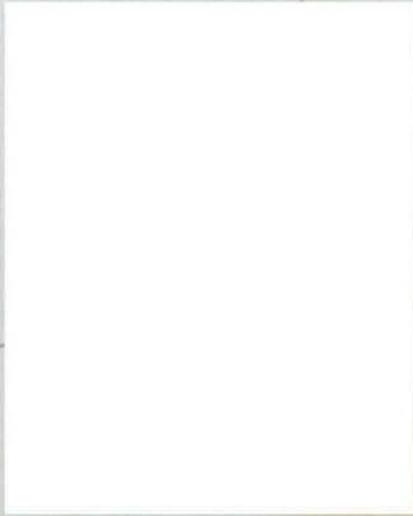




**US Army Corps  
of Engineers**

Toxic and Hazardous  
Materials Agency

6102



**Master Environmental Plan  
for Fort Devens, Massachusetts**

FINAL

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April 1992

Environmental Assessment and Information Sciences Division  
Argonne National Laboratory, Argonne, Illinois 60439-4801

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# Master Environmental Plan for Fort Devens, Massachusetts

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## NOTATION

### ACRONYMS, INITIALISMS, AND ABBREVIATIONS

|         |   |
|---------|---|
| ANL     | Argonne National Laboratory   |
| AOC     | area of concern   |
| AR      | Army regulation   |
| ARAR    | applicable or relevant and appropriate requirement                    |
| BDL     | below detection limit   |
| Bldg.   | building  |
| BRAC    | Base Realignment and Closure  |
| CERCLA  | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFR     | Code of Federal Regulations   |
| Chap.   | chapter   |
| CMR     | Code of Massachusetts Regulations                                     |
| CRP     | community relations plan  |
| CWA     | Clean Water Act   |
| 2,4-D   | 2,4-dichlorophenoxyacetic acid  |
| DA      | Department of the Army  |
| DCA     | dichloroethane  |
| DCE     | dichloroethylene  |
| DDT     | dichlorodiphenyltrichloroethane                                       |
| DEH     | Directorate of Engineering and Housing                                |
| DERP    | Defense Environmental Restoration Program                             |
| DIO     | Directorate of Industrial Operations                                  |
| DOD     | U.S. Department of Defense  |
| DOE     | U.S. Department of Energy   |
| DPCA    | Directorate of Personnel and Community Activities                     |
| DRMO    | Defense Reutilization and Marketing Office                            |
| EOD     | explosive ordnance disposal   |
| EP      | extraction procedure  |
| EPA     | U.S. Environmental Protection Agency                                  |
| FORSCOM | U.S. Army Forces Command  |
| Fig.    | figure  |
| FR      | Federal Register  |
| FTD     | Fort Devens   |
| HMX     | cyclotetramethylene tetranitramine                                    |
| HOC     | halogenated organic compound  |
| HSL     | hazardous substance list  |

|              |   |
|--------------|---|
| HSWA         | Hazardous and Solid Waste Amendments                              |
| IRP          | Installation Restoration Program                                  |
| LUST         | leaking underground storage tank                                  |
| MCL          | maximum contaminant level   |
| MCLG         | maximum contaminant level goal                                    |
| MDEP         | Massachusetts Department of Environmental Protection              |
| MDEQE        | Massachusetts Department of Environmental Quality Engineering     |
| MDWPC        | Massachusetts Division of Water Pollution Control                 |
| MEP          | master environmental plan   |
| MGL          | Massachusetts General Law   |
| MSL          | mean sea level  |
| NA           | not analyzed  |
| NCP          | National (Oil and Hazardous Substance Pollution) Contingency Plan |
| ND           | not detected  |
| No.          | number  |
| NPL          | National Priorities List  |
| PA           | preliminary assessment  |
| PCB          | polychlorinated biphenyl  |
| PFLT         | paint filter liquids test   |
| POL          | petroleum, oil, and lubricants                                    |
| PRP          | potentially responsible party                                     |
| PVNT MED SVC | Preventive Medicine Service                                       |
| RCRA         | Resource Conservation and Recovery Act                            |
| RDX          | hexahydro-1,3,5-trinitro-1,3,4-triazine                           |
| RI/FS        | remedial investigation/feasibility study                          |
| ROD          | record of decision  |
| RPM          | regional project manager  |
| SA           | study area  |
| SARA         | Superfund Amendments and Reauthorization Act                      |
| SDWA         | Safe Drinking Water Act   |
| Sec.         | section   |
| SI           | site inspection   |
| TC           | toxicity characteristic   |
| TCE          | trichloroethylene   |
| TCLP         | toxicity characteristic leaching procedure                        |
| TNT          | trinitrotoluene   |
| TOC          | total organic carbon  |
| TOV          | total organic volatiles   |
| TOX          | total organic halogens  |
| TPH          | total petroleum hydrocarbons                                      |
| TSCA         | Toxic Substances Control Act                                      |

|          |  |
|----------|--|
| USACE    | U.S. Army Corps of Engineers                   |
| USAEHA   | U.S. Army Environmental Hygiene Agency         |
| USATHAMA | U.S. Army Toxic and Hazardous Materials Agency |
| USGS     | U.S. Geological Survey                         |
| UST      | underground storage tank                       |
| UXO      | unexploded ordnance                            |
|          |  |
| VOC      | volatile organic compounds                     |
|          |  |
| WWII     | World War II                                   |
| WWTP     | wastewater treatment plant                     |

## UNITS OF MEASURE

|                 |                         |
|-----------------|-------------------------|
| Btu             | British thermal unit(s) |
| °C              | degree(s) Celsius       |
| cm              | centimeter(s)           |
| d               | day                     |
| °F              | degree(s) Fahrenheit    |
| ft              | foot (feet)             |
| ft <sup>2</sup> | square foot (feet)      |
| ft <sup>3</sup> | cubic foot (feet)       |
| gal             | gallon(s)               |
| g               | gram(s)                 |
| h               | hour(s)                 |
| in.             | inch(es)                |
| L               | liter(s)                |
| lb              | pound(s)                |
| m               | meter(s)                |
| mg              | milligram(s)            |
| mi              | mile(s)                 |
| mi <sup>2</sup> | square miles            |
| min             | minute(s)               |
| mo              | month(s)                |
| ppb             | part(s) per billion     |
| ppm             | part(s) per million     |
| s               | second(s)               |
| ton             | short ton(s)            |
| wk              | week(s)                 |
| yd <sup>3</sup> | cubic yard(s)           |
| yr              | year(s)                 |
| µg              | microgram(s)            |
| µmho            | micromho(s)             |

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## MASTER ENVIRONMENTAL PLAN FOR FORT DEVENS, MASSACHUSETTS

by

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### SUMMARY

This master environmental plan is based on the results of an environmental assessment conducted at Fort Devens, Massachusetts, by Argonne National Laboratory. It addresses the current status, projected data requirements, and recommended actions for 58 designated sites (referred to as study areas [SAs] or areas of concern). Only one of the SAs, a hazardous waste storage area, is regulated under the Resource Conservation and Recovery Act.

Because of the length of time that Fort Devens has been operational, records of some of the activities were not available and some of the SAs could not be located or adequately characterized. For example, several of the south-post landfills date back to the nineteenth century.

Proposed initial response actions for the SAs include the following:

- Conduct reconnaissances or geophysical surveys at 16 SAs,
- Collect surface soil samples at 24 SAs,
- Collect surface water and sediment samples at 10 SAs,
- Drill soil borings at 12 SAs,
- Install new monitoring wells at 11 SAs,
- Collect samples from monitoring wells at 15 SAs, and
- Excavate test pits and sample deeper soil at 4 SAs.

Various other actions are recommended for several SAs, including measuring groundwater levels and flow, collecting incinerator ash samples, searching records to obtain additional information, and restricting or monitoring site use. Recommendations for installation-wide studies include characterization of general hydrogeology and surface water quality, soils analyses, and ecological assessments.

For many SAs, additional actions (e.g., sampling or monitoring) are contingent on the results of the initial actions. Although action priorities have been outlined for the SAs, the ranking is preliminary and subject to change as additional data become available.

## 1 INTRODUCTION

A master environmental plan (MEP) consists of an assessment of the environmental status of study areas (SAs) and areas of concern (AOCs), a discussion of necessary investigations, and recommendations for potential responses to environmental contamination. This MEP for Fort Devens, Massachusetts, presents data collected during several site assessments and the evaluation of those data in terms of the plan objectives for environmental restoration. Based on MEP findings, the SAs and AOCs have been assigned priorities for response action. The priority assignments could become critical if shortages in program funding necessitate a phased approach.

This section provides an overview of the history and the mission of Fort Devens (FTD). The climate, geology, and hydrology of the area are described in Sec. 2. The regulatory background that provides the basis for federal facility actions is discussed in Sec. 3. Section 4 characterizes the SAs and discusses recommended actions. A summary of the proposed actions and findings is presented in Sec. 5, and a priority ranking of the SAs is given in Sec. 6.

### 1.1 BACKGROUND

Camp Devens was established in 1917 (during World War I) as a temporary training camp for soldiers from the New England area. Since that time, it has been an installation of the U.S. Army Forces Command (FORSCOM). Peak military strength during the World War I era was 38,000. In 1922, it was designated a summer training camp for several military groups, ROTC cadets, and Civilian Military Training Camp candidates. Between 1929 and 1930, it served as the location for test firing of rockets. By 1931, the camp became a permanent post and was renamed Fort Devens. Between 1931 and 1940, Fort Devens was a training installation. From November 1940 until May 1946, Fort Devens functioned as an induction center for an estimated 650,000 people. At the close of World War II, Fort Devens served as a demobilization center and was subsequently placed in caretaker status. It was again used as an induction and training center during and after the Korean and Vietnam conflicts.

Currently, the mission of Fort Devens is to command and train its assigned duty units and to support the U.S. Army Security Agency Training Center and School, U.S. Army Reserves, Massachusetts National Guard, Reserve Officer Training Programs, and Air Defense sites in New England. No major industrial operations occur at Fort Devens, although several small-scale industrial operations are performed under (1) the Directorate of Plans, Training, and Security; (2) the Directorate of Industrial Operations (DIO); and (3) the Directorate of Engineering and Housing (DEH). The major waste-producing operations performed by these groups are photographic processing and maintenance of vehicles, aircraft, and small engines.

As a result of the Base Realignment and Closure (BRAC) Act of 1990, Fort Devens has been designated as a BRAC 91 installation. The on-going Installation Restoration Program will be supplemented by environmental restoration activities in preparation for base closure; these activities will meet the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 and Superfund Amendments and Reauthorization Act (SARA) of 1986. The range of investigative activities, from preliminary

assessment to completion of remedial actions, is discussed in Secs. 3.5.1 through 3.5.6. Section 1.3 discusses the relationship between base closure and remedial activities.

## 1.2 OBJECTIVE

The objective of this project is to provide the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) with an MEP that will focus priorities for the environmental restoration of Fort Devens. The MEP has been developed in compliance with the Massachusetts Department of Environmental Protection (MDEP)\* hazardous waste regulations, the Superfund Amendments and Reauthorization Act (SARA) of 1986, the corrective action provisions of the 1984 Hazardous and Solid Waste Amendments (HSWA) of 1984, and the Toxic Substances Control Act (TSCA).

The MEP represents a working document that will be updated annually by preparing addendum reports that can be used to aid in fulfilling preremedial activity requirements mandated by SARA and to support environmental restoration activities at Fort Devens. Pursuant to Sec. 120 of SARA, which sets out requirements for preremedial activities at federal facilities, a preliminary assessment and site investigation may be required based on information submitted to the U.S. Environmental Protection Agency (EPA) under (1) Secs. 3005, 3010, and 3016 of the Resource Conservation and Recovery Act (RCRA) and (2) Sec. 103 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

Although this MEP examines the environmental status of the designated SAs, it does not fully address potential off-site impacts, migration pathways, and target populations. These issues may need to be addressed further by preremedial activities. Preremedial activities that form the foundation for the Superfund Remedial Program have been established by EPA and are discussed in further detail in Sec. 3 of this plan.

## 1.3 EFFECTS OF BASE CLOSURE

Because of Fort Devens' status as a BRAC 91 installation, additional activities are being undertaken to prepare the property for sale or transfer (Heppner 1991). A qualitative site evaluation will be performed by conducting an enhanced preliminary assessment (PA). An enhanced PA has a broader scope because it is not limited to evaluating activities that are governed by CERCLA, and it includes activities such as assessment of buildings for asbestos, radon, transformers, and underground storage tanks (USTs). The enhanced PA for Fort Devens was begun in September 1991 and is expected to be completed in March 1992 (Heppner 1991).

For the areas of Fort Devens that the enhanced PA identifies as contaminated or potentially contaminated, a remedial investigation and a feasibility study will be conducted to determine the nature and extent of contamination. When these studies are completed, public meetings will be held and comments will be accepted. For all actions, a preferred alternative will be selected and a proposed plan will be developed; the remedial alternative and plan will be documented in a record of decision. Areas that are found to be free of contamination may be sold or transferred.

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\*Before July 1989, the MDEP was known as the Massachusetts Department of Environmental Quality Engineering (MDEQE).

Pursuant to the Code of Federal Regulations, Title 40, Part 373 (40 CFR 373, *Responsibility of a Federal Agency Prior to the Sale of Federal Land*), a statement of condition will be issued after remedial activities are completed and the site has been restored. This statement will summarize the environmental studies, remedial actions, and present status of the property. It will be included in the formal deed at the time of the sale or transfer. Pursuant to CERCLA Section 120, all deeds will contain an acknowledgment of the future liability of the Department of the Army.

In some instances, property may be sold or transferred while it is undergoing remedial action. In these cases, the statement of condition would reflect conditions at the time of the sale or transfer and would be amended upon completion of the remediation.

#### 1.4 APPROACH

Argonne National Laboratory (ANL) staff conducted the on-site portion of the assessment of Fort Devens during the week of November 14, 1988. The site visit included a review of documents available at the environmental office and DEH, site inspections of all SAs, and interviews with Fort Devens staff. The initial scope of work included 40 SAs; however, 18 additional areas have been added to the MEP for further study. A summary list of all SAs is included at the beginning of Sec. 4.

Because of the length of time Fort Devens has been in existence, comprehensive documentation regarding operations and locations for some of the SAs was limited or unavailable. The SAs that could not be located are of two types: (1) those unlikely to have current environmental significance because of their dates of operation and (2) those that have been destroyed and removed but not documented (e.g., demolition of warehouses). It is recommended that these areas be removed from further consideration. A detailed presentation is included in Sec. 4.

Additional studies of the soil, local geological conditions, and groundwater are considered essential. Available information indicates that very little characterization of this type has been done at Fort Devens.

The MEP is a living document and, as such, requires continual updating to keep track of the progressing studies and new information that is discovered about the SAs or AOCs. On an annual basis, the Army will prepare an addendum report that will briefly explain changes to the MEP and tell the reader where more detailed information can be located. Additionally, the schedules located in Appendix B will be updated quarterly and submitted to all parties as part of the Army's quarterly report to the regulators.

## 2 DESCRIPTION OF THE STUDY AREA

### 2.1 LOCATION AND GEOGRAPHY

Fort Devens is located about 35 miles (mi) northwest of Boston, adjacent to the town of Ayer, in Middlesex and Worcester counties, Massachusetts (Fig. 2.1). The installation includes portions of the towns of Ayer, Harvard, Lancaster, and Shirley. Other towns in the vicinity include Fitchburg, Leominster, Harvard, Lancaster, and Lowell.

Fort Devens comprises about 9,400 acres of undulating terrain, characterized by rounded, wooded hills. The installation is divided into three parts, or posts (Fig. 2.2). The north post (1,500 acres) is separated from the main cantonment area by Ayer's Main Street, which crosses Fort Devens east to west; the north post contains Moore Army Airfield, a wastewater treatment plant (WWTP), and training areas. The main cantonment area (2,300 acres) contains administrative and support facilities. The south post (5,600 acres), which is separated from the cantonment area by State Route 2, contains ranges and training areas. The area is drained by the Nashua River, which flows through the installation generally from south to north. One lake and several ponds are located within Fort Devens.

Land surface elevations within Fort Devens range from about 200 feet (ft) above mean sea level (MSL) along the Nashua River on the northern boundary to 450 ft above MSL in the

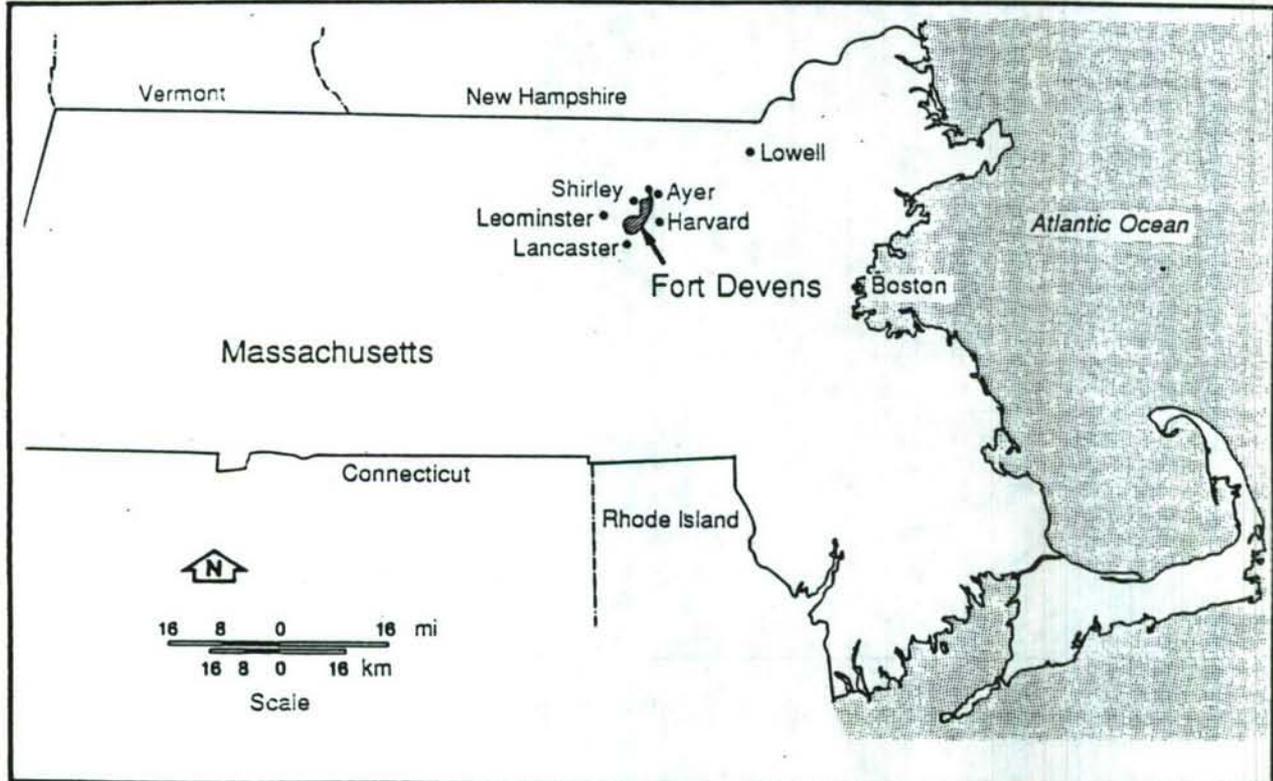


FIGURE 2.1 Location of Fort Devens in Massachusetts (Source: Adapted from McMaster et al. 1982)

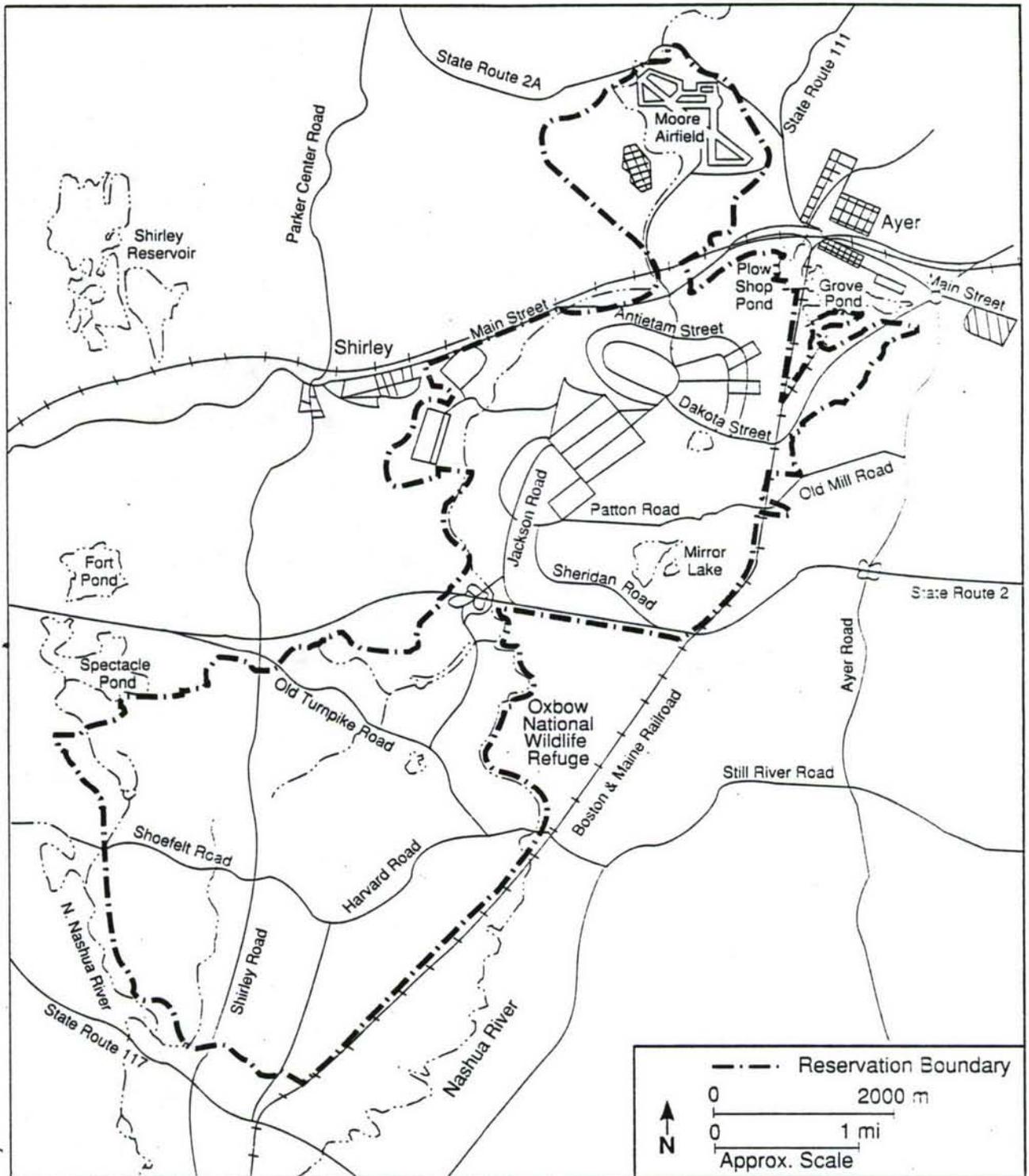


FIGURE 2.2 Map of Fort Devens (Source: Based on FORSCOM 1987)

southern portion of the installation. Figure 2.3 shows the topography of Fort Devens (USGS 1988a, b). The surrounding terrain is generally rolling to hilly and includes residential, commercial, industrial, agricultural, and woodland areas. The largest undeveloped tract in the region, Oxbow National Wildlife Refuge, is located along the east-central portion of Fort Devens. This 688-acre wetland area was deeded to the U.S. Department of the Interior by Fort Devens in 1973 (McMaster et al. 1982).

## 2.2 CLIMATE

The following description of the climatic conditions at Fort Devens is based on Gates et al. (1986), Gates (1987), and McMaster et al. (1982).

The climate of Fort Devens is typical of the northeastern United States, with long cold winters and short, moderately warm summers. Average temperatures vary from a low of 17°F in January to a high of 83°F in July, with an annual mean temperature of about 50°F. There are normally 12 days per year when the temperature reaches 90°F or above and 134 days when it is at or below freezing.

The area receives about 39 inches (in.) of precipitation per year. Average annual snowfall is 65 in. The mean monthly precipitation varies from a low of 2.3 in. in June to a high of 5.5 in. in September.

On an annual basis, westerly winds predominate, with a mean annual speed of about 5 miles per hour (mi/h). March and April have the highest average wind speed, 7 mi/h, and September has the lowest average, 4 mi/h.

## 2.3 ECOLOGY

The ecology of Fort Devens is varied and characteristic of the New England region. Vegetation ranges from early successional stages (e.g., grasslands and ruderal areas) to climax forest associations. The on-site vegetation underwent a change from mature northern hardwood forests to agricultural cropland farmed by the Nashaway Indians and early colonists. Once the resources of the Midwest were discovered, these croplands were abandoned and the fields-to-forest succession began again (DA 1980).

The ecological diversity of the area provides numerous wildlife habitats. The Army has documented 39 species of mammals, 16 species of reptiles, 9 species of amphibians, and numerous species of birds and fish. Bird species were reported to be abundant, with both migratory and resident species. Fort Devens and the Nashua River watershed lie within one of the major waterfowl flyways and provide habitat for large numbers of migratory diving ducks and resident puddling ducks. Nongame bird species are also common to the site. An inventory of plant and animal species occurring at Fort Devens was developed for the environmental impact statement for on-going mission activities at Fort Devens (DA 1980). Appendix A presents this inventory.

Forests are approximately 75% transition forests comprised of mixed hardwood and softwood species. Mature forests occurring on site include a climax pitch pine-scrub oak

### Topographic Map Symbols

- Primary highway, hard surface
- Secondary highway, hard surface
- Light-duty road, hard or improved surface
- Unimproved road; trail
- Route marker: interstate; U. S. State
- Railroad: standard gage; narrow gage
- Bridge: drawbridge
- Foambridge; overpass; underpass
- Built-up area: only selected landmark buildings shown
- House; barn; church; school; large structure
- Boundary:
  - National, with monument
  - State
  - County, parish
  - Civil township, precinct, district
  - Incorporated city, village, town
  - National or State reservation; small park
- Control: horizontal station; vertical station; spot elevation
- Contour: index; intermediate; supplementary; depression
- Distorted surface: steep rise, level; sand
- Sounding; depth curve
- Perennial lake and stream; intermittent lake and stream
- Rapids, large and small; falls, large and small
- Swamp; marsh
- Submerged marsh; sand subject to seasonal inundation
- Woodland; scattered trees

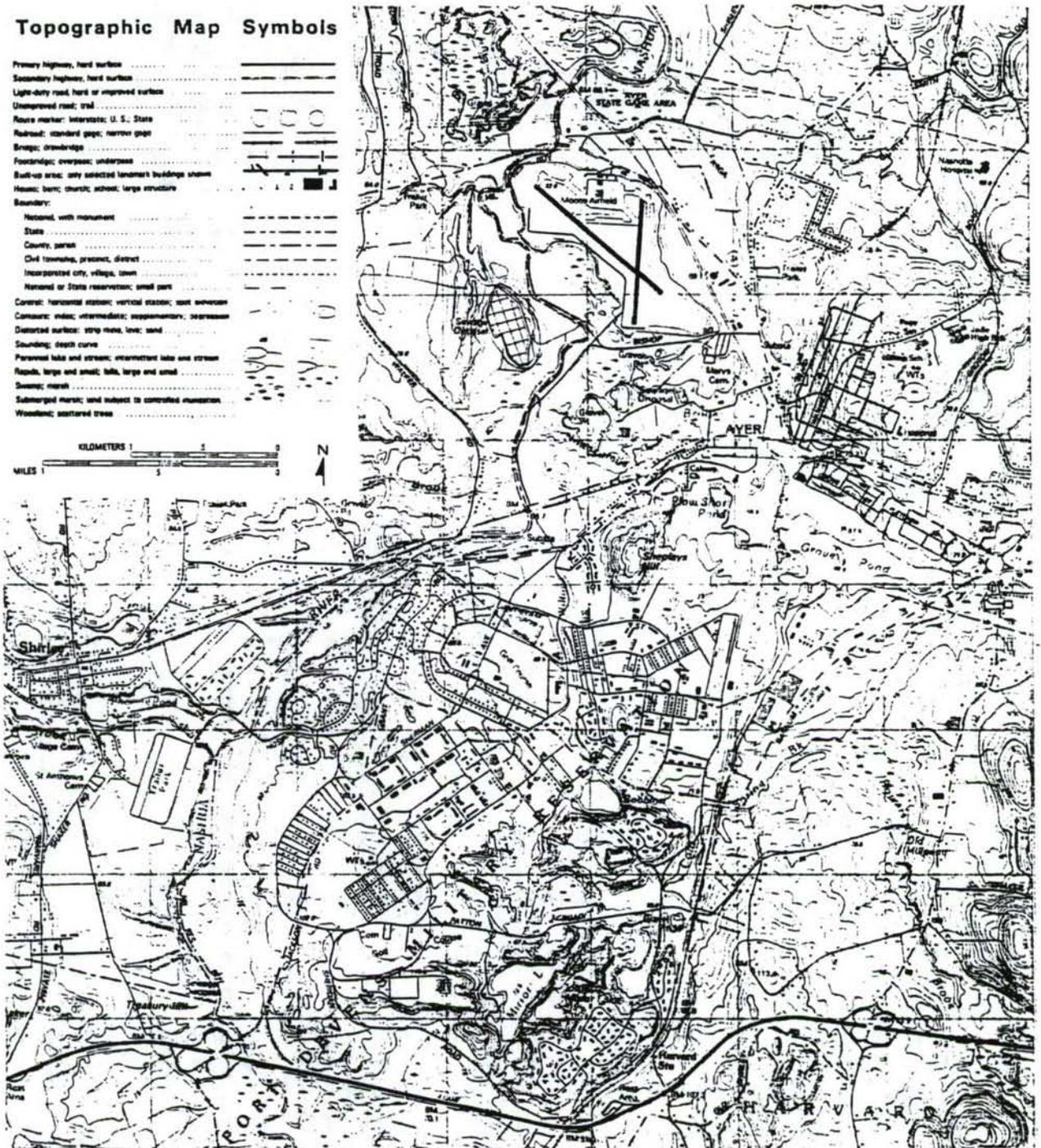


FIGURE 2.3 Topography and Drainage Features of Fort Devens (Source: USGS 1988a, b)

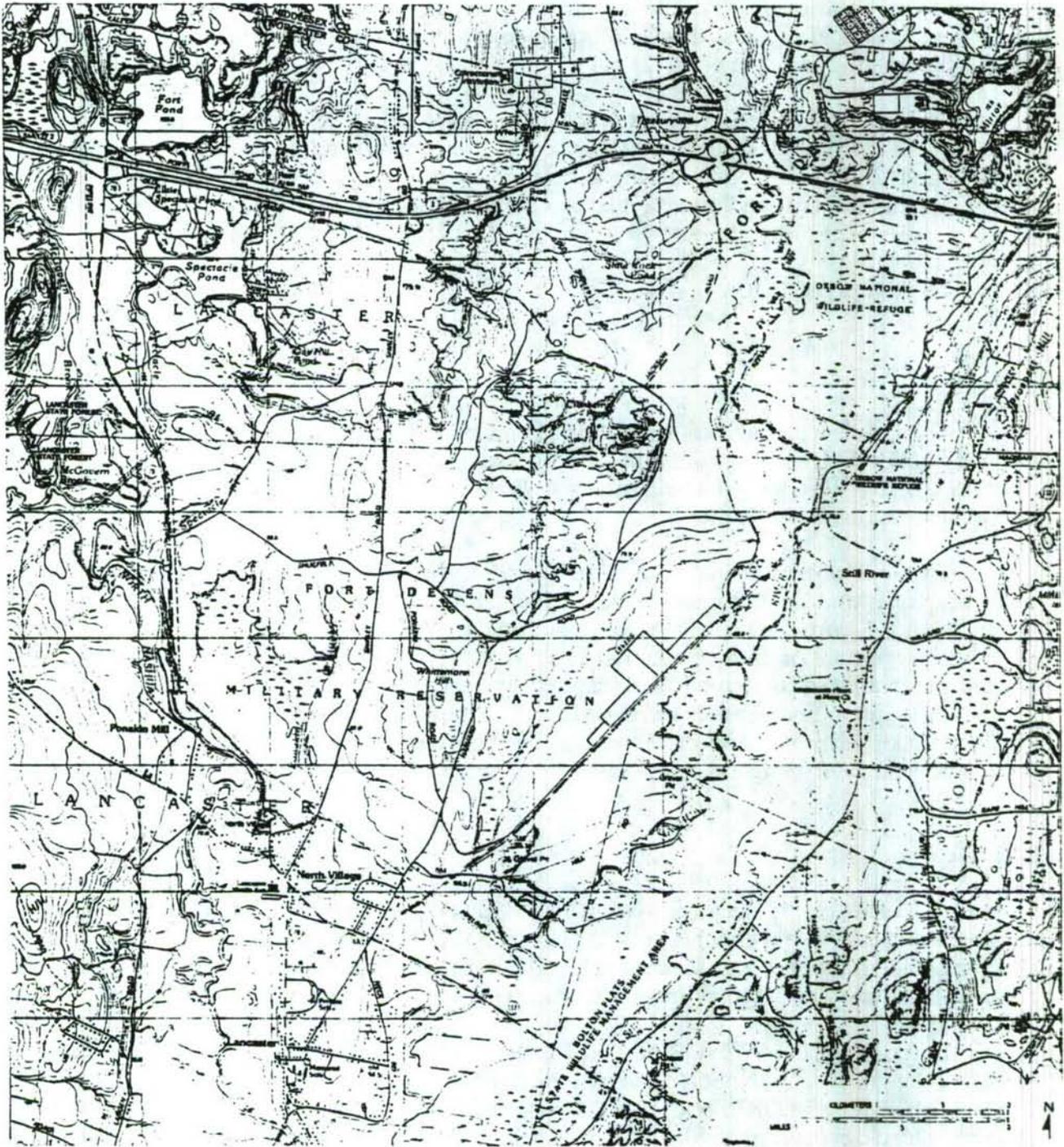


FIGURE 2.3 (Cont'd)

community in an alluvial sand plain near the Nashua River, a climax spruce fir community Cranberry Pond, and a climax beech-hemlock community near the southwestern boundary of the south post (McMaster et al. 1982).

Major wetlands found on site include the area around Cranberry Pond, Mirror Lake (including an associated spruce-peat bog on its southeastern edge), and marsh areas along drainage and tributaries in the training and range areas of the south post. Wetlands contain a variety of sedges, reeds, and aquatic plants suitable for waterfowl (McMaster et al. 1982).

## 2.4 SOILS AND GEOLOGY

### 2.4.1 Soils

The U.S. Department of Agriculture, Soil Conservation Service, has prepared a general soils map of Fort Devens (presented in Nicholls et al. 1980). Nicholls et al. (1980) and McMaster et al. (1982) have described the soils found at Fort Devens. The following discussion is taken from their reports and soils map.

The soils of Fort Devens can be divided into six associations, each consisting of a few major soil series and several minor series. The associations are named for the dominant series within them. Figure 2.4 shows the distribution of the soils on Fort Devens, and Table 2.1 provides descriptions of the associations. The majority of the area (59%) is characterized by well-drained permeable soils, about 12% is covered by moderately well-drained soils with reduced permeability due to fine subsoils or hardpan, and about 22% is covered by fine or organic soils, which are poorly drained and characterized by high water tables. The remaining 7% of Fort Devens is the artillery impact area, and its soils have not been assigned to any association.

### 2.4.2 Geology

Fort Devens is located within the Upland Subprovince of the New England physiographic province (Fenneman 1946). This subprovince is characterized by glacial deposits overlying folded, faulted, and metamorphosed sedimentary and volcanic rocks that have been intruded by numerous plutonic masses (Fenneman 1946).

Emerson (1917), Peck (1975), and Russell and Allmendinger (1975) have mapped and described the geology in the Fort Devens area. Farrell (1980a), Gates et al. (1986), Gates (1987), (1982), Nicholls et al. (1980), Nickelson (1986), and Porter (1986) have summarized the soils, geology, hydrology, and geohydrology of Fort Devens. The following description is based on their reports.

The land surface is almost completely covered with unconsolidated glacial deposits, resulting in few bedrock outcrops. During the Pleistocene glacial epoch, one and possibly two ice sheets covered the area. Erosion by the ice sheets modified and rounded the bedrock topography. Largely because the granitic and metamorphic bedrock of northern Massachusetts is not readily eroded, the glacial deposits are relatively thin, patchy, and stony. However, ice

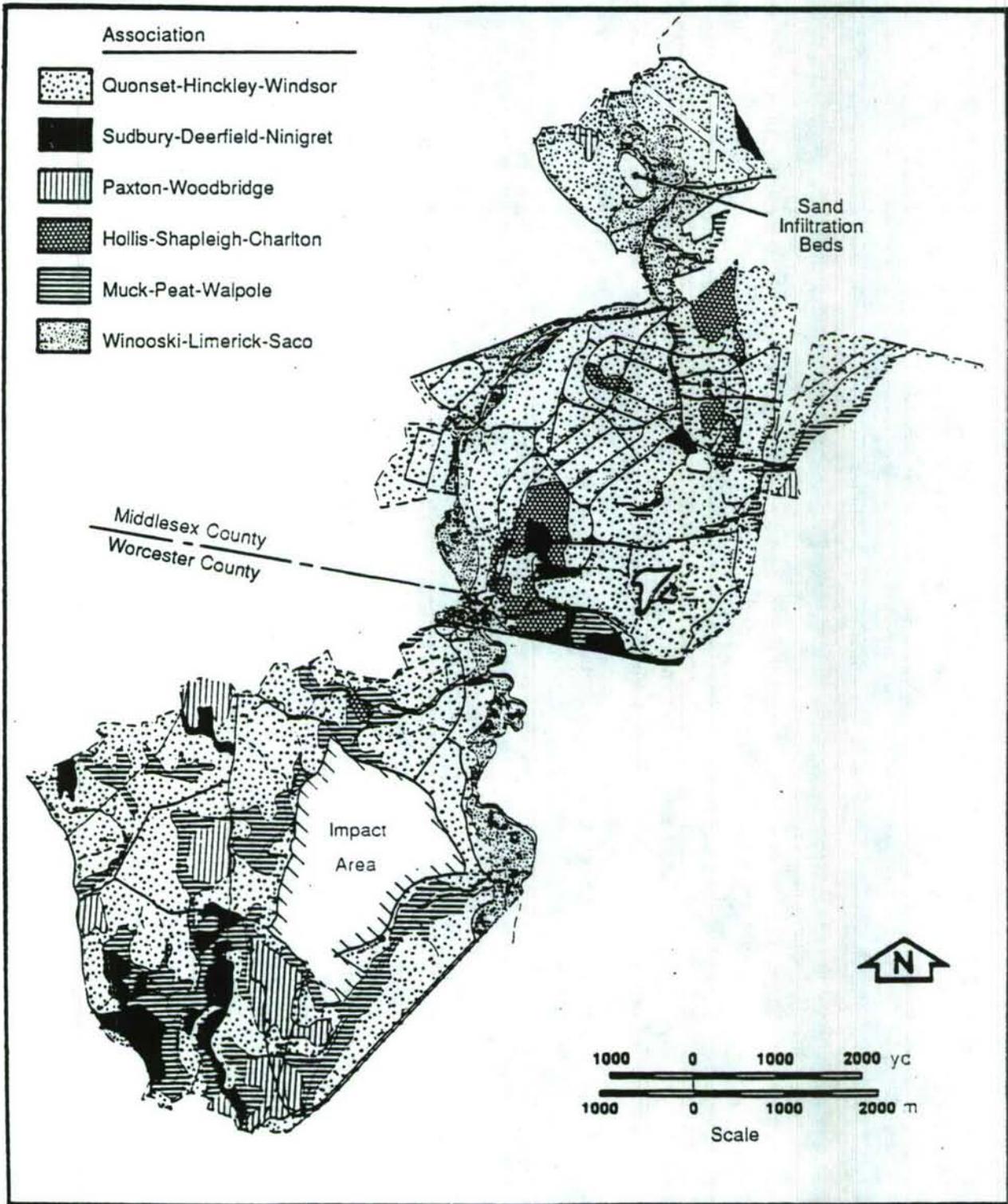


FIGURE 2.4 Soils Map of Fort Devens (Source: Adapted from McMaster et al. 1982)

TABLE 2.1 Major Soil Associations on Fort Devens

| Soil Association <sup>a</sup> | General Characteristics  | Drainage                                  | Permeability               | Area (%) | Comment  |
|-------------------------------|--|---|----------------------------|----------|--|
| Quonset-Hinckley-Windsor      | Droughty, sandy and gravelly soils underlain by stratified sand and gravel | Well drained                              | High                       | 59       | Low water table                                |
| Sudbury-Deerfield-Ninigret    | Sandy and gravelly soils with silty subsoils                               | Moderately well drained                   | Moderate to low in subsoil | 5        |  |
| Paxton-Woodbridge             | Very stony soils underlain by hardpan                                      | Well to moderately well drained           | Low in hardpan             | 4        |  |
| Hollis-Shapleigh-Charlton     | Glacial till soils and shallow to bedrock soils                            | Well drained                              | Moderate to low            | 3        |  |
| Muck-Peat-Walpole             | Organic and sandy soils  | Poorly drained                            | Low                        | 12       | High water table                               |
| Winoski-Limerick-Saco         | Silty soils  | Moderately well drained to poorly drained | Low                        | 10       | High water table, subject to seasonal flooding |
| Unassigned                    | Unknown  | Unknown                                   | Unknown                    | 7        | Impact area                                    |

<sup>a</sup>See Fig. 2.4.

Source: McMaster et al. 1982.

contact features such as outwash plains, kames, kame terraces, drumlins, and eskers are found in abundance. Regionally, the weight of the ice sheets depressed the land surface. Since the end of the Wisconsin glacial stage, the land surface has been in the process of rebounding. This rebound and the presence of blocking glacial deposits in the northern limits of the main cantonment area have diverted the Nashua River to the north and resulted in sluggish flow in this reach of the river.

#### 2.4.2.1 Bedrock

The bedrock of northern and north-central Massachusetts is a complex assemblage of igneous, metamorphic, and sedimentary rocks. Mapping by Emerson (1917) determined that two distinct rock units underlay Fort Devens: Oakdale quartzite and Ayer granite. The Oakdale quartzite, of Mississippian age, is described as being slightly biotic with calcareous lenses. The Ayer granite, of Pennsylvania age, intrudes into and underlies the Oakdale quartzite (Emerson 1917). Peck (1975) and Russell and Allmendinger (1975) remapped the bedrock of the area and discontinued usage of the Oakdale quartzite nomenclature. According to these authors, the bedrock in the Fort Devens area is a complex of intensely folded and faulted metamorphic and granitic rocks belonging to three mappable rock units of lower Paleozoic (probably Silurian and Devonian) age. They did not assign any formal stratigraphic names to the three rock units. Their mapping showed that most of the formational contacts are northeast-striking faults. On Fort Devens, the bedrock appears at the surface on Shepley's Hill and other scattered outcrops. The bedrock surface is eroded; its relief, though moderate, is greater than that of the present surface topography. The major bedrock surface feature is the bedrock valley of the ancestral Nashua River.

#### 2.4.2.2 Unconsolidated Sediments

Throughout Fort Devens, the bedrock is overlain by unconsolidated glacial till, outwash, and lake deposits. The till consists of poorly sorted clay, silt, sand, gravel, and boulders deposited by advancing glaciers. In most areas, the glacial till has been eroded and is overlain by younger glacial outwash deposits. Outwash deposits consist of sand, gravel, and boulders deposited by melt water flowing from the retreating glacier. Also present are some glacial lake deposits consisting of sand and clay.

Evidence is sketchy regarding a pre-Wisconsin ice sheet in this area. In some locations, a darker, more indurated till, laid down by an earlier but undated ice sheet, underlies the younger Wisconsin-age till, the earliest dated glacial deposit. This unconsolidated till is a poorly sorted deposit of silt, sand, gravel, and boulders, with a minor amount of clay deposited by the advancing glacier directly on the bedrock surface. Till occurs either as a ground moraine or as drumlins. Drumlins are rounded, oval-shaped hills of thick till deposits formed by the retreating glacier. On Fort Devens, ground moraine is exposed on Shepley's Hill and drumlins form both Whittemore Hill and Hill 635 in the training area. Elsewhere, till probably exists but is covered by younger deposits.

Overlying the till throughout most of Fort Devens are outwash deposits of sand and gravel. These deposits, known as kames and kame terraces, form the most conspicuous glacial-derived feature on Fort Devens, a pitted outwash plain. The plain, which forms the land surface

throughout most of the installation, was formed by stagnation and melting of the glacier. Rivers flowing from the ice sheet deposited coarse sands, pebbles, and boulder gravels in ice channels and open areas among wasting ice blocks or as lake deltas that formed along the edge of the glacier. As the blocks of ice melted, depressions known as kettles developed. Outwash deposits range in thickness from 40 ft in the kettles to 100 ft in the deltas.

One lake that developed as the ice retreated formed in the preglacial Nashua River valley. This lake, known as glacial Lake Nashua, originally extended from the margins of the retreating ice southwest to an outlet near Holden, Massachusetts. As the ice receded farther northward, successively lower outlets were uncovered and the level of the lake dropped by corresponding stages. Fort Devens is underlain by several outwash sequences, and each stage of the lake left a different sequence. The sequences are of such diverse origins that their composition can rarely be predicted with assurance. Glacial lake bottom sands and clays are present, notably underlying the Oxbow Wildlife Refuge, where they are masked by recent swamp deposits.

## 2.5 HYDROLOGY

The following summary of the hydrologic conditions of Fort Devens is based on the reports of Fox (1988a, b), Gates et al. (1986), McMaster et al. (1982), and Porter (1986).

### 2.5.1 Surface Water

Fort Devens is located in the Nashua River basin, which encompasses 529 square miles ( $\text{mi}^2$ ) within New Hampshire and Massachusetts (Fig. 2.5). The Nashua River flows north through Fort Devens to the Merrimack River at Nashua, New Hampshire. The major tributaries of the Nashua River are the Squannacook and Nissitissit rivers. Nashua River tributary drainage basins found on Fort Devens are shown in Figs. 2.3 and 2.6.

Many natural impoundments exist in the Nashua River basin. Those completely within the boundaries of Fort Devens include Robbins Pond, Cranberry Pond, Mirror Lake, Little Mirror Lake, and Oak Hill Pond. Slate Rock Pond is an artificial pond in the south post. Closely associated water bodies include Plow Shop Pond and Grove Pond, located along the northeastern boundary, and Spectacle Pond, located along the northwestern boundary of the south post.

### 2.5.2 Groundwater

No investigations have yet detailed the hydrogeological conditions of Fort Devens; however, some general observations can be made on the basis of limited site-specific data.

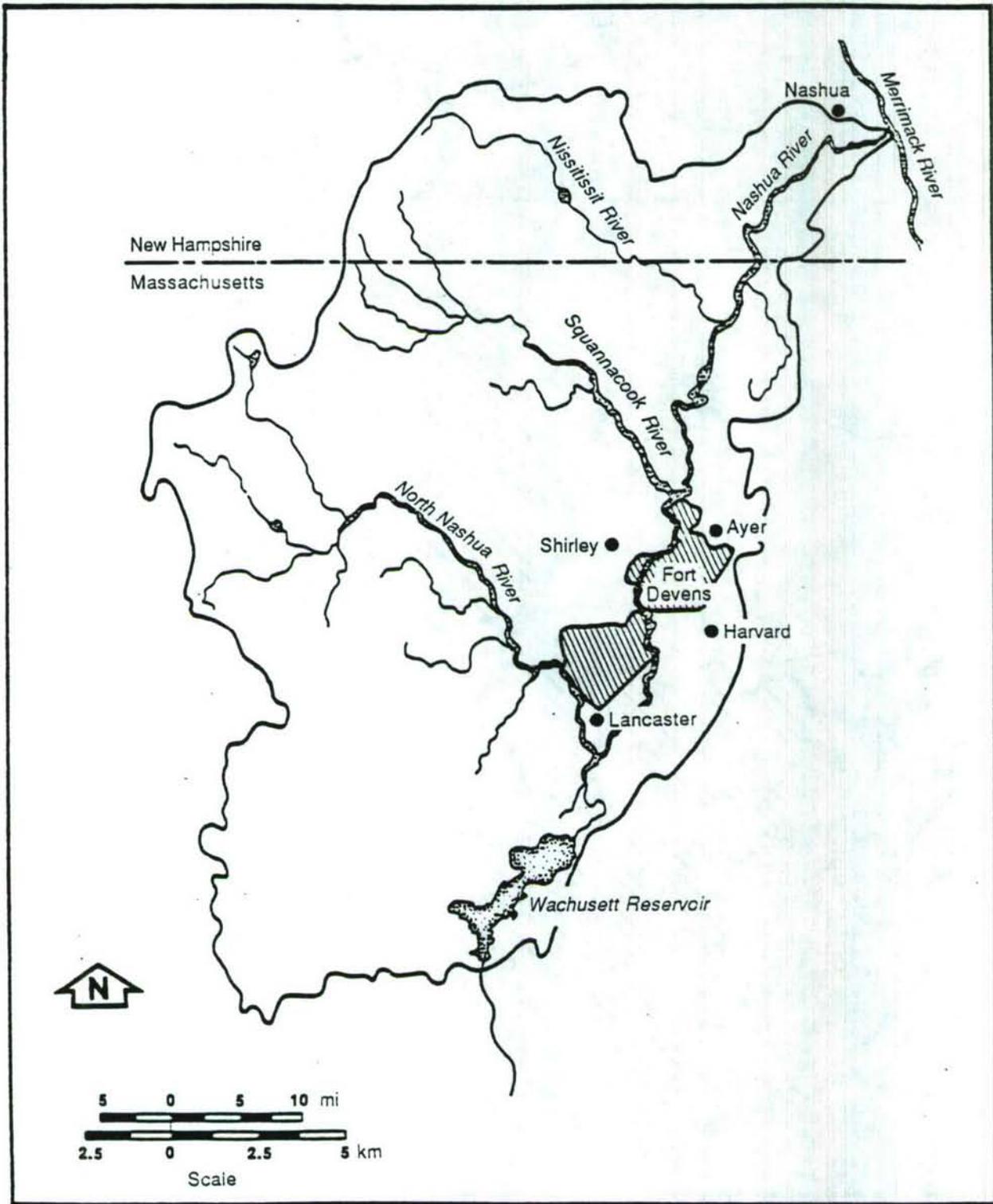


FIGURE 2.5 The Nashua River Basin and Fort Devens (Source: Adapted from McMaster et al. 1982)

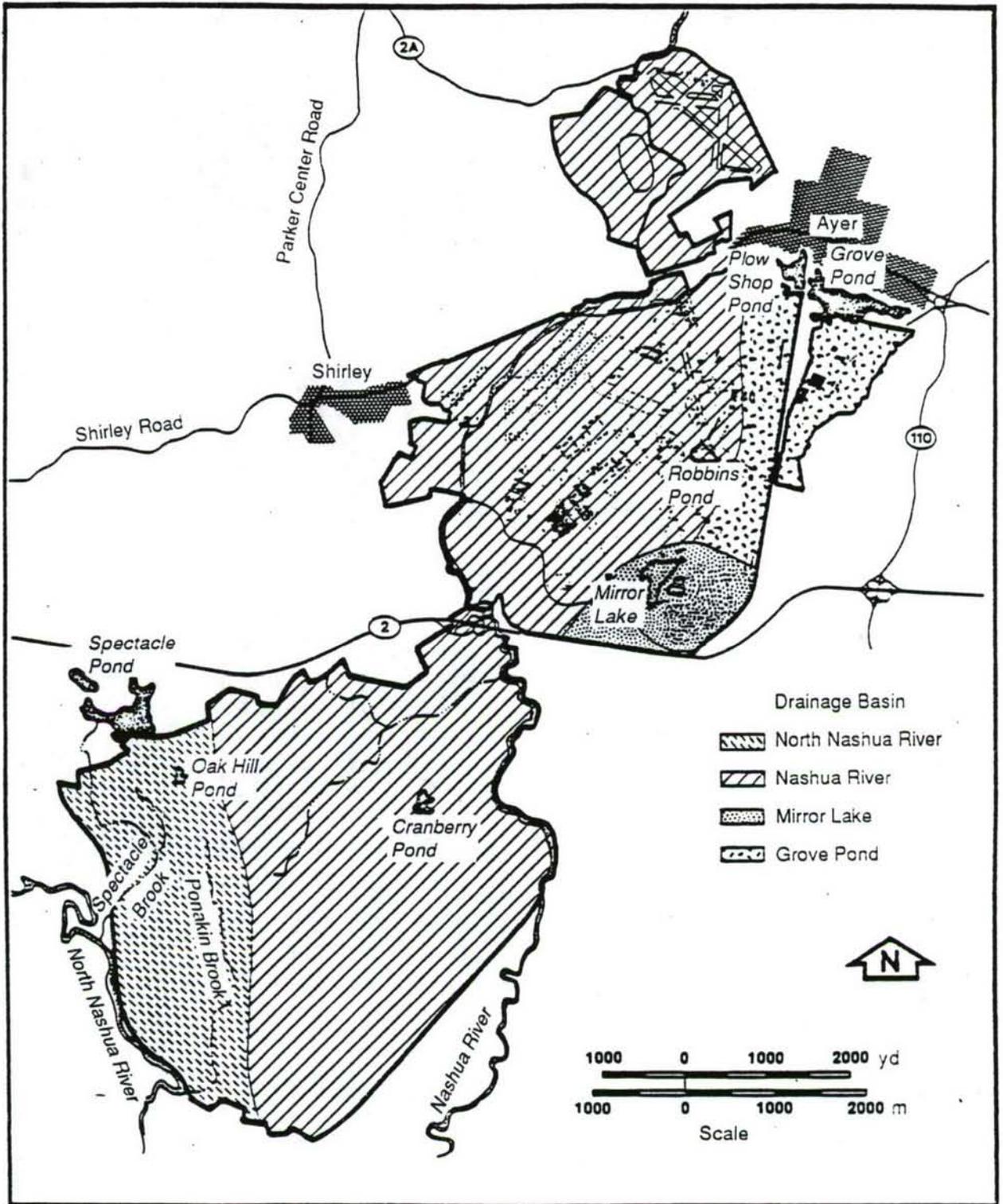


FIGURE 2.6 Tributary Drainage Basins at Fort Devens (Source: Adapted from McMaster et al. 1982)

Throughout most of Fort Devens, groundwater supplies are found primarily in the unconsolidated glacial outwash deposits. Permeability of these sediments generally is high, especially in gravel beds. Depth to the water table varies from the land surface to depths greater than 32 ft below land surface. The major local aquifer comprises thick outwash deposits and occurs along the Nashua Valley and in the eastern and western thirds of the cantonment area (Fig. 2.7), where the saturated thickness of the aquifer is as great as 66 ft. Elsewhere, minor amounts of groundwater can be obtained from thinner sequences of glacial sediments and occasionally from fractured bedrock.

With the exception of a few sites, the groundwater flow direction has not been determined; however, the regional hydrogeology indicates that groundwater flows toward the nearest surface stream or river.

Fort Devens has three large wells (Shabokin, Patton, and McPherson) and a well field (Grove Pond) consisting of 74 small wells; all wells are screened (McMaster et al. 1982). Well depths range from 34 to 93 ft, and well yields are about 960 gallons per minute (gal/min) for large-diameter wells. Locations of the wells are shown in Fig. 2.8, and their physical characteristics are described below.

The Grove Pond well field consists of two fields containing a total of 74 small-diameter wells, or "sand points," which are connected to a central header and pump with a rated capacity of 1,000 gal/min. Field 1 was constructed in 1918 and consists of 39 wells, ranging in depth from 34 to 39 ft (McMaster et al. 1982). Field 2 was constructed in 1941 and consists of 35 small-diameter wells, ranging in depth from 35 to 75 ft.

The Shabokin well, constructed in 1941, is 75 ft deep, has a nominal 20-in. casing, and has a rated capacity of 1,000 gal/min. This well is located at Bldg. 3628 in the main cantonment area, along Sheridan Road north of Route 2.

The Patton well is located at Bldg. 3630 in the main cantonment area, north of Mirror Lake along Patton Road. This well, which was constructed in 1953, is 67 ft deep, has a nominal 20-in. casing, and has a rated capacity of 1,000 gal/min.

The McPherson well, constructed in 1966, is 93 ft deep, has a nominal 18-in. casing, and has a rated capacity of 1,000 gal/min. This well is located in the north post area, east of McPherson Road and the Nashua River and north of Verbeck Gate.

## 2.5.3 Water Quality

### 2.5.3.1 Surface Water

The MDEP's Division of Water Pollution Control (MDWPC) and the U.S. Geological Survey (USGS) have monitored the Nashua River water quality for many years. Historical data indicate that the Nashua River has had water quality problems along its entire length (McMaster

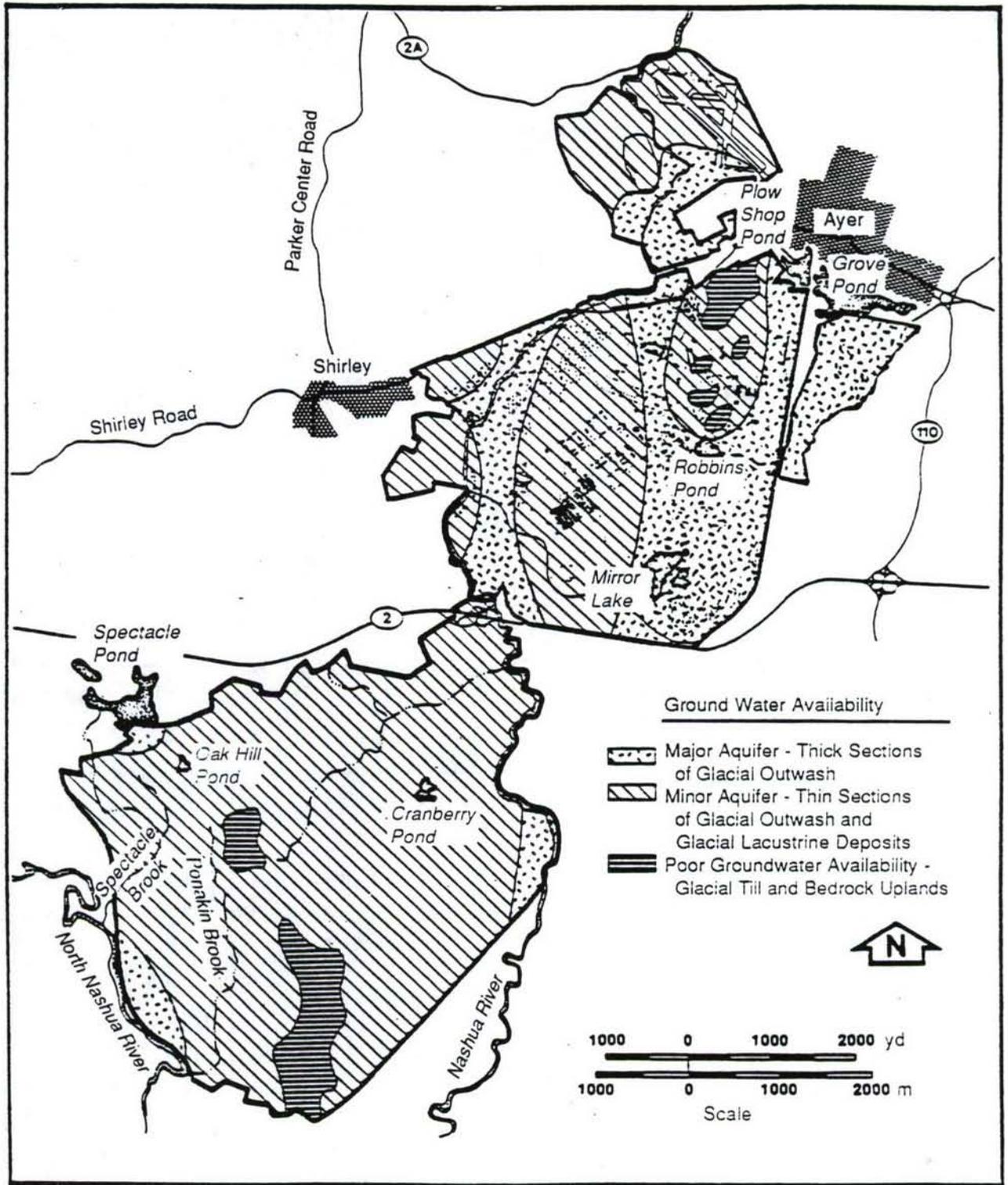


FIGURE 2.7 Groundwater Availability Map for Fort Devens (Sources: Adapted from McMaster et al. 1982; Brackley and Hansen 1977)

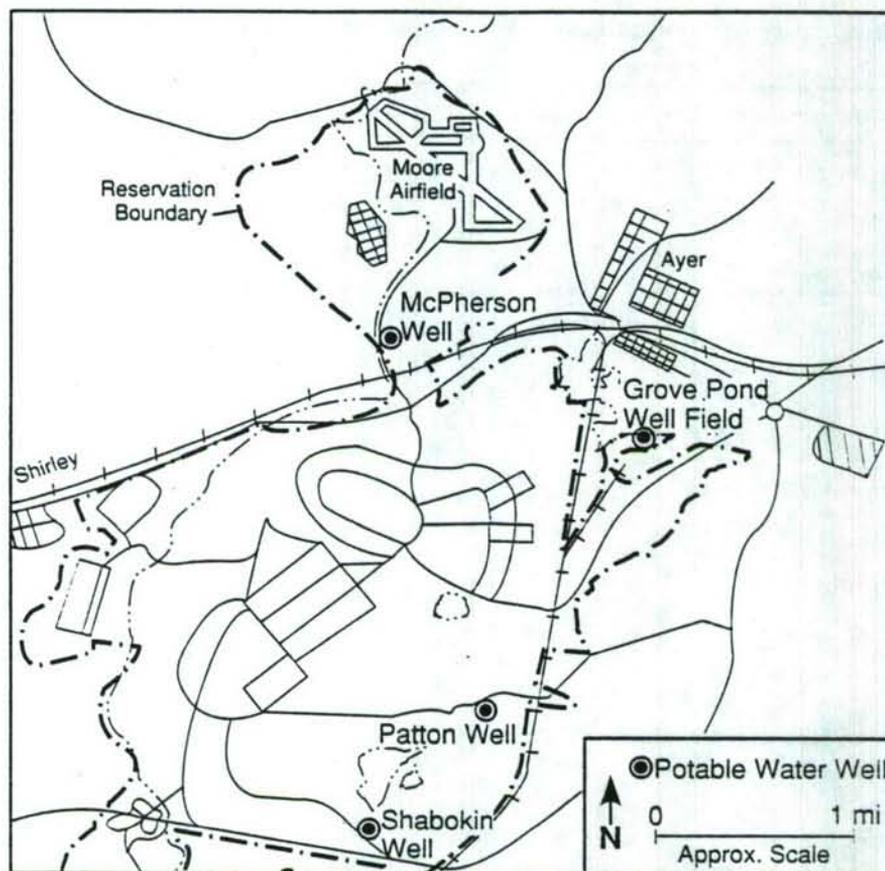


FIGURE 2.8 Well Locations at Fort Devens (Source: Locations from McMaster et al. 1982)

et al. 1982). However, data collected by the USGS from 1970 to 1980 show trends similar to those found by studies conducted by Massachusetts and indicate that the quality of the Nashua River has improved.

The Nashua River currently is classified as a Class B waterway by Massachusetts (MDEQE 1986). Historical data show that the river has normally violated the Massachusetts Class B water quality standard for dissolved oxygen (5 milligrams per liter [mg/L]) at the point where the river enters Fort Devens (McMaster et al. 1982). Total nitrogen levels in the river were about 3.5 mg/L at the southern boundary of the installation, decreasing to about 3.0 mg/L at the northern boundary. Phosphate levels from past surveys showed similar trends, with the levels decreasing through Fort Devens (from south to north) from 3.5 to 2.7 mg/L.

In 1985, the MDWPC resampled the quality of the waters in the Nashua River basin. Samples of the water were collected at 28 stations on the Nashua River and its tributaries. One of these stations was located at the STP Bridge\* on Fort Devens. Table 2.2 presents the chemical quality of the Nashua River near Fort Devens, as determined by the MDWPC survey.

\*Named after the sewage treatment plant, the former name of the WWTP.

TABLE 2.2 Quality of Nashua River Water near Fort Devens on Various Dates in 1985

| Parameter                      | Unit             | 3/26/85         | 5/7/85 | 6/3/85 | 9/3/85 |
|--------------------------------|------------------|-----------------|--------|--------|--------|
| Dissolved oxygen <sup>a</sup>  | mg/L             | 11.5            | 8.9    | 8.1    | 8.5    |
| Total Kjeldahl nitrogen        | mg/L             | 1.6             | 1.2    | 1.6    | 1.7    |
| Ammonia-nitrogen               | mg/L             | 0.57            | 0.51   | 0.08   | 0.42   |
| Nitrite-nitrogen               | mg/L             | NA <sup>b</sup> | NA     | 24     | 0.032  |
| Nitrate-nitrogen               | mg/L             | 0.5             | 0.7    | 0.8    | 0.6    |
| Phosphorus as P                | mg/L             | 0.14            | 0.17   | 0.20   | 0.14   |
| Suspended solids               | mg/L             | 5.5             | 11     | 5.0    | 5.5    |
| Total solids                   | mg/L             | 130             | 90     | 150    | 130    |
| Alkalinity, total              | mg/L             | NA              | 23     | 17     | NA     |
| pH                             | units            | 6.4             | 6.6    | 6.8    | 6.8    |
| Chloride                       | mg/L             | 32              | 30     | 32     | 32     |
| Hardness, as calcium carbonate | mg/L             | 32              | 35     | 42     | 32     |
| Turbidity                      | NTU <sup>c</sup> | 1.9             | 2.4    | 3.2    | 1.8    |
| Specific conductance           | µmho/cm          | NA              | NA     | 177    | NA     |
| Aluminum                       | mg/L             | <0.10           | <0.10  | 0.10   | <0.10  |
| Arsenic                        | mg/L             | 0.001           | 0.001  | 0.003  | <0.010 |
| Cadmium                        | mg/L             | 0               | 0      | <0.02  | <0.02  |
| Chromium                       | mg/L             | 0               | 0      | <0.02  | <0.02  |
| Copper                         | mg/L             | 0               | 0      | <0.02  | <0.02  |
| Lead                           | mg/L             | 0               | 0      | <0.04  | <0.04  |
| Nickel                         | mg/L             | 0               | 0      | <0.05  | <0.05  |
| Silver                         | mg/L             | 0               | 0      | <0.02  | <0.02  |
| Zinc                           | mg/L             | 0.03            | 0      | <0.03  | 0.04   |

<sup>a</sup>Dissolved oxygen measured on 7/25/85 was 4.8 mg/L; no other parameter values were reported for that date.

<sup>b</sup>Parameter not analyzed.

<sup>c</sup>Nephelometric turbidity units.

Source: MDEQE 1986.

### 2.5.3.2 Groundwater

The groundwater supplies at Fort Devens were sampled and analyzed in 1981. The analytical results presented by McMaster et al. (1982) showed that this groundwater, which is plentiful and of good quality, is a moderately hard and can be used as a potable source with minimal treatment. Except for sodium, the physical and chemical qualities of on-site potable water consistently have met Massachusetts water quality standards. The installation has been complying with the state regulation for reporting samples with sodium concentrations in excess of 20 mg/L.

In 1986, Fort Devens applied for a Massachusetts Ground-Water Discharge Permit for the WWTP land treatment system. Groundwater within Fort Devens was designated as Class I groundwater by Massachusetts and was considered to be a source of potable water. When implemented, state regulations will require the conditions of the permit to include groundwater monitoring, record keeping, and reporting of monitoring results to the state to assure compliance with the permit limitations.

### 3 REGULATORY OVERVIEW

In the twentieth century, organic chemistry has made possible an explosive growth of synthetic products: fabrics, pesticides, plastics, drugs, paints, and solvents, to name a few. Each found a place in commerce; however, the processing of each left behind some by-products, waste materials, and intermediate chemicals, which required disposal. Materials and products that are now considered fundamentals of modern life are created from an array of heterogeneous chemicals. Although these chemicals create useful products, their dangerous properties often remain in the wastes, sometimes for a brief time, sometimes virtually forever. As the number of materials and products increases, so do the volume and complexity of their hazardous wastes (Epstein et al. 1982).

As recently as 15 years ago, hazardous waste was virtually an unknown public health problem. Early air and water pollution legislation was debated and enacted without awareness or consideration of what to do with wastes once they were no longer dumped into the air and water. Awareness of the disposal problem has dramatically increased, particularly since the late summer of 1978, when Love Canal became so widely known; similar waste disposal sites have since come to light in nearly every region of the United States (Epstein et al. 1982).

One way of understanding the potential toxic effect of hazardous waste is to examine its transport, fate, and persistence in the environment and living organisms. Some wastes are considered *immortal* because their toxic qualities are intrinsic to their structure, which remains unchanged over time. Heavy metal wastes are prominent examples of this group (Epstein et al. 1982).

A second group may be called *semi-immortal* because degradation occurs very slowly in the environment. Chlorinated hydrocarbons are examples of this group. Some *immortal* and *semi-immortal* compounds (heavy metals such as lead and chromium, chlorinated hydrocarbons such as vinyl chloride) pose additional problems because they selectively concentrate in living organisms and progressively bioaccumulate in the food chain, culminating with man (Epstein et al. 1982).

A third group of toxics is very short-lived, or *mortal*. These are acids, bases, and other strongly reactive materials like cyanides. Mortal toxics are quickly degraded or neutralized in the environment (Epstein et al. 1982).

Chemicals from each of the three groups discussed above have been detected at all of the areas included in the scope of the current investigation. The following sections discuss the legal requirements and steps that must be considered or followed during remedial actions at hazardous waste sites.

#### 3.1 STATUTES AND REGULATIONS

##### 3.1.1 National Oil and Hazardous Substance Pollution Contingency Plan

The National Oil and Hazardous Substance Pollution Contingency Plan (NCP) originated under the Clean Water Act (CWA), Section 311. It was developed to provide response capability

in the event of a release that posed an imminent and substantial threat to the public health or welfare because of a discharge of oil to navigable waters from any offshore or onshore facility. The NCP initially addressed the need to respond to these emergencies and to provide a mechanism for assigning liability and recovering compensation. As an increased awareness of the environment developed, it became apparent that the need for emergency response actions was not limited to disasters on the nation's waterways. In 1980, CERCLA, commonly referred to as Superfund, expanded the powers of the NCP to include emergency response for (1) releases or substantial threats of releases of hazardous substances into the environment or (2) releases of pollutants or contaminants that may present an imminent and substantial danger to public health or welfare. It provides for effective response to discharges of oil and releases of hazardous substances, pollutants, and contaminants. The purpose of the NCP is to effect the response powers and responsibilities created by CERCLA and the authorities established by Section 311 of the CWA.

The following information summarizes the significant changes to the NCP as a result of the 1990 revision (Muhly 1990). Some changes will affect the way that cleanup criteria or alternatives are selected:

- Subpart E (formerly Subpart F in the 1985 NCP), which addresses the elements of hazardous substance response, now implements the requirements of CERCLA Section 121. It focuses on selecting treatment technologies, using nine criteria when evaluating and selecting remedies, conducting early actions, and streamlining remedial activities.
- The 1990 NCP requires protection of human health at an acceptable risk level for any selected remedy at a CERCLA site ( $10^{-4}$  to  $10^{-6}$  for carcinogens).
- MCLGs will be used for establishing cleanup levels in cases where groundwater is or could be used for drinking water or in cases where multiple contaminants or pathways pose a risk in excess of  $10^{-4}$ .
- Best demonstrated available technology (BDAT) standards prescribed under the land disposal restrictions will not be generally appropriate for remediation of contaminated soil and debris at Superfund sites.

Other revisions will effect administrative changes and enhance public participation:

- Subpart F is a new subpart added to implement an earlier mandate to promulgate regulations for substantial and meaningful state involvement in CERCLA response actions. The major new aspects are the Superfund Memoranda of Agreement (SMOA) between EPA regions and the states and the concurrence of the EPA and the state on the selected remedy.
- Subpart I is a new subpart that implements an earlier mandate for establishing an administrative record.
- A new category, "Construction Completion," places sites in a complete status when remedies have been implemented and are operating properly.

- New community relations requirements for the administrative record (CERCLA Sec. 113) and public participation (CERCLA Sec. 117) include:
  - For emergency and time-critical removal actions, the administrative record must be available to the public no later than 60 days after initiation of on-site removal actions. The notice of availability must be published and available at a central location. The lead agency must also provide a 30-day public comment period and respond to public comments.
  - Where on-site removal activities will exceed 120 days, the lead agency must conduct interviews with local residents and officials, establish repositories, publish notices of availability of documents, provide a public comment period of not less than 30 days following the issuance of the engineering evaluation/cost analysis, and prepare written responses.

Under the 1990 NCP, the primary administrative record and public participation requirements for remedial actions are approximately the same as those for removal actions. These requirements extend to include activities associated with the record of decision and the proposed plan (described in Sec. 3.6), with an additional requirement: if, after adoption of the record of decision, the remedial action differs significantly from the scope, performance, or cost set forth in the record of decision, an explanation must be published and made available. If the changes fundamentally alter the record of decision, an amendment must be proposed, followed by a public notice, a comment period, and a response.

Developed somewhat in parallel with CERCLA were the Safe Drinking Water Act (SDWA), which established national primary drinking water standards, and the Resource Conservation and Recovery Act (RCRA), which provides for safe management and disposal of hazardous waste.

### 3.1.2 Federal Water Quality Criteria

Federal drinking water regulations are given in Table 3.1. The maximum contaminant levels (MCLs), which include the national primary drinking water standards (40 CFR 141), are enforceable standards used for developing remedial actions. Maximum contaminant level goals (MCLGs) are recommended levels rather than enforceable standards. MCLGs that are included in SARA as potential applicable or relevant and appropriate requirements (ARARs) are set at levels that cause no known or anticipated adverse health effects and allow for an adequate margin of safety (52 FR 32496). Goals for all carcinogens are zero. The 10-day and lifetime health advisory criteria refer to exposures for a 10-day period or more and for a lifetime, respectively. Table 3.2 gives federal water quality criteria. These criteria are not enforceable standards but are presented because they are potential ARARs. For water that is to be used for drinking, the MCLs are generally the applicable or relevant and appropriate standard (EPA 1988a).

TABLE 3.1 Federal Drinking Water Regulations ( $\mu\text{g/L}$  except as noted otherwise)<sup>a</sup>

| Chemical   | Maximum Contaminant Level <sup>b</sup>       | Maximum Contaminant Level Goal <sup>c</sup>  | Health Advisories |                |
|--|--|--|-------------------|----------------|
|  |  |  | Exceeding 10-Days | Lifetime       |
| Acrylamide   | TT <sup>d,e</sup>                            | 0 <sup>e</sup>                               | 70                | -              |
| Acrylonitrile                                      | -  | -  | 4                 | -              |
| Alachlor   | 2 <sup>e</sup>                               | 0 <sup>e</sup>                               | -                 | -              |
| Aldicarb   | 3 <sup>e</sup>                               | 1 <sup>e</sup>                               | -                 | 1              |
| Aldicarb sulfone                                   | 2 <sup>e</sup>                               | 1 <sup>e</sup>                               | -                 | 2              |
| Aldicarb sulfoxide                                 | 4 <sup>e</sup>                               | 1 <sup>e</sup>                               | -                 | 1              |
| Antimony   | 5 <sup>f</sup>                               | 3 <sup>f</sup>                               | 15 <sup>f</sup>   | 3 <sup>f</sup> |
| Arsenic  | 50   | 0  | -                 | -              |
| Asbestos   | 7 × 10 <sup>6</sup><br>fibers/L <sup>g</sup> | 7 × 10 <sup>6</sup><br>fibers/L <sup>g</sup> | -                 | -              |
| Atrazine   | 3 <sup>e</sup>                               | 3 <sup>e</sup>                               | 200               | 3              |
| Barium   | 2 <sup>e</sup>                               | 2 <sup>e</sup>                               | -                 | 2              |
| Benz(a)anthracene                                  | 0.1 <sup>f</sup>                             | 0 <sup>f</sup>                               | -                 | -              |
| Benzene  | 5  | 0  | -                 | -              |
| Beryllium  | 1 <sup>f</sup>                               | 0 <sup>f</sup>                               | 20                | 5              |
| Cadmium  | 5 <sup>e</sup>                               | 5 <sup>e</sup>                               | -                 | -              |
| Carbofuran   | 40 <sup>e</sup>                              | 40 <sup>e</sup>                              | 200               | 40             |
| Carbon tetrachloride                               | 5  | 0  | 300               | -              |
| Chlordane  | 2  | 0  | -                 | -              |
| Chlorinated benzenes                               |  |  |                   |                |
| Hexachlorobenzene                                  | 1 <sup>f</sup>                               | 0 <sup>f</sup>                               | 200               | -              |
| o-, m-Dichlorobenzene                              | 600  | 600  | 30,000            | 600            |
| p-Dichlorobenzene                                  | 75   | 75   | 40,000            | 75             |
| Monochlorobenzene                                  | 100 <sup>e</sup>                             | 100 <sup>e</sup>                             | 7,000             | -              |
| Chlorinated ethanes                                |  |  |                   |                |
| 1,2-Dichloroethane                                 | 5  | 0  | 2,600             | -              |
| 1,1,1-Trichloroethane                              | 200  | 200  | 100,000           | 200            |
| 1,1,2-Trichloroethane                              | 5 <sup>f</sup>                               | 3 <sup>f</sup>                               | 1,000             | 3              |
| Chlorinated phenols,<br>pentachlorophenol          | 1 <sup>e</sup>                               | 0 <sup>e</sup>                               | 1,000             | -              |
| Chlorophenoxy                                      |  |  |                   |                |
| 2,4-Dichlorophenoxyacetic acid<br>(2,4,-D)         | 70   | 70   | 400               | 70             |
| 2,4,5-Trichlorophenoxypropionic acid<br>(2,4,5-TP) | 50   | 50   | 300               | 50             |
| Chloroform   | 100 <sup>h</sup>                             | 0  | -                 | -              |
| Chromium (total)                                   | 100 <sup>e</sup>                             | 100 <sup>e</sup>                             | 800               | 100            |
| Copper   | 1,300 <sup>i</sup>                           | 1,300 <sup>i</sup>                           | -                 | -              |
| Cyanide  | -  | 200  | -                 | -              |
| DDT  | -  | 0  | -                 | -              |
| p-Dichlorobenzene                                  | 75   | 75   | 40,000            | 75             |
| o-, m-Dichlorobenzene                              | 600  | 600  | 30,000            | 600            |
| 1,1-Dichloroethylene                               | 7  | 7  | 4,000             | 7              |
| 1,2-Dichloroethylene (cis)                         | 70   | 70   | 11,000            | 70             |
| 1,2-Dichloroethylene (trans)                       | 100  | 100  | 6,000             | 100            |

TABLE 3.1 (Cont'd)

| Chemical                          | Maximum Contaminant Level <sup>b</sup> | Maximum Contaminant Level Goal <sup>c</sup> | Health Advisories   |                    |
|-----------------------------------|--|---|---------------------|--------------------|
|                                   |  |   | Exceeding 10-Days   | Lifetime           |
| Dichloromethane                   | 5 <sup>f</sup>                         | 0 <sup>f</sup>                              | -                   | -                  |
| Dibenz(a,h)anthracene             | 3                                      | 0   | -                   | -                  |
| Dibromochloropropane (DBCP)       | 2 <sup>e</sup>                         | 0 <sup>e</sup>                              | -                   | -                  |
| 1,2-Dichloropropane               | 5                                      | 0   | -                   | -                  |
| Dichloropropylenes                | -                                      | -   | -                   | -                  |
| Dieldrin                          | -                                      | -   | 2                   | -                  |
| 2,4-Dinitrotoluene                | -                                      | -   | -                   | -                  |
| 2,6-Dinitrotoluene                | -                                      | -   | -                   | -                  |
| Endrin                            | 2 <sup>f</sup>                         | 2 <sup>f</sup>                              | 10                  | 2                  |
| Epichlorohydrin                   | TT <sup>e</sup>                        | 0 <sup>e</sup>                              | 70                  | 400                |
| Ethylbenzene                      | 700                                    | 700   | 3,000               | 700                |
| Ethylene dibromide (EDB)          | 0.05 <sup>e</sup>                      | 0 <sup>e</sup>                              | -                   | -                  |
| Fluoride                          | 4,000                                  | 4,000                                       | -                   | -                  |
| Halomethanes                      | -                                      | 0   | -                   | -                  |
| Heptachlor                        | 0.4 <sup>e</sup>                       | 0   | 5                   | -                  |
| Heptachlorexopide                 | 0.2 <sup>e</sup>                       | 0 <sup>e</sup>                              | 0.1                 | -                  |
| Hexachlorobenzene                 | 1 <sup>f</sup>                         | 0 <sup>f</sup>                              | 200                 | -                  |
| Hexachlorocyclohexanes            |  |   |                     |                    |
| α-Hexachlorocyclohexane           | -                                      | 0   | -                   | -                  |
| β-Hexachlorocyclohexane           | -                                      | 0   | -                   | -                  |
| γ-Hexachlorocyclohexane (lindane) | 0.2 <sup>e</sup>                       | 0.2 <sup>e</sup>                            | 100                 | 0.2                |
| Hexachlorocyclopentadiene         | 50 <sup>f</sup>                        | 50 <sup>f</sup>                             | -                   | -                  |
| n-Hexane                          | -                                      | -   | 10,000              | -                  |
| Isophorone                        | -                                      | -   | -                   | -                  |
| Kerosene/fuel oil No. 2           | -                                      | -   | 350 <sup>i</sup>    | -                  |
| Lead (at source)                  | 5 <sup>i</sup>                         | 0 <sup>i</sup>                              | -                   | -                  |
| Mercury                           | 2 <sup>e</sup>                         | 2 <sup>e</sup>                              | 2                   | 2                  |
| Methoxychlor                      | 40 <sup>e</sup>                        | 40 <sup>e</sup>                             | 200                 | 40                 |
| Methyl ethyl ketone               | -                                      | -   | 9,000               | 200                |
| Nickel                            | 100 <sup>f</sup>                       | 100 <sup>f</sup>                            | 600                 | 100                |
| Nitrate, as N                     | 10,000 <sup>e</sup>                    | 10,000 <sup>e</sup>                         | -                   | -                  |
| Nitrite, as N                     | 100 <sup>e</sup>                       | 100 <sup>e</sup>                            | -                   | -                  |
| Total nitrate and nitrite, as N   | 10,000 <sup>e</sup>                    | 10,000 <sup>e</sup>                         | -                   | -                  |
| 1,3-Dinitrobenzene                | -                                      | -   | 140                 | 1                  |
| p-Nitrophenols                    | -                                      | -   | 3,000 <sup>f</sup>  | 60 <sup>f</sup>    |
| Phenol                            | -                                      | -   | 20,000 <sup>f</sup> | 4,000 <sup>f</sup> |
| Phthalate esters                  |  |   |                     |                    |
| Dimethyl phthalate (PAE)          | -                                      | -   | -                   | -                  |
| Diethyl phthalate (PAE)           | -                                      | -   | -                   | 5 <sup>f</sup>     |
| Dibutyl phthalate (PAE)           | 4 <sup>f</sup>                         | 800 <sup>f</sup>                            | -                   | -                  |
| Diethylhexyl phthalate (PAE)      | 4 <sup>f</sup>                         | 0   | -                   | -                  |

TABLE 3.1 (Cont'd)

| Chemical                          | Maximum Contaminant Level <sup>b</sup> | Maximum Contaminant Level Goal <sup>c</sup> | Health Advisories  |                    |
|-----------------------------------|--|---|--------------------|--------------------|
|                                   |  |   | Exceeding 10-Days  | Lifetime           |
| Polychlorinated biphenyls (PCBs)  | 0.5 <sup>e</sup>                       | 0 <sup>e</sup>                              | -                  | -                  |
| Polynuclear aromatic hydrocarbons | 0.2 <sup>f</sup>                       | 0 <sup>f</sup>                              | -                  | -                  |
| RDX                               | -                                      | -   | 400                | 2                  |
| Selenium                          | 50 <sup>e</sup>                        | 50 <sup>e</sup>                             | -                  | -                  |
| Silver                            | 50                                     | -   | -                  | -                  |
| Styrene                           | 100 <sup>e</sup>                       | 100 <sup>e</sup>                            | -                  | -                  |
| 2,4,5-TP (Silvex)                 | 50 <sup>e</sup>                        | 50 <sup>e</sup>                             | 300                | 50                 |
| 2,3,7,8-TCDD (dioxin)             | -                                      | 0   | -                  | -                  |
| Tetrachloroethylene               | 5                                      | 0   | 5,000              | -                  |
| Thallium                          | -                                      | -   | -                  | -                  |
| Toluene                           | 1,000 <sup>e</sup>                     | 1,000                                       | 7,000              | 1,000              |
| Toxaphene                         | 3 <sup>e</sup>                         | 0   | -                  | -                  |
| Trichloroethylene                 | 5                                      | 0   | -                  | -                  |
| Trihalomethanes                   | 100 <sup>h</sup>                       | -   | -                  | -                  |
| Trinitroglycerol                  | -                                      | -   | 5                  | 5                  |
| Trinitrotoluene (TNT)             | -                                      | -   | 20                 | 2                  |
| Vinyl chloride                    | 2                                      | 0   | 50                 | -                  |
| Xylenes, total                    | 10,000 <sup>e</sup>                    | 10,000 <sup>e</sup>                         | 100,000            | 10,000             |
| Zinc                              | -                                      | -   | 9,000 <sup>f</sup> | 2,000 <sup>f</sup> |

<sup>a</sup>A hyphen denotes that a federal standard has not been adopted for drinking water.

<sup>b</sup>These standards are part of the national primary drinking water regulations (40 CFR 141).

<sup>c</sup>MCLGs are nonenforceable health goals that are set at a level at which no known or anticipated adverse health effect occurs and that allows an adequate safety margin. The MCLG for all carcinogens is zero.

<sup>d</sup>TT = treatment technique.

<sup>e</sup>Effective July 30, 1992.

<sup>f</sup>Proposed value (see EPA 1991).

<sup>g</sup>Fibers longer than 10  $\mu\text{m}$ .

<sup>h</sup>The summed concentration of the four trihalomethanes (chloroform, bromodichloromethane, dibromochloromethane, and bromoform) must be less than 100  $\mu\text{g/L}$ .

<sup>i</sup>Effective December 7, 1992.

Source: EPA 1991.

