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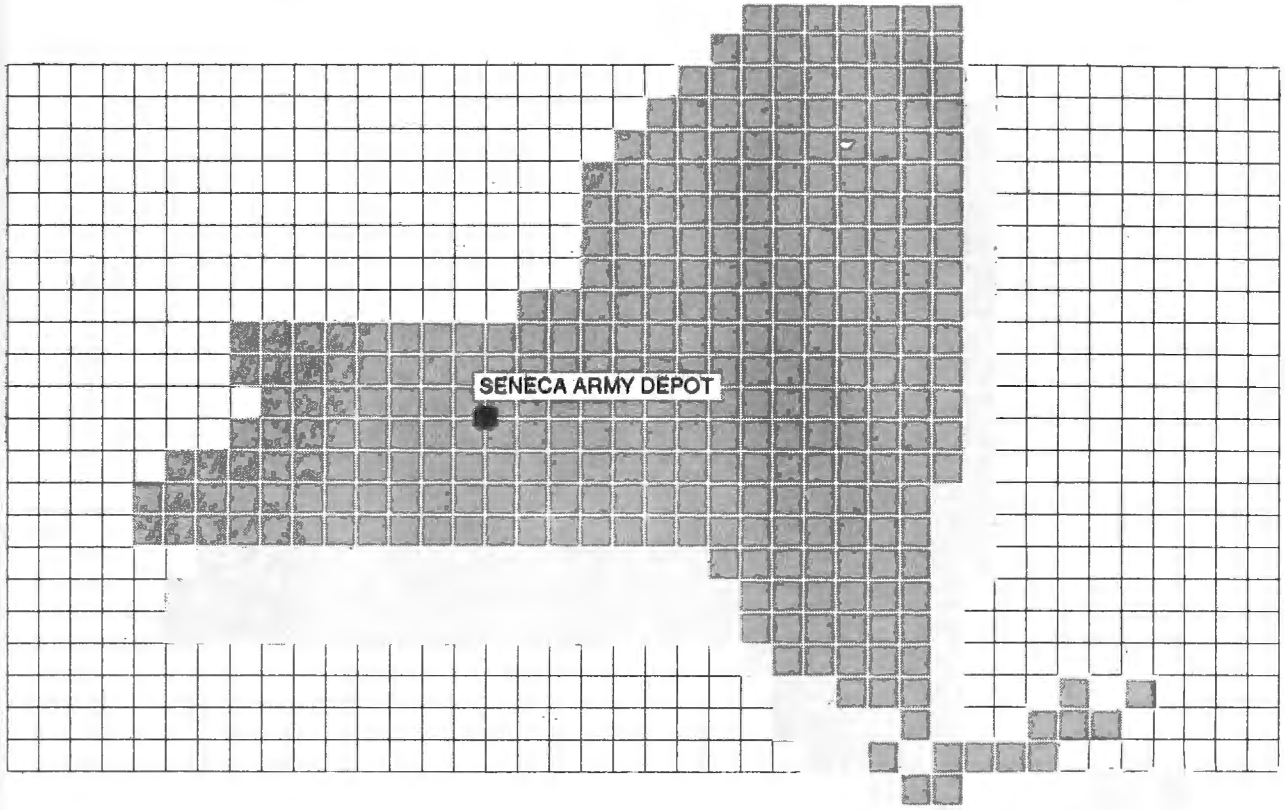
U.S. ARMY ENGINEER DIVISION
HUNTSVILLE, ALABAMA

Final Draft

SENECA ARMY DEPOT



WORKPLAN

ARCHITECT-ENGINEER SERVICES FOR PERFORMING A REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS) AT THE OPEN-BURNING (OB) GROUNDS

THIS WORKPLAN INCLUDES OCTOBER AND NOVEMBER 1991 ADDENDUMS

FINAL DRAFT

WORKPLAN FOR CONDUCTING A REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS) AT THE OPEN BURNING/OPEN DETONATION (OB/OD) GROUNDS

SENECA ARMY DEPOT
ROMULUS, NEW YORK

PREPARED BY:

CHAS. T. MAIN, INC.
PRUDENTIAL CENTER
BOSTON, MA

1345-082-3228

AUGUST 1991

APPROVAL SHEET

The following personnel have reviewed this workplan for accuracy, content and quality of presentation.

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LIST OF ACRONYMS AND ABBREVIATIONS

AA	Atomic Adsorption
AB/N	Acid, Base/Neutrals
ADI	Acceptable Daily Intake
AIHA	American Industrial Hygiene Association
4-Am-DNT	4-Amino-2,6-Dinitrotoluene
2-AM-DNT	2-Amino-2,6-Dinitrotoluene
AOC	Area of Concern
AP	Armor Piercing
APERS	Anti-Personnel Ejection Round Special
ARAR	Applicable or Relevant and Appropriate Requirement
AWQC	Ambient Water Quality Criteria
BD	Base Detonating
bgs	below ground surface
°C	degrees Celsius
CaCO3	Calcium Carbonate
CEC	Cation Exchange Capacity
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CDAP	Chemical Data Aquisition Plan
CFR	Code of Federal Regulations
CPF	Cancer Potency Factor
CV	Coefficient of Variation
CVAA	Cold Vapor Atomic Adsoption
CPR	Cardio Pulmonary Resuscitation
CRQL	Contract Required Quantitation Limit
CRZ	Contamination Reduction Zone
DARCOM	U.S. Army Material Development and Readiness Command
1,3-DNB	1,3-Dinitrobenzene
2,6-DNT	2,6-Dinitroboluene
2,4-DNT	2,4-Dinitrotoluene
DO	Dissolved Oxygen
DOD	Department of Defense
DQCR	Daily Quality Control Report
DQO	Data Quality Objective
EC_{50}	Effective concentration observed in 50% of the population
ECL	Environmental Conservation Law
EDMI	Electronic Distance Meter Instrument
EM	electromagnetic
EMSL	Environmental Monitoring Systems Laboratory
EOD	Explosive ordnance disposal
EP	Extraction Procedure
EPA	U.S. Environmental Protection Agency
ESE	Environmental Science and Engineering, Inc.
ET	Electronic Time
eV	electron volts
FEMA	Federal Emergency Management Agency
FID	Flame Ionization Detector
FIRM	Flood Insurance Rate Maps
FS	Feasibility Study
FSAP	Field Sampling and Analysis Plan
ft	feet
ft/mile	feet per mile
ft-bls	feet below land surface

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued, Page 2 of 4)

ft^3	cubic foot
gal	gallon
GFAA	Graphite Furnace Atomic Adsorption
GPR	Ground-Penetrating Radar
HA	Health Advisories
HASP	Health and Safety Plan
HE	High Explosive
HEA	Health Effects Assessment
HEAT	High Explosive Anti-Tank
HFA	Human Factors Applications Inc.
HMX	Octahydro-1,3,5,7-Tetranitro-1,3,5-7-Tetrazocine
IAG	Interagency Agreement
ICM	Improved Conventional Munition
ICP	Inductively Coupled Plasma
IIA	Initial Installation Assessment
ISV	In-Situ Vitrification
IP	Ionization Potential
IRIS	Integrated Risk Information System
kV	Kilovolt
km	kilometer
L	liter
LAPP	Louisanna Army Ammuniction Plant
LC_{50}	Lethal concentration at which 50% of the population has expired
LD_{50}	Lethal dose at which 50% of the population has expired
L/min	liter per minute
lb	pound
m	meter
MAIN	Chas. T. Main, Inc.
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
M&E	Metcalf and Eddy
mg	milligram
MP	melting point
MS	Matrix Spike
MSD	Matrix Spike Duplicate
MT	Mechanical Time
mg/L	milligrams per liter
NAAQS	National Ambient Air Quality Standards
NAPL	Non-Aqueous Phase Liquids
NB	Nitrobenzene
2-NT	2-Nitrotolune
3-NT	3-Nitrotoluene
4-NT	4-Nitrotoluene
NCP	National Contingency Plan
NGVD	National Geodetic Vertical Datum
NIOSH	National Institute of Occupational Safety and Health
NPL	National Priority List
NYCRR	New York State Codes, Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDWS	New York State Drinking Water Standard

FINAL DRAFT

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued, Page 3 of 4)

NTU's	Nephelometric Turbidity Units
NWI	National Wetland Inventory
OB/OD	Open Burning/Open Detonation
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
PAH's	Polynuclear Aromatic Hydrocarbons
PCB's	Polychlorinated Biphenyls
PD	Point Detonating
PE	Professional Engineer
PIBD-Lucky	Point Initiating Base Detonating - Lucky
PEL	Permissible Exposure Limit
PEP	Propellants, Explosives and Pyrotechnics
PID	Photoionization Detector
POC	Principal Organic Contaminant
PPE	Personnel Protective Equipment
ppm	parts per million
PQAA	Project Quality Assurance Analyst
PTTF	Powder Train Time Fuze
PVC	Polyvinyl Chloride
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
QC	Quality Control
QCSR	Quality Control Summary Report
RADAR	Radar Ordnance Search System
RCRA	Resource Conservation and Recovery Act
RDX	Hexahydro-1,3,5-Trinitro-1,3,5-Triazine
RfD	Reference Dose
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RPD	Relative Percent Difference
RQD	Rock Quality Designation
RSCC	Regional Sample Control Center
RSD	Relative Standard Deviation
SADA	Savanna Army Depot Activity
SARA	Superfund Amendments and Reauthorization Act
SCBA	Self-Contained Breathing Apparatus
SD	Standard Deviation
SDWA	Safe Drinking Water Act
SEAD	Seneca Army Depot
SIR	Subsurface Interface Radar
SOW	Statement of Work
S/S	Solidification/Stabilization
STOLS	Surface Towed Ordnance Locator System
SWMU	Solid Waste Management Unit
TAGMS	Technical and Administrative Guidance Manuals
TAL	Target Analyte List
TCL	Target Compound List
Tetryl	Methyl-2,4,6-Trinitrophenylnitramine
1,3,5-TNB	1,3,5-Trinitrobenzene

1.0 INTRODUCTION

Chas T. Main, Inc. (MAIN) has been retained by the U.S. Army Corps of Engineers (USACE) to develop a Work Plan (WP) for conducting a Remedial Investigation and Feasibility Study (RI/FS) at the Seneca Army Depot (SEAD) Open Burning/Open Detonation Grounds (OB/OD). The area to be investigated is restricted to the nine (9) open burning pads and adjacent areas within the Open Burning/Open Detonation (OB/OD) Grounds. The area of concern encompasses approximately 30 acres. The RI/FS will determine the nature and extent of environmental impacts, if any exist, and will evaluate and propose the most appropriate remedial action, if required.

The Work Plan (WP) has been prepared in two phases. The first phase was the preparation and submittal of the Scoping Document. The second phase was the preparation of the Task Plan for each task of the WP. The purpose of this phased approach to the WP preparation was to involve the regulatory authorities, the U.S. Environmental Protection Agency (EPA) and the New York State Department of Environmental Conservation (NYSDEC), in the initial planning phases of the RI/FS process. The overall intent of this approach is to expedite the RI/FS process by incorporating the regulatory review and comments during the development of the WP. Since the comments for the Scoping Document will be received prior to completion of the WP, this will focus the project in a direction acceptable to all parties involved, thereby avoiding the delays associated with resolving these differences at a later date in the project schedule.

The Work Plan consists of six sections. Section 1.0 (Introduction) provides an overview of the WP approach and background information. Section 2.0 (Site Conditions) is a summary of the existing data and presents the general environmental setting. Section 3.0 (Scoping of the RI/FS) describes the scoping process, including: 1) Conceptual Site Model; 2) Identification of Potential Exposure Pathways; 3) Scoping of Potential Remedial Action Alternatives; 4) Preliminary Identification of Applicable or Relevant and Appropriate Requirements (ARARs); 5) Data Needs and Data Quality Objectives (DQOs); and 6) Data Gaps. Sections 4.0 and 5.0 contains the detailed task plans for the RI/FS. Section 6.0 (Plans and Management) presents the overall project management structure and includes the schedule for completing the RI/FS. Appendices to the WP will include: Appendix A, The Field Sampling and Analysis Plan; Appendix B, The Health and Safety Plan; Appendix C, Chemical Data Acquisition Plan (CDAP); Appendix D, The Response to Comments, and Appendix E, The Scope of Work.

1.1 BACKGROUND

The Seneca Army Depot (SEAD), a 10,587 acre facility in Seneca County, Romulus, New York, has been owned by the United States Government and operated by the Department of the Army since 1941. Figure 1, The Seneca Army Depot Location Map, identifies the location of the depot. Since its inception in 1941, SEAD's primary mission has been the receipt, storage, maintenance, and supply of military items. This function includes disposal of military ammunition and explosives by burning and detonation. The 90 acre demolition area, includes the 30 acre OB/OD grounds. Within the 30 acre OB/OD grounds are located nine (9) burning pads. These pads have been used for burning propellants, explosives and pyrotechnics (PEP). The practice of open burning on these pads has been discontinued. The last open burning activity on the burn pads was performed in 1987. Although open burning of PEP's have been discontinued, burning of PEP's is performed in an aboveground welded steel tray as described in SEAD's RCRA Part B permit application under Subpart X of 40 CFR Part 264. The adjoining 60 acres will continue to be used for ordnance disposal as a detonation ground. The 30 acres associated with the burning pads is the subject of this investigation.

The US Army Toxic and Hazardous Materials Agency (USATHAMA) conducted an evaluation of the Seneca Army Depot, beginning in May, 1979. This study was "to assess the environmental quality of SEAD with regard to the use, storage, treatment, and disposal of toxic and hazardous materials". It was to "define any conditions which may adversely affect the health and welfare or result in environmental degradation". The conclusions reached, and discussed in the report (USATHAMA No. 157 (1980)), were: 1) Geological conditions are such that contaminants, if present, could migrate in surface or subsurface waters, and 2) The demolition/burning ground is potentially contaminated with heavy metals and explosives. The report recommended further investigation of this area.

Subsequent to the site assessment, seven (7) groundwater monitoring wells (MW-1 through MW-7) were installed in 1981. Six (6) wells were located at the perimeter of

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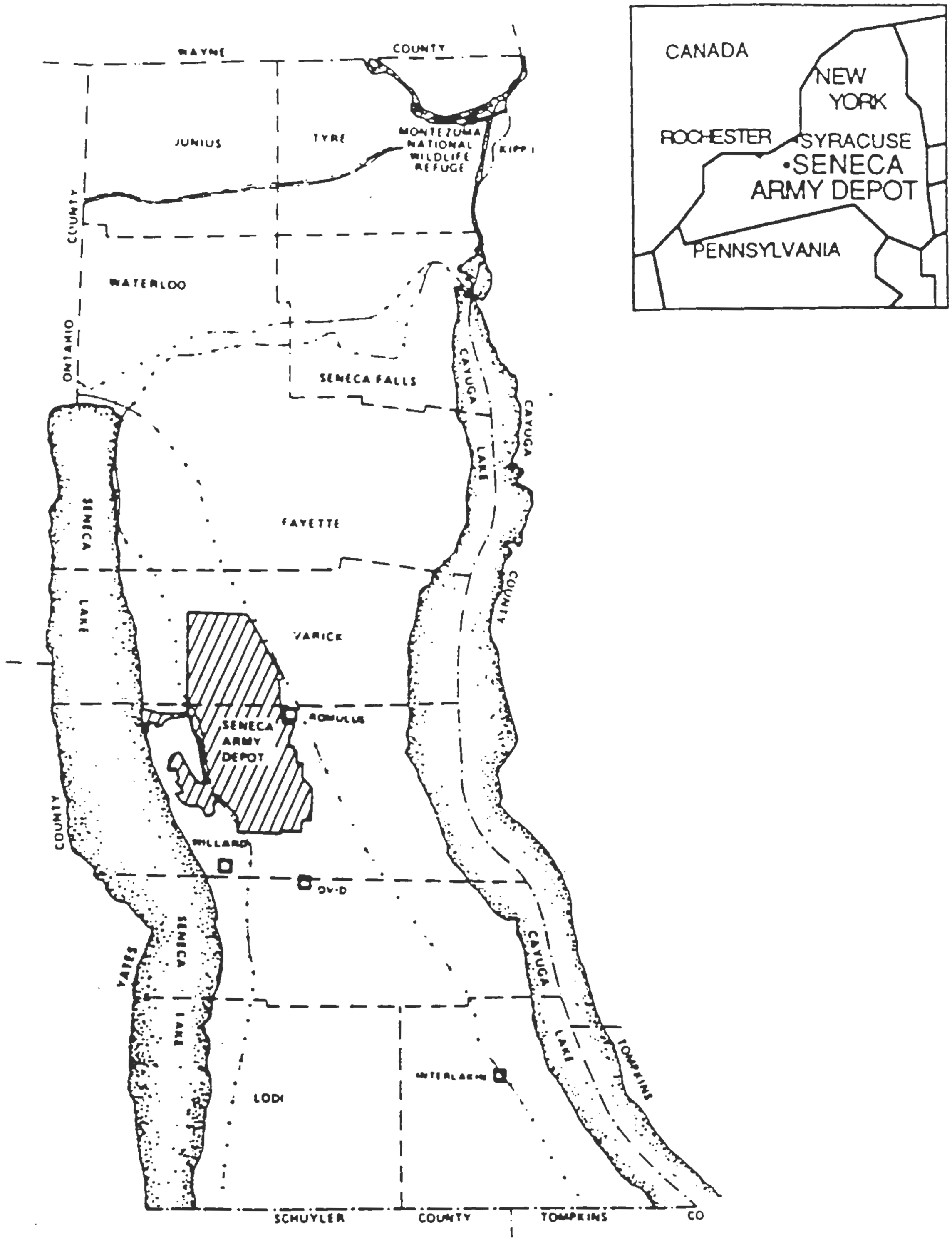

N

SCALE
6 0 6 12 MILES
6 0 6 12 KILOMETERS

SOURCE: USATHAMA, 1980; ESE, 1990.

SENECA ARMY DEPOT

LOCATION MAP

FIGURE 1 AUGUST 1991

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1893
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the OB/OD site to establish groundwater flow direction and determine if migration had occurred.

MW-1 was located between the adjacent detonation ground and the burn pads. The wells were screened in the glacial till at, or just above, the till-shale (bedrock) contact zone.

Groundwater monitoring began in January, 1982. The collected samples were analyzed on a quarterly basis during 1982. Following this initial year of monitoring, sampling and analysis continued on an annual basis through 1987 for six (6) explosives, metals, Total Organic Carbon (TOC), Total Organic Halogens (TOX), pH, pesticides, nitrates, and specific conductivity.

These results are summarized in the US Army Environmental Hygiene Agency (USAEHA) Ground Water Contamination Survey No. 38-26-0868-88, Interim Final Report on the Evaluation of Solid Waste Management Units (SWMU), Seneca Army Depot July, 1987.

In response to information acquired as a result of this and other surveys performed at similar installations, USAEHA performed a four (4) phased evaluation of the OB/OD grounds for the US Army Materials Command (USAMC). Phase I involved screening the USAMC installations for potential soil, surface water, and groundwater contamination in and around the OB/OD areas. Phase II involved a series of field studies to sample surface soils at the OB/OD areas. Phase III involved summarizing all of the Phase II studies into one overall evaluation of the various USAMC OB/OD grounds. Phase IV involved resampling selected OB/OD grounds to determine the horizontal and vertical extent of contamination identified during the Phase II studies.

The Phase II study of the USAEHA Program was conducted in 1982 at the SEAD OB/OD grounds in order to characterize the environmental hazards associated with the OB/OD area. The study's objectives were to: 1) evaluate the site relative to federal hazardous waste regulations; 2) evaluate the potential for contaminant migration in ground and surface waters; 3) determine total explosive and metal content in soils and residues; 4) determine if the soils and residues constitute a hazardous waste based on Extraction Procedure (EP) Toxicity analysis; and 5) determine the need for additional sampling and analyses. The study included twenty-four (24) surficial soil samples collected from 0-6 inches at Burn Pads B through H. Pads A and J were not sampled. Of the 24 samples collected, two samples from Pad B were found to contain concentrations of Ba (508 ppm and 246 ppm) in excess of the EP Toxicity standard of 100 ppm. Two samples, both from Pad H, (24.6 and 6.3 ppm) exceeded the 5 ppm EP Toxicity standard for lead. Pad F had one soil sample which contained 9,270 ppm (0.9%) of 2,4,6-TNT.

O'Brien & Gere Engineers, Inc. were contracted in 1984 to review previous studies and recommend procedures for the environmentally sound closure of Burning Pads B and H, under RCRA guidelines. The report was prepared under Contract DAC87-84-C-0077, dated November 1984. The recommended closure procedure was source excavation, on-site treatment, and removal of contaminated material to a permitted and secure off-site landfill, with subsequent capping of the site. The site was to be surrounded with a low permeability soil/bentonite slurry wall to prevent groundwater migration from the site. There were no recommendations made regarding the remaining seven pads.

During the same time frame, (1984), USAEHA conducted a Phase IV evaluation of the OB/OD ground (Hazardous Waste Study No. 37-26-0479-85). The study confirmed the presence of heavy metals and explosives in the burn pads and determined the vertical and horizontal extent of these materials in Pads B, H, and F. Surficial soil samples, performed during Phase II, failed to detect contaminants in the remaining pads and, therefore, no further investigation of these pads were deemed appropriate. This Phase IV evaluation included: 1) the installation of soil borings; 2) collection of subsurface soil samples; 3) collection of borehole water samples; 4) collection of sediment samples, and; 5) collection of surface soil samples. These samples were analyzed for explosives, dissolved metals for water, and EP Toxicity metals for soil.

In July of 1987, the Seneca Army Depot applied for a Part B, RCRA permit. The demolition ground was included in the April 1988 revision to this application.

In the 1987 identification and review of the Solid Waste Management Units (SWMU's) at SEAD, (Groundwater Contamination Survey No. 38-26-0868-88, referred to previously), the detonation ground and burning pads were combined into a single SWMU. This report concluded the OB/OD required additional sampling of groundwater and soils.

2.0 SITE CONDITIONS

SEAD is an active military installation, therefore, entry and exit are monitored 24 hours a day by armed Department of Defense (DOD) personnel. Access to SEAD is limited to military personnel and civilians with temporary military clearance. The OB/OD ground, which includes the 30 acres of the burning pads and adjacent area, is surrounded by an eight-foot high chain link fence topped with barbed wire. Additionally, entry to the OB/OD grounds is restricted via a locked gate and is patrolled by armed DOD personel.

2.1 PHYSICAL SETTING

Constructed on a 10,587 acre site in 1941, SEAD is located in an uplands area, (generally over 600 feet (ft) in elevation), approximately 40 miles (mi) south of Lake Ontario, near Romulus, New York (see Figure 1, The Seneca Army Depot Location Map). The upland area forms a divide separating two of the New York Finger Lakes, Cayuga Lake on the east and Seneca Lake on the west. Sparsely populated farmland covers most of the surrounding area. New York State Highways 96 and 96A adjoin SEAD on the east and west boundaries, respectively. The demolition ground is located in the northwest portion of SEAD. Figure 2, The Seneca Army Depot Site Plan, presents a site plan of SEAD.

The OB/OD area is situated on gently sloping terrain, vegetated with grasses and brush. Drainage is generally to the east-northeast via a series of drainage ditches and culverts into Reeder Creek. There are several seasonal poor drainage areas where water collects. Low surface gradients, less than 40 ft in 2,500 ft, a high fine content in the surface soil and underlying till contribute to poor drainage conditions. These poor draining soil conditions made burning difficult and was the reason why the pads, originally constructed on the soil surface, were built up with crushed shale quarried from an area at the base.

Open burning-open detonation (OB/OD) operations had been conducted for more than forty years in the 90 acre munition destruction area, consisting of a detonation area and the open burning area, which includes the nine (9) burning pads. The burning of munitions was performed at the nine (9) pads. Figure 3, The Demolition Ground Layout Area, depicts the layout, with the burning pads labeled A through G and J. The focus of this investigation will be on the 30 acre OB/OD area which includes the nine (9) former

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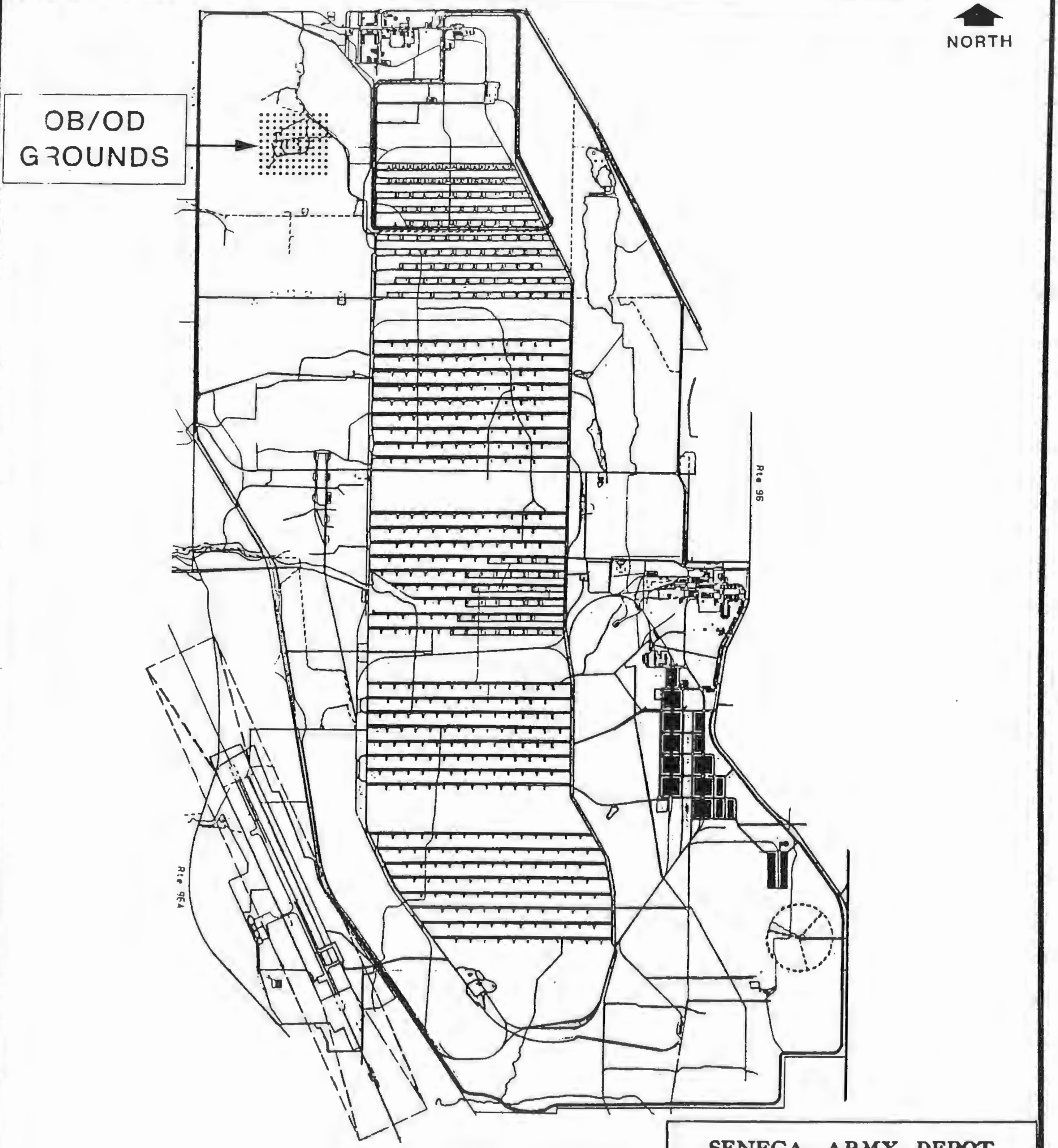

SENECA ARMY DEPOT

SITE PLAN

FIGURE 2 AUGUST 1991

MAIN
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SOURCE: Seneca Army Depot

SOURCE: RICKARD AND FISHER
GEOLOGIC MAP OF NEW YORK,
FINGER LAKES SHEET, 1970

MESOZOIC

Lower Cretaceous

MESOZOIC INTRUSIVES

Kimberlite and alnoite dikes and diatremes.

PALEOZOIC

Upper Devonian

CONNEAUT GROUP
600-1000 ft. (180-300 m.)

Germania Formation—shale, sandstone; Whitesville Formation—shale, sandstone; Hinsdale Sandstone; Wellsville Formation—shale, sandstone; Cuba Sandstone.

CANADAWAY GROUP
800-1200 ft. (240-370 m.)

Machias Formation—shale, siltstone; Rushford Sandstone; Caneadea, Canisteo, and Hume Shales; Canaseraga Sandstone; South Wales and Dunkirk Shales; In Pennsylvania: Towanda Formation—shale, sandstone.

JAVA GROUP
300-700 ft. (90-210 m.)

Wiscoy Formation—sandstone, shale; Hanover and Pipe Creek Shales.

WEST FALLS GROUP
1100-1600 ft. (340-490 m.)

Nunda Formation—sandstone, shale.

West Hill and Gardeau Formations—shale, siltstone;

Rorick Glen ~~Shale~~; upper Beers Hill Shale; Grimes Siltstone.

lower Beers Hill Shale; Dunn Hill, Millport, and Moreland Shales.

Nunda Formation—sandstone, shale; West Hill Formation—shale, siltstone; Corning Shale.

"New Milford" Formation—sandstone, shale.

Gardeau Formation—shale,. siltstone; Roricks Glen Shale.

Slide Mountain Formation—sandstone, shale, conglomerate.

Beers Hill Shale; Grimes Siltstone; Dunn Hill, Millport, and Moreland Shales

SONYEA GROUP
200-1000 ft. (60-300 m.)

In west: Cashaqua and Middlesex Shales.

In east: Rye Point Shale; Rock Stream ("Enfield") Siltstone; Pulteney, Sawmill Creek, Johns Creek, and Montour Shales.

GENESEE GROUP AND TULLY LIMESTONE
200-1000 ft. (60-300 m.)

West River Shale; Genundewa Limestone; Penn Yan and Geneseo Shales; all except Geneseo replaced eastwardly by Ithaca Formation—shale, siltstone and Sherburne Siltstone.

Oneonta Formation—shale, sandstone.

Unadilla Formation—shale, siltstone.

Tully Limestone.

Middle Devonian

HAMILTON GROUP
600-1500 ft. (180-460 m.)

Moscow Formation—In west: Windom and Kashong Shales, Menteth Limestone Members; In east: Cooperstown Shale Member, Portland Point Limestone Member.

Ludlowville Formation—In west: Deep Run Shale, Tichenor Limestone, Wanakah and Ledyard Shale Members, Centerfield Limestone Member. In east: King Ferry Shale and other members, Stone Mill Sandstone Member.

Skaneateles Formation—In west: Levanna Shale and Stafford Limestone Members; In east: Butternut, Pompey, and Delphi Station Shale Members, Mottville Sandstone Member.

Marcellus Formation—In west: Oakta Creek Shale Member; In east: Cardiff and Chittenango Shale Members, Cherry Valley Limestone and Union Springs Shale Members.

Panther Mountain Formation—shale, siltstone, sandstone.

ONONDAGA LIMESTONE AND ORISKANY SANDSTONE
75-150 ft. (23-45 m.)

Onondaga Limestone—Seneca, Morehouse (cherty) and Nedrow Limestone Members, Edgecliff cherty Limestone Member, local bioherms.

Oriskany Sandstone.

Lower Devonian

HELDERBERG GROUP
0-200 ft. (0-60 m.)

Coeymans and Manlius Limestones; Rondout Dolostone.

Upper Silurian

AKRON DOLOSTONE, COBLESKILL LIMESTONE, AND SALINA GROUP
700-1000 ft. (210-300 m.)

Akron Dolostone; Bertie Formation—dolostone, shale.

Camillus and Syracuse Formations—shale, dolostone, gypsum, salt.

Cobleskill Limestone; Bertie and Camillus Formations—dolostone, shale.

Syracuse Formation—dolostone, shale, gypsum, salt.

Vernon Formation—shale, dolostone.

LOCKPORT GROUP
80-175 ft. (25-55 m.)

Oak Orchard and Penfield Dolostones, both replaced eastwardly by Sconondoa Formation—limestone, dolostone.

CLINTON GROUP
150-325 ft. (40-100 m.)

Decew Dolostone; Rochester Shale.

Lower Silurian

Irondequoit Limestone; Williamson Shale; Wolcott Furnace Hematite; Wolcott Limestone; Sodus Shale; Bear Creek Shale; Wallington Limestone; Furnaceville Hematite; Maplewood Shale; Kodak Sandstone.

Herkimer Sandstone; Kirkland Hematite; Willowvale Shale; Westmoreland Hematite; Sauquoit Formation—sandstone, shale; Oneida Conglomerate.

MEDINA GROUP AND QUEENSTON FORMATION
0-900 ft. (0-270 m.)

Medina Group: Grimbsy Formation—sandstone, shale.

Queenston Formation—shale, siltstone.

Upper Ordovician

Undifferentiated Medina Group and Queenston Formation.

LORRAINE GROUP
700-900 ft. (210-270 m.)

Oswego Sandstone.

Pulaski and Whetstone Gulf Formations—siltstone, shale.

TRENTON GROUP
100-300 ft. (30-90 m.)

Middle Ordovician

Utica Shale.

Hamilton group	Moscow shale	43±	Lower two-thirds of section is a fossiliferous, soft gray calcareous shale; upper third highly friable but less calcareous and fossiliferous. Staining by iron oxide very common. Concretions present in greater abundance in lower beds, but irregular calcareous masses occur throughout section. Joints parallel, tightly sealed, trending N.65°E. and N.25°-30°W.
	Ludlowville shale	43±	Lower beds are thinly laminated, light-colored, fossiliferous, shaly passage beds; overlain by hard calcareous black shales 13 to 30 centimeters thick and rich in corals and brachiopods; hard layers responsible for falls and cascades. Middle beds are less fossiliferous, soft gray arenaceous shales, rich in concretions, calcareous lenses, and occasional thin sandstone layers. Upper beds (Tichenor limestone member) are thin, irregularly bedded gray shales becoming light blue gray upon exposure, calcareous, coarsely textured, and fossiliferous. Joints parallel 5 to 50 centimeters apart, well developed but tight.
	Skaneateles shale	56±	Basal beds composed of dark fissile shale. Upper shale more calcareous, grayish to bluish impure limestone layers. Joint pattern N.75°E. and N.30°W.; diagonal joints N.50°E. Joints sealed, parallel and spaced 15 centimeters to 1.2 meters apart.
	Marcellus shale	15	Black, slatelike, bituminous shale with occasional limestone layers in sequence, and containing zones rich in iron sulfides or calcareous concretions, often with septarian structures; very fissile, iron-stained and gray when weathered. Joint pattern N.25°W., N.65°E., 2.5 centimeters to 1.2 meters apart.

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SENECA ARMY DEPOT

BEDROCK STRATIGRAPHIC COLUMN

FIGURE 5 DATE: NOVEMBER, 1998

MAIN
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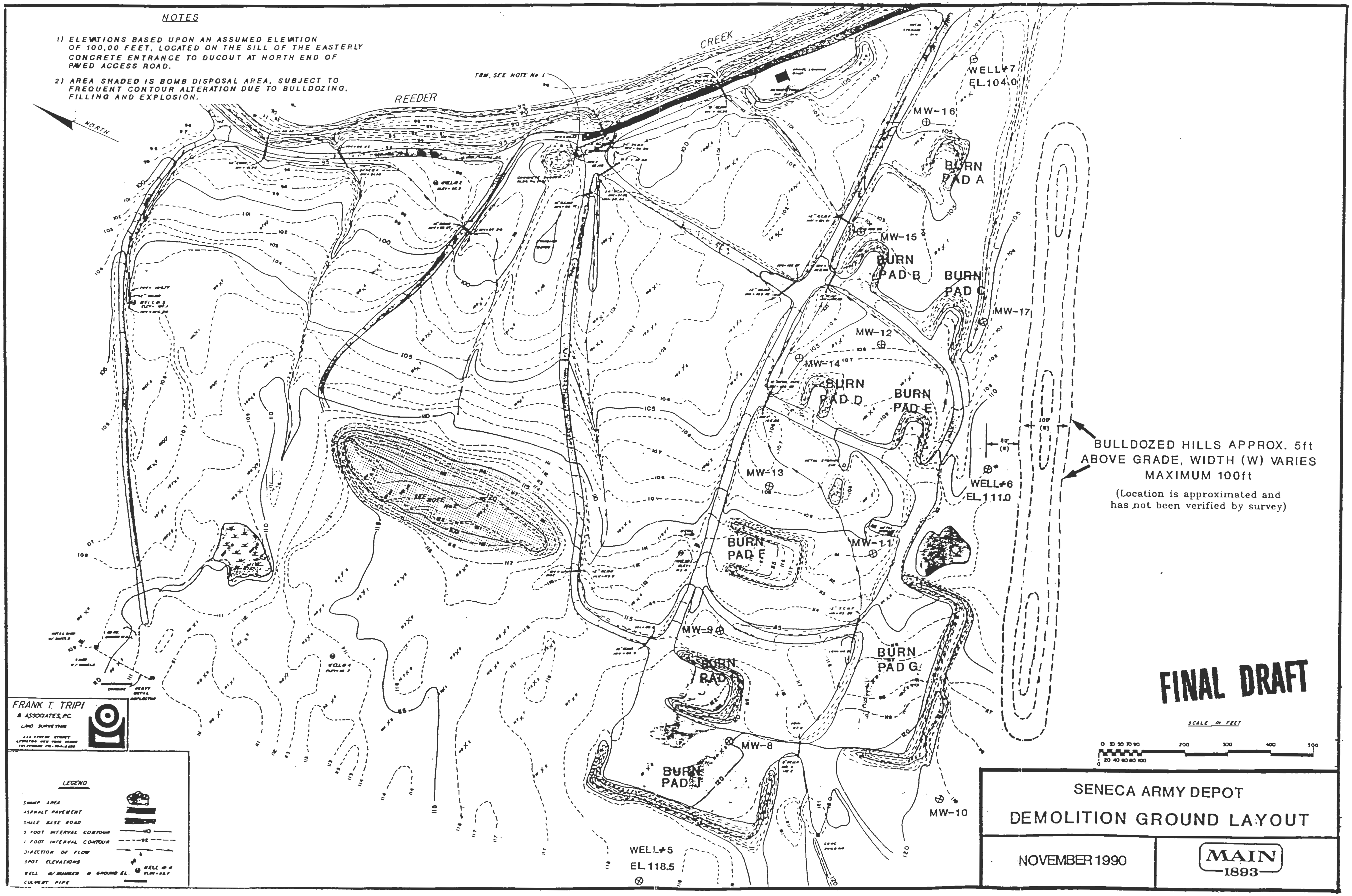

NOTES

1) ELEVATIONS BASED UPON AN ASSUMED ELEVATION OF 100.00 FEET, LOCATED ON THE SILL OF THE EASTERLY CONCRETE ENTRANCE TO DUGOUT AT NORTH END OF PAVED ACCESS ROAD.

2) AREA SHADED IS BOMB DISPOSAL AREA, SUBJECT TO FREQUENT CONTOUR ALTERATION DUE TO BULLDOZING, FILLING AND EXPLOSION.

BULLDOZED HILLS APPROX. 5ft ABOVE GRADE, WIDTH (W) VARIES MAXIMUM 100ft

(Location is approximated and has not been verified by survey)

FRANK T. TRIPI
& ASSOCIATES, P.C.
LAND SURVEYING

LEGEND

SWAMP AREA
ASPHALT PAVEMENT
SHALE BASE ROAD
5 FOOT INTERVAL CONTOUR ——110——
1 FOOT INTERVAL CONTOUR - - - 92 - - -
DIRECTION OF FLOW
SPOT ELEVATIONS
WELL W/ NUMBER & GROUND EL. ● WELL # 4
CULVERT PIPE

FINAL DRAFT

SENECA ARMY DEPOT
DEMOLITION GROUND LAYOUT

NOVEMBER 1990

MAIN
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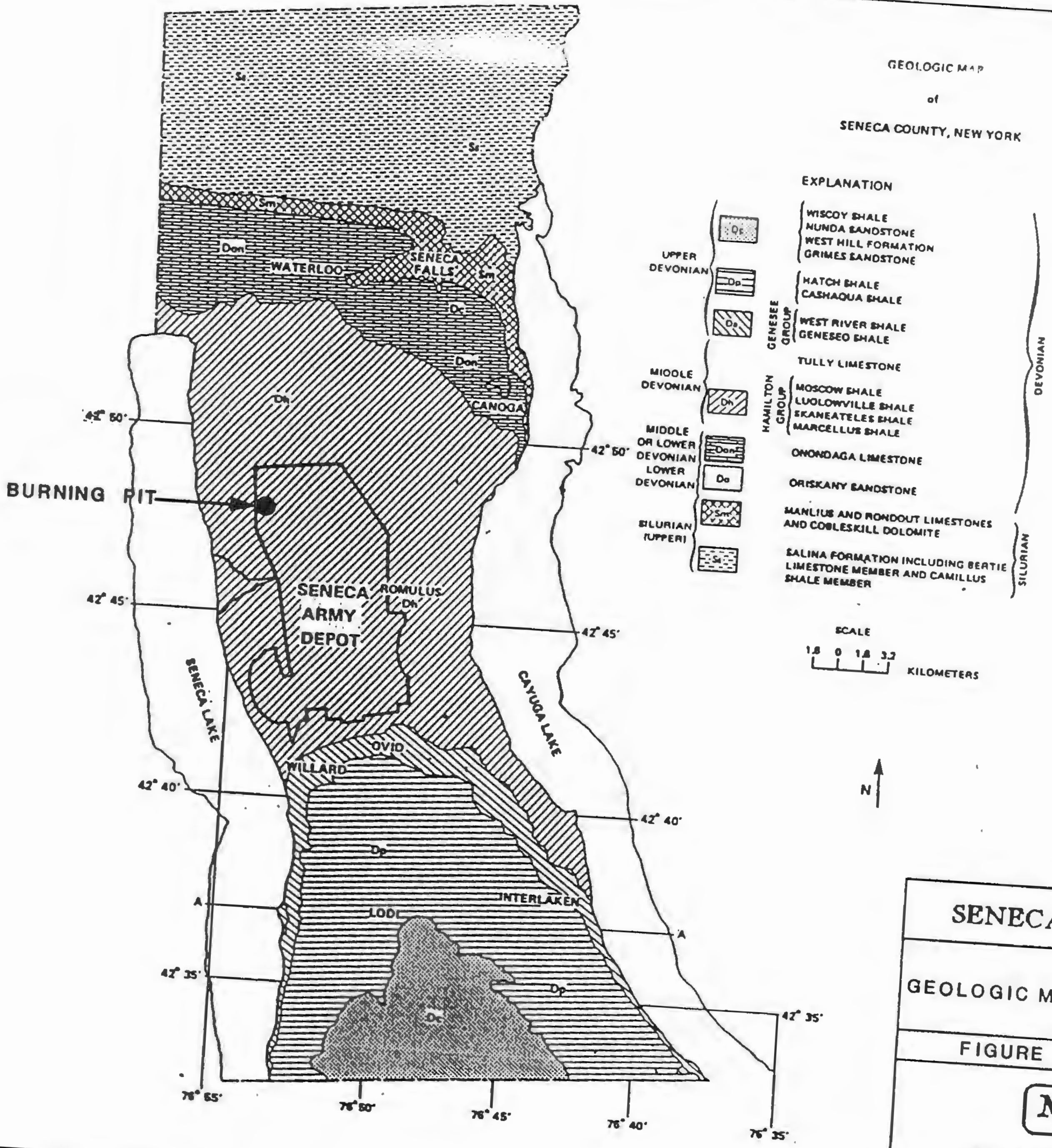
burning pads. Munition destruction activities will continue to be conducted in the 60 acre detonation area ajoining the burn pad site on the north. Burning of PEP's will continue in aboveground steel trays as described in SEAD's RCRA Part B permit application under Subpart X of 40 CFR Part 264. Open burning of PEP's has not occurred since 1987.

2.2 GEOLOGIC SETTING

The Finger Lakes uplands area is underlain by a broad north-to-south trending series of rock terraces mantled by glacial till. As part of the Appalachian Plateau, the region is underlain by a tectonically undisturbed sequence of Paleozoic rocks consisting of shales, sandstones, conglomerates, limestones and dolostones. Figure 4, The Generalized Geologic Map of Seneca County, shows the regional geology of Seneca County. In the vicinity of SEAD, monoclinal black shale of the Devonian age (385 million years bp), Hamilton group, dip shallowly to the south, 35 feet per mile, and show little evidence of tectonic disturbance, by folding or faulting.

Locally, the shale is a soft, grey, fissle, highly jointed upper member of the Hamilton Group. Figure 5, The Bedrock Stratigraphic Column, is a stratigraphic section of Paleozoic rocks of Central New York. The shale contains interbeds of calcareous shale and limestone. The shale is extensively jointed or fractured at the contact with overlying tills. Joint spacings are 1 inch to 4 feet in surface exposures. Prominent joint directions are N 60° E, N 30° W, and N 20° E, with the joints being primarily vertical. Corings performed on the upper 5 to 8 feet of the bedrock revealed low Rock Quality Designations (RQD's), i.e., <5% with almost 100% recovery. This information indicates that at the glacial till/shale interface, the rock is highly fractured but has not weathered to the point of being unrecoverable. Much of the fracturing in the underlying bedrock may be attributed to the glacial event, coupled with regional stresses.

Pleistocene age (Wisconsin event, 20,000 bp) glacial till deposits overlie bedrock shales. Figure 6, The Physiographic Map of Seneca County, presents an overview of the subsurface soils in the area. The site is shown on Figure 6 as lying on the western edge of a large glacial till plain between Seneca Lake and Cayuga Lake. The till matrix, the result of glaciation, varies locally but generally consists of horizons of unsorted silt, clay, sand, and gravel. The Phase IV hazardous waste evaluation report indicated the soils to



SENECA ARMY DEPOT

GEOLOGIC MAP OF SENECA COUNTY

FIGURE 4 AUGUST 1991

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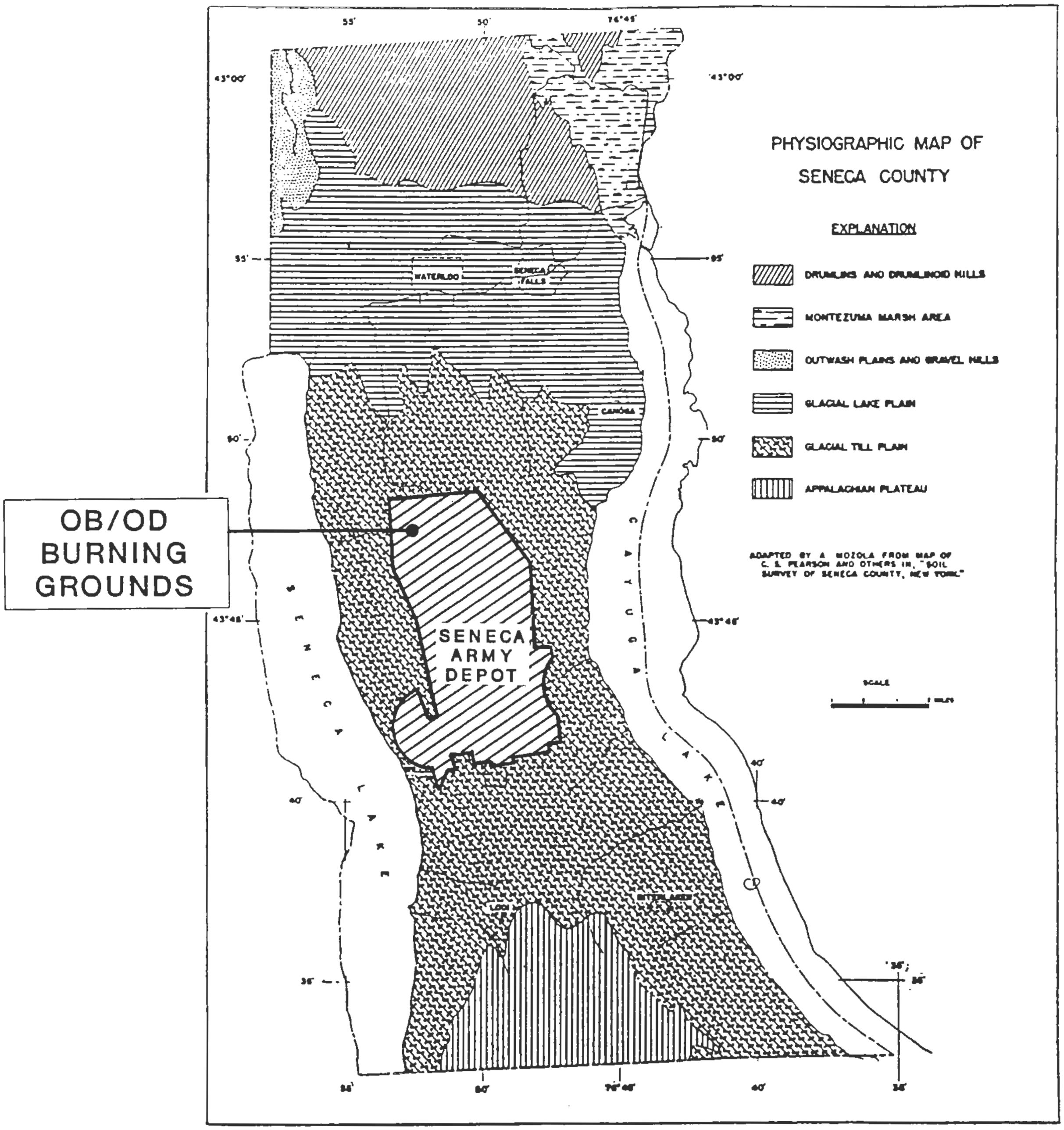

SOURCE: The Groundwater
Resources of Seneca County,
New York; Mozola, A.J.,
Bulletin GW-26, Albany, NY, 1951

SENECA ARMY DEPOT

THE PHYSIOGRAPHIC MAP
OF SENECA COUNTY

FIGURE 6 AUGUST 1991

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be classified as inorganic clays, inorganic silts, and silty sands. Being derived from the underlying shales, the tills would be expected to have a high percentage of clay. Thicknesses of the glacial till deposits on SEAD ranges from 1 to 15 feet. Darien silt-loam soils, 0 to 18 inches thick, have developed over Wisconsonian age glacial tills. These soils are developed on glacial till where they overlie the shale. In general, the topographic relief associated with these soils is 3-8%. Around the burn pads much of the topsoil has been disturbed or removed in association with construction of the berms around the burn pads and the activities related to the detonation ground.

Table 1, Average Background Concentrations For Rocks, Soils, and Sediments, compares average metal content in shale, sandstone, limestone, soil and sediment of the Great Lakes for As, Ba, Cd, Cr, Hg, Pb, and Se. These are many of the same heavy metals of concern associated with open burning activities. The table shows shales to contain from 2 to more than 10 times the quantity of metals, than other sedimentary rocks. This is due to the cation complexing capacity of the clays that make up the shales. It is probable that soils developed over shales, or over tills derived from shales, would contain metal values greater than those listed for average soils.

2.3 HYDROGEOLOGY

2.3.1 Regional

Regionally, four (4) distinct hydrologic units have been identified within Seneca County. These include two (2) distinct shale formations, a series of limestone units and unconsolidated beds of Pleistocene glacial drift. Overall, the groundwater in the county is very hard, and therefore, the quality is minimally acceptable for use as potable water. Approximately 95 percent of the wells are used for domestic or farm supply and the average daily pumpage of water is around 500 gallons (0.35 gpm). About five percent of the wells in the County are used for commercial, industrial, or municipal purposes. Seneca Falls and Waterloo, the two largest communities in the County, are in the hydrogeologic region which is most favorable for the development of a groundwater supply. However, because the hardness of the groundwater is objectionable to the industrial and commercial establishments operating within the villages, both villages utilize surface water as their municipal supplies. The villages of Ovid and Interlaken, both of which are without substantial industrial establishments, utilize groundwater as their public

TABLE 1

AVERAGE BACKGROUND CONCENTRATIONS FOR ROCKS, SOILS, AND SEDIMENTS

	SHALE	SANDSTONE	LIMESTONE	SOILS	SEDIMENT*
As	15	1	2.5	5	12
Ba	700	50	100	500	NA
Cd	0.2	<0.1	0.1	1	2.5
Cr	100	35	10	50	75
Hg	0.5	0.07	0.05	0.03	0.0
Pb	40	7	8	20	55
Se	0.6	NA	0.08	0.2	NA

Source: Levinson, 1980, unless otherwise noted.
All concentrations as total metals in ppm
Values are an average of samples from Earth's crust, which can vary significantly.
*From MOE (1988): upper 95% confidence limit of pre-industrial concentrations in Great Lakes sediments.

water supplies. Ovid obtains its supply from two shallow gravel-packed wells, and Interlaken is served by a developed seepage-spring area. Regionally, the phreatic aquifer of the unconsolidated surficial glacial deposits of the region would be expected to flow in a direction consistant with the ground surface elevations. Geologic cross-sections from Seneca Lake and Cayuga Lake have been constructed by the State of New York, (Mozola, A.J., 1951). This information suggests that a groundwater divide exists approximately half way between the two finger lakes. SEAD is located on the western slope of this divide and therefore MAIN would expect regional surficial groundwater to flow westward, toward Seneca Lake. Southerly flow would likely be blocked by the Valley Heads Moraine.

A substantial amount of information concerning the hydrogeology in the area has been compiled by the State of New York, (Mozola, A.J., 1951). This report has been reviewed in order to better understand the hydrogeology of the area surrounding SEAD. The data indicates that within a four (4) mile radius of the site, a total of thirty-two (32) wells exist for which information has been obtained. This information includes: 1) the depth of individual wells, the diameter of wells; 2) the individual well's yield; and 3) the geological strata the well was drilled into. This data is useful in providing an understanding and characterization of the aquifer(s) present. A review of this information indicates that three (3) geologic strata have been used to produce water for both domestic and agricultural purposes. These include: 1) a bedrock aquifer, which in this area is predominantly shale; 2) an overburden aquifer, which includes Pliestocene deposits (glacial till); and 3) deep beds of limestone. The occurance of limestone is considered to be unusual for this area and is more commonplace to the north of this area. As of 1957, twenty-five (25) wells utilized water from the shale aquifer, six (6) wells tapped the overburden aquifer, and one (1) used the deep limestone as a source of water.

For the six (6) wells which utilized groundwater extracted from the overburden, the average yield was approximately 7.5 gpm. The average depth of these wells was thirty-six (36) feet. The geologic material which comprised the aquifer is generally Pleistocene till, with the exception of one well located to the northeast of the site. This well had penetrated an outwash sand and gravel deposit. The yields from these overburden wells ranged from 4 to 15 gpm. The well located in the outwash sand and gravel deposit, drilled to 60 feet, yielded only 5 gpm. Surprisingly, a 20 foot hand dug well, located southeasterly from the outwash well, yielded 10 gpm. The difference in well yield could be influenced by the difference in the diameter of the two wells.

The information reviewed indicates that the upper portions of the shale formation would be expected to yield small supplies of water, although adequate for domestic use. For mid-Devonian shales such as those of Hamilton group, the obtained yields, (i.e., less than 15 gpm), are consistent with what would be expected for shales (LaSala, 1968). The deeper portions of the shale formation, (i.e., at depths greater than 235 feet) have provided yields up to 150 gpm. These high yields may be due to the interception of limestone cavities. The solutioning of limestone joints can cause the formation of cavities. In general, as the depth of penetration into the shale is increased, i.e., >100 feet, the yields become less, unless a limestone cavity is intercepted. A limestone cavity was noted in one well log at approximately 610 feet. This well, drilled to a final depth of 787 feet, yielded approximately 150 gpm. It appears that the yields in the upper 100 feet almost doubled those measured at depths below 100 feet. This is consistent with what would be expected, i.e., as the depth of penetration is increased, the fracturing in the shale is decreased making less water available.

As mentioned previously, in the deep portions of the shale, limestone cavities are encountered which provide substantial quantities of water. This source of water is considered to comprise a separate source of groundwater for the area. Very few wells in the region adjacent to SEAD utilize the limestone as a source of water, which may be due to the drilling depths required to intercept this water.

2.3.2 Local

All previous studies at the OB/OD site have focused upon groundwater from the unconfined till. This has assumed that any groundwater in the till and the underlying fractured/weathered shales is essentially the same aquifer. The water table for the shallow aquifer is 3-6 feet deep, with the shale-till contact being 3 to 15 feet below the ground surface. Recharge to these shallow aquifers is via percolation associated with local precipitation (29.4 in/yr).

Surface and shallow groundwater flow at the OB/OD site are directed northeast into Reeder Creek which is in a sub-basin within the main Seneca Lake drainage basin.

Figure 7, The Open Burning (OB) Ground Drainage Plan, provides an indication of surface drainage patterns at the site. Reeder Creek is located approximately 1,000 feet northeast of Burning Pad A. The creek flows north through the Demolition Grounds and then turns west and discharges into Seneca Lake, approximately three miles away. On-site hydraulic conductivity determinations were performed by Metcalf and Eddy (1989) on the last ten (10) newly installed monitoring wells. The data was analyzed according to a procedure described by Hvorslev (1951). The average hydraulic conductivity of the ten determinations was 5.0×10^{-1} ft/day (1.8×10^{-4} cm/sec). The hydraulic conductivities ranged from 2.02×10^{-2} ft/day (7.06×10^{-6} cm/sec) to 1.47 ft/day (5.19×10^{-4} cm/sec). These hydraulic conductivity measurements, were within an order of magnitude agreement with previous results by O'Brien and Gere, (1984). O'Brien and Gere determined the average hydraulic conductivity of the till material to be approximately 2.8×10^{-1} ft/day (9.9×10^{-5}cm/sec). A comparison of the measured values with the typical range of hydraulic conductivities, indicates that the glacial till at the site exists along the more permeable end of typical glacial till values. Soils were collected during the 1984 Phase IV investigation of the boreholes and were sampled to characterize the permeability of the pads. Soil permeabilities were measured by recompacting the soil in a mold to 95% standard proctor density. The average permeability for five (5) measurements was 1.01×10^{-3} ft/day (3.56×10^{-7} cm/sec). The typical range of glacial tills described by Freeze and Cherry (1979), is between 3×10^{-1} ft/day (1×10^{-4} cm/sec) and 3×10^{-7} ft/day (1×10^{-10} cm/sec).

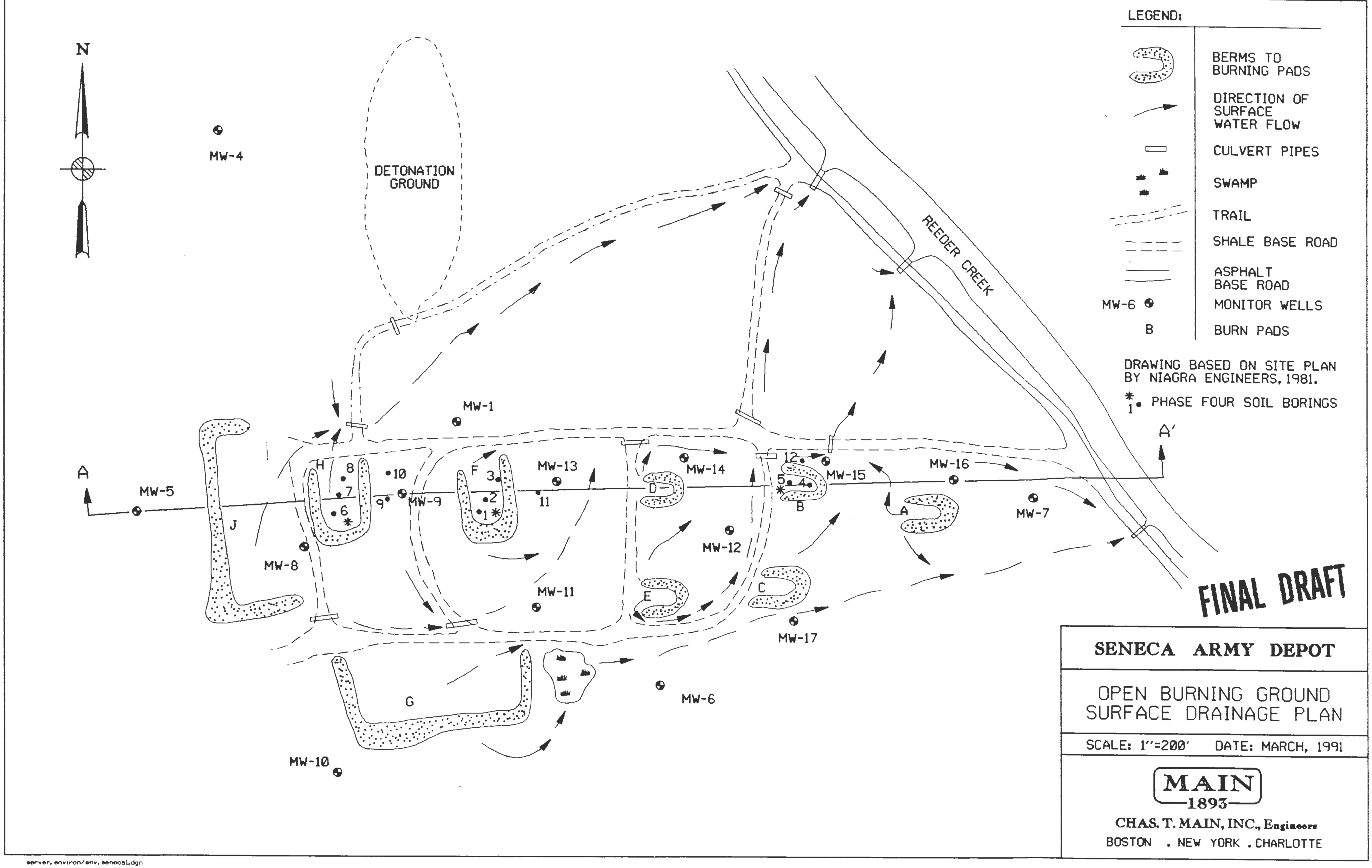
Hydrogeologic well data for all the monitoring wells are summarized in Table 2, Demolition Ground Monitoring Well Summary. Based on this data, the local groundwater flow is to the east, toward Reeder Creek.

2.4 RESULTS OF PREVIOUS INVESTIGATIONS

The following reports have provided data for the development of the Scoping Document. These include:

1. Installation Assessment of Seneca Army Depot, Report No. 157, AMXTH-IR-A-157, January 1980; Conducted by the U.S. Army Toxic and Hazardous Materials Agency, (USATHMA).

FIGURE 7



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SENECA ARMY DEPOT

OPEN BURNING GROUND
SURFACE DRAINAGE PLAN

SCALE: 1"=200' DATE: MARCH, 1991

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TABLE 2

DEMOLITION GROUND MONITORING WELL SUMMARY

Well ID	Total Depth of Boring	Depth to Weathered Rock	Depth Cored	Depth to Top of Screen	Screen Length (ft)	% Rec.	% RQD	Elev. of Casing Top[2]	Depth to Water[3]	Elev. of Water[3]
MW-1	13.0	12.0	NA	7	5	NA	NA	NA	NA	NA
MW-2	7.0	6.5	NA	1	5	NA	NA	NA	NA	NA
MW-3	11.0	9.5	NA	4.5	5	NA	NA	NA	NA	NA
MW-4	10.0	9.5	NA	4.5	5	NA	NA	NA	NA	NA
MW-5	10.0	9.0	NA	4.0	5	NA	NA	NA	NA	NA
MW-6	9.0	9.0	NA	4.0	5	NA	NA	NA	NA	NA
MW-7	6.5	6.0	NA	1.0	5	NA	NA	NA	NA	NA
MW-8	18.5	9	13.5-18.5	4.5	5	100	0	122.08	6.96	115.12
MW-9	15.0	10.0	10-15	3.0	4	100	0	117.89	4.30	113.59
MW-10	18.5	15.0	13.5-18.5	4.0	5	100	0	122.24	6.40	115.84
MW-11	17.5	9.0	12.5-17.5	4.0	5	100	37	113.95	6.30	107.65
MW-12	15.0	7.5	10-15	3.0	4	100	0	107.74	3.98	103.76
MW-13	17.0	6.5	12-17	3.0	5	100	17	114.00	4.90	109.10
MW-14	16.5	9.0	11.5-16.5	3.5	5	100	0	107.43	5.47	101.96
MW-15	13.5	6.5	8.5-13.5	3.0	3.5	100	0	105.01	3.18	101.83
MW-16	13.5	6.5	8.5-13.5	3.0	3.5	100	0	105.73	5.32	100.41
MW-17	19.0	8.0	14-19	4.5	5	100	0	107.89	4.12	103.77

NA - Not available

1 - All depths are relative to the ground surface, all depths in feet

2 - Temporary Bench Mark (TBM) was assumed to be 100.00 and is located at the doorway of the bunker in northwestern corner of the Demolition Grounds.

3 - Measured in January 1988

2. Phase 2, Hazardous Waste Management Special Study: No. 39-26-0147-83, US Army Material Development and Readiness Command (DARCOM) Open-Burning/Open Detonation Grounds Evaluation, 1983.
3. O'Brien and Gere Engineers, Burning Pads B and H Closure, 1985
4. Phase 4 Evaluation of the Opening Burning/Open Detonation Grounds. Investigation of Soil Contamination, 1984; Conducted by the US Army Environmental Hygiene Agency, (USAEHA).
5. Evaluation of Solid Waste Management Units, Seneca Army Depot, Interim Final Report, Groundwater Contamination Survey No. 38-26-0868-88, 1988; Conducted by USAEHA.
6. Metcalf & Eddy, Criteria Development Report for Closure of Nine Burning Pads, 1989.

The complete list of references is given in the Reference section of this document. The US Army Toxic and Hazardous Materials Agency (USATHAMA) conducted an evaluation of the Seneca Army Depot, beginning in May, 1979. This Initial Installation Assessment of the Seneca Army Depot was "to assess the environmental quality of Seneca Army Depot (SEAD) with regard to the use, storage, treatment, and disposal of toxic and hazardous materials". It was to "define any conditions which may adversely affect the health and welfare or result in environmental degradation". Following a review of existing documents and site investigations of potential areas of concern (AOC) this study concluded: 1) geological conditions are such that contaminants, if present, could migrate in surface or subsurface waters; and 2) the demolition/ burning ground is potentially contaminated with heavy metals and explosives. The USATHAMA Report No. AMXTH-IR-A-157 recommends additional investigations to determine if contaminant migration exists.

Subsequent to the depot assessment conducted by USATHAMA, a four (4) phased DARCOM Open Burning/Open Detonation Ground Evaluation was begun in 1981. Seven (7) groundwater monitoring wells (MW-1 thru MW-7) were installed in 1981. Six (6) monitoring wells were installed along the perimeter of the site. One well, MW-1, was located between the detonation ground and the burn pads. The wells were screened in the glacial till at, or just above, the till-shale (bedrock) contact. Groundwater monitoring began in January 1982, metals and explosives were analyzed quarterly for 1982. No EP Toxicity metals or explosives were detected in the 27 samples analyzed in that first year.

However, wells MW-1 and MW-7 exceeded iron standards on three occassions and wells MW-5, 6, and 7 (around the OB grounds) exceeded manganese standards. Presumably, because of early high values, these elements, plus fluorine and nitrogen, were analyzed a total of 65 times through 1987. Table 3, Summary of Monitoring Well Analyses, (1981-1987, USAEHA, 1988), summarizes the results. Included in this extended monitoring were pH, TOC, pesticides, specific conductivity, and TOX. The pH was slightly acidic to moderately basic over the monitoring period. MW-1 registered both the most acidic and most basic values. Monitoring of these original wells continued on an annual basis through 1987 for explosives, metals, TOC, TOX, pH, pesticides, nitrates, and specific conductivity. These results are summarized in USAEHA Groundwater Contamination Survey No. 38-26-0868-88, Interim Final Report on the Evaluation of Solid Waste Management Units (SWMU), Seneca Army Depot.

The Phase II study (No. 39-26-0147-83), was performed in 1982 in order to characterize the environmental hazards associated with the OB/OD area. This study concentrated on attempting to determine total explosive and metal content in soils and residues. This program was to determine if the soils and residues were hazardous wastes, based on EP Toxicity. The study included 24 soil samples from 0-6 inches, from Burn Pads B through H. Pads A and J were not sampled. Pad B was found to contain Ba (to 508 ppm) in excess of the EP Toxicity standard for Ba (100 ppm). Pad H exceeded the standard for lead (24.6 ppm, standard 5 ppm). Pad F had one soil sample containing 9,270 ppm (0.9%) 2,4,6-TNT. This data is summarized in Table 4, Summary of Soils Analyses (USAEHA Phase II and Phase IV).

The Phase 2 report concluded that the areas were not hazardous by characteristic EP Toxicity for heavy metals, although two (2) of three (3) samples from Pad B exceeded the barium standard and two (2) of the three (3) Pad H samples exceeded Pb standards. This study recommended that no additional studies be conducted.

Based on the data from the Phase 2 investigation, O'Brien & Gere Engineers, Inc. were contracted in 1984 to review previous studies and recommend procedures for the environmentally sound closure of Burning Pads B and H, following RCRA guidelines. The Phase 2 report had identified only Pads B and H as having soil concentrations in excess of allowable EP Toxicity Limits. The report was prepared under Contract DAC87-84-C-0077, dated November 1984. The report was based on analytical data from

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TABLE 3

SUMMARY OF MONITORING WELL ANALYSES
WELLS MW-1 TO MW-7
(1981 thru 1987)

Chemical	EPA MCL[a] (ug/l)	NYSGWS[b] (ug/L)	Detection Limit (ug/L)	Range Detected (ug/L)	Total	>Det.[c]	>STD[d]	Wells of Concern[e]
Inorganics								
As	50	25	10	ND	26	0	0	
Ba	1000	1000	100	ND	26	0	0	
Cd	5	10	5	ND	26	0	0	
Cr	100	50	10	ND	26	0	0	
Hg	2	2	0.2	ND	26	0	0	
Pb	50	25	10	ND	26	0	0	
Se	50	10	5	ND	26	0	0	
Ag	50	50	10	ND	26	0	0	
Fe	NA	300	2-100	ND-1,020	65	40	3	1,7
Mn	NA	300	1-30	ND-320	65	02	17	2,5,6,7
F	4,000	1,500	100	100-300	27	27	0	5
NO_3	10,000[f]	10,000[f]	50	ND-10,000	27	23	1	5
Explosives								
HMX	NA	(35)[g]	100	ND	46	0	0	
RDX	NA	(35)[g]	30	ND	46	0	0	
Tetryl	NA	(1)[g]	10	ND	46	0	0	
2,4,6-TNT	NA	(1)[g]	1	ND	46	0	0	
2,6-DNT	NA	(1.1)[h]	1	ND	46	0	0	
2,4-DNT	NA	(1)[g]	1	ND	46	0	0	
pH	NA	(6.5-8.5)[i]		6.7-8.1[i]	300	300	0	
TOC	NA	NA	100	1,000-54,000	340	340	NA	
TOX	NA	NA	10	ND-130	335	133	NA	

Data Summarized from the 1987 USAEHA Groundwater Contamination Survey

a. MCL - Maximum Contaminant Level
b. NYSGWS - New York State Groundwater Standard
c. >Det. - Number of samples exceeding detection limits
d. >STD - Number of samples greater than standards
e. Well(s) with concentration above standard
f. Standard is for NO_3 only
g. Guidelines proposed from the Criteria Development Report for the Closure of Nine Burning Pads; (M&E, Oct. 1989)
h. EPA Water Quality Criteria for 10^{-5} Risk
i. Units are pH
NA Not Available
ND Not Detected

d#1

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TABLE 4

SUMMARY OF SOIL ANALYSES
DATA FROM THE
USAEHA PHASE 2 (1982) REPORT FOR BURN PADS B THRU G

CHEMICAL	EP TOXICITY LIMIT	DETECTION LIMIT[a]	RANGE	TOTAL	>DET[d]	>TOXICITY LIMIT[e]	PADS IN EXCESS OF DETECTION LIMIT	PADS IN EXCESS OF EP TOXICITY
Inorganics[b]								
As	5	0.5	ND	24	0	0	0	0
Ba	100	10	ND - 508	24	2	2	All from B	B
Cd	1	0.1	ND - 0.17	24	3	0	F,E,G[g]	0
Cr	5	0.5	ND	24	0	0	0	0
Hg	0.02	0.02	ND	24	0	0	0	0
Pb	5	0.5	ND - 24.6	24	2	2	All from H	H
Se	1	0.1	ND	24	0	0	0	0
Ag	5	0.5	ND	24	0	0	0	0
Explosives[c]								
HMX	NA	1	ND	24	0	NA	0	NA
RDX	NA	1	ND - 7	24	18	NA	B,C,D,E,F,G,H	NA
Tetryl	NA	1	ND - 2.7	24	1	NA	D	NA
2,4,6-TNT	NA	1	ND - 9270	24	6	NA	F+,D,G	NA
2,6-DNT	NA	1	ND - 23.0	24	4	NA	F,H	NA
2,4-DNT	NA	1	ND - 45.0	24	5	NA	F,H	NA

NOTE: All samples were collected from 0-6"
+Pad F Sample Contained The High Value

DATA FROM THE
USAEHA PHASE 4 (1984) REPORT FOR BURN PADS, B, F, and H

CHEMICAL	EP TOXICITY LIMIT	DETECTION LIMIT[a]	RANGE	TOTAL	>DET[d]	>TOXICITY LIMIT[e]	PADS IN EXCESS OF DETECTION LIMIT	PADS IN EXCESS OF EP TOXICITY
Inorganics[b]								
As	5	0.5	ND	47	0	0	0	0
Ba	100	10	ND - 424	47	3	2	B	B
Cd	1	0.1	ND	47	0	0	0	0
Cr	5	0.5	ND	47	0	0	0	0
Hg	0.2	0.02	ND	47	0	0	0	0
Pb	5	0.5	-	47	12	3	F,B,H	F,B,H
Se	1	0.1	ND	47	0	0	0	0
Ag	5	0.5	ND	47	0	0	0	0
Explosives[c]								
HMX	NA	1	ND - 4.0	47	2	NA	B	NA
RDX	NA	1	ND - 8.2	47	4	NA	F,B	NA
Tetryl	NA	1	ND	47	0	NA	NA	NA
2,4,6-TNT	NA	1	ND - 124.5	47	7	NA	F,B	NA
2,6-DNT	NA	1	ND - 2.2	47	2	NA	H	NA
2,4-DNT	NA	1	ND - 2.2	47	5	NA	F,H	NA

NA - Not applicable
ND - Note detected
a. For EP Toxicity the conc is mg/l, for explosives the conc. is ug/g.
b. As EP Toxicity (mg/l)
c. As total concentrations (ug/g)
d. Number of samples exceeding the detection limit
e. Number of samples exceeding the regulatory EP Toxicity Limit

previous studies and a magnetics survey of the two pads. The magnetics survey indicated high anomolies at the pad berms. Pad B has moderate magnetic anomolies in the northwest berms and in the southern berms. Pad H has a magnetic anomoly extending from the pad to the south.

O'Brien and Gere's recommended closure procedure was excavation, on-site treatment, and removal of contaminated material to a permitted and secure off-site landfill, with subsequent capping of the site. There were no recommendations made regarding the remaining seven (7) pads, as they were not included in this study.

During 1984, in a study nearly coincident with the O'Brien and Gere study, the U.S. Army Environmental Hygiene Agency conducted an additional investigation of the soils at Burn Pads B, F, and H (Phase 4 Evaluation, Hazardous Waste Study No. 37-26-0479-85, USAEHA). Presumably, Pad F was included for further investigation along with Pad B and H due to the high concentration of 2,4,6-TNT, (0.9%), obtained in one sample. The study confirmed the presence of EP Toxic heavy metals and explosives and determined the vertical and horizontal extent of these contaminants. A total of 47 samples were collected, with 46 analyzed, from the pads, berms, and adjoining soils and drainage areas. A total of eight (8) soil borings were completed in the three (3) pads for a total of 41 feet in borings. Three (3) borings were completed in Pad F, two (2) borings in Pad B, and three (3) borings in Pad H. In addition, four (4) borings were completed in areas adjacent to Pads B, H, and F. Two (2) borings were performed adjacent to Pad H, one adjacent to Pad F, and one adjacent to Pad B. Three composite berm samples were collected from each pad. There are three (3) berms per pad yielding a total of (9) composite samples. Additionally, three (3) ditch sediment samples were collected.

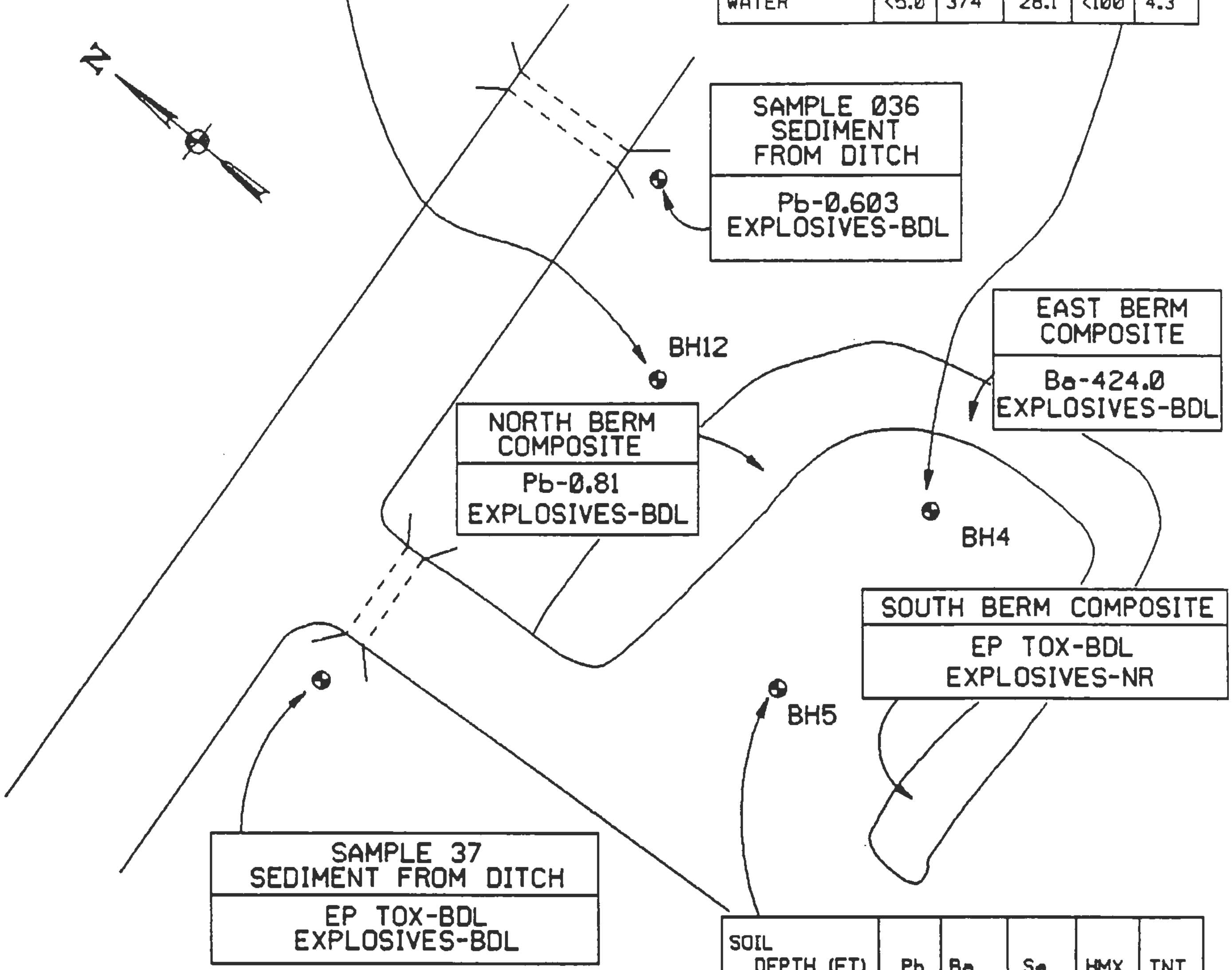
Sample locations and data results from the Phase 4 program for Burning Pads B, F and H are summarized in Figures 8, 9 and 10 respectively. Soils at Pad B were found to contain Pb (101 ppm) and Ba (424 ppm) values in excess of the EP Toxicity limits of 5 ppm and 100 ppm. Pad F has one soil sample (Pb 10.7 ppm) exceeding the standards for lead, (5 ppm). Pad H had one sample (Pb, 5.64 ppm) which exceeded lead standards and detected small amounts of 2,6-DNT and 2,4-DNT.

Borehole water samples contained lead concentrations up to 112 ppb at Pad F which exceed the 25 ppb NY State groundwater standards for lead. The data is summarized in

FINAL DRAFT

SOIL DEPTH (FT)	Pb	HMX	TETRYL	TNT
0.5-1.5	<0.5	<1.0	<5.0	<1.0
1.5-2.5	1.51	<1.0	<5.0	<1.0
WATER	<5.0	166.6	43.0	2.1

SOIL DEPTH (FT)	Pb	Ba	Se	HMX	TNT
0-1	1.43	<10.0	<0.1	4.0	<1.0
1-2	3.81	<10.0	<0.1	<1.0	11.6
4	<0.6	42.6	<0.1	<1.0	<1.0
4.5-6	<0.6	<10.0	<0.1	<1.0	<1.0
WATER	<5.0	374	28.1	<100	4.3



SOIL DEPTH (FT)	Pb	Ba	Se	HMX	TNT
0-0.5	<0.6	<10.0	<0.1	<1.0	<1.0
0.5-1.0	0.83	<10.0	<0.1	3.6	<1.0
3.5-4.5	<0.6	187.0	<0.1	<1.0	<1.0
5-6	101.5	<10.0	<0.1	<1.0	<1.0
WATER	13.3	<300	22.9	<100	3.3

NOTES:

1. ONLY COMPOUNDS DETECTED ARE SHOWN
   SOIL CONCENTRATIONS ARE AS ug/g (ppm)
   WATER CONCENTRATIONS ARE AS ug/L (ppb)
2. HEAVY METALS IN SOIL REPRESENT EP TOXICITY CONCENTRATIONS
3. HEAVY METALS IN WATER ARE DISSOLVED (FILTERED SAMPLES)
4. WATER WAS OBTAINED FROM BOREHOLES USING TEMPORARY WELLS WHICH ARE CURRENTLY NON-EXISTANT
5. BDL - BELOW DETECTABLE LIMITS
6. NR - NOT REPORTED BY LABORATORY

REF: HAZARDOUS WASTE STUDY NO. 37-26-0479-85
PHASE 4 OF AMC OPEN BURNING/
OPEN-DETONATION GROUNDS
EVALUATION INVESTIGATION OF SOIL
CONTAMINATION AT THE OPEN BURNING GROUNDS

SENECA ARMY DEPOT, ROMULUS, NEW YORK
AUGUST 13-19, 1984.

SENECA ARMY DEPOT

SOIL AND GROUND WATER
DATA FROM BURNING PAD B

FIGURE 8 AUGUST 1991

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780 MISCE:ENV. 052:C35.1]SENDATA8.DGN

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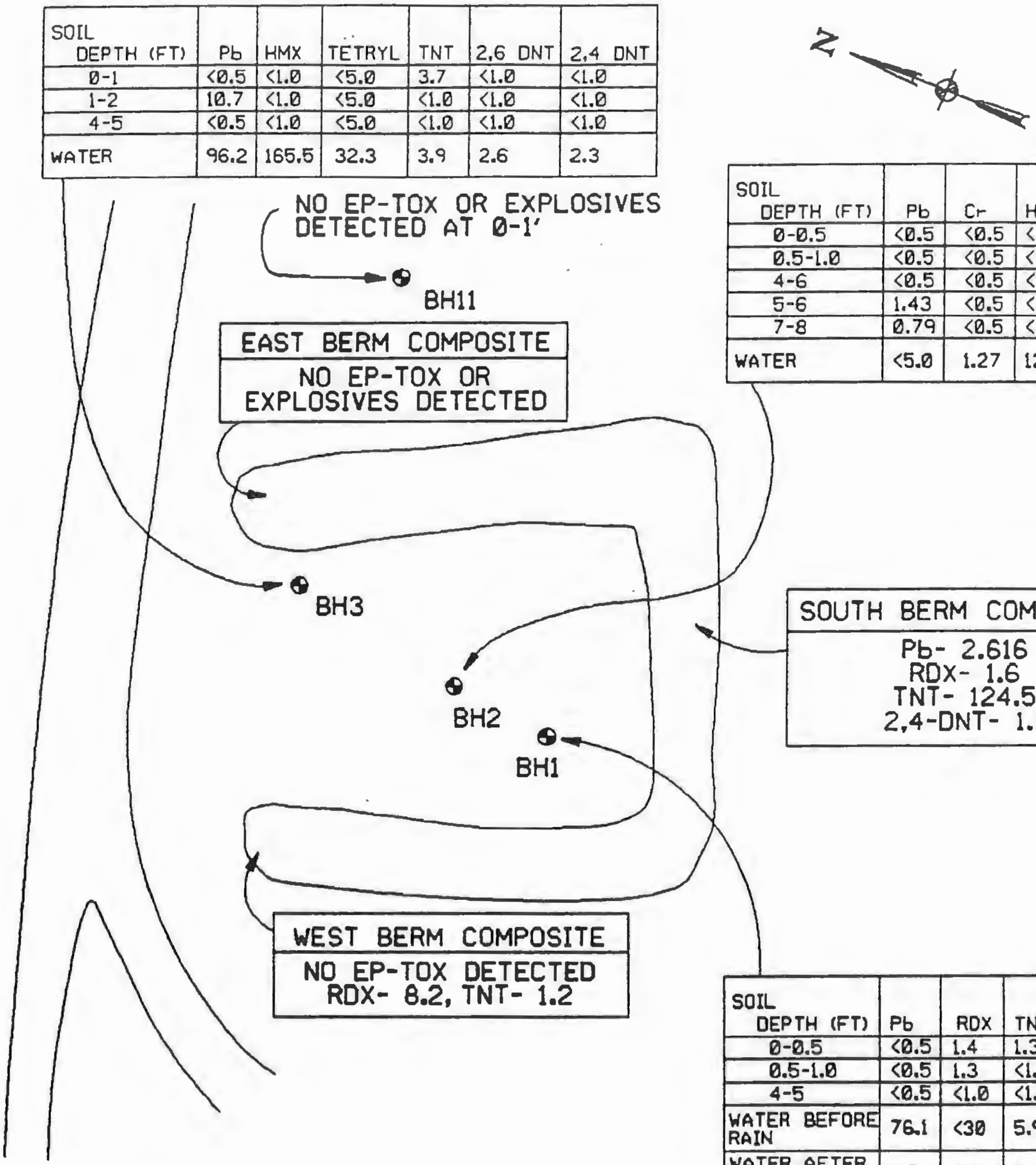
SOIL DEPTH (FT)	Pb	HMX	TETRYL	TNT	2,6 DNT	2,4 DNT
0-1	<0.5	<1.0	<5.0	3.7	<1.0	<1.0
1-2	10.7	<1.0	<5.0	<1.0	<1.0	<1.0
4-5	<0.5	<1.0	<5.0	<1.0	<1.0	<1.0
WATER	96.2	165.5	32.3	3.9	2.6	2.3



NO EP-TOX OR EXPLOSIVES DETECTED AT 0-1'

SOIL DEPTH (FT)	Pb	Cr	HMX	TNT
0-0.5	<0.5	<0.5	<1.0	3.3
0.5-1.0	<0.5	<0.5	<1.0	18.7
4-6	<0.5	<0.5	<1.0	<1.0
5-6	1.43	<0.5	<1.0	<1.0
7-8	0.79	<0.5	<1.0	<1.0
WATER	<5.0	1.27	126.1	<1.0

EAST BERM COMPOSITE

NO EP-TOX OR
EXPLOSIVES DETECTED

SOUTH BERM COMPOSITE

Pb- 2.616
RDX- 1.6
TNT- 124.5
2,4-DNT- 1.1

WEST BERM COMPOSITE

NO EP-TOX DETECTED
RDX- 8.2, TNT- 1.2

SOIL DEPTH (FT)	Pb	RDX	TNT	HMX
0-0.5	<0.5	1.4	1.3	<1.0
0.5-1.0	<0.5	1.3	<1.0	<1.0
4-5	<0.5	<1.0	<1.0	<1.0
WATER BEFORE RAIN	76.1	<30	5.9	124.8
WATER AFTER RAIN	112	<30	2.1	<100

NOTES:

1. ONLY COMPOUNDS DETECTED ARE SHOWN
   SOIL CONCENTRATIONS ARE AS ug/g (ppm)
   WATER CONCENTRATIONS ARE AS ug/L (ppb)
2. HEAVY METALS IN SOIL REPRESENT EP TOXICITY CONCENTRATIONS
3. HEAVY METALS IN WATER ARE DISSOLVED (FILTERED SAMPLES)
4. WATER WAS OBTAINED FROM BOREHOLES USING TEMPORARY WELLS WHICH ARE CURRENTLY NON-EXISTANT
5. BDL - BELOW DETECTABLE LIMITS
6. NR - NOT REPORTED BY LABORATORY

REF: HAZARDOUS WASTE STUDY NO. 37-26-0479-85
PHASE 4 OF AMC OPEN BURNING/
OPEN-DETONATION GROUNDS
EVALUATION INVESTIGATION OF SOIL
CONTAMINATION AT THE OPEN BURNING GROUNDS

SENECA ARMY DEPOT, ROMULUS, NEW YORK
AUGUST 13-19, 1984.

SENECA ARMY DEPOT

SOIL AND GROUND WATER
DATA FROM BURNING PAD F

FIGURE 9 AUGUST 1991

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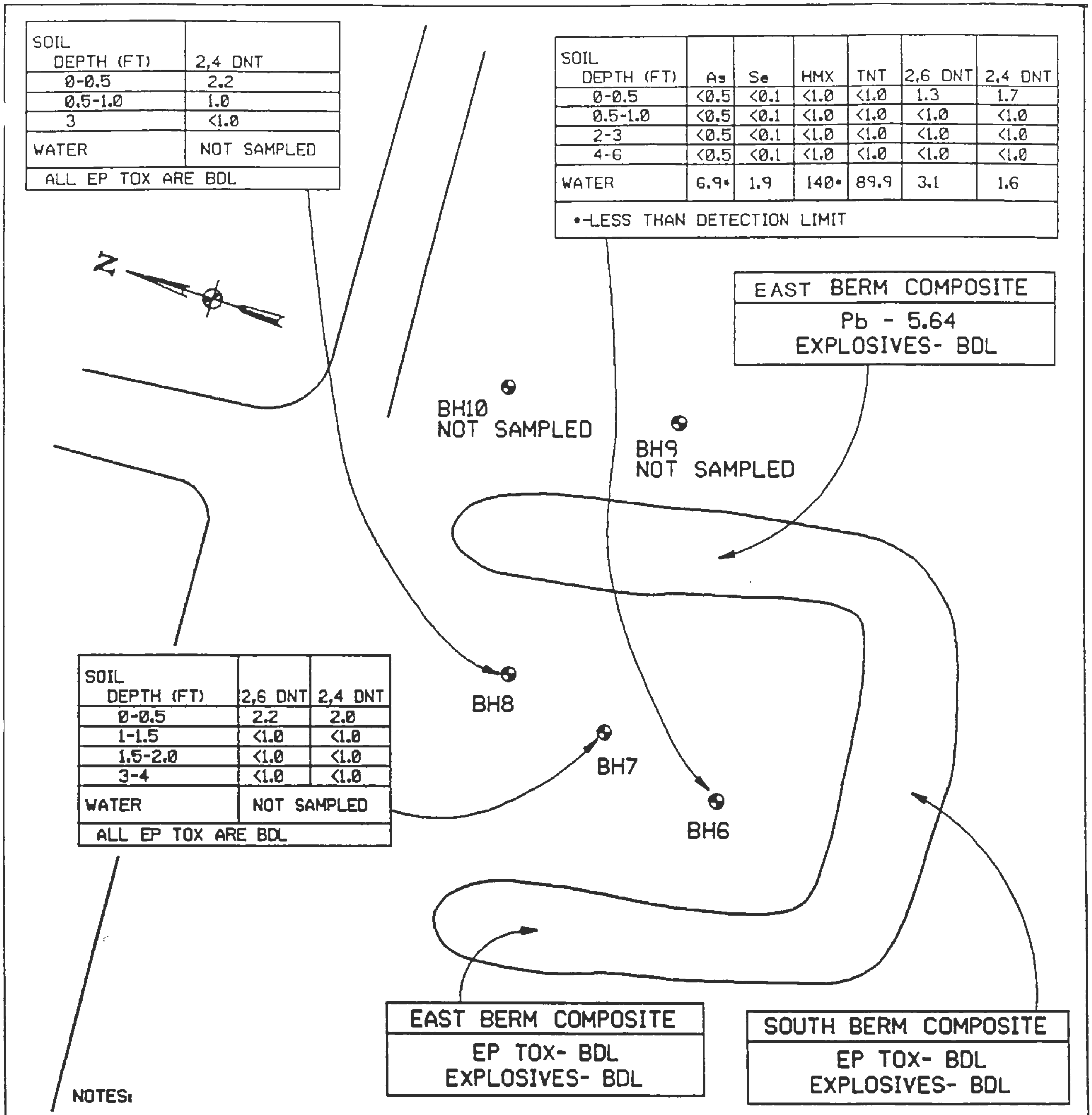

SOIL DEPTH (FT)	2,4 DNT
0-0.5	2.2
0.5-1.0	1.0
3	<1.0
WATER	NOT SAMPLED
ALL EP TOX ARE BDL	

SOIL DEPTH (FT)	As	Se	HMX	TNT	2,6 DNT	2,4 DNT
0-0.5	<0.5	<0.1	<1.0	<1.0	1.3	1.7
0.5-1.0	<0.5	<0.1	<1.0	<1.0	<1.0	<1.0
2-3	<0.5	<0.1	<1.0	<1.0	<1.0	<1.0
4-6	<0.5	<0.1	<1.0	<1.0	<1.0	<1.0
WATER	6.9•	1.9	140•	89.9	3.1	1.6
•-LESS THAN DETECTION LIMIT						

EAST BERM COMPOSITE

Pb - 5.64
EXPLOSIVES- BDL

SOIL DEPTH (FT)	2,6 DNT	2,4 DNT
0-0.5	2.2	2.0
1-1.5	<1.0	<1.0
1.5-2.0	<1.0	<1.0
3-4	<1.0	<1.0
WATER	NOT SAMPLED	
ALL EP TOX ARE BDL		

EAST BERM COMPOSITE

EP TOX- BDL
EXPLOSIVES- BDL

SOUTH BERM COMPOSITE

EP TOX- BDL
EXPLOSIVES- BDL

NOTES:

1. ONLY COMPOUNDS DETECTED ARE SHOWN
   SOIL CONCENTRATIONS ARE AS ug/g (ppm)
   WATER CONCENTRATIONS ARE AS ug/L (ppb)
2. HEAVY METALS IN SOIL REPRESENT EP TOXICITY CONCENTRATIONS
3. HEAVY METALS IN WATER ARE DISSOLVED (FILTERED SAMPLES)
4. WATER WAS OBTAINED FROM BOREHOLES USING TEMPORARY WELLS WHICH ARE CURRENTLY NON-EXISTANT
5. BDL - BELOW DETECTABLE LIMITS
6. NR - NOT REPORTED BY LABORATORY

REF: HAZARDOUS WASTE STUDY NO. 37-26-0479-85
PHASE 4 OF AMC OPEN BURNING/
OPEN-DETONATION GROUNDS
EVALUATION INVESTIGATION OF SOIL
CONTAMINATION AT THE OPEN BURNING GROUNDS

SENECA ARMY DEPOT, ROMULUS, NEW YORK
AUGUST 13-19, 1984.

SENECA ARMY DEPOT

SOIL AND GROUND WATER DATA FROM BURNING PAD H

FIGURE 10 AUGUST 1991

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780 MISCE:ENV.052:C36.1]SENDATAH.DGN

Table 5, Summary of Monitoring Well Analyses (USAEHA, Phase IV and M&E, 1989). Near Pad B approximately two quarts of 50mm tracer bullets were removed during the boring operations. (All the borings were done with remote boring equipment.)

In 1980, the Seneca Army Depot applied for a RCRA Part A permit, which included the OB/OD demolition grounds.

In November of 1986 the Seneca Army Depot applied for a Part B, RCRA permit. The OB/OD demolition grounds was included in the April 1988 revision to this application after standards were promulgated for Subpart X of 40 CFR 264.

In the 1987 identification and review of SWMU's at SEAD (Groundwater Contamination Survey No. 38-26-0868-88, referred to previously) the detonation ground and burning pads were combined into a single SWMU. This report concluded the OB/OD required additional sampling of groundwater and soils. The groundwater results were discussed earlier in this section.

Under RCRA guidelines, in 1989, Metcalf and Eddy Engineers (M&E) was contracted to evaluate previous studies, conduct further investigations as necessary, and develop a closure plan at the open burning site. Their program included: 1) two (2) types of geophysical surveys to site monitoring wells; 2) auger and core drilling of ten (10) additional monitoring wells, with well development, and; 3) sampling and analyses of the ten (10) new wells and six (6) of the seven (7) existing wells. The report reviewed closure procedures for in-place containment made by O'Brien and Gere, and made recommendations for alterations to containment procedures (installation of an additional grout curtain to contain shallow groundwater). The M&E study conducted magnetic and EM geophysical surveys prior to siting monitoring wells. This data indicated that metallics were not generally dispersed from the pads with the exception of an area between Pads D and E. Consequently, monitoring well MW-12 was not positioned in an advantageous location to determine if groundwater dispersal of contaminants had occurred at Pad E.

During the installation of the ten (10) additional monitoring wells, M&E collected soil samples for sieve analysis. The sieve analyses, performed in accordance with ASTM methods, characterized the till as poorly sorted sands with some silt and clay. Upper

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TABLE 5

SUMMARY OF MONITORING WELL ANALYSES
DATA FROM THE
PHASE 4 (1984) REPORT
7 BOREHOLES IN OR NEAR PADS, B, F, AND H

CHEMICAL	EPA MCL[a]	NYSGWS[b]	DET. LIMIT	RANGE DETECTED	NUMBER OF SAMPLES	>DET.[c]	GREATER THAN LOWER STD.[d]	PADS IN EXCESS OF DET. LIMIT	PADS IN EXCESS OF STD.
Inorganics									
As	50	25	10	ND - 6.9	9	0	0	NA	NA
Ba	1000	1000	300	ND - 374	9	1	0	B	NA
Cd	5	10	1	ND	9	0	0	NA	NA
Cr	100	50	1	ND - 1.27	9	1	0	F	NA
Pb	50	25	5	ND - 112	9	4	3	F,B	F
Se	50	10	5	ND - 28.1	9	3	2	B,H	B
Explosives									
HMX	NA(35)[e]	NA	100	ND - 166.6	9	5	NA	B,F,H	NA
RDX	NA(35)[e]	NA	30	ND	9	0	NA	NA	NA
Tetryl	NA(1)[e]	NA	10	ND - 43	9	2	NA	B,F	NA
2,4,6-TNT	NA(1)[e]	NA	1	ND - 89.9	9	7	NA	B,F,H	NA
2,6-DNT	NA	NA	1	ND - 8.5	9	2	NA	F,H	NA
2,4-DNT	NA(1.1)[f]	NA	1	ND - 4.2	9	3	NA	B,F,H	NA

METCALF & EDDY DATA (1989)
WELLS MW-1 TO 6, MW-8 TO 17

CHEMICAL	EPA MCL[a] (UG/L)	NYSGWS[b] (UG/L)	DETECTION LIMIT (UG/L)	DETECTION RANGE WELLS 1-6 (UG/L)	DETECTION RANGE WELLS 8-17 (UG/L)	NUMBER OF TIMES GREATER THAN DETECTED WELLS 1-6	NUMBER OF TIMES GREATER THAN DETECTED WELLS 8-17	TIMES DETECTED GREATER THAN STANDARDS WELLS 1-6	TIMES DETECTED GREATER THAN STANDARDS WELLS 8-17
Inorganics									
As	50	25	10	ND - 19.3	ND	1	0	0	0
Ba	1000	1000	200	ND - 859	ND	5	0	0	0
Cd	5	10	5	ND - 18.8	ND	1	0	1(4)	0
Cr	100	50	10	21.5-152	ND	6	0	4(1,4,5,6)	0
Hg	2	2	0.2	ND - 0.58	ND	2	0	0	0
Pb	50	25	5	38.9-206	ND - 9.9	6	3	6(1,2,3,4,5,6)	0
Se	50	10	5	ND -14.3	ND - 5.6	2	1	1(5)	0
Explosives									
PETN	NA	NA	4.5	ND - 45	ND	2	0	NA	NA
HMX	NA(35)[e]	NA	1.3	ND	ND	0	0	NA	NA
RDX	NA(35)[e]	NA	0.63	ND -1.84	ND - 0.71	2	1	NA	NA
Tetryl	NA(1)[e]	NA	0.66	ND -0.96	ND	1	0	NA	NA
2,4,6-TNT	NA(1)[e]	NA	0.78	ND	ND - 5.6	0	2	NA	NA
2,6-DNT	NA(1.1)	NA	0.55	ND	ND	0	0	NA	NA
2,4-DNT	NA	NA	0.6	ND	ND	0	0	NA	NA

a. MCL-EPA Maximum Contaminant Level
b. NYSGWS-New York State Groundwater Standard
c. >Det. - Number of Samples Exceeding Detection Limits
d. Number of Samples Exceeding Standards or Guidelines; Pads from where samples were obtained
e. Proposed Guidelines From Criteria Development Report for the Closure of the Nine Burning Pads, (M&E, Oct. 1988)
f. EPA Water Quality Criteria for $1x10^{-5}$ risk of the Nine Burning Pads, (M&E, Oct. 1988)
g. Well Identification Number with Levels Above Standards are in parantheses
All Concentrations as ug/l (ppb).
NA - Not Applicable

FINAL DRAFT

3.0 SCOPING OF THE RI/FS

The previous sections have presented the current database for the site. This section will integrate and interpret the previously presented information yielding a conceptual understanding or model which will define the current conditions at the site. Consistent with this understanding will be the selection of likely potential receptors of pollutants from this site and potential technologies which may be appropriate, should a remedial action be necessary. Finally, Data Quality Objectives (DQOs) will be established which will define the quality and quantity of the data necessary to make decisions regarding this site.

3.1 CONCEPTUAL SITE MODEL

The conceptual site model for the SEAD Open Burning Ground combines both site conditions and expected pollutant behavior into a cohesive understanding of the site. This will serve as the basis for the deciding upon what activities will be performed during the RI. The model was developed by evaluating the following aspects:

1. Physical site characteristics: This considers the physical aspects of environmental conditions and the effect these conditions may have on potential pollutant migration.

2. Environmental fate of constituents: This considers the expected behavior of residual materials in the environment based upon the pollutants' known chemical properties.

The known disposal of military ordnance by burning has been conducted at the OB site since the early 1960's. Typically, disposed of munitions contained metals (as organometallic compounds and metallic components of munitions, e.g., iron, copper, aluminum, arsenic, barium, lead, tin, zinc, etc.), inorganic elements and compounds (e.g., phosphorus, nitrobarite) and organic compounds (usually nitrated hydrocarbons, e.g., TNT). These constituents represent potential pollutants of concern on the site and adjoining properties.

3.1.1 Physical Site Characterization

The nine (9) open-air munitions burning pads and adjoining area occupy a thirty (30) acre area of concern (AOC) within the entire demolition area of 90 acres. An active bomb disposal site is within this demolition area, but is not a part of this study. The OB area is located in the northwest portion of the Seneca Army Depot. Surface drainage at SEAD appears to flow westward into Seneca Lake via several small creeks, including Reeder Creek. Locally, surface drainage from the site is to the northeast into Reeder Creek. Figure 7, The Open Burning Surface Drainage Plan, presented in Section 2.3.2, provides conceptual understanding of the likely surface drainage routes into Reeder Creek. Reeder Creek eventually drains into Seneca Lake. Overall site relief is low, approximately 20 feet in 2,500 feet (<1%). Annual rainfall is approximately 30 inches.

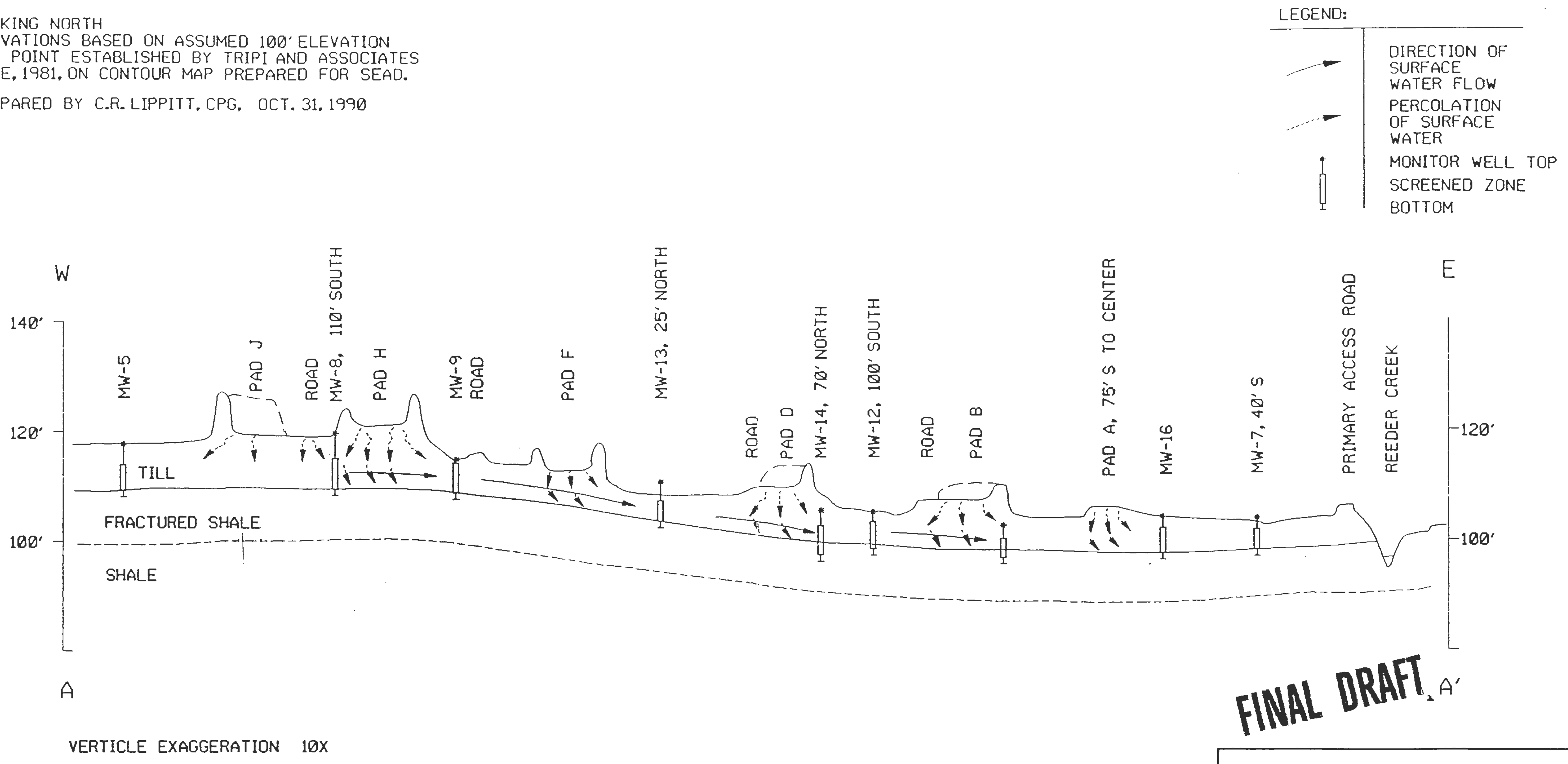
Silty clay loam soils, developed over glacial tills, have such poor percolation characteristics that the original burn pads had to be built up because it was difficult to maintain the burn due to the wet soils. As a result, the burn pads are constructed of crushed shale, from SEAD quarries, and form the topographic highs on the site. Berms around the pads are composed of soil and till pushed up around the pads. The glacial till has a variable composition ranging from clay to sandy gravel.

Black fissile shale (±500 feet thick), with interbedded limestone, is the bedrock. The shale has been relatively unaffected by tectonic events to the south and east. Bedding dips to the south at approximately 35 feet per mile. The upper 3 feet to more than 5 feet of shale is highly fractured, probably as a result of glaciation and normal erosion. RQD's for core samples from the upper 5-8 feet of shale were generally less than 5%., the highest being 37%. The tectonically undisturbed nature of the shales in this area reduces the potential of vertical migration of shallow groundwater into deeper (>100 feet) aquifers, as there is no evidence of major structures.

As many as three aquifers exist in the OB/OD area, a shallow unconfined aquifer in the glacial till, the fractured shale immediately below the till, and a deep aquifer in the underlying competent shales and limestone. The hydraulic gradients of the shallow, unconfined aquifers tends to mirror surface topography, with measured hydraulic conductivities at the higher velocity end of the typical range for glacial tills. Figure 11, The Burning Pad Scoping Site Cross-Section A-A, illustrates probable percolation and groundwater flow directions. The location of the cross-section A-A is shown on Figure 7, Open Burning Ground Surface Drainage Plan. Figure 7 is presented earlier in the document in Section 2.3.2. Hydraulic characteristics of the deep, confined, bedrock aquifers are not fully understood, however, recharge is assumed to be from the north along bedding plane partings.

LOOKING NORTH
ELEVATIONS BASED ON ASSUMED 100′ ELEVATION
FOR POINT ESTABLISHED BY TRIPI AND ASSOCIATES
JUNE, 1981, ON CONTOUR MAP PREPARED FOR SEAD.

PREPARED BY C.R. LIPPITT, CPG, OCT. 31, 1990



VERTICLE EXAGGERATION 10X

FINAL DRAFT

SENECA ARMY DEPOT

BURNING PAD SCOPING
SITE CROSS-SECTION A-A′

HORIZONTAL SCALE: 1″=200′ DATE: NOVEMBER, 1990

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BOSTON . NEW YORK . CHARLOTTE . PORTLAND

780: MISCE_ENV: 0S2435_L1SENECA2.DGN

During and subsequent to burning, potential contaminants may have been dispersed into the environment, away from individual burning pads. Explosions associated with burning may have ejected materials from pad sites. Ash generated during burning, and ash and dust subsequent to burning, can result in the wind-blown dispersal of the more volatile or light-weight particles.

Erosion, dissolution, degradation, and biodegradation allow a variety of materials to disperse into the soils beneath, and downslope from, the pads and berms. Surficial erosion may have transported dissolved and suspended materials along drainage paths, potentially into surface waters (Reeder Creek) and off the site. Relatively level topography and indirect drainage paths with intermittent poor draining areas decreases surface dispersal by erosion or surface water. Clay content of soil and underlying till will reduce percolation of surface water into the bedrock aquifers but will encourage run-off, particularly during large storm events such as thunderstorms.

The groundwater at the Seneca OB/OD grounds has been classified by NYSDEC as GA. The best usage of class GA waters is as a source of potable water. Class GA waters are fresh groundwaters found in the saturated zone of unconsolidated deposits and consolidated rock or bedrock.

From the mouth of Reeder Creek to a point 2 miles upstream, the surface water at the site has been classified as C(T). From this point to the source of the creek, Reeder Creek is classified as D. The best use of Class C waters is for fishing and fish propagation. These waters shall be suitable for fish propagation and survival, including trout. The (T) designation of the surface water classification refers to this stream as being a trout stream. The water quality shall also be suitable for primary and secondary contact recreation although other factors may limit the use for these purposes. Class C(T) refers to the suitability of these waters for trout, which is reflected in the water quality standards for dissolved oxygen, (the minimal daily average may not be less than 6.0 mg/l; the minimum single value is 5 mg/l). Class C(T) waters must also meet criteria for coliform, pH, and TDS. Class D waters are suitable for fishing. The water quality shall be suitable for primary and secondary contact recreation, even though other factors may limit the use for that purpose. Due to such natural conditions as intermittency of flow and the water conditions not being conducive to the propagation of game fish, due to stream bed conditions, Class D waters will not support fish propagation. However, Class D waters must meet criteria set for coliform, pH, and dissolved oxygen.

Activities associated with pad maintenance and construction, and possible unknown activities (i.e, trenches) can increase the possibility of contaminants being dispersed. Visual inspection, during a preliminary site visit, found metallic materials on most of the pads, with some unexploded ordnance. The contaminant levels in the berms may constitute the most significant area for pollutant accumulation, as field evidence and previous reports suggest the pads were cleared by dozing the residual material into the berms. The berms will be more permeable due to being disturbed by heavy equipment and digging activities by rodents.

Although the possibility exists for dispersal during burn activities, precautions were taken. Planning for burns included consideration of environmental factors. These requirements would tend to reduce the possibility of contaminants leaving the disposal site. The requirements included burning only during very low wind conditions and during times of no precipitation. These restrictions reduced the risk of materials escaping the area of concern during burn operations, via wind or surface erosion. Additionally, enclosed cages were used to minimize the risk of projectiles being ejected from burn sites. Propellant burns were policed to recover unburned material which was collected and disposed of in subsequent burns.

3.1.2 Environmental Fate of Constituents at SEAD

This section discusses the expected behavior of the residuals which remain following the burning of propellants, explosives and pyrotechnics (PEP's). The assessment is based upon the information acquired from the several studies performed by SEAD and described earlier. In addition to this, information obtained by MAIN which identifies the chemical/physical properties of the organic explosives will also be incorporated into this fate assessment.

The focus of previous investigations at this site has been upon two classes of chemicals. These are:

- Explosives - HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7 tetrazocine), RDX (Hexahydro-1,3,5-trinitro-1,3,5-triazine), Tetryl (N-methyl-2,4,6-trinitrophenylnitramine), TNT (1,3,5-Trinitrotoluene), 2,4-DNT (2,4-Dinitrotoluene) 2,6-DNT (2,6-Dinitrotoluene)

- Heavy Metals - (As, Ba, Cd, Cr, Hg, Pb, Se and Ag)

MAIN's approach will be to evaluate the environmental fate and behavior based on understanding of the critical chemical/physical properties which can control the environmental behavior of these compounds. Supplemental to this, an evaluation will be conducted of the previous investigations regarding the environmental fate of the compounds of concern.

3.1.2.1 Explosives

Table 6, Chemical/Physical Properties of Explosives, presents information which will serve as a basis for understanding the likely environmental fate of explosives at the burning grounds. The chemical class of the compounds identified in Table 6 is considered to be semi-volatile. This is based upon the high molecular weights of these compounds and their low vapor pressures, typical of most semi-volatile compounds. The most volatile of the five (5) explosives considered at this site is 2,6-Dinitrotoluene (2,6 DNT), with a vapor pressure of 0.018 torr (24 ppm). Compared to Benzene, a volatile compound, which has a vapor pressure of 95.2 torr (125,000 ppm) it is apparent that volatilization of this compound is expected to be low, especially in soils which have a high clay content. Soils with a high clay content generally have a high, >50%, ratio of water filled to air filled porosity, therefore, there is a small amount of air space through which vapor can migrate. Compounds such as RDX and HMX have extremely low vapor pressures and would not volatilize through the soils. Consequently, volatilization of RDX and HMX are not expected to represent a significant environmental pathway. However, volatilization half-lives calculated by Spanggord et. al. (1979) indicates that, although small, volatilization of the di and trinitrotoluenes may be an environmental fate mechanism.

The potential for explosives to leach to the groundwater is a complicated consideration and influenced by many factors such as solubility, cation exchange capacity (CEC), clay content and percolation rate. For this evaluation, solubility will be considered as the most representative parameter for leaching potential. Of the six (6) explosives considered, the most soluble of the explosives are the di and trinitrotoluenes. Their solubilities range from approximately 130 mg/l to 270 mg/l. These are similar to the solubilities of other organic hydrocarbons such as toluene, (500 mg/l), or the xylenes, (150 mg/l). This range of solubilities, 100 mg/l to 500 mg/l, is considered to represent a moderate degree of leaching potential. Compounds which would represent a high degree of leachibility, i.e., high

TABLE 6

CHEMICAL/PHYSICAL PROPERTIES OF EXPLOSIVES

Chemical	Molecular Wt.	Density g/cm^3 (20°C)	Solubility (mg/l)	Henry's Constant (torr/M)	Volatilization Half-Life (days)	Melting Point (°C)	K_{oc} Sorption Partition Coefficient	Vapor Pressure Torr (ppm)
2,4,6-Trinitrotoluene (TNT)	227	1.654 117 200	130	0.18	990	80 300	190	1x10^{-4}, (0.13)
2,6-Dinitrotoluene (DNT)	182	1.283	182	18 140	9	64-66 249	100	0.018, (24)
2,4-Dinitrotoluene (DNT)	182	1.52	270	3.4 410	47	71 201	87	0.005 (6.7)
Tetryl N-Methyl 2,4,6-Trinitrophenyl-nitramine	287	1.73	NA	NA	NA	129	NA	NA
RDX	222	1.82 crystal	50 44	2.0x10^{-5}	9.0x10^{-6}	204	420 538	4.1x10^{-9}, (5.4x10^{-6})
HMX	296	1.90 crystal	66 50	Negligible	NA	273	508	3.9x10^{-9}, (5.1x10^{-6})

Source: Evaluation of Critical Parameters Affecting Contaminant Migration Through Soils; Report No. AMXTH-TE-CR-85030, Final Report; Prepared by: Environmental Science and Engineering, Inc., Prepared for: U.S. Army Toxic and Hazardous Materials Agency (USATHAMA); July 1985.

NA - Not Available

solubility, would be methylene chloride, (30,000 mg/l), Benzene (1780 mg/l) and TCE, (1100 mg/l). The solubilities of HMX and RDX are approximately four (4) times less than that for the di and trinitrotoluenes and therefore represent a smaller potential for leaching.

A review of the melting points (MP) of these compounds indicates that these compounds are solids at room temperature and therefore would not migrate through soil as separate phases. Instead as precipitation interacts with these solid residues a small portion would dissolve or erode away. Complete leaching would require a long interaction period.

Field studies have confirmed the long-term potential for leaching of explosives into the groundwater. A 1985 USATHAMA evaluation of the critical parameters affecting the migration of explosives through soils indicated that at a former propellant manufacturing facility, 2,4-DNT leached from soil contaminated with smokeless powder for over 35 years after cessation of operations. At another facility, leaching of 2,4-DNT into groundwater from former burning grounds has been documented to occur for as long as 10 years after operations had been discontinued.

The sorption of organic chemicals is a function of the chemical and the media it is in contact with. The organic carbon sorption coefficient, K_{oc}, defines the ability of a chemical to sorb. The higher the K_{oc}, the better the potential for the chemical to be sorbed. Consequently, those chemicals with high K_{oc}'s will tend to remain bound to the soil, especially if the soil contains a substantial quantity of such materials as organic matter and/or clay. The compounds considered in this evaluation show sorption coefficients, K_{oc}, which range from approximately 100 to 500. The OB site soils have been shown to possess a high percentage of fines including clay, thereby increasing the sorption potential of these compounds to the soil. Table 7, Relative Relationships Between K_{oc} and Mobility, provides a basis for evaluating the relationship between mobility in the soil and K_{oc}. For the range of K_{oc} exhibited by explosives, i.e., 100-500, these compounds would be considered to be intermediately mobile.

3.1.2.2 Environmental Degradation of Explosives

Environmental degradation of these parent organic compounds have been shown to occur by various investigators. The information available on this subject is substantial and beyond to detailed discussion the scope of this work plan. However, MAIN has performed a review

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TABLE 7

RELATIVE RELATIONSHIPS BETWEEN K_{OC} AND MOBILITY

K_{oc}	Mobility Class
>2000	I - Immobile
500-2000	II - Low Mobility
150-500	III - Intermediate Mobility
50-150	IV - Mobile
<50	V - Very Mobile

Source: The Soil Chemistry of Hazardous Materials; James Dragun, Ph.D; The Hazardous Materials Control Research Institute; 1988.

of the available information. This database shows that nitroaromatic and nitramines are susceptible to environmental transformations. Since some of the byproducts of these transformations may be environmentally persistent, there is a potential for concern.

Much of the available research has been conducted on the environmental transformation of TNT. Figure 12, Transformation Pathways and Products for TNT, provides a summary of the identified byproducts resulting from environmental degradation. Figure 13, Transformation Pathways and Products for 2,4-DNT, presents byproducts which have been identified from the breakdown of 2,4-DNT. The environmental fate of RDX is less defined than that of the other two compounds previously mentioned. Figure 14, Transformation Pathways and Products for RDX, provides an overview of the expected degradation pathways and the byproducts produced as a result of this degradation. Clearly, the number of byproducts which have been identified is diverse. Analytical methods have only recently been developed which are capable of accurately detecting these compounds. The widespread application of these analytical techniques are greatly limited by the availability of standards which are essential for the analyses. Responding to the need for accurate analytical procedures and recognizing that standards for every breakdown product is unavailable, USATHAMA has developed Method 8330. This method is intended for the analysis of explosive residues in water, soils and sediments.

Table 8, Analytes for Method 8330, presents a breakdown of each explosive analyte, the compound's abbreviation and evaluates each compound as either a primary explosive analyte or a breakdown product. Method 8330 is the proposed method for the analysis of explosive residues at SEAD. This method is the latest most up-to-date version of Methods SMO-1 and SMO-2 and is the method required by the USACE.

3.1.2.3 Heavy Metals

The behavior of heavy metals in soil is unlike organic compounds in many aspects. For example, volatilization of metals from soil is not considered a realistic mechanism for pollutant migration and will not be considered. However, leaching and sorption will be considered.

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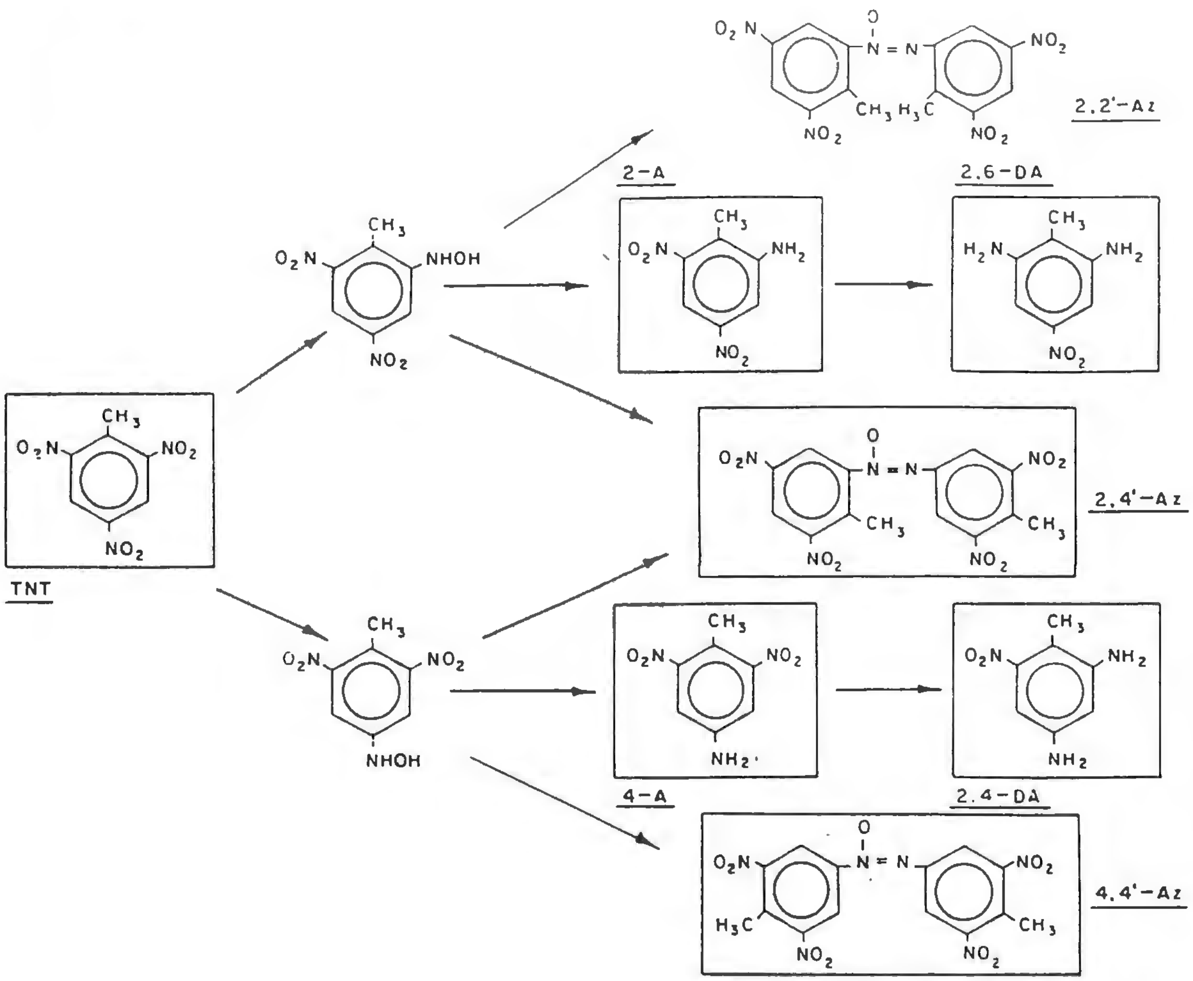

NOMENCLATURE:

2-A	- 2-amino-4,6-dinitrotoluene
4-A	- 4-amino-2,6-dinitrotoluene
2,2'-AZ	- 4,4'-dinitro-2,2'-azoxytoluene
2,4'-AZ	- 2'4-dinitro2,4'-azoxytoluene
4,4'-AZ	- 2,2'-dinitro-4,4'-azoxytoluene
2,6-DA	- 2,6-diamino-4-nitrotoluene
2,4-DA	- 2,4-diamino-6-nitrotoluene

SOURCE:

Special Report 90-2; Environmental Transformation Products of Nitroaromatics and Nitramines; Literature Review and Recommendations for Analytical Method Development;

U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory, Feb. 1990

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TRANSFORMATION
PATHWAYS AND PRODUCTS
FOR TNT

FIGURE 12 AUGUST 1991

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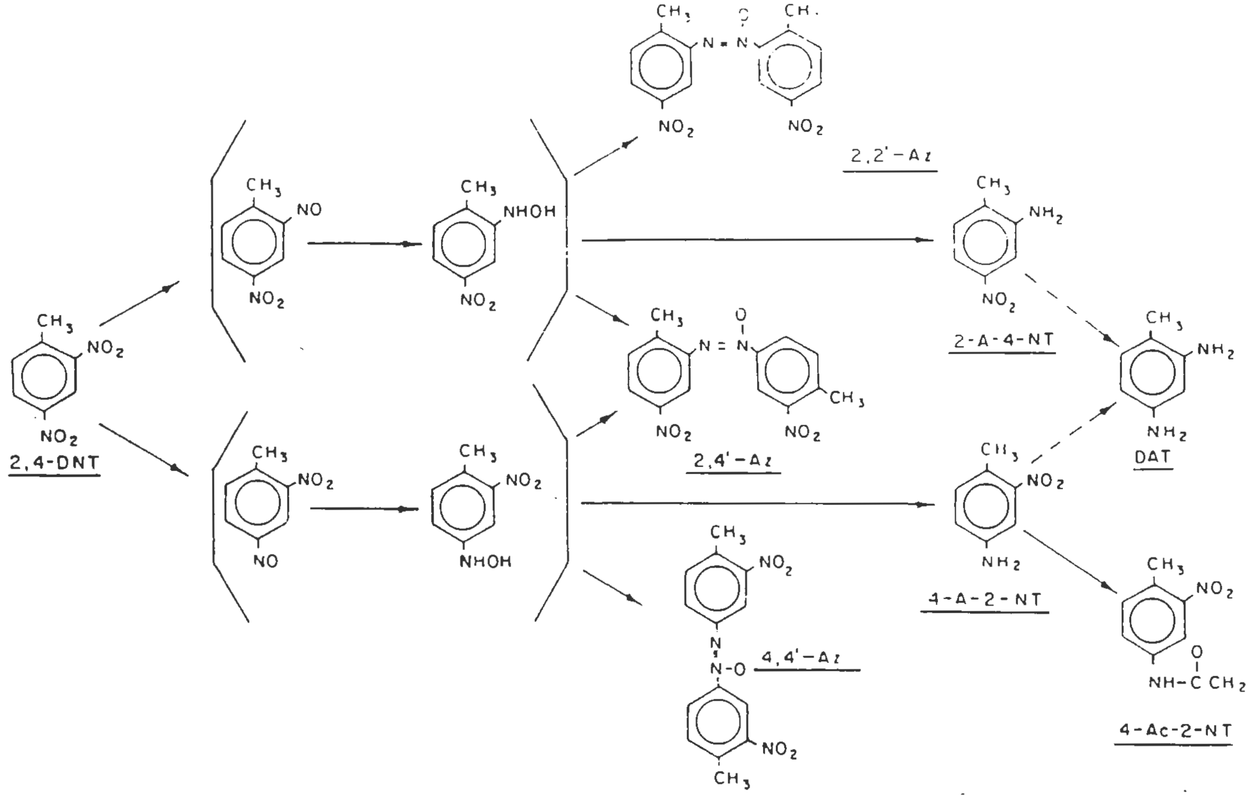

NOMENCLATURE:

2,2'-AZ - 4,4'-dinitro-2,2'-azoxytoluene
2,4'-AZ - 2',4-dinitro-2,4'-azoxytoluene
4,4'-AZ - 2,2'-dinitro-4,4'-azoxytoluene
DAT - Diaminotoluene
2-A-4-NT - 2-amino-4-nitrotoluene
4-A-2-NT - 4-amino-2-nitrotoluene
4-AC-2-NT - 4-acetamide-2-nitrotoluene

SOURCE:

Special Report 90-2; Environmental Transformation Products of Nitroaromatics and Nitramines; Literature Review and Recommendations for Analytical Method Development;

U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory, Feb. 1990

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TRANSFORMATION
PATHWAYS AND PRODUCTS
FOR 2,4-DNT

FIGURE 13 AUGUST 1991

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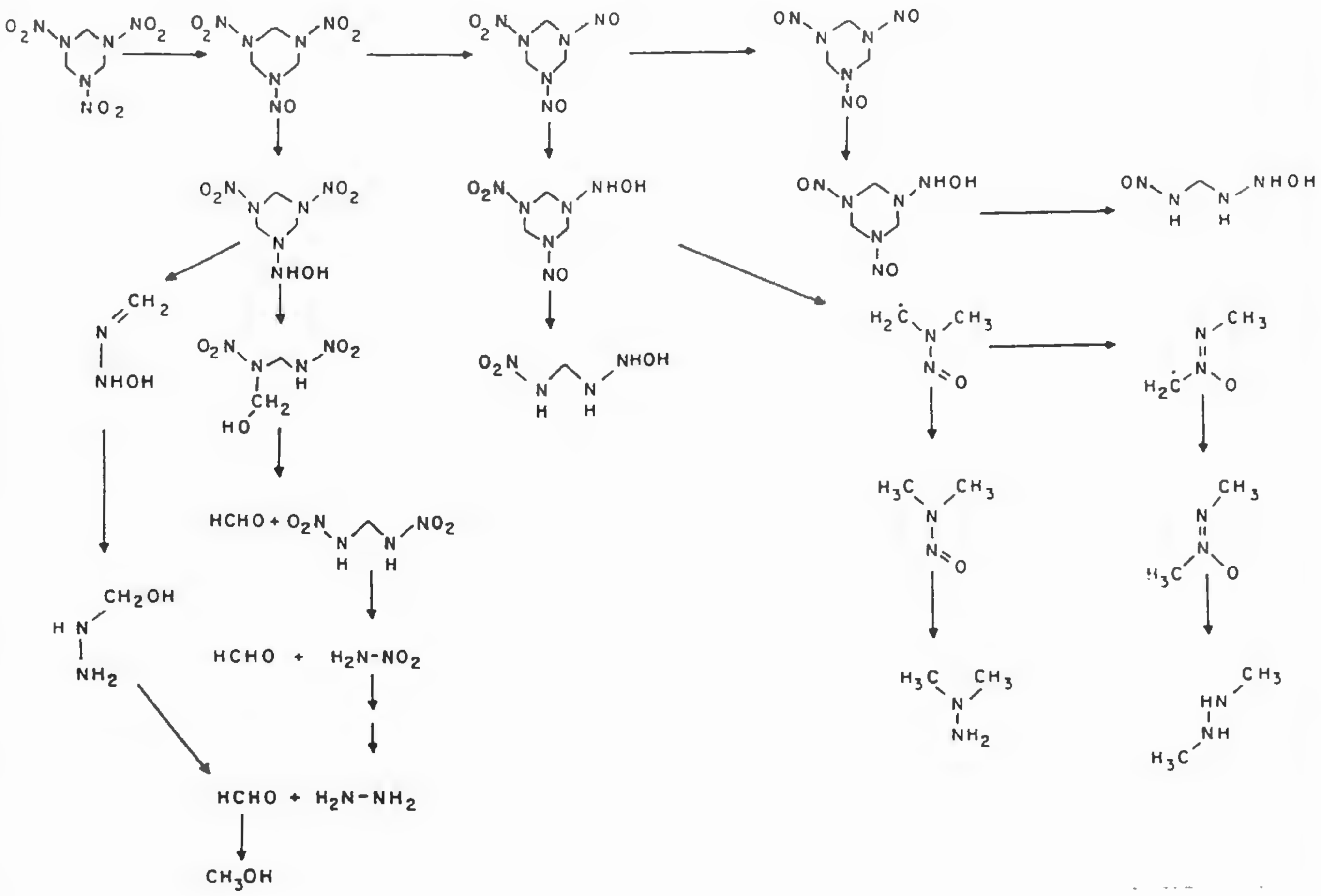

SOURCE:

Special Report 90-2; Environmental Transformation Products of Nitroaromatics and Nitramines; Literature Review and Recommendations for Analytical Method Development;

U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory, Feb. 1990

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TRANSFORMATION
PATHWAYS AND PRODUCTS
FOR RDX

FIGURE 14 AUGUST 1991

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TABLE 8

ANALYTES FOR METHOD 8330

ANALYTE	ABBREVIATION	PRIMARY OR BY-PRODUCT
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine	HMX	Primary
Hexahydro-1,3,5-trinitro-1,3,5-triazine	RDX	Primary
1,3,5-Trinitrobenzene	1,3,5-TNB	Primary
1,3-Dinitrobenzene	1,3-DNB	Primary
Methyl-2,4,6-trinitrophenylnitramine	Tetryl	Primary
Nitrobenzene	NB	Primary
2,4,6-Trinitrotoulene	2,4,6-TNT	Primary
4-Amino-2,6-dinitrotoluene	4-Am-DNT	By-Product
2-Amino-4,6-dinitrotoluene	2-Am-DNT	By-Product
2,6-Dinitrotoluene	2,6-DNT	Primary
2,4-Dinitrotoluene	2,4-DNT	Primary
2-Nitrotoluene	2-NT	Primary
4-Nitrotoluene	4-NT	Primary
3-Nitrotoluene	3-NT	Primary

Leaching of heavy metals from soil is controlled by numerous factors. Most importantly is its chemical form (base metal or cation) in the soil. The leaching of metals from soils is substantial if the metal exists as a soluble salt. The use of metallic salts has been identified as a component of such items as tracer ammunition, ignitor compositions, incendiary ammunition, flares, colored smoke and primer explosive compositions. In particular, Barium Nitrate, Lead Styphnate, Lead Azide, and Mercury Fulminate are likely heavy metal salts or complexes which were burned on the pads. During the burning of these materials, a portion of these salts were likely oxidized to their metallic oxide forms. In general, metal oxides are considered less likely to leach metallic ions than metallic salts. Upon contact with surface water or precipitation, the heavy metals, either as metal oxides or unburned metal salts, can be solubilized, eventually leaching to the groundwater.

Heavy metals may also exist in the base metallic form as a component of the projectile itself. Bullets are composed mainly of lead, which may contain trace amounts of cadmium and selenium. Metals which exist in metallic form, i.e., as bullets or projectiles, will tend to dissolve more slowly versus the metallic salts.

3.1.3 Data Summary and Conclusions

Characterization studies included soil sampling, geophysical surveys, drilling for overburden characterization, core drilling, monitoring well construction and groundwater sampling. These efforts have identified the presence of both heavy metals and explosives in the berms, the surficial soil of the pads, the subsurface soils below the Pads, and the groundwater below pads B, F, and H. Concentrations of heavy metals in excess of drinking water standards were detected in wells MW-1, MW-3, MW-4, MW-5, and MW-6 by M&E during 1988. These studies have not established background concentrations of these metals for the site. This section will summarize the data collected to date and draw conclusions as to the likely environmental impacts these constituents have had to the site.

3.1.3.1 Groundwater Data Summary and Conclusions

The results of monitoring well (MW-1 to MW-17) sampling and borehole water sampling are presented previously in Tables 3 and 5 of Section 2.4, Results of Previous Investigations. The monitoring wells MW-1 to MW-7 contained no EP Toxicity metals in excess of EPAs MCLs or New York Drinking Water Standards when originally sampled. Wells MW-1 to

MW-7 were originally sampled in 1982. During M&E's evaluation, drinking water standards were exceeded in MW-1 (Cr, Pb), MW-2 (Pb), MW-3 (Pb), MW-4 (Cd, Cr, Pb), MW-9 (Cr, Pb, Se), and MW-6 (Cr, Pb). Well MW-1 lies between the detonation ground and the burn pads and could reflect the result of activities conducted at either area. Verbal communication with USAEHA suggests that the collected groundwater samples were invalid due to high turbidity.

The data suggests that leaching of metals from Pad F, Pad H, and possibly Pad B has occurred due to the presence of heavy metals in the filtered groundwater samples collected from several boreholes at the pads. These samples are considered to reflect the highest concentration of constituents at the pads since the boreholes were installed directly in the pads and not adjacent to the pads as are the monitoring wells. The groundwater sample taken from Borehole 1 in Pad F, which was filtered, showed the presence of Pb at 76 and 112 ug/l. The sample from Borehole 3, also in Pad F, showed the presence of Pb at 96.2 ug/l. Additionally, Pb was detected in the borehole water sample from Pad B at 13 ug/l. Only the borehole samples collected from Pad F (76.1, 112 and 96.2 ug/l) exceeded the drinking water standard for Pb which is 50 ug/l. Selenium (Se) was detected in the borehole water samples of Pads B and H at 28 ug/l and 8 ug/l, respectfully. Only the sample from Pad B exceeded the drinking water standard of 10 ug/l (EPA MCL) and 20 ug/l (NYSDWS). Barium (Ba) was detected in the borehole water of Pad B at 374 ug/l. Both the EPA and New York State drinking water standard for Ba is 1000 ug/l.

A small amount of leaching of explosives into groundwater has been documented at each pad tested, specifically Pads F, B and H. Of the explosives present, only 2,4-DNT has an established federal guideline for water. This is the Federal water quality criteria for protection of human health. Although measurable, the observed groundwater concentrations barely exceeded the water quality criteria for 2,4-DNT of 1.1 ug/l for a 10^{-5} risk. For example, Pad B which overall had the highest concentration of explosives, indicated the presence of 2,4-DNT at 4.2 ug/l.

Although no water criteria has been established for the other explosives found on site, concentrations of other explosives in the groundwater directly below and adjacent to the pads have been documented. HMX has been detected as high as 167 ug/l near Pad B. 2,4,6 TNT was detected at 90 ug/l in the groundwater below Pad H. No concentrations of RDX have been detected above 30 ug/l in any samples collected from any of the pads.

As a group, the organic explosives at this site are considered to be moderately mobile. Of the explosives found at the site, 2,4-dinitrotoluene and 2-6,dinitrotoluene are considered to be the most mobile in the soil. The mobility of these compounds is influenced by soil and environmental factors. The high percentage of material passing the 200 mesh sieve which ranges between 47% to 93%, provides a large amount of sorptive potential, thereby retarding the movement of pollutants through the soil column. This will tend to decrease the vertical movement of these pollutants since the soil permeability is low, and the actual volumetric rate is slow.

These prior groundwater studies did not analyze soils for the degradation products of explosives and, therefore any questions regarding the presence of these compounds can not be answered. However, future groundwater analyses, will include analyses for these degradation products, in addition to the Target Compound List (TCL) for semi-volatile organics.

3.1.3.2 Soil Data Summary and Conclusions

The presence of heavy metals contained in the soils is of concern. The disposal of heavy metals at the pads (Pb, Se, Cd, Cr and Ba) was either as nitrate salts or as organometallic complexes. During the combustion of these materials, a portion of these salts and complexes were likely transformed to their oxide forms. As metallic oxides, their potential to leach is less than if they remained as the previously mentioned salts and complexes. However, under acidic conditions, such as acid rain percolation, a portion of these metals will dissolve and leach to the groundwater.

Geophysical studies used to site wells MW-8 to 17, found evidence of metallics in the upper 5.5 feet of soil downgradient from Pads D and E. The magnetic survey around Pads B and H found magnetic highs in the berms and in areas adjacent to the berms.

Soil borings at Pad B found tracer bullets at the contact between the upper 5 feet of crushed shale and the underlying soils. This data suggest that other pads may have residual materials buried beneath the current pad surface. Since there is no data for Pads A, C, D, E, G, or J for soils buried beneath the pads, it is uncertain as to the status of these pads. There is visible metallic material in most berms (aluminum, shell casings, bullets, and steel). EP Toxicity tests detected Barium (Pad B), Cadmium (Pads E, F, G) and Lead (Pads B, F, B, and H exceeded the EP Toxicity limit of 5 ppm for Lead. The high sample in Pad B was at the interval where the bullets were intersected. Heavy metals analyses of soils are summarized in Table 4 of Section 2.4.

Substantial sampling and analyses efforts have been undertaken by the U.S. Army over the last several years. The result of these efforts indicates that although environmentally present, both the concentration and number of samples which detected explosives and heavy metals have failed to indicate that a substantial environmental problem exists at the site.

The evaluation of the information collected to date has indicated that leaching of heavy metals and explosives are occurring. However, off-site groundwater migration of these materials does not appear likely, due to the slow groundwater velocity, the groundwater flow direction and the sorptive capacity of the subsurface soils.

Surficial soil contamination has been documented in all the pads tested. Pads B, F, and H appear to have more surficial impacts than the other pads tested. Since percolation of rainfall is minimal, surface water transport of soil appears to be a significant pathway by which contaminants found in the surficial soils and berms surrounding the pads can migrate. These materials will likely be deposited in the drainage channels and streams which drain the area. Further, windblown migration of the surficial soils may also occur since these materials are at the surface of the pads.

3.2 IDENTIFICATION OF POTENTIAL RECEPTORS AND EXPOSURE SCENARIOS

This section will identify the source areas, release mechanisms, potential exposure pathways and the likely human and environmental receptors at the OB/OD grounds, based upon the results of the conceptual site model, which was described in the previous section.

The complete potential exposure pathways from sources to receptors are shown schematically in Figure 15, The Exposure Pathway Model.

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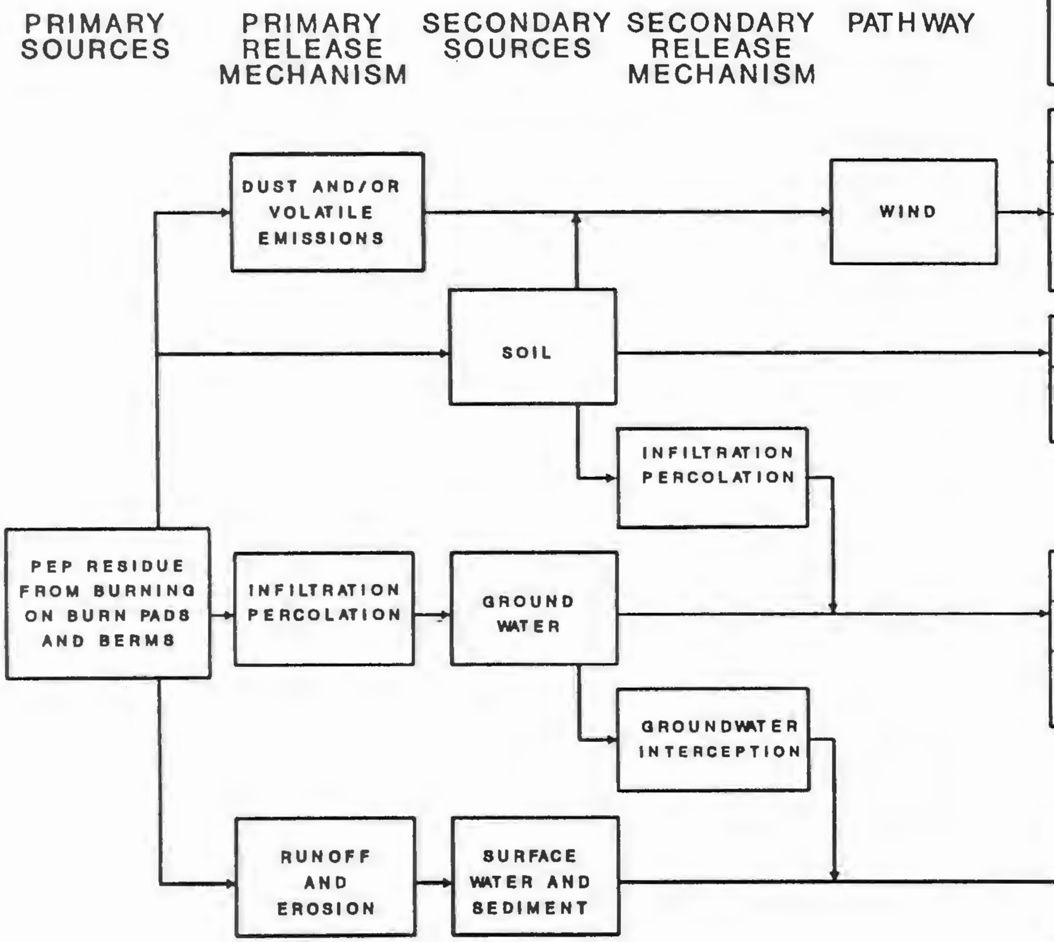

EXPOSURE ROUTE	RECEPTOR			
	HUMAN		BIOTA	
	AREA RES.	SITE VISITORS	TERR.	AQUATIC
INGESTION	●			
INHALATION	●	●	●	
DERMAL CONTACT	●			
INGESTION		●	●	
DERMAL CONTACT		●	●	
INGESTION	●			
INHALATION	●			
DERMAL CONTACT	●	●		
INGESTION	●	●	●	●
DERMAL CONTACT	●	●	●	●

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EXPOSURE PATHWAY MODEL

FIGURE 15 AUGUST 1991

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3.2.1 Potential Source Areas and Releases Mechanism

The source areas in the OB/OD grounds are the burn pads and the berms which surround them. These areas contain various heavy metals, explosive compounds, and shell casings. All of the pads tested have shown elevated levels of heavy metals and explosive compounds in the surface soils.

The primary release mechanism from the source areas is due to surface water run-off and surface soil erosion. Leaching of metals and explosive compounds has been demonstrated at some of the burn pads, however, the relatively low permeability of the soils would suggest that leaching is probably responsible for less movement of contaminants, both with respect to mass and distance, than surface run-off and erosion.

Since the constituents of concern areas are contained primarily in surface soils, the movement of contaminants with fugitive dust may constitute a release mechanism. Volatilization of the tri- and di-nitrotoluene compounds from primary and secondary sources may also constitute a significant release mechanism.

These sources have the potential to contaminate the groundwater beneath the site, the sediments and surface water of the drainage areas on the OB/OD grounds, the sediments and surface water of Reeder Creek and the surface soils in and around the OB/OD grounds.

3.2.2 Potential Exposure Pathways and Receptors - Current Uses

There are five primary receptor populations for potential releases of contaminants from the OB/OD grounds:

1. Area residents living near the SEAD facility.
2. Area residents who may use Reeder Creek for recreational purposes.
3. SEAD personnel who work on or near the OB/OD grounds.
4. Aquatic biota in Reeder Creek.
5. Terrestrial biota on or near the OB/OD grounds.

The exposure pathways and media of exposure are described below as they may effect the various receptors.

3.2.2.1 Ingestion and Dermal Exposure Due to Surface Water Run-Off and Erosion

Surface water run-off migrates to the small low lying areas that have formed in depressions within the site and the two drainage ditches to Reeder Creek. Reeder Creek discharges into Seneca Lake about 3 miles downstream of the site. Surface soils eroded from the site deposit within the on-site drainage ditches and Reeder Creek.

The primary environmental receptors of any impacted surface water and sediment are the biota of the on-site low lying areas and Reeder Creek. Organisms which feed on the biota may be affected due to bioaccumulation of pollutants from the sediments. Terrestrial biota that drink from impacted surface waters may be affected.

Although Seneca Lake is a potential receptor, it will only be considered if exposures are demonstrated in Reeder Creek and contaminant migration to the lake, through surface water, sediment or biota, is expected.

The primary human receptors of the surface water and sediment impacts are people who may eat fish or other organisms from off-site portions of Reeder Creek. Dermal exposure may result from wading or other recreational use of off-site areas of the creek.

3.2.2.2 Inhalation of Fugitive Dust Emissions

Contaminated fugitive dusts may be released from the OB/OD grounds due to high winds, vehicle traffic through the area, or disturbance of the soils during site use. The primary human receptors of fugitive dust emissions are SEAD personnel who may be working at the OB/OD grounds or other nearby areas. The strict controls on access to the SEAD facility make exposure of other people to fugitive dust emissions a remote possibility. Fugitive dusts would not be expected to be transported in significant quantities beyond site boundaries, which are a minimum of one mile away from the site.

Some transport of dusts may reach the farm fields which border the site resulting in a potential exposure of farm personnel and potential uptake of contaminants into vegetable crops, however, this exposure is not anticipated to be significant.

Volatilization of the tri- and dinitrotoluene compounds may result in low-level exposure of SEAD personnel working on or near the site. As with fugitive dusts, volatilized contaminants would not be expected to migrate to off-site in significant concentrations.

The fugitive dusts are likely to deposit to the surface in nearby areas outside the OB/OD grounds. This may result in exposure of the terrestrial biota. The dust may also be washed to the local surface waters, resulting in the exposures identified for surface waters and sediments.

Figure 15 is set up to show that area residents may experience ingestion, dermal and inhalation exposure via movement of fugitive dust off site. Dermal contact with dust to site visitors is not included in this block since dermal exposure to soils is a greater degree of exposure and would be covered by the dermal exposure to soils scenario.

MAIN expects to estimate the potential exposures from these routes and assess the significance of these exposures in the risk assessment. The statement in the preliminary risk assessment section is a preliminary judgement of the potential effects and will be corroborated, however the estimates and comparisons to "significant levels" is part of the risk assessment, not the Work Plan.

During field activities at the site, real-time monitoring for volatile organic compounds (VOC's) and particulates will be conducted at the downwind OB grounds site boundary. If the level of VOCs at the downwind OB grounds site boundary exceeds 5 ppm above background levels measured upwind from the work area, then all activities must be stopped and corrective measures implemented to control the source of the release. If the level of airborne particulates at the downwind site boundary exceeds the action level of 150 ug/m^3, all work activities must be stopped and corrective measures implemented to control the source of the release. This information will be utilized to formulate likely exposure scenarios.

3.2.2.3 Incidental Soil Ingestion and Dermal Contact

Incidental ingestion is a potential exposure pathway for SEAD personnel who may be working in the OB/OD grounds or other nearby areas. Contaminants may be absorbed dermally or ingested.

3.2.2.4 Ingestion of Groundwater

The groundwater beneath the OB/OD grounds is not used as a drinking water source and connection to other potable groundwater aquifers has not been demonstrated. It is not anticipated that there will be direct exposure to the groundwater from the site under current uses.

Groundwater beneath the site flows generally toward Reeder Creek and may be recharging the creek. The potential groundwater contribution to the surface water could result in the exposures identified for surface water and sediments above.

3.2.3 Potential Exposure Pathways and Receptors - Future Uses

Under current site conditions, access to the site is strictly limited. Potential future uses, whether under the ownership of SEAD or by others, cannot assure the current level of security surrounding the site. Strict land use control cannot be ensured in future uses, although limitations may be imposed through zoning or deed restrictions. SEAD does not anticipate that unrestricted residential or other private development would be allowed in future uses of the OB/OD ground. However, as a worst case exposure scenario, the future use of the site will be considered to be residential.

One mechanism for restricting future land use is zoning. The question of future land use due to existing zoning regulations was considered. MAIN contacted the Romulus Town Clerk, Jonie Hamilton, regarding zoning maps for the site and surrounding area. According to Ms. Hamilton, no zoning maps exist for the site or surrounding areas in the Town of Romulus. Consequently, the use of this area for residential purposes is not restricted by local zoning laws and could be permitted.

As a follow-up to the scenario of residential land use the question was raised regarding the ability of the groundwater to support multiple residences. If local residences use the groundwater for potable water then residential use would be more likely since the installation of water mains is usually cost prohibitive for a small amount of residences.

The Seneca County Department of Health was contacted regarding the presence of private residential wells near the site. Charles Carroll of this office stated that the Seneca Army Depot was serviced by water from Seneca Lake. The residences to the west of the depot all have private wells as no water service is provided to this area, according to Charles Carroll. Based on this information the nearest residential wells would be approximately 1.5 miles to the west of the OB grounds. The Department of Health does not maintain a list of private wells. Mr. Carroll also knew of no planned developments in the area of the site.

The exposure pathways and receptors under residential use would be similar to those under current uses. On-site exposures to fugitive dusts and surface soils would be more frequent then currently experienced by SEAD personnel. These differences in exposure frequency would be taken into account in the exposure and risk characterizations. Site visitors are not strictly excluded from exposure through ingesting or dermal contact to contaminated dust. Rather the exposure to on-site workers is believed to be much greater than that for visitors since the frequency of visits is less than that for a worker. While visitors would be exposed via the above mentioned pathways, their exposure would be expected to be much less than that for an on-site worker.

Under a no-action scenario, contaminated groundwater may migrate beyond the property line and would be available for use as drinking water or for irrigation of crops. This would result in potential ingestion, dermal and inhalation exposure to groundwater contaminants in residential use and potential ingestion exposure through bioaccumulation of contaminants in food crops and livestock.

MAIN will characterize the terrestrial animals as part of an initial survey and, if present, the potential impact on borrowing organisms will be included.

MAIN will consider impacts to terrestrial biota for exposure pathways of inhalation of fugitive dust emissions, incidental soil ingestion, and dermal contacts.

3.3 SCOPING OF POTENTIAL REMEDIAL ACTION ALTERNATIVES

In order to scope potential remedial action alternatives, remedial action objectives must be established. In this case, two groups of contaminants are of concern; heavy metals and explosives. In general, the objectives of a remedial action are to comply with all ARAR's and reduce the overall environmental and human health site risk to an acceptable level. Remedial response objectives for each media of concern are part of Table 9, Remedial Action Objectives, General Response Action, Technology Types and Examples of Process Options. Human health objectives would likely be concerned with preventing direct contact or ingestion of soil and surface water impacted with contaminants, either carcinogenic or non-carcinogenic. For groundwater these objectives may include NYSDWS for Class GA waters, which maintains that the groundwater on the site should be useable as a potable water supply. ARAR's and TBC's for surface water and soils will have to be achieved.

General response actions specific to each media are part of Table 9. Categories of remedial actions include:

1. No action/institutional action,
2. Containment,
3. Excavation or collection, treatment, and disposal.

Treatment technologies include: physical, chemical, or biological treatment processes. The last column of Table 9 describes process options that may be applicable for the containment, treatment, excavation, and disposal of the media contaminated with metals and explosives specific to this site.

