01111

FINAL REPORT

DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

CRITERIA DEVELOPMENT REPORT FOR THE CLOSURE OF NINE BURNING PADS

SENECA ARMY DEPOT
ROMULUS, NEW YORK

CONTRACT DACW41-86-D-0112
DELIVERY ORDER 23

VOLUME I

Prepared by:

METCALF & EDDY, INC.
10 Harvard Mill Square
Wakefield, Massachusetts

Submitted to:

DEPARTMENT OF THE ARMY
Kansas City District, Corps of Engineers
700 Federal Building
Kansas City, Missouri

OCTOBER, 1989

Metcalf & Eddy

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

1.0 EXECUTIVE SUMMARY

Two studies were completed prior to the preparation of closure plan, for the Open Burning/Open Detonation Area of the Seneca Army Depot (SEAD), Romulus, New York. These studies were part of the Defense Environmental Restoration Program (DERP) and included: 1) a groundwater contamination investigation and 2) an evaluation of in-place containment of contaminated soils in the burning pad area.

Since 1941, propellants, explosives, and pyrotechnics (PEP) wastes have been disposed of in the Open Burning/Open Detonation (OB/OD) Grounds at SEAD. Recently, the Army has decided to close the burning pads in the SEAD OB grounds. Since PEP wastes are hazardous due to their characteristic of "reactivity", and previous studies conducted by the US Army Environmental Hygiene Agency (US AEHA, August 1984) indicated failure of the "EP Toxicity" hazardous waste characteristic test (40 CFR 261) by some burning pad soils, closure must be in accordance with Resource Conservation Recovery Act (RCRA) and New York State hazardous waste regulations.

The groundwater investigation involved the installation of ten groundwater monitoring wells and the sampling and analysis of these monitoring wells in addition to seven existing monitoring wells in the Open Burning/Open Detonation (OB/OD) grounds. The installation of the newly installed wells served several purposes: 1) to monitor upgradient groundwater conditions and determine possible groundwater contamination downgradient of each burning pad, 2) to characterize overburden and underlying bedrock, and 3) to serve as post closure monitoring wells for long term groundwater monitoring following in-place containment of contaminated soils.

Groundwater samples were analyzed for selected total recoverable metals, explosives (2,4-DNT, 2,6-DNT, 2,4,6-TNT, PETN, HMX, Tetryl, and RDX), and petroleum hydrocarbons.

Total recoverable metal concentrations were below New York State (NYS) and National Priority Drinking Water Standards in all newly installed monitoring believed that these additional measures would not meet regulatory requirements due to the shallowness of groundwater, lack of competent bedrock to key the slurry wall/grout curtain into, and the potential for groundwater leakage.

Subsequently, M&E developed a second closure alternative. Alternative 2 involves the excavation of contaminated burning pad soil and on-site treatment using chemical solidification/stabilization. The solidified material would be combined into a single fill zone encompassing the excavated holes from Pads F, G and H and areas in-between. This solidified material would be capped and the remaining burning pads backfilled/graded with clean soil.

A Clean Closure Alternative (Alternative 3) was also evaluated. This alternative included: 1) the excavation of contaminated soils, 2) the on-site incineration of the contaminated soils, 3) the stabilization of the ash and scrubber water, and 4) the off-site landfill disposal of the stabilized material. The remaining soil would meet health based criteria and no post closure monitoring would be required. However, clean closure is not a reasonable alternative. The Open Detonation Grounds which are downgradient but adjacent to the Open Burning Grounds will remain in operation. Therefore, the potential for future contaminant migration via air dispersion from the Open Detonation Grounds to the Open Burning Area would not be eliminated.

Thus, although Alternative 1 is more economical and Alternative 3 eliminates the need for post-closure monitoring, M&E recommends Alternative 2 for closure as the most viable technically reliable and regulatory compliant option.

Since groundwater contamination was not detected in the newly installed monitoring wells, groundwater cleanup was not addressed by any of the closure alternatives.

2.0 GENERAL

2.1 Introduction

The Department of Defense (DOD) produces, stores, and utilizes large quantities of munition items: pyrotechnics, explosives, propellants (PEP). Each year, large quantities of PEP and PEP-related materials must be disposed of as waste.

To treat PEP and PEP containing wastes, open burning/open detonation (OB/OD) grounds were established in the 1940s throughout the United States, by the U.S. Army Material Command.

Recently, the Department of Defense has opted to cease open burning operations at several OB/OD sites. The subject of this report is the Criteria Development for the Closure of Nine Burning Pads at the Seneca Army Depot in Romulus, New York. The Huntsville Division of the Army Corps of Engineers (COE) is responsible for administering the Criteria Development Investigations and the eventual closure of OB/OD grounds in the United States.

This Criteria Development Report describes: 1) the groundwater contamination investigation performed and 2) the evaluation of in-place containment at the open burning and open detonation (OB/OD) area at Seneca Army Depot prior to preparation of a Closure Plan. Project objectives and background information are presented in Section 2. Details of the well installation and sampling program conducted by Metcalf & Eddy are described in Section 3. An analytical results summary of the current groundwater investigation is presented in Section 4. A discussion, potential health implications, conclusions of the contamination evaluation are presented in Section 5. The evaluation of in-place containment is discussed in Section 6. Final Criteria Development recommendations are presented in a separate letter. In addition, the following information has been appended: geophysical data (Appendix A), well logs and field data (Appendix B), monitoring well completion diagrams (Appendix C), well survey data (Appendix D), Laboratory sampling program analytical results (Appendix E), and Weston quality control analytical results

(Appendix F), in-situ permeability calculations (Appendix G), and in-place containment calculations (Appendix H).

2.2 Project Objectives

The objectives of this investigation include:

1. To determine the presence and migration of PEP contaminants in groundwater within the burning pad area.

2. To further evaluate the alternative of in-place containment of contamination presented in a previous report (O'Brien & Gere, 1985), and present another alternative, if necessary.

3. To provide data and information to be used in developing a Closure Plan.

4. To provide monitoring wells for post-closure groundwater monitoring of the burning pad area.

To accomplish these objectives the following work was conducted:

1. A site visit for the collection of background information and establishment of preliminary monitoring well and sampling locations.

2. Two types of geophysical surveys to determine final monitoring well locations.

3. The installation of ten groundwater monitoring wells.

4. The collection and laboratory analysis of groundwater samples.

5. An evaluation of physical and analytical data.

6. A technical and regulatory evaluation of in-place containment.

2.3 Open Burning/Open Detonation Grounds (OB/OD)

2.3.1 General Information

Since 1941, PEP and PEP-containing materials have been disposed of at U.S. Army OB/OD grounds. These materials include: manufacturing wastes and residues, items in storage or manufacture which have failed quality assurance tests, obsolete and out-of-date explosives, propellants, and munitions items, any unsafe munitions items and related wastes which have been contaminated by contact with PEP during production, storage, and handling.

Although the Army has developed an Explosive Waste Incinerator and a Contaminated Waste Processor for the incineration of PEP-contaminated wastes, these units are considered by the Army, difficult to operate, impractical and uneconomical (US AEHA, 1986). Consequently, the Army contends that OB/OD grounds are the most effective and economical method for the destruction of PEP-containing wastes available at this time.

Due to their characteristic of reactivity, most PEP and PEP-containing wastes are classified as hazardous wastes. Therefore, these wastes are regulated under the Resource Construction and Recovery Act (RCRA) of 1984. Thus, the OB/OD process constitutes hazardous waste treatment (US AEHA, 1986).

Beginning in 1981, a five phase investigation was conducted by the U.S. Army Environmental Hygiene Agency (USAEHA) to evaluate the potential impact of OB/OD operations on public health and the environment, to evaluate the status of OB/OD grounds relative to Federal hazardous waste regulations, and to determine which OB/OD grounds should remain in operation. Subsequently, the Department of Defense opted to cease open burning operations at several sites throughout the United States. The Open Burning grounds located at the Seneca Army Depot in Romulus, New York are scheduled for RCRA Closure and are the focus of this investigation.

2.3.2 Background Information, Seneca Army Depot (SEAD)

2.3.2.1 Site Location

Seneca Army Depot encompasses approximately 10,000 acres in the Finger Lakes Region of Seneca County near the town of Romulus, New York. The site is located east of Seneca Lake, west of Cayuga Lake and approximately 50 miles southeast of Rochester, New York (Figure 2.1).

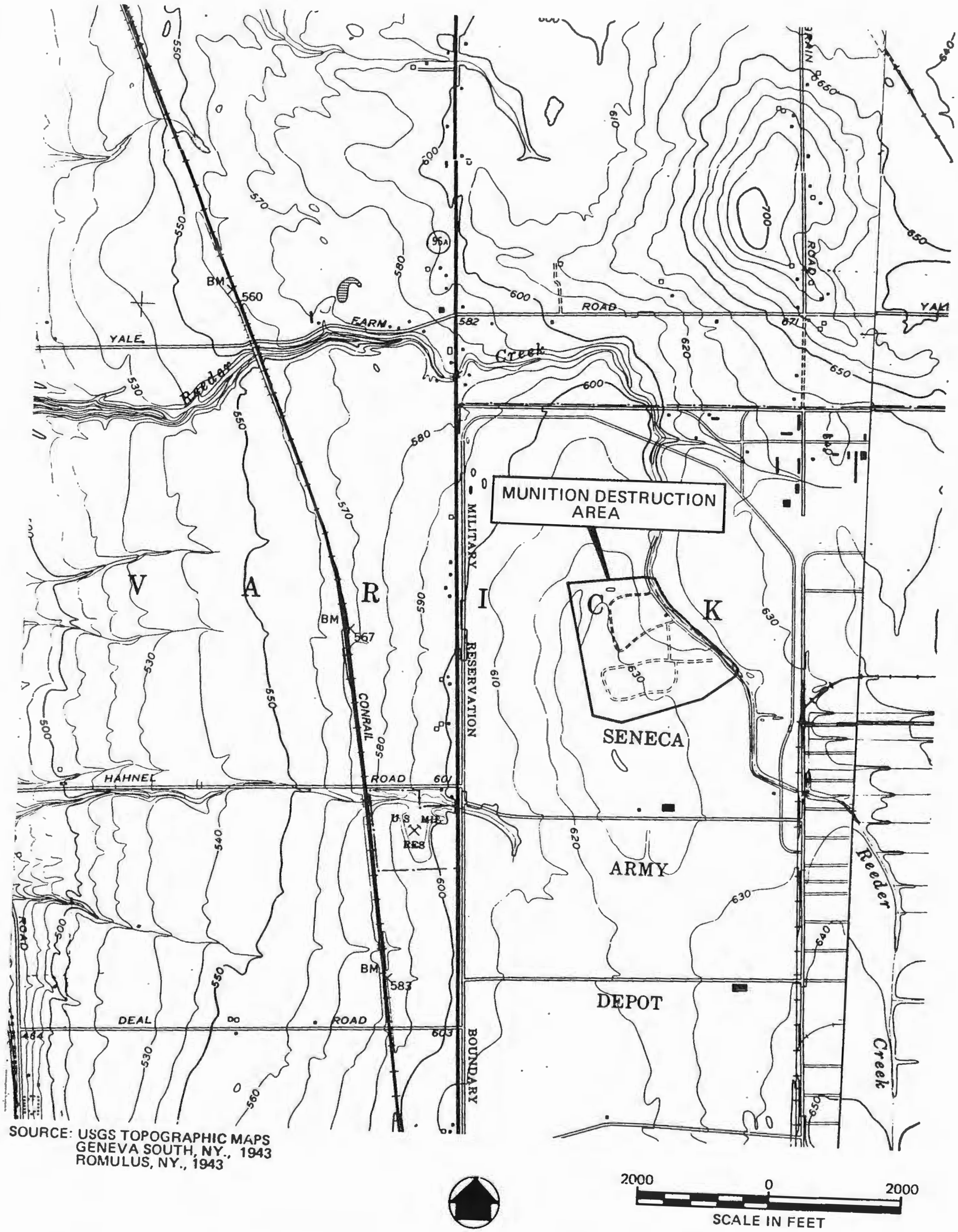


FIGURE 2. 1 SITE LOCATION MAP, MUNITION DESTRUCTION AREA, SENECA ARMY DEPOT, ROMULUS, NEW YORK

2.3.2.2 Site Description

Open burning-open detonation (OB/OD) operations have been conducted for more than forty years in the 90 acre munition destruction area located in the northwestern section of the Seneca Army Depot. The Demolition Grounds consist of a detonation area and nine burning pads (A through I). Figure 2.2 depicts layout of the Demolition Grounds. The original burning pads consisted of clay and were often too muddy to use. These pads were therefore built up with shale to their present level. Munition destruction activities will continue to be conducted in the open detonation area located north of the burning pad area. Burning operations are presently conducted in a metal trough located in the open burning area. Entry and exit from SEAD is monitored 24 hours a day by armed Department of Defense personnel. Access to SEAD is limited to military personnel and civilians with temporary military clearance. The Munition Destruction Grounds are surrounded by an 8 foot chain link fence topped with barbed wire. Entry to the Munition Destruction grounds is via a locked gate.

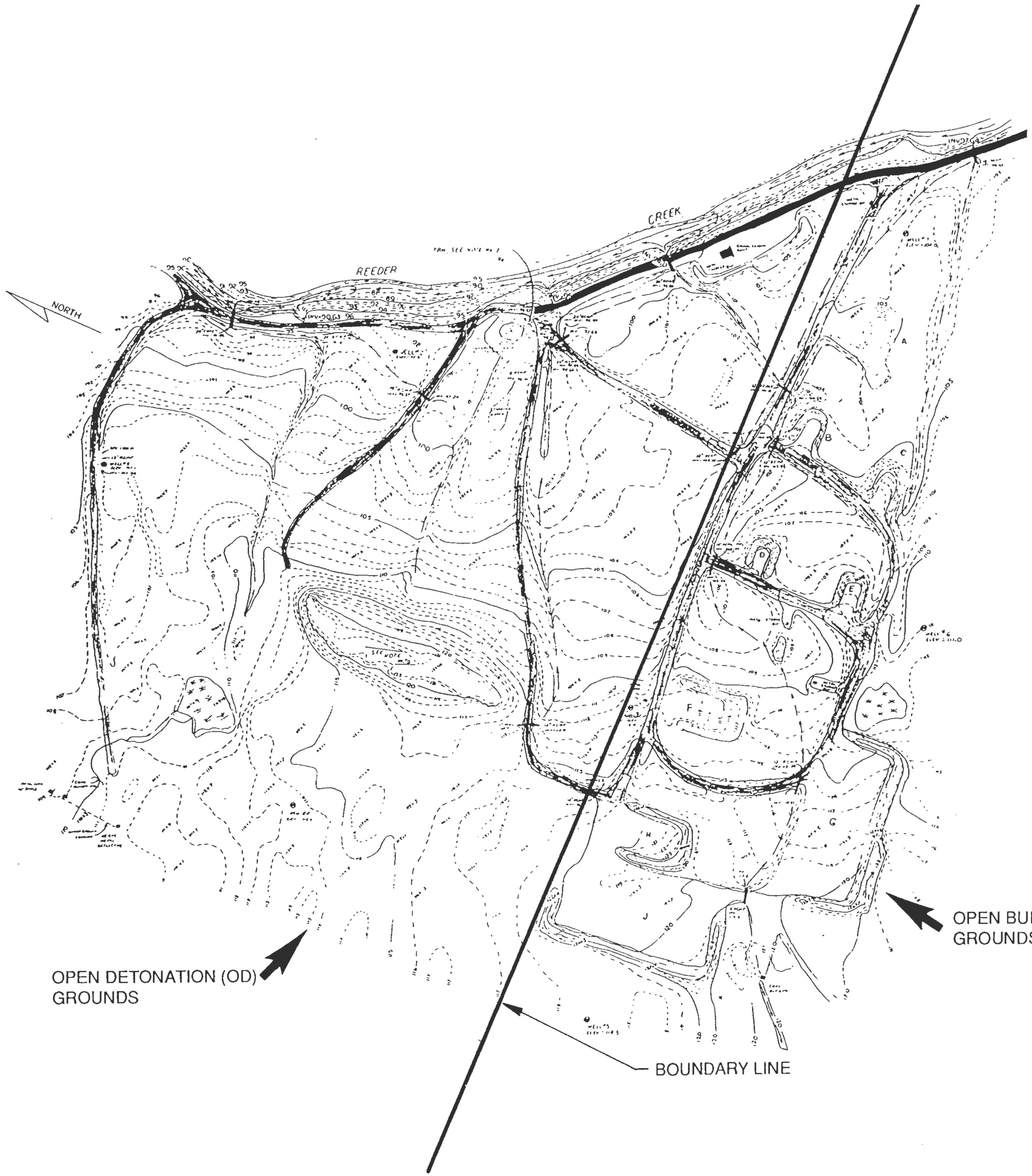
2.3.2.3 Disposal Practices SEAD Munition Destruction Area (OB/OD Grounds)

Obsolete or off-specification pyrotechnics, explosives, propellants and their packaging materials were routinely burned at this OB facility since 1941. Burning operations are presently conducted in a metal trough located on the OB grounds. Munition destruction activities will continue to be conducted in the open detonation area. Burning pads G and J have been used only for the burning of PEP-contaminated trash. The remaining pads were used to destroy a variety of materials including machine gun ammunition, fuses, and projectiles containing trinitrotoluene (TNT), composition B explosives, and amatol (US AEHA, 8/84).

2.3.2.4 Geology

General Physiography

Seneca Army Depot is situated in the Finger Lakes Region which is located within the Allegheny Physiographic Province. During the Wisconsin Stage of



300 0 300
SCALE IN FEET

NOTES:

1. Elevations are 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. Bomb disposal area subject to frequent contour alteration due to bulldozing, filling, and explosion.

LEGEND

SWAMP AREA
ASPHALT PAVEMENT
SHALE BASE ROAD
—— 110 —— 5 FOOT INTERVAL CONTOUR
- - - 92 - - - 1 FOOT INTERVAL CONTOUR
124.7 SPOT ELEVATIONS
CULVERT PIPE
DIRECTION OF SURFACE DRAINAGE
INFERRED DIRECTION OF GROUNDWATER FLOW
EXISTING MONITORING WELL LOCATIONS

SOURCE: HIBBARD ENGINEERS

FIGURE 2.2 MUNITION DESTRUCTION AREA, SENECA ARMY DEPOT, ROMULUS, NEW YORK the Pleistocene Age, glaciation excavated north-south trending stream valleys forming the Finger Lakes. Seneca Army Depot is on the western side of a series of north-south trending rock terraces which separate Seneca Lake and Cayuga Lake. Rock terraces are erosional remnants that divide glacially scoured lake basins. Rock terraces in the Finger Lakes Region range in elevation from 490 to 1600 feet above MSL. Elevations at Seneca Army Depot range from 450 feet above MSL on the western boundary to 760 feet above MSL in the southeast corner (US AEHA, 1985).