TABLE 3.2 Federal Water Quality Criteria

| Chemical Name               | CWA <sup>a</sup> Water Quality Criteria for Protection of Human Health <sup>b</sup> |                              | CWA <sup>a</sup> Ambient Water Quality Criteria for Protection of Aquatic Life <sup>b</sup> |  |
|-----------------------------|---|------------------------------|---|--|
|                             | Water and Fish Ingestion (mg/L)   | Fish Consumption Only (mg/L) | Freshwater Acute/Chronic <sup>c</sup> (mg/L)  | Marine Acute/Chronic <sup>c</sup> (mg/L)       |
| Acenaphthene                | -   | -                            | 1.7*/0.5*   | 0.9*/0.7*                                      |
| Acenaphthylene              | -   | -                            | -   | 3.0 × 10 <sup>-1</sup> *                       |
| Acrolein                    | 3.2 × 10 <sup>-1</sup>  | 7.8 × 10 <sup>-1</sup>       | 6.8 × 10 <sup>-2</sup> /2.1 × 10 <sup>-2</sup> *  | 5.5 × 10 <sup>-2</sup> *                       |
| Acrylonitrile               | 5.8 × 10 <sup>-5</sup>  | 6.5 × 10 <sup>-4</sup>       | 7.5*/2.6*   | -  |
| Aldrin                      | 7.4 × 10 <sup>-8</sup>  | 7.9 × 10 <sup>-8</sup>       | 3.0 × 10 <sup>-3</sup>  | 1.3 × 10 <sup>-3</sup>                         |
| Anthracene                  | -   | -                            | -   | -  |
| Antimony and compounds      | 1.5 × 10 <sup>-1</sup>  | 45                           | 9.0/1.6   | -  |
| Arsenic and compounds       | 2.2 × 10 <sup>-6</sup>  | 1.8 × 10 <sup>-5</sup>       | -   | -  |
| Arsenic (V) and compounds   | -   | -                            | 0.8*/4.8 × 10 <sup>-2</sup> *   | 2.3*/1.3 × 10 <sup>-2</sup>                    |
| Arsenic (III) and compounds | -   | -                            | 0.3/0.1   | 6.9 × 10 <sup>-2</sup> /3.6 × 10 <sup>-2</sup> |
| Asbestos                    | -   | -                            | -   | -  |
| Barium and compounds        | 1   | -                            | -   | -  |
| Benz(a)anthracene           | -   | -                            | -   | -  |
| Benz(c)acridine             | -   | -                            | -   | -  |
| Benzene                     | 6.6 × 10 <sup>-4</sup>  | 4.0 × 10 <sup>-2</sup>       | 5.3*  | 5.1*/0.7*                                      |
| Benzidine                   | 1.2 × 10 <sup>-4</sup>  | 5.3 × 10 <sup>-4</sup>       | 2.5*  | -  |
| Benzo(a)pyrene              | -   | -                            | -   | -  |
| Benzo(b)fluoranthene        | -   | -                            | -   | -  |
| Benzo(ghi)perylene          | -   | -                            | -   | -  |
| Benzo(k)fluoranthene        | -   | -                            | -   | -  |
| Beryllium and compounds     | 6.8 × 10 <sup>-6</sup>  | 1.2 × 10 <sup>-4</sup>       | 0.1*/5.3 × 10 <sup>-3</sup> *   | -  |
| Bis(2-chloroethyl)ether     | -   | -                            | -   | -  |
| Bis(2-chloroisopropyl)ether | -   | -                            | -   | -  |
| Bis(chloromethyl)ether      | -   | -                            | -   | -  |
| Cadmium and compounds       | 1.0 × 10 <sup>-2</sup>  | -                            | 3.9 × 10 <sup>-3</sup> †/1.1 × 10 <sup>-3</sup> †   | 4.3 × 10 <sup>-2</sup> /9.3 × 10 <sup>-2</sup> |
| Carbon tetrachloride        | 4.0 × 10 <sup>-4</sup>  | 6.9 × 10 <sup>-3</sup>       | 3.5 × 10 <sup>1</sup>   | 5.0 × 10 <sup>1</sup>                          |
| Chlordane                   | 4.6 × 10 <sup>-7</sup>  | 4.8 × 10 <sup>-7</sup>       | 2.4 × 10 <sup>-3</sup> /4.3 × 10 <sup>-6</sup>  | 9.0 × 10 <sup>-5</sup> /4.0 × 10 <sup>-6</sup> |

TABLE 3.2 (Cont'd)

| Chemical Name                          | CWA <sup>a</sup> Water Quality Criteria for Protection of Human Health <sup>b</sup> |                              | CWA <sup>a</sup> Ambient Water Quality Criteria for Protection of Aquatic Life <sup>b</sup> |   |
|--|---|------------------------------|---|---|
|  | Water and Fish Ingestion (mg/L)   | Fish Consumption Only (mg/L) | Freshwater Acute/Chronic <sup>c</sup> (mg/L)  | Marine Acute/Chronic <sup>c</sup> (mg/L)      |
| Chlorinated benzenes                   | -   | -                            | $2.5 \times 10^{-1}$ / $5.0 \times 10^{-2}$ *   | $1.6 \times 10^{-1}$ / $1.2 \times 10^{-1}$ * |
| Chlorinated naphthalenes               | -   | -                            | 1.6*  | $7.5 \times 10^{-3}$ *                        |
| Chloroalkyl ethers                     | -   | -                            | $2.3 \times 10^{2}$ *   | -   |
| Chlorobenzene (Mono)                   | -   | -                            | -   | -   |
| Chlorodibromomethane                   | -   | -                            | -   | -   |
| Chloroform                             | $1.9 \times 10^{-4}$  | $1.8 \times 10^{-2}$         | $2.8 \times 10^{1}$ / $1.2$ *   | -   |
| 2-Chlorophenol                         | -   | -                            | $4.3$ / $2.0$ *   | -   |
| Chromium III and compounds             | 170   | 3,433                        | $1.7$ / $0.2$ †   | $1.0 \times 10^1$                             |
| Chromium VI and compounds              | $5.0 \times 10^{-2}$  | -                            | $1.6 \times 10^{-2}$ / $1.1 \times 10^{-2}$   | $1.1$ / $5.0 \times 10^{-2}$                  |
| Copper and compounds                   | -   | -                            | $1.8 \times 10^{-2}$ † / $1.2 \times 10^{-2}$ †   | $2.9 \times 10^{-3}$ / $2.9 \times 10^{-3}$   |
| Cyanides                               | $2 \times 10^{-1}$  | -                            | $2.2 \times 10^{-2}$ / $5.2 \times 10^{-3}$   | $1.0 \times 10^{-3}$ / $1.0 \times 10^{-3}$   |
| DDT                                    | $2.4 \times 10^{-8}$  | $2.4 \times 10^{-8}$         | $1.1 \times 10^{-3}$ / $1.0 \times 10^{-6}$   | $1.3 \times 10^{-4}$ / $1.0 \times 10^{-6}$   |
| Dibutyl phthalate                      | 35  | 154                          | -   | -   |
| Dichlorobenzenes                       | $4 \times 10^{-1}$  | 2.6                          | $1.1$ / $7.6 \times 10^{-1}$ *  | 1.9*  |
| 1,2-Dichlorobenzene                    | -   | -                            | -   | -   |
| 1,3-Dichlorobenzene                    | -   | -                            | -   | -   |
| 1,4-Dichlorobenzene                    | -   | -                            | -   | -   |
| 3,3'-Dichlorobenzidine                 | $1 \times 10^{-4}$  | $2 \times 10^{-5}$           | -   | -   |
| 1,2-Dichloroethane (EDC)               | $9.4 \times 10^{-4}$  | $2.4 \times 10^{-1}$         | $1.1 \times 10^{2}$ / $2.0 \times 10^1$ *   | $1.1 \times 10^{2}$ *                         |
| Dichloroethylenes                      | $3.3 \times 10^{-5}$  | $1.9 \times 10^{-3}$         | $1.1 \times 10^1$ *   | $2.22 \times 10^2$ *                          |
| 1,1-Dichloroethylene                   | 3.1   | -                            | $1.1 \times 10^1$ *   | $2.2 \times 10^2$ *                           |
| 2,4-Dichlorophenol                     | -   | -                            | $2.0$ / $0.3$ *   | -   |
| 2,6-Dichlorophenol                     | -   | -                            | -   | -   |
| 3,4-Dichlorophenol                     | -   | -                            | -   | -   |
| 2,3-Dichlorophenol                     | -   | -                            | -   | -   |
| 2,5-Dichlorophenol                     | -   | -                            | -   | -   |
| 2,4-Dichlorophenoxyacetic acid (2,4-D) | -   | -                            | -   | -   |

TABLE 3.2 (Cont'd)

| Chemical Name                      | CWA <sup>a</sup> Water Quality Criteria for Protection of Human Health <sup>b</sup> |                              | CWA <sup>a</sup> Ambient Water Quality Criteria for Protection of Aquatic Life <sup>b</sup> |  |
|------------------------------------|---|------------------------------|---|--|
|                                    | Water and Fish Ingestion (mg/L)   | Fish Consumption Only (mg/L) | Freshwater Acute/Chronic <sup>c</sup> (mg/L)  | Marine Acute/Chronic <sup>c</sup> (mg/L) |
| 1,3-Dichloropropene                | $8.7 \times 10^{-2}$  | 14.1                         | 6.0*/0.2*   | 0.7*                                     |
| Dieldrin                           | $7.1 \times 10^{-8}$  | $7.6 \times 10^{-8}$         | $2.5 \times 10^{-3}/1.9 \times 10^{-6}$   | $0.7 \times 10^{-3}/1.9 \times 10^{-6}$  |
| Diethylphthalate                   | 350   | 1,800                        | -   | -  |
| Bis(2-ethylhexyl)phthalate (DEHP)  | -   | -                            | -   | -  |
| Diethylnitrosamine                 | -   | -                            | -   | -  |
| 7,12-Dimethylbenz(a)anthracene     | -   | -                            | -   | -  |
| Dimethylnitrosamine                | -   | -                            | -   | -  |
| 2,4-Dimethylphenol                 | -   | -                            | 2.1*  | -  |
| Dimethylphthalate                  | 313   | 2,900                        | -   | -  |
| 4,6-Dinitro-o-cresol               | -   | -                            | -   | -  |
| 2,4-Dinitrophenol                  | -   | -                            | -   | -  |
| 1,2-Diphenylhydrazine              | -   | -                            | -   | -  |
| Endosulfan                         | $7.4 \times 10^{-2}$  | $1.6 \times 10^{-1}$         | $2.2 \times 10^{-4}/5.6 \times 10^{-5}$   | $3.4 \times 10^{-5}/8.7 \times 10^{-6}$  |
| Endrin                             | $1 \times 10^{-3}$  | -                            | $1.8 \times 10^{-4}/2.3 \times 10^{-6}$   | $3.7 \times 10^{-5}/2.3 \times 10^{-6}$  |
| Ethylbenzene                       | 1.4   | 3.3                          | $3.2 \times 10^1$   | $4.3 \times 10^{-1}$                     |
| Fluoranthene                       | $4.2 \times 10^{-2}$  | $5.4 \times 10^{-2}$         | 3.9*  | $4.0 \times 10^{-2}/1.6 \times 10^{-2}$  |
| Fluorides                          | -   | 4.0                          | -   | -  |
| Heptachlor                         | $2.8 \times 10^{-7}$  | $2.9 \times 10^{-7}$         | $5.2 \times 10^{-4}/3.8 \times 10^{-6}$   | $5.3 \times 10^{-5}/3.6 \times 10^{-6}$  |
| Hexachlorobenzene                  | $7.2 \times 10^{-7}$  | $7.4 \times 10^{-7}$         | -   | -  |
| Hexacalorobutadiene                | $4.5 \times 10^{-4}$  | $5 \times 10^{-2}$           | $9.0 \times 10^{-2}/9.3 \times 10^{-3}$   | $3.2 \times 10^{-2}$                     |
| alpha-Hexachlorocyclohexane (HCCH) | $9.2 \times 10^{-6}$  | $3.1 \times 10^{-5}$         | -   | -  |
| gamma-HCCH (Lindane)               | -   | -                            | -   | -  |
| Technical-HCCH                     | $1.2 \times 10^{-5}$  | $4.1 \times 10^{-5}$         | -   | -  |
| Hexachlorocyclopentadiene          | $2.1 \times 10^{-1}$  | -                            | $7.0 \times 10^{-3}/5.2 \times 10^{-3}$   | $7.0 \times 10^{-3}$                     |
| Hexachloroethane                   | $1.9 \times 10^{-3}$  | $8.74 \times 10^{-3}$        | $9.8 \times 10^{-1}/5.4 \times 10^{-1}$   | $9.4 \times 10^{-1}$                     |
| Iodomethane                        | -   | -                            | -   | -  |
| Isophorone                         | -   | -                            | $1.17 \times 10^2$  | $1.2 \times 10^1$                        |

TABLE 3.2 (Cont'd)

| Chemical Name                       | CWA <sup>a</sup> Water Quality Criteria for Protection of Human Health <sup>b</sup> |                              | CWA <sup>a</sup> Ambient Water Quality Criteria for Protection of Aquatic Life <sup>b</sup> |   |
|-------------------------------------|---|------------------------------|---|---|
|                                     | Water and Fish Ingestion (mg/L)   | Fish Consumption Only (mg/L) | Freshwater Acute/Chronic <sup>c</sup> (mg/L)  | Marine Acute/Chronic <sup>c</sup> (mg/L)  |
| Lead and compounds (inorganic)      | $5 \times 10^{-2}$  | -                            | $8.0 \times 10^{-2}/3.2 \times 10^{-3†}$  | $0.1/5.6 \times 10^{-3}$                  |
| Mercury and compounds (alkyl)       | -   | -                            | $2.4 \times 10^{-3}/1.2 \times 10^{-5}$   | $2.14 \times 10^{-3}/2.5 \times 10^{-5}$  |
| Mercury and compounds (inorganic)   | $1.4 \times 10^{-4}$  | $1.5 \times 10^{-4}$         | $2.4 \times 10^{-3}/1.2 \times 10^{-5}$   | $2.1 \times 10^{-3}/2.5 \times 10^{-5}$   |
| Methoxychlor                        | $1 \times 10^{-1}$  | -                            | $0.3 \times 10^{-4*}$   | $0.3 \times 10^{-4*}$                     |
| Methyl chloride                     | -   | -                            | -   | -   |
| 2-Methyl-4-chlorophenol             | -   | -                            | -   | -   |
| 3-Methyl-4-chlorophenol             | -   | -                            | -   | -   |
| 3-Methyl-6-chlorophenol             | -   | -                            | -   | -   |
| 3-Monochlorophenol                  | -   | -                            | -   | -   |
| 4-Monochlorophenol                  | -   | -                            | -   | -   |
| Nickel and compounds                | $1.3 \times 10^{-10}$   | $1 \times 10^{-1}$           | $1.4†/1.6 \times 10^{-1†}$  | $7.5 \times 10^{-2}/8.3 \times 10^{-3}$   |
| Nitrate (as N)                      | 10  | -                            | -   | -   |
| Nitrobenzene                        | 20  | -                            | $2.7 \times 10^{1*}$  | 6.6                                       |
| Nitrophenols                        | -   | -                            | $2.3 \times 10^{-1*}/1.5 \times 10^{-1*}$   | 4.8*                                      |
| Nitrosamines                        | -   | -                            | 5.8*  | $3.3 \times 10^{3*}$                      |
| n-Nitrosodiphenylamine              | $4.9 \times 10^{-3}$  | $1.6 \times 10^{-2}$         | -   | -   |
| N-Nitrosopyrrolidine                | $1.6 \times 10^{-5}$  | $9.2 \times 10^{-2}$         | -   | -   |
| Para Dichlorobenzene                | -   | -                            | -   | -   |
| Pentachlorinated ethanes            | -   | -                            | $7.2*/1.1*$   | $3.9 \times 10^{-1*}/2.8 \times 10^{-1*}$ |
| Pentachlorobenzene                  | $7.4 \times 10^{-2}$  | $8.5 \times 10^{-2}$         | -   | -   |
| Pentachlorophenol                   | 1   | -                            | $2.0 \times 10^{-2}/1.3 \times 10^{-2}$   | $1.3 \times 10^{-2}/7.9 \times 10^{-3}$   |
| Phenanthrene                        | -   | -                            | -   | -   |
| Phenol                              | 3.5   | -                            | $1.0 \times 10^1/2.5$   | 5.8                                       |
| Phthalate esters                    | -   | -                            | $9.4 \times 10^{-1*}/3.0 \times 10^{-3*}$   | $2.9*/3.4 \times 10^{-3*}$                |
| Polychlorinated biphenyls (PCBs)    | $7.9 \times 10^{-8}$  | $7.9 \times 10^{-8}$         | $2.0 \times 10^{-3}/1.4 \times 10^{-5}$   | $1.0 \times 10^{-2}/3.0 \times 10^{-5}$   |
| Radionuclides, gross alpha activity | -   | 15 pCi/L                     | -   | -   |
| Radium 226 and 228                  | -   | 5 pCi/L                      | -   | -   |

TABLE 3.2 (Cont'd)

| Chemical Name                        | CWA <sup>a</sup> Water Quality Criteria for Protection of Human Health <sup>b</sup> |                              | CWA <sup>a</sup> Ambient Water Quality Criteria for Protection of Aquatic Life <sup>b</sup> |  |  |
|--------------------------------------|---|------------------------------|---|--|--|
|                                      | Water and Fish Ingestion (mg/L)   | Fish Consumption Only (mg/L) | Freshwater Acute/Chronic <sup>c</sup> (mg/L)  | Marine Acute/Chronic <sup>c</sup> (mg/L)   |  |
| Selenium and compounds               | $1.0 \times 10^{-2}$  | $1.0 \times 10^2$            | $2.6 \times 10^{-1}/3.5 \times 10^{-2}$   | $4.1 \times 10^{-1}/5.4 \times 10^{-2}$    |  |
| Silver and compounds                 | $5.0 \times 10^{-2}$  | $5.0 \times 10^2$            | $4.1 \times 10^{-3†}/1.2 \times 10^{-4}$  | $2.3 \times 10^{-3}$                       |  |
| Strontium-90                         | -   | 8 pCi/L                      | -   | -  |  |
| 2,3,7,8-TCDD (dioxin)                | -   | -                            | $<1.0 \times 10^{-5} / <1.0 \times 10^{-8}$   | -  |  |
| Tetrachlorinated ethanes             | -   | -                            | 9.3*  | -  |  |
| 1,2,4,5-Tetrachlorobenzene           | $3.8 \times 10^{-2}$  | $4.8 \times 10^2$            | -   | -  |  |
| 1,1,2,2-Tetrachloroethane            | $1.7 \times 10^{-4}$  | $1.1 \times 10^2$            | 2.4*  | 9.0*                                       |  |
| Tetrachloroethanes                   | -   | -                            | 9.3*  | -  |  |
| Tetrachloroethylene                  | $8 \times 10^{-4}$  | $8.9 \times 10^3$            | $5.2^*/8.4 \times 10^{-1}$ *  | $1.0 \times 10^{1^*}/4.5 \times 10^{-1}$ * |  |
| 2,3,4,6-Tetrachlorophenol            | -   | -                            | -   | $4.4 \times 10^{-1}$                       |  |
| Thallium and compounds               | $1.3 \times 10^{-2}$  | $4.8 \times 10^2$            | $1.4^*/4.0 \times 10^{-2}$ *  | $2.1 \times 10^{-3}$ *                     |  |
| Toluene                              | 14  | 420                          | $1.7 \times 10^{1^*}$   | $6.3^*/5.0^*$                              |  |
| Toxaphene                            | $7.1 \times 10^{-7}$  | $7.3 \times 10^7$            | $7.3 \times 10^{-4}/2.0 \times 10^{-7}$   | $2.1 \times 10^{-4}/2 \times 10^{-7}$      |  |
| Tribromomethane (Bromoform)          | -   | -                            | -   | -  |  |
| Trichlorinated ethanes               | -   | -                            | $1.8 \times 10^{1^*}$   | -  |  |
| 1,1,1-Trichloroethane                | 18  | 1,000                        | -   | $3.1 \times 10^{1^*}$                      |  |
| 1,1,2-Trichloroethane                | $6 \times 10^{-4}$  | $4.2 \times 10^2$            | 9.4*  | -  |  |
| Trichloroethylene                    | $2.7 \times 10^{-3}$  | $8.1 \times 10^2$            | $4.5 \times 10^{1^*}/2.1 \times 10^{1^*}$   | 2.0*                                       |  |
| Trichloromonofluoromethane           | -   | -                            | -   | -  |  |
| 2,4,5-Trichlorophenol                | 2.8   | -                            | -   | -  |  |
| 2,4,6-Trichlorophenol                | $1.2 \times 10^{-3}$  | $3.6 \times 10^3$            | $9.7 \times 10^{-1}$ *  | -  |  |
| 2,4,5-Trichlorophenoxypropionic acid | -   | -                            | -   | -  |  |
| Trihalomethanes (total) b            | -   | -                            | -   | -  |  |
| Tritium                              | -   | -                            | -   | -  |  |
| Vinyl chloride                       | $2 \times 10^{-3}$  | $5.3 \times 10^{-1}$         | -   | -  |  |
| Zinc and compounds                   | -   | -                            | $1.3 \times 10^{-1}/1.1 \times 10^{-1}$   | $9.6 \times 10^{-2}/8.6 \times 10^{-2}$    |  |

TABLE 3.2 (Cont'd)

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<sup>a</sup> Clean Water Act.

<sup>b</sup> Federal water quality criteria (FWQC) are not legally enforceable standards but are potentially relevant and appropriate to CERCLA actions. CERCLA § 121 (d)(2)(B)(i) requires consideration of four factors when determining whether FWQC are relevant and appropriate: (1) the designated or potential use of surface or groundwater, (2) the environmental media affected, (3) the purposes for which such criteria were developed, and (4) the latest information available.

<sup>c</sup> An asterisk denotes lowest observed effect level. A dagger denotes hardness-dependent criteria (100 mg/L used).

<sup>d</sup> Not available.

Source: EPA 1988a.

### 3.1.3 Commonwealth of Massachusetts Water Quality Criteria

#### 3.1.3.1 Drinking Water

The Commonwealth of Massachusetts has adopted the Federal National Primary Drinking Water Regulations (40 CFR 141) as primary and secondary drinking water regulations for Massachusetts. The commonwealth adopted all requirements for siting, MCLs, monitoring, chemical analysis, reporting, public notification, and record keeping (Massachusetts General Law [MGL], Chap. 21, Secs. 26-53). With one exception, the MCLs for the Massachusetts primary drinking water regulations are the same as the federal MCLs given in Table 3.1. Massachusetts has adopted an MCL of 20 mg/L for sodium.

Secondary drinking water regulations apply to any substance in drinking water that may adversely affect the taste, odor, or appearance of water or that may adversely affect the public welfare. The state secondary drinking water standards are given in Table 3.3.

#### 3.1.3.2 Surface Water

The Commonwealth of Massachusetts has promulgated surface water quality standards for Class A waters. These standards, which apply to waters designated for use as a source of public water supply, are given in Table 3.4. Water-quality-based effluent limitations for Class I groundwaters are listed in Table 3.5. These standards limit the discharge of effluent to protect groundwater as a source of potable water. The minimum criteria are applicable to all waters of the commonwealth unless criteria specified for individual classes are more stringent.

**TABLE 3.3 Massachusetts Secondary Drinking Water Standards**

| Parameter                     | Standard     |
|-------------------------------|--------------|
| Chloride (mg/L)               | 250.0        |
| Color (units)                 | 15.0         |
| Copper (mg/L)                 | 1.0          |
| Corrosivity                   | Noncorrosive |
| Fluoride (mg/L)               | 2.0          |
| Foaming agents (mg/L)         | 0.5          |
| Iron (mg/L)                   | 0.3          |
| Manganese (mg/L)              | 0.05         |
| Odor (odor number)            | 3.0          |
| pH (standard units)           | 6.50-8.5     |
| Sulfate (mg/L)                | 250.0        |
| Total dissolved solids (mg/L) | 500.0        |
| Zinc (mg/L)                   | 5.0          |

Source: Gates et al. 1986.

TABLE 3.4 Massachusetts Class A Water Quality Standards

| Parameter                                | Criteria  |
|--|---|
| <u>All Waters</u>                        |   |
| Aesthetic                                | <p>All waters shall be free from pollutants in concentrations or combinations that:</p> <ul style="list-style-type: none"> <li>(a) Settle to form objectionable deposits;</li> <li>(b) Float as debris, scum, or other matter to form nuisances;</li> <li>(c) Produce objectionable odor, color, taste, or turbidity; or</li> <li>(d) Result in the dominance of nuisance species.</li> </ul>   |
| Radioactive substances                   | <p>Shall not exceed the recommended limits of the EPA's National Drinking Water Regulations.</p>  |
| Tainting substances                      | <p>Shall not be in concentrations or combinations that produce undesirable flavors in the edible portions of aquatic organisms.</p>   |
| Color, turbidity, total suspended solids | <p>Shall not be in concentrations or combinations that would exceed the recommended limits on the most sensitive receiving water use.</p>   |
| Oil and grease                           | <p>The water surface shall be free from floating oils, grease, and petrochemicals. Any concentrations or combinations in the water column or sediments that are aesthetically objectionable or deleterious to the biota are prohibited. For oil and grease of petroleum origin, the maximum allowable discharge concentration is 15 mg/L.</p>   |
| Nutrients                                | <p>Shall not exceed the site-specific limits necessary to control accelerated or cultural eutrophication.</p>   |
| Other constituents                       | <p>Waters shall be free from pollutants in concentrations or combinations that:</p> <ul style="list-style-type: none"> <li>(a) Exceed the recommended limits on the most sensitive receiving water use;</li> <li>(b) Injure, are toxic to, or produce adverse physiological or behavioral responses in humans or aquatic life; or</li> <li>(c) Exceed site-specific safe exposure levels determined by bioassay using sensitive species.</li> </ul> |

TABLE 3.4 (Cont'd)

| Parameter               | Criteria  |
|-------------------------|---|
| <u>Inland Waters</u>    |   |
| Dissolved oxygen        | Shall be minimum of 5.0 mg/L in warm water fisheries and a minimum of 6.0 mg/L in cold water fisheries.   |
| Temperature             | Shall not exceed 83°F (28.3°C) in warm water fisheries or 68°F (20°C) in cold water fisheries nor shall the rise resulting from artificial origin exceed 4.0°F (2.2°C). |
| pH                      | As naturally occurs.  |
| Total coliform bacteria | Shall not exceed a log mean for a set of samples of 50 per 100 mL during any monthly sampling period.   |
| Turbidity               | None other than of natural origin.  |
| Total dissolved solids  | Shall not exceed 500 mg/L.  |
| Chlorides               | Shall not exceed 250 mg/L.  |
| Sulfates                | Shall not exceed 250 mg/L.  |
| Nitrate                 | Shall not exceed 10 mg/L as nitrogen.   |

Source: 314 Code of Massachusetts Regulations (CMR) 4.00.

Fort Devens has no surface water discharge points. The installation does discharge effluent, from the rapid infiltration beds, that must meet Class I requirements. Currently, Fort Devens is violating the nitrate standard for Class I groundwater and has applied for a variance from the state.

## 3.2 HAZARDOUS WASTE

### 3.2.1 Federal

Solid wastes are divided into the categories of hazardous and nonhazardous. For regulatory purposes, solid wastes are hazardous if they are among any of the following: (1) those listed in 40 CFR 261, Subpart D; (2) those having at least one of four characteristics listed in 40 CFR 261, Subpart C; or (3) those that contain a hazardous constituent listed in 40 CFR 261, Appendix VIII. A waste may be excluded from regulation by 40 CFR 261, Appendix IX. If it is not specifically or categorically excluded, a waste may still be hazardous

TABLE 3.5 Massachusetts Class I Groundwater Water-Quality-Based Effluent Limitations

| Parameter                      | Effluent Limitation<br>(mg/L except as noted)  |
|--------------------------------|--|
| Coliform bacteria              | Shall not be discharged in amount sufficient to (1) render groundwaters detrimental to public health, safety, or welfare or (2) impair the groundwater for use as a source of potable water. |
| Arsenic                        | 0.05   |
| Barium                         | 1.0  |
| Cadmium                        | 0.01   |
| Chlorides                      | 250.0  |
| Chromium                       | 0.05   |
| Copper                         | 1.0  |
| Fluoride                       | 2.4  |
| Foaming agents                 | 1.0  |
| Iron                           | 0.3  |
| Lead                           | 0.05   |
| Manganese                      | 0.05   |
| Mercury                        | 0.002  |
| Nitrate nitrogen (as nitrogen) | 10.0   |
| Nitrogen (total)               | 10.0   |
| Oil and grease                 | 15.0   |
| Total dissolved solids         | 1,000.0  |
| Total trihalomethanes          | 0.1  |
| Selenium                       | 0.01   |
| Silver                         | 0.05   |
| Sulfate                        | 250.0  |
| Zinc                           | 5.0  |
| Endrin                         | 0.0002   |
| Lindane                        | 0.004  |
| Methoxychlor                   | 0.01   |
| Toxaphene                      | 0.005  |
| Chlorophenoxys                 | 0.1  |
| 2,4,5-TP Silvex                | 0.01   |
| Radioactivity                  | Shall not exceed the maximum radionuclide contaminant levels as stated in the National Interim Primary Drinking Water Regulations.   |
| pH                             | 6.5-8.5 standard units or not more than 0.2 units outside of the naturally occurring range.  |

Source: 314 CMR 6.00.

unless it can be determined that it "is not capable of posing a substantial presence or potential hazard to human health or the environment when improperly treated, stored, transported or disposed of, or otherwise managed" (40 CFR 261.11).

Wastes, such as contaminated soils, can be characteristically hazardous (Subpart C) based on ignitability, corrosivity, reactivity, or exceedance of a prescribed concentration when extracted (extraction procedure, or EP, toxicity). Extraction procedure toxicity tests the leachability of 14 chemical components regulated by the National Interim Primary Drinking Water Standards (40 CFR 141). In 1986, EPA proposed to amend the EP toxicity test by expanding the list of components and introducing a new leaching procedure known as the toxicity characteristic leaching procedure (TCLP).

On March 5, 1990, EPA issued the final toxicity characteristic (TC) rule. The rule was published in the Federal Register on March 29 (55 FR 11798) and became effective for all generators on March 29, 1991. Table 3.6 lists the TC compounds and their regulatory levels. The TC rule applies to the 14 compounds regulated under the EP toxicity rule, as well as 25 additional compounds. Wastes identified as hazardous under the TC will also become hazardous substances under Section 101(14) of CERCLA.

A solid waste exhibits the characteristic of ignitability if it meets any of the following criteria:

- It is a nonaqueous liquid and has a flash point below 140°F;
- It is not a liquid and can cause fire through friction, absorption of moisture, or spontaneous chemical change;
- When ignited, it burns so vigorously and persistently that it creates a hazard; or
- It is an ignitable compressed gas or an oxidizer.

A solid waste is characteristically corrosive if (1) it has a pH less than or equal to 2 or greater than or equal to 12.5 or (2) it is a liquid that corrodes steel (under prescribed conditions).

A solid waste is reactive if it is capable of (1) detonation or explosive reaction when subjected to a strong initiating source or heated under confinement or (2) detonation or explosive decomposition at standard temperature and pressure. Explosives are included under reactivity. Two classes of explosives are recognized -- Class A and Class B. Class A contains detonating explosives, including priming devices (such as lead azide) and high explosives (such as TNT, tetryl, and black powder). Class B contains rapidly burning explosives (such as propellants). Some of each class are present at Fort Devens.

TABLE 3.6 Toxicity Characteristic Constituents and Regulatory Levels

| Constituent                     | EPA Waste No. | Regulatory Level (mg/L) |
|---------------------------------|---------------|-------------------------|
| Arsenic                         | D004          | 5.0                     |
| Barium                          | D005          | 100.0                   |
| Benzene                         | D018          | 0.5                     |
| Cadmium                         | D006          | 1.0                     |
| Carbon tetrachloride            | D019          | 0.5                     |
| Chlordane                       | D020          | 0.03                    |
| Chlorobenzene                   | D021          | 100.0                   |
| Chloroform                      | D022          | 6.0                     |
| Chromium                        | D007          | 5.0                     |
| o-Cresol <sup>a</sup>           | D023          | 200.0                   |
| m-Cresol <sup>a</sup>           | D024          | 200.0                   |
| p-Cresol <sup>a</sup>           | D025          | 200.0                   |
| Cresol <sup>a</sup>             | D026          | 200.0                   |
| 2,4-D                           | D016          | 10.0                    |
| 1,4-Dichlorobenzene             | D027          | 7.5                     |
| 1,2-Dichloroethane              | D028          | 0.5                     |
| 1,1-Dichloroethylene            | D029          | 0.7                     |
| 2,4-Dinitrotoluene <sup>b</sup> | D030          | 0.13                    |
| Endrin                          | D012          | 0.02                    |
| Heptachlor (and its hydroxide)  | D031          | 0.008                   |
| Hexachlorobenzene <sup>b</sup>  | D032          | 0.13                    |
| Hexachloro-1,3-butadiene        | D033          | 0.5                     |
| Hexachloroethane                | D034          | 3.0                     |
| Lead                            | D008          | 5.0                     |
| Lindane                         | D013          | 0.4                     |
| Mercury                         | D009          | 0.2                     |
| Methoxychlor                    | D014          | 10.0                    |
| Methyl ethyl ketone             | D035          | 200.0                   |
| Nitrobenzene                    | D036          | 2.0                     |
| Pentachlorophenol               | D037          | 100.0                   |
| Pyridine <sup>b</sup>           | D038          | 5.0                     |
| Selenium                        | D010          | 1.0                     |
| Silver                          | D011          | 5.0                     |
| Tetrachloroethylene             | D039          | 0.7                     |
| Toxaphene                       | D015          | 0.5                     |

TABLE 3.6 (Cont'd)

| Constituent           | EPA Waste No. | Regulatory Level (mg/L) |
|-----------------------|---------------|-------------------------|
| Trichloroethylene     | D040          | 0.5                     |
| 2,4,5-Trichlorophenol | D041          | 400.0                   |
| 2,4,6-Trichlorophenol | D042          | 2.0                     |
| 2,4,5-TP (Silvex)     | D017          | 1.0                     |
| Vinyl chloride        | D043          | 0.2                     |

<sup>a</sup>If o-, m-, and p-cresol concentrations cannot be differentiated, then the total cresol (D026) concentration is used.

<sup>b</sup>Because the quantification limit is greater than the regulatory level, the quantification limit becomes the regulatory level.

Source: 55 FR 11804.

### 3.2.2 Commonwealth of Massachusetts

In determining whether a waste will be regulated as hazardous, the MDEP first considers the following criteria (310 CMR 30.110-111 as amended by G.L.c.21E):

- The extent to which the waste meets the state's statutory definition and
- The extent to which other state or federal agencies with experience and expertise in regulating and managing hazardous substances have identified or characterized a component of the waste as hazardous or potentially hazardous to public health, safety, or welfare or to the environment.

In addition to the above criteria, the MDEP applies specific criteria to identify wastes to be regulated as hazardous (310 CMR 30.140):

- It is a hazardous waste listed in 310 CMR 131-133, 136;
- It is a mixture of waste and one or more listed hazardous wastes when a hazardous waste listed in 310 CMR 30.130-136 is first added to the waste;
- It can be measured or detected for the characteristics of ignitability, corrosivity, reactivity, and EP toxicity;
- It is a residue remaining in an empty container as defined in 310 CMR 30.010; or
- It is generated in a product or raw material storage tank, a product or raw material pipeline, or in a manufacturing process unit.

Pursuant to 310 CMR 144, the state retains authority to further identify hazardous waste when a waste is not identified or otherwise described in 310 CMR 30.120-125 or 30.130-136. That waste is subject to 310 CMR 30.000 under the following conditions:

- The MDEP, in the course of inspecting any premises, has reason to believe that the waste being generated, transported, stored, treated, used, or disposed of meets the general criteria of a hazardous waste or
- The MDEP believes that an imminent threat exists pursuant to MGL Chap. 21C, Secs. 9 and 11.

Massachusetts also designates hazardous waste numbers for special use. M099 is used for nonhazardous waste that is shipped using a hazardous waste manifest. M144 is used for wastes further identified pursuant to 310 CMR 144. These two numbers may be applied to wastes generated by small-quantity generators or to designate "special wastes." Table 3.7 lists several wastes classified as hazardous by Massachusetts that are not included in federal lists of hazardous wastes.

Massachusetts requirements and procedures for performing remedial actions (effective October 1988) are given in 310 CMR 40.00. The MDEP Commissioner promulgates these regulations pursuant to MGL, Chap. 21E, Secs. 3 and 6.

**TABLE 3.7 Wastes Designated by Massachusetts as Hazardous that Are Not Included on Federal Lists**

| Mass.<br>Waste<br>Number | Waste Description  |
|--------------------------|--|
| M001                     | Waste oil that is not otherwise hazardous waste pursuant to 310 CMR 30.120-30.136.   |
| M002                     | Wastes that contain polychlorinated biphenyls (PCBs) in concentrations equal to or greater than 50 parts per million (ppm).  |
| M003                     | Any spent solvent that consists of a mixture of solvents listed under two or more of EPA waste Nos. F001, F002, F003, F004, and F005.  |
| M004                     | Waste generated in the manufacture of paint (e.g., oils, shellac, varnish, stains, lacquer, latex, enamel, alkyds, urethanes, acrylics, casein) that is not otherwise regulated as hazardous waste pursuant to 310 CMR 30.120-30.125 (characteristics of hazardous waste) or 30.130-30.136 (lists of hazardous wastes) if: <ol style="list-style-type: none"> <li>(1) The paint is formulated with one or more ingredients that are listed as hazardous constituents in 310 CMR 30.160 or</li> <li>(2) The paint is formulated with any ingredient that contains 1% or more by weight of hazardous constituents listed in 310 CMR 30.160.</li> </ol> |

Source: 310 CMR 130.

The exceptions to hazardous waste regulation that are applicable to Fort Devens are as follows:

- Domestic sewage,
- Any mixture of domestic sewage and other wastes passing through a sewer system to a publicly owned treatment works for treatment;
- Industrial wastewater discharges that are point source discharges permitted pursuant to MGL, Chap. 21, Sec. 43;
- Household waste;
- Samples collected for the sole purpose of testing to determine their properties, characteristics, or composition (when complying with given requirements);
- Explosives that are disposed of by, or if the disposal is supervised by, U.S. Army Explosive Ordnance personnel, if the explosives are generated by a small-quantity generator;
- Explosives regulated by the Department of Public Safety pursuant to MGL, Chap. 148, Sec. 9 and regulations codified at 527 CMR 13.00 et seq., if such explosives are generated by a small-quantity generator; and
- Wastes stored and burned by a resource recovery facility managing only municipal solid waste if it receives and burns only:
  - Household waste or
  - Commercial or industrial solid waste that does not contain hazardous waste.

### 3.3 HAZARDOUS AND SOLID WASTE AMENDMENTS OF 1984

The Hazardous and Solid Waste Amendments (HSWA) of 1984 greatly expanded authorities under RCRA for requiring corrective action for releases of hazardous wastes and constituents at facilities that manage hazardous wastes. To protect human health and the environment, the amendments also required the EPA to establish levels or treatment methods that substantially reduce the toxicity of a waste or the likelihood of the migration of hazardous constituents from the waste.

Pursuant to HSWA, RCRA authorizes the EPA to require corrective action via an administrative order or as part of a permit whenever there is or has been a release of hazardous waste or hazardous constituents into the environment. HSWA further directs the EPA to require corrective action beyond the facility boundary on a case-by-case basis. The EPA interprets corrective action as the full range of possible actions, from studies and short-term solutions to complete cleanups. Where applicable, on-site treatment, storage, and disposal at CERCLA sites must meet RCRA technical requirements for the design and operation or closure of the facility.

On November 7, 1986, the EPA promulgated a final rule (51 FR 40572) implementing RCRA Section 3004(e). This rule established the general framework for the land disposal restrictions program and the treatment standards for listed hazardous wastes from nonspecific sources: solvent-containing wastes F001-F005 and dioxin-containing wastes F020-F023 and F026-F028 (54 FR 26595). Effective November 8, 1986, the HSWA prohibited land disposal (except by underground injection into deep wells) of solvent wastes F001-F005 and dioxin wastes F020-F023 (54 FR 26595).

The HSWA established a program to eliminate land disposal of hazardous wastes, unless the EPA determines that such disposal does not endanger human health and the environment. Accordingly, the statute requires the EPA to systematically evaluate all RCRA wastes to determine if land disposal bans are appropriate.

These amendments also specify effective dates for prohibiting land disposal of hazardous wastes unless they meet one of two criteria: (1) the waste meets EPA treatment standards that minimize short- and long-term threats resulting from land disposal or (2) through an approved, site-specific petition, it can be demonstrated to a reasonable degree of certainty that the waste will not migrate from the disposal unit for as long as it remains hazardous. Table 3.8 lists EPA's schedule for implementing land disposal restrictions for hazardous wastes.

The treatment standards for solvent wastes are based on their inherently toxic characteristics, effects on clay and synthetic liners, and effects on other wastes and on the ability of treatment technologies to remove, destroy, or immobilize hazardous constituents in the wastes. Because of variances and exemptions, some of the banned wastes continue to be land disposed. Tables 3.9-3.11 list the wastes regulated by the land disposal restrictions and their treatment standards.

The ban on landfilling also includes:

- The disposal of bulk, noncontainerized liquids (hazardous or nonhazardous) in facilities permitted under RCRA;
- The disposal of hazardous waste into or above any formation within 0.25 mi of an underground source of drinking water;

**TABLE 3.8 EPA Schedule for Implementing Land-Ban Regulations**

| Waste                                 | Effective Date |
|---------------------------------------|----------------|
| Solvent-containing wastes             | Nov. 8, 1986   |
| Dioxin-containing wastes              | Nov. 8, 1986   |
| California-list wastes                | July 8, 1987   |
| One-third of wastes                   | Aug. 8, 1988   |
| Two-thirds of wastes                  | June 8, 1989   |
| All remaining listed hazardous wastes | May 8, 1990    |
| Characteristic hazardous wastes       | May 8, 1990    |

**TABLE 3.9 Treatment Standards for Wastes Contaminated with F001-F005 Solvents**

| F001-F005<br>Solvent Constituents         | Standard (mg/L)                            |                                      |
|---|--|--------------------------------------|
|   | Wastewater<br>Containing<br>Spent Solvents | All Other<br>Spent Solvent<br>Wastes |
| Acetone                                   | 0.05                                       | 0.59                                 |
| n-Butyl alcohol                           | 5.0  | 5.0                                  |
| Carbon disulfide                          | 1.05                                       | 4.81                                 |
| Carbon tetrachloride                      | 0.05                                       | 0.96                                 |
| Chlorobenzene                             | 0.15                                       | 0.05                                 |
| Cresols (and cresylic acid)               | 2.82                                       | 0.75                                 |
| Cyclohexanone                             | 0.125                                      | 0.75                                 |
| 1,2-Dichlorobenzene                       | 0.65                                       | 0.125                                |
| Ethyl acetate                             | 0.05                                       | 0.75                                 |
| Ethyl benzene                             | 0.05                                       | 0.053                                |
| Ethyl ether                               | 0.05                                       | 0.75                                 |
| Isobutanol                                | 5.0  | 5.0                                  |
| Methanol                                  | 0.25                                       | 0.75                                 |
| Methylene chloride                        | 0.20                                       | 0.96                                 |
| Methylene chloride <sup>a</sup>           | 12.7                                       | 0.96                                 |
| Methyl ethyl ketone                       | 0.05                                       | 0.75                                 |
| Methyl isobutyl ketone                    | 0.05                                       | 0.33                                 |
| Nitrobenzene                              | 0.66                                       | 0.125                                |
| Pyridine                                  | 1.12                                       | 0.33                                 |
| Tetrachloroethylene                       | 0.079                                      | 0.05                                 |
| Toluene                                   | 1.12                                       | 0.33                                 |
| 1,1,1-Trichloroethane                     | 1.05                                       | 0.41                                 |
| 1,1,2-Trichloro-1,2,2-<br>trifluoroethane | 1.05                                       | 0.96                                 |
| Trichloroethylene                         | 0.062                                      | 0.091                                |
| Trichlorofluoromethane                    | 0.05                                       | 0.96                                 |
| Xylene                                    | 0.05                                       | 0.15                                 |

<sup>a</sup>From the pharmaceutical industry.

Source: 51 FR 40572.

**TABLE 3.10 Treatment Standards for Dioxin Wastes**

| Dioxin                       | Concentration (ppm) |
|------------------------------|---------------------|
| Hexachlorodibenzo-p-dioxins  | <0.001              |
| Hexachlorodibenzofurans      | <0.001              |
| Pentachlorodibenzo-p-dioxins | <0.001              |
| Pentachlorodibenzofurans     | <0.001              |
| Tetrachlorodibenzo-p-dioxins | <0.001              |
| Tetrachlorodibenzofurans     | <0.001              |
| 2,4,5-Trichlorophenol        | <0.05               |
| 2,4,6-Trichlorophenol        | <0.05               |
| 2,3,4,6-Tetrachlorophenol    | <0.10               |
| Pentachlorophenol            | <0.01               |

Source: 51 FR 40572.

- The disposal of bulk liquids in salt domes, salt beds, underground mines, or caves; and
- The use of waste oil as a dust suppressant if it is contaminated with hazardous waste (except ignitable wastes).

Five exceptions to the land disposal ban are provided: national capacity variance, no-migration petition, case-by-case extension, treatment variance, and treatment in surface impoundments. The exceptions are based on the following considerations:

1. At the time the land-ban rules were promulgated, a national capacity variance was established for the wastes. However, only the EPA can request a national capacity variance.
2. The no-migration demonstration must address whether the present or future migration of hazardous waste from the site will affect human health or the environment.
3. The case-by-case extension is not applicable if off-site capacity is not available for a waste that has been banned from disposal.
4. A treatment variance is relevant if a generator finds it difficult to meet an established standard.
5. Treatment of a waste in an impoundment is permitted if certain minimum technology standards are met and if the waste is removed within one year (RCRA Sec. 3005).

TABLE 3.11 Treatment Standards for California-List Wastes

| California-List Waste                                     | Treatment Standard | Comment   |
|---|--------------------|---|
| Free cyanides   | 1,000 mg/L         | The PFLT <sup>a</sup> is recommended for determining the liquidity; method 9010 is recommended for testing the liquid portion.  |
| Metals (elements or compounds)                            |                    |   |
| Arsenic   | 500 mg/L           |   |
| Cadmium   | 100 mg/L           |   |
| Chromium  | 500 mg/L           | The PFLT is recommended for determining the liquidity; see Chapter 3 of SW-846 for recommended test methods.  |
| Lead  | 500 mg/L           |   |
| Mercury   | 20 mg/L            |   |
| Nickel  | 134 mg/L           |   |
| Selenium  | 100 mg/L           |   |
| Thallium  | 130 mg/L           |   |
| Corrosives  | ≤2.0 pH            | The PFLT is required for determining the liquidity; see 40 CFR 261.22 (A)(1) for the required test.   |
| Polychlorinated biphenyls <sup>b</sup>                    | 50 ppm             | Both liquid and solid portions of waste must be tested.   |
| Halogenated organic compounds (HOCs) in dilute wastewater | 1,000 mg/L         | Applies to liquid hazardous waste consisting primarily of water with an HOC content of less than 1% or 10,000 mg/L; both liquid and solid portions of waste must be tested. |
| Other HOCs  | 1,000 mg/L         | Applies to all other liquid and solid wastes containing HOCs; both liquid and solid portions of waste must be tested.   |

<sup>a</sup>Paint filter liquids test.

<sup>b</sup>Applies to liquid wastes (as determined by the PFLT method) containing (1) any chemical substance limited to biphenyl molecule that has been chlorinated to varying degrees or (2) any combination of substances containing a substance listed in 40 CFR Part 266 or having any of the four hazardous characteristics listed in CFR 261, Subpart C.

Source: 52 FR 25760.

The EPA is preparing guidance for the second, third, and fourth exceptions. Land disposal under the HSWA is defined to include placement in a landfill, surface impoundment, waste pile, injection well, land treatment facility, salt dome or bed formation, underground mine or cave, or concrete vault or bunker. Restrictions apply to wastes to be disposed after the effective date of the prohibition. Wastes that are land disposed prior to the applicable effective date for prohibition do not have to be removed for treatment. However, any hazardous wastes that are removed after the effective date are subject to disposal restrictions and treatment provisions (40 CFR 268.2).

Pursuant to the HSWA, RCRA authorizes the EPA to require corrective action under an order or as part of a permit whenever there is or has been a release of hazardous waste or constituents into the environment. The HSWA further directs the EPA to require corrective action beyond the facility boundary on a case-by-case basis. The EPA interprets corrective action to cover the full range of possible actions, from studies and quick-fix measures to complete cleanups. Wherever applicable, on-site treatment, storage, or disposal of hazardous waste at CERCLA sites must meet RCRA technical requirements for the design and operation or closure of the facility. Individuals involved in such on-site activities are not required to comply with administrative requirements of RCRA.

### **3.4 REGULATIONS SPECIFIC TO FEDERAL FACILITIES**

#### **3.4.1 Superfund Amendments and Reauthorization Act of 1986**

The SARA, enacted on January 21, 1986, includes provisions for federal facilities, cleanup standards, and an environmental restoration program to be carried out at U.S. Department of Defense (DOD) facilities. The federal facilities provisions (Sec. 120) of SARA state that all federal facilities are subject to the same guidelines, rules, regulations, and criteria for hazardous substances that are applicable to any nonfederal facility. This applies in particular to preremedial activities, remedial actions, and evaluations under the National Contingency Plan. The EPA's preremedial activity procedures form the foundation for the Superfund Remedial Program. The agency has developed a structured process to determine what, if any, cleanup actions are appropriate for sites included in the national inventory of potential hazardous waste sites. The process has two major phases. The first phase leads to proposal of sites for the National Priorities List (NPL). This preremedial phase consists of discovery, preliminary assessment, site investigation, and scoring on the Hazard Ranking System. The second phase consists of remedial planning. Remedial actions at DOD or U.S. Department of Energy (DOE) facilities may be modified as necessary to protect national security interests.

The SARA provisions on cleanup standards (Sec. 121) state that remedial actions in which the volume, mobility, or toxicity of hazardous substances or contaminants is permanently and significantly reduced by treatment are preferred over passive actions, such as land disposal without treatment. Off-site transport and disposal without such treatment should be the least-preferred action if practicable treatment technologies are available. Any off-site transfer of hazardous substances must be to an approved facility. The unit receiving the hazardous substances must not be releasing any hazardous waste or constituent into the groundwater, surface water, or soil.

Remedial actions must be selected to attain a degree of cleanup that ensures protection of human health and the environment. Pollutants or hazardous substances remaining after completion of the remedial action are subject to all legally applicable or relevant and appropriate requirements (ARARs). Applicable requirements are cleanup or control standards or environmental limitations that specifically address a hazardous substance, remedial action, location, or circumstance at a CERCLA site. Relevant and appropriate requirements are cleanup standards, control standards, or environmental limitations that address site situations that are sufficiently similar to those encountered at a CERCLA site.

Section 121(d)(2) of CERCLA, as amended by SARA, also states that remedial actions should satisfy ARARs under the SDWA, CWA, and RCRA. It also requires specifically that MCLGs and federal water quality criteria (Table 3.1) should be satisfied where they are relevant and appropriate for the actual or potential release (EPA 1987).

Federal statutes specifically cited in SARA are the SDWA, CWA, Toxic Substances Control Act, Solid Waste Disposal Act, and Marine Protection Research and Sanctuaries Act. On-site remedial action is to attain at least the MCL standards of the SDWA and the water quality criteria of the CWA. MCLs include the national primary drinking water standards (40 CFR 141) and are enforceable standards used for developing remedial actions. In general, state standards that are more stringent than federal standards should be applied to any remedial action. Where no specific ARARs exist, pertinent health advisory levels should be identified through the use of reference doses, health effects advisories, EPA guidance (e.g., EPA 1988b), and other federal and state criteria.

Section 211 of SARA establishes the Defense Environmental Restoration Program (DERP). This program directs DOD to manage restoration monies provided in 1984 by Congress through the Defense Environmental Restoration Account. Funding is provided on a priority basis to identify and remedy sites containing chemical, biological, and low-level radiological wastes and unexploded ordnance; correct environmental damage that poses an actual or imminent danger to public health or the environment; carry out research, development, and demonstration to meet the goals of SARA; notify federal (i.e., EPA), state, and local authorities of activities; and provide annual reports to Congress. Goals of the program include the following:

1. Identification, investigation, research and development, and cleanup of contamination from hazardous substances, pollutants, and contaminants.
2. Correction of other environmental damage (such as detection and disposal of unexploded ordnance) that may create an imminent and substantial threat to the public health or welfare or to the environment.
3. Demolition and removal of unsafe buildings and structures, including buildings and structures at sites formerly used by the DOD or under the jurisdiction of the Secretary of Defense.

### **3.4.2 Department of the Army Regulations**

The Department of the Army (DA) regulation that effects the Installation Restoration Program (IRP) is contained in Army Regulation (AR) 200-1, Chapter 9, *Environmental Protection*

*and Enhancement*. It provides guidance for implementing remedial response activities at Army facilities and for conducting IRPs for real property under U.S. jurisdiction. It assigns responsibilities for IRP activities, determines policy, and requires that the use of funds be consistent with DERP objectives. It also mandates activities that are consistent with the NCP.

### 3.5 INSTALLATION RESTORATION PROGRAM

USATHAMA, acting on behalf of the Assistant Chief of Engineers, is required to execute the IRP in accordance with protocols established by the DA and AR 200-1 (Heppner 1989). USATHAMA responsibilities for restoration activities include (1) preliminary assessments and site inspections, (2) remedial investigations and feasibility studies, and (3) removal and remedial actions. USATHAMA provides support for interaction between installations and regulators and provides reporting information for notification requirements. Figure 3.1 illustrates the IRP process and Army terminology associated with activities. The details and objectives of the IRP are discussed in the following sections (EPA 1988b).

#### 3.5.1 Preliminary Assessment

After the discovery of a release or the potential for a release, the initial evaluation, or *preliminary assessment* (PA), is conducted. The purpose is to eliminate from further consideration those releases for which available data indicate that no real or potential threat to public health or the environment exists, to further evaluate the nature of real or potential releases, to determine if there is any potential need for a removal action, and to establish priorities for scheduling a site inspection. The PA involves records searches for available information on past and present activities and land uses, both on the site and in the surrounding area. Some of the sources are the installation environmental impact statement (if any) and supporting documentation, USATHAMA records, operational records, Army environmental offices, and state and local authorities.

#### 3.5.2 Site Inspection

A *site inspection* (SI) consists of a visual inspection of potential waste sites and routinely includes collection of samples. The purpose of the SI is to determine which releases pose no real or potential threat to public health and the environment; to determine if there is an immediate threat to individuals living or working near the release; and to collect data, where appropriate, to determine whether the site should be included on the NPL. The NPL serves as a basis to guide the allocation of Superfund resources among release sites; however, except as provided by CERCLA Section 111(e)(3), federal facilities listed on the NPL are not eligible for Superfund-financed remedial action.

#### 3.5.3 Remedial Investigation

Following the SI phase of site evaluation, the decision is made regarding further investigation. The next and more in-depth phase is a *remedial investigation* (RI), which emphasizes data collection and site characterization. The RI is undertaken by the lead agency

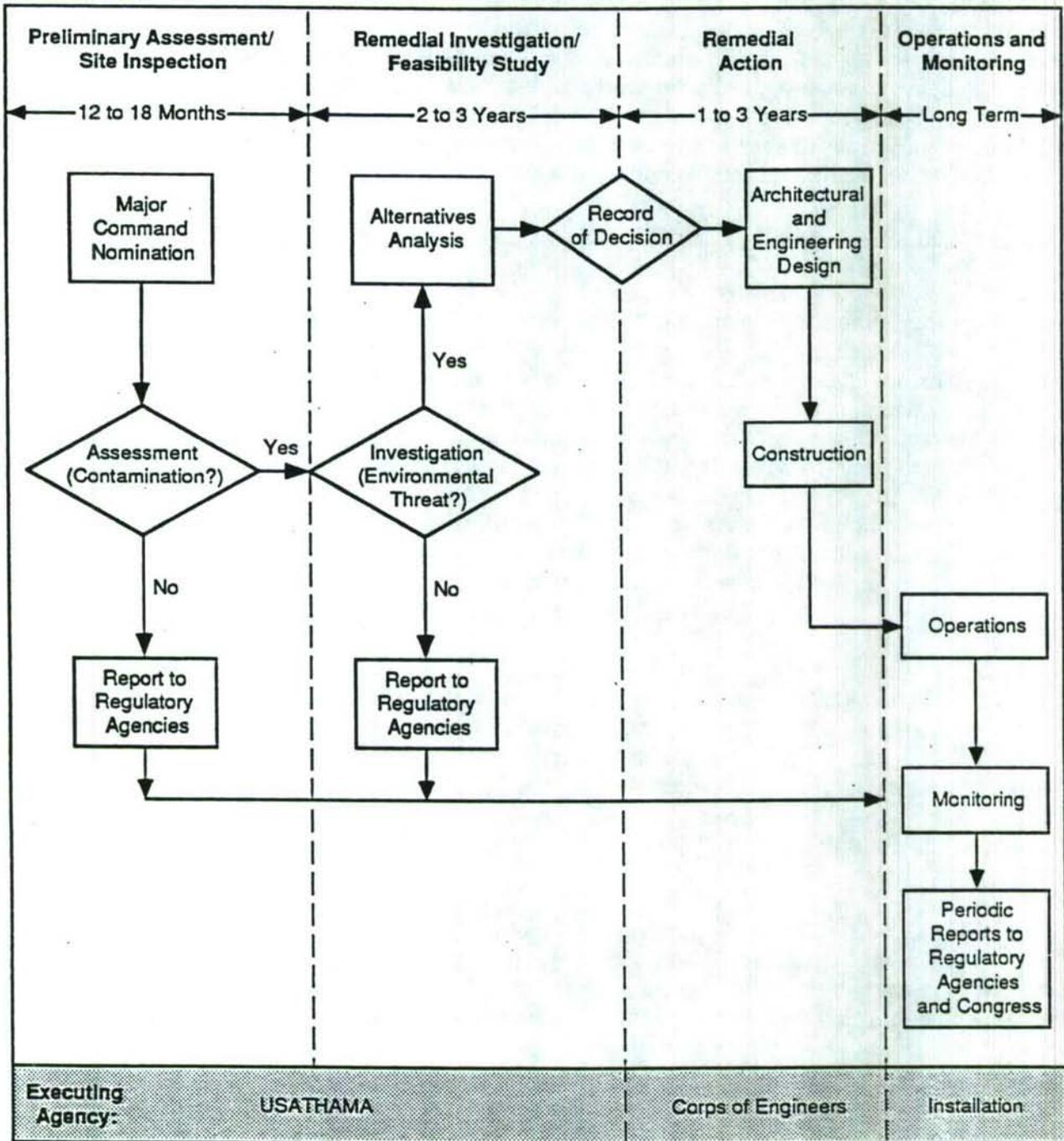


FIGURE 3.1 Installation Restoration Program Process (Source: Adapted from AMCCOM 1989)

or the potentially responsible party (PRP), if the PRP is to develop the cleanup proposal. Lead organizations for IRP projects may be the installation itself, USATHAMA, or the U.S. Army Corps of Engineers (USACE). The RI determines the nature and extent of the problem presented by the release through sampling, monitoring, and analysis as necessary; it provides information sufficient to determine the necessity for, and proposed extent of, remedial action. Part of the RI is an assessment of whether the threat can be minimized or mitigated by controlling the source of the contamination at or near the area where the contaminants were originally located. It must also assess whether additional actions will be necessary because the contaminants have migrated.

### 3.5.3.1 Scoping

Scoping is the initial planning phase of the RI. Those conducting and supporting the effort meet to (1) identify the types of actions that may be required; (2) determine whether interim actions are necessary or appropriate to mitigate potential threats, prevent further environmental damage, or reduce risks; and (3) develop the best sequence of actions for the site. Once the general site approach is determined, more specific aspects of the project, such as the types of data needed to support decisions regarding remedial response activities, can be developed. Adequate determination of the scope of a specific project depends on the amount and quality of available information. This information is used to develop a conceptual site model that focuses activities to minimize unnecessary sampling and analysis and to maximize data quality. The model incorporates information on waste sources, pathways, and receptors, which allows an evaluation of potential risks to human health and the environment.

One of the most important parts of scoping is the identification of data needs. This is accomplished by evaluating existing data and determining what additional data are required to characterize the site, define ARARs, and narrow the range of remedial alternatives being identified. When data needs are being determined, time and resource constraints must be balanced with the data quality objectives. Once the quality objectives are established, strategies for sampling and analysis are determined. The details and methods to be used are incorporated into a site-specific sampling and analysis plan, a quality assurance project plan, and a work plan for site remediation.

Once a conceptual understanding of the site has been developed, potential remedial action objectives are identified for each contaminated medium. A range of remedial action alternatives are then defined to meet these objectives. The range of alternatives should include at least one that emphasizes treatment that significantly reduces the toxicity, mobility, or volume of waste; one or more alternatives that use containment with little or no treatment; and a no-action alternative. These should be limited to relevant alternatives that have a reasonable potential for being implemented at the site. Identifying technologies at this stage helps to ensure that sampling and analysis produce the data required to evaluate those technologies for a specific site. For example, the specific heat of a waste needs to be known to evaluate a thermal destruction technology.

All activities of this phase are subject to established requirements of the needs agreed upon in the quality assurance plan. This plan presents the organization, objectives, functional activities, and specific quality assurance and quality control activities designed to achieve the data quality objectives for the investigation. All data collected during the RI are stored in the installation restoration data management system. In order to provide a defensible data base to support the conclusions of the RI, data are validated using USATHAMA protocols, EPA

guidance, or an equivalent method. This information and the RI are used further to support the risk assessment and the choice of remedial action.

A work plan is developed to document the decisions, and evaluations made during scoping to anticipate future tasks and otherwise provide a framework for the RI/FS. The plan also assigns responsibilities and sets the project schedules.

### 3.5.3.2 Site Characterization

Because on-site information can be limited, a phased RI may be conducted so that sampling efforts can be successively focused. Initial data collection efforts develop a general understanding of the site. Subsequent data collection focuses on filling previously unidentified gaps in the understanding of site characteristics and on gathering information necessary to evaluate remedial alternatives. During the initial phase, additional sampling may be required if the early results of field screening and analyses show that site conditions are significantly different than originally believed. RI data are used to define potential pathways of migration and receptor populations and to provide sufficient engineering data for developing and screening remedial action alternatives. Typical data categories are surface features, geology, soils, hydrology, hydrogeology, meteorology, human populations, land uses, and ecology.

The final objective of the field investigation is to define sources of contamination and determine the nature and extent of the contamination. Source characterization uses data that describe the types and quantities of waste that may have been released. Characteristics of the facility, such as storage areas and manufacturing operations, are used to identify source locations and the physical or chemical characteristics of wastes present at the source. Determining the nature and extent of contamination requires information on source location and physical site data (e.g., groundwater flow directions) to estimate current locations of contaminants that have migrated. Iterative sampling of soil borings and groundwater monitoring wells is used to document the locations and concentrations of contaminants that have migrated into the environment.

Baseline risk assessment is an integral part of the RI/FS process. There are four basic parts of this assessment: (1) data collection and analysis, (2) exposure assessment, (3) toxicity assessment, and (4) risk characterization. The site characterization and data collected during the RI can be used in a baseline risk assessment that evaluates the potential threat to human health and the environment in the absence of any remedial action. The results are used to help determine whether additional response action is necessary, to modify preliminary remediation goals, to help support selection of the no-action alternative where appropriate, to document the magnitude of risk at a site, and to identify the primary causes of that risk.

The purpose of data collection and analysis is to evaluate site data relevant to human health and to identify contaminants that will be the focus of the risk assessment process. Contaminants of concern may be selected because of their intrinsic toxicological properties; because of their quantities; or because they are in, or can move into, critical exposure pathways. Some contaminants of concern may be considered indicator chemicals because they represent the most toxic, persistent, or mobile substances.

An exposure assessment is conducted to estimate the magnitude of the real or potential human exposure, the frequency and duration of the exposure, and the pathways by which

humans can be exposed. Identification of pathways helps to explain how contaminants may have migrated from a source to an existing or potential point of contact. Once the source and release mechanism have been identified, the fate and transport of the contaminants are analyzed. To accomplish this, reasonable maximum estimates of exposure are developed for both current and future land use scenarios. The analyses include (1) identification of the type of contaminant release, exposed populations, and pathways of exposure and (2) estimation of exposure-point concentrations for specific pathways and contaminant intakes for each pathway.

The toxicity assessment considers (1) the types of adverse health effects associated with chemical exposures, (2) the relationship between the magnitude of exposure and adverse effects, and (3) related uncertainties, such as the weight of evidence for the potential carcinogenicity of a chemical. This aspect relies on existing toxicity information developed for specific chemicals. Available compilations of information on toxicity and dose response allow both a qualitative and a quantitative estimate of the risks associated with the chemicals.

Risk characterization is the final component of the risk assessment process. It involves estimating the potential risks of adverse health or environmental effects for each of the exposure scenarios developed during the exposure assessment. Chemical-specific toxicity information is compared against both the measured contaminant exposure levels and the levels predicted through fate and transport modeling to determine whether current or future levels at or near the site are of potential concern.

Ecological assessment (EA) is the part of the baseline risk assessment that evaluates the actual or potential effects of a contaminated site on the environment. It focuses on the effects of contaminants on ecosystems within or near the site and the environmental and biological factors that influence those effects.

The EA is conducted to provide the following information:

- Identification of the components of the local ecology (e.g., communities and populations) that could be affected by site contaminants and contaminated media,
- Identification of the actual or potential effects of the site contaminants on selected portions of the local biotic resources,
- Identification of areas that may pose unacceptable risks to the environment because of the effects of contaminated media on local biotic resources,
- An estimate of the magnitude and variation of toxic effects, and
- An estimate of the extent to which these effects are the result of the presence of hazardous and toxic chemicals (as opposed to other associated effects such as habitat disruption).

Because human health is inextricably linked to the quality of the environment, human health and environmental evaluation activities are conducted in parallel.

### 3.5.4 Feasibility Study

A *feasibility study* (FS) is undertaken by the lead agency or PRP to develop, evaluate, and select remedial actions. The purpose of the FS is to provide the decision maker with an assessment of remedial alternatives, including their relative strengths and weaknesses, and the trade-offs in selecting one alternative over another. The FS occurs in four phases: (1) establishment of protective remedial action objectives, (2) development of alternatives, (3) screening of alternatives (including treatability studies, if any), and (4) detailed analysis of alternatives (including selection of the preferred alternative).

#### 3.5.4.1 Establishment of Remedial Action Objectives

The initial step in the FS is development of remedial action objectives that address the contaminants and media of concern, potential exposure pathways, and preliminary remediation goals. The objectives consist of medium-specific or operable-unit-specific goals for protecting human health and the environment and include the contaminants of concern, exposure routes and receptors, and an acceptable contaminant level or range of levels for each exposure route (i.e., a preliminary remediation goal). The objectives should be as specific as possible without restricting the range of alternatives that can be developed. The preliminary goals are established from readily available information or frequently used standards and are refined or confirmed at the conclusion of the risk assessment. The approach for developing refined goals involves the following:

- Identifying chemical-specific ARARs,
- Identifying concentrations at which ARARs are not protective, based on limiting factors (e.g., multiple contaminants and exposure pathways), and
- Developing refined remediation goals that are protective of human health for all combinations of substances and exposure pathways being addressed.

#### 3.5.4.2 Development of Alternatives

Once remedial action objectives have been established, the lead agency or PRP can develop general response actions (e.g., no action, treatment, containment, excavation, pumping) that could be taken to satisfy the objectives for the site. This involves two primary activities. First, volumes or areas of waste that need to be addressed by response actions are determined from information on the nature and extent of contamination, ARARs, chemical-specific environmental fate and toxicity information, and engineering analyses. Second, the remedial action alternatives and associated technologies are screened to identify those that would be effective for the contaminants and media of interest at the site.

The information developed in these two activities is used to assemble technologies\* into alternatives for the overall site or a specific operable unit. In this step, the universe of potentially applicable technology types and process options is reduced by evaluating the options with respect to technical feasibility (also referred to as "implementability"), effectiveness, and cost. Technical feasibility considers both the technical and administrative feasibility of a technology. Evaluation eliminates technologies that are clearly unworkable. For example, in the event that the needed disposal capacity were not available at nearby facilities, the off-site disposal option would not be feasible. Effectiveness is based on a comparison of technology types. It focuses on the potential effectiveness of process options in handling the estimated areas or volumes of waste and meeting the remediation goals, the potential impacts to human health and the environment during the construction and implementation phase, and how proven and reliable the process is with respect to the contaminants and conditions at the site. Cost considerations are limited to relative capital and operation and maintenance (O&M) costs. Cost is estimated on the basis of engineering judgment, and each process is evaluated as high, medium, or low cost relative to other options in the same technology. Information on site characteristics is taken from the RI.

To assemble alternatives, the evaluators should combine general response actions and the process options chosen to represent the various technologies for each medium or operable unit. In situations where numerous alternatives are developed, it may be necessary to screen them to shorten the list for further evaluation. This aids in streamlining the FS while ensuring consideration of the most promising alternatives.

#### 3.5.4.3 Screening of Alternatives

Until this point in the FS, few details of the individual process options have been identified, and the operational scales or remediation time frames have not been fully characterized. In addition, the FS has not yet considered interactions among media that may influence activities. The alternatives have been developed to meet the remedial action objectives only for each medium of interest. During screening, the assembled alternatives should be evaluated to ensure that they protect human health and the environment from each potential pathway of concern or from those areas of the site being addressed as operable units. In refining alternatives, this protection may require that concentrations of contaminants be reduced to levels that cannot be reasonably be achieved by the leading options. The alternatives also may need modification to prevent exposure by another means.

Refinement of volumes or areas of contaminated media is important for sites at which continual releases from the source significantly affect contaminant levels in other media; the most ready example being the interaction possible between soil and groundwater. Such interactions may not have been addressed when the alternatives were developed. Interactions can be evaluated by grouping medium-specific response actions. If these interactions are present, the effect of source control actions on the remediation levels or time frames for other media should be evaluated.

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\*In this discussion, treatment technologies refer to general categories, such as thermal destruction or chemical treatment. Process options refer to specific processes within a technology, e.g., the technology of thermal destruction includes incinerators, and process options within this technology include incinerator types (rotary kiln, fluidized bed).

The initial evaluation determined whether the alternative could meet the remedial action objective. The refined alternatives are again evaluated for effectiveness, feasibility, and cost. Evaluation at this stage should be sufficiently detailed to differentiate the alternatives. Each alternative should be evaluated for effectiveness in providing protection and for reducing contaminant mobility, toxicity, or volume. Short-term effectiveness considers the construction and implementation phases, while long-term refers to the time after the remedial action is complete. Reduction of mobility, toxicity, or volume refers to changes in one or more characteristics of the hazardous substances that, as a result of treatment, decrease the inherent threats or associated risks.

Evaluation of feasibility considers the technical and administrative feasibility of constructing, operating, and maintaining a remedial action alternative. Technical feasibility refers to the ability to construct, reliably operate, and meet technology-specific regulations for process options. It also includes O&M, replacement, and monitoring of technical components into the future. Administrative feasibility refers to the ability to obtain permits and approvals; the availability of treatment, storage, and disposal services; and the requirements for, and availability of, specific equipment and technical specialists.

Absolute accuracy of the cost estimates is not essential during screening. However, as the alternatives are refined, comparative estimates must be prepared with relative accuracy sufficient to support screening decisions based on cost. Cost estimates can be based on cost curves, generic unit costs, vendor information, conventional cost estimating guides, and previous estimates for similar conditions as modified by site-specific information. Capital and O&M costs should be considered to include those costs that will be incurred both during and after the remedial action. A present worth analysis should be used to evaluate expenditures that occur over different time periods. A better comparative analysis of alternatives is possible when all costs are discounted to a common base year.

#### **3.5.4.4 Treatability Studies**

As site information is developed, the RI may identify additional data needs necessary to adequately evaluate alternatives during the detailed analysis. Treatability studies may provide the additional data to allow treatment alternatives to be fully developed and evaluated. The studies may also reduce cost and performance uncertainties, determine operating parameters, and better define relative costs of potential remedial technologies.

Treatability testing can be performed using bench-scale or pilot-scale techniques; however, testing generally includes preparation of a work plan, field sampling followed by bench- or pilot-scale testing, evaluation of data from field studies, and documentation of the results. The actual results are then compared with the estimates of the technology's effectiveness, feasibility, and cost. Major differences may necessitate retesting of the technology.

#### **3.5.4.5 Detailed Analysis of Alternatives**

During the detailed analysis, each alternative is assessed against specific evaluation criteria; the results are arrayed such that comparisons between alternatives can be made; and key trade-offs are identified. Nine evaluation criteria, some of which are related to human health evaluation and risk, have been developed to address statutory requirements as well as additional

technical and policy considerations that have proven to be important for choosing among remedial alternatives. These evaluation criteria serve as the basis for conducting the detailed analysis and for subsequently selecting an appropriate remedial action.

The first two criteria – overall protectiveness and compliance with ARARs – are threshold determinations and must be met before a remedy can be selected. Evaluation of the overall protectiveness of an alternative should focus on how well it achieves protection over time and reduces site risks.

The next five criteria are primary balancing criteria: long-term effectiveness and permanence; reduction of mobility, toxicity, or volume through the use of treatment; short-term effectiveness; feasibility; and cost. Risk information is an important factor in the analysis of effectiveness and permanence. It includes an evaluation of the residual risk at the site after response objectives have been met. The primary focus is on effectiveness of the controls that will be applied to manage risk posed by treatment residuals or any untreated wastes that may remain. The evaluation also considers the potential impacts on human health and the environment if the remedy fails.

The last two criteria – state acceptance and community acceptance – are considered modifying criteria and do not include risk information. These criteria are evaluated after the state regulatory agency and public have commented on the RI/FS report and the proposed plan. They are addressed once a final decision is being made and the record of decision (ROD) is being prepared.

#### **3.5.4.6 Selection of the Preferred Alternative**

After the completion of the RI/FS, the lead agency identifies a preferred alternative for the proposed cleanup of the site before presenting it for formal public comment. The detailed analysis, combined with the risk management judgments, provide the rationale for selecting a preferred alternative and preparing the proposed plan of remediation. A detailed analysis highlights the relative advantages and disadvantages of each alternative. The trade-offs, coupled with the risk management decisions, serve as the basis for the choice and provide a transition between the RI/FS and the development of the proposed plan. The preferred alternative must be protective, meet ARARs, and provide the best balance of trade-offs with respect to the five balancing criteria.

#### **3.5.5 Proposed Plan**

The preferred alternative for a site is presented to the public in the proposed plan. The plan provides a brief summary of all alternatives studied in the detailed analysis phase of the RI/FS, highlighting and explaining the key factors that led to the identification of the preferred alternative. The plan should use an appropriate level of detail and terminology to relay information about each alternative and its site-specific application. Table 3.12 contains the outline of the proposed plan. The discussion in the following sections are based on information in EPA Superfund guidance (EPA 1989).

**TABLE 3.12 Outline for the Proposed Plan**

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**Introduction**

- Site name and location
- Identification of lead and support agencies
- Purpose of the document:
  - fulfillment of statutory requirements
  - description of alternatives
  - identification of preferred alternative and explanation of rationale for its preference
  - companion document to the RI/FS and administrative file
  - involvement of public in remedy selection
- Description of public participation, with an emphasis on its importance

**Site Background**

- Brief overview of the site
- Site history

**Scope and Role of the Operable Unit or Response Action**

- Description of the scope of the problem to be addressed by the action
- Description of the role of the action within the overall site strategy
- Explanation of how the action addresses principal threats

**Summary of Site Risks**

- Overview of baseline risk assessment describing:
  - contaminated media
  - chemicals of concern
  - baseline exposure scenarios (routes of exposure, land uses)
  - current and potential site risks
- Ecological risks, as appropriate

**Summary of Alternatives**

Description of each alternative evaluated in the detailed analysis of the FS

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Source: EPA 1989.

Three separate statutory requirements of CERCLA provide the framework for the proposed plan. Section 113(k)(2)(B) establishes the minimum procedures for public involvement in selecting a response action. Under this requirement, the plan must provide notice to potentially affected persons and the public, as well as a brief analysis of the remedial plan and alternative plans that were considered. It must also provide a reasonable opportunity for comment and fully explain the plan. Section 117(a) establishes the minimum public participation requirements for remedial activities: publication of a notice, a brief analysis of the proposed plan, and a provision to make the plan available to the public. Following this, a reasonable opportunity for submission of written comments must be provided, along with the opportunity for a public meeting and oral comments. Section 121(f)(1)(G) specifies the minimum involvement EPA should afford to the state in the decision process. Notice and the opportunity to comment must be provided to the state, followed by a response to the comments of the state.

#### **3.5.5.1 Purpose of the Proposed Plan**

The purpose of the proposed plan is to facilitate public participation in the remedy selection by:

- Identifying the preferred alternative for a remedial action at a site or operable unit and explaining the reasons for the preference,
- Describing other remedial options that were considered in detail in the RI/FS report,
- Soliciting public review and comment on all of the alternatives described, and
- Providing information on how the public can be involved in the remedy selection process.

#### **3.5.5.2 Scope and Role of Operable Units or Response Actions**

This section of the proposed plan summarizes the lead agency's overall strategy for remediating the site and describes how the action being considered in the proposed plan fits into the overall strategy for the site. It describes the rationale for each operable unit and the sequence of events for each. It is an indication of how and through what type of action or series of actions the principal threats posed by the site will be addressed. By providing a rationale for the actions to be taken in response to the identified threat, this section of the proposed plan provides the basis for the finding made in the ROD that addresses whether the selected remedy satisfies the preference for using treatment as a principal element.

#### **3.5.5.3 Summary of Site Risks**

A summary of the extent of contamination at the site and of the risks posed to human health and the environment is presented using information developed during the RI. The summary of site risks includes findings made in the baseline risk assessment. The key elements include identification of contaminants of concern and the affected media, description of exposure

pathways and the potentially exposed population, and discussion of the acceptable environmental risks and how current risks compare to the remediation goals. This section relays an appropriate understanding of the risks posed by the site; therefore, the description of site risks does not rely solely on standard numeric risk representations, but is accompanied by a discussion that explains carcinogenic and noncarcinogenic effects and their meaning in terms of risk to an actually or potentially exposed population.

#### **3.5.5.4 Summary of Alternatives**

The summary of alternatives provides a brief narrative of the alternatives that were studied in the detailed analysis phase of the RI/FS. The summary specifies the treatment technologies, engineering controls, institutional controls, quantities of waste handled, implementation requirements, estimated construction and O&M costs, and the estimated implementation time associated with each remedy proposed for the site.

The summary also incorporates the major ARARs associated with each option within the alternative. For example, for treatment alternatives, the ARARs associated with treating hazardous waste may be RCRA land disposal regulations or RCRA incineration standards. These should be discussed and an explanation given of how the alternative has been structured to comply as appropriate.

#### **3.5.6 Record of Decision (ROD)**

The components of the ROD are the declaration, decision summary, and responsiveness summary. The purpose of the ROD is to document the remedial action plan for a site or an operable unit. Table 3.13 presents an outline for the ROD.

##### **3.5.6.1 Declaration**

The three primary objectives of the declaration are to (1) serve a legal function by certifying that the remedy selection process was carried out in accordance with the requirements of CERCLA and the NCP; (2) provide a technical document that outlines the engineering components and remediation goals of the selected remedy; and (3) provide the public with a condensed source of information about the history, characteristics, and risks posed by the conditions at the site, as well as a summary and an evaluation of the cleanup alternatives considered and the rationale for the selected remedy.

##### **3.5.6.2 Decision Summary**

The decision summary is an overview of the site-specific factors and analysis that led to the selection of the remedy for the site or operable unit. In general, it includes the history of the site and the contamination, a description of the alternatives evaluated, an analysis leading to the final remedy selection, and an explanation of how the selected remedy satisfies the statutory requirements. Although much of this information is similar to that of the declaration, it provides greater detail and a supporting rationale for the declaration.

### 3.5.6.3 Responsiveness Summary

The responsiveness summary is the third component of the ROD and serves several purposes: (1) it provides the lead agency with information about community preferences regarding both the remedial alternatives and general concerns about the site, (2) it demonstrates how public comments were integrated into the decision-making process, and (3) it allows EPA to respond to comments as a part of the record. This provides any court that reviews the record an opportunity to decide whether EPA responded reasonably to comments. It is a concise and complete summary of significant comments received from the public (including PRPs) during the public comment period and is accompanied by the lead agency's responses to the comments.

**TABLE 3.13 Outline for the Record of Decision**

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**Declaration**

- Site name and location
- Statement of basis and purpose
- Assessment of the site
- Description of the selected remedy
- Statutory determinations
- Signature and support agency acceptance of the remedy

**Decision Summary**

- Site name and location
- Site history and enforcement activities
- Highlights of community participation
- Scope and role of the operable unit
- Site characteristics
- Summary of the site risks
- Description of alternatives
- Summary of comparative analysis of alternatives
- Selected remedy
- Statutory determinations

**Responsiveness Summary**

- Community preferences
  - Integration of comments
- 

Source: EPA 1989.

### 3.5.7 Remedial Action

The remedial action begins after completion and approval of the remedial design. The type of agreement used to initiate the remedial action depends on the party that will implement the action. The types of agreements are different for federal lead, state lead, and PRP lead actions. Since Fort Devens is a federal lead site, this discussion is limited to those types of agreements appropriate for that scenario (EPA 1989).

The following deliverables will be required for the remedial design (RD) and remedial action (RA) phases:

- RD/RA work plan
- Preliminary design (30%) of the alternative
- Intermediate design (60%) of the alternative
- Pre-final design (95%) of the alternative
- Final design of the alternative
- Construction QA/QC plan
- Contingency plan
- Operating and maintenance plan
- Report of completion of the project.

The Army initiates remedial action for their federal-land sites and obtains the approval of the EPA regional project manager (RPM) and the state. It is the responsibility of the Army to procure a contractor and initiate the remedial action. The ultimate responsibility for the remedial action is retained by Fort Devens.

The procurement process is accomplished by formally advertising a fixed-price contract. A site inspection by bidders may be necessary to provide the scope of the project or to answer questions regarding design or implementation. The U.S. Army Corps of Engineers (USACE) is responsible for reviewing bids and submitting the bid documents for government review.

#### 3.5.7.1 Implementation

Records and reports of all activities are maintained and are part of the final certification of the remedial action. Monitoring and oversight of construction activities are an integral part of the action. During all on-site construction, the Army provides a full-time inspector who is authorized to stop all activities that are deemed not in compliance with all requirements of the contract, including those relating to environmental compliance. The USACE is responsible for inspecting the site, and the EPA is present in an oversight capacity.

Detailed progress reports are required for the duration of the remedial action. These reports are used to monitor progress and provide a chronological record of all site activities. They include such items as percentage estimates of completion of the project, costs to date, community relations activities, change orders, and any problems encountered.

As the remedial action nears completion, a prefinal construction conference with the contractor is required. The objective is to discuss procedures and requirements for project completion and closeout. The Army and EPA are the primary participants, but they may request that the state and the PRPs be present at the meeting. Agenda items for consideration include:

- Submission of the final O&M plan,
- Cleanup responsibilities,
- Demobilization activities,
- Security requirements,
- Prefinal inspection schedule,
- Facility startup and testing, and
- Operator training.

#### **3.5.7.2 Post-Remedial Action Activities**

As the agency with primary responsibility for construction inspections, the USACE leads the prefinal inspection. Other participants are the parties that attended the prefinal construction conference. The inspection is a walk-through of the entire project site. The RPM and state then determine whether the project has been completed according to contract requirements and the EPA-approved remedy. Any outstanding items must be noted and resolved. Start-up and testing of a treatment system built as part of the remedial action is considered part of the remedial action. The contractor certifies that the equipment performance meets the specifications and completes any retesting that may be required. The prefinal inspection report includes all outstanding construction items and required actions, a schedule, and a date for the final inspection.

The final inspection is a walk-through of the project site using the prefinal report as a checklist. The RPM and state determine whether all outstanding items have been resolved. If any issues are unresolved, another inspection is required.

Within 60 days of satisfactory completion of the final inspection, a remedial action report is prepared and submitted to the RPM. If the remedial action is deemed complete, the EPA Regional Administrator provides written notice of acceptance to the USACE. The EPA region can then recommend that a site be deleted from the NPL if the EPA, in consultation with the state, has determined that responsible parties have completed all appropriate response actions.

For many sites, ongoing O&M activities are associated with the completed remedial action. The date certified in the remedial action report is the date on which the project is

complete, the remedy is operational, and O&M begins. The conditions of the O&M period are agreed upon by the lead agency and the party assuming responsibility for O&M. When O&M activities are completed, a report is submitted to EPA containing a description of O&M activities: results of site monitoring, indicating that the remedy meets the performance criteria, and, if necessary, an explanation of additional O&M to be conducted for the site.

### 3.6 COMMUNITY RELATIONS

The Superfund community relations effort promotes two-way communication between members of the public, including PRPs, and the lead agency responsible for response actions. The community relations program consists of all those activities conducted throughout the planning and implementation of response actions.

#### 3.6.1 Community Involvement Objectives

The overall objectives of community relations are to accomplish the following (EPA 1988b):

- Give the public the opportunity to comment on and provide input to technical decisions. An ongoing community relations effort should encourage the local public to contribute to decisions that will have long-term effects on their community.
- Inform the public of planned or ongoing actions. Community relations activities should inform the public of the nature of the environmental problem, the threat it may pose, the responses under consideration, and the progress being made.
- Focus and resolve conflict. Conflict may be unavoidable in some circumstances, but it can be constructive if it brings out alternative viewpoints that are based on sound reasons for criticism and dissent. An effective community relations effort channels conflict into a forum where it can serve a useful purpose.

#### 3.6.2 Policies and Procedures

Community relations efforts are critical once a site is scheduled for a long-term RI/FS. A mailing list is developed and community interviews are conducted to gather information on the public's past and current involvement with the site. Information repositories are the most effective way to disseminate information. Locations for public meetings are also identified. When the draft RI work plan and community relations plan (CRP) are complete, a public briefing is often held to explain these plans. Fact sheets are also distributed to describe technical activities planned during the RI/FS, announce the locations of repositories for site information, and inform the public of the CRP. Table 3.14 contains typical activities for a community relations program.

## 4 SITE ASSESSMENTS AND PROPOSED ACTIONS

Fort Devens is a large Army base encompassing an area of about 9,400 acres, including 6,000 acres used for training of military personnel and 3,400 acres used for housing, schools, and other facilities. No major industrial activities have been conducted on this site.

The list of areas to be characterized was initially created during 1985, when Fort Devens applied for a Part B permit for its hazardous waste storage facility. As part of the submission, Fort Devens was required to include a list of all SAs that had the potential to release hazardous waste or hazardous waste constituents. In cooperation with the MDEP, EPA Region 1 issued a draft permit and selected 10 SAs for corrective action: SAs 5, 12, 15, 20, 21, 25, 26, 27, 28, and 31. In 1986, a final permit was issued along with a final list of 40 SAs (1-40). At the request of Fort Devens, six additional SAs were added to the list at the time of the site visit by ANL. In 1989, Fort Devens was placed on the National Priority List. During a second site visit by ANL in 1989, 8 additional sites were added. During a 1990-1991 tank removal program, 4 additional SAs (Nos. 55-58) were added to bring the total to 58.

Four SAs, Nos. 4, 5, 18, and 40, have been redesignated as areas of concern (AOCs). An AOC is a site known to have substantial contamination. An RI/FS, a proposed plan, and a record of decision is required for all AOCs. The SA designation indicates that wastes may have been handled, stored, treated, or disposed of at the site. Unless indicated otherwise in this MEP, an SI is required for all SAs to determine whether they pose a threat to human health or the environment. Table 4.1 summarizes 54 SAs and 4 AOCs and indicates their period of use, the associated activity, and current status.

At the completion of an SI, the data will be evaluated to determine whether the site is free of contamination or has been contaminated during previous activities. For each SA, the SI will have one of three possible outcomes:

- If no contamination is found, no further investigation will be recommended for the SA; the SA will become a *No-Action SA*.
- If the results of the SI show gross contamination, the SA will be redesignated as an AOC. An RI will be recommended to determine the nature and extent of contamination, extent of migration, and impacts to human health and the environment.
- If low-level contamination is discovered or the results are inconclusive, the Army, the EPA, and the state will consider the environmental risk determined by the SI and decide whether the site should be redesignated as an AOC (necessitating an RI).

Appendix B contains schedules for environmental characterization and remedial activities for the AOCs and SAs at Fort Devens.

