH of the field water. Calibration will consist of the following general procedures:

1. Adjust the reading of the pH meter, by using the calibration knob with the electrode placed in the pH 7 buffer. Rinse the electrodes with distilled water between buffer adjustments.

2. With the electrode placed in the pH 4 buffer, adjust the reading of the meter with the slope knob. Adjust using the temperature knob if the meter has no slope knob.

3. Repeat steps 1 and 2 until the meter gives acceptable readings (±0.1 pH unit) for all the buffers used for calibration.

Note: Always use the same electrode for measurements that was used in the calibration. Recalibrate the meter if the electrode is replaced. Although the temperature setting on the pH meter often does not match the sample temperature after calibration, the pH readings will still be accurate in these cases provided that the response to the buffers is correct.

Record the time of analysis and temperature of the buffer in the field notebook whenever the pH meter is calibrated.

SAMPLE COLLECTION FIELD SHEET
REMEDIAL INVESTIGATION
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

SAMPLE NUMBER: ____________________

DATE and TIME OF COLLECTION: ____________________________

COLLECTED BY: __________________________________

SAMPLE MEDIA: Soil Water Sediment

SAMPLE DEPTH: ______________

SAMPLING EQUIPMENT: _____________________________________

SAMPLING METHOD: __________________________________

SAMPLE SPLIT? NO YES SPLIT SAMPLE NUMBER: ____________________________

QA/QC SAMPLES? NO YES QA/QC SAMPLE NUMBERS: ____________________________

Sample Container	Preservative	Analysis Requested

SAMPLE DESCRIPTION: ____

INSTRUMENT SCREENING: ____

COMMENTS: ____

Figure 1
Sample Collection Field Sheet

WOODWARD-CLYDE
GROUNDWATER SAMPLE COLLECTION FIELD DATA LOG

Project Name: ______________________

Location: ______________________

Project No.: ______________________

Inspector(s): ______________________

Weather Conditions: ______________________

Meters/Instruments

pH: ______________________

Temperature: ______________________

Conductivity: ______________________

HNu: ______________________

Well ID Number:____________

WELL INFORMATION

Well Condition:
Well Type:
Screened Interval (ft):
Reference Point:
Well Diameter:
Well Depth (ft):

PURGING

Depth to Water (ft):
Water Column Ht. (ft):
1 Purge Volume (gal):
Purged Volume (gal):
Purge Date/Time:
Purge Method:
Purge Depth:
DTW After Purge (ft):
Purge Observations:

SAMPLING

DTW Before Sampling (ft):
Sample Date/Time:
Sampling Method:
Sampling Depth:
Sample Analysis:
Analytical Lab:
Sampling Observations:

SAMPLE CHEMISTRY

Temperature (C):
pH:
Conductivity (umhos):
Turbidity:
Salinity:

AIR QUALTITY DATA (ppm)

Background:
Well Head:
Purge Water:

COMMENTS: ______________________

Figure 2
Groundwater Sample Collection Field Data Log

STANDARD OPERATING PROCEDURE NUMBER 4

SLUG TESTING

TABLE OF CONTENTS

Section Page

1.0

PURPOSE AND SCOPE

This document defines the standard procedure for slug testing monitoring wells. This Standard Operating Procedure (SOP) serves as a supplement to the Chemical Data Acquisition Plan (CDAP). This SOP gives descriptions of equipment and field procedures used to estimate the hydraulic conductivity of the aquifer. Hydraulic conductivity will be determined by a positive displacement test and/or a negative displacement test.

2.0
SLUG TESTING PROCEDURES

2.1 EQUIPMENT LIST

Field equipment to be used for the slug testing activities includes:

- Electronic water level indicator
- Field books
- Slug of known volume for 2-inch diameter wells
- Pressure transducer (10-50 psig)
- Data logger (Hermit) and Operation Manual (Hermit)
- Weighted Measuring tape (100 feet)
- Nylon rope
- Keys to well locks
- Paper towels (organic and lint free)
- Stainless steel knife
- Camera and film
- Waterproof and permanent marking pens
- Clock
- Appropriate health and safety equipment

2.2 PRE-TEST DATA RECORDING

Pre-test data will be collected in accordance with the following procedures:

A. The well casing will be approached from upwind.

B. The well cap will be unlocked and removed.

C. Before beginning the slug test, the following information will be recorded:

remove or add the volume as quickly as possible because the analysis assumes an "instantaneous" change in volume in the well. Falling head tests are not valid for wells where the water level is below the top of the screen. Only rising head test data should be recorded from such wells.

C. With the moment (time) of volume addition or removal assigned time zero, the depth of water will be measured and recorded. The pressure transducer will monitor water level change. Care must be taken to ensure that the transducer is submerged throughout the test. Once the test has started, the transducer elevation must not be changed.

D. The test will continue until the water level has stabilized or 90 percent of the excess head has dissipated.

E. The slug testing equipment will be removed and wrapped for decontamination.

F. The well will be locked upon completion.

G. Gloves, aluminum foil/visquene will be disposed of as appropriate.

H. The slug will be decontaminated before the next slug test, in accordance with the procedures discussed in Section 3.0 and SOP No. 7 - Decontamination.

I. The slug test data will be downloaded from the data logger to a field printer to confirm the successful completion of the test prior to departing the site.

3.0
DECONTAMINATION

All slug testing equipment will be decontaminated prior to use. The slug will be decontaminated with:

- Soap (Liquinox) and potable water wash with scrub brush
- Potable water rinse
- Distilled water rinse
- Air drying of the equipment

All decontaminated equipment will be stored on clean aluminum foil sheeting or visquene, and the equipment will not be allowed to touch the ground adjacent to the well.

4.0
SLUG TEST DATA ANALYSIS

Slug test data will be evaluated using the method of Bouwer and Rice (1976) and Bouwer (1989). The Bouwer and Rice method is applicable to unconfined and confined aquifers and considers the effect of partial penetration, the radius of the filter pack, and the effective radius of influence of the test.

STANDARD OPERATING PROCEDURE NUMBER 5

WATER LEVEL MEASUREMENT

TABLE OF CONTENTS

FIGURES

1.0

PURPOSE AND SCOPE

This document defines the standard procedure for measuring water levels in wells. This Standard Operating Procedure (SOP) serves as a supplement to the Chemical Data Acquisition Plan (CDAP). This procedure describes equipment and field procedures necessary to collect water level measurements. The well locations and frequency of measurement are specified in the CDAP. This procedure is intended to be used together with the CDAP and other SOPs. SOP No. 7 describes decontamination procedures which are applicable to this SOP.

2.0
WATER LEVEL MEASUREMENT PROCEDURE

2.1 EQUIPMENT LIST

The equipment necessary to measure water levels includes:

- Solinst Model 101 water level meter or equivalent
- Two 5-gal buckets (with lids) or equivalent for decontamination
- Decontamination brushes
- Alconox soap
- Deionized or distilled water
- Potable water
- Spray bottle
- Field data sheets
- Field notebook
- Appropriate health and safety equipment

2.2 MEASUREMENT PROCEDURE

This section gives the sequence of events to follow when measuring water levels. Appropriate health and safety equipment, as described in the Health and Safety Plan (HSP) should be worn during well opening, well measurement, and decontamination.

- The water level probe shall be decontaminated prior to use in each monitoring well. Decontamination procedures are discussed in SOP No. 7.

- The well will be approached from upwind, the well cap unlocked and removed.

- After any measurement is taken, the water level probe shall be decontaminated as described in Section 2.3.

2.3 DECONTAMINATION

The water level indicator and the salinity-conductivity-temperature meter must be decontaminated before use, and at the conclusion of measurements. The probes will be decontaminated according to the procedure for decontamination of sampling equipment described in SOP No. 7.

Probe decontamination will be completed at the wells and wash and rinse water will be discharged on the ground surface, at least 20 feet downgradient from the well.

2.4 DOCUMENTATION

This section describes the documentation necessary for water level measurement.

The water level data sheet, shown as Figure 1, shall be completed during each measuring event. Field data sheets will include date, time, well number, total well depth, water level, static water elevation, salinity, specific conductance, temperature, and comments. A field notebook will also be kept during water level measurement activities describing decontamination procedures, calibration procedures, monitoring procedures, and other observations during water level measurement. Both the data sheets and notebook shall be neat and legible, and shall be signed and dated by the person completing the page.

The depth to water, in feet below the measuring point, will be subtracted from the measuring point elevation to determine the elevation of the static water level. The resulting elevation shall be checked in the field to see that it is reasonable and that the subtraction was performed correctly. If there is a discrepancy, the well shall be measured again.

3.0
CALIBRATION

The length of the water level measurement probe cord should be calibrated at least once per month or more often as needed to ensure the desired accuracy. The calibration check consists of laying out 100 feet of steel tape next to 100 feet of the probe cord. Note any measurement discrepancies between the two at 2-foot intervals. The probe cord shall be rechecked if there is a possibility it could have been stretched or damaged during water level measurements.

The procedures followed during any calibration and verification of equipment shall be documented in the field notebook along with any calculations. If a correction is required, the probe will be tagged to indicate the correction.

Project Name/Number:
Project Location
Inspector:
Instrument:

Well/Piezometer Number	Well Depth	Depth to Water	Water Elevation	Date	Time	Salinity	Specific Conduct.	Temp.	Remarks

Figure 1
Water Level Data Form

STANDARD OPERATING PROCEDURE NUMBER 6

SAMPLE IDENTIFICATION, HANDLING, AND DOCUMENTATION

TABLE OF CONTENTS

LIST OF FIGURES

1.0

PURPOSE AND SCOPE

This document defines the standard protocols for sample identification, handling, and documentation. This Standard Operating Procedure (SOP) serves as a supplement to the Chemical Data Acquisition Plan (CDAP). This procedure is intended to be used in conjunction with the CDAP and other SOPs.

2.0

PROCEDURES FOR SAMPLE IDENTIFICATION, HANDLING, AND DOCUMENTATION

2.1 SAMPLE IDENTIFICATION

Samples collected during site activities will be assigned unique sample identification numbers. These numbers are necessary to identify and track each of the samples collected for analysis during the duration of this project. In addition, the sample identification numbers will be used in documentation to identify and retrieve the analytical results received from the laboratory as well as other data.

Each sample will be identified by a unique alpha-numeric code which indicates the particular sample type and location information.

The sample identification code developed for this remedial investigation is based on an identifier for the location of the sample as the first set of characters or digits and a second set of characters or digits designating the depth of the sample.

The following codes are designated for the corresponding information on sample types:

WC, MW, LW, ECD = Monitoring Well
S = Shallow monitoring well screened interval
D1 = approximately 30 to 50 foot monitoring well screened interval
D2 = approximately 90 to 110 foot monitoring well screened interval
T = intertidal zone transect
US = upstream sampling location
DS = downstream sampling location
MB = Marine Basin sampling location
008 = outfall 008 sampling location

Each of these sample type codes are followed by the sequential number of that type. Thus, for example, wells are numbered WC-1S, WC-2S, etc.

The second set of codes, if used, will correspond to the depth (in units of inches) sampled from the surface grade. This code will differentiate samples collected at the same location but at different depths. Thus, the code "0-6" indicates a sampling depth of 0 to 6 inches. Many depths will be determined in the field based on observations at the time of sample collection. These depths are indicated as two codes: "a-b" and "c-d". These letter codes will be replaced by the numeric depth designation at the time of sampling. The codes "S", "D1" and "D2" are used to indicate if a monitoring well is screened at a shallow or deep interval.

Groundwater samples collected from monitoring wells will be numbered with the corresponding well number. Existing monitoring well numbers are maintained as originally assigned in previous investigations. Wells in the lagoon area have the "MW" code changed to "LW" to avoid confusion for existing wells with identical numbers but in different locations. Similarly, the existing well in Area 4 has the "MW" code changed to "ECD".

2.2 SAMPLE LABELING

Sample labels will be filled out completely by a designated member of the sampling team. All sample labels shall be filled out using waterproof ink. If needed for protection, labels will also be covered with transparent tape. At a minimum, each label shall contain the following information (see Figure 1):

- site name
- sample identification code
- date and time of sample collection
- analyses requested
- sample preservation
- sample matrix

2.3 SAMPLE HANDLING

This section discusses proper sample containers, preservatives, and packaging and shipping procedures. The CDAP summarizes the information contained in this section and also includes the sample holding times for each analyte.

2.3.1 Sample Containers

Certified, commercially clean (to EPA standards) sample containers shall be obtained from the contract analytical laboratory. The bottles shall be labeled by the lab to indicate the type of analyte to be collected in the container.

The CDAP lists appropriate sample containers for the specific analyses required for this project.

2.3.2 Sample Preservation

Sample preservation efforts shall commence with container preparation at the laboratory and will continue until analyses are performed. Required preservatives shall be prepared and placed in the bottles at the laboratory prior to shipment to the site. Samples will be stored with ice or cold packs in coolers immediately following collection to maintain sample temperature of approximately 4°C. Additional sample preservation requirements based on analytical methodology are presented in the CDAP. Freezing samples to extend holding times will not be permitted.

2.3.3 Sample Packaging and Shipping

After collection, lids for each sample container will be secured, the sample label attached, and samples stored with ice in an insulated cooler to maintain sample temperature of approximately 4°C.

All sediment, water, and soil samples are expected to contain low concentrations of contaminants and will be shipped as environmental samples according to applicable guidance documents and DOT regulations. Sample packaging and shipping procedures are described below:

- Secure sample bottle lids. Check that sample label is securely attached.
- Place sample bottles in recloseable clear plastic bags and wrap them with protective packing material.
- Tape the drain shut on the inside and outside of a waterproof metal (or equivalent strength plastic) cooler.
- Line the sides and bottom of the cooler with protective packing material.
- Line the cooler with a large plastic bag.
- Place vermiculite or other absorbent material in the bottom of the cooler in case of leakage or bottle breakage.
- Place containers upright in the cooler in such a way that they do not touch.
- Pack samples with ice (either chemical ice packs or ice cubes sealed in plastic bags).
- Fill the cooler with cushioning material.
- Close large plastic bag in cooler and tape or secure shut.
- Place chain-of-custody form and other paperwork in a clear plastic bag and tape the bag to the inside lid of the cooler.
- Place address label on inside lid of the cooler.

- Wrap the cooler completely around with strapping tape at two locations. Do not cover any labels.

- Place address label on top of cooler.

- Attach "THIS SIDE UP" labels on all four sides and "FRAGILE" labels on at least two sides and the top of the cooler. ("FRAGILE" labels are optional for coolers not containing glass bottles).

- Affix signed custody seals on the cooler. Cover the seals with wide, clear tape.

- Make a copy of the airbill for the project file and place the original in a clear envelope secured to the cooler lid.

2.4 HOLDING TIMES AND ANALYSES

The holding time is specified as the maximum allowable time between sample collection and analysis and/or extraction, based on the analyte of interest and stability factors, and preservative (if any) used. Holding times are listed in the CDAP. Samples should be sent to the laboratory as soon as possible after collection by overnight express courier service.

Chemical constituents which will be analyzed during the field investigation have been identified in the Sampling and Analysis Plan. These constituents and other parameters to be measured are listed in the CDAP.

2.5 SAMPLE DOCUMENTATION AND TRACKING

This section describes documentation required in the field notes and on the sample Chain-of-Custody forms. Additional information concerning documentation is presented in the CDAP.

2.5.1 Field Notes

Documentation of observations and data acquired in the field will provide information on the acquisition of samples and also provide a permanent record of field activities. The observations and data will be recorded using pens with permanent waterproof ink in a permanently bound weatherproof field log book. The log book pages will be consecutively numbered.

The information in the field book or on the data sheets will include the following as a minimum. Additional information is included in the specific SOPs regarding the data sheets.

- Project name
- Location of sample
- Sampler's printed name and signature
- Date and time of sample collection
- Sample identification code
- Duplicate samples (if any)
- Description of samples (matrix sampled)
- Sample type (grab or composite)
- Sample depth (if applicable)
- Analysis to be performed
- Number and volume of samples
- Sampling methods or reference to the appropriate SOP
- Sample handling, including filtration and preservation, as appropriate for separate sample aliquots
- Analytes of interest
- Field observations
- Results of any field measurements, such as depth to water, pH, temperature, and conductivity
- Personnel present

- Level of PPE used during sampling

Changes or deletions in the field book should be lined out with a single strike mark and initialed and dated by the person making the change or deletion. Sufficient information should be recorded to allow the sampling event to be reconstructed without relying on the sampler's memory.

Each page in the field books will be signed by any persons making entries on that page. Anyone making entries in another person's field book will sign and date those entries.

2.5.2 Sample Chain-Of-Custody

During field sampling activities, traceability of the sample must be maintained from the time the samples are collected until laboratory data are issued. Initial information concerning collection of the samples will be recorded in the field log book. Information on the custody, transfer, handling, and shipping of all samples will be recorded on a Chain-of-Custody (COC) form. An example COC form is shown on Figure 2.

The sampler will be responsible for initiating and filling out the Chain-of-Custody form. The field team members are responsible for the care and custody of the samples collected until the samples are transferred to another individual or shipped to the laboratory. The field team, under the direction of the Field Manager, is responsible for enforcing COC procedures during fieldwork. The COC will be signed, with date and time, by the sampler and when the sampler relinquishes the samples to anyone else. Chain-of-Custody forms will accompany the samples at all times. All individuals who subsequently take possession of the samples will also sign, with date and time, the COC. Each cooler containing samples sent to the analytical laboratory will be accompanied by a chain-of-custody (COC) record. The COC will contain the following information:

- Sampler's signature and company affiliation
- Project number
- Date and time of collection
- Sample identification number
- Sample type
- Sample media
- Preservative used
- Analyses requested
- Number of containers
- Signature of persons relinquishing custody, dates, and times
- Signature of persons accepting custody, dates, and times
- Method of shipment
- Shipping air bill number (if appropriate)

The chain-of-custody procedures are provided below.

- At the time of sample collection, the chain-of-custody form is completed for the sample collected. The sample identification number, date, type of sample (i.e. grab or composite), sample media, type and size of sample container, analysis requested, and preservation is recorded on the form.

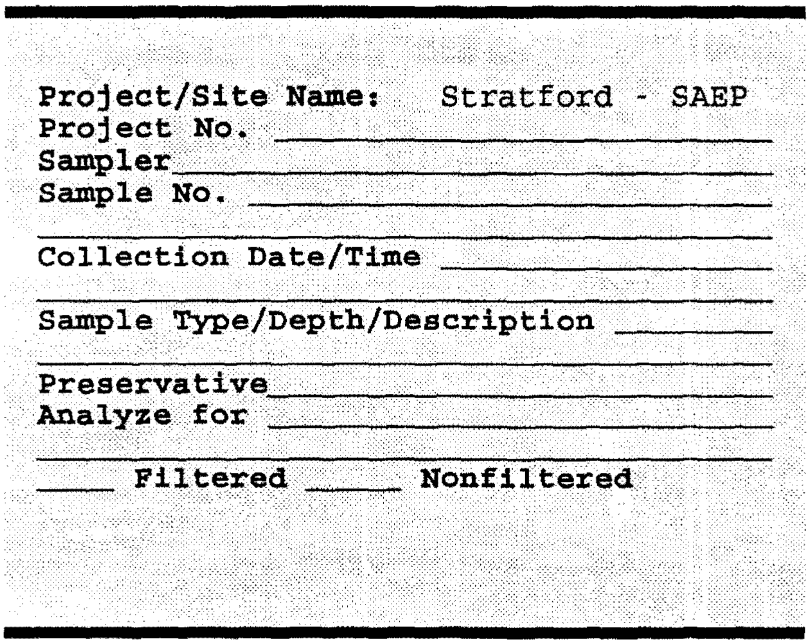
- When the form is full or when all samples have been collected that will fit in a single cooler, the field team members will cross-check the form for possible errors and sign the chain-of-custody record. Corrections are made to the record with a single strike mark and dated and initialed. All entries will be made in blue or black ink.

- A shipping bill is completed and the shipping bill number recorded in the COC record prior to enclosing the COC record, placing inside a clear plastic bag and attaching it to the inside of the cooler lid.

When transferring custody of the samples, the individual relinquishing custody of the samples will verify sample numbers and condition and will document the sample acquisition and transfer by signing, with date and time, the COC. Samples are packaged for shipment and dispatched to the analytical laboratory with a separate COC form accompanying each cooler.

A copy of each chain-of-custody form is retained by the sampling team for the project file and the original is sent with the samples. Bills of lading will also be retained as part of the documentation for the chain-of-custody records.

In conjunction with data reporting, the analytical laboratory will return the original or a photocopy of the original COC to the Project Manager for inclusion into the central project file.



Project/Site Name: Stratford - SAEP

Project No. ______________________

Sampler______________________

Sample No. ______________________

____

Collection Date/Time ______________

____

Sample Type/Depth/Description ________

____

Preservative______________________

Analyze for ______________________

____

____ **Filtered** ____ **Nonfiltered**

FIGURE 1

Typical Sample Label

CHAIN-OF-CUSTODY FORM

PROJECT NUMBER:	PROJECT / SITE NAME:	PROJECT / SITE LOCATION:	TEAM LEADER: __________ SAMPLERS: (SIGNATURES): __________

Sample I.D. Number	Sample Location	Sample Collection		Sample Matrix	Container Description (Size / Type)	Quantity	Requested Analysis	Comments
		Date	Time					

CHAIN - OF - CUSTODY CHRONICLE

Relinquished by:	Date	Time	Received by:	Date	Time
Relinquished by:	Date	Time	Received by:	Date	Time
Relinquished by:	Date	Time	Received at Laboratory by:	Date	Time
Method of Shipment:			Airbill (Shipping Number):		

FIGURE-2
CHAIN OF CUSTODY FORM
REMEDIAL INVESTIGATION
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

STANDARD OPERATING PROCEDURE NUMBER 7

DECONTAMINATION

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1.0
INTRODUCTION AND TYPES OF CONTAMINATION

This document defines the standard procedure for decontamination. This Standard Operating Procedure (SOP) serves as a supplement to the Chemical Data Acquisition Plan (CDAP) and the Site Safety and Health Plan (SSHP). The procedure is intended to be used together with the CDAP and the other SOPs.

Site and/or Sample Cross-Contamination

The overall objective of multimedia sampling programs is to obtain samples which accurately depict the chemical, physical, and/or biological conditions at the sampling site. Extraneous contaminant materials can be brought onto the sampling location and/or introduced into the medium of interest during the sampling program (e.g., by bailing or pumping of ground water with equipment previously contaminated at another sampling site). Trace quantities of these contaminant materials can consequently be captured in a sample and lead to false positive analytical results and, ultimately, to an incorrect assessment of the contaminant conditions associated with the site. Decontamination of sampling equipment (e.g., bailers, pumps, tubing, soil and sediment sampling equipment) and field support equipment (e.g., drill rigs, vehicles) is therefore required prior to, during and after use at SAEP to ensure that sampling cross-contamination is prevented, and that on-site contaminants are not carried off-site.

If contaminants detected in field blanks are reported above the method detection limit for any analytical procedure, the possible source of contamination will be investigated. If a problem is found, it will be corrected and samples rerun, if necessary. If no analytical problems are identified, the data will be flagged accordingly. Decontamination techniques will also be adjusted in the field prior to collection of additional samples.

2.0
PROCEDURE

2.1 EQUIPMENT LIST

The following is a list of equipment that may be needed to perform decontamination:

- Brushes
- Wash tubs
- Buckets
- Scrapers, flat bladed
- Hot water - high-pressure sprayer
- Disposal drums (55-gallon with secure lids)
- Sponges or paper towels
- Liquinox detergent
- Methanol
- Nitric acid
- Potable tap water
- Organic free deionized water
- Garden-type water sprayers

2.2 DECONTAMINATION

Sampling order will be selected to minimize cross contamination. The first locations sampled at each site will be those expected to have the lower concentrations of contaminants and the sampling order will proceed to the expected higher contaminated areas. Present chemical data, visual site inspection, and logical contamination movement will be used to select sampling order.

If PPE is upgraded to Level C, then work zones shall be required. Three work zones will be established: the exclusion zone, the contamination reduction zone, and the support zone.

An exclusion zone is an area where contamination could or does occur. The exclusion zone will be demarcated using orange cones and/or flagging. All W-C or subcontractor personnel who enter the exclusion zone must be cleared by the SSHO, have signed a safety compliance agreement form, and wear the level of protective equipment specified in the Site Safety and Health Plan.

The contamination reduction zones are located immediately outside the exclusion zone. This zone is designed to limit the migration of contaminants from potentially contaminated areas to noncontaminated areas. Personnel decontamination facilities will be located in this area.

The support zone is an uncontaminated area. Supporting equipment and facilities will be located in this area.

2.2.1 Personnel

Personnel decontamination will be limited to removal of disposable gloves and boot covers for work performed while in Level D personnel protection equipment. Disposable gloves and boot covers will be drummed and stored on site. However, all field personnel will be required to wash their hands and face with water and soap prior to eating or drinking. If an upgrade to Level C is required, personnel decontamination will be required as follows:

1. Wash boots and outer gloves using Liquinox/potable water wash and potable water rinse.

2. Remove outer gloves and disposable coveralls and place in plastic bags.

3. Remove respirator (if used) and wash and store according to manufacturer's instructions.

4. Remove disposable inner gloves and place in plastic bag.

5. Wash hands and face with water and soap prior to eating or drinking.

All decontamination water will be allowed to evaporate on site. Decontamination refuse, and used protective gear for Level C work will be disposed in trash dumpsters on site.

2.2.2 Sampling Equipment

The following steps will be used to decontaminate sampling equipment:

- Personnel will dress in suitable safety equipment to reduce personal exposure as required by the Site Safety and Health Plan.
- Gross contamination on equipment will be scraped off at the sampling or construction site.
- Equipment that will not be damaged by water will be placed in a wash tub containing Liquinox and potable water and scrubbed with a bristle brush or similar utensil. Equipment will be rinsed with tap water in a second wash tub followed by a methanol rinse. The equipment will be allowed to air dry and then rinsed with deionized water. Equipment used for metals sampling will be rinsed with a 10 % nitric acid solution.
- Equipment that may be damaged by water will be carefully wiped clean using a sponge and detergent water and rinsed with deionized water. Care will be taken to prevent any equipment damage.
- Rinse and detergent water will be replaced with new solutions between borings or sample locations.

Following decontamination, equipment will be placed in a clean area on clean plastic sheeting to prevent contact with contaminated soil. If the equipment is not used immediately, the equipment will be wrapped in foil (shiney side out) to minimize potential contact with airborne contamination.

2.2.3 Drilling and Heavy Equipment

Drilling rigs will be decontaminated on a decontamination pad. The decontamination pad will be designed to capture any water generated by the decontamination process. The following steps may be used to decontaminate drilling and heavy equipment:

- Personnel will dress in suitable safety equipment to reduce personal exposure as required by the Health and Safety Plan.
- Equipment showing gross contamination or having caked-on drill cuttings will be scraped with a flat-bladed scraper at the sampling or construction site.
- Equipment that will not be damaged by water, such as drill rigs, augers, drill bits, and shovels, will be sprayed with a hot water, high-pressure washer. Care will be taken to adequately clean the insides of the hollow-stem augers.

Following decontamination, drilling equipment will be placed back on the clean drill rig. If the equipment is not used immediately, it should be stored in a designated clean area.

2.2.4 Equipment Leaving the Site

Vehicles used for noncontamination activities shall be cleaned on an as-needed basis, as determined by the Site Safety and Health Officer, using soap and water on the outside and vacuuming the inside. On-site cleaning will be required for very dirty vehicles which will be leaving the area. On-site construction equipment such as trucks, drilling rigs, backhoes, trailers, etc., will be pressure washed on-site before the equipment is removed from the site to limit exposure of off-site personnel to potential contaminants.

2.2.5 Wastewater

Wash and rinse solutions obtained from decontamination operations will be allowed to evaporate. Any water remaining at the end of the field program will be containerized for proper disposal.

2.2.6 Other Wastes

Solid wastes such as used personal protective equipment will be placed in plastic bags and disposed in trash dumpsters on site.

2.3 DOCUMENTATION

Sampling personnel will be responsible for documenting the decontamination of sampling and drilling equipment. The documentation will be recorded with waterproof ink in the sampler's field notebook with consecutively numbered pages. The information entered in the field book concerning decontamination should include the following:

- Decontamination personnel
- Date and start and end times
- Decontamination observations
- Weather conditions

3.0
QUALITY ASSURANCE REQUIREMENTS

Field blank samples will be taken using decontaminated sampling equipment to verify the effectiveness of the decontamination procedures. The procedure will include rinsing organic free deionized water through or over a decontaminated sampling tool (such as a split spoon sampler or bailer) and collecting the rinsate water into the sample bottles, which will be sent to the laboratory for analysis. The procedure, including the sample number, will be recorded in the field notebook. Water used to make field blanks will be supplied by the analytical laboratory.

If contaminants detected in field blanks are reported above the method detection limit for any analytical procedure, the possible source of contamination will be investigated. If a problem is found, it will be corrected and samples rerun, if necessary. If no analytical problems are identified, the data will be flagged accordingly. Decontamination techniques will also be adjusted in the field prior to collection of additional samples.

STANDARD OPERATING PROCEDURE NUMBER 8

BIOLOGICAL TISSUE COLLECTION

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LIST OF FIGURES

1.0
PURPOSE AND SCOPE

This document defines the standard procedures for collecting biological tissues for analytical chemistry, percent moisture, and percent lipid analyses. This Standard Operating Procedure (SOP) serves as a supplement to the Chemical Data Acquisition Plan (CDAP). This procedure presents descriptions of equipment, field procedures, and QA/QC procedures necessary to collect sediment samples. The sample locations and frequency of collection are specified in the Field Sampling Plan (FSP).

This SOP is intended to be used in conjunction with the CDAP and several other SOPs. Sample identification, handling, and documentation procedures are described in SOP No. 6. SOP No. 7 describes decontamination procedures which are also applicable to this SOP. Health and safety procedures and equipment that will be required during the investigation are detailed in the Site Safety and Health Plan (SSHP).

2.0
PROCEDURES FOR BIOLOGICAL TISSUE SAMPLING

Samples for evaluation of biological tissue will be based on the availability of sedentary benthic organisms at the time of sampling. Ideally, a sedentary benthic organism consumed by humans (such as a clam or a mussel) is the test organism of choice for the assessment of both human health and environmental risks. A reconnaissance will be conducted to determine whether clams or mussels occur on either the intertidal flats or the jetty adjacent to SAEP and at a "background" location in the river upgradient of the facility. If either of these organisms occur in sufficient numbers, biological tissue samples from one species will be collected for use in the Baseline Risk Assessment, for both the Environmental Evaluation and the Human Health Evaluation.

2.1 EQUIPMENT LIST

The following list of equipment will be needed to collect biological tissue samples:

Biological Tissue Sampling Equipment

- Clam rakes
- Five-gallon buckets
- Plastic bags
- Scrub brushes
- Field books/field sheets
- Stainless steel shucking knife
- Measuring board
- Scales
- Sample bottles provided by the laboratory
- Sample bottle labels
- Cooler with ice
- Label tape (clear)
- Paper towels
- Camera and film
- Waterproof and permanent marking pens

- Appropriate health and safety equipment, as specified in the SSHP
- Appropriate decontamination supplies
- Organic free deionized water
- Buoys and/or stakes to mark sampling locations.

2.2 DECONTAMINATION

Before clams or mussels are shucked, the shucking knife will be decontaminated according to the procedures contained in SOP No. 7. The knife will be decontaminated before shucking clams or mussels collected from different sampling locations.

2.3 SAMPLING PROCEDURE FOR BIOLOGICAL TISSUE SAMPLING

The procedures for collecting biological tissue samples for analytical chemistry, percent moisture and percent lipids are provided below. Mussels (if present) will likely be attached to hard surfaces such as the jetty or breakwater and may be collected by hand at mid to low tide. Clams (if present) inhabit the soft substrate of the intertidal flats, and a boat will be required to reach the clam beds (if present) during a mid to high tide. Caution will be used when conducting any sampling from a boat.

Clams

- Position boat over clam bed and record the location on a site map and in the field log book.

- Don a clean pair of rubber or surgical gloves.

- Lower clam rake to bottom of bay/river.

- Pull clam rake through sediment and pull rake up to boat.

- Place captured clams in bucket with bay/river water.

- Repeat steps 4 through 6 (if necessary) to obtain a sufficient quantity of clams at each location to provide five replicate samples for analytical chemistry, percent moisture, and percent lipids analyses.

- Using bay/river water and scrub brush, scrub sediment off of clam shells.

- Label sample jars according to SOP No. 6.

- Shuck clams with decontaminated shucking knife (measure shell length and weigh meat from each clam used for analysis), place tissue in laboratory supplied sample jar.

- Return unused live clams to the collection location.

- Store and document sample according to SOP No. 6.

- Record applicable information on the Sample Collection Field Sheet (Figure 1) and Chain-of-Custody (COC).

- Mark sampling location with either a buoy or stake for subsequent surveying of sample locations.

Mussels

- Position boat in desired sampling location and record location on a site map and in field logbook.

- Don surgical or rubber gloves.

- Pull mussels off of rocks or wooden breakwater by hand. If mussels are submerged, use clam rake to dislodge and collect mussels.

- Place mussels into bucket of bay/river water.

- Repeat steps 3 and 4 (if necessary) to obtain a sufficient quantity of mussels at each location to provide five replicate samples for analytical chemistry, percent moisture, and percent lipids analyses.

- Using bay/river water and scrub brush, scrub sediment and/or detritus off of mussel shells.

- Label sample jars according to SOP No. 6.

- Shuck mussels with decontaminated shucking knife (measure shell length and weight meat from each mussel used for analysis), place tissue into laboratory provided sample jar.

- Return unused live mussels to the collection location.

- Store and document sample according to SOP No. 6.

- Record applicable information on the Sample Collection Field Sheet (Figure 1) and Chain-of-Custody (COC).

- Mark sampling location with either a buoy or stake for subsequent surveying of sample locations.

2.4 FIELD QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

Field Quality Assurance/Quality Control (QA/QC) samples are designed to help identify and minimize potential sources of sample contamination due to field procedures and to evaluate potential error introduced by sample collection and handling. All field QA/QC samples are labeled with QA/QC identification numbers and sent to the laboratory with the other samples for analyses. The frequency of QA/QC samples is specified in the CDAP.

2.4.1 Field Rinsate Samples

An equipment rinsate sample of sampling equipment is intended to check if decontamination procedures have been effective. A rinsate sample will be collected from the decontaminated sampling equipment (shucking knife) before it is used to shuck the clams/mussels. Organic-free deionized water will be rinsed over the decontaminated knife and transferred to the sample bottles. The same parameters that are being analyzed in the samples will be analyzed in the rinsate samples. The rinsate sample is assigned a QA/QC sample identification number, stored in an iced cooler, and shipped to the laboratory on the day it is collected.

2.4.2 Duplicate Samples

Duplicate samples are samples collected as close as possible to each other in time and space to check for the natural sample variance and the consistency of field techniques and laboratory analysis. The duplicate samples will be collected at the same time as the primary samples. For example, primary sample bottles for the PCB analysis will be filled first, then the duplicate sample bottles for PCB, and so on until all necessary sample bottles for both the primary sample and the duplicate sample have been filled. The duplicate sample will be handled in the same manner as the primary sample. The duplicate sample will be assigned a QA/QC identification number, stored in an iced cooler, and shipped to the laboratory on the day it is collected.

2.4.3 Matrix Spikes and Matrix Spike Duplicates

Matrix spikes are used to determine the long-term precision and accuracy of the laboratory analytical method on various matrices. For this procedure duplicate samples are collected with the field samples and spiking is done by the lab. Samples are labeled as matrix spikes for the lab. It is useful to collect enough additional sample for both the matrix spike and duplicate samples from the same location.

2.4.4 Blind Spikes and/or Blanks

The USACE may provide blind spikes and/or blanks for laboratory analysis to determine the accuracy of the laboratory analytical method. The samples will be assigned a QA/QC identification number, stored in an iced cooler, and shipped to the laboratory on the day received.

2.5 SAMPLE IDENTIFICATION, HANDLING, AND DOCUMENTATION

Samples will be identified, handled and recorded as described in this SOP and SOP No. 6. The parameters for analysis and preservation are specified in the CDAP.

2.6 DOCUMENTATION

Each field activity must be properly documented to facilitate a timely and accurate reconstruction of events in the field (see SOP No. 6). Sample collection field sheets will be completed for all sediment samples submitted for chemical analysis (Figure 1).

2.6.1 Field Logbook

The most important aspect of documentation is thorough, organized, and accurate record keeping. All information pertinent to the investigation and not documented on the boring log will be recorded in a bound logbook with consecutively numbered pages. All entries in logbooks will be made in waterproof ink and corrections will consist of line-out deletions that are initialed and dated. Entries in the logbook will include the following, as applicable:

- Project name and number
- Sampler's name
- Date and time of sample collection
- Sample number, location, and depth
- Sampling method
- Sampling media
- Sample type (grab or composite)
- Sample preservation
- Observations at the sampling site
- Unusual conditions
- Information concerning drilling decisions
- Decontamination observations

- Weather conditions
- Names and addresses of field contacts
- Names and responsibilities of field crew members
- Names and titles of any site visitors
- Location, description, and log of photographs (if taken)
- References for all maps and photographs
- Information concerning sampling changes, scheduling modifications, and change orders
- Summary of daily tasks and documentation on any cost or scope of work changes required by field conditions
- Signature and date by personnel responsible for observations

Field investigation situations vary widely. No general rules can include each type of information that must be entered in a logbook for a particular site. A site-specific logging procedure will be developed to include sufficient information so that the sampling activity can be reconstructed without relying on the memory of field personnel. The logbooks will be kept in the field team member's possession or in a secure place during the investigation. Following the investigation, the logbooks will become a part of the final project file.

2.6.2 Sample Collection Field Sheet

Sample Collection Field Sheets will be completed for each sample by the sampling personnel (geologist, geological engineer, or geotechnical engineer). The form is shown on Figure 1. Most of the information required on the field sheet will have been completed at the conclusion of the biological tissue sampling task.

SAMPLE COLLECTION FIELD SHEET
REMEDIAL INVESTIGATION
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

SAMPLE NUMBER:____________________

DATE and TIME OF COLLECTION:____________________________

COLLECTED BY:__________________________________

SAMPLE TYPE: ________________________________

SAMPLE DEPTH:______________

SAMPLING EQUIPMENT:_____________________________________

SAMPLING METHOD:__________________________________

SAMPLE SPLIT? NO YES SPLIT SAMPLE NUMBER: ____________________________

QA/QC SAMPLES? NO YES QA/QC SAMPLE NUMBERS: ____________________________

Sample Container	Preservative	Analysis Requested

SAMPLE DESCRIPTION: ____

INSTRUMENT SCREENING: ____

COMMENTS: ____

Figure 1
Sample Collection Field Sheet

STANDARD OPERATING PROCEDURE NUMBER 9

SEDIMENT SAMPLING

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LIST OF FIGURES

1.0
PURPOSE AND SCOPE

This document defines the standard procedure for collecting sediment samples for analytical chemistry, physical parameter, solid phase toxicity, and benthic macroinvertabrate community analyses. This Standard Operating Procedure (SOP) serves as a supplement to the Chemical Data Acquisition Plan (CDAP). This procedure presents descriptions of equipment, field procedures, and QA/QC procedures necessary to collect sediment samples. The sample locations and frequency of collection are specified in the Field Sampling Plan (FSP).

This SOP is intended to be used in conjunction with the CDAP and several other SOPs. Sample identification, handling, and documentation procedures are described in SOP No. 6. SOP No. 7 describes decontamination procedures which are also applicable to this SOP. Health and safety procedures and equipment that will be required during the investigation are detailed in the Site Safety and Health Plan (SSHP).

2.0
PROCEDURES FOR SEDIMENT SAMPLING

Both surface and subsurface sediment for analytical chemistry will be collected either by hand or vibracoring methods using plastic core tubes. Surficial sediment for physical parameter testing will also be collected using the core tubes. Bulk surficial sediment for solid phase toxicity testing and benthic macroinvertebrate community analyses will be collected using a standard (9 in x 9 in) Ponar grab sampler.

2.1 EQUIPMENT LIST

The following list of equipment will be needed to collect sediment samples:

Sediment Sampling Equipment

- Stainless steel standard Ponar grab sampler with appropriate length of line
- Gas-powered vibracore motor with core tube collar and vibrating head
- Eight foot cellulose acetate butyrate (CAB) plastic core tubes
- Ruler marked in 1/10 feet divisions
- Field books/field sheets
- Stainless steel knife and spatula
- Stainless steel bowls and spoons
- Sample bottles provided by the laboratory
- Sample bottle labels
- Cooler with ice
- Label tape (clear)
- Paper towels
- Camera and film
- Waterproof and permanent marking pens
- Plastic sheeting

- Plastic bags
- Appropriate health and safety equipment, as specified in the SSHP
- Appropriate decontamination supplies
- Pipe cutter
- Organic free deionized water
- Buoys and/or stakes to mark sampling locations

2.2 DECONTAMINATION

Before sampling begins, the Ponar grab sampler, stainless steel bowls, and spoons will be decontaminated according to the procedures contained in SOP No. 7. The equipment will be decontaminated between sampling locations. Core tubes will not be decontaminated since a new core tube will be used at each sampling location.

2.3 SEDIMENT SAMPLING PROCEDURE FOR ANALYTICAL AND PHYSICAL PARAMETER TESTING

The procedures for collecting surface and subsurface sediment samples for analytical chemistry and physical parameters are provided below. A hand or vibratory corer will be used since it can be used to collect a relatively undisturbed sample that shows a profile of stratification.

For offshore areas, a boat will be required in order to reach the designated sample locations. Caution will be used when conducting any sampling from a boat.

The following procedures will be used during this sampling activity:

- Position the boat at the sampling location using NOAA nautical chart, USGS quadrangle, and/or onshore landmarks.

- Anchor the boat at the sampling location.

- Record the sample location on a site map and in the field log book.

- Decontaminate stainless steel sampling equipment according to SOP No. 7.

- Don a clean pair of rubber or surgical gloves.

- Push core tube into surface of sediment.

- Measure length of core tube above surface of water.

- Manually push or hammer the core tube into the sediment to the four foot depth.

- If the tube cannot be manually pushed into the sediment to the four foot depth, attach the vibrating collar to the top of the core tube and start gas-powered vibracoring motor.

- Then, guide core tube vertically into sediment to the four foot depth.

- Shut off vibracoring motor (if necessary).

- Fill core tube with water (to remove air above sediment/water interface) and cap top of core tube.

- Pull core tube out of sediment, as bottom of tube breaks water surface cap bottom of core.

- Measure the sediment in the core tube to determine depth of penetration and recovery.

- Transfer (using a decontaminated spoon) each selected depth interval of sediment into separate stainless steel bowls.

- Repeat the steps for pushing and retrieving the core tube to obtain a sufficient quantity of sediment for all chemical and physical analyses.

- Label sample jars according to SOP No. 6.

- Homogenize sediment from each depth interval and transfer the sediment into appropriate sample containers using the decontaminated spoon.

- Individual bottles will be filled in the following order:
    - PAHs
    - PCBs
    - Metals
    - Physical parameters

- Fill the appropriate sample container for geotechnical analyses with sediment from the 0 to 6 inch interval.

- Return unused sediment to the collection location.

- Store and document sample according to SOP No. 6.

- Record applicable information on the Sample Collection Field Sheet (Figure 1) and Chain-of-Custody (COC).

- Mark sampling location with either a buoy or stake for subsequent surveying of sample locations.

2.4 SEDIMENT SAMPLING PROCEDURE FOR TOXICITY TESTING

The procedure for collecting bulk surface sediment for use in the solid phase toxicity tests are provided below. The standard Ponar grab sampler will be used to collect sediments for toxicity testing, as it will sample to a depth of approximately six inches and will generally collect a sufficient volume of sediment (one gallon) in one grab.

- Anchor boat at sampling location.

- Measure and record water quality parameters (dissolved oxygen, temperature, salinity, conductivity, and pH) using the appropriate instruments. The instrument probes shall be lowered into the water to the mid-depth interval.

- Decontaminate Ponar grab, stainless steel bowl and spoon.

- Attach Ponar grab to appropriate length of line, and tie free end of line to fixed support to prevent accidental loss of Ponar grab.

- Open jaws of Ponar grab until latched.

- Slowly lower Ponar grab through the water column until it contacts sediment.

- Allow line some slack, and slowly retrieve Ponar grab.

- Open Ponar grab over stainless steel bowl, allowing bowl to catch sediment.

- Repeat the steps for lowering and retrieving the Ponar (if necessary) to obtain sufficient quantity of sediment for toxicity testing.

- Homogenize the sediment in a decontaminated stainless steel bowl using a decontaminated stainless steel spoon.

- Label sample bottles and fill with homogenized sediment.

- Replace caps on sample bottles and place in cooler, on ice.

- Record all appropriate data in field logbook.

- Fill out chain-of-custody forms.

2.5 SAMPLING PROCEDURE FOR COLLECTING BENTHIC MACROINVERTABRATE COMMUNITY SAMPLES

Sediment for benthic macroinvertebrate community analyses will be collected with a standard Ponar grab sampler following the same basic procedure described in Section 2.4, except that three replicate grab samples will be collected at 15 of the sediment sampling locations and the replicates will not be homogenized. If the grab sampler is not completely full, the sample will be discarded and another attempt will be made to obtain a full sample. Each full replicate sample will be removed from the Ponar grab and processed as follows:

- Transfer contents of Ponar grab into a 500 micron mesh sieve.
- Sieve sample using river water to remove fine sediments.
- Place sieved samples into labeled sample containers and preserve sample using a 10 percent buffered formalin solution with Rose Bengal stain.
- Record all appropriate data in field logbook.
- Package samples to prevent breakage and transport samples to WCC laboratory for processing and analysis.

2.6 FIELD QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

Field Quality Assurance/Quality Control (QA/QC) samples are designed to help identify and minimize potential sources of sample contamination due to field procedures and to evaluate potential error introduced by sample collection and handling. All field QA/QC samples are labeled with QA/QC identification numbers and sent to the laboratory with the other samples for analyses. The frequency of QA/QC samples is specified in the CDAP.

2.6.1. Field Rinsate Samples

An equipment rinsate sample of sampling equipment is intended to check if decontamination procedures have been effective. A rinsate sample will be collected from the decontaminated sampling equipment before it is used to obtain the sample. Organic-free deionized water will be rinsed over the decontaminated sampling apparatus and transferred to the sample bottles. The same parameters that are being analyzed in the samples will be analyzed in the rinsate samples. The rinsate sample is assigned a QA/QC sample identification number, stored in an iced cooler, and shipped to the laboratory on the day it is collected.

2.6.2 Duplicate Samples

Duplicate samples are samples collected as close as possible to each other in time and space to check for the natural sample variance and the consistency of field techniques and laboratory analysis. The duplicate samples will be collected at the same time as the primary samples. For example, primary sample bottles for the PAH analysis will be filled first, then the duplicate sample bottles for PAH, and so on until all necessary sample bottles for both the primary sample and the duplicate sample have been filled. The duplicate sample will be handled in the same manner as the primary sample. The duplicate sample will be assigned a QA/QC identification number, stored in an iced cooler, and shipped to the laboratory on the day it is collected.

2.6.3 Matrix Spikes and Matrix Spike Duplicates

Matrix spikes are used to determine the long-term precision and accuracy of the laboratory analytical method on various matrices. For this procedure duplicate samples are collected with the field samples and spiking is done by the lab. Samples are labeled as matrix spikes for the lab. It is useful to collect enough additional sample for both the matrix spike and duplicate samples from the same location.

2.6.4 Blind Spikes and/or Blanks

The USACE may provide blind spikes and/or blanks for laboratory analysis to determine the accuracy of the laboratory analytical method. The samples will be assigned a QA/QC identification number, stored in an iced cooler, and shipped to the laboratory on the day received.

2.7 SAMPLE IDENTIFICATION, HANDLING, AND DOCUMENTATION

Samples will be identified, handled and recorded as described in this SOP and SOP No. 6. The parameters for analysis and preservation are specified in the CDAP.

2.8 DOCUMENTATION

Each field activity must be properly documented to facilitate a timely and accurate reconstruction of events in the field (see SOP No. 6). Sample collection field sheets will be completed for all sediment samples submitted for chemical analysis (Figure 1).

2.8.1 Field Logbook

The most important aspect of documentation is thorough, organized, and accurate record keeping. All information pertinent to the investigation and not documented on the boring log will be recorded in a bound logbook with consecutively numbered pages. All entries in logbooks will be made in waterproof ink and corrections will consist of line-out deletions that are initialed and dated. Entries in the logbook will include the following, as applicable:

- Project name and number
- Sampler's name
- Date and time of sample collection
- Sample number, location, and depth
- Sampling method
- Sampling media
- Sample type (grab or composite)
- Sample preservation
- Observations at the sampling site
- Unusual conditions
- Information concerning drilling decisions
- Decontamination observations

- Weather conditions
- Names and addresses of field contacts
- Names and responsibilities of field crew members
- Names and titles of any site visitors
- Location, description, and log of photographs (if taken)
- References for all maps and photographs
- Information concerning sampling changes, scheduling modifications, and change orders
- Summary of daily tasks and documentation on any cost or scope of work changes required by field conditions
- Signature and date by personnel responsible for observations

Field investigation situations vary widely. No general rules can include each type of information that must be entered in a logbook for a particular site. A site-specific logging procedure will be developed to include sufficient information so that the sampling activity can be reconstructed without relying on the memory of field personnel. The logbooks will be kept in the field team member's possession or in a secure place during the investigation. Following the investigation, the logbooks will become a part of the final project file.

2.8.2 Sample Collection Field Sheet

Sample Collection Field Sheets will be completed for each sample by the sampling personnel (geologist, geological engineer, or geotechnical engineer). The form is shown on Figure 1. Most of the information required on the field sheet will have been completed at the conclusion of the sediment sampling task.

SAMPLE COLLECTION FIELD SHEET

REMEDIAL INVESTIGATION
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

SAMPLE NUMBER:____________________

DATE and TIME OF COLLECTION:____________________________

COLLECTED BY:__________________________________

SAMPLE MEDIA: Soil Water Sediment

SAMPLE DEPTH:______________

SAMPLING EQUIPMENT:______________________________________

SAMPLING METHOD:____________________________________

SAMPLE SPLIT? NO YES SPLIT SAMPLE NUMBER: ____________________________

QA/QC SAMPLES? NO YES QA/QC SAMPLE NUMBERS: ____________________________

Sample Container	Preservative	Analysis Requested

SAMPLE DESCRIPTION: ____

INSTRUMENT SCREENING: ____

COMMENTS: ____

Figure 1
Sample Collection Field Sheet

STANDARD OPERATING PROCEDURE NUMBER 10

PHYSICAL PROPERTY TESTING

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1.0
PURPOSE AND SCOPE

This document defines the standard procedures to be used for physical property testing of soil samples. It is anticipated that these procedures will be performed in an off-site laboratory. This Standard Operating Procedure (SOP) serves as a supplement to the Chemical Data Acquisition Plan (CDAP). The ASTM standard practices to be used are referenced in this SOP, and they include complete descriptions of procedures necessary to perform physical property testing. Actual laboratory methods may be modifications of these ASTM standard practices or based on other regulatory guidance standards. The laboratory will prepare a QA plan presenting analytical standard practices and methodologies, and laboratory techniques and procedures.

The following ASTM standard practices will be used:

D1452-80	STANDARD PRACTICE FOR SOIL INVESTIGATION AND SAMPLING BY AUGER BORINGS
D1586-84	STANDARD METHOD FOR PENETRATION TEST AND SPLIT-BARREL SAMPLING OF SOILS
D1587-83	STANDARD PRACTICE FOR THIN-WALLED TUBE SAMPLING OF SOILS
D2937-83	STANDARD TEST METHOD FOR DENSITY OF SOIL IN PLACE BY THE DRIVE-CYLINDER METHOD
D4220-89	STANDARD PRACTICES FOR PRESERVING AND TRANSPORTING SOIL SAMPLES
D2487-85	STANDARD TEST METHOD FOR CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

D2488-84	STANDARD PRACTICE FOR DESCRIPTION AND IDENTIFICATION OF SOILS (VISUAL-MANUAL PROCEDURE)
D421-85	STANDARD PRACTICE FOR DRY PREPARATION OF SOIL SAMPLES FOR PARTICLE-SIZE ANALYSIS AND DETERMINATION OF SOIL CONSTANTS
D422-63	STANDARD METHOD FOR PARTICLE SIZE ANALYSIS OF SOILS
C117-87	STANDARD TEST METHOD FOR MATERIALS FINER THAN 75 MICRONS (NO. 200) SIEVE IN MINERAL AGGREGATES BY WASHING
D4318-84	STANDARD TEST METHOD FOR LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS
D2216-80	STANDARD METHOD FOR LABORATORY DETERMINATION OF WATER (MOISTURE) CONTENT OF SOIL, ROCK, AND SOIL-AGGREGATE MIXTURES
F480-81	STANDARD SPECIFICATION FOR THERMOPLASTIC WATER WELL CASING PIPE AND COUPLINGS MADE IN STANDARD DIMENSION RATIOS (SDR)
C150-86	STANDARD SPECIFICATION FOR PORTLAND CEMENT
D1193-77	STANDARD SPECIFICATION FOR REAGENT WATER
D2974-87	STANDARD TEST METHODS FOR MOISTURE, ASH, AND ORGANIC MATTER OF PEAT AND OTHER ORGANIC SOILS

FINAL

APPENDIX B

SAFETY AND HEALTH PLAN

PHASE II REMEDIAL INVESTIGATION WORK PLAN

STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

Prepared for
U.S. Department of the Army
Corps of Engineers, Omaha District
Omaha, Nebraska
November 1994

Woodward-Clyde

101 South 108 Avenue
Omaha, Nebraska 68154
WC Project No. C3M11LL

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INTRODUCTION

This Site Safety and Health Plan (SSHP) establishes guidelines and requirements for safety of personnel during the performance of field activities associated with remedial investigations at the Stratford Army Engine Plant (SAEP). All employees and subcontractors of Woodward-Clyde (W-C) involved in field activities for this project are required to abide by the provisions of this SSHP. They are required to read the SSHP and sign the attached Safety and Health Plan Compliance Agreement. This SSHP is prepared in accordance with OSHA Regulations 29 CFR Part 1910.120 (Hazardous Waste Operations and Emergency Response, Final Rule - March 6, 1989).

The health and safety guidelines and requirements presented herein are based on a review of available information and an evaluation of potential hazards. Because of the variety of possible work activities and site conditions which may be encountered and the uncertainties associated with potential health effects from exposures to various constituents which may be present, no guarantees can be made regarding the potential for health effects associated with field activities at the SAEP. This SSHP describes the health and safety procedures and equipment required for activities at the SAEP to reduce the potential for exposure of field personnel.

W-C has been retained by the Department of the Army, Corps of Engineers, Omaha District (USACE) to conduct sampling activities at the SAEP. This SSHP is only for activities defined in the Phase II Remedial Investigation Work Plan.

Regulations applying to the proposed field activities during the remedial investigations are listed below. These regulations will be enforced during all activities described in this SSHP.

Government Regulations	Subject
FAR Clause 52.236-13	Accident Prevention
USACE EM 385-1-1	Safety and Health Requirements Manual
OSHA 29 CFR 1926	Construction Industry Standards
OSHA 29 CFR 1910	General Industry Standards
OSHA 29 CFR 1910.120	Hazardous Waste Site Operations and Emergency Response
OSHA 29 CFR 1910.20	Recordkeeping/Recording
OSHA 29 CFR 1904	Recordkeeping/Recording
OSHA 29 CFR 1910.1000	OSHA Permissible Exposure Limits
OSHA 29 CFR 1910.134	Respiratory Protection
NIOSH/OSHA/USCG/EPA	Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities

1.0
PROJECT IDENTIFICATION

CLIENT:	Department of the Army Corps of Engineers, Omaha District
SITE:	Stratford Army Engine Plant Stratford, Connecticut
PROJECT NO:	C3M11LL-1.1
BUSINESS UNIT:	New York Metro
PROJECT MANAGER:	Marion E. Craig
DATE OF SSHP:	January 31, 1992 Revised: November 28, 1994
MANDATORY REVIEW DATE OF SSHP:	May 28, 1995

2.0
SITE INFORMATION

2.1 SITE DESCRIPTION

SAEP is an industrial facility which is mostly paved or covered by buildings. Surrounding land uses are mainly light industrial, commercial, and residential.

2.1.1 SITE LOCATION

SAEP is located in Stratford, Connecticut, on the Stratford Point peninsula in the southeast corner of Fairfield County. The plant lies on the borders of the Bridgeport and Milford United States Geological Survey (USGS) Quadrangles (Figure 2-1). Latitudinal and longitudinal coordinates of SAEP are approximately 41°10' North and 73°07' West. The property consists of about 126 acres including about 49 acres of riparian rights along the Housatonic River. Existing property features are shown in Figure 2-2.

2.1.2 SITE OWNERSHIP AND OPERATIONS HISTORY

The SAEP property was used for agriculture until 1929 when the first manufacturing facility was built on about 26 acres. The property has been used for development, manufacture, and assembly of aircraft or engines since 1929. The plant history has been categorized into the following periods:

- 1929 to 1939: Sikorsky Aero Engineering Corporation developed and manufactured sea planes at the Stratford plant from 1929 to 1939.

- 1939 to 1948: Chance Vought Aircraft located its operations at the Stratford plant in 1939, and the company became known as the Vought-Sikorsky Aircraft Division. Sikorsky developed the first helicopter, but left the plant in 1943 because of overcrowding. Chance Vought developed the "Corsair" for U.S. Navy, and mass produced Corsairs during World War II. Chance Vought vacated the Stratford plant in 1948.

- 1948 to 1951: The Stratford plant was idle.

- 1951 to 1976: The U.S. Air Force procured the plant in 1951 and named it Air Force Plant No. 43. The Bridgeport Lycoming Division of the Avco Corporation was contracted by the Air Force to operate the plant. Avco developed and manufactured radial engines in the 1950s, and turbine engines in the 1960s and 1970s.

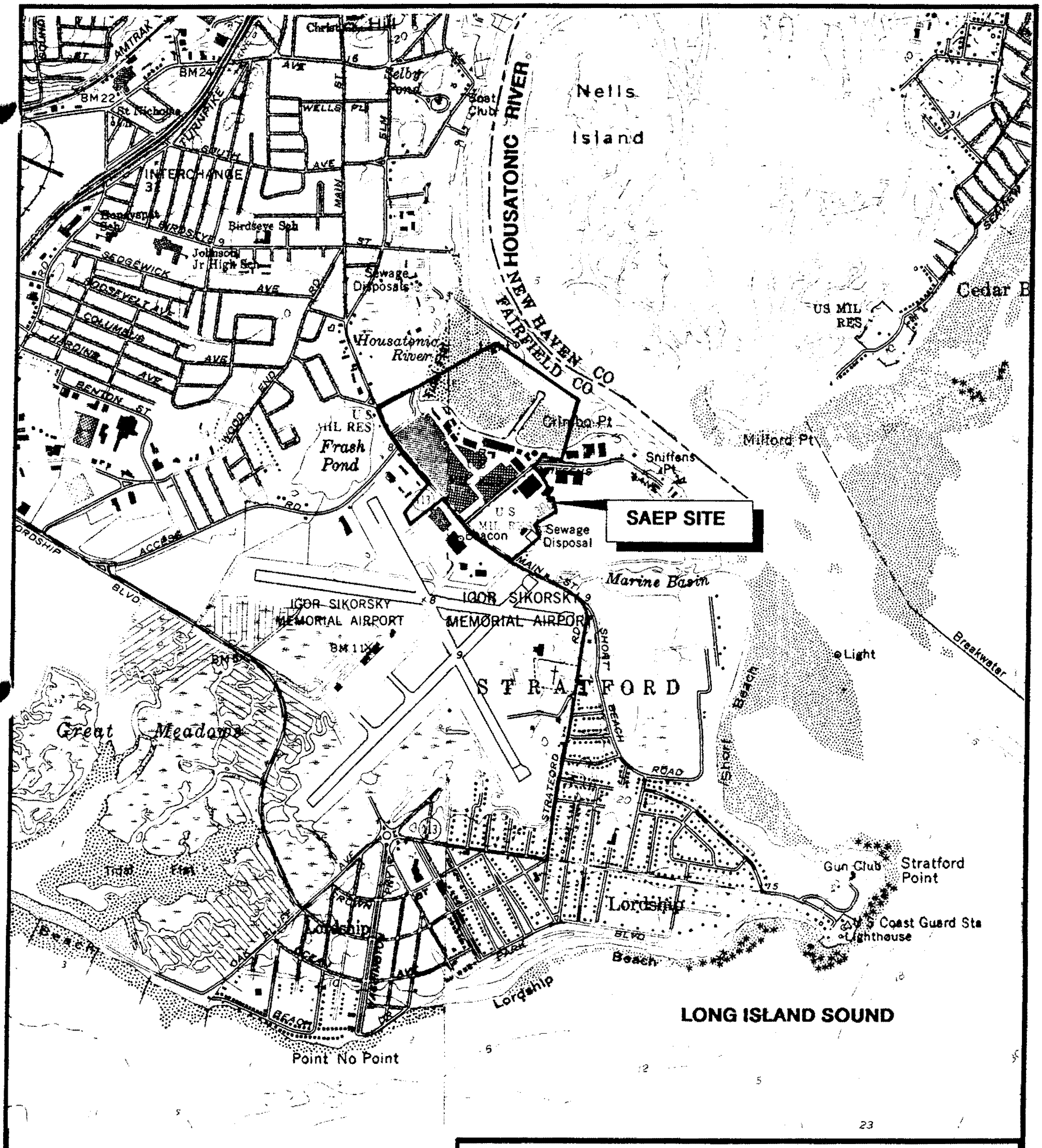
- 1976 to Present: The plant was transferred from the U.S. Air Force to the Army in 1976; at that time the plant was renamed the Stratford Army Engine Plant (SAEP). Avco was contracted by the Army to develop the AGT-1500 engine to power the Abrams tank. Avco also developed and manufactured marine and industrial engines. Avco merged with Textron in December 1985 and formed Textron Lycoming. AlliedSignal Aerospace purchased Textron Lycoming in 1994. Today, turbine engines for military and commercial aircraft, as well as land vehicles, continue to be developed, manufactured, and tested at SAEP. Figure 2-2 shows the layout of the site, including building locations.