Stratigraphy

In the vicinity of Seneca Army Depot, consolidated Pleistocene glacial till deposits overlie Devonian age bedrock consisting primarily of shales. A till matrix, the result of such glaciation, varies locally but generally consists of horizons of unsorted silt, clay, sand and gravel. Thickness of the glacial till deposits on SEAD ranges from 1 to 10 feet. A zone of fractured and weathered bedrock 2-4 feet thick underlies the glacial deposits.

The bedrock unit underlying SEAD is the Ludlowville shale of the Hamilton Formation; a soft, grey fissile, highly jointed unit with thinly interbedded calcareous shale and limestone layers. The shale parts along bedding and dips a few degrees to the south-southwest. Faults are uncommon in this area.

2.3.2.5 Hydrogeology

Regional Hydrogeology

Topography and surface water drainage patterns suggest that regional groundwater flow beneath the Seneca Army Depot is westward toward Seneca Lake. Southerly drainage of the Finger Lakes Region is blocked by the Valley Heads Moraine. For this reason the Finger Lakes drain northward into the Ontario Lowlands.

Local Hydrogeology

Local groundwater flow at the Demolition Grounds is directed northeast into Reeder Creek which is in a sub-basin within the main Seneca Lake drainage basin. Reeder Creek is located approximately 1000 feet northeast of Burning Pad A. The creek flows north through the Demolition Grounds and then turns west and discharges into Seneca Lake. Surface water at the Demolition Grounds flows through drainage ditches and streamlets all of which empty into Reeder Creek.

Surficial Aquifer Unit

Groundwater is under water table conditions and occurs in the unconsolidated glacial till at Seneca Army Depot. The thickness of the till aquifer is generally less than ten feet. Previous studies indicate the water table is located 3 to 6 feet below ground (O'Brien and Gere, 1985). It is expected that small supplies of water would be available from the till due to its low permeability. Typical hydraulic conductivities for glacial till range from 10^{-1} ft/day to 10^{-7} ft/day (Freeze and Cherry, 1979). According to previous data obtained at Seneca Army Depot, it is expected that soil permeabilities may range from 10^{-3} to 10^{-4} ft/day (US AEHA, 1986).

Bedrock Aquifer Unit

Figure 2.3 presents the bedrock stratigraphic column for the Finger Lakes Region of New York. The bedrock that lies directly beneath the surficial deposits at SEAD is the Ludlowville member of the Hamilton Group. Groundwater at Seneca Army Depot is generally found in the joints and bedding planes of the shale. The frequency of fractures decreases with depth and faults are not suspected in this area.

In general, shale formations yield only small supplies of water adequate for domestic use. Shale formations that contain limestone layers, for example, may yield up to 40 gallons per minute (gpm) due to solutioning of joints to form cavities. Solutioning occurs where groundwaters come in contact with

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;
Roricks 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.

Middle Devonian

Oneonta Formation—shale, sandstone.
Unadilla Formation—shale, siltstone.
Tully Limestone.

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,

Lower Devonian

Edgecliff cherty Limestone Member, local bioherms.
Oriskany Sandstone.

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.

Middle Ordovician

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

Utica Shale.

FIGURE 2.3 GENERALIZED STRATIGRAPHIC COLUMN FOR CENTRAL NEW YORK STATE

SOURCE: RICKARD AND FISHER GEOLOGIC MAP OF NEW YORK, FINGER LAKES SHEET, 1970 limestone and dissolve joints and fractures, thus creating cavities through which groundwater flows. However, for mid-Devonian Shales such as the Ludlowville, most yields are expected to be less than 15 gpm (LaSala, 1968). A zone of highly fractured and weathered bedrock 2-4 feet in thickness directly overlies the shale. It is expected that the numerous fractures in this weathered zone would yield more water than the underlying competent bedrock.

2.3.2.6 Previous Investigation

Prior to conducting the current field investigation, Metcalf & Eddy reviewed the results of previous monitoring well installation to optimize the current efforts. Programs conducted by O'Brien and Gere Engineers between 1979 and 1985 are summarized below. This discussion details the rationale for selection of monitoring well locations.

Previous Monitoring Well Installation

O'Brien & Gere Engineers, Inc. employed Parratt-Wolff Inc. as a drilling subcontractor to install MW-1 through MW-7 (see Figure 3.1). Specifically, wells MW-1 through MW-4 were installed in August 1979, while wells MW-5 through MW-7 were installed in July 1981 (US AEHA, 1985).

Selection of Monitoring Well Locations

Monitoring wells MW-1 through MW-4 were placed to encircle the detonation area. Consequently, Monitoring Wells MW-1, 2, 3 and 4, respectively, were installed south, east, north, and west of the detonation area. MW-5 was installed downgradient of burning pads J and H (O'Brien & Gere, 1985). MW-6 and MW-7 were installed to complete the unmonitored perimeter of the remaining burning pads (Pers. Comm., Steve Garver, O'Brien and Gere, Inc.). The seven wells were sited to determine general site groundwater flow directions, characterize background groundwater quality at the site and assess groundwater quality downgradient from the open burning pads.

Monitoring Wells MW-1 through MW-7 were constructed of 4-inch ID, Schedule 40 PVC. Each ten slot well screen of five feet in length was installed at the top of bedrock (personal comm., Mike Ellingsworth, Parratt-Wolff). Well depths range from 6 ft. to 12 ft. below the land surface. Table 2.1 details specifications of previous monitoring well construction. These wells were installed without protective casings and have been unsecured since their installation.

TABLE 2.1. FINISHED SPECIFICATIONS FOR PREVIOUSLY EXISTING MONITORING WELLS (1981) SENECA ARMY DEPOT

MW Number	Boring Depth(ft)	Well Depth(ft)	Depth to Bedrock(ft)	Depth to Water	Screen Length(ft)	Screened Depth Interval(ft)
MW-1	13.0	13.0	12.0	4.3	5	7-12
MW-2	7.0	7.0	6.0	3.8	5	1-6
MW-3	11.0	10.5	9.5	4.1	5	4.5-9.5
MW-4	10.0	10.0	9.5	5.9	5	4.5-9.5
MW-5	10.0	10.0	9.0	Dry	5	4.0-9.0
MW-6	9.0	9.0	9.0	3.0	5	4.0-9.0
MW-7	6.5	6.5	6.0	4.2	5	1.0-6.0

Source: O'Brien & Gere, 1985.

3.0 CONTAMINATION INVESTIGATION CONDUCTED BY METCALF & EDDY

3.1 Introduction

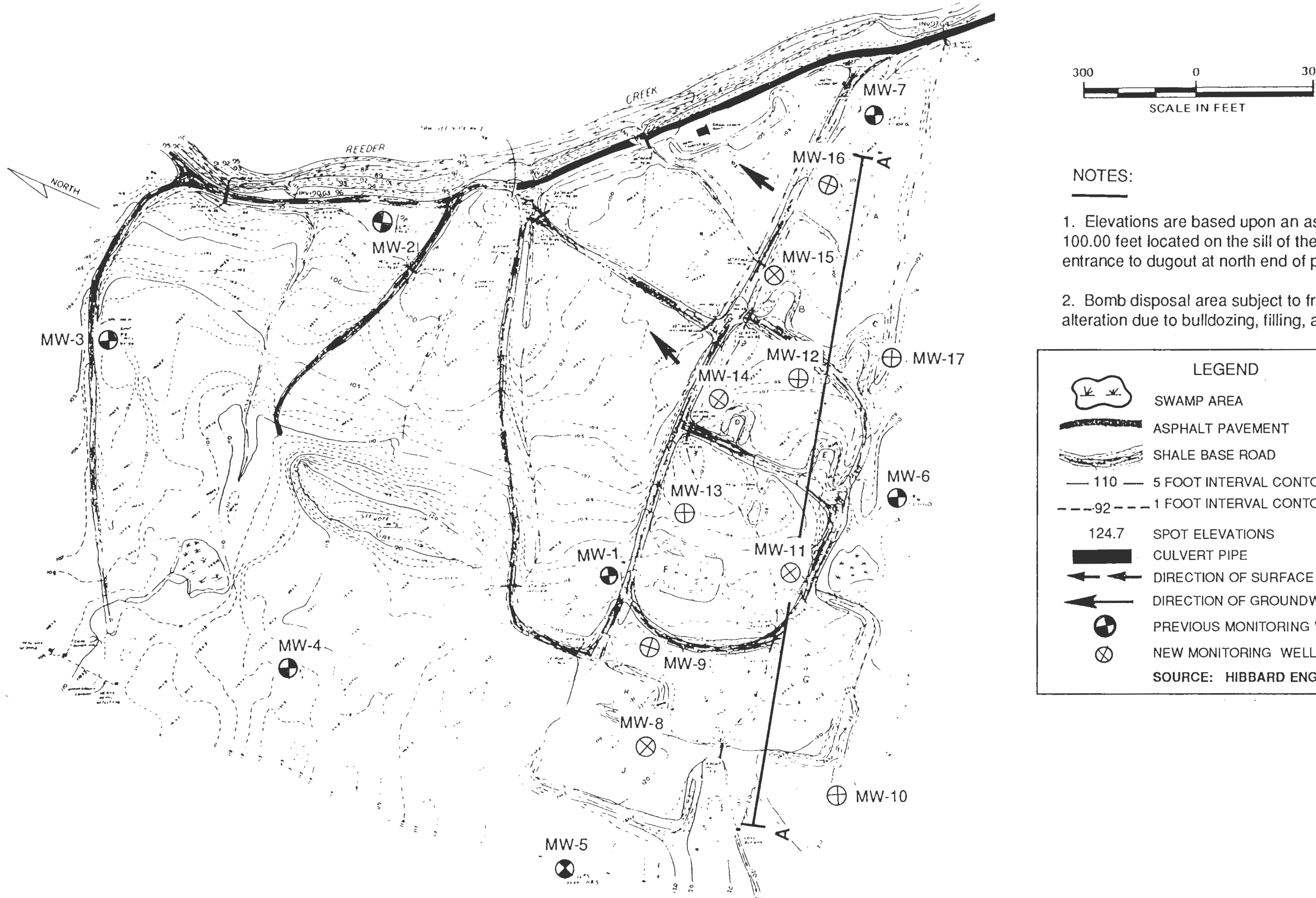
The Department of Defense contracted Metcalf & Eddy, Inc. to conduct a contamination evaluation prior to preparation of a Closure Plan for the Closure of Nine Burning Pads (A through J) located in the Munition Destruction Area (OB/OD Grounds) at SEAD. The drilling of soil and rock borings and installation of monitoring wells provided the data necessary to characterize the general movement and chemical composition of groundwater in the uppermost water bearing strata. A contamination evaluation, based on environmental samples collected at the site, was performed in an effort to assess levels of contaminants found on site. This portion of the report includes a discussion of: geophysical surveys, drilling operations, site-specific geology, well construction and development procedures, and the sampling program.

An initial site visit was conducted by M&E on November 9th and 10th of 1987 in order to visually assess existing site conditions and determine preliminary well locations. The selection of monitoring well locations (Figure 3.1), was based upon: (1) the intent to monitor groundwater at each of the nine burning pads, (2) known contaminant sources isolated in previous investigations conducted at the site, and (3) known groundwater flow directions based on existing data.

Well locations were generally chosen between 50 and 100 feet downgradient of each burning pad along suspected contaminant migration pathways. One upgradient monitoring well was expected to provide background water quality data.

3.2 Work Plans

Subsequent to the site visit and preliminary sampling location determinations, work plans were developed to outline site investigation procedures. These work plans included:



NOTES:

1. Elevations are 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. Bomb disposal area subject to frequent contour alteration due to bulldozing, filling, and explosion.

LEGEND

- SWAMP AREA
- ASPHALT PAVEMENT
- SHALE BASE ROAD
- 110 — 5 FOOT INTERVAL CONTOUR
- 92 — 1 FOOT INTERVAL CONTOUR
- 124.7 SPOT ELEVATIONS
- CULVERT PIPE
- DIRECTION OF SURFACE DRAINAGE
- DIRECTION OF GROUNDWATER FLOW
- PREVIOUS MONITORING WELL LOCATIONS
- NEW MONITORING WELL LOCATIONS

SOURCE: HIBBARD ENGINEERS

FIGURE 3.1 LINE OF SUBSURFACE CROSS SECTION RELATIVE TO MONITORING WELL LOCATIONS AT THE MUNITION DESTRUCTION AREA, SENECA ARMY DEPOT, ROMULUS, NEW YORK.

METCALF & EDDY

- Site Specific Health and Safety Plan (COE approved, January 19, 1988).
- Site Specific Monitoring Well Installation Plan (COE approved, April 7, 1988).
- Site Specific Quality Assurance Project Plan (QAPP) (COE approved, May 5, 1988).

COE approval of these work plans was obtained prior to commencement of field work. The field team adhered to the procedures described in the above work plans.

The specific work plans were submitted to the COE as separate documents and have not been presented within this document. However, a summary of field techniques employed during the investigation has been included in Sections 3.3 and 3.4. The analytical methodology is provided in the QAPP and summarized in Section 4. The analytical results of the QC samples have been evaluated and compared against the goals stated in the QAPP. A quality assurance summary for the project is included in Section 3.5.

3.3 Field Investigation

Due to the danger of unexploded ordnance on-site, geophysical surveys were conducted in the areas around the proposed monitoring well locations.

Subsequently, ten shallow groundwater wells were installed in the till overburden at Seneca Army Depot in compliance with the COE approved Final Site Specific Well Installation Plan of March, 1988. The following sections briefly discuss the geophysical survey, drilling procedures, geological and geotechnical findings, well installation, well development and testing for hydraulic conductivities.

3.3.1 Geophysical Surveys

Geophysical surveys were conducted in August 1988 by Hager-Richter Geoscience, Inc., at each of the ten proposed well locations within the Munition

Destruction Area. The purpose was to detect the presence of large subsurface metal objects which may be encountered during drilling operations. A 50 ft. x 50 ft. grid was set up surrounding each well location to conduct a magnetic survey using the G856 portable magnetometer and an electromagnetic survey using the Geonics EM-31D conductivity meter. Geophysical survey results indicated that 8 of the 10 proposed locations were free of buried metal.

A second survey was conducted in October 1988 at the proposed sites of monitoring wells 12 and 16 to find more suitable subsurface conditions. At well site 12 the grid was enlarged to encompass a 180 ft. x 150 ft. area. The closest metal-free drilling location was determined to be approximately 170 ft. downgradient (northeast) of Burning Pad E. Monitoring well 16 was relocated to an area within the original survey grid deemed free of metal. Results of the surface geophysical surveys are presented in Appendix A.

3.3.2 Monitoring Well Installation

Monitoring wells MW-8 through MW-17 were installed within the Munition Destruction Area at the Seneca Army Depot. The wells were installed by Metcalf & Eddy with the intention of: 1) defining groundwater flow direction beneath each of the burning pads, 2) obtaining representative groundwater samples to determine the presence or absence of contamination that may have been the result of DOD activities conducted on the burning pads, as well as, 3) post closure groundwater monitoring. Table 3.1 specifically describes these well locations in relation to each burning pad.

Results of the Phase 2 and Phase 4 OB/OD Hazardous Waste Management Studies performed by USAEHA indicated that the distribution and concentration of contaminants in the burning pad area is highly variable. Although significant levels of contaminants were found at only three burning pads, this did not preclude the possibility that further sampling would reveal contamination migrating from other pads.

TABLE 3.1. LOCATION OF MONITORING WELLS INSTALLED BY METCALF & EDDY

Well Number	Well Location in Relation to the Center of Burning Pads
MW-8	NE of Pad J and W of Pad H
MW-9	160' E and downgradient of Pad H
MW-10	Background. 330' SW and upgradient of Pad G. Upgradient of the Burning Pad Area
MW-11	280' NE and downgradient of Pad G
MW-12	220' NE and downgradient of Pad E
MW-13	200' E of Pad F. Adjacent to surface water drainage that flows between Pads F and G
MW-14	85' NE and downgradient of Pad D
MW-15	100' NE and downgradient of Pad B
MW-16	180' NE and downgradient of Pad A
MW-17	120' SE of Pad C, adjacent to surface drainage that flows by Pad C.

In addition, RCRA closure of the nine burning pads would require one post closure monitoring well per waste unit (40 CFR 265). Consequently ten monitoring wells were installed; one downgradient of each burning pad and one background well; MW-10, upgradient of the burning area. The final monitoring well sites were based upon: 1) the particular uses of each of the nine burning pads, 2) previous investigations of waste sources conducted at the site, 3) expected groundwater flow directions determined by the evaluation of existing data, 4) geophysical survey results, and 5) site-specific field conditions experienced during drilling operations.

Approximate groundwater flow directions were determined from groundwater elevation measurements taken from the previously installed wells. A general north-northeast flow towards Reeder Creek exists beneath pads A through F.

Groundwater flow through the till and bedrock is relatively slow, ranging on the order of from 10^{-2} to 10^{1} ft/day. Therefore, to detect contaminant migration, one well was installed in relatively close proximity to each burning pad. MW-8 was installed to monitor the area east of pad J and west of burning pad H, while MW-9 was expected to monitor the area east of burning pad H. MW-10 was expected to provide background water quality data, water table elevation, and aid in determining groundwater flow direction in the southwestern section of the OB area.

MW-11, MW-12, MW-13, MW-14, MW-15, and MW-16 were installed downgradient (northeast) of burning pads G, E, F, D, B, and A, respectively. Groundwater flow near pad C was expected to move southeast towards the adjacent local surface water drainage. Thus, MW-17 was located adjacent to this drainage.

3.3.2.1 Boring Operations

Drilling at the Munitions Destruction Area began October 4, 1988. A CME-850 track rig was used by Parratt-Wolff, Inc. for the drilling of two borings at each of the ten well locations. During the first boring, soil samples and rock cores were collected to establish a lithology. The second boring was located approximately 5 feet upgradient for the purpose of well installation in the overburden using 6¼-inch ID hollow stem augers.

For the initial boring, 4-inch hollow stem augers were utilized. Due to the danger of encountering unexploded ordnance grab samples were obtained from the auger flights every 2 feet within the till to a depth of 10 feet, or until penetration of the weathered zone was established. At depths below 10 feet, split spoon samples were collected to characterize the weathered zone and augers were spun, until competent bedrock was reached. A 5-foot length of NX bedrock core was then obtained at each location. Fresh, potable water was used for the coring and obtained from the base fire department. The cores were stored in wooden core boxes within a secured area at the site. The core holes were sealed with a bentonite slurry. Cuttings from the drilling operation were replaced in their respective boreholes which were then sealed to the surface with bentonite slurry.

The drilling rig was steam cleaned according to the procedures outlined in the approved Site Specific Monitoring Well Installation Plan (April 1988). All tools, augers and split spoons used during boring operations were scrubbed with Alconox detergent and steam cleaned before beginning each boring.

3.3.2.2 Geologic Data

Similar materials were encountered in each of the ten well locations within the OB/OD Grounds. A generalized subsurface cross section at the Munition Destruction Area along the line indicated in Figure 3.1 is shown in Figure 3.2. The wells were set within the overburden which consists of till ranging in thickness from 6.5 ft. to 9.5 ft.