This section describes historical aspects (when available), site conditions, and recommended actions to discover any potential for releases to the environment. For many of the SAs, the recommended response actions will be the first investigations conducted for those

TABLE 4.1 Summary of the 58 Study Areas (SAs) at Fort Devens

| SA/AOC No.     | Site Name  | Period of Use   | Activity  | Current Status | SA Type <sup>a</sup> |
|----------------|--|-----------------|---|----------------|----------------------|
| 1              | Cutler Army Hospital incinerator (Bldg. 3654)            | 1977-present    | Medical/biological wastes incinerated (104 ton/yr)                                    | Active         | I                    |
| 2              | Veterinary clinic incinerator (Bldg. 1450)               | 1970-present    | Animal carcasses incinerated (21 ton/yr)  | Active         | I                    |
| 3              | Intelligence School incinerator, main cantonment area    | 1971-1976       | Classified documents incinerated (twice/wk)   | Demolished     | I                    |
| 4 <sup>b</sup> | Sanitary landfill incinerator (Bldg. 38)                 | 1941-late 1940s | Household debris incinerated (quantity unknown)                                       | Inactive       | I                    |
| 5 <sup>b</sup> | Sanitary landfill (landfill No. 1), main cantonment area | 1917-present    | Disposal of household refuse, construction debris, and military refuse (6,500 ton/yr) | Active         | L                    |
| 6              | Landfill No. 2, south post (near training area 7b)       | 1850-1920       | Disposal of household refuse and glass (quantity unknown)                             | Inactive       | L                    |
| 7              | Landfill No. 3, south post (impact area)                 | 1850-1920       | Disposal of household refuse and glass (quantity unknown)                             | Inactive       | L                    |
| 8              | Landfill No. 4, south post (training area 8a)            | 1900-1930       | Disposal of household refuse and military items (quantity unknown)                    | Inactive       | L                    |
| 9              | Landfill No. 5, main cantonment area                     | 1955-1978       | Disposal of construction debris, tree stumps, and limbs (quantity unknown)            | Inactive       | L                    |
| 10             | Landfill No. 6, near Shirley Gate                        | 1975-1980       | Disposal of debris from demolition of six warehouses                                  | Inactive       | I                    |

TABLE 4.1 (Cont'd)

| SA/AOC No.      | Site Name  | Period of Use | Activity   | Current Status | SA Type <sup>a</sup> |
|-----------------|--|---------------|--|----------------|----------------------|
| 11              | Landfill No. 7, near Lovell Street   | 1975-1980     | Disposal of debris from demolition of hospital (quantity unknown)  | Inactive       | L                    |
| 12              | Landfill No. 8, south post (near combat pistol range)                              | 1960-present  | Disposal of construction and range operation debris (quantity unknown)   | Inactive       | L                    |
| 13              | Landfill No. 9, main cantonment area (at Lake George Street and Hattonsville Road) | 1965-1970     | Disposal of construction debris, tree stumps, and possibly oil (quantity unknown)  | Inactive       | L                    |
| 14              | Landfill No. 10, south post (near Dixie Road)                                      | Unknown       | Abandoned cars placed in quarry (quantity unknown)   | Inactive       | U                    |
| 15              | Landfill No. 11, south post (near the helipad)                                     | 1963-1966     | Fuel oil burned (quantity unknown)   | Inactive       | L                    |
| 16              | Shoppette landfill (No. 12), main cantonment area                                  | 1985          | Disposal of household rubbish (quantity unknown)   | Inactive       | L                    |
| 17              | Little Mirror Lake (landfill No. 13), main cantonment area                         | Unknown       | WWII-era grenades placed in the lake (200 discovered)  | Inactive       | L                    |
| 18 <sup>b</sup> | Sanitary landfill asbestos cell, main cantonment area                              | 1982-present  | Disposal of asbestos and asbestos containing debris (about 6.6 ton)  | Active         | L                    |
| 19              | Wastewater treatment plant, north post   | 1942-present  | Treatment of sanitary sewage, floor drainage, wash rack discharge, boiler blowdown, swimming pool water, filter backwash (1.3 million gal/d) | Active         | W                    |

TABLE 4.1 (Cont'd)

| SA/AOC No. | Site Name  | Period of Use   | Activity  | Current Status | SA Type <sup>a</sup> |
|------------|--|-----------------|---|----------------|----------------------|
| 20         | Rapid infiltration basins, north post                                      | 1942-present    | Treatment of WWTP effluent (1.3 million gal/d)                                    | Active         | W                    |
| 21         | Sludge drying beds, north post   | 1942-present    | Application of sludge from WWTP Imhoff tanks (10 acres)                           | Active         | W                    |
| 22         | Hazardous waste storage facility (Bldg. 1650)                              | 1980-present    | RCRA Part B permitted storage of hazardous waste (35,750 gal)                     | Active         | S                    |
| 23         | Paper recycling center (Bldg. 1650)  | 1984-1985       | Storage and transfer facility for recycle paper (160 ton/yr)                      | Inactive       | S                    |
| 24         | Waste explosives storage bunker 187 (Bldg. 3644)                           | 1979-present    | Storage of waste explosives from both military and civilian sources (2,000 lb/yr) | Active         | S                    |
| 25         | Waste explosives detonation range (EOD range), south post (impact area)    | 1979-present    | Destruction of various explosives stored in bunker 187 (1,200 lb/yr)              | Active         | D                    |
| 26         | Waste explosive detonation range (Zulu I and II), south post (impact area) | Unknown-present | Training area/hand grenade range, open burning of explosives                      | Active         | D                    |
| 27         | Waste explosives detonation range (Hotel), south post (impact area)        | Unknown-present | Training area, waste explosives burning/detonation                                | Active         | D                    |
| 28         | Hand-grenade range J, south post   | 1940s-1970s     | Training area   | Inactive       | D                    |

TABLE 4.1 (Cont'd)

| SA/AOC No. | Site Name   | Period of Use | Activity  | Current Status | SA Type <sup>a</sup> |
|------------|---|---------------|---|----------------|----------------------|
| 29         | Transformer storage area at the DEH yard (Bldg. 1438) | 1980-present  | Storage of out-of-service transformers prior to disposal                    | Active         | S                    |
| 30         | Moore Army Airfield drum storage area                 | 1975-present  | 90-day accumulation of hazardous waste (550-825 gal)                        | Active         | S                    |
| 31         | Moore Army Airfield fire-fighting training area       | 1975-1986     | Burning of jet fuel and solvents for training                               | Inactive       | D                    |
| 32         | DRMO yard (Bldg. 204)                                 | 1964-present  | Storage of scrap metal, drained batteries, tires, and used office equipment | Active         | S                    |
| 33         | DEH entomology shop (Bldg. 262)                       | 1982-present  | Storage and mixing of pesticides and herbicides                             | Active         | S                    |
| 34         | Former DEH entomology shop (Bldg. 245)                | 1978-1982     | Storage and mixing of pesticides and herbicides                             | Inactive       | S                    |
| 35         | Former DEH entomology shop (Bldg. 254)                | 1978-1982     | Storage and mixing of pesticides and herbicides                             | Inactive       | S                    |
| 36         | Former DEH entomology shop (Bldg. 2728)               | 1968-1978     | Storage and mixing of pesticides and herbicides                             | Inactive       | S                    |
| 37         | Golf course entomology shop (Bldg. 3622)              | 1976-1987     | Short-term storage of pesticides  | Active         | S, T                 |

TABLE 4.1 (Cont'd)

| SA/AOC No.         | Site Name   | Period of Use | Activity   | Current Status | SA Type <sup>a</sup> |
|--------------------|---|---------------|--|----------------|----------------------|
| 38                 | Battery repair area (Bldg. 3713)  | 1978-present  | Battery acid neutralized (10-200 batteries per week) | Inactive       | Sp                   |
| 39                 | Transformer near Bldg. 4250 (old Sylvania buildings)                                | Unknown       | Leak from PCB-contaminated transformer               | Inactive       | Sp                   |
| 40 <sup>b</sup>    | Cold Spring Brook landfill, main cantonment area                                    | Unknown       | Disposal of construction debris and unmarked drums   | Inactive       | L                    |
| 41                 | Unauthorized dumping area (site A), south post                                      | Unknown       | Disposal of unknown materials                        | Unknown        | U                    |
| 42                 | Popping furnace, south post (near Trainfire Road)                                   | Unknown       | Incineration of small-arms ammunition                | Inactive       | I                    |
| 43,54 <sup>c</sup> | Historic gas station sites (19 sites, designated A through S), main cantonment area | Unknown       | Gasoline storage and distribution                    | Inactive       | T                    |
| 44                 | Cannibalization yard (Bldg. 3713)   | Unknown       | Vehicle storage prior to disassembly for parts       | Active         | Sp                   |
| 45                 | Wash rack at Lake George Street, main cantonment area                               | Unknown       | Possible private vehicle maintenance                 | Active         | U                    |
| 46                 | Training area 6d, south post (near intersection of Shoefelt and Firebreak roads)    | Unknown       | Disposal of unknown materials                        | Unknown        | U                    |

TABLE 4.1 (Cont'd)

| SA/AOC No. | Site Name   | Period of Use   | Activity  | Current Status | SA Type <sup>a</sup> |
|------------|---|-----------------|---|----------------|----------------------|
| 47         | Moore Army Airfield leaking underground storage tank (LUST) site (Bldg. 3816) | ca. 1970-1989   | Diesel fuel handling and storage                    | Inactive       | T                    |
| 48         | Bldg. 202 leaking underground storage tank site                               | ca. 1941-1989   | Fuel handling and storage                           | Inactive       | T                    |
| 49         | Bldg. 3602 leaking underground storage tank site                              | ca. 1942-1975   | Fuel handling and storage                           | Inactive       | T                    |
| 50         | Moore Army Airfield WWII aircraft fuel system                                 | ca. 1941-1945   | Fuel storage  | Inactive       | T                    |
| 51         | O'Neil Bldg. spill site   | Unknown-present | Diesel fuel handling and storage                    | Active         | Sp                   |
| 52         | TDA maintenance yard (Class III lead, storage yard), main cantonment area     | Unknown-present | Vehicles with significant leaks' stored for repairs | Active         | Sp                   |
| 53         | South post POL spill areas  | Unknown-present | Fuel handling and temporary storage                 | Active         | Sp                   |
| 55         | Shirley housing area trailer park (fuel tanks), main cantonment area          | Unknown-present | Fuel storage  | Active         | T                    |
| 56         | Bldg. 2417 leaking underground storage tank                                   | Unknown         | Fuel storage  | Inactive       | T                    |
| 57         | Bldg. 3713 fuel oil spill   | Unknown-present | Fuel storage  | Active         | Sp                   |

TABLE 4.1 (Cont'd)

| SA/AOC No. | Site Name  | Period of Use | Activity     | Current Status | SA Type <sup>a</sup> |
|------------|--|---------------|--------------|----------------|----------------------|
| 58         | Bldgs. 2648 and 2650 leaking underground storage tanks | Unknown       | Fuel storage | Inactive       | T                    |

<sup>a</sup>B = burial; C = containers; D = open burning/detonation area; I = incinerator; L = landfill; S = storage; Sp = spill; T = underground storage tanks; U = unauthorized dumping; W = wastewater treatment.

<sup>b</sup>Site has been designated as an AOC.

<sup>c</sup>Sites 43-0 and 54 are the same site; therefore, SA 54 is not listed separately.

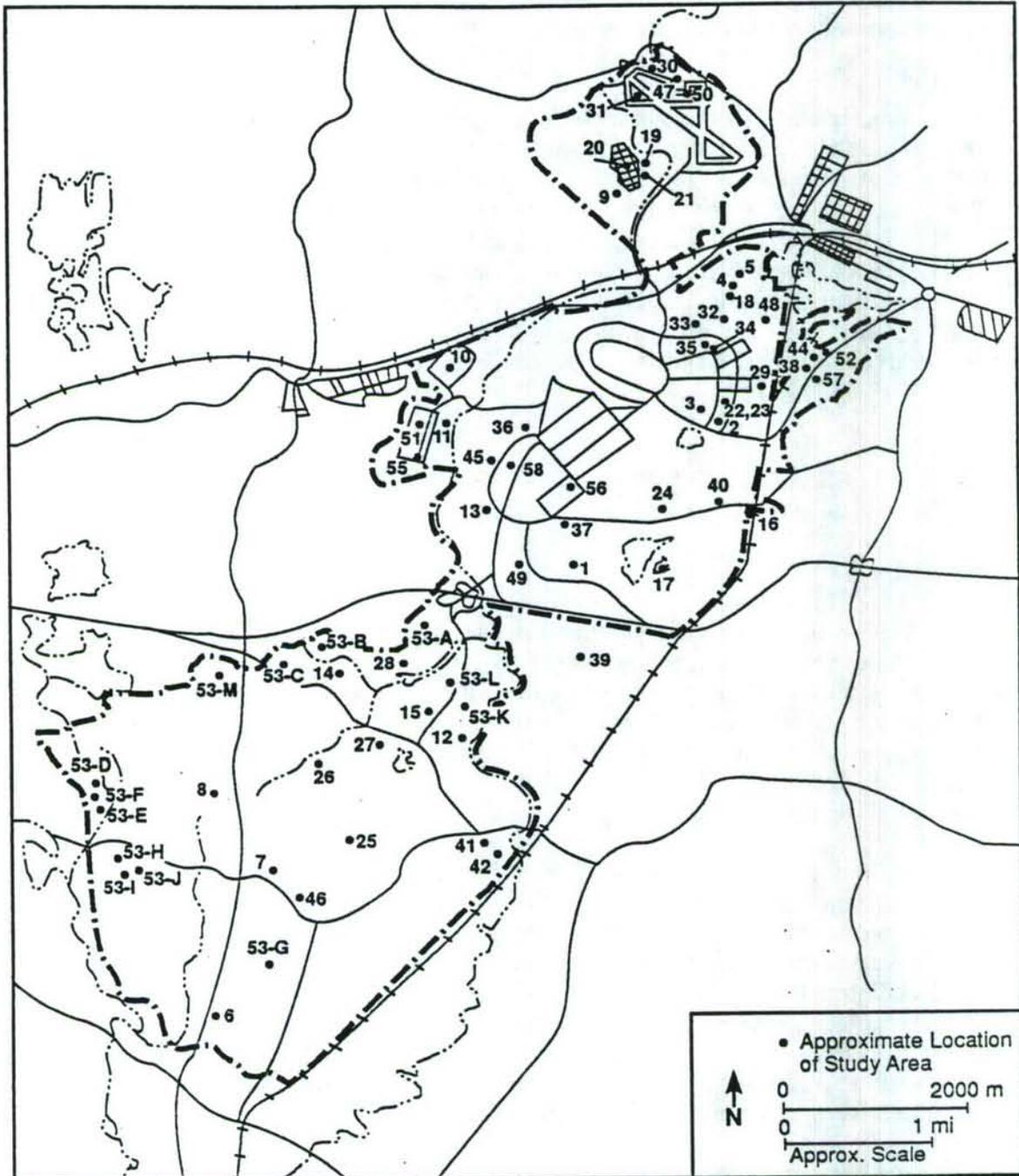


FIGURE 4.1 Approximate Locations of Study Areas at Fort Devens (Source: Map based on FORSCOM 1987)

areas. At least five of the SAs could not be precisely located. Figure 4.1 shows the entire site and the locations of 53 of the SAs and the four AOCs. (The nature of SA 43, which is scattered across the cantonment area, made its inclusion in the figure impractical; for a map of SA 43, see Sec. 4.40.)

Some recommended actions include analysis for specific potential contaminants. For convenience, analytical parameters are grouped into several categories provided in Tables C.1 through C.4 in Appendix C. Table C.1 lists compounds on EPA's hazardous substance list (HSL), Table C.2 lists explosives commonly used in munitions, Table C.3 lists TCLP compounds, and Table C.4 lists pesticides and herbicides. This MEP's recommendations for proposed action specify analytical parameters for environmental samples. For brevity, these recommendations refer to the analytical categories provided in the Appendix C tables rather than provide a list of the parameters for each set of samples. All field investigations should be conducted in accordance with *Geotechnical Requirements for Drilling Monitor Wells, Data Acquisition, and Reports* (USATHAMA 1987).

## 4.1 SA 1 – CUTLER ARMY HOSPITAL INCINERATOR

### 4.1.1 Site History

The Cutler Army Hospital incinerator is located in the main cantonment area near Queenstown Street south of the golf course. It is used to incinerate pharmaceutical wastes and nonhazardous medical wastes, including dirty syringes, hypodermic needles, human body parts, and clothing and bedding used by diseased patients. No laboratory wastes are incinerated. This incinerator is one of two active incinerators at Fort Devens, the other being the veterinary incinerator (in Bldg. 1450). The locations of Cutler Army Hospital (Bldg. 3654) and the incinerator are shown in Fig. 4.2.

The incinerator has a volume of 10 cubic feet (ft<sup>3</sup>) and is 36 ft high; the inside top diameter is 2 ft. Built and installed in 1977, this incinerator is gas-fed and operates year-round. It can be operated eight hours per day, five days per week, and can incinerate about 100 lb/h (104 ton/yr). Normally, the unit is used about three times per day, each incineration lasting one to two hours (Alston 1988). The incinerator ash is normally scraped out of the chamber once every other day, placed into garbage cans, and then thrown into a covered dumpster. When the dumpster is full, it is taken to the sanitary landfill. Although the facility is reportedly in compliance with applicable Massachusetts pathologic waste regulations (Lewis 1989), the ash storage facilities were deteriorated at the time of the 1989 site visit.

The incinerator is located outside of and immediately adjacent to Bldg. 3654. The incinerator pad dimensions are about 13 by 20 ft. The area adjacent to the pad is paved with asphalt for use by vehicles.

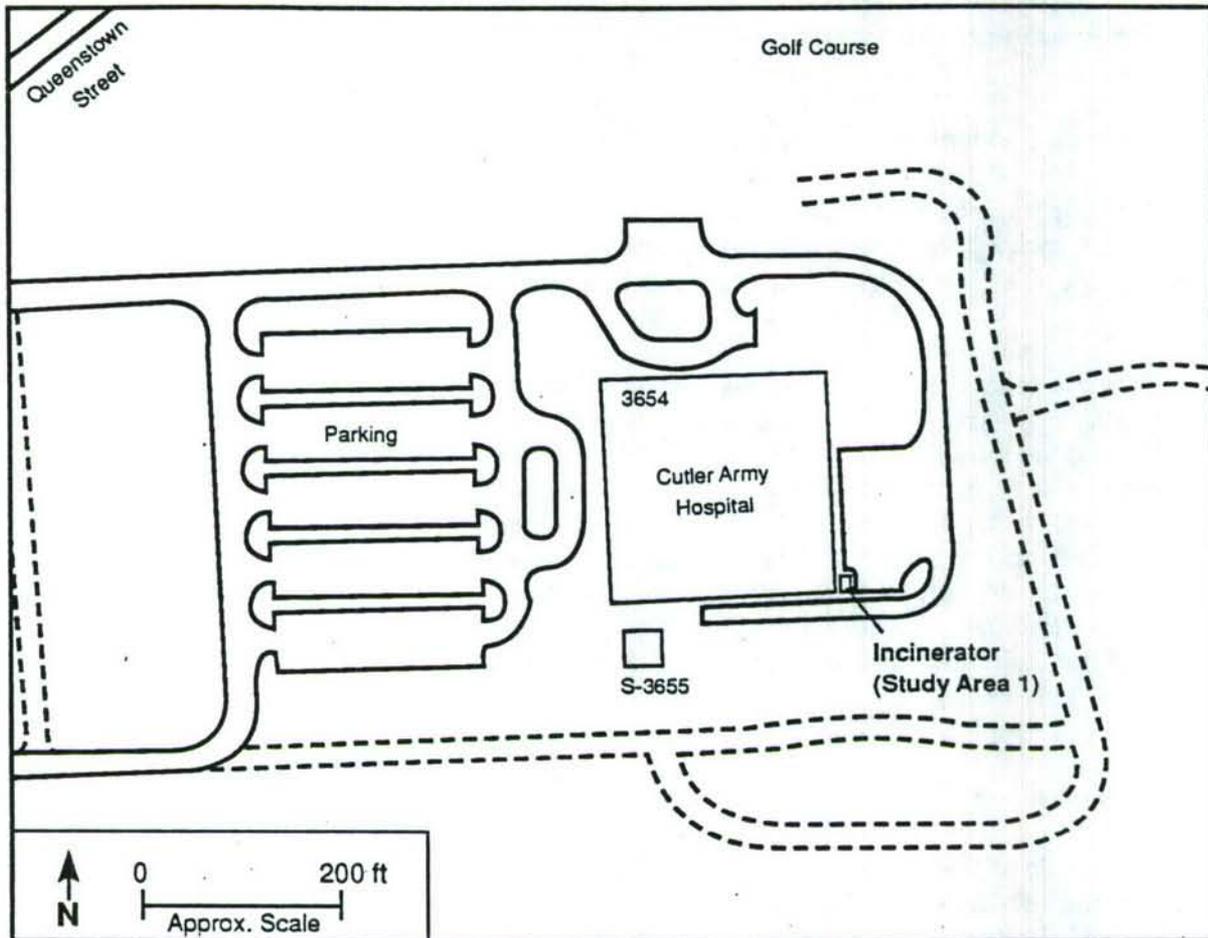


FIGURE 4.2 Location of SA 1, the Cutler Army Hospital Incinerator (Source: Map based on Keene 1967)

#### 4.1.2 Geology and Hydrology

The entire base can be considered an outwash plain dotted with small conical and drumlinoid hills. The plain was formed by glacial deltas prograding into glacial Lake Nashua during various stages. Sand and gravel were deposited by the deltas around blocks of stagnant ice. As the block ice melted, depressions known as kettels developed. One of these kettels formed Little Mirror Lake (Brown 1981).

The groundwater at Fort Devens occurs largely in the permeable glacial-deltaic outwash deposits of sand, gravel, and boulders. Minor amounts of groundwater may also be found in thin, permeable glacial lenses. These lenses may occur as multiple perched zones and, in some cases, exit the ground surface as springs and seeps. The area's major (glacial outwash) aquifer occurs along the Nashua Valley and through the northwest part of Fort Devens. It is believed that the unconsolidated aquifer is hydraulically connected to the surface water bodies at Fort Devens. This belief infers that the aquifer is unconfined and is vulnerable to contamination (McMaster et al. 1982; Brown 1981).

Soils in the area are classified as the Quonset-Hinckley-Windsor Association. They are typically droughty sand and gravel underlain by stratified sand and gravel and are well drained, with high permeability (McMaster et al. 1982).

#### 4.1.3 Nature and Extent of Contamination

During the site assessment, the physical condition of the incinerator was noted. The gaskets of the incinerator door were severely deteriorated and missing in several places. The firebrick inside the first hearth chamber was in poor condition; many of the firebricks were cracked.

The ash from this incinerator has been periodically sampled and analyzed to determine the EP toxicity. In early 1980, one such analysis showed that results for one out of five samples exceeded the criterion for lead (5.0 mg/L) (McMaster et al. 1982). No source of lead was found, and the result was considered an anomaly. The result of a subsequent test completed in September 1980 showed that lead did not exceed the toxicity standard. All other analytes were well below the concentrations that would classify the ash as toxic waste (Brown 1981). Based on these results, continued disposal of the ash in the installation's sanitary landfill was considered acceptable. Because of the asphalt base in the immediate vicinity, transfer and transport of the incinerator ash is not likely to contribute to any appreciable soil or groundwater contamination. No other data are available on the type or extent of contamination at the site.

#### 4.1.4 Proposed Action

A sample of the incinerator ash should be collected by Fort Devens personnel each time the incinerator ash is scraped out for disposal. A composite sample should be analyzed quarterly for TCLP and PAH. Samples should be analyzed for radionuclides and dioxins semiannually. After one year, if the results indicate a trend, then the sampling frequency can be changed accordingly, perhaps to quarterly grab samples.

A phased sampling and monitoring program should be conducted to characterize the site and determine if rainwater and melting snow have contaminated the surrounding soil. The initial program should consist of collecting surface soil samples. A surface reconnaissance of the site should be made to determine runoff patterns and locate any visibly stained soil. Two surface soil (6-12 in.) samples should be collected adjacent to the incinerator pad, and two should be collected from a downgradient storm-sewer outlet. The soil samples should be analyzed for total HSL metals and TC metals.

If the soil samples indicate the presence of contamination, then a second phase should be initiated. During this phase, additional soil samples should be collected from all contaminated areas identified during the first phase (particularly areas of soil discoloration) and analyzed for parameters with elevated concentrations. If necessary, soil borings and groundwater monitoring wells could be included in the second phase.

Remedial action should be initiated to address all significantly contaminated areas. If no evidence of contamination is found in these investigations, it is recommended that no further action be taken for this site.

## 4.2 SA 2 – VETERINARY CLINIC INCINERATOR

### 4.2.1 Site History

The veterinary incinerator is located inside Bldg. 1450 in the main cantonment area (Fig. 4.3). It is one of two active incinerators operated at Fort Devens, the other being the Cutler Army Hospital incinerator. The veterinary incinerator is used primarily to incinerate animal carcasses, although it is also used to burn classified materials, needles, medical or veterinary wastes, and expired drugs (Burrs 1988). Occasionally, the incinerator is used to incinerate photographs and paper, as well as medical and pharmaceutical wastes from the Cutler Army Hospital when its incinerator (SA 1) is shut down.

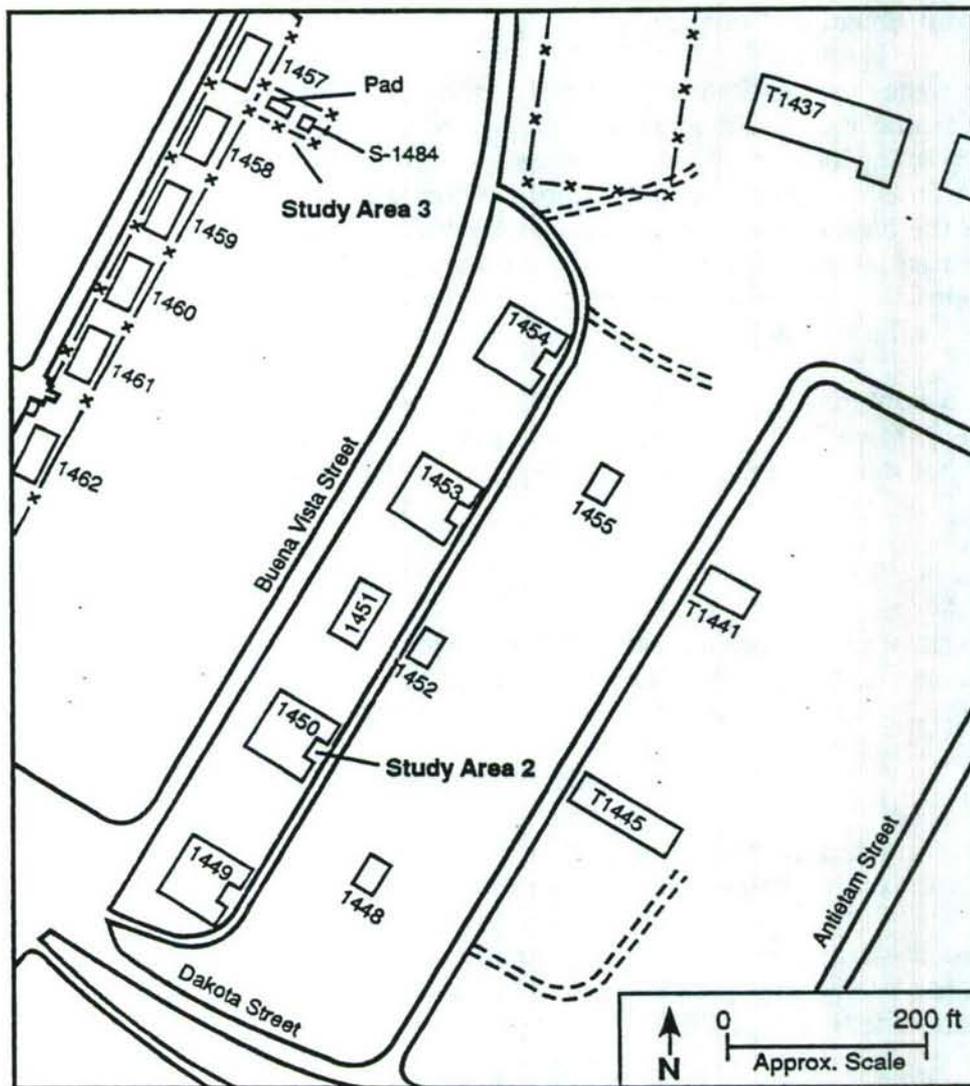


FIGURE 4.3 Locations of SAs 2 and 3, the Veterinary Clinic and Intelligence School Incinerators (Source: Map based on Keene 1967)

The gas-fired veterinary incinerator has a volume of 12 ft<sup>3</sup> and is 23.6 ft tall, with an inside top diameter of 1.0 ft. The incinerator can handle a maximum loading of 100 lb/h; typically, an incineration run lasts about four hours. The incinerator, which is normally used about two or three times per week, processes about 21 ton/yr (Burrs 1988). The ash is normally placed in plastic bags and sent to the sanitary landfill (SA 5).

#### 4.2.2 Geology and Hydrology

The site is located on the Muck-Peat-Walpole Association, which consists of organic and sandy soils. This area drains poorly and has a low permeability (Nicholls et al. 1980; McMaster et al. 1982). The surface water nearest the site is Robbins Pond, which is about 800 ft south-southwest.

#### 4.2.3 Nature and Extent of Contamination

During the site assessment, several operational problems were noted, including problems concerning the gasket seals around the incinerator door and cracks in the asbestos casing at the top of the incinerator base. Concerns were raised about the operational incineration temperature and the temperature gauges used to monitor this temperature. The incinerator was constructed in the basement of the veterinary clinic; during incinerations, soot enters heating vents, leaving dust on the office desks and equipment. The staff has occasionally complained of sinus problems due to this dust (Burrs 1988). To minimize such effects, most incinerations occur during evening hours.

The ash from this incinerator has been periodically tested for EP toxicity for metals, with negative results (Brown 1981; McMaster et al. 1982). The results of these analyses could not be located. No other data are available on the type and extent of contamination at the site.

#### 4.2.4 Proposed Action

A sample of the incinerator ash should be collected by Fort Devens personnel each time the incinerator ash is scraped out for disposal. A composite sample should be analyzed quarterly for TCLP. Samples should be analyzed for radionuclides and dioxins semiannually. After one year, if the results indicate a trend, then the sampling frequency can be changed accordingly.

The heating and ventilation system of Bldg. 1450, air intakes in particular, should be modified to minimize the intake of incinerator ash.

Because the incinerator is indoors, which prevents migration of the ash, and because no contamination has been found in ash from the incinerator, no further investigation or remedial action is recommended.

### 4.3 SA 3 – INTELLIGENCE SCHOOL INCINERATOR

#### 4.3.1 Site History

The Intelligence School incinerator was located outside Bldg. 1484 in the main cantonment area (Fig. 4.3) on a cement pad about 20 ft long by 10 ft wide. It was used from 1971 until 1976 to burn paper (classified documents) about twice weekly. The incinerator had a capacity of 318 lb/h, with afterburns of 600 Btu/lb of waste input. In 1976, Fort Devens received notice from Massachusetts that the incinerator was exceeding capacity standards, and the incinerator remained inactive until it was demolished.

#### 4.3.2 Geology and Hydrology

The site is located on the Muck-Peat-Walpole Association, which consists of organic and sandy soils. These soils have a low permeability and drain poorly (Nicholls et al. 1980; McMaster et al. 1982).

#### 4.3.3 Nature and Extent of Contamination

During the site assessment, the physical condition of the incinerator was noted. The incinerator was very rusty, and all the gaskets had deteriorated. The incinerator door had rusted shut, and a crowbar was needed to open it for inspection. The firebrick had severely deteriorated, and the incinerator still contained ash. Near the incinerator was an enclosed storage rack that contained old rusty paint cans.

Although it is not known whether ash from the incinerator had been tested for EP toxicity, it is not expected that the ash would fail the test, due to the nature of the materials that were reportedly incinerated.

#### 4.3.4 Proposed Action

The incinerator has not burned waste for more than 13 years. It is possible that most, if not all, contaminants that could have resulted from potential leaching of the incinerator ash have completely disappeared by means of dissolution, oxidation, adsorption, and biodegradation. However, a sampling program should be conducted to characterize the site and determine if any soil is contaminated. The initial program should consist of collecting and analyzing soil and ash samples.

A sample of the ash in the incinerator pad area (if present) should be collected and analyzed for TC metals, PAH, and dioxin. Because the incinerator is no longer in use and is deteriorated, it should be dismantled and the underlying soil tested for possible contamination. A surface reconnaissance of the site should be made to locate any visibly stained areas. Surface soil (6-12 in.) samples should be collected on each side of the incinerator pad and possible runoff areas and analyzed for total HSL metals and TC metals.

If the initial samples indicate the presence of contamination, then a second phase should be initiated. During this phase, significantly contaminated soils should be excavated and disposed of in accordance with state and federal requirements. If no evidence of contamination is found in these investigations, it is recommended that no further action be taken for this site.

#### 4.4 SA 4 – SANITARY LANDFILL INCINERATOR

The sanitary landfill incinerator was located near Cook Street within the area included in Phase I of the sanitary landfill closure (Fig. 4.4). The site was located in former Bldg. 38, which was built in 1941; the incinerator was operated until the late 1940s. Building 38 was a two-story, cinder-block building with a full basement and slate roof. Utilities included two overhead electric lines and an underground water line and sewer line (1.5 and 4 ft in diameter, respectively). No gas or steam lines served the building (Ford 1989).

The incinerator burned household debris generated on site; glass and incinerator ash were placed in a landfill next to the building. In September 1967, the incinerator (which was not used after the 1940s) was demolished and placed in the sanitary landfill. In 1976, the building foundation was also removed and landfilled on site.

Because the incinerator was located and disposed of on a portion of the sanitary landfill (SA 5), discussion of the geology and hydrology, the nature and extent of any contamination, and the proposed action is included in Sec. 4.5.

#### 4.5 SAs 5 AND 18 – SANITARY LANDFILL (NO. 1) AND ASBESTOS CELL

##### 4.5.1 Site History

The sanitary landfill (landfill No. 1\*) is in the northeastern portion of the main cantonment area (Fig. 4.4). It encompasses about 34 acres adjacent to Plow Shop Pond on the east and Shepley's Hill on the west. Immediately north (within 1 mi) is the town of Ayer, and to the south, along Cook Street, is the Defense Reutilization and Marketing Office (DRMO). Landfill operations date as far back as 1917. A small portion of SA 5 south of Plow Shop Pond (near wells 3 and 7) is the site of a former railroad roundhouse. The roundhouse was used between 1900 and 1935. Because of the age of the facility, any contaminants would probably be the result of coal and steam-era wastes. Currently, the landfill receives about 6,500 ton/yr of household refuse, military refuse, and construction debris.

The landfill is operated using the modified trench method. There is evidence that trenches in the northwest portion have cut into previously used areas containing glass and spent shell casings. The glass dated from the mid-nineteenth century to as late as 1920. The total depth of the refuse is about 30 ft (DEH 1985b).

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\*Thirteen landfills, numbered 1 through 13, are discussed in this report. The landfill numbers are those used in Fort Devens records and should not be confused with study area, or SA, numbers.

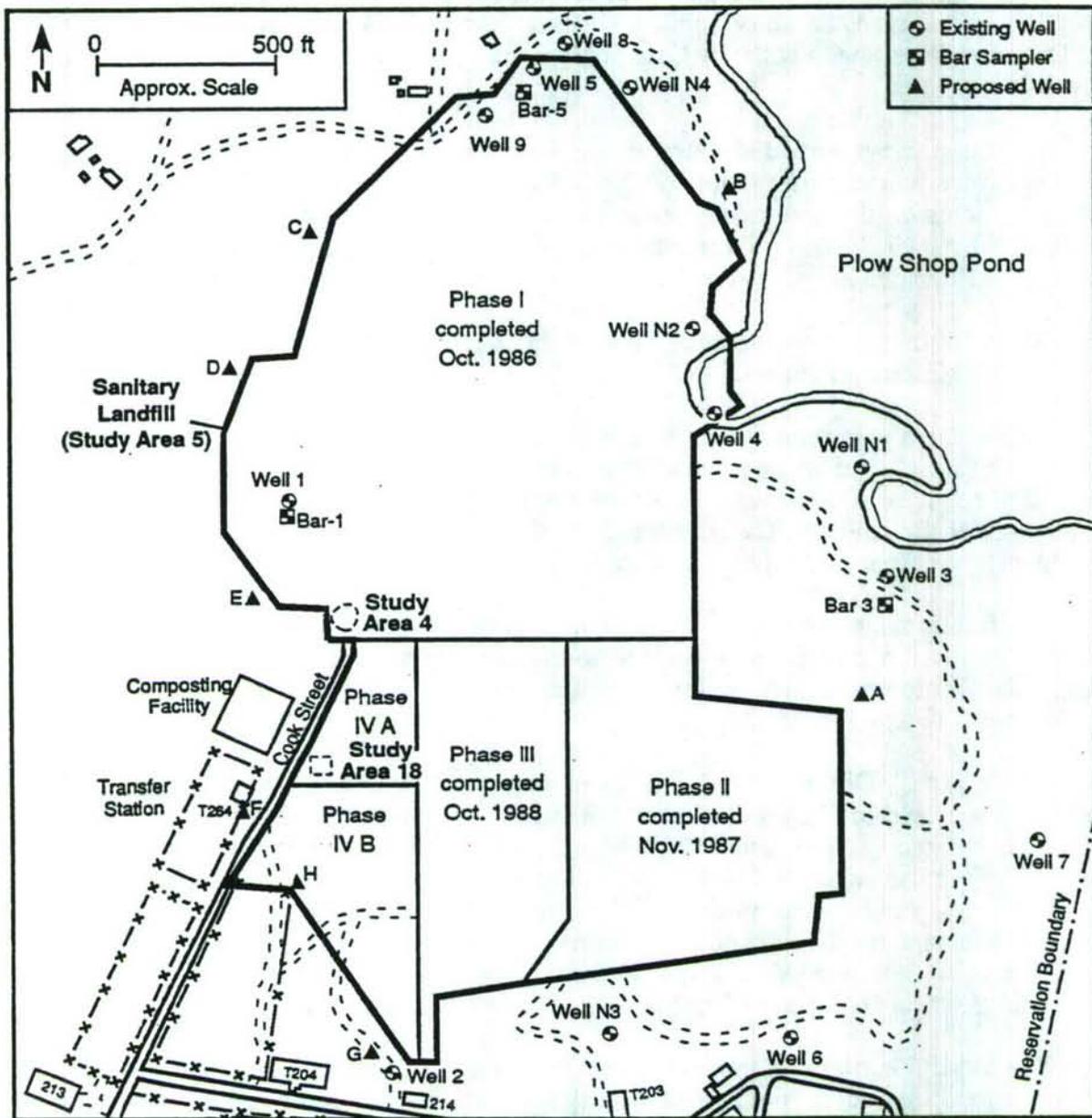


FIGURE 4.4 Location of SAs 4, 5, and 18, the Sanitary Landfill Incinerator, the Sanitary Landfill, and the Asbestos Cell (Source: Adapted from Gale Engineering 1985)

Fort Devens has an operating permit from the MDEP, and according to available information, the landfill is operating within these requirements. As part of a corrective action, the last section of the landfill is scheduled for closure in 1992; most of the landfill has already been closed (Fig. 4.4). Fort Devens is coordinating the closure with state authorities and has an approved closure plan that includes regrading, gas ventilation, membrane capping, and applying a final vegetative cover. Some of the areas adjacent to Plow Shop Pond lie within the 100-yr floodplain. These areas were excavated according to the approved closure plan.

In an effort to abate the potential for off-site contaminant migration, Fort Devens initiated the Fort Devens Sanitary Landfill Closure Plan in 1984, in accordance with 310 CMR 19.00. The four-stage plan, written by Gale Engineering, was submitted to MDEP for review and approval.

The initial stage included determining the extent of the landfill. Toward this end, 40 test borings were placed throughout the landfill area. When the details of the borings were compiled, 15 acres on the eastern perimeter of the Phase I and Phase II sections of the landfill were classified as virgin soil. Drawings (No. 655-3339, 25 sheets) showing the details and locations of the borings are available through the DEH office at Fort Devens.

The second stage was the design for the final grade required to control surface erosion from rainwater runoff and runoff.

In the third stage, nine monitoring wells were placed outside the perimeter of the landfill, and a catch basin was constructed to control surface water in the capped areas of the landfill. The basin is located near Cook Street and is connected to five manholes within the southern edge of the landfill. The runoff water collected by this system empties into a ditch in the southwestern corner of the Phase II area, flows north, and discharges into Plow Shop Pond.

The fourth stage of the closure plan was the capping and gas-venting design. A 30-mil PVC liner is sandwiched between two 12- to 18-in. layers of sand and overlain by an 8-in. layer of loam. Gas vents are located 400 ft apart and connect under the capped surface through perforated pipes (Black 1989).

In 1985, the MDEP reviewed and approved the closure plan. As shown in Fig. 4.4, the landfill is being closed in phases. In Phase I, 50 acres were capped in October 1986; in Phase II, 15 acres were capped in November 1987; and in Phase III, 9.2 acres were capped in March 1989. In May 1989, Fort Devens presented a proposal to MDEP to extend the Phase IV closure date. A "conceptual approval" was given by the Worcester Office. The MDEP requested the installation to reconsider the thickness of the liner that was originally approved in 1985, change the slope, and divide Phase IV into two sections. The Phase IV closure plan was modified to create Sections A and B. Closure will take place independent of IRP activities.

The landfill contains a permitted asbestos cell (SA 18) that was used for disposal of asbestos construction debris from on-site activities. An estimated 6.6 tons were placed in the cell between March 1982 and November 1985. It is located in Section A of the Phase IV area. The cell was originally scheduled for capping in late 1989 or early 1990, and a new asbestos disposal location has been identified in the southeastern corner of the landfill. The original Phase IV will be divided into revised Phases V and VI. The site is currently scheduled for closure in late 1992.

#### 4.5.2 Geology and Hydrology

The landfill (including SAs 4, 5, and 18) is in a thick section of glacial outwash consisting primarily of sand and gravel. The bedrock is Ayer Granite, a light-gray, foliated, phaneritic biotite granodiorite. It lies close to the ground surface at the western edge of the landfill and in some locations is within 2 ft of the surface. To the east, the bedrock surface is deeper and covered by a veneer of bluish-gray glacial till. The till is beneath the glacial outwash

layer. The bedrock surface forms a northwest-trending trough that apparently controls the northerly groundwater flow.

The water table depth ranges from 5 to 30 ft (MacLean 1989). Leachate formed in the landfill may seep directly into Plow Shop Pond (Gale Engineering 1985).

### 4.5.3 Nature and Extent of Contamination

The landfill site was probably selected because it was a wetland area and was an expedient choice for direct disposal of wastes. Information indicates that it was formerly operated as an open burning site. At a later time, waste was incinerated and the residue was buried. Con-Test (1989) reports that during a 1984 investigation, the test borings discussed above were drilled in various locations. The results revealed an area of special concern in the southeastern portion of the landfill, an area reportedly used to dispose of flammable fluids. The report cited by Con-Test indicates that contamination was not substantiated, however, by test pits or other research. A detailed review of the analytical parameters and results would help to substantiate the presence or absence of contamination from disposal activities in this area.

#### 4.5.3.1 Current Monitoring Networks

As seen in Fig. 4.4, two numbering systems are used to identify monitoring wells for the site. Wells 1 through 9 constitute an older network installed during 1986, and wells N1 through N4 are a newer series of monitoring wells installed in 1988. Wells 6 and N3 are the upgradient wells.

Wells 2, 4, 8, and 9 contain two samplers and a conventional well screen. The polyethylene samplers are 1.5 in. in diameter and 18 in. long. Water samples can be obtained through 3/16-in. nylon tubing that connects the sampler to the top of the well. Samplers are placed at various depths below the screen. A construction diagram is shown in Fig. 4.5. These wells function similarly to nested multiple wells by collecting water samples from various depths. The samplers are designated BAR-2, BAR-4, BAR-8, and BAR-9. The number following the word "BAR" corresponds to the well in which it is located. In addition, when multiple samplers are in one well, a second number is used to designate the position of the sampler, e.g., BAR-4-1 is the number for sampler No. 1 in well 4. The screen bottom depths, depth to water, screen lengths, and sampler depths are summarized in Tables 4.2 and 4.3. In well 2, sampler BAR-2A-1 replaces sampler BAR-2-1, which was damaged during installation. Sampler No. 2 is always set shallower than sampler No. 1.

Wells N1 through N4 are conventional monitoring wells. The screen lengths, screen bottom depths, and depth to water are summarized in Table 4.4.

In addition to these monitoring networks, there is also a series of casings containing only samplers. These are designated BAR-1, BAR-3, and BAR-5, and they contain multiple samplers that follow the numbering convention described above. These casings are located within 10 ft of the corresponding wells numbered 1, 3, and 5. No samplers have been installed near wells 6 and 7. According to Fort Devens personnel, many of these samplers are blocked or damaged and will not constitute part of the monitoring network. The sampler depths and depth to water are summarized in Table 4.5.

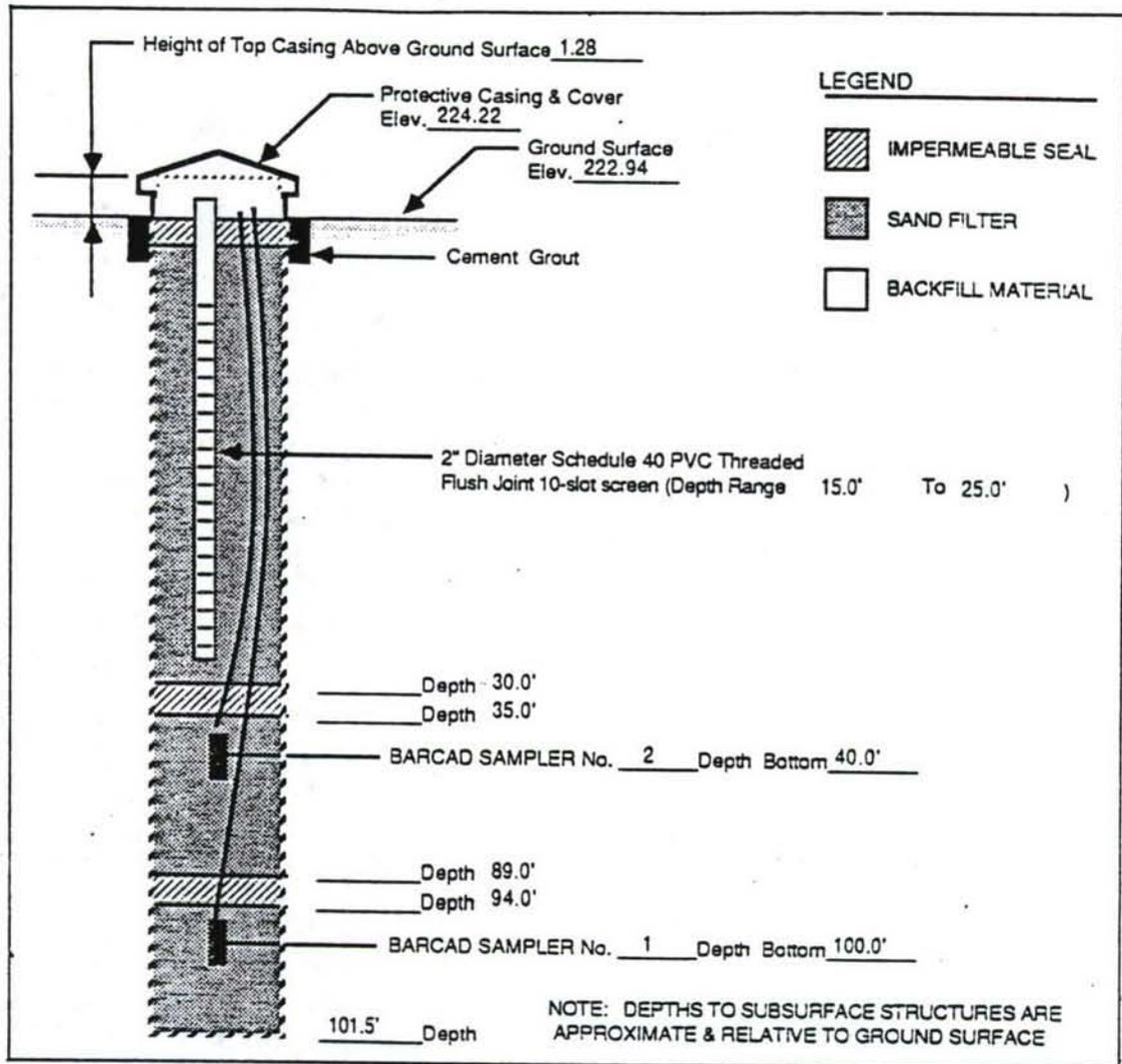


FIGURE 4.5 Construction Details of a Representative BAR Sampler at the Sanitary Landfill (Source: SEA Consultants 1986)

#### 4.5.3.2 Sampling and Analytic Results

Since 1987, groundwater from landfill wells 1 through 9 and the BAR samplers has been routinely collected and analyzed for volatile organics, metals, total organic carbon (TOC), total organic halogens (TOX), conductance, hardness, chloride, iron, and sodium. Results for May 1987, September 1987, and January 1989 are summarized in Tables 4.6 through 4.12 and discussed below. For brevity, the following discussion will refer to sampler locations, which coincide with the monitoring well locations.

**May 1987.** Low levels of volatile organics were detected only in the samplers, primarily at locations 4, 5, and 8. The low concentrations and types of contaminants may indicate the degradation of trichloroethylene (TCE) to the isomers of dichloroethylene (DCE) and dichloroethane (DCA), and ultimately to vinyl chloride (found in the 1989 sampling).

**TABLE 4.2 Construction Details and Water Levels for Wells 1 through 9 at the Sanitary Landfill**

| Well | Screen Bottom Depth (ft) | Total Boring Depth (ft) | Screen Length (ft) | Depth to Water (ft) | Date Measured |
|------|--------------------------|-------------------------|--------------------|---------------------|---------------|
| 1    | 7.0                      | 7.0                     | 5                  | 6.40                | 3/7/86        |
|      |                          |                         |                    | 6.33                | 4/9/86        |
|      |                          |                         |                    | Dry                 | 10/8/86       |
| 2    | 25.0                     | 37.5                    | 10                 | 22.03               | 3/7/86        |
|      |                          |                         |                    | 21.75               | 4/9/86        |
|      |                          |                         |                    | 25.04               | 10/8/86       |
| 3    | 34.0                     | 35.0                    | 10                 | 30.43               | 3/7/86        |
|      |                          |                         |                    | 30.50               | 4/9/86        |
|      |                          |                         |                    | 30.76               | 10/8/86       |
| 4    | 13.0                     | 29.2                    | 10                 | 10.94               | 3/7/86        |
|      |                          |                         |                    | 10.71               | 4/9/86        |
|      |                          |                         |                    | 11.02               | 10/8/86       |
| 5    | 13.0                     | 15.0                    | 10                 | 4.30                | 3/7/86        |
|      |                          |                         |                    | 3.92                | 4/9/86        |
|      |                          |                         |                    | 5.52                | 10/8/86       |
| 6    | 59.5                     | 101.5                   | 10                 | 28.65               | 10/8/86       |
| 7    | 21.0                     | 101.5                   | 10                 | 18.65               | 10/8/86       |
| 8    | 14.0                     | 77.0                    | 10                 | 7.00                | 10/8/86       |
| 9    | 25.0                     | 101.5                   | 10                 | 10.40               | 10/8/86       |

Source: SEA Consultants 1986.

Benzene was elevated in sampler locations 4, 5, and 8, ranging in concentration from 8 to 23  $\mu\text{g}/\text{L}$ . Since the depths range from 18 to 79 ft, the low concentrations appear to be diffuse; however, higher concentrations were found in the deeper samplers, both in the May sampling and in the subsequent sampling in September.

Almost all of the wells and samplers contained detectable concentrations of lead, cadmium, chromium, and arsenic. Only chromium levels did not exceed the chromium MCL of 0.05 mg/L. Low levels of lead were prevalent, exceeding the lead MCL (0.05 mg/L) in well 1 and in five samplers in the 1, 4, and 5 locations. Well 6, designated as the upgradient well, also contained detectable concentrations of lead.

**TABLE 4.3 Construction Details and Water Levels for BAR Samplers in Wells 2, 4, 8, and 9 at the Sanitary Landfill**

| Sampler          | Sampler Bottom Depth (ft) | Total Boring Depth (ft) | Depth to water (ft) | Date Measured |
|------------------|---------------------------|-------------------------|---------------------|---------------|
| BAR 2A-1, well 2 | 37.2                      | 37.5                    | 24.15               | 3/7/86        |
|                  |                           |                         | a                   | 4/9/86        |
|                  |                           |                         | 24.57               | 10/8/86       |
| BAR 4-2, well 4  | 18.5                      | 29.2                    | 10.50               | 3/7/86        |
|                  |                           |                         | 10.71               | 4/9/86        |
|                  |                           |                         | 11.13               | 10/8/86       |
| BAR 4-1, well 4  | 28.0                      | 29.2                    | 10.50               | 3/7/86        |
|                  |                           |                         | 10.67               | 4/9/86        |
|                  |                           |                         | 10.99               | 10/8/86       |
| BAR 8-2, well 8  | 56.0                      | 77.0                    | 6.37                | 10/8/86       |
| BAR 8-1, well 8  | 71.0                      | 77.0                    | 7.13                | 10/8/86       |
| BAR 9-2, well 9  | 40.0                      | 101.5                   | 10.41               | 10/8/86       |
| BAR 9-1, well 9  | 100.0                     | 101.5                   | 10.85               | 10/8/86       |

<sup>a</sup>Data not available.

Source: SEA Consultants 1986.

**TABLE 4.4 Construction Details and Water Levels for Wells N1 through N4 at the Sanitary Landfill (ft)**

| Well | Screen Bottom Depth | Total Boring Depth | Screen Length | Depth to Water <sup>a</sup> |
|------|---------------------|--------------------|---------------|-----------------------------|
| N1   | 39.0                | 45.0               | 15.0          | 31.32                       |
| N2   | 27.0                | 45.0               | 15.0          | 19.02                       |
| N3   | 30.0                | 60.0               | 15.0          | 23.64                       |
| N4   | 19.39               | 70.0               | 15.0          | 7.37                        |

<sup>a</sup>Measured on January 19, 1989.

Source: MacLean 1989.

**TABLE 4.5 Construction Details and Water Levels for BAR Samplers near Wells 1, 3, and 5 at the Sanitary Landfill**

| Sampler | Sampler Bottom Depth (ft) | Total Boring Depth (ft) | Depth to Water (ft) | Date Measured |
|---------|---------------------------|-------------------------|---------------------|---------------|
| BAR-1-1 | 28.0                      | 28.70                   | 12.55               | 3/7/86        |
|         |                           |                         | 12.50               | 4/9/86        |
|         |                           |                         | 23.05               | 10/8/86       |
| BAR-3-1 | 42.5                      | 42.5                    | a                   | 3/7/86        |
|         |                           |                         | a                   | 4/9/86        |
|         |                           |                         | a                   | 10/8/86       |
| BAR-5-1 | 79.0                      | 83.0                    | 2.15                | 3/7/86        |
|         |                           |                         | b                   | 4/9/86        |
|         |                           |                         | 4.63                | 10/8/86       |
| BAR-5-2 | 60.0                      | 83.0                    | 3.50                | 3/7/86        |
|         |                           |                         | b                   | 4/9/86        |
|         |                           |                         | 5.15                | 10/8/86       |
| BAR-5-3 | 45.0                      | 83.0                    | 5.41                | 3/7/86        |
|         |                           |                         | b                   | 4/9/86        |
|         |                           |                         | 4.88                | 10/8/86       |
| BAR-5-4 | 25.0                      | 83.0                    | 4.20                | 3/7/86        |
|         |                           |                         | 4.12                | 4/9/86        |
|         |                           |                         | 4.35                | 10/8/86       |

<sup>a</sup>An obstruction prevented measurement.

<sup>b</sup>No data available.

Source: SEA Consultants 1986.

Cadmium concentrations exceeded the cadmium MCL (0.01 mg/L) in wells 4 and 5 and the shallow sampler in well 4. All of those samples were collected from approximately the same depths. Although arsenic was present in nearly all of the wells and samplers, the arsenic MCL (0.05 mg/L) was exceeded only in shallow wells 1 and 5 and in sampler 5-3.

**September 1987.** Many of the same volatile organics detected in the May 1987 sampling were present at low concentrations in September 1987, but they were less prevalent. They were found in well 4, the deeper sampler in well 4, and the deepest samplers in locations 5 and 8. These depths range from 13 to 79 ft, again suggesting that the contaminants are diffuse.

TABLE 4.6 Analytic Results for Inorganics in Groundwater from Sanitary Landfill Wells and Samplers, May 1987 (mg/L, except as noted)<sup>a</sup>

| Well or Sampler | Pb   | Cd   | Cr   | Hg <sup>b</sup> | As   | Se   | Fe    | Na   | Chloride | Hardness | Conductance <sup>c</sup> |
|-----------------|------|------|------|-----------------|------|------|-------|------|----------|----------|--------------------------|
| 1               | 0.06 | 0.01 | 0.01 | 0.38            | 0.05 | 0.01 | 1.67  | 54.2 | 6.1      | 28.1     | 79                       |
| BAR-1-1         | 0.33 | 0.01 | ND   | 0.01            | 0.01 | ND   | 0.24  | 0.08 | 9.2      | 40.9     | 56                       |
| 2               | ND   | ND   | 0.04 | 0.10            | 0.01 | ND   | ND    | 11.5 | 48       | 235.4    | 340                      |
| 3               | 0.01 | 0.01 | 0.01 | 0.17            | 0.02 | ND   | 0.01  | 46.2 | 5.62     | 62.5     | 300                      |
| 4               | ND   | 0.02 | 0.01 | 0.20            | 0.03 | ND   | 4.33  | 6.17 | 15.8     | 92.5     | 310                      |
| BAR-4-1         | 0.08 | 0.01 | 0.01 | 0.13            | 0.03 | ND   | 0.14  | 9.97 | 71.1     | 190.7    | 530                      |
| BAR-4-2         | 0.07 | 0.02 | ND   | 0.26            | 0.01 | ND   | 1.42  | 82.6 | NA       | NA       | NA                       |
| 5               | ND   | 0.03 | 0.01 | 0.38            | 0.08 | 0.01 | 0.91  | 5.31 | 16.4     | 58.7     | 61                       |
| BAR-5-1         | 0.04 | 0.01 | ND   | 0.13            | 0.05 | 0.01 | 8.75  | 8.90 | 22       | 160.7    | 210                      |
| BAR-5-2         | 0.03 | 0.01 | 0.01 | ND              | ND   | ND   | 2.21  | 27.9 | 53.7     | 186.6    | 910                      |
| BAR-5-3         | 0.24 | 0.01 | 0.01 | 0.16            | 0.08 | 0.02 | 30.66 | 43.4 | 33.7     | 178.7    | 1,450                    |
| BAR-5-4         | 0.06 | 0.01 | ND   | 0.10            | 0.01 | ND   | 0.12  | 9.13 | 24       | 422.6    | 40                       |
| 6               | 0.04 | 0.01 | 0.01 | 0.10            | 0.02 | ND   | 0.86  | 21.2 | 47.5     | 64.2     | 280                      |
| 7               | ND   | 0.01 | 0.01 | 0.12            | 0.04 | ND   | 1.20  | 13   | 32.7     | 132.4    | 270                      |
| 8               | ND   | ND   | ND   | 0.10            | 0.02 | ND   | 0.34  | 2.59 | 8.7      | 68.8     | 90                       |
| BAR-8-1         | 0.02 | 0.01 | ND   | ND              | 0.01 | ND   | 6.3   | 8.97 | 14.8     | 106.3    | 260                      |
| BAR-8-2         | 0.03 | ND   | ND   | ND              | 0.01 | ND   | 0.08  | 73.5 | 52.1     | 76.5     | 510                      |
| 9               | 0.02 | 0.02 | 0.01 | 0.27            | 0.03 | ND   | 7.19  | 7.07 | 12.8     | 185      | 540                      |
| BAR-9-1         | 0.03 | 0.01 | 0.01 | 0.13            | 0.01 | ND   | 0.13  | 38.4 | 59.3     | 271      | 610                      |
| BAR-9-2         | 0.03 | 0.01 | ND   | 0.10            | 0.02 | ND   | 8.74  | 18.9 | 29.14    | 214.9    | 560                      |

<sup>a</sup>Key to abbreviations: Pb = lead, Cd = cadmium, Cr = chromium, Hg = mercury, As = arsenic, Se = selenium, Fe = iron, Na = sodium, NA = not analyzed, and ND = not detected.

<sup>b</sup>Micrograms per liter (µg/L).

<sup>c</sup>Micromhos (µmho).

Source: Briggs Associates 1987a.

**TABLE 4.7 Analytic Results for Organics in Groundwater from Sanitary Landfill Wells and Samplers, May 1987 (mg/L)**

| Well or Sampler | 1,1,1-TCA | 1,1,-DCA | Benzene | 1,2-DCE | TOC | TOX  |
|-----------------|-----------|----------|---------|---------|-----|------|
| 1               | ND        | ND       | ND      | ND      | 7.4 | 1.0  |
| BAR-1-1         | NA        | NA       | NA      | NA      | 6.4 | 1.0  |
| 2               | ND        | ND       | ND      | ND      | 229 | ND   |
| 3               | ND        | ND       | ND      | ND      | 175 | 1.5  |
| 4               | NA        | NA       | NA      | NA      | 30  | ND   |
| BAR-4-1         | 0.0019    | 0.0034   | 0.009   | ND      | 28  | 1.0  |
| BAR-4-2         |           | ND       | 0.009   | 0.0041  | 160 | 20.5 |
| 5               | NA        | NA       | NA      | NA      | 534 | 4.1  |
| BAR-5-1         | ND        | ND       | 0.011   | ND      | 69  | ND   |
| BAR-5-2         | ND        | ND       | 0.008   | ND      | 69  | 6.1  |
| BAR-5-3         | ND        | ND       | 0.023   | ND      | 31  | 4.1  |
| BAR-5-4         | ND        | ND       | 0.0099  | ND      | 3.3 | 9.2  |
| 6               | ND        | ND       | ND      | ND      | 7.3 | ND   |
| 7               | ND        | ND       | ND      | ND      | 20  | 2.04 |
| 8               | ND        | ND       | ND      | ND      | 61  | 1.0  |
| BAR-8-1         | ND        | ND       | 0.012   | ND      | 24  | 7.2  |
| BAR-8-2         | ND        | ND       | ND      | ND      | 3.2 | ND   |
| 9               | ND        | ND       | ND      | ND      | 106 | ND   |
| BAR-9-1         | ND        | ND       | ND      | ND      | 6   | 3    |
| BAR-9-2         | ND        | ND       | ND      | ND      | 9.1 | 4.1  |

<sup>a</sup>Key to abbreviations: TCA = trichloroethane, DCA = dichloroethane, DCE = dichloroethylene, TOC = total organic carbon, TOX = total organic halogens, NA = not analyzed, and ND = not detected.

Source: Briggs Associates 1987a.

As in the May 1987 sampling, benzene was found in locations 5 and 8. In sampler BAR-8-1, the concentration was about the same as that in May (7.7 µg/L at 71 ft). The concentrations at location 5, however, were quite different from those found in May. The concentration in sampler BAR-5-4 was lower (1.3 µg/L), and that in BAR-5-2 was much higher (129 µg/L). This may suggest the downward migration of contaminants.

Results showed detectable levels of metals, but with less frequency than in May. Lead levels again exceeded the MCL only in locations 4 and 5. Cadmium levels exceeded the MCL only in well 5. Although chromium was detected, the levels did not exceed the chromium MCL in any wells or samplers. Arsenic levels below criteria were found in wells 2, 4, 5, 7, and 9 and in samplers at locations 4 and 5. This indicates that low-level arsenic contamination is present both upgradient and downgradient of the site.

No results were given for well 1. It is often dry, and the only results given were for May 1987.

TABLE 4.8 Analytic Results for Inorganics in Groundwater from Sanitary Landfill Wells and Samplers, September 1987  
(mg/L, except as noted)<sup>a</sup>

| Well or Sampler <sup>b</sup> | Pb   | Cd   | Cr   | Hg <sup>c</sup> | As   | Se   | Fe   | Na   | Chloride | Hardness | Conductance <sup>d</sup> |
|------------------------------|------|------|------|-----------------|------|------|------|------|----------|----------|--------------------------|
| 2                            | 0.04 | ND   | ND   | ND              | 0.01 | 0.02 | 0.20 | 7.63 | 3        | 147.3    | 330                      |
| BAR-2-2                      | NA   | NA   | NA   | 0.19            | NA   | NA   | NA   | 14.6 | 8.9      | 35.6     | 145                      |
| 3                            | 0.01 | ND   | ND   | ND              | ND   | 0.01 | 1.12 | 5.92 | 8        | 66.9     | 80                       |
| 4                            | 0.06 | 0.01 | 0.01 | 0.28            | 0.03 | 0.01 | 1.32 | 47.6 | 66.6     | 376.8    | 1,200                    |
| BAR-4-1                      | 0.08 | 0.01 | 0.01 | 0.38            | 0.03 | 0.01 | 0.08 | 11.9 | 61.6     | 149.5    | 420                      |
| 5                            | 0.03 | 0.03 | ND   | ND              | 0.03 | ND   | 3.12 | 7.2  | 5        | 100.7    | 240                      |
| BAR-5-1                      | 0.07 | 0.01 | ND   | ND              | 0.01 | ND   | 0.12 | 34.5 | 83.5     | 596.6    | 1,025                    |
| BAR-5-2                      | 0.06 | 0.01 | 0.01 | 0.18            | ND   | ND   | 0.12 | 33.3 | 48.7     | 261.9    | 730                      |
| BAR-5-3                      | 0.06 | 0.01 | 0.02 | 0.12            | ND   | 0.01 | 13.6 | 13.5 | 7        | 476.5    | 920                      |
| BAR-5-4                      | 0.03 | ND   | 0.02 | ND              | ND   | ND   | 0.10 | 8.63 | 2        | 193.8    | 380                      |
| 6                            | 0.01 | ND   | ND   | ND              | ND   | ND   | 0.31 | 30.5 | 37.1     | 56.7     | 275                      |
| 7                            | 0.01 | ND   | 0.03 | 0.10            | 0.01 | ND   | 0.25 | 8.09 | 18.9     | 65.1     | 260                      |
| 8                            | ND   | ND   | 0.01 | ND              | ND   | ND   | 0.78 | 4.73 | ND       | 35.2     | 82                       |
| BAR-8-1                      | ND   | ND   | ND   | ND              | ND   | 0.01 | 0.10 | 7.87 | 8.9      | 76.9     | 195                      |
| BAR-8-2                      | ND   | ND   | ND   | ND              | ND   | ND   | 0.13 | 18.6 | 8.9      | 43       | 160                      |
| 9                            | 0.03 | ND   | 0.01 | ND              | 0.01 | 0.01 | 0.68 | 8.51 | 5        | 142.5    | 465                      |
| BAR-9-1                      | 0.02 | 0.01 | 0.03 | 0.39            | ND   | ND   | 1.5  | 29.6 | 45.7     | 231.4    | 580                      |
| BAR-9-2                      | 0.03 | 0.01 | 0.01 | ND              | ND   | ND   | 3.63 | 29.5 | 26.8     | 209.8    | 650                      |

<sup>a</sup>Key to abbreviations: Pb = lead, Cd = cadmium, Cr = chromium, Hg = mercury, As = arsenic, Se = selenium, Fe = iron, Na = sodium, NA = not analyzed, and ND = not detected.

<sup>b</sup>Sampler BAR 4-2 was not listed in the results.

<sup>c</sup>µg/L.

<sup>d</sup>µmho.

Source: Briggs Associates 1987a.

**TABLE 4.9 Analytic Results for Organics in Groundwater from Sanitary Landfill Wells and Samplers, September 1987 (mg/L)<sup>a</sup>**

| Well or Sampler <sup>b</sup> | 1,1,1-TCA | 1,1-DCA | Benzene | TCE    | TOC | TOX  |
|------------------------------|-----------|---------|---------|--------|-----|------|
| 2                            | ND        | ND      | ND      | ND     | ND  | ND   |
| BAR-2-2                      | ND        | ND      | ND      | ND     | 21  | 17.9 |
| 3                            | ND        | ND      | ND      | ND     | ND  | ND   |
| 4                            | 0.002     | 0.0084  | ND      | ND     | ND  | ND   |
| BAR-4-1                      | 0.0014    | 0.0038  | ND      | ND     | 45  | 2.98 |
| 5                            | ND        | ND      | ND      | ND     | 15  | 3.98 |
| BAR-5-1                      | 0.006     | ND      | ND      | ND     | ND  | 4.97 |
| BAR-5-2                      | ND        | ND      | 0.129   | ND     | 15  | ND   |
| BAR-5-3                      | ND        | ND      | ND      | ND     | ND  | ND   |
| BAR-5-4                      | ND        | ND      | 0.0013  | ND     | ND  | ND   |
| 6                            | ND        | ND      | ND      | ND     | ND  | 0.5  |
| 7                            | ND        | ND      | ND      | ND     | ND  | 1.49 |
| 8                            | ND        | ND      | ND      | ND     | ND  | ND   |
| BAR-8-1                      | ND        | ND      | 0.0077  | 0.0011 | ND  | 1.5  |
| BAR-8-2                      | ND        | ND      | ND      | ND     | ND  | ND   |
| 9                            | ND        | ND      | ND      | ND     | ND  | 0.5  |
| BAR-9-1                      | ND        | ND      | ND      | ND     | ND  | 0.5  |
| BAR-9-2                      | ND        | ND      | ND      | ND     | ND  | 1.5  |

<sup>a</sup>Key to abbreviations: TCA = trichloroethane, DCA = dichloroethane, TCE = trichloroethylene, TOC = total organic carbon, TOX = total organic halogen, and ND = not detected.

<sup>b</sup>Sampler BAR-4-2 was not listed in the results.

Source: Briggs Associates 1987b.

**January 1989.** Low levels of volatile organics (below their respective MCLs) were found in well 4, sampler BAR-4-1, and well N2. Low concentrations (3.0 µg/L) of benzene were found in wells 7 and N2, but they did not exceed the benzene MCL. Although the concentration was low (3 µg/L), the vinyl chloride level exceeded the MCL of 2.0 µg/L in well N2.

Only wells 3 through 9 and wells N1 through N4 were sampled for metals. In comparison with the earlier sampling, elevated concentrations of metals were not as prevalent. Lead levels exceeding the MCL were found only in wells N2 (0.12 mg/L) and N3 (0.10 mg/L). Cadmium was not detected in any of the wells. Chromium levels exceeded the MCL in wells 7, N2, N3, and N4. Arsenic was more prevalent than the other metals and was detected in each of the 11 wells sampled. The arsenic MCL was exceeded in samples from wells 4, 7, 9, and N1 through N4; water from the newer wells contained the highest arsenic concentrations. Well N3, designated as an upgradient well, contained 0.20 mg/L of chromium, 0.10 mg/L of lead, and 0.34 mg/L of arsenic.

**TABLE 4.10 Analytic Results for Inorganics in Groundwater from Sanitary Landfill Wells, January 1989 (mg/L)<sup>a,b</sup>**

| Well <sup>c</sup> | Pb   | Cr   | As    | Fe   | Na    |
|-------------------|------|------|-------|------|-------|
| 3                 | ND   | ND   | 0.008 | 7.0  | 3.71  |
| 4                 | ND   | ND   | 0.14  | 363  | 14.91 |
| 5                 | ND   | ND   | 0.02  | 17.9 | 3.59  |
| 6                 | ND   | ND   | 0.027 | 23.3 | 22.7  |
| 7                 | ND   | 0.09 | 0.08  | 71.5 | 14.31 |
| 8                 | ND   | 0.01 | 0.015 | 22.1 | 4.2   |
| 9                 | ND   | ND   | 0.071 | 30.5 | 7.34  |
| N1                | ND   | ND   | 0.07  | 37.5 | 5.88  |
| N2                | 0.12 | 0.14 | 0.69  | 250  | 33.45 |
| N3                | 0.10 | 0.20 | 0.34  | 189  | 14.02 |
| N4                | ND   | 0.07 | 0.42  | 122  | 20.24 |

<sup>a</sup>Key to abbreviations: Pb = lead, Cr = chromium, As = arsenic, Fe = iron, Na = sodium, and ND = not detected.

<sup>b</sup>Chloride, hardness, and conductance were not analyzed. Cadmium, mercury, and selenium were not detected.

<sup>c</sup>BAR samplers were not sampled.

Source: Con-Test 1989.

**Summary of Sampling Results.** Generally, in all of the sampling for indicator parameters, the highest values for chloride, conductance, sodium, and hardness were found in water from well N2. Past sampling has shown that the highest hardness levels were found in wells 4 and 9, but well N2 shows the highest current levels. Well 4 contains the highest concentration of iron, 363 mg/L (Table 4.10), which far exceeds the Massachusetts Secondary Drinking Water Standard of 0.3 mg/L. These wells are all located in the northeast, downgradient of the site.

TOC values ranged from "not detected" to 54 mg/L, the value determined at well 6. Elevated levels of TOC were detected at wells 4, 5, 6, 9 and N4. All of these results indicate the presence of low-level contamination both upgradient and downgradient of the site. It appears that metals have contaminated the upgradient wells, or that the background concentrations of metals are high.

Six surface water samples were collected in January 1989 and analyzed for volatile organic compounds, inorganic compounds, TOC, and TOX. The results and general sample locations are given in Table 4.12. The specific sample locations are not known.

Sample 4 contained the highest concentrations of contaminants and the highest value for conductance. These same contaminants have historically been elevated in groundwater

TABLE 4.11 Analytic Results for Organics in Groundwater from Sanitary Landfill Wells and Samplers, January 1989 (mg/L)<sup>a</sup>

| Well or Sampler <sup>b</sup> | 1,2-DCA | Benzene | Vinyl Chloride | 1,2-DCE | TCE   | TOC  | TOX  |
|------------------------------|---------|---------|----------------|---------|-------|------|------|
| 3                            | ND      | ND      | ND             | ND      | ND    | 8.4  | ND   |
| 4                            | ND      | ND      | ND             | ND      | ND    | 2.2  | ND   |
| BAR-4-1                      | 0.003   | ND      | ND             | 0.026   | 0.005 | NA   | NA   |
| 5                            | ND      | ND      | ND             | ND      | ND    | 12.0 | ND   |
| 6                            | ND      | ND      | ND             | ND      | ND    | 54.0 | 0.18 |
| 7                            | ND      | 0.003   | ND             | ND      | ND    | 6.2  | ND   |
| 8                            | ND      | ND      | ND             | ND      | ND    | 2.7  | ND   |
| 9                            | ND      | ND      | ND             | ND      | ND    | 17.0 | 0.18 |
| N1                           | ND      | ND      | ND             | ND      | ND    | 1.4  | 0.10 |
| N2                           | ND      | 0.003   | 0.003          | 0.004   | ND    | 7.8  | ND   |
| N3                           | ND      | ND      | ND             | ND      | ND    | 5.6  | ND   |
| N4                           | ND      | ND      | ND             | ND      | ND    | 3.0  | ND   |

<sup>a</sup>Key to abbreviations: DCA = dichloroethane, DCE = dichloroethylene, TCE = trichloroethylene, TOC = total organic carbon, TOX = total organic halogens, NA = not analyzed, and ND = not detected.

<sup>b</sup>No organics were detected in BAR samplers 5-1, 5-2, 5-3, 5-4, 8-1, 8-2, and 9-2. BAR samplers 4-2 and 9-1 were not listed in the results. None of the BAR samplers were analyzed for TOC or TOX.

Source: Con-Test 1989.

samples from well 4. None of the surface water samples exceeded the Secondary Drinking Water Standard for chloride (250 mg/L) or the MCL for arsenic (0.05 mg/L). All of the samples exceeded the standard for iron (0.3 mg/L).

Tables 4.13 through 4.16 present the ranges of analytic results for inorganics and organics during four quarters of sampling for 1989 and 1990. The concentrations and locations of contaminants detected throughout the year were similar to the results obtained in January. For inorganics, cadmium was not detected in any of the wells; chromium levels exceeded the MCLs in wells 3, 4, 7, N2, N3, and N4 (detections in wells 3 and 4 occurred later during 1989); and arsenic continued to be more prevalent than other metals. For organics, low levels were found in scattered wells, and TOC and TOH values were detected for all wells sampled.

Information regarding 1988 monitoring results was not available; however, the established trends between the results for 1987 and those for 1989 and 1990 did not vary significantly. Additionally, new information for all of the landfill wells will be acquired and evaluated as part of the remedial investigation for this site.

**TABLE 4.12 Analytic Results for Surface Water from Plow Shop and Grove Ponds, January 1989**

| Sample No. and Location           | Conduc-tance (µmho) | pH  | Chloride (mg/L) | Metals (mg/L) |        |                | TOC <sup>a</sup> (mg/L) |
|-----------------------------------|---------------------|-----|-----------------|---------------|--------|----------------|-------------------------|
|                                   |                     |     |                 | Iron          | Sodium | Arsenic        |                         |
| Plow Shop Pond                    |                     |     |                 |               |        |                |                         |
| 1 - Near R.R. tracks <sup>b</sup> | 194                 | 7.4 | 27.3            | 0.74          | 17.3   | - <sup>c</sup> | 3.3                     |
| 2 - Near well N4                  | 200                 | 7.5 | 45.3            | 0.42          | 37.4   | 0.0014         | 4.0                     |
| 3 - Near well 3                   | 69                  | 7.0 | 4.2             | 1.33          | 4.74   | 0.027          | 1.6                     |
| 4 - Near well 4                   | 201                 | 6.7 | 72.1            | 22.4          | 32.3   | 0.021          | 5.0                     |
| Grove Pond                        |                     |     |                 |               |        |                |                         |
| 5 - Southwest side                | 176                 | 7.2 | 25.0            | 1.37          | 18.7   | 0.0015         | 2.2                     |
| 6 - Northwest side                | 182                 | 7.3 | 46.0            | 0.48          | 32.0   | -              | 4.3                     |

<sup>a</sup>Volatile organics (EPA method 624) and TOX were not detected.

<sup>b</sup>The railroad tracks are on the eastern edge of Plow Shop Pond.

<sup>c</sup>No information given for this location.

Source: MacLean 1989.

#### 4.5.4 Proposed Action

Presently, 13 monitoring wells are at the site. Two of the wells (Nos. 1 and 2) are often dry and should be replaced. Additional wells are required in order to better characterize the site and the nature and extent of contamination. Proposed locations for five new wells are shown in Fig. 4.4. Each new well should be set in the borehole such that the water table intersects the screened area. The final well locations and screen placement should be determined by the field geologist when the wells are installed.

To include upgradient locations in this study, the wells at the POL site (Fig. 4.4) should be sampled. Water levels should be measured in all wells quarterly for one year to determine the groundwater flow direction and gradient. Slug tests are recommended for all wells to determine the in-situ parameter values of transmissivity and storativity; however, due to possibly high hydraulic conductivity that is usually present in sand and gravel outwash aquifers, slug tests may not be adequate and aquifer pump tests may be required. After proper well development, samples should be obtained from the old and new wells and analyzed for HSL compounds and explosives. After recovery of normal groundwater levels, a second, complete round of well sampling should be conducted.

TABLE 4.13 Range of Analytic Results for Inorganics in Landfill Wells, 1989 (mg/L unless otherwise noted)

| Parameter                   | 3         | 4          | 5         | 6          | 7           | 8 <sup>a</sup> | 9         | N1         | N2          | N3 <sup>b</sup> | N4 <sup>a,b</sup> |
|-----------------------------|-----------|------------|-----------|------------|-------------|----------------|-----------|------------|-------------|-----------------|-------------------|
| Arsenic                     | ND-0.008  | ND-0.14    | ND-0.27   | ND-0.027   | ND-0.11     | ND-0.015       | ND-0.07   | ND-0.07    | ND-0.69     | ND-0.034        | ND-0.18           |
| Cadmium                     | ND        | ND         | ND        | ND         | ND          | ND             | ND        | ND         | ND          | ND              | ND                |
| Chromium                    | ND-0.036  | ND-0.087   | ND-0.005  | ND-0.006   | 0.006-0.09  | ND-0.01        | ND-0.0035 | ND-0.007   | ND-0.14     | ND-0.20         | ND-0.07           |
| Lead <sup>c</sup>           | ND-0.976  | ND         | ND        | ND         | ND          | ND             | ND        | ND         | ND-0.12     | ND-0.10         | ND                |
| Selenium                    | ND        | ND         | ND        | ND         | ND          | ND             | ND        | ND         | ND          | ND-0.015        | ND                |
| Sodium                      | 1.68-4.53 | 4.3-17.3   | 1.28-3.8  | 20.8-25    | 7.42-15.2   | 2.47-4.2       | 2.41-7.34 | 0.202-12.2 | 0.120-33.45 | 2.66-14.02      | 12.9-30           |
| Iron <sup>c</sup>           | 1.05-9.67 | 12.3-363   | 1.87-17.9 | 0.473-23.3 | 1.55-71.5   | 0.729-22.1     | 4.52-30.5 | 0.35-37.5  | 0.053-250   | 1.43-189        | 1.12-122          |
| Mercury <sup>c</sup>        | ND        | ND         | ND        | ND         | ND          | ND             | ND        | ND         | ND          | ND              | ND                |
| pH <sup>c</sup>             | 6.6-6.8   | 6.1-6.6    | 5.8-6.4   | 5.6-5.8    | 6.2-6.4     | 6.2-6.4        | 6.4-6.6   | 6.3-7.1    | 6.1-6.7     | 6.4-6.6         | 6.3-6.4           |
| Specific conductance (µmho) | 63-200    | 150-240    | 140-425   | 270-390    | 95-390      | 64-175         | 200-340   | 30-140     | 150-565     | 80-130.0        | 140-9000          |
| Chloride                    | 2.0-6.0   | 4.0-15.4   | 4-10.3    | 41.1-46    | 4-26        | 4-5.1          | 2-6       | 5.1-30.0   | 8-38        | 1.9-2.0         | 20-84             |
| Hardness                    | 24-48     | 52-98      | 56-110    | 48-62      | 36-80       | 16-170         | 88-124    | 5.1-3.4    | 56-180      | 20-60           | 4-238             |
| MEK <sup>d</sup>            | ND        | ND         | ND        | ND         | ND          | ND             | ND        | ND         | ND          | ND              | ND                |
| MIBK                        | ND        | ND         | ND        | ND         | ND          | ND             | ND        | ND         | ND          | ND              | ND                |
| TOC                         | 2.9-8.4   | 2.4-14     | 1.7-19.0  | ND-54.0    | 1.2-6.2     | ND-3           | 8.3-17    | 1.4-5.0    | 1.5-9.0     | ND-5.6          | 1.3-4.0           |
| TOX (µg/L)                  | ND-24     | 49.39-69.0 | 24-44.49  | 21-47.82   | 27.13-13.31 | 16.95-33       | 15.99-39  | 11.3-30.0  | ND-25       | ND-28           | 26-62             |

<sup>a</sup>No data for the fourth quarter.<sup>b</sup>No data for the third quarter.<sup>c</sup>Not tested during the fourth quarter.<sup>d</sup>Methyl ethyl ketone.

Source: Prior 1991.

TABLE 4.14 Range of Analytic Results for Organics in Landfill Wells, 1989 (mg/L)

| Parameter                     | 3               | 4  | 5  | 6  | 7        | 8 <sup>a</sup> | 9  | N1       | N2       | N3       | N4 <sup>a,b</sup> |
|-------------------------------|-----------------|----|----|----|----------|----------------|----|----------|----------|----------|-------------------|
| Chloromethane                 | ND <sup>a</sup> | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| Bromomethane                  | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| Vinyl chloride                | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND-0.003 | ND                |
| Chloroethane                  | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| Methylene chloride            | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| Acetone <sup>c</sup>          | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| Carbon disulfide <sup>c</sup> | ND-1.95         | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| 1,1-Dichloroethene            | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| 1,1-Dichloroethane            | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| Trans-1,2-dichloroethene      | ND              | ND | ND | ND | ND       | ND             | ND | ND-0.004 | ND       | ND       | ND                |
| Chloroform                    | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| 1,2-Dichloroethane            | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| 2-Butanone                    | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| 1,1,1-Trichloroethane         | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| Carbon tetrachloride          | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| Vinyl acetate                 | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| Bromodichloromethane          | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| 1,2-Dichloropropane           | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| Trans-1,3-dichloropropene     | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| Trichloroethene               | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| Dibromochloromethane          | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| 1,1,2-Trichloroethane         | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| Benzene                       | ND              | ND | ND | ND | ND-0.003 | ND             | ND | ND       | ND-0.003 | ND       | ND                |
| Cis-1,3-dichloropropene       | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| 2-Chloroethylvinyl ether      | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| Bromoform                     | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| 2-Hexanone                    | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| 4-Methyl-2-pentanone          | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| Tetrachloroethene             | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| 1,1,2,2-Tetrachloroethane     | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| Toluene                       | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| Chlorobenzene                 | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| Ethylbenzene                  | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| Total xylenes                 | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |
| Trichlorofluoromethane        | ND              | ND | ND | ND | ND       | ND             | ND | ND       | ND       | ND       | ND                |

<sup>a</sup>No data for the fourth quarter.

<sup>b</sup>No data for the third quarter.

<sup>c</sup>Parameter not analyzed in the fourth quarter.

Source: Prior 1991.

TABLE 4.15 Range of Analytic Results for Inorganics in Landfill Wells, 1990 (mg/L)

| Parameter                   | 3                | 4                | 5                    | 6         | 7         | 8 <sup>a</sup>          | 9         | N1               | N2                   | N3        | N4        |
|-----------------------------|------------------|------------------|----------------------|-----------|-----------|-------------------------|-----------|------------------|----------------------|-----------|-----------|
| Silver                      | ND               | ND               | ND                   | ND        | ND        | ND                      | ND        | ND               | ND                   | ND        | ND-0.06   |
| Arsenic                     | ND               | ND-0.16          | ND-0.021             | ND-0.012  | ND-0.01   | ND-0.0068               | ND-0.025  | ND-0.71          | ND-0.21              | ND-0.12   | ND        |
| Cadmium                     | ND-0.0006        | ND-0.0008        | ND-0.0025            | ND-0.0005 | ND-0.0005 | ND-0.003                | ND        | ND-0.0006        | ND                   | ND-0.0018 | ND-0.001  |
| Chromium                    | ND-0.006         | ND-0.006         | ND-0.0056            | ND-0.0059 | ND-0.0046 | ND                      | ND-0.0036 | ND-0.015         | ND-0.0077            | ND-0.08   | ND-0.0045 |
| Iron                        | 0.04-1.40        | 4.0-17.0         | N1 <sup>b</sup> -7.0 | 0.05-3.90 | 0.08-3.9  | 0.04-0.25               | 5.3-6.7   | 0.19-64          | 8.3-100              | 0.06-57.0 | 0.04-1.10 |
| Mercury                     | ND               | ND               | ND-0.0006            | ND        | ND        | N1 <sup>b</sup> -0.0005 | ND        | ND               | ND                   | ND        | ND-0.0005 |
| Lead                        | ND-0.0021        | ND-0.006         | ND-0.0013            | ND-0.0014 | ND-0.0034 | ND-0.0014               | ND-0.0018 | ND-0.0074        | ND-0.0074            | ND-0.029  | ND-0.0013 |
| Selenium                    | ND               | ND               | ND                   | ND        | ND        | ND                      | ND        | ND               | ND                   | ND        | ND        |
| TOC                         | BDL <sup>b</sup> | BDL <sup>c</sup> | BDL <sup>c</sup>     | BDL       | BDL       | BDL                     | BDL       | BDL              | BDL                  | BDL       | BDL       |
| TOX (µg/L)                  | BDL-35           | BDL-89           | BDL-52               | BDL-21    | BDL-15    | BDL-31                  | BDL-43    | BDL <sup>d</sup> | (40-79) <sup>d</sup> | BDL-20    | BDL-50    |
| Specific conductance (µmho) | 41-86            | 105-145          | 105-225              | 240-270   | 94-180    | 84-127                  | 96-250    | 39-520           | 535-735              | 125-151   | 67-165    |
| Chloride                    | ND-2.5           | ND-20            | ND-0.50              | 17-46     | 0.5-5.8   | 2.5-7.0                 | ND-1.0    | ND-2.0           | ND                   | ND-14     | 7-35      |
| Hardness <sup>e</sup>       | 12-28            | 38-50            | 32-58                | 54-58     | 34-40     | 28-34                   | 102-120   | 16-24            | 42-180               | 44-92     | 24-32     |
| MEK                         | ND               | ND               | ND                   | ND        | ND        | ND                      | ND        | ND               | ND                   | ND        | ND        |
| MIBK                        | ND               | ND               | ND                   | ND        | ND        | ND                      | ND        | ND               | ND                   | ND        | ND        |
| Sodium                      | 1.3-3.4          | 1.3-3.4          | 3.2-6.3              | 23-32     | 2.8-7.8   | 5.8-8.8                 | 2.7-4.3   | 1.5-3.1          | 26-55                | 6.5-10.0  | 7.3-24    |

<sup>a</sup>Well not sampled during the first quarter.