This section briefly describes remedial alternatives which may be applicable for use at the SEAD OB/OD grounds. Based on the conceptual site model, groundwater impacts appear minimal. This will be verified by future site investigations. Types and levels of contamination may vary from burn pad to burn pad, therefore a single alternative will probably not be able to be applied to the entire site. These alternatives fall into several categories: 1) No action; 2) Capping; 3) Excavation and Landfilling; 4) In-situ

Table 9
REMEDIAL ACTION OBJECTIVES, GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES AND EXAMPLES OF PROCESS OPTIONS

ENVIRONMENTAL MEDIA	REMEDIAL ACTION OBJECTIVES OBJECTIVES (FOR ALL REMEDIAL ACTION OBJECTIVES)	GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY TYPES (FOR GENERAL RESPONSE ACTIONS)	PROCESS OPTIONS
Soil				
	For Human Health:	No Action/Institutional Actions:		
	Prevent ingestion/direct contact with soils having contaminants both carcinogenic and non-carcinogenic in excess of clean-up goals.	No Action Access/use restrictions	No Action Fences Deed restrictions	None
	Prevent direct contact and handling of soils having unexploded ordnances.	Containment Actions:	Capping Vertical barriers Horizontal barriers Surface controls	Clay caps, Membranes, Slurry wall, Sheetpiling, Liners, Diversion, Collection, Grading, Curtain barriers
	For Environmental Protection:		Sediment barriers, Dust control	
	Prevent migration of contaminants into groundwater.	Excavation, Treatment Actions:	Removal: Excavation	
		Excavation, Treatment, Disposal, In-situ treatment, Excavation, Disposal	Treatment: Solidification Stabilization Physical Chemical Biological In-situ Thermal	Encapsulation, Pozzolanic Solidification, Soil Washing, Solvent Extraction, Composting, Soil Slurry Bio-Reactor, Bioreclamation Soil Flushing, Incineration, Pyrolysis
			Disposal: On-site or off-site	

Table 9 (Continued)
REMEDIAL ACTION OBJECTIVES, GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES AND EXAMPLES OF PROCESS OPTIONS

ENVIRONMENTAL MEDIA	REMEDIAL ACTION OBJECTIVES OBJECTIVES (FOR ALL REMEDIAL ACTION OBJECTIVES)	GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY TYPES (FOR GENERAL RESPONSE ACTIONS)	PROCESS OPTIONS
Groundwater				
	For Human Health:	No Action/Institutional Controls:		
	Restore groundwater to acceptable levels according to NYSGWS for class GA waters, or a potable water supply. Prevent ingestion of water having carcinogen(s) or any contaminant in excess of NYSGWS for class GA waters	No Action Use/Access Restrictions Monitoring Alternate Residential Water Supply	No Action Fences, Deed Restrictions Groundwater Classification Change	None
		Containment:	Capping, Vertical barriers, Horizontal barriers, Hydraulic containment	Clay Cap, Membranes, Slurry Walls, Sheet Pilings, Liners, Groundwater Recirculation Systems
	For Environmental Protection:			
	Restore groundwater aquifer to acceptable concentrations of metal and explosive contaminant supply	Removal, Treatment:		
		Collection, Treatment, Discharge, In-situ Groundwater Treatment, Individual Home Treatment	Removal: Groundwater Pumping Diversion, Collection, Drainages Treatment: Physical Chemical In-situ Disposal: Discharge to Surface Water, Discharge to Upgradient Groundwater	Wells, Subsurface Drains or Leachate Collection Drains Ion Exchange, Evap/Dewater, Act. Carbon, Oxidation/Reduction, Precipitation, Chemical Oxidation, Bioremediation

Table 9 (Continued)
REMEDIAL ACTION OBJECTIVES, GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES AND EXAMPLES OF PROCESS OPTIONS

ENVIRONMENTAL MEDIA	REMEDIAL ACTION OBJECTIVES OBJECTIVES (FOR ALL REMEDIAL ACTION OBJECTIVES)	GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY TYPES (FOR GENERAL RESPONSE ACTIONS)	PROCESS OPTIONS
Sediment				
	For Human Health:	No Action/Institutional Actions:	No Action/Institutional Options:	
	Eliminate exposure pathways which would yield a total excess cancer risk > 10^{-4} to 10^{-7}.	No Action Assess restrictions to monitoring	Fences Deed restrictions Groundwater Classification Change	None
		Excavation Actions:		
	For Environmental Protection:		Removal Technologies:	Sediment excavation
		Excavation		
	Prevent the release of contaminants in sediments that would result in surface water concentrations in excess of ambient water quality standards.	Excavation/Treatment Actions: Removal/Disposal Removal/Treatment/Disposal	Excavation Containment Technologies: Capping Vertical barriers Horizontal barriers Sediment control barriers	Removal with Clay Cap, Multilayer, Asphalt, Slurry wall, Sheet Piling, Liners, Grout Injection, Coffer Dams, Curtain Barriers, Capping Barriers
	Reduce concentrations of pollutants below NYSDEC sediment criteria levels.		Treatment Technologies:	
			Solidification, Fixation, Stabilization	Sorption, Pozzolanic agents, Encapsulation
			Dewatering Physical treatment Chemical treatment Biological treatment In-situ treatment Thermal treatment	Sedimentation, Dewatering and Drying beds, Water/Solids Leaching (with subsequent treatment), Neutralization, Oxidation, Electrochemical, Reduction, Landfarming, Surface Bioreclamation, Incineration, Pyrolysis, Soil Washing, Solvent Extraction

Table 9 (Continued)
REMEDIAL ACTION OBJECTIVES, GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES AND EXAMPLES OF PROCESS OPTIONS

ENVIRONMENTAL MEDIA	REMEDIAL ACTION OBJECTIVES OBJECTIVES (FOR ALL REMEDIAL ACTION OBJECTIVES)	GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY TYPES (FOR GENERAL RESPONSE ACTIONS)	PROCESS OPTIONS
Surface Water	For Human Health	No Action/Institutional Actions:	No Action/Institutional Options:	
	Prevent ingestion of surface water having carcinogens or any ambient water quality standards for New York contaminants in excess of surface water standards.	No Action Access restrictions Monitoring	Fences Deed restrictions	None
		Collection/Treatment:	Collection:	
	For Environmental Protection	Surface Water Run-Off Interception, Treatment	Surface controls	Grading, Diversion, and Collection
	NYSDEC Classification for Class C and D Surface Waters.		Treatment:	
			Physical Chemical In-situ	Precipitation, Air Stripping Coag/Flocc, Filtration, Ion Exchange, Bioreclamation, Chemical Oxidation
			Disposal:	
			Discharge to Surface Water	

Detoxification; 5) Solidification; 6) Resource Reclamation; 7) Implementation of Institutional Controls; 8) Composting; 9) Soil Washing/Flushing, and 10) Excavation/Incineration. Following a thorough site investigation these alternatives will be evaluated for technical implementability, ability to achieve ARAR's and economic impacts. A complete study of both existing and potential groundwater remedial action alternatives include: 1) Carbon adsorption; 2) Ion exchange; 3) Chemical oxidation; and 4) Reverse osmosis.

3.3.1 No Action

No action may be applicable if it can be demonstrated that no appreciable contamination or risk due to contamination exists at the site. Such a program would require that the area remain secured by fences and regular military patrols. A modified no action program could include regular monitoring of the existing wells at the boundaries of the OB/OD ground. Samples from the existing wells would be collected and analyzed on a routine basis. Statistically significant changes in concentration of any contaminant of concern would then require additional action.

3.3.2 Capping

Capping the OB/OD can reliably seal the subsurface from the aboveground environment which could in turn reduce underground migration of wastes, and both prevent windborn dispersion of particulates and sediment transport via run-off. Caps can be constructed relatively quickly and if properly installed, will perform for at least 20 years. Unforseen settling, invasions by burrowing animals and deep-rooted plants contribute to the need for periodic monitoring and maintenance of the cap. However, even with these long-term maintenance requirements, capping may still be considerably more economical than other remedial alternatives. In addition, it may only be necessary or advisable to cap significantly contaminated pads.

The designs of modern caps usually conform to the performance standards in 40 CFR 264.310, which addresses RCRA landfill closure requirements. These standards include minimum liquid migration through the wastes, low cover maintenance requirements, efficient site drainage, high resistance to damage by settling or subsidence, and a permeability lower than or equal to the natural soils.

3.3.3 Excavation and Landfilling

Excavation of hazardous materials is performed extensively for site remediation. Excavation is usually accompanied by on or offsite treatment or disposal in an on or off-site secured landfill. Excavation employs the use of bulldozers, front end loaders, back hoes, and other earth moving equipment to physically remove soil and buried materials. There are no absolute limitations on the types of waste which can be excavated and removed. However, worker health and safety weighs heavily in the decision to excavate explosive waste material. Other factors which will be considered include the mobility of the wastes, the feasibility of on-site containment, and the cost of disposing the waste or rendering it non-hazardous once it has been excavated. A frequent practice at hazardous waste sites is to excavate and remove contaminant "hot spots" and to use other remedial measures for less contaminated soils.

Excavation and removal can almost totally eliminate the contamination at a site and the need for long-term monitoring. Another advantage is that the time to achieve beneficial results can be short relative to such alternatives as in-situ bioremediation.

The biggest drawbacks with excavation, removal, and off-site disposal are associated with worker safety, cost, and institutional aspects. Where highly hazardous materials are present, excavation can pose a substantial risk to worker safety. Costs associated with off-site disposal are high and frequently result in the elimination of this alternative as a cost-effective alternative. Finally, institutional aspects can add significant delays to program implementation.

The construction of an on-site RCRA type hazardous waste landfill has been successfully used to manage contaminated soils at other CERCLA sites. However, landfilling of hazardous materials is becoming increasingly difficult and more expensive due to steadily growing regulatory control of this technology. Landfilling can usually be regarded as the least attractive alternative for a site cleanup action.

3.3.4 In-Situ Detoxification and Solidification

Since the disturbance and excavation of unstable explosive materials in and around the burn pads will be potentially extremely hazardous, some in-situ technologies have inherent advantages, since they do not require removal of the unstable explosive materials. For these technologies to be considered feasible, the majority of the materials to be detoxified must be already consolidated in a local area. For example, should the sampling data indicate that the presence of contamination away from the pads is negligible and the majority of the constituents of concern is localized in a few of the pads, then in-situ processing will be considered. MAIN believes that there are three (3) in-situ technologies which may be applied should site conditions be favorable. These are:

- In-situ vitrification
- In-situ radio frequency heating
- In-situ solidification.

In-situ vitrification involves vitrifying soil in place by the application of a high electric current. In-situ vitrification (ISV) uses an electrical network to melt soil or sludge at temperatures of 1,600 to 2,000°C, thus destroying organic pollutants by pyrolysis. Inorganic pollutants are incorporated within the vitrified mass, which has properties of glass. Both the organic and inorganic airborne pyrolysis byproducts are captured in a hood, which draws the contaminants into an off-gas treatment system that removes particulates and other pollutants of concern.

The vitrification process begins by inserting large electrodes into contaminated zones containing sufficient soil to support the formation of a melt. An array (usually square) of four electrodes are placed to the desired treatment depth in the volume to be treated. Because soil typically has low conductivity, flaked graphite and glass frit are placed on the soil surface between the electrodes to provide a starter path for electric current. The electric current passes through the electrodes and begins to melt soil at the surface. As power is applied, the melt continues to grow downward, at a rate of 1 to 2 inches per hour. Individual settings (each single placement of electrodes) may grow to encompass a total melt mass of 1,000 tons and a maximum width of 30 feet are considered possible. Depths of 17 feet have been achieved to date with the existing large scale equipment. Adjacent settings can be positioned to fuse to each other and to completely process the desired volume at a site. Stacked settings to reach deep contamination are also possible.

The large-scale system melts soil at a rate of 4 to 6 tons per hour. Since the void volume present in particulate materials (20-40% for typical soils) is removed during processing, a corresponding volume reduction occurs. Volume is further reduced as some materials present in the soil, such as humus and organic contaminants, are removed as gases and vapors during processing. After cooling, a vitrified monolith results, with a silicate glass and microcrystalline structure. This monolith possesses excellent structural and environmental properties.

For vitrification to be a viable treatment option, the waste must contain enough silica/alumina to provide the "glass structure". This limits in situ vitrification to soils with low levels of organic, heavy metal, and other contaminants. Additionally, this technology is still somewhat experimental and has not been used in widespread applications.

Factors that will affect the applicability of this technology include:

1. The moisture content of the soil influences the energy cost,
2. The depth of the soil to be vitrified,
3. The types and concentrations of the contaminants in the soil,
4. The vitrified soil is denser, therefore the ground surface settles and must be filled and,
5. The high levels of organics and metals in some soils and the low oxygen levels above the melt could result in reduction of metal oxides, affecting the leachability of the "glass."

In-situ radio frequency heating involves the application of radio frequency waves to soil. This technology has been successfully used to heat soil in place. Soil temperatures up to 350°F have been reached. Since many of the explosives expected to be present are relatively non-volatile, the addition of heat may provide a viable means to stimulate their removal as a vapor. The extracted vapors can be controlled by various control technologies such as catalytic incineration, incineration or carbon adsorption. As with in-situ vitrification, electrodes are installed in an isolated area, and radio frequency waves are applied to the soil. The technology heats soil in a manner similar to the way the microwave oven heats food. As with in-situ vitrification, this technology has not been used extensively.

In-situ solidification involves the formation of an in-place monolithic mass through the mixing of a pozzolantic or a siliceous material with the existing soil. Multi-axis overlapping hollow stem augers are used to inject solidification/stabilization (S/S) agents and blend them with contaminated soils in-situ. The augers are mounted on a crawler-type base machine. A batch mixing plant and raw materials storage tanks are also involved. The machine can treat 90 to 140 cubic yards of soil per 8-hour shift at depths up to 100 feet.

The product of the in-situ S/S technology is a monolithic block down to the treatment depth. Since material is added to the soil a volume increase occurs which ranges from 10 to 30 percent, depending on the nature of the soil matrix and the amount of fixation reagents and water required for treatment. Solidification or stabilization is more effective when the material is excavated first, mixed and replaced. In-situ mixing can produce gaps and voids that would not occur if the material were excavated. However, if conditions are correct in-situ mixing can be successful in decreasing leaching of contaminants.

This technology is applicable to soils contaminated with metals and semivolatile organic compounds (pesticides, PCBs, phenols, PAHs, etc.). It should be noted that this technique has been used in mixing soil cement, or chemical grout for more than 18 years on various construction applications, including cutoff walls and soil stabilization, and is widely applied.

3.3.5 Resource Reclamation

The amount of copper, brass, lead and aluminum on-site may warrant a resource reclamation program. This program could be in lieu of or in conjunction with the previously described options. The resource reclamation program would probably consist of the following operations:

- Bulk materials recovery
- Initial materials separation
- Explosive materials detonation
- Secondary materials separation and cleaning
- Smelting operations
- Purification and benefaction operations.

Many other unit operations such as water and wastewater treatment would also be required. Economic and technologic analyses would be used to determine the viability of this option.

3.3.6 Institutional Controls

Institutional controls is a viable remedial alternative for the SEAD OB/OD. An institutional control could be to have the future land use restricted, thereby preventing exposure due to dermal contact, etc. The land use restriction would prevent excavation, building, or construction in the area. The land use would be restricted in a legal document such as the deed for the property, so that if it were sold, it would be under the restrictions of the document. It is also possible to reclassify the on-site groundwater so that it could not be used as a source of potable water.

3.3.7 Composting

Composting is a biological process used typically for the treatment of wastes with a high concentration of biodegradable organic solids. The fate of inorganics (metals) is not completely understood. Composting is initiated by mixing biodegradable organic matter with organic carbon sources and bulking agents (to enhance the porosity of the mixture). The organic rich environment leads to intense microbial metabolic action, increasing the temperature. This self heating environment promotes more microbial activity, up to a certain temperature, at which point the microbial population begins to decline.
Materials and facilities required for composting are:

1. Biodegradable organic substrate,
2. Bulking agent,
3. Water,
4. Containment structure,
5. Mixing equipment, and
6. Means to provide oxygen.

There are three general levels of composting that exist. The lowest technological approach requires that the material is shaped into a pile and allowed to heat. Water and nutrients are added. Air exchange is generally poor, although the pile can be turned to increase aeration. Temperature control is also poor. In the second level, aeration is increased by providing perforated pipes under the pile. Attached blowers aid in aeration and cooling of the pile. The third level is that of the enclosed composting pile with automated materials handling for aeration and cooling. With increased control over the process, cost obviously increases.

Successful composting of explosives and propellant contaminated soil in laboratory and pilot scale tests have been performed by USATHAMA. A field scale demonstration project was conducted at the Louisiana Army Ammunition Plant. (USATHAMA - Task Order 8, Field Demonstration - Composting of Explosives - Contaminated Sediments at LAPP - September 88). The results of this and other research projects of biotransformation and composting of 2,4,6 TNT, RDX, HMX, and tetryl having determined the following:

1. TNT is microbially transformed, but not completely mineralized. High organic carbon concentrations, aerobic conditions and the presence of readily biodegradable substrates have enhanced the biotransformation of TNT. No conclusive evidence of aromatic ring cleavage exists. The nitro group reduction is usually catalyzed by microbes leading to biotransformation products that are strongly adsorbed to organic material.

2. Anaerobic conditions have been found to enhance RDX biotransformation. High TOC levels or low redox potential have been found to enhance RDX degradation in the presence of sufficient organic nutrients. When RDX degradation was incomplete, nitrous intermediates were produced.

3. Complete biodegradation of HMX has not been observed in aqueous or soil systems. However up to 53% removal has been observed. Partial HMX degradation is facilitated by anaerobic conditions. High TOC and low redox potential have been found to enhance HMX degradation also. Degradation products include mono and dinitroso products, methanol, and formaldehyde.

4. Tetryl biotransformation has little reported information. 80% to 90% of C^{14} tetryl initially spiked into compost was detected as an unextractable residue after 56 days.

Pathways of transformation for TNT, 2,4-DNT, and RDX are discussed more in Section 3.1.2.2, Environmental Degradation of Explosives. Parameters effecting composting efficiency include:

1. Temperature,
2. Moisture content,
3. Chemical and biological characteristics and concentrations of substrate,
4. Concentrations of inorganic nutrients, (nitrogen and phosphorus),
5. Heat production and retention of compost, and
6. Partial pressure of oxygen within the composting material.

Optimization of all of these parameters for each explosive has not been determined.

Composting has several characteristics which relate to its applicability to a particular situation. These include:

1. Material volume to be treated, space required,
2. Time requirement,
3. Level of contamination initially,
4. Level of contamination required and
5. Transformation products

Composting requires space and time, if the volumes of soil to be treated is large, this might make composting an unrealistic option. Composting has been used to treat highly contaminated soils with concentrations of explosives in the range of 10,000 mg/kg - 600,000 mg/kg. The concentration of the explosive waste at Seneca are much less than, making composting inappropriate, or possibly altogether unnecessary.

Another possible application of biological treatment for soils is in-situ bioreclamation. In-situ bioreclamation is used to treat contaminated areas that contain biodegradable organic compounds as a primary source of contamination. In situ bioreclamation is more economical for soils with 10-10,000 ppm of contamination, with higher levels being more suitable for excavation and aboveground treatment, such as composting. In-situ bioreclamation has been more difficult at sites with environmental influences that slow microbial processes. High concentrations of metals and organics that are toxic to microbes being could be a potential problem. Hydrology at the site must allow for rapid and controlled movement of nutrient enriched water through the contaminated region. Success of this technology has been observed mostly in gasoline and other light hydrocarbons. It has not been applied to remediation or explosive material and would have little, if any, affect upon decreasing the concentration of heavy metals in soils.

3.3.8 Soil Washing/Soil Flushing

Soil washing is a treatment option applicable to soils contaminated with semi-volatile organics. In the process, soil is slurried with water and subjected to intense scrubbings. To improve the efficiency of soil washing, the process may include the use of surfactants, detergents, chelating agents or pH adjustment. After contaminants are removed from the soil, the washing solutions can be treated in a wastewater treatment system. The washing fluid can then be recycled, continuing the soil washing process. In the case of in-situ soil flushing, the treated washing solution can be reinjected into the soil via a recirculation system.

Certain site factors can limit the success of soil washing/flushing:

1. Highly variable soil conditions,
2. Low permeability (high silt or clay content) which will reduce percolation and leaching,
3. Chemical reactions with soil cation exchange and pH effects may decrease contaminant mobility and
4. If performed in-situ, the groundwater flow must be well defined in order to recapture washing solutions.

For soils with a high percentage of silt or clay, the solid-liquid separations following the soil washing, has been prone to problems. The excavation requirement for soil washing is also a drawback due to the unexploded ordinances at the site.

Biotrol is a commercially available soil washing process. Reduction of levels of metals ranged from 45-84%. The degree to which metals can be removed depends on the type of metallic compound, oxide, insoluble salt, etc. The data from the Biotrol treatability tests is not sufficient to draw any conclusions on the effectiveness of soil washing as a metal remover. However, removal of organics ranged between 90-99%. Total costs include mobilization and treatment costs. Costs for the disposal of residuals generated during soil washing must also be contended with. Costs are significantly lower for large volumes of soil.

3.3.9 Excavation, Incineration, and Disposal

The Rotary Kiln Incinerator process was determined to be a success according to a program commissioned by USATHAMA. The results of the program were as follows:

1. A transportable incineration system could be disassembled transported and reassembled and operational within 2 weeks.
2. 99.99% destruction efficiency in the kiln ash, 99.999% destruction efficiency in the fabric filters ash, no explosives detected in the stack gas.
3. Stack emissions in compliance with federal, state and local regulations including: SO_2, Hydrocarbons, NO_x, CO, and particulates, and
4. Ash residues were not hazardous from the standpoint of EP toxicity and reactivity.

The soils incinerated were from the Savanna Army Depot Activity (SADA) and the Louisiana Army Ammunition Plant (LAPP). The soils had very different characteristics. SADA soil was drier, sandier, had a higher TNT content, plus little or no HMX or RDX. LAPP soil was moister, higher HMX and RDX concentration and metals content.
The equipment required for a rotary kiln incineration system include the following:

1. Soil feed system,
2. Primary combustion chamber (rotary kiln),
3. Secondary combustion chamber (after burner),
4. Heat exchanger,
5. Fabric filter collector, and an
6. Induced draft fan and stack.

Preliminary testing was done to establish maximum soil feed rates and minimum kiln temperatures to determine whether explosives breakthrough would be detectable in the stack gas or ash.

The following are some potential groundwater and surface water remedial alternatives:

3.3.10 Carbon Adsorption

Carbon adsorption can be used to treat groundwater and surface water containing soluble organics and certain metals. Full scale experience indicates removals of aromatics, phenols, and PAH to 1ppb or less.

3.3.11 Ion Exchange

Ion exchange is a physical process that can be used to treat water contaminated with heavy metals and is potentially applicable to ionic organic compounds. Ion exchange can theoretically remove all of the selected ionic constituents if adequate resin contact time and proper resin is used.

3.3.12 Chemical Oxidation (O_3, UV)

Chemical oxidation can be used to treat contaminated, pumped groundwater, and contaminated segregated surface water. It has been used to degrade organic compounds. The use of ultraviolet light in combination with ozone has been shown to enhance the reactivity of ozone with certain chemical constituents. The degree to which ozone/UV oxidizes organic compounds depends on: ozone dosage, the initial concentration of chemicals in solution, molecular structure and contact time.

3.3.13 Reverse Osmosis

Reverse osmosis can be used to treat contaminated, pumped groundwaters and surface waters. It has been used to remove metals and organics with a molecular weight greater than 200. Organics tend to cause fouling of membranes however. Also the process serves only to concentrate the contaminants which still then have to be disposed of.

3.4 PRELIMINARY IDENTIFICATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

3.4.1 Introduction

The 1986 Superfund Amendments and Reauthorization Act (SARA) adopted and expanded a provision of the 1985 National Contingency Plan (NCP) that remedial actions must at least attain compliance with applicable or relevant and appropriate requirements (ARARs) of other environmental and public health statutes when conducting remedial actions.

Applicable or relevant and appropriate requirements have been defined by the EPA as follows:

> "Applicable requirements means those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site." (Final NCP Rule, 55 FR 8814, March 8, 1990).
>
> "Relevant and appropriate requirements means those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site." (Final NCP Rule, 55 FR 8817, March 8, 1990).

ARARs typically fall into the following three classifications:

- Chemical-specific ARARs are health or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values of allowable soil, water, or air contamination. These concentration limits are specific for a hazardous substance, pollutant, or contaminant in the various environmental media. Examples of chemical specific ARARs include maximum contaminant levels (MCLs), federal ambient water quality criteria (AWQC), state water quality standards, and National Ambient Air Quality Standards (NAAQS).

- Location-specific ARARs are restrictions placed on the concentrations of hazardous substances or the conduct of activities solely because they are in specific locations. These requirements are described in environmental laws and regulations which control actions that may be required in performing a remedial action. For example, a section of the Clean Water Act contains prohibitions regarding the unrestricted discharge of dredged or fill material into wetlands. The filling of wetlands can sometimes be necessary if roads are required for mobilization of heavy equipment.

- Action specific ARARs are requirements and/or limitations on managing hazardous waste which may be generated as a result of a remedial action. These requirements and limitations are described in laws and regulations which govern the application of various technologies or activities at CERCLA sites. RCRA statutes, which primarily deal with hazardous waste management, generally contain the most action-specific requirements which are applied to CERCLA actions. New hazardous waste regulations, such as the RCRA corrective action regulations and the Land Ban restrictions, will be reviewed for their applicability to activities performed during a remedial action.

Identification and refinement of ARARs will occur throughout the remedial investigation and feasibility study. A preliminary identification of ARARs has been performed based upon the initial site characterization data compiled by the Army. In addition, several of the location specific ARARs have been evaluated as to their relevance and applicability. As more specific information is developed regarding the chemicals released on site, special site conditions, and potential use of various remedial technologies, additional ARARs will be selected and existing ARARs will be reviewed for their appropriateness.

3.4.2 Preliminary Identification of ARARs and TBCs

3.4.2.1 Potential ARARs

The following federal and state regulatory requirements are potentially applicable or relevant and appropriate to the site. Table 10, Sources of Chemical Specific ARAR's, Table 11, Sources of Location Specific ARAR's, and Table 12, Sources of Action Specific ARAR's,

TABLE 10

SOURCES OF CHEMICAL SPECIFIC ARAR'S

Federal:

- Resource Conservation and Recovery Act (RCRA), Groundwater Protection Standards and Maximum Concentration Limits (40 CFR 264, Subpart F)
- Clean Water Act, Water Quality Criteria (Section 304) (May 1, 1987 - Gold Book)
- Safe Drinking Water Act, Maximum Contaminant Levels (MCLs) (40 CFR 141.11-.16)

New York State:

- New York State Codes, Rules and Regulations (NYCRR) Title 6, Chapter X
- New York Groundwater Quality Standards (6 NYCRR 703)
- New York Safe Drinking Water Act, Maximum Contaminant Levels (MCLs) (10 NYCRR 5)
- New York Surface Water Quality Standards (6 NYCRR 702)
- New York State, Chapter 1 State Sanitary Codes, Subpart 5-1, Public Water Supplies, July 3, 1991.
- New York State Raw Water Quality Standards (10 NYCRR 170.4)
- New York RCRA Groundwater Protection Standards (6 NYCRR 373-2.6 (e))
- New York State Department of Environmental Conservation, Division of Water, Technical and Operational Guidance Series (1.1.1), Ambient Water Quality Standards and Guidance Values, September 25, 1990
- Surface Water and Groundwater Classifications and Standards (6 NYCRR 700-705)
- Declaration of Policy, Article 1 Environmental Conservation Law (ECL)
- General Functions, Powers, Duties and Jurisdiction, Article 3 Environmental Conservation Law, Department of Environmental Conservation
- ECL, Protection of Water, Article 15, Title 5.
- Use and Protection of Waters, (6 NYCRR, Part 608)

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TABLE 11

SOURCES OF LOCATION SPECIFIC ARAR'S

Federal:

- Executive Orders on Floodplain Management and Wetlands Protection (CERCLA Floodplain and Wetlands Assessments) #11988 and 11990

- National Historic Preservation Act (16 USC 470) Section 106 et seq. (36 CFR 800) (Requires Federal agencies to identify all affected properties on or eligible for the National Register of Historic Places and consult with the State Historic Preservation Office and Advisory Council on Historic Presentation)

- RCRA Location Requirements for 100-year Floodplains (40 CFR 264.18(b)).

- Fish and Wildlife Coordination Act (16 USC 661 et seq.) (Requires actions to protect fish or wildlife when diverting, channeling or modifying a stream)

- Clean Water Act, Section 404, and Rivers and Harbor Act, Section 10, Requirements for Dredge and Fill Activities (40 CFR 230)

- U.S. Army Corps of Engineers Regulations for Construction and Discharge of Dredged or Fill Materials in Navigable Waterway (33 CFR 320-330).

- Wetlands Construction and Management Procedures (40 CFR 6, Appendix A).

- USDA/SCS - Farmland Protection Policy (7CFR 658)

- USDA Secretary's memorandum No. 1827, Supplement 1, Statement of Prime Farmland, and Forest Land - June 21, 1976.

- EPA Statement of Policy to Protect Environmentally Significant Agricultural Lands - September 8, 178.

- Farmland Protection Policy Act of 1981 (FPPA)(7 USC 4201 et se q).

- Wild and Scenic Rivers Act (16 USC 1271).

- Endangered Species Act (16 USC 1531).

- Wilderness Act (16 USC 1131).

New York State:

- New York State Freshwater Wetlands Law (ECL Article 24, 71 in Title 23).

- New York State Freshwater Wetlands Permit Requirements and Classification (6 NYCRR 663 and 664).

- New York State Floodplain Management Act and Regulations (ECL Article 36 and 6 NYCRR 500).

- Endangered and Threatened Species of Fish and Wildlife Requirements (6 NYCRR 182).

- New York State Flood Hazard Area Construction Standards.

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TABLE 12
SOURCES OF ACTION SPECIFIC ARAR'S

Federal:

- RCRA Subtitle C Hazardous Waste Treatment Facility Design and Operating Standards for Treatment and Disposal systems, (i.e., landfill, incinerators, tanks, containers, etc.) (40 CFR 264 and 265); Minimum Technology Requirements.
- RCRA Closure Standards (40 CFR 264, Subpart X).
- RCRA, Subtitle C, Closure and Post-Closure Standards (40 CFR 264, Subpart G).
- RCRA Groundwater Monitoring and Protection Standards (40 CFR, Subpart F).
- RCRA Generator Requirements for Manifesting Waste for Offsite Disposal (40 CFR 262).
- RCRA Transporter Requirements for Off-Site Disposal (40 CFR 263).
- RCRA, Subtitle D, Non-Hazardous Waste Management Standards (40 CFR 257).
- Safe Drinking Water Act, Underground Injection Control Requirements (40 CFR 144 and 146).
- RCRA Land Disposal Restrictions (40 CFR 268) (On and off-site disposal of excavated soil).
- Clean Water Act, - NPDES Permitting Requirements for Discharge of Treatment System Effluent (40 CFR 122-125).
- Effluent Guidelines for Organic Chemicals, Plastics and Resins (Discharge Limits) (40 CFR 414).
- Clean Water Act Discharge to Publically - Owned Treatment Works (POTW) (40 CFR 403).
- DOT Rules for Hazardous Materials Transport (49 CFR 107, 171.1-171.500).
- Occupational Safety and Health Standards for Hazardous Responses and General Construction Activities (29 CFR 1904, 1910, 1926).

New York State:

- New York State Pollution Discharge Elimination System (SPDES) Requirements (Standards for Stormwater Run-off, Surfacewater, and Groundwater discharges (6 NYCRR 750-757).
- New York State RCRA Standards for the Design and Operation of Hazardous Waste Treatment Facilities (i.e., landfills, incinerators, tanks, containers, etc.); Minimum Technology Requirements (6 NYCRR 370-373).
- New York State RCRA Closure and Post-Closure Standards (Clean Closure and Waste-in-Place Closures) (6 NYCRR 372).
- New York State Solid Waste Management Requirements and Siting Restrictions (6 NYCRR 360-361).
- New York State RCRA Generator and Transporter Requirements for Manifesting Waste for Off-Site Disposal (6 NYCRR 364 and 372).
- SARA (42 USC 9601).
- OSHA (29 CFR 1910.120).
- Clean Air Act (40 CFR 50.61).

are presented as a listing of state and federal regulations which have been considered as potential sources of ARAR's.

The applicability of the chemical specific ARAR's listed in Table 10 have been determined by the existing conditions at the site. The groundwater could be used as a drinking water supply since the State of New York has classified the groundwater as GA. The surface water at the site is Reeder Creek. Depending on the location, it has been classified as Class C(T) or D water. Figure 16, State of New York Classification of Reeder Creek, illustrates the current New York DEC classification of Reeder Creek.

Several available documents pertaining to SEAD have been reviewed to determine if the location specific ARAR's of Table 11 have been complied with. The following summarizes the preliminary research.

According to the Fish and Wildlife Management Plan (July 1988) prepared by the U.S. Army Material Command, there are ten areas of SEAD which have been designated as freshwater wetlands by NYSDEC. The freshwater wetland areas identified on the New York State Wetland Inventory Maps, which are in the vicinity of the OB grounds, are shown on Figure 17. Although none of these designated areas are near the OB/OD grounds, a more detailed wetlands delineation will be performed as part of the terrestrial survey. It is possible that dredging and fill activities might take place. ARAR's pertaining to these activities have been included on Table 11.

The Installation Assessment of the Seneca Army Depot (January 1980) did not indicate that any endangered species were present at SEAD, but did indicate that the following endangered species are known to exist in the area: the Indiana Bat (Myots Sodalis) and the American osprey (Pandion halaietus carolinensis). The report also stated that since no large or deep permanent streams exist, protected aquatic species have not been considered and that the state-protected bog turtle (Clemmys muhlenbergi) dwells in marshy areas which are numerous in the area.

Recent telephone conversations with state and federal wildlife specialists suggest that the presence of endangered species or critical habitats is unlikely at the OB/OD grounds. The U.S. Fish and Wildlife Service has indicated that there are no critical habitats or endangered or threatened species in the SEAD area, although some transient species may occur and

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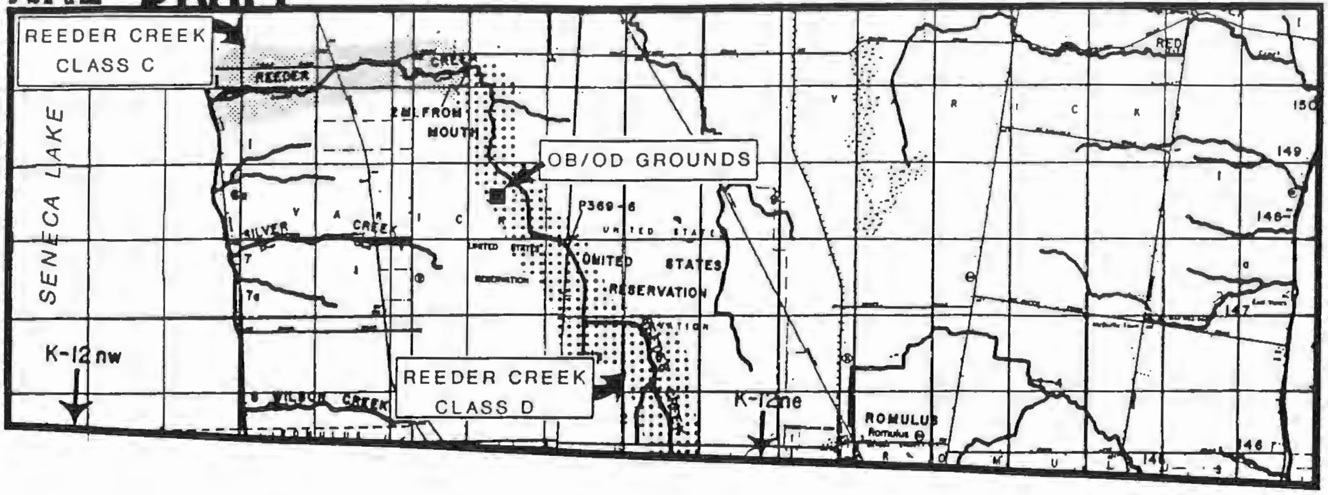

Name	Description	Map Ref #	Class	Standards
Reeder Creek	Enters Seneca Lake from east at a point 0.3 mile southeast of intersection of East Lake Road and Yale Farm Road and extending 2.0 miles upstream to a point which is located 0.4 mile east of intersection of Route 96A and Yale Farm Road.	J-12sw	C	C(T)
Reeder Creek	From a point 2.0 miles upstream from mouth to source.	J-12sw J-12se K-12ne	D	D

CLASS "C"

Best usage of waters:

The waters are suitable for fishing and fish propagation. The water quality shall be suitable for primary and secondary contact recreation even though other factors may limit the use for that purpose.

CLASS "D"

Best usage of waters:

The waters are suitable for fishing. The water quality shall be suitable for primary and secondary contact recreation even though other factors may limit the use for that purpose. Due to such natural conditions as intermittency of flow, water conditions not conducive to propagation of game fishery or stream bed conditions, the waters will not support fish propagation.

Conditions related to best usage of waters:

The waters must be suitable for fish survival.

SOURCE:
Code of Rules and Regulations, State of New York, Title 6 Conservation 700-705, Section 898.4.
Classified in 1967.

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STATE OF NEW YORK
CLASSIFICATION OF REEDER CREEK

FIGURE 16 AUGUST 1991

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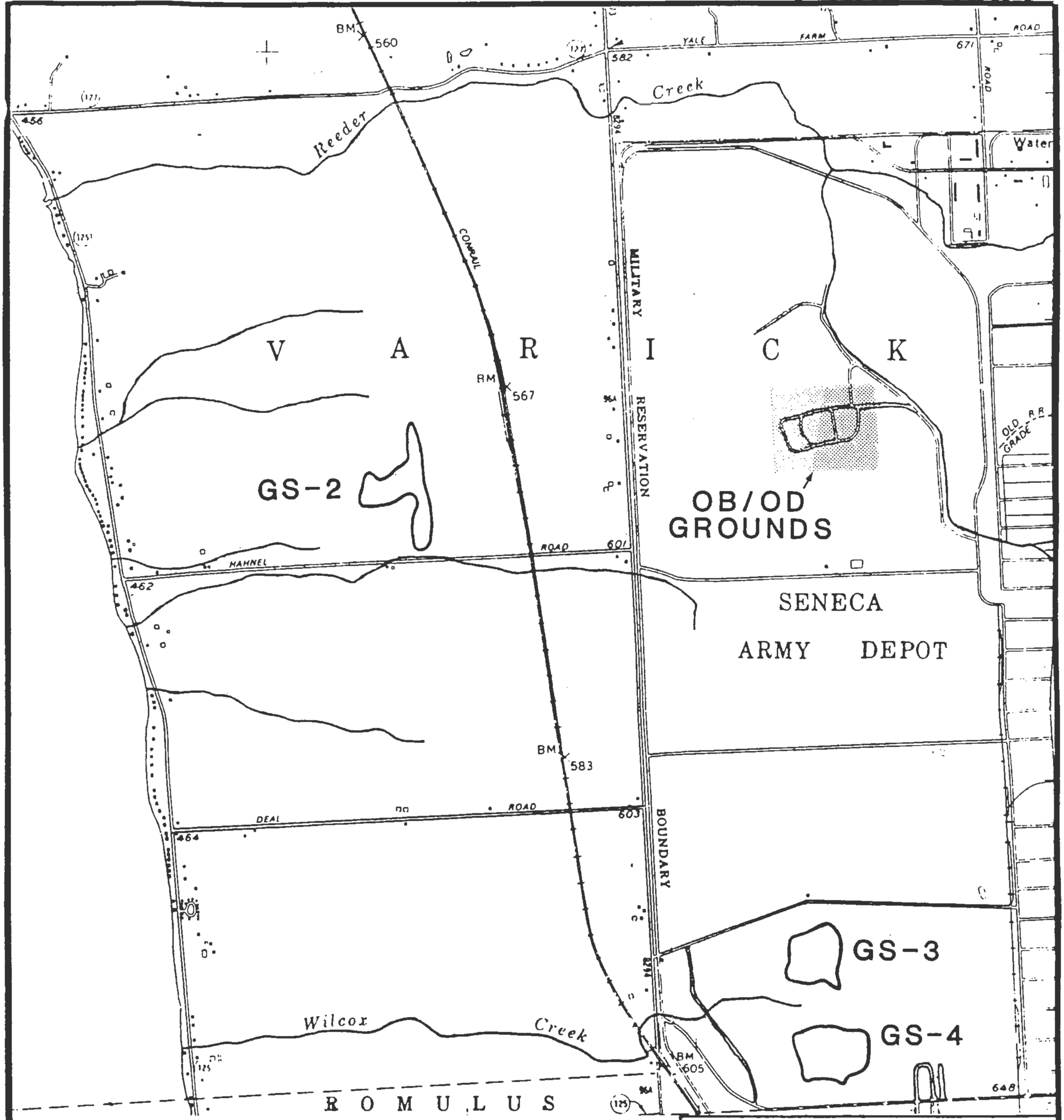

LEGEND

GS-3 APPROXIMATE NYSDEC-REGULATED WETLAND BOUNDARY WITH WETLAND IDENTIFICATION CODE

SOURCE: NEW YORK STATE FRESHWATER WETLANDS MAP, SENECA COUNTY, MAP 7 OF 16, USGS GENEVA SOUTH QUADRANGLE, 1978

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LOCATION OF FRESHWATER WETLANDS

FIGURE 17 AUGUST 1991

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that there are Bald Eagles (Haliaeetus Leucocephalus) nesting at the Montezuma National Wildlife Refuge (personal communication: Paul Nickerson and Mark Clough, U.S. Fish and Wildlife Service). According to the National Heritage Program of NYSDEC, there are no state listed endangered or threatened species in the general area of SEAD (personal communication: Burrel Buffington, Information Officer, National Heritage Program).

Preliminary information has been reviewed concerning the applicability of the Wild and Scenic Rivers Act to SEAD. Those rivers which have been designated as wild and scenic in accordance with the Act are listed in 16 U.S.C. 1271. According to the administering agency, the National Park Services, there are no designated rivers located within the Seneca region (personal communication: Phil Huffman, National Park Service). The state of New York has similar state legislation--the Wild, Scenic and Recreation Rivers Act. According to the Lands and Forests Division of the Department of Environmental Conservation (NYSDEC), the nearest state designated river is the Genesee River, approximately 45 miles to the west.

The Flood Insurance Rate Map (FIRM) of the Federal Emergency Management Agency (FEMA) places the Seneca Army Depot OB/OD grounds within Panel 5, Town of Varick, New York, Seneca County (Community Panel Number 360758 0005 B). The entire northern half of the Depot is not subject to flooding and is located within "areas determined to be outside the 500-year flood plain" (Zone X).

The U.S. Fish and Wildlife Service administers the Wilderness Act and the National Wildlife Refuge System. Through review of the NY statewide comprehensive plan, it has been determined that there are no areas protected by the Wilderness Act in the State of New York. The nearest National Refuge, Montezuma National Wildlife Refuge, is located approximately 20 miles to the northeast of the Seneca Army Depot.

In order to determine if the National Historic Preservation Act should be considered a location specific ARAR, <u>An Archeological Overview and Management Plan for Seneca Army Depot</u> (September 1986) was obtained and reviewed. According to this document, four prehistoric archeological sites are known to exist at SEAD and 231 potential historic archeological sites were identified based on documentary sources. According to the report, no specific historic sites are recorded at SEAD and, according to an earlier report, <u>Historical Report on Seneca Army Depot</u>, 1972 Heraldic Section, DARCOM there are no sites worthy of inclusion on the National Register. MAIN has reviewed a report entilted "An Archaeological Overview and Management Plan for Seneca Army Depot (September 1986). Figure A-1 in the plan indicates that two prehistorical/historic sites (NYSM, 4826, NYSM 4824) are not near the OB grounds. MAIN cannot be more specific on the potential for discovery of prehistoric sites as this information is not available from the 1986 Plan.

The nearest known archeological sites are located approximately 2.3 miles to the south of the OB/OD grounds. None of the potential historic archeological sites are located within the OB/OD grounds. The closest potential sites include locations of former farmsteads, circa 1850, and are located near existing roads approximately 1,000 feet to the east, 3,000 feet to the south and 1,500 feet to the west of the OB/OD grounds.

Action specific ARAR's are listed because of the potential for various kinds of treatment. The action specific ARAR's used in conjunction with chemical specific ARAR's will be considered in evaluating technologies early in the planning process.

3.4.2.2 Potential Sources of Items "To Be Considered" (TBC) as Alternative Sources of ARAR's

When ARARs do not exist for a particular chemical or remedial activity or when the existing ARARs are not protective of human health or the environment, other criteria, advisories and guidance may be useful in designing and selecting a remedial alternative. The criteria, advisories and guidance were developed by EPA, other Federal agencies, and state agencies. Table 13 lists Potential Sources of Items "To Be Considered" as Alternatives for ARAR's.

3.4.2.3 Potential Chemical-Specific ARAR and TBC Levels

A preliminary evaluation of the site conditions indicates the media of potential concern are groundwater, surface water, sediments, and soil. The following tables provide numerical listings of potential chemical-specific ARARs and TBCs for the constituents detected at the

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TABLE 13
POTENTIAL SOURCES OF ITEMS "TO BE CONSIDERED" AS ALTERNATIVES FOR ARAR'S

Federal:

- Safe Drinking Water Act National Primary Drinking Water Regulations, Maximum Contaminant Level Goals (MCLGs).
- Proposed Maximum Contaminant Levels (50 Federal Register 46936-47022, November 13, 1985).
- Proposed Maximum Contaminant Levels Goals (50 Federal Register 46936-47022, November 13, 1985).
- Proposed Requirements for Hybrid Closures (combined waste-in-place and clean closures) (52 Federal Register 8711).
- USEPA Drinking Water Health Advisories, long-term only.
- USEPA Health Effect Assessment (HEAs).
- TSCA Health Data.
- Toxicological Profiles, Agency for Toxic Substances and Disease Registry, U.S. Public Health Service.
- Policy for the Development of Water-Quality-Based Permit Limitations for Toxic Pollutants (49 Federal Register 9016).
- Cancer Assessment Group (National Academy of Science) Guidance.
- Groundwater Classification Guidelines.
- Groundwater Protection Strategy.
- Waste Load Allocation Procedures.
- Fish and Wildlife Coordination Act Advisories.
- Federal Guidelines for Specification of Disposal Site for Dredged or Fill Material.
- USEPA Interim Guidance for Establishing Soil Lead Clean Up Levels.
- RCRA Clean-Up Criteria for Soils/Groundwater (RFI Guidance), EPA 530-SW-89-031.

New York State:

- New York State Proposed Safe Drinking Water Standards Maximum Contaminant Levels for VOCs (10 NYCRR 5).
- New York State Underground Injection/Recirculation at Groundwater Remediation Sites (Technical Operating Guidance (TOG) Series 7.1.2).

TABLE 13
(Continued)

- New York State Analytical Detectability for Toxic Pollutants (85-W-40 TOG).
- New York State Toxicity Testing for the SPDES Permit Program (TOG 1.3.2).
- New York State Regional Authorization for Temporary Discharges (TOG Series 1.6.1).
- Sediment Criteria - December, 1989 - Used as Guidance by the Bureau of Environmental Protection, Division of Fish and Wildlife, New York State Department of Environmental Conservation.
- New York State, Division Technical and Administrative Guidance Memorandum (TAGM): Habitat Based Assessment Guidance Document for Conducting Environmental Risk Assessments at Hazardous Waste Sites, December 28, 1989

site during previous investigations. Table 14, Preliminary Identification of ARAR's for Groundwater, and Table 15, Preliminary Identification of ARAR's for Surface Water, summarize the potential chemical-specific ARARs for groundwater. As an additional source of ARAR's, records of decisions (ROD's) from similar sites will be examined to obtain clean-up levels which may be considered as ARAR's.

3.5 DATA QUALITY OBJECTIVES (DQO)

Ultimately, the RI/FS process requires decisions regarding future site remedial actions, including whether or not any actions are required. These decisions will be based upon the data collected during the RI. Consequently, the collected data must be of sufficient quantity and quality to support this decision-making process. Data Quality Objectives (DQO's) is the portion of the RI/FS which considers issues related to data quality and quantity. As the name implies, DQO's establish objectives and requirements for data collection which, if reasonably met, will assure that the collected data is valid for its intended use. The DQO process is typically performed during the initial phases of the project and is an integral part of the scoping process. Establishing DQO's during the preliminary phases of the project is appropriate since the sampling and analysis program must be designed with the intent of meeting or exceeding all the requirements established by the DQO's.

In response to the need to better define the types of data necessary to support this DQO process, EPA (1987) identified five (5) levels of data quality. These levels range from screening techniques, identified as Level 1, to non-standardized analytical techniques, specified as Level 5. Figure 17, Summary of Analytical Levels Appropriate to Data Uses, provides an overview of the various levels of data quality and the appropriate uses of the data.

Level 1 data is classified as field screening data, generally obtained by the use of portable instruments. This information can provide real-time data to assist in the optimization of sampling locations and for health and safety support. Data can be generated regarding the presence or absence of certain contaminants (especially volatile organic compounds, VOC's), at sampling locations. For example, generally during soil boring operations, the soils obtained from the split-spoon sampler is screened for the presence of volatile organics using a hand-held instrument equipped with a Photoionization Detector (PID). The occurrence of high readings, above normal background levels, from a sampling location provides a

TABLE 14

PRELIMINARY IDENTIFICATION OF ARARS FOR GROUNDWATER

	NEW YORK STATE GROUNDWATER QUALITY STANDARDS[1]			NATIONAL PRIMARY DRINKING WATER REGULATIONS[4]	EFFLUENT CRITERIA[5]	LIFETIME HA ADJUSTED FOR DRINKING WATER ONLY[6]	CARCINOGENIC POTENTIAL VALUE[7] (CPV)	CARCINOGENIC POTENTIAL
	PROMULGATED[2] (ug/L)	PROPOSED[3] (ug/L)	(ug/L)[9]	(ug/L)	(ug/L)	(ug/L)	(AS DOSE) (IN ug/L)	ug/L
COMPOUNDS:								
Arsenic	25	25	50	50	N/A			
Barium	1000	1000	1000	1000	N/A			
Cadmium	5	10	10	10	N/A			
Chromium (Hex)	N/A	N/A	N/A	N/A	N/A			
Chromium (Tot)	100	50	50	50	N/A			
Lead	25	50	50	50	N/A			
Mercury	2	2	2	2	N/A			
Selenium	50	10	10	10	N/A			
Petroleum Hydrocarbons	NA	NA	N/A	N/A	N/A			
EXPLOSIVES:								
PETN	NA	NA	N/A	N/A	N/A	-	-	-
HMX	NA	NA	N/A	N/A	30	2,000	-	-
RDX	NA	NA	N/A	N/A	30	10	3	-
TETRYL	NA	NA	N/A	N/A	N/A	-	-	-
2,4,6-TNT	NA	NA	N/A	N/A	40	10	10	-
2,6-DNT	NA	NA	N/A	N/A	N/A	-	-	.07
2,4-DNT	NA	NA	N/A	N/A	0.7	-	-	1.8

NOTES:

1. All New York State Standards Assure Class GA Waters.
2. New York Department of Environmental Conservation, Classes and Quality of Groundwaters 703.5, 1978.
3. New York Department of Environmental Conservation Proposed Revision of Water Quality Regulations for Surface Waters and Groundwaters 703.5, April 1990. Concentrations given as ug/l.
4. Maximum Contaminant Levels (MCLs) are from 40 CFR 141.11.
5. Federal Register, 43 21506-21518, 1978 and 44 15926-15981 values based on effluent criteria.
6. EPA Lifetime Health Advisories (HAs) provide specific advise on the levels of exposure at which adverse health effects would not be anticipated. They do not condone the presence of contaminants in drinking water; nor are they legally enforceable standards.
7. HMX is not currently cited as a human carcinogen. Animal study data were extrapolated to derive human exposure value. Values presented represent a 10^{-5} level of human health risk.
8. EPA known carcinogens (Group A and B). Carcinogenic values have been developed by USABRDL. Values presented are for protection of human health for drinking water and correspond to a 10^{-5} level of human health risk.
9. New York State maximum contaminant level determination as defined in subpart 5-1 of the New York Sanitary Code.

NA Not available.

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TABLE 15

PRELIMINARY IDENTIFICATION OF ARARs FOR SURFACE WATER

	NEW YORK STATE SURFACE WATER QUALITY STANDARDS[1]		FEDERAL WATER QUALITY CRITERIA[2]		
HUMAN	HUMAN (ug/l)	AQUATIC (ug/l)	ACUTE (ug/l)	(ug/l)	CHRONIC (ug/l)
COMPOUNDS:					
Arsenic	50	190	360	360	0.0022
Barium	1000	N/A	N/A	N/A	1000.0
Cadmium	10	0.66	1.8[3]	0.66[3]	10
Chromium (Hex)	N/A	11	16	11	50
Chromium (Tot)	50	117	N/A	N/A	N/A
Lead	50	1.3	34[3]	1.3[3]	50
Mercury	2	0.2	2.4	0.012	0.144
Selenium	10	1	N/A	N/A	10
Petroleum Hydrocarbons	N/A	N/A	N/A	N/A	N/A
EXPLOSIVES:					
PETN	N/A	N/A	N/A	N/A	N/A
HMX	N/A	N/A	N/A	N/A	N/A
RDX	N/A	N/A	N/A	N/A	N/A
TETRYL	N/A	N/A	N/A	N/A	N/A
2,4,6-TNT	N/A	N/A	N/A	N/A	N/A
2,6-DNT	N/A	N/A	590	N/A	N/A
2,4-DNT	N/A	N/A	590	N/A	0.11

NOTES:

1. New York Department of Environmental Conservation, Division of Water Technical and Operational Guidance Series (1.1.1) Ambient Water Quality Standards and Guidance Values. All numbers are based on Class "AA", Source Water Supply For Drinking, Culinary or Food Processing Purposes and Other Uses.
2. United States Environmental Protection Agency, Quality Criteria for Water, May, 1986.
3. These compounds have criteria that are dependent on the hardness of the water. These concentrations assume the water has a hardness of 50 mg/L $CaCO_3$.

NA Not available

qualitative indication that volatiles are present and, therefore, samples collected from this location should be subjected to more rigorous analytical techniques.

Level 2 data is also screening data but is characterized as a higher level of screening quality data. Depending upon the level of QA/QC associated with the techniques used to generate this data, it may be used in support of engineering decisions. Another important factor which will relate to the quality of the data collected at this level is the skill of the operator. Usually the operator must be an analytical chemist familiar with good laboratory practices.

Level 2 data would include both field and laboratory analyses which require the use of portable analytical instruments, mobile laboratories stationed at or near the site, and analyses performed in the laboratory without the extensive QA/QC of the higher level of data quality. Depending upon the types of contaminants, sample matrices, and personnel skills, reliable qualitative and quantitative data can be obtained. In general, when quantitative data is desired, confirmation of field results will be obtained by submitting duplicate samples to the laboratory for analysis. The accuracy of field results will be assessed by comparing the results. Level 2 data cannot be used for risk assessment calculations, as the QA/QC requirements are not rigorous enough to assure that the quality of the information is sufficient for this use. Although Level 2 data can include method blanks, internal standards, and surrogate spikes, it usually does not include such QA/QC procedures as matrix spikes or multipoint calibration curves which is required for higher level data.

Level 3 data is generated by laboratories which follow strict EPA QA/QC requirements as stated in the written methods. Level 3 analyses provide confirmed identification and quantification of organic and inorganic compounds in water, sediment, and soil samples. Analytical procedures includes spikes, spike duplicates, laboratory duplicates, and multipoint calibration curves. Level 4 data is generated by analyses performed in the Contract laboratory Program (CLP). Routine Analytical Services (RAS) are performed according to methods established by the USEPA and the CLP Statement of Work (SOW). The New York State Department of Environmental Conservation (NYSDEC) has also established CLP Protocols for routine analyses with requirements that are considered equivalent to the USEPA requirements for Level 4 data. Level 4 analyses are characterized by rigorous QA/QC requirements defined in the SOW. The data package submittal from the laboratory contains all the raw data generated in the analyses, including mass spectral identification charts, mass spectral tuning data, spike recoveries laboratory duplicate results, method blank results, instrument calibration, and holding times documentation.

Level 5 data is generated by the performance of non-routine analyses classified as Special Analytical Services (SAS). These analyses incorporate many of the QA/QC measures used in the CLP routine methods with additional specific QA/QC measures as required by the method. The components of a Level 4 RAS data package submittal can be modified to accommodate these non-routine analyses. The determination of explosives in soil and water at SEAD will be conducted by using a non-routine analytical method and, thus, will be reported as Level 5 data quality.

3.5.1 Intended Use of Data

The requirements of DQO's are dictated by the intended use of the data. Since the intended use of the data is to support several decisions for the RI/FS process, the first step in establishing DQO's is to identify these decisions. Once the decisions, which the collected data will support, have been identified, the levels of data quality can be specified. The sampling program and the analytical techniques to be employed must be consistent with the required levels of data quality. For the SEAD project these decisions have been identified and include the following:

- Determining the nature and extent of current environmental impacts
- Monitoring for health and safety
- Assessing the risk to human health and the environment
- Selecting appropriate remedial alternatives
- Designing remedial actions, if necessary
- Determining background levels of constituents of concern
- Determining regulatory compliance with ARAR's.

3.5.2 Data Quality

Figure 18, Summary of Analytical Levels Appropriate to Data Uses, identifies the levels of data quality required for the various intended uses. As shown in Figure 18, EPA has indicated that at a minimum, Level 3 quality data should be collected to support many of the decisions to be made at the SEAD site, such as Risk Assessment. However, in order to meet the requirements of New York State, samples for metals in soils/sediments and

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 - FIELD TEST KITS	- INSTRUMENTS RESPOND TO NATURALLY-OCCURING COMPOUNDS	- IF INSTRUMENTS CALIBRATED AND DATA INTERPRETED CORRECTLY, CAN PROVIDE INDICATION OF CONTAMINATION
SITE CHARATERIZATION 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, NS	- 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 IDENTIFICATON 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	- NON-CONVENTIAL PARAMETERS - METHOD-SPECIFIC DETECTION LIMITS - MODIFICATION OF EXISTING METHODS - APPENDIX 8 PARAMETERS	- MAY REQUIRE METHOD DEVELOPMENT/MODIFICATION - MECHANISM TO OBTAIN SERVICES REQUIRES SPECIAL LEAD TIME	- METHOD-SPECIFIC

SOURCE: DATA QUALITY OBJECTIVES FOR REMEDIAL RESPONSE ACTIVITIES DEVELOPMENT PROCESS EPA, 1987

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SUMMARY OF ANALYTICAL LEVELS APPROPRIATE TO DATA USES

FIGURE 18 AUGUST 1991

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surface water/groundwater will be collected and analyzed according to NYSDEC CLP protocols and the data reported as Level 4. The analysis for explosives in soil/sediment and surface water/groundwater is a non-routine EPA method and will be analyzed and reported as Level 5. Specifying Level 4 and Level 5 quality data will assure that the data collected in this program is of sufficient quality for the intended use. Figure 19, Data Use and Media Sampling Matrix for SEAD, identifies the intended uses of the data for SEAD.

Level 1 data will involve headspace scanning of the opened spoon using a hand-held vapor meter equipped with a Photoionization Detector (PID). The presence of elevated readings indicate soils which need special handling precautions as the presence of explosives may be indicated. Precision and accuracy for Level 1 data has not been established by EPA. The intended use of this information is for health and safety monitoring and identification of gross contamination.

Level 2 data will be collected during the soil collection program. This level of data quality will be collected during the soil sampling program. The soil sampling program envisioned for this site will likely establish a grid which will be used to estimate the number of samples to be collected. The grid will cover all areas of interest (i.e., the burning pads), and the surrounding areas. The area to be evaluated will include the entire 30 acre parcel and will likely involve the collection of hundreds of soil samples. Due to the large number of samples to be evaluated soil screening techniques will be utilized. The soil screening data will constitute both Level 1 and Level 2 data. Soil samples will be screened for the presence of explosives using a Spectronic 20. The procedure for screening explosives in soils involves extracting the explosives in acetone, KOH, and Na_2SO_3, followed by the spectrographic analysis using a Spectronic 20 or equivalent. MAIN's review of the data indicates that 246 TNT is a reasonable indicator compound for a field screening. Based upon both visual and Level 1 headspace readings, special handling precautions may be employed. The intended use of this data is for defining the nature and extent of explosives at the site and for the engineering evaluation of alternatives.

The screening of heavy metals in soil will be performed at the on-site field laboratory. The procedure will involve an acid extraction followed by analysis, on-site, using atomic adsorption (AA). MAIN's review of the existing data indicates that lead is a suitable indicator compound for the presence of heavy metals in soil. The presence of lead above certain established criteria may warrant further evaluation.

DATA USE MEDIA	SITE EVALUATION	HEALTH AND SAFETY MONITORING	RISK ASSESSMENT	EVALUATION OF ALTERNATIVES	ENGINEERING DESIGN OF ALTERNATIVES	ASSESSING BACKGROUND CONCENTRATIONS	REGULATORY COMPLIANCE WITH ARAR'S
SOURCE SAMPLING	LEVEL 2/4/5	LEVEL 1	LEVEL 4/5	LEVEL 4/5	LEVEL 4/5	NA	LEVEL 4/5
SOIL SAMPLING	LEVEL 2/4/5	LEVEL 1	LEVEL 4/5	LEVEL 4/5	LEVEL 4/5	LEVEL 4/5	LEVEL 4/5
GROUNDWATER SAMPLING	LEVEL 4/5	LEVEL 1	LEVEL 4/5	LEVEL 4/5	LEVEL 4/5	LEVEL 4/5	LEVEL 4/5
SURFACE WATER SEDIMENT SAMPLING	LEVEL 4/5	LEVEL 1	LEVEL 4/5	LEVEL 4/5	LEVEL 4/5	LEVEL 4/5	LEVEL 4/5
AIR SAMPLING	*	*	*	*	*	*	*
BIOLOGICAL SAMPLING	LEVEL 4/5	NA	LEVEL 4/5	LEVEL 4/5	NA	LEVEL 4/5	LEVEL 4/5

NOTE: NA - NOT APPLICABLE (i.e. DATA COLLECTED WILL NOT BE USED FOR THIS USE)

* - NO SAMPLING PROPOSED

LEVEL 4 QUALITY DATA WILL BE COLLECTED FOR THE ANALYSIS OF VOA's AND METALS

LEVEL 5 QUALITY DATA WILL BE COLLECTED FOR THE ANALYSIS OF EXPLOSIVES

SENECA ARMY DEPOT

DATA USE AND MEDIA SAMPLING MATRIX FOR SEAD

AUGUST 1991
FIGURE 19

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The reasons for incorporating a Level 2 screening into this program include:

- Cost - Comparison of the cost for screening for heavy metals and explosives will decrease the cost by a factor of approximately four (4) compared to the cost of obtaining all Level 4 and 5 data.

- Amount of Samples - The amount of samples to be collected will be substantial enough to warrant screening.

- Constituents to be Screened - Since there is substantial interest in heavy metals, and explosives screening will be required for each class of chemical. Methodologies have been developed which will provide a reasonable degree of confidence in the data. This may involve two types of screening, i.e., one for metals, and one for explosives. The level of effort involved in performing these screening analyses in substantially less than that required by Level 4 and 5. Furthermore, the screening results can be reported in 24 and 48 hours and will aid in decision-making for field operations. Full Level 4 data packages will take up to 35 days to obtain the results.

Since the objective of this sampling program is to collect valid samples, samples considered valid must be defined. Table 16, Goals of Data Quality, identifies the range of accuracy and precision which will be used as a factor in determining if the samples are considered valid. These goals are based upon historical determinations of accuracy and precision from the CLP program. Other considerations, such as holding time, proper shipping methods and chain-of--custody forms, will be considered and evaluated during the data validation process. These considerations will not be described in this section.

The evaluation of data quality will be based upon a formal data validation process, which will evaluate the quality of data from a laboratory perspective. This process considers numerous factors such as laboratory blanks, spike recoveries, holding time consideration, spectral identification matching and instrument calibration. In addition to the evaluation of the data from a laboratory perspective, consideration will be given to the precision of the data from a field perspective. This will involve the collection of sufficient field duplicate samples, usually between 10% to 20%, field blanks and trip blanks.

TABLE 16

GOALS FOR DATA QUALITY

Chemical Class	Precision (% RPD[1])		Accuracy (% Recovery[2])	
	Water	Soil	Water	Soil
Heavy Metals	75-125	50-150	50-150	20-180
Explosives	75-125	50-150	70-130	50-150
Volatiles	75-125	50-150	70-130	50-150

---

[1] %RPD - Relative Percent Difference of Spike Duplicates

[2] % Recovery - Recovery of Spikes

If sufficient data points have been collected, the variability associated with the occurrence of pollutants in the environment will be quantitated. The error associated with environmental data is generally expressed as a confidence interval of the measurement. Confidence intervals provide a basis for assessing the inherent variability associated with any distribution of environmental data. Several techniques can be used to estimate confidence intervals associated with data points. These techniques begin by determining the type of distribution of data set comprises. The two types of data distribution usually encountered in environmental measurements are normal distributions and lognormal distributions. The distinction between the two can be determined from the evaluation of the histogram. The histogram is a graphical presentation between frequency of occurrence and a data set. Once the frequency of distribution has been established, the confidence interval associated with each measurement is determined through a statistical evaluation of the variance associated with the measurements. The techniques to be employed are beyond the scope of this discussion, other than simply indicating that the confidence interval with each data set will be evaluated and presented with the collected data.

3.5.3 Data Quantity

The issue of determining an appropriate minimum database for an investigation of a hazardous waste site, such as at SEAD, is critical to a proper sampling and analysis plan.

EPA (1987), has provided guidance related to the methods which the agency considers appropriate in performing this analysis. The technique involves the use of geostatistics or the statistical analysis of regionalized variables.

The field of geostatistics, which includes a technique called "Kriging", was developed for estimating reserves for mining operations. These methods are applicable for site assessment and monitoring situations where data are collected on a spatial network of sampling locations. The methods can be employed to determine sample spacing for collection networks and can be used to obtain probability maps of pollutant concentration. The primary advantage of geostatistics, over other spatial estimation techniques, is that the technique has the ability to determine both the precision of the resulting estimates and the range of influence of the sample. Kriging, in environmental assessments is used to obtain the minimum variance which will produce unbiased estimates of the concentration of a pollutant at a point. This information can be used to determine the average concentration in an area or a volume.

Kriging is a weighted moving average method used to interpolate values from a sample data set. The Kriging weights are computed from a variogram which measures the degree of correlation among sample values as a function of the distance and direction between samples. Unlike classical statistics, the deviation between data points is not assumed to be random, as factors affecting the deviation at one point also operate at nearby points.

All geostatistical evaluations begin by first constructing a variogram. The variogram is generally a plot of variance verses distance between sample pairs, The plot describes how the variance between samples changes as a function of distance and direction between samples. Calculation of variance begins by first compiling all data pairs which are the same distance between them. Variance is then calculated as one-half the average squared difference between these sample pairs.

The general formula for calculation of variance, γ *(h), is:*

$$\gamma(h) = \frac{1}{2n} \sum_{i=1}^{n} (X_i - X'_i)^2$$

Where:

n = number of pairs of samples a distance h apart
x_i = value of first sample in i-th pair
x'_i = value of second sample in i-th pair

The "general model" shown in Figure 20, General Variogram Model and Examples of Individual Variogram Models, shows the main parameters derived from a variogram model, namely:

- The <u>sill</u>, which shows the highest level of variance measured by the variogram. Some variograms do not have a sill.
- The <u>range</u> is the distance at which the variogram plateaus or reaches the sill value and represents a measure of the maximum distance of influence of a drill hole in the direction concerned. Beyond this distance, sample values are independent of one another. Some variograms do not have a range.

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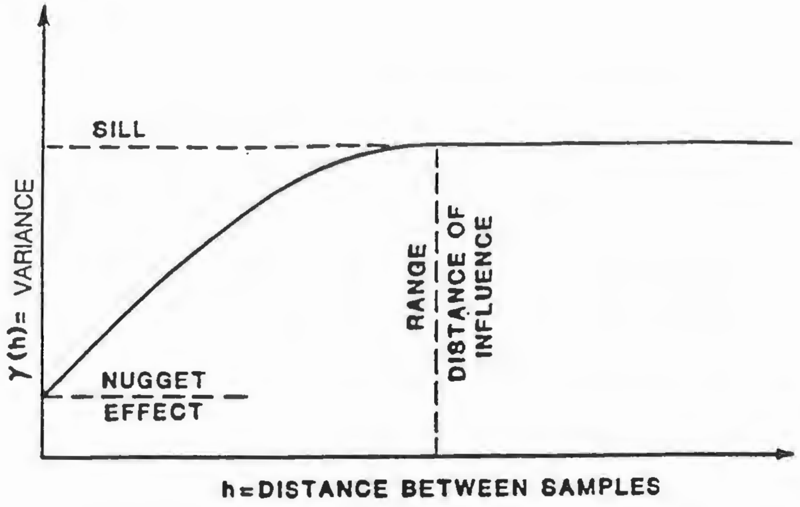
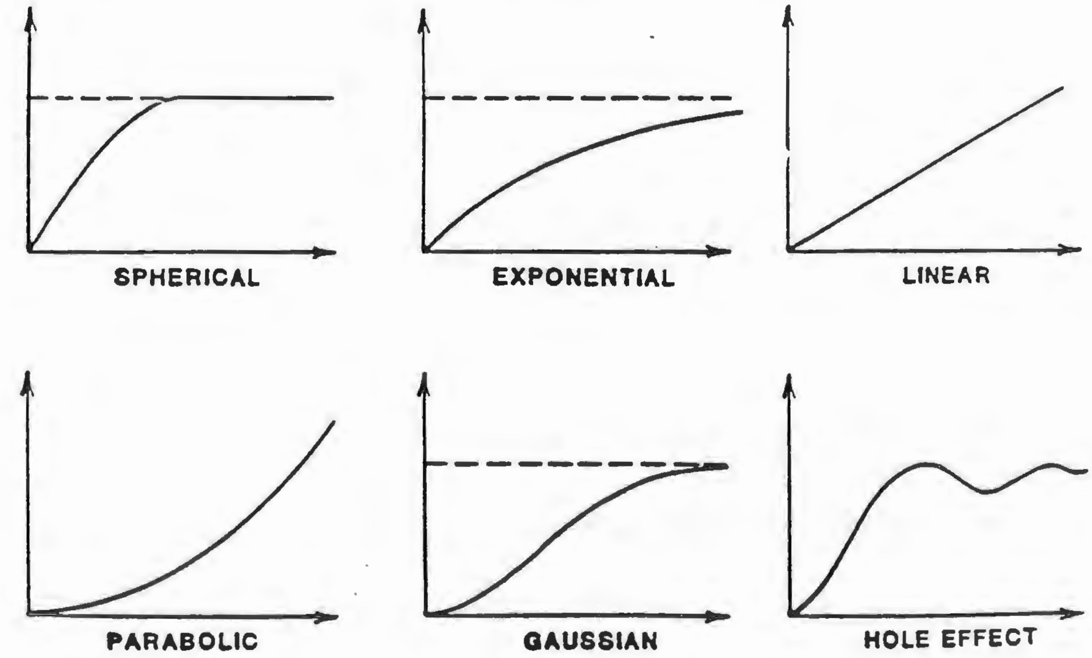


GENERAL MODEL


SPHERICAL EXPONENTIAL LINEAR

PARABOLIC GAUSSIAN HOLE EFFECT

INDIVIDUAL MODELS

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GENERAL VARIOGRAM MODEL
AND EXAMPLES OF
INDIVIDUAL VARIOGRAM MODELS

FIGURE 20 AUGUST 1991

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- The nugget effect is the value of the variogram at zero distance. It represents the sample variability at a small distance caused by small scale geologic controls. It also gives an important indication of the presence and magnitude of sampling and assaying errors.

A variety of variogram models may be used to develop the variograms of experimental data. Examples of such models are shown in Figure 19. The most common single model is the spherical model. Other models which are commonly found include:

- The exponential model, which does not have a range but reaches a sill asymptotically.

- The parabolic model, which indicates a linear drift or trend and a high level of continuity in the sample values. It will be observed if there is a systematic linear increase or decrease in values.

- The Gaussian model, which behaves like the parabolic model for short distances but plateaus at large distances.

- The linear model, which indicates that the variability is directly proportional to the distance.

- The "hole effect" model, which may be indicative of periodicities in the data, or may only reflect improper sample spacing.

Once a semivariogram has been calculated, it must be interpreted by fitting to it a mathematical formula or "model" which will help to identify the characteristics of the deposit and yield numerical parameters which describe the deposit's continuity.

From a properly modelled variogram one can determine whether the data are correlated, if this correlation is isotropic, the distance at which samples become independent, if there is a nugget effect (variability smaller than scale of observation), and whether any drift is present. Care must be taken in the variogram modeling to characterize the data distribution, as environmental variables are often logarithmically distributed and will require a transformation prior to variogram calculations. One advantage of geostatistics is that variances of the errors associated with making an estimate (extension variance) can be calculated from the variogram. The distribution of the errors can then be used to develop confidence intervals about an estimate. The Kriging system is then developed by minimizing the extension variance using the method of Lagrange multipliers as described by Zirchky, J.H., (1986). Once the Kriging is performed, a procedure known as cross-validation can be used to refine the variogram model. Cross validation compares actual values and Kriging estimates, if the variogram models are correct the average error between values should be near zero.

In summary, geostatistical evaluations (variograms, kriging, and cross validation) of the sampling data will be incorporated into data quality objectives to:

- Allow calculation of minimum variance and unbiased estimates;
- Account for actual spatial variability at a site;
- Determine precision of resulting estimates and range of influence of a sample;
- Account for directional correlations between sample points;
- Estimate average concentrations of blocks to facilitate clean-up criteria design.

MAIN has conducted a geostatistical analysis of the soils data collected to date. This data has been obtained from the 1984 Phase 4 hazardous waste study conducted by USAEHA. The soils data from Phase 2 was not used because the exact sample location could not be determined and therefore coordinates for geostatistical analysis could not be ascertained.

Variograms were computed using GEO-EAS, a geostatistical package developed by the EPA Environmental Monitoring Systems Laboratory (EMSL) of Las Vegas, Nevada. The U.S. Army, during the Hazardous Waste Management Study Phases II and IV, has collected a total of seventy-one (71) soil samples, twenty-four (24) for Phase II and forty-seven (47) for Phase IV. None of the Phase II samples could be utilized for geostatistical review since no location could be assigned to the samples. Of the forty-seven (47) samples collected, 46 were considered, one was destroyed during shipment. Samples were combined and averaged to yield only two stratas, 0-2' and 2'-6'. Twenty-one (21) samples were considered representative of the 0-2' strata and nine (9) were considered for the 2'-6' strata.

The samples collected at the 0-2' strata are considered representative of the surficial soil in the pads and adjacent areas. This data base included three (3) sediment samples that were obtained from surface drainage ditches which drain the pad area. Since the numbers of data points from the 0-2' strata was over two times more than that for the 2-6' strata the focus of the geostatistical evaluation was only on the data set compiled from the 0-2' strata.

The goal of the preliminary geostatistical evaluation of the data collected from the USAEHA Phase 4 soil investigation was to determine two sample grid spacings, one for the entire 30 acre site and one for the burn pads. Since the burn pads are expected to comprise the majority of the soil source areas, a tighter sample grid spacing than that for the 30 acres was expected. The tighter grid spacing of the pads would provide a sufficient level of confidence to assure that the nature and extent of pollutants at the pads had been sampled. Consequently, the geostatistical approach utilized for determining the required grid spacing for the entire 30 acres included all the 21 data points from the 0-2' strata of the Phase 4 report. The required grid spacing for the individual burn pads utilized only the data from an individual pad, (Pad B), not all the pads.

In determining a database for the geostatistical determinations of the proper sample spacing over the entire site, consideration was given to those pollutants which were detected the most. MAIN's evaluation indicated that both TNT and Lead were detected a sufficient number of times to warrant a geostatistical analysis. Prior to preliminary geostatistical calculations, several assumptions were made during the data preparation. These assumptions include:

- Assigning of values for BDL data at one-half (1/2) the detection limit.
- The assignment of coordinates for the bore-hole locations.
- Evaluating the berm samples the same as the surface bore-hole samples.

Variograms were obtained for both TNT and Lead. The variogram for TNT indicated a smaller range than Lead and therefore a smaller grid spacing. Consequently, only the variogram for TNT is presented. Figure 21, Variogram and Model Data Set for Ln of 246-TNT, illustrates the obtained variogram when all the Phase 4 TNT data was geostatistically analyzed.

The result of this analysis determined the range to be approximately 400 feet. This means that a grid spacing greater than 400 feet would yield data which could not be reasonably correlated to any other point. In other words, if the grid spacing was in excess of 400 feet, then the spacing would be to large to adequately detect the presence of any continuous source areas. MAIN proposes a grid spacing over the entire 30 acres of 200 feet. This is half the required spacing indicated by the variogram and provides a factor of safety.

Analogous to the approach taken for the entire data set, the data from three pads B, F and

FINAL DRAFT

MODEL

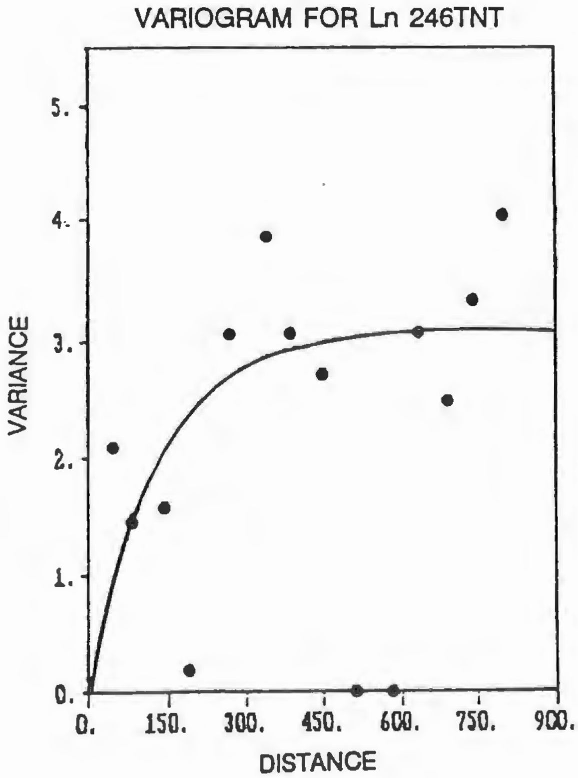
	Pairs	Avg Distance	Value
1	18	45.902	2.075
2	29	86.148	1.466
3	15	143.431	1.577
4	2	193.205	.192
5	9	271.534	3.033
6	17	332.786	3.797
7	14	384.880	3.044
8	6	448.447	2.708
9	3	508.234	.000
10	2	583.511	.000
11	8	634.256	3.039
12	10	692.828	2.469
13	15	742.046	3.327
14	11	799.000	4.043
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			

Model

Nugget : .000

Type	Sill	Range
Exponent.	3.100	400.000

Entire Burn Pad Area
(All Data Including BDL's)



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VARIOGRAM AND MODEL DATA
FOR Ln Of 246TNT

FIGURE 21 **AUGUST 1991**

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H were used to determine a grid spacing for the burn pads. The variograms for Lead provided the smallest range and is presented here. Figure 22, Variogram and Model Data for Ln of Lead (Pb), illustrates the results of the geostatistical analysis performed using the data from Pad B only. The Lead data from Pad B provided a total of 21 data pairs, which was the largest data set of the three pads analyzed. The variogram shown in Figure 22 indicates the range to be 50 feet. This represents the maximum grid spacing which would be possible to provide adequate coverage over the burn pads. As with the proposed overall spacing, MAIN proposes to provide a grid spacing of 25 feet over the burn pads. This will provide a degree of safety which will ensure adequate sample collection.

3.6 DATA GAPS AND DATA NEEDS

The data gaps, and, subsequent, data needs for the Open Burning ground are a direct result of the need to meet the DQO's previously identified. By media, these data needs are:

1. Groundwater Data Needs
    - Verification of the results from the monitoring wells already established at the OB/OD site. This will entail the redevelopment of the existing 14 monitoring wells in the shallow aquifer. Groundwater flow has been determined to be to the east-northeast toward Reeder Creek. Based on field reconnaissance, no residential wells have been determined to be located directly downgradient of the OB/OD grounds. However, if during the course of the investigation residential wells are to be located near and downgradient from the site, they will be sampled and analyzed for contaminants. While residences with private drinking water wells are present west of SEAD, presently, MAIN does not feel that it is necessary to sample groundwater from these residential wells farther downgradient of the site.
    - Determination of background concentrations. This will involve determination of background for the OB/OD grounds at SEAD. MAIN will install a background well off the OB site but within the general site area. This well will yield data characterizing the background quality of the SEAD groundwater.
    - Installation of additional monitoring wells screened in both the weathered shale and the overburden glacial till. Collected data will establish vertical hydraulic gradients and pollutant concentrations in the weathered shale.
    - Establish database to determine compliance with ARAR's.

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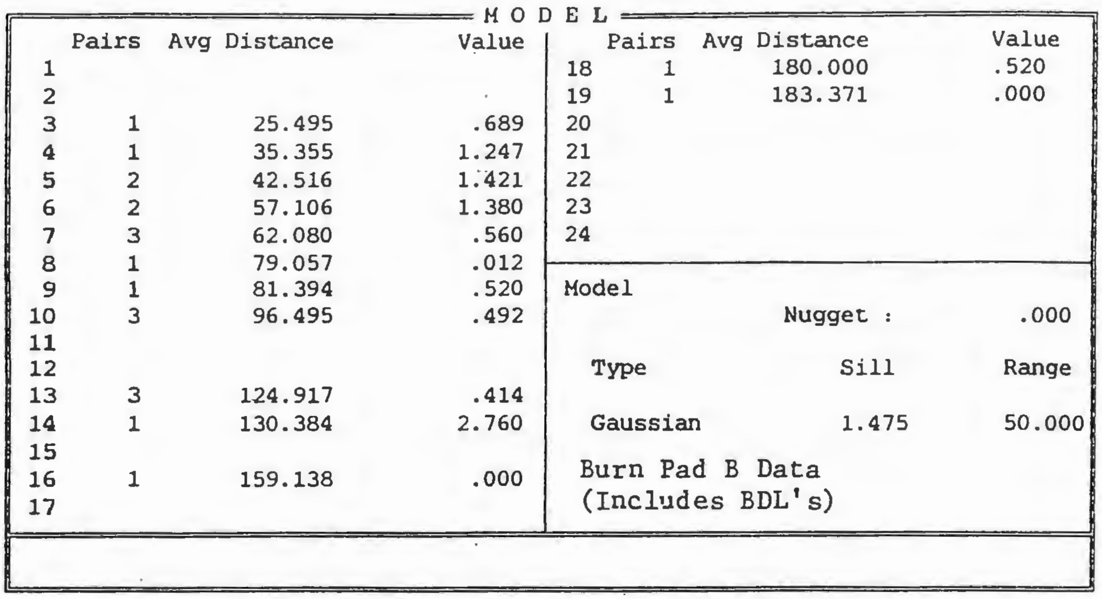
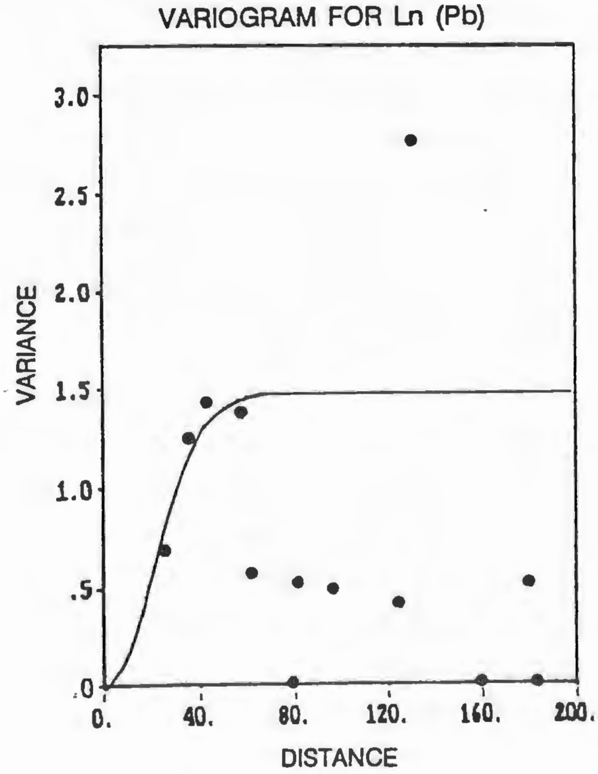


```
================================ M O D E L =================================
   Pairs  Avg Distance          Value | Pairs  Avg Distance          Value
 1                                    | 18     1      180.000         .520
 2                                    | 19     1      183.371         .000
 3     1        25.495           .689 | 20
 4     1        35.355          1.247 | 21
 5     2        42.516          1.421 | 22
 6     2        57.106          1.380 | 23
 7     3        62.080           .560 | 24
 8     1        79.057           .012 |-------------------------------------
 9     1        81.394           .520 | Model
10     3        96.495           .492 |              Nugget :          .000
11                                    |
12                                    |  Type              Sill       Range
13     3       124.917           .414 |
14     1       130.384          2.760 |  Gaussian          1.475     50.000
15                                    |
16     1       159.138           .000 |  Burn Pad B Data
17                                    |  (Includes BDL's)
```



SENECA ARMY DEPOT

VARIOGRAM AND MODEL DATA
FOR Ln Of Lead (Pb)

FIGURE 22 AUGUST 1991

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- In addition to assessing the groundwater quality, hydrologic properties of the aquifer must be determined to assess contaminant migration and potential remedial actions. Hydraulic conductivity will be determined for several wells at the site.
- The physical conditions of the existing monitoring wells will be determined.
- Groundwater quality will be assessed by specifying analytical protocols which will include analysis for explosives, metals, volatiles, and also degradation products of the explosives. The complete list for the TCL and the Inorganic TAL is shown in Tables 17-21 of Section 4.0. This expanded analytical database will encompass any possible pollutant which could be disposed of at the site.

2. Surface Water/Sediment
    - Determination of nature and extent of contamination for offsite surface waters and sediment. Sample collection will concentrate on drainages leaving the OB/OD grounds and Reeder Creek where it borders the OB/OD site.
    - Establish concentration levels in Reeder Creek, upstream and downstream from the OB/OD site.
    - Establish database for environmental compliance with ARAR's or clean-up goals.
    - The analytical protocol for surface water will include an analysis for explosives, metals, hardness, nitrates, volatiles, and degradation products of the explosives.
    - Total Organic Carbon (TOC) will be performed on sediment samples to assess the sorptive potential of these sediments.

3. Soils
    - Determine the nature and extent of contamination across the 30 acre site. Collection of sufficient samples for risk evaluation is necessary.
    - Determine the nature and continuity of contamination around the Burn Pads. Data for risk evaluation is necessary for all pads.
    - Establish background levels for similar soils, off the OB/OD grounds. MAIN will take precautions to assure that soil background samples are collected from nearby "clean areas." Background surface water and groundwater samples will be collected from nearby the site to determine the quality of water at the site. MAIN does not feel it will be necessary to collect background samples from areas outside of the Seneca Army Depot.
    - The Analytical Protocol for soils will include analysis for explosives, their degradation products and the complete TCL/TAL list.

- Data needs for assessing general response actions of capping, excavation or in-situ treatments include: soil properties (permeability, moisture content, gradation, TOC).
- Treatability studies may be required to assess certain technologies: stabilization/ solidification, vitrification and/or soil washing/flushing.
- Number and depth of soil borings are more completely described in the Task Plan for the RI. There will be 50 boring locations across the 30-acre site at 200 foot spacing. There are approximately 40 burn pad boring locations and 80 berm and low lying hill sample locations.

4. Air
   - No sampling planned.

5. Biological
   - Ecological Assessment to systematically document visual observations discriminating between obviously and potentially impacted and non-impacted areas. This will determine where and if there is a need for further investigation.
   - Delineation of wetlands on the OB grounds and surrounding areas.
   - A complete analysis of flora/fauna and endangered species in the vicinity is required.

4.0 TASK PLAN FOR RI

This section describes the tasks to be performed during the Remedial Investigation (RI) at the OB/OD grounds. The following tasks are included in this WP:

1. Pre-field Activities
2. Field Investigations
3. Data Reduction, Interpretation and Assessment
4. Data Reporting
5. Task Plan Summary

4.1 PRE-FIELD ACTIVITIES

The pre-field activities include the following:

1. A site inspection to familiarize key project personnel with site conditions and finalize direction and scope of field activities,
2. A comprehensive review of the Health & Safety Plan with field team members to insure that the hazards that might occur and preventive and protective measures for those are completely understood,
3. An inspection of all equipment necessary for field activities to insure proper functioning and usage, and
4. A comprehensive review of sampling and work procedures with field team members.

4.2 FIELD INVESTIGATIONS

Five (5) major subtasks comprise the field investigation of the RI:

1. Geophysical Investigation,
2. Soils Investigation,
3. Surface Water Investigation,
4. Groundwater Investigation, and
5. Ecological Investigation.

The following sections describe the general scope of work involved in each of these subtasks. A detailed description of proposed sampling procedures is included in the Field Sampling and Analysis Plan, attached as Appendix A.

4.2.1 Geophysical Investigation

The areas to be subjected to the geophysical investigation include all the burn pads and the areas where soil borings will be performed. Figure 23, Extent of Geophysical Investigation, illustrates the areas to be subjected to geophysics.

The proposed Unexploded Ordnance (UXO) Geophysical Plan for the SEAD OB/OD site will consist of the following major tasks:

1. Hand Held Magnetometer survey of the sampling sites and related access routes.
2. GSSI Subsurface Interface Radar (SIR) -10 System survey of the pad surface areas.
3. Cross section sampling of subsurface geophysical anomalies detected during ground penetrating radar (GPR) and magnetometer surveys. This will include excavation using heavy equipment in order to identify the subsurface anomaly.

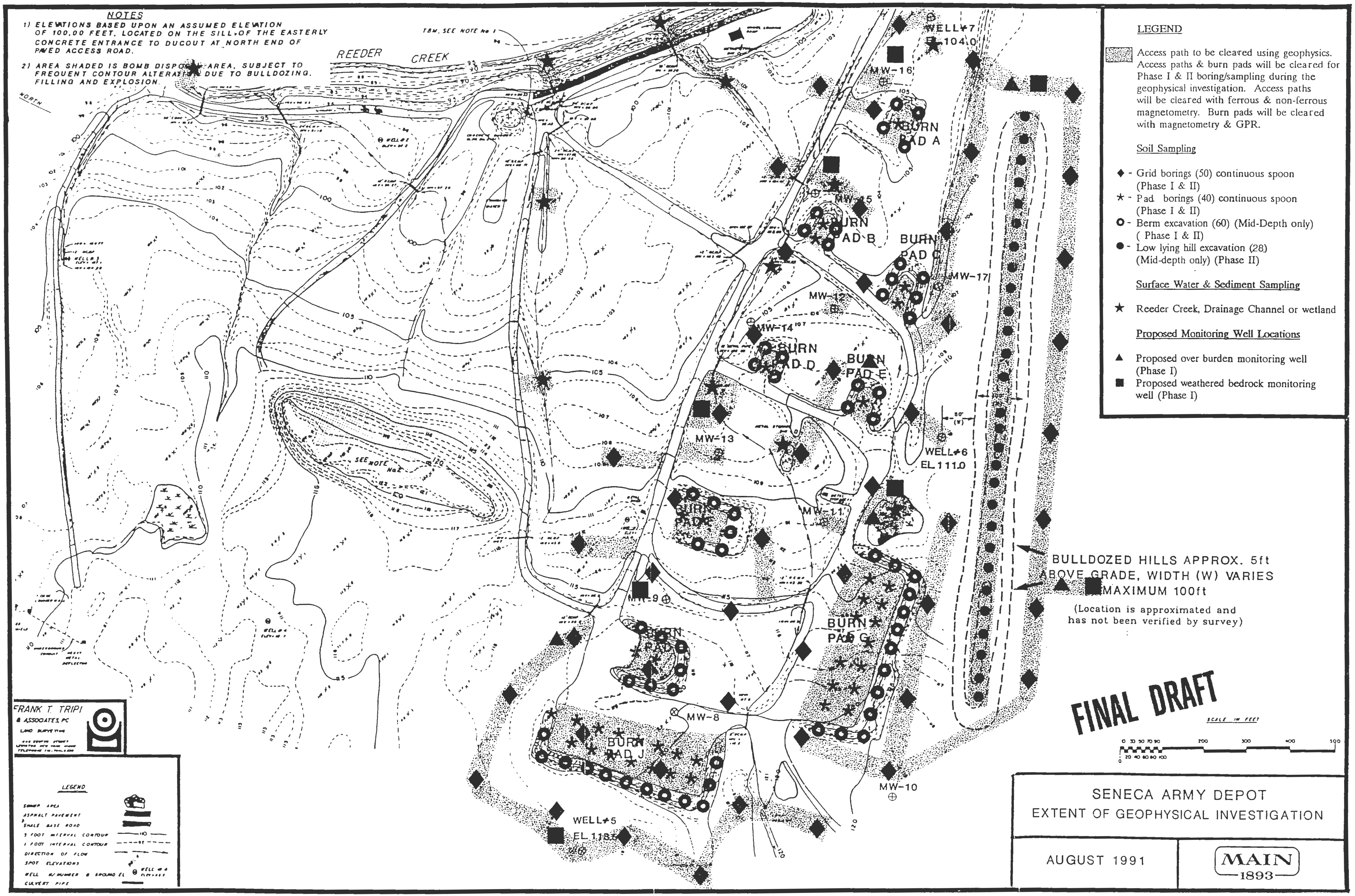
Each of the tasks described produces a result unique to the application of the task. The following sections describe the objectives and procedures associated with the previously mentioned tasks.

4.2.1.1 Hand Held Magnetometry Survey

The main purpose of the Hand Held Magnetometry survey is to ensure the safe entry of personnel and equipment into each of the sampling sites. Additionally, the hand held magnetometry instruments can be used to survey difficult to access areas.

HFA will be using an electromagnetic (active all-metals) induction detector and a passive ferrous metals detector to search the access routes, sampling areas, and areas difficult to access (i.e. the face and top areas of the pad berms) on the OB site. The hand held magnetometers and a description of their operation are listed below:

FIGURE 23



NOTES

1) ELEVATIONS BASED UPON AN ASSUMED ELEVATION OF 100.00 FEET, LOCATED ON THE SILL OF THE EASTERLY CONCRETE ENTRANCE TO DUGOUT AT NORTH END OF PAVED ACCESS ROAD.

2) AREA SHADED IS BOMB DISPOSAL AREA, SUBJECT TO FREQUENT CONTOUR ALTERATION DUE TO BULLDOZING, FILLING AND EXPLOSION.

LEGEND

▨ Access path to be cleared using geophysics. Access paths & burn pads will be cleared for Phase I & II boring/sampling during the geophysical investigation. Access paths will be cleared with ferrous & non-ferrous magnetometry. Burn pads will be cleared with magnetometry & GPR.

Soil Sampling

◆ - Grid borings (50) continuous spoon (Phase I & II)

★ - Pad borings (40) continuous spoon (Phase I & II)

○ - Berm excavation (60) (Mid-Depth only) (Phase I & II)

● - Low lying hill excavation (28) (Mid-depth only) (Phase II)

Surface Water & Sediment Sampling

★ Reeder Creek, Drainage Channel or wetland

Proposed Monitoring Well Locations

▲ Proposed over burden monitoring well (Phase I)

■ Proposed weathered bedrock monitoring well (Phase I)

FRANK T. TRIPI
& ASSOCIATES, PC
LAND SURVEYING

LEGEND

SWAMP AREA
ASPHALT PAVEMENT
SHALE BASE ROAD
5 FOOT INTERVAL CONTOUR
1 FOOT INTERVAL CONTOUR
DIRECTION OF FLOW
SPOT ELEVATIONS
WELL W/ NUMBER & GROUND EL
CULVERT PIPE

SENECA ARMY DEPOT
EXTENT OF GEOPHYSICAL INVESTIGATION

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1. Electromagnetic (Active All-Metals) Induction Detectors

- Active locators, as a class, generate a magnetic field. Their detection ranges are determined by the strength of their magnetic field, the attenuation of the field in the soil, the size and makeup of the items being sought, and the amount of conductive clutter in the search area. These factors tend to limit active detection ranges to three (3) feet or less, depending on the search instrument. A major advantage to this type of detector is its all metals capabilities. These instruments are capable of detecting ordnance constructed of both ferrous and nonferrous metals. Active locators can affect influence fuzing; therefore it is necessary to have some knowledge of the types of ordnance and their fuzing systems that may be encountered within the search area. The U.S. military currently utilizes locators that employ the multiple-coil, balanced bridge, and phase-imbalance types of active locators.

- The active all-metals magnetometer used by HFA is the White's Eagle II SL 90. The White's Eagle II SL 90 is able to detect a 75 to 81 mm projectiles at a depth of 1.5 to 2 feet. There are many environmental considerations that can effect the depth of detection (magnetic signatures), i.e., soil characteristics (minerals and salts present), type of metal being detected, size of the metal object, orientation of the object (vertical or horizontal to the linear axis of the object), metallic contamination of the site (wide spread fragmentation), and the capabilities of the detector. Activities such as earth removal and tree grubbing can also change the magnetic signatures in the earth.

2. Passive Ferrous Metals Detector

- Passive ferrous metal detectors detect anomalies in the earth's magnetic field which are produced by ferromagnetic (ferrous metal) targets. Generally, passive locators respond to either: 1). the magnitude of the magnetic field strength (Proton-Precession) or 2). the gradient or rate of change of the field (Fluxgate). The detection ranges of passive locators are dependent on not only the resolution of the device, but also the magnetic features of both the search area and the items being located. Within the EOD community the standard passive magnetometers in use today are of the Fluxgate and the Proton-Precession types.

- The passive ferrous metal magnetometers currently used by HFA are the Mk 26, Mod 0 Ordnance Locator (Förster Ferex 4.021) and the Schonstedt Model GA-52B. These are Fluxgate type ferrous metals passive magnetometers. The detection depth capability of these magnetometers is greater than the White's Eagle II SL 90, however it will only detect ferrous metal UXOs. The environmental factors listed above for the Eagle II also effect the performance of the Mk 26, Mod 0 Ordnance Locator (Förster Ferex 4.021) and the Schonstedt Model GA-52B.

Due to the extremely heavy contamination of the OB/OD site with ordnance components and UXOs, extreme care for the personnel and equipment entering the 200 foot site and 25 foot burn pad sampling areas is required. Nearly all of these items have been exposed to fire or explosions and because of this, any of these items which are still explosively loaded are extremely hazardous. The active all-metals and passive detectors will be used to search the access routes and sampling sites for hazardous items. Dependant upon the object size, physical properties (ferrous or nonferrous) and depth of burial, large metal objects can also be located and marked on the OB/OD site. Excavation to determine the identification of these items will be performed as needed to complete the study of the OB/OD site.

Specialized techniques such as down hole magnetometry can also be performed. If manual operation of the soil boring equipment is performed, rechecks of the bore hole at 2 foot intervals will be performed until virgin soil is encountered. If remote drilling procedures are employed, no additional checks of the site are required after the initial active all-metals and passive ferrous metals inspection of the sampling site have been performed.

Data verification for the Hand Held Magnetometry survey will be an ongoing process during the clearance or the access routes and sampling areas with the main emphasis being the location of hazardous UXOs and components.

4.2.1.2 GSSI Subsurface Interface Radar (SIR) - 10 System Survey

Using the SIR-10 system, a GPR survey of the pad surface areas will be performed to determine if there are any burn trenches, burn pits, or UXO / residue burial areas under the burn pad sites. The SIR-10 can also identify the built up burn pad and original ground surface interface.

The SIR-10 system will be hand operated on the burn pad sites. As the SIR-10 is pulled across the burn pad site, the reflected radar pulses are transmitted to the receiver unit where they are converted analog signals. The analog signal is then transmitted to the control unit where the signal is electronically processed and then sent to the graphic recorder. The graphic recorder produces a continuous chart display on electro-sensitive paper. This real-time display enables the operator to interpret the data on site.

The data from the SIR-10 survey can then be applied to the burn pad grid spacing of 25 feet for plotting the subsurface anomalies. The subsurface geophysical data obtained by the SIR-10 survey will then be used to evaluate each of the burn pad 25 foot grids to identify areas requiring additional study and to also avoid potentially hazardous areas during the soil boring and sampling operations.

Data verification for the SIR-10 survey will be performed during the sampling and excavation of the burn pad sites. The HFA UXO technicians will excavate as required to perform the verifications deemed necessary.

4.2.1.3 Cross Section Sampling of Subsurface Geophysical Anomalies

Cross section sampling of subsurface geophysical anomalies is performed to verify the data obtained during the GPR and magnetometer surveys. Additionally, a greater area can be exposed for visual examination and collection of contaminated materials.

The cross section sampling excavations will be performed with a backhoe operated by an HFA UXO technician. At no time will non-UXO personnel be permitted on the excavation site until they are cleared to enter by the HFA UXO Safety Officer. The excavation will extend to a distance of 2 feet on either side of the subsurface anomaly. The width, length, and depth will be based on the size of the geophysical anomaly with applicable considerations for prevailing conditions such as flooding or stability of the excavation. Based on consultation with the MAIN Project Leader, HFA UXO Project Leader, and HFA UXO Safety Officer, a decision will be made at which point to cut off the excavation. The boom and bucket of the backhoe will be operated in such a manner as to not exert impact or shock to the soil or its contents. The depth of the excavation increment will be at the discretion (not to exceed 2 feet) of the HFA UXO Safety Officer. The contents of each bucket of material removed from the excavation will be gently placed on the ground and spread out so as to expose the contents as much as possible for a visual inspection. A staging area, which includes run-off containment features, will be set up for visual inspection of the contents so that soils partially contaminated with hazardous constituents are not spread out over the site. If at any time during the excavation the HFA UXO Safety Officer determines that the risk and hazards are too great to proceed with the excavation, the excavation will be halted. The HFA UXO Safety Officer has absolute and final authority in determining the procedures and safety issues associated with the excavation.

The excavation will be continuously monitored by MAIN with an organic vapor meter, a gieger counter and a particulate meter. At no time will any personnel be permitted to enter the excavation. If the pit is not to be closed immediately after the required samples have been obtained, the excavation will be barricaded to prevent accidental entry by personnel working on the site. Each excavation will be marked after closure as needed for identification of the site.

A log containing the location of each cross section sample site will be maintained by the HFA UXO team. The log at a minimum will contain all of the data required to identify each cross section sample site and related data such as size, UXO or UXO related components, and other significant data. Records pertaining to sampling, geological data and associated requirements will be maintained by MAIN. Where possible, the geophysical equipment will be calibrated using the results of the depth and orientation of any uncovered UXOs.

Due to the potential hazards associated with the cross section sampling, when necessary, HFA will obtain samples for MAIN in accordance with the sample collection procedures. The excavation equipment will be cleaned between cross section site sampling operations.

4.2.2 Soils Investigation

The purpose of the soils investigation program will be to:

1. Determine the nature and extent of contamination across the site,
2. Provide a data base for the site risk assessment,
3. Provide a data base for the feasibility study, and
4. Determine if the soils exceed background levels.

The program will consist of different types of soil samples; 1) Continuous split spoon soil borings across the OB/OD grounds to refusal, which is anticipated to be at 10 feet deep, 2) Continuous split spoon soil borings on each pad to refusal, which is anticipated to be at 10 feet deep, and 3) Mid-depth, cross sectional, berm samples.

4.2.2.1 Approach to Soils Investigation

A geostatistical evaluation of the data collected from the USAEHA Phase 4 soils investigation was used to determine two soil sample grid spacings. One grid spacing was for the entire 30 acre OB grounds and one was for the burn pads. Section 3.5.3, Data Quality, provides a detailed discussion of these grid spacings. A grid sample spacing of 200' was determined for the entire 30 acre site, and a 25'-50' spacing was determined for the burn pads (Figure 23). A tighter grid spacing for the burn pads is deemed appropriate since the pads are expected to comprise most of the soil source areas. The spacings provide a degree of conservatism, by a factor of 2, to ensure adequate sample collection. In other words, the spacings are tighter than those determined necessary by the geostatistical evaluation.

Soil borings will be performed by the continuous spoon method. This is deemed necessary because of the condition of the site. Prior sampling, performed during the USAEHA Phase 4 soils investigation, has determined that there are certain zones and discrete areas of contamination that could be overlooked if samples were not collected continuously. The extensive soil sampling program and frequency of sampling is justifiable due to the expected variability of contamination.

At each boring location a 0-6" surficial soil sample will be collected in addition to the 2 foot intervals to be collected as a result of continuous split spoon sampling. The surficial samples will be used to evaluate potential exposure pathways for the risk assessment.

The soil borings will be performed until refusal. Normally, refusal is defined as when 100 blows to the split spoon using a 140 lb hammer dropped from a height of 30 inches fails to drive the spoon 1 foot into the earth. This is expected to be at approximately 10 feet of depth across the site. However, since UXO's may be encountered at the site, the definition of refusal will be modified. For the safety of the drilling contractor, refusal may be a field decision by the driller based upon his/her experience that he/she has encountered UXO or a suspicious object.

Split spoon samples will be collected continuously for the length of the boring. Samples collected from the ground surface to the depth of the first spoon sample in saturated, naturally deposited sediments will be sent to the laboratory for Level II analysis. Continuous split spoon sampling will occur for the remainder of the boring, however, the samples will not be submitted for Level II analysis. Because one of the goals of the subsurface investigation is to characterize source areas, MAIN does not feel that it is necessary to analyze split spoon samples below the upper portion of the saturated zone in naturally deposited sediments since source contamination (i.e. explosive sand heavy metal residues from burning) would not be present in natural undisturbed saturated soils. All split spoon samples collected in fill material will be submitted for Level II analysis.

Based upon the Level II data, a select portion of these samples will undergo Level IV and V NYSDEC CLP analysis for metals, explosives and volatile organics. Overall, there will be two complete Level IV or V analyses per borehole. This higher level of data quality will be used to assess the accuracy of the Level II analysis. In addition, this level of data quality is required to ensure that the Data Quality Objectives for the risk assessment, the site evaluation and the evaluation of remedial alternatives are obtained.

The Level II analyses will only be performed for certain indicator compounds. The indicator compounds selected for the screening program are Lead for heavy metals, TNT for explosives, and total volatile hydrocarbons for the volatiles. Lead and TNT are judged to be good indicator compounds because they were found to be prevalent in earlier soil investigations and at elevated concentrations. Volatile hydrocarbons have not been previously analyzed at this site. However, the groundwater has been analyzed for Total Organic Halogens (TOX) and did indicate that low levels were present in the groundwater.

TOX is a gross indicator of the presence of halogenated organics. Total Petroleum Hydrocarbons (TPH) analyses were also performed by M&E, but these analyses failed to detect the presence of TPH in any of the existing 14 monitoring wells.

The reasons for incorporating a Level II analytical program into the soil boring include:

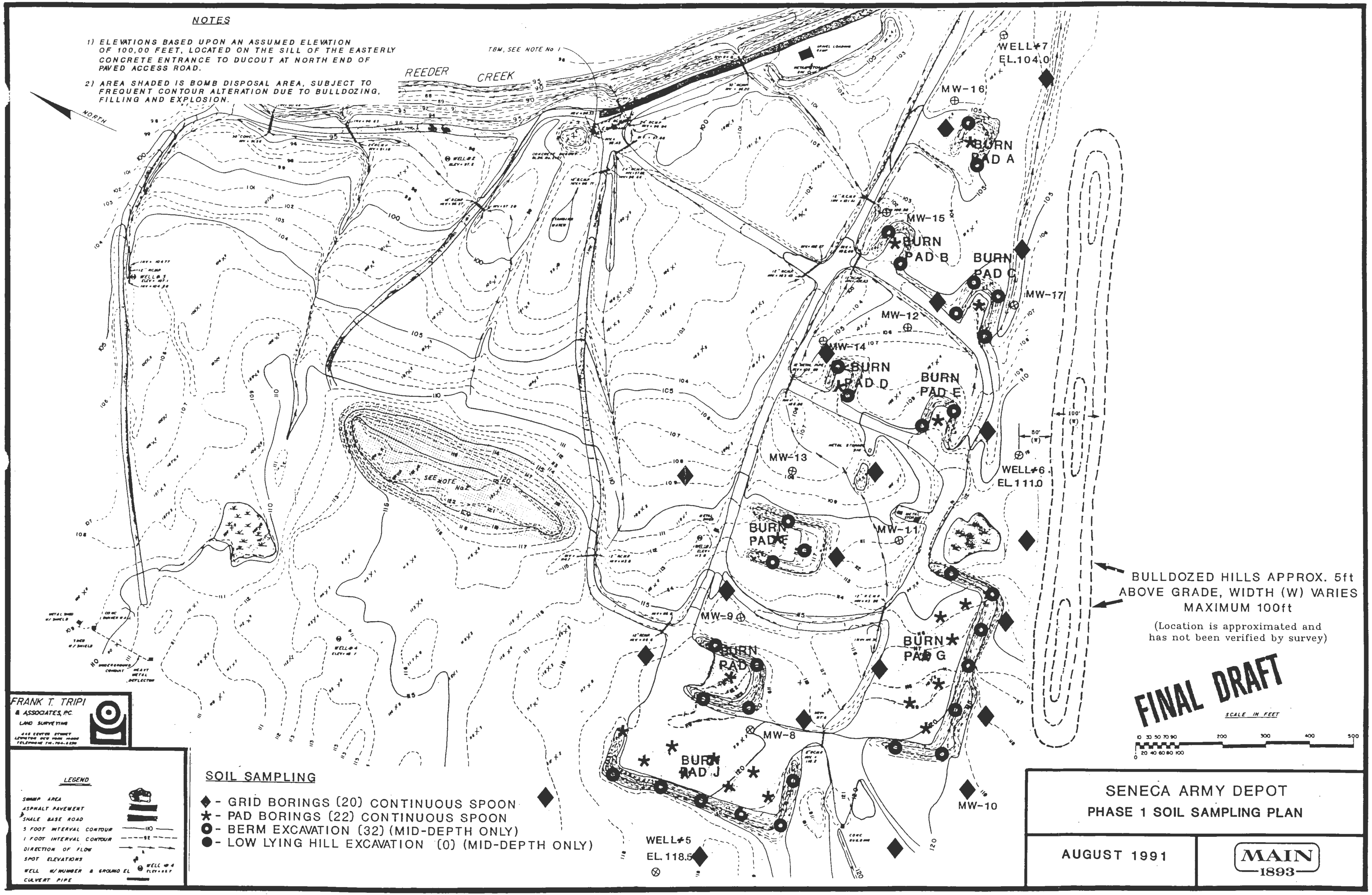
- Cost - It will cost approximately ten times less to screen a soil sample than to perform Level IV and V analyses on that sample.
- Number of Samples - The number of samples to be collected warrant screening.
- Level of Effort and Turnaround Time - The level of effort required for Level II is much less than for Level IV and V analysis. The Level II results can be reported in 24-48 hours and will aid in decision making for field operations.

4.2.2.2 Soil Sampling Program

MAIN will conduct the soil boring and excavation sampling program in two phases. Phase I will consist of: 1) 20 grid borings, 2) 22 burning pad borings and 3) 32 berm excavations (Figure 24). A second phase of borings and excavation sampling (Phase II) will be performed on the site after the completion of Phase I. Phase II will consist of: 1) 30 grid borings, 2) 18 burning pad borings, 3) 28 berm excavations and 4) 28 low-lying hill excavations (Figure 25). The locations of the Phase II sampling may be altered slightly depending on the outcome of the Phase I sampling. The grid sample spacing across the entire 30 acre site was determined to be 200 feet. This results in 50 boring locations, 20 to be performed during Phase I and 30 to be performed during Phase II. The grid was modified along several lines to allow a more representative coverage (Figure 23). One (1) surficial soil sample will be collected at each boring location resulting in 50 surficial soil samples. Five (5) subsurface soil samples will be taken from each boring, resulting in 250 subsurface samples.

The berms which surround each of the nine burn pads and the long, low lying hill adjacent to the burn pads will be considered as individual single areas for sampling. Individual burn pads will be subject to the tighter grid spacing of 25'-50', depending on the size of the burn pad (Figure 23). The grid points at the burn pads will constitute locations for soil borings, from which it is expected that one surficial soil sample and five subsurface samples will be

FIGURE 24



NOTES

1) ELEVATIONS BASED UPON AN ASSUMED ELEVATION OF 100,00 FEET, LOCATED ON THE SILL OF THE EASTERLY CONCRETE ENTRANCE TO DUCOUT AT NORTH END OF PAVED ACCESS ROAD.

2) AREA SHADED IS BOMB DISPOSAL AREA, SUBJECT TO FREQUENT CONTOUR ALTERATION DUE TO BULLDOZING, FILLING AND EXPLOSION.

SOIL SAMPLING

◆ - GRID BORINGS (20) CONTINUOUS SPOON
★ - PAD BORINGS (22) CONTINUOUS SPOON
○ - BERM EXCAVATION (32) (MID-DEPTH ONLY)
● - LOW LYING HILL EXCAVATION (0) (MID-DEPTH ONLY)

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PHASE 1 SOIL SAMPLING PLAN

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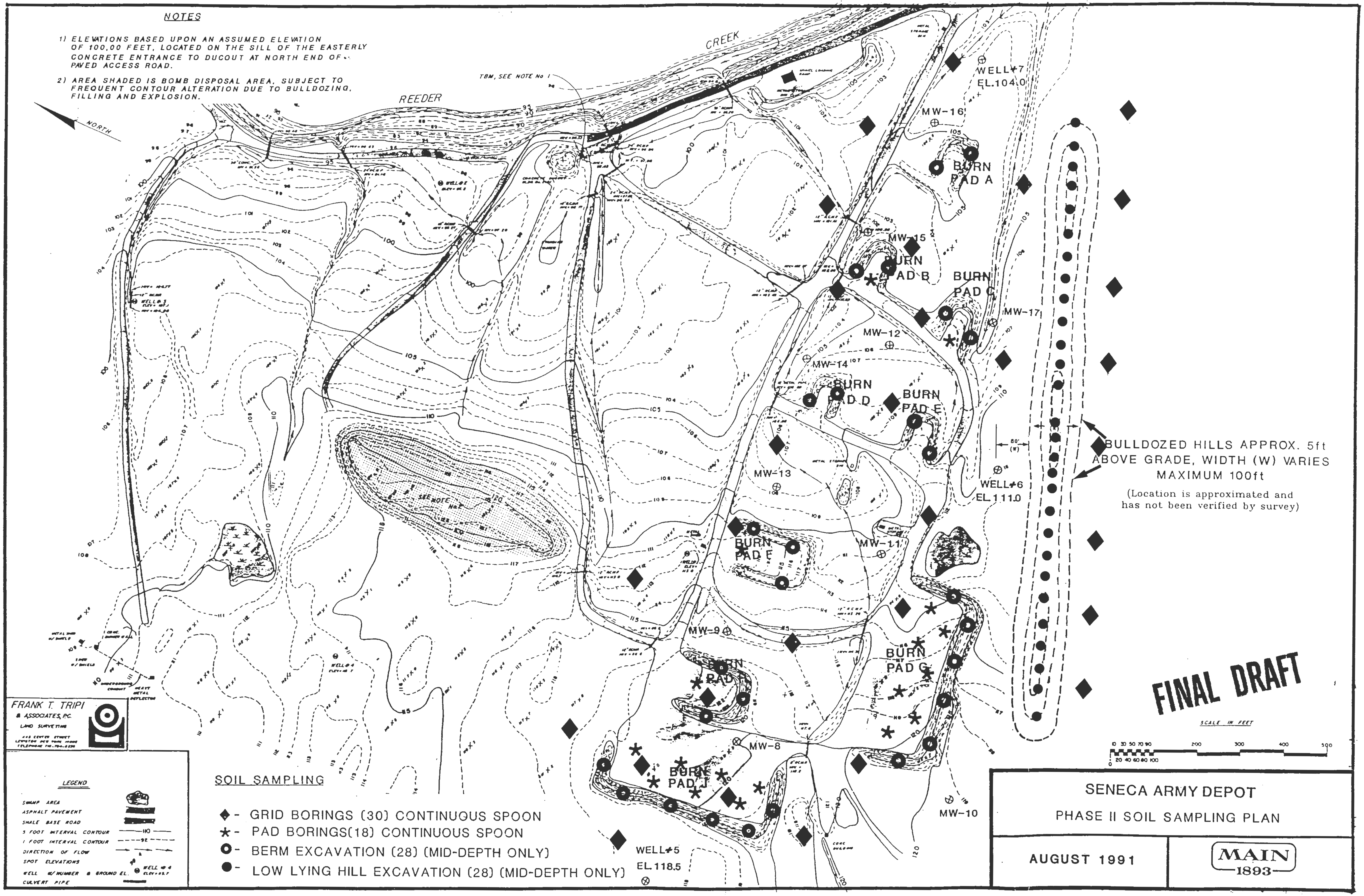
FIGURE 25



NOTES

1) ELEVATIONS BASED UPON AN ASSUMED ELEVATION OF 100,00 FEET, LOCATED ON THE SILL OF THE EASTERLY CONCRETE ENTRANCE TO DUCOUT AT NORTH END OF PAVED ACCESS ROAD.

2) AREA SHADED IS BOMB DISPOSAL AREA, SUBJECT TO FREQUENT CONTOUR ALTERATION DUE TO BULLDOZING, FILLING AND EXPLOSION.

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& ASSOCIATES, P.C.
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LEGEND

SWAMP AREA
ASPHALT PAVEMENT
SHALE BASE ROAD
5 FOOT INTERVAL CONTOUR —110—
1 FOOT INTERVAL CONTOUR - - -92- - -
DIRECTION OF FLOW
SPOT ELEVATIONS
WELL W/ NUMBER & GROUND EL.
CULVERT PIPE

SOIL SAMPLING

◆ - GRID BORINGS (30) CONTINUOUS SPOON
★ - PAD BORINGS(18) CONTINUOUS SPOON
○ - BERM EXCAVATION (28) (MID-DEPTH ONLY)
● - LOW LYING HILL EXCAVATION (28) (MID-DEPTH ONLY)

SENECA ARMY DEPOT
PHASE II SOIL SAMPLING PLAN

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collected. The grid points that are located on the berms and the hill will be grab samples. Grab samples will be taken at mid-depth along the cross-section of the berm and the hill. A backhoe or suitably equivalent piece of equipment will be used to open the berms for sampling.

MAIN proposes to conduct the sampling of the berms in such a way as to minimize the spreading of contaminated soils across the OB grounds. MAIN will accomplish this in the following way.

1) Using designated areas for temporary storage of the soil during excavation and collection of the sample. The temporary storage area will be immediately adjacent to the excavated area;

2) The backhoe or suitably equivalent machinery used for berm sampling will be decontaminated after excavating at each sampling location. In addition, the decontamination procedures in Section 4.5 may also be employed; and

3) Returning the excavated soil immediately to the berm upon completion of the soil sampling.

A total of 40 borings will be performed on the burn pads, 22 to be performed during Phase I and 18 to be performed during Phase II. A total of 60 excavations will be performed into the berms of the burn pads, 32 to be performed during Phase I and 28 to be performed during Phase II. Twenty-eight (28) excavations will be performed during Phase II in the low lying hill, adjacent to the burn pads. This will result in 100 sample locations on the burnpads (54 for Phase I and 46 for Phase II) and 28 in the low-lying hill (Phase II). Since 5 subsurface soil samples are expected to be collected from each pad boring, 200 subsurface samples will be collected on the burn pads (110 for Phase I and 90 for Phase II). Surficially, 178 samples will be collected, 50 from the soil surrounding the pads (20 during Phase I and 30 during Phase II) 40 from the surface of the pads (22 during Phase I and 18 during Phase II), 60 from the midpoint of each berm surrounding the pads (32 during Phase I and 28 during Phase II), and 28 from the midpoint of the low-lying hill (during Phase II). Subsurficially, 450 samples will be collected (210 during Phase I and 240 during Phase II). The total number of samples to be collected will therefore be 628 (284 during Phase I and 344 during Phase II).

The drilling necessary for the soil borings will be done remotely. Borings will be advanced using hollow stem augers. Representative undistributed soil samples will be collected with a split spoon ahead of the auger. Samples will be collected and placed into appropriate bottles. The appropriate size and containers are described in Appendix C, The Chemical Data Aquisition Plan. Remote drilling procedures will be as follows:

1. Manual - Drive drill rig to hole location
2. Manual - Set up hollow stem auger and drive split spoon
3. Remote - Drill to 5 feet or less
4. Remote - Drive split spoon sample
5. Remote - Retrieval of split spoon sample
6. Manual - Ordnance clearance of UXO's and/or chemical agents by technical escort service provided by HFA.
7. Manual or remote - Grout test boring and remove hollow stem augers.

Surficial grab soil samples will be obtained by troweling quantities of soil into suitable sized sample bottles. These are usually collected from depths of 0 to 6" and from individual points in the burn pad berms and the low lying hill. The mid-depth samples collected from the berm and low lying hill cross sections will also be collected as grab samples.

Decontamination procedures will be followed as specified in Appendix A, The Field Sampling and Analysis Plan. All drilling equipment will be steam cleaned at a designated area before entering or leaving the site. This area will be able to contain this waste water produced.

For Level IV and V samples collected, 10% will be duplicates and 10% will be equipment blanks. For Level II samples collected, 5% will be duplicated and 5% will be equipment blanks.

4.2.2.3 Analytical Program

Level II analyses will be performed at the laboratory on the soil samples collected. Samples collected from the ground surface to the depth of the first spoon sample in saturated naturally deposited sediments will be sent to the laboratory for Level II analysis. Continuous split spoon sampling will occur for the remainder of the boring, however, the samples will not be submitted for Level II analysis. Because one of the goals of the subsurface investigation is to characterize source areas, MAIN does not feel that it is necessary to analyze split spoon samples below the upper portion of the saturated zone in naturally deposited sediments. All split spoon samples collected in fill material will be submitted for Level II analysis. These analyses will be for the indicator compounds mentioned previously, Pb and TNT and for total VOAs. These compounds, being most prevalent at the site, will be used to indicate which samples will undergo further analysis. For each borehole, it is expected that six (6) samples, including the surficial sample, will be collected and analyzed by Level II methods. Of these six (6) samples, the surficial soil sample and one (1) other from the remaining five (5) will undergo Level IV and V analyses. Appendix C, The Chemical Data Aquisition Plan, describes the analytical protocols which will be utilized in this program. A criteria for the Level II soil analysis program has been developed due to the high number of samples that must be evaluated.

As mentioned previously, soil samples will be collected from across the 30-acre OB/OD grounds. To perform Level IV CLP analyses on all of these samples would be cost and time prohibitive. Consequently, MAIN proposes to utilize a Level II analytical screening program for most soil samples to be collected and select samples from this group based upon the criteria presented in Figure 26, Level II Criteria for Soil Analyses. In addition to selecting samples for Level IV and V analyses, the Level II screening data will be used to evaluate the extent of vertical and horizontal contamination at the site.

The methods that will be used for the Level II screening are considered to be reasonably accurate to use the information in this manner. For volatile organics analyses, a purge and trap G.C. method will be used which is equipped with a Photoionization Detector (PID) and a Flame Ionization Detector (FID) in series. Total flame ionizable hydrocarbons will be expressed as Benzene equivalents. Total photoionizable hydrocarbons will be expressed as TCE equivalents. In both cases, individual peaks will not be determined. The detection limits of these analyses is approximately 10 ppb per peak detected.

The Level II method for the analysis of Lead in soil will involve microwave acid digestion. This extraction technique is identical to the procedure used for the Level IV CLP method. Following digestion, the extract will be analyzed for Lead using an Inductively Coupled Plasma (ICP) emission spectrophotometer. This instrument is also used for the Level IV CLP analytical methodology. The difference between the Level II method and the Level IV method is the amount of documentation which will be provided by the laboratory to

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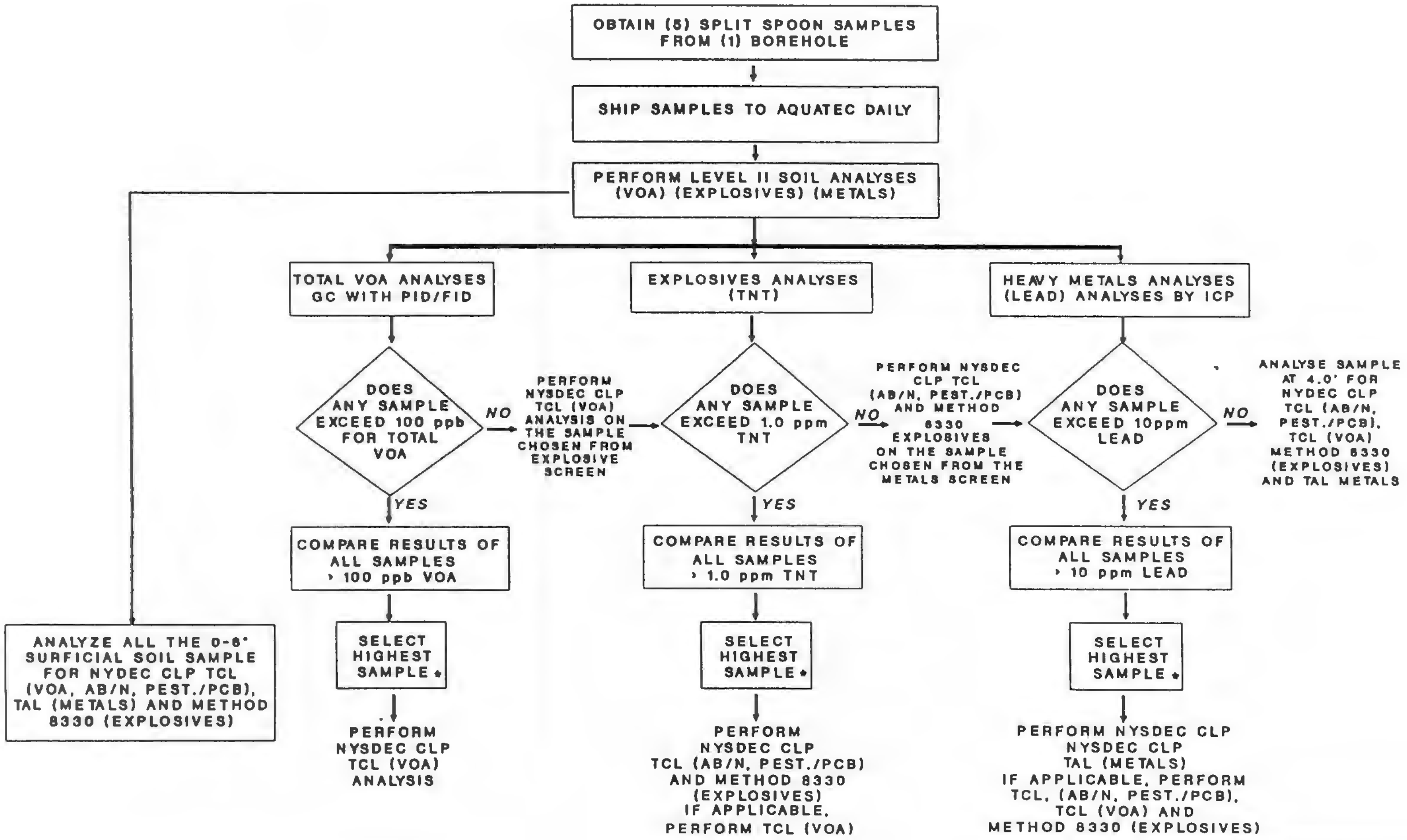
LEVEL II CRITERIA FOR SOIL ANALYSIS



* IN THE CASE OF THE SMALL BURN PADS (A,B,C,D,E) THE TWO HIGHEST BERM SAMPLES WILL BE SELECTED. IN THE CASE OF THE LARGE BURN PADS (F,G,H,J,) THE FIVE HIGHEST BERM SAMPLES WILL BE SELECTED.

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LEVEL II CRITERIA
FOR
SOIL ANALYSES

FIGURE 26 AUGUST 1991

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support the analysis. This actual analytical methods are not significantly different. The detection limit is 10 ppm.

Explosives will be screened according to the method for TNT in soils described in USATHAMA Special Report Number 90-38. The detection limit is 0.5 ppm. This method has been found to have a good recovery (80-100%) for moderately contaminated soil. A more detailed description of the Level II methods which will be used is presented in Appendix C, The Chemical Data Aquisition Plan.

Soils collected from the split spoon samples will also be screened for radioactivity using a hand held giegercounter. This screening will be for health and safety purposes.

Level IV analyses for acid and base/neutral extractables will be performed by the NYSDEC CLP method; Level IV analyses for volatile organics will be performed using the NYSDEC CLP method. Explosives will be analyzed by Method 8330. Since this is not a routine CLP method, it is considered to be a Level V analysis. These methods will determine the concentration of each compound listed on the Target Compound List (TCL), the Target Analyte List (TAL) and the explosive list of Method 8330. Tables 17, 18, 19, 20, and 21 presents the compounds to be analyzed for each list and the quantitation limits for the Level IV and V analyses.

The Level V explosives analysis will be done by Method 8330 using High Performance Liquid Chromatography (HPLC). Soil samples are extracted using acetonitrile, filtered and chromatographed by the high level direct injection method.

The Level IV and Level V analyses will meet the data requirements of the risk assessment and will be used to verify the Level II analyses. The exposure scenarios for this site do not include exposure to subsurface soils, only exposure to surficial soils are included and therefore, each surficial soil sample at each borehole will be analyzed using Level IV and Level V methods.

The sample which contains the highest concentration of the constituents screened from each borehole will also be analyzed using Level IV and Level V methods. This information will be used to determine compliance with ARAR's or TBC's. The extent of impacts and the volume to be remediated will be determined using both the Level II and the Level IV and V analyses.

TABLE 17

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL)* FOR VOLATILE ORGANIC ANALYTE (VOA'S)

VOA'S	Quantitation Limits** Water (ug/L)	Quantitation Limits** Low Soil/Sediment[a] (ug/Kg)
1. Chloromethane	10	10
2. Bromomethane	10	10
3. Vinyl Chloride	10	10
4. Chloroethane	10	10
5. Methylene Chloride	5	5
6. Acetone	10	10
7. Carbon Disulfide	5	5
8. 1,1-Dichloroethene	5	5
9. 1,1-Dichloroethane	5	5
10. 1,2-Dichloroethene (total)	5	5
11. Chloroform	5	5
12. 1,2-Dichloroethane	5	5
13. 2-Butanone	10	10
14. 1,1,1-Trichloroethane	5	5
15. Carbon Tetrachloride	5	5
16. Vinyl Acetate	10	10
17. Bromodichloromethane	5	5
18. 1,2-Dichloropropane	5	5
19. cis-1,2-Dichloropropene	5	5
20. Trichloroethene	5	5
21. Dibromochloromethane	5	5
22. 1,1,2-Trichloroethane	5	5
23. Benzene	5	5
24. trans-1,2-Dichloropropene	5	5
25. Bromoform	5	5
26. 4-Methyl-2-pentanone	10	10
27. 2-Hexanone	10	10
28. Tetrachloroethene	5	5
29. Toluene	5	5
30. 1,1,2,2-Tetrachloroethane	5	5
31. Chlorobenzene	5	5
32. Ethyl Benzene	5	5
33. Styrene	5	5
34. Xylenes (Total)	5	5

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[a] Medium Soil/Sediment Contract Required Quantitation Limits (CRQL) for volatile TCL Compounds are 125 times the individual Low Soil/Sediment CRQL.

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

** Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight based as required by the contract, will be higher.

TABLE 18

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL)* FOR ACID, BASE/NEUTRALS (ABIN'S)

	Quantitation Limits**	
AB/N'S	Water (ug/L)	Low Soil/Sediment[a] (ug/Kg)
35. Phenol	10	330
36. bis (2-Chloroethyl) ether	10	330
37. 2-Chlorophenol	10	330
38. 1,3-Dichlorobenzene	10	330
39. 1,4-Dichlorobenzene	10	330
40. Benzyl alcohol	10	330
41. 1,2-Dichlorobenzene	10	330
42. 2-Methylphenol	10	330
43. bis (2-Chloroisopropyl) ether	10	330
44. 4-Methylphenol	10	330
45. N-Nitroso-di-n-dipropylamine	10	330
46. Hexachloroethane	10	330
47. Nitrobenzene	10	330
48. Isophorone	10	330
49. 2-Nitrophenol	10	330
50. 2,4-Dimethylphenol	10	330
51. Benzoic acid	10	330
52. bis (2-Chloroethoxy) methane	10	330
53. 2,4-Dichlorophenol	10	330
54. 1,2,4-Trichlorobenzene	10	330
55. Naphthalene	10	330
56. 4-Chloroaniline	10	330
57. Hexachlorobutadiene	10	330
58. 4-Chloro-3-methylphenol (para-chloro-meta-cresol)	10	330
59. 2-Methylnaphthalene	10	330
60. Hexachlorocyclopentadiene	10	330
61. 2,4,6-Trichlorophenol	10	330
62. 2,4,5-Trichlorophenol	10	330
63. 2-Chloronaphthalene	10	330
64. 2-Nitroaniline	50	1600
65. Dimethylphthalate	10	330
66. Acenaphthylene	10	330
67. 2,6-Dinitrotoluene	10	330
68. 3-Nitroaniline	50	1660
69. Acenaphthene	10	330
70. 2,4-Dinitrophenol	50	1600
71. 4-Nitrophenol	50	1600
72. Dibenzofuran	10	330

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TABLE 18 (cont.)

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL)* FOR ACID, BASE/NEUTRALS (ABIN'S)

	Quantitation Limits**	
AB/N'S	Water (ug/L)	Low Soil/Sediment[a] (ug/Kg)
73. 2,4-Dinitrotoluene	10	330
74. Diethylphthalate	10	330
75. 4-Chlorophenyl-phenyl ether	10	330
76. Fluorene	10	330
77. 4-Nitroaniline	50	1600
78. 4,6-Dinitro-2-methylphenol	50	1600
79. N-nitrosodiphenylamine	10	330
80. 4-Bromophenyl-phenylether	10	330
81 Hexachlorobenzene	10	330
82. Pentachlorophenol	50	1600
83. Phenanthrene	10	330
84. Anthracene	10	330
85. Di-n-butylphthalate	10	330
86. Fluoranthene	10	330
87. Pyrene	10	330
88. Butylbenzylphthalate	10	330
89. 3,3-Dichlorobenzidine	20	660
90. Benzo(a)fluoranthene	10	330
91. Chrysene	10	330
92. bis(2-Ethylhexyl)phthalate	10	330
93. Di-n-octylphthalate	10	330
94. Benzo(b)fluoranthene	10	330
95. Benzo(k)fluoranthene	10	330
96. Benzo(a)pyrene	10	330
97. Indeno(1,2,3-cd)pyrene	10	330
98. Dibenz(a,h)anthracene	10	330
99. Benzo(g,h,i)perylene	10	330

[a] Medium Soil/Sediment Contract Required Quantitation Limits (CRQL) for volatile TCL Compounds are 125 times the individual Low Soil/Sediment CRQL.

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

** Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight based as required by the contract, will be higher.

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TABLE 19

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL)* FOR PESTICIDES AND POLYCHLORINATED BIPHENYLS (PCB'S)

	Quantitation Limits**	
Pesticides/PCB's	Water (ug/L)	Low Soil/Sediment[a] (ug/Kg)
100. alpha-BHC	0.05	8.0
101. beta-BHC	0.05	8.0
102. delta-BHC	0.05	8.0
103. gamma-BHC (Lindane)	0.05	8.0
104. Heptachlor	0.05	8.0
105. Aldrin	0.05	8.0
106. Heptachlor epoxide	0.05	8.0
107. Endosulfan I	0.05	8.0
108. Dieldrin	0.10	16.0
109. 4,4-DDE	0.10	16.0
110. Endrin	0.10	16.0
111. Endosulfan II	0.10	16.0
112. 4,4-DDD	0.10	16.0
113. Endosulfan sulfate	0.10	16.0
114. 4,4-DDT	0.10	16.0
115. Methoxychlor	0.05	80.0
116. Endrin Ketone	0.10	16.0
117. alpha-Chlordane	0.5	80.0
118. gamma-Chlordane	0.5	80.0
119. Toxaphene	1.0	160.0
120. Aroclor-1016	0.5	80.0
121. Aroclor-1221	0.5	80.0
122. Aroclor-1232	0.5	80.0
123. Aroclor-1242	0.5	80.0
124. Aroclor-1248	0.5	80.0
125. Aroclor-1254	1.0	160.0
126. Aroclor-1260	1.0	160.0

[a] Medium Soil/Sediment Contract Required Quantitation Limits (CRQL) for volatile TCL Compounds are 125 times the individual Low Soil/Sediment CRQL.

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

** Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight based as required by the contract, will be higher.

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TABLE 20

INORGANIC TARGET ANALYTE LIST (TAL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL)

Inorganic Analyte	Contract Required Detection Limit ug/L
Aluminum	200
Antimony	60
Arsenic	10
Barium	200
Beryllium	5
Cadmium	5
Calcium	5000
Chromium	10
Cobalt	50
Copper	25
Iron	100
Lead	3
Magnesium	5000
Manganese	15
Mercury	0.2
Nickel	40
Potassium	5000
Selenium	5
Silver	10
Sodium	5000
Thallium	10
Vanadium	50
Zinc	20
Cyanide	10

TABLE 21

LIST OF EXPLOSIVE ANALYTES AND QUANTITATION LIMITS FOR METHOD 8330

ANALYTE	ABBREVIATION	WATER LOW LEVEL (ug/L)	SOIL (ug/g)
Octahydro-1,3,5,7-tetranitro-1,3,5,7 tetrazocien	HMX	NA	2.2
Hexahydro-1,3,5-trinitro-1,3,5-triazine	RDX	0.84	1.0
1,3,5-Trinitrobenzene	1,3,5-TNB	0.26	0.25
1,3-Dinitrobenzene	1,3-DNB	0.11	0.25
Methyl-2,4,6-trinitrophenylnitramine	Tetryl	NA	0.65
Nitrobenzene	NB	NA	0.26
2,4,6-Trinitrotoluene	2,4,6-TNT	0.113	0.25
4-Amino-2,6-dinitrotoluene	4-Am-DNT	0.06	NA
2-Amino-4,6-dinitrotoluene	2-Am-DNT	0.03	NA
2,6-Dinitrotoluene	2,6-DNT	0.31	0.26
2,4-Dinitrotoluene	2,4-DNT	0.02	0.25
2-Nitrotoluene	2-NT	NA	0.25
4-Nitrotoluene	4-NT	NA	0.25
3-Nitrotoluene	3-NT	NA	0.25

NA - Quantitation Limits have not been established

The criteria to be used for selecting which samples are to be analyzed by Level IV and V methods are presented in Figure 26, Level II Criteria for Soil Analyses. As mentioned previously, each 0"-6" surficial soil sample will be screened and will also undergo a complete NYSDEC CLP analysis for VOA, AB/N, PEST./PCB, TAL (metals) and Method 8330 for explosives.

The remaining five (5) subsurface samples will also undergo the Level II analyses. There will be one (1) additional sample chosen from the five subsurface samples which will be analyzed using NYSDEC CLP methods. The samples chosen to undergo the Level IV and the Level V analyses will be chosen according to the flow chart of Figure 26. As shown in Figure 26, if any of the five (5) subsurface samples exceeds 100 ppb for total volatile organics as Benzene or TCE equivalents, the highest of these will be selected for analysis via the NYSDEC CLP TCL (VOA) method. If none of the five (5) subsurface samples exceeds 100 ppb, total volatile organics, as Benzene or TCE equivalents, the sample chosen for the explosives analysis will be the one which will be chosen for the VOA analysis.

If any of the five (5) subsurface samples, per borehole, exceeds 1 ppm TNT for the Level II analysis, then the highest of these will be selected to undergo the NYSDEC CLP analysis for TCL (AB/N, PEST./PCB) and Method 8330 for (explosives). This sample could also be analyzed for the modified NYSDEC CLP analysis for VOAs if none of the Level II results exceeded 100 ppb for total VOAs. If none of the Level II results for TNT exceeds the 1 ppm TNT cutoff criteria then the samples chosen for the metals analysis will undergo the explosive analysis also. If applicable, the TCL (VOA) analysis will also be performed.

If any of the five (5) subsurface samples per borehole exceeds 10 ppm of Lead for the Level II analysis, the highest of these will be selected to undergo the NYSDEC CLP analysis for TAL metals. If none of the samples exceeds 10 ppm for Lead, then the sample at 4'0" will be analyzed using the NYSDEC CLP TCL analysis for AB/N, PEST./PCB, TCL VOA, (modified NYSDEC CLP) Method 8330 (Explosives) and TAL metals, depending upon which samples were selected previously from the Level II results.

In summary, at a minimum, two (2) soil samples from each borehole, will undergo Level IV and V CLP analysis for heavy metals, VOA's, AB/N's, Pesticides/PCB's and Explosives. The higher level of data quality will provide a database for the risk assessment, ARAR compliance, determining the extent of impacts and, if necessary, in the evaluation of the remedial alternatives. In addition, 10% of the total number of samples will be duplicated and equipment blank samples will be submitted to the lab at a rate of 10%. Graphical relationships between Level II soil results and the Level IV and Level V results will be performed. This will provide support for evaluating the quality of the Level II data. The intent of the Level II screening criteria presented in Figure 26 is:

1. Validation of the most important Level II data (high concentrations),
2. Reduce number of samples to undergo the more expensive and time consuming analysis of Level IV and V.

There are to be 50 borehole locations across the 30-acre site, based upon the 200 foot grid spacing (20 to be performed during Phase I and 30 to be performed during Phase II). At each of these 50 locations, a surficial soil sample will be taken at 6" which will undergo both a Level II and a complete Level IV and V analysis for metals, explosives and volatile organics.

In addition to the surficial sample, there will be (1) one other complete Level IV and V analysis, including volatile organics, metals, and explosives, per borehole. This second CLP analysis may not always be performed on the sample from the same depth. For example, if a sample is analyzed and found to contain the highest concentration of metals, it will then undergo further Level IV laboratory analysis for metals. If another sample, from the same borehole, is found to contain the highest concentration of explosives, that sample will then undergo further laboratory analysis for explosives but may not be at the same depth as the sample analyzed for metals. If no samples are found to contain high concentrations of explosives, metals, or volatile organics, a sample from mid-depth of the borehole will be chosen to undergo the Level IV and V analysis for all classes of contaminants. In this way, two samples will undergo complete Level IV and V analyses for metals, explosives, and volatile organics per borehole. One of the two samples will be the surficial sample, the other analyses will be performed on another sample selected from the same borehole.

Unlike the boreholes, where one sample is selected for Level IV and V analyses, the application of the screening criteria to the burn pad berms and the low lying hill is complicated since more than one Level IV and V sample will be selected from these areas. The Level II sampling interval of the berms and the low lying hill is 50 feet, which is consistent with the interval to be used for the pads. A Level II analysis will be performed

on each sample collected. Since the origin of these berms was the material remaining on the burn pads following a PEP burn, the composition of the berms and the low lying hill is expected to be more uniform than the pads because the materials were mixed during the construction of the berms and the hill. Consequently, MAIN has proposed a Level IV and V sampling frequency of 100 feet. Consideration has also been given to the size of the burn pad berm to be sampled.
MAIN's estimate for Level IV and V berm sampling is as follows:

1. Small Burn Pad Berms (A, B, C, D and E) - The two (2) highest samples from the Level II data, (10 samples total).
2. Large Burn Pad Berms (F, G, H and J) - The five (5) highest samples from the Level II data, (20 samples total).
3. Low Lying Hill - Select the twelve (12) highest Level II samples.

The breakdown of sample locations and numbers of samples to be collected is as follows:

1. 50 borehole locations (20 for Phase I and 30 for Phase II) at 6 samples per borehole = 300 Level II samples and 100 Level IV and V samples.
2. 40 borehole locations (22 for Phase I and 18 for Phase II) on the burn pads at 6 samples per borehole = 240 Level II samples and 80 Level IV and V samples.
3. 60 mid-depth berm locations (32 for Phase I and 28 for Phase II) at 1 sample per location = 60 Level II samples and 30 Level IV and V samples.
4. 28 mid-depth low lying hill locations (for Phase II) at 1 sample per location = 28 Level II samples and 12 Level IV and V samples.
5. The total number of Level II soil samples, excluding QA/QC, (both surficially and subsurficially) is 628 (284 for Phase I and 344 for Phase II).
6. The total number of Level IV and V samples, excluding QA/QC is 222 (100 for Phase I and 122 for Phase II).

In addition to the analyses mentioned previously grain size distribution of select soils at the OB/OD grounds will be determined. The grain size distribution curve will be used to size the sand pack of monitoring wells and understand the structural make-up of the soil.

4.2.3 Surface Water Investigation

4.2.3.1 Approach to Surface Water Investigation

The intent of the surface water investigation is to determine the nature and extent of impacts to the on-site and off-site surface waters and will evaluate the relationship between groundwater and surface water. Sample collection will concentrate on surface water bodies at the OB/OD grounds and Reeder Creek where it borders the OB/OD site. Concentration levels in Reeder Creek, upstream of the OB/OD site, will be used as background. Based on a review of available data to date, MAIN has not uncovered information indicating that upstream areas have been impacted by other SEAD sources or off-site sources. The surface water investigation will also involve the sampling and characterization of surface water on the burning ground, if present. The types of water will include standing water which may potentially represent a wetland. MAIN intends to delineate wetlands on the OB site using the Unified Federal Routine Method. Sediment samples will be collected from the same location as each surface water sample collected.

The migration of groundwater toward Reeder Creek has been identified previously by M&E. The relationship between groundwater and surface water is of concern since if a groundwater plume is detected, it may be discharging to Reeder Creek. The elevation of the surface water of Reeder Creek will be measured and used to interpret the connection between groundwater and surface water. Additionally, streamflow measurements will be obtained to provide an understanding of the size of Reeder Creek. This information will be essential for performing a water balance.

MAIN's initial site visit identified several standing water sites. These will be sampled along with Reeder Creek to determine the extent of impacts. Dermal exposure through wading or other recreational activities in the creek have been identified as potential exposure pathways. Ingestion of fish from Reeder Creek has also been identified as an exposure pathway. On-site surface water, if impacted, may represent an environmental risk to on-site biota. The data collected during this program will be used to assess these potential exposure pathways if necessary.

MAIN's choice of sample locations in "potential wetland" areas is based on a cursory inspection of the site. These areas were identified as being most likely to be impacted by site activities.

MAIN's intent is to sample the six low-lying areas, which were determined to be likely areas of temporary surface water storage and therefore areas of sediment deposition. These areas were identified by field reconnaissance. It is not MAIN's intent to sample all wetlands identified using the methods described above, because any potential on-site wetland may not represent an area of sediment deposition.

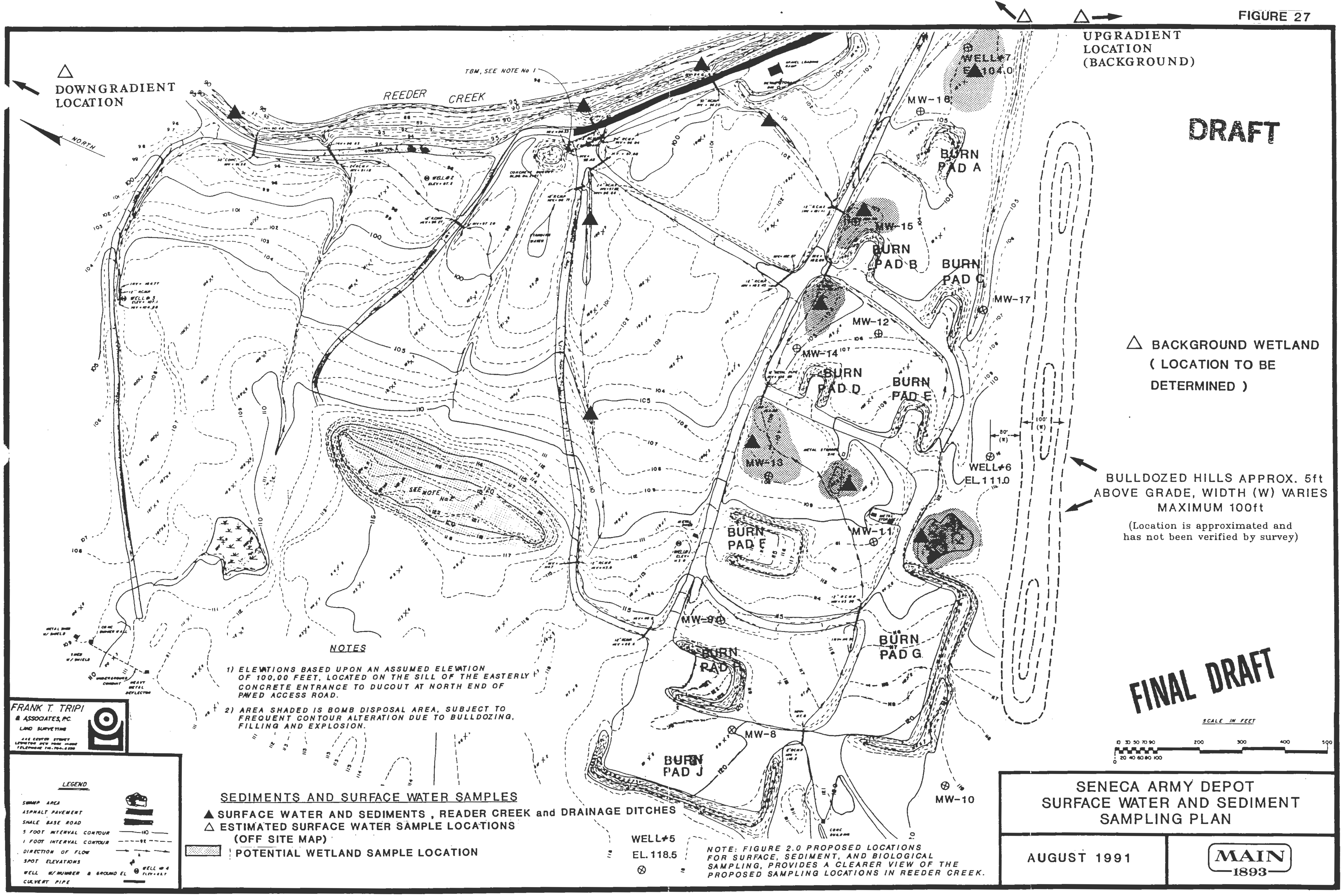
MAIN feels that the selection of on-site low-lying areas and drainage channel samples will provide a good indication as to whether surface run-off from on-site activities have impacted these areas. The surface water flow patterns for the site, Figure 7, indicates that surface water flow is toward Reeder Creek. As seen from the figure, surface water flows through one or more of the sampling locations. The selection of these locations was based upon these identified surface water flow patterns and the topographic site contours.

4.2.3.2 Surface Water Sampling and Sediment Program

Figure 27, The Surface Water and Sediment Sampling Plan, identifies six (6) potential on-site surface water sample locations at the Burning Ground. Additionally, four (4) samples from Reeder Creek will be collected in close proximity to the OB/OD grounds, as shown in Figure 27. Included in the surface water sampling program are one (1) upstream location and one (1) downstream location. Also, three (3) drainage channel locations and one (1) background wetland location will be sampled (Figure 27).

The concentration of pollutants in surface water will vary from season to season. The time of greatest impacts to Reeder Creek is during the low-flow conditions. During low-flow conditions, stream dilution is minimal. Reeder Creek would be most susceptible to impacts from the OB/OD ground by surface run-off or groundwater recharge. The late summer or early fall is considered the best time for surface water samplings and would be when MAIN would sample the creek. Information on rainfall data will be collected prior to sampling. Field data on the geometry of Reeder Creek will be measured if it is not available in the

FIGURE 27



NOTES

1) ELEVATIONS BASED UPON AN ASSUMED ELEVATION OF 100,00 FEET, LOCATED ON THE SILL OF THE EASTERLY CONCRETE ENTRANCE TO DUCOUT AT NORTH END OF PAVED ACCESS ROAD.

2) AREA SHADED IS BOMB DISPOSAL AREA, SUBJECT TO FREQUENT CONTOUR ALTERATION DUE TO BULLDOZING, FILLING AND EXPLOSION.

LEGEND

SWAMP AREA	
ASPHALT PAVEMENT	
SHALE BASE ROAD	
5 FOOT INTERVAL CONTOUR	——110——
1 FOOT INTERVAL CONTOUR	- - - -92- - - -
DIRECTION OF FLOW	——→
SPOT ELEVATIONS	
WELL W/ NUMBER & GROUND EL	⊗ WELL # 4 ELEV.
CULVERT PIPE	

SEDIMENTS AND SURFACE WATER SAMPLES

▲ SURFACE WATER AND SEDIMENTS , READER CREEK and DRAINAGE DITCHES
△ ESTIMATED SURFACE WATER SAMPLE LOCATIONS (OFF SITE MAP)
▨ POTENTIAL WETLAND SAMPLE LOCATION

NOTE: FIGURE 2.0 PROPOSED LOCATIONS FOR SURFACE, SEDIMENT, AND BIOLOGICAL SAMPLING, PROVIDES A CLEARER VIEW OF THE PROPOSED SAMPLING LOCATIONS IN REEDER CREEK.

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literature. This information will include stream bed cross-sections, reach lengths, stream slopes, and (n-values) manning roughness factors. Water discharges in the streams will be measured following the standard operating procedures for stream flow measurements in described Appendix A, The Field Sampling and Analysis Plan. The temperature and the Dissolved Oxygen (DO) of the water will be measured. Stream flow gauging will include velocity measurements in the creek at the sediment sampling locations. The velocities will be measured at 0.6 of the stream depth to represent mean velocities. Flow will be computed as the product of average stream velocity and cross-sectional area. The height of the surface of Reeder Creek will be obtained by installing graduated stream staff gauges in Reeder Creek. The elevation of the top of these gauges will be obtained during the field surveying.

Approximately sixteen (16) surface water (Reeder Creek, drainage channels, and low-lying areas) locations, as shown in Figure 27, will be sampled and analyzed for Level IV total TAL metals, hardness, nitrate, TCL organics (VOA's, AB/N's and Pesticides/PCB's), and Level V Method 8330 explosives. The locations shown will establish levels in Reeder Creek up and downstream from the OB/OD ground and establish concentration levels of pollutants in the on-site surface water.

Surface water samples will be taken as grab samples. Surface water samples will be collected using a Kenmerer bottle, a Beta Sampler, or a telescoping aluminum pole with an attached clamp and beaker. Station conditions and point of sampling will be recorded for each sampling effort. Samples will be taken at mid-channel and mid-depth in Reeder Creek.

Sediment samples will be grab samples also. An appropriate sample container will be used to scrape up sediments in the on-site surface water and Reeder Creek. In deep water bodies a beaker can be clamped to a telescoping aluminum pole or a Ponar sampler can be used. In all situations care and thought will be given to assure that a representative sample is taken. All sediment samples will be analyzed for Level IV TAL total metals, TCL organics (VOA's, AB/N's Pesticides/PCB's) and explosives via the Level V Method 8330. Additionally, the sediment samples will be analyzed for Total Organic Carbon (TOC). Ten percent (10%) of the total number of surface water and sediment samples will be collected as duplicates and blanks.