Laboratory tests were performed on soil samples from the till for water content and sieve analysis in accordance with ASTM methods. Results of these tests confirmed field observations and characterized the till overburden as consisting of poorly sorted sands and gravels with some silt and clay. A zone of weathered shale 2 ft. to 4 ft. thick is located directly below the till.

Competent bedrock is located approximately 8.5 to 13 ft. below grade and consists of a fissile sandy shale. The shale parts along bedding 2 to 6 inches thick at 0-5° from horizontal. A general Rock Quality Designator (RQD) ranging from 0% to 37% indicates the bedrock is fractured and that some water is likely to enter through the fractures. Vertical joints are oriented in one direction, some of which contain fine silt.

Results of physical tests performed on soil samples, boring logs and core logs are presented in Appendix B.

3.3.2.3 Monitoring Well Construction

Ten groundwater monitoring wells were constructed within the till overburden at the SEAD Demolition Grounds in accordance with the COE Approved Final Site Specific Well Installation Plan. All the wells were constructed such that the bottom of the well screen is located at the bedrock/till interface. A 6 inch

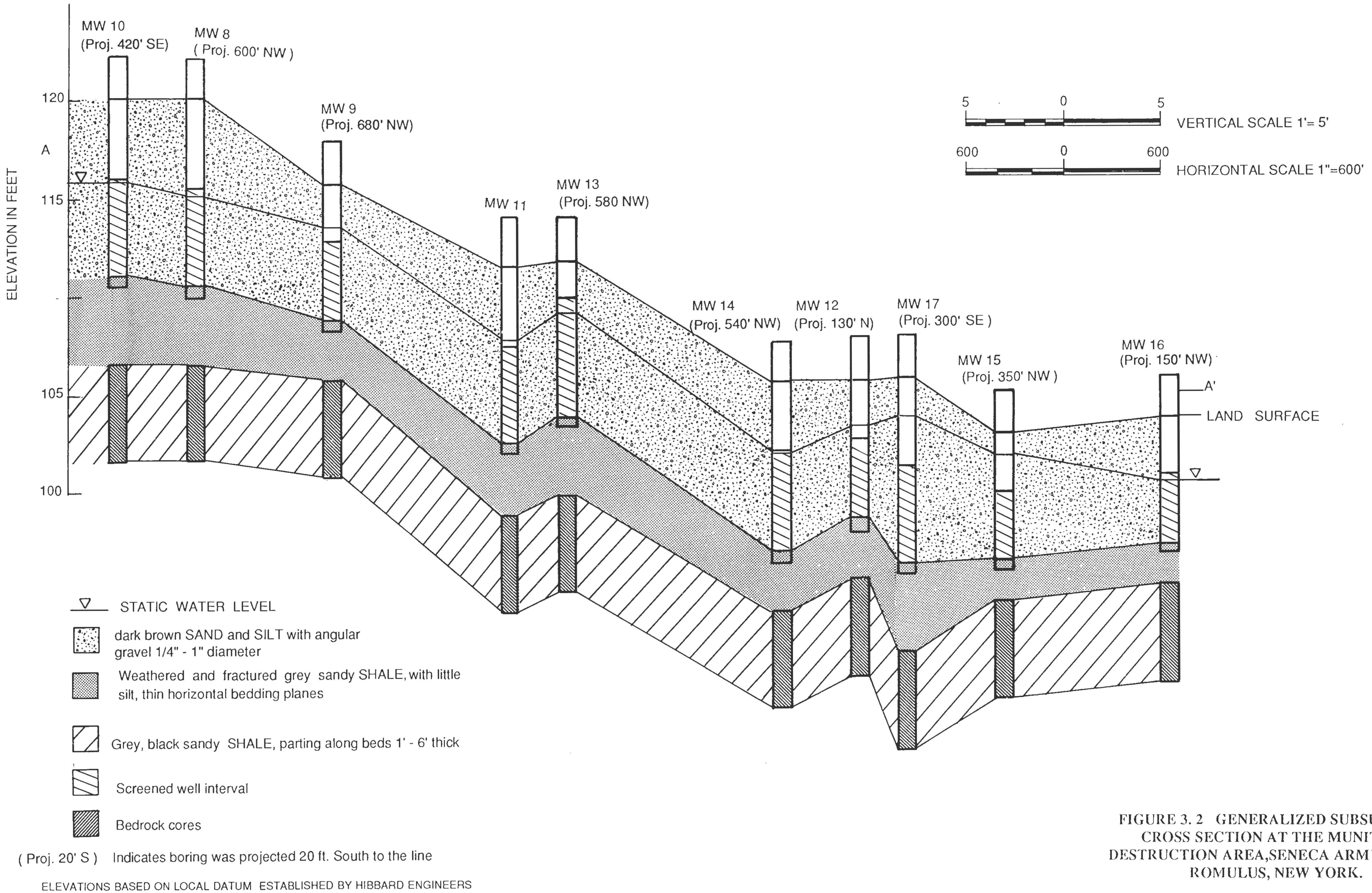


FIGURE 3. 2 GENERALIZED SUBSURFACE CROSS SECTION AT THE MUNITION DESTRUCTION AREA,SENECA ARMY DEPOT, ROMULUS, NEW YORK.

sand sump was set into the weathered zone below each screen. Monitoring wells MW-8, MW-10, MW-11, MW-13, MW-14 and MW-17 contain 5-foot screens. The shallow depth to bedrock in MW-9 and MW-12 required that the screens be cut to 4-feet and MW-15 and MW-16 screens were cut to 3.5 feet. All screens and risers were washed with a solution of Alconox detergent and deionized water and rinsed with deionized water prior to installation.

Borings for the wells were made using $6\frac{1}{4}$ inch ID hollow stem augers providing a ten inch diameter hole. Schedule 40, 2 inch PVC riser and screen were centralized within the hole and dry sand was added slowly by tremie pipe with frequent tape checks as the augers were raised. This ensured that bridging did not occur and that a proper interval of sand pack filled the annular space between the PVC screen and the borehole wall. A 6 inch sand sump was set below each screen and sand was extended $1\text{-}1\frac{1}{2}$ feet above the top of the screen.

A bentonite seal $1\text{-}1\frac{1}{2}$ feet thick was placed above the sand pack using 3/8 inch bentonite pellets which were allowed to hydrate at least 8 hours. Volclay powdered bentonite was used for the bentonite slurry (3% by weight Volclay and Huron Portland I) which sealed the hole to ground surface.

A concrete pad 3 feet square and 4 inches thick was constructed on the ground surface and steel protective casing with a side vented cap was placed on top of each well. Three guard posts and an engraved brass survey marker were permanently placed in the cement pad that surrounds each protective casing. The protective caps are secured by locks which are keyed the same for all the wells.

The cuttings from each hole were placed in separate 55 gallon drums which were sealed and labelled according to the hole. After all the wells were completed, the drums were moved to a specified location in the OB/OD grounds until a determination of their hazardous characteristics is complete. Sampling, analysis, and disposal of these cuttings are the responsibility of the COE. Table 3.2 details the finished specifications of each monitoring well. Individual monitoring well completion diagrams are presented in Appendix C.

TABLE 3.2. FINISHED WELL SPECIFICATIONS SENECA ARMY DEPOT, ROMULUS, NEW YORK

Well No.	Well Depth	Screen Length (ft)	Thickness of Sand Above Screen (ft)	Thickness of Bentonite Pellets (ft)	Thickness of Bentonite Grout (ft)
MW-8	9.5	5	1.5	1.5	1.5
MW-9	7	4	1	1	1
MW-10	9	5	1.5	1.5	1
MW-11	9	5	1.5	1.5	1
MW-12	7	4	1	1	1
MW-13	8	5	1	1	1
MW-14	8.5	5	1	1.5	1
MW-15	6.5	3.5	1	1	1
MW-16	6.5	3.5	1	1	1
MW-17	9.5	5	1.5	1.5	1.5

3.3.2.4 Well Development

Well development procedures were completed in accordance with the Final SEAD Site Specific Monitoring Well Installation Plan (April, 1988). All grout seals in the wells were allowed to cure a minimum of 48 hours prior to development. Wells were generally slow to recharge and were developed by bailing except for MW-11 and MW-17 which recharged rapidly enough to allow pumping. The wells were bailed dry and allowed to recharge. A surge block was moved up and down through the screened interval for periods of ten minutes to pull fine materials through the screen. The wells were then bailed dry again. The glacial overburden material at Seneca contained a high percentage of silt. Turbidity was noted to decrease as well development proceeded, however the appearance of the development water was still cloudy after all other development criteria had been met.

The development process was repeated for a period of 2-6 hours depending on the recharge rate and water clarity. Initial readings of pH and conductivity were taken and measurements were repeated at regular intervals throughout the development process. Photographs of samples show several wells which did not appear free of suspended solids; however, it is assumed that through periodic bailing and surging a good hydraulic connection between the well screen, filter pack, and formation was created. All wells contain a sufficient amount of water for developing with the exception of MW-16 which was nearly dry. However, MW-16 recovered before sampling was initiated. Well development characteristics are outlined in Table 3.3. Well development logs have been included in Appendix B.

TABLE 3.3. WELL DEVELOPMENT CHARACTERISTICS
SENECA ARMY DEPOT DEMOLITION GROUNDS, ROMULUS, NEW YORK

Approx. Volume Well No.	Development Development Method	of Water Removed (gallons)	Time (hours)
MW-8	Surge & Bail	9.5	5
MW-9	Surge & Bail	16.	4
MW-10	Surge & Bail	14.5	7.5
MW-11	Surge & Pump	52	4.
MW-12	Surge & Bail	18	4.5
MW-13	Surge & Bail	20	4
MW-14	Surge & Bail	14	4
MW-15	Surge & Bail	9.6	6.5
MW-16	Surge & Bail	Almost Dry	4.5
MW-17	Surge & Pump	35	2

3.3.2.5 Water Levels and Elevations

Water level measurements in each monitoring well were recorded prior to well development, sampling and recovery tests. Water level measurements prior to recovery tests are presented in Table 3.4. Surveyed coordinates and

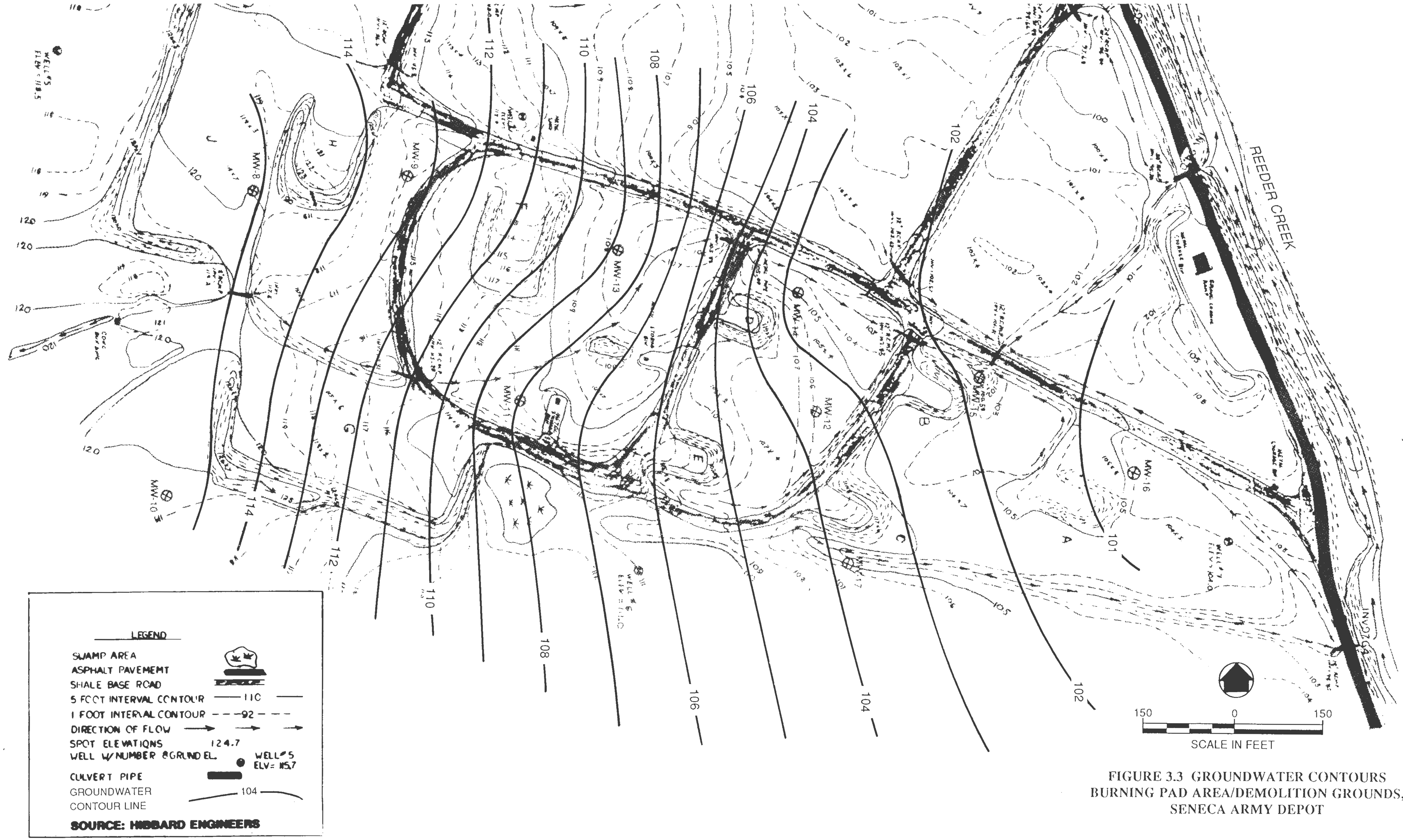


FIGURE 3.3 GROUNDWATER CONTOURS
BURNING PAD AREA/DEMOLITION GROUNDS,
SENECA ARMY DEPOT

3.3.2.6 Hydraulic Conductivities

Recovery tests were conducted on the ten monitoring wells following the collection of analytical groundwater samples in accordance with the COE Approved Final Monitoring Well Installation Plan. In-situ hydraulic conductivity values based on these tests were presented in Table 3.4.

The tests were conducted in the following manner: The static water level in the monitoring well was measured and recorded; an instantaneous change in head was caused by bailing a known volume of water from the well; water level recovery was monitored using an electronic well tape. The rate of recovery is a function of the aquifer characteristics. Data were analyzed using the Hvorslev method in order to obtain hydraulic conductivity values (Hvorslev, 1951). Plots and calculations of the normalized water level data vs. time for each well are presented in Appendix G. The average length of saturated sandpack calculations for use in the Hvorslev equation are also included in Appendix G.

The hydraulic conductivity measured values ranged from 0.02 to 1.47 ft/day for the ten newly installed wells. These values fall into the typical range of values for glacial till: 10^{-1} to 10^{-7} ft/day (Freeze and Cherry, 1979 and were in agreement with the hydraulic conductivities of 10^{-1} ft/day presented in O'Brien & Gere, 1985) for the existing wells (MW-1 through MW-6). However, these hydraulic conductivities were found to be several orders of magnitude faster than the 10^{-3} to 10^{-4} ft/day presented in US AEHA, 1986. Yet, it should be noted that the values presented in US AEHA, 1986 were calculated from laboratory tests using the standard proctor test and not from actual field measurements.

3.4 Sampling Program

The field sampling episode was conducted by Metcalf & Eddy from November 14-19, 1988. Sampling protocol and procedures were presented in the Final Quality Assurance Project Plan submitted to the Army Corps of Engineers in April, 1988.

The contamination evaluation conducted by Metcalf & Eddy included the sampling and analysis of the ten groundwater monitoring wells, just described, in addition to seven existing wells that had been installed in 1979 and 1981.

The parameters chosen for analysis were outlined in the SEAD Scope of Work (September, 1987) provided by the U.S. Army Corps of Engineers. The analyte selection reflects expected possible types of contamination resulting from past DOD activities, and includes selected total metals, explosives (HMX, RMX, 2,4-DNT, 2,6 DNT, 2,4,6 TNT, PETN) petroleum hydrocarbons, pH, specific conductance, and temperature.

3.4.1 Sampling Locations

The individual sampling locations were selected to assess particular areas of the site. Each location is briefly described to indicate the siting rationale and is illustrated in Figure 3.1.

3.4.2 Sampling Methods

Detailed sampling and analytical procedures were provided in the QAPP. Brief summaries of methodology are presented in the following section.

The sampling and analytical methods utilized to collect and analyze these samples were consistent with the QAPP, wherever possible. No additional blanks of any type were requested or added to the sample load. However, the number of field triplicates was increased from one to three and the number of equipment blanks were decreased from six to four as approved by the COE. In addition, the Kansas City District COE provided a new methodology for explosives. This analytical method is presented in Appendix E.

3.4.2.1 Groundwater Sampling

To assure that the groundwater samples collected were representative of the water in the aquifer, 5 well casing volumes were to be removed or the wells bailed to dryness. Table 3.5 presents well purging data. Sampling of the

TABLE 3.5. WELL PURGING DATA

Well No.	SWL (feet)	Quantity in Well (gallons)	Quantity Purged (gallons)	Well Volumes Purges
MW-1	2.88	1.90	4.1	2.16*
MW-2	1.74	1.25	1.0	0.80**
MW-3	5.78	3.75	5.25	1.40*
MW-4	2.26	1.50	1.33	0.89**
MW-5	3.03	2.00	1.50	0.75**
MW-6	3.05	2.00	4.0	2.00*
MW-7	0.44	0.30	<.30	Well dry
MW-8	3.79	0.75	3.75	5.00
MW-9	4.34	0.71	3.75	5.30
MW-10	5.61	0.92	5.0	5.43
MW-11	4.46	0.73	3.75	5.14
MW-12	4.01	0.65	3.75	5.77
MW-13	4.34	0.75	3.75	5.00
MW-14	4.19	0.75	3.75	5.00
MW-15	4.80	0.78	4.00	5.13
MW-16	3.00	0.48	2.50	5.20
MW-17	6.61	1.08	6.25	5.79

SWL = Standing water level in well
* Well bailed to dryness.
** Due to mud in well bottom, these wells were impossible to bail dry

seventeen monitoring wells entailed: measurement of the static water level and the well depth, purging of a minimum of 5 well casing volumes or to dryness, sufficient recovery of the water level in the well for sampling, and the collection of water samples. A teflon bailer was dedicated to each well and employed for well purging and sample collection.

3.4.2.2 Sampling Episode

The sampling episode was conducted from November 14-19, 1988. No problems were encountered during sampling, however, due to slow recharge, monitoring wells MW-1 through MW-7 were bailed to dryness before 5 well volumes were removed. MW-7 was dry during the sampling effort and was not sampled. After bailing MW-1 through MW-6, wells were checked for sufficient recharge for collection of samples (as directed by the COE) using an decontaminated audible water level detector. No measurable amount of recharge occurred before nightfall. Groundwater samples from MW-1 through MW-6 were collected the following day in the order in which they had been bailed the previous day; sampling continued until all monitoring wells were sampled. Groundwater samples collected from monitoring wells MW-1 through MW-6 contained an appreciable amount of suspended sediments. The ten remaining wells MW-8 through MW-17 were relatively free of suspended sediments and were sampled immediately after 5 well volumes were removed.