<sup>b</sup>BDL = below detection limit.

<sup>c</sup>Parameter not analyzed during the fourth quarter in this well.

<sup>d</sup>Parameter not analyzed during the second quarter in this well.

<sup>e</sup>Parameter not analyzed during the third quarter in any well.

Source: Prior 1991.

TABLE 4.16 Range of Analytic Results for Organics in Landfill Wells, 1990 (mg/L)

| Parameter                  | 3  | 4  | 5  | 6  | 7  | 8 <sup>a</sup> | 9  | N1 | N2       | N3 | N4 |
|----------------------------|----|----|----|----|----|----------------|----|----|----------|----|----|
| Chloromethane              | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| Bromomethane               | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| Vinyl chloride             | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| Chloroethane               | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| Methylene chloride         | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| Trichlorofluoromethane     | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| 1,1-Dichloroethylene       | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| 1,1-Dichloroethane         | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| Trans-1,2-dichloroethylene | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| Chloroform                 | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| 1,2-Dichloroethane         | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| 1,1,1-Trichloroethane      | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| Carbon tetrachloride       | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| Bromodichloromethane       | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| 1,2-Dichloropropane        | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| Cis-1,3-dichloropropene    | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| Trichloroethylene          | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| Benzene                    | ND | ND | ND | ND | ND | ND             | ND | ND | ND-0.001 | ND | ND |
| Chlorodibromomethane       | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| Trans-1,3-dichloropropene  | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| 1,1,2-Trichloroethane      | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| 2-Chloroethylvinyl ether   | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| Bromoform                  | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| 1,1,2,2-Tetrachlorethane   | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| Tetrachloroethylene        | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| Toluene                    | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| Chlorobenzene              | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| Ethyl benzene              | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| Xylenes                    | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |
| Dichlorobenzenes           | ND | ND | ND | ND | ND | ND             | ND | ND | ND       | ND | ND |

<sup>a</sup>Well not sampled during the first quarter.

Source: Prior 1991.

If leachate is flowing from the landfill, samples of the leachate should be collected and analyzed for HSL compounds and explosives. Soil samples from erosion gullies around the landfill should be obtained and analyzed for the same parameters as the leachate. Because of the proximity of Plow Shop Pond, it is possible that contaminated groundwater and leachate may migrate to the pond. It is recommended that about 15 surface water and sediment samples be collected from the pond and analyzed for HSL compounds and explosives. Sediment samples should be evaluated for grain size and analyzed for TOC. This number of samples represents about one sample every 175 ft along the pond's shoreline.

Since contamination has already been detected at this SA, a full remedial investigation is recommended to determine the extent of the contamination. The investigation should address SAs 4, 5, and 18.

## 4.6 SA 6 -- LANDFILL NO. 2

### 4.6.1 Site History

McMaster et al. (1982) reported that landfill No. 2 (SA 6) was probably an old town dump used by local residents for disposal of household rubbish and glass from about 1850 to 1920, before the site's incorporation into Fort Devens. The site's supposed location is somewhere in the south post near training area 7b (Fig. 4.1). The existence and location of inactive landfill No. 2 is in doubt. Despite repeated attempts, Fort Devens personnel have not been able to locate the site, and no surface evidence has been found to indicate its location. Access to the site's general location would be from Shirley Road. The exact size of the landfill is unknown, but it has been reported to have been about 1 acre in extent.

Knowledge of historical practices at similar disposal sites indicates that rubbish was probably just dumped over the edge of a bluff or hill.

### 4.6.2 Geology and Hydrology

Without knowing the exact location of this landfill, it is not possible to accurately define the geological and hydrological conditions of the site. The metamorphic and granitic bedrock of the region is mantled and obscured by a veneer of glacial deposits of undetermined thickness. The glacial deposits are probably an outwash deposit of sand, gravel, and boulders.

If the site is along a bluff overlooking Ponakin Brook, the soil associations at the site are probably either the Quonset-Hinckley-Windsor or the Sudbury-Deerfield-Ninigret (Nicholls et al. 1980). If the site is in the wetlands at the foot of the bluff, then the association would be the Muck-Peat-Walpole. The Quonset-Hinckley-Windsor Association is described as droughty sand and gravelly soil underlain by stratified sand and gravel. The soil is well drained and has high permeability. The Sudbury-Deerfield-Ninigret Association is described as sand and gravelly soil, with silty subsoil. The soil is moderately well drained, with moderate to low permeability in the subsoil. The Muck-Peat-Walpole Association consists of poorly drained, organic and sandy soil having a high water table.

The hydrogeological conditions at this location have been mapped as a minor aquifer consisting of thin sections of glacial outwash and glacial lacustrine deposits. Goldberg-Zoino & Associates (1976) showed the saturated thickness to be less than 20 ft in this area.

### 4.6.3 Nature and Extent of Contamination

The nature and extent of any soil or groundwater contamination is unknown, for no records exist detailing the quantities or nature of the material disposed of at this landfill. This site, if it exists, has not received any debris for more than 71 years; therefore, it is probable that any contaminants have completely disappeared due to evaporation, dissolution, oxidation, and biodegradation.

#### 4.6.4 Proposed Action

Because of the type of wastes that would have been placed in this landfill (if it exists) and the time of its operation, there is very little reason to believe that the site is contaminated. An attempt should be made to locate the landfill through examination of aerial photographs and a field reconnaissance. A geophysical survey may be used to help delineate the extent of the landfill. If the landfill is located, soil samples should be collected and analyzed for indicator parameters. If it cannot be located, it is recommended that no further action be taken.

#### 4.7 SA 7 -- LANDFILL NO. 3

##### 4.7.1 Site History

Landfill No. 3 (SA 7) is reported to have been an undocumented estate or farm dump where household rubbish and glass were disposed of from the mid 1800s to about 1920 (McMaster et al. 1982). The landfill, which cannot be found, is reported to have been located in the middle of the south post; it existed before Fort Devens acquired the south post property. The site was reported to be about 1 acre in extent. Based on the landfill's estimated location (Fig. 4.1), the site would be approximately east of SA 25 (EOD range) in the impact area.

##### 4.7.2 Geology and Hydrology

Without knowing the exact location of this landfill, it is not possible to accurately define the geological and hydrogeological conditions of the site. The general geology of the area consists of unconsolidated glacial deposits of undetermined thickness overlying Paleozoic metamorphic and granitic bedrock.

The soil association at the site is probably the Quonset-Hinckley-Windsor, which is described as droughty sand and gravelly soil underlain by stratified sand and gravel (Nicholls et al. 1980). The soil is well drained and has high permeability.

The hydrogeological conditions in the area have been mapped as a minor aquifer consisting of thin sections of glacial outwash and glacial lacustrine deposits. Goldberg-Zoino & Associates (1976) showed the saturated thickness to be less than 20 ft in this area.

##### 4.7.3 Nature and Extent of Contamination

This site, if it exists, has not received any debris for more than 71 years. No records are available concerning the nature of the material disposed of at this site, and no data are available on soil or groundwater contamination in the area. It is probable that any contaminants have completely disappeared due to evaporation, dissolution, oxidation, and biodegradation.

#### 4.7.4 Proposed Action

Because of the type of wastes placed in this landfill and the time of its operation, there is very little reason to believe that the site is contaminated. An attempt should be made to locate the landfill through examination of aerial photographs and a field reconnaissance. A geophysical survey may be needed to help delineate the extent of the landfill. If the landfill is located, soil samples should be collected and analyzed for indicator parameters. If the site cannot be located, it is recommended that no further action be taken.

### 4.8 SA 8 – LANDFILL NO. 4

#### 4.8.1 Site History

As with SAs 6 and 7, the exact location of landfill No. 4 (SA 8) is unknown. The landfill reportedly was used from about 1900 to 1930 for the disposal of household items and military items, both before and after the land was incorporated into Fort Devens (McMaster et al. 1982; Nicholls 1986b). The landfill is reported to have been about 6 acres in size and located in the south-central part of the south post (McMaster et al. 1982; Nicholls 1986b). The site's approximate location is shown in Fig. 4.1. Based on the site's general location, the landfill would appear to have been located west of Shirley Road in tactical training area 8a. Even though Fort Devens environmental personnel have searched for the site, and troops have traversed area 8 and adjacent training areas for years, the site has not been found. No surface evidence has been found to indicate its location.

#### 4.8.2 Geology and Hydrology

Without knowing the exact location of this landfill, it is not possible to accurately define the geological and hydrogeological conditions of the site. The metamorphic and granitic bedrock of the region is mantled and obscured by a veneer of glacial deposits of undetermined thickness. The glacial deposits are probably an outwash deposit consisting of sand, gravel, and boulders.

The soil association at the site is probably the Quonset-Hinckley-Windsor, which is described as droughty sand and gravelly soil underlain by stratified sand and gravel (Nicholls et al. 1980). The soil is well drained and has high permeability.

The hydrogeological conditions at this location have been mapped as a minor aquifer consisting of thin sections of glacial outwash and glacial lacustrine deposits. Goldberg-Zoino & Associates (1976) showed the saturated thickness to be less than 20 ft in this area.

#### 4.8.3 Nature and Extent of Contamination

This site, if it exists, has not received any debris for about 61 years. No records are available concerning the nature of the material disposed of at this site; therefore, the nature and extent of any soil or groundwater contamination in this area is unknown. It is probable than any

contaminants have completely disappeared due to evaporation, dissolution, oxidation, and biodegradation.

#### 4.8.4 Proposed Action

Because of the type of wastes placed in this landfill and the time of its operation, there is very little reason to believe that the site is contaminated. An attempt should be made to locate the landfill through examination of aerial photographs and a field reconnaissance. A geophysical survey may help to delineate the extent of the landfill. If the landfill is located, samples should be collected and analyzed for indicator parameters. If the site cannot be located, it is recommended that no further action be taken.

### 4.9 SA 9 -- LANDFILL NO. 5

#### 4.9.1 Site History

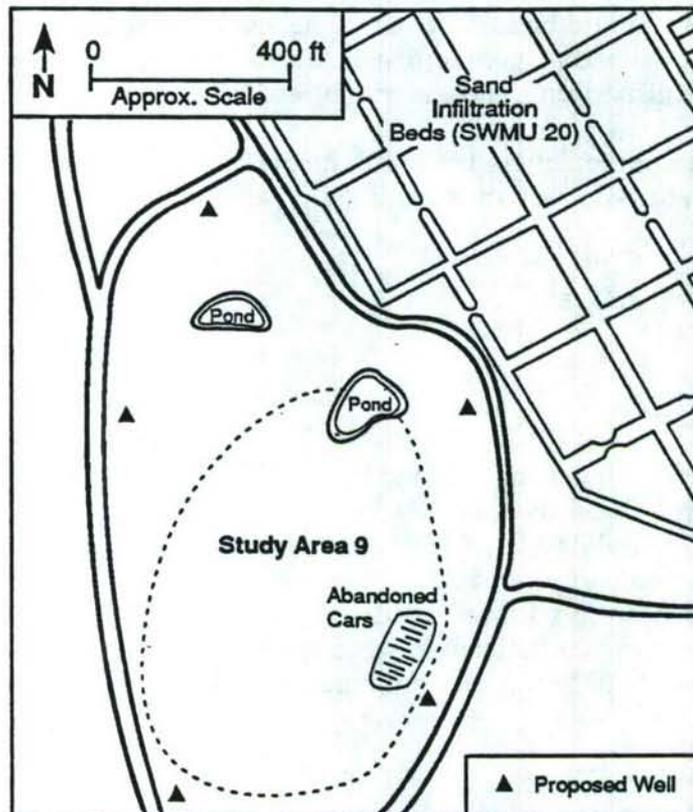
Landfill No. 5 (SA 9) is located south of the WWTP in the north post (Fig. 4.6); it occupies 14.8 acres. The landfill, located on a sand and gravel glacial deposit, is an old "stump dump," used primarily for construction debris and tree stumps; it operated from the late 1950s until 1978, when it was closed. Originally, this site was a low wet area, but the ground level has been raised by 34.4-39.4 ft (McMaster et al. 1982; DEH 1985b). It was reported that debris from nearly 100 demolished buildings was placed in this landfill (McMaster et al. 1982; DEH 1985b). The site was used by the Army, National Guard, contractors, and off-post personnel. The type of disposal involved was area fill and trench landfill (McMaster et al. 1982). Access was not controlled during the period when the dump was operated (McMaster et al. 1982; DEH 1985b). Even today, access is not strictly controlled (Sharma 1988), and it is not known to what extent unauthorized dumping has occurred (McMaster et al. 1982; DEH 1985b). As shown in Fig. 4.6, a portion of the landfill contains abandoned cars.

#### 4.9.2 Geology and Hydrology

Soils at the site are of the Quonset-Hinckley-Windsor Association, consisting of droughty sand and gravel soils underlain by stratified sand and gravel. This area drains well, and the soil is highly permeable (Nicholls et al. 1980; McMaster et al. 1982; DEH 1985b). Typical hydraulic conductivities for this area are in the range of 0.001 to 0.01 centimeter per second (cm/s) (Satterwhite et al. 1976a). No groundwater monitoring wells are located at this site.

#### 4.9.3 Nature and Extent of Contamination

The presence or extent of contamination at this site is not known. Since access was not restricted, it is likely that illegal dumping occurred. During the site assessment, the landfill was noted to contain wood (lumber and stumps), rubble, and scrap metal. Near the middle of the landfill (along the northern boundary, near the WWTP sand filter beds), several old cars had



**FIGURE 4.6** Location of SA 9, Landfill No. 5 (Note: The ponds have not existed since 1972) (Source: Map based on USACE undated)

been junked. This car "graveyard" contained old car body parts, brake linings, tires, asphalt, bed springs, and several crushed old 5-gal cans. Because all past disposal practices and the highly permeable soils, contamination is possible.

#### 4.9.4 Proposed Action

As a precautionary measure, the junked automobiles and car parts should be removed. Access to this landfill needs to be controlled.

Site boundaries should be located through a geophysical survey and examination of aerial photographs (if available). To determine if soil or groundwater is contaminated at this site, a sampling program should be conducted to characterize it. This program should include excavating test pits, collecting soil samples, and installing groundwater monitoring wells.

If soil in the area of the abandoned cars is visibly stained, surface samples should be collected and analyzed for HSL compounds, asbestos, and TPH.

Five groundwater monitoring wells should be installed; suggested locations are shown in Fig. 4.6. Groundwater should be sampled and analyzed for HSL compounds and explosives. The results will indicate whether contaminants are migrating from the site. A monitoring program should be established on the basis of the results.

If elevated contaminant levels are found, further investigation is recommended. If none are present, no further study is recommended.

#### **4.10 SA 10 – LANDFILL NO. 6**

##### **4.10.1 Site History**

Landfill No. 6 (SA 10) was reported to be a trench that received debris from demolition of six warehouses (Bldgs. T-955 through T-960). The 642nd Engineer Company removed the buildings between 1975 and 1980 (Ford 1989). The landfill's reported location is the flat area northwest of the enlisted housing near Shirley Gate along the west side of the main cantonment area and between Perimeter and Lowell roads (Fig. 4.7). If the landfill was in this area, no evidence is available attesting to its former existence. At the time of the site visit (November 1988), an attempt was made to locate this site, but it could not be recognized. The site is level and overgrown with grass.

##### **4.10.2 Geology and Hydrology**

Geologic conditions of the region consist of unconsolidated glacial deposits of undetermined thickness overlying metamorphic and granitic bedrock. Because of the absence of test wells in the area, the thickness of the glacial deposits is unknown.

The soils at the site are of the Quonset-Hinckley-Windsor Association, which is described as droughty sand and gravelly soil underlain by stratified sand and gravel (Nicholls et al. 1980). The soil is well drained and has high permeability.

The hydrogeological conditions at this location have been mapped as a minor aquifer consisting of thin sections of glacial outwash and glacial lacustrine deposits. Goldberg-Zoino & Associates (1976) showed the saturated thickness to be less than 20 ft in this area.

As shown in Fig. 4.7, Trout Brook, a tributary of the Nashua River, flows along the northeast side of site's presumed location. The Nashua River flows along the southeast side of the site. Although site-specific hydrogeological information is lacking, it is assumed that any groundwater in this area would flow toward and into the Nashua River.

##### **4.10.3 Nature and Extent of Contamination**

No specific information was found about disposal activities at this site. There have been no previous investigations of the site.

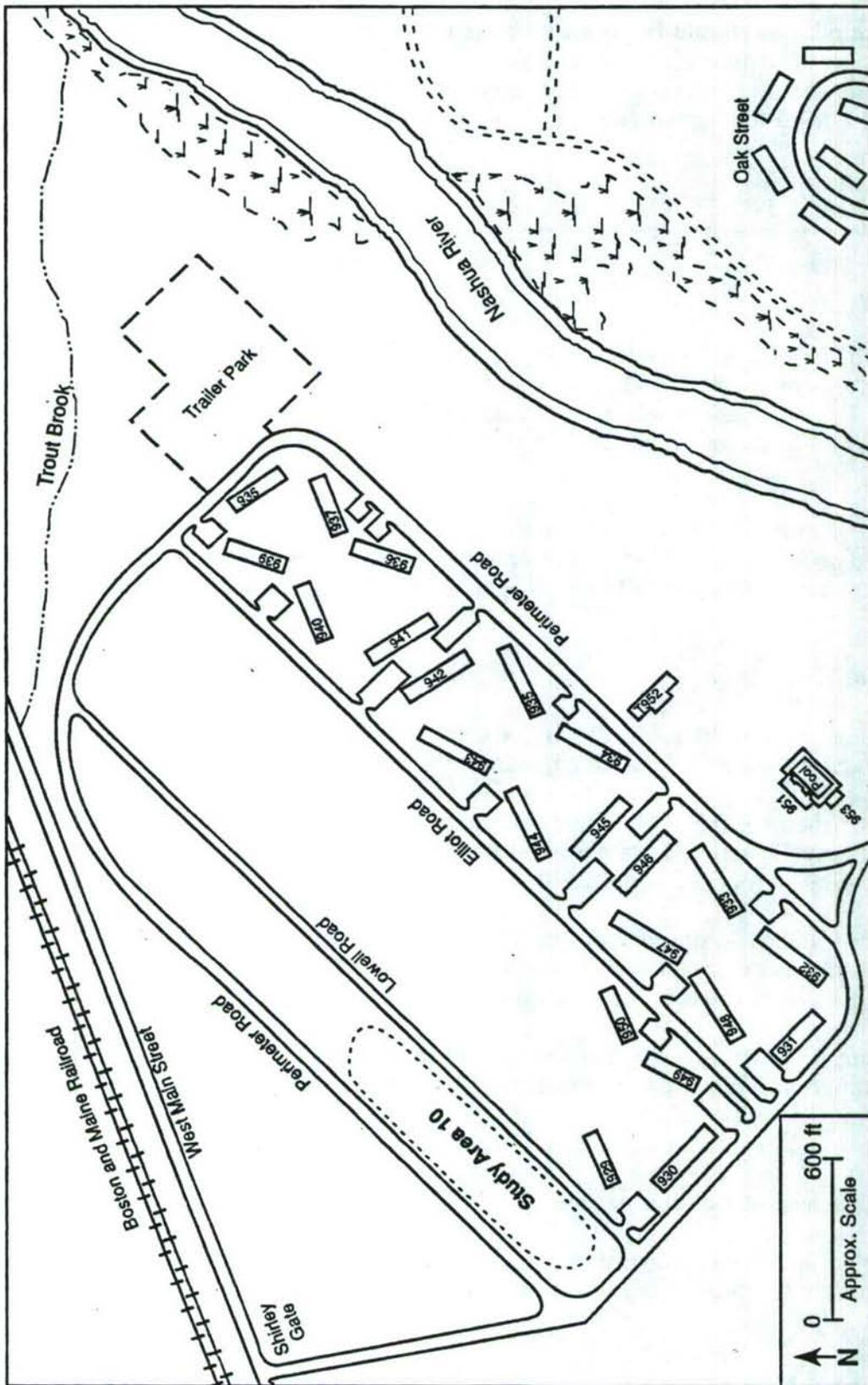


FIGURE 4.7 Location of SA 10, Landfill No. 6 (Source: Map based on Keene 1967)

#### 4.10.4 Proposed Action

The site boundaries should be located through a geophysical survey and examination of aerial photographs (if available). Test pits should be excavated in the landfill area, and samples from the pits should be analyzed for TC metals and asbestos. Results of those analyses would determine the need for further studies.

### 4.11 SA 11 – LANDFILL NO. 7

#### 4.11.1 Site History

Landfill No. 7 (SA 11), located just east of Lovell Street in the main cantonment area (Fig. 4.8), was active from 1975 to 1980. The site, about 2 acres in extent, was part of a small gully leading down to the Nashua River, about 200 ft distant. During the time the site was active, it received wood-frame hospital demolition debris. The landfill was covered and graded after closure.

Between 1980 and 1982, Fort Devens used this area to dispose of tree limbs and other vegetation uprooted or felled during heavy storms. This material was placed on the surface, not buried. According to available information, no illegal dumping occurred at this site (Black 1989).

#### 4.11.2 Geology and Hydrology

General geologic conditions in the area consist of unconsolidated glacial deposits of undetermined thickness overlying Paleozoic metamorphic and granitic bedrock.

The soils at the site are of the Quonset-Hinckley-Windsor Association, described as droughty sand and gravelly soil underlain by stratified sand and gravel. The soil is well drained and has high permeability (Nicholls et al. 1980).

The hydrogeological conditions at this location have been mapped as a minor aquifer consisting of thin sections of glacial outwash and glacial lacustrine deposits. Goldberg-Zoino & Associates (1976) showed the saturated thickness to be less than 20 ft in this area.

The Nashua River flows along the east side of the site and about 25 ft below the crest of the ridge. Although site-specific hydrogeological information is lacking, it is assumed that any groundwater in this area would flow toward and into the Nashua River.

#### 4.11.3 Nature and Extent of Contamination

Construction debris and vegetation are reported to be the only material disposed of in this landfill. Therefore, the probability of contamination in this area is very low.

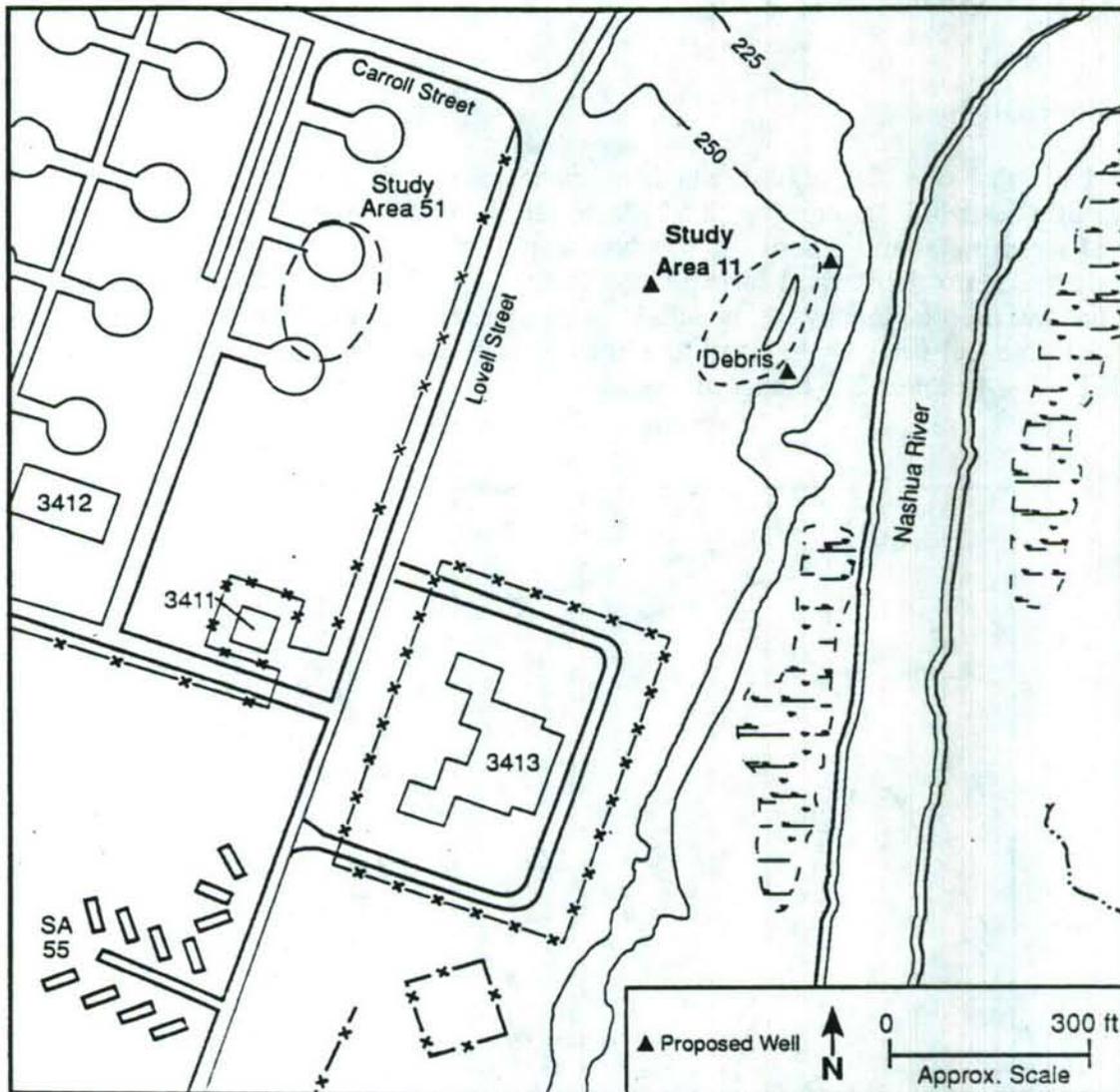


FIGURE 4.8 Location of SA 11, Landfill No. 7 (Source: Map based on Keene 1967)

At the time of the site visit (November 1988), it was observed that construction of Bldg. 3413 and parking lots had disturbed the landfill and left some old construction material, including plastic, rebar, wood, and roofing, lying on the surface.

#### 4.11.4 Proposed Action

The disposal area boundaries should be located through a geophysical survey and examination of aerial photographs (if available). To detect any contaminants, two monitoring wells will be placed downgradient and one will be placed upgradient of the site. The soil and wells will be sampled for HSL compounds, pesticides, and PCBs.

## 4.12 SA 12 – LANDFILL NO. 8

### 4.12.1 Site History

Landfill No. 8 (SA 12) consists of debris randomly dumped without supervision over the edge of a 30-ft hill. According to McMaster et al. (1982), from 1960 to the present, a wide variety of scrap metal and wooden debris has been disposed of at this site. In November 1988, it appeared that no debris had been placed in this area for a number of years, and the site should be classified as inactive. The site is located across from the combat pistol range in the south post area between Dixie Road and the Nashua River (Fig. 4.9). The Oxbow National Wildlife Refuge is about 250 ft east of the site.

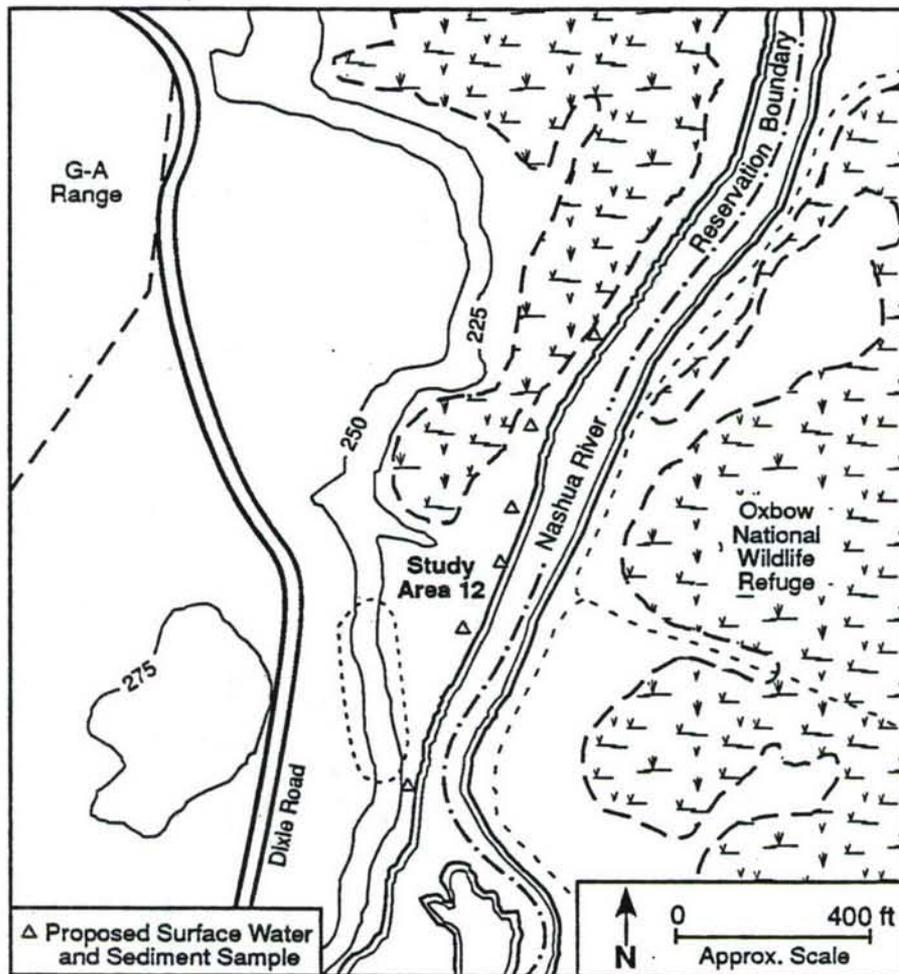


FIGURE 4.9 Location of SA 12, Landfill No. 8 (Source: Map based on USACE 1988)

#### 4.12.2 Geology and Hydrology

The site is located along the eastern edge of a pitted outwash plain consisting of unconsolidated glacial deposits of unknown thickness overlying metamorphic and granitic bedrock.

The soils at the site are of the Quonset-Hinckley-Windsor Association along the bluff and the Winooski-Limerick-Saco Association in the valley at the foot of the bluff (Nicholls et al. 1980). The Quonset-Hinckley-Windsor Association is described as a droughty sand and gravelly soil underlain by stratified sand and gravel. The soil is well drained and has high permeability. The Winooski-Limerick-Saco Association is described as moderately well drained to poorly drained silty soil having low permeability.

Hydrogeological conditions of the site have not been determined; no monitoring wells or soil borings have been drilled at the site. The hydrogeological conditions in the area have been mapped as a minor aquifer consisting of thin sections of glacial outwash and glacial lacustrine deposits. Goldberg-Zoino & Associates (1976) showed the saturated thickness to be less than 20 ft in this area. Although site-specific hydrogeological information is lacking, it is assumed that any groundwater in this area would flow toward and into the Nashua River.

The Nashua River, which flows along the base of the cliff, has incised a channel about 30 ft deep through the area. A large wetlands area stretches north and, on the other side of the river, east of the site.

#### 4.12.3 Nature and Extent of Contamination

No records are available concerning the quantities or nature of the material disposed of at this site. Gates (1987) reported that material disposed of here consisted of concrete blocks, barbed wire, old stumps, tree cuttings, brush, wood, and other inert materials. Gates also noted that there is no record of any hazardous materials or putrescible wastes being dumped at the location. Although the nature and extent of any soil or groundwater contamination in this area are unknown, the nature of the material reportedly disposed of at this facility means that the potential for soil or water contamination is minimal. In November 1988, metal and wood debris were observed lying on the surface.

#### 4.12.4 Proposed Action

Even though the potential for soil or water contamination is small, the site should be thoroughly investigated because of its proximity to wetlands and the Nashua River and the hydrological connection between the groundwater and surface water. The proposed actions are based on the assumption that any leachate or runoff migrates down the steeply sloping hillside and accumulates at the base of the hill.

The landfill's areal extent should be determined through a reconnaissance of the site, examination of aerial photographs (if available), and, if practical, a surface geophysical survey. The reconnaissance should locate indicators of the landfill, such as metal objects and construction debris.

When the landfill's extent is determined, a surface water and sediment sampling program should be conducted. Six surface water and sediment samples should be collected up- and downstream of the fill area in the wetland and the river. Figure 4.9 shows suggested sampling locations. Final sampling locations should be determined by best field judgment with regard to site conditions. This approach should determine the extent of any contamination, since any leachate would flow downhill. All samples should be analyzed for HSL compounds, explosives. All sediment samples should be evaluated for grain size and analyzed for TOC.

If contamination is indicated, then a second, more comprehensive phase should be initiated to determine the extent of contamination. It may be necessary to collect additional surface water and sediment samples, collect surface soil samples, drill soil borings, and install groundwater monitoring wells. The number and locations of these sites will depend on the results of the initial surveys.

All debris and metal objects found lying on the surface should be removed and disposed of in a properly designed and operated landfill. If necessary, remedial action should be taken at the site, in accordance with state and federal requirements, to prevent further contamination.

#### **4.13 SA 13 – LANDFILL NO. 9**

##### **4.13.1 Site History**

According to McMaster et al. (1982), landfill No. 9 (SA 13) was used from 1965 to 1970 for the disposal of construction debris, tree trunks, stumps, and possibly waste oil. The site, about 1 acre in size, is located in the main cantonment area at Lake George Street and Hattonville Road (Fig. 4.10).

In November 1988, the landfill's exact location was not apparent because it was covered when it was closed. The only evidence of a landfill was a miscellaneous mixture of wood, metal objects, cans, and other debris scattered about on the surface of a small gully that leads to the Nashua River, about 2,350 ft to the north-northwest. During the March 1990 site visit, active dumping of stumps and brush was observed.

##### **4.13.2 Geology and Hydrology**

General geologic conditions of the site consist of unconsolidated glacial deposits of undetermined thickness overlying metamorphic and granitic bedrock.

The soil association at the site is the Quonset-Hinckley-Windsor, a droughty sand and gravelly soil underlain by stratified sand and gravel. The soil is well drained and has high permeability (Nicholls et al. 1980).

Detailed hydrogeological conditions of the site have not been determined, as no monitoring wells or soil borings have been drilled there. The regional hydrogeology has been

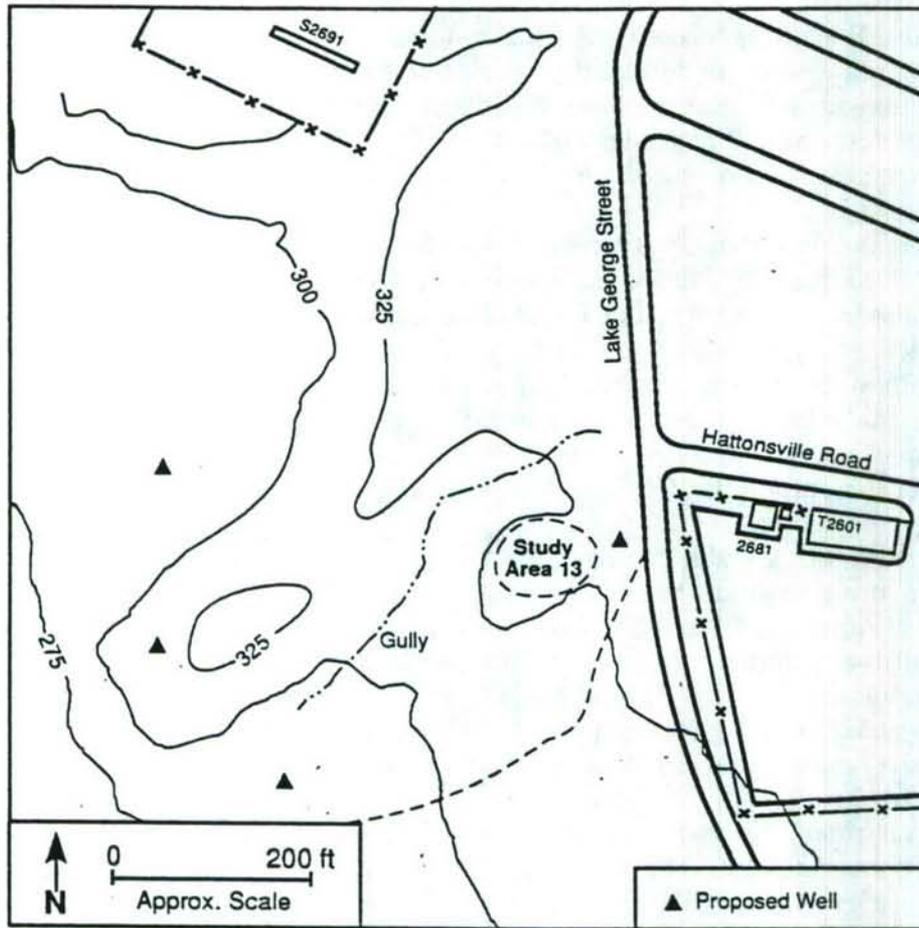


FIGURE 4.10 Location of SA 13, Landfill No. 9 (Source: Map based on Keene 1967)

mapped as a major aquifer consisting of thick sections of glacial outwash and glacial lacustrine deposits. Although site-specific hydrogeological information is lacking, it is assumed that any groundwater in this area would flow toward and into the Nashua River.

The gully below the site, in which debris was found, normally is dry. The only nearby surface water is the Nashua River.

#### 4.13.3 Nature and Extent of Contamination

The site has not received waste for more than 21 years; therefore, it is possible that any contaminants placed in the disposal site have completely disappeared as a consequence of evaporation, dissolution, oxidation, and biodegradation. No detailed records are available concerning the nature or quantities of the material disposed of at this facility; therefore, the nature and extent of any soil or groundwater contamination in this area are unknown. Evidence of the site consists of a mixture of such materials as wood, metals, and cans scattered about on the surface of a small gully, but it is not clear whether these items are from the landfill.

#### 4.13.4 Proposed Action

Because the site is located adjacent to a gully that leads to the Nashua River, there is a potential for the spread of any soil or water contamination. Because of the hydrological connection between the groundwater and surface water, the site should be thoroughly investigated to determine if any degradation by-products are present. A phased sampling and monitoring program should be conducted to locate the site and then characterize it.

During the first phase, the areal extent of the former landfill should be determined. The site's location should be determined through examination of aerial photographs (if available) and a field reconnaissance to locate visible metal objects, construction debris, etc. The reconnaissance should be followed by a geophysical survey. When the boundaries of the abandoned landfill have been defined, the extent of groundwater and soil contamination should be determined by collecting and analyzing soil samples and installing groundwater monitoring wells. Surface soil (6-12 in.) samples should be collected from three locations in the gully leading from the site and analyzed for HSL compounds, TPH, and explosives.

Four monitoring wells should be installed. One well should be located east (upgradient) of the site and three between the site and the Nashua River (downgradient). Suggested well locations, which are based on the landfill's estimated location, are shown in Fig. 4.10. Final locations of all wells and sample sites should be determined by field inspection. Following proper well development (USATHAMA 1987), groundwater samples should be collected from each well and analyzed for HSL compounds and explosives. If elevated concentrations of TPH are found in the soil samples, groundwater should also be analyzed for TPH.

If contamination is indicated, then a second phase should be initiated to determine the extent of that contamination. The second phase may include collecting additional soil samples, drilling soil borings, and installing additional groundwater monitoring wells. The number and locations of these sampling sites will depend on the results of the initial surveys.

All debris and metal objects found lying on the surface should be removed and disposed of in a properly designed and operated landfill. If necessary, remedial action should be taken at the site, in accordance with state and federal requirements, to prevent further contamination.

#### 4.14 SA 14 – LANDFILL NO. 10

##### 4.14.1 Site History

Study area 14, referred to as landfill No. 10 by Fort Devens, is not strictly a landfill but rather an abandoned quarry, about 1 acre in size, into which unwanted automobiles are illegally dumped. The cars are periodically removed by base personnel.

The site is located in the south post, about 3,000 ft west along an unnamed dirt road from the intersection of Dixie Road and Jackson Road (Fig. 4.11).

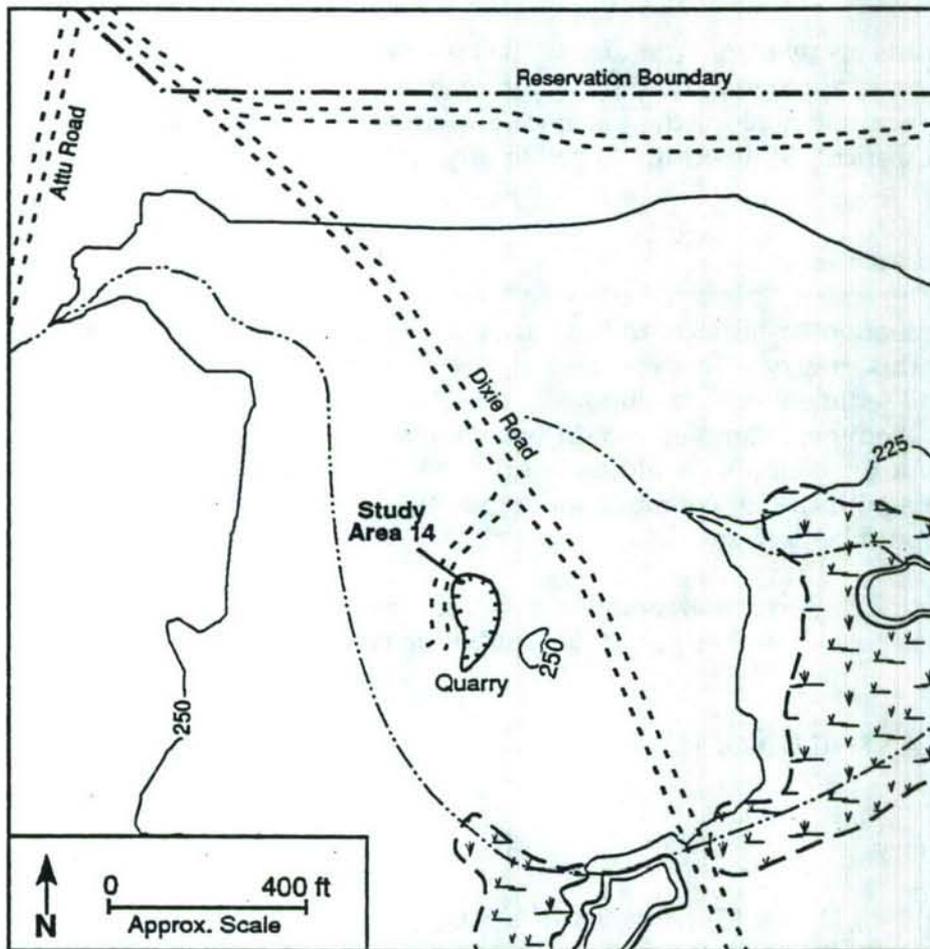


FIGURE 4.11 Location of SA 14, Landfill No. 10 (Source: Map based on USACE 1988)

#### 4.14.2 Geology and Hydrology

General geologic conditions in the area consist of a metamorphic slate bedrock knob sticking up out of unconsolidated glacial deposits of undetermined thickness.

The surrounding soils have been mapped as the Quonset-Hinckley-Windsor Association (Nicholls et al. 1980). The soil is well drained and has high permeability. No wells have been drilled through the glacial moraine in this vicinity, and its thickness is unknown.

The quarry is spring-fed, and no surface water flows in or out. The regional hydrogeological conditions at this location have been mapped as a minor aquifer consisting of thin sections of glacial outwash and glacial lacustrine deposits. Goldberg-Zoino & Associates (1976) showed the saturated thickness to be less than 20 ft in this area.

#### **4.14.3 Nature and Extent of Contamination**

No records are available concerning the number of automobiles disposed of at this site. No contamination is apparent, and all the automobiles reportedly have been removed (Poole 1988), but there is a potential for the presence of petroleum hydrocarbons. The quarry is very deep, making it difficult to determine whether any cars are in the water.

#### **4.14.4 Proposed Action**

Contamination of surface and groundwater is possible from the illegal disposal of automobiles in this quarry. To determine if any contamination has occurred, two or three surface water and sediment samples should be collected and analyzed for TPH, HSL compounds, and explosives. Sediment samples should be evaluated for grain size and analyzed for TOC. Information about the bedrock should be examined to determine the presence of any fractures that might form a pathway for contaminant migration. If contamination is detected, a remedial investigation should be performed.

If no evidence of contamination is found, it is recommended that the site be secured to prevent future disposal and that no further studies be conducted.

### **4.15 SA 15 – LANDFILL NO. 11**

#### **4.15.1 Site History**

Landfill No. 11 (SA 15) consisted of a series of pits in which fuel oil, primarily heavy No. 4 and No. 6, was burned (Gates 1989). While active (1963-1966), the landfill encompassed about 3 acres and was located adjacent to the helipad on Jackson Road in the south post (Fig. 4.12). The pits have been closed, and no evidence is visible today attesting to their former existence. The site was located and sampled during an environmental audit of Fort Devens in 1985 by the U.S. Army Environmental Hygiene Agency (USAEHA) (Gates et al. 1986; Gates 1987, 1989).

#### **4.15.2 Geology and Hydrology**

Geologic conditions for this site consist of glacial-deltaic and outwash sands overlying metamorphic and granitic bedrock. No wells have been drilled in this area, and the exact thickness of the glacial deposits is unknown.

Quonset-Hinckley-Windsor soils surround the site (Nicholls et al. 1980). The soil, which is well drained and has high permeability, is classified as a poorly sorted (i.e., uniform) sand (Gates 1989).

The hydrogeological conditions at this location have been mapped as a minor aquifer consisting of thin sections of glacial outwash and glacial lacustrine deposits. Goldberg-Zoino & Associates (1976) showed the saturated thickness to be less than 20 ft in this area.

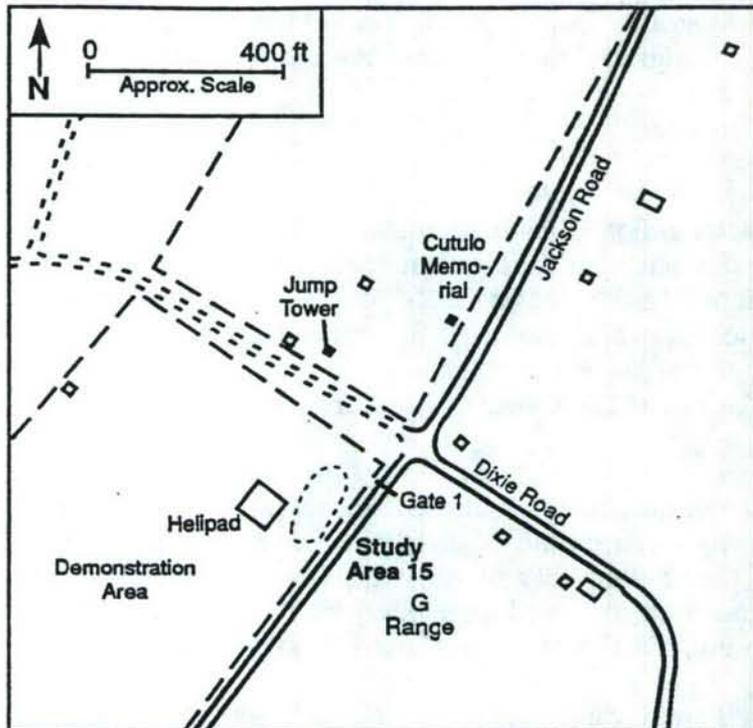


FIGURE 4.12 Location of SA 15, Landfill No. 11 (Source: Map based on USACE 1988)

During the course of his investigation, Gates (1987) determined that the groundwater in this area flows to the west, north, and east in a semiradial pattern toward the Nashua River Valley.

#### 4.15.3 Nature and Extent of Contamination

This site was investigated in 1985 to determine what petroleum, oil, and lubricants (POL) were present and if any fuel residues had migrated downward (Gates 1989). To determine whether contamination was present, a backhoe was used to excavate five trenches 5 ft deep. Samples were obtained from the trench walls at the surface and at depths of 0.5-1.5 ft and 4 ft below the surface. Because of the heavy POL product, the fuel had tended to coalesce within the first 6 in. of soil, visibly limiting downward migration.

The soil samples were analyzed for total POL, PCBs, pesticides, and the metals arsenic, chromium, cadmium, mercury, and lead (both total and extractable) (Gates 1989). The 1985 study concluded that the soil was contaminated with a POL product, and this conclusion was reported to EPA Region 1 in April 1986. All samples contained metal concentrations less than the maximum concentrations allowed by federal and state law. In addition, the samples contained no detectable concentrations of PCBs or pesticides.

Gates (1987) stated that additional burning of the material caused the formation of an asphalt-like cap that inhibited infiltration of water, further inhibiting downward migration.

Because of the physiochemical nature of the waste, the volatile fuel by-products tended to migrate toward the heat source, burning fuel. Gates (1987) doubted that much of the fuel or volatile by-products had migrated down toward the groundwater.

#### **4.15.4 Proposed Action**

The site characterization investigation started by Gates should be completed. The site boundaries should be defined by a geophysical survey and examination of aerial photographs (if available). Four soil borings should be drilled to the water table to delineate the extent of any contamination. The location and depth of the soil borings should be determined by field personnel, depending on the presence of visible contamination and the depth of the water table. Samples should be collected at 2.5-ft intervals and analyzed for TPH, total HSL metals, and TC metals.

If significant contamination is indicated, then a minimum of one upgradient and three downgradient monitoring wells should be installed. Groundwater samples should be collected and analyzed for the parameters with elevated concentrations (in the initial sampling). The sampling program should be reviewed after one year to determine which parameters should continue to be monitored or if the program should be terminated.

If necessary, all significantly contaminated soils should be excavated and disposed of in accordance with state and federal requirements.

### **4.16 SA 16 – SHOPPETTE LANDFILL (NO. 12)**

#### **4.16.1 Site History**

Study area 16, a small landfill (No. 12) about 1 acre in size, was operated for three weeks in 1985 to reduce the volume of material entering the sanitary landfill. It received construction debris generated at the installation (Black 1989).

The landfill's location is reported to be in the main cantonment area southeast of the Shoppette and the intersection of Patton Road and Marne Street and west of the Boston and Maine Railroad tracks (Fig. 4.13). During the site visit in November 1988, no surface evidence attested to the landfill's prior existence.

#### **4.16.2 Geology and Hydrology**

Geologic conditions of the area consist of glacial outwash deposits overlying granite and metamorphic bedrock.

The soils at the site are of the Quonset-Hinckley-Windsor Association, which is described as droughty sand and gravelly soil underlain by stratified sand and gravel (Nicholls et al. 1980). The soil is well drained and has high permeability.

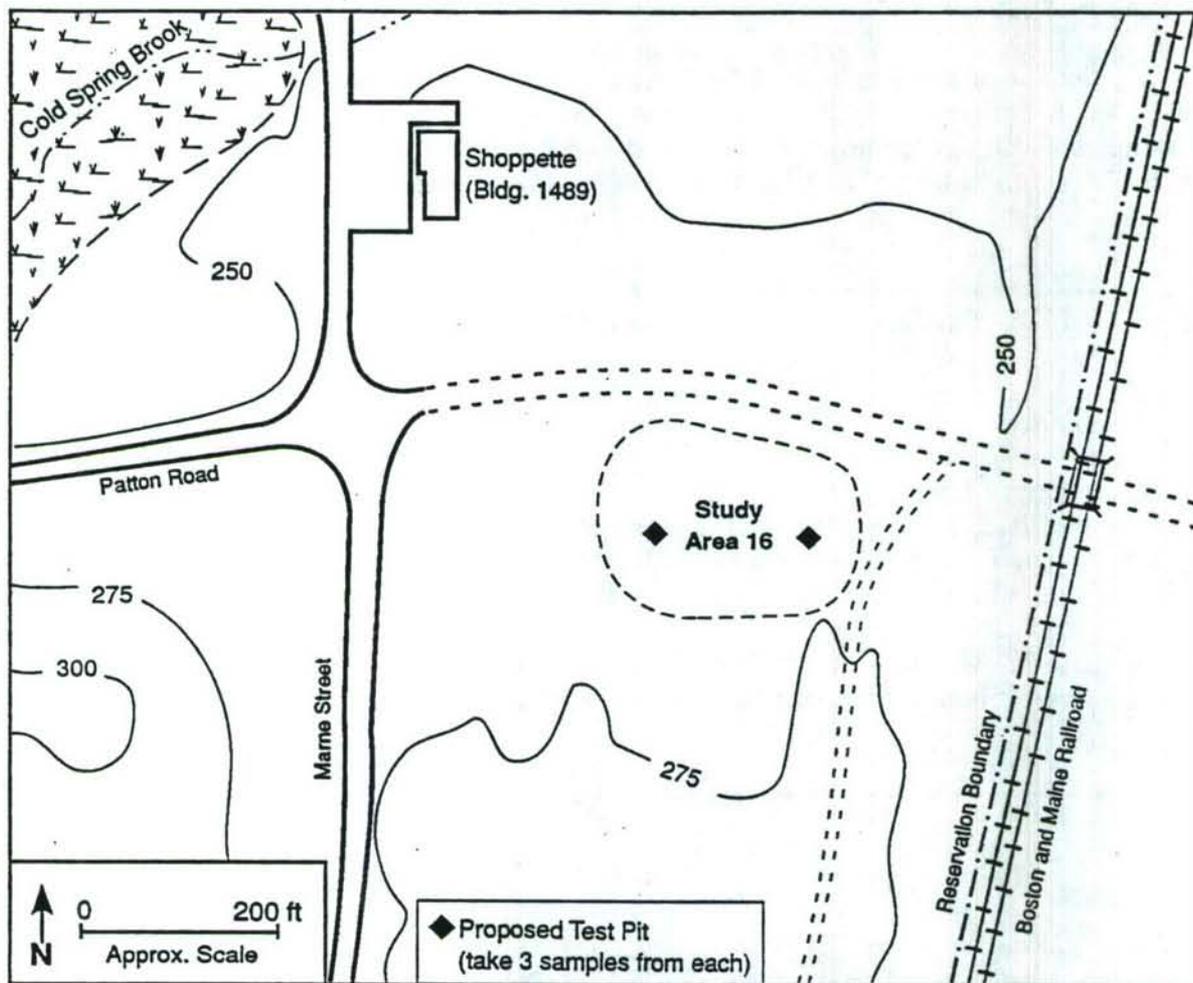


FIGURE 4.13 Location of SA 16, Landfill No. 12 (Source: Map based on Keene 1967)

The hydrogeological conditions at this location have been mapped as a major aquifer consisting of thick sections of glacial outwash and glacial lacustrine deposits.

The surface water nearest the site is Cold Spring Brook, about 700 ft to the north. Although site-specific hydrogeological information is lacking, it is assumed that any groundwater in this area would flow north-northeast toward and into Cold Spring Brook.

#### 4.16.3 Nature and Extent of Contamination

It is reported that an unknown amount of 2-in. metal chain and three to four truckloads of debris were disposed of in the Shoppette landfill. Disposal was supervised by DEH. Operations were stopped because of the proximity of a wetland and Cold Spring Brook (Black 1989).

During the site visit, no visual evidence of the landfill (e.g., surface debris) could be identified. No contamination is apparent, and none has been reported.

#### 4.16.4 Proposed Action

The extent of the site should be determined by a geophysical survey. Two test pits should be excavated to verify the waste types. Suggested locations are shown in Fig. 4.13. Three samples should be obtained from each pit and analyzed for HSL compounds and TPH. If significant contamination is found, a second, more extensive investigation should be conducted.

### 4.17 SA 17 – LITTLE MIRROR LAKE (LANDFILL NO. 13)

#### 4.17.1 Site History

Little Mirror Lake (SA 17) is in the southeastern portion of the main cantonment area near the enlisted housing (Fig. 4.14). It is separated from the larger Mirror Lake by a natural berm. The Mirror Lake area is a major wetland, with an associated spruce-peat bog on the northeastern side, and is a recreational area for fishing, boating, and swimming.

At an unknown time, World War II-era grenades were placed in the lake. Some 200 of the grenades were discovered about 1970, when the water level of the lake was low.

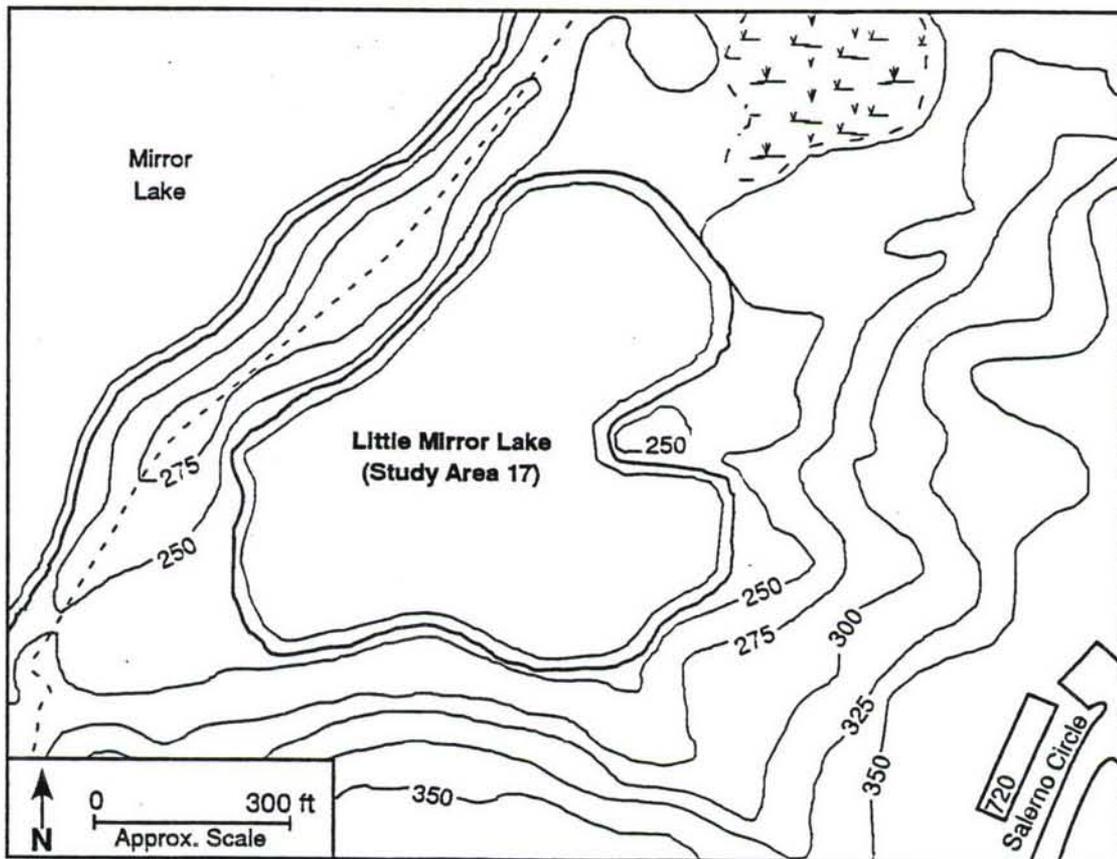


FIGURE 4.14 Location of SA 17, Little Mirror Lake (Source: Map based on Keene 1967)

#### 4.17.2 Geology and Hydrology

The entire base can be considered an outwash plain dotted with small conical and drumlinoid hills. The plain was formed by glacial deltas prograding into glacial Lake Nashua during various stages. Sand and gravel were deposited by the deltas around blocks of stagnant ice. As the block ice melted, depressions known as kettles developed. One of these kettles formed Little Mirror Lake (Brown 1981).

The groundwater at Fort Devens occurs largely in the permeable glacial-deltaic outwash deposits of sand, gravel, and boulders. Minor amounts of groundwater may also be found in thin, permeable glacial lenses. These lenses may occur as multiple perched zones and, in some cases, exit the ground surface as springs and seeps. The major (glacial outwash) aquifer occurs along the Nashua Valley and through the northwest part of Fort Devens. Both Mirror Lake and Little Mirror Lake are in this area. It is believed that the unconsolidated aquifer is hydraulically connected to the surface water bodies at Fort Devens. This belief infers that the aquifer is unconfined and is vulnerable to contamination (McMaster et al. 1982; Brown 1981).

Soils in the area are classified as the Quonset-Hinckley-Windsor Association. They are typically droughty sand and gravel underlain by stratified sand and gravel and are well drained with high permeability (McMaster et al. 1982).

#### 4.17.3 Nature and Extent of Contamination

At an unknown time, World War II-era grenades were disposed of in Little Mirror Lake. During a low water period in the early 1970s, about 200 were exposed. They were removed and destroyed by the 14th Ordnance Disposal Detachment at Fort Devens. Little information exists regarding the removal action or the exact location where they were found.

#### 4.17.4 Proposed Action

Although the possibility for contamination is considered low, it should be addressed for several reasons. Since the lake is hydraulically connected to the unconsolidated aquifer, it may represent a pathway for migration of contaminants.

It is recommended that the records of the 14th Ordnance Disposal Detachment be searched for details regarding the completeness of the removal action. If a complete removal can be documented, several sediment samples should be obtained and analyzed for TC metals. If contaminants are not elevated, further action or studies are not necessary for this site. If removal cannot be documented, an underwater reconnaissance should be performed; surface water and sediment samples should be collected and analyzed for explosives and TC metals. If concentrations are elevated or if grenades are found, a more comprehensive investigation should be conducted.

#### 4.18 SAs 19-21 – WASTEWATER TREATMENT PLANT, RAPID INFILTRATION BEDS, AND SLUDGE DRYING BEDS

##### 4.18.1 Site History

Because of their interrelated functions, the WWTP (SA 19), the rapid infiltration beds (SA 20), and the sludge drying beds (SA 21) are discussed together. The WWTP, formerly called the sewage treatment plant, is located in the north post (Fig. 4.15). Built in 1942, it has a design capacity of 3.0 million gal/d. The average daily flow is about 1.3 million gal/d (McMaster et al. 1982; Nicholls et al. 1980; DEH 1985b; Gates et al. 1986). Although designed to serve a population of 30,000 people, the WWTP served an effective population of only about 11,000 people in 1985. Less than 1% of the flow is from industrial sources, including vehicle washrack discharge, caustic radiator wash water, floor drains, heating plant boiler blowdown, and swimming pool filter backwash (McMaster et al. 1982; DEH 1985b). The facility does not require an NPDES permit since it does not discharge to surface waters (McMaster et al. 1982).

Wastewater from the main cantonment area and north post is carried to the main pumping station via a gravity-flow sanitary sewer (with the aid of several small pump stations) (Nicholls et al. 1980). Figure 4.16 shows a schematic diagram of the wastewater treatment unit operations at Fort Devens. At the main pumping station, the wastewater is pretreated by passing through a bar screen, grit chamber, and comminutor. The wastewater is then pumped to three parallel Imhoff tanks, a 30,000-gal dosing tank, 22 rapid infiltration sand beds (0.8 acre each), and 4 sludge drying beds. Each of the sludge drying beds can be divided into half beds (8 half-beds appear in Fig. 4.15). This division is not the normal practice. Settleable solids are anaerobically digested in the lower compartments of the Imhoff tanks; gases from the digestion process are vented to the atmosphere. The clarified (unchlorinated) primary effluent from the Imhoff tanks discharges into a dosing tank, which intermittently applies wastewater to rapid infiltration basins.

Normally, the infiltration basins are used in rotation. Reportedly, the current application cycle involves discharge to nine basins for nine days, to another seven basins for seven days, and to the remaining six basins for six days (McMaster et al. 1982; DEH 1985b). The application rate for each rapid infiltration basin has been calculated to be about 25-28 m/yr (USAEHA 1979). During the application, effluent may accumulate on the bed to a depth of 0.5-1.6 ft; it infiltrates within two to three days of the initial application period (Satterwhite et al. 1976a; Nicholls et al. 1980).

Sludge, typically about 4-10% solids, from the Imhoff tanks gravimetrically drains to four uncovered sludge drying beds two to three times annually. The sludge drying beds are equipped with 4-, 8-, and 10-in. clay pipe underdrains to collect supernatant. Before 1985, the supernatant was discharged to an adjacent wetland area located on the east bank of the Nashua River. After 1985, supernatant was collected and pumped back into an infiltration basin. Because these pipes have collapsed over the years and the sludge drying beds are located on the same deposit, it is likely that most of the supernatant infiltrates into the permeable subsurface.

Dried sludge, typically about 70% solids, from the sludge drying beds is removed and applied to the land at Moore Army Airfield per the requirements of a state Class III Sludge application permit.

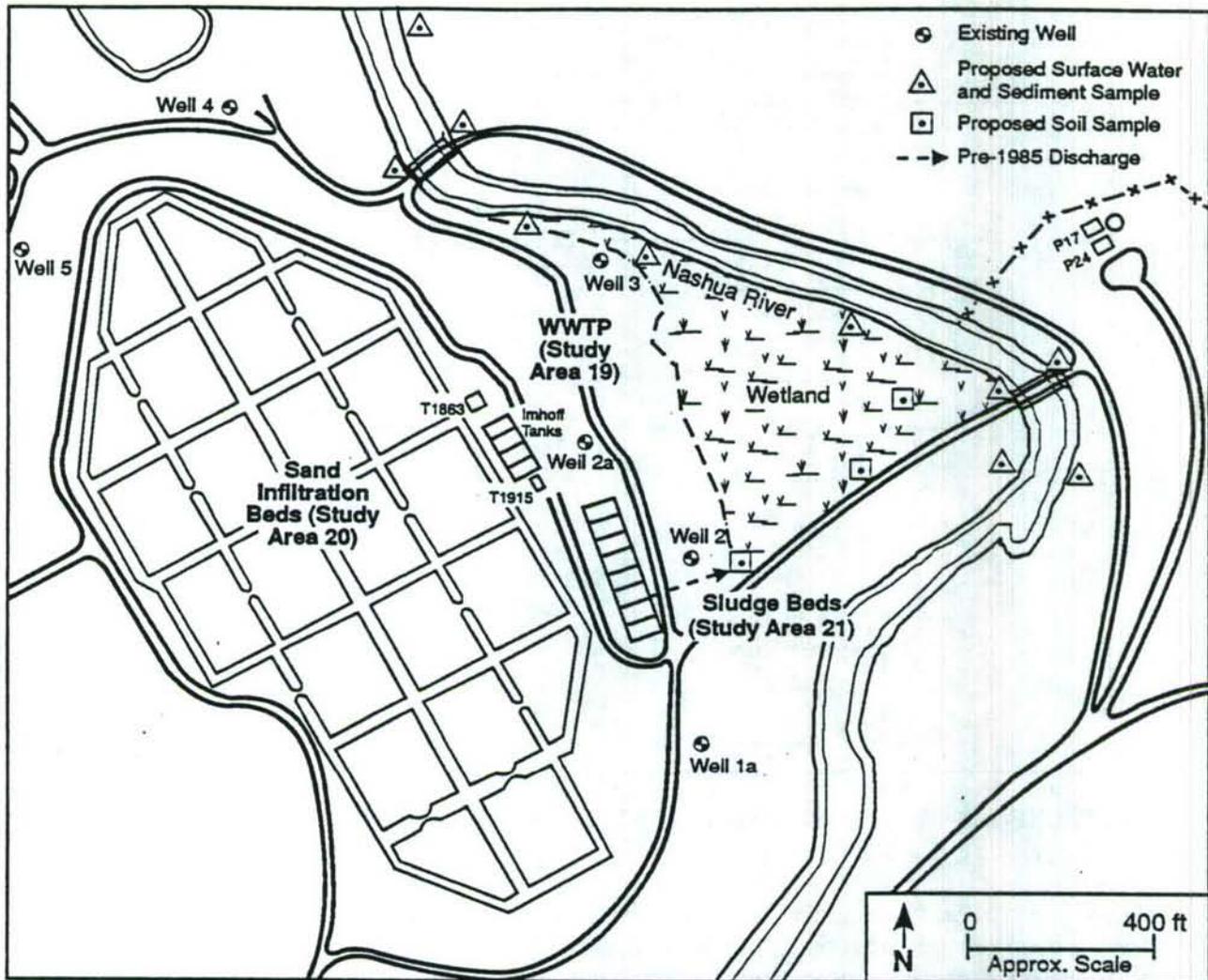


FIGURE 4.15 Location of SAs 19-21, the Wastewater Treatment Plant and Associated Facilities (Sources: Map based on USACE undated; existing well locations from Pierce 1989)

The major operational problem noted at the WWTP has been the maintenance of the distribution troughs in the infiltration sand beds; there has been evidence of erosion in cells with damaged distribution systems (McMaster et al. 1982). A USAEHA assessment (Nicholls et al. 1980) noted that Fort Devens had experienced some infiltration and inflow problems in the sanitary sewer; this is cause for concern, particularly near the WWTP, where a portion of the sanitary sewer line is located parallel to the Nashua River within the floodplain.

#### 4.18.2 Geology and Hydrology

Study areas 19-21 are located on the Quonset-Hinckley-Windsor Association, which consists of droughty sand and gravelly soil underlain by stratified sand and gravel. This area drains well, and the soil is highly permeable (Nicholls et al. 1980; McMaster et al. 1982;

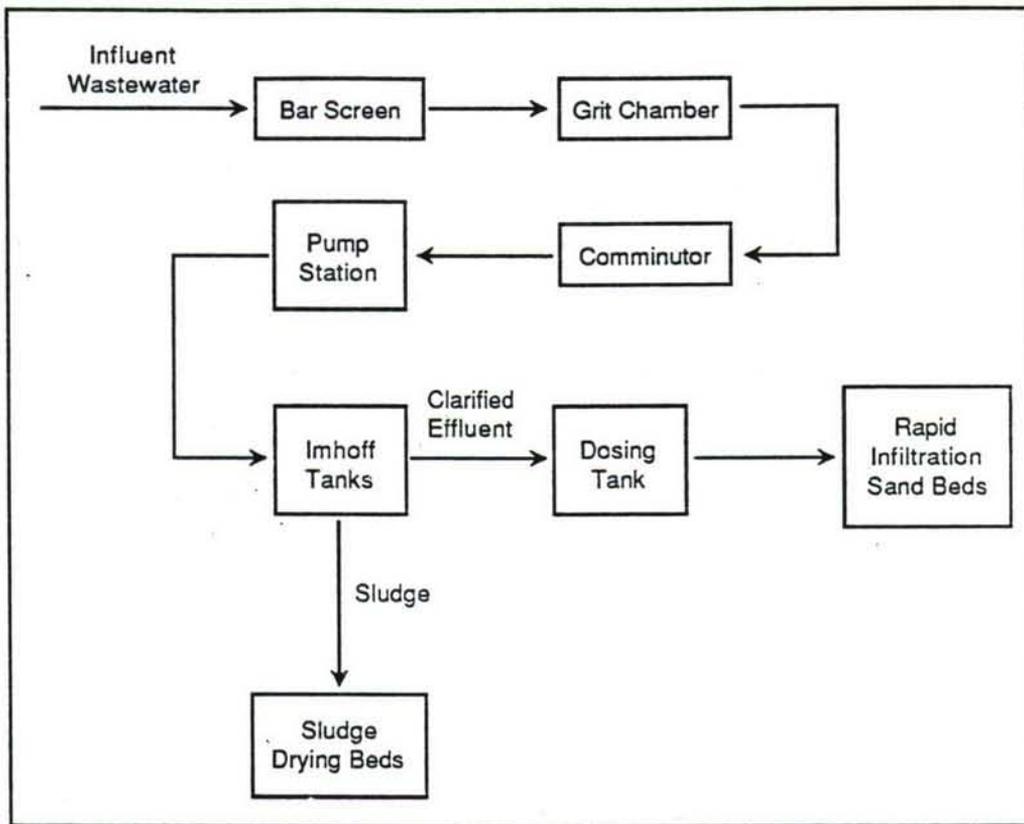


FIGURE 4.16 Flow Diagram for WWTP Unit Operations at Fort Devens

DEH 1985b). Hydraulic conductivities range from  $3.0 \times 10^{-4}$  to  $2.4 \times 10^{-2}$  cm/s (Satterwhite et al. 1976a). Groundwater movement at the treatment site is in a north and northeast direction, as determined from groundwater gradients and water quality in the various observation wells (Satterwhite et al. 1976b).

Two sets of wells have been installed at this site. The USACE installed the first set of 20 observation wells in 1974. These wells, which are no longer in use, provided data on water elevation and the effectiveness of the infiltration beds (see Satterwhite et al. 1976a, b). The current monitoring network consists of six wells (see Fig. 4.15 – upgradient well 1 is 500 ft southwest of the WWTP and is not shown in the figure). Wells 1-4 were installed in 1984, and wells 1a and 2a were installed in 1988.

The rapid infiltration sand beds are located on a large oval-shaped, steep-sided kame composed of stratified sand that rises about 70 ft above the Nashua River floodplain (Satterwhite et al. 1976a). Background soil samples have previously been collected from a formation consisting of stratified horizons of sand and gravel. Coarse to medium sand constituted the major portion of the 10-ft profile, with gravel accounting for a large percentage in the 1- to 3-ft horizon. Below 3 ft, the formation consisted of 6 ft of medium sand, underlain by strata of sandy gravel and gravelly sand. Silts and clays constituted about 10-15% of the volume in the upper profile, but accounted for less than 1% below 1.6 ft (Satterwhite et al. 1976a).

### 4.18.3 Nature and Extent of Contamination

#### 4.18.3.1 Wastewater Treatment Plant

Based on a review of the plant records and associated files, no contamination problems are apparent at the WWTP. The concentrations have not exceeded those required under their Class III permit.

#### 4.18.3.2 Rapid Infiltration Sand Beds

The rapid infiltration sand beds are working remarkably well considering the length of their service (Nickelson 1986). The beds were not specifically designed or operated for removal of nitrogen. The total nitrogen concentration ranges from 15.8 to 30.7 mg/L (with about 90% present as nitrates) (Nickelson 1986). Of particular significance to the nitrogen problem (and its contribution to groundwater contamination with nitrate) is the location of the rapid infiltration basins with respect to the Nashua River (Nickelson 1986). The Nashua River is less than 1,200 ft from the infiltration basins and is located downgradient of the system. No users are downgradient of the groundwater recharged from the bottom of the infiltration basins. Nickelson (1986) reported an estimate that 100% of the water infiltrating from the bottom of these basins enters the Nashua River, although it is not known what effect this recharge has on the water quality of the Nashua River.

The major operational problem in the rapid infiltration sand beds has reportedly been the maintenance of the distribution troughs, resulting in eroded cells with damaged distribution systems (McMaster et al. 1982; DEH 1985b).

Samples taken from the current monitoring well network between September 1987 and May 1989 show that nitrate levels continue to exceed the 10-mg/L standard for Massachusetts Class I groundwater quality. Analytic results for nitrate are presented in Table 4.17.

Results from well 1 show the background nitrate concentrations. Since groundwater flow is generally north-northwest, well 1a also showed generally low nitrate levels. The highest nitrate concentration (42.5 mg/L) was found in water from well 2, which is near the sludge beds. Nitrate concentrations in water from other wells ranged from 0.72 to 21.2 mg/L. It is not known whether the nitrate source is the infiltration beds, sludge beds, or both.

#### 4.18.3.3 Sludge Drying Beds

A 1974 study to evaluate the WWTP and determine its effects on subsurface soils and groundwater used monitoring well data to confirm the observation that most of the supernatant from the sludge drying beds infiltrated into the permeable subsurface (Satterwhite et al. 1976a). Results of that investigation are summarized in Table 4.18. Compared with the native groundwater in the surrounding area, the monitoring wells show elevated specific conductivity, alkalinity, chloride, and total coliform measurements, with slightly elevated concentrations of nitrogen species (total,  $\text{NO}_3$ ,  $\text{NH}_4$ , and organic). This was confirmed by Satterwhite et al.

**TABLE 4.17 Nitrate (as N) Levels  
in the Current Monitoring Well  
Network at the WWTP (September  
1987 to May 1989)**

| Well | No. of<br>Samples | Concentration<br>(mg/L) |            |
|------|-------------------|-------------------------|------------|
|      |                   | Mean                    | Range      |
| 1    | 6                 | 0.51                    | 0.14-1.30  |
| 1a   | 2                 | 3.42                    | 0.25-6.60  |
| 2    | 7                 | 19.31                   | 2.25-42.50 |
| 2a   | 2                 | 14.70                   | 9.40-20.00 |
| 3    | 6                 | 8.09                    | 0.73-21.20 |
| 4    | 6                 | 7.68                    | 0.73-14.20 |

Source: Prior 1989.

(1976a). (If the WWTP were to add a chlorination unit to the process, the extremely high total coliform number resulting from the effluent from the Imhoff tanks [typically about  $32 \times 10^6/100$  mL] would be greatly reduced.) Effluent nitrogen consisted primarily of organic nitrogen and ammonia, with a small amount of nitrate and nitrite, while the groundwater nitrogen was primarily nitrate, with small amounts of ammonia and organic nitrogen (Satterwhite et al. 1976a). Calculations by Satterwhite et al. (1976a) showed that the organic carbon present at the surface of the treatment beds was insufficient to facilitate denitrification (provided other environmental conditions are amenable). In 1983, DEH implemented a project to return sludge bed seepage to the Imhoff tanks (DEH 1985b).

As discussed in Sec. 4.18.3.2, high nitrate levels have been found in groundwater samples from the current monitoring well network. The sludge drying beds are a potential source of the nitrate.

Table 4.19 summarizes analytic results for sludge from the Imhoff tanks (Klebacher 1985a; DEH 1985b). For comparison, the state standards for Type I and II sludges are listed in Table 4.20. A Type I sludge, if approved by MDEP, may be used as fertilizer and may be used, sold, distributed, or offered for use, sale, or distribution on any site without further state approval. A Type II sludge has the same basic definition as a Type I sludge, except that MDEP approval is required for each transaction. Two parameters that exceed Massachusetts standards for a Type I sludge are cadmium and selenium. The state standard is 2 mg/kg, while the Fort Devens sludge contains 3-6 mg/kg. The state standard for selenium is 0.01 mg/kg, while the Fort Devens sludge contains 0.03 mg/kg. Nickelson (1986) attributed this elevated cadmium concentration to the frequency of sludge removal from the bottom of the Imhoff tanks (only twice a year until 1985). The results from several other analyses performed on the sludge are listed in Table 4.21; the parameters exceeding the state limitations for Type I and Type II sludges are noted in the table. Generally, the sludge does not meet the standards for cadmium, copper, and molybdenum.

**TABLE 4.18 Summary of Chemical and Bacteriological Characteristics of Imhoff Tank Effluent and Groundwater in Selected Observation Wells**

| Parameter <sup>a</sup>           | Concentration<br>(mg/L unless otherwise indicated) <sup>b,c</sup> |   |                                | Removal<br>(%) <sup>e</sup> |
|----------------------------------|---|---|--------------------------------|-----------------------------|
|                                  | Imhoff<br>Effluent<br>Tank<br>(mean)                              | Well Water <sup>d</sup><br>(average<br>range) | Background<br>Water<br>(range) |                             |
| pH (standard units)              | 6.2-8.0   | 6.1-6.8                                       | 6.2-6.6                        | -                           |
| Specific conductance (µmho/cm)   | 511   | 71-405  | 36-71                          | -                           |
| Alkalinity, as CaCO <sub>3</sub> | 155   | 14-120  | 17-53                          | 23-91                       |
| Hardness, as CaCO <sub>3</sub>   | 41  | 12-71   | 6-31                           | -                           |
| BOD <sub>5</sub>                 | 112   | 0.8-12  | 0.8-3.5                        | 89-99                       |
| COD                              | 192   | 8-42  | 9-13                           | 78-96                       |
| Total nitrogen*                  | 47  | 1.3-28.0                                      | 1.9-12.1                       | 40-97                       |
| Organic nitrogen*                | 23.4  | 0.5-8.3                                       | 0.5-1.2                        | 65-98                       |
| NH <sub>4</sub> -nitrogen*       | 21.4  | 0.3-5.3                                       | 0.3-1.0                        | 75-99                       |
| NO <sub>3</sub> -nitrogen*       | 1.3   | 0.2-19.5                                      | 0.2-2.6                        | -                           |
| NO <sub>2</sub> -nitrogen*       | 0.02  | 0.01-0.4                                      | 0.01-0.02                      | -                           |
| Total phosphorus*                | 11  | 0.4-5.9                                       | 0.4-1.9                        | 46-96                       |
| Orthophosphate as P*             | 9   | 0.1-5.6                                       | 0.1-0.2                        | 38-99                       |
| Chloride*                        | 150   | 15-257  | 15-40                          | -                           |
| Sulfate*                         | 42  | 7-48  | 7-9                            | -                           |
| Total coliform* (No./100 mL)     | 32 x 10 <sup>6</sup>  | 110-3,900                                     | 120-370                        | 99-100                      |

<sup>a</sup>Monitoring of parameters identified with an asterisk (\*) is included in the proposed actions (Sec. 4.18.4).

<sup>b</sup>Except as noted for pH, conductivity, and total coliform.

<sup>c</sup>Source: Satterwhite et al. 1976a.

<sup>d</sup>These data are from the 1974 observation wells, which are no longer in use.

<sup>e</sup>Source: Nickelson 1986.

#### 4.18.4 Proposed Action

The following proposed actions are based on the assumption that contamination from the rapid infiltration sand basins and sludge drying beds flows downgradient of these areas and enters the Nashua River. A phased sampling and monitoring program should be conducted to determine the nature and extent of soil or groundwater contamination at this site.

The initial phase of the program should consist of collecting 8-10 surface water and sediment samples from the Nashua River and analyzing them for HSL compounds and

**TABLE 4.19 Test Results for Imhoff Tank Sludge<sup>a</sup>**  
(mg/L except for pH)

| Parameter <sup>b,c</sup> | Concentration<br>in Sludge | Class I<br>Maximum<br>Concentration |
|--------------------------|----------------------------|-------------------------------------|
| Arsenic                  | 0.018                      | 0.05                                |
| Barium                   | 0.1                        | 1.0                                 |
| Cadmium                  | <0.01                      | 0.01                                |
| Chromium                 | 0.03                       | 0.05                                |
| Fluoride                 | 1.0                        | 2.4                                 |
| Lead                     | <0.05                      | 0.05                                |
| Mercury                  | 0.0006                     | 0.002                               |
| Selenium                 | 0.030                      | 0.01                                |
| Silver                   | <0.02                      | 0.05                                |
| Endrin                   | <0.001                     | 0.0002                              |
| Lindane                  | <0.001                     | 0.004                               |
| Methoxychlor             | <0.005                     | 0.1                                 |
| Toxaphene                | <0.005                     | 0.005                               |
| Chlorophenoxys: 2,4-D    | <0.01                      | 0.1                                 |
| 2,4,5-TP (Silvex)        | <0.01                      | 0.01                                |
| Copper                   | <0.05                      | 1.0                                 |
| Foaming agents           | 0.13                       | 1.0                                 |
| Iron                     | 0.47 <sup>d</sup>          | 0.3                                 |
| Manganese                | 0.10 <sup>d</sup>          | 0.05                                |
| Oil and grease           | 2,257 <sup>d</sup>         | 15                                  |
| pH                       | 6.6                        | 6.5-8.5                             |
| Sulfate                  | 28                         | 250                                 |
| Zinc                     | 0.14                       | 5.0                                 |
| Nitrate as N             | 0.04                       | 10.0                                |
| Total nitrogen as N      | 37 <sup>d</sup>            | 10.0                                |
| Chlorides                | 62                         | 250                                 |
| Total dissolved solids   | 343                        | 1,000                               |
| PCBs                     | <0.001                     | Not specified                       |

<sup>a</sup>Samples were taken on April 2, 1985.

<sup>b</sup>Because the samples were nonsterile, bacterial analysis could not be performed.

<sup>c</sup>The samples were also analyzed for VOCs (detection limit was 1 µg/L); the only VOC detected was toluene at 16 µg/L.

<sup>d</sup>Exceeds effluent limitations for Class I groundwaters.

Sources: DEH 1985b; Klebacher 1985a.

**TABLE 4.20 Massachusetts Standards for Type I and Type II Sludge**

| Heavy Metal<br>or Chemical    | Maximum<br>Allowable<br>Concentration<br>(mg/kg dry<br>weight) |                   |
|-------------------------------|--|-------------------|
|                               | Type I<br>Sludge   | Type II<br>Sludge |
| Cadmium                       | 2  | 25                |
| Lead                          | 300  | 1,000             |
| Nickel                        | 200  | 200               |
| Zinc                          | 2,500  | 2,500             |
| Copper                        | 1,000  | 1,000             |
| Chromium, total               | 1,000  | 1,000             |
| Mercury                       | 10   | 10                |
| Molybdenum                    | 10   | 10                |
| Boron, water soluble          | 300  | 300               |
| PCBs in Type I sludge         |  |                   |
| Used as commercial fertilizer | 2  | -                 |
| Used as soil conditioner      | 1  | -                 |
| PCBs in Type II sludge        | -  | 10                |

Source: MDEQE 1983.

explosives. Samples should be collected from locations both upstream and downstream of the site. In addition, groundwater from the current monitoring wells (six) should be collected and analyzed for HSL compounds; explosives; and the nitrogen, phosphate, chloride, sulfate, and coliform parameters specified in Table 4.18 (see footnote a). Wells installed at SA 9 will monitor the southwestern corner of this study area.

Three surface soil samples should be collected from the wetland area to determine any impact from past discharges (discontinued in 1985) and analyze for HSL compounds and explosives. If contamination is indicated, a more extensive investigation should begin. This may include further sampling, soil borings, and installation of additional groundwater monitoring wells. The extent of a second investigative phase should be determined by the results of the initial phase.

All significantly contaminated soil and groundwater should be removed or restored in accordance with state and federal requirements. After the cleanup operations, the soil and groundwater should again be sampled and tested to verify the completeness of cleanup.

Regardless of whether evidence of any soil or groundwater contamination is determined from these investigations, it is recommended that sampling of monitoring wells continue as long as the WWTP is active.

TABLE 4.21 Mean Imhoff Tank Sludge Analyses<sup>a</sup>

| Parameter               | Concentration on Sample Date (mg/kg) <sup>a</sup> |                     |                      |                     | Required<br>Detection Limit<br>(mg/kg) |
|-------------------------|---|---------------------|----------------------|---------------------|--|
|                         | 10/2/84   | 10/4/85             | 12/18/86             | 8/26/87             |  |
| Cadmium                 | - <sup>b</sup>                                    | 14.3 <sup>c</sup>   | 14.3 <sup>c</sup>    | 12.0 <sup>c</sup>   | 0.25                                   |
| Chromium                | -   | 44.7                | 59.7                 | 48.9                | 2.5                                    |
| Copper                  | -   | -                   | 1,190 <sup>c,d</sup> | 999.3               | 5.0                                    |
| Lead                    | -   | 262.7               | 266.7                | 242.0               | 2.5                                    |
| Mercury                 | -   | 12.0 <sup>c,d</sup> | 4.93                 | 8.76                | 0.013                                  |
| Molybdenum              | -   | -                   | 16.5 <sup>c,d</sup>  | 16.6 <sup>c,d</sup> | 5.0                                    |
| Nickel                  | -   | -                   | 57.8                 | 47.1                | 2.0                                    |
| Kjeldahl                | 401.3   | -                   | 1,165.3              | 592.3               | 10                                     |
| Zinc                    | -   | -                   | 2,436.7              | 1,926.7             | 12.5                                   |
| Total Kjeldahl nitrogen | 21,175.0  | -                   | 15,696.7             | 4,223.3             | 0.5                                    |
| Nitrate                 | 1.21  | -                   | 333.3                | 19.3                | 0.5                                    |
| Ammonia                 | 289.7   | -                   | 1.82                 | 128.0               | 0.1                                    |
| Total phosphorus        | 4,379.7   | -                   | 1,256.7              | 242.0               | 2.5                                    |
| Boron                   | -   | -                   | 0.08                 | 24.4                | 0.1                                    |
| Arsenic                 | -   | 20.7                | -                    | -                   | -                                      |
| Barium                  | -   | 766.7               | -                    | -                   | -                                      |
| Selenium                | -   | 17.3                | -                    | -                   | -                                      |
| Silver                  | -   | 32.7                | -                    | -                   | -                                      |
| PCBs                    | 0.58  | -                   | -                    | -                   | -                                      |
| pH (standard units)     | 6.76  | -                   | 7.04                 | 5.16                | -                                      |
| Solids content (%)      | 69.0  | 7.7                 | 27.0                 | 53.0                | -                                      |

<sup>a</sup>Except as noted for pH and solids content.

