Public Health Assessment for

FORT DEVENS
AYER, MIDDLESEX COUNTY, MASSACHUSETTS
CERCLIS NO. MA7210025154
JULY 12, 2000

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

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PUBLIC HEALTH ASSESSMENT

FORT DEVENS

AYER, MIDDLESEX COUNTY, MASSACHUSETTS

CERCLIS NO. MA7210025154

Prepared by:

Federal Facilities Assessment Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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FOREWORD

The Agency for Toxic Substances and Disease Registry, ATSDR, was established by Congress in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act, also known as the *Superfund* law. This law set up a fund to identify and clean up our country's hazardous waste sites. The Environmental Protection Agency, EPA, and the individual states regulate the investigation and clean up of the sites.

Since 1986, ATSDR has been required by law to conduct a public health assessment at each of the sites on the EPA National Priorities List. The aim of these evaluations is to find out if people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. If appropriate, ATSDR also conducts public health assessments when petitioned by concerned individuals. Public health assessments are carried out by environmental and health scientists from ATSDR and from the states with which ATSDR has cooperative agreements. The public health assessment program allows the scientists flexibility in the format or structure of their response to the public health issues at hazardous waste sites. For example, a public health assessment could be one document or it could be a compilation of several health consultations - the structure may vary from site to site. Nevertheless, the public health assessment process is not considered complete until the public health issues at the site are addressed.

Exposure: As the first step in the evaluation, ATSDR scientists review environmental data to see how much contamination is at a site, where it is, and how people might come into contact with it. Generally, ATSDR does not collect its own environmental sampling data but reviews information provided by EPA, other government agencies, businesses, and the public. When there is not enough environmental information available, the report will indicate what further sampling data is needed.

Health Effects: If the review of the environmental data shows that people have or could come into contact with hazardous substances, ATSDR scientists evaluate whether or not these contacts may result in harmful effects. ATSDR recognizes that children, because of their play activities and their growing bodies, may be more vulnerable to these effects. As a policy, unless data are available to suggest otherwise, ATSDR considers children to be more sensitive and vulnerable to hazardous substances. Thus, the health impact to the children is considered first when evaluating the health threat to a community. The health impacts to other high risk groups within the community (such as the elderly, chronically ill, and people engaging in high risk practices) also receive special attention during the evaluation.

ATSDR uses existing scientific information, which can include the results of medical, toxicologic and epidemiologic studies and the data collected in disease registries, to determine the health effects that may result from exposures. The science of environmental health is still developing, and sometimes scientific information on the health effects of certain substances is not available. When this is so, the report will suggest what further public health actions are needed.

Conclusions: The report presents conclusions about the public health threat, if any, posed by a site. When health threats have been determined for high risk groups (such as children, elderly, chronically ill, and people engaging in high risk practices), they will be summarized in the conclusion section of the report. Ways to stop or reduce exposure will then be recommended in the public health action plan.

ATSDR is primarily an advisory agency, so usually these reports identify what actions are appropriate to be undertaken by EPA, other responsible parties, or the research or education divisions of ATSDR. However, if there is an urgent health threat, ATSDR can issue a public health advisory warning people of the danger. ATSDR can also authorize health education or pilot studies of health effects, full-scale epidemiology studies, disease registries, surveillance studies or research on specific hazardous substances.

Community: ATSDR also needs to learn what people in the area know about the site and what concerns they may have about its impact on their health. Consequently, throughout the evaluation process, ATSDR actively gathers information and comments from the people who live or work near a site, including residents of the area, civic leaders, health professionals and community groups. To ensure that the report responds to the community's health concerns, an early version is also distributed to the public for their comments. All the comments received from the public are responded to in the final version of the report.

Comments: If, after reading this report, you have questions or comments, we encourage you to send them to us.

Letters should be addressed as follows:

Attention: Chief, Program Evaluation, Records, and Information Services Branch, Agency for Toxic Substances and Disease Registry, 1600 Clifton Road (E-56), Atlanta, GA 30333.

TABLE OF CONTENTS

FOREWORD i

LIST OF TABLES v

LIST OF FIGURES vi

LIST OF ABBREVIATIONS vii

SUMMARY 1

BACKGROUND 3
- Site Description and History 3
- ATSDR Involvement 5
- Demographics 6
- Land Use 6
- Quality Assurance and Quality Control 7

EVALUATION OF ENVIRONMENTAL CONTAMINATION AND HUMAN EXPOSURE PATHWAYS 9
- Introduction 9
- Evaluation of the Groundwater Exposure Pathway 10
- Evaluation of the Surface Water and Sediment Exposure Pathway 17
- Evaluation of the Food Chain Pathway 21
- Evaluation of the Indoor Air Pathway 24

COMMUNITY HEALTH CONCERNS 26

ATSDR CHILD HEALTH INITIATIVE 33

CONCLUSIONS 34

PUBLIC HEALTH ACTION PLAN 36

REFERENCES 39

TABLES 43

FIGURES 70

APPENDIX A: List of Comparison Values A-1

APPENDIX B: Glossary B-1

APPENDIX C: Estimated Exposures and Health Effects C-1

APPENDIX D: Responses to Public Comments D-1

LIST OF TABLES

Table 1: Evaluation of Potential Public Health Hazards Associated with Major Study Areas and Areas of Contamination at Fort Devens 44

Table 2: Local Public Water Supplies 59

Table 3. Exposure Pathways 60

Table 4: Summary of Contaminants in the On-Site Groundwater 64

Table 5: Summary of Contaminants in Grove Pond and Plow Shop Pond Surface Water . . . 65

Table 6: Summary of Contaminants in Grove Pond and Plow Shop Pond Sediment 66

Table 7: Summary of Contaminants in Grove Pond Fish 67

Table 8: Summary of Contaminants in Plow Shop Pond Fish 68

Table 9: Summary of Contaminants in Mirror Lake Fish 69

LIST OF FIGURES

Figure 1: Site Map 71

Figure 2: Demographics Within a 1-Mile Buffer of Fort Devens 72

Figure 3: ATSDR's Exposure Evaluation Process 73

Figure 4: Grove Pond Wells 74

Figure 5: Grove Pond and Plow Shop Pond 75

LIST OF ABBREVIATIONS

ABS	absorption factor
AF	adherence factor
AOC	area of contamination
AT	averaging time
ATSDR	Agency for Toxic Substances and Disease Registry
BRAC	Base Realignment and Closure
BW	body weight
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	conversion factor
CPF	cancer potency factor
CREG	ATSDR's cancer risk evaluation guide
CV	comparison value
DDD	1,1-dichloro-2,2-*bis*(*p*-chlorophenyl)ethane
DDE	1,1-dichloro-2,2-*bis*(*p*-chlorophenyl)ethylene
EF	exposure frequency
ED	exposure duration
EMEG	ATSDR's environmental media evaluation guide
EPA	U.S. Environmental Protection Agency
FDA	Food and Drug Administration
FI	fraction ingested
IR	ingestion rate
IRP	Installation Restoration Program
kg	kilogram
LTHA	EPA's Lifetime Health Advisory for Drinking Water
MADEP	Massachusetts Department of Environmental Protection
MDPH	Massachusetts Department of Public Health
MCL	EPA's maximum contaminant level
MRL	ATSDR's minimal risk level
mg/kg	milligrams of contaminants per kilogram
mg/kg/day	milligrams of contaminant per kilogram per day
NPL	National Priorities List
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PCE	tetrachloroethylene
PHA	Public Health Assessment
PHAP	Public Health Action Plan
ppb	parts per billion
ppm	parts per million

LIST OF ABBREVIATIONS (continued)

RAB	Restoration Advisory Board
RD/RA	remedial design and remedial action
RfD	EPA's reference dose
RMEG	ATSDR's reference dose media evaluation guide
ROD	record of decision
SA	surface area
TPHC	total petroleum hydrocarbon
UST	underground storage tank
VOCs	volatile organic compounds
WW II	World War II

SUMMARY

The Agency for Toxic Substances and Disease Registry (ATSDR) has prepared this public health assessment to evaluate potential exposure pathways for contaminants from the Fort Devens site to cause harm to people living near or accessing the site. From a review of the available environmental data and exposure information, ATSDR finds that the Fort Devens site poses *no apparent public health hazard.*

Fort Devens is located 35 miles northwest of Boston, Massachusetts. The site covers approximately 9,311 acres in the towns of Ayer, Harvard, Lancaster, and Shirley. Initially established as a temporary training camp, Fort Devens eventually processed military equipment. During normal operations, some processing chemicals were released to the surrounding soil and groundwater, and other environmental media. In 1989, the U.S. Environmental Protection Agency (EPA) placed the site on the National Priorities List because groundwater was contaminated by volatile organic compounds (used to clean equipment) and/or metals. Most of the contamination reportedly is contained within the Fort Devens property, although some contamination has migrated via groundwater to an adjacent property.