2.2 SUMMARY OF FINDINGS FROM THE PHASE I REMEDIAL INVESTIGATION

This summary presents the results of the second phase of an environmental assessment of SAEP - the Phase I Remedial Investigation (RI) - in which physical and chemical data on site conditions were gathered and evaluated. Results of the findings of the RI, concluded on June of 1993, are summarized below.

2.2.1 Physical Characterization

- The site is underlain by fill, peat, silt and glacial deposits which are variable in lateral extent and thickness across the site.

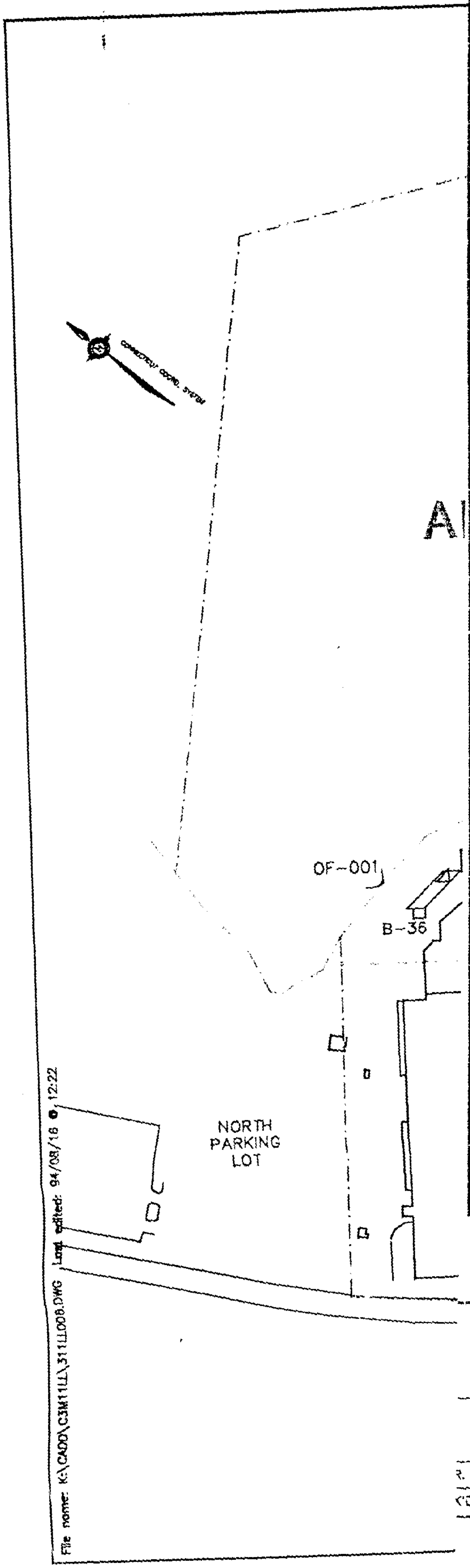


MAP SOURCE:
FROM BRIDGEPORT & MILFORD, CT. USGS QUADRANGLE MAP, 1970 & 1960, PHOTOREVISED 1984.

WOODWARD – CLYDE CONSULTANTS
ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

VICINITY MAP
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

DR. BY: FWD	DATE: JAN 1992	PROJ. NO:	FIGURE NO.:
CK'D BY: MEC	DATE: JAN 1992	89C114CC	2–1



BUILDING NUMBER	BUILDING NAME
B-1	MAIN ADMINISTRATIVE & GOVERNMENT OFFICES
B-2	MANUFACTURING OPERATIONS
B-3	RESEARCH & DEVELOPMENT ENGINEERING
B-3A	ENGINEERING LABORATORIES
B-4	STORES AND AGT-1500 REPAIR
B-5	FUEL SYSTEM TEST
B-6	ENGINE ENVIRONMENTAL & COMPONENT TEST
B-6A	ENGINE MECHANICAL COMPONENT TEST
B-7	ENGINE FUEL SYSTEM TEST
B-7A	ENGINE FUEL SYSTEM TEST
B-8	VOLATILE STORAGE
B-9	AUTOMOTIVE MAINTENANCE
B-10	RECUPERATOR MANUFACTURE
B-12	MAINTENANCE DEPARTMENT
B-13	SCRAP & MATERIAL RECLAMATION
B-15	LUBRICATION STORAGE & FIRE HOUSE
B-16	PRODUCTION & DEVELOPMENTAL TEST CELLS
B-17	ENGINEERING TEST FACILITY
B-18	CHEMICAL WASTE TREATMENT PLANT (CWTP)
B-19	COMPONENT TEST FACILITY
B-33	COOLING TOWER PUMP STATION
B-34	FUEL PUMPING STATION
B-36	STORM DRAIN PUMPING STATION (OF-001)
B-37	STORM DRAIN PUMPING STATION (OF-002)
B-38	STORM DRAIN PUMPING STATION (OF-003)
B-40	STORM DRAIN PUMPING STATION (OF-004)
B-41	STORM DRAIN PUMPING STATION (OF-005)
B-42	SPRINKLER BOOST PUMP STATION (400K GAL.)
B-43	FUEL PUMPING STATION
B-44	STORES & CARPENTER SHOP
B-48	ENGINE CONTAINER REBUILD
B-52	STORES & ADJUNCT TO B-2
B-53	SURPLUS EQUIPMENT STORAGE
B-58	QUALITY & TESTING FACILITY
B-59	ENGINEERING STORAGE
B-60	HI-PRESSURE NATURAL GAS PUMPING STATION
B-61	REFRIGERATION PLANT
B-63	CWTP PUMPING STATION
B-64-1	OIL ABATEMENT PLANT PUMP HOUSE
B-64-2	OIL ABATEMENT TREATMENT PLANT (OATP)
B-65	STORAGE FACILITY
B-67	GENERAL STORES
B-68	EMERGENCY GENERATOR
B-69	USACE RESIDENT ENGINEER
B-70	CYANIDE DESTRUCTION FACILITY (CDF)
B-71	CWTP SOLIDS HANDLING
B-72	FUEL PUMPING STATION
B-77	OFFICE
B-79	SSE BUILDING

0 150 300 600

SCALE (FEET)

FACILITY BUILDINGS AND AREAS OF POTENTIAL ENVIRONMENTAL CONCERN
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

WOODWARD-CLYDE CONSULTANTS

ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
OMAHA, NEBRASKA

R. BY MVB	SCALE 1" = 300'	DWG. NO. 311LL006	PROJ. NO. C3M11LL
D. BY MEC	DATE AUG 16, 1994	FIG. NO. 2-2	

- Groundwater flow at the site is generally in a northerly direction, toward the intertidal flats in the shallow and deep aquifer zones of the underlying aquifer.

- During high tide there is a reversal of flow (southerly) in the deep aquifer zone within 500 ft of the shore. This effect is not evident in the shallow aquifer zone.

- The water table is relatively flat across the site, but steepens within 500 ft of the shore.

- The average hydraulic conductivity of the deep and shallow aquifer zones (from slug tests) is 3.6 ft/day (1.3×10^{-3} cm/sec). These values appear to be consistent for the lithologies that were encountered during drilling at the site.

- There is generally an upward vertical gradient between the deep zone and shallow zone in the immediate vicinity of the shore line. The vertical gradient between the two aquifer zones varies between upward and downward throughout the remainder of the site.

2.2.2 Chemical Characterization

2.2.2.1 Soil

Volatile Organics

- The highest levels of VOs were detected in the vicinity of B-13 and B-15. The highest levels were below 10,000 μg/kg (10 mg/kg). At such levels these compounds are probably not of concern in terms of potential human contact or contact with groundwater.

- The types of volatile compounds detected are consistent with past and present site activities.

Base Neutrals

- With minor exceptions, BNs were generally detected in total concentrations of less than 15,000 μg/kg (15 mg/kg). At such levels these compounds are probably not of concern in terms of potential human contact or contact with groundwater.

- The PAH BNs detected are consistent with past and present site activities. The ubiquitous presence of phthalates is not obviously consistent with site activities.

Acid Extractables

- The highest concentration of acid extractable compounds was about 6,000 μg/kg (6 mg/kg); most were below 100 μg/kg. At such levels these compounds are probably not of concern in terms of potential human contact or contact with groundwater.

- The source of AE compounds in SAEP soils is not known.

PCBs

- The levels of PCBs detected in SAEP soils are acceptable for industrial property site use.

- The source of PCBs in the northwest end of Area 3 is not known.

Cyanide

- Cyanide was not detected and is therefore not an issue for SAEP soils.

Metals

- Slightly elevated total metal concentrations in SAEP soils may not be of concern based on companion TCLP results. Lead concentrations in the area of B-13 and B-15 will probably become an issue if this soil was to be excavated and disposed.

- Metals detected in SAEP soil appear to be consistent with past and present site activities with the possible exception of antimony.

2.2.2.2 Groundwater

Volatile Organics

- Shallow groundwater appears to have been impacted by releases of solvents and/or waste solvents, primarily chlorinated hydrocarbons.

- The highest concentrations of chlorinated compounds are in areas adjacent to solvent storage tanks and/or degreaser areas indicating these areas are or were possible sources of shallow groundwater contamination.

- The difference in the contaminants detected in deep wells WC-2D and PZ-9D suggests different sources of contamination. The very low ground water gradients make it impossible to conclusively state that there is an off-site source of the deep contamination in PZ-9D.

- WC-2D may be more contaminated than the adjacent shallow well because:

    - the shallow water bearing zone is subject to "flushing" by tidal effects thus removing the residual sources; and/or
    - there may be an unidentified upgradient source from which constituents have migrated downward into the deeper zone.

- There is, in most wells, a decrease in contaminant concentration from Round 1 to Round 2. This could be a function of a higher groundwater level accessing the residual source in the soil to a larger extent in Round 1.

- There is also evidence that there has been a release(s) of gasoline or kerosene (jet fuel). This is evidenced by the presence of BTEX compounds at a number of locations.

Base Neutral/Acid Extractables

- BN/AE compounds have not significantly impacted groundwater quality in the shallow aquifer.

PCBs/Cyanide

- Neither PCBs nor Cyanide have impacted groundwater quality in the shallow aquifer.

Metals

- There is no clear pattern to the distribution of wells that have exceedances of one or more metals. Exceedances are randomly distributed across the site with the majority and highest exceedances occurring in wells in Area 3 adjacent to the tidal flats, and in Area 4 wells.

- The metals most frequently found in the groundwater are consistent with industrial activities (plating, manufacturing, etc.).

- The metals found in groundwater were consistent with those found in the soil (with the exception of antimony which was not found in exceedance of the MCLs in groundwater).

2.2.2.3 Sediment

Volatile Organics

- Volatile organic compounds have not significantly impacted sediment at the locations sampled except at the tidal flat outfall location 02 near the tank farm. Sediment at this location appears to have been impacted by release(s) of gasoline or kerosene (jet fuel) evidenced by the presence of BTEX compounds. This location is also near the shallow monitoring wells where the highest concentrations of VOs were detected in groundwater.

Base/Neutrals

- Elevated levels of PAHs were detected in the sediment samples from most of the tidal flat outfall locations, from the three tidal flat locations and from the two Area 8 tidal drainage ditch locations, while no PAHs were detected in the intertidal background samples. Sediment at these locations appear to have been impacted by a petroleum product related release(s). The vertical extent of PAH contamination was not defined at most sample locations evidenced by the fact that PAHs were detected in the deep (12 to 24 inches) as well as the shallow (0 to 12 inches) samples with some locations having higher deep PAH concentrations than the shallow samples.

- Phthalates were detected in both the site samples as well as in the intertidal background samples, and therefore may not be attributable to releases from SAEP.

- The sediment at the locations sampled has not been significantly impacted by halogenated hydrocarbons.

- Elevated levels of miscellaneous BNs were detected in the Area 8 tidal drainage ditch sediment samples.

Acid Extractables

- The sediment at the locations sampled has not been significantly impacted by acid extractable compounds.

PCBs

- PCBs were detected at more than half the sample locations with the shallow and deep samples from the tidal flat outfall location 02 having significantly higher (greater than an order of magnitude) concentrations than the other locations. The fact that no PCBs were detected in the intertidal background sample suggests that their occurrence may be related to past or present SAEP activities.

Cyanide

- Elevated levels of cyanide were detected in samples from the two Area 8 tidal drainage ditch locations as well as from the tidal flat outfall locations 04 and 05.

Metals

- Elevated levels of metals, relative to the intertidal background samples, were detected in most of the sediment samples from the site with the concentrations of some metals being one to two orders of magnitude more than the intertidal background samples. The metals detected in elevated concentrations are consistent with past and present site activities.

2.2.2.4 Surface Water

Volatile Organics

- The low concentrations of halogenated aliphatics detected in surface water samples from the intertidal outfall locations 04 and 07 as well as from the two Area 8 tidal drainage ditch locations are probably associated with the effluent from outfalls 07 and 08. These outfalls were continuously discharging at the time of the sampling. These low concentrations may have little impact on the marine aquatic life in the adjacent waters because the effluent is diluted relatively quickly evidenced by the fact that these analytes were not detected or detected at very low concentrations at the tidal flat sample locations.

- The detected concentrations of the ketone 2-propanone in samples from the Area 8 tidal drainage ditch are probably associated with the effluent from outfall 08 which was continuously discharging at the time the samples were collected.
- Monocyclic aromatic hydrocarbons have not impacted surface water quality in the vicinity of the SAEP.

Base/Neutrals

- PAHs were only detected at very low concentrations at two sample locations and have not impacted surface water quality.

Acid Extractables

- Acid extractables were only detected at very low concentrations at two sample locations and have not affected surface water quality.

Cyanide

- Cyanide was only detected in the sample from the tidal flat outfall location 07 at a concentration which exceeds the USEPA acute and chronic criteria for the protection of marine aquatic life. Even though the concentration of cyanide detected exceeds the criteria it may not impact marine aquatic life based the fact that USEPA developed the criteria on an acid soluble concentration basis and the criteria may be overly protective.

Metals

- Elevated levels of some metals, relative to the intertidal background samples, were detected in more than half of the surface water samples from the tidal flat outfall locations and Area 8 tidal drainage ditch location 08-BG with the concentrations of some metals being an order of magnitude more than the intertidal background sample. The relatively high concentrations of some metals at these locations are probably associated with manufacturing processes at SAEP. The elevated concentrations of these metals appear to be diluted relatively quickly because the concentrations of these metals detected in the three tidal flat samples located a few hundred feet away were considerably lower than those detected in the tidal flat outfall location samples. Even though there were some exceedances of the USEPA criteria for copper, lead, mercury and zinc at some sample locations marine aquatic life may not be impacted on the basis that the USEPA developed the criteria on an acid soluble concentration basis and the criteria may be overly protective.

2.3 PREVIOUS ENVIRONMENTAL INVESTIGATIONS

Several previous investigations at SAEP have involved sampling and chemical analysis of environmental media. In addition, analytical data collected in compliance with permits are available. This section of the report briefly summarizes the results of the previous investigations and other analytical work.

2.3.1 National Pollution Discharge Elimination System Permit Monitoring

Water samples collected at Outfalls 007 and 008 (see Figure 2-2) have been analyzed in compliance with the facility National Pollution Discharge Elimination System (NPDES) permit. Water discharging from the Oil Abatement Treatment Plant (OATP) goes to Outfall 007, and Outfall 008 receives discharges from the Chemical Waste Treatment Plant (CWTP). The permitted average daily concentrations (ADC) of certain analytes were exceeded at different times between 1980 and 1984. For Outfall 007, phenols, total suspended solids, and oil and grease occasionally exceeded ADC limits of 0.1, 20, and 10 parts per million (ppm), respectively. At Outfall 008, the following analytes occasionally exceeded the indicated ADC limits: hexavalent chromium (0.1 ppm), total chromium (1.0 ppm), nickel (1.0 ppm), cadmium (0.1 ppm), total suspended solids (10 ppm), and pH (maximum of 8.75).

The NPDES permit issued in 1985 added outfalls 001, 002, 003, 004, 005, and 006, which discharge intermittent storm water. In addition, permit requirements included maximum daily and average monthly concentrations for various analytes. Textron followed the 1985 NPDES permit conditions while the draft 1990 NPDES permit was reviewed by CDEP. During calendar year 1990, several permit violations were noted (W-C, 1991): average daily flow limitations were exceeded at both outfalls, maximum daily concentration limitations were exceeded for nickel and cyanide, and the limitation for total toxic organics was exceeded.

The 1990 NPDES permit was approved July 10, 1991, and it added toxicity testing to the monitoring program. The first Aquatic Toxicity Monitoring Report (dated November 7, 1991) documented toxicity and analytical results which were within permitted limits.

2.3.2 Buildings B-10 and B-70

Greenish-blue groundwater was observed during construction activities at the cyanide destruction facility (B-70, mid-1980s) and the recuperator manufacturing building (B-10, late-1970s). A subsurface investigation was completed in 1986 to evaluate the soils in the area. East Coast Drilling, Inc. drilled ten test borings and collected soil samples for analysis by Environmental Monitoring Laboratory, Inc. Soil samples were collected above and below the water table, and were analyzed for the EP Toxicity metals. No metals were detected in five of the test borings. In the remaining borings, the following metals were detected in the indicated concentration ranges: total chromium (not detected (nd) to 0.64 ppm), hexavalent chromium (nd to 0.42 ppm), copper (nd to 0.34 ppm), and nickel (nd to 0.48 ppm). The maximum concentrations for total and hexavalent chromium were found at 18 to 20 feet below land surface. The highest concentrations of copper and nickel were found at a depth of 8 to 10 feet below land surface. All of the detectable metals occurred at or below the ground water table. Two of these borings were converted to monitoring wells. These wells were reportedly sampled, but results were not available as of the preparation of this report.

2.3.3 Discharge Toxicity Evaluation

IPC Corporation performed a discharge toxicity evaluation of Outfalls 007 and 008 in 1988. The complete evaluation involved acute toxicity tests towards freshwater and marine organisms, chemical analysis of the effluents, and a dye dispersion study. Effluent samples were collected on three dates.

IPC's report states that the following analytes were detected in effluent samples from Outfall 007: copper (nd to 0.09 ppm), zinc (0.18 to 0.27 ppm), oil and grease (2 to 5 ppm), phenols (nd to 0.08 ppm), ammonia (nd to 1.17 ppm), and 1,1,1-trichloroethane (0.058 to 2.4 ppm). Toxicity testing was conducted with 100% effluent, using Daphnia pulex and the fathead minnow as the test organisms (D. pulex is a type of crustacean commonly referred to as "water flea"). One of the three samples showed toxicity to D. pulex, and also contained the maximum observed concentration of 1,1,1-trichloroethane. No effects were observed in the test using the fathead minnow.

The following analytes were reported by IPC to be present in effluent samples from Outfall 008: ammonia (nd to 1.7 ppm), total chromium (nd to 0.40 ppm), hexavalent chromium (nd to 0.05 ppm), copper (0.12 to 2.14 ppm), nickel (nd to 0.13 ppm), zinc (nd to 0.01 ppm), chloroform (0.007 ppm) and 1,1,1-trichloroethane (0.019 ppm). Toxicity was evaluated using mysid shrimp and the sheepshead minnow. Some degree of toxicity was observed for both of the organisms. The IPC report suggested that the toxic effects may have been associated with copper concentrations in the effluent. Since the time of the IPC Corporation report, toxicity testing was added to Textron's NPDES permit monitoring requirements. The first Aquatic Toxicity Monitoring Report (dated November, 1991) documented toxicity and analytical results which were within permitted limits.

2.3.4 Tank Farm Near Building B-34

Soil and groundwater conditions in the area near the tank farm at B-34 (Figure 2-2) were evaluated in a subsurface investigation by Zecco, Inc. (1990). Seven test borings were drilled and soil samples were collected at 5-foot intervals. One soil sample from each boring was composited from all the depths sampled, and was analyzed for total petroleum hydrocarbons (TPH). Four of the borings were converted to monitoring wells, which were sampled and analyzed for volatile organic compounds and TPH.

Analytical results for the composite soil samples show that six of the seven borings contain measurable levels of TPH, ranging from 43 to 5500 ppm. The highest concentrations were in the borings adjacent to B-16 (MW-2 and MW-3 on Figure 2-2). Groundwater from MW-1 contained no detectable TPH or volatile organic compounds. The remaining three wells contained the indicated ranges of the following analytes: TPH (2.9 to 15.0 ppm), benzene (0.017 to 0.620 ppm), ethylbenzene (0.017 to 0.077 ppm), and xylenes (0.009 to 0.086 ppm). The overall highest concentrations of these analytes were in MW-2.

2.3.5 Groundwater Assessment Monitoring Program

Prior to 1989, four lagoons (one equalization lagoon and three sludge storage lagoons) existed on site and were regulated under the Resource Conservation and Recovery Act (RCRA). Spent plating baths were discharged to the equalization lagoon. Wastewater from this lagoon was pumped to a chemical waste treatment plant, converted to a metal hydroxide sludge, and finally pumped to the sludge storage lagoons. Groundwater monitoring wells were installed and sampled beginning in 1981, although changes in the requested analytical parameters resulted in the consideration of the 1983-1984 data as the "first year" of record. Metcalf and Eddy, Inc. (1987) reported the monitoring results. The lagoons were closed in 1989, but the monitoring program continued as required under RCRA closure. ESE completed the most recent monitoring report, the "seventh year" annual summary for 1990. This section summarizes the conclusions of the two groundwater assessment monitoring reports: Metcalf and Eddy, Inc, 1987, and ESE, Inc, 1991.

Metcalf and Eddy, Inc. (1987) reported that five monitoring wells were installed in 1981, two were installed in 1983, and six were installed in 1985, for a total of thirteen monitoring wells in the lagoon area. The Connecticut Department of Environmental Protection (CDEP) specified the following analytical parameters for the monitoring program: cadmium, hexavalent chromium, total chromium, copper, mercury, nickel, zinc, amenable cyanide, total cyanide, pH, halogenated volatile organics, aromatic volatile organics, specific conductivity, total organic carbon, and total organic halogens. The "first year" results (1983-1984) indicated that Connecticut Public Drinking Water Code (CPDWC) standards were exceeded in samples from MW-1 through MW-5 for total chromium, hexavalent chromium, total cyanide, trichloroethylene, and tetrachloroethylene. In "second year" samples (1984-1985), the CPDWC standards at these five wells were exceeded for total chromium and total cyanide. Metcalf and Eddy, Inc. installed six additional monitoring wells in 1985. The "third year" analytical results (1985-1986) showed that CPDWC standards were exceeded for total chromium, hexavalent chromium, total cyanide, trichloroethylene, and tetrachloroethylene at MW-1, MW-2, MW-3, and MW-5.

Lagoon closure was completed in 1989, and ESE (1991) presented results for the "seventh year" of monitoring (1989-1990). In 1990, an upgradient well (MW-10) contained cadmium in exceedance of CPDWC standards. The following analytes were above CPDWC standards in at least one of several wells (MW-1 through MW-5, MW-7, MW-9 through MW-10, and MW-12) in 1990, and have varied over the indicated concentrations over the entire period of record: cadmium (4-70 ppb), vinyl chloride, 1,1-dichloroethene, 1,2-trans-dichloroethene (2-6500 ppb), and trichloroethene (2-150 ppb). (Concentration ranges for vinyl chloride and 1,1-dichloroethene were not reported.) ESE's statistical analysis of the data indicated that the following analytes showed a statistically significant increase in the downgradient wells (MW-1 through MW-5, and MW-13) as compared to the upgradient well (MW-10): 1,2 trans-dichloroethene, tetrachloroethene, trichloroethene, total organic carbon (TOC), specific conductance, and pH. Note that these results assume that the source of contamination is the closed lagoons; and no further conclusions regarding alternative sources of contamination were made in either of the assessment monitoring reports.

3.0
FIELD SAMPLING PROGRAM

3.1 SAMPLING PROGRAM

The SAEP is a government-owned contractor-operated facility located in Stratford, Connecticut. The USDA owns the land, the buildings, and much of the production equipment at the SAEP. The U.S. Army Aviation Systems and Troup Command (ATCOM, formerly AVSCOM) has responsibility for the jurisdiction, control, and accountability of the SAEP. AlliedSignal Engines, a unit of AlliedSignal Aerospace, operates the SAEP under a facilities contract with ATCOM. AlliedSignal manufactures and tests turbine engines at the SAEP, primarily for the USDA. AlliedSignal also produces turbine engines for the U.S. Navy, for foreign military sale, and for commercial use.

The USDA is currently considering the lease or sale of government-owned property at the SAEP to AlliedSignal. USDA regulations require that an environmental investigation of the property be performed.

USACE has been tasked by ATCOM to prepare a Phase II Remedial Investigation Work Plan for the SAEP. The USACE has contracted the preparation of this Work Plan to W-C under Indefinite Delivery Contract No. DACW45-93-D-0005.

3.2 SAMPLING OBJECTIVES

The sampling described herein is designed to determine the extent of contamination identified in Phase I of this Remedial Investigation. In addition to investigating contamination, the investigation will include a study of the site hydrogeology.

3.3 SAMPLING AND ANALYSIS PROGRAM

A brief discussion of the planned sampling and analytical program is provided in this section. A more detailed discussion, with maps and tables, is given in the Field Sampling Plan. Sampling locations are shown in a set of figures described in more detail within the Field Sampling Plan. In addition, the Project Schedule for the Remedial Investigation at SAEP is contained in the Work Plan.

3.3.1 Introduction

The primary objective of Phase I of this RI was to evaluate the presence or absence of contamination at the site. The primary objectives of Phase II of this RI are to delineate contamination and obtain the additional information needed for developing a Risk Assessment for the site. The overall approach to Phase II field sampling will be to evaluate the extent and biological effects of contamination which was identified in Phase I. The data from Phase I and Phase II will form part of the data set for the Baseline Risk Assessment.

As with the Phase I investigation, sampling will focus on the two major exposure pathways identified in the PAS:

- releases to sediment potentially resulting from discharge from outfalls in Areas 1 and 8; and,
- releases to subsurface soils from disposal, spills, or leaks with potential for leaching to groundwater and subsequent migration of groundwater to sediment in the Housatonic River.

The environmental media of concern to be sampled are:

- sediment and biota in the intertidal flats and the Housatonic River and connected waterways adjacent to the site;
- groundwater beneath the site; and,

- subsurface soils in on-shore areas.

Environmental data from the Phase I and Phase II investigations will be used to develop a Baseline Risk Assessment (BRA). The Assessment will evaluate site-related risks to human health and biota.

The overall approaches to sampling each medium and to developing the Baseline Risk Assessment are summarized in the following sections. Specific details regarding sampling are contained in the Field Sampling Plan (FSP) and Chemical Data Acquisition Plan (CDAP).

3.3.1.1 Overall Approach to Sediment and Benthos Sampling

Sediment chemistry, toxicity testing, tissue analysis and benthic community analyses will be performed to evaluate sediment contamination in the vicinity of SAEP.

Sediment samples will be collected from four areas as follows: intertidal flats, drainage ditch, downstream and upstream of SAEP. The vertical extent of contamination will be determined by collecting samples at two depth intervals (0-6 inches and 2 to 4 feet) at each location. Sediment samples will be collected from the intertidal flats adjacent to the site along transects extending away from the potential sources of contamination (i.e. outfalls) to determine the lateral extent of contamination identified in Phase I investigations. Sediment samples will also be collected from drainageways in Area 8. Because of potential for sediment movement from tidal action, sediment samples will also be collected from one location downstream from SAEP, in the Housatonic River. Because of the potential for sediment contamination from upstream sources, sediment samples will be collected from two upstream locations which are presumed to be unaffected by SAEP activities.

Sediment samples will be analyzed for PAHs, PCBs, and Priority Pollutant Metals. These parameters were selected based on the results of Phase I sediment analyses.

In order to determine the effects of sediment contamination on organisms living on or in the sediment, sediment will be tested for toxicological effects. Biota tissue will be analyzed for contaminant content, and the distribution of the benthic macroinvertebrate community will be studied.

Sediment toxicity testing will be performed using the amphipod *Ampelisca abdita* following ASTM method E 1367-90. Using this protocol, the amphipods are directly exposed to the sediment, allowed to bury themselves and consume whatever foodstuffs are available. At the end of the testing period the organisms are assessed for any toxic response.

To determine whether organisms living adjacent to the site are accumulating site related contaminants in their tissues, biological tissues (if available) will be sampled and analyzed for mercury, cadmium, chromium, nickel, lead, PCBs, percent moisture and percent lipids. These parameters were selected based on their bioaccumulation potential, apparent relation to previous site activities, and detection in sediment samples during the Phase I investigation. Should they occur in sufficient numbers in the intertidal flats, sedentary species such as blue mussel (*Mytilus edulis*), hard clam (*Mercenaria*), or Eastern oyster (*Crassostrea virginica*) will be collected for tissue analysis. Because these organisms are consumed by other aquatic organisms as well as humans, these data can be used in both the Human Health and Environmental Evaluation portions of the BRA.

To determine whether the sediments adjacent to SAEP are negatively affecting the resident benthic macroinvertebrate community, benthic sampling will be conducted at the same locations where samples for solid phase toxicity testing are collected, including the three background locations. The samples will be taken to the laboratory and sorted. The data will provide an estimation of density (number of individuals per unit area) and species richness (number of different types of organisms) at each location, which will be compared to the reference locations and any other available benthic invertebrate data for nearby areas (if any).

3.3.1.2 Overall Approach to Groundwater Sampling

Chemicals that have entered groundwater tend to travel horizontally away from the source in a downgradient direction. In the Phase I site investigations, groundwater monitoring wells were positioned downgradient of a number of potential sources to evaluate the effect of these individual sources on groundwater quality, and upgradient to monitor the quality of groundwater entering the area (background conditions). The results of the Phase I investigations indicated that shallow and deep groundwater at one of the presumed upgradient locations was contaminated. Phase II groundwater investigations will focus on delineating the contamination by installing and sampling additional wells in that area. In addition, The Phase II investigations will include a complete round of samples from all of the wells on site to confirm previous results and supply additional data for the BRA.

Samples from all monitoring wells will be analyzed for TCL VOs plus a 10 compound library search, and total metals. The library search is used to tentatively identify the 10 highest chromatogram peaks, other than those peaks for TCL compounds. The computer library used for the search contains approximately 50,000 compounds.

Shallow (water table) overburden, intermediate overburden, and deep overburden ground water monitoring wells will be installed. Shallow overburden wells will be installed so that their screened portions intersect the water table. Intermediate overburden wells will be screened at depths of approximately 40 to 50 feet. This depth corresponds to approximately the middle of the overburden materials. Deep overburden well will be screened in the 10-foot interval above the top of bedrock. The top of bedrock is expected to be encountered between 100 and 150 feet below ground surface.

All new monitoring wells will be surveyed for location and elevation. Slug testing and/or single-well pumping tests will be completed on all newly installed monitoring wells to estimate aquifer characteristics.

3.3.1.3 Overall Approach to Soil Sampling

Soil samples will be collected from pilot boreholes for the installation of monitoring wells for the purposes of chemical analysis, geotechnical analysis, and/or visual classification. Soil samples for chemical analysis will be obtained from a depth of 2 to 4 ft from one borehole at each new well cluster location. Soil samples for geotechnical analysis will be collected from screened intervals and as appropriate to characterize subsurface stratigraphic units. Soil samples for visual classification will be collected every 2.5 ft for the first 10 ft and every 5 ft for the remaining depth of each boring.

Soil samples will be obtained from split spoon samplers in borings advanced by a truck mounted drilling rig. Split spoon samplers to be used to collect samples for chemical analysis will be stainless steel. Other samples will be collected with non-stainless steel split spoon samplers or thin-wall sampler (Shelby tube) as appropriate.

Soil samples for chemical analysis will be analyzed for TCL VOs +10 and Priority Pollutant Metals. These parameters were selected based on the types of contaminants detected in groundwater on site. Soil samples for geotechnical analysis will be analyzed for grain size distribution, Atterberg Limits, and moisture content.

This SSHP does not cover any site activities other than those listed above. Other possible work activities not described in this section may only be conducted after approval of an appropriate addendum to this SSHP by the Project Manager, Corporate Health and Safety Administrator/Eastern Operating Group Health and Safety Officer, and the New York Metro Business Unit Health and Safety Officer.

This SSHP must be reviewed and reauthorized by January 3, 1995. Use of this SSHP after this date to perform the work activities described herein, or other activities in addition to those described herein, is not permitted and constitutes a violation of W-C's health and safety protocols. If work is to be performed after this date, the SSHP must be reviewed and modified, if necessary, by the New York Metro Business Unit Health and Safety Officer.

4.0
ON-SITE HAZARDS

4.1 HAZARD ASSESSMENT

An assessment of the hazards has been made for the sampling activities to be conducted under the SSHP by reviewing the SAEP's historical and current operations and data compiled in the Environmental Baseline Study. The hazards which were assessed include:

- Biological hazards: poison ivy, mosquitoes, ticks, mice/rats, and snakes
- Chemical hazards: inhalation, ingestion and contact with the contaminants of concern
- Physical hazards: use of excavating, drilling, sampling and support equipment
- Radiological hazards

4.1.1 Biological Hazards

The surface debris, particularly the standing water and general industrial waste, and the presence of natural marshes, provides a breeding ground for numerous types of pest organisms, including mosquitoes. The use of insect repellents before donning personal protective equipment (PPE) will be encouraged. To avoid bites from rodents and snakes, personnel will check carefully for these animals before walking through grassy or debris strewn areas. A first aid kit, snake bite kit and insect repellent will be available for use in the field. In many parts of the northeast United States, tick-borne diseases pose a significant health risk during warm months. Attachment 1 presents a discussion of Ticks and Tick-Borne Diseases. Lyme disease, a bacterial (Borrelia Burgdorferi) infection carried by ticks and some species of mosquitoes, is of particular concern. Tick repellant will be available at the field office.

Poison ivy may be present at site. Appropriate clothing should be worn to prevent exposure to poison ivy and a protective barrier lotion should be worn on exposed skin. Tubes of the barrier lotion will be available at the field office.

4.1.2 Chemical Hazards

Some of the areas in which drilling and well installation will be performed are suspected of containing petroleum based materials; halogenated solvents, organic solvents, aromatic compounds, fuels, lubricating oils, cutting oils and greases. The majority of these contaminants may be released either by volatilization from their liquid form or by volatilization from contaminated soil, cement and asphalt. The majority of these organic compounds and mixtures have generally low boiling points and high vapor pressures, thus evaporation/volatilization of these compounds and mixtures may occur readily. Other nonvolatile compounds that have been positively identified in the sediments are PCB (polychlorinated byphenyls). These compounds are considered immediate dermal hazards with the potential of long-term chronic effects. The air concentration of the volatile compounds may increase during hot and dry days. In addition, the sampling activities described in Section 3.0 may increase the exposure of workers to these chemicals since ground disrupting activities may facilitate the volatilization of the volatile compounds and the risk of coming in contact with the nonvolatile compounds such as PCBs is greatly increased.

Other chemicals of concern are inorganic compounds and metals that could be found in the pavement, asphalt, soil, sediment in tidal marshes and flats, and water. These compounds include cyanides, nickel, chromium, bromine, and lead.

A summary of personal exposure information for the chemicals of concern is contained in Table 4-1. Table 4-2 presents a summary of chemical and physical properties of the chemicals of concern.

The primary exposure pathways of concern for these contaminants are inhalation and skin absorption (particularly for some of the chromium and bromine compounds).

In addition to the chemicals that may be potentially found mixed in with the soil and water, the field personnel should be cognizant of the chemicals that are handled during the day to day operations in the plant. A full inventory of these chemicals may be found within the Hazard Communication Plan, as per 29 CFR 1910.1200 for SAEP. The Material Safety Data Sheets (MSDS) may be found in the SAEP's security office and medical station.

4.1.2.1 Inhalation

Volatile organic compounds (VOs) and other organic compounds that have high vapor pressures and low boiling points may vaporize readily upon exposure to air during excavation and drilling through asphalt pavement and concrete slabs, floors and sub-floors since these structures may have acted as shields or caps, preventing volatilization. The extent and rate of volatilization will increase with increasing temperature and decreasing soil moisture levels. As a result, on-site workers will be exposed to the highest levels of organic vapors during dry, hot periods and when the air exchange or wind speed is low.

Particulate solids containing inorganic crystals, arsenic-based compounds, asbestos, cyanides and metallic compounds such as nickel, chromium and thorium may be generated during intrusive operations. The majority of the sampling activities have the potential for generating dust since they will involve breaking through concrete, asphalt and compact soil and rock (as found at the dike).

Most of the VOs can cause irritation of the mucous membrane at the nasal cavities, trachea and lungs. Dust-containing inorganic compounds may cause inflammation and irritation of the mucous membrane at the nasal cavities, trachea and lungs and may become permanently deposited in the lung cavities (especially asbestos and silica-based compounds).

4.1.2.2 Ingestion

Since exposure may occur at any time when the field personnel are near or within the SAEP, a constant response to risk must be enforced. Ingestion of the contaminants of concern will be controlled by prohibiting eating and smoking during any field activity within the SAEP property and by requiring all field personnel to decontaminate themselves upon leaving the sampling areas.

4.1.2.3 Dermal Contact

Skin and eye contact with most of the volatile and nonvolatile contaminants can cause skin or mucous membrane irritation and inflammation. Many of these contaminants can be absorbed into the bloodstream through the skin or eyes.

Many of the inorganic contaminants and metals can cause allergic reactions to the skin and eye, thus causing irritation, inflammation, and ulcers. They may also permeate through the skin and eyes and be absorbed into the bloodstream affecting the liver, kidneys, digestive system, as well as the nervous system.

4.1.3 Physical Hazards

Possible physical hazards during sampling activities include flying debris during concrete and asphalt breaking operations. Physical hazards associated with drilling are identified and safety procedures presented in Attachment 2, Safety Guidelines for Drilling. Also, there is a risk of scalding during decon procedures where steam cleaners/power washers are used, thus the workers should avoid contact with the steam by power washing away from the user and by standing upwind of the spray. Hearing protection will be required whenever sound-pressure levels exceed 85 dB steady-state or 140 dB impulse.

In addition, high noise levels are expected during the ground breaking operations. Field workers should be aware of the slippery conditions existing at the tidal flats and tidal conditions since they can hinder sampling activities and create loose footing conditions, thus increasing the risk of falling.

A summary of the physical hazards which may be encountered while working at the SAEP is provided in Table 4-3.

TABLE 4-1
PERSONAL EXPOSURE INFORMATION
CHEMICALS OF CONCERN
STRATFORD ARMY ENGINE PLANT

Chemical	OSHA			ACGIH		Acute Symptoms	Target Organs	Carcinogen
	TWA (ppm)	STEL (ppm)	Ceiling (ppm)	TLV-TWA (ppm)	TLV-STEL (ppm)			
VOLATILE ORGANIC COMPOUNDS								
Vinyl chloride	1	5	5	5	--	Weakness, abdominal pain	Liver, blood, CNS[7]	Confirmed
Methylene chloride	500	2000[6]	1000	50	--	Nausea, eye & skin irritation, fatigue, weakness, sleeplessness, limbs numb	Skin, eyes, CNS, cardiovascular system	Suspected
Trans-1,2-Dichloroethene	200	--	--	200	--	Skin irritation, CNS depressant, eye irritation	Liver, kidneys, heart, eyes	Suspected
Chloroform	2	--	--	10	--	Dizziness, skin & eye irritation, nausea, disorientation, heat fatigue	Liver, kidneys, heart, eyes, skin	Suspected
1,1,1-Trichloroethane	350	--	1000[8]	350	450	Irritation, CNS depressant	CNS, eyes, nose, kidneys	
Trichloroethene	50	200[6]	200	50	200	Irritation, CNS depressant	CNS, eyes, nose, kidneys	Suspected
Benzene	1	5	25	10	--	Eye & nose Irritation, nausea	Blood, CNS, respiratory system	Suspected

TABLE 4-1, Continued
PERSONAL EXPOSURE INFORMATION
CHEMICALS OF CONCERN
STRATFORD ARMY ENGINE PLANT

Chemical	OSHA			ACGIH		Acute Symptoms	Target Organs	Carcinogen
	TWA (ppm)	STEL (ppm)	Ceiling (ppm)	TLV-TWA (ppm)	TLV-STEL (ppm)			
VOLATILE ORGANIC COMPOUNDS, continued								
4-methyl 2-Pentanone	50	75	3000^{8}	50	75	Eye irritation, dermatitis,drowsiness	Skin, eyes, CNS, respiratory system	
2-Butanone	200	300	3000^{8}	200	300	Eye & nose irritation, dizziness, vomiting	CNS, lungs	
Tetrachloroethene	25	300^{9}	--	50	200	Eye, nose, & throat irritation	Liver, kidneys, CNS, respiratory system	Suspected
Ethyl benzene	100	125	2000^{8}	100	125	Eye and mucous membrane irritation, dermatitis	Eyes, skin, CNS, respiratory system	
Phenol	5	15.6	15.6	5	--	Eye, nose, & throat irritation, dermatitis	Liver, kidneys, skin	
1,2-Dichlorobenzene	50	--	50	50	--	Eye & nose irritation, skin blisters	Liver, kidneys, skin, eyes	
1,2,4-Trichlorobenzene	5	--	5	5	--	Eye & skin irritation	Liver, kidneys, skin, eyes	
1,1-dichloroethane	100	--	4000^{8}	200	250	CNS depressant, skin irritation	Kidneys, liver, skin	

TABLE 4-1, Continued
PERSONAL EXPOSURE INFORMATION
CHEMICALS OF CONCERN
STRATFORD ARMY ENGINE PLANT

Chemical	OSHA			ACGIH		Acute Symptoms	Target Organs	Carcinogen
	TWA (ppm)	STEL (ppm)	Ceiling (ppm)	TLV-TWA (ppm)	TLV-STEL (ppm)			
VOLATILE ORGANIC COMPOUNDS, Continued 1,2 Dichloroethane	1	2	4000[8]	10	--	CNS depressant, skin & eye irritation, nausea, vomiting, irritation	Kidneys, liver, skin, eyes, CNS	Suspected
2-Methylphenol	5	--	250[8]	5	--	Confusion, rapid respiration, eye and skin burns	CNS, respiratory system, kidneys, liver, skin, eyes	
4-Methylphenol	5	--	250[8]	5	--	Confusion, rapid respiration, eye and skin burns	CNS, respiratory system, liver, skin, eyes	
Naphthalene	10	15	500[8]	10	15	Eye irritant, excitement, vomiting, nausea	Eyes, blood, liver, kidneys, skin, RBC(10), CNS	

TABLE 4-1, Continued
PERSONAL EXPOSURE INFORMATION
CHEMICALS OF CONCERN
STRATFORD ARMY ENGINE PLANT

Chemical	OSHA			ACGIH		Acute Symptoms	Target Organs	Carcinogen
	TWA	STEL	Ceiling	TLV-TWA	TLV-STEL			
SEMI-VOLATILE COMPOUNDS Bis (2-Ethylhexyl) phthalate	5	--	--	--	10 ppm	Eye irritation	Eyes, upper respiratory system, GI(11)	
Di-n-Butyl phthalate	5	--	9300[2] ppm	--		Upper respiratory irritation, stomach irritation/discomfort	Respiratory system, GI	
Coal Tar Pitch Volatiles	0.2 mg/m^3 0.1 mg/m^3 (cyclohexane extractibles)	--	700[2] mg/m^3	0.2 ppm (as Benzene Solubles)	--	Dermatitis,bronchitis	Respiratory system, bladder, kidneys, skin	Confirmed
Bromoform	0.5 ppm	--	Unknown[8]	.5 ppm	--	Eye and respiratory system irritation, CNS depressant	Liver, CNS,kidneys, skin, respiratory system	Suspected
Chlorodiphenyl (PCB) 48% Chlorine	1 mg/m^3 skin	--	10[8]mg/m^3	1 mg/m^3 skin	--	Eye irritation Chloracne Derm.	Liver, skin, eyes	Confirmed
Chlorodiphenyl (PCB) 54% Chlorine	0.5 mg/m^3 skin	--	5[8]mg/m^3	0.5 mg/m^3 skin		Eye irritation Chloracne	Liver, skin, eyes	Confirmed
METALS Lead	0.03 mg/m^3	--	700[2] mg/m^3	0.15 mg/m^3	--	Weakness, eye irritation, trembling	GI, CNS, kidneys, blood, gingival tissue	Suspected

TABLE 4-1, Continued
PERSONAL EXPOSURE INFORMATION
CHEMICALS OF CONCERN
STRATFORD ARMY ENGINE PLANT

Chemical	OSHA			ACGIH		Acute Symptoms	Target Organs	Carcinogen
	TWA	STEL	Ceiling	TLV-TWA	TLV-STEL			
Mercury	0.01 mg/m^3 Alkyl Compounds (organic mercury) 0.05 mg/m^3 vapor/skin (inorganic compounds)	.03 mg/m^3	10 $mgm^{3(8)}$ 28 $mg/m^{3(8)}$	0.01 mg/m^3 Alkyl Compounds (organic mercury) 0.05 mg/m^3 vapors (inorganic compounds) 0.1 mg/m^3 skin Alkyl and inorganic compounds	0.03 ppm -- --	Irritation, cough, chest pain, weakness, dizziness, vomit, skin burns, bronchial pneumonia, impaired vision, diarrhea, insomnia, emotional disturbance	CNS, respiratory system, eyes, kidneys, skin	
Nickel	1 mg/m^3 (metal dust) 0.1 mg/m^3 (soluble compounds)	--	N/A	--	--	Allergic asthma, eye and respiratory system irritation, vertigo, nausea, vomiting	Lungs, skin, nasal cavities, CNS	Suspected

TABLE 4-1, Continued
PERSONAL EXPOSURE INFORMATION
CHEMICALS OF CONCERN
STRATFORD ARMY ENGINE PLANT

Chemical	OSHA			ACGIH		Acute Symptoms	Target Organs	Carcinogen
	TWA	STEL	Ceiling	TLV-TWA	TLV-STEL			
METALS, Continued								
Chromium	1 mg/m^3 (metal dust)	--	N/A	0.5 mg/m^3 (metal dust)	--	Irritation, dermatitis	Lungs, skin	Suspected
	0.05 mg/m^3 Hexavalent Cr(VI)	--	--	0.05 mg/m^3 Hexavalent Cr(VI)	--	Irritation, dermatitis	Lungs, skin	Suspected
Bromine	0.1 ppm (metallic dust)	0.3 ppm	10 ppm	0.1 ppm	0.3 ppm	Irritation, headaches, dizziness, pneumonia, diarrhea, eye burns, skin burns	Lungs, CNS, eyes	
Thorium	N/A (metallic dust)		N/A		N/A		Liver, kidneys, blood, bone marrow, respiratory system	Suspected
INORGANIC COMPOUNDS								
Cyanides	5 mg/m^3		50 mg/m^3		5 mg/m^3	Asphyxia, weakness, headache, confusion, nausea, incoherence, eye & skin irritation	Liver, kidneys, skin, lungs, cardiovascular system, CNS	
Arsenic trioxide	0.010 mg/m^3	0.002[4] mg/m^3	0.002[4] mg/m^3	--	--	Ulceration of nasal septum, dermatitis, GI(11) disturbances, respiratory irritation, peripheral neuropathy, hyperpigmentation of skin	Liver, kidneys, skin, lungs, lymphatic system	Confirmed

TABLE 4-1, Continued
PERSONAL EXPOSURE INFORMATION
CHEMICALS OF CONCERN
STRATFORD ARMY ENGINE PLANT

ACTION LEVELS WILL BE A MAXIMUM OF ONE-HALF OF THE OSHA AND/OR ACGIH. IN THE EVENT THAT THE OSHA PELs DIFFER FROM ACGIH TLVs, THE MORE RESTRICTIVE SHALL PREVAIL.

REFERENCES:

Threshold Limit Values and Biological Exposure Indices for 1991-1992 American Conference of Governmental Industrial Hygienists (ACGIH).
Air Contaminants - Permissible Exposure Limits (Title 29 CFR Part 1910.1000) Occupational Safety and Health Administration (OSHA), 1989.

NOTES:

(1)OSHA TWA - Occupational Safety and Health Administration Time-Weighted Average: the employee's average airborne exposure in any 8-hour work shift of a 40-hour work week which shall not be exceeded, as established by OSHA.

(2)OSHA STEL - Occupational Safety and Health Administration Short-Term Exposure Limit: the employee's 15-minute time-weighted average exposure which shall not be exceeded at any time during a work day unless another time limit is specified in a parenthetical notation below the limit. If another time period is specified, the time-weighted average exposure over that time limit shall not be exceeded at any time during the working day. These limits are established by OSHA.

(3)OSHA Ceiling - Occupational Safety and Health Administration Ceiling: the employee's exposure which shall not be exceeded during any part of the work day. If instantaneous monitoring is not feasible, then the ceiling shall be assessed as a 15-minute time weighted average exposure which shall not be exceeded at any time over a working day.

(4)TLV-TWA - Threshold Limit Value - Time-Weighted Average: the time-weighted average concentration for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect (ACGIH). These values are updated annually by the ACGIH and represent guidelines based on the latest toxicological data.

(5)TLV-STEL - Threshold Limit Value - Short Term Exposure Limit: the concentration to which workers can be exposed continuously for a short period of time without suffering from 1) irritation, 2) chronic or irreversible tissue damage, or 3) narcosis of sufficient degree to increase the likelihood of accidental injury, impair self-rescue or materially reduce work efficiency, and provided that the daily TLV-TWA is not exceeded. It is not a separate independent exposure limit; rather, it supplements the time-weighted average (TWA) limit where there are recognized acute effects from a substance whose toxic effects are primarily of a chronic nature. STELs are recommended only where toxic effects have been reported from high short-term exposures in either humans or animals. A STEL is defined as a 15-minute TWA exposure which should not be exceeded at any time during a workday even if the 8-hour TWA is within the TLV-TWA. Exposures above the TLV-TWA up to the STEL should not be longer than 15 minutes and should not occur more than four times per day. There should be at least 60 minutes between successive exposures in this range. An averaging period other than 15 minutes may be recommended when this is warranted by observed biological effects (ACGIH). These values are updated annually by the ACGIH and represent guidelines based on the latest toxicological data.

TABLE 4-1, Continued
PERSONAL EXPOSURE INFORMATION
CHEMICALS OF CONCERN
STRATFORD ARMY ENGINE PLANT

(6)	- Maximum peak duration of 5 minutes in any 2 hours
(7)CNS	- Central Nervous System
(8)	- IDLH - Immediately Dangerous to Life or Health
(9)	- Maximum peak duration of 5 minutes in any 3 hours
(10)RBC	- Red Blood Cell Count
(11)GI	- Gastrointestinal

TA[illegible] 4-2
CHEMICAL AND PHYSICAL PROPERTIES
CHEMICALS OF CONCERN
STRATFORD ARMY ENGINE PLANT

Chemical	CAS #	Boiling Pt. (°C) (760 mm Hg)	Vapor Pressure (mm Hg)	Flash Pt. (°C)	Vapor Density (air=1.0)	Solubility	Spec Gravity d^{20}_{4}	Reactivity
Volatile Organic Compounds								
Vinyl Chloride	75-01-4	-13.37	2530 (20°C)	-78°		Slight	0.9106	
Methylene Chloride	75-09-2	39.75				2%	1.3255	
Trans-1, 2- Dichloroethene		47.2	180-264^{N}			Insoluble	~1.28	Oxidizes in air
Chloroform	67-66-3	61-62				1 ml/250 ml H_20	1.484	Light sensitive
1,1,1-Trichloroethane		74.1		Non-Flammable		Insoluble	1.3376	
Trichloroethene	79-01-6	86.7		Non-Flammable	4.53	Very Low	1.4649	
Benzene	71-43-2	80.1		-11 (12°F)		0.188%	0.8787	
4-methyl 2-Pentanone		117		73°F		1.91%	0.801	
2-Butanone	78-93-3	79.6		21°F		27.5%	.805	
Tetrachloroethene	127-18-4	121		Non-Flammable			1.623	
Ethyl benzene	100-41-4	136.25		64°F		Insoluble	0.866	
Phenol	108-95-2	182		175°F		1 g/15 ml H_20	1.071	
1,2 Dichlorobenzene	95-50-1	180.5		151°F		Insoluble	1.3059	
1,2,4-Trichlorobenzene		213		230°F		Insoluble	1.4634	
1,1-Dichloroethane	75-34-3	57.3				.5%	1.1757	

TABLE 4-2, Continued
CHEMICAL AND PHYSICAL PROPERTIES
CHEMICALS OF CONCERN
STRATFORD ARMY ENGINE PLANT

Chemical	CAS #	Boiling Pt. (°C) (760 mm Hg)	Vapor Pressure (mm Hg)	Flash Pt. (°C)	Vapor Density (air=1.0)	Solubility	Spec Gravity d^{20}_4	Reactivity
1,2-Dichloroethane		83		56°F		1 part/120 parts	1.2569	
2-Methyl-phenol		191		81-83°		1 part/40 parts	1.047	
4-Methyl-phenol		201.8				2.5 g/100 cc @ 50°	1.0341	
Napthalene	91-20-3	217.9		174°F		Insoluble	1.162	
Bis (2-ethylhexyl) phthalate								
Di-n-Butylpthalate (dibutylphthalate)		340°		170°C		1:2500	1.0459	Incompatible with Nitrates, Strong Oxidizers and Acids
Bromoform	75-25-2	149-150°				1:800	d^{15}_4 2.9035	Chemically Active Metals Sodium Potassium, Calcium Powdered Aluminum Zinc, Magnesium, Strong Caustics
Metals Lead	7439-92-1	1740°					11.34	Strong Oxidizers Hydrogen Peroxide Active Metals, Sodium, Potassium
Mercury			at 25° $2x10^{-3}$mm				d^{25} 13.534	Strong Oxidizers such as Chlorine
Nickel	7440-02-0	2837°						Strong Acids, Sulfur
Chromium	7440-47-3	2642°					7.14	Strong Oxidizers

TABLE 4[illegible], Continued
CHEMICAL AND PHYSICAL PROPERTIES
CHEMICALS OF CONCERN
STRATFORD ARMY ENGINE PLANT

Chemical	CAS #	Boiling Pt. (°C) (760 mm Hg)	Vapor Pressure (mm Hg)	Flash Pt. (°C)	Vapor Density (air=1.0)	Solubility	Spec Gravity d^{20}_{4}	Reactivity
Bromine	7726-95-6	59.47°						Compostible Organics, Oxidizable Material Aqueous Ammonia. Anhydrous Br_2 reacts with Aluminum Titanium Mercury Potassium, Wet Br_2 reacts with other metals
Inorganics Cyanide								Strong Oxidizers such as Nitrates, Chlorates, Acids, Acid Salts
Arsenic Trioxide	7740-38-2	465°				1:15 Hot H_20		

4.1.4 Heat Stress and Cold Exposure

The PPE required for some activities (coveralls and respirators) places a physical strain on the wearer. The Heat Stress Casualty Prevention Plan as specified in Attachment 3 will be implemented to deal with this health hazard during warm weather. The Plan outlines heat stress identification, treatment, prevention intervals during the work periods in order to maintain adequate body fluid levels for the field personnel. Attachment 4 presents the Cold Exposure Casualty Prevention Plan for this project.

TABLE 4-3

PHYSICAL HAZARDS
STRATFORD ARMY ENGINE PLANT

Hazard	Description	Location	Procedure Used to Monitor/Reduce Hazard
Heavy Equipment	Construction Machinery	Throughout Site	Personnel maintain eye contact with operators; hard hats, safety shoes, and eye protection worn (as appropriate) during equipment operation. Avoid interfering with SAEP operations.
Refuse and Materials	Construction refuse and construction materials	Throughout Site	Maintain clean work areas; dispose of refuse immediately; do not block access routes with materials.
Heat Producing/Electrical Equipment	Generators, Construction Equipment and Steam Cleaners Power Washing Equipment	Throughout Site	Operate equipment away from vegetation and other materials that may ignite. Maintain fire-fighting equipment in the vicinity of operating equipment. Personnel should position themselves upwind of steam cleaning activities.
Heat Stress(1)/Cold Exposure(2)	Personnel working under extreme temperature are subject to adverse temperature-related effects.	Throughout Site	Employ buddy system. Each worker is responsible for visually monitoring his/her partner for signs of heat stress/cold exposure. Site safety personnel will also monitor worker's conditions and establish work/rest regimens.

NOTES:

(1) Heat stress monitoring protocols shall be implemented, as appropriate. Work/rest schedules shall be determined based upon ambient temperature, humidity, wind speed, solar radiation intensity, duration and intensity of work, and protective equipment ensembles. In cases where impervious clothing is worn (full-body), the NIOSH/OSHA/USCG/EPA "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities" protocol for prevention of heat stress shall be followed, and heat stress monitoring shall commence at temperatures of 70 degrees Fahrenheit and above. Where impervious clothing is not worn, the most current published ACGIH heat stress standard shall be used. Both of these guidance documents are contained in Attachment 3.

(2) Cold stress monitoring protocols shall be implemented, as appropriate. Work/rest schedules shall be determined based upon ambient temperature, humidity, wind speed (wind chill), solar radiation intensity, duration and intensity of work, and protective equipment ensembles. For cold stress monitoring to help prevent frostbite and hypothermia, the ACGIH cold stress standard contained in Attachment 4 must be followed.

5.0
ENVIRONMENTAL MONITORING, PERSONAL MONITORING, PERIMETER MONITORING, AND HAZARD MITIGATION

5.1 ENVIRONMENTAL MONITORING

During field activities at the SAEP, environmental monitoring will be performed by the SSHO and other appropriately trained W-C personnel and recorded on forms provided in Attachment 6 and summarized in the Daily Health and Safety Reports. Several instruments, as discussed below, will be utilized to monitor the environment in the work zones.

5.1.1 Organic Vapor Monitoring

An organic vapor monitor will be used to detect concentrations of certain vapors in the air. Specifically, an HNu Model PI 101 photoionization detector (HNu PID) with an 11.7 eV probe or OVA flame ionization detector (OVA FID) will be used to monitor organic vapors. Readings will be taken in the employee breathing zone during all work activities. It should be kept in mind that the organic vapor monitor detects mixtures of compounds simultaneously and readings do not indicate concentrations of any individual compound when a mixture of compounds are present.

Organic vapors will be monitored a minimum of every 15 minutes in the breathing zone of workers deemed to be subjected to the greatest exposure.

If more than one work zone is active at the same time, additional air quality monitoring will be performed by qualified personnel assigned to each operation.

Air purifying respirators are not effective in environments containing vinyl chloride, methylene chloride, and chloroform. These compounds exhibit poor absorption qualities or poor warning properties. It will be necessary to monitor the concentrations of these chemicals individually. Draeger colorimetric tubes will be used to analyze the presence of these chemicals as well as for benzene, during periods of HNu PID or OVA FID readings above 1 ppm.

5.1.2 Combustible Gas Monitoring

A Combustible Gas Indicator (CGI) will be used to monitor the release of explosive gases and vapors. A Gas Tech Triple Range Monitor, or similar instrument, will be used.

5.1.3 Airborne Dust Monitoring

Because there is concern for contaminated dusts being generated by vehicular travel on the access roads and other areas within the SAEP, work areas will be initially monitored for total airborne dusts with a MIE, Inc. MINIRAM PDM-3.

5.1.4 Noise Level Monitoring

Noise levels around drilling operations will be monitored and logged. A sound level meter will be used to determine levels of noise to which personnel are exposed.

5.1.5 Instrument Calibration

The OVA FID, HNu PID and CGI monitors will be calibrated twice daily (before the start of any activities and at the end of the work day) in accordance with the manufacturers' specifications for calibration. Calibration procedures are described in Attachment 6. Daily instrument calibrations will be documented in an instrument calibration log book which will be kept at the SAEP. The MINIRAM will be calibrated in accordance with manufacturer's instructions. All equipment calibrations will be performed by the SSHO and other appropriately trained W-C personnel.

5.2 PERSONAL EXPOSURE MONITORING

Personal exposure monitoring for selected chemicals of concern will be performed to confirm actual employee exposures. Chemicals of concern previously found in high concentrations will be targeted (eg. tetrachloroethene, 1,1 dichloroethane, trichloroethene, 1,1,1-trichloroethane, asbestos and lead) as well as contaminants with low PELs (benzene, chloroform, carbon tetrachloride, and vinyl chloride).

Attachment 5 presents a summary of Personal Exposure Sampling Methods and applicable National Institute for Occupational Safety and Health (NIOSH) analytical methods. Personal exposure monitoring samples will be analyzed only by laboratories successfully participating in and meeting the requirements of the American Industrial Hygiene Association's (AIHA) Proficiency Analytical Testing (PAT) or Laboratory Accreditation programs. Galson Laboratories of East Syracuse, New York will be performing analytical testing for the personal exposure monitoring program. The results of these analyses will be used to indicate the relative response of the HNu PID and/or OVA FID and evaluate the efficacy of the environmental monitoring program.