<sup>b</sup>- = no data.

<sup>c</sup>Exceeds standards for a Type I sludge.

<sup>d</sup>Exceeds standards for a Type II sludge.

Sources: Daubel 1985, Klebacher 1985b, Environmental Industrial Research Associates 1986, and Environmental Industrial Research Associates 1987 for the 1984, 1985, 1986, and 1987 samples, respectively.

#### 4.19 SA 22 – HAZARDOUS WASTE STORAGE FACILITY AT BUILDING 1650

##### 4.19.1 Site History

The hazardous waste storage facility (SA 22) is located at Bldg. 1650 in the northeastern part of the main cantonment area (Fig. 4.17). It has been a storage facility since 1980 and was remodeled in 1984. Previously the facility was used as a maintenance shop and as a stockade. It is classified as conforming storage and is a Part B permitted facility (identification

No. MA7210025154). About 750 gal of waste are currently stored there. Table 4.22 lists the types of wastes typically stored (Fox 1988a).

The total size of the facility, including the outdoor areas, is 26,000 ft<sup>2</sup> (Fox 1988a). The outside portion of the facility is fully paved. Waste is not stored outside. The indoor area is 3,000 ft<sup>2</sup> and has cement flooring. It contains an office and a series of bermed storage areas. There are no floor drains, and wastes were clearly marked and segregated. Aisle space was adequate, and none of the wastes was stacked during the site visit. The storage portion of the building is totally enclosed and has an exit that leads to a working and loading area. There are two loading docks, one in the rear and one on the side.

#### 4.19.2 Geology and Hydrology

Information on site-specific geology in this area is limited. Generally, the bedrock is a complex of metamorphic and igneous rocks that are intensely folded and faulted. Bedrock composition ranges from metasediments to granodiorite, and the bedrock is found from 0 to 100 ft below the land surface (McMaster et al. 1982).

The soils in this part of the base are of the Quonset-Hinckley-Windsor Association. These soils are described as droughty sand and gravel underlain by stratified sand and gravel. They are generally well drained and highly permeable (McMaster et al. 1982).

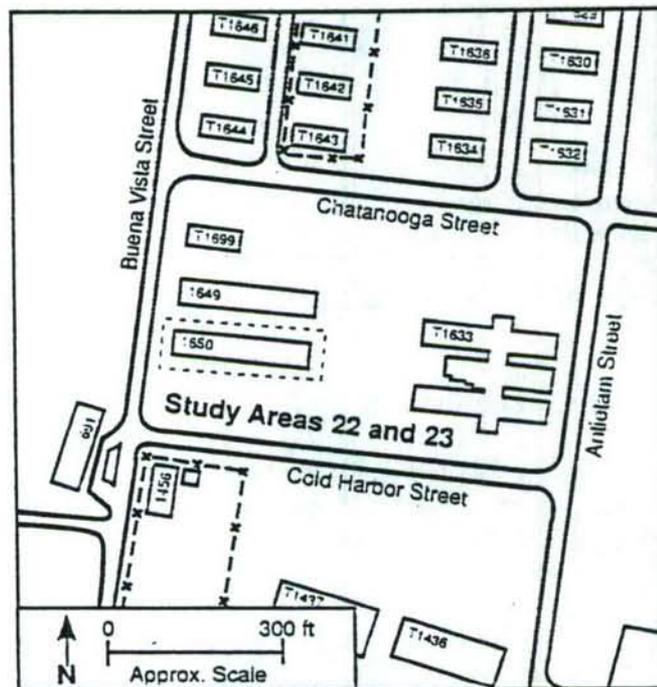


FIGURE 4.17 Location of SAs 22 and 23, the Hazardous Waste Storage Facility and Paper Recycling Center (Source: Map based on Keene 1967)

TABLE 4.22 Wastes Typically Stored in Building 1650

| Waste Description                              | EPA or Mass. Waste No. |
|--|------------------------|
| Flammable liquid                               | D001                   |
| Compound lacquer                               | D001, D008             |
| Compound paint                                 | D001, D007             |
| Corrosive alkaline liquid                      | D002                   |
| Electrolyte/battery fluid                      | D002, D006             |
| Flammable solid/lithium batteries              | D003                   |
| Arsenical compound                             | D004, D010             |
| Mercury compound                               | D009                   |
| Solvent  | F001                   |
| Solvent  | F002                   |
| Oil  | M001                   |
| Hazardous solid                                | M001                   |
| PCBs   | M002                   |
| Hexachlorophene                                | U132                   |
| Reserpine                                      | U200                   |
| Cyclophosphamide                               | U058                   |
| Ferric dextran                                 | U139                   |
| Chlorambucil                                   | U035                   |
| Chlordane                                      | U036                   |
| Hexachlorocyclohexane                          | U129                   |
| Hexachlorobenzene                              | U127                   |
| Formaldehyde                                   | U122                   |
| 1,1,1-Trichloroethane                          | U226                   |
| Toluene  | U220                   |
| Phenol   | U188                   |
| 3-(alpha-acetonylbenzyl)-<br>4-hydroxycoumarin | P001                   |
| Epinephrine                                    | P042                   |

Source: Fox 1988a.

#### 4.19.3 Nature and Extent of Contamination

No spills or releases from this facility have been reported (Fox 1988a; Gates et al. 1986). At the time of the site visit, all of the areas were scrupulously clean and showed no visible staining or other indications of spills or leaks.

#### 4.19.4 Proposed Action

Based on the available information, permitting status, and observations, an inspection should be completed to ensure that no releases have occurred since the last inspection. If records show that releases have occurred, soil samples should be collected and analyzed for indicator parameters. If no releases have occurred, no further action is recommended for this site.

## 4.20 SA 23 – PAPER RECYCLING CENTER (BLDG. 1650)

### 4.20.1 Site History

The paper recycling center (SA 23) was in Bldg. 1650, the current hazardous waste storage facility (SA 22 – see Fig. 4.17). It was a storage and transfer facility for recycling computer paper, computer tab cards, and high-grade office paper. About 160 ton/yr of paper was recycled. The period of operation was April 1984 until sometime in 1985 (Fox 1988a). At the time of the site visit, the recycling operation was inactive. Section 4.19 fully describes the activities in Bldg. 1650.

### 4.20.2 Geology and Hydrology

The recycling center was collocated with hazardous waste storage, and the site description is the same as that given in Sec. 4.19.2.

### 4.20.3 Nature and Extent of Contamination

Operations were restricted to storage and recycling of several types of paper. There is no record of any associated liquids or releases that would endanger human health or the environment.

### 4.20.4 Proposed Action

Because of the nature of the operation, no further action is recommended for this facility. This site does not meet the definition of a study area and should be removed from the list of Fort Devens SAs.

## 4.21 SA 24 – WASTE EXPLOSIVES STORAGE BUNKER 187 (BLDG. 3644)

### 4.21.1 Site History

The magazine area is in the southeastern portion of the main cantonment area, about 0.5 mi north of Mirror Lake (Fig. 4.18). Waste explosives storage bunker 187 (SA 24) is in the magazine area, which requires a prearranged security pass. At the time of the site visit, a pass was not available, so the bunker was not accessible.

The U.S. Army 14th Explosive Ordnance Disposal Detachment controls both bunker 187 and the EOD range (SA 25). Explosives that are designated for detonation at the EOD range are stored in the bunker. The bunker, an in-ground igloo with cement floors, has been used since 1979. Fort Devens provides disposal for the entire New England area, both civilian and military. The sources of waste explosives range from on-site finds during excavation to explosives found, confiscated, or otherwise removed by the state police. About 1,000 lb of explosive wastes are destroyed annually (DEH 1985b).

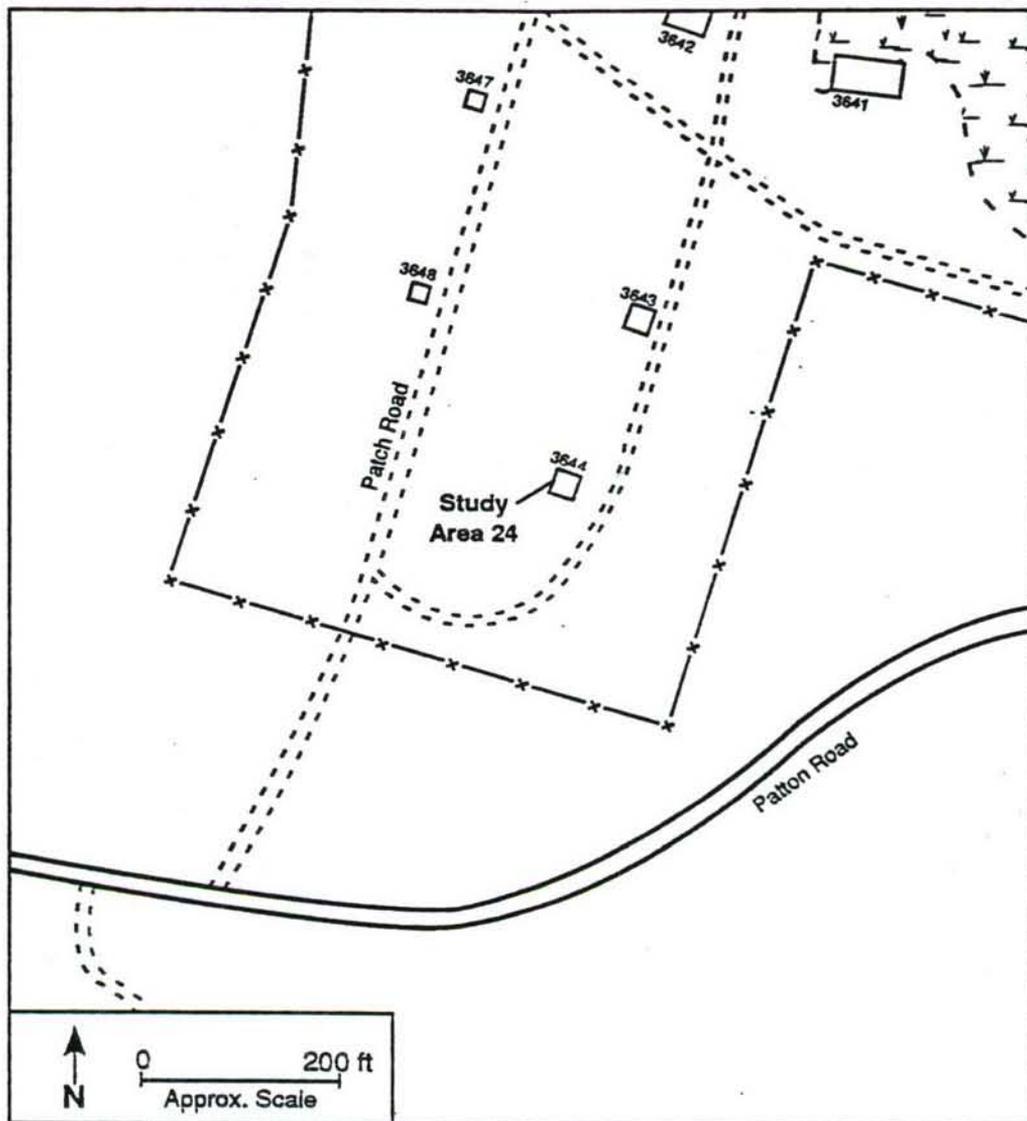


FIGURE 4.18 Location of SA 24, Waste Explosives Storage Bunker 187 (Bldg. 3644) (Source: Map based on Keene 1967)

#### 4.21.2 Geology and Hydrology

Bunker 187 is located within the Mirror Lake drainage basin. In general, this area consists of glacial till comprising poorly sorted clay, silt, sand, gravel, and boulders. The local bedrock is a complex of metamorphic and intensely folded and faulted igneous rocks.

Soils belong to the Quonset-Hinckley-Windsor Association. These soils are generally well drained, highly permeable, droughty sand and gravel underlain by stratified sand and gravel (McMaster et al. 1982).

#### 4.21.3 Nature and Extent of Contamination

The types of explosives stored in the bunker include a broad range of materials that varies over time. Table 4.23 lists typical items that are stored in the bunker and detonated at the EOD range (DEH 1985b; Fox 1988a).

The waste explosives storage bunker is used only for storing explosive items prior to detonation at the EOD range. Many of the items are encased (e.g., grenades and rockets), and by their description, it is obvious that they are not "opened" until they are detonated on a range. Therefore, many of the stored items can be eliminated as likely sources for contamination. Other items are stored in containers.

#### 4.21.4 Proposed Action

A visual inspection should be made of the bunker, the perimeter, and all loading areas. Any areas with visible staining or discoloration should be sampled and analyzed for explosives and TC metals. Three surface soil (0-6 in.) samples should be collected from random locations in the entry area and analyzed for the same parameters.

If the results of the sampling show elevated concentrations of contaminants, contaminated soil should be removed as soon as practicable, followed by confirmation sampling for the contaminants with elevated concentrations.

#### 4.22 SA 25 - WASTE EXPLOSIVES DETONATION RANGE (EOD RANGE)

Study areas 25-28 are impact areas where various explosives have been detonated. Included are small-arms firing ranges and aerial bombing ranges. Active impact areas are not used for training.

TABLE 4.23 Waste Explosives Stored and Detonated at Fort Devens

|                              |                                    |
|------------------------------|------------------------------------|
| Small arms                   | PETN (pentaerythritoltetranitrate) |
| Artillery mortar             | RDX (cyclotrimethylene             |
| Grenades                     | trinitroamine)                     |
| Rockets                      | C-4 (RDX, polyisobutylene)         |
| Pyrotechnic compound         | Compound B (RDX, TNT, Wax)         |
| Propellant                   | Octol (cyclotetramethylene,        |
| Bulk explosives              | tetranitroamine)                   |
| Photoflash powder            | White phosphorus (aluminum,        |
| Lead azide                   | magnesium, barium, nitrate,        |
| Black powder                 | potassium perchlorate)             |
| Hazardous explosive material | TNT (trinitrotoluene)              |

Sources: DEH 1985b; Fox 1988a.

#### 4.22.1 Site History

About 1,000 lb/yr of explosives and ammunition have been disposed of at an area in the explosive ordnance demolition (EOD) range (SA 25) since 1979. Small-arms ammunition, smoke grenades, and pyrotechnics (see Table 4.23) are covered by scrap packing materials, soaked with diesel fuel, and burned in open pits. Larger items are detonated with C-4 or TNT (Porter 1986).

The EOD range, which is located in the impact area in the south post, extends about 0.5 mi east from Firebreak Road (Fig. 4.19). The disposal pits are located in an area of about 5 acres along the southeastern boundary of the range. Porter (1986) reported that this site was included in the Fort Devens RCRA Part A permit application as a hazardous waste thermal treatment facility.

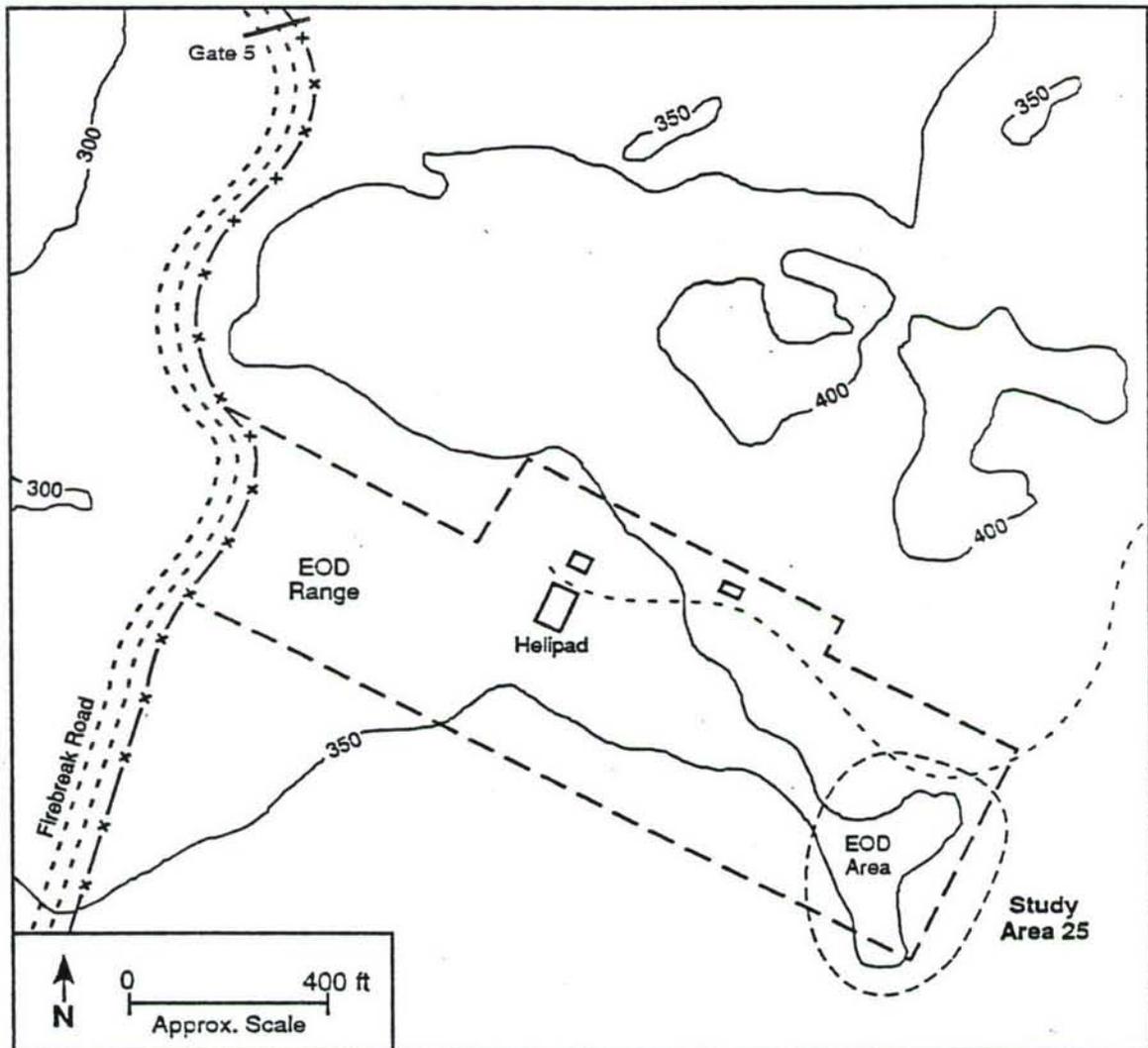


FIGURE 4.19 Location of SA 25, the EOD Range (Source: Map based on USACE 1988)

#### 4.2.2.2 Geology and Hydrology

Porter (1986), who has made the most extensive study of the geologic conditions of this site, described the disposal pits as being in a kettle opening to the west. Bedrock occurs 10-30 ft below the surface and is composed of granitic and metamorphic rocks of Paleozoic age. Surficial materials are composed of glacial-deltaic and outwash deposits of poorly graded sands, well graded sands, silty and clayey sands, and some lenses of clay (Porter 1986).

The sand and gravelly soil at this site, which is underlain by stratified sand and gravel, is part of the Quonset-Hinckley-Windsor Association.

Although perched groundwater water lenses occur, the water table generally lies just above the bedrock at a depth of about 30 ft below the surface. A northeasterly trending groundwater divide, parallel to the eastern boundary of the site, causes the groundwater under the range to flow west. The groundwater enters the Slate Rock Pond drainage system, which eventually flows into the Nashua River (Porter 1986).

#### 4.2.2.3 Nature and Extent of Contamination

Thermally treated materials disposed of at SA 25 consist primarily of C-4, smokeless powder, PETN, and RDX. Other materials disposed of are composition B, dynamite, white phosphorus, TNT, pyrotechnics, octol, black powder, photoflash powder, lithium batteries, and lead azide (Porter 1986).

In 1985, the USAEHA investigated this site to determine the extent of any contamination (Porter 1986). Seven boreholes were drilled, five pits were excavated, and soil samples were collected and analyzed for physical and chemical constituents. Locations of the sample sites are shown in Fig. 4.20. All the samples were analyzed for EP toxic metals, total metals, explosives, volatile organics, and acid and base-neutral extractable organics. Surface soil was largely sand and gravel; because of the small quantities of sample obtained from BH<sub>3</sub>, sample 305 could not be analyzed for EP toxic metals or total metals. While highly variable, the number of constituents and their concentrations tended to decrease with depth, and most of the constituents found in the samples were present in low concentrations (Tables 4.24 through 4.29).

Results for total metals, volatile organics, and base-neutral extractable organic compounds from boreholes 3-7 and the pit samples were reported by Porter (1986). Although the results from boreholes 1 and 2 and the results for EP toxicity were not reported, there was mention of some of these results. The total metals analysis revealed concentrations as high as 39.6 ppm (sample 704, total arsenic), but only one sample (No. 102) showed any evidence of EP toxic metals at a very low concentration (0.524 ppm extractable lead). Porter (1986) believed that the lack of EP toxic metals indicates that the metals are bound to the soil and very unlikely to leach out under normal conditions.

Results from the boreholes also showed high concentrations of trichloroethylene (18,000 ppm), 1,1,1-trichloroethane (38 ppm), tributyl phosphate (up to 10 ppm), and bis(2-ethylhexyl) phthalate (up to 60 ppm) in the soil. The presence of tributyl phosphate may be explained by the operations at the range, and phthalates are a common laboratory contaminant, which could explain the presence of the bis(2-ethylhexyl)phthalate; however, trichloroethylene

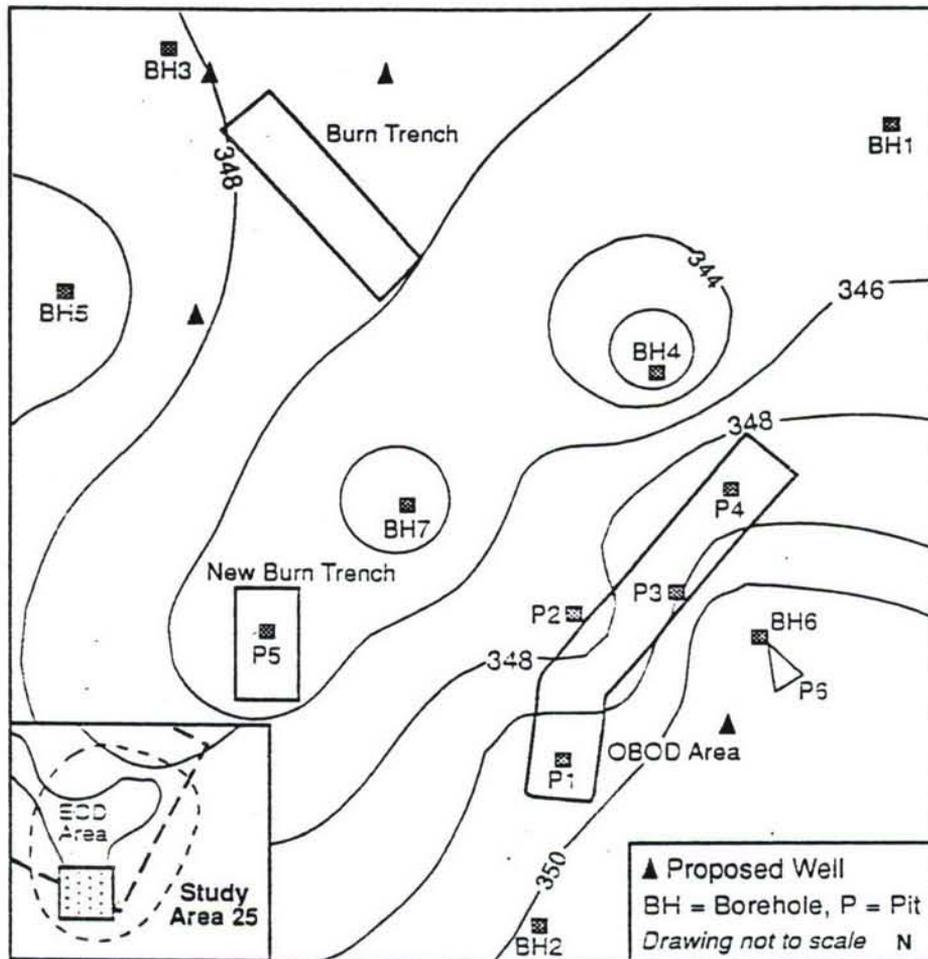


FIGURE 4.20 USAEHA Sampling Locations at SA 25 (the inset locates the sampling area on the site map, Fig. 4.19) (Source: Adapted from Porter 1986)

and 1,1,1-trichloroethane should not be present under normal operating conditions. The elevated values of trichloroethylene, dichloroethylene, and other VOCs in sample 602 (Table 4.27) were attributed to laboratory error. The site where sample 602 was obtained was resampled in order to verify the results or determine laboratory error. A bucketloader was used to dig a sixth pit down to 4.5 ft in a location near borehole 6 (P6 in Fig. 4.20). Concentrations of VOCs in the soil were below the limit of detection of 0.0003 ppm, indicating that earlier concentrations for each constituent were probably due to laboratory error (Porter, 1986).

Other constituents found at low concentrations were 2-butanone, di-N-octyl phthalate, 1,2-dichlorobenzene, di-N-butyl phthalate, trichlorofluoromethane, and trimethyl-2-heptene. The concentrations of these constituents were so low that they should not present any substantial threat to human health or the environment (Porter 1986).

Samples from the pits were analyzed for EP toxic metals, total metals, explosives, volatile organics, and acid and base-neutral extractable organics. According to Porter (1986), the

TABLE 4.24 Analytic Results from Borehole 3 Samples at SA 25 (ppm)

| Parameter             | Sample 301,<br>0-1.5 ft | Sample 302,<br>4.5-6 ft | Sample 303,<br>10 ft | Sample 304,<br>15 ft | Sample 305,<br>20 ft | Sample 306,<br>24-25 ft |
|-----------------------|-------------------------|-------------------------|----------------------|----------------------|----------------------|-------------------------|
| Arsenic, total        | 15.9                    | 16.5                    | 10.6                 | 10.5                 | <sup>b</sup>         | 7.9                     |
| Chromium, total       | 5.94                    | 6.95                    | 9.89                 | 6.0                  | <sup>b</sup>         | 7.2                     |
| Mercury, total        | 0.15                    | -                       | 0.13                 | -                    | <sup>b</sup>         | -                       |
| Lead, total           | 19.1                    | 6.25                    | 2.58                 | 2.79                 | <sup>b</sup>         | 4.12                    |
| Selenium, total       | 7.15                    | -                       | 4.73                 | 5.3                  | <sup>b</sup>         | 4.22                    |
| 1,1,1-Trichloroethane | 38.0                    | -                       | -                    | -                    | -                    | -                       |
| Hydrocarbons          |                         |                         |                      |                      |                      |                         |
| Low boiling point     | -                       | -                       | -                    | -                    | 60.0                 | -                       |
| High boiling point    | 300.0                   | 200.0                   | 150.0                | 400.0                | 150.0                | 250.0                   |
| Tributyl phosphate    | 10.0                    | 3.0                     | -                    | -                    | -                    | 2.0                     |
| Di-N-butyl phthalate  | -                       | -                       | -                    | 2.0                  | -                    | -                       |
| Trimethyl-2-heptane   | -                       | 2.0                     | -                    | -                    | -                    | -                       |

<sup>a</sup>For safety, the top 4 in. of soil were moved before drilling.

<sup>b</sup>Sample not analyzed for total metals or EP toxicity.

<sup>c</sup>Below the detection limit.

Source: Porter 1986.

TABLE 4.25 Analytic Results from Borehole 4 Samples at SA 25 (ppm)

| Parameter                  | Sample 401,<br>0-1.5 ft | Sample 402,<br>4.5-6 ft | Sample 403,<br>10 ft | Sample 404,<br>15 ft | Sample 405,<br>20 ft |
|----------------------------|-------------------------|-------------------------|----------------------|----------------------|----------------------|
| Arsenic, total             | 17.1                    | 12.0                    | <sup>a</sup>         | 10.2                 | 21.2                 |
| Chromium, total            | 12.3                    | 7.3                     | 6.65                 | 17.7                 | 8.95                 |
| Mercury, total             | -                       | 0.193                   | 0.14                 | 0.186                | 0.23                 |
| Lead, total                | 15.1                    | 3.56                    | -                    | 3.11                 | 5.8                  |
| Selenium, total            | 8.64                    | 5.25                    | 3.82                 | 8.4                  | 6.1                  |
| 1,1,1-Trichloroethane      | -                       | -                       | -                    | -                    | 38.0                 |
| Hydrocarbons               |                         |                         |                      |                      |                      |
| Low boiling point          | -                       | -                       | -                    | -                    | 60.0                 |
| High boiling point         | 200.0                   | 200.0                   | 200.0                | 100.0                | 200.0                |
| Tributyl phosphate         | 1.0                     | -                       | -                    | -                    | -                    |
| Di-N-butyl phthalate       | -                       | -                       | 1.0                  | -                    | -                    |
| Bis(2-ethylhexyl)phthalate | -                       | -                       | 3.0                  | -                    | 1.0                  |

<sup>a</sup>Below the detection limit.

Source: Porter 1986.

**TABLE 4.26 Analytic Results from Borehole 5 Samples at SA 25 (ppm)**

| Parameter            | Sample 501, 0-1.5 ft <sup>a</sup> | Sample 502, 4.5-6 ft <sup>b</sup> |
|----------------------|-----------------------------------|-----------------------------------|
| Arsenic, total       | 26.9                              | 34.9                              |
| Chromium, total      | 13.1                              | 15.9                              |
| Mercury, total       | 0.14                              | 0.10                              |
| Lead, total          | 7.55                              | 14.2                              |
| Selenium, total      | 9.25                              | 9.88                              |
| Hydrocarbons         |                                   |                                   |
| Low boiling point    | b                                 | 150.0                             |
| High boiling point   | 100.0                             | 100.0                             |
| Di-N-butyl phthalate | 1.0                               | 1.0                               |

<sup>a</sup>For safety, the top 12 in. of soil were moved before drilling.

<sup>b</sup>Below the detection limit.

Source: Porter 1986.

total metals analysis revealed concentrations as high as 97.2 ppm total cadmium, but only one sample (P1) showed any evidence of EP toxic metals (3.1 ppm extractable cadmium). This sample exceeded the maximum allowable concentration of 1.0 ppm extractable cadmium (40 CFR 261). The lack of EP toxic metals in the soils indicates that the metals are bound to the soil and that very little metal is likely to leach out under normal conditions (Porter 1986). The high concentrations of total cadmium in the P1 sample may account for the higher EP toxicity level found in that sample. Other constituents that were found at very low concentrations in the pits are TNT, bis(2-ethylhexyl)phthalate, di-N-butyl phthalate, diethyl phthalate, and N-nitrosodiphenylamine. Porter (1986) believed that these constituents are at such low concentrations that they should not present any substantial threat to human health or the environment.

During the site visit in November 1988, old shell casings were observed in two pits. No contamination was apparent.

#### 4.22.4 Proposed Action

Because the soil contamination has already been thoroughly investigated by Porter (1986), no further soil samples are recommended. It is recommended that one upgradient and three downgradient groundwater monitoring wells be installed (see Fig. 4.20 for suggested locations). Following proper well development (USATHAMA 1987), groundwater samples should be collected and analyzed for HSL compounds, explosives, and TPH. Porter (1986)

TABLE 4.27 Analytic Results from Borehole 6 Samples at SA 25 (ppm)

| Parameter                    | Sample<br>601,<br>0-1.5 ft <sup>a</sup> | Sample<br>602,<br>4.5-6 ft <sup>a</sup> | Sample<br>603,<br>10 ft <sup>a</sup> | Sample<br>604,<br>15 ft <sup>a</sup> |
|------------------------------|---|---|--------------------------------------|--------------------------------------|
| Arsenic, total               | 29.3                                    | 20.7                                    | 29.4                                 | 21.0                                 |
| Chromium, total              | 6.68                                    | 7.75                                    | 10.0                                 | 24.4                                 |
| Mercury, total               | 0.13                                    | 0.12                                    | 0.14                                 | <sup>b</sup>                         |
| Lead, total                  | 22.7                                    | 24.2                                    | 7.3                                  | 12.9                                 |
| Selenium, total              | 5.4                                     | 3.78                                    | 3.7                                  | 6.73                                 |
| Benzene                      | -                                       | 18.0                                    | -                                    | -                                    |
| Carbon tetrachloride         | -                                       | 10.0                                    | -                                    | -                                    |
| Chloroform                   | -                                       | 17.0                                    | -                                    | -                                    |
| 1,1-Dichloroethylene         | -                                       | 6.0                                     | -                                    | -                                    |
| 1,2-Dichloroethylene (trans) | -                                       | 70.0                                    | -                                    | -                                    |
| 1,2-Dichloroethylene         | -                                       | 101.0                                   | -                                    | -                                    |
| Tetrachloroethylene          | -                                       | 24.0                                    | -                                    | -                                    |
| Trichloroethylene            | -                                       | 18,000.0                                | -                                    | -                                    |
| Hydrocarbons                 |   |   |                                      |                                      |
| Low boiling point            | 150.0                                   | -                                       | 100.0                                | 60.0                                 |
| High boiling point           | 300.0                                   | 100.0                                   | 100.0                                | 150.0                                |
| Tributyl phosphate           | 1.0                                     | -                                       | -                                    | 4.0                                  |
| Di-N-butyl phthalate         | 1.0                                     | -                                       | -                                    | -                                    |
| Bis(2-ethylhexyl)phthalate   | -                                       | -                                       | 60.0                                 | 2.0                                  |
| Di-N-octyl phthalate         | -                                       | -                                       | 3.0                                  | -                                    |

<sup>a</sup>For safety, the top 6 in. of soil were moved before drilling.

<sup>b</sup>Below the detection limit.

Source: Porter 1986.

reported the existence of springs downgradient of the site. Water from these springs should be sampled and analyzed for the same parameters. The need for additional investigation should be based on the results of these analyses.

All debris and metal objects found on the surface should be removed and disposed of in a properly designed and operated landfill. If necessary, remedial action should be taken in accordance with state and federal requirements.

#### 4.23 SA 26 – WASTE EXPLOSIVES DETONATION RANGE (ZULU I AND II)

##### 4.23.1 Site History

The 20-acre Zulu range (SA 26) consists of two range areas, Zulu I and Zulu II. It is in the south post on the western boundary of the impact area (Fig. 4.21). Zulu I and Zulu II are adjacent and similar in size and terrain.

TABLE 4.28 Analytic Results from Borehole 7 Samples at SA 25 (ppm)

| Parameter                  | Sample<br>701,<br>0-1.5 ft | Sample<br>702,<br>4.5-6 ft | Sample<br>703,<br>10 ft | Sample<br>704,<br>15 ft | Sample<br>705,<br>20 ft |
|----------------------------|----------------------------|----------------------------|-------------------------|-------------------------|-------------------------|
| Arsenic, total             | 16.7                       | 30.1                       | 27.9                    | 39.6                    | 31.0                    |
| Chromium, total            | 33.2                       | 5.5                        | 7.55                    | 7.9                     | 17.2                    |
| Mercury, total             | 0.16                       | 0.17                       | 0.173                   | 0.178                   | - <sup>a</sup>          |
| Lead, total                | 16.9                       | 4.61                       | 8.5                     | 7.78                    | 5.44                    |
| Selenium, total            | 5.5                        | 2.81                       | 5.94                    | 4.6                     | 3.92                    |
| Hydrocarbons               |                            |                            |                         |                         |                         |
| Low-boiling pt.            | -                          | -                          | 200.0                   | 60.0                    | 30.0                    |
| High-boiling pt.           | 300.0                      | 250.0                      | 300.0                   | 200.0                   | 200.0                   |
| Tributyl phosphate         | 1.0                        | -                          | -                       | -                       | -                       |
| Di-N-butyl phthalate       | 1.0                        | -                          | 1.0                     | 1.0                     | -                       |
| Bis(2-ethylhexyl)phthalate | -                          | 1.0                        | -                       | -                       | -                       |

<sup>a</sup>Below the detection limit.

Source: Porter 1986.

TABLE 4.29 Analytic Results from Pit Samples at SA 25 (ppm)<sup>a</sup>

| Parameter                   | Sample<br>P1 | Sample<br>P2   | Sample<br>P3 | Sample<br>P4 | Sample<br>P5 | Sample<br>P6 |
|-----------------------------|--------------|----------------|--------------|--------------|--------------|--------------|
| Arsenic, total              | 5.94         | 6.1            | 4.34         | 7.55         | 9.97         | 8.3          |
| Barium, total               | 13.9         | 15.2           | 19.7         | 14.3         | 21.3         | 9.909        |
| Cadmium, total <sup>b</sup> | 97.2         | 3.74           | 4.54         | 4.77         | 4.69         | 4.35         |
| Chromium, total             | 6.73         | 13.8           | 6.71         | 13.3         | 11.0         | 6.92         |
| Mercury, total              | 0.04         | - <sup>c</sup> | 0.039        | 0.04         | 0.059        | 0.059        |
| Lead, total                 | 25.7         | 37.4           | 31.6         | 41.7         | 39.1         | 19.8         |
| Trinitrotoluene             | 1.2          | -              | 1.0          | -            | -            | -            |
| N-Nitrosodiphenylamine      | -            | 1.0            | -            | -            | -            | -            |
| Benzene acetic acid         | -            | -              | -            | -            | 3.0          | -            |
| Hydrocarbons                | -            | -              | -            | -            | 20.0         | -            |
| Diethyl phthalate           | -            | -              | 2.0          | -            | -            | 1.0          |
| Di-N-butyl phthalate        | -            | 2.0            | -            | 1.0          | -            | -            |
| Bis(2-ethylhexyl)phthalate  | -            | 1.0            | -            | -            | -            | -            |

<sup>a</sup>Sample depths: 0-15 ft for samples P1-P4, 3.5 ft for sample P5, and 4.5-6 ft for sample P6.

<sup>b</sup>Samples were also analyzed for EP toxic metals; the only detectable result was 3.1 mg/L extractable cadmium in sample P1.

<sup>c</sup>Below the detection limit.

Source: Porter 1986.

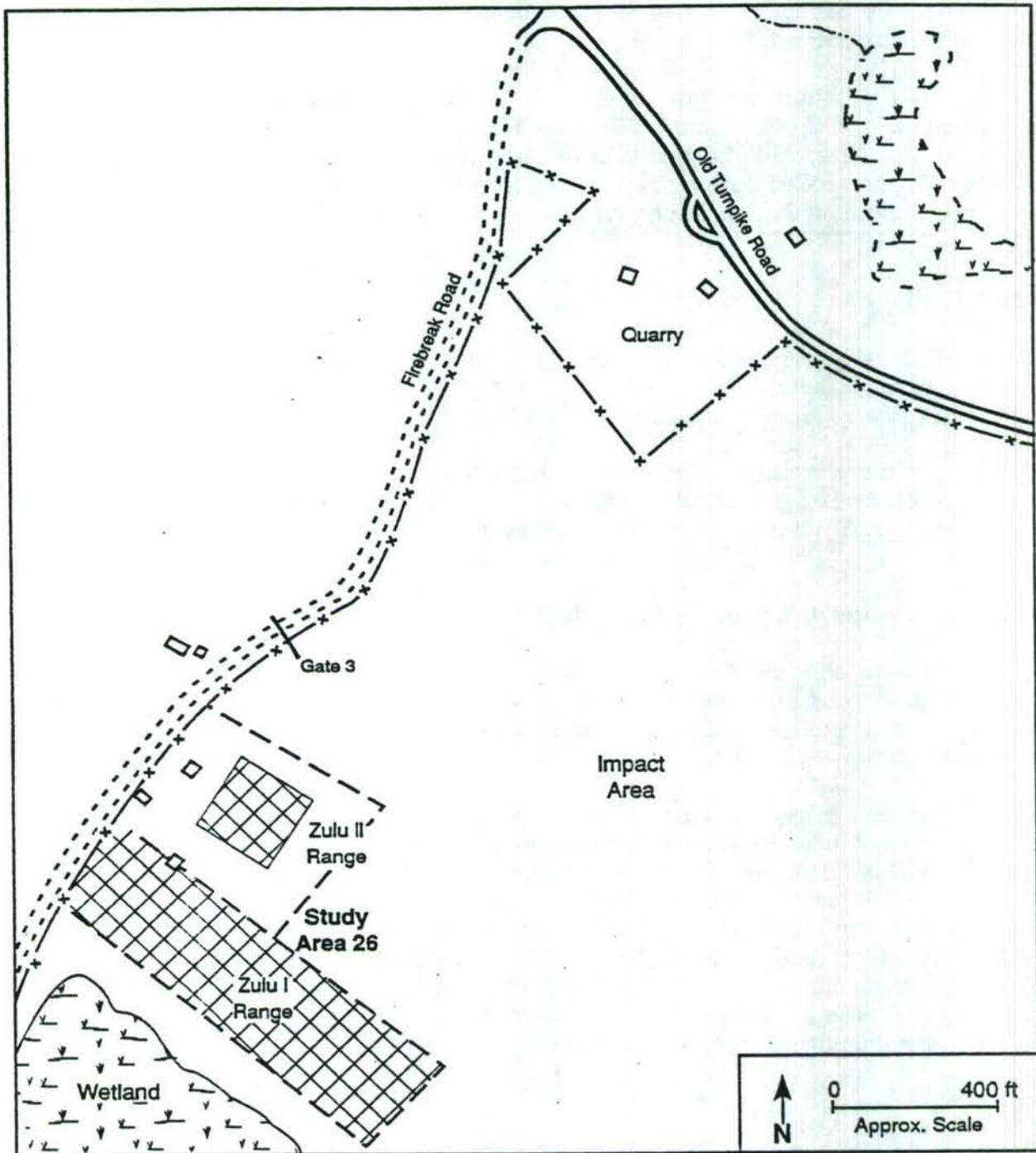


FIGURE 4.21 Location of SA 26, Waste Explosives Detonation Range (Zulu I and II) (Source: Map based on USACE 1988)

Zulu I is a 10-acre bowl-like area used primarily for hand grenade and demolition activity training. Although current operation does not include disposal, open detonation of high explosives has occurred (Brown 1981).

Zulu II is used for burning explosives and explosively contaminated items, such as propellants, C-4, TNT, RDX, and HMX (Brown 1981). Blasting mats are used to cover reactions and to control the spread of fire and debris. Specialized training for cutting metals and similar objects using controlled burning is performed here. According to site personnel, there is no ordnance disposal at Zulu II; hence, no unexploded ordnance (UXO) is expected there.

#### 4.23.2 Geology and Hydrology

Both ranges are in a kettle opening to the west. Bedrock of the Worcester Formation is estimated to be about 30 ft below the surface. Soil is composed of glacial-deltaic and outwash silty sands, poorly graded sands, and gravels interspersed with clay lenses (Brown 1981).

A wetland area of about 6 acres adjoins Zulu I; at the time of the site visit, activity by heavy equipment had disturbed the soil, revealing an apparent water table about 2 ft below the ground surface. Surface runoff from the area eventually enters the Nashua River (Brown 1981).

#### 4.23.3 Nature and Extent of Contamination

Prior to 1979, the Zulu range was used to dispose of explosive items. Explosives were destroyed by burning or detonation. Small-arms rounds, smoke grenades, and pyrotechnics were covered, soaked with diesel fuel, and burned in open pits. Larger explosive items were covered with tamped earth and detonated with C-4 or TNT (Fox 1988a).

Past and current activities, as well as the disposal methods (i.e., the use of diesel fuel), may have contributed to some contamination of the range. Explosives contamination could result from incomplete burning and from demolition. Because of the proximity of a wetland area and the local hydrologic characteristics, the possibility of contaminant migration must be addressed. In an effort to control migration, the soil is periodically removed; however, it is very permeable, and contaminants could migrate downward before removal or as the result of incomplete removal. No information was available to indicate the disposition of the soil when it is removed. There was no indication that confirmation sampling is done on a routine basis to determine the effectiveness of soil removal.

#### 4.23.4 Proposed Action

To address the potential of contaminant migration, sampling is recommended for both Zulu ranges. Because the sites are large, personnel familiar with the use of the ranges should first lay out sample grids in the portions used most frequently. The proposed sampling programs for each site are detailed below.

Regardless of whether elevated contaminant levels are found, it is recommended that Fort Devens implement annual or biannual sampling at both Zulu ranges to monitor the potential for the release of contaminants.

#### 4.23.4.1 Zulu I

As an initial phase, about 12 soil borings should be drilled to 10 ft throughout the grid area of Zulu I. Samples from the top, middle, and bottom of the boring cores should be analyzed for HSL compounds, explosives, TC metals, and TPH. In addition, about ten surface water and sediment samples should be collected from the wetland area and analyzed for the same parameters. Sediment samples should also be evaluated for grain size and analyzed for TOC.

If contaminant levels in the soil borings are significantly elevated, then groundwater monitoring wells should be installed upgradient and downgradient of the site and monitored on a regular basis.

#### 4.23.4.2 Zulu II

As an initial phase, between six and ten soil borings should be drilled to 10 ft throughout the grid area of Zulu II. Samples from the top, middle, and bottom of the boring cores should be analyzed for HSL compounds, explosives, TC metals, and TPH.

If contaminant levels in the soil borings are significantly elevated, then groundwater monitoring wells should be installed upgradient and downgradient of the site and monitored on a regular basis.

### 4.24 SA 27 – WASTE EXPLOSIVES DETONATION RANGE (HOTEL)

#### 4.24.1 Site History

Hotel range (SA 27) covers an area of about 7 acres on the northwestern edge of the impact area about 500 yd west of Cranberry Pond (Fig. 4.22). Because of the prevalence of UXO on the range, access is permitted only during an emergency and only if accompanied by an EOD escort.

Hotel is a training range used for firing several types of rifle grenades and 20-mm automatic cannons with red phosphorus tracers. Before 1979, this range was used for explosive ordnance disposal of old or defective high-explosive grenades and 3.5-mm rocket projectiles.

#### 4.24.2 Geology and Hydrology

The range is in a kettle that opens to the north. Although site-specific information is limited, bedrock is estimated to be 30 ft below the surface and is probably part of the Worcester Formation. Surface materials comprise interbedded and cross-bedded glacial-deltaic and outwash sands and silty sands and gravels that are interspersed with small clay lenses.

Based on the available hydrogeological information, the groundwater probably flows easterly to Cranberry Pond and on to the Nashua River (Brown 1981). Cranberry Pond is a kettle lake recharged by groundwater and surface runoff from the surrounding area (Fox 1988a).

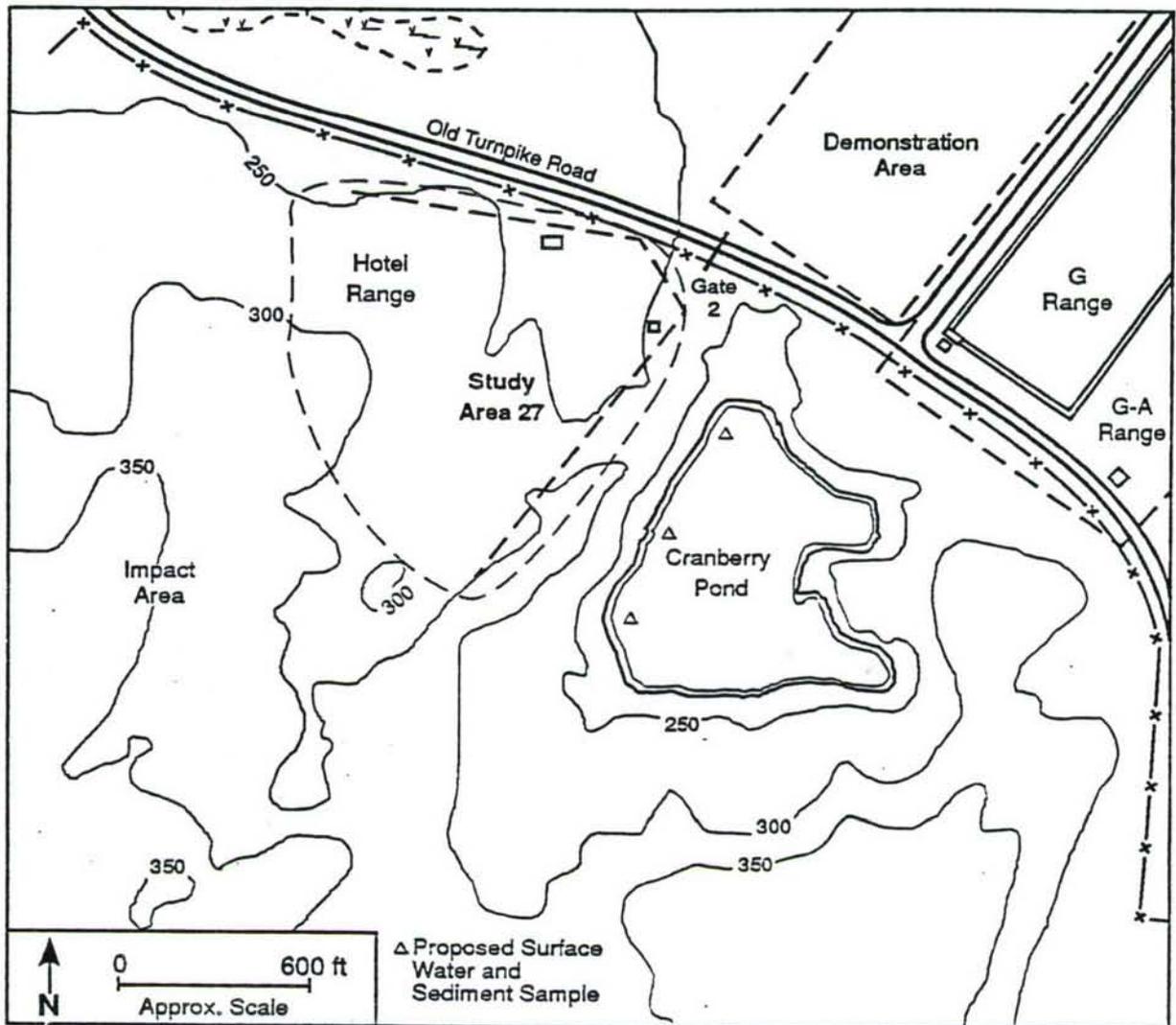


FIGURE 4.22 Location of SA 27, Waste Explosives Detonation Range (Hotel) (Source: Map based on USACE 1988)

#### 4.24.3 Nature and Extent of Contamination

Before 1979, Hotel range was used to dispose of explosive items. Explosives were destroyed by burning or detonation. Small-arms rounds, smoke grenades, and pyrotechnics were covered, soaked with diesel fuel, and burned in open pits. Larger explosive items were covered with tamped earth and detonated with C-4 or TNT (Fox 1988a).

Past and current activities, as well as the disposal methods (i.e., the use of diesel fuel), may have contributed to some contamination of the range. Explosives contamination could result from incomplete burning and from demolition. Because of the proximity of Cranberry Pond and the local hydrologic characteristics, the possibility of contaminant migration should be addressed.

#### 4.24.4 Proposed Action

To characterize the underlying geology, a geophysical survey should be completed. To assess any impacts on Cranberry Pond and the local groundwater, a soil sampling program is recommended. As an initial phase, about eight soil borings should be drilled to 10 ft in the areas most likely to be contaminated. Samples from the top, middle, and bottom of the cores should be analyzed for HSL compounds, explosives, TC metals, and TPH. Three samples of surface water and sediment should be obtained and analyzed for the same parameters.

If contaminant levels in the soil borings are elevated, then groundwater monitoring wells should be installed upgradient and downgradient of the site and monitored on a regular basis.

#### 4.25 SA 28 – HAND-GRENADE RANGE J

##### 4.25.1 Site History

Study area 28 is a 6-acre area formerly used as hand-grenade range J in the south post. It is bounded on the south by Slate Rock Pond, on the east by Jackson Road, on the west by Old Turnpike Road, and on the north by the south post boundary (Fig. 4.23). The range is currently used as a medical litter obstacle course.

The range currently is a tactical training area in constant use by active and reserve units. According to Gates (1987), the following historical activities occurred at this site. Hand grenade

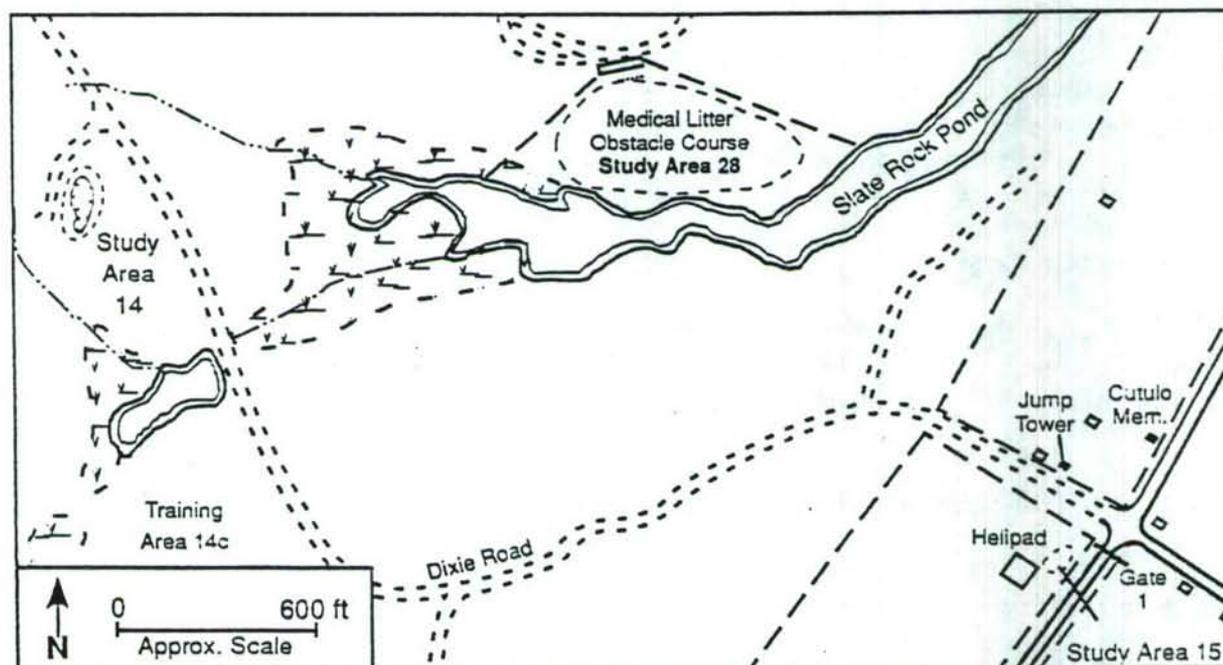


FIGURE 4.23 Location of SA 28, Hand-Grenade Range J (Source: Map based on USACE 1988)

range J was established in the 1940s. No other weapons were used on this range, nor is there any record of burning or disposal of hazardous materials. In the 1970s, the hand grenade range was moved, and the J range was cleared of UXO and EOD debris and converted to Facility 8, a medical litter obstacle course. Since being converted, several thousand soldiers have used the course and no hazards have been reported.

#### **4.25.2 Geology and Hydrology**

Geologic conditions of the site consist of unconsolidated glacial till and outwash deposits overlying undivided metamorphic and granitic bedrock. The lithology and nature of the bedrock are expected to be similar to the slate bedrock outcrop at nearby SA 14. The glacial outwash deposits are about 30 ft thick (Gates 1987).

The soils at the site are of the Quonset-Hinckley-Windsor Association (Nicholls et al. 1980). These are described as drougthy, sandy, and gravelly soils underlain by stratified sand and gravel.

The regional hydrogeology has been mapped as a minor aquifer consisting of thin sections of glacial outwash and glacial lacustrine deposits. Goldberg-Zoino & Associates (1976) showed the saturated thickness to be less than 20 ft in the eastern one half of the site and more than 20 ft in the western half.

Groundwater under the site probably flows toward Slate Rock Pond. The creek associated with the pond flows along the west and north sides of the range.

#### **4.25.3 Nature and Extent of Contamination**

No soil or groundwater contamination has been reported in this area. Gates (1987) noted that only hand grenades were exploded at the site and that no hazardous wastes were burned or disposed. This activity ceased more than 10 years ago, and since that time no activities that could cause contamination have taken place on this range.

#### **4.25.4 Proposed Action**

Although this site does not fit the definition of a study area (no hazardous wastes have ever been disposed of at the site), a site reconnaissance should be conducted and soil samples should be collected and analyzed for explosives.

### **4.26 SA 29 – TRANSFORMER STORAGE AREA AT THE DEH YARD (BLDG. 1438)**

#### **4.26.1 Site History**

The transformer storage area (SA 29) is in the northeastern part of the main cantonment area, near DEH (Fig. 4.24). The storage facility, known as Bldg. 1438, has been in use since 1980

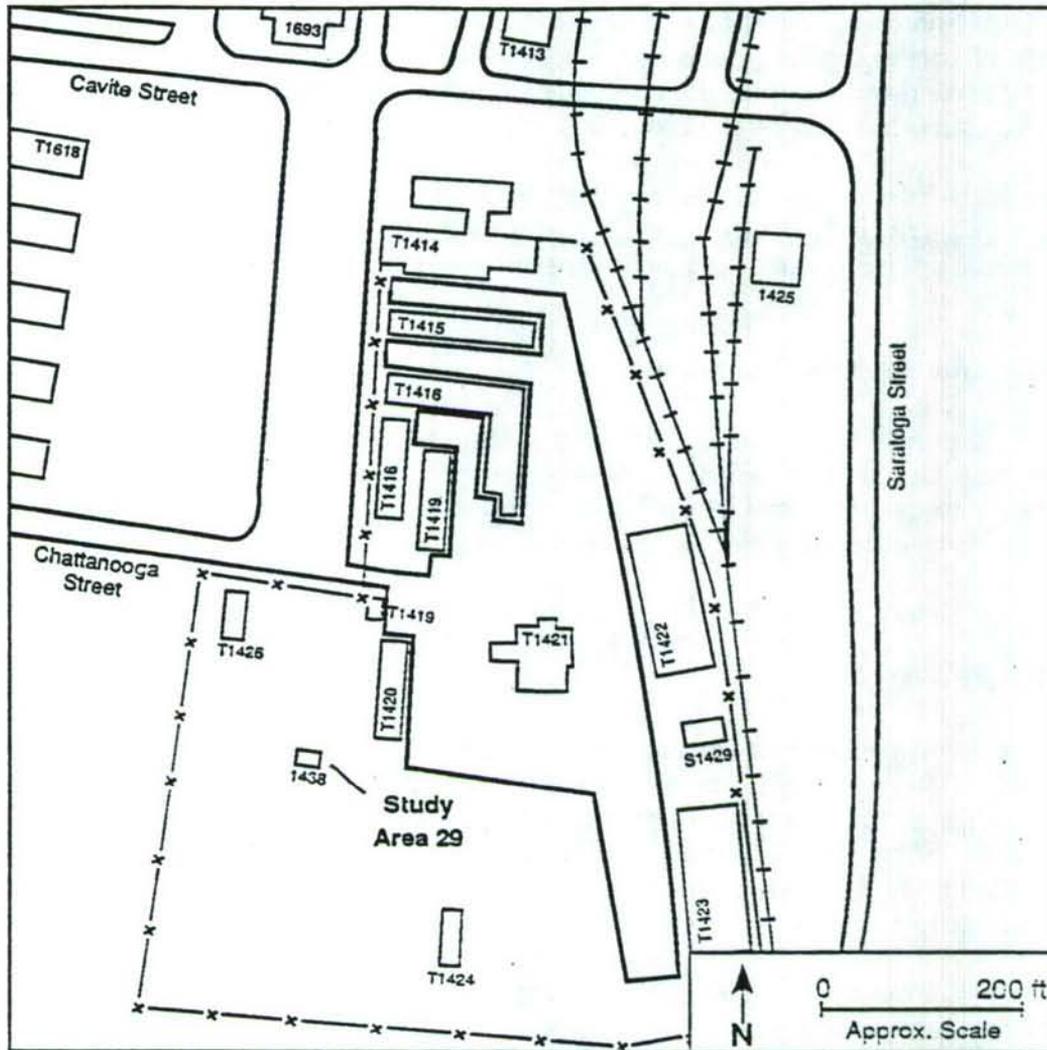


FIGURE 4.24 Location of SA 29, Transformer Storage Area at the DEH Yard (Bldg. 1438) (Source: Map based on Keene 1967)

and has a total area of 1,600 ft<sup>2</sup>. It has a roof and paved floor, is enclosed on three sides, and is secured by a locked gate that serves as the fourth wall. About 33 ft<sup>2</sup> is bermed for temporary storage of PCB transformers that have been taken out of service. All of the transformers are tested for PCB content. If a unit exceeds 25 ppm PCB content or it is determined that it is unserviceable, it is designated for disposal (Fox 1988a).

Because one to two years is required to dispose of transformers (Gates et al. 1986), the enclosed storage area was full. A second storage yard was in use at the time of the site visit. This second yard (about 400 ft<sup>2</sup>) was unprotected and unpaved, and according to Fort Devens personnel, held about 14 PCB-contaminated transformers. None was drained or properly marked. During the first quarter of 1989, the transformers were transferred to the hazardous waste storage area until disposal. The regional DRMO is responsible for transportation of hazardous wastes and is ultimately responsible for the disposition of the transformers.

#### 4.26.2 Geology and Hydrology

Information on site-specific geology in this area is limited. Generally, the local bedrock is a complex of metamorphic and igneous rocks that are intensely folded and faulted. The bedrock composition ranges from metasediments to granodiorite and is found from 0 to 100 ft below the land surface (McMaster et al. 1982).

The soils in this part of the base are of the Quonset-Hinckley-Windsor Association. These soils are described as droughty sand and gravel underlain by stratified sand and gravel. They are generally well drained and highly permeable (McMaster et al. 1982).

#### 4.26.3 Nature and Extent of Contamination

The Bldg. 1438 transformer storage area showed no signs of spills or leaks. Available information indicates that there have not been any reportable spills or releases (Fox 1988a). Neither have there been any spills or releases reported in the yard storage area (nonconforming storage) where excess transformers were stored temporarily. The potential exists that leaks could have occurred.

#### 4.26.4 Proposed Action

The open yard should be closely inspected for visible staining. Surface (6-12 in.) samples of all stained soil should be obtained and analyzed for PCBs. Six surface soil samples should be taken at random from the areas that are, or have been, used to store any PCB items and analyzed for PCBs. If PCBs are found at elevated levels (25 ppm or greater), soil borings should be drilled to 10 ft to determine the extent of contamination. Samples should be analyzed for TC compounds.

All contaminated areas should be excavated and disposed of as hazardous waste. Following removal of contaminated material, confirmation samples should be taken to ensure completeness of cleanup.

### 4.27 SA 30 -- MOORE ARMY AIRFIELD DRUM STORAGE AREA

#### 4.27.1 Site History

The temporary drum storage area (SA 30) at Moore Army Airfield (north post) was an outdoor temporary satellite accumulation point for storage of containerized hazardous waste for 90 days or less. This storage area was reportedly used between 1975 and 1990. Pallets with space for 10 to 15 55-gal drums were positioned at the end of the aircraft defueling area (Fig. 4.25) (DEH 1985b). During 1990, Fort Devens constructed a prefabricated 90-day storage area at another location, and SA 30 is no longer in use.

This area was used to store materials such as alkaline cleaners (EPA waste D002), methyl ethyl ketone (F005), contaminated JP-4 jet fuel (D001), and paint thinners (D001, D008)

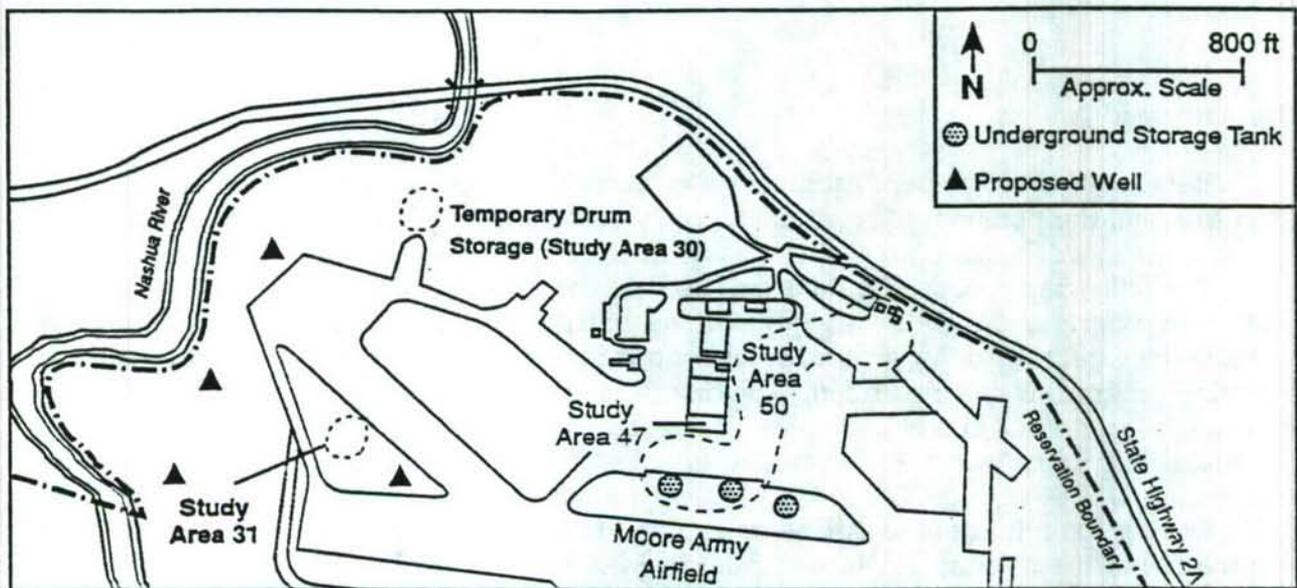


FIGURE 4.25 Locations of SAs 30 and 31, the Temporary Drum Storage and Firefighting Training Areas at Moore Army Airfield (Source: Map based on Cameron and Footit undated)

(DEH 1985b). During the site assessment in 1988, the following materials were being stored at this site: naphtha, dry cleaning solution (such as PD-680), JP-4, aircraft cleaning compounds, lube oil, and waste solvent (F-list wastes). The JP-4 drum was resting on asphalt rather than being placed on the pallet. In addition to these materials, five empty drums were present (out of a total of 21 drums). Several drums were damaged. The drums were all exposed to the natural elements, and water had accumulated on the drum tops. Several bungs appeared to be broken.

#### 4.27.2 Geology and Hydrology

The site is located on the Quonset-Hinckley-Windsor Association, which consists of droughty sand and gravelly soil underlain by stratified sand and gravel. This area drains well and has a high permeability (Nicholls et al. 1980; McMaster et al. 1982). Typical hydraulic conductivities for this area are in the range of 0.001 to 0.01 cm/s (Satterwhite et al. 1976a). Groundwater flows toward the Nashua River.

#### 4.27.3 Nature and Extent of Contamination

The temporary storage location was not bermed or sheltered. It was set apart from the airfield with railroad ties. The asphalt storage pad had several cracks, and leaks were apparent on the soil and asphalt surface. This site is located north of the runways near the top of a hill. The Nashua River lies in the valley below the site, and contaminants, if any, would probably migrate downhill to the river. No monitoring wells are in this area (Sharma 1988).

It was reported that former activities included pouring waste oils, fuels, and solvents from aircraft maintenance operations into 55-gal drums near the current airfield waste storage

area. The drums occasionally overflowed, and soil contamination was evident in the area (McMaster et al. 1982).

#### 4.27.4 Proposed Action

Because of the high permeability and excellent drainage characteristics associated with soils at this site, the potential for contamination of surface water (Nashua River) is high.

The following proposed actions are based on the assumption that runoff from the drum storage area migrates down the steeply sloping hillside and enters the Nashua River. To determine the extent of soil or groundwater contamination at this site, a phased sampling and monitoring program is recommended. The first phase should consist of collecting soil samples and surface water and sediment samples. If needed, a second phase would include collecting additional soil, surface water, and sediment samples and monitoring groundwater quality.

During the initial phase, soil samples should be collected around the storage area and down the hill to the river at depths of 0.5-1.0 ft, 3.0-3.5 ft, and 4.5-5.0 ft at each location. One sample should be obtained from the center of each side of the pad. The other locations should be at 50-ft intervals along drainage paths between the pad and the river. About four surface water and sediment samples should be collected from the river. The number of samples and their locations should be based on any visible evidence of contamination or drainage. Samples should be analyzed for HSL compounds and TPH. Sediment samples should also be evaluated for grain size and analyzed for TOC.

If the first phase indicates the presence of contamination, a second phase should be initiated to collect additional soil, surface water, and sediment samples. It may be necessary to install groundwater monitoring wells in areas identified as contaminated during the first phase. Samples should be analyzed for HSL compounds, TPH, and TC compounds.

All significantly contaminated soil and groundwater should be removed or restored in accordance with state and federal requirements. After the cleanup operations, the soil and groundwater should again be sampled and tested to verify the completeness of cleanup.

### 4.28 SA 31 – MOORE ARMY AIRFIELD FIREFIGHTING TRAINING AREA

#### 4.28.1 Site History

The Moore Army Airfield firefighting training area (SA 31) is located on an abandoned portion of the Fort Devens airport runway apron in the north post (Fig. 4.25). The area, which was used between 1975 and 1986, consists of a 50- by 50-ft asphalt-covered concrete pad that is 8 in. thick. The pad is surrounded by a 12-in. high by 24-in. wide earthen containment berm. The center of the pit contains the shell of a U-8 airplane used during exercises. Fuels used during the training included contaminated fuel and paint thinner (DEH 1985b). No discharge of fuel from the training pit has been reported (McMaster et al. 1982). Other disposal activities at SA 31 included burning of fuel samples from the laboratory about once per year (McMaster et al. 1982)

#### 4.28.2 Geology and Hydrology

Due to the proximity of this site to the temporary drum storage area (SA 30), the geology and hydrology are similar to those described in Sec. 4.27.2.

#### 4.28.3 Nature and Extent of Contamination

Gates et al. (1986) reported that the concrete foundation of the pad is an assemblage of concrete slabs, some of which have cracked due to age. Waste oil and JP-4 jet fuel products, which were poured onto the pad for the fire-fighting exercises, could have seeped through the cracks and joints into the subsurface soil; thus, potential exists for contamination of the underlying groundwater. Gates et al. (1986) pointed out, however, that the potential for fuel seepage was very low because the fuel products were ignited and burned immediately. Reportedly, very little product was noted on the pad after a fire was extinguished (Gates et al. 1986). However, due to the nature of the training exercises, the potential for contaminant migration in the subsurface does exist, particularly if the fuel products were not reignited (after the training exercises) to burn the remaining fuel as completely as possible.

During the site assessment, numerous cracks were noted on the asphalt surface. Segments of both the asphalt and soil had an oily appearance (staining). About six extinguished smoke bombs were also found at the site.

#### 4.28.4 Proposed Action

A phased sampling and monitoring program should be conducted to determine if contamination is present at this site. The program should consist of collecting and analyzing soil samples and installing groundwater monitoring wells.

Five soil samples (10 ft in depth) should be collected from beneath the pad by boring through the pad. Samples from the top, middle, and bottom sections will be obtained and analyzed for HSL compounds, TPH, and TC compounds. In addition, four groundwater monitoring wells should be installed; one well should be located upgradient of the site and three downgradient. Although suggested locations are shown in Fig. 4.25, well placement should be based on best field judgment of a qualified hydrogeologist. The monitoring wells should be screened at the water table to detect floating contaminants. After proper well development (USATHAMA 1987), groundwater samples should be collected at each location and analyzed for HSL compounds and TPH.

All significantly contaminated soils and groundwater should be removed or restored in accordance with state and federal requirements. After the cleanup operations, the soil and groundwater should again be sampled and tested to verify the completeness of cleanup. If no evidence of contamination of any media is determined from this investigation, it is recommended that no further action be taken for this site.

## 4.29 SA 32 – DRMO YARD (BLDG. 204)

### 4.29.1 Site History

The DRMO yard (SA 32) is in the northeastern portion of the main cantonment area near the sanitary landfill (SA 5). Its location is shown in Fig. 4.26. Records of operations are available as far back as 1964. Numerous items are stored at the DRMO, including scrap metal, vehicles, batteries, tires, and used office equipment. All items are stored before reuse or resale. No hazardous wastes are received or stored there (Fox 1988a).

Cook Street intersects the two main storage areas. The yard on the west side is fenced on four sides and is about 150 by 600 ft in area. It contains various types of used equipment. The northwest corner of the yard is dedicated to storage of used lead-acid batteries. All battery acid is drained by the generator prior to arrival. Batteries are stacked on pallets, with the top of the battery turned sideways to avoid any accumulation of precipitation. At the time of the site visit, about 750 batteries were being stored in this manner. About 40,000 lb of batteries pass through the DRMO each month. The batteries are accumulated for four to six weeks and sold to DOE (Berry 1988).

The yard on the east side is about 600 by 300 ft in area. A warehouse and offices are also located there. On the west end of the yard, vehicles are cut and disassembled to recover usable parts. This yard contains scrap metal, tires, stored items that are ready for sale, and the accumulation point for used photographic solution. The recovery of scrap precious metals (silver and platinum) from the solution is subcontracted (Berry 1988).

### 4.29.2 Geology and Hydrology

The geology and hydrology of this area are similar to those of the adjacent sanitary landfill (SA 5 – see Sec. 4.5.2).

### 4.29.3 Nature and Extent of Contamination

The west yard is completely paved with asphalt. The perimeter of the yard is lower than the yard and there is a considerable amount of runoff. As much as 2 in. of water may accumulate or run off during a moderate rainfall (Gates et al. 1986). The soil around the yard appeared to be discolored. Personnel from the Environmental Management Office sampled the soil at various locations. The focal point was near the battery storage area. Soil samples were tested for EP toxicity. There were no elevated concentrations of EP toxic metals (Hopkins 1988).

Most of the east yard is also paved with asphalt. However, several small square areas have no asphalt, and the soil is exposed. The reasons for leaving these areas unpaved is not known.

Massachusetts considers used motor oil a hazardous waste. Because of the nature of the operations, it is possible that motor oil and other possibly hazardous wastes may have leaked onto the ground. Contamination due to runoff is also possible.

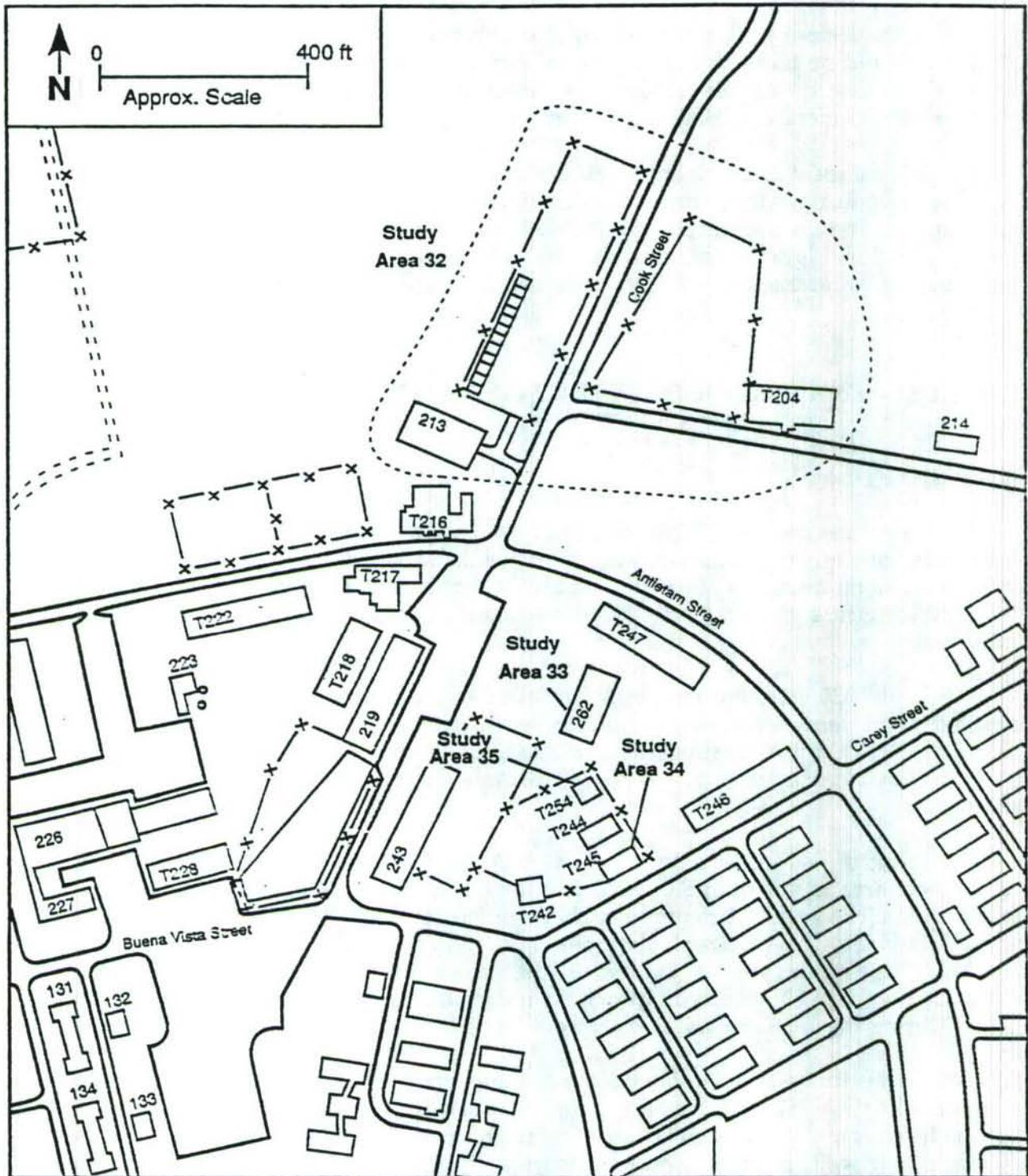


FIGURE 4.26 Locations of SAs 32-35, the DRMO Yard (Bldg. 204), DEH Entomology Shop (Bldg. 262), and Former DEH Entomology Shops (Bldgs. 245 and 254) (Source: Map based on Keene 1967)

#### 4.29.4 Proposed Action

In the eastern yard, a representative number (minimum of three) of surface soil samples (6-12 in.) should be taken from each area of exposed soil. Eight additional samples should be collected from perimeter areas that receive runoff. All soil samples should be analyzed for HSL compounds, TC metals, TPH, and platinum.

If significant contaminant levels are found in the surface samples, soil borings should be drilled to groundwater to determine the extent of contamination. Because of the proximity of the landfill and the probability of mounded groundwater, the source of contamination in this area may be difficult to determine. If the soil borings indicate deeper contamination, monitoring wells should be installed. If no contamination is found, then no further field investigation is recommended.

### 4.30 SA 33 - DEH ENTOMOLOGY SHOP (BLDG. 262)

#### 4.30.1 Site History

Pesticides and herbicides have been used at Fort Devens for general pest control and elimination of vegetation in a 1-ft strip on each side of the base's boundary fences, in hard-to-mow areas along fences, in athletic areas, and at the bases of antenna guy wires (Nicholls et al. 1980). Weeds are removed to slow the spread of possible ground fires and for general appearance.

Table 4.30 identifies the pests controlled and the pesticides used across the site. Four certified pest exterminators use manufacturer-specified concentrations of these pesticides. The certified pest exterminators supervise application of pesticides at the golf course. All golf course personnel are required to draw out only quantities needed to meet short-term needs (five to seven days).

Pesticides are stored in Bldg. 262 (SA 33). The location of this SA in the main cantonment area is shown in Fig. 4.26. It is a metal building with an area of 960 ft<sup>2</sup>, designed to meet USAEHA and EPA requirements. Completed in 1982, it is the newest pesticide storage area (DEH 1985b). On October 1, 1982, pesticides from other DEH storage areas (Bldgs. 245, 254, and 2728) were moved to Bldg. 262, and all pesticide activities were consolidated at this location (McMaster et al. 1982). According to site personnel, all containers are closed when not being used. During the 1988 site visit, labels were affixed and could be easily read.

Drains in the locker rooms of the building are connected to the sanitary sewer system (Gates et al. 1986). These drains are completely blocked off when chemicals are being mixed. Any spills are contained using clay adsorbent. This pesticide shop/storage building is dry, fire-resistant, and well secured by locked doors and fences (Gates et al. 1986). During a 1985 evaluation, pesticides were stored either on the floor or on wooden pallets and were not segregated by type. Gates et al. (1986) noted that pesticides should be stored off the floor to prevent moisture damage to containers and contents, containers should be stored with their labels plainly visible, and aisles should be accessible to permit inspection. The insecticides,

TABLE 4.30 Pesticide Use at Fort Devens in 1977

| Pest             | Pesticide | Form     | Amount    | Technique <sup>a</sup> | Area Treated              | Location <sup>b</sup> |
|------------------|-----------|----------|-----------|------------------------|---------------------------|-----------------------|
| Japanese beetles | Malathion | Emulsion | 560 gal   | SP                     | 4 acres                   | DEW                   |
| Mosquitoes       | Malathion | Emulsion | 7,115 gal | M                      | 282 acres                 | DEW                   |
| Rats             | Warfarin  | Bait     | 130 lb    | B                      | 2,600,000 ft <sup>2</sup> | WHS                   |
| Ticks            | Diazinon  | Emulsion | 400 gal   | SP                     | 4 acres                   | OPG                   |
| Wasps and bees   | Carbaryl  | Emulsion | 447 gal   | ER                     | 40 acres                  | RES                   |
| Weeds            | Bromacil  | Emulsion | 465 gal   | SP                     | 12 acres                  | OPG                   |
|                  | 2,4-D     | Emulsion | —         | SP                     | 10 acres                  | GPC <sup>c</sup>      |
| Ants             | Diazinon  | Emulsion | 189 gal   | R                      | 429,000 ft <sup>2</sup>   | RES                   |
| Cockroaches      | Diazinon  | Emulsion | 268 gal   | R                      | 637,000 ft <sup>2</sup>   | RES                   |
|                  | Diazinon  | Emulsion | 560 gal   | R                      | 336,000 ft <sup>2</sup>   | FHB                   |
|                  | Diazinon  | Emulsion | 72 lb     | R                      | 82,000 ft <sup>2</sup>    | RES                   |
|                  | Diazinon  | Dust     | 14 lb     | R                      | 14,000 ft <sup>2</sup>    | RES                   |
|                  | Diazinon  | Emulsion | 41 gal    | R                      | 104,000 ft <sup>2</sup>   | FHB                   |
|                  | Diazinon  | Dust     | 10 lb     | R                      | 14,000 ft <sup>2</sup>    | FHB                   |
|                  | Pyrethrum | Emulsion | 0.26 gal  | S                      | 40,000 ft <sup>2</sup>    | FHB                   |
| Flies            | Carbaryl  | Emulsion | 447 gal   | SP                     | 4 acres                   | RES                   |
|                  | Malathion | Emulsion | 9,960 gal | SP                     | 12 acres                  | DEW                   |
| Fleas            | Diazinon  | Emulsion | 40 gal    | R                      | 42,000 ft <sup>2</sup>    | RES                   |

<sup>a</sup>Key to control techniques: R = residual application, SP = spraying with power equipment, S = space treatment, D = hand dusting or granule application, B = baiting, M = misting, and ER = residual applications on building exteriors.

<sup>b</sup>Key to treatment locations: RES = residential building, DEW = densely wooded area, FHB = food-handling building, CPC = golf course fairways and greens, WHS = warehouse or storage area, OPG = open grassy areas, and MOS = marsh or swamp.

<sup>c</sup>Records are not kept of other usage at the golf course, although fungicides and weed killers are applied by residual application and spraying with power equipment to control fungi and weeds.

Source: Nicholls et al. 1980.

herbicides, and fungicides were not segregated by either distance or physical barriers, such as wire cages. Fertilizers were observed in the facility. To preclude possible contamination of the fertilizers, they should not be stored with pesticides.

During the 1988 site visit, the following pesticides and herbicides were noted: Tersan 1991 DF (turf fungicide), 26019 FLO fungicide, Turf Green, Oftanol, Daconil 2787 (ornamental fungicide), Acti-Dione TGF, Bayleton (turf and ornamental fungicide), Aqua-Gro S spreadable, Diazinon granular, Dursban Professional Killer, Dursban lawn insecticide, Dursban Termiticide TC, Malathion, Roundup (herbicide), 2 Plus 2, and Weed Rhap LV-4D. In a smaller storage area within this building, roach pots, mothballs, Roach Control Systems, and Max Force Roach Control Systems were stored on steel pallets and shelves, while aerosols were stored in steel cabinets. An area alongside the building was littered with debris (scrap metal, wood, etc.).

The Industrial Hygiene Section of the Preventive Medicine Service (PVNTMED Svc) performed a ventilation reading at Bldg. 262 during the course of the operational review (Gates et al. 1986). To provide adequate ventilation in pesticide storage areas, at least six air changes per hour are required; the reading in the pesticide area indicated the ventilation was adequate (6.4 air changes/hour). However, because this value was only slightly above the requirement, USAEHA recommended that readings be made on a routine basis. The smaller pesticide storage area had no means of ventilation. The pesticide room hood covered the entire length of the workbench surface and sink and provided a face velocity of 74 ft/min. A hood face velocity in the range of 100-150 ft/min. is required, depending on the toxicities and flammabilities of the pesticides and solvents being used. USAEHA also observed that the pest control heating system did not operate using outdoor air only. This resulted in incomplete furnace combustion, causing smoke and possible recirculation of pesticide contaminants throughout the building. At the time of the operational review, insufficient hazard signs were posted both inside and outside of Bldg. 262. USAEHA further noted that the outdoor mixing area at Bldg. 262 was inadequate.

#### 4.30.2 Geology and Hydrology

This site is located on the Quonset-Hinckley-Windsor Association, which consists of droughty sand and gravelly soil underlain by stratified sand and gravel. This area drains well and has a high permeability (Nicholls et al. 1980; McMaster et al. 1982). Typical hydraulic conductivities for this area range from 0.001 to 0.01 cm/s (Satterwhite et al. 1976a).

#### 4.30.3 Nature and Extent of Contamination

Very little documentation exists relating to contamination associated with pesticides at this site. A distinct chlorine smell was noted inside the building during the site 1988 assessment. The exhaust system did not perform efficiently. The USAEHA has previously recommended that ventilation readings of this building be taken periodically (Gates et al. 1986). Scattered debris were observed around the outside of the building.

Gates et al. (1986) have previously recommended that Bldg. 262 be provided with adequate cold weather protective gear, an adequate change room, proper segregation and storage pallets for pesticides, adequate ventilation and mixing hood face velocity, sufficient hazard signs, proper labeling for hand sprayers, and an adequate outdoor pesticide mixing area.

#### 4.30.4 Proposed Action

To determine if the site is contaminated by pesticides, herbicides, or any degradation by-products, a surface soil sampling program should be conducted. Four surface soil (6-12 in.) samples should be collected near the entrance of the building. These samples should be analyzed for pesticides, herbicides, phosphate, and nitrate. If contamination is found, additional soil samples should be collected. If elevated concentrations of pesticides or herbicides are found, samples should be analyzed for TC compounds. If necessary, soil borings should be drilled to determine the depth of contamination, and groundwater monitoring wells should be installed in contaminated areas. All soil and water samples should be analyzed for parameters with elevated concentrations.

All significantly contaminated soils and groundwater should be removed or restored in accordance with state and federal requirements. After the cleanup, the soil should again be sampled and tested to verify the completeness of cleanup. If no evidence of any soil or groundwater contamination is determined from these investigations, it is recommended that no further action be taken at this site.

In addition, the building's ventilation system should be checked by a ventilation expert to ensure that it is performing adequately, and stored materials should be properly segregated.