3.5 Quality Assurance

As required by the Seneca Army Depot QAPP, a quality assurance summary report was prepared upon the conclusion of all sample collection, analysis and data reduction activities. The purpose of such a report is to summarize and present all pertinent quality control data and discuss the influence of quality assurance issues on the overall data quality. This report consists of the discussion and results provided in this section.

As applied to field measurements and laboratory analyses performed during this project, Quality Assurance is the demonstration and documentation of data quality. These procedures include the recording of all quality control measures undertaken by the field team, and the assessment of the analytical performance of the subcontracted laboratory through the analysis of internal and external control and audit samples.

3.5.1 Field Sampling and Measurements

All field sampling was in compliance with the QAPP; all field samples and QC samples with the exception of MW-7 were collected as planned. All wells were surveyed after sampling, proper decontamination procedures were followed, field analytical parameters of conductivity, pH, and temperature were recorded as required, and chain of custody procedures including sample labelling were adhered to. One well, MW-8, was found unsecure but unopened upon the arrival of the sampling team on-site.

3.5.2 Field Replicate Collection

Three blind field triplicates were collected and described as MW-10, MW-18, and MW-19, MW-11, MW-20 and MW-21, and MW-17, MW-22, and MW-23. MW-18 has been presented in this report as MW-10 field duplicate; MW-19 was collected at MW-10 and sent to MRDED-L. MW-20 has been described as MW-11 field duplicate; MW-21 was collected at MW-11 location was sent to MRDED-L. MW-22 has been presented as MW-17 field duplicate; MW-23 was collected at MW-17 location and sent to MRDED-L. Analytical results from MW-19, MW-21 and MW-23 were made available to M&E and have been included in Appendix E. (See Table 3.6.)

3.5.3 Analytical Methods

The analytical methods utilized to analyze program samples are presented in detail in the QAPP. Table 3.6 summarizes the specific methods utilized.

3.5.4 Laboratory Analysis, Systems and Performance Audit

The Army Corps of Engineers, Missouri River Division Laboratory (MRDED-L) conducted a performance and system audit of Weston Laboratories to validate their ability to perform work under this contract. The independent performance audit conducted by the COE involved preparation and analysis of samples prepared by the Army COE Missouri River Division (MRD) Quality Assurance Laboratory.

The purpose of the performance audit samples was to provide an independent determination of any problem areas in sample handling, analysis, and reporting by the subcontracted laboratory. The program also provided data to document performance of the various measurement systems.

Performance audit samples were submitted as blind samples to Weston for comparison of results. The samples submitted had been selected by the MRD QA Laboratory to include analyses of duplicate standard pairs, low and high range standards, as well as blanks. The performance audit samples were prepared in certified organic free water, not actual site samples.

TABLE 3.6 ANALYTICAL SUMMARY

Location	Date	Sample No.	Sample Parameters	EPA Method No.
MW-1	11/18/88	3161-101	Explosives	(a), (b)
			Total recoverable metals	**(c)
			Petroleum hydrocarbons	418.1(d)
MW-2	11/18/88	3161-102,	Explosives	(a), (b)
			Total recoverable metals	**(c)
			Petroleum hydrocarbons	418.1(d)
MW-3	11/18/88	3161-103	Explosives	(a), (b)
			Total recoverable metals	**(c)
			Petroleum hydrocarbons	418.1(d)
MW-4	11/19/88	3161-104	Explosives	(a), (b)
			Total recoverable metals	**(c)
			Petroleum hydrocarbons	418.1(d)
MW-5	11/18/88	3161-105	Explosives	(a), (b)
			Total recoverable metals	**(c)
			Petroleum hydrocarbons	418.1(d)
MW-6	11/18/88	3161-106,	Explosives	(a), (b)
			Total recoverable metals	**(c)
			Petroleum hydrocarbons	418.1(d)
MW-8	11/18/88	3161-108	Explosives	(a), (b)
			Total recoverable metals	**(c)
			Petroleum hydrocarbons	418.1(d)
MW-9	11/16/88	3161-109	Explosives	(a), (b)
			Total recoverable metals	**(c)
			Petroleum hydrocarbons	418.1(d)

TABLE 3.6 ANALYTICAL SUMMARY (Continued)

Location	Date	Sample No.	Sample Parameters	EPA Method No.
MW-10 (triplicate)	11/16/88	3161-110	Explosives	(a), (b)
		3161-118	Total recoverable metals	**(c)
		3161-119*	Petroleum hydrocarbons	418.1(d)
MW-11 (triplicate)	11/17/88	3161-111	Explosives	(a), (b)
		3161-120	Total recoverable metals	**(c)
		3161-121*	Petroleum hydrocarbons	418.1(d)
MW-12	11/18/88	3161-112	Explosives	(a), (b)
			Total recoverable metals	**(c)
			Petroleum hydrocarbons	418.1(d)
MW-13	11/16/88	3161-113	Explosives	(a), (b)
			Total recoverable metals	**(c)
			Petroleum hydrocarbons	418.1(d)
MW-14	11/18/88	3161-114	Explosives	(a), (b)
			Total recoverable metals	**(c)
			Petroleum hydrocarbons	418.1(d)
MW-15	11/16/88	3161-115	Explosives	(a), (b)
			Total recoverable metals	**(c)
			Petroleum hydrocarbons	418.1(d)
MW-16	11/16/88	3161-116	Explosives	(a), (b)
			Total recoverable metals	**(c)
			Petroleum hydrocarbons	418.1(d)
MW-17 (triplicate)	11/17/88	3161-117	Explosives	(a), (b)
		3161-122	Total recoverable metals	**(c)
		3161-123*	Petroleum hydrocarbons	418.1(d)

TABLE 3.6 ANALYTICAL SUMMARY (Continued)

Location	Date	Sample No.	Sample Parameters	EPA Method No.
Equipment Blk				
EB-1,	11/17/88	3161-126	Explosives	(a), (b)
EB-2	11/17/88	3161-127*	Total recoverable metals	**(c)
EB-3	11/18/88	3161-128,	Petroleum hydrocarbons	418.1(d)
EB-4	11/18/88	3161-129*,		
EB-5	11/18/88	3161-130,		
EB-6	11/18/88	3161-131*,		
EB-7	11/18/88	3161-132,		
EB-8	11/18/88	3161-133*		
Travel Blk				
TB-1	11/17/88,	3161-134,	Petroleum hydrocarbons	418.1(d)
TB-2	11/17/88,	3161-135,*		
TB-3	11/18/88	3161-136,		
TB-4	11/18/88	3161-137*		
TB-5	11/19/88	3161-138,		
TB-6	11/19/88	3161-139*		

a. USATHAMA Method UW01
b. USATHAMA Method AMD.2/MERT2.1 7/21/82
c. Test Methods for Evaluating Solid Waste, SW-846, 3rd ed., U.S. EPA, November 1986.
d. Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, 1983.
* Sample sent to MRDED-L. Results were made available to M&E and are included in Appendix E of this report.
** Arsenic: 3020/7060, Barium, Cadmium Chromium, and Lead: 3005/6010, Mercury: 7470, Selenium: 3020/7740; Silver: 3005/6010

The results of the MRD audit were not made available to M&E, however, MRD stated that Weston was approved to conduct the required analyses under this contract. The laboratory-related quality control activities undertaken during the course of this project were designed to assure that measurement systems as well as activities specific to a given site evaluation were under control.

The ongoing laboratory-related quality control activities consisted principally of the evaluation of data obtained from the following sample categories; (a) calibration standards, (b) working standards, (c) field samples, (d) laboratory duplicates, (e) laboratory spikes, (f) laboratory methods blanks, (g) trip blanks, (h) laboratory split samples. Procedures to be used to evaluate that data would include calculation of arithmetic means, standard deviations, and relative percent differences for duplicate samples and comparison of differences between standards of spiked and experimentally determined values expressed as percent recovery. Identification and treatment of outliers was not appropriate as no marked deviations were noted in the data set. The information used to evaluate the laboratory quality control activities was to be obtained from the subcontract laboratory performing the analytical work. An assessment of the laboratory's compliance with stated objectives presented in the Seneca Army Depot QAPP is summarized below.

Quality Assurance data are presented in tables in Appendix F. The tables include results for field duplicate analysis, laboratory sample spikes, and laboratory replicates.

3.5.5 Sample Quality Assurance

Field duplicate analysis with the exception of silver and 2,4,6-TNT in Monitoring Well MW-10, selenium in MW-11, and petroleum hydrocarbons in MW-17 were within QAPP objectives as presented in Table F.1. Results of laboratory sample spikes presented in Table F.2 were within QA objectives for recovery, replication and relative percent difference except in the following instances: For MW-9 the selenium matrix spike recovery was low; matrix spike recoveries were low for arsenic, cadmium, lead, and silver in MW-1; cadmium, lead, and silver matrix spike recoveries were low for MW-12; Mercury matrix spike recovery was high for MW-4; PETN recoveries were low for one of each of the duplicates run on the equipment blanks. Laboratory replicates for total metals were within QA objectives as listed in Table F.3 except for selenium in MW-1. Laboratory control samples and standards were within QA objectives. This data has been included in Appendix E. It should be noted that the presence of sediments in MW-1 through MW-6 may have caused interferences and matrix effects in groundwater samples collected from these wells.

The above observations are minor in nature, thus the analytical sample data presented within this report is satisfactory and completely usable for the original objective of this site characterization.

3.5.6 Weston Quality Assurance

All sample holding times were met as required by 40 CFR 136. All calibration verification checks were within the required control limits of 90-110% (85-115%) for Mercury. All preparation blanks were analyzed below the required detection limits. All laboratory control standards were within the control limits of 80-120%. Laboratory replicates were with the 20% guidance limit.

Matrix spike recoveries were outside 75-125% guidance limits for selenium in MW-9, for mercury in MW-4, and for silver, arsenic, cadmium, lead, and selenium for MW-1. Weston suggested interference present in the sample matrix and/or sample inhomogenity as possible explanations for the varied analytical results.

Analytical results were rechecked by Weston to verify the presence of petroleum hydrocarbons. Weston did not determine any analytical abnormalities or calculation errors during analysis or reporting. The method blank had no detectable hydrocarbons and the spike recoveries were within acceptable limits. The possibility of contamination during laboratory analysis must be considered, however insufficient sample remains for reanalysis.

4.0 PRESENTATION OF RESULTS

This section contains a summary of sample analysis results and a presentation of groundwater standards and criteria associated with the analyses measured. The analytical results are discussed and compared to the standards and criteria in Section 5 to determine the presence or absence of groundwater contamination at the site.

4.1 Analytical Results

Table 4.1 summarizes the monitoring well sample data. The complete analytical results are presented in Appendix E.

4.2 Water Standards and Criteria

To put the level of contamination into perspective, analyte concentrations measured are compared to the following criteria: National Priority Drinking Water Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs; non enforceable health based goals) developed under the Safe Drinking Water Act, New York State (NYS) groundwater standards and guidance, and explosive limits set by the Surgeon General and U.S. Navy Bureau of Medicine and Surgery. These criteria have been presented in Table 4.2. For all detected analyses in groundwater, NYS groundwater standards are more stringent than the Federal MCLs, therefore NYS groundwater standards are used to compare potential metal contamination. Data which exceeded groundwater standards is summarized in Table 4.3.

Since residences with private wells reportedly exist within one mile of the Seneca Army Depot, the New York State groundwater standards employed for this evaluation were those applicable to Class GA groundwater. The best usage of Class GA waters is a source of potable water supply.

Interim drinking water limits established by the Surgeon General for HMX, TNT, and RDX were employed. The EPA Water Quality Criteria documents were used as a basis for 2,4-DNT and 2,6-DNT comparisons. The criteria for 2,4 and 2,6-DNT

Table 4.1 MONITORING WELL SAMPLE RESULTS

Sample location:	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6
M&E Sample ID#:	3161-101	3161-102	3161-103	3161-104	3161-105	3161-106
Units:	(ug/l)	(ug/l)	(ug/l)	(ug/l)	(ug/l)	(ug/l)
TOTAL METALS:						
Arsenic	< 10.0	< 10.0	< 10.0	< 10.0	19.3	< 10.0
Barium	551	< 200	294	835	440	859
Cadmium	< 5.0	< 5.0	< 5.0	18.8	< 5.0	< 5.0
Chromium	52.3	21.5	31.2	152.0	55.0	143.0
Lead	104.0	38.9	100.0	206.0	83.2	106.0
Mercury	0.58	< 0.20	0.47	< 0.20	< 0.20	< 0.20
Selenium	7.5	< 5.0	< 5.0	< 5.0	14.3	< 5.0
EXPLOSIVES:						
PETN	< 4.5	< 4.5	< 4.5	< 45*	8.5	< 4.5
HMX	< 1.30	< 1.30	< 1.30	< 1.30	< 1.30	< 1.30
RDX	0.86	< 0.63	< 0.63	1.84	< 0.63	< 0.63
Tetryl	< 0.66	< 0.66	< 0.66	<0.96 G	< 0.66	< 0.66
2,4,6-TNT	< 0.78	< 0.78	< 0.78	< 0.78	< 0.78	< 0.78
2,6-DNT	< 0.55	< 0.55	< 0.55	< 0.55	< 0.55	< 0.55
2,4-DNT	< 0.60	< 0.60	< 0.60	< 0.60	< 0.60	< 0.60
PETROLEUM HYDROCARBONS:	< 1000	< 1000	< 1000	< 1000	< 1000	< 1000
FIELD MESUREMENTS:						
pH	6.85	7.40	7.19	7.05	7.58	7.33
Conductivity (umhos/cm)	854	1380	1282	792	700	707
Temperature (C)	11.8	10.8	11.4	11.6	11.3	14.9

NOTES:

< - Indicates that the following value is an instrument detection limit.
* - 1:9 Sample dilution was necessary due to interferences present.

Table 4.1 MONITORING WELL SAMPLE RESULTS (continued)

Sample location:	MW-8	MW-9	MW-10(a)	MW-11	MW-12	MW-13	MW-14	MW-15	MW-16	MW-17
M&E Sample ID#:	3161-108	3161-109	3161-110	3161-111	3161-112	3161-113	3161-114	3161-115	3161-116	3161-11
Units:	(ug/l)	(ug/l)	(ug/l)	(ug/l)	(ug/l)	(ug/l)	(ug/l)	(ug/l)	(ug/l)	(ug/l)
TOTAL METALS:										
Arsenic	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Barium	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200
Cadmium	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Chromium	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Lead	< 5.0	< 5.0	< 5.0	9.0	< 5.0	< 5.0	< 5.0	6.0	< 5.0	9.9
Mercury	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Selenium	< 5.0	5.6	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
EXPLOSIVES:										
PETN	< 4.5	< 4.5	< 4.5	< 4.5	< 4.5	< 4.5	< 4.5	< 4.5	< 4.5	< 4.5
HMX	< 1.30	< 1.30	< 1.30	< 1.30	< 1.30	< 1.30	< 1.30	< 1.30	< 1.30	< 1.30
RDX	< 0.63	< 0.63	< 0.63	< 0.63	< 0.63	0.71	< 0.63	< 0.63	< 0.63	< 0.63
Tetryl	< 0.66	< 0.66	< 0.66	< 0.66	< 0.66	< 0.66	< 0.66	< 0.66	< 0.66	< 0.66
2,4,6-TNT	< 0.78	5.61	1.80	< 0.78	< 0.78	< 0.78	< 0.78	< 0.78	< 0.78	< 0.78
2,6-DNT	< 0.55	< 0.55	< 0.55	< 0.55	< 0.55	< 0.55	< 0.55	< 0.55	< 0.55	< 0.55
2,4-DNT	< 0.60	< 0.60	< 0.60	< 0.60	< 0.60	< 0.60	< 0.60	< 0.60	< 0.60	< 0.60
PETROLEUM HYDROCARBONS:	< 1000	< 1000	< 1000	< 1000	< 1000	< 1000	< 1000	< 1000	< 1000	< 1000
FIELD MESUREMENTS:										
pH	7.11	7.06	6.51	7.06	7.32	7.12	7.02	7.01	7.10	7.20
Conductivity (umhos/cm)	1260	977	855	1321	1153	840	1134	1470	956	674
Temperature (C)	12.9	10.5	13.1	10.0	10.3	11.2	11.7	11.0	12.1	10.9

NOTES:

< - Indicates that the following value is an instrument detection limit.
(a) Background Well

Table 4.1 MONITORING WELL SAMPLE RESULTS (continued)

Sample location: M&E Sample ID#: Units:	EB1 3161-126 (ug/l)	EB3 3161-128 (ug/l)	EB5 3161-130 (ug/l)	EB7 3161-132 (ug/l)	TB1 3161-134 (ug/l)	TB3 3161-136 (ug/l)	TB5 3161-138 (ug/l)	TB7 3161-140 (ug/l)
TOTAL METALS:								
Arsenic	< 10.0	< 10.0	< 10.0	< 10.0				
Barium	< 200	< 200	< 200	< 200				
Cadmium	< 5.0	< 5.0	< 5.0	< 5.0				
Chromium	< 10.0	< 10.0	< 10.0	< 10.0				
Lead	< 5.0	< 5.0	< 5.0	< 5.0				
Mercury	< 0.20	< 0.20	< 0.20	< 0.20				
Selenium	< 5.0	< 5.0	< 5.0	< 5.0				
EXPLOSIVES:								
PETN	< 4.5	< 4.5	< 4.5	< 4.5				
HMX	< 1.30	< 1.30	< 1.30	< 1.30				
RDX	< 0.63	< 0.63	< 0.63	< 0.63				
Tetryl	< 0.66	< 0.66	< 0.66	< 0.66				
2,4,6-TNT	< 0.78	< 0.78	< 0.78	< 0.78				
2,6-DNT	< 0.55	< 0.55	< 0.55	< 0.55				
2,4-DNT	< 0.60	< 0.60	< 0.60	< 0.60				
PETROLEUM HYDROCARBONS:	1700	< 1000	< 1000	< 1000	< 1000	< 1000	< 1000	< 1000

NOTES:

< - Indicates that the following value is an instrument detection limit.