Copies of all sample test results will be submitted to the SAEP Safety Office.

Personal exposure monitoring will be performed during the first two weeks of field work for employees of highest expected exposure. Sampling will be performed by the Site Safety and Health Officer (SSHO) under the direction of a Certified Industrial Hygienist. (CIH) The need for additional personal exposure monitoring will be evaluated by the SSHO and a CIH.

5.3 PERIMETER MONITORING

The SSHO and other appropriately trained W-C personnel will conduct periodic perimeter air monitoring at frequencies no longer than 1 hour if air quality measurements 20 ft downwind of any work area or in any work area accessible to non-project personnel (whichever is closer) exceed 50% of the maximum levels permissible under Level D PPE to document that personnel in the Support Zone, off-site populations, and the environment are not adversely exposed as a result of field activities. If the perimeter monitoring reveals sustained levels greater than 25% of these action levels, work will be stopped in the work area causing these elevated readings and corrective measures will be implemented on-site. The location and type of monitoring will be determined in the field by the SSHO based on the nature of the work being performed on-site, the results of the air quality monitoring program, and the type of exposure being experienced at the perimeter of the work area. Meteorological monitoring shall be performed on-site as needed and used as an adjunct in determining perimeter and any off-site monitoring or air sampling locations.

5.4 HAZARD MITIGATION

5.4.1 Mitigation of Organic Vapors

Any wash water used in drilling and purge water will be collected into chemical resistant containers that can be readily sealed for future disposal and/or treatment upon proper chemical and physical classification.

An explosion-proof fan or blower may be used to dissipate fumes emanating from the soil and/or water surface in areas where the air exchange is inadequate, where the sampling area falls below the surface grade, or if the area is surrounded by buildings or structures high enough to prevent any air circulation.

Engineering controls, such as the use of vapor suppressant foams, wetting of the ground surface and plastic sheeting, will be used to reduce the volatilization of organic vapors.

5.4.2 Mitigation of Airborne Dust

Water mists and sprays may be used during ground disrupting activities to reduce the emission of any contaminated fugitive dust. They may be applied by using portable pump sprayers as the ones used for the application of herbicides and pesticides with a liquid capacity of 3 gallons.

5.4.3 Mitigation of Noise

Hearing protection, such as foam earplugs or earmuffs, will be worn when noise levels maintain an intensity of over 85 dBA.

6.0
ACTION LEVELS BY TASK

The action levels presented herein are based on the chemicals of concern (Table 4-1), their respective exposure limits (OSHA PELs and ACGIH TLVs), and the relative response of the instruments to the contaminants. The PELs for the compounds with the highest concentrations (chlorinated solvents and aromatics) are in the range of 50 to 350 ppm. However, some contaminants found at the SAEP at lower concentrations have PELs of 1 ppm.

The selected action level of 5 ppm for a 1 minute average sustained reading is chosen because the estimate of the 5 ppm is from any constituent with published exposure levels of 1 ppm. It is expected that the highest airborne concentrations will be tetrachloroethene and 1,1,1-trichloroethane, which have PELs of 25 ppm and 350 ppm, respectively, with 1,1,1-trichloroethane expected in higher concentrations than tetrachloroethene.

ACTION LEVELS WILL BE A MAXIMUM OF ONE-HALF OF THE OSHA PELS AND/OR ACGIH TLVS. IN THE EVENT THAT OSHA PELs DIFFER FROM ACGIH TLVS, THE MORE RESTRICTIVE SHALL PREVAIL.

In the event that work must be stopped, personnel will vacate the work area and proceed to a predetermined location, as selected by the SAEP's Manager of Health, Safety and Loss Control and the SSHO. This location will be chosen and discussed each morning, and will not have concentrations of airborne contaminants above the SAEP background levels. The maximum working levels (with appropriate PPE) are 50 ppm for total volatile organic compounds and 20 percent LEL for combustible gases and 10 percent if airflow is restricted in the work area (i.e., confined spaces, underground installations, etc.). If either of these levels are measured, the work area will be vacated, allowed to vent, and be monitored for organic compounds and combustible gases every 15 minutes by the SSHO.

The following action levels will be used for sampling activities conducted at the SAEP.

Soil Boring, Sampling and Monitoring Well Installation

Total VOCs	Level of Protection
Background level to 5 ppm	Level D
5 ppm to 50 ppm	Level C
>50 ppm	Evacuate work area and allow area to ventilate. Return only after total VOC levels are less than 50 ppm

Vinyl Chloride	Level of Protection
< 0.5 ppm	Level D
>0.5 ppm	Evacuate work area and allow area to ventilate. Return only after vinyl chloride levels are less than 1 ppm

Chloroform	Level of Protection
< 1 ppm	Level D
>1 ppm	Evacuate work area and allow area to ventilate. Return only after chloroform levels are less than 2 ppm

Benzene	Level of Protection
< 0.5 ppm	Level D
0.5 ppm to 10 ppm	Level C
>10 ppm	Evacuate work area and allow area to ventilate. Return only after benzene levels are less than 10 ppm.

Combustible Gases	Action
< 20 Percent LEL < 10 Percent LEL for confined spaces	Perform work
> 20 Percent LEL > 10 Percent LEL for confined spaces	Stop work, remove ignition sources, evacuate work area and allow area to ventilate. Return only after gases return to less than 20 percent LEL or less than 10 percent LEL in confined spaces

Drilling Through Paved Areas and Excavating (in addition to previously discussed action levels)

Total Dust Concentration	Level of Protection
< 5 mg/m^3	Level D
5 mg/m^3 to 10 mg/m^3	Level C
> 10 mg/m^3	Stop work, evacuate work area, return only after dust concentrations return to less than 10 mg/m^3

7.0
KEY HEALTH AND SAFETY PERSONNEL

W-C's health and safety responsibilities lie in a chain of command headed by the Corporate Health and Safety Administrator (CHSA) and the Eastern Operating Group Corporate Health and Safety Officer (EOG CHSO). Consultation, internal review, and approval of SSHPs are provided by the CHSA, EOG CHSO and the New York Metro Business Unit Health and Safety Officer (New York Metro BUHSO). The New York Metro BUHSO assists the Project Manager in matters of health and safety but does not have everyday on-site responsibilities. Site safety is maintained in the field by the Site Safety and Health Officer (SSHO). The SSHO reports to the Project Manager. The Project Manager coordinates all operations and reports to the Program Director.

The health and safety chain of command is shown in Figure 7-1. Resumes of key health and safety personnel are presented in Attachment 7.

7.1 PROJECT MANAGER: MARION E. CRAIG

The Project Manager has the following responsibilities:

- To see that the project is performed in a manner consistent with W-C's Health and Safety Program
- To have a SSHP prepared and approved
- To provide the New York Metro BUHSO with project information related to health and safety matters and development of the SSHP
- To implement the SSHP
- To monitor the compliance with the SSHP by W-C personnel

The Project Manager has the authority to take the following actions:

- To determine personnel assignments on this project
- To temporarily suspend field activities if the health and safety of personnel are endangered, pending further consideration by the New York Metro BUHSO.
- To temporarily suspend an individual from field activities for infractions of the SSHP pending further consideration by the New York Metro BUHSO.

7.2 CORPORATE HEALTH AND SAFETY ADMINISTRATOR: PHILLIP L. JONES, CIH

The Corporate Health and Safety Administrator and Safety Officer have the following responsibilities:

- To develop, implement and oversee W-C's Health and Safety Program and provide recommendations for improvement of the program
- To coordinate health and safety activities of the business units
- To develop, implement and oversee SSHPs
- To investigate reports of incidents or accidents
- To determine whether an accidental exposure or injury merits a change in the affected individual's work assignments and whether changes in work practices are required.
- To perform site audits.

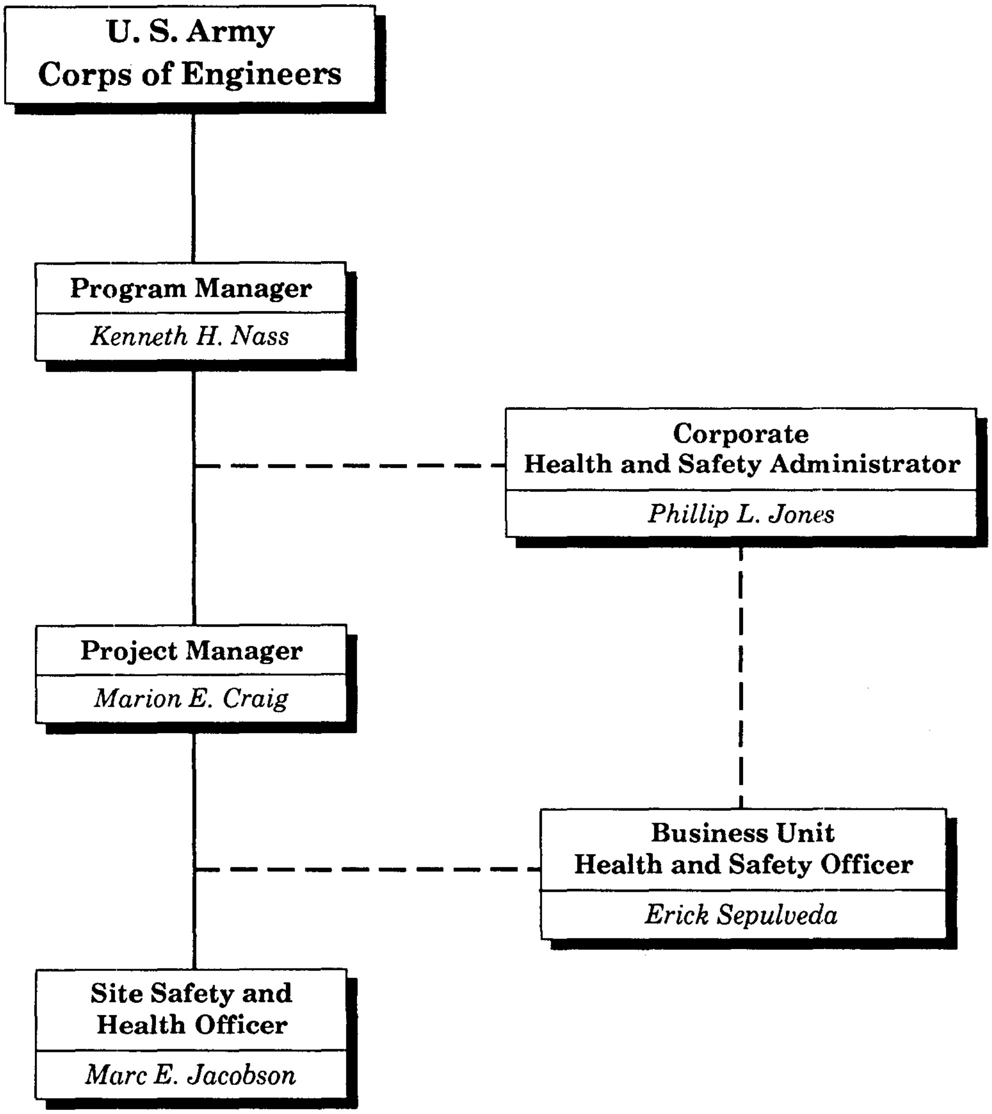


FIGURE 7–1

**CHAIN OF COMMAND STRUCTURE
FOR HEALTH AND SAFETY
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT**

The CHSA have the authority to take the following actions:

- To approve or disapprove SSHPs
- To access project files
- To direct changes in personnel work practices to improve health and safety of employees involved in hazardous waste management projects
- To remove individuals from projects, if their conduct jeopardizes their health and safety or that of co-workers
- To suspend work on any project which jeopardizes the health and safety of personnel involved.

7.3 NEW YORK METRO BUSINESS UNIT HEALTH AND SAFETY OFFICER: ERICK SEPULVEDA

The New York Metro Business Unit Health and Safety Officer has the following responsibilities:

- To interface with the Project Manager in matters of health and safety
- To develop a SSHP for the project and to submit it to the CHSA for approval
- To monitor compliance with the approved SSHP
- To assist the Project Manager in seeing that proper health and safety equipment is available for the project
- To approve personnel to work on this site with regard to medical examination and health and safety training

- To report safety-related incidents or accidents to the CHSA
- The New York Metro BUHSO will not have everyday on-site responsibilities

The New York Metro BUHSO has the authority to take the following actions:

- To suspend work or otherwise limit exposures to personnel if the SSHP appears to be unsuitable or inadequate.
- To direct workers to change work practices if they are deemed to be hazardous to the health and safety of personnel.
- To remove personnel from the project if their actions or conditions endanger their health and safety or the health and safety of co-workers.

7.4 SITE SAFETY AND HEALTH OFFICER: MARC E. JACOBSON

The Site Safety and Health Officer has the following responsibilities:

- To implement and continually enforce W-C's Health and Safety Program
- To report safety-related incidents or accidents to the Project Manager and New York Metro BUHSO
- To implement and continually enforce the SSHP
- To maintain health and safety equipment on-site, as specified in the SSHP
- To inspect health and safety activities on-site, as specified in the SSHP, and report results to the Project Manager and the New York Metro BUHSO

The SSHO has the authority to take the following actions:

- To temporarily suspend field activities, if health and safety of personnel are endangered, pending further consideration by the New York Metro BUHSO.
- To temporarily suspend an individual from field activities for infractions of the SSHP, pending further consideration by the New York Metro BUHSO.
- To designate an alternate SSHO in his absence.

7.5 ALTERNATE SITE SAFETY AND HEALTH OFFICER:

The Alternate Site Safety Officer assumes the responsibilities and authorities of the SSHO in the absence of the assigned SSHO.

8.0
ANTICIPATED PERSONAL PROTECTIVE EQUIPMENT LEVELS FOR SITE ACTIVITIES

The initial level of protection assigned to each work task, except where noted below, covered by this SSHP is Level D. Level D represents W-C's best estimate of the PPE necessary to reduce the potential for exposure of field personnel to potential hazards to acceptable levels. This level of protection may be upgraded based on visual observations or the results of air monitoring.

8.1 PERSONAL PROTECTIVE EQUIPMENT

The personal protective equipment specified in this SSHP will be provided for all field personnel. The following requirements are in accordance with OSHA regulations:

- Facial hair that interferes with proper fit of respirators must not be worn
- Contact lenses must not be worn
- Eyeglasses that interfere with proper fit to full-face respirators must not be worn

The following descriptions of personal protective equipment ensembles shall constitute the cited Levels of Protection as used in this SSHP for the sampling activities at the SAEP:

Modified Level D Personal Protective Equipment

- Hard hat using the SAEP recommended colors
- Safety glasses, goggles, or face shield(1)
- Chemical-resistant steel-toed and steel shank work boots
- Overboots or disposable "booties" (dark color preferred)(2)
- Outer gloves(3)
- Latex surgical gloves (to be worn underneath outer gloves)(2)
- Gray or dark blue Tyvek coveralls(4)

(1) if splash or dust hazard exists

(2) personnel should wear neoprene overboots or "booties" in Areas containing PCBs; rubber overboots or "booties" may be worn, as required, in other areas of the facility.

(3) personnel should wear neoprene outer gloves in Areas identified as containing PCBs; nitrile rubber outer gloves may be worn, as required, in other areas of the facility.

(4) polycoated Tyvek or Saranex impregnated coveralls should be worn in areas identified as containing PCBs.

Level C Personal Protective Equipment

- Hard hat using the SAEP's recommended colors
- Full-face air purifying respirator with GMC-H combination cartridges
- Chemical-resistant steel-toed and steel shank work boots
- Nitrile rubber outer gloves or a material compatible with the suspected chemicals
- Latex surgical gloves (to be worn underneath outer gloves)
- Rubber overboots or disposable "booties" (dark color preferred)
- Gray or dark blue hooded Saranex impregnated or polycoated Tyvek coveralls (taped at cuffs)

Level B Personal Protective Equipment

- Positive pressure-demand full-facepiece self-contained breathing apparatus (SCBA), or positive pressure-demand supplied air respirator with a 15 minute escape SCBA
- Gray or dark blue hooded Saranex impregnated or polycoated Tyvek coveralls (taped at cuffs, seams and facepiece)
- Nitrile rubber outer gloves or a material compatible with the expected chemicals
- Latex surgical gloves (to be worn underneath outer gloves)
- Chemical-resistant steel-toed and steel shank work boots
- Rubber overboots or disposable "booties" (dark color preferred)

In addition to this equipment, a first aid kit, snakebite kit, emergency eyewash in accordance with ANSI Z-358.1, and multi-purpose dry chemical UL Class 10A-10B-C fire extinguisher must be maintained at each work site.

The anticipated levels of protection for the planned field activities at the Stratford Army Engine Plant (SAEP) are documented in Table 8-1.

A list of required personal protective equipment is provided in Attachment 8.

TABLE 8-1
LEVELS OF PROTECTION FOR FIELD ACTIVITIES AT THE STRATFORD ARMY ENGINE PLANT (SAEP)

Activity	Potential Hazards	Initial Level of Protection	Monitoring Requirements*(1)	Action Levels
Installation of Monitoring Wells	Metals, VOCs, Semi-Volatile Organic Compounds, Halogenated Organic Compounds	Level D	Explosive Gases (CGI) Hydrogen Sulfide (H_2S) (CGI) Total VOCs (HNu PID, OVA FID or Draeger Tubes*(3))	Total VOCs*(2): <5 ppm - Modified Level D 5-50 ppm - Level C >50 ppm - Evacuate Explosive gases: <20% - Modified Level D >20% - Evacuate H_2S: <1.5ppm - Modified Level D 1.5-5 ppm - Level C >5 ppm - Evacuate
Sampling of Monitoring Wells	Metals, VOCs, Semi-Volatile Organic Compounds, Halogenated Organic Compounds	Level D	Hydrogen Sulfide (CGI) Total VOCs (HNu PID, OVA FID or Draeger Tubes*(3))	Total VOCs*(3): <5 ppm - Modified Level D 5-50 ppm - Level C >50 ppm - Evacuate Explosive gases: <20% - Modified Level D >20% - Evacuate H_2S: <1.5ppm - Modified Level D 1.5-5 ppm - Level C >5 ppm - Evacuate
Soil Sampling	Metals, VOCs, Semi-Volatile Organic Compounds, Halogenated Organic Compounds	Level D	Total VOCs (HNu PID, OVA FID or Draeger Tubes*(3)) Hydrogen Sulfide (CGI)	Total VOCs*(3): <5 ppm - Modified Level D 5-50 ppm - Level C >50 ppm - Evacuate H_2S: <1.5ppm - Modified Level D 1.5-5 ppm - Level C >5 ppm - Evacuate

TABLE 8-1 (Continued)
LEVELS OF PROTECTION FOR FIELD ACTIVITIES
AT THE STRATFORD ARMY ENGINE PLANT (SAEP)

Activity	Potential Hazards	Initial Level of Protection	Monitoring Requirements*(1)	Action Levels
Sediment Sampling	PCBs, Semi-Volatile Organic Compounds, VOCs	Level D*(2)	Total VOCs (HNu PID, OVA FID or Draeger Tubes*(3)) Hydrogen Sulfide (CGI) Draeger Tubes *(2)	Total VOCs*(3): <5 ppm - Modified Level D 5-50 ppm - Level C >50 ppm - Evacuate H_2S: <1.5ppm - Modified Level D 1.5-5 ppm - Level C >5 ppm - Evacuate
Benthic Macroinvertebrate Community Characterization	PCBs, Semi-Volatile Organic Compounds, VOCs	Level D*(2)	Total VOCs (HNu PID, OVA FID or Draeger Tubes*(3)) Hydrogen Sulfide (CGI)	Total VOCs*(3): <5 ppm - Modified Level D 5-50 ppm - Level C >50 ppm - Evacuate H_2S: <1.5ppm - Modified Level D 1.5-5 ppm - Level C >5 ppm - Evacuate
Biological Tissue Samples	PCBs, Semi-Volatile Organic Compounds	Level D*(2)	None	None

Note:

*(1) The frequency of air quality monitoring for worker protection will be at the discretion of the SSHO and will be based on the likelihood of changes in air quality, the nature of the work being performed, and the previous measurements. Initially, air quality measurements with the HNu PID or OVA FID will be made at 30-minute in the breathing zone of the most highly exposed worker(s) (i.e., closest to sources) at the Site. Air quality monitoring will initially be performed using a CGI at least each 30 minutes in areas where flammable conditions, oxygen deprivation or enrichment, and/or elevated levels of hydrogen sulfide may develop.

*(2) Individual(s) involved in these field activities should wear polycoated Tyvek or Saranex impregnated coveralls.

*(3) Draeger tubes shall be used if the Total VOC readings are detected above background airborne concentrations.

*(4) Monitoring will take place near individuals with the greatest potential for exposure in all work zones.

9.0
GENERAL HEALTH AND SAFETY REQUIREMENTS

9.1 MEDICAL EXAMINATION

Before entering any Contamination Reduction Zone (CRZ) or Exclusion Zone all W-C and subcontractor personnel and visitors (i.e., non-project personnel) must take a medical examination as part of a medical surveillance program. W-C's medical surveillance program is specified in Section 3 of W-C's Hazardous Waste Management Practice Health and Safety Manual, dated November 1990, and meets the requirements of OSHA Regulations 29 CFR 1910.120(f)and ANSI Z-88.2. A description of this program is provided in Attachment 9 of this SSHP.

Before working on-site, written certification for each W-C and subcontractor employee expected to enter either the CRZ or Exclusion Zone of participation in a Medical Surveillance Program, ability to wear a respirator and the date of last medical examination will be compiled by the SSHO. These documents will be provided to the SAEP Manager of Health, Safety and Loss Control prior to that individual engaging in field work. Additional copies of this documentation will be kept on-site by the SSHO. The written medical opinion from the reviewing physician concerning fitness to work on-site and ability to wear a respirator required by OSHA Regulations 29 CFR 1910.120 (f)(7) shall be made available upon request to the Contracting Officer's Representative.

9.2 TRAINING

All W-C personnel and subcontractor exposed to hazardous substances, health hazards or safety hazards must be thoroughly trained as specified in OSHA Regulations 29 CFR 1910.120(e). Training includes attendance at an initial 40-hr basic health and safety training course, annual health and safety refresher courses, a minimum of three days of actual field experience under the direct supervision of a trained, experienced supervisor, and on-site, site-specific training. On-site supervisors must have completed the Management and Supervisor Training course as specified in OSHA Regulations 29 CFR 1910.120(e)(4). At least two First Aid and CPR trained and currently certified person must be present on-site at all times when fieldwork is being performed. In addition, these individuals shall be trained and thoroughly familiar with bloodborne pathogens, hazard control and isolation during first aid cases, as documented in 29 CFR 1910.1030. Documentation concerning the type, duration and dates of training, including fit-test certificates, for all W-C and subcontractor on-site personnel and visitors will be provided to the SAEP Manager of Health, Safety and Loss Control prior to that individual entering any CRZ or Exclusion Zone. Additional copies of this documentation will be kept at the site by the SSHO. The SSHO shall conduct site-specific training covering site hazards, procedures, and all contents of the SSHP for W-C and subcontractor on-site personnel and visitors to the site prior to entering any CRZ or Exclusion Zone. Documentation of appropriate training for all W-C and subcontractor site personnel and site visitors shall be maintained on-site and submitted to the Contracting Officer's Representative at the conclusion of the site work.

9.3 INCIDENT REPORTING

In the event of fire, explosion, illness, and/or injuries occurring on site at SAEP, SAEP Security Headquarters, (Extension 2767 (2SOS)) will be notified at the time of occurrence.

Any incident or accident involving W-C field personnel or W-C subcontractors will require that a Hazardous Waste Incident Report be filed. Situations covered by this policy include, but are not limited to, fires, explosions, illnesses injuries, and automobile accidents. Those reports must be sent to the New York Metro BUHSO within 24-hours of the incident/accident. Worker's Compensation Insurance reports should be filed with the individual's employer within 48-hours of each accident or illness which results from work related activities and requires medical attention. See Attachment 10 for a copy of the Hazardous Waste Incident Report Form. The SSHO will complete this form in case of an accident or incident.

The USACE requires the following to be reported on ENG Form 3394 in cases of an incident or accident:

1) Notify USACE within 24 hours of the event

2) Report within two working days sufficient information to allow completion of ENG 3394 in accordance with AR 385-40 and USACE Supplement 1 to that regulation, Attachment 18.

    a) First aid
    b) Lost-time
    c) Property damage: $1,000 or more to government or contractor property
    d) $50,000 or more damage to government or contractor property, requires immediate board of investigation
    e) Questionable property damage
    f) Fatalities; 5 or more people sent to a hospital

The SSHO will be responsible for completing ENG Form 3394.

Incidents or accidents requiring immediate reporting required by OSHA Regulation 29 CFR 1904):

1) Fatalities or catastrophe (5 or more people sent to a hospital)

All other personal injuries requiring first aid or resulting in lost time must be recorded on OSHA Form 200. OSHA does not require this to be sent in, but W-C is required to keep this Form for the purpose of inspections by OSHA.

Accidents will be investigated in-depth to identify all causes and to recommend hazardous control measures. Except for rescue and emergency measures, the accident scene shall not be disturbed until it has been released by the investigating official. The consequences requiring an in-depth investigation are:

- Fatal Injury
- Five or more persons admitted to a hospital
- Property damage in an amount specified by the designated authority

The Project Manager must be notified as soon as possible of all accidents or incidents which require either a ENG Form 3394 or OSHA Form 200 to be completed.

9.4 ILLUMINATION AND SANITATION

If practical, all major work tasks will occur during daylight hours. The illumination requirements set forth in OSHA Regulation 29 CFR 1910.120(m) will be met when these tasks are performed. Needs for artificial illumination are primarily expected to be limited to work inside buildings. An electric lamp will be used in these areas. In compliance with OSHA Regulation 29 CFR 1926.56, the minimum intensity of lighting in work areas will be 5 foot candles.

The sanitation requirements regarding potable and non-potable waters, toilet facilities and washing facilities will be followed as set forth in OSHA Regulation 29 CFR 1910.120(n). Food handling areas and temporary sleeping quarters requirements are not applicable to the work covered by this SSHP.

Attachment 15 contains OSHA Regulations on Illumination and Sanitation at Temporary Work Places.

9.5 COMPLIANCE AGREEMENT

The Site Manager and/or the SSHO will hold meetings with W-C and subcontractor field personnel before work commences. During the meetings, all personnel will be provided with a copy of this SSHP; the SSHP will be reviewed and discussed and questions answered; fit testing and care of respirators will be reviewed. Signed Compliance Agreement Forms will be collected by the Site Manager and filed. Individuals refusing to sign the Compliance Agreement will not be allowed to work at the SAEP. A copy of the Compliance Agreement Form is contained in Attachment 11.

9.6 RESPIRATOR MAINTENANCE

Each person is responsible for their own respirator. Respirators, if used, will be cleaned daily according to procedures prescribed by the manufacturer. GMC-H combination cartridges will be used and replaced either daily or if breakthrough is detected at any time while is use. Reuse of cartridges from one day to another is prohibited; care will be taken to ensure that cartridges are not damaged or exposed to chemicals which might affect their efficiency when masks are stored during the work day (eg., during lunch). Cartridges will be stored in their original manufacturer's boxes (sealed individually in factory plastic bags) in a secure area of the project trailer. Use of other cartridges must be approved by the New York Metro BUHSO. The following checks will be performed on a daily basis on each individual respirator in use:

- Exhalation valve - pull off plastic cover and check valve for debris or tears in the neoprene valve which could cause leakage.
- Inhalation valves (two) - screw off cartridges and visually inspect neoprene valves for tears. Make sure that the inhalation valves and cartridge receptacle gaskets are in place.
- Make sure a protective lens cover is attached to the lens. Lenses are expensive to replace and must be protected at all times.
- Make sure you have the right cartridge (use GMC-H).
- Make sure that the face piece harness is not damaged. The serrated portion of the harness can fragment which will prevent proper face seal adjustment.
- Make sure the speaking diaphragm retainer ring is hand tight.

Additional information on respirator inspection, care, maintenance and storage is provided in Attachment 12.

9.7 PROJECT MANAGER NOTIFICATION

All field personnel must inform the Project Manager or designated representative before entering the SAEP.

> IF ANY UNEXPECTED POTENTIAL HAZARDS ARE DISCOVERED DURING FIELD WORK, LEAVE THE AREA OF CONCERN IMMEDIATELY AND CALL THE SITE SAFETY AND HEALTH OFFICER FOR FURTHER INSTRUCTIONS.

The SAEP Manager of Health, Safety and Loss Control, extension 3278, and the Contracting Officer's Representative will be notified as soon as possible by the SSHO if unexpected potential hazards which were not addressed in this SSHP are discovered during field work. Field activities in such areas shall be halted until the SSHP has been modified to reflect these changed conditions and reviewed/approved by the SAEP Manager of Health, Safety and Loss Control and the Contracting Officer's Representative.

9.8 DAILY HEALTH AND SAFETY SUMMARY REPORT

A Daily Health and Safety Summary Report will be used to record entry and exit times of all W-C and subcontractor personnel and work area visitors; accidents, injuries, and illnesses; incidences of safety infractions by field personnel; air quality and personal exposure monitoring data; and other information related to safety matters. Daily health and safety inspections shall be conducted by the SSHO to determine if operations are being performed in accordance with the SSHP; results of these inspections will be documented in the Daily Health and Safety Summary Report. All accidents, illnesses, or other incidents will be reported to the Project Manager, the New York Metro BUHSO, and SAEP Manager of Health, Safety and Loss Control. A copy of the form for the Daily Health and Safety Summary Report for this project is presented in Attachment 13. The Daily Health and Safety Summary Reports, including personnel/visitor logs and results of environmental and personal exposure monitoring/sampling shall be completed and maintained on-site by the SSHO and submitted to the Contracting Officer's Representative at the conclusion of the site work.

9.9 OSHA JOB SAFETY AND HEALTH PROTECTION POSTER

In accordance with the Occupation Safety and Health Act of 1970, a copy of the OSHA Job Safety and Health Protection poster must be present on all sites. This poster is appended as Attachment 14. It should be posted at its full size (11 inches x 17 inches) on-site.

9.10 PROHIBITIONS

- Smoking, eating, drinking, chewing tobacco or toothpicks, application of cosmetics, storing food or food containers, or having open fires will not be permitted in the Exclusion Zone and the Contamination Reduction Zone and any manufacturing and/or storage areas. Good personal hygiene will be practiced by field personnel to avoid ingestion of contaminants. Washing the face and hands will be performed after personal decontamination.

- Approach or entry into areas or confined spaces where toxic or explosive concentrations of gases or dusts may exist is prohibited.

9.11 WORK PROCEDURES

Whenever possible, field personnel will work from a position upwind of work activities.

All operations conducted on the intertidal flats including collection of surface water and sediment samples, must be performed with a dedicated "watcher" on-shore. If working from a boat, all personnel on the boat must wear U.S. Coast Guard approved flotation jackets while on the boat and suitable slip resistant footwear.

9.12 UNDERGROUND STRUCTURES

Extreme caution will be exercised whenever possibility of encountering buried utilities, (i.e., tanks) exists. Prior to commencement of intrusive activities, all available sources of information such as site utility drawings, public utility drawings, and construction drawings will be reviewed. If underground obstructions are unexpectedly encountered, the area will be manually excavated until the nature of the obstruction is discerned.

9.13 SITE SAFETY MEETINGS

During field operations, an initial size orientation meeting and daily safety meetings will be held by the SSHO to review and plan specific health and safety aspects of scheduled work. Potential subjects to be discussed are presented here:

1. Preliminary

   - Medical clearances for all on-site personnel
   - Written SSHP availability (copies provided to all participants)
   - Personal protective equipment availability, demonstration and fit testing (if necessary)
   - General construction protocols.

2. Training Topics

   - Delineation of responsibilities of on-site personnel.
   - Review of SSHP including:
     - types of hazards;
     - pathways of exposure;
     - levels of protection;
     - contamination avoidance;
     - physical hazards;
     - decontamination;

  - emergency procedures; and,
  - specific on-site area/work tasks of concern

- Decontamination review including:

  - delineation of work zones; and
  - set-up and dry run of decontamination equipment.

- Personnel protective clothing - use and dress out procedures

- Monitoring equipment review

- Questions and answers

- Completion of SSHP Compliance Agreement

9.14 WORK ZONES

To minimize the movement of contaminants from contaminated areas of the SAEP to uncontaminated areas, work zones will be set up. The work zones will include, at a minimum, the following:

Zone 1:	Exclusion Zone
Zone 2:	Contamination Reduction Zone
Zone 3:	Support Zone

The Exclusion Zone is the zone where contamination does or could occur. All persons entering this zone must wear the Level of Protection set forth in Section 8. These levels of protection guidelines are based on the different types of field activities.

Because work at several areas may be performed concurrently, an Exclusion Zone and Contamination Reduction Zone will be established at each area of work. These

Contamination Reduction Zones will be in addition to the Contamination Reduction Zone located near the support trailers. All personnel must decontaminate after leaving Exclusion Zones.

All work zone entrances and exits will be clearly marked or displayed in accordance with the SAEP Requirements and Standard Operating Procedures. Yellow and black striped caution tape will be used to demark the zones. Exclusion Zones will be established using the back of the drilling rig as the center of the zone by delineating a circle (see Figure 9-1). The radius can vary, depending on wind direction and speed, physical obstructions, and the minimum space requirements for safe and effective work. Typically the minimum radius is 25 feet. Monitoring equipment will be used to aid in delineating these zones. A wind direction indicator (i.e. wind sock) will be deployed at each work site.

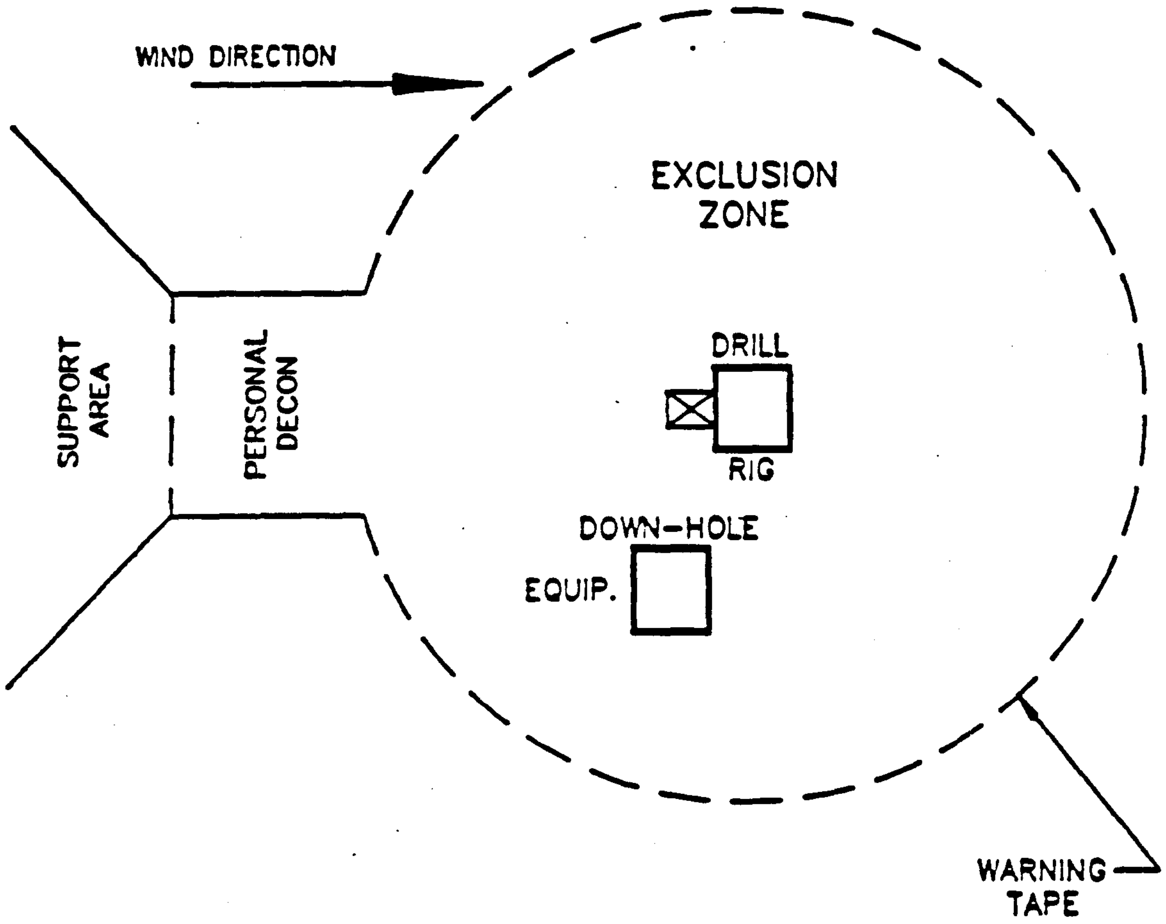
9.15 WORKING FROM BOATS OR NEAR WATER

The following precautions should be taken when working from boats or near water:

- All work in a boat or near the water shall be performed by at least a two-person team. Type III, Type V or better U.S. Coast Guard approval personal flotation devices shall be worn at all times.

- If the work requires reaching, stretching, etc., from the boat or bank, the worker shall be equipped with a harness and lifeline. The lifeline shall be attached to the boat (if boat work) or a sturdy object on the bank (if bank work).

- The sampling area of the boat shall be lined with plastic to reduce contamination of the boat.



TYPICAL WORK ZONES
AROUND DRILLING OPERATIONS
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

FIGURE 9–1

10.0
SITE ACCESS AND SITE CONTROL

10.1 SITE ACCESS

All access to the SAEP must be cleared through the SAEP security and administrative personnel and the USDA.

Access to the SAEP will be limited to authorized personnel. Such personnel may include W-C employees, subcontractors, and designated client, state and federal agencies.

10.2 SITE CONTROL

Certain procedures must be followed to ensure suitable site control and limitation of access so that those persons who may be unaware of site conditions are not exposed to inherent hazards.

All machinery and equipment shall be stored in an on-site area designated by AlliedSignal's personnel upon completion of daily activities. All potentially contaminated materials, such as bottles, containers and soil will be stored in an on-site area to prevent unauthorized tampering.

Anyone from the general public, AlliedSignal personnel and/or media requesting information about site activities should be referred to the Site Manager or the SAEP Manager of Communications. Do not give your opinion or information to anyone asking questions about this project.

Communications will be maintained at the SAEP with two-way radios operating on a designated channel whenever work groups are not within a reasonable proximity of each other. The buddy system will be used when working in any Exclusion Zone.

A telephone at the SAEP will be used to communicate with others off-site. All emergency services will be addressed by SAEP's Security Headquarters, Extension 2767. Cellular telephones are not permitted at the SAEP.

10.3 SITE SECURITY

Areas within the SAEP will be provided for the office trailers, parking of drilling equipment and storage of supplies. These areas are surrounded by a chain link fence. Access to these areas is controlled by security guards 24 hours per day.

Controlled access to the site will be established. This controlled access will be through the main access road and the SAEP gates.

Only authorized personnel (AlliedSignal personnel, USDA personnel and ID visitors (by SAEP security)) shall be permitted to enter the SAEP. No one shall enter the SAEP without appropriate authorization from SAEP's security personnel. All individuals entering the site will sign the daily log and be given SAEP identification (visitors) badges.

All persons entering the sampling areas at the SAEP shall be equipped with appropriate personal protective equipment. Documentation of ability to work on hazardous waste sites, wear respiratory protection, and training must be provided to the SSHO.

All persons entering the sampling areas at the site must be familiar with and abide by the SSHP and the SAEP's HAZCOM Program, Emergency Response Plan and Standard Operating Procedures.

11.0
DECONTAMINATION

11.1 GENERAL INFORMATION

Personnel involved with hazardous substances may be exposed to contaminants in a number of ways, despite the most stringent protective procedures. Personnel may come in contact with vapors, gases, mists, or particulates in the air. Use of monitoring instruments and construction equipment can also result in exposure to hazardous substances. This contamination must be removed before leaving any contaminated area.

In general, decontamination involves scrubbing or spraying with a non-phosphate soap/water solution followed by clean water rinses. All disposable items will be disposed of in a dry container. Certain parts of contaminated respirators, such as harness assemblies, are difficult to decontaminate. These components can be soaked in soap and water and scrubbed with a brush. In addition to being decontaminated, all respirators, non-disposable protective clothing, and other personal articles must be sanitized before they can be used again. The manufacturer's instructions should be followed in sanitizing the respirators. The SSHO will be responsible for ensuring that personal protective equipment is used properly.

11.2 DECONTAMINATION AREA

A decontamination pad will be set up near the support trailers. This pad will be for decontaminating heavy equipment leaving the SAEP. A high-pressure hot water "steam-type" cleaner for cleaning tires and undercarriages of drilling rigs and other vehicles and down-hole equipment will be kept on-site.

Each work zone will also have decontamination facilities. Personal decontamination equipment will be near each work zone. All field personnel will thoroughly decontaminate before leaving the Contamination Reduction Zone and entering the Support Zone.

Decontamination water will be allowed to evaporate. All decontamination water remaining at the end of the field effort will be collected in drums for analysis and appropriate disposal. All used disposable PPE will be placed in heavy gauge plastic bags for proper disposal.

11.3 PERSONAL DECONTAMINATION PROCEDURES

The following steps must be taken for personnel decontamination when leaving Exclusion Zones (subject to modification by SSHO) for PPE Levels C and D:

- Deposit equipment that needs to be decontaminated on plastic drop cloths.
- Wash boots and outer gloves with long handled brushes in wash tub containing detergent and water.
- Rinse boots and outer gloves with long handled brush in a wash tub containing clean water or use a sprayer to rinse off boots and gloves.
- Rinse suit with portable spray bottle if it is water resistant
- Remove tape and place in plastic bag
- Remove outer gloves and place in plastic bag
- Remove coveralls and place in plastic bag
- When applicable, remove air purifying respirator, SCBA or positive pressure-demand supplied air respirator and place in a separate area to be decontaminated[1].
- Remove inner gloves and place in plastic bag
- Wash hands and face

Decontamination procedures to be used in case of an emergency are described in Section 12.

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[1] This step is for work activities performed in Level C Personal Protective Equipment and Level B Personal Protective Equipment.

11.4 EQUIPMENT DECONTAMINATION PROCEDURES

11.4.1 Small Sampling Equipment Decontamination

The following steps must be taken for decontaminating small sampling equipment when removing such equipment from the Exclusion Zone (subject to modification by the SSHO):

- After use, small equipment such as that associated with sampling (split tube samplers, trowels, shovels, picks, chisels, hammers, other specific samplers, etc.) will be transported from the Exclusion Zone to the decontamination pad in the adjacent Contamination Reduction Zone.
- Equipment will first be washed with a hot water high-pressure hot water "steam-type" cleaner.
- Equipment will then be scrubbed down with soapy water using brushes and a phosphate-free soap.
- Equipment will then be rinsed, by hose, with water.
- Equipment will then be placed on the plastic sheet covered area on the decontamination pad to air dry.

11.4.2 Large Sampling Equipment Decontamination

The following steps must be taken for decontaminating large sampling equipment when such equipment leaves the Exclusion Zone (subject to modification by the SSHO):

- Large sampling equipment such as drill rigs, hollow-stem augers, etc., shall be driven or carted from the Exclusion Zone to the decontamination pad.
- Equipment will first be washed with a high-pressure hot water "steam-type" cleaner.

- Equipment will then be scrubbed down with soapy water using brushes and a phosphate-free soap.

- Equipment will then be rinsed, by hose, with water.

- Equipment will then be placed on the plastic sheet covered area on the decontamination pad to air dry.

11.4.3 Respirator Care, Maintenance and Storage

Respirator care, maintenance and storage are discussed in Attachment 12.

12.0
EMERGENCY PROCEDURES

12.1 GENERAL

The purpose of this section of SSHP is to address how site personnel will respond to emergencies. The types of potential emergencies that are addressed by this SSHP include:

- Fire and explosion
- Medical (chemical exposures and physical injuries)
- Chemical spills

It is policy at the SAEP that:

- Industrial Security and Loss Control Department Personnel will respond to all emergency situations.

- Qualified professional medical personnel will be on duty in the Medical Department from 0700 to 2330 hours, Monday through Friday. Medical Department personnel will respond to an accident scene involving injury or illness to personnel upon notification from Security Headquarters.

- In instances when the Medical Department is closed, the Security Department will assume the First Aid responsibility for the affected personnel.

- Plant Engineering, Maintenance and Environmental Personnel will respond to accident scenes, and/or chemical spill/release scenes when notified by Security Headquarters.

- Emergency Medical Technicians (EMTs) will respond to an accident scene involving personnel injury or illness when notified by Security Headquarters.

12.2 EMERGENCY RECOGNITION AND PREVENTION

12.2.1 Fires and Explosion

Fires and explosions are possible whenever flammable gases, vapors, or contaminants are present in proper concentrations and an ignition source is present. While flammable gases or vapors are not expected to be a concern during the activities covered by this SSHP, there is need to protect against potential explosive situations. A CGI will be on-site for monitoring any activity that may lead to the release of explosive gases or vapors. This is especially relevant when drilling.

12.2.2 Medical

12.2.2.1 Chemical Exposure

Work will be performed in such a manner that exposure to contaminants through skin or eye contact, inhalation or ingestion is minimized. Work practices that will be followed to reduce chemical exposures include:

- PPE, as specified in Section 8, for the appropriate work activities and areas as defined by the SSHO, will be used by all personnel. A formal revision to the SSHP must be made by the New York Metro BUHSO in order to modify the PPE requirements.
- Keep hands away from face during work activities.
- Minimize all skin and eye contact with contaminants.

Early recognition of chemical exposure symptoms is essential to the prevention of serious chemical exposure incidents. Symptoms of exposure to the type of compounds potentially present at the SAEP include the following: fatigue, weakness; eye, nose, throat irritation; headache; dizziness; nausea; vomiting; malaise; tremors; aggressive confusion; cyanosis (blue color to skin); anemia; and muscle spasms.

If a person experiences any of these symptoms, or others recognize any of the symptoms in a fellow worker, the person experiencing the symptoms will stop work and report his or her symptoms to the SSHO. All work shall stop. The SSHO shall increase monitoring and make a decision whether upgrading will be necessary. If the symptoms persist or appear to be damaging in any way, the SSHO will make arrangements to take the individual to a hospital for medical treatment. If symptoms are serious, work activities in the area where the person was exposed will be discontinued until more is known about the incident. Incident reporting procedures as specified in Section 9.3 will be initiated.

12.2.2.2 Physical Injury

Site personnel should constantly look for potential safety hazards such as holes or ditches; precariously positioned objects, such as drums, on-site tires, or equipment that may fall; sharp objects, such as nails, metal shards, and broken glass; protruding objects at eye or head level; slippery surfaces; steep grades; uneven terrain or unstable surfaces. Site personnel should inform the SSHO of any potential hazards identified so that mitigative action can be taken.

12.3 EMERGENCY ALERTING PROCEDURES

The SSHO will alert the appropriate work groups when and if an emergency occurs relating to the site investigation activities through the use of radios or by directly contacting the work group. The SSHO and any isolated work group will carry radios if reasonable contact cannot be maintained. If radios fail, repeated short blasts from an alarm horn will be used to signal workers to stop work and assemble in the Contamination Reduction Zone. Workers will become familiar with emergency hand signals during the site briefing.

12.4 EMERGENCY NOTIFICATION PROCEDURES

All Emergency Calls will be directed to Security Headquarters, Extension 2SOS (2767). Upon receipt of an emergency notification call, the Security Officer will request the following information:

1. Type of Accident/Illness/Emergency.
2. Specific Location of the Patient/Incident, (By Column Number, Floor, Building Number and Telephone Extension).
3. Description of the emergency and circumstances of illness/injury.
4. Name of the Caller.

Upon receipt of an Alarm Signal, the Security Officer will dispatch/notify the appropriate personnel to respond to the incident as indicated.

Written record (documentation) of all incidents shall be prepared by Security Headquarters and copies distributed to the Loss Control and other departments as applicable.

Table 12-1 presents a Summary of Emergency Telephone Numbers.

12.5 EMERGENCY RESPONSE PROCEDURES

The following procedures will be followed in the notification of accidents, illnesses, fire conditions, chemical spills, natural disasters, etc., which occur at the SAEP.

12.5.1 Medical

- Security Headquarters will contact the Medical Department by direct phone and will contact the EMT Captain for that Zone via radio. Information will include the nature of the incident and location.

- Based upon the Medical Department's or EMT's evaluation of the injured, the Emergency Medical Service (EMS) will be contacted by phone (911) by Security Headquarters.

- Medical Department personnel may request/require transportation to the injury scene. If transportation is required, a Security Officer will respond with vehicle.

TABLE 12-1

EMERGENCY TELEPHONE NUMBERS
STRATFORD ARMY ENGINE PLANT

SAEP Security Headquarters	2SOS
Barnert Memorial Hospital Center (Dr. Cronin/Dr. Wilkenfeld)	(201) 977-6764
Poison Control Center	(800) 962-1253
WCC Wayne Office	(201) 785-0700
WCC Plymouth Meeting Office	(215) 825-3000

- Security, Fire, Safety and Medical personnel will be notified, according to need, and will form the Response Team.

- The Duty Lieutenant will remain in the Security Control Center to act as coordinator and maintain a level of continuity. A Security or Safety Supervisor will act as "Incident Commander" at the scene during normal duty hours. After hours, the Duty Lieutenant will perform "Incident Commander" responsibilities while a fellow Security Officer remains in the Security Control Center to coordinate communications, etc.

- At the scene, the "Incident Commander" will assume responsibility for the direction and coordination of all necessary actions and support personnel. The Incident Commander will then notify Security Headquarters of the actual situation (via radio). If EMS is required, the Duty Officer will initiate the phone call, and give EMS all of the necessary information, i.e., which gate to respond to, nature of the injury/illness, etc.

- Should EMS be required, the Duty Lieutenant will be responsible to dispatch Security Officers to meet the EMS at the gate and direct them to the scene.

- Should the on-scene situation be of sufficient magnitude (multiple injuries/illnesses), with the concurrence of on-scene medical personnel, additional AlliedSignal EMT Personnel would be called from adjacent zones to assist.

- EMS will assume Medical Control for the injured upon arrival. The Incident Commander/Duty Lieutenant/Medical Representative (as applicable) will advise the EMS representative of the circumstances and the nature of illness/injury along with current medical status.

- The Incident Commander or Medical Representative will secure the injured's identification badge prior to transportation with EMS. A report shall be forwarded to the Medical Department on the appropriate form (AL734).

- All information pertaining to the emergency will be recorded in the Daily Health and Safety Summary Report and the Incident Report.

12.5.2 Fire

- The Duty Lieutenant upon receipt of a Fire Alarm notification call or alarm will immediately dispatch a Security Officer to the scene. A Security or Safety Supervisor will also be notified for the purpose of performing as Incident Commander if required.

- Fire Protection Specialists will be directed to the fire location via radio communications.

- Fire Squad members for the Emergency Zone where the fire alarm was reported will also be notified via the EMT radio system to report to the location.

- Based on on-scene situation reports received from the Security Officer or Fire Protection Specialist sent to the reported location - the Duty Lieutenant will determine whether the fire is in the incipient stage or larger.

- Incipient stage fires will be controlled and extinguished by in-plant resources.

- In the event the incipient stage fire intensifies or the actual fire is of greater intensity than can be handled internally - the Duty Lieutenant will immediately notify the Stratford Fire Department.

- The Duty Lieutenant will advise the Stratford Fire Department of the location, intensity and point of entry to the plant, etc.

- A Security Officer will be dispatched to the plant perimeter entrance that the responding equipment will use to direct them to the fire location.

- The Duty Lieutenant will activate the Fire Alarm in the affected Emergency Zone where the fire is located, and also provide voice evacuation directions to the employees working in the Zone.

- Security Officers and Fire Squad members will provide area control and evacuation duties as required.

- The Duty Lieutenant will notify Plant Engineering and Plant Maintenance representatives to remove electrical power, provide ventilation fans, other equipment or cleanup as required.

- When the Duty Lieutenant/Incident Commander have determined that the danger is no longer present and the fire has been extinguished, will direct employees to return to work and will notify senior management of the details.

- An Incident Report will be prepared which summarizes the event and the actions taken to neutralize the fire.

12.5.3 Chemical Spill

- The Duty Lieutenant, when notified that a chemical spill has occurred on plant property, will request the following information:

  (1) Description of the emergency.
  (2) Extent of injuries/exposure.
  (3) Name of chemical involved and quantity spilled.
  (4) Location of the spill.
  (5) Name of the Caller.

- Upon receipt of the above information, the Duty Lieutenant will dispatch a Security Officer, Fire Prevention Specialist, Safety Specialist and Environmental Engineer to the scene.

- The Duty Lieutenant will immediately contact the Primary and Alternate Emergency Coordinator for Chemical Spills.

- All visitors or workers not engaged in cleanup of the chemical spill will be evacuated immediately.

- The Emergency Coordinator will identify the severity of the incident and determine if the Emergency Response Plant and emergency evacuation procedures need to be implemented.

- The Emergency Coordinator will identify the chemicals or hazardous wastes involved, the origin of the problem, the amount of materials involved, and the proximity of other material or wastes. He or she should assess possible hazards to human health or the environment that may occur.

- The Emergency Coordinator will indicate the appropriate protective clothing and breathing apparatus, the use of materials and equipment which are appropriate for the characteristics of the hazardous release.

- If the chemical spill can be handled by in-plant resources then routine clean-up procedures will be followed.

- The Duty Lieutenant will provide support to the Emergency Coordinator as requested.

- Plant Maintenance and Engineering representatives will be notified to provide logistics support, clean-up and repair (if required) to the spill scene.

12.6 EMERGENCY RESPONSE PERSONNEL

The SSHO will have the primary role in responding to all W-C on-site emergencies. All site personnel will contact the SSHO in case of emergency. The SSHO, or designee, must be present on-site during all site work. If reasonable contact cannot be maintained, the SSHO will carry a two-way radio and the work group will also have a two-way radio. If any emergency such as a fire, chemical exposure, or physical injury occurs, the SSHO will be immediately contacted. The SSHO and any designees performing in this capacity will have current certification in First Aid and Cardiopulmonary Resuscitation (CPR). All W-C site personnel will take direction from the SSHO and all SAEP emergency response personnel in cases of emergency response. If the SSHO or designee is not present, the Site Manager will respond to emergencies. Coordination with the SAEP Manager of Health, Safety and Loss Control will be made before work recommences.

12.7 EMERGENCY DECONTAMINATION PROCEDURES

Decontamination of an injured or exposed worker will be performed only if decontamination does not interfere with essential treatment.

If decontamination can be done: wash, rinse, and/or cut off protective clothing and equipment.

If decontamination cannot be done:

- Wrap the victim in blankets, plastic or rubber to reduce contamination of other personnel

- Alert emergency and off-site medical personnel to potential contamination

- The SSHO or other personnel familiar with the incident and site contaminants will accompany the victim to the hospital

12.8 PHYSICAL INJURIES

On-site First Aid or CPR may be administered by the SSHO and/or other personnel who have been appropriately certified. General medical treatment procedures include:

- Remove the injured or exposed person(s) from immediate danger.
- Render First Aid, if necessary, and decontaminate affected personnel, if necessary.
- Evacuate other personnel in the work area on-site to a safe place until the Site Manager (assisted by the SSHO) determines that it is safe for work to resume.

ALL PHYSICAL INJURIES, EVEN IF TREATED BY THE SSHO OR OTHER W-C PERSONNEL, MUST BE REPORTED TO THE SECURITY HEADQUARTERS AND THE MEDICAL DEPARTMENT IN ACCORDANCE WITH SECTION 2.5.1.

Additional information on Emergency First Aid Procedures is presented in Attachment 15. Charts providing information on medical procedures for artificial respiration, choking and emergency first aid are presented in Attachment 16.

13.0
PERSONNEL ASSIGNMENTS

13.1 PROJECT PERSONNEL

W-C personnel authorized to enter the site and work on this project subject to compliance with provisions of the SSHP are:

Project Manager	Marion E. Craig
Site Safety and Health Officer	Marc E. Jacobson
New York Metro Business Unit Health and Safety Officer	Erick Sepulveda
Corporate Health and Safety Administrator	Phillip L. Jones, CIH

13.2 PROJECT SAFETY PERSONNEL

Personnel responsible for implementing this SSHP are the Project Manager and the SSHO. Their specific responsibilities and authority are described in W-C's Health and Safety Manual (November, 1990).

14.0
SITE SAFETY AND HEALTH PLAN APPROVALS

Marion Craig 12/1/94

Marion E. Craig
Project Manager

Date

for 12/1/94

Erick Sepulveda
New York Metro Business Unit
Health and Safety Officer

Date

Phillip L Jones, CIH 12/1/94

Phillip L. Jones, CIH
Corporate Health and Safety Administrator

Date

ATTACHMENTS

ATTACHMENT 1
TICKS AND TICK-BORNE DISEASES

ATTACHMENT 1
TICKS AND TICK-BORNE DISEASES

Field personnel should be aware of an increased occurrence of tick-borne disease in the United States. In the northeast, the most likely carriers are the white-footed mouse and the white-tailed deer. These animals are most prevalent in areas where suburban environments abut open fields or woodlands. Although exposure is increased in these areas, other carriers, such as dogs and horses, can be found in a variety of environments.

All field personnel should take proper precautions to limit exposure to ticks and tick-borne diseases. These include:

Cinching and taping clothing at the ankles and wrists, especially the ankles. Ticks lie low on grass blades and shrubs. They encounter your feet, ankles or lower legs and then crawl upward. When checking for ticks, pay special attention to the neck, groin, arm pits and scalp.

Wear light-colored clothing to facilitate spotting the ticks, and check your clothing periodically. Be especially careful in terrain with tall grass, bushes or woods.

Use a tick repellant on skin or clothing. Always read the labels before using. Clothing repellents should never be used on the skin.

Recognize the signs of a bite or an infection. It takes several hours for a tick to attach and feed; removing it promptly lessens the chance of being infected.

Seal field clothes in plastic bags until cleaned. Do not take them into the house as a tick may be attached.

Pregnant women should be particularly careful since the effects of the most common tick-borne disease in the northeast, Lyme disease, upon the fetus is unknown.

If a tick is discovered on the skin, it is important to remove the entire insect as soon as possible. The most effective method is to grasp the tick as close as possible to the mouth with tweezers or thin, curved forceps. Then, without jerking, pull it upward steadily (a small amount of skin may be removed in the process).

After removing the tick, disinfect the bite with rubbing alcohol or povidone iodine (Betadine). Don't handle the tick; spirochetes could enter the body through breaks in the skin. Dispose of it in alcohol or flush it down the drain. And check the bite occasionally for at least two weeks to see if a rash forms. If it does, you've been infected and should seek treatment promptly.

The rash appears at the bite location from two days to a few weeks after the bite. It usually starts as a small red spot that expands as the spirochetes spread beyond the bite. Most commonly, the rash develops into a reddish circle or oval about two to three inches in diameter. It fades with or without treatment after a few weeks.

Much larger rashes - anywhere from 6 to 20 inches in diameters - may also occur, especially on the back. Despite their size, large rashes may be easy to miss because they're often very faint.

Other variants include a rash with a red perimeter and a clear center and the so-called bull's-eye rash, which consists of several concentric red rings. Rashes may vary in shape, depending on where they occur on the body. Frequent sites are the thigh, groin, and armpits. People often develop a rash in more than one place.

Early symptoms may include profound fatigue, a stiff neck, and flu-like symptoms such as headache, chills, fever, and muscle aches. Since tick bites don't always produce a rash, those symptoms alone may warrant a medical check for possible Lyme infection - especially if they occur in summer and you live in an area that is endemic for Lyme disease.

Without treatment, the spirochetes usually multiply and the disease progressively worsens. The second stage, occurring within weeks to months of the bite, may affect the heart and nervous system. Third is the chronic arthritic stage, which begins up to a year or more after the bite.

ATTACHMENT 2
SAFETY GUIDELINES FOR DRILLING

SAFETY GUIDELINES FOR DRILLING

Drill rig maintenance and safety is the responsibility of the drill rig operator. The following is provided as a general guideline for safe drilling practices on-site.

OFF-ROAD MOVEMENT OF DRILL RIGS

The following safety guidelines related to off-road movement:

- Before moving a drill rig, first walk the route of travel, inspecting for depressions, slumps, gulleys, ruts and similar obstacles.
- Always check the brakes of a drill rig carrier before traveling, particularly on rough, uneven or hilly ground.
- Discharge all passengers before moving a drill rig on rough or hilly terrain.
- Engage the front axle (for 4x4, 6x6, etc., vehicles or carriers) when traveling off highway on hilly terrain.
- Use caution when traveling side-hill. Conservatively evaluate side-hill capability of drill rigs, because the arbitrary addition of drilling tools may raise the center of mass. When possible, travel directly uphill or downhill.
- Attempt to cross obstacles such as small logs and small erosion channel or ditches squarely, not at an angle.
- Use the assistance of someone on the ground as a guide when lateral or overhead clearance is close.
- After the drill rig has been moved to a new drilling site, set all brakes and/or locks. When grades are steep, block the wheels.

- Never travel off-road with the mast (derrick) of the drill rig in the raised or partially raised position.

- Tie down loads on the drill rig and support trucks during transport.

OVERHEAD AND BURIED UTILITIES

The use of a drill rig near electrical power lines and other utilities requires that special precautions be taken by both supervisors and members of the exploration crew. electricity can shock, it can burn, and it can cause death.