#### 4.31 SA 34 – FORMER DEH ENTOMOLOGY SHOP AT BUILDING 245

##### 4.31.1 Site History

As described in Sec. 4.30.1, pesticides were formerly stored and mixed in Bldg. 245 (SA 34) in the main cantonment area (Fig. 4.26). This building, which has an area of 1,825 ft<sup>2</sup>, was used for pesticide storage and control during the period 1978-1982 (DEH 1985b). The facility, which was used to store pesticides such as Diazanone, Baygone, Dursban, boric acid, and Pyrethrum, did not meet EPA guidelines (McMaster et al. 1982; 40 CFR Part 165). Although pesticides are no longer handled within this building, it is still under Entomology control (DEH 1985b). The building is currently used to store cleaning solutions.

##### 4.31.2 Geology and Hydrology

Because of the site's proximity to Bldg. 262 (SA 33), the geology and hydrology discussion in Sec. 4.30.2 also applies to this SA.

##### 4.31.3 Nature and Extent of Contamination

Although the dates of releases are unknown, the facility had a history of small rinse-water discharges and small spills into the sanitary sewer system (DEH 1985b). During the site assessment it was noted that the drain pipe from the sink exits to the ground immediately outside of the building; it is not known when the sink's drain was disconnected from the sanitary sewer. The sink drain discharge area is not bermed. Scattered debris were observed around the outside of the building.

#### 4.31.4 Proposed Action

A surface soil sampling program should be conducted to determine if soil or groundwater is contaminated at this site. Four surface soil (6-12 in.) samples should be collected from the areas used to prepare pesticide and herbicide solutions, and the samples should be analyzed for pesticides, herbicides, phosphate, and nitrate. Three additional samples collected from the sink discharge outside the building should be analyzed for the same parameters. Because of the concern for possible contamination from the drain pipe, samples at this location should be collected at depths of 0, 2, 4, and 6 ft and analyzed for pesticides and herbicides. If elevated concentrations of pesticides or herbicides are found, soil samples should be analyzed for TC compounds.

If contamination is found, additional soil samples should be collected. If necessary, groundwater monitoring wells should be installed in contaminated areas. All samples should be analyzed for contaminants with elevated concentrations.

All significantly contaminated soil and groundwater should be removed or restored in accordance with state and federal requirements. After the cleanup, the soils should again be sampled and tested to verify the completeness of cleanup. If no evidence of any soil or groundwater contamination is detected in these investigations, no further action should be taken for this site.

### 4.32 SA 35 -- FORMER DEH ENTOMOLOGY SHOP AT BUILDING 254

#### 4.32.1 Site History

Building 254 (SA 35) is located in the main cantonment area (Fig. 4.26). It has an area of 740 ft<sup>2</sup> and was used for pesticide storage and mixing during the period 1978-1982 (DEH 1985b). The inventory included pesticides such as Malathion, Diuron, VG Trol, and Weeder; the building did not meet EPA guidelines (McMaster et al. 1982; 40 CFR Part 165). Although pesticides are no longer handled within this building, it is still under Entomology control (DEH 1985b). It is now used to store some types of equipment and dry cleaning solvents.

#### 4.32.2 Geology and Hydrology

Because the site is close to Bldg. 262, the geology and hydrology discussion in Sec. 4.30.2 applies here as well.

#### 4.32.3 Nature and Extent of Contamination

Although the dates of releases are unknown, the facility had a history of small rinse-water discharges and small spills into the sanitary sewer system (DEH 1985b). Numerous pipes, wood pallets, and other miscellaneous debris, which hindered inspection for contaminated soil, were located behind the building. Inside the facility, two large bags of fertilizer (about 50 lb each) were ruptured and their contents were spilling out onto the floor.

#### 4.32.4 Proposed Action

Although this site has not been used for storage or mixing of pesticides and herbicides for more than nine years, a soil sampling program should be conducted to characterize the site and determine if contamination exists. Four surface soil (6-12 in.) samples should be collected from the areas used to prepare pesticide and herbicide solutions and analyzed for pesticides, herbicides, phosphate, and nitrate. If elevated concentrations of pesticides or herbicides are found, samples should be analyzed for TC compounds. If contamination is found, additional soil samples should be collected. All samples should be analyzed for contaminants with elevated concentrations in the initial testing.

All significantly contaminated soil should be removed in accordance with state and federal requirements. After the cleanup, the soil should again be sampled and tested to verify the completeness of cleanup. If no evidence of any soil or groundwater contamination is determined from these investigations, it is recommended that no further action be taken for this site.

### 4.33 SA 36 – FORMER DEH ENTOMOLOGY SHOP AT BLDG. 2728

#### 4.33.1 Site History

As described in Sec. 4.30.1, pesticides were formerly stored and mixed in Bldg. 2728 (SA 36) in the main cantonment area (Fig. 4.27). This building, which has an area of 3,219 ft<sup>2</sup>, was used for pesticide storage during the period 1968-1978 (DEH 1985b). Pesticides and herbicides stored in Bldg. 2728 included Diazanone, Baygone, Dursban, boric acid, Pyrethrum, Malathion, Diuron, VG Trol, and Weeder (McMaster et al. 1982).

#### 4.33.2 Geology and Hydrology

This site is located on the Quonset-Hinckley-Windsor Association, which consists of droughty sand and gravelly soil underlain by stratified sand and gravel. This area drains well and has a high permeability (Nicholls et al. 1980; McMaster et al. 1982). Typical hydraulic conductivities are in the range of 0.001-0.01 cm/s (Satterwhite et al. 1976a).

Building 2728 is now used by the Fort Devens Directorate of Personnel and Community Activities, Administrative and Marketing Services Division. The activities of this organization include designing and printing plans and storing small quantities of supplies.

#### 4.33.3 Nature and Extent of Contamination

Although dates of releases from the former storage and mixing activities are unknown, the facility had a history of small rinse water discharges and small spills into the sanitary sewer system (DEH 1985b). Because soil in the area is highly permeable, groundwater contamination with pesticides and herbicides is possible if sufficient quantities were released.

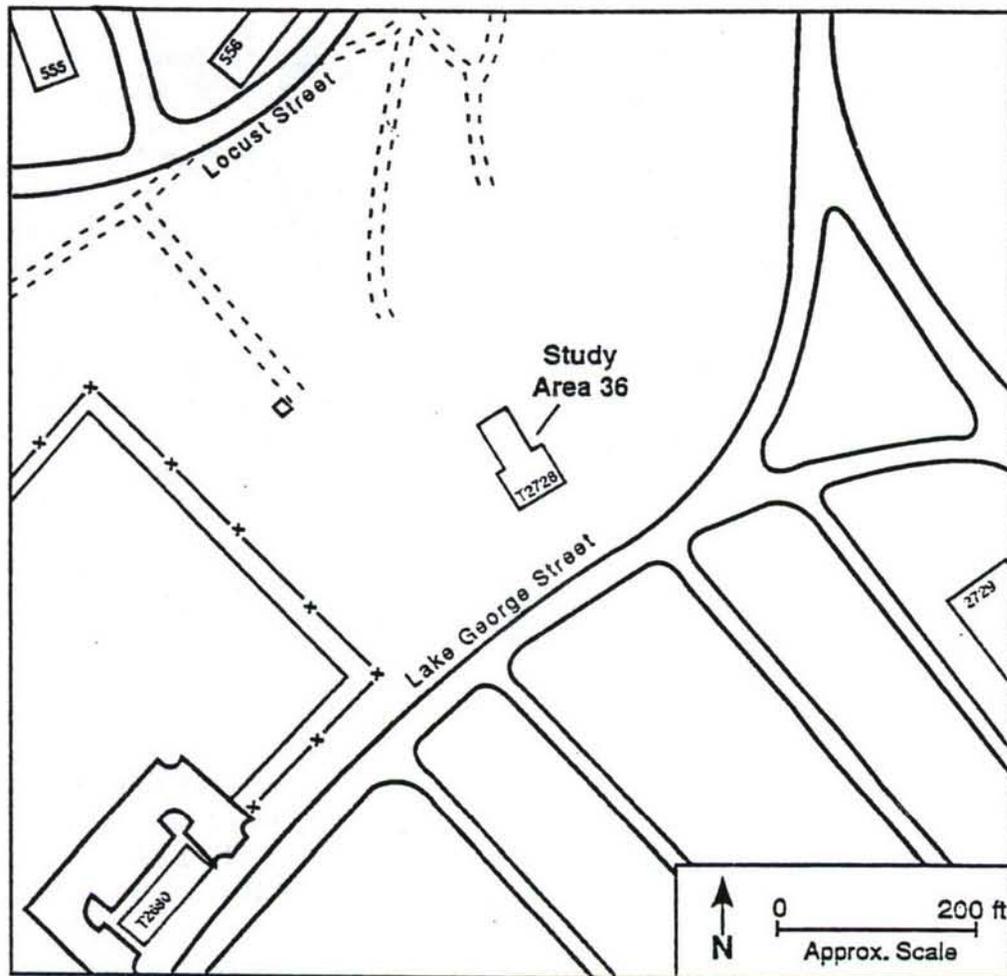


FIGURE 4.27 Location of SA 36, the Former DEH Entomology Shop at Building 2728 (Source: Map based on Keene 1967)

#### 4.33.4 Proposed Action

Although Bldg. 2728 has not been used for storage or mixing of pesticides and herbicides for more than 13 years, a soil sampling program should be conducted to characterize the site and determine if any contamination exists. Eight surface soil (6-12 in.) samples should be collected from areas used to prepare pesticide and herbicide solutions and analyzed for pesticides, herbicides, TPH, nitrate, and phosphate. If elevated concentrations of pesticides or herbicides are found, soil samples should be analyzed for TC compounds.

If contamination is found, additional soil samples should be collected. If necessary, groundwater monitoring wells should be installed in contaminated areas. All samples should be analyzed for parameters with elevated concentrations.

All significantly contaminated soil and groundwater should be removed or restored in accordance with state and federal requirements. After the cleanup, the soil should again be sampled and tested to verify the completeness of cleanup. If no evidence of any soil or

groundwater contamination is determined from these investigations, it is recommended that no further action be taken for this site.

#### 4.34 SA 37 – GOLF COURSE ENTOMOLOGY SHOP (BLDG. 3622)

##### 4.34.1 Site History

Pesticides were stored and mixed in Bldg. 3622 (SA 37) until 1987. It is on the golf course in the main cantonment area. The location of this site is shown in Fig. 4.28. This building, which has an area of 1,386 ft<sup>2</sup>, was used for pesticide storage and mixing between 1976 and 1987. Pesticides and fungicides such as Dursban, TGF, Daconil, and Antidrone Thinner Plus F were stored at this site. It is of wood-frame construction, and the storage room is secured with a padlock. A 1985 assessment by the USAEHA (Gates et al. 1986) noted many inadequacies related to the building's current use. Building 3622 was found to lack fire-resistance, warning signs, ventilation, spill containment measures, and other provisions to prevent environmental

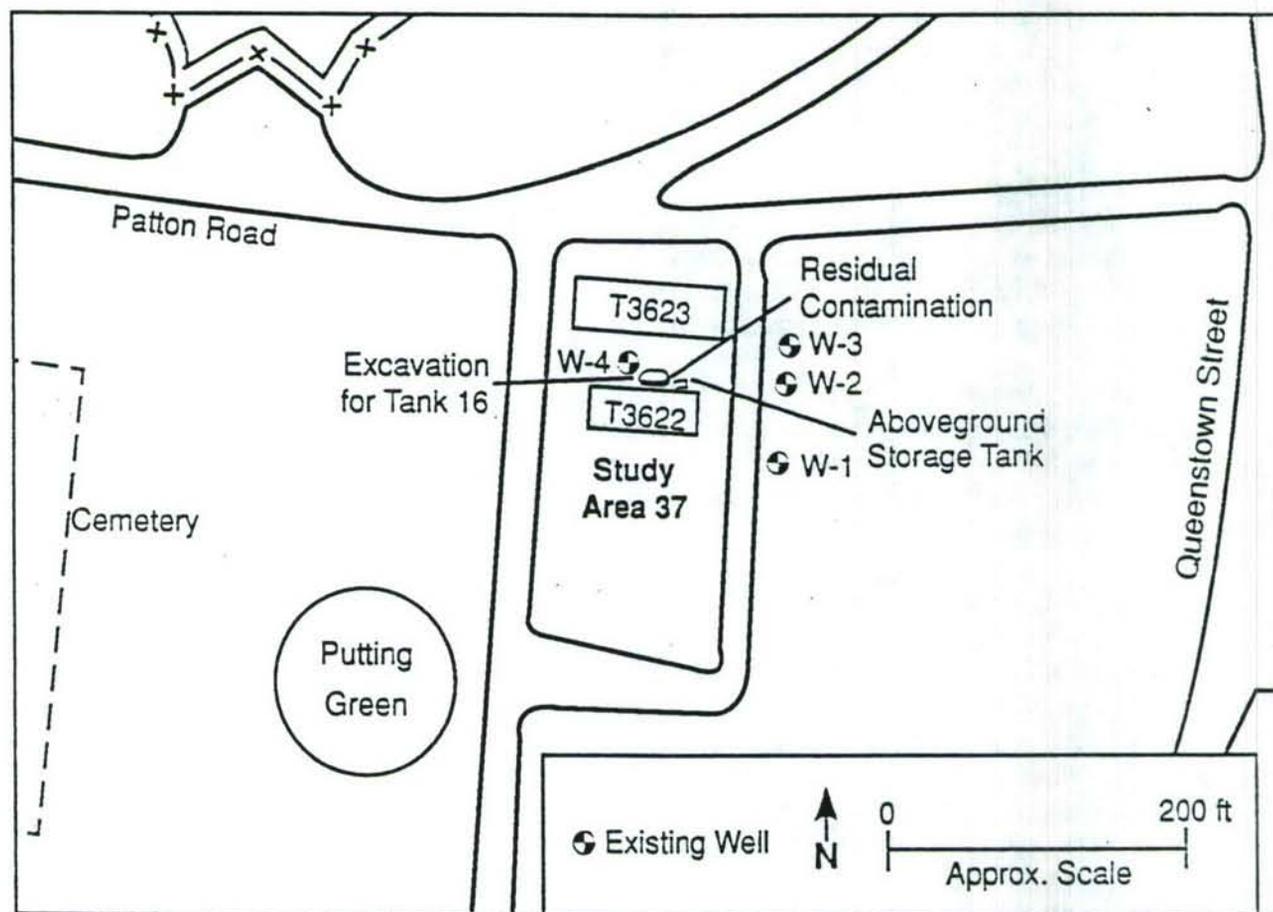


FIGURE 4.28 Location of SA 37, the Golf Course Entomology Shop at Building 3622 (Sources: Map based on Keene 1967; well locations from Prior 1991)

contamination. During another assessment, DEH (1985b) reported an odor attributed to Dursban. In general, the pesticide storage area in Bldg. 3622 does not meet EPA guidelines for such facilities (McMaster et al. 1982; 40 CFR Part 165).

#### 4.34.2 Geology and Hydrology

This site is located on the Quonset-Hinckley-Windsor Association, which consists of droughty sand and gravelly soil underlain by stratified sand and gravel. This area drains well and has a high permeability (Nicholls et al. 1980; McMaster et al. 1982). Typical hydraulic conductivities for this area range from 0.001 to 0.01 cm/s (Satterwhite et al. 1976a).

#### 4.34.3 Nature and Extent of Contamination

Although the dates of releases are unknown, the facility may have a history of small rinse water discharges and small spills into the sanitary sewer system. The building had no exhaust system and was very poorly lit. There was evidence of soil contamination in the rear of the building, possibly from fuel (Brooks 1988). Many fertilizer bags were on wooden pallets; it was estimated that about 150 50-lb bags of N:P:K type 22:0:16 fertilizer were present. Some of the bags had seriously deteriorated, spilling their contents onto the floor. The floor was wood and tile, but without any berms or containment. Several old, rusty paint cans were in the rear of the building. Old machinery (lawnmowers, spreaders, etc.) was also present. These were scheduled for shipment to DRMO (Brooks 1988). The soil around these pieces of equipment had visible staining.

One 1,000-gal underground storage tank was removed from this site. The tank was last used to store fuel for the building heating system. The integrity of the tank was questioned because product was visible on the ground surface near the fill pipe. When the tank was removed it was found to be structurally sound; therefore, the visible product was probably the result of over-filling the tank, or loose piping.

About 30 yd<sup>3</sup> of contaminated soil was removed. It was clear that there was further contamination, but it was not removed because further excavation might have endangered the structural integrity of the building foundation. Soil samples obtained during the installation of four monitoring wells contained some volatile organic compounds.

#### 4.34.4 Proposed Action

A soil sampling program should be conducted to define the extent of contamination at this site. Six surface (6-12 in.) soil samples should be collected at equal intervals around the perimeter of the building. The samples should be analyzed for VOCs, nitrate, TPH, phosphate, pesticides, and herbicides. If contamination is found, additional soil samples should be collected, and, if necessary, additional groundwater monitoring wells should be installed. All samples should be analyzed for parameters with elevated concentrations.

All significantly contaminated soil and groundwater should be removed in accordance with state and federal requirements. After the removal, the soil should be resampled and tested to verify the completeness of cleanup. Monitoring wells should be sampled quarterly for TPH,

pesticides, herbicides, and volatile organics. If no evidence of soil or groundwater contamination is determined from these investigations, it is recommended that no further action be taken for this site. If organic contaminants are detected, remedial action should be taken.

#### **4.35 SA 38 – BATTERY REPAIR AREA (BLDG. 3713)**

##### **4.35.1 Site History**

One of the DIO Maintenance Division industrial operations conducted in Bldg. 3713 is battery repair, which generates about 106 gal of waste battery acid each month (Brown 1981; McMaster et al. 1982). Building 3713 is located in the northeast corner of Fort Devens along Barnum Road (Fig. 4.29). Waste acid currently is stored in federally approved containers and later taken to the DEH hazardous waste storage area.

Before 1978, waste electrolyte was placed in a pit northwest of Bldg. 3713 and neutralized with sodium bicarbonate. It was reported that the pit was covered and paved over in 1981 (McMaster et al. 1982). From 1978 to August 1980, the waste battery acid was neutralized in a large tank and discharged to the sewer system (Brown 1981; McMaster et al. 1982). This discharge was discontinued in 1980, when a chemical analysis indicated that the waste contained cadmium in excess of the limits for EP toxicity.

##### **4.35.2 Geology and Hydrology**

Geologic conditions of the site consist of unconsolidated glacial deposits overlying metamorphic and granitic bedrock of Paleozoic age. The soil association at the site is the Quonset-Hinckley-Windsor, described as droughty sand and gravelly soil underlain by stratified sand and gravel (Nicholls et al. 1980). The soil is well drained and has high permeability.

The hydrogeology at this location has been mapped as an area of good groundwater availability.

Building 3713 is about 1,400 ft west of Cold Spring Brook and about 2,200 ft south of Grove Pond. The Grove Pond well field is located along the bank of Grove Pond, north of the site. Specific hydrogeological information is lacking for this site.

##### **4.35.3 Nature and Extent of Contamination**

There have been no previous investigations at this site. Any soil or water contamination from the battery repair operations would be associated with the former waste electrolyte pit east of Bldg. 3713. While the potential for contamination around the old waste pit does exist, there have been no reports of contaminated surface soil or water around the site. This pit has not received any waste battery electrolyte in more than 13 years.

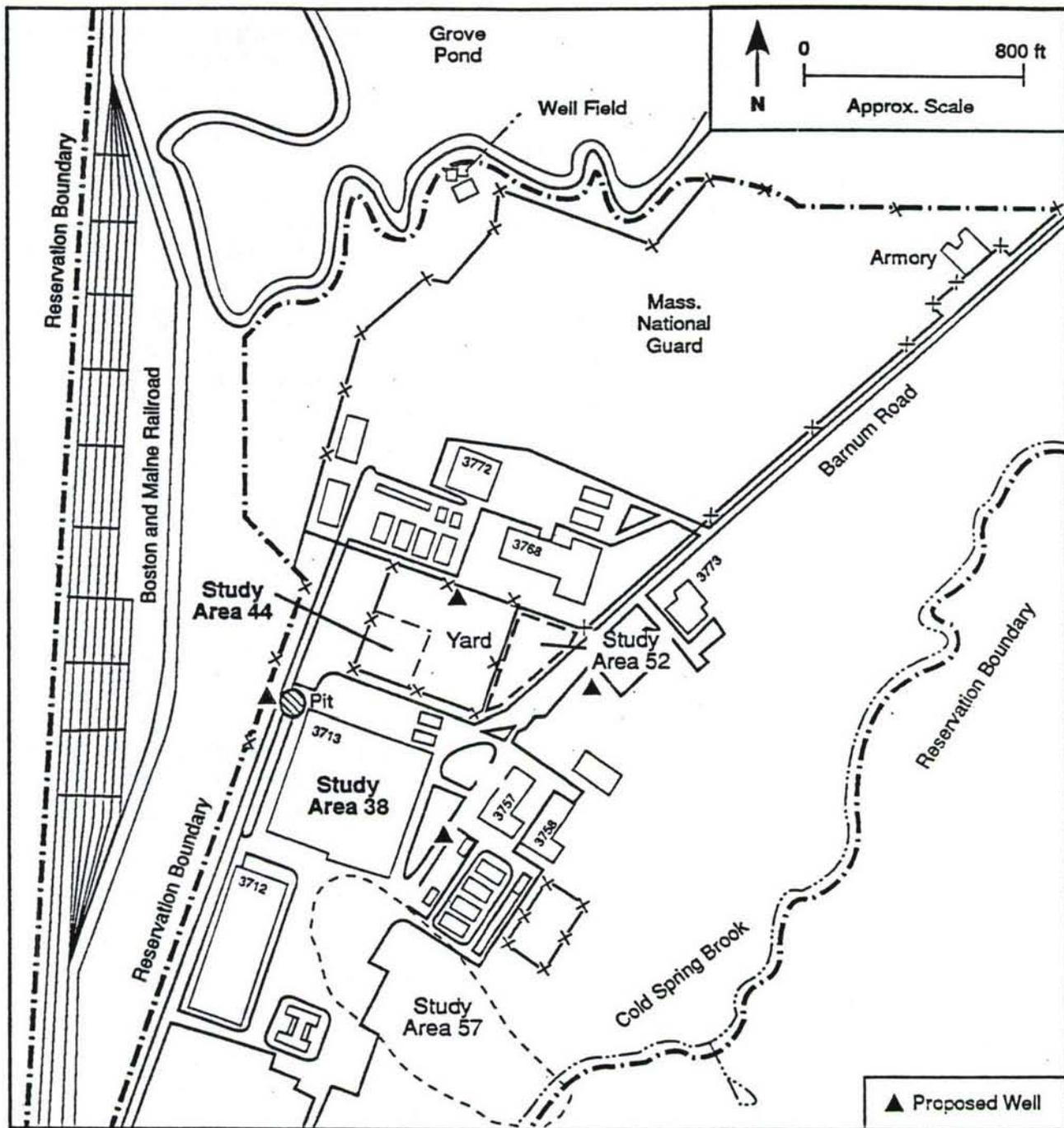


FIGURE 4.29 Location of SAs 38 and 44, the Battery Repair Area and Cannibalization Yard at Building 3713 (Source: Map based on Cameron and Footit undated)

#### 4.35.4 Proposed Action

Even though no water or soil contamination has been reported, the site should be thoroughly investigated because of its proximity to Cold Spring Brook and the Grove Pond well field.

Four groundwater monitoring wells should be installed. One well should be placed upgradient of the site, and three should be placed downgradient (see Fig. 4.29 for suggested locations). Groundwater from the wells should be analyzed for HSL compounds. Three surface water and sediment samples should be collected from Cold Spring Brook. The samples should be collected at the upper end of the site, in the middle of the site, and at the lower end of the site. The water and sediment samples should be analyzed for HSL compounds. The sediment samples should also be evaluated for grain size and analyzed for TOC. If contamination is found, remedial action should be taken at the site, in accordance with state and federal requirements, to prevent further contamination.

#### 4.36 SA 39 – TRANSFORMER NEAR BUILDING 4250

##### 4.36.1 Site History

The locations of two buildings (Nos. 4249 and 4250), formerly referred to as the old Sylvania buildings, are within the Oxbow National Wildlife Refuge, which was formerly part of the south post (Fig. 4.30). The refuge was deeded by Fort Devens to the U.S. Department of Interior in 1973 (McMaster et al. 1982). The study area was not accessible at the time of the site visit. According to available information, a spill area was discovered near Bldg. 4250 in September 1984. The oil stain, which was adjacent to a transformer (found empty), had an estimated area of 288 ft<sup>2</sup> (DEH 1985a).

##### 4.36.2 Geology and Hydrology

The entire refuge is within the Nashua River drainage basin. In general, this area consists of glacial till comprising poorly sorted clay, silt, sand, gravel, and boulders. The bedrock composition ranges from metasediments to granodiorite.

Site-specific information regarding soils is limited; however, since the refuge is classified as a wetland, the moderately to poorly drained soil associations known to exist in this part of the base are the Muck-Peat-Walpole and the Winooski-Limerick-Saco. The Muck-Peat-Walpole is organic and sandy, is poorly drained, and has low permeability. The Winooski-Limerick-Saco consists of silty soil that ranges from moderately well drained to poorly drained with low permeability. The water table is high and may be subject to seasonal flooding (McMaster et al. 1982).

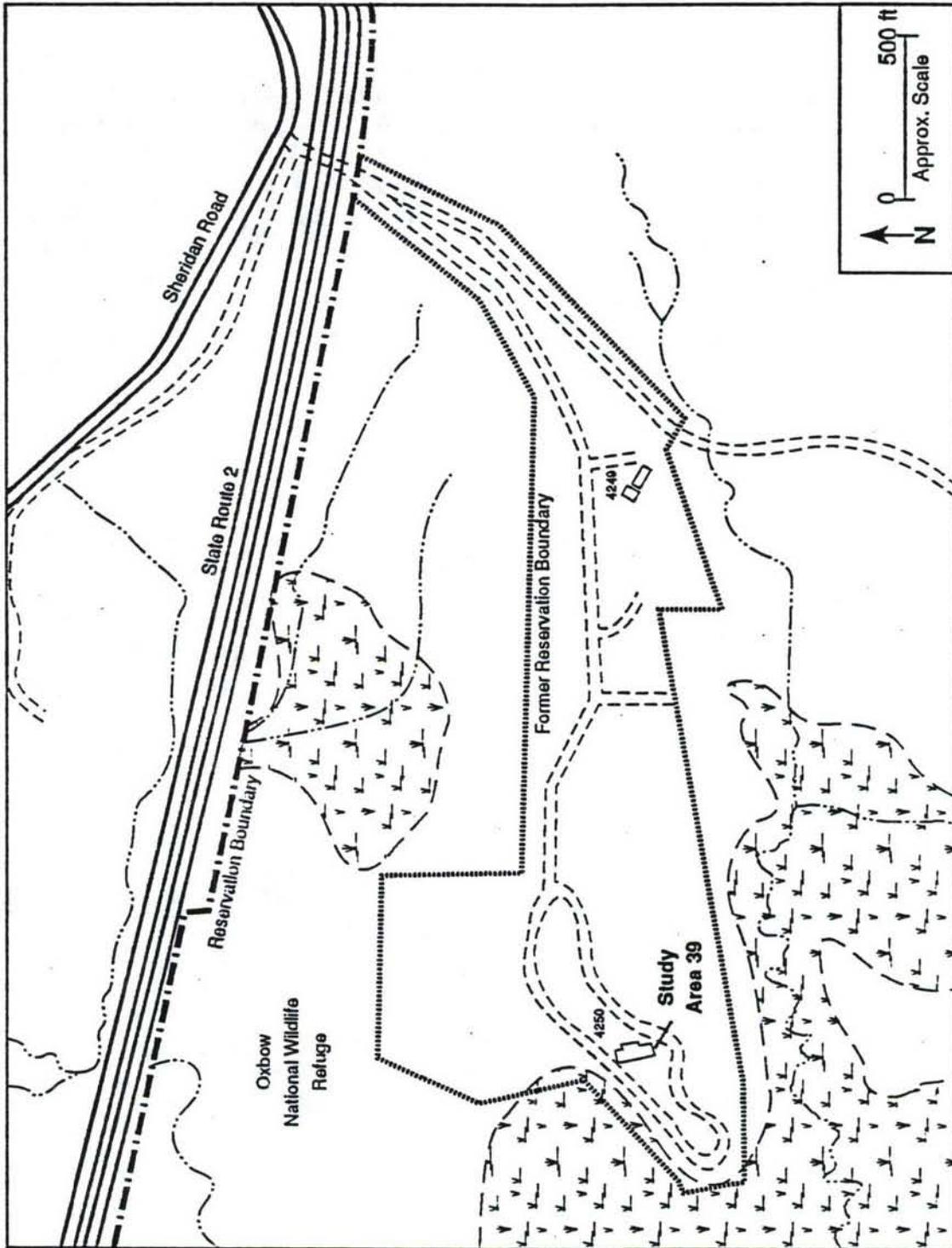


FIGURE 4.30 Location of SA 39 at the Old Sylvania Buildings (Source: Map based on USACE: 1988)

### 4.36.3 Nature and Extent of Contamination

The 1984 oil spill area was divided into four quadrants as follows:

- Quadrant I – visibly stained area
- Quadrant II – transformer and concrete slab
- Quadrants III and IV – areas believed to be contaminated with oil leaked from the transformer (DEH 1985a).

The locations of these quadrants are shown in Fig. 4.31.

A spill report documents the cleanup action taken for the transformer and the stained soil. After the spill was discovered in September 1984, samples were taken from each of the quadrants during October and November 1984. The sample results are given in Table 4.31. Relative locations (as they appear in the report) show the depth of contamination.

During December 1984, eight 35-gal drums of PCB-contaminated soil (50 ppm or above) and the transformer were removed and taken to the hazardous waste storage area. In January 1985, confirmation samples were taken (DEH 1985a). The analytic results are shown in Table 4.32.

### 4.36.4 Proposed Action

In April 1987, the EPA adopted spill requirements under the TSCA for cleanup of all spills that occur after that date. The level of required cleanup of any spill before April 1987 is subject to approval by EPA Region 1. The original sample results detected concentrations above 50 ppm only in quadrant I, considered the obvious leak site. Following the soil removal, all of

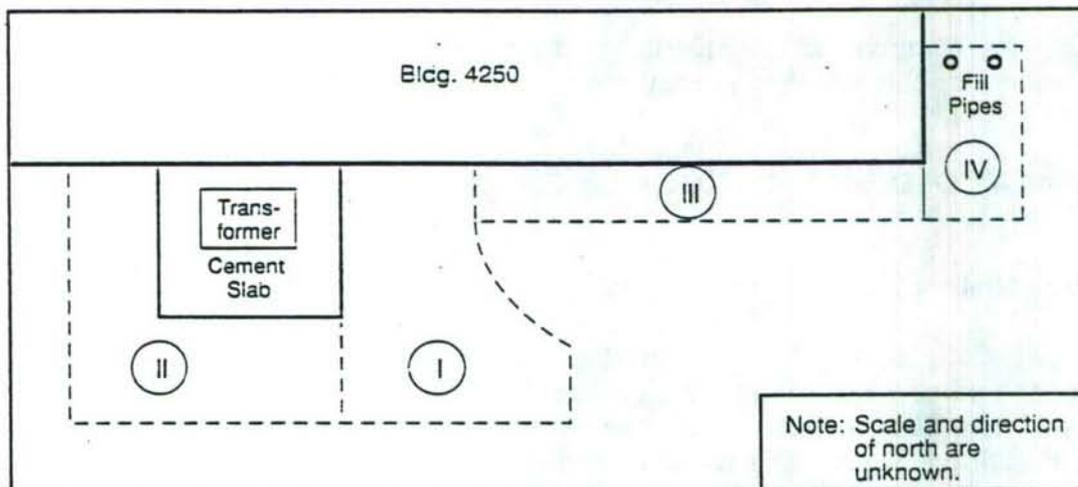


FIGURE 4.31 Sampling Quadrants for the Oil Spill at Building 4250 (Source: Adapted from DEH 1985a)

TABLE 4.31 Sample Results from the Oil Spill at Building 4250

| Quadrant Sampled <sup>a</sup> | Date     | Location                                    | Depth (in.) | PCB Concentration (ppm) |
|-------------------------------|----------|---|-------------|-------------------------|
| I                             | 9/26/84  | 10 ft from building, 4 ft from concrete pad | 1           | 60                      |
| I                             | 11/09/84 | 10 ft from building, 4 ft from concrete pad | 4           | 11                      |
| I                             | 11/09/84 | 10 ft from building, 4 ft from concrete pad | 12          | 5.2                     |
| II                            | 12/13/84 | Concrete pad                                | 1           | 5.3                     |
| III                           | 12/13/84 | 8 ft from right front of building           | 1-2         | 7.5                     |
| IV                            | 12/13/84 | Next to oil fill pipes                      | 1-2         | 14.3                    |

<sup>a</sup>See Fig. 4.31 for locations of sampling quadrants.

Source: DEH 1985a.

TABLE 4.32 Confirmation Sample Results for Quadrant I (December 1984)

| Location                                    | Depth (in.) | PCB Concentration (ppm) |
|---|-------------|-------------------------|
| 10 ft from building, 4 ft from concrete pad | 2           | 20                      |
| 16 ft from building, 4 ft from concrete pad | 2           | 15                      |
| 20 ft from building, 4 ft from concrete pad | 2           | 20                      |
| 10 ft from building, 4 ft from concrete pad | 6           | 20                      |

Source: DEH 1985a.

the PCB concentrations in all quadrant I samples were below 50 ppm. Further action recommended for this site is to present the results to MDEP for approval.

#### 4.37 SA 40 – COLD SPRING BROOK LANDFILL

##### 4.37.1 Site History

The Cold Spring Brook landfill (SA 40) is in the southeastern part of the main cantonment area near the Shoppette on Patton Road (Fig. 4.32). It is considered an abandoned landfill and was discovered in November 1987, when fourteen 55-gal drums were uncovered along Cold Spring Brook. The waste extended about 850 ft along the edge of the brook and involved an area of 10-20 acres. Wastes included concrete slabs, wire, tanks, rebar, timber, and

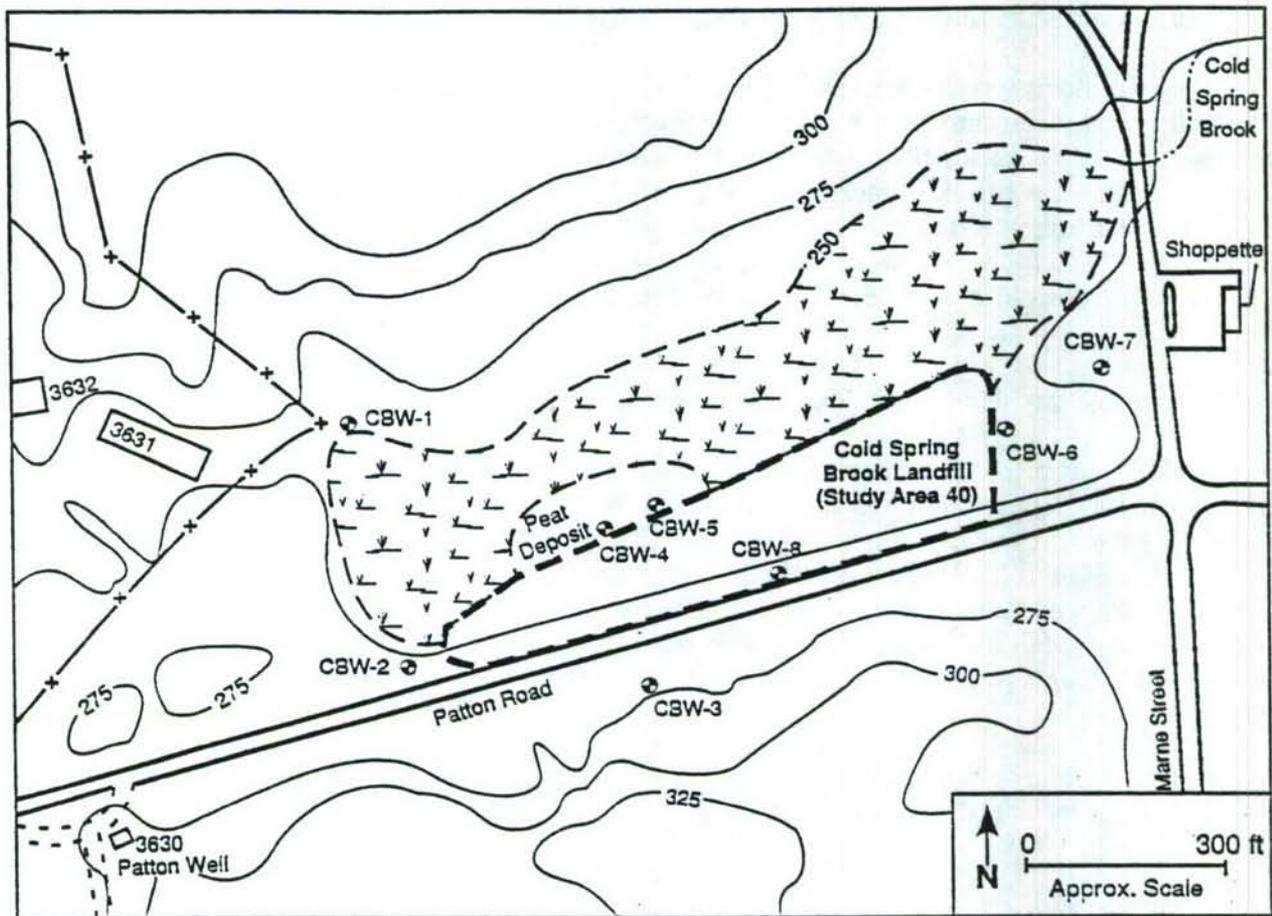


FIGURE 4.32 Location of SA 40, the Cold Spring Brook Landfill (Source: Adapted from Fox 1988b)

debris found at depths of between 10 and 25 ft (Hopkins 1988). It is possible that the area was filled to raise the surface elevation near Patton Road. It is not known if the drums were placed in the landfill when it was first excavated or at a later date.

An identification number on the drums indicated that the original contents had been antifreeze manufactured by Union Carbide and that they were 15-20 years old. Apparently, the drums had been painted yellow and reused (Hopkins 1988). In March 1988, the drums were examined by a response team from Union Carbide, New Hampshire.

#### 4.37.2 Geology and Hydrology

The USAEHA completed a hydrological investigation of SA 40 in 1988. Locations of the eight wells installed by USAEHA are shown in Fig. 4.32. The investigation showed that the landfill is located over glacial sand and gravel deposits in, or adjacent to, a former wetland. USGS information indicates that the area is underlain by swampy deposits of muck and peat with adjacent units of sand and gravel from kame deposits. With the exception of two borings, coarse or medium to fine grained sand interspersed by fine to coarse gravel was the primary

subsurface material. Two borings (CBW-4 and CBW-5) adjacent to a peat deposit contained organic matter with the silt and sand or clay (Fox 1988b).

Monitoring wells were installed in each of the boreholes to determine groundwater flow in the upper aquifer and to monitor groundwater quality. Flow in the this area is influenced by the brook and by seasonal variations in the water table. Initial water level measurements have indicated that the brook is recharging the aquifer. Monitoring well CBW-5 was destroyed in 1991. More information should be provided by continued water level measurements (Fox 1988b).

A production well, the Patton well, is located about 900 ft southwest of the site (see Sec. 2.4.2).

#### 4.37.3 Nature and Extent of Contamination

The landfill site was sampled on three different occasions in 1988 (March 25, April 12, and April 19). The results are summarized below (Fox 1988b).

On March 25, 1988, surface water samples were taken from the brook in the drum area. Three of the contaminants found in the samples were HSL pollutants, and concentrations exceeded the MCLs (Table 4.33). Of these pollutants, bromoform, 1,2-dichloroethane, and 1,1,2,2-tetrachloroethane are carcinogens (Fox 1988b).

TABLE 4.33 Analytic Results for Samples from the Drum Area at SA 40

| Parameter                              | Maximum Concentration (mg/L) | MCL (mg/L) |
|--|------------------------------|------------|
| Barium                                 | 0.046                        | -          |
| Total organic carbon                   | 13.6                         | -          |
| trans-1,3-Dichloropropene <sup>a</sup> | 6.10                         | -          |
| 1,1,1-Trichloroethane                  | 18.4                         | 0.20       |
| Bromoform                              | 32,300                       | 0.10       |
| 1,2-Dichloroethane                     | 7.2                          | 0.005      |
| 1,1,2,2-Tetrachloroethane              | 14.0                         | -          |

<sup>a</sup>Because of a typographical error in the source, the identity of the compound is in doubt.

Source: Fox 1988b.

During an inspection of the site on April 12, 1988, a submerged drum was noticed. Four surface water samples and five sediment samples were taken and analyzed for metals. Results for the water samples showed elevated levels of selenium (0.130-0.177 mg/L), silver (0.010-1.320 mg/L), and arsenic (0.16-0.18 mg/L). The MCLs for these metals are 0.01 mg/L, 0.05 mg/L, and 0.05 mg/L, respectively (Fox 1988b). Barium in sediment samples ranged from 0.018 to 0.123 mg/L. The following compounds were each detected only once: arsenic (0.18 mg/L), cadmium (0.02 mg/L), chromium (0.02 mg/L), selenium (0.13 mg/L), and silver (1.32 mg/L). No soil samples were taken.

On April 19, 1988, three surface water and sediment samples, one groundwater sample from Patton well, and seven soil samples were collected and analyzed for volatile organics by EPA Method 601. Locations of the samples cannot be determined from available information. None of the water samples showed elevated concentrations of contaminants. Two sediment samples contained detectable levels of 1,1-dichloroethene (3.3 and 1.7 mg/L), (Fox 1988b). Although there is no enforceable standard for this compound in soil, the MCL is 0.007 mg/L. Methylene chloride was found in one sample at 8.3 mg/L. Soil samples contained no detectable compounds.

In spring 1988, the eight monitoring wells were sampled for HSL pollutants, RCRA metals, pesticides, PCBs, and herbicides. Results are reported as follows (Fox 1988b):

- One volatile organic compound (trichlorofluoromethane) was detected at 8 mg/L. All other volatiles were below detection limits.
- Well CBW-3 contained 40 µg/L of bis(2-ethylhexyl)phthalate. All other HSL pollutants were below detection limits.
- Two samples contained arsenic above the Primary Drinking Water Standards (0.05 mg/L). Wells CBW-4 and CBW-5 contained 0.94 mg/L and 0.24 mg/L, respectively. All other metal concentrations were below Primary Drinking Water Standards.

Two possible sources of arsenic are natural accumulation in the organic matter and pesticides that may have been used at the landfill area (Fox 1988a).

#### 4.37.4 Proposed Action

Because elevated levels of volatiles and metals were detected in the sampling discussed above, an RI/FS should be conducted for this area. It should include sampling of the surface water, sediment, soil, and groundwater. About ten surface water and sediment samples should be collected along the fill area on the brook side and analyzed for HSL compounds, explosives, and TPH. Sediment samples should be evaluated for grain size and analyzed for TOC. About ten soil borings should be drilled and sampled at depths of 0.5-1.0, 2.5-3.0, and 4.5-5.0 ft. The samples should also be analyzed for HSL compounds, explosives, and TPH.

Samples from the seven existing monitoring wells should be collected and analyzed for HSL compounds, explosives, and TPH. Water levels in all wells should be measured quarterly to determine the groundwater flow direction and gradient. Quarterly measurements should

continue until the area can be sufficiently characterized and any potential impact to water supply wells in the area identified. The flow direction or analytic results may indicate the need for additional monitoring wells.

#### **4.38 SA 41 – UNAUTHORIZED DUMPING AREA (SITE A)**

##### **4.38.1 Site History**

An old unauthorized landfill or dump (SA 41) was found in the south post area by Fort Devens personnel. The 1-acre site is completely overgrown with trees and vegetation, and no records are available detailing when the site was used or what material was placed in it. From the appearance of the rubbish, it appears that the site was used up to the 1950s for disposal of nonexplosive military and household debris.

The site consists of debris scattered over a hill slope about 10 ft high. It is located between Harvard Road and new Cranberry Pond in the south post (Fig. 4.33). The location of the site relative to surface water is shown in Fig. 4.33.

##### **4.38.2 Geology and Hydrology**

Like most of the other study areas in the south post, the geological and hydrological conditions of the site have not been mapped. In general, geological conditions in the area consist of glacial outwash deposits overlying metamorphic and granitic bedrock of Paleozoic age. The soils at the site are probably of the Quonset-Hinckley-Windsor Association (Nicholls et al. 1980).

Hydrogeological conditions at this location have been mapped as a minor aquifer consisting of thin sections of glacial outwash and glacial lacustrine deposits. The saturated thickness is less than 20 ft in this area (Goldberg-Zoino & Associates 1976). A small wetland is just south of the site. Although site-specific hydrogeological information is lacking, it is assumed that any groundwater in this area would flow southeast toward and into Cranberry Pond and the Nashua River.

##### **4.38.3 Nature and Extent of Contamination**

No records are available concerning the nature of the material disposed of at this site; therefore, the nature and extent of any soil or groundwater contamination in this area are unknown. No contamination is apparent other than broken glass and rusty metal objects lying on the surface. Some of the cans looked like brake fluid cans. The site is now overgrown with vegetation.

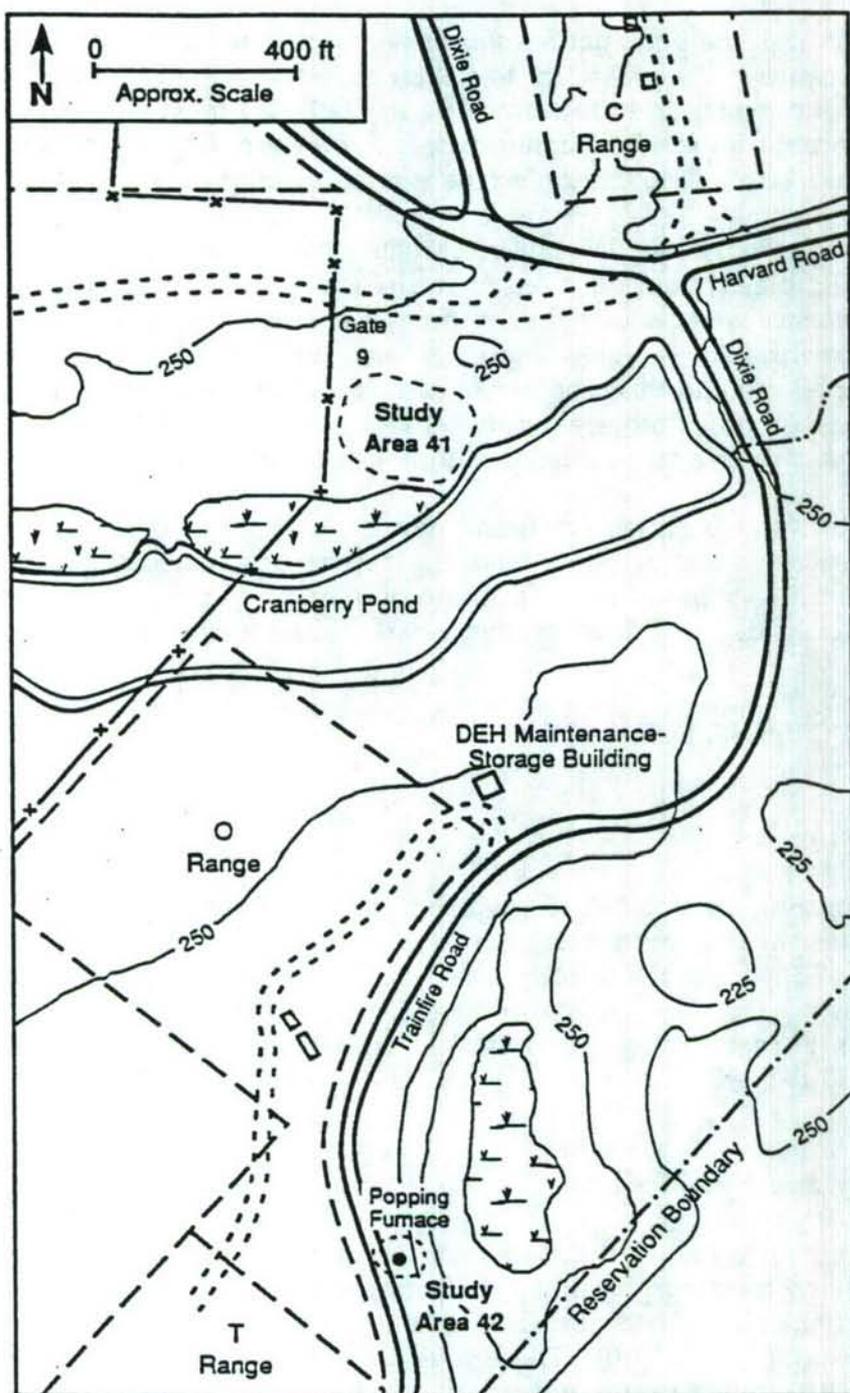


FIGURE 4.33 Location of SAs 41 and 42, the Unauthorized Dumping Area and Popping Furnace (Source: Map based on USACE 1988)

#### 4.38.4 Proposed Action

Even though the potential for soil or water contamination is small, the site should be investigated because of its proximity to the small wetlands and the hydrological connection between the groundwater and the surface water. Soil, sediment, and surface water should be sampled to determine if the site is contaminated. Before sampling is conducted, a reconnaissance of the site should be made to determine the extent of dumping.

After the extent of the landfill is estimated, nine 10-ft soil borings should be drilled in the fill area. Samples should be taken from the top, middle, and bottom of each boring. In addition, five surface water and sediment samples should be collected from the area at the foot of the embankment. All samples should be analyzed for HSL compounds and explosives. Sediment samples should also be evaluated for grain size and analyzed for TOC. If contamination is found, a more extensive investigation should be implemented. This may include geophysical surveys, additional sampling, and groundwater monitoring.

All debris and metal objects found on the surface should be removed and disposed of in a properly designed and operated landfill. If necessary, remedial action should be taken at the site in accordance with state and federal requirements to prevent further contamination. If no contamination is detected, it is recommended that no further action be taken for this site.

### 4.39 SA 42 – POPPING FURNACE

#### 4.39.1 Site History

The popping furnace (SA 42), which does not appear to have been used since World War II, is located in the south post area of Fort Devens off of Trainfire Road, across from O Range (Fig. 4.33). Since the activity conducted at the site is not documented, its history is largely unknown. The site consists of an old "furnace" in which small-caliber ammunition apparently was burned. Waste material (ash and casings) may have been thrown down a hillside about 30 ft high.

#### 4.39.2 Geology and Hydrology

Geological conditions of the area consist of glacial outwash deposits of undetermined thickness overlying metamorphic and granitic bedrock. Bedrock is not exposed in the area, and no wells have drilled to the bedrock. The soils at the site are of the Quonset-Hinckley-Windsor Association (Nicholls et al. 1980). These soils are described as droughty, sandy, and gravelly soils underlain by stratified sand and gravel.

Regional hydrogeological conditions have been mapped as a minor aquifer consisting of thin sections of glacial outwash and glacial lacustrine deposits. The saturated thickness is less than 20 ft in this area (Goldberg-Zoino & Associates 1976). Although site-specific hydrogeological information is lacking, it is assumed that any groundwater in this area would flow toward and into the Nashua River.

The valley below the site contains the north-flowing Nashua River bordered by a wetlands.

#### 4.39.3 Nature and Extent of Contamination

No records are available concerning the nature of the material disposed of at this site. There are no records of any hazardous materials or wastes being dumped at this site. Bullet casings were evident around the furnace and on the hillside. A few small rusty cans were seen on the surface and at the base of the cliff.

Because of the assumed nature of the material disposed of at this facility, the potential for soil or water contamination is minimal.

#### 4.39.4 Proposed Action

Even though the potential for soil or water contamination is small, the site should be investigated because of its proximity to the wetlands and the Nashua River and because of the hydrological connection between the groundwater and the surface water. The following proposed actions are based on the assumption that any leachate would have migrated down the steeply sloping hillside and into the wetland. Soil, surface water, and sediment should be sampled to determine if contamination is present.

In the furnace area, four 3-ft soil borings should be drilled and sampled at 0.5-1.0 ft and 2.5-3.0 ft. In addition, three surface water and sediment samples should be collected from the wetlands downgradient from the site. All samples should be analyzed for HSL compounds, explosives, and TC metals. Sediment samples should also be evaluated for grain size and analyzed for TOC.

If significant contamination is detected, a more extensive investigation should be implemented. Depending on the results of the initial sampling, this could include additional sampling, groundwater monitoring, or both.

All debris and metal objects found on the surface should be removed and disposed of in a properly designed and operated landfill. If necessary, remedial action should be taken at the site, in accordance with state and federal requirements, to prevent further contamination. If no contamination is detected, it is recommended that no further action be taken for this site.

### 4.40 SAs 43 and 54 – HISTORIC GAS STATION SITES

#### 4.40.1 Site History

A number of historic gas station sites are located at Fort Devens, but the only available documentation for these sites is a map (circa 1941, see Fig. 4.34) that shows the locations of 17 former gasoline dispensing stations and 1 central distribution station in the current main



FIGURE 4.34 1941 Map of Fort Devens Showing Locations of Historic Gas Stations (Source: Barbour 1941; map reproduced from best available copy)

cantonment area (Barbour 1941). These were located in the central portion of the cantonment area. Collectively, these sites are referred to here as SA 43. Figure 4.35 shows the locations of the sites on a current Fort Devens map; the locations were inferred from present landmarks, such as the Nashua River and some of the roads. The legend of the 1941 map indicates that all of the underground storage tanks were 5,000 gal, with two different types of connections to the pumps. The central dispensing station appears to have been located near the current landfill and the DRMO. The length of time that they were in operation is not known.

An Underground Storage Tank (UST) Management Program is being conducted at Fort Devens. During investigations for that program, tanks were discovered at Bldg. 2680 in December 1989. The building was identified as a former motor pool fueling point that had two 5,000-gal tanks used to store fuel oil between 1942 and 1975. The site was added to the MEP list as SA 54.

Upon further evaluation of the tanks and the WWII-era plans, it was discovered that this study area is the same as SA 43-O (Fig. 4.34). Since these sites are the same, SA 54 is not discussed separately.

#### 4.40.2 Geology and Hydrology

Information on site-specific geology in the main cantonment area is limited. Generally, the bedrock is a complex of metamorphic and igneous rocks that are intensely folded and faulted. The bedrock composition ranges from metasediments to granodiorite and is found from 0 to 100 ft below the surface (McMaster et al. 1982).

The soils are probably of the Quonset-Hinckley-Windsor Association. These soils are described as droughty sand and gravel underlain by stratified sand and gravel. They are generally well drained and highly permeable (McMaster et al. 1982).

#### 4.40.3 Nature and Extent of Contamination

Because of the limited information regarding actual locations of these USTs, they can only be addressed categorically. According to available information, it is unlikely that many of the tanks have been removed. To date, activities of the UST Management Program have located the tanks for sites 43A, L, M, and O. The age of the tanks and the method of tank placement and construction in the 1940s are factors that indicate a high probability of leaks. No information is available to determine whether any tanks were emptied before their inactivation.

Underground storage tanks at sites 43-A, L, M, and O were removed by a contractor under the UST Management program. All of these tanks were used by the vehicle servicing facilities for storing fuel. These sites, as well as SA-H, SA-I, and SA-K, are discussed below.

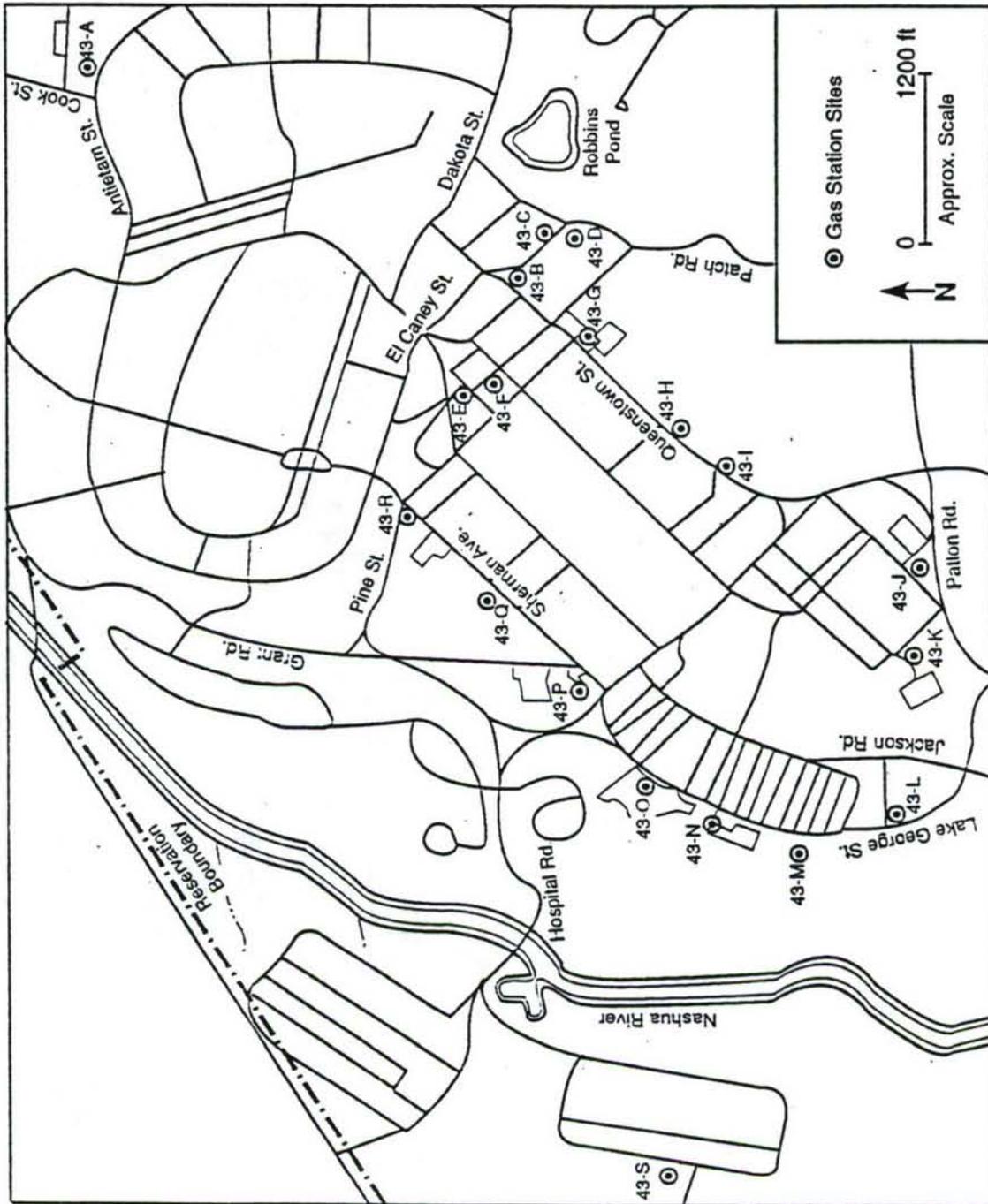


FIGURE 4.35 Estimated Locations of Historic Gas Station Sites (Source: Map based on Cameron and Footit undated; site locations from Barbour 1941)

#### 4.40.3.1 SA 43-A, POL Storage Leaking Underground Storage Tank Site

Four 12,600-gal tanks and one 10,000-gal tank were removed from SA 43-A. Reportedly, the tanks were last used for storing No. 2 fuel oil. When they were removed, all of the tanks were structurally sound, so it is believed that soil contamination was the result of overfilling or loose piping. About 800 yd<sup>3</sup> of contaminated soil was removed. The site was over-excavated to reach a depth at which a photoionizing detector showed no further contamination. During the installation of three groundwater monitoring wells (Fig. 4.36), low concentrations of volatile organic compounds were found in a soil boring near the water table. The groundwater contained no detectable concentration of TPH. Based on these analyses, contaminants did not exceed state limiting criteria as required under MGL, Chap. 21E; therefore, these excavations were considered clean by site personnel (GZA 1990).

#### 4.40.3.2 SA 43-H, Building 602 Leaking Underground Storage Tank Site

A 1,000-gal UST used to store waste oil was removed from SA 43-H at Bldg. 602. It has not been determined whether this tank was associated with the WWII-era gas station at this location. There were no visible leaks or damage to the tank and its associated piping. Soil was removed to a depth that contained less than 10 ppm TOV. A composite soil sample was obtained from the bottom of the excavation and analyzed for total petroleum hydrocarbons. It

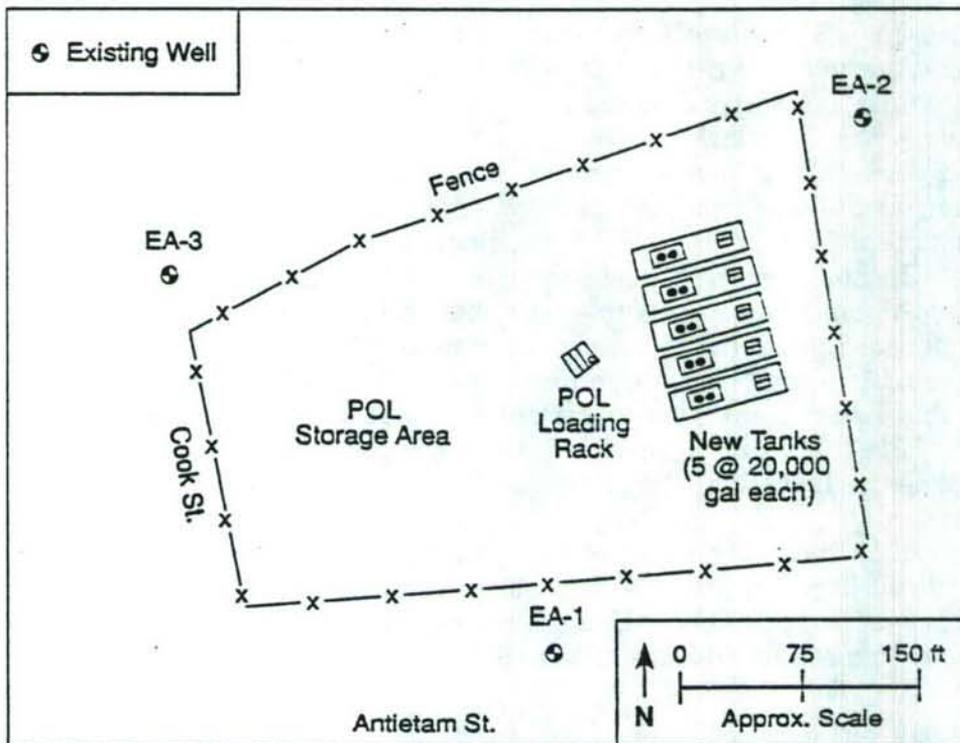


FIGURE 4.36 Locations of Monitoring Wells at SA 43-A (Source: Adapted from Prior 1991)

contained less than 100 ppm TPH, and did not exceed the state limiting criteria (GZA 1990). Since there was no violation of state requirements, this waste oil tank should not be included in the MEP.

#### 4.40.3.3 SA 43-I, Building 604 Leaking Underground Storage Tank Site

A 1,000-gal UST used to store waste oil was removed from SA 43-I in February 1989. It has not been determined whether this tank was associated with the WWII-era gas station at this location. Contaminated soil was found around the fill pipes and extended along the eastern side of the tank. There were no visible leaks or damage to the tank and its associated piping. The only signs of leakage were attributed to the area around the fill pipe. The tank contained 900 gal of waste oil and 28 gal (by volume) of sediment. It was 3.5 ft below ground surface, and no groundwater was encountered during the removal. About 80 yd<sup>3</sup> of contaminated soil were removed and screened for total organic volatiles (TOV) using soil gas. The soil contained less than 10 ppm TOV; the state limiting criteria is 10 ppm TOV. A composite soil sample was obtained from the bottom of the excavation and analyzed for total petroleum hydrocarbons. It contained 1,517 ppm TPH and exceeded the state limiting criteria of 100 ppm TPH. A confirmation sample was obtained; it contained 74 ppm TPH. All of the soil was disposed of in an off-site facility (Environmental Engineering & Geotechnics 1989; Prior 1991).

#### 4.40.3.4 SA 43-K, Building 2517 Leaking Underground Storage Tank Site

A 1,000-gal UST used to store waste oil was removed from SA 43-K in February 1989. It has not been determined whether this tank was associated with the WWII-era gas station at this location. Minor quantities of contaminated soil were encountered during removal of the tank. There were no visible leaks or damage to the tank and its associated piping. It was 4.5 ft below ground surface, and groundwater was encountered at 3.5 ft. A pump was used for dewatering during the removal. The tank contained 300 gal of waste oil and about 28 gal (by volume) of sediment. About 10 yd<sup>3</sup> of contaminated soil was removed and screened for TOV using soil gas. The soil contained 1.4-9.0 ppm TOV, which is below the state limiting criteria of 10 ppm TOV. A composite soil sample was obtained from the bottom of the excavation and analyzed for total petroleum hydrocarbons. It contained 3,539 ppm TPH and exceeded the state limiting criteria of 100 ppm TPH. A confirmation sample was obtained; it contained 663 ppm TPH. Water that had accumulated in the excavated area was analyzed and found to contain only 4.8 ppm TPH. All of the soil was disposed of in an off-site facility (Environmental Engineering & Geotechnics 1989; Prior 1991).

In May 1989, two soil borings were drilled near the excavation. Samples were obtained from depths of 0-2 ft, 5-7 ft, and 10-12 ft. The samples were analyzed and found to contain 663 ppm TPH and 0.6 ppm TOV. There is no information to indicate where there has been further testing of the soil in this area (Prior 1991).

#### 4.40.3.5 SA 43-L, Building 2601 Leaking Underground Storage Tank Site

Three 5,000-gal tanks (tanks 5, 6, and 13) were removed from SA 43-L by Franklin Environmental Service. Two (tanks 5 and 6) were removed on November 29 and 30, 1989. They were located about 10 ft west of Bldg. 2681 in a paved area. Both tanks contained about 100 gal

of fuel mixed with water. Before the tanks were removed, their contents were emptied into a vacuum truck. The tanks were then cleaned with a pressure washer and purged of vapor with dry ice. The wash water was also placed in the vacuum truck. Both tanks were inspected and found to be in good condition. About 150 yd<sup>3</sup> of soil was removed (Kurtz, 1991).

Nine soil samples were collected from each tank excavation area and screened using a photoionizing detector. The samples from the tank 5 excavation contained concentrations of volatile organics ranging from 0.4 to 3.4 ppm. Two composite soil samples contained 57 and 95 ppm TPH. The samples from the tank 6 excavation contained concentrations of volatile organics ranging from 0.8 to 6.8 ppm. Two composite soil samples contained TPH of 98-108 ppm. Based on this information, the excavations were backfilled and closed (Kurtz 1991).

Tank 13 was removed on December 5, 1989. It contained about 48 in. of fuel mixed with water and waste oil. Before the tank was removed, the contents were pumped into a vacuum truck. The tank was then cleaned with a pressure washer and purged of vapor with dry ice. The wash water was also placed in the vacuum truck. The tank was inspected and found to be in good condition. About 3 yd<sup>3</sup> of soil was removed. Groundwater was not encountered during the removal (Kurtz 1991).

Nine soil samples were collected from the excavation and screened using a photoionizing detector. The sample concentrations ranged from not detected to 1.0 ppm TOV. Two composite soil samples contained TPH of 280 and 300 ppm. Because of these elevated TPH concentrations, more soil was excavated on January 11, 1990, and the site was resampled. Of the two composite samples analyzed, one showed no detectable TPH, and the other showed 80 ppm TOV. Based on this information, the excavations were backfilled and closed (Kurtz 1991).

#### 4.40.3.6 SAs 43-O and 54, Building 2680 Leaking Underground Storage Tank Site

Two tanks were discovered at Bldg. 2680 in December 1989 during the UST Management Program. The building was identified as a former motor pool fueling point that had two 5,000-gal tanks used between 1942 and 1975 to store fuel oil. Contamination was encountered during removal of these tanks, and about 100 yd<sup>3</sup> of contaminated soil was excavated (Fig. 4.37). Soil samples contained TPH concentrations that warrant further investigation and remediation (Prior 1991).

#### 4.40.4 Proposed Action

Stricter regulation of tanks began with the administration of the Leaking Underground Storage Tank Program established by Subtitle I of HSWA (RCRA Secs. 9001-9010). A UST is defined as any one or a combination of tanks (including connected pipes) containing petroleum or hazardous substances, of which more than 10% of the volume is beneath the ground level. Each state was required to prepare an inventory of tanks containing petroleum and submit it to EPA by August 1987. The following major points apply to USTs at Fort Devens:

- If a UST was installed before December 1988, it must meet two major requirements: (1) corrosion protection and spill and overflow prevention and (2) leak detection.

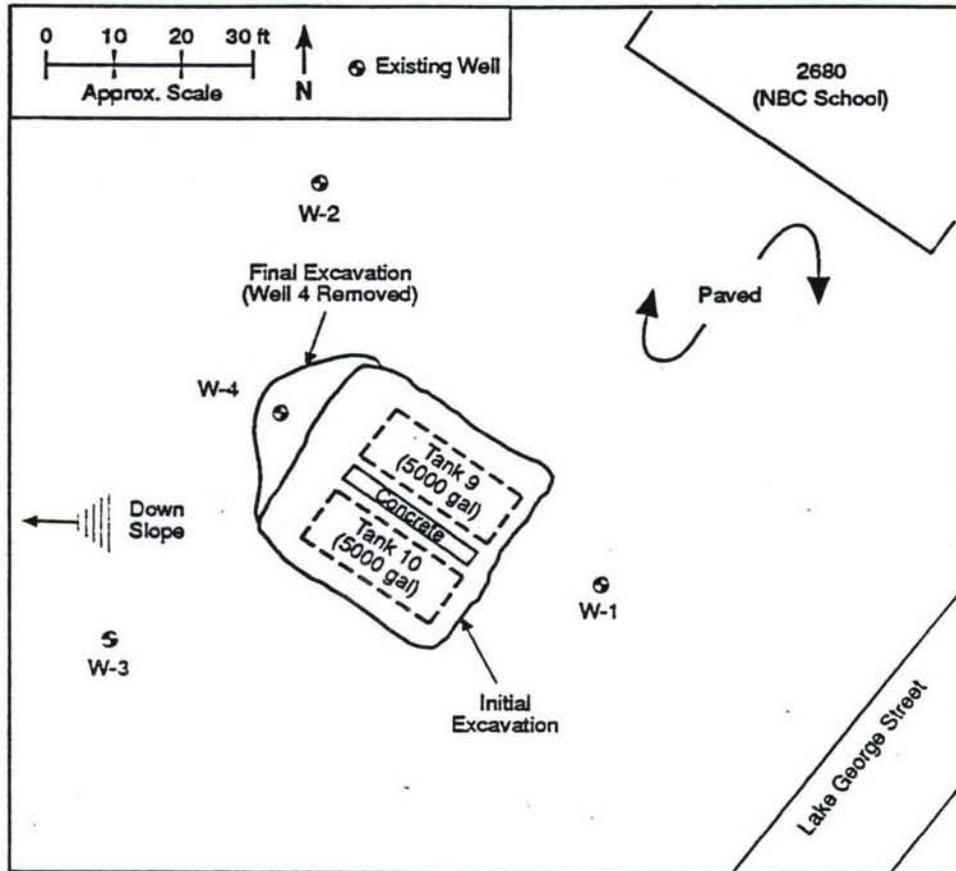


FIGURE 4.37 Excavation and Well Placement at SA 43-0 (SA 54) (Source: Adapted from Prior 1991)

- Corrective action must be taken in response to leaks.
- Closure requirements must be followed for tanks that are temporarily or permanently closed.
- The owner is financially responsible for the cost of cleaning up a leak and compensating other people for bodily injury and property damage caused by a leaking UST.

As is ostensibly the case for these USTs, any tank that is not protected from corrosion and remains closed for more than 12 months, or is subject to permanent closure, is subject to the following requirements for permanent closure:

1. The regulatory authority must be notified 30 days prior to closure.
2. It must be determined whether leaks have damaged the surrounding environment. If there is damage, corrective action is required.
3. The tank can either be removed or left in the ground. In both cases, the tank must be emptied and cleaned by removing all liquids, dangerous vapor levels, and accumulated sludge. If a UST is left in the ground, it must be

filled with a harmless, chemically inactive solid, like sand. All closure actions should be approved by the MDEP.

Based on consideration of the statutory requirements, it is recommended that the remainder of the USTs at Fort Devens be located. Records should be searched to determine the approximate locations of the tanks. This should be followed by a geophysical survey and a soil gas analysis. Because of the length of time elapsed, there does not appear to be a reliable method to determine if leaks occurred or to what extent. Therefore, after locating the tanks, the prudent approach would be to excavate around the tank and sample the surrounding soil for total petroleum hydrocarbons.

If elevated levels of contamination are detected, the soil should be removed to the extent of contamination and disposed of according to MDEP requirements. If no contamination is apparent, a cost-effective approach would be to leave the tank in place following the requirement set out above (item 3).

The USTs that have been removed or show no evidence of further releases should be removed from the list of study areas requiring further action.

Additional investigation should be conducted at the sites where tanks have been removed but soil with residual contamination has been left.

#### **4.41 SA 44 – CANNIBALIZATION YARD (BLDG. 3713)**

##### **4.41.1 Site History**

The cannibalization yard (SA 44) is an unpaved area (about 150 by 75 ft) east of Bldg. 3713 where vehicles are stored before dismantlement for reusable parts. The operational history of the building (SA 38) is discussed in detail in Sec. 4.35.1, and its location is shown in Fig. 4.29 (see Sec. 4.35).

The storage time for vehicles varies, depending on the demand for parts. At the time of the site visit, no visibly stained areas were apparent. According to site personnel, the topsoil is periodically removed. The most recent removal was in 1988, when the upper 2 ft of soil was removed and disposed of in an off-site disposal facility (Prior 1989).

##### **4.41.2 Geology and Hydrology**

Available information on site-specific geology and hydrology is discussed in Sec. 4.35.2.

##### **4.41.3 Nature and Extent of Contamination**

Vehicle storage for an indeterminate time makes it possible that used oil, gasoline, and other vehicle fluids could have been released onto the ground. The yard is not paved or bermed in any way. Although there was no visibly stained soil, this could be the result of routine

clearing operations that remove the top layer of soil. The possibility exists for soil and water contamination from the yard and a nearby disposal pit (see Sec. 4.35).

#### 4.41.4 Proposed Action

Even though no contamination has been reported, the site should be investigated because it is near Cold Spring Brook and the Grove Pond well field. A record search should be conducted to better define past and current activities.

The extent of contamination should be determined by drilling about six soil borings to 10 ft. Locations should include any areas of stained soil. Borings should be sampled continuously at 2.0-ft intervals for HSL compounds and TPH. If the deepest samples contain contaminants in significant quantities, monitoring wells should be installed both upgradient and downgradient of the contaminated areas. If wells are necessary, their placement should be coordinated with well installation for SA 38 (Sec. 4.35.4).

Regardless of whether contamination is detected, Fort Devens should monitor the use of this lot and periodically check for soil contamination.

### 4.42 SA 45 – WASH RACK AT LAKE GEORGE STREET

#### 4.42.1 Site History

A vehicle wash rack (SA 45) is on the northwestern portion of the main cantonment area along Lake George Street (Fig. 4.38). It is an open, asphalt-paved area with eight bays for washing privately owned autos. The bays contain drains that empty into an adjacent sump or the sewer. A site inspection revealed no additional information about the outfall from this site. According to site personnel, the sump that is just north of site contained about 6 in. of oil on the water. A new sewer connection has been installed near the sump (Hopkins 1988). The topography of the area suggests that the site is directly upgradient of the Nashua River, and that an uncontrolled outfall could have an impact on the wetland adjacent to the river.

#### 4.42.2 Geology and Hydrology

Site-specific information on the geology and hydrology of the area is limited. Generally, the site consists of unconsolidated glacial deposits of undetermined thickness, overlying metamorphic and granitic bedrock.

The soils in the area are probably of the Quonset-Hinckley-Windsor Association. These soils are described as droughty sand and gravel underlain by stratified sand and gravel. They are generally well drained and highly permeable (McMaster et al. 1982).

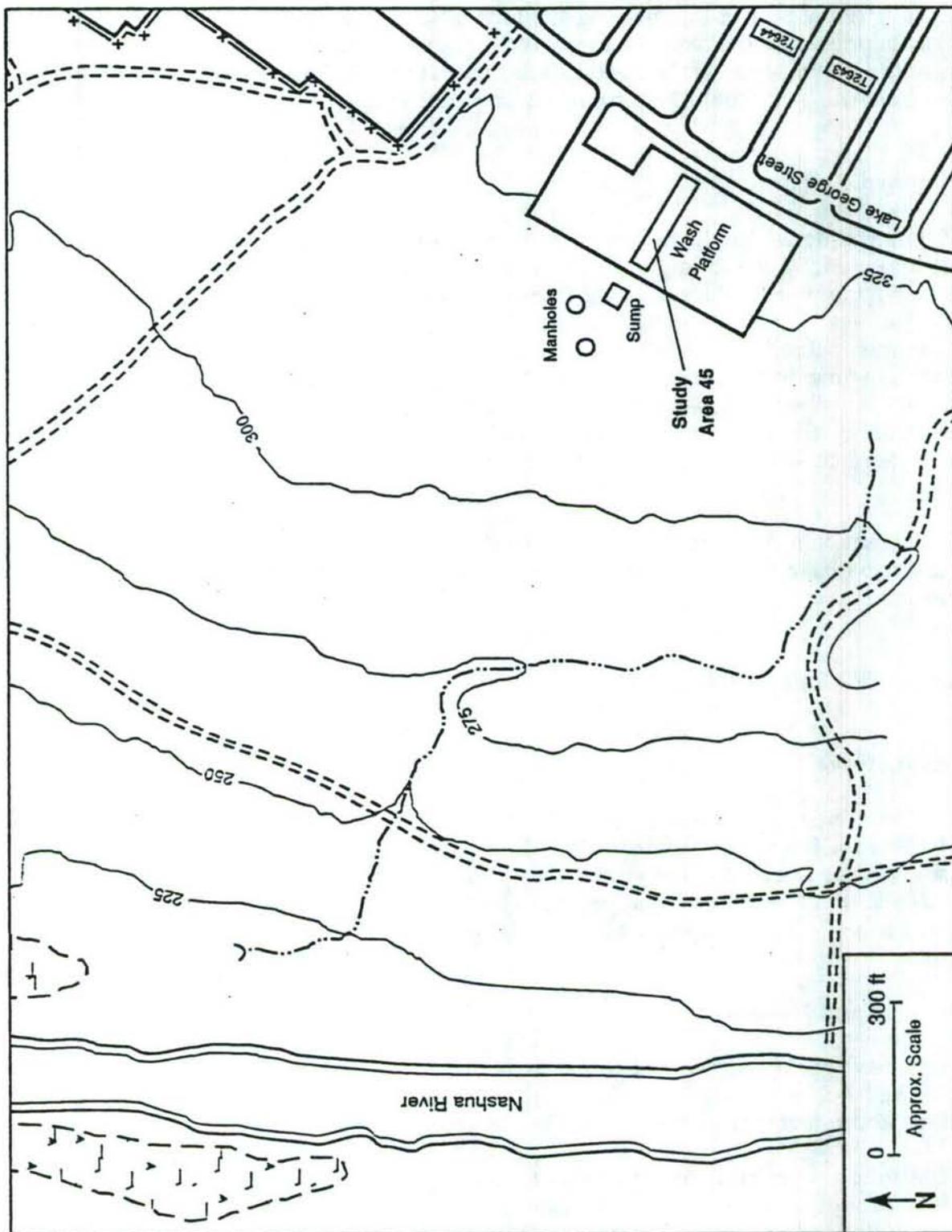


FIGURE 4.38 Location of SA 45, the Wash Rack at Lake George Street (Source: Map based on Keene 1967)

#### 4.42.3 Nature and Extent of Contamination

Access to the site is open and activities are not controlled. There are no detailed records of operations. The concern for this site is the possibility that it could be used for other vehicle maintenance activities such as oil changing and lubrication. The oily sump water would indicate that this has happened in the past. Not only is this an unsound environmental practice, but in Massachusetts used motor oil is classified as a hazardous waste. The potential for unauthorized discharges from this site should be scrutinized carefully.

#### 4.42.4 Proposed Action

Several remedies could resolve any violations of allowable discharge from the wash racks: (1) investigating the location of the outfall and the types of discharges from activities, (2) instituting a monitor to oversee site activities, or (3) closing the site.

The sewer lines should be traced on a sewer map of the area in order to determine whether and how the drains are connected. If the drains are connected to the sewer, installation of a sand filter, an oil-water separator, or both may be required. If the drains are not connected to the sewer, an investigation should be made to locate and eliminate the outfall. At the point of discharge, surface soil samples should be collected and analyzed for HSL compounds, PCBs, and TPH.

If contaminant concentrations are elevated, additional soil samples should be collected along drainage paths to the river. Based on the level of contamination, groundwater monitoring may be necessary.

### 4.43 SA 46 – TRAINING AREA 6D

#### 4.43.1 Site History

Training area 6d (SA 46) is on the southwestern boundary of the impact area in the south post, near the intersection of Shoefelt and Firebreak Roads (Fig. 4.39). It is a small (about 200 ft<sup>2</sup>), sandy area. During the site visit, the area contained two abandoned armored tanks and an abundance of spent canisters that appeared to have contained tear gas. The types of activities conducted at this site were not known by installation personnel.

#### 4.43.2 Geology and Hydrology

The area's geology consists of glacial-deltaic and outwash sands overlying metamorphic and granitic bedrock of the Worcester Formation. Because the site has not been characterized, the thickness and orientation of the glacial deposits are unknown.

The soils are probably of the Quonset-Hinckley-Windsor Association. These soils are described as droughty sand and gravel underlain by stratified sand and gravel. They are generally well drained and highly permeable (McMaster et al. 1982).

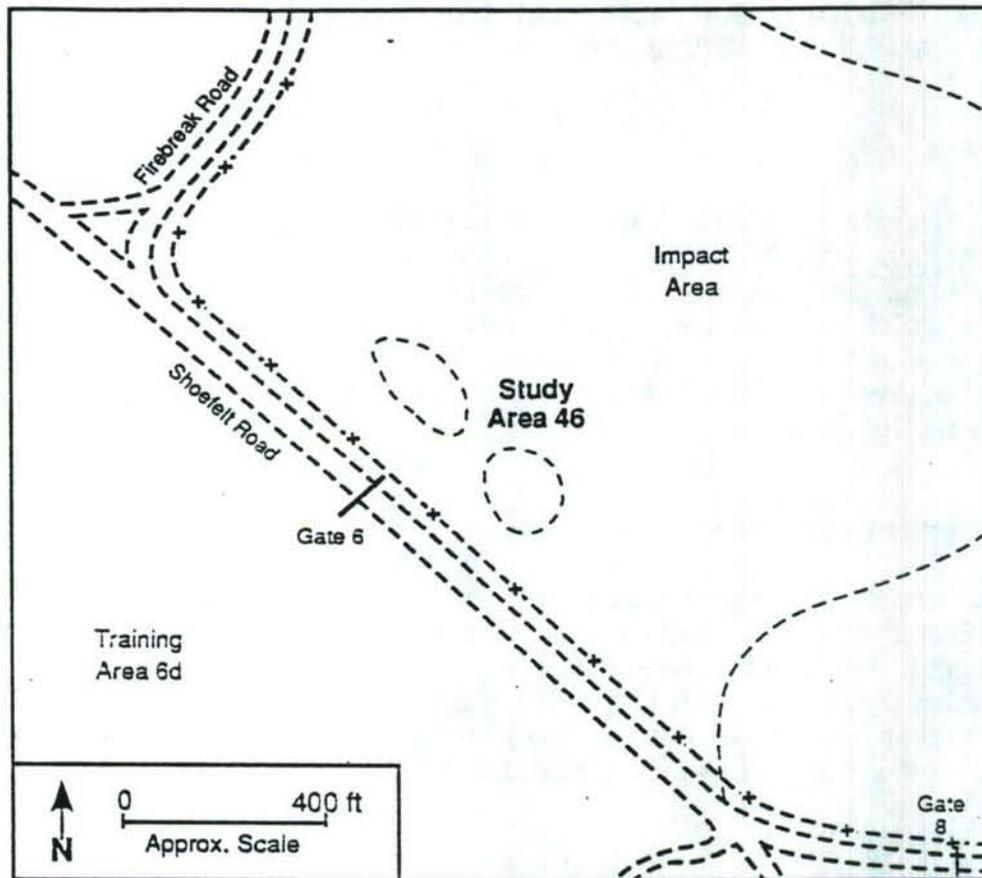


FIGURE 4.39 Location of SA 46, Training Area 6d (Source: Map based on USACE 1988)

#### 4.43.3 Nature and Extent of Contamination

Very little is known about the activities at this site. The sandy, permeable nature of the soils and the observed conditions indicate that there is a possibility for contamination. There were no visibly stained areas.

#### 4.43.4 Proposed Action

Three surface soil (6-12 in.) samples from the areas near each abandoned tank should be collected and analyzed for HSL compounds, explosives (Tables A.1 and A.2), and TPH. If the soil samples indicate areas of contamination, the extent of contamination should be determined by a more extensive investigation, which could include further sampling, soil borings, and groundwater monitoring.

If no contamination is found, the only recommended further action is to clear the site of debris.

#### 4.44 SA 47 – MOORE ARMY AIR FIELD LEAKING UNDERGROUND STORAGE TANK SITE (BLDG. 3816)

##### 4.44.1 Site History

The Moore Army Air Field leaking underground storage tank (LUST) site (SA 47) is on the north post near Bldg. 3816, the flight control tower (Fig. 4.40). The tank was used to store fuel for an electric generator between 1970 and 1989. On January 10, 1989, the Environmental Management Office was informed that a 500-gal underground fuel tank was scheduled for removal by an outside contractor on January 11. The Fort Devens Fire Chief inspected the tank after it was removed and stated that it was in "fair" condition. It was disposed of by the contractor (Fort Devens 1990).

##### 4.44.2 Geology and Hydrology

Information on site-specific geology in this area is limited. Generally, the local bedrock is a complex of metamorphic and igneous rocks that are intensely folded and faulted. The bedrock is composed of metasediments of Oakdale quartzite and is found at least 50 ft below the land surface (McMaster et al. 1982). The soils in this part of the base are of the Quonset-Hinckley-Windsor Association. These soils are described as droughty sand and gravel underlain by stratified sand and gravel. They are generally well drained and highly permeable (McMaster et al. 1982).

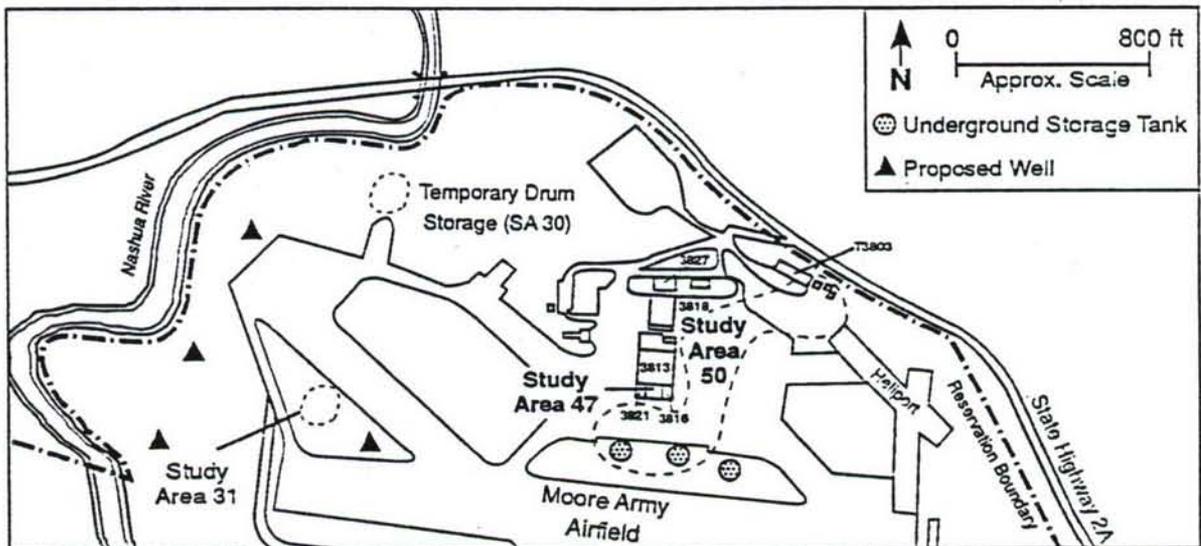


FIGURE 4.40 Locations of SA 47, Moore Army Air Field Leaking Underground Storage Tanks and SA 50, WWII Aircraft Fuel System (Source: Map based on Keene 1967)

#### 4.44.3 Nature and Extent of Contamination

Soils were visibly contaminated at the excavation site, and about 15 yd<sup>3</sup> of material was removed by Fort Devens personnel. It is reported that visible contamination appeared to be confined to directly under the tank, and that there was little migration. The excavation had reached 8.5 ft below the ground surface when the sides of the excavation began to show signs of collapse. It was determined that any further excavation or removal would endanger the foundation of the flight tower, so all of the contaminated soil could not be removed (Fort Devens 1990).