Sediment samples will be classified according to "Standard Practice For Description and Identification of Soils (Visual-Manual Procedure) (ASTM D-2488-84). This will provide an accurate description of the sediment, including grain size percentages. MAIN does not feel it is appropriate to perform sieve analyses on these samples.

4.2.4 Groundwater Investigation

4.2.4.1 Approach to Groundwater Investigation

Although fourteen (14) monitoring wells have been installed in the shallow overburden aquifer and the groundwater flow direction has been determined to be easterly towards Reeder Creek, the vertical and lateral extent of potential pollutant migration from the nine (9) burn pads has not been fully characterized. Of the existing monitoring well network, none have been screened in the weathered bedrock and consequently there is no data assessing the vertical migratory potential of pollutants. In addition, the potentiometric mapping of the overburden groundwater indicates that four (4) of the nine (9) burn pads, (Pads C, E, G, and J), do not have monitoring wells located downgradient of these pads. Accordingly, the lateral migration of pollutants from these pads may not be adequately characterized.

Both the off-site fractured shale aquifer and the overburden aquifer beyond the SEAD area is currently used by local residents as a source of drinking water. Although possible, the potential for impacts to these off-site residential drinking water wells from the OB/OD grounds is considered remote, due to the distances between any known off-site residential wells. In general, the concentrations of constituents which have been detected in the on-site monitoring wells have been low. For example, USAEHA conducted a groundwater contamination survey, from 1982 to 1987 which monitored the six (6) monitoring wells installed in 1981 by Parratt-Wolff for Hibbard Engineers. According to this report, Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium and Silver were monitored quarterly during 1982 and failed to detect any of these metals above the low parts-per-billion detection limits of the methods used. Additionally, these wells were monitored from 1984 through 1987 for the part-per-billion presence of explosives and failed to detect any explosive material. The potential for off-site contamination became of concern when, during a sampling round conducted by M&E in November, 1988, Cadmium (MW-4), Chromium

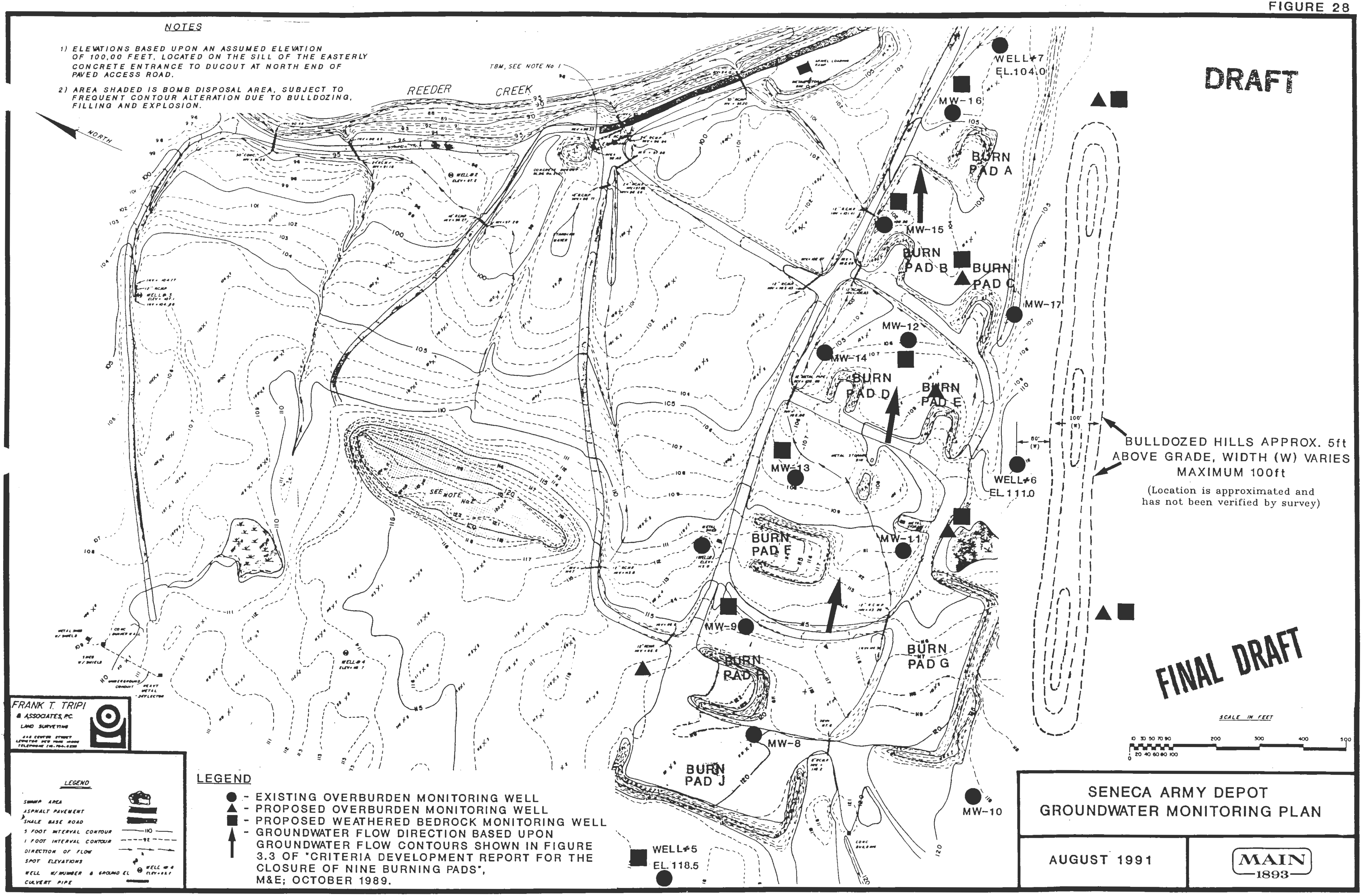
MW-1, MW-4, MW-5 and MW-6) Lead (MW-1 through MW-6) Selenium (MW-5) was detected in concentrations which exceeded federal and state drinking water standards.

In addition, NYSDEC has classified the OB/OD groundwater as GA which requires the groundwater to be useable as a source for drinking water. Consequently, an investigation into the upper portions of the weathered shale aquifer, appears necessary as a means of determining if this subsurface water has been degraded beyond compliance limits or normal background levels and to determine if migration has occurred.

Consequently, the goals of the proposed groundwater investigation are to determine the interelationship between groundwater and surface water, verify the data collected from previous monitoring well analyses site and evaluate the vertical and lateral extent of pollutant migration. To accomplish those goals, MAIN is proposing the addition of six (6) overburden and ten (10) weathered bedrock wells. Additionally, background concentrations of the constituents of concern will be established at a location upgradient of the burn pads. This will involve the installation of an overburden and weathered bedrock well cluster. The investigation will include the redevelopment of the existing fourteen (14) monitoring wells, installed by Parratt-Wolff Inc., in the shallow aquifer. The location of these existing wells and the proposed additional overburden and weathered bedrock monitoring wells are shown in Figure 28, The Groundwater Monitoring Plan. The wells will be developed and sampled according to procedures outlined in Appendix A, The Field Sampling and Analysis Plan.

An important facet of the information to be obtained from installing shallow weathered bedrock wells will be to determine if the weathered shale zone, believed to be continuous at the OB/OD grounds, is a transmissive zone. This layer could provide a pathway for downward vertical recharge of the bedrock aquifer by the phreatic till aquifer. The determination of recharge potential will be made from a comparison of the piezometric heads in the shallow bedrock and the overburden till. Should piezometric elevations in the weathered bedrock wells be substantially higher than those of the overburden, then MAIN would expect little recharge to the underlying shales. In this case, flow would be upward. Alternatively, if the piezometric head of the overburden monitoring wells are substantially higher than the piezometric head in the weathered bedrock then there is a potential for recharge to the underlying bedrock aquifer. This situation could result in vertical migration of pollutants depending upon the leakage through the weathered shale. The occurrence of similar constituents in the bedrock and the overburden wells will serve as a further indication

FIGURE 28



BULLDOZED HILLS APPROX. 5ft ABOVE GRADE, WIDTH (W) VARIES MAXIMUM 100ft

(Location is approximated and has not been verified by survey)

NOTES

1) ELEVATIONS BASED UPON AN ASSUMED ELEVATION OF 100,00 FEET, LOCATED ON THE SILL OF THE EASTERLY CONCRETE ENTRANCE TO DUCOUT AT NORTH END OF PAVED ACCESS ROAD.

2) AREA SHADED IS BOMB DISPOSAL AREA, SUBJECT TO FREQUENT CONTOUR ALTERATION DUE TO BULLDOZING, FILLING AND EXPLOSION.

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& ASSOCIATES, P.C.
LAND SURVEYING

LEGEND

SWAMP AREA	
ASPHALT PAVEMENT	▬
SHALE BASE ROAD	▬
5 FOOT INTERVAL CONTOUR	——110——
1 FOOT INTERVAL CONTOUR	- - - 92 - - -
DIRECTION OF FLOW	→ → →
SPOT ELEVATIONS	
WELL W/ NUMBER & GROUND EL	⊕ WELL # 4
CULVERT PIPE	▬

LEGEND

- ● - EXISTING OVERBURDEN MONITORING WELL
- ▲ - PROPOSED OVERBURDEN MONITORING WELL
- ■ - PROPOSED WEATHERED BEDROCK MONITORING WELL
- ↑ - GROUNDWATER FLOW DIRECTION BASED UPON GROUNDWATER FLOW CONTOURS SHOWN IN FIGURE 3.3 OF "CRITERIA DEVELOPMENT REPORT FOR THE CLOSURE OF NINE BURNING PADS", M&E; OCTOBER 1989.

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of downward vertical migration. Finally, if the potentiometric head difference between the bedrock and the overburden wells are identical then it is likely that the weathered shale layer is a continuation of the till aquifer. In this case the majority of the groundwater flow would be expected to be lateral, toward Reeder Creek instead of being vertical. Again, water quality measurements will provide information confirming the interconnection and the migration of pollutants in the two geologic units.

In addition, groundwater flow is controlled by both the hydraulic potential and the hydraulic conductivity of the geologic water bearing units. Measurements of in-situ hydraulic conductivity provide an understanding of the ability of the saturated soil matrix to transmit water. The test to be performed are slug tests. Slug tests provide a relatively rapid method of estimating the hydraulic conductivity of a portion of an aquifer and the transmissivity (if the saturated thickness of the unconfined or confined aquifer is known). While the performance of a pumping test is the optimum aquifer testing method for estimation of hydraulic conductivities, transmissivities and storage coefficients, pumping tests are relatively expensive and time consuming. In-situ testing, on the other hand, is much less expensive, less time intensive per test and several wells or piezometers can be tested in a single day by one technician. Hydraulic conductivity measurements will be performed in all newly installed wells and previously installed wells of the site. In the event that groundwater remediation is determined to be necessary, a pumping test will be performed at a later date to obtain additional aquifer characteristics.

There are two types of tests: slug injection tests and slug withdrawal tests. In a slug injection test, a slug of a known volume is injected into the well. The slug displaces an equal volume of water in the well. The initial head, time of injection and resultant increase in head is recorded, and the change in head is measured at appropriate time intervals for the duration of the test. The rate of change in head per unit time and knowledge of the geometry of the well can be used to calculate the hydraulic conductivity of the aquifer in the immediate vicinity of the observation well.

A slug withdrawal test, or bail test, is performed in a fashion nearly identical to the slug test. In a slug withdrawal test, the initial head is recorded and a slug of known volume is removed from the well. The time of removal, and the resultant decrease in head is recorded, and the change in head is measured at appropriate time intervals for the duration of the test. Data from a slug withdrawal test are analyzed in a manner analogous to that for processing slug test data.

For optimal results, the water table should intercept the well above the screened interval. There will be some error associated with the determination of hydraulic conductivity if the screen is above the water table, since the well screen available for the dissipation of the induced head difference will be variable.

In cases where the water table is below the top of the well screen, only slug out data will be used to determine hydraulic conductivity. This is to avoid the error associated with displacing water into the unsaturated zone and evaluating this data as a change in the hydraulic head due to the stress applied to the saturated aquifer.

The methodology for a slug test is relatively simple. An initial water level measurement in the well must be obtained in order to establish the static water table. A pressure transducer is then lowered into the well to obtain hydraulic head measurements during the slug test. The slug is rapidly introduced to the well and set above the transducer but below the top of the water table. The pressure transducer measures the hydraulic head levels, per time, as the excess head dissipates in the well. The slug test is terminated when the excess head has reduced to equilibrium and the static water level, measured earlier, is attained. A slug withdrawal test is then performed to verify the results of the slug injection test. The slug is rapidly removed from the well and head measurements are recorded over time until equilibrium head level in the well is attained. The slug test is now completed. The pressure transducer placed at the bottom of the well measures the time, the measured head, and the head after injection or removal of the slug above the transducer. In this study, data from both the injection and removal of the slug will be collected but in cases where the water table is below the top of the screen, only the slug removal data will be evaluated.

The most widely used method to reduce slug test data is that of Hvorslev (1951). Normalized recovery rates are plotted against time on a semi-logarithmic plot and the hydraulic conductivity is determined graphically. In addition to the analytic solution for hydraulic conductivity, a more convenient computer program is available to quickly reduce the test data. In addition to the Hvorslev method, slug test data may also be reduced by the method of Bouwer and Rice (1978). This method, however, is more tedious than that of

Hvorslev. In general, both methods show similar results which are within the error of the measurement of the method.

The goals of this program will be to:

1. Determine the groundwater quality downgradient from each of the nine (9) burn pads;
2. Establish the upgradient (background) groundwater quality in an area off-site of the OB/OD grounds yet representative of similar geologic interactions;
3. Determine the potential for vertical movement of groundwater into the upper weathered shale bedrock aquifer;
4. Determine if the weathered shale layer is more transmissive than the upper till layer;
5. Establish the quality of the groundwater in the bedrock;
6. Define the lateral extent of pollutant movement toward Reeder Creek; and
7. Determine the hydraulic conductivity of each well at the site.

In order to accomplish these goals, the groundwater investigation program proposed by MAIN at the OB/OD grounds will involve the following:

1. Installation of six (6) groundwater monitoring wells located directly downgradient of Pads C, E, G, J and the low lying hill. These wells will be screened above the weathered shale in the glacial till;
2. Installation of ten (10) weathered bedrock monitoring wells. These wells will be installed below the gacial till shale into the upper zone of the weathered shale;
3. Installation of both an overburden and a weathered bedrock monitoring well, each upgradient of the entire OB/OD ground. These wells will be used to determine the

background quality of the groundwater in the overburden glacial till and the underlying weathered shale bedrock;

4. Measurement of in-situ saturated hydraulic conductivity in each on-site monitoring well and background wells. At least two rounds of groundwater measurements in separate phases of the investigation, to investigate any changes in groundwater flow direction; and

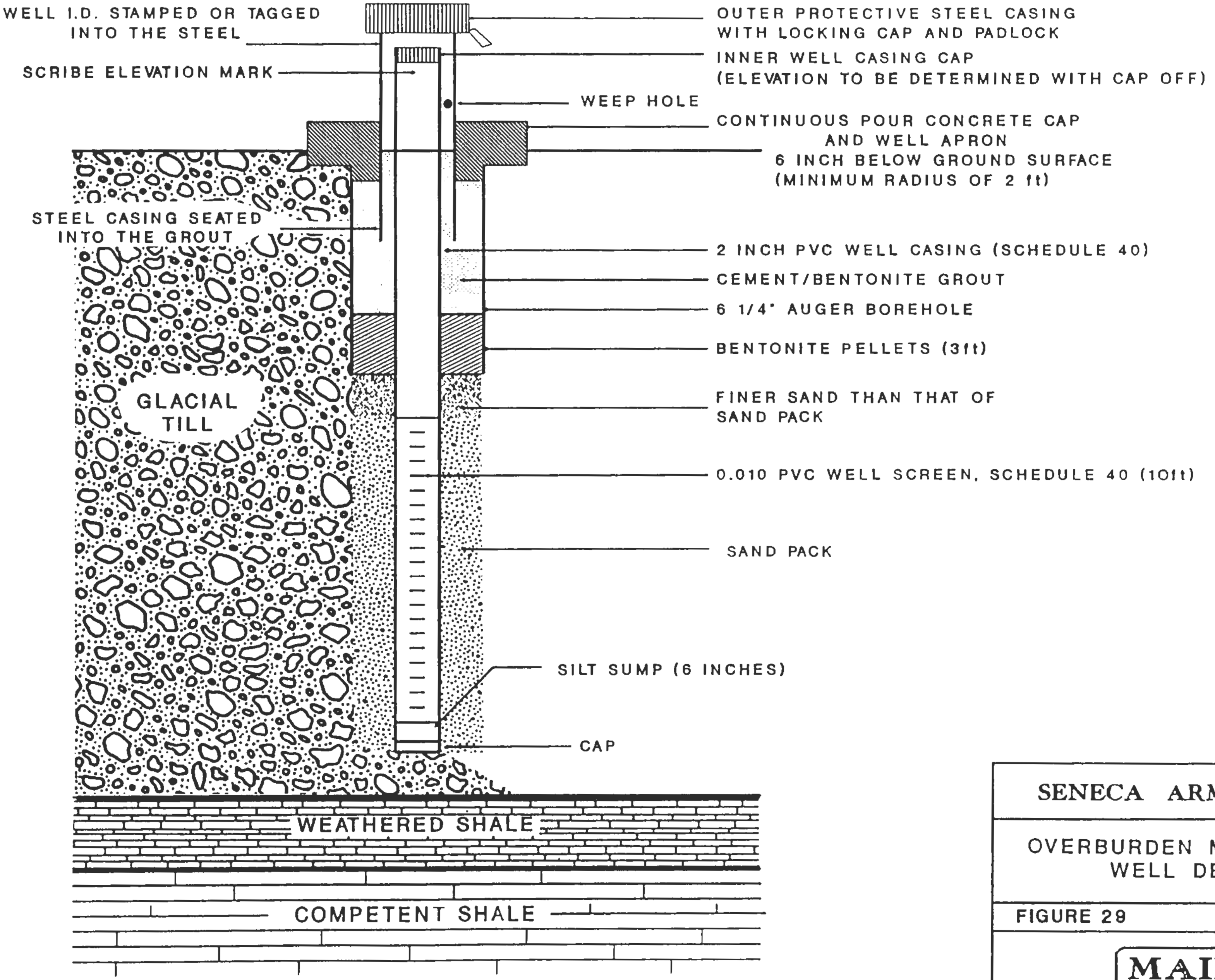
5. Sample each monitoring well initially. A second round will occur to confirm any "hits" and any "non-detects". The sample analytical procedures will differ between those groundwater samples collected from wells which failed to detect the presence of VOA's and those wells which showed the presence of VOA's. NYSDEC CLP methods will be used to confirm the presence of VOA's in wells from which VOA's were detected during the first round. Method 524, which will include the ketone compounds listed as part of the TCL, will be used to obtain the lower detection limits required to confirm compliance with ARARs. Any discrepancies between the first and the second round of sampling will be settled with a third round of sampling, if deemed necessary.

The location of these wells are shown on Figure 28, The Groundwater Monitoring Plan, and Figure 31, The Proposed Locations for Surface Water, Sediment, Biological Sampling and of Background Monitoring Wells.

4.2.4.2 Monitoring Well Installation Program

Proper design, construction and installation of the proposed wells are essential for accurate interpretation of the groundwater data. The program to be implemented is consistent with the USEPA Region II CERCLA QA Manual and the NYSDEC Technical and Administrative Guidance Manuals (TAGMS) regarding design, installation, development and collection of groundwater samples. Further, the program is in compliance with all requirements described in the NYSDEC, 6 NYCRR Part 360, Solid Waste Management Facilities Regulations, Section 360-2.11, which details groundwater monitoring well requirements.

Overburden wells will be installed remotely using hollow-stem augers. These wells will not penetrate through the weathered shale zone. Figure 29, Overburden Monitoring Well Details, illustrates a typical overburden monitoring well. Previous well logs suggest these wells will not be more than 15-20 feet deep. Screen lengths will be ten (10) feet, extending from the bottom of the till up ten feet. This should provide coverage throughout the entire saturated thickness. Soil split spoon samples will be collected continuously as the auger penetrates the formation. Soil samples will be collected as described in the soil boring program. The monitoring wells will be constructed of 2" National Sanitation Foundation



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SENECA ARMY DEPOT

OVERBURDEN MONITORING WELL DETAIL

FIGURE 29 AUGUST 1991

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(NSF) or ASTM approved Poly Vinyl Chloride (PVC). MAIN expects that the screen slot size will be 0.010." The actual screen size will be determined following sand pack sizing. PVC has been chosen to be consistent with the previous monitoring well database and to be cost effective. These wells will not be used for long term monitoring since NYSDEC policy requires stainless steel. No solvents, or glues or other adhesives will be used to connect the PVC casing.

A sand pack will surround the well screen. The exact composition of the sand will be determined from an analysis of soil gradation curves. These curves will be obtained from soil samples collected during the split spoon sampling. The sand pack will be placed by a tremie pipe in the annular space surrounding the well screen and the hollow stem auger. The sand pack will not extend more than two feet above the top, or six inches below the bottom of the screen. A finer grained sand pack material, six inches thick, will be placed at the top of the sand pack, between the sand pack and the bentonite seal. Bentonite pellets, up to three feet thick, will be used to seal the well and will be poured within the annular space. The remaining annular space will be completely filled with a grout mixture of cement/bentonite. The grout mixture will be placed in the annular space using a tremie pipe. Auger flights will remain in the borehole during grouting to prevent caving. Augers will be removed as the grouting progresses. In all instances, wells will be protected with a steel casing, at least two inches larger in diameter than the PVC well casing. This protective steel casing will extend four (4) feet below the ground surface to prevent heaving by frost. The protective casing will have a locking cap and a weather resistant padlock. Duplicate keys will be obtained. A cement collar will surround the well. A weep hole will be drilled at the base of the protective steel casing above the cement collar to allow drainage of water. An expanding cap will also be placed in the top of the PVC well casing. This cap will provide protection from inappropriate filling of the well, should the protective casing lock be broken. A permanent well identification marker will be attached to the steel protective casing.

Monitoring wells will be installed in the weathered shale layer in a manner which will minimize the potential for transferring groundwater from the glacial till to the weathered shale. The drilling techniques to be used will be identical to those previously mentioned. If hollow stem augering does not penetrate the weathered bedrock, air rotary techniques will be used to advance the boring to the specified depth.

The monitoring well construction details will be similar to those of the overburden wells. However, the screen length will be 2 to 5 feet, depending upon the thickness of the weathered bedrock encountered. The slot size is expected to be 0.010 inch. The screened zone will be sand packed which will be installed with a tremie pipe to avoid bridging. The bentonite seal will be up to two feet thick and will be placed to seal the weathered shale from the overburden. The remainder of the annular space will be grouted to the surface with a cement/bentonite grout. The cement/bentonite grout will be installed using a tremie pipe. A steel protective casing with a locking cap and weather resistant padlock will be installed to prevent tampering with the well. The PVC well casing will also be sealed with an expanding cap. The steel protective casing will have a weep hole drilled at the base to provide a drainage pathway for any collected water. A permanent well identification mark will be attached to the outside of the well using a steel stamp or a metal tag. Figure 30, Weathered Bedrock Monitoring Well Details, illustrates the details of the proposed monitoring well.

4.2.4.3 Groundwater Monitoring Well Development Program

The collection of valid groundwater samples is dependent upon the turbidity of the sample. Guidance provided by NYSDEC indicates that a valid sample is considered to be one which is less than 50 Nephelometric Turbidity Units (NTU's). Accordingly, development will continued until the water for the well has stabilized at less than this value. NTU's will be measured in the field with a portable field-analyzer.

The geologic material which these wells are screened in are known to contain large amounts of fines and development will likely remove larger volumes of water which would normally be removed. The procedure to be utilized for well development will not require the addition of water to the well, as in high velocity jetting, or air, as in air surging. Instead, the procedure will surge the well water several times using a bailer. This will loosen the fines in the nearby formation causing the fines to migrate into the well water inside the casing. The well water should increase in turbidity as the fines are mixed with the water. Once completely mixed, the suspension will be pumped from the well with either a suction lift centrifugal pump or a submersible pump. All development water will be stored in 55 gallon drums at the well for later disposal. This process will continue until the well has stabilized at <50 NTU's.

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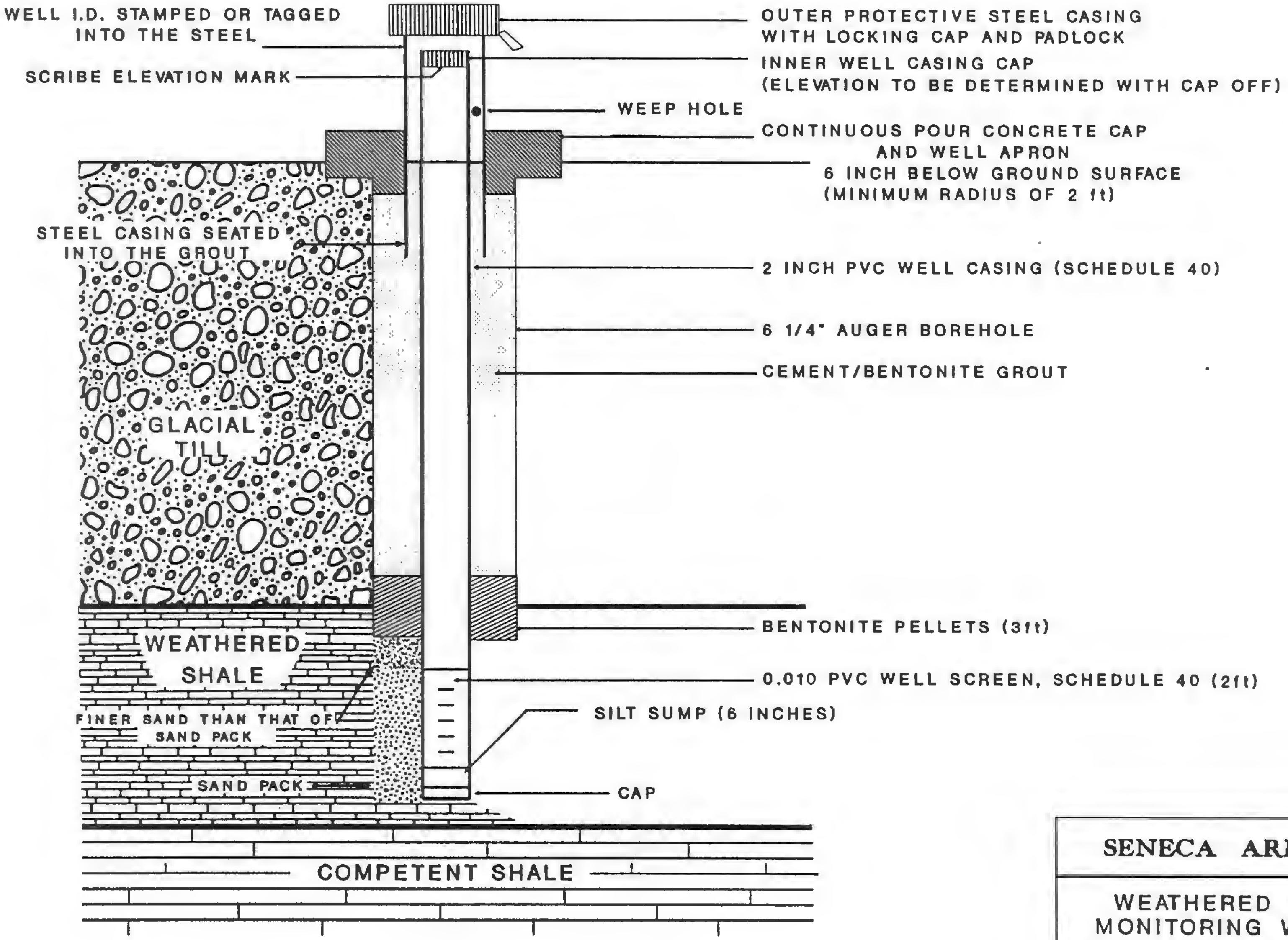

SENECA ARMY DEPOT

WEATHERED BEDROCK MONITORING WELL DETAIL

FIGURE 30 AUGUST 1991

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4.2.4.4 Groundwater Sampling Program

Following proper development of the existing fourteen (14) monitoring wells and the additional wells, the wells will be sampled for the following parameters:

1. Target Compound List (TCL) for Volatile Organic Analytes (VOA)
2. Target Compound List (TCL) Acid, Base/Neutral, Polychlorinated Biphenyls (AB/N's, Pesticides and PCB's)
3. Target Analyte List (TAL) (Metals)
4. Method 8330 (Explosives)
5. Nitrates
6. Method 524 (To obtain lower detecion limits for VOA's in the second round)

Table 17 provides a description of the TCL for volatiles and the Contract Required Quantitation Limits (CRQL) for both water and soils. Table 18 provides the CRQL's for acid, base/neutrals (AB/N's) water and soils. Table 19 presents each Pesticide and the PCB Arochlors which will be analyzed and the CRDL. Table 20 presents each metal of the TAL and the CRDL for waters. Table 21 presents a list of each explosive analyte for Method 8330 and the quantitation limit.

All groundwater wells will be sampled initially and the wells which show "hits" will be sampled a second time for confirmation. If there is a discrepancy between the initial sampling round and the second confirmation round a third sampling round will be performed.

4.2.5 Ecological Investigation

The potential mechanisms for the movement of pollutants from the OB/OD Grounds to off-site areas include physical and biological means, acting independently or in combination with each other. The purpose of this investigation is to assess any possible environmental impacts. This information is required to fully evaluate the risk from this site. Environmental risk includes risk to aquatic and terrestrial biota which may be impacted due to the inadvertent intake of constituents found at the site or which have migrated off the site. Ecological assessment, as per EPA's 1989 Environmental Evaluation Manual, is defined as "a qualitative and/or quantitative appraisal of the actual or potential effects of a hazardous waste site on plants and animals other than people and domesticated species". At SEAD, the ecological assessment will focus upon the terrestrial biota residing on the OB Grounds and the aquatic species in Reeder Creek.

The ecological assessment will take place in two phases. Phase I will be an initial site reconnaissance and biological sampling. Phase I will include a habitat characterization to obtain information on what species are likely to utilize the site, as well as an assessment of soil, sediment, and aquatic chemistry. MAIN proposes to delineate wetlands on the approximately 30 acre OB grounds using the Unified Federal Routine Method. Figure 27 illustrates the approximate area of the OB grounds. Wetland covertypes will be evaluated using aerial photographs, existing wetland maps (NYSDEC Wetland Regulatory Maps and United States Fish and Wildlife Service (USFWS) National Wetland Inventory Maps) and field reconnaissance. Wetland boundaries will not be surveyed as part of this delineation. Wetlands outside the OB grounds will be evaluated using aerial photographs, existing wetland maps (NYSDEC Wetland Regulatory Maps and USFWS National Wildlife Inventory Maps) and field reconnaissance to confirm wetland delineations, where necessary. This biotic survey of habitats and communities is intended to be an initial assessment. If necessary, Wetland Evaluation Technique (WET) or a comparable technique will be used to conduct a functional wetland assessment. Following an analysis of Phase I results, a determination regarding the necessity and scope of tissue sampling will be made. If results show concentrations of pollutants above background levels, or stressed biological communities, tissue sampling to investigate both bioaccumulation and potential pathways to man, may be warranted (Phase II). Phase II studies will include sampling of the aquatic and terrestrial biota as well as toxicity studies.

The Phase I assessment will investigate the biota populations which would most likely be exposed. These biological populations include fish and shellfish which may inhabit Reeder Creek and any wetlands which may exist adjacent to the OB/OD Grounds as well as terrestrial habitats.

The ecological assessment objectives are:

1. To document the terrestrial and aquatic habitats on and adjacent to the OB/OD Grounds;
2. To determine the concentrations of pollutants in aquatic organisms;
3. To identify any wetland habitats; and
4. To provide a database for the assessment of environmental risks.

4.2.5.1 Approach to the Ecological Assessment

Phase I: MAIN ecologists will collect aquatic community data which will generally describe the aquatic ecosystem. That is, all fish collected at each station will be identified and enumerated. Any gross abnormalities in fish will be recorded during fish sampling. Table A-9 in Appendix A identifies MAIN's standard fish collecting forms. Macroinvertebrates will be collected by scraping hard surfaces or substrate sampling. Taxa will be grossly identified (order to genus, as practicable) and listed. These data will provide an overview of the aquatic community from which the specimens were collected. This information will be considered when describing the occurrence of any environmental risks associated with the ecological community.

In order to fully understand the interrelationship of the OB/OD Grounds and their association with the environment, it is necessary to document existing, surrounding, vegetative cover types. Cover typing is done by traversing the site on foot and noting major cover types in relation to the location of the OB/OD Grounds. The terrestrial ecology team will characterize and map the upland and wetland vegetation cover types within the general study area depicted in Figure 31, Proposed Locations for Surface Water, Sediment, Biological Sampling and Background Monitoring Wells.

Phase II: Following an analysis of Phase I results, a determination regarding the necessity and scope of tissue sampling will be made. The criteria for this determination will be: 1) habitat abnormalities and 2) soil chemistry data. Phase II studies will include sampling of aquatic and terrestrial biota and possible as toxicity testing studies.

Heavy metals and explosives are expected to be associated with colloidal material and sediment. From the sediment these pollutants can move through the food chain. These pollutants may be taken up by organisms in the lower trophic levels (e.g., zooplankton and macrobenthos) which are ultimately consumed by fish. Bioaccumulation occurs within each trophic level and may lead to biomagnification at higher trophic levels. MAIN will analyze the tissue of macroinvertebrates, fish, and shellfish collected at select stations during Phase II. Actual tissue analyses will be dependent upon what species are collected and in what size and abundance. The approach to the Phase I ecological assessment will consist of documenting the biological conditions at the OB Grounds, including nearby areas upgradient

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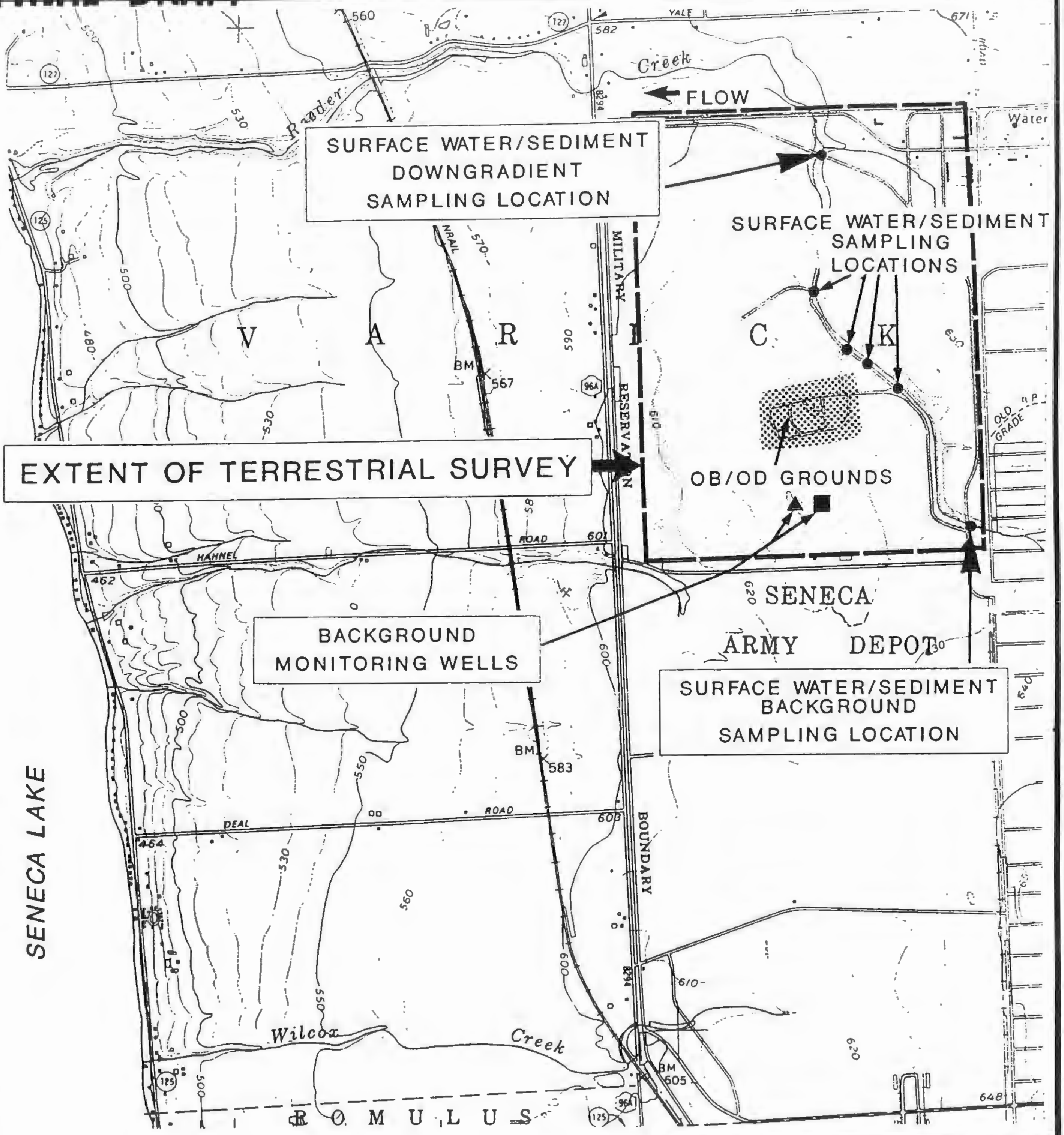

NOTE:

▲ - PROPOSED BACKGROUND LOCATION FOR THE OVERBURDEN WELL

■ - PROPOSED BACKGROUND LOCATION FOR SHALLOW BEDROCK WELL

GENEVA SOUTH QUADRANGLE
SECOND EDITION - 1978 NEW YORK STATE DOT

SENECA ARMY DEPOT

PROPOSED LOCATIONS FOR
SURFACE WATER, SEDIMENT,
BIOLOGICAL SAMPLING
AND BACKGROUND MONITORING WELLS

FIGURE 31 AUGUST 1991

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of OB/OD ground. The Phase II ecological assessment will involve taking select aquatic organism tissue samples for bioaccumulation analysis.

One potential pathway for pollutant migration is associated with the introduction of impacted sediment-ladden water to the aquatic ecosystems. If this pathway of transport is being utilized, then metals and/or explosives should be present in the tissue of shellfish. Shellfish are filter feeders and strain water to remove the microorganics that are used for food. Because they are not selective in this straining process, suspended particulate matter is often ingested with the food. This is especially true during periods of naturally high suspended particles, such as after heavy rains or when bottom sediments are disturbed. Once ingested, pollutants can bioaccumulate. The Phase I evaluation will document the presence and overall quality of the shellfish present. If deemed appropriate, the analysis of shellfish tissue provides a sensitive measurement for potential biological pathways of pollutant transport. If shellfish are not present or plentiful in Reeder Creek, another macroinvertebrate will be sought, such as crayfish or amphipods.

Fish may also provide a means of off-site pollutant movement. The extent that this is likely, depends on the species of fish and range of movement experienced by the fish. Fish are not as effective biomarkers as macroinvertebrates, because it is not known for certain where the fish have been prior to collection, and therefore, in many cases the presence of pollutants in the tissues of fish cannot be readily associated with a particular source. From a preliminary understanding of Reeder Creek, the types of species which would be encountered, at the upgradient location, would be expected to be less likely to migrate over large areas, including areas adjacent to the OB/OD grounds, since the creek is slow moving and relatively small. Consequently, should it become necessary to sample fish the upgradient location, shown on Figure 31, Proposed Locations for Surface Water, Sediment, Biological Sampling and Background Monitoring Wells, will likely represent background levels of pollutants in fish and will serve as a baseline for comparing fish concentrations collected at other locations. Fish collected at locations adjacent to the OB/OD grounds may be subject to the greatest potential concentrations of pollutants. Fish collected at locations further downstream and downgradient may provide an indication of the extent of off-site biological transport. The annual hydrologic cycle of Reeder Creek will determine the distribution of fish in waters flowing past the OB/OD Grounds and ultimately their exposure potential. This will be taken into account in the environmental risk assessment.

Toxicity testing will depend upon the results of Phase I. For example, if pollutants are reaching Reeder Creek and do not seem to effect terrestrial organisms in route then toxicity testing for Reeder Creek organisms only would be conducted. In general the toxicity testing would probably involve one or more of the following: earthworms--to study effects on terrestrial invertebrates; bobwhite, pheasants or mallards--to study effects on birds; laboratory studies of rats, mice and rabbits--to study effects on mammals; Daphnia or fathead minnows--to study effects on aquatic life; and seed germination tests--to study effects on plants.

The toxicity tests will utilize site soils or water. In that way any synergistic effects of more than one chemical will be included in the testing protocol. The focus of the toxicity tests will be to determine LC_{50} or EC_{50}, the concentration causing acute effects (LC_{50}) or a specific, predetermined effect (EC_{50}). Consideration will be given to when exposures are chronic or episodic (e.g., constant leaching or precipitation-caused leaching) in terms of deriving a correct testing protocol.

To the extent possible, the data collected in this program will be compared to other data collected by the NYSDEC or reported in the literature in order to put results into perspective regarding biota concentrations.

Wildlife directly observed or for which signs (e.g., tracks, droppings, nests) are observed will be noted during the terrestrial survey. Species likely to use the given habitats but not observed during the field survey will also be noted. The plants and animals reported herein may serve as biological pathways for movement of pollutants from the immediate area or to higher trophic levels. Knowledge of the site terrestrial environs will play a role in formulating an evaluation of the environmental risk.

4.2.5.2 Sampling Program

The Phase I sampling program will focus upon habitat and community descriptions. Phase II sampling, if necessary, will focus upon more detailed biological tissue sampling and toxicity testing.

Phase I: Fish will be collected at appropriate stations using a variety of sampling methods including 25-foot beach seine, a backpack electroshocker, trotline, minnow traps, and angling. The sampling will follow MAIN's Standard Operating Procedures for fish sampling located in Appendix A, "Field Sampling and Analysis Plan." Relative abundance of fish species by gear type will be provided to the extent that the gear employed allow such quantification. All game fish collected will be weighed and measured.

Phase II: Fish sampling for tissue analyses may occur at several stations in Reeder Creek which are adjacent to the OB/OD grounds and upstream and downstream of the OB/OD grounds. The location and the number of samples collected will be determined after the Phase I investigation. Actual station locations will be noted and indicated on a map. MAIN would submit for analysis to a DEC approved laboratory, fish fillets, skin on, provided sufficient quantities of tissue samples can be obtained for meaningful analyses. The minimum required sample size for tissue analysis is 10 grams. If only small individuals of certain species can be collected, whole specimens will be used for tissue analysis. Analytical methodologies will be those approved by the EPA and the DEC.

Precision in fish tissue analyses will be determined from duplicate samples. A duplicate sample is defined as a fish filet obtained from one fish, which is split into two separate samples. The small size of the species expected to be encountered may not likely allow for enough sample to be split. However, if a biota sample of sufficient size is collected, one duplicate sample will be submitted. Results from samples collected from the same species will serve as an indicator of variability between individuals.

The hierarchy of fish collection for tissue analyses are:

1. Non-migratory sport fish (i.e., bass, pickerel or catfish);
2. Migratory sport fish, (i.e., trout or salmon); and
3. Forage species (i.e., darter or shinner).

As previously mentioned, shellfish provide a useful measure of potential uptake of chemicals in the biota because they are relatively nonmobile and filter feeders. Therefore, the presence of organics, heavy metals and explosives in shellfish samples represent a sensitive indicator of the presence or absence of these chemicals in specific aquatic habitats. MAIN ecologists will attempt to collect shellfish samples at each of the chosen stations. A MAIN ecologist will initially canvass the faster flowing waters where sediment buildup is minimal. Depending upon availability of organisms, these chosen station locations may change. Final station locations from which shellfish are collected will be noted and indicated on a map. In the event that annual hydrologic conditions or sedimentation inhibit establishment of unionid populations, MAIN will attempt to collect another invertebrate species (e.g., amphipods or crayfish).

At each station, a qualitative evaluation of the macroinvertebrate community will be made by hand scraping of hard substrates (rocks, tree limbs). Detailed taxonomic study is not proposed (organisms will be identified to genus, family, or order) as the objective of such sampling is to generally characterize the Reeder Creek invertebrate community for which little or no data exists. In addition, an inventory of sediment-dwelling macroinvertebrates will be made by using a petite Ponar grab sampler, which samples a 6-inch by 6-inch portion of the bottom (provided the gear can be utilized where the substrate is suitable for sampling with such gear, e.g., organic material, silt, sand, or smaller sized gravel). Sediment will be washed through a 0.5 mm screen and any remaining invertebrates preserved for later identification. Invertebrate collections will be combined such that a taxa list can be developed for each station.

The results of the macroinvertebrate community survey and tissue analyses will be used to provide an indication of the invertebrate community. This data will comprise the database for determining the occurrence of any environmental risks. This information, together with the sediment and surface water data, will serve as the basis for deciding the necessity for a Phase II investigation.

For the vegetative cover type mapping, forested areas will be characterized based on dominant tree species after Stout (1958) and U.S. Fish and Wildlife Service (USFWS)(1979) (e.g., northern hardwood, birch/pine forest). Nonforested areas will be typed based on physical features and dominant plant types (e.g., meadow, old field/shrubland). Wetland cover types will be based on the classification of Cowardin et al. (1979), which is currently used by the USFWS for their National Wetland Inventory mapping. As noted previously, wetlands are potential sinks or transport receptors for pollutant migration in the environment. MAIN ecologists will map wetlands in the study area. Dominant plant species in the overstory, understory, and ground cover will be identified. The study area includes: (1) Areas that are unlikely to be exposed to surface runoff from the OB/OD Grounds (which can be considered controls); and (2) Areas that are potentially affected by pollutants due to the known topography and hydraulic gradient of the off-site area. This vegetation characterization will be qualitative in nature. The description and classification of the forested and nonforested areas will be used to support conclusions reached during the environmental risk assessment.

Any toxicity testing that may be deemed necessary as part of Phase II studies will be done according to procedures outlined in EPA's manual entitled Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference. Toxicity tests will focus upon the organisms potentially exposed (e.g., fish, burrowing mammals, plants, etc.). At this time it is anticipated that in situ studies or onsite studies would be most appropriate given the multitechnical nature of the contamination.

If toxicity is documented, this data will be used in planning the remedial action. If no toxicity is observed, then it might reasonably be assumed that any stress noted to biota on or adjacent to the OB grounds is due to habitat disruption, external sources of toxic chemicals, natural variability, etc.

Toxicity testing would be conducted by a DEC-approved testing firm. A protocol for toxicity testing will be developed focusing upon: species to be tested; media to be tested; acute or chronic testing procedure; and reporting of results. Interpretation of results will be jointly derived by MAIN ecologists familiar with the site and the toxicologists performing the analysis. Results will be presented in a short report detailing the approach, rationale, methods, results and interpretation. MAIN's Project Manager will use these results as part of the remedial action assessment procedure.

In summary, the ecological investigation will involve the following tasks:

1. Review of existing data including FEMA maps, wildlife management plans, and other information which has been compiled from the NYDEC and EPA.

2. Identify and assess the terrestrial and aquatic habitats during a field reconnaissance program. This program will include:

- Identification of ground cover, wildlife, and terrestrial habitats,
- Wetlands identification in the ecological study area,
- Identification of the aquatic habitat of Reeder Creek in the areas defined in the ecological study area,
- Sample both fish and shellfish for pollutant concentration in aquatic tissue if necessary,
- Collect invertebrate samples at the identified sediment sampling locations, if necessary,
- Conduct toxicity testing, if necessary.

4.2.6 Surveying

Surveying will be performed at the OB/OD grounds to provide accurate site base maps which will be used for the following purposes:

1. Map the direction and compute the velocity of groundwater movement,
2. Locate all the environmental sampling points,
3. Serve as the basis for volume estimates of impacted soils and sediments which may require a remedial action, and
4. Map the extent of any impacted groundwater above established ARAR limits.

The survey will involve photogrametric mapping, followed by a field survey. By having an aerial photographic survey performed for the site, the site topographic data can be electronically inputted to MAIN's Engineering Site Package (ESP) software on our Intergraph CAD System. This approach will produce more accurate site maps and since the software stores the data as a 3-dimensional file, it will facilitate a great deal more flexibility in its future use. Typical examples of what this software can produce automatically are stormwater run-off calculations, cut and fill calculations, and graphical cross-section through any part of the site. The field control will establish horizontal and vertical control and will serve as the basis for relating the photogrametric information to actual land elevations and the New York State Plane Coordinate System.

During the field survey, plastic or wooden hubs shall be used for all basic control points. A minimum of five (5) concrete monuments with 3.25-inch domed brass or aluminum alloy survey markers (caps) and witness posts will be established at the site. The concrete monuments will be located within the project limits and will be set 50 feet from the edge of any existing roads in the interior of the project limits and will be a minimum of 500 feet apart. The placement of all monuments, hubs, etc., shall be coordinated with SEAD. Witness posts, etc., shall be durable and brightly colored to preclude damage due to normal landscaping activities. Concrete monuments shall be constructed so as to preclude damage due to frost action. Horizontal control (1:10,000) and vertical control (1:5,000) of third-order or better shall be established for the network required for all the monuments. The caps for the new monuments shall be stamped in a consecutively numbered sequence as follows:

SEAD-7-1990 USAED-HUNTSVILLE

SEAD-8-1990 USAED-HUNTSVILLE

SEAD-9-1990 USAED-HUNTSVILLE

The dies for stamping the numbers and letters into these caps shall be of 1/8 inch in size. All coordinates will be to the closest 0.01 foot and will be referenced to the State Plane Coordinate System and all elevations are to be referenced to the 1929 North American Vertical Datum. Elevations to the closest 0.10 foot shall be provided for the ground surface at each soil boring. Elevations to the closest 0.01 foot shall also be established for the survey marker and the top of casing (measuring point) at each monitoring well.

The location, identification, coordinates and elevations of all the control points recovered and/or established at the site and all of the geophysical survey areas, soil borings, monitoring wells (new and existing) and all surface water sampling points will be plotted on a topographic map (at a scale of 1 inch = 50 feet) to show their location with respect to surface features within the project area. U.S.G.S control points exist at the Seneca Base. This information will be provided to the surveyor prior to the survey. A tabulated list of the monuments, the soil borings and the surface water sample points including their coordinates and elevations, a "Description Card" for each monument established or used for this project, the 1 inch = 50 feet map and all field books and computations will be prepared. The tabulation shall consist of the designated number of each boring, monument or surface water sampling point, the X- and Y- coordinates and all the required elevations. The Description Card shall show a sketch of each monument; its location relative to reference marks, buildings, roads, towers, etc.; written description telling how to locate the monument from a known point; the monument name or number and the adjusted coordinates and elevations. During the field survey, level circuits will close on a benchmark whose elevation is known (other than the starting benchmark is possible). The following criteria will be met in conducting the survey:

- Instruments will be pegged regularly.
- Rod levels will be used.
- Foresight and backsight distances will be reasonably balanced.
- Elevation readings will be recorded to 0.01 foot.

Temporary monuments will be set and referenced for future recovery. All monuments will be described in the field notes. Sufficient description will be provided to facilitate their recovery.

Traverses will be closed and adjusted in the following manner:

- Bearing closures will be computed and adjusted, if within limits.
- Coordinate closures will be computed using adjusted bearings and unadjusted field distances.
- Coordinate positions will be adjusted if the traverse closes within the specified limits. The method of adjusting shall be determined by the surveyor.
- Final adjusted coordinates will be labeled as "adjusted coordinates." Field coordinates will be specifically identified as such.
- The direction and length of the unadjusted error of closure, the ratio of error over traverse length, and the method of adjustment will be printed with the final adjusted coordinates.

Level circuits will be closed and adjusted in the following manner:

- For a single circuit, elevations will be adjusted proportionately, provided the raw closure is within the prescribed limits for that circuit.
- In a level net where the elevation of a point is established by more than one circuit, the method of adjustment will consider the length of each circuit, the closure of each circuit, and the combined effect of all the separate circuit closures on the total net adjustment.

For this project, all surveys shall be third-order plane surveys as defined by the following standards and specifications:

Traverse

Standard error of the mean for length measurements	1 in 10,000
Position closure per loop in feet after azimuth adjustment	1:5,000 checkpoint or 3.34 M** (whichever is smaller)

Leveling

Levels error of closure per loop in feet	0.05 M**

M** is the square root of distance in miles.

Third-order plane surveys and horizontal angular measurements will be made with a 20-second or better transit. Angles will be doubled, with the mean of the doubled angle within 10 seconds of the first angle. Distance measurements will be made with a calibrated tape corrected for temperature and tension or with a calibrated electronic distance meter instrument (EDMI). When using EDMI, the manufacturer's parts per million (ppm) error is applied, as well as corrections for curvature and refraction.

Site surveys will be performed in accordance with good land surveying practices and will conform to all pertinent state laws and regulations governing land surveying. The surveyor shall be licensed and registered in New York. Upon completion of the project, all original field notebooks, computations, and pertinent reference materials will be available at the surveyor's office. Photostatic copies of these materials will be kept in the project files.
All field note reduction will be checked and marked in such a way that a visual inspection of the field notes will confirm that checks have been made. All office entries in field notebooks will be made in colored pencil. The office worker who reduces or checks field notes will initial each page worked on in the color used on that page.

Monitoring well locations will be surveyed only after the installation of the tamperproof locking cap guard pipe or road box, which will be set in concrete. The following elevations will be measured:

- Top of the outer protective casing at the point opposite the lock or bolt on the guard pipe or road box.
- Top of the inner PVC riser pipe (on the lip, not the cap).
- Finished concrete pad adjacent to the outer well casing.

The aerial photographic survey will be performed with an aerial camera equal to or better than a Ziess RMKA 15/23 with a focal length of 6 inches. The scale of the photography will be suitable for determination of 2 foot ground contours, but will not be greater than 1" = 600. Black and white aerial photographs will be sufficient. The photographs to be taken will be sufficient enough to cover the entire area to be investigated, including the sections of Reeder Creek which will be sampled. Specifically, the survey will correspond approximately to the area defined as the "Extent of Terrestrial Survey" on Figure 31. A U.S.G.S topographic map will be used to determine the limits of the photographic survey. A copy of the survey boundary will be a deliverable for the surveyor. Since the site is within the confines of the Seneca Army Depot, an active military installation, written permission will be necessary to conduct the aerial flyover. The deliverables for the surveyor will include:

1. A list indicating the location, identification, coordinates and elevations of each monument, soil boring, monitoring well and surface water sample point.
2. Two sets of black and white contacts.
3. An Intergraph IDGS file, on tape, of the topographic map.
4. Photostatic copies of the surveyor's field notes.

4.3 DATA REDUCTION, ASSESSMENT AND INTERPRETATION

Upon completion of all field investigations identified in Section 4.2, the data will be reviewed, processed evaluated and interpretated. Conclusions will be described for each of the following subcategories. The need for additional data will be identified through the assessment and interpretation process.

4.3.1 Geophysical

The methodology and sampling procedures found in Section 4.2.1, Geophysical Investigation, will produce a variety of subsurface data which will be reduced and analyzed. Objectives of this assessment will include:

- Identification of the location and extent of the distribution of any buried objects and former trenches.

The following figures will be prepared to support the interpretation of the geophysical data:

Electromagnetic Induction Survey (EM)

1) The EM survey grid will be shown on a base map of the site.
2) Contours of the quadrature and in-phase component readings will be prepared and shown on a base map of the site. The individual EM readings will be provided on tables.

Ground Penetrating Radar (GPR) Survey

3) The GPR survey lines will be shown on a base map of the site.
4) The subsurface image radar profiles from the graphic strip recorder, annotated by the geophysicist, will be provided as an appendix.

EM and GPR Surveys

5) Anomalous areas defined by the EM and GPR survey will be shown as shaded areas on a base map of the site.

4.3.2 Soils

The data that will be collected in accordance with Section 4.2.2, Soils Investigation, will be reviewed and complied in a manner which will allow easier evaluation. The summarized sampling data will be evaluated to meet the following objectives:

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- Identify the pollutants found in the soil including the location, the approximate subsurface elevation and the concentration levels.

- Portray the high levels of impacts (Source Areas) using plan and cross-sectional views.

- Validate the quality of the Levell II and Level IV and V data.

- Estimate the volume and mass of pollutants in each source area.

- Evaluate the human health and environmental risk.

4.3.3 Surface Water

Section 4.2.3, Surface Water and Sediment Investigation, data will be reviewed and analyzed. The objectives of the evaluation of the collected surface water and sediment samples will be the following:

- Describe Reeder Creek and other surface water bodies in terms of typical seasonal and historic flow characteristics, as well as point of origin variations in water elevation.

- Validate the Level IV and V data.

- Identify and quantify contaminants found in surface water sample.

- Evaluate and quantify the composition of sediment samples.

- To the extent wetlands are present and contribute to the aquatic system, describe the characteristics of the wetlands and identify and quantify contaminants found in water and sediment samples.

- Estimate the volume and extent of impacted sediments in Reeder Creek.

- Estimate the human health and environmental risk posed by the surface water/sediments.

4.3.4 Groundwater

Sampling data that is gathered in accordance with the approach described in Section 4.2.4, Groundwater Investigation, will be analyzed as follows:

- Tabulation of data collected from the monitoring wells, including groundwater elevation, water quality monitoring well construction characteristics.

- Identify and evaluate the groundwater characteristics such as transmissivity, hydraulic conductivity and pumping capacity.

- Validate the Level IV and V data.

- Vertical and horizontal hydraulic gradients will be estimated and used to identify groundwater flow characteristics.

- Identify the chemical constituents and their concentrations in the groundwater.

- Spatially identify the extent of dispersion of chemical concentrations. The resulting plume will be displayed graphically. This data will be compared with MAIN's conceptual site model for consistency.

- Compare data to that which has been evaluated in previous reports in order to track over time the apparent dispersion of any contaminant plume.

- Evaluate the human health and environmental risk.

4.3.5 Ecological

Based on the approach and sampling program identified by Section 4.2.5, Ecological Investigation, an ecological assessment and interpretation of data will be conducted. The following objectives will be met by this evaluation:

- Describe the presence of important terrestrial and aquatic habitats.
- Identify significant receptor populations and assess relevant routes of exposure.
- Characterize all significant ecological threats.
- Perform an environmental risk assessment.

4.3.6 Survey

The survey data will be evaluated for accuracy and completeness. All future site maps will be prepared from the base map of this survey. The base map will provide ground elevations, well casing elevations, well locations, surface water bodies and any other pertinent features of the OB/OD grounds.

4.3.7 Evaluation of ARARs

A preliminary identification of ARARs has been made in Section 3.4, Preliminary Identification of Applicable or Relevant and Appropriate Requirements (ARARs). Several ARARs were evaluated to determine their applicability. The list of ARARs found in the Tables in Section 3.4 are subject to modification as the remedial investigation progresses and new information is collected.

The data and information collected during the field investigation and the data analysis stages will serve as the basis by which a comparison to each listed ARAR may take place. The evaluation of all potential ARARs will be conducted in a manner consistent with the procedures described in the EPA CERCLA Compliance with Other Laws Manual, (Interim Final), (August 1988) CERCLA Compliance with Other Laws Manual: Part II Clean Air Act and Other Environmental Statutes and State Requirements (August 1989), and other pertinent guidance documents. Each requirement will be evaluated to the data to determine if it is applicable. If the requirement is not applicable, a procedure to determine whether it is relevant and appropriate will be implemented. Because of the site specific nature of the investigation, a requirement must both be relevant and appropriate to the site's particular situation if it is to be complied with. In the absence of a chemical, location or action specific ARAR, other available criteria or guidelines (TBCs) will be evaluated and considered. These regulations constitute Federal and State advisories, guidance and proposed standards that are not legally binding. Where applicable, such advisories will be used in the absence of ARARs and be considered during the course of the remedial investigation.

4.4 BASELINE RISK ASSESSMENT

Following data evaluation, a risk assessment will be performed using methods described in the EPA Risk Assessment Guidance for Superfund (1989) Volume I (Human Health Evaluation Manual) and Volume II (Environmental Evaluation Manual). The objective of the risk assessment is to characterize the current and potential public health and environmental risks that would exist under the no-action alternative. The risk assessment will be an evaluation of available demographic, geographic, physical, chemical, and biological factors that describe the impacts of hazardous waste releases form the site. The assessment will evaluate the types and concentrations of hazardous chemicals present at the site, the migration potential of contaminants through various media, their toxicology, and the degree of exposure to the environment and public health. The results of the exposure assessment will be coupled with the toxicological evaluation to determine the degree of endangerment posed by exposure. The Guidance for Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish (USEPA, 1989) will be used when appropriate during the course of the FI/FS.

The assessment of both environmental and human health risk plays a critical role in the CERCLA RI/FS process. The RI/FS process is designed to support risk management decisions for control of hazardous waste sites. In other words, critical decisions regarding the necessity for implementing a remedial action and allowable soil and water concentration are supported by risk analyses. The role that risk information activities plays in the RI/FS process is illustrated in Figure 32, Risk Information Activities in the RI/FS Process.

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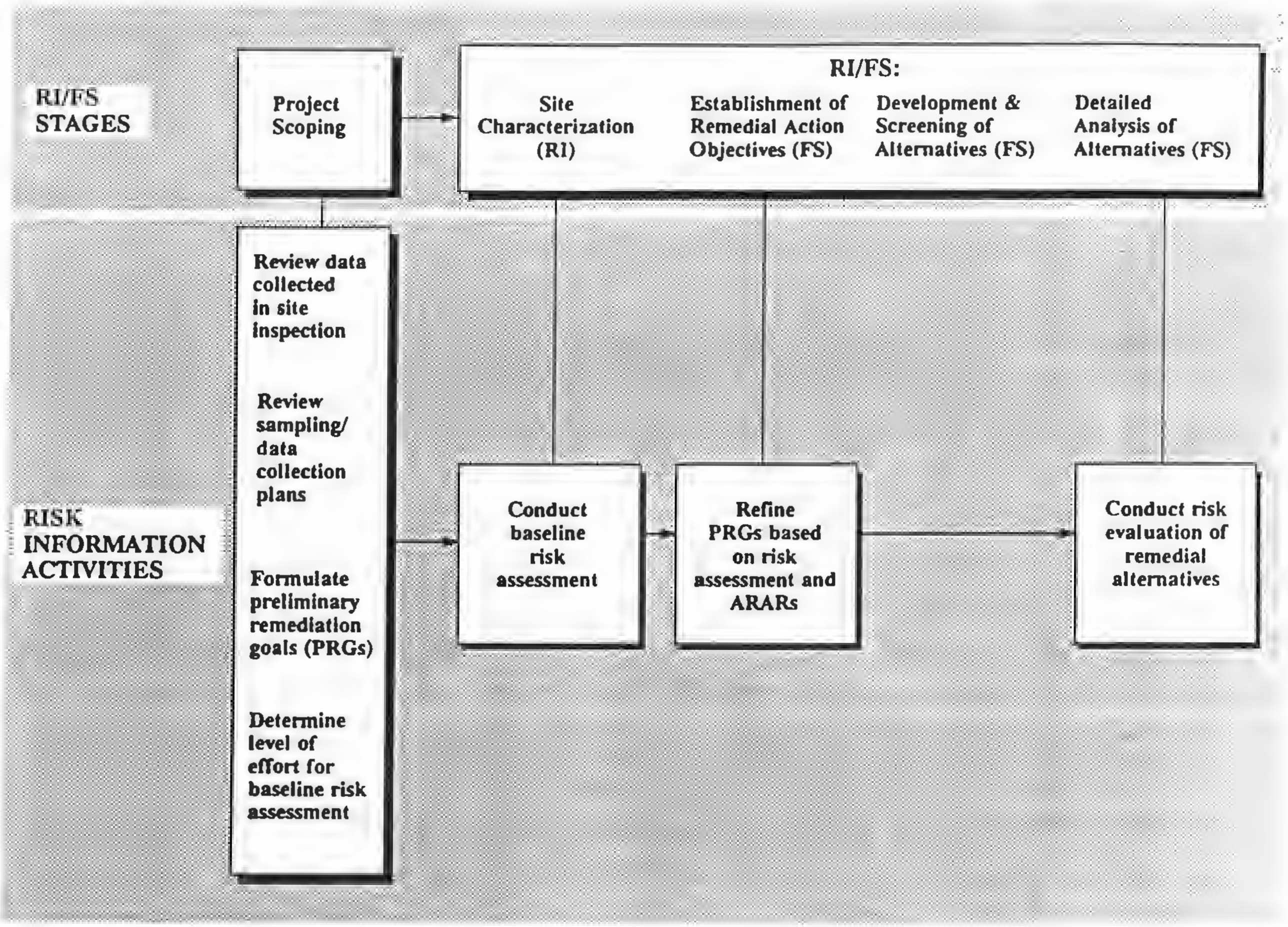

Source: USEPA, Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, December 1989.

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RISK INFORMATION ACTIVITIES
IN THE RI/FS PROCESS

FIGURE 32 AUGUST 1991

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The human health risk assessment process will include, at a minimum, the following basic steps; as shown in Figure 33, Human Health Baseline Risk Assessment Process.

1. Data collection and evaluation,
2. Exposure assessment,
3. Toxicity assessment,
4. Risk characterization.

4.4.1 Identification of Contaminants of Concern

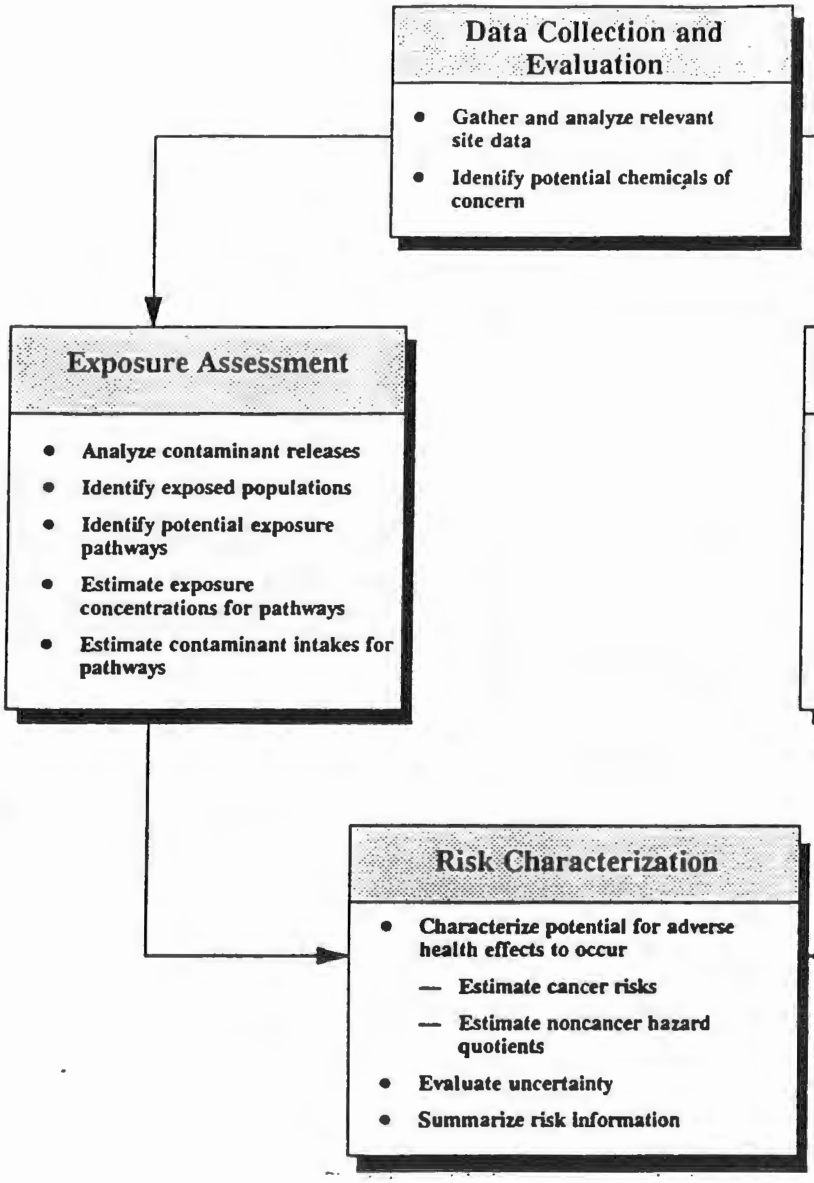
The first step in the public health evaluation is the identification of the contaminants of concern for which a quantitative risk analysis will be performed. It is MAIN's intent to carry most compounds through the risk assessment and only exclude compounds with proper justification. Based on the preliminary review of available data, three chemical classes, volatile organics, explosives and metals, are of concern at the site. Indicator chemicals will be selected on the basis of a number of factors in order to represent the entire spectrum of compounds measured on site. These factors include:

- Magnitude of environmental concentrations
- Frequency detected
- Distribution among site matrices
- Toxicity
- Environmental fate
- Presence in area background samples
- Evidence in laboratory contamination

Chemicals of potential interest for this site are discussed in Subsection 3.1.3, Data Summary and Conclusions.

4.4.2 Exposure Assessment

The second step in the public health evaluation is the characterization of potential exposure pathways and receptors. A preliminary identification of the potential populations at risk and the most likely exposure routes was presented in Section 3.2, Identification of Potential



Source: USEPA, Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, December 1989.

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HUMAN HEALTH BASELINE RISK ASSESSMENT PROCESS

FIGURE 33 AUGUST 1991

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Receptors and Exposure Scenarios. Section 3.2 also identifies possible exposure scenarios for potential future land uses.

MAIN has previously identified a number of pathways of human exposure. These include:

1. Dermal exposure to surface water and sediments,
2. Inhalation of fugitive dust emissions and volatile organic emissions,
3. Incidental ingestion and dermal exposure to onsite soils,
4. Ingestion of groundwater,
5. Ingestion of biota from Reeder Creek,
6. Ingestion of food crops and livestock exposed to fugitive dusts and contaminated irrigation water.

Receptors identified in the risk assessment will include sensitive subpopulations (e.g., schools, hospitals, etc.) locations of nearby residences, and surrounding land use, etc.

Ingestion of groundwater and ingestion of food crops and livestock are not significant current pathways since the on-site groundwater is not a likely source of potable water. However, a potable water well survey and a survey of springs will be performed within a one-mile radius of the installation. Groundwater related pathways will be considered under future use scenarios.

Dermal exposure to surface water and sediments would occur to people wading in off-site portions of Reeder Creek. Wading in the creek is possible for people fishing in the off-site portions of the creek and for children playing in the creek. Ingestion of fish caught in Reeder Creek could result in human exposure through bioaccumulation and biomagnification of the contaminants in the surface and sediments.

Surficial soil and dust could become airborne due to vehicular traffic or high winds. Persons at or near the site could inhale particulates which have been contaminated with on-site material. Particulate and HNu monitoring is planned during the RI. Values for particulates in the air and the concentration of contaminants in the surficial soils will be used to estimate particulate concentration and the concentration of contaminants in the airborne particulates.

A Gaussian plume dispersion model will be used to assess dispersion of airborne contaminants; both particulate and vapor phase, from the site to potential receptors. Estimation of vapor and fugitive dust concentrations will be performed using models contained in Methods for Estimating Fugitive Particulate Emissions from Hazardous Waste Sites (USEPA, 1988a), as well as other publications. Use of the variety of models depends on the particular site areas to be assessed as sources (e.g., bare fields, grassy fields, berms, etc.) and an explanation of each of the models that will potentially be used is too lengthy. All models used in the risk assessment will be described and their use justified.

Workers who may visit the site may be required to excavate or come in contact with soil at the OB/OD grounds. Exposure to excavation workers will include both surface and subsurface soils. Exposure could occur due to ingestion of soils retained on the hands and from inhalation of fugitive dusts generated during site activities.

Potential future uses of the site will also be considered in the exposure assessment. Conversion of the OB/OD grounds for light industrial use will be considered as the most minimally restrictive use that will be allowed at the site. Under assured baseline (i.e., non-action) conditions, the future use exposure scenarios would be the same as those under current conditions. Exposure frequencies for people at the site would be increased, based on the assumption that future workers would be on the site daily, rather than the occasional on-site visits which characterize current use exposures.

The upper 95% confidence limit on the arithmetic mean of the log-transform data will be used to model site contaminant concentrations.

Exposure point concentrations for the chemicals of concern in the various environmental media will be determined from results of direct measurements (e.g. surface water concentrations are exposure concentrations for Reeder Creek biota) or from the application of environmental fate and transport models to the data developed in the Remedial Investigation. For each medium and each receptor, reasonable maximum exposure concentrations will be developed. The general basis and guidelines used for exposure projections will be in accordance with the Risk Assessment Guidance for Superfund (RAGs) and the newly developed Human Health Evaluation Manual, Supplemental Guidance:

Standard Default Exposure Factors (U.S. EPA, 1991). The Superfund Exposure Assessment Manual (USEPA, 1988a) and the Exposure Factors Handbook (USEPA, 1990) will only be used for scenarios not included in the Supplemental Guidance.

The exposure concentrations will be used to determine chemical intakes for each of the receptors for individual media and to determine total chemical intakes for receptors exposed to multiple contaminated media. The chemical intakes will be calculated using standard USEPA assumptions for inhalation, ingestion, and dermal contact with contaminated medial (USEPA. 1988a). These parameters are listed in Table 22, Standard Assumptions for Calculation of Chemical Intakes. Exposure of children is accounted for in chemical intake calculations and activity patterns (e.g., wading in offsite portions of Reeder Creek) although these are not specifically applied to children. Parameters for the calculation of chemical intakes from other pathways (e.g., fish and food crop ingestion) will be taken from the Exposure Factors Handbook (USEPA, 1990).

4.4.3 Toxicity Assessment

The toxicity assessment will collect and summarize the relevant toxicological data for the chemicals of concern. The primary source of toxicological data used in the analysis will be the EPA's Integrated Risk Information System (IRIS). IRIS is the definitive source for Reference Dose (RFD) and Carcinogenic Slope Factor (CSF) data published by the EPA. The IRIS database is updated frequently and some data may be superceded during the preparation of the risk assessment. The IRIS database will be consulted at the beginning of the draft Toxicity Assessment and the data obtained will be used through the complete draft document. IRIS will be consulted again prior to completion of the final document to check for significant changes in the database used in the risk assessments.

If a chemical of concern is not in the IRIS database, other sources will be consulted in order to develop estimates for RFD and CSF values. Estimates for these parameters will be developed using route-to-route extrapolation or structure activity analogies. The following sources will be used as supplemental sources of information: (1) The USEPA's Health Effects Assessments (HEAs), (2) Toxicological profiles prepared by the Agency for Toxic Substances and Disease Registry (ATSDR), (3) Air and Water Quality Criteria Documents, (4) NIOSH and OSHA Occupational Health Guidelines, and (5) Scientific literature sources of toxicological and chemical data. The USEPA will be consulted if it is felt that

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PATHWAY	RISK EVALUATION	INTAKE ASSUMPTIONS
DERMAL WATER	CARCINOGENIC	SA = SKIN SURFACE AREA FOR CONTACT = 1.94 M2 (ADULT) EF = EXPOSURE FREQUENCY = 7 DAYS/YEAR = NAT. AVG. SWIMM. ED = EXPOSURE DURATION = 70 YEARS (LIFETIME) BW = BODYWEIGHT = 70 KG (ADULT AVERAGE) AT = AVERAGING TIME = 70 YEARS X 365 DAYS/YEAR
	NONCARCINOGENIC	SA = SKIN SURFACE AREA FOR CONTACT = 1.94 M2 (ADULT) 0.728 (CHILD) EF = EXPOSURE FREQUENCY = 7 DAYS/YEAR = NAT. AVG. SWIMM. ED = EXPOSURE DURATION = 30 YEARS (90 % AT 1 RES.) BW = BODYWEIGHT = 70 KG (ADULT AVERAGE) 16 KG (CHILDREN 1-6 YEARS) AT = AVERAGING TIME = 70 YEARS X 365 DAYS/YEAR
DERMAL SOIL	CARCINOGENIC	SA = SKIN SURFACE AREA FOR CONTACT = 0.86 M2 (ADULT) EF = EXPOSURE FREQUENCY = 350 DAYS/YEAR ED = EXPOSURE DURATION = 70 YEARS (LIFETIME) BW = BODYWEIGHT = 70 KG (ADULT AVERAGE) AT = AVERAGING TIME = 70 YEARS X 365 DAYS/YEAR AF = SOIL TO SKIN ADHERENCE = 2.77 MG/CM2 (SOIL STD.)
	NONCARCINOGENIC	SA = SKIN SURFACE AREA FOR CONTACT = 0.86 M2 (ADULT) 0.39 (CHILD) EF = EXPOSURE FREQUENCY = 350 DAYS/YEAR ED = EXPOSURE DURATION = 30 YEARS (90 % AT 1 RES.) BW = BODYWEIGHT = 70 KG (ADULT AVERAGE) 16 KG (CHILDREN 1-6 YEARS) AT = AVERAGING TIME = ED X 365 DAYS/YEAR AF = SOIL TO SKIN ADHERENCE = 2.77 MG/CM2 (SOIL STD.)
INHALATION	CARCINOGENIC	EF = EXPOSURE FREQUENCY = 350 DAYS/YEAR IR = INHALATION RATE = 20 M3/DAY (ADULT AVERAGE) ED = EXPOSURE DURATION = 70 YEARS (LIFETIME) AT = AVERAGING TIME = 70 YEARS X 365 DAYS/YEAR BW = BODYWEIGHT = 70 KG (ADULT AVERAGE)
	NONCARCINOGENIC	EF = EXPOSURE FREQUENCY = 350 DAYS/YEAR IR = INHALATION RATE = 20 M3/DAY (ADULT AVERAGE) BW = BODYWEIGHT = 70 KG (ADULT AVERAGE) 16 KG (CHILD)
INGESTION WATER	CARCINOGENIC	EF = EXPOSURE FREQUENCY = 350 DAYS/YEAR IR = INGESTION RATE = 2 LITERS/DAY (ADULT 90 %) ED = EXPOSURE DURATION = 70 YEARS (LIFETIME) AT = AVERAGING TIME = 70 YEARS X 365 DAYS/YEAR BW = BODYWEIGHT = 70 KG (ADULT AVERAGE)
	NONCARCINOGENIC	EF = EXPOSURE FREQUENCY = 350 DAYS/YEAR IR = INGESTION RATE = 2 LITERS/DAY (ADULT 90 %) BW = BODYWEIGHT = 70 KG (ADULT AVERAGE) 16 KG (CHILD)
INGESTION SOIL	CARCINOGENIC	EF = EXPOSURE FREQUENCY = 350 DAYS/YEAR IR = INGESTION RATE = 100 MG/DAY (ADULT AVERAGE) ED = EXPOSURE DURATION = 70 YEARS (LIFETIME) AT = AVERAGING TIME = 70 YEARS X 365 DAYS/YEAR BW = BODYWEIGHT = 70 KG (ADULT AVERAGE)
	NONCARCINOGENIC	EF = EXPOSURE FREQUENCY = 350 DAYS/YEAR IR = INGESTION RATE = 200 MG/DAY (CHILD) BW = BODYWEIGHT = 16 KG (CHILDREN 1-6 YEARS)

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STANDARD ASSUMPTIONS FOR CALCULATION OF CHEMICAL INTAKE

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there are valid technical reasons for selecting toxicity values other than those found in the references cited above. Summary toxicity profiles which summarize pertinent information regarding the chemicals will be developed for each chemical, using the references cited. The hierarchy for toxicity information will be Iris > Heast tables > consultation with USEPA ECAD in Cincinnati, Ohio.

4.4.4 Risk Characterization

The Risk Characterization process integrates the information from the Exposure and Toxicity Assessments to develop estimates of the route-specific and overall risks to the exposed populations. The process characterizes the nature and magnitude of potential risks associated with exposure to soils, groundwater, surface water, sediments and air at the site.

The initial step in Risk Characterization is a comparison of exposure concentrations to ARAR's. This step identifies the media specific contamination which exceeds established regulatory criteria for both health-based and non-health-based ARAR's.

Risk estimates are calculated for all media and chemicals of concern. This step is performed regardless of ARAR exceedance or conformance because (1) not all ARAR's are health based, and (2) even if a health-based ARAR is not exceeded, media and chemical specific risk calculations are required for summarizing risk estimates access chemicals and media.

The risk will be calculated for potential carcinogenic and non-carcinogenic risks posed to the human populations from exposure to the chemicals of concern. The risks of individual chemical exposures within a medium will be combined for similar effects. The Risk Assessment Guidance for Superfund (USEPA, 1989) recommends summing of the carcinogenic risks across chemicals without consideration of potential synergistic or antagonistic effects. Non-carcinogenic risks, however, are summed only for chemicals which produce similar toxic effects. For example, the potential risks of developing liver effects from chemical A, as expressed by a hazard index value, would not be added to the potential risks of developing neurological effects from exposure to chemical B. The characterizations will be developed on a media and route specific basis. Where appropriate, the media and route specific risk estimates will be combined to provide and overall assessment of the population risk.

The risk characterization will be performed according to the procedures contained in the Risk Assessment Guidance for Superfund (USEPA, 1989).

4.4.5 Environmental Assessment

An environmental assessment will be performed for the site with the objective of ascertaining existing and potential future environmental impacts of the site if no remedial action is taken. The results of this analysis will then be used in the development and evaluation of remedial alternatives. The first phase of the assessment will be largely qualitative.

A primary methodology to be utilized in assessing aquatic environmental impacts is a comparison of site water concentration levels to water quality criteria for the protection of aquatic life. These aquatic life criteria, based primarily on toxicity, are listed within the USEPA, Ambient Water Quality Criteria Document (May 1, 1987, The "Goldbook"). In addition, New York state has established a set of water criteria for fishing and fish propagation. These data will be combined with the ecological evaluation completed for the Remedial Investigation to qualitatively determine the aquatic impact. The ecological investigation will be performed according to the RAGs, Part II.

To evaluate terrestrial environmental impacts, published information concerning the toxicity of various chemical constituents to terrestrial organisms will be considered. If warranted, concentrations of contamination in on-site contaminated matrices will be extrapolated to probable contaminant concentrations at or within the organism (i.e., extrapolation allowing for dilution, organism uptake, bioaccumulation).

Contaminants of concern will be selected separately for the environmental assessment and based on the criteria for human health assessment: Magnitude and frequency of detection, distribution, toxicity, environmental fate, and other factors. Toxicity criteria will be based on potential effects to habitats and environmental receptors and environmental fate considerations will put greater emphasis on the potential for bioaccumulation and biomagnification.

The selection of organisms for tissue analysis (Phase II) will depend on the results of the habitat assessment (Phase I). Quantitative exposure doses will not be determined for organisms not sampled. Because tissue sampling is to be included as part of Phase II, details regarding how macroinvertebrate tissue sample data, if collected, will be used will be provided upon review of the Phase I data. In general, tissue sample data will be used to assess the bioaccumulation of contaminants of concern so that estimates of the potential for effecting humans and other higher organisms can be assessed. Shell fish are indicator species which can represent worst case bioaccumulation.

MAIN will collect data on fish populations as defined on the "Fish Data Sheet," Figure A-9.

4.4.6 Identification of ARARs

Chemical-specific ARARs will be determined for the contaminants at the site. The chemical-specific concentration limits established by either federal or state environmental laws will be compiled with for each applicable environmental medium.

Location-specific ARARs are those requirements that establish restrictions on remedial activities or limitations on contaminant levels on the basis of site characteristics or the physical characteristics of the surrounding area. Currently, there are no known location-specific ARARs for the general site area. As part of this project, location-specific ARARs will be further researched to ensure compliance.

Activity-specific ARARs are standards that establish restrictions or controls on particular kinds of remedial activities related to management of hazardous substances or pollutants. Specific remedial activities will be evaluated as opposed to the specific chemicals present at this site. Examples of activity-specific ARARs include closure regulations, incineration standards, and pretreatment standards for discharges to publicly owned treatment works. Because different types of remedial actions will be evaluated, different activity-specific ARARs will apply to the various alternatives.

4.5 DATA REPORTING

The program described in this work plan is intended to provide a data base which will yield an understanding of on-site conditions in accordance with all applicable state and federal law, including numerous guidance documents. However, MAIN recognizes that during the RI process there may be a need to expand a particular task. Consequently, the expeditious completion of the program requires good communication between MAIN, SEAD, USACE, NYSDEC and EPA. This section describes the mechanisms which will ensure that communications between all concerned is maintained.

4.5.1 Preliminary Reports

At the completion of the first round of field sampling, a letter report characterizing the site will be furnished by the Army Project Manager. This letter report will at a minimum list the locations and quantities of contaminants at the site. Should a second and even a third round of confirmatory sampling be required, additional letter reports will be prepared at the conclusion of each.

At the conclusion of the field work, a Preliminary Site Characterization Summary in the format of the first four chapters of an RI report will be prepared. This document will form the basis of the discussion at a Project Manager's progress meeting.

A draft RI report will be prepared at completion of the site investigation and the data evaluation. The report will summarize the results of the field investigation and record searches and present the data and conclusions in a clear, concise record. The RI report will also present the results of the data evaluation. This task is compete upon review, comments and revision of the draft RI report document as governed by the Interagency Agreement (IAG).

4.5.2 Quarterly Reports

The Army shall submit to EPA and NYSDEC quarterly reports, no later than the 10th day of the months of January, April, July, and October, which shall include the following:

1. Minutes of all formal Project Manager, Technical Review Committee (TRC), or other formal meetings held during the preceding period. This shall also include a summary of issues discussed at the Project Manager meetings which may have occurred in the last quarter;

2. Status report on all milestones met during the period, report and explanation for any milestones not met during the preceding period and assessment of milestones scheduled for the next reporting period;

3. Outside inspection reports, audits, or other administrative information developed during the preceding period, including notice of any outside inspections or audits scheduled during the next reporting period;

4. Permit status as applicable;

5. Personnel staffing status or update;

6. Copies of all Quality Assurance Data and sampling and test results and all other laboratory deliverables received by the Army during the reporting period, if any; and

7. Community relations activity update.

4.5.3 Monthly Reports

When field work, associated with response activities, is being conducted at the Site, the Army shall submit a monthly Field Activity Report to EPA and NYSDEC, not later than the 10th day of the month addressing the following:

1. A summary of work completed in the field, i.e., sampling events or well installation. Upon request, copies of trip reports and/or field logs shall be provided;

2. Anticipated or actual delay of a scheduled field activity, to include basis and any effect on subsequent events or scheduled activities;

3. Discovery or indication of significant additional contamination or any new family of hazardous substances at an AOC other than that previously recognized or expected for the AOC location;

4. Quantum increase in concentration of hazardous substances of any media beyond that previously recognized or expected for that AOC location;

5. Determination of any specific or potential increase of danger to the public, the environment, or to individuals assigned to work at the site. Such a determination shall be reported to the EPA and NYSDEC as soon as discovered; and

6. Copies of all Quality Assurance Data and sampling and test results and all other laboratory deliverables received by the Army during the month, if any.

4.6 TASK PLAN SUMMARY

The previous five sections of the task plan have described activities which will be conducted as part of performing the RI and the reports to be prepared during this program. This section provides a summary of the activities which will be performed for each media to be sampled. A summary of the number and type of samples to be collected, along with parameters for analysis is presented in Table 23, Summary of Media Sampling and Analysis. All laboratory analyses will be performed in accordance with the methodology presented in the Chemical Data Acquisition Plan (Appendix C).

The subsurface and surface soil samples will be collected during two phases, Phase I and Phase II. Biota tissue sampling, if necessary, will be conducted during Phase II after completion of the Phase I habitat assessment.

Approximately 628 soil samples will be collected from the surrounding soils of the pads, the pads, the low lying hill and the berms of the pads. All these soil samples will be analyzed using Level II methods at the laboratory. The indicator compounds are total VOA's, Lead for the heavy metals and TNT for explosives. Of the 628 samples collected, 222 samples, excluding QA/QC samples, will be analyzed by Aquatec for full CLP analyses of VOA's, heavy metals and explosives. The criteria to be used for choosing which sample to be analyzed for full CLP analyses is presented in Figure 26, Level II Criteria for Soil Analyses. Prior to disposal, TCLP will be used to determine if drummed soils are RCRA characteristic contaminants.

TABLE 23
SUMMARY OF MEDIA SAMPLING AND ANALYSES

MEDIA TO BE SAMPLED		# OF SAMP. LOC.	# OF BACK-GROUND SAMP.[1]	# OF SAMPLES MINUS QA/QC						OTHER ANALYSES[4]	# OF QC SAMP. DUPLIC. LEV. II IV, & V[5]	# OF EQUIP. BLANKS, LEV. II IV, & V[5]	# OF QA SAMPLES[6]	TOTAL # OF SAMPLES[7] LEV. II	LEV. IV & V
				TAL[2] LEV.II	TAL[2] LEV.IV	EXPLOSIVES LEV.II	EXPLOSIVES LEV.V	TCL[3] LEV.II	TCL[3] LEV.IV						
SUBSURFACE SOILS															
Grid Soil Borings	I	20	4	104	21	104	21	104	21		(5,2)	(5,2)	2	114	27
(200' spacing)	II	30	0	150	30	150	30	150	30		(8,3)	(8,3)	3	166	39
Burn Pad Borings	I	22	0	110	22	110	22	110	22		(6,2)	(6,2)	2	122	28
(25'-50' spacing)	II	18	0	90	18	90	18	90	18		(4,2)	(4,2)	2	98	24
SURFACE SOILS															
Grid Soil Borings	I	20	1	20	20	20	20	20	20		(1,2)	(1,2)	2	22	26
	II	30	0	30	30	30	30	30	30		(2,3)	(2,3)	3	34	39
Burn Pad Borings	I	22	0	22	22	22	22	22	22		(1,2)	(1,2)	3	24	29
	II	18	0	18	18	18	18	18	18		(1,2)	(1,2)	1	20	23
Berms	I	32	0	32	16	32	16	32	16		(2,2)	(2,2)	2	36	22
	II	28	0	28	14	28	14	28	14		(1,1)	(1,1)	1	30	17
Low Lying Hill	II	28	0	28	12	28	12	28	12		4	4	2	34	18
SURFACE WATER															
Potential Wetlands Plus Drainage Chan.	I	8	1	0	9	0	9	0	9	9	1	1	1	0	12[8]
Reeder Creek	I	5	1	0	6	0	6	0	6	6	1	1	1	0	9
SEDIMENT															
Potential Wetlands Plus Drainage Chan.	I	8	1	0	9	0	9	0	9	9	1	1	1	0	12[8]
Reeder Creek	I	5	1	0	6	0	6	0	6	6	1	1	1	0	9
GROUNDWATER															
Existing Wells	I	14	2	0	16	0	16	0	16	16	2	2	2	0	22
New Wells	I	16	0	0	16	0	16	0	16	16	2	2	2	0	22

---

1. Background is defined as upgradient locations which are uninfluenced by site conditions.
2. Surface water samples will be analyzed for total metals; all groundwater samples (16) will be analyzed for total metals (unfiltered).
3. TCL includes VOAs, ABINs, PCBs/Pest.; Level II analysis will include a total volatile screen only
4. Other analysis include: Nitrates (Surface Water and Groundwater), Hardness (Surface Water) and Total Organic Carbon (Sediments).
5. The first number in the parentheses is the number of samples to be collected for Level II analyses. The second number in the parentheses is the number of samples to be collected for Level IV and V analyses.
6. QA samples are split samples which will be submitted to an independent government laboratory for analysis.
7. Total number of samples for Level IV and V = (number of sample - QA/QC) + number of background + number of duplicates + number of blanks + number of QA samples. Total number of samples for Level II = (number of samples - QA/QC) + number of background + number of duplicates + number of blanks.
8. At four locations grid borings and potential wetlands samples coincide.

NOTE: Subsurface and surface soils will be sampled during two phases of investigation, Phase I and Phase II. The Phase I and II of the sampling is indicated under the "Media To Be Sampled" column as I and II, respectively. Proposed sample estimates are optimistic estimates of what can be collected.

On-site areas, defined during the terrestrial survey as wetlands, will be sampled. A total of six (6) surface water and sediment samples are planned from these areas. One (1) background wetland sample will also be collected. Each area will be sampled once. Three (3) drainage channel samples will be collected. Additionally, the surface water and sediments of Reeder Creek will be sampled. A total of six (6) samples will be submitted for full CLP, nitrates, hardness and explosive analyses.

The aquatic habitat of Reeder Creek will be assessed in addition to the terrestrial habitat of the area surrounding the OB/OD grounds. Sixteen (16) additional groundwater wells, both in the overburden and the weathered bedrock will be installed. The number of overburden wells to be installed are six (6), five (5) at the O/B/OD grounds and one (1) off-site as background. Ten (10) weathered bedrock wells will be installed, nine (9) at the OB/OD grounds and one (1) off-site for background. The wells will be sampled for full CLP analytes including, heavy metals (unfiltered), nitrates and explosives.

MAIN personnel will validate data received in accordance with the EPA Region II Standard Operating Procedure (SOPs) for Evaluating Organic and Inorganic Data. Factors to be considered include: sample holding times, instrument calibration, blanks, surrogate recoveries, matrix spike duplicates, and other quality control parameters. The Guidance For Data Useability in Risk Assessment (U.S. EPA, 1990) will be used to evaluate data to be used in the risk assessment. Quality Assurance (QA) will be documented by comparison between Aquatec results and the independent government laboratory. The EPA currently does not provide guidelines for Level II data validation. The QC program for the Level II analyses will include: instrument calibration, duplicates, and blanks. MAIN personnel will validate this data in consultation with Aquatec.

Data evaluation will be completed upon receipt of the data from the field investigation. Data will be compared to project objectives and summarized into a usable format for data manipulation. Tables will be created to exhibit data, contaminant levels will be plotted on site maps, and groundwater contour maps and geologic cross sections will be developed. Contaminant receptors will be identified, contaminant migration pathways refined, as part of the risk assessment. The results of this task will be used in the FS and in the evaluation of remedial alternatives.

5.0 TASK PLAN FOR THE FS

In accordance with the current EPA guidance manual, Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA Interim Final (October 1988), a feasibility study (FS) for the site will be conducted based on the results of the remedial investigation (RI). The subtasks comprising this FS will include:

1. The development of remedial action objectives,
2. The development of alternative remedial actions,
3. The screening of alternative remedial actions, and
4. A detailed evaluation of remedial actions.

A flowchart of the approach to the alternative development is shown in Figure 34, Feasibility Study -Development and Screening of Alternatives.

5.1 DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES

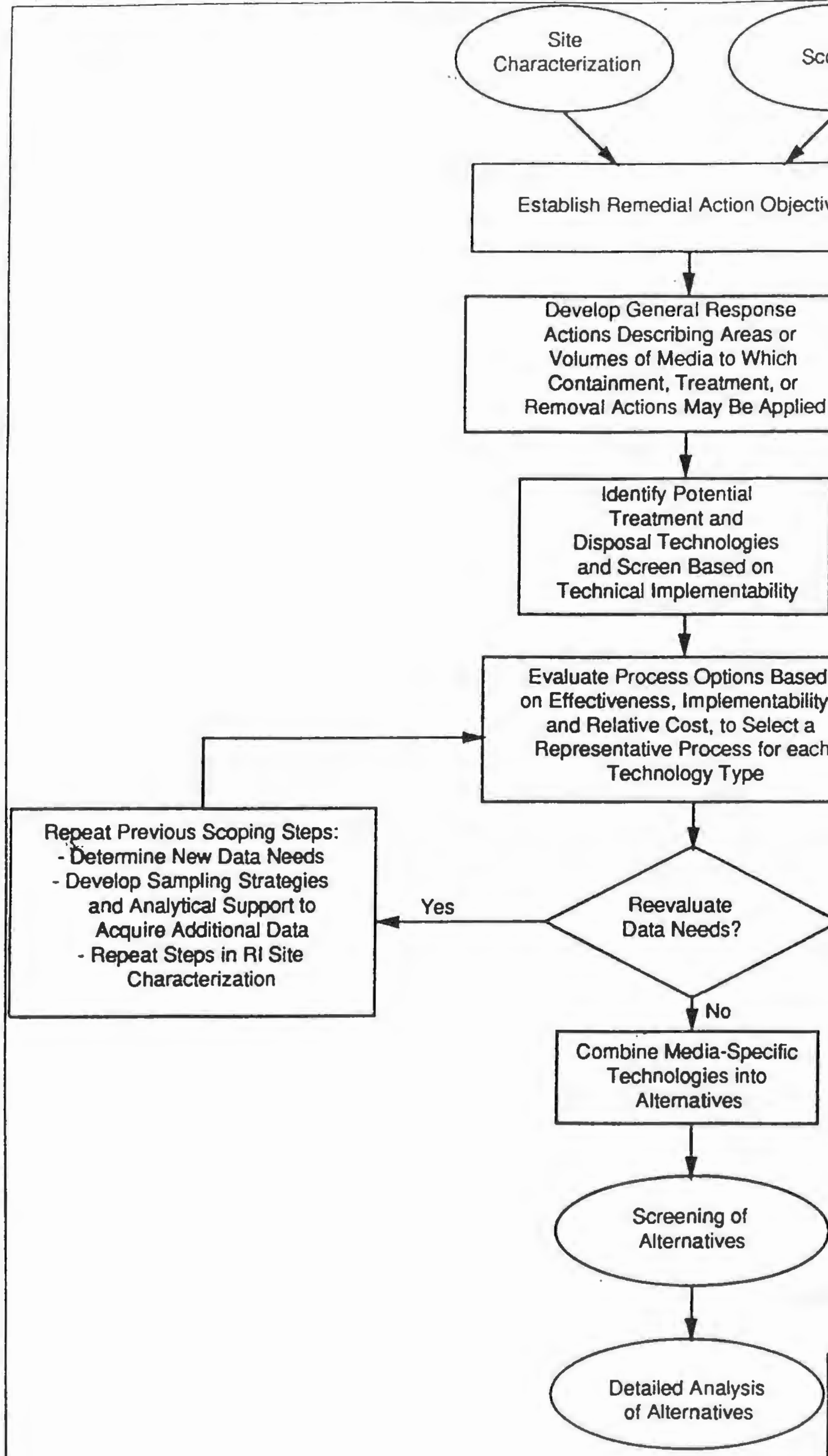
Based on the data collected in the RI, the contamination migration pathways and the potential receptors defined in the Risk Assessment, remedial action objectives will be developed. The remedial action objectives will consist of medium specific or operable unit specific goals for protecting human health and the environment.

The remedial response objectives for protection of human health and the environment should:

1. Manage the migration of the contaminants of concern,
2. Eliminate or minimize any exposure routes, and
3. Be acceptable contaminant levels in soils, air and water, which must be met during remedial action.

Protection of human receptors usually involves reducing exposure and reducing contaminant levels. Protection of environment receptors usually seeks to preserve or restore a resource and therefore needs to define the media of interest and contaminant levels required.

Initially, the objectives are based on information such as reference doses and risk specific doses, the final objectives will be specific to the site and based on results of the risk assessment and evaluation of expected exposures. Development of response objectives will



Source: EPA Guidance Document for Conducting RI/FS Under CERCLA (Interim Final, October 1988)

SENECA ARMY DEPOT

FEASIBILITY STUDY
DEVELOPMENT AND SCREENING
OF ALTERNATIVES

FIGURE 34 AUGUST 1991

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also include refinement of ARAR's specific to the site. Overall, the objectives will seek to define clean-up levels that will minimize risks to human health and the environment.

5.2 DEVELOPMENT OF REMEDIAL RESPONSE ALTERNATIVES

5.2.1 Develop Remedial Response Actions

Based on the remedial action objectives defined, remedial response actions will be developed to satisfy those objectives. A preliminary identification of remedial response actions were defined during scoping. These remedial response actions emphasize soil remedial action alternatives since groundwater impacts appear minimal at this time. The alternatives are:

1. No action,
2. Capping,
3. Excavation and landfilling,
4. In-situ detoxification,
5. Solidification,
6. Resource reclamation,
7. Implementation of institutional controls, and
8. Excavation and off-site incineration,
9. Composting,
10. Soil washing/flushing,
11. Carbon adsorption (groundwater),
12. Ion exchange (groundwater),
13. Chemical oxidation (groundwater),
14. Reverse osmosis (groundwater).

The response actions defined during scoping will be refined as information about the site increases with the collection of data during the RI. In the development of alternatives, response action may be combined due to varied contamination and migration pathways at the site.

5.2.2 Identify Volumes and Areas of Media to Which Response Actions Apply

During this stage of the FS an initial determination is made of areas or volumes of media to which the response actions apply. Interactions between media must be taken into account, and will be more fully examined when data has been collected from the RI. Defining these areas and volumes of media to which response actions apply should consider:

1. Acceptable exposure levels;
2. Potential exposure routes; and
3. The nature and extent of contamination.

MAIN's initial data review has indicated that contamination is likely to be varied. This may have occurred due to the continued use and reuse of this area for PEP destruction. Historical information indicates that the current burn pads were built-up over former burn areas because it was difficult to maintain burns due to the wetness of the poor draining base soils. MAIN's volume estimates will account for variability in the underlying subsurface by collection of continuous spoon samples. Volume versus concentration relationships will be defined and alternatives will be developed by which specific response actions will reduce exposure to protective levels.

5.2.3 Identify and Screen Applicable Technologies and Process Options

This step of the FS is used to identify applicable technologies types. Technology types is a broad term used to describe general categories, such as chemical treatment or capping. For each technology type, several processes may be included.

During this screening step, process options and entire technologies are eliminated on the basis of technical implementibility. Finally, one process type for each technology is selected. The evaluation uses the criteria of:

1. Effectiveness;
2. Implementability; and
3. Cost.

The effectiveness evaluation focuses on:

1. Potential effectiveness of a process option to deal with the volumes of media required to be processed, in addition to being able to obtain remediation goals,
2. Potential impacts to human health and environment, and the
3. Reliability the process has shown for the given contaminants.

The implementation evaluation focuses on:

1. Ability to obtain necessary permits;
2. Availability of treatment, storage, or disposal services; and

3. Availability of equipment and people to implement the technology.

The cost evaluation focuses on relative capital and O&M costs which are used to compare process options within the same technology.

5.2.4 Assemble Selected Technologies Into Alternatives

Alternatives for the entire site are formed from the response actions and process options for each medium or operable unit. Each remedial alternative will be an overall site remedy. The no action alternative will be considered as a baseline against which all other alternatives can be evaluated.

5.3 SCREENING OF REMEDIAL ACTION ALTERNATIVES

Alternatives which have been determined to meet the remedial action objectives for each medium of interest will be screened. Before screening, it may be necessary to further define some aspects of the selected remedial action alternatives, such as interactions among different media and remediation timeframes. Analysis of alternatives should include such aspects as time to achieve a desired risk level for a certain media.

The alternatives will be evaluated, as were the process options, on the basis of:

1. Effectiveness;
2. Implementability; and
3. Cost.

The purpose of the screening is to select alternatives for detailed analysis. At this stage it may be necessary to identify and verify action specific areas and begin treatability testing.

5.4 DETAILED ANALYSIS OF REMEDIAL ACTION ALTERNATIVES

In this stage of the FS, alternatives brought through screening are further refined based on site characterization information or treatability studies. The analysis should provide adequate information for the final selection of an alternative. This should include:

1. Further definition of each alternative with respect to areas/volumes of media to be addressed;
2. A summary profile of each alternative against the evaluation criteria; and

6.0 PLANS AND MANAGEMENT

The purpose of this Work Plan is to present and describe the activities that will be required for the development of the preliminary assessment/site investigation. The Field Sampling and Analyses Plan (Appendix A), details procedures which will be used during the field activities. Included in this plan are procedures for sampling soil, sediments, surface water, fish, shellfish and groundwater. Also included in this plan are procedures for developing and installing monitoring wells, measuring water levels and packaging and shipment of samples.

The Health and Safety Plan (Appendix B) details procedures to be followed during field activities to protect personnel involved in the field program.

The Chemical Data Acquisition Plan (Appendix C) describes the procedures to be implemented to assure the collection of valid data. It also describes the laboratory and field analytical procedures which will be utilized during the RI.

6.1 SCHEDULING

Figure 35, The RI/FS Schedule, presents the proposed matrix which relates defined work tasks with time to complete each task.

6.2 STAFFING

This section contains a listing of project staff and describes the functional relationships of the organizational structure and responsibilities of the support functions. The project organization is presented in Figure 36. Each of the MAIN personnel listed serves in a supervisory role. These personnel will provide overview and guidance to the project team and will assist the project manager in the resolution of technical difficulties.

The USACE project manager will oversee the entire project. He is the contact at the Corps of Engineers to which MAIN must report to.

The MAIN project manager, Mr. Michael Duchesneau, P.E., is responsible for the effective day-to-day management of the project staff; direct communication and liaison with the USACE and Seneca; technical approach and review of deliverables, management of resources, schedules, and budgets, and communication among the general and technical support functions.

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FIGURE 35
SENECA ARMY DEPOT
SENECA OB/OD GROUNDS
REMEDIAL INVESTIGATION/FEASIBILITY STUDY SCHEDULE

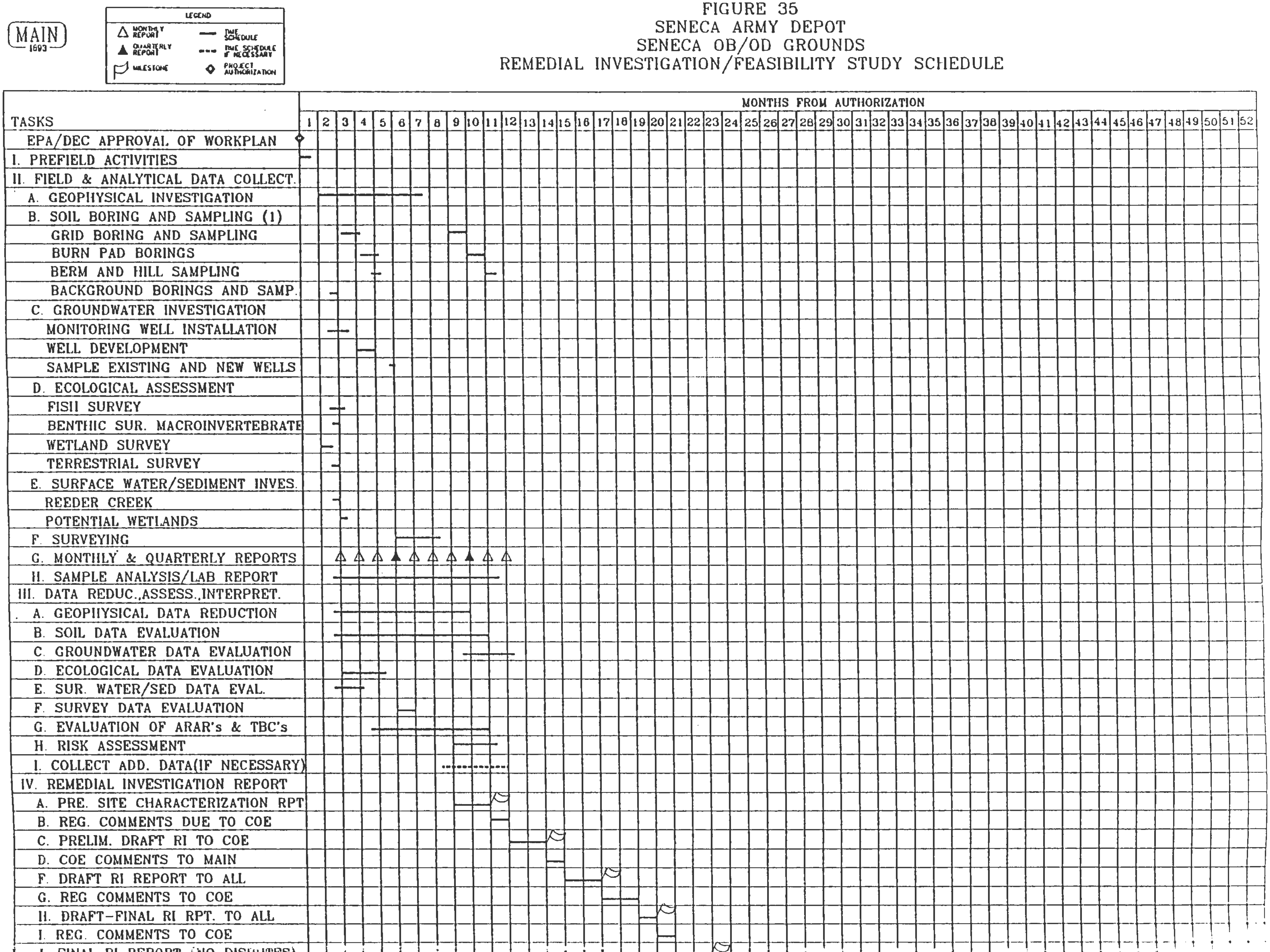

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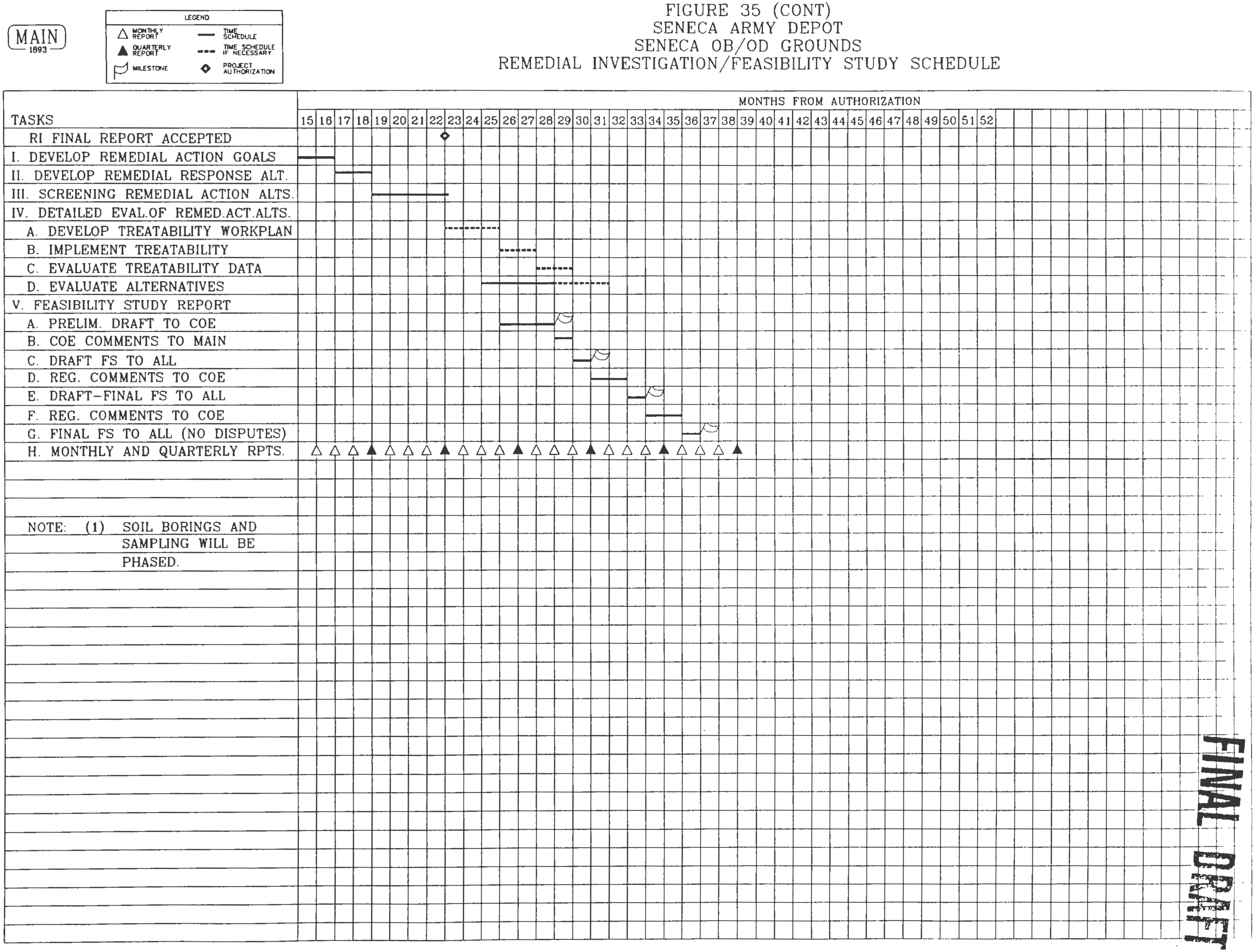
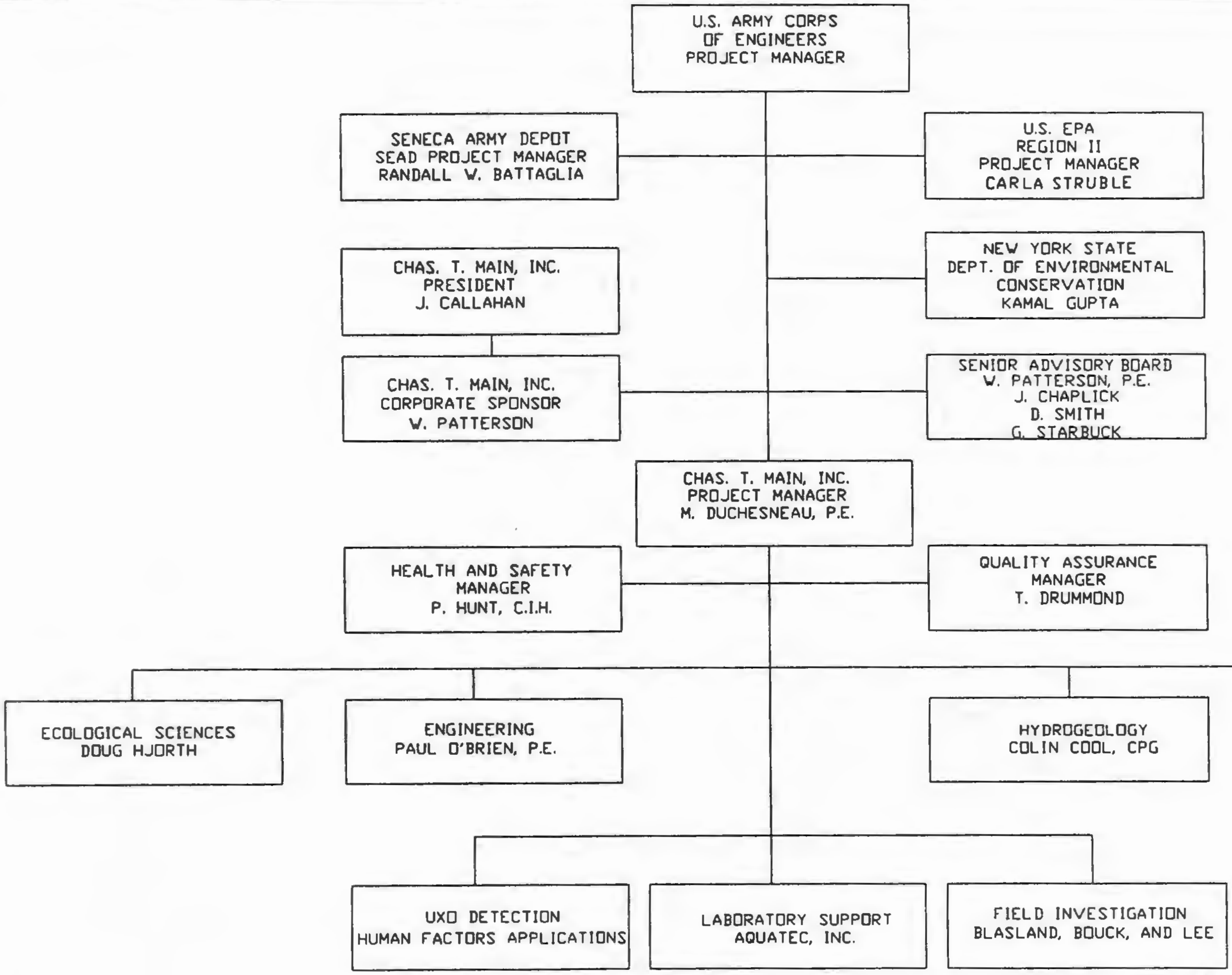
FIGURE 35 (CONT)
SENECA ARMY DEPOT
SENECA OB/OD GROUNDS
REMEDIAL INVESTIGATION/FEASIBILITY STUDY SCHEDULE



NOTE: (1) SOIL BORINGS AND SAMPLING WILL BE PHASED.

FINAL DRAFT

FINAL DRAFT



SENECA ARMY DEPOT

PROJECT ORGANIZATION

FIGURE 36 AUGUST 1991

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The general support personnel include a health and safety manager and quality assurance manager. The health and safety manager is responsible for preparing the health and safety plan for site activities and training project personnel in safety practices. The quality assurance manager is responsible for monitoring and periodically auditing to assure QC procedures outlined in the Chemical Data Acquisition Plan are followed by the field team and the laboratory.

The support personnel in ecological sciences, engineering, hydrogeology, and regulatory compliance will provide technical support and assist in the resolution of difficulties related to their individual fields.

Outside support has been retained by MAIN to assist in the field investigation (Blasland, Bock, and Lee), to provide laboratory assistance (Aquatec, Inc.), and to aid in UXO detection and handling (Human Factors Applications).

FINAL DRAFT

APPENDIX A

FIELD SAMPLING AND ANALYSIS PLAN

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List of Attachments

FINAL DRAFT

LIST OF FIGURES

1.0 INTRODUCTION

Environmental measurements are subject to a wide variety of instrument, spatial, and temporal variables. A representative sample of the material from which it is collected must accurately depict the spatial, temporal, physical, and chemical qualities of the material. Standard operating procedures help to minimize those errors which result in the collection of invalid data or nonrepresentative samples. This is important as field data collection provides the primary basis upon which site investigations, assessments, and remedial actions are based.

There are four basic factors which affect the quality of sampling data. These are: 1) Selection of the sample collection site; 2) Method of sample collection; 3) Sample preparation, preservation and storage methods; and 4) Sample analysis. Samples must be representative of the media from which they are extracted, and maintain their integrity and/or constituents between the time of sampling and the time of analysis. Field measurement devices and procedures also must follow set procedures to obtain precise and accurate readings at representative locations.

This document presents MAIN's Field Sampling and Analysis Plan (FSAP) for the collection of precise, accurate, and representative field data. If the provided FSAP does not cover a situation encountered in the field, procedures recommended by the EPA or other suitable authority will be followed.

Performance of certain tasks described herein require adherence to health and safety procedures defined in the Health and Safety Plan provided in Appendix B. Addenda to the Site Health and Safety Plan will be developed, as may be necessary, for specific field data collection tasks.

2.0 PRESAMPLING CONSIDERATIONS

2.1 COMMUNICATIONS

Personnel responsible for the design and/or implementation of field sampling activities are encouraged to establish and maintain close communications with personnel responsible for the performance of chemical, physical, or biological characterization activities. Development of open communication between these two parties can provide an important conduit via which information relevant to the representativeness, integrity, and quality of the sample can be transferred. For example, laboratory personnel can be an important source of information and materials that are essential to ensure that samples are properly preserved at the time of their collection. Laboratory personnel can also assist sampling personnel with the definition of sample volume and number of sample aliquots that are required to complete the analyses of interest. Furthermore, laboratory personnel should also assist program management and field personnel with the definition of analytical procedures that are used to quantify the pollutants of concern, to ensure that suitable procedures with appropriate detection limits are specified. Field personnel should provide laboratory personnel with advance notification of sample shipment to minimize the period of time that samples sit unattended prior to analysis. Furthermore, this mechanism can be used to advise laboratory personnel of unusual properties exhibited by samples as they were being collected. Finally, the establishment of open communications between field and laboratory personnel can facilitate implementation of managerial decisions to refocus the emphasis or extent of certain investigations.

Specifically, field personnel are responsible for the following:

1) Daily communication with the project manager to advise of the project status.
2) Communication with the laboratory prior to and during sampling of sediment, soil, and water.
3) Communication with subcontractors, the frequency of which is to be determined by the project manager.

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2.2 SAMPLE INTEGRITY ISSUES

The selection and use of suitable sample containers is an important facet of any field sampling and analysis project. Storage of samples in unsuitable containers can lead to sample loss, sample contamination, and/or sample degradation, each of which has direct implications on the representativeness, and therefore the utility of the data that is ultimately reported.

Prior to the initiation of field work, project personnel should familiarize themselves with sample bottle, storage, and packaging requirements and recommendations. Specific issues that should be reviewed include analytical sample size requirements, sample bottle type, sample preservation requirements, and holding times between collection and analysis. Sources of this information include conversations with laboratory personnel and review of analytical methodology descriptions provided in any of numerous reference sources, such as those listed in SW-846.

Once familiar with sample packaging and preservation requirements, project personnel should obtain the necessary sample bottles and transport containers as well as essential preservative chemicals and supplies. Frequently, sample bottles and transport containers can be obtained directly from the laboratory where the subsequent analyses will be completed; although occasionally outside vendors of these materials should also be considered. In either case it is important to insure that all containers are suitably precleaned, dried, capped, and stored prior to their use for holding samples. Whenever the integrity of any sample container is suspect, due to presence of foreign liquids or debris or due to conditions of suspected or known incomplete container closure, the sample container should not be used and recleaned prior to use.

Sample preservation should be completed immediately after the collection of the required sample volume. Frequently, sample preservation includes the performance of some field determination (e.g., pH measurement), the addition of a small quantity of a chemical material to the sample, the closure of the sample container and its placement in a device (e.g., ice chest) where a controlled environment (4° C or room temperature) has been established. Alternately, some subset of the listed steps may be required. Regardless of the level of sample preservation required, it is imperative that required procedures be implemented immediately at the time of sample collection.

More complete discussions of sample bottle preparation, sample preservation, sample storage, and packaging and shipping are presented in Sections 4 and 5.

2.3 QUALITY CONTROL SAMPLES

Three types of quality control samples should be produced and submitted to the laboratory as a result of each field study. These samples are called Trip Blanks, Field or Equipment Blanks, and Field Duplicates. All water used for trip blanks, field equipment rinse blanks and the final rinse in the decontamination procedure will be demonstrated as analyte-free. Descriptions of these samples are presented below.

Trip Blank: This sample is used to determine whether contaminants are being introduced to field samples due to improper laboratory procedures, poor container precleaning operations or due to conditions encountered during transport. Normally, trip blanks are prepared only for volatile organic compound determinations, but situations may arise where other analytes should be considered.

A trip blank is prepared by filling a precleaned screw cap septum vial with demonstrated analyte-free water, preserving it, and followed by sealing the vial and placing it into the transport chest with other empty bottles. This sample is transported to the field, where it remains stored with the empty sample bottles until those bottles are used. Trip blanks will accompany shipments of aqueous samples for volatile organic analysis. Then the trip blank is stored with the samples until they are analyzed at the analytical laboratory. Typically one trip blank is provided for each day of anticipated field sample collection.

Field (Equipment)
Blank: This sample is used to determine whether field sampling (decontamination and sample collection) procedures or the environment of the job site are possible sources of contaminant introduction. Generally, one field blank sample is prepared each day a decontamination event is carried out, not to exceed one per day. In the field, blank water is poured into the sampling device, and then transferred to the sample container. Water should be ASTM Type III quality, but other sources may be used as long as it is free of all analytes of interest. Whenever sources of blank water other than ASTM Type III are used, information defining its origin and quality should be recorded in the field notes.

Field Duplicate: Field duplicates are used to provide an estimate of the precision of field sampling and analytical procedures. A field sample is defined as two samples that are collected simultaneously from one location. Duplicate samples will each have unique sample numbers, and they will be analyzed separately as two unknowns within the laboratory. Information denoting the true identify of each duplicate should be recorded in the field notebook. One field duplicate for every increment of 20 field samples or less should be collected.

2.4 SAMPLE NUMBERING SCHEME

A uniform sample numbering scheme will be used to be certain that each sample has a unique number. The Site Manager will clearly assign blocks of numbers or the equivalent to be sure that site workers do not duplicate numbers. The general numbering scheme will be as follows:

X0011-Y

where:

X = type of material (e.g., A for air, S for soil/sediment, W for surface water, G for groundwater and X for other)
00 = month
11 = day of the month
Y = daily consecutive number

The depth interval for soil samples will be recorded in a field logbook along with the corresponding sample number.

3.0 FIELD OPERATIONS

The proposed field operations for the OB/OD Grounds area will consist of the following major tasks:

1. Geophysical Survey
2. Soil Sampling
3. Monitoring Well Installation, Development and Sampling
4. Surface Water and Sediment Sampling
5. Biota Sampling

The following sections describe the objectives and techniques associated with the previously mentioned tasks.

3.1 GEOPHYSICAL SURVEY

The proposed Unexploded Ordnance (UXO) Geophysical Plan for the SEAD OB/OD site will consists of the following major tasks:

1. Hand Held Magnetometer survey of the sampling sites and related access routes.
2. GSSI Subsurface Interface Radar (SIR) -10 System survey of the pad surface areas not accessible to the RADAR system.
3. Cross section sampling of subsurface geophysical anomalies detected during ground penetrating radar (GPR) and magnetometer surveys.

Each of the tasks described produces a result unique to the application of the task. The following sections describe the objectives and procedures associated with the previously mentioned tasks. The sequence for the geophysical investigations is 1) Hand Held Magnetometer Survey, and 2) GGSI Subsurface Interface Radar (SIR) System. Ferrous and non-ferrous magentometry will be performed on the access paths. Magentometry and GPR will be performed on the burning pads.

3.1.1 Hand Held Magnetometry Survey

3.1.1.1 Objectives

The main purpose of the Hand Held Magnetometry survey is to ensure the safe entry of personnel and equipment into each of the sampling sites. Additionally, the hand held magnetometry instruments can be used to survey areas which are not easily accessible.

3.1.1.2 Hand Held Magnetometry Procedures

HFA will be using an electromagnetic (active all-metals) induction detector and a passive ferrous metals detector to search the access routes, sampling areas, and areas difficult to access (i.e. the face and top areas of the pad berms) of the OB/OD site.

The hand held magnetometers and a description of their operation are listed below:

1. Electromagnetic (Active All-Metals) Induction Detectors

   - Active locators, as a class, generate a magnetic field. Their detection ranges are determined by the strength of their magnetic field, the attenuation of the field in the soil, the size and makeup of the items being sought, and the amount of conductive clutter in the search area. These factors tend to limit active detection ranges to three (3) feet or less, depending on the search instrument. A major advantage to this type of detector is its all metals capabilities. These instruments are capable of detecting ordnance constructed of both ferrous and nonferrous metals. Active locators can affect influence fuzing; therefore it is necessary to have some knowledge of the types of ordnance and their fuzing systems that may be encountered within the search area. The U.S. military currently utilizes locators that employ the multiple-coil, balanced bridge, and phase-imbalance types of active locators.

   - The active all-metals magnetometer used by HFA is the White's Eagle II SL 90. The White's Eagle II SL 90 is able to detect a 75 to 81 mm projectile at a depth of 1.5 to 2 feet. There are many environmental considerations that can effect the depth of detection (magnetic signatures), i.e., soil characteristics (minerals and salts present), type of metal being detected, size of the metal object, orientation of the object (vertical or horizontal to the linear axis of the object), metallic contamination of the site (wide spread fragmentation), and the capabilities of the detector. Activities such as earth removal and tree grubbing can also change the magnetic signatures in the earth. With all factors taken into consideration, there are no iron clad measurements regarding the sizes of UXOs or depths at which they can be detected.

2. Passive Ferrous Metals Detector

- Passive ferrous metal detectors detect anomalies in the earth's magnetic field which are produced by ferromagnetic (ferrous metal) targets. Generally passive locators respond to either: 1). The magnitude of the magnetic field strength (Proton-Precession) or 2). The gradient or rate of change of the field (Fluxgate). The detection ranges of passive locators are dependent on not only the resolution of the device, but also the magnetic features of both the search area and the item being located, as soil boring as the search technique being used (i.e., continuous sweep or grid mapping). Within the EOD community the standard passive magnetometers in use today are of the Fluxgate and the Proton-Precession types.

- The passive ferrous metal magnetometers currently used by HFA are the Mk 26 Mod 0 Ordnance Locator (Forster Ferex 4.021) and the Schonstedt Model GA-52B.

Due to the extremely heavy contamination of the OB/OD site with ordnance components and UXOs, extreme care for the personnel and equipment entering the 200 foot grid site and the 25 foot burn pad sampling areas is required. Nearly all of these items have been exposed to fire or explosions and because of this, any of these items which are still explosively loaded are extremely hazardous. The active all-metals and passive detectors will be used to search the access routes and sampling sites for hazardous items.

Dependant upon the object size, physical properties (ferrous or nonferrous) and depth of burial large metal objects can also be located and marked on the OB/OD site. Excavation to determine the identification of these items will be performed as needed to complete the study of the OB/OD site.

Specialized techniques such as down hole magnetometry can also be performed. If manual operation of the soil boring equipment is performed, rechecks of the bore hole at two (2) foot intervals until virgin soil is encountered will be performed. If remote drilling procedures are employed, no additional checks of the site are required after the initial active all-metals and passive ferrous metals inspection of the sampling site have been performed.

UXO's will not be moved unless absolutely necessary. A qualified SEAD UXO removal team will be required to move and properly dispose of any UXOs.

All UXOs that can be safely moved and must be moved, will be moved remotely. Under no circumstances will any of the following items be moved (remotely or otherwise) by HFA EOD personnel:

1. UXO with a PIBDL fuze
2. UXO with a Mechanical Time fuze
3. UXO with an All-Ways-Acting fuze
4. UXO with a Cocked Strike fuze
5. UXO with a Graze Back Up fuze
6. Any UXO that the fuze system cannot be identifed.

3.1.1.3 Data Verification

Data verification for the Hand Held Magnetometry survey will be an ongoing process during the clearance or the access routes and sampling areas with the main emphasis being the location of hazardous UXOs and components.

3.1.2 Subsurface Interface Radar (SIR) -10 System Survey

3.1.2.1 Objectives

Using the SIR-10 system, a GPR survey of the pad surface areas not accessible by the RADAR system will be performed to determine if there are any burn trenches, burn pits, or UXO/residue burial areas under the burn pad sites. The SIR-10 can also identify the built-up burn pad and original ground surface interface.

3.1.2.2 GSSI Survey Procedures

The SIR-10 system will be hand operated on the burn pad sites. As the SIR-10 is pulled across the burn pad site, the reflected radar pulses are transmitted to the receiver unit where they are converted analog signals. The analog signal is then transmitted to the control unit where the signal is electronically processed and then sent to the graphic recorder. The graphic recorder produces a continuous chart display on electro-sensitive paper. This real-time display enables the operator interpret the data on site.

The data from the SIR-10 survey can then be applied to the burn pad grid spacing of 25 feet for plotting the subsurface anomalies. The subsurface geophysical data obtained by the SIR-10 survey will than be used to evaluate each of the burn pad 25 foot grids to identify areas requiring additional study and to also avoid potentially hazardous areas during the soil boring and sampling operations.

3.1.2.3 Data Verification

Data verification for the SIR-10 survey will be performed during the sampling and excavation of the burn pad sites. The HFA UXO technicians will excavate as required to perform the verifications deemed necessary.

3.1.3 Cross Section Sampling of Subsurface Geophysical Anomalies

3.1.3.1 Objectives

Cross section sampling of subsurface geophysical anomalies is performed to verify the data obtained during the GPR and magnetometer surveys. Additionally, a greater area can be exposed for visual examination and collection of contaminated materials.

3.1.3.2 Cross Section Sampling Procedures

The cross section sampling excavations will be performed with a backhoe operated by a HFA UXO technician. At no time will non-UXO personnel be permitted on the excavation site until they are cleared to enter by the HFA UXO Safety Officer. The excavation will extend to a distance of 2 feet on either side of the subsurface anomaly. The width, length, and depth will be based on the size of the geophysical anomaly with applicable considerations for prevailing conditions such as flooding or stability of the excavation. Based on consultation with the C.T. Main Project Leader, HFA UXO Project Leader, and HFA UXO Safety Officer, a decision will be made at which point to cut off the excavation. The boom and bucket of the backhoe will be operated in such a manner as to not exert impact or shock to the soil or its contents. The depth of the excavation increment will be at the discretion (not to exceed 2 feet) of the HFA UXO Safety Officer. The contents of each bucket of material removed from the excavation will be gently placed on the ground and spread out so as to expose the contents as much as possible for a visual inspection. If at any time during the excavation the HFA UXO Safety Officer determines that the risk and hazards are too great to proceed with the excavation, the excavation will be halted. The HFA UXO Safety Officer has absolute and final authority in determining the procedures and safety issues associated with the excavation.

The excavation will be continuously monitored by C.T. Main with a PID or OVA. At no time will any personnel be permitted to enter the excavation. If the pit is not to be closed immediately after the required samples have been obtained, the excavation will be barricaded to prevent accidental entry by personnel working on the site. Each excavation will be marked after closure as needed for identification of the site.

A log containing the location of each cross section sample site will be maintained by the HFA UXO team. The log at a minimum will contain all of the data required to identify each cross section sample site and related data such as size, UXO or UXO related components, and other significant data. Records pertaining to sampling, geological data and associated requirements will be maintained by C.T. Main.

Due to the potential hazards associated with the cross section sample sites, when necessary, HFA will obtain samples for C.T. Main in accordance with the sample collection procedures.

The excavation equipment will be cleaned between cross section site sampling operations in accordance decontamination procedures outlined in Appendix A, Section 4.5.

3.2 SOIL SAMPLING

3.2.1 Objectives

A series of soil borings will be drilled as part of a phased boring program at the OB/OD Grounds across the entire 30-acre site, and also in the individual burn pads. Mid-depth, the point halfway between the top and bottom elevations of the berms, soil samples will be collected from a cross section of the berms and the low lying hill adjacent to the burn pads. The phased boring program and final locations and frequency of the borings and the berm samples are discussed in the Task Plan for the RI. Surface and subsurface soil samples will be obtained to (1) Determine the nature and extent of contamination across the 30-acre site; (2) Determine the nature and continuity of contamination around Burn Pads; and (3) Establish background levels for similar soils of the OB/OD Grounds.

3.2.2 Boring Techniques

The boring technique to be used will be hollow stem auguring with split spoon sampling of the undisturbed formation ahead of the hollow stem auger. The hollow stem auger will provide an open hole for sampling. The borings will be drilled to refusal, which is anticipated to be ten (10) feet. Six (6) samples will be collected from each boring, including a surficial sample. Samples will be screened visually and with either an OVA or HNu. Continuous split spoon samples will be collected for the length of the boring.

Soil boring techniques will involve a remote drilling operation. The remote drilling operations are necessary due to the unexploded ordinance conditions. Drilling procedures may involve the manual set up of the augers and split spoons, remote auguring, remote driving of the split spoon and manual retrieval of the split spoon sample.

All borings will be logged using a standardized boring log form (Figure A-1). Soil samples will be classified according to the Unified Soil Classification System (USCS). Each boring log will record:

1. Boring identification and location,
2. Type of and manufacturer's name of drilling equipment,
3. Type and size of sampling and drilling equipment,

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FIGURE A-1

CHAS. T. MAIN, INC.	TEST BORING REPORT	BORING NO. : ______

PROJECT : ______
CLIENT : ______
CONTRACTOR : ______

JOB NO. : ______
SHEET NO. : ______
ELEV. DATUM : ______
ELEV. (GS) : ______
ELEV. (TOC) : ______
DATE START : ______
DATE FINISH : ______
DRILLER : ______
INSPECTOR : ______

	CASING	SAMPLER	CORE BARREL
TYPE :			
SIZE ID/OD :			
HAMMER WEIGHT :			
HAMMER FALL :			

GROUNDWATER READINGS			
DATE	TIME	DEPTH TO WATER	STABILIZATION TIME

DEPTH (feet)	SAMPLE					SAMPLE DESCRIPTION	STRATUM DESCRIPTION	EQUIPMENT INSTALLED	REMARKS
	CASING BLOWS PER FOOT	SAMPLE BLOWS PER 6 INCHES	DEPTH REC. (feet)	SAMPLE DEPTH RANGE	VOC SCREEN (ppm)				
0									
5									
10									
15									
20									
25									
30									

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	CONSISTENCY
0–4	V. LOOSE	<2	V. SOFT
4–10	LOOSE	2–4	SOFT
10–30	M. DENSE	4–8	M. STIFF
30–50	DENSE	8–15	STIFF
>50	V. DENSE	15–30	V. STIFF
		>30	HARD

VOL. WATER LOST : ______gal. DATE WELL DEVELOPED : ______
VOC DETECTOR : ______
WELL PIPE : TYPE ______ DIAM. ______ SLOT SIZE ______
PROTEC. CASING : TYPE ______ DIAM. ______ KEY : Y N
REMARKS :

4. Starting and ending dates of drilling,
5. Length and depth of each sampled interval,
6. Length of each recovered sample,
7. Depth of all stratigraphic changes,
8. Lithologic description according to standard USCS nomenclature,
9. Depth at which groundwater is first encountered,
10. Depths and rates of any water losses,
11. Depth to static water level,
12. Depths at which drilling problems occur and how the problems are solved,
13. Total boring depth,
14. Reason for terminating borehole, and
15. Surface elevation.

Upon completion of sampling, all borings will be backfilled with a bentonite - cement grout to the surface. A cement/bentonite grout seal will be placed from the top of the bentonite seal to approximately 3 ft-bls by means of a tremie pipe. The grout mixture will consist of Portland cement (ASTM C 150-86) and water in the proportion of not more than 7.0 to 8.0 gallons (gal) of clean water per bag of cement [1 cubic foot (ft^3) or 94 pounds (lb)). Additionally, 3 percent by weight of bentonite powder will be added to help reduce shrinkage of the grout mixture. The grout will be allowed to set a minimum of 48 hours. A bentonite backfill consisting of bentonite pellets will be placed from the top of the cement/bentonite grout seal to the ground surface and allowed to hydrate.

3.2.3 <u>Sampling Procedures and Analyses</u>

Access routes and sampling work areas will receive a UXO search by HFA UXO personnel prior to soil sampling operations. The boundaries of the access routes will be marked with orange survey flags. All UXOs located during the search operation will be flagged with yellow survey markers.

All samples collected during the soil sampling operations will be inspected by HFA UXO personnel for small UXO components prior to on site testing or shipment for off site laboratory testing.

In areas heavily contaminated by UXOs or UXO components, samples will be collected by HFA UXO personnel. Sampling operations by other contractor personnel will be monitored by HFA personnel to ensure safety of these personnel.

Samples will be collected using a standard two inch diameter, two foot long carbon steel split spoon barrel. Soil samples will be characterized and screened for the presence of volatile organic compounds using a Photoionization Detector (PID) or an Organic Vapor Analyzer (OVA) at the borehole. The soil from each interval will then be divided between three sample containers. A grab soil sample from the location in the split spoon sampler with the highest meter (OVA/HNu) response will be placed in a 250 mL amber glass container, placed on ice and used for Level II analysis at the laboratory. To gain representativeness; the remaining soil from the spoon will be homogenized in a clean stainless steel bowl and placed in one 250 ml amber glass and one 500 ml clear glass containers. These will be retained for possible CLP laboratory analysis. Two 40 ml vials with septum seals will be filled with soil from the spoon exhibiting the next highest meter response for possible CLP analysis. Samples to be submitted for CLP laboratory analysis will be based on the Level II analysis for the presence of total volatiles, Lead and TNT (Trinitrotoluene). Level II analysis procedures are outlined in the Chemical Data Acquisition Plan.

Split spoon barrels will be decontaminated between locations using a sequence of washes and rinses described in Section 4.5 of Appendix A. These decontamination procedures conform to those described in the Rgion II QA Manual. In addition, drilling augers will be steam cleaned along with other drilling equipment between boring locations.

Soil samples will be further analyzed based on the results of the Level II analyses. Split spoon samples will be collected continuously for the length of the boring. Samples collected from the ground surface to the depth of the first spoon sample in saturated naturally deposited sediments will be sent to the laboratory for Level II analysis. Continuous split spoon sampling will occur for the remainder of the boring, however, the samples will not be submitted for Level II analysis. Because one of the goals of the subsurface investigation is to characterize source areas, MAIN does not feel that it is necessary to analyze split spoon samples below the upper portion of the saturated zone in naturally deposited sediments. All split spoon samples collected in fill material will be submitted for Level V analysis. The Level II analysis for Lead in soils will be by acid dissolution and analysis by Inductively

Coupled Plasma Emission (ICP); for explosives the analysis for TNT will be with a spectrophotomer, the analysis of volatiles will be with purge and trap followed compound separation with a GC equipped with an FID and PID in series. Select samples, one from the surface and one from the borehole, will undergo Level IV and V CLP Analysis. These sample selections will be used to determine the maximum contamination levels and the vertical extent of contamination and to verify Level II analysis. The Level IV and V are methods from the CLP Statement of Work (SOW) and USACE Method 8330 for explosives. The purpose of the Level II analyses is to reduce the number of samples that will undergo the expensive Level IV and V analyses for soils. This is due to the fact that the soil samples are so numerous.

Grab samples of surface soils are generally recovered by placing scooped or troweled quantities of soil into suitable sized sample bottles. These samples are typically obtained from individual points near the surface (0-6 inches). Surface soil samples will be collected with a stainless steel trowel or scoop.

At this time, no composite samples are to be collected. However, if composite samples are determined to be necessary they will be collected according to the following description. Composites may be prepared for surface soils. These samples require considerably more handling and time to prepare. To prepare surface soil composites, equal sized subsamples or materials from extended surface areas are placed into a receiver (e.g., bowl, pan) and thoroughly mixed. The required volume is then recovered and placed into the sample container, while the excess is discarded. Whenever possible compositing of soils should be limited to situations where dry or loosely bound (non-agglomerated) materials are present, as wet or agglomerated materials are difficult to homogenize without mechanical devices.

Subsurface soil samples will be collected from boring locations on a grid. Safety and health considerations are more numerous than those reviewed for surface soils, as there are possibilities that UXO's underground utilities, buried containers or pockets of highly contaminated material may be encountered. Subsurface soil samples will be collected using remote drilling rigs equipped with hollow stem augers. Split spoon soil samples will be collected continuously as the auger is advanced.

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3.3 MONITORING WELL INSTALLATION

This section outlines the installation of overburden and weathered bedrock monitoring wells. A hollow-stem continuous auger and air rotary methods will be employed for drilling and installing the monitoring wells.

All activities described in this procedure will be overseen by a qualified MAIN geologist.

3.3.1 Objectives

The objectives of this task is to install monitoring wells which will provide representative samples of water quality at two sections of the aquifer and also provide accurate determinations of piezometric head. A typical monitoring well is shown as Figure A-2, Typical Monitoring Well.

3.3.2 Decontamination of Equipment

Every appropriate precaution must be taken during drilling and construction of monitoring wells to avoid introducing decontamination into the borehole. All equipment to be placed into the boring must be decontaminated before use at the site and between boreholes. Equipment must be steam-cleaned between holes and only potable water may be used during drilling operations, unless otherwise approved by the NYSDEC.

3.3.3 Well Installation

Proper design, construction, and installation of the proposed wells are essential for accurate interpretation of the groundwater data. The program to be implemented is consistent with the USEPA Region II CERCLA QA Manual and the NYSDEC Technical and Administrative Guidance Manuals (TAGMS) regarding design, installation, development and collection of groundwater samples. Further, the program is in compliance with all requirements described in the NYSDEC, 6 NYCRR Part 360, Solid Waste Management Facilities Regulations, Section 360-2.11, which details groundwater monitoring well requirements.

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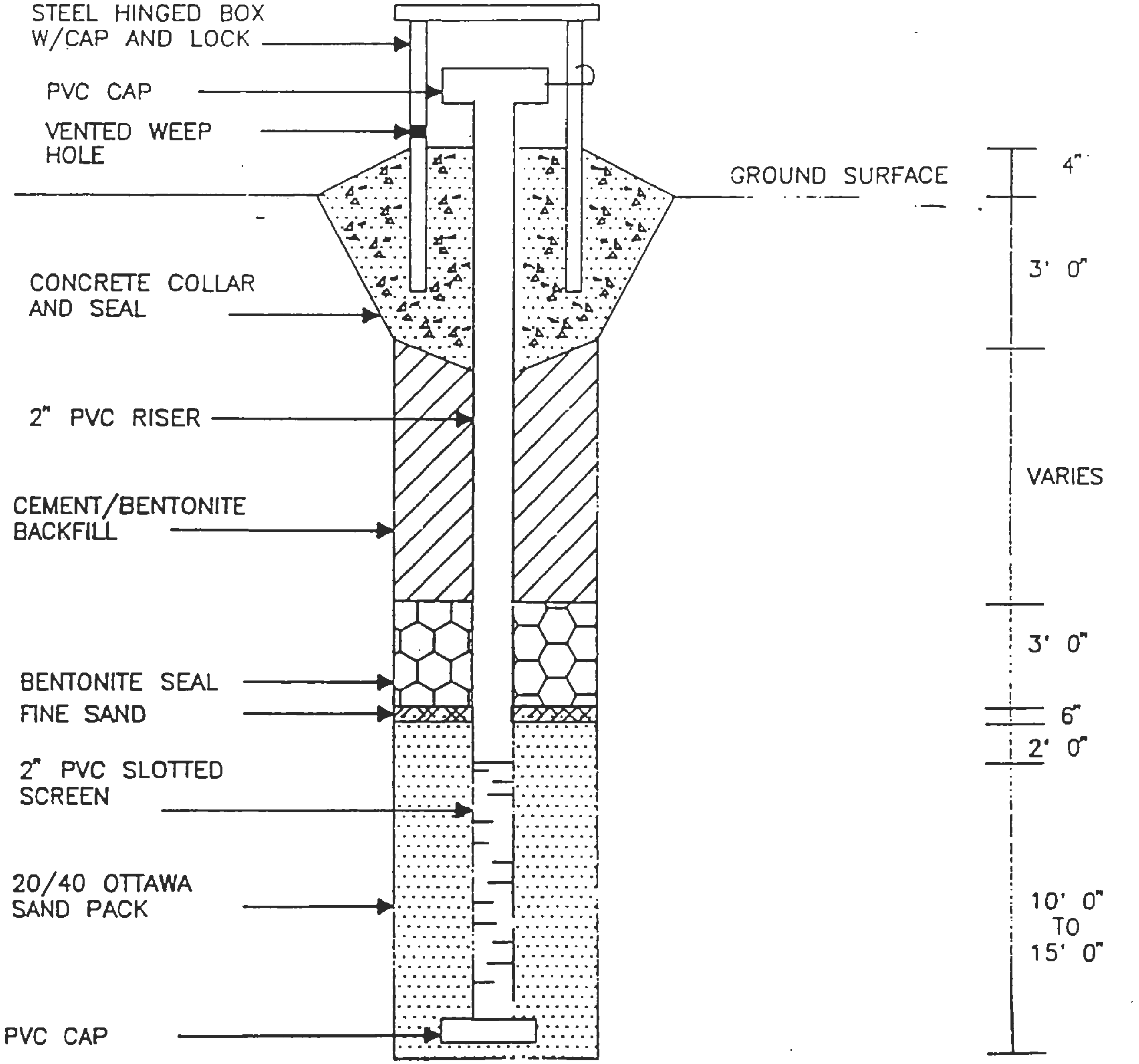
FIGURE A-2

TYPICAL MONITORING WELL



NOT TO SCALE

The installation of each monitoring well will begin after the boring has been completed. Installation will begin within 48 hours for fully cased boreholes. Once installation has begun, no breaks in the installation process will be made until the well has been grouted and the drill casing removed.

Monitoring wells may be placed individually or as well clusters. Well clusters consist of individual wells at varying depths in close proximity to each other. Each monitoring well must be installed in its own boring. Multiple wells placed into one large borehole are prohibited, unless NYSDEC approval is obtained. Where possible, upgradient wells should be drilled first.

Overburden wells will be installed remotely using hollow-stem augers. These wells will not penetrate through the weathered shale zone. Figure 27, Overburden Monitoring Well Details illlustrates a typical overburden monitoring well. Previous well logs suggest these wells will not be more than 15-20 feet deep. Screen lengths will be ten (10) feet, extending from the bottom of the till up ten feet. This should provide coverage throughout the entire saturated thickness. Soil split spoon samples will be collected continuously as the auger penetrates the formation. Soil samples will be collected as described in the soil boring program. The monitoring wells will be constructed of 2" National Sanitation Foundation (NSF) or ASTM approved Poly Vinyl Chloride (PVC). MAIN expects that the screen slot size will be 0.010." The actual screen size will be determined following sand pack sizing. PVC has been chosen to be consistent with the previous monitoring well database and to be cost effective. These wells will not be used for long term monitoring since NYSDEC policy requires stainless steel. No solvents, or glues or other adhesives will be used to connect the PVC casing.

A sand pack will surround the well screen. The exact composition of the sand will be determined from an analysis of soil gradation curves. These curves will be obtained from soil samples collected during the split spoon sampling. The sand pack will be placed by a tremie pipe in the annular space surrounding the well screen and the hollow stem auger. The sand pack will not extend more than two feet above the top, or six inches below the bottom of the screen. A finer grained sand pack material, six inches thick, will be placed at the top of the sand pack, between the sand pack and the bentonite seal. Bentonite pellets, at least three feet thick, will be used to seal the well and will be poured within the annular space. The remaining annular space will be completely filled with a grout mixture of cement/bentonite. The grout mixture will be placed in the annular spare using a tremie pipe. Auger flights will remain in the borehole during grouting to prevent caving. Augers will be removed as the grouting progresses. In all instances, wells will be protected with a steel casing, at least two inches larger in diameter than the PVC well casing. This protective steel casing will extend four (4) feet below the ground surface to prevent heaving by frost. The protective casing will have a locking cap and a weather resistant padlock. Duplicate keys will be obtained. A cement collar will surround the well. A weep hole will be drilled at the base of the protective steel casing above the cement collar to allow drainage of water. An expanding cap will also be placed in the top of the PVC well casing. This cap will provide protection from inappropriate filling of the well, should the protective casing lock be broken. A permanent well identification marker will be attached to the steel protective casing.

Monitoring wells will be installed in the weathered shale layer in a manner which will minimize the potential for transferring groundwater from the glacial till to the weathered shale. The drilling techniques to be used will be identical to those previously mentioned. If hollow stem auguring does not penetrate the weathered bedrock, air rotary techniques will be used to advance the boring to the specified depth.

The weathered bedrock monitoring well construction details will be similar to those of the overburden wells. However, the screen length will be 2 to 5 feet. The slot size is expected to be 0.010 inch. The screened zone will be sand packed which will be installed with a tremie pipe to avoid bridging. A finer grade of sand at least 6 inches thick will be placed above the sand pack between the sand pack and the bentonite seal. The bentonite seal will be up to three feet thick and will be placed to seal the weathered shale from the overburden. The remainder of the annular space will be grouted to the surface with a cement/bentonite grout. The cement/bentonite grout will be installed using a tremie pipe. A steel protective casing with a locking cap and weather resistant padlock will be installed to prevent tampering with the well. The PVC well casing will also be sealed with an expanding cap. The steel protective casing will have a weep hole drilled at the base to provide a drainage pathway for any collected water. A permanent well identification mark will be attached to the outside of the well using a steel stamp or a metal tag. Figure 28, Weathered Bedrock Monitoring Well Details, illustrates the details of the proposed monitoring well.

3.3.3.1 Type of Drilling

The method of drilling to be utilized at the OB/OD grounds is the hollow stem auger. The hollow-stem continuous-flight auger is among the most frequently employed tools used in drilling monitoring wells in unconsolidated materials. The drill rigs used for this drilling method are usually mobile, fast, and relatively inexpensive to operate. Drilling fluids normally are not used, and disturbance to the aquifers of concern is minimal. Auger drilling is usually limited to unconsolidated materials and to depths of approximately 150 feet. In formations where the borehole will not stand open, the well is constructed inside the hollow-stem auger prior to the auger's removal from the ground. Hollow-stem augers with inside diameters of six and one-quarter inches are readily available for this purpose and will be used. Generally, the diameter of the well than can be constructed with this type of drill rig is limited to four inches or less, although firms now manufacture eight and one-quarter inch, inside diameter, hollow-stem augers and are experimenting with ten and one-quarter inch, inside diameter, hollow-stem augers. The differential between the inner diameter of the auger and the outer diameter of the well casing should ideally be at least three to five inches to permit effective placement of filter pack and annular sealant.

The use of hollow-stem auger drilling in heaving sand environments presents some difficulties. However, with care and the use of proper drilling procedures, this difficulty can be overcome. For example, a positive pressure head within the auger stem can be developed by filing the auger with clean water. The heaving sands are thus displaced when a knock-out plug (which is part of the auger) is removed.

Because glacial till is expected to be encountered in the subsurface, the likelihood of encountering heaving sands is low. However, as an alternate drilling method to hollow stem augering, air rotary will be used. Air rotary methods will be used to install wells in the weathered bedrock if the desired depth can not be reached using hollow stem augering.

3.3.3.2 Well Casings and Well Screen

The proposed wells will be constructed of material similar to the existing wells. The well screen and casing will be constructed of new Schedule 40, machine-slotted PVC monitoring well pipe. Although the existing wells have a screen slot size of 0.010", the final slot size will be based upon the sand pack selection. The minimum casing diameter will be 2 inches. All the pipe will be new and have threaded, flush joints. No glued connections will be used. Based on sample characteristics, the Site Manager may require the screen to have a larger slot size. The slot size of the screen well be compatible with the sand pack. Water table variations, site stratigraphy, expected contaminant behavior, and groundwater flow will be considered in determining the screen length, materials, and position.

A number of factors need to be evaluated before the length and depth of well screens can be selected for placement at a sampling location. The number of wells at a sampling location will depend on the heterogeneity and simplicity of the geology, the physical/chemical properties of the contaminants, and the location of the suspected sources of pollutants. In general, one well will be installed at a sampling location where there is one relatively thin and homogeneous aquifer that has no dense or light non-aqueous phase layers (NAPLs). Multiple wells will be installed in a cluster when there are multiple aquifers or flow zones, perched water tables, discontinuous lithology, fracture zones in rock, or contaminants are encountered at specific depths.

The lengths of screens can be a significant factor in the detection of contaminants in groundwater and groundwater flow directions. At locations where a single well will be installed, the well screen will extend 2 to 3 feet above the water level to detect light NAPL's and approximately 8 to 10 feet below the water table. For overburden wells the screen lengths will be ten (10) feet, extending from the bottom of the till up 10 feet. This should provide coverage throughout the entire saturated thickness. At cluster well locations, the screen lengths will vary depending on the factors discussed in this section. In general, a well screen will span a contaminated zone, an aquifer, or a flow zone and will not be placed across more than one unit. At the OB/OD grounds the deeper zone of interest is the weathered shale zone. This unit is located above the competent shale bedrock but below the till overburden. The weathered bedrock layer is approximately 5 feet thick. For weathered bedrock wells, a 2 to 5 foot screen will be placed between 6 inches and 1 foot above refusal on competent shale. A greater screen length will be used in the weathered bedrock zone where possible.

3.3.3.3 Monitoring Well Filter Pack

Proper sizing of artificial filter materials and screen openings are perhaps the most important aspect of well design. Several methods for sizing filter materials and well screen openings are available in the literature. The methods are cited in Aller et al., (1989), Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells, Environmental Monitoring Systems Laboratory Office of Research and Development, U.S. Environmental Protection Agency, Las Vegas, Nevada, EPA 600/4-89/034, and Driscoll, F.G. (1988) Groundwater and Wells. Most methods are similar in concept and do not differ appreciably in their results. The first step in designing the filter pack is to obtain sieve analyses on the sample of the formation intended to be monitored. The filter pack material size is selected on the basis of the finest formation materials present.