Overhead and buried utilities should be located, noted and emphasized on all boring location plans and boring assignment sheets.

Before raising the drill rig mast (derrick) on a site in the vicinity of power lines, walk completely around the drill rig. Determine what the minimum distance from any point on the drill rig to the nearest power line will be when the mast is raised and/or being raised. Do not raise the mast or operate the drill rig if this distance is less than 20 feet. In general, the distance between the overhead power line and the boom should be no less than the height of the boom.

Keep in mind that both hoist and overhead power lines can be moved toward each other by the wind.

Drilling personnel should double-check any side underground electrical and piping drawings prior to initiating drilling. If an obstruction is encountered during drilling, proceed with extreme caution until the possibility of an exposed electrical line or combustible product pipeline is excluded.

CLEARING THE WORK AREA

Prior to drilling, adequate site cleaning and leveling should be performed to accommodate the drill rig and supplies and provide a safe working area. Drilling should not be commenced when tree limbs, protruding objects, unstable ground or site obstructions or debris cause unsafe tool handling conditions and/or limited, awkward work spaces. An area clear of obstructions or debris should be maintained 180 degrees around the drilling or sampling activities, where practical.

NOTE: In coordination with the Drilling Crew, the Site Safety Officer will review the precautions taken to insure that the drill rig is leveled and stabilized.

HOUSEKEEPING ON AND AROUND THE DRILL RIG

The first requirement for safe field operations is that the drilling crew safety supervisor understands and fulfills the responsibility for maintenance and "housekeeping" on and the drill rig.

Suitable storage locations should be provided for all tools, materials and supplies so that they can be conveniently and safety handled without hitting or falling on a member of the drill crew or a visitor, without creating tripping hazards, and without protruding at eye or head level.

Avoid storing or transporting tools, materials or supplies within or on the mast (derrick) of the drill rig.

Pipe, drill rods, bit casings, augers and similar drilling tools should be orderly stacked on racks or sills to prevent spreading, rolling or sliding.

Penetration of other driving hammers should be placed at a safe location on the ground or be secured to prevent movement when not in use.

Work areas, platforms, walkways, scaffolding and other accessways should be kept free of materials, obstructions and substances such as ice, excess grease or oil that could cause a surface to become slick or otherwise hazardous.

Keep all controls, control linkages, warning and operation lights and lenses free of oil, grease and/or ice.

Do not store gasoline in any portable container other than a non-sparking, red container with a flame arrester in the fill spout and having the word "gasoline" easily visible.

Welding gas cylinders should be stored in an upright position to avoid gas leaks.

SAFE USE OF HAND TOOLS

There are almost an infinite number of hand tools that can be used on or around a drill rig. "Use the tool for its intended purpose" is the most important rule. The following are a few specific and some general suggestions which apply to safe use of several hand tools that are often used on and around drill rigs.

- When a tool becomes damaged, either repair it before using it again or get rid of it.
- When using a hammer, any kind of hammer, for any purpose, wear safety glasses and require all others near you to wear safety glasses.
- When using a chisel, any kind of chisel, for any purpose, wear safety glasses and require all others around you to wear safety glasses.
- Keep all tools cleaned and orderly stored when not in use.
- Replace hook and heel jaws when they become visibly worn.

- When breaking tool joints on the ground or on a drilling platform, position your hands so that your fingers will not be smashed between the wrench handle and the ground or the platform, should the wrench slip or the joint suddenly let go.

SAFE USE OF WIRE LINE HOISTS, WIRE ROPE AND HOISTING HARDWARE

The use of wire line hoists, wire rope and hoisting hardware should be as stipulated by the American Iron and Steel Institute's Wire Rope Users Manual.

All wire ropes and fittings should be visually inspected during use and thoroughly inspected at least once a week for: abrasion, broken wires, wear, reduction in rope diameter, reduction in wire diameter, fatigue, corrosion, damage from heat, improper weaving, jamming, crushing, bird caging, kinking, core protrusion and damage to lifting hardware and any other feature that would lead to failure. Wire ropes should be replaced when inspection indicates excessive damage according to the wire rope users manual.

If a ball-bearing type hoisting swivel is used to hoist drill rods, swivel bearings should be inspected and lubricated daily to assure that the swivel freely rotates under load.

If a rod slipping device is used to hoist drill rods, do not drill through or rotate drill rods through the slipping device, do not hoist more than 1-foot (0.3 m) of the drill rod column above the top of the mast (derrick), do not hoist a rod column with loose tool joints and do not make up, tighten or loosen tool joints while the rod column is being supported by a slipping device. If drill rods should slip back into the borehole, do not attempt to brake the fall of the rods with your hands.

Most sheaves on drill rigs are stationary with a single part line. The number of parts of line should not ever be increased without first consulting with the manufacturer of the drill rig. Wire ropes must be properly matched with each sheave.

The following procedures and precautions must be understood and implemented for safe use of wire ropes and rigging hardware.

Use tool handling hoists only for vertical lifting of tools (except when angle hole drilling). Do not use tool handling hoists to pull on objects away from the drill rig; however, drills may be moved using the main hoist as the wire rope is pulled through proper sheaves according to the manufacturer's recommendations.

When stuck tools or similar loads cannot be raised with a hoist, disconnect the hoist line and connect the stuck tools directly to the feed mechanisms of the drill. Do not use hydraulic leveling jacks for added pull to the hoist line or the feed mechanisms of the drill.

When attempting to pull out a mired down vehicle or drill rig carrier, only use a winch or the front or rear of the vehicle or drill rig carrier and stay as far as possible away from the wire rope. Do not attempt to use tool hoists to pull out a mired down vehicle or drill rig carrier.

Minimize shock loading of a wire rope - apply loads smoothly and steadily.

- Protect wire rope from sharp corners or edges.
- Replace faulty guides and rollers.
- Replace worn sheaves or worn sheave bearings.
- Replace damaged safety latches on safety hooks before using.
- Know the safe working load of the equipment and tackle being used. Never exceed this limit.
- Clutches and brakes of hoists should be periodically inspected and tested.

- Know and do not exceed the rated capacity of hooks, rings, links, swivels, shackles and other lifting aids.

- Always wear gloves when handling wire ropes.

- Do not guide wire ropes or hoist drums with your hands.

- Follow the installation of a new wire rope, first lift a light load to allow the wire rope to adjust.

- Never carry out any hoisting operations when the weather conditions are such that hazards to personnel, the public, or property are created.

- Never leave a load suspended in the air when the hoist is unattended.

- Keep your hands away from hoists, wire rope, hoisting hooks, sheaves and pinch points as slack is being taken up and when the load is being hoisted.

- Safety rules described in OSHA Regulations 29 CFR 1926.552 and guidelines contained in the Wire Rope User's Manual published by the American Iron and Steel Institute shall be used whenever wire line hoists, wire rope, or hoisting hardware are used.

- Never hoist loads over anyone's head.

- The operator and tool handler should establish a system of responsibility for the series of various activities required for auger drilling, such as connecting and disconnecting auger sections, and inserting and removing the auger fork. The operator must insure that the tool handler is well away from the auger column and that the auger fork is removed before starting rotation.

- Only use the manufacturer's recommended method of securing the auger to the power coupling. Do not touch the coupling or the auger with your hands, a wrench or any other tool during rotation.

- Whenever possible, use tool hoists to handle auger sections.

- Never place hands or fingers under the bottom of an auger section when hoisting the auger over the top of the auger section in the ground or other hard surfaces such as the drill rig platform.

- Never allow feet to get under the auger section that is being hoisted.

- When rotating augers, stay clear of the rotating auger and other rotating components of the drill rig. Never reach behind or around a rotating auger for any reason whatsoever.

- Never place your hands between the drill rig and an auger, even when attempting to free a damaged or bound Shelby tube from the auger.

- Never use your hands or feet to move cuttings away from the auger.

- Augers should be cleaned only when the drill rig is in neutral and the augers are stopped from rotating.

SAFETY DURING ROTARY AND CORE DRILLING

Rotary drilling tools should be safety checked prior to drilling:

- Water swivels and hoisting plugs should be lubricated and checked for "frozen" bearings before use.

- Drill rod chuck jaws should be checked periodically and replaced when necessary.

- The capacities of hoists and sheaves should be checked against the anticipated weight of the drill rod string plus other expected hoisting loads. All cables should be inspected daily.

Special precautions that should be taken for safety rotary or core drilling involve chucking, joint break, hoisting and lowering of drill rods:

- Drill rods should not be braked during lowering into the hole with drill rod chuck jaws.

- Drill rods should not be held or lowered into the hole with pipe wrenches.

- If a string of drill rods are accidentally or inadvertently released into the hole, do not attempt to grab the falling rods with your hands or a wrench.

- In the event of a plugged bit or other circulations blockage, the high pressure in the piping and hose between the pump and the obstruction should be relieved or bled down before breaking the first tool joint.

- When drill rods are hoisted from the hole, they should be cleaned for safe handling with a rubber or other suitable rod wiper. Do not use your hands to clean drilling fluids from drill rods.

- If work must progress over a portable drilling fluid (mud) pit, do not attempt to stand on narrow sides or cross members. The mud pit should be equipped with a rough surface, fitted cover panels of adequate strength to hold drill rig personnel.

- Drill rods should not be lifted and leaned unsecured against the mast. Either provide some method of securing the upper ends of the drill rod sections for safe vertical storage or lay the rods down.

- All hydraulic lines should be periodically inspected for integrity and replaced as needed.

START UP

All drill rig personnel and visitors should be instructed to "stand clear" of the drill rig immediately prior to and during starting of an engine.

Make sure all gear boxes are in neutral, all hoist levers are disengaged, all hydraulic levers are in the correct non-actuating positions and the cathead rope is not on the cathead before starting a drill rig engine.

GENERAL SAFETY DURING DRILLING OPERATIONS

Safety requires the attention and cooperation of every worker and site visitor.

Do not drive the drill rig from hole to hole with the mast (derrick) in the raised position.

Before raising the mast (derrick) look up to check for overhead obstructions. (Refer to previous Section on overhead and buried utilities).

Before raising the mast (derrick), all drill rig personnel and visitors (with exception of the operator) should be cleared from the areas immediately to the rear and the sides of the mast. All drill rig personnel and visitors should be informed that the mast is being raised prior to raising it.

Before the mast (derrick) of a drill rig is raised and drilling is commenced, the drill rig must be first leveled and stabilized with leveling jacks and/or solid cribbing. The drill rig should be re-leveled if it settles after initial set up. Lower the mast (derrick) only when leveling jacks are down and do not raise the leveling jack pads until the mast (derrick) is lowered completely.

Before starting drilling operations, secure and/or lock the mast (derrick) if required according to the drill manufacturer's recommendations.

The operator of a drill rig should only operate a drill rig from the position of the controls. The operator should shut down the drill engine before leaving the vicinity of the drill rig.

Do not consume alcoholic beverages or other depressants or chemical stimulants prior to starting work on a drill rig or while on the job.

Watch for slippery ground when mounting and dismounting from the platform.

All unattended boreholes must be adequately covered or otherwise protected to prevent drill rig personnel, site visitors or animals from stepping or falling into the hole. All open boreholes should be covered, protected or backfilled adequately and according to local or state regulations on completion of the drilling project.

"Horsing around" within the vicinity of the drill rig and tool and supply storage areas should never be allowed, even when the drill rig is shut down.

Be careful when lifting heavy objects. Before lifting a relatively heavy object, approach the object by bending at the knees, keeping your back vertical and unarched while obtaining a firm footing. Grasp the object firmly with both hands and stand slowly and squarely while keeping your back vertical and unarched. In other words, perform the lifting with the muscles in your legs, not the muscles in your lower back.

Drilling operations should be terminated during an electrical storm.

The minimum number of personnel necessary to achieve the objectives shall be within 25 feet of the drilling or sampling activity. Back-up personnel should remain at least 25 feet from the drilling or sampling activity, where practical.

Hardhats and steel boots are to be worn by all personnel in the vicinity of the drilling activities. Drilling personnel should not wear loose-fitting or baggy clothing which may be awkward or get caught on equipment. Jewelry, including rings and necklaces, should not be worn around electrical wires or rotating equipment.

ATTACHMENT 3
HEAT STRESS

HEAT STRESS PLAN
(IF NOT WEARING IMPERVIOUS FULL-BODY CLOTHING)

HEAT STRESS

Note: Materials on the Notice of Intended Changes have been incorporated into the text and are indicated by a † preceding the revision/addition and by a vertical rule in the margin.

The heat stress TLVs specified in Table 1 and Figure 1 refer to heat stress conditions under which it is believed that nearly all workers may be repeatedly exposed without adverse health effects. These TLVs are based on the assumption that nearly all acclimatized, fully clothed (e.g., lightweight pants and shirt) workers with adequate water and salt intake should be able to function effectively under the given working conditions without exceeding a deep body temperature of 38°C (100.4°F).

Since measurement of deep body temperature is impractical for monitoring the workers' heat load, the measurement of environmental factors is required which most nearly correlate with deep body temperature and other physiological responses to heat. At the present time, the Wet Bulb Globe Temperature Index (WBGT) is the simplest and most suitable technique to measure the environmental factors. WBGT values are calculated by the following equations:

1. Outdoors with solar load:
   $WBGT = 0.7\ NWB + 0.2\ GT + 0.1\ DB$
2. Indoors or Outdoors with no solar load:
   $WBGT = 0.7\ NWB + 0.3\ GT$

where:

WBGT = Wet Bulb Globe Temperature Index
NWB = Natural Wet-Bulb Temperature
DB = Dry-Bulb Temperature
GT = Globe Temperature

The determination of WBGT requires the use of a black globe thermometer, a natural (static) wet-bulb thermometer, and a dry-bulb thermometer.

Higher heat exposures than those shown in Table 1 and Figure 1 are permissible if the workers have been undergoing medical surveillance and it has been established that they are more tolerant to work in heat than the average worker. Workers should not be permitted to continue their work when their deep body temperature exceeds 38°C (100.4°F).

Evaluation and Control

I. Measurement of the Environment

The instruments required are a dry-bulb, a natural wet-bulb, a globe thermometer, and a stand. The measurement of the environmental factors should be performed as follows:

TABLE 1. Permissible Heat Exposure Threshold Limit Values [Values are given in °C and (°F) WBGT]

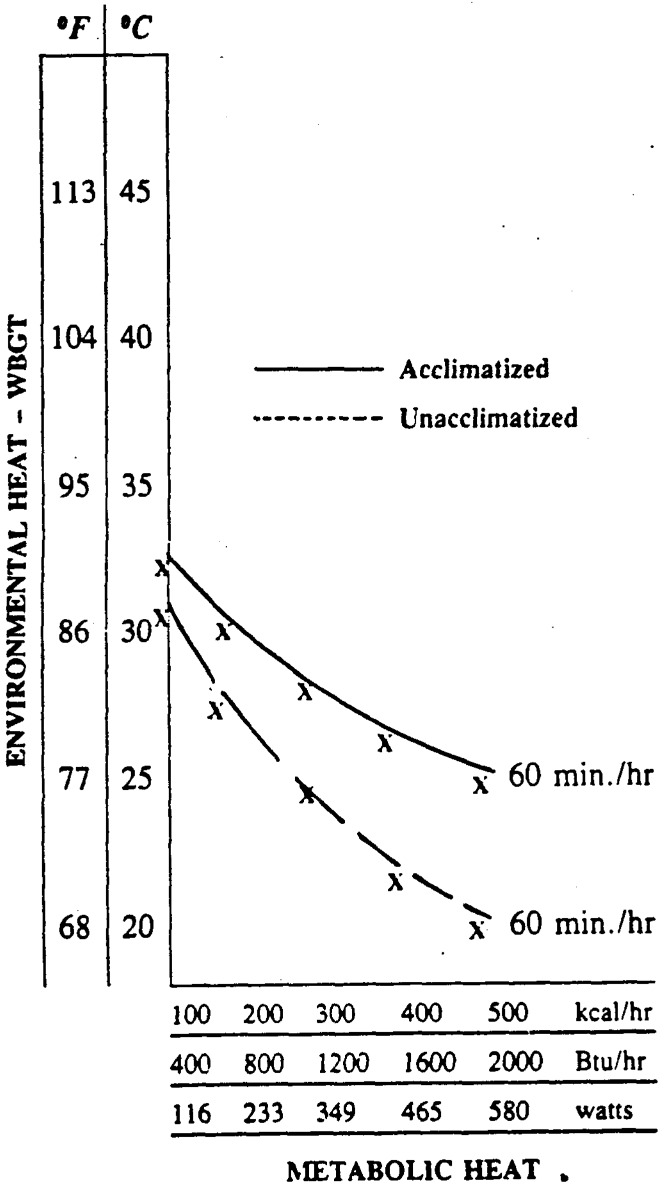
	Work Load		
Work—Rest Regimen	Light	Moderate	Heavy
Continuous work	30.0 (86)	26.7 (80)	25.0 (77)
75% Work — 25% Rest, each hour	30.6 (87)	28.0 (82)	25.9 (78)
50% Work — 50% Rest, each hour	31.4 (89)	29.4 (85)	27.9 (82)
25% Work — 75% Rest, each hour	32.2 (90)	31.1 (88)	30.0 (86)

A. The range of the dry and the natural wet bulb thermometer should be -5°C to +50°C (23°F to 122°F) with an accuracy of ± 0.5°C. The dry bulb thermometer must be shielded from the sun and the other radiant surfaces of the environment without restricting the airflow around the bulb. The wick of the natural wet-bulb thermometer should be kept wet with distilled water for at least 1/2 hour before the temperature reading is made. It is not enough to immerse the other end of the wick into a reservoir of distilled water and wait until the whole wick becomes wet by capillarity. The wick should be wetted by direct application of water from a syringe 1/2 hour before each reading. The wick should extend over the bulb of the thermometer, covering the stem about one additional bulb length. The wick should always be clean and new wicks should be washed before using.

B. A globe thermometer, consisting of a 15-cm (6-inch) diameter hollow copper sphere painted on the outside with a matte black finish or equivalent, should be used. The bulb or sensor of a thermometer (range -5°C to +100°C [23°F to 212°F] with an accuracy of ± 0.5°C) must be fixed in the center of the sphere. The globe thermometer should be exposed at least 25 minutes before it is read.

C. A stand should be used to suspend the three thermometers so that they do not restrict free air flow around the bulbs, and the wet-bulb and globe thermometer are not shaded.

D. It is permissible to use any other type of temperature sensor that gives a reading identical to that of a mercury thermometer under the same conditions.



†Figure 1—Permissible heat exposure Threshold Limit Values for heat acclimatized and unacclimatized workers.

E. The thermometers must be placed so that the readings are representative of the conditions under which the employees work or rest, respectively.

II. *Work Load Categories*

Heat produced by the body and the environmental heat together determine the total heat load. Therefore, if work is to be performed under hot environmental conditions, the workload category of each job should be established and the heat exposure limit pertinent to the workload evaluated against the applicable standard in order to protect the worker exposure beyond the permissible limit.

A. The work load category may be established by ranking each job into light, medium, or heavy categories on the basis of type of operation:

(1) light work (up to 200 kcal/hr or 800 Btu/hr): e.g., sitting or standing to control machines, performing light hand or arm work,
(2) moderate work (200–350 kcal/hr or 800–1400 Btu/hr): e.g., walking about with moderate lifting and pushing, or
(3) heavy work (350–500 kcal/hr or 1400–2000 Btu/hr): e.g., pick and shovel work.

Where the work load is ranked into one of said three categories, the permissible heat exposure TLV for each workload can be estimated from Table 1 or calculated using Tables 2 and 3.

B. The ranking of the job may be performed either by measuring the worker's metabolic rate while performing a job or by estimating the worker's metabolic rate with the use of Tables 2 and 3. Additional tables available in the literature[1–4] may be utilized also. When this method is used, the permissible heat exposure TLV can be determined by Figure 1.

III. *Work-Rest Regimen*

The TLVs specified in Table 1 and Figure 1 are based on the assumption that the WBGT value of the resting place is the same or very close to that of the workplace. Where the WBGT of the work area is different from that of the rest area, a time-weighted average value should be used for both environmental and metabolic heat.

The time-weighted average metabolic rate (M) should be determined by the equation:

$$\text{Av. M} = \frac{M_1 \times t_1 + M_2 \times t_2 + \ldots + M_n \times t_n}{t_1 + t_2 + \ldots + t_n}$$

where M_1, M_2...and M_n are estimated or measured metabolic rates for the various activities and rest periods of the worker during the time periods t_1, t_2...and t_n (in minutes) as determined by

TABLE 2. Assessment of Work Load

Average values of metabolic rate during different activities.

A. Body position and movement	kcal/min
Sitting	0.3
Standing	0.6
Walking	2.0-3.0
Walking up hill	add 0.8 per meter (yard) rise

B. Type of Work		Average kcal/min	Range kcal/min
Hand work	*light*	0.4	0.2-1.2
	heavy	0.9	
Work with one arm	*light*	1.0	0.7-2.5
	heavy	1.7	
Work with both arms	*light*	1.5	1.0-3.5
	heavy	2.5	
Work with body	*light*	3.5	2.5-15.0
	moderate	5.0	
	heavy	7.0	
	very heavy	9.0	

TABLE 3. Activity Examples

- Light hand work: writing, hand knitting
- Heavy hand work: typewriting
- Heavy work with one arm: hammering in nails (shoemaker, upholsterer)
- Light work with two arms: filing metal, planing wood, raking of a garden
- Moderate work with the body: cleaning a floor, beating a carpet
- Heavy work with the body: railroad track laying, digging, barking trees

Sample Calculation

Assembly line work using a heavy hand tool.

A.	Walking along	2.0 kcal/min
B.	Intermediate value between heavy work with two arms and light work with the body	3.0 kcal/min
	Subtotal:	5.0 kcal/min
C.	Add for basal metabolism	1.0 kcal/min
	Total:	6.0 kcal/min

a time study.

The time-weighted average WBGT should be determined by the equation:

$$\text{Av. WGBT} = \frac{\text{WBGT}_1 \times t_1 + \text{WBGT}_2 \times t_2 + \ldots + \text{WBGT}_n \times t_n}{t_1 + t_2 + \ldots + t_n}$$

where WBGT_1, WBGT_2 ... and WBGT_n are calculated values of WBGT for the various work and rest areas occupied during total time periods; t_1, t_2 ... and t_n are the elapsed times in minutes spent in the corresponding areas which are determined by a time study. Where exposure to hot environmental conditions is continuous for several hours or the entire work day, the time-weighted averages should be calculated as an hourly time-weighted average, i.e., $t_1 + t_2 + \ldots t_n = 60$ minutes. Where the exposure is intermittent, the time-weighted averages should be calculated as two-hour time-weighted averages, i.e., $t_1 + t_2 + \ldots + t_n = 120$ minutes.

The TLVs for continuous work are applicable where there is a work–rest regimen of a 5-day work week and an 8-hour work day with a short morning and afternoon break (approximately 15 minutes) and a longer lunch break (approximately 30 minutes). Higher exposure values are permitted if additional resting time is allowed. All breaks, including unscheduled pauses and administrative or operational waiting periods during work, may be counted as rest time when additional rest allowance must be given because of high environmental temperatures.

IV. *Water and Salt Supplementation*

During the hot season or when the worker is exposed to artificially generated heat, drinking water should be made available to the workers in such a way that they are stimulated to frequently drink small amounts, i.e., one cup every 15–20 minutes (about 150 ml or 1/4 pint).

The water should be kept reasonably cool, 10°C to 15°C (50°F to 60°F) and should be placed close to the workplace so that the worker can reach it without abandoning the work area.

The workers should be encouraged to salt their food abundantly during the hot season and particularly during hot spells. If the workers are unacclimatized, salted drinking water should be made available in a concentration of 0.1% (1 g NaCl to 1.0 liter or 1 level tablespoon of salt to 15 quarts of water). The added salt should be completely dissolved before the water is distributed, and the water should be kept reasonably cool.

V. *Other Considerations*

A. *Clothing:* The permissible heat exposure TLVs are valid for light summer clothing as customarily worn by workers when working under hot environmental conditions. If special clothing is required for performing a particular job and this clothing is heavier or it impedes sweat evaporation or has higher insulation value, the worker's heat tolerance is reduced, and the permissible heat exposure TLVs indicated in Table 1 and Figure 1 are not applicable. For each job category where special clothing is required, the permissible heat exposure TLV should be established by an expert.

†Table 4 identifies TLV WBGT correction factors for representative types of clothing.

B. *Acclimatization and Fitness:* Acclimatization to heat involves a series of physiological and psychological adjustments that occur in an individual during the first week of exposure to hot environmental conditions. The recommended heat stress TLVs are valid for acclimated workers who are physically fit. Extra caution must be employed when unacclimated or physically unfit workers must be exposed to heat stress conditions.

†**C.** *Adverse Health Effects:* The most serious of heat-induced illnesses is heat stroke because of its potential to be life threatening or result in irreversible damage. Other heat-induced illnesses include heat exhaustion which in its most serious form leads to prostration and can cause serious injuries as well. Heat cramps, while debilitating, are easily reversible if properly and promptly treated. Heat disorders due to excessive heat exposure include electrolyte imbalance, dehydration, skin rashes, heat edema, and loss of physical and mental work capacity.

If during the first trimester of pregnancy, a female worker's core temperature exceeds 39°C (102.2°F) for extended periods, there is an increased risk of malformation to the unborn fetus. Additionally, core temperatures above 38°C (100.4°F) may be associated with temporary infertility in both females and males.

†TABLE 4. TLV WBGT Correction Factors for Clothing

Clothing Type	Clo Value*	WBGT Correction
Summer work uniform	0.6	0
Cotton coveralls	1.0	-2
Winter work uniform	1.4	-4
Gortex® (water barrier)	1.2	-6
Tyvek® (vapor barrier) (fully encapsulating suit, gloves, boots & hood)	1.2	-10

*Clo: Insulation value of clothing. One clo unit = 5.55 kcal/m²/hr of heat exchange by radiation and convection for each °C of temperature difference between the skin and adjusted dry bulb temperature.

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HEAT STRESS PLAN
(IF WEARING IMPERVIOUS FULL-BODY CLOTHING)

Heat Stress and Other Physiological Factors

Wearing PPE puts a hazardous waste worker at considerable risk of developing heat stress. This can result in health effects ranging from transient heat fatigue to serious illness or death. Heat stress is caused by a number of interacting factors, including environmental conditions, clothing, workload, and the individual characteristics of the worker. Because heat stress is probably one of the most common (and potentially serious) illnesses at hazardous waste sites, regular monitoring and other preventive precautions are vital.

Individuals vary in their susceptibility to heat stress. Factors that may predispose someone to heat stress include:

- Lack of physical fitness.
- Lack of acclimatization.
- Age.
- Dehydration.
- Obesity.
- Alcohol and drug use.
- Infection.
- Sunburn.
- Diarrhea.
- Chronic disease.

Reduced work tolerance and the increased risk of excessive heat stress is directly influenced by the amount and type of PPE worn. PPE adds weight and bulk, severely reduces the body's access to normal heat exchange mechanisms (evaporation, convection, and radiation), and increases energy expenditure. Therefore, when selecting PPE, each item's benefit should be carefully evaluated in relation to its potential for increasing the risk of heat stress. Once PPE is selected, the safe duration of work/rest periods should be determined based on the:

- Anticipated work rate.
- Ambient temperature and other environmental factors.
- Type of protective ensemble.
- Individual worker characteristics and fitness.

Monitoring

Because the incidence of heat stress depends on a variety of factors, all workers, even those not wearing protective equipment, should be monitored.

- For workers wearing permeable clothing (e.g., standard cotton or synthetic work clothes), follow recommendations for monitoring requirements and suggested work/rest schedules in the current American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values for Heat Stress [11]. If the actual clothing worn differs from the ACGIH standard ensemble in insulation value and/or wind and vapor permeability, change the monitoring requirements and work/rest schedules accordingly [12].
- For workers wearing semipermeable or impermeable[1] encapsulating ensembles, the ACGIH standard cannot be used. For these situations, workers should be monitored when the temperature in the work area is above 70°F (21°C) [6].

To monitor the worker, measure:

- Heart rate. Count the radial pulse during a 30-second period as early as possible in the rest period.

  If the heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same.

  If the heart rate still exceeds 110 beats per minute at the next rest period, shorten the following work cycle by one-third [12].
- Oral temperature. Use a clinical thermometer (3 minutes under the tongue) or similar device to measure the oral temperature at the end of the work period (before drinking).

  If oral temperature exceeds 99.6°F (37.6°C), shorten the next work cycle by one-third without changing the rest period.

  If oral temperature still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, shorten the following work cycle by one-third [12].

  Do *not* permit a worker to wear a semipermeable or impermeable garment when his/her oral temperature exceeds 100.6°F (38.1°C)[12].
- Body water loss, if possible. Measure weight on a scale accurate to ±0.25 lb at the beginning and end of each work day to see if enough fluids are being taken to prevent dehydration. Weights should be taken while the employee wears similar clothing or, ideally, is nude. *The body water loss should not exceed 1.5 percent total body weight loss in a work day* [12].

Initially, the frequency of physiological monitoring depends on the air temperature adjusted for solar radiation and the level of physical work (see Table 8-10). The length of the work cycle will be governed by the frequency of the required physiological monitoring.

Prevention

Proper training and preventive measures will help avert serious illness and loss of work productivity. Preventing heat stress is particularly important because once someone suffers from heat stroke or heat exhaustion, that person may be predisposed to additional heat injuries. To avoid heat stress, management should take the following steps:

- Adjust work schedules:

  Modify work/rest schedules according to monitoring requirements.

  Mandate work slowdowns as needed.

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[1] Although no protective ensemble is "completely" impermeable, for practical purposes an outfit may be considered impermeable when calculating heat stress risk.

  - Rotate personnel: alternate job functions to minimize overstress or overexertion at one task.
  - Add additional personnel to work teams.
  - Perform work during cooler hours of the day if possible or at night if adequate lighting can be provided.
- Provide shelter (air-conditioned, if possible) or shaded areas to protect personnel during rest periods.
- Maintain workers' body fluids at normal levels. This is necessary to ensure that the cardiovascular system functions adequately. Daily fluid intake must approximately equal the amount of water lost in sweat, i.e., 8 fluid ounces (0.23 liters) of water must be ingested for approximately every 8 ounces (0.23 kg) of weight lost. The normal thirst mechanism is not sensitive enough to ensure that enough water will be drunk to replace lost sweat [14]. When heavy sweating occurs, encourage the worker to drink more. The following strategies may be useful:
  - Maintain water temperature at 50° to 60°F (10° to 15.6°C).
  - Provide small disposable cups that hold about 4 ounces (0.1 liter).
  - Have workers drink 16 ounces (0.5 liters) of fluid (preferably water or dilute drinks) before beginning work.
  - Urge workers to drink a cup or two every 15 to 20 minutes, or at each monitoring break. A total of 1 to 1.6 gallons (4 to 6 liters) of fluid per day are recommended, but more may be necessary to maintain body weight.
  - Weigh workers before and after work to determine if fluid replacement is adequate.
- Encourage workers to maintain an optimal level of physical fitness:
  - Where indicated, acclimatize workers to site work conditions: temperature, protective clothing, and workload (see *Level of Acclimatization* at the end of this chapter).
  - Urge workers to maintain normal weight levels.
- Provide cooling devices to aid natural body heat exchange during prolonged work or severe heat exposure. Cooling devices include:
  - Field showers or hose-down areas to reduce body temperature and/or to cool off protective clothing.
  - Cooling jackets, vests, or suits (see Table 8-5 for details).
- Train workers to recognize and treat heat stress. As part of training, identify the signs and symptoms of heat stress (see Table 8-11).

Other Factors

PPE decreases worker performance as compared to an unequipped individual. The magnitude of this effect varies considerably, depending on both the individual and the PPE ensemble used. This section discusses the demonstrated physiological responses to PPE, the individual human characteristics that play a factor in these responses, and some of the precautionary and training measures that need to be taken to avoid PPE-induced injury.

The physiological factors may affect worker ability to function using PPE include:

- Physical condition.
- Level of acclimatization.
- Age.
- Gender.
- Weight.

Physical Condition

Physical fitness is a major factor influencing a person's ability to perform work under heat stress. The more fit someone is, the more work they can safely perform. At a given level of work, a fit person, relative to an unfit person, will have [5,8,15,16]:

- Less physiological strain.
- A lower heart rate.
- A lower body temperature, which indicates less retained body heat (a rise in internal temperature precipitates heat injury).
- A more efficient sweating mechanism.
- Slightly lower oxygen consumption.
- Slightly lower carbon dioxide production.

Level of Acclimatization

The degree to which a worker's body has physiologically adjusted or acclimatized to working under hot conditions affects his or her ability to do work. Acclimatized individuals generally have lower heart rates and body temperatures than unacclimatized individuals [17], and sweat sooner and more profusely. This enables them to maintain lower skin and body temperatures at a given level of environmental heat and work loads than unacclimatized workers [18]. Sweat composition also becomes more dilute with acclimatization, which reduces salt loss [8].

Acclimatization can occur after just a few days of exposure to a hot environment [15,16]. NIOSH recommends a progressive 6-day acclimatization period for the unacclimatized worker before allowing him/her to do full work on a hot job [16]. Under this regimen, the first day of work on site is begun using only 50 percent of the anticipated workload and exposure time, and 10 percent is added each day through day 6 [16]. With fit or trained individuals, the acclimatization period may be shortened 2 or 3 days. However, workers can lose acclimitization in a matter of days, and work regimens should be adjusted to account for this.

When enclosed in an impermeable suit, fit acclimatized individuals sweat more profusely than unfit or unacclimatized individuals and may therefore actually face a greater danger of heat exhaustion due to rapid dehydration. This can be prevented by consuming adequate quantities of water. See previous section on *Prevention* for additional information.

Table 8-10. Suggested Frequency of Physiological Monitoring for Fit and Acclimatized Workers[a]

ADJUSTED TEMPERATURE[b]	NORMAL WORK ENSEMBLE[c]	IMPERMEABLE ENSEMBLE
90°F (32.2°C) or above	After each 45 minutes of work	After each 15 minutes of work
87.5°-90°F (30.8°-32.2°C)	After each 60 minutes of work	After each 30 minutes of work
82.5°-87.5°F (28.1°-30.8°C)	After each 90 minutes of work	After each 60 minutes of work
77.5°-82.5°F (25.3°-28.1°C)	After each 120 minutes of work	After each 90 minutes of work
72.5°-77.5°F (22.5°-25.3°C)	After each 150 minutes of work	After each 120 minutes of work

Source: Reference [13].

[a] For work levels of 250 kilocalories/hour.

[b] Calculate the adjusted air temperature (ta adj) by using this equation: ta adj °F = ta °F + (13 × % sunshine). Measure air temperature (ta) with a standard mercury-in-glass thermometer, with the bulb shielded from radiant heat. Estimate percent sunshine by judging what percent time the sun is not covered by clouds that are thick enough to produce a shadow. (100 percent sunshine = no cloud cover and a sharp, distinct shadow; 0 percent sunshine = no shadows.)

[c] A normal work ensemble consists of cotton coveralls or other cotton clothing with long sleeves and pants.

Table 8-11. Signs and Symptoms of Heat Stress[a]

- Heat rash may result from continuous exposure to heat or humid air.
- Heat cramps are caused by heavy sweating with inadequate electrolyte replacement. Signs and symptoms include:
  - muscle spasms
  - pain in the hands, feet, and abdomen
- Heat exhaustion occurs from increased stress on various body organs including inadequate blood circulation due to cardiovascular insufficiency or dehydration. Signs and symptoms include:
  - pale, cool, moist skin
  - heavy sweating
  - dizziness
  - nausea
  - fainting
- Heat stroke is the most serious form of heat stress. Temperature regulation fails and the body temperature rises to critical levels. Immediate action must be taken to cool the body before serious injury and death occur. Competent medical help must be obtained. Signs and symptoms are:
  - red, hot, usually dry skin
  - lack of or reduced perspiration
  - nausea
  - dizziness and confusion
  - strong, rapid pulse
  - coma

[a] Source: Reference [6].

Age

Generally, maximum work capacity declines with increasing age, but this is not always the case. Active, well-conditioned seniors often have performance capabilities equal to or greater than young sedentary individuals. However, there is some evidence, indicated by lower sweat rates and higher body core temperatures, that older individuals are less effective in compensating for a given level of environmental heat and work loads [19]. At moderate thermal loads, however, the physiological responses of "young" and "old" are similar and performance is not affected [19].

Age should not be the sole criterion for judging whether or not an individual should be subjected to moderate heat stress. Fitness level is a more important factor.

Gender

The literature indicates that females tolerate heat stress at least as well as their male counterparts [20]. Generally, a female's work capacity averages 10 to 30 percent less than that of a male [8]. The primary reasons for this are the greater oxygen-carrying capacity and the stronger heart in the male [15]. However, a similar situation exists as with aging: not all males have greater work capacities than all females.

Weight

The ability of a body to dissipate heat depends on the ratio of its surface area to its mass (surface area/weight). Heat loss (dissipation) is a function of surface area and heat production is dependent on mass. Therefore, heat balance is described by the ratio of the two.

Since overweight individuals (those with a low ratio) produce more heat per unit of surface area than thin individuals (those with a high ratio), overweight individuals should be given special consideration in heat stress situations. However, when wearing impermeable clothing, the weight of an individual is not a critical factor in determining the ability to dissipate excess heat.

ATTACHMENT 4
COLD EXPOSURE

COLD STRESS

The cold stress TLVs are intended to protect workers from the severest effects of cold stress (hypothermia) and cold injury and to describe exposures to cold working conditions under which it is believed that nearly all workers can be repeatedly exposed without adverse health effects. The TLV objective is to prevent the deep body temperature from falling below 36°C (96.8°F) and to prevent cold injury to body extremities (deep body temperature is the core temperature of the body determined by conventional methods for rectal temperature measurements). For a single, occasional exposure to a cold environment, a drop in core temperature to no lower that 35°C (95°F) should be permitted. In addition to provisions for total body protection, the TLV objective is to protect all parts of the body with emphasis on hands, feet, and head from cold injury.

Introduction

Fatal exposures to cold among workers have almost always resulted from accidental exposures involving failure to escape from low environmental air temperatures or from immersion in low temperature water. The single most important aspect of life-threatening hypothermia is the fall in the deep core temperature of the body. The clinical presentations of victims of hypothermia are shown in Table 1. Workers should be protected from exposure to cold so that the deep core temperature does not fall below 36°C (96.8°F); lower body temperatures will very likely result in reduced mental alertness, reduction in rational decision making, or loss of consciousness with the threat of fatal consequences.

Pain in the extremities may be the first early warning of danger to cold stress. During exposure to cold, maximum severe shivering develops when the body temperature has fallen to 35°C (95°F). This must be taken as a sign of danger to the workers and exposure to cold should be immediately terminated for any workers when severe shivering becomes evident. Useful physical or mental work is limited when severe shivering occurs.

Since prolonged exposure to cold air, or to immersion in cold water, at temperatures well above freezing can lead to dangerous hypothermia, whole body protection must be provided.

TABLE 1. Progressive Clinical Presentations of Hypothermia*

Core Temperature		
°C	°F	Clinical Signs
37.6	99.6	"Normal" rectal temperature
37	98.6	"Normal" oral temperature
36	96.8	Metabolic rate increases in an attempt to compensate for heat loss
35	95.0	Maximum shivering
34	93.2	Victim conscious and responsive, with normal blood pressure
33	91.4	Severe hypothermia below this temperature
32	89.6	Consciousness clouded; blood pressure becomes difficult to obtain; pupils dilated but react to light; shivering ceases
31	87.8	
30	86.0	Progressive loss of consciousness; muscular rigidity increases; pulse and blood pressure difficult to obtain; respiratory rate decreases
29	84.2	
28	82.4	Ventricular fibrillation possible with myocardial irritability
27	80.6	Voluntary motion ceases; pupils nonreactive to light; deep tendon and superficial reflexes absent
26	78.8	Victim seldom conscious
25	77.0	Ventricular fibrillation may occur spontaneously
24	75.2	Pulmonary edema
22	71.6	Maximum risk of ventricular fibrilation
21	69.8	
20	68.0	Cardiac standstill
18	64.4	Lowest accidental hypothermia victim to recover
17	62.6	Isoelectric electroencephalogram
9	48.2	Lowest artificially cooled hypothermia patient to recover

* Presentations approximately related to core temperature. Reprinted from the January 1982 issue of *American Family Physician*, published by the American Academy of Family Physicians.

1. Adequate insulating dry clothing to maintain core temperatures above 36°C (96.8°F) must be provided to workers if work is performed in air temperatures below 4°C (40°F). Wind chill cooling rate and the cooling power of air are critical factors. [Wind chill cooling rate is defined as heat loss from a body expressed in watts per meter squared which is a function of the air temperature and wind velocity upon the exposed body.] The higher the wind speed and the lower the temperature in the work area, the greater the insulation value of the protective clothing required. An equivalent chill temperature chart relating the actual dry bulb air temperature and the wind ve-

locity is presented in Table 2. The equivalent chill temperature should be used when estimating the combined cooling effect of wind and low air temperatures on exposed skin or when determining clothing insulation requirements to maintain the deep body core temperature.

2. Unless there are unusual or extenuating circumstances, cold injury to other than hands, feet, and head is not likely to occur without the development of the initial signs of hypothermia. Older workers or workers with circulatory problems require special precautionary protection against cold injury. The use of extra insulating clothing and/or a reduction in the duration of the exposure period are among the special precautions which should be considered. The precautionary actions to be taken will depend upon the physical condition of the worker and should be determined with the advice of a physician with knowledge of the cold stress factors and the medical condition of the worker.

Evaluation and Control

For exposed skin, continuous exposure should not be permitted when the air speed and temperature results in an equivalent chill temperature of -32°C (25.6°F). Superficial or deep local tissue freezing will occur only at temperatures below -1°C (30.2°F) regardless of wind speed.

At air temperatures of 2°C (35.6°F) or less, it is imperative that workers who become immersed in water or whose clothing becomes wet be immediately provided a change of clothing and be treated for hypothermia.

Recommended limits for properly clothed workers for periods of work at temperatures below freezing are shown in Table 3.

Special protection of the hands is required to maintain manual dexterity for the prevention of accidents:

1. If fine work is to be performed with bare hands for more than 10-20 minutes in an environment below 16°C (60.8°F), special provisions should be established for keeping the workers' hands warm. For this purpose, warm air jets, radiant heaters (fuel burner or electric radiator), or contact warm plates may be utilized. Metal handles of tools and control bars should be covered by thermal insulating material at temperatures below -1°C (30.2°F).
2. If the air temperature falls below 16°C (60.8°F) for sedentary, 4°C (39.2°F) for light, -7°C (19.4°F) for moderate work and fine manual dexterity is not required, then gloves should be used by the workers.

To prevent contact frostbite, the workers should wear anticontact gloves.

1. When cold surfaces below -7°C (19.4°F) are within reach, a warning should be given to each worker by the supervisor to prevent inadvertent contact by bare skin.

TABLE 2. Cooling Power of Wind on Exposed Flesh Expressed as Equivalent Temperature (under calm conditions)*

Estimated Wind Speed (in mph)	Actual Temperature Reading (°F)											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	Equivalent Chill Temperature (°F)											
calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
(Wind speeds greater than 40 mph have little additional effect.)	*LITTLE DANGER* In < hr with dry skin. Maximum danger of false sense of security					*INCREASING DANGER* Danger from freezing of exposed flesh within one minute.			*GREAT DANGER* Flesh may freeze within 30 seconds.			
	Trenchfoot and immersion foot may occur at any point on this chart.											

* Developed by U.S. Army Research Institute of Environmental Medicine, Natick, MA.

TABLE 3. Threshold Limit Values Work/Warm-up Schedule for Four-Hour Shift*

Air Temperature—Sunny Sky		No Noticeable Wind		5 mph Wind		10 mph Wind		15 mph Wind		20 mph Wind	
°C (approx.)	°F (approx.)	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks
-26° to -28°	-15° to -19°	(Norm. Breaks)	1	(Norm. Breaks)	1	75 min	2	55 min	3	40 min	4
-29° to -31°	-20° to -24°	(Norm. Breaks)	1	75min	2	55 min	3	40 min	4	30 min	5
-32° to -34°	-25° to -29°	75 min	2	55 min	3	40 min	4	30 min	5	Non-emergency work should cease	
-35° to -37°	-30° to -34°	55 min	3	40 min	4	30 min	5	Non-emergency work should cease			
-38° to -39°	-35° to -39°	40 min	4	30 min	5	Non-emergency work should cease					
-40° to -42°	-40° to -44°	30 min	5	Non-emergency work should cease							
-43° & below	-45° & below	Non-emergency work should cease		↓		↓		↓		↓	

Notes for Table 3:

1. Schedule applies to moderate to heavy work activity with warm-up breaks of ten (10) minutes in a warm location. For Light-to-Moderate Work (limited physical movement): *apply the schedule one step lower. For example*, at -35°C (-30°F) with no noticeable wind (Step 4), a worker at a job with little physical movement should have a maximum work period of 40 minutes with 4 breaks in a 4-hour period (Step 5).
2. The following is suggested as a guide for estimating wind velocity if accurate information is not available:
   5 mph: light flag moves; 10 mph: light flag fully extended; 15 mph: raises newspaper sheet; 20 mph: blowing and drifting snow.
3. If only the wind chill cooling rate is available, a rough rule of thumb for applying it rather than the temperature and wind velocity factors given above would be: 1) special warm-up breaks should be initiated at a wind chill cooling rate of about 1750 W/m^2; 2) all non-emergency work should have ceased at or before a wind chill of 2250 W/m^2. In general the warm-up schedule provided above slightly under-compensates for the wind at the warmer temperatures, assuming acclimatization and clothing appropriate for winter work. On the other hand, the chart slightly over-compensates for the actual temperatures in the colder ranges, since windy conditions rarely prevail at extremely low temperatures.
4. TLVs apply only for workers in dry clothing.

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* **Adapted from *Occupational Health & Safety Division*, Saskatchewan Department of Labour.**

2. If the air temperature is −17.5°C (0°F) or less, the hands should be protected by mittens. Machine controls and tools for use in cold conditions should be designed so that they can be handled without removing the mittens.

Provisions for additional total body protection are required if work is performed in an environment at or below 4°C (39.2°F). The workers should wear cold protective clothing appropriate for the level of cold and physical activity:

1. If the air velocity at the job site is increased by wind, draft, or artificial ventilating equipment, the cooling effect of the wind should be reduced by shielding the work area or by wearing an easily removable windbreak garment.
2. If only light work is involved and if the clothing on the worker may become wet on the job site, the outer layer of the clothing in use may be of a type impermeable to water. With more severe work under such conditions, the outer layer should be water repellent, and the outerwear should be changed as it becomes wetted. The outer garments should include provisions for easy ventilation in order to prevent wetting of inner layers by sweat. If work is done at normal temperatures or in a hot environment before entering the cold area, the employee should make sure that clothing is not wet as a consequence of sweating. If clothing is wet, the employee should change into dry clothes before entering the cold area. The workers should change socks and any removable felt insoles at regular daily intervals or use vapor barrier boots. The optimal frequency of change should be determined empirically and will vary individually and according to the type of shoe worn and how much the individual's feet sweat.
3. If exposed areas of the body cannot be protected sufficiently to prevent sensation of excessive cold or frostbite, protective items should be supplied in auxiliary heated versions.
4. If the available clothing does not give adequate protection to prevent hypothermia or frostbite, work should be modified or suspended until adequate clothing is made available or until weather conditions improve.
5. Workers handling evaporative liquid (gasoline, alcohol or cleaning fluids) at air temperatures below 4°C (39.2°F) should take special precautions to avoid soaking of clothing or gloves with the liquids because of the added danger of cold injury due to evaporative cooling. Special note should be taken of the particularly acute effects of splashes of "cryogenic fluids" or those liquids with a boiling point that is just above ambient temperature.

Work-Warming Regimen

If work is performed continuously in the cold at an equivalent chill temperature (ECT) or below −7°C (19.4°F), heated warming shelters (tents, cabins, rest rooms, etc.) should be made available nearby. The workers should be encouraged to use these shelters at regular intervals, the frequency depending on the severity of the environmental exposure. The onset of heavy shivering, frostnip, the feeling of excessive fatigue, drowsiness, irritability, or euphoria are indications for immediate return to the shelter. When entering the heated shelter, the outer layer of clothing should be removed and the remainder of the clothing loosened to permit sweat evaporation or a change of dry work clothing provided. A change of dry work clothing should be provided as necessary to prevent workers from returning to work with wet clothing. Dehydration, or the loss of body fluids, occurs insidiously in the cold environment and may increase the susceptibility of the worker to cold injury due to a significant change in blood flow to the extremities. Warm sweet drinks and soups should be provided at the work site to provide caloric intake and fluid volume. The intake of coffee should be limited because of the diuretic and circulatory effects.

For work practices at or below −12°C (10.4°F) ECT, the following should apply:

1. The worker should be under constant protective observation (buddy system or supervision).
2. The work rate should not be so high as to cause heavy sweating that will result in wet clothing; if heavy work must be done, rest periods must be taken in heated shelters and opportunity for changing into dry clothing should be provided.
3. New employees should not be required to work fulltime in the cold during the first days of employment until they become accustomed to the working conditions and required protective clothing.
4. The weight and bulkiness of clothing should be included in estimating the required work performance and weights to be lifted by the worker.
5. The work should be arranged in such a way that sitting still or standing still for long periods is minimized. Unprotected metal chair seats should not be used. The worker should be protected from drafts to the greatest extent possible.
6. The workers should be instructed in safety and health procedures. The training program should include as a minimum instruction in:
   - a. Proper rewarming procedures and appropriate first aid treatment.
   - b. Proper clothing practices.
   - c. Proper eating and drinking habits.
   - d. Recognition of impending frostbite.
   - e. Recognition of signs and symptoms of impending hypothermia or excessive cooling of the body even when shivering does not occur.
   - f. Safe work practices.

Special Workplace Recommendations

Special design requirements for refrigerator rooms include the following:

1. In refrigerator rooms, the air velocity should be minimized as much as possible and should not exceed 1 meter/sec (200 fpm) at the job site. This can be achieved by properly designed air distribution systems.
2. Special wind protective clothing should be provided based upon existing air velocities to which workers are exposed.

Special caution should be exercised when working with toxic substances and when workers are exposed to vibration. Cold exposure may require reduced exposure limits.

Eye protection for workers employed out-of-doors in a snow and/or ice-covered terrain should be supplied. Special safety goggles to protect against ultraviolet light and glare (which can produce temporary conjunctivitis and/or temporary loss of vision) and blowing ice crystals should be required when there is an expanse of snow coverage causing a potential eye exposure hazard.

Workplace monitoring is required as follows:

1. Suitable thermometry should be arranged at any workplace where the environmental temperature is below 16°C (60.8°F) so that overall compliance with the requirements of the TLV can be maintained.
2. Whenever the air temperature at a workplace falls below −1°C (30.2°F), the dry bulb temperature should be measured and recorded at least every 4 hours.
3. In indoor workplaces, the wind speed should also be recorded at least every 4 hours whenever the rate of air movement exceeds 2 meters per second (5 mph).
4. In outdoor work situations, the wind speed should be measured and recorded together with the air temperature whenever the air temperature is below −1°C (30.2°F).
5. The equivalent chill temperature should be obtained from Table 2 in all cases where air movement measurements are required; it should be recorded with the other data whenever the equivalent chill temperature is below −7°C (19.4°F).

Employees should be excluded from work in cold at −1°C (30.2°F) or below if they are suffering from diseases or taking medication which interferes with normal body temperature regulation or reduces tolerance to work in cold environments. Workers who are routinely exposed to temperatures below −24°C (11.2°F) with wind speeds less than five miles per hour, or air temperatures below −18°C (0°F) with wind speeds above five miles per hour, should be medically certified as suitable for such exposures.

Trauma sustained in freezing or subzero conditions requires special attention because an injured worker is predisposed to cold injury. Special provisions should be made to prevent hypothermia and freezing of damaged tissues in addition to providing for first aid treatment.

ATTACHMENT 5
PERSONAL EXPOSURE SAMPLING METHODS AND NIOSH ANALYTICAL METHODS

PERSONAL EXPOSURE SAMPLING METHODS

1.0 APPLICABILITY

This document applies to monitoring programs employing low volume air sampling devices including those manufactured by Gilian and SKC and the Dawson air sampling pump. Procedures are provided for routine operations, calibration and maintenance of these systems.

2.0 REFERENCES AND SUPPORTING DOCUMENTS

- Operating Manual for the HFS 513 Air Sampling System - Gilian
- Operating Manual for SKC Sample Pump Model 224-PCXR3
- Operating Manual for Dawson Sampling Pump

3.0 EQUIPMENT REQUIRED

3.1 System Components

- Gilian Sampling Pump, Model # HFS 513A
- SKC Sampling Pump, Model # 224-PCXR3
- Dawson Air Sampling Pump (AC power)
- Rotameter Calibrator Cases Model IHCP-HL-300
  Rotameters include 10-70 ml, 20-200 ml, 50-800 ml, and 500-5000 ml ranges
- Gilian Battery Chargers
- SKC 224 Battery Chargers

3.2 Accessory Items

- Multiple flow controller manifolds with 1,2,3,4&5 sampling points
- "Small" sorbent tube holders (THH-S-225)
- "Large" sorbent tube holders (THH-L-247)
- "Large" sorbent tube holder modifiers (ie, # 800138)
- Connectors for joining tube holders in series end nozzles
- Screw driver (phillips and slots) for flow adjustment
- Sampling Tripods
- Glass impingers - liquid media sampling
- Cartridge adapters

4.0 FORMS REQUIRED

- Form AQ-500.1: Personal Air Sample Data Sheet
- Form AQ-500.2: Low Volume Ambient Sample Data Sheet

5.0 DISPOSITION OF DOCUMENTATION

All calibration documents called for in this SOP will be distributed as follows:

- One copy remains with the instrument and is placed in the instrument's Calibration and Maintenance File at the field site

- One copy is submitted to the Program Manager at the Wayne, NJ office

- One copy is submitted to the Data Processing and Validation Department at the Wayne, NJ office

6.0 PERSONAL SAMPLING OPERATION

The low volume pumps are designed to sample a broad category of contaminants at a range of flow rates utilizing a variety of sorbent and collection media. The setup and monitoring procedures for personal sampling are provided in the following sections.

6.1 Charging the Sampling Pumps

Before use, it is necessary to properly charge the Gilian and SKC pump's internal battery. Pumps require 16 hours to recharge from a completely discharged state. It is not advisable to charge the pumps at the high (standard) rate for more than 24 hours. If the batteries are to charge for more than 24 hours, the charger should be switched to low (trickle) rate. When charging pumps, check the charger to make sure it is the correct charger for the pumps to be charged. This is VERY IMPORTANT before departing for the field or sending pumps to other offices. When preparing a pump for sampling check battery charge by pressing the "bat ck" switch.

After the pumps are charged, test each pump for correct operation using the following procedures:

1) Remove the pump from the charger and using the slot screwdriver supplied with the unit, turn the pump on by flipping the switch located near the bottom right of the pump's face. The pump should begin running immediately. If it does not, repeat the step.

   If the pump will not run, it may require further charging. If a red light appears at the center of the face of the pump, then a problem exists with the flow stream within the pump. Do not use this pump. Turn it off, and call the Wayne office.

2) The flow controller adjustment screw is located just to the right of the on/off switch. Use the screwdriver to adjust the flow up and down several times. You should hear the pump volume and speed change with the movement, and see the flowmeter located on the right of the pump react.

If the pump will not react to flow adjustment, do not use this pump. Turn it off and contact the Wayne office.

3) Return the pump flowrate to approximately 2 to 3 liters/min using the unit's flowmeter. Using the screwdriver press lightly the small blue button located at the bottom of the unit's face, between the on/off switch and the adjustment screw. As you hold this button down the LCD clock face located in the center of the pump will light up. The amount of time (in minutes) that has passed since you first turned the pump on will appear, along with a blinking dot representing seconds.

If the clock does not appear, do not use the pump.

4) If the pump passes all the above tests, it is ready for use.

6.2 Adjusting the Flowrate

After testing the pumps, begin to set them up for sampling. The first step is to perform a rough flow rate adjustment using the following procedures. Note: Personal sampling for Health and Safety requires higher accuracy, hence a gilibrator or a bubblemeter should be used in place of a rotameter to adjust the flowrate.

1) Place the calibration case onto a flat and level surface. Open the case and pull the top fully into its upright position. To adjust the pump to the proper flowrate for arsenic sampling use the rotameter marked High Flow, FM 1. The second rotameter and the vacuum gauge will not be require

for this application. The rotameter should be calibrated against an NBS traceable device (bubblemeter), at 5-points within the last 3 months.

2) Various lengths of tygon tubing have been supplied with the unit, remove the one that is 2 feet long, and has no nozzles or clips attached to it. Attach one end of this tube to the inlet nozzle on the pump (the pump should not be running at this time). The inlet is the clear plastic attachment located on the right side of the pump. Attach the other end onto the calibration case nozzle marked B1, Pump Suction.

3) Place the pump down next to the case and turn it on using the screwdriver. Make sure the pump outlet (at the top of the pump) and the calibration case nozzle marked B2 are not covered or blocked in any way.

4) The high flow rotameter should immediately react to the suction being applied. Give the pump several seconds to produce a steady flowrate, then using the screwdriver, adjust the flowrate to 2-3 liters/minute on the rotameter. Hold the pump still on the level surface during adjustment. Do not pick it up and hold it in the air!

   The rotameter should not be fluctuating more than plus or minus 0.1 after the adjustment. If the rotameter is showing a wide fluctuation in readings, then check the tygon tube connections. If the connections are tight, be sure the case B2 nozzle and the pump's outlet are clear. If the rotameter continued to fluctuate, do not use the pump.

5) After adjustment, turn the pump off and remove it from the calibration case. Repeat the steps for the other pumps.

6.3 Preparation for Sampling

The next procedure is to install the sample filter and make the final adjustments for sampling using the following procedures. Note: Personal sampling for Health and Safety requires higher accuracy, hence a gilibrator or bubblemeter should be used in place of a rotameter to make the final adjustments to flow rates.

1) First complete the Personal Sample Data Sheet (Form AQ-500.1) with the following information.

    1. Date
    2. Name of the person to be sampled.
    3. Name of the person's company.
    4. The person's job description.
    5. The filter number.

2) Remove one of the preassembled sample filter cassettes and place a label on it containing the same information.

3) Remove one of the supplied tubes (tygon or teflon) which have a nozzle and metal clip attached. Connect this tube to the pump. Remove the short tygon tube that has only a nozzle, and attach it to the calibration case B 1 nozzle.

4) Remove the two protective plugs from the filter cassette. Do not throw these away or lose them. They will be needed again. Connect the end of the cassette nearest to the sample filter to the tubing from the pump by pushing it onto the nozzle with a slight twisting action. Do not force it on too tightly. Use wide masking or cellophane tape to secure the cassette onto the tube.

5) Next place the pump next to the calibration case and connect the other end of the filter cassette to the tubing from the case's nozzle B 1.

6) You are now ready to make the final adjustment to the pump flow rate. As before, turn the pump on as it sits on a level surface. While reading the rotameter adjust the flow rate until you achieve 2.0 liters/minute. If a steady flow rate cannot be achieved, check all connections for tightness.

7) Once you have the proper flow, turn the pump off, wait a moment and then turn it back on. You should again have a reading of 2.0 on the rotameter. If it is off by 0.2 liters/minute or more, readjust the flowrate, and repeat this step. Record your initial flowrate on Form AQ-500.1.

8) It is the preferred method to leave the pump running, disconnect it from the calibration case, and immediately place it on the person to be sampled. If this is not possible, then turn the pump off, disconnect it from the case, and seal the end of the filter cassette with one of the plugs.

9) Once you are ready to sample, attach the pump to the person's belt or place in a pocket if they are wearing overalls. Make sure that the outlet is not blocked, or covered by his clothing. Bring the filter cassette over the person's shoulder and clip it as near the person's face as is convenient. Have the open end of the cassette facing downwards, to limit the amount of dirt falling in, rather than being drawn in with air. Remove the plug from the cassette, and turn the pump on. Record the start time of the sampling in Form AQ-500.1

6.4 Sample Collection

During the monitoring, check the pump as often as possible for correct operation. Check the following items:

1. Is the filter cassette secured?
2. Is the pump running?
3. Is the red light showing on the pump face?
4. Does the running time show when the button is pressed?

Also check the condition of the cassette itself, how much dust has entered, have mud or chemicals been splashed on it, etc.

If the pump has stopped during the run and the red light is showing then the outlet or inlet has been blocked. Change the pump's position to prevent this, record the elapsed time, turn the pump off to reset, and begin sampling again.

Once sampling has begun it should never be stopped, even if the person is to leave the site temporarily. Average running times should be between 6 and 8 hours. A second sample filter should be used to replace the first filter after 2 or 3 hours if very heavy dust conditions exist and the pump flow rate is difficult to maintain.

6.5 Sample Removal

When monitoring is complete, the person wearing the unit should return to the area with the calibration case. Without turning off the pump, remove the unit and cassette from the person. Immediately connect the filter cassette to the rotameter. Record the final flow rate and the time on the sample data sheet. Note: Personal sampling for Health and Safety requires higher accuracy, hence a gilibrator or bubblemeter should be used in place of a rotameter to check the final flow rates.