Two soil samples were obtained; one was a composite from each of the pit sides, and the other was from the bottom of the pit. All of the excavated soil was stored until the results for these samples were available; information about these results was not available.

#### 4.44.4 Proposed Action

Because of the permeable nature of the soils in this area there is a potential for contaminant migration. There are limitations to further excavation because the structural integrity of the flight tower may be in jeopardy; therefore, this site should be monitored. Three groundwater monitoring wells should be installed and sampled regularly for TPH and VOCs. Soil samples should be obtained from a depth of at least 8.5 ft and analyzed for the same parameters. If contaminant concentrations are elevated, the extent of migration should be determined and remedial action should be implemented.

### 4.45 SA 48 – BUILDING 202 LEAKING UNDERGROUND STORAGE TANK SITE

#### 4.45.1 Site History

The Bldg. 202 LUST site (SA 48) is south of the sanitary landfill (SA 5) near the intersection of Carey and St. Mihiel streets (Fig. 4.41). The LUST was a 1,000-gal tank used between 1942 and 1989 to store waste oil from the vehicle servicing facilities. As part of the Fort Devens UST Management Program (FY 1988), waste oil storage tanks were being replaced with above-ground storage tanks. This and several other tanks were removed on February 13 and 14, 1989 (Environmental Engineering & Geotechnics 1989).

#### 4.45.2 Geology and Hydrology

This area of Fort Devens is in a thick section of glacial outwash, consisting primarily of interbedded sands and gravels. The bedrock is Ayer Granite, a light-gray, foliated, phaneritic biotite granodiorite. The bedrock surface is covered by bluish-gray till that is beneath the glacial outwash layer. The bedrock surface forms a northwest-trending trough that may control the groundwater flow. The depth of the water table in this area ranges from 5 to 30 ft (Gale Engineering 1985).

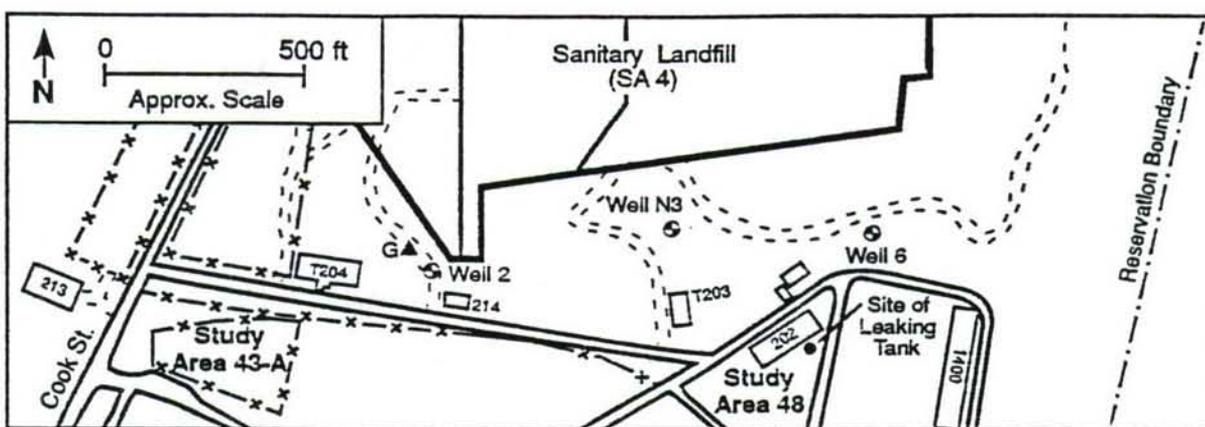


FIGURE 4.41 Location of SA 48, Building 202 Leaking Underground Storage Tank Site (Source: Map based on Keene 1967)

#### 4.45.3 Nature and Extent of Contamination

When the tank was removed, minor discolorations of the soil were noted, and elevated readings on a photoionizing detector were recorded. After the tank was removed, a separation was found in one of the seams. The tank contained 300 gal of waste oil and about 80 gal (by volume) of sediment. It was 4 ft below the ground surface, and no groundwater was encountered during the removal. About 100 yd<sup>3</sup> of contaminated soil was removed and screened for total organic vapor. Soil was removed to a depth which contained less than 10 ppm TOV. A composite soil sample was obtained from the bottom of the excavation. The soil contained 916 ppm total petroleum hydrocarbon. A confirmation sample was obtained; it contained 3,213 ppm TPH. All of the soil was disposed of in an off-site facility (Environmental Engineering & Geotechnics 1989; Prior 1991).

In May 1989, two soil borings (32 ft deep) were drilled near the excavation (Fig. 4.42). Samples were obtained and analyzed for TOV. All but one of the samples contained less than 0.6 ppm TOV. A sample from the 18 - 20 ft. depth contained 150 ppm TOV. There is no information that indicates that there has been any further testing of the soil in this area (Prior 1991).

In July 1991, groundwater monitoring wells were installed at SA 48 (Fig. 4.42); they will be monitored quarterly for TPH, HSL compounds, and water quality parameters.

#### 4.45.4 Proposed Action

Because of the permeable nature of the soils in this area, there is a potential for contaminant migration. To delineate the extent of the contamination, soil borings should be drilled to groundwater and samples obtained from the top, middle, and bottom sections. The soil borings should be located at the limit of the area known to be contaminated. Samples should be analyzed for TPH and VOCs. If contaminant concentrations are significantly

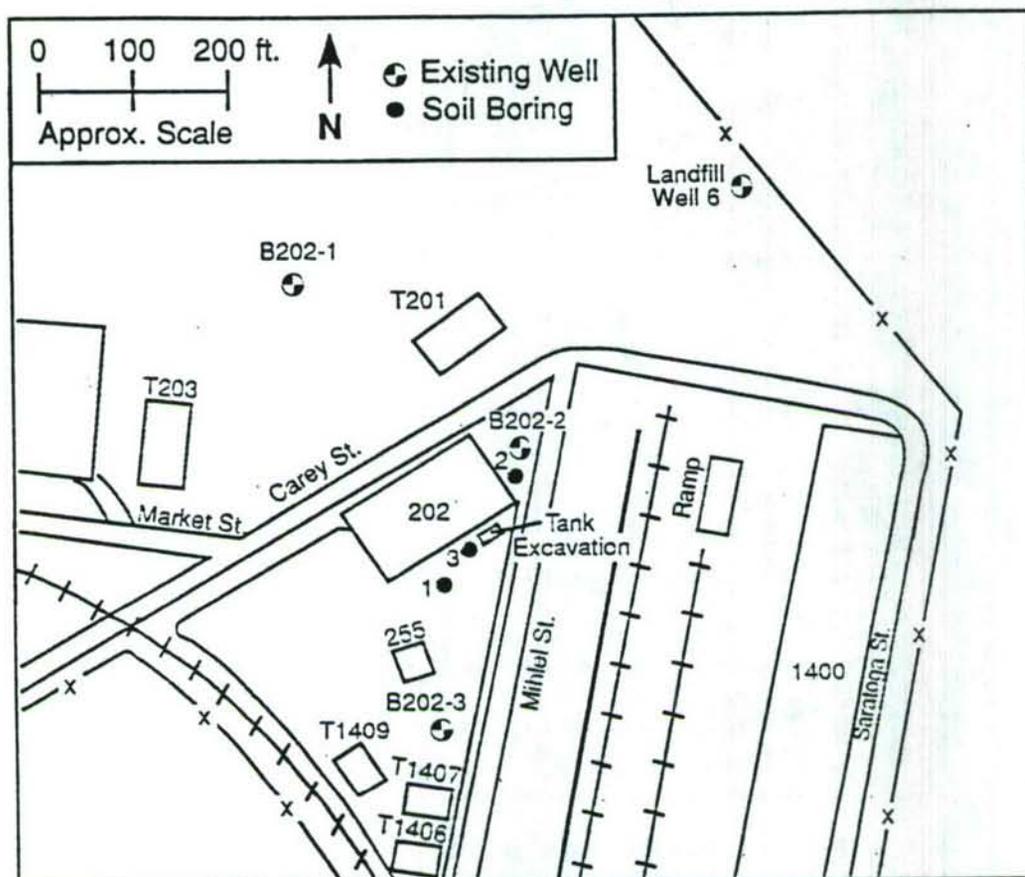


FIGURE 4.42 Locations of Borings and Monitoring Wells at SA 48 (Source: Adapted from Prior 1991)

elevated, groundwater monitoring wells should be installed and sampled regularly for TPH and volatile organics. If contaminant concentrations are elevated, the extent of migration should be determined, and remedial action should be implemented.

#### 4.46 SA 49 - BUILDING 3602 LEAKING UNDERGROUND STORAGE TANK SITE

##### 4.46.1 Site History

The Bldg. 3602 LUST site (SA 49) is north of the golf course along Sheridan Road in the main cantonment area (Fig. 4.43). Two 5,000-gal tanks were removed from the site. The tanks were originally used to store gasoline and diesel fuel for a motor pool that was located in nearby Bldg. 3601. They were also used for in-ground bulk storage of No. 2 fuel oil. They were used by the motor pool from 1942 to 1975. An apparent leak was first discovered in December 1989. The tanks then were removed under an FY 1989 Abandoned UST Removal Contract (no. EQ-19175-8P) (Fort Devens 1990).

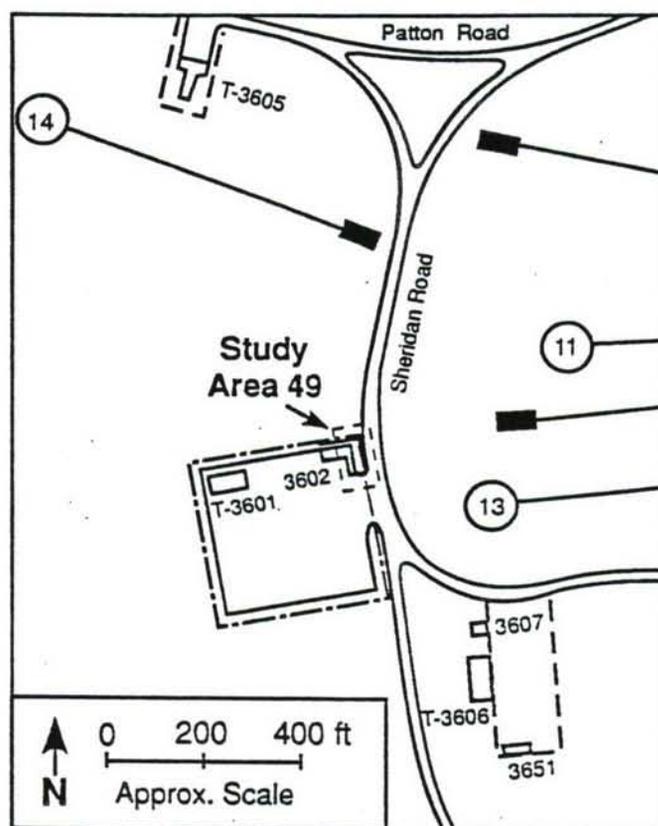


FIGURE 4.43 Location of SA 49, Building 3602 Leaking Underground Storage Tank Site (Source: Map based on Keene 1967)

#### 4.46.2 Geology and Hydrology

This site is located on the Quonset-Hinckley-Windsor Association, which consists of droughty sand and gravelly soil underlain by stratified sand and gravel. This area drains well and has a high permeability (Nicholls et al. 1980; McMaster et al. 1982). Typical hydraulic conductivities for this general area range from 0.001 to 0.01 cm/s (Satterwhite et al. 1976a).

#### 4.46.3 Nature and Extent of Contamination

When the two tanks were excavated, they were structurally sound, but there was a strong gasoline odor. The contamination was probably the result of over-filling or loose piping. About 250 yd<sup>3</sup> of contaminated soil was removed (Fig. 4.44). The soil was excavated beyond the area of contamination until the water table was encountered. Four monitoring wells were installed and elevated concentrations of volatile organics were detected in samples of the soil borings (Fort Devens 1990).

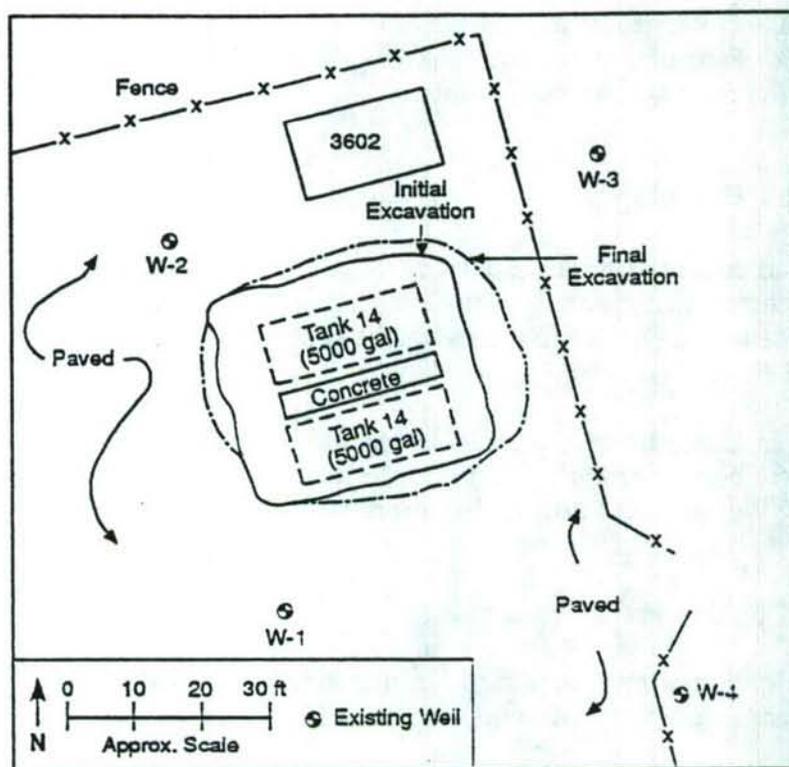


FIGURE 4.44 Excavation and Well Placement at SA 49 (Source: Adapted from Prior 1991)

#### 4.46.4 Proposed Action

Because of the permeable nature of the soils in this area and the proximity of the Nashua River, there is a potential for contaminant migration. To delineate and monitor the extent of the contamination, groundwater monitoring wells at this site should be sampled for TPH and VOCs for at least two quarters. If contaminant concentrations are elevated, the extent of migration should be determined by further investigation, and remedial action should be implemented.

#### 4.47 SA 50 – WWII AIRCRAFT FUEL SYSTEM

##### 4.47.1 Site History

The WWII aircraft fuel system (SA 50) is on the main cantonment area near Bldg. 3618, the flight control tower for Moore Army Air Field (Fig. 4.40). It is estimated that there are four locations where aviation fueling activities occurred between 1941 and 1945 (Prior 1991).

This SA is adjacent to the east-west runway and consists of piping, two groups of aircraft fuel tanks, fuel points, and truck fill stands. One group of fuel tanks (three 25,000-gal tanks) is east of Bldg. T-3803. Plans showing the details of these three tanks, a water separator

pit, piping to two truck fill stands, and the truck fill stands date back to August 1942 (drawing X100-109/43A). A second group of fuel tanks (two 25,000-gal tanks) is east of Building 3818. Plans dating back to February 1941 (drawing 6101-243) show the details of these tanks and the associated piping for four aircraft fuel points.

#### **4.47.2 Geology and Hydrology**

Information on site-specific geology in this area is limited. Generally, the local bedrock is a complex of metamorphic and igneous rocks that are intensely folded and faulted. The bedrock is composed of Oakdale quartzite and is found at least 50 ft. below the land surface (McMaster et. al. 1982).

The soils in this part of the base are of the Quonset-Hinckley-Windsor Association. These soils are described as droughty sand and gravel underlain by stratified sand and gravel. They are generally well drained and highly permeable (McMaster et. al. 1982).

#### **4.47.3 Nature and Extent of Contamination**

No investigations have been made in this area, and thus the nature and extent of any contamination is not known. No fueling activities have taken place at this site since the late 1940s (Prior 1991).

#### **4.47.4 Proposed Action**

Because of the permeable nature of the soils in this area and the proximity of the Nashua River, there is a potential for some contaminant migration; however, the fuels used in this area were highly volatile aviation fuels. The integrity of the piping systems should be investigated and traced to discover the location of the associated USTs. If the piping shows signs of leakage, samples from the soils surrounding the pipes should be obtained and analyzed for volatile organics and TPH. If contaminant concentrations are significantly elevated, groundwater monitoring wells should be installed and sampled regularly for TPH and volatile organics. If contaminant concentrations are elevated, the extent of migration should be determined and remedial action should be implemented.

### **4.48 SA 51 – O'NEIL BUILDING SPILL SITE**

#### **4.48.1 Site History**

The O'Neil building spill site (SA 51) is located just west of Lovell Street in the main cantonment area (Fig. 4.45). This site is the location of the former Lovell Army Hospital. It is an active training site for radio operators and uses high frequency, diesel-powered generators to provide electricity. The generators are filled daily, and any water is drained from the fuel tank (Fort Devens 1990).

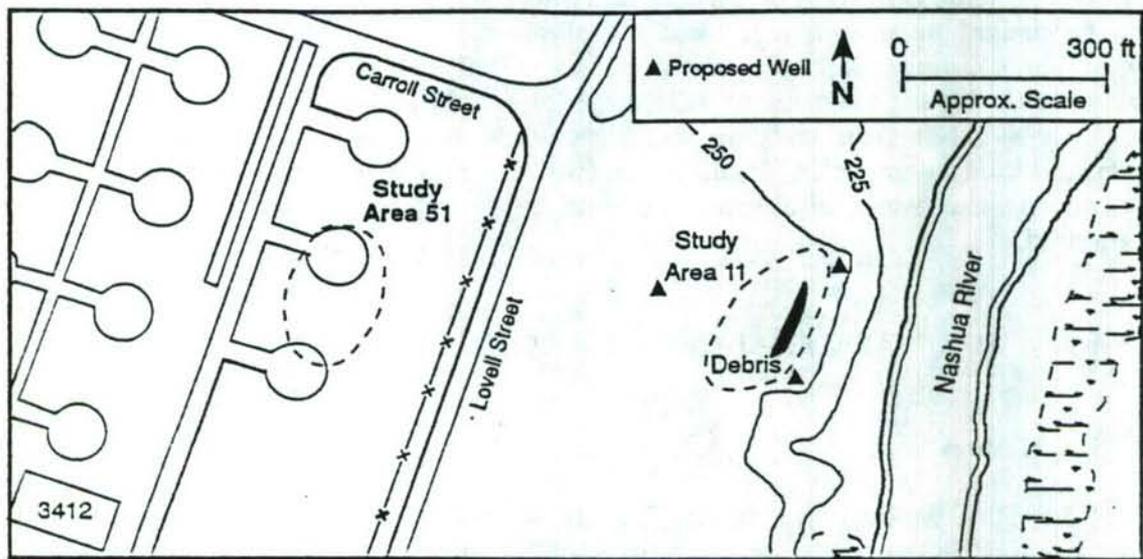


FIGURE 4.45 Location of SA 51, O'Neil Building Spill Site (Source: Map based on Keene 1967)

#### 4.48.2 Geology and Hydrology

The geology of the area includes unconsolidated glacial deposits of undetermined thickness, overlying Paleozoic metamorphic bedrock. The soils of this area are in the Quonset-Hinckley-Windsor Association, described as droughty sand and gravelly soil underlain by stratified sand and gravel. The soil is well drained and has high permeability (Nicholls et al. 1980).

The hydrogeology in this area includes an aquifer consisting of thin sections of glacial outwash and glacial lacustrine deposits. Goldberg-Zoino & Associates (1976) showed the saturated thickness to be less than 20 ft. The Nashua River is along the eastern side of the site, and although site-specific hydrogeological information is lacking, it is assumed that any groundwater in this area would flow toward and into the river.

#### 4.48.3 Nature and Extent of Contamination

About 15 gal of fuel was spilled onto the ground when a drain valve was left open. When the spill area was inspected, it was evident that this was not an isolated incident. Even after 200 yd<sup>3</sup> of soil was removed, significant contamination was still evident. Several soil samples were obtained and analyzed. They contained 90 to 200 ppm total petroleum hydrocarbon (Fort Devens 1990).

#### 4.48.4 Proposed Action

Because of the permeable nature of the soils in this area and the proximity of the Nashua River, there is a potential for contaminant migration. A site reconnaissance should be

conducted, and soil samples from stained areas should be collected and analyzed for TPH and VOCs. To delineate the extent of the contamination, soil borings from significantly stained areas should be drilled to groundwater and samples obtained from the top, middle, and bottom sections. The soil borings should be placed at the limit of the area known to be contaminated. Samples should be analyzed for volatile organics and TPH. If contaminant concentrations are significantly elevated, groundwater monitoring wells should be installed and sampled regularly for TPH and volatile organics. If the groundwater contains significantly elevated contaminant concentrations, the extent of migration should be determined and remedial action should be implemented.

#### **4.49 SA 52 – TDA MAINTENANCE YARD (CLASS III LEAK, STORAGE YARD)**

##### **4.49.1 Site History**

The TDA Maintenance Yard (SA 52) is adjacent to SA 38 and SA 44 in the main cantonment area, in the northeast corner of Fort Devens along Barnum Road (Fig. 4.46). It is an active storage area for vehicles with oil leaks that are awaiting repair (Fort Devens 1990).

##### **4.49.2 Geology and Hydrology**

Available information on site-specific geology and hydrology is discussed in Sec. 4.35.2.

##### **4.49.3 Nature and Extent of Contamination**

According to Fort Devens personnel, there are many small patches of soil visibly contaminated with motor oil or hydraulic fluid. The average size is 2-3 ft in diameter. The extent of the contamination has not yet been investigated (Fort Devens 1990).

##### **4.49.4 Proposed Action**

Because of the proximity of surface water and the Grove Pond well field, the site should be investigated. The extent of contamination should be determined by drilling soil borings to groundwater. Boring locations should include any areas of significantly stained soil. Samples should be obtained from the top, middle, and bottom sections of each boring and analyzed for volatile and semivolatile HSL compounds and for TPH. If the deepest samples contain contaminants in significant concentrations, monitoring wells should be installed and sampled regularly for elevated contaminants.

Regardless of whether contamination is detected, Fort Devens should monitor the use of this lot and periodically check for soil contamination.

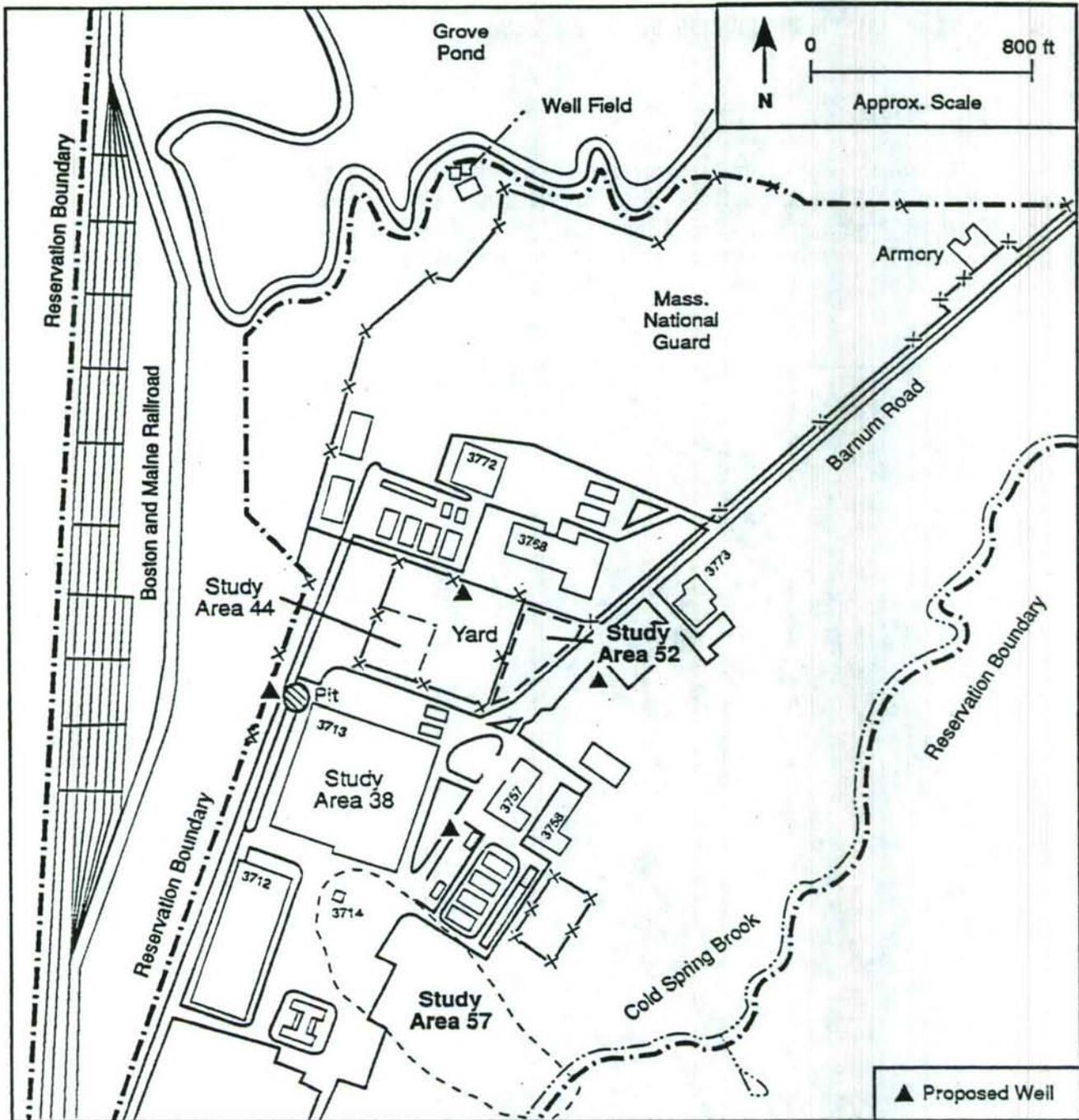


FIGURE 4.46 Locations of SA 52, TDA Maintenance Yard, and SA 57, the Building 3713 Fuel Oil Spill (Source: Map based on Keene 1967)

## 4.50 SA 53 – SOUTH POST POL SPILL AREAS

### 4.50.1 Site History

The south post contains most of the ranges and training areas. The POL spill areas, designated as SA 53-A through SA 53-M, are locations where fueling and POL storage occur as part of troop training exercises (Figs. 4.47 through 4.51) and, therefore, are potentially contaminated. According to site personnel, many of these areas are limited in area and primarily store fuel and oil for vehicles.

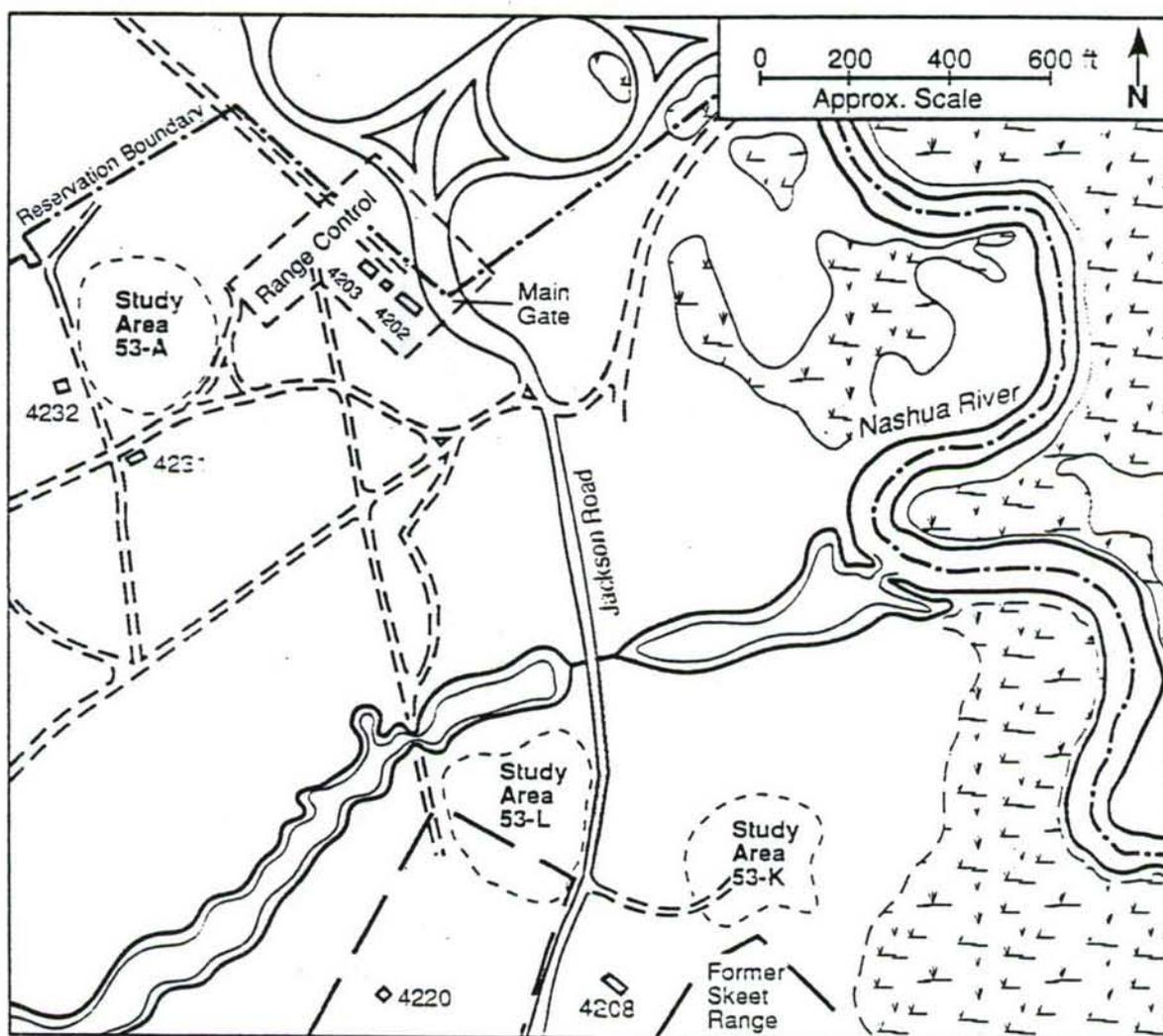


FIGURE 4.47 Locations of South Post POL Spill Areas SA 53-A, SA 53-K, and SA 53-L (Source: Map based on USACE 1988)

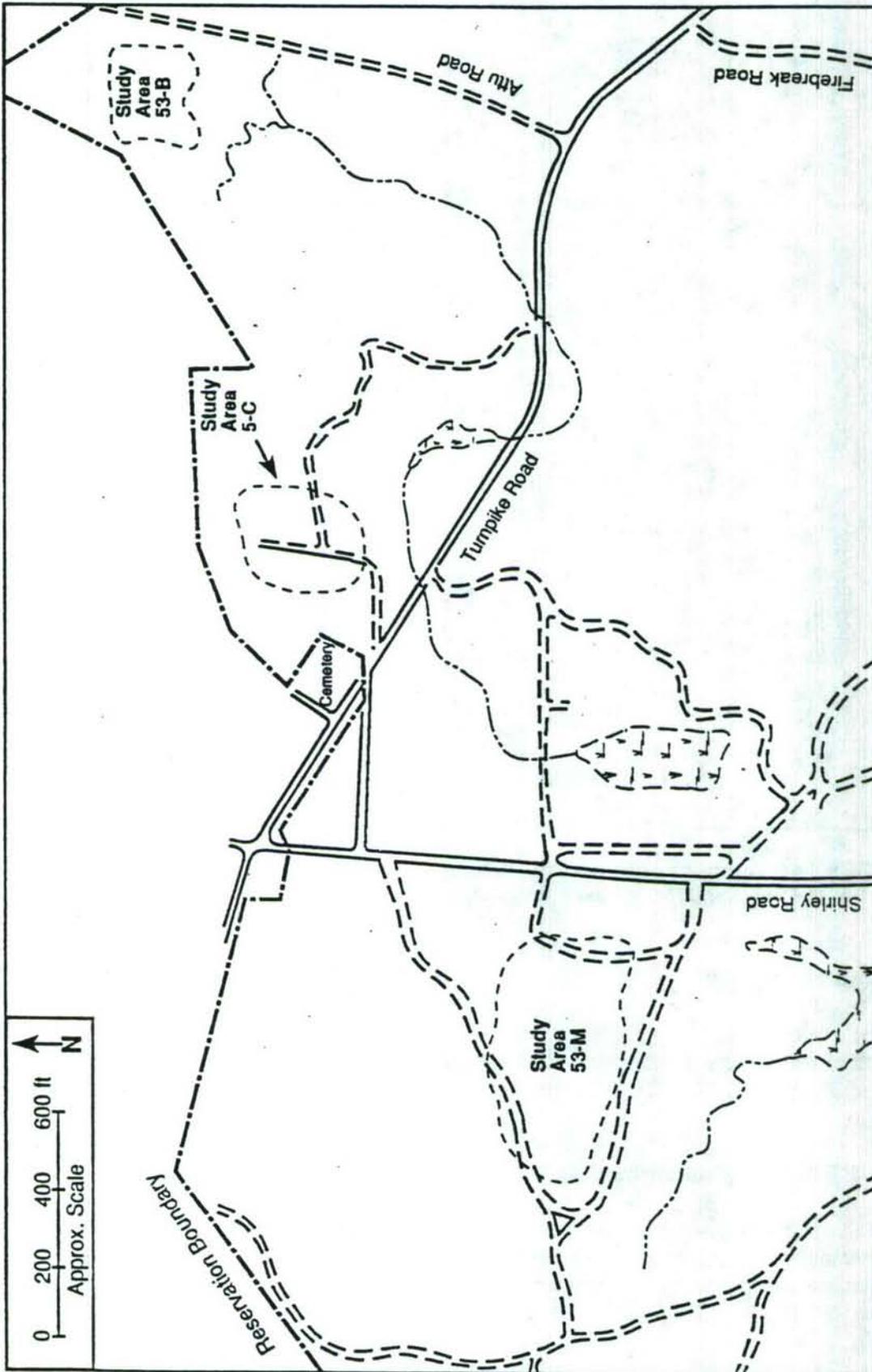


FIGURE 4.48 Locations of South Post POI Spill Areas SA 53-B, SA 53-C, and SA 53-M (Source: Map based on USACE 1988)

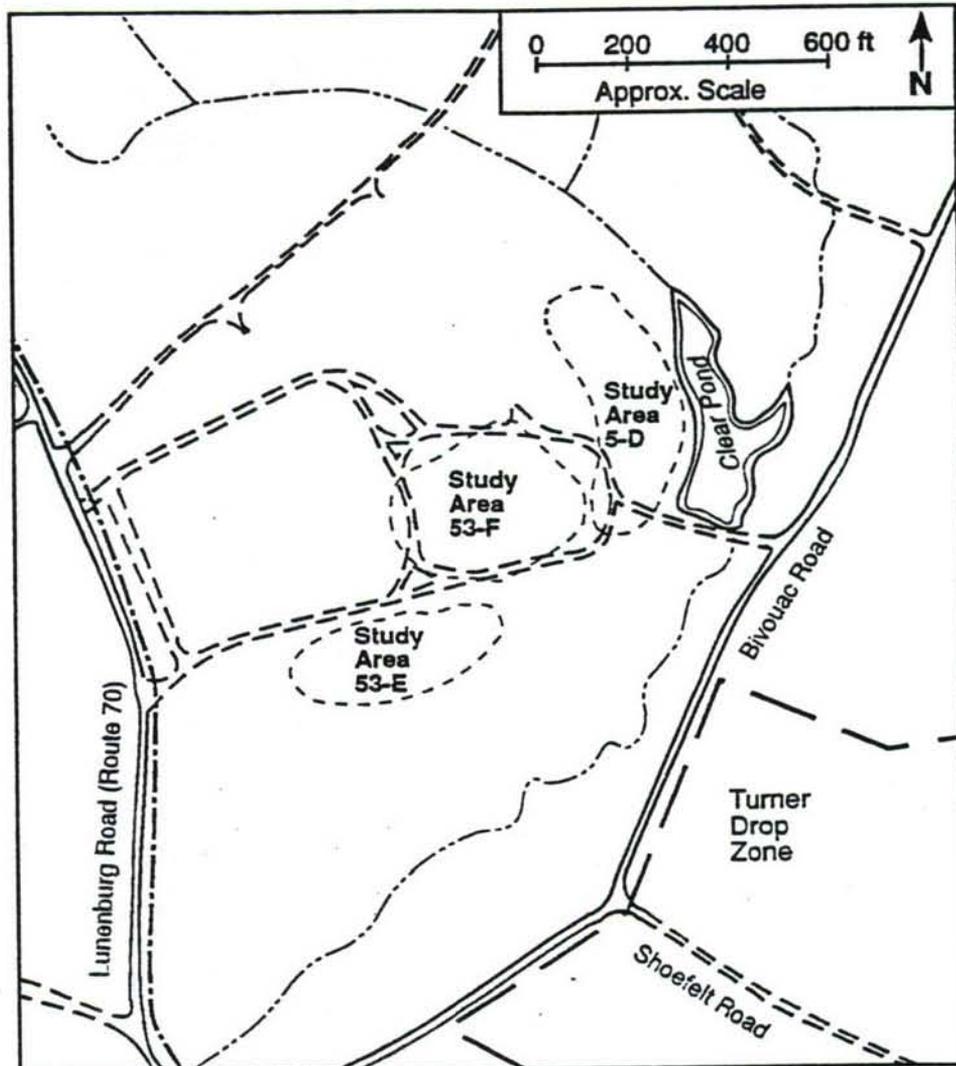


FIGURE 4.49 Locations of South Post POL Spill Areas SA 53-D, SA 53-E, and SA 53-F (Source: Map based on USACE 1988)

#### 4.50.2 Geology and Hydrology

Site-specific information regarding geology and hydrology is limited. The potential spill sites are located throughout the south post, so these characteristics will be similar to those for SAs 25, 26, 27, and 28 (Secs. 4.22, 4.23, 4.24, and 4.25).

#### 4.50.3 Nature and Extent of Contamination

The south post generally comprises outwash sands and gravels that are fairly permeable. Because of the permeable nature of the soils in this area and (for some locations) the proximity of surface water, there is a potential for contaminant migration.



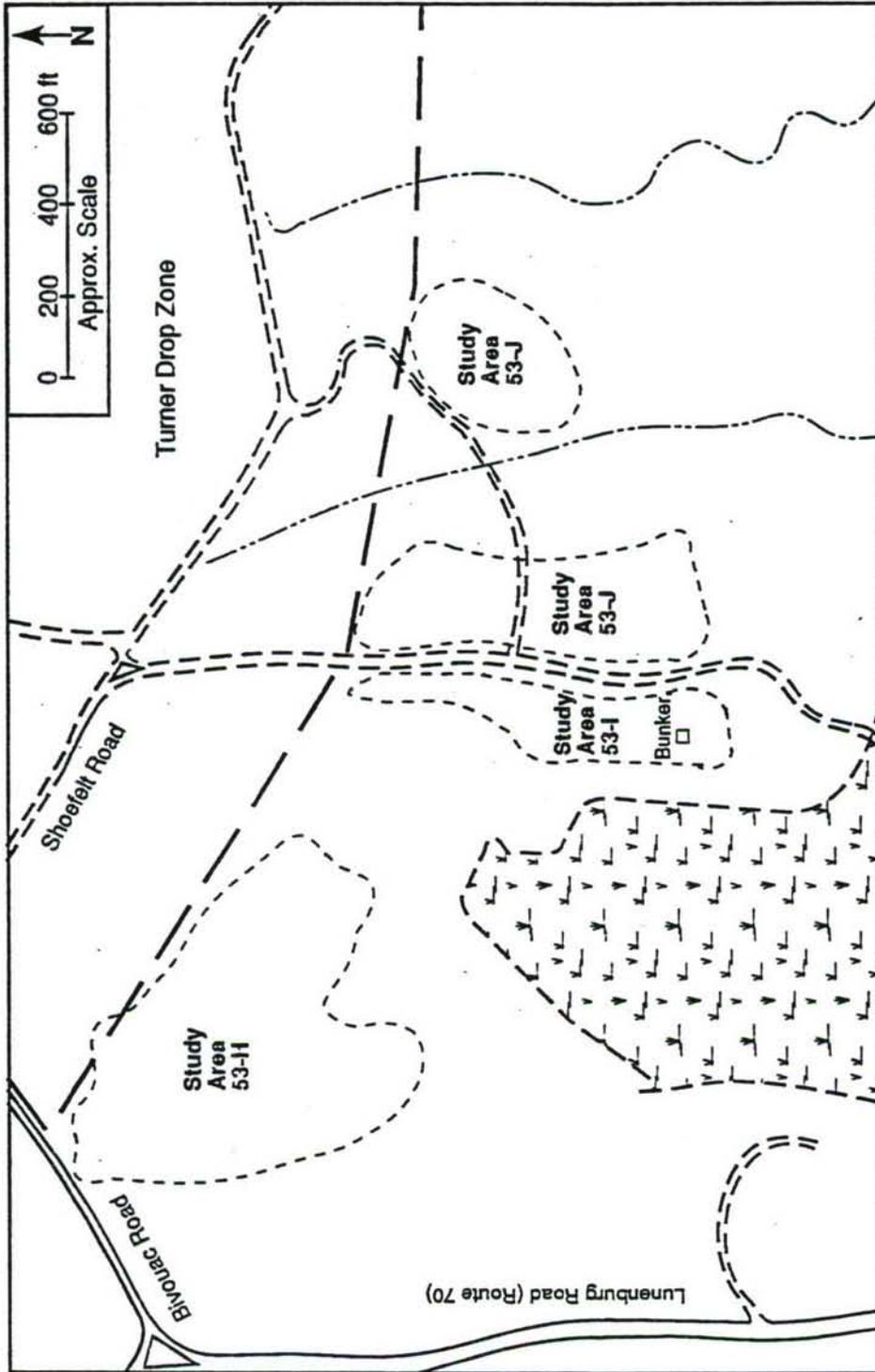


FIGURE 4.51 Locations of South Post POL Spill Areas SA 53-I, SA 53-J, and SA 53-K (Source: Map based on USA CF 1988)

#### 4.51 SA 55 – SHIRLEY HOUSING AREA TRAILER PARK (FUEL TANKS)

##### 4.51.1 Site History

The Shirley Housing Area Trailer Park (SA 55) is located in the northwest portion of the main cantonment area along Hoff and Lovell Streets (Fig. 4.52). Each of 30 privately owned trailers has a 225-gal underground tank formerly used for storing heating fuel (Prior 1991). Massachusetts requires removal of tanks that are no longer being used. To date, the contents of 24 tanks have been removed. The contents of six tanks (lots 6, 7, 11, 12, 13, and 14) have not been removed because porches or other permanent structures obstruct access to the tanks (Prior 1991). A five-year plan for the removal of the tanks was submitted to the state on May 8, 1991. The plan provides for removing the tanks as the occupants of the trailers are reassigned and leave.

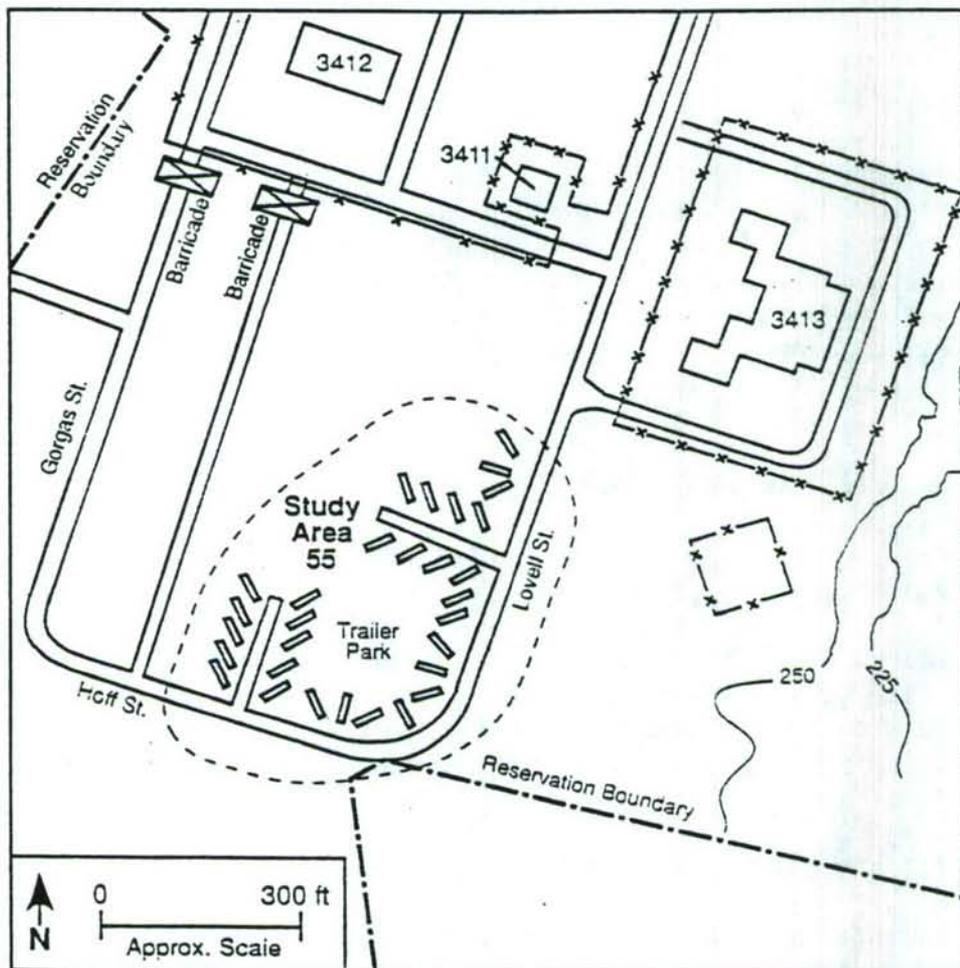


FIGURE 4.52 Location of SA 55, Shirley Housing Area Trailer Park (Source: Map based on Keene 1967)

#### 4.51.2 Geology and Hydrology

Although there have been no site-specific investigations in this area, the geology of this general area includes unconsolidated glacial deposits of undetermined thickness overlying Paleozoic metamorphic bedrock. The soils of this area are in the Quonset-Hinckley-Windsor Association, describes as droughty sand and gravelly soil underlain by stratified sand and gravel. This type of soil is well drained and has high permeability (Nicholls et al. 1980).

#### 4.51.3 Nature and Extent of Contamination

According to site personnel, contamination from some of the heating fuel tanks has been observed. There have been no investigations of this site, and the extent of contamination of soil or groundwater has not been determined. Because the closure of Fort Devens appears certain and would occur before the proposed five-year plan could be completed, the current phase of remedial action should include removal of the tanks and an assessment of the extent of contamination resulting from leaks.

#### 4.51.4 Proposed Action

A site reconnaissance should be performed, and surface soil samples from stained areas should be collected and analyzed for VOCs and TPH. In locations where contaminant concentrations are elevated, samples of subsurface soil should be obtained and analyzed for the elevated contaminant. If contaminant concentrations in the subsurface soil are significantly elevated, groundwater monitoring wells should be installed and sampled regularly for TPH and VOCs. If the groundwater contains significantly elevated contaminant concentrations, the extent of migration should be determined, and remedial action should be implemented.

### 4.52 SA 56 – BUILDING 2417 LEAKING UNDERGROUND STORAGE TANK SITE

#### 4.52.1 Site History

Building 2417 (SA 56) is located near Givry Street in the southwest portion of the main cantonment area (Fig. 4.53). One 1,000-gal UST that contained fuel oil was located between the southeast side of the building and an asphalt access road. It was removed on October 24, 1990 (Prior 1991). There was no evidence of piping associated with the tank.

#### 4.52.2 Geology and Hydrology

Information on site-specific geology in the main cantonment area is limited. Generally, the bedrock is a complex of metamorphic and igneous rocks that are intensely folded and faulted. The bedrock composition ranges from metasediments to granodiorite and is found from 0 to 100 ft below the surface (McMaster et al. 1982).

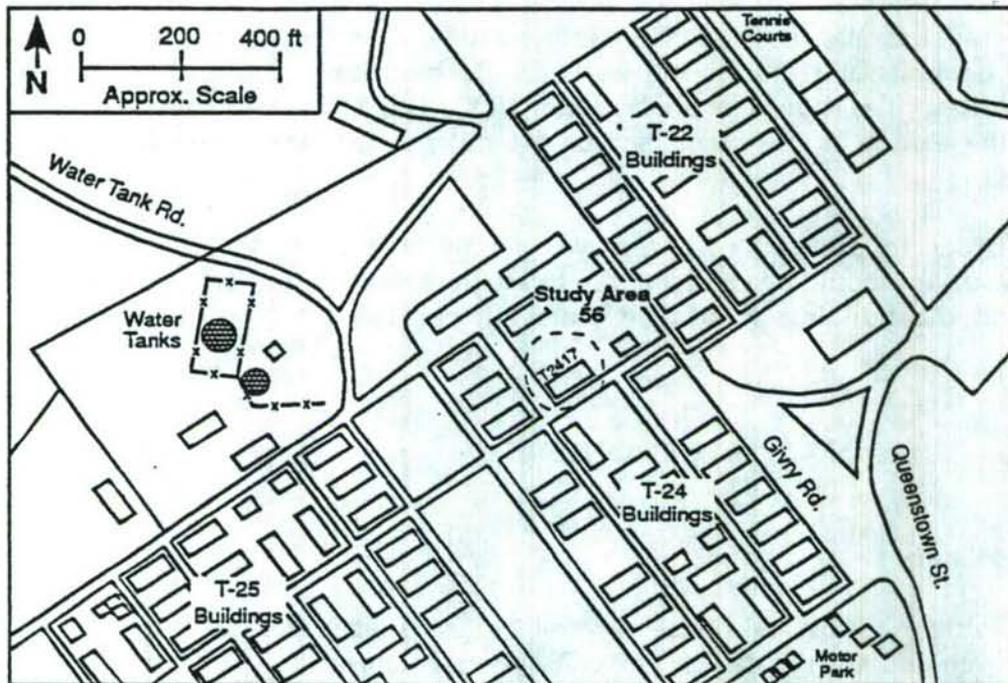


FIGURE 4.53 Location of SA 56, Building 2417 LUST Site (Source: Map based on Keene 1967)

The soils are probably of the Quonset-Hinckley-Windsor Association. These soils are described as droughty sand and gravel underlain by stratified sand and gravel. They are generally well drained and highly permeable. Groundwater flow in this area is eastward (McMaster et al. 1982).

#### 4.52.3 Nature and Extent of Contamination

When the tank was removed, there was a strong petroleum odor and stained soil was visible. The tank was filled with water (assumed to be from rain) and residual No. 2 fuel oil (Prior 1991). The water table, which was about 4 ft below the ground surface, appeared to contain no free product; however, a slight petroleum sheen was noted. The excavation extended from the edge of the building to the road. Further soil removal was not possible without risking damage to the building and a water main adjacent to the road. (Damage to the water main may have allowed any contamination to spread.) Two soil samples were obtained and analyzed for TPH. They contained 226 and 234 ppm TPH (Prior 1991).

Utility plans show that the 6-in. water main is parallel to the access road and immediately adjacent to the tank site (Prior 1991). Although the exact course of the water main could not be determined from the plans, it extends from water tanks on a hill above the site to another location in the main cantonment area. Because of the climate, it was probably placed at least 5 ft deep to prevent freezing.

Currently the excavation site is open; however, it will be backfilled until a decision is made on whether further remediation is required.

#### 4.52.4 Proposed Action

The site should be backfilled immediately in order to prevent any contaminant migration. Groundwater monitoring wells should be installed around the site and sampled regularly. All samples should be analyzed for VOCs and TPH. If contamination is detected in the wells, the extent of migration should be determined, and remedial action should be implemented.

In order to proceed with removal of any remaining soil that is contaminated, a geophysical survey should be conducted to locate the water main. The contaminated soil under the road and the building should be removed, perhaps in conjunction with base closure activities.

### 4.53 SA 57 – BUILDING 3713 FUEL OIL SPILL

#### 4.53.1 Site History

Building 3713 (SA 44) houses several industrial activities, including a repair shop for large Army vehicles such as tanks. In 1978, several thousand gallons of No. 4 fuel oil were spilled (Prior 1991). This was the result of accidentally overfilling a 30,000-gal underground storage tank. The fuel oil entered storm drains, which discharge to Cold Spring Brook (Fig. 4.46). Immediately downstream of the point where fuel oil entered the brook, an earthen dam was constructed to prevent the oil from traveling any farther.

#### 4.53.2 Geology and Hydrology

The geology and hydrology of this area are discussed in Sec. 4.41.

#### 4.53.3 Nature and Extent of Contamination

According to available information, there were some cleanup activities. It is believed that some earth-type adsorbents were used to soak up the oil (Prior 1991). The presence of an asphalt-like material interbedded with waste and soil on the banks of Cold Spring Brook (SA 40) would indicate that the spill was not completely cleaned up (the Cold Spring Brook site is discussed in further detail in Sec. 4.37). There is no further available information regarding the cleanup of this spill.

#### 4.53.4 Proposed Action

A site reconnaissance should be conducted. Surface soil samples from visibly stained areas should be collected and analyzed for VOCs and TPH. In locations where contaminant concentrations are elevated, samples of subsurface soil should be obtained and analyzed for the elevated contaminant. If contaminant concentrations are significantly elevated, groundwater monitoring wells should be installed and sampled regularly for TPH and VOCs. If the

groundwater contains significantly elevated concentrations of contaminants, the extent of migration should be determined, and remedial action should be implemented.

#### 4.54 SA 58 – BUILDINGS 2648 AND 2650 LEAKING UNDERGROUND STORAGE TANKS

##### 4.54.1 Site History

Buildings 2648 and 2650 are located in the southwestern portion of the main cantonment area (Fig. 4.54). According to available information, they were last used as storage buildings. In conjunction with the (partial) demolition of these buildings, two underground storage tanks formerly used for heating oil were removed (Prior 1991).

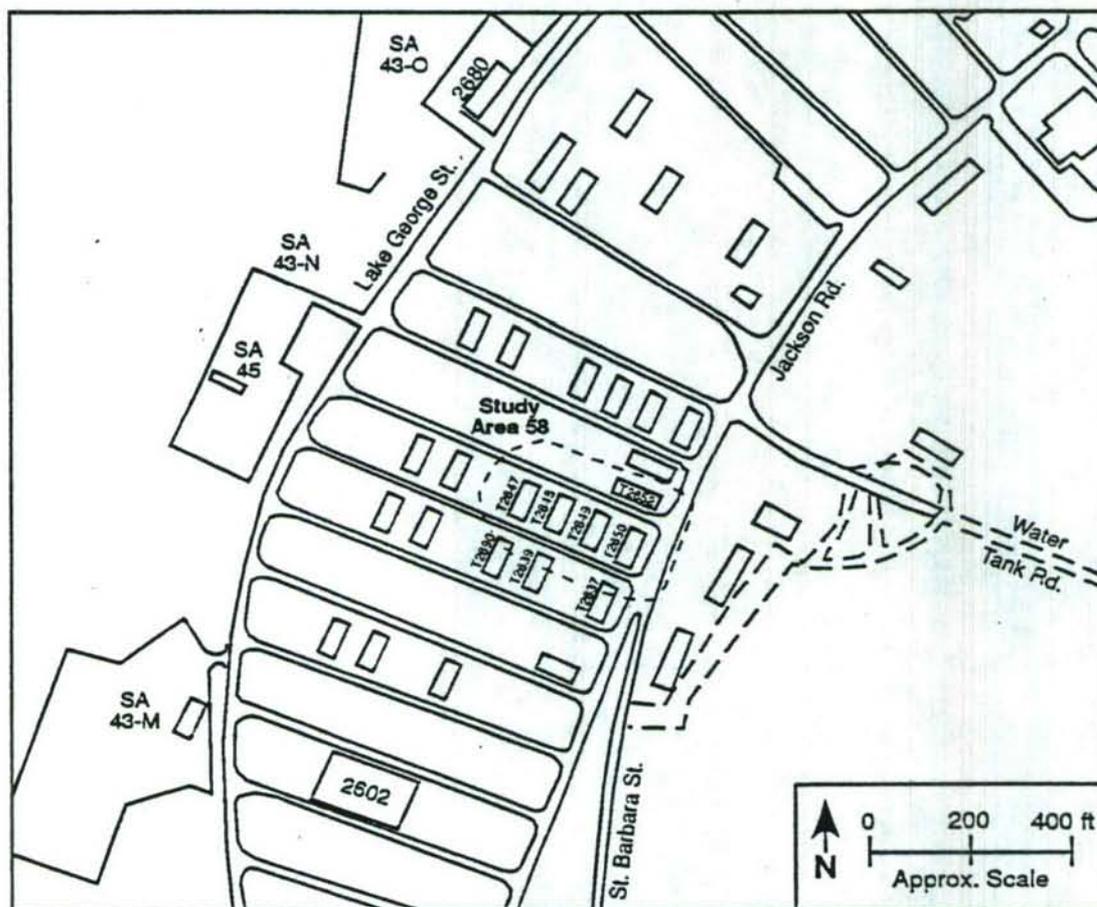


FIGURE 4.54 Location of SA 58, Buildings 2648 and 2650 LUST Site (Source: Map based on Keene 1967)

## 5 SUMMARY OF RECOMMENDED ACTIONS

### 5.1 RECOMMENDED SITE-SPECIFIC ACTIONS

This section summarizes the recommended actions for all of the study areas included in this MEP. Details of the recommendations and supporting rationale are provided in Sec. 4.

#### 5.1.1 SA 1 – Cutler Army Hospital Incinerator

- Analyze composite samples of incinerator ash quarterly for TCLP and PAH.
- Analyze ash samples for radionuclides and dioxin semiannually.
- Inspect area to determine runoff and potential drainage areas. Collect surface soil samples from these areas and analyze for HSL metals, TCLP, and dioxin.
- If significant contamination is found, expand the investigation.

#### 5.1.2 SA 2 – Veterinary Clinic Incinerator

- Analyze composite samples of incinerator ash quarterly for TCLP and PAH.
- Analyze ash samples for radionuclides and dioxin semiannually.
- Upgrade the Bldg. 1450 ventilation system to prevent soot intake.

#### 5.1.3 SA 3 – Intelligence School Incinerator

- Collect an ash sample from the incinerator and analyze it for TC metals, PAH, and dioxin.
- Collect surface soil samples from each side of the pad.
- Dismantle the incinerator and sample the underlying soil.
- Analyze all samples for total HSL metals and TC metals.
- If significant contamination is found, expand the investigation.

#### 5.1.4 SA 4 – Sanitary Landfill Incinerator

Include this study area in the action plan for SAs 5 and 18.

**5.1.5 SAs 5 and 18 – Sanitary Landfill (No. 1) and Asbestos Cell**

- Replace wells 1 and 2 and install five new monitoring wells.
- After developing the new wells, collect two rounds of samples from all wells.
- Measure water levels quarterly in all wells for one year to determine gradients.
- Conduct slug tests in all wells; if necessary, conduct pump tests.
- Sample any leachate flowing from the landfill.
- Collect 15 surface water and sediment samples from Plow Shop Pond.
- Analyze all samples for HSL compounds and explosives.

**5.1.6 SA 6 – Landfill No. 2**

- Examine aerial photographs and perform a field reconnaissance to locate the landfill. If necessary, conduct a geophysical survey.
- If it is located, sample the soil for indicator parameters. If it is not located, no further action is recommended.

**5.1.7 SA 7 – Landfill No. 3**

- Examine aerial photographs and perform a field reconnaissance to locate the landfill. If necessary, conduct a geophysical survey.
- If it is located, sample the soil for indicator parameters. If it is not located, no further action is recommended.

**5.1.8 SA 8 – Landfill No. 4**

- Examine aerial photographs and perform a field reconnaissance to locate the landfill. If necessary, conduct a geophysical survey.
- If it is located, sample the soil for indicator parameters. If it is not located, no further action is recommended.

**5.1.9 SA 9 – Landfill No. 5**

- Conduct a geophysical survey.
- Remove abandoned automobiles and parts and restrict access to the site.
- Inspect the area for visible staining or discoloration. Collect surface soil samples from these areas and excavate test pits. Analyze samples for TPH, asbestos, and HSL compounds.
- Install five groundwater monitoring wells and sample for HSL compounds and explosives.
- If significant contamination is found, expand the investigation.

**5.1.10 SA 10 – Landfill No. 6**

- Conduct a geophysical survey.
- Examine aerial photographs.
- Excavate test pits in the waste area to verify types of wastes disposed.
- Analyze samples for TC metals and asbestos.

**5.1.11 SA 11 – Landfill No. 7**

- Conduct a geophysical survey.
- Install monitoring wells.
- Sample soil and groundwater for HSL compounds, pesticides, and PCBs.

**5.1.12 SA 12 – Landfill No. 8**

- Determine the location and extent of the former landfill by conducting a geophysical survey, if practical, and inspecting the area for visible contamination.
- Collect four to six surface water and sediment samples downgradient from the fill area in the wetlands and analyze for HSL compounds, TPH, and explosives.
- If warranted by analytic results, install soil borings and monitoring wells to determine the extent of contamination.
- Remove any debris from the area.

**5.1.13 SA 13 – Landfill No. 9**

- Determine the location and extent of the former landfill by conducting a geophysical survey and inspecting the area for visible contamination.
- Collect surface soil samples from three locations in the gully.
- Install four monitoring wells (one upgradient of the site and three downgradient, between the site and the river) and collect samples.
- Analyze all samples for HSL compounds, TPH, and explosives.
- If warranted by analytic results, conduct additional studies to determine the extent of contamination.

**5.1.14 SA 14 – Landfill No. 10**

- Sample surface water and sediment and analyze for explosives, TOC, and HSL compounds.
- Restrict access to the quarry.
- If significant contamination is found, conduct a remedial investigation.

**5.1.15 SA 15 – Landfill No. 11**

- Drill four soil borings to the water table and sample the cores at 2.5-ft intervals for TPH, HSL metals, and TC metals.
- If significant contamination is found, install monitoring wells for further site characterization.

**5.1.16 SA 16 – Shoppette Landfill (No. 12)**

- Conduct a geophysical survey.
- Excavate two test pits and sample the soil for HSL compounds and TPH.

**5.1.17 SA 17 – Little Mirror Lake (Landfill No. 13)**

- Conduct a record search of the 14th Ordnance Detachment to detail the removal of grenades.
- If necessary, conduct an underwater reconnaissance.

- Collect surface water and sediment samples and analyze for TC metals and explosives.
- If significant contaminant levels are found, expand the investigation.

**5.1.18 SAs 19-21 – Wastewater Treatment Plant, Rapid Infiltration Beds, and Sludge Drying Beds**

- Sample the existing wells and analyze for HSL compounds, explosives, and parameters identified in Table 4.18.
- Collect eight to ten surface water and sediment samples from the river and analyze for HSL compounds and explosives.
- Collect three surface soil samples from the wetland and analyze for HSL compounds and explosives.
- If contamination is found, expand the investigation.
- Monitor the groundwater annually as long as the WWTP is active.

**5.1.19 SA 22 – Hazardous Waste Storage Facility at Building 1650**

- Conduct an inspection of the facility.
- If no releases are documented, no further action is recommended.

**5.1.20 SA 23 – Paper Recycling Center**

No action is recommended. The site should be removed from the list of Fort Devens study areas.

**5.1.21 SA 24 – Waste Explosives Storage Bunker 187**

- Inspect the bunker entry area, its perimeter, and all loading areas.
- Collect three surface soil samples from random locations in the entrance.
- Analyze all samples for explosives and TC metals.
- Remove any soil identified as contaminated and take confirmation samples from the areas in question.

**5.1.22 SA 25 – Waste Explosives Detonation Range (EOD Range)**

- Install one upgradient and three downgradient monitoring wells.
- Sample wells for HSL compounds, TPH, and explosives.
- Locate the springs downgradient from the site and sample them for HSL compounds, TPH, and explosives.
- Remove all loose debris and metal.

**5.1.23 SA 26 – Waste Explosives Detonation Range (Zulu I and II)**

- Construct sample grids across the most frequently used portions of each range.
- Institute annual or biannual sampling at each range.

**5.1.23.1 Zulu I**

- Drill about 12 soil borings to 10 ft and analyze samples from the top, middle, and bottom of each core for HSL compounds, explosives, TPH, and TC metals.
- If warranted by analytic results, implement a more in-depth study.

**5.1.23.2 Zulu II**

- Drill six to ten soil borings to 10 ft. Analyze the top, middle, and bottom of each core for HSL compounds, explosives, TPH, and TC metals.
- If warranted by analytic results, implement a more in-depth study.

**5.1.24 SA 27 – Waste Explosives Detonation Range (Hotel)**

- Perform a geophysical survey.
- Drill about eight soil borings to 10 ft and analyze the top, middle, and bottom of each core for HSL compounds, explosives, TPH, and TC metals.
- If warranted by sample analyses, install a minimum of one upgradient and three downgradient wells. Sample wells quarterly for contaminants of concern.
- Institute annual or biannual sampling.

**5.1.25 SA 28 – Hand-Grenade Range J**

- Perform a site reconnaissance.
- Collect surface soil samples from random locations and analyze for explosives.

**5.1.26 SA 29 – Transformer Storage Area at the DEH Yard**

- Inspect the open yard area for visible staining and discoloration.
- Collect surface soil samples from each stained area.
- Collected six random soil samples from the yard area used to store PCB items.
- Analyze all samples for PCBs.
- If PCB levels are 25 ppm or greater, drill soil borings to 10 ft to determine the extent of contamination.
- Excavate all contaminated areas and conduct confirmation sampling to verify cleanup.

**5.1.27 SA 30 – Moore Army Airfield Drum Storage Area**

- Collect one soil sample from the center of each edge of the drum storage pad and four soil samples to the river at 50-ft intervals; collect samples from depths of 0.5-1.0, 3.0-3.5, and 4.5-5.0 ft.
- Analyze stained soil for HSL compounds, TC compounds, and TPH.
- Collect four surface water and sediment samples at the river's edge.
- Analyze all surface water samples for HSL compounds and TPH.
- Analyze sediment samples for HSL compounds, TPH, and TOC.
- If contamination is found, expand the investigation.

**5.1.28 SA 31 – Moore Army Airfield Firefighting Training Area**

- Collect five soil samples from beneath the pad at 1.0- to 1.5-ft depths and analyze for HSL compounds, TC compounds, and TPH.
- Install four monitoring wells (one upgradient and three downgradient); sample groundwater for HSL compounds and TPH.

**5.1.29 SA 32 – DRMO Yard (Bldg. 209)**

- Collect at least three soil samples from each area of exposed soil (within the yards) and about eight samples from perimeter areas that receive runoff.
- Analyze all samples for HSL compounds, TC metals, platinum, and TPH.
- If elevated contaminant levels are found, drill soil borings to groundwater to determine the extent of contamination. If warranted, install monitoring wells. Analyze for detected contaminants.

**5.1.30 SA 33 – DEH Entomology Shop (Bldg. 262)**

- Check the Bldg. 262 ventilation system.
- Collect four surface soil samples near the entrance of the building and analyze for pesticides, herbicides, phosphate, and nitrate.
- If elevated concentrations of pesticides or herbicides are found, soil should be analyzed for TC compounds.
- If warranted by the analytic results, expand the investigation.

**5.1.31 SA 34 – Former DEH Entomology Shop at Building 245**

- Collect surface soil samples from four locations that were used to prepare pesticide and herbicide solutions; collect samples at depths of 0, 2, 4, and 6 ft at the sink drain discharge.
- Analyze all samples for pesticides, herbicides, phosphate, and nitrate.
- If elevated concentrations of pesticides or herbicides are found, soil should be analyzed for TC compounds.
- If warranted by the analytic results, expand the investigation.

**5.1.32 SA 35 – Former DEH Entomology Shop at Building 254**

- Collect four surface soil samples from locations that were used to prepare pesticide and herbicide solutions; analyze for pesticides, herbicides, phosphate, and nitrate.
- If elevated concentrations of pesticides or herbicides are found, soil should be analyzed for TC compounds.
- If warranted by analytic results, expand the investigation.

**5.1.33 SA 36 – Former DEH Entomology Shop at Building 2728**

- Collect eight surface soil samples from locations that were used to prepare pesticide and herbicide solutions; analyze for pesticides, herbicides, phosphate, and nitrate.
- If elevated concentrations of pesticides or herbicides are found, soil should be analyzed for TC compounds.
- If warranted by analytic results, expand the investigation.

**5.1.34 SA 37 – Golf Course Entomology Shop (Bldg. 3622)**

- Collect six surface soil samples around the perimeter of the building and analyze them for VOCs, TPH, pesticides, herbicides, phosphate, and nitrate.
- If warranted by analytic results, expand the investigation.

**5.1.35 SA 38 – Battery Repair Area (Bldg. 3713)**

- Install four monitoring wells on the east side of the building to bedrock or groundwater.
- Collect three surface water and sediment samples from Cold Spring Brook.
- Analyze all samples for HSL compounds.
- If warranted by analytic results, expand the investigation.

**5.1.36 SA 39 – Transformer near Building 4250**

Present the results of confirmation samples to the MDEP for approval of the final levels obtained during excavation and removal. This site should be removed from the list of Fort Devens study areas.

**5.1.37 SA 40 – Cold Spring Brook Landfill**

- Collect samples from the existing monitoring wells.
- Collect about ten surface water and sediment samples along the edge of the fill area on the brook side.
- Drill ten soil borings to 5 ft and sample the cores at depths of 0.5-1.0, 2.5-3.0, and 4.5-5.0 ft.
- Analyze all samples for HSL compounds, explosives, and TPH.

- Evaluate sediment grain size and analyze for TOC.
- Measure water levels quarterly to define the groundwater flow direction and gradient.
- If warranted by analytic results and water level measurements, install additional monitoring wells to further characterize the area.

#### **5.1.38 SA 41 – Unauthorized Dumping Area (Site A)**

- Drill nine 10-ft soil borings in the fill area and sample the cores at 0.5-1.0 and 2.5-3.0 ft.
- Collect five surface water and sediment samples from the base of the embankment.
- Analyze all samples for HSL compounds and explosives.
- If warranted by analytic results, expand the investigation.
- Remove all loose debris and metal.

#### **5.1.39 SA 42 -- Popping Furnace**

- Drill four 3-ft soil borings around furnace area and sample the cores at 0.5-1.0 and 2.5-3.0 ft.
- Collect three surface water and sediment samples from the wetlands.
- Analyze all samples for HSL compounds, explosives, and TC metals.
- Remove all loose debris and metal.

#### **5.1.40 SAs 43 and 54 – Historic Gas Station Sites**

- Search Fort Devens records to obtain additional information about the locations of the underground storage tanks.
- Perform a geophysical survey and soil gas analysis to confirm the locations.
- Notify the MDEP of all activities prior to action.

- Excavate around the tanks and sample the surrounding soil for TPH. Remove all soil with elevated contaminant levels and conduct confirmation sampling.
- If there is no indication of contamination, the tanks may remain in the ground if they are filled with sand or another harmless, inert solid.

#### 5.1.41 SA 44 – Cannibalization Yard (Bldg. 3713)

- Drill six soil borings to 10 ft and sample cores at 2-ft intervals.
- Analyze samples for HSL compounds and TPH.
- If warranted by analytic results, install groundwater monitoring wells upgradient and downgradient of the site to determine the extent of contamination.
- Monitor the use of this site and periodically check soil for contamination.

#### 5.1.42 SA 45 – Lake George Street Vehicle Wash Area

- Trace the sewer lines to determine if and how the drains from the wash bays are connected to the sewer. If a connection is found, take appropriate action to prevent unpermitted discharge into the sewer system.
- If drains are not connected, determine the actual discharge point(s). If the outfall is uncontrolled, collect surface soil samples and analyze for HSL compounds, PCBs, and TPH.
- If warranted by analytic results, expand the investigation.

#### 5.1.43 SA 46 – Training Area 6d

- Collect three surface soil samples and analyze for HSL compounds, TPH, and explosives.
- If warranted by analytic results, expand the investigation.

#### 5.1.44 SA 47 – Moore Army Air Field Leaking Underground Storage Tank Site

- Install groundwater monitoring wells and sample quarterly for TPH and VOCs.
- If contaminant concentrations are elevated, expand the investigation.

**5.1.45 SA 48 – Building 202 Leaking Underground Storage Tank Site**

- Drill soil borings to groundwater and sample soil for TPH and VOCs.
- Install three groundwater monitoring wells and analyze samples for TPH and VOCs.
- If contaminant concentrations are elevated, expand the investigation.

**5.1.46 SA 49 – Building 3602 Leaking Underground Storage Tank Site**

- Drill soil borings to groundwater and sample soil for TPH and VOCs.
- If contaminant concentrations are elevated, expand the investigation.

**5.1.47 SA 50 – WWII Aircraft Fuel System**

- Inspect the piping system and the surrounding soils.
- Trace the locations of the associated underground storage tanks.
- Collect soil samples and analyze for TPH and VOCs.
- If contaminant concentrations are elevated, expand the investigation.

**5.1.48 SA 51 – O'Neil Building Spill Site**

- Perform a site reconnaissance.
- Collect soil samples from areas with significant staining.
- In all areas with significant staining, drill soil borings to groundwater and obtain soil and groundwater samples.
- Analyze all samples for TPH and VOCs.
- If contaminant concentrations are elevated, expand the investigation.

**5.1.49 SA 52 – TDA Maintenance Yard (Class III Leak, Storage Yard)**

- In significantly stained areas, drill 10-ft. soil borings and analyze samples for TPH and volatile and semivolatile organic compounds.
- If contaminant concentrations are significantly elevated, install groundwater monitoring wells and sample regularly.

**5.1.50 SA 53 – South Post POL Spill Areas**

- Conduct a site reconnaissance.
- Obtain surface soil, surface water, and sediment samples (as appropriate for each site) from areas with visible staining and analyze all samples for TPH and volatile organic compounds.
- If contaminant concentrations are elevated, expand the investigation.

**5.1.51 SA 55 – Shirley Housing Area Trailer Park (fuel tanks)**

- Conduct a site reconnaissance.
- Obtain surface soil samples from stained areas and analyze for VOCs and TPH.
- In locations where contaminant concentrations are elevated, obtain subsurface soil samples and analyze them for the elevated contaminant.
- If contaminant concentrations in the subsurface soil are significantly elevated, install groundwater monitoring wells and sample regularly for TPH and VOCs.
- If contaminant concentrations are elevated, expand the investigation.

**5.1.52 SA 56 – Building 2417 Leaking Underground Storage Tank Site**

- Conduct a geophysical survey to locate the water main.
- Backfill the site in order to prevent any contaminant migration.
- Remove the contaminated soil under the road and the building.
- Install groundwater monitoring wells around the site and sample regularly.
- Analyze all samples for VOCs and TPH.
- If contamination is detected in the wells, expand the investigation.

**5.1.53 SA 56 – Building 3713 Fuel Oil Spill**

- Conduct a site reconnaissance.
- Obtain surface soil samples from visibly stained areas and analyze them for VOCs and TPH.

- In locations where contaminant concentrations are elevated, obtain samples of subsurface soil and analyze them for the elevated contaminant.
- If contaminant concentrations are elevated, expand the investigation.

#### **5.1.54 SA 57 – Buildings 2648 and 2650 Leaking Underground Storage Tanks**

- Backfill the site in order to prevent any contaminant migration.
- Install groundwater monitoring wells around the site and sample regularly.
- Analyze all samples for VOCs and TPH.
- If contaminant concentrations are elevated, expand the investigation.

## **5.2 RECOMMENDATIONS FOR GENERAL EVALUATIONS**

It became apparent to the authors when preparing this document that additional environmental studies, other than those associated with the 58 study areas, should be conducted at Fort Devens. These studies are detailed below.

### **5.2.1 Hydrogeological Conditions**

Detailed information on the hydrogeological conditions of Fort Devens is lacking. The groundwater and surface water of Fort Devens are an important resource easily affected by surface activities. Lack of definitive subsurface hydrogeological data in numerous cases prevented detailed site-specific monitoring recommendations.

In order to adequately evaluate the site-specific hydrogeology, the following information is needed: (1) the current condition of wells, including an assessment of well construction details, groundwater elevations, and pump test results and (2) data analyses of the overall quality of the groundwater. Mapping of bedrock in parts of the installation may be necessary. These activities will occur as part of the Group IA and Group IB investigations (see Sec. 6).

### **5.2.2 Quality of Surface Water**

The following information is needed to complete a study of site-wide surface water quality: analysis of existing data; designation of water types; baseline surveys of all wetlands; assessment of the impacts of drainage; and a site-wide evaluation of the quality of surface water and sediment. The analyses of existing data and the water and sediment evaluation were started with the Group IA RI and the Group 1B SI (Sec. 6).

### 5.2.3 Soils

Site-wide investigations of soils at Fort Devens have been conducted in the past by both the Army and outside contractors. These investigations have determined soil types and background concentrations of various inorganic compounds. This existing data should be reviewed in order to identify additional data requirements.

### 5.2.4 Natural Resources

Many previous investigations contain summaries of the natural resources at Fort Devens; however, much of this information is not specific enough about the SAs being investigated. A thorough understanding of these resources is essential for ecological assessment. A phased approach that parallels the priority ordering of the AOCs and SAs is recommended and would develop as follows: as sites are redesignated from SAs to AOCs, ecological risk assessments would be scheduled as part of each RI. Since many locations contain multiple SAs (not all of which will be redesignated), all of the SAs within the area of an AOC would be included in the assessment. By using this approach, the data base will develop progressively and eventually encompass enough of the installation to provide both site-specific and installation-wide assessment of ecological risk.

## 6 PRIORITIES FOR RESPONSE ACTIONS

Because of the age of Fort Devens, no records are available on some of the activities that have been conducted there, and some of the study areas could not be specifically located. However, several factors must be considered when establishing priorities for investigation and possible remedial action. Fort Devens has always been a processing center and training base. Because its mission has never been industrial, many of the problems associated with industrial activities do not exist. Because of the large number of SAs and AOCs, the sites have been segregated into groups (1A, 1B, and 2 through 12) to facilitate their investigation. Sites with similar waste types or sites located in proximity to each other were grouped together. The rationale for the order of priority assigned to the study areas in this section is presented in the following paragraphs. Table 6.1 summarizes the group each SA and AOC has been placed into and explains the rationale for priority ranking.

Six prevailing types of waste generation are considered by this MEP: (1) landfilling, (2) wastewater treatment, (3) waste explosives storage and disposal, (4) chemical, pesticide, and herbicide storage, (5) incineration, and (6) miscellaneous activities. The impacts from these activities have been considered based on information available at the time of the study and the best judgment of the authors. Priorities have been developed according to existing or potential impacts to public health and the environment and geographical location.

The characteristics associated with some of the study areas warrant a higher priority for action than others. An implicit ordering was used that places priority, from highest to lowest, on (1) protection of public health and the environment, (2) protection of groundwater and surface water, and (3) protection of soil. This ranking led to the use of the following priority categories:

1. *High* priority for action. All group 1 study areas have known contamination. Group 1A includes sites that have ongoing remedial investigations. Group 1B includes sites that have ongoing site inspections.
2. *Moderate to high* priority for action. Study areas in groups 3, 5, and 6 have moderate to high potential for releasing contaminants to soil or water.
3. *Moderate* priority for action. Study areas in groups 2 and 7 have a moderate potential for releasing contaminants.
4. *Low to moderate* priority for action. Study areas in groups 4, 8, and 11 have low to moderate potential for releasing contamination to soil or no potential for releasing contamination.
5. *Low* priority for action. Study areas in groups 9 and 10 have low potential for releasing contaminants.
6. *No action*. Study areas in group 12 have no potential for contamination or do not meet the definition of a study area.

TABLE 6.1 Priorities and Rationales for Response Actions

| SA/<br>AOC   | Group | Rationale   |
|--------------|-------|---|
| 1            | 11    | Incinerator is deteriorated, possibly dispersing ash.   |
| 2            | 11    | Incinerator is in the basement of Bldg. 1450. Ash samples have tested negative for EP toxicity.   |
| 3            | 11    | Incinerator was only used to dispose of paper and has not been used since 1976.   |
| 4<br>5<br>18 | 1A    | Study areas are all part of the sanitary landfill, which has known groundwater contamination. Study areas are near the town of Ayer.  |
| 6            | 10    | Landfill was operated circa 1850-1920, before Fort Devens owned the property. Wastes probably consisted of household rubbish and debris from local residences.  |
| 7            | 10    | Landfill was operated circa 1850-1920, before Fort Devens owned the property. It was a local dump for household rubbish and glass.  |
| 8            | 10    | Landfill was operated circa 1900-1930 for the disposal of household rubbish. The exact location is unknown.   |
| 9            | 5     | Uncontrolled access creates the potential for unauthorized disposal. Sandy soils are highly permeable, and abandoned automobiles may be a source of contaminants.   |
| 10           | 9     | Records show that the landfill received only construction debris from the demolition of six warehouses (T955-T960).   |
| 11           | 9     | Records show that the area received only tree limbs and vegetation.   |
| 12           | 7     | No disposal records exist. It is reported that disposal was limited to construction materials, wire, wood, and other inert materials. A potential exists for unauthorized disposal. Soils are highly permeable. |
| 13           | 2     | Possible disposal of waste oil has been reported. Landfill is near the Nashua River.  |
| 14           | 7     | Abandoned automobiles may be a source of contaminants.  |
| 15           | 1B    | Study area consists of unlined pits in which fuel oil was burned.   |
| 16           | 8     | Records show that disposal was limited to metal chains and some debris. Operations lasted for only three weeks.   |
| 17           | 8     | There is no documentation that removal of the grenades was complete. Deterioration of grenades could possibly release explosives.   |

TABLE 6.1 (Cont'd)

| SA/<br>AOC | Group | Rationale   |
|------------|-------|---|
| 19-21      | 5     | Known groundwater contamination exists. The site is hydrologically connected to the Nashua River.   |
| 22         | -     | Wastes are stored in conforming storage. Site will be deleted from list of study areas requiring further investigation.   |
| 23         | -     | This site is no longer in use and at no time met the definition of a study area.  |
| 24         | 1B    | Potential for spills or releases of explosives is low.  |
| 25         | 1B    | Soil is contaminated with metals and low levels of explosives and volatiles. Site has possible hydrological connection to Slate Rock Brook.                                 |
| 26         | 1B    | Study area is potentially contaminated with organics. Site has possible hydrological connection with adjacent wetlands and the Nashua River.                                |
| 27         | 7     | Study area is potentially contaminated with organics. Site has possible hydrological connection with Cranberry Pond. Surface water runoff may enter the pond.               |
| 28         | 7     | The site was converted to an obstacle course in 1970. No burning or disposal has occurred at this site.   |
| 29         | 8     | Past storage of PCB items did not meet conforming storage requirements.   |
| 30         | 6     | Surface water and soil were potentially contaminated with HSL compounds from spills and standard operating practices.   |
| 31         | 6     | Groundwater and soil are potentially contaminated with HSL compounds due to use of a deteriorated pad during training practices.  |
| 32         | 1B    | The nature of the operations create a potential for an unrecognized contribution to contamination in the area. Study area is near the town of Ayer.                         |
| 33         | 4     | Past operating practices may have released pesticides and herbicides into the environment.  |
| 34         | 4     | Past operating practices may have released pesticides and herbicides into the environment. Pesticides may have been directly discharged to the ground from the mixing area. |
| 35         | 4     | Past operating practices may have released pesticides and herbicides into the environment.  |
| 36         | 4     | Past operating practices may have released pesticides and herbicides into the environment.  |

TABLE 6.1 (Cont'd)

| SA/<br>AOC | Group | Rationale   |
|------------|-------|---|
| 37         | 4     | Past operating practices may have released pesticides and herbicides into the environment.  |
| 38         | 3     | Potential impact from past disposal practices (for acids and other unknown substances). Study area is probably hydrologically connected with surface water and groundwater.   |
| 39         | 8     | Contaminated soils have been removed. The property is no longer owned by Fort Devens.   |
| 40         | 1A    | Groundwater is known to be contaminated by volatile and semivolatile organics and arsenic. Soil, surface water, and sediments contain elevated concentrations of volatile organics and metals. Study area is near the Patton production well. |
| 41         | 7     | Potential exists for unauthorized disposal of hazardous wastes. Site is near wetlands and is probably hydrologically connected with surface water and groundwater.  |
| 42         | 7     | Study area is potentially contaminated with explosives. Site is near wetlands and is probably hydrologically connected with surface water and groundwater.  |
| 43<br>54   | 2     | Fort Devens is potentially liable for USTs that have not undergone approved closure. Contaminated soils have been removed. Potential for releases of used petroleum.  |
| 44         | 3     | Study area is possibly contaminated from operations. Site is probably hydrologically connected with surface water and groundwater.  |
| 45         | 2     | Used petroleum products are potentially released through unknown discharge points.  |
| 46         | 10    | Unknown activities may have released contaminants to the environment.   |
| 47         | 6     | Contaminated soils have been removed. Potential for releases of used petroleum products. Site is probably hydrologically connected with surface and groundwater.  |
| 48         | 1B    | Contaminated soils have been removed. Potential for releases of used petroleum products.  |
| 49         | 2     | Contaminated soils have been removed. Potential for releases of used petroleum products.  |
| 50         | 6     | Contaminated soils have been removed. Potential for releases of used petroleum products.  |

TABLE 6.1 (Cont'd)

| SA/<br>AOC | Group | Rationale  |
|------------|-------|--|
| 51         | 9     | Contaminated soils have been removed. Potential for releases of used petroleum products. Site is probably hydrologically connected with surface and groundwater. |
| 52         | 3     | Contaminated soils have been removed. Potential for releases of used petroleum products. Site is probably hydrologically connected with surface and groundwater. |
| 53         | 10    | Presence of multiple spill areas creates a potential for releases of used petroleum products. Sites have been used over a long period of time.                   |
| 55         | 9     | Potential for releases of heating fuel from underground storage tanks.   |
| 56         | 2     | Contaminated soils have been removed. Potential for releases of used petroleum products from open excavation.  |
| 57         | 2     | Overfilling of an underground storage tank caused a major spill of fuel oil. Potential for releases of fuel oil from this area.                                  |
| 58         | 2     | Contaminated soils have been removed. Potential for release of contaminants from residual concentrations in open excavation.                                     |

The 58 study areas are listed in these priority categories in Table 6.2. Priorities are subject to change based on the availability of new information. Because sampling and investigations are being recommended for all priority categories except for priority category 6, study areas have not been assigned individual priorities within a group. As the study areas are further characterized, development of priorities for individual sites may be appropriate.