Table 4.2. Water Criteria

	National Primary Drinking Water Regulations MCLG (a) (ug/L)	National Primary Drinking Water Regulations MCL (b) (ug/L)	Other Federal Criteria (ug/L)	New York State Groundwater Standards (c) (ug/L)	Data Ranges Well #'s MW-1 to 6 (ug/L)	Data Ranges Well #'s MW-8 to 17 (ug/L)
METALS:						
Arsenic	50 (p)	50		25	<10-19.3	<10
Barium	1,500 (p)	1,000		1,000	<200-859	<200
Cadmium	5 (p)	10		10	<5-18.8	<5
Chromium	120 (p)	50		50	21.5-152	<10
Lead	0 (pp)	50 (d)		25	38.9-206	<5-9
Mercury	3 (p)	2		2	<0.2-0.58	<0.2
Selenium	45 (p)	10		20	<5-14.3	<5-5.6
EXPLOSIVES:						
PETN			NA		<4.5-8.5, <45	<4.5
HMX			35 (e)		<1.3	<1.3
RDX			35 (f)		<0.63-1.84	<0.63-0.71
Tetryl			1.0 (g)		<0.96	<0.66
2,4,6-TNT			1 (f)		<0.78	<0.78-5.61
2,6-DNT			1.1 (f)		<0.55	<0.55
2,4-DNT			1.1 (f)		<0.60	<0.60

NOTES:
- (a) MCLG - Maximum contaminant level goal; non-enforceable, health based goal.
- (b) MCL - Maximum contaminant level; interim guidance levels.
- (c) New York State Ambient Water Quality Standards and Guidance Values, New York State Department of Environmental Conservation April 1, 1987.
- (d) The MCL for Lead was proposed to be lowered to 5 ug/l (53 FR 31516, August 18, 1988).
- (f) EPA Water Quality Document, US AEHA, 1986. (10E-5 risk)
- (g) U.S. Navy target for Tetryl breakdown products
- (e) Part B Permit for Seneca Army Depot, Health-Based Criteria p.I-5.
- (p) Proposed values taken from 50 FR 46936, November 13, 1985.
- (pp) Proposed value taken from 53 FR 31516, August 18, 1988.

TABLE 4.3. DATA WHICH EXCEEDS GROUNDWATER STANDARDS

	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	Federal MCL ug/l	NYSGW Standard ug/l
Cadmium				18.8			10	10
Chromium	52.3			152	55	143	50	50
Lead	104	38.9	100	206	83.2	106	50	25
Selenium					14.3		10	20

is based upon information regarding the protection of human health from the potential carcinogenic effects through ingestion of drinking water containing 2,4-DNT resulting in an increased cancer risk of 10^{-5} (US AEHA, 1986).

Data regarding health effects of tetryl are insufficient and its instability indicates likely decomposition. Therefore, target interim maximum concentration level established by the U.S. Navy Bureau of Medicine and Surgery (February 1982) for picric acid (a possible decomposition product) was used as criteria.

No criteria has been established for PETN (US AEHA, 1985; personal communication with Kim Fleischmann US AEHA).

4.3 Potential Health Implications

Environmental and public health risks associated with groundwater contamination may be assessed qualitatively. The ten monitoring wells installed by M&E were free of visible sediment. Potential health implication of contaminants detected in these wells may be isolated. Four compounds were found above detection limits in one or more of these wells: lead, selenium, RDX, and 2,4,5-TNT. Each of these compounds were below current water criteria levels, as shown in Table 4.2.

Samples from the existing wells MW-1 to MW-6 demonstrated high levels of several metals, but these samples were contaminated by sediment. PETN was detected in one of the existing wells (MW-5).

Lead has well-known toxic effects on the central nervous system, certain blood enzymes, and the kidneys. Since a large number of people are already exposed to levels above any threshold for health effects, exposures to lead through any source should be minimized. Selenium is probably an essential element for humans, but chronic toxicity occurs when people ingest food containing excessive selenium levels (Clement Associates, 1985).

The three compounds detected in the groundwater wells which are clearly associated with munitions operations are PETN, RDX, and TNT. Toxicological information was not found for PETN. There is a moderate amount of toxicologic data available for RDX and TNT.

TNT is rapidly metabolized in the liver, which is a primary site of toxic action. In a subacute oral toxicity test in the dog, a sensitive species, no effects were observed at a dose of 0.20 mg/kg/day (Oak Ridge National Lab, 1984, p. 66). Human TNT intoxication was widespread in the United States during both World Wars, primarily through the inhalation and dermal contact routes in industrial situations.

The primary toxic effect of RDX is on the central nervous system. Industrial exposures are via inhalation, but intoxication from RDX ingestion has been detected. In a chronic rat study and a subchronic dog study, no effects were noted at up to 10 mg/kg/day, except for temporary episodes of emesis in the dogs (Oak Ridge National Lab, 1984, p. 72).

Aquatic plants and animals could potentially be exposed to contaminants in water moving from subsurface aquifers to Reeder Creek. Table 4.4 compares levels of two explosives found in groundwater on-site with levels found to be toxic in aquatic organisms. These data indicate that no adverse effects on aquatic plants and animals are expected under baseline conditions.

TABLE 4.4. TOXICITY OF TNT AND RDX TO AQUATIC ORGANISMS

	TNT	RDX
Algae Tested	Blue-green algae (Microcystis aeruginosa)	Green algae (Selenastrum capricornutum
Inhibition of algae growth	0.32 ppm	0.32 ppm
Fish Tested	Fathead minnow (Pimephalus promelas)	Fathead minnow (Pimephalus promelas)
Fish LC50	1.2 ppm	5.8 ppm
Maximum detected in groundwater at SEAD	0.00561 ppm	0.00071 ppm

Note: Inhibition of algae growth is lowest concentration inhibiting growth in a sensitive algae species.
Fish LC50 is the concentration of contaminant expected to kill 50% of fish exposed for 96 hours.

Reference:

Oak Ridge National Laboratory, 1984. "Database Assessment of the Health and Environmental Effects of Munition Production Waste Products." AD/ORNL-6018.

There are a few homes with private wells one-half mile west of the burn pads, just outside Seneca Army Depot, but these are not downgradient of the burning pads area. Homes that presumably use private wells are downgradient along Reeder Creek, at a distance of over one mile from the site (U.S.G.S. Geneva South Quad). Due to the distance involved and the characteristics of glacial till, appreciable groundwater contamination from the burning pads area is not expected in the area of the private wells.

5.0 DISCUSSION AND CONCLUSIONS

5.1 Introduction

The objective of this study was to provide a contamination evaluation to determine presence or absence of chemical contamination in groundwater which may have resulted from DOD activities at the Open Burning/Open Detonation Grounds at Seneca Army Depot. To accomplish this objective: ten groundwater monitoring wells were installed (one downgradient of each burning pad and one upgradient of the entire burning pad area), and groundwater samples were collected from each of the ten newly installed wells in addition to the six existing wells.

New York State groundwater standards were used as a basis for comparison for total metals. Interim drinking water limits established by the surgeon general were used for HMX, TNT, and RDX. The criterion used for 2,4-DNT and 2,6-DNT were based upon EPA Water Quality Criteria Documents. Health effects of tetryl are insufficient, but target maximum concentration levels established for picric acid (a decomposition product of tetryl) was used for comparison (US Navy Bureau of Medicine and Surgery). No criteria has been established for PETN.

5.2 Discussion

Total metal concentrations were found to be below New York State (NYS) drinking water standards in all the ten newly installed wells (MW-8 through MW-17). However, several existing wells (MW-1 through MW-6) exhibited total metal concentrations above acceptable limits. Specifically, cadmium was detected at 18.8 ug/l in MW-4, exceeding the NYS standard of 10 ug/l. Chromium was detected above the NYS limit of 50 ug/l in MW-1, MW-4, MW-5 and MW-6 at concentrations of 52 ug/l, 152 ug/l, 55 ug/l, and 143 ug/l, respectively. Concentrations of lead greatly exceeded the NYS standard of 25 ug/l in all existing monitoring wells samples with concentrations ranging from 39 ug/l in MW-2 to 206 ug/l in MW-4. In addition, selenium in MW-5, (14 ug/l) exceeded the NYS standard of 10 ug/l.

Yet, as previously described in Section 3.4.2.2, the presence of sediment in the existing well samples may have increased the contaminant concentrations in the groundwater samples collected. In addition, analytical data of groundwater collected from the existing wells presented in (AEHA, 1988) indicated that dissolved metal concentrations were below MCLs. This data is included in Appendix E. Groundwater samples collected during M&E's study were unfiltered in accordance with the revised Scope of Work (September 28, 1987).

Explosives HMX, 2,4-DNT, and 2,6-DNT were not detected in any groundwater samples. RDX was detected in MW-1, MW-4, and MW-13, however, at concentrations below acceptable limits. 2,4,6-TNT was detected in MW-9 and MW-10 again below interim drinking water limits set by the surgeon general. Petroleum hydrocarbons were not detected in any samples, however were detected in Equipment Blank EB-1. This suggests possible laboratory contamination. PETN was detected in MW-5 alone.

5.3 Conclusions

- Groundwater at the Seneca Army Depot Demolition Grounds in generally directed north-northeast and discharges into Reeder Creek.
- The velocity of Groundwater flow beneath the Demolition Grounds is on the order of 3.2×10^{-2} ft/day. Seasonal variation is likely to influence groundwater flow volume and velocity.
- Evaluation of the analytical data collected from the ten newly installed wells which contained little or no sediment (MW-8 through MW-17) indicated no groundwater contamination of total metals, petroleum hydrocarbons or explosives above acceptable levels in the Open Burning Grounds at Seneca Army Depot.
- Analytical data collected from MW-1 through MW-6 indicated total metal concentrations which exceeded Federal MCLs and NYS drinking water standards. However, the data should not be considered in an evaluation of groundwater contamination in the Open Burning grounds for the following reasons:

  1. Sediment present may have influenced total metal concentrations.
  2. Previous AEHA reports indicated below detection limit quantities of metals in groundwater collected from wells MW-1 through MW-7 when samples were filtered.

3. Monitoring wells MW-2, MW-3, and MW-4 are located in the Detonation Area, which is not scheduled for closure.

- Due to the distance and characteristics of glacial till, appreciable groundwater contamination from the burning pad area is not expected to impact private wells in the vicinity of the site.

- 2,4,6-TNT and RDX concentrations detected in groundwater indicate no adverse effects on aquatic plants and animals under baseline conditions.

6.0 RCRA CLOSURE EVALUATION

6.1 Introduction

The objective of this section was to evaluate methods for RCRA closure of the Seneca Army Depot (SEAD) burning pads/OB grounds. In this section a conceptual overview is presented to address regulatory, technical, and economic feasibility of in-place containment.

Three closure alternatives were developed and evaluated. These include Alternative 1 - landfill closure, Alternative 2 - modified landfill closure, and Alternative 3 - clean closure. Landfill closure involves on-site containment of the wastes and post-closure monitoring. Clean closure (USEPA, 1987) involves removal or decontamination of all wastes and if successful, no post closure care or monitoring is required. However, the NYSDEC may require some post closure monitoring.

Alternative 1 (landfill closure) involves capping the burning pad soils and the installation of groundwater migration barriers. This alternative was originally developed by O'Brien & Gere Engineers in a report outlining closure of burning pads B and H (O'Brien & Gere, May 1985) and modified by M&E. Alternative 2 was developed after evaluation of the O'Brien & Gere approach. M&E believed that Alternative 1 posed excessive risk in terms of technical feasibility as well as regulatory compliance. Alternative 2 (modified landfill) involves the excavation of contaminated burning pad soil and on-site treatment using chemical solidification/stabilization. The stabilized material would then be combined, capped and contained on-site.

Alternative 3 (clean closure) involves the excavation of contaminated burning pad soil, on-site treatment and off-site disposal. On-site treatment would involve incineration followed by chemical solidification/stabilization, if necessary, of the ash. All treated soils would then be transported and disposed of in a solid waste landfill.

6.2 Evaluation Assumptions

Table 6.1 presents the assumptions used in the evaluations of in-place containment. The burning pads/OB grounds are the only area of the site in which RCRA Closure will be addressed. The OD grounds will continue to operate explosive destruction and will not be closed. For the purposes of this evaluation all burning pads A through J have been assumed to require closure. RCRA closure would be required due to the presence of hazardous soils with RCRA characteristics (toxicity, reactivity, etc.) or that exceed Applicable or Relevant and Appropriate Requirements (ARARs) under CERCLA.

The areal extent of hazardous soil around each pad was assumed to be a perimeter 5 feet away from the outer edge of the berm. The vertical extent of hazardous soil was assumed to include all pad berm soil as well as soil to an average depth of 3 feet below the pad surface. Since it was not the objective of this study to analyze any soil samples, the extent of soil contamination was based solely on two previous sampling episodes conducted at the Seneca Army Depot during AEHA's five phase program of OB/OD grounds evaluations. During Phase 2 (Dept. of the Army, May 1982) AEHA collected and analyzed soil samples from the top 0-6 inches from pads B-H for EP Toxicity metals and explosives. During Phase 4 (Dept. of the Army, August 1984), AEHA expanded the depth and areal extent of soil sampling from pads B, F, and H. Samples were collected at a range of depths from 0-8 feet, from the pad berms and from locations off the pads. Analytical results of these previous investigations are presented in Appendix E.

In general, the analytical data indicated: 1) the presence of explosives in the berm soil and top one-foot of pad soil, 2) the detection of EP Toxicity metals deeper in the soil column, and 3) below detection limit concentrations of metals and explosives outside the bermed areas. The most common explosive detected and measured in highest concentration was 2,4,6-TNT. Lead and barium were the most predominate metals detected. Based on Phase 2 and Phase 4 analytical data, a five (5) foot distance perimeter from the outer edge of each pad's berms and a three (3) foot vertical depth should supply a sufficient safety factor for the extent of soil contamination. M&E's groundwater sampling of the ten newly installed monitoring wells revealed no

TABLE 6.1. EVALUATION ASSUMPTIONS

---

1. Only burning pads/OB grounds are considered. Study or closure of the open detonation (OD) grounds is beyond the Scope of Work.

2. All Burning Pads A-J will require closure due to their content of hazardous soils. Hazardous is defined as soil having RCRA characteristics of toxicity, reactivity, ignitability, or leachability or exceeding CERCLA Applicable or Relevant and Appropriate Requirements (ARARs).

3. Areal extent of hazardous soil includes a perimeter 5 feet out from the outer edge of each pad berm. Vertical extent of hazardous soil includes all berm soil as well as sub-surface pad soil to a depth of 3 feet. Areal and vertical extent of contamination was based on previous soil sampling by AEHA.

4. Remediation of existing groundwater was not included in the evaluation based on M&E's groundwater contamination study.

5. No RCRA listed hazardous wastes (as defined in 40 CFR Part 268) have been disposed in burning pad areas.

6. Closure will occur under New York's Final Status Standards.

---

groundwater contamination of the analytes measured. Furthermore, the average depth to groundwater from the ground surface on the OB grounds was determined to be 3 feet.

It is assumed that no RCRA listed wastes as defined in 40 CFR Part 268 (Land Disposal Restrictions) have been disposed of in burning pad soils.

O'Brien & Gere's report assumed that the New York regulations requiring a minimum 10 foot separation between any waste and an aquifer or bedrock would apply. This requirement is in New York's Final Status Standards but is not a requirement of the state's Interim Status Standards. M&E has assumed closure will occur in accordance with New York State Final Status Standards for the purpose of this evaluation.

Environmental and public health considerations require that site contaminants be isolated not only from groundwater but from the ground surface. First, a barrier between the contaminants and the surface of the soil is therefore needed to minimize direct exposures to humans and most wildlife species. Second, the opportunity for leaching to groundwater should be eliminated. Evaluation of in-place containment considered environmental and public health risks qualitatively.

6.3 Regulatory Feasibility

At this point in time New York State has only received authorization for pre-HSWA (Hazardous and Solid Waste Amendments of 1984) RCRA regulatory control. Therefore both state and federal regulations will need to be met for the burning pads/OB grounds closure. In addition, SEAD is a Department of Defense Facility and will need to comply with military regulations. The applicable federal regulations are found in Title 40 of the Code of Federal Regulations (40 CFR). Applicable state regulations are found in Title 6 of the New York Codes, Rules and Regulations (6 NYCRR). Applicable military regulations are found in the Department of the Army's technical manual for hazardous waste land disposal/land treatment facilities (DA TM 5-814-7).

Land disposal units which received RCRA hazardous wastes after November 19, 1980 are subject to RCRA closure requirements. The Seneca Army Depot must close the burning pads/OB grounds in compliance with regulations under 40 CFR Part 265, Interim Status Standards For Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities. The activities conducted at the burning pads classify the units as thermal treatment subject to Subpart P of 40 CFR 265. The waste pile requirements of 40 CFR 264.250 are not applicable to cases where a waste pile is closed with wastes left in place. Closure requirements of this Subpart P are identified under 40 CFR 265.381. These closure requirements specify that "the owner or operator must remove all hazardous waste and hazardous waste residues (including, but not limited to, ash) from the thermal treatment process equipment". If the hazardous residues are not removed then the burning pads would be subject to the landfill closure requirements of 40 CFR 265.310 and 6 NYCRR 373-2.14.

These regulations will pose certain engineering requirements for Alternatives 1 (capping/groundwater controls) and 2 (chemical solidification/stabilization). A closure-post closure plan will be required for both Alternatives 1 and 2 (40 CFR 265 Subpart G). Both alternatives will require groundwater monitoring upgradient and downgradient. Upgradient monitoring will be conducted initially to establish baseline groundwater quality. Downgradient monitoring/sampling will be conducted annually (40 CFR 265 Subpart F) to determine groundwater quality and semi-annually to determine groundwater contamination. Alternative 1 would require a hazardous waste cap (40 CFR 265.310(5)) and the 10 foot separation between the bottom of capped waste and an aquifer (6 NYCRR 373-2.14 (2)). Regulatory requirements for a liner system are clearly defined and would be applicable to Alternative 2. Federal (40 CFR 264.300(d)) and state regulations (6 NYCRR 372-2.14(3)) regarding liners are similar and specify that a new or existing landfill must install a double liner and leachate collection system.

However, the double liner and leachate collection system requirements can be waived as stated in Federal (40 CFR 265.300 (d)(2)(c)(ii)) and state regulations (6NYCRR 373-2.14(5)(ii)(b)) if:

> "The owner or operator demonstrates that the monofill is located, designed and operated so as to assure that there will be no migration of any hazardous constituent into groundwater or surface water at any future time."

Successful application of Alternative 2 (chemical solidification/stabilization) will immobilize contaminants and should mitigate migration of hazardous constituents.

6.4 Technical Feasibility

The technical feasibility of the three alternatives were evaluated. Technical issues regarding Alternative 1 (Landfill Closure) included: 1) the reliability of the grout curtain/slurry wall to contain contaminated groundwater and provide the necessary ten foot of separation between groundwater and soil, and 2) the feasibility of the attaching the grout curtain/slurry wall to questionably competent bedrock.

Alternative 2 (modified landfill closure) was evaluated with regard to the use of chemical solidification/stabilization to fix on-site contaminated soils and prevent future migration of metals, explosives and hazardous constituents into groundwater.

Alternative 3 (Clean Closure) was evaluated regarding the destruction of organics via incineration and the containment of metals in the ash and scrubber water via chemical solidification/stabilization. This may allow off-site disposal of ash in a solid waste landfill.