Turn the pump off, and remove the cassette from the calibration case. Remove the cassette from the pump tubing, and immediately seal the open ends of the cassette with the plugs. Use tape to secure the plugs, and place the cassette into a clean zip lock bag for storage. Record any problems or unusual events that occurred during sampling in the Remarks section of Form AQ-500.1. Record the average temperature and barometric pressure during the run. This can be taken from the closest meteorological or NWS station.

Clean off any dirt from the pump and tubing, and connect it to the charger for reuse later.

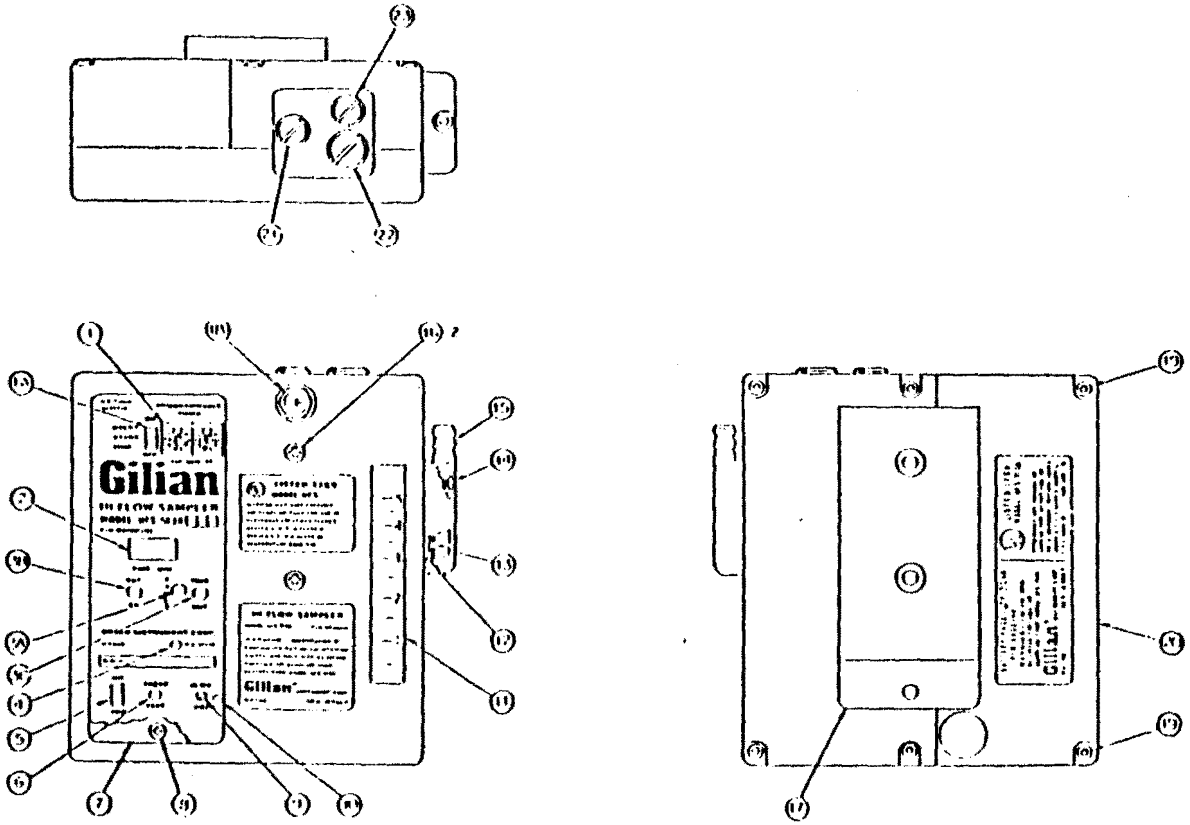

FIGURE 500-1 AIR SAMPLING PUMP

FORM AQ500-1
PERSONAL AIR SAMPLE DATA SHEET

FILTER SAMPLE NUMBER	PERSON SAMPLED	COMPANY	JOB DESCRIPTION	DATE SAMPLED	START TIME	INTIAL FLOWRATE	STOP TIME	FINAL FLOWRATE
AVERAGE AIR TEMPERATURE				BAROMETRIC PRESSURE				
AVERAGE AIR TEMPERATURE				BAROMETRIC PRESSURE				
AVERAGE AIR TEMPERATURE				BAROMETRIC PRESSURE				
AVERAGE AIR TEMPERATURE				BAROMETRIC PRESSURE				
AVERAGE AIR TEMPERATURE				BAROMETRIC PRESSURE				

REMARKS; ____
____

FORM AQ-500.2
LOVOLUME AMBIENT SAMPLE DATA SHEET

DATE ____________________
WOODWARD - CLYDE CONSULTANTS
WAYNE, NEW JERSEY
Page 1 of 2

OPERATOR'S NAME ____________________

GILIAN / DAWSON MULTI - SAMPLE DATA SHEET

PROJECT NAME ; ____________________

PROJECT NO. ____________________

SAMPLER LOCATION ID ____________________
ROTOMETERS SERIAL NOS. __________ / __________ CALIBRATION DATE ____________________
SAMPLER WCC SERIAL NO. ____________________

SAMPLE IDENTIFICATION NUMBERS

VO - CHARCOAL ____________________
AMMONIA - SILICA GEL ____________________
HCN - IMPINGER/FILTER ____________________
HS - IMPINGER ____________________

WEATHER CONDITIONS DURING RUN

TEMPERATURE RANGE ____________________ C RH __________
WINDS ____________________
VISIBILITY ____________________
SKY CONDITION ____________________
PRECIP. ____________________
SOIL CONDITION ____________________
MISC ____________________

SAMPLER LOCATION AND ACTIVITY DESCRIPTION

aq500-1.xls

FORM AQ-500.2
LOVOLUME AMBIENT SAMPLE DATA SHEET
WOODWARD - CLYDE CONSULTANTS
WAYNE, NEW JERSEY
Page 2 of 2

FLOWRATE AND ENVIRONMENTAL DATA

SAMPLING START TIME ______________ SAMPLING STOP TIME ______________

TIME	FLOWRATES FOR SAMPLE NO.					AIR TEMP
	1	2	3	4		
______						
______						
______						
______						
______						
______						
______						
______						
AVER FLOW						

TOTAL RUN TIME ______________ AVERAGE TEMPERATURE ______________

OPERATIONAL CHECKLIST

	YES	NO
1. WERE SAMPLES AND GILIAN CORRECTLY IMPLACED?	______	______
2. WERE FLOWRATES WITHIN 10% OF ESTABLISHED RATE ? (200 ML / MIN)	______	______
3. ALL CONNECTIONS SECURED ?	______	______
4. GILIANS OPERATED CORRECTLY?	______	______
5. ROTOMETER OPERATED CORRECTLY ?	______	______
6. SAMPLES INTACT AND NON - CONTAMINATED?	______	______

(IF ANY ANSWER IS "NO",OR ANY VARIATION IN NORMAL OPERATION IS FOUND, DESCRIBE IT IN THE REMARKS SECTION)

REMARKS;

____

____

____

SAMPLES WAS COLLECTED IN ACCORDANCE WITH QUALITY ASSURANCE GUIDELINES ? YES ______ NO ______

SIGNATURE ______________________________

REVIEWD BY: ______________________________

NIOSH ANALYTICAL METHODS

COAL TAR PITCH VOLATILES

FORMULA: various organic-soluble compounds [1,2,3]
M.W.: various

METHOD: 5023
ISSUED: 5/15/85

OSHA: 0.2 mg/m^3 (benzene-solubles)
NIOSH: 0.1 mg/m^3/10 hr (cyclohexane-solubles) [2,3]
ACGIH: 0.2 mg/m^3 (benzene solubles) [4]

PROPERTIES: liquid; d ~1.06 g/mL @ 38 °C; 60 to 85% distills @ ≤355 °C [5]; creosote distills @ 270 to 395 °C [2]

SYNONYMS: benzene-solubles, cyclohexane-solubles, coal tar pitch volatiles (CAS #8007-45-2), creosote from coal tar.

SAMPLING

SAMPLER: FILTER
(2-µm, 37-mm PTFE membrane)

FLOW RATE: 1 to 4 L/min

VOL-MIN: 500 L @ 0.2 mg/m^3
-MAX: 2400 L

SHIPMENT: routine

SAMPLE STABILITY: unknown

FIELD BLANKS: 10% (≥2) of samplers

ACCURACY

RANGE STUDIED: not studied

BIAS: unknown

OVERALL PRECISION (s_r): not determined

MEASUREMENT

TECHNIQUE: GRAVIMETRIC

ANALYTE: organic-solubles (includes anthracene, benzanthracene, benzo(a)pyrene, carbazole, chrysene, phenanthrene, pyrene and others [1,2,3,4])

EXTRACTION: benzene, cyclohexane or other appropriate solvent; ultrasonic 20 min

CALIBRATION: National Bureau of Standards Class M weights

RANGE: 0.1 to 2 mg per sample

ESTIMATED LOD: 0.05 mg per sample [6]

PRECISION (s_r): 0.02 at 1.35 mg [6];
0.23 for blanks [6]

APPLICABILITY: The working range is 0.1 to 2 mg/m^3 for a 1000-L air sample. The method is useful for air monitoring of coke oven emissions, petroleum combustion products such as diesel emissions, and petroleum asphalt fumes. The method may be applied to bulk samples. The method is non-specific and measures all substances in the sample which are soluble in the solvent selected and which can be desorbed from particulate matter present on the filter.

INTERFERENCES: Changes in temperature or humidity during pre- and post-collection weighing affect accuracy. Losses may occur due to volatilization of collected aerosol during or after sampling.

OTHER METHODS: This method modifies and combines P&CAM 217 [7] and the criteria document method [2].

REAGENTS:

1. Solvent: Benzene,* cyclohexane or other solvent, reagent grade.
2. Dichromic acid cleaning solution.
3. Acetone, reagent grade.
4. Hexane.

*See SPECIAL PRECAUTIONS.

EQUIPMENT:

1. Sampler: PTFE laminated membrane filter, 2-µm pore size, 37-mm diameter (Zeflour, Membrana Inc., Pleasanton, CA or equivalent) backed by a gasket (37 mm OD, 32 mm ID) cut from a cellulose support pad in plastic filter holder.
2. Personal sampling pump, 1 to 4 L/min, with flexible connecting tubing.
3. Ultrasonic bath.
4. Microbalance, readable to 1 µg, with NBS Class M weights.
5. Environmental chamber for balance, e.g., 20 °C ±0.3 °C and 50% ±5% relative humidity.
6. Weighing cups, PTFE, 2-mL, approximate tare weight 60 mg, in metal rack.
7. Vacuum oven.

   NOTE: Keep the interior of the vacuum oven dust-free for maximum sensitivity, reproducibility, and accuracy.
8. Forceps.
9. Test tubes, PTFE-lined, screw cap, 13 mm x 100 mm.*
10. Filter, 0.5-µm (Millex-SR, Millipore Corp., Bedford, MA or equivalent).
11. Pipets, 1- and 5-mL.*

*Rinse with distilled water, acetone, and hexane; dry.

SPECIAL PRECAUTIONS: Benzene and coal tar pitch volatiles are suspect carcinogens [1,2,3,4].

SAMPLING:

1. Calibrate each sampling pump with a representative sampler in line.
2. Sample at an accurately known flow rate between 1 and 4 L/min for a total sample volume of 500 to 2400 L. Do not exceed a filter loading of ca. 2 mg total particulate.
3. Replace caps in cassette and ship to laboratory.

SAMPLE PREPARATION:

4. Transfer filter carefully using forceps to test tube. Add 5.0 mL solvent via pipet. Cap the tube.

   NOTE 1: Cyclohexane is recommended as solvent because of the carcinogenic potential of benzene [2].

   NOTE 2: This extraction is also applicable to bulk samples (ground and sieved to ca. 250 µm). Extract 250 mg bulk sample with 5.0 mL solvent.
5. Place tube upright in beaker containing water to the same level as the liquid in the tube. Place beaker and tube in ultrasonic bath. Sonicate for 20 min.
6. Filter solution through a 0.5-µm filter into a clean, preweighed weighing cup. Discard the filter.

   NOTE: An aliquot of the solution may be taken at this step if other analyses (e.g., polynuclear aromatic hydrocarbons) are to be performed on the sample. Apply the appropriate aliquot factor in calculations.

FORMULA: Pb

LEAD

METHOD: 7082
ISSUED: 2/15/84

M.W.: 207.19 (Pb); 223.19 (PbO)

OSHA: 0.05 mg/m^3
NIOSH: 0.05 mg/m^3 [1]
ACGIH: 0.15 mg/m^3; STEL 0.45 mg/m^3

PROPERTIES: soft metal;
d 11.3 g/cm^3; MP 327.5 °C;
valences +2, +4 in salts

SYNONYMS: vary depending upon the chemical form (elemental lead and lead compounds except alkyl lead); CAS #1317-36-8 (PbO); CAS #7439-92-1 (Pb).

SAMPLING

SAMPLER: FILTER
(0.8-µm cellulose ester membrane)

FLOW RATE: 1 to 4 L/min

VOL-MIN: 200 L @ 0.05 mg/m^3
-MAX: 1200 L

SHIPMENT: routine

SAMPLE STABILITY: stable

BLANKS: 2 to 10 field blanks per set

ACCURACY

RANGE STUDIED: 0.13 to 0.4 mg/m^3 [2];
0.15 to 1.7 mg/m^3 (fume) [3]

BIAS: not significant [2]

OVERALL PRECISION (s_r): 0.072 [2];
0.068 (fume) [3]

MEASUREMENT

TECHNIQUE: ATOMIC ABSORPTION, FLAME

ANALYTE: lead

ASHING: conc. HNO_3, 6 mL; 140 °C

FINAL SOLUTION: 10% HNO_3, 10 mL

FLAME: air-acetylene, oxidizing

WAVELENGTH: 283.3 nm

BACKGROUND CORRECTION: D_2 or H_2 lamp

CALIBRATION: Pb^{++} in 10% HNO_3

RANGE: 10 to 200 µg per sample [3,8]

ESTIMATED LOD: 2.6 µg per sample [9]

PRECISION (s_r): 0.03 [2]

APPLICABILITY: The working range is 0.025 to 0.5 mg/m^3 for a 400-L air sample. The method is applicable to elemental lead, including Pb fume, and all other aerosols containing lead. This is an elemental analysis, not compound specific. Aliquots of the samples can be analyzed separately for additional elements.

INTERFERENCES: Use D_2 or H_2 continuum background correction to control flame or molecular absorption. High concentrations of calcium, sulfate, carbonate, phosphate, iodide, fluoride, or acetate can be corrected.

OTHER METHODS: This method combines and replaces P&CAM 173 [8] and S341 [7,9] for lead. Method 7300 (ICP-AES) is an alternate analytical method.Method 7505 is specific for lead sulfide. The following have not been revised: the dithizone method, which appears in P&CAM 102 [4] and the lead criteria document [1]; P&CAM 191 (ASV) [5]; and P&CAM 214 (graphite furnace-AAS) [6].

REAGENTS:

1. Nitric acid, conc.
2. Nitric acid, 10% (w/v). Add 100 mL conc. HNO_3 to 500 mL water; dilute to 1 L.
3. Hydrogen peroxide, 30% H_2O_2 (w/w), reagent grade.
4. Calibration stock solution, 1000 µg Pb/mL. Commercial standard or dissolve 1.00 g Pb metal in minimum volume of (1+1) HCl and dilute to 1 L with 1% (v/v) HCl. Store in a polyethylene bottle. Stable $\geq$ one year.
5. Air, compressed, filtered.
6. Acetylene.
7. Distilled or deionized water.

EQUIPMENT:

1. Sampler: Cellulose ester filter, 0.8-µm pore size, 37-mm diameter; in cassette filter holder.
2. Personal sampling pump, 1 to 4 L/min, with flexible connecting tubing.
3. Atomic Absorption Spectrophotometer with an air-acetylene burner head.
4. Lead hollow cathode lamp or electrode dischargeless lamp.
5. Regulators, two-stage, for air and acetylene.
6. Beakers, Phillips, 125 mL, or Griffin, 50 mL with watchglass covers.*
7. Volumetric flasks, 10- and 100-mL.*
8. Assorted volumetric pipets as needed.*
9. Hotplate, surface temperature 140° C.
10. Bottles, polyethylene, 100-mL.

*Clean all glassware with conc. nitric acid and rinse thoroughly with distilled or deionized water before use.

SPECIAL PRECAUTIONS: Perform all acid digestions in a fume hood.

SAMPLING:

1. Calibrate each personal sampling pump with a representative sampler in line.
2. Sample at an accurately known flow rate between 1 and 4 L/min for up to 8 hrs for TWA measurements. Do not exceed a filter loading of ca. 2 mg total dust.

SAMPLE PREPARATION:

NOTE: The following sample preparation gave quantitative recovery (see EVALUATION OF METHOD) [9]. Steps 4 through 9 of Method 7300 or other quantitative ashing techniques may be substituted, especially if several metals are to be determined on a single filter.

3. Open the cassette filter holders and transfer the samples and blanks to clean beakers.
4. Add 3 mL conc. HNO_3, and 1 mL 30% H_2O_2 and cover with a watchglass. Start reagent blanks at this step.
   NOTE: If PbO_2 is not present in the sample, the 30% H_2O_2 need not be added [3,9].
5. Heat on hotplate (140 °C) until most of the acid has evaporated.
6. Repeat two more times using 2 mL conc. HNO_3 and 1 mL 30% H_2O_2 each time.
7. Heat on 140 °C hotplate until a white ash appears.
8. When sample is dry, rinse the watchglass and walls of the beaker with 3 to 5 mL 10% HNO_3. Allow the solution to evaporate to dryness.
9. Cool each beaker and dissolve the residues in 1 mL conc. HNO_3.
10. Transfer the solution quantitatively to a 10-mL volumetric flask and dilute to volume with distilled water.
    NOTE: If the concentration ($\underline{M}$) of any of the following is expected to exceed the lead concentration ($\underline{M}$) by 10-fold or more, add 1 mL 1 $\underline{M}$ Na_2EDTA to each flask before dilution to volume: $CO_3^=$, PO_4^{-3}, I^-, F^-, CH_3COO^-. If Ca^{++} or $SO_4^=$ are present in 10-fold excess, make all standards and samples 1% (w/w) in La^{++} [8].

FORMULA: $CH_2=CHCl$; C_2H_3Cl

M.W.: 62.50

VINYL CHLORIDE

METHOD: 1007
ISSUED: 2/15/84

OSHA: 1 ppm; C 5 ppm
NIOSH: minimum measurable
ACGIH: 5 ppm (human carcinogen) [1]
(1 ppm = 2.56 mg/m³ @ NTP)

PROPERTIES: BP -14 °C; vapor density 2.2 (air = 1)

SYNONYMS: chloroethylene; chloroethene; CAS #75-01-4.

SAMPLING

SAMPLER: SOLID SORBENT TUBE
(2 tandem tubes, each with 150 mg activated coconut charcoal)

FLOW RATE: 0.05 L/min

VOL-MIN: 0.7 L
-MAX: 5 L

SHIPMENT: separate primary and backup tubes and cap each

SAMPLE STABILITY: 10 days @ 25 °C

BLANKS: 2 to 10 field blanks per set

ACCURACY

RANGE STUDIED: 1 to 64 mg/m³ [2]

BIAS: -6% of calculated concentration [2]

OVERALL PRECISION (s_r): 0.06 [2]

MEASUREMENT

TECHNIQUE: GAS CHROMATOGRAPHY, FID

ANALYTE: vinyl chloride

DESORPTION: 1 mL carbon disulfide; 30 min

INJECTION ALIQUOT: 5 µL

COLUMN: stainless steel, 6.1 m x 3.2 mm, 10% SE-30 on 80/100 mesh Chromosorb W (AW-DMCS)

CARRIER GAS: He, 40 mL/min

TEMPERATURE-INJECTOR: 230 °C
-DETECTOR: 230 °C
-COLUMN: 60 °C

CALIBRATION: solutions of vinyl chloride in CS_2

RANGE: 0.002 to 0.2 mg per sample [2]

ESTIMATED LOD: 0.00004 mg per sample [2]

PRECISION (s_r): not determined

APPLICABILITY: The working range is 0.4 to 40 mg/m³ (0.16 to 16 ppm) for a 5-L air sample. The method is applicable to 15-min samples at concentrations of 1 ppm or higher.

INTERFERENCES: Other than the possibility of loss of sample upon storage of two weeks or more at room temperature, none have been noted.

OTHER METHODS: This is a revision of P&CAM 178 [3].

REAGENTS:

1. Carbon disulfide,* chromatographic quality.
2. Vinyl chloride,*, 99.9%, in lecture bottle fitted with valve and septum.
3. Calibration stock solution, 0.26 mg/mL.
   a. Insert the tip of a gas syringe containing 1 mL vinyl chloride gas under the surface of 5 mL CS_2 in a 10-mL volumetric flask.
   b. Open the valve of the syringe and withdraw the plunger to pull CS_2 into the barrel. (As vinyl chloride dissolves, a vacuum will be created, pulling CS_2 into the syringe.)
   c. Push the solution from the syringe into the flask. Rinse the syringe twice with 1-mL portions of CS_2 and add the washings to the flask.
   d. Dilute to the mark with CS_2.
4. Helium, purified.
5. Hydrogen, purified.
6. Air, filtered.

*See Special Precautions.

EQUIPMENT:

1. Sampler: two tandem glass tubes, 7 cm long, 6 mm OD, 4 mm ID, flame-sealed ends, each containing 150 mg of 20/40 mesh activated (600 °C) coconut shell charcoal. A silylated glass wool plug precedes the charcoal beds and a 3-mm urethane foam plug follows the charcoal beds. Plastic caps are included for sealing after use. Pressure drop across each tube at 1 L/min airflow must be less than 3.4 kPa.
   NOTE: A pair of two-section (100 mg/50 mg) tubes may be used.
2. Personal sampling pump, 0.05 L/min, with flexible connecting tubing.
3. Gas chromatograph, flame ionization detector, integrator and column (page 1007-1).
4. File.
5. Bent wire for removing plugs from sampling tube.
6. Vials, 2-mL, glass with PTFE-lined septa and crimp-on seals.
7. Volumetric flasks, 10-mL, with polyethylene stoppers.
8. Pipettes, delivery, 1.0-mL, graduated in 0.1-mL increments, 2- and 5-mL, with pipet bulb.
9. Air sampling bags, Tedlar, 10-L.
10. Gas syringe, with gas-tight valve, 0.1- and 1-mL.
11. Syringe, 10-µL, with 0.1-µL graduations.

SPECIAL PRECAUTIONS: Carbon disulfide is toxic and an acute fire and explosion hazard (flash point = -30 °C); work with it only in a hood.

Vinyl chloride is a human carcinogen [1].

SAMPLING:

1. Calibrate each personal sampling pump with a representative sampler in line.
2. Break the ends of the tubes immediately before sampling. Attach two tubes, with ends touching, with a short piece of tubing. Label one tube as the back tube and insert the back tube into the flexible tubing attached to the personal sampling pump.
3. Sample at 0.05 L/min for 15 to 100 min. Do not sample more than 5 L of air.
4. Separate the primary and backup tubes and cap each tube for shipment.

SAMPLE PREPARATION:

5. Add 1.0 mL CS_2 to an empty vial. Loosely cap the vial.
6. Score each sampler tube with a file in front of the glass wool plug. Break the tube at the score line.

FORMULA: mixture: $C_{12}H_{10-x}Cl_x$
[where x = 1 to 10]
M.W.: ca. 258 (42% Cl ; $C_{12}H_7Cl_2$);
ca. 326 (54% Cl ; $C_{12}H_5Cl_5$)

POLYCHLOROBIPHENYLS

METHOD: 5503
ISSUED: 2/15/84
REVISION #1: 8/15/87

OSHA: 1 mg/m³ (42% Cl);
0.5 mg/m³ (54% Cl)
NIOSH: 0.001 mg/m³ [1,2]
ACGIH: 1 mg/m³ (42% Cl); STEL 2 mg/m³
0.5 mg/m³ (54% Cl); STEL 1 mg/m³
(skin)

PROPERTIES:
42% Cl: BP 325 to 366 °C; MP -19 °C;
d 1.38 g/mL @ 25 °C;
VP 0.01 Pa (8×10^{-5} mm Hg;
1 mg/m³) @ 20 °C [3]
54% Cl: BP 365 to 390 °C; MP 10 °C;
d 1.54 g/mL @ 25 °C;
VP 0.0004 Pa (3×10^{-6} mm Hg;
0.05 mg/m³) @ 20 °C [3,4]

SYNONYMS: PCB; CAS #1336-36-3; 1,1'-biphenyl chloro (CAS #27323-18-8); chlorodiphenyl, 42% Cl (Aroclor 1242; CAS #53469-21-9), and 54% Cl (Aroclor 1254; CAS #11097-69-1)

SAMPLING

SAMPLER: FILTER + SOLID SORBENT
(13-mm glass fiber + Florisil,
100 mg/50 mg)

FLOW RATE: 0.05 to 0.2 L/min or less

VOL-MIN: 1 L @ 0.5 mg/m³
-MAX: 50 L

SHIPMENT: transfer filters to
glass vials after sampling

SAMPLE STABILITY: unknown for filters;
2 months for Florisil
tubes [5]

BLANKS: 10% of samples

ACCURACY

RANGE STUDIED: not studied

BIAS: none identified

OVERALL PRECISION (s_r): not evaluated

MEASUREMENT

TECHNIQUE: GAS CHROMATOGRAPHY, ECD (^{63}Ni)

ANALYTE: polychlorobiphenyls

DESORPTION: filter + front section, 5 mL hexane;
back section, 2 mL hexane

INJECTION VOLUME: 4 µL with 1-µL backflush

TEMPERATURE-INJECTION: 250 - 300 °C
-DETECTOR: 300 - 325 °C
-COLUMN: 180 °C

CARRIER GAS: N_2, 40 mL/min

COLUMN: glass, 1.8 m x 2 mm ID, 1.5% OV-17/1.95%
QF-1 on 80/100 mesh Chromosorb WHP

CALIBRATION: standard PCB mixture in hexane

RANGE: 0.4 to 4 µg per sample [6]

ESTIMATED LOD: 0.03 µg per sample [6]

PRECISION (s_r): 0.044 [5]

APPLICABILITY: The working range is 0.01 to 10 mg/m³ for a 40-L air sample [5]. With modifications, surface wipe samples may be analyzed [7,8].

INTERFERENCES: Chlorinated pesticides, such as DDT and DDE, may interfere with quantitation of PCB. Sulfur-containing compounds in petroleum products also interfere [9].

OTHER METHODS: This method revises Methods S120 [10], 5503 (dated 2/15/84), and P&CAM 244 [5]. Methods S121 [11] and P&CAM 253 [12] for PCB have not been revised.

REAGENTS:

1. Hexane, pesticide quality.
2. Florisil, 30/48 mesh sieved from 30/60 mesh. After sieving, dry at 105 °C for 45 min. Mix the cooled Florisil with 3% (w/w) distilled water.
3. Nitrogen, purified.
4. Stock standard solution of the PCB in methanol or isooctane (commercially available).*

*See SPECIAL PRECAUTIONS.

EQUIPMENT:

1. Sampler: 13-mm glass fiber filter without binders in a Swinnex cassette (Cat. No. SX 0001300, Millipore Corp.) followed by a glass tube, 7 cm long, 6 mm OD, 4 mm ID containing two sections of 30/48 mesh deactivated Florisil. The front section is preceded by glass wool and contains 100 mg and the backup section contains 50 mg; urethane foam between sections and behind the backup section. Join the cassette and Florisil tube with PVC tubing, 3/8" L x 9/32" OD x 5/32" ID, on the outlet of the cassette and with another piece of PVC tubing, 3/4" L x 5/16" OD x 3/16" ID, complete the union.
2. Personal sampling pump, 0.05 to 0.2 L/min, with flexible connecting tubing.
3. Tweezers.
4. Vials, glass, 4- and 7-mL, with aluminum or PTFE-lined caps.
5. Gas chromatograph, electron capture detection (^{63}Ni), integrator and column (page 5503-1).
6. Volumetric flasks, 10-mL and other convenient sizes for preparing standards.
7. Syringe, 10-µL.

SPECIAL PRECAUTIONS: Avoid prolonged or repeated contact of skin with PCB and prolonged or repeated breathing of the vapor [1,2,13].

SAMPLING:

1. Calibrate each personal sampling pump with a representative sampler in line.
2. Break the ends of the Florisil tube immediately before sampling. Connect Florisil tube to Swinnex cassette and attach sampler to personal sampling pump with flexible tubing.
3. Sample at an accurately known flow rate between 0.05 and 0.2 L/min for a total sample size of 1 to 50 L.

   NOTE: At low PCB concentrations, the sampler was found to be efficient when operated at flow rates up to 1 L/min, for 24 hours [8]. Under these conditions, the limit of detection was 0.02 $\mu g/m^3$.
4. Transfer the glass fiber filters to 7-mL vials. Cap the Florisil tubes with plastic (not rubber) caps and pack securely for shipment.

SAMPLE PREPARATION:

5. Place the glass wool and 100-ml Florisil bed in the same 7-mL vial in which the filter was stored. Add 5.0 mL hexane.

   NOTE: For surface wipe samples, extract each gauze pad with 25 mL hexane [7].
6. In a 4 mL vial, place the 50-mg Florisil bed including the two urethane plugs. Add 2.0 mL hexane.
7. Allow to stand 20 min with occasional agitation.

HYDROCARBONS, BP 36 – 126 °C

FORMULA: Table 1

M.W.: Table 1

METHOD: 1500
ISSUED: 2/15/84

OSHA, NIOSH, ACGIH: Table 2

PROPERTIES: Table 1

COMPOUNDS: (Synonyms in Table 1)
- benzene
- cyclohexane
- cyclohexene
- n-heptane
- n-hexane
- methylcyclohexane
- n-octane
- n-pentane
- toluene

SAMPLING

SAMPLER: SOLID SORBENT TUBE (coconut shell charcoal, 100 mg/50 mg)

FLOW RATE, VOLUME: Table 3

SHIPMENT: no special precautions

SAMPLE STABILITY: at least 2 weeks

BLANKS: 2 to 10 field blanks per set

BULK SAMPLE: desirable, 1 to 10 mL; ship in separate containers from samples

ACCURACY

RANGE STUDIED,
BIAS and OVERALL PRECISION (s_r): Table 3

MEASUREMENT

TECHNIQUE: GAS CHROMATOGRAPHY, FID

ANALYTES: hydrocarbons listed above

DESORPTION: 1 mL CS_2; stand 30 min

INJECTION VOLUME: 5 µL

TEMPERATURE-INJECTION: 250 °C
-DETECTOR: 250 °C
-COLUMN: see step 11

CARRIER GAS: N_2 or He, 25 mL/min

COLUMN: glass, 3.0 m x 2 mm, 20% SP-2100 on 80/100 mesh Supelcoport

CALIBRATION: analytes in CS_2

RANGE AND PRECISION (s_r): Table 4

ESTIMATED LOD: 0.001 to 0.01 mg per sample with capillary column [1]

APPLICABILITY: This method is intended for determining the OSHA-regulated hydrocarbons included within the boiling point range of n-pentane through n-octane. It may be used for simultaneous measurements; however, interactions between analytes may reduce breakthrough volumes and change desorption efficiencies.

INTERFERENCES: At high humidity, breakthrough volumes may be reduced by as much as 50%. Other volatile organic solvents, e.g., alcohols, ketones, ethers, and halogenated hydrocarbons, are likely interferences. If interference is suspected, use a more polar column or change column temperature.

OTHER METHODS: This method is based on and supercedes Methods P&CAM 127, benzene and toluene [2]; S28, cyclohexane [3]; S82, cyclohexene [3]; S89, heptane [3]; S90, hexane [3]; S94, methylcyclohexane [3]; S311, benzene [4]; S343, toluene [4]; S378, octane [4]; and S379, pentane [4]. For benzene or toluene in complex mixture of alkanes ($\leq C_{10}$), Method 1501 (aromatic hydrocarbons) is more selective.

REAGENTS:

1. Eluent: Carbon disulfide*, chromatographic quality with (optional) suitable internal standard.
2. Analytes, reagent grade.*
3. Nitrogen or helium, purified.
4. Hydrogen, prepurified.
5. Air, filtered.

*See Special Precautions.

EQUIPMENT:

1. Sampler: glass tube, 7 cm long, 6 mm OD, 4 mm ID, flame-sealed ends, containing two sections of activated (600 °C) coconut shell charcoal (front = 100 mg, back = 50 mg) separated by a 2-mm urethane foam plug. A silylated glass wool plug precedes the front section, and a 3-mm urethane foam plug follows the back section. Pressure drop across the tube at 1 L/min airflow must be less than 3.4 kPa. Tubes are commercially available.
2. Personal sampling pump, 0.01 to 0.2 L/min, with flexible connecting tubing.
3. Gas chromatograph, FID, integrator and column (page 1500-1).
4. Vials, glass, 1-mL, with PTFE-lined caps.
5. Pipet, 1-mL, with pipet bulb.
6. Syringes, 5-, 10-, 25- and 100-µL.
7. Volumetric flasks, 10-mL

SPECIAL PRECAUTIONS: Carbon disulfide is toxic and extremely flammable (flash point = -30 °C); benzene is a suspect carcinogen. Prepare samples and standards in a well-ventilated hood.

SAMPLING:

1. Calibrate each personal sampling pump with a representative sampler in line.
2. Break the ends of the sampler immediately before sampling. Attach sampler to personal sampling pump with flexible tubing.
3. Sample at an accurately known flow rate between 0.01 and 0.2 L/min (0.01 to 0.05 L/min for n-pentane) for a total sample size as shown in Table 3.
4. Cap the samplers with plastic (not rubber) caps and pack securely for shipment.

SAMPLE PREPARATION:

5. Place the front and back sorbent sections of the sampler tube in separate vials. Discard the glass wool and foam plugs.
6. Add 1.0 mL eluent to each vial. Attach crimp cap to each vial immediately.
7. Allow to stand at least 30 min with occasional agitation.

CALIBRATION AND QUALITY CONTROL:

8. Calibrate daily with at least five working standards over the appropriate range (ca. 0.01 to 10 mg analyte per sample; see Table 4).
   a. Add known amounts of analyte to eluent in 10-mL volumetric flasks and dilute to the mark.
   b. Analyze together with samples and blanks (steps 11, 12 and 13).
   c. Prepare calibration graph (peak area of analyte vs. mg analyte).
9. Determine desorption efficiency (DE) at least once for each batch of charcoal used for sampling in the calibration range (step 8). Prepare three tubes at each of five levels plus three media blanks.
   a. Remove and discard back sorbent section of a media blank sampler.
   b. Inject a known amount of analyte directly onto front sorbent section with a microliter syringe.

c. Cap the tube. Allow to stand overnight.
d. Desorb (steps 5 through 7) and analyze together with working standards (steps 11, 12 and 13).
e. Prepare a graph of DE vs. mg analyte recovered.

10. Analyze three quality control blind spikes and three analyst spikes to insure that the calibration graph and DE graph are in control. Check for possible contamination during shipment of field samples by comparing results from field blanks and media blanks.

MEASUREMENT:

11. Set gas chromatograph according to manufacturer's recommendations and to conditions given on page 1500-1. Select appropriate column temperature:

	Approximate Retention Time (min), at Indicated Column Temperature			
Substance	40 °C	70 °C	100 °C	Programmed[a]
n-pentane	2.2	1.2		1.8
solvent (CS_2)	3.0	1.6		2.4
n-hexane	5.1	2.2		3.5
benzene[b]	7.7	3.2		4.5
cyclohexane[b]	8.4	3.4		4.7
cyclohexene	9.5	3.8		4.9
n-heptane	12	4.3		5.4
methylcyclohexane	14	5.2	2.2	5.9
toluene	17	6.5	2.6	6.5
n-octane	19	8.7	3.2	7.1

[a] Temperature program: 50 °C for 2 min, then 15 °C/min to 150 °C, 2-min final hold.
[b] Not completely resolved.

NOTE: Alternatively, column and temperature may be taken from Table 4.

12. Inject sample aliquot manually using solvent flush technique or with autosampler.
NOTE: If peak area is above the linear range of the working standards, dilute with eluent, reanalyze and apply the appropriate dilution factor in calculations.
13. Measure peak area.

CALCULATIONS:

14. Determine the mass, mg (corrected for DE) of analyte found in the sample front (W_f) and back (W_b) sorbent sections, and in the average media blank front (B_f) and back (B_b) sorbent sections.
NOTE: If $W_b > W_f/10$, report breakthrough and possible sample loss.
15. Calculate concentration, C, of analyte in the air volume sampled, V (L):

$$C = \frac{(W_f + W_b - B_f - B_b)\cdot 10^3}{V}, \text{ mg/m}^3.$$

FORMULA: Table 1

M.W.: Table 1

HYDROCARBONS, HALOGENATED

METHOD: 1003
ISSUED: 2/15/84
REVISION #1: 8/15/87

COMPOUNDS: (synonyms in Table 1)
- benzyl chloride
- bromoform
- carbon tetrachloride
- chlorobenzene
- chlorobromomethane
- chloroform
- o-dichlorobenzene
- p-dichlorobenzene
- 1,1-dichloroethane
- 1,2-dichloroethylene
- ethylene dichloride
- hexachloroethane
- methylchloroform
- tetrachloroethylene
- 1,1,2-trichloroethane
- 1,2,3-trichloropropane

SAMPLING

SAMPLER: SOLID SORBENT TUBE
(coconut shell charcoal, 100 mg/50 mg)

FLOW RATE: 0.01 to 0.2 L/min

VOL-MIN: Table 2
-MAX: Table 2

SHIPMENT: routine

SAMPLE STABILITY: not determined

FIELD BLANKS: 10% of samples

ACCURACY

RANGE STUDIED: see EVALUATION OF METHOD [1]

BIAS: not significant [1]

OVERALL PRECISION (s_r): see EVALUATION OF METHOD [1]

MEASUREMENT

TECHNIQUE: GAS CHROMATOGRAPHY, FID

ANALYTE: compounds above

DESORPTION: 1 mL CS_2, stand 30 min

INJECTION VOLUME: 5 µL

TEMPERATURES: Table 3

CARRIER GAS: N_2 or He, 30 mL/min

COLUMN: Table 3; alternates are SP-2100, SP-2100 with 0.1% Carbowax 1500 or DB-1 fused silica capillary column

CALIBRATION: standard solutions of analyte in CS_2

RANGE: Table 3

ESTIMATED LOD: 0.01 mg per sample [2]

PRECISION (s_r): see EVALUATION OF METHOD [1]

APPLICABILITY: See Table 2 for working ranges. This method can be used for simultaneous determination of two or more substances suspected to be present by changing gas chromatographic conditions (i.e., temperature program). High humidity during sampling will prevent organic vapors from being trapped efficiently on the sorbent and greatly decreases breakthrough volume.

INTERFERENCES: None identified. The chromatographic column or separation conditions may be changed to circumvent interferences.

OTHER METHODS: This method combines and replaces P&CAM 127 [3], S101 [4], S110 [5], S113 [6], S114 [7], S115 [8], S122 [9], S123 [10], S126 [11], S133 [12], S134 [13], S135 [14], S281 [15], S314 [16], S328 [17], S335 [18], S351 [19], and Method 1003 (dated 2/15/84).

REAGENTS:

1. Carbon disulfide, chromatographic quality.*
2. Analyte, reagent grade.
3. Calibration stock solutions:
   a. benzyl chloride, 10 mg/mL in _n_-heptane.
   b. bromoform, 10 mg/mL in _n_-hexane.
   c. _o_-dichlorobenzene, 200 mg/mL in acetone.
   d. _p_-dichlorobenzene, 300 mg/mL in acetone.
   e. hexachloroethane, 25 mg/mL in toluene.
4. Decane, _n_-undecane, octane or other internal standards (see step 6).
5. Nitrogen or helium, purified.
6. Hydrogen, prepurified.
7. Air, filtered.

*See SPECIAL PRECAUTIONS.

EQUIPMENT:

1. Sampler: glass tube, 7 cm long, 6 mm OD, 4 mm ID, flame-sealed ends with plastic caps, containing two sections of 20/40 mesh activated (600 °C) coconut shell charcoal (front = 100 mg; back = 50 mg) separated by a 2-mm urethane foam plug. A silylated glass wool plug precedes the front section and a 3-mm urethane foam plug follows the back section. Pressure drop across the tube at 1 L/min airflow must be less than 3.4 kPa. Tubes are commercially available (e.g., SKC #226-01).
2. Personal sampling pump, 0.01 to 0.2 L/min, with flexible connecting tubing.
3. Gas chromatograph, FID, integrator and column (see Table 3).
4. Vials, 2-mL, glass, PTFE-lined septum crimp caps.
5. Volumetric flasks, 10-mL.
6. Syringes, 10-µL, readable to 0.1 µL.
7. Pipet, TD, 1-mL, with pipet bulb.

SPECIAL PRECAUTIONS: Carbon disulfide is toxic and a serious fire and explosion hazard (flash point = -30 °C); work with it only in a hood. Several of the analytes are suspect carcinogens (Table 1). _n_-Heptane, _n_-hexane, and acetone are fire hazards.

SAMPLING:

1. Calibrate each personal sampling pump with a representative sampler in line.
2. Break the ends of the sampler immediately before sampling. Attach sampler to personal sampling pump with flexible tubing.
3. Sample at an accurately known flow rate between 0.01 and 0.2 L/min for a total sample size between the limits shown in Table 2.
4. Cap the samplers. Pack securely for shipment.

SAMPLE PREPARATION:

5. Place the front and back sorbent sections of the sampler tube in separate vials. Discard the glass wool and foam plugs.
6. Add 1.0 mL CS_2 to each vial. Cap each vial.
   NOTE: A suitable internal standard, such as decane [16], _n_-undecane [6,19], or octane [9,13,17] at 0.1% (v/v) may be added at this step and at step 8.
7. Allow to stand 30 min with occasional agitation.

CALIBRATION AND QUALITY CONTROL:

8. Calibrate daily with at least five working standards over the appropriate range (Table 3).
   a. Add known amounts of neat analyte or calibration stock solution to CS_2 in 10-mL volumetric flasks and dilute to the mark.
   b. Analyze with samples and blanks (steps 11 and 12).
   c. Prepare calibration graph (peak area vs. mg analyte).
9. Determine desorption efficiency (DE) at least once for each lot of charcoal used for sampling in the range of interest. Prepare three tubes at each of five levels plus three media blanks.

a. Remove and discard back sorbent section of a media blank sampler.
b. Inject a known amount (2 to 20 µL) of pure analyte, or calibration stock solution (see REAGENTS, 3.), directly onto front sorbent section with a microliter syringe.
c. Cap the tube. Allow to stand overnight.
d. Desorb (steps 5 through 7) and analyze together with working standards (steps 11 and 12).
e. Prepare a graph of DE vs. mg analyte recovered.

10. Analyze three quality control blind spikes and three analyst spikes to insure that the calibration graph and DE graph are in control.

MEASUREMENT:

11. Set gas chromatograph according to manufacturer's recommendations and to conditions given on page 1003-1 and in Table 3. Inject sample aliquot manually using solvent flush technique or with autosampler.
    NOTE: If peak area is above the linear range of the working standards, dilute with CS_2, reanalyze and apply the appropriate dilution factor in calculations.
12. Measure peak area.

CALCULATIONS:

13. Determine the mass, mg (corrected for DE), of analyte found in the sample front (W_f) and back (W_b) sorbent sections and in the average media blank front (B_f) and back (B_b) sorbent sections.
    NOTE: If $W_b > W_f/10$, report breakthrough and possible sample loss.
14. Calculate concentration, C, of analyte in the air volume sampled, V (L):

$$C = \frac{(W_f + W_b - B_f - B_b) \cdot 10^3}{V}, \text{ mg/m}^3.$$

EVALUATION OF METHOD:

Laboratory testing was performed with spiked samples and generated atmospheres using SKC Lot 105 coconut shell charcoal [1]. Results were:

Compound	Range, mg/m³	Sample Size	Precision (s_r) Overall	Precision (s_r) Measurement	Desorption Efficiency	Ref.
Benzyl chloride	2–8	10 L	0.096	0.031	0.90 @ 0.03–0.1 mg	[8]
Bromoform	3–10	10 L	0.071	0.043	0.80 @ 0.025 mg	[7]
Carbon tetrachloride	65–299	15 L	0.092	0.037	0.96 @ 1.3–4.8 mg	[16]
Chlorobenzene	183–736	10 L	0.056	0.025	0.91 @ 1.8–7.1 mg	[12]
Chlorobromomethane	640–2655	5 L	0.061	0.051	0.94 @ 3.3–13 mg	[6]
Chloroform	100–416	15 L	0.057	0.047	0.97 @ 1.8–7.4 mg	[19]
o-Dichlorobenzene	150–629	3 L	0.068	0.013	0.86 @ 0.5–1.9 mg	[14]
p-Dichlorobenzene	183–777	3 L	0.052	0.022	0.91 @ 0.7–2.7 mg	[15]
1,1-Dichloroethane	212–838	10 L	0.057	0.011	1.01 @ 1.9–8 mg	[10]
1,2-Dichloroethylene*	475–1915	3 L	0.052	0.017	1.00 @ 2.4–9.5 mg	[5]
Ethylene dichloride	195–819	3 L	0.079	0.012	0.96 @ 0.6–2.5 mg	[9]
Hexachloroethane	5–25	10 L	0.121	0.014	0.98 @ 0.05–0.2 mg	[4]
Methyl chloroform	904–3790	3 L	0.054	0.018	0.99 @ 2.9–11 mg	[17]
Tetrachloroethylene	655–2749	3 L	0.052	0.013	0.96 @ 2.1–8 mg	[18]
1,1,2-Trichloroethane	26–111	10 L	0.057	0.010	0.97 @ 0.3–1.2 mg	[13]
1,2,3-Trichloropropane	163–629	10 L	0.068	0.027	0.95 @ 1.5–6 mg	[11]

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*isomer used (i.e., cis- or trans-) in evaluation unknown.

ELEMENTS (ICP)

METHOD: 7300
ISSUED: 2/15/84

M.W.: Table 1

OSHA/NIOSH/ACGIH: Table 1

PROPERTIES: Table 1

ELEMENTS:
aluminum
arsenic
beryllium
cadmium
calcium
chromium
cobalt
copper
iron
lead
lithium
magnesium
manganese
molybdenum
nickel
phosphorus
platinum
selenium
silver
sodium
tellurium
thallium
tin
titanium
tungsten
vanadium
yttrium
zinc
zirconium

SYNONYMS: vary depending upon the compound.

SAMPLING

SAMPLER: FILTER
(0.8-μm, cellulose ester membrane)

FLOW RATE: 1 to 4 L/min

VOL-MIN: Table 1
-MAX: Table 1

SHIPMENT: routine

SAMPLE STABILITY: stable

BLANKS: 2 to 10 field blanks per set

ACCURACY

RANGE STUDIED: not studied

BIAS: none identified

OVERALL PRECISION (s_r): not evaluated

MEASUREMENT

TECHNIQUE: INDUCTIVELY COUPLED ARGON PLASMA,
ATOMIC EMISSION SPECTROSCOPY

ANALYTE: elements above

ASHING REAGENTS: conc. HNO_3, 4 mL;
and conc. $HClO_4$, 1 mL
CONDITIONS: room temperature, 30 min;
150 °C to near dryness

FINAL SOLUTION: 4% HNO_3, 1% $HClO_4$, 10 mL

WAVELENGTH: depends upon element; Table 2

BACKGROUND CORRECTION: spectral wavelength shift

CALIBRATION: elements in 4% HNO_3, 1% $HClO_4$

RANGE: 2.5 to 1000 μg per sample [1]

ESTIMATED LOD: 1 μg per sample [1]

PRECISION (s_r): Table 2

APPLICABILITY: The working range of this method is 0.005 to 2.0 mg/m³ for each element in a 500-L air sample. This is simultaneous elemental analysis, not compound specific. Verify that the types of compounds in the samples are soluble with this ashing procedure.

INTERFERENCES: Spectral interferences are the primary interferences encountered in ICP-AES analysis. These are minimized by judicious wavelength selection, interelement correction factors and background correction [1,2].

OTHER METHODS: This method replaces P&CAM 351 [2] for trace elements. Atomic absorption spectroscopy (e.g., Methods 70XX) is an alternate analytical technique for many of these elements.

REAGENTS:
1. Nitric acid, conc.
2. Perchloric acid, conc.*
3. Ashing acid: 4:1 (v/v) HNO_3:$HClO_4$. Mix 4 volumes conc. HNO_3 with 1 volume conc. $HClO_4$.
4. Calibration stock solutions, 1000 µg/mL. Commercially available, or prepared per instrument manufacturer's recommendation (see step 12).
5. Dilution acid, 4% HNO_3, 1% $HClO_4$. Add 50 mL ashing acid to 600 mL water; dilute to 1 L.
6. Argon.
7. Distilled,deionized water.

*See Special Precautions.

EQUIPMENT:
1. Sampler: cellulose ester membrane filter, 0.8-mm pore size, 37-mm diameter; in cassette filter holder.
2. Personal sampling pump, 1 to 4 L/min, with flexible connecting tubing.
3. Inductively coupled plasma-atomic emission spectrometer, equipped as specified by the manufacturer for analysis of elements of interest.
4. Regulator, two-stage, for argon.
5. Beakers, Phillips, 125-mL, or Griffin, 50-mL, with watchglass covers.*
6. Volumetric flasks, 10- and 100- mL.*
7. Assorted volumetric pipets as needed.*
8. Hotplate, surface temperature 150 °C.

*Clean all glassware with conc. nitric acid and rinse thoroughly in distilled water before use.

SPECIAL PRECAUTIONS: Perform all perchloric acid digestions in a perchloric acid hood.

SAMPLING:
1. Calibrate each personal sampling pump with a representative sampler in line.
2. Sample at an accurately known flow rate between 1 and 4 L/min for a total sample size of 200 to 2000 L (see Table 1) for TWA measurements. Do not exceed a filter loading of approximately 2 mg total dust.

SAMPLE PREPARATION:

3. Open the cassette filter holders and transfer the samples and blanks to clean beakers.
4. Add 5 mL ashing acid. Cover with a watchglass. Let stand 30 min at room temperature.
   NOTE: Start a reagent blank at this step.
5. Heat on hotplate (120 °C) until ca. 0.5 mL remains.
   NOTE: Some species of Li, Mn, Mo, Sn, W, and Zr will not be completely solubilized by this procedure. Alternative solubilization techniques for most of these elements can be found elsewhere [2,3,4,5,6,7].
6. Add 2 mL ashing acid and repeat step 5. Repeat this step until the solution is clear.
7. Remove watchglass and rinse into the beaker with distilled water.
8. Increase the temperature to 150 °C and take the sample to dryness.
9. Dissolve the residue in 2 to 3 mL dilution acid.
10. Transfer the solutions quantitatively to 10-mL volumetric flasks.
11. Dilute to volume with dilution acid.

CALIBRATION AND QUALITY CONTROL:

12. Calibrate the spectrometer according to the manufacturers recommendations.
    NOTE: Typically, an acid blank and 10 µg/mL multielement working standards are used. The following multielement combinations are chemically compatible in 4% HNO_3/1% $HClO_4$:
    a. Ag, Ca, Co, Mn, Pb, V, Zn;
    b. Al, Be, Cd, La, Li, Ni, Tl;
    c. As, B, Ba, Mg, Mo, P, Sn;

d. Cu, Fe, Na, Pt, Sr, Te, Y;
e. Cr, K, Sb, Se, Ti, Zr; and
f. Si, W (distilled water only)

13. Analyze a standard for every ten samples.
14. Check recoveries with at least two spiked media blanks per ten samples.

MEASUREMENT:

15. Set spectrometer to conditions specified by manufacturer.
16. Analyze standards and samples.
    NOTE: If the values for the samples are above the range of the standards, dilute the solutions with dilution acid, reanalyze and apply the appropriate dilution factor in the calculations.

CALCULATIONS:

17. Obtain the solution concentrations for the sample, C_s (µg/mL), and the average media blank, C_b (µg/mL), from the instrument.
18. Using the solution volumes of sample, V_s (mL), and media blank, V_b (mL), calculate the concentration, C (mg/m³), of each element in the air volume sampled, V (L):

$$C = \frac{C_sV_s - C_bV_b'}{V}, \text{ mg/m}^3.$$

EVALUATION OF METHOD:

Method P&CAM 351 was evaluated in 1981 [1,2]. The precision and recovery data were determined at 2.5 and 1000 µg of each element per sample on spiked filters. The precision and recovery data, instumental detection limits, sensitivity, and analytical wavelengths are listed in Table 2. The values in Table 2 were determined with a Jarrell-Ash Model 1160 ICP operated according to manufacturer's instructions.

REFERENCES:

[1] Hull, R.D. "Multielement Analysis of Industrial Hygiene Samples," NIOSH Internal Report, presented at the American Industrial Hygiene Conference, Portland, Oregon (May 1981).
[2] NIOSH Manual of Analytical Methods, 2nd ed., V. 7, P&CAM 351, U.S. Department of Health and Human Services, Publ. (NIOSH) 82-100 (1981).
[3] Ibid, S341 (Lead).
[4] Ibid, V. 2, S5 (Manganese), U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-157-B (1977).
[5] Ibid, V. 4, P&CAM 271 (Tungsten), U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 78-175 (1978).
[6] Ibid, V. 5, P&CAM 173 (Metals by Atomic Absorption), U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 79-141 (1979).
[7] Ibid, V. 3, S183 (Tin), S185 (Zirconium), and S376 (Molybdenum), U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-157-C (1977).

METHOD REVISED BY: R. DeLon Hull and Mark Millson, NIOSH/DPSE.

Table 1. Properties and sampling volumes.

Element (Symbol)	Properties		Permissible Exposure Limits, mg/m^3 TWA	Air Volume @ OSHA, L	
	Atomic Weight	MP, °C	OSHA/NIOSH/ACGIH	MIN	MAX
Silver (Ag)	107.87	961	0.01/ — / 0.1	250	2000
Aluminum (Al)	26.98	660	— / — / 10.	5 (g)	100 (g)
Arsenic (As)	74.92	817*	0.5/C 0.002/ 0.2	5	2000
Beryllium (Be)	9.01	1278	0.002/ 0.0005/ 0.002	1250	2000
Calcium (Ca)	40.08	842	5 (b)/ — / 2 (b)	5	200
Cadmium (Cd)	112.40	321	0.2/ 0.04/ 0.05	13	2000
Cobalt (Co)	58.93	1495	0.1/ — / 0.1	25	2000
Chromium (Cr)	52.00	1890	1.0 (c)/ 0.025/ 0.5 (c)	5	1000
Copper (Cu)	63.54	1083	1.0/ — / 1.0	5	1000
Iron (Fe)	55.85	1535	10 (b)/ — / 5 (b)	5	100
Lithium (Li)	6.94	179	0.025 (d)/ — / 0.025 (d)	100	2000
Magnesium (Mg)	24.31	651	15 (b)/ — / 10 (b)	5	67
Manganese (Mn)	54.94	1244	C 5/ — / C 5	5	200
Molybdenum (Mo)	95.94	651	15 (e)/ — / 10 (e)	5	67
Sodium (Na)	22.99	98	2 (f)/ C 2 (f)/ C 2 (f)	13	2000
Nickel (Ni)	58.71	1453	1/ 0.015/ 1 (c)	5	1000
Phosphorus (P)	30.97	44	— / — / 0.1	25 (g)	2000 (g)
Lead (Pb)	207.19	328	0.05/ 0.1/ 0.15	50	2000
Platinum (Pt)	195.09	1769	0.002 (a)/ — / 1 (c)	1250	2000
Selenium (Se)	78.96	217	0.2/ — / —	13	2000
Tin (Sn)	118.69	232	2/ — / 2 (c)	5	500
Tellurium (Te)	127.60	450	0.1/ — / 0.1	25	2000
Titanium (Ti)	47.90	1675	— / — / 10 (b)	5	100
Thallium (Tl)	204.37	304	0.1 (a)/ — / 0.1 (a)	25	2000
Vanadium (V)	50.94	1890	C 0.5/ 1 (c)/ 0.05 (V_2O_5)	5	2000
Tungsten (W)	183.85	3410	— / 5 (e)/ 5 (e)	5 (g)	200 (g)
Yttrium (Y)	88.91	1495	1/ — / 1	5	1000
Zinc (Zn)	65.37	419	5 (b)/ 5 (b)/ 5 (b)	5	200
Zirconium (Zr)	91.22	1852	5/ — / 5	5	200

(a) soluble
(b) oxide
(c) metal
(d) hydride
(e) insoluble
(f) hydroxide
(g) at the ACGIH TLV

Table 2. Measurement procedures and data (a).

				Recovery (%)		Precision (s_r) (N = 3)	
Element	Wavelength (nm)	Instrumental LOD (ng/mL)	Sensitivity (Intensity/ μg/mL)	@ 2.5 μg/ filter (b)	@ 1000 μg/ filter	@ 2.5 μg/ filter	@ 1000 μg/ filter
Ag	328.3	26	0.65	111	91	0.02	0.075
Al	308.2	14	0.23	93	100	0.092	0.023
As	193.7	13	0.57	103	99	0.062	0.026
Be	313.0	1.5	1.29	107	90	0.040	0.034
Ca	315.9	10	0.49	99	95	0.036	0.014
Cd	226.5	1.6	0.83	107	99	0.032	0.020
Co	231.2	7.4	0.38	101	95	0.040	0.005
Cr	205.6	1.3	0.50	98	106	0.053	0.016
Cu	324.8	2.1	0.72	98	99	0.036	0.022
Fe	259.9	3.9	0.13	94	97	0.068	0.016
Li	670.8	2.8	0.48	89	95	0.171	0.043
Mg	279.6	24	0.22	105	106	0.084	0.027
Mn	257.6	0.4	0.74	84	93	0.062	0.035
Mo	281.6	7.0	0.18	94	88	0.023	0.049
Na	589.0	10	0.76	(c)	101	(c)	0.045
Ni	231.6	3.4	0.41	105	97	0.027	0.020
P	214.9	22	0.17	(c)	91	(c)	0.056
Pb	220.4	17	0.42	105	95	0.060	0.011
Pt	203.7	15	0.69	106	91	0.041	0.075
Se	190.6	21	0.28	105	97	0.068	0.049
Sn	190.0	64	0.49	74	67	0.33	0.16
Te	214.3	29	0.41	102	94	0.050	0.063
Ti	334.9	1.2	0.55	96	108	0.051	0.029
Tl	190.9	17	0.22	103	99	0.043	0.017
V	310.2	3.2	0.88	99	94	0.043	0.014
W	207.9	13	2.58	35	23	0.053	0.60
Y	371.0	0.8	2.35	99	100	0.015	0.013
Zn	213.9	0.6	0.60	101	94	0.013	0.013
Zr	339.2	1.9	0.88	75	98	0.049	0.008

(a) Values reported were obtained with a Jarrell-Ash Model 1160 ICP; performance may vary with instrument and should be independently verified.

(b) 2.5 μg/filter corresponds to 5 μg/m³ for a 500-L air sample.

(c) Blank levels too high to make accurate determinations

FORMULA: various

M.W.: various

FIBERS

METHOD: 7400
ISSUED: 2/15/84
REVISION #3: 5/15/89

OSHA: 0.2 asbestos fiber (≥5 µm long)/cc;
1 asbestos fiber/cc/30 minute excursion [1]
MSHA: 2 asbestos fibers (>5 µm long)/cc [2]
NIOSH: carcinogen; control to lowest level possible [3]; 3 glass fibers (>10 µm x <3.5 µm)/cc [4]
ACGIH: 0.2 crocidolite; 0.5 amosite; 2 chrysotile and other asbestos, fibers/cc [5]

PROPERTIES: solid, fibrous

SYNONYMS: actinolite [CAS #13768-00-8] or ferroactinolite; cummingtonite-grunerite (amosite) [CAS #12172-73-5]; anthophyllite [CAS #17068-78-9]; chrysotile [CAS #12001-29-5] or serpentine; crocidolite [CAS #12001-28-4] or riebeckite; tremolite [CAS #14567-73-8]; amphibole asbestos; fibrous glass.

SAMPLING

SAMPLER: FILTER
(0.45- to 1.2-µm cellulose ester membrane, 25-mm diameter; conductive cowl on cassette)

FLOW RATE*: 0.5 to 16 L/min

VOL-MIN*: 400 L @ 0.1 fiber/cc
-MAX*: (step 4, sampling)
*Adjust to give 100 to 1300 fibers/mm^2

SHIPMENT: routine (pack to reduce shock)

SAMPLE STABILITY: stable

FIELD BLANKS: 10% of samples

ACCURACY

RANGE STUDIED: 80 to 100 fibers counted

BIAS: see EVALUATION OF METHOD

OVERALL PRECISION (s_r): 0.115 to 0.13 [7]

MEASUREMENT

TECHNIQUE: LIGHT MICROSCOPY, PHASE CONTRAST

ANALYTE: fibers (manual count)

SAMPLE PREPARATION: acetone/triacetin "hot block" method [6]

COUNTING RULES: Described in previous version of this method as A rules [1,7]

EQUIPMENT:
1. Positive phase-contrast microscope
2. Walton-Beckett graticule (100-µm field of view) Type G-22
3. phase-shift test slide (HSE/NPL)

CALIBRATION: HSE/NPL test slide

RANGE: 100 to 1300 fibers/mm^2 filter area

ESTIMATED LOD: 7 fibers/mm^2 filter area

PRECISION: 0.10 to 0.12 [7]; see EVALUATION OF METHOD

APPLICABILITY: The quantitative working range is 0.04 to 0.5 fiber/cc for a 1000-L air sample. The LOD depends on sample volume and quantity of interfering dust, and is <0.01 fiber/cc for atmospheres free of interferences. The method gives an index of airborne fibers. It is primarily used for estimating asbestos concentrations, though PCM does not differentiate between asbestos and other fibers. Use this method in conjuction with electron microscopy (e.g., Method 7402) for assistance in identification of fibers. Fiber <ca. 0.25 µm diameter will not be detected by this method [8]. This method may be used for other materials such as fibrous glass by using alternate counting rules (see Appendix C).