As a general rule, filter packs are recommended where the d_{10} passing grain size is smaller than 0.25 mm (0.010 inches) and the uniformity coefficient is less than 3. The uniformity coefficient is defined as the ratio between the grain size at which 60 percent of the aquifer materials are finer, d_{60}, (percent passing equivalent sieve opening) and the 10 percent finer grain size, d_{10}, ($C_u = d_{60}/d_{10}$. The general procedure, common to most filter pack design techniques, specifies a filter pack ratio and sizing the filter based upon this ratio. The filter pack ratio is defined as the ratio of the filter pack grain size to the formation grain size. Generally, this ratio refers to either the d_{50} or the d_{30} passing grain sizes of the filter and the formation material. For example, the USEPA (1975) recommends that a filter pack size be selected by multiplying the d_{30} passing grain size of the formation by a factor between 4 and 6.

Four (4) is used if the formation grain size distribution curve indicates the aquifer is fine grained and uniform. A factor of six (6) is used if the formation is coarser and non-uniform. In both cases, the uniformity coefficient, C_u, of the filter pack materials should not exceed 2.5 and the gradation of the filter material should form a smooth and gradual size distribution when plotted. Specifications for the filter material is finalized by selecting sieve sizes which would fall on the grain size distribution curve defined by the d_{30} and the C_u (d_{60}/d_{10}). Consideration should be given to the availability of local supplies.

Although graded filter packs can be used in specific instances, uniform filter packs are generally preferred for monitoring wells. Graded packs are more susceptible to the invasion of formation fines at the formation filter pack interface. This invasion results in a partial filling of the voids between grains with a corresponding decrease in permeability. With a uniform filter, the fines of the formation will travel between the filter pack material during development, maintaining the high permeability of the filter pack.

The size of the well intake openings are selected after the filter pack grain size is obtained. The opening (slot) size is generally chosen on the basis of its ability to hold back between 85 to 90 percent of the filter material.

A finer grained sand pack material (100 percent passing the No. 30 sieve and less than 2 percent passing the No. 200 sieve), 6 inches thick, must be placed at the top of the sand pack between the sand and the bentonite seal. For most wells, a filter thickness from 4 to 6 inches is suitable. Silica or other related silicate material are preferred for filter materials. This material will be visually inspected prior to placement by the MAIN geologist. The sand pack material must be placed using a tremie method or another method approved by the NYSDEC if bridging is to be avoided. The tremie system is practical for placing filter material in shallow to moderately deep wells (to 2,000 ft.) and will be used to install the wells, if necessary, as the wells will likely be very shallow.

Use of a tremie pipe to install the filter pack will minimize the tendency for particle separation and bridging. This is the preferred method for filter pack placement. A string of 2 inch or larger pipe is lowered into the annular space to be filter packed. The filter pack is fed into a hopper at the well head.

The filter pack will extend from the bottom of the well intake to approximately 2 to 3 feet above the well intake providing the intake does not result in cross-connection with an overlying zone. If cross-connection is a potential problem, as may be the case for the wells to be screened in the weathered shale bedrock, the height of the filter pack may be adjusted as necessary. This decision will be the responsibility of the MAIN field geologist.

3.3.3.4 Bentonite Seal

Bentonite pellets will be placed above the sand pack using a tremie pipe or other approved method to form a seal up to three (3) feet thick. For wells installed in weathered rock, the thicknesses of sand and bentonite above the screened interval will be adjusted so that the bentonite seal will be in weathered rock. Sound rock is below the depth at which the boring encountered refusal. This should be below the weathered zone. The anticipated 5' thickness of the weathered bedrock will allow for a bentonite seal between the weathered bedrock and till after well installation. However, the weathered bedrock is anticipated to be too thin to obtain a seal across the weathered bedrock and till interface during drilling.

3.3.3.5 Annular Sealant

The remaining annular space will be backfilled with a clean grout containing at least 2-4% by weight bentonite to cement to a depth of about 2.5 feet below ground surface. All grout seals placed below the water table will be tremie piped into place. Care will be taken to seal across potentially confining stratigraphic layers to eliminate/reduce the possibility of cross-contaminating different aquifer units.

The grout mixture must set up without being diluted by formation water, and must displace water in the annular space to ensure continuous seal. The grout mixture must be placed under pressure using a tremie or alternative NYSDEC and EPA approved method.

3.3.3.6 Protective Casing

A protective casing will be installed over the PVC pipe. The protective casing will consist of a steel pipe 4 or 6 inches in diameter with a locking protective cap. The steel protective casing will be installed so that the top of the PVC pipe is 0.1 to 0.5 feet below the top of the steel protective casing and about 2.5 feet of the steel casing is above ground surface.

The well casings will be marked with the well number using metal stamps or a metal plate pop riveted to the steel casing, not the cover.

3.3.3.7 Documentation of Well Installation

The details of the borings and well installation will be recorded on the Test Boring Report Form shown previously as Figure A-1. In addition, a daily field report, will be competed each day. Figure A-3, Daily Field Report, presents MAIN's typical format for daily documentation of field work. This form will summarize information on boring footage, equipment used to install monitoring wells, and general activities on site.

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FIGURE A-3

DAILY FIELD REPORT

JOB NO. ______________ DATE ______________ REPORT NO. ______________

PROJECT & LOCATION ______________

CLIENT ______________ INSPECTOR(S) ______________ INSPECTION TIME ______________

CONTRACTOR ______________ DRILLERS ______________

TYPE OF RIG(S) ______________ NO. RIGS WORKING ______________ WORKING TIME ______________

NON-PRODUCTIVE TIME

WEATHER ______________ EQUIPMENT BREAKDOWN ______________ LATE ______________ OTHER ______________

WORK PRODUCTION TODAY

Boring No.	Drilling Boring Type	Over Burden (Lin. Ft.)	Continuous Sampling (Lin. Ft.)	Rock Core (Lin. Ft.)	Samples Type & No.	Wells and Tests	Remarks

STATUS OF TOTAL PRODUCTION

ITEM	LINEAR FOOTAGE				NO. BORINGS		RIG-DAYS	
	Today	Total to Date	Eng. Est.	% Compl.	To Date	Remain	To Date	Remain
Drive and Wash								
Auger								
Rock Core								
Wells								
Test Pits								

SEE OTHER SIDE FOR SYMBOLS AND REMARKS

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FIGURE A-3 (cont.)

SYMBOLS

S – Split Spoon Samples
T – Shelby Tube
W – Monitoring Well
P – Permeability Test
R – Pressure Test

SITE ACTIVITIES AND REMARKS

3.4 MONITORING WELL DEVELOPMENT AND SAMPLING

3.4.1 Objectives

The task involves the development of the existing monitoring wells and the newly installed monitoring wells. The task also involves sampling these wells at the OB/OD grounds and the determination of background levels by sampling wells off the OB/OD grounds site.

3.4.2 Monitor Well Development

The development of monitoring wells will be performed 2 to 7 days after well installation and at least 7 days before well sampling and monitoring activities.

Access routes and sampling work areas will receive a UXO search by HFA UXO personnel prior to monitoring well development and sampling operations. The boundaries of the access routes will be marked with orange survey flags. All UXOs located during the search operation will be flagged with yellow survey markers. In areas heavily contaminated by UXOs or UXO components, samples will be collected by HFA UXO personnel. Sampling operations by other contractor personnel will be monitored by HFA UXO personnel to ensure safety of these personnel.

Development of wells will be accomplished by pumping with an electric-powered submersible pump or a gasoline-powered centrifugal pump until the water is clear, (<50NTUs), and the well as free of sediment as practical. Well development will continue until pH, temperature and conductivity vary no more than 10 percent. If well yields cannot sustain the flow rate of the submersible or centrifugal pump, a PVC bailer will be used. Water will not be added to the well to aid in development. All development equipment will be decontaminated prior to use in the first well and between use in each well. The decontamination procedures for downhole development equipment are provided in Section 4.5, Equipment and Material Decontamination of Appendix A.

As the wells may be slow to recharge due to the low permeability of the formation, surging and overpumping may need to be performed numerous times on each well, with complete recharge between each episode. Every attempt will be made to remove excessive turbidity from the wells because high turbidity is believed to be responsible for elevated metal concentrations detected in the groundwater at the site during previous sampling events. A well development report will be completed, as shown on Figure A-4, Well Development Report.

3.4.3 Development Criteria

The criteria for determining if the well has been properly developed is based upon the guidance provided by the NYSDEC, TAGM #HWR-88-4015. This guidance document specifies an upper level of allowable levels of turbidity in monitoring wells which is considered acceptable for determining the water quality of metals in the aquifer. This policy does not apply to surface waters.

Development operations shall be performed until the following conditions are met:

1. The water is less than 50 NTU's
2. The temperature, specific conductivity and pH of the well water vary by no more than 10 percent.

Temperature and specific conductivity will be measured in the field using a YSI model 33 SCT meter; pH will be measured in the field using an Orion model 230 A pH meter.

3.4.4 Well Survey

The locations and elevations of all existing monitoring wells must be surveyed to obtain their location which is then plotted on a map in the hydrogeologic report. The location of each well will be tied to the New York State coordinate system.

The vertical location of the ground surface and the mark made on the top of the monitoring well riser pipe must be accurately measured to the nearest one-hundredth of a foot. The mark on the top of the PVC will be a cut notch, not a mark made with a permanent marker.

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FIGURE A-4

CHAS. T. MAIN, INC.	WELL DEVELOPMENT REPORT

WELL NO.: ______________________ DATE OF WELL INSTALLATION: __________

DEVELOPMENT DATE: ______________ TIME: ______________

WELL DEVELOPER: ______________ MAIN PERSONNEL: ______________

CALCULATIONS

WATER DEPTH (TOC): __________ FT. WELL DEPTH (TOC: __________ FT.

WELL DIAMETER: __________ IN. BORING O.D: __________ IN.

A = Standing Water Depth _____ Ft. x Well Diam. Factor _____ Gal/Ft. = __________ Gals.

B = [Standing Water Depth ____ Ft. x Boring OD Factor ___ Gal/Ft. = A ___Gals]. 3 = ____ Gals

FACTORS

Diameter (In.)/Ft.	1	2	3	4	5	6	7	8	9	10	11	12
Gal./Ft.	.041	.163	.367	.654	1.02	1.47	2.00	2.61	3.30	4.08	4.93	5.87

Standing Water Volume = A + B = _____ Gal.

Water Volume Loss During Drilling = _____ Gal.

DEVELOPMENT

	PUMP	SURGE BLOCK	OTHER: _____
Type	______	______	______
Pumping Rate	______	______	______
Volume Removed	______	______	______
Total Purging Time	______	______	______

Water Characteristics

Start	_____	_____	______	______
End	_____	_____	______	______

REMARKS

3.4.5 Groundwater Sampling Procedures and Analyses

The 14 existing monitoring wells on the OB/OD grounds, the additional 16 newly installed monitoring wells, and the two monitoring wells off the site (for background) will be sampled during this investigation. Each well will be sampled initially, then again to confirm any obtained "hits". A final sampling round will be performed if there is a discrepancy between the initial round and the second confirmation round.

Prior to groundwater sample collection, water levels in all monitor wells will be measured relative to the top of the well casing. Measurement will be by the U.S. Geological Survey (USGS) wetted-tape method, using a decontaminated steel tape, or an electric water level indicator. Down hole equipment will be decontaminated according to the procedures outlined in Section 4.5, Equipment and Material Decontamination in Appendix A.

A polyethylene ground cloth will be placed beneath all sampling equipment during well purging and sampling to prevent contamination. Well purging will consist of pumping or bailing at least three (3) submerged well volumes and will continue until the pH, temperature, and specific conductivity are observed to vary less than 10% and the water sample is less than 50 NTU's as described in Section 4.4.3.2, Surface and Groundwater Sampling Procedure, Appendix C. Sampling will occur within 3 hours of purging for high yield wells. If the well does not recharge fast enough to permit continuous pumping, the well will be pumped nearly dry at least twice, allowing for 80-percent recharge between pumping, and the well will be allowed to recharge before sampling. If the well does not recharge sufficiently to allow for a second well volume to be purged after 2 hours have elapsed, the well will be allowed to recharge enough to permit sampling. Where possible, the pump will be set above the screen.

After purging the well, the sampling team will change to new PVC gloves for sample collection. Samples will be obtained using a decontaminated Teflon bailer. Groundwater samples collected for volatile analyses will be collected first, before any of the other parameters of interest and will be obtained in a manner that will minimize the loss of volatile compounds. Well samples will be collected with the required quality assurance/quality control (QA/QC) samples being transmitted to the laboratory for chemical analysis in accordance with the Chemical Data Acquisition Plan (CDAP). The groundwater samples will go directly to the lab for analysis by USACE method 8330 for explosives and methods from the NYSDEC CLP statement of work (SOW) for metals and organics.

The procedure for filtration of aqueous metals samples is provided below.

A. Decontamination of Apparatus

When filtering aqueous metals samples, a device made of polyethylene, polypropylene or borosilicate glass should be used. The apparatus should be pre-cleaned by rinsing with a 10% HNO_3 solution, followed by a demonstrated analyte-free deionized water rinse, and should be cleaned in the same manner between samples. Also, a field rinse blank must be collected for this apparatus.

B. Filtration Procedures and Preservation

The filter used should be a cellulose-based membrane filter of 0.45 um nominal pore size. Samples must be filtered immediately after their collection to minimize changes in the concentration of the substances of interest. Samples are only passed through the filtration apparatus once, they are not to be passed through repeatedly until they are free of turbidity. Samples are then preserved immediately with undiluted ultrapure HNO_3 and the pH checked to ensure proper pH has been attained. No samples for cyanide, conventional parameters, or organics may be filtered in this manner.

Samples will be preserved and packed in ice for shipment to the laboratory. Field groundwater, surface water, and sediment sampling logs will include on-site measurements of water quality (pH, specific conductance, and temperature), volume purged, method of purging, static water level, sample time and date, and fraction sampled. Figure A-5, presents a sample of MAIN's typical Sampling Record Forms. Chain-of-custody records will be maintained, as shown in Figure A-6. All sample bottles will have individual sample labels. Figure A-7 illustrates a typical Sample Label. The labels will be marked with indelible waterproof ink.

The sample bottle supplier will be ESS. The cleaning/QC procedures on the bottles are provided in Table C-0 in Appendix C.

FINAL DRAFT

FIGURE A-5

CHAS. T. MAIN, INC.	**SAMPLING RECORD**	SR #: PAGE OF

Job No. __________
Project __________
Client __________
Location __________
Sampling Date __________
Field Personnel __________

Laboratory Name __________
Address __________
____
Laboratory Contact __________
Delivery Date __________

WEATHER TEMP. (°f) <20 - 20 - 30 -40 - 50 - 60 - 70 - 80 - 90 ->90

Sunny		Dry	Wind	
Partly Cloudy		Slightly Humid		Wind Direction
Overcast		Moderately Humid	None to Little	N
Heavy Clouds		Very Humid	Little to Moderate	
Rain			Moderate to Heavy	From:
Sleet	Light		Steady	
Snow	Heavy		Variable	

GROUND SURFACE CONDITIONS

Dry Standing Water

SOIL SAMPLING AND SURFACE WATER SAMPLING INFORMATION

Sample No.	Depth	Time	Sample Description (For water: odor, color, clarity)	Sampling Device	Cleaning Procedure	Container Type

General Comments: (i.e., Field Filtrations, persons communicated with at site, QA/QC samples etc.):

STMD = Wash with soapy water, rinse with tap water, methanol, and distilled water.

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FIGURE A-5 (cont.)

SIDE 2

SAMPLING RECORD

PAGE OF

SR #:

FILE NO. CLIENT SAMPLING DATE

GROUNDWATER SAMPLING INFORMATION

WELL NO.							
WATER DEPTH (GS)							
TIME							
PRODUCT							
DEPTH OF WELL (GS)							
STANDING WATER DEPTH							
WELL I.D.							
VOLUME OF WATER IN WELL							
PURGING DEVICE							
VOLUME OF BAILER/ PUMP CAPACITY							
CLEANING PROCEDURE							
BAILS REMOVED/ VOLUME REMOVED							
TIME PURGING STARTED STOPPED							
SAMPLING DEVICE							
CLEANING PROCEDURE							
TIME SAMPLES TAKEN	VOA						
	ABN						
	METALS						
ODOR							
COLOR							
CLARITY							
pH							
TEMP. °C							
SALINITY							
CONDUCTIVITY							

REMARKS (i.e., Field filtration, purging and sampling problems, etc.):

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MAIN
1893

CHAIN-OF-CUSTODY RECORD

PAGE OF

JOB NO. ____________________
PROJECT ____________________
CONTACT ____________________

LABORATORY ____________________
ADDRESS ____________________
CONTACT ____________________

DELIVERY DATE ____________________
DATE FINAL REPORT DUE ____________________
PROJECT MANAGER'S INITIALS ____________________

SAMPLE NO.	LABORATORY SAMPLE NO.	SAMPLING		SAMPLE DEPTH	SAMPLE TYPE	ANALYSES										NO. OF CONTAINERS	COMMENTS (Special instructions, cautions, etc.)
		DATE	TIME			VOA	ABN	METALS	PEST/PCB	PET. ID	O & G						

Sampled and Relinquished by Sign Print Firm Date Time	Received by Sign Print Firm Date Time
Relinquished by Sign Print Firm Date Time	Received by Sign Print Firm Date Time
Relinquished by Sign Print Firm Date Time	Received by Sign Print Firm Date Time

Evidence Samples tampered with? ☐ No ☐ Yes

If Yes, explain in remarks.

VOA Vial											LIQUID
Glass Bottle											
Plastic Bottle											
Preservative											
Container Volume											
VOA Vial											SOLID
Glass Jar											
Plastic Jar											
Preservative											
Container Volume											

REMARKS: (Sample storage, nonstandard sample bottles)

Note: Sample bottles supplied by lab, unless indicated.

PRESERVATION KEY: A - Sample chilled,
B - Filtered, C - Acidified with ____________
D - NaOH, E - NaThiosulfate, F - Other

FIGURE A-6

CHAS. T. MAIN, INC. | **Job No.**

LOCATION	__________	**DATE**	__________
B/TP NO.	__________	**SAMPLE NO.**	__________
DEPTH	__________	**TIME**	__________
TYPE	__________	**SAMPLED BY**	__________

ANALYSES: VOA ABN METALS PEST/PCB

O&G PET.ID OTHER __________

PRESERVATIVE: __________

INSTRUCTIONS/CAUTIONS __________

____

LABORATORY __________

TYPICAL SAMPLE LABEL

FIGURE A-7

FINAL DRAFT

All water generated during drilling and well development and purging will be collected on-site. MAIN will contain all drill cuttings, well development water, and rinsate in approved 55-gallon drums. All drums shall be labeled as to contents and origins. At the end of each phase of drilling, MAIN will provide documentation (based on results of the required chemical analyses, evaluation of site conditions and knowledge of regulatory requirements) which will recommend the disposition for each drum. For each drum considered to contain contaminated material, MAIN will recommend a specific optimum method of disposal, along with a price for disposal. The material will be disposed of under manifest, using the SEAD RCRA disposal permit. Actual disposal shall be the responsibility of SEAD.

3.5 SURFACE WATER AND SEDIMENT SAMPLING

3.5.1 Objectives

As described in the WP, surface water sampling at the site will be performed to determine the nature and areal extent of contamination in Reeder Creek and surface water areas of the site. The analyses will determine the potential exposure levels for the risk assessment.

Surface water samples will be collected using the procedures described in the following subsections. Data generated in the field during the surface water and sediment sampling will be recorded in the site logbook.

3.5.2 Surface Water Sampling Procedures and Analysis

Access routes and sampling work areas will receive a UXO search by HFA UXO personnel prior to surface water sampling operations. The boundaries of the access routes will be marked with orange survey flags. All UXOs located during the search operation will be flagged with yellow survey markers.

In areas heavily contaminated by UXOs or UXO components, surface water samples will be collected by HFA personnel. Sampling operations by other contractor personnel will be monitored by HFA personnel to ensure safety of these personnel.

Surface water sampling equipment will be decontaminated prior to use in accordance with the procedures outlined in Section 4.5 of Appendix A, Field Sampling and Analysis Plan. Surface water sampling will be obtained from the designated locations shown in the WP. The sampling will be accomplished by using the following procedure:

1. Establish the exact location of each sampling station in the field. The sample site will be noted on a site plan and marked in the field with flagging and a 4-foot wooden stake. The stake will be labeled with the sample site number.

2. Measure the volatile organic vapors in the atmosphere above the water body with the HNU. If the concentration at breathing level is steadily elevated above background levels, use appropriate health and safety equipment as described in the Health and Safety Plan (Appendix B).

3. Collect the sample from the surface water body by immersing a clean beaker or the sample bottle without preservatives. The sampling beaker should be completely submerged in an inverted position and then turned in an upstream direction and allowed to fill without collecting any surface debris. If bottles are used for sample collection, a 45-degree angle should be used. Sampling will proceed from downstream locations to minimize impacts associated with disturbance of sediments. If the sample is collected by sampling personnel wading into the body of water, the sampler should approach the sampling location from downstream and all parts of the sampler's body should remain downstream of the sample container during sample collection (wading will be avoided if possible). Water samples will be collected for total metals and explosive analysis. Total metals are defined as the metals concentration in a sample that has been acidified and then has undergone a vigorous digestion in the lab.

4. Fill all appropriate sample containers (listed in Appendix C, Chemical Data Acquisition Plan) directly or from the intermediate sample collection container, if necessary.

5. Measure the following parameters by direct immersion of instrument probes into the water body, if possible:

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1. Temperature,
2. pH, and
3. Specific conductance

If direct measurement is not possible, measure these parameters from water obtained from a field sample container, separate from the analytical sample container.

6. Complete all field notebooks and the daily field sampling record, (Figure A-5) and initiate chain-of-custody records.

3.5.3 Sediment Sampling Procedures

Obtaining sediment samples is normally not a difficult task unless sampling is being conducted at great depth, in which case a boat and appropriate sampling device would be necessary. There are no set procedures for the collection of representative samples of stream sediments where the stream materials may be quite variable, i.e., coarse gravels to fine clays. Therefore, caution must be taken to obtain samples that will be representative of the contaminant of interest versus the sediment materials present. Sampling will proceed from downstream locations to minimize the impacts associated with distrubance of sediments. The sampler will approach the sample location from downstream.

Usually, very simple techniques are used to collect sediment samples. Most samples are grab samples, which can be kept as individual samples or combined to form composite samples. The following are some suggested techniques for sediment sampling:

1. In small, low flowing streams or near the shore of a pond or lake, the appropriate device (i.e. a Ponar sampler, beaker, etc.) may be used to scrape up sediments. The appropriate sampler will be used to collect the surface sediments in Reeder Creek.

2. To obtain sediments from larger streams or further from the shore of a pond or lake, a beaker made from the appropriate material can be clamped to a telescoping aluminum pole. A Ponar sampler could also be used.

3. To obtain sediments from rivers or in deeper lakes and ponds, a spring loaded sediment dredge or benthic sampler can be used.

When sampling from large rivers, ponds, or lakes, it may be necessary to lay out a visual or surveyed grid, if possible, then collect individual or composite samples from locations within the grid. All surface water and sediment locations are specifically outlined in the Task Plan for the RI. There are approximately six potential wetlands and six sites in Reeder Creek which will be sampled for surface water and sediments. It is necessary that there be surface water and sediment samples everywhere there is biological sampling. Since the biological sampling sites may vary slightly due to biological samples present, these sites are only estimates. Ten percent of both the surface water and sediment samples will be collected for QA/QC. The QA/QC samples will be duplicates.

All soil and sediment samples collected, except those for volatile organic analysis, must be homogenized prior to being placed into sample containers.

Surface water and sediment samples will go directly to the lab for Level IV and V analysis. These methods are described in Appendix C, The Chemical Data Acquisition Plan.

In addition, a daily field report should be filled out summarizing all activities as shown in Figure A-5. All samples collected should have a label containing all information required as exhibited in Figure A-7.

3.6 BIOTA SAMPLING

3.6.1 Biota Sampling Procedures

The objectives of this task is to obtain biota samples of the organisms which are present in the aquatic sediments and surface waters of Reeder Creek. This data, in addition to the sediment and surface water quality, will be used in evaluating both the human health and the environmental risk.

3.6.2 Objectives

Biota sampling is performed by obtaining grab samples of the sediment using a Ponar sampler. A Ponar sampler is a clamshell type grab sampler which penetrates and collects soft sediments and the organisms residing therein. Ponar grab samples will be taken to determine the community of organisms living on or within the soft substrates of the water body. The rationale behind this type of sampling is that the sample is taken from a fixed surface area of sediment and the data collected from such samples are assumed to be representative of the sampling area.

A ponar grab sampler collects organisms in aquatic habitats, consisting of soft sediment. In general the fauna is non-motile and therefore is not subject to disturbance by the gear. Since some aquatic organisms live closely associated with the sediment, a device such as a grab sampler will sample not only the surface of the substrate but also several inches into the sediments thereby collecting burrowing organisms too. In general, this gear is used in conjunction with other aquatic macroinvertebrate sampling devices to give a comprehensive picture of that community.

The following collection equipment is necessary for biota sampling:

- Petite ponar grab samples with attached line or cable
- Benthic sample wash screen (0.5-mm screen size)
- Tubs for receiving samples
- Funnel
- Sample jars
- Seventy percent ethanol
- Internal labels for bottles
- Pencils
- Benthos data sheets
- Hand brush or tooth brush for cleaning any rock in samples

Upon arrival at the station:

- Measure bottom water temperature and dissolved oxygen. Record on data sheet along with water depth.
- Drop the Ponar Grab to the bottom: let line or cable slacken; pull sharply upward on the line to trip closing mechanism; retrieve sample and deposit into tub for subsequent sieving through screen.
- Insert thermometer into sediment.
- Repeat for replicate grabs.
- Record sediment temperature, other appropriate remarks (water body condition and a subjective description of the substrate), and note time.

- Wash each sample through a 0.5 mm sieve screen (or an appropriate subsample if sample is very large) to remove excess fine sediments. Large stones may also be removed by hand after careful washing or brushing to remove clinging organisms.
- Place sample via funnel into appropriately labeled container, preserve in 70 percent ethanol.

Before leaving station, check data sheets to be sure all necessary information is legibly recorded. Initial data sheets.

Check all samples to be sure all are preserved and labeled. Read over all data sheets to check for legibility and completion; make conversions from metric to English where necessary.

Each sample should have an interior and exterior label containing the following information:

1. Study location
2. Station number
3. Grab Number (replicate)
4. Date
5. Gear
6. Sample serial number

The following criteria have been established to determine whether a sample is valid in terms of the amount of sediment collected. If all the criteria are not met, the sample should be discarded and a new one taken:

- All three grabs must be of approximately equal volume. If not, discard the sample most unlike the other two and recollect.
- If upon retrieval of the grab, material is lodged between its jaws (thereby allowing for the loss of part of the sample), that grab should be repeated.

Shellfish captured in ponar grab samples may be used for tissue analysis for select chemical analyses as needed.

MAIN's Benthos data sheets, as shown in Figure A-8, will be filled out both in the field and in the laboratory, as appropriate.

FINAL DRAFT

BENTHOS DATA SHEET

SERIAL NO. ☐☐☐☐ B A (1 – 6)

NO. OF REPLICATES ☐ (8)

CLIENT ☐☐☐☐☐☐☐ (12 – 18)

SITE ☐☐☐☐☐☐☐☐ (20 – 27)

STATION ☐☐☐☐ (29 – 32)

GEAR ☐☐☐☐ (34 – 37)

DATE DAY ☐☐ MONTH ☐☐ YEAR ☐☐ : HOUR ☐☐ : MIN. ☐☐ (39, 41, 44, 47, 50)

COLLECTORS: __________

WEATHER: __________

WATER BODY: __________

REMARKS: __________

____

____

RECORDED BY: __________

WATER QUALITY DATA

SERIAL NO. ☐☐☐☐ B B (1 – 6)

SERIAL NO. ☐☐☐☐ B C (1 – 6)

SERIAL NO. ☐☐☐☐ B D (1 – 6)

	DEPTH ( )	TEMP. ( )	D.O.	COND (µMHO)	pH
START	☐☐.☐☐ (8 – 11)	☐☐☐☐.☐ (13 – 17)	☐☐.☐ (19 – 22)	☐☐☐☐☐ (24 – 27)	☐☐☐.☐ (29 – 32)
END	☐☐.☐☐ (8 – 11)	☐☐☐☐.☐ (13 – 17)	☐☐.☐ (19 – 22)	☐☐☐☐☐ (24 – 27)	☐☐☐.☐ (29 – 32)
INST. NO.	☐☐☐☐ (8 – 11)	☐☐☐☐☐ (13 – 17)	☐☐☐☐ (19 – 22)	☐☐☐☐☐ (24 – 27)	☐☐☐☐ (29 – 32)

SERIAL NO. ☐☐☐☐ B E (1 – 6)

	START	END
SECCHI ( )	☐☐.☐ (8 – 11)	☐☐.☐ (13 – 16)
RIVER STAGE ( )	☐☐.☐ (18 – 21)	☐☐.☐ (23 – 26)
WATER DEPTH ( )	☐☐.☐ (28 – 31)	☐☐.☐ (33 – 36)

SEDIMENT TYPE ☐ (38) { C=1 SL=2 S=3 H=4 O=5 }

SEDIMENT TEMP.( ) ☐☐☐.☐ (40 – 44)

RECORDED BY: __________

ARTIFICIAL SUBSTRATE DATA

SERIAL NO. ☐☐☐☐ B F (1 – 6)

DATE SET DAY ☐☐ MONTH ☐☐☐ YEAR ☐☐ (8, 10, 13)

DATE RETRIEVED ☐☐☐☐☐☐☐ (16, 18, 21)

RECORDED BY: __________

TOTAL DAYS ☐☐☐ (24 – 26)

NO. OF REPLICATES ☐ (28)

QUALITY CONTROL BY: __________ DATE: __________

MAIN

BENTHOS DATA SHEET

SORTED BY: ____________________

IDENTIFIED BY: ____________________

SHEET ________ OF ________

SERIAL NO. ☐☐☐☐ B G (1–6)

OBS. NO. 8 10	ORGANISM NAME	ORGANISM NUMBER 12 27	LIFE STAGE 29	SERIAL NO. ☐☐☐☐ A DENSITY OR REL. ABUND. 31 (.) 35	SERIAL NO. ☐☐☐☐ B DENSITY OR REL. ABUND. 37 ( ) 41	SERIAL NO. ☐☐☐☐ C DENSITY OR REL. ABUND. 43 ( ) 47	COMMENTS

QUALI ONTROL BY: ____________________

DATE: ____________________

MAIN

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FIGURE A-8 (cont)

3.6.3 Collection of Shellfish For Tissue Chemical Analyses

The purpose of this Standard Operating Procedure (SOP) is to describe field procedures for collecting shellfish (bivalves). Shellfish are considered to be good biomarkers for xenobiotic substances because they are relatively immobile and filter significant quantities of water as part of their normal feeding behavior. In contrast to community characterization surveys, the objective of collecting shellfish for tissue analysis is to collect an appropriate volume of soft tissue within the general confines of the collection station. However, if an inventory survey of the benthic community is also to be implemented, shellfish specimens can be obtained from those collections, as long as there is proper documentation of the source of the specimens.

In freshwater systems, shellfish usually occur in relatively shallow water (less than three feet deep) although they can occur in much deeper habitats. Substrates preferred by those species of shellfish that do not attach to rigid structures by byssal threads include gravel, sand, and in some cases, silt. Sampling techniques used to collect shellfish should allow on-site flexibility to select the method most applicable to the specific site conditions encountered at each collection station.

If site-specific conditions are known in advance, it may be appropriate to forego the use of certain types of equipment. Perhaps the most efficient collection technique is to simply gather shellfish by hand if it is known that shellfish beds exist in shallow water. Therefore, additional collection equipment is listed as optional.

The following gear should be taken to accomplish the collection tasks:

- Balance scale
- Knife/dissection tools
- Soap solution
- Disposable latex or vinyl gloves
- Cooler(s)
- Dry ice or cube ice with salt
- Chain-of-custody sheet
- Deionized or distilled water
- Spray bottles
- Paper towels

- Stainless steel bowls
- Fish data sheets
- Sample labels
- Plastic (polyethylene) sealable freezer bags
- Aluminum foil
- Pencils and markers
- Boat (optional)
- Petite ponar sampler (optional)
- Shovel and/or rake (optional)
- Five gallon bucket (optional)
- Strapping tape

Prior to collecting shellfish, it is important to coordinate with the analytical laboratory regarding their specific needs for the analyses being conducted. The minimum amount of shellfish tissue required for analysis should be established by the laboratory. Sample handling procedures, will follow procedures established by this SOP. All equipment should be checked ahead of time to ensure that it is in working order.

Shellfish specimens should be collected from throughout the station to avoid collecting atypical specimens that do not reflect the overall conditions at the station. If possible, the specimens collected should be the same taxa and represent the range of sizes available at the time of collection from both experimental and control stations. It is preferable to collect many (i.e., three) individuals for tissue analysis, rather than one large individual. If enough individuals cannot be collected by hand, it may be necessary to use additional shore-based or boat-based collection techniques, including petite ponar grab samplers and/or a shovel or a rake to sift through bottom material for shellfish. Bottom material can be shoveled into a bucket and sorted on shore for shellfish. All shellfish collected should be sorted by taxa on site. The most common taxa should be selected for analysis. If few specimens of several species are present, it may be necessary to combine taxa to obtain an adequate sample size. In the event that the habitat at the station is unsuited to shellfish, the specific conditions should be documented. It may be appropriate to attempt to collect specimens near but outside the originally established sampling station boundary if the sampling objective can still be achieved by doing so.

Shellfish selected for tissue analysis should be:

- Carefully opened with a knife and all soft tissue scraped from the shell.
- Soft tissue should be blotted dry with an absorbent paper towel and placed on the balance scale for weighing.
- Minimum sample size is 10 grams (more tissue is preferred).
- Retain all shells from each station for identification, measurement and count
- The tissue is wrapped in three layers of aluminum foil and placed in a labeled sealable plastic bag and immediately stored in a cooler with dry ice
- Seal the cooler with the samples using strapping tape
- Complete a chain of custody form for the samples and transport the cooler to the laboratory as soon as possible
- Check ice again within 24 hours if cooler is not delivered to the laboratory within one day of being sealed and replenish ice as needed.

Confirm the identity of all specimens by shell characteristics included in each shellfish sample using, as needed, appropriate keys and reference materials. Measure the maximum shell width of each specimen to the nearest millimeter. Confirm the count of individual specimens. Record this information on the appropriate data sheet.

If the sampling project reveals that shellfish (bivalves) are scarce and will not provide sufficient sample biomass for analysis, then crayfish (e.g., Orconectes spp.) will be substituted as the target organism if their abundance provides sufficient sample biomass within reasonable collection efforts. Achieving sufficient biomass will require whole-body compositing of several specimens for each sample.

Crayfish are also members of the marcoinvertebrate community, and exhibit the following characteristics which make them reasonable alternative if shellfish are unavailable:

- Aquatic detrital consumer;
- Direct substrate contact;
- Limited mobility;
- Important in aquatic and terrestrial food chains.

Crayfish (e.g., Orconectes spp.) will be collected using a modified minnow trap, dip net, seine, or baited throwline. Reasonable efforts will be made to collect sample specimens within a 50-yard radius of the first specimen captured at the sample station. Low abundance of specimens may require the collecting activities to cover a larger area than anticipated.

The actual collecting boundaries will be designated on the station location map. Crayfish collected for a single sample will:

- Be temporarily stored alive in a stainless steel bowl (1-quart capacity) containing about 2 inches of deionized or distilled water while the collection is being made.
- Only specimens of the same species will be combined for a composite sample
- If more than one taxa is collected, and tissue from several specimens are needed to meet minimum sample weight requirements then all specimens will be combined into one composite sample.
- All sample handling equipment will be thoroughly cleaned before collecting the next sample.
- All of the appropriate aforementioned SOP sections for shellfish will be followed.

NOTE: If neither shellfish nor crayfish are available for tissue sampling, it may be possible that amphipods can be collected. This possibility will be attempted prior to discontinuing the macroinvertebrate tissue analysis portion of the program.

3.6.4 Fish Seining

The seining program is designed to capture fish that frequent shoreline and shallow water areas, over bottoms that are relatively flat and free of snags. Seining is done at shoreline locations at either specified "representative" sampling locations or at "randomly" chosen locations depending upon project objectives. The seining program will be closely coordinated with the other fisheries efforts, as appropriate. The program will provide information on the near shore fish community as well as spawning and/or nursery areas of fish.

The following gear should be taken to accomplish each seining effort:

- Beach seine (straight or bag net) in good working order (with no holes), and poles or bridles
- Fish data sheets
- Pencils, labels and a water proof covered notebook
- Fish-measuring board, if necessary
- Balance and spring scale, if necessary
- Taxonomic key for local fish species
- Holding containers for fish

- Plastic jars for preserved specimens, if necessary
- Formalin
- Chest waders or hip boots
- Scientific collection permit
- Beach seine patching kit
- Water temperature and dissolved oxygen instrumentation

The area should be checked for objects in the water which could cause injury if stepped on. All the gear on the equipment list should be gathered and noted. Data sheets should be put in a plastic notebook. Check to make sure the seine is properly rigged with poles and has no holes in the bag and/or wings. Make necessary repairs with nylon twine and spare mesh. The substrate should be firm, thereby allowing for secure footing. Water depths should not be greater than the height of the seine to be used.

The sampling procedures are:

- The area to be seined is clear of obstructions that would snag the seine.
- Hold the lead line close to or on the water body substrate.
- Deploy the seine quickly and quietly either parallel or perpendicular to the shore (depending on the seine design and water depth).
- Retrieve the seine with a steady, even pull keeping the lead line on the substrate such that fishes are quickly encircled.
- Collect all juvenile and adult fishes and identify the species, and count the number collected.
- Collect water quality data and preserve and label selected specimens to be returned to the laboratory for confirmation of field identification and further examination if required.

Following sample collection, put equipment back in its proper place. Store the seine in a dry area away from direct sunlight after it has been cleaned of debris. Make necessary conversions on data sheets and check the data sheet for errors or omissions.
A seine haul is considered void (non-quantitative) under any of the following conditions:

- If a haul cannot be completed or is hampered because of snags, accidents, or poor technique;
- If a hole is found in the bag and/or wings that would allow fish to escape. A hole in the bag or wings should be reported on data sheets;

- If the seine is found to be tangled so the lead and float lines are not clear of each other.

Voiding a sample takes judgement on the part of the crew leader. Every effort should be made to do each seine haul efficiently and with proper technique. Fish captured in voided and/or valid seine hauls may be used for tissue analyses as needed, so long as the fish are properly labeled as to the date, station, etc. The sample area must not be disturbed before or during the seine. If the seine has to be redone, from 15 to 30 minutes is allowed to elapse to let the area settle before re-sampling a station. Alternatively, the repeated seine can be conducted adjacent to the previous seine.

All field data will be entered onto MAIN's Fish Data Sheets shown on Figure A-9.

3.6.5 Backpack Electroshocking

Backpack electroshocking is an efficient method for collecting near shore or small stream fishes particularly in habitats with snags and obstructions which limit seining operations. It is effective in most freshwaters of normal conductivity (100-500 micromhos/cm). The principal of electroshocking is to produce, by the electroshocker, a voltage gradient between the natural electrical balance of the fish and the surrounding water thereby stunning it and allowing capture by nets.

The procedure is to isolate a known length section of stream or shoreline. This section is flagged. Electroshocking begins from downstream and proceeds upstream. Amperage level output from the shocker is maintained at a constant setting by adjusting voltage as water depth changes. As fish are stunned they are collected by net and placed in a bucket containing ambient water.

Snags, rocks, brush piles and the like can be sampled effectively by electrofishing. Since the electric field will penetrate such obstructions.

The collection equipment include:

- Coffelt BP-2 backpack electroshocker
- Fish data sheets
- Pencils, labels and a waterproof covered notebook

FINAL DRAFT

FIGURE A-9

FISH DATA SHEET

SERIAL NO. ☐☐☐☐ F A
1 6

NO. OF REPLICATES ☐

CLIENT ☐☐☐☐☐☐☐
12 18

COLLECTORS:__________

SITE ☐☐☐☐☐☐☐☐
20 27

WEATHER:__________

WATER BODY:__________

REMARKS:__________

STATION ☐☐☐☐
29 32

GEAR ☐☐☐☐
34 37

RECORDED BY:__________

TIME OF COLLECTION
- START: DAY ☐☐ MONTH ☐☐☐ YEAR ☐☐ : HOUR ☐☐ : MIN. ☐☐
  39 41 44 47 50
- END: ☐☐ ☐☐☐ ☐☐ : ☐☐ : ☐☐
  53 55 58 61 64

TOTAL ☐☐ : ☐☐
67 70

SERIAL NO. ☐☐☐☐ F B
1 6

DEPTH
- START: WATER BODY ( ) ☐☐☐ 8 10 SAMPLE ( ) ☐☐☐ 12 14 RIVER STAGE ( ) ☐☐☐.☐ 16 19
- END: ☐☐☐ 21 23 ☐☐☐ 25 27 ☐☐☐.☐ 29 32

WATER QUALITY DATA

SERIAL NO. ☐☐☐☐ F C
1 6

	TEMP. ( )	D.O.	COND. (µMHO)	pH
START	☐☐☐.☐ 8 12	☐☐.☐ 14 17	☐☐☐☐ 19 22	☐☐.☐ 24 27
END	☐☐☐.☐ 29 33	☐☐.☐ 35 38	☐☐☐☐ 40 43	☐☐.☐ 45 48
INSTRUMENT NO.	☐☐☐☐☐ 50 54	☐☐☐☐ 56 59	☐☐☐☐ 61 64	☐☐☐☐ 66 69

SECCHI ( )
- START ☐☐.☐
  71 74
- END ☐☐.☐
  76 79

RECORDED BY:__________

QUALITY CONTROL BY:__________ DATE:__________

MAIN

FISH DATA SHEET

SORTED BY: ______________________ SHEET ________ OF ________

IDENTIFIED BY: ______________________ SERIAL NO. ☐☐☐☐ F D (1–6)

OBS. NO. (8–10)	ORGANISM NAME	ORGANISM NUMBER (12–27)	LIFE STAGE (29)	COUNT (31–35)	TL (MM) (37–40)	WEIGHT (GM) (42–46)	SEX M (48)	SEX F (50)	SEX U (52)	REPROD. COND. (54)	DIS. / PAR. (56)	GRP. DATA (58)	COMMENTS

QUALITY CONTROL BY: ______________________ SCALE OR BALANCE CALIBRATION DATE: ______________________ DATE: __________

MAIN

FORM ESG-3 3/81

FIGURE A-9 (cont.)

FINAL DRAFT

- Fish-measuring board, if necessary
- Balance and spring scale, if necessary
- Taxonomic key for local fish species
- Holding containers for fish
- Plastic jars for preserved specimens, if necessary
- Formalin
- Polarized sunglasses
- Rubber gloves
- Chest waders or hip boots
- Scientific collecting permit
- Water temperature and dissolved oxygen instrumentation

All gear on the equipment list should be gathered and noted. Data sheets should be put in a plastic notebook. Check to make sure that the shocker battery is fully charged. The unit is usually plugged into a wall socket for 8-12 hours of charging prior to use with the toggle switch turned to the charging position. Check that the electrode nets have no extraneous holes that would allow fish to escape capture.

Sampling is as follows:

- Begin at the downstream end of the sampling station (rubber gloves should be worn at all times).
- Place both electrodes in the water at about equal depth. Turn on the shocker and depress the switches.
- Note amperage and adjust to 0.5 or greater amperes by changing voltage setting.
- Make sure that the deadman's switch on each electrode pole is working properly.
- Proceed slowly upstream sweeping the entire breadth of the stream with the electrodes (one crew member should occasionally release the deadman's switch to interrupt the current field; this procedure reduces the tendency for fish to sense the field at a distance and flee).
- Stunned fish should be netted and placed in a bucket of ambient water for processing when the station sampling is completed.
- When finished, turn off the shocker and process the fish, recording the relevant data on the fish data sheet.
- All juveniles and adult fishes collected are identified to species and counted.

- When possible an estimate of the numbers including species and size that escaped collection is made and recorded in order to obtain a qualitative evaluation of collection efficiency.
- Collect water quality data and preserve and label selected specimens to be returned to the laboratory for confirmation of field identification and further examination, if required.

Following collection be sure the shocker is turned off. Store in a dry area in an upright position. Check over all data sheets to assure that all entries have been made. Check preserved samples to insure integrity and no leakage.

Electroshocking is considered void (non-quantitative) under any of the following conditions:

- The electroshocker cannot be adjusted to a minimum output of 0.5 amps;
- A tear or hole is discovered in a collecting net;
- Water turbidity or darkness precludes seeing all stunned fish.

Voiding a sample takes judgement on the part of the crew leader. Every effort should be made to efficiently and completely cover each sampling station. Fish captured in voided and/or valid electroshocking samples may be used for tissue analyses as needed.

All field data will be entered onto MAIN's fish data sheets shown previously as Figure A-9.

3.6.6 Collection of Fish Tissue For Chemical Analyses

The purpose of this Standard Operating Procedure (SOP) is to describe field procedures for collecting fish tissue. In contrast to community characterization surveys, the objective of collecting fish for tissue analysis is to collect sufficient biomass for subsequent chemical analysis. However, if a quantitative survey of the fisheries community is also to be implemented, specimens can be obtained from those quantitative collections. When specimens are removed from quantitative collections for tissue analyses the source of the specimens should be documented on the fish data sheets to avoid inaccuracies in calculating relative abundance of species.

Sampling techniques used to collect fish should allow on-site flexibility to select the method most applicable to the site-specific conditions encountered at each collection station.

It is recommended that more than one method of fish collection be available to the field sampling crew. Although recommended, it is not necessarily appropriate to have all collection equipment listed in this section. This equipment includes:

- Balance or spring scale
- Knife/dissection tools
- Soap solution
- Disposable latex or vinyl gloves
- Cooler(s)
- Dry ice or cube ice with salt
- Chain of custody sheet
- Deionized or distilled water
- Spray bottles
- Paper towels
- Stainless steel bowls
- Fish data sheets
- Sample labels
- Plastic (polyethylene) sealable freezer bags
- Aluminum foil
- Pencils and markers
- Boat
- Beach seine (one or more sizes)
- Backpack electroshocker
- Conventional fishing rod(s)
- Gill nets
- Measuring board
- Strapping tape
- SOP's for collection gear
- Scientific collecting permit

Prior to collecting fish, it is important to coordinate with the analytical laboratory regarding their specific needs for the analyses being conducted. The minimum amount of fish tissue required to complete defensible analytical results should be established by the laboratory. Sample preservation procedures, contamination avoidance measures, in-field preparation procedures, packaging requirements and chain-of-custody procedures will follow procedures established by this SOP and the SOP for Sample Packaging, Shipping and Chain-of-Custody Procedures. All equipment should be checked ahead of time to ensure that it is in working order.

Fish selected at each station for tissue analysis should, if possible, be of the same species. It is preferred that the species to be collected have an existing historical database.
Typical sampling programs require the collection of fish to occur in areas considered free of pollutants (reference area). These areas are normally described in the sampling work plan. Although areas are described in the work plan, the final sampling location is a field decision.

The aquatic reference (control) area should have faunal and floral characteristics similar to the exposure study (experimental) site and should be located hydrologically upgradient of the exposure study sites. The reference area should share a high number of biological and physical characteristics with the experimental/exposure locations. Sampling should continue with reasonable efforts until enough individuals are collected for meaningful analyses.

Fish Processing of samples is as follows:

- Once the individuals selected for analysis have been chosen, they should be weighed (nearest gram), measured (nearest mm) and tissue samples (fillets) extracted. The entire fish is submitted for analysis if the sample is a forage fish and/or a young-of-year specimen.
- Fillet samples should be blotted dry with an absorbent paper towel and placed on the balance scale for weighing (minimum sample size is 10 grams).
- All dissection tools are to be rinsed, washed with soap solution, rinsed, rinsed twice with distilled or deionized water and dried between each sample dissection.
- The portion of edible flesh analyzed is referred to as the "standard fillet" unless otherwise noted below. For some species, the procedure is modified as indicated below. These modifications are per NYSDEC method OCI.103.
- All tissue samples will be wrapped in three layers of aluminum foil and sealed in separately labeled plastic bags.
- Samples are to be stored in a cooler with dry ice.
- All chain-of-custody documentation and handling/packing procedures will be followed.

- The field sampling team will identify in the field notebook all pertinent information regarding the fish samples collected.
- Remove scales from fish. Do not remove the skin.

Standard fillets are obtained as follows:

- Make a cut along the ventral midline of the fish from the vent to the base of the jaw.
- Make diagonal cut from base of cranium following just behind gill to the ventral side just behind pectoral fin.
- Remove the flesh and ribcage from one-half of the fish by cutting from the cranium along the spine and dorsal rays to the caudal fin. The ribs should remain on the fillet.

Four modifications of the standard fillet procedure are designed to account for variations in fish size or known preferred preparation methods of the fish for human consumption.

Some fish are too small to fillet by the above procedure. Fish less than approximately 6 inches long and rainbow smelt are analyzed by cutting the head off from behind the pectoral fin and eviscerating the fish. Ensure that the belly flap is retained on the carcass to be analyzed. When this modification is used, it should be noted when reporting analytical results.

Some species are generally eaten by skinning the fish. The skin from these species is also relatively difficult to homogenize in the sample. Hence, for the following list of species, the fish is first skinned prior to filleting:

Brown bullhead
White catfish
Yellow bullhead
Channel catfish
Black bullhead
Lake sturgeon
Atlantic sturgeon

American eels are analyzed by removing the head, skin and viscera; filleting is not attempted.

Forage fish and young-of-year fish are analyzed whole. This category is considered to be less than 150 mm (6 inches).

Following sampling, check all data sheets including chain of custody forms for legibility and completeness. Return all equipment to the proper places after cleaning and performing any needed maintenance. All samples will go directly to the lab for Level IV.

3.7 VEGETATION SURVEY

To more fully understand the interrelationship of the OB/OD Grounds and their association with the environment, it is necessary to document existing surrounding vegetative cover types. Cover typing is done by traversing the site on foot and noting major cover types in relationship to the location of the OB/OD grounds. A Vegetation Data Sheet, Figure A-10, is used to document these observations.

FINAL DRAFT

FIGURE A-1

VEGETATION DATA SHEET

DATE: ________________ TIME: ________________

SITE: ________________________________

OBSERVER (S): ________________________

TRANSECT: ____________ PLOT: ________________

WEATHER CONDITIONS (check one)

_____ CLEAR, SUNNY
_____ PARTLY CLOUDY, <50% CLOUD COVER
_____ PARTLY CLOUDY, ≥50% CLOUD COVER
_____ COMPLETE CLOUD COVER
_____ SNOWING
_____ RAINING

TEMPERATURE: _____ °F _____ °C

WIND SPEED & DIRECTION: _____ mph FROM THE _____

GROUND CONDITIONS (check one):

_____ NO COVER, DRY
_____ SNOW, _____ INCHES
_____ ICE, _____ INCHES
_____ DAMP OR WET

CANOPY (5 x 20 m plots)									
SPECIES (dbh >2.54 cm)	DIAMETER AT BREAST HEIGHT (cm)								

FINAL DRAFT

FIGURE A-10 (cont.)

UNDERSTORY (1 x 4 m plots)

SPECIES (dbh < 2.54 cm and height > 0.5 m)	COVER-ABUNDANCE RATING	SPECIES (dbh < 2.54 cm and height > 0.5 m)	COVER-ABUNDANCE RATING

HERBACEOUS (0.5 x 2 m plots)

SPECIES (≤ 0.5 m tall)	COVER-ABUNDANCE RATING	SPECIES (≤ 0.5 m tall)	COVER-ABUNDANCE RATING

4.0 POST SAMPLE COLLECTION PROCEDURES

Once a solid or liquid sample has been collected, it needs to be preserved and stored. There are no plans to take composite samples at this time. If it is determined to be necessary however, samples will be composited after collection. Sampling equipment used for sample collection or field determinations must also be decontaminated prior to reuse.

4.1 COMPOSITING

Although there are currently no plans to take composite samples, occasionally, samples may need to be composited prior to chemical or physical characterization. Although compositing is most easily accommodated in a laboratory environment, specific instances may arise mandating the preparation of the composite in the field. Instances commonly encountered include situations where regulatory or client organizations require split sample, or cases in which field duplicates are being prepared. Another common occurrence arises when soils are being collected from a large grid, using a statistically based design, to determine if there is a positive indication of contaminant migration. Whenever compositing is contemplated, consideration most be given to issues of sample loss, contamination and degradations. Samples for certain determinations (e.g., Volatile Organic Compounds, Oil and Grease, etc.) should never be collected as composites.

When composites can be and are to be prepared in the field, collect sufficient sample volume to fill all required containers. If discrete subsamples are to be combined to produce one final sample, collect equivalent sized (weight, volume) aliquots from each selected locations and combine these in a common receptacle. Perform all necessary sample preparative operations (e.g., sample filtration, sleeve screening) on the combined sample and fully homogenize the remaining material. When liquid samples requiring chemical stabilization are collected, add necessary preservatives at the required level and mix. Remove necessary sample aliquots and place into clean sample bottles and package for shipment. The laboratory will be notified as to how many samples were composited so that the correct detection limit will be used.

4.2 FIELD FILTRATION

Groundwater samples will be analyzed for total metals. Samples of groundwater may be analyzed for dissolved metals. Groundwater samples will be analyzed for metals according to the decision flow chart shown in Figure A-11. The two methods are:

1. Total Methods - The concentration of metals is determined from an unfiltered sample after vigorous digestion. This requires the preservation of the sample in the field with nitric acid.
2. Dissolved Methods - The water samples to be analyzed for dissolved will be filtered in the field through a .45-micron filter and then acidified in the field with nitric acid. Filtration equipment will consist of a pump (either peristaltic or hand operated), silicone tubing, and a filter cartridge similar to a QEDFF-8100 Standard Quick Filter or a FF-8200 High Capacity Quick Filter.

The procedure for field filtration of aqueous metals samples is provided below.

A. Decontamination of Apparatus

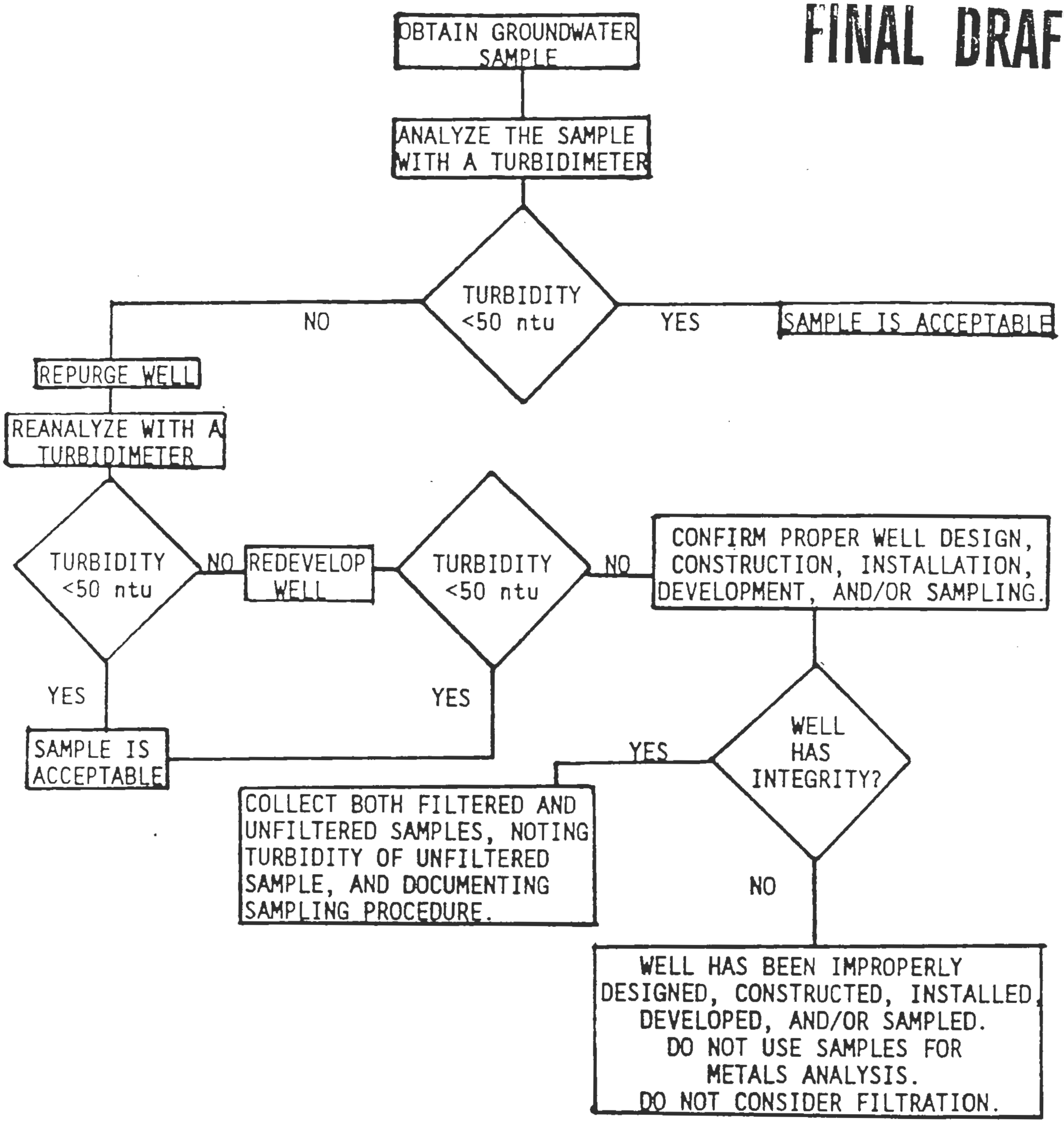
When filtering aqueous metals samples, a device made of polyethylene, polypropylene or borosilicate glass should be used. The apparatus should be pre-cleaned by rinsing with a 10% HNO_3 solution, followed by a demonstrated analyte-free deionized water rinse, and should be cleaned in the same manner between samples. Also, a field rinse blank must be collected for this apparatus.

B. Filtration Procedures and Preservation

The filter used should be a cellulose-based membrane filter of 0.45 um nominal pore size. Samples must be filtered immediately after their collection to minimize changes in the concentration of the substances of interest. Samples are only passed through the filtration apparatus once, they are not to be passed through repeatedly until they are free of turbidity. Samples are then preserved

DECISION FLOW CHART: FILTRATION OF GROUNDWATER SAMPLES COLLECTED FOR METALS ANALYSIS

FINAL DRAFT



SOURCE: NYSDEC TAGM
NUMBER HWR-88-4015
SEPTEMBER 30, 1988.

SENECA ARMY DEPOT

DECISION FLOW CHART FOR FILTRATION OF WATER SAMPLES FOR METALS ANALYSIS

FIGURE A-11 AUGUST 1991

MAIN
1893
CHAS. T. MAIN, INC., Engineers
BOSTON . NEW YORK . CHARLOTTE . PORTLAND

immediately with undiluted ultrapure HNO_3 and the pH checked to ensure proper pH has been attained. No samples for cyanide, conventional parameters, or organics may be filtered in this manner.

4.3 SAMPLE PRESERVATION

Sample preservation should be performed in the field, immediately after sample collection and field preparative steps are completed. Soils and other forms of solid materials are preserved by completely filling the sample container with sample, tightly securing the container top, followed by placement of the sample on ice or in a freezer and out of sunlight. Additional information on sample preservation procedures can be obtained from consultation with laboratory personnel and through review of analytical procedures. In many cases where pH control or additions of reagents are required, separate bottles and chemical preservatives may be supplied by the laboratory. In other cases the reagents or preservatives may be placed in the sample bottle prior to delivery to the site. Most samples collected for organic and inorganic component determination are partially preserved by storing at 4°C or less. Table 4.1 of the Chemical Data Acquisition Plan (Appendix C) outlines containers, preservation, and holding times for fish, soil, and water samples.

Many concentrated acids, bases, and many other chemicals required for sample preservation can not be shipped by air. This limitation should be anticipated and these materials should be shipped to the job site before sampling begins.

4.4 SAMPLE STORAGE

Samples should be stored in a nonreactive and noncontaminating containers. Appropriate containers include those made of polyethylene, glass, or teflon. In general, samples collected for metals and general water quality parameters are stored in plastic bottles. Samples collected for organic analysis are routinely placed in glass preferably amber glass bottles. Soil samples are generally placed in glass jars with teflon lids or cap liners.

In most cases, bottles will be supplied by the laboratory conducting the analyses. It is the responsibility of the project staff to inform the laboratory of the exact analyses that will be conducted so the lab can supply the appropriate bottles.

4.5 EQUIPMENT AND MATERIAL DECONTAMINATION

All equipment used during the collection, preparation, preservation, and storage of environmental samples must be cleaned prior to their use and after each subsequent use. Frequently, sampling equipment must be cleaned between successive uses in the field to prevent cross contamination. When field cleaning is needed, it is essential that it be conducted diligently, to ensure that all sample contacted parts of the field equipment are properly decontaminated.

Supplies needed for cleaning or decontamination is dependent upon the materials and equipment to be cleaned. When small items require cleaning in the field, several small buckets and small containers of reagents or wash liquids are adequate. However, when major items, such as large pumps, require decontamination, it may be necessary to transport large wash basins and larger volumes of washing solutions. The following is a generalized equipment list that may be used during field decontamination operations.

1. Detergent, such as Alconox.
2. Potable water.
3. Deionized demonstrated analyte free water.
4. Methanol, Hexane and/or other suitable solvents to remove petroleum products.
5. Storage vessels to transport large volumes of water to the site.
6. Buckets for washing and rinsing equipment.
7. Paper towels, clean rags or chemwipes to remove excessive soil or petroleum products before the equipment is decontaminated.
8. Ultrapure HNO_3.

The following procedure will be used to decontaminate the sampling equipment:

1. Wipe with rag, towel or chemwipes to remove excess soils or debris.
2. Wash and scrub with low phosphate detergent.
3. Tap water rinse.
4. Rinse with 1% HNO_3, ultrapure.
5. Rinse with high-purity methanol followed by hexane rinse.
6. Rinse well with deionized demonstrated analyte free water.
7. Air dry, and

8. Use equipment immediately or wrap in clean aluminum foil or teflon film for temporary storage.

Groundwater purging and developing equipment will be decontaminated as follows:

a. Rinse elevation tapes and slugs (slug testing) with tap water, followed by DI water. Place in a polyethylene bag to prevent contamination during storage or transit.
b. Clean submersible pumps used for purging the deep wells prior to use and between wells by pumping copious amounts of tap water through the pumps and associated hoses, followed by rinsing with DI water. Clean the exterior of the submersible pumps and hoses that contact formation water by washing with Liquinox® solution, followed by tap water rinse, and a final DI water rinse. Dedicate all tubing to individual wells; i.e., do not reuse tubing. To prevent degradation of or damage to submersible pump seals, impellers, and electric motors, do not rinse with solvents and/or acids. Typically, do not collect analytical samples through submersible pumps. Clean the exterior of drop pipes and tubing used to purge the shallow wells prior to use and between wells by washing with Liquinox® solution, rinsing with tap water or potable water, followed by rinsing with analyte-free water, followed with a final rinse of analyte-free water. Rinse the interior of drop pipes and tubing with copious amounts of tap water. Dedicate all tubing to individual wells; i.e., do not reuse tubing. Typically, do not collect analytical samples through centrifugal pumps and/or drop pipes.
c. If bailers are used to evacuate wells, decontaminate the bailers as described in Section 4.6.2.

5.0 SAMPLE PACKAGING, SHIPPING, AND CHAIN-OF-CUSTODY PROCEDURES

Once the samples have been collected, prepared, preserved, and appropriately stored, they must be packaged and shipped. In addition, from the time of sample collection until analyses have been completed, chain-of-custody procedures must be implemented and manufactured to document control and handling of the samples. This section outlines procedures for the packing and shipping environmental samples and general chain-of-custody procedures.

5.1 PACKAGING AND SHIPPING PROCEDURES FOR ENVIRONMENTAL SAMPLES

All sample containers must be placed in a sturdy, insulated shipping container for transport to the laboratory. A metal or plastic picnic cooler is recommended. The following is an outline of the procedures to be followed.

1. Using fiberglass tape, secure the drain plug at the bottom of the cooler to ensure that liquid from sample container breakage or melting ice does not leak from the cooler.

2. Line the bottom of the cooler with a layer of absorbent material such as vermiculite.
3. Use pieces of carved-out plastic foam or individually wrapped glass containers to help prevent breakage.
4. Pack sample bottles in the cooler. Hand tighten all screw caps and mark sample volume level on the outside of large containers.
5. Pack small containers, such as 40 milliliter vials, in small plastic sandwich bags. When shipping these with larger containers cushion smaller vials to minimize breakage.
6. Pack additional cushioning material, such as vermiculite or bubble pack, between the sample containers.
7. Pack ice, sealed in plastic bags, on top of the samples in the cooler when samples must be kept cold.
8. Seal the chain-of-custody form in a plastic bag and attach it to the inside or top of the cooler lid.
9. Close the lid of the cooler; be sure it is tightly fastened.

10. Seal the container with strong tape (fiberglass reinforced). Wrap the tape vertically around the cooler: two wraps each on the long and short dimensions.
11. Attach a shipping label with a return address to the outside of the cooler, along with, arrows indicating "This End Up" on all four sides, and "This End Up" label on the top of the lid.
12. Apply additional labels such as "Fragile" or "Liquid In Glass" as necessary.
13. If the cooler is not equipped with a padlock, apply a signed custody seal between the lid and body of the cooler.

Samples packaged in this way can be shipped by commercial carrier. Staff should be prepared to open and reseal the cooler for inspection when offering them for shipment. Be aware that some commercial carriers have limits for the number of pounds per item that can be shipped. Notify the laboratory of the name of the carrier, the containers' Bill of Lading numbers, and it's expected delivery date.

5.2 PACKING AND SHIPPING HAZARDOUS SAMPLES EXCLUDING THOSE FROM CLOSED CONTAINERS

1. Place one, decontaminated, labeled sample container in a 2-mil-thick self-sealing plastic bag. Care should be taken to position the sample label so that it may be read through the bag.
2. Place some vermiculite in the bottom of a half-gallon or gallon metal paint can to absorb shock and leaking material in the event of sample breakage. The sealed sample bag is then placed in the can. Additional vermiculite is added to fill the remaining space in the can. Close the can lid and seal in place with clips.
3. Attach address and return mailing labels to each can. Attach additional Department of Transportation Labels as are required by provisions of 49 CFR 171, 172, 173, or 178. Such labels may include "Flammable Liquid", "Flammable Solid", "Corrosive", etc.
4. Place the can in a cooler that has been partially filled with vermiculite. Additional vermiculite should then be placed where needed to secure the metal can. If more than one can is being shipped, this should be specified in the carrier's bill of lading. Seal a copy of the chain-of-custody record in a plastic bag, place it in the cooler, and shut and fasten the cooler lid.

5. Mark the top of the cooler with a "This End Up" label. The outside must display the same labels as are present on the metal can inside; In addition, arrows pointing to the top must appear on all four sides. Attach a label marked "Laboratory Samples" to the lid.
6. Secure the drain plug and lid of the cooler with fiberglass tape and custody seals as described in Section 5.1.
7. Check to be sure that the carrier's bill of lading is completed and signed. The sampler's certification for restricted articles must also be completed and signed.

Personnel should be prepared to open and reseal the cooler if requested by the carrier. If transported by air, samples should be shipped by cargo aircraft only.

5.3 RECORD KEEPING AND CHAIN-OF-CUSTODY PROCEDURES

5.3.1 Record Keeping

Photographs of all sampling locations and operations are desirable, although they frequently will not be allowed. If photographs are taken, the photographer should record time, date, site location, and brief description of the subject on the back of the photo, (polaroid) or in a log book and then sign it. Photographs documentation that may be used as evidence should be handled in a way to ensure that chain-of-custody can be established.

5.3.2 Custody Procedures

Each sample must be labeled using waterproof ink and sealed immediately after it is collected. Labels should be filled out before collection to minimize handling of sample container. Figure A-5 is a sample Chain-of-Custody Record and Figure A-6 is an example of a sample label.

Labels and tags must be firmly affixed to the sample containers. Be sure that the container is dry enough for a gummed label to be securely attached. Tags attached by string are acceptable when gummed labels are not applicable.

Sampling information will be recorded in the field on the Sampling Record form, (Figure A-5).

Chain-of-custody documentation must be implemented and followed whenever samples are collected, transferred, stored, analyzed, or destroyed. The primary objective of these procedures is to create an accurate written record that traces the possession and handling of the sample from the moment of its collection through analysis, to disposal.

A sample is defined as being in someone's "custody" if:

1. It is in one's actual possession, or
2. It is in one's view, after being in one's physical possession, or
3. It is in one's physical possession and then locked up so that no one can tamper with it, or
4. It is kept in a secured area, restricted to authorized personnel only.

The number of persons involved in collecting and handling samples should be kept to a minimum.

The chain-of-custody record will be initiated at the time each sample is collected (Figure A-6).

One member of the sampling team will be designated Field Sample Custodian. The samples and forms are turned over to the Field Sample Custodian by the team members who collect the samples at the end of each day.

When transferring the samples, the receiver and sender must sign and record the date and time of transfer on the chain-of-custody record. Custody transfers made to the Field Sample Custodian should account for each sample, although samples may be transferred as a group. Every person who takes custody must fill in the appropriate section of the chain-of-custody record.

The Field Sample Custodian is responsible for packaging and dispatching samples to the appropriate laboratory. This responsibility includes filling out, dating, and signing the appropriate portion of the chain-of-custody record.

All packages sent to the laboratory should be accompanied by the chain-of-custody record and other pertinent forms. A copy of these forms should be retained by the originating office (either carbon copy or photocopy). Mailed packages can be registered with return receipt requested. For packages sent by common carrier, receipts should be retained as part of the permanent chain-of-custody documentation. The laboratory custodian should sign field chain of custody forms to acknowledge receipt of the samples in the labs and either initiate separate laboratory custody procedures or maintain the field, chain-of-custody until the sample is disposed. All chain-of-custody documentation will be returned to the central file.

6.0 HYDROGEOLOGIC DATA COLLECTION PROCEDURES

6.1 GROUNDWATER ELEVATION MEASUREMENTS

The depth to groundwater will be measured in the wells and peizometers located on site. This information could be collected from a group of wells during a short period of time (1 to 3 hours) to evaluate groundwater flow direction or from a few wells over a long period of time (for example, 12 or 24 hours) to evaluate groundwater elevation variations over time.

When no light non-aqueous phase layer (NAPL) is suspected to be present, a battery-operated water level indicator will be used to measure the depth to groundwater. The indicator will be calibrated against a tape measure to provide an accurate depth measurement. The calibration will occur at the beginning of each field program and once a month thereafter.

All groundwater depth measurements will be referenced to the top of the well casing, not the top of the protective casing. If there is no mark on the top of the well casing, then the highest point on the well casing rim will be the reference mark.

Groundwater elevation information will be recorded in the field on the Sampling Record form as shown in Figure A-5.

6.2 SURFACE WATER ELEVATION MEASUREMENTS

Staff gauges will be placed at locations noted in the work plan to monitor the elevation of surface water. The gauge will consist of a metal rod driven into the sediment to refusal or a final depth of 30 inches. The top of the rod will be surveyed and act as the reference point for water level measurements. The rod will be graduated in inches to the nearest one-hundredth of a foot. The height of the surface water from the top of the staff gauge will be recorded in the field book.

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6.3 SURFACE WATER FLOW MEASUREMENTS

Stream flow rates will be measured taking velocity measurements with a Teledyne Gurley Model 622-F flowmeter or similar device at one or more points along a line perpendicular to the flow direction. Each velocity measurements will be taken at one or two specific depths depending on the total water depth at that point. The approximate cross section of the stream will also be measured and the flow will be calculated by multiplying the cross section times the average velocity.

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ATTACHMENT 1
STANDARD PRACTICE FOR DESCRIPTION AND IDENTIFICATION OF SOILS (VISUAL - MANUAL METHOD)

Designation: D 2488 – 84

Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)[1]

1. Scope

1.1 This practice covers procedures for the description of soils for engineering purposes.

1.2 This practice also describes a procedure for identifying soils, at the option of the user, based on the classification system described in Test Method D 2487. The identification is based on visual examination and manual tests. It must be clearly stated in reporting an identification that it is based on visual-manual procedures.

1.2.1 When precise classification of soils for engineering purposes is required, the procedures prescribed in Test Method D 2487 shall be used.

1.2.2 In this practice, the identification portion assigning a group symbol and name is limited to soil particles smaller than 3 in. (75 mm).

1.2.3 The identification portion of this practice is limited to naturally occurring soils.

NOTE 1—This practice may be used as a descriptive system applied to such materials as shale, claystone, shells, crushed rock, etc. (See Appendix X2).

1.3 The descriptive information in this practice may be used with other soil classification systems or for materials other than naturally occurring soils.

1.4 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements see Section 8.

1.5 The values stated in inch-pound units are to be regarded as the standard.

2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Terms and Symbols Relating to Soil and Rock[2]

D 1452 Practice for Soil Investigation and Sampling by Auger Borings[2]

D 1586 Method for Penetration Test and Split-Barrel Sampling of Soils[2]

D 1587 Practice for Thin-Walled Tube Sampling of Soils[2]

D 2113 Practice for Diamond Core Drilling for Site Investigation[2]

D 2487 Test Method for Classification of Soils for Engineering Purposes[2]

3. Definitions

3.1 Except as listed below, all definitions are in accordance with Terms and Symbols D 653.

NOTE 2—For particles retained on a 3-in. (75-mm) US standard sieve, the following definitions are suggested:

Cobbles—particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) sieve, and

Boulders—particles of rock that will not pass a 12-in. (300-mm) square opening.

3.1.1 *clay*—soil passing a No. 200 (75-μm) sieve that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dry. For classification, a clay is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index equal to or greater than 4, and the plot of plasticity index versus liquid limit falls on or above the "A" line (see Fig. 3 of Test Method D 2487).

3.1.2 *gravel*—particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve with the following subdivisions:

coarse—passes a 3-in. (75-mm) sieve and is retained on a ¾-in. (19-mm) sieve.

fine—passes a ¾-in. (19-mm) sieve and is retained on a No. 4 (4.75-mm) sieve.

3.1.3 *organic clay*—a clay with sufficient organic content to influence the soil properties. For classification, an organic clay is a soil that would be classified as a clay, except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.4 *organic silt*—a silt with sufficient organic content to influence the soil properties. For classification, an organic silt is a soil that would be classified as a silt except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.5 *peat*—a soil composed primarily of vegetable tissue in various stages of decomposition usually with an organic odor, a dark brown to black color, a spongy consistency, and a texture ranging from fibrous to amorphous.

3.1.6 *sand*—particles of rock that will pass a No. 4 (4.75-mm) sieve and be retained on a No. 200 (75-μm) sieve with the following subdivisions:

coarse—passes a No. 4 (4.75-mm) sieve and is retained on a No. 10 (2.00-mm) sieve.

medium—passes a No. 10 (2.00-mm) sieve and is retained on a No. 40 (425-μm) sieve.

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[1] This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.07 on Identification and Classification of Soils.

Current edition approved Oct. 3, 1984. Published December 1984. Originally published as D 2488 – 66 T. Last previous edition D 2488 – 69 (1975).

[2] *Annual Book of ASTM Standards*, Vol 04.08.

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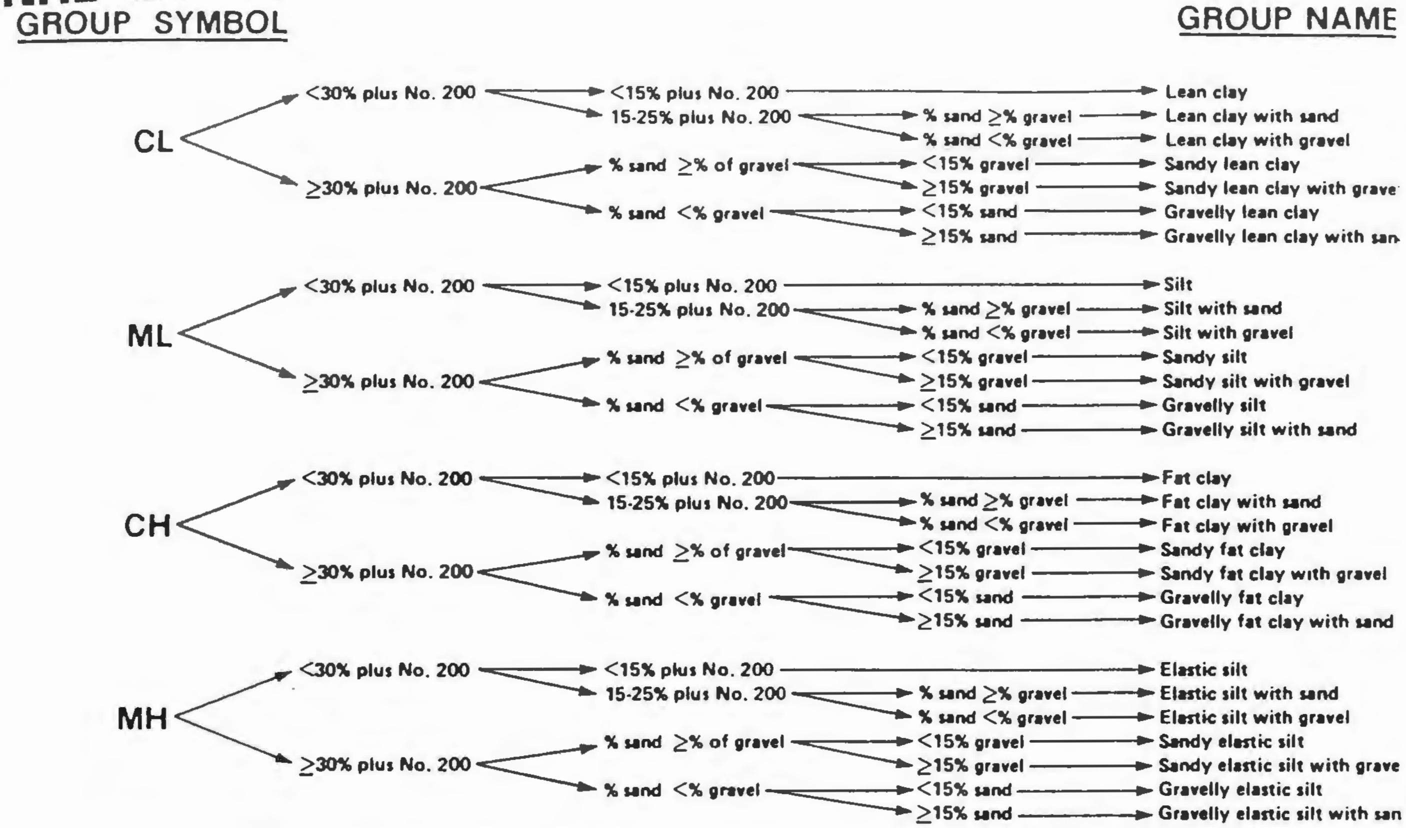


NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)

fine—passes a No. 40 (425-µm) sieve and is retained on a No. 200 (75-µm) sieve.

3.1.7 *silt*—soil passing a No. 200 (75-µm) sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air dry. For classification, a silt is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index less than 4, or the plot of plasticity index versus liquid limit falls below the "A" line (see Fig. 3 of Test Method D 2487).

4. Summary of Practice

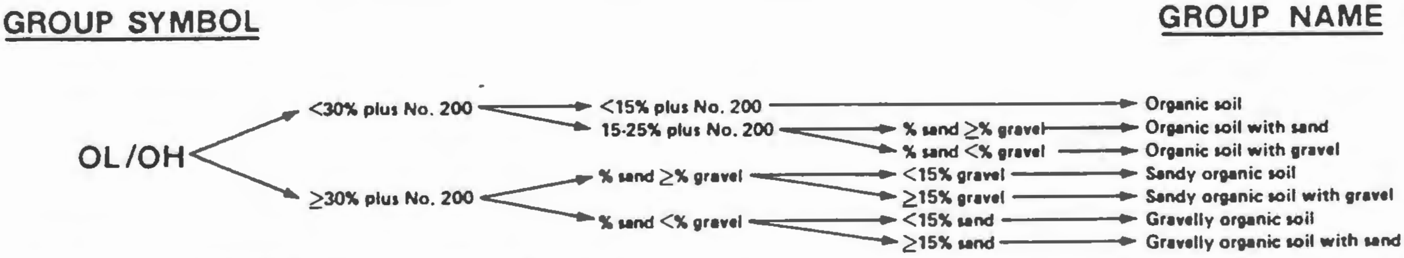
4.1 Using visual examination and simple manual tests, this practice gives standardized criteria and procedures for describing and identifying soils.

4.2 The soil can be given an identification by assigning a group symbol(s) and name. The flow charts, Figs. 1a and 1b for fine-grained soils, and Fig. 2, for coarse-grained soils, can be used to assign the appropriate group symbol(s) and name If the soil has properties which do not distinctly place it int a specific group, borderline symbols may be used, se Appendix X3.

NOTE 3—It is suggested that a distinction be made between *dua symbols* and *borderline symbols.*

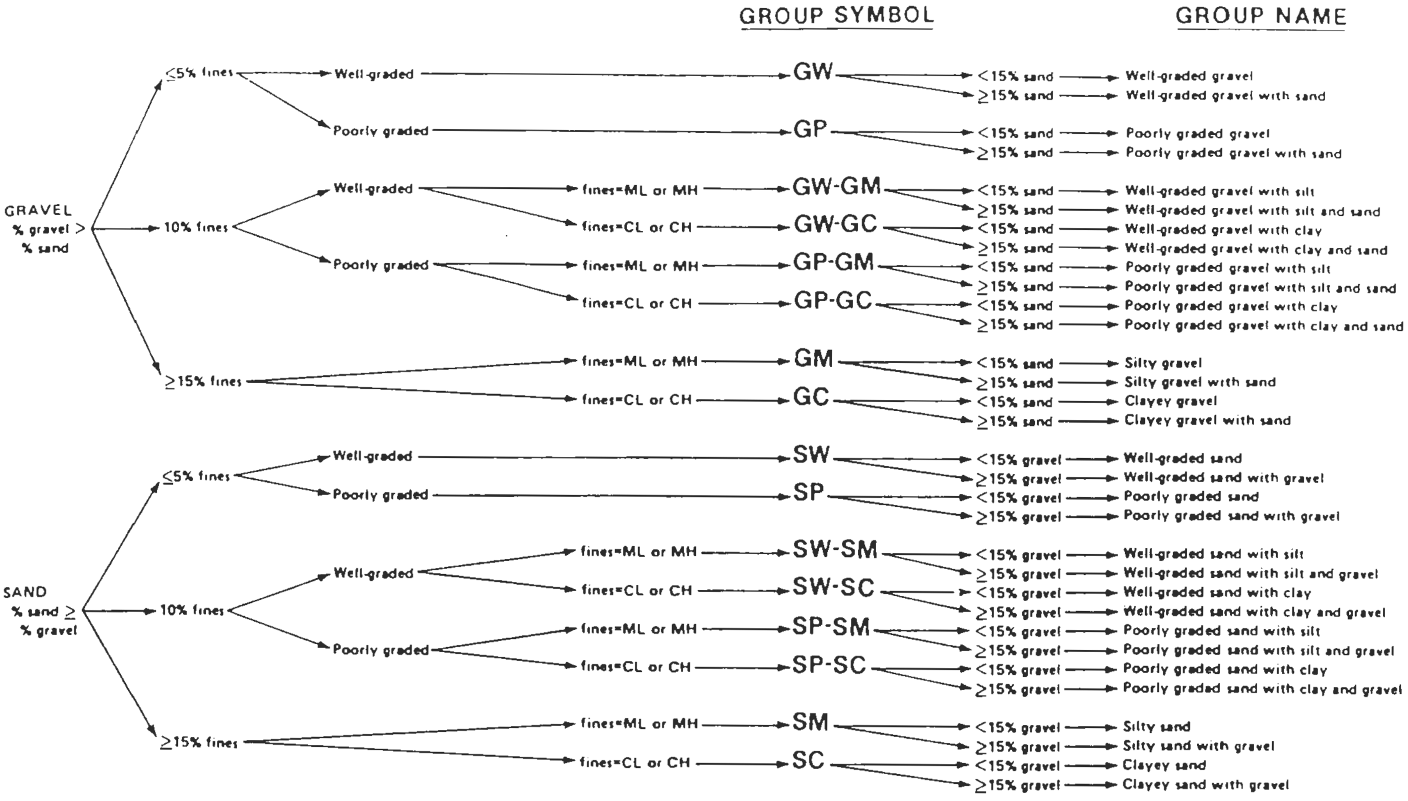
Dual Symbol—A dual symbol is two symbols separated by a hyphen. for example, GP-GM, SW-SC, CL-ML used to indicate that the soil ha been identified as having the properties of a classification in accordanc with Test Method D 2487 where two symbols are required. Tw symbols are required when the soil has between 5 and 12 % fines o when the liquid limit and plasticity index values plot in the CL-ML are of the plasticity chart.

Borderline Symbol—A borderline symbol is two symbols separated by a slash, for example, CL/CH, GM/SM, CL/ML. A borderline symbol should be used to indicate that the soil has been identified as having properties that do not distinctly place the soil into a specific group (see Appendix X3).



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1b Flow Chart for Identifying Organic Fine-Grained Soil (50 % or more fines)



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)

5. Significance and Use

5.1 The descriptive information required in this practice can be used to describe a soil to aid in the evaluation of its significant properties for engineering use.

5.2 The descriptive information required in this practice should be used to supplement the classification of a soil as determined by Test Method D 2487.

5.3 This practice may be used in identifying soils using the classification group symbols and names as prescribed in Test Method D 2487. Since the names and symbols used in this practice to identify the soils are the same as those used in Test Method D 2487, it shall be clearly stated in reports and all other appropriate documents, that the classification symbol and name are based on visual-manual procedures.

5.4 This practice is to be used not only for identification of soils in the field, but also in the office, laboratory, or wherever soil samples are inspected and described.

5.5 This practice has particular value in grouping similar soil samples so that only a minimum number of laboratory tests need be run for positive soil classification.

NOTE 4—The ability to describe and identify soils correctly is learned more readily under the guidance of experienced personnel, but it may also be acquired systematically by comparing numerical laboratory test results for typical soils of each type with their visual and manual characteristics.

5.6 When describing and identifying soil samples from a given boring, test pit, or group of borings or pits, it is not necessary to follow all of the procedures in this practice for every sample. Soils which appear to be similar can be grouped together; one sample completely described and identified with the others referred to as similar based on performing only a few of the descriptive and identification procedures described in this practice.

6. Apparatus

6.1 *Required Apparatus:*

6.1.1 *Pocket Knife or Small Spatula.*

6.2 *Useful Auxiliary Apparatus:*

6.2.1 *Small Test Tube and Stopper* (or jar with a lid).

6.2.2 *Small Hand Lens.*

7. Reagents

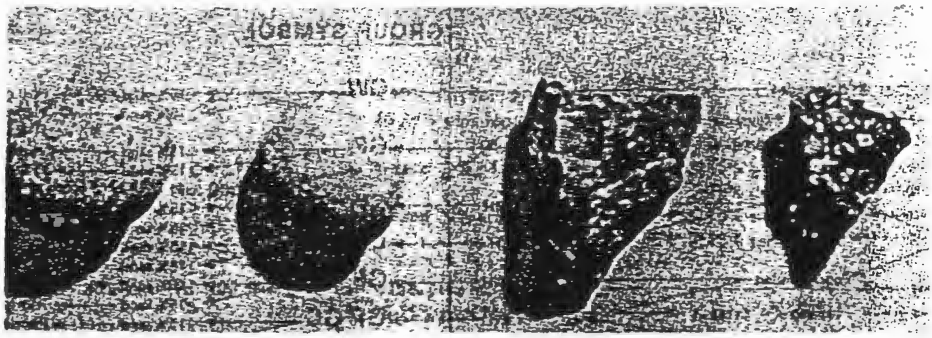
7.1 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean water from a city water supply or natural source, including non-potable water.

7.2 *Hydrochloric Acid*—A small bottle of dilute hydrochloric acid, HCl, one part HCl (10 *N*) to three parts water (This reagent is optional for use with this practice). See Section 8.

8. Safety Precautions

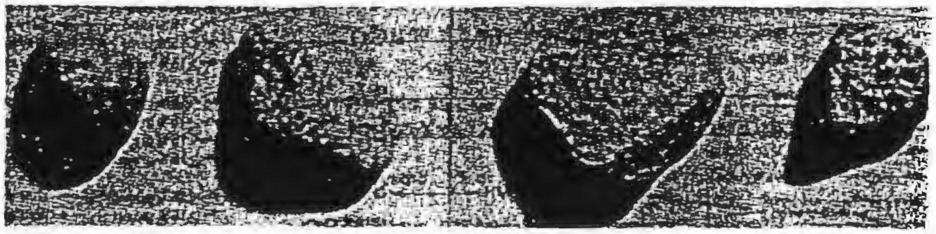
8.1 When preparing the dilute HCl solution of one part concentrated hydrochloric acid (10 *N*) to three parts of distilled water, slowly add acid into water following necessary safety precautions. Handle with caution and store safely. If solution comes into contact with the skin, rinse thoroughly with water.

8.2 **Caution**—Do not add water to acid.



(a) Rounded

(b) Angular



(c) Subrounded

(d) Subangular

FIG. 3 Typical Angularity of Bulky Grains

9. Sampling

9.1 The sample shall be considered to be representative of the stratum from which it was obtained by an appropriate, accepted, or standard procedure.

NOTE 5—Preferably, the sampling procedure should be identified as having been conducted in accordance with Practices D 1452, D 1587, or D 2113, or Method D 1586.

9.2 The sample shall be carefully identified as to origin.

NOTE 6—Remarks as to the origin may take the form of a boring number and sample number in conjunction with a job number, a geologic stratum, a pedologic horizon or a location description with respect to a permanent monument, a grid system or a station number and offset with respect to a stated centerline and a depth or elevation.

9.3 For accurate description and identification, the minimum amount of the specimen to be examined shall be in accordance with the following schedule:

Maximum Particle Size, Sieve Opening	Minimum Specimen Size, Dry Weight
4.75 mm (No. 4)	100 g (0.25 lb)
9.5 mm (3/8 in.)	200 g (0.5 lb)
19.0 mm (3/4 in.)	1.0 kg (2.2 lb)
38.1 mm (1½ in.)	8.0 kg (18 lb)
75.0 mm (3 in.)	60.0 kg (132 lb)

NOTE 7—If random isolated particles are encountered that are significantly larger than the particles in the soil matrix, the soil matrix can be accurately described and identified in accordance with the preceeding schedule.

TABLE 1 Criteria for Describing Angularity of Coarse-Grained Particles (see Fig. 3)

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

9.4 If the field sample or specimen being examined is smaller than the minimum recommended amount, the report shall include an appropriate remark.

10. Descriptive Information for Soils

10.1 *Angularity*—Describe the angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, subangular, subrounded, or rounded in accordance with the criteria in Table 1 and Fig. 3. A range of angularity may be stated, such as: subrounded to rounded.

10.2 *Shape*—Describe the shape of the gravel, cobbles, and boulders as flat, elongated, or flat and elongated if they meet the criteria in Table 2 and Fig. 4. Otherwise, do not mention the shape. Indicate the fraction of the particles that have the shape, such as: one-third of the gravel particles are flat.

10.3 *Color*—Describe the color. Color is an important property in identifying organic soils, and within a given locality it may also be useful in identifying materials of similar geologic origin. If the sample contains layers or patches of varying colors, this shall be noted and all representative colors shall be described. The color shall be described for moist samples. If the color represents a dry condition, this shall be stated in the report.

10.4 *Odor*—Describe the odor if organic or unusual. Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation. This is especially apparent in fresh samples, but if the samples are dried, the odor may often be revived by heating a moistened

TABLE 2 Criteria for Describing Particle Shape (see Fig. 4)

The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle, respectively.

Flat	Particles with width/thickness > 3
Elongated	Particles with length/width > 3
Flat and elongated	Particles meet criteria for both flat and elongated

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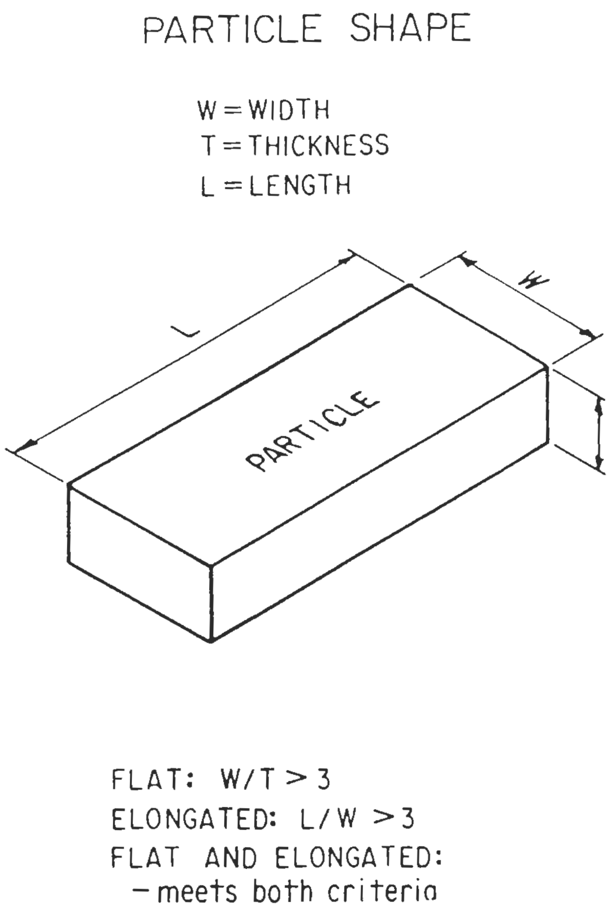

FIG. 4 Criteria for Particle Shape

TABLE 3 Criteria for Describing Moisture Condition

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

sample. If the odor is unusual (petroleum product, chemical, and the like), it shall be described.

10.5 *Moisture Condition*—Describe the moisture condition as dry, moist, or wet, in accordance with the criteria in Table 3.

10.6 *HCl Reaction*—Describe the reaction with HCl as none, weak, or strong, in accordance with the critera in Table 4. Since calcium carbonate is a common cementing agent, a report of its presence on the basis of the reaction with dilute hydrochloric acid is important.

10.7 *Consistency*—For intact fine-grained soil, describe the consistency as very soft, soft, firm, hard, or very hard, in accordance with the criteria in Table 5. This observation is inappropriate for soils with significant amounts of gravel.

TABLE 4 Criteria for Describing the Reaction With HCl

Description	Criteria
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

TABLE 5 Criteria for Describing Consistency

Description	Criteria
Very soft	Thumb will penetrate soil more than 1 in. (25 mm)
Soft	Thumb will penetrate soil about 1 in. (25 mm)
Firm	Thumb will indent soil about ¼ in. (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very hard	Thumbnail will not indent soil

10.8 *Cementation*—Describe the cementation of intact coarse-grained soils as weak, moderate, or strong, in accordance with the criteria in Table 6.

10.9 *Structure*—Describe the structure of intact soils in accordance with the criteria in Table 7.

10.10 *Range of Particle Sizes*—For gravel and sand components, describe the range of particle sizes within each component as defined in 3.1.2 and 3.1.6. For example, about 20 % fine to coarse gravel, about 40 % fine to coarse sand.

10.11 *Maximum Particle Size*—Describe the maximum particle size found in the sample in accordance with the following information:

10.11.1 *Sand Size*—If the maximum particle size is a sand size, describe as fine, medium, or coarse as defined in 3.1.7. For example: maximum particle size, medium sand.

10.11.2 *Gravel Size*—If the maximum particle size is a gravel size, describe the maximum particle size as the smallest sieve opening that the particle will pass. For example, maximum particle size, 1½ in. (will pass a 1½-in. square opening but not a ¾-in. square opening).

10.11.3 *Cobble or Boulder Size*—If the maximum particle size is a cobble or boulder size, describe the maximum dimension of the largest particle. For example: maximum dimension, 18 in. (450 mm).

10.12 *Hardness*—Describe the hardness of coarse sand and larger particles as hard, or state what happens when the particles are hit by a hammer, for example, gravel-size particles fracture with considerable hammer blow, some gravel-size particles crumble with hammer blow. "Hard" means particles do not crack, fracture, or crumble under a hammer blow.

10.13 Additional comments shall be noted, such as the presence of roots or root holes, difficulty in drilling or augering hole, caving of trench or hole, or the presence of mica.

10.14 A local or commercial name or a geologic interpretation of the soil, or both, may be added if identified as such.

10.15 A classification or identification of the soil in accordance with other classification systems may be added if identified as such.

11. Identification of Peat

11.1 A sample composed primarily of vegetable tissue in various stages of decomposition that has a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor, shall be designated as a highly organic soil and shall be identified as peat, PT, and not subjected to the

TABLE 6 Criteria for Describing Cementation

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

TABLE 7 Criteria for Describing Structure

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

identification procedures described hereafter.

12. Preparation for Identification

12.1 The soil identification portion of this practice is based on the portion of the soil sample that will pass a 3-in. (75-mm) sieve. The larger than 3-in. (75-mm) particles must be removed, manually, for a loose sample, or mentally, for an intact sample before classifying the soil.

12.2 Estimate and note the percentage of cobbles and the percentage of boulders. Performed visually, these estimates will be on the basis of volume percentage.

NOTE 8—Since the percentages of the particle-size distribution in Test Method D 2487 are by dry weight, and the estimates of percentages for gravel, sand, and fines in this practice are by dry weight, it is recommended that the report state that the percentages of cobbles and boulders are by volume.

12.3 Of the fraction of the soil smaller than 3 in. (75 mm), estimate and note the percentage, by dry weight, of the gravel, sand, and fines (see Appendix X4 for suggested procedures).

NOTE 9—Since the particle-size components appear visually on the basis of volume, considerable experience is required to estimate the percentages on the basis of dry weight. Frequent comparisons with laboratory particle-size analyses should be made.

12.3.1 The percentages shall be estimated to the closest 5 %. The percentages of gravel, sand, and fines must add up to 100 %.

12.3.2 If one of the components is present but not in sufficient quantity to be considered 5 % of the smaller than 3-in. (75-mm) portion, indicate its presence by the term *trace*, for example, trace of fines. A trace is not to be considered in the total of 100 % for the components.

TABLE 8 Criteria for Describing Dry Strength

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface
Very high	The dry specimen cannot be broken between the thumb and a hard surface

13. Preliminary Identification

13.1 The soil is *fine grained* if it contains 50 % or mor fines. Follow the procedures for identifying fine-grained soil of Section 14.

13.2 The soil is *coarse grained* if it contains less than 50 % fines. Follow the procedures for identifying coarse-graine soils of Section 15.

14. Procedure for Identifying Fine-Grained Soils

14.1 Select a representative sample of the material fo examination. Remove particles larger than the No. 40 siev (medium sand and larger) until a specimen equivalent t about a handful of material is available. Use this specime for performing the dry strength, dilatancy, and toughnes tests.

14.2 *Dry Strength:*

14.2.1 From the specimen, select enough material to mold into a ball about 1 in. (25 mm) in diameter. Mold the material until it has the consistency of putty, adding water i necessary.

14.2.2 From the molded material, make at least three test specimens. A test specimen shall be a ball of material about ½ in. (12 mm) in diameter. Allow the test specimens to dry in air, or sun, or by artificial means, as long as the temperature does not exceed 60°C.

14.2.3 If the test specimen contains natural dry lumps, those that are about ½ in. (12 mm) in diameter may be used in place of the molded balls.

NOTE 10—The process of molding and drying usually produces higher strengths than are found in natural dry lumps of soil.

14.2.4 Test the strength of the dry balls or lumps by crushing between the fingers. Note the strength as none, low, medium, high, or very high in accorance with the criteria in Table 8. If natural dry lumps are used, do not use the results of any of the lumps that are found to contain particles of coarse sand.

14.2.5 The presence of high-strength water-soluble cementing materials, such as calcium carbonate, may cause exceptionally high dry strengths. The presence of calcium carbonate can usually be detected from the intensity of the reaction with dilute hydrochloric acid (see 10.6).

14.3 *Dilatancy:*

14.3.1 From the specimen, select enough material to mold into a ball about ½ in. (12 mm) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.

14.3.2 Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the

TABLE 9 Criteria for Describing Dilatancy

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

TABLE 10 Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness

reaction as none, slow, or rapid in accordance with the criteria in Table 9. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

14.4 *Toughness:*

14.4.1 Following the completion of the dilatancy test, the test specimen is shaped into an elongated pat and rolled by hand on a smooth surface or between the palms into a thread about ⅛ in. (3 mm) in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.) Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about ⅛ in. The thread will crumble at a diameter of ⅛ in. when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading.

14.4.2 Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table 10.

14.5 *Plasticity*—On the basis of observations made during the toughness test, describe the plasticity of the material in accordance with the criteria given in Table 11.

14.6 Decide whether the soil is an *inorganic* or an *organic* fine-grained soil (see 14.8). If inorganic, follow the steps given in 14.7.

14.7 *Identification of Inorganic Fine-Grained Soils:*

14.7.1 Identify the soil as a *lean clay*, CL, if the soil has medium to high dry strength, no or slow dilatancy, and medium toughness and plasticity (see Table 12).

14.7.2 Identify the soil as a *fat clay*, CH, if the soil has high to very high dry strength, no dilatancy, and high toughness and plasticity (see Table 12).

14.7.3 Identify the soil as a *silt*, ML, if the soil has no to low dry strength, slow to rapid dilatancy, and low toughness and plasticity, or is nonplastic (see Table 12).

14.7.4 Identify the soil as an *elastic silt*, MH, if the soil has low to medium dry strength, no to slow dilatancy, and low to medium toughness and plasticity (see Table 12).

TABLE 11 Criteria for Describing Plasticity

Description	Criteria
Nonplastic	A ⅛-in. (3-mm) thread cannot be rolled at any water content
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit

NOTE 11—These properties are similar to those for a lean clay. However, the silt will dry quickly on the hand and have a smooth, silky feel when dry. Some soils that would classify as MH in accordance with the criteria in Test Method D 2487 are visually difficult to distinguish from lean clays, CL. It may be necessary to perform laboratory testing for proper identification.

14.8 *Identification of Organic Fine-Grained Soils:*

14.8.1 Identify the soil as an *organic soil*, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

NOTE 12—In some cases, through practice and experience, it may be possible to further identify the organic soils as organic silts or organic clays, OL or OH. Correlations between the dilatancy, dry strength, toughness tests, and laboratory tests can be made to identify organic soils in certain deposits of similar materials of known geologic origin.

14.9 If the soil is estimated to have 15 to 25 % sand or gravel, or both, the words "with sand" or "with gravel" (whichever is more predominant) shall be added to the group name. For example: "lean clay with sand, CL" or "silt with gravel, ML" (see Figs. 1a and 1b). If the percentage of sand is equal to the percentage of gravel, use "with sand."

14.10 If the soil is estimated to have 30 % or more sand or gravel, or both, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if there appears to be more sand than gravel. Add the word "gravelly" if there appears to be more gravel than sand. For example: "sandy lean clay, CL", "gravelly fat clay, CH", or "sandy silt, ML" (see Figs. 1a and 1b). If the percentage of sand is equal to the percent of gravel, use "sandy."

15. Procedure for Identifying Coarse-Grained Soils (Contains less than 50 % fines)

15.1 The soil is a *gravel* if the percentage of gravel is estimated to be more than the percentage of sand.

15.2 The soil is a *sand* if the percentage of gravel is estimated to be equal to or less than the percentage of sand.

15.3 The soil is a *clean gravel* or *clean sand* if the percentage of fines is estimated to be 5 % or less.

15.3.1 Identify the soil as a *well-graded gravel*, GW, or as a *well-graded sand*, SW, if it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes.

15.3.2 Identify the soil as a *poorly graded gravel*, GP, or as a *poorly graded sand*, SP, if it consists predominantly of one size (uniformly graded), or it has a wide range of sizes with

TABLE 12 Identification of Inorranic Fine-Grained Soils from Manual Tests

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	None	High

some intermediate sizes obviously missing (gap or skip graded).

15.4 The soil is either a *gravel with fines* or a *sand with fines* if the percentage of fines is estimated to be 15 % or more.

15.4.1 Identify the soil as a *clayey gravel*, GC, or a *clayey sand*, SC, if the fines are clayey as determined by the procedures in Section 14.

15.4.2 Identify the soil as a *silty gravel*, GM, or a *silty sand*, SM, if the fines are silty as determined by the procedures in Section 14.

15.5 If the soil is estimated to contain 10 % fines, give the soil a dual identification using two group symbols.

15.5.1 The first group symbol shall correspond to a clean gravel or sand (GW, GP, SW, SP) and the second symbol shall correspond to a gravel or sand with fines (GC, GM, SC, SM).

15.5.2 The group name shall correspond to the first group symbol plus the words "with clay" or "with silt" to indicate the plasticity characteristics of the fines. For example: "well-graded gravel with clay, GW-GC" or "poorly graded sand with silt, SP-SM" (see Fig. 2).

15.6 If the specimen is predominantly sand or gravel but contains an estimated 15 % or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example: "poorly graded gravel with sand, GP" or "clayey sand with gravel, SC" (see Fig. 2).

15.7 If the field sample contains any cobbles or boulders, or both, the words "with cobbles" or "with cobbles and boulders" shall be added to the group name. For example: "silty gravel with cobbles, GM."

16. Report

16.1 The report shall include the information as to origin, and the items indicated in Table 13.

NOTE 13—*Example: Clayey Gravel with Sand and Cobbles, GC*—About 50 % fine to coarse, subrounded to subangular gravel; about 30 % fine to coarse, subrounded sand; about 20 % fines with medium plasticity, high dry strength, no dilatancy, medium toughness; weak reaction with HCl; original field sample had about 5 % (by volume) subrounded cobbles, maximum dimension, 150 mm.

In-Place Conditions—Firm, homogeneous, dry, brown
Geologic Interpretation—Alluvial fan

NOTE 14—Other examples of soil descriptions and identification are given in Appendixes X1 and X2.

NOTE 15—If desired, the percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages, as follows:

Trace—Particles are present but estimated to be less than 5 %
Few—5 to 10 %
Little—15 to 25 %
Some—30 to 45 %
Mostly—50 to 100 %

16.2 If, in the soil description, the soil is identified using a classification group symbol and name as described in Test Method D 2487, it must be distinctly and clearly stated in log forms, summary tables, reports, and the like, that the symbol and name are based on visual-manual procedures.

17. Precision and Bias

17.1 This practice provides qualitative information only, therefore, a precision and bias statement is not applicable.

TABLE 13 Checklist for Description of Soils

1. Group name
2. Group symbol
3. Percent of cobbles or boulders, or both (by volume)
4. Percent of gravel, sand, or fines, or all three (by dry weight)
5. Particle-size range:
   Gravel—fine, coarse
   Sand—fine, medium, coarse
6. Particle angularity: angular, subangular, subrounded, rounded
7. Particle shape: (if appropriate) flat, elongated, flat and elongated
8. Maximum particle size or dimension
9. Hardness of coarse sand and larger particles
10. Plasticity of fines: nonplastic, low, medium, high
11. Dry strength: none, low, medium, high, very high
12. Dilatancy: none, slow, rapid
13. Toughness: low, medium, high
14. Color (in moist condition)
15. Odor (mention only if organic or unusual)
16. Moisture: dry, moist, wet
17. Reaction with HCl: none, weak, strong

For intact samples:

18. Consistency (fine-grained soils only): very soft, soft, firm, hard, very hard
19. Structure: stratified, laminated, fissured, slickensided, lensed, homogeneous
20. Cementation: weak, moderate, strong
21. Local name
22. Geologic interpretation
23. Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating, etc.

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLES OF VISUAL SOIL DESCRIPTIONS

X1.1 The following examples show how the information required in 16.1 can be reported. The information that is included in descriptions should be based on individual circumstances and need.

X1.1.1 *Well-Graded Gravel with Sand (GW)*—About 75 % fine to coarse, hard, subangular gravel; about 25 % fine to coarse, hard, subangular sand; trace of fines; maximum size, 75 mm, brown, dry; no reaction with HCl.

X1.1.2 *Silty Sand with Gravel (SM)*—About 60 % predominantly fine sand; about 25 % silty fines with low plasticity, low dry strength, rapid dilatancy, and low toughness; about 15 % fine, hard, subrounded gravel, a few gravel-size particles fractured with hammer blow; maximum size, 25 mm; no reaction with HCl (Note—Field sample size smaller than recommended).

In-Place Conditions—Firm, stratified and contains lenses of silt 1 to 2 in. (25 to 50 mm) thick, moist, brown to gray; in-place density 106 lb/ft^3; in-place moisture 9 %.

X1.1.3 *Organic Soil (OL/OH)*—About 100 % fines with low plasticity, slow dilatancy, low dry strength, and low toughness; wet, dark brown, organic odor; weak reaction with HCl.

X1.1.4 *Silty Sand with Organic Fines (SM)*—About 75 % fine to coarse, hard, subangular reddish sand; about 25 % organic and silty dark brown nonplastic fines with no dry strength and slow dilatancy; wet; maximum size, coarse sand; weak reaction with HCl.

X1.1.5 *Poorly Graded Gravel with Silt, Sand, Cobbles and Boulders (GP-GM)*—About 75 % fine to coarse, hard, subrounded to subangular gravel; about 15 % fine, hard, subrounded to subangular sand; about 10 % silty nonplastic fines; moist, brown; no reaction with HCl; original field sample had about 5 % (by volume) hard, subrounded cobbles and a trace of hard, subrounded boulders, with a maximum dimension of 18 in. (450 mm).

X2. USING THE IDENTIFICATION PROCEDURE AS A DESCRIPTIVE SYSTEM FOR SHALE, CLAYSTONE, SHELLS, SLAG, CRUSHED ROCK, AND THE LIKE

X2.1 The identification procedure may be used as a descriptive system applied to materials that exist in-situ as shale, claystone, sandstone, siltstone, mudstone, etc., but convert to soils after field or laboratory processing (crushing, slaking, and the like).

X2.2 Materials such as shells, crushed rock, slag, and the like, should be identified as such. However, the procedures used in this practice for describing the particle size and plasticity characteristics may be used in the description of the material. If desired, an identification using a group name and symbol according to this practice may be assigned to aid in describing the material.

X2.3 The group symbol(s) and group names should be placed in quotation marks or noted with some type of distinguishing symbol. See examples.

X2.4 Examples of how group names and symbols can be incororated into a descriptive system for materials that are not naturally occurring soils are as follows:

X2.4.1 *Shale Chunks*—Retrieved as 2 to 4-in. (50 to 100-mm) pieces of shale from power auger hole, dry, brown, no reaction with HCl. After slaking in water for 24 h, material identified as "Sandy Lean Clay (CL)"; about 60 % fines with medium plasticity, high dry strength, no dilatancy, and medium toughness; about 35 % fine to medium, hard sand; about 5 % gravel-size pieces of shale.

X2.4.2 *Crushed Sandstone*—Product of commercial crushing operation; "Poorly Graded Sand with Silt (SP-SM)"; about 90 % fine to medium sand; about 10 % nonplastic fines; dry, reddish-brown, strong reaction with HCl.

X2.4.3 *Broken Shells*—About 60 % gravel-size broken shells; about 30 % sand and sand-size shell pieces; about 10 % fines; "Poorly Graded Gravel with Sand (GP)."

X2.4.4 *Crushed Rock*—Processed from gravel and cobbles in Pit No. 7; "Poorly Graded Gravel (GP)"; about 90 % fine, hard, angular gravel-size particles; about 10 % coarse, hard, angular sand-size particles; dry, tan; no reaction with HCl.

X3. SUGGESTED PROCEDURE FOR USING A BORDERLINE SYMBOL FOR SOILS WITH TWO POSSIBLE IDENTIFICATIONS.

X3.1 Since this practice is based on estimates of particle size distribution and plasticity characteristics, it may be difficult to clearly identify the soil as belonging to one category. To indicate that the soil may fall into one of two possible basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example: SC/CL or CL/CH.

X3.1.1 A borderline symbol may be used when the percentage of fines is estimated to be between 45 and 55 %. One symbol should be for a coarse-grained soil with fines and the other for a fine-grained soil. For example: GM/ML or CL/SC.

X3.1.2 A borderline symbol may be used when the percentage of sand and the percentage of gravel are estimated to be about the same. For example: GP/SP, SC/GC, GM/SM. It is practically impossible to have a soil that would have a borderline symbol of GW/SW.

X3.1.3 A borderline symbol may be used when the soil could be either well graded or poorly graded. For example: GW/GP, SW/SP.

X3.1.4 A borderline symbol may be used when the soil could either be a silt or a clay. For example: CL/ML, CH/MH, SC/SM.

X3.1.5 A borderline symbol may be used when a fine-grained soil has properties that indicate that it is at the boundary between a soil of low compressibility and a soil of high compressibility. For example: CL/CH, MH/ML.

X3.2 The order of the borderline symbols should reflect similarity to surrounding or adjacent soils. For example: soils in a borrow area have been identified as CH. One sample is considered to have a borderline symbol of CL and CH. To show similarity, the borderline symbol should be CH/CL.

X3.3 The group name for a soil with a borderline symbol should be the group name for the first symbol, except for:

CL/CH lean to fat clay
ML/CL clayey silt
CL/ML silty clay

X3.4 The use of a borderline symbol should not be used indiscriminately. Every effort shall be made to first place the soil into a single group.

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X4. SUGGESTED PROCEDURES FOR ESTIMATING THE PERCENTAGES OF GRAVEL, SAND, AND FINES IN A SOIL SAMPLE

X4.1 *Jar Method*—The relative percentage of coarse- and fine-grained material may be estimated by thoroughly shaking a mixture of soil and water in a test tube or jar, and then allowing the mixture to settle. The coarse particles will fall to the bottom and successively finer particles will be deposited with increasing time; the sand sizes will fall out of suspension in 20 to 30 s. The relative proportions can be estimated from the relative volume of each size separate. This method should be correlated to particle-size laboratory determinations.

X4.2 *Visual Method*—Mentally visualize the gravel size particles placed in a sack (or other container) or sacks. Then, do the same with the sand size particles and the fines. Then, mentally compare the number of sacks to estimate the percentage of plus No. 4 sieve size and minus No. 4 sieve size present. The percentages of sand and fines in the minus sieve size No. 4 material can then be estimated from the wash test (X4.3).

X4.3 *Wash Test (for relative percentages of sand and fines)*—Select and moisten enough minus No. 4 sieve size material to form a 1-in (25-mm) cube of soil. Cut the cube in half, set one-half to the side, and place the other half in a small dish. Wash and decant the fines out of the material in the dish until the wash water is clear and then compare the two samples and estimate the percentage of sand and fines. Remember that the percentage is based on weight, not volume. However, the volume comparison will provide a reasonable indication of grain size percentages.

X4.3.1 While washing, it may be necessary to break down lumps of fines with the finger to get the correct percentages.

APPENDIX B
HEALTH AND SAFETY PLAN

SENECA ARMY DEPOT
OB/OD GROUNDS
ROMULUS, NEW YORK

PREPARED BY: ____________________

APPROVED BY: ____________________
Health and Safety Officer

APPROVED BY: ____________________
Project Manager

1345-082-6228

OCTOBER 1991

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FINAL DRAFT

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of this Health and Safety Plan (HASP) is to establish personnel protection standards and mandatory safety practices and procedures for field investigation efforts. This plan assigns responsibilities, establishes standard operating procedures, and provides for contingencies that may arise during field investigations at the Seneca Army Depot OB/OD Grounds, Romulus, New York. This plan will be modified by Addenda to accommodate specific work plans and task specific and location specific hazards for the various site investigation activities. Addenda to this plan will incorporate data obtained during subsequent sampling.

The provisions of the plan are mandatory for all MAIN personnel engaged in on-site hazardous waste operations. Subcontractors working for MAIN must conform to this Health and Safety Plan unless they prepare and administer a plan with equivalent requirements. All MAIN and MAIN contract personnel who engage in project activities must be familiar with this plan and comply with its requirements; these personnel must sign-off on the Plan Acceptance Form (to be attached), which will be submitted to the MAIN Project Manager for retention in the project file. All personnel performing work under this plan must be trained and have a current medical examination in accordance with 29 CFR 1910.120.

1.2 PERSONNEL

All MAIN site personnel and MAIN subcontractors performing duties or working in areas where there is the potential for exposure to hazardous material will meet the training requirements of OSHA 29 CFR 1910.120 before working on-site. Site personnel and their duties are outlined below:

1. MAIN's Site Manager, responsible for all MAIN personnel and MAIN's subcontractors on-site and designates duties to the on-site personnel. The name of the Site Manager or, if the Site Manager is absent, the name of the acting Site Manager, shall be posted in the command post.

2. The Site Safety Officer is responsible for carrying out the provisions of this HASP with regard to site work, and will ensure that all personnel entering the site understand and adhere to the provisions of this plan and that personnel meet the training and

medical monitoring requirements of 29 CFR 1910.120. Any changes in the provisions of this HASP shall be made in writing by the Site Safety Officer and shall be approved by the Project Safety Officer or Corporate Health and Safety Officer. Any personnel protective equipment upgrades or downgrades shall be documented in writing by the Site Safety Officer. The Site Safety Officer shall have the authority to stop an operation or site work if, in the opinion of the Site Safety Officer, the site conditions or the manner in which the work is being conducted, presents a hazard to site personnel, surrounding populations, or the environment. The name of the Site Safety Officer or, if the Site Safety Officer is absent, the name of the Acting Site Safety Officer, shall be posted in the Command Post.

3. UXO personnel will be responsible for locating and identifying unexploded ordinance on the site and for clearing access pathways to sampling and work locations. UXO personnel shall not move or dispose of any UXO found. Disposal and demolition of UXO's will be perfomed by SEAD EOD personnel. Human Factors Associates (HFA) has been contracted to supply UXO personnel for the OB/OD grounds site work.

4. SEAD EOD personnel will be responsible for diposal and demolition of any UXO's found at the site.

5. The Site Safety Monitors are responsible for all air monitoring. Air monitoring requirements for the Seneca Site are set forth in Section 6.0 of the plan.

6. Field personnel will be involved in sampling, inspections, field monitoring, and decontamination, as specified in the HASP and the project sampling and work plan. These activities will be carried out in accordance with the QA/QC protocols in the Quality Assurance Project Plan (QAPP). Site personnel will only perform tasks for which they have received appropriate training.

Site visitors who are not affiliated with MAIN, MAIN's subcontractors, or Seneca Army Depot will not be allowed into active work areas without making arrangements with Seneca and MAIN well in advance of the planned visit. If no prior arrangements have been made, visitors will be allowed only into the command post and public areas.

Seneca Army Depot employees will be permitted into active work areas after presenting a letter addressed to MAIN's Site Safety Officer certifying they have passed a physical examination and are certified to wear the appropriate respiratory protective equipment.

All visitors will follow the advice and instructions of MAIN's Site Manager and Site Safety Officer. Failure to follow these instructions may endanger the health and safety of visitors and other on-site personnel.

2.0 SITE CHARACTERIZATION

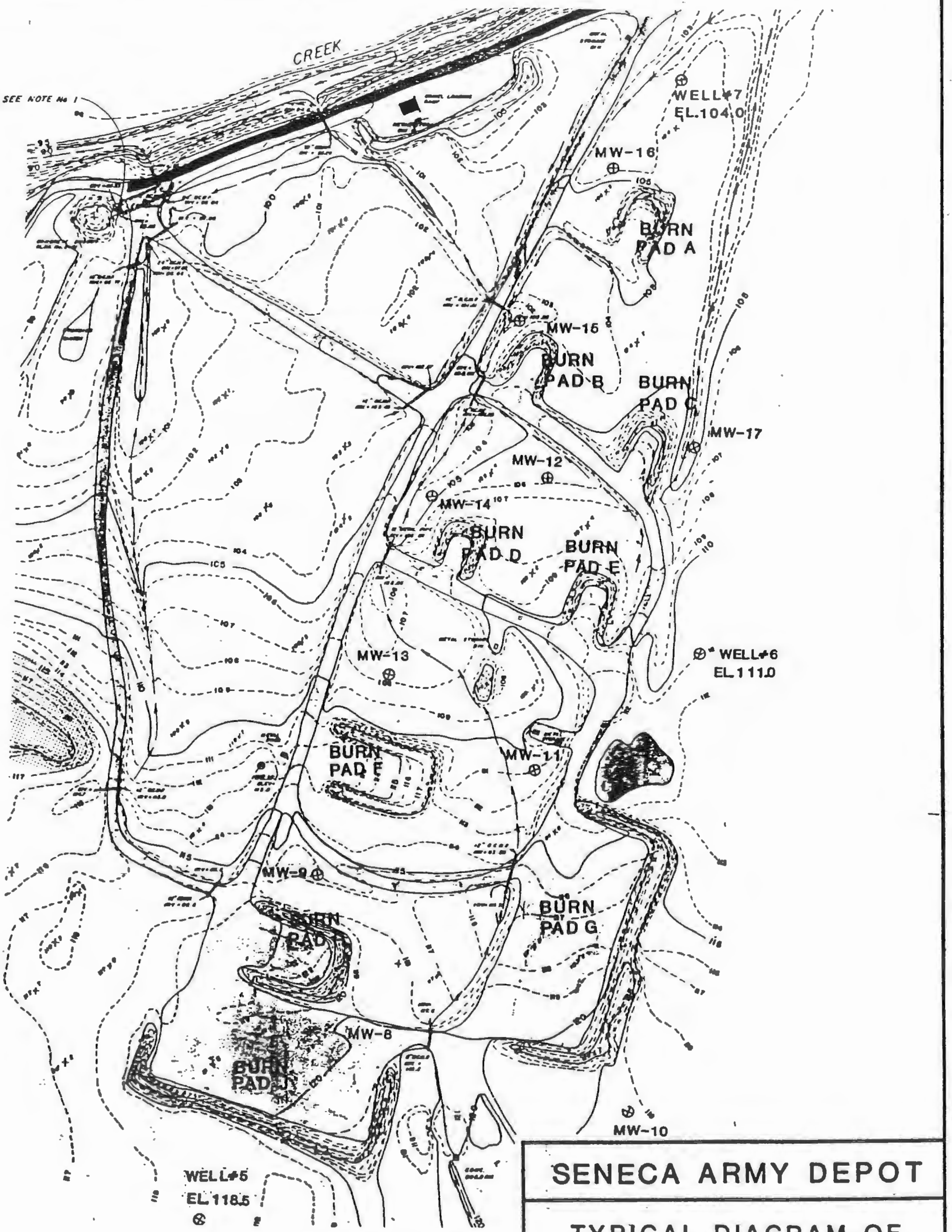
2.1. SITE HISTORY AND DESCRIPTION

The Seneca Army Depot, a 10,587 acre facility in Seneca County, Romulus, New York, has been owned by the United States Government and operated by the Department of the Army since 1941. Since its inception in 1941, SEAD's primary mission has been the receipt, storage, maintenance, and supply of military items. This function includes disposal of military ammunition and explosives by burning and detonation. The 90 acre demolition area, OB/OD grounds, encompasses a detonation area and nine (9) burning pads. These pads have been used for burning propellants, explosives and pyrotechnics (PEP). The practice of open burning on these pads was discontinued in 1985. Although open burning of PEP's have been discontinued, burning of PEP's is performed in an aboveground, welded, steel tray as described in Subpart X of the Seneca Army Depot's RCRA Part B permit. The 30 acres associated with the burning pads is the subject of this investigation, the adjoining 60 acres will continue to be used for ordnance disposal as a detonation ground. The OB/OD grounds are shown in Figure B-1.

Due to the previous open burning of PEP at the OB/OD grounds, there is very likely to be unexploded orndinance dispersed over the site as a result of the "kick-out" of materials during burning. Large portions of the site have not been surveyed for UXO's and no catalog of locations of UXO's is available. The presence of UXO's on the site presents a **EXTREMELY HAZARDOUS CONDITION.**

Several investigations have been conducted at the OB/OD grounds including:

1. Installation Assessment of Seneca Army Depot, Report No. 157, AMXTH-IR-A-157, January 1980; Conducted by the U.S. Army Toxic and Hazardous Materials Agency, (USATHMA).
2. Phase 2, Hazardous Waste Management Special Study: No. 39-26-0147-83, US Army Material Development and Readiness Command (DARCOM) Open-Burning/Open Detonation Grounds Evaluation, 1983.
3. O'Brien and Gere Engineers, Burning Pads B and H Closure, 1985
4. Phase 4 Evaluation of the Opening Burning/Open Detonation Grounds. Investigation of Soil Contamination, 1984; Conducted by the US Army Environmental Hygiene Agency, USAEHA.



SENECA ARMY DEPOT

TYPICAL DIAGRAM OF SITE WORK ZONES

FIGURE B-1

MAIN 1893

5. Evaluation of Solid Waste Management Units, Seneca Army Depot, Interim Final Report, Groundwater Contamination Survey No. 38-26-0868-88, 1988; Conducted by USAEHA.
6. Metcalf & Eddy, Criteria Development Report for Closure of Nine Burning Pads, 1989.

The initial Installation Assessment of the Seneca Army Depot consisted of a review of existing documents and initial site investigations of potential areas of concern (AOC). The findings of the study were: 1) geological conditions are such that contaminants, if present, could migrate in surface or subsurface waters; and 2) the demolition/burning ground is potentially contaminated with heavy metals and explosives.

The DARCOM Open Burning/Open Detonation Ground Evaluation was begun in 1981. Seven (7) groundwater monitoring wells (MW-1 thru MW-7) were installed in 1981. Six (6) monitoring wells were installed along the perimeter of the site. One well, MW-1, was located between the detonation ground and the burn pads. The wells were screened in the glacial till at, or just above, the till-shale (bedrock) contact. Wells MW-1 and MW-7 exceeded iron standards on three occassions and wells MW-5, 6, and 7 (around the OB grounds) exceeded manganese standards. Monitoring of these original wells continued on an annual basis through 1987 for explosives, metals, TOC, TOX, pH, pesticides, nitrates, and specific conductivity.

The Phase II study (No. 39-26-0147-83), was performed in 1982 in order to characterize total explosive and metal content in soils and residues. The study included 24 soil samples from 0-6 inches, from burn pads B through H. Pads A and J were not sampled. Pad B was found to contain Ba (to 508 ppm) in excess of EP Toxicity standards (100 ppm). Pad H exceeded the standard for lead (24.6 ppm, standard 5ppm). Pad F had one soil sample containing 9,270 ppm (0.9%) 2,4,6-TNT.

O'Brien & Gere Engineers, Inc. were contracted in 1984 to review previous studies and recommend procedures for the closure of Burning Pads B and H. A magnetics survey conducted to as a part of this study indicated high anomolies at the pad berms. Pad B has moderate magnetic anomolies in the northwest berms and in the southern berms. Pad H has a magnetic anomoly extending from the pad to the south. This study did not include the remaining seven (7) pads.

During 1984, the U.S. Army Environmental Hygiene Agency conducted an additional investigation of the soils at Burn Pads B, F, and H (Phase 4 Evaluation, Hazardous Waste Study No. 37-26-0479-85, USAEHA). Presumably, Pad F was included for further investigation along with Pad B and H due to the high concentration of 2,4,6-TNT, (0.9%), obtained in one sample.

Soils at Pad B were found to contain Pb (101 ppm) and Ba (424 ppm) values in excess of the EP Toxicity limits of 5 ppm and 100 ppm. Pad F has one soil sample (Pb 10.7 ppm) exceeding the standards for lead, (5 ppm) and one sample which contained 0.9% 2,4,6 TNT. Pad H had one sample (Pb, 5.64 ppm) which exceeded lead standards and detected small amounts of 2,6-DNT and 2,4-DNT. Borehole water samples contained lead concentrations up to 112 ppb at Pad F which exceed the 25 ppb NY State groundwater standards for lead. Near Pad B approximately two quarts of 50mm tracer bullets were removed during the boring operations. (All the borings were done with remote boring equipment.)

Additional studies conducted in 1989 by Metcalf and Eddy Engineers (M&E) included two (2) types of geophysical surveys to site monitoring wells and the installation of ten (10) additional monitoring wells.

The magnetic and EM geophysical survey data indicated that metallics were not generally dispersed from the pads with the exception of an area between Pads D and E.

Well samples collected for EP Toxicity metals and explosive analysis contained no metals or explosives greater than established criteria. While several of the previous six wells had elevated metals, this was attributed to poor well development as evidenced by water turbidity.

2.2 PLANNED SITE ACTIVITIES

The field activities at the Seneca site consist of five basic tasks: geophysical surveying including UXO detection and removal, soil sampling, monitoring well development and sampling, surface water and sediment sampling, and biological sampling.

2.3 HAZARD EVALUATION

The chemical and physical hazards which may be encountered at the Seneca site are described below.

2.3.1 Exposure Potential

The primary sources of exposure at the Seneca site will be the surface and subsurface soils at the burn pads. These are heavily contaminated with metals and explosives. The exposure potential for each of the planned site activities is described below.

Geophysical Monitoring and UXO Detection and Removal - The geophysical monitoring is non-intrusive and generally has a low exposure potential. There is some potential for exposure to metal and explosive contaminated surface soils, mostly at the burn pads, but also across the entire 30-acre site. Several types of geophysical techniques will be used to detect the presence of UXO's and buried trenches which may contain UXO's. Once detected, these areas will be flagged and the high anomalies will be removed by qualified UXO trained demolition experts. There are high risks associated with these operation due to premature detonation. UXO handling procedures are described in Section 9.

Soil Sampling - The primary route of exposure during the soil sampling will be through contact with metal and explosive contaminated soil. There is also potential inhalation exposure during drilling. There is also the potential explosive situation due to unexploded ordnance. This risk will be minimized by a prior clearing of boring locations and by implementing a remote drilling program. The overall exposure potential for soil sampling is moderate due to remote drilling procedures. There is a high potential for direct contact with contaminated soils.

Sediment Sampling - The primary route of potential exposure during sediment sampling is through contact with contaminated sediments and surface waters. There is some potential for exposure to volatile contaminants which may be contained in the sediments. The exposure potential for fugitive dusts is low, since the handled sediments will be wet and will not produce dusts.

Monitoring Well Development and Sampling - The exposure potential for the monitoring well development and sampling is similar to that of soil sampling. There will be no additional monitoring wells installed so remote drilling and UXO hazards are decreased. There is potential contact exposure to contaminated groundwater, particularly, during well development.

Surface Water Sampling - The exposure potential for the surface water sampling to be conducted at the Seneca site is low. The waters to be sampled are primarily stream waters not expected to contain high levels of contaminants. There are water sources on-site such as drainage swales and pooled water within the burning grounds that may contain higher levels. There is some potential for contact exposure to dissolved metals and explosives in surface water.

Berm Excavation - Shallow excavations will be dug in the burn pad berms to collect soil samples. There is a medium potential for UXO dentonation during the excavation. The area to be sampled will be cleared by UXO personnel after the excavation and prior to the collection of the samples. During the sampling there is a modearte potential for contact exposure to metals and explosive compound contaminated soils.

Biological Sampling - The primary route of potential exposure during biological sampling at the Seneca site is the same as that for surface water and sediment sampling. There is also a small potential exposure during direct contact with biological samples that may be contaminated.

2.3.2 Chemical Hazards

A large number of compounds have been detected in previous soil and groundwater investigations at the Seneca OB/OD Grounds. Most of these compounds are heavy metals and explosives. A list of compounds included in the hazard evaluation was obtained from the results of the previous investigation.

The following is a summary of the toxic effects of these compounds. Exposure limits and physical properties are given in Table B-1 and in the Chemical Hazard Evaluation Sheets contained in Attachment A.

Arsenic - Arsenic becomes a skin irritant with prolonged exposure: moist areas of the skin; respiratory mucosa; angles of eyes, ears, nose, and mouth; and the wrists being common sites of irritation. Acute exposure symptoms include abdominal pain, vomiting, and watery diarrhea followed by shock due to fluid loss. Acute inhalation exposure can cause chest pain, coughing, giddiness, and general weakness which precede gastrointestinal symptoms. Symptoms of chronic inhalation exposure proceed in three phases. Initial symptoms are weakness, loss of appetite, occasional nausea and vomiting, and some diarrhea. The second phase consists primarily of irritant effects of

TABLE B-1

PERMISSIBLE EXPOSURE LIMITS FOR COMPOUNDS DETECTED AT SENECA OB/OD GROUNDS, ROMULUS, NEW YORK

		PEL (1)(mg/m3)	Carcinogenic Rating(2)
Metals	Arsenic	0.01	A
	Barium	0.5	--
	Cadmium	0.2	B1
	Chromium	0.1	A
	Copper	1.0	--
	Lead	0.05	B2
	Mercury	0.1	--
	Nickel	1.0	--
	Selenium	0.2	--
Explosives	HMX		--
	RDX		C
	2,4,6 TNT	1.5	(3)
	2,6 DNT	1.5	B2
	2,4 DNT	1.5	B2

Notes:

(1) OSHA permissible exposure limits. For metals, PEL shown is lowest of compounds listed for that element.

(2) EPA weight of evidence ratings for each compounds.

- A Confirmed human carcinogen
- B1 Probable confirmed human carcinogen. Limited human evidence.
- B2 Probable confirmed human carcinogen. Sufficient animal evidence.
- C Possible Human Carcinogen, Limited Animal Evidence
- -- No data or carcinogenic rating not determined.

(3) Substance identified as suspected or confirmed human carcinogen by agency other than USEPA.

the eyes, nose, and respiratory passages, with perforation of the nasal septum common, and allergic reactions of the skin. The third phase consists of peripheral neural effects, usually numbness. Arsenic has been causally associated with skin cancer and implicated in increases in the incidence of lung cancer.

<u>Barium</u> - Barium and its compounds are highly toxic. Acute symptoms are excessive salivation; vomiting; colic; diarrhea; convulsive tremors; slow, hard pulse; and elevated blood pressure. Bleeding in the stomach, intestines, and kidneys may occur. Chronic exposure results in enlargement of the liver and spleen, and increases in white blood cell counts. Barium has been found to produce lung cancer in rats.

<u>Cadmium</u> - Cadmium compounds induce vomiting at low oral doses and systemic oral poisoning is rare. Acute exposure can occur by inhalation, producing irritation in the respiratory tract followed hours later by coughing, chest pain, sweating and chills and, later, general weakness, severe respiratory irritation, and fluid build up in the lungs. These symptoms can lead to emphysema or death. Chronic exposure can lead to emphysema, kidney damage, and possible heart and blood pressure effects. Animal studies have shown cadmium to produce cancer, birth defects, testicular atrophy, and liver and nerve damage. Some studies in man have shown an association of cadmium exposure with cancers of the prostate and kidney.

<u>Chromium</u> - Chromium compounds can act as allergens, resulting in local irritation of the skin and respiratory tract. Systemic effects are generally a result of the irritating properties of chromium compounds on the eyes, nose, and respiratory tracts. Chromium compounds has been shown to be carcinogenic in rats and has been associated with increases in lung cancer in humans. The irritant and carcinogenic effects differ widely for various compounds of chromium.

<u>Copper</u> - Copper is a soft, heavy metal which occurs naturally as a variety of salts, as well as in the pure metallic form. Copper is an essential trace element in humans and animals. Copper salts are irritating to the skin and cause itching, erythema, and dermatitis. They may cause conjunctivitis, ulceration and clouding of the cornea. Metallic copper can cause keratinization of the hands and soles of the feet. Inhalation of copper fumes can cause congestion of the nasal mucous membranes and perforation of the septum. Ingestion causes irritation of the gastrointestinal tract, producing nausea, vomiting, gastritis, and diarrhea. If vomiting fails to occur, gradual absorption from the bowel may cause systemic poisoning. The systemic effects of copper include

capillary damage, kidney and liver damage, and excitation followed by depression. Jaundice and hemolytic anemia can also occur following acute poisoning.

Lead - Lead has no local toxic effects. Systemic poisoning symptoms are non-specific: fatigue, headache, poor sleeping, aching bones and muscles, constipation, abdominal pains, and decreased appetite. All these symptoms are reversible with time away from exposure. Continued exposure results in anemia, pallor, "lead line" on the gums, and decreased hand grip strength. Lead also has central nervous systems effects and has been implicated in producing learning deficiencies in exposed children. Compounds of lead display a variety of toxic effects that are more specific to the compound than to lead. Some of these compounds have been found to be carcinogenic in experimental animals.

Mercury - Mercury is a local irritant of skin and mucous membranes any may be a skin sensitizer in some people. Acute poisoning symptoms are generally irritant: acute inhalation exposure results in inflammation of the lung and bronchioles. Chronic exposure sysmptoms are non-specific: weight loss, appetite loss, memory loss, insomnia, indigestion, weakness, metallic taste in mouth, tremors in eyelids, fingers, lips, or tongue, and loosening of teeth. Symptoms may vary among individuals. Long-term or high dose exposures can produce irritability, delirium, anxiety, or manic depressive psychosis.

Nickel - Dermal exposure to nickel and nickel compounds results in contact dermatitus and chronic exzema. Nickel and its compounds are also irritants to the conjunctiva of the eye and mucous membranes of the upper respiratory tract. Chronic exposure to elemental nickel and its salts may result in lung and nasal passage cancer. Effects are also seen on the heart, muscles, brain, and kidney.

Selenuim - Selenuim and various selenium compounds can effect the body if inhaled, if they come into contact with the eyes or skin, or if swallowed. Selenium compounds if inhaled in large quantities can cause severe breathing difficulties. Skin contact can cause burns or rashes. Long-term exposure can cause paleness, stomach disorders, coated tongue, and nervousness. Fluid in the abdominal cavity, damage to the liver and spleen have been reported in animals.

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HMX - The chemical name of HMX is octahydro-1,3,5,7 -tetranitro -1,3,5,7 - tetrayocine. Considered a poison by ingestion or intravenous injection, HMX remains an explosive of concern to many industries who handle this compound. At high temperatures, HMX decomposes violently and emits toxic fumes of NOX.

RDX - The chemical name of RDX is hexahydro-1,3,5 -trimethyl -1,3,5 -triazine. The solubility of RDX in water at 18° was found to be 44.7 ppm and hydrolysis is slow. RDX is a corrosive irritant to the skin, eyes and mucous membranes. Experimental reproductive abnormalities and epileptiform convulsions from exposure have been reported. It is one of the most powerful high explosives in use today. RDX has more shattering power than TNT and is often mixed with TNT as a bursting charge for aerial bombs, mines and torpedoes. When heated to decomposition it emits toxic fumes of NO_x.

2,4,6-TNT - The chemical name of 2,4,6-TNT is 2,4,6-TRINITROTOLUNE. It is not been known to undergo hydrolysis in the environment. Symptoms of exposure to TNT are sneezing, coughing, sore throat, and muscle pain. TNT effets the blood, liver kidneys, skin, central nervous system, and cardiovascular system. Human systemic effects when ingested include: hallucinations, cyanosis, and gastrointestinal changes. Experimental reproductive abnormalities and mutagenic data have been reported. This chemical has been classified as a skin irritant and has been implicated in aplastic anemia. TNT can cause headaches, weakness, anemia, liver injury and may be absorbed through the skin. TNT is flammable or explosive when exposed to heat or flame.

Moderate explosion hazard; will detonate under strong shock. It is a comparitively insensitive explosive, however, sudden heating of any quantity will cause detonation.

2,6-DNT - The chemical name of 2,6-DNT is 2,6-dinitrotoluene. It is not expected to hydrolyze under normal environmental conditions. NIOSH recommends to reduce exposure to DNT to the lowest levels possible. Experimental testing of 2,6-DNT has shown it to be more active as a liver carcinogen than 2,4-DNT isomer. The major target organs are the blood, liver, and central nervous system. Symptoms of exposure include anoxia, cyanos, anemia, and jaundice.

2,4-DNT - The chemical name of 2,4-DNT is 2,6-dinitrotoluene. It is not expected to hydrolyze under normal environmental conditions. 2,4-DNT is poisonous if swallowed or injected subcutaneously. It has been shown to be carcinogenic, teratogenic, and mutagenic in experimental tests. 2,4-DNT can cause anemia, methemoglobinemia, cyanosis, and liver damage. The chemical will combust when exposed to heat or flame; can react with oxidizing materials. There have been cases of explosion during manufacture and storage and mixture with nitric acid is a high explosive. Other mixtures such as alkalies can cause a significant increase in pressure. When heated to decomposition it emits toxic fumes of NO_x.

2.3.3 Physical Hazards

Due to the previous open burning of PEP at the OB/OD grounds, there is very likely to be unexploded ordinance dispersed over the site as a result of the "kick-out" of materials during burning. Large portions of the site have not been surveyed for UXO's and no catalog of locations of UXO's is available. The presence of UXO's on the site presents a **EXTREMELY HAZARDOUS CONDITION.**

Human Factors Associates (HFA) personnel trained in the discovery and handling of UXO's shall perform all UXO clearance for the OB/OD grounds. Cleared pathways and work areas shall be marked with red "DANGER" tape.

When working in cleared areas, the work crews and equipment shall be positioned such that the chance for accidental movement into uncleared areas is minimized. Equipment shall be placed so as not to impede emergency escape and evacuation along the cleared pathways.

Cleared roads and pathways shall be marked. **ON-SITE WORKERS SHALL NOT STRAY FROM THE CLEARED PATHWAYS AND ROAD!** UXO's found on the site may have been subjected to stresses which render them very unstable and the UXO's may dentonate with even very slight disturbance. **ON-SITE WORKERS SHALL NOT TOUCH, KICK, OR OTHERWISE DISTURB ANY MATERIALS ON-SITE WHICH MAY BE UXO's.**

Other than the presence of UXO's, the principle physical hazards at the Seneca site involve working around heavy equipment, site terrain, and site debris.

Terrain hazards include marshy areas, areas of rough terrain, and areas of protruding debris. In areas where access is difficult or hazardous, access paths shall be cleared and maintained, and movement through these areas shall be along the access paths.

Activities on-site will include:

1. Site visits;
2. Geophysical surveys;
3. Unexploded ordinance detection and removal;
4. Soil boring and sampling;
5. Surface water and sediment sampling, and;
6. Biological sampling.

Hazards associated with these activities are varied and include vehicle/pedestrian collisions; fire; contact or crushing injuries resulting from materials handling and equipment operations; unexploded ordinance contact; abrasions, contusions, lacerations, etc. resulting from use of power tools; and elevated noise levels. The potential for such hazards necessitates that all onsite personnel wear appropriate protective clothing, including coveralls, gloves, eye and face protection, safety boots, and hard hats.

2.3.3.1 Motor Vehicles and Motorized Equipment

All motor vehicles will be maintained in a safe operating condition and in accordance with local and state safety requirements. All vehicles and moving equipment will be operated on-sites and en route to and from sites in accordance with state and local motor vehicle regulations for speed, lights and warnings, passenger carrying, and operation. If any equipment is left unattended at night adjacent to a highway in use, it will be provided with suitable barricading, lighting, reflectors, or other suitable visual warnings to identify its location.

Any mobile equipment, including drilling rigs, earth-moving machinery, or other similar types of equipment, will be operated in strict compliance with the manufacturer's instructions, specficiations, and limitations, as well as any applicable regulations. The operator is responsible for inspecting the equipment daily to assure that it is functioning properly and safely. This inspection will include all parts subject to faster than normal wear and all lubrication points.

Hand and audible (horn) signals to equipment operators will be the commonly accepted industry standard signals for the type of equipment being used. All signals will be reviewed by the operator and signaller before work begins. Only one person will signal the equipment operator at any given time.

When equipment with moving booms, arms, or masts is operated near overhead hazards, the operator, with assistance from the designated signaling person, will assure that the moving parts of the equipment maintain safe vertical and horizontal clearances to the hazards. Moving booms, arms, or masts will be lowered and secured prior to being moved from one location to another, even on the same site, Equipment will be kept at least 10 feet (ft) away from energized electrical lines rated up to 50 kilo volts (kV) and 16 ft away from lines rated over 50 and up to 750 kV.

Drill rigs and other equipment not specifically designed to move with the boom, mast, or arm elevated will be returned to traveling position and condition before being moved. Movement through the depot facility shall be along established roads. All site equipment will be inspected before each use to ensure that it is in proper working order. Any equipment found to be unsafe shall be repaired or taken out of service.

2.3.4 Heat Stress

Site work at Seneca will occur during the summer and early fall months and heat stress is a serious concern. Heat stress monitoring for employees wearing protective clothing will be conducted whenever the temperature is above 60°F. For employees not wearing protective clothing, heat stress monitoring will be conducted when the temperature is above 80°F. Pulse rate and oral temperature measured at the end of each work period will be used to monitor heat stress in on-site employees. Heat stress monitoring procedures are described in Appendix B, Standard Operating Procedures for Emergencies Due to Heat and Heat Stress Monitoring.

2.3.5 Cold Stress

Site work at Seneca may be conducted during cold weather. Cold stress monitoring for employees working outdoors will be conducted. Two factors influence the development of a cold injury: ambient temperature and wind velocity. Cold stress monitoring will be conducted when temperatures are below 4°C (40°F). Cold stress monitoring procedures are described in Attachment B, Standard Operating Procedures for Emergencies Due to Cold and Cold Stress Monitoring.

3.0 HEALTH AND SAFETY TRAINING

All site workers involved in hazardous work have met the training requirements set forth in 29 CFR 1910.120(e). All employees engaged in hazardous waste site work have received 40 hours of training in hazardous waste site operations and safety procedures. Written certification of this training will be provided as an attachment to the HASP. This training has been followed by 3 days of supervised on-site experience. Employees performing hazardous waste work prior to March 1987, who received initial training that was standard at that time, are assumed to satisfy 29 CFR 1910.120 as a result of training and experience.

Supervisors and site managers have received an additional 8 hours of specialized training on the safe management of site operations. All employees have received annual updated training. Additional training has been provided to those employees designated to respond to site emergencies. Additional training will be provided to those employees who may be exposed to unique or special hazards at the site.

On-site safety training will consist of a detailed safety meeting and training session prior to the beginning of any field work. This meeting will cover all site activities and will also review the site emergency response plan. All site workers and managers are required to attend this meeting. Other topics to be discussed will include donning and doffing of personnel protective equipment as well as a brief toxicological review of site-specific known and suspected contaminants.

Daily safety meetings will also be conducted prior to each day's activities. These meetings will cover the safety measures to be employed during that day's activities and the emergency response and evacuation procedures for each work site and work crew.

On-site training will be documented using the form contained in Attachment C, On-Site Documentation Forms.

3.1 INITIAL SITE TRAINING

Initial site training shall consist of a review of this site specific HASP and shall cover the following topics.

- Site Personnel and Duties
- Site Description
- Site Characterization
- Chemical and Physical Hazard Evaluation
- Toxicological Information
- Heat Stress and Cold Stress
- Site Layout, Site Control Measures, and Work Zones
- Personnel Protective Equipment
- Air Monitoring
- Safe Working Practices and Engineering Controls
- Decontamination Procedures
- Emergency Response Plan
- On-site Emergency Plan
- Off-site Emergency Plan
- Evacuation Procedures
- Safe Distances and Places of Refuge
- Emergency Decontamination
- Emergency and Personnel Protective Equipment
- Emergency Telephone Numbers
- Directions to Hospital
- Medical Surveillance Requirements
- Health and Safety Training

HFA will provide site specific basic UXO Recognition and Avoidance Training. The following areas will be included:

1. Basic UXO and UXO component recognition training
2. UXO avoidance and reporting procedures
3. Specific hazards related to UXOs
4. UXO emergency procedures
5. Emergency medical care related to UXOs

3.2 SAFETY BRIEFINGS

Safety briefings shall be conducted at least weekly and at the beginning of new operations, changes in site conditions, and changes in operating procedures due to weather, new equipment, or additional site information.

The topics covered in the safety briefings will include, as appropriate:

- Evacuation routes and emergency procedures
- Use of additional protective equipment
- Terrain hazards
- Weather hazards
- New chemical or toxicological information
- Periodic review of portions of the site specific HASP
- Review of site incidents, follow-up, and corrective measures.

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4.0 MEDICAL SURVEILLANCE

All personnel involved in hazardous work on the site will be participating in a medical surveillance program which meets the criteria set forth in OSHA 29 CFR Part 1910.120. This rule requires that employees engaged in hazardous waste site work receive a medical examination at least annually, and they be certified by the examining physician to wear a respirator without restrictions. All subcontractors involved in hazardous work must certify to MAIN that all site workers meet the above criteria. Written certification of completion of medical exams for designated project employees will be provided as a separate attachment of this HASP.

Employees of Seneca Army Depot (SEAD) who will be performing activities in active work areas at the OB/OD grounds will be required to participate in SEAD's medical surveillance program for respirator use.

4.1 PHYSICAL EXAMINATIONS

Employees receive physical exams annually and at the time of termination from MAIN or reassignment from the Hazardous Work Assignments.

Personnel who are significantly exposed to hazardous materials may require special exams. The need for these tests will be determined by the attending physician after consulting with supervisors and health and safety personnel. Provisions will be made to repeat tests when necessary.

Physical exams will be conducted by or under the direct supervision of a licensed physician or a medical consultant who is Board Certified or Board Eligible in Occupation or Aerospace Medicine by the American Board of Preventive Medicine, Inc. with at least three years of experience in occupational medicine.

The examining physician will furnish MAIN's Health and Safety Officer with an oral report and indicate any adverse effects. A written report will follow. The physician is instructed, however, to reveal any specific findings or diagnoses unrelated to occupational exposure to the employee or the employee's designee only.

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Medical records for MAIN personnel are kept on file by MAIN for at least 30 years plus the length of employment. Medical monitoring for MAIN employees is the responsibility of MAIN, and MAIN will bear the entire cost.

5.0 SITE LAYOUT AND CONTROL MEASURES

5.1 UNEXPLODED ORDINANCE CLEARANCE

The OB/OD grounds are known to contain various types of unexploded ordinance (UXO). All movement on the site shall be along cleared roads and pathways. Cleared roads and pathways shall be marked. **ON-SITE WORKERS SHALL NOT STRAY FROM THE CLEARED PATHWAYS AND ROAD!** UXO's found on the site may have been subjected to stresses which render them very unstable and the UXO's may dentonate with even very slight disturbance. **ON-SITE WORKERS SHALL NOT TOUCH, KICK, OR OTHERWISE DISTURB ANY MATERIALS ON-SITE WHICH MAY BE UXO's.**

Human Factors Associates (HFA) personnel trained in the discovery and handling of UXO's shall perform all UXO clearance for the OB/OD grounds. Cleared pathways and work areas shall be marked with red "DANGER" tape.

When working in cleared areas, the work crews and equipment shall be positioned such that the chance for accidental movement into uncleared areas is minimized. Equipment shall be placed so as not to impede emergency escape and evacuation along the cleared pathways.

5.2 WORK ZONES

The support zone and command post for the field work at the OB/OD site will consist of an office trailer and storage areas. The location of the support zone will be determined prior to the commencement of the field work.

The main decontamination facilities for equipment and personnel will be located adjacent to the support zone. These facilities will be used for vehicle and heavy equipment decontamination and for personnel decontamination and personal hygiene facilities. Temporary decontamination facilities will be set up at the individual burn pads as necessary.

Exclusion zones will be set up at individual work locations when necessary. Generally, exclusion zones will include all on-site areas beyond the areas flagged by HFA personnel as cleared of UXO's. Additionally, exclusion zones will be set up for drilling and other fixed locations. The exclusion zone will consist of a 50-foot buffer around all sides of the drill rig, marked by barrier tape or fencing. If surface contamination is not suspected in the area and none is created as a result of the operations, the exclusion zone barriers will be removed.

If surface contamination is created or suspected as a result of the operations, an exclusion zone will be defined around the suspected surface contamination until the problem has been mitigated. Drilling will be performed by remote operations on the burn pads as a safety measure for unexploded ordnances.

Mobile operations, such as sediment sampling and geophysical surveying, will not have defined exclusion zones.

5.3 UTILITIES CLEARANCE

Facility maps will be obtained and consulted prior to commencing any intrusive work. Borehole sites will be positioned accordingly, marked with wooden stakes, and then cleared with SEAD. Drilling is to be done at the marked, cleared locations only.

5.4 SITE CONTROL

Seneca is responsible for overall site security. All MAIN personnel and subcontractors and all equipment to be used in the field investigation shall be logged in each day at the command post prior to proceeding to other areas of the site. All persons other than work crews wishing to enter the active work areas shall first sign in at the command post.

5.5 SITE COMMUNICATIONS

Routine site communications will be maintained between all work crews and the support zone with two-way radios. On-site emergency communications will be maintained by the use of air horns. Details of the emergency communications are contained in the Emergency Response Plan in Section 11.0 of this HASP.

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6.0 MONITORING

6.1 GENERAL

Standard Operating Procedures for the calibration and operation of all monitoring instruments and copies of the operating manuals for these instruments will be kept in the command post. Instruments will be field calibrated daily (each day the instrument is used). Instruments will be calibration checked a minimum of twice daily, before and after use. Calibration log sheets will be kept for each instrument and will become part of the permanent file. A copy of a calibration log sheet is contained in Attachment C, On-Site Documentation Forms.

Instruments will be kept on charge whenever not in use. All monitoring and instrument calibration will be done by persons who have been trained in the use of the equipment.

6.2 ON-SITE MONITORING

All site work which breaks the ground surface will be monitored, at a minimum, with an O_2 meter/explosimeter and an organic vapor monitor (HNu photoionization detector (PID) equipped with a 10.2 cV lamp, or OVA flame ionization detector (FID)). Instrument settings on all direct reading air monitoring instruments will be set on the most sensitive scale (i.e., OVA: X1; HNu: 0-20 ppm) unless a reading is detected. The action levels for changes in personnel protective equipment and personnel actions are given in Table B-2, Action Levels for Changes in Respiratory Protection. The action levels specified for the HNu and OVA may be increased or decreased if air sample analysis (GC or GC/MS) results indicate a greater or lesser degree of hazard for the given HNu and OVA readings. Any changes in the action levels will be documented in writing by the Site Safety Officer and approved by the Project Safety Officer or the Corporate Health and Safety Officer.

Monitoring of airborne particulates will be conducted in areas where surface contamination is expected to be high. Aerosol monitoring will be performed with an MIE Mini-Ram.

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TABLE B-2
ACTION LEVELS FOR CHANGES IN RESPIRATORY PROTECTION AND SITE EVACUATION

LEVEL OF PROTECTION/ACTION TAKEN

INSTRUMENT	LEVEL D	LEVEL C	LEVEL B	PROCEED WITH CAUTION	EVACUATE SITE
HNU (ppm)	BKGD	< 5	< 500		> 500
OVA (ppm)	BKGD	< 5	< 500		> 500
OXYGEN (%)	19.5 - 23	19.5 - 23	< 19.5		> 23
LOWER EXPLOSIVE LIMIT (%)	< 10	< 10	<10	10<LEL<25	> 25
RADIATION METER (mR/HR)	< 0.5	< 0.5	< 0.5	0.5<mR<5	> 5
AEROSOL MONITOR (mg/m3)	< 1.0	< 10	< 50		> 50

6.3 ACTION LEVELS AND RESPIRATORY PROTECTION

Action levels for all instruments are given in Table B-2. Action Levels for Changes in Respiratory Protection. When an action level is equalled or exceeded, immediately shut down the operation and evacuate the work area. Allow the levels to stabilize and reenter the work area to make a measurement. Restart work if levels are below the action levels. If the action level remains exceeded, re-assess the situation. Upgrade personnel protective equipment (PPE) prior to reentry of the area.

Periodic measurements will be made for total VOC's at the work face (e.g., top of well, drill cuttings, excavation spoils). If the total VOC levels at the work force are higher than action level but ambient levels are below action levels, proceed carefully and monitor more frequently. If total VOC's at the work face exceed 10 times the ambient air action level, upgrade personnel protective equipment.