TABLE 6.2 Priority Grouping of Study Areas

| Priority Category | Group No. | Study Area or Area of Concern |  |
|-------------------|-----------|-------------------------------|--|
|                   |           | No.                           | Name   |
| 1                 | Group 1A  | 4                             | Sanitary landfill incinerator                          |
|                   |           | 5                             | Sanitary landfill                                      |
|                   |           | 18                            | Sanitary landfill asbestos cell                        |
|                   |           | 40                            | Cold Spring Brook landfill                             |
|                   | Group 1B  | 15                            | Landfill No. 11  |
|                   |           | 24                            | Waste explosives storage bunker 187                    |
|                   |           | 25                            | Waste explosives detonation range (EOD range)          |
|                   |           | 26                            | Waste explosives detonation range (Zulu I and II)      |
|                   |           | 32                            | DRMO yard  |
|                   |           | 48                            | Bldg. 202 LUST site                                    |
| 3                 | Group 2   | 13                            | Landfill No. 9   |
|                   |           | 43,                           | Historic gas station sites                             |
|                   |           | 54                            |  |
|                   |           | 45                            | Lake George Street vehicle wash area                   |
|                   |           | 49                            | Bldg. 3602 LUST site                                   |
|                   |           | 54                            | Bldg. 2680 LUST site (same as 43 - 0)                  |
|                   |           | 56                            | Bldg. 2417 leaking underground storage tank            |
|                   |           | 57                            | Bldg. 3713 fuel oil spill                              |
|                   |           | 58                            | Bldgs. 2648 and 2650 leaking underground storage tanks |
| 2                 | Group 3   | 38                            | Battery repair area                                    |
|                   |           | 44                            | Cannibalization yard                                   |
|                   |           | 52                            | TDA Maintenance Yard                                   |
| 4                 | Group 4   | 33                            | DEH entomology shop (Bldg. 262)                        |
|                   |           | 34                            | Former DEH entomology shop at Bldg. 245                |
|                   |           | 35                            | Former DEH entomology shop at Bldg. 254                |
|                   |           | 36                            | Former DEH entomology shop at Bldg. 2728               |
|                   |           | 37                            | Golf course entomology shop (Bldg. 3622)               |
| 2                 | Group 5   | 9                             | Landfill No. 5   |
|                   |           | 19                            | Wastewater treatment plant                             |
|                   |           | 20                            | Rapid infiltration beds                                |
|                   |           | 21                            | Sludge drying beds                                     |
| 2                 | Group 6   | 30                            | Moore Army Airfield drum storage area                  |
|                   |           | 31                            | Moore Army Airfield fire-fighting training area        |
|                   |           | 47                            | Moore Army Airfield LUST site (Bldg. 3816)             |
|                   |           | 50                            | WWII aircraft fuel system                              |

TABLE 6.2 (Cont'd)

| Priority Category | Group No. | Study Area or Area of Concern |  |
|-------------------|-----------|-------------------------------|--|
|                   |           | No.                           | Name   |
| 3                 | Group 7   | 12                            | Landfill No. 8                                       |
|                   |           | 14                            | Landfill No. 10                                      |
|                   |           | 27                            | Waste explosives detonation range (Hotel)            |
|                   |           | 28                            | Waste explosives detonation range (training area 14) |
|                   |           | 41                            | Unauthorized dumping area (site A)                   |
|                   |           | 42                            | Popping furnace                                      |
| 4                 | Group 8   | 16                            | Landfill No. 12                                      |
|                   |           | 17                            | Little Mirror Lake (landfill No. 13)                 |
|                   |           | 29                            | Transformer storage area                             |
|                   |           | 39                            | Transformer near Bldg. 4250                          |
|                   |           | 55                            | Shirley housing area trailer park (fuel tanks)       |
| 5                 | Group 9   | 10                            | Landfill No. 6                                       |
|                   |           | 11                            | Landfill No. 7                                       |
|                   |           | 51                            | O'Neil building spill site                           |
| 5                 | Group 10  | 6                             | Landfill No. 2                                       |
|                   |           | 7                             | Landfill No. 3                                       |
|                   |           | 8                             | Landfill No. 4                                       |
|                   |           | 46                            | Training area 6d                                     |
|                   |           | 53                            | South post POL spill areas                           |
| 4                 | Group 11  | 1                             | Cutler Army Hospital incinerator                     |
|                   |           | 2                             | Veterinary clinic incinerator                        |
|                   |           | 3                             | Intelligence School incinerator                      |
| 6                 | Group 12  | 22                            | Hazardous waste storage facility at Bldg. 1650       |
|                   |           | 23                            | Paper recycling center                               |

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**APPENDIX A:**  
**BIOTA IN THE VICINITY OF FORT DEVENS**

TABLE A.1 Vegetation Identified at Fort Devens

| Classification                | Common Name(s)      |
|-------------------------------|---------------------|
| <u>Tree Species (47)</u>      |                     |
| Aceraceae                     |                     |
| <i>Acer rubrum</i>            | Red maple           |
| <i>Acer saccharum</i>         | Sugar maple         |
| Anacardiaceae                 |                     |
| <i>Cotinus obovatus</i>       | Smoketree           |
| Cornaceae                     |                     |
| <i>Cornus florida</i>         | Flowering dogwood   |
| Corylaceae                    |                     |
| <i>Betula lenta</i>           | Black birch         |
| <i>Betula papyrifera</i>      | White birch         |
| <i>Betula populifolia</i>     | Gray birch          |
| <i>Carpinus Caroliniana</i>   | Hornbeam, ironwood  |
| <i>Ostrya Virginiana</i>      | Hop hornbeam        |
| Fagaceae                      |                     |
| <i>Castanea dentata</i>       | Chestnut            |
| <i>Quercus alba</i>           | White oak           |
| <i>Quercus bicolor</i>        | Swamp white oak     |
| <i>Quercus borealis</i>       | Northern red oak    |
| <i>Quercus coccinea</i>       | Scarlet oak         |
| <i>Quercus ilicifolia</i>     | Scrub oak           |
| <i>Quercus palustris</i>      | Pin oak             |
| <i>Quercus prinus</i>         | Chestnut oak        |
| <i>Quercus rubra</i>          | Red oak             |
| <i>Quercus velutina</i>       | Black oak           |
| Juglandaceae                  |                     |
| <i>Carya glabra</i>           | Pignut hickory      |
| <i>Carya ovata</i>            | Shagbark hickory    |
| <i>Juglans cinerea</i>        | Butternut           |
| Leguminosae                   |                     |
| <i>Gleditsia tricanthos</i>   | Honey locust        |
| <i>Robina pseudoacacia</i>    | Black locust        |
| Nyssaceae                     |                     |
| <i>Nyssa sylvatica</i>        | Sour-gum, black gum |
| Oleaceae                      |                     |
| <i>Fraxinus americana</i>     | White ash           |
| <i>Fraxinus pennsylvanica</i> | Green ash           |

TABLE A.1 (Cont'd)

| Classification                                  | Common Name(s)                           |
|---|--|
| <b>Pinaceae</b>                                 |  |
| <i>Chamaecyparis thyoides</i>                   | Atlantic white cedar                     |
| <i>Juniperus virginiana</i>                     | Red cedar                                |
| <i>Larix laricina</i>                           | American larch                           |
| <i>Picea abies</i>                              | Norway spruce                            |
| <i>Picea glauca</i>                             | White spruce                             |
| <i>Picea mariana</i>                            | Black spruce                             |
| <i>Pinus resinosa</i>                           | Red pine                                 |
| <i>Pinus rigida</i>                             | Pitch pine                               |
| <i>Pinus strobus</i>                            | White pine                               |
| <i>Tsuga canadensis</i>                         | Eastern hemlock                          |
| <b>Platanaceae</b>                              |  |
| <i>Platanus occidentalis</i>                    | Sycamore, buttonwood                     |
| <b>Rosaceae</b>                                 |  |
| <i>Prunus pennsylvanica</i>                     | Pin cherry                               |
| <i>Prunus serotina</i>                          | Wild black cherry                        |
| <i>Pyrus malus</i>                              | Domestic apple                           |
| <b>Salicaceae</b>                               |  |
| <i>Populus grandidentata</i>                    | Bigtooth aspen                           |
| <i>Populus tremuloides</i>                      | Quaking aspen                            |
| <b>Tiliaceae</b>                                |  |
| <i>Tilia americana</i>                          | American basswood                        |
| <b>Ulmaceae</b>                                 |  |
| <i>Ulmus americana</i>                          | American elm                             |
| <i>Ulmus rubra</i>                              | Slippery elm                             |
| <b><u>Shrub and Woody Vine Species (55)</u></b> |  |
| <b>Anacardiaceae</b>                            |  |
| <i>Rhus glabra</i>                              | Smooth sumac                             |
| <i>Rhus radicans</i>                            | Poison-ivy                               |
| <i>Rhus typhina</i>                             | Staghorn sumac                           |
| <b>Aquifoliaceae</b>                            |  |
| <i>Ilex opaca</i>                               | American holly                           |
| <i>Ilex verticillata</i>                        | Common winterberry<br>holly, black alder |

TABLE A.1 (Cont'd)

| Classification               | Common Name(s)      |
|------------------------------|---------------------|
| <b>Caprifoliaceae</b>        |                     |
| <i>Dierovilla lonicera</i>   | Bush honeysuckle    |
| <i>Lonicera morrowi</i>      | Honeysuckle         |
| <i>Sambucus canadensis</i>   | Elderberry          |
| <i>Staphylea trifolia</i>    | Bladdernut          |
| <i>Symphoricarpos albus</i>  | Snowberry           |
| <i>Viburnum acerifolium</i>  | Maple-leaf viburnum |
| <i>Viburnum dentatum</i>     | Arrow-wood viburnum |
| <i>Viburnum lentago</i>      | Nanny-berry         |
| <b>Clethraceae</b>           |                     |
| <i>Clethra alnifolia</i>     | Pepperbush          |
| <b>Cornaceae</b>             |                     |
| <i>Cornus florida</i>        | Flowering dogwood   |
| <i>Cornus stolonifera</i>    | Red-osier dogwood   |
| <b>Corylaceae</b>            |                     |
| <i>Alnus rugosa</i>          | Speckled alder      |
| <i>Corylus americana</i>     | American hazelnut   |
| <i>Corylus cornuta</i>       | Beaded hazelnut     |
| <b>Ericaceae</b>             |                     |
| <i>Gaylussacia baccata</i>   | Huckleberry         |
| <i>Gaylussacia frondosa</i>  | Dangleberry         |
| <i>Kalmia angustifolia</i>   | Sheep laurel        |
| <i>Kalmia latifolia</i>      | Mountain laurel     |
| <i>Leucothoe racemosa</i>    | Fetterbush          |
| <i>Ligustrum vulgare</i>     | Common privet       |
| <i>Lyonia ligustrina</i>     | Maleberry           |
| <i>Rhododendron vaseyi</i>   | Pinkshell azalea    |
| <i>Rhododendron viscosum</i> | Swamp azalea        |
| <i>Vaccinium corymbosum</i>  | Blueberry           |
| <i>Vaccinium vacillans</i>   | Lowbush blueberry   |
| <b>Hamamelidaceae</b>        |                     |
| <i>Hamamelis virginiana</i>  | Common witch-hazel  |
| <b>Luaraceae</b>             |                     |
| <i>Sassafras albidum</i>     | Sassafras           |
| <b>Leguminosae</b>           |                     |
| <i>Robina hispida</i>        | Bristly locust      |
| <b>Liliaceae</b>             |                     |
| <i>Smilax rotundifolia</i>   | Greenbrier          |

TABLE A.1 (Cont'd)

| Classification                     | Common Name(s)         |
|------------------------------------|------------------------|
| Myricaceae                         |                        |
| <i>Comptonia peregrina</i>         | Sweet fern             |
| Pinaceae                           |                        |
| <i>Juniperus communis</i>          | Dwarf juniper          |
| <i>Juniperus horizontalis</i>      | Trailing juniper       |
| Rosaceae                           |                        |
| <i>Amelanchier laevis</i>          | Shadbush, serviceberry |
| <i>Aronia arbutifolia</i>          | Chokeberry             |
| <i>Crataegus phaenopyrum</i>       | Washington hawthorne   |
| <i>Prunus virginiana</i>           | Chokecherry            |
| <i>Rosa Carolina</i>               | Carolina rose          |
| <i>Rosa rugosa</i>                 | Wrinkled rose          |
| <i>Rubus</i> spp.                  | Blackberry             |
| <i>Spiraea latifolia</i>           | Meadowsweet            |
| <i>Spiraea tomentosa</i>           | Steeplebush            |
| Rubiaceae                          |                        |
| <i>Cephalanthus occidentalis</i>   | Button bush            |
| Salicaceae                         |                        |
| <i>Salix humilis</i>               | Dwarf gray willow      |
| <i>Salix rigisa</i>                | Rigid willow           |
| <i>Salix</i> spp.                  | Willow                 |
| Thymelaeaceae                      |                        |
| <i>Dirca palustris</i>             | Leatherwood            |
| Vitaceae                           |                        |
| <i>Parthenocissus quinquefolia</i> | Virginia creeper       |
| <i>Vitis</i> sp.                   | Grape                  |
| <u>Herb Species (83)</u>           |                        |
| Alismataceae                       |                        |
| <i>Sagittaria latifolia</i>        | Arrowhead              |
| Apocynaceae                        |                        |
| <i>Apocynum androsaemifolia</i>    | Dogbane                |
| Araceae                            |                        |
| <i>Arisaema tyiphillum</i>         | Jack-in-the-pulpit     |
| <i>Calla palustris</i>             | Wild calla, water arum |
| <i>Symplocarpus foelidus</i>       | Skunk cabbage          |

TABLE A.1 (Cont'd)

| Classification   | Common Name(s)                          |
|--|---|
| Araliaceae<br><i>Aralia nudicaulis</i>                                       | Sarasparilla                            |
| Asclepiadaceae<br><i>Asclepias</i> sp.                                       | Milkweed                                |
| Balsaminaceae<br><i>Impatiens</i> sp.  | Touch-me-not                            |
| Cistaceae<br><i>Helianthemum canadense</i>                                   | Frostweed                               |
| Composite  |   |
| <i>Achillea millefolium</i>  | Yarrow                                  |
| <i>Antennaria plantaginifolia</i>  | Plantain-leaved pussytoes               |
| <i>Chrysanthemum leucanthemum</i>  | Ox-eye daisy                            |
| <i>Erigeron pulchellus</i>   | Robin-plantain                          |
| <i>Erigeron strigosus</i>  | Daisy fleabane                          |
| <i>Eupatorium rogosum</i>  | White snakeroot                         |
| <i>Hieracium floribundum</i>   | Smoothish hawkweed                      |
| <i>Hieracium pilosella</i>   | Mouse-ear hawkweed                      |
| <i>Prenathes alba</i>  | Rattlesnake root                        |
| <i>Rudbeckia hirta</i>   | Black-eyed susan                        |
| <i>Senecio aureus</i>  | Golden ragwort                          |
| <i>Solidago</i> sp.  | Goldenrod                               |
| <i>Taraxacum officinale</i>  | Dandelion                               |
| Cyperaceae<br><i>Carex</i> spp.  | Carex                                   |
| Ericaceae<br><i>Gualtheria procumbens</i><br><i>Epigaea repens</i>           | Checkerberry<br>Trailing arbutus        |
| Geraniaceae<br><i>Geranium maculatum</i>                                     | Wild geranium                           |
| Gramineae<br><i>Panicum</i> spp.<br><i>Poa annua</i><br><i>Pos pratensis</i> | Panic grass<br>Spear grass<br>Bluegrass |
| Iridaceae<br><i>Iris versicolor</i><br><i>Iris pseudacorus</i>               | Blue flag<br>Water flag                 |

TABLE A.1 (Cont'd)

| Classification               | Common Name(s)                          |
|------------------------------|---|
| Juncaceae                    |   |
| <i>Juncus</i> spp.           | Rush                                    |
| <i>Luzula campestris</i>     | Wood rush                               |
| Leguminosae                  |   |
| <i>Baptisia australis</i>    | Blue false indigo                       |
| <i>Lupinus perennis</i>      | Wild lupine                             |
| <i>Melilotus officinalis</i> | Yellow sweet clover                     |
| <i>Trifolium pratense</i>    | Red clover                              |
| <i>Trifolium repens</i>      | White clover                            |
| <i>Vicia dasycarpa</i>       | Vetch                                   |
| Lentibulariaceae             |   |
| <i>Utricularia</i> sp.       | Bladderwort                             |
| Liliaceae                    |   |
| <i>Asparagus officinalis</i> | Asparagus                               |
| <i>Clintonia borealis</i>    | Corn lily                               |
| <i>Convallaria majalis</i>   | Lily-of-the-valley,<br>Canada mayflower |
| <i>Medeola virginiana</i>    | Indian cucumber root                    |
| <i>Polygonatum biflorum</i>  | Solomon seal                            |
| <i>Smilacina racemosa</i>    | False solomon seal                      |
| <i>Trillium undulatum</i>    | Painted trillium                        |
| <i>Uvalaria sessilifolia</i> | Wild oats, bellwort                     |
| Nymphaeaceae                 |   |
| <i>Nuphar advena</i>         | Yellow water lily                       |
| <i>Nymphaea odorata</i>      | Fragrant water-lily                     |
| Onagraceae                   |   |
| <i>Oenothera biennis</i>     | Evening primrose                        |
| Orchidaceae                  |   |
| <i>Cypripedium acaule</i>    | Lady slipper                            |
| Phytolaccaceae               |   |
| <i>Phytolacca americana</i>  | Pokeweed                                |
| Pantaginaceae                |   |
| <i>Plantago rugelii</i>      | Pale plantain                           |
| Polygonaceae                 |   |
| <i>Fagopyrum esculentum</i>  | Buckwheat                               |
| <i>Rumex acetosella</i>      | Red sorrel                              |
| <i>Rumex crispus</i>         | Curly dock                              |

TABLE A.1 (Cont'd)

| Classification                        | Common Name(s)           |
|---------------------------------------|--------------------------|
| <b>Pontederiaceae</b>                 |                          |
| <i>Lysimachia ciliata</i>             | Fringed loosestrife      |
| <i>Lysimachia</i> sp.                 | Loosestrife              |
| <i>Trientalis borealis</i>            | Starflower               |
| <b>Pyrolaceae</b>                     |                          |
| <i>Chimaphila maculata</i>            | Spotted wintergreen      |
| <i>Chimaphila umbellata</i>           | Pipsissewa               |
| <i>Moneses uniflora</i>               | One-flowered wintergreen |
| <b>Ranunculaceae</b>                  |                          |
| <i>Actaea alba</i>                    | Baneberry                |
| <i>Aquilegia canadensis</i>           | Colombine                |
| <i>Coptis groenlandica</i>            | Goldthread               |
| <i>Ranunculus abortivus</i>           | Kidneylead               |
| <b>Rosaceae</b>                       |                          |
| <i>Potentilla argenta</i>             | Silvery cinquefoil       |
| <i>Potentilla canadensis</i>          | Five-fingers             |
| <b>Rubiaceae</b>                      |                          |
| <i>Houstonia caerulea</i>             | Bluets                   |
| <i>Mitchella repens</i>               | Partridge berry          |
| <b>Santalaceae</b>                    |                          |
| <i>Comandra richardsoniana</i>        | Bastard toad flax        |
| <b>Scrophulariaceae</b>               |                          |
| <i>Veronica officinalis</i>           | Common speedwell         |
| <i>Verbascum thapsus</i>              | Common mullein           |
| <b>Typhaceae</b>                      |                          |
| <i>Typha latifolia</i>                | Common cattail           |
| <b>Umbelliferar</b>                   |                          |
| <i>Sanicula marilandica</i>           | Black snakeroot          |
| <i>Zizia aurea</i>                    | Golden alexander         |
| <b>Violaceae</b>                      |                          |
| <i>Viola</i> sp.                      | Blue violet              |
| <b><u>Pteriphyte Species (16)</u></b> |                          |
| <b>Equisetaceae</b>                   |                          |
| <i>Equisetum sylvaticum</i>           | Wood horsetail           |

TABLE A.1 (Cont'd)

| Classification                        | Common Name(s)        |
|---------------------------------------|-----------------------|
| <b>Lycodiaceae</b>                    |                       |
| <i>Lycopodium annotinum</i>           | Stiff clubmoss        |
| <i>Lycopodium complanatum</i>         | Running pine          |
| <i>Lycopodium obscurum</i>            | Tree clubmoss         |
| <i>Lycopodium tristachyum</i>         | Ground pine           |
| <b>Osmundaecae</b>                    |                       |
| <i>Osmunda cinnamomea</i>             | Cinnamon fern         |
| <i>Osmunda claytoniana</i>            | Interrupted fern      |
| <i>Osmunda regalis</i>                | Royal fern            |
| <b>Polypodiaceae</b>                  |                       |
| <i>Athyrium flexifolium</i>           | Lady fern             |
| <i>Cystopteris fragilis</i>           | Fragile fern          |
| <i>Dennstaedtia punctilobula</i>      | Hayscented fern       |
| <i>Dryopteris marginalis</i>          | Marginal wood fern    |
| <i>Onoclea sensibilis</i>             | Sensitive fern        |
| <i>Polystichum acrostichoides</i>     | Christmas fern        |
| <i>Pteridium aquilinum</i>            | Bracken fern          |
| <i>Thelypteris noveboracensis</i>     | New York fern         |
| <b><u>Introduced Species (23)</u></b> |                       |
| <i>Abies balsamea</i>                 | Balsam fir            |
| <i>Abies concolor</i>                 | White fir             |
| <i>Acer platanoides</i>               | Norway maple          |
| <i>Apocynaceae</i> spp.               | Common periwinkle     |
| <i>Cercis canadensis</i>              | Eastern redbud        |
| <i>Cercidiphyllum japonicum</i>       | Katsura tree          |
| <i>Chionanthus virginicus</i>         | White fringe tree     |
| <i>Clethra alnifolia</i>              | Sweet pepperbush      |
| <i>Cornus amomum</i>                  | Silky dogwood         |
| <i>Cuxas scampervivens</i>            | Common boxwood        |
| <i>Euonymus</i> sp.                   | Euonymus              |
| <i>Ginkgo biloba</i>                  | Ginkgo tree           |
| <i>Juniperus chinensis</i>            | Phitzler juniper      |
| <i>Liquidambar styraciflua</i>        | Sweet gum             |
| <i>Picea pungens</i>                  | Colorado blue spruce  |
| <i>Pinus nigra</i>                    | Australian pine       |
| <i>Pinus resinosa</i>                 | Red pine              |
| <i>Pinus sylvestris</i>               | Scotch pine           |
| <i>Pyrus aucuparia</i>                | European mountain ash |

TABLE A.1 (Cont'd)

| Classification            | Common Name(s)     |
|---------------------------|--------------------|
| <i>Taxus canadensis</i>   | American yew       |
| <i>Taxus cuspidata</i>    | Spreading yew      |
| <i>Thuja occidentalis</i> | Eastern arorviatae |
| <i>Tilia tomentosa</i>    | Silver linden      |

Source: DA 1980.

**TABLE A.2 Mammals, Amphibians, and Reptiles Known or Thought to Exist at Fort Devens**

| Classification                  | Common Name            |
|---------------------------------|------------------------|
| <u>Mammals</u>                  |                        |
| Canidae                         |                        |
| <i>Vulpes vulpes</i>            | Red fox                |
| <i>Urocyon cinereoargenteus</i> | Gray fox               |
| Felidae                         |                        |
| <i>Lynx rufus</i>               | Bobcat                 |
| Sciuridae                       |                        |
| <i>Marmota monax</i>            | Woodchuck              |
| <i>Tamias striatus</i>          | Eastern chipmunk       |
| <i>Sciurus carolinensis</i>     | Eastern gray squirrel  |
| <i>Tamiasciurus hudsonicus</i>  | Red squirrel           |
| <i>Glaucomys</i> spp.           | Flying squirrel        |
| Castoridae                      |                        |
| <i>Castor canadensis</i>        | Beaver                 |
| Cricetidae                      |                        |
| <i>Peromyscus maniculatus</i>   | Deermouse              |
| <i>Microtus pennsylvanicus</i>  | Meadow vole            |
| <i>Ondatra zibethicus</i>       | Muskrat                |
| Muridae                         |                        |
| <i>Rattus norvegicus</i>        | Norway rat, brown rat  |
| <i>Mus musculus</i>             | House mouse            |
| Zapidae                         |                        |
| <i>Zapus hudsonicus</i>         | Meadow jumping mouse   |
| Erethizontidae                  |                        |
| <i>Erethizon dorsatum</i>       | Porcupine              |
| Didelphidae                     |                        |
| <i>Didelphis virginiana</i>     | Opposum                |
| Talpidae                        |                        |
| <i>Parascalops breweri</i>      | Hairy-tailed mole      |
| <i>Scalopus aquaticus</i>       | Eastern mole           |
| <i>Condylura cristata</i>       | Star-nosed mole        |
| Soricidae                       |                        |
| <i>Sorex cinereus</i>           | Common or masked shrew |
| <i>Sorex palustris</i>          | Water shrew            |
| <i>Blarina brevicauda</i>       | Short-tailed shrew     |

TABLE A.2 (Cont'd)

| Classification                   | Common Name                   |
|----------------------------------|-------------------------------|
| <b>Vespertilionidae</b>          |                               |
| <i>Myotis lucifugus</i>          | Little brown myotis           |
| <i>Myotis Keenii</i>             | Keen's myotis                 |
| <i>Lasionycteris noctivagans</i> | Silver-haired bat             |
| <i>Pipistrelus subflavus</i>     | Eastern pipistrelle           |
| <i>Eptesicus fuscus</i>          | Big brown bat                 |
| <i>Lasiurus borealis</i>         | Red bat                       |
| <i>Lasiurus cinereus</i>         | Hoary bat                     |
| <b>Procyonidae</b>               |                               |
| <i>Procyon lotor</i>             | Raccoon                       |
| <b>Mustelidae</b>                |                               |
| <i>Mustela erminea</i>           | Ermine                        |
| <i>Mustela frenata</i>           | Long-tailed weasel            |
| <i>Mustela vison</i>             | Mink                          |
| <i>Lutra canadensis</i>          | River otter                   |
| <i>Mephitis mephitis</i>         | Striped skunk                 |
| <b>Leporidae</b>                 |                               |
| <i>Sylvilagus transitionalis</i> | New England cottontail        |
| <i>Lepus americanus</i>          | Snowshoe hare                 |
| <b>Cervidae</b>                  |                               |
| <i>Odocoileus virginianus</i>    | White-tailed deer             |
| <b><u>Amphibians</u></b>         |                               |
| <b>Ambystomidae</b>              |                               |
| <i>Ambystoma maculatum</i>       | Spotted salamander            |
| <b>Salamandridae</b>             |                               |
| <i>Notophthalmus viridescens</i> | Common newt, red elf          |
| <b>Plethodontidae</b>            |                               |
| <i>Plethodon cinereus</i>        | Red-backed salamander         |
| <i>Eurycea bislineata</i>        | Two-lined salamander          |
| <b>Bufonidae</b>                 |                               |
| <i>Bufo americanus</i>           | American toad                 |
| <i>Bufo woodhousei</i>           | Fowler's toad, woodhouse toad |
| <b>Hylidae</b>                   |                               |
| <i>Hyla crucifer</i>             | Spring peeper                 |
| <i>Hyla versicolor</i>           | Gray treefrog                 |

TABLE A.2 (Cont'd)

| Classification                   | Common Name            |
|----------------------------------|------------------------|
| <b>Ranidae</b>                   |                        |
| <i>Rana catesbeiana</i>          | Bullfrog               |
| <i>Rana ciamitans</i>            | Green frog             |
| <i>Rana pipiens</i>              | Leopard frog           |
| <i>Rana palustris</i>            | Pickerel frog          |
| <i>Rana sylvatica</i>            | Wood frog              |
| <br><b>Reptiles</b>              |                        |
| <b>Chelydridae</b>               |                        |
| <i>Chelydra serpentina</i>       | Snapping turtle        |
| <i>Sternotherus odoratus</i>     | Stinkpot, musk turtle  |
| <i>Clemmys guttata</i>           | Spotted turtle         |
| <i>Clemmys insculpta</i>         | Wood turtle            |
| <i>Terrapene carolina</i>        | Box turtle             |
| <i>Chrysemys picta</i>           | Painted turtle         |
| <br><b>Colubridae</b>            |                        |
| <i>Natrix</i> sp.                | (Northern) water snake |
| <i>Storeria dekayi</i>           | Brown snake            |
| <i>Storeria occipitomaculata</i> | Red-bellied snake      |
| <i>Thamnophis sirtalis</i>       | Garter snake           |
| <i>Thamnophis sauritus</i>       | Ribbon snake           |
| <i>Heterodon platyrhinos</i>     | Hognose snake          |
| <i>Diadophis punctatus</i>       | Ringneck snake         |
| <i>Elaphe obsoleta</i>           | Black rat snake        |
| <i>Opheodrys vernalis</i>        | Smooth green snake     |
| <i>Lampropeltis getulus</i>      | Milk snake             |

Source: DA 1980.

TABLE A.3 Birds Known to Exist in the Nashua River Basin

| Classification                 | Common Name               | Notes <sup>a</sup> |
|--------------------------------|---------------------------|--------------------|
| <u>Water-Oriented Birds</u>    |                           |                    |
| Gaviidae                       |                           |                    |
| <i>Gavia immer</i>             | Common loon               | r, T               |
| Podicipedidae                  |                           |                    |
| <i>Podiceps auritis</i>        | Horned grebe              | Tu                 |
| <i>Podilymbus podiceps</i>     | Pied-billed grebe         | N, SRr, TC, *      |
| Phalacrocoracidae              |                           |                    |
| <i>Phalacrocorax auritus</i>   | Double-crested cormorant  | Tr                 |
| Ardeidae                       |                           |                    |
| <i>Ardea herodias</i>          | Great blue heron          | SRu, Tc, *         |
| <i>Butorides virescens</i>     | Green heron               | N, SRc, Tc         |
| <i>Florida caerulea</i>        | Little blue heron         | SVr                |
| <i>Bubulcus ibis</i>           | Cattle egret              | Vr, Tr             |
| <i>Casmerodius albus</i>       | Great egret               | SVr                |
| <i>Leucophoyx thula</i>        | Snowy egret               | SVr                |
| <i>Nycticorax nycticorax</i>   | Black-crowned night heron | SV                 |
| <i>Ixobrychus exilis</i>       | Least bittern             | N?, SRri, Tr       |
| <i>Botaurus lentiginosus</i>   | American bittern          | N, SRu, Tu         |
| Threskiornithidae              |                           |                    |
| <i>Plegadis falcinellus</i>    | Glossy ibis               | Tr                 |
| Anatidae                       |                           |                    |
| <i>Branta canadensis</i>       | Canada goose              | Tc                 |
| <i>Branta bernicla</i>         | Brant                     | Tr                 |
| <i>Chen hyperborea</i>         | Snow goose                | Tu                 |
| <i>Anas platyrhynchos</i>      | Mallard                   | N, PRc, *          |
| <i>Anas rubripes</i>           | Black duck                | N, PRc, *          |
| <i>Anas acuta</i>              | Pintail                   | Tc                 |
| <i>Anas carolinensis</i>       | Green-winged teal         | N?, SRr, Ta        |
| <i>Anas discors</i>            | Blue-winged teal          | Tc, *              |
| <i>Mareca americana</i>        | American wigeon           | Tu                 |
| <i>Spatula clypeata</i>        | Northern shoveler         | Tr                 |
| <i>Aix sponsa</i>              | Wood duck                 | N, SRc, Tc, *      |
| <i>Aythya americana</i>        | Redhead                   | Tr                 |
| <i>Aythya collaris</i>         | Ring-necked duck          | Tc                 |
| <i>Aythya valisineria</i>      | Canvasback                | Tu                 |
| <i>Aythya marila</i>           | Greater scaup             | Tc                 |
| <i>Aythya affinis</i>          | Lesser scaup              | Tc                 |
| <i>Bucephala clangula</i>      | Common goldeneye          | Tc                 |
| <i>Bucephala albeola</i>       | Bufflehead                | Tc                 |
| <i>Clangula hyemalis</i>       | Oldsquaw                  | Tr                 |
| <i>Melanitta deglandi</i>      | White-winged scoter       | Tr                 |
| <i>Melanitta perspicillata</i> | Surf scoter               | Tr                 |

TABLE A.3 (Cont'd)

| Classification                 | Common Name             | Notes <sup>a</sup> |
|--------------------------------|-------------------------|--------------------|
| <i>Oidemia nigra</i>           | American scoter         | Tr                 |
| <i>Oxyura jamaicensis</i>      | Ruddy duck              | Tu                 |
| <i>Lophodytes cucullatus</i>   | Hooded merganser        | N, SRu, Tc         |
| <i>Mergus merganser</i>        | Common merganser        | WRu, Tc            |
| <i>Mergus serrator</i>         | Red-breasted merganser  | Tr                 |
| <b>Pandionidae</b>             |                         |                    |
| <i>Pandion haliaetus</i>       | Osprey                  | Tc*                |
| <b>Rallidae</b>                |                         |                    |
| <i>Rallus limicola</i>         | Virginia rail           | Tr, N              |
| <i>Porzana carolina</i>        | Sora                    | Tr, N              |
| <i>Fulica americanus</i>       | American coot           | Tu                 |
| <b>Charadriidae</b>            |                         |                    |
| <i>Charadrius semipalmatus</i> | Semipalmated plover     | Tu                 |
| <i>Charadrius vociferous</i>   | Killdeer                | N, SRc, Tc*        |
| <i>Pluvialis dominica</i>      | American golden plover  | Tr                 |
| <i>Squatarola squatarola</i>   | Black-bellied plover    | Tr                 |
| <b>Scolopacidae</b>            |                         |                    |
| <i>Philohela minor</i>         | American woodcock       | N, SRc, Tc         |
| <i>Capella gallinago</i>       | Common snipe            | N, SRu, Tc         |
| <i>Bartramia longicauda</i>    | Upland sandpiper        | Tr                 |
| <i>Actitis macularia</i>       | Spotted sandpiper       | N, SRc, Tc*        |
| <i>Tringa solitaria</i>        | Solitary sandpiper      | Tu, *              |
| <i>Totanus melanoleucus</i>    | Greater yellowlegs      | Tc*                |
| <i>Totanus flavipes</i>        | Lesser yellowlegs       | Tu                 |
| <i>Erolia melanotos</i>        | Pectoral sandpiper      | Tu                 |
| <i>Erolia fuscicollis</i>      | White-rumped sandpiper  | Tr                 |
| <i>Erolia bairdii</i>          | Baird's sandpiper       | Tr                 |
| <i>Erolia minutilla</i>        | Least sandpiper         | Tc                 |
| <i>Erolia alpina</i>           | Dunlin                  | Tr                 |
| <i>Limnodromus griseus</i>     | Short-billed dowitcher  | Tu                 |
| <i>Limnodromus scolopaceus</i> | Long-billed dowitcher   | Tr                 |
| <i>Ereunetes pusillus</i>      | Semipalmated sandpiper  | Tc                 |
| <i>Ereunetes mauri</i>         | Western sandpiper       | Tr                 |
| <i>Tryngites subruficollis</i> | Buff-breasted sandpiper | Tr                 |
| <i>Philomachus pugnax</i>      | Ruff                    | Tr                 |
| <i>Steganopus tricolor</i>     | Wilson's phalarope      | Tr                 |

TABLE A.3 (Cont'd)

| Classification                    | Common Name             | Notes <sup>a</sup> |
|-----------------------------------|-------------------------|--------------------|
| <b>Laridae</b>                    |                         |                    |
| <i>Larus hyperboreus</i>          | Glaucous gull           | WVr                |
| <i>Larus glaucooides</i>          | Iceland gull            | WVr                |
| <i>Larus marinus</i>              | Great black-backed gull | V                  |
| <i>Larus argentatus</i>           | Herring gull            | PRc*               |
| <i>Larus delawarensis</i>         | Ring-billed gull        | Vu                 |
| <i>Chlidonias niger</i>           | Black tern              | Tr                 |
| <b>Alcedinidae</b>                |                         |                    |
| <i>Megaceryle alcyon</i>          | Belted kingfisher       | N, SRc, Tc*        |
| <b>Motacillidae</b>               |                         |                    |
| <i>Anthus spinoletta</i>          | Water pipit             | Tc                 |
| <b><u>Land-Oriented Birds</u></b> |                         |                    |
| <b>Cathartidae</b>                |                         |                    |
| <i>Cathartes aura</i>             | Turkey vulture          | Tr                 |
| <b>Accipitridae</b>               |                         |                    |
| <i>Accipiter gentilis</i>         | Goshawk                 | WRu, Tu            |
| <i>Accipiter striatus</i>         | Sharp-shinned hawk      | Tu                 |
| <i>Accipiter cooperii</i>         | Cooper's hawk           | Tr                 |
| <i>Buteo jamaicensis</i>          | Red-tailed hawk         | N, PRc*            |
| <i>Buteo lineatus</i>             | Red-shouldered hawk     | SRr, Tr            |
| <i>Buteo platypterus</i>          | Broad-winged hawk       | N, SRc, Tc         |
| <i>Haliaeetus leucocephalus</i>   | Bald eagle              | Vr                 |
| <i>Buteo lagopus</i>              | Rough-legged hawk       | WVr                |
| <i>Arcus cyaneus</i>              | Marsh hawk              | N?, SRr, Tu        |
| <b>Falconidae</b>                 |                         |                    |
| <i>Falco peregrinus</i>           | Peregrine               | Tr                 |
| <i>Falco columbarius</i>          | Merlin                  | Tr                 |
| <i>Falco sparverius</i>           | American kestrel        | N, PRc*            |
| <b>Tetraonidae</b>                |                         |                    |
| <i>Bonasa umbellus</i>            | Ruffed grouse           | N, PR, u*          |
| <b>Phasianidae</b>                |                         |                    |
| <i>Phasianus colchicus</i>        | Ring-necked pheasant    | N, PRc             |
| <b>Columbidae</b>                 |                         |                    |
| <i>Columbia livia</i>             | Rock dove               | N, PRc*            |
| <i>Zenaidura macroura</i>         | Mourning dove           | N, PRc*            |

TABLE A.3 (Cont'd)

| Classification                   | Common Name               | Notes <sup>a</sup> |
|----------------------------------|---------------------------|--------------------|
| <b>Cuculidae</b>                 |                           |                    |
| <i>Coccyzus americanus</i>       | Yellow-billed cuckoo      | N, SRr, Tr         |
| <i>Coccyzus erythrophthalmus</i> | Black-billed cuckoo       | N, SRu, Tu         |
| <b>Strigidae</b>                 |                           |                    |
| <i>Orus asio</i>                 | Screech owl               | N, PRu             |
| <i>Bubo virginianus</i>          | Great horned owl          | N, PRu             |
| <i>Strix varia</i>               | Barred owl                | WVu                |
| <i>Aegolius acadicus</i>         | Saw-whet owl              | WVr                |
| <i>Nyctea scandiaca</i>          | Snowy owl                 | WVi                |
| <i>Asio flammeus</i>             | Short-eared owl           | Tr                 |
| <b>Cuprimulgidae</b>             |                           |                    |
| <i>Caprimulgus vociferous</i>    | Whippoorwill              | N, SRu, Tu         |
| <i>Chordeiles minor</i>          | Common night hawk         | N, SRc, TC         |
| <b>Apodidae</b>                  |                           |                    |
| <i>Chaetura pelagica</i>         | Chimney swift             | N, SRt, Tc         |
| <b>Trochilidae</b>               |                           |                    |
| <i>Archilochus colubris</i>      | Ruby-throated hummingbird | N, SRc, Tu         |
| <b>Picidae</b>                   |                           |                    |
| <i>Colaptes auratus</i>          | Common flicker            | N, SRc, TC*        |
| <i>Dryocopus pileatus</i>        | Pileated woodpecker       | N, PRr             |
| <i>Sphyrapicus varius</i>        | Yellow-bellied sapsucker  | Tu                 |
| <i>Picoides villosus</i>         | Hairy woodpecker          | N, PRc, *          |
| <i>Picoides pubescens</i>        | Downy woodpecker          | N, PRc*            |
| <b>Tyrannidae</b>                |                           |                    |
| <i>Tyrannus tyrannus</i>         | Eastern kingbird          | N, SRc, Tc         |
| <i>Myiarchus crinitus</i>        | Great crested flycatcher  | N, SRc, Tu         |
| <i>Sayornis phoebe</i>           | Eastern phoebe            | N, SRc, Tc*        |
| <i>Empidonax flaviventris</i>    | Yellow-bellied flycatcher | Tr                 |
| <i>Empidonax traillii</i>        | Willow flycatcher         | N, SRr, Tu         |
| <i>Empidonax minimus</i>         | Least flycatcher          | N, SRc, Tc         |
| <i>Contopus virens</i>           | Eastern wood pewee        | N, SRc, Tc         |
| <i>Nuttalornis borealis</i>      | Olive-sided flycatcher    | Tr                 |
| <b>Alaudidae</b>                 |                           |                    |
| <i>Eremophila alpestris</i>      | Horned lark               | N, PRu, Tc         |

TABLE A.3 (Cont'd)

| Classification                   | Common Name             | Notes <sup>a</sup> |
|----------------------------------|-------------------------|--------------------|
| <b>Hirundinidae</b>              |                         |                    |
| <i>Iridoprocne bicolor</i>       | Tree swallow            | N, SRc, Ta         |
| <i>Riparia riparia</i>           | Bank swallow            | N, SRc, Tc         |
| <i>Stelgidopteryx ruficollis</i> | Rough-winged swallow    | N, SRu             |
| <i>Hirundo rustica</i>           | Barn swallow            | N, SRc, Ta         |
| <i>Petrochelidon pyrrhonota</i>  | Cliff swallow           | N, SRu, Tu         |
| <i>Progne subis</i>              | Purple martin           | Tr                 |
| <b>Corvidae</b>                  |                         |                    |
| <i>Cyanocitta cristata</i>       | Blue jay                | N, PRa, Tu*        |
| <i>Corvus brachyrhynchos</i>     | Common crow             | N, PRc, *          |
| <b>Paridae</b>                   |                         |                    |
| <i>Parus atricapillus</i>        | Black-capped chickadee  | N, PRa, Tu*        |
| <i>Parus hudsonicus</i>          | Boreal chickadee        | WVi                |
| <i>Parus bicolor</i>             | Tufted titmouse         | N, PRc*            |
| <b>Sittidae</b>                  |                         |                    |
| <i>Sitta carolinensis</i>        | White-breasted nuthatch | N, PRc*            |
| <i>Sitta canadensis</i>          | Red-breasted nuthatch   | Tc, *N             |
| <b>Certhidae</b>                 |                         |                    |
| <i>Certhia familiaris</i>        | Brown creeper           | Tc, *N             |
| <b>Troglodytidae</b>             |                         |                    |
| <i>Troglodytes aedon</i>         | House wren              | N, SRc, Tc         |
| <i>Troglodytes troglodytes</i>   | Winter wren             | Tu                 |
| <i>Cistotorus palustris</i>      | Long-billed marsh wren  | Tr, N              |
| <b>Mimidae</b>                   |                         |                    |
| <i>Mimus polyglottos</i>         | Mockingbird             | N, PR              |
| <i>Dumetella carolinensis</i>    | Gray catbird            | N, SRc, Tu*        |
| <i>Toxostoma rufum</i>           | Brown thrasher          | N, SRc, Tc         |
| <b>Turdidae</b>                  |                         |                    |
| <i>Turdus migratorius</i>        | American robin          | N, PRC, Ta*        |
| <i>Hylocichla musfelina</i>      | Wood thrush             | N, SRc, Tc         |
| <i>Hylocichla guttata</i>        | Hermit thrush           | Tc                 |
| <i>Hylocichla ustulata</i>       | Swainson's thrush       | Tu                 |
| <i>Hylocichla minima</i>         | Gray-cheeked thrush     | Tr                 |
| <i>Hylocichla fuscescens</i>     | Veery                   | N, SRc, Tc         |
| <i>Sialia sialis</i>             | Eastern bluebird        | N, SRu, Tu         |
| <b>Sylviidae</b>                 |                         |                    |
| <i>Poliophtila caerulea</i>      | Blue-gray gnatcatcher   | Tu                 |
| <i>Regulus satrapa</i>           | Golden-crowned kinglet  | WRi, Tc*           |
| <i>Regulus calendula</i>         | Ruby-crowned kinglet    | Tc*                |

TABLE A.3 (Cont'd)

| Classification                 | Common Name                  | Notes <sup>a</sup> |
|--------------------------------|------------------------------|--------------------|
| <b>Bombycillidae</b>           |                              |                    |
| <i>Bombycilla garruius</i>     | Bohemian waxwing             | WVri               |
| <i>Bombycilla cedrorum</i>     | Cedar waxwing                | N, PRi*            |
| <b>Lanidae</b>                 |                              |                    |
| <i>Lanius excubitor</i>        | Northern shrike              | WVr                |
| <i>Lanius ludovicianus</i>     | Loggerhead shrike            | Tr                 |
| <b>Sturnidae</b>               |                              |                    |
| <i>Sturnus vulgaris</i>        | Starling                     | N, PRa*            |
| <b>Vireonidae</b>              |                              |                    |
| <i>Vireo solitarius</i>        | Solitary vireo               | Tc                 |
| <i>Vireo olivaceus</i>         | Red-eyed vireo               | N, SRa, Tc         |
| <i>Vireo philadelphicus</i>    | Philadelphia vireo           | Tr                 |
| <i>Vireo gilvus</i>            | Warbling vireo               | N, SRu, Tu         |
| <b>Parulidae</b>               |                              |                    |
| <i>Mniotilta varia</i>         | Black and white warbler      | N, SRc, Tc         |
| <i>Vermivora chrysoptera</i>   | Golden-winged warbler        | SRr, Tu            |
| <i>Vermivora pinus</i>         | Blue-winged warbler          | N, SRr, Tu         |
| <i>Vermivora peregrina</i>     | Tennessee warbler            | Tc                 |
| <i>Vermivora celata</i>        | Orange-crowned warbler       | Tr                 |
| <i>Vermivora ruficapilla</i>   | Nashville warbler            | N, SRu, Tc         |
| <i>Parula americana</i>        | Northern parula              | Tc                 |
| <i>Dendroica petechia</i>      | Yellow warbler               | N, SRc, Tc         |
| <i>Dendroica magnolia</i>      | Magnolia warbler             | Tc                 |
| <i>Dendroica tigrina</i>       | Cape May warbler             | Tu                 |
| <i>Dendroica caerulescens</i>  | Black-throated blue warbler  | SRr, Tu            |
| <i>Dendroica coronata</i>      | Yellow-rumped warbler        | Ta                 |
| <i>Dendroica virens</i>        | Black-throated green warbler | N, SRu, Tc         |
| <i>Dendroica fusca</i>         | Blackburnian warbler         | Tu                 |
| <i>Dendroica pennsylvanica</i> | Chestnut-sided warbler       | N, SRc, Tu         |
| <i>Dendroica castanea</i>      | Bay-breasted warbler         | Tu                 |
| <i>Dendroica striata</i>       | Blackpoll warbler            | Ta                 |
| <i>Dendroica pinus</i>         | Pine warbler                 | TuN                |
| <i>Dendroica discolor</i>      | Prairie warbler              | N, SRu, Tu         |
| <i>Dendroica palmarum</i>      | Palm warbler                 | Tc                 |
| <i>Seiurus aurocapillus</i>    | Ovenbird                     | N, SRc, Tc         |
| <i>Seiurus noveboracensis</i>  | Northern waterthrush         | Tc                 |
| <i>Seiurus motacilla</i>       | Louisiana waterthrush        | N, SRr             |
| <i>Oporornis agilis</i>        | Connecticut warbler          | Tr                 |
| <i>Oporornis philadelphia</i>  | Mourning warbler             | Tr                 |
| <i>Geothlypis trichas</i>      | Yellowthroat                 | N, SRc, Tc, *      |
| <i>Wilsonia pusilla</i>        | Wilson's warbler             | Tu                 |
| <i>Wilsonia canadensis</i>     | Canada warbler               | N, SRu, Tc         |
| <i>Setophaga ruticilla</i>     | American redstart            | N, SRu, Tc         |

TABLE A.3 (Cont'd)

| Classification                   | Common Name            | Notes <sup>a</sup> |
|----------------------------------|------------------------|--------------------|
| Ploceidae                        |                        |                    |
| <i>Passer domesticus</i>         | House sparrow          | N, PRa*            |
| Icteridae                        |                        |                    |
| <i>Dolichonyx oryzivorus</i>     | Bobolink               | N, SRc, Tc         |
| <i>Sturnella magna</i>           | Eastern meadowlark     | N, SRc, Tc*        |
| <i>Agelaius phoeniceus</i>       | Red-winged blackbird   | N, SRc, Ta         |
| <i>Icterus galbula</i>           | Northern oriole        | N, SRc, Tc         |
| <i>Euphagus carolinus</i>        | Rusty blackbird        | Tu*                |
| <i>Quiscalus quiscula</i>        | Common grackle         | N, SRa, Ta*        |
| <i>Molothrus ater</i>            | Brown-headed cowbird   | N, SRc, Tc*        |
| Thraupidae                       |                        |                    |
| <i>Piranga olivacea</i>          | Scarlet tanager        | N, SRc, Tc         |
| Fringillidae                     |                        |                    |
| <i>Richmondia cardinalis</i>     | Cardinal               | N, PRc             |
| <i>Pheucticus ludovicianus</i>   | Rose-breasted grosbeak | N, SRc, Tc         |
| <i>Passerina cyanea</i>          | Indigo bunting         | N, SRu, Tu         |
| <i>Hesperiphona vespertina</i>   | Evening grosbeak       | WRi, Tc            |
| <i>Carpodacus purpureus</i>      | Purple finch           | N, PRi, Ti*        |
| <i>Carpodacus mexicanus</i>      | House finch            | N?, WVr            |
| <i>Pinicola enucleator</i>       | Pine grosbeak          | WVi, Ti            |
| <i>Acanthis flammea</i>          | Common redpoll         | WVi, Ti            |
| <i>Spinus pinus</i>              | Pine siskin            | N, Vi, Ti          |
| <i>Spinus tristis</i>            | American goldfinch     | N, PRc*            |
| <i>Loxia curvirostra</i>         | Red crossbill          | WVi, Ti            |
| <i>Loxia leucoptera</i>          | White-winged crossbill | WVi, Ti            |
| <i>Pipilo erythrophthalmus</i>   | Rufous-sided towhee    | N, SRa, Ta         |
| <i>Passerculus sandwichensis</i> | Savannah sparrow       | N, SRc, Tc*        |
| <i>Poocetes gramineus</i>        | Vesper sparrow         | N, SRv, Tu*        |
| <i>Junco hyemalis</i>            | Dark-eyed junco        | WRc, Tc*           |
| <i>Spizella arborea</i>          | Tree sparrow           | WRc, Tc            |
| <i>Spizella passerina</i>        | Chipping sparrow       | N, SRc, Tc*        |
| <i>Spizella pusilla</i>          | Field sparrow          | N, SRu, Tc*        |
| <i>Zonotrichia leucophrys</i>    | White-crowned sparrow  | Tu*                |
| <i>Zonotrichia albicollis</i>    | White-throated sparrow | Ta*                |
| <i>Passerella iliaca</i>         | Fox sparrow            | Tc                 |
| <i>Melospinza lincolnii</i>      | Lincoln's sparrow      | Tu*                |
| <i>Melospinza georgiana</i>      | Swamp sparrow          | N, SRc, Tc         |
| <i>Melospinza melodia</i>        | Song sparrow           | N, PRc, Ta*        |
| <i>Plectrophenax nivalis</i>     | Snow bunting           | WVi, Tu            |

(See next page for footnotes.)

**TABLE A.4 Composition of Finfish Species in 1974 Collections from Various Reaches of the Nashua River (%)**

| Classification                   | Mainstem in Mass. <sup>a</sup> | North Branch <sup>b</sup> |
|----------------------------------|--------------------------------|---------------------------|
| <b>Gamefish</b>                  |                                |                           |
| Chain pickerel                   | 1.23                           | --                        |
| Largemouth bass                  | 4.81                           | 5.42                      |
| Small mouth bass                 | 0.10                           | --                        |
| White perch                      | 0.06                           | --                        |
| Walleye pike                     | --                             | --                        |
| Total gamefish                   | 6.20                           | 5.42                      |
| <b>Panfish</b>                   |                                |                           |
| Pumpkinseed sunfish              | 9.00                           | --                        |
| Redbreasted sunfish <sup>c</sup> | --                             | --                        |
| Bluegill sunfish                 | 4.14                           | 0.40                      |
| Black crappie                    | 0.51                           | 0.10                      |
| Yellow perch                     | 1.57                           | 0.10                      |
| Rock bass                        | --                             | --                        |
| Total panfish                    | 15.22                          | 1.60                      |
| <b>Forage fish</b>               |                                |                           |
| Fallfish                         | --                             | --                        |
| Golder shiner                    | 23.58                          | 14.23                     |
| Spottail shiner                  | 2.65                           | 0.03                      |
| Total forage fish                | 26.23                          | 14.26                     |
| <b>Rough fish</b>                |                                |                           |
| White sucker                     | 33.15                          | 36.54                     |
| Brown bullhead                   | 1.88                           | 4.07                      |
| Yellow bullhead                  | 9.77                           | 37.60                     |
| Carp                             | --                             | --                        |
| Goldfish                         | 7.50                           | 0.10                      |
| American eel                     | --                             | --                        |
| Total rough fish                 | 52.30                          | 78.31                     |

<sup>a</sup>Sample size: 1,110 fish from 5 collection zones.

<sup>b</sup>Sample size: 973 fish from 7 collection zones.

<sup>c</sup>Apparent disappearance of the redbreast sunfish (*Lepomis cyanellus*) in Massachusetts waters, and appearance of bluegill (*L. macrochirus*) may represent a disagreement as to identification rather than a species shift.

Source: DA 1980.

**APPENDIX B:  
SCHEDULES FOR REMEDIAL ACTIVITIES**



**APPENDIX B:**  
**SCHEDULES FOR REMEDIAL ACTIVITIES**

This appendix presents schedules that summarize milestones and planned activities for the study areas at Ft. Devens. The schedules presented are current as of March 17, 1992. Because of the ever-changing nature of the work being conducted at Ft. Devens, the schedules will be updated in quarterly reports prepared by the Army.

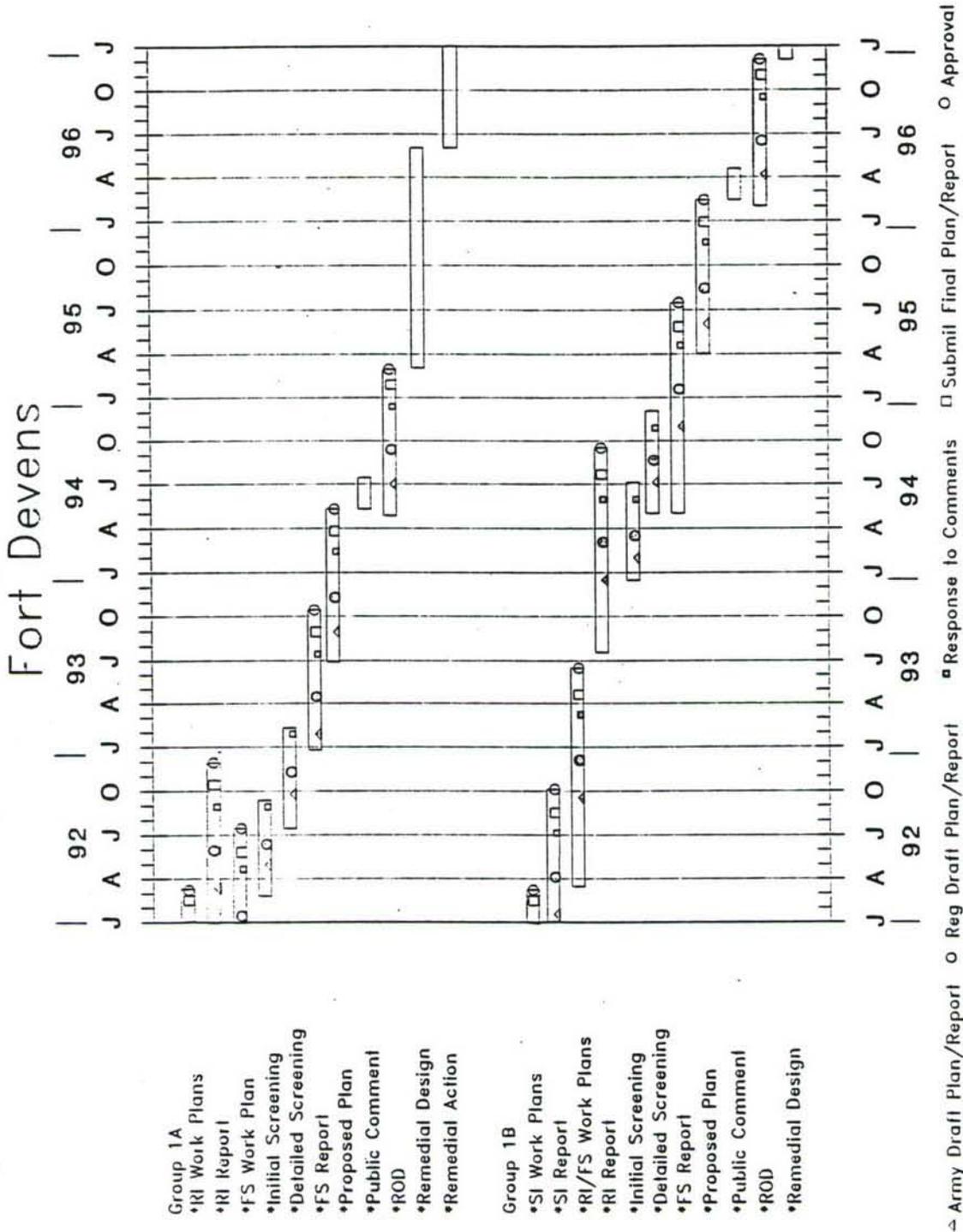


FIGURE B.1 Summary of 1992-1996 Milestones for Study Areas and Areas of Concern at Fort Devens as of March 17, 1992

# Fort Devens

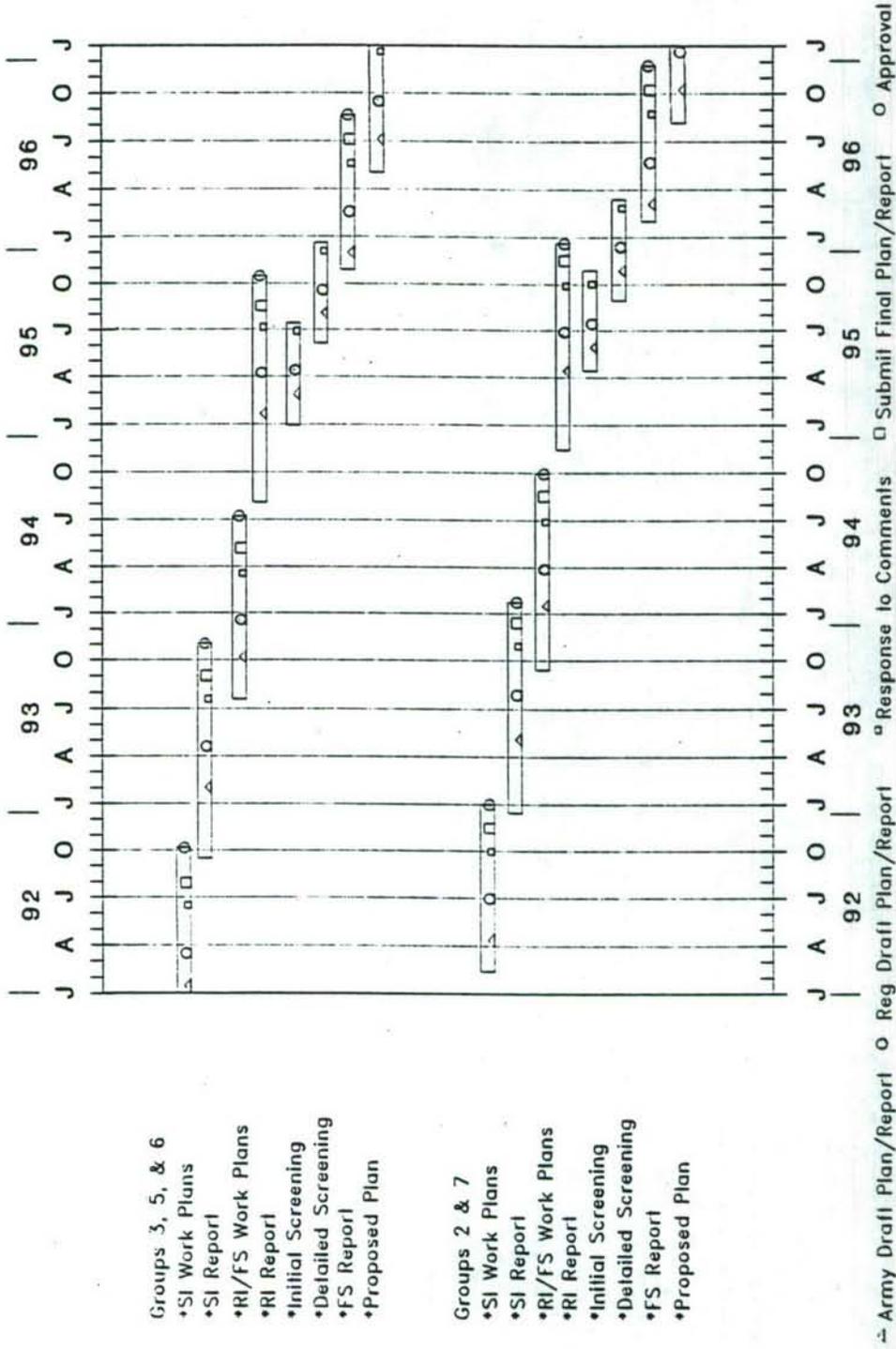
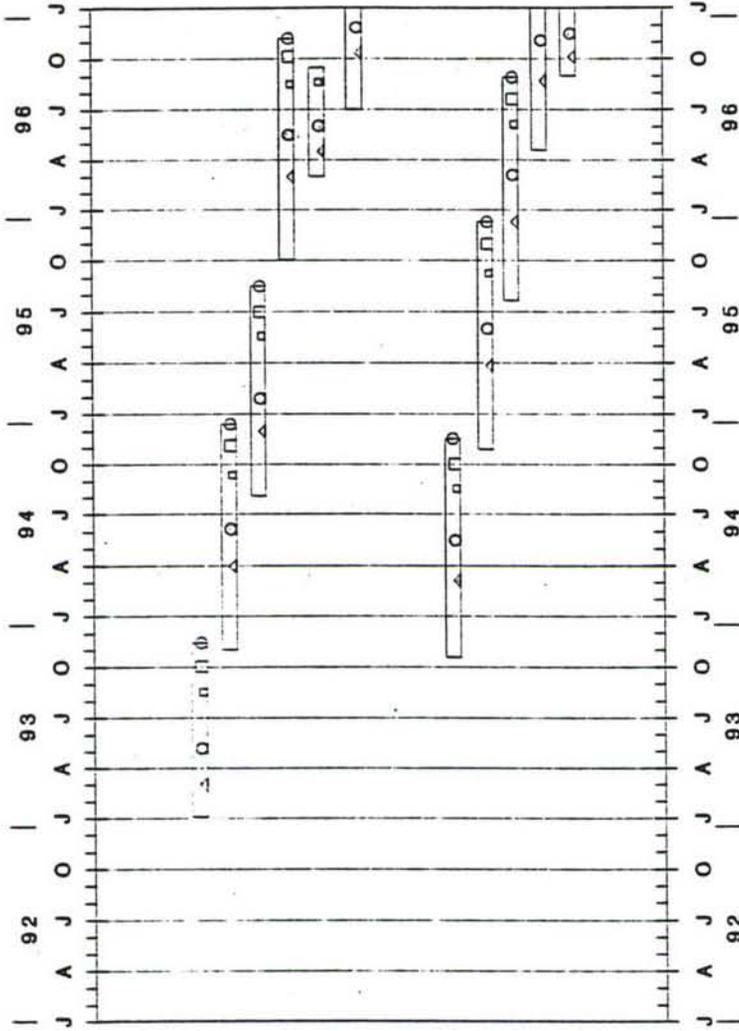


FIGURE B.1 (Cont'd)

# Fort Devens



Groups 4, 8, & 11  
 \*SI Work Plans  
 \*SI Report  
 \*RI/FS Work Plans  
 \*RI Report  
 \*Initial Screening  
 \*Detailed Screening

Groups 9 & 10  
 \*SI Work Plans  
 \*SI Report  
 \*RI/FS Work Plans  
 \*RI Report  
 \*Initial Screening

- Army Draft Plan/Report    O Reg Draft Plan/Report    □ Response to Comments    □ Submit Final Plan/Report    O Approval

FIGURE B.1 (Cont'd)

# Fort Devens

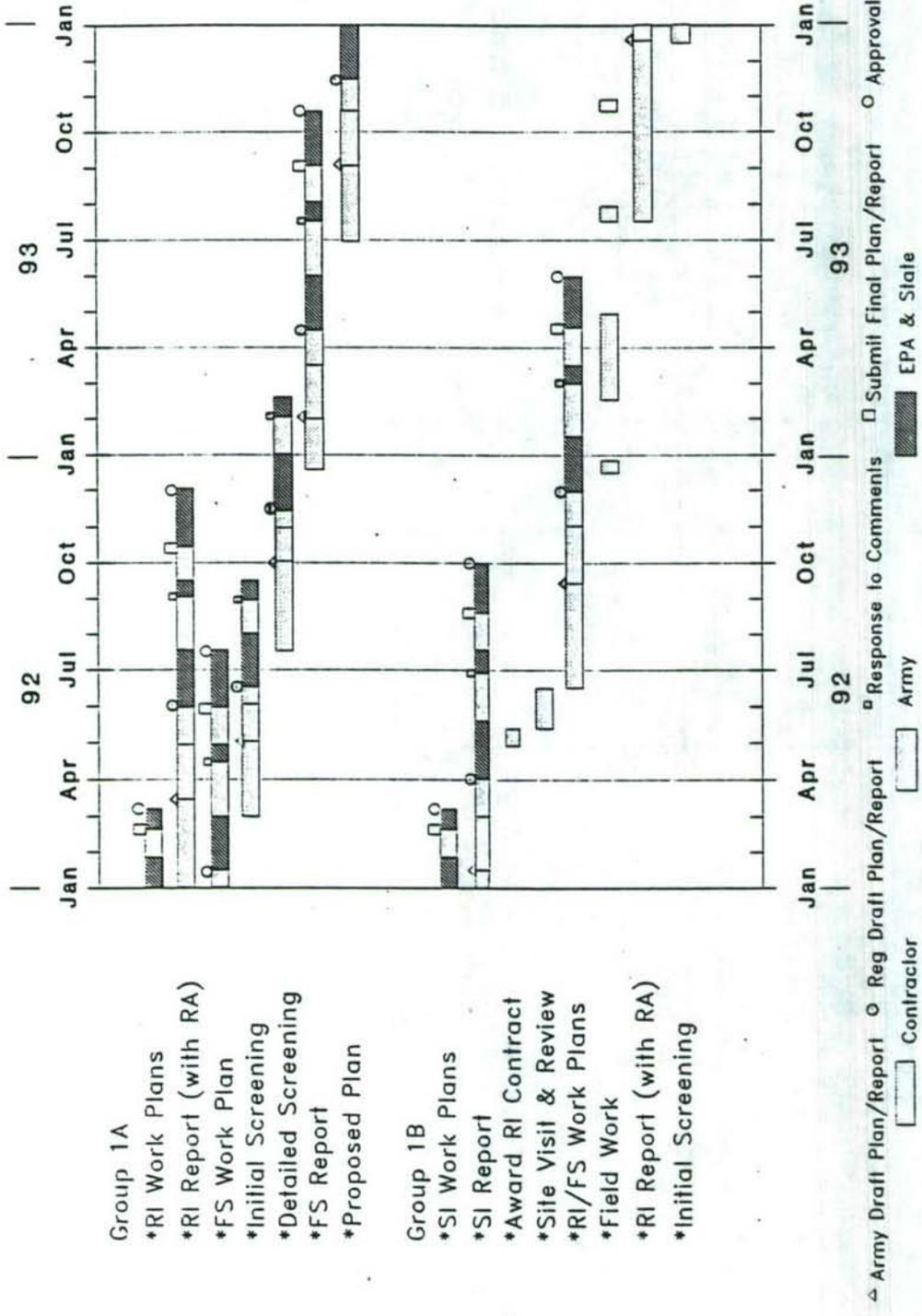


FIGURE B.2 Summary of 1992-1993 Activities for Study Areas and Areas of Concern at Fort Devens as of March 17, 1992

# Fort Devens

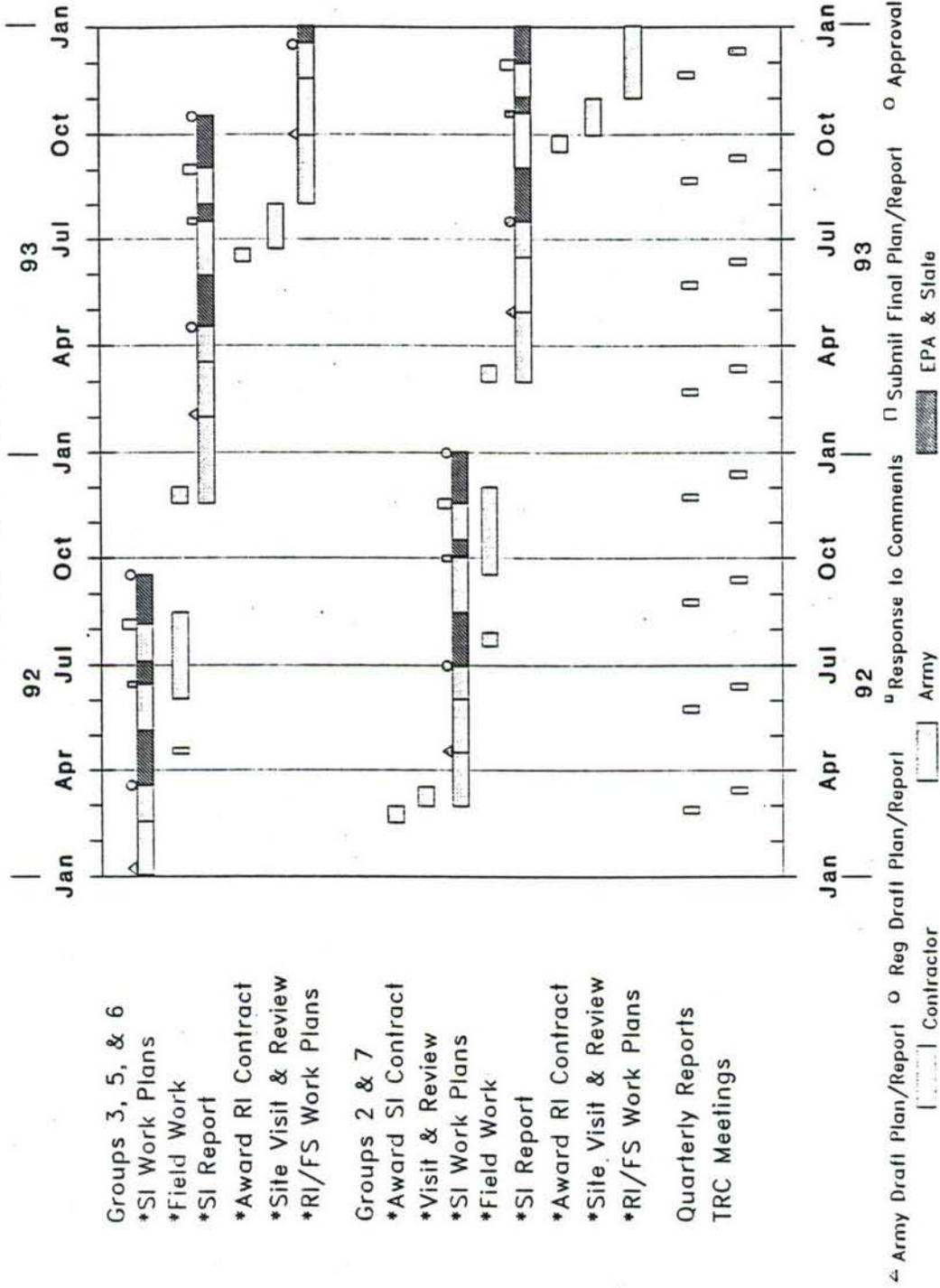


FIGURE B.2 (Cont'd)



# Fort Devens

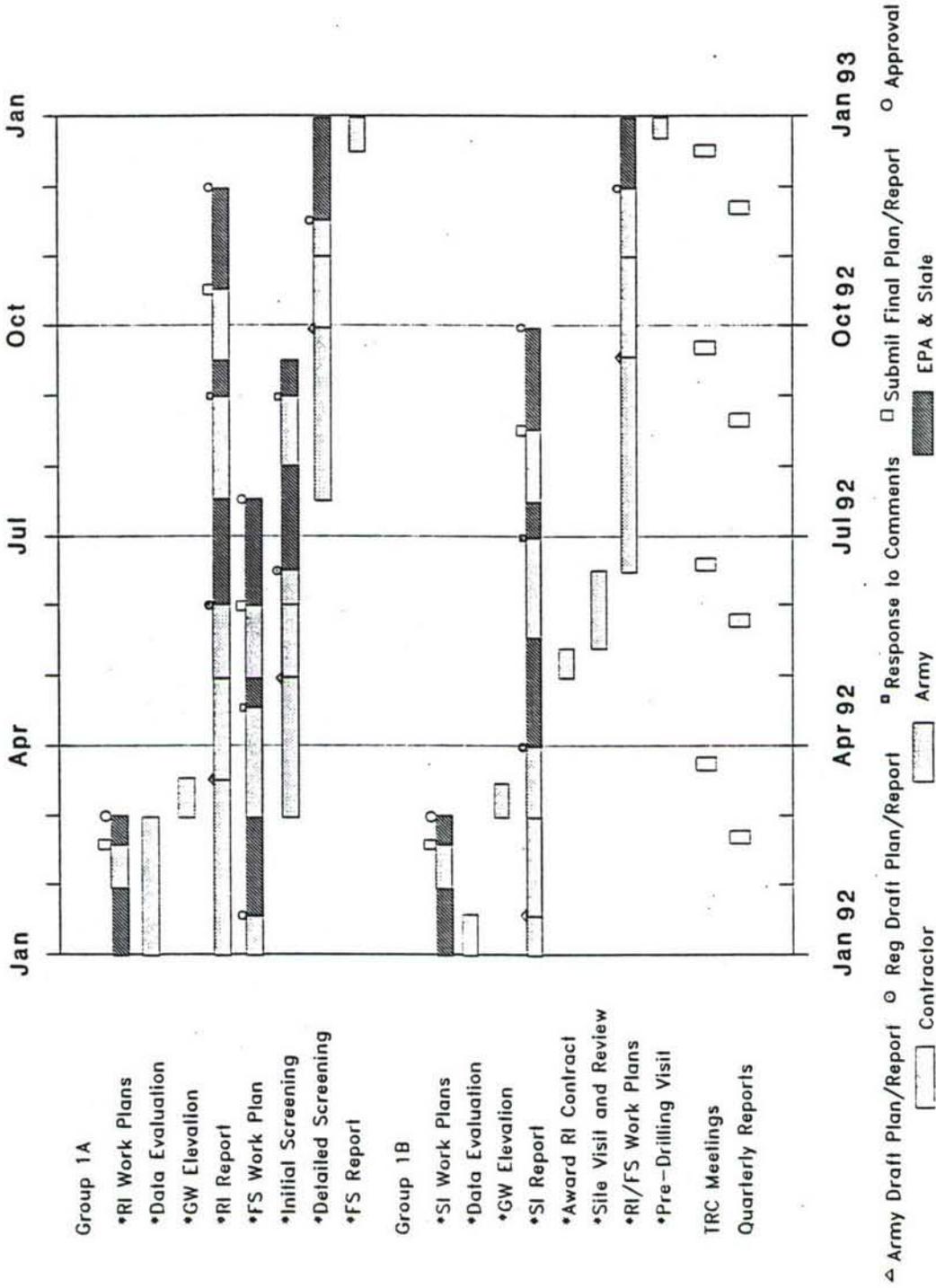


FIGURE B.3 Summary of 1992 Activities for Study Areas at Fort Devens as of March 17, 1992

# Fort Devens

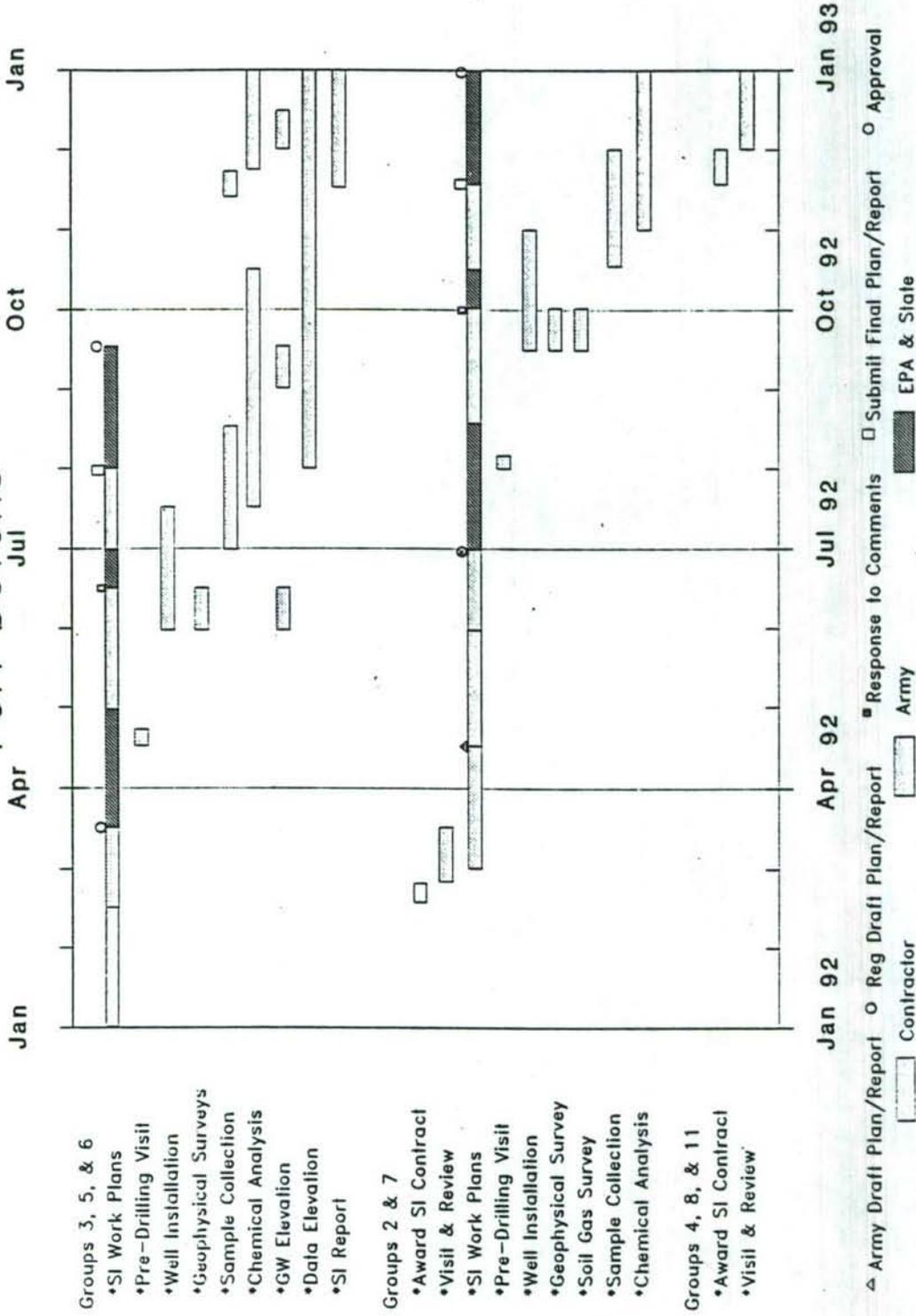


FIGURE B.3 (Cont'd)

**APPENDIX C:  
ANALYTICAL PARAMETERS**



TABLE C.1 U.S. EPA Hazardous Substance List (Target Compound List)

Volatiles

|                            |                             |
|----------------------------|-----------------------------|
| Acetone                    | cis-1,3-Dichloropropylene   |
| Benzene                    | trans-1,2-Dichloropropylene |
| Bromoform                  | Ethylbenzene                |
| Bromodichloromethane       | Methylene chloride          |
| Bromomethane               | Methyl butyl ketone         |
| Carbon disulfide           | Methyl ethyl ketone         |
| Carbon tetrachloride       | Methyl isobutyl ketone      |
| Chlorobenzene              | Styrene                     |
| Chloroethane               | 1,1,2,2-Tetrachloroethane   |
| Chloromethane              | Tetrachloroethylene         |
| Chlorodibromomethane       | Toluene                     |
| Chloroform                 | 1,1,1-Trichloroethane       |
| 1,1-Dichloroethane         | 1,1,2-Trichloroethane       |
| 1,2-Dichloroethane         | Trichloroethylene           |
| 1,1-Dichloroethylene       | Vinyl acetate               |
| cis-1,2-Dichloroethylene   | Vinyl chloride              |
| trans-1,2-Dichloroethylene | Xylenes (o-, m-, p-)        |
| 1,2-Dichloropropane        |                             |

Semivolatiles

|   |                            |
|---|----------------------------|
| Acenaphthene                                | Di-n-octylphthalate        |
| Acenaphthylene                              | Dibenzo (a,h) anthracene   |
| Anthracene                                  | Dibenzofuran               |
| 4-Chloroaniline                             | 1,2-Dichlorobenzene        |
| Benzo (a) anthracene                        | 1,3-Dichlorobenzene        |
| Benzo (a) pyrene                            | 1,4-Dichlorobenzene        |
| Benzyl alcohol                              | 3,3-Dichlorobenzidine      |
| Benzoic acid                                | 2,4-Dichlorophenol         |
| Benzo (b) fluoranthene                      | Diethyl phthalate          |
| Benzo (ghi) perylene                        | Dimethyl phthalate         |
| Benzo (k) fluoranthene                      | 2,4-Dimethylphenol         |
| Bis (2-chloroethoxy) methane                | 4,6-Dinitro-2-methylphenol |
| Bis (2-chloroethyl) ether                   | 2,4-Dinitrophenol          |
| Bis (2-chloroisopropyl) ether               | 2,4-Dinitrotoluene         |
| Bis (2-ethylhexyl) phthalate                | 2,6-Dinitrotoluene         |
| 4-Bromophenyl phenyl ether                  | Fluoranthene               |
| Butyl benzyl phthalate                      | Fluorene                   |
| 4-Chloro-3-methylphenol (P-chloro-M-cresol) | Hexachlorobenzene          |
| 2-Chloronaphthalene                         | Hexachlorobutadiene        |
| 2-Chlorophenol                              | Hexachlorocyclopentadiene  |
| 4-Chlorophenyl phenyl ether                 | Hexachloroethane           |
| Chrysene                                    | Indeno (1,2,3,-cd) pyrene  |
| Di-n-butylphthalate                         | Isophorone                 |
|   | 2-Methylnaphthalene        |

TABLE C.1 (Cont'd)

Semivolatiles (Cont'd)

|                        |                        |
|------------------------|------------------------|
| N-Nitrosodipropylamine | 2-Nitrophenol          |
| N-Nitrosodiphenylamine | 4-Nitrophenol          |
| Naphthalene            | Pentachlorophenol      |
| 2-Nitroaniline         | Phenanthrene           |
| 3-Nitroaniline         | Phenol                 |
| 4-Nitroaniline         | Pyrene                 |
| Nitrobenzene           | 1,2,4-Trichlorobenzene |
| 2-Methyl phenol        | 2,4,6-Trichlorophenol  |
| 4-Methyl phenol        | 2,4,5-Trichlorophenol  |

Pesticides/PCBs

|                    |                       |
|--------------------|-----------------------|
| Aldrin             | BHC (Alpha)           |
| Dieldrin           | BHC (Beta)            |
| Alpha-chlordane    | BHC (Gamma) (Lindane) |
| Gamma-chlordane    | BHC (Delta)           |
| 4,4'-DDT           | Methoxychlor          |
| 4,4'-DDD           | Toxaphene             |
| 4,4'-DDE           | PCB 1242              |
| Endosulfan I       | PCB 1254              |
| Endosulfan II      | PCB 1221              |
| Endosulfan sulfate | PCB 1232              |
| Endrin             | PCB 1248              |
| Endrin ketone      | PCB 1260              |
| Heptachlor         | PCB 1016              |
| Heptachlor epoxide |                       |

Metals

|           |           |
|-----------|-----------|
| Aluminum  | Lead      |
| Antimony  | Magnesium |
| Arsenic   | Manganese |
| Barium    | Mercury   |
| Beryllium | Nickel    |
| Cadmium   | Potassium |
| Calcium   | Selenium  |
| Chromium  | Sodium    |
| Cobalt    | Silver    |
| Copper    | Thallium  |
| Cyanide   | Vanadium  |
| Iron      | Zinc      |

TABLE C.2 Explosives

| Compound                                      | USATHAMA<br>Test Name |
|---|-----------------------|
| 1,3-Dinitrobenzene                            | 13DNB                 |
| 1,3,5-Trinitrobenzene                         | 135TNB                |
| 2,4-Dinitrotoluene                            | 24DNT                 |
| 2,6-Dinitrotoluene                            | 26DNT                 |
| 2,4,6-Trinitrotoluene (TNT)                   | 246TNT                |
| Cyclotetramethylenetetranitramine (HMX)       | HMX                   |
| Hexahydro-1,3,5-trinitro-1,3,4-triazine (RDX) | RDX                   |
| N-methyl-N-2,4,6-tetranitroaniline            | TETRYL                |
| Nitrobenzene                                  | NB                    |

TABLE C.3 TCLP Compounds

|                                 |                                |
|---------------------------------|--------------------------------|
| Arsenic                         | Hexachlorobenzene <sup>a</sup> |
| Barium                          | Hexachloro-1,3-butadiene       |
| Benzene                         | Hexachloroethane               |
| Cadmium                         | Lead                           |
| Carbon tetrachloride            | Lindane                        |
| Chlordane                       | Mercury                        |
| Chlorobenzene                   | Methoxychlor                   |
| Chloroform                      | Methyl ethyl ketone            |
| Chromium                        | Nitrobenzene                   |
| o-Cresol <sup>b</sup>           | Pentachlorophenol              |
| m-Cresol <sup>b</sup>           | Pyridine <sup>a</sup>          |
| p-Cresol <sup>b</sup>           | Selenium                       |
| Cresol <sup>b</sup>             | Silver                         |
| 2,4-D                           | Tetrachloroethylene            |
| 1,4-Dichlorobenzene             | Toxaphene                      |
| 1,2-Dichloroethane              | Trichloroethylene              |
| 1,1-Dichloroethylene            | 2,4,5-Trichlorophenol          |
| 2,4-Dinitrotoluene <sup>a</sup> | 2,4,6-Trichlorophenol          |
| Endrin                          | 2,4,5-TP (Silvex)              |
| Heptachlor (and its hydroxide)  | Vinyl chloride                 |

<sup>a</sup>Because the quantification limit is greater than the regulatory level, the quantification limit becomes the regulatory level.

<sup>b</sup>If o-, m-, and p-cresol concentrations cannot be differentiated, then the total cresol (D026) concentration is used.

Source: 55 FR 11804.

TABLE C.4 Pesticides and Herbicides

Pesticides<sup>a</sup>

|                    |                       |
|--------------------|-----------------------|
| Aldrin             | Endrin                |
| Dieldrin           | Endrin ketone         |
| Alpha-chlordane    | Heptachlor            |
| Gamma-chlordane    | Heptachlor epoxide    |
| 4,4'-DDT           | BHC (Alpha)           |
| 4,4'-DDD           | BHC (Beta)            |
| 4,4'-DDE           | BHC (Gamma) (Lindane) |
| Endosulfan I       | BHC (Delta)           |
| Endosulfan II      | Methoxychlor          |
| Endosulfan sulfate | Toxaphene             |

Herbicides

|       |                   |
|-------|-------------------|
| 2,4-D | 2,4,5-TP (Silvex) |
|-------|-------------------|

<sup>a</sup>The listed pesticides are the same as those listed in Table C.1.