In evaluating potential public health hazards at Fort Devens, ATSDR reviewed available information from Fort Devens, the Ayer Department of Public Works, the Massachusetts Department of Environmental Protection, the Massachusetts Department of Public Health, the Massachusetts Department of Environmental Management, Massachusetts Development Finance Agency (MassDevelopment, and formerly known as Devens Commerce Center), Nashoba Associated Board of Health, and EPA. ATSDR also held public availability sessions in Ayer, Harvard, Lancaster, and Shirley to hear health concerns of residents living near Fort Devens, and prepared health consultations to respond to some of their concerns.

From a preliminary review of the data and community discussions, ATSDR identified contaminated groundwater that might feed into public or private drinking water supplies as the principal exposure pathway of concern. After reviewing available data in greater detail, however, ATSDR determined that site-related contaminants pose no public health hazard to people who currently use, or people who have used, area drinking water supplies. The Army continues to take measures to reduce potential future exposures to groundwater by identifying and intercepting contaminants before they can reach area drinking water supplies.

ATSDR also evaluated potential exposures from contacting Grove Pond and Plow Shop Pond surface water and sediment, breathing indoor air at the former Devens Elementary School, and eating pond fish. In evaluating these pathways, ATSDR considered whether people might have been (past), are (current), or could be (future) exposed to contaminants from Fort Devens at levels known to cause public health hazards. Following its review, ATSDR has drawn these conclusions:

- No harmful exposures have occurred in the past, nor are likely to occur for people who wade, boat, or catch and release fish, at Grove Pond and Plow Shop Pond. Advisories currently recommend against swimming at either pond.

- Air inside the former Devens Elementary School poses no current or future public health hazards from contaminants associated with historic fuel oil spills. Although limited data were collected around the time of the release, information gathered to date suggest the air inside the school was probably not adversely impacted in the past.

- People most likely were not exposed to harmful levels of contaminants when they ate fish in the past from Grove Pond, Plow Shop Pond, or Mirror Lake. Advisories currently recommend that people limit or refrain from consumption of fish caught from these ponds. As a precautionary measure, people can best protect themselves by continuing to follow the recommendations in the advisory posted at each of these water bodies.

BACKGROUND

Site Description and History

Fort Devens (also known as the Reserve Forces Training Area [Devens]) is a military base located approximately 35 miles northwest of Boston, Massachusetts. The site covers approximately 9,300 acres in the towns of Ayer, Harvard, Lancaster, and Shirley (BRAC, 1996). As Figure 1 indicates, Fort Devens is divided into three functionally distinct parts: the Main Post, the North Post, and the South Post (Fort Devens, 1995a). The three posts are described below:

Main Post. The Main Post, situated on 3,528 acres, was the center for residential, industrial, educational, and recreational activities at Fort Devens. Most of the Main Post is located in the town of Harvard.

North Post. Located north of West Main Street in the towns of Ayer and Shirley, the 900-acre North Post contains the Moore Army Air Field, the installation's water treatment plant, and training areas. The wastewater treatment plant does not currently meet Massachusetts standards. The post Reuse Plan calls for its replacement with a state-of-the art water treatment plant.

South Post. Separated from the Main Post by Route 2, the 4,883-acre South Post has been and is still used for firing practices and training. The area, also known as the Tactical Training Area or the South Post Impact Area, is entirely within the boundaries of the town of Lancaster.

Fort Devens was established in 1917 as Camp Devens, a temporary training camp for military personnel. By 1931, the camp had become a permanent installation, known as Fort Devens, for the training and induction of military personnel and the processing of military equipment. More recently, Fort Devens has "demobilized" and "out processed" equipment assigned to Army units in New England (BRAC, 1996).

In support of its mission, the Army conducted operations (e.g., storage and distribution of fuel oil, maintenance of vehicles and air crafts, photographic processing, and landfilling) that used a variety of chemicals. As a result of these past operations and waste disposal practices, hazardous materials have been released to the environment. Some of these chemicals, including volatile organic compounds (VOCs), explosive compounds, fuels, and, perhaps, inorganic compounds (e.g., arsenic) might have been released to the soil and into the underlying groundwater (BRAC, 1996). Most of the contamination reportedly is contained on the Fort Devens property, though some contamination has migrated via groundwater to adjacent property. Today, hazardous material and wastes generated at the property are disposed off or recycled at off-site waste disposal facilities.

In 1989, the U.S. Environmental Protection Agency (EPA) placed Fort Devens on the National Priorities List (NPL) of sites identified for possible long-term remedial response. The post was placed on the list as a result of VOC contamination in groundwater at Shepley's Hill Landfill, metal contamination in groundwater at Cold Spring Brook Landfill (area of contamination [AOC] 40), and the proximity of these locations to drinking water wells (Grove Pond Wells and Patton Well) (Fort Devens, 1995b).

The Army has conducted numerous and extensive investigations of environmental contamination associated with past operations and waste handling practices at Fort Devens through its installation restoration program (IRP). Over the years, more than 300 sites have been identified for environmental investigation, including landfills, industrial areas, gas stations, post spill sites, waste storage areas, and underground and above ground storage tanks. Most of the sites have been investigated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as Superfund (Horne Engineering Services, Inc., 1996), many of which have been designated as requiring no further action, while other sites are in varying stages of cleanup with Massachusetts Department of Environmental Protection (MADEP) and EPA oversight. Table 1 describes the use, chemical contamination, and current status of many of the study areas and AOCs at Fort Devens.

The Federal Base Realignment and Closure (BRAC) Commission has since recommended closing Fort Devens, and retaining a reserve enclave, which includes all of the South Post Impact Area and significant portions of the Main and North Post. The goal of the BRAC is to quickly transfer excess military property (about 50 percent of the total acreage) to other parties for economic reuse and development. To guide remedial activities at Fort Devens, the Army has grouped study areas and AOCs that share similar contaminated media or geographic proximity and assigned them to one of six operable units (Fort Devens, 1998).

Today, the Main Post and North Post are not actively used for military support, but the South Post is and will continue to be used by the Army for military training. In 1996, large portions of the Main Post and North Post were transferred to the local redevelopment authority, the Massachusetts Government Land Bank, for the development of the Devens Regional Enterprise Zone (referred to as "Devens"). A Reuse Plan outlines many of the proposed uses for the enterprise zone. Once transferred or leased, the management of the physical property and associated environmental issues will be the responsibility of the Massachusetts Development Finance Agency (MassDevelopment, also previously known as Devens Commerce Center). Any ongoing major environmental response actions at Fort Devens will continue to be managed by the Army (BRAC, 1996; MADEP, 1999a). With state legislative approval, the area will eventually be transferred to the local community for economic development and reuse (MADEP, 1998a; Vanasse Hangen Brustlin, Inc., 1994). For ease of presentation, this PHA will refer to the site only as "Fort Devens" and will no longer refer to the site as "Devens."

ATSDR Involvement

As part of the public health assessment process, the Agency for Toxic Substances and Disease Registry (ATSDR) conducted an initial scoping visit and met with representatives from the Army, Fort Devens, EPA, MADEP, and Massachusetts Department of Public Health (MDPH) in March 1991. ATSDR gathered information on potential pathways of human exposure to contaminants and held session(s) with the public to gather information about community health concerns. From these meetings and a review of the data then available, ATSDR determined that no immediate threats to public health existed, but that several potential exposure pathways and community health concerns required further evaluation.