6.4 WIND DIRECTION INDICATOR

A wind direction indicator will be erected at every active work site. This will enable the site safety monitor and on-site personnel to determine upwind locations necessary for proper health and safety procedure implementation and, if necessary, evacuation procedures. The wind direction indicator will simply be a flag or length of flagging tape that will allow on-site personnel to determine wind direction visually. There are no plans to have an anemometer on-site.

7.0 PERSONNEL PROTECTIVE EQUIPMENT

The selection and use of personnel protective equipment at the Seneca site will be in accordance with MAIN's Personnel Protective Equipment Program, contained in Attachment D, Chas. T. Main's Personnel Protective Equipment Program. The unknown nature of hazardous waste site work and the possibility of changing conditions during the conduct of the work may require changes in the personnel protective equipment. When changes in personnel protective equipment become necessary, these changes shall be made in accordance with the action levels and criteria set forth in this plan and according to the established procedures contained in MAIN's Personnel Protective Equipment Program.

Routine site work at the Seneca site will be performed in Level D protection, augmented with overboots, inner surgical gloves, and chemical-resistant outer gloves. Level C respiratory protection with organic vapor/acid gas cartridges will be carried by all work crews to be donned when air monitoring indicates the need for respiratory protection. Required equipment for Levels B, C, and D are detailed in Table B-3, Description of Personnel Protective Equipment and Levels of Protection.

The HNu photoionization detector (PID) will be the primary instrument for determining contaminant concentrations which may trigger a change in respiratory protection. Level C Protection wil be worn in situations where inhalation of fugitive dust containing metals or explosives is determined to be present in high levels. Action levels for changes in personnel protection equipment are shown in Table B-2.

In the event that personnel protective equipment (PPE) is ripped or torn, work shall stop and PPE shall be removed and replaced as soon as possible.

The minimum levels of protection required for specific site tasks and specific locations will be specified in the Task Specific Safe Operating Guidelines. The minimum levels of protection to be worn and the equipment which shall be available for general site tasks are shown in Table B-4, Minimum Levels of Protection and Available Protection.

TABLE B-3
DESCRIPTION OF PERSONAL PROTECTIVE EQUIPMENT AND LEVELS OF PROTECTION

LEVEL D	HARD HAT EYE PROTECTION - SAFETY GOGGLES, GLASSES, OR FACE SHIELD SAFETY SHOES - STEEL TOE, LEATHER [or] SAFETY BOOTS - STEEL TOE, NEOPRENE
LEVEL C	LEVEL D PROTECTIVE EQUIPMENT PLUS: RESPIRATORY PROTECTION - FULL FACEPIECE RESPIRATOR, CARTRIDGE OR CANISTER SKIN PROTECTION - HOODED POLY-COATED TYVEK OR SARANEX COVERALL* INNER LATEX GLOVES* OUTER NEOPRENE GLOVES* NEOPRENE BOOT COVERS*
LEVEL B	LEVEL C PROTECTIVE EQUIPMENT EXCEPT FOR: RESPIRATORY PROTECTION - FULL FACEPIECE SELF-CONTAINED BREATHING APPARATUS (SCBA) INSTEAD OF RESPIRATOR

*OTHER MATERIALS MAY BE SPECIFIED TO PROVIDE BETTER PROTECTION WHEN WORKING WITH CERTAIN TYPES OF CHEMICALS.

TABLE B-4

MINIMUM LEVELS OF PROTECTION AND AVAILABLE UPGRADE PROTECTION FOR SITE TASKS

Activity	PPE Worn	PPE With Crew	Emergency PPE at Command Post
Geophysical Survey	D	C	
Soil Boring and Sampling	D	C	B
Monitoring Well Development and Sampling	D	C	B
Surface Water and Sediment Sampling	D	C	B
Biological Sampling	D	-	C
Decontamination	C	-	B
Test Pits	C	-	B

8.0 SAFE WORK PRACTICES AND ENGINEERING CONTROLS

Safe work practices and engineering controls shall be implemented to comply with OSHA 29 CFR 1910.120 to limit employee exposure to hazardous substances or conditions. The use of personnel protective equipment has limitations and presents hazards of its own, such as physical stress and interference with peripheral vision, calling for the consideration and implementation of work practices and engineering controls prior to beginning site tasks and before the use of personnel protective equipment is instituted.

The safe work practices and engineering controls discussed below apply to general site procedures.

8.1 SAFE WORK PRACTICES

The following work practices are intended for use when site activities involve potential exposure to hazardous substances or conditions.

1. The OB/OD grounds are known to contain various types of unexploded ordinance (UXO).
   All movement on the site shall be along cleared roads and pathways.
   ON-SITE WORKERS SHALL NOT STRAY FROM THE CLEARED PATHWAYS AND ROAD!
   ON-SITE WORKERS SHALL NOT TOUCH, KICK, OR OTHERWISE DISTURB ANY MATERIALS ON-SITE WHICH MAY BE UXO's.
2. The buddy system will be utilized at all times within the exclusion zone.
3. Entry into and exit from zones within the site must be made via the established access control points.
4. Prescribed personnel protective equipment must be worn as directed by the Site Health and Safety Office and Project Manager.
5. Assumptions will not be made concerning the nature of materials found on the site. Should any unusual situations occur (not covered by the Site Standard Operating Procedures), operations will cease and the Site Health and Safety Officer and the Project Manager will be contacted for further guidance.
6. Communication hand signals must be understood and reviewed daily.
7. Consultation with the Project Manager shall be made to avoid any uncertainties.

8. Ground fault circuit interrupters shall be used on all field electrical equipment. Improperly grounded/guarded tools shall be tagged out-of- service and the Project Manager shall be notified immediately.
9. If a piece of equipment fails or is found to be in need of repair, it will be immediately tagged out-of-service and the Project Manager shall be notified. This equipment will not be returned to service until repairs have been completed and the equipment tested by a competent individual.
10. Unsafe conditions shall be reported immediately.
11. Unusual odors, emissions, or signs of chemical reaction shall be reported immediately.
12. Workers will minimize contact with hazardous materials by:
    a. Avoiding areas of obvious contamination
    b. Using poly sheeting to help contain contaminants
    c. Avoiding contact with toxic materials
13. Only essential personnel will be permitted in the work zones.
14. Whenever possible, personnel will be located upwind during material handling.
15. At the first sign of odors detected inside the facepiece of a respirator, the employee shall leave the exclusion zone and report the incident to the Health and Safety Officer and the Project Manager.
16. If an employee begins experiencing any signs or symptoms of exposure to site toxic material (this information will be discussed during the daily meeting and can be found on the appropriate material safety data sheets), the employee will leave the area immediately and report the incident to the Health and Safety Officer and Project Manager.

8.2 PERSONAL HYGIENE PRACTICES

The following personal hygiene practices will apply to field work conducted at the SEAD OB/OD site:

1. No smoking or chewing of tobacco or gum shall be allowed within the exclusion or decontamination zones.
2. No eating or drinking shall be allowed in the exclusion or decontamination zones.
3. On-site personnel shall remove protective clothing and wash face and hands prior to leaving the exclusion and decontamination zones.
4. Disposable outerwear will be placed in drums located in the personnel decontamination area. Drums will be staged on-site at a central location for later disposal.

8.3 UXO CONTAMINATED SAMPLING OPERATIONS

For safety purposes, soil, and well boreholes are normally checked with HFA's Forster Ferex/4.021 (Mk 26 Mod)) Ordnance Locator. It is a USACE requirement that all boreholes in areas possibly contaminated with UXOs must be rechecked at 2 foot to 4 foot intervals during drilling operations. This can be eliminated if remote drilling equipment is used.

In areas of heavy UXO equipment contamination, HFA EID technicians can collect samples with hand augers or similar equipment. The physical hazards and measures used to deal with those are outlined in Section 2.3, Hazard Evaluation.

8.3.1 Inspection of Laboratory Samples Prior to Off Site Shipment

Many of the UXO components intended for disposal on the OB site are quite small and could easily be included in laboratory samples for off site testing. These items although quite small will produce small fragments moving at a high velocity if initiated during laboratory testing. These fragments could cause fairly severe injuries to laboratory personnel processing these samples. All samples should be inspected by qualified HFA EOD personnel to ensure that they do not contain any small UXO components.

8.4 FIRE CONTROL

No smoking will be allowed during drilling or sampling activities. Fire extinguishers, suitable for Class A, B, and C fires (rated at least 1A, 10BC), will be available at sampling sites for use on small fires. All samples must be treated as flammable or explosive. The site safety officer will have available the telephone number of the nearest fire station and local law enforcement agencies in case of a major fire emergency.

8.5 SPILL CONTROL

In the event of a spill, the site safety officer will be notified immediately. The important factors are that no personnel are overexposed to vapors, gases, or mists and that the liquid does not ignite. Waste spillage must not be allowed to contaminate any local water source. Small dikes will be erected to contain spills, if necessary, until proper disposal can be completed. Subsequent to cleanup activities, the site safety officer will survey the area to ensure that no toxic or explosive vapors remain.

8.6 EXPLOSIVE FIRES

Under no circumstances will an attempt be made to fight an explosive fire. If a fire involving explosive materials should occur on the site, all personnel will immediately evacuate the site. Fire department personnel responding to the incident must be informed of the fact that the fire involves explosive materials.

9.0 UNEXPLODED ORDNANCE

The OB site is heavily contaminated with UXO components and UXOs. All HFA EOD operations will be performed in accordance with the following procedures:

1. **HFA Explosive Ordnance Disposal Services** - The specific services which HFA proposes for support of this project are listed below. It should be noted that the services are orientated to site safety during evaluation of the OB site.

    a. **Unexploded Ordnance Safety Training** - In accordance with 29 CFR Part 1910.120 paragraph (e), HFA has developed an Unexploded Ordnance (UXO) Safety Training class that is provided to the prime contractor for the training of all personnel who will be working on the site. This class includes an instructional guide and handouts for workers on the site.

    b. **UXO Inspection of the Sampling Sites** - HFA will provide the personnel and equipment required to inspect the access routes and sampling sites for UXOs. Based on observations made during the site visit, this will be an extremely difficult operation because the entire site is heavily contaminated with both ferrous and nonferrous ordnance components and fragments. The magnetometry equipment utilized by HFA is capable of detecting both ferrous and nonferrous objects however, heavy metallic contamination will greatly hinder operations on the site.

        (1) **Marking Access Routes and Sampling Site Boundaries** - Dependant upon the equipment size and quantity being brought into a sampling site, a 10' to 20' wide access route will be searched for UXOs. The boundaries of the access route will be marked at 25' intervals with orange survey flags. As with the equipment considerations for the access route, the size of the sampling area may range from an area 50' x 50' to 100' x 100' in size.

        (2) **Marking and Handling of UXOs** - After more than forty (40) years of use, the potential for UXO contamination on the OB site is extremely high. In addition to the ordnance items disposed of on the OB site, it can be expected that "ordnance kick-outs" from the

adjacent demolition range can be expected to be found on site. All explosive loaded UXOs will be marked with yellow survey flags.

c. **HFA EOD Site Procedures** - The following practices are standard HFA EOD procedures used on DoD installations throughout the United States. The HFA EOD search team (consisting of two EOD technicians of which one holds a Master EOD rating) will conduct a visual surface and electronic subsurface UXO search of the access route and sampling site. In conjuntion with the UXO search, HFA EOD will perform the following steps:

(1) Identify and mark the boundaries of the access route and sampling site areas that will require UXO search operations.

NOTE: Hand excavation is the preferred method of excavation for buried UXOs; however, if a UXO is buried at great depth or the soil conditions are such that hand excavation is not possible, a backhoe will be used if necessary. All excavations performed by HFA will be in compliance with 29 CFR Part 1926 and EM 385-1-1.

(2) Using visual surface locations techniques, electronic subsurface techniques and excavation as required, locate and identify UXOs within the boundaries of the access route and sampling site.

(3) When an explosive, chemical, propellant, or pyrotechnic loaded UXO is located the following steps will be followed:

(a) Mark the UXO's location with a yellow marker flag.
(b) Determine the type of UXO, i.e. projectile, rocket, bomb, etc.
(c) Detemine the condition of the UXO (Armed or Unarmed).
(d) Determine which of the following explosive/hazard categories is applicable:

1 High Explosive (HE)
2 High Explosive Anti-Tank (HEAT)
3 Armor Piercing High Explosive (APHE)
4 Improved Conventional Munition (ICM)

- 5 Anti-Personnel Ejection Round Special (APERS)
- 6 White/Red Phophorous
- 7 Other

(e) Determine which of the following fuzing categories is applicable:

- 1 Point Detonating (PD)
- 2 Base Detonating (BD)
- 3 Point Initiating Base Detonating - Lucky (PIBD-Lucky)
- 4 Mechanical Time (MT)
- 5 Electronic Time (ET)
- 6 Proximity (VT)
- 7 Powder Train Time Fuze (PTTF)
- 8 All-Ways Acting (as in the 40 mm grenade system)

NOTE: If the site contains numerous UXOs, report the initial UXO located and continue search operations. Perform all of the steps outlined in paragraphs 1.c(3). through 1.c(3)(e)8. and then report the total number located at the end of the day.

(f) Report the UXO to the Contractor Representative and Government Representative with project oversight responsibility.

(g) Request demolition of the UXOs by the SEAD EOD Detachment.

NOTE: Due to scheduling and other mission requirements of the SEAD EOD Detachment, they may not be able to respond on the day called or for several days afterwards.

(4) If the delayed Government EOD support for destruction of the UXOs will hinder or halt project operations and the Contractor or Government Representative requests movement of the UXO(s), the following is applicable for HFA operations on SEAD:

(a) If the Contractor Representative request that the UXO(s) be moved, refer this individual to the Government Representative having oversight of the project. The Contractor Representative does not have authority to direct the movement of UXOs on the project site.

(b) Upon request of the Government Representative, the HFA EOD Team Leader will reevaluate the UXO(s) to determine which if any can be moved.

NOTE: Very careful evaluation of the UXO will be required. As a rule, ordnance items with attached fuzing systems which have been exposed to fire or a detonation are not to be moved and must be destroyed in place. The HFA EOD Team Leader is the only person with the authority to make the decision of whether or not the HFA EOD personnel will move an UXO.

(c) Unarmed/Unfired UXOs - Any UXO which has not been fired/launched or experienced any other actions (exposed to fire or detonations) required to put the UXO in an armed condition.

1 If the UXO in the unarmed/unfired condition includes any positive safety devices (safety pin/clip, electrical shunts, etc.), and these items are missing, the UXO shall be considered to be armed.

2 If the unarmed/unfired UXO has been damaged by fire or has other physical damage, it shall be considered to be armed.

(d) Armed UXO - Any UXO which has experienced the required actions to place it in an armed condition.

NOTE: Only unarmed and armed UXOs that are determined to be safe to move will be moved. Under no circumstances will any of the following UXOs be moved:

- HEAT with a PIBD -Lucky fuzing system
- Any munition with a Mechanical Time (MT) fuze
- Any munition with a fuze containing an impact back-up (graze feature)
- Any munition containing an All-Ways Acting fuze (as in the 40 mm grenade system)
- Any munition that you can not determine the type of fuze or if it is safe to move.

(e) Based on the field evaluation of the UXO(s) by the HFA EOD Team Leader a final decision will be made if the UXO is safe to move. If the HFA EOD Team leader determines that the UXO(s) can safely be moved, the following procedures will be followed:

1 Establish an UXO explosive holding area. This area must be separate from the nonexplosive loaded ordnance component holding area.
2 This holding area will be a minimum of 100 meters from any structures, power lines, and equipment.
3 The holding area will be clearly marked with yellow flags on its four (4) corners.
4 The location of the UXO holding area will be identified to both the contractor and Government site representatives.
5 The UXO(s) will be moved one (1) at a time and in the proper attitude.
6 Except as indicated below, the UXO(s) should be moved to the holding area by hand. If required, both EOD technicians will carry the UXO(s) to the holding area.
7 Large UXOs (155 mm and above) may be trans-ported by vehicle (backhoe, front end loader, etc.) to the holding area.
8 A record of all UXOs placed in the explosive holding area will be maintained by the HFA EOD Team Leader.

(5) Nonexplosive loaded ordnance components will be collected and stored in a designated location for pick up by SEAD Range Operations personnel at their convenience. Items in this category would include but not be limited to the following types of ordnance/residue:

NOTE: The location of items too large to be moved by hand will be reported to the SEAD Range Operations Personnel for collection at a later date.

(a) Armor Piercing (AP) projectiles
(b) Empty ejection munitions
(c) Spent rocket motors (when found separated from warheads)
(d) Nonexplosive loaded training munitions

(6) A record of all UXOs will be maintained in a log book.
(7) Upon completion of UXO search operations, a UXO Density Report will be provided to the Contractor and Government Representatives.

2. **Sampling Operations** - During sampling operations, HFA will provide EOD services as needed. Some of the required additional EOD services normally provided on projects of this nature are listed below:

a. **Borehole Magnetometry** - For safety purposes, soil and well boreholes are normally checked with HFA's Förster Ferex® 4.021 (Mk 26 Mod 0) Ordnance Locator. This is a USACOE requirement that all boreholes in areas that are possibly contaminated with UXOs must be rechecked at 2' or 4' intervals during drilling operations.

NOTE: The requirement for rechecking the boreholes at 2' and 4' foot intervals can be eliminated if remote drilling equipment is used.

b. **Collection of Samples** - In areas of heavy UXO contamination, HFA EOD technicians can collect samples with hand augers or similar equipment. This eliminates the requirement to expose other contractor personnel in high hazard areas.

c. **Excavation Services** - In some cases excavation of trenches for a cross section study of the soil or to obtain samples may be required. Normally the trenching is accomplished with a backhoe. Because of the high level of hazards from the UXOs in the area, HFA will provide EOD operators for the backhoe. HFA's technicians are experienced in this area and are familiar with all aspects from sample collection to equipment decontamination between sampling sites.

10.0 DECONTAMINATION

Decontamination is the physical removal of contaminants from clothing and equipment or the chemical change of such contaminants to innocuous substances. Decontamination procedures will take place in the contamination reduction zone. Disposal is an available option in lieu of decontamination when decontamination is impractical.

The following decontamination procedures are intended to meet the requirements of 29 CFR 1910.120(k). No personnel or equipment shall enter the contaminated zone of the site until workers have acknowledged the decontamination procedures and operating procedures intended to minimize contamination. These procedures shall be monitored by the Site Health and Safety Officer to determine their effectiveness. Ineffective procedures will be corrected.

10.1 DECONTAMINATION FACILITIES

The main decontamination facilities at the SEAD OB/OD site will be located adjacent to the support zone. These decontamination facilities will be used for vehicle and heavy equipment decontamination and for personnel decontamination and personnel hygiene facilities.

10.2 PERSONNEL DECONTAMINATION

Personnel decontamination will consist primarily of disposal of any disposable clothing worn during site work and washing of hands and face. No heavy contamination of clothing is expected and disposable protective clothing will be disposed of as non-hazardous waste. However, if contamination is detected, personnel protective equipment and cartridges from respirators will be bagged separately from daily garbage. Facilities for personnel and sampling equipment decontamination will be set up between the equipment decontamination pad and the site trailer. Personnel will not enter the office trailer without first going through decontamination, and hands and face must be thoroughly washed before eating, drinking, etc.

Level C Decontamination - The activities to be carried out at each station are described on Table B-5, Measures for Level C Decontamination.

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TABLE B-5
MEASURES FOR LEVEL C DECONTAMINATION

Station 1:	Equipment Drop	Deposit equipment used on-site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths. Segregation at the drop reduces the probability of cross contamination. During hot weather operations, cool down station may be set up within this area.
Station 2:	Outer Garment, Boots and Gloves Wash and Rinse	Scrub outer boots, outer gloves and splash suit with decon solution or detergent water. Rinse off using copious amounts of water.
Station 3:	Outer Boots and Glove removal	Remove outer boots and gloves. Deposit in container with plastic liner.
Station 4:	Canister or Mask	If worker leaves exclusive zone to change canister (or mask), this is the last step in the decontamination procedure. Worker's canister is exchanged, new outer gloves and boot covers donned, joints taped, and worker returns to duty.
Station 5:	Outer Garment Removal	Remove outer garment. Place on plastic for further cleaning or in barrel for disposal.
Station 6:	Face Piece Removal	Facepiece is removed. Avoid touching face with fingers, Facepiece deposited on plastic sheets.
Station 7:	Inner Boot and Glove Removal	Boots and inner gloves removed and deposited in separate containers lined with plastic.
Station 8:	Field Wash	Hands and face are thoroughly washed. Shower as soon as possible.

Level B Decontamination - The activities to be carried out at each station are described on Table B-6, Measures for Level B Decon termination.

10.3 EQUIPMENT DECONTAMINATION

Equipment and vehicle decontamination will consist of pressure washing followed by steam cleaning. Solvent and soap and water washes will be performed when required for sampling or for heavy contamination. Gross contamination, such as caked mud and dirt on augers and split spoons, will be removed at the work site and placed back in the borehole, or drummed with other drilling spoils if contaminant indicators (i.e., HNu readings) warrant drumming of the soils.

10.4 PREVENTION OF CONTAMINATION

In an effort to minimize contact with waste and decrease the potential for contamination, the points outlined below will be adhered to during all phases of field investigation and sampling.

1. Personnel will make every effort not to walk through puddles, mud, any discolored surface, and/or any area of obvious contamination.
2. Personnel will not kneel or sit on the ground in the exclusion zone and/or in the Contamination Reduction Zone (CRZ).
3. Personnel will not place equipment on drums, containers, vehicles, or on the unprotected ground.
4. Where appropriate, personnel will wear disposable outer garments and use disposable equipment.

TABLE B-6
MEASURES FOR LEVEL B DECONTAMINATION

Station 1: Equipment Drop	Deposit equipment used on-site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths. Segregation at the drop reduces the probability of cross contamination. During hot weather operations, cool down station may be set up within this area.
Station 2: Outer Garment, Boots	Scrub outer boots, outer gloves and splash suit with and Gloves Wash and Rinse decon solution or detergent water. Rinse off using copious amounts of water.
Station 3: Outer Boots and Glove removal	Remove outer boots and gloves. Deposit in container with plastic liner.
Station 4: Tank Change	If worker leaves exclusive zone to change air tank, this is the last step in the decontamination procedure. Worker's air tank is exchanged, new outer gloves and boot covers donned, joints taped, and worker returns to duty.
Station 5: SCBA Removal	SCBA backpack and facepiece is removed. Avoid touching face with finger. SCBA deposited on plastic sheets.
Station 6: Outer Garment Removal	Remove outer garments. Place on plastic for further cleaning or in barrel for disposal.
Station 7: Inner Boot and Glove Removal	Boots and inner gloves removed and deposited in separate containers lined with plastic.
Station 8: Field Wash	Hands and face are thoroughly washed. Shower as soon as possible.

11.0 EMERGENCY RESPONSE PLAN

This Emergency Response Plan applies to site work at the OB/OD grounds. Copies of this plan are to be kept at the site command post and support areas. The list of emergency telephone numbers and directions to the nearest hospital will be prominently posted in the command post. Copies of the directions to the nearest hospital will be kept in all site vehicles.

This emergency response plan shall be coordinated with SEAD emergency response procedures prior to the beginning of site work.

11.1 ON-SITE EMERGENCIES

On site emergencies can range from minor cuts and scrapes to explosions, fires, and the release of toxic gases. Apparently minor incidents at hazardous waste sites can have serious consequences or may indicate the presence of a previously unknown health and safety hazard. Explosions, fires, and the release of toxic gases will not only involve site workers, but may affect the neighboring populations and the environment.

All incidents will be reported as soon as possible to the Site Manager and the Site Safety Officer who will determine the appropriate steps to be taken.

When the incident is minor, the work may continue. When an incident is considered serious, work will be discontinued until the emergency situation has been brought under control, the incident has been evaluated, and any conditions which may have contributed to the emergency have been mitigated.

All site incidents, including near misses, will be investigated and documented, using the Incident Report Form and Incident Follow-Up Report Form in Attachment C, On-Site Documentation Forms.

11.2 OFF-SITE EMERGENCIES

In the unlikely event of a vapor release off-site, the contamination source will be secured, if possible.

Emergency response contacts will be notified in the following order:

1. SEAD Security and Environmental Office
2. MAIN Safety Officer
3. MAIN Project Manager

The phone numbers of the these contacts are listed in Table B-8 and will be posted in the site trailer.

11.3 SITE PERSONNEL AND LINES OF AUTHORITY

A clear chain-of-command in emergency situations ensures clear and consistent communication between site personnel and, therefore, results in more effective response to the emergency situation. The duties of site personnel in emergency situations are outlined below:

The **Site Manager,** Mr. Michael Duchesneau, P.E. will direct all emergency response operations, designate duties to other site personnel, and serve as liaison with government officials and emergency response teams.

The **Site Safety Officer,** Mr. Jason Cupp will make initial contact with off-site emergency response teams (first aid, fire, police, etc.), make recommendations on work stoppage, and provide for on-site first aid and rescue.

The **Command Post Supervisor** will be designated when no one is performing this function during normal site work. This person will maintain contact with off-site response teams and notify additional agencies or offices that need to be contacted.

Decontamination personnel will stand by to perform emergency decontamination. Decontamination personnel will also assist the safety officer in rescue operations when necessary.

Field personnel will assist in rescue operations or take over for decontamination personnel when they are required for other duties.

11.4 EMERGENCY SITE COMMUNICATIONS

Normal site communications will be maintained by means of two-way radios carried by each crew and kept in the command post.

Emergency communications will be maintained by use of air horns kept in the support areas and with each work crew. The emergency communications codes are given in Table B-7, On-Site Emergency Communications.

11.5 EVACUATION PROCEDURES

The OB/OD grounds are known to contain various types of unexploded ordinance (UXO). All movement on the site, **EVEN UNDER EMERGENCY CONDITIONS**, shall be along cleared roads and pathways. Cleared roads and pathways shall be marked. **ON-SITE WORKERS SHALL NOT STRAY FROM THE CLEARED PATHWAYS AND ROAD!** Evacuation from work sites shall be along the acess paths cleared to the various worksites. Equipment shall be placed so as not to impede emergency escape and evacuation along the cleared pathways. Evacuation routes from work areas shall be discussed daily for each work crew as a part of the daily safety meeting.

11.6 EMERGENCY DECONTAMINATION AND FIRST AID

Decontamination procedures used in emergency situations will vary greatly with the severity and particulars of the situation. The MAIN Site Safety Officer will provide advice on the decontamination procedures to be used in each emergency situation. General guidelines for first aid and decontamination procedures are given below.

11.6.1 Inhalation Exposure

Remove the victim from the exposure area, only if proper protective gear (Level B or C) is available for the rescue team, to an area with fresh air. Remove protective clothing and respiratory protective gear as soon as possible to determine if the administration of CPR is necessary. If so, complete decontamination while CPR is being administered. Continue CPR until emergency medical unit arrives. If CPR is not required, complete decontamination and transport to hospital; administer other first-aid as indicated.

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TABLE B-7
ON-SITE EMERGENCY COMMUNICATIONS

AIR HORN SIGNAL	ACTION
THREE SHORT BLASTS	SHUT DOWN EQUIPMENT, STAND BY RADIO
ONE LONG BLAST	RETURN TO NEAREST SUPPORT ZONE
CONTINUOUS LONG BLASTS	EVACUATE SITE BY BEST, FASTEST
ROUTE	

HAND SIGNALS	MEANING
HAND GRIPPING THROAT	OUT OF AIR; CAN'T BREATHE
GRIP PARTNER'S WRIST	LEAVE AREA IMMEDIATELY; NO DEBATE
HANDS ON TOP OF HEAD	NEED ASSISTANCE
THUMBS UP	OK; I'M ALL RIGHT; I UNDERSTAND
THUMBS DOWN	NO; NEGATIVE

11.6.2 Contact Exposure

Remove victim from area and flush affected area with water only. Be careful not to spread the contamination to other parts of the body. Remove protective clothing and flush area with water only. Consult references to determine if soap and water wash is indicated. Do not remove respirator until removal of contaminant from body is reasonably assured and the victim is well into a clean zone.

11.6.3 Physical Injury

If a physical injury occurs or worker collapses in a clean zone. First aid will be administered as indicated.

If a physical injury occurs in a contaminated zone, care must be taken to prevent contact of any contaminant with open wounds. The wound can provide easy access to the body for toxic chemicals which are not normally a skin absorption problem. Protective clothing will be removed carefully to avoid additional injury and avoid any exposure of the wound to contaminants on the clothing.

If a worker collapses or loses consciousness in a contaminated zone, remove protective clothing and respiratory protective gear as soon as possible to determine if the administration of CPR is necessary. If so, complete decontamination while CPR is being administered. Continue CPR until emergency medical units arrive. If CPR is not required, complete decontamination and transport to hospital; administer other first-aid as indicated.

11.7 EMERGENCY MEDICAL TREATMENT AND FIRST AID

A first aid kit large enough to accommodate anticipated emergencies will be kept in the support zone. In addition, each work crew will carry a smaller first aid kit for minor injuries. If any injury should require advanced medical assistance, the victim will be transported to the hospital.

Each work site will have a vehicle for transportation to the hospital. Keys will be left in or near the ignition.

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11.8 EMERGENCY AND PERSONNEL PROTECTIVE EQUIPMENT

The support zone will have the following emergency equipment:

Self-Contained Breathing Apparatus (SCBA)
First Aid Kit
Fire Extinguisher (A, B, C Type)
15-Minute Emergency Eyewash Station
Air Horn

Each work crew will have at the work site the following emergency equipment:

First Aid Kit
Fire Extinguisher (A, B, C Type)
Hand-Held Eyewash
Air Horn

11.9 EMERGENCY TELEPHONE NUMBERS

Emergency telephone numbers for medical and chemical emergencies are given in Table B-8, Emergency Telephone Numbers. These numbers will be displayed prominently near each site phone.

11.10 DIRECTIONS TO HOSPITAL

Directions to the nearest hospital are shown and described in Figure B-2, Route to Seneca Hospital. The map will be displayed in the command post and kept in every site vehicle.

TABLE B-8

EMERGENCY TELEPHONE NUMBERS

SENECA ARMY DEPOT
ROMULUS, NEW YORK

Ambulance	SEAD	(607) 869-1436
Fire	SEAD	(607) 869-1316
Police	SEAD	(607) 869-0448
Geneva General Hospital 186-198 North Street Geneva, New York		(315) 798-4222
SEAD Staff Duty Officer		(607) 869-0251
Seneca Army Depot Security		(607) 869-0274
Seneca Army Depot Clinic		(607) 869-1243
On Post Calls		3-0-xxx or 4-1-xxx
Chemtrec		(800) 424-9300
National Response Center - Environmental Emergencies		(800) 424-8802
Randy Battaglia -	Seneca Army Depot Environmental Contact	(607) 869-1450
Samuel Hooper, Sr. -	HFA Senior EOD Field Supervisor	(301) 743-2377
Michael Duchesneau -	MAIN Project Manager	(617) 859-2492
Phillip Hunt -	MAIN Health and Safety Officer	(617) 859-2590

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SENECA ARMY DEPOT

ROUTE TO
SENECA HOSPITAL

FIGURE B-2

MAIN 1893

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ATTACHMENT A

CHEMICAL HAZARD EVALUATION SHEETS

CHEMICAL HAZARD EVALUATION

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CHEMICAL NAME :	Arsenic	CAS Number:	7440-38-2

SYNONYMS :

REFERENCES CONSULTED: Merck Index

CHEMICAL PROPERTIES

Chemical Formula :	As	Vapor Pressure/Density :	1 mm @ 372°C
Molecular Weight :	74.92	Specific Gravity :	5.73
Physical State :	Metal	Odor Threshold :	
Solubility (H_2O) :	Insoluble	Flash Point :	
Boiling Point :	613°C	Flammable Limits :	
Freezing Point :	818°C @ 36 atm	Incompatibilities :	Hot acids

BIOLOGICAL PROPERTIES

TLV-TWA :	0.2 mg/m^3	PEL/STEL :	
Odor Characteristics:	Garlic-like	Carcinogen :	Experimental
Route of Exposure :	Inhalation, ingestion, skin absorption	Rat :	LD50 25 mg/kg

SUBSCRIPT

HANDLING RECOMMENDATIONS (Personal protective measures)

Respirators with particulate cartridges worn at levels of 0.2 mg/m^3.

HEALTH HAZARDS AND FIRST AID

Radiation hazard at levels of 2 x 10^{-6} uCi/ml in air.

SYMPTOMS

Acute: Stomach irritation, nausea, vomiting, diarrhea; can progress to shock and death.

Chronic: Exfoliation and pigmentation of skin, herpes, polyneuritis, altered hematopoiesis, degeneration of liver and kidneys.

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CHEMICAL HAZARD EVALUATION

CHEMICAL NAME : Barium

CAS Number: 7440-39-3

SYNONYMS : Barium carboante, barium hydroxide, barium sulfate

REFERENCES CONSULTED:

CHEMICAL PROPERTIES

Chemical Formula : Ba

Molecular Weight : 137.34

Physical State : Lumps of powder

Solubility (H_2O) :

Boiling Point : 1640°C

Freezing Point : Appx. 725°C

Vapor Pressure/Density : 10 mm @ 1049°C

Specific Gravity : 3.6

Odor Threshold :

Flash Point :

Flammable Limits :

Incompatibilities :

BIOLOGICAL PROPERTIES

TLV-TWA : 0.5 mg/m^3

Odor Characteristics:

Route of Exposure : Inhalation, ingestion, direct contact

PEL/STEL : 0.5 mg/m^3

IDLH : 250 mg/m^3

Human :

HANDLING RECOMMENDATIONS (Personal protective measures)

All water or acid soluble barium compounds are poisonous. Respirators with particulate cartridges required at 0.5 mg/m^3.

HEALTH HAZARDS AND FIRST AID

Remove from exposure. May be radiation hazard if in excess of 1 x 10^{-6} uCi/ml in air.

SYMPTOMS

Acute: Eye irritant, benign pneumoniosis, skin irritation, gastroenteritis, muscular paralysis, slow pulse rate.

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CHEMICAL HAZARD EVALUATION

CHEMICAL NAME : Cadmiuim

CAS Number: 7440-43-9

SYNONYMS :

REFERENCES CONSULTED: NIOSH/OSHA Pocket Guide; Patty's Industrial Hygiene and Toxicology

CHEMICAL PROPERTIES

Chemical Formula : Cd
Molecular Weight : 112.40
Physical State : Solid
Solubility (H_2O) : Insoluble
Boiling Point : 767°C
Freezing Point : 321°C

Vapor Pressure/Density :
Specific Gravity : 8.6
Odor Threshold : -
Flash Point : -
Flammable Limits : -
Incompatibilities : Strong oxidizers, elemental sulfur, selenium, tellurium

BIOLOGICAL PROPERTIES

TLV-TWA : 0.05 mg/m^3
Odor Characteristics: -
Route of Exposure : Ingestion, inhalation

PEL/STEL : 0.2 mg/m^3 / 0.6 mg/m^3
IDLH : 4.0 mg/m^3
Rabbit : LD50: 150 mg/kg LC50: 2500

Subscript

HANDLING RECOMMENDATIONS (Personal protective measures)

Wear impervious clothing, gloves, boots; eye protection; respiratory with cartridges at 0.05 mg/m^3; SCBAs required at 0.5 mg/m^3.

HEALTH HAZARDS AND FIRST AID

Eye: irrigate immediately
Inhalation: remove, artificial respiration
Skin: flush with water, soap and water wash
Ingestion: water, induce vomiting

SYMPTOMS

Acute: Salivation, choking, vomiting, diarrhea, abdominal pain, difficulty breathing, chest tightness, cough, pulmonary edemia.

Chronic: Proteinuria, emphysemia, anemia, hypertension.

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CHEMICAL HAZARD EVALUATION

CHEMICAL NAME : Chromium CAS Number: 7440-47-3

SYNONYMS : Chrome, chromium metal, ASTM 1481

REFERENCES CONSULTED: NIOSH/OSHA Pocket Guide

CHEMICAL PROPERTIES

Chemical Formula	: Cr	Vapor Pressure/Density	: 1 mm @ 1610°C
Molecular Weight	: 52	Specific Gravity	: 7.14
Physical State	: Solid	Odor Threshold	:
Solubility (H_2O)	: Insoluble	Flash Point	: 752°F
Boiling Point	: 4784°F	Flammable Limits	: Nonflammable
Freezing Point	: 3452°F	Incompatibilities	: Nonflammable strong oxidizers, acids, strong alkalies

BIOLOGICAL PROPERTIES

TLV-TWA	: 0.5 mg/m^3	PEL/STEL	: 1 mg/m^3
Odor Characteristics:	Odorless	IDLH	: 500 mg/m^3
Route of Exposure	: Inhalation, ingestion	Human	:

HANDLING RECOMMENDATIONS (Personal protective measures)

Skin: Wear impervious clothing, gloves, and face shield.
Inhalation: APR with appropriate cartridges.

HEALTH HAZARDS AND FIRST AID

Eyes: Flush with large amounts of water.
Skin contact: Wash with soap or mild detergent and water.
Inhalation: Move person to fresh air and give artificial respiration if necessary.
Ingestion: Large quantities of water and induce vomiting.

SYMPTOMS

Acute: Pulmonary/respiratory irritation, dizziness, vomiting.

Chronic: Cancer, proteinuria, hematuria, oliguria, anuria, uremia, shock.

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CHEMICAL HAZARD EVALUATION

CHEMICAL NAME :	Copper	CAS Number:	7440-50-8

SYNONYMS : Copper sulfate, cuprous chloride

REFERENCES CONSULTED: NISOH/OSHA Pocket Guide

CHEMICAL PROPERTIES

Chemical Formula :	Cu	Vapor Pressure/Density :	
Molecular Weight :		Specific Gravity :	8.92
Physical State :	Solid	Odor Threshold :	
Solubility (H_2O) :	Insoluble	Flash Point :	
Boiling Point :	2567°C	Flammable Limits :	
Freezing Point :	1083.4°C	Incompatibilities :	Acetylene gas, magnesium metal, strong acids, organic acids

BIOLOGICAL PROPERTIES

TLV-TWA :	1 mg/m^3	PEL/STEL :	1 mg/m^3
Odor Characteristics:		IDLH :	1
Route of Exposure :	Inhalation, ingestion, direct skin contact	Mouse :	LD50 3.5 mg/kg

HANDLING RECOMMENDATIONS (Personal protective measures)

Respirators worn at levels of 1 mg/m^3. Use particulate cartridges.

HEALTH HAZARDS AND FIRST AID

Radiation hazard levels at 2 x 10^{-6} uCi/ml in air.

SYMPTOMS

Acute: Irritation of upper respiratory tract, ulceration and perforation of nasal septum, cough, fever, digestive disorders, headache, corneal ulcerations.

Chronic: Dermatitis.

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CHEMICAL HAZARD EVALUATION

CHEMICAL NAME : Lead

CAS Number: 7439-92-1

SYNONYMS : White lead, lead flake, CI 77575

REFERENCES CONSULTED: NIOSH/OSHA Pocket Guide, Merck Index

CHEMICAL PROPERTIES

Chemical Formula	Pb	Vapor Pressure/Density	1 mm @ 970°C
Molecular Weight	207.19	Specific Gravity	11.35
Physical State	Solid	Odor Threshold	
Solubility (H_2O)	Insoluble	Flash Point	Incombustible
Boiling Point	1783°F	Flammable Limits	Incombustible
Freezing Point	473°F	Incompatibilities	Strong oxidizers, hydrogen peroxide, active metals: sodium potassium

BIOLOGICAL PROPERTIES

TLV-TWA	0.15 mg/m^3	PEL/STEL	0.05 mg/m^3
Teratogen	Suspected	IDLH	Variable
Route of Exposure	Inhalation, ingestion, direct contact	Human	

HANDLING RECOMMENDATIONS (Personal protective measures)

Prevent skin contact; wear impervious clothing and gloves and boots; respirator required at levels of 0.5 mg/m^3; positive pressure respirator at 100 ppm; eye protection should be worn.

HEALTH HAZARDS AND FIRST AID

If into eyes, immediately wash eyes with large amounts of water; onto skin, wash with soap (mild detergent) and water; if breathed in, get to fresh air; perform artificial respiration if breathing stopped; if ingested, remove by gastric levage with magnesium sulfate or sodium sulfate.

SYMPTOMS

Chronic: Lassitude, insomnia, cyanosis, eye grounds, gingival lead line, anorexia, weight loss, malnutrition, constipation, abdominal pain, hypotension, anemia, tremors, wrist drop, reproductive effects, lowered sperm count.

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CHEMICAL HAZARD EVALUATION

CHEMICAL NAME : Mercury
CAS Number : 7439-97-6
SYNONYMS : Quicksilver, NA 2809, OHS 14020
REFERENCES CONSULTED: NIOSH/OSHA Pocket Guide, Merck Index

CHEMICAL PROPERTIES

Chemical Formula : Hg
Molecular Weight : 201
Physical State : Liquid
Solubility (H_2O) : 0.002%
Boiling Point : 674 °F
Freezing Point : -38 °F

Vapor Pressure/Density : 0.0012/7.0
Specific Gravity : 13.59
Odor Threshold :
Flash Point : Nonflammable
Flammable Limits : N/A
Incompatibilities : Acetylenes, ammonia gases

BIOLOGICAL PROPERTIES

TLV-TWA : 0.05 mg/m^3
Odor Characteristics: Odorless
Route of Exposure : Inhalation, absorption, direct contact

PEL/STEL : 0.1 mg/m^3 ceiling; 0.05 mg/m^3
IDLH : 28 mg/m^3
Human : LD_{LO} 1429 mg/kg
Carcinogen : Indefinite animal

HANDLING RECOMMENDATIONS (Personal protective measures)

Prevent skin contact; wear impervious clothing, gloves, and boots; face shields; respirators required at 1 mg/m^3; SCBAs required at 28 mg/m^3. Eye protection should be worn.

HEALTH HAZARDS AND FIRST AID

Radiation hazard at 7×10^{-7} uCi/ml in air; avoid exposure for long periods; flush eyes with water; wash skin with soap and water.

SYMPTOMS

Acute: Coughing, dyspnea, dermatitis, salivation, lacrimation, thirst, metallic taste, nausea, vomiting, gastrointestinal paint.

Chronic: Pneumonia, bronchitis, acidosis, leukopenia, hematuria, proteinuria, diarrhea, blood stools, gingival lead line, central nervous system depression, anorexia, anemia, paresthesia, hallucinations, mental depression, nervousness, incoordination, insomnia, headache, weight loss, tremors, convulsions, cardiac depression, liver damage, kidney damage, numbness in extremities, fatigue.

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CHEMICAL HAZARD EVALUATION

CHEMICAL NAME : Nickel

CAS Number: 7440-02-0

SYNONYMS : Nickel catalyst, Raney nickel, UN1378

REFERENCES CONSULTED: NIOSH/OSHA Pocket Guide

CHEMICAL PROPERTIES

Chemical Formula : Ni

Molecular Weight : 58.7

Physical State : Solid

Solubility (H_2O) : .018%

Boiling Point : 4946 °F

Freezing Point : 2648 °F

Vapor Pressure/Density : 1 mm @ 1800 °C

Specific Gravity : 8.908

Odor Threshold :

Flash Point : N/A

Flammable Limits : N/A

Incompatibilities : Nitric acid, chlorine, other oxidizers, combustible vapors, wood, sulfur

BIOLOGICAL PROPERTIES

TLV-TWA : 1 mg/m^3

Odor Characteristics: Odorless

Route of Exposure : Inhalation, ingestion, direct skin contact

PEL/STEL : 1 mg/m^3

IDLH :

Carcinogen : Animal, human

Mutagen : Positive

Teratogen : Animal

HANDLING RECOMMENDATIONS (Personal protective measures)

Skin: Impervious clothing, gloves, and face shield.

Inhalation: Respiratory protection needed at 1 mg/m^3 and SCBAs at 10 mg/m^3.

HEALTH HAZARDS AND FIRST AID

Eyes: Immediately wash the eyes with large amounts of water.

Skin: Wash with soap or mild detergent and water.

Inhalation: Move to fresh air and start artificial respiration if necessary.

Ingestion: Do not induce vomiting; remove by gastric lavage.

SYMPTOMS

Acute: Nausea, vomiting, diarrhea.

Chronic: Dermatitis, asthma, skin sensitization, pulmonary respiratory hemorrhage, pulmonary/respiratory inflammation, edema, sinus cancer, respiratory cancer, asthma.

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ATTACHMENT B

STANDARD OPERATING PROCEDURES FOR EMERGENCIES DUE TO COLD AND COLD STRESS MONITORING

STANDARD OPERATING PROCEDURE FOR EMERGENCIES DUE TO HEAT AND HEAT STRESS MONITORING

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COLD STRESS

Field operations during winter months can create a variety of hazards for the employee. Frostbite, frostnip, and hypothermia can be experienced and, if not remedied, cause severe health effects and even death. Therefore, it is important that all employees are able to recognize the symptoms of these conditions and correct the problem as quickly as possible.

A. THE EFFECTS OF COLD

Persons working outdoors in temperatures at or below freezing may experience frostbite. Extreme cold for a short time may cause severe injury to the body surface or result in profound generalized cooling, causing death. Extremities such as fingers, toes, and ears are most susceptible.

Prolonged exposure to extreme cold produces the following symptoms: shivering, numbness, low body temperature, drowsiness, and marked muscular weakness.

Two factors influence the development of a cold injury: ambient temperature and wind velocity. Windchill is used to describe the chilling effect of moving air in combination with low temperatures. Table 1 shows a windchill chart. As a general rule, the greatest incremental gain in windchill occurs when a wind velocity increases from 5 mph to 10 mph. Additionally, water conducts heat 240 times faster than air. Therefore, the body cools dramatically when personal protective equipment is removed and clothing underneath is perspiration-soaked.

There are three categories of cold-injury: frostnip, frostbite, and hypothermia.

1. Frostnip

Frostnip is the initial symptom of frostbite and is characterized by a whitened area of the skin accompanied by a burning or painful feeling.

Emergency Care

Warm the affected area either by body heat or warm (not hot) water.

2. Frostbite

Frostbite is local tissue damage caused by exposure to low temperatures. Ice crystals form, either superficially or deeply, in the fluids and underlying soft tissue of the skin. The nose, cheeks, ears, fingers, and toes are most commonly affected.

Frostbite Symptoms

- Skin is cold, hard, white, and numb.
- Skin may be blistering.

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- Victim may not be in pain.
- In advanced cases victim experiences mental confusion.
- Judgment impairment.
- Victim will stagger.
- Eyesight failure.
- Unconsciousness.
- Shock symptoms, followed by death.

Frostbite Emergency Care

Cover the frozen area and warm the victim with extra clothing and blankets. Bring the victim indoors (if possible) and allow victim to drink warm liquids.

Rewarm the frozen area quickly by immersion in warm (not hot) water. The best temperature is between 102 and 105°F. This procedure may take up to thirty minutes. The victim will experience greater and greater pain as tissues thaw.

If warm water is not available or not practical to use, wrap the affected area in a sheet and warm blankets.

Severe swelling will develop rapidly after thawing. Discontinue warming the victim as soon as the affected area becomes flush.

When the affected area has been warmed, have the victim exercise it. If the fingers or toes are involved, place dry, sterile gauze between the digits to separate them.

If travel is necessary, cover the affected parts with sterile or clean clothes and keep the injured areas elevated. Obtain medical assistance as soon as possible.

It is important during treatment that you do not:

- Rub the affected area as rubbing may cause gangrene (tissue death).
- Allow the victim to put the affected part near a hot stove or fire.
- Break blisters.
- Allow the victim to walk if the affected area is the feet. (However, walking on a frozen foot is better than staying in the cold.)
- Apply other dressings unless the victim is to be transported for medical aid.
- Allow the victim to smoke or drink alcohol.

It is important to protect the frozen area from further injury, to warm the affected area rapidly, and to maintain respiration. Never allow the affected area to refreeze. This may lead to further damage and result in eventual amputation.

It is also important to remember that areas that have had frostbite are more susceptible to recurrent frostbite.

3. Hypothermia

Hypothermia results from prolonged exposure to the cold thereby lowering the body's core temperature. Cold does not necessarily mean temperatures below freezing, as hypothermia can be caused by temperatures above 32°F when the person is hungry, wet, tired, and over-exerted. The target organ of hypothermia is the brain.

Hypothermia Symptoms

- Severe shivering.
- Abnormal behavior characterized by decreased efficiency, decreased level of communication, forgetfulness, repetitive behavior, poor motor skills, poor judgment, and general apathy.
- Listlessness and sleepiness.
- Weakness, inability to walk, and repeated falling.
- Later stages include collapse, stupor, unconsciousness, and eventual death.

During hypothermia, the body's thermoregulatory mechanisms may shut down. Shivering is the body's way of warming itself. At 95°F, the body will produce maximum shivering. At 87.8°F, the body loses its capacity to shiver. Table 2 lists the signs of hypothermia. The worker's exposure to cold should be immediately terminated when severe shivering becomes evident.

It is important to note that if a victim is found in a remote area, despite the death-like appearance, the person may be saved. All attempts should be made to revive the victim.

Hypothermia Emergency Care

All stages of hypothermia are treated by either passive or active rewarming. Passive rewarming is accomplished by better conservation of the patient's body heat. However, the victim's thermoregulatory mechanisms must be intact.

Active rewarming means heat is applied to the victim by an external source, either surficially and/or through the core. Treatment includes:

- Preventing further heat loss. Remove the victim to warm, dry place (out of the wind, cold, and rain/snow).

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- Remove wet clothing piece-by-piece and dry the underlying skin.
- Dress in several layers of warm, dry clothing, giving preference to the central body core rather than the extremities.
- Cover the victim's head, then wrap victim in blankets.
- If the victim is conscious, allow him/her to drink hot fluids.
- Monitor oral body temperature every 15 minutes. If body temperature falls below 96.8°F, the team member should not be allowed outside until body temperature returns to normal.

In more severe cases of hypothermia, implement the above treatment but also institute some type of active rewarming, including:

- Electric pads or blankets
- Hot-air blowers or heaters
- Heated blankets or clothes
- Use of human body heat

It is important to watch for signs of return of the normal thermoregulatory mechanisms (shivering, teeth chattering, "goose flesh"), and to monitor mental status.

Victim should be transferred to a medical facility after the emergency care steps have been initiated and should not be allowed to return to work for at least 48 hours.

If there has been severe hypothermia, the victim should not be considered dead despite his/her appearance. Treat the victim as stated above and prepare for transfer to a medical facility. If the victim is pulseless and not breathing, perform CPR.

Table 3 lists Threshold Limit Values for working in the cold.

Work-Warming Regimen

If work is performed continuously in the cold at an equivalent chill temperature (ECT) or below -7°C (20°F) heated warming shelters (tents, cabins, rest rooms, etc.) shall be made available nearby and the workers 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 shall 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 shall be provided as necessary to prevent workers from returning to their 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

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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 diuretic and circulatory effect.

For work practices at or below -12°F (10°F) ECT, the following shall apply:

1. The worker shall 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 shall be provided.
3. New employee shall not be required to work full-time in cold in the first days until they become accustomed to the working conditions and required protective clothing.
4. The weight and bulkiness of clothing shall be included in estimating the required work performance and weights to be lifted by the worker.
5. The work shall be arranged in such a way that sitting still or standing still for long periods is minimized. Unprotected metal chair seats shall not be used. The worker should be protected from drafts to the greatest extent possible.
6. The workers shall be instructed in safety and health procedures. The training program shall 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 signs and symptoms of impending hypothermia or excessive cooling of the body even when shivering does not occur.
   f. Safe work practices.

Special caution shall be exercised when working with toxic substances. Cold exposure may require reduced exposure limits.

Eye protection for workers employed out-of-doors in a snow and/or ice-covered terrain shall 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 are required where there is an expanse of snow coverage causing a potential eye exposure hazard.

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Workplace monitoring is required as follows:

a. Suitable thermometry should be arranged at any workplace where the environmental temperature is below 16°C (60°F) to enable overall compliance with the requirements of the TLV to be maintained.

b. Whenever the air temperature at a workplace falls below -1°C (30°F), the dry bulb temperature should be measured and recorded at least every four hours.

c. In indoor workplaces, the wind speed should also be recorded at least every four hours whenever the rate of air movement exceeds 2 meters per second (5 mph).

d. 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°F).

e. The equivalent chill temperature shall be obtained from Table 1 in all cases where air movement measurements are required, and shall be recorded with the other data whenever the equivalent chill temperature is below -7°C (20°F).

Employees shall be excluded from work in cold at -1°C (30°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 (-10°F) with wind speeds less than 5 mph, or air temperatures below -18°C (0°F) with wind speeds above 5 mph 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 secondary cold injury. Special provisions must be made to prevent hypothermia and secondary freezing of damaged tissues, in addition to providing for first aid treatment.

TABLE 1

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TABLE 1

COOLING POWER OF WIND ON EXPOSED FLESH EXPRESSED AS AN 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.

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TABLE 2

SIGNS 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	91.4	Severe hypothermia below this temperature.
32	89.4	Consciousness clouded, blood pressure becomes difficult to obtain 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 fibrillation.
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.

THRESHOLD LIMIT VALUES WORK / ·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	MAXIMUM WORK PERIOD	NUMBER OF BREAKS	MAXIMUM WORK PERIOD	NUMBER OF BREAKS	MAXIMUM WORK PERIOD	NUMBER OF BREAKS	MAXIMUM WORK PERIOD	NUMBER OF BREAKS	MAXIMUM WORK PERIOD	NUMBER OF BREAKS
1.	-26° TO -28°	-15° TO -19°	(NORMAL BREAKS)	1	(NORMAL BREAKS)	1	75 MINUTES	2	55 MINUTES	3	40 MINUTES	4
2.	-29° TO -31°	-20° TO -24°	(NORMAL BREAKS)	1	75 MINUTES	2	55 MINUTES	3	40 MINUTES	4	30 MINUTES	5
3.	-32° TO -34°	-25° to -29°	75 MINUTES	2	55 MINUTES	3	40 MINUTES	4	30 MINUTES	5	NON-EMERGENCY WORK SHOULD CEASE	
4.	-35° TO -37°	-30° TO -34°	55 MINUTES	3	40 MINUTES	4	30 MINUTES	5	NON-EMERGENCY WORK SHOULD CEASE			
5.	-38° TO -39°	-35° to -39°	40 MINUTES	4	30 MINUTES	5	NON-EMERGENCY WORK SHOULD CEASE					
6.	-40° TO -42°	-40° TO -44°	30 MINUTES	5	NON-EMERGENCY WORK SHOULD CEASE							
7.	-43° & BELOW	-45° & BELOW	NON-EMERGENCY WORK SHOULD CEASE									

Notes: (a) Schedule applies to moderate to heavy work activity with warm-up beaks 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 -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 four breaks in a 4-hour period (Step 5).

(b) 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.

(c) If only the windchill 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 windchill of about 1750 W/m^2; (20 all non-emergency work should have cased at or below a windchill 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.

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*Adapted from Occupational Health & Safety Division, Saskatchewan Department of Labour.

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Field operations during the summer months can create a variety of hazards to the employee. Heat cramps, heat exhaustion, and heat stroke can be experienced; and if not remedied, can threaten life or health. Therefore, it is important that all employees be able to recognize symptoms of these conditions and be capable of arresting the problem as quickly as possible.

A. THE EFFECTS OF HEAT

As the result of normal oxidation processes within the body, a predictable amount of heat is generated. If the heat is liberated as it is formed, there is no change in body temperature. If the heat is liberated more rapidly, the body cools to a point at which the production of heat is accelerated and the excess is available to bring the body temperature back to normal.

Interference with the elimination of heat leads to its accumulation and thus to the elevation of body temperature. As a result, the person is said to have a fever. When such a condition exists, it produces a vicious cycle in which certain body processes speed up and generate additional heat. Then the body must eliminate not only the normal but also the additional quantities of heat.

Heat produced within the body is brought to the surface largely by the bloodstream and escapes to the cooler surroundings by conduction and radiation. If air movement or a breeze strikes the body, additional heat is lost be convection. However, when the temperature of the surrounding air becomes equal to or rises above that of the body, all of the heat must be lost by vaporization of the moisture or sweat from the skin surface. As the air becomes more humid (contains more moisture), vaporization from the skin slows down. Thus, on a day when the temperature is 95 to 100°F, with high humidity and little or no breeze,, conditions are ideal for the retention of heat within the body. It is on such a day, or more commonly a succession of such days (a heat wave), that medical emergencies due to heat are likely to occur. Such emergencies are classified in three categories: heat cramps, heat exhaustion, and heat stroke.

1. HEAT CRAMPS

Heat cramps usually affect people who work in hot environments and perspire a great deal. Loss of salt from the body causes very painful cramps of the leg and abdominal muscles. Heat cramps also may result from drinking iced water or other drinks either too quickly or in too large a quantity.

Heat Cramp Symptoms. The symptoms of heat cramp are:

- Muscle cramps in legs and abdomen,
- Pain accompanying the cramps,
- Faintness, and
- Profuse perspiration.

Heat Cramp Emergency Care. Remove the patient to a cool place. Give him sips of liquids such as "Gatorade" or its equivalent. Apply manual pressure to the cramped muscle. Remove the patient to a hospital if there is any indication of a more serious problem.

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2. HEAT EXHAUSTION

Heat exhaustion occurs in individuals working in hot environments, and may be associated with heat cramps. Heat exhaustion is caused by the pooling of blood in the vessels of the skin. The heat is transported from the interior of the body to the surface by the blood. The blood vessels in the skin become dilated and a large amount of blood is pooled in the skin. This condition, plus the blood pooled in the lower extremities when an individual is in an upright position, may lead to an inadequate return of blood to the heart and eventually to physical collapse.

Heat Exhaustion Symptoms. The symptoms of heat exhaustion are:

- Weak pulse;
- Rapid and usually shallow breathing;
- Generalized weakness;
- Pale, clammy skin;
- Profuse perspiration;
- Dizziness;
- Unconsciousness; and
- Appearance of having fainted (the patient responds to the same treatment administered in cases of fainting).

Heat Exhaustion Emergency Care. Remove the patient to a cool place and remove as much clothing as possible. Administer cool water, "Gatorade," or its equivalent. If possible, fan the patient continually to remove heat by convection, but do not allow chilling or overcooling. Treat the patient for shock, and remove him to a medical facility if there is any indication of a more serious problem.

3. HEAT STROKE

Heat stroke is a profound disturbance of the heat-regulating mechanism, associated with high fever and collapse. Sometimes this condition results in convulsions, unconsciousness, and even death. Direct exposure to sun, poor air circulation, poor physical condition, and advanced age (over 40) bear directly on the tendency to heat stroke. It is a serious threat to life and carries a 20 percent mortality rate. Alcoholics are extremely susceptible.

Heat Stroke Symptoms. The symptoms of heat stroke are:

- Sudden onset;
- Dry, hot, and flushed skin;
- Dilated pupils;
- Early loss of consciousness;
- Full and fast pulse;
- Breathing deep at first, later shallow and almost absent;
- Muscle twitching, growing into convulsions; and
- Body temperature reaching 105 to 106°F or higher.

Heat Stroke Emergency Care. Remember that this is a true emergency. Transportation to a medical facility should not be delayed. Remove the patient to a cool environment if possible, and remove as much clothing as possible. Assure an open airway. Reduce body temperature promptly, preferably by wrapping in a wet sheet or else by dousing the body with water.

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If cold packs are available, place them under the arms, around the neck, at the ankles, or at any place where blood vessels that lie close to the skin can be cooled. Protect the patient from injury during convulsions, especially from tongue biting.

B. AVOIDANCE OF HEAT-RELATED EMERGENCIES

Please note that in the case of heat cramps or heat exhaustion, "Gatorade" or its equivalent is suggested as part of the treatment regime. The reason for this type of liquid refreshment is that such beverages will return much-needed electrolytes to the system. Without these electrolytes, body systems cannot function properly, thereby increasing the represented health hazard. Therefore, when personnel are working in situations where the ambient temperatures and humidity are high, and especially in situations where protection Levels A, B, and C are require, the site safety officer must:

- Assure that all employees drink plenty of fluids ("Gatorade" or its equivalent);
- Assure that frequent breaks are scheduled so overheating does not occur; and
- Revise work schedules, when necessary, to take advantage of the cooler parts of the day (e.g., 5:00 a.m. to 1:00 p.m. and 6:00 p.m. to nightfall).
- Assure that workers are acclimated before allowing them to work for extended periods. Heat induces a series of physiological and psychological stresses that the individual worker must adjust to during the first week of heat exposure. Workers should slowly work into their peak work performance over a two-week period. Workers absent from the site several days must be allowed to become reacclimated.

If protective clothing must be worn, especially Levels A and B, the suggested guidelines for ambient temperature and maximum wearing time per excursion are given in the following Table:

Suggested guidelines for continuous use of Level A or Level B protection:

Ambient Temperature (°F)	Maximum Wearing Time per Excusion (minutes)
Above 90	15
85 to 90	30
80 to 85	60
70 to 80	90
60 to 70	120
50 to 60	180

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C. REST-RECOVERY REGIME

One method of measuring the effectiveness of employees' rest-recovery regime is by monitoring the heart rate. The "Brouha Guideline" is one such method:

- During a three-minute period, count the pulse rate for the last 30 seconds of the first minute, the last 30 seconds of the second minute, and the last 30 seconds of the third minute.
- Double the count.

If the recovery pulse rate during the last 30 seconds of the first minute is at 110 beats/minute or less, and the deceleration between the first, second, and third minutes is at least 10 beats/minute, the work-recovery regime is acceptable. If the employee's rate is above that specified, a longer rest period is required, accompanied by an increase intake of fluids .

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HEAT STRESS MONITORING

NAME: ______________________ DATE/TIME: ________________

SITE: ________________

COMPANY: ______________________ LOCATION: ________________

Pulse Rate Monitoring (30 second rest prior to first measurement):

Starting Time: __________ Pulse Rate: ________ beats/minute;

rest 30 sec.; ___________; rest 30; ___________ b/m;

rest 30 sec.; ___________; rest 60; ___________ b/m;

rest 60 sec.; ___________; rest 60: ___________ b/m;

Starting Time: __________ Pulse Rate: ________ beats/minute;

rest 30 sec.; ___________; rest 30; ___________ b/m;

rest 30 sec.; ___________; rest 60; ___________ b/m;

rest 60 sec.; ___________; rest 60: ___________ b/m;

Starting Time: __________ Pulse Rate: ________ beats/minute;

rest 30 sec.; ___________; rest 30; ___________ b/m;

rest 30 sec.; ___________; rest 60; ___________ b/m;

rest 60 sec.; ___________; rest 60: ___________ b/m;

Starting Time: __________ Pulse Rate: ________ beats/minute;

rest 30 sec.; ___________; rest 30; ___________ b/m;

rest 30 sec.; ___________; rest 60; ___________ b/m;

rest 60 sec.; ___________; rest 60: ___________ b/m;

Method of Measurement:

Carotid Artery: __________; Instrument (specify type): ______________

Self-Determined & Reported: _______

Site Safety Officer: __________(Contractor); _______(Contract Monitor)

____
Site Safety Officer

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ATTACHMENT C

ON-SITE DOCUMENTATION FORMS

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ON-SITE SAFETY MEETING RECORD

Page 1 of 2

= =

PROJECT NAME: ______________________________ JOB No.: ____________

DATE: ____________ TIME:_______ LOCATION:__________________________

REASON FOR MEETING: (Check all that apply)

[ ] Initial site safety briefing.
[ ] Beginning of new task. Task: __________________________
[ ] Periodic safety meeting.
[ ] New site procedures.
[ ] New site information.
[ ] Review of site incident.
[ ] Other (explain) _____________________________________

____

EETING ATTENDEES:

	Name	Affiliation
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
).		
11.		
12.		

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ON-SITE SAFETY MEETING RECORD

Page 2 of 2

PROJECT NAME: JOB No.:

DATE: TIME: LOCATION:

SAFETY TOPICS PRESENTED:

[ ] Site Safety Personnel
[ ] Site Description
[ ] Work Area Description
[ ] Site Characterization
[ ] Work Area Characterization
[ ] Chemical Hazard Evaluation
[ ] Physical Hazard Evaluation
[ ] Toxicological Review
[ ] Heat Stress
[ ] Cold Stress
[ ] Site Layout and Control Measures
[ ] Work Zones
[ ] Personnel Protective Equipment
[ ] Air Monitoring
[ ] Safe Work Practices - General
[ ] Safe Work Practices - Task
[ ] Decontamination Procedures
[ ] Emergency Response Plan
[ ] Emergency Response Personnel
[ ] On-site Emergencies
[ ] Off-site Emergencies
[ ] Site Evacuation Procedures
[ ] Work Area Evacuation Procedures
[ ] Places of Refuge
[ ] Emergency Decontamination
[ ] Emergency Equipment
[ ] Emergency Telephone Numbers
[ ] Directions to Hospital
[ ] Medical Monitoring
[ ] Training

Other Topics or Notes :

NAME OF PRESENTER:

TITLE OF PRESENTER:

SIGNATURE: DATE:

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INCIDENT REPORT

Page 1 of 6

Inc. rpt. no.:_______-___

DATE OF REPORT ________________

SITE: ____

SITE LOCATON: ____

REPORT PREPARED BY: _____________________________________

NAME PRINTED TITLE

INCIDENT CATEGORY
(check all that apply)

- ___ Injury
- ___ Near Miss
- ___ Motor Vehicle
- ___ Mechanical
- ___ Illness
- ___ Fire
- ___ On site equipment
- ___ Other
- ___ Property Damage
- ___ Chemical Exposure
- ___ Electrical

DATE AND TIME OF INCIDENT ______________________________________

Narrative Report of Incident:
(Provide sufficient detail so that the reader may fully understand the actions leading to or contributing to the incident, the incident occurrence, and actions following the incident. Append additional sheets of paper if necessary.)

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INCIDENT REPORT
Page 2 of 6

Inc. rpt. no.:_______-___

WITNESSES TO INCIDENT

1. NAME______________________________COMPANY________________
ADDRESS____
TELEPHONE NO.____

2. NAME______________________________COMPANY________________
ADDRESS____
TELEPHONE NO.____

INJURIES

FIRST INJURED PERSON

Name and Address of Injured: ____________________________

____

SSN: _______________ Age:______ Sex:______

Years of Service: _________ Time on Present Job: ______

Title/Classification: __________________________________

Severity of Injury or Illness: _____ Non-disabling
____ Disabling ____ Medical Treatment
____ Fatality

Estimated Number of Days Away From Job: _________________

Nature of Injury or Illness: ___________________________

____

Classification of Injury:

____ Fractures ____ Heat Burns ____ Cold Exposure
____ Dislocations ____ Chemical Burns ____ Frostbite

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Inc. rpt. no.:_______-____

____ Sprains
____ Abrasions
____ Lacerations
____ Punctures
____ Faint/Dizziness
____ Respiratory Allergy
____ Dermal Allergy

____ Radiation Burns
____ Bruises
____ Blisters
____ Toxic Respiratory Exposure

____ Heat Stroke
____ Heat Exhaustion
____ Concussion
____ Bites
____ Toxic Ingestion

Part of Body Affected: ______________________________
Degree of Disability: ______________________________

Date Medical Care was Received: ____________________
Where Medical Care was Received: ____________________
Address (if off-site):

____

If Hospitalized
Name, Address and Telephone No. of Hospital:

____

Name, Address and Telephone No. of Physician

____

SECOND INJURED PERSON

Name and Address of Injured: ______________________

____

SSN: ______________ Age:______ Sex:______

Years of Service: ________ Time on Present Job: _____

Title/Classification: ____________________________

Severity of Injury or Illness: ____ Non-disabling
____ Disabling ____ Medical Treatment
____ Fatality

Estimated Number of Days Away From Job: ______________

Nature of Injury or Illness: ______________________
____

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Inc. rpt. no.:________-____

Classification of Injury:

____ Fractures
____ Dislocations
____ Sprains
____ Abrasions

____ Lacerations
____ Punctures
____ Faint/Dizziness
____ Respiratory Allergy

____ Dermal Allergy

____ Heat Burns
____ Chemical Burns
____ Radiation Burns
____ Bruises

____ Blisters
____ Toxic Respiratory Exposure

____ Cold Exposure
____ Frostbite
____ Heat Stroke
____ Heat Exhaustion
____ Concussion
____ Bites
____ Toxic Ingestion

Part of Body Affected: ______________________________
Degree of Disability: ______________________________
Date Medical Care was Received: ____________________
Where Medical Care was Received: ___________________
Address (if off-site):

____

If Hospitalized
Name, Address and Telephone No. of Hospital:

____

Name, Address and Telephone No. of Physician

____

(If more than two injuries, provide information on separate sheet).

PROPERTY DAMAGE

Brief Description of Property Damaged

____
____
____

Estimate of damage: $____________________________

INCIDENT REPORT
Page 5 of 6

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Inc. rpt. no.:________-____

INCIDENT LOCATION

____

____

____

INCIDENT ANALYSIS

Causative agent most directly related to accident (Object, substance, material, machinery, equipment, conditions):

____

____

Was weather a factor?: ______________________________

Unsafe mechanical/physical/environmental condition at time of incident (Be specific):

____

____

Unsafe act by injured and/or others contributing to the incident (Be specific, must be answered):

____

____

Personal factors (Improper attitude, lack of knowledge or skill, slow reaction, fatigue):

____

____

On Site Incidents

Level of personal protection equipment required in Site Safety Plan:______________

____

____

Modifications:______________________________

____

____

Was injured using required equipment?:______________________________

____

____

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Inc. rpt. no.:_______-____

If not, how did actual equipment use differ from plan:

ACTION TAKEN TO PREVENT RECURRENCE

(Be very specific. What has or will be done? When will it be done? Who is the responsible party to insure that the correction is made?)

INCIDENT REPORT COMPLETED BY

HSO Name Printed

HSO Signature

OTHERS PARTICIPATING IN INVESTIGATION

Name Printed	Signature	Title
Name Printed	Signature	Title
Name Printed	Signature	Title

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INCIDENT FOLLOW-UP REPORT

Incident No.: ____________________ Date of Incident: ____________

Site Name: ____________________________ Project No.: ____________

Follow-up Prepared By: ______________________ Date: ____________

Outcome of Incident: ____

____

Physicians Recommendations:
First Injured Person: ____

Second Injured Person: ____

Other Injured Persons: ____

____

Date Returned to Work:
First Injuried Person: ____________________

Second Injured Person: ____________________

Other Injured Persons: ____________________

____

Have corrective actions recommended by investigation been implemented ? If not, explain why not. What alternative actions have been taken?

____

____

____

____

Investigation Team:

Name Printed	Signature	Title

ATTACH ANY ADDITIONAL INFORMATION

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SCBA

RESPIRATORY LOG

SITE: ______________________________

LOCATION: ____________________________

DATES OF INVESTIGATION: ________________

User	Date of Use	SCBA#	Satisfactory Check-Out (Yes/No - Initials)	Date Cleaned

SCBA Performance Comments:

Site Health and Safety Officer Date

or ES Project Manager

Return to Office Health and Safety Representative at the completion of field activities.

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AIR PURIFYING

RESPIRATOR LOG

SITE: ____________________

LOCATION: ____________________

DATES OF INVESTIGATION: ____________________

User	Date of Use	Cleaned and Inspected Prior To Use (Initials)	Cartridges Changed Prior to Use (Yes, NO, N/A)	Total Hours on Cartridge

____

Site Health and Safety Officer or ES Project Manager — Date

Return to Office Health and Safety Representative at the completion of field activities.

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Site Entry Log:

SITE: ______________________________

LOCATION: ______________________________

DATES OF INVESTIGATION: ______________________________

Date	Name	Company	Activity	Time in / Time out

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FIELD AIR MONITORING LOG

DATE ____________

SITE: ____

PAGE ____ OF ____

SITE SAFETY OFFICER: ____________________

SAFETY MONITORS: ____________________

____

WEATHER CONDITIONS: ____

INSTRUMENTATION CONDITIONS: ____

ACTIVITY/REASON FOR MONITORING	LOCATION	TIME	READING	INITIALS

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AIR MONITORING INSTRUMENT

page ___ of ___

CALIBRATION LOG

Project Name : ______________________ Project Location: ______________________

Job Number: ______________________

Instrument Type: ______________________ Instrument Number: ______________________

Date	Cal Gas Conc.	Instrument Reading	Adjusted (Y/N)	New Setting	New Reading	Maintenance Notes	Initials

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ATTACHMENT D

PERSONAL PROTECTIVE EQUIPMENT PROGRAM

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Personal Protective Equipment Program

Chas. T. Main, Inc.

January 1991

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PERSONAL PROTECTIVE EQUIPMENT PROGRAM

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Chas. T. Main, Inc.

PERSONAL PROTECTIVE EQUIPMENT PROGRAM

1.0 PROGRAM ADMINISTRATION

1.1 PURPOSE

It is the responsibility of Chas. T. Main, Inc. to provide a safe and healthful workplace. The purpose of this operating procedure is to ensure the protection of all hazardous waste operations employees from respiratory and other site hazards, through proper use of Personal Protective Equipment (PPE). The term PPE includes equipment for eye and face protection, respiratory protection, occupational head protection, and occupational foot protection. Respirators are to be used only where engineering control of respiratory hazards is not feasible, while engineering controls are being installed, or in emergencies. This program supplements the corporate Health and Safety Manual and conforms to 29 CFR 1910 Subpart I shown as Attachment A.

1.2 RESPONSIBILITY

The Manager of the Environmental Division is solely responsible for all facets of this program and has full authority to make necessary decisions to ensure success of this program. This authority includes requisition of personnel and equipment purchases necessary to implement and operate the program.

The Corporate Health and Safety Officer (HSO) will develop written detailed instructions covering each of the basic elements in this program. The HSO and the Manager are the only people authorized to amend these instructions.

Chas. T. Main, Inc. has expressly authorized the HSO to halt any hazardous waste operation of the company where there is danger of serious personal injury. This policy includes respiratory hazards.

1.3 PROGRAM ELEMENTS

1.3.1 The HSO will develop detailed written standard operating procedures (SOP) governing the selection and use of PPE. Outside consultation, manufacturer's assistance, and other recognized authorities will be consulted if there is any doubt regarding proper selection and use of PPE. Only the HSO in conjunction with the Health and Safety Committee may amend these procedures.

1.3.2 PPE will be selected on the basis of hazards to which the worker is exposed. All selections will be made by the Site Safety Officer (SSO) and reviewed and approved by the HSO. Only NIOSH/MSHA-certified respirators will be selected and used.

1.3.3 The user will be instructed and trained in the proper use of PPE including respirators and their limitations. Supervisors and workers will be so instructed by a qualified person. Training should provide the employee an opportunity to handle the respirator, have it fitted properly, test its facepiece-to-face seal, wear it in normal air for a long familiarity period, and finally to wear it in a test atmosphere. Every

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respirator wearer will receive fitting instructions, including demonstrations and practice in how the respirator should be worn, how to adjust it, and how to determine if it fits properly.

Respirators should not be worn when conditions prevent a good face seal. Such conditions may be a growth of beard, sideburns, a skull cap that projects under the facepiece, or temple pieces on glasses. No employees of Chas. T. Main, Inc., who are required to wear respirators, may wear beards. Also the absence of one or both dentures can seriously affect the fit of a facepiece. The worker's diligence is observing these factors will be evaluated by periodic checks. To assure proper protection, the facepiece fit will be checked by the wearer each time the wearer puts on the respirator. This will be done by following the manufacturer's facepiece-fitting instructions.

1.3.4 Where practicable, the respirators will be assigned to individual workers for their exclusive use.

1.3.5 Respirators will be regularly cleaned and disinfected. Those issued for the exclusive use of one worker will be cleaned after each day's use, or more often if necessary. Those used by more than one worker will be thoroughly cleaned and disinfected after each use. The HSO will establish a respirator cleaning and maintenance facility and develop detailed written cleaning instructions if warranted because there are multiple users of each respirator at any site.

1.3.6 PPE will be stored in a clean and sanitary location.

1.3.7 Respirators used routinely will be inspected during cleaning. Worn or deteriorated parts will be replaced. Respirators for emergency use such as self-contained devices will be thoroughly inspected at least once a month and after each use. Inspection for emergency SCBA breathing gas pressure will be performed weekly.

1.3.8 Appropriate surveillance of work area conditions and degree of employee exposure or stress will be performed.

1.3.9 There will be regular inspection and evaluation to determine the continued effectiveness of the program. The SSO will make frequent inspections of all areas where PPE is used to ensure compliance with this program.

1.3.10 Persons will not be assigned to tasks requiring use of respirators unless it has been determined that they are physically able to perform the work and use the equipment. Parson's physician will determine what health and physical conditions are pertinent. The respirator user's medical status will be reviewed annually.

1.3.11 Only certified respirators will be used.

2.0 PROCEDURE FOR SELECTION OF RESPIRATORY PROTECTION EQUIPMENT*

2.1 INTRODUCTION

Personnel performing hazardous waste site operations often encounter harmful dusts, vapors, and gases above the permissible exposure limit. This section provides procedures to aid personnel in the selection of respiratory protection equipment.

2.2 SELECTION PROCEDURE

The investigation of hazardous waste sites presents workers with a number of potential environmental exposure situations, some of which are better defined than others. Each site situation is unique. This document recognizes that many respiratory decisions involve aspects of risk assessment. This procedure ensures that all relevant data are considered in the process of conducting respiratory risk assessments resulting in the selection of specific respiratory equipment items for protection against hazardous chemical exposure. Steps to take include:

1. Assimilate all available information pertaining to the hazard including: past activities, suspected materials, historical information, land use, analytical data, nature of current activities, etc.

2. Evaluate the relevancy and timeliness of the data to determine the appropriate protective level needed for the task.

    a) Is the analytical data relevant?

    b) Was the past sampling or monitoring conducted during the same season as is anticipated for the activities planned? If not what implication might this hold?

    c) Was past sampling or monitoring conducted from a medium which is pertinent to evaluate hazards associated with the activities specified in the task work plan?

3. Identify substances present at the work area.

4. Utilizing the topics listed below, evaluate any of the known or suspected chemicals on site. Topics requiring elaboration are detailed in the decision logic criteria section (see Figure 2-1).

    a) Permissible Exposure Limits (PEL), Threshold Limit Values (TLV).

    b) Eye irritation potential for substance (see decision logic criteria section).

---

* This procedure is derived from Engineering-Science, Inc. Health and Safety Training Manual for Hazardous Waste Operations, May 1988.

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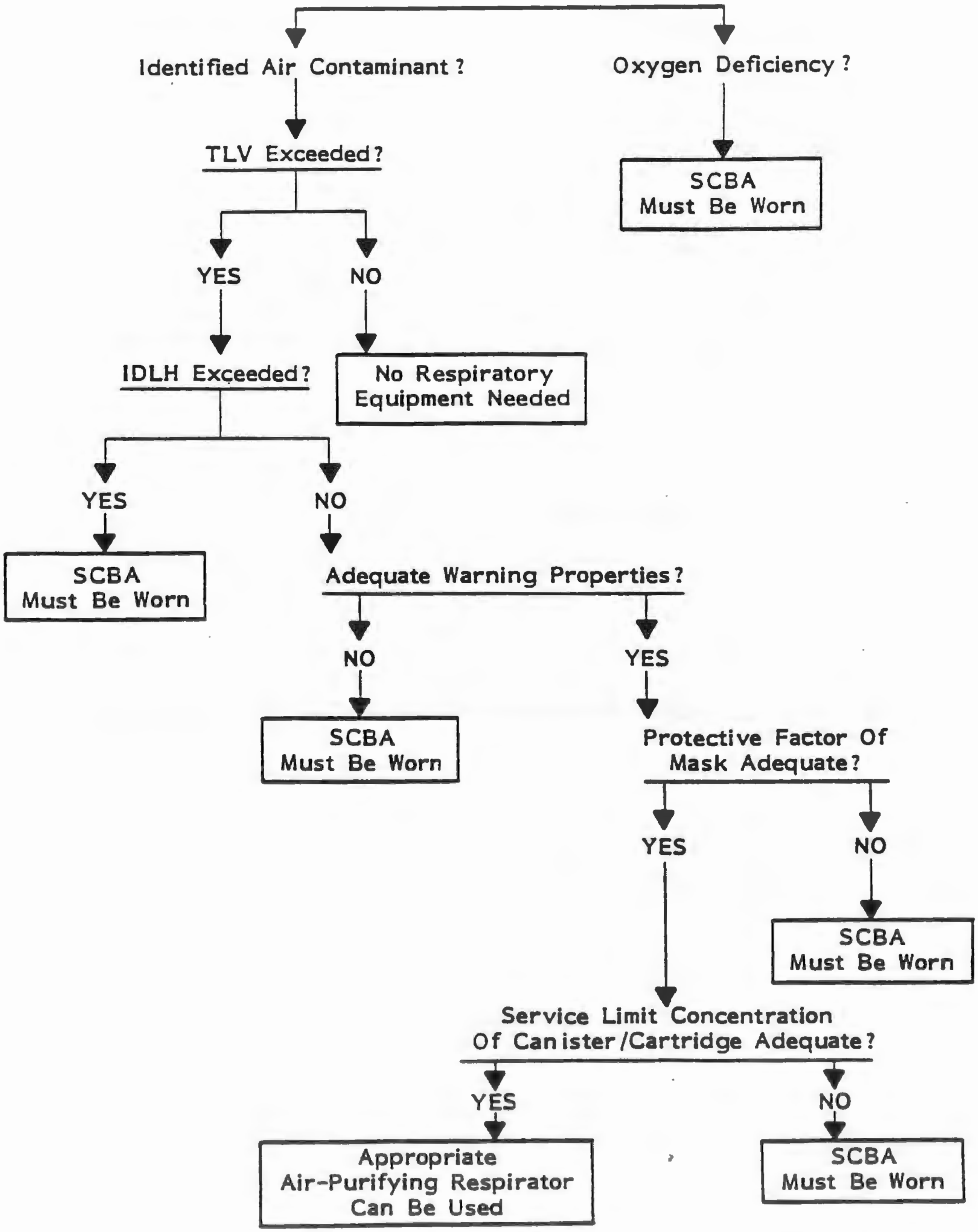
FIGURE 2-1

DECISION LOGIC FLOW CHART ON CHOOSING APPROPRIATE RESPIRATOR



c) Warning properties of substance (see decision logic criteria section).

d) Immediately Dangerous to Life and Health (IDLH) (see decision logic criteria section).

e) Any possibility of poor sorbent efficiency at IDLH concentrations and below.

f) Is there a possibility of severe skin irritation resulting from contact of the skin with corrosive gases (see decision logic criteria section).

g) The vapor pressure of the substance.

h) Any possibility of high heat of reaction with sorbent material in cartridge or canister (see below, decision logic criteria).

i) Is there a possibility of shock sensitivity of chemical being sorbed onto the cartridge or canister (see below, decision logic criteria).

5. Determine the physical state(s) of the substance as it is likely to be encountered at the hazardous waste site. It will be either: a) a gas or vapor; b) particulate (dust, fume, or mist), or c) a combination of (a) and (b).

6. Oxygen deficient atmospheres (ANSI Z88.2-1980) -- air-purifying respirators shall not be worn in environments deficient in oxygen (<19.5% by volume or partial pressure less than 100 mm of mercury).

2.3 DECISION LOGIC CRITERIA

2.3.1 Skin Adsorption and Irritation

A supplied-air suit may provide skin protection from extremely toxic substances which may be absorbed through the skin or cause severe skin irritation. Most information concerning skin irritation is not quantitative but rather is presented in commonly used descriptive terms, such as "a strong skin irritant, highly irritating to the skin" and "corrosive to the skin." Decisions made concerning skin irritation are judgmental and are often based on this nonquantitative information. As a guideline for the use of the supplied-air suit for substances that are sorbed through the skin, a single skin penetration LD_{50} of 2 g/kg for any animal species is used.

2.3.2 Poor Warning Properties

Air-purifying devices cannot be used to protect against organic vapors with poor warning properties. Warning properties include odor, eye irritation, taste imparting characteristics, and respiratory irritation. Warning properties provide an indication to the wearer of possible cartridge exhaustion or of poor face piece fit. Adequate warning properties can be assumed when the substances odor, taste, or irritation effects are detectable and persistent at concentrations at or below the Threshold Limit Value.

If the odor or irritation threshold of a substance is more than three times greater than the TLV, this substance should be considered to have poor warning properties. If the substance odor or irritation threshold is slightly above the Threshold Limit Value (not in excess of three times the limit) and there is no ceiling limit, consideration should be given to whether undetected exposure in this concentration range could cause serious or irreversible health effects. Some substances have extremely low thresholds of odor and irritation in relation to the permissible exposure limit. These substances can be detected by a worker within the face piece of the respirator even when the respirator is functioning properly. These substances are considered to have poor warning properties (see Table 2-1).

Although 30 CFR Part 11* does not specifically eliminate the use of air-purifying respirators for pesticides with poor warning properties, prudent practices dictate that a respirator should not be used to protect against any substance with poor warning properties.

2.3.3 Sorbents

There are certain limitations to the use of sorbent cartridge/canister respirators. When the following conditions exist, a sorbent cartridge is not recommended:

- A cartridge/canister air-purifying respirator can never be used when evidence exists of immediate (less than 3 minutes) break-through time at or below the IDLH concentration.
- An air-purifying canister/cartridge respirator shall not be used when there is reason to suspect that the sorbent does not provide adequate efficiency against the removal of a specific contaminant(s) that may be encountered at the site.
- Where there is reason to suspect that a sorbent has a high heat of reaction with a substance, use of that sorbent is not allowed.
- Where there is reason to suspect that a substance sorbed onto the surface of a cartridge or canister is shock sensitive, use of air-purifying respirators is prohibited.

2.3.4 Eye Irritation

The decision of whether to use a full-face respirator or a half or quarter-face respirator is often made by considering the chemical's potential for producing eye irritation or damage. The following guidelines deal with eye protection.

Any eye irritation is considered unacceptable for routine work activities. Therefore, only full-face respirators are permissible in contaminant concentrations that produce eye irritation. For escape, some eye irritation is permissible if it is determined that such irritation would not inhibit escape and such irritation is reversible.

---

*The primary technical criteria for what constitutes a permissible respirator is determined by the technical requirements of 30 CFR Part 11 (Department of Interior, Bureau of Mines, Respiratory Protective Devices and Test for Permissibility).

TABLE 2-1
COMPARISON OF SELECTED ODOR THRESHOLDS AND TLVs FOR CHEMICAL COMPOUNDS

Compounds	Odor Threshold (ppm)	TLV (ppm)
Group 1 - Odor Threshold and TLV Approximately the Same		
Acrylonitrile	21	20
Arsine	0.21	0.05
Cyclohexane	300	300
Cyclohexanol	100	50
Epichlorhydrin	10	5
Ethyl benzene	200	100
Ethylene diamine	11	10
Hydrogen chloride	10	5
Methyl acetate	200	200
Methylamine	10	10
Methyl chloroform	500	350
Nitrogen dioxide	5	5
Propyl alcohol	200	200
Styrene monomer	200	100
Turpentine	200	100
Group 2 - Odor Threshold from 2 to 10 Times the TLV		
Acrolein	0.2	0.1
Allyl alcohol	7	2
Carbon tetrachloride	75	10
Chloroform	200	25
1,2-Dichloroethylene	500	200
Dichloroethyl ether	35	5
Dimethyl acetamide	46	10
Hydrogen selenide	0.3	0.05
Isopropyl glycidyl ether (IGE)	300	50
Group 3 - Odor Threshold Equal to or greater than 10 Times the TLV		
Bromoform	530	0.5
Camphor (synthetic)	1.6-200	2
Chloroacetophenone	1	0.05
Chloropicrin	1	0.1
Crotonaldehyde	7	0.1
Diglycidyl ether (DGE)	5	0.5
Dimethylformamide	100	0
Ethylene oxide	500	50
Methyl formate	2000	100
Methanol	2000	200
Methyl cyclohexanol	500	50
Phosgene	1.0	0.1
Toluene 2,4-diisocyanate (TDI)	2	0.2

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In instances where quantitative eye irritation data cannot be found in literature references, and theoretical considerations indicate that the substance should not be an eye irritant, half-face piece respirators are allowed.

In cases where a review of the literature indicates a substance causes eye irritation but no eye irritation threshold is specified, the full-face piece respirators can be used.

2.3.5 IDLH

The definition of IDLH provided in 30 CFR 11.3(t) is as follows:

> "Immediately dangerous to life or health" means conditions that pose an immediate threat to life or health or conditions that pose an immediate threat of severe exposure to contaminants, such as radioactive materials, which are likely to have adverse cumulative or delayed effects on health."

The purpose of establishing an IDLH exposure concentration is to insure that the worker can escape without injury or irreversible health effects in the event of failure of the respiratory protective equipment. The IDLH is considered the maximum concentration above which only a highly reliable positive-pressure self contained breathing apparatus is permitted. Since IDLH values are conservatively set, any approved respirator may be used up to its maximum use concentration below the IDLH.

In establishing the IDLH concentration the following factors are considered:

1. Escape without loss of life or irreversible health effects. Thirty minutes is considered the maximum permissible exposure time for escape.

2. Severe eye or respiratory irritation or other reactions which would prevent escape without injury.

IDLH should be determined from the following sources:

1. Specific IDLH concentration provided in the literature such as the AHIA Hygienic Guides

2. Human exposure data

3. Acute animal exposure data

4. Acute toxicological data from analogous substances.

The following guidelines should be used to interpret toxicological data reported in the literature for animal species:

1. Where acute inhalation exposure data (30 minutes to 4 hours) are available for various animal species, the lowest exposure concentration causing death or irreversible health effects in any species is determined to be the IDLH concentration.

2. Chronic exposure data may have little relevance to the acute effects and should not be used in determining the IDLH.

2.3.6 Protection Factors

The protection factors of respiratory protection devices are a useful numerical tool to aid in the selection of appropriate respiratory protection. Protection factors measure the overall effectiveness of a respirator.

The protection factor of a given respirator for a specific user multiplied by the TLV for a given substance is the maximum allowable concentration of that substance for which the respirator may be used. For example, if the protection factor for a full-face mask respirator is 50 and substance X has a PEL (or TLV) of 10 ppm, the full-face mask respirator will provide protection up to 500 ppm (see Table 2-2). However, air purifying respirators may not be used at or above the IDLH.

2.3.7 Escape

Employees will carry an escape respirator on initial site entries (as required in 29 CFR Part 1910.120) or where exposure to extremely toxic substances may occur. (An extremely toxic substance is defined as a gas or vapor having an LC_{50} equal to or less than 10 ppm).

2.4 Respirator Types

2.4.1 Air-Purifying Respirators

Air-purifying respirators can be used only if the atmosphere contains greater than 19.5 percent oxygen, the contaminant is present at a concentration below the IDLH level and there is a suitable filter or sorbent medium. Canisters for APRs are color coded for the air contaminants to be protected against. This color code, per 29 CFR1910.134-(g), is shown in Table 2-3. Another important consideration in selecting APRs is that the contaminant in question has properties which will alert the user that the filter or sorbent is about to be exhausted. The various types of APRs are as follows:

Disposable Dust Respirators - Many disposable cloth and paper respirators are NIOSH approved, and many more are not. Those with approval provide protection against nuisance dusts. With this type of respirator it is very difficult to fit-test and maintain a good facepiece-to-face seal.

Mouthbit Respirators - Mouthbit respirators are approved for escape only. The mouth piece is held by the teeth and a clamp is used to close the nostrils. A cartridge-type filter removes the contaminant from the atmosphere. This type of respirator can only be used when the hazard is identified and the respirator is approved for that hazard.

Quarter-Mask Respirators - The quarter-mask is used with cartridges or cloth filters for toxic and nontoxic dusts with TLVs above 0.05 mg/m^3. At concentrations below 0.05 mg/m^3, a more efficient respirator must be used.

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TABLE 2-2
SELECTED PROTECTION FACTORS OF RESPIRATORS FOR COMBINED GAS/VAPOR AND PARTICULATE EXPOSURE[1]

Assigned Protection Factor	Type of Respirator
10	Any half-mask air purifying respirator (APR). Any half-mask supplied-air respirator operated in a demand mode
25	Any powered APR with a loose-fitting hood or helmet
50	Full facepiece APR. Any supplied air respirator with a tight facepiece operated in continuous flow mode
1000	Any half-mask supplied air respirator operated in pressure demand mode
2000	Any full facepiece supplied air respirator operated in pressure demand mode
10000	SCBAS with full facepiece operated in pressure demand mode Any full facepiece supplied air respirator operated in a pressure demand mode with an auxiliary SCBA

[1] NIOSH 1987 Respirator Decision Logic DHHS Publication No. 87-108.

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TABLE 2-3

ATMOSPHERIC CONTAMINANTS TO BE PROTECTED AGAINST	COLORS ASSIGNED*
Acid gases	White
Hydrocyanic acid gas	White with 1/2 inch green stripe completely around the canister near the bottom
Chlorine gas	White with 1/2 inch yellow stripe completely around the canister near the bottom
Organic vapors	Black
Ammonia Gas	Green
Acid gases and ammonia gas	Green with 1/2 inch white stripe completely around the canister near the bottom
Carbon monoxide	Blue
Acid gases and organic vapors	Yellow
Hydrocyanic acid gas and chloropicrin vapor	Yellow with 1/2 inch blue stripe completely around the canister near the bottom
Acid gases, organic vapors, and ammonia gases	Brown
Radioactive materials, excepting tritium and noble gases	Purple (Magenta)
Particulates (dusts, fumes, mists, fogs, or smokes in combination with any of the above gases or vapors	Canister color for contaminant, as designated above, with 1/2 inch gray strip completely around the canister near the top
All of the above atmospheric contaminants	Red with 1/2 inch gray stripe completely around the canister near the top

*Gray shall not be assigned as the main color for a canister designed to remove acids or vapors.

NOTE: Orange shall be used as a complete body, or stripe color to represent gases not included in this table. The user will need to refer to the canister label to determine the degree of protection the canister will afford.

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The mask fits from the top of the nose to top of the chin. The breathing resistance is high in comparison to larger masks.

Half-Mask Respirators - A half-mask respirator fits from under the chin to above the nose. One or two cartridges are used to filter the air and discarded once the use limits are reached. Whereas the quarter-mask is approved for only dusts, the half-mask has approved cartridges for pesticides, organic vapors, dusts, mists, fumes, acid gases, ammonia, and several combinations.

Full Face Mask Respirators - The whole face, including the eyes, is protected by the full face mask. It gives 5 times the protection of a half-mask (full face mask PF = 50, half-mask PF = 10). Full face masks are more expensive, but the added protection is certainly advantageous, no matter how small the risk in a given situation.

The full face mask may be used with twin cartridges, chin-mounted canisters, or chest or back-mounted canisters. Filters are available for the same materials as for the half-mask, plus several more.

Powered Respirators - There is no breathing resistance associated with powered respirators. These respirators are used with half-mask, full face mask, and special helmets.

2.4.2 Atmospheric Supplying Respirators

Atmosphere supplying respirators provide from 5 minutes to several hours of breathing air. The amount of protection provided is based upon the type of face piece and its mode of operation. The full face mask provides the best protection. Of the three modes of operation, continuous, demand, and pressure-demand, the pressure-demand mode provides the best protection and is the only mode allowed, except for donning.

There are four types of atmosphere supplying respirators: oxygen generating, hose mask, airline, and self-contained breathing apparatus (SCBA). A description of each is presented below.

Oxygen Generating - The oxygen-generating respirator utilizes a canister of potassium superoxide. This chemical reacts with exhaled CO_2 and water vapor to produce oxygen. Oxygen-generating respirators have been used in the military and for escape purposes in mines.

Hose Mask - The hose mask uses a maximum 75-foot long, large diameter hose to transport clean air from a remote area. The air is usually forced to the user by a blower.

Airline Respirator - The airline respirator is similar to the hose mask, except that the air is compressed. The mode of operation must be pressure-demand except during donning. The air must be Grade D or better breathing air, characteristics of Grade D and better breathing air are shown in Table 2-4. No more than 300 feet of airline is allowed.

Self-Contained Breathing Apparatus - The self-contained breathing apparatus (SCBA) allows the wearer to carry a cylinder of compressed air or oxygen without the confinement of a hose or airline. Air must be of Grade D or better quality.

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TABLE 2-4

CHARACTERISTICS OF GRADE D AND BETTER BREATHING AIR

Limiting Characteristics			GRADES			
	D	E	F	G	H	I
%O_2 (v/) Balance predominately N^2 (Note 1)	atm. 19.5-123.5	atm. 19.5-23.5	atm. 19.5-23.5	atm. 19.5-123.5	atm. 19.5-23.5	atm. 19.5-23.5
Water	Note 2	Note 2	Note 2	Note 2	Note 2	1-10.4°F
Hydrocarbons (condensed) in Mg/m^3 of gas at NTP (Note 3)	5	5				
CO	20	10	5	5	5	1
Odor	*	*	*	*	*	*
CO_2	1000	500	500	500	0.5	
Gaseous Hydrocarbons (as methane)			25	15	10	0.5
Nitrogen Dioxide				2.5	0.5	0.1
Nitrous Oxide						0.1
Sulfur Dioxide				2.5	1	0.1
Halogenated Solvents				10	1	0.1
Acetylene						0.05

*Adapted from Compressed Gas Association, Inc., Air Specifications G-7.1

[Note 1: The term "atm" (atmospheric) denotes the normal oxygen content of atmospheric air numbers indicate oxygen limits for synthesized air.
Note 2: The water content of compressed air required for a particular grade can vary from saturated to dry depending upon the intended use. If a specific water limit is required, it should be specified as a limiting dewpoint (expressed in temperature °F at one atmosphere absolute pressure) or concentration ppm (v/v).
Note 3: No limits are given for condensed hydrocarbons beyond Grade E since gaseous hydrocarbon limits could not be met if condensed hydrocarbons were present.]

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Depending upon the source of air, the SCBA can be either open or closed-circuit. Closed circuit devices mix pure oxygen from a small cylinder and exhaled breath (CO_2 removed) to provide breathing air. This type of device, also referred to as a rebreather, is approved only as a demand-type respirator.

Open-circuit SCBAs are approved as pressure demand because of the greater protection afforded by pressure-demand apparatus.

An escape SCBA must have at least 5 minutes of breathing air stored in a small cylinder or coiled stainless steel tube. Some devices on the market have 15 minute air supplies.

Escape devices should never be used for entry into hazardous atmospheres.

3.0 PROCEDURE FOR SELECTION OF CHEMICAL PROTECTIVE CLOTHING

3.1 INTRODUCTION

Chemical protective clothing (CPC) is needed to ensure the health and safety of field personnel involved with hazardous substances. Specific protective garments are selected on the basis of a variety of criteria. Clothing is selected by evaluating the performance characteristics of the clothing against the requirements and limitations of the site- and task-specific conditions. The selection of chemical protective clothing is a complex task and should be performed by personnel with training and experience.

3.2 CONSIDERATIONS FOR CHOICE OF PROTECTIVE CLOTHING

3.2.1 Performance Requirement

Clothing must be able to withstand a variety of physical abuses. The advantages and disadvantages of reusable versus disposable clothing must be considered.

3.2.2 Construction Requirements

The construction requirements of any garment depend on the intended use of the garment. The material that the garment is made of has been selected due to its effectiveness as a barrier against specific hazards there is no such thing as "universal" protection.

a) The physical construction of the garment must prevent penetration (e.g., location of seams and zippers, size of clothing).

b) The material that the garment is constructed of must resist penetration. In some instances, it may be necessary to layer protective clothing to achieve the desired protection.

3.2.3 Permeation Rate

Permeation rate is affected by a combination of the base material, the nature of the chemicals to which the material is exposed, and the duration and nature of exposure. Most materials allow some degree of permeation.

3.2.4 Ease and Cost of Decontamination

Considerations that should be made upon purchasing garments are the ability and degree to which the garment can be decontaminated and the cost of decontamination. Disposable clothing may be advantageous in some situations; however, such clothing is rather expensive in the long run. In most instances, field personnel will use a combination of disposable and reusable clothing.

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3.2.5 Protective Materials

The following materials are generally available for a number of garments.

1. Cellulose or paper

2. Natural and synthetic fibers
   a) Tyvek
   b) Nomex

3. Elastomers
   a) Polyethylene
   b) Saran-Dow-product
   c) Polyvinyl chloride
   d) Neoprene
   e) Butyl rubber
   f) Chlorapel
   g) Viton
   h) Nitrit

Materials such as Tyvek or paper offer little or no protection against liquid or gaseous hazardous contaminants. Such materials can, however, protect against particulate contaminants. Tyvek should be used as an outer covering over the primary protective gear such as splash or fully encapsulating suits. Although Tyvek provides little chemical resistance, it does limit the amount of direct contamination on the primary protective gear. Tyvek garments are disposable.

Elastomers (polymeric materials that, after being stretched, return to about their original length) provide the best protection against chemical degradation, permeation, and penetration from toxic and corrosive liquids or gases. Elastomers are used in boots, gloves, overalls, and fully encapsulating suits. They are sometime combined with a flame-resistant fabric called Nomex to enhance durability and protection.

The abilities of elastomers to resist degradation and permeation range from poor to excellent. The selection of a particular material should be based on its resistance to chemical degradation, as well as on its ability to resist permeation.

3.2.6 Types of Protective Clothing

Each type of protective clothing has a specific purpose; many, but not all, are designed to protect against chemical exposure. Tables 3-1, and 3-2 describes the types of protective clothing available, details the protection they offer, and lists factors to consider in their selection and use.

3.3 Selection of Work Ensemble

The individual components of clothing and equipment must be assembled into a full protective ensemble that both protects the worker from the site-specific hazards and minimizes the hazards and drawbacks of the personal protective equipment ensemble itself. The four levels of protection presented in the corporate Health and Safety Manual are repeated in the following sections.

TABLE 3-1
CHEMICAL PROTECTION OF CLOTHING MATERIALS BY GENERIC CLASS

GENERIC CLASS	BUTYL RUBBER	POLYVINYL CHLORIDE	NEOPRENE	NATURAL RUBBER
Alcohols	E	E	E	E
Aldehydes	E-G	G-F	E-G	E-F
Amines	E-F	G-F	E-G	G-F
Esters	G-F	P	G	F-P
Fuels	F-P	G-P	E-G	F-P
Halogenated Hydrocarbons	G-P	G-P	G-F	F-P
Hydrocarbons	F-P	F	G-F	F-P
Inorganic acids	G-F	E	E-G	F-P
Inorganic bases and salts	E	E	E	E
Ketones	E	P	G-F	E-F
Natural fats and oils	G-F	G	E-G	G-F
Organic acids	E	E	E	E

Key: E, excellent; F, fair; G, good; P, poor.

Source: "Survey of Personnel Protective Clothing and Respiratory Apparata.." September 1974, Department of Transportation, Office of Research and Development.

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TABLE 3-2
PROTECTIVE CLOTHING AND ACCESSORIES

TYPE OF CLOTHING OR ACCESSORY	DESCRIPTION	TYPE OF PROTECTION
Fully-Encapsulating suit	One-piece garment. Boots and gloves amy be integral, attached and replaceable, or separate.	Protects entire body against splashes, dust, gases, and vapors.
Non-encapsulating suit	Jacket, hood, pants, or bib overalls, and one-piece coveralls.	Protects body against splashes, dust, and other materials but not against gases and vapors. Does not protect parts of head or neck.
Aprons, leggings, and sleeve protectors	Fully sleeved and gloved apron. Separate coverings for arms and legs. Commonly work over nonencapsulating suit.	Provides additional splash protection of chest, forearms, and legs.
Firefighters' protective clothing	Gloves, helmet, running or bunker coat, running or bunker pants (NFPA No. 1971, 1972, 1973), and boots.	Protects against heat, hot water, and some particles. Does not protect against gases and vapors, or chemical permeation or degradation. NFPA Standard No. 1971 specifies that a garment consist of an other shell, an inner liner, and a vapor barrier with a minimum water penetration of 25 lbs/in^2 (1.8 kg/cm^2) to prevent the passage of hot water.
Safety helmet	(Hard plastic or rubber hat)	Protects the head from blows. Helmets shall meet OSHA Standard 29 CFR Part 1910.135.

TABLE 3-2
PROTECTIVE CLOTHING AND ACCESSORIES

TYPE OF CLOTHING OR ACCESSORY	DESCRIPTION	TYPE OF PROTECTION
Face shield	Full-face coverage, eight-inch minimum	Protects face and eyes against chemical splashes.
Safety glasses	Plastic or glass lenses with side shields.	Protects eyes against large particles and projectiles. Safety glasses shall meet OSHA Standards 29 CFR Part 1910.133.
Gloves and sleeves	May be integral, attached, or separate from other protective clothing.	Protects hands and arms from chemical contact.
	Overgloves.	Provides supplemental protection to the wearer and protects more expensive undergarments from abrasions, tears, and contamination.
Safety Boots	Boots constructed of chemical-resistant materials (e.g., neoprene, nitrile, butyl rubber, etc.).	Protects feet from contact with chemicals.

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TABLE 3-2
PROTECTIVE CLOTHING AND ACCESSORIES

TYPE OF CLOTHING OR ACCESSORY	DESCRIPTION	TYPE OF PROTECTION
Safety boots (continued)	Boots constructed with some steel materials (e.g., toes, shanks, insoles).	Protects feet from compression, crushing, or puncture by falling, moving, or sharp objects. All boots must meet specifications required by OSHA (29 CFR Part 1910.136).
	Boots constructed from nonconductive, spark-resistant materials or coatings.	Protects the wearer against electrical hazards and prevents ignition of combustible gases or vapors.
Disposable shoe or boot covers	Made of a variety of materials. Slip over the shoe or boot.	Protects safety boots from contamination. Protects feet from contamination.

SOURCE: NIOSH, OSHA, USCG, EPA. 1985. Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities.

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3.3.1 Level A

Level A protection should be used when percutaneous hazards exist or where there is no known data to rule out percutaneous hazards. Since wearing a fully encapsulated suit is physiologically and psychologically stressful, the decision to use this protection must be carefully considered. The following conditions suggest a need for Level A protection.

- The hazardous substance has been identified and requires the highest level of protection for skin, eyes, and the respiratory system based on either the measured (or potential for) high concentration of atmospheric vapors, gases, or particulates; or based on the site operations and work functions involve a high potential for splash, immersion, or exposure to unexpected vapors, gases, or particulates of materials that are harmful to skin or capable of being absorbed through the intact skin.
- Substances with a high degree of hazard to the skin are known or suspected to be present, and skin contact is possible.
- Operations must be conducted in confined, poorly ventilated areas and the absence of conditions requiring Level A have not yet been determined.

The following items constitute Level A protection.

1. Positive pressure, full-facepiece, self-contained breathing apparatus (SCBA) or positive pressure supplied air respirator with escape SCBA, approved by NIOSH/MSHA.
2. Totally-encapsulating chemical-protective suit
3. Coveralls
4. Long underwear*
5. Gloves, outer, chemical resistant
6. Gloves, inner, chemical resistant
7. Boots, chemical-resistant, steel toe and shank
8. Hard hat (under suit)*
9. Disposable protective suit, gloves and boots (depending on suit construction, may be worn over totally-encapsulating suit)
10. Two-way radios (worn inside encapsulating suit).*

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*Optional, as applicable.

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Before a fully encapsulated suit can be worn into a hazardous situation, the suit must be properly inspected. The following is a checklist for visually inspecting all types of fully encapsulated suits.

1. Spread suit out on flat surface
2. Examine the following:
   a) Fabric and seams for abrasions, cuts, or holes
   b) Zippers and other connecting devices for proper sealing
   c) Visor for dirt and cracks
   d) Exhaust valves (if applicable) for inhibiting debris and proper functioning
3. If air source is available seal the suit and inflate it. Check for any leaks on surface and seams using a mild soap solution.
4. Record each suit's inspection, use, and repair status

3.3.2 Level B

Level B protection should be worn when the highest level of respiratory protection is necessary, but a lesser level of skin protection is needed. The following conditions constitute a need for Level B protection.

- Atmospheres with concentrations of known substance greater than protective factors associated with full-face, air-purifying respirators and require less skin protection.

- The atmosphere contains less than 19.5 percent oxygen

- Site operations make it highly unlikely that the small, exposed areas of the head or neck will be contacted by splashes of extremely hazardous substances.

- Type(s) and concentration(s) of vapors in air do not present a cutaneous or percutaneous hazard to the small, unprotected areas of the body.

The following items constitute Level B protection:

1. Positive pressure, full-facepiece, self-contained breathing apparatus (SCBA), or positive pressure supplied air respirator with escape SCBA, (NIOSH) approved.
2. Hooded chemical-resistant clothing (overalls and long-sleeved jacket; coveralls; one or two-piece chemical splash suit; disposable chemical-resistant overalls).
3. Coveralls*
4. Gloves, outer, chemical resistant
5. Gloves, inner, chemical resistant
6. Boots, outer, chemical-resistant, steel toe and shank
7. Boot covers, outer, chemical-resistant (disposal)*
8. Hard hat
9. Two-way radios*
10. Face Shield*.

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*Optional, as applicable.

3.3.3 Level C

Level C protection should be worn when the type(s) of airborne substance(s) is measured, and the criteria for using air-purifying respirators met. The following conditions suggest a need for Level C protection.

- The atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect or be absorbed through any exposed skin;
- The types of air contaminants have been identified, concentrations measured, and a canister or cartridge respirator is available that can remove the contaminants;
- All criteria for the use of air-purifying respirators are met;

The following items constitute Level C protection:

1. Full-face or half-mask, air-purifying canister or cartridge equipped respirators, approved by NIOSH/MSHA
2. Hooded chemical-resistant clothing (overalls; two-piece, chemical-splash suit; disposal, chemical-resistant overalls)
3. Coveralls*
4. Gloves, outer, chemical-resistant
5. Gloves, inner, chemical-resistant
6. Boots (outer), chemical-resistant, steel toe and shank*
7. Boot covers, outer, chemical-resistant (disposable*)
8. Hard Hat*
9. Escape mask*
10. Two-way radios*
11. Face shield*

3.3.4 Level D

Level D protection should not be worn on any site where respiratory or skin hazard exist. Level D protection should be used when:

- The atmosphere contains no known hazard
- Work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.

The following constitute Level D protection:

1. Coveralls
2. Gloves*
3. Boots/shoes, chemical-resistant, steel toe and shank
4. Boots, outer, chemical-resistant (disposable*)
5. Safety glasses or chemical splash goggles*
6. Hard hat*
7. Escape Mask*
8. Face shield*

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*Optional, as applicable

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3.4 REEVALUATION OF PROTECTION LEVEL

The type of clothing used and the overall level of protection should be reevaluated periodically as information about the site increase and as workers perform different operations. The Project Health and Safety Officer will determine when to upgrade or downgrade the level of protection for site personnel.

Reasons to upgrade:

- Known or suspected presence of dermal hazards
- Occurrence or likely occurrence of gas or vapor emission
- Change in work task that will increase contact or potential contact with hazardous materials
- Request of the individual performing the task

Reasons to downgrade:

- New information indicating that the situation is less hazardous than was originally thought.
- Change in site conditions that decreases the hazard.
- Change in work task that will reduce contact with hazardous materials

3.5 Dermal Toxicity Data

The Oil and Hazardous Materials Technical Assistance Data System (OHMTADS) identifies 350 chemicals as being dermally active. OHMTADS is a primary source of information on about 1300 chemicals. If it does not list a particular chemical as a skin hazard, other references should be consulted.

4.0 PROPER USE OF PERSONAL PROTECTIVE EQUIPMENT

4.1 INTRODUCTION

Personal protective equipment (PPE) can only provide a high degree of protection if it is used properly. The following areas must be addressed for an effective PPE program:

- o Training.
- o Work duration.
- o Fit testing.
- o Donning of equipment.
- o In-use monitoring.
- o Heat Stress and Cold Related Injury
- o Doffing of equipment.
- o Inspection.
- o Storage.

4.2 TRAINING

PPE training is required for all employees engaged in hazardous waste operations. Training allows the user to become familiar with the equipment. As a minimum, PPE training should delineate the users responsibilities and explain the following:

- o OSHA requirements as delineated in 29 CPR 1910 subparts I and Z.

- o The proper use and maintenance of PPE, including capabilities and limitations.

- o Instruction in inspecting, donning, checking, fitting, and using PPE.

- o Individualized respirator fit testing to ensure proper fit.

- o The user's responsibility (if any) for decontamination cleaning, maintenance, and repair of PPE.

- o Emergency procedures and self-rescue in the event of PPE failure.

4.3 WORK MISSION DURATION

Prior to entering a hazardous waste site in personal protective equipment, the anticipated work mission duration must be established in the project health and safety plan. Several factors limit the work mission length. These are:

- o Air supply.
- o The permeation and penetration rates of chemical contaminants.
- o Ambient temperature.

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4.4 RESPIRATOR FIT TESTING

The integrity of the face piece-to-face seal of a respirator affects its effectiveness. A secure fit is important with positive-pressure equipment, and is necessary to the safe functioning of negative-pressure equipment. Most face pieces are designed to fit only a certain percentage of the population; thus, every face piece must be tested on the potential wearer. The procedure for fit testing an air-purifying respirator (APR) is presented below.

Prior to each use of the APR, the user will inspect the respirator including the straps and conduct a negative pressure and positive pressure sealing test.

4.4.1 Negative Pressure Sealing Test

1. With the cartridge in place, cover the porous area of the cartridge with your hand.
2. Inhale attempting to achieve a negative pressure in the face piece.
3. Inhability to achieve or maintain negative seal may be indicative of poor respirator fit or malfunction.
4. Recheck integrity of the respirator and reposition respirator for better seal.
5. Repeat step 1 and 2.
6. Do not use respirator if unable to achieve a negative pressure.
7. This is not respirator qualitative fit test, but rather a quick check of respirator integrity and seal.

4.4.2 Positive Pressure Sealing Test

1. Remove the protective covering of the exhalation valve and seal the exhalation port with your hand.
2. Exhale slightly.
3. Inability to maintain a slight positive pressure without indications of leakage may be indicative of poor respirator fit or malfunction.

A quantitating respirator fit rest according to 29 CFR 1910.1025 using irritant smoke and isoamyl acetate is required semiannually for employees wearing negative pressure respirators or prior to using a new APR.

4.4.3 ISOAMYL Acetate (Banana Oil) Fit Testing

1. Perform odor threshold screening for each subject prior to fit testing. If subject fails, another test must be used.

2. Each respirator used for fitting and fit testing shall be equipped with organic vapor cartridges or offer protection against organic vapors.

3. After selecting, donning, and properly adjusting a respirator the test subject shall wear it to the fit test room. This room should be separate from the room used for odor threshold screening.

4. Each test subject should wear his/her respirator for at least 10 minutes before starting the test.

5. Upon entering the test chamber, the test subject will be given a 6" by 5" piece of absorbent single ply material, folded in half and wetted with 0.75 ml of pure IAA to hang inside the chamber.

6. Allow 2 minutes for the IAA test concentration to stabilize before starting the fit-test exercises. Each exercise should be performed for at least one minute.

7. If at any time during the test, the subject detects the banana-like odor of IAA, he shall quickly exit from the test chamber and leave the test area to avoid olfactory fatigue. NOTE: there is no respiratory danger involved with using IAA.

8. Upon returning to the selection room the subject shall remove the respirator, repeat the odor sensitivity test, select and put on another respirator, return to the test chamber, etc. The process continues until a respirator that fits well has been found. Should the odor sensitivity test be failed, the subject should wait about 5 minutes before retesting. Odor sensitivity will usually have returned by this time.

9. When a respirator is found that passes the test, its efficiency can be demonstrated for the subject by having him break the face seal and take a breath before exiting the chamber.

4.4.4 Irritant Smoke - Fit Testing

1. The respirator to be tested shall be equipped with high efficiency (HEPA) cartridges or filters.

2. The test subject shall be allowed to smell a weak concentration of the irritant smoke before the respirator is donned to become familiar with its characteristic odor.

3. Break both ends of a irritant smoke tube containing stannic oxychloride. CAUTION: To protect from flying glass, wear eye protection. Avoid skin contact.

4. Attach a short length of tubing to both ends of the smoke tube. Attach one end of the smoke tube with rubber tubing to the outlet end of the aspirator bulb.

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5. The test conductor directs the stream of irritant smoke from the tube towards the face seal area of the test subject, beginning at a distance of at least 12 inches from the face piece and gradually move to within one inch, moving around the whole perimeter of the mask.

6. Each test subject passing the smoke test without evidence of a response shall be given a sensitivity check of the smoke from the same tube once the respirator has been removed to determined whether he/she reacts to the smoke. Failure to evoke a response shall void the fit test.

4.5 DONNING OF EQUIPMENT

Periodic practice for donning chemical resistent clothing and respirators should be established. Assistance should be provided since donning and doffing operations are difficult to perform alone. Table 4-1 lists sample procedures for donning a chemically resistent suit/SCBA ensemble.

After the equipment has been donned, the fit should be evaluated. Clothing that are too small will restrict movement, thus increasing the possibility of tearing the suit and increasing worker fatigue. Clothing that is too large increases the possibility of snagging the suit and the worker's dexterity and coordination may be compromised. In each case, the worker should be recalled and refitted.

4.6 IN-USE MONITORING

The wearer of protective clothing must understand all aspects of the clothing's operation and limitation. This is particularly important for fully-encapsulating ensembles where misuse could result in suffocation.

Worker should report any perceived problems or difficulties with equipment to their Project Health and Safety Officer. These malfunctions include, but are not limited to:

- Degradation of protective clothing.
- Perception of odor while wearing a respirator.
- Skin irritation.
- Resistance in breathing during respirator use.
- Fatigue due to respirator use.
- Vision or communication difficulties.
- Personal responses such as rapid pulse, chest pain, and nausea.

If a supplied-air respirator is being used, all hazards that might endanger the integrity of the air line should be removed from the working area prior to use. During use, air lines should be kept as short as possible and other workers and vehicles should be excluded from the area.

TABLE 4-1
SAMPLE DONNING PROCEDURES

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1. Inspect respiratory equipment and clothing before donning.
2. Standing or sitting, put on chemically-resistant suit. Secure the suit by closing all fasteners on openings.
3. Put on chemically-resistant safety boots. Tape the leg cuff over the tops of the boots.
4. Put on inner gloves (surgical gloves). Additional overgloves may be worn. Tape the sleeves of the suit over the gloves.
5. Put on air tanks and harness assembly of the SCBA. Don the face piece and adjust it to be secure, but comfortable. Perform negative and positive respirator face-piece seal test procedures. Open the main valve.
6. Put on hard hat.
7. Have assistant check all closures.
8. Have assistant observe the wearer for a period of time to ensure that the wearer is comfortable, psychologically stable, and that the equipment is functioning properly.

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4.7 HEAT STRESS AND COLD RELATED INJURY

4.7.1 Heat Stress

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.

Factors Influencing Heat Stress - 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
- Alcolol 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.

Table 4-2 lists symptoms and treatment for heat stress.

Heat Stress Monitoring - Monitoring should be conducted when employees are wearing impermeable clothing and air temperatures are >70°F. Heart rate and oral temperature procedures are recommended. The suggested frequency of physiological monitoring for workers is listed in Table 4-3.

TABLE 4-2

HEAT STRESS SYMPTOMS AND TREATMENT

Heat Stress Symptoms	Heat Stress Treatment
A. Heat rash	A. Heat rash
	- Remove individual from hot, humid work environment - Wear dry and/or permeable clothing - Body powders or medications
B. Heat cramps	B. Heat cramps
- Muscle spasms; - Pain in hands, feet, and abdomen	- Replace fluids/electrolytes - Rest in cool environment
C. Heat exhaustion	C. Heat exhaustion
- Pale, cool, moist skin - Heavy sweating - Body temperature <104° - Dizziness - Nausea - Fainting	- Rest in cool environment - Replace body fluids/electrolytes (salt 1/4 tsp in 1 qt water; Gatorade) - Transport to medical facility if necessary - Monitor individual closely on subsequent work days
D. Heat Stroke	D. Heat stroke
- Red, hot, usually dry skin - Lack of or reduced perspiration - Body temperature >104° - Nausea - Dizziness, rapid pulse - Coma	- Rapidly lower body temperature (ice, cold water, shade, remove clothing, alcohol bath, etc.) - Transport victim to hospital as soon as possible

TABLE 4-3

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. (28.1°-30.8°C)	After each 90 minutes of work	After each 60 minutes of work
77.5°-82.5 (25.3°-28.1°C)	After each 120 minutes of work	After each 90 minutes of work
72.5°-77.5 (22.5°-25.3°C)	After each 150 minutes of work	After each 120 minutes of work

[a] For work levels of 250 kiocalories/hour.

[b] Calculate the adjusted air temperature (ta adj) by using this equation: ta adj °F = ta °F = ta + (13 x % 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.

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Heart rate monitoring should proceed as follows:

- Count radial pulse for 30-seconds early in rest period.
- If heart rate >110 beats/minute, shorten next work cycle by 1/3 and keep next rest period the same.
- If heart rate still >110 beats/minute at the next rest period, further shorten following work cycle by 1/3.

The oral temperature monitoring procedure is:

- Use clinical thermometer under tongue as directed.
- If temperature >99.6°F, shorten next work cycle by 1/3.
- If temperature still >99.6° at the next rest period, shorten following work cycle by 1/3.
- Do not permit worker to wear semi- or impermeable PPE when oral temperature exceeds 100.6°F.

Record information in log and/or mark on employees work suit.

Heat Street Prevention

o Maintain worker's body fluids at normal levels.

  - 1 to 1.6 gallons/day or more.
  - Water temperature of 50° to 60°F recommended.
  - Weigh workers before and after work to determine adequate fluid replacement.

o Adjust work schedule.

  - Modify work/rest schedules according to monitoring results discussed previously.
  - Mandate work slowdowns as needed.
  - Rotate personnel/add additional personnel.
  - Perform work during cooler portions of day.
  - Provide cool shelter/rest area.

o Provide personnel cooling devices.

  - Shower or hose-down areas.
  - Cooling jackets, vests, suits.

o Train workers to recognize heat stress symptoms.

o Encourage workers to maintain optimum level of physical fitness.

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4.7.2 Cold Related Injury

Two factors influence the development of cold injury: ambient temperature and wind velocity (wind chill). This relationship is shown in Figure 4-1. Furthermore, water conducts heat 240 times faster than air. Thus, when PPE is removed, the body cools rapidly. Figure 4-lprovides a recommended work warm-up schedule for work under cold conditions. Refer to the current ACGIH TVL publication for TLVs for Cold Stress. The following is a summary of symptoms and treatment of frostbite and hypothermia, respectively.

Frostbite: -
Frostbite Symptoms - Frostbites most commonly affects distal body parts.

- o Frostnip.
  - Skin becomes whitened, slight burning or painful sensation.
- o Superficial Frostbites.
  - Waxy, white skin with firm sensation but some resiliency. Warm feelings with notable cessation of pain.
- o Deep Frostbite.
  - Tissue damage below skin. Appearance is cold, pale and firm or hard.

Frostbite Treatment -

- o Frostnip.
  - Rewarm affected area.
- o Frostbite.
  - Rapid rewarming, give hot liquids orally, no alcohol, and remove all covering from injured part. Do not break blisters.

Hypothermia -

Hypothermia Symptoms - Hypothermia is defined as decrease in body core temperature to <95°F.

- o Mild Hypothermia
  - Shivering still present
  - Change in behavior
  - Worker efficiency declines
  - Decreased level of communication
  - Forgetfulness
  - Repetitive behavior
  - Poor motor skills
  - Poor judgement
  - Distraction

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TABLE 20

Cooling Power of Wind on Exposed Flesh Expressed as an 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 21

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	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
1. -26° to -28°	-15° to -19°	(Norm. Breaks)	1	(Norm. Breaks)	1	75 min	2	55 min	3	40 min	4
2. -29° to -31°	-20° to -24°	(Norm. Breaks)	1	75min	2	55 min	3	40 min	4	30 min	5
3. -32° to -34°	-25° to -29°	75 min	2	55 min	3	40 min	4	30 min	5	Non-emergency work should cease	
4. -35° to -37°	-30° to -34°	55 min	3	40 min	4	30 min	5	Non-emergency work should cease			
5. -38° to -39°	-35° to -39°	40 min	4	30 min	5	Non-emergency work should cease					
6. -40° to -42°	-40° to -44°	30 min	5	Non-emergency work should cease							
7. -43° & below	-45° & below	Non-emergency work should cease									

Notes for Table 21:

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 −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 Factor 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 of about 1750 W/m²/hr; 2) All non-emergency work should have ceased at or before a wind chill of 2250 W/m²/hr. 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 absolute temperatures in the colder ranges, since windy conditions rarely prevail at extremely low temperatures.

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* From Occupational Health & Safety Division, Saskatchewan Dept. of Labour.

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- Moderate Hypothermia
    - Person clearly incapable of effective functioning
    - Core temperature to 92°F
    - Shivering absent
    - Stupor
    - Disorientation
    - Hallucinations
    - Bizzare behavior
    - Slow heart rate
    - Feeling of cold diminished

- Severe Hypothermia
    - Coma
    - Pulse/respiration weak
    - Death

Hypothermia Treatment -

- Passive or active reheating.
- Move victim to protected environment.
- Remove wet or damp clothing.
- Cover head with hat or blanket.
- Cover victim with blankets.
- Supply hot fluids.
- Monitor temperature.
- Transport to hospital.

4.8 DOFFING OF EQUIPMENT

Procedures for removing chemically-resistant suit/SCBA ensembles must be developed and followed precisely in order to prevent the spread of contaminants from the work area to the wearer's body, and to decontamination of the suited worker. Throughout the doffing procedure, both the worker and decontamination personnel should avoid direct contact with the outside surface of the suit. Decontamination procedures are provided in Parson's Health and Safety Plan.

4.9 INSPECTION

An effective PPE program will consist of three different inspections:

- Inspection of equipment as it is issued to workers.
- Inspection after use in training.
- Periodic inspection of stored equipment.

Each inspection will cover different areas in varying degrees of detail. Explicit inspection procedures available from the manufacturer should be used. The inspection checklists provided in Table 4-4 will also to be an aid. It is the responsibility of the field worker to inspect the integrity of his or her equipment prior to use on a site. Identification numbers should be assigned to all reusable pieces of equipment (ID numbers) and inspection records should be kept by that number. As a minimum, each inspection should record the ID number, date, inspector, findings, and any future actions to be taken. Periodic review of these records may indicate an item or type of item with excessive maintenance costs or a high level of down time.

4.10 STORAGE

Clothing and respirators must be properly stored to prevent damage or malfunction due to exposure to dust, moisture, sunlight, temperature extremes, and impact. Procedures should be developed for pre-issuance warehousing and post-issuance (in-use) storage. Improper storage can cause equipment failures.

4.10.1 Clothing Storage

- Contaminated clothing should be stored in an area separate from street clothing.

- Contaminated clothing should be stored in a well-ventilated area.
- Different types and materials of clothing and gloves should be stored separately to prevent issuing the wrong material by mistake.

4.10.2 Respirator

- Facepieces of SCBAs and air-purifying respirators should be cleaned and disinfected after each use.

4.11 RECORDKEEPING

The following records shall be retained:

- Respirator fit test certificate.
- Respirator usage logs for SARs and APRs.
- Site entry logs identifying level of protection and duration of exposure.

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TABLE 4-4
SAMPLE PPE INSPECTIONS CHECKLIST

Clothing

To be performed to use:

- Determine that the clothing material is correct for the specific task at hand.
- Visually inspect for:
  - imperfect seams
  - non-uniform coatings
  - tears
  - malfunctioning closures
- Hold up to light and check for pinholes.
- Flex product:
  - observe for cracks
  - observe for other signs of shelf deterioration
- If the product has been used previously, inspect inside and out for signs of chemical attack:
  - discoloration
  - swelling
  - stiffness

To be performed during the work task:

- Evidence of chemical attack (e.g., discoloration, softening, etc.). Chemical permeation can occur without visible signs.
- Tears
- Punctures
- Seam discontinuities

TABLE 4-4
SAMPLE PPE INSPECTION CHECKLIST
(Continued)

Gloves

To be performed prior to use:

- Pressurize the gloves to check for holes. Either blow into glove, then roll gauntlet towards fingers or inflate glove and hold under water. In any event, no air should escape.

Air-Purifying Respirator

The respirator shall be inspected after each cleaning and prior to each use. The following items, at a minimum, must be addressed in the course of each inspection:

- Cartridges are fresh and of the appropriate type for the contaminant(s) encountered (check prior to use).
- Cartridge receptacle gaskets are present (2 each).
- Inhalation valve seats and flapper valves are in place (2 each).
- Exhalation flapper valve is in place.
- The speaking diaphragm and gasket are in place.
- The lens ring is secure with 2 nuts.
- The respirator is capable of maintaining a negative and positive pressure seal when fully assembled.

Self-Contained Breathing Apparatus (SCBA)

The following list of items must be addressed by the user immediately prior to donning of SCBAs. Any malfunctioning found should be cause to set the unit aside until it can be repaired by a certified repair person.

- Check all connections for tightness.
- Check material conditions for:
  - signs of pliability
  - signs of deterioration
  - signs of distortion

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TABLE 4-4
SAMPLE PPE INSPECTION CHECKLIST
(Continued)

- Check for proper setting and operation of regulations and valves (according to manufacturer's instruction).
- Check operation of low pressure alarm
- Check face shield and lens for:

  - cracks
  - crazing
  - fogginess.

SCBAs shall be inspected once a month by an Office Health and Safety Representative to insure that they are working properly. Monthly inspection involve the following:

- The routine check-out procedures used by personnel before every use of a SCBA.
- A complete physical examination must be made of all external working parts on a monthly basis.
- Gaskets, seals, and rubber parts are examined for pliability and signs of deterioration.
- A physical examination of the diaphragm, diaphragm spring, and level assembly must be made.

SCBAs must be checked twice a year on a portable regulator tester to ensure that the regulator is mechanically sound. Checks on the regulator tester must include the following:

- Static Pressure check
- Airflow performance test
- A test for excess aspiration of the regulator.

Air tanks must also be hydrostatically tested to insure soundness. Aluminum cylinders wound in fiberglass must be tested every three years, steel cylinder need only be tested every five years. All test dates must be recorded in the inspection log book for SCBAs.

Occupational Health Guideline for Hexane

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: $CH_3(CH_2)_4CH_3$
- Synonyms: Hexyl hydride; normal hexane
- Appearance and odor: Colorless liquid with a mild, gasoline-like odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for hexane is 500 parts of hexane per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 1800 milligrams of hexane per cubic meter of air (mg/m^3). NIOSH has recommended that the permissible exposure limit be reduced to 100 ppm (350 mg/m^3) averaged over a work shift of up to 10 hours per day, 40 hours per week, with a ceiling level of 510 ppm (1,800 mg/m^3) averaged over a 15-minute period. The NIOSH Criteria Document for Alkanes should be consulted for more detailed information.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Hexane can affect the body if it is inhaled, comes in contact with the eyes or skin, or is swallowed.

- **Effects of overexposure**

1. Short-term Exposure: Overexposure to hexane may cause lightheadedness, giddiness, nausea, and headache. It may also cause irritation of the eyes and nose. Greater exposure may cause unconsciousness and death.

2. Long-term Exposure: Prolonged overexposure to the liquid may cause irritation of the skin.

3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to hexane.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to hexane at potentially hazardous levels:

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the employee at increased risk, and to establish a baseline for future health monitoring. Examination of the central and peripheral nervous systems and the skin should be stressed.

—Skin disease: Hexane is a defatting agent and can cause dermatitis on prolonged exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent.

—Chronic respiratory disease: In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of hexane might cause exacerbation of symptoms due to its irritant properties.

—Liver disease: Although hexane is not known as a liver toxin in humans, the importance of this organ in the biotransformation and detoxification of foreign substances should be considered before exposing persons with impaired liver function.

—Kidney disease: Although hexane is not known as a kidney toxin in humans, the importance of this organ in the elimination of toxic substances justifies special consideration in those with impaired renal function.

2. Periodic Medical Examination: The aforementioned examinations should be performed on an annual basis.

- **Summary of toxicology**

Hexane vapor is a narcotic; it also is a mild upper respiratory irritant. Polyneuropathy has been reported to occur in Japanese workers exposed to hexane vapors. Effects appeared to be reversible. Concentrations of 30,000 ppm produced narcosis in mice within 30 to 60

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

minutes; convulsions and death occurred at 35,000 to 40,000 ppm; at 64,000 ppm respiratory arrest was produced in 2.5 to 4.5 minutes from the start of exposure. Concentrations up to 8000 ppm produced no anesthesia. In human subjects, 2000 ppm for 10 minutes produced no effects, but 5000 ppm resulted in dizziness and a sensation of giddiness. Other investigators reported slight nausea, headache, and irritation of the eyes and throat at 1400 to 1500 ppm. In industrial practice, mild narcotic symptoms such as dizziness have been observed when concentrations exceeded 1000 ppm, but not below 500 ppm. Chronic effects have rarely been reported. The liquid is a defatting agent, and prolonged exposure may cause irritation of the skin. Aspiration may cause a chemical pneumonia.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 86
2. Boiling point (760 mm Hg): 68.9 C (156 F)
3. Specific gravity (water = 1): 0.7
4. Vapor density (air = 1 at boiling point of hexane): 3.0
5. Melting point: −95 C (−139 F)
6. Vapor pressure at 20 C (68 F): 124 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 0.014
8. Evaporation rate (butyl acetate = 1): Data not available

- **Reactivity**

1. Conditions contributing to instability: Heat
2. Incompatibilities: Contact with strong oxidizing agents may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide) may be released in a fire involving hexane.
4. Special precautions: Hexane will attack some forms of plastics, rubber, and coatings.

- **Flammability**

1. Flash point: −21.7 C (−7 F) (closed cup)
2. Autoignition temperature: 225 C (437 F)
3. Flammable limits in air, % by volume: Lower: 1.1; Upper: 7.5
4. Extinguishant: Dry chemical, foam, carbon dioxide

- **Warning properties**

1. Odor Threshold: No quantitative information is available.
2. Irritation Levels: The *Documentation of TLV's* notes that "Drinker, Yaglou, and Warren found slight nausea, headache, and eye and throat irritation at 1400 to 1500 ppm. Nelson found no irritation at 500 ppm in unacclimated subjects."
3. Evaluation of Warning Properties: Since hexane can be detected at a concentration approximately 3 times the permissible exposure limit, it is treated as a material with good warning properties.

MONITORING AND MEASUREMENT PROCEDURES

- **Eight-Hour Exposure Evaluation**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

- **Ceiling Evaluation**

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of hexane. Each measurement should consist of a fifteen (15) minute sample or series of consecutive samples totalling fifteen (15) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

- **Method**

Sampling and analyses may be performed by collection of hexane vapors using an adsorption tube with subsequent desorption with carbon disulfide and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure hexane may be used. An analytical method for hexane is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 2, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00260-6).

RESPIRATORS

- Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.
- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquid hexane.
- Any clothing which becomes wet with liquid hexane should be removed immediately and not reworn until the hexane is removed from the clothing.
- Clothing wet with liquid hexane should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of hexane from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the hexane, the person performing the operation should be informed of hexane's hazardous properties.
- Employees should be provided with and required to use splash-proof safety goggles where liquid hexane may contact the eyes.
- Where there is any possibility that employees' eyes may be exposed to hexane, an eye-wash fountain should be provided within the immediate work area for emergency use.

SANITATION

- Skin that becomes wet with liquid hexane should be promptly washed or showered with soap or mild detergent and water to remove any hexane.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to hexane may occur and control methods which may be effective in each case:

Operation	Controls
Use as an extractant of agricultural products	Process enclosure; general dilution ventilation
Use in manufacture of polyolefins and certain elastomers as a catalyst carrier and assist in controlling molecular weight by dropping polymer out of solution when a certain molecular weight is reached	Process enclosure; general dilution ventilation; personal protective equipment
Use as an extractant of animal fat	Process enclosure; general dilution ventilation; personal protective equipment
Use as a solvent in adhesives to control viscosity and reduce drying time	General dilution ventilation; personal protective equipment
Use in pharmaceutical industry as a reaction medium, immiscible solvent, and extraction ergot	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment
Use during compounding of adhesives as a diluent or vehicle solvent; use in compounding printing inks, lacquers, or stains; use as a laboratory reagent and general solvent; use in manufacture of low-temperature thermometers	Local exhaust ventilation; general dilution ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

- **Eye Exposure**

If hexane gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation persists after washing, get medical attention. Contact lenses should not be worn when working with this chemical.

- **Skin Exposure**

If hexane gets on the skin, promptly wash the contaminated skin using soap or mild detergent. If hexane soaks through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent. If irritation persists after washing, get medical attention.

- **Breathing**

If a person breathes in large amounts of hexane, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

- **Swallowing**

If hexane has been swallowed, do not induce vomiting. Get medical attention immediately.

- **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL, LEAK, AND DISPOSAL PROCEDURES

- Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.
- If hexane is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. For small quantities, absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for evaporating vapors to completely clear the hood ductwork. Burn the paper in a suitable location away from combustible materials. Large quantities can be collected and atomized in a suitable combustion chamber. Hexane should not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion.

- Waste disposal method:

Hexane may be disposed of by atomizing in a suitable combustion chamber.

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RESPIRATORY PROTECTION FOR HEXANE

Condition	Minimum Respiratory Protection* Required Above 500 ppm
Vapor Concentration	
1000 ppm or less	Any chemical cartridge respirator with an organic vapor cartridge(s). Any supplied-air respirator. Any self-contained breathing apparatus.
5000 ppm or less	A gas mask with a chin-style or a front- or back-mounted organic vapor canister. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
Greater than 5000 ppm or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any gas mask providing protection against organic vapors. Any escape self-contained breathing apparatus.

*Only NIOSH-approved or MSHA-approved equipment should be used.

HMX-1

EXECUTIVE SUMMARY

Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX) is a colorless, crystalline solid used in military munitions formulations. HMX is poorly absorbed when administered orally to rats or mice, and most of an administered dose is recovered unmetabolized in the feces (70% of the original dose in mice, 85% in rats). After intravenous administration, little HMX accumulates in the tissues, excretion is mainly via the urine (61%), and there is minimal metabolism. Poor absorption of HMX via the oral route is probably related to the low aqueous solubility of the preparation.

No adverse effects have been reported in workers potentially exposed to HMX in a munitions plant. The oral LD_{50} values of HMX in mice and rats are approximately 6.3 and 2.3 g/kg, respectively. After a single dose, effects on the central nervous system (CNS), including hyperkinesia and ataxia, have been noted; after higher doses, convulsions are observed.

In a 14-day study with a limited number of rats (six/sex), histologic changes were observed in the livers of both males and females receiving 9,000 mg/kg/day, but no marked effects on the liver were reported in those receiving 3,000 mg/kg/day. In a 14-day study with mice, CNS effects (hyperkinesia and excitability) were seen at the lowest doses tested, 100 mg/kg/day in males and 320 mg/k$/day in females. Because histopathology was limited to animals that died, effects on the livers of mice could not be evaluated.

In a 13-week feeding study with rats, HMX was administered to males and females at levels between 50 and 4,000 mg/kg/day and between 50 and 1,500 mg/kg/day, respectively. Histologic changes in the liver (enlarged centrilobular

HMX-2

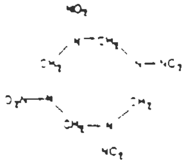
cells with pale nuclei) were seen in males receiving 450, 1,350, and 4,000 mg/kg/day, and tubular kidney changes (focal atrophy and dilation) were seen in females receiving 270, 620, and 1,500 mg/kg/day. The No-Observed-Adverse-Effect Level (NOAEL) was 50 mg/kg/day for males and 115 mg/kg/day for females. In a 13-week feeding study with mice, excessive mortality was seen in females receiving 250 and 750 mg/kg/day and in males receiving 200 mg/kg/day. At dose levels up to 75 mg/kg/day in males and 90 mg/kg/day in females, no signs of toxicity or changes in clinical laboratory parameters were affected, and no remarkable gross or histopathologic changes were observed.

No lifetime studies were performed in animals fed HMX. HMX has not been shown to be mutagenic; however, the concentrations tested were low because of the limited solubility of HMX and its tendency to precipitate in biological fluids. No studies were found evaluating developmental toxicity, reproductive effects, or carcinogenicity. HMX is classified as Group D: Not Classified as to Human Carcinogenicity.

Based on the adverse hepatic and renal effects of rats administered HMX in the diet for 13 weeks, the Longer-term Health Advisory (HA) for exposure in a 10-kg child has been determined to be 5 mg/L (5,000 ug/L). In the absence of adequate animal data to determine a One-day or Ten-day Health Advisory, the Longer-term HA for a 10-kg child, 5 mg/L (5,000 ug/L), is used as a conservative estimate of the One-day or Ten-day HA. The Longer-term HA for an adult was established at 20 mg/L (20,000 ug/L). A Lifetime HA of 0.40 mg/L (400 ug/L) for a 70-kg adult was determined based on a Drinking Water Equivalent Level (DWEL) of 2.0 mg/L (2,000 ug/L). The DWEL is based on a NOAEL of 50 mg/kg/day; the NOAEL is based on the absence of liver lesions in male rats fed HMX for 13 weeks.

HMX-3

Table II-1. General Chemical and Physical Properties of HMX

CAS No.	2691-41-0
Synonyms	Cyclotetramethylenetetranitramine HMX Octahydro-1,3,5,7-tetranitroazocine Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine Octogen RRI 1,3,5,7-tetranitro-1,3,5,7-tetraazocyclooctane
Molecular weight	296.16
Empirical formula	$C_4H_8N_8O_8$
Structure	
Physical state	Colorless, crystalline solid; four polymorphic forms, beta form least sensitive and most stable
Specific gravity	1.87 (beta form)
Melting point	276 to 280°C
Vapor pressure	3 x 10-9 mmHg @ 100°C
Heat of combustion	9.43 kJ/g
Solubility characteristics	
Water (mg/L)	1.14 (5°C) 4.42 (10°C) 6.63 (20°C) 11.56 (30°C) 17.43 (35°C) 140 (83°C)
Acetone (mg/L)	2,200 (30°C)
Cyclohexanone (mg/L)	5,300 (30°C)
Acetic anhydride (mg/L)	1,300 (30°C)
Dimethyl sulfoxide (g/100 g)	57

SOURCE: Adapted from Kitchens et al. (1979); Sullivan et al. (1979); Pal and Ryon (1986).

Occupational Health Guideline for Dinitrotoluene

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: 2,4-$(NO_2)_2C_6H_3CH_3$
- Synonyms: 2,4-Dinitrotoluene; DNT
- Appearance and odor: Orange-yellow solid (sometimes shipped molten in tank cars) with a characteristic odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for dinitrotoluene is 1.5 milligrams of dinitrotoluene per cubic meter of air (mg/m^3) averaged over an eight-hour work shift.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Dinitrotoluene can affect the body if it is inhaled, comes in contact with the eyes or skin, or is swallowed; It is readily absorbed through the skin. Even a small amount absorbed from clothes or shoes may cause toxic symptoms.

- **Effects of overexposure**

1. Short-term Exposure: Dinitrotoluene affects the ability of blood to carry oxygen normally. A bluish discoloration of the skin may occur with headache, irritability, dizziness, weakness, nausea, vomiting, shortness of breath, drowsiness, and unconsciousness. If treatment is not given promptly, death may occur. The onset of symptoms may be delayed. The ingestion of alcohol may cause increased susceptibility to the effects of dinitrotoluene.

2. Long-term Exposure: Repeated or prolonged exposure to dinitrotoluene may cause anemia and jaundice.

3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to dinitrotoluene.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to dinitrotoluene at potentially hazardous levels:

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the blood, liver, and cardiovascular system should be stressed.

—A complete blood count: Dinitrotoluene has been shown to cause methemoglobinemia. Those with blood disorders may be at increased risk. A complete blood count should be performed, including a red cell count, a white cell count, a differential count of a stained smear, as well as hemoglobin and hematocrit. Observe for Heinz bodies.

—Liver function tests: Since liver damage has been observed in humans exposed to dinitrotoluene, a profile of liver function should be obtained by using a medically acceptable array of biochemical tests.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis. Methemoglobin determinations should be performed at any time overexposure is suspected or signs and symptoms of toxicity occur. The level of dinitrotoluene in the urine should be determined; excretion of dinitrotoluene in excess of 25 mg/liter indicates significant absorption.

- **Summary of toxicology**

Dinitrotoluene absorption, whether from inhalation of the vapor or absorption of the solid through skin, causes anoxia due to the formation of methemoglobin; jaundice and anemia have been reported. Signs and symptoms of

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These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

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overexposure are due to the loss of oxygen-carrying capacity of the blood. Rapid absorption through the intact skin is frequently the main route of entry. The onset of symptoms of methemoglobinemia is often insidious, and may be delayed for up to 4 hours; headache is commonly the first symptom and may become quite intense as the severity of methemoglobinemia progresses. Cyanosis develops early in the course of intoxication, first in the lips, the nose, and the ear lobes, and is often recognized by fellow workers. Cyanosis occurs when the methemoglobin concentration is 15% or more. The individual may feel well, have no complaints, and may insist that nothing is wrong until the methemoglobin concentrations approaches approximately 40%. At methemoglobin concentrations of over 40% there usually is weakness and dizziness; at up to 70% concentration there may be ataxia, dyspnea on mild exertion, tachycardia, nausea, vomiting, and drowsiness. Ingestion of alcohol is reported to aggravate the toxic effects of dinitrotoluene.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 182.1
2. Boiling point (760 mm Hg): Slow decompostion at 250 C (482 F); self-sustained decomposition at 270 C (518 F)
3. Specific gravity (water = 1): Solid: 1.52; Liquid: 1.32
4. Vapor density (air = 1 at boiling point of dinitrotoluene): Not applicable (too high boiling)
5. Melting point: 70 C (158 F)
6. Vapor pressure at 20 C (68 F): 1 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 0.03
8. Evaporation rate (butyl acetate = 1): Not applicable

- **Reactivity**

1. Conditions contributing to instability: Temperatures above 250 C (482 F)
2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions. Contact with caustics and chemically active metals such as tin or zinc may cause evolution of heat and increase in pressure.
3. Hazardous decomposition products: Toxic gases and vapors (such as oxides of nitrogen and carbon monoxide) may be released in a fire involving dinitrotoluene.
4. Special precautions: Liquid dinitrotoluene will attack some forms of plastics, rubber, and coatings.

- **Flammability**

1. Flash point: 206.7 C (404 F) (closed cup)
2. Autoignition temperature: Data not available
3. Impact sensitivity (minimum fall of a 2 kg weight to cause at least one explosion in ten trials): Greater than 100 centimeters
4. Flammable limits in air, % by volume: Not available
5. Extinguishant: Water, dry chemical, carbon dioxide

- **Warning properties**

1. Odor Threshold: No quantitative information is available concerning the odor threshold of dinitrotoluene.
2. Eye Irritation Level: Grant states that "a severe burn of the skin, eyelids, and cornea of one eye, with permanent scarring, has been attributed in one instance to hot fumes of dinitrotoluene." There is no quantitative information available concerning the concentrations which would produce these effects.
3. Evaluation of Warning Properties: Since no quantitative information is available relating the warning properties of dinitrotoluene to air concentration, this substance is treated as a material with poor warning properties.

MONITORING AND MEASUREMENT PROCEDURES

- **General**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

- **Method**

An analytical method for dinitrotoluene is in the *NIOSH Manual of Analytical Methods,* 2nd Ed., Vol. 4, 1978, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00317-3).

RESPIRATORS

- Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.
- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent any possibility of skin contact with molten dinitrotoluene.
- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent skin contact with dinitrotoluene or liquids containing dinitrotoluene, where skin contact may occur.
- If employees' clothing may have become contaminated with solid dinitrotoluene, employees should change into uncontaminated clothing before leaving the work premises.
- Clothing contaminated with dinitrotoluene should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of dinitrotoluene from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the dinitrotoluene, the person performing the operation should be informed of dinitrotoluene's hazardous properties.
- Where exposure of an employee's body to dinitrotoluene or liquids containing dinitrotoluene may occur, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.
- Non-impervious clothing which becomes wet with molten dinitrotoluene or liquids containing dinitrotoluene should be removed immediately and non-impervious clothing which becomes contaminated with solid dinitrotoluene should be removed promptly and such clothing should not be reworn until the dinitrotoluene is removed from the clothing.
- Employees should be provided with and required to use splash-proof safety goggles where there is any possibility of molten dinitrotoluene contacting the eyes.

SANITATION

- Skin that becomes wet with molten dinitrotoluene or liquids containing dinitrotoluene should be immediately washed or showered with soap or mild detergent and water to remove any dinitrotoluene.
- Workers subject to skin contact with dinitrotoluene or liquids containing dinitrotoluene should wash with soap or mild detergent and water any areas of the body which may have contacted dinitrotoluene at the end of each work day.
- Skin that becomes contaminated with dinitrotoluene should be promptly washed or showered with soap or mild detergent and water to remove any dinitrotoluene.
- Eating and smoking should not be permitted in areas where dinitrotoluene or liquids containing dinitrotoluene are handled, processed, or stored.
- Employees who handle dinitrotoluene or liquids containing dinitrotoluene should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to dinitrotoluene may occur and control methods which may be effective in each case:

Operation	Controls
Use in the manufacture of toluene diisocyanate for production of polyurethane plastics	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in production of military and some commercial explosives; use to plasticize cellulose nitrate in explosives; use to moderate burning rate of propellants and explosives; use in manufacture of gelatin explosives (less sensitive to shock or friction); use as a water-proofing coating for some smokeless powders; use as an intermediate in TNT manufacture	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in manufacture of azo dye intermediates; use in organic synthesis in preparation of toluidines, dyes, and explosives	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

- **Eye Exposure**

If dinitrotoluene or liquids containing dinitrotoluene get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. If molten dinitrotoluene gets into the eyes, flush the eyes immediately with large amounts of water to remove heat. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

- **Skin Exposure**

If dinitrotoluene or liquids containing dinitrotoluene get on the skin, immediately wash the contaminated skin using soap or mild detergent and water. If dinitroto-

luene or liquids containing dinitrotoluene penetrate through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. Get medical attention immediately. If molten dinitrotoluene gets on the skin, immediately flush the skin with water to remove heat. Wash the skin with soap or mild detergent and water. Get medical attention immediately.

- **Breathing**

If a person breathes in large amounts of dinitrotoluene, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

- **Swallowing**

When dinitrotoluene has been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

- **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL AND DISPOSAL PROCEDURES

- Persons not wearing protective equipment and clothing should be restricted from areas of spills until cleanup has been completed.
- If dinitrotoluene is spilled, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill.
3. For small quantities, sweep onto paper or other suitable material and burn in a suitable combustion chamber which allows burning in an unconfined condition and is equipped with an appropriate effluent gas cleaning device. Large quantities may be reclaimed; however, if this is not practical, dissolve in fuel oil and atomize in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.
4. If in the molten form, allow to cool and solidify and treat as in (3) above.

- Waste disposal methods:

Dinitrotoluene may be disposed of:

1. By making packages of dinitrotoluene in paper or other flammable material and burning in a suitable combustion chamber which allows burning in an unconfined condition and is equipped with an appropriate effluent gas cleaning device.
2. By dissolving dinitrotoluene in fuel oil and atomizing in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

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RESPIRATORY PROTECTION FOR DINITROTOLUENE

Condition	**Minimum Respiratory Protection*** **Required Above 1.5 mg/m³**
Particulate or Vapor Concentration	
15 mg/m³ or less	Any supplied-air respirator. Any self-contained breathing apparatus.
75 mg/m³ or less	Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
200 mg/m³ or less	A Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet, or hood operated in continuous-flow mode.
Greater than 200 mg/m³ or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any gas mask providing protection against organic vapors and particulates. Any escape self-contained breathing apparatus.

*Only NIOSH-approved or MSHA-approved equipment should be used.

Occupational Health Guideline for Methyl Alcohol

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: CH_3OH
- Synonyms: Methanol; wood alcohol; Columbian spirits; carbinol
- Appearance and odor: Colorless liquid with a characteristic, pungent odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for methyl alcohol is 200 parts of methyl alcohol per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 260 milligrams of methyl alcohol per cubic meter of air (mg/m^3). NIOSH has recommended that the permissible exposure limit be changed to 200 ppm averaged over a work shift of up to 10 hours per day, 40 hours per week, with a ceiling of 800 ppm averaged over a 15-minute period. The NIOSH Criteria Document for Methyl Alcohol should be consulted for more detailed information.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Methyl alcohol can affect the body if it is swallowed, is inhaled, or comes in contact with the skin or eyes.

- **Effects of overexposure**

1. Short-term Exposure: Swallowing methyl alcohol or breathing very high concentrations of methyl alcohol may produce headache, weakness, drowsiness, lightheadedness, nausea, vomiting, drunkenness, and irritation of the eyes, blurred vision, blindness, and death. A person may get better and then worse again up to 30 hours later.

2. Long-term Exposure: Prolonged exposure to higher concentrations of methyl alcohol may result in headaches, burning of the eyes, dizziness, sleep problems, digestive disturbances, and failure of vision. Repeated or prolonged skin exposure may cause skin irritation.

3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to methyl alcohol.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to methyl alcohol at potentially hazardous levels:

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the employee at increased risk, and to establish a baseline for future health monitoring. Examination of the skin, liver, kidneys, and eyes should be stressed.

—Skin disease: Methyl alcohol is a defatting agent and can cause dermatitis on prolonged exposure. Persons with pre-existing skin disorders may be susceptible to the effects of this agent.

—Liver function tests: Methyl alcohol may cause liver damage. A profile of liver function should be obtained by utilizing a medically acceptable array of biochemical tests.

—Kidney disease: Although methyl alcohol has not been proven to be kidney toxin in humans, the importance of this organ in the elimination of toxic substances justifies special consideration in those with impaired renal function.

—Eye disease: Because methyl alcohol may cause optic atrophy and blindness, those with pre-existing eye diseases may be at increased risk from exposure.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis. In addition, anyone developing the above-listed conditions or who has been splashed in the eyes with,

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has ingested, or otherwise has been exposed to methyl alcohol should be placed under medical surveillance.

- **Summary of toxicology**

Ingestion of methyl alcohol is a well-known cause of optic neuropathy and may be lethal. Severe acidosis may result from ingestion or high exposures. Animals exposed to vapor concentrations above 8000 to 10,000 ppm show narcotic effects progressing from lethargy, to ataxia, to prostration and death in a state of profound acidosis due in part to the metabolic formation of formaldehyde and formic acid. Occupational exposure to high concentrations of methyl alcohol vapor has been reported to cause death or blindness, usually from working in a confined space. A woman died after exposure for 12 hours to vapor concentrations calculated at 4000 to 13,000 ppm. Chronic poisoning manifested by marked diminution of vision and enlargement of the liver has been reported in a workman exposed at levels of 1200 to 8000 ppm for a period of 4 years. Direct skin contact with methy alcohol may cause dermatitis, erythema, and scaling.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 32
2. Boiling point (760 mm Hg): 64.5 C (148 F)
3. Specific gravity (water = 1): 0.8
4. Vapor density (air = 1 at boiling point of methyl alcohol): 1.1
5. Melting point: −98 C (-144 F)
6. Vapor pressure at 20 C (68 F): 97 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): Miscible in all proportions
8. Evaporation rate (butyl acetate = 1): 5.9

- **Reactivity**

1. Conditions contributing to instability: Heat
2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide and formaldehyde) may be released in a fire involving methyl alcohol.
4. Special precautions: Methyl alcohol will attack some forms of plastics, rubber, and coatings. It may also react with metallic aluminum at high temperatures.