6.4.1 Alternative 1 - Capping/Groundwater Controls (Landfill Closure)

Alternative 1 was based on the recommended remediation method from O'Brien & Gere Engineers' report on the closure of burning pads B and H (O'Brien & Gere, May 1985). This alternative involved leaving all burning pad soils (including berms) undisturbed, adding fill to create an even embankment and then capping the embankment. Details of this are included in Appendix H. Groundwater controls were required to lower the groundwater table so that a minimum separation of 10 feet exists between the bottom of the hazardous soil and the top of the aquifer. Evaluation of data collected from the installation of the ten monitoring wells indicated the average depth to groundwater from the ground surface on the burning pads/OB grounds was 3 feet and the average depth to bedrock from the ground surface was 8 feet. Thus a head of 5 feet will be created from the separation required.

O'Brien & Gere proposed to lower the groundwater by installing a slurry trench/wall around the perimeter of the capped pad. This slurry wall would be keyed into the bedrock. O'Brien & Gere proposed that an active groundwater pumping/ removal system would not be required and that the slurry wall alone would be sufficient to maintain the 10 foot separation over the operating lifetime of the containment.

Several technical concerns and deficiencies arose from M&E's review of O'Brien & Gere's proposed remediation. The proposed cap was believed to be inadequate in meeting closure regulations. In addition, no measures were added for dewatering the soils within the slurry wall containment or in measuring future water levels to monitor for leakage. The largest concern, however, was for the total reliance upon a static slurry wall keyed into questionably competent bedrock in maintaining the 10 foot groundwater separation for the standard 30 year operating lifetime of the containment.

To characterize the bedrock, M&E, as part of the current study, drilled and collected NX bedrock core samples from the upper 5 feet of the shale bedrock. Rock Quality Designation (RQDs) ranged from 0-37% and vertical joints were present in some cores. Additionally, groundwater monitoring study of the OB/OD grounds at the Seneca Army Depot was conducted by the U.S. Army Environmental Hygiene Agency (US AEHA, 1985). This study concluded that: groundwater at SEAD is generally found in the joints and bedding planes of the shale at depths ranging from 1 to 23 feet into bedrock. From this information it appeared very likely that groundwater would migrate underneath the slurry wall and into the contained zone.

M&E believed that regulatory agencies would not find the proposed O'Brien & Gere option acceptable. The USEPA's record of decision for the Baird & McGuire Superfund site in Holbrook, Massachusetts (USEPA, Sept. 1986) stated this opinion:

> "The containment of contaminated soils and groundwater by means of a surface cap and a slurry wall tied into the till, without a system for withdrawal and treatment of the contaminated groundwater, addresses the direct contact threat but does not <u>reliably</u> address the problem of contaminated groundwater ... the lack of an impermeable till, among other reasons, casts considerable doubt on the ability of this alternative to reliably prevent future continued offsite migration of contaminated groundwater".

M&E has proposed the following measures for upgrading the O'Brien & Gere option. These include: 1) upgrade of the cap, 2) installation of a bedrock grout curtain to be connected to the slurry wall containment and 3) pumping and removal of the trapped groundwater contained within the slurry will and grout curtain barrier; and monitoring of future water levels to determine leakage. These measures are detailed in Figure 6.1. Cap upgrades will include a 24-inch soil layer to withstand explosions from the OD grounds and

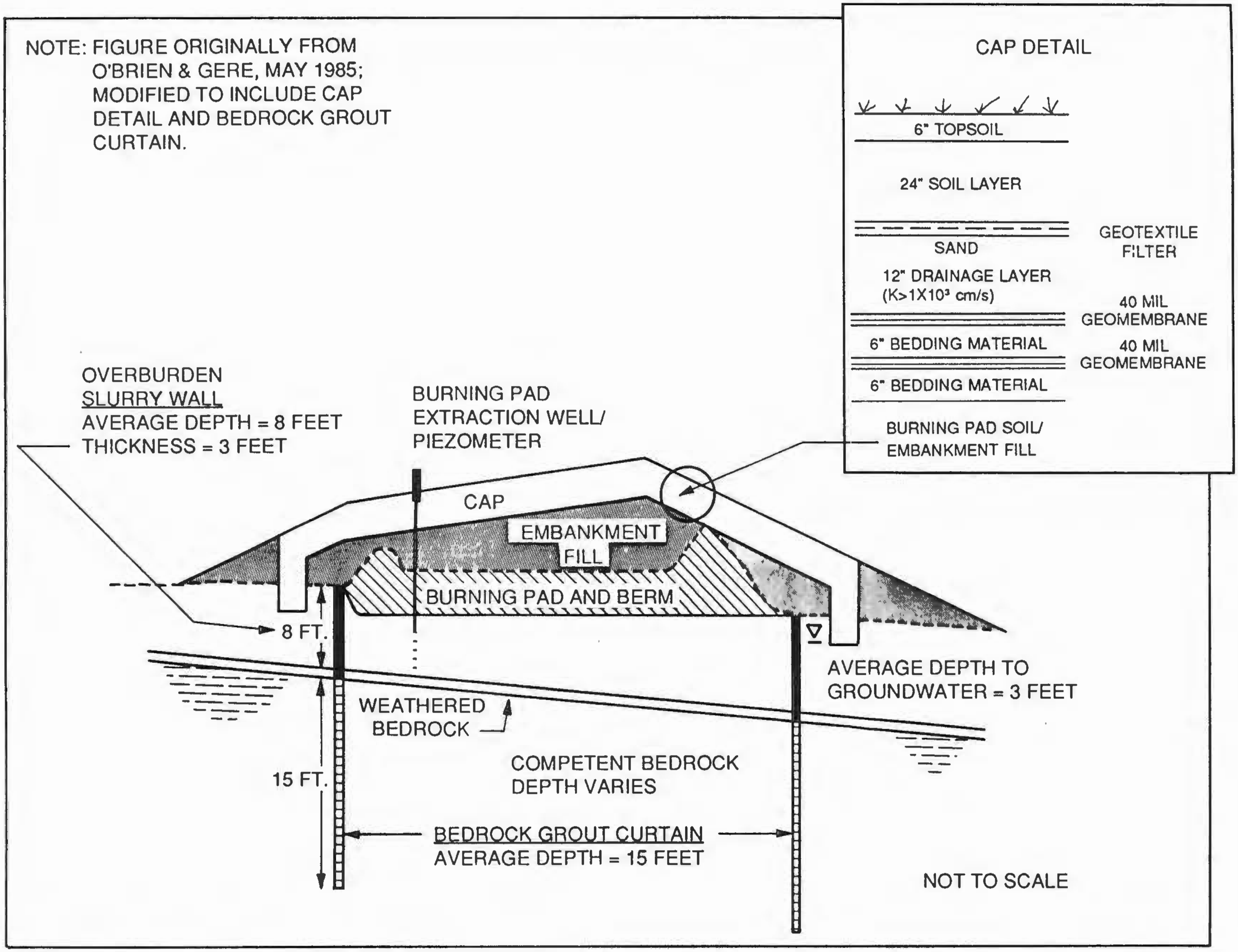


FIGURE 6.1 ALTERNATIVE 1: CAPPING/GROUNDWATER CONTROLS

the use of two 40 mil HDPE (high density polyethylene) geomembranes in place of the single 20 mil geomembrane and two foot clay layer proposed by O'Brien & Gere. A 4-inch diameter stainless steel well would be installed into each burning pad. Two wells each would be installed in pads G and J, due to their size. The purpose of these wells would be twofold; first, to act as extraction wells for the removal of groundwater within the containment and, second, to monitor containment leakage by providing access for measurement of water levels. Finally, a bedrock grout curtain would be installed below the slurry wall along the same areal perimeter containment line. An average depth of 15 feet into bedrock was assumed. The grout curtain should improve the containment barrier. It is unknown, however, to what extent the bedrock fractures continue below the 15 foot depth. Even if the fractures do not extend this deep, a perfect grout curtain, slurry wall and interface between the grout curtain and slurry wall would be required to prevent leakage.

Thus, the technical reliability of Alternative 1 is questionable with regard to providing an impermeable barrier to the migration of groundwater via the attachment of a grout curtain/slurry wall to possibly incompetent bedrock.

6.4.2 Alternative 2 - Chemical Solidification/Stabilization (Modified Landfill Closure)

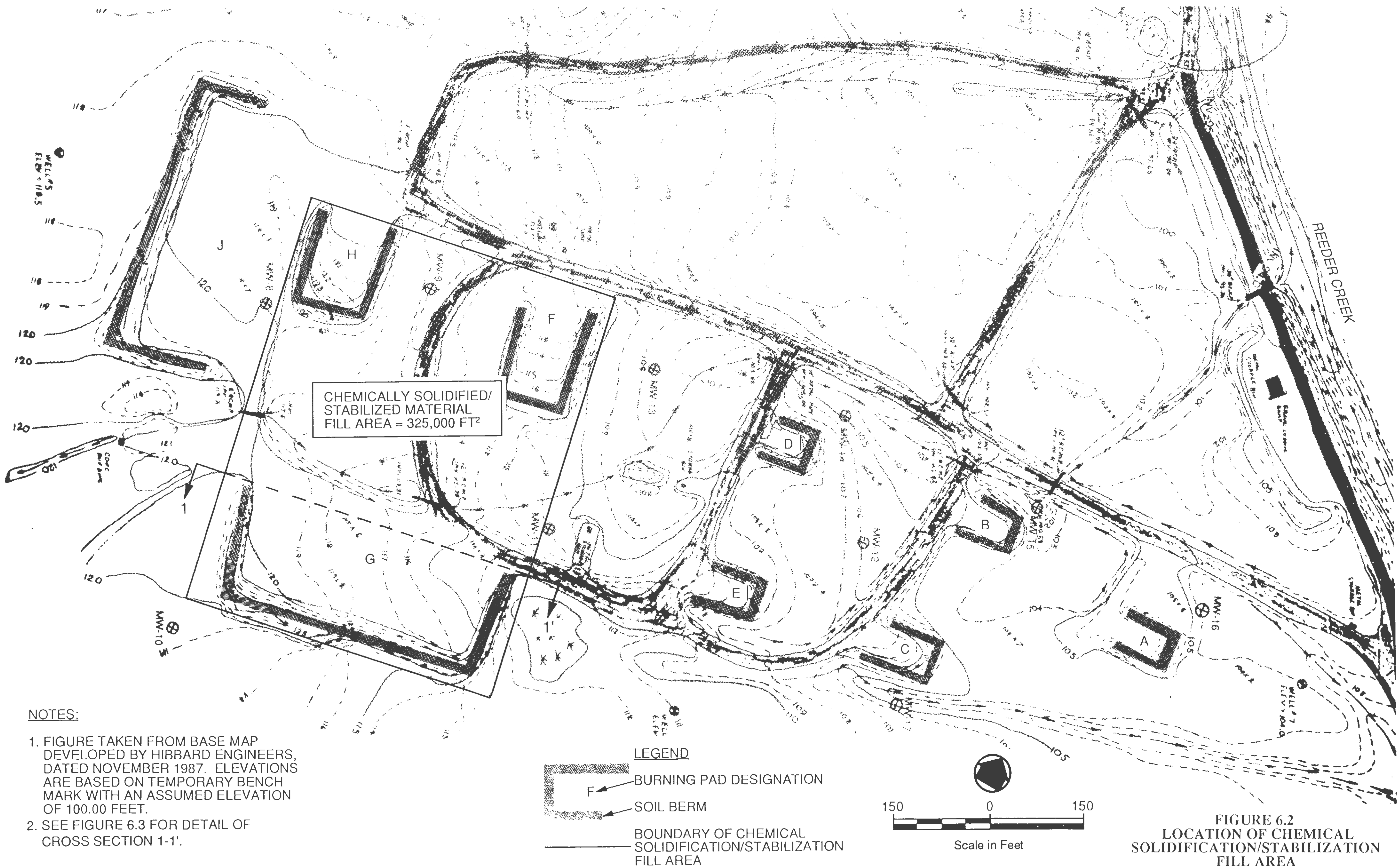
Alternative 2 involved the excavation of contaminated soils from the burning pads and on-site treatment using chemical solidification/stabilization (chemical s/s). The principal goal of chemical s/s is to limit the leaching potential of contaminants by combining the waste with admixtures that chemically and physically react with the waste to reduce contaminant mobility. Other goals of chemical s/s treatment are to limit contaminant solubility, improve waste handling, decrease waste surface area, transform toxic wastes to non-toxic wastes (decharacterization) and meet regulatory requirements for waste disposal.

As previously described in Section 6.2, burning pad soils would be excavated from a perimeter 5 feet distant from the outer edge of each pad berm. All berm soil would be removed as well as subsurface pad soil to an average depth of 3 feet. Additional soil sampling, however, should be conducted to confirm the areal and vertical extent of contamination. All soils, after completing treatment from the chemical s/s process, would be combined into a single fill area. The location of the chemical s/s fill area is shown on Figure 6.2. Figure 6.3 illustrates a cross-section and cap detail of this fill area. Pads A-E and J would be backfilled with clean fill, regraded and revegetated. The upper foot of clean topsoil between Pads F, G and H, that is within the chemical s/s fill boundary, would be excavated and set aside for use as topsoil on the cap. The chemically s/s material, to minimize the potential for leaching, should not be placed into groundwater. Pads F and G, therefore, would be backfilled up to grade with 2 feet of clean fill. This should keep the stabilized material above the groundwater table. Backfilling pad H would not be required due to sufficient vertical distance between the bottom of excavation and the groundwater table. All calculations regarding the areas of excavation, soil quantities, etc. have been included in Appendix H.

Due to the potential for buried explosives, geophysical investigations of all pads and berms would be conducted before excavation. The purpose of these investigations would be to accurately determine the locations of buried metal objects so that they can be marked and safely excavated. A grid network would be surveyed and laid out for each pad. Geophysical instruments such as ground penetrating radar and magnetometers would then be used to locate anomalies. Reasonably accurate location of anomalies should be possible due to the shallowness of excavation (3 feet).

General civil excavation and chemical s/s processing of soils without anomalies should not pose any problems due to explosion hazards. Soils with the following high concentrations of explosives were subjected to a series of tests and found to be unreactive in all cases (Atlantic Research Corp., May 1986):

2,4,6 - TNT	115,000 mg/kg	(11.5%)
RDX	60,000 mg/kg	(6.0%)
HMX	1,600 mg/kg	(0.16%)
Tetryl	5,000 mg/kg	(0.5%)



NOTES:

1. FIGURE TAKEN FROM BASE MAP DEVELOPED BY HIBBARD ENGINEERS, DATED NOVEMBER 1987. ELEVATIONS ARE BASED ON TEMPORARY BENCH MARK WITH AN ASSUMED ELEVATION OF 100.00 FEET.
2. SEE FIGURE 6.3 FOR DETAIL OF CROSS SECTION 1-1'.

FIGURE 6.2
LOCATION OF CHEMICAL SOLIDIFICATION/STABILIZATION FILL AREA

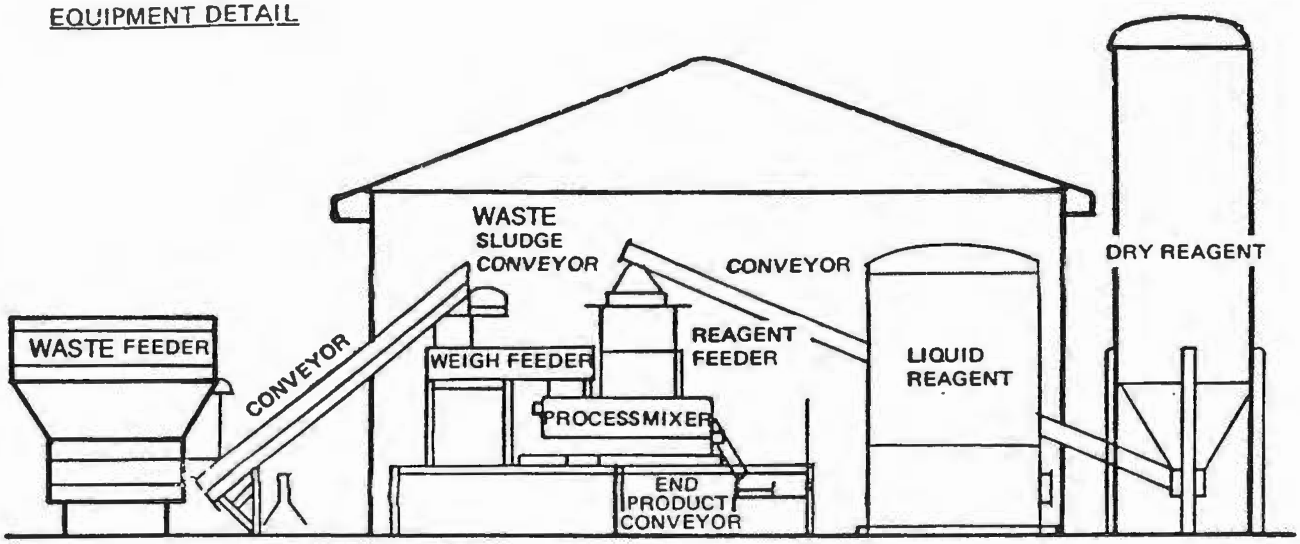
The reactivity tests performed (I.M.E., March 1989) included evaluation of heat stability (up to 167°F), physical impacts, reactivity to fire (leading to detonation), reactivity to electric charge/spark, reaction to blasting agents as well as ability to autoignite. The concentrations of explosives in soil on the burning pads/OB grounds area, previously discussed in section 6.2, were far below the above concentrations. Chemical s/s processing of the soil would involve physical contacting and mixing as well as a moderate temperature rise (20 to 30°F). Based on the discussion above explosion hazards from this soil would appear to be minimal. However, pilot scale explosives testing of the soils should be conducted to verify this.

Chemical solidification/stabilization would involve the construction of a treatment facility on-site. A typical chemical s/s processing facility is shown in Figure 6.4. During mixing the waste is pliable and pumpable, thereby allowing this material to be transferred to its final disposal place. Treated soils will be in the form of a cement slurry which will harden after placement into the fill. Temporary runoff controls in the fill area would collect any liquids that escape from the slurry prior to hardening. These liquids would be recycled back to process the mixer.

Treatment of soils at the Seneca burning pad/OB grounds is likely to include the use of fly ash or cement. Use of either binder mixed with the waste will increase the total volume by approximately 10 to 30 percent, based on previous bench-scale studies and vendor experience.