ATSDR has revisited the Fort Devens site on several occasions, to confirm that no situations requiring immediate attention existed and to further evaluate community health concerns. ATSDR has also attended Restoration Advisory Board (RAB) meetings throughout the years in order to remain current with environmental and health issues. At the request of MADEP, ATSDR evaluated potential health hazards associated with explosive compounds in groundwater underlying the South Post. In a December 1994 health consultation, ATSDR presented its conclusion that explosive compounds were not likely to move from the source areas to drinking water supplies.

As part of its ongoing involvement at Fort Devens, ATSDR conducted another site visit and met with representatives from the Army, MADEP, and EPA on March 23, 1998. Also, ATSDR met with representatives of the U.S. Department of Justice, Federal Bureau of Prisons, Nashoba Associated Board of Health, League of Women Voters, Ayer Department of Public Works, U.S. Fish and Wildlife Service, Nashua River Watershed Association, Ayer Committee for Community Wellness, Devens Reuse Task Force, and MassDevelopment. ATSDR attended a RAB meeting, where ATSDR staff listened to community health concerns and presented an overview of the public health assessment process (ATSDR, 1998). ATSDR has continued to attend RAB meetings throughout the year where ATSDR presented information as well as gathered additional community concerns. In March 1998, ATSDR also held public availability sessions in Ayer, Harvard, Lancaster, Shirley, and at Fort Devens to provide an additional opportunity for the public to express any site-related health concerns. More than 50 people attended these sessions. ATSDR addresses the public's health concerns in the "Evaluation of Potential Exposure Pathways" and "Community Health Concern" sections of this public health assessment.

From the public availability meetings, ATSDR learned that community members were particularly concerned about the possibility of health effects from drinking water drawn from the Ayer Grove Pond wells and from recreational uses of Grove Pond and Plow Shop Pond. In response, ATSDR developed focused health consultations and fact sheets on the health consequences of drinking Ayer Grove Pond well water (July 1998) and recreational uses of Grove Pond and Plow shop Pond (December 1998). This PHA summarizes the findings of these health consultations, as well

as assesses other potential pathways of exposures (e.g., indoor air at the Devens Elementary School), and responds to specific health concerns expressed by community members.

Demographics

ATSDR examines demographic information, or population information, to identify the presence of sensitive populations, such as young children and the elderly, in the vicinity of a site. Demographics also provide details on residential history in a particular area—information that helps ATSDR assess time frames of potential human exposure to contaminants. Demographic information for the residential areas surrounding Fort Devens is presented in this section.

Fort Devens has been a major employer of military and civilian personnel for the area. According to the 1990 census data, Fort Devens supported more than 2,200 civilian and 6,200 military personnel. About 80% of the military personnel (about 4,900 persons) and family members (4,280 persons) stationed at Fort Devens lived on post. Many military retirees also used services provided by the post. Since closure procedures began, the Fort Devens workforce has decreased to a daytime population of about 900 civilian and 250 military personnel (Ecology and Environment, 1994; Fort Devens, 1999a). The daytime population is expected to increase as businesses move into the newly created enterprise zone at Fort Devens (Fort Devens 1999a).

A number of small towns are located around Fort Devens, the nearest of which are Ayer, Harvard, Lancaster, and Shirley. The towns of Ayer (population of 6,029 persons) and Shirley (population of 5,473 persons) abut the Main Post to the north and west, respectively. Portions of Lancaster (population of 6,610 persons) lie adjacent to the South Post and to the east of the site is the town of Harvard (population of 6,816 persons) (Vanasse Hangen Brustlin, Inc., 1994). Figure 2 shows demographic information for the population within a 1-mile radius of Fort Devens boundaries. As the figure indicates, approximately 20,000 residents of the surrounding communities live within a 1-mile buffer of the site boundaries, including approximately 2,600 children ages 6 and under and 1,000 adults ages 65 and older (ATSDR, 1999).

Land Use

ATSDR also reviewed land use at or near the Fort Devens site to identify valuable information on the types and frequency of activities of the surrounding population and the possibility of exposure through these activities. The predominant land use in the four towns surrounding the site is residential, while commercial and industrial uses are concentrated along Route 2A. Still, large portions of undeveloped, wooded, and open pasture land exist in the four town region. One of the larger undeveloped areas is the Oxbow National Wildlife Refuge, which is located along the east-central portion of Fort Devens. Some nearby land is also used for agriculture, particularly in the town of Harvard where several orchards exist (Vanasse Hangen Brustlin, Inc., 1994)

Groundwater at Fort Devens is found largely in the permeable glacial-deltaic outwash deposits of sand, gravel, and boulders. Small amounts of groundwater can also be obtained from the fractured bedrock aquifer. The top of the saturated zone, or water table, in the area of Fort Devens is encountered about 0 to 90 feet below ground surface (Vanasse Hangen Brustlin, Inc., 1994). Groundwater flow direction varies locally, but is generally toward the Nashua River (Ecology and Environment, 1994).

Groundwater, which meets MADEP's designation as a Class I potable water source, serves as a major source of drinking water for the region (Vanasse Hangen Brustlin, Inc., 1994). Each of the four towns and Fort Devens provides groundwater-supplied public drinking water to its residents. Table 2 describes the location, history, and use of area public drinking water wells. Some water is drawn from the medium- or high-yield aquifers lying beneath portions (about 30%) of the Fort Devens property.

Some area residents rely on private wells in lieu of public water. While no complete list of active private wells in the area currently exists, through a review of files at the Massachusetts Department of Environmental Management and information obtained from the Nashoba Boards of Health, ATSDR estimates that approximately 700 private wells have been installed in the four town area since the 1960s. Of these wells, roughly 100 to 300 private wells are located within a 1-mile buffer of the Fort Devens site. A few wells serve industrial and agricultural purposes, but most wells are registered for domestic uses (MDEM, 1999; Nashoba Associated Board of Health, 1999). Because of the limitations of these data and the absence of recent well information, we do not know with certainty, however, whether the private wells are still used, or even if they have ever been used.

Fort Devens is located within the Nashua River Basin and more than 8 miles of rivers and streams flow through its property (Vanasse Hangen Brustlin, Inc., 1994). About 100 acres of ponds and lakes are used for outdoor recreation, including Robbins Pond, Mirror Lake, and Little Mirror Lake (Vanasse Hangen Brustlin, Inc., 1994). Two other ponds, Grove Pond and Plow Shop Pond, are situated along the northern boundary of the Fort Devens property. To reduce potential exposure to contaminants that might be present fish and/or sediment, Mirror Lake is posted with a fish consumption advisory and Grove Pond and Plow Shop Pond are posted with a catch and release fishing only and no swimming advisory.

Quality Assurance and Quality Control

In preparing this public health assessment, ATSDR relied on the information provided in the referenced documents. Documents prepared for the IRP program meet specific standards for adequate quality assurance and control measures for chain-of-custody procedures, laboratory procedures, and data reporting. The validity of the analyses and conclusions drawn in this document are dependent upon the availability and reliability of the referenced information. The environmental data presented in the public health assessment are from the environmental

investigations for Fort Devens; water quality data provided by the Ayer Department of Public Works; and additional data provided by the EPA, MADEP, and MDPH. The limitations of these data have been identified in the associated reports.

EVALUATION OF ENVIRONMENTAL CONTAMINATION AND HUMAN EXPOSURE PATHWAYS

Introduction

In this section, ATSDR evaluates whether community members have been (past), are (current) or could be (future) exposed to harmful levels of chemicals. Figure 3 describes the conservative exposure evaluation process used by ATSDR. As the figure indicates, ATSDR considers how people might come into contact with, or be exposed to, contaminated media. Specifically, ATSDR determines whether an exposure could occur through ingestion, dermal (skin) contact with contaminated media, or inhalation of vapors, and also considers the likely length (duration) and frequency of the exposure.