INTERFERENCES: Any other airborne fiber may interfere since all particles meeting the counting criteria are counted. Chain-like particles may appear fibrous. High levels of non-fibrous dust particles may obscure fibers in the field of view and increase the detection limit.

OTHER METHODS: This method introduces changes for improved sensitivity and reproducibility. It replaces P&CAM 239 [7,9] and NIOSH Method 7400, Revision #2 (dated 8/15/87).

REAGENTS:

1. Acetone.*
2. Triacetin (glycerol triacetate),reagent grade.

*See SPECIAL PRECAUTIONS.

EQUIPMENT:

1. Sampler: field monitor, 25-mm, three-piece cassette with ca. 50-mm electrically-conductive extension cowl and cellulose ester filter, 0.45- to 1.2-µm pore size, and backup pad.
   NOTE 1: Analyze representative filters for fiber background before use. Discard the filter lot if mean is ≥5 fibers per 100 graticule fields. These are defined as laboratory blanks. Manufacturer-provided quality assurance checks on filter blanks are normally adequate as long as field blanks are analyzed as described below.
   NOTE 2: The electrically-conductive extension cowl reduces electrostatic effects. Ground the cowl when possible during sampling [10].
   NOTE 3: Use 0.8-µm pore size filters for personal sampling. The 0.45-µm filters are recommended for sampling when performing TEM analysis on the same samples. However, their higher pressure drop precludes their use with personal sampling pumps.
2. Sampling pump, 0.5 to 16 L/min (see step 4 for flow rate), with flexible connecting tubing.
3. Microscope, positive phase (dark) contrast, with green or blue filter, adjustable field iris, 8 to 10X eye-piece, and 40 to 45X phase objective (total magnification ca. 400X); numerical aperture = 0.65 to 0.75.
4. Slides, glass, frosted-end, pre-cleaned, 25- x 75-mm.
5. Cover slips, 22- x 22-mm, No. 1-1/2, unless otherwise specified by microscope manufacturer.
6. Lacquer or nail polish.
7. Knife, #10 surgical steel, curved blade.
8. Tweezers.
9. Heated aluminum block for clearing filters on glass slides (see ref. [6] for specifications or see manufacturer's instructions for equivalent devices).
10. Micropipets, 5-µL and 100- to 500-µL.
11. Graticule, Walton-Beckett type, 100-µm diameter circular field (area = 0.00785 mm^2) at specimen plane (Type G-22). Available from PTR Optics Ltd., 145 Newton Street, Waltham, MA 02154 [phone (617) 891-6000] and McCrone Accessories and Components, 850 Pasquinelli Drive, Westmont, IL 60559 [phone (312) 887-7100].
    NOTE: The graticule is custom-made for each microscope. (See Appendix A for the custom-ordering procedure).
12. HSE/NPL phase contrast test slide, Mark II. Available from PTR Optics Ltd. (address above).
13. Telescope, ocular phase-ring centering.
14. Stage micrometer (0.01-mm divisions).
15. Wire, multi-stranded, 22-gauge.
16. Tape, shrink- or adhesive-.

SPECIAL PRECAUTIONS: Acetone is extremely flammable. Take precautions not to ignite it. Heating of acetone in volumes greater than 1 mL must be done in a ventilated laboratory fume hood using a flameless, spark-free heat source.

SAMPLING:

1. Calibrate each personal sampling pump with a representative sampler in line.
2. For personal sampling, fasten sampler to the worker's lapel near the worker's mouth. Remove top cover from cowl extension ("open-face") and orient face down. Wrap joint between cowl and monitor body with tape to help hold the cassette together, keep the joint free of dust, and provide a marking surface to identify the cassette.

   NOTE: If possible, ground the cassette to remove any surface charge, using a wire held in contact (e.g., with a hose clamp) with the conductive cowl and an earth ground such as a cold-water pipe.
3. Submit at least two field blanks (or 10% of the total samples, whichever is greater) for each set of samples. Handle field blanks in the same fashion as other samplers. Open field blank cassettes at the same time as other cassettes just prior to sampling. Store top covers and cassettes in a clean area with the top covers from the sampling cassettes during the sampling period.
4. Sample at 0.5 L/min or greater [11]. Adjust sampling flow rate, Q (L/min), and time, t(min), to produce a fiber density, E, of 100 to 1300 fibers/mm^2 ($3.85\bullet10^4$ to $5\bullet10^5$ fibers per 25-mm filter with effective collection area A_c= 385 mm^2) for optimum accuracy. These variables are related to the action level (one-half the current standard), L (fibers/cc), of the fibrous aerosol being sampled by:

$$t = \frac{A_c\bullet E}{Q\bullet L\bullet 10^3}, \text{ min.}$$

   NOTE 1: The purpose of adjusting sampling times is to obtain optimum fiber loading on the filter. A sampling rate of 1 to 4 L/min for 8 hrs is appropriate in atmospheres containing ca. 0.1 fiber/cc in the absense of significant amounts of non-asbestos dust. Dusty atmospheres require smaller sample volumes ($\leq$400 L) to obtain countable samples. In such cases take short, consecutive samples and average the results over the total collection time. For documenting episodic exposures, use high flow rates (7 to 16 L/min) over shorter sampling times. In relatively clean atmospheres, where targeted fiber concentrations are much less than 0.1 fiber/cc, use larger sample volumes (3000 to 10000 L) to achieve quantifiable loadings. Take care, however, not to overload the filter with background dust. If $\geq$ 50% of the filter surface is covered with particles, the filter may be too overloaded to count and will bias the measured fiber concentration.

   NOTE 2: OSHA regulations specify a maximum sampling rate of 2.5 L/min [1].

   NOTE 3: OSHA regulations specify a minimum sampling volume of 48 L for an excursion measurement [1].
5. At the end of sampling, replace top cover and end plugs.
6. Ship samples with conductive cowl attached in a rigid container with packing material to prevent jostling or damage.

   NOTE: Do not use untreated polystyrene foam in shipping container because electrostatic forces may cause fiber loss from sample filter.

SAMPLE PREPARATION:

NOTE 1: The object is to produce samples with a smooth (non-grainy) background in a medium with refractive index of $\leq$1.46. This method collapses the filter for easier focusing and produces relatively permanent mounts which are useful for quality control and interlaboratory comparison. The aluminum "hot block" or similar flash vaporization techniques may be used outside the laboratory [6]. Other mounting techniques meeting the above criteria may also be used (e.g., the laboratory fume hood procedure for generating acetone vapor as described in Method 7400 - revision of 5/15/85, or the non-permanent field mounting technique used in P&CAM 239 [3,7,9,12]). A videotape of the mounting procedure is available from the NIOSH Publication Office [13].

NOTE 2: Excessive water in the acetone may slow the clearing of the filters, causing material to be washed off the surface of the filter. Also, filters that have been exposed to high humidities prior to clearing may have a grainy background.

7. Ensure that the glass slides and cover slips are free of dust and fibers.
8. Adjust the rheostat to heat the "hot block" to ca. 70 °C [6].

   NOTE: If the "hot block" is not used in a fume hood, it must rest on a ceramic plate and be isolated from any surface susceptible to heat damage.
9. Mount a wedge cut from the sample filter on a clean glass slide.
   a. Cut wedges of ca. 25% of the filter area with a curved-blade knife using a rocking motion to prevent tearing. Place wedge, dust side up, on slide.

      NOTE: Static electricity will usually keep the wedge on the slide.
   b. Insert slide with wedge into the receiving slot at the base of "hot block". Immediately place tip of a micropipet containing ca. 250 µL acetone (use the minimum volume needed to consistently clear the filter sections) into the inlet port of the PTFE cap on top of the "hot block" and inject the acetone into the vaporization chamber with a slow, steady pressure on the plunger button while holding pipet firmly in place. After waiting 3 to 5 sec for the filter to clear, remove pipet and slide from their ports.

      CAUTION: Although the volume of acetone used is small, use safety precautions. Work in a well-ventilated area (e.g., laboratory fume hood). Take care not to ignite the acetone. Continuous, frequent use of this device in an unventilated space may produce explosive acetone vapor concentrations.
   c. Using the 5-µL micropipet, immediately place 3.0 to 3.5 µL triacetin on the wedge. Gently lower a clean cover slip onto the wedge at a slight angle to reduce bubble formation. Avoid excess pressure and movement of the cover glass.

      NOTE: If too many bubbles form or the amount of triacetin is insufficient, the cover slip may become detached within a few hours. If excessive triacetin remains at the edge of the filter under the cover slip, fiber migration may occur.
   d. Glue the edges of the cover slip to the slide using lacquer or nail polish [14] Counting may proceed immediately after clearing and mounting are completed.

      NOTE: If clearing is slow, warm the slide on a hotplate (surface temperature 50 °C) for up to 15 min to hasten clearing. Heat carefully to prevent gas bubble formation.

CALIBRATION AND QUALITY CONTROL:

10. Microscope adjustments. Follow the manufacturer's instructions. At least once daily use the telescope ocular (or Bertrand lens, for some microscopes) supplied by the manufacturer to ensure that the phase rings (annular diaphragm and phase-shifting elements) are concentric. With each microscope, keep a logbook in which to record the dates of calibrations and major servicings.
    a. Each time a sample is examined, do the following:
       (1) Adjust the light source for even illumination across the field of view at the condenser iris. Use Kohler illumination, if available. With some microscopes, the illumination may have to be set up with bright field optics rather than phase contrast optics.
       (2) Focus on the particulate material to be examined.
       (3) Make sure that the field iris is in focus, centered on the sample, and open only enough to fully illuminate the field of view.
    b. Check the phase-shift detection limit of the microscope periodically for each analyst/microscope combination:
       (1) Center the HSE/NPL phase-contrast test slide under the phase objective.
       (2) Bring the blocks of grooved lines into focus in the graticule area.

           NOTE: The slide contains seven blocks of grooves (ca. 20 grooves per block) in descending order of visibility. For asbestos counting the microscope optics must completely resolve the grooved lines in block 3 although they may appear somewhat faint, and the grooved lines in blocks 6 and 7 must be invisible when centered in the graticule area. Blocks 4 or 5 must be at least partially visible but may vary slightly in visibility between microscopes. A microscope which fails to meet these requirements has resolution either too low or too high for fiber counting.

(3) If image quality deteriorates, clean the microscope optics. If the problem persists, consult the microscope manufacturer.

11. Document the laboratory's precision for each counter for replicate fiber counts.
    a. Maintain as part of the laboratory quality assurance program a set of reference slides to be used on a daily basis [15]. These slides should consist of filter preparations including a range of loadings and background dust levels from a variety of sources including both field and PAT samples. The Quality Assurance Officer should maintain custody of the reference slides and should supply each counter with a minimum of one reference slide per workday. Change the labels on the reference slides periodically so that the counter does not become familiar with the samples.
    b. From blind repeat counts on reference slides, estimate the laboratory intra- and intercounter s_r (step 21). Obtain separate values of relative standard deviation for each sample matrix analyzed in each of the following ranges: 5 to 20 fibers in 100 graticule fields, >20 to 50 fibers in 100 graticule fields, >50 to 100 fibers in 100 graticule fields, and 100 fibers in less than 100 graticule fields. Maintain control charts for each of these data files.

       NOTE: Certain sample matrices (e.g., asbestos cement) have been shown to give poor precision [16]

12. Prepare and count field blanks along with the field samples. Report counts on each field blank.

    NOTE 1: The identity of blank filters should be unknown to the counter until all counts have been completed.

    NOTE 2: If a field blank yields greater than 7 fibers per 100 graticule fields, report possible contamination of the samples.

13. Perform blind recounts by the same counter on 10% of filters counted (slides relabeled by a person other than the counter). Use the following test to determine whether a pair of counts by the same counter on the same filter should be rejected because of possible bias: Discard the sample if the absolute value of the difference between the square roots of the two counts (in fiber/mm^2) exceeds 2.8 (X) s_r, where X = the average of the square roots of the two fiber counts (in fiber/mm^2) and s_r = one-half the intracounter relative standard deviation for the appropriate count range (in fibers) determined from step 11. For more complete discussions see reference [15].

    NOTE 1: Since fiber counting is the measurement of randomly placed fibers which may be described by a Poisson distribution, a square root transformation of the fiber count data will result in approximately normally distributed data [15].

    NOTE 2: If a pair of counts is rejected by this test, recount the remaining samples in the set and test the new counts against the first counts. Discard all rejected paired counts. It is not necessary to use this statistic on blank counts.

14. The analyst is a critical part of this analytical procedure. Care must be taken to provide a non-stressful and comfortable environment for fiber counting. An ergonomically designed chair should be used, with the microscope eyepiece situated at a comfortable height for viewing. External lighting should be set at a level similar to the illumination level in the microscope to reduce eye fatigue. In addition, counters should take 10 to 20 minute breaks from the microscope every one or two hours to limit fatigue [17]. During these breaks, both eye and upper back/neck exercises should be performed to relieve strain.

15. All laboratories engaged in asbestos counting should participate in a proficiency testing program such as the AIHA-NIOSH *Proficiency* Analytical Testing (PAT) Program or the AIHA Asbestos Analyst Registry and routinely exchange field samples with other laboratories to compare performance of counters.

    NOTE: OSHA requires that each analyst performing this method take the NIOSH direct training course #582 or equivalent [1]. Instructors of equivalent courses should have attended the NIOSH #582 course at NIOSH within three years of presenting an equivalent course.

FORMULA: various

M.W.: various

ASBESTOS (bulk)

METHOD: 9002
ISSUED: 5/15/89

EPA Standard (Bulk): 1%

PROPERTIES: solid, fibrous, crystalline, anisotropic

SYNONYMS: actinolite [CAS #13768-00-8], or ferroactinolite; cummingtonite-grunerite (amosite) [CAS #12172-73-5]; anthophyllite [CAS #17068-78-9]; chrysotile [CAS #12001-29-5] or serpentine; crocidolite [CAS #12001-28-4] or riebeckite; tremolite [CAS #14567-73-8]; amphibole asbestos.

SAMPLING

BULK SAMPLE: 1 to 10 grams

SHIPMENT: seal securely to prevent escape of asbestos

SAMPLE STABILITY: stable

BLANKS: none required

ACCURACY

RANGE STUDIED: <1% to 100% asbestos

BIAS: not determined

PRECISION: not determined

MEASUREMENT

TECHNIQUE: MICROSCOPY, STEREO AND POLARIZED LIGHT, WITH DISPERSION STAINING

ANALYTE: actinolite asbestos, amosite, anthophyllite asbestos, chrysotile, crocidolite, tremolite asbestos

EQUIPMENT: microscope, polarized light: 100-400X dispersion staining objective, stereo microscope: 10-45X

RANGE: 1% to 100% asbestos

ESTIMATED LOD: <1% asbestos [1]

PRECISION: not determined

APPLICABILITY: This method is useful for the qualitative identification of asbestos and the semi-quantitative determination of asbestos content of bulk samples, expressed as a percent of projected area. The method measures percent asbestos as perceived by the analyst in comparison to standard area projections, photos, and drawings, or trained experience. The method is not applicable to samples containing large amounts of fine fibers below the resolution of the light microscope.

INTERFERENCES: Other fibers with optical properties similar to the asbestos minerals may give positive interferences. Optical properties of asbestos may be obscured by coating on the fibers. Fibers finer than the resolving power of the microscope (ca. 0.3 µm) will not be detected. Heat and acid treatment may alter the index of refraction of asbestos and change its color.

OTHER METHODS: This method (originally designated as method 7403) is designed for use with NIOSH Methods 7400 (phase contrast microscopy) and 7402 (electron microscopy/EDS). The method is similar to the EPA bulk asbestos method [1].

REAGENTS:

1. Refractive index (RI) liquids for Dispersion Staining: high-dispersion (HD) series, 1.550, 1.605, 1.620.
2. Refractive index liquids: 1.670, 1.680, and 1.700.
3. Asbestos reference samples such as SRM #1866, available from the National Institute of Standards and Technology.*
4. Distilled Water (optional).
5. Concentrated HCl: ACS reagent grade (optional).

*See SPECIAL PRECAUTIONS

EQUIPMENT:

1. Sample containers: screw-top plastic vials of 10- to 50-mL capacity.
2. Microscope, polarized light, with polarizer, analyzer, port for retardation plate, 360° graduated rotating stage, substage condenser with iris, lamp, lamp iris, and:
   a. Objective lenses: 10X, 20x, and 40X or near equivalent.
   b. Ocular lense: 10X minimum.
   c. Eyepiece reticle: crosshair.
   d. Dispersion staining objective lens or equivalent.
   e. Compensator plate: ca. 550 nm ± 20 nm, retardation: "first order red" compensator.
3. Microscope slides: 75 mm x 25 mm.
4. Cover slips: 22 mm x 22 mm.
5. Ventilated hood or negative pressure glove box.
6. Mortar and pestle: agate or porcelain.
7. Stereomicroscope, ca. 10 to 45X.
8. Light source: incandescent or fluorescent.
9. Tweezers, dissecting needles, spatulas, probes, and scalpels.
10. Glassine paper or clean glass plate.
11. Low-speed hand drill with coarse burr bit (optional).

SPECIAL PRECAUTIONS: Asbestos, a human carcinogen, should be handled only in an exhaust hood (equipped with a HEPA filter). [2] Precautions should be taken when collecting unknown samples, which may be asbestos, to preclude exposure to the person collecting the sample and minimize the disruption to the parent material [3]. Disposal of asbestos-containing materials should follow EPA Guidelines [4].

SAMPLING:

1. Place 1 to 10 g of the material to be analyzed in a sample container.
   NOTE: For large samples (i.e., whole ceiling tiles) that are fairly homogenous, a representative small portion should be submitted for analysis. Sample size should be adjusted to ensure that it is representative of the parent material.
2. Make sure that sample containers are taped so they will not open in transit.
3. Ship the samples in a rigid container with sufficient packing material to prevent damage or sample loss.

SAMPLE PREPARATION:

4. Visually examine samples in the container and with a low-magnification stereomicroscope in a hood. (If necessary, a sample may be carefully removed from the container and placed on glassine transfer paper or clean glass plate for examination). Break off a portion of the sample and examine the edges for emergent fibers. Note the homogeneity of the sample. Some hard tiles can be broken, and the edges examined for emergent fibers. If fibers are found, make an estimate of the amount and type of fibers present, confirm fiber type (steps 6 through 13) and quantify (steps 14 through 16).

5. In a hood, open sample container and with tweezers remove small, representative portions of the sample.
   a. If there are obvious separable layers, sample and analyze each layer separately.
   b. If the sample appears to be slightly inhomogeneous, mix it in the sample container with tweezers or a spatula before taking the portion for analysis. Alternatively, take small representative portions of each type of material and place on a glass slide.
   c. On hard tiles that may have thin, inseparable layers, use a scalpel to cut through all the layers for a representative sample. Then cut it into smaller pieces after placing RI liquid on it before trying to reduce the thickness. Alternatively, use a low-speed hand drill equipped with a burr bit to remove material from hard tiles. Avoid excessive heating of the sample which may alter the optical properties of the material.
   NOTE: This type of sample ofter requires ashing or other specialized preparation.
   d. If the sample has large, hard particles, grind it in a mortar. Do not grind so fine that fiber characteristics are destroyed.
   e. If necessary, treat a portion of the sample in a hood with an appropriate solvent to remove binders, tars, and other interfering materials which may be present in the sample. Make corrections for the non-asbestos material removed by this process.
   NOTE: Other methods of sample preparation such as acid and sodium metaphosphate treatment and ashing are not normally necessary. However, if needed, use as described in Reference [1].
6. After placing a few drops of RI liquid on the slide, put a small portion of sample in the liquid. Tease apart with a needle or smash small clumps with the flat end of a spatula or probe, producing a uniform thickness of particles so that better estimates of projected area percentages can be made. Mix the fibers and particles on the slide so that they are as homogeneous as possible.
   NOTE: An even dispersion of sample should cover the entire area under the cover slip. Some practice will be necessary to judge the right amount of material to place on the slide. Too little sample may not give sufficient information and too much sample cannot be easily analyzed.

CALIBRATION AND QUALITY CONTROL:

7. Check for contamination of microscope slides, cover slips and refractive index liquids once per day of operation. Record results in a separate logbook.
8. Verify the refractive indices of the refractive index liquids used once per week of operation. Record these checks in a separate logbook.
9. Follow the manufacturer's instructions for illumination, condenser alignment and other microscope adjustments. Perform these adjustments prior to each sample set.
10. Determine precent of each identified asbestos species by comparision to standard projections (Figure 1) [1]. If no fibers are detected in a homogeneous sample, examine at least two additional preparations before concluding that no asbestos is present.
11. If it appears that the preparation technique might not be able to produce a homogeneous or representative sample on the slide, prepare a duplicate slide and average the results. Occasionally, when the duplicate results vary greatly, it will be necessary to prepare additional replicate slides and average all the replicate results. Prepare duplicate slides of at least 10% of the samples analyzed. Average the results for reporting.
12. Analyze about 5% blind samples of known asbestos content.
13. Laboratories performing this analytical method should participate in the National Voluntary Labortory Accreditation Program [5] or a similar interlaboratory quality control program. Each analyst should have completed formal training in polarized light microscopy and its application to crystalline materials. In lieu of formal training, laboratory training in asbestos bulk analysis under the direction of a trained asbestos bulk analyst may be substituted. Due to the subjective nature of the method, frequent practice is essential in order to remain proficient in estimating projected area percentages.

QUALITATIVE ASSESSMENT:

14. Scan the slide to identify any asbestos minerals using the optical properties of morphology, refractive indices, color, pleochroism, birefringence, extinction characteristics, sign of elongation, and dispersion staining characteristics.

    NOTE: Identification of asbestos using polarized light microscopy is unlike most other analytical methods. The quality of the results is dependent on the skill and judgment of the analyst. This method does not lend itself easily to a step-wise approach. Various procedures devised by different analysts may yield equivalent results. The following step-wise procedure repeatedly utilizes the sample preparation procedure previously outlined.

    a. Prepare a slide using 1.550 HD RI liquid. Adjust the polarizing filter such that the polars are partially crossed, with ca. 15° offset. Scan the preparation, examining the morphology for the presence of fibers. If no fibers are found, scan the additional preparations. If no fibers are found in any of the preparations, report that the sample does not contain asbestos, and stop the analysis at this point.

    b. If fibers are found, adjust the polarizing filter such that the polars are fully crossed. If all of the fibers are isotropic (disappear at all angles of rotation) then those fibers are not asbestos. Fibrous glass and mineral wool, which are common components of suspect samples, are isotropic. If only isotropic fibers are found in the additional preparations, report no asbestos fibers detected, and stop the analysis.

    c. If anisotropic fibers are found, rotate the stage to determine the angle of extinction. Except for tremolite-actinolite asbestos which has oblique extinction at 10-20°, the other forms of asbestos exhibit parallel extinction. Tremolite may show both parallel and oblique extinction.

    d. Insert the first-order red compensator plate in the microscope and determine the sign of elongation. All forms of asbestos have a postive sign of elongation except for crocidolite. If the sign of elongation observed is negative, go to step "g".

       NOTE: To determine the direction of the sign of elongation on a particular microscope configuration, examine a known chrysotile sample and note the direction (NE-SW or NW-SE) of the blue coloration. Chrysotile has a positive sign of elongation.

    e. Remove the first-order red compensator and uncross the polarizer. Examine under plane polarized light for blue and gold-brown Becke colors at the fiber-oil interface (i.e., index of refraction match). Becke colors are not always evident. Examine fiber morphology for twisted, wavy bundles of fibers which are characteristic of chrysotile. Twisted, ribbon-like morphology with cellular internal features may indicate cellulose fibers. It may be necessary to cross the polars partially in order to see the fibers if the index of refraction is an exact match at 1.550. If the fibers appear to have higher index of refraction, go to step "h", otherwise continue.

    f. Identification of chrysotile. Insert the dispersion staining objective. Observing dispersion staining colors of blue and blue-magenta confirms chrysotile. Cellulose, which is a common interfering fiber at the 1.550 index of refraction, will not exhibit these dispersion staining colors. If chrysotile is found, go to step 15 for quantitative estimation.

    g. Identification of crocidolite. Prepare a slide in 1.700 RI liquid. Examine under plane-polarized light (uncrossed polars); check for morphology of crocidolite. Fibers will be straight, with rigid appearance, and may appear blue or purple-blue. Crocidolite is pleochroic, i.e., it will appear to change its color (blue or gray) as it is rotated through plane polarized light. Insert the dispersion staining objective. The central stop dispersion staining colors are red magenta and blue magenta, however these colors are sometimes difficult to impossible to see because of the opacity of the dark blue fibers. If observations above indicate crocidolite, go to step 15 for quantitative estimation.

h. Identification of amosite. Prepare a slide in 1.680 RI liquid. Observe the fiber morphology for amosite characteristics: straight fibers and fiber bundles with broom-like or splayed ends. If the morphology matches amosite, examine the fibers using the dispersion staining objective. Blue and pale blue colors indicate the cummingtonite form of amosite, and gold and blue colors indicate the grunerite form of amosite. If amosite is confirmed by this test, go to step 15 for quantitative estimation, otherwise continue.

i. Identification of anthophyllite-tremolite-actinolite. Prepare a slide in 1.605 HD RI liquid. Examine morphology for comparision to anthophyllite-tremolite-actinolite asbestos. The refractive indices for these forms of asbestos vary naturally within the species. Anthophyllite can be distinguished from actinolite and tremolite by its nearly parallel extinction. Actinolite has a light to dark green color under plane-polarized light and exhibits some pleochroism. For all three, fibers will be straight, single fibers possibly with some larger composite fibers. Cleavage fragments may also be present. Examine using the central stop dispersion staining objective. Anthophyllite will exhibit central stop colors of blue and gold/gold-magenta; tremolite will exhibit pale blue and yellow; and actinolite will exhibit magenta and golden-yellow colors.

NOTE: In this refractive index range, wollastonite is a common interfering mineral with similiar morphology including the presence of cleavage fragments. It has both positive and negative sign of elongation, parallel extinction, and central stop dispersion staining colors of pale yellow and pale yellow to magenta. If further confirmation of wollastonite versus anthophyllite is needed, go to step "j". If any of the above forms of asbestos was confirmed above, go to step 15 for quantitative estimation. If none of the tests above confirmed asbestos fibers, examine the additional preparations and if the same result occurs, report the absence of asbestos in this sample.

j. Wash a small portion of the sample in a drop of concentrated hydrochloric acid on a slide. Place the slide, with cover slip in place, on a warm hot plate until dry. By capillary action, place 1.620 RI liquid under the cover slip and examine the slide. Wollastonite fibers will have a "cross-hatched" appearance across the length of the fibers and will not show central stop dispersion colors. Anthophyllite and tremolite will still show their original dispersion colors.

NOTE: There are alternative analysis procedures to the step-wise approach outlined above which will yield equivalent results. Some of these alternatives are:

i. Perform the initial scan for the presence of asbestos using crossed polars as well as the first-order red compensator. This allows for simultaneous viewing of birefringent and amorphous materials as well as determining their sign of elongation. Some fibers which are covered with mortar may best be observed using this configuration.

ii. Some analysts prefer to mount their first preparation in a RI liquid different than any asbestos materials and conduct their initial examination under plane-polarized light.

iii. If alternative RI liquids are used from those specified, dispersion staining colors observed will also change. Refer to an appropriate reference for the specific colors associated with asbestos in the RI liquids actually used.

QUANTITATIVE ASSESSMENT:

15. Estimate the content of the asbestos type present in the sample using the 1.550 RI preparation. Express the estimate as an area percent of all material present, taking into account the loading and distribution of all sample material on the slide. Use Figure 1 as an aid in arriving at your estimate. If additional unidentified fibers are present in the sample, continue with the qualitative measurement (step 14).

NOTE: Point-counting techniques to determine percentages of the asbestos minerals are not generally recommended. The point-counting method only produces accurate quantitative data when the material on the slide is homogeneous and has a uniform thickness, which is difficult to obtain [6]. The point-counting technique is, recommended by the EPA to determine the amount of asbestos in bulk [1]; however in the more recent Asbestos Hazard Emergency Response Act (AHERA) regulations, asbestos quantification may be performed by a point-counting or equivalent estimation method [7].

16. Make a quantitative estimate of the asbestos content of the sample from the appropriate combination of the estimates from both the gross and microscopic examinations. If asbestos fibers are identified, report the material as "asbestos-containing". Asbestos content should be reported as a range of percent content. The range reported should be indicative of the analyst's precision in estimating asbestos content. For greater quantities use figure 1 in arriving at your estimate.

EVALUATION OF METHOD:

The method is compiled from standard techniques used in mineralogy [8-13], and from standard laboratory procedures for bulk asbestos analysis which have been utilized for several years. These techniques have been successfully applied to the analysis of EPA Bulk Sample Analysis Quality Assurance Program samples for more than 8 years [1,5]. However, no formal evaluation of this method, as written, has been performed.

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Table 1. Optical Properties of Asbestos Fibers

		Refractive Index (Approximate Values)		
Mineral	Morphology and Color	⊥ to Elongation	∥ to Elongation	Birefringence
Chrysotile	Wavy fibers with kinks. Splayed ends on larger bundles. Colorless to light brown upon being heated. Nonpleochroic. Aspect ratio typically >10:1.	1.54	1.55	0.002 - 0.014
Cummingtonite-Grunerite (Amosite)	Straight fibers and fiber bundles. Bundle ends appear broom-like or splayed. Colorless to brown upon heating. May be weakly pleochroic. Aspect ratio typically >10:1.	1.67	1.70	0.02 - 0.03
Crocidolite (Riebeckite)	Straight fibers and fiber bundles. Longer fibers show curvature. Splayed ends on bundles. Characteristic blue color. Pleochroic. Aspect ratio typically >10:1.	1.71	1.70	0.014 - 0.016 Interference colors may be masked by blue color.
Anthophyllite	Straight fibers and fiber bundles. Cleavage fragments may be present. Colorless to light brown. Nonpleochroic to weakly pleochroic. Aspect ratio generally <10:1.	1.61	1.63	.019 - .024
Tremolite-Actinolite	Straight and curved fibers. Cleavage fragments common. Large fiber bundles show splayed ends. Tremolite is colorless. Actinolite is green and weakly to moderately pleochroic. Aspect ratio generally <10:1.	1.60 - 1.62 (tremolite) 1.62 - 1.67 (actinolite)	1.62 - 1.64 (tremolite) 1.64 - 1.68 (actinolite)	0.02 - 0.03

Table 1. Optical Properties of Asbestos Fibers (Continued)

			Central Stop Dispersion Staining Colors		
Mineral	Extinction	Sign of Elongation	RI Liquid	⊥ to Vibration	‖ to Vibration
Chrysotile	Parallel to fiber length	+ (length slow)	1.550 ^{HD}	Blue	Blue-magenta
Cummingtonite-Grunerite (Amosite)	Parallel to fiber length	+ (length slow)	1.670	Red magenta to blue	Yellow
			Fibers subjected to high temperatures will not dispersion-stain.		
Cummingtonite			1.680	pale blue	blue
Grunerite			1.680	blue	gold
Crocidolite (Riebeckite)	Parallel to fiber length	− (length fast)	1.700	Red magenta	Blue-magenta
			1.680	yellow	pale yellow
Anthophyllite	Parallel to fiber length	+ (length slow)	1.605 ^{HD}	Blue	Gold to gold-magenta
			1.620 ^{HD}	Blue-green	Golden-yellow
Tremolite-Actinolite	Oblique — 10 to 20° for fragments. Some composite fibers show ‖ extinction.	+ (length slow)	1.605 ^{HD}	Pale blue (tremolite) Yellow (actinolite)	Yellow (tremolite) Pale yellow (actinolite)

HD = high-dispersion RI liquid series.

ATTACHMENT 6

CALIBRATION OF MONITORING INSTRUMENTS FOR HEALTH AND SAFETY

CALIBRATION OF MONITORING INSTRUMENTS FOR HEALTH AND SAFETY

It is essential that each piece of air quality monitoring equipment be calibrated on a routine basis. This assures that a given monitoring instrument is both working and working with a reasonable degree of accuracy. This operating procedure outlines required calibration frequencies and techniques. The manufacturer's instructions for calibration should be kept at the site and consulted when calibrating monitoring instruments.

FREQUENCY OF CALIBRATION

The following instruments must be calibrated daily before use:

- Combustible Gas Indicator (CGI)
- Oxygen Meter
- HNu Photoionization Detector, Model PI101 (HNu PID)
  (As well as other photoionization detectors such as the Photovac TIP, AID OVM, etc.)
- Foxboro Organic Vapor Analyzer Flame Ionization Detector (OVA FID)
- Air Sampling Pumps

The following instruments require an annual factory calibration:

- Radiation Survey Meter

CALIBRATION TECHNIQUES

Combustible Gas Indicator

CGI's are both separate instruments or multi-purpose instruments (CGI/0_2, CGI/0_2/H_2S, etc.). CGI's are calibrated using a variety of different organic compounds. The most common of these are methane, hexane, and pentane. Allow a few minutes for instrument warmup prior to calibration. The calibration for a CGI is normally performed by attaching a cylinder of "factory" calibration gas to the CGI inlet or blanketing the CGI detector element (element) with an atmosphere from a calibration gas cylinder. The CGI readout is then set to that value using whatever device (set-screw, etc.) the CGI possesses to adjust the instrument to the calibration value.

Depending on which calibration gas is used for a particular CGI, the instrument manufacturer normally provides data on the relative response of other organic solvents relative to the "factory" calibration. For example, a CGI calibrated for methane could be used to measure benzene, if the manufacturer supplies a relative response curve for that compound. Of course, most solvent measurements are of mixtures and it is often difficult to accurately assess these mixtures. This is one reason that CGI's are normally set to alarm at conservative levels (usually 20 percent of the Lower Exposure Limit (LEL) of the organic compound chosen as the calibration standard).

Oxygen Meter

The meter should be allowed to warm up for a few minutes prior to calibration. A cylinder of calibration gas (typically containing 17 percent oxygen and 25,000 parts per million (ppm) methane) is attached to the meter inlet. (In the case of passive air flow instruments, a hood or cover is placed over the detectors and this in turn is connected to the calibration gas.) Calibration to 21 percent of 0_2 may also be performed using ambient air.

The calibration gas is turned on and is allowed to stabilize for 15 to 30 seconds. The meters are then adjusted (following manufacturer's instructions) to proper calibration. This usually involves adjusting a set screw at the base of the meter. The instrument should then be rechecked for proper return to zero.

HNu Photoionization Detector, Model PI 101 (HNu PID)

The instrument is turned to the battery check position first. Assuming proper charge, the main control switch is set to the standby position using the zero knob. The instrument is then allowed to warm up for about five minutes in the standby mode. The calibration gas (usually isobutylene from the HNu factory) is attached to the probe by a flexible hose. The proper range setting is selected (usually 0 to 200 ppm) and the calibration gas turned on.

The gas flows through an orifice which reduces its flow rate to the proper rate for calibration purposes. The normal factory calibration of this instrument is for benzene in air. Isobutylene is used for normal calibration because it is less toxic. The relative response of isobutylene as compared to benzene is about 70 percent with the 10.2 eV and 11.7 eV lamps (there is a slight difference between the relative response of the two different energy probes, but it is not considered significant for most field calibration purposes). Accordingly, a bottle of isobutylene calibration gas that contains 100 ppm isobutylene will read out at about 70 ppm on a factory calibrated instrument. A bottle of factory calibration gas will state the proper readout on the instrument "as benzene."

If the instrument does not calibrate exactly, the span pot knob is normally adjusted to bring the instrument into calibration. The normal "factory" settings are 9.8 for the 10.2 eV lamp and 5.0 for the 11.7 eV lamp. If the instrument cannot be brought into calibration by using the span pot knob, the lamp may need to be cleaned or other maintenance items performed so that the unit will calibrate accurately.

Foxboro Organic Vapor Analyzer Flame Ionization Detector (OVA FID)

The instrument must first be checked for adequate hydrogen supply and battery charge. It should then be started up and stabilized for about five minutes with the flame lit. The calibration gas (usually 100 ppm methane) is then attached to the probe inlet. The span pot is adjusted to bring the instrument into proper calibration (using the X10 scale).

Periodic Instrument Response Checks

It is important that each piece of monitoring equipment be checked occasionally during its use to determine that it is responding to contaminants. For the CGI/0_2 meter, this can be done by exhaling on the 0_2 sensor (exhaled air has less than 18 percent oxygen) periodically to check for proper alarming. A butane lighter or "Zippo" lighter can be used as a source to check for proper alarming of the CGI element.

The HNu PID should periodically be exposed to a magic marker or Zippo lighter to check response.

A butane lighter or magic marker works well to demonstrate that the OVA FID is responding.

These "response checks" are key to providing confidence to the user that the instrument is at least functioning and responding to contaminants.

The same type of response check can be performed with the radiation meter using low level test sources with the appropriate type of probe (alpha, beta, or gamma).

MULTI-GAS MONITOR CALIBRATION LOG

MAKE ____________________
MODEL ____________________
S/N ____________________

DATE / TIME	*OXYGEN*				*LEL*				*TOX*				Comments
	Calib. Stnd.	Exp. Value	Obsvd. Value	Adj. To	Calib. Stnd.	Exp. Value	Obsvd. Value	Adj. To	Calib. Stnd.	Exp. Value	Obsvd. Value	Adj. To	

Woodward–Clyde Consultants
201 Willowbrook Boulevard
Wayne, New Jersey 07470

HNu PHOTOIONIZATION DETECTOR CALIBRATION DATA SHEET

HNu PID Meter No. ________________

HNu PID Probe No. ________________

Lamp Ionization Potential ______ **eV**

Date	Time (hrs)	Expected Value @ Span Setting (from calibration gas cylinder)		Actual Value @ Span Setting (PPM)	Span Setting Req'd to Calibrate to Expected Value	Comments
		PPM @	SPAN			

WOODWARD - CLYDE CONSULTANTS

SUMMARY OF PHOTOIONIZATION DETECTOR MEASUREMENTS

Dates: ____________ to ____________

Instrument: ______________________

Serial No.: ______________________

WCC SSO: ______________________

Date Time (hrs)	Temperature/ Weather	Reading (ppm)	Monitoring Location[1]	Work Activity	Comments

NOTES:

[1] All measurements taken about 5ft above ground (unless indicated otherwise).

[2] 'BG' indicates background measurement.

ADDITIONAL COMMENTS:

G:\TEMPLATE\HNU.XLS

10/19/94

WOODWARD - CLYDE CONSULTANTS

CGI Serial No. ______________________

SUMMARY OF GASTECH TRIPLE DETECTOR (CGI) MEASUREMENTS
DATE: ______________________

Time	Temp/ Weather	CGI Reading			Location	Dist. above ground (ft)	Work Activity	Remarks
		% O2	% LEL	H2S (ppm)				

WOODWARD - CLYDE CONSULTANTS

SUMMARY OF AEROSOL AND DUST DETECTOR MEASUREMENTS

Dates: ____________ to ____________

Instrument: ______________________________

Serial No.: ______________________________

WCC SSO: ______________________________

Date Time (hrs)	Temperature/ Weather	Reading (mg/m^3)	Monitoring Location[1]	Work Activity	Comments

NOTES:

[1] All measurements taken about 5ft above ground (unless indicated otherwise).

[2] 'BG' indicates background measurement.

ADDITIONAL COMMENTS:

____

____

____

____

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10/19/94

ATTACHMENT 7
RESUMES OF SAFETY PERSONNEL

PHILLIP L. JONES

health & safety administration
industrial hygiene
health & safety training

EDUCATION

Temple University: M.S., Industrial Hygiene, 1977
Houghton College: B.A., Chemistry, 1974

REGISTRATION

Certified Industrial Hygienist (CIH) in Comprehensive Practice by the American Board of Industrial Hygiene, 1981, Certificate #2116

PROFESSIONAL HISTORY

Woodward-Clyde Consultants, Associate, 1989-present; Corporate Health & Safety Administrator, 1985-1989
Johnson Matthey, Inc., Manager, Safety and Health, 1979-1985
PMA Insurance Company, Industrial Hygienist, 1977-1979
City of Philadelphia, Water Quality Chemist, 1975-1976

REPRESENTATIVE EXPERIENCE

Mr. Jones' twelve years of experience in occupational health/ industrial hygiene includes safety and health management at chemical process plants (Johnson Matthey, Inc.), industrial hygiene assistance to manufacturing facilities (PMA Insurance Company), as well as extensive experience in hazardous waste health and safety. Air sampling, noise monitoring, radiation monitoring, asbestos sampling, and related hazard evaluation techniques have been utilized by Mr. Jones for a broad range of work environments. In addition to the technical aspects of industrial hygiene, expertise in training, regulatory compliance, and health and safety administration is noted.

Mr. Jones' most extensive experience is in health and safety training. Training experience at Johnson Matthey, Inc. included RCRA hazardous waste safety training, management seminars on safety and health, worker training on specific hazards (lead, drum handling, platinum allergy, asbestos, etc.), hazard communication classes, and seminars for industrial hygiene graduate students. Over 100 training courses for workers at hazardous material sites have been organized and conducted by Mr. Jones since joining Woodward-Clyde Consultants. These 40-hour courses (mandated by OSHA 1910.120) include a combination of lecture and hands-on workshops with course locations including Anchorage, Baton Rouge, Chicago, Denver, Houston, Kansas City, Las Vegas, Los Angeles, New Mexico, Philadelphia, San Diego, and San Francisco.

Project experience in hazardous waste includes preparation of health and safety plans for remedial cleanup projects and remedial investigations. Sites have included the Rocky Mountain Arsenal (Colorado), Nike Missile sites (Pennsylvania, Maryland, Virginia), waste incineration site (Louisiana), construction operations at hazardous waste sites (New York), and a solvent cleanup site (New York). As Corporate Health and Safety Administrator, Mr. Jones has reviewed and approved over two hundred site-specific safety and health plans. Site audits are conducted to evaluate health and safety plan implementation.

As administrator of Woodward-Clyde Consultants health and safety program, the responsibilities include coordination of the medical surveillance and training programs for twenty-six offices, regular updating of the Health and Safety Manual, investigation of incidents, routine regulatory review, health and safety policy development, health and safety plan approval, and program record keeping.

Mr. Jones' industrial hygiene experience includes extensive studies in secondary metals refining (platinum group metals, lead, silver, gold), specialty chemicals, pharmaceutical manufacturing, and catalyst manufacturing. Additional experience is noted in oil refineries, pigment manufacturing, semiconductor production, textile manufacturing, electroplating, foundries, and asbestos abatement.

Regulatory experience includes preparation of contingency plans for compliance with the Resource Conservation and Recovery Act (RCRA) and preparation of a product application under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). Over twenty separate OSHA inspections were handled while at Johnson Matthey, Inc. including five contested citations. Hazardous waste health and safety regulatory experience includes work with EPA and the Corps of Engineers on site-specific health and safety plans.

RECENT PRESENTATIONS

Construction Health and Safety at Hazardous Waste Sites. American Industrial Hygiene Conference, June 1, 1987.

Interpreting OSHA's Hazardous Waste Workers Standard. American Public Health Association Meeting (Occupational Health and Safety Section), April 24, 1987.

Hazardous Waste Health and Safety Training for Blue Collar Workers. American Industrial Hygiene Conference, May 17, 1988.

Hazardous Waste Health and Safety for Consulting Firms. Hazardous Waste Action Coalition Meeting, November, 1987.

AFFILIATIONS

American Industrial Hygiene Association
American Society of Safety Engineers
American Academy of Industrial Hygiene
Hazardous Waste Action Coalition, Health and Safety Committee
National Environmental Training Association

ERICK SEPULVEDA

health and safety
risk assessment

EDUCATION

State University of New York at Stony Brook; B.S., Chemistry, Minor Biology, 1984

PROFESSIONAL HISTORY

Woodward-Clyde Consultants, Senior Staff Scientist, 1991-present
James C. Anderson Associates, Inc., Health and Safety, Assistant Project Manager, 1990-1991
Pall Corporation, Sr. Test Engineer, New Market Development, R&D Staff, 1984-1990

TRAINING

Hazardous Waste Management, 1986
Industrial Hydraulics and Pneumatic Systems, 1986
Advance Hazardous Waste Management (Level A/B), 1986
FT-1R Instrumentation and Analytical Evaluation, 1987
Basic Health and Safety Training, 1989
Site Supervisor Training, 1990
Air/Stack Sampling, Monitoring and Assessment, 1991
EPA/AHERA/NYState Building Inspector/Restricted III, 1991

REPRESENTATIVE EXPERIENCE

Health and Safety:

Mr. Sepulveda is the Health and Safety Officer for the New York Metropolitan Business Units. As such, he is responsible for the development of Health and Safety Plans which are site specific and meet all the compliance requirements established by WCC internal policies as well as the regulations stipulated under local, state and federal regulations. Mr. Sepulveda also supports WCC internal programs, OSHA and medical monitoring. He has received Level A, B, C and D training and has extensive experience in confined space entry work including above and below ground storage tanks, sewers and water supply tunnels.

Mr. Sepulveda is involved in Health and Safety activities involving sanitary landfills as well as hazardous waste sites, drum sampling, classification, bulking and final disposal.

In addition to landfills and hazardous waste sites, he has been involved in a number of road and rail projects where extensive monitoring of the ambient air, water and soil is demanded due to the presence of toxic materials.

Mr. Sepulveda has extensive experience in the sample collection, analysis and remediation for microorganisms (pathogenic and non-pathogenic), for indoor as well as outdoor environments. He has conducted studies on medical waste found on landfills where tubercular, legionella, coliform and hepatitis etiological agents are present. In addition he has also conducted studies in enclosed structures, such as buildings, factories, warehouses, sewage treatment plants and discharge mains.

He also has extensive experience in field sampling and inspection activities of structures insulated, built or shielded with asbestos containing materials (ACMs). Moreover, Mr. Sepulveda was heavily involved with the lab analysis of field samples, through the use of Polarized Light Microscopy (PLM), Scanning Electron Microscopy (SEM) and, gravimetric particle/fiber size and type distribution.

Filtration:

Mr. Sepulveda has extensive experience in the field of filtration and purification. He has worked on water and solid waste separation and purification systems such as reverse osmosis systems for the U. S. Navy, ultrafine filtration for water filtration and fecal separation for NASA's space shuttle and space station. He has also worked with the U.S. Armed Forces in the Nuclear, Biological and Chemical (NBC) program, gas mask air purification systems and etiological agents removal.

In addition, he was involved in the research and development and implementation of air filtering systems, industrial food and beverage filtration, industrial hydraulics and residential water filtration.

PROFESSIONAL AFFILIATIONS

American Chemical Society

MARC E. JACOBSON	hazardous waste management site investigation risk assessment laboratory and analytical services

EDUCATION

Pennsylvania State University: B.S., Earth Sciences. Concentration in Geosciences, 1983

TRAINING

Hazardous Materials Health & Safety Training (OSHA); 40 hours, 1987
Advanced Health and Safety Training, Level B, 1989
Red Cross Basic First Aid Training, 1991
Red Cross CPR Training, 1991
Site Health and Safety Supervisory Training (OSHA), 1991

PROFESSIONAL HISTORY

Woodward-Clyde Consultants; Wayne, New Jersey; Senior Staff Scientist to Assistant Project Scientist, 1989 - date
Woodward-Clyde Consultants; Overland Park, Kansas; Staff Scientist, 1986 - 1989
Environmental Testing and Certification Corporation (ETC), Edison, New Jersey; Sample Manager and Production Control Supervisor, 1984 to 1986

REPRESENTATIVE EXPERIENCE

Mr. Jacobson has over seven years of experience in hazardous waste management, site investigations, risk assessment, laboratory testing and analytical services. He has participated in projects located in 11 states focused on site investigation assessment, and characterization, research, endangerment evaluation, work plan, sampling plan, QA plan development, and field activities including drilling, trenching, multi-media sampling, and groundwater remediation. His previous involvement at ETC with various aspects of sample testing and associated analytical services familiarized him with laboratory function and operation. He has served as Site Safety Officer on many sites and has extensive experience using HNu Photoionization Detectors, OVA Flame Ionization Detectors, Combustible Gas Indicators, Personal Samplers and Draeger Colorimetric Detector Tubes. He has also been responsible for preparing documentation of Health and Safety air quality monitoring on these sites. Representative examples of Mr. Jacobson's project experiences are summarized below.

Field Manager, Site Safety Officer, and sampling supervisor for a multi-phased remedial investigation at an abandoned PCB site in upstate New York. As Site Safety Officer, Mr. Jacobson was responsible for performing real-time measurements of air quality during intrusive investigatory and remedial operations.

Team member for field investigation activities at the Rocky Mountain Arsenal in Denver, Colorado. Responsibilities included preparation and peer review of field standard operating procedures (SOPs) and participated in Level C and B field activities.

Prepared the QA/QC Plan for the RI/FS project at the Pelham Bay Landfill in Bronx, New York.

Team member for field investigation activities at the Rocky Mountain Arsenal in Denver, Colorado.

Supervised installation and startup operation of a groundwater monitoring and product recovery system for an UST investigation at a trucking terminal in Carlstadt, New Jersey.

Field activities coordinator and Site Health and Safety Officer for a groundwater and soil investigation at a New Jersey ECRA site.

Prepared the Community Relations Plan and the Quality Assurance Plan for a US Army Corps of Engineers RI/FS at a former ammunitions depot in Nebraska.

Designed and implemented field sampling activities for site investigation at an abandoned metal smelting and structural steel facility in Kansas City, Kansas. Activities included soil borings, monitoring well installation, surface soil, and storm water surface runoff sampling.

Records and Sample Custodian for a remedial investigation in a pesticide-contaminated rural Illinois town. Responsible for review and approval of field documentation, coordination of packing and shipping samples to the laboratory and tracking of all samples collected. Assistant to the Field Manager in coordinating daily operations and direction of the sampling team activities. Coordinated community relations including visits to residents and integrated access locations with the planned sampling points.

Researched and developed a Level 3 Endangerment Assessment Report for a former waste disposal site at a U.S. Air Force facility in Tennessee. Concentrated on exposure assessment, chemical fate, transport integration and risk characterization as part of the Endangerment Study.

Conducted a comprehensive QA/QC audit at an environmental analytical laboratory in compliance with a site-specific QA plan.

REM II - Superfund staff member responsible for various duties and assignments pertaining to the management and enforcement support services of 23 USEPA - Region VII hazardous waste Superfund sites.

- Developed and wrote Work Plans and amendments, Project Operations and Quality Assurance Plans (POP/QAPP) and Health and Safety Plans, for presenting scope of work activities during RI/FS and enforcement support services at Superfund sites. Also responsible for QA review of Work Plan budgets.

- Performed REM II oversight of PRP field activities including soil sampling at a former pesticide plant and boring and trenching operations at a former landfill. Also responsible for split sample collection at sites for the USEPA Region VII laboratory.

Production Control Group Scheduler at an environmental testing laboratory in New Jersey. Coordinated client lab work, monitored shift production and computer status of samples for extractions and sample preparation departments. Insured accurate and proper laboratory application of USEPA, CLP and state protocols and methodologies.

Sample Manager for national testing laboratory. Duties focused on sample receipt, identification and cataloging of samples, processing documentation, client services and special handling of high hazard and complex matrix samples. Also responsible for development, review and revision of standard operating procedures and staff training.

AFFILIATIONS

Air & Waste Management Association

ATTACHMENT 8
REQUIRED PERSONAL PROTECTIVE EQUIPMENT

REQUIRED PERSONAL PROTECTIVE EQUIPMENT

LEVEL D PERSONAL PROTECTIVE EQUIPMENT

- Hard hat using the SAEP recommended colors
- Safety glasses, goggles, or face shield(1)
- Chemical-resistant steel-toed and steel shank work boots (PVC) or rubber
- Overboots or disposable "booties" (dark color preferred)(2)
- Outer gloves(3)
- Latex surgical gloves (to be worn underneath outer gloves)
- Gray or dark blue Tyvek coveralls

(1) if splash or dust hazard exists

(2) personnel should wear neoprene overboots or "booties" in Areas 1, 3 and 8 as identified on Figure 2-2 of the Work Plan as these areas may contain PCBs; rubber overboots or "booties" should be worn, as required, in other areas of the facility.

(3) personnel should wear neoprene outer gloves in Areas 1, 3 and 8 as identified in Figure 2-2 of the Work Plan as these areas may contain PCBs; nitrile rubber outer gloves should be worn, as required, in other areas of the facility.

LEVEL C PERSONAL PROTECTIVE EQUIPMENT

- Hard hat using the SAEP's recommended colors
- Full-face air purifying respirator with GMC-H combination cartridges
- Chemical-resistant steel-toed and steel shank work boots
- Nitrile rubber or neoprene outer gloves(1)
- Latex surgical gloves (to be worn underneath outer gloves)
- Rubber or neoprene overboots or disposable "booties" (dark color preferred)(1)
- Gray or dark blue hooded Saranex impregnated or polycoated Tyvek coveralls (taped at cuffs)

(1) choice at discretion of SSHO

LEVEL B PERSONAL PROTECTIVE EQUIPMENT

- Positive pressure-demand full-facepiece self-contained breathing apparatus (SCBA), or positive pressure-demand supplied air respirator with escape SCBA
- Gray or dark blue hooded Saranex impregnated or polycoated Tyvek coveralls (taped at cuffs, seams and facepiece)
- Nitrile rubber or neoprene outer gloves (1)
- Latex surgical gloves (to be worn underneath outer gloves)
- Chemical-resistant steel-toed and steel shank work boots
- Rubber or neoprene overboots or disposable "booties" (dark color preferred)(1)

(1) choice at discretion of SSHO

ATTACHMENT 9
MEDICAL SURVEILLANCE PROGRAM

MEDICAL SURVEILLANCE PROGRAM

Medical surveillance is a major component of the WCC health and safety program. It was established to monitor and promote the health of employees engaged in projects which have the potential for exposure to hazardous substances.

Medical surveillance provides a clinical base of information useful in evaluating employee's fitness to work at hazardous waste sites, to identify anomalies in a person's medical history that may be related to potential impaired health, to evaluate a person's capability to use respiratory protection equipment, and to identify illnesses that may be related to chemical exposure while on the job. This base of medical information includes personnel health history, exposure history, physical examination results, laboratory analyses, and results of screening and special tests. Medical examinations include:

- **Past Medical History** - on entry to the program, information concerning past occupational exposures and personal as well as family history of disease.
- **Present Medical Profile** - all pertinent medical information regarding present state of health and during each year of field work in hazardous material projects.
- **Exposure History** - information concerning the cumulative duration of time spent on potentially hazardous sites, the primary toxic substances, and the levels of protection employed by each site.
- **Laboratory Analyses** - hematology, liver and kidney function tests, and urinalysis.
- **Hearing test.**
- **Vision test.**
- **Pulmonary function test.**
- **Electrocardiogram.**

- **X-ray.**

- **Physical examination.**

- **Special Tests** - medical information concerning the effects of exposure to specific contaminants.

OBJECTIVES

The objectives of the medical surveillance component of the health and safety program are:

- Protect the health of employees assigned to work on hazardous material projects.

- Pre-assignment screening of employee's health to determine present status and to identify existing problems that may be aggravated by chemical exposures or physical stress.

- Monitoring employee health for early signs of work-related illness and employee suitability for further field or laboratory assignments on sites containing potentially hazardous substances.

- Evaluation and care of individuals with work-related illnesses or injuries.

- Satisfy the requirements of OSHA Part 1910.134 regarding respiratory protection and OSHA 1910.120 for hazardous waste workers.

RESPONSIBILITIES OF WCC OPERATING UNITS

Each operating unit, through its HSO, must comply with the medical surveillance provisions of the health and safety program. It is the responsibility of the operating unit manager to assure that the following activities are punctually and thoroughly conducted.

- Arrange for health monitoring services by a qualified local physician or medical organization, preferably with occupational health expertise. The physician must be willing to perform all physician-related tasks described in the WC medical surveillance program.

- Identify personnel within the operating unit required to enter the program.

- Inform participants of the specific arrangements for scheduling and receiving medical examinations.

- Comply with the examining and/or the reviewing physician's recommendations regarding work restrictions and attending to all work-related illnesses.

- Document and report work/exposure histories for all employees engaged in field activities.

REQUIREMENTS

Under Part 1910.120, OSHA requires medical surveillance for personnel involved in hazardous waste operations. OSHA states that persons should not be assigned to tasks unless it has been determined that they are physically able to perform the work and use the equipment.

The OSHA program has two essential components: routine health care and emergency treatment. Routine health care and maintenance shall consist of at least:

1. Pre-employment medical examinations to establish the individual's state of health, baseline physiological data, and ability to wear personal protective equipment. The frequency and type of examination to be conducted thereafter should be determined by medical personnel knowledgeable in the area of occupational medicine.

2. Arrangements to provide special medical examinations, care, and counseling in case of known or suspected exposures to toxic substances. Any special tests

performed depend on the chemical substance in which the individual has been exposed.

The site safety plan must address emergency medical care and treatment of personnel, including possible exposures to toxic substances and injuries due to physical hazards. The following items should be considered in emergency care provisions.

- The name, address, and telephone number of the nearest medical treatment facility should be conspicuously posted. A map and/or directions for locating the facility, plus the travel time, should be readily available.

- The facility's ability to provide care and treatment of personnel exposed or suspected of being exposed to toxic (or otherwise hazardous) substances should be ascertained. If the facility lacks toxicological capability, arrangements should be made for consultant services.

- All administration arrangements for accepting patients should be made in advance with the facility.

- Arrangements should be made to quickly obtain ambulance, emergency, fire, and police services. Telephone numbers and procedures for obtaining these services should be conspicuously posted.

- Emergency showers, eye wash fountains, and first aid equipment should be readily available on-site. Personnel should have first aid and medical emergency training.

- Provisions should be made for rapid identification of the substance to which the worker has been exposed (if this has not previously been done). This information must be provided to medical personnel.

MEDICAL EXAMINATIONS

Initial Baseline Examination

All applicable employees shall be given a baseline examination before being assigned to work at sites containing potentially hazardous substances. The purpose of the baseline examination is pre-assignment screening.

Routine Examinations

All personnel who have taken the initial baseline examination and have received clearance by the examining and/or reviewing physician to participate in field or laboratory activities shall be re-examined on an annual or biennial basis. Generally, employees with less than 100 hours of annual hazardous waste field work will have biennial examinations. Employees with greater than 100 hours hazardous waste field work will have annual examinations. The reviewing physician will have final authority in regard to examination frequency.

Exit Examination

An exit examination shall be given to any employee whose employment with WC has included hazardous materials work and who has been a participant in medical surveillance. The exit examination may be waived if the most recent examination was in the past six months.

Special Testing

Special testing may be required on certain projects due to the potential for exposure to specific substances. This may also be necessary where the potential for heat or cold stress exists. The need for special testing will be assessed on a project-by-project basis. Examples of special testing conditions include sites containing asbestos, arsenic, or lead where specific OSHA medical requirements for these compounds are in effect.

EXAMINATION PROTOCOLS

The protocols presented in Table 1 apply to baseline, annual, and exit examinations. A detailed health/work history questionnaire is provided before baseline and routine examinations. The protocols may be expanded by the reviewing or examining physician after consultation with WCC.

PHYSICIAN'S REPORTS

Examining physicians will use information provided by the employee in the questionnaire, the examination results, and the results of laboratory tests to determine if any work restrictions or occupational health problems appear to be present. The examining physician will provide the results of the examination to the WCC reviewing physician for final evaluation of employee suitability for work at hazardous material sites. The reviewing physician's conclusions shall supercede those of the examining physician. A physician's report on the examination will be sent directly to the employee with a separate letter stating ability to work at hazardous waste sites sent to WCC.

Employer reports received by WCC shall be reviewed by the HSO and kept in the Operating Unit's health and safety file. Physician recommendations regarding limitations must be followed.

EMPLOYEE MEDICAL SURVEILLANCE PROGRAM

The employee medical surveillance program (EMSP) is a computerized database which stores and processes employee medical surveillance information such as medical examination results, exposure history, training and respirator fit testing data. The purpose of EMSP is to facilitate record documentation, the reviewing physician's evaluation of the medical surveillance data, and administration of the WCC Health and Safety Program. Administrative and quality control features include: profile reports on employee eligibility for site work, medical examination scheduling reports, training requirement notices, and listing of qualified staff by operating unit and firmwide.

REVIEWING PHYSICIAN

Dr. Peter Greaney of Anaheim, California has been retained to provide medical oversight to the WCC medical surveillance program. The reviewing physician receives copies of all medical questionnaires, examinations, and laboratory testing results, reviews the opinions of examining physicians, and determines an employee's fitness for work at hazardous material sites. The physician also provides advice and assistance regarding site specific medical monitoring needs and programs.

CONFIDENTIALITY

Employee medical records are confidential and available for review only by the examining and/or reviewing physicians and their medical personnel.

Each employee can obtain information on his/her health by asking the examining physician for the information at the time of, or after, an examination. The employee may also request release of records or information, and/or designate a representative, in a letter to the physician. The request must contain the full name and address of the representative and indicate the records to be released. Medical information about an employee will not be made available to anyone without authorization from the individual concerned.