- **Flammability**

1. Flash point: 11 C (52 F) (closed cup)
2. Autoignition temperature: 385 C (725 F)
3. Flammable limits in air, % by volume: Lower: 6.7; Upper: 36
4. Extinguishant: Dry chemical, alcohol foam, carbon dioxide

- **Warning properties**

1. Odor Threshold: May and Summer report that the odor threshold of methyl alcohol (methanol) is 5900 ppm. The AIHA *Hygienic Guide* states that the odor is faint at 2000 ppm.
2. Eye Irritation Level: The *Hygienic Guide* states that irritation occurs only at high concentrations. Grant states that "external contact of methanol with the eye has been alleged to have caused corneal opacities, but this must be far from the rule . . . . By exposure of cats to methanol vapors an attempt has been made to induce vacuoles in the corneal epithelium similar to those produced by other solvents, but this has been unsuccessful."

Browning reports that concentrations ranging from 7500 ppm to 69,000 ppm irritate mucous membranes.

3. Evaluation of Warning Properties: Methyl alcohol (methanol) has poor warning properties.

MONITORING AND MEASUREMENT PROCEDURES

- **Eight-Hour Exposure Evaluation**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

- **Ceiling Evaluation**

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of methyl alcohol. Each measurement should consist of a fifteen (15) minute sample or series of consecutive samples totalling fifteen (15) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

- **Method**

Sampling and analyses may be performed by collection of methyl alcohol in an adsorption tube containing silica gel, followed by desorption with water, and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure methyl alcohol may be used. An analytical method for methyl alcohol is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 2, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00260-6).

RESPIRATORS

- Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the

process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquid methyl alcohol.
- Clothing wet with liquid methyl alcohol should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of methyl alcohol from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the methyl alcohol, the person performing the operation should be informed of methyl alcohol's hazardous properties.
- Any clothing which becomes wet with liquid methyl alcohol should be removed immediately and not reworn until the methyl alcohol is removed from the clothing.
- Employees should be provided with and required to use splash-proof safety goggles where liquid methyl alcohol may contact the eyes.

SANITATION

- Skin that becomes wet with liquid methyl alcohol should be promptly washed or showered to remove any methyl alcohol.
- Eating and smoking should not be permitted in areas where liquid methyl alcohol is handled, processed, or stored.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to methyl alcohol may occur and control methods which may be effective in each case:

Operation	Controls
Liberation during application of surface coatings such as shellac, wood dyes, nitrocellulose lacquers, water-proofing formulations, and phenolic resins	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use as a solvent for rotogravure inks, aniline dyes, and duplicator fluids	General dilution ventilation
Liberation during manual application of methanol as a cleaner for coated surfaces, leather, gloves, and metal and resins surfaces prior to further treatment	General dilution ventilation; personal protective equipment
Liberation during manufacture of formaldehyde by oxidation or dehydrogenation	Local exhaust ventilation; general dilution ventilation
Use in plastics industry to produce plasticizers, softening agents, and acrylic resins	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Liberation during use as an intermediate in the preparation of methacrylates, methyl chlorides, methyl ethers, dimethyl sulfate, methyl formate, and methyl bromide	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Liberation during application as an extractant in industrial chemical processes such as refinery gasoline and oils and purifying pharmaceuticals such as steroids and hormones	Local exhaust ventilation; general dilution ventilation
Use as a solvent in rubber industry	Local exhaust ventilation; general dilution ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

- **Eye Exposure**

If methyl alcohol gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention as soon as possible. Contact lenses should not be worn when working with this chemical.

- **Skin Exposure**

If methyl alcohol gets on the skin, promptly flush the contaminated skin with water. If methyl alcohol soaks through the clothing, remove the clothing immediately and flush the skin with water. If there is skin irritation, get medical attention.

- **Breathing**

If a person breathes in large amounts of methyl alcohol, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

- **Swallowing**

When methyl alcohol has been swallowed, get medical attention immediately. If medical attention is not immediately available, get the afflicted person to vomit by having him touch the back of his throat with his finger or by giving him syrup of ipecac as directed on the package. This non-prescription drug is available at most drug stores and drug counters and should be kept with emergency medical supplies in the workplace. Do not make an unconscious person vomit.

- **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL, LEAK, AND DISPOSAL PROCEDURES

- Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.
- If methyl alcohol is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. For small quantities, absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for evaporating vapors to completely clear the hood ductwork. Burn the paper in a suitable location away from combustible materials. Large quantities can be collected and atomized in a suitable combustion chamber. Methyl alcohol should not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion.

- Waste disposal methods:

Methyl alcohol may be disposed of:

1. By absorbing it in vermiculite, dry sand, earth or a similar material and disposing in a secured sanitary landfill.
2. By atomizing in a suitable combustion chamber.

REFERENCES

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RESPIRATORY PROTECTION FOR METHYL ALCOHOL

Condition	**Minimum Respiratory Protection* Required Above 200 ppm**
Vapor Concentration	
2000 ppm or less	Any supplied-air respirator. Any self-contained breathing apparatus.
10,000 ppm or less	Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
25,000 ppm or less	A Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet, or hood operated in continuous-flow mode.
Greater than 25,000 ppm or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any escape self-contained breathing apparatus.

*Only NIOSH-approved or MSHA-approved equipment should be used.

RDX-1

EXECUTIVE SUMMARY

Hexahydro-1,3,5-trinitro-1,3,5-triazine, commonly known as RDX (British code name for Research Department Explosive or Royal Demolition Explosive), is a white crystalline solid that has been extensively used in military munitions formulations.

The pharmacokinetic properties of RDX have been extensively studied in rats. RDX was found to be completely absorbed via the oral route; the rate of absorption was reported to be a direct function of the particle size of the powder in the slurry administered. The rate of gastrointestinal absorption was found to be faster in rats than in humans or miniature swine; in rats, peak plasma levels were reached in 2 to 3 hours, whereas in swine and probably in humans, plasma levels peaked approximately 12 hours after dosing. Absorbed RDX is rapidly cleared from the plasma and distributed to tissues. The half-lives of clearance of RDX from plasma are of a similar order of magnitude in rats and humans: the $t_{1/2}$ was found to be 10.1 hours in rats and 15.1 hours in the one available human study. The highest RDX levels are found in the kidneys, followed by the levels in the liver, brain, and heart. RDX is metabolized by the liver, and its metabolites are excreted primarily in the urine. The metabolites have not been identified or characterized.

In humans, the toxic effects of RDX have been on the central nervous system (CNS). Exposure of workers in a munitions plant via inhalation of dust containing RDX has resulted in nausea, irritability, convulsions, unconsciousness, and amnesia. Military personnel have been exposed to RDX while burning composition C-4 explosives in the field to heat food; inhalation of the smoke resulted in clonic/tonic convulsions. Ingestion of RDX has caused similar CNS effects.

RDX-2

Acute toxicity studies indicated oral LD_{50} values of about 80 mg RDX/kg in mice and 118 mg RDX/kg in rats. Intravenous administration of single doses of RDX to beagle dogs caused convulsions and death at a dose of 40 mg/kg, central nervous system hyperactivity and nonlethal convulsions at a dose of 20 mg/kg, and decreased blood pressure and erratic electroencephalographic patterns at doses of 3.37 and 6.78 mg/kg.

Subchronic 90-day feeding studies in mice and rats indicate effects on the blood and liver. In mice of both sexes, increased liver weights were noted in groups receiving 320 mg RDX/kg/day, and anemia was seen in males receiving 160 mg RDX/kg/day. In rats, anemia was observed at a dose level of 28 mg RDX/kg/day in males, and increased liver weight was noted at a dose level of 100 mg RDX/kg/day in females. In a 10-day oral gavage study in monkeys, vomiting and convulsions were seen in five of six animals dosed with RDX at 10 mg/kg/day, but no central nervous system effects were observed at 1 mg/kg/day.

Lifetime feeding studies in rats and mice produced CNS effects, increased mortality, weight loss, anemia, hepatotoxicity, renal toxicity, testicular degeneration, and inflammation of the prostate. In male and female rats fed RDX in the diet at a level to give a daily intake of 40 mg/kg, tremors and convulsions, increased mortality, and enlargement of the liver were observed. Anemia and enlargement of the kidneys accompanied by histologic changes were also found in males receiving 40 mg RDX/kg/day. Inflammation of the prostate was found when RDX was administered at 1.5, 8, and 40 mg/kg/day; no effects were noted at a dose of 0.3 mg/kg/day. When mice were administered 175 mg RDX/kg/day, increased mortality was seen within 10 weeks. The high dose was reduced to 100 mg RDX/kg/day. Decreased weight gain was seen in females receiving 100 mg RDX/kg/day between 10 weeks postadministration and study

RDX-3

termination. Increased liver weights were found in males and females receiving RDX at 100 mg/kg/day, and testicular degeneration was found in males receiving 35 or 100 mg/kg/day; no important toxic effects were observed at 7 mg/kg/day.

RDX was not found to be mutagenic in bacteria and gave negative results in the dominant-lethal test and in an unscheduled DNA synthesis assay. RDX was not carcinogenic in rats. In B6C3F$_1$ mice, a significant increase was observed in the combined incidence of hepatocellular carcinomas and adenomas in females receiving RDX at 7, 35, or 100 mg/kg/day for 2 years. Mortality in mice receiving the highest dose was excessive, and the dose was lowered from 175 to 100 mg/kg at week 11. RDX is classified as Group C: Possible Human Carcinogen.

In a two-generation reproduction study in rats, decreased fertility was observed at 50 mg RDX/kg/day. Developmental effects (decreased pup weights) were seen at 16 and 50 mg RDX/kg/day; there were no effects at 5 mg/kg/day. RDX was found to be embryotoxic in rats at 20 mg/kg/day but was not found to be teratogenic.. In a study in rabbits, RDX caused maternal toxicity at 20 mg/kg/day, and there was suggestive evidence for a teratogenic effect at 2 and 20 mg/kg/day.

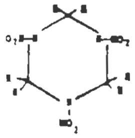
Based on these findings and on the results of a 90-day oral toxicity study in monkeys where convulsions occurred in five of six animals administered 10 mg RDX/kg/day but no CNS effects were seen in monkeys administered 1 mg/kg/day, the Longer-term Health Advisory (HA) for a 10-kg child has been determined to be 0.1 mg/L (100 µg/L). In the absence of adequate animal data to determine a One-day or Ten-day Health Advisory, the Longer-term HA for a 10-kg child, 0.1 mg/L (100 µg/L), is used as a conservative estimate of the One-day or Ten-day HA. The Longer-term HA for an adult was established at 0.35 mg/L (400 µg/L). A Lifetime HA of 0.002 mg/L (2 µg/L) for an adult was determined based on a

RDX-4

Drinking Water Equivalent Level (DWEL) of 0.100 mg/L (100 µg/L). The DWEL is based on a Reference Dose (RfD) of 0.003 mg/kg/day where the effect was suppurative inflammation of the prostate of male rats fed RDX for 2 years.

RDX-5

Table II-1. General Chemical and Physical Properties of RDX

CAS No.	121-82-4
Synonyms	Cyclonite/Hexogen Cyclotrimethylenetrinitramine Hexahydro-1,3,5-trinitro-1,3,5-triazine RDX sym-Trimethylenetrinitramine T_4 1,3,5-Trinitrohexahydro-s-triazine
Molecular weight	222.26
Empirical formula	$C_3H_6N_6O_6$
Chemical structure	
Physical state	White crystalline solid-orthorhombic crystal
Specific gravity	1.816 @ 20°C
Melting point	204.1°C
Heat of combustion	2,259.4 cal/g
Solubility characteristics:	
Water	0.00076% w/v @ 25°C (7.6 mg/L) to 42.3 mg/L (20°C) reported
Cyclohexanone	12.7% w/w @ 25°C
Cyclopentone	9.9% w/w @ 25°C
Acetone	8.3% w/w @ 25°C
Nitrobenzene	1.5% w/w @ 25°C
Methylisobutenyl ketone	3.0% w/w @ 25°C
Methylacetate	1.9% w/w @ 20°C
Acetic anhydride	4.9% w/v @ 30°C
Conversion factors (air)	1 ppm = 9.09 mg/m^3

SOURCE: Adapted from Hawley (1977); Small and Rosenblatt (1974); Windholz (1983); Sullivan et al. (1979); Etnier (1986).

Occupational Health Guideline for Selenium and Its Inorganic Compounds (as Selenium)*

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

APPLICABILITY

The general guidelines contained in this document apply to all selenium and its inorganic compounds. Physical and chemical properties of several specific compounds are provided for illustrative purposes.

SUBSTANCE IDENTIFICATION

Selenium

- Formula: Se
- Synonyms: Selenium, metallic; selenium, elemental
- Appearance and odor: Black, gray, or red odorless solid.

Sodium selenite

- Formula: Na_2SeO_3
- Synonyms: None
- Appearance and odor: Colorless and odorless solid.

Sodium selenate

- Formula: Na_2SeO_4
- Synonyms: None
- Appearance and odor: Colorless and odorless solid.

Selenium dioxide

- Formula: SeO_2
- Synonyms: None
- Appearance and odor: Colorless and odorless solid.

Selenium oxychloride

- Formula: $SeOCl_2$
- Synonyms: None
- Appearance: Colorless to yellow liquid.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for selenium and its inorganic compounds is 0.2 milligram of selenium and its inorganic compounds (as selenium) per cubic meter of air (mg/m^3) averaged over an eight-hour work shift.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Selenium, sodium selenite, sodium selenate, or selenium dioxide can affect the body if they are inhaled, if they come in contact with the eyes or skin, or if they are swallowed. Selenium oxychloride and selenium dioxide may enter the body through the skin.

- **Effects of overexposure**

1. Short-term Exposure: Inhalation of large quantities of selenium dioxide or selenium oxychloride may cause severe breathing difficulties which may not appear for several hours after exposure. Skin contact with selenium dioxide or selenium oxychloride may cause skin burns. Skin exposure to selenium dioxide dust may cause a skin rash. Splashes of selenium dioxide may cause eye irritation. Selenium dioxide dust may cause "rose eye," an allergy of the eyelids in which they may become puffy.

2. Long-term Exposure: Prolonged exposure to selenium, sodium selenite, sodium selenate, or selenium dioxide may cause paleness, coated tongue, stomach disorders, nervousness, metallic taste and a garlic odor of the breath. Fluid in the abdominal cavity, damage to the liver and spleen, and anemia have been reported in animals. Prolonged skin contact with selenium oxide or selenium oxychloride may cause skin sensitization.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service   Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

3. *Reporting Signs and Symptoms:* A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to selenium and its inorganic compounds.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to selenium and its inorganic compounds at potentially hazardous levels:

1. *Initial Medical Examination:*

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Persons with a history of asthma, allergies, or known sensitization to selenium, or with a history of other chronic respiratory disease, gastrointestinal disturbances, disorders of liver or kidneys, or recurrent dermatitis would be expected to be at increased risk from exposure. Examination of the eyes, respiratory system, liver, kidneys, and blood should be stressed. The skin should be examined for evidence of chronic disorders. Special consideration should be given to women of childbearing age since the possibility that selenium may be teratogenic might place these women in a high risk group.

—Urinalysis: Proper function of the kidneys is necessary to validate levels of selenium in the urine. A urinalysis should be obtained to include at a minimum specific gravity, albumin, glucose, and a microscopic on centrifuged sediment.

—Liver function tests: Selenium causes liver damage and tumors in animals. A profile of liver function should be obtained by using a medically acceptable array of biochemical tests.

2. *Periodic Medical Examination:* The aforementioned medical examinations should be repeated on an annual basis.

- **Summary of toxicology**

Elemental selenium and certain selenium compounds as dusts, vapors, and fumes irritate the eyes, upper respiratory tract, and skin. Animals exposed to selenium anhydride at a concentration of 150 mg/m^3 for 4 hours developed conjunctivitis, pulmonary edema, and convulsions preceding death; there were degenerative changes in the liver, kidneys, spleen, and heart. Prolonged feeding of animals with diets containing selenium in amounts of 5 to 15 ppm caused hepatic necrosis, hemorrhage, and cirrhosis; marked and progressive anemia occurred in some species. The possibility of teratogenic effects from exposure to selenium has been raised, based upon observations in animals, but it has not been established in man. Eleven of 53 rats developed adenoma or low-grade carcinoma in cirrhotic livers, and four others had advanced adenomatoid hyperplasia, after having survived for 18 to 24 months on diets containing 5, 7, or 10 ppm of selenium; no tumors occurred in 73 rats surviving less than 18 months, although after 3 months cirrhosis was frequent. In control rats 18 to 24 months of age, the incidence of spontaneous hepatic tumors was less than 1%. A group of workers briefly exposed to high concentrations of selenium fume developed severe irritation of the eyes, nose, and throat, followed by headaches; transient dyspnea occurred in one case. In workers exposed to an undetermined concentration of selenium oxide there was bronchospasm and dyspnea, followed within 12 hours by chills, fever, headache, and bronchitis, leading to pneumonitis in a few cases; all were asymptomatic within a week. In a study of workers in a selenium plant, workroom air levels ranged from 0.2 to 3.6 mg/m^3, while urinary levels ranged from below 0.10 to 0.43 mg/l; the chief complaints were garlic odor of the breath, metallic taste, gastrointestinal disturbances, and skin eruptions. An accidental spray of selenium dioxide, in unspecified form and concentration, into the eyes of a chemist caused superficial burns of the skin and immediate irritation of the eyes; within 16 hours vision was blurred, and the lower portions of both corneas appeared dulled; 16 days after the accident the corneas were normal. Acute burns of the skin can be caused by selenium oxychloride and selenium oxide, which are highly vesicant. Contact with the fume of heated selenium dioxide caused an acute, weeping dermatitis, with the development of hypersensitivity in some cases.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data—Selenium**

1. Molecular weight: 78.96
2. Boiling point (760 mm Hg): 685 C (1265 F)
3. Specific gravity (water = 1): 4.45 to 4.8
4. Vapor density (air = 1 at boiling point of selenium): Not applicable
5. Melting point: 150 C (302 F)
6. Vapor pressure at 20 C (68 F): Less than 0.001 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble
8. Evaporation rate (butyl acetate = 1): Not applicable

- **Physical data—Sodium selenite**

1. Molecular weight: 173
2. Boiling point (760 mm Hg): Decomposes
3. Specific gravity (water = 1): 3.1
4. Vapor density (air = 1 at boiling point of sodium selenite): Not applicable
5. Melting point: 710 C (1310 F) (decomposes)
6. Vapor pressure at 20 C (68 F): Less than 0.001 mg Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 85
8. Evaporation rate (butyl acetate = 1): Not applicable

- **Physical data—Sodium selenate**

1. Molecular weight: 188.9
2. Boiling point (760 mm Hg): Decomposes
3. Specific gravity (water = 1): 3.1

4. Vapor density (air = 1 at boiling point of sodium selenate): Not applicable
5. Melting point: Decomposes
6. Vapor pressure at 20 C (68 F): Less than 0.001 mm Hg
7. Solubility in water, g/200 g water at 20 C (68 F): 83
8. Evaporation rate (butyl acetate = 1): Not applicable

- **Physical data—Selenium dioxide**

1. Molecular weight: 110.9
2. Boiling point (760 mm Hg): 315 C (599 F) (sublimes)
3. Specific gravity (water = 1): 3.95
4. Vapor density (air = 1 at boiling point of selenium dioxide): Not applicable
5. Melting point: 340 C (644 F)
6. Vapor pressure at 20 C (68 F): 0.001 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 257
8. Evaporation rate (butyl acetate = 1): Not applicable

- **Physical data—Selenium oxychloride**

1. Molecular weight: 165.9
2. Boiling point (760 mm Hg): 176 C (349 F)
3. Specific gravity (water = 1): 2.42
4. Vapor density (air = 1 at boiling point of selenium oxychloride): 5.7
5. Melting point: 10.8 C (51 F)
6. Vapor pressure at 20 C (68 F): 0.35 mm approximately
7. Solubility in water, g/100 g water at 20 C (68 F): Decomposes
8. Evaporation rate (butyl acetate = 1): Not applicable

- **Reactivity**

1. Conditions contributing to instability: None hazardous
2. Incompatibilities: Contact of selenium with acids may cause formation of poisonous hydrogen selenide gas. Contact of selenium with strong oxidizing agents may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors may be released in a fire involving selenium, sodium selenite, sodium selenate, selenium dioxide, and selenium oxychloride.
4. Special precautions: None

- **Flammability**

1. Flash point: Not applicable
2. Autoignition temperature: Selenium: Data not available; sodium selenite, sodium selenate, selenium dioxide, and selenium oxychloride: Not applicable
3. Flammable limits in air, % by volume: Not applicable
4. Extinguishant: For selenium, water

- **Warning properties**

The *Documentation of TLV's* notes that "Clinton reported intense irritation of eyes, nose, and throat, followed by headache, in a group of workers briefly exposed to high concentrations of selenium fume." The ILO reports that "persons who work in atmospheres containing selenium dioxide dust may develop a condition known among the workers as 'rose eye,' a pink allergy of the eyelids, which often become puffy. There is usually also a conjunctivitis of the palpebral conjunctiva but rarely of the bulbar conjunctiva." The *Hygienic Information Guide* for selenium states that "in contact with the eye, selenium compounds exert a rapid irritant action leading to inflammation." Grant reports that both selenium dioxide and selenium sulfide can produce toxic effects on the eye. Quantitative information concerning air concentrations of selenium compounds which cause eye irritation is not available.

MONITORING AND MEASUREMENT PROCEDURES

- **General**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

- **Method**

Sampling and analyses may be performed by collection of selenium and its inorganic compounds on a filter, followed by treatment with acid and atomic absorption spectrophotometric analysis. An analytical method for selenium and its inorganic compounds is in the *NIOSH Manual of Analytical Methods,* 2nd Ed., Vol. 3, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00261-4).

RESPIRATORS

- Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.
- In addition to respirator selection, a complete respiratory protection program should be instituted which

includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent any possibility of skin contact with selenium oxychloride or liquids containing selenium oxychloride.
- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with selenium, sodium selenite, sodium selenate, or liquids containing these compounds.
- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent skin contact with selenium dioxide or liquids containing selenium dioxide, where skin contact may occur.
- If employees' clothing has had any possibility of being contaminated with selenium oxychloride, sodium selenite,sodium selenate, selenium dioxide, or liquids containing these compounds, employees should change into uncontaminated clothing before leaving the work premises.
- Clothing which has had any possibility of being contaminated with selenium oxychloride, sodium selenite, sodium selenate, or selenium dioxide should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of contaminant from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the contaminant, the person performing the operation should be informed of contaminant's hazardous properties.
- Where there is any possibility of exposure of an employee's body to selenium, selenium oxychloride, sodium selenite, sodium selenate, selenium dioxide, or liquids containing these compounds, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.
- Non-impervious clothing which becomes contaminated with selenium, sodium selenite, sodium selenate, selenium dioxide or liquids containing these compounds should be removed promptly and not reworn until the contaminant is removed from the clothing.
- Non-impervious clothing which becomes contaminated with selenium oxychloride should be removed immediately and not reworn until the selenium oxychloride is removed from the clothing.
- Employees should be provided with and required to use dust- and splash-proof safety goggles where there is any possibility of selenium dioxide, selenium oxychloride, or liquids containing these compounds contacting the eyes.
- Employees should be provided with and required to use dust- and splash-proof safety goggles where sodium selenite, sodium selenate, or liquids containing these compounds may contact the eyes.
- Where there is any possibility that employees' eyes may be exposed to selenium oxychloride, selenium dioxide, or liquids containing these compounds, an eyewash fountain should be provided within the immediate work area for emergency use.

SANITATION

- Workers subject to skin contact with selenium oxychloride, sodium selenite, sodium selenate, selenium dioxide, or liquids containing these compounds should wash any areas of the body which may have contacted selenium oxychloride, sodium selenite, sodium selenate, selenium dioxide, or liquids containing these compounds at the end of each work day.
- Skin that becomes contaminated with selenium, sodium selenite, sodium selenate, selenium dioxide, or liquids containing these substances should be promptly washed or showered to remove any contaminant.
- Skin that becomes contaminated with selenium oxychloride should be immediately washed or showered to remove any selenium oxychloride.
- Eating and smoking should not be permitted in areas where selenium oxychloride, sodium selenite, sodium selenate, selenium dioxide, or liquids containing these compounds are handled, processed, or stored.
- Employees who handle selenium oxychloride, sodium selenite, sodium selenate, selenium dioxide, or liquids containing these compounds should wash their hands thoroughly before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to selenium and its inorganic compounds may occur and control methods which may be effective in each case:

Operation	Controls
Liberation during mining recovery, and purification and manufacture of selenium compounds	Local exhaust ventilation; general dilution ventilation; personal protective equipment

Operation	Controls
Use in glassware industry for decolorization of fiberglass, scientific glassware, vehicular tail lights, traffic and other signal lenses, and infrared equipment; use in manufacture of electrical components in welding, transformers, semiconductors, photoelectric cells, etc.	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in manufacture of photography and photocopy devices; manufacture of dyes, pigments, and colored glazes for metal etching and for printing on glass	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in manufacture of lubricating oils and extreme pressure lubricants as antioxidants and detergency improvers	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in rubber industry for manufacture and use as vulcanization accelerators and antioxidants; use in manufacture of pharmaceuticals, fungicides, and dermatitis control	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use as a catalyst for hardening fats for soaps, waxes, edible fats, and plastics	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in manufacture of insecticides, parasiticides, bactericides, and herbicides for agricultural and citrus crops	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in manufacture of flame-proofing agents on textiles and electric cables	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in manufacture of delayed action blasting caps	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use as solvents in paint and varnish removers; rubber, resin, and glue solvent; use for organic synthesis in oxidation, hydrogenation, and dehyrogenation	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in refining of copper, silver, gold, or nickel ores or during recycling of scrap metal	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in miscellaneous operations in manufacture of insect repellants, activators, hardeners, special ceramic materials, plasticizers, and mercury vapor detectors	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use for preparation of feed additives for poultry and swine	Local exhaust ventilation; general dilution ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

- **Eye Exposure**

If selenium or its inorganic compounds get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with these chemicals.

- **Skin Exposure**

If selenium or its inorganic compounds get on the skin, immediately wash the contaminated skin. If selenium, sodium selenite, sodium selenate, or selenium dioxide soak through the clothing, remove the clothing immediately and wash the skin. If irritation persists after washing, get medical attention.

- **Breathing**

If a person breathes in large amounts of selenium sodium selenite, sodium selenate, or selenium dioxide, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration.

Keep the affected person warm and at rest. Get medical attention as soon as possible.

- **Swallowing**

When selenium, sodium selenite, sodium selenate, selenium oxychloride, or selenium dioxide have been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

- **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL AND DISPOSAL PROCEDURES

- Persons not wearing protective equipment and clothing should be restricted from areas of spills until cleanup has been completed.
- If selenium or its inorganic compounds are spilled, the following steps should be taken:

1. Ventilate area of spill.
2. Collect spilled material in the most convenient and safe manner and deposit in sealed containers for reclamation or for disposal in a secured sanitary landfill. Liquid containing selenium and its inorganic compounds should be absorbed in vermiculite, dry sand, earth, or a similar material.

- Waste disposal method:

Selenium and its inorganic compounds may be disposed of in sealed containers in a secured sanitary landfill.

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* SPECIAL NOTE

Selenium and its inorganic compounds (as selenium) appear on the OSHA "Candidate List" of chemicals being considered for further scientific review regarding their carcinogenicity (*Federal Register*, Vol. 45, No. 157, pp. 5372-5379, 12 August 1980).

RESPIRATORY PROTECTION FOR SELENIUM AND ITS INORGANIC COMPOUNDS (AS SELENIUM)

Condition	Minimum Respiratory Protection* Required Above 0.2 mg/m^3
Particulate Concentration	
10 mg/m^3 or less	A high efficiency particulate filter respirator with a full facepiece. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
100 mg/m^3 or less	A Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet, or hood operated in continuous-flow mode. A powered air-purifying respirator with a high efficiency particulate filter and a full facepiece, helmet, or hood.
Greater than 100 mg/m^3 or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	A high efficiency particulate filter respirator with a full facepiece. Any escape self-contained breathing apparatus with a full facepiece.

*Only NIOSH-approved or MSHA-approved equipment should be used.

Occupational Health Guideline for Trinitrotoluene

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: $CH_3C_6H_2(NO_2)_3$
- Synonyms: TNT; trinitrotoluol; 2,4,6-trinitrotoluene; sym-trinitrotoluene
- Appearance and odor: Colorless to pale yellow, odorless solid.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for trinitrotoluene is 1.5 milligrams of trinitrotoluene per cubic meter of air (mg/m^3) averaged over an eight-hour work shift. The American Conference of Governmental Industrial Hygienists has recommended for trinitrotoluene a Threshold Limit Value of 0.5 mg/m^3 with a skin notation.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Trinitrotoluene can affect the body if it is inhaled, if it comes in contact with the eyes or skin, or if it is swallowed. It may enter the body through the skin.

- **Effects of overexposure**

Exposure to trinitrotoluene can cause liver damage with yellow jaundice and anemia which may be fatal. It may also cause irritation of the eyes, nose, and throat with sneezing, cough, and sore throat. It may cause a skin rash and stain the skin, hair, and nails a yellowish color. It may affect the ability of the blood to carry oxygen. This may result in a bluish discoloration of the skin, weakness, drowsiness, shortness of breath and unconsciousness. In addition, it may cause muscular pains, heart irregularities, kidney irritation, cataracts of the eyes, menstrual irregularities, and nerve damage.

- **Reporting signs and symptoms**

A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to trinitrotoluene.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to trinitrotoluene at potentially hazardous levels:

1. *Initial Medical Examination:*

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Persons with a history of asthma, allergies, or known sensitization to trinitrotoluene would be expected to be at increased risk from exposure. Examination of the blood, liver, eyes, cardiovascular system, nervous system, and kidneys should be stressed. The skin should be examined for evidence of chronic disorders.

—A complete blood count: Trinitrotoluene has been shown to cause aplastic anemia in humans. A complete blood count should be performed including a red cell count, a white cell count, a differential count of a stained smear, as well as hemoglobin and hematocrit.

—Liver function tests: Since liver damage has been observed in humans exposed to trinitrotoluene, a profile of liver function should be obtained by using a medically acceptable array of biochemical tests.

—Urinalysis: Since kidney damage has been observed in humans exposed to trinitrotoluene, a urinalysis should be obtained to include at a minimum specific gravity, albumin, glucose, and a microscopic on centrifuged sediment.

2. *Periodic Medical Examination:* The aforementioned medical examinations should be repeated on a semi-annual basis.

- **Summary of toxicology**

Trinitrotoluene (TNT) dust or fume causes liver

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

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damage, aplastic anemia, cyanosis, and dermatitis. There have been numerous fatalities of workers exposed to TNT in munitions plants; in a series of 22 fatal cases, 8 died from toxic hepatitis, 13 from aplastic anemia, and 1 from a combination of both. The vapor or dust can cause irritation of mucous membranes, resulting in sneezing, cough, and sore throat. Although intense or prolonged exposure to TNT may cause some cyanosis, it is not regarded as a strong producer of methemoglobin. Other occasional effects are leukocytosis or leukopenia, peripheral neuritis, muscular pains, cardiac irregularities, and renal irritation. Cataracts have been observed in a considerable proportion of chronically exposed workers; one report indicates that 26 of 61 workers with an average exposure of 8.4 years had a characteristic peripheral cataract. TNT causes sensitization dermatitis; the hands, wrists, and forearms are most commonly affected, but skin at friction points such as the collar line, belt line, and ankles is also often involved; erythema, papules, and an itchy eczema can be severe. The skin, hair, and nails of exposed workers may be stained yellow.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 227
2. Boiling point (760 mm Hg): 240 C (464 F) (explodes)
3. Specific gravity (water = 1): 1.65
4. Vapor density (air = 1 at boiling point of trinitrotoluene): Not applicable
5. Melting point: 81 C (178 F)
6. Vapor pressure at 85 C (185 F): 0.053 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 0.013
8. Evaporation rate (butyl acetate = 1): Not applicable

- **Reactivity**

1. Conditions contributing to instability: Slow decomposition occurs above 180 C (356 F). Exposure to light may increase impact sensitivity. Rapid heating may cause detonation.
2. Incompatibilities: Contact with strong oxidizers may cause fire. Contact with ammonia or with strong alkalies may increase sensitivity to shock. Can react vigorously with oxidizable materials.
3. Hazardous decomposition products: Toxic gases and vapors (such as oxides of nitrogen and carbon monoxide) may be released in a fire involving trinitrotoluene.
4. Special precautions: Protect from shock.

- **Flammability**

1. Flash point: Explodes
2. Impact sensitivity (minimum fall of a 2 kg weight to cause at least one explosion in ten trials): 100 cm
3. Explosion temperature (temperature required to cause explosion in five seconds): 475 C (887 F)
4. Extinguishant: Water may be used on small fires. Do not attempt to extinguish large fires.

- **Warning properties**

1. Odor Threshold: No quantitative information is available concerning the odor threshold of TNT.
2. Eye Irritation Level: Grant states that "irritation of the eyes and skin is not uncommon among munitions workers exposed to its dust and fumes." No quantitative information is available concerning the air concentrations which produce the eye irritation.
3. Evaluation of Warning Properties: Since no quantitative information is available relating warning properties to air concentrations of TNT, this substance is treated as a material with poor warning properties. The concentration in saturated air at 20 C might result in a significant exposure relative to the permissible exposure.

MONITORING AND MEASUREMENT PROCEDURES

- **General**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

- **Method**

At the time of publication of this guideline, no measurement method for trinitrotoluene had been published by NIOSH.

RESPIRATORS

- Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.
- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with solid trinitrotoluene or liquids containing trinitrotoluene.
- If employees' clothing may have become contaminated with solid trinitrotoluene, employees should change into uncontaminated clothing before leaving the work premises.
- Clothing which may have become contaminated with solid trinitrotoluene or liquids containing trinitrotoluene should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of trinitrotoluene from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the trinitrotoluene, the person performing the operation should be informed of trinitrotoluene's hazardous properties.
- Non-impervious clothing which becomes contaminated with trinitrotoluene should be removed promptly and not reworn until the trinitrotoluene is removed from the clothing.
- Employees should be provided with and required to use dust- and splash-proof safety goggles where solid trinitrotoluene or liquids containing trinitrotoluene may contact the eyes.

SANITATION

- Workers subject to skin contact with solid trinitrotoluene or liquids containing trinitrotoluene should wash with soap or mild detergent and water any areas of the body which may have contacted trinitrotoluene at the end of each work day.
- Skin that becomes contaminated with trinitrotoluene should be promptly washed or showered with soap or mild detergent and water to remove any trinitrotoluene.
- Eating and smoking should not be permitted in areas where solid trinitrotoluene or liquids containing trinitrotoluene are handled, processed, or stored.
- Employees who handle solid trinitrotoluene or liquids containing trinitrotoluene should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to trinitrotoluene may occur and control methods which may be effective in each case:

Operation	Controls
Use in the manufacture of shells, bombs, grenades, and mines; use in commercial explosives, and propellant compositions	Process enclosure; local exhaust ventilation; personal protective equipment
Use in the production of intermediates for synthesis of dyestuffs and photographic chemicals	Process enclosure; local exhaust ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

- **Eye Exposure**

If trinitrotoluene or liquids containing trinitrotoluene get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

- **Skin Exposure**

If trinitrotoluene or liquids containing trinitrotoluene get on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If trinitrotoluene or liquids containing trinitrotoluene penetrate through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. Get medical attention immediately.

- **Breathing**

If a person breathes in large amounts of trinitrotoluene, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

- **Swallowing**

When trinitrotoluene or liquids containing trinitrotoluene have been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

- **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL AND DISPOSAL PROCEDURES

- Persons not wearing protective equipment and clothing should be restricted from areas of spills until cleanup has been completed.
- If trinitrotoluene is spilled, the following steps should be taken:

1. Ventilate area of spill.
2. Attempt to reclaim spilled material; however, do not sweep or burn unless this is supervised by explosives experts.

- Waste disposal method:

Trinitrotoluene may be disposed of only by explosives experts.

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RESPIRATORY PROTECTION FOR TRINITROTOLUENE

Condition	Minimum Respiratory Protection* Required Above 1.5 mg/m³
Particulate or Vapor Concentration	
15 mg/m³ or 1.5 ppm or less	Any supplied-air respirator. Any self-contained breathing apparatus.
75 mg/m³ or 7.5 ppm or less	Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
3000 mg/m³ or 300 ppm or less	A Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet, or hood operated in continuous-flow mode.
Greater than 3000 mg/m³ or 300 ppm or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any gas mask providing protection against organic vapors and particulates. Any escape self-contained breathing apparatus.

*Only NIOSH-approved or MSHA-approved equipment should be used.

APPENDIX C
Chemical Data Acquisition Plan for Open-Burning/Open-Detonation Grounds at Seneca Army Depot Romulus, New York

APPROVED BY: James P Chaplick
MAIN Chief Environmental Engineer

APPROVED BY: Michael Duchesneau
MAIN Project Manager

APPROVED BY: ______________________
Aquatec Project Director

APPROVED BY: ______________________
Aquatec Quality Assurance Officer

CHAS. T. MAIN, INC.
PRUDENTIAL CENTER
BOSTON, MA 02199

October 1991

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1.0 SITE BACKGROUND

This Chemical Data Acquisition Plan (CDAP) has been prepared for the Remedial Investigation and Feasibility Study (RI/FS) at the Seneca Army Depot (SEAD) Open Burning/Open Detonation Grounds (OB/OD) and will serve as the Quality Assurance Project Plan (QAPP) for this site. This CDAP presents the policies, organization, objectives, quality assurance (QA), and quality control (QC) activities to be implemented in this RI/FS. This document has been prepared in accordance with the U.S. Army Corps of Engineers Regulation "Chemical Data Quality Management for Hazardous Waste Remedial Activities" (ER 1110-1-263; March 1990), "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans" (QAMS-005/80, EPA 1980) and NYS Department of Environmental Conservation Division of Hazardous Substances Regulation "RCRA Quality Assurance Project Plan Guidance" (July 1989).

Chas T. Main (MAIN) has been retained by the U.S. Army Corps of Engineers to conduct an RI/FS to determine the nature and extent of environmental impacts from the site. The data collected will be evaluated and the most appropriate remedial action, if any, proposed. The area to be investigated is restricted to the nine (9) open burning pads and adjacent areas within the Open Burning/Open Detonation Grounds encompassing approximately 30 of the site's 90 acres. MAIN has subcontracted three firms to assist in this investigation. Human Factors Applications, Inc. of Indian Head, Maryland will provide expertise in explosive ordinance disposal, Aquatec, Inc. of South Burlington, Vermont will assist in sampling and provide laboratory analytical services, and Blasland, Bouck and Lee Inc. of Syracuse, New York will assist in fieldwork.

Matrices to be sampled and analyzed during the RI/FS include soil, groundwater, surface water, and biota. In performing these analyses, Aquatec's laboratory will follow all procedures specified in the 1989 New York State Department of Environmental Conservation Contract Laboratory Program (NYSDEC CLP) Protocols for standard analyses and Draft Method 8330; a modified NYSDEC CLP Method will be used for VOAs.

The Work Plan (WP), including the Field Sampling and Analysis Plan (FSAP) and the Health and Safety Plan (HASP), prepared for this site contains complete discussions of specific task objectives, their relationships to previous investigations, detailed project design, sampling protocols, and Quality Assurance/Quality Control requirements for sampling. The

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number and type of samples collected and submitted to the laboratory for analysis are outlined in these plans.

2.0 QUALITY CONTROL AND QUALITY ASSURANCE PROCEDURES, ORGANIZATION, AND RESPONSIBILITIES

2.1 PROJECT ORGANIZATION

This section describes the organizational structure, lines of authority, and responsibilities of individuals who will be responsible for the successful execution of the CDAP. Subcontractor personnel providing services in support of this project will perform work in strict compliance with the appropriate contract specifications for this activity. A complete description of the firms involved and their responsibilities in relation to the entire investigation is presented in the Work Plan.

The RI/FS investigation at SEAD will involve MAIN and three subcontractors.. MAIN is responsible for overall project activities including coordination of the three firms subcontracted for sampling, analytical services, and consultation. Human Factors Applications, Inc. will provide expertise in the area of explosive ordinance disposal. They will be the first consultants on-site to assess sampling conditions. MAIN, Blasland Bouck and Lee and Aquatec, Inc. will provide all necessary field sampling services. Aquatec, Inc. will also provide laboratory analyses for samples associated with this investigation. MAIN is additionally responsible for the preparation of all final evaluation reports.

Mr. Michael Duchesneau, P.E. of MAIN, the Project Manager, is responsible for managing the implementation and performance of the project on a day-to-day basis. He will have the overall responsibility of managing and administrating project tasks, schedules, budgets, and completion. He will also be responsible for coordinating the efforts of the assigned project staff and for establishing--in concert with the Chief Discipline Engineers, Chief Discipline Scientists, and the Project Quality Assurance Analyst--the performance standards and data quality objectives for all work initiated.

Mr. Duchesneau will be supported during the performance of this program by numerous individuals at MAIN. Principal assistance will be provided by Chief Discipline Engineers and Scientists, who are responsible for assuring the quality of work conducted by individuals that fall under their line management responsibility. Figure 34 of Section 6 of the Work Plan illustrates MAIN's organizational structure as it applies to this project.

The horizontal organization shows a structure of project management supported by technical disciplines which include health and safety, QA/QC, environmental engineering, environmental science, hydrogeologic, and risk assessment personnel. The vertical structure has all project personnel reporting to the Project Manager, as well as to their discipline manager. The horizontal and vertical elements of this structure have been developed to assure the performance of the project tasks, and high scientific or engineering standards.

Mr. James Chaplick is the Chief Discipline Engineer responsible for establishing work performance objectives and standards for all operations related to remedial investigations or studies. Assisting, and reporting directly to, Mr. Chaplick are three lead engineers or scientists who focus and specialize on specific disciplines that are required during implementation of the RI/FS. These include Mr. Colin Cool, lead hydrogeologist; Mr. Paul O'Brien, lead environmental engineer; and Mr. Philip Hunt, the safety and health officer.

Mr. Doug Hjorth is the Chief Discipline Scientist responsible for the definition and monitoring of work performance standards and objectives for all operations related to ecological assessment of the Seneca site. These operations will be necessary to assess the possible impact of contamination on the local flora and fauna.

Independent oversight of quality related issues pertinent to this project will be maintained by Mr. Theodore Drummond, who is MAIN's corporate Quality Assurance Officer. Mr. Drummond will be assisted in the performance of these duties by a Project Quality Assurance Analyst (PQAA) who has been assigned to oversee and monitor all day-to-day and project-specific data collection and generation activities. The PQAA will function as an independent reviewer of the project's adherence to the QA/QC procedures identified in this document. Specifically, he will be responsible for initiating and documenting the findings of required Performance and Systems Audits; for overseeing Preventative Maintenance activities; for defining measures as they may be necessary to correct conditions that are out of control; and for reporting all findings to designated project management. The PQAA will report findings directly to Mr. Drummond, Mr. Duchesneau, and MAIN's management. The PQAA will also prepare monthly reports showing findings of his review activities (see Reports to Management described below) which will be provided to the EPA in Monthly Progress Reports.

2.2 FIELD SAMPLING RESPONSIBILITIES

All field sampling activities will be coordinated through the Project Manager. He is responsible for the development, review, and implementation of sampling work plans for the investigation. The implementation of these work plans includes performance and system audits of the sampling activities by the PQAA with reports submitted to the Project Manager for initiation of corrective action.

The project contact at Aquatec, Inc., will be Pauline Malik. Ms. Malik is responsible for coordinating the field and analytical activities as they pertain to Aquatec personnel. Field sampling crews, and equipment will be mobilized as requested by the Project Manager.

Sampling personnel will be experienced in U.S.EPA and NYSDEC procedures for surface and subsurface soils and water sampling. In addition, all on-site personnel will have completed the 40-hour health and safety training course in accordance with Occupational Safety and Health Administration (OSHA) requirements. The project Health and Safety Plan (HASP) will be made available for all personnel on-site. Sign-off sheets verifying that personnel have read the SHERP will be maintained on file.

Sampling personnel have the responsibility for field calibration of measurement and test equipment on their respective project tasks. All equipment used in the field, such as a pH meter, thermometer, and specific conductance meter will have a calibration check on a daily basis to use. They will maintain field notebooks documenting project activities and will complete other documentation including boring and sampling logs. They will also be responsible for proper labeling, handling, storage, shipping, and chain-of-custody procedures for samples collected during their project tasks.

2.3 CONTRACT LABORATORY RESPONSIBILITIES

A discussion of Aquatec, Inc. including location, personnel, facilities, instrumentation, and capabilities is contained in Aquatec's Quality Assurance Program Plan (QAPP) attached as Attachment A to this Appendix.

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Samples will be analyzed in the Aquatec's laboratory in South Burlington, Vermont under the direction of Neal Van Wyck, Laboratory Director, assisted by Karen R. Chirgwin, Aquatec's Quality Assurance Officer; Joseph J. Orsini, Ph.D., Inorganic Laboratory Supervisor; and Gary B. Stidsen, Organic Laboratory Supervisor. Analysts and technicians in each laboratory section are responsible for analyzing the samples and performing QC analyses and specified procedures to ensure reliability of the data. They are responsible for proper documentation of all analyses and QC procedures, including the primary data review of results.

3.0 QUALITY ASSURANCE OBJECTIVES

3.1 PROJECT OBJECTIVES AND SCOPE

Specific project objectives include:

- Characterize the potential migration pathways of constituents of concern.
- Determine background levels of constituents of concern .
- Evaluate the vertical and horizontal extent, and magnitude of migration, of constituents of concern along various pathways.
- Perform a baseline risk assessment to determine the potential risk to human health and environment from the site, in the absence of any remedial action.
- Evaluation of remedial alternatives consistent with regulatory guidelines and requirements
- Determine regulatory compliance with ARAR's

The subsurface and surface soil sampling will be performed in two phases, Phase I and Phase II.

Based on the number of proposed soil borings and anticipated subsurface conditions, approximately 628 subsurface soil samples will be collected and screened for the presence of volatile organics, Lead, and TNT. The screening results will be used to select one sample from each boring for the analysis of the expanded parameter list. In addition to the sample selected from screen results, the surface sample from each boring will be analyzed for the Level IV and V parameter list. In total, two samples form each soil boring will be analyzed for the expanded parameter list that includes the full target compound list (TCL) for organics, the full target analyte list (TAL) for inorganics, nine (9) explosives and two (2) degradation products. The results of these analyses will be used to determine the nature and extent of contamination across the 30 acre site, and the nature and continuity of contamination around the burn pads. Background levels will be established by collecting and analyzing similar soil from an off-site or unimpacted on-site location.

It is anticipated that approximately fifty (50) groundwater and surface water samples will be collected, and submitted to the laboratory for analysis. Each of the groundwater and surface water samples will be analyzed for the expanded parameter list. Surface waters will be also analyzed for hardness and nitrates. Groundwater will be analyzed for nitrates. The aqueous

samples will not be screened on-site. The results of the groundwater analyses will be used to verify the results from monitoring wells already established at the OB site and determine the background levels. The results of the surface water analyses will be used to determine the nature and extent of contamination for on-site and off-site surface waters. An increase in concentration levels in Reader Creek, if any, will be established by collecting and analyzing samples upstream and downstream from the OB site.

An ecological assessment will be conducted to systematically document visual observations discriminating between obviously and potentially impacted and non-impacted areas. The results of this assessment will determine where and if there is a need for further investigation. If necessary, during Phase II, fish tissue will be sampled and analyzed to evaluate the possible exposure due to the ingestion of contaminated fish. Shellfish will be analyzed to assess the impacts to stream maroinvertebrates. The fish tissue and shellfish tissue will be analyzed for the expanded parameter list. Sediment samples will be the expanded parameters list, collected from Reeder Creek and analyzed for total organic carbon (TOC).

At this writing, no air monitoring programs is planned. If results are obtained during the course of this RI/FS investigation indicating that an air monitoring program would aid in the characterization of the site, then air samples will be collected and analyzed for the contaminants of concern.

3.2 QUALITY ASSURANCE OBJECTIVES FOR CHEMICAL MEASUREMENTS

The data quality objectives, discussed below, will ensure that all data generated or developed will be in accordance with procedures appropriate for its intended use, and that the data will be of known and documented quality and be able to withstand scientific and legal scrutiny. The quality of the measurement data can be defined in terms of completeness, representativeness, accuracy, precision, comparability, and traceability. Each of these terms is defined as follows:

- Completeness is defined as the percentage of measurements that are judged to be valid measurements. Factors that negatively affect completeness include the following: missing scheduled sampling events, submitting improper quantity of sample, sample leakage or breakage in transit or during handling, missing prescribed holding times, losing sample during laboratory analysis through accident or improper handling, improper

leakage or breakage in transit or during handling, missing prescribed holding times, losing sample during laboratory analysis through accident or improper handling, improper documentation such that traceability is compromised, or rejection of sample results due to failure to conform to QC criteria specifications. A completeness objective of at least 90% of the data specified by the statement of work is the goal established for this project.

- Representativeness expresses the degree to which the sample data accurately and precisely represent the population from which the sample was collected. Representativeness is a qualitative parameter that will be controlled by the proper design and management of the sampling program. The QA goal will be to have all samples and measurements be representative of the media sampled and aliquots taken for analysis should be representative of the sample received.

- Accuracy is the measure of agreement between an analytical result and its "true" or accepted value. Large deviations from a known value represent a change in the measurement system. Potential sources of deviation include (but are not limited to) the sampling process, sample preservation, sample handling, matrix effects, sample analysis, and data reduction. Sampling accuracy is typically assessed by collecting and analyzing field and trip blanks for the parameters of interest. Analytical laboratory accuracy is determined by comparing results from the analysis of matrix spikes, surrogates, or check standards to their known values. Accuracy results are generally expressed as Percent Recovery (%R). Accuracy goals for the parameters to be analyzed are presented in Section 9 of this document.

- Precision is the determination of the reproducibility of measurements under a given set of conditions, or a quantitative measure of the variability of a group of measurements compared to their average value. Precision is typically measured by analyzing field duplicates and laboratory duplicates (sample duplicate, matrix spike duplicate, check standard duplicate, and/or laboratory blank duplicate). Precision is most frequently expressed as standard deviation (SD), percent relative standard deviation (%RSD), coefficient of variation (CV), or relative percent difference (%RPD). Precision goals for the parameters to be analyzed are presented in Section 9 of this document.

- Comparability is a qualitative parameter expressing the confidence with which one dataset can be compared with another. Sample data should be comparable with other

measurement data for similar samples collected under similar sampling conditions. The utilization of standard sampling techniques, analytical methodologies, and reporting units will aid in ensuring the comparability of data. All results will be reported in a standard format using appropriate, defined units of measure. All laboratory data will be reported according to New York State Department of Environmental Conservation Contract Laboratory Protocols for Level IV and Level V data deliverables.

- Traceability is the extent to which reported analytical results can be substantiated by supporting documentation. Traceability documentation exists in two essential forms; those which link the quantitation process to authoritative standards, and those which explicitly describe the history of each sample from collection to analysis and disposal. The traceability goal for this project is 100%.

The fundamental mechanisms that will be employed to achieve these quality goals are; (1) Prevention of defects in quality through planning and design, documented instructions and procedures, and careful selection and training of skilled, qualified personnel, (2) Quality assessment through a program of regular audits and inspections, and (3) Corrective action in response to audit findings. This CDAP has been prepared in response to these goals and describes the Quality Assurance Program to be implemented and the QC procedures to be followed by MAIN and MAIN's subcontractors during the course of the RI/FS investigation at Seneca Army Depot OB/OD Grounds.

4.0 SAMPLING PROCEDURES

A detailed description of field activities and procedures are included in a separate Field Sampling and Analysis Plan (FSAP).

Sampling issues closely associated with quality assurance are discussed in this section, including sample containers, preservation and holding time requirements, field documentation, field quality control samples, and personnel qualifications and training requirements.

4.1 LIST OF EQUIPMENT, CONTAINERS, AND SUPPLIES TO BE TAKEN TO THE FIELD

A complete listing of all the field equipment (numbers and types) is contained in the FSAP. In general, the following equipment will be necessary for a sampling event; prepared sampling containers (as specified in Section 4.4), coolers, ice packs, appropriate sampling equipment, decontamination supplies, deionized water for field equipment blank, personal protection equipment, field notebooks, indelible pens, and field screening equipment.

4.2 SAMPLING LOCATIONS

A complete presentation of the sampling locations is provided in the Work Plan and FSAP. These documents describe in detail, the rationale that governed the selection of sampling locations.

4.3 GENERAL INFORMATION AND DEFINITIONS

a. Contractor Laboratory. The laboratory performing analysis of the field samples. This may be an AE laboratory, a Remedial Action contractor laboratory or a laboratory subcontracted by either.

b. QA and QC Samples. Samples analyzed for the purpose of assessing the quality of the sampling effort and of the analytical data. QA and QC samples include splits or replicates of field samples, rinsate blanks, trip blanks, and background (upgradient) samples.

QC Samples. Quality Control samples are collected by the sampling team for use by the contractor's laboratory. The identity of these samples is held blind to the analysts and laboratory personnel until data are in deliverable form. The checks that the data generated by the contractor's analytical lab are of suitable quality. QC samples represent approximately 10% of the field samples.

QA Samples. Samples sent to a USACE QA laboratory by overnight delivery and analyzed to evaluate AE and contractor laboratory performance. QA samples represent approximately 10% of the field samples. The contractor shall coordinate with the designated QA laboratory not less than 48 hours before sampling to assure that the QA laboratory is alerted to receive the QA samples and process then within the time limits specified by applicable EPA regulations and guidelines.

c. Split Samples. Samples that are collected as a single sample, homogenized, divided into two or more equal parts, and placed into separate containers. The sample shall be split in the field prior to delivery to a laboratory. Ordinarily split samples are analyzed by two different laboratories.

d. Replicate (duplicate, triplicate, etc.) Samples. Multiple grab samples, collected separately, that equally represent a medium at a given time and location. This is the required type of collocated sample for volatile organic analyses and most groundwater and surface water samples.

e. Rinsate Blank (Field Equipment Blank). Samples consisting of demonstrated analyte-free water collected from a final rinse of sampling equipment after the decontamination procedure has been performed. The purpose of rinsate blanks is to determine whether the sampling equipment is causing cross contamination of samples.

f. Trip Blank. Containers of demonstrated analyte-free water that are kept with the field sample containers from the time they leave the laboratory until the time they are returned to the laboratory. The purpose of trip blanks is to determine whether samples are being contaminated during transit or sample collection. Trip blanks pertain only to volatile organic analyses; therefore, the containers must contain no headspace.

Only one trip blank is needed for one day's sampling and shall satisfy trip blank requirements for all matrices for that day if the volatile samples are shipped in the same cooler.

Triple sample volume will be collected for the aqueous extractable parameters in order for the lab to perform the matrix spike/matrix spike duplicate analysis.

4.4 SAMPLING AND PRESERVATION PROCEDURES

4.4.1 Sample Containers and Preservation

It is essential to the validity of analytical results that samples be collected and stored in properly prepared containers to minimize sources of contamination. New sampling glassware and containers will be used whenever possible. Sample containers provided by ESS will be used in this RI/FS. The bottle cleaning procedures are presented in Table C-0. The type and size of sample containers required are indicated in Table C-1.

Proper sample preservation techniques are important to maintain the integrity of the sample and the validity of the analytical results. Methods of preservation are intended to: (1) Retard biological activity, (2) Retard hydrolysis of chemical compounds and complexes, (3) Reduce volatility of constituents, and (4) Reduce absorption effects. Preservation methods are generally limited to pH control, chemical additives, refrigeration, and freezing. The USACE Sample Handling Protocols (Appendix E to ER 1110-1-263) for the contaminants of concern at SEAD are listed in Table C-1.

Laboratory personnel will prepare "lab packs" for each sampling event to include all the materials necessary to properly preserve samples upon collection. For example, the bottles used for the collection of surface water samples for metals analyses will be prepared with the proper amount of nitric acid. The only type of preservation used for soil samples is refrigeration at 4°C, so field personnel will ensure that the necessary supplies such as ice and ice chests are readily available at the collection site. Sample preservation will be initiated by field personnel immediately upon sample collection or filtering, as required.

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TABLE C-0
SAMPLE CONTAINER CLEANING PROCEDURES WITHIN THE LABORATORY

Analysis/Parameter	Container Type	Matrix	Fraction Code	Cleaning Protocol*
Volatile organics analysis	Glass septum vial with Teflon-lined septum	Water	VP	B
	Wide-mouth glass jar with Teflon-lined cap	Soil/ Sediment	SV	B
Metals	Linear polyethylene cubitainer with polyethylene cap	Water	N	C
Acid, Base-Neutral Extractables	Glass jar with Teflon-lined cap	Water	MS	A
	Glass jar with Teflon-lined cap	Soil/ Sediment	SS	A

Note: Glass = amber for all organic analysis

*Cleaning Protocol A	B	C	Specifications
X	X	X	Wash with hot tap water using laboratory-grade, nonphosphate detergent.
X	X	X	Rinse three times with tap water.
X		X	Rinse with 1:a nitric acid (reagent-grade nitric acid diluted with the American Society for Testing and Materials (ASTM) Type 1 deionized water).
X	X	X	Rinse three times with ASTM Type 1 deionized water.
X			Rinse with pesticide-grade hexane using 20 mL per 64-ounce (oz) bottle, 10 mL per 32- or 16-oz bottle, or 5 mL per 8- or 4-oz bottle. Hexane is used as organics rinse.
X	X		Oven dry, using a forced-air oven, at 105° to 125°C for 1 hour.
		X	Invert and air dry in contaminant-free environment. No cleaning required; use new cubitainers (only).

TABLE C-1
REQUIRED CONTAINERS, PRESERVATION AND HOLDING TIMES

	Containers[1]	Preservation	Holding Time
I. Groundwater/Surface Water			
1. Mercury	P[2]	HNO_3 to pH<2	26 days
2. Metals, except Mercury	P[2]	HNO_3 to pH<2	180 days
3. Explosives	G[3]	Cool, 4°C	7/40 days[4]
4. TCL Volatiles	G[8]	HCL to pH<2, 4°C	7 days
5. TCL Semivolatiles	G[3]	Cool, 4°C	5/40 days[9]
6. TCL Pesticides/PCBs	G[3]	Cool, 4°C	5/40 days[9]
7. Cyanide, Total	P[2]	NaOH to pH>12	12 days
8. Nitrates	G[3]	Cool, 4°C	26 days
9. Hardness	P[2]	HNO_3 to pH<2	180 days
II. Soil			
1. Mercury	G[5]	Cool, 4°C	26 days
2. Metals, except Mercury	G[5]	Cool, 4°C	180 days
3. Explosives	G[6]	Cool, 4°C	7/40 days[4]
4. TCL Volatiles	G[8]	Cool, 4°C	7 days
5. TCL Semivolatiles	G[6]	Cool, 4°C	5/40 days[9]
6. TCL Pesticides/PCBs	G[6]	Cool, 4°C	5/40 days[9]
7. Cyanide, Total	P[5]	Cool, 4°C	12 days
8. Total Organic Carbon	G[5]	Cool, 4°C	26 days
III. Fish Tissue			
1. Mercury	G[7]	Freeze	26 days
2. Metals, except Mercury	G[7]	Freeze	180 days
3. Explosives	G[7]	Freeze	7/40 days[4]
4. TCL Volatiles	G[7]	Freeze	7 days
5. TCL Semivolatiles	G[7]	Freeze	5/40 days[9]
6. TCL Pesticides/PCBs	G[7]	Freeze	5/40 days[9]
7. Cyanide, Total	P[7]	Freeze	12 days

[1] Polyethylene (P) or Glass (G)
[2] 500 ml plastic containers with appropriate preservation
[3] 2.3 liter amber glass container with Teflon lined cap
[4] 7 days from sample receipt to extraction/40 days from extraction to analysis.
[5] 500 ml glass container with polyethylene liner
[6] 250 ml amber glass container with Teflon lined cap
[7] Sufficient size for fish
[8] 40 ml vial with septa top
[9] 5 days from sample receipt to extraction/40 days from extraction to analysis.

The following procedure, adapted from the drinking water methods will be used for acidification of volatile organic samples with HCl to a pH less than 2.

> Adjust the pH of the sample to <2 by carefully adding 1:1 HCl drop by drop to the required 2 (40 ml) VOA sample vials. The number of drops of 1:1 HCl required should be determined on a third portion of sample water of equal volume.

If acidification of the sample causes effervescence, the sample should be submitted without preservation except for cooling to 4 degrees C. This sample property will be approximately noted when present. When adding sodium thiosulfate to samples containing residual chlorine, the thiosulfate should be added to the vial prior to addition of the sample followed by addition of HCl. The 1:1 HCl solution should be made up with concentrated HCl (12N) and demonstrated analyte-free deionized water.

The following guidelines should be utilized for the cyanide aliquot:

- Test a drop of sample with potassium iodide-starch test paper (KI-starch paper). A resulting blue color indicates the presence of oxidizing agents and the need for treatment. Add ascorbic acid, a few crystals at a time, until a drop of sample produces no color on the indicator paper. Then add an additional 0.6 g of ascorbic acid for each liter of sample volume.

- Test a drop of sample on lead acetate paper moistened with acetic acid buffer solution. Darkening of the paper indicates the presence of S_2 (Sulfide). If S_2 is present, add powdered cadmium carbonate until a drop of the treated solution does not darken the lead acetate test paper. Filter the solution before raising the pH for stabilization.

- Preserve samples with 2 mL of 10 N sodium hydroxide per liter of sample (pH > 12).

- Store the samples at 4°C until the time of analysis.

4.4.2 Holding Times

Maximum holding times for all analytes of interest are presented in Table C-1. These holding times satisfy the requirements of the NYSDEC CLP Protocols and the USACE Sample Handling Protocols (Appendix E to ER 1110-1-263).

4.4.3 Details of Sampling and Preservation Procedures

The Work Plan and FSAP will discuss the details of sampling with respect to equipment, location, and frequency. This document will discuss those elements of field sampling and preservation that directly impact the quality assurance aspects of the RI/FS. An integral part of any field sampling program is the implementation of a Quality Control program. The QC program for the OB/OD grounds RI/FS includes the collection of field replicates, equipment blanks, trip blanks, and matrix spike samples for all matrices. QC samples will be collected at a minimum frequency of one per ten samples (10%). In addition, QC samples will be handled, preserved, and documented in exactly the same manner as required for the matrix and analyte of interest. Field duplicate samples will be submitted to the laboratory blind.

The following procedure, adapted from the drinking water methods will be used for acidification of volatile organic samples with HC1 to a pH less than 2.

> Adjust the pH of the sample to <2 by carefully adding 1:1 HC1 drop by drop to the required 2 (40 ml) VOA sample vials. The number of drops of 1:1 HC1 required should be determined on a third portion of sample water of equal volume.

If acidification of the sample causes effervescence, the sample should be submitted without preservation except for cooling to 4 degrees C. This sample property will be approximately noted when present. When adding sodium thiosulfate to samples containing residual chlorine, the thiosulfate should be added to the vial prior to addition of the sample followed by addition of HC1. The 1:1 HC1 solution should be made up with concentrated HC1 (12N) and demonstrated analyte-free deionized water.

4.4.3.1 Soil Sampling Procedure

Using stainless steel or Teflon sampling equipment enough solid material is removed from a specified depth to fill the required containers. The soil is placed in a clean stainless steel bowl and mixed thoroughly with stainless steel implements (spoons, spades, etc.), then divided among the sample containers to be filled and properly preserved. QC and/or QA sample containers shall be filled from the same mixture as one of the samples.

4.4.3.2 Surface and Groundwater Sampling Procedure

Valid, representative samples must be obtained. Before a sample is collected from a well, the water level shall be measured and recorded. The well will be pumped or bailed with clean equipment to remove a quantity of water equal to at least three times the submerged volume of the casing and filter pack. If the well does not recharge fast enough to permit removing three casing volumes, the well shall be pumped or bailed nearly dry, and sampled as soon as sufficient recharge has occurred. The field parameters of pH, conductivity, and temperature must vary less than 10% before sampling and the water sample is less than 50 NTUs. If preservative is added to the bottles prior to shipment to the field, care must be taken not to overfill the containers and pH must be measured on samples where a value is specified. Surface water samples will be grab samples.

4.4.3.3 Other Matrices

Sampling methods and equipment used shall meet the requirements of EPA or NIOSH methods. Sampling for fish will require the following equipment: trap nets, electrofishing gear either backmounted or larger boat mounted electroshocker equipment. Sufficient amounts of fish tissue from selected species must be collected for analytical analysis. For larger fish, individuals will be analyzed. For smaller fish, a composite sample may be required to obtain the necessary mass of tissue for analysis. Field sampling personnel will record the condition of the fish when captured and their weight and length. Scales from larger game fish, such as smallmouth bass or walleye, will be collected if available. Fish tissue samples will be analyzed with "skin on" instead of the normal fillet to correlate data with New York State's database. In addition to the contaminants of concern, lipid content will be measured.

4.4.3.4 Replicate Samples

One replicate sample will be collected for each batch of 10 or fewer samples per matrix sampled. This requirement applies to all matrices. Replicate water quality samples will be collected by alternately filling the appropriate containers until the required volume has been obtained. Replicate soil samples will be mixed until a representative homogeneous sample can be obtained. Homogenization will be accomplished by filling a properly decontaminated intermediate bowl (stainless steel or Teflon) and mixing. The extent of mixing required will depend on the nature of the material and will be considered complete when a consistent physical appearance is achieved.

4.4.3.5 Field Equipment Blanks

A field equipment blank will be collected to detect possible sources of contamination introduced from field sampling equipment that may influence analytical results. The field equipment blank will consist of one set of sample containers for all analytes of interest. Demonstrated analyte-free water will be poured over or through the sampling equipment after the decontamination process. In the event that dedicated sampling equipment is used, field equipment blanks will not be collected. One field equipment blank will be collected each day that sampling activities occur for each matrix sampled. The field equipment blanks will be handled, transported, and analyzed in the same manner as all other samples collected during the sampling event.

4.4.3.6 Trip Blanks

A trip blank will be collected for each day of sampling to detect possible sources of volatile organic contamination during sample collection or in transit. Trip blanks will be prepared in the laboratory, using demonstrated analyte-free reagent water, and shipped to the site with the sampling containers. The trip blank will accompany the sampling containers during field sampling activities without being opened. The trip blank is then packed for shipment along with the volatile organic samples for the day. The trip blank will be logged in and analyzed for TCL volatile organics. The data is reported with the sample data.

4.4.3.7 Matrix Spike Samples

The use of matrix spikes gives insight into the analytical proficiency and efficiency of the analytical methods. During the field sampling activities, sufficient sample volume must be collected (triple the normal sample volume) so that a matrix spike/matrix spike duplicate pair for organic constituents and a matrix spike/replicate pair for inorganic constituents can be prepared. Samples for matrix spikes will be collected for each batch of 10 or fewer field samples of the same matrix. A description of the laboratory procedures are outlined in Section 7.0 of this document.

4.5 FIELD DOCUMENTATION

The purpose of documenting site activities is to provide a complete record of all sampling procedures, site conditions, and sample chain-of-custody. A strict field documentation program consistent with the following documents will be implemented.

- RCRA Groundwater Monitoring Technical Enforcement Guidance Document. U.S. EPA (OSWER-9950.1) September 1986.
- Protocol for Groundwater Evaluations. U.S. EPA (OSWER Dir. 9080.0-1) September 1986.
- Guidance on Remedial Investigations and Feasibility Studies Under CERCLA. U.S. EPA (EPA/540/G-89/004-OSWER Dir. 9355.3-01) October 1988.

4.5.1 Field Logbook

Field logbooks will be used to record all site activities during field operations. Logbooks will be provided to each field sampling team and dedicated to the OB Remedial Investigation project. Durable hardcover bound logbooks with waterproof pages such as those manufactured by TeleDyne will be used. All pages will be numbered consecutively and will not be removed under any circumstances. Entries will be recorded using black indelible ink. Each entry will be dated, legibly written, and contain an accurate and complete description of site activities. Each page will be signed by all personnel making an entry on that particular page. Any changes or corrections will be initialed by the person making the alterations. At the completion of each field sampling event, the field logbook entries will be photocopied and placed on file.

Logbook entries will include the following types of information (this is not intended to be an exhaustive list).

- Project name, job number, and location
- Date and time of arrival and departure from the site
- Purpose of site visit such as quarterly sampling, surveying, surface water sampling, etc.
- Name of person keeping the log
- Name and affiliation of all persons on-site
- Reference to FSAP, if applicable
- Sample identification number

- Location of sampling point including sample collection depth for surface water and sediment samples.
- Description of sampling method including procedures followed, equipment used, well volume removed, calibration of field equipment, sampling sequence, etc.
- Sample description (i.e., groundwater, sediment, surface water), appearance, condition, and volume of the samples collected.
- Results of field measurements such as pH, conductivity, temperature, etc.
- Type of preservation used for each sample
- Description of sample containers; type, quantity, volume, lot numbers and analysis required.
- Date and time of sample collection
- Name of collector(s)
- Weather and field conditions at time of sampling and any changes occurring throughout the sampling event
- Photographic information including description of what was photographed, date and time, and number of the negative on the roll.
- Description of chain-of-custody procedures followed including custody seals, chain-of-custody records, and disposition of samples.
- Significant site observations, such as condition of monitoring wells, color of leachate seeps, etc.
- Summary of the days activities

5.0 SAMPLE OF CUSTODY

5.1 SAMPLE LABELS

Sample labels will be affixed to all sample containers during collection. Sample labels will be filled out in indelible ink and include:

- Date and time of collection
- Sample location
- Matrix
- Sample number
- Analysis to be performed
- Sampler's name and affiliation

After the labels have been completed and affixed to the sample container, they will be covered with clean Mylar tape to guard against obliteration of the sample label.

5.2 CHAIN-OF-CUSTODY PROCEDURES

The goal of implementing chain-of-custody procedures is to ensure that the sample is traceable from the time of collection through analysis, reporting, and disposal. The chain-of-custody procedures, sample seals and forms, are initiated in the field at the time of sample collection. Each sample container is sealed with chain-of-custody tape after sampling is complete. Chain-of-custody forms including the signatures of the relinquishers and the receiver, the date and time, and any pertinent remarks are filled out and sent along with the samples to the laboratory. The samples and their chain-of-custody form are placed in coolers and the coolers additionally sealed with chain-of-custody tape. The coolers are then transported to Aquatec's laboratory for analysis. Upon arrival at the laboratory, the chain-of-custody form will be signed and a copy retained with the field data sheets for that round of sampling.

Once the samples are logged into the laboratory system, an internal chain-of-custody record is maintained. An analyst requesting a sample must sign this chain-of-custody form before the sample is released to their possession. When the analysis is complete, samples are returned to Sample Management and the chain-of-custody form updated. For a complete discussion of laboratory chain-of-custody procedures, and copies of chain-of-custody forms, refer to Aquatec's QAPP attached as Attachment A of this document.

5.3 SAMPLE PACKING AND SHIPPING PROCEDURES

In order to minimize the possibility of sample leakage, breakage, or spillage and to comply with USACE Sample Handling Protocol (Appendix E of ER 1110-1-263) and U.S. Department of Transportation shipping regulations, samples will be packaged and shipped according to the procedures summarized below:

- Package all samples so they do not spill, leak or vaporize
- Uniquely identify and properly label each sample
- Enter all sample information on a chain-of-custody form
- Individually wrap all containers and carefully pack them, upright, in an appropriate cooler. Use cooling packs and packing material to fill the excess space in the cooler.
- Enter the custody tape number on the chain-of-custody form, sign and date the "Relinquished By" space, seal the chain-of-custody form in plastic, and attach it to the inside lid of the container.
- Seal the cooler with (signed and dated) custody tape such that the cooler cannot be opened without breaking the tape. Secure the cooler with strapping (fiber) tape.
- Put "This Side Up" labels on all four sides and "Fragile" labels on at least two sides.
- Record the packaging and shipping details (sample numbers, custody form numbers, custody seal numbers, airbill number, etc.) in the Field Activities Notebooks.
- Ship the cooler for overnight delivery to the analytical laboratory.

6.0 CALIBRATION PROCEDURES

Calibration criteria for laboratory instrumentation are summarized in Table C-2. Aquatec's laboratory calibrates its analytical instrumentation at a frequency consistent with the methodologies referenced in Table C-2 Calibration standards are obtained from the USEPA, the National Bureau of Standards, Inorganic Ventures, Inc., and USACE. The formulations of calibration standards are documented in logbooks including information for traceability such as the supplier, lot number, and expiration date.

Calibration standards for each parameter are chosen to bracket the expected concentrations of those parameters in the sample while still operating within the linear response range of the instrument. Samples can be diluted until bracketed by the calibration standards.

Calibration curves are established using the least square linear regression model for inorganic and TCL Pesticide/PCB analyses. The calibration must reflect a correlation coefficient (r) of at least 0.995 to be acceptable. In cases where $r<0.995$, the analyst must change instrumental conditions and recalibrate.

For explosives analyses, a complete recalibration is not required every day. A mid-range concentration calibration standard (check standard) is analyzed prior at the beginning of each day and compared to the original calibration curve. A mid-range concentration calibration standard (closing standard) is also analyzed after all samples in an analytical series. If the response in the check standard does not differ from the initial curve by more than two (2) standard deviations, then sample analyses can proceed. If the response of the check standard differs from the initial curve by more than two (2) standard deviations, then the system must be re-calibrated. If the response of the closing standard differs from the initial curve by more than two (2) standard deviations, then all samples analyzed since the last passing check standard must be re-analyzed.

The GC/MS systems are calibrated using an internal standard method and fixed response model. Relative response factors are calculated for each compound and used to evaluate the calibration standards. The initial and continuing calibration standards must satisfy the requirements in Table C-2 for sample analysis to proceed. If the calibration criteria cannot be met, the instrument conditions are evaluated and the instrument is recalibrated.

TABLE C-2
CALIBRATION CRITERIA

METHOD	INSTRUMENT	CALIBRATION FREQUENCY	CALIBRATION POINTS	CRITERIA FOR PASSING
NYSDEC CLP Statement of Work Metals by ICP	Perkin Elmer Plasma II ICP	Calibration at the beginning of each analytical series Calibration check every 10 samples	3-t initial calibration standards	correlation > 0.995 calibration check within 10% of true value
NYSDEC CLP Statement of Work Mercury by Cold Vapor	Perkin Elmer 306 AA	Calibration at the beginning of each analytical series Calibration check every 10 samples	4 initial calibration standards + 1 blank	correlation >0.995 calibration check within 20% of true value
NYSDEC CLP Statement of Work Metals by Graphite Furnace AA	Perkin Elmer 5000 Graphite Furnace AA	Calibration at the beginning of each analytical series Calibration check every 10 samples	3 initial calibration standards + 1 blank	correlation >0.995 calibration check within 10% of true value
Explosive by Method 8330	Waters High Pressure Liquid chromatograph with UV and Fluorescence detectors	Calibration of the beginning of each analytical series calibration check daily	4 initial calibration standards + 1 blank	Correlation >0.995 calibration check within 2 sd of initial standard

TABLE C-2
CALIBRATION CRITERIA

METHOD	INSTRUMENT	CALIBRATION FREQUENCY	CALIBRATION POINTS	CRITERIA FOR PASSING
NYSDEC CLP TCL Volatile Organics Statement of Work	Finnigan OWA GC/MS	Tune Verification and check calibration every 12 hours	5 initial calibration standards 20,50,100, 150, 200 ppb On-going calibration 50 ppb standard	Refer to NYSDEC Statement of Work
NYSDEC CLP TCL Semivolatile Organics Statement of Work	Finnigan 5100 GC/MS	Tune Verification and check calibration every 12 hours	5 initial calibration standards 20,50,80, 120, 160 ng On-going calibration 50 ng standard	Refer to NYSDEC Statement of Work
NYSDEC CLP Cyanide	Bausch and Lomb UV/VIS Spec. 2000	Calibration at the beginning of each analytical series Calibration check every 10 samples	4 initial calibration standards	check standard within 15% of true value
NYSDEC CLP TCL Statement of Work Pesticides/PCBs	Hewlett Packard 5890 GC/ECD	Calibration at the beginning of each analytical series Calibration check every 10 samples	Initial calibration linearity characterization over 100 fold range	Refer to NYSDEC SOW

TABLE C-2
CALIBRATION CRITERIA

METHOD	INSTRUMENT	CALIBRATION FREQUENCY	CALIBRATION POINTS	CRITERIA FOR PASSING
SID, S3 Total Organic Carbon	Carlo Erba EA1108 elemental analyzer	Calibration at the beginning of each analytical series Calibration check every 10 samples	1 calibration std + 1 blank	Within 10% of true value
Hardness, EDTA Titrimetric Method, EPA Method 130.2	Titration Burette	Calibrate Titrant at the Beginning of each analytical Areas	Not Applicable	None
Nitrate, Cadmium Reduction Method, EPA Method 353.3	Spec. 20	Calibration at the beginning of each analytical series Calibration check every 10 samples	5 Calibration stds. and 1 blank	Within 10% of true value
Level II Analysis for Volatile Organics	Hewlett Packard 5890 GC FID and PID in series	Calibration daily every 24 hours	1 calibration standard + 1 blank	None
Level II Analysis for Lead	Perkin Elmer Plasma II ICP	Calibration daily every 24 hours	1 calibration standard + 1 blank	None

During the course of the analytical series, calibration check standards are routinely analyzed to ensure that the instrumental response has not changed. The criterion stipulated in each method, Table C-2, for expected response is used by the analyst to determine whether the instrument must be recalibrated.

7.0 LABORATORY ANALYTICAL PROCEDURES

All analytical testing, documentation, and reporting will be performed by Aquatec's personnel. Specific laboratory operations are governed by Aquatec's QAPP which discusses laboratory activities from the arrival of samples to the reporting of validated analytical data. Supplemental QC criteria are provided in the individual methods and in Aquatec's Standard Operating Procedures, as appropriate.

This section of the CDAP outlines the particular provisions of the laboratory QAPP applicable to the testing of solid and aqueous samples collected from SEAD OB/OD Grounds according to the FSAP.

7.1 GENERAL LABORATORY PROCEDURES

Aquatec's QAPP, attached as Attachment A, contains detailed discussions of the laboratory facilities, storage areas, analytical instrumentation, equipment and system performance checks, preventative maintenance, glassware cleaning, sample preservation and storage, chemical inventory, and personnel training program. These items will not be discussed in this document.

7.2 ANALYTICAL METHODS

Solid and aqueous samples from SEAD OB/OD Grounds will be analyzed by qualified laboratory personnel according to the methods listed in Table C-3 (quantitation limits are shown in Tables C-4, C-5, C-6 and C-7) from the following references:

1. NYSDEC CLP Analytical Services Protocol, September 1989, Statement of Work for Organics and Inorganics Analyses.
2. Special Report (90-38), Development of a Simplified Field Method for the Determination of TNT in Soil. USACE Cold Regions Research & Engineering Laboratory, November 1990.
3. Nitroaromatics and Nitramines by High Performance Liquid Chromatography (HPLC), Method 8330.
4. Methods for Chemical Analyses for Water & Waste, EPA-600/4-79-020.

TABLE C-3

	Preparation Method	Analytical Method	Reporting Limits (ug/Kg)
I. Soil Boring Program			
A. Inorganics			
1. Level II Analysis	Microwave	ICP’	
i. Lead			
2. Level IV Analysis			
i. Aluminum	NYSDEC CLP	NYSDEC CLP	20,000
ii. Antimony	NYSDEC CLP	NYSDEC CLP	6,000
iii. Arsenic	NYSDEC CLP	NYSDEC CLP	1,000
iv. Barium	NYSDEC CLP	NYSDEC CLP	20,000
v. Beryllium	NYSDEC CLP	NYSDEC CLP	500
vi. Cadmium	NYSDEC CLP	NYSDEC CLP	508
vii. Calcium	NYSDEC CLP	NYSDEC CLP	500,000
viii. Chromium	NYSDEC CLP	NYSDEC CLP	1,000
ix. Cobalt	NYSDEC CLP	NYSDEC CLP	5,000
x. Copper	NYSDEC CLP	NYSDEC CLP	2,500
xi. Iron	NYSDEC CLP	NYSDEC CLP	10,000
xii. Lead	NYSDEC CLP	NYSDEC CLP	500
xiii. Magnesium	NYSDEC CLP	NYSDEC CLP	500,000
xiv. Manganese	NYSDEC CLP	NYSDEC CLP	1,500
xv. Mercury	NYSDEC CLP	NYSDEC CLP	20
xvi. Nickel	NYSDEC CLP	NYSDEC CLP	4,000
xvii. Potassium	NYSDEC CLP	NYSDEC CLP	500,000
xviii. Selenium	NYSDEC CLP	NYSDEC CLP	500
xix. Silver	NYSDEC CLP	NYSDEC CLP	1,000
xx. Sodium	NYSDEC CLP	NYSDEC CLP	500,000
xxi. Thallium	NYSDEC CLP	NYSDEC CLP	1,000
xxii. Vanadium	NYSDEC CLP	NYSDEC CLP	5,000
xxiii. Zinc	NYSDEC CLP	NYSDEC CLP	2,000
xxiv. Cyanide, total	NYSDEC CLP	NYSDEC CLP	1,000
B. Organics			
1. Level II Analysis			
i. Volatile Organics	5030	8000[1]	
ii. TNT		Spec. 20[1]	
2. Level IV Analyses			
i. TCL Volatile Organics	NYSDEC CLP[3]	NYSDEC CLP[3]	Table C-4[3]
ii. TCL Semivolatile Organics	NYSDEC CLP	NYSDEC CLP	Table C-5
iii. TCL Pesticide/PCBs	NYSDEC CLP	NYSDEC CLP	Table C-6
iv. Explosives	NYSDEC CLP	8330	Table C-7
II. Groundwater Monitoring Program			(ug/L)
A. Inorganics			
1. Aluminum	NYSDEC CLP	NYSDEC CLP	200
2. Antimony	NYSDEC CLP	NYSDEC CLP	60
3. Arsenic	NYSDEC CLP	NYSDEC CLP	10
4. Barium	NYSDEC CLP	NYSDEC CLP	200

TABLE C-3 (Continued)
PARAMETER LIST FOR INORGANIC AND ORGANIC ANALYSES

		Preparation Method	Analytical Method	Reporting Limits
II.	Groundwater Monitoring Program (Continued)			(mg/l)
5.	Beryllium	NYSDEC CLP	NYSDEC CLP	5
6.	Cadmium	NYSDEC CLP	NYSDEC CLP	5
7.	Calcium	NYSDEC CLP	NYSDEC CLP	5,000
8.	Chromium	NYSDEC CLP	NYSDEC CLP	10
9.	Cobalt	NYSDEC CLP	NYSDEC CLP	50
10	Copper	NYSDEC CLP	NYSDEC CLP	25
11.	Iron	NYSDEC CLP	NYSDEC CLP	100
12.	Lead	NYSDEC CLP	NYSDEC CLP	5
13.	Magnesium	NYSDEC CLP	NYSDEC CLP	5,000
14.	Manganese	NYSDEC CLP	NYSDEC CLP	15
15.	Mercury	NYSDEC CLP	NYSDEC CLP	0.2
16.	Nickel	NYSDEC CLP	NYSDEC CLP	40
17.	Potassium	NYSDEC CLP	NYSDEC CLP	5,000
18.	Selenium	NYSDEC CLP	NYSDEC CLP	5
19.	Silver	NYSDEC CLP	NYSDEC CLP	10
20.	Sodium	NYSDEC CLP	NYSDEC CLP	5,000
21.	Thallium	NYSDEC CLP	NYSDEC CLP	10
22.	Vanadium	NYSDEC CLP	NYSDEC CLP	50
23.	Zinc	NYSDEC CLP	NYSDEC CLP	20
24.	Cyanide, total	NYSDEC CLP	NYSDEC CLP	10
25.	Nitrate	NYSDEC CLP	NYSDEC CLP	0.01
B.	Organics			
1.	TCL Volatile Organics	NYSDEC CLP[3]	NYSDEC CLP[3]	Table C-4[3]
2.	TCL Semivolatile Organics	NYSDEC CLP	NYSDEC CLP	Table C-5
3.	TCL Pesticide/PCBs	NYSDEC CLP	NYSDEC CLP	Table C-6
4.	Explosives	NYSDEC CLP	NYSDEC CLP	Table C-7
III.	Surface Water Monitoring Program			
A.	Organics & Inorganics Same as Groundwater Monitoring Program			
B.	Hardness	NYSDEC CLP	NYSDEC CLP	2
IV.	Fish Tissue			
A.	Same as soil boring program for expanded parameters			
V.	Sediment			
A.	Total Organic Carbon		SID, S3	0.01%

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[1] See specific screening methodology.

[2] Refer to Attachment B.

[3] Modified NYSDEC CLP Method.

TABLE C-4

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL)* FOR VOLATILE ORGANIC ANALYTE (VOA'S)

VOA'S	Quantitation Limits** Water (ug/L)	 Low Soil/Sediment[a] (ug/Kg)
1. Chloromethane	10	10
2. Bromomethane	10	10
3. Vinyl Chloride	10	10
4. Chloroethane	10	10
5. Methylene Chloride	5	5
6. Acetone	10	10
7. Carbon Disulfide	5	5
8. 1,1-Dichloroethene	5	5
9. 1,1-Dichloroethane	5	5
10. 1,2-Dichloroethene (total)	5	5
11. Chloroform	5	5
12. 1,2-Dichloroethene	5	5
13. 2-Butanone	10	10
14. 1,1,1-Trichloroethane	5	5
15. Carbon Tetrachloride	5	5
16. Vinyl Acetate	10	10
17. Bromodichloromethane	5	5
18. 1,2-Dichloropropane	5	5
19. cis-1,2-Dichloropropene	5	5
20. Trichloroethene	5	5
21. Dibromochloromethane	5	5
22. 1,1,2-Trichloroethane	5	5
23. Benzene	5	5
24. trans-1,2-Dichloropropene	5	5
25. Bromoform	5	5
26. 4-Methyl-2-pentanone	10	10
27. 2-Hexanone	10	10
28. Tetrachloroethene	5	5
29. Toluene	5	5
30. 1,1,2,2-Tetrachloroethane	5	5
31. Chlorobenzene	5	5
32. Ethyl Benzene	5	5
33. Styrene	5	5
34. Xylenes (Total)	5	5

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[a] Medium Soil/Sediment Contract Required Quantitation Limits (CRQL) for volatile TCL Compounds are 125 times the individual Low Soil/Sediment CRQL.

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

** Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight based as required by the contract, will be higher.

TABLE C-5

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL)* FOR ACID, BASE/NEUTRALS (ABIN'S)

	Quantitation Limits**	
AB/N'S	Water (ug/L)	Low Soil/Sediment[a] (ug/Kg)
35. Phenol	10	330
36. bis (2-Chloroethyl) ether	10	330
37. 2-Chlorophenol	10	330
38. 1,3-Dichlorobenzene	10	330
39. 1,4-Dichlorobenzene	10	330
40. Benzyl alcohol	10	330
41. 1,2-Dichlorobenzene	10	330
42. 2-Methylphenol	10	330
43. bis (2-Chloroisopropyl) ether	10	330
44. 4-Methylphenol	10	330
45. N-Nitroso-di-n-dipropylamine	10	330
46. Hexachloroethane	10	330
47. Nitrobenzene	10	330
48. Isophorone	10	330
49. 2-Nitrophenol	10	330
50. 2,4-Dimethylphenol	10	330
51. Benzoic acid	10	330
52. bis (2-Chloroethoxy) methane	10	330
53. 2,4-Dichlorophenol	10	330
54. 1,2,4-Trichlorobenzene	10	330
55. Naphthalene	10	330
56. 4-Chloroaniline	10	330
57. Hexachlorobutadiene	10	330
58. 4-Chloro-3-methylphenol (para-chloro-meta-cresol)	10	330
59. 2-Methylnaphthalene	10	330
60. Hexachlorocyclopentadiene	10	330
61. 2,4,6-Trichlorophenol	10	330
62. 2,4,5-Trichlorophenol	10	330
63. 2-Chloronaphthalene	10	330
64. 2-Nitroaniline	50	1600
65. Dimethylphthalate	10	330
66. Acenaphthylene	10	330
67. 2,6-Dinitrotoluene	10	330
68. 3-Nitroaniline	50	1660
69. Acenaphthene	10	330
70. 2,4-Dinitrophenol	50	1600
71. 4-Nitrophenol	50	1600
72. Dibenzofuran	10	330

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TABLE C-5 (cont.)

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL)* FOR ACID, BASE/NEUTRALS (ABIN'S)

	Quantitation Limits**	
AB/N'S	Water (ug/L)	Low Soil/Sediment[a] (ug/Kg)
73. 2,4-Dinitrotoluene	10	330
74. Diethylphthalate	10	330
75. 4-Chlorophenyl-phenyl ether	10	330
76. Fluorene	10	330
77. 4-Nitroaniline	50	1600
78. 4,6-Dinitro-2-methylphenol	50	1600
79. N-nitrosodiphenylamine	10	330
80. 4-Bromophenyl-phenylether	10	330
81 Hexachlorobenzene	10	330
82. Pentachlorophenol	50	1600
83. Phenanthrene	10	330
84. Anthracene	10	330
85. Di-n-butylphthalate	10	330
86. Fluoranthene	10	330
87. Pyrene	10	330
88. Butylbenzylphthalate	10	330
89. 3,3-Dichlorobenzidine	20	660
90. Benzo(a)fluoranthene	10	330
91. Chrysene	10	330
92. bis(2-Ethylhexyl)phthalate	10	330
93. Di-n-octylphthalate	10	330
94. Benzo(b)fluoranthene	10	330
95. Benzo(k)fluoranthene	10	330
96. Benzo(a)pyrene	10	330
97. Indeno(1,2,3-cd)pyrene	10	330
98. Dibenz(a,h)anthracene	10	330
99. Benzo(g,h,i)perylene	10	330

[a] Medium Soil/Sediment Contract Required Quantitation Limits (CRQL) for volatile TCL Compounds are 125 times the individual Low Soil/Sediment CRQL.

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

** Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight based as required by the contract, will be higher.

TABLE C-6

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL)* FOR PESTICIDES AND POLYCHLORINATED BIPHENYLS (PCB'S)

	Quantitation Limits**	
Pesticides/PCB's	Water (ug/L)	Low Soil/Sediment[a] (ug/Kg)
100. alpha-BHC	0.05	8.0
101. beta-BHC	0.05	8.0
102. delta-BHC	0.05	8.0
103. gamma-BHC (Lindane)	0.05	8.0
104. Heptachlor	0.05	8.0
105. Aldrin	0.05	8.0
106. Heptachlor epoxide	0.05	8.0
107. Endosulfan I	0.05	8.0
108. Dieldrin	0.10	16.0
109. 4,4-DDE	0.10	16.0
110. Endrin	0.10	16.0
111. Endosulfan II	0.10	16.0
112. 4,4-DDD	0.10	16.0
113. Endosulfan sulfate	0.10	16.0
114. 4,4-DDT	0.10	16.0
115. Methoxychlor	0.05	80.0
116. Endrin Ketone	0.10	16.0
117. alpha-Chlordane	0.5	80.0
118. gamma-Chlordane	0.5	80.0
119. Toxaphene	1.0	160.0
120. Aroclor-1016	0.5	80.0
121. Aroclor-1221	0.5	80.0
122. Aroclor-1232	0.5	80.0
123. Aroclor-1242	0.5	80.0
124. Aroclor-1248	0.5	80.0
125. Aroclor-1254	1.0	160.0
126. Aroclor-1260	1.0	160.0

[a] Medium Soil/Sediment Contract Required Quantitation Limits (CRQL) for volatile TCL Compounds are 125 times the individual Low Soil/Sediment CRQL.

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

** Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight based as required by the contract, will be higher.

TABLE C-7
METHOD 8330 QUANTITATION LIMITS

Compound	Quantitation Limits** Water (ug/L)		Soil[a] (ug/g)
	Low Level	High Level	
HMX	--	13.0	2.2
RDX	0.836	14.0	1.0
1,3,5-TNB	0.258	7.3	0.25
1,3-DNB	0.108	4.0	0.25
Tetryl	--	4.0	0.65
2,4,6-TNT	0.113	6.9	0.25
4-AM-DNT*	0.0598	--	--
2-AM-DNT*	0.0349	--	--
2,6-DNT	0.314	9.4	0.26
2,4-DNT	0.0205	5.7	0.25

[a] See Table C-4, for a discussion of Quantitition Limits

** See Table C-4, for a discussion of Soil Quantitation Limits

* Breakdown Degradation Products

NYSDEC CLP methods will be used for the analysis of inorganic and organic constituents in soil, groundwater, and surface water. Nitrates will be analyzed using the EPA Method 353.3, the Cadmium Reduction Method. Hardness will be analyzed using the EPA Method, 130.2 EDTA Titrimetric Method. Method 8330 will be used for the analysis of explosives in soil and water. Sediment samples will be analyzed for total organic carbon using the Corp of Engineers method S1D, S3. These non-standard methods were provided to the laboratory and are attached as Attachment B to this document.

Volatile and semivolatile organic constituents will be analyzed on GC/MS Systems. Pesticides/PBCs will be analyzed by GC/ECD. Inorganic metallic elements will be analyzed on the Inductively Coupled Plasma Spectrophotometer (ICP) according to the NYSDEC CLP Statement of Work; analyzed on the Graphite Furnace Atomic Absorption Spectrophotometer (GFAA) according to the NYSDEC CLP Statement of Work; analyzed on the Cold Vapor Atomic Absorption Spectrophotometer (CVAA) according to the NYSDEC CLP Statement of Work. Explosives will be analyzed on a High Pressure Liquid Chromatography (HPLC) system by Method 8330.

Instrument detection limits are determined quarterly for inorganic parameters according to NYSDEC Protocol. Method detection limits for organic parameters are determined by analyzing seven replicates os a sample with a low analyte concentration, three to five times the instrument detection limit. The standard deviation of the results are calculated. The Method Detection Limit is calculated as:

$$MDS = (t_{n-1})_a \text{ (std.dev)}$$

where:

t_{n-1} = Student's t-value with n-1 degrees of freedom
a = Probability of a type I error (use $a=0.005$)
n = number of replicates in standard deviation calculation

The reporting limits listed in Table C-3 are above the instrument detection limits but well below the health based limits for ingestion published by USEPA.

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7.2.1 Field Screening

7.2.1.1 Lead

Approximately six hundred (600) soil samples will be collected and screened for the presence of lead. The Level II screening will be performed at Aquatec. The samples will be acid digested using a CEM Corporation MDF 80 microwave digestion system. The digestates will be analyzed on a Perkin Elmer Plasma II ICP. The results derived from this screening procedure are intended to be indicators of where lead is present on the site. Their sole purpose is to provide a basis on which to select samples to be analyzed for the full TAL inorganic parameter list. Samples sent to the laboratory will be re-analyzed for lead on a graphite furnace atomic absorption spectrometer (GFAA) following an acid digestion. The results from the analysis of these samples can be compared to the screening results to evaluate the effectiveness of the screening procedure.

7.2.1.2 TNT

Approximately six hundred (600) soil samples will be collected and screened for the presence of TNT as an indicator of explosive residue. The screening will be performed using a Spec 20. The field method provided by USACE, attached as Attachment C, will be utilized for this RI/FS investigation. The samples will be extracted in Acetone, KOH, and Na_2SO_3 and analyzed on a spectrophotometer. The results derived from this screening procedure are intended to be indicators of where explosive residues are present on the site. This information will provide a basis on which to select samples to be analyzed for the TCL semivolatiles, TCL Pesticides/PCBs and expanded explosives analyte list. Selected samples will be re-analyzed for TNT on a Waters HPLC system. The results from the analysis of these samples can be compared to the screening results to evaluate the effectiveness of the screening procedure.

7.2.1.3 Volatile Organics

Approximately six hundred (600) samples will be collected and screened for the presence of volatile organic compounds. The samples will be analyzed by purge and trap GC with FID/PID detectors. The results derived from the screening procedure are intended to be indicators of where volatile organics are present on the site. This information will provide a basis for which to select samples to be analyzed for the TCL volatile organic analyte list. Selected samples will be analyzed on a GC/MS System for quantitation of the volatile organics detected.

8.0 DATA REDUCTION, VALIDATION, AND REPORTING

8.1 DATA REDUCTION

Data reduction, validation, and reporting of this project will primarily involve the analytical laboratory and any contracted data validation services. General data reduction and validation procedures used by Aquatec's personnel are contained in the QAPP. Sample calculations are contained in Standard Operating Procedures, and the method specifications.

All concentration data shall be expressed in units of micrograms per liter (ug/L) or micrograms per kilogram (ug/Kg) dry weight, as appropriate for the matrix. The field measurements of pH, conductivity, and temperature shall be reported in standard logarithmic, umho/cm, and degrees Celsius respectively.

All analytical results are carefully reviewed and formatted into final submittal form by experienced quality control personnel. Each result reported by the laboratory undergoes four levels of data review. The analysts and technicians provide primary data review at the bench level, secondary and tertiary review is performed by independent experienced quality control personnel, and the final data packages are reviewed by Mr. Binkerd before submission to MAIN. Data submittals will be in the format specified in NYSDEC CLP Protocols Level IV for standard analyses and Level V for non-standard analyses.

Raw data from GC/MS, GC, HPLC and ICP systems are linked directly to Aquatec's microVAX network. Results entered into our Laboratory Management System and CLP final reporting forms are archived every 48 hours by the microVAX system. Archived data can be restored to the operating system upon request. The hardcopy of supportive documentation for this project will be stored for a minimum of seven (7) years unless otherwise specified.

8.2 DATA VALIDATION

8.2.1 Data Quality Review

Data validation shall be conducted by trained and qualified environmental geologists, engineers, environmental analysts, and the Project QA Analyst.

Consistent data quality for this project will be obtained by the application of a standard data analysis and validation process. Critical review of data is designed to isolate spurious values. Data will be reviewed at a minimum by the analyst, laboratory QC personnel, laboratory Project Manager, and the Project QA Analyst.

8.2.2 Screening Data

Screening data will be validated using one of three procedures:

1. Routine checks will be made during the processing of data. For example, the field work will be observed and documentation will be checked for completeness and accuracy.

2. Checks for consistency of the data set over time will be performed. This can be accomplished by visually comparing data sets against gross upper limits obtained from historical data sets, or by testing for historical consistency. Anomalous data will be identified and evaluated.

3. Checks may be made for consistency with parallel data sets, that is, data sets obtained presumably from the same population (for example, for the same region of the aquifer or volume of soil.

The purpose of these validation checks and tests is to identify outliers; that is, an observation that does not conform to the pattern established by other observations. Outliers may be the result of transcription errors or instrument malfunctions. Outliers may also be manifestations of a greater degree of spatial or temporal variability than expected.

After an outlier has been identified, a decision concerning its fate will be rendered. Obvious mistakes in data (e.g., transcription errors) will be corrected when possible, and the correct value will be inserted. If the correct value cannot be obtained, the data may be excluded.

An attempt will be made to explain the existence of the outlier. If no plausible explanation can be found for the outlier, it will be included in the data set, but a note highlighting its presence and associated concerns will be included in the report. Also, an attempt will be made to determine the effect of the outlier when both included and excluded from the data set. A determination will be made whether it is appropriate to resample.

8.2.3 Laboratory

Aquatec will follow data validation procedures recommended and approved by the U.S. EPA. The EPA Region II Standard Operating Procedures (SOPs) for Evaluating Organic and Inoranic Data will be used to validate the data produced.

Data in the chemical analyses reports for the samples will be validated as part of the QA/QC program. The validation program will evaluate the accuracy and reliability of the information obtained for the laboratory based on the duplicate and blank samples analysis results obtained from the laboratory. This validation program will be conducted in addition to the laboratory's in-house QA/QC program.

Data Review and Tabulation - During the time the chemical analysis reports are received from the laboratory, the reports will be examined for errors and problems with the analysis. Typical errors include incorrect sample numbers as compared to the sampling records and Chain of Custody; holding time exceedences; recoveries outside acceptable ranges; number of laboratory blanks, duplicates, and spikes do not meet criteria; and typographic errors in analysis results.

The sample chemical analysis data will be tabulated on a computerized data base. The data will be sorted by site, then type of medium. Older chemical analysis data may be included in the table if the on-site environmental conditions are similar, the analytical results are comparable, and significant differences in concentration are consistent with site usage. When an analyte is not detected in a sample, the detection limit will be included in the table. Also the type of detection limit will be noted in the table.

During final summarizations the compounds that were never detected in any of the samples will be eliminated from the data table and listed in a separate table.

Comparison of QA/QC and Sample Data - Chemical analysis of laboratory spike recoveries, field and laboratory duplicates, and field and laboratory blanks will be used to evaluate the chemical analysis of the samples. The sample data will be judged to be valid, an estimated concentration, or invalid. The symbol "J" will be placed after estimated data and "R" will be placed after invalid data. If samples were extracted and/or analyzed outside of the recommended holding time, the data for those samples will be considered invalid. For water samples, if the duplicate analyte concentration is between 50 percent and 150 percent of the original sample, the data is valid for the set of samples associated with the duplicate sample. Outside this range the sample data is invalid. For soil samples, data within the range of 50 percent and 150 percent is valid. Data outside this range will be labelled as an estimated concentration.

Trip blanks detect cross-contamination between samples. Field blanks detect contamination that occurs during sampling. These blanks are associated with a group of samples; therefore, the blanks will be used to validate their associated group of samples.

If recoveries for an analyte were outside the range considered acceptable by the laboratory, the analyte concentrations in the samples associated with the spiked sample will be considered an estimated concentration.

Reporting Procedures - The Project Manager will be kept informed of all non-conformance issues and ensure that corrective action is taken prior to data manipulation and assessment routines. Once the QA/QC review has been completed, the Project Manager may direct the team leaders or others to initiate and finalize the analytical data assessment.

8.2.4 Identification and Treatment of Outliers

Any data point which deviates markedly from others in its set of measurements will be investigated; however, the suspected outlier will be recorded and retained in the data set while it is investigated. One or both of the following tests will be used to identify outliers.

Dixon's Test/T Test - Dixon's test for extreme observations is an easily computed procedure for determining whether a single very large or very small value is consistent with the remaining data. The one-tailed "t" test for differences may also be used in this case. It should be noted that these tests are designed for testing a single value. If more than one outlier is suspected in the same set of data, other statistical sources will be consulted and the most appropriate test of hypothesis will be used and documented.Since an outlier may result from unique circumstances at the time of sample analysis or data collection, those persons involved in the analysis and data reduction will be consulted. This may provide an experimental reason for the outlier. Further statistical analyses will be performed with and without the outlier to determine its effect on the conclusions. In many cases, two data sets will be reported, one including and one excluding the outlier.

In summary, every effort will be made to include the outlying value in the reported data. If the value is rejected, it will be identified as an outlier, reported with its data set, and its omission noted.

8.3 REPORTING

8.3.1 Field Data

Field data results will be documented on forms designated in the FSAP (Appendix A) and in field notebooks assigned to the project. The form, shown in Appendix A, shall be used for routine procedures such as sampling, borings, well installation, water level measurements, and test pitting. The field notebook shall be used to describe the overall work for the day and any deviations from the standard operating procedures.

8.3.2 Laboratory Data Reports

The report from the analytical laboratory will include a tabulation of sample results, dates of analysis, method references, completed chain-of-custody forms, blank analysis data, precision and accuracy information for each method, and narrative discussion of any difficulties experienced during analysis. A copy of each data package will be sent by the laboratory to the Project Manager. The Project Manager will immediately arrange for making additional copies of the data packages including copies for the Document Controller and Project Quality Assurance Analyst (PQAA). A second or working copy will be used to generate summary tables. If possible, the sample analysis data will be tabulated by the laboratory and presented to the Project Manager on computer diskettes. These tables will form the foundation of a working database for assessment of the site contamination condition.

8.3.3 Monthly Field Activity Reports

While field work associated with the response activities is being conducted at the site, a monthly Field Activity Report to the EPA and NYSDEC shall be submitted no later than the 10th addressing the following:

1. A summary of work completed in the field,
2. Anticipated or actual delays,
3. Discovery of significant additional contaminants other than expected,
4. Quantum increase in concentration of hazardous substances of any media beyond that expected,
5. Determination of any specific or potential increase of danger to the public, the environment, or to individuals working at the site, and
6. Copies of all Quality Assured Data and sampling test results and other laboratory deliverables received during the month.

8.3.4 Sampling Letter Report

At the completion of the first round of field work sampling, a letter report characterizing the site will be furnished by the Project Manager. This report will at a minimum list the locations and quantities of contaminants at the site. Should additional sampling rounds be required to confirm initial sampling, additional letter reports will also be required.

8.3.5 Quarterly Reports

Quarterly Reports will be submitted to EPA and NYSDEC no later than the 10th day of January, April, July, and October. The quarterly reports shall address the following:

1. Minutes of all formal Project Manager, Technical Review Committee (TRC) and other formal meetings held during the preceding period,
2. Status report on all milestones on schedule, report and explanation for milestones not met, and assessment of milestones to be met during next period,
3. Outside inspection reports, audits and other administrative information developed,
4. permit status as applicable,
5. Personnel staffing status or update,
6. Copies of all Quality Assured Data and sampling test results and all other laboratory deliverables received during that quarter, and
7. A community relations activity update.

8.3.6 Preliminary Site Characterization

At the conclusion of the field work a Preliminary Site Characterization Summary in the format of the first four chapters of and RI Report will be prepared. This document will be the basis of discussion at a Project Managers progress meeting.

9.0 INTERNAL QUALITY CONTROL

9.1 INORGANIC ANALYSES

Aquatec's QAPP contains a discussion of quality control measures employed by the laboratory. The work plans contain quality control requirements as they apply to each sampling task. The precision, accuracy, and completeness requirements for each method are presented in Tables C-8 and C-9.

At a minimum, the following general QC measures will be employed by the laboratory, as appropriate for the method:

> Calibration - Prior to each round of analyses, the analytical instrument will be calibrated to define the linear range of the instrument. Calibration will be performed each day prior to sample analysis. For ICP analysis, the instrument will be calibrated according to the analytical method cited in Table C-3. For flame, graphite furnace, and cold vapor AA, the calibration will consist of at least three concentrations (other than the blank) that define the linear range of the instrument or the working range of the analysis.
>
> Check Standards - Check standards, at concentrations near the mid-point of the calibration curve, will be analyzed at a frequency of once every 10 samples or as specified in the method. Results will be used to verify the standard calibration curve being used. Check standard recoveries will be compared to the control limits; 90-110% for ICP and GFAA and 80-120% for CVAA. If the recovery of the check standards exceeds the control limits, the analytical instrument will be recalibrated and the associated samples re-analyzed.
>
> Matrix Spike - An aliquot of at least one out of every 20 samples per matrix will be spiked with a known quantity of standard. This fortified sample will be prepared and analyzed to assess the accuracy of the analytical method for that matrix. Recovery of the matrix spike should be between 50-150% of the amount spiked for water samples and 20-180% of the amount spiked for soil samples.

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TABLE C-8

Matrix Spikes, Precision, Accuracy, Completeness

Measurement Parameter	Method Reference	Precision RPD		Accuracy % Rec.		Completeness
TCL-VOC		Water	Soil	Water	Soil	
1,1-Dichloroethene	NYSDEC CLP Statement of Work	14	22	61-145	59-172	90%
Trichloroethene		14	24	71-120	62-137	
Benzene		11	21	76-127	66-142	
Toluene		13	21	76-125	59-139	
Chlorobenzene		13	21	75-130	60-133	
TCL-A/BN		Water	Soil	Water	Soil	
Phenol	NYSDEC CLP Statement of Work	42	35	12-110	26-90	90%
2-Chlorophenol		40	50	27-123	25-102	
1,4-Dichlorobenzene		28	27	36-97	28-104	
N-Nitroso-di-n-Propylamine		38	38	41-116	41-126	
1,2,4 Trichlorobenzene		28	23	39-38	38-107	
4-Chloro-3-Methylphenol		42	33	23-97	26-103	
Acenaphthene		31	19	46-118	31-137	
4-Nitrophenol		50	50	10-80	11-114	
2,4-Dinitrotoluene		38	47	24-96	28-89	
Pentachlorophenol		50	47	9-103	17-109	
Pyrene		31	36	26-127	25-142	
TCL-PESTICIDES/PCB		Water	Soil	Water	Soil	
Gamma-BHC	NYSDEC CLP Statement of Work	15	50	56-123	46-127	90%
Heptachlor		20	31	40-131	35-130	
Aldrin		22	43	40-120	34-132	
Dieldrin		18	38	52-126	31-134	
Endrin		21	45	56-121	42-139	
4,4'-DDT		27	50	38-127	23-134	
TAL METALS		Water	Soil	Water	Soil	
	NYSDEC CLP Statement of Work	25	50	50-150	20-180	90%
Explosives	Method 8330	25	50	70-130	50-150	90%

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TABLE C-9

Surrogate Spikes
Accuracy and Completeness

Measurement Parameter	Method Reference	Precision RPD	Accuracy % Rec.		Completeness
TCL-VOC			Water	Soil	
	NYSDEC CLP				
toluene	Statement of Work		88-110	81-117	90%
Bromofluorbenzene			86-115	74-121	
1,2-dichloroethene			76-114	70-121	
TCL-A/BN			Water	Soil	
	NYSDEC CLP				
Nitrobenzene-d_5	Statement of Work		35-114	23-120	90%
2-fluorobiphenyl			43-116	30-115	
Terphenyl-d_{14}			33-141	18-137	
Phenol-d_6			10-94	24-113	
2-Fluorophenol			21-100	25-121	
2,4,6-Tribromophenol			10-123	19-122	
TCL-PESTICIDES/PCB			Water	Soil	
	NYSDEC CLP				
Dibutylchlorendate	Statement of Work		24-154	20-150	90%

Duplicate - One duplicate analysis will be performed at a minimum frequency of one for every 20 samples per matrix. Relative percent difference of duplicate samples should be between 75-125% for water samples and 50-150% for soil samples.

Method Blank - At least one blank for every 20 samples will be digested and analyzed to detect possible interferences introduced in the laboratory. Results of the method blank should be less than the reporting limit for all elements of interest, or the blank and all associated samples must be redigested and re-analyzed.

9.2 ORGANIC ANALYSES

At a minimum, the following general QC measures will be employed by the laboratory:

Initial Calibration - Initial HPLC instrument performance must be evaluated before samples are analyzed. A successful initial calibration will conform to method specifications for resolution, retention time, and %RSD.

Continuing Calibration Checks - A calibration check will be performed at the beginning and end of each day as appropriate. The response of the continuing calibration check standard must be within specified criteria of the response of the standard in the initial calibration, or the system is out-of-control and must be re-calibrated. Additional samples cannot be analyzed until another satisfactory initial calibration is achieved.

Method Blank - A method blank is carried through the entire analytical procedure as a sample. One method blank will be generated for every analytical sequence or extraction batch of 20 samples or less per matrix. Results of the method blank should be less than the reporting limit for all elements of interest, or the blank and all associated samples must be re-extracted and re-analyzed.

Matrix Spike/Matrix Spike Duplicate/Matrix Spike Blank (MS/MSD/MSB) - An MS/MSD pair will be analyzed at least once for every 20 field samples per matrix. Known concentrations of representative compounds added to identical aliquots from a field sample. An MSB will also be analyzed at least once for every 20 field samples per matrix. An MSB is prepared by adding known concentrations of representative compounds to reagent water.

10.0 PERFORMANCE AND SYSTEM AUDITS

QA system performance shall be performed under the direction and approval of the PQAA. Functioning as an independent body and reporting directly to project and company management, the PQAA will select personnel to conduct the audit as well as plan and schedule system and performance audits based upon company and project-specific procedures and requirements. These audits may be implemented to evaluate the capability and performance of project and subcontractor staff and their compliance with the QA/QC Plan, in addition to the effectiveness of or impact to the existing project QA/QC Plan and its associated governing documents. Each performance and system audit shall be conducted by a trained and qualified head auditor and designated trained and qualified auditors.

At times, the PQAA may request additional staff with specific expertise from the company and/or project groups to assist in conducting performance audits. In these instances, however, the responsibility for the performance audit will remain with the head auditor and auditors, with the additional staff expertise responsible for clarifying and delineating technical requirements.

The PQAA and auditors shall maintain accurate records of the scope of the audit, identification of items subject to the audits, and results. Quality assurance audits may be initiated by the Project Manager, the PQAA, or the Site Manager, if, in their opinion, a situation exists that warrants an audit. The EPA states "such audits should be performed at sufficiently required intervals during the field investigation."

10.1 Performance Audits

A field audit may be performed by the PQAA or designated auditor during collection of the field samples to verify that field samplers are following established sampling procedures. A laboratory audit may be performed by the PQAA or designated auditor during analysis of the field samples to verify that the laboratory is following established procedures.

Performance audits shall be scheduled twice per each year of the field investigation.

10.2 SYSTEM AUDITS

System audits, performed by the PQAA or designated auditors, will evaluate the effectiveness of the procedures used to collect data. In addition, field and laboratory quality control procedures and associated documentation may be system audited. System audits shall be scheduled twice per each year of the field investigation. The Project Manager or Site Manager may request the PQAA to perform unscheduled audits if conditions adversely affecting data quality are detected.

10.3 FORMALIZED AUDITS

Formalized audits refer to any system or performance audit that is documented and implemented by the PQAA. The auditors will use a written procedure or checklist to objectively verify that quality assurance requirements have been developed, documented, and instituted in accordance with the Work Plan. Formalized audits may be performed on project and subcontractor work at various locations.

Audit reports will be written by the PQAA or his designee after gathering and evaluating all resultant data. Items, activities, and documents determined by lead auditors to be in non-conformance shall be identified at exit interviews conducted by the involved management. Non-conformances will be logged and documented using audit findings listed in the audit report. These audit findings will be directed to the Project Manager to institute corrective actions in a specified and timely manner. All audit findings and acceptable resolutions will be approved by the PQAA prior to issue. Implementation of acceptable resolutions may be determined by re-audit or documented surveillance of the item or activity. Upon verification acceptance, the PQAA will close out the audit report and findings. Section 13, Corrective Action, outlines in detail methods for corrective action.

11.0 PREVENTIVE MAINTENANCE

11.1 PREVENTIVE MAINTENANCE PROCEDURES

Equipment, instruments, tools, gauges, and other items requiring preventive maintenance will be serviced in accordance with the manufacturer's specified recommendations or written procedures developed by the operators. Documentation should be generated in support of these activities.

11.2 SCHEDULES

Project-specific written procedures will identify, where applicable, the schedule for servicing critical items in order to minimize the downtime of the measurement system. It will be the responsibility of the operator to adhere to this maintenance schedule and to arrange any necessary and prompt service as required. Service to the equipment, instruments, tools, and gauges shall be performed by qualified personnel. These procedures shall be reviewed and approved by the Project Manager and PQAA and shall be subject to audit.

In the absence of any manufacturer's recommended maintenance criteria, a maintenance procedure will be developed by the operator based upon experience and previous use of the equipment.

11.3 RECORDS

Logs will be established to record and control maintenance and service procedures and schedules. All maintenance records will be documented and traceable to the specific equipment, instruments, tools, and gauges. Records produced shall be reviewed, maintained, and filed by the operators at the laboratories and by the data and sample control personnel when, and if, equipment, instruments, tools, and gauges are used at the sites. The PQAA shall audit these records to verify complete adherence to these procedures.

11.4 SPARE PARTS

A list of critical spare parts will be identified by the operator. These spare parts will be stored for availability and use in order to reduce the downtime. In lieu of maintaining an inventory of spare parts, a service contract for rapid instrument repair or back-up instruments will be available.

Aquatec's laboratory maintains a large inventory of spare parts, and employs qualified in-house technicians for instrument repair and maintenance.

12.0 DATA ASSESSMENT PROCEDURES

12.1 CALCULATION OF MEAN VALUES AND ESTIMATES OF PRECISION

The mean, C of a series of replicate measurements of concentration C_i, for a given surrogate compound or analyte will be calculated as;

$$C = \frac{1}{n} \mathop{}_{i=1}^{n} C_i$$

Where: n = number of replicate measurements; C, C_i are both in mg/L or mg/kg.

The estimate of precision of a series of replicate measurements will usually be expressed as the relative standard deviation, RSD:

$$RSD = \frac{SD \times 100\%}{C}$$

Where: SD = Standard Deviation

$$SD = \frac{\mathop{}_{i=1}^{n} (C_i - C)^2}{(n-1)}$$

Alternatively, for data sets with a small number of points the estimate of precision may be expressed as a range percent, R:

$$R = \frac{(C_1 - C_2) \quad x\ 100\%}{C}$$

Where: C_1 = highest concentration value measured in data set
C_2 = lowest concentration value measured in data set

The standard deviations will be compared on a weekly basis with the respective goals identified in Section 9.

Precision is also measured by calculating the relative percent difference (RPD) between duplicate analyses. The following equation is used:

$$\%RPD = \frac{D_1 - D_2}{(D_1 + D^2)/2} \times 100$$

where:

RPD = Relative Percent Difference
D_1 = First Sample Value
D_2 = Second Sample Value (duplicate)

12.2 ASSESSMENT OF ACCURACY

Accuracy will be evaluated by comparing the recovery of surrogate and matrix spike compounds the goals identified in Section 9. The recovery of a surrogate compound will be defined as:

$$\text{Recovery, \%} = \frac{Cs \times Vs \text{ (or Ws)}}{Q} \times 100$$

Where: C_s = measured concentration of surrogate compound in sample, mg/L (or mg/kg)
$V_s(W_s)$ = Total volume (or weight) of sample to which surrogate was added, L (or kg)
SA = Quantity of surrogate compound added to sample, mg

The individual component recoveries for the matrix spike sample are defined as:

$$\text{Matrix Spike Percent Recovery} = \frac{SSR - SR}{SA} \times 100$$

where:

SSR = Spike Sample Results
SR = Sample Results
SA = Spike Added (concentration)

12.3 VERIFICATION OF MASS SPECTRA

Mass spectra is visually verified by a laboratory staff member expereinced in mass spectral interpretation. The GC/MS laboratory data reviewers use the guidelines that are specified in the USEPA CLP Statement of Work. These guidelines are paraphrased as follows:

1. All ions present in the standard mass spectra at a relative intensity greater than 10% (most abundant ion in the spectrum equals 100%) are to be present in the sample spectrum.

2. The relative intensities of those ions are to agree within plus or minus 20% between the standard and sample spectra.

3. Ions greater than 10% in the sample spectrum are considered and accounted for by the analyst making the comparison.

For target analytes (TCL) the laboratory uses the spectra generated from the working calibration standard as the primary spectral reference. The National Bureau of Standards (NBS) spectral library is the primary reference for non-target analytes, tentatively identified compounds, (TIC).

The laboratory commonly used spectral subtraction to resolve interferences arising from closely eluting compounds. The laboratory has a system of independent review and evaluation of spectral analysis. Any decisions made by the primary reviewer as to the identification and confirmation of mass spectra will be independently reviewed by a secondary data reviewer. Any points of discrepancy are discussed and a resolution reached.

13.0 CORRECTIVE ACTIONS

Corrective action may be initiated at any time by any person performing work in support of the field investigation.

All project personnel have the responsibility, as part of the normal work duties, to promptly report these situations and implement the corrective action as required. The following procedures have been established to assure that situations such as malfunctions, deficiencies, deviations, and errors are promptly investigated, documented, evaluated, and corrected. When a situation is identified, the cause will be evaluated and a corrective action will be proposed to preclude repetition. The corrective action will be approved by the PQAA and the Project Manager. The situation, cause, and resulting corrective action will be documented and reported to the Field Supervisor, Chief Discipline Engineers and Scientists, the Corporate QA Manager, and involved subcontractor management, as appropriate. Corrective actions may be initiated as a result of any of the following:

1. When predetermined acceptance standards are not attained
2. When procedure or data compiled are determined deficient
3. When equipment or instrumentation is found faulty
4. When samples and test results are questionably traceable
5. When quality assurance requirements have been violated
6. When designated approvals have been circumvented
7. As a result of a management assessment
8. As a result of laboratory comparison studies

Corrective action required as a result of performance, system, and formalized audits shall require formal documented corrective action procedures.

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

The following data quality control reports will be submitted during the course of the RI/FS at SEAD at the specified frequency:

a. Daily Quality Control Report (DQCR) during field activities,

b. Departure from Approved Plans; Includes problems identified, corrective actions taken, and verbal/written instructions from USACE personnel for sampling or re-analysis. These reports of significant problems should be sent to the Project Manager within 48 hours of the occurrence.

c. Data Report to QA Laboratory; The contractors's data must be submitted to the designated quality assurance laboratory (for data validation and comparison purposes) as soon as it is available. This submittal should 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.

D. Quality Control Summary Report (QCSR)/Final Investigation Report. Ordinarily these reports are completed within thirty days of the availability of results. The QCSR addresses quality control practices employed and summarizes the DQCR. For investigative activities the QCSR may be included in the Final Engineering Report.

ATTACHMENT A - Aquatec's Quality Assurance Program Plan (QAPP)

FINAL DRAFT

Resume

JANINE L. BANKS

Sample Management

EDUCATION

Rensselear Polytechnic Institute, Troy, NY, 1980-1982
Studied Computer Science and Management

PROFESSIONAL HISTORY

Aquatec, Inc., South Burlington, VT, 1984-Present

PROJECT RELATED EXPERIENCE

1984-Present

Responsible for the logging in of samples, ensuring contractual requirements (for government or private industry contracts) are met through scrutiny of both samples and corresponding documentation.

Responsible for following chain-of-custody procedures and enforcing the in-house custody system.

Responsible for managing a team of sample custodians.

Other responsibilities include the examination of samples for proper preservation and bottles as they arrive for log-in, preserving the integrity of samples while in the laboratory, keeping bottle stocks for the field department, shipping of bottles to clients, proper disposal of remaining samples, and career development of sample custodians.

FINAL DRAFT

Resume

KAREN R. CHIRGWIN

Quality Assurance Officer

EDUCATION

M.S. University of Vermont, Burlington, VT, 1988
(Biostatistics)
B.A. University of Vermont, Burlington, VT, 1985
(Biology)
B.A. University of Vermont, Burlington, VT, 1985
(Mathematics)

PROFESSIONAL HISTORY

Aquatec, Inc., South Burlington, VT, 1987-Present
University of Vermont Department of Mathematics and Statistics, Burlington, VT, 1986-1988
Environmental Science, Inc., Middletown, CT, 1986

REPRESENTATIVE EXPERIENCE

1989-Present, Aquatec, Inc.

As Quality Assurance Officer, Ms. Chirgwin is responsible for the continued development and implementation of a Quality Assurance Program for inorganic and organic analyses of environmental samples. Her responsibilities include the preparation and maintenance of the Laboratory Quality Assurance Program Plan (QAPP), conducting audits, participating in and responding to audits from government and regulatory agencies, and monitoring the use of quality controls within the laboratory sections. In addition, Ms. Chirgwin oversees the development, revision, and implementation of standard operating procedures within the laboratory sections. She is also involved with the preparation and review of Quality Assurance Project Plans (QAPjP) and work plans for large environmental projects.

1987-1989, Aquatec, Inc.

As an analytical chemist, Ms. Chirgwin was responsible for the analysis of volatile and semivolatile organic contaminants in environmental samples by GC/MS. Analyses required the use of GC/MS methodologies including EPA 500, 600, SW846, and EPA and New York State Contract Laboratory Protocols (CLP).

1986-1988, University of Vermont

Ms. Chirgwin was a Graduate Teaching Fellow responsible for lecturing, preparing exams, and grading students in introductory level statistics courses.

REPRESENTATIVE EXPERIENCE (continued)

1986, Environmental Science Corp.
Ms. Chirgwin was an analytical chemist responsible for the preparation and analysis of environmental samples for inorganic contaminants using atomic spectroscopy and conventional wet chemistry methods. She developed and implemented a program for total halogen analysis in contaminated oil samples, using the Parr Bomb, for 45-50 samples daily.

Supported the organic chemists by preparing BNA extracts for analysis by GC/MS and setting up autosampler runs for the analysis of PCBs and VOAs in contaminated oil samples by GC.

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Resume

JOSEPH K. COMEAU, Ph.D.

Vice President, Chemistry

EDUCATION

B.S., Manhattan College, NY, 1968
(Chemistry)
Ph.D., State University of New York, Buffalo, NY, 1975
(Analytical Chemistry)

PROFESSIONAL ASSOCIATIONS

American Chemical Society

SPECIALIZED TRAINING

Incos Applications Programming, Finnigan Institute, 1985
Infrared Spectroscopy, Perkin Elmer Corporation, 1981
Capillary Chromatography for GC/MS, Finnigan Institute, 1980
Analysis of Priority Pollutants, Finnigan Institute, 1980
Infrared Data Station Operation, Perkin Elmer Corporation, 1981
Miniranger Operation and Electronic Maintenance, Motorola Government Electronics Division, 1975

Other

General Radiotelephone Operator License, 1987

EMPLOYMENT HISTORY

Aquatec, Inc., South Burlington

Vice President	1985 - Present
Laboratory Director	1976 - 1990
Chemist	1973 - 1976

Vermont Water Resources Laboratory, Montpelier, VT

Chemist	1972 (summer)

Ayerst Laboratories, Rouses Point, NY

Chemist	1965 - 1971 (summers)

RECENT RESPONSIBILITIES AT AQUATEC, INC.

Managerial - Responsible for overall work flow and project direction for a group of fifty scientists and technicians. Duties include goal setting, resource planning, staffing and client contact.

Technical - active in method design and implementation. Responsible for all technical aspects leading to Aquatec's entry into the EPA organic Contract Laboratory Program (CLP) in 1983. Currently involved in consultation on industrial waste treatment, high purity water production, process control and technical insurance matters.

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REPRESENTATIVE PUBLICATIONS AND REPORTS

A Study of Organic Levels and General Water Quality in Champlain Water District Water. Prepared for IBM Corporation, 1978.

A Study of the Anodic Behavior of Propane Using Techniques of Electrochemical Mass Spectrometry, Ph.D. Thesis, SUNY at Buffalo, 1975.

Binkerd, R., H.G. Johnston, and J.K. Comeau. Physical Impact Evaluation of the Discharge of Heated Water from the C.P. Crane Generating Station. Prepared for State of Maryland Department of Natural Resources, 1978.

Bruckenstein, S., and J. Comeau. "Electrochemical Mass Spectrometry," Intermediates in Electrochemical Reactions, The chemical Society, Faraday Division 56, 1973.

Chemical Characterization and Treatability Study of Industrial Waste Effluent. Prepared for RCA Corporation, Mountaintop, PA, 1975.

Identification and Quantification of PCB's As Isomer Groups by Gas Chromatography/Electron Capture Detection on Low Level Extracts. Prepared for EPA Region 1, 1986.

James A. Fitzpatrick Nuclear Power Plant Cooling Water System Flow Study. Prepared for the Power Authority of the State of New York, 1975.

Krol, G., G. Boyden, R. Moody, B. Kho, and J. Comeau. "Thin Layer Separation and Detection of Free Estrogens," J. Chromatogr. 61, 1971.

Physical Impact Evaluation of Chalk Point Generating Station's Cooling Water System of the Patuxent River. Prepared for the State of Maryland Department of Natural Resources, 1979.

Proposed Methods for Treatment of Plating Waste Discharge. Prepared for Fairbanks-Morse Weighing Systems, Division of the Colt Industries Operating Corporation, 1974.

The Analysis of Fish for Trace Organic Contaminants Using Liquid Chromatography and Capillary GC/MS. Prepared for the State of Vermont Department of Health, 1981.

The Analysis of Polynuclear Aromatic Hydrocarbons in the Burlington Barge Canal Using Liquid Chromatography and Capillary GC/MS. Prepared for the State of Vermont Department of Health, 1981.

FINAL DRAFT

Resume

PHILIP C. DOWNEY, Ph.D.

Biology Laboratory Director

EDUCATION

B.S. Marietta College, 1975
(Biology)
B.S. University of Michigan, 1975
(Natural Resources; Field of Specialization - Fisheries)
M.S. Louisiana State University, 1978
(Fisheries)
Ph.D. University of Idaho, 1982
(Forestry Wildlife and Range Sciences; Field of Specialization - Fisheries Resources)

PROFESSIONAL HISTORY

Aquatec, Inc., South Burlington, VT, 1981-Present
Lecturer, Unity College, Unity, ME, August 1982
Instructor, Washington State University/University of Idaho Summer Institute, June 1981
Consultant, Sterling H. Nelson and Sons, Inc., 1979

PROFESSIONAL ASSOCIATIONS AND CERTIFICATIONS

Certified Fisheries Scientist (Certification No. 1970)
Phi Sigma Biology Honor Society
American Fisheries Society (AFS)
Bioengineering Section of AFS
Fish Culture Section of AFS
Fish Health Section of AFS
American Society of Limnology and Oceanography
Vermont Subcommittee on Endangered Fishes

SPECIALIZED TRAINING

Hydroacoustic Assessment Techniques, Biosonics, Inc., 1986
Habitat Evaluation Procedures (HEP), Certified, 1984
Hazardous Materials Incident Response Operations (165.5)
SCUBA, NAUI Certified, 1976

REPRESENTATIVE EXPERIENCE

1985-Present

As the director of the biological division, Dr. Downey supervises the environmental, microbiology and toxicity laboratories. Recent fisheries projects have included environmental studies on lake Champlain and investigations of the habitat preferences of the American shad. Dr. Downey was the project director for a fish enhancement study conducted at a number of hydroelectric facilities. Behavioral studies conducted have included Atlantic salmon smolt outmigration with radiotelemetry. Dr. Downey was a fisheries consultant on the State of Vermont's project for locating a new State fish hatchery. His responsibilities

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REPRESENTATIVE EXPERIENCE (continued)
included conducting studies on lake water quality for bioengineering design criteria and making projections of hatchery effluent, based upon design and operating criteria, for the discharge permit.

1981-1984
Upon joining Aquatec, Inc. in 1981, Dr. Downey developed a comprehensive fisheries and aquatic biology investigative program to assess potential impacts of thermal effluent discharged during the summer to the Connecticut River. These studies concentrated on fish health, growth, survival and species composition of representative resident fishes. Other projects included feasibility studies for hydroelectric sites and fish health inspections for bait dealers in the State of New Hampshire.

1978-1981
During these years, Dr. Downey was involved in several projects in addition to his research responsibilities for his doctoral work. He was a co-author of a manual for trout and salmon production, published by Sterling H. Nelson and Sons, Inc., a major fish food producer. He also represented the United States as a delegate to the North Pacific Aquaculture Symposium, an international technical and scientific exchange program. Selected delegates from the United States, Canada, Japan and Union of Soviet Socialist Republics attended this biannual meeting.

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Resume

CONSTANCE C. DUMAS

Microbiologist

EDUCATION

B.S. University of Vermont, 1967

PROFESSIONAL HISTORY

Aquatec, Inc., South Burlington, VT, 1984-Present
Medical Center Hospital of Vermont, Burlington, VT, 1964-1974

PROFESSIONAL CERTIFICATION

MT (ASCP) #60505
Medical Technologist (American Society of Clinical Pathology), 1967

SPECIALIZED TRAINING

DNA Probe Hybridization-Assay, 1987

REPRESENTATIVE EXPERIENCE

1984-Present

Mrs. Dumas' responsibilities include microbiological analyses of food products, especially in the dairy industry, according to the Bacteriological Analytical Manual (BAM) and drinking water analysis in our State Certified laboratory. Other microbiological analyses include monitoring sewage treatment discharges for permit requirements, developing techniques for identifying autotrophic bacteria and investigation of biodegradation of petroleum products by bacteria. Mrs. Dumas also assisted in developing techniques for the use of epifluorescent microscopy for monitoring ultra-pure water systems. Since 1987, she has been responsible for the maintenance, development and quality control within microbiology.

1970-1974

During this time as a staff technologist in hematology and bacteriology, Mrs. Dumas was involved with daily analytical work, quality control, special coagulation studies and laboratory instruction of new medical technology students.

1967-1969

As a rotating staff technologist, responsibilities included analysis in bacteriology, hematology, chemistry, blood bank, serology and urinalysis in the clinical laboratory of a teaching hospital.

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Resume

RICHARD T. GOMEZ

Chemist

EDUCATION

B.S. University of Vermont, 1975
(Biochemistry)
M.S. University of Vermont, 1982
(Cell Biology)

PROFESSIONAL HISTORY

Aquatec, Inc., South Burlington, Vermont, 1982 to Present
Parke-Davis Co., Holland, Michigan. Analytical Chemist, 1980-82
University of Vermont, Department of Pathology, College of Medicine, Burlington, Vermont. Research Technician (1975-1979), Technician in the Electron Microscope Facility (1979-1980)
International Business Machines, Corporation, Essex Junction, Vermont. Analytical Chemist, Summer 1974

PROFESSIONAL ASSOCIATIONS

American Chemical Society, past member

SPECIALIZED TRAINING

Waters Associates Liquid Chromatography School, 1982
Hewlett Packard High Resolution Capillary Chromatography School, 1984

REPRESENTATIVE EXPERIENCE

1987-Present

Mr. Gomez continues to serve as the director of several large analytical support projects on behalf of premier engineering firms and corporate clients. He also serves as Aquatec's primary customer service representative for the Chemistry Division, successfully providing assistance and guidance to existing and potential clients through the integration of his laboratory experience with a sound working knowledge of current EPA methodologies and environmental regulations.

1985-1987

Work centered around conducting special chemistry projects for corporate clients, as field studies involving high purity water pilot testing and trouble shooting, and cooling tower monitoring programs. Mr. Gomez conducted a laboratory pilot study to determine the potential for biodegradation of fuel oil in contaminated soil following application of nutrients to stimulate endogenous and exogenously applied bacteria. He was also the project director for the New York State DEC contract lab program at this time.

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REPRESENTATIVE EXPERIENCE (Continued)

1982-1985
Mr. Gomez has been employed at Aquatec since 1982. For the first three years, he worked as an analytical chemist analyzing water, soil/sediments, and hazardous waste samples. Analytical techniques performed during this time included gas chromatography (GC), gas chromatography/mass spectrometry (GC/MS), infrared, ion chromatography, inductively coupled plasma and flame atomic absorption techniques for metals determination, bomb calorimetry, flashpoints, and a multitude of wet chemistry and bacteriological testing.

1980-1982
Worked as an analytical chemist at Parke-Davis Co. in Holland, Michigan. Duties included the analysis of all raw materials used in chemical manufacturing, as well as intermediary reaction products formed during the synthesis of specialty chemicals and pharmaceutical products. Analytical techniques routinely performed included gas chromatography, high pressure liquid chromatography, infrared, UV-Visible spectrophotometry, and nuclear magnetic resonance, as well as other tests listed in the U.S. Pharmacopoeia.

1979-1980
Worked as an electron microscopist for the University of Vermont Department of Pathology. Duties included tissues preparation and thin sectioning of the plasticized tissue, electron microscopy (EM) of thin sections, photographic plate developing of the EM pictures taken, and printing the pictures by standard darkroom techniques.

1975-1979
Worked as a research assistant at the University of Vermont on a National Childhood Development grant. Project goals centered on establishing a link between fetal kidney damage and pulmonary hypoplasia. Experimental methods performed included the use of radioisotopic techniques and electrolytic radiorespirometry to biochemically evaluate chick embryo metabolism after administering nephrotoxic polyamines to damage the kidneys. Electron microscopy of fetal tissues was performed to provide morphological support of this theory.

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Resume

David H. Hardwick

Chemist

EDUCATION

B.S. University of Vermont, 1977
(Biochemistry)

PROFESSIONAL HISTORY

Aquatec, Inc., South Burlington, Vermont, 1987 to Present
University of Vermont, Department of Pathology and Psychiatry, Burlington, Vermont, 1984 to 1987
St. Francis Hospital, Colorado Springs, Colorado, 1981 to 1984
University of Vermont, Department of Pathology and Biochemistry, Burlington, Vermont 1977 to 1981

PROFESSIONAL ASSOCIATIONS

Member, Alpha Zeta Honorary Society

REPRESENTATIVE EXPERIENCE

1987-Present
Primarily concerned with aqueous, soil, and sludge samples. Responsible for ion chromatography, organic/inorganic carbon analysis, organic halide analysis and a wide variety of spectrophotometric and titrimetric procedures. Safety Officer for section. Acting Manager in absence of Supervisor.

1984-1987
Department of Pathology - Upper Level Technician studying asbestos toxicity. Extensive experience with tissue/organ culture, radioimmunoassays, and enzymatic measurement. Routine use of carcinogens and radioisotopes. Graphics and photographics production.

Department of Psychiatry - Laboratory Administrator and Technologist in lab studying blood platelet activation and differentiation of neuroblastoma hybrid cells. Research responsibilities included tissue culture, drawing human blood donors, monoclonal antibody production, column chromatography and radioimmune procedures. Administration duties related to 4-6 lab personnel and their associated projects, equipment, set-up and maintenance; equipment and supply ordering. Laboratory Photographer.

1981-1984
Processing of all routine and STAT blood chemistry tests, and the drawing of venous and arterial blood specimens. During employment, assumed increased responsibilities for quality control and instrument maintenance. The nature of the work stressed individual precision, accuracy, and organization, while demanding the ability to function as part of a team.

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REPRESENTATIVE EXPERIENCE (continued)
1977-1981
Department of Pathology - Laboratory Technician. Investigated secretory mechanisms of tracheal organ cultures as pertaining to cystic fibrosis. Work involved tissue and organ culture techniques, bacterial toxins, carcinogenic and radioactive compounds. Preparation of samples of scanning and transmission electron microscopy. Use of JEOL 35 SEM. Extensive photographic responsibilities.

Department of Biochemistry - Laboratory Technician. Beryllium toxicity in murine fibroblast monolayers in culture. Laboratory Photographer.

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Resume

H. GREGORY JOHNSTON

Vice President, Technical Services Division

EDUCATION
B.S. University of Vermont, 1974
(Mathematics)
M.S. University of Vermont, 1976
(Mathematics)

PROFESSIONAL ASSOCIATIONS
American Association of Computing Machinery

SPECIALIZED TRAINING
Incos Application Programming, Finnigan Institute, 1985
Miniranger Operation and Electronic Maintenance, Motorold Government Electronics Division, 1978

EMPLOYMENT EXPERIENCE
1975-Present
Aquatec, Inc., South Burlington, VT

1970-1972
U.S. Air Force

RECENT PROJECT RESPONSIBILITIES
Overall responsibility for the design, implementation, operation, and maintenance of computer network, support systems, and laboratory instrumentation. Currently involved in development of computer systems for laboratory automation and electronic delivery and management of data.

Development of software, automation techniques, and mathematical models for project applications.

REPRESENTATIVE PUBLICATIONS AND REPORTS
Binkerd, R., H.G. Johnston, and J.K. Comeau. Physical Impact Evaluation of the Discharge of Heated Water from the C.P. Crane Generating Station. Prepared for State of Maryland Department of Natural Resources, 1978.

Determination of Optimal Setting of Condenser Cooling System Facilities. Prepared for Vermont Yankee Nuclear Power Corporation, 1983.

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REPRESENTATIVE PUBLICATIONS AND REPORTS (continued)

Diffuser Performance Investigation at Indian Point Nuclear Generating Station. Prepared for Consolidated Edison Company of New York, 1978.

Hydrographic Study of Hawk Inlet using Fluorescence Tracer Techniques. Prepared for Martin Marietta Corporation, 1980.

Operational and Biological Studies. Prepared for Vermont Yankee Nuclear Power Corporation, 1983.

Physical Impact Evaluation of Chalk Point Generating Station's Cooling Water System of the Patuxent River. Prepared for the State of Maryland Department of Natural Resources, 1979.

Turbine Discharge Determination, Sawmill Station. Prepared for James River Corporation, 1981.

Turbine Discharge Determination, Shawmut Station. Prepared for Central Maine Power Company, 1982.

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Resume

PAULINE T. MALIK

Chemist

EDUCATION

B.A. State University of New York at Buffalo, Buffalo, NY, 1982
(Chemistry)
Ph.D. University of Vermont, Burlington, VT, expected 1991
(Inorganic Chemistry)

PROFESSIONAL ASSOCIATIONS

American Chemical Society
Women in Science

PROFESSIONAL HISTORY

Aquatec, Inc., South Burlington, VT, 1988-Present
University of Vermont, Burlington, VT, 1982-1987
State University of New York at Buffalo, Buffalo, NY, 1981-1982

PROJECT RELATED EXPERIENCE

1989-Present, Aquatec, Inc.

Ms. Malik is a customer service representative which includes communicating information to clients concerning sample handling, applicability of EPA methodologies, relaying their needs to the laboratory personnel, and interpreting results when requested. At the same time Ms. Malik also manages and supervises small environmental projects. As needed, Ms. Malik is responsible for soliciting Aquatec's services to environmental consulting and engineering firms. She is also responsible for responding to RFP/RFQ's requiring technical expertise.

From September 1989 to April 1990, Ms. Malik became a full time project director for Stone & Webster Engineering Corporation who was conducting a multi-site investigation for New York City Department of Environmental Conservation. The scope of work consisted of receiving approximately 500 samples over a six week period for the full Target Compound List plus a number of additional conventional parameters. Duties included supervising large shipments of lab packs, daily inspection of samples arriving at Aquatec, communication with the client and final publication of data packages. Due to the large scope of work, Ms. Malik provided support in primary data review for both the volatile organics and metals laboratories. She additionally supported the metals instrumental laboratory by operating one of Aquatec's Inductively Coupled Plasma Spectrophotometer (ICP).

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PROJECT RELATED EXPERIENCE (continued)

1982-1987, University of Vermont
Ms. Malik was a Graduate Teaching Assistant responsible for instructing the advanced freshman inorganic chemistry laboratory.

1981-1982, State University of New York at Buffalo
Ms. Malik was an Undergraduate Research Assistant synthesizing organometallic compounds with subsequent kinetic studies.

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Resume

R. MASON McNEER, Ph.D.

Senior Chemist

EDUCATION

B.S. University of Chicago, 1948
Ph.D. University of Chicago, 1952

PROFESSIONAL ASSOCIATIONS

American Chemical Society
Phi Beta Kappa
The Society of the Sigma Xi

PROFESSIONAL HISTORY

Summers, 1970-1973; Full time, 1974-Present
Aquatec, Inc., South Burlington, VT, Chemist

Summers, 1968-1970
Biological Division, Webster-Martin, Inc., South Burlington, VT, Chemist

Summers, 1952-1967
Department of Water Resources, State of Vermont, Chemist

1951-1974, Professor, 1965-1974
Department of Chemistry, Norwich University, Northfield, VT,

REPRESENTATIVE EXPERIENCE

1974-Present

Evaluation of analytical work performed for clients in private industry. Including the detailed review of analytical data produced by the organic and inorganic laboratories.

Technical resource for the laboratory in the fields of organic and inorganic analytical chemistry.

Provides consultation to clients in private industry in applying various methods of chemical analysis and in interpreting analytical results.

1974-1983

Project Director, Ecological Studies, Vermont Yankee Nuclear Power Station, Vernon, Vermont.

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Resume

JOSEPH J. ORSINI JR., Ph.D.

Metals Laboratory Section Head

EDUCATION

Ph.D.	University of Vermont, 1989 (Analytical Chemistry)
B.A.	Plattsburgh College of Arts and Science, State University of New York, 1982 (Chemistry)

PROFESSIONAL ORGANIZATIONS

American Chemical Society, Division of Inorganic Chemistry
Analytical Chemistry, and Industrial and Engineering Chemistry
Green Mountain Section of American Chemical Society

EDUCATIONAL TRAINING

9/82 to 9/88 - University of Vermont, Burlington, Vermont. Candidate for Dr. of Philosophy under Professor William E. Geiger. Specializing in the electrochemistry of organometallic rhodium, palladium and manganese compounds. Included speciation studies of rhodium hydrogenation catalysts via high speed cyclic voltammetry.

9/79 to 5/80, summers 1980, 1981 and 1982. Plattsburgh College of Arts and Science, Plattsburgh, New York. Studied mixed-valence benzotriazolato copper clusters using electron paramagnetic resonance spectroscopy.

REPRESENTATIVE EXPERIENCE

1988-Present
Trace Metals Analysis Laboratory Section Head responsiblities include personnel management, ICP analysis and development for ICP, furnace and cold vapor analyses. Recently developed ICP hydride methodologies for the analysis of arsenic and selenium in difficult matrices.

1982-1988 - Ph.D. Candidate at the University of Vermont
Expertise in modern electroanalytical techniques including voltammetric and coulometric methods.

Synthesis of organometallic, inorganic and organic compounds.

Experienced with nuclear magnetic resonance spectroscopy including use of fourier transform instruments to study various nuclei in static and dynamic environments.

Use and interpretation of mass spectral data.

Strong background in manipulations of air sensitive materials by schlenk and vacuum line techniques.

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REPRESENTATIVE EXPERIENCE (Continued)
Spectroscopic techniques including electron paramagnetic resonance, ultraviolet, visible and infrared spectroscopy.

Utilized gas chromatography in the analysis of organics from organometallic decomposition reactions.

Working knowledge of computerized data analysis and simulations of cyclic voltammograms and nuclear magnetic resonance spectra.

PUBLICATIONS

"Two-Dimensional Dynamic Jahn-Teller Effects in a Mixed-Valence Benzotriazolato Copper Cluster, $Cu_5 (BTA)_6 (RNC)_4$," Kokoszka, G.F.; Baranowski, J.; Goldstein, C.; Orsini, J.; Mighell, A.D.; Himes, V.L.; and Siedle, A.R. J. Am. Chem. Soc. 1983, 105, 5627.

"ESR Spectra of New Dicopper (II) Complexes of Novel Binucleating Ligands, Karlin, K.D.; Cruse, R.M.; Kokoszka, G.F.; and Orsini, J.J. Inorg. Chim. Acta 1982, 66, L57.

RELATED EMPLOYMENT

9/82 to 9/88: Teaching Assistantship at University of Vermont.
9/81 to 5/82: Teaching Assistantship at Plattsburgh State College, Plattsburgh, New York.
Summers of 1980, 1981 and 1982: Undergraduate Research Assistant with professor Gerald F. Kokoszka, Plattsburgh, New York.

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Resume

MARTHA E. ROY

Project Director

EDUCATION

B.A. St. Michael's College, Winooski, Vermont, 1983
(Biology)
M.S. University of Vermont, Burlington, Vermont, 1985
(Limnology)

PROFESSIONAL HISTORY

Aquatec, Inc., South Burlington, VT, 1985-Present
University of Vermont, Burlington, Vermont, 1983-1985
St. Michael's College, Winooski, Vermont, 1981-1982

REPRESENTATIVE EXPERIENCE

1988-Present
Project Director of four EPA and Superfund affiliated projects. Responsibilities include client contact, initiation of required analysis, and coordination of results and supportive documentation into a data package for the client. Also responsible for maintaining Aquatec's laboratory certifications.

1985-1988
As a QA/QC Assistant, primarily responsible for the review of inorganic data generated at Aquatec. Other duties included some review of GC and GC/MS data, communicating with clients, organizing final client reports, and supervising two large government contracts.

1983-1985
During this time period worked at the University of Vermont as a laboratory instructor and research technician. Duties included teaching laboratory sessions, supervising work study students, collecting water and benthic samples as part of an acid rain study, and doing extensive data analysis on the information gathered.

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Resume

ANGELA d. SHAMBAUGH

Biologist

EDUCATION

B.A. University of Montana, 1982
(Botany/German)
M.A. University of Montana, 1989
(Botany with emphasis on Phycology)

PROFESSIONAL HISTORY

Aquatec, Inc., South Burlington, VT, 1986-Present
University of Montana Biological Station, Flathead Lake, MT. 1985-1986
University of Montana Botany Department, Missoula, MT 1983-1985

PROFESSIONAL ASSOCIATIONS AND CERTIFICATIONS

Fulbright Scholarship Recipient, August 1982 to September 1983, Universitaet Regensburg, Federal Republic of Germany
Phycological Society of America

REPRESENTATIVE EXPERIENCE

1986-Present
The biology section conducts evaluations of a variety of water bodies and biological communities ranging from bacteria to fish. Ms. Shambaugh's responsibilities reflect this varied format, with primary responsibilities being analysis of algae investigation, and serving as Biology Laboratory Coordinator. She evaluates daily laboratory data for precision and completeness. Other responsibilities include designing/conducting experiments utilizing electron microscopy, preparation of otoliths for age analysis for light microscopy, microbiological water testing, biotoxicity testing, field sample collection, and report generation.

1983-1989
Ms. Shambaugh's master thesis focused on the relationships among individual benthic algae in a nutrient-limited environment. The spatial aspects of this community were evaluated using scanning electron microscopy and light microscopy. Development and growth of the benthic community were followed from bare substrate to maturity, identifying individual species and their role in community architecture.

1985-1986
As a research assistant at the University of Montana Biological Station, Ms. Shambaugh identified and enumerated phytoplankton samples from Flathead Lake. Other responsibilities included collection of monthly field samples (including zooplankton, water quality,

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REPRESENTATIVE EXPERIENCE (continued)
chlorophyll and carbon-14 photosynthesis samples); preparation of chlorophyll and C_{14} samples for analysis, preparation of P_{32} samples for scintillation analysis, and production of report summaries for publication purposes.

1983-1985
Botanical teaching assistant responsibilities during this period included development of laboratory classes for undergraduate students in plant physiology, general biology, and phycology.

1982-1983
As a Fulbright Scholarship recipient in the Federal Republic of Germany, Ms. Shambaugh was employed in the electron microscopy laboratory, Universitaet Regensburg Biology Department. Her responsibilities included specimen preparation and operation of transmission and scanning electron microscopes.

Resume

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GEORGE W. STARBUCK

President

EDUCATION

B.A. University of Vermont, 1962
(Biology and Chemistry)

PROFESSIONAL HISTORY

Aquatec, Inc., South Burlington, VT, 1970-Present
President and Chairman of Board of Directors
Webster-Martin, Inc., South Burlington, VT
Aquatic Biologist and Director of Water Quality Division, 1965-1968; Chief Executive Officer, 1968-1970; Vice President and Corporate Director, 1970-1975
Vermont Department of Water Resources, Montpelier, VT, 1962-1965
Aquatic Biologist

SPECIALIZED TRAINING

Thermal Pollution and Thermal Addition to the Marine Environment
M.I.T. summer session on Engineering of Heat Disposal from Power Generation, 1972
Biological Aspects of Thermal Pollution - U.S. Public Health Service, 1966
Graduate studies in Biology, University of Vermont, 1965-1966
Bio-assay and Pollution Ecology - U.S. Public Health Service, 1965

PUBLIC SERVICE EXPERIENCE

Corporator and Advisory Council, Bank of Vermont, 1982-1986
Chairman, American Diabetes Association, Vermont Affiliate, 1986-1987; Vice Chairman, 1984-1986
Member, Water Resources Research Council, University of Vermont, 1980-1984
Committee Member, Vermont D.U., 1977-1978
Trustee, Village of Essex Junction, VT, 1974-1977
Member, New England Regional Commission, Committee on Aquaculture, 1967-1969

REPRESENTATIVE EXPERIENCE

1970-Present

Mr. Starbuck organized Aquatec, Inc. in 1970 as a company designed to provide industry and government with a wide range of environmental services. In addition to his administrative responsibilities as President of Aquatec, he is directly involved with project reports and publications of the company. Since Aquatec's inception, Mr. Starbuck

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REPRESENTATIVE EXPERIENCE (continued)
has directed the company to keep pace with National Environmental issues. He has supervised and provided consulting services for industry, local, state and federal governmental agencies and private developers. He is active in the environmental permit process and current issues such as EPA Superfund and priority pollutant surveys and analysis.

1965-1970
An environmental division at Webster-Martin was established by Mr. Starbuck and he was responsible for conducting biological surveys, water quality analyses, weed and algae control projects and related studies. He established and supervised long-term physical, chemical and biological monitoring programs and prepared environmental statements and reports for submission to regulatory agencies. In 1968 Mr. Starbuck established a Hydrographic Studies Division which conducted dye diffusion surveys and bathymetric surveys as well as temperature, salinity and current measurement studies throughout much of the United States.

1962-1965
As an aquatic biologist, Mr. Starbuck conducted baseline environmental studies for classification of Vermont State water and was responsible for collection and identification of aquatic biota, chemical analysis of surface water and wastewater from primary and secondary sewage treatment plants. During this period he studied and designed systems to alleviate aquatic nuisances and conducted baseline biological surveys of Lake Champlain.

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Resume

GARY B. STIDSEN

Section Head, Organic Extraction and Gas Chromatography Laboratories

EDUCATION

B.S. Norwich University, Northfield, VT, 1981
(Environmental Engineering Technology)

PROFESSIONAL HISTORY

Aquatec, Inc., South Burlington, VT, 1982-Present

SPECIALIZED TRAINING

Finnigan Mat Institute "ITD Data System Operation" Training Course, 1988
Hewlett Packard High Resolution Capillary Chromatography School, 1984

REPRESENTATIVE EXPERIENCE

1986-Present

Section Head of the Organic Laboratory including the Extraction Laboratory and the Gas Chromatography Laboratory. Areas of analysis include pesticides/PCBs, base/neutral/acids, herbicides, volatile organic compounds in water, soil, air, and biota samples. Methods of analysis followed are the EPA 500, 600, 800 and NIOSH methods and methods according to protocols set by New York State, EPA Superfund, etc. Responsible for training of personnel, flow of samples through the laboratory and instrument maintenance. Provide technical input for collection of air, soil and water samples designed for organic analysis.

1987-1988

Project: Responsible for the sample preparation of soils for the Love Canal Habitability Study performed by New York State. The object of the project was to compare the concentration of targeted organic compounds from the Emergency Declaration Area around Love Canal to other areas in Niagara Falls and Buffalo, New York.

1985-1986

Project: Responsible for the sample preparation and gas chromatograph analysis for PCBs as Congeners of 1700 water, soil and biota samples from the New Bedford Harbor, Massachusetts area under the EPA Superfund. Work in the Extraction Laboratory included extraction and extensive clean up of the sample extracts. In the Gas Chromatography Laboratory the sample extracts were analyzed for PCBs as Congeners using electron capture detection with low parts per trillion detection limit in the sample extracts.

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REPRESENTATIVE EXPERIENCE (continued)

1983-1986
Worked as a chemist in the Extraction Laboratory and the Gas Chromatography Laboratory. In the Extraction Laboratory samples were prepared for organic analysis, including pesticide/PCBs, base/neutral/acids, and herbicides. Analysis performed in the Gas Chromatography Laboratory included pesticide/PCBs, herbicides, base/neutral/acids by GC, and volatile organic compounds.

1982-1983
Worked as a chemist in the Inorganic Laboratory. Analysis performed included COD, BOD, nitrate, nitrite, phosphate, sulfur, pH, turbidity, oil and grease, solids, metals by flame atomic adsorption, formaldehyde, hardness, alkalinity, fluoride, and TOC. Also during this time period collected air samples using the techniques in EPA Method 5, and organic compounds in air using techniques in EPA Method 25.

1982
Worked with the Aquatec Survey Division. Survey experience consisted of building layouts and horizontal control for power lines. Instrumentation used included a one second Theodolite, Kern DM502, and a KNE Range IV for determining distances.

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Resume

NEAL E. VAN WYCK

Laboratory Director

EDUCATION

B.A. University of Vermont, 1982
(Chemistry)
M.S. University of Arizona, 1985
(Physical Chemistry)

PROFESSIONAL HISTORY

Aquatec, Inc., South Burlington, VT, 1985-Present
University of Arizona, Tucson, AZ, 1982 - 1985

SPECIALIZED TRAINING

Waste Testing and Quality Assurance Symposium, EPA, 1988

REPRESENTATIVE EXPERIENCE

1990-Present
Responsible for coordinating the overall activities of the analytical laboratories on a daily basis and providing long-term direction as Aquatec's Laboratory Director. Responsibilities include scheduling analytical work and personnel, developing new methods and technologies, and working with Technical Support to develop procedures to automate the review and reporting of analytical data.