If exposure was or is possible, ATSDR then considers whether chemicals were or are present at levels that might be harmful to people. ATSDR does this by screening the concentrations of contaminants in an environmental medium against health-based comparison values. Comparison values are chemical concentrations that health scientists have determined are not likely to cause adverse effects, even when assuming very conservative/safe exposure scenarios. Because comparison values are not thresholds of toxicity, environmental levels that exceed comparison values would not necessarily produce adverse health effects. If a chemical is found in the environment at levels exceeding its corresponding comparison value, ATSDR examines potential exposure variables and the toxicology of the contaminant. ATSDR emphasizes that regardless of the level of contamination, *a public health hazard exists only if people come in contact with, or are otherwise exposed to, harmful levels of contaminated media.*

After an initial review of potential health hazards at the Fort Devens site, ATSDR identified the groundwater, surface water/sediment, food chain, and indoor air exposure pathways as requiring further evaluation. Following the strategy outlined above, ATSDR examined whether human exposure to harmful levels of contaminants via these pathways existed in the past, exists now, or could potentially exist in the future. ATSDR summarizes its evaluation of potential exposure pathways in Table 3 and describes it in more detail in the discussion that follows. To acquaint readers with terminology used in this report, a list of comparison values and a glossary are included in Appendices A and B, respectively. In addition, Appendix C presents the methods and assumptions used to estimate exposures and support some of the report's conclusions.

Evaluation of the Groundwater Exposure Pathway

Conclusion

After a detailed review of drinking water sources and environmental monitoring data, ATSDR has concluded that no apparent public health hazards are associated with past or current uses of groundwater-supplied drinking water sources. The Army, MADEP, and EPA will continue to take precautions and test groundwater to protect the underlying aquifer and prevent contaminants from reaching drinking water supplies in the future.

Discussion

Groundwater Use

Groundwater is the primary source of drinking water for Fort Devens and the surrounding communities of Ayer, Harvard, Lancaster, and Shirley. Fort Devens has relied on on-site drinking water from four groundwater-supplied drinking water wells or wellfields. These wells/wellfields include: the MacPherson well located on the North Post; the Fort Devens Grove Pond wellfield, the Patton well, and the Shebokin well (the primary supply well) situated on the Main Post; and Well D-1 located at the South Post. Unlike the other drinking water wells, the Fort Devens Grove Pond wellfield actually comprises eight individual wells that are connected via a single pumping system. Currently, this wellfield supplies only a small portion of the drinking water supplied to the Fort Devens community since it operates at only one-fifth of its full capacity (MADEP, 1999a). According to the Reuse Plan, the wells on the Main Post and North Post will continue to be used in the future for drinking water, and Well D-1 will continue to be used by the military as a drinking water supply for troops training in the area (Ecology and Environment, Inc., 1994). There are no plans to install new drinking water supply wells on either the Main or North Post, although existing wells could be expanded to meet anticipated water demand.

Communities surrounding Fort Devens also rely on groundwater for public drinking water supplies. Table 2 describes the years of operation, the location, and use pattern for public drinking water wells located in Ayer, Harvard, Lancaster, and Shirley. Of these wells, Ayer's Grove Pond wells are nearest to the Fort Devens boundary, located just beyond the site's northern boundary.

Some people in the area of Fort Devens rely on private wells. A complete inventory on the location and use pattern of private wells in the vicinity of Fort Devens is not available. In discussions with town representatives and following a review of private well registration information, ATSDR learned that no private wells exist in or immediately downgradient from contaminated on-site areas (Harvard Water Department, 1998; Shirley Water District, 1998; Lancaster Water Department, 1998; ADPW, 1998a; Ayer, 1998). It should be noted that several new homes with private wells are located upgradient from a source of groundwater contamination

known as AOC 50. We discuss the potential health consequences of contamination at AOC 50 later in this PHA.

Groundwater Quality

As a result of past site activities various chemicals have been released to soil and subsequently to groundwater underlying the Fort Devens property. The Army has collected groundwater samples at many of the AOCs and study areas on Fort Devens to determine where chemical contaminants are located and where they might move. Samples were analyzed for a wide variety of chemicals suspected to have been used at Fort Devens, including VOCs and metals. Selected samples were also analyzed for explosives, pesticides, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs).

In general, VOCs and metals were widely distributed and present in the highest concentrations, whereas explosives, pesticides, and PCBs were much less common in groundwater beneath the post. Table 4 summarizes the results of groundwater monitoring data for VOCs and metals. For each contaminant, the table presents the maximum concentration, the location of that detection, and the most conservative comparison value. As the table indicates, some of the highest levels of VOCs and metals were found in groundwater samples collected at Shepley's Hill Landfill (AOCs 4, 5, and 18) located in the northern portion of the Fort Devens property; the former World War II [WW II] Fuel Points) (AOC 50) located on the northeastern boundary of Moore Army Air Field; and the Historic Gas Station Site (AOC 43G) located in the central portion of the Main Post (see Figure 1). In these areas, several VOCs (i.e., tetrachloroethylene [PCE], 1,2-dichloroethane) and metals (i.e., arsenic, chromium, aluminum) exceeded health-based comparison values. Since detecting groundwater contamination in these areas, the Army has removed or is controlling contaminated sources, and they have started long-term groundwater monitoring programs.

Most of the groundwater contamination appears to be contained on the Fort Devens property. Recent monitoring data, however, indicate that some contaminants have migrated with groundwater beyond the Fort Devens property at the Moore Army Air Field (AOC 50). PCE has entered the groundwater beneath the Army's former Parachute Rigging Facility at the Moore Army Air Field, where the chemical was stored in drums. Although the general direction of groundwater flow in this area is to the southwest, PCE has been transported northward, reportedly as a result of backflow (MADEP, 1998b). The PCE contamination has spread across Route 2A to the Merrimack Warehouse property, where concentrations exceed ATSDR's conservative comparison value for cancer (i.e., cancer risk evaluation guide [CREG]) but are below EPA's Maximum Contaminant Level (MCL) of 5 parts per billion (ppb). (*See* Appendix A for a description of CREGs and MCLs). Contamination has *not* spread further north beyond the warehouse property where residential properties are located (Oakhurst Street). In fact, no detectable concentrations were found in potable wells at the Massachusetts Game Farm located north of the source area or even in monitoring wells far north of the source area and closest to

residential areas (MADEP, 1999a). The Army installed a soil vapor extraction system as part of an interim removal action to control the source of PCE contamination (MADEP, 1998b). Between 1994 and 1996, the system removed approximately 240 pounds of PCE from soil.

The Army, with MADEP and EPA oversight, continues to track contamination north of AOC 50 through their extensive network of groundwater monitoring wells. In the fall of 1998, the Army drilled more monitoring wells in the area between the suspected source and the new residential property to the north. These monitoring wells will help to clarify the extent of PCE contamination associated with AOC 50. They also continue to evaluate options aimed at reducing the PCE contamination in the groundwater associated with AOC 50.

The discussion that follows presents information on the potential for exposure to contaminated groundwater through the area drinking water supplies identified above.

Fort Devens Drinking Water Supply (On-site)

Past and Current Exposure

No exposure has occurred through use of water supplied by these on-site wells, primarily because contaminants associated with Fort Devens have never reached areas where any of the Main Post or North Post drinking water wells are located. Furthermore, water from each well is tested quarterly for compliance with state and federal drinking water quality standards to ensure its safety, chlorinated, and then delivered to a central area where it is co-mingled with water from other drinking water wells (MADEP, 1999a; Fort Devens, 1999a).

ATSDR previously evaluated potential health hazards associated with exposure to contaminated groundwater beneath South Post and use of Well D-1 in its 1994 health consultation (ATSDR, 1994). From that evaluation, ATSDR concluded that the explosive contamination in Fort Devens South Post is not a threat to human health because no one drinks water drawn from the contaminated area. A 1996 record of decision (ROD) for the South Post recommended that no further formal remedial action was needed to ensure protection of human health, but the Army is committed to assessing the groundwater quality through long-term monitoring (Horne Engineering Services, Inc., 1996).

Future Exposure

The on-site wells will continue to be used for drinking water in the future. *Most of these wells are not likely to be threatened by contamination in the future because they do not currently lie in or downgradient from areas of contamination.* Furthermore, many measures to protect the groundwater entering these drinking water supply wells are being considered as a major goal in the reuse planning efforts. For example, development of areas overlying the aquifer will be protected through a variety of measures outlined in a Water Resource Protection provision

contained in the Reuse Plan Bylaws. MADEP concurs with the provisions as outlined in the reuse plan (MADEP, 1999a). Specific measures in the Bylaws include best management practices for operations on the property and continued monitoring and regulatory control of the aquifer (Vanasse Hangen Brustlin, Inc., 1994). These efforts should help to ensure that the water supply is protected from contaminants in the future.