Before the chemical s/s treatment technology could be applied to the waste areas, a bench-scale investigation must be performed on the waste. Results of this investigation would determine the effectiveness of several different binders (pozzolan), and information required to develop conceptual and preliminary design considerations. The solidified samples must then be physically tested for unconfined compressive strength, permeability and freeze/thaw testing. It must also be chemically analyzed for the leachability potential of organic and inorganic compounds through EP Toxicity and TCLP testing. These leachability tests should, in addition to standard procedures,

EQUIPMENT DETAIL



PROCESS FLOW DIAGRAM

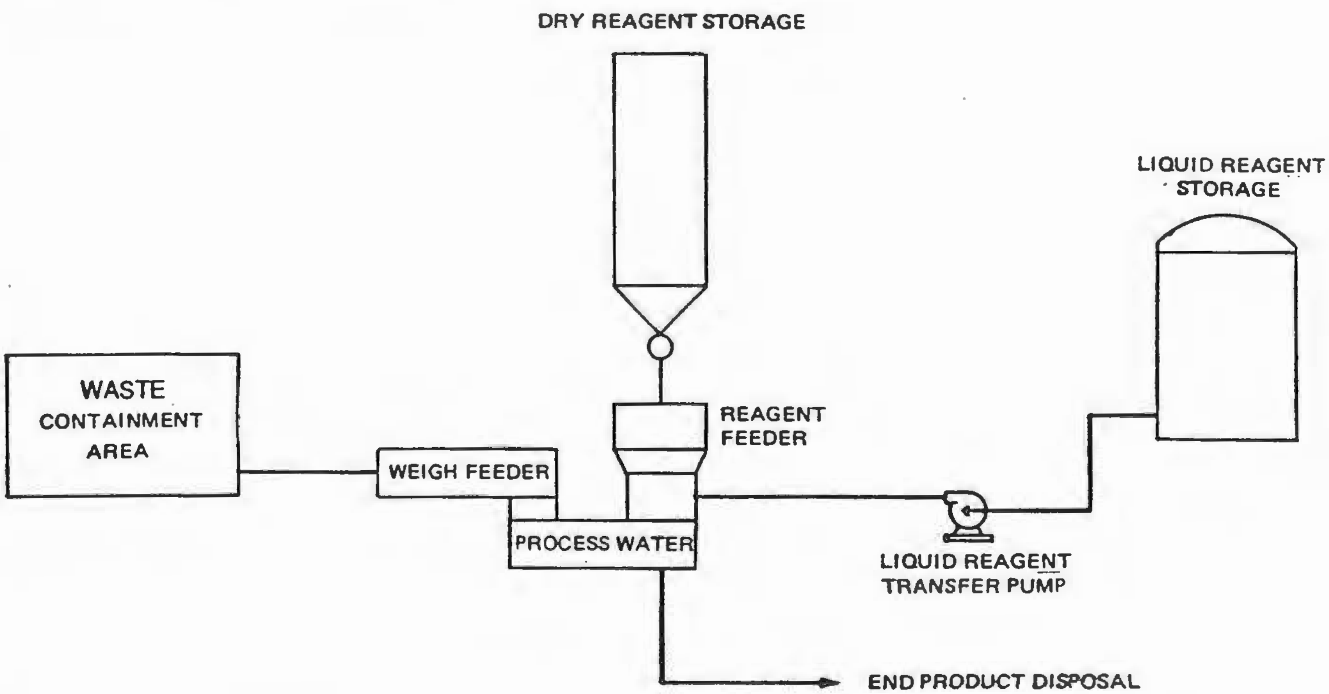


FIGURE 6.4 TYPICAL CHEMICAL SOLIDIFICATION/STABILIZATION PROCESSING FACILITY

also evaluate the use of on-site groundwater as a leaching agent. This will better simulate actual field conditions. Data obtained from these tests can then be used to determine the longevity of the solidified product.

Organic solvents and oils are the primary types of organics that can impede cement and pozzolan based solidification by physically coating soil particles which inhibits bond formation. Organic solvents interfere by physical coating as well as vapor formation (for volatile solvents) which impedes setting and bond formation. Physical coating of soils requires that significant quantities of oils or solvents be present, however, neither organic solvents nor oils have been found, or reportedly disposed of, in the burning pad soils at SEAD. Furthermore, the types of organics destroyed on the burning pads were primarily solid-phase explosives and not liquid phase organics.

Several studies, however, have demonstrated successful solidification of soils containing other types of organics as well as lesser concentrations of oils and solvents. In one study, PCB and lead spiked soils were successfully solidified (Dole, 1987). This study tested two soil types, dry fill and oily peat. Both soil types contained oil and grease concentrations of 10 percent by weight. PCB concentrations ranged from 206-216 ppm and lead concentrations from 936 to 31,490 ppm.

A second study tested solidification of several types of organics in soil, sludge and liquids (IWT, 1987). Solidification was found to be feasible in several cases. These included solidification of pentachlorophenol (11,000 ppm) and PCB's (1,140 ppm) in soil. Sludge containing acrylonitrile, acetonitrile, acrolein and acrylic acid in ranges of 5-150 ppm was also solidified and found to be feasible. Another case involved solidification of RCRA waste number K051 API separator bottoms sludge from petroleum refining. This sludge consisted of filter clay contaminated by oil and grease (24.9 percent by weight) and a combination of metals and other organics. Metals included chromium (630 ppm), lead (250-332 ppm) and volatile organics included ethyl benzene and xylenes (10-43 ppm). In addition the sludge contained several coal-tar organics including anthracene, chrysene, methylnapthalene, naphthalene and phenanthrene (19-470 ppm). Results of the TCLP testing indicated that chemical solidification/stabilization was a feasible treatment method.

M&E has also discussed preliminary results of a bench-scale testing program conducted by a leading chemical s/s vendor for the U.S. Dept. of Energy. This project involved stabilization of evaporator bottoms highly concentrated with metals and nitrate salts. In O'Brien & Gere, 1985, it is noted that metals and nitrate salts (which would be break down products of burning) would be major components in the residues left behind. The preliminary results of the bench scale testing indicated that chemical s/s was feasible for treatment of these wastes.

Bench-scale testing of similar wastes indicate that Alternative 2 is a technically viable method to decharacterize the contaminated burning pad soils and mitigate future contact with groundwater. In addition, the placement of the chemically stabilized/solidified material in a central location between pads F, G, and H should: 1) provide sufficient vertical distance between the bottom of excavation and the groundwater table and 2) allow for future use by SEAD of those areas presently occupied by pads A-E and J.

6.4.3 Alternative 3 - Incineration/Stabilization/Disposal (Clean Closure)

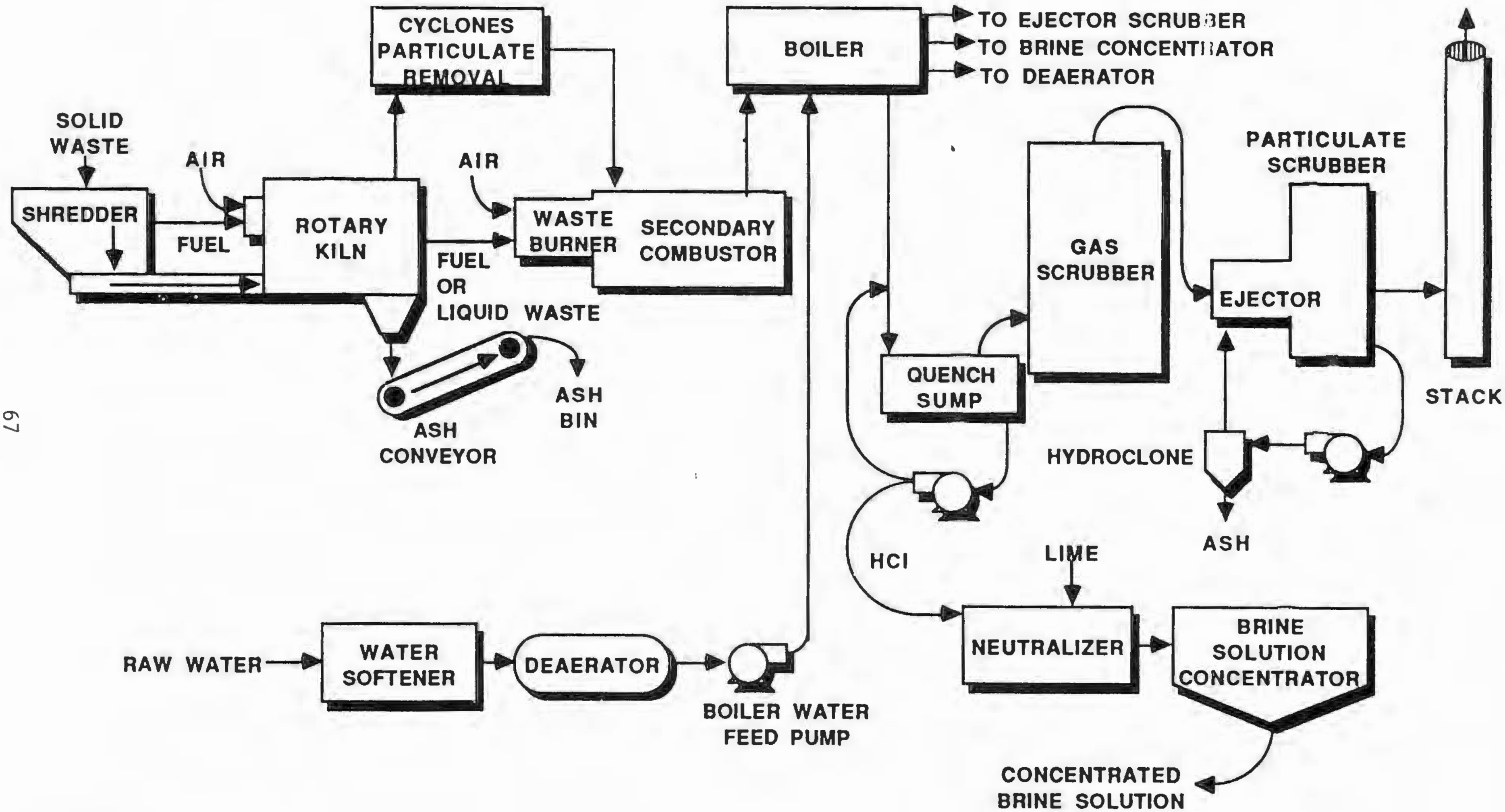
Alternative 3 involves the on-site treatment of burning pad soils by incineration. After incineration the ash will be tested for metals leachability to determine if it is still an RCRA characteristic hazardous waste. It is not possible to predict whether the metals in the soil will volatize as a fume and be removed by the air pollution control equipment or whether they will stay in the ash. A test burn (bench or pilot scale study) or a trial burn (full scale on-site testing) would be required to determine the metals partitioning between the off-gas and the ash. Due to this uncertainty, this report has assumed that the ash would be hazardous and would require treatment by chemical solidification/stabilization. The stabilized ash would then be disposed of off-site by landfill as a solid waste.

Incineration using a mobile rotary kiln is the most versatile and demonstrated unit available for on-site thermal destruction of burning pad soils. Units currently available consist of a rotary kiln or primary combustion chamber, a secondary combustion chamber, a heat recovery boiler, an air pollution control train, a control room and laboratory, and effluent neutralization and concentration equipment. Figure 6.5 presents a conceptual process flow diagram for a transportable rotary kiln system.

To effectively design an incineration system for the SEAD burning pads site requires additional information on waste characteristics not previously measured. These characteristics include: Btu content, water content, soil type and percentage, etc. This will necessitate some design support activities consisting of an analysis of feed material and an evaluation of expected incinerator residue. The feed material analysis will determine additional chemical and physical characteristics of the feed material. These characteristics will dictate certain aspects of the design of the incinerator. As a result, the on-site material needs to be fully defined in terms of contaminant concentrations, amounts, and physical characteristics to evaluate compatability with the incineration unit. The evaluation of incinerator residue will determine the concentrations of contaminants expected to remain with the ash after incineration. These data, along with analysis of the feed material, will be used to determine the size of the system through use of heat and material balances.

Initially, a Trial Burn Plan must be submitted to the Regional EPA Administrator and the New York State Department of Environmental Conservation (NYSDEC). After review of the trial burn plan, the EPA Regional Administrator and NYSDEC will approve the Trial Burn Plan and specify the Principal Organic Hazardous Constituents (POHCs) for which removal efficiencies will be calculated.

Following the performance of the trial burn, the operator will be required to provide: an analysis of trial burn POHCs' analysis of the exhaust gas for POHC's, O_2 and HCl; a quantitative analysis of scrubber water and ash residues; computations of destruction and removal efficiencies (DRE's) for



SOURCE:
ENSCO ENVIRONMENTAL SERVICES; MODEL
MWP-2000 ROTARY KILN INCINERATOR

FIGURE 6.5 ROTARY KILN INCINERATION PROCESS FLOW DIAGRAM

POHCs' removal efficiencies for HCl; measurements of particulate emissions; an identification of sources of fugitive emissions; and measurements of temperature, combustion gas velocity, and CO.

After reviewing the results of the trial burn, the EPA Regional Administrator and NYSDEC will set operating parameters for CO, waste feed rate, combustion temperature, gas velocity, and specify allowable variations in operating procedures and conditions which will insure satisfactory removal efficiencies.

In addition to source specific emission requirements, impacts to ambient air quality must be evaluated to assure no adverse impacts to ambient air quality. Dispersion modeling of the calculated incinerator emission will be conducted to predict downwind receptor concentrations of contaminants.

During excavation, excavated contaminated soil is fed into the rotary kiln. Air is pumped into the kiln to generate combustion and auxiliary fuel must be added to maintain temperature. The ash and decontaminated soil move from the rotary kiln into an ash receiving tank. Laboratory testing (EP Toxicity characteristics Test) would be performed on the ash. If it is determined to be hazardous due to the inorganic material (heavy metals) not destroyed in the incinerator, further treatment in the form of chemical solidification and stabilization would be conducted. Stabilization of the ash would be conducted in the same manner as described for Alternative 2.

The secondary combustor chamber incinerates any organics which escaped destruction in the rotary kiln and oxidizes compounds to NO_x, H_sO, CO_2 and HCl Scrubber water, once spent, will be blown down and removed from the system. The spent scrubber water would then be combined with the water required for the chemical solidification and stabilization of the ash.

The transportable rotary kiln incinerator described is capable of completely destroying all organic material; the required DRE (Destruction and Removal Efficiency) of 99.99 percent for POHCs (Principal Organic Hazardous Constituents) can easily be achieved.

The incinerator and auxiliary equipment would require a surface area of approximately 200 feet by 300 feet. Adjacent to the incinerator facility will be a staging area of approximately 50 feet by 100 feet, capable of storing 1,500 yd^3 of waste prior to incineration. Prior to construction, the site area would need to be leveled, compacted and covered with gravel. The incineration system is brought to the site in 20 truck loads and most of the large equipment is built on the trailer beds. The incinerator units would be set in place as shown in Figure 6.6. Ancillary structures and utilities required at the incineration facility would include:

- Ash storage bin;
- Diked tank area for scrubber water;
- Power source/auxiliary fuel source (natural gas); and
- Process water

Thus, Alternative 3 is the most technically complete alternative. The successful on-site incineration of contaminated soils should facilitate the destruction of organics that may be present in these soils. In addition, the on-site chemical stabilization/solidification of the ash and scrubber water should serve to decharacterize the residues and allow off-site disposal in a solid waste landfill.

6.5 Cost Feasibility

A summary of capital and net present worth operating costs are presented for each alternative in Tables 6.2, 6.3 and 6.4. Detailed backup is presented in Appendix H. All costs are as of June 1989 and based on the ENR Construction Index of 4593.

The total cost for site remediation using Alternative 1, capping/groundwater controls, was estimated to be $9.9 million. The cost for Alternative 2, chemical solidification/stabilization and capping, was estimated to be $12.7 million. The total cost for Alternative 3, incineration/solidification and off-site disposal, was estimated to be $23.9 million. These estimates include capital costs and operation and maintenance (O&M) costs (calculated on a net

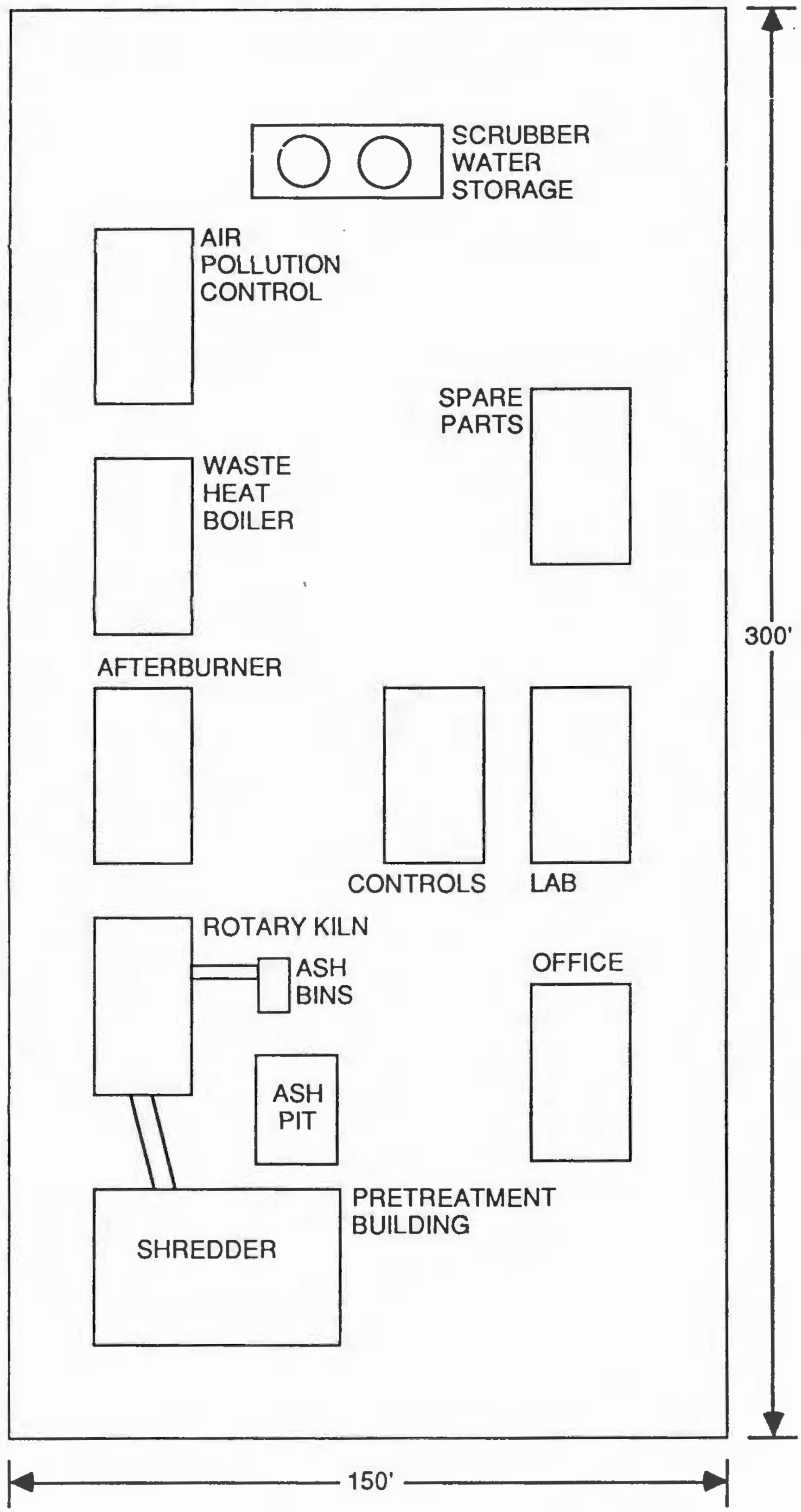


FIGURE 6.6 MOBILE ROTARY KILN INCINERATOR CONCEPTUAL LAYOUT

TABLE 6.2 ALTERNATIVE 1: SUMMARY OF COSTS

Remedial Alternative Component			Cost June 1989 $ (ENR Index = 4593)
I. Capital Costs:			
Embankment Fill			949,618
Hazardous Waste Cap			2,681,401
Regrading/Revegetation			16,616
Overburden Soil-Bentonite Slurry Wall			54,978
Bedrock Grout Curtain			1,640,925
Burning Pad Wells/Piezometers			38,643
Groundwater Removal/Disposal		+	43,700
Subtotal, Direct Capital Costs			5,425,881
Contractor Overhead & Profit:	22 %	+	1,193,694
Engineering Allowance:	10 %	+	542,588
Subtotal, Direct and Indirect Capital Costs			7,162,163
Contingency:	25 %	+	1,790,541
Total Capital Costs			$8,952,704
II. Operation & Maintenance Costs, Net Present Worth:			
Cap Maintenance			101,950
Groundwater Monitoring		+	830,650
Total O&M Costs (NPW)			$932,600
Grand Total, Alternative 1 Costs			$9,885,304