1985-1990
Chemist and Project Director for Environmental Chemical Analysis. Involvement with extensive chemical analysis programs for hazardous waste site characterization, discharge monitoring and delisting petitions. Specific laboratory analysis responsibilities have included the supervision of the Analytical Atomic Spectroscopy Group and the development of Inductively Coupled Plasma Emission Spectrometry for trace metals determination.

1982-1985
Research and Teaching Assistant in the University of Arizona Department of Chemistry. Teaching responsibilities included preparation of lectures and supervision over general and advanced physical chemistry laboratory sections. Research activities centered about nonlinear optical investigations of thin films and surfaces. Various multiphoton techniques were explored and developed. They are surface coherent Anti-Stokes Raman Spectroscopy, Surface Second Harmonic Generation Spectroscopy and Two Photon Spectroscopy in Film Organic Optical Waveguides.

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Resume

KIM BRYANT WATSON

Project Director

EDUCATION
B.S. cum laude, Norwich University, 1981
(Environmental Engineering Technology)

PROFESSIONAL HISTORY
Aquatec, Inc., South Burlington, Vermont, 1982-present
Project Director, Environmental Engineering Technologist, Quality Control Specialist
Vermont Agency of Environmental Conservation, 1981-1982
Air and Solid Waste Technician

PROFESSIONAL ASSOCIATIONS AND CERTIFICATIONS
Norwich University Engineering Society
President and co-founder of Chi Beta Chapter of Tau Alpha Phi

REPRESENTATIVE EXPERIENCE
1988-Present
Project Director of Superfund and government contracts, final review and publication of USEPA Superfund data package submittals. USEPA Special Analytical Service Solicitations Contact.

1987-1988
LCIC Habitability Study; responsible for daily electronic upload of GC/MS analytical data to project bulletin board. Responsible for review and final-publication of analytical data.

1986-1987
PCB study, New Bedford, MA. Performed review and quality control of GC/MS analysis for the development of analytical procedures published in "Application of a Mixed-Method Analytical Scheme for Analysis of PCB in Water and Sediment Samples from a Polluted Estuary," Richard A. McGrath, William Steinhauer and Siegfried Stockinger (1987).

1983-1988
Close association with quality control/quality assurance associated with USEPA Superfund projects. Co-author of Analytical Laboratory Standard Operating Procedures Sections on QA/QC.

1982-1983
Extraction Lab Technician

FINAL DRAFT

REPRESENTATIVE EXPERIENCE (continued)

1981-1982

Environmental Engineering design of solid waste disposal facilities for the State of Vermont Solid Waste Program. Assistant author of State Certifications of Solid Waste facilities. Performed water quality monitoring at the majority of the solid waste facilities in the State of Vermont.

FINAL DRAFT

Resume

JOHN W. WILLIAMS

Toxicity Laboratory Section Head

EDUCATION

B.S. University of Massachusetts, 1968
(Marine Fisheries Biology)

Graduate-level courses completed:
Harvard University, 1984-1985
(Biochemistry, Molecular Biology)
Boston University, 1983
(Statistics for the Biological Sciences)
Southeastern Massachusetts University, 1976
(Estuarine Ecology)

PROFESSIONAL HISTORY

Aquatec, Inc., South Burlington, VT, 1990-Present
Cosper Environmental Services, Northport, NY, 1989-1990
Battelle Ocean Sciences, Duxbury, MA, 1975-1989

PROFESSIONAL ASSOCIATIONS

Society of Environmental Toxicologist and Chemists (co-author on several research papers)
National Association of Underwater Instructors

SPECIALIZED TRAINING

Solid-phase Sediment Tests (USCOE), Sludge Tests (EPA), Drilling Fluid Tests.
Supervised and conducted GLP (Good Laboratory Practices) and non-GLP toxicity studies using dosing and flow-through systems.
Supervised organism culture facility (species: Mysidopsis bahnia, Cyprinodon variegatus, Menidia beryllina, Arbacia punctulate, Champia parvula.
Operated research vessels to 42'.
Supervised SCUBA operations, NAUI certified instructor.

REPRESENTATIVE EXPERIENCE

1990-Present

Mr. Williams supervises the toxicity testing laboratory personnel. Responsibilities include scheduling testing, QA/QC procedures and analysis of samples with marine and fresh water organisms.

FINAL DRAFT

REPRESENTATIVE EXPERIENCE (continued)

1989-1990

Managed operation of an aquatic toxicity testing and consulting laboratory located on Long Island in Northport, New York. Work focused on NPDES biomonitoring, both marine and freshwater.

FINAL DRAFT

Resume

KIRK F. YOUNG

QC Supervisor

EDUCATION

Virginia Military Institute, Lexington, VA, 1969 to 1970
B.S. Lehigh University, Bethlehem, PA, 1970 to 1973
(Civil Engineering)

PROFESSIONAL CERTIFICATION

Currently certified as a Professional Engineer in the Commonwealth of Virginia and the State of Vermont.

REPRESENTATIVE EXPERIENCE

1981-Present
Aquatec, Inc., South Burlington, VT
Performance of industrial wastewater treatability studies and design of hazardous waste treatment and disposal processes.

Daily administration of the laboratory's work within U.S. Environmental Protection Agency's Contract Laboratory Program from 1983 to 1988. The position was one of coordinating related laboratory activities as well as directing the effort of detailed review, validation and publication of the analytical data. During this period, the laboratory participated extensively in special analytical services work in support of EPA regional needs and national program development.

Current participation in the operational aspects of the laboratory, with a focus on detailed project planning and the implementation of specialized project work. In addition to this, is the responsibility for directing the effort of detailed review, validation and publication of analytical data from the GC/MS laboratory and directing activities associated with data validation services.

1978-1981
Donald L. Hamlin, Consulting Engineers, Inc., Essex Junction, VT, Professional Engineer
Project Engineer for the design and construction of municipal wastewater treatment facilities, with experience in the design of secondary and advanced treatment processes, site planning, and construction supervision.

1974-1978
Commonwealth of Virginia/Northern Regional Office of the State Water Control Board, Engineer
Shared responsibility for conducting engineering inspections and reviewing plans and specifications of municipal and industrial wastewater treatment facilities throughout the time of employment.

FINAL DRAFT

REPRESENTATIVE EXPERIENCE (continued)
Coordination for the industrial wastewater program within the region which, in addition to regulatory duties, included the responsibility for engineering review of industrial waste treatment proposals.

Administration of the Construction Grants Program established under Public Law 92-500, involving Virginia municipalities within the Washington, D.C. metropolitan area. This work included new facilities planning, review of treatment designs, and the allocation of grant funds.

FINAL DRAFT

Aquatec, Inc. - LABORATORY PERSONNEL

Date: November 1990

FULL NAME	TITLE	HIGHEST DEGREE					AREA OF STUDY		Primary * DUTIES						Primary ** WORK AREA				YRS. EXP.	TYPE *** EXP.			
		HS	AA	BS	MS	PhD	Major	Minor	A	B	C	D	E	F	1	2	3	4		U	H	I	P
Joseph K. Comeau	VP-Chemistry					X	Analytical Chemistry		X						X		X		24				X
R. Mason McNeer	Sr. Chemist					X	Organic Chemistry	Math		X			X		X		X		38	X			X
Neal E. Van Wyck	Chemistry Lab Director				X		Physical Chemistry		X						X		X		4				X
Kirk F. Young	QC Supervisor			X			Civil Eng.		X	X					X		X		15				X
Joseph Edwin	Chemist					X	Chemistry			X							X		14	X			X
Richard T. Gomez	Chemist				X		Bio-chemistry	Cell Biology					X		X		X		15		X	X	X
Karen R. Chirgwin	QA Officer				X		Bio-statistics		X	X					X	X	X		4				X
Gary B. Stidsen	GC Section Head			X			Env. Eng. Technology		X		X						X		8				X
Nicholas C. Santo	Chemist			X			Chemistry				X				X				15				X
Joseph J. Orsini	Metals Section Head					X	Chemistry		X		X				X				2				X
Pauline T. Malik	Chemist					X	Chemistry			X			X	X	X		X		2				X
Martha E. Roy	Chemist				X		Limnology			X			X		X		X		4				X
Philip C. Downey	Bio. Lab Director					X	Fisheries		X				X			X		X	11				X
Angela d. Shambaugh	Biologist				X		Botany	German			X					X		X	3				X
Richard A Evans	Biologist				X		Aquatic Science	Statistics			X							X	2	X			X
Kim B. Watson	Chemist			X			Env. Eng Technology			X					X		X		7	X			X
Bennye A. Ames	Chemist			X			Env. Eng. Technology				X				X				10	X			X

* = DUTIES

A. Supervisor
B. Data[illegible]lysis
C. Ana[illegible]
D. Lab. Assistant
E. Project Manager
F. Other

** = WORK AREA

1. Inorganics
2. Microbiology
3. Organics
4. Biology

*** = TYPE EXPERIENCE

U. University/Government Lab.
H. Hospital
I. Industry
P. Private Lab.

[illegible]Septemb

Aquatec, Inc. - LABORATORY PERSONNEL

Date: November 1990

FULL NAME	TITLE	HIGHEST DEGREE					AREA OF STUDY		Primary * DUTIES						Primary ** WORK AREA				YRS. EXP.	TYPE *** EXP.			
		HS	AA	BS	MS	PhD	Major	Minor	A	B	C	D	E	F	1	2	3	4		U	H	I	P
Jeffery J. Rusik	Chemist			X			Agriculture				X				X				10	X			X
Kathleen R. O'Hara	Chemist			X			Env. Science				X				X				9				X
David H. Hardwick	Wet Chem. Section Head			X			Bio-chemistry		X		X				X				12	X			X
Kristine L. Aubin	Chemist			X			Bio-chemistry			X					X				3				X
Kelly A. Thompson	Chemist			X			Chemistry				X						X		5				X
Janet A. Morton	Chemist			X			Biology	Chemistry		X							X		4	X			X
Bryce E. Stearns	Chemist			X			Env. Science				X						X		6	X			X
James C. Vose	Chemist			X			Chemistry				X						X		13			X	X
David L. Banks	Programmer			X			Computer Science			X							X		6				X
William R. DesJardins	Chemist			X			Biology				X						X		10				X
Jon P. Wilkinson	Chemist			X			Env. Engineering				X						X		4				X
Bradley W. Chirgwin	Chemist			X			Biochemistry				X						X		2				X
Michael R. Veilleux	Chemist			X			Ecology				X						X		2				X
Caroline I. Camara	Chemist			X			Biochemistry			X	X						X		2				X
Cindy M. Petersen	Chemist			X			Biology				X						X		4				X
James W. Madison	Chemist			X			Geology	Env. Sci.			X						X		4				X
Jeff S. Tanguay	Chemist			X			Env. Studies				X						X		3				X

* = DUTIES
A. Supervisor
B. Data Analysis
C. Analyst
D. Lab. Assistant
E. Project Manager
F. Other

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FINAL DRAFT

FINAL DRAFT

Aquatec, Inc. - LABORATORY PERSONNEL

Date: November 1990

FULL NAME	TITLE	HIGHEST DEGREE					AREA OF STUDY		Primary * DUTIES						Primary ** WORK AREA				YRS. EXP.	TYPE *** EXP.			
		HS	AA	BS	MS	PhD	Major	Minor	A	B	C	D	E	F	1	2	3	4		U	H	I	P
Mark P. Biercevicz	Technician			X			Natural Res. Conservation				X							X	3				X
Constance C. Dumas	Biologist			X			Med. Tech.				X					X			15		X		X
Nicholas R. Staats	Biologist			X			Biology				X							X	4	X			X
Puy N. Tam	Technician	X					General				X	X			X				4				X
Carol M. Sullivan	Chemist			X			Chemistry				X						X		2				X
Stanley G. Brinkman	Technician	X					General				X						X		4				X
Vanaja A. Sayala	Technician			X			Chemistry				X				X				3				X
Maureen R. Henry	Technician	X					General							X	X	X	X		2				X
Janine L. Banks	Sample Custodian	X					Management		X						X	X	X		5				X
Frederick P. Cota	Technician	X					General				X				X				2				X
Richard W. St. Pierre	Technician	X					General				X				X				2				X
William A. Schmidt	Technician		X				Engineering				X						X		2				X
David J. Peterson	Chemist			X			Env. Engineering				X						X		2				X
Denise M. Gregory	Chemist			X			Env. Science				X				X				1				X
Karol A. Wilson	Chemist			X			Biology			X							X		1				X
Lisa A. Usher	Chemist			X			Env. Science				X				X				1				
Scot P. Swanborn	Chemist			X			Env. Science				X						X		4				

* = DUTIES

A. Supervisor
B. Data [illegible]lysis
C. Ana[illegible]
D. Lab. Assistant
E. Project Manager
F. Other

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I. Industry
P. Private Lab.

Aquatec, Inc. - LABORATORY PERSONNEL

Date: November 1990

FULL NAME	TITLE	HIGHEST DEGREE HS	AA	BS	MS	PhD	AREA OF STUDY Major	Minor	Primary * DUTIES A	B	C	D	E	F	Primary ** WORK AREA 1	2	3	4	YRS. EXP.	TYPE *** EXP. U	H	I	P
Richard W. Barton	Technician		X				Science					X				X		X	1				X
John W. Williams	Biologist			X			Marine Biology				X					X		X	16				X
Steven J. Fluck	Chemist			X			Biology					X					X		8	X			X
Jocelyn A. Mills	Technician			X			Anthropology							X	X	X	X		1				X

* = DUTIES

- A. Supervisor
- B. Data Analysis
- C. Analyst
- D. Lab. Assistant
- E. Project Manager
- F. Other

** = WORK AREA

1. Inorganics
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- U. University/Government Lab.
- H. Hospital
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- P. Private Lab.

(September '89)

FINAL DRAFT

ATTACHMENT B - Non-Standard Analytical Methods

FINAL DRAFT

A - Water and Wastewater Analysis

Method	Description
110.2	Color (std. units)
120.1	Conductivity (umhos/cm)
130.2	Total Hardness as CaCO3
150.1	pH (std. units)
160.1	Total Dissolved Solids
160.2	Total Suspended Solids
160.3	Total Solids
160.4	Volatile Total Solids
160.5	Settleable Solids (ml/L)
180.1	Turbidity (NTU)
200	Digestion, ICP, fu Sb
200	Digestion, fu, fl/ICP Ag
200	Digestion, fl
200.7	Silver, Total
200.7	Aluminum, Total
200.7	Arsenic, Total
200.7	Boron, Total
200.7	Barium, Total
200.7	Beryllium, Total
200.7	Calcium, Total
200.7	Cadmium, Total
200.7	Cobalt, Total
200.7	Chromium, Total
200.7	Copper, Total
200.7	Iron, Total
200.7	Potassium, Total
200.7	Lithium, Total
200.7	Magnesium, Total
200.7	Manganese, Total
200.7	Molybdenum, Total
200.7	Sodium, Total
200.7	Nickel, Total
200.7	Lead, Total
200.7	Antimony, Total
200.7	Selenium, Total
200.7	Silicon, Total
200.7	Tin, Total
200.7	Strontium, Total
200.7	Titanium, Total
200.7	Thallium, Total
200.7	Vanadium, Total
200.7	Zinc, Total
202.1	Aluminum, Total
202.2	Aluminum, Total
204.1	Antimony, Total
204.2	Antimony, Total
206.2	Arsenic, Total
208.1	Barium, Total
208.2	Barium, Total
210.1	Beryllium, Total
210.2	Beryllium, Total
213.1	Cadmium, Total
213.2	Cadmium, Total
215.1	Calcium, Total

FINAL DRAFT

A - Water and Wastewater Analysis

Method	Description
218.1	Chromium, Total
218.2	Chromium, Total
218.4	Chromium, Hexavalent
220.1	Copper, Total
220.2	Copper, Total
231.1	Gold, Total
231.2	Gold, Total
236.1	Iron, Total
236.2	Iron, Total
239.1	Lead, Total
239.2	Lead, Total
242.1	Magnesium, Total
243.1	Manganese, Total
243.2	Manganese, Total
245.1	Mercury, Total
246.1	Molybdenum, Total
246.2	Molybdenum, Total
249.1	Nickel, Total
249.2	Nickel, Total
258.1	Potassium, Total
270.2	Selenium, Total
272.1	Silver, Total
272.2	Silver, Total
273.1	Sodium, Total
273.2	Sodium, Total
279.1	Thallium, Total
279.2	Thallium, Total
282.1	Tin, Total
282.2	Tin, Total
286.1	Vanadium, Total
286.2	Vanadium, Total
289.1	Zinc, Total
289.2	Zinc, Total
300.0	Ion Chromatography
305.1	Acidity (as $CaCO_3$)
310.1	Alkalinity (as $CaCO_3$)
320.1	Bromide
325.3	Chloride
330.1	Total Residual Chlorine
330.4	Total Residual Chlorine
335.1	Cyanide,Total & Amenable
335.1	Cyanide, Amenable to Cl_2
335.2	Cyanide, Total
340.2	Fluoride
350.1	Ammonia-Nitrogen
350.2	Ammonia-Nitrogen
351.3	Total Kjeldahl Nitrogen
353.3	Nitrate/Nitrite Nitrogen
354.1	Nitrite Nitrogen
360.2	Oxygen, Dissolved
365.2	Orthophosphate as P
365.2	Phosphate, Total as P
370.1	Silica, Dissolved
375.4	Sulfate

A - Water and Wastewater Analysis

Method	Description
376.2	Sulfide
377.1	Sulfite
405.1	BOD5
410.1	Chemical Oxygen Demand
413.1	Oil & Grease
415.1	Organic Carbon, Total
418.1	Petroleum Hydrocarbons
420.1	Phenols, Total
420.1	Phenols, Total
425.1	MBAS (mg LAS/L)
450.1	Organic Halides, Total

B - Organic Compounds in Drinking Water

Method	Description
501.1	Trihalomethanes
501.2	Trihalomethanes
502.2	Volatile Organics
503.1	Volatile Aromatics
504	EDB and DBCP
505	Pesticides/PCB's
505	Drinking Water Pesticide
510.1	Trihalomethanes
515	Herbicides
515	Drinking Water Herbicide
524.2	Volatile Organics

C - Organics in Municipal Industrial Wastewater

Method	Description
601	Purgeable Halocarbons
601-602	Purgeable Organics
602	Purgeable Aromatics
603	Acrolein & Acrylonitrile
604	Phenols
606	Phthalate Esters
607	Nitrosamines
608	Pesticides/PCB's
609	Nitroaromatics/Isophoron
610	Polynuclear Aromatics
611	Haloethers
612	Chlorinated Hydrocarbons
613	Dioxin, Screen
614	Organophosphorus Pest.
615	Chlorinated Herbicides
619	Triazine Pesticides
622	Organophosphorus Pest.
624	Volatile Organics
625	Semivolatile Organics
625	Acid Extractables
625	Base/Neutral Extractable
680	Pesticides/PCB's

FINAL DRAFT

D - Biological Analysis

Method	Description
100262	Chlorophyll a,(ug/l)
1002CIF	Phytoplankton (units/l)
907A	Bacteria, Total (CFU/ml)
907C	Bacteria, Total (CFU/ml)
908A	Coliform,Total(col/100ml
908C	Coliform,Fecal(col/100ml
909A	Coliform,Total(col/100ml
909C	Coliform,Fecal(col/100ml
910B	Strep.,Fecal (col/100ml)
918A	Bact., Iron (qualitative
918C2	Bact,Iron Prof(col/100ml
918C2A	Bact,Spha/Lept(col/100ml
918C2D	Bact, Het.Iron(col/100ml
9213D	E. Coli (CFU/100ml)
AQBAC1	Coliform,Total (P/A)
AQBAC2	Coliform,Total(CFU/100ml
BA1	Bioassay F.M. Embryo
BA2	Bioassay F.M. Larval
BA3	Bioassay C-Daphnia Repr.
BA4	Bioassay Daphnia AC. 48
BA5	Bioassay F.M. AC. 48
BAM1	Coliform,Total (CFU/g)
BAM2	Coliform,E. Coli (CFU/g)
BAM3	Bacteria, Total (CFU/g)
BAM4	Salmonella Spp (P/A)
BAM5	Salmonella Spp (P/A)
ISOGRID1	Yeast & Mold,Total(Col/g
ISOGRID2	Bact.,Gram Neg. (CFU/g)
ISOGRID3	Staph. aureus (Col/g)

Method	Description
1010	Ignitability (F)
1110	Corrosivity
1310	EP Tox Extraction(metals
1310	EP Tox Ext.(Pest/Herb)
3005	Digestion, fl/ICP W, D/R
3010	Digestion, fl/ICP W, T
3020	Digestion, fu W,fl/ICP A
3020	Digestion, fu W, As/Se
3040	Dissolution
3050	Digestion, fl/ICP O
3050	Digestion, fu O,fl/ICP A
3510	Sep. Funnel Liq-Liq Ext.
3520	Continuous Liq-Liq-Ext.
3530	Acid-Base Cleanup Ext.
3540	Soxhlet Extraction
3540	Soxhlet Extraction
3550	Sonication Extraction
3820	Hexadecane Ext. & Screen
6010	Silver, Total
6010	Aluminum, Total
6010	Arsenic, Total
6010	Boron, Total
6010	Barium, Total
6010	Beryllium, Total
6010	Calcium, Total
6010	Cadmium, Total
6010	Cobalt, Total
6010	Chromium, Total
6010	Copper, Total
6010	Iron, Total
6010	Potassium, Total
6010	Lithium, Total
6010	Magnesium, Total
6010	Manganese, Total
6010	Molybdenum, Total
6010	Sodium, Total
6010	Nickel, Total
6010	Lead, Total
6010	Antimony, Total
6010	Selenium, Total
6010	Silicon, Total
6010	Strontium, Total
6010	Titanium, Total
6010	Thallium, Total
6010	Vanadium, Total
6010	Zinc, Total
7040	Antimony, Total
7041	Antimony, Total
7060	Arsenic, Total
7080	Barium, Total
7090	Beryllium, Total
7091	Beryllium, Total
7130	Cadmium, Total

FINAL DRAFT

Method	Description
7131	Cadmium, Total
7190	Chromium, Total
7191	Chromium, Total
7196	Chromium, Hexavalent
7196	Chromium, Hexavalent
7210	Copper, Total
7211	Copper, Total
7420	Lead, Total
7421	Lead, Total
7470	Mercury, Total
7471	Mercury, Total
7520	Nickel, Total
7521	Nickel, Total
7740	Selenium, Total
7760	Silver, Total
7761	Silver, Total
7840	Thallium, Total
7841	Thallium, Total
7910	Vanadium, Total
7911	Vanadium, Total
7950	Zinc, Total
7951	Zinc, Total
8010	Halogenated Volatiles
8015	Nonhalogenated Volatiles
8020	Aromatic Volatiles
8030	Acrolein/Acrylon./Aceton
8040	Phenols
8060	Phthalate Esters
8080	Organochlorine Pest/PCB'
8080	PCB's on Wipes
8080	EP Tox Pesticides
8090	Nitroaromatics/Cyc.Keton
8100	Polynuclear Aromatics
8120	Chlorinated Hydrocarbons
8140	Organophosphorus Pest.
8150	Chlorinated Herbicides
8150	EP Tox Herbicides
8240	Volatile Organics
8270	Semivolatile Organics
8270	Acid Extractables
8270	Base Neutral Extractable
8280	Dioxin (Subcon)
8310	Polynuclear Aromatics
9010	Cyanide,Total & Amenable
9010	Cyanide, Total
9010	Cyanide, Amenable to Cl2
9010A	Cyanide, Total
9020	Total Organic Halides
9030	Sulfides
9040	pH (std. units)
9041	pH Paper Method
9045	Soil pH (std. units)
9045	Soil pH (std. units)
9050	Conductivity (umhos/cm)

FINAL DRAFT

E - Hazardous Waste

Method	Description
9060	Total Organic Carbon
9070	Oil/Grease,Total Recover
9071	Oil/Grease
9080	Cation-Exch. (Am.Acetate
9081	Cation-Exch.(Sod.Acetate
9095	Paint Filter Liquids
TCLP	TCLP Metals Extraction
TCLP	TCLP Organic Extraction
TCLP	TCLP Volatile Extraction

F - CLP Methods

Method	Description
CLP.HCA	Aroclors/Toxaphene GC/EC
CLP.HCAT	HC Aroclors/Toxaphene &P
CLP.HCEA	Extract.Analysis by GC/M
CLP.HCEE	Extractable Ex.&Screenin
CLP.HCPP	HC Pesticides/PCB's
CLP.HCPS	Phase Separation
CLP.HCV	VOA Analysis by GC/MS
CLP.HCVE	VOA Extraction&Screening
CLP.INORG	CLP Cyanide
CLP.MET	Selenium, Total
CLP.METALS	CLP Metals
CLP.METALS	CLP Metals
CLP.PESTAN	CLP Pest./PCB Analysis
CLP.PESTEX	CLP Pest./PCB Extraction
CLP.SEMIAN	CLP Semivolatile Analysi
CLP.SEMIEX	CLP Semivolatile Extract
CLP.VOL	CLP Volatile Analysis

FINAL DRAFT

G - Aquatec Inorganic Analysis

Method	Description
ICPHYD	Arsenic, Total
ICPHYD	Selenium, Total
IN101	Air Particulate Mass
IN154	ALA
IN162	Alkalinity (as CaCO3)
IN166	Ammonia-Nitrogen
IN171	Ash %
IN241	BOD (__Add.Rd. @$5 ea.)
IN266	Heating Value (BTU/lb.)
IN291	Bulk Density/Sieve
IN316	Chloride, Total Inorgani
IN368	Chlorine, Total
IN375	CHN (% w/w)
IN380	Cyanide, Total
IN421	Density (g/ml)
IN423	Density (g/ml)
IN425	Density (g/g)
IN526	Formaldehyde (ppm at 25C
IN528	Formaldehyde (ppm at 25C
IN530	Formaldehyde (mg/Kg)
IN532	Formaldehyde(Qualitative
IN558	ICP Semi-Quantitat. Scan
IN584	Inorganic Carbon in Soil
IN585	Inorganic Carbon in Wate
IN610	IR Scan
IN623	% Solids
IN625	Moisture/Ash
IN630	Moisture/Ash Woodchips
IN633	Nitrate-Nitrite Nitrogen
IN634	Nitrite-Nitrogen
IN636	Odor (Qualitative)
IN661	Oil/Grease
IN662	Oil/Grease (mg/Kg)
IN670	Petroleum Hydrocarbons
IN688	pH (std. units)
IN701	Phosphorus, Total
IN703	Reactivity
IN703	Reactive Cyanide
IN703	Reactivity Description
IN703	Reactive Sulfide
IN708	Phosphate, Total as P
IN714	Strontium
IN780	Total Kjeldahl Nitrogen
IN847	Total Organic Carbon
IN849	Total Organic Carbon
IN899	Total Organic Halide
IN951	Water (%) by Karl Fische

FINAL DRAFT

G - Aquatec Organic Analysis

Method	Description
OR101	Acetic Acid
OR127	Low Molec. Wgt. Alcohols
OR128	Low Molec. Wgt. Alcohols
OR154	Low Molec. Wgt. Amines
OR155	Low Molec. Wgt. Amines
OR180	Aromatics in Gasoline
OR207	B.T.E.X. (ug/l)
OR208	B.T.E.X. (ug/Kg)
OR209	B.T.E.X. &Hydrocar.(ug/l
OR210	B.T.E.X. & Hydrocarbons
OR211	Halogenated Org.Air Tube
OR212	B.T.E.X. in Air Tubes
OR260	Chlorinated Hydrocarbons
OR313	Ethylene Glycol
OR366	Fuel Oil Fingerprint
OR370	Volatile Hydrocarbons
OR372	Volatile Hydrocarbons
OR445	IPA/Acetone
OR472	NMP/Butyl Acetate-Water
OR499	Naphthalene (ug/l)
OR524	PCB's in Sludge
OR526	PCB's in Oil (ppm)
OR530	PCB Congeners in Water
OR531	PCB Congeners in Soil
OR532	PCB Congeners in Tissue
OR533	PCB Congeners in Waste
OR554	Perchloroethylene (ug/l)
OR580	Polynuclear Aromatics
OR606	Pyridine Compounds
OR607	Pyridine Compounds
OR620	GC Solvent Scan 2 (%v/v)
OR633	BNA Screen in Water
OR634	BNA Screen in Other
OR635	Pesticide Screen in Water
OR636	Pesticide Screen in Other
OR638	VOA Screen in Water
OR639	VOA Screen in Other
OR739	VOC(7-Hall/PID) in Water
OR741	VOC (6-Hall/PID) in Water
OR745	GC Solvent Scan 1 (%v/v)
OR792	Air Monitoring Groups
OR938	624 Modified Soil
OR951	Added Compound GC/MS

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APPENDIX C

Certifications

VERMONT DEPARTMENT OF HEALTH
LABORATORY CERTIFICATION
DRINKING WATER

FINAL DRAFT

Laboratory: Aquatec, Inc.

Address: 75 Green Mt. Dr.
So. Burlington, Vt. 05403

Site Visit Date: 6/7/90

Site Visit Team: Harold Stowe
Joseph Ceresa

Enclosed is the report of our inspection of your laboratory. Based upon this report and on proficiency tests, your lab is certified for the chemical analysis of drinking water for:

X Inorganics: Residual Chlorine Nitrate Fluoride
Turbidity Nitrite

X Metals: Arsenic Copper Mercury
Barium Chromium Selenium
Cadmium Lead Silver

Volatile Organic Compounds
X THM: Chloroform BromodiChloroMethane diBromoChloroMethane
X Regulated VOC's: Vinyl Chloride CarbontetraChloride
Benzene 12-diChloroEthane triCHloroEthylene
111-triChloroEthane 11-diChloroEthylene p-diChloroBenzene
X EPA List 1 VOC's: ChloroBenzene EthylBenzene
Toluene cis/trns-12-diChloroEthylene 12-diChloropropane
Styrene cis/trns-13-diChloroPropylene *22-diChloropropane
o-diChloroBenzene tetraChloroEthylene *112-triChloroEthane
m-diChloroBenzene *13-diChloroPropane *11-diChloroPropylene
11-diChloroEthane *1122-tetraChloroEthane *diBromoMethane
o-Xylene *1112-tetraChloroEthane *BromoMethane
m-Xylene *o-ChloroToluene *diChloroMethane
p-Xylene *p-ChloroToluene *BromoBenzene
*Chlorothane *ChloroMethane *123-triChloroPropane
X *Compounds certified for identification only.

X Pesticides: Endrin Methoxychlor Chlordane Toxaphene
X Herbicides 24-D 245-TP

X Full Certification
---- Provisional, pending completion of recommended changes in procedure.
---- Interim, pending on site confirmation of completed changes.

This Certification Expires: 7/31/91

Harold Stowe, Certification Officer

6/25/90
Date

AquaCertC90 6/25/90 WP XI

FINAL DRAFT

John R. McKernan, Jr.
Governor

Rollin Ives
Commissioner

STATE OF MAINE
DEPARTMENT OF HUMAN SERVICES
AUGUSTA, MAINE 04333

PUBLIC HEALTH LABORATORY
221 State Street
Augusta, Maine 04333
Telephone (207) 289-2727

CERTIFICATION BY RECIPROCITY

AQUATEC, INC.
75 GREEN MOUNTAIN DRIVE
SOUTH BURLINGTON, VT. 05403

Is certified by reciprocity for all regulated organic and inorganic Chemical Primary Drinking Water Standards listed on the drinking water certificate issued by the State of VERMONT for drinking water samples originating in the State of Maine.

Certification by reciprocity does not apply to microbiological contaminants.

This certificate is valid for one year from date of issue provided it is attached to a copy of a current valid VERMONT drinking water certificate issued under the provisions of the Safe Drinking Water Act.

Date of Issue October 25, 1989

Michael C. Sodano

Michael C. Sodano
Laboratory Certification Officer
Laboratory Improvement Program
Public Health Laboratory

MCS/rpk

FINAL DRAFT

The State of New Hampshire
Department of Environmental Services

CERTIFICATE OF APPROVAL
Drinking Water Analysis

Under the provisions of the Regulations in WS 306, as adopted under RSA 148 - B, the Department of Environmental Services hereby issues a certificate to Aquatec, Inc.

Located at 75 Green Mountain Drive *in* S. Burlington, VT

for the following analyses of:

FULL CERTIFICATION: Antimony, Arsenic, Barium, Berullium, Cadmium, Cheomium, Copper, Lead, Mercury, Nickel, Selenium, Silver, Nitrate-N, Nitrite-N, Fluoride, Insecticides, 2,4-D, Silvex, Trihalomethanes, Volatile Organics, Total Filterable Residue, pH, Turbidity, Alkalinity, Corrosivity, Sodium, Calcium, Total Cyanide, Total Coliform by Membrane Filtration, Total Coliform by MPN

PROVISIONAL CERTIFICATION: Thallium

The names of the laboratory personnel to whom this Certificate is issued are: Neal VanWyck, J. Comeau, G. Stidsen, D. Hardwick, J. Orsini, P. Downey, C. Dumas, K. Young, R.M. McNeer, J. Edwin, M. Roy and K. Watson

CERTIFICATE NUMBER 200690-B

DATE OF ISSUE December 19, 1990

EXPIRATION DATE December 18, 1991

Charles

Certifying Officer

FINAL DRAFT

The State of New Hampshire
Department of Environmental Services

CERTIFICATE OF APPROVAL
Wastewater Analysis

Under the provisions of the Regulations in WS 306. as adopted under RSA 148 - B. the Department of Environmental Services hereby issues a certificate to Aquatec Inc.

Located at 75 Green Mountain Drive *in* So. Burlington, VT

for the following analyses of:

FULL CERTIFICATION: Aluminum, Arsenic, Beryllium, Cadmium, Cobalt, Chromium, Copper, Iron, Mercury, Manganese, Nickel, Lead, Selenium, Vanadium, Zinc, Antimony, Silver, Thallium, Titanium, Molybdenum, Strontium, pH, TDS, Total Hardness, Calcium, Magnesium, Sodium, Potassium, Total Alkalinity, Chloride, Fluoride, Sulfate, Ammonia-N, Nitrate-N, Orthophosphate, TKN, Total Phosphorus, COD, BOD, TOC, Total Cyanide, Oil & Grease, Non-Filterable Residue, Total Phenolics Total Residual Chlorine, Specific Conductance, PCBs in Water, PCBs in Oil, Pesticides and Volatile Organics

PROVISIONAL CERTIFICATION: NONE

The names of the laboratory personnel to whom this Certificate is issued are: Neal VanWyck, J. Comeau, G. Stidsen, D. Hardwick, J. Orsini, P. Downey, C. Dumas, K. Young, R.M. McNeer, J. Edwin, M. Roy and K. Watson

CERTIFICATE NUMBER 200690-B

DATE OF ISSUE December 19, 1990

EXPIRATION DATE December 18, 1991

Charles N.
Certifying Officer

PROPERTY OF

NEW YORK STATE DEPARTMENT OF HEALTH

DAVID AXELROD, M.D. *COMMISSIONER*

Expires 12:01 AM April 1, 1991
ISSUED April 1, 1990
REVISED August 11, 1990

INTERIM CERTIFICATE OF APPROVAL FOR LABORATORY SERVICE

(Issued in accordance with the Laws of New York State)
pursuant to Section 502 of the Public Health Law

Laboratory ID. Number 10391

Director: Dr. Joseph Comeau

Laboratory Name: Aquatec Inc.
Number & Street: 75 Green Mountain Drive
City,State,Zip : S. Burlington VT 05403
VALID AT THIS ADDRESS ONLY

is hereby APPROVED as an Environmental Laboratory for the category

ENVIRONMENTAL ANALYSES/SOLID AND HAZARDOUS WASTE

All approved subcategories and/or analytes are listed below:

- Characteristic Testing :
    - Corrosivity
    - Ignitability
    - Reactivity
    - Toxicity
- Metals II (ALL)
- Polynuclear Aromatic Hydrocarbons (ALL)
- Phthalate Esters (ALL)
- Purgeable Aromatics (ALL)
- Volatile Chlorinate Organics (ALL)
- Miscellaneous :
    - Cyanide, Total
    - Hydrogen Ion (pH)
    - Sulfide (as S)
- Haloethers (ALL)
- Nitroaromatics Isophorone (ALL)
- Polychlorinated Biphenyls (ALL)
- Priority Pollutant Phenols (ALL)
- Purgeable Halocarbons (ALL)
- Acrolein and Acrylonitrile (ALL)
- Chlorophenoxy Acid Pesticides (ALL)
- Chlorinated Hydrocarbon Pesticides (ALL)
- Chlorinated Hydrocarbons (ALL)
- Metals I (ALL)
- Organophosphate Pesticides (ALL)

Herbert W. Dick

Herbert W. Dickerman, M.D., Ph.D.
Director
Wadsworth Center for Laboratories and Research

FINAL

FORM LR 23.F

7060

PROPERTY OF

NEW YORK STATE DEPARTMENT OF HEALTH

DAVID AXELROD, M.D. *COMMISSIONER*

FINAL DRAFT

Expires 12:01 AM April 1, 1991
ISSUED April 1, 1990
REVISED August 11, 1990

INTERIM CERTIFICATE OF APPROVAL FOR LABORATORY SERVICE

(Issued in accordance with the Laws of New York State)
pursuant to Section 502 of the Public Health Law

Laboratory ID. Number 10391

Director: Dr. Joseph Comeau

Laboratory Name: Aquatec Inc.
Number & Street: 75 Green Mountain Drive
City,State,Zip : S. Burlington VT 05403
VALID AT THIS ADDRESS ONLY

is hereby APPROVED as an Environmental Laboratory for the category

ENVIRONMENTAL ANALYSES/AIR AND EMISSIONS

All approved subcategories and/or analytes are listed below:

- Chlorinated Hydrocarbon Pesticides (ALL)
- Fuels (ALL)
- Metals I (ALL)
- Polynuclear Aromatics (ALL)
- Polychlorinated Biphenyls (ALL)
- Purgeable Aromatics (ALL)
- Purgeable Halocarbons (ALL)

Herbert W. Dickerman, M.D., Ph.D.
Director
Wadsworth Center for Laboratories and Research

FOR 23.F

7059

PROP' ' OF

NEW YORK STATE DEPARTMENT OF HEALTH

DAVID AXELROD, M.D. *COMMISSIONER*

Expires 12:01 AM April 1, 1991
ISSUED April 1, 1990
REVISED August 11, 1990

INTERIM CERTIFICATE OF APPROVAL FOR LABORATORY SERVICE

(Issued in accordance with the Laws of New York State)

pursuant to Section 502 of the Public Health Law

Laboratory ID. Number 10391

Director: Dr. Joseph Comeau

Laboratory Name: Aquatec Inc.
Number & Street: 75 Green Mountain Drive
City,State,Zip : S. Burlington VT 05403

VALID AT THIS ADDRESS ONLY

is hereby APPROVED as an Environmental Laboratory for the category

POTABLE WATER NON-POTABLE WATER

All approved subcategories and analytes are listed on the attached addendum

Herbert W. Dicke

Herbert W. Dickerman, M.D., Ph.D.
Director
Wadsworth Center for Laboratories and Research

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FORM LR 23.F

FINAL DRAFT

Potable Water

Drinking Water Bacteriology

Coliform, Total
Standard Plate Count

Drinking Water Pesticide/Herbicides

2,4-D
Endrin
Lindane
Methoxychlor
2,4,5-TP (Silvex)
Toxaphene

Drinking Water Volatile Aromatics

Benzene
Bromobenzene
n-Butylbenzene
sec-Butylbenzene
tert-Butylbenzene
Chlorobenzene
2-Chlorotoluene
4-Chlorotoluene
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
Ethyl benzene
Hexachlorobutadiene
Isopropylbenzene
p-Isopropyltoluene (P-Cymene)
n-Propylbenzene
Styrene
Toluene
1,2,3-Trichlorobenzene
1,2,4-Trichlorobenzene
1,2,4-Trimethylbenzene
1,3,5-Trimethylbenzene
m-Xylene
o-Xylene
p-Xylene

Drinking Water Metals

Arsenic, Total
Barium, Total
Cadmium, Total
Chromium, Total
Copper, Total
Iron, Total
Lead, Total
Mercury, Total
Manganese, Total
Selenium, Total
Silver, Total
Sodium, Total
Zinc, Total

Drinking Water Trihalomethanes

Bromodichloromethane
Bromoform
Dibromochloromethane
Chloroform

Drinking Water Microextractables

1,2-Dibromoethane
1,2-Dibromo-3-chloropropane

Drinking Water Non-Metals

Alkalinity
Chloride
Color
Corrosivity
Fluoride, Total
Calcium Hardness
Hydrogen Ion (pH)
Nitrate (as N)
Solids, Total Dissolved
Sulfate (as SO4)

Drinking Water Volatile Halocarbons

Bromochloromethane
Bromomethane
Carbon tetrachloride
Chloroethane
Chloromethane
Dibromomethane
Dichlorodifluoromethane
1,1-Dichloroethane
1,2-Dichloroethane
1,1-Dichloroethene
cis-1,2-Dichloroethene
trans-1,2-Dichloroethene
1,2-Dichloropropane
1,3-Dichloropropane
2,2-Dichloropropane
1,1-Dichloropropene
cis-1,3-Dichloropropene
trans-1,3-Dichloropropene
methylene chloride
1,1,1,2-Tetrachloroethane
1,1,2,2-Tetrachloroethane
Tetrachloroethene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethene
Trichlorofluoromethane
1,2,3-Trichloropropane
Vinyl chloride

Non - Potable Water

FINAL DRAFT

d

Biochemical Oxygen Demand
Chemical Oxygen Demand

Mineral

Acidity
Alkalinity
Chloride
Fluoride, Total
Calcium Hardness
Hardness, Total
Sulfate (as SO4)

Wastewater Metals II

Aluminum, Total
Antimony, Total
Arsenic, Total
Beryllium, Total
Chromium VI
Mercury, Total
Selenium, Total
Vanadium, Total
Zinc, Total

Benzidines

Benzidine
3,3-Dichlorobenzidine

Haloethers

Bis(2-chloroethyl)ether
Bis (2-chloroisopropyl) ether
Bis(2-chloroethoxy)methane
4-Chlorophenylphenyl ether
4-Bromophenylphenyl ether

Phthalate Esters

Benzyl butyl phthalate
Bis(2-ethylhexyl) phthalate
Diethyl phthalate
Dimethyl phthalate
Di-n-butyl phthalate
Di-n-octyl phthalate

Residue

Solids, Total Dissolved
Solids, Total Suspended
Solids, Total

Nutrient

Ammonia (as N)
Kjeldahl Nitrogen, Total
Nitrate (as N)
Nitrite (as N)
Orthophosphate (as P)
Phosphorus, Total

Wastewater Metals III

Cobalt, Total
Gold, Total
Molybdenum, Total
Palladium, Total
Platinum, Total
Tin, Total
Thallium, Total
Titanium, Total

Chlorinated Hydrocarbons

2-Chloronaphthalene
Hexachlorobenzene
Hexachlorobutadiene
Hexachloroethane
Hexachlorocyclopentadiene
1,2,4-Trichlorobenzene

Nitroaromatics and Isophorone

2,4-Dinitrotoluene
2,6-Dinitrotoluene
Isophorone
Nitrobenzene

Wastewater Bacteriology

Coliform, fecal
Standard Plate Count
Coliform, Total

Wastewater Metals I

Barium, Total
Cadmium, Total
Calcium, Total
Chromium, Total
Copper, Total
Iron, Total
Lead, Total
Magnesium, Total
Manganese, Total
Nickel, Total
Potassium, Total
Silver, Total
Sodium, Total

Acrolein and Acrylonitrile

Acrolein
Acrylonitrile

Dioxins

2,3,7,8-Tetrachlorodibenzo-p-dioxin

Nitrosoamines

N-Nitrosodimethylamine
N-Nitrosodiphenylamine
N-Nitrosodi-n-propylamine

Polychlorinated Biphenyls

PCB-1016
PCB-1221
PCB-1232
PCB-1242
PCB-1248
PCB-1254
PCB-1260

FINAL DRAFT

Non - Potable Water

Polynuclear Aromatics

Acenaphthene
Anthracene
Acenaphthylene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(ghi)perylene
Benzo(k)fluoranthene
Chrysene
Dibenzo(a,h)anthracene
Fluoranthene
Fluorene
Indeno(1,2,3-cd)pyrene
Naphthalene
Phenanthrene
Pyrene

Purgeable Halocarbons

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

Priority Pollutant Phenols

4-Chloro-3-methylphenol
2-Chlorophenol
2,4-Dichlorophenol
2,4-Dimethylphenol
2,4-Dinitrophenol
2-Methyl-4,6-dinitrophenol
2-Nitrophenol
4-Nitrophenol
Pentachlorophenol
Phenol
2,4,6-Trichlorophenol

Chlorinated Hydrocarbon Pesticides

Aldrin
alpha-BHC
beta-BHC
delta-BHC
Lindane
Chlordane Total
4,4'-DDD
4,4'-DDE
4,4'-DDT
Dieldrin
Endosulfan I
Endosulfan II
Endosulfan sulfate
Endrin
Endrin aldehyde
Heptachlor
Heptachlor epoxide
Methoxychlor
Toxaphene

Organophosphate Pesticides

Azinphos methyl
Diazinon
Disulfoton
Demeton-O
Demeton-S
Malathion
Parathion ethyl
Parathion methyl

Purgeable Aromatics

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

Chlorophenoxy Acid Pesticides

Dicamba
2,4-D
2,4,5-T
2,4,5-TP (Silvex)

Volatile Chlorinated Organics

Benzyl chloride
Epichlorohydrin

Wastewater Miscellaneous Analytes

Boron, Total
Cyanide, Total
Phenols
Oil & Grease Total Recoverable
Specific Conductance
Surfactant (MBAS)
Silica, Dissolved
Color
Corrosivity
Bromide
Organic Carbon, Total
Sulfide (as S)
Hydrogen Ion (pH)
Temperature

FINAL DRAFT

The Commonwealth of Massachusetts
Department Of Environmental Quality Engineering
Lawrence Experiment Station
37 Shattuck Street, Lawrence, Massachusetts 01843

CERTIFICATION FOR ENVIRONMENTAL ANALYSIS

LABORATORY: VT008
Aquatec
75 Green Mountain Drive
South Burlington, VT 05403

DATE: 01/01/91

EXPIRATION DATE: 12/31/91

DIRECTOR: Dr. Joseph Comeau
802-658-1074

PRIMARY CATEGORIES (DRINKING WATERS)

FULL CERTIFICATION: Trace Metals, Nitrate, Fluoride, Pesticides, Herbicides, Trihalomethanes, Corrosivity Series, Sodium, Cyanide

PROVISIONAL CERTIFICATION: Volatile Organics

SECONDARY CATEGORIES (OTHER MATRICES)

FULL CERTIFICATION: Metals, Minerals, Nutrients, Demand, PCBs, Pesticides, Volatile Halocarbons, Volatile Aromatics, Cyanide, Oil & Grease, Phenolics

PROVISIONAL CERTIFICATION: None at Present

This certificate supercedes all previous certificates issued to this laboratory. Reporting of analyses other than those authorized above shall be cause for revocation of certification.

Original Certificate, not copies, must be displayed in a prominent place at all times. Certification subject to approval by OGC.

DEQE
NOW IS
THE DEPARTMENT OF
ENVIRONMENTAL PROTECTION

John E. Delaney
John E. Delaney, Ph.D., Director,
Division of Environmental Analysis

FINAL DRAFT

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

DEPARTMENT OF THE ARMY
MISSOURI RIVER DIVISION, CORPS OF ENGINEERS
P.O. BOX 103, DOWNTOWN STATION
OMAHA, NEBRASKA 68101-0103

REPLY TO
ATTENTION OF

July 25, 1989

Geotechnical, Chemistry &
Materials Branch

Aquatec, Inc.
75 Green Mountain Drive
South Burlington, VT 05403

Gentlemen:

Your laboratory has been evaluated by the U. S. Army Corps of Engineers for multiple-media sample analysis of Volatile and Semivolatile Organics, Organochlorine Pesticides, PCBs, Chlorinated Herbicides, Polynuclear Aromatic Hydrocarbons, RCRA Metals, Phenols, Total Organic Carbon, Cyanide and Total Recoverable Petroleum Hydrocarbons. Enclosed for your information is a copy of the Laboratory Inspection Report.

The period of validation is eighteen (18) months from the date of this letter. During the eighteen month period, the Corps of Engineers reserves the right to conduct additional laboratory auditing and/or to suspend validation status if deemed necessary. This lab validation does not guarantee the award of any contracts from a Corps of Engineers Contracting Officer. If you have any questions or comments, please contact Mr. C. R. Mao at (402) 221-7494.

Sincerely,

William P. Todsen, P.E.
Chief, Engineering Division

Enclosure

FINAL DRAFT

CEMRD-ED-GC (200)

17 July 1989

MEMORANDUM THRU

CEMRD-ED-GC

CEMRD-ED-G TWS

CEMRD-ED

FOR FILES (CEMRD-ED-GC)

SUBJECT: Laboratory Inspection and Evaluation - Aquatec Inc., Burlington, VT - 28 June 1989

1. General:

a. Date of inspection: 28 June 1989.

b. Contract for which laboratory will be used:

North Pacific Division Laboratory General QA

c. Description of contract: Chemical analysis of metals, volatile organics, semi-volatile organics, pesticides, PCB's and TRPH in water, sediment and soil samples; cyanide, TOC, phenols, PAH and herbicides in water.

d. General information on laboratory inspected:

Business Name: Aquatec, Inc.

Street Address: 75 Green Mountain Drive.

City and State: South Burlington, VT 05403

Phone: (802) 658-1074

Number employed: 60; about two thirds classified as chemists.

Additional information: Aquatec corporate offices and laboratory are at the one location, which also provides boats, sampling crews and full sampling capabilities. They were among the first eighteen EPA CLP laboratories and have remained a CLP lab ever since. Aquatec holds certifications from New Hampshire, Maine, New York and Massachusetts. The average sample turnaround time in the lab is two weeks. The building contains 22,300 square feet, 3,500 of which are devoted to analytical activities.

FINAL DRAFT

2. Summary of Inspection Results:

a. The audit sample results from Aquatec were outstanding. They were the most responsive of labs recently worked with, and submitted one of the best data packages we have received. They analyzed the samples with a high degree of accuracy, experiencing minor problems with only one parameter, TRPH.

b. The laboratory has a large number of qualified personnel, has adequate instrumentation, and an average sample turnaround time of two weeks. This should allow them to support most, if not all, USACE contracts.

c. Aquatec was inspected by Marcia Davies of CEMRD-ED-GC. The detailed results are addressed below and an inspection check list is available upon request.

3. Interviews:

a. George W. Starbuck, President, Joseph Comeau, Chemistry Laboratory Director, Martha Roy, Contract Project Manager, and Karen Chirgwin, Quality Assurance Office were present during the Entrance Interview. Topics discussed were Aquatec's corporate policies and experience in the HTW fields, the USACE QA Program, and audit sample results.

b. At the conclusion of the inspection an exit interview was held with Joseph Comeau, Martha Roy and Karen Chirgwin. The latter two persons accompanied the inspector to lead the lab tour and answer questions. The TRPH problem was discussed at this time, but no conclusions could be drawn. The lab was asked to communicate further with C.R. Mao and/or Prem Arora of CEMRD.

4. Conclusions:

a. A full set of performance audit samples was successfully analyzed by the laboratory on the first attempt and a very complete data set sent for evaluation.

b. The laboratory's Quality Assurance Program Plan was reviewed and found to contain the information required and a sample SOP notebook was quickly surveyed by the inspector. Each analytical department maintains its own set of SOP's.

c. Aquatec has a corporate emphasis on quality control/quality assurance and has build up a well trained group to do data analysis and assessment. Internal quality control practices are ratable as excellent.

FINAL DRAFT

d. A corporate maintenance department is staffed with technicians who have been factory trained in the repair and upkeep of all the major instruments in the lab as well as the water purification/delivery systems, air handling, and refrigerators. The temperature in the refrigerators is computer monitored with an alarm system for unacceptable excursions.

e. No major or minor deficiencies which would adversely affect the ability of the lab to conduct the required analyses were noted.

5. Summary:

This is an outstanding laboratory with very complete capabilities. They do not subcontract samples to other labs. They have excellent facilities and staff and a very good sample turnaround. There are responsive and eager to work in a problem solving mode as well as on routine samples, and have good capabilities for doing so.

Marcia C Davies
MARCIA C. DAVIES
Chief, HTW Chemistry Review Section

FINAL DRAFT

METHOD 8330

NITROAROMATICS AND NITRAMINES BY HIGH PERFORMANCE LIQUID CHROMATOGRAPHY (HPLC)

This method is intended for the analysis of explosives residues. This Method is limited to use by analysts experienced in handling and analyzing explosive residues.

1.0 SCOPE AND APPLICATION

1.1 Method 8330 is used to determine the concentration of the following compounds in a water, soil or sediment matrix:

Compounds	Abbrev.	CAS No.[a]
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine	HMX	2691-41-0
Hexahydro-1,3,5-trinitro-1,3,5-triazine	RDX	121-82-4
1,3,5-Trinitrobenzene	1,3,5-TNB	99-35-4
1,3-Dinitrobenzene	1,3-DNB	99-65-0
Methyl-2,4,6-trinitrophenylnitramine	Tetryl	479-45-8
Nitrobenzene	NB	98-95-3
2,4,6-Trinitrotoluene	2,4,6-TNT	118-96-7
4-Amino-2,6-dinitrotoluene	4-Am-DNT	1946-51-0
2-Amino-4,6-dinitrotoluene	2-Am-DNT	355-72-78-2
2,6-Dinitrotoluene	2,6-DNT	606-20-2
2,4-Dinitrotoluene	2,4-DNT	121-14-2
2-Nitrotoluene	2-NT	88-72-2
4-Nitrotoluene	4-NT	99-99-0
3-Nitrotoluene	3-NT	99-08-1

[a] Chemical Abstracts Service Registry number

1.2 Method 8330 provides a salting-out extraction procedure for low concentration (parts per trillion or nanograms per liter) of explosives residues in surface or ground water. Direct injection of diluted and filtered water samples can be used for water samples of higher concentration (See Table 1).

1.3 All of these compounds are either used in the manufacture of explosives or are the degradation products of

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compounds used for that purpose. When making stock solutions for calibration, treat each compound as if it were extremely explosive.

1.4 The practical quantitation limits (PQLs) of target analytes determined by Method 8330 in water and soil are presented in Table 1.

1.5 This method is restricted to use by or under the supervision of analysts experienced in the use of HPLC, skilled in the interpretation of chromatograms, and experienced in handling explosive materials. Each analyst must demonstrate the ability to generate acceptable results with this method.

2.0 SUMMARY OF METHOD

2.1 Method 8330 provides high performance liquid chromatographic (HPLC) conditions for the detection of ppb levels of certain explosives residues in water, soil and sediment matrix. Prior to use of this method, appropriate sample preparation techniques must be used.

2.2 Low-Level Salting-out Method: Aqueous samples of low concentration are concentrated by a salting-out extraction procedure with acetonitrile and sodium chloride. The acetonitrile extract is further concentrated to less than 1.0 mL using a Kuderna-Danish evaporator and brought to 1.0 mL using acetonitrile. The concentrated extract is diluted with 3.0 mL of reagent grade water, filtered, separated on a C-18 reverse phase column, determined at 254 nm, and confirmed on a CN reverse phase column.

2.3 High-Level Direct Injection Method: Aqueous samples of higher concentration can be diluted 1/1 (v/v) with methanol or acetonitrile, filtered, separated on a C-18 reverse phase column, determined at 254 nm, and confirmed on a CN reverse phase column. If HMX is an important target analyte, methanol is preferred.

2.4 Soil and sediment samples are extracted using acetonitrile in an ultrasonic bath, filtered and chromatographed as in Section 2.3.

3.0 INTERFERENCES

3.1 Solvents, reagents, glassware and other sample processing hardware may yield discrete artifacts and/or elevated baselines, causing misinterpretation of the chromatograms. All of these materials must be demonstrated to be free from

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4.2.4 Water bath - Heated, with concentric ring cover, capable of temperature control (±5 °C). The bath should be used in a hood.

4.2.5 Balance - ± 0.1 mg.

4.3 Materials

4.3.1 High pressure injection syringe - 500 µL, (Hamilton liquid syringe or equivalent).

4.3.2 Disposable cartridge filters - 0.45 µm Teflon filter.

4.3.3 Pipettes - 50 mL, 10 mL, 5 mL, 4 mL, 2 mL, 1 mL, volumetric, Class A, glass.

4.3.4 Pasteur pipettes.

4.3.5 Scintillation Vials - 20 mL, glass.

4.3.6 Vials - 15 mL, glass, Teflon-lined cap.

4.3.7 Vials - 40 mL, glass, Teflon-lined cap.

4.3.8 Disposable syringes - Plastipak, 3 mL and 10 mL or equivalent.

4.3.9 Separatory funnel - 500 mL.

4.3.10 Volumetric flasks - 10 mL, 20 mL, 50 mL, 100 mL, 200 mL and 250 mL.

4.3.11 Vacuum desiccator - Glass.

4.3.12 Mortar and pestle - Steel.

4.3.13 Boiling chips - Solvent extracted, approximately 10/40 mesh (Teflon or equivalent).

4.3.14 Sieve - 30 mesh.

4.3.15 Oven - Forced air, without heating.

4.4 Preparation

4.4.1 Prepare all materials to be used as described in Chapter 4 for semivolatile organics.

interferences, under the conditions of the analysis, by running method blanks. Specific selection of reagents and purification of solvents by distillation in all-glass systems may be required.

3.1 2,4-DNT and 2,6-DNT elute at similar retention times (retention time difference of 0.2 minutes). A large concentration of one isomer may mask the response of the other isomer. If it is not apparent that both isomers are present (or are not detected), an isomeric mixture should be reported.

3.2 Tetryl decomposes rapidly in methanol/water solutions, as well as with heat. All aqueous samples expected to contain tetryl should be diluted with acetonitrile prior to filtration. All samples expected to contain tetryl should not be exposed to temperatures above room temperature.

3.3 Degradation products of tetryl appear as a shoulder on the 2,4,6-TNT peak. Peak heights rather than peak areas should be used when tetryl is present in concentrations that are significant relative to the concentration of 2,4,6-TNT.

4.0 APPARATUS AND MATERIALS

4.1 HPLC system

4.1.1 HPLC - equipped with a pump capable of achieving 4000 psi, a 100-µL loop injector and a 254-nm UV detector (Perkin Elmer Series 3 or equivalent).

4.1.2 C-18 Reverse phase HPLC column, 25-cm x 4.6-mm (5 µm), (Supelco LC-18 or equivalent).

4.1.3 CN Reverse phase HPLC column, 25-cm x 4.6-mm (5 µm), (Supelco LC-CN or equivalent).

4.1.4 Strip chart recorder.

4.1.5 Digital integrator (optional).

4.1.6 Autosampler (optional).

4.2 Other Equipment

4.2.1 Temperature controlled ultrasonic bath.

4.2.2 Vortex mixer.

4.2.3 Kuderna-Danish evaporator - 40 mL, micro Kuderna-Danish evaporator (Supelco #64718 or equivalent).

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5.0 REAGENTS

5.1 HPLC grade chemicals shall be used in all tests. It is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lowering the accuracy of the determination.

5.2 General

5.2.1 HMX - Standard Analytical Reference Material.

5.2.2 RDX - Standard Analytical Reference Material.

5.3.2 1,3-DNB - Standard Analytical Reference Material.

5.2.4 Tetryl - Standard Analytical Reference Material.

5.2.5 2,4,6-TNT - Standard Analytical Reference Material.

5.2.6 2-Am-DNT -

5.2.7 4-Am-DNT - Reagent grade (Aldrich Chemical or equivalent).

5.2.8 2,4-DNT - Standard Analytical Reference Material.

5.2.9 2,6-DNT - Standard Analytical Reference Material.

5.2.10 1,3,5-TNB - Standard Analytical Reference Material.

5.2.11 NB - Standard Analytical Reference Material.

5.2.12 2-NT - Reagent grade.

5.2.13 3-NT - Reagent grade.

5.2.14 4-NT - Reagent grade.

5.2.15 Reagent water - All references to water in this method refer to water in which an interference is not observed at the method detection limit of the compounds of interest. Reagent water can be generated by passing tap water through a carbon filter bed containing about 1 pound of activated carbon. A water purification system may be used to generate organic-free deionized water.

5.2.16 Acetonitrile - HPLC grade.

5.2.17 Methanol - HPLC grade, distilled in glass.

5.2.18 Sodium Chloride, NaCl - Reagent grade. If possible use NaCl from glass bottles. High background levels have been observed from NaCl shipped in plastic containers.

5.2.19 Calcium Chloride, $CaCl_2$ - Reagent grade. Prepare an aqueous solution of 5 g/L.

5.3 Stock Standard Solutions

5.3.1 Dry each analyte standard to constant weight in a vacuum desiccator in the dark. Place about 100 mg (weighed to the nearest 0.1 mg) of a single analyte into a 100-mL volumetric flask and dilute to volume with acetonitrile. Invert flask several times until dissolved. Store in refrigerator at 4°C in the dark. Calculate the concentration of the stock solution from the actual weight used (nominal concentration = 1,000 mg/L). Stock solutions may be used for up to one year.

5.4 Intermediate Standards Solutions

5.4.1 If both 2,4-DNT and 2,6-DNT are to be determined, prepare two separate intermediate stock solutions containing (1) HMX, RDX, 1,3,5-TNB, 1,3-DNB, NB, 2,4,6-TNT, 2,4-DNT and 2-Am-DNT and (2) tetryl, 2,6-DNT, 4-Am-DNT, 2-NT, 3-NT and 4-NT. Dilute the intermediate stock standard solutions to prepare two solutions at 1,000 µg/L in acetonitrile.

5.4.2 Dilute the two intermediate stock concentrate solutions with acetonitrile to prepare intermediate standard solutions that cover the range of 2.5 - 1,000 µg/L. These solutions should be refrigerated on preparation and stored in the dark, and may be used for 30 days.

5.4.3 For the low-level method, the analyst must conduct a detection limit study and devise dilution series appropriate to the desired range. Standards for the low level method must be prepared immediately prior to use.

5.5 Working Standards

5.5.1 Calibration standards at a minimum of five concentration levels should be prepared through dilution of the intermediate standards solutions by 50% (v/v) with 5 g/L calcium chloride solution (Section 5.2.19). These solutions

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must be refrigerated and stored in the dark, and prepared fresh on the day of calibration.

5.6 Surrogate Standards

5.6.1 The analyst should monitor the performance of the extraction and analytical system and the effectiveness of the method in dealing with each sample matrix by spiking each sample, standard and reagent water blank with one or two surrogates (e.g., analytes not expected to be present in the sample).

5.7 Eluent

5.7.1 To prepare 1 liter of eluent, add 500 mL of methanol to 500 mL of reagent water.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 Grab samples must be collected and stored in glass containers. Follow conventional sampling procedures.

6.2 Samples must be kept below 4°C and in the dark from the time of collection through analysis, except during drying.

6.3 Soil and sediment samples should be air dried to constant weight at room temperature or colder after collection.

6.4 All water samples must be extracted within 7 days of collection and analyzed within 40 days after extraction. All soil and sediment samples must be extracted within 14 days of collection and analyzed within 40 days after extraction.

7.0 PROCEDURE

7.1 Sample Preparation

7.1.1 Aqueous Samples: It is highly recommended that all samples of this type be screened with the high-level method (>50 µg/L) to determine if the low-level method (1-50 µg/L) is required.

7.1.1.1 Low-Level Method (salting-out extraction)

7.1.1.1.1 Place a 400 mL aliquot of water sample in a 500 mL separatory funnel and add 130 g of NaCl. Vigorously shake the sample until all of the NaCl is completely dissolved. Be sure to dissolve all salt before adding acetonitrile, or the dissolution process takes much longer.

7.1.1.1.2 Add a 100 mL volume of acetonitrile using a glass volumetric pipette. Shake the separatory funnel vigorously for 5 minutes. Allow the funnel to stand undisturbed for 30 minutes while the two phases separate. Discard the water (lower) layer and collect the acetonitrile (upper) layer (approximately 23 mL) in a 40 mL Teflon-capped vial. Rinse the separatory funnel with 5 mL of acetonitrile and add the rinsate to the extract.

7.1.1.1.3 If the collected sample was turbid, centrifuge the 40 mL vial at 4000 rpm's for 5 minutes. Remove the acetonitrile (upper) layer with a Pasteur pipette and transfer it to a clean vial.

7.1.1.1.4 Reduce the acetonitrile extract to less than 1.0 mL using a Kuderna-Danish evaporator and bring the total volume to 1.0 mL using acetonitrile. Dilute this concentrated extract with 3.0 mL of reagent water.

7.1.1.1.5 Filter the diluted extract through a 0.45-μm Teflon filter. Discard the first 0.5 mL of filtrate, and retain the remainder in a Teflon-capped vial for RP-HPLC analysis as in Section 7.4.

7.1.1.2 High-Level Method

7.1.1.2.1 Sample filtration: Place a 5 mL aliquot of each water sample in a scintillation vial, add 5 mL of acetonitrile, shake thoroughly, and filter through a 0.45-μm Teflon filter. Discard the first 3 mL of filtrate, and retain the remainder in a Teflon-capped vial for RP-HPLC analysis as in Section 7.4. HMX quantitation can be improved with the use of methanol rather than acetonitrile for dilution before filtration.

7.1.2 Soil and Sediment Samples

7.1.2.1 Sample homogenization: Dry soil samples in air at room temperature or colder, being careful not to expose the samples to direct sunlight. Grind and homogenize the dried sample thoroughly in an acetonitrile rinsed mortar to pass a 30 mesh sieve.

7.1.2.2 Sample extraction

7.1.2.2.1 Place a 2.0 g subsample of each soil sample in a 15 mL glass vial. Add 10.0 mL of acetonitrile, cap with Teflon-lined cap, vortex swirl for one minute, and place in an cooled ultrasonic bath for 18 hours.

7.1.2.2.2 After sonication, allow sample to settle for 30 minutes. Remove 5.0 mL of supernatant, and combine with 5.0 mL of calcium chloride solution (Section 5.2.19) in a 20 mL vial. Shake, and let stand for 15 minutes.

7.1.2.2.3 Place supernatant in a disposable syringe and filter through a 0.45-μm Teflon filter. Discard first 3 mL and retain remainder in a Teflon-capped vial for RP-HPLC analysis as in Section 7.4.

7.2 Chromatographic Conditions

Primary Column:	C-18 reverse phase HPLC column, 25-cm x 4.6-mm, 5 μm, (Supelco LC-18 or equivalent).
Secondary Column:	CN reverse phase HPLC column, 25-cm x 4.6-mm, 5 μm, (Supelco LC-CN or equivalent).
Mobile Phase:	50/50 (v/v) methanol/organic-free reagent water.
Flow Rate:	1.5 mL/min
Injection volume:	100-μL
UV Detector:	254 nm

7.3 Calibration of HPLC

7.3.1 All electronic equipment is allowed to warm up for 30 minutes. During this period, at least 15 void volumes of mobile phase are passed through the column (approximately 20 min at 1.5 mL/min) and continued until the baseline is level at the UV detector's greatest sensitivity.

7.3.2 Analyze working standards in triplicate, using the chromatographic conditions given in Section 7.2. Prepare calibration curve using peak heights or peak areas, as appropriate. The calibration curve should be linear with zero intercept.

7.3.3 Initial Calibration. Triplicate injections of each calibration standard over the concentration range of interest are sequentially injected into the HPLC in random order. Peak heights or peak areas are obtained for each analyte. Experience indicates that a linear calibration curve with zero intercept is appropriate for each analyte. Therefore, a response factor for each analyte can be taken as the slope of the best-fit regression line.

7.3.4 Daily Calibration. Analyze midpoint calibration standards, at a minimum, in triplicate at the beginning of the day, singly at the midpoint of the run and singly after the last sample of the day. Obtain the response factor for each analyte from the mean peak heights or peak areas and compare it with the response factor obtained for the initial calibration. The mean response factor for the daily calibration must agree within ±25% of the response factor of the initial calibration for the first seven daily calibrations and within two standard deviations of the initial calibration for subsequent calibrations. If this criterion is not met, a new initial calibration must be obtained.

7.4 HPLC Analysis

7.4.1 Analyze the samples using the chromatographic conditions given in Section 7.2. All positive measurements observed on the C-18 column must be confirmed by injection onto the CN column.

7.4.2 In limited applications (e.g., aqueous process wastes) direct injection of filtered and diluted sample into the HPLC system with a 100-μL loop may be appropriate. The quantitation limits are high, therefore, it is only permitted where concentrations in excess of 50 μg/L are expected.

7.4.3 Follow Section 7.6 in Method 8000 for instructions on the analysis sequence, appropriate dilutions, establishing daily retention time windows, and identification criteria. Include a mid-level standard after each group of 10 samples in the analysis sequence. If column temperature control is not employed, special care must be taken to ensure that temperature shifts do not cause peak misidentification.

7.4.4 Table 2 summarizes the estimated retention times on both C-18 and CN columns for a number of analytes analyzable using this method. An example of the separation achieved by Column 1 is shown in Figure 1.

7.4.5 Record the resulting peak sizes in peak heights or area units. The use of peak heights is recommended to improve reproducibility of low level samples.

7.4.6 Calculation of concentration is covered in Section 7.8 of Method 8000.

7.4.7 If analytical interferences are suspected, or for the purpose of confirmation, analysis using the second HPLC column is required.

8.0 QUALITY CONTROL

8.1 Prior to preparation of stock solutions, acetonitrile, methanol, and water blanks should be run to determine possible interferences with analyte peaks. If the acetonitrile, methanol, or water blanks show contamination, a different batch should be used.

8.2 Refer to Chapter One for specific quality control procedures. Quality control to validate sample extraction is covered in Method 3500.

8.3 Mandatory quality control to validate the HPLC system operation is found in Method 8000, Section 8.6.

8.4 The laboratory must, on an ongoing basis, analyze a method blank, a matrix spike, and a matrix spike duplicate/duplicate for each analytical batch (up to a maximum of 20 samples/batch) to assess accuracy. For laboratories analyzing one to ten samples per month, at least one spiked sample per month is required.

8.5 A minimum of one duplicate sample shall be run with each analytical batch. If the samples are generally non-detect samples, a matrix spike duplicate must be run with the analytical batch.

8.6 Method Blanks

8.6.1 Method blanks for the analysis of aqueous samples should be reagent water carried through all sample storage, preparation and handling procedures.

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8.6.2 Method blanks for the analysis of soil samples should be uncontaminated soil carried through all sample storage, extraction, and handling procedures.

9.0 METHOD PERFORMANCE

9.1 Method 8330 was tested by six laboratories. The results of this testing indicate that the results presented in Tables 3 through 5 are to be expected.

10.0 REFERENCES

1. Bauer, C.F., T.F. Jenkins, S.M. Koza, P.W. Schumacher, P.H. Miyares and M.E. Walsh (1989). Development of an analytical method for the determination of explosive residues in soil. Part 3. Collaborative test results and final performance evaluation. USA Cold Regions Research and Engineering Laboratory, CRREL Report 89-9.

2. Grant, C.L., A.D. Hewitt and T.F. Jenkins (1989) Comparison of low concentration measurement capability estimates in trace analysis: Method Detection Limits and Certified Reporting Limits. USA Cold Regions Research and Engineering Laboratory, Special Report 89-20

3. Jenkins, T.F., C.F. Bauer, D.C. Leggett and C.L. Grant (1984) Reversed-phase HPLC method for analysis of TNT, RDX, HMX and 2,4-DNT in munitions wastewater. USA Cold Regions Research and Engineering Laboratory, CRREL Report 84-29.

4. Jenkins, T.F. and M.E. Walsh (1987) Development of an analytical method for explosive residues in soil. USA Cold Regions Research and Engineering Laboratory, CRREL Report 87-7.

5. Jenkins, T.F., P.H. Miyares and M.E. Walsh (1988a) An improved RP-HPLC method for determining nitroaromatics and nitramines in water. USA Cold Regions Research and Engineering Laboratory, Special Report 88-23.

6. Jenkins, T.F., P.W. Schumacher, M.E. Walsh and C.F. Bauer (1988b) Development of an analytical method for the determination of explosive residues in soil. Part II: Further development and ruggedness testing. USA Cold Regions Research and Engineering Laboratory, CRREL Report 88-8.

7. Leggett, D.C., T.F. Jenkins and P.H. Miyares (1990) Salting-out solvent extraction for preconcentration of neutral

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polar organic solutes from water. Analytical Chemistry, 62: 1355-1356.

8. Miyares, P.H. and T.F. Jenkins (1990) Salting-out solvent extraction for determining low levels of nitroaromatics and nitramines in water. USA Cold Regions Research and Engineering Laboratory, Special Report 90-30.

11.0 SAFETY

11.1 Standard precautionary measures used for handling other organic compounds should be sufficient for safe handling of the analytes targeted by Method 8330.

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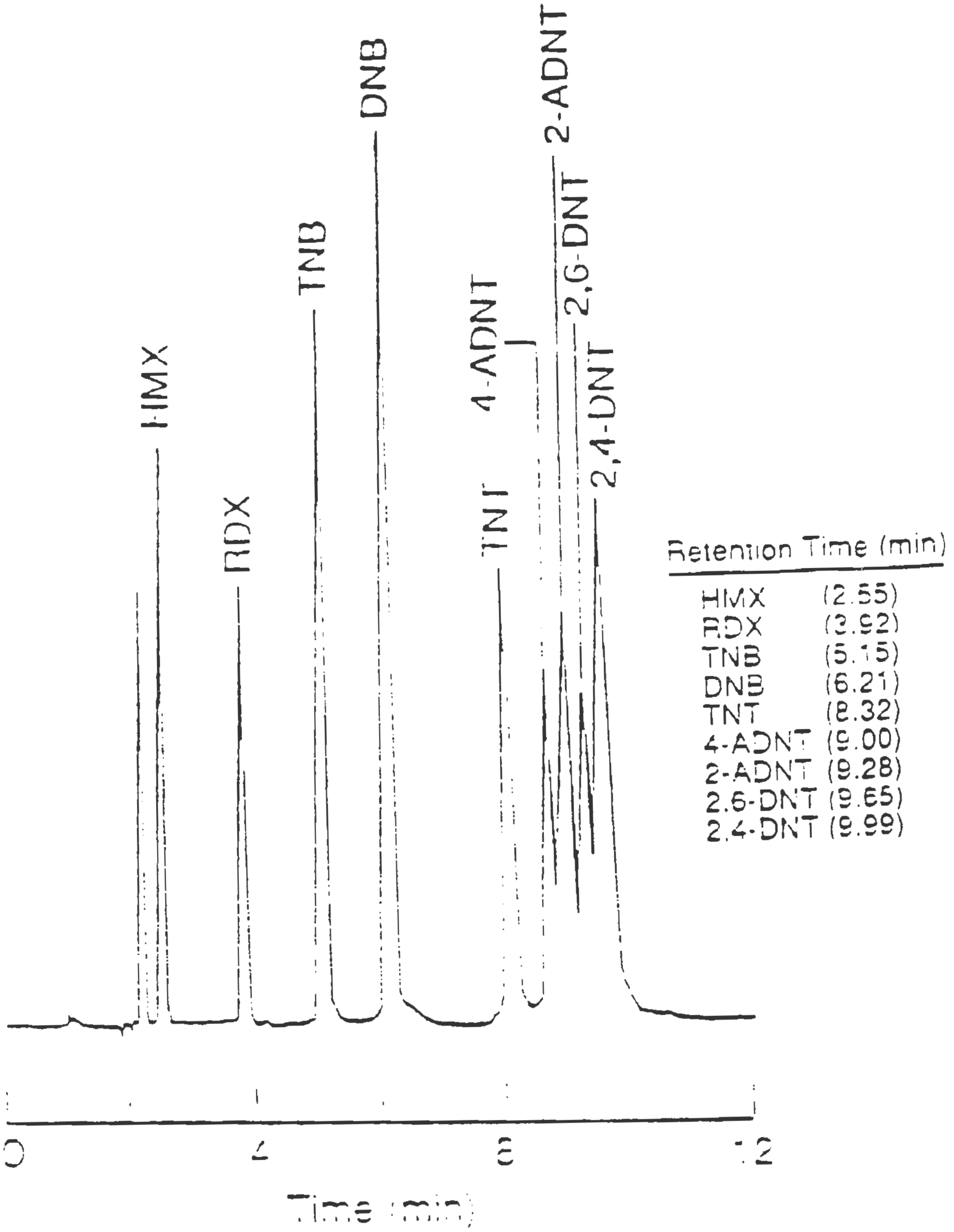
Column: C-18 (25 cm x 4.6 mm, 5 μm)
Mobile Phase: 1/1 (v/v) Methanol/Water, 1.5 mL/min
Detector: UV



Retention Time (min)	
HMX	(2.55)
RDX	(3.92)
TNB	(5.15)
DNB	(6.21)
TNT	(8.32)
4-ADNT	(9.00)
2-ADNT	(9.28)
2,6-DNT	(9.65)
2,4-DNT	(9.99)

Figure 1. Liquid Chromatogram of Explosives Residues.

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TABLE 1
PRACTICAL QUANTITATION LIMITS

Compounds	Water (µg/L) Low-Level	Water (µg/L) High-Level	Soil (µg/g)
HMX	-	13.0	2.2
RDX	0.836	14.0	1.0
1,3,5-TNB	0.258	7.3	0.25
1,3-DNB	0.108	4.0	0.25
Tetryl	-	4.0	0.65
NB	-	6.4	0.26
2,4,6-TNT	0.113	6.9	0.25
4-Am-DNT	0.0598	-	-
2-Am-DNT	0.0349	-	-
2,6-DNT	0.314	9.4	0.26
2,4-DNT	0.0205	5.7	0.25
2-NT	-	12.0	0.25
4-NT	-	8.5	0.25
3-NT	-	7.9	0.25

TABLE 2
RENTION TIMES FOR ANALYTES ON C-18 AND CN COLUMNS

C-18 Compounds	C-18 Retention Time (min)	CN Compounds	CN Retention Time (min)
HMX	2.4	NB	3.8
RDX	3.7	1,3,5-TNB	4.1
1,3,5-TNB	5.1	1,3-DNB	4.2
1,3-DNB	6.2	2-NT	4.4
Tetryl	6.9	4-NT	4.4
NB	7.2	3-NT	4.5
2,4,6-TNT	8.4	2,6-DNT	4.6
2,6-DNT	9.8	2,4-DNT	4.9
2,4-DNT	10.1	2,4,6-TNT	5.0
2-NT	12.3	RDX	6.2
4-NT	13.3	Tetryl	7.4
3-NT	14.2	HMX	8.4

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TABLE 3
INTRALABORATORY PRECISION OF METHOD FOR SOIL SAMPLES

	Spiked Soils			Field-Contaminated Soils		
	Mean Conc. (μg/g)	SD	%rsd	Mean Conc. (μg/g)	SD	%rsd
HMX	46	1.7	3.7	14	1.8	12.8
				153	21.6	14.1
RDX	60	1.4	2.3	104	12	11.5
				877	29.6	3.4
1,3,5-TNB	8.6	0.4	4.6	2.8	0.2	7.1
	46	1.9	4.1	72	6.0	8.3
1,3-DNB	3.5	0.14	4.0	1.1	0.11	9.8
Tetryl	17	3.1	17.9	2.3	0.41	18.0
TNT	40	1.4	3.5	7.0	0.61	9.0
				669	55	8.2
2,4-DNT	5.0	0.17	3.4	1.0	0.44	42.3

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TABLE 4
INTRALABORATORY ERROR OF METHOD FOR SOIL SAMPLES

	Spiked Soils			Field-Contaminated Soils		
	Mean Conc. (µg/g)	SD	%rsd	Mean Conc. (µg/g)	SD	%rsd
HMX	46	2.6	5.7	14	3.7	26.0
				153	37.3	24.0
RDX	60	2.6	4.4	104	17.4	17.0
				877	67.3	7.7
1,3,5-TNB	8.6	0.61	7.1	2.8	0.23	8.2
	46	2.97	6.5	72	8.8	12.2
1,3-DNB	3.5	0.24	6.9	1.1	0.16	14.5
Tetryl	17	5.22	30.7	2.3	0.49	21.3
TNT	40	1.88	4.7	7.0	1.27	18.0
				669	63.4	9.5
2,4-DNT	5.0	0.22	4.4	1.0	0.74	74.0

TABLE 5
INTERLABORATORY VARIANCE OF METHOD FOR WATER SAMPLES[a]

Compounds	Mean Conc. (µg/L)	SD	%rsd
HMX	203	14.8	7.3
RDX	274	20.8	7.6
2,4-DNT	107	7.7	7.2
2,4,6-TNT	107	11.1	10.4

[a] Nine laboratories.

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CARBON, TOTAL ORGANIC AND INORGANIC

Carbon may exist in sediment and water samples as either inorganic or organic compounds. Inorganic carbon is present as carbonates, bicarbonates, and possibly free carbon dioxide. Specific types of compounds that are considered to be included in the organic carbon fraction are nonvolatile organic compounds (sugars), volatile organic compounds (mercaptans), partially volatile compounds (oils), and particulate carbonaceous materials (cellulose).[1,2*]

The basis of the method is the catalytic or chemical oxidation of carbon in carbon-containing compounds to carbon dioxide followed by the quantification of the carbon dioxide produced. Alternately, the carbon may be reduced to methane and appropriately quantified. It follows, then, that the distinction between inorganic carbon and organic carbon is the method of sample pretreatment. There are presently two procedures for defining this separation. One method is based on sample treatment with a strong acid. Analysis of an untreated sample is a measure of total carbon while analysis of the acid-treated fraction is a measure of organic carbon. Inorganic carbon is calculated by subtraction. The second method of separation is based on differential thermal combustion with organic compounds being converted to carbon dioxide at 500°C to 650°C[3,4] and inorganic carbon being converted to carbon dioxide at 950°C to 1300°C.[4,5]

Sample Handling and Storage

Flowcharts for the handling of samples intended for organic carbon and inorganic carbon analysis are presented in Figure 3-6 and Figure 3-7. Water and sediment samples to be analyzed for inorganic carbon may be stored in glass or plastic containers. There is no effective preservative because of the carbon dioxide reserve in the atmosphere. The only precaution that can be taken for inorganic

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* References for this procedure can be found on page 3-76.

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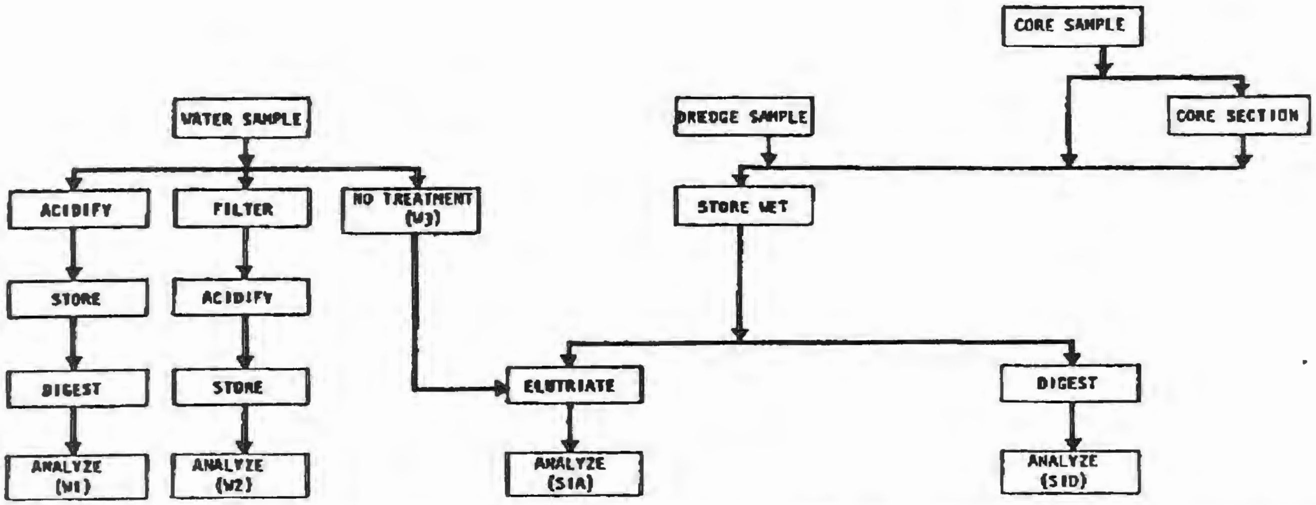
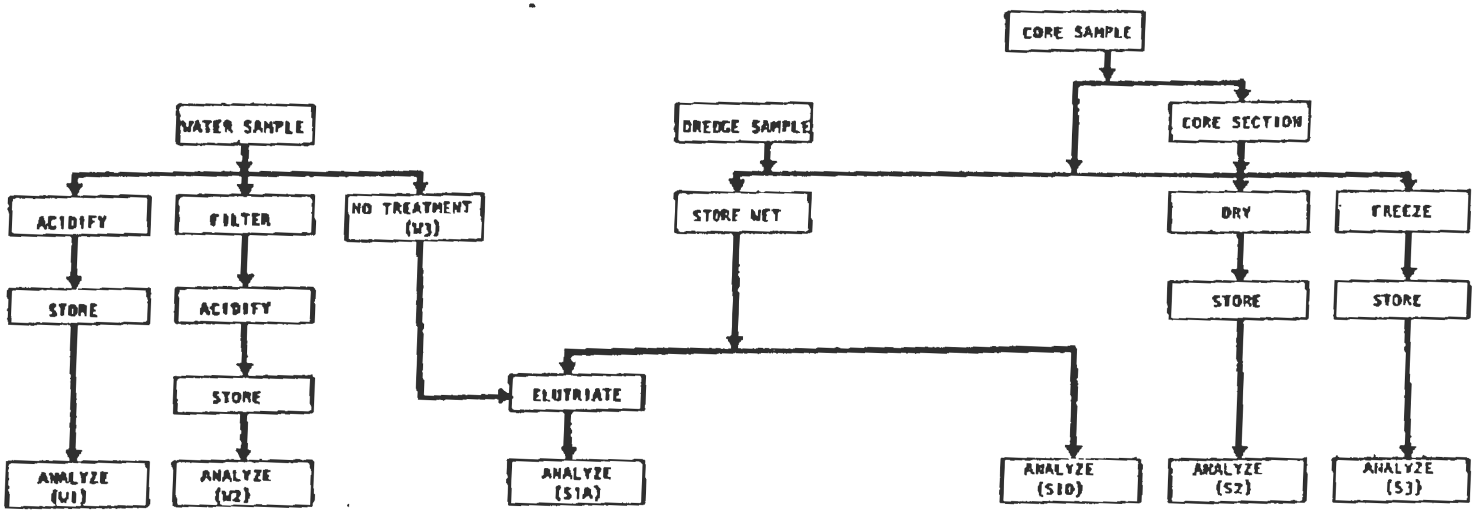


SAMPLE DESIGNATION	W1	W2	W3	S1A	S1B	S1C	S1D	S2	S3
PURPOSE	Total Water Conc.	Soluble Water Conc.	Used in Elutriate	Mobile Conc.			Total Sediment Conc.		
CONTAINER	G,P	G,P	G,P	G,P			G,P		
SAMPLE TREATMENT	None	Filter	None	None			None		
PRESERVATIVE	4°C (Minimize Air Contact.)	4°C	4°C	4°C (Minimize Air Contact. Keep Field Moist.)			4°C		
STORAGE TIME	24 hr	24 hr	-	24 hr					
DIGESTION SOLUTION									
SAMPLE VOLUME OR WEIGHT	100 ml	100 ml	-	100 ml			1 g		

Figure 3-6. Handling and storage of samples for total inorganic carbon analysis



SAMPLE DESIGNATION	W1	W2	W3	S1A	S1D	S2	S3
PURPOSE	Total Water Conc.	Soluble Water Conc.	Used in Elutriate	Mobile Conc.	Total Sediment Conc.	Total Sediment Conc.	Total Sediment Conc.
CONTAINER	G	G	G	G,P	G,P	G,P	G,P
SAMPLE TREATMENT	None	Filter	None	None	None	Air dry	Freeze
PRESERVATIVE	HCl or H_2SO_4 to pH2 4°C	HCl or H_2SO_4 to pH2 4°C	4°C	4°C	4°C	None	None
STORAGE TIME	24 hr	24 hr	<1w	<1w	-	-	-
SAMPLE VOLUME OR WEIGHT	30-100 ml	30-100 ml	Variable		0.5-5.0 g	0.5-5.0 g	0.5-5.0 g

Figure 3-7. Handling and storage of samples for total organic carbon analysis.

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carbon is to completely fill the sample container at the time of sampling (exclude all air bubbles), tightly seal the container, and complete the analysis immediately (Figure 3-6).

Water samples for organic carbon analysis should be stored in glass containers unless substitute containers have been shown not to affect total organic carbon (TOC) analyses. Samples should be processed as soon as possible (within 24 hr if possible) to minimize change due to chemical or biological oxidation. Atmospheric uptake of carbon dioxide is less critical since it would be evolved when the sample is acidified prior to analysis. Sediment samples for organic carbon analysis may be stored in either plastic or glass containers (Figure 3-7). Air drying of sediments (S2) may lead to low TOC results due to oxidation or volatilization. Therefore, moist storage (SID) or frozen storage (S3) would be the preferred method of storage. If samples are frozen, excessive temperatures should not be used to thaw the samples.

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Procedures for Sediment Samples (S1D, S3)

Method 1: Sample Ignition

Apparatus

Induction furnace such as the Leco WR-12, Dohrmann DC-50, Coleman CH analyzer, or Perkin Elmer 240 elemental analyzer

Combustion boats

Microbalance

Desiccator

Reagents

10 percent hydrochloric acid: mix 100 ml concentrated HCl with 900 ml distilled water.

Copper oxide fines.

Benzoic acid.

Procedure

Dry at 70°C and grind the sediment sample.

Weigh a combustion boat and record the weight. Place 0.2 to 0.5 g homogenized sediment in the combustion boat and reweigh. Combustion boats should not be handled with the bare hand during this process.

If total carbon or inorganic carbon is to be determined, Cupric oxide fines may be added to the sample to assist in combustion. Combust the sample in an induction furnace. Record the result as total carbon.

If organic carbon is to be determined, treat a known weight of dried sediment with several drops of 10 percent HCl. Wait until the effervescing is completed and add more acid. Continue this process until the incremental addition of acid causes no further effervescence. Do not add too much acid at one time as this may cause loss of sample due to frothing.

Dry the sample at 70°C and place in a desiccator. Add Cupric oxide fines, combust the sample in an induction furnace, and record the result as organic carbon.

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Calculations

The carbon content of the sample can be calculated as:

$$\%C = \frac{\text{weight of tube (after-before)}}{\text{sample weight}} \times 27.29$$

Derivation of factor:

$$27.29 = \frac{12.011 \text{ (molecular weight carbon)}}{44.011 \text{ (molecular weight carbon dioxide)}} \times 100\%$$

When the total sample results are used, the result is percent carbon in the sample. When acid-treated samples are used, the result is percent organic carbon. Inorganic carbon is calculated as total carbon minus organic carbon.

Method 2: Differential Combustion[4,5]

Apparatus

Sargent programmed microcombustion apparatus or equivalent

Microbalance

Procedure

Air dry the sediment sample. Using a mortar and pestle, grind the sample to pass a 100-mesh screen.

Combust a known weight of sediment at a programmed heating rate of 300° to 950°C in 10 min and then maintain 950°C for 20 min. Trap the CO_2 in ascarite and record the weight as total carbon. A sample size should be selected that will produce 25 to 50 mg CO_2.

Weigh a second portion of the dried sediment. Combust this sample at a programmed rate of 300° to 650°C in 10 min and maintain 650°C for 20 min. Trap the CO_2 in ascarite and record the weight as organic carbon.

Calculations

The total carbon concentration, C_t, of the sample (in mg/g) is calculated as follows:

$$C_t = \frac{(x_t)\left(\frac{12}{44}\right)}{(g)}$$

where

x_t = weight of CO_2 evolved at 950°C, mg

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g = weight of sample combusted, g

The organic carbon, C_o, concentration of the sample (in mg/g) is calculated as follows:

$$C_o = \frac{(x_o)\left(\frac{12}{44}\right)}{(g)}$$

where

x_o = weight of CO_2 evolved at 650°C, mg

g = weight of sample combusted, g

Inorganic carbon, C_I, (in mg/g) is calculated as:

$$C_I = C_t - C_o$$

Method 3: Wet Combustion[4,8]

A third method has been used for carbon in sediments. This is based on the oxidation of the sample with dichromate and back titration of the sample with ferrous ammonium sulfate. References are provided for the procedure but details are not given. The procedure is similar to the chemical oxygen demand test which is not specific for carbon. The wet combustion method is a redox procedure and any reduced chemicals in the sediment samples (ferrous iron, manganous manganese, sulfide) will react with the dichromate. Therefore, this procedure is not recommended unless other instrumentation is not available.

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PREFACE

This project was supported by Grant EPA-4805572010 between the Environmental Protection Agency and the Research Foundation of the State University of New York. Funding for this project was equally shared between the U. S. Environmental Protection Agency and the U. S. Army Engineer Waterways Experiment Station. The objective of the effort was to prepare a procedures manual that will contain summaries and descriptions of the tests, sample collection and preservation procedures, analytical procedures, and calculations required for the evaluation of Section 404 permits as specified in Public Law 92-500.

This work was conducted during the period March 1978 - March 1980 by the Great Lakes Laboratory (GLL), State University College of New York at Buffalo, Buffalo, New York. The investigation was conducted by Dr. Russell H. Plumb, Jr., Associate Director, GLL. The study was under the general supervision of Dr. Robert A. Sweeney, Director, GLL.

The contract was monitored by Mr. Jim Westhoff and Dr. Robert M. Engler of the Environmental Laboratory (EL), U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi; and Dr. Michael D. Mullin, U. S. Environmental Protection Agency, Grosse Ile Laboratory, Grosse Ile, Michigan. Directors of WES during the conduct of this study and preparation of this manual were COL J. L. Cannon, CE, and COL N. P. Conover, CE. Technical Director was Mr. F. R. Brown.

This report should be cited as follows:

Plumb, R. H., Jr. 1981. "Procedure for Handling and Chemical Analysis of Sediment and Water Samples," Technical Report EPA/CE-81-1, prepared by Great Lakes Laboratory, State University College at Buffalo, Buffalo, N. Y., for the U. S. Environmental Protection Agency/Corps of Engineers Technical Committee on Criteria for Dredged and Fill Material. Published by the U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

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APPENDIX 2

ACID VOLATILE SULFIDE

Procedure Used at Manhattan College

The apparatus consists of the following vessels:

A 500-mL Erlynmeyer flask fitted with a three-hole stopper, where the sample to be analyzed is placed.

Three 250-mL Erlynmeyer flasks. Into the first is placed 175-200 mL of pH 4 buffer (0.05M potassium hydrogen phthlate). The second and third contain 175-200 mL of a 0.1M silver nitrate solution. Each of these is fitted with a two-hole stopper.

The four flasks are connected in sequence with appropriately shaped glass and Tygon tubing. All fittings must be air tight.

A nitrogen gas line is introduced into the first vessel through one hole of the stopper. A thistle tube with a stopcock is placed in the second hole. The exit line from the first to the second vessel is placed in the third hole. The second, third and fourth stoppers contain the entry and exit lines, the entry line being below the liquid surface and the exit line, above.

Between the nitrogen tank and the first vessel, an oxygen-scrubbing system must be placed. This system consists of a vanadous chloride solution in the first scrubbing tower and the matrix of the analyte (usually seawater or freshwater) in the second tower. The solution used in the first tower is prepared in the following manner. Four grams of ammonium metavanadate is boiled with 50 mL of concentrated hydrochloric acid and diluted to 500 mL. This solution is then transferred to the tower. Amalgamated zinc, prepared by taking about 15 grams of zinc, covering it with deionized water and adding 3 drops of concentrated hydrochloric acid before adding a small amount of mercury to complete the amalgamation, is then added to the vanadous chloride solution in the first tower. The solution should now be blue or green. When nitrogen is bubbled through it for a time it will turn purple. When the solution is exhausted, it will turn back tp blue or green. It may be replenished by adding more amalgamated zinc or a few drops of concentrated hydrochloric acid.

The sample or standard to be analyzed is placed in the first vessel after the entire system has been purged with nitrogen for about an hour. The usual sample size is 10-15 grams of wet sediment. Any water used in the transfer of the sample to the vessel must be completely deaerated. The system is again purged for 5-10 minutes. Deaerated 6M hydrochloric acid is now added from the thistle tube as to achieve a final concentration in the vessel of 0.5M.

The system is now run for an hour with the nitrogen at a bubble rate of about four/sec. The sample vessel should be swirled every five or ten minutes. When the reaction is complete and all hydrogen sulfide produced has been converted to silver sulfide in the third vessel, the solution in that vessel should be relatively clear and the precipitate should have settled to the bottom. There should be no precipitate in the fourth vessel.

The suspension in the third vessel is passed through a 1.2 micron GF glass fiber filter, which is dried at 102°C. and weighed.

A standard can be prepared from appropriate quantities of iron(II) sulfate and sodium sulfide, the latter being best added from a solution standardized against lead perchlorate.

Typical silver sulfide precipitates are in the range 10-30 mg. When a blank is run (sample without acid), about 0.9 mg silver sulfide is obtained. When the acid is run without a sample, about 0.6 mg silver chloride is obtained.

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ATTACHMENT C - Development of a Simplified Field Method for The Determination of 246 TNT in Soil

Special Report 90-38

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U.S. Army Corps
of Engineers
Cold Regions Research &
Engineering Laboratory

Development of a Simplified Field Method for the Determination of TNT in Soil

Thomas F. Jenkins

November 1990

Prepared for
USA TOXIC AND HAZARDOUS MATERIALS AGENCY
REPORT CETHA-TS-CR-90125

APPENDIX A: METHOD DOCUMENTATION (USATHAMA 1987)
FORMAT CERTIFICATION
FIELD METHOD FOR THE DETERMINATION OF 246 TNT IN SOIL

I. Summary

A. Analytes: This method is suitable for determining the concentration of 246 TNT in the field using battery-operated equipment.

B. Matrix: This method is suitable for the determination of 246 TNT in soil or sediment.

C. General Method: A 20-g subsample of undried soil is placed in a 4-oz (120-mL) glass bottle and 100 mL of acetone added. The bottle is capped and shaken manually for three minutes. The bottle is then allowed to stand for 5 minutes to allow the particles to settle, and then a 25-mL aliquot of the extract is filtered through a 0.5-mm Millex SR filter into a 25-mL cuvette. The absorbance of this solution is obtained at 540 nm. About 0.1 to 0.5 g of sodium sulfite (Na_2SO_3) and one pellet of potassium hydroxide (KOH) are added, the cuvette capped and shaken for 3 minutes. The resulting solution is immediately poured into the barrel of a 50-mL plastic syringe and filtered through another Millex SR filter into a clean cuvette. The absorbance is again measured at 540 nm as soon as possible (within 60 minutes) after filtration. The initial absorbance difference is doubled and subtracted from the final reading and this is proportional to 246 TNT concentration.

II. Application

A. Calibration Range:

The calibrated range over which measurement can be made is 1.11 to 22.3 µg/g. Concentrations in excess of 22.3 µg/g can be obtained by volumetric dilution of the extract with acetone such that the measured absorbance is less than 0.6 absorbance units. Whenever dilutions are made, a small amount of water is added (3 mL to 100 mL of solution) to ensure that sufficient solubility of the reagents is maintained. When this is done, the background absorbance is obtained after the addition of water.

B. Tested Concentration Range: This method was tested over the range of 246 TNT concentration from 1.11 to 22.3 µg/g.

C. Sensitivity: The absorbance per µg/g of 246 TNT was found to be 0.029 absorbance units, resulting in 0.032 absorbance units at the certified reporting limit (1.11 µg/g).

D. Interferences: A number of other nitroaromatic compounds were found to develop a visible color as well as 246 TNT. The colors observed are given below:

Tetryl—Orange
TNB—Red
DNB—Purple
2,4-DNT—Blue
2,6-DNT—Pink

No color development was observed for: RDX, HMX, Nitrobenzene, o-nitrotoluene, m-nitrotoluene, p-nitrotoluene, nitroglycerine, 4-amino-2,6-dinitrotoluene or 2-amino-4,6-dinitrotoluene. Humic organic matter, normally present in soil, is extracted to some degree and will result in a yellow extract that becomes darker yellow on addition of the reagents. The contribution to the absorbance at 540 nm is small but can be corrected by doubling the absorbance reading before addition of reagents and subtracting from the absorbance after addition of KOH and Na_2SO_3.

E. Safety Information: The normal safety precautions associated with the use of a flammable organic solvent should be employed. If acetone containing KOH is spilled on the skin, it should be rapidly rinsed off with water. Eye protection is recommended when shaking bottles or cuvettes to protect against splash from poorly sealed containers.

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III. Apparatus and Chemicals

A. Instrumentation

1. Field portable, battery-operated colorimeter (HACH DR2 spectrophotometer or equivalent, bandpass 20 nm).

2. Mechanical balance, to measure soil weights.

B. Analyte

246 TNT (2,4,6-trinitrotoluene)
BP: 280°C (explodes)
MP: 80.1°C
Solubility in water: 130 mg/L
Octanol/water partition coefficient: 68
CAS # 118-96-7.

C. Reagents and SARMs:

1. 246 TNT (SARM quality)
2. Acetone
3. Potassium hydroxide, reagent grade pellets
4. Sodium sulfite, reagent grade.

D. Glassware/Equipment

1. 4 oz (Qorpak or equivalent) glass bottles with caps
2. Glass volumetric pipets
    0.50 mL
    1.00 mL
    2.00 mL
    5.00 mL
    10.00 mL
    25.0 mL
3. 100-mL graduated cylinder
4. Cuvette bottles with caps (25-mL capacity), 25-mm path length.
5. Glass volumetric flask (2)—50 mL.
6. Filters (Millex SR, 0.5 µm)
7. Syringes (Plastipak), 20 and 50 mL.
8. Forceps.
9. Spatula.

IV. Calibration

A. Initial Calibration:

1. Preparation of Standards

Solid TNT (SARM or reagent grade) was dried to constant weight in a vacuum desiccator in the dark. About 0.1 g is weighed out to the nearest 0.1 mg, transferred to a 250-mL volumetric flask and diluted to volume with acetone. The TNT concentration of this stock standard is about 400 mg/L. This stock standard should be prepared in the laboratory before going to the field.

A working stock standard is prepared by diluting 25.0 mL of the stock TNT standard to 250 mL in a glass volumetric flask and bringing to volume with acetone. The concentration of this working stock standard is about 40 mg/L.

Calibration solutions are prepared as described in Table A1. Glass volumetric pipettes are used to dispense the working stock standard and the distilled water, and a 100-mL graduated cylinder is used to add the acetone. Each solution is prepared in a 4-oz glass bottle, capped and shaken.

2. Instrument Calibration

Approximately 0.2 g of sodium sulfite (excess) and one pellet of potassium hydroxide are added to a 25-mL aliquot of each standard; samples are shaken for 3 minutes and allowed to stand 2 minutes. The solutions are then filtered into a 25-mL glass cuvette bottle (19-mm path length) and the absorbance measured at 540 nm using a battery-operated spectrophotometer. The zero absorbance setting was first established using pure acetone, and the instrument was zeroed according to manufacture's instructions.

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Table A1. Preparation of calibration solutions.

Solution	*Volume of working std. (mL)*	*Volume of acetone added (mL)*	*Volume of distilled water added (mL)*	*Approx.* conc. (mg/L)*	*Associated† soil conc. (µg/g)*
A	0	100	3.00	0.0	0.0
B	0.50	99.5	3.00	0.2	1.0
C	1.00	99	3.00	0.4	2.0
D	2.00	98	3.00	0.8	4.0
E	5.00	95	3.00	2.0	10.0
F	10.00	90	3.00	4.0	20.0

* Does not include volume of water. The reason is that all field soils will contain water of an unknown quantity and all calculations will ignore this small volume contribution.

† This concentration is the comparable soil RDX concentration if 20 g of soil is used and 100 mL of acetone used for extraction. The concentration is based on wet weight of soil.

3. Calculations

Absorbance readings for solutions A-F should be in a range from 0.0 to 0.7 absorbance units. If so, the absorbance should be linear with TNT concentration on either a milligram per liter basis or an equivalent microgram per gram of wet soil basis. The slope of this relationship (or the response factor) was found to average about 0.15 absorbance units per mg/L in the extract (or about 0.029 absorbance units per µg/g of wet soil).

B. Daily Calibration

Since a linear relationship with zero intercept is the expected result for initial calibration, daily calibration is obtained using solution E (Table A1) and calculating a response factor as described above.

V. Certification Testing

A. Preparation of Spiking Solutions:

The spiking stock standard is prepared in an identical manner to the calibration stock standard described in Section IV-A-1. The soil spiking solution is prepared in an identical manner to the working stock standard also described in Section IV-A-1.

B. Soil Spiking

Subsamples of 20.0 g of USATHAMA Standard Soil are placed in each of six 4-oz glass bottles. A 3.00-mL aliquot of water is added to each since the standard soil has been previously dried. The six bottles are labeled, blank, 0.5X, 1X, 2X, 5X and 10X. Aliquots of the TNT spiking solution are added to these bottles as described in Table A2. The spiked soils are allowed to stand for 1 hour capped prior to extraction.

Table A2. Preparation of spiked soils.

Designation	*Volume of TNT Spiking solution added (mL)*	*TNT concentration* (µg/g)*
Blank	—	0.0
0.5 X	0.50	.0
1 X	1.00	2.0
2 X	2.00	4.0
5 X	5.00	10.0
10 X	10.00	20.0

C. Soil Extraction and Analysis

A volume of acetone is added to each bottle in a manner to make the total solution volume added (spike + acetone addition) equal 100 mL. The bottles are capped and shaken vigorously by hand for 3 minutes. The soil is allowed to settle for 5 minutes and a 25-mL aliquot filtered through a 0.5-µm Millex SR syringe filter into a 25-mL glass cuvette using a 50-mL Plastipak syringe. The absorbance of this solution is measured on the portable spectrophotometer at 540 nm relative to pure acetone. The cuvette is removed from the instrument, about 0.1–0.5 g of Na_2SO_3 added along with one pellet of potassium hydroxide, and the bottle is capped and manually shaken for 3 minutes. The solution is immediately poured into the barrel of a 50-mL Plastipak syringe equipped with a Millex SR filter. The plunger is replaced and the solution filtered into a fresh 25-mL glass cuvette. The absorbance is again read at 540 nm. The glass cuvette bottles must be thoroughly rinsed with water and acetone between samples.

D. Calculations

The absorbance of the soil extract at 540 nm prior to the addition of the reagents is doubled and subtracted from the absorbance of the extract after addition of the reagents:

$$\text{TNT absorbance} = (\text{Absorbance after}) - 2\,(\text{Absorbance before}).$$

The doubling of the absorbance before the reagents are added takes into account an increase in absorbance due to the reaction of KOH with extracted soil humic materials.

The soil concentration is then obtained by dividing the TNT absorbance by the response factor obtained by analysis of solution E:

$$\text{Soil conc. } (\mu g/g) = \frac{\text{TNT absorbance (absorbance units)}}{\text{Response factor (absorbance units/}\mu g/g)}.$$

VI. Sampling Handling

This method is designed to be used with field soils that have not been previously dried. If dried soils are used, 3.0 mL of distilled water should be added to the 20-g soil sample before extraction.

The soil sample is mixed as thoroughly as possible, a 20-g subsample added to a 4-oz glass bottle and the bottle capped until extraction is conducted. The samples should be kept cold (4°C) and in the dark until extraction takes place. Samples should be analyzed the same day they are collected.

VII. Procedure

A. Sample Processing

A 20-g subsample of soil is added to a 4-oz glass bottle and 100 mL of acetone are added using a graduated cylinder. The bottles are capped and shaken manually for 3 minutes. The soil is allowed to settle for 5 minutes and a 25-mL aliquot is filtered into a 25-mL glass cuvette bottle through a Millex SR syringe filter using a 20-mL Plastipak syringe. The absorbance is obtained at 540 nm relative to pure acetone.

About 0.1–0.5 g of Na_2SO_3 and one pellet of KOH is then added to the cuvette bottle; the bottle capped tightly and shaken manually for 3 minutes to allow full color development. The solution is poured into the barrel of a 50-mL Plastipak syringe which is equipped with a Millex SR filter and filtered into a fresh 25-mL glass cuvette bottle. The absorbance is again obtained at 540 nm. The glass cuvettes must be thoroughly rinsed with water and acetone between samples. If the measured absorbance is greater than 0.7 A.U., an aliquot of the unreacted extract should be diluted with acetone to achieve an absorbance between 0.1 and 0.7 A.U. when reacted with KOH and Na_2SO_3. When dilutions are made, a small volume of water (about 3 mL to a total volume of 100 mL) should be added to ensure that sufficient reagent solubility is maintained.

VIII. Calculations

The TNT absorbance is obtained by subtracting twice the absorbance at 540 nm prior to addition of the reagents from the absorbance after addition of the reagents and dividing by the response factor obtained from analysis of solution E (Table A1) as described in Section V-D.

IX. Daily Quality Control

A blank and a spiked soil at 1X (2 µg/g) are analyzed each day. Results are maintained on a control chart and control limits are established as described in the USATHAMA Installation Restoration Quality Assurance Program.

X. Reference

Jenkins, T.F. (1990) Development of a simplified field method for the determination of TNT in soil. USA Cold Regions Research and Engineering Laboratory, Special Report. (in prep).

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13. ABSTRACT (*Maximum 200 words*)

A simple field method was developed for determining the concentration of 2,4,6-trinitrotoluene (TNT) in soil. The method involves extraction of the soil with acetone, generation of the red-colored Jackson–Meisenheimer anion by addition of potassium hydroxide and sodium sulfite, and measurement of color intensity at 540 nm using a battery-operated spectrophotometer. The method was shown to follow the Beer–Lambert law with linear calibration through an absorbance of 0.9 absorbance units, and was found to be both precise and accurate in tests with spiked soils, providing a detection limit of about 1 µg/g. The extraction step recovered a mean of 96% of the TNT recoverable by a more exhaustive laboratory extraction procedure. A comparison was made of concentration estimates from the field method with those from the standard RP-HPLC laboratory procedure using a set of field-contaminated soils. An excellent correlation existed between the two when both 1,3,5-trinitrobenzene and TNT concentrations from the laboratory measurements were included. The method is susceptible to interference from a number of polynitroaromatic compounds including the following: 1,3,5-trinitrobenzene (red), tetryl (orange), 2,6-dinitrotoluene (pinkish purple), 2,4-dinitrotoluene (blue) and 1,3-dinitrobenzene (purple). No color was observed for nitramine explosives, such as RDX or HMX, or nitrate esters such as nitroglycerine or pentaerythritol tetranitrate.The method was field tested at Umatilla Army Depot and found to provide a simple, rapid method for estimating TNT concentrations in the field. Concentration estimates from field analysis correlated well with laboratory analyses of the same samples.

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DEPARTMENT OF THE ARMY
MISSOURI RIVER DIVISION, CORPS OF ENGINEERS
P.O. BOX 103, DOWNTOWN STATION
OMAHA, NEBRASKA 68101-0103

8 October 1991

REPLY TO
ATTENTION OF

Environmental, Hazardous
and Toxic Waste Division

Aquatec, Inc.
75 Green Mountain Drive
South Burlington, VT 05403

Gentlemen:

This correspondence addresses the recent evaluation of Aquatec, Inc. Laboratory in South Burlington, Vermont by the U.S. Army Corps of Engineers (USACE) for hazardous and toxic waste analysis.

The laboratory has successfully analyzed audit samples as listed below:

METHOD	PARAMETERS	MATRIX
8240	Volatile Organics	water
8010	Halogenated Volatile Organics	water
8020	Aromatic Volatile Organics	water
8270	Semivolatile Organics	water
8270	Semivolatile Organics	sediment
8080	Organochlorine Pesticides	water
8080	Polychlorinated Biphenyls	water
8080	Polychlorinated Biphenyls	sediment
8150	Chlorinated Herbicides	water
SW-846	CLP TAL Metals[1]	water
SW-846	CLP TAL Metals[1]	sediment
9010/9012	Total and Amenable Cyanide	water
300 Series	Common Anions	water
418.1	TRPH	water
418.1	TRPH	soil
9060	Total Organic Carbon	water
9010	Cyanide	water
8330	Explosives	water
8330	Explosives	soil

Remarks: 1. CLP TAL Metals: 23 EPA Contract Laboratory Program, Target Analyte List (TAL) metals (aluminum, antimony, arsenic,

iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc.)

Based on the successful analysis of the audit samples indicated in the table in Paragraph 2, your laboratory is revalidated for multi-media sample analysis by the above methods. A full valiation of eighteen (18) months is approved by the USACE Contract Laboratory Evaluation Committee on September 30, 1991. The expiration date of validation is April 7, 1993. During the 18-month period, USACE reserves the right to conduct laboratory auditings or to suspend validation status for any or all of the listed parameters if deemed necessary. It should be noted that your laboratory may not subcontract USACE analytical work to any other laboratory location without the approval of this office. This lab validation does not guarantee the award of any contracts from a USACE Contracting Officer. If you have any questions or comments, please contact Dr. Chung-Rei Mao at (402) 221-7494.

Sincerely,

Marcia C Davies

Marcia C. Davies
Chief, Environmental, HTW Division
Engineering and Planning Directorate

Enclosure

10-2-91

DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS
3909 HALLS FERRY ROAD
VICKSBURG, MISSISSIPPI 39180-6199

ATTENTION OF

ES-EE-A 24 May 1991

RANDUM FOR RECORD

Audit samples submitted to Aquatec, Burlington, VT on 8 April 1991.

1. Volatiles by Method 8240 good, all compounds identified and quantified within 2-sigma.

2. BNA in water good, all compounds identified and quantified within 2-sigma.

3. BNA in sediment had three false negatives, all other compounds within 2-sigma.

4. PCB in sediment good, Aroclor correct and value within 2-sigma.

5. PCB in water good, Aroclor correct and value within 2-sigma.

6. Pesticides in water good, all compounds within 2-sigma.

ANN B. STRONG
Chief, ALG, EED, EL

5 August 1991

7. TAL metals in sediment good except Mn and V slightly high within 3-sigma.

8. All metals in water appear to have a dilution error except Hg which was within 2-sigma.

9. Ca, Mg, K and Na appear to have a dilution error.

10. Cyanide may be within 2-sigma if the concentration units are corrected.

11. Nitrate and phosphate in water values within 2-sigma.

12. Chloride, fluoride, and sulfate in water values within 2-sigma.

13. Herbicides in water values within 2-sigma.

14. Total organic carbon in water value within 2-sigma.

15. Volatiles by Method 8010 good, all values within 2-sigma.

16. Volatiles by Method 8020 good, all values within 2-sigma.

20 September 1991

17. TAL metals in water values all within 2-sigma.

18. Ca, Mg, Na, and K in water values within 2-sigma.

DEPARTMENT OF THE ARMY
MISSOURI RIVER DIVISION, CORPS OF ENGINEERS
DIVISION LABORATORY
OMAHA, NEBRASKA 68102

Subject: TRPH Performance Audit Sample Results WO#391

Project: Aquatec Environmental Services, So. Burlington, VT.
Intended Use: DERA/Superfund Laboratory Certification (Seneca Army Depot, IRP & Detroit District UST Removal Project)
Source of Material: Missouri River Division Laboratory

Submitted by: Chung-Rei Mao/Prem N. Arora
Date Sample Sent: 09 Apr 91 Date Results Received: 17 May 91
Method of Test or Specification: EPA-9071/418.1, EPA-418.1

References:
1. Soil Sample Identification: MRD-1207-32
2. Water Sample Identification: MRD-83-14 (EPA-418.1)
3. Date request received by MRD lab: 5 April 91

1. Results submitted by the laboratory were reviewed by Prem N. Arora on 17 May 91. The results for both the soil and water samples were acceptable.

2. The details of the results are as follows:

MATRIX	SAMPLE IDENTI.	LAB RESULTS	MRD LAB RESULT	UNITS	ACCEPTED RANGE
Soil	MRD-1207-32	392		mg/Kg	
Water	MRD-83-14	3.89		mg/L	

3. This is the lab's first attempt to analyze the PA samples. The lab reported duplicate analysis results for soil sample and were 385 mg/kg.

Submitted by,

Douglas B. Taggart

DOUGLAS B. TAGGART
Director, MRD Laboratory

Arora/bln/444-4318

FINAL DRAFT

APPENDIX D
RESPONSE TO COMMENTS

FINAL DRAFT

MAIN
1893

CHAS. T. MAIN, INC.
PRUDENTIAL CENTER, BOSTON, MASSACHUSETTS 02199 • TELEPHONE 617 262-3200 • TELEX 4430035 • FAX 617 859-2575

February 5, 1991
1345-082-3228

Mr. John Romeo
CEHND-PM-E
U.S. Army Corps of Engineers
Huntsville Division
Huntsville, AL 35807-4301

Dear Mr. Romeo:

In response to the comments received January 3, 1991, corrections have been made to the Draft Scoping Document and incorporated into the Draft-Final document, which was re-submitted to you on January 16, 1991. MAIN received three sets of review comments, two written and one verbal. MAIN accepts and concurs with all the comments and has changed the document.

The corrections made to the document are summarized as follows (according to Mr. Kevin Healy's comments):

1. All typographical, spelling and grammatical errors of the following item numbers have been corrected; 4, 6, 7, 8, 9, 11, 12, 13, 15, 16, 17, 18, 20, 21, 22, 23, 24, 25.

2. Item number 1 indicated a preference for not having the text right justified. This was eliminated.

3. Item number 3, concerned the phased approach of the two documents which are, the Project Scoping Document and the Work Plan. MAIN agrees with these comments and has incorporated them. Regulatory review comments on the Project Scoping Document will be received prior to completion of the entire Work Plan. This will help to clarify the focus for the subsequent preparation of the Work Plan.

4. Item number 5 concerned a reference to a Phase II study. The Phase II study referred to in paragraph 4 of page 1-4 is the same Phase II referred to in the previous paragraph discussing Phases I through IV performed by AEHA.

5. Item number 10 notes that pads A through G and J referred to on page 2-1 were not identified on Figure 3. Figure 3 has been marked up to include these designations.

6. Item number 14 refers to page 20-17, paragraph 4. The four boreholes mentioned are in addition to the eight boreholes mentioned in the previous sentence.

7. Item number 19 refers to Table 3-4-7. Table 3-4-7 has been deleted due to the fact that the values were not actually regulatory values but rather the contractors proposed action levels in soil and water.

Additional corrections have been made to the document as follows (according to Mr. Keith Hoddinott's comments):

1. Item number 1 concerns Table 1 which presents the average background concentrations for soil, rock, and water. This table provides important information concerning these average concentrations and is not intended to take the place of a site-specific determination of background which will be part of the work plan. The table has been left in since the point of

FINAL DRAFT

the discussion was to indicate that shales, which is the bedrock at Seneca, can contain heavy metals. This fact may help support the occurrence of heavy metals in the background wells should this in the future became an issue.

2. Item number 2 concerns Table 3-4-7. Table 3-4-7 has been deleted due to the fact that the values presented in the table are the contractor's proposed action levels in soil and water not regulatory values.

3. Item number 3 concerns page 3-10 paragraph 3. The wording in the paragraph has been corrected. The sentence now reads: "The high percentage of material passing the 200 mesh sieve, which ranges between 46% to 93%, provides a large amount of sorptive potential, thereby retarding the movement of pollutants through the soil column."

   Item number 3 also concerns a sentence which claims the nitrated metal compounds transform to oxides. This was corrected to state that a portion of the nitrated metal compounds transform to oxides.

4. Item number 4 concerns the geophysical studies which found metallics in the upper 5.5 feet, not 55 feet. This typographical error was changed.

5. Item number 5 concerns the exposure pathway of the contaminants. The recommendation indicated that before the contractor is allowed to assess Seneca Lake for possible contamination it should be proven that contaminants can be found in waters leading up to Seneca Lake from the site, and that they have a reasonable chance of reaching the lake. MAIN agrees with this recommendation and will focus the investigation only on Reeder Creek. All reference to investigating the effects of the site in Seneca Lake have been deleted.

6. Item number 6 concerns possible exposure pathways of contaminants. Section 3.2.3, Incidental Soil Ingestion, was included as a potential pathway.

7. Item number 7 concerns institutional controls as a potential remedial action alternative. A possible institutional control would be to restrict the future land use of the OB/OD grounds, possibly by changing the deed to the property. This would restrict the type of excavation or construction which could take place in the area of concern. By placing land use restrictions in the deed future owners of the land would be restricted from using this area of the base for certain types of development. Section 3.3.6, Institutional Controls, has been added to Section 3.3, Scoping of Potential Remedial Action Alternatives.

8. Item number 8 concerns the application of statistics to determine the spatial array for a sampling grid. MAIN's initial approach was to consider the entire 30 acres as one site, instead, the recommendation is to recalculate the spacing for an average pad.

   MAIN has reevaluated the existing database in response to item 8. A substantial amount of discussion regarding geostatistics has been added in Section 3.5.3, Data Quality. This was done to help develop the concept which MAIN applied. The goestatistical model, GEO-EAS, was again used to determine two grid spacings.

FINAL DRAFT

The two grid spacings are necessary since a 200 foot spacing may be adequate for the overall site. It is not adequate to provide coverage for the individual pads, many of which are less than 200 feet wide. Accordingly, to determine the grid spacing for the entire site, all the data from all the pads and adjacent areas were used. Figure 14 illustrates the results of this effort. The pad spacing was determined in a similar manner but only the data from pad B, which contained the most samples was used. Figure 15 illustrates the results of this efforts.

Mr. Gary Kittell provided comments, via the telephone, from the SEAD. The majority of these comments were related to typographical or grammatical errors, all of which were addressed. Mr. Kittell indicated an objection regarding the term "wetland" since the term implies that the Wetland Protection Act may control or limit the ability to perform any excavation. If, in fact, these areas are defined as wetlands by a person capable of making this determination, then the Wetland Protection Act should be abided, however, he was unaware that this has been done and therefore would prefer a different description of these areas. MAIN agrees with this comment and has changed all references to "wetlands" to "low lying areas of poor drainage."

Copies of all written comments are attached for your review.

Please feel free to contact me at 617-859-2492 if you have any questions regarding these items.

Very truly yours,

CHAS. T. MAIN, INC.

Michael Duchesneau, P.E.
Project Manager

Response Requested _Yes _x_No
Date Requested ______

MD/cmf/D#1

Enclosures

FINAL DRAFT

2492

U.S. ARMY CORPS OF ENGINEERS
HUNTSVILLE DIVISION

FACSIMILE HEADER

COMMAND	NAME/ OFFICE SYMBOL	TELEPHONE NO.	AUTHORIZED RELEASER'S SIGNATURE		
FROM: USAEDH	JOHN ROMEO CEHND-PM-E	205-955-5803 645-5803(AV)			
			DATE-TIME	MONTH	YEAR
TO: C.T. MAIN	MIKE DUCHESNEAU	617-859-2492	03-1600	JAN	1991

CLASSIFICATION	NO. PGS.	PRECEDENCE	REMARKS:
UNCLASSIFIED	5	ROUTINE	HEADER IS SHEET 1 OF 5

SPACE BELOW IS FOR COMMUNICATIONS CENTER USE ONLY

MACHINE NUMBER	VERIFICATION NUMBER	VERIFICATION REQUIRED
617-859-2575	617-859-2492	X YES ___ NO

DA FORM 3918-R
1 AUG 72

ATTACHED ARE HUNTSVILLE DIVISION'S COMMENTS ON THE DRAFT SCOPING DOCUMENT FOR THE OB GROUNDS AT SENECA AD. CONTRARY TO MY PREVIOUS STATEMENT, GARY KITTELL'S COMMENTS RELAYED TO YOU VERBALLY, WERE NOT WRITTEN DOWN. THEREFORE, REQUEST YOU INCORPORATE GARY'S VERBAL COMMENTS. IF YOU HAVE A PROBLEM WITH ANY OF THE COMMENTS, PLEASE CONTACT ME.

BASED ON YOUR PHONE CALL EARLIER, COORDINATED WITH KEVIN HEALY ON AEHA'S COMMENT #8. IT IS OUR OPINION THAT KEITH'S COMMENT SHOULD BE INCORPORATED. IF YOU HAVE ANY QUESTIONS ON THIS, PLEASE CONTACT KEVIN DIRECTLY. I WILL NOT BE IN THE OFFICE TOMORROW, BUT I WILL BE IN ON MONDAY.

Rly for RBD

U.S. ARMY ENGINEER DIVISION HUNTSVILLE

CORPS OF ENGINEERS

DESIGN REVIEW COMMENTS

PROJECT AMC-SEAD OB Grounds RI/FS (12-270, 3 Jan)

☒ SITE DEV & GEO TECH
☐ ENVIR PROT & UTIL
☐ ARCHITECTURAL
☐ STRUCTURAL
☐ MECHANICAL
☐ MFG TECHNOLOGY
☐ ELECTRICAL
☐ INSTR & CONTROLS
☐ SAFETY
☐ ADV TECH
☐ ESTIMATING
☐ SPECIFICATIONS
☐ SYSTEMS ENG
☐ VALUE ENG
☐ OTHER

REVIEW Draft Project Scoping Document (TYPE)
DATE 2 Jan 91
NAME Healy/ag

ITEM	DRAWING NO OR REFERENCE	COMMENT	ACTION
1	General	Overall presentation was very good. As a matter of personal preference, however, would rather not have right justified pages if they're justified at the expense of the reviewers understanding. Although many of my comments seem picky, my aim is to assure that the report is understandable to future reviewers who are less familiar with the site.	
2	Pg 1-1, Par 3	The phased approach will incorporate regulatory review comments on the Project Scoping Document only, thereby clarifying our focus prior to completion of the entire Work Plan. Regulatory review of the entire plan will not be done until <u>after</u> the plan itself is completed in draft. A clarification should be made.	
3	Pg 1-1, Par 3	Upon acceptance of the scoping document, it will be <u>used as the focus for the subsequent preparation</u> of the WP, not incorporated into the submitted WP. A clarification should be made.	
4	Pg 1-1, Par 4	Correct "scopining".	
5	Pg 1-4, Par 4	Suggest additional specificity in the reference to "A Phase II Study". It is unclear whether this study was performed by AEHA and whether it is analogous to the format explained in paragraph 3.	
6	Pg 1-5, Sentence 1	Change "not sampled of the 24 samples" to "not sampled. Of the 24 samples...".	

ACTION CODES:
A — ACCEPTED/CONCUR
D — ACTION DEFERRED
W — WITHDRAWN
N — NON-CONCUR
VE — VE POTENTIAL/VEP ATTACHED

FINAL LEVEL

CEHND FORM 7 (Revised)

PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE

*U.S.GPO:1989-636-564/00015

FINAL DRAFT

U.S. ARMY ENGINEER DIVISION HUNTSVILLE CORPS OF ENGINEERS

DESIGN REVIEW COMMENTS

PROJECT AMC-SEAD OB Grounds RI/FS (12-270, 3 Jan)

☒ SITE DEV & GEO TECH
☐ ENVIR PROT & UTIL
☐ ARCHITECTURAL
☐ STRUCTURAL
☐ MECHANICAL
☐ MFG TECHNOLOGY
☐ ELECTRICAL
☐ INSTR & CONTROLS
☐ SAFETY
☐ ADV TECH
☐ ESTIMATING
☐ SPECIFICATIONS
☐ SYSTEMS ENG
☐ VALUE ENG
☐ OTHER

REVIEW Draft Project Scoping Document TYPE
DATE 2 Jan 91
NAME Healy/ag

ITEM	DRAWING NO. OR REFERENCE	COMMENT	ACTION
7	Pg 1-6, Par 1	Change "EPA's Superfund list, and became" to "EPA's Superfund list and subsequent remediation of targeted problem sites became". Also, change "This agreement is intended" to "An agreement was made to". Finally, the Army's RCRA corrective action obligations are being integrated with CERCLA response actions mandated by the NPL listings, not vice versa.	
8	Pg 1-6, Final Line	Substitute "will be developed" for "has been developed".	
9	Pg 2-1, Par 2.1	In line 3 "See Figure 1...Location Map" should be in parentheses. In lines 7 and 8, "boundaries" should be followed by ", respectively" and "SEAD Figure 2" should be separated by a period. In the final sentence simply say that "Figure 2 presents a site plan of SEAD". The phrase "breakdown of SEAD" is ambiguous.	
10	Pg 2-1, Final Sentence	Delete the second occurrence of "Figure 3". Also, the labels for Pads A through G and J were not apparent on Figure 3.	
11	Pg 2-7	In the first paragraph, correct "assocciated". In the second, delete the second occurrence of "average" and correct "derved" and "whould".	
12	Pg 2-10, Par 1	Change "yields are...below 100 ft.." to "yields in the upper 100 ft. are almost double those measured at depths below 100 ft."	
13	Pg 2-11	In line 1, correct "acquifers". in paragraph 1, correct "patters".	

ACTION CODES:
A — ACCEPTED/CONCUR
D — ACTION DEFERRED
W — WITHDRAWN
N — NON-CONCUR
VE — VE POTENTIAL/VEP ATTACHED

CEHND FORM 7 (Revised)
15 A 89

PREVIOUS EDITIONS OF [illegible]IS FORM ARE OBSOLETE

PAGE 2 OF 4

*U.S.GPO:1989-636-564/0001

U.S. ARMY ENGINEER DIVISION HUNTSVILLE

CORPS OF ENGINEERS

DESIGN REVIEW COMMENTS

PROJECT AMC-SEAD OB Grounds RI/FS (12-270, 3 Jan)

☒ SITE DEV & GEO TECH
☐ ENVIR PROT & UTIL
☐ ARCHITECTURAL
☐ STRUCTURAL

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☐ ELECTRICAL
☐ INSTR & CONTROLS

☐ SAFETY
☐ ADV TECH
☐ ESTIMATING
☐ SPECIFICATIONS

☐ SYSTEMS ENG
☐ VALUE ENG
☐ OTHER

REVIEW TYPE Draft Project Scoping Document
DATE 2 Jan 91
NAME Healy/ag

ITEM	DRAWING NO OR REFERENCE	COMMENT	ACTION
14	Pg 2017, Par 4	It is unclear what is meant by "The four (4) boreholes...". Are they in addition to or part of the eight referenced in the prior sentence?	
15	Pg 2-24, Par 4	Correct "vertually".	
16	Pg 3-1, First & Last Par	Correct "quantity" and "uunknown".	
17	Pg 3-2, Par 3.1.1	Would recommend avoiding the phrase "disturbed area". Could change "disturbed area" to "OB/OD area". Also, change "the northeast Figure 6" to "the northeast. Figure 6".	
18	Pg 3-6, Par 3.1.2.1	In the last sentence, it would appear more correct to say that the "Volatilization of RDX and HMX is not expected...". Also, do we mean "Alternatively" or "Consequently".	
19	Table 3-4-7	Correct "ARARA's".	
20	Pg 3-13	In line 2, correct "Volmetric". In paragraphs 1 and 2, correct "ordinances" and "behavoir", respectively.	
21	Pg 3-14. Par 3.2.1	Correct "effected".	
22	Pg 3-16, Par 3.3.1	Change "risk of contamination" to "risk due to contamination".	

ACTION CODES:
A — ACCEPTED/CONCUR
D — ACTION DEFERRED
W — WITHDRAWN
N — NON-CONCUR
VE — VE POTENTIAL/VEP ATTACHED

FINAL DRAFT

FINAL DRAFT

U.S. ARMY ENGINEER DIVISION HUNTSVILLE   CORPS OF ENGINEERS

DESIGN REVIEW COMMENTS

PROJECT AMC-SEAD OB Grounds RI/FS (12-270, 3 Jan)

☒ SITE DEV & GEO TECH
☐ ENVIR PROT & UTIL
☐ ARCHITECTURAL
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☐ ADV TECH
☐ ESTIMATING
☐ SPECIFICATIONS
☐ SYSTEMS ENG
☐ VALUE ENG
☐ OTHER

REVIEW Draft Project Scoping Document TYPE
DATE 2 Jan 91
NAME Healy/ag

ITEM	DRAWING NO OR REFERENCE	COMMENT	ACTION
23	Pg 3-18, Par 3.3.4	Clarify "birds them".	
24	Pg 3-20	In line 1, clarify "or are contamination". In paragraph 2, define "SHPS".	
25	Pg 3-31, First Par	Correct "osil".	

ACTION CODES.
A — ACCEPTED/CONCUR
D — ACTION DEFERRED
W — WITHDRAWN
N — NON-CONCUR
VE — VE POTENTIAL/VEP ATTACHED

CEH FORM 7 (Revised)
15 A 89

PREVIOUS EDITIONS OF IS FORM ARE OBSOLETE

PAGE 4 OF 4

FINAL DRAFT

DEPARTMENT OF THE ARMY
U.S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

REPLY TO
ATTENTION OF

HSHB-ME-SR (40)

07 DEC 1990

MEMORANDUM FOR Division Engineer, U.S. Corps of Engineers,
Huntsville Division, ATTN: CEHND-ED-PM
(Mr. Perro), P.O. Box 1600, Huntsville, AL
35807-4301

SUBJECT: Workplan for Remedial Investigation/Feasibility Study at the Open Burning Grounds, Seneca Army Depot, NY, November 1990

1. Review of the RI/FS Workplan has been completed.

2. Primary concerns are discussed in Enclosure 1.

3. Detailed comments and recommendations are provided in Enclosure 2.

4. Because of the seriousness of our concerns, this document should be resubmitted to AEHA for further review prior to finalization.

5. The scientist reviewing this document was Mr. Keith Hoddinott. Our points of contact are Mr. Keith Hoddinott or MAJ William Legg, this Agency, DSN/AUTOVON 584-2953 or commercial (301) 671-2953.

FOR THE COMMANDER:

2 Encls

PAUL THIES
LTC, MS
Chief, Waste Disposal Engineering
Division

CF (w/encl):
HQDA(SGPS-PSP-E)
Cdr, HSC, ATTN: HSCL-P
Cdr, MRDC, ATTN: SGRD-PLC
Cdr, USAMC, ATTN: AMCEN-A
Cdr, Seneca AD, ATTN: SDSSE-HE

FINAL DRAFT

PRIMARY CONCERNS
WORKPLAN FOR
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
AT THE OPEN BURNING GROUNDS
SENECA ARMY DEPOT, NEW YORK
NOVEMBER 1990

1. Missing Pathway
    The contractor does not consider incidental soil ingestion.

2. Unjustified Receptor
    The contractor should not include affects of the site contaminants on receptors in Seneca Lake until it is shown that site contaminants reach the lake.

3. Inappropriate ARAR's
    The contractor presented a list of risk based contaminant levels as ARAR's, which is not valid.

4. Missing Remedial Alternative
    The contractor should consider the use of institutional controls and the individual capping of the burn pads.

Encl 1

FINAL DRAFT

DETAILED COMMENTS AND RECOMMENDATIONS
WORKPLAN FOR
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
AT THE OPEN BURNING GROUNDS
SENECA ARMY DEPOT, NEW YORK
NOVEMBER 1990

1. Page ?, Table 1, Mr. Hoddinott
Average Background Concentrations for Soil, Rock, and Water
<u>Comment</u>: While these values show a conceptual relationship well suited for planning, this table does not replace the need for determining a site-specific background.
<u>Recommendation</u>: Include a site-specific determination of background in the workplan.

2. Page 3-9, Table 3-4-7, Mr. Hoddinott
Potential ARAR's.
<u>Comment</u>: The values presented in this table are the contractor's proposed action levels in soil and water. These are not regulatory and thus are not ARAR's. It should also be pointed out that these calculations are based on highly conservative assumptions and not any data supported by an active or future exposure scenario for this site.
<u>Recommendation</u>: Since the actual ARAR's and "to be considered" guidance are presented elsewhere, the contractor and the COE should delete this table from the text.

3. Page 3-10, Section 3.1.3, Mr. Hoddinott
Data Summary and Conclusions
<u>Comment 1</u>: The wording of the first paragraph needs to be changed. While these soils contain a significant amount of clay, the sieve analysis measures different grades of sand, and a combined value for silt and clay. It is highly unlikely that these soils contain a range of clay from 31 to 78%. This is the range of the combined silt and clay fractions. If the soil's clay content is required, a hydrometer analysis would have to be performed.
<u>Recommendation</u>: Re-word the affected paragraph(s) to reflect the actual type of data observed from a sieve analysis. This would also explain the higher permeability rates found in the soil. A soil with 78% silt and clay has a higher expected permeability than a soil with 78% clay. This comment also applies to page 3-12.

<u>Comment 2</u>: The idea that all of the nitrated metal compounds would transform to the oxide assumes 100% burn efficiency. This is not valid as evident by the residual explosive compounds. If this was true, there would not be any explosive contamination.
<u>Recommendation</u>: Change the affected paragraphs to introduce the idea that some of the original salts will remain.

Encl 2

FINAL DRAFT

4. Page 3-11, Section 3.1.3, Mr. Hoddinott
Data Summary and Conclusions
Comment: The previous geophysical studies found metalics in the upper 5 feet not 55 feet. We assume this is a typographic error but it was too important to go unmentioned.
Recommendation: Correct the depth value in this section.

5. Page 3-14, Section 3.2.1, Mr. Hoddinott
Surface Water Runoff and Erosion
Comment: Before the contractor is allowed to risk assess the impact of this site on the food chain through Seneca Lake, they will have to conclusively prove through sampling that a significant amount of site contamination is reaching Seneca Lake.

Recommendation: A phase assessing the effect on the food chain (or other receptors) through Seneca Lake should wait until it is show that a significant amount of contaminants are migrating offpost, with a reasonable chance of reaching the lake.

6. Page 3-14, Section 3.2.2, Mr. Hoddinott
Fugitive Dust Emissions
Comment: The contractor has not considered incidental soil ingestion as a viable exposure.
Recommendation: Include incidental soil ingestion as an exposure pathway or justify its exclusion.

7. Page 3-15, Section 3.3, Mr. Hoddinott
Scoping of Potential Remedial Action Alternatives
Comment: The contractor has not considered institutional controls as a viable option.
Recommendation: Include institutional controls as option or justify its exclusion. The contractor should also consider the capping of only those pads which are significantly contaminated.

8. Page 3-42, Section 3.5, Mr. Hoddinott KIETH
DQO's
Comment: The contractor use of statistics to determine the distance between samples should follow a different conceptual base. The contractor has conceptually considered the entire 30 acres as one site coming up with a distance of 200 feet between samples. The contractor should consider each pad as a contaminant source and recalculate the distance for an average pad.
Recommendation: Reconsider the conceptual basis for the geostatistics from one contamination source to a source from each pad.

MAIN
1893

CHAS. T. MAIN, INC.

PRUDENTIAL CENTER, BOSTON, MASSACHUSETTS 02199 • TELEPHONE 617 262-3200 • TELEX 4430035 • FAX 617 859-2575

FINAL DRAFT

August 26, 1991
1345-082-6228

Mr. John Romeo
CEHND-PM-E
U.S. Army Corps of Engineers
Huntsville Division
Huntsville, Alabama 35807-4301

SUBJECT: RI/FS Work Plan, OB Grounds

Dear Mr. Romeo:

In response to the comments received from Jeff Healy of Alliance Technologies Corporation (Alliance), Carla Struble of the U.S. Environmental Protection Agency (EPA) and Kamal Gupta of the New York State Department of Environmental Protection (NYSDEC), Chas. T. Main, Inc. (MAIN) submits the following responses to the OB Grounds Work Plan originally submitted by MAIN in April of 1991. The comments received from Alliance, EPA, and NYSDEC are underlined and followed by MAIN's responses. These responses have incorporated the information obtained from discussion which took place in several conference calls (August 8, 12, and 15, 1991) as part of MAIN's request for clarification on several issues (July 31, 1991 letter).

ALLIANCE PAGE-SPECIFIC COMMENTS

Section 3.2 - Identification of Potential Receptors and Exposure Scenarios

P. 3-19 This comment concerns dermal exposure to fugitive dusts.

The exposure pathway model presented in Figure 15 indicates that dermal contact with dusts will be evaluated for area residents, but not for site visitors, while the discussion on pages 3-21 and 3-22 seems to imply exposure to dusts will be greater for site visitors than for area residents. This exposure pathway should be clarified. Additionally, no distinction is made between surface and subsurface soils.

Figure 15 is set up to show that area residents may experience ingestion, dermal, and inhalation exposure via movement of fugitive dusts offsite. Dermal contact with dust to site visitors is not included in this block because they may be subject to dermal exposure to soils, a much greater magnitude exposure than the exposure envisioned for area residents. Thus, the dermal contact with dust for visitors is covered by the dermal exposure to soils scenario. A distinction between surface and subsurface soils will be made, where appropriate. The Work Plan will be clarified.

FINAL DRAFT

P. 3-22 This comment concerns 1) environmental impact of contaminated soils on burrowing mammals, and 2) future use of the site as light industrial.

1) The potential environmental impact of contaminated soils on burrowing mammals should be included in the discussion of exposure pathways and receptors.

2) Further justification should be provided in support of the assumption that future use of the site will be restricted to light industrial uses. Justification should include: information on local zoning, master plans for neighboring communities, additional information on nearest residences and sources of drinking water supplies. The potential for additional residences utilizing groundwater as a source of drinking water being located adjacent to or on the site at some time in the future may need to be considered in developing future exposure scenarios.

1) MAIN will characterize the terrestrial animals as part of an initial survey, and if present, the potential impacts on burrowing animals shall be included. This will be stated in the Work Plan.

2) The additional information for the assumption that the future use of the site will be restricted to light industrial uses is provided below.

MAIN contracted the Romulus Town Clerk, Jonie Hamilton, regarding zoning maps for the site and surrounding area. According to Ms. Hamilton, no zoning maps exist for the site or surrounding areas in the Town of Romulus. She also stated that there were no plans for neighboring communities. She did state that New York State has preliminary plans for a correctional facility in Seneca on Route 96A near Deal Road, approximately 1.5 miles southwest of the site. However, these plans have been delayed due to the state's financial difficulties. She was not able to provide plans for the facility. She did state that any development would have to meet the requirements of the New York State Uniform Fire Prevention and Building Codes and Subdivision Regulations of New York state.

MAIN contacted the Building Code Enforcement Office regarding the proposed correctional facility development. Wayland Daffler of this office stated that the development was on hold for financial reasons. He knew of no other planned developments in the area.

The Seneca County Department of Health was contacted regarding the presence of private residential wells near the site. Charles Carroll of this office stated that the Seneca army depot was serviced by water from Seneca Lake. The residences to the west of the depot all have private wells as no water service is provided to this area, according to Charles Carroll. Based on this

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information the nearest residential wells would be approximately 1.5 miles to the west of the OB grounds. The Department of Health does not maintain a list of private wells. Mr. Carroll also knew of no planned developments in the area of the site.

Given the current and anticipated use of the site as a restricted area for open burning, it is unlikely that it will be used for residential development in the future.

This information will be incorporated into the Work Plan.

Section 3.4 - Preliminary Identification of Applicable or Relevant and Appropriate Requirements

P. 3-45 This comment concerns evaluating potential impacts on white deer.

While there are no ARARs protecting the rare white deer found on the Seneca Army Depot (Department of the Army, Installation Environmental Assessment for the Seneca Army Depot, 1980), it may be appropriate to discuss potential site impacts on this unique population.

Currently, the Seneca Army Depot has in place a Wildlife Management Plan which includes the white deer. As part of the plan, population indices prepared by NYSDEC are compared to aerial counts performed by SEAD employees. Together they provide accurate year to year data on the number of deer and the white-to-brown ratio.

Because the deer are known to live and feed outside the area which makes up the OB grounds, MAIN does not feel that the impacts of the site on this population can be accurately assessed. The RI investigation will collect a great deal of data on the OB grounds, however, data on other areas outside the OB grounds will not be collected. It would be inappropriate to evaluate the impacts to the deer based on data from only the OB grounds, as the off-site areas also have the potential to impact the deer. Distinguishing between on-site and off-site impacts to the white deer is beyond the scope of the RI/FS. MAIN is not aware of how this could be evaluated during the RI/FS. No change will be made to the Work Plan.

Section 3.6 - Data Gaps and Data Needs

P. 3-65 This comment concerns sampling groundwater at residential locations.

If residential wells are determined to be located near and downgradient from the site while gathering background information, water samples should be collected and analyzed for contaminants to establish a baseline.

Groundwater flow has been determined to be to the east-northeast toward Reeder Creek (Figure 26). Based on field reconnaissance, no residential wells have been

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determined to be located directly downgradient of the OB grounds. However, if during the course of the investigation residential wells are to be located near and downgradient from the site, they will be sampled and analyzed for contaminants. While residences with private drinking water wells are present west of SEAD, presently, MAIN does not feel that it is necessary to sample groundwater from these residential wells farther downgradient of the site. This clarification will be added to the Work Plan.

P. 3-68 This comment concerns the collection of background soil and groundwater samples.

Item 3 - Data Needs for Soils includes as the third bullet, to "establish background levels for similar soils, off the OB/OD grounds."

During the collection of background samples, MAIN should take precautions to assure that all background samples are collected from "clean areas." This is essential due to the large number of other suspected source areas present on the SEAD property. It may be advisable to collect background samples off site.

MAIN will take precautions to assure that soil background samples are collected from nearby "clean areas." Background surface water and groundwater samples will be collected from nearby the site in upgradient locations to determine the quality of water entering the site. MAIN does not feel that it will be necessary to collect background samples from areas outside of the Seneca Army Depot.

This information will be added to the Work Plan.

P. 3-69 This comment concerns wetlands delineation.

A wetlands delineation should be included in the biological data needs section.

A wetlands delineation of the OB grounds will be included in the biological data needs section.

MAIN proposes to delineate wetlands on the approximately 30 acre OB grounds using the Unified Federal Routine Method Routine Method. Figure 29 illustrates the approximate area of the OB grounds. Wetland covertypes will be evaluated using aerial photographs, existing wetland maps (NYSDEC Wetland Regulatory Maps and United States Fish and Wildlife Service (USFWS) National Wetland Inventory Maps) and field reconnaissance. Wetland boundaries will not be surveyed as part of this delineation.

Wetlands outside the OB grounds will be evaluated using aerial photographs, existing wetland maps (NYSDEC Wetland Regulatory Maps and USFWS National Wildlife Inventory Maps) and field reconnaissance to confirm wetland delineations,. where necessary.

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Section 4.2 - Field Investigation

Section 4.2.1 - Geophysical Investigation

P. 4-3 This comment concerns the areas of the geophysical surveys.

Figure 22 does not clearly indicate the different survey areas for the four proposed geophysical exploration techniques. No explanation is provided on the figure for the two different shaded regions, except that they are both the "areas of geophysical survey." Also, the twenty-foot wide access paths shown on the figure are not discussed in the text.

The figure should be amended to illustrate the extent of coverage for the four different geophysical surveys. The overall perimeter of the geophysical investigation for the OB area should be clearly indicated.

An explanation for the two regions of the proposed geophysical surveys will be added to the map (Note: the RADAR and STOLS surveys will not be performed per the discussion during the June 24, 1991 conference call between EPA, Seneca and their contractors). The Work Plan will be modified to reflect only the two geophysical surveys. The 20 foot wide access paths will be discussed in the text.

The overall perimeter of the geophysical surveys will be clearly indicated on Figure 22.

P. 4-4 This comment concerns the grid spacing for the RADAR and STOLS surveys.

The second paragraph discusses a 30-acre grid consisting of a 200-foot grid node spacing. This grid system, and the overall grid perimeter, should be illustrated on a figure.

Is the 200-by-200-foot grid spacing being proposed for the RADAR and STOLS surveys? Additional information regarding the adequacy of this grid spacing for location of individual UXOs should be discussed. Are the proposed grid spacings adequate to locate objects of the expected size of the UXO? Discussion of the width detection of the RADAR and STOLS surveys should be included.

This information will be deleted from the Work Plan as the RADAR and STOLS surveys will not be performed per the above note.

P. 4-8 This comment concerns the 25 foot grid spacing plots for the SIR-10 System geophysical survey.

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The 25 feet grid spacing plots discussed in the third paragraph which will be used for the geophysical surveying and soil sampling should be illustrated on a figure.

The 25 foot grid spacing plots correspond to soil sampling locations.

P. 4-8 This comment concerns a staging area for excavated soils.

The last paragraph of page 4-8 discusses cross-section excavation and sampling of subsurface geophysical anomalies. MAIN states, "The contents of each bucket of material removed from the excavation will be gently placed on the ground and spread out so as to expose the contents as much as possible for visual inspection." A staging area, which includes run-off containment features, should be set up for visual inspection of the contents so that soils potentially contaminated with hazardous constituents are not spread out over the site.

Agreed. A staging area, similar to that described above, will be set up for visual inspection of the soils. This will be stated in the Work Plan.

P. 4-9 This comment concerns calibration of geophysical equipment based on information of depth and orientation of uncovered UXOs.

Information regarding the depth and orientation of the UXO relative to the transect will be useful in calibration of the geophysical results. This information should be collected and analyzed to evaluate if predicted depths to UXO can be refined as experience with analysis of the geophysical results at the site increases.

Where possible, the geophysical equipment will be calibrated using the results of the depth and orientation of any uncovered UXOs. This will be stated in the Work Plan.

Section 4.2.2 - Soils Investigation

P. 4-9 This comment concerns conditions for terminating borings.

The conditions for termination of the soil borings at the OB grounds are unclear. The last paragraph of page 4-9 states that continuous split-spoon soil borings will be collected across the OB grounds and on each burning pad form 0 to 10 feet deep. Yet, in the fourth paragraph on page 4-10, it is stated that the soil borings will be performed until refusal, and that refusal is expected at 10 feet.

The soil borings should be advanced to refusal, as is stated on page 4-10. The last paragraph on page 4-9 should therefore be edited to avoid confusion about the conditions at which borings will be terminated. MAIN should change "0-10 feet deep" to "refusal, which is anticipated to be at ten feet deep."

Agreed. The conditions for terminating the soil borings will be made consistent as described above.

P. 4-10 This comment concerns detection limits and levels of potential risk.

In paragraph 6, MAIN states that two complete Level IV and Level V analyses per borehole will satisfy the Data Quality Objectives (DQOs) of the risk assessment. The following comment is noted.

In cases where potential site contaminants are suspected to pose toxicological risks at environmental concentrations below the Contract Required Quantitation Limits (CRQLs) (based on a review of toxicity data), it may be advisable to analyze a percentage of the TCL/TAL analyses to a lower detection limit for those specific compounds, to verify that the suspect contaminants are not present at these lower concentrations.

As agreed upon in previous meetings, MAIN will use NYSDEC CLP protocols, including the standard quantitation limits, for the analyses to be performed. A review of potential site contaminants and detections limits indicates that none of the contaminants presents a significant toxicological risk at the detection limit. No change will be made to the Work Plan.

P. 4-11 This comment concerns the Level II screening analysis.

The first paragraph states, "Level II analyses will only be performed to certain indicator compounds. The indicator compounds selected for the screening program are lead for heavy metals, TNT for explosives, and total volatile hydrocarbons for the volatiles." MAIN states that lead and TNT were judged to be good indicator compounds "because they were found to be prevalent in earlier soil investigations and at elevated concentrations."

Level II analyses for the indicator compounds will be performed on all of the subsurface soil samples taken at the OB grounds during soil investigation activities. Based on these Level II results, one subsurface soil sample for each boring will be collected for Level IV and Level V analyses consisting of NYSDEC CLP analytical methods for TCL and TAL constituents and Method 8330 for explosives.

2,4-DNT and 2,6-DNT have been detected in site soils during previous sampling efforts. MAIN states that 2,4-DNT and 2,6-DNT are considered to be moderately mobile and are the most mobile of the explosives detected on site. Furthermore, MAIN states in Section 3.1.3, that 2,4-DNT was detected in a groundwater sample in excess of Federal water quality criteria.

Under the proposed soil sampling strategy, only one subsurface soil sample from each boring will be analyzed for the full Level IV and Level V analyses. While the full

Level V explosive analyses will be performed on the split spoon sample containing the highest level of TNT, the sample submitted for full explosives analyses may not necessarily contain the highest explosive contaminant concentration of the interval samples collected for the boring due to the limited indicator compound list.

Based on the above discussion, MAIN should provide discussion on why the indicator compounds for the Level II screening of subsurface soil samples does not include 2,4-DNT and 2,6-DNT.

MAIN's understanding of a screening program is select indicator compounds to streamline the number of constituents to be analyzed and the complexity of the analysis. Furthermore, analytical screening methods are not available for all the explosive constituents found at the site. The approach taken by MAIN is to select indicator compounds for the various chemical groups of interest. To expand these indicator compounds is beyond the scope of screening program and will complicate the selection criteria for samples which will undergo a higher level of analysis. MAIN respectfully requests EPA reconsider this position and provide guidance as to why the selection of these indicator compounds is inappropriate.

MAIN has proposed the use of field screening techniques to provide a larger data base then would be available if full level IV analyses were performed on all of the samples, given reasonable financial limitations for laboratory analyses. MAIN used the general methodology outlined in EPA's "Data Quality Objectives For Remedial Response Activities" Development Process (March 1987) (EPA 540/G-87/003) to identify data quality needs for the RI/FS. The EPA document cites the use of Level II data to determine "extent of contamination."

In addition, the field screening program was based on review of the available analytical data, the capabilities of Level II data, and the volume of data generated when Level II and Level IV are combined. Specifically, MAIN has chosen TNT as an indicator compound for explosives. In reviewing the data presented in TAbles 3 and 4 and on subsequent figures (8, 9, and 10) it is evident that TNT is a good indicator compound for explosives in soil for the following reasons:

- Table 4 USAEHA Phase 2 Data: TNT ranges from ND-9270 ppm and is fairly prevalent (occurs in 6 of 24 samples) when compared to the lower concentrations detected for other explosive compounds which are less prevalent. The exception is RDX which occurs in 18 of 24 samples, however, the concentrations of this compound are low (ND-2.7 ppm).
- Table 4 USAEHA Phase 2 Data: The same general relationships for TNT and other explosive compounds can be seen in this 1984 data summary. TNT is the most prevalent explosive compound and also was detected at the highest concentrations.

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- In Figures 8 through 10 the analytical summary boxes indicate the vertical presence of TNT and other explosive compounds. In most instances explosive compounds including TNT were detected at the surface from 0-0.5 feet. As MAIN's sampling program includes Level IV analysis of every surface soil sample (0-0.5 feet) per boring, as well as one other sample per boring, which based upon screening, has been shown to contain explosive compounds.

In a similar manner, the existing background data was reviewed. Based upon the frequency of occurrence and the concentrations of lead was selected as an indicator compound for the heavy metal fraction.

When Level II and IV data are combined, the resulting data set is expected to provide the most information about the concentrations and extent of contamination on-site.

No change was made to the Work Plan.

P. 4-11 This comment concerns earth moving methods and the spreading of contaminated migrating soils.

MAIN states in the last sentence of p. 4-11 that "A backhoe or suitably equivalent piece of equipment will be used to open berms for sampling."

MAIN should provide further discussion on the proposed earth-moving methods during berm sampling that will mitigate the potential of spreading contaminated soils across the OB grounds during this activity.

MAIN proposes to conduct the sampling of the berms in such a way as to minimize the spreading of contaminated soils across the OB grounds. MAIN will accomplish this in the following way.

1) Using designated areas for temporary storage of the soil during excavation and collection of the sample. The temporary storage area will be immediately adjacent to the excavated area;

2) The backhoe or suitably equivalent used for berm sampling will be decontaminated using a steam cleaner after excavating at each sampling location. In addition, the decontamination procedures in Section 4.5 may also be employed; and

3) Returning the excavated soil immediately to the berm upon completion of the soil sampling.

This information will be added to the Work Plan.