Although no new wells are planned, the capacity of a given well may be increased to meet anticipated water demands. So far, the Patton well is slated for expansion. The Patton well is located about 600 feet from the Cold Spring Landfill (AOC 40), and the landfill sits within the well's recharge area. Under current pumping conditions, the Patton well is not affected by debris or contamination in the landfill. However, groundwater modeling indicates that when the well is pumped continuously near its capacity of 1,000 gallons per minute, contaminants from the landfill could migrate to the Patton well. If this were to occur, material from the landfill could pose a potential threat to the drinking water supply in the future. A ROD recommending excavation of the landfill (as wells as excavation of AOC 9 and 11 and study area 13, with limited removal of contaminated surface soil at AOC 41 and study areas 12) was signed in July 1999 (Devens Commerce Center, 1998; EPA, 1999; BRAC, 1999).

Public Drinking Water Supplies (Off-site)

The majority of public water supply wells are not at risk of contamination because they are not within or downgradient from areas of contamination. In addition, public water suppliers, under MADEP requirements, ensure the quality and safety of their drinking water through routine testing. The Ayer Grove Pond wells are, however, located just north of Fort Devens. Ayer residents have expressed concern about the proximity of the Ayer Grove Pond wells to the AOCs at Fort Devens, the closest of which are AOCs 44 and 52, about 2,500 feet away. In the particular, residents voiced concern about potential impacts from the Shepley's Hill Landfill, located about 3,500 feet away from the wells (see Figure 4). Because of this concern, ATSDR conducted a focused evaluation on potential harmful exposure associated with use of the Grove Pond wells. The findings of this evaluation were released in a health consultation in July 1998 and are summarized in discussion that follows.

Past Exposure

The Ayer Department of Public Works used the Grove Pond wells in the past to supplement water drawn from wells at Spectacle Pond. Grove Pond wells were taken out of service in 1993 after numerous instances in which iron, manganese, and arsenic were detected. While the source of these metals is not known with certainty, it is very likely that they are at least in part naturally occurring for the geographic region (MADEP, 1999a). The wells were placed back in service in 1998. Because the wells were closed between 1993 and 1998, exposure to contaminants, if any, in Grove Pond wells could not have occurred during that time.

ATSDR reviewed the MADEP files to gather available water quality data to determine if unhealthy levels of chemicals existed in the water supply prior to 1993. Complete sampling data for all operating years prior to the 1993 shutdown of the Grove Pond wells are not available, however.[1] It is therefore unclear for how long Grove Pond wells contained iron, manganese, and arsenic and at what levels. Sampling data collected sporadically since the 1960s indicate that iron and manganese levels in raw water often exceeded the current secondary MCLs for aesthetic quality (e.g., taste, color, and/or odor properties) (CDM, 1968, 1993; SEA Consultants, Inc., 1990).[2] After 1978, however, raw water from the Grove Pond wells, when operating, was then co-mingled with Spectacle Pond well water, thereby diluting contamination, if any, in the Grove Pond well water before it reached residential taps (ADPW, 1998a). All other contaminant concentrations were safely below safe drinking water standards.

Both manganese and arsenic are known to cause health problems at high enough levels, but iron is rarely toxic to humans. In evaluating potential health hazards associated with drinking water containing manganese and arsenic, ATSDR estimated the dose of these metals an individual might have received using site-specific considerations and conservative assumptions about how often people drink water and how much water they drink. ATSDR also assumed that an individual drank water containing the highest detected concentrations of manganese and arsenic in well water. This is a highly conservative and unlikely scenario because often the water was blended and/ or treated before use by the consumer.

ATSDR then compared the estimated exposures to acceptable health guidelines to determine the likelihood, if any, that Ayer residents could have been exposed to harmful levels of manganese or arsenic in their drinking water. This evaluation is described in greater detail in Appendix C. The results of the evaluation indicate that the estimated exposure doses for Ayer residents are below levels at which health effects have been reported in the toxicologic literature, even when assuming exposure to the maximum detected contaminant concentrations. *ATSDR therefore concluded that Ayer residents have not been exposed to harmful levels of contaminants when they used water originating from the Grove Pond wells in the past.*

Current Exposure

Following a formal evaluation of the water treatment system and a permitting process, the Ayer Department of Public Works resumed production at the Grove Pond wells during in the summer

[1] During the early years of operation, sampling, if any, centered around bacteriological concerns. Later, when the Grove Pond wells were used only for emergencies, sampling probably did not occur because the wells were so infrequently used (MADEP, 1998a).

[2] Secondary MCLs are not health-based standards, rather they are unenforceable federal guidelines regarding taste, odor, and color effects of drinking water. EPA recommends them to the states as reasonable goals, but federal law does not require water systems to comply with them.

of 1998. For several weeks after startup, EPA, MADEP, and the Ayer Department of Public Works closely monitored the effectiveness of the new system and the quality of its water. They found that by treating the raw water for iron, manganese, and arsenic, and then blending the treated water with water from Spectacle Pond wells, they produced finished drinking water that safely met drinking water standards. Since the Grove Pond wells have come back on line, testing by both the EPA and Ayer Department of Public Works has shown that the public water supply has safely met drinking water standards (ADPW, 1998a; 2000). Under the guidance of the states drinking water program, Ayer Department of Public Works will continue to monitor routinely VOCs and inorganic compounds (e.g., arsenic, manganese, iron). *ATSDR has concluded that Ayer residents are not exposed to harmful levels of contaminants when drinking water from the Ayer public water supply.*

Future Exposure

During the 5-year review of the Shepley's Hill Landfill, it became evident that seeps containing leachate had formed nearby. Leachate is water that enters the landfill as precipitation and becomes contaminated as it moves through the decomposing refuse. Community members expressed concern about leachate discharging into local surface water bodies, such as Plow Shop Pond, or into deeper groundwater, and eventually reaching drinking water supplies. ATSDR also identified five AOCs/SAs that lie within the Zone II area of influence for the Grove Pond wells (see Figure 4), to identify potential future hazards. As defined by MADEP, a Zone II area of influence "...is the area of groundwater contribution to the wells under the most extreme severe pumping and recharge conditions." The sites in the Zone II include the Battery Repair and Storage Area (study area 38), the Maintenance Yards (AOCs 44 and 52), the Plow Shop and Grove Ponds (study area 72), Lower Cold Spring Brook (study area 73), and the Massachusetts National Guard property, a site located between Fort Devens property and the wells (NEET, 1997).

ATSDR closely evaluated information on Shepley's Hill Landfill and the five sites within the Zone II area of influence for evidence of potential future threats to the Grove Pond wells, and concluded that they are not likely to affect the quality of drinking water. This conclusion is based on the following observations:

- *The Shepley's Hill Landfill is outside the Zone II area of influence.* Although Shepley's Hill Landfill has high concentrations of groundwater contaminants (primarily VOCs and arsenic), the landfill is unlikely to influence the groundwater entering the Grove Pond wells because it is located outside the Zone II area of influence and water passing through the landfill moves to the north and east and away from the Grove Pond wells. Furthermore, the Army will take measures to ensure the quality of the aquifer that lies beneath the site and to monitor possible contaminant migration.

- *The Battery Repair and Storage Area, the Maintenance Yards, Lower Cold Spring Brook, and the Massachusetts National Guard property have no or very low levels of*

groundwater contamination. Any existing low level contamination is unlikely to reach the Grove Pond wells. Furthermore, the Army has removed the contaminated source material (e.g., contaminated soil), thereby reducing the likelihood of contaminant migration from these areas in the future.

- *Grove Pond and Plow Shop Pond are expected to have minimal impacts, if any, on the wells in the future.* EPA is collecting data on how much groundwater recharge from the ponds enter the drinking water wells. ATSDR will evaluate the relationship between the ponds and the wells when this information becomes available.

On the basis of this information, ATSDR has concluded that residents will not be exposed in the future to harmful levels of contaminants when drinking water that comes from the Grove Pond wells.