TABLE 6.3 ALTERNATIVE 2: SUMMARY OF COSTS

Remedial Alternative Component			Cost June 1989 $ (ENR Index = 4593)
I. Capital Costs:			
Geophysical Survey			133,607
Excavate/Sort Burning Pad Soils			476,648
Chemical Solidification/Stabilization Processing			3,505,500
Placement of Solidified Material			403,900
Backfill Excavated Pads			399,840
Cap			2,478,002
Regrading/Revegetation		+	30,876
Subtotal, Direct Capital Costs			7,428,373
Contractor Overhead & Profit:	22 %	+	1,634,242
Engineering Allowance:	10 %	+	742,837
Subtotal, Direct and Indirect Capital Costs			9,805,452
Contingency:	25 %	+	2,451,363
Total Capital Costs			$12,256,815
II. Operation & Maintenance Costs, Net Present Worth:			
Cap Maintenance			141,850
Groundwater Monitoring		+	255,600
Total O&M Costs (NPW)			$397,450
Grand Total, Alternative 2 Costs			$12,654,265

TABLE 6.4 ALTERNATIVE 3: SUMMARY OF COSTS

Remedial Alternative Component			Cost June 1989 $ (ENR Index = 4593)
I. Capital Costs:			
Geophysical Survey			133,607
Excavate/Sort Burning Pad Soils			476,648
Incineration			5,985,000
Chemical Solidification/Stabilization Processing			3,505,500
Transport of Solidified Ash to SW Landfill			980,900
Tipping Fees, Solid Waste Landfill			2,775,370
Backfill Excavated Pads			529,550
Regrading/Revegetation		+	16,616
Subtotal, Direct Capital Costs			14,403,191
Contractor Overhead & Profit:	22 %	+	3,168,702
Engineering Allowance:	10 %	+	1,440,319
Subtotal, Direct and Indirect Capital Costs			19,012,212
Contingency:	25 %	+	4,753,053
Total Capital Costs			$23,765,265
II. Operation & Maintenance Costs, Net Present Worth:			
Cap Maintenance			0
Groundwater Monitoring		+	118,000
Total O&M Costs (NPW)			$118,000
Grand Total, Alternative 3 Costs			$23,883,265

present worth basis). Factors of 22% for contractor overhead and profit and 10% for engineering were added to direct capital costs to obtain direct and indirect capital costs. A 25% factor of the direct and indirect sum was then added for contingency to obtain the total capital cost. Net present worth for O&M costs for Alternatives 1 and 2 were calculated using a 30 year operating lifetime, a discount factor of 8% and an inflation rate of 5%. Net present worth O & M costs for Alternative 3 were calculated using a 3 year operating timelength with the discount factor and inflation rate the same as Alternatives 1 and 2.

The largest capital cost item for Alternative 1 was for the hazardous waste cap (49% of total capital cost) with the second largest due to the bedrock grout curtain (30%). The necessary upgrade of the cap construction and addition of the grout curtain significantly increased the costs of this alternative when compared with the equivalent estimate from O'Brien & Gere, 1985. The single largest capital cost item for Alternative 2 was due to chemical solidification/stabilization processing (47%). The next largest cost was for the cap (33%). The largest capital cost item for Alternative 3 was for incineration (33% of total capital cost). Second largest was for soil disposal which includes transport and landfill tipping fees (26%). The remaining large item cost was due to chemical solidification/stabilization processing (24%).

The primary O&M costs were due to cap maintenance and groundwater monitoring. Cap maintenance costs were estimated on a per acre basis. Groundwater monitoring involved sampling monitoring wells twice per year. Groundwater analyses included testing for explosives, total and dissolved metals and nitrate-nitrogen. Alternative 2 had higher cap maintenance costs than Alternative 1 due to the larger area of the new fill as compared with the total capped area of the existing burning pads. The new fill area was required to be larger due to the volume increase added from the chemical s/s processing. Alternative 3 will not require cap maintenance and thus has zero O&M cost for this activity. Groundwater monitoring costs for Alternative 1, however, were significantly higher than those of Alternative 2. Each individual pad in Alternative 1 would require long term monitoring. Thirteen

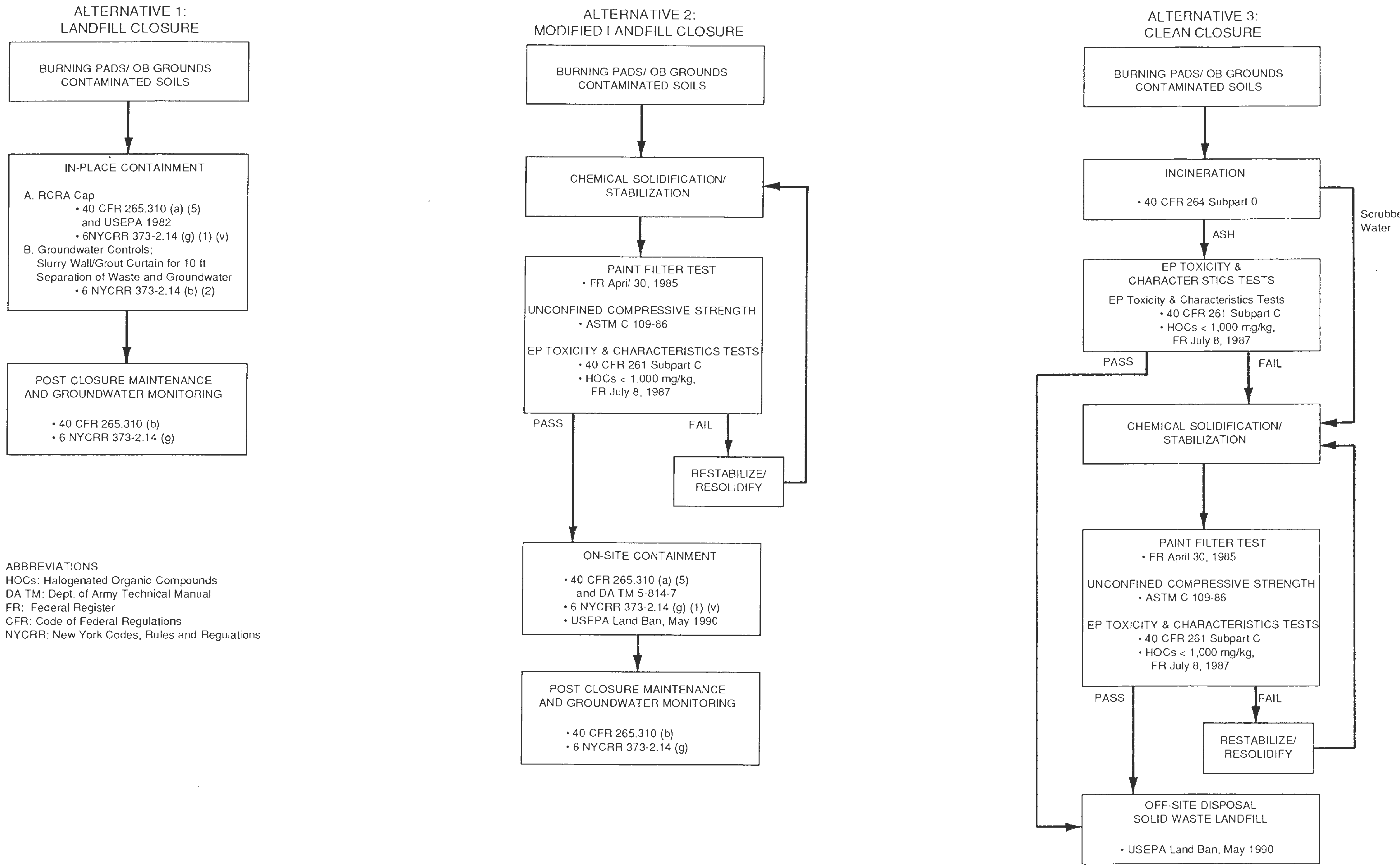
(13) wells would require monitoring using Alternative 1 while only four (4) wells would require monitoring for the single large fill area of Alternative 2. Groundwater monitoring for 3 years may be required by the NYSDEC as part of Alternative 3. This monitoring would involve sampling of thirteen (13) wells for the same parameters and frequency as outlined for Alternative 1.

6.6 Summary

Three alternatives were presented in Section 6.0 for closure of the burning pads/OB grounds area. These alternatives were compared on a regulatory, technical and cost feasibility basis. Alternative 1 involved capping and installation of groundwater migration barriers at each burning pad. Alternative 2 involved excavation of burning pad soils, treatment using chemical solidification/stabilization, and combining the treated soils into a single, capped fill area. Alternative 3 involved excavation of burning pad soils, on-site treatment by incineration, and on-site chemical solidification/stabilization of the ash prior to off-site disposal. The regulatory framework for the three alternatives is summarized in Figure 6.7. A summary of preliminary design criteria for each alternative is presented in Table 6.5.

Alternative 1 was found to have serious deficiencies in meeting some of the regulatory and design criteria. Regulatory requirements would involve creating a vertical separation between the contaminated soil and the groundwater table. This separation was to be met by installing an overburden soil-bentonite slurry wall and bedrock grout curtain around the perimeter of each capped pad. M&E believed that these measures would not meet requirements or sufficient vertical separation due to: 1) the shallowness of the groundwater table, 2) the lack of an impermeable zone to key slurry wall/grout curtain into, and 3) the need for near perfect construction of the slurry wall and grout curtain to prevent leakage of groundwater.

Alternative 2 alleviates the need for groundwater migration barriers by excavating and treating the soils. Chemical solidification/stabilization should irreversibly bond and encapsulate the metal and organic (explosive)



ABBREVIATIONS
HOCs: Halogenated Organic Compounds
DA TM: Dept. of Army Technical Manual
FR: Federal Register
CFR: Code of Federal Regulations
NYCRR: New York Codes, Rules and Regulations

FIGURE 6.7
REGULATORY FRAMEWORK

TABLE 6.5 SUMMARY OF PRELIMINARY DESIGN CRITERIA

Alternative 1	Alternative 2	Alternative 3
1. Embankment Fill required: 62,270 yd^3	1. Area for geophysical survey: 233,500 ft^2	1. Area for geophysical survey: 233,500 ft^2
2. Total area for capping: 233,500 ft^2	2. Excavate/sort and chemical S/S of soil (excavated basis): 42,750 yd^3	2. Excavate/sort and incineration of soil (excavated basis): 42,750 yd^3
3. Total length of slurry wall, (average depth = 8 ft): 5,610 ft	3. Clean backfill required: 23,520 yd^3	3. Chemical Solidification/ Stabilization of ash: 42,750 yd^3
4. Total length of grout curtain, (Average depth = 15 ft): 5,610 ft	4. Placement of chemical s/s material: 57,700 yd^3	4. Transport and off-site solid waste landfill disposal: 57,700 yd^3, 300 mile roundtrip
5. Number of burning pad wells, (Average depth = 16 ft): 11	5. Total area for capping: 325,000 ft^2	5. Clean backfill required: 31,100 yd^3
6. Removal/disposal of ground-water within containment systems: 437,000 gallons	6. Regrading/revegetation: 9.96 acres	6. Regrading/revegetation: 5.36 acres
7. Regrading/revegetation: 5.36 acres		

compounds to prevent leaching and migration. The stabilized material would be placed above the groundwater table and capped. These measures would prevent contact of the solidified material with surface or groundwater. Even if contact should occur due to leakage or other reasons, the stabilized material would resist leaching contaminants. Thus, Alternative 2 provides a double containment of the contaminated soils.

Alternative 3 entails the use of incineration to destroy the organic matter that may be present in the contaminated soil. The ash and scrubber water produced will then be treated using chemical solidification/stabilization. Subsequently offsite disposal of the treated ash in a solid waste landfill will allow for clean closure (US EPA, 1987b) of the site. However, since the Open Detonation Grounds will remain in operation, clean closure is not a reasonable alternative. The potential for future contamination of the Open Burning Area above health based criteria via air dispersion from activities at the OD grounds would not be eliminated. In addition, the implementation of Alternative 3 would nearly double remediation costs relative to Alternative 2.

Therefore, M&E recommends that the Seneca Army Depot burning pads/OB grounds be closed using Alternative 2 - Chemical solidification/ stabilization followed by capping. Although this alternative is more expensive than Alternative 1 ($12.7 million compared with $9.9 million) M&E believes that it is the most viable option meeting regulatory and technical requirements.

Deborah M. Simone
Site Manager

Christopher L. Hagger, P.E.
Professional Engineer
The State of New York
Reg. No. 065139

7.0 REFERENCES

Atlantic Research Corporation, R.C. Doyle, et al, Composting Explosives/Organics Contaminated Soils, prepared for USATHAMA, May 1986.

Clement Associates, 1985, Chemical, Physical, and Biological Properties of Compounds Present at Hazardous Waste Sites Prepared for US EPA Selenium, pg. 2.

Department of the Army, Headquarters, November 1984. Technical Manual No. 5-814-7, Hazardous Waste Land Disposal/Land Treatment Facilities.

Department of the Army, USAEHA, 1988, Interim Final Report, Groundwater Contamination Survey No. 38-26-0868-88, Evaluation of Soil Waste Management Units, Seneca Army Depot, Romulus, NY, 27-31, July 1987.

Department of the Army, USAEHA, 1986, Phase 5, Hazardous Waste Study No. 37-26-0593-86, Summary of AMC Open-Burning/Open Detonation Grounds Evaluations, March 1981 - March 1985.

Department of the Army, USAEHA, 1985, Groundwater Monitoring Study No. 38-26-0457-86, AMC Open Burning/Open Detonation Facilities, February 1984 - March 1985.

Department of the Army, USAEHA, 1984, Hazardous Waste Study No. 37-26-0479-83, Phase 4 of AMC Open-Burning/Open Detonation Grounds Evaluation, Investigation of Soil Contamination at the Open Burning Grounds, Seneca Army Depot, Romulus, NY, 13-19, August 1984.

Department of the Army, USAEHA, 1984, Phase 3, Hazardous Waste Study No. 37-26-0147-84, Summary of AMC Open-Burning/Open-Detonation Ground Evaluations, Nov. 1981 - Sept. 1983.

Department of the Army, USAEHA, 1983, Groundwater Monitoring Results for Seneca Army Depot, NY.

Department of the Army, USAEHA, 1983, Phase 2, Hazardous Waste Management Special Study: No. 39-26-0147-83, DARCOM Open-Burning/Open-Detonation Grounds Evaluation, Seneca Army Depot, Seneca, NY, 2-13, May 1982.

Dole, Leslie R., Leach Testing of In-Situ Immobilized Soils Contaminated with PCBs and Lead, Proceedings of the 194th National Meeting of ACS: Symposium of Leach Testing for Radioactive and Chemically Hazardous Wastes, New Orleans, 1987.

Freeze, R.A., and Cherry, J.A., Groundwater, Prentice-Hall Inc., Englewood Cliffs, New Jersey, 1979.

Hvorslev, M.J., 1951, Time Lag and Soil Permeability in Groundwater Observations, U.S. Army Corps of Engineers, Waterways Exp. Sta. Bull, 36, Vicksburg, Mississippi.

I.M.E., Institute of Makers of Explosives, Washington, D.C., Personal communication between Thomas Dowling and D. Peters, Metcalf & Eddy Inc., regarding explosives and reactivity testing, March 1989.

IWT, International Waste Technologies, Jeffrey P. Newton, Advanced Chemical Fixation for Organic Content Wastes, 1987.

LaSala, A.M. Jr., 1968, Groundwater Resources of the Erie-Niagara Basin, New York: Basic Planning Report ENB-3, State of New York Conservation Department with Resources Commission, 114 pp.

Metcalf & Eddy, Focused Feasibility Study, Big Hill/BEMS Landfill RI/FS Project, Final Draft. Prepared for the New Jersey Department of Environmental Protection, March 1988.

Muller, E.H., and Caldwell, D.H., Surficial Geologic Map of New York, Finger Lakes Sheet, New York State Museum-Geol. Survey, Map and Chart Series No. 40. 1986.

O'Brien & Gere Engineers, Burning Pads B and H Closure, Seneca Army Depot, Romulus New York, Prepared for the Department of the Army, Corps of Engineers Huntsville Division, May 1985.

Rickard, L.V., and Fisher, D.W., Geologic Map of New York, Finger Lakes Sheet, New York State Museum and Science Service, Map and Chart Series No. 15. 1970.

Ryon, M.G. et. al., Data Base Assessment of the Health and Environmental Effects of Munition Production Waste Products, No. AD/ORNL-6018, Oak Ridge National Laboratory, Oak Ridge, TN, 1984.

USEPA, Compendium of Costs of Remedial Technologies at Hazardous Waste Sites. No. EPA/600/2-87/087, October 1987a.

USEPA, Surface Impoundment Clean Closure Guidance Manual No. EPA/530-SW-87-022, October 1987b.

USEPA, RCRA Guidance Manual for Subpart G Closure and Post Closure Care Standards and Subpart H Cost Estimating Requirements, No. PB87-158978, January 1987c.

USEPA, Handbook for Stabilization/Solidification of Hazardous Wastes, Document EPA/540/2-86/001, June 1986.

USEPA, Record of Decision, Remedial Alternative Selection, Baird & McGuire Superfund site, Holbrook, Massachusetts, September 1986.

USEPA, 1982. RCRA Guidance Document for Landfill Design - Liner Systems and Final Cover. Draft. Office of Solid Waste, Land Disposal Division, Washington, D.C.

United States Geological Survey, Geneva South Quadrangle.