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P. 4-14 This comment concerns the Level II screening data and determining the extent of vertical and horizontal contamination of the site.

The second paragraph states that "the Level II screening data will be used to evaluate the extent of vertical and horizontal contamination at the site." Only the vertical and horizontal extent of lead, TNT and total volatile hydrocarbons will be able to be evaluated. Other contaminants which have been previously detected on site, such as barium, TDX, HMX, tetryl, 2,4-DNT and 2,6-DNT, are not included on the indicator compound list for Level II screening of subsurface soils and, therefore, limited data will be available. This data will include one surface soil result and one subsurface soil result (which will probably be taken for various intervals throughout the site) from each boring. The vertical and horizontal extent of contamination of these other compounds may not be able to be evaluated effectively due to the varying soil sample collection depth.

MAIN's response is the same as in the first comment on p. 4-11, above. No change was made to the Work Plan.

Section 4.2.3 - Surface Water Investigation

P. 4-25 This comment concerns background concentrations in Reeder Creek, and wetland sampling.

The first paragraph of Section 4.2.3 states "concentration levels in Reeder Creek, upstream of the OB/OD grounds will be used as background." MAIN should provide a statement regarding whether or not upstream areas have been impacted by other SEAD sources or offsite sources.

In the same paragraph, MAIN states that onsite surface water will be sampled "if the size of water represents a wetland." MAIN should state the minimum size that would represent a wetland.

In order to fully characterize the nature and extent of contamination of surface waters and sediments at the OB grounds, surface water and sediment samples should be collected from all identified onsite wetlands areas and drainage ditches.

Based on the review of the available data to date, MAIN has not uncovered information indicating that upstream areas have been impacted by other SEAD sources or off-site sources. This will be stated in the Work Plan.

MAIN intends to delineate wetlands on the OB grounds site. Wetland determinations on the OB grounds will not be based on size alone rather the methods described below. MAIN proposes to delineate wetlands on the approximately 30 acre OB grounds using the Unified Federal Routine Method Routine Method. Figure 29 illustrates the approximate area of the OB grounds. Wetland covertypes will be evaluated using aerial photographs, existing wetland maps (NYSDEC Wetland Regulatory Maps and United States Fish and Wildlife Service (USFWS) National Wetland Inventory Maps) and field reconnaissance. Wetland boundaries will not be surveyed as part of this delineation.

Wetlands outside the OB grounds will be evaluated using aerial photographs, existing wetland maps (NYSDEC Wetland Regulatory Maps and USFWS National Wildlife Inventory Maps) and field reconnaissance to confirm wetland delineations, where necessary.

MAIN's choice of sample locations in "potential wetland" areas is based on a cursory inspection of the site. These areas were identified as being most likely to be impacted by site activities.

MAIN's intent is to sample the six low-lying areas, which were determined to be likely areas of temporary surface water storage and therefore areas of sediment deposition. These areas were identified by field reconnaissance. It is not MAIN's intent to sample all wetlands identified using the methods described above, because any potential on-site wetland may not represent an area of sediment deposition.

MAIN feels that the selection of on-site low-lying areas and drainage channel samples will provide a good indication as to whether surface run-off from on-site activities have impacted these areas. The surface water and flow patterns for the site, Figure 25, indicates that surface water flow is toward Reeder Creek. As seen from the figure, surface water flows through one or more of the sampling locations. The selection of these locations was based upon these identified surface water flow patterns and the topographic site contours. For clarification, sampling points for the identified potential wetland areas and drainage channels will be marked on the Surface Water and Sediment Sampling Plan, Figure 25, as requested. An explanation for selecting the six sampling locations will be added to the Work Plan.

P. 4-25 This comment concerns sediment and surface water sampling locations.

<u>The first paragraph of Section 4.2.3.1 states that "Sediment samples will be collected for each surface water sample collected." The RI/FS Work Plan does not state whether or not sediment sampling locations will correspond with surface water sampling locations.</u>

<u>Sediment samples should be collected at the same point as corresponding surface water samples.</u>

To clarify this, the sediment samples will be collected for the same general location as the surface water samples. Specifically, the sediment samples will be collected from areas of deposition and the surface water samples will be collected from areas of slow moving water. These two locations will be the same in Reeder Creek. This will be clarified in the Work Plan.

P. 4-26 This comment concerns surface water sampling, rainfall data, analysis of material sediment for hardness, and organic carbon.

In Section 4.2.3.2, MAIN recognizes the impact of seasonal variation in the site water level and suggests that surface water sampling will take place in late summer to minimize dilution of contaminants. It would be preferable to have replicate surface water and sediment samples for each location taken at different times during the remedial investigation, if possible.

Information on local rainfall, including average annual rainfall and total rainfall for the year prior to sampling would be useful and should be obtained.

The following additional water and sediment quality parameters should be determined: hardness and dissolved organic carbon. These parameters affect the availability of the contaminants and are sometimes necessary for calculating target criteria.

Presently, MAIN is confident that the sampling program for surface water and sediment will provide the appropriate data to meet the data needs identified in the data quality objectives, however, MAIN will evaluate the potential for an additional round of surface water and sediment sampling upon review of the first round.

Information on rainfall data will be collected prior to sampling.

Analysis for hardness will be performed for surface water. Through the clarification process it was learned that the reference to dissolved organic carbon was a typing error and this should be ignored. MAIN will ignore this. Hardness will be added to the text and tables.

Section 4.2.4 - Groundwater Investigation

P. 4-31 This comment concerns performance of pumping tests.

If groundwater remediation is determined to be necessary , pump tests will be required to determine additional aquifer characteristics such as the "radius of influence" of capture wells.

Agreed. In the event that groundwater remediation is determined to be necessary, a pumping test will be performed to obtain additional aquifer characteristics. This statement will be added to the Work Plan.

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P. 4-33 This comment concerns an additional well and movement of one well.

In Figure 26, it appears that weathered bedrock monitoring wells will not be installed downgradient of burning pads D and E. Also, the proposed locations of the weathered bedrock monitoring well at burning pad C is shown adjacent to, and not downgradient of, the burning pad.

MAIN should consider including a single bedrock monitoring well downgradient of burning pads D and E, and that MAIN consider repositioning the location of the proposed bedrock well by burning pad C so that it is downgradient of the pad, and coupled with the proposed overburden well in this area.

Agreed, MAIN will install an additional well downgradient of burning pads D and E. The proposed bedrock well by burning pad C will be located downgradient of the pad and coupled with the proposed overburden well in this area. These modifications will be incorporated into the Work Plan.

P. 4-35 This comment concerns drilling methods.

Paragraph 2 states, "The drilling techniques to be used [for bedrock wells] will be identical to those previously mentioned [for overburden wells]." Overburden wells will be installed remotely using hollow stem augers.

Difficulties may be encountered in using hollow stem augers to boreholes for weathered bedrock well installation. Based on the proposed well construction specifications, a minimum of three feet must be drilled into the bedrock. If auger refusal is reached before the three feet is drilled or the weathered zone is thinner than three feet, other drilling methods may have to be used. MAIN should discuss alternative drilling methods they intend to use (i.e., wash rotary, air rotary, coring methods, etc.) in the event that hollow stem augering is inadequate.

In the event that hollow stem augering does not penetrate the weathered bedrock, air rotary techniques will be used to advance the boring to the specified depth. This statement will be added to the Work Plan.

Section 4.2.5 - Ecological Investigation

P. 4-39 This comment concerns collection of mammals and water fowl for tissue analysis.

MAIN proposes to collect tissues of aquatic organisms for contaminant analyses. It may be appropriate to collect and analyze waterfowl or mammal tissue samples, in addition to the aquatic organisms as well, since the base is used for hunting (Department of the Army, Installation Environmental Assessment for the Seneca Army Depot, 1980).

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Based on discussions held during the request for clarification period, MAIN proposes to conduct tissue sampling, if necessary, as part of a Phase II Investigation. The first phase will be a habitat characterization to obtain information on what species are likely to utilize the site, as well as an assessment of soil, sediment and aquatic chemistry. Following an analyses of Phase I results, a determination regarding necessity and scope of tissue sampling plan will be made. The Work Plan will be revised to incorporate a phased approach to tissue sampling.

p. 4-41 This comment concerns measurement endpoints for terrestrial organisms.

<u>The second paragraph states that "Toxicity testing will depend upon the results of Phase One. For example, if pollutants are reaching Reeder Creek and do not seem to effect terrestrial organisms in route then toxicity testing for Reeder Creek organisms only would be conducted." While a tiered approach is recommended for ecological assessments, the criteria for determining whether terrestrial organisms are effected needs to be further defined.</u>

The criteria will be 1) habitat abnormalities (vegetational) and 2) soil chemistry data. This information will be added to the Work Plan.

P. 4-42 This comment concerns gross abnormalities in fish.

<u>Observations of gross abnormalities in fish should be recorded during fish sampling.</u>

<u>If fish tissue samples are to be collected from migratory fish, it may be necessary to restrict sampling to young-of-the-year fish to link contamination to the site, if other sources of contamination are possible.</u>

Agreed. This is done as a matter of routine during fish sampling. Table A-9 identifies MAIN's standard fish collecting forms and these forms make note of abnormalities. No change will be made to the Work Plan.

Yes, collection of young-of-the-year fish would be our intent, if they are present. Sampling adults, however, would provide a more direct link to human consumption.

<u>Section 4.2.6 - Surveying</u>

P. 4-46 This comment concerns identification of control points prior to the aerial photographic survey.

<u>MAIN discusses the location and identification of survey control points in the second paragraph. Control points should be located prior to the aerial photographic survey to assure that the control points are able to be identified during the flight.</u>

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U.S.G.S control points exist at the Seneca Base. This information is available to the surveyor and will be used by the surveyor.

P. 4-48 This comment concerns determining the boundary for the aerial photographs survey and photographing existing conditions outside the base boundary.

<u>MAIN discusses aerial photographic surveying activities in the third paragraph of page 4-48, and states that "The photographs to be taken will be sufficient enough to cover the entire area to be investigated, including the sections of Reeder Creek which will be sampled."</u>

<u>Additional discussion should be provided on the boundaries of the aerial photographic survey. If the intent of the aerial survey is to provide information for determining groundwater and surface water movement, existing conditions outside the base boundary may help identify onsite conditions. A U.S.G.S. topographic map should be used in determining the limits of the photographic survey. A copy of the survey boundary should be included as a deliverable for the surveyor.</u>

As stated in the Work Plan "the photos taken will be sufficient enough to cover the entire area to be investigated including the sections of Reeder Creek which will be sampled." The boundary of the photographic survey will correspond approximately to the area defined as the "Extent of Terrestrial Survey" on Figure 29. A U.S.G.S. topographic map will be used to determine the limits of the photographic survey. MAIN will provide a copy of the survey boundary as a deliverable to the surveyor.

<u>Section 4.3 - Data Reduction, Assessment and Interpretation</u>

P. 4-49 This comment concerns the interpretation of the geophysical data.

<u>In Section 4.3.1, MAIN provides the objectives of the geophysical investigation. No discussion is given on the proposed use of the geophysical information. MAIN should provide a description of the figures that will be included in the RI report to illustrate and interpret collected geophysical data.</u>

The following figures will be prepared to support the interpretation of the geophysical data:

<u>Electromagnetic Induction Survey (EM)</u>

1) The EM survey grid will be shown on a base map of the site.
2) Contours of the quadrature and in-phase component readings will be prepared and shown on a base map of the site. The individual EM readings will be provided on tables.

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Ground Penetrating Radar (GPR) Survey

3) The GPR survey lines will be shown on a base map of the site.
4) The subsurface image radar profiles from the graphic strip recorder, annotated by the geophysicist, will be provided as an appendix.

EM and GPR Surveys

5) Anomalous areas defined by the EM and GPR survey will be shown as shaded areas on a base map of the site.

Section 4.4 - Baseline Risk Assessment

P. 4-52 This comment concerns selection of indicator compounds.

The Guidance for Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish (U.S. EPA, 1989) should be used to interpret fish tissue sampling data.

Current guidance favors carrying most contaminants through the risk assessment unless there is adequate justification for eliminating them, rather than selecting a few indicator compounds. It is unclear from the Work Plan which approach will be taken.

The Guidance for Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish (USEPA, 1989) will be used when appropriate during the course of the FI/FS. This will be referenced in the Work Plan.

It is MAIN's intent to carry most compounds through the risk assessment and only exclude compounds with proper justification. This will be clarified in the Work Plan.

P. 4-55 This comment concerns identification of receptor populations and future use scenarios.

The preliminary identification of receptor populations presented in Section 3.2 should be expanded in the risk assessment; the location of nearest residences, sensitive subpopulations (e.g., schools, hospitals, etc.), surrounding land use, etc. should be provided.

Future exposure scenarios may need to include the possibility of exposure to onsite surface water and sediments, especially in the wetlands areas.

Receptors identified in the risk assessment will include sensitive populations and locations of nearby residences, etc. Information on these potential receptors and on current and future land uses will be obtained from local sources as a part of the risk assessment.

Future exposure scenarios will include the possibility of exposure to onsite surface waters and sediments. This will be clarified in the Work Plan.

P. 4-56 This comment concerns models for air contamination estimation and future use scenarios.

The model to be used to determine concentrations of airborne contaminants should be specified and described.

It is unclear whether scenarios involving excavation workers will include exposure to both surface and subsurface soils.

Future scenarios may need to consider the possibility of residential development of the area. If such scenarios are not to be considered, the rationale for their exclusion should be fully justified.

The use of the Risk Assessment Guidance for Superfund (RAGs) and the newly-developed, Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors (U.S. EPA, 1991) should be used as the primary source for exposure parameters. The Superfund Exposure Assessment Manual (U.S. EPA, 1990) and the Exposure Factors Handbook (U.S. EPA, 1990) should only be used for scenarios not included in the supplemental guidance.

A Gaussian plume dispersion model will be used to assess dispersion of airborne contaminants; both particulate and vapor phase, from the site to potential receptors. Estimation of vapor and fugitive dust concentrations will be performed using models contained in Methods for Estimating Fugitive Particulate Emissions from Hazardous Waste Sites (USEPA, 1988a), as well as other publications. The particular models to be used depends on the nature of the site areas to be assessed as sources (e.g., bare fields, grassy fields, berms, etc.) and an explanation of each of the models that may be used is too lengthy to be included in the Work Plan. All models used in the risk assessment will be described and their use justified. This statement will be added to the Work Plan.

Exposure to excavation workers will include exposure to both surface and subsurface soils. The Work Plan will be changed to state this.

Future uses scenarios considering residential development are to be further clarified through the above correspondence between EPA, NYSDEC, MAIN and Alliance.

Agreed. Supplemental Guidance will be used. The Work Plan will be changed to state this.

P. 4-57 This comment concerns exposure scenarios, dermal absorption factors and intake assumptions.

Separate exposure scenarios should be developed for children since they represent a sensitive subpopulation.

The Absorption Factor given is recommended for use with potting soil; the absorption factor for kaolin clay may be more appropriate at this site.

Intake assumptions presented in Table 22 should be modified to be consistent with the new guidance cited above.

Exposure of children is accounted for in chemical intake calculations and activity patterns (e.g., wading in offsite portions of Reeder Creek), although these are not specified as applying to children in the text.

The absorption factor for kaolin clay will be used. The Work Plan will be changed to state this.

Agreed. Intake assumptions in Table 22 will be modified.

P. 4-59 This comment concerns the environmental assessment.

The discussion of the Environmental Assessment is not well-defined. It is unclear: (1) how contaminants of concern will be selected or if the contaminants of concern selected for the human health exposure assessment will be used; (2) whether the assessment will be entirely qualitative, and if not, how exposure doses will be determined for classes of organisms not sampled, (3) how macroinvertebrate tissue sample data will be utilized; and (4) if data will be collected on fish populations while collecting fish for tissue analysis. The data to be used in the environmental assessment and the methods of interpretation should be clearly specified.

1) Contaminants of concern will be selected separately for the environmental assessment using the same criteria for human health assessment: Magnitude and frequency of detection, distribution, toxicity, environmental fate, and other factors. Toxicity criteria will be based on potential effects to habitats and environmental receptors and environmental fate considerations will put greater emphasis on the potential for bioaccumulation and biomagnification.

2) The first phase of the assessment will be largely qualitative.

3) The selection of organisms for tissue analysis (Phase II) will depend on the results of the habitat assessment (Phase I). Quantitative exposure doses will not be determined for organisms not sampled. Because tissue sampling is to be included as part of Phase II, details regarding the use of macroinvertebrate

tissue sample data, if collected, will be provided upon review of the Phase I data. In general, tissue sample data will be used to assess the bioaccumulation of contaminants of concern so that estimates of the potential for effecting humans and other higher organisms can be assessed. Shell fish are indicator species which can represent worst case bioaccumulation.

4) MAIN will collect data on fish populations as defined on the "Fish Data Sheet," Figure A-9.

The above mentioned items will be clarified in the Work Plan.

Section 4.6 - Task Summary Plan

P. 4-62 This comment concerns data useability for risk assessment.

The Guidance for Data Useability in Risk Assessment (U.S. EPA, 1990) should be used in evaluating data to be used in the risk assessment.

Agreed. This document will be used and the Work Plan will be modified accordingly.

P. 4-63 This comment concerns background samples in wetlands.

Table 23 implies that background samples will not be included for wetlands. Background samples are necessary for evaluating data collected at locations influenced by the site.

Background samples for wetlands will be performed. The background wetlands will be comparable in function to on-site wetlands. The background wetland sample location will be chosen based on the results of the wetlands determination. The Work Plan will be modified to incorporate this.

Section 5.1 - Development of Remedial Action Objectives

P. 5-1 This comment concerns remedial response objectives.

MAIN states in the second paragraph that "The remedial response objectives for protection of human health and the environment should: ... Determine acceptable contaminant levels in soils, air, and water."

Response objectives do not determine acceptable contaminant levels, rather response objectives are contaminant levels which must be met during remedial action. The contaminant levels are determined during the risk assessment.

Agreed. Remedial action objectives are acceptable contaminant levels. Wording in the Work Plan will be changed to reflect this. However, MAIN believes that acceptable contaminant levels are determined during the feasibility study, not during the baseline risk assessment.

Section 5.2 - Development of Remedial Action Alternatives

P. 5-3 This comment concerns preliminary remedial response actions.

In Section 5.2.1, MAIN identifies preliminary remedial response actions. However, these preliminary remedial response actions are for soil only and do not include the groundwater remedial response actions which were proposed in Section 3.3 (carbon adsorption, ion exchange, chemical oxidation, and reverse osmosis). Also, two of the soil remedial response actions of Section 3.3 are not included on the list on page 5-3 (composting and soil washing/flushing).

Agreed. MAIN will include in Section 5.2.1 the groundwater alternatives listed in Section 3.3. Composting and soil washing/flushing will be included on the list on page 5-3.

P. 5-3 This comment concerns volume estimates based on sampling and analyses of split spoon samples.

MAIN states that volume estimates will account for variability in the underlying subsurface by collection of continuous spoon samples. It is questionable whether or not the collection of split-spoon samples can be used to establish a three-dimensional depiction of the areas and/or volumes of media requiring treatment considering the fact that only one subsurface split-spoon sample per boring will be analyzed for the complete TCL/TAL.

To what extent does MAIN intend to utilize the Level II screening data, as opposed to the Level IV and Level V data, to establish the volumes and/or areas of media requiring treatment?

MAIN is confident that the proposed sampling program involving continuous split spoon sampling at all boring locations and collection of field screening (level II) and NYSDEC CLP (Level IV) data will provide adequate information to establish volumes of contaminated media. MAIN proposed to collect one surface sample and one subsurface sample from each boring for Level IV NYSDEC CLP analyses.

In addition, the screening parameters (TNT, Pb, and total volatiles) collected from the split spoon samples will provide additional information on the distribution of the indicator compounds as well as the associated compounds. MAIN realizes that this approach involves assumptions regarding association of indicator compounds with the remaining compounds not analyzed for during screening, however, MAIN feels that the sampling program provides for the best mix of screening and Level IV data to estimate volumes of contaminated media.

The Level II screening data will supplement the Level IV and V data and will help determine contaminated from noncontaminated areas based on indicator compound associations.

Section 6.1 - Scheduling

P. 6-1 This comment concerns the scheduling of borings and reduction of geophysical data.

Based on Figure 33, it appears that the soil boring programs and the monitoring well installation tasks will begin prior to the initiation of the geophysical data reduction task. Geophysical data should be interpreted and assessed prior to commencement of the soil boring program or installation of monitoring wells.

The reduction of geophysical data and the boring program overlap because the data will be interpreted and addressed as the investigation proceeds allowing the boring program to begin in the areas investigated. The geophysical investigation will be performed periodically during the course of the subsurface investigation to locate UXOs. Borings will not be performed in areas not previously investigated (including data reduction) by geophysics.

Appendix A - Field Sampling and Analysis Plan

P. 2-1 This comment concerns actual responsibilities of field personnel.

Section 2.1, Communications provides reasonable considerations for site communication, but what are the actual responsibilities of field personnel during the RI regarding communication? These should be stated.

The actual responsibilities of the field personnel during the RI regarding communication will be stated in the Work Plan.

P. 2-3 This comment concerns quality control samples.

Section 2.3, Quality Control Samples, should be modified to state that: (1) Trip blanks will be preserved; and (2) Trip blanks must accompany shipments of aqueous samples for volatile organics analysis.

Agreed. This section will be modified to state the suggested language.

P. 2-4 This comment concerns labeling the lower depth interval of soil samples.

Section 2.4, Sample Numbering Scheme, does not indicate how the depth interval for collection of the samples will be identified. For instance, two digits which represent the lower depth interval for the sample could be added to the numbering scheme for

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clarification [i.e., a sample collected from 10 to 12 feet would have "-12" appear at the end of the sample identification number].

The depth interval of soil samples will be recorded in a field log and on the boring log book which indicates the sample number. The Work Plan will be modified to state this.

P. 3-1 This comment concerns use of geophysical methods.

Section 3.1, Geophysical Survey, identifies a number of geophysical surveys to be completed during the RI; however, this section does not identify the survey methods which will precede other survey methods. MAIN should clearly define the sequence and strategy of the survey activities.

The RADAR and STOLS geophysical methods will not be performed as per discussion during the June 24, 1991 conference call between EPA, Seneca and their contractors. Therefore, the sequence for the remaining geophysical surveys will be 1) GSSI Subsurface Interface Radar (SIR) System, and 2) Hand-held magnetometer survey. Both survey methods will be conducted periodically during the subsurface investigation to locate UXOs.

The results from the two methods will be superimposed, where appropriate, to make determinations of subsurface objects.

The above referenced information will be added to the Work Plan.

P. 3-2 This comment concerns the ground penetrating radar survey.

Section 3.1.1, Ground Penetrating Radar Survey, should clearly define which areas at the site are accessible, and what the approximate aerial extent of these areas is.

This comment is not applicable as the RADAR survey will not be performed on-site. The Work Plan will be modified to show this change.

P. 3-4 This comment concerns the magnetometry survey and determination of UXOs encountered.

In Section 3.1.2.2, Magnetometry Survey Procedures, what types of procedures will MAIN utilize to determine when and what type of UXOs have been encountered? Will trenching operations be used to verify UXO type?

Section 3.1.5.2 in Appendix A, provides an explanation of how cross sectional sampling will be performed on the areas of subsurface geophysical anomalies. This will be clarified in the Work Plan.

P. 3-9 This comment concerns air monitoring during cross sectional sampling.

Section 3.1.5.2, Cross Section Sampling Procedures, should propose air monitoring with a combustible gas indicator (CGI), and a photoionization detector (HNu/PID) or Organic Vapor Analyzer (OVA) during this activity.

MAIN will use an HNu meter or OVA to monitor the excavated area. The HFA UXO safety officer will have absolute and final authority in determining procedures and safety issues associated with the excavation. See Section 3.1.5.2 in Appendix A for more information on specific procedures to be performed during cross section sampling.

P. 3-10 This comment concerns decontamination procedures for excavation equipment.

Section 3.1.5.2 states, "excavation equipment will be cleaned between cross section site sampling operations in accordance with decontamination procedures." These decontamination procedures should be cross-referenced in this section.

The decontamination procedures for the excavation equipment will be cross-referenced in this section of the Work Plan.

P. 3-10 This comment concerns the use of the term "mid-depth".

In Section 3.2, Soil Sampling, the term "mid-depth" soil samples should be clearly defined to assist field personnel in retrieving these samples.

MAIN defines "mid-depth" to mean the point half way between the top and bottom elevations of the berms. This will be clarified in the Work Plan.

P. 3-10 This comment concerns the termination of borings.

In the last paragraph, MAIN states "The ultimate depth of the exploratory borings will be at the top of competent bedrock or at ten feet."

As previously mentioned, the condition for boring termination is not well-defined. Will drilling continue if the bedrock is found to be at a depth greater than ten feet? All borings should be advanced to refusal regardless of the expected depth of bedrock.

Agreed. Drilling will continue to refusal if the bedrock is found to be at a depth greater than 10 feet..

P. 3-11 This comment concerns grouting of borings and continuous split spoon sampling.

Section 3.2.2, Boring Techniques, states that upon completion of sampling, borings will be backfilled with bentonite/cement grout to the surface. The discussion of grouting should be more specific. Typically, 2 to 4 percent by weight of bentonite to cement is recommended. MAIN should clarify this discussion.

This section implies, but does not specifically state, that all soil borings will be continuously sampled. This should be stated.

The grout will be mixed in the field and consist of 2 to 4 weight percent of bentonite to cement. These percentages have also been incorporated on page 3-20. Grout will be placed into the hole using a tremie pipe to prevent bridging of a collar, and thus an ineffective seal. Further clarification of this will be provided in the Work Plan.

The text will be changed to include continuous split spoon sampling for the length of the boring.

P. 3-13 This comment concerns clarification of sampling procedures.

Section 3.2.3, Sampling Procedures, Paragraph 4, should be clarified. The VOA fraction should be a grab sample from the location in the split spoon with the highest meter (OVA/HNu) response. To gain representativeness, the remaining soil from the spoon should be homogenized in a clean stainless steel bowl, then put in the appropriate laboratory jars and placed on ice.

Agreed. The sampling procedures will be clarified as suggested.

P. 3-14 This comment concerns continuous split spoon sampling.

Paragraph 4 states continuous sampling will be conducted. Again, this should be stated in the soil boring section (Section 3.2.2).

This comment was previously addressed. The Work Plan will be clarified.

P. 3-16 This comment concerns well construction specifications.

The well construction specifications appear to be a modification to the Region QA specifications for well construction (p. 40, Section VII, QA Manual). Typical well construction includes: a sand pack installed to 2 feet above the screen, and a 2-foot bentonite seal. MAIN should discuss their well-construction rationale. Also, what is the reason for including a 6 inch layer of fine sand above the sand pack?

MAIN's well construction specifications follow the general requirements outlined in Section VII of the Region II QA Manual. MAIN's well specifications call for a sand pack installed to two feet above the well screen in accordance with the Region II QA Manual. Although the Region II QA Manual specifies a two-foot thick bentonite seal, a 3-foot bentonite seal is indicated in the Work Plan to ensure a good seal.

The 6 inch layer of fine sand between the bentonite seal and filter pack is to prevent any bentonite material from penetrating into the filter pack around the well screen. This procedure is outlined in "6 NYCRR Part 360, Solid Waste Facilities," December 31, 1988, a NYSDEC publication.

P. 3-17 This comment concerns alternate types of drilling if heaving sands are encountered.

In reference to Section 3.3.3.1, Type of Drilling, if extreme heaving sands are encountered, will MAIN utilize an alternate drilling method (e.g., drive and wash techniques)?

What procedures will be used to install wells in the weathered bedrock layer? These are not stated.

Because glacial till is expected to be encountered in the subsurface, heaving sands are not expected. However, as an alternate drilling method to hollow stem augering, air rotary will be used. Air rotary methods will be used to install wells in the weathered bedrock if the desired depth can not be reached using hollow stem augering.

P. 3-18 This comment concerns well casing and well screen.

Section 3.3.3.2, Well Casing and Well Screen, should be modified to state that the interface of the weathered bedrock and the till will be sealed to prevent the spread of contamination during drilling into the rock. Are the layers of till or bedrock anticipated to be too thin to install such a seal?

This section does not contain site specific details discussed in the main body of the RI task plan. Specifically, the RI task plan states that ten foot lengths of well screen will be employed starting at a depth at the base of the till layer. The Field Sampling and Analysis Plan does not include details of well construction.

Section 3.3.3.3, Monitoring Well Filter Pack, states that methods for sizing filter material and well screen opening are available in the literature. The specific references should be cited.

The weathered bedrock is expected to be too thin to obtain seal across the weathered bedrock and till interface during drilling. The anticipated 5' thickness of the weathered bedrock will allow for a bentonite seal between the weathered bedrock and till after well installation.

Details of the well construction will be added to Appendix A, Section 3.3.3, Well Installation of Field Sampling and Analysis Plan.

Specific references for the methods for sizing filter materials and well screen opening will be cited in the Work Plan.

P. 3-19 This comment concerns the appropriate method to place a sand pack around the monitoring well.

Paragraph 4 states that "The sand pack material must be placed using the a tremie method or another method approved by NYSDEC if bridging is to be avoided." These methods should be identified and discussed. Note that the depth of the well is the most critical parameter for determining the appropriate method.

A discussion of the specific methods (i.e. tremie method) will be identified and discussed in the Work Plan.

P. 3-20 This comment concerns sealing of the weathered bedrock/till interface prior to drilling.

Section 3.3.3.4, Bentonite Seal, does not state whether the interface of the weathered bedrock will be sealed with grout prior to drilling into the rock, to prevent overburden contaminants from entering the weathered zone. This should be stated.

The weathered bedrock is expected to be too thin to obtain a seal across the weathered bedrock and till interface during drilling. The anticipated 5' thickness of the weathered bedrock will allow for a bentonite seal between the weathered bedrock and till after well installation.

P. 3-20 This comment concerns a typing error.

In Section 3.3.3.5, Annular Sealant, Paragraph 2, "The ground mixture..." should state "The grout mixture..."

In Section 3.3.3.5, Annular Sealant, Paragraph 2, "The ground mixture..." will be changed to "The grout mixture..."

P. 3-20 This comment concerns a typing error.

Section 3.3.3.6 is titled "Protective Coating." This should be "Protective Casing."

Section 3.3.3.6 titled "Protective Coating" will be changed to "Protective Casing."

P. 3-21 This comment concerns well development.

Well development should continue until pH, temperature, and conductivity vary no more than 10 percent. This should be stated.

Agreed. The Work Plan has been modified to include this specification.

P. 3-23 This comment concerns well development criteria.

Section 3.4.3, Development Criteria, Item 2 (stabilization criteria for temperature, pH, and conductivity), should be stated in the procedures section (see previous comment). Also, the types of field meters to be used for these measurements should be stated.

Agreed. Development criteria will be stated in the procedures section.

The manufacturer and model number of the thermometer, pH meter, and specific conductivity meter will be stated in the Work Plan.

P. 3-23 This comment concerns the well survey.

Section 3.4.4, Well Survey, states the vertical location of the ground surface and the mark made on the top of the monitoring well riser pipe will be accurately measured. What type of mark? A notch in the top of the PVC is recommended as opposed to a permanent marker.

The mark on the top of the PVC will be a cut notch, not a mark made with a permanent marker.

P. 3-23 This comment concerns decontamination of downhole development equipment.

The methods to be used for decontamination of downhole development equipment is not provided in the FASP and should be discussed.

The decontamination procedures for downhole development will be referenced in Section 4.5, Equipment and Material Decontamination in Appendix A.

P. 3-25 This comment concerns groundwater sampling procedures/analyses.

In Section 3.4.5, Groundwater Sampling Procedures/Analyses, the number of new monitoring wells should be stated.

Paragraph 3 should define percent stabilization requirements for well purging. Pumping the well dry is not recommended for well purging. Pumping the well dry is not recommended due to the loss of potential volatiles due to the cascading effect in the screen. The pump should be set above the screen.

At a minimum, Appendix C, the Chemical Data Acquisition Plan, should be referenced as a source for this information.

The number of new proposed monitoring wells (16) has been added to Section 3.4.5, Groundwater Sampling Procedures/Analyses.

Prior to sampling, the wells will be purged such that when indication parameters such as pH, temperature and specific conductance are observed to vary less than 10% over the removal of successive well volumes. In accordance with the EPA Region II CERCLA QA Manual, in wells with very low recoveries, removal of 3-5 well volumes may not be practical and in this case, the well will be evacuated to near dryness and allowed to recover sufficiently prior to sampling. This will be the procedure stated in the Work Plan.

Where possible the pump to evacuate the well will be placed above the well screen to prevent loss of volatiles due to cascading. This will be stated in the Work Plan.

Appendix C will be referenced in this section.

P. 3-31 This comment concerns monitoring for volatile organic compounds while sampling of surface water for metals.

This section describes sampling of surface water for metals. If only metals analyses are being conducted, why does MAIN propose monitoring for volatiles with an HNu?

In Item 3, if bottles are used for sample collection, a 45-degree angle should be proposed for collecting samples. Also, sampling should proceed from downstream locations to upstream locations to minimize impacts associated with disturbance of sediments.

Monitoring for volatile organic compounds during surface water sampling for metals will be performed for health and safety reasons as volatiles are a potential contaminant on the site.

Agreed. If bottles are used for sample collection, a 45-degree angle will be used. Sampling will proceed from downstream locations to upstream locations to minimize impacts associated with disturbance of sediments. The Work Plan will be modified to incorporate this.

P. 3-32 This comment concerns sediment sampling procedures in Section 3.5.3.

In Section 3.5.3, Sediment Sampling Procedures, the techniques provided are only suggested techniques. This should be explained. What techniques will be used in the field? Could a hand auger be used to obtain sediment samples?

Collection of Reeder Creek surface water and stream sediment samples should begin at the most downgradient sampling point and progress upstream to ensure that downstream sampling locations are not contaminated by the disturbance and resuspension of upstream sediments. If wading into Reeder Creek is required for surface water or and sediment sample collection, the sampler should approach the

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sampling location from downstream so as to not disturb the surrounding sediments. Note that areas of high flow should be avoided when collecting sediment samples.

The discussion in this section is meant as a quick overview of the different sampling techniques. Per discussions held during the request for clarification period, MAIN will use a ponar sampling device to collect surface sediment samples from 0-6" deep. A hand auger will not be used to collect the samples.

Reeder Creek sample collection will begin at downstream locations and proceed to upstream locations. The sampler will approach the sample location from a downstream position.

P. 3-33 This comment concerns collection of QA/QC samples and sampling equipment.

Paragraph 1 states that ten percent of the surface water/sediment samples will be collected for QA/QC. Does MAIN suggest these to be duplicate samples?

The statement that equipment needed to collect soil samples is the same as that for soil samples is incorrect.

The samples collected for QA/QC will be duplicate samples. This will be clarified in the Work Plan.

The statement that equipment needed to collect soil samples is the same as that for soil samples will be removed from the Work Plan.

THE FOLLOWING COMMENTS ARE FROM EPA'S TOXIC AND HAZARDOUS WASTE SECTION

Appendix A - Field Sampling and Analysis Plan

Section 2.3, Quality Control Samples

P. 2-2 and 2-3 This comment concerns the use of demonstrated analyte-free water.

a) All water used for the trip blank, field equipment rinse blank and for the final water rinse in the decontamination procedure must be demonstrated as analyte-free. This is defined as water which has been tested prior to the start of the sampling event for the organic and inorganic parameters of interest and found to contain less than the reported quantitation limits of these compounds.

b) The trip blanks are only required when aqueous samples are collected for volatile organic analysis.

c) The frequency of collection for field equipment rinse blanks should be as stated in the QAPP for the Ash Landfill, dated May 1991, Section 4.4.2, page C-67.

a) Agreed. All water used for trip blanks, field equipment rinse blanks and for the final rinse in the decontamination procedure will be demonstrated as analyte-free.

b) This section does state that trip blanks are only prepared for volatile organic compound determinations.

c) The frequency of collection for field equipment rinse blanks will be stated as in the QAPP for the Ash Landfill, dated May 1991, Section 4.4.2, page C-67. Specifically one equipment rinse blank will be collected each day a decontamination event is carried out, not to exceed one per day.

Section 3.1 - Geophysical Survey

P. 3-1 This comment concerns the use of RADAR and STOLS.

Correct this section by eliminating the use of RADAR and STOLS as per the discussion during the June 24, 1991 conference call between EPA, Seneca and their contractors.

All references to RADAR and STOLS have been eliminated as requested.

Section 3.2.3 - Sampling Procedures and Analyses

P. 3-13 and 3-14 This comment concerns sampling procedures and analyses.

a) The split spoons used should be carbon steel.

b) The correct bottles to be used for the volatile organics in soil are 40 ml glass vials with septum seals.

c) Can the laboratory assure delivery of the field screening results in a timely manner and still meet the holding time for the full laboratory analyses?

d) The split spoons and other field sampling equipment must be decontaminated as per the procedure outlined in Attachment 1. It is acceptable for the drilling augers to be steam cleaned prior to and in between use.

e) All soil/sediment samples collected, except those for volatile organic analysis, must be homogenized in a stainless steel bowl with a stainless steel spoon prior to being paced into the sample containers.

f) Surface soil samples should be collected with stainless steel trowels or scoops.

a) A carbon steel split spoon sampler will be used.

b) 40 ml glass vials with septum seals will be used for the volatile organics in soil.

c) Yes, the laboratory can assure the delivery of the field screening results in a timely manner and still meet the holding time for the full laboratory analyses.

d) The split spoons and other sampling equipment will be decontaminated as per the procedures outlined on EPA's Region II QA Manual. This procedure will be incorporated in Section 4.5, Equipment and Material Decontamination.

e) Agreed. The Work Plan will incorporate this.

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f) Surface sediments from Reeder Creek will be collected using an appropriate sampling device (i.e. ponar sampler, beaker, etc.).

Section 3.3.3.2

P. 3-17 This comment concerns well screen slot size.

Please correct the first paragraph here to state the well screen slot size in the existing wells.

The slot size of the existing wells (0.010") will be added to the text.

Section 3.4.2

P. 3-21 This comment concerns turbidity units for water.

The correct units for water turbidity are NTUs. Please correct the text.

The Work Plan has been corrected.

P. 3-23 This comment concerns decontamination of equipment used for developing and purging wells.

All equipment used to develop and purge the groundwater wells must be cleaned as stated in the QA Project Plan for the Ash Landfill, dated May 1991, Section 4.6.3, pages C-72 and C-73.

The decontamination procedures for equipment used to develop and purge the groundwater wells is the same as that described in the QA Project Plan for the Ash Landfill. This information will be added to Appendix A, Section 4.5, Equipment and Material Decontamination.

Section 3.4.5 - Groundwater Sampling Procedures and Analysis

P. 3-25 This comment concerns groundwater sampling procedures and analyses.

a) Comment 6 above applies here as well.
b) Any ground covers used must be made of polyethylene, not plastic, in order to avoid phthalate contamination.
c) Sampling must occur within 3 hours of purging for high yield wells.
d) All sampling equipment must be decontaminated as per the procedure in Attachment 1.
e) Groundwater samples undergoing volatile organic analysis must be collected first, before any of the parameters of interest.

f) In the fourth paragraph here, it is stated that the samples for explosives and metals analyses will be sent directly to the lab for analysis. Why aren't the samples for organic analysis included here as well?

a) Decontamination of sampling equipment is described in Appendix A, Section 4.5. This section will be referenced.
b) Agreed. Ground covers will be made of polyethylene, not plastic.
c) Agreed. Sampling will occur within 3 hours for high yield wells.
d) Agreed. These decontamination procedures will be used. They will be incorporated into Section 4.5, Equipment and Material Decontamination. These procedures will be referenced in this section.
e) Agreed. Groundwater samples undergoing volatile organic analysis will be collected first, before any other parameters of interest.
f) The Work Plan will be corrected so that the samples for organic analyses are included in the samples submitted.

P. 3-26 This comment concerns the bottle supplies.

As per my comments on the Ash Landfill QAPP, the sample bottle supplier must be named and the cleaning/QC procedures used on the bottles must be supplied.

Agreed. The sample bottle supplier will be named and the cleaning/QC procedures used on the bottles will be supplied.

Section 3.5.2 - Surface Water Sampling Procedures and Analysis

P. 3-31 These comments concern surface water sampling procedures and analysis.

a) The surface water sampling equipment must be cleaned as per the procedures stated in Attachment 1.
b) As was previously discussed during the review period for the Ash Landfill documents, Region II only accepts results for total metals. Therefore, for the ash landfill investigation, it was decided that filtering of samples will not be performed.

The same regional policy applies here as well, only total metals data will be accepted. If it is decided that filtered metals samples (both acid soluble and dissolved metals) will be collected in any event, additional details regarding the filtering procedure must be provided. The type of detail sought is provided in Attachment 2.

a) Agreed. The surface water sampling equipment will be cleaned as per the procedures in the EPA Region II CERCLA QA Manual.
b) Total metals surface water samples will be collected. The Work Plan will be modified to state this.

Section 3.5.3 - Sediment Sampling Procedures

P. 3-32 These comments concern sediment sampling.

a) A stainless steel scoop or trowel may be used to collect sediment samples, in addition to the sample container, in small streams or near the shoreline.
b) If a beaker is used to collect sediment samples, it should be made of stainless steel or glass
c) When sampling from a river or deep lake with a dredge, care should be taken to avoid collecting the sample from the edge of the sampler, if the material of construction is not stainless steel.
d) All soil and sediment samples collected, except those for volatile organic analysis, must be homogenized prior to being placed into the sample containers.

a & b) Per discussions held during the request for clarification, an appropriate sampling device (i.e. ponar sampler, beaker, etc.) will be used to collect surface sediment samples.
c) Agreed. The specified care will be taken.
d) Agreed. This general comment was previously addressed.

Section 4.1 - Compositing

P. 4-1 This comment concerns compositing soil samples.

If sample compositing is performed, note that the individual parameter's detection limit is raised by a factor equal to the number of samples composited. For example, if three samples are composited, then the detection limit for each parameter is raised by a factor of three.

The lab will be notified as to how many samples were composited so that the correct detection will be used. This will be incorporated into the Work Plan.

Section 4.2 - Field Filtration

P. 4-1 This comment concerns field filtration.

Regarding field filtration, comment 9b above applies here as well.

Agreed. This comment was previously addressed in comment 9b. This will be clarified in the Work Plan.

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Section 4.4 - Sample Storage

P. 4-2 This comment concerns sample storage.

Samples collected for metals and water quality parameters must be stored in glass or polyethylene bottles, as plastic is not acceptable.

Agreed. Samples collected for metals and water quality parameters will be stored in glass or polyethylene as requested.

Section 4.5 - Equipment and Material Decontamination

P. 4-4 This comment concerns equipment decontamination.

The decontamination procedure must be corrected as stated in Attachment 1.

Agreed. The decontamination procedures outlined in the EPA's Region II CERCLA QA Manual will be incorporated into the Work Plan.

APPENDIX C - CHEMICAL DATA ACQUISITION PLAN (CDAP)

Section 1.0 - Site Background

P. 1-1 This comment concerns the use of USATHAMA methods

The third paragraph here states that non-standard analyses will follow USATHAMA methods. Please verify this statement as I am not aware of any USATHAMA methods being cited in this CDAP. For the explosives, Method 8330 from SW-846 will be employed.

Comment number 15 with regard to the CDAP states that the method for explosives should be referenced as Method 8330 from SW-846. Method 8330 has not been incorporated into SW-846 at this time as it is still a draft method awaiting promulgation. The reference to USATHMA approval is because USATHMA provided a copy of draft method 8330 as a recommendation for explosives analysis. The reference will be clarified to state draft method 8330 of SW-846. Any reference to USATHAMA will be deleted from the Work Plan.

Section 2.2 - Field Sampling Responsibilities

P. 2-3 This comment concerns maintenance of field equipment.

All equipment used in the field, such as a pH meter, thermometer, and a specific conductivity meter must have the calibration checked on a daily basis prior to use.

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Any standards/buffer solutions used must have the expiration date printed on the bottles.

Agreed. These protocols will be incorporated into the Work Plan.

Section 4.3 - General Information and Definitions

P. 4-2 This comment concerns the use of demonstrated analyte free water, trip blanks and frequency of equipment rinse blanks.

Comment 1 above applies to parts e and f here as well.

Agreed. Comment 1 will be applied to parts e and f in this section.

Section 4.4.1 - Sample Conditions and Preservation

P. 4-3 This comment concerns the bottle supplier to be used and the use of hydrochloric acid for VOA preservation.

a) Comment 8 above regarding the sample bottles applies here as well. As per the Army Corps of Engineers Project Manager, Kevin Healy, I-Chem will not be used as the bottle supplier. Delete this reference from the text.
b) The amount of hydrochloric acid used to preserve the aqueous volatile organic samples must be determined in the field by the procedure enclosed as Attachment 3 in EPA's comment letter.

a) Agreed. This reference will be deleted.
b) Agreed. The procedures outlined in EPA Region II CERCLA QA Manual for preserving aqueous volatile organic samples will be used. This will be incorporated into the Work Plan.

Table C-1 - Required Containers, Preservation and Holding Times

P. 4-4 This comment concerns Table C-1.

a) In order for the holding times specified to be met, all samples must be shipped from the field to the lab within 24 hours from collection.
b) Add the following preservation to the TCL volatiles in water entry: HCl to pH < 2, cool to 4 degrees C. When these samples are preserved with HCl, the holding time is extended to 14 days from collection.
c) The aqueous cyanide samples must be tested for the presence of oxidizers and sulfides prior to the preservation with sodium hydroxide, as per Attachment 4.
d) Triple sample volume must be collected for the aqueous extractable parameters (semi-volatiles, pesticides/PCBs) in order for the lab to perform the matrix spike/matrix spike duplicate analysis.

a) Agreed. Samples will be shipped from the field to the lab within 24 hours from collection. This will be stated in the Work Plan.
b) This comment regarding the CDAP states that with preservation, TCL volatiles can be analyzed in a holding time of 14 days. This statement is in conflict with the NYSDEC CLP protocols which states that analysis must be completed within 7 days of validated time of sample receipt. The holding times for NYSDEC may differ from Federal CLP, but because MAIN has referenced using the methodologies from NYSDEC CLP Protocols these will be used. Table C-1 will be changed to include "HCL to pH <2, cool to 4 degrees C." MAIN will follow the holding times presented in the NYSDEC CLP.
c) Agreed. The aqueous cyanide sample will be tested for the presence of oxidizers and sulfides prior to the preservation with sodium hydroxide as described in Attachment 4 of the EPA comment letter. This will be included in the Work Plan.
d) Agreed. Triple sample volume will be collected for the aqueous extractable parameters in order for the lab to perform the matrix spike/matrix spike duplicate analysis. This statement will be added to the Work Plan.

Section 4.4.3.2 - Surface and Groundwater Sampling

P. 4-5 This comment concerns adding preservatives to samples.

Preservatives must be added to the samples immediately after collection, as per Section 4.4.1, page 4-3, paragraph 3. This is especially important of the aqueous volatile organic samples since once the vial containing the sample is closed, it may not be reopened to test the pH or to add additional acid as a loss of the volatiles will occur. Following the procedure in Attachment 3 will allow determination of the volume of acid required on a "test" vial which will be discarded.

Agreed. This information will be incorporated into this section.

Section 4.4.3.5 - Field Equipment Blanks

P. 4-6 This comment concerns the use of demonstrated analyte-free water

As per comment 1a above, the water used to collect field equipment rinse blanks must be demonstrated as analyte free.

Agreed. Water used to collect field equipment rinse blanks will be demonstrated as analyte-free.

Section 4.4.3.6 - Trip Blanks

P. 4-7 This comment concerns trip blanks for volatile organics.

Comment 1b above applies here as well.

Agreed. This information will be incorporated into the Work Plan.

Section 8.2.3 - Laboratory

P. 8-3 This comment concerns use of EPA Region II SOPs for Evaluating Organic and Inorganic Data.

The EPA Region II Standard Operating Procedures (SOPs) for Evaluating Organic and Inorganic Data must be used to validate the data produced, in lieu of the National Functional Guidelines. The regional SOPs are enclosed as Attachment 5.

Agreed. The EPA SOPs will be used in lieu of the National Functional Guidelines.

This will be added to the Work Plan.

Appendix C - Laboratory Certifications

These comments concern Aquatec Lab.

a) The certifications of interest for the NYSDOH for Solid and Hazardous Waste and for Potable/Non-Potable Water are expired as of April 1991. Please provide the current certificates.
b) Please provide the acceptance letter from the Army Corps of Engineers upon completion of their evaluation of Aquatec Lab. The letter currently provided in this CDAP, dated July 25, 1989, is no longer valid.

The response from Aquatec Labs is as follows:

"Comment number 24(a) and (b) with regard to the CDAP refer to our certification status. Our NYSDOH certificate did expire in April 1991. I have enclosed a copy of a letter we received from NYSDOH in March of 1991 concerning recertification. At this time we are still waiting for our new certificate to be issued.

We have recently contacted USACE concerning our PE results, and for scheduling an audit. We cannot be approved until an on-site audit has been performed. We have expressed to them the urgency of this approval. Perhaps you should call the Missouri River Division of the Corps of Engineers and reiterate the importance of our approval and provide them with proposed time schedule for the project."

Per discussions held August 8, 1991, a final response is pending a phone call from Kevin Healy to the Missouri River Division of the Corps of Engineers.

EPA'S HAZARDOUS WASTE FACILITIES (HWF) BRANCH OF THE AIR AND WASTE MANAGEMENT DIVISION

1. This comment concerns the classification of the unit (i.e., the site as a Subpart X or miscellaneous unit under RCRA 40 CFR 264.

   According to the report, obsolete pyrotechnics, explosives, propellants (PEP) and their packaging materials were routinely burned at the Open Burning grounds. The activities conducted at this site classify the unit as a Subpart X or Miscellaneous unit under RCRA 40 CFR 264. Therefore, closure of this unit must comply with the environmental performance standards specified in 40 CFR § 264.601, and the post-closure care of the unit must comply with §264.603.

   A reference to the Subpart X or Miscellaneous classification of the OB grounds will be added to the ARARs in Section 3.4, Preliminary Identification of Applicable or Relevant and Appropriate Requirements.

2. This comment concerns performing TCLP analyses on the soil to determine if the soils are RCRA characteristic hazardous waste.

   The report indicates that extensive soil sampling will be conducted at this unit and the soil samples will be analyzed for the compounds listed on the Target Compound List (TCL), the Target Analyte List (TAL) and the explosive list of SW-846 Method 8330. In addition to the proposed analysis, HWF recommends that the Toxicity Characteristic Leaching Procedure (TCLP) test be performed on the soil, for both toxic characteristic metals and organics, to determine if the soils are RCRA characteristic hazardous waste. Please refer to 40 CFR §261.24, Table 1, for the list of toxicity characteristic contaminants.

   TCLP will be used to determine if drummed soils are RCRA characteristic hazardous waste prior to disposal. This will be added to the Task Plan Summary section of the Work Plan.

3. This comment concerns Table 12.

   Standards applicable to Generators of Hazardous Waste are contained in 40 CFR Part 262 and standards applicable to Transporters of Hazardous Waste are contained in Part 263, not in 40 CFR Parts 263 and 270 as indicated in Table 12 of the Work Plan.

   This correction to the Work Plan will be made.

4. This comment concerns capping as an alternative for the remediation of the OB grounds.

Section 3.32 of the report indicates that capping is one of the alternatives under consideration for the remediation of the OB grounds. The report also indicates that the design of modern caps must conform to the performance standards contained in 40 CFR 264.310. Please be advised that the final cover must include a component which has a maximum inplace saturated hydraulic conductivity of 1×10^{-7} cm/sec.

This comment is acknowledged.

EPA'S PRE-REMEDIAL AND TECHNICAL SUPPORT SECTION OF THE PROGRAM SUPPORT BRANCH COMMENT AS FOLLOWS:

P. 3-15 to 3-16 This comment concerns filtered groundwater samples.

The Report cited groundwater concentrations for filtered samples. Unfiltered groundwater samples should be utilized in the Risk Assessment.

Agreed. Unfiltered groundwater samples will be used in the Risk Assessment.

P. 3-22 This comment concerns potential future residential use of the site.

What will prevent "Unrestricted residential or other private development" of the site?

Local zoning and planning information will be consulted during performance of risk assessment to determine if unrestricted residential use is a potential future use.

P. 3-23 This comment concerns future use of groundwater.

Couldn't site groundwater be used under on-site future use scenario?

See comment for p. 3-22 above.

P. 4-52 This comment concerns non-explosive semi-volatiles.

Are non-explosive semi-volatiles potentially of concern at the site?

Available analytical data indicate that non-explosive semi-volatiles are not a problem at the site.

P. 4-56 This comment concerns reasonable maximum exposures.

Only reasonable maximum exposures, as outlined in the RAGS guidance, need to be included in the Risk Assessment.

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Exposure concentrations may also increase, depending on assumptions regarding future groundwater use on-site.

The upper 95% confidence limit on the arithmetic mean of the log-transformed data should be used to model site contaminant concentrations.

Agreed. Reference to use of averages will be removed and reasonable maximum exposures will be used in the Work Plan.

Acknowledged.

The upper 95% confidence limit of the log transformed data will be used, where applicable. This will be added to the Work Plan.

P. 4-58 This comment concerns obtaining toxicity information.

The Hierarchy of toxicity information should be Iris > Heast Tables > Consultation with USEPA ECAO in Cincinnati, Ohio.

Agreed. The suggested hierarchy of toxicity information will be used. This will be included in the Work Plan.

Note: Section 3.2 and 4.4.2 are somewhat unclear with regard to proposed exposure pathways. The proposed pathways should be presented more clearly in table form, and should be discussed in one, rather than two sections of the document.

Note: A table will be added for proposed pathways. However, format for the work plan and RI task plan dictates that the exposure pathways be discussed in these two sections.

P. 4-59 This comment concerns the ecological assessment.

The Ecological Assessment should be performed according to the RAGS, Part II.

Agreed.

THE FOLLOWING COMMENTS ARE FROM EPA'S WATER MANAGEMENT DIVISION

1. This comment concerns use of 500 series methods of analysis for volatile organic compounds in groundwater.

According to the U.S. EPA's proposed Groundwater Classification Guidelines, groundwater at this site is at least Class IIB, a potential source of drinking water. Because of this classification, maximum contaminant levels (MCLs) are applicable or relevant and appropriate requirements (ARARs) for groundwater at the site, and the 500 series methods of analysis should be used for determining volatile organic chemical (VOC) concentrations.

MAIN proposes to use Level IV NYSDEC CLP analysis for volatile organic compounds in groundwater which requires strict QA/QC procedures. MAIN will not use the 500 series for analysis of volatile organic compounds.

2. This comment concerns title inconsistencies in Table 1 and the text.

On Page 2-8, the first line of Paragraph 3, reads Table 1, AVERAGE BACKGROUND CONCENTRATIONS AND RELATIVE MOBILITIES FOR ROCKS, SOILS, AND WATERS, but contradicts the actual table heading which reads AVERAGE BACKGROUND CONCENTRATIONS FOR ROCKS, SOILS, AND SEDIMENTS.

The reference to Table 1 will be made consistent.

3. This comment concerns a typing error.

On Page 2-10, second line of Paragraph 1, the word "pheratic" should be "phreatic."

The error will be corrected in the Work Plan.

4. This comment concerns sampling of downgradient and off-site private and public wells.

Sampling and analysis of groundwater from private and public wells, which are located off-site and downgradient from site, should be performed to ascertain whether or not contaminants have migrated off-site.

Groundwater flow has been determined to be to the east-northeast toward Reeder Creek (Figure 26). Based on field reconnaissance, no private or public wells have been determined to be located directly downgradient of the OB grounds. However, if during the course of the investigation private or public wells are to be located near and downgradient from the site, they will be sampled and analyzed for contaminants. While residences with private drinking water wells are present west of SEAD, presently, MAIN does not feel that it is necessary to sample groundwater from residential wells farther downgradient of the site.

5. This comment concerns two rounds of water level measurements and sampling in "wet" and "dry" seasons.

At least two rounds of water level measurements and samples should be taken, preferably in a "wet" season and "dry" season, to determine whether or not there are significant seasonal variations in groundwater flow directions.

MAIN expects to collect groundwater elevation data in two phases during field investigation. Groundwater data from these phases is expected to provide data from different seasons (i.e., fall and spring). Groundwater flow direction determined from this study will be compared to the flow directions determined by Metcalf & Eddy (October, 1989) and O'Brien & Gere (1985). Precipitation data from October 1989 and the time of the measurements by MAIN will be compared to determine if there is a significant difference in precipitation, as recharge to the shallow aquifers is via percolation associated with local precipitation.

6. This comment concerns EP Toxicity Limits for Mercury.

For Table 4, note the following:

The Extraction Procedure (EP) Toxicity Limit for Mercury should be 0.2 ug/L.

The correction will be made.

7. This comment concerns federal and New York State maximum contaminant levels.

For Tables 3, 5, and 14, note the following:

COMPARISON OF FEDERAL TO NEW YORK STATE MCLS FOR REGION II
(As of January 1991)

INORGANIC

all units are micrograms per liter (ppb)

Chemical	FEDMCL*	NYMCL**
Arsenic	50	50
Cadmium	5	10
Chromium	100	50
Selenium	50	10
Fluoride	4000	2200

* Federal Maximum Contaminant Level

** New York State Maximum Contaminant Level

The current standard for Lead is 15 ppb, which replaces the 50 ppb MCL. This new standard is an action level.

The comment is acknowledged. The chemicals have been reviewed and corrected in the referenced tables.

8. This comment concerns quantification limits and chemical specific ARARs.

For Tables 17, 18, and 20, the quantitation limits for the following compounds should be below chemical-specific ARARs.

Chemical	Quantitation Limit (ug/L)	CHEMICAL-SPECIFIC ARARs MCL* (ug/L)	PMCL**
Vinyl Chloride	10	2.0	-
1,2,4-Trichlorobenzene	10		9
Hexachlorobenzene	10		1
Pentachlorophenol	50		1
Thallium	10		1

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* Federal Maximum Contaminant Level
** New York State Maximum Contaminant Level

This comment is acknowledged. None of the compounds in the table for this comment are expected to be present at the site, therefore, the quantitation limits are not as imperative as for compounds known to exist at the site. MAIN proposes to use NYSDEC CLP quantitation limits.

9. This comment concerns wetlands.

The Work Plan proposes to identify wetland habitats (page 4-38), to characterize and map wetland vegetation within the study area (page 4-39), and to "...map the larger wetlands..." (page 4-44). Page 3-33 of Appendix A states that "There are approximately six potential wetlands... which will be sampled..." Marine Wetlands Protection Branch (MWPB) recommends that all on-site wetlands, regardless of size, be mapped using the three-part methodology detailed in the Federal Manual for Identifying and Delineating Jurisdictional Wetlands (1989). Contaminated off-site wetlands downgradient from the Open Burning/Open Detonation (OB/OD) site should also be delineated.

MAIN proposes to delineate wetlands on the approximately 30 acre OB grounds using the Unified Federal Routine Method Routine Method. Figure 29 illustrates the approximate area of the OB grounds. Wetland covertypes will be evaluated using aerial photographs, existing wetland maps (NYSDEC Wetland Regulatory Maps and United States Fish and Wildlife Service (USFWS) National Wetland Inventory Maps) and field reconnaissance. Wetland boundaries will not be surveyed as part of this delineation.

Wetlands outside the OB grounds will be evaluated using aerial photographs, existing wetland maps (NYSDEC Wetland Regulatory Maps and USFWS National Wildlife Inventory Maps) and field reconnaissance to confirm wetland delineations, where necessary.

10. This comment concerns sampling of on-site wetlands and drainage channels.

Additional sampling and testing of groundwater, surface water, soils, sediments, and biota will occur. The surface water and sediment sampling plan (Figures 25, 29) shows that Reeder Creek will be sampled, but sample points are not depicted for the on-site wetland area(s) and drainage channels. MWPB suggests that these locations also be tested for contamination.

MAIN has added three drainage channel sampling locations for contaminant analysis to Figure 25. All wetland and drainage channels sampling locations will be shown on Figure 25.

11. This comment concerns the use of WET technique.

Impacts to wetlands and other aquatic habitats resulting from future remedial actions must be avoided or minimized. If impacts are expected, MWPB recommends that a functional assessment of affected wetlands be performed using the Army Corps of Engineer's Wetland Evaluation Technique (WET). This assessment would provide information needed for the development of a restoration plan.

If necessary, the WET or a comparable technique would be used to conduct functional assessment, although the usefulness of the WET technique is questionable.

THESE COMMENTS ARE PROVIDED BY EPA's ENVIRONMENTAL IMPACTS BRANCH:

1. This comment concerns impacts to terrestrial biota.

On pages 3 -22 and 3-23, the exposure pathways of inhalation of fugitive dust emissions, incidental soil ingestion, and dermal contact include only discussion of impacts to human health. The impacts of these pathways to terrestrial biota may need to be considered.

MAIN will include in the Work Plan exposure pathways of inhalation of fugitive dust emissions, incidental soil ingestion, and dermal contact as they apply to terrestrial biota.

2. This comment concerns cultural resources.

The discussion of cultural resources on page 3-46 is not clear with respect to the potential for discovery of prehistoric sites within the OB/OD Grounds. The report, An Archaeological Overview and Management Plan for Seneca Army Depot

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(September 1986), should be reviewed in conjunction with the RI/FS activities and likely remedial actions to determine the need for cultural resource survey investigations.

MAIN has reviewed the report of "An Archaeological Overview and Management Plan for Seneca Army Depot (September 1986), and the Work Plan has been clarified with regard to the potential for discovery of prehistoric sites. Figure A-1 indicates that two prehistorical/historic sites (NYSM, 4826, NYSM 4824) are not near the OB grounds. MAIN can not be more specific on the potential for discovery of prehistoric sites as this information is not available from the 1986 management plan.

3. This comment concerns wetlands survey.

The OB/OD Grounds include at least two potential wetlands of concern ("swampy areas"). A meeting was held on February 27, 1991, with the Project Manager and representatives of the facility regarding the Ash Landfill Area. It was our understanding from this meeting that a site-wide wetlands delineation and assessment would be performed. Accordingly, the Work Plan should include discussion of these actions.

MAIN proposes to delineate wetlands on the approximately 30 acre OB grounds using the Unified Federal Routine Method Routine Method. Figure 29 illustrates the approximate area of the OB grounds. Wetland covertypes will be evaluated using aerial photographs, existing wetland maps (NYSDEC Wetland Regulatory Maps and United States Fish and Wildlife Service (USFWS) National Wetland Inventory Maps) and field reconnaissance. Wetland boundaries will not be surveyed as part of this delineation.

Wetlands outside the OB grounds will be evaluated using aerial photographs, existing wetland maps (NYSDEC Wetland Regulatory Maps and USFWS National Wildlife Inventory Maps) and field reconnaissance to confirm wetland delineations, where necessary.

4. This comment concerns compliance with NEPA.

As you are aware, EPA has determined that its CERCLA/SARA remedial process if functionally equivalent with the National Environmental Policy Act (NEPA). To date, the Army has not made such a determination about its process. Accordingly, the Army will have to take action to ensure that its RI/FS and subsequent remedial action comply with NEPA.

This comment is acknowledged.

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EPA'S BIOLOGICAL TECHNICAL ASSISTANCE GROUP PROVIDES THE FOLLOWING COMMENTS:

1. This comment concerns wetlands sampling.

Until the level and extent of contamination have been identified, the proposed biota sampling may be premature. Qualitative descriptions of site flora and fauna, as well as information obtained during the wetland delineation should be sufficient to characterize site conditions at this time. If the level and extent of contamination warrants biota sampling, we request a sampling plan which describes specific data quality objectives. Some of the methods currently proposed may be problematic, and results sought should be clearly defined.

Based on discussions held during the request for clarification period, MAIN proposes to conduct tissue sampling, if necessary, as part of a Phase II Investigation. The first phase will be a habitat characterization to obtain information on what species are likely to utilize the site as well as an assessment of soil, sediment, and aquatic chemistry.

2. This comment concerns wetland sampling.

The BTAG recommends that potential contamination in effected wetlands be characterized. Wetlands represent depositional areas and are frequently found to be contaminant sinks. At this time, it appears that there are several potential pathways for contaminants to migrate into wetlands. To characterize these pathways, the BTAG recommends that groundwater discharge points and surface drainage patterns be identified. In addition, the BTAG suggests that the proposed surface water and sediment sampling should occur during high flow conditions in order to characterize stormwater run-off patterns. The BTAG further suggests that the sediment sampling plan should include the following elements: collection in depositional areas, not random locations, as currently proposed; valid sediment sampling protocols for quality assurance; use of appropriate sampling devices; a better depiction of sampling locations; and TOC and grain size analyses.

MAIN proposes to sample six identified low-lying areas, which may be wetlands, to characterize any contamination in these depositional areas. Groundwater discharge points and surface water drainage patterns will be identified on the appropriate figures. Surface water would be maximally diluted during high flow, MAIN proposes to sample during low flow to obtain a worst case scenario for aquatic conditions. Sediment will be sampled using an appropriate sampling device (i.e. ponar sampler, beaker, etc.) from depositional areas. Sediment sampling locations have not been randomly selected. Locations are based upon surface water drainage locations to Reeder Creek from the OB site. Additionally, other locations were selected to provide an indication of expected downstream concentrations and one location was selected to provide an indication of upstream conditions. This was based upon the flow of Reeder Creek. The actual sample collection spot is variable depending upon the conditions observed at the time of sampling. MAIN will collect sediment samples at locations which correspond to depositional areas. TOC will be performed on sediment samples.

MAIN believes that the protocol proposed are valid and appropriate. MAIN does not feel that it is necessary to perform sieve analyses on sediment sample collected from Reeder Creek which are to be analyzed for contaminants. To ensure that a representative sediment sample is collected MAIN will use the appropriate sampling device (i.e. ponar sampler, beaker, etc.). MAIN will sample fine-grained sediments from areas of deposition not coarse-grained sediments. The samples will be classified according to the method outlined in "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) (ASTM D-2488-84). MAIN feels that this method will be appropriate to characterize the sample. MAIN does not feel that it would be appropriate to perform grain size analysis by sieving and hydrometer in the laboratory on these samples from Reeder Creek. The use of a grain size distribution curve is questionable for this sampling, as the ASTM Visual-Manual Method would provide documentation regarding grain size.

3. This comment concerns EP Toxicity Levels.

<u>The BTAG notes that contaminant levels in soils and sediments are compared to EP toxicity limits (Table 4, page 2-18). While EP toxicity limits define hazardous materials for disposal purposes, these levels do not necessarily reflect toxicity to indigenous biota.</u>

Acknowledged.

4. This comment concerns the format for human health and environmental risk assessment.

<u>The Work Plan addresses the human health and the environmental risk assessments jointly; we suggest that they be addressed separately as different elements may be of concern. For example, when describing exposure pathways, only human health risks are addressed. Both terrestrial and aquatic biota risk pathways should be included in an environmental assessment.</u>

The discussion of human health and environmental risk assessments will be clarified. Both terrestrial and aquatic pathways will be included in the environmental assessment.

EPA AIR PROGRAMS BRANCH COMMENTS

1. This comment concerns inhalation of fugitive dust emissions.

Page 3-21 Inhalation of Fugitive Dust Emissions - "Some transport of dusts may reach the farm fields which border the site resulting in a potential exposure of farm personnel and potential uptake of contaminants into vegetable crops, however, this exposure is not anticipated to be significant," and "Volatilization of the tri- and dinitrotoluene compounds may result in low-level exposure of SEAD personnel working on our near the site. As with fugitive dusts, volatilized contaminants would not be expected to migrate to off-site in significant concentrations."

These statements should be corroborated with a demonstration which clearly indicates that levels of particulates and volatiles are below "significant levels." To this end, significant levels must be defined and impacts shown to be below these levels. New York State's Air Guide-1 is an excellent document which contains Ambient Guideline Concentrations for many toxic contaminants including the organic and inorganic species found at this site. This demonstration could be included as a task in Section 4.3.2, Soils Investigation, Task Plan for the RI. Please contact me for more information regarding Air Guide--1.

MAIN expects to estimate the potential exposures from these routes and assess the significance of these exposures in the risk assessment. The statement in the preliminary risk assessment section is a preliminary judgement of the potential effects and will be corroborated, however the estimates and comparisons to "significant levels" is part of the risk assessment, not the Work Plan.

2. This comment concerns the use of a wind direction indicator.

Health and Safety Plan, Page 6-2 - WIND DIRECTION INDICATOR - "A wind direction indicator will be erected at every active work site. This will enable the site safety monitor and on-site personnel to determine upwind locations necessary for proper health and safety procedure implementation and, if necessary, evaluation procedures."

Please describe the "wind direction indicator" if it isn't a standard wind vane and provide details regarding location of the vane on-site, and height aboveground level. Also, mention whether or not an anemometer will be deployed on-site.

The wind direction indicator will simply be a flag or length of flagging tape that will allow on-site personnel to determine wind direction visually. There are no plans to have an anemometer on-site.

THE FOLLOWING COMMENTS ARE FROM NYSDEC (JUNE 3, 1991 LETTER)

1. This comment concerns Figure 2.

2.1: Figure 2 needs a north arrow.

A north arrow will be added to Figure 2.

2. This comment concerns the explosive list provided in Table 6.

3.1.2.1: This table should also include the Chemical/Physical Properties of Tetryl (N-methyl-2,4,6- trinitrophenylnitramine).

Data for Tetryl (N-methyl-2,4,6-) trinitrophenylnitramine will be added to Table 6.

3. This comment concerns potential receptors.

3.2: The evaluation of the human exposure pathways needs to explain why site visitors are excluded from being potential receptors from ingesting or having dermal contact to contaminated dust. The text indicates on-site workers are potentially exposed by those pathways. This would indicate visitors are also potentially exposed. The reasons for these exclusions need to be stated.

Site visitors are not strictly excluded from exposure through ingesting or dermal contact to contaminated dust. Rather the exposure to on-site workers is believed to be much greater than that for visitors. While visitors would be exposed via the above mentioned pathways, their exposure would be expected to be much less than that for an on-site worker.

4. This comment concerns inhalation of fugitive dust emissions.

3.2.2.2: It is stated that the site boundary is at a minimum of 1 mile away from the site. Upon measurement from the Facility Site Plan, we find the site boundary is about 2000 feet away from the site. Route 96-A is at the boundary and thus exposure to the traffic from the fugitive Dust Emissions and Volatile Organic Compounds (VOCs) is a significant threat. We, therefore, once again recommend that whenever field activities occur at the site, there must be continuous real-time monitoring conducted for VOCs and particulates at the downwind site perimeter. If the level of airborne particulates at the downwind site perimeter exceeds the action level of 150 ug/m^3, all work activities must be stopped and corrective measures implemented to control the release of airborne particulates. Particulate monitoring is especially important since surficial soils have been shown to contain elevated levels of metals.

During field activities at the site, real-time monitoring for volatile organic compounds (VOC's) and particulates will be conducted at the downwind OB grounds site boundary. If the level of VOCs at the downwind OB grounds site boundary exceeds

5 ppm above background levels measured upwind from the work area, then all activities must be stopped and corrective measures implemented to control the source of the release. If the level of airborne particulates at the downwind site boundary exceeds the action level of 150 ug/m^3, all work activities must be stopped and corrective measures implemented to control the source of the release.

5. This comment concerns Table 14 and the New York State Drinking Water Standards as defined in part 5-1 of the New York State Sanitary Code.

3.4: Table 14 must include New York State Drinking Water Standards, as defied in Part 5-1 of the New York State Sanitary Code. These NYSDOH drinking water standards represent an Applicable or Relevant and Appropriate Requirement (ARARs) at this site.

These standards will be included in Table 14.

6. This comment concerns screen length for the weathered bedrock wells.

4.2.4.2: A screen length of 2 feet has been proposed for weathered bedrock monitoring wells. No rationale has been given for this proposed 2 feet screen length. From Table 2 and Figure 11, it appears that the thickness of weathered bedrock is approximately 10 feet and therefore it is possible to provide screen more than 2 feet. Unless there is a reason for the 2 foot screen length, we propose a screen length of 10 feet or depth of weathered bedrock whichever is less. In case of weathered bedrock thickness less than 7 feet, we also recommend that part of the bentonite seal in upper glacial and part in weathered bedrock to provide sufficient screen length.

This comment was addressed by MAIN in the August 8, 1991 conference call, and it was agreed that a 2 foot screen length would be used in the weathered bedrock. The discussion was based on the limited thickness of the weathered bedrock zone (approximately 5 feet) which, when using EPA-approved procedures for well construction (i.e., 2 feet of sand above the screen and 2 feet of bentonite), allows for a screen length of 2 feet. A greater screen length will be used in the weathered bedrock zone when possible. This will be added to the Work Plan.

7. This comment concerns scheduling for the RI/FS.

Scheduling: According to the proposed schedule for the RI/FS at the Open Burning/Open Denotation ground, the time required from the date of the RI/FS Work Plan approval to the date the Feasibility Study report is finalized could take 44 months. This is an exceptionally long schedule and is not consistent with the schedule included in the Interagency Agreement for a typical RI/FS and therefore is unacceptable to the NYSDEC. If the consultant needs more time for a specific task, a justification for the extra time should be given in this section.

MAIN will perform certain aspects of the FS during the RI which will shorten the total schedule somewhat. MAIN will shorten the FS portion of the project by 8 months. However, the actual schedule will not be within the confines of the generic schedule outlined in the IAG.

MAIN feels that the generic schedule for an RI/FS provided in Attachment D of the Interagency Agreement is not appropriate for the RI/FS on the OB/OD grounds. The OB/OD grounds RI will be completed by about the 11th month according to MAIN's schedule, however, this is due to the fact that preparation of a Preliminary Site Characterization Report is necessary to met EPA requirements; this does not appear to be accounted for in the IAG schedule, which allows for 5 months. In addition, MAIN's schedule calls for a 10 month draft preparation and comment period and MAIN feels this is more realistic than the 3 month period provided in the IAG.

With regard to the FS report preparation, the IAG allows approximately 1 month for development of remedial response alternatives and feasibility studies prior to submittal of the draft FS report. MAIN will begin FS work during the RI as suggested.

8. This comment concerns the health and safety plan.

Appendix B, Health and Safety Plan: We acknowledge the receipt of this Health and Safety Plan. However, it should be understood that our review of this document is limited to ensure the health and safety of our employees and does not extend beyond it. The review and acceptance of this document for the health and safety of site workers is the sole responsibility of the Department of the Army.

This comment is acknowledged.

9. This comment concerns expiration of the certificate of approval for laboratory services.

Appendix C, Chemical Data Acquisition Plan: This section contains copies of the NYSDOH "Certificate of Approval for Laboratory Services" for Aquatic, Inc., which expired April 1, 1991. New certificates need to be obtained and replace the copes in Section C.

The response is provided in the response to the first comment of the Field Sampling and Analysis Plan provided by the EPA's Toxic and Hazardous Waste Section of the Monitoring Management Branch.

THE FOLLOWING COMMENTS ARE FROM NYSDEC (JUNE 18, 1991 LETTER)

1. This comment concerns inhalation of fugitive emissions.

3.2.2.2: It is stated that the site boundary is at a minimum of 1 mile away from the site. Upon measurement from the Facility Site Plan, we find the site boundary is about 2000 feet away from the site. Route 96-A is at the boundary and thus exposure to the traffic from the fugitive Dust Emissions and Volatile Organic Compounds (VOCs) is a significant threat. In addition, Seneca Army Depot (SEAD) employees may also be working in the adjacent areas of the Open Burning Grounds and may be subject to the effects of the site activities. We, therefore, once again recommend that whenever field activities occur at the site, there must be continuous real-time monitoring conducted for VOCs and particulates at the downwind Open Burning Ground site perimeter. If the level of VOCs at the downwind Open Burning Ground site perimeter exceeds 5 ppm above background levels measured upwind from the work area, then all activities must be stopped and corrective measures implemented to control the source of the release. If the level of airborne particulates at the downwind Open Burning Ground site perimeter exceeds the action level of 150 ug/m^3, all work activities must be stopped and corrective measures implemented to control the release of airborne particulates. Particulate monitoring is especially important since surficial soils have been shown to contain elevated levels of metals.

This comment was previously addressed in the response to the NYSDEC June 3, 1991 comments.

2. This comment concerns Table 15 and aquatic water criteria..

3.4.2: Table 15 on page 3-51 lists aquatic water quality criteria for Cadmium, Chromium (T), Lead and Mercury as "not available". This statement is incorrect; values are included in the 9/90 version of TOGS 1.1.1. If one assumes a water hardness of 50 mg/l as $CaCO_3$ then the respective criteria are 0.66, 117, 1.3 and 0.2 mg/l.

This comment is acknowledged. The Work Plan has been modified.

3. This comment concerns Figure 25 and sampling of drainage ditches.

4.2.3: A review of Figure 25 indicates that additional sampling sites are necessary. Each of the drainage ditches noted on this Figure should be sampled where it discharges to Reeder Creek (there appear to be 4). If these sites are dry during the intended sampling date(2) then they must be revisited and sampled during a period of stormwater run-off.

MAIN will sample three of the major drainage ditches (three sample locations) that are most likely to transport surface water run-off from the OB grounds to Reeder Creek. MAIN does not feel it is necessary to sample all of the drainage ditches on-site at this time. Further sampling of the on-site ditches will be evaluated after the initial results have been collected. The locations of the sampling points will be shown on Figure 25. The last sentence of this comment is acknowledged.

4. This comment concerns additional parameters for groundwater and surface water sampling. It also involves screening with a geiger counter.

3.6: <u>The groundwater and surface water should also be analyzed for nitrates, phenols (total), and total dissolved solids based on their potential presence. In addition, a geiger counter should be used during the field program to screen for the presence of radioactive material. In the event that radioactivity is encountered, then field activity should cease and the RI/FS program should be re-scoped to deal with this issue.</u>

MAIN proposes to conduct analyses for phenols as part of the TCL which will yield low detection limits. Nitrates will be added to the groundwater and surface water analyses. Values for nitrate have previously been determined for groundwater on the site and are not a concern. Table 3 of MAIN's RI/FS Work Plan provides a summary of these analyses. In addition, total dissolved solids values have previously been determined for the OB grounds site and are provided in an "Interim Final Report, Groundwater Contamination Survey No. 38-26-0868-88" July 1987. No other total dissolved solids data will be collected. MAIN feels that it is more important to concentrate on volatile organics, semi-volatile organics, explosives, and metals.

The use of a geiger counter is not believed to be necessary as the site is not a mixed waste facility.

5. This comment concerns sampling for acid soluble metals.

4.6: <u>A review of Table 23 indicates that the surface water will also be analyzed for acid soluble metals. At this time no acceptable analytical method for acid soluble metals in water exists. Therefore, these analyses should not be included in the Work Plan. Typically "total" results are used for comparison to ARARs.</u>

Only total metals samples will be collected from surface water sampling locations. The Work Plan will be modified to state this.

<u>Comments related to ecological resources</u>:

6. This comment concerns wetlands delineation.

3.4.2.1: <u>The document states that ten areas of the SEAD are designated as fresh water wetlands by NYSDEC and that none of these are near the OB/OD grounds. The Work Plan calls for "...a more detailed wetlands delineation...". Though the Work Plan does not identify what a more detailed delineation means, it seems premature to delineate wetlands in more detail than is identified in Step I of the Habitat Based Assessment until it is determined through the course of the remedial investigation that</u>

wetlands will have to be disturbed. If, at some point in the RI process, it is determined that it is probable that wetlands will have to be disturbed, then a more detailed delineation may be appropriate. Doing the detailed delineation now may add unnecessary cost to the remedial investigation and may not be useful in determining remedial methods.

MAIN proposes to delineate wetlands on the approximately 30 acre OB grounds using the Unified Federal Routine Method. Figure 29 illustrates the approximate area of the OB grounds. Wetland covertypes will be evaluated using aerial photographs, existing wetland maps (NYSDEC Wetland Regulatory Maps and United States Fish and Wildlife Service (USFWS) National Wetland Inventory Maps) and field reconnaissance. Wetland boundaries will not be surveyed as part of this delineation.

Wetlands outside the OB grounds will be evaluated using aerial photographs, existing wetland maps (NYSDEC Wetland Regulatory Maps and USFWS National Wildlife Inventory Maps) and field reconnaissance to confirm wetland delineations, where necessary.

7. This comment concerns media of preliminary potential concern.

3.4.2.3: Potential Chemical-Specific ARAR and TBC Levels indicates media of preliminary potential concerns as groundwater, surface water, and soil. Sediments should be added to this preliminary evaluation.

Agreed. Sediments will be added to media of potential concern.

8. This comment concerns aquatic toxicity and tissue sampling.

3.6: Surface water chemical analysis should also include hardness. The aquatic toxicity of certain metals can not be interpreted without hardness value. 2) It is stated that fish tissue sampling is required to evaluate the possible exposure due to ingestion of contaminated fish and that analyses of tissue will include the NYSDEC TCL and TAL list of compounds. In our letter dated February 21, 1991 to you, we suggested that the fish tissue sampling be delayed until Steps I and III of the Habitat Based Assessment are performed. This is still believed to be wise for the following reasons.

a) Fish tissue sampling is expensive and not needed if contaminants important to aquatic resources can not be found at the site or if found there is no pathway to the resources. If those conditions exist, fish tissue sampling provides no value since it can not aid in determining remedial methods.

b) Reeder Creek is small and collection of organisms in quantities necessary for analysis could in and of itself have potential adverse impacts on the resource. If those potential impacts can be avoided, they should.

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c) Doing full TCL and TAL might be unnecessary and costly. ONce target contaminants that have effects on aquatic resources can be identified at the site then an analytical list can be determined which is not so extensive.

Based on discussions held during the request for clarification period, MAIN proposes to conduct tissue sampling, if necessary, as part of a Phase II Investigation. Phase I will be a habitat characterization to obtain information on what species are likely to utilize the site as well as an assessment of soil, sediment, and aquatic chemistry.

9. This comment concerns the approach to the ecological assessment.

4.2.5.1: Approach to Ecological Assessment states that MAIN ecologists will collect aquatic community data by making aquatic collections. It is premature to make such collections and such collections will induce unnecessary mortality. The first description and risk analysis for aquatic resources should be based on available records or presumptions from other aquatic ecology studies for creeks similar to Reeder Creek. Should risk analysis at some future date need collections then they should be instituted. The aquatic community collections proposed may never be needed for determining remedial measures and would be an unnecessary cost.

In order to determine the inhabitants of Reeder Creek, MAIN must collect samples of aquatic organisms. MAIN does not feel that this would unnecessarily disturb these aquatic communities.

10. This comment concerns fish tissue sampling.

4.2.5.2: 1) Page 4-42; Sampling Program states that chemical analyses for fish samples will be "...fish fillets, skin off, ...". DEC procedures generally leave the skin on fish fillets. See the enclosed DEC procedures. Taking the skins off will make comparisons with an existing DEC database difficult, if not impossible. 2) Page 4-43; Sediment collections should be from depositional areas not "... faster flowing water...". 3) Page 4-44; It is stated, "[i]f no toxicity is observed, then it might reasonably be assumed that any stress noted to biota on or adjacent to the OB grounds is due to habitat description, external sources of toxic chemicals, natural variability, etc." Emphasis added. A clarification is needed since there is no way of determining the difference between external or other sources of toxicity by chemical analysis.

Based on discussions held during the request for clarification period, MAIN proposes to conduct tissue sampling, if necessary, as part of a Phase II Investigation. Phase I will be a habitat characterization to obtain information on what species are likely to utilize the site as well as an assessment of soil, sediment, and aquatic chemistry.

1) If performed as part of Phase II, the DEC method for such preparation should be used.

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2) Acknowledged. This will be stated in the Work Plan.

3) This discussion will be clarified in the Work Plan.

11. This comment concerns tissue sampling.

4.4.5: Environmental Assessment does not mention how tissue sample analyses will be used in risk assessment. Since tissue samples are a big part of the proposed biota sampling scheme, how those values are to be interpreted and their purposes should be clearly stated. This section should state how sediment analyses will be interpreted with respect to aquatic resources.

Tissue sampling will be performed as part of Phase II, if necessary. This section of the Work Plan will also provide a statement of how sediment analyses will be interpreted with respect to aquatic resources.

MAIN will conduct the soil boring and excavation sampling program in two phases. Phase I will consist of 1) 20 grid borings, 2) 22 burning pad borings and 3) 32 berm excavations. A second phase of borings and excavation sampling (Phase II) will be performed on the site after the completion of Phase I. Phase II will consist of 1) 30 grid borings, 2) 18 burning pad borings, 3) 28 berm excavations and 4) 28 low-lying hill excavations. The locations of the Phase V and sampling locations may be altered slightly depending on the outcome of the Phase I sampling.

In accordance with discussions held during the request for clarification period, split spoon samples will be collected continuously for the length of the boring. Samples collected from the ground surface to the depth of the first spoon sample in saturated naturally deposited sediments will be sent to the laboratory for Level II analysis. Continuous split spoon sampling will occur for the remainder of the boring, however, the samples will not be submitted for Level II analysis. Because one of the goals of the subsurface investigation is to characterize source areas, MAIN does not feel that it is necessary to analyze split spoon samples below the upper portion of the saturated zone on naturally deposited sediments. All split spoon samples collected in till material will be submitted for Level V analysis.

If you have any questions regarding this letter, please do not hesitate to call me at (617)859-2492.

Very truly yours,

CHAS. T. MAIN, INC.

Michael Duchesneau

Michael Duchesneau, P.E.
Environmental Engineer
Project Manager

MD/at

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APPENDIX E
SCOPE OF WORK

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ANNEX A

REMEDIAL INVESTIGATIONS AND FEASIBILITY STUDIES
AT THE OPEN BURNING GROUNDS
PHASE I - PREPARATION OF WORK PLANS
SENECA ARMY DEPOT, ROMULUS, NEW YORK

1.0 GENERAL STATEMENT OF SERVICES

1.1 Background. As part of its continuing program of evaluating its hazardous waste management practices, the Army will perform Remedial Investigations/Feasibility Studies (RI/FS) at the Open Burning (OB) Grounds at Seneca Army Depot (SEAD). The RI/FS investigations are to be conducted to determine the magnitude of environmental contamination and appropriate remedial actions. The US Army Corps of Engineers, Huntsville Division, on behalf of SEAD, will contract for the required work.

1.2 Location. Seneca Army Depot is a US Army facility located in Seneca County, New York. SEAD occupies approximately 10,700 acres. It is bounded on the west by State Route 96A and on the east by State Route 96. The cities of Geneva and Rochester are located to the northwest (14 and 50 miles, respectively); Syracuse is 53 miles to the northeast and Ithaca is 31 miles to the south. The surrounding area is generally used for farming.

1.3 Regulatory Status. Seneca Army Depot was proposed for the Federal Facilities National Priorities List on 13 July 1989. Consequently, all work to be performed under this contract shall be performed according to CERCLA guidance as put forth in the Interim Final "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA", dated October 1988 (Reference 11.20). Additionally, all work performed as part of this contract shall be performed according to the Interagency Agreement negotiated between Seneca Army Depot, the New York State Department of Environmental Conservation (NYSDEC) and the U.S. Environmental Protection Agency (USEPA), Region II (Reference 11.25).

1.4 Previous Investigations. Previous investigations have been performed at various SEAD units. An "Installation Assessment and Update" (USATHAMA Reports No. 157 (1980) and 157(U) (1987), respectively) were conducted by the U.S. Army Toxic and Hazardous Materials Agency. The purpose of the assessments was to identify potentially contaminated areas at the Depot. The U.S. Army Environmental Hygiene Agency's Groundwater Contamination Survey No. 38-26-0868-88, "Evaluation of Solid Waste Management Units, Seneca Army Depot" (Reference 11.19) identifies and describes all solid waste management units (SWMU's) at SEAD. In addition, a Criteria Development study (Reference 11.22) has been performed and closure plans were being considered for the burning pads (SEAD-23). However, closure is presently not being considered pending the outcome of the RI/FS for this operable unit. A complete list of previous investigations is presented as References in Section 11.0.

1.5 Units to be Investigated Under this Contract. The RI/FS investigations will be focused on the open burning grounds; specifically, the burning pads and adjacent ground area. The approximate area of concern is 30 acres.

1.6 Security Requirements. Compliance with SEAD security requirements is mandated. These requirements are presented in Section 9.0.

1.7 Contaminants of Concern. Since 1941, propellant, explosive and pyrotechnic (PEP) wastes have been disposed of at the OB grounds. The contaminants of concern in this investigation are heavy metals and explosives.

2.0 OBJECTIVE. The objective of this delivery order Statement of Work (SOW) is to develop a complete Work Plan for RI/FS investigations to be performed at the Open Burning grounds. This Work Plan shall be developed as defined by Office of Solid Waste and Emergency Response Directive 9355, beginning with the RI/FS scoping process and ending with a regulatorally approved Work Plan at the identified site. Additionally, this Work Plan shall maintain the basic format of the Work Plan developed for the SEAD Ash Landfill RI/FS which is presently being finalized following regulatory review (Reference 11.23).

3.0 DETAILED DESCRIPTION OF SERVICES

3.1 General Requirements. All work performed by the AE shall be designed and implemented in a manner which complements earlier investigations and shall conform to this SOW. The AE, through the Work Plans, shall present a complete description of the RI/FS process as applied to this site. All work shall be performed under the general supervision of both a Professional Engineer registered in the State of New York and a certified geologist.

3.2 <u>RI/FS Work Plan Preparation.</u> The AE shall prepare two documents; a RI/FS Project Scoping Document and a RI/FS Work Plan Document which are intended to do the following: (1) to provide a consolidated report on site history, current site activities, and resulting environmental impacts; (2) to familiarize personnel who will be working on the project with site conditions; and (3) to provide project plans and proposed tasks by which RI/FS activities shall be conducted. The documents shall be prepared as follows:

3.2.1 <u>(Task A-1) Site Visit and Review Existing Data.</u> The AE shall perform a visual inspection of the site, review the records, reports and other data provided by the Contracting Officer and the facility, or made available to the AE from sources such as public records, the USEPA, the State Regulators, the State Geological Survey, or from interviews with local residents and officials who have knowledge of past site activities.

3.2.2 <u>(Task A-2) RI/FS Project Scoping Document.</u> This Task corresponds to a portion of EPA Task 1 in Appendix B of the RI/FS Guidance Manual. The AE shall prepare and submit a RI/FS Project Scoping Document which provides a summary of site conditions, gives an overview of the RI/FS process and describes how the process will be implemented at the OB Grounds. The RI/FS Project Scoping Process shall contain, as a minimum, the following elements:

3.2.2.1 <u>Physical Characteristics of the Site.</u> The AE shall provide a site description which includes location, ownership, topography, geology, hydrology, land use, waste type, estimates of waste volume, synopsis of findings and results of previous investigations, and other pertinent details. The description shall also include historical events of concern such as chemical storage and disposal practices, results and findings of previous studies and a "quality assurance" evaluation of the existing data in order to estimate its reliability.

3.2.2.2 <u>Conceptual Site Model</u>. From the analysis of the data reviewed, the AE shall make a preliminary determination of the physical characteristics of the site and prepare a Conceptual Site Model of the known contaminants. The description is to give an overview of site conditions, probable and potential contaminants of concern, severity of contamination, and the potential impacts on the environment. As a minimum the Conceptual Site Model shall include potential routes of migration, potential receptors and anticipated impacts.

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3.2.2.3 Develop and Evaluate Preliminary Remedial Action Objectives and Alternatives. The AE shall present an overview of the remedial actions that could be reasonably used to mitigate adverse site conditions. The choice of alternatives shall be based on proven effectiveness of the technology and the anticipated cost of implementation. This is not meant to be a detailed investigation of all potentially available remedial technology.

3.2.2.4 Preliminary Identification of ARAR's and TBC Requirements. The AE shall make a preliminary determination of potential contaminant, location, and action specific ARAR's based upon an evaluation of existing site data.

3.2.2.5 Develop Data Needs and Data Quality Objectives. The AE shall evaluate the existing data and determine the additional data necessary to characterize the site, complete the conceptual site model, better define the ARAR's, and narrow the range of preliminary identified remedial alternatives. The AE shall consider the intended uses of existing data as well as data to be collected under this contract and determine the type, quantity, and quality of additional data needed for each site.

3.2.3 (Task A-3) RI/FS Work Plan. This Task corresponds to a portion of EPA Task 1 in Appendix B of the RI/FS Guidance Manual. The AE shall prepare an RI/FS Work Plan Document, the basis and format of which are presented in Reference 11.23. Quality Control/Quality Assurance procedures, Standard Operating Procedures, methods, equipment, and specific personnel (along with their qualifications) that an AE would need to use to accomplish the RI/FS shall be identified and discussed at appropriate locations within the plan. As a minimum the RI/FS Work Plan shall include the following:

3.2.3.1 Health and Safety Program Plan (HSP). The AE shall develop and maintain a Health and Safety Program Plan in compliance with the requirements of OSHA standard 29 CFR 1910.120 (b)(1) through (b)(4). Written certification that the HSP has been developed and implemented shall be submitted to the Contracting Officer and the plan shall be made available upon request.

3.2.3.1.1 The AE shall develop a Site-Specific Safety and Health Plan (SSHP), as part of the HSP, in accordance with the requirements of Section 5.0 of this SOW and similar to Appendix B of reference 11.23. The SSHP shall be submitted to the Contracting Officer for review and approval prior to commencing any field work.

3.2.3.2 Chemical Data Acquisition Plan (CDAP). The AE shall prepare and submit a Chemical Data Acquisition Plan (CDAP) according to the requirements of Section 6 of this SOW and similar to Appendix C of reference 11.23. This portion of the RI/FS Work Plan shall also describe in detail, the following: 1) Site Background; 2) Quality control and quality assurance procedures to be exercised including organization and responsibilities; 3) QA objectives; 4) Sampling procedures; 5) Sample custody; 6) Calibration procedures; 7) Analytical procedures; 8) Data reduction, validation and reporting; 9) Internal quality control; 10) Performance and system audits; 11) Preventive maintenance; 12) Data assessment procedures; 13) Corrective actions; and, 14) Quality assurance reports.

3.2.3.3 Field Sampling and Analysis Plan. The AE shall prepare and submit, as part of the RI/FS Work Plan, a Field Sampling and Analysis Plan (FSAP). The FSAP shall describe in detail all sampling and analysis activities to be exercised including site background, sampling objectives, sampling locations and frequency, designations, equipment and procedures and handling and analysis requirements to be applied at each site. Section 3.3.1 of this SOW provides for numerous field investigation activities which will be applied to the project **(except that actual performance of these field activities is not part of this delivery order SOW)**. It is intended that the AE, in the FSAP, propose and justify how the field investigation activities will be allocated. In addition to the specific requirements of the RI/FS Guidance Document, the AE shall provide the following subplans as part of the FSAP.

3.2.3.3.1 Geophysical Investigation Plan. The AE shall prepare and submit a brief work plan which describes specific equipment, methods and personnel which the AE will utilize to accomplish the geophysical investigations. The plan shall propose the linear footage of geophysical surveying to be performed and shall propose specific locations for proposed geophysical investigations. The plan shall include justification for the method selected for use in order to meet the objective of the geophysical investigations which is to obtain information on the physical, subsurface conditions at the site and to locate unexploded ordnance (UXO) prior to the commencement of drilling activities.

3.2.3.3.2 Soil Boring and Monitoring Well Installation Plan. The AE shall prepare and submit a Soil Boring and Monitoring Well Installation

Plan according to the requirements of Section 7.0 of this SOW and Section 4.2 of Reference 11.23. This portion of the RI/FS Work Plan shall include proposals for the number, depth, total linear footage and locations of specific borings and monitoring wells based on previous investigations and the AE's own evaluation of the site.

3.2.4 (Task A-4) Community Relations Plan. A Community Relations Plan (CRP) is presently being developed, by CETHAMA, for Seneca Army Depot, as a whole, according to the requirements of the RI/FS Guidance Manual, Appendix B, Task 2. It will describe how and when the community will be informed of RI/FS activities and findings. The Plan will describe how the RI/FS is to be implemented and managed, describe the information expected from each task and how the information will be gathered, interpreted and incorporated into the RI/FS Reports. The Plan will describe the full RI/FS process, through implementation of Remedial Action, (eventhough this delivery order SOW does not carry the RI/FS process to that point) so that the entire process is described. The AE shall, where appropriate, provide input on aspects of the plan that are site specific.

3.3 Remedial Investigation/Feasibility Studies. The objective of this SOW is to prepare a Work Plan for RI/FS investigations to be performed as laid out in the EPA Guidance Manual. The following items comprise the field work requirements of the proposed RI/FS and are provided here to aid in preparation of the Work Plan. The implementation of the work shown in this Section is to be completed as part of a subsequent delivery order once regulatory approval is given on the Work Plans. Task designations are included to provide a systematic approach to structuring the Work Plans. **Actual performance of tasks in this Section is not part of this delivery order.**

3.3.1 Remedial Investigations.

3.3.1.1 Field Investigations. The work required in this Section corresponds to EPA Task 3 in Appendix B of the RI/FS Guidance Manual. The RI field investigations shall be performed in order to characterize the site and determine the nature and extent of soil and groundwater contamination. The work shall be performed according to the approved work plan and as follows:

3.3.1.1.1 (Task A) Geophysical Surveys. Investigations shall include the performance of Geophysical Surveying according to the requirements of the approved GIP. The AE shall utilize a method of geophysical investigation capable of detecting buried metal and debris, if existing, to a depth of 15 feet. The purpose of the geophysical surveys is to obtain detailed information necessary for source characterization. The AE shall utilize sufficient location control in the field to ensure that geophysical anomalies are located by State Plane Coordinates to the closest 1.0 foot.

3.3.1.1.2 (Task B) Drill Soil Borings. Investigations shall include the installation of soil borings as laid out in the approved FSAP. In addition, the AE shall install soil borings for the purpose of determining background conditions at the site. Soil samples, the number and frequency of which are laid out in the FSAP, will be collected as part of this subtask for subsequent chemical analysis under Task E.

3.3.1.1.3 (Task C) Surface Water Sampling. The AE shall collect one round of surface water samples. The required number and locations of samples are as directed in the approved FSAP. Field samples shall be collected at locations for analysis under Task F.

3.3.1.1.4 (Task D) Surveying. Location surveys and mapping shall be performed according to the requirements of Section 8.0 of this Statement of Work and Section 4.2.5 of Reference 11.23. The following locations shall be established as part of this task:

Task Number	Description
A	Locations of geophysical survey grid points
B	Soil borings
C	Surface water sampling points
F	14 existing monitoring wells- mapping only

3.3.1.2 Chemical Sampling and Analysis. The work required in this Section corresponds to EPA Tasks 4 and 5 in Appendix B of the RI/FS Guidance Manual. The AE shall collect and analyze samples in a manner determined in the approved FSAP. The total number of samples to be collected by the AE along with required and approved analysis methods are presented in the FSAP. The AE shall submit a Table which provides the results of each round of analytical data as soon as it is received from the laboratory, and not wait for the next scheduled report submission. Samples of the Tables to be used in presenting the type and number of analytical samples to be taken are provided in Section 6 of this SOW.

3.3.1.2.1 (Task E) Analysis of Soil Samples. The AE shall analyze all soil samples previously collected from the soil borings drilled. EP Toxicity tests should be performed only at sites that show a high metals content. The AE shall submit a Table which provides the results of each round of analytical data as soon as it is received from the laboratory, and not wait for the next scheduled report submission.

3.3.1.2.2 (Task F) Collection and Analysis of Groundwater Samples. The AE shall redevelop each of the 14 existing monitoring wells. Following individual well redevelopement, the AE shall collect and chemically analyze one groundwater sample from each of the wells. A total of 14 wells will be sampled under this subtask. Of the 14 individual samples taken, three shall be split for filtration. Of the three filtration split samples, one shall be split twice more; once to produce a filtration QA sample and once to produce a filtration QC sample. The purpose of the filtration samples is to qualify sediment influences on analysis results. Of the remaining 11 individual samples, one shall be split twice; once to produce an unfiltered QA sample and once to produce an unfiltered QC sample. In addition, the AE shall chemically analyze the surface water samples collected in Task C. The total number of water and QA/QC samples to be taken and the required analyses are summarized in the FSAP. The AE shall submit a Table which provides the results of each round of analytical data as soon as it is received from the laboratory, and not wait for the next scheduled report submission.

3.3.1.3 (Task G) Baseline Risk Assessment. The work required in this Section corresponds to EPA Task 6 in Appendix B of the RI/FS Guidance Manual. Using the information gathered from the record search, the field work and data analyses, the AE shall prepare and submit a Risk Assessment. The Risk Assessment shall provide an evaluation of the potential threat to human health and the environment in the absence of any remedial action and provide the basis for determining whether or not remedial action is necessary. The Risk Assessment Report shall be prepared using the guidance presented in the RI/FS Guidance Manual and, as a minimum, contain a baseline risk assessment, an exposure assessment, and a standards analysis. The Risk Assessment shall be submitted as part of the RI/FS Report. The AE shall provide information including, but not necessarily limited to, the following:

3.3.1.3.1 Identification of Contaminants of Concern. Using the information gathered from field work, record search, and consultation with appropriate local, State and Federal Officials the AE shall identify the contaminants which are of concern. The AE shall provide a summary of each identified contaminant describing why it was selected, and the effects of its chronic and acute toxicity to humans and the environment.

3.3.1.3.2 Exposure Assessment. The AE shall identify actual or potential exposure paths and routes, characterize potentially exposed populations, and estimate expected exposure levels. As part of the Exposure Assessment, the following Task shall also be performed:

3.3.1.3.2.1 Water Well Survey. The AE shall make a reasonable effort to determine the existence of all operating water wells used for human consumption within one mile of the Installation that may be affected by deteriorated water quality on the Installation. A "house-to-house" survey is not intended. However, whenever possible, the AE shall include well location, depth, screened interval, water use, and number of people served by the well. This task may be performed through the examination of records available at public sources, backed by occasional field checks. The information shall be provided both in tabular form and on suitable maps.

3.3.1.3.2.2 Spring Survey. The AE shall make a reasonable effort to determine the existence of all springs used for human consumption within one mile of the Installation that may be affected by deteriorated water quality on the Installation. The information shall be provided both in tabular form and on suitable maps.

3.3.1.3.3 Toxicity Assessment. The AE shall make a comparison of acceptable levels of contamination with actual levels identified during the exposure assessment. The comparison shall be based upon available ARARs, TBCs and other toxicological data, where existing.

3.3.1.3.4 Risk Characterization. The AE shall, based upon other components of the Risk Assessment, characterize the risk associated with the site. The AE shall consider the carcinogenic risk, noncarcinogenic risk and the environmental risk. The characterization shall include a summary of each projected exposure route for contaminants of concern and the distribution of risk across various sectors of the population. Such factors as weight-of evidence associated with toxicity information, the estimated uncertainty of the component parts, and the assumptions contained within the estimates shall be discussed.

3.3.1.3.5 Propose Applicable or Relevant and Appropriate Requirements (ARAR's) and To Be Considered (TBC) Requirements. The AE shall develop and propose contaminant and location specific "Applicable or Relevant and Appropriate Requirements" (ARAR's) and To Be Considered (TBC) Requirements which, after review and possible modification as directed by the Contracting Officer, will be utilized to evaluate subsequent proposed remedial actions. ARAR's and TBC's shall be prepared using guidance presented in the RI/FS Guidance Manual.

3.3.1.4 (Task H) Treatability Study Requirements Assessment. The work required in this Section corresponds to EPA Task 7 in Appendix B of the RI/FS Guidance Manual. The AE shall recommend if specific Treatability Studies are required or if the existing situation is well enough understood and described in scientific, engineering and other technical literature such that site specific treatability studies do not appear to be necessary. If treatability studies are recommended, the AE shall assess existing data on technologies identified as Remedial Action Alternatives to determine data needs required to undertake treatability investigations following completion of alternatives development. If treatability studies are recommended, the AE shall develop a Treatability Study Concept Plan. The Treatability Study Requirements Assessment (and Concept Plan if, required) shall be submitted as part of the RI/FS Report.

3.3.2 (Task I) Feasibility Study. The work required in this Section corresponds to EPA Task 9 in Appendix B of the RI/FS Guidance Manual. The primary objective of this phase of the FS is to develop an appropriate range of waste management options that protect human health and the environment.

3.3.2.1 Develop Remedial Action Objectives. The AE shall develop remedial action objectives which protect human health and the environment and then describe general response action which will satisfy the remedial action objectives.

3.3.2.2 Identify and Evaluate Alternative Remedial Actions. The AE shall describe all available technologies that could be reasonably used as remedial actions at SEAD. The AE shall then screen the list to remove any potential Remedial Actions which are clearly illogical, inadequate, unfeasible, or otherwise ill-suited to the site. Remedial actions presented past the initial screening shall consist of only those representing proven technologies adequate to address site conditions. A detailed evaluation including the strengths and weaknesses of each technology shall be performed. The initial screening shall be based upon effectiveness, implementability and cost. Where appropriate, the AE may combine feasible remedial actions. The "no action" alternative shall be described in detail as part of this task. Additional data needed shall also be described.

3.3.3 <u>(Task J) Prepare RI/FS Report</u>. The work required in this Section corresponds to EPA Tasks 8 and 11 in Appendix B of the RI/FS Guidance Manual. At the completion of the preceding tasks, the AE shall prepare the Remedial Investigation/ Feasibility Study Report, fully documenting all work performed. The report shall be prepared according to the requirements of this SOW and the referenced guidance documents. The report shall also describe any recommended work to be performed during a follow-on RI/FS and make specific recommendations, and provide the justification, for sampling locations and analytes proposed for the follow-on work. As part of this report the AE shall evaluate the need for interim or expedited remedial actions at the site. If the AE recommends that either is appropriate, he shall so propose and justify.

3.3.4 <u>(Task K) Proposed Remedial Action Plan.</u> The work involved in this Section corresponds to Chapter 2 of the "Draft Guidance on Preparing Superfund Decision Documents: The Proposed Plan and Record of Decision", Reference 11.24. The AE shall prepare and submit for inclusion in the Administrative Record, a Proposed Remedial Action Plan (PRAP), the purpose of which is to highlight the RI/FS report; provide a brief analysis of the remedial alternatives under consideration for this site; identify the preferred remedial action and provide the public with information on how they may participate in the remedy selection process.

3.3.5 <u>(Task L) Record of Decision.</u> The work required in this Section corresponds to EPA Task 12 in Appendix B of the RI/FS Guidance Manual. The AE shall prepare and submit a document for the signature of the SEAD Commander addressing the decision to implement the approved remedial action alternative.

3.3.4 <u>(Task M) Monthly Reports.</u> The AE shall prepare and submit monthly reports describing, at a minimum, all field activities conducted that month and those anticipated for the upcoming month. These reports shall be completed as mandated in Section 26 of the Interagency Agreement (Reference 11.25).

4.0 SUBMITTALS AND PRESENTATIONS

4.1 Format and Content. All submittals for this contract and the contract for field work implementation shall be prepared in accordance with the suggested RI/FS Format as presented in the RI/FS Guidance Manual. Each submittal shall be accompanied by an EPA completeness checklist (where existing), completed by the AE, which references the specific location within the submitted document, of the required item. All drawings shall be of engineering quality in drafted form with sufficient detail to show interrelations of major features on the installation site map. When drawings are required, data may be combined to reduce the number of drawings. The documents shall consist of 8-1/2" x 11" pages with drawings folded, if necessary, to this size. A decimal paragraphing system shall be used, with each section and paragraph of the documents having a unique decimal designation. The document covers shall consist of vinyl 3-ring binders and shall hold pages firmly while allowing easy removal, addition, or replacement of pages. A document title page shall identify the AE, the Corps of Engineers, Huntsville Division, and the date. The AE identification shall not dominate the title page. Each page of draft and draft-final documents shall be stamped "DRAFT" and "DRAFT-FINAL" respectively. Each document shall identify the members and title of the AE's staff which had significant, specific input into the document's preparation or review. Submittals shall include incorporation of all previous review comments accepted by the AE as well as a section describing the disposition of each comment. Disposition of comments submitted with the final document shall be separate from the document itself. All final submittals shall be sealed by both the registered Professional Engineer-In-Charge and certified geologist.

4.2 Presentations. The AE shall make presentations of work performed according to the schedule in paragraph 4.6. Each presentation will consist of a summary of the work accomplished and anticipated followed by an open discussion among those present. The AE shall provide a minimum of two persons at the meetings which are expected to last one day each.

4.3 Conference Notes. The AE will be responsible for taking notes and preparing the reports of all conferences, presentations, and review meetings. Conference notes will be prepared in typed form and the original furnished to the Contracting Officer (within five (5) working days after date of conference) for concurrence and distribution to all attendees. This report shall include the following items as a minimum:

a. The date and place the conference was held with a list of attendees. The roster of attendees shall include name, organization, and telephone number.

b. Written comments presented by attendees shall be attached to each report with the conference action noted. Conference action as determined by the Government's Project Manager shall be "A" for an approved comment, "D" for a disapproved comment, "W" for a comment that has been withdrawn, and "E" for a comment that has an exception noted.

c. Comments made during the conference and decisions affecting criteria changes, must be recorded in the basic conference notes. Any augmentation of written comments should be documented by the conference notes.

4.4 Confirmation Notices. The AE will be required to provide a record of all discussions, verbal directions, telephone conversations, etc., participated in by the AE and/or representatives on matters relative to this contract and the work. These records, entitled "Confirmation Notices", will be numbered sequentially and shall fully identify participating personnel, subject discussed, and any conclusions reached. The AE shall forward to the Contracting Officer as soon as possible (not more than five (5) work days), a reproducible copy of said confirmation notices. Distribution of said confirmation notices will be made by the Government.

4.5 Progress Reports and Charts. The AE shall submit progress reports to the Contracting Officer with each request for payment. The progress reports shall indicate work performed, and problems incurred during the payment period. Upon award of this delivery order, the AE shall, within 15 days, prepare a progress chart to show the proposed schedule for completion of the project. The progress chart shall be prepared in reproducible form and submitted to the Contracting Officer for approval. The actual progress shall be updated and submitted by the 15th of each month and may be included with the request for payment.

4.6 Schedule of Deliverables and Review Meetings.

Deliverables shall be submitted according to the following schedule.

Deliverable/Meeting	Days following NTP
Draft RI/FS Scoping Document, Work Plan and Community Relations Plan Revision	80
Draft Comments Received by the Army	110
Scoping Process Presentation at SEAD	125
Draft-Final RI/FS Scoping Document, Work Plan, and Community Relations Plan Revision	145
Draft-Final Work Plan Comments due to the Army	175
Final RI/FS Scoping Document, Work Plan, and Community Relations Plan (No Disputes)	205

The above schedule is a "best-case" schedule and is dependent upon whether the comments are reviewed per the IAG without any extensions or iterations.

4.7 Submittals.

4.7.1 General Submittal Requirements.

4.7.1.1 Distribution. The AE is responsible for reproduction and distribution of all documents. The AE shall furnish copies of submittals to each addressee listed in paragraph 4.7.3 in the quantities listed in the document submittal list. Submittals are due at each of the addressees not later than the close of business on the dates shown in paragraph 4.6.

4.7.1.2 Partial Submittals. Partial submittals will not be accepted unless prior approval is given.

4.7.1.3 Cover Letters. A cover letter shall accompany each document and indicate the project, project phase, the date comments are due, to whom comments are submitted, the date and location of the review conference, etc., as appropriate. (Note that, depending on the recipient, not all letters will contain the same information.) The contents of the cover letters should be coordinated with CEHND-ED-PM prior to the submittal date. The cover letter shall not be bound into the document.

4.7.1.4 Supporting Data and Calculations. The tabulation of criteria, data, circulations, and etc., which are performed but not included in detail in the report shall be assembled as appendices. Criteria information provided by CEHND need not be reiterated, although it should be referenced as appropriate. Persons performing and checking calculations are required to place their full names on the first sheet of all supporting calculations, and etc., and initial the following sheets. These may not be the same individual. Each sheet should be dated. A copy of this SOW shall be included as an appendix in the Draft Work Plans only.

4.7.1.5 Reproducibles. One camera-ready, unbound copy of the finaleach submittal shall be provided to the Contracting Officer in addition to the submittals required in the document and submittal list. All final submittals shall also be provided on floppy disks compatible with the Intel 310/80286 computer in ASCII format and in Word Star 2000 release 2.0 format.

4.7.2 Specific Submittal Requirements.

a. SSHP (Draft, Draft-Final, Final)
b. RI/FS Project Scoping Document (Draft, Draft-Final, Final)
c. Work Plans (Draft, Draft-Final, Final)
d. Community Relations Plan Revision (Draft, Draft-Final, Final)

4.7.3 Addressees.

Commander
U.S. Army Corps of Engineers
Huntsville Division
ATTN: CEHND-ED-PM (Mr. Walt Perro)
PO Box 1600
Huntsville, AL 35807-4301

Commander
U.S. Army Environmental
Hygiene Agency (USAEHA)
ATTN: HSHB-ME-SR (Mr. Hoddinott)
Building 1677
Aberdeen Proving Ground, MD 21010-5422

Commander
U.S. Army Material Command (USAMC)
ATTN: AMCEN-A
5001 Eisenhower Ave.
Alexandria, VA 22333-0001

Commander
U.S. Army Corps of Engineers
Toxic and Hazardous Materials Agency
ATTN: CETHA-IR-D (Ms. Katherine Gibson)
Aberdeen Proving Ground, MD 21010-5401

Commander
U.S. Army Depot Systems
Command (DESCOM)
ATTN: AMSDS-EN-FD
(Mr. Tim Toplisek)
Chambersburg, PA 17201

Commander
U.S. Army Corps of Engineers
Missouri River Division
ATTN: CEMRD-ED-EA (Mr. Doug Plack)
PO Box 103, Downtown Station
Omaha, NE 68101-0103

Commander
U.S. Army Corps of Engineers
Missouri River Division
ATTN: CEMRD-ED-GL
420 South 18th St.
Omaha, NE 68102

Commander
Seneca Army Depot
ATTN: SDSSE-HE (Randy Battaglia)
Romulus NY 14541

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Commander
U.S. Army Corps of Engineers,
North Atlantic Division,
ATTN: CENAD-CO-EP
90 Church Street
New York, NY 10007-9998

Commander
HQUSACE
ATTN: CEMP-RI
20 Massachusettes Ave., NW
Room 2209
Washington, D.C. 20314-1000

4.6.4 Document and Submittal List.

	All Submittals		
	Draft	Draft-Final	Final
CEHND-ED-PM	3	3	3
USAMC	1	1	1
DESCOM	2	2	2
CETHA-IR-D	1	1	1
CEMRD-ED-EA	3	3	3
CEMRD-EA-GL	1	1	1
SDSSE-HE	23	23	23
CENAD-CO-EP	1	1	1
USAEHA	3	3	3
CEMP-RI	0	0	0
TOTAL	37	37	37

5.0 SAFETY REQUIREMENTS. The AE shall prepare and submit the Site-Specific Safety and Health Plan (SSHP) to the contracting Officer (CO) for review and acceptance prior to commencement of any field work, according to the schedule in paragraph 4.6. The SSHP shall be prepared in accordance with the requirements specified in this Section and shall be complete and in a form such that, as a stand alone document, it may be implemented immediately in the field. No field work (other than the initial visual inspection) may be performed until all plans are reviewed and approved by the CO. All work shall be performed according to the approved plans.

5.1 The SSHP shall be prepared by a board certified or board eligible Industrial Hygienist with at least 2 years hazardous waste site operations experience. Board certification or eligibility shall be documented by written confirmation by the American Board of Industrial Hygiene (ABIH) and submitted to the Contracting Officer. A fully trained and experienced health and safety officer (SSHO), responsible to the AE and the AE's Industrial Hygienist may be delegated to implement the on-site elements of the SSHP.

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5.1.1 The SSHP shall be in a form usable by Corps of Engineers or U.S. Government management personnel and all other visitors to the site during site operations. The following topics shall be discussed at a minimum in the SSHP:

5.2. Site Description and Contamination Characterization. A description of the site, including a complete summary of contaminants anticipated onsite (chemical/biological names, concentration ranges, media in which found, locations onsite and estimated quantities/volumes) shall be provided.

5.3 Staff Organization, Qualifications and Responsibilities. The operational and health and safety responsibilities of each key person shall be discussed. The organizational structure, including lines of authority for safety and health and overall responsibilities of the AE and all subcontractors shall be provided. An organizational chart showing the lines of authority from the site level up through corporate management shall be provided.

5.4 Hazard Assessment and Risk Analysis. The AE shall identify the chemical, physical, safety and biological hazards of concern for each task and or operation to be performed. Include routes and sources of exposure, anticipated onsite and off-site exposure potential levels, and the applicable regulatory or recommended protective exposure standards. Action levels shall be specified and justified for the protection of onsite personnel and for the prevention or minimization of hazards/exposures to the off-site public from site activities.

5.5 Accident Prevention. All Accident Prevention Plan topics required by EM 385-1-1, Appendix Y, but not specifically covered by these elements shall be addressed in this section of the SSHP.

5.6 Training. Training for all onsite personnel as well as site specific, supervisory, refresher and visitor training shall be in accordance with 29 CFR 1910.120 Final Rule. The content, duration, and frequency, of training shall be described. Written certification that the required training has been received by affected personnel shall be submitted to the contracting officer prior to engaging in onsite activities.

5.7 Personal Protective Equipment. A written Personal Protective Equipment (PPE) Program shall be provided in the SSHP. The program shall address all the elements of 29 CFR 1910.120 (g)(5) and 29 CFR 1910.134. Specify minimum levels of protection necessary for each task/operation to be performed based on the hazard assessment/risk analysis required in paragraph

5.4 Include specific types and materials for protective clothing and respiratory protection. Establish and justify upgrade/downgrade criteria based upon the action levels established as required by paragraph 5.4.

5.8 Medical Surveillance. All personnel performing onsite activities shall participate in an ongoing medical surveillance program meeting the requirements of 29 CFR 1910.120 and ANSI Z-88.2. The medical examination protocols and results shall be overseen by a licensed physician who is certified in Occupational Medicine by the American Board of Preventive Medicine, or who by necessary training and experience is board eligible. Exam content and frequency shall be provided in the SSHP.

5.9 Air Monitoring. Specify for onsite and perimeter the types and frequency of air monitoring/ sampling to be performed. When applicable NIOSH and or EPA sampling and analytical methods shall be used. Personnel samples shall 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 Program. Include as appropriate real-time (direct-read) monitoring and integrated Time Weighted Average (TWA) sampling for specific contaminants of concern. Discuss instrumentation and calibration to be performed. All air monitoring results shall be compared to action levels to determine the need for corrective actions.

5.10 Site Control. The SSHP shall include a site map, description of work zone delineation, on/off site communication systems, site access controls, and security procedures.

5.11 Personnel and Equipment Decontamination. Specify decontamination procedures and equipment for personnel, personal protective equipment, sampling equipment and heavy equipment. Specify necessary facilities and their locations.

5.12 Emergency Response: Equipment and Procedures. An Emergency Response Plan as required by 29 CFR 1910.120 shall be prepared. Specify the emergency equipment and the location of such equipment to be present on site. Provide telephone numbers and points of contact for emergency services and the USACE Representative. Provide a map showing the route to the hospital that has been contacted and informed of the type of work and potential hazards on the site. At least one person trained and certified in first aid/CPR is to be on site at all times during site operations. Documentation of certification is to be submitted with documentation of other required training.

5.13 Standard Operating Procedures, Engineering Controls and Work Practices. Discuss and site rules and prohibitions for safe work practices. Include such topics as use of the buddy system, smoking restrictions, material handling procedures, confined space entry, excavation safety, heat/cold stress monitoring, illumination, sanitation, daily safety inspections. This list of topics is not intended to be all inclusive.

5.14 Logs, Reports and Recordkeeping. Describe recordkeeping procedures for training logs, daily safety inspection logs, employee/visitor registers, medical surveillance records and certifications and air monitoring results and personal exposure records. All personnel exposure and medical monitoring records shall be maintained in accordance with applicable OSHA standards, CFR 1910 and 1926.

5.15 Unexploded Ordnance. The facility is a military installation and has been used for storage, evaluation and disposal of ordnance and/or explosive materials as well as for military training. More specifically, the OB Grounds was used for the purpose of burning munitions and explosive wastes. Consequently, the potential for encountering unexploded ordnance does exist. If unexploded ordnance is ever encountered at any time during operations at the site the AE shall mark the location, immediately stop operations in the affected area, and notify the Contracting Officer. The Government will make appropriate arrangements for evaluation and proper disposal. It is anticipated that in the event that such conditions arise, they will be overcome with only slight delays to the AE. It is the express intention of the Government that the AE is not to drill, excavate, or otherwise disturb the subsurface in areas where ordnance or explosives may reasonably be suspected unless specific, detailed plans to do so are prepared and approved.

5.16 Suggested SHERP Format.

STAFF ORGANIZATION
- Principal Engineer
- Program Manager
- Certified Industrial Hygienist
- Certified Safety Professional
- First Aid/CPR Personnel
- Field Personnel
- Subcontractor Personnel

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HAZARD COMMUNICATION AND TRAINING
- Comprehensive Health and Safety Indoctrination
- Specialized Training
- Visitor Training
- Pre-Investigation Health and Safety Briefing
- Post-Investigation Health and Safety Briefing
- Morning Safety Meetings

MEDICAL SURVEILLANCE
- Medical Surveillance
- Licensed Occupational Physician
- Medical Examinations

EXPOSURE MONITORING
- Environmental and Personnel Monitoring
- Meteorological Monitoring
- Sampling and Analytical Methods
- Heat/Cold Stress Monitoring

HEALTH AND SAFETY EQUIPMENT
- Personal Protective Equipment
- Environmental Monitoring Equipment
- Decontamination Equipment
- Emergency Equipment
- Emergency-Use Respirators
- Spill Control Equipment
- Fire Extinguishers
- First Aid Equipment and Supplies
- Emergency Eye Wash/Shower (ANSI Z358.1)
- Personnel Hygiene
- Personnel Decontamination
- Communications

STANDARD OPERATING PROCEDURES
- Health and Safety Site Plan
- Site Description
- Site Inspection
- Site Security
- Site Entry Procedures
- Responsibilities
- Work Zones
- Hazard Evaluation
- Activity Hazard Analysis
- Accident Prevention
- Accident Reporting
- Safe Work Practices
- Confined Space Entry Procedures
- Material Handling Procedures
- Levels of Protection
- Decontamination Procedures
- Emergency Information
- Emergency Response Plan
- Illumination
- Sanitation

Well Installation/Logging
Sampling
Land Survey
Laboratory Analysis
Logs, Reports, and Recordkeeping

6.0 CHEMICAL DATA AND LABORATORY REQUIREMENTS.

6.1 Approval. The work plan must be approved by the Contracting Officer (CO) prior to performing any field work. In the event corrections or comments are made by the Contracting Officer on the draft plan, any necessary changes shall be implemented by the A-E before final approval.

6.2 Chemical Data Aquisition Plan (CDAP). The plan shall address all of the following: sampling and analyses, quality assurance and quality control methods, equipment, evaluations, reports and procedures as required for the work specified in this SOW. The plan shall describe field as well as laboratory procedures. The plan shall be a brief and concise description of the field and laboratory work required. Results of the field and laboratory controls shall be evaluated and reported in accordance with References 11.8 and 11.9. The AE shall provide the laboratory QA/QC plan as an appendix to the CDAP. The plan shall address each requirement as identified in ER 1110-1-263 (Reference 11.21) and shall be written in the format shown in Appendix C, paragraph C.5 of that same document.

6.3 Laboratory Requirements. The analytical laboratory utilized by the AE must be validated by the Corps of Engineers' Missouri River Division (CEMRD) as well as approved by the State of New York to perform the analytical methods required by this SOW.

6.4 Quality Assurance Laboratory Requirements. The AE must provide coordination and quality assurance samples (collected and transported by the AE) to the Government Quality Assurance (QA) laboratory. The QA samples shall be splits of the required field control samples. Each field control sample collected shall be divided equally, one portion sent to the QA laboratory and the remainder sent to the AE's lab. QA samples include all sample matrices and analysis parameters. The AE will provide the QA lab a two week notice of sample shipment. The Government will identify the QA lab.

6.5 Data Reporting Requirements. The AE shall provide the following data reporting elements: sample ID, sample receipt, organic and inorganic reporting, internal quality control reporting (lab blanks, surrogate spike

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samples, lab duplicates or matrix spikes) and field duplicates and blanks. This data package shall be reported in accordance with Reference 11.26. The data package shall be submitted in draft and final report. The AE's laboratory must hold and make available all project raw data for a period of two years after samples have been analyzed.

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SAMPLE TABLE
Types and Numbers of Samples Collected

		Quality Assurance and Quality Control					
	Field Samples	Splits/Dups		Rinsates		Trip Blanks	
		QC(AE)	QA(CE)	QC(AE)	QA(CE)	QC(AE)	QA(CE)
GROUNDWATER:							
Volatiles	_____	_____	_____	_____	_____	_____	_____
B/N/A	_____	_____	_____	_____	_____	NR	NR
Pesticides/PCB's	_____	_____	_____	_____	_____	NR	NR
TRPH	_____	_____	_____	_____	_____	NR	NR
Metals	_____	_____	_____	_____	_____	NR	NR
Other:_________	_____	_____	_____	_____	_____	_____	_____
SURFACE WATER:							
Volatiles	_____	_____	_____	_____	_____	_____	_____
B/N/A	_____	_____	_____	_____	_____	NR	NR
Pesticides/PCB's	_____	_____	_____	_____	_____	NR	NR
TRPH	_____	_____	_____	_____	_____	NR	NR
Metals	_____	_____	_____	_____	_____	NR	NR
Other:_________	_____	_____	_____	_____	_____	_____	_____
SURFACE SOILS:							
Volatiles	_____	_____	_____	NR	NR	NR	NR
B/N/A	_____	_____	_____	NR	NR	NR	NR
Pesticides/PCB's	_____	_____	_____	NR	NR	NR	NR
TRPH	_____	_____	_____	NR	NR	NR	NR
Metals	_____	_____	_____	NR	NR	NR	NR
Other:_________	_____	_____	_____	NR	NR	NR	NR
SUBSURFACE SOILS:							
Volatiles	_____	_____	_____	NR	NR	NR	NR
B/N/A	_____	_____	_____	NR	NR	NR	NR
Pesticides/PCB's	_____	_____	_____	NR	NR	NR	NR
TRPH	_____	_____	_____	NR	NR	NR	NR
Metals	_____	_____	_____	NR	NR	NR	NR
EP TOX	_____	_____	_____	NR	NR	NR	NR
Explosives	_____	_____	_____	NR	NR	NR	NR

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TABLE 3
SUGGESTED METHODS FOR SAMPLE ANALYSIS

Analyte	Technique	Soil	Groundwater	Surface Water(1)
Arsenic (As)	GF	3050/7060	7060	206.2
	H	7061	7061	206.3
Barium (Ba)	DA	3050/7080	3005/7080	208.1
	GF	----	----	208.2
	ICP	3050/6010	3005/6010	200.7
Cadmium (Cd)	DA	3050/7130	3005/7130	213.1
	GF	3050/7131	3020/7131	213.2
	ICP	3050/6010	3005/6010	200.7
Chromium (Cr)	DA	3050/7190	3005/7190	218.1
	GF	3050/7190	3020/7191	218.2
	ICP	3050/6010	3005/6010	200.7
Lead (Pb)	DA	3050/7420	3005/7420	239.1
	GF	3050/7421	3020/7421	239.2
	ICP	3050/6010	3005/6010	200.7
Mercury (Hg)	CV	7471	7470	245.1
Selenium (Se)	GF	3050/7740	7740	270.2
	H	7741	7741	270.3
Silver (Ag)	DA	7760	7760	272.1
	GF	----	----	272.2
	ICP	3050/6010	3005/6010	200.7
EP Toxicity	---	1310	----	----
Volatile Organics	GC/MS	8240	8240	624
Explosives		SM02	SM01	SM01

DA=Direct Aspiration
GF=Graphite Furnace
H=Hydride
CV=Cold Vapor

ICP=Inductively Coupled Plasma
GC=Gas Chromatograph
GC/MS=Gas Chromatograph/Mass Spectroscopy

(1) Surface water samples may also be analyzed by the SW-846 methods listed for groundwater.

(2) USATHAMA Methods.

7.0 SOIL BORING AND MONITORING WELL REQUIREMENTS.

7.1 Subsurface Drilling.

7.1.1 Location. Soil boring and monitoring well locations shall be proposed by the AE as part of the Work Plans prior to commencement of drilling activities. The AE shall obtain written approval from the facility engineer, to drill at each site to avoid disturbing buried utilities. Following written approval, tentative locations shall be determined in the field based on the results of the geophysical surveys.

7.1.2 Conduct of Subsurface Drilling with Respect to UXO. The AE shall provide a 2-person UXO team, an UXO Supervisor and an UXO specialist to assure that drilling crews do not encounter surface/subsurface UXO. The UXO team, prior to initiating each 2-foot increment of subsurface drilling, shall, utilizing a method suitable for detection of buried brasses and ferrous metals, check for suspected subsurface UXO. This will preclude drilling into small UXO which may not be detectable from the surface. If meter readings indicate suspected UXO, such UXO shall be marked, AE personnel diverted from the site and the CO notified for Government action. The AE UXO team shall not excavate, render-safe or dispose of any encountered UXO.

7.1.2.1 Qualifications of the UXO Team. The UXO Specialist shall be a graduate of the USN EOD School, Indian Head, Maryland and shall have served at least 3 years in military EOD assignments. The UXO Supervisor shall be a graduate of the same school and shall have at least 10 years in military EOD assignments, of which at least 5 years shall have been in supervisory positions.

7.2. AE Responsibility for Monitoring Wells. It is the responsibility of the AE to properly plan, design, install, develop, and test monitoring wells so that they are suitable to produce groundwater samples representative in quantity and quality of subsurface conditions. The AE shall ensure that the requirements of this scope of work and best construction practices are carried out.

8.0 SURVEY REQUIREMENTS.

8.1 Control Points. Plastic or wooden hubs shall be used for all basic control points. A minimum of five (5) concrete monuments with 3.25-inch domed brass or aluminum alloy survey markers (caps) and witness posts shall be established at the site. The concrete monuments shall be located within the project limits, be set 50 feet from the edge of any existing roads in the interior of the project limits and be a minimum of 500 feet apart. The placement of all monuments, hubs etc., shall be coordinated with SEAD. Witness posts, etc., shall be durable and brightly colored to preclude damage due to normal landscaping activities. Concrete monuments shall be constructed so as to preclude damage due to frost action. Horizontal control (1:10,000) and vertical control (1:5,000) of third order or better shall be established for the network required for all the monuments. The caps for the new monuments shall be stamped in a consecutively numbered sequence as follows:

SEAD-7-1990	SEAD-8-1990	SEAD-9-1990
USAED-HUNTSVILLE	USAED-HUNTSVILLE	USAED-HUNTSVILLE

The dies for stamping the numbers and letters into these caps shall be of 1/8-inch in size. All coordinates are to be referenced to the State Plane Coordinate System and all elevations are to be referenced to the 1929 North American Vertical Datum.

8.2 Location Surveys. Coordinates and elevations shall be established for the four corners and a baseline of each area that is investigated by a geophysical survey: for each soil boring and surface water sampling point and for each monitoring well. The coordinates shall be to the closest 1.0-foot and referenced to the State Plane Coordinate System. Elevations to the closest 0.10 foot shall be provided for the ground surface at each soil boring. Elevations to the closest 0.01-foot shall also be established for the survey marker and the top of casing (measuring point) at each monitoring well. These elevations shall be referenced to the National Geodetic Vertical Datum of 1929.

8.3 The location, identification, coordinates and elevations of all the control points recovered and/or established at the site and all of the geophysical survey areas, soil borings, monitoring wells (new and existing) and all surface water sampling points shall be plotted on a planimetric map (at a scale of 1 inch=50 feet) to show their location with respect to surface features within the project area. A tabulated list of the monuments, the soil borings and the surface water sample points including their coordinates and elevations, a "Description Card" for each monument established or used for this project, the 1 inch=50 feet map and all field books and computations shall be prepared and submitted to the Huntsville Division (CEHND), ATTN: CEHND-ED-CS. The tabulation shall consist of the designated number of each boring, monument or surface water sampling point, the X- and Y-coordinates and all the required elevations. The Description Card shall show a sketch of each monument; its location relative to reference marks, buildings, roads, towers, etc.; a written description telling how to locate the monument from a known point; the monument name or number and the adjusted coordinates and elevations. These items shall be submitted to CEHND no later than the Draft Report Submission (305 days following submission).

9.0 SECURITY REQUIREMENTS. The following requirements must be followed by the AE at Seneca Army Depot to facilitate entry and exit of AE employees and to maintain security.

9.1 Personnel Registration:

9.1.1 A list of all AE employees, sub-contractors and suppliers indicating firm name and address will be furnished through POC/COR to the Counterintelligence Division, Building 710, 72 hours prior to commencement of work.

9.1.2 A confirmation of employment SDSSE-SC Form 268 will be executed by the AE concerning each employee, to include all sub-contractors and their personnel. No forms will be transferred to another file if the AE has other on-going contracts at SEAD. The AE will provide a list of personnel who are authorized to sign Form 268 for the firm. A sample of each signature is required. Counterintelligence Division must be notified, in writing, of any changes to this list. All completed forms will be provided through COR/POC to the Counterintelligence Division 72 hours prior to commencement of work. Failure to complete Form 268 correctly will result in employee's denial of access to Seneca. The Counterintelligence Division must be notified, in writing through POC/COR to Counterintelligence, at least 72 hours prior to requesting any action. The chain of command for all AE actions will be through POC/COR to Counterintelligence Division. There will be no exceptions.

9.1.3 Camera permits require written notice from the POC/COR prior to access. Open camera permits will not be issued. The following information is required:

(a) Camera make, model and serial number.

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(b) Contract name and name of individual responsible for the camera.

(c) Dates camera will be used.

(d) Where it will be used.

(e) What will be photographed and why.

9.1.4 If a rental, leased or privately owned vehicle is required in place of a company vehicle, the following information is needed.

(a) Name of individual driving.

(b) Year, make, model, color and license plate of the vehicle.

(c) Typed letter on company letterhead indicating that the company assumes responsibility for rental, leased or privately owned vehicles.

9.1.5 All access media will be destroyed upon expiration date of contract. If an extension is required a list of employee names and new expiration date must be furnished to the Counterintelligence Division. Contract extensions must be made prior to the contract expiration date or new Form 268s will be required for each individual that requires an extension.

9.2 <u>Traffic Regulations:</u>

9.2.1 Traffic Laws, State of New York, apply with emphasis on the following regulations.

9.2.2 Speed Limit: Controlled Area - as posted
Ammo Area - 5 mph
Limited/Exclusion Area - 25 mph

9.2.3 All of the above are subject to change with road conditions or as otherwise posted.

9.3 <u>Parking:</u> AE vehicles (trucks, rigs, etc.) will be parked in areas designated by the Director of Law Enforcement and Security. Usually parking will be permitted within close proximity to the work site. Do not park within 30 feet of a depot fence, as these are clear zones.

9.4 <u>Gates:</u>

9.4.1 Post 1, Main Gate - NY Highway 96, Romulus, New York is open for personnel entrance and exit 24 hours daily, 7 days a week.

9.4.2 Post 3, entrance to North Depot Troop Area, located at end of access road from Route 96-A is open 7 days a week for personnel and vehicle entrance and exit.

9.5 Security Regulations:

9.5.1 Prohibited Property:

9.5.1.1 Cameras, binoculars, weapons and intoxicating beverages will not be introduced to the installation, except by written permission of the Director/Deputy Director of Law Enforcement and Security.

9.5.1.2 Matches or other spark producing devices will not be introduced into the Limited/Exclusion or Ammo Area's except when the processor of such items is covered by a properly validated match or flame producing device permit.

9.5.1.3 All vehicles and personal parcels, lunch pails, etc. are subject to routine security inspections at any time while on depot property.

9.5.1.4 All building materials, equipment and machinery must be cleared by the Director of Engineering and Housing who will issue a property pass for outgoing equipment and materials.

9.6 AE Employee Circulation:

9.6.1 AE employees are cleared for entrance to the location of contract work only. Sight-seeing tours or wandering from work site is NOT AUTHORIZED.

9.6.2 Written notification will be provided to the Counterintelligence Division (Ext. 30202) at least 72 hours prior to overtime work or prior to working on non-operating days.

9.6.3 Security Police (Ext. 30448/30366) will be notified at least two hours in advance of any installation or movement of slow moving heavy equipment that may interfere with normal flow of traffic, parking or security.

9.7 Unions: Representatives will be referred to the Depot Industrial Labor Relations Officer (Ext. 41317).

9.8 Offenses: (Violations of law or regulations)

9.8.1 Minor: Offenses committed by AE personnel which are minor in nature will be reported by the Director of Law Enforcement and Security to the Contracting Officer who in turn will report such incidents to the AE for appropriate disciplinary action.

9.8.2 Major: Serious offenses committed while on the installation will be reported to the FBI. Violators may be subject to trial in Federal Court.

9.9 Explosive Laden Vehicles:

9.9.1 Vehicles such as vans, cargo trucks, etc. carrying explosives will display placards or signs stating "EXPLOSIVES".

9.9.2 Explosive ladened vehicles will not be passed.

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9.9.3 When an explosive laden vehicle is approaching, pull over to the side and stop.

9.9.4 When catching up with an explosive laden vehicle, slow down and allow that vehicle to remain at least 100 feet ahead.

9.9.5 When approaching an intersection where an explosive laden vehicle is crossing - STOP - do not enter the intersection until such time as the explosive carrier has passed thru, and cleared the intersection.

9.9.6 When passing a vehicle that is parked, and displaying "Explosive" signs, slow down to 10 miles per hour, and take every precaution to allow more than ample clearance.

9.10 Clearing Post: All AE employees are required to return all identification badges, and passes on the last day of employment on the depot. The AE is responsible for the completion of all turn-ins by his employees, and informing the Counterintelligence Division and the depot organization administering the contract, for termination of any employee's access to the depot.

10.0 PUBLIC AFFAIRS. The AE shall not publicly disclose any data generated or reviewed under this contract. The AE shall refer all requests for information to CEHND. Reports and data generated under this contract shall become the property of the Department of Defense and distribution to any other source by the AE, unless authorized by the Contracting Officer, is prohibited.

11.0 REFERENCES

11.1 "Procedures Manual for Groundwater Monitoring at Solid Waste Disposal Facilities," USEPA Publ. No. EPA/530/SW-611.

11.2 "Manual of Water Well Construction Practices, " USEPA Publ. NO. EPA/570/9-75-001.

11.3 "Methods of Determining Permeability, Transmissibility, and Drawdown," U.S. Geological Survey Water Supply Paper No. 1536-1, 1963.

11.4 "U.S. Corps of Engineers Safety and Health Requirements Manual," U.S. Army Engineering Manual No. EM-385-1-1, April 1981.

11.5 "Code of Federal Regulations, "Volume 40, Parts 260 through 265 plus 270, July 1986.

11.6 "American Society for Testing and Materials," ASTM D-421, D-422, D-423, D-424, D-2216, and D-2436.

11.7 "Code of Federal Regulation," Volume 40, Part 300, July 1987.

11.8 "Methods for Chemical Analysis of Water and Wastes," U.S. Environmental Protection Agency, Publ. No. EPA/625/6-7-003a.

11.9 "Test Methods for Evaluating Solid Wastes," USEPA Publ. No. SW- 846, July 1982.

11.10 "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act," 40 CFR 136, Federal Register, Oct 26, 1984.

11.11 "RCRA Groundwater Monitoring Technical Enforcement Guidance Document" (Draft) Office of Waste Programs Enforcement, USEPA, August 1985.

11.12 "Handbook for Analytical Quality Control in Water and Wastewater Laboratories," EPA Manual 600/4-79-019, March 1979.

11.13 "Safety and Occupational Health Document Requirements for Hazardous Waste Site Remedial Actions," U.S. Army Engineering Regulation (ER) 385-1-192.

11.14 "Engineer Guidance Design Manual for Architect-Engineer," US Army Corps of Engineer. HNDM-1110-1-1. Rev. 1986.

11.15 RCRA Corrective Action Plan, OSWER Directive 9902.3, November, 1986.

11.16 U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), Initial Installation Assessment of Seneca Army Depot, N.Y. Report no. AMXTH-IR-A-157, 1980.

11.17 U.S. Army Environmental Hygiene Agency (USAEHA), Final Report, Army Pollution Abatement Program Study No. D-1031-W, Landfill Leachate Study, Seneca Army Depot, 1981.

11.18 U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), Update of the Initial Installation Assessment of Seneca Army Depot, N.Y. Report No. AMXTH-IR-A-157(U), 1988.

11.19 "Evaluation of Solid Waste Management Units, Seneca Army Depot", Interim Final Report, Groundwater Contamination Survey No.38-26-0868-88, U.S. Army Environmental Hygiene Agency.

11.20 Interim Final, "Guidance For Conducting Remedial Investigations and Feasibility Studies Under CERCLA", OSWER Directive 9355.3-01, U.S. EPA, Office of Emergency and Remedial Response, October 1988.

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11.21 ER 1110-1-263, "Chemical Data Quality Management for Hazardous Waste Remedial Activities," U.S. Army Corps of Engineers Regulation, CEMP-RT, Mar 1990.

11.22 "Criteria Development Report For the Closure of Nine Burning Pads, Seneca Army Depot", Metcalf and Eddy, October 1989.

11.23 "Final Work Plan, Remedial Investigation/Feasibility Study at the Ash Landfill, Seneca Army Depot, Romulus, New York", Environmental Science and Engineering, Inc., ______ 1990.

11.24 "Draft Guidance on Preparing Superfund Decision Documents: The Proposed Plan and Record of Decision", OSWER Directive 9355.3-02.

11.25 "Federal Facility Agreement Under CERCLA Section 120, Seneca Army Depot, Romulus, New York" , ______ 1990.

11.26 Memorandum, "Minimum Chemistry Data Reporting Requirements for DERP and Superfund HTW Projects." U.S. Army Corps of Engineers, CEMRD-ED-GL, August 1989.

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PROPOSAL INFORMATION

INSTRUCTIONS FOR SUPPORTING DATA FORMAT

The use of a Seven Item Breakdown in presenting a proposal is required. The enclosed SUPPORTING DATA FORMAT is furnished as a form guide to aid in this presentation. In addition, all proposals exceeding $25,000 must be supported by a narrative description showing the source (basis) of each cost item proposed. For example: Explain how the labor rates were determined; if actual rates are proposed, show the pay period used; if estimated rates are used, show how they were developed; also show the basis for any escalation factors used. An explanation of each of Seven Items and what is contained in each item is as follows:

(1) DIRECT LABOR COST: Direct labor shall be broken down by task and identifiable to the work breakdown structure (WBS). Each task shall be listed, as referenced in the Scope of Work, giving the man-hours for each discipline and the cost per man-hour, using the format furnished.

(2) OVERHEAD ON DIRECT LABOR: The percent of overhead shall be entered in the space provided, with information as to base on which applied, i.e., sum of direct labor and additives applicable to direct labor.

(3) GENERAL AND ADMINISTRATIVE OVERHEAD: The percent of F&A overhead shall be entered in the space provided, with information as to base on which applied.
NOTE: It is desirable but not necessary that these overhead rates be separate. If accounting procedures do not readily provide separate rate, a combined rate may be used.

(4) MATERIALS, SUPPLIES: Materials and supplies shall be items charged directly to the work that would not normally be chargeable on an indirect basis, i.e., overhead accounts.

(5) TRAVEL: Travel shall be broken down into three parts: man-trips, transportation, and per diem. Man-trips shall be a total number of trips per contract or modification. Transportation shall be economy travel by air or train and auto rental, if any, at the destination. Per diem is the amount of subsistence given per man per day.

(6) OTHERS: All other charges not chargeable above. Reproduction will be broken down into prints, reproducible sepias and reproducible mylars. Cost of reproduction is to be computed on a square foot basis. Printing of specifications will be based on a minimum of 50 impressions per master. Xerox will be based on a per cent costs.

(7) PROFIT OR FEE: Enter the percent of fee in the space provided.

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SUMMARY SHEET

SUPPORTING DATA FORMAT

7-Item Breakdown:

(1) Direct Labor Cost: (see attached sheets)

a. Task No. 1 $ ______________________

b. Task No. 2 $ ______________________

c. Task No. 3 $ ______________________

d. Task No. 4 $ ______________________

(additional lines to be added as needed)

SUBTOTAL DIRECT LABOR $ ______________________

(2) Overhead on Direct Labor (%) $ ______________________

(3) Gen. and Admin. Overhead (%) $ ______________________

(4) Materials. Supplies $ ______________________

(5) Travel $ ______________________

(6) Others (Renderings, Reproduction, Printing, Consultants, etc. (Describe in detail) $ ______________________

SUBTOTAL $ ______________________

Options (if any) $ ______________________

(7) Profit or fee (%) $ ______________________

TOTAL ESTIMATE $ ______________________

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ARCHITECT-ENGINEER COST ESTIMATE

ARCHITECT - ENGINEER FIRM NAME AND ADDRESS

DESIGN STAGE
MODIFIED CONCEPT
(OPTION) FINAL

RFP/CONTRACT NUMBER
DACA87- __ - __ - ______

LOCATION:

PREPARED BY:

PROJ. TITLE:

PROJ. NO:

APPROVED BY:

DATE:

TASK NAME / BUILDING / OTHER

TASK NO:

COST OR PRICING DATA REFERENCE

ITEM 'A' - TASK EFFORT BREAKDOWN

TASK RECAP: ____________ MH = $ ____________

SPECIALITIES	JOB TITLES	MAN-HOURS	RATES $	AMOUNTS $	TOTALS $	
PROJECT MANAGEMENT						
CIVIL						
NO. OF DWGS. ( )						
ARCHITECTURAL						
NO. OF DWGS. ( )						
STRUCTURAL						
NO. OF DWGS. ( )						
MECHANICAL						
NO. OF DWGS. ( )						
HV/AC						
NO. OF DWGS. ( )						
ENVIRONMENTAL						
NO. OF DWGS. ( )						
ELECTRICAL						
NO. OF DWGS. ( )						
SPECIFICATIONS						
ESTIMATES						
OTHER						

TOTAL DRAWINGS		TOTAL MAN-HOURS		TOTAL DIRECT SALARIES		
ITEM 'B' OVERHEAD POOLS						

	TITLES	RATES %	BASES $			
1						
2						
3						

ITEM 'C' OTHER COST (CONSULTANTS, TELEPHONE, REPRODUCTION, POSTAGE, ATTACH ESTIMATES AS REQUIRED)		
ITEM 'D' TRAVEL COST		
ITEM 'E' MATERIAL AND SUPPLIES (ATTACH ESTIMATES AS REQUIRED)		

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PAGE ________ OF ________

ARCHITECT - ENGINEER
COST ESTIMATE

PROJECT TITLE: **FINAL DRAFT**

AE NAME & ADDRESS:

PREPARED BY:

PROJECT LOCATION:

PROJECT NO.

DATE:

TASK DESCRIPTION:

TASK NO.

RFP/ CONTRACT NO.
DACA87 - ____ - ____ - ____

REPORTING DISCIPLINE:

MECH ____ CIVIL ____ ARCH ____ ESTIMATES ____

ELECT ____ STRUCT ____ SPECS ____ P.M. ____ OTHER ____

TASK AND DRAWING DESCRIPTION	CONCEPT					FINAL				
	DWGS		MAN-HOURS			DWGS		MAN-HOURS		
	NEW	REV.	SUPERVISOR	JOURNEYMAN	DRAFTSMAN	NEW	REV.	SUPERVISOR	JOURNEYMAN	DRAFTSMAN

NO. DWGS ____ NO. MHs ____ MHs / DWG ____

FINAL DRAFT

U. S. ARMY
HUNTSVILLE DIVISION, CORPS OF ENGINEERS

ARCHITECT ENGINEER COST ESTIMATE	ARCHITECT-ENGINEER FIRM NAME AND ADDRESS	DESIGN STAGE	
		MODIFIED CONCEPT	(OPTION) FINAL
RFP/CONTR. NUMBER DACA87- ___ - ___ - ______		LOCATION:	
PREPARED BY:	PROJ. TITLE:	PROJ. NO:	
APPROVED BY:	DATE:	TASK NAME / BUILDING / OTHER:	TASK NO:

ITEM "D" TRAVEL COST:

TRIP NO. ______

ANNEX

______ MAN-TRIPS FROM ______ TO ______ FOR ______ DAYS
______ ROUND TRIP AIR FARES @ $______ = $______
______ DAYS PER DIEM @ $______ = $______
______ DAYS RENTAL CAR @ $______ = $______
OTHER (ITEMIZE)

TOTAL COST TRIP NO. $ ______

TRIP NO. ______

ANNEX

______ MAN-TRIPS FROM ______ TO ______ FOR ______ DAYS
______ ROUND TRIP AIR FARES @ $______ = $______
______ DAYS PER DIEM @ $______ = $______
______ DAYS RENTAL CAR @ $______ = $______
OTHER (ITEMIZE)

TOTAL COST TRIP NO. $ ______

TRIP NO. ______

ANNEX

______ MAN-TRIPS FROM ______ TO ______ FOR ______ DAYS
______ ROUND TRIP AIR FARES @ $______ = $______
______ DAYS PER DIEM @ $______ = $______
______ DAYS RENTAL CAR @ $______ = $______
OTHER (ITEMIZE)

TOTAL COST TRIP NO. $ ______

TRIP NO. ______

ANNEX

______ MAN-TRIPS FROM ______ TO ______ FOR ______ DAYS
______ ROUND TRIP AIR FARES @ $______ = $______
______ DAYS PER DIEM @ $______ = $______
______ DAYS RENTAL CAR @ $______ = $______
OTHER (ITEMIZE)

TOTAL COST TRIP NO. $ ______

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PAGE ______ OF ______

FINAL DRAFT

CONTRACT PRICING PROPOSAL COVER SHEET

1. SOLICITATION/CONTRACT/MODIFICATION NO.

FORM APPROVED OMB NO. 3090-0116

NOTE: This form is used in contract actions if submission of cost or pricing data is required. *(See FAR 15.804-6(b))*

2. NAME AND ADDRESS OF OFFEROR *(Include ZIP Code)*

3A. NAME AND TITLE OF OFFEROR'S POINT OF CONTACT

3B. TELEPHONE NO.

4. TYPE OF CONTRACT ACTION *(Check)*

☐ A. NEW CONTRACT	☐ D. LETTER CONTRACT
☐ B. CHANGE ORDER	☐ E. UNPRICED ORDER
☐ C. PRICE REVISION/ REDETERMINATION	F. OTHER *(Specify)*

5. TYPE OF CONTRACT *(Check)*

☐ FFP ☐ CPFF ☐ CPIF ☐ CPAF

☐ FPI ☐ OTHER *(Specify)*

6. PROPOSED COST *(A+B=C)*

A. COST	B. PROFIT/FEE	C. TOTAL
$	$	$

7. PLACE(S) AND PERIOD(S) OF PERFORMANCE

8. List and reference the identification, quantity and total price proposed for each contract line item. A line item cost breakdown supporting this recap is required unless otherwise specified by the Contracting Officer. *(Continue on reverse, and then on plain paper, if necessary. Use same headings.)*

A. LINE ITEM NO.	B. IDENTIFICATION	C. QUANTITY	D. TOTAL PRICE	E. REF.

9. PROVIDE NAME, ADDRESS, AND TELEPHONE NUMBER FOR THE FOLLOWING *(If available)*

A. CONTRACT ADMINISTRATION OFFICE

B. AUDIT OFFICE

10. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS WORK? *(If "Yes," identify)*

☐ YES ☐ NO

11A. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT? *(If "Yes," complete Item 11B)*

☐ YES ☐ NO

11B. TYPE OF FINANCING *(✓ one)*

☐ ADVANCE PAYMENTS ☐ PROGRESS PAYMENTS

☐ GUARANTEED LOANS

12. HAVE YOU BEEN AWARDED ANY CONTRACTS OR SUBCONTRACTS FOR THE SAME OR SIMILAR ITEMS WITHIN THE PAST 3 YEARS? *(If "Yes," identify item(s), customer(s) and contract number(s))*

☐ YES ☐ NO

13. IS THIS PROPOSAL CONSISTENT WITH YOUR ESTABLISHED ESTIMATING AND ACCOUNTING PRACTICES AND PROCEDURES AND FAR PART 31 COST PRINCIPLES? *(If "No," explain)*

☐ YES ☐ NO

14. COST ACCOUNTING STANDARDS BOARD (CASB) DATA *(Public Law 91-379 as amended and FAR PART 30)*

A. WILL THIS CONTRACT ACTION BE SUBJECT TO CASB REGULATIONS? *(If "No," explain in proposal)*

☐ YES ☐ NO

B. HAVE YOU SUBMITTED A CASB DISCLOSURE STATEMENT *(CASB DS-1 or 2)? (If "Yes," specify in proposal the office to which submitted and if determined to be adequate)*

☐ YES ☐ NO

C. HAVE YOU BEEN NOTIFIED THAT YOU ARE OR MAY BE IN NONCOMPLIANCE WITH YOUR DISCLOSURE STATEMENT OR COST ACCOUNTING STANDARDS? *(If "Yes," explain in proposal)*

☐ YES ☐ NO

D. IS ANY ASPECT OF THIS PROPOSAL INCONSISTENT WITH YOUR DISCLOSED PRACTICES OR APPLICABLE COST ACCOUNTING STANDARDS? *(If "Yes," explain in proposal)*

☐ YES ☐ NO

This proposal is submitted in response to the RFP contract, modification, etc. in Item 1 and reflects our best estimates and/or actual costs as of this date.

NAME AND TITLE *(Type)*

16. NAME OF FIRM

17. SIGNATURE

18. DATE OF SUBMISSION

NSN 7540-01-142-9845

1411-101

STANDARD FORM 1411 (10-83)
Prescribed by GSA

☆ U.S. GOVERNMENT PRINTING OFFICE

Rec'd 9-4-90

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

DEPARTMENT OF THE ARMY
HUNTSVILLE DIVISION, CORPS OF ENGINEERS
P.O. BOX 1600
HUNTSVILLE, ALABAMA 35807-4301

FINAL DRAFT

REPLY TO
ATTENTION OF
Project Management Branch

AUGUST 31 1990

SUBJECT: Proposed Delivery Order "A" to Proposed New Contract for Environmental Projects for Federal Agencies and Other Programs Supported by U.S. Army Engineer Division, Huntsville, for Seneca Army Depot, New York, Request for Proposal DACA87-90-R-0101

Chas T. Main, Inc.
Prudential Center
Boston, Massachusetts 02199

Gentlemen:

You, as Architect-Engineer, are notified that the requirements for TITLE I services detailed in Annex A (enclosure 1) are proposed for inclusion into the basic contract.

The addition of Delivery Order "A" will require submission of a written price proposal for negotiations. Therefore, you should submit supporting data provided in appropriate form and detail to permit review and analysis. The supporting data should follow substantially the format prescribed by enclosure 2. The proposal should be submitted on SF 1411 (enclosure 3) to this office, ATTN: CEHND-ED-PM, A-E Contracts Section, not later than September 14, 1990. Cost and pricing data should be submitted in accordance with instructions furnished with the basic request for proposal.

Negotiations are scheduled to be held in this office on September 21, 1990. Please advise us prior to that date of the names and telephone numbers of the persons authorized to conduct negotiations and commit your firm to the negotiated amount.

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If additional information is required prior to the negotiation, please contact Mr. Walter Perro, Project Manager, at 205-895-5142. In the event the Project Manager is unavailable, please contact Mr. Robert F. Shearer, Lead Project Manager, at 205-895-5801.

Sincerely,

Barry W. Peterman
Major, U.S. Army
Contracting Officer

Enclosures