Private Wells (Off-site)

Past, Current, and Future Exposures

No contamination has spread to areas where private wells exist. As previously mentioned, PCE has moved from the former Parachute Rigging Facility at AOC 50, but the contamination has not moved further north to where new private wells are located (Ayer, 1998; Fort Devens, 1999b). The MADEP, EPA, and Army will continue to track groundwater contamination and take actions to further reduce any potential effects on off-site areas with existing private wells. At this time, a groundwater study, undertaken by the Army with EPA and MADEP oversight, is pending. *ATSDR concluded that area private wells users are not exposed, nor have they been in the past, to site-related contaminants when using their well water. MADEP, EPA, and the Army continue to take precautions and track contamination in areas near off-site private wells to limit the potential for future exposures.*

Evaluation of the Surface Water and Sediment Exposure Pathway

Conclusion

No harmful exposures have occurred in the past, nor are likely to occur for people who wade, boat, or catch and release fish, at Grove Pond and Plow Shop Pond. As a precautionary measure, advisories currently recommend against swimming at either pond.

Discussion

The community surrounding Fort Devens has used Grove Pond and Plow Shop Pond for recreational uses in the past. A "catch and release fishing only and no swimming advisory" has been posted at the ponds because of concerns about contamination in pond sediment and surface water. In response to community concern, ATSDR evaluated potential public health hazards from recreational uses of Grove Pond and Plow Shop Pond in a health consultation released in December 1998. In the discussion that follows, ATSDR summarizes the findings of that focused evaluation.

Grove Pond and Plow Shop Pond Description and Uses

Grove Pond and Plow Shop Pond are shallow water bodies located along Fort Devens' northern boundary (see Figure 5). Grove Pond, once known as the Tannery Pond, is a 60-acre pond that receives inflowing water from Balch Pond and Cold Spring Brook. Water from Grove Pond flows through a stone arch culvert beneath a railroad causeway and into Plow Shop Pond, so named for the Ames Plow Foundry formerly located at the pond. Plow Shop Pond, the smaller of the two ponds (30 acres), receives most of its water from the upstream Grove Pond. Water from Plow Shop Pond eventually discharges from a dam at the northwest corner of the pond to Nonacoicus Brook, which flows about 1 mile north before joining the Nashua River (ABB, 1995).

Land use surrounding the ponds is diverse. Property along Grove Pond includes a mix of residential (along the northern shore), recreational (Pirone Park), and industrial, including an active railyard and a former tannery. The tannery operated between the mid-1900s and the 1960s in the northeast corner of Grove Pond (east of the railroad). Until 1953, the tannery reportedly discharged much of its process wastewater into Grove Pond, often with little or no treatment. While the former tannery was once a source of metal contamination for the pond, the findings of a joint 1997 EPA and MADEP removal site evaluation indicate that it no longer poses an imminent threat to either human health or the environment. Plow Shop Pond is largely surrounded by industrial property. Over the years, the industrial uses included railroad operations to the east, an industrial park to the north, and Fort Devens' Shepley's Hill Landfill area to the west and southwest (ABB, 1995).

Grove Pond and Plow Shop Pond might have been used in the past for recreational activities, but today, little, if any, swimming or subsistence fishing is believed to occur at either pond (ADPW, 1998b). In 1992, the Army posted an advisory at Plow Shop Pond recommending that people not swim in the pond or eat pond fish. The Army took this precautionary measure because of concerns about contaminants in pond sediment and the possibility that these contaminants were accumulating in fish (ATSDR, 1992). Following this action, ATSDR advocated that similar precautions be followed for uses of the adjacent Grove Pond (ATSDR, 1992). It should be noted that people can still enjoy boating and catch and release fishing at both ponds.

In informing the community about the advisory, the Army coordinated outreach with other agencies (e.g., ATSDR, MDPH, MADEP, EPA, and local boards of health) and abutting landowners, including the B & M railroad. The advisory was also posted at key access points to each pond. The EPA is responsible for providing replacement signs, and the Ayer Department of Public Works and MassDevelopment are responsible for maintaining the signs along the ponds in the future (ADPW, 1998b). In addition to the postings, information on these advisories (and all Massachusetts fish consumption advisories) is summarized by MDPH and distributed with Massachusetts fishing licenses by the Massachusetts Division of Fisheries and Wildlife.

Grove Pond and Plow Shop Pond Surface Water and Sediment Quality

The Army conducted several rounds of surface water and shallow sediment sampling to characterize the environmental conditions of Grove Pond and Plow Shop Pond. Samples were collected from the interior of each pond and along shoreline areas. Samples were analyzed for metals, and selected samples were analyzed for pesticides, PAHs, and PCBs. ATSDR examined the sampling data and compared this information against current ATSDR comparison values to identify contaminants of potential health concern.

Table 5 summarizes surface water sampling results for both ponds. As the table indicates, the metals arsenic, chromium, lead, and manganese were present in pond surface water. Arsenic, chromium, and lead were found in only a few of samples, and rarely at levels above ATSDR comparison values for drinking water. Manganese was present in every sample, at times at levels (up to 130 ppb) above its drinking water comparison value for a child (50 ppb), but most often at levels below the comparison value.

Table 6 shows chemical concentrations measured in sediment samples collected from both Grove Pond and Plow Shop Pond.[3] The table also specifically indicates to what extent these chemicals were present in the sediment samples taken from the Grove Pond shoreline at Pirone Park. This area is of interest to ATSDR and the community since children visit the park and concentrations detected near the park most directly reflect the levels to which children could be exposed.

[3] Table 6 summarizes information on contaminants that exceed comparison values only.

According to the sampling data, sediment samples taken from both ponds contained elevated levels of arsenic, cadmium, chromium, lead, manganese, and mercury. The highest levels of these metals were generally noted in the interior of Grove Pond and Plow Shop Pond or along the shoreline of nonpublic areas. In these areas, arsenic, cadmium, lead, and manganese concentrations exceeded ATSDR's comparison values or EPA's interim screening values for soil. Chromium and mercury were also measured in sediment, but no comparison values for sediment or soil currently exist for these chemicals. Along the shoreline of Pirone Park, where people are more likely to frequent, arsenic (up to 110 ppm) and cadmium (up to 23.3 ppm) concentrations were sometimes measured at levels higher than their respective comparison value for a child, but most often were lower.

Distribution patterns for several contaminants found in Grove Pond sediment provide some indication of their potential source. Chromium, used in tannery operations, was the most frequently detected contaminant and was found in the highest concentrations in sediment along the northwest cove of Grove Pond, where the former tannery once stood. Arsenic, manganese, and mercury were distributed similarly to chromium, suggesting the tannery is likewise a source of these metals. In contrast, however, distribution of metals in Plow Shop Pond sediment showed no clear pattern and varied by chemical. Historical sources of contamination in Plow Shop Pond include Shepley's Hill Landfill (e.g., arsenic, iron, manganese), railroad activities (e.g., PAHs and mercury), and inflow from Grove Pond (e.g., arsenic) (ABB, 1995). It is also suspected that the tannery directly discharged materials to Plow Shop Pond via a pipe under the railroad track (Fort Devens, 1999a).

PAHs were also detected in sediment, but they were not nearly so widespread nor in as high concentrations as metals. Most PAHs were located near the railroad corridor and are likely associated with railroad activities (ABB, 1995). Concentrations of individual PAHs were generally comparable to the comparison value (0.1 parts per million [ppm]) for the PAH compound, benzo(a)pyrene.[4] Other tested compounds (i.e., PCBs, pesticides) were either not detected or were detected at concentrations below comparison values.

Past Exposure

The infrequently occurring elevated levels of metals found in surface water or sediment along public areas, such as Pirone Park, would not have harmed the health of people who used the park for wading, boating, and catch-and-release fishing. The highest levels of contaminants were detected in the interior of the pond or near the tannery. We do not have evidence that people swam in the portions of the pond where higher levels of contaminants were found. If people did access these areas, their infrequent and brief exposure to the most contaminated sediment is

[4] Though likely not of health concern, it should be noted that detection levels for some of the individual PAHs were slightly higher (up to 0.8 ppm) than ATSDR's comparison value for benzo(a)pyrene.

unlikely to have caused adverse health effects. *For this reason, no exposure is likely to have occurred in the past at levels causing public health concern.*

Current and Future Exposures

ATSDR did not find any indications that people use or will use either pond for recreation in ways that would result in significant dermal contact with harmful levels of chemicals (i.e., swimming). Nonetheless, as a precautionary measure, an advisory posted at Grove Pond and Plow Shop Pond recommends against swimming at either pond. In response to ongoing community concern about exposure, particularly for children, however, ATSDR further evaluated exposure that might occur while a person wades along the shoreline where the highest levels of contaminants were detected, as well as exposure that might occur in public areas, such as Pirone Park.