FINANCIAL RESPONSIBILITY

The costs of baseline, routine, special, and exit examinations will be paid to the examining physician by WCC operating units. The cost of examinations and tests that the employee voluntarily takes on recommendations by the examining or reviewing physician shall be borne by the employee unless the examinations/tests are related to the employee ability to work or to diagnose a work-related illness. The cost of the reviewing physician and the EMSP data base will be paid by Corporate Health and Safety.

TABLE 1

MEDICAL EXAMINATION PROTOCOL

	Test	Testing Frequency Baseline	 Routine	 Other	Remarks
1.	Cardiogram	X		X	Preplacement every 3 years for less than or equal to 40 years old. Every examination for more than 40 years old.
2.	Chest X-Ray	X		X	Preplacement every 3 years for less than or equal to 40 years old. Every 2 years for more than or equal to 40 years old to less than or equal to 55 years old. Every exam for more than 55 years old.
3.	Audiogram	X	X		
4.	Blood Chemistry Panel	X	X		

Required:

Glucose
Sodium
Potassium
Chloride
BUN
Creatinine
Uric Acid
Phosphate
Calcium
Cholesterol
Triglycerides
Total Protein
Albumin
Globulin
Total Bilirubin
Direct Bilirubin

TABLE 1
(continued)

Test	Testing Frequency			Remarks
	Baseline	Routine	Other	
4. Blood Chemistry Panel Required: (continued)				
Alk. Phosphatase				
G-Glutamyl Transpep.				
Transaminase, SGO				
Transaminase, SGP				
LDH				
Iron				
Optional:				
Magnesium				
Albumin/Globulin Ratio				
BUN/Creatinine Ratio				
5. CBC Count (Hemogram)	X	X		
WDC				
RBC				
HGB				
HCT				
MCV				
MCH				
MCHC				
Differential White Count		X		
Seg				
Band				
Lymph				
Mono				
Eosin				
Baso				
Platelets				
Platelets Count				
Reticulocyte Count				

TABLE 1
(continued)

Test	Testing Frequency		Other	Remarks
	Baseline	Routine		
6. Serum Iron and Total Iron Binding Capacity (TIBC)	X			
7. Urinalysis	X	X		
Appearance Color pH Ketones Direct Bilirubin Total Bilirubin Glucose Blood Urobilinogen L. Esterase WDC RBC Casts Mucus Bacteria Eiptherlial Crystals Yeast MCG/DL				
8. Morphology (Present, Absent, Unknown)	X	X		
Anisocytosid Poikilocytosis Hypochromia Polychromasia Basophilic Stippling				

ATTACHMENT 10

HEALTH AND SAFETY INCIDENT REPORT

WOODWARD-CLYDE CONSULTANTS
HEALTH AND SAFETY INCIDENT REPORT

Project Number ____________________ Date/Time of Incident ____________________

[illegible]oject Name ____________________ Project Location ____________________

DESCRIPTION OF INCIDENT (Describe what happened and possible cause, identify individuals involved, witnesses, and their affiliations, and describe emergency or corrective action taken.)

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Reporter: ____________________ ____________________ ____________________
Print Name Signature Date

Reporter must deliver this report to the New York Metro BUHSO within one day of the date of incident for medical treatment cases and within five days for other incidents.

Reviewed by: ____________________ ____________________ ____________________
Print Name Signature Date
New York Metro Business Unit Health and Safety Officer

Distribution:

__________ WCC Corporate Health and Safety Administrator, ____________________
__________ EOG Corporate Health and Safety Officer, ____________________
__________ New York Metro Manager of Health and Safety, ____________________
__________ New York Metro BUHSO, ____________________
__________ Business Unit Manager, ____________________
__________ Responsible Professional, ____________________
__________ Project Manager, ____________________
__________ Site Safety Officer, ____________________
__________ Personnel Manager (Medical Treatment Cases Only), ____________________

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ATTACHMENT 11
SITE SAFETY AND HEALTH PLAN COMPLIANCE AGREEMENT

SITE SAFETY AND HEALTH PLAN COMPLIANCE AGREEMENT

I,________________________________(print name), have received a copy of the Site Safety and Health Plan for the Stratford Army Engine Plant (WCC Project No. 89C114CC). I have read the SSHP, understand it, and agree to comply with all of its provisions. I understand that I could be prohibited from working on the project for violating any of the safety requirements specified in the SSHP.

Signed:

________________________________	________________________________
Signature	Date

ATTACHMENT 12
RESPIRATOR INSPECTION, CARE, MAINTENANCE AND STORAGE

RESPIRATOR INSPECTION, CARE, MAINTENANCE, AND STORAGE

The purpose of this Attachment is to provide guidance on the proper care and use of respiratory protective devices, to assist in adequately protecting personnel as well as complying with OSHA Part 1910.134.

APPLICABILITY

This procedure is applicable for use in caring for half-face and full-face respirators of either air-purifying or air supplying type. Proper care of respirators is essential for their satisfactory performance. Of importance are respirator inspection, care, maintenance, and storage.

REQUIREMENTS

OSHA requires, as part of an inspection program, that all respirators be leak checked, a determination that the complete assembly is gas tight. Follow field inspection procedures to examine the freshly cleaned, reassembled respirator.

Cleaning and Disinfecting - OSHA Part 1910.134 states "routinely used respirators shall be collected, cleaned and disinfected as frequently as necessary to ensure that proper protection is provided..." and that emergency use respirators "shall be cleaned and disinfected after each use."

The OSHA standard states that "replacement or repair shall be done by experienced persons with parts designed for the respirators." Besides being contrary to OSHA requirements, substitution of parts from a different brand or type of respirator invalidates approval (i.e., NIOSH, MSHA) of the device.

OSHA requires that respirators be stored to protect against:

- Dust;
- Sunlight;
- Heat;

- Extreme cold;
- Excessive moisture;
- Damaging chemicals; and,
- Mechanical damage.

The OSHA standard suggests that respirators be in their original cartons, however, this may provide only minimal protection from mechanical damage.

INSPECTION

Air-Purifying Respirators

Routinely used air-purifying respirators should be checked as follows before and after each use:

1. Examine the facepiece for:
    - Excessive dirt;
    - Cracks, tears, holes or physical distortion of shape from improper storage;
    - Inflexibility of rubber facepiece (stretch and knead to restore flexibility);
    - Cracked or badly scratched lenses in full facepieces;
    - Incorrectly mounted full facepiece lenses, or broken or missing mounting clips; and,
    - Cracked or broken air-purifying element holder(s), badly worn threads or missing gasket(s), if required.
2. Examine the head straps or head harness for:
    - Breaks;
    - Loss of elasticity;
    - Broken or malfunctioning buckles and attachments; and,
    - Excessively worn serrations on head harness, that might permit slippage (full facepieces only).

3. Examine the exhalation valve for the following after removing its cover:

   - Foreign material, such as detergent residue, dust particles or human hair under the valve seat;
   - Cracks, tears or distortion in the valve material;
   - Improper insertion of the valve body in the facepiece;
   - Cracks, breaks, or chips in the valve body, particularly in the sealing surface;
   - Missing or defective valve cover; and,
   - Improper installation of the valve in the valve body.

4. Examine the air-purifying element for:

   - Incorrect cartridge, canister or filter for the hazard;
   - Incorrect installation, loose connections, missing or worn gasket or cross threading in the holder;
   - Expired shelf-life date on the cartridge or canister; and,
   - Cracks or dents in the outside case of the filter, cartridge or canister, indicated by the absence of sealing material, tape, foil, etc., over the inlet.

5. If the device has a corrugated breathing tube, examine it for:

   - Broken or missing end connectors;
   - Missing or loose hose clamps; and,
   - Deterioration, determined by stretching the tube and looking for cracks.

6. Examine the harness of a front-or back-mounted gas mask for:

   - Damage or wear to the canister holder, that may prevent its being held in place; and,
   - Broken harness straps for fastening.

Atmosphere-Supplying Respirators

For a routinely used atmosphere-supplying device, use the following procedures:

1. If the device is a tight-fitting facepiece, use the procedures outlined under air-purifying respirators, except those pertaining to the air-purifying elements.

2. If the device is a hood, helmet, blouse or full suit, use the following procedures:

    - Examine the hood, blouse or full suit for rips and tears, seam integrity, etc.;

    - Examine the protective headgear, if required, for general condition with emphasis on the suspension inside the headgear;

    - Examine the protective face shield, if any, for cracks or breaks or impaired vision; and,

    - Make sure the protective screen is intact and secured correctly over the face shield.

3. Examine the air supply systems for:

    - Integrity and good condition of air supply lines and hoses, including attachment and end fittings; and,

    - Correct operation and condition of all regulators, or other air flow regulators.

In addition to the above, for self-contained breathing apparatus (SCBA) units also determine that:

1. The high pressure cylinder of compressed air or oxygen is sufficiently charged for the intended use, preferably full charged.

2. On closed circuit SCBA, a fresh canister of CO_2 (carbon dioxide) sorbent is installed.

3. On open circuit SCBA, the cylinder has been recharged if less than 25 percent of the useful service time remains.

All SCBAs are required to have a warning device that indicates when the 25 percent level is reached. However, it is recommended that an open-circuit SCBA be fully charged before use.

Respirator Disassembly

The used respirators should be collected and deposited in a central location. They are taken to an area where the filters, cartridges or canisters are removed and discarded. Canisters should be damaged or marked to prevent accidental reuse. If facepieces are equipped with reusable dust filters, they may be cleaned with compressed air in a hood. This prevents dust from getting into the room and affecting the respirator maintenance personnel. If SCBAs are used, tanks should be removed and taken to an area where the SCBA regulators and low-air warning devices are tested. SCBA facepieces are cleaned like air-purifying respirator facepieces.

Defects Found in Field Inspection

If defects are found during any field inspection, two remedies are possible. If the defect is minor, repair and/or adjustment may be made immediately. If it is major, the device should be removed from service until it can be repaired. (A spare unit should replace the unit removed from service.) Under no circumstances should a device that is known to be defective remain in the field.

Inspection During Cleaning

Because respirator cleaning usually involves some disassembly, it presents a good opportunity to examine each respirator thoroughly. The procedures outlined above for a field inspection should be used. Respirators should be inspected after cleaning operations and reassembly have been accomplished.

Respirator Care

When used routinely, respirators should be exchanged daily for cleaning and inspection. Where respirators are used only occasionally, the exchange period could be weekly or monthly. Workers maintaining their own respirators should be thoroughly briefed on cleaning and disinfecting them. Although workers may not be required to maintain their own respirators, briefing on the cleaning procedure will encourage their acceptance of a respirator by providing knowledge of what is a clean, disinfected, properly maintained device. This is particularly important where respirators are not individually assigned.

Where respirators are individually assigned (a practice to be encouraged), they should be identified to ensure that the worker always receives the same device. Identification markers must not penetrate the facepiece, block the filter, cartridge parts or exhaust valves.

When a relatively small number of respirators are used, or where workers clean their own respirators, the generally accepted procedure is washing with detergent and warm water using a brush, thoroughly rinsing in clean water, and drying in a clean place. Precautions should be taken to prevent damage from rough handling during this procedure.

When large numbers of respirators are used, it is recommended that centralized cleaning and maintenance be performed and that specialized equipment and personnel trained in respirator maintenance be utilized.

Cleaning and Sanitizing

The actual cleaning may be done in a variety of ways. A commercial dishwasher can be used. A standard domestic clothes washer may also be used if a rack is installed around the agitator to hold the facepieces in fixed positions. If the facepieces are placed loose in the washer, the agitator may damage them. A standard domestic dishwasher may be used, but it is not preferred because it does not immerse the facepieces. any good detergent may be used followed by a disinfecting rinse or a combination disinfectant-detergent for a one step operation. Disinfection is not absolutely necessary if the respirator is reused by the same person. However, where individual issue is not practical, disinfection is strongly recommended. Reliable, effective disinfectants may be made from readily available household solutions, including:

1. Hypochlorite solution [50 parts per million (ppm) of chlorine] made by adding approximately two milliliters of bleach (such as Clorox) to one liter of water, or two tablespoons of bleach per gallon of water. A two minute immersion disinfects the respirators.

2. Aqueous solution of iodine (50 ppm of iodine) made by adding approximately 0.8 milliliters of tincture of iodine per liter of water, or one teaspoon of tincture of iodine per gallon of water. A two-minute immersion disinfects the receptors.

If the respirators are washed by hand, a separate disinfecting rinse may be provided. If a washing machine or dishwasher is used, the disinfectant must be added to the rinse cycle; the amount of water in the machine at that time will have to be measured to determine the correct amount of disinfectant.

To prevent damaging the rubber and plastic in the respirator facepieces, the cleaning water should not exceed 140°F (60°C), but it should not be less than 120°F (49°C) to ensure adequate cleaning. In addition, if commercial or domestic dishwashers are used, the drying cycle should be eliminated, since the temperatures reached in these cycles may damage the respirators.

Rinsing

The cleaned and disinfected respirators should be rinsed thoroughly in water [140°F (60°C) maximum] to remove all traces of detergent and disinfectants. This is very important for preventing dermatitis.

Drying

The respirators may be allowed to dry in room air on a clean surface. They may also be hung from a horizontal wire, like drying clothes, but care must be taken not to damage or distort the facepieces. Another method is to equip a standard steel storage cabinet with an electric heater that has a built-in circulating fan, and to replace the solid steel shelves with steel mesh.

Reassembly and Inspection

The clean, dry respirator facepieces should be reassembled and inspected in an area separate from the disassembly area to avoid contamination. The inspection procedures have been discussed; special emphasis should be given to inspecting the respirators for detergent or soap residue left by inadequate rinsing. This appears most often under the seat of the exhalation valve, and can cause valve leakage or sticking.

The respirator should be thoroughly inspected and all defects corrected. New or retested cartridges and canisters should be installed, and the completely reassembled respirator should be tested for leaks.

Maintenance and Repair

Maintenance personnel must be thoroughly trained. They must be aware of the limitations and never try to replace components or make repairs and adjustments beyond the manufacturer's recommendations, unless they have been specially trained by the manufacturer.

These restrictions apply primarily to maintenance of the more complicated devices, especially closed- and open-circuit SCBA, and more specifically, regulator valves and low pressures warning devices. These devices should be returned to the manufacturer or to a trained technician for adjustment or repair. There should be no major problems in repairing and maintaining most respirators, particularly the commonly used air-purifying type.

An important aspect of any maintenance program is having enough spare parts on hand. Only continual surveillance of replacement rates will determine what parts and quantities should be kept in stock. It is desirable to have a recording system to indicate spare parts usage and the inventory on hand.

For SCBA devices, the facepiece should be combined with the tested regulator and the fully charged cylinder, and an operational check performed.

<u>Respirator Storage</u>

Damage and contamination of respirators may take place if they are stored on a workbench, or in a tool cabinet or toolbox, among heavy tools, greases and dirt. Freshly cleaned respirators should be placed in heat-sealed, ziplock, or other reusable plastic bags until reissue. They should be stored in a clean, dry location away from direct sunlight. They should be placed in a single layer with the facepiece and exhalation valve in an undistorted position to prevent rubber or plastic from taking a permanent distorted "set."

Air-purifying respirators kept ready for non-routine or emergency used should be stored in a cabinet with individual compartments. The storage cabinet should be readily accessible, and all workers should be made aware of its location, as is done for fire extinguishers. Preventing serious injury from the inhalation of a toxic substance depends entirely on how quickly workers can get to the emergency respirators.

A chest or wall-mounted storage case may be used for storing SCBAs for use in emergencies. Again, the location of SCBA should be well-known and clearly marked. Unlike fire extinguishers, however, they should be located in an area that will predictably remain uncontaminated. Putting on a SCBA in a highly contaminated atmosphere such as might be created by massive release of a hazardous material may take too long a time to perform safely in that area. Therefore, the first reaction should be to escape to an uncontaminated area, then put on the SCBA that should be located there, and re-enter the hazardous area for whatever task must be done. Exceptions to this rule may be encountered; only a thorough evaluation of the process and escape routes will permit a final decision about the correct storage location for SCBAs. Respirators should be stored in a plastic bag inside a rigid container within an area that is expected to remain uncontaminated.

Workers who are adequately trained should develop a respect for respirators that will be an automatic incentive to protect respirators from damage. Besides providing better assurance of adequate protection, this training will lower maintenance costs by decreasing damage.

Recordkeeping

Records should be maintained to document that proper care and maintenance has been performed on respiratory protection devices. Records should indicate when and what was done to each respirator, and also by whom.

OPERATING PROCEDURE NO. HS-302

302.0 RESPIRATOR FIT TESTING

302.1 PURPOSE

The purpose of this Operating Procedure is to identify and to establish respirator fit testing requirements and procedures.

302.2 REQUIREMENTS

In compliance with Occupational Safety and Health Administration (OSHA) regulation Title 29 Code of Federal Regulations (CFR) 1910.134, all Woodward-Clyde (W-C) employees whose job assignments require use of non-powered air-purifying respirators (APR) or air-supplied respirators (ASR) that operate in the demand mode, must be fit tested using the isoamyl acetate (IAA) and/or the irritant smoke (IS) test. Fit tests shall be performed to identify the brand and size of respirator that fits each employee and to facilitate final fitting adjustments in the field.

Fit tests must be recorded for each tested employee. The record shall include test dates and identify the brands, models, and sizes of respirators tested.

302.3 ISOAMYL ACETATE TEST

302.3.1 Isoamyl Acetate Test Equipment

- Isoamyl acetate (USP grade in bottles or in ampules).
- Two bottles for odor recognition testing.
- Test enclosure. A simple test enclosure can be constructed by cutting a small slit at the center of the closed end of a clear plastic bag and inserting the hook of a wire clothes hanger through the slit so that the bag will hang open side down. The bag should be at least 3 mil thick and approximately the size of a garbage bag (large size).

302.3.2 Isoamyl Acetate Testing Procedures

1. The subject must exhibit his/her ability to recognize the odor of IAA. One bottle shall contain water and another, a solution of IAA and water. The subject must be able to discern which bottle contains the IAA solution, thus verifying his/her ability to recognize the odor.

2. The wearer puts on the respirator and adjusts the facepiece and head straps to achieve a snug, but comfortable fit. The positive-negative pressure test (see Section 302.6) should be applied at this point. If the respirator is the air-purifying type, it must be equipped with a fresh cartridge(s) or canister designed to protect against organic vapors.

3. The wearer is exposed to IAA by entering a test enclosure containing IAA vapors. The wearer is exposed first while holding his/her head still. If the wearer does not smell IAA, he/she is exposed again while performing the activities listed in Section 302.5.

4. If the wearer does not smell IAA while active and inactive, a satisfactory fit can be assumed; however, if the wearer smells IAA, he/she readjusts the facepiece and/or headstraps, and Step 2 is repeated.

5. If the wearer continues to smell IAA, an attempt is made to locate the leakage point. If the leakage point cannot be found or corrected, another respirator of the same brand and size is tried. If the respirator leaks, a respirator of another size or brand is tried.

302.4 IRRITANT SMOKE TEST

1. The wearer puts on the respirator and adjusts facepiece and head straps to achieve a snug, but comfortable fit. The positive-negative pressure test (see Section 302.6) should be applied at this point. If the respirator is the air-purifying type, it must be equipped with a HEPA (high efficiency) filter(s).

2. The wearer stands with his/her back towards a fume hood or other ventilation source and is asked to keep his/her eyes closed during the test. (Note: eyes must be closed even when full-face respirators are tested.)

3. With the wearer holding his/her head still, the tester lightly puffs smoke over the facepiece, holding the tube at least 2 feet from it. The volume of smoke should be kept minimal and the wearer's reaction observed between puffs.

4. If the wearer detects no leakage, the tester increases smoke density and moves the tube progressively closer to the wearer, but no closer than 6 inches. If no leakage is detected, exposure is continued while the wearer performs the activities listed in Section 302.5.

5. If no leakage is detected with and without head movements, a satisfactory fit can be assumed. However, if leakage is detected, smoke generation should be stopped and Steps 3 and 4 repeated after the wearer readjusts the facepiece and/or head straps.

6. If a respirator under test continues to leak, another respirator of the same brand, model, and size should be tried. If it does not pass the test, another size or another brand should be tried.

302.5 ACTIVITIES

If, during the IAA or IS test, no leakage occurs while the wearer is holding his/her head still, the test shall be continued while the wearer is instructed to perform the following activities:

1. Deep breathing as in heavy exertion. This activity should not be done long enough to cause hyperventilation.

2. Side-to-side, then up-and-down head movements (exaggerated).
3. Read the "Rainbow Passage." Must be loud enough to be heard by someone standing nearby.

302.6 POSITIVE-NEGATIVE PRESSURE TESTS

These tests can be performed by the wearer alone and requires no special equipment. The tests should be performed only on respirators that have passed the IAA or IS tests and for preliminary fitting during the IAA and IS tests.

In the positive pressure test, the wearer closes off the exhalation valve of the respirator by gently placing his/her palm over the valve and gently exhaling into the facepiece. The fit is considered satisfactory if a slight pressure builds up in the facepiece without any evidence of outward leakage.

In the negative pressure test, the wearer closes off the inlet of the canister, cartridge(s) or filter(s) with his/her palm or of the breathing tube of a SA respirator by squeezing the tube and inhaling gently so that the facepiece collapses slightly. Breath is held for about 10 seconds. If the facepiece remains slightly collapsed and no inward leakage is detected during the 10-second period, fit may be considered satisfactory.

302.7 TEST FREQUENCY

An IAA and/or IS test must be performed whenever an employee is provided: (1) a respirator for the first time and (2) a replacement respirator of a different brand, model, or size. A test must also be performed whenever: (1) medical records indicate that an employee may have been exposed despite wearing a respirator and (2) an employee complains of having a faulty respirator.

302.8 DOCUMENTATION

Respirator fit-test records must be maintained. Form HS-302 should be used to document the results of each fit test. It should be signed by the individual being tested and also the person administering the test.

HS-302
WOODWARD-CLYDE
HEALTH AND SAFETY TRAINING
RESPIRATOR FIT TEST RECORD

Name: ______________________ **Social Security No:** ______________________

Company/Office: ______________________ **Last Medical Exam:** ______________________

Fit Test Date: ______________________ **Corrective Lenses Needed:** Yes ☐ No ☐

Briefed on fundamental principles of respiratory protection, use, selection, inspection cleaning, maintenance and storage of equipment. Yes ☐ No ☐

Isoamyl acetate odor recognition Yes ☐ No ☐

	RESPIRATOR 1	RESPIRATOR 2	RESPIRATOR 3
Equipment Type			
Manufacturer's Name			
Model			
Size			
Facepiece Composition (Rubber Silicone)			

TEST PERFORMED	RESPIRATOR 1	RESPIRATOR 2	RESPIRATOR 3
Negative Pressure Test:	P ☐ F ☐	P ☐ F ☐	P ☐ F ☐
Positive Pressure Test:	P ☐ F ☐	P ☐ F ☐	P ☐ F ☐
Isoamyl Acetate Vapor Test:	P ☐ F ☐	P ☐ F ☐	P ☐ F ☐
Irritant Smoke Test:	P ☐ F ☐	P ☐ F ☐	P ☐ F ☐

The individual named above has been fit-tested according to procedures specified in Woodward-Clyde's Operating Procedure HS-302. This qualitative fit test protocol has been adapted from OSHA 29 CFR 1910 and 29 CFR 1926.

______________________ ______________________ ______________________
Examiner's Name (Please Print) Examiner's Signature Date

______________________ ______________________
Employee's Signature Date

ATTACHMENT 13
DAILY HEALTH AND SAFETY SUMMARY REPORT

WOODWARD-CLYDE CONSULTANTS
DAILY HEALTH AND SAFETY REPORT
STRATFORD ARMY ENGINE PLANT
WCC PROJECT NO. 89C114CC

[illegible]CC SSO: ____________________ DATE: ____________________

Weather: ____

WCC Personnel Present:
(include times)

Other Personnel Present
and Affiliation:
(include times)

Work Activities:

Level of Protection:

Summary of Ambient Measurements*:

_____ ppm (HNu PID) _____ ppm (CGI/H_2S)
_____ ppm (Foxboro OVA) _____ ppm _____ (Draeger)
_____ % 0_2 (CGI/0_2) _____ ppm _____ (Draeger)
_____ % LEL (CGI/% LEL) _____ mR/hr (Ludlum Radiation Meter)

Summary of Environmental Monitoring in Breathing Zone*:

_____ ppm (HNu PID) _____ ppm (CGI/H_2S)
_____ ppm (Foxboro OVA) _____ ppm _____ (Draeger)
_____ % 0_2 (CGI/0_2) _____ ppm _____ (Draeger)
_____ % LEL (CGI/% LEL) _____ mR/hr (Ludlum Radiation Meter)

Notes, Incidents and Comments:

* Detailed record of measurements contained in Inspectors' Field Inspection Reports

ATTACHMENT 14
OSHA JOB SAFETY & HEALTH PROTECTION POSTER

JOB SAFETY & HEALTH PROTECTION

The Occupational Safety and Health Act of 1970 provides job safety and health protection for workers by providing safe and healthful working conditions

If upon inspection OSHA believes an employer has violated the Act, a citation alleging such violations will be issued to the employer. Each citation will specify a time period within which the alleged violation must be corrected.

The OSHA citation must be prominently displayed at or near the place of alleged violation for three days, or until it is corrected, whichever is later, to warn employees of dangers that may exist there.

Employers in States operating OSHA approved State Plans should obtain and post the State's equivalent poster.

Under provisions of Title 29,Code of Federal Regulations, Part 1903.2(a)(1) employers must post this notice (or facsimile) in a conspicuous place where notices to employees are customarily posted.

More Information

Additional information and copies of the Act, specific OSHA safety and health standards, and other applicable regulations may be obtained from your employer or from the nearest OSHA Regional Office in the following locations:

Atlanta, GA	(404) 347-3573
Boston, MA	(617) 565-7164
Chicago, IL	(312) 353-2220
Dallas, TX	(214) 767-4731
Denver, CO	(303) 844-3061
Kansas City, MO	(816) 426-5861
New York, NY	(212) 337-2378
Philadelphia, PA	(215) 596-1201
San Francisco, CA	(415) 744-6670
Seattle,WA	(206) 442-5930

Lynn Martin

Lynn Martin, Secretary of Labor

U.S. Department of Labor

Occupational Safety and Health Administration

Washington, DC
1991 (Reprinted)
OSHA 2203

ATTACHMENT 15
OSHA REGULATIONS ON ILLUMINATION AND SANITATION AT TEMPORARY WORKPLACES

shall be decontaminated or disposed of properly.

(5) *Personal protective clothing and equipment.* (i) Protective clothing and equipment shall be decontaminated, cleaned, laundered, maintained or replaced as needed to maintain their effectiveness.

(ii) Employees whose non-impermeable clothing becomes wetted with hazardous substances shall immediately remove that clothing and proceed to shower. The clothing shall be disposed of or decontaminated before it is removed from the work zone.

(6) *Unauthorized employees.* Unauthorized employees shall not remove protective clothing or equipment from change rooms.

(7) *Commercial laundries or cleaning establishments.* Commercial laundries or cleaning establishments that decontaminate protective clothing or equipment shall be informed of the potentially harmful effects of exposures to hazardous substances.

(8) *Showers and change rooms.* Where the decontamination procedure indicates a need for regular showers and change rooms outside of a contaminated area, they shall be provided and meet the requirements of 29 CFR 1910.141. If temperature conditions prevent the effective use of water, then other effective means for cleansing shall be provided and used.

(l) *Emergency response by employees at uncontrolled hazardous waste sites*—(1) *Emergency response plan.* (i) An emergency response plan shall be developed and implemented by all employers within the scope of this section to handle anticipated emergencies prior to the commencement of hazardous waste operations. The plan shall be in writing and available for inspection and copying by employees, their representatives, OSHA personnel and other governmental agencies with relevant responsibilities.

(ii) Employers who will evacuate their employees from the workplace when an emergency occurs, and who do not permit any of their employees to assist in handling the emergency, are exempt from the requirements of this paragraph if they provide an emergency action plan complying with section 1910.38(a) of this part.

(2) *Elements of an emergency response plan.* The employer shall develop an emergency response plan for emergencies which shall address, as a minimum, the following:

(i) Pre-emergency planning.

(ii) Personnel roles, lines of authority, and communication.

(iii) Emergency recognition and prevention.

(iv) Safe distances and places of refuge.

(v) Site security and control.

(vi) Evacuation routes and procedures.

(vii) Decontamination procedures which are not covered by the site safety and health plan.

(viii) Emergency medical treatment and first aid.

(ix) Emergency alerting and response procedures.

(x) Critique of response and follow-up.

(xi) PPE and emergency equipment.

(3) *Procedures for handling emergency incidents.* (i) In addition to the elements for the emergency response plan required in paragraph (l)(2) of this section, the following elements shall be included for emergency response plans:

(A) Site topography, layout, and prevailing weather conditions.

(B) Procedures for reporting incidents to local, state, and federal governmental agencies.

(ii) The emergency response plan shall be a separate section of the Site Safety and Health Plan.

(iii) The emergency response plan shall be compatible and integrated with the disaster, fire and/or emergency response plans of local, state, and federal agencies.

(iv) The emergency response plan shall be rehearsed regularly as part of the overall training program for site operations.

(v) The site emergency response plan shall be reviewed periodically and, as necessary, be amended to keep it current with new or changing site conditions or information.

(vi) An employee alarm system shall be installed in accordance with 29 CFR 1910.165 to notify employees of an emergency situation; to stop work activities if necessary; to lower background noise in order to speed communication; and to begin emergency procedures.

(vii) Based upon the information available at time of the emergency, the employer shall evaluate the incident and the site response capabilities and proceed with the appropriate steps to implement the site emergency response plan.

(m) *Illumination.* Areas accessible to employees shall be lighted to not less than the minimum illumination intensities listed in the following Table H-120.1 while any work is in progress:

TABLE H-120.1—MINIMUM ILLUMINATION INTENSITIES IN FOOT-CANDLES

Foot-candles	Area or operations
5	General site areas.
3	Excavation and waste areas, accessways, active storage areas, loading platforms, refueling, and field maintenance areas.
5	Indoors: Warehouses, corridors, hallways, and exitways.

TABLE H-120.1—MINIMUM ILLUMINATION INTENSITIES IN FOOT-CANDLES—Continued

Foot-candles	Area or operations
5	Tunnels, shafts, and general underground work areas. (Exception: Minimum of 10 foot-candles is required at tunnel and shaft heading during drilling mucking, and scaling. Mine Safety and Health Administration approved cap lights shall be acceptable for use in the tunnel heading.)
10	General shops (e.g., mechanical and electrical equipment rooms, active storerooms, barracks or living quarters, locker or dressing rooms, dining areas, and indoor toilets and workrooms.)
30	First aid stations, infirmaries, and offices.

(n) *Sanitation at temporary workplaces.*—(1) *Potable water.* (i) An adequate supply of potable water shall be provided on the site.

(ii) Portable containers used to dispense drinking water shall be capable of being tightly closed, and equipped with a tap. Water shall not be dipped from containers.

(iii) Any container used to distribute drinking water shall be clearly marked as to the nature of its contents and not used for any other purpose.

(iv) Where single service cups (to be used but once) are supplied, both a sanitary container for the unused cups and a receptacle for disposing of the used cups shall be provided.

(2) *Nonpotable water.* (i) Outlets for nonpotable water, such as water for firefighting purposes, shall be identified to indicate clearly that the water is unsafe and is not to be used for drinking, washing, or cooking purposes.

(ii) There shall be no cross-connection, open or potential, between a system furnishing potable water and a system furnishing nonpotable water.

(3) *Toilet facilities.* (i) Toilets shall be provided for employees according to the following Table H-120.2.

TABLE H-120.2—TOILET FACILITIES

Number of employees	Minimum number of facilities
20 or fewer	One.
More than 20, fewer than 200.	One toilet seat and one urinal per 40 employees.
More than 200	One toilet seat and one urinal per 50 employees.

(ii) Under temporary field conditions, provisions shall be made to assure that at least one toilet facility is available.

(iii) Hazardous waste sites not provided with a sanitary sewer shall be provided with the following toilet facilities unless prohibited by local codes:

(A) Chemical toilets;

(B) Recirculating toilets;

(C) Combustion toilets; or

(D) Flush toilets.

(iv) The requirements of this paragraph for sanitation facilities shall not apply to mobile crews having transportation readily available to nearby toilet facilities.

(v) Doors entering toilet facilities shall be provided with entrance locks controlled from inside the facility.

(4) *Food handling.* All food service facilities and operations for employees shall meet the applicable laws, ordinances, and regulations of the jurisdictions in which they are located.

(5) *Temporary sleeping quarters.* When temporary sleeping quarters are provided, they shall be heated, ventilated, and lighted.

(6) *Washing facilities.* The employer shall provide adequate washing facilities for employees engaged in operations where hazardous substances may be harmful to employees. Such facilities shall be in near proximity to the worksite; in areas where exposures are below permissible exposure limits and published exposure levels and which are under the controls of the employer; and shall be so equipped as to enable employees to remove hazardous substances from themselves.

(7) *Showers and change rooms.* When hazardous waste clean-up or removal operations commence on a site and the duration of the work will require six months or greater time to complete, the employer shall provide showers and change rooms for all employees exposed to hazardous substances and health hazards involved in hazardous waste clean-up or removal operations.

(i) Showers shall be provided and shall meet the requirements of 29 CFR 1910.141(d)(3).

(ii) Change rooms shall be provided and shall meet the requirements of 29 CFR 1910.141(e). Change rooms shall consist of two separate change areas separated by the shower area required in paragraph (n)(7)(i) of this section. One change area, with an exit leading off the worksite, shall provide employees with a clean area where they can remove, store, and put on street clothing. The second area, with an exit to the worksite, shall provide employees with an area where they can put on, remove and store work clothing and personal protective equipment.

(iii) Showers and change rooms shall be located in areas where exposures are below the permissible exposure limits and published exposure levels. If this cannot be accomplished, then a ventilation system shall be provided that will supply air that is below the permissible exposure limits and published exposure levels.

(iv) Employers shall assure that employees shower at the end of their work shift and when leaving the hazardous waste site.

(o) *New technology programs.* (1) The employer shall develop and implement procedures for the introduction of effective new technologies and equipment developed for the improved protection of employees working with hazardous waste clean-up operations, and the same shall be implemented as part of the site safety and health program to assure that employee protection is being maintained.

(2) New technologies, equipment or control measures available to the industry, such as the use of foams, absorbents, adsorbents, neutralizers, or other means to suppress the level of air contaminates while excavating the site or for spill control, shall be evaluated by employers or their representatives. Such an evaluation shall be done to determine the effectiveness of the new methods, materials, or equipment before implementing their use on a large scale for enhancing employee protection. Information and data from manufacturers or suppliers may be used as part of the employer's evaluation effort. Such evaluations shall be made available to OSHA upon request.

(p) *Certain Operations Conducted Under the Resource Conservation and Recovery Act of 1976 (RCRA).* Employers conducting operations at treatment, storage, and disposal (TSD) facilities specified in paragraph (a)(1)(iv) of this section not exempted by paragraph (a)(2)(iii) of this section shall provide and implement the programs specified in this paragraph.

(1) *Safety and health program.* The employer shall develop and implement a written safety and health program for employees involved in hazardous waste operations that shall be available for inspection by employees, their representatives and OSHA personnel. The program shall be designed to identify, evaluate and control safety and health hazards in their facilities for the purpose of employee protection, to provide for emergency response meeting the requirements of paragraph (p)(8) of this section and to address as appropriate site analysis, engineering controls, maximum exposure limits, hazardous waste handling procedures and uses of new technologies.

(2) *Hazard communication program.* The employer shall implement a hazard communication program meeting the requirements of 29 CFR 1910.1200 as part of the employer's safety and program.

NOTE TO 1910.120.—The exemption for hazardous waste provided in § 1910.1200 is applicable to this section.

(3) *Medical surveillance program.* The employer shall develop and implement a medical surveillance program meeting the requirements of paragraph (f) of this section.

(4) *Decontamination program.* The employer shall develop and implement a decontamination procedure meeting the requirements of paragraph (k) of this section.

(5) *New technology program.* The employer shall develop and implement procedures meeting the requirements of paragraph (o) of this section for introducing new and innovative equipment into the workplace.

(6) *Material handling program.* Where employees will be handling drums or containers, the employer shall develop and implement procedures meeting the requirements of paragraphs (j)(1) (ii) through (viii) and (xi) of this section, as well as (j)(3) and (j)(8) of this section prior to starting such work.

(7) *Training program*—(i) *New employees.* The employer shall develop and implement a training program, which is part of the employer's safety and health program, for employees involved with hazardous waste operations to enable employees to perform their assigned duties and functions in a safe and healthful manner so as not to endanger themselves or other employees. The initial training shall be for 24 hours and refresher training shall be for eight hours annually. Employees who have received the initial training required by this paragraph shall be given a written certificate attesting that they have successfully completed the necessary training.

(ii) *Current employees.* Employers who can show by an employee's previous work experience and/or training that the employee has had training equivalent to the initial training required by this paragraph, shall be considered as meeting the initial training requirements of this paragraph as to that employee. Equivalent training includes the training that existing employees might have already received from actual site work experience. Current employees shall receive eight hours of refresher training annually.

(iii) *Trainers.* Trainers who teach initial training shall have satisfactorily completed a training course for teaching the subjects they are expected to teach or they shall have the academic credentials and instruction experience necessary to demonstrate a good command of the subject matter of the courses and competent instructional skills.

(8) *Emergency response program*—(i) *Emergency response plan.* An emergency response plan shall be developed and implemented by all employers. Such plans need not duplicate any of the subjects fully addressed in the employer's contingency planning required by permits, such as those issued by the U.S. Environmental Protection Agency, provided that the contingency plan is made part of the emergency response plan. The emergency response plan shall be a written portion of the employers safety and health program required in para-

ATTACHMENT 16
EMERGENCY FIRST AID PROCEDURES

EMERGENCY FIRST AID PROCEDURES

If an employee working in a contaminated area is physically injured, Red Cross first aid procedures will be followed. Depending on the severity of the injury, emergency medical response may be sought. If the employee can be moved, they will be taken to the edge of the work area (on a stretcher, if needed) where contaminated clothing will be removed (if possible), emergency first aid administered, and transportation to local emergency medical facility awaited.

If the injury to the worker is chemical in nature (e.g., overexposure), the following first aid procedures are to be instituted as soon as possible:

- Eye Exposure - If contaminated solid or liquid gets into the eyes, wash eyes immediately at the emergency eyewash stations using large amounts of water and lifting the lower and upper lids occasionally. Obtain medical attention immediately. (Contact lenses are not permitted in the Exclusion Areas.)

- Skin Exposure - If contaminated solid or liquid gets on the skin, promptly wash contaminated skin using soap or mild detergent and water. If solids or liquid penetrate through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. Obtain medical attention immediately if symptoms warrant.

- Breathing - If a person breathes in large amounts of organic vapor, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Obtain medical attention as soon as possible.

- Swallowing - Place victim on side if vomiting. Phone SAEP Security Headquarters at extension 2767 (2S0S); have containers in hand if possible. Follow directions from SAEP Security Headquarters. Contact the Poison Control Center if necessary at (800) 962-1253. Monitor the victim's vital signs (i.e., breathing and pulse). Save containers and any vomit.

GENERAL FIRST AID PROCEDURES

- Remove the injured or exposed person(s) from immediate danger.
- Render first aid if necessary, and decontaminate affected personnel, if necessary.
- Call an ambulance for transport to local hospital immediately. This procedure should be followed even if there is no apparent serious injury.
- Evacuate other personnel on-site to a safe place until the Site Manager (assisted by the WCC SSO) determines that it is safe for work to resume.
- Report the accident to the New York Metro BUHSO immediately.

ATTACHMENT 17
FIRST AID PROCEDURES CHARTS

EMERGENCY FIRST AID INSTRUCTION

EMERGENCY FIRST AID INSTRUCTION

IN CASE OF A SERIOUS ACCIDENT:

MOVE FAST!

1. RESCUE: **Remove victim from a dangerous situation.**
2. CHECK BREATHING: **Give artificial respiration if necessary.**
3. CONTROL SEVERE BLEEDING: **Use direct pressure and elevation.**
4. DILUTE POISONS: **Use large quantities of milk or water.**
5. CALL FOR HELP (ACTIVATE EMERGENCY MEDICAL SYSTEM) - "Let them hang up first - **YOU HANG UP LAST!**"

Give this information:

L location of emergency - phone # you are calling from
I injury (number and type)
F first aid given
E equipment needed or available

STOPPAGE OF BREATHING

Give artificial respiration — Mouth-to-mouth method:

Head-Tilt/Chin-Lift

1. Determine unresponsiveness - "Are you OK?"
2. SHOUT for help.
3. Open airway - use Head-Tilt/Chin-Lift.
4. Check breathing (3-5 seconds).
5. Determine if not breathing.
6. Give two full slow breaths (maintain open airway, pinch nose, inhale, seal mouth).
7. Look, listen, and feel (about 5 seconds).
8. Check PULSE for 5-10 seconds.
9. **CALL 911 or 0 FOR HELP (ACTIVATE EMS SYSTEM)**
10. START rescue breathing.
    Breathe for: adults once every 5 seconds.
    children once every 4 seconds.
    infants once every 3 seconds (gentle puffs).

WOUNDS

1. Control bleeding: Direct pressure on wound with a sterile dressing (if available). Elevate injured area if possible. Apply pressure to supplying blood vessel.
2. Apply dry sterile dressings, if needed add more dressing **OVER** the area. **DO NOT REMOVE THE OLD DRESSINGS!**
3. Cleanse minor injuries thoroughly. Use mild hand soap and water (wash your hands first).
4. Treat for shock.
5. If evidence of infection appears, see a doctor.

BURNS

1. Relieve pain and prevent contamination. Small minor burns - cold water (**NOT ICE WATER**). Large extensive burns - dry sterile dressings. Bandage to exclude air.
2. Treat for shock.
3. Seek medical assistance.

SHOCK

1. Limit activity. Lay victim down. (If face is red RAISE the HEAD) (if face is pale RAISE the FEET - 8 to 12 inches)
2. Cover victim ONLY enough to keep from losing body heat.
3. Shock may be FATAL - **CALL FOR HELP (ACTIVATE EMS SYSTEM).**

FROSTBITE

1. Cover the frozen part. Separate frozen fingers or toes with dry sterile gauze.
2. Provide extra clothing and blankets.
3. Quickly immerse chilled part in warm water (102° - 105°F).
4. DO NOT RUB frozen part.
5. Give a warm non-alcoholic drink - if victim is conscious and not vomiting.
6. **CALL FOR HELP (ACTIVATE EMS SYSTEM).**

HEART ATTACK

Symptoms: Chest pain, pain radiating down left arm, breathing difficulty, swelling of ankles, chronic cough, bluish color of face, finger nail beds, under eyelids, inside mouth or under tongue. Shock as a rule.

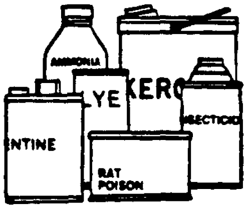
First Aid:

1. Comfortable position - loosen all tight clothing.
2. Raise head and chest if breathing is difficult.
3. If breathing stops, apply artificial respiration or cardiopulmonary resuscitation (CPR), if indicated.
4. **CALL FOR HELP (ACTIVATE EMS SYSTEM)** - equipped with oxygen and contact victim's own doctor.

FRACTURES

1. Maintain open airway and apply artificial respiration if indicated.
2. Do not move victim - unless in case of life threatening danger.
3. **CALL FOR HELP (ACTIVATE EMS SYSTEM)** if indicated.
4. Keep the broken bone ends and adjacent joints quiet.
5. Control bleeding if present and apply splints.

POISONING (conscious victim only)



1. Dilute poison with milk or water (except petroleum product poisoning). Discontinue if victim becomes nauseated.
2. Save the label, container and/or a sample of the vomit for chemical analysis and identification.
3. **CALL FOR HELP (ACTIVATE EMS SYSTEM)** and call the Poison Control Center.
4. If breathing stops, maintain open airway, apply artificial respiration or cardiopulmonary resuscitation (CPR), if indicated.
5. Induce vomiting (except acids, alkali, convulsions, petroleum based, semiconscious or unconscious) **IF MEDICAL ADVICE OR HELP IS DELAYED OR IF THE POISON CONTROL CENTER INDICATES TO DO SO.**

HEAT EXHAUSTION

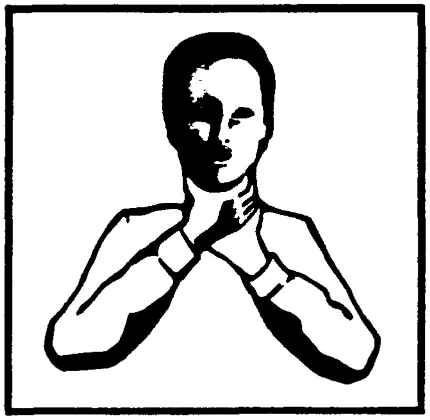
1. Give sips of salt water for 1 hour (one tsp. salt per 1/2 glass every 15 minutes - **STOP** if victim becomes nauseated).
2. Provide rest, loosen clothing and raise feet 8-12 inches.
3. Apply wet, cool cloths and fan victim or remove him to an air-conditioned room.
4. Take victim, as soon as possible, to hospital.

SIMPLE FAINTING

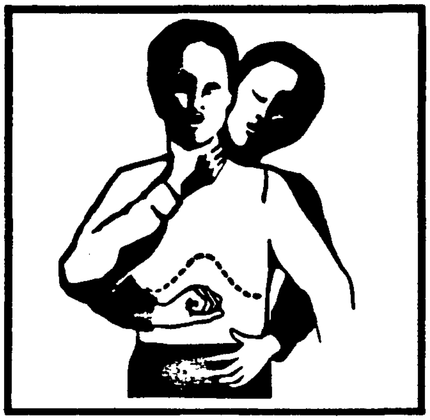
1. Keep victim laying down with feet raised 8-12 inches until recovery is complete.
2. Loosen any tight clothing and keep crowds away. Maintain open airway.
3. Bathe face gently with cool water - DO NOT POUR WATER OVER VICTIM'S FACE.
4. Unless recovery is prompt - **CALL FOR HELP (ACTIVATE EMS SYSTEM).**

FIRST AID FOR CHOKING

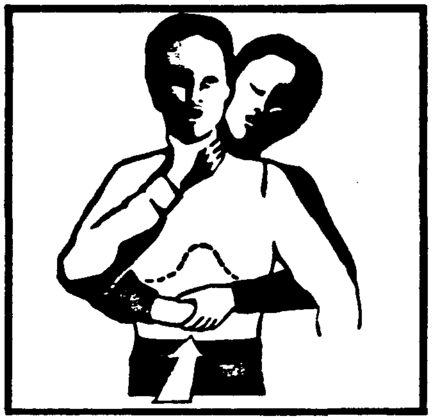
FIRST AID FOR CHOKING



1. Ask:
"Are You Choking?"
If victim cannot breathe, cough, or speak . . .
Call (Shout) for HELP!

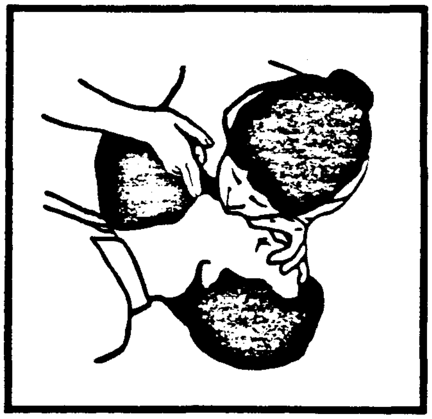


2. Give the
Heimlich Maneuver.
Stand behind the victim.
Wrap your arms around the victim's waist.
Make a fist with one hand. PLACE your FIST (thumbside) against the victim's stomach in the midline just ABOVE THE NAVEL AND WELL BELOW THE RIB MARGIN.



Grasp your fist with your other hand.
PRESS INTO STOMACH WITH A QUICK UPWARD THRUST.

3. Repeat until object is expelled or until victim becomes unconscious.



IF A VICTIM HAS BECOME UNCONSCIOUS:
CALL 911 or 0 FOR HELP (ACTIVATE THE EMS SYSTEM)

4. Sweep the mouth.

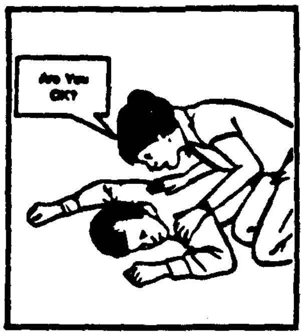
5. Attempt rescue breathing.

6. Give 6-10 abdominal thrusts. Repeat Steps 4, 5 and 6 as necessary.

Everyone should learn how to perform the steps above for choking and how to give rescue breathing and CPR. Call your local American Red Cross chapter for information on these and other first aid techniques. Caution: The Heimlich Maneuver (abdominal thrust) may cause injury. Do not *practice* on people.

FIRST AID FOR ARTIFICIAL RESPIRATION

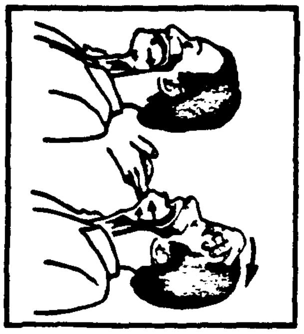
ARTIFICIAL RESPIRATION



MOUTH-TO-MOUTH METHOD

IF A VICTIM APPEARS TO BE UNCONSCIOUS TAP VICTIM ON THE SHOULDER AND SHOUT, "ARE YOU OKAY?"

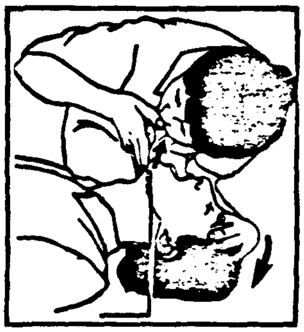
TO ATTRACT ATTENTION SHOUT FOR "HELP".



IF THERE IS NO RESPONSE

TILT THE VICTIM'S HEAD. Place the fingers on one hand under the bony part of the lower jaw near the chin and lift to bring the chin forward. At the same time, push with the other hand on the victim's forehead. This will rotate the head and cause the tongue to move away from the back of the throat to open the airway.

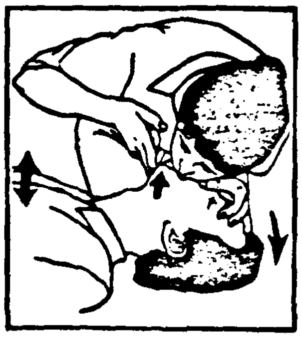
IMMEDIATELY LOOK. LISTEN AND FEEL FOR AIR While maintaining the backward head tilt position, place your cheek and ear close to the victim's mouth and nose. Look for the chest to rise and fall while you listen and feel for the return of air. Check for 3-5 seconds.



IF THE VICTIM IS NOT BREATHING

GIVE TWO FULL SLOW BREATHS. Maintain the backward head tilt, pinch the victim's nose with the hand that is on the victim's forehead to prevent leakage of air, open your mouth wide, take a deep breath, seal your mouth around the victim's mouth, and blow into the victim's mouth with two full breaths. Adequate time for the two breaths (1 to 1.5 seconds per breath) should be allowed to provide for good chest expansion.

If you do not get an air exchange when you blow the first time, REPOSITION THE HEAD AND TRY AGAIN. If chest rises, check for pulse on the neck. Activate EMS System. If chest fails to rise, give abdominal thrusts.



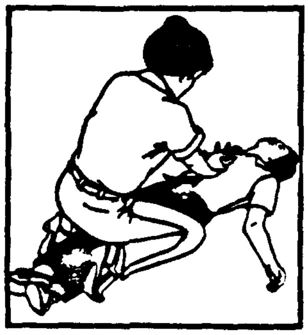
IF THERE IS STILL NO BREATHING

CALL FOR HELP (ACTIVATE EMS SYSTEM) AND BEGIN ARTIFICIAL RESPIRATION.
Change Rate To:
Adults:
One breath every 5 seconds
Children:
One breath every 4 seconds
Infants:
One breath every 3 seconds
Continue until help arrives.

MOUTH-TO-NOSE METHOD

For the mouth-to-nose method, maintain the position by placing the heel of the hand on the forehead and using the other hand to lift the victim's lower jaw (bony part) and close the mouth. Seal your lips around the victim's nose and blow into the nose. On the exhalation phase, open the victim's mouth to allow air to exhale.

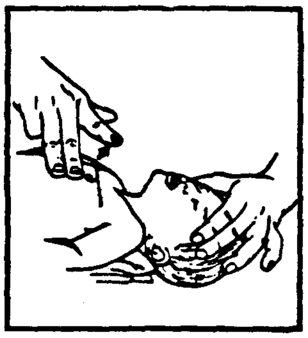
RELATED INFORMATION



FOR ADULTS,
HEIMLICH MANEUVER

Straddle victims knees or one leg if victim is large. Place heel of one hand against victim's abdomen in the midline slightly above navel and well below the sternum. Place second hand directly over first hand, keep fingers elevated. Press into the abdomen with quick upward thrusts with the intent of expelling the blockage. Perform 6-10 abdominal thrusts.

FOR CONSCIOUS INFANTS. CLEAR OBSTRUCTION WITH BACK BLOWS Place the infant face down over the rescuer's forearm resting on thigh. Support head and neck with hand and fingers. Keep infant in head down position, and deliver 4 back blows, forcefully, between the shoulder blades with the heel of your hand.



CHEST THRUSTS

While supporting the head and neck, sandwich infant between your hands and forearms and turn onto back, with head lower than trunk. Then, lie infant on firm surface and deliver 4 thrusts in the midsternal region (2-3 fingers on sternum, 1 finger's width below imaginary line between nipples).

CLEAR MOUTH WITH LITTLE FINGER IF OBJECT CAN BE SEEN. DO NOT ATTEMPT TO REMOVE THE OBJECT IF IT IS NOT SEEN! REPEAT UNTIL OBJECT IS EXPELLED.

If child becomes unconscious, yell for HELP - give 2 puffs of air then repeat steps above.

ATTACHMENT 18
INCIDENT REPORT FORM ENG 3394

(For Safety Staff only)	REPORT NO.	EROC CODE	UNITED STATES ARMY CORPS OF ENGINEERS ACCIDENT INVESTIGATION REPORT (For Use of this Form See Attached Instructions and USACE Suppl to AR 385-40)	REQUIREMENT CONTROL SYMBOL: CEEC-S-8(R2)

1. ACCIDENT CLASSIFICATION

a. GOVERNMENT	(1) INJURY/ILLNESS/FATAL	(2) PROPERTY DAMAGE	(3) MOTOR VEHICLE INVOLVED	(4) DIVING
☐ CIVILIAN ☐ MILITARY →	☐	☐ FIRE INVOLVED ☐ OTHER	☐	☐
b. CONTRACTOR →	☐	☐ FIRE INVOLVED ☐ OTHER	☐	☐
c. PUBLIC →	☐ FATAL ☐ OTHER		☐	

2. PERSONAL DATA

a. NAME *(Last,First,MI)*

b. AGE

c. SEX ☐ MALE ☐ FEMALE

[redacted]

f. JOB SERIES/TITLE

g. DUTY STATUS AT TIME OF ACCIDENT

(1) ☐ ON DUTY (2) ☐ TDY

(3) ☐ OFF DUTY

3. GENERAL INFORMATION

a. DATE OF ACCIDENT *(month/day/year)* / /

b. TIME OF ACCIDENT *(Military time)* / /

c. EXACT LOCATION OF ACCIDENT

d. CONTRACTOR'S NAME

(1) PRIME:

(2) SUBCONTRACTOR:

e. CONTRACT NUMBER

\#

☐ CIVIL WORKS ☐ MILITARY

☐ OTHER

f. TYPE OF CONTRACT

☐ CONSTRUCTION ☐ SERVICE

☐ A/E ☐ DREDGE

☐ OTHER *(Specify)*

g. HAZARDOUS/TOXIC WASTE ACTIVITY

☐ SUPERFUND ☐ DERP

☐ IRP ☐ OTHER *(Specify)*

4. CONSTRUCTION ACTIVITIES ONLY *(Fill in line and corresponding code number in box from list - see instructions)*

a. CONSTRUCTION ACTIVITY (CODE) #

b. TYPE OF CONSTRUCTION EQUIPMENT (CODE) #

5. INJURY/ILLNESS INFORMATION *(include name on line and corresponding code number in box for items e, f & g - see instructions)*

a. SEVERITY OF INJURY

(1) ☐ FATAL (2) ☐ LOST-TIME (3) ☐ NON LOST-TIME (4) ☐ FIRST AID

b. ESTIMATED DAYS LOST

c. ESTIMATED DAYS HOSPITALIZED

d. ESTIMATED DAYS, RESTRICTED DUTY

e. BODY PART AFFECTED

PRIMARY (CODE) #

SECONDARY (CODE) #

f. NATURE OF INJURY (CODE) #

g. TYPE AND SOURCE OF INJURY

TYPE (CODE) #

SOURCE (CODE) #

6. PUBLIC FATALITY *(Fill in line and corresponding code number in box - see instructions)*

a. ACTIVITY AT TIME OF ACCIDENT (CODE) #

b. PERSONAL FLOATATION DEVICE USED? ☐ YES ☐ NO ☐ NA

7. MOTOR VEHICLE ACCIDENT

a. TYPE OF VEHICLE

☐☐ PICKUP/VAN ☐☐ AUTOMOBILE

☐☐ TRUCK ☐☐ OTHER *(Specify)*

b. TYPE OF COLLISION

☐ HEAD ON ☐ REAR END ☐ BACKING

☐ BROADSIDE ☐ SIDE SWIPE

☐ ROLL OVER ☐ OTHER

c. SEAT BELTS	USED	NOT USED	NOT AVAILABLE
(1) FRONT SEAT			
(2) REAR SEAT			

8. PROPERTY/MATERIAL INVOLVED

a. NAME OF ITEM	b. OWNERSHIP	c. $ AMOUNT OF DAMAGE
(1)		
(2)		
(3)		

9. VESSEL/FLOATING PLANT ACCIDENT *(Fill in line and corresponding code number in box from list - see instructions)*

a. TYPE OF VESSEL/FLOATING PLANT (CODE) #

b. TYPE OF COLLISION/MISHAP (CODE)

10. ACCIDENT DESCRIPTION *(Use additional paper, if necessary)*

11. CAUSAL FACTOR(S) *(Read Instruction Before Completing)*

a. *(Explain YES answers in Item 13)*	YES	NO
DESIGN: Was design of facility,workplace or equipment a factor?	☐	☐
INSPECTION/MAINTENANCE: Were inspection & maintenance procedures a factor?	☐	☐
PERSON'S PHYSICAL CONDITION: In your opinion, was the physical condition of the person a factor?	☐	☐
OPERATING PROCEDURES: Were operating procedures a factor?	☐	☐
JOB PRACTICES: Were any job safety/health practices not followed when the accident occurred?	☐	☐
HUMAN FACTORS: Did any human factors such as, size or strength of person, etc.,contribute to accident?	☐	☐
ENVIRONMENTAL FACTORS: Did heat, cold, dust, sun, glare, etc., contribute to the accident?	☐	☐

a. *(CONTINUED)*	YES	NO
CHEMICAL AND PHYSICAL AGENT FACTORS: Did exposure to chemical agents, such as dust,fumes,mists,vapors or physical agents, such as, noise,radiation,etc.,contribute to accident?	☐	☐
OFFICE FACTORS: Did office setting such as, lifting office furniture,carrying,stooping,etc.,contribute to the accident?	☐	☐
SUPPORT FACTORS: Were inappropriate tools/resources provided to properly perform the activity/task?	☐	☐
PERSONAL PROTECTIVE EQUIPMENT: Did the improper selection, use or maintenance of personal protective equipment contribute to the accident?	☐	☐
DRUGS/ALCOHOL: In your opinion,was drugs or alcohol a factor to the accident?	☐	☐

b. WAS A WRITTEN JOB/ACTIVITY HAZARD ANALYSIS COMPLETED FOR TASK BEING PERFORMED AT TIME OF ACCIDENT?

☐ YES *(If yes, attach a copy.)* ☐ NO

12. TRAINING

a. WAS PERSON TRAINED TO PERFORM ACTIVITY/TASK?

☐ YES ☐ NO

b. TYPE OF TRAINING.

☐ CLASSROOM ☐ ON JOB ☐ NONE

c. DATE OF MOST RECENT FORMAL TRAINING.