When evaluating this potential exposure pathway, ATSDR estimated how much of a particular metal an individual might contact and absorb. To do this, ATSDR developed exposure doses for dermal contact with sediment based on conservative or "safe" scenarios and compared these doses to the health-based guidelines. ATSDR selected for further evaluation arsenic, cadmium, chromium, and mercury because they either were measured at levels above comparison values or they currently lack a comparison value. In estimating exposure ATSDR assumed that an individual might wade at the pond or visit Pirone Park every day during warm months (i.e., 140 days a year) over the course of many years (i.e., up to 30 years for an adult or 6 years for a child). Appendix C describes the methods and assumptions used in ATSDR's evaluation in greater detail. The results of the comparison indicated that estimated exposure doses were all below ATSDR noncancer and cancer health guidelines, or below levels at which adverse health effects have been reported. Moreover, the chemicals found in the sediment are not likely to pose a health problem because they are not readily absorbed through the skin and are not present in very high concentrations in public access areas. *Therefore, contact with pond sediment poses no health hazards to adults or children who might wade along the shoreline of Grove Pond or Plow Shop, even when assuming contact with highest detected contaminant concentrations frequently (140 days a year) over an extended period of time.*

Evaluation of the Food Chain Pathway

Conclusion

Mercury has been found in fish collected from Plow Shop Pond, Grove Pond, and Mirror Lake. As a precautionary measure, health officials are advising residents to limit or refrain from eating fish caught from these water bodies. People can best protect themselves by continuing to follow the recommendations in the advisory posted at each water body.

Discussion

Mirror Lake, Grove Pond, and Plow Shop Pond are water bodies where people enjoy recreational fishing. As mentioned, fish consumption advisories posted at these water bodies, however, advise people to limit (Mirror Lake) or refrain from eating fish (Grove Pond and Plow Shop Pond). In the discussion that follows, ATSDR presents its evaluation of fish sampling data collected for these water bodies to determine whether contaminant concentrations, if any, in fish indicate a public health concern or whether additional protective measures need to be taken.

Fish Monitoring Data

Three sampling programs have collected fish samples from Grove Pond, Plow Shop Pond, and Mirror Lake, and analyzed fish samples for metals, pesticides (i.e., 1,1-dichloro-2,2-*bis*(*p*-chlorophenyl)ethylene [DDD], 1,1-dichloro-2,2-*bis*(*p*-chlorophenyl)ethane [DDE]), and PCBs.[5] The three programs include:

- The Army collected 15 fish samples (bluegills, largemouth bass, and brown bullheads) from Plow Shop Pond in 1992 (Fort Devens, 1995b). The detection of high levels of chemicals in pond sediment and concern about the possibility that fish were accumulating the chemicals led to this investigation.

- The U.S. Fish and Wildlife Service collected 28 fish samples (largemouth bass, bluegill, brown bullhead, and yellow bullhead) from Grove Pond in September 1992 (U.S. F&W, 1993; 1997). Likewise, this investigation was prompted by concerns about high levels of pond sediment contamination.

[5] Some samples were "reconstructed" using the fillet and the partial body sample. The concentration for the reconstructed whole body sample is the sum of the fillet concentration and the partial body sample concentration divided by the total body weight.

- The MADEP collected 18 fish from Mirror Lake in June 1995. MADEP collected the fish samples as part of its obligation under the Massachusetts Interagency Fish Toxics Program (MADEP, 1995).

Tables 7, 8, and 9 provide the fish sampling results for Grove Pond, Plow Shop Pond, Mirror Lake, respectively. ATSDR reviewed these sampling data to determine what chemicals, if any, had accumulated in fish.

- **Grove Pond and Plow Shop Pond**: Metals, PCBs, and pesticides were present in fish samples collected from one or both of these ponds. ATSDR compared the fish tissue concentrations to available Food and Drug Administration (FDA) action levels for commercial fish. Action or tolerance levels are available for mercury, PCBs, and some pesticides (e.g., DDD and DDE) only. As Tables 7 and 8 indicate, mercury exceeded its FDA action level (1 milligram per kilogram [mg/kg]) in a largemouth bass, while concentrations of other compounds (i.e., PCBs, DDD, and DDE) for all fish were safely below their respective FDA action or tolerance level.[6] Mercury found in fish from these ponds is probably associated with the low-level mercury-contaminated sediment found near the tannery and the railroad area. The findings of the sampling supported the existing precautionary fish consumption advisory.

- **Mirror Lake:** Metals were present in fish samples collected from Mirror Lake, but PCBs and pesticides were not detected. Mercury concentrations were below the FDA action level, but the average concentration of mercury in all largemouth bass was above the Massachusetts Department of Public Health's (MDPH) level of 0.5 mg/kg for issuing a limited advisory. On the basis of this finding, the state issued a limited advisory recommending that the general public limit their consumption of largemouth bass from Mirror Lake to two meals per month and that sensitive individuals (e.g., children, pregnant women) avoid affected Mirror Lake fish.

It should also be noted, however, that mercury is a widespread problem in Massachusetts' and many other states' freshwater rivers, ponds, and lakes. As a precautionary measure, MDPH issued a statewide advisory in September 1994 to urge pregnant women not to eat fish caught from freshwater bodies in Massachusetts because of the potential harmful effects of mercury on the fetus (MDPH, 1995).

[6] The MDPH, the state agency responsible for issuing fish consumption advisories, uses the FDA action level of 1 mg/kg for mercury in commercial fish as the basis for issuing a full advisory (do not eat any fish). While protective of health, the values do account for economic considerations. MDPH uses 0.5 mg/kg for mercury as the basis for issuing a limited advisory.

Past Exposure

Although mercury was detected at concentrations greater than the FDA action level, consumption of pond fish containing this level of mercury would not necessarily result in adverse health effects. To further evaluate this exposure pathway, ATSDR estimated exposure doses considering site-specific parameters and the maximum concentrations of contaminants detected in pond fish (see Appendix C, Tables C-4 and C-5). ATSDR then compared the doses to health-based guidelines. Although the estimated dose for a child slightly exceeded ATSDR's health-based guidelines, health effects are unlikely to occur. First, a number of safety factors have been applied to the ATSDR health-based guidelines, as a result estimated doses above these guidelines would not necessarily produce health effects. Second, the estimated exposure dose probably overestimates the actual exposure a child might have received because the likelihood that a child frequently consumed the most contaminated fish for extended periods is remote. Furthermore, with the exception of a few samples of largemouth bass, most mercury concentrations were below the FDA action level. *Therefore, ATSDR has concluded that no harmful exposures to mercury or other contaminants are likely to have occurred in the past for people who ate fish from either Grove Pond, Plow Shop Pond, or Mirror Lake.*

Current and Future Exposures

Currently, advisories recommend that people not eat fish or limit their consumption of fish caught from either Grove Pond, Plow Shop Pond, or Mirror Lake. Because mercury is persistent in the environment, levels in fish may have increased since the initial fish sampling. Therefore, as a precautionary measure, people should continue to follow the recommendations in the advisory until additional data suggest otherwise. The Ayer Department of Public Works and MassDevelopment have agreed to maintain the signs provided by EPA at Grove Pond and Plow Shop Ponds. *Therefore, no public health hazards are occurring now, nor are they expected to occur in the future for people who follow the recommendations in the advisory.*

Evaluation of the Indoor Air Pathway

Conclusion

Air inside the former Devens Elementary School poses no current or future public health hazards from contaminants associated with historic fuel oil spills. Available indoor air monitoring indicates that no fuel contaminants have been found inside the school at levels of health concern..

Discussion

In 1972 and again in 1978 fuel oil No. 2 was accidentally released into the subsurface soils and groundwater adjacent to and beneath the Devens Elementary School (AOC 69W), located on the northwest portion of the Main Post. The release was assumed to be from damaged piping near and within the footprint of the school (EPA, 1998). Since 1993, the Army has closed the school for reasons unrelated to the release, removed the damaged piping along with 3,500 cubic yards of contaminated soil, and MassDevelopment has converted the heating system to a gas-based operation (MADEP, 1999a; MassDevelopment, 2000). Teachers and other community members raised concerns about the release and whether contaminants associated with the release had or could affect the air inside the school.