/ /
(Month) (Day) (Year)

13. FULLY EXPLAIN WHAT ALLOWED OR CAUSED THE ACCIDENT; INCLUDE DIRECT AND INDIRECT CAUSES *(See instruction for definition of direct and indirect causes.)* *(Use additional paper, if necessary)*

a. DIRECT CAUSE

b. INDIRECT CAUSE(S)

14. ACTION(S) TAKEN, ANTICIPATED OR RECOMMENDED TO ELIMINATE CAUSE(S).

DESCRIBE FULLY:

15. DATES FOR ACTIONS IDENTIFIED IN BLOCK 14.

a. BEGINNING *(Month/Day/Year)* / /

b. ANTICIPATED COMPLETION *(Month/Day/Year)* / /

c. SIGNATURE AND TITLE OF SUPERVISOR COMPLETING REPORT

CORPS ____________________

CONTRACTOR ____________________

d. DATE *(Mo/Da/Yr)*

___ / ___ / ___

___ / ___ / ___

e. ORGANIZATION IDENTIFIER *(Div, Br, Sect)*

f. OFFICE SYMBOL

16. MANAGEMENT REVIEW *(1st)*

a. ☐ CONCUR b. ☐ NON CONCUR c. COMMENTS

SIGNATURE

TITLE

DATE

17. MANAGEMENT REVIEW *(2nd - Chief Operations, Construction, Engineering, etc.)*

a. ☐ CONCUR b. ☐ NON CONCUR c. COMMENTS

SIGNATURE

TITLE

DATE

18. SAFETY AND OCCUPATIONAL HEALTH OFFICE REVIEW

a. ☐ CONCUR b. ☐ NON CONCUR c. ADDITIONAL ACTIONS/COMMENTS

SIGNATURE

TITLE

DATE

19. COMMAND APPROVAL

COMMENTS

COMMANDER SIGNATURE

DATE

(Reverse of ENG Form 3394)

GENERAL. Complete a separate report for each person who was *injured, caused,* or *contributed* to the accident (excluding uninjured personnel and witnesses). Use of this form for reporting USACE employee first-aid type injuries *NOT* to be submitted to the Department of Labor (DOL); Office of Workers' Compensation Programs (OWCP) shall be at the discretion of the FOA Commander. Please type or print legibly. Appropriate items shall be marked with an "X" in the box(es). If additional space is needed, provide the information on a separate sheet and attach to the completed form. Ensure that these instructions are forwarded with the completed report to the designated management reviewers indicated in sections 16. and 17.

INSTRUCTIONS FOR SECTION 1— ACCIDENT CLASSIFICATION. *(Mark All Boxes That Are Applicable.)*

a. GOVERNMENT. Mark "CIVILIAN" box if accident involved government civilian employee; mark "MILITARY" box if accident involved U.S. military personnel.

(1) INJURY/ILLNESS/FATALITY—Mark if accident resulted in any government civilian employee injury, illness, or fatality that requires the submission of Office of Workers Compensation Programs (OWCP) Forms CA-1 (injury), CA-2 (illness), or CA-6 (fatality), to the Department of Labor OWCP, or military personnel lost-time or fatal injury.

(2) PROPERTY DAMAGE—Mark the appropriate box if accident resulted in any damage of $1000 or more to government property (including motor vehicles).

(3) VEHICLE INVOLVED—Mark if accident involved a motor vehicle, *regardless* of whether "INJURY/ILLNESS" or "PROPERTY DAMAGE" are marked.

(4) DIVING ACTIVITY—Mark if the accident involved an in-house USACE diving activity.

b. CONTRACTOR.

(1) INJURY/ILLNESS/FATALITY—Mark if accident resulted in any contractor lost-time injury/illness or fatality.

(2) PROPERTY DAMAGE—Mark the appropriate box if accident resulted in any damage of $1000 or more to contractor property (including motor vehicles).

(3) VEHICLE INVOLVED—Mark if accident involved a motor vehicle, regardless of whether "INJURY/ILLNESS" or "PROPERTY DAMAGE" are marked.

(4) DIVING ACTIVITY—Mark if the accident involved a USACE Contractor diving activity.

c. PUBLIC.

(1) INJURY/ILLNESS/FATALITY—Mark if accident resulted in public fatality. (The "OTHER" box will be marked when requested by the FOA to report an unusual non-fatal public accident that could result in claims against the government or as otherwise directed by the FOA Commander).

(2) VOID SPACE—Make no entry.

(3) VEHICLE INVOLVED—Mark if accident resulted in a fatality to a member of the public and involved a motor vehicle, *regardless* of whether "INJURY/ILLNESS" is marked.

(4) VOID SPACE—Make no entry.

INSTRUCTIONS FOR SECTION 2—PERSONAL DATA

a. NAME—(MANDATORY FOR GOVERNMENT ACCIDENTS. OPTIONAL AT THE DISCRETION OF THE FOA COMMANDER FOR CONTRACTOR AND PUBLIC ACCIDENTS). Enter last name, first name, middle initial of person involved.

b. AGE—Enter age.

c. SEX—Mark appropriate box.

d. SOCIAL SECURITY NUMBER—(FOR GOVERNMENT PERSONNEL ONLY) Enter the social security number (or other personal identification number if no social security number issued).

e. GRADE—(FOR GOVERNMENT PERSONNEL ONLY) Enter pay grade. Example: O-6; E-7; WG-8; WS-12; GS-11; etc.

f. JOB SERIES/TITLE—For *government civilian employees* enter the pay plan, full series number, and job title, e.g. GS-0810/Civil Engineer. For *military personnel* enter the primary military occupational specialty (PMOS), e.g., 15A30 or 11G50. For *contractor employees* enter the job title assigned to the injured person, e.g. carpenter, laborer, surveyor, etc.,

g. DUTY STATUS—Mark the appropriate box.

(1) ON DUTY—Person was at duty station during duty hours or person was away from duty station during duty hours but on official business at time of the accident.

(2) TDY—person was on official business, away from the duty station and with travel orders, at time of accident.

(3) OFF DUTY—person was not on official business at time of accident.

h. EMPLOYMENT STATUS—(FOR GOVERNMENT PERSONNEL ONLY) Mark the most appropriate box. If "OTHER" is marked, specify the employment status of the person.

INSTRUCTION FOR SECTION 3—GENERAL INFORMATION

a. DATE OF ACCIDENT—Enter the month, day, and year of accident.

b. TIME OF ACCIDENT—Enter the local time of accident in military time. Example: 1430 hrs (not 2:30 p.m.).

c. EXACT LOCATION OF ACCIDENT—Enter facts needed to locate the accident scene. (installation/project name, building number, street, direction and distance from closest landmark, etc.).

d. CONTRACTOR NAME

(1) PRIME—Enter the exact name (title of firm) of the prime contractor.

(2) SUBCONTRACTOR—Enter the name of any subcontractor involved in the accident.

e. CONTRACT NUMBER—Mark the appropriate box to identify if contract is civil works, military, or other: if "OTHER" is marked, specify contract appropriation on line provided. Enter complete contract number of prime contract, e.g., DACW 09-85-C-0100.

f. TYPE OF CONTRACT—Mark appropriate box. A/E means architect/engineer. If "OTHER" is marked, specify type of contract on line provided.

g. HAZARDOUS/TOXIC WASTE ACTIVITY (HTW)—Mark the box to identify the HTW activity being performed at the time of the accident. For Superfund, DERP, and Installation Restoration Program (IRP) HTW activities include accidents that occurred during inventory, predesign, design, and construction. For the purpose of accident reporting, DERP Formerly Used DoD Site (FUDS) activities and IRP activities will be treated separately. For Civil Works O&M HTW activities mark the "OTHER" box.

INSTRUCTIONS FOR SECTION 4—CONSTRUCTION ACTIVITIES

a. CONSTRUCTION ACTIVITY—Select the *most appropriate* construction activity being performed at time of accident from the list below. Enter the activity name and place the corresponding code number identified in the box.

CONSTRUCTION ACTIVITY LIST

1. MOBILIZATION
2. SITE PREPARATION
3. EXCAVATION/TRENCHING
4. GRADING (EARTHWORK)
5. PIPING/UTILITIES
6. FOUNDATION
7. FORMING
8. CONCRETE PLACEMENT
9. STEEL ERECTION
10. ROOFING
11. FRAMING
12. MASONRY
13. CARPENTRY
14. ELECTRICAL
15. SCAFFOLDING/ACCESS
16. MECHANICAL
17. PAINTING
18. EQUIPMENT/MAINTENANCE
19. TUNNELING
20. WAREHOUSING/STORAGE
21. PAVING
22. FENCING
23. SIGNING
24. LANDSCAPING/IRRIGATION
25. INSULATION
26. DEMOLITION

b. TYPE OF CONSTRUCTION EQUIPMENT—Select the equipment involved in the accident from the list below. Enter the name and place the corresponding code number identified in the box. If equipment is not included below, use code 24, "OTHER", and write in specific type of equipment.

CONSTRUCTION EQUIPMENT

1. GRADER
2. DRAGLINE
3. CRANE (ON VESSEL/BARGE)
4. CRANE (TRACKED)
5. CRANE (RUBBER TIRE)
6. CRANE (VEHICLE MOUNTED)
7. CRANE (TOWER)
8. SHOVEL
9. SCRAPER
10. PUMP TRUCK (CONCRETE)
11. TRUCK (CONCRETE/TRANSIT MIXER)
12. DUMP TRUCK (HIGHWAY)
13. DUMP TRUCK (OFF HIGHWAY)
14. TRUCK (OTHER)
15. FORKLIFT
16. BACKHOE
17. FRONT-END LOADER
18. PILE DRIVER
19. TRACTOR (UTILITY)
20. MANLIFT
21. DOZER
22. DRILL RIG
23. COMPACTOR/VIBRATORY ROLLER
24. OTHER

INSTRUCTIONS FOR SECTION 5—INJURY/ILLNESS INFORMATION

a. SEVERITY OF INJURY—Mark the appropriate box

(1) FATAL—Injured person died or is missing and presumed dead.

(2) LOST TIME—a non-fatal injury that causes any loss of time from work beyond the day or shift in which it occurred or a non-fatal illness/disease that causes disability at any time.

(3) NO LOST TIME—a non-fatal, traumatic injury that does not cause loss of time from work beyond the day or shift in which it occurred.

(4) FIRST AID—One time treatment (and/or one follow visit for observation) for minor scratches, cuts and similar injuries that do not ordinarily require medical attention.

b. ESTIMATED DAYS LOST—Enter the estimated number of workdays the person will lose from work.

c. ESTIMATED DAYS HOSPITALIZED—Enter the estimated number of workdays the person will be hospitalized.

d. ESTIMATED DAYS RESTRICTED DUTY—Enter the estimated number of workdays the person, as a result of the accident, will not be able to perform all of their regular duties.

e. BODY PART AFFECTED—Select the most appropriate primary and when applicable, secondary body part affected from the list below. Enter body part name on line and place the corresponding code letters identifying that body part in the box.

GENERAL BODY AREA	CODE	BODY PART NAME
ARM/WRIST	AB	ARM AND WRIST
	AS	ARM OR WRIST
TRUNK, EXTERNAL MUSCULATURE	B1	SINGLE BREAST
	B2	BOTH BREASTS
	B3	SINGLE TESTICLE
	B4	BOTH TESTICLES
	BA	ABDOMEN
	BC	CHEST
	BL	LOWER BACK
	BP	PENIS
	BS	SIDE
	BU	UPPER BACK
	BW	WAIST
	BZ	TRUNK OTHER
HEAD, INTERNAL	C1	SINGLE EAR INTERNAL
	C2	BOTH EARS INTERNAL
	C3	SINGLE EYE INTERNAL
	C4	BOTH EYES INTERNAL
	CB	BRAIN
	CC	CRANIAL BONES
	CD	TEETH
	CJ	JAW
	CL	THROAT, LARYNX
	CM	MOUTH
	CN	NOSE
	CR	THROAT, OTHER
	CT	TONGUE
	CZ	HEAD OTHER INTERNAL
ELBOW	EB	BOTH ELBOWS
	ES	SINGLE ELBOW
FINGER	F1	FIRST FINGER
	F2	BOTH FIRST FINGERS
	F3	SECOND FINGER
	F4	BOTH SECOND FINGERS
	F5	THIRD FINGER
	F6	BOTH THIRD FINGERS
	F7	FOURTH FINGER
	F8	BOTH FOURTH FINGERS
TOE	G1	GREAT TOE
	G2	BOTH GREAT TOES
	G3	TOE OTHER
	G4	TOES OTHER
HEAD, EXTERNAL	H1	EYE EXTERNAL
	H2	BOTH EYES EXTERNAL
	H3	EAR EXTERNAL
	H4	BOTH EARS EXTERNAL
	HC	CHIN
	HF	FACE
	HK	NECK/THROAT
	HM	MOUTH/LIPS
	HN	NOSE
	HS	SCALP
KNEE	KB	BOTH KNEES
	KS	KNEE
LEG, HIP, ANKLE, BUTTOCK	LB	BOTH LEGS/HIPS/ANKLES/BUTTOCKS
	LS	SINGLE LEG/HIP ANKLE/BUTTOCK
HAND	MB	BOTH HANDS
	MS	SINGLE HAND
FOOT	PB	BOTH FEET
	PS	SINGLE FOOT
TRUNK, BONES	R1	SINGLE COLLAR BONE
	R2	BOTH COLLAR BONES
	R3	SHOULDER BLADE
	R4	BOTH SHOULDER BLADES
	RB	RIB
	RS	STERNUM (BREAST BONE)
	RV	VERTEBRAE (SPINE; DISC)
	RZ	TRUNK BONES OTHER
SHOULDER	SB	BOTH SHOULDERS
	SS	SINGLE SHOULDER
THUMB	TB	BOTH THUMBS
	TS	SINGLE THUMB
TRUNK, INTERNAL ORGANS	V1	LUNG, SINGLE
	V2	LUNGS, BOTH
	V3	KIDNEY, SINGLE
	V4	KIDNEYS, BOTH
	VH	HEART
	VL	LIVER
	VR	REPRODUCTIVE ORGANS
	VS	STOMACH
	VV	INTESTINES
	VZ	TRUNK, INTERNAL; OTHER

f. NATURE OF INJURY—Select the most appropriate nature of injury from the list below. This nature of injury shall correspond to the *primary body part* selected in 5.e. above. Enter the nature of injury name on the line and place the corresponding CODE letters identifying the nature of injury in the box provided.

* This injury or condition selected below must be caused by a specific incident or event <u>which occurred during a single work day or shift.</u>

GENERAL NATURE CATEGORY	CODE	NATURE OF INJURY NAME
*TRAUMATIC INJURY OR DISABILITY	TA	AMPUTATION
	TB	BACK STRAIN
	TC	CONTUSION; BRUISE; ABRASION
	TD	DISLOCATION
	TF	FRACTURE
	TH	HERNIA
	TK	CONCUSSION
	TL	LACERATION, CUT
	TP	PUNCTURE
	TS	STRAIN, MULTIPLE
	TU	BURN, SCALD, SUNBURN
	TI	TRAUMATIC SKIN DISEASES/ CONDITIONS INCLUDING DERMATITIS
	TR	TRAUMATIC RESPIRATORY DISEASE
	TQ	TRAUMATIC FOOD POISONING
	TW	TRAUMATIC TUBERCULOSIS
	TX	TRAUMATIC VIROLOGICAL/ INFECTIVE/PARASITIC DISEASE
	T1	TRAUMATIC CEREBRAL VASCULAR CONDITION/STROKE
	T2	TRAUMATIC HEARING LOSS
	T3	TRAUMATIC HEART CONDITION
	T4	TRAUMATIC MENTAL DISORDER; STRESS; NERVOUS CONDITION
	T9	TRAUMATIC INJURY — OTHER (EXCEPT DISEASE, ILLNESS)

**A nontraumatic physiological harm or loss of capacity produced by systemic infection; continued or repeated stress or strain; exposure to toxins, poisons, fumes, etc.; or other continued and <u>repeated exposures to conditions of the work environment over a long period of time</u>. For practical purposes, an occupational illness/disease or disability is any reported condition which does not meet the definition of traumatic injury or disability as described above.

GENERAL NATURE CATEGORY	CODE	NATURE OF INJURY NAME
**NON-TRAUMATIC ILLNESS/DISEASE OR DISABILITY		
RESPIRATORY DISEASE	RA	ASBESTOSIS
	RB	BRONCHITIS
	RE	EMPHYSEMA
	RP	PNEUMOCONIOSIS
	RS	SILICOSIS
	R9	RESPIRATORY DISEASE, OTHER
VIROLOGICAL, INFECTIVE & PARASITIC DISEASES	VB	BRUCELLOSIS
	VC	COCCIDIOMYCOSIS
	VF	FOOD POISONING
	VH	HEPATITIS
	VM	MALARIA
	VS	STAPHYLOCOCCUS
	VT	TUBERCULOSIS
	V9	VIROLOGICAL/INFECTIVE/ PARASITIC—OTHER
DISABILITY, OCCUPATIONAL	DA	ARTHRITIS, BURSITIS
	DB	BACK STRAIN, BACK SPRAIN
	DC	CEREBRAL VASCULAR CONDITION; STROKE
	DD	ENDEMIC DISEASE (OTHER THAN CODE TYPES R&S)
	DE	EFFECT OF ENVIRONMENTAL CONDITION
	DH	HEARING LOSS
	DK	HEART CONDITION
	DM	MENTAL DISORDER, EMOTIONAL STRESS NERVOUS CONDITION
	DR	RADIATION
	DS	STRAIN, MULTIPLE
	DU	ULCER
	DV	OTHER VASCULAR CONDITIONS
	D9	DISABILITY, OTHER

GENERAL NATURE CATEGORY	CODE	NATURE OF INJURY NAME
SKIN DISEASE OR CONDITION	SB	BIOLOGICAL
	SC	CHEMICAL
	S9	DERMATITIS, UNCLASSIFIED

g. TYPE AND SOURCE OF INJURY (CAUSE)—Type and Source Codes are used to describe what caused the incident. The Type Code stands for an ACTION and the Source Code for an OBJECT or SUBSTANCE. Together, they form a brief description of how the incident occurred. Where there are two different sources, code the *initiating* source of the incident (see example 1, below). Examples:

(1) An employee tripped on carpet and struck his head on a desk.
TYPE: 210 (Fell on Same Level) SOURCE: 0110 (walking/ working surface)

NOTE: This example would NOT be coded 120 (struck against) and 0140 (furniture).

(2) A Park Ranger contracted dermatitis from contact with poison ivy/ oak.
TYPE: 510 (contact) SOURCE: 0920 (plant)

(3) A lock and dam mechanic punctured his finger with a metal sliver while grinding a turbine blade.
TYPE: 410 (punctured by) SOURCE: 0830 (metal)

(4) An employee was driving a government vehicle when it was struck by another vehicle.
TYPE: 800 (traveling in) SOURCE: 0421 (government owned vehicle, as driver)

NOTE: The Type Code 800, "Traveling In" is different from the other type codes in that its function is not to identify factors contributing to the injury or fatality, but rather to collect data on the type of vehicle the employee was operating or traveling in at the time of the incident.

Select the most appropriate TYPE and SOURCE identifier from the list below and enter the name on the line and the corresponding code in the appropriate box.

CODE	TYPE OF INJURY NAME
	STRUCK
0110	STRUCK BY
0111	STRUCK BY FALLING OBJECT
0120	STRUCK AGAINST
	FELL, SLIPPED, TRIPPED
0210	FELL ON SAME LEVEL
0220	FELL ON DIFFERENT LEVEL
0230	SLIPPED, TRIPPED (NO FALL)
	CAUGHT
0310	CAUGHT ON
0320	CAUGHT IN
0330	CAUGHT BETWEEN
	PUNCTURED, LACERATED
0410	PUNCTURED BY
0420	CUT BY
0430	STUNG BY
0440	BITTEN BY
	CONTACTED
0510	CONTACTED WITH (INJURED PERSON MOVING)
0520	CONTACTED BY (OBJECT WAS MOVING)
	EXERTED
0610	LIFTED, STRAINED BY (SINGLE ACTION)
0620	STRESSED BY (REPEATED ACTION)
	EXPOSED
0710	INHALED
0720	INGESTED
0730	ABSORBED
0740	EXPOSED TO
0800	TRAVELING IN

CODE	SOURCE OF INJURY NAME
0100	BUILDING OR WORKING AREA
0110	WALKING/WORKING SURFACE (FLOOR, STREET, SIDEWALKS, ETC)
0120	STAIRS, STEPS
0130	LADDER
0140	FURNITURE, FURNISHINGS, OFFICE EQUIPMENT
0150	BOILER, PRESSURE VESSEL
0160	EQUIPMENT LAYOUT (ERGONOMIC)
0170	WINDOWS, DOORS
0180	ELECTRICITY

CODE	SOURCE OF INJURY NAME
0200	ENVIRONMENTAL CONDITION
0210	TEMPERATURE EXTREME (INDOOR)
0220	WEATHER (ICE, RAIN, HEAT, ETC.)
0230	FIRE, FLAME, SMOKE (NOT TOBACCO)
0240	NOISE
0250	RADIATION
0260	LIGHT
0270	VENTILATION
0271	TOBACCO SMOKE
0280	STRESS (EMOTIONAL)
0290	CONFINED SPACE
0300	MACHINE OR TOOL
0310	HAND TOOL (POWERED: SAW, GRINDER, ETC.)
0320	HAND TOOL (NONPOWERED)
0330	MECHANICAL POWER TRANSMISSION APPARATUS
0340	GUARD, SHIELD (FIXED, MOVEABLE, INTERLOCK)
0350	VIDEO DISPLAY TERMINAL
0360	PUMP, COMPRESSOR, AIR PRESSURE TOOL
0370	HEATING EQUIPMENT
0380	WELDING EQUIPMENT
0400	VEHICLE
0411	AS DRIVER OF PRIVATELY OWNED/RENTAL VEHICLE
0412	AS PASSENGER OF PRIVATELY OWNED/RENTAL VEHICLE
0421	DRIVER OF GOVERNMENT VEHICLE
0422	PASSENGER OF GOVERNMENT VEHICLE
0430	COMMON CARRIER (AIRLINE, BUS, ETC.)
0440	AIRCRAFT (NOT COMMERCIAL)
0450	BOAT, SHIP, BARGE
0500	MATERIAL HANDLING EQUIPMENT
0510	EARTHMOVER (TRACTOR, BACKHOE, ETC.)
0520	CONVEYOR (FOR MATERIAL AND EQUIPMENT)
0530	ELEVATOR, ESCALATOR, PERSONNEL HOIST
0540	HOIST, SLING CHAIN, JACK
0550	CRANE
0551	FORKLIFT
0560	HANDTRUCK, DOLLY
0600	DUST, VAPOR, ETC.
0610	DUST (SILICA, COAL, ETC.)
0620	FIBERS
0621	ASBESTOS
0630	GASES
0631	CARBON MONOXIDE
0640	MIST, STEAM, VAPOR, FUME
0641	WELDING FUMES
0650	PARTICLES (UNIDENTIFIED)
0700	CHEMICAL, PLASTIC, ETC.
0711	DRY CHEMICAL—CORROSIVE
0712	DRY CHEMICAL—TOXIC
0713	DRY CHEMICAL—EXPLOSIVE
0714	DRY CHEMICAL—FLAMMABLE
0721	LIQUID CHEMICAL—CORROSIVE
0722	LIQUID CHEMICAL—TOXIC
0723	LIQUID CHEMICAL—EXPLOSIVE
0724	LIQUID CHEMICAL—FLAMMABLE
0730	PLASTIC
0740	WATER
0750	MEDICINE
0800	INANIMATE OBJECT
0810	BOX, BARREL, ETC.
0820	PAPER
0830	METAL ITEM, MINERAL
0831	NEEDLE
0840	GLASS
0850	SCRAP, TRASH
0860	WOOD
0870	FOOD
0880	CLOTHING, APPAREL, SHOES
0900	ANIMATE OBJECT
0911	DOG
0912	OTHER ANIMAL
0920	PLANT
0930	INSECT
0940	HUMAN (VIOLENCE)
0950	HUMAN (COMMUNICABLE DISEASE)
0960	BACTERIA, VIRUS (NOT HUMAN CONTACT)
1000	PERSONAL PROTECTIVE EQUIPMENT
1010	PROTECTIVE CLOTHING, SHOES, GLASSES, GOGGLES
1020	RESPIRATOR, MASK
1021	DIVING EQUIPMENT
1030	SAFETY BELT, HARNESS
1040	PARACHUTE

INSTRUCTIONS FOR SECTION 6 — PUBLIC FATALITY

a. ACTIVITY AT TIME OF ACCIDENT—Select the activity being performed at the time of the accident from the list below. Enter the activity name on the line and the corresponding number in the box. If the activity performed is not identified on the list, select from the *most* appropriate primary activity area (water related, non-water related or other activity), the code number for "Other", and write in the activity being performed at the time of the accident.

WATER RELATED RECREATION

1. Sailing
2. Boating—powered
3. Boating—unpowered
4. Water skiing
5. Fishing from boat
6. Fishing from bank dock or pier
7. Fishing while wading
8. Swimming/supervised area
9. Swimming/designated area
10. Swimming/other area
11. Underwater activities (skin diving, scuba, etc.)
12. Wading
13. Attempted rescue
14. Hunting from boat
15. Other

NON-WATER RELATED RECREATION

16. Hiking and walking
17. Climbing (general)
18. Camping/picnicking authorized area
19. Camping/picnicking unauthorized area
20. Guided tours
21. Hunting
22. Playground equipment
23. Sports/summer (baseball, football, etc.)
24. Sports/winter (skiing, sledding, snowmobiling etc.)
25. Cycling (bicycle, motorcycle, scooter)
26. Gliding
27. Parachuting
28. Other non-water related

OTHER ACTIVITIES

29. Unlawful acts (fights, riots, vandalism, etc.)
30. Food preparation/serving
31. Food consumption
32. Housekeeping
33. Sleeping
34. Pedestrian struck by vehicle
35. Pedestrian other acts
36. Suicide
37. "Other" activities

b. PERSONAL FLOTATION DEVICE USED—If fatality was water-related was the victim wearing a person flotation device? Mark the appropriate box.

INSTRUCTIONS FOR SECTION 7—MOTOR VEHICLE ACCIDENT

a. TYPE OF VEHICLE—Mark appropriate box for each vehicle involved. If more than one vehicle of the same type is involved, mark both halves of the appropriate box. USACE vehicle(s) involved shall be marked in left half of appropriate box.

b. TYPE OF COLLISION—Mark appropriate box.

c. SEAT BELT—Mark appropriate box.

INSTRUCTIONS FOR SECTION 8—PROPERTY/ MATERIAL INVOLVED

a. NAME OF ITEM—Describe all property involved in accident. Property/material involved means material which is damaged or whose use or misuse contributed to the accident. Include the name, type, model; also include the National Stock Number (NSN) whenever applicable.

b. OWNERSHIP—Enter ownership for each item listed. (Enter one of the following: *USACE; OTHER GOVERNMENT; CONTRACTOR; PRIVATE*)

c. $ AMOUNT OF DAMAGE—Enter the total estimated dollar amount of damage (parts and labor), if any.

INSTRUCTIONS FOR SECTION 9—VESSEL/FLOATING PLANT ACCIDENT

a. TYPE OF VESSEL/FLOATING PLANT—Select the most appropriate vessel/floating plant from list below. Enter name and place corresponding number in box. If item is not listed below, enter item number for "OTHER" and write in specific type of vessel/floating plant.

VESSEL/FLOATING PLANTS

1. ROW BOAT
2. SAIL BOAT
3. MOTOR BOAT
4. BARGE
5. DREDGE/HOPPER
6. DREDGE/SIDE CASTING
7. DREDGE/DIPPER
8. DREDGE/CLAMSHELL, BUCKET
9. DREDGE/PIPE LINE
10. DREDGE/DUST PAN
11. TUG BOAT
12. OTHER

b. COLLISION/MISHAP—Select from the list below the object(s) that contributed to the accident or were damaged in the accident.

COLLISION/MISHAP

1. COLLISION W/OTHER VESSEL
2. UPPER GUIDE WALL
3. UPPER LOCK GATES
4. LOCK WALL
5. LOWER LOCK GATES
6. LOWER GUIDE WALL
7. HAULAGE UNIT
8. BREAKING TOW
9. TOW BREAKING UP
10. SWEPT DOWN ON DAM
11. BUOY/DOLPHIN/CELL
12. WHARF OR DOCK
13. OTHER

INSTRUCTIONS FOR SECTION 10—ACCIDENT DESCRIPTION

DESCRIBE ACCIDENT—Fully describe the accident. Give the sequence of events that describe what happened leading up to and including the accident. Fully identify personnel and equipment involved and their role(s) in the accident. Ensure that relationships between personnel and equipment are clearly specified. Continue on blank sheets if necessary and attach to this report.

INSTRUCTIONS FOR SECTION 11—CAUSAL FACTORS

a. Review thoroughly. Answer each question by marking the appropriate block. If any answer is yes, explain in item 13 below. Consider, as a minimum, the following:

(1) DESIGN—Did inadequacies associated with the building or work site play a role? Would an improved design or layout of the equipment or facilities reduce the likelihood of similar accidents? Were the tools or other equipment designed and intended for the task at hand?

(2) INSPECTION/MAINTENANCE—Did inadequately or improperly maintained equipment, tools, workplace, etc. create or worsen any hazards that contributed to the accident? Would better equipment, facility, work site or work activity inspections have helped avoid the accident?

(3) PERSON'S PHYSICAL CONDITION—Do you feel that the accident would probably not have occurred if the employee was in "good" physical condition? If the person involved in the accident had been in better physical condition, would the accident have been less severe or avoided altogether? Was over exertion a factor?

(4) OPERATING PROCEDURES—Did a lack of or inadequacy within established operating procedures contribute to the accident? Did any aspect of the procedures introduce any hazard to, or increase the risk associated with the work process? Would establishment or improvement of operating procedures reduce the likelihood of similar accidents?

(5) JOB PRACTICES—Were any of the provisions of the Safety and Health Requirements Manual (EM 385-1-1) violated? Was the task being accomplished in a manner which was not in compliance with an established job hazard analysis or activity hazard analysis? Did any established job practice (including EM 385-1-1) fail to adequately address the task or work process? Would better job practices improve the safety of the task?

(6) HUMAN FACTORS—Was the person under undue stress (either internal or external to the job)? Did the task tend toward overloading the capabilities of the person; i.e., did the job require tracking and reacting to many external inputs such as displays, alarms, or signals? Did the arrangement of the workplace tend to interfere with efficient task performance? Did the task require reach, strength, endurance, agility, etc., at or beyond the capabilities of the employee? Was the work environment ill-adapted to the person? Did the person need more training, experience, or practice in doing the task? Was the person inadequately rested to perform safely?

(7) ENVIRONMENTAL FACTORS—Did any factors such as moisture, humidity, rain, snow, sleet, hail, ice, fog, cold, heat, sun, temperature changes, wind, tides, floods, currents, dust, mud, glare, pressure changes, lightning, etc., play a part in the accident?

(8) CHEMICAL AND PHYSICAL AGENT FACTORS—Did exposure to chemical agents (either single shift exposure or long-term exposure) such as dusts, fibers (asbestos, etc.), silica, gases (carbon monoxide, chlorine, etc.), mists, steam, vapors, fumes, smoke, other particulates, liquid or dry chemicals that are corrosive, toxic, explosive or flammable, by-products of combustion or physical agents such as noise, ionizing radiation, non-ionizing radiation (UV radiation created during welding, etc.) contribute to the accident/incident?

(9) OFFICE FACTORS—Did the fact that the accident occurred in an office setting or to an office worker have a bearing on its cause? For example, office workers tend to have less experience and training in performing tasks such as lifting office furniture. Did physical hazards within the office environment contribute to the hazard?

(10) SUPPORT FACTORS—Was the person using an improper tool for the job? Was inadequate time available or utilized to safely accomplish the task? Were less than adequate personnel resources (in terms of employee skills, number of workers, and adequate supervision) available to get the job done properly? Was funding available, utilized, and adequate to provide proper tools, equipment, personnel, site preparation, etc?

(11) PERSONAL PROTECTIVE EQUIPMENT—Did the person fail to use appropriate personal protective equipment (gloves, eye protection, hard-toed shoes, respirator, etc.) for the task or environment? Did protective equipment provided or worn fail to provide adequate protection from the hazard(s)? Did lack of or inadequate maintenance of protective gear contribute to the accident?

(12) DRUGS/ALCOHOL—Is there any reason to believe the person's mental or physical capabilities, judgement, etc., were impaired or altered by the use of drugs or alcohol? Consider the effects of prescription medicine and over the counter medications as well as illicit drug use. Consider the effect of drug or alcohol induced "hangovers".

b. WRITTEN JOB/ACTIVITY HAZARD ANALYSIS—Was a written Job/Activity Hazard Analysis completed for the task being performed at the time of the accident? Mark the appropriate box. *If one was performed, attach a copy of the analysis to the report.*

INSTRUCTIONS FOR SECTION 12—TRAINING

a. WAS PERSON TRAINED TO PERFORM ACTIVITY/TASK?—For the purpose of this section "trained" means the person has been provided the necessary information (either formal and/or on-the-job (OJT) training) to competently perform the activity/task in a safe and healthful manner.

b. TYPE OF TRAINING—Mark the appropriate box that best indicates the type of training; (classroom or on-the-job) that the injured person received before the accident happened.

c. DATE OF MOST RECENT TRAINING—Enter the month, day, and year of the last *formal* training completed that covered the activity/task being performed at the time of the accident.

INSTRUCTIONS FOR SECTION 13—CAUSES

a. DIRECT CAUSES—The direct cause is that single factor which most directly lead to the accident. See examples below.

b. INDIRECT CAUSES—Indirect causes are those factors which contributed to but did not directly initiate the occurrence of the accident.

Examples for section 13:

a. Employee was dismantling scaffold and fell 12 feet from unguarded opening.
Direct cause: failure to provide fall protection at elevation.
Indirect causes: failure to enforce USACE safety requirements; improper training/motivation of employee (possibility that employee was not knowledgeable of USACE fall protection requirements or was lax in his attitude towards safety); failure to ensure provision of positive fall protection whenever elevated; failure to address fall protection during scaffold dismantling in phase hazard analysis.

b. Private citizen had stopped his vehicle at intersection for red light when vehicle was struck in rear by USACE vehicle. (note USACE vehicle was in proper/safe working condition).
Direct cause: failure of USACE driver to maintain control of and stop USACE vehicle within safe distance.
Indirect cause: Failure of employee to pay attention to driving (defensive driving).

INSTRUCTIONS FOR SECTION 14—ACTION TO ELIMINATE CAUSE(S)

DESCRIPTION—Fully describe all the actions taken, anticipated, and recommended to eliminate the cause(s) and prevent reoccurrence of similar accidents/illnesses. Continue on blank sheets of paper if necessary to fully explain and attach to the completed report form.

INSTRUCTIONS FOR SECTION 15—DATES FOR ACTION

a. BEGIN DATE—Enter the date when the corrective action(s) identified in Section 14 will begin.

b. COMPLEYE DATE—Enter the date when the corrective action(s) identified in Section 14 will be completed.

c. TITLE AND SIGNATURE—Enter the title and signature of supervisor completing the accident report. For a GOVERNMENT employee accident/illness the immediate supervisor will complete and sign the report. For PUBLIC accidents the USACE Project Manager/Area Engineer responsible for the USACE property where the accident happened shall complete and sign the report. For CONTRACTOR accidents the Contractor's project manager shall complete and sign the report and provide to the USACE supervisor responsible for oversight of that contractor activity. This USACE Supervisor shall also sign the report. Upon entering the information required in 15.d, 15.e and 15.f below, the responsible USACE supervisor shall forward the report for management review as indicated in Section 16.

d. DATE SIGNED—Enter the month, day, and year that the report was signed by the responsible supervisor.

e. ORGANIZATION NAME—For GOVERNMENT employee accidents enter the USACE organization name (Division. Branch. Section, etc.) of the injured employee. For PUBLIC accidents enter the USACE organization name for the person identified in block 15.c. For CONTRACTOR accidents enter the USACE organization name for the USACE office responsible for providing contract administration oversight.

f. OFFICE SYMBOL—Enter the latest complete USACE Office Symbol for the USACE organization identified in block 15.e.

INSTRUCTIONS FOR SECTION 16—MANAGEMENT REVIEW (1st)

1ST REVIEW—Each USACE FOA shall determine who will provide 1st management review. The responsible USACE supervisor in section 15.c shall forward the completed report to the USACE office designated as the 1st Reviewer by the FOA. Upon receipt, the Chief of the Office shall review the completed report, mark the appropriate box, provide substantive comments, sign, date, and forward to the FOA Staff Chief (2nd review) for review and comment.

INSTRUCTIONS FOR SECTION 17—MANAGEMENT REVIEW (2nd)

2ND REVIEW—The FOA Staff Chief (i.e., FOA Chief of Construction, Operations, Engineering, Planning, etc.) shall mark the appropriate box, review the completed report, provide substantive comments, sign, date, and return to the FOA Safety and Occupational Health Office.

INSTRUCTIONS FOR SECTION 18—SAFETY AND OCCUPATIONAL HEALTH REVIEW

3RD REVIEW—The FOA Safety and Occupational Health Office shall review the completed report, mark the appropriate box, ensure that any inadaquacies, discrepancies, etc, are rectified by the responsible supervisor and management reviewers, provide substantive comments, sign, date and forward to the FOA Commander for review, comment, and signature.

INSTRUCTION FOR SECTION 19—COMMAND APPROVAL

4TH REVIEW—The FOA Commander shall (to include the person designated Acting Commander in his absence) review the completed report, comment if required, sign, date, and forward the report to the FOA Safety and Occupational Health Office. Signature authority shall not be delegated.

ATTACHMENT 19
TRAINING DOCUMENTATION

Health & Safety Training

8 Hour Refresher

This Certifies That

Edward Hastings

Has completed eight hours of training toward fulfillment of annual refresher training requirements for hazardous waste/materials workers under OSHA 29 CFR 1910.120

Phillip Jones

Phillip L. Jones, M.S., C.I.H.
Health and Safety Manager

Rod Petri

Rod D. Petri, M.S., C.E.T.
Training Program Manager

Course Date: **March 24, 1994**

Course Location: **Wayne, NJ**

Serial Number: Redacted - Privacy Act

Woodward-Clyde

Engineering & sciences applied to the earth & its environment

Certificate

This is to certify that

ED HASTINGS

is hereby awarded this Certificate signifying
the successful completion of

HEALTH & SAFETY OPERATIONS AT HAZARDOUS MATERIALS SITES
29 CFR 1910.120 (E)(2) 32 HOURS

Attested to this 28 *day of* MARCH *19* 87

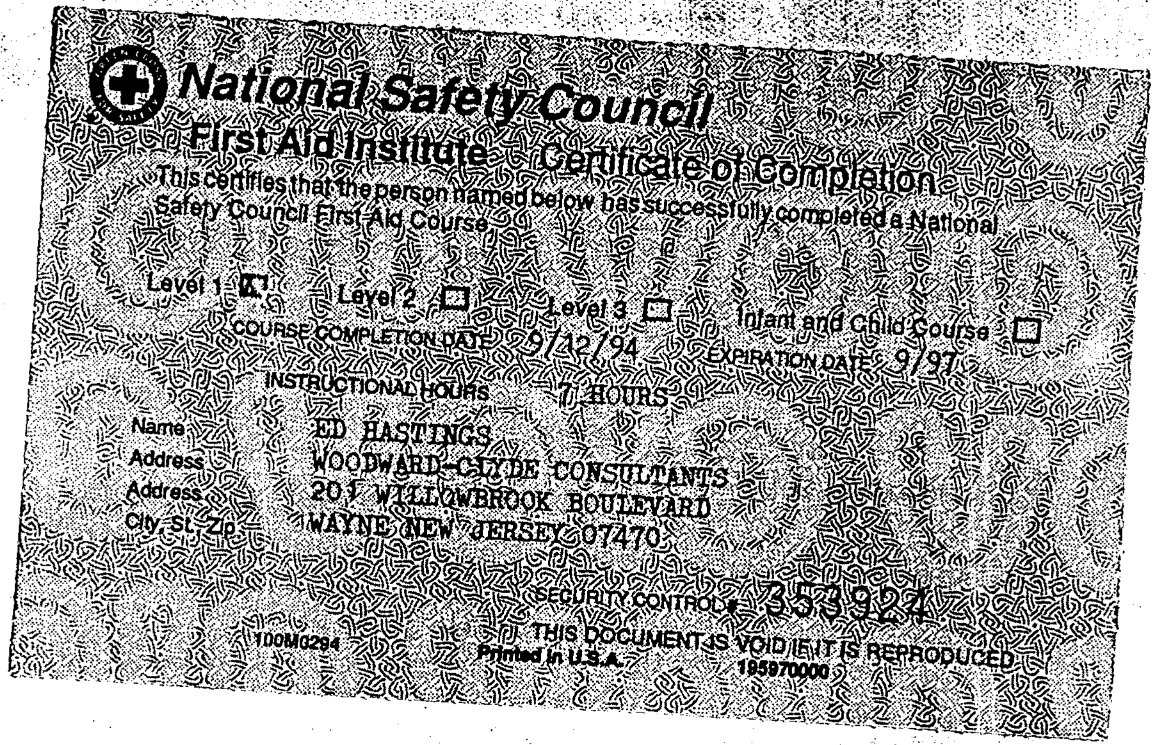
County Executive

Steven P. Mackowsky
Instructor

Raymond W. Rush
County Fire Coordinator

# of Training

Redacted - Privacy Act



National Safety Council

First Aid Institute Certificate of Completion

This certifies that the person named below has successfully completed a National Safety Council First Aid Course.

Level 1 ☒ Level 2 ☐ Level 3 ☐ Infant and Child Course ☐

COURSE COMPLETION DATE 9/12/94 EXPIRATION DATE 9/97

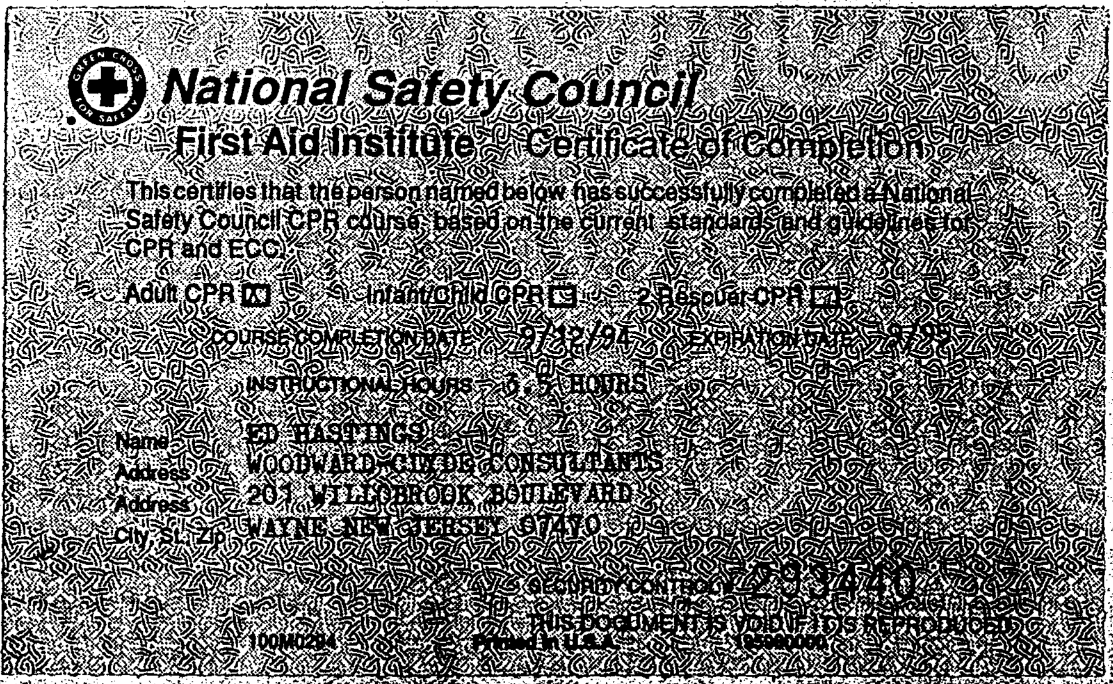
INSTRUCTIONAL HOURS 7 HOURS

Name ED HASTINGS
Address WOODWARD-CLYDE CONSULTANTS
Address 201 WILLOWBROOK BOULEVARD
City, St., Zip WAYNE NEW JERSEY 07470

SECURITY CONTROL # 353924

THIS DOCUMENT IS VOID IF IT IS REPRODUCED

100M0294 Printed in U.S.A. 195970000



National Safety Council

First Aid Institute Certificate of Completion

This certifies that the person named below has successfully completed a National Safety Council CPR course, based on the current standards and guidelines for CPR and ECC.

Adult CPR ☒ Infant/Child CPR ☐ 2 Rescuer CPR ☐

COURSE COMPLETION DATE 9/12/94 EXPIRATION DATE 9/95

INSTRUCTIONAL HOURS 3.5 HOURS

Name ED HASTINGS
Address WOODWARD-CLYDE CONSULTANTS
Address 201 WILLOBROOK BOULEVARD
City, St., Zip WAYNE NEW JERSEY 07470

SECURITY CONTROL # 293440

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Edward M. Hastings

HAS SUCCESSFULLY COMPLETED 8 HOURS
OF

WOODWARD-CLYDE

LEVEL B TRAINING

Denver, Colorado
August 28, 1992
Serial # Redacted - Privacy Act

Phillip L. Jones

Phillip L. Jones, MS, CIH

WASTE
SITE
SUPERVISOR
TRAINING

Woodward-Clyde Consultants

This certifies that

Edward M. Hastings

has sucessfully completed

Eight hours training fulfilling supervisor training requirements of OSHA 1910.120

Phillip Jones

Phillip L. Jones, C.I.H.
Woodward-Clyde Consultants

Course Date: **April 5, 1991**
Course Location: **Plymouth Meeting, PA**
Serial Number: Redacted - Privacy Act

Health & Safety Training

This Certifies That

Edward M. Hastings

Has successfully completed eight hours of Confined Space Entry/Level B training.

Phillip L Jones

Phillip L. Jones, M.S., C.I.H.
Health and Safety Manager

David M. Carl

David M. Carl, CET
Health and Safety Officer

Course Date: **April 14, 1994**

Course Location: **Philadelphia, PA**

Serial Number: Redacted - Privacy Act

Woodward-Clyde
Engineering & sciences applied to the earth & its environment

40-Hour BASIC HEALTH AND SAFETY TRAINING

Woodward-Clyde Consultants

This certifies that

Marc Jacobson

has sucessfully completed

Forty hours training fulfilling initial training requirements for hazardous waste workers under OSHA 1910.120 (e)

Phillip L Jones

Phillip L. Jones, C.I.H.
Woodward-Clyde Consultants

Course Date: **March 18-21, 1987**
Course Location: **Chicago, Illinois**
Serial Number: Redacted - Privacy Act

Health & Safety Training

8-Hour Refresher

HEALTH & SAFETY
Woodward-Clyde

This Certifies That

Marc Jacobson

Has completed eight hours of training toward fulfillment of annual refresher training requirements for hazardous waste/materials workers under OSHA 29 CFR 1910.120

Phillip L. Jones, M.S., C.I.H.
Health and Safety Manager

Rod D. Petri, M.S., C.E.T.
Training Program Manager

Course Date: **July 21, 1994**

Course Location: **Wayne, New Jersey**

Serial Number: Redacted - Privacy Act

Woodward-Clyde
Engineering & sciences applied to the earth & its environment

Redacted - Privacy Act

ADVANCED HEALTH AND SAFETY TRAINING

Woodward-Clyde Consultants

This certifies that

Marc E. Jacobson

has successfully completed

Eight hours waste site supervisor plus
eight hours level B equipment use training

Phillip Jones

Phillip L. Jones, C.I.H.
Woodward-Clyde Consultants

April 3, 1989

Seminar
Date

WASTE SITE SUPERVISOR TRAINING

Woodward-Clyde Consultants

This certifies that

Marc E. Jacobson

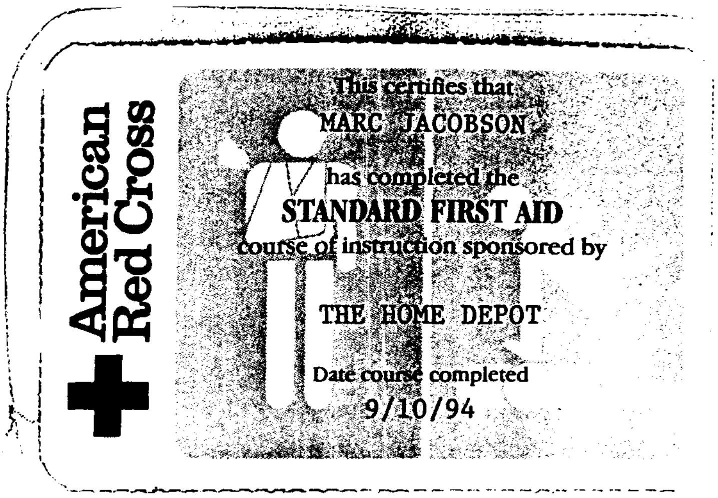
has sucessfully completed

Eight hours training fulfilling supervisor training requirements of OSHA 1910.120 (e)

Phillip Jones

Phillip L. Jones, C.I.H.
Woodward-Clyde Consultants

Course Date: **December 18-19, 1991**
Course Location: **Wayne, New Jersey**
Serial Number: Redacted - Privacy Act



American Red Cross

This certifies that

MARC JACOBSON

has completed the

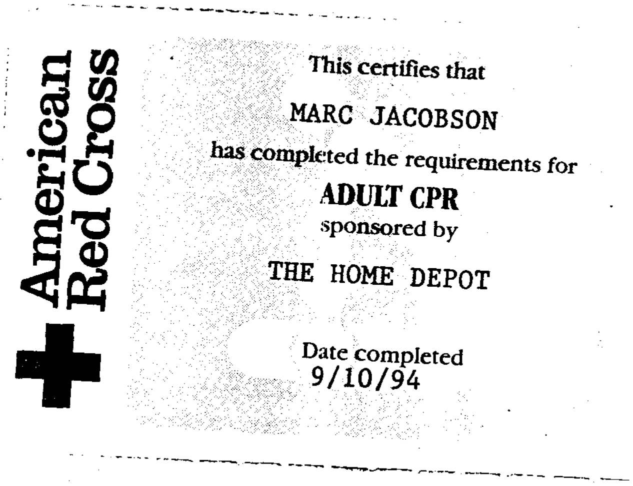
STANDARD FIRST AID

course of instruction sponsored by

THE HOME DEPOT

Date course completed

9/10/94



American Red Cross

This certifies that

MARC JACOBSON

has completed the requirements for

ADULT CPR

sponsored by

THE HOME DEPOT

Date completed

9/10/94

Chairman, American Red Cross

Instructor's Signature

Robert West

Holder's Signature

S202 Cert. 3207 (Rev. July 1992)

COMMUNITY HEALTH SERVICES

Chairman, American Red Cross

Instructor's Signature

Robert West

Holder's Signature

The American Red Cross recognizes this training as valid
for one year from completion date.

S202 Cert. 653212 (Jan. 1993)

HAZARDOUS MATERIALS

HANDLING & TRANSPORT TRAINING CENTERS

FLANDERS, NEW JERSEY

This is to acknowledge that

ZOLTAN E. KOLLER

Certificate #94-05-2905

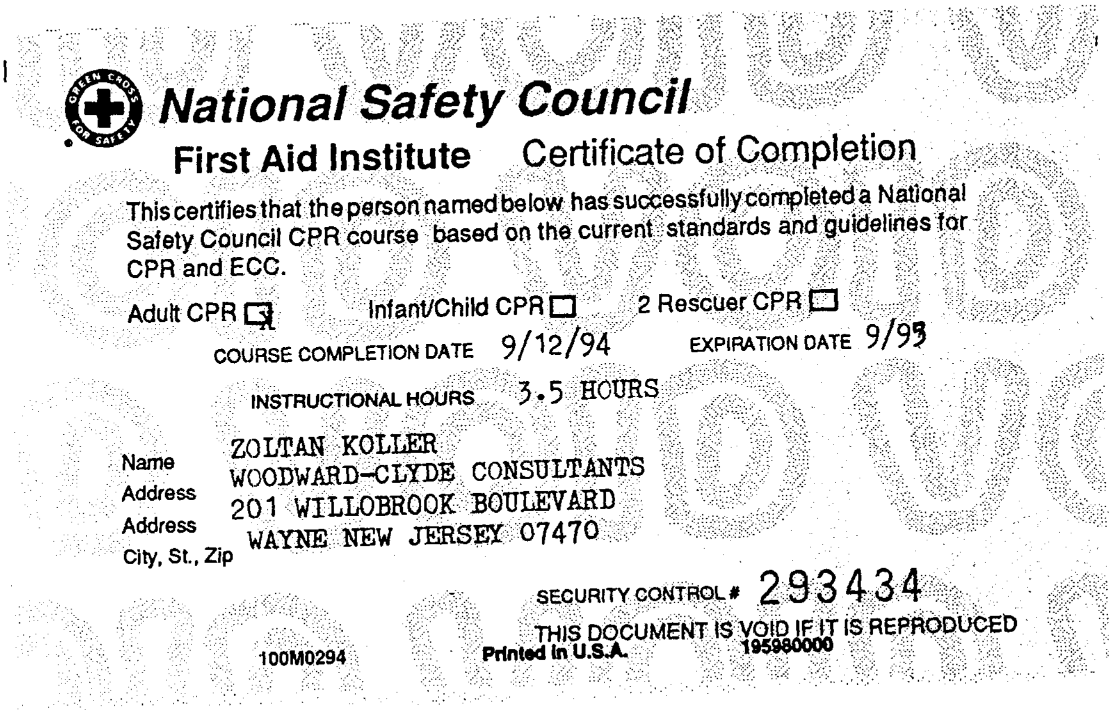
has successfully completed the course entitled

HEALTH & SAFETY FOR HAZARDOUS WASTE OPERATIONS

29 CFR 1910.120 (e)(3)(i)

CENTER DIRECTOR 02-27-94 DATE INSTRUCTOR

Redacted - Privacy Act



National Safety Council

First Aid Institute Certificate of Completion

This certifies that the person named below has successfully completed a National Safety Council CPR course based on the current standards and guidelines for CPR and ECC.

Adult CPR ☒ Infant/Child CPR ☐ 2 Rescuer CPR ☐

COURSE COMPLETION DATE 9/12/94 EXPIRATION DATE 9/95

INSTRUCTIONAL HOURS 3.5 HOURS

Name ZOLTAN KOLLER
Address WOODWARD-CLYDE CONSULTANTS
Address 201 WILLOBROOK BOULEVARD
City, St., Zip WAYNE NEW JERSEY 07470

SECURITY CONTROL # 293434

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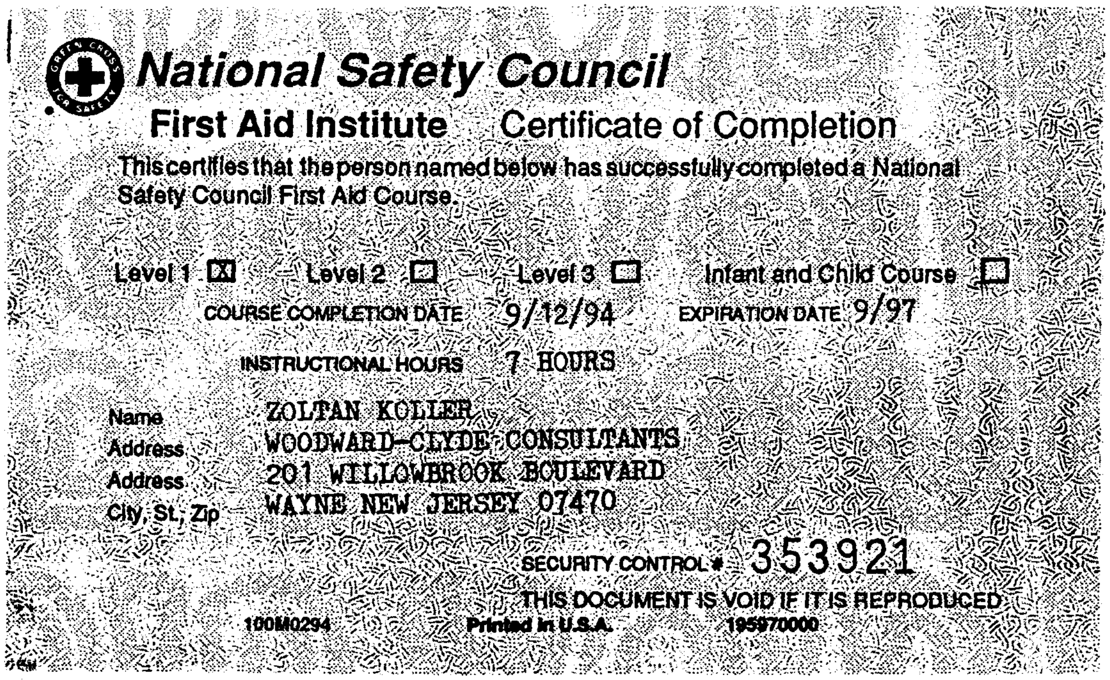

National Safety Council

First Aid Institute Certificate of Completion

This certifies that the person named below has successfully completed a National Safety Council First Aid Course.

Level 1 ☒ Level 2 ☐ Level 3 ☐ Infant and Child Course ☐

COURSE COMPLETION DATE 9/12/94 EXPIRATION DATE 9/97

INSTRUCTIONAL HOURS 7 HOURS

Name ZOLTAN KOLLER
Address WOODWARD-CLYDE CONSULTANTS
Address 201 WILLOWBROOK BOULEVARD
City, St., Zip WAYNE NEW JERSEY 07470

SECURITY CONTROL # 353921

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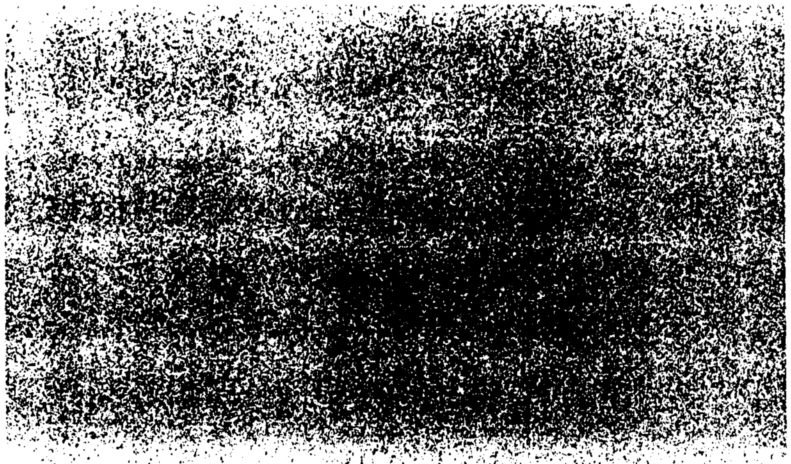
Health & Safety Training



HEALTH & SAFETY

Woodward-Clyde

This Certifies That

Zoltan Koller

Has successfully completed eight hours of Confined Space Entry/Level B training.

Phillip L Jones

Phillip L. Jones, M.S., C.I.H.
Health and Safety Manager

David M. Carl

David M. Carl, CET
Health and Safety Officer

Woodward-Clyde

Engineering & sciences applied to the earth & its environment

Course Date: **April 14, 1994**

Course Location: **Philadelphia, PA**

Serial Number: Redacted - Privacy Act

FUGRO-McCLELLAND ENVIRONMENTAL, INC.
Asbestos & Environmental Consultants

CERTIFICATE OF COMPLETION

PRESENTED TO

ANJANETTE WICKER G IETL
Redacted - Privacy Act

FOR COMPLETION OF

SAFETY & HEALTH AT HAZARDOUS
WASTE SITES - 40 HOURS
29CFR1910.120

January 20-24, 1992
Date

Henry J Smahlik
Director

FUGRO McClelland
Environmental

Health & Safety Training

HEALTH & SAFETY
Woodward-Clyde

Woodward-Clyde
Engineering & sciences applied to the earth & its environment

This Certifies That

Anjanette Gietl

Has completed eight hours of training toward fulfillment of annual refresher training requirements for hazardous waste/materials workers under OSHA 29 CFR 1910.120

Phillip L Jones
Phillip L. Jones, M.S., C.I.H.
Health and Safety Manager

Rod Petri
Rod D. Petri, M.S., C.E.T.
Training Program Manager

Course Date: **November 9, 1994**

Course Location: **Wayne, NJ**

Serial Number: Redacted - Privacy Act

Redacted - Privacy Act

Woodward-Clyde Consultants

Health and Safety Training

This Certifies that

Robert Gaibrois

has successfully completed

'Basic Health & Safety Training'

Date: Oct. 16-19, 1985 Location: White Plains, N.Y.

Phillip L. Jones, CIH
Phillip L. Jones
WCC Health and Safety Adminstrator

Steve Maslansky
Steve Maslansky
President, Geoenvironmental Consultants

Health & Safety Training

8-Hour Refresher

This Certifies That

Robert Gaibrois

Has completed eight hours of training toward fulfillment of annual refresher training requirements for hazardous waste/materials workers under OSHA 29 CFR 1910.120

Phillip L. Jones, M.S., C.I.H.
Health and Safety Manager

Rod D. Petri, M.S., C.E.T.
Training Program Manager

Course Date: **July 21, 1994**

Course Location: **Wayne, New Jersey**

Serial Number: Redacted - Privacy Act

Woodward-Clyde

Engineering & sciences applied to the earth & its environment

Redacted - Privacy Act

Health & Safety Training

This Certifies That

Robert Gaibrois

Has successfully completed eight hours of Confined Space Entry/Level B training.

Phillip L Jones

Phillip L. Jones, M.S., C.I.H.
Health and Safety Manager

David M. Carl

David M. Carl, CET
Health and Safety Officer

Course Date: **April 14, 1994**

Course Location: **Philadelphia, PA**

Serial Number: Redacted - Privacy Act

Woodward-Clyde

Engineering & sciences applied to the earth & its environment

BASIC HEALTH AND SAFETY TRAINING

Woodward-Clyde Consultants

This certifies that

Ronald Gautreau

has successfully completed

Forty hours training fulfilling initial training requirements for hazardous waste workers under OSHA 1910.120

Phillip Jones

Phillip L. Jones, C.I.H.
Woodward-Clyde Consultants

April 4-7, 1989

Seminar
Date