In 1998, the EPA collected air quality data to determine if fuel-related contaminants present in the soil and groundwater were migrating up through the soil and into the school.[7] Eleven samples were collected at the following locations: six in various rooms throughout the school; three outdoors; one in the crawlspace near the old boiler room; and one in the crawlspace beneath the kitchen. Samples were analyzed for components of fuel oil found in the soil and groundwater, primarily VOCs and semivolatile organic compounds.

Of the compounds analyzed for, methylene chloride was the only compound detected at levels above air guidelines. Methylene chloride is not a constituent of fuel oil No. 2, but it is often present as a common laboratory contaminant. Therefore, the presence of methylene chloride in the samples is probably not related to the spill, but likely resulted from decontamination procedures used to clean the air sampling tubes (ATSDR, 1995). No other compounds were detected at levels of health concern.

[7] The Army also conducted two rounds of sampling (1996 and 1997) in the school. Although the tests were qualified as inconclusive because of data quality issues and sample contamination, EPA has used these data to compare to the 1998 EPA testing data.

Past Exposure

The only available air data comes from a one-time 8-hour samples collected during the spring of 1998. These data provide only a "snapshot" of actual conditions that might have existed since the release. Because of these data limitations, ATSDR cannot conclusively determine whether harmful levels of contaminants were present inside the school while it was open. Based on recent air monitoring data, however, there does not appear to be any evidence that contaminants from the oil spill exist in the school. If similar conditions existed around the time following the release, it is unlikely that harmful exposures have occurred.

Some community members were particularly concerned about breast cancer among teachers and a possible link to the release. To date, no studies have examined breast cancer in former occupants of the school, but MDPH's review of health outcome data indicates that breast cancer rates are not elevated in the community of Ayer. Although these data are not specific to the school, the information is indicative of the general health of the population of the surrounding community, where occupants of the school might reside.

Current and Future Exposures

The school has been closed since 1993 and therefore no exposures are currently occurring. Although the school is scheduled to reopen in 2000, ATSDR believes that the indoor air is unlikely to pose health threats to future occupants for the following reasons: 1) current air monitoring data suggest the air meets safe air quality guidelines and 2) the Army has removed most of the fuel-contaminated soil associated with the releases.[8] The EPA has determined that no further actions are needed to clean up soil contamination, but they will oversee long-term monitoring of groundwater in the area.

[8] It should be noted that the indoor air samples were taken during the spring when the heating system was inactive. Because the suspected source of contamination has been removed, it is doubtful that any higher concentrations would be present even when the building is tightly closed or in use with the heating system on.

COMMUNITY HEALTH CONCERNS

The following discussion evaluates community health concerns. This public health assessment states each concern and presents a brief summary of ATSDR's conclusions. ATSDR also received comments and questions from community members regarding the draft PHA for the Fort Devens site (June 1999). Responses to comments received during the public comment period are addressed in Appendix D of this PHA.

- *Concern about tumors in domestic animals in the community around Fort Devens and their relevance to humans.*

Scientists consider many factors when evaluating the likelihood of developing cancer. One such factor is species-specific sensitivity or response to a potential carcinogen. It should be noted that an animal's response to a carcinogen is dependent not only on its species-specific biochemical makeup but on physiological and anatomical features as well. Therefore, mechanisms that lead to cancer or tumor development in domestic animals may not exist for humans.

MDPH monitors human cancer incidence in Massachusetts communities. MDPH reviewed the most recent available information (1982-1992) from the Massachusetts Cancer Registry for the town of Ayer (MDPH, 1997). For the time period of 1982 to 1992, the cancer incidence in Ayer was approximately equal to or just slightly higher (but not statistically higher) than expected for the majority of cancers. On the basis of this review, the MDPH concluded that there does not appear to be an unusual occurrence of cancer in Ayer.

Community members who would like more information about cancer rates in other communities surrounding Fort Devens or would like to express their concerns should contact the Massachusetts Department of Public Health at 617-624-5757.

- *Concern that rates of breast cancer are slightly higher than normal among former teachers of the former Devens Elementary School.*

Several risk factors have been associated with breast cancer, including life style, genetic factors, and, even to a certain extent, environmental factors. In pursuing a possible environmental link, ATSDR first examines exposure pathways related to a site of concern. If ATSDR determines that a *completed exposure pathway* poses a public health threat, ATSDR then gathers health outcome data to complement the environmental and exposure data.

ATSDR did not identify any completed exposure pathways linking air contaminants associated with the fuel spill to the school occupants. Given this finding, we do not have reason to suspect that the spill adversely impacted air or that teachers were exposed to contaminant levels that could adversely affect their health or increase their likelihood of developing cancer. MDPH's

review of health outcome data for the community of Ayer indicated that breast cancer rates were not elevated. While not specific to teachers at the school, this information is indicative of the breast cancer experience of the population of Ayer, where some of the occupants of the school may reside.

For individuals concerned about breast cancer occurrence, you should know that the Massachusetts Department of Public Health has compiled information about risk factors for breast cancer. A copy this information can be obtained by calling 617-624-5757.

- *Concern about a link between manganese in drinking water and attention deficit disorder among Ayer school children.*

Some community members of Ayer are concerned about a possible link between drinking water containing manganese and attention deficit disorder among school children. As discussed in the "Evaluation of Potential Environmental Pathways" section of this document, the Ayer Grove Pond well water contained elevated levels of manganese (up to 1,900 ppb) before it was closed in 1993. Despite high levels of manganese in these wells, it is unlikely that people were actually exposed to these levels because water from these well was blended with uncontaminated water prior to distribution to households. Also, levels of manganese fluctuated over time and were generally much lower than maximum levels while the wells were used for drinking water. Since reopening the wells in 1998, the Ayer Department of Public Works has treated the well water to ensure that high quality water is delivered to consumers.

Manganese is a naturally occurring element that is essential for normal functioning of the human body. There are many reports of human toxicity from exposure to manganese by inhalation; however, ingested manganese has rarely been associated with toxicity. One reason for this may be that very little manganese is taken up by the stomach and absorbed into the body. Human health studies suggest that ingesting high levels of manganese in drinking water over a long period of time may be associated with neurological changes resembling Parkinson's disease (Kawamura et al., 1941; Kondakis et al., 1989; Goldsmith et al., 1990). Although the findings suggest that environmental exposure to high levels of manganese may be a health concern, there are just too many limitations to these studies to provide conclusive evidence. It should be noted that the exposure doses estimated by ATSDR for persons ingesting water from the Ayer Grove Pond wells were almost 15 times lower than adverse effect levels reported in these studies.

There is some concern by scientists that infants may be at increased risk of toxicity from manganese ingestion because infants take up manganese from the stomach at a higher rate than adults and they have less ability to excrete manganese from the body. To date, there are no reports of manganese toxicity, including attention deficit disorder, reported for infants. Again, the exposure doses ATSDR estimated for children and adults who may have ingested water from the Ayer Grove Pond wells are within ranges of "safe dietary intakes" and are lower than levels

shown to cause even adverse effects (including neurological effects) in scientific studies. ATSDR has evaluated exposure to manganese in greater detail in Appendix C of this document.

Over the past decade, scientists have explored a number of possible theories about what causes the attention deficit disorder, but researchers at the National Institute of Mental Health stress that the cause is still not known. While much of the evidence from recent investigations suggests that the disorder stems from biological causes rather than from factors in the home environment, scientists continue to investigate possible causes of the disorder.

- *Concern about safety hazards from unexploded ordnance at the South Post.*

The South Post has been used as a training range for various types of small arms fire, grenade detonation, and ordnance demolition. Unexploded ordnance used in training may still remain buried in sections of this area. As a safety measure, Fort Devens maintains a fence around the South Post Impact Area and posts warning signs to discourage unauthorized access to the South Post. ATSDR agrees with these measures that will help limit public access and improve safety.

- *Concern about safety hazards while walking around Mirror Lake.*

Historically, World War II grenades were placed in Mirror Lake. In 1965, the 14th EOD Detachment Station at Fort Devens removed the grenades from the lake (BRAC, 1996). It should be noted that the grenades removed from the lake were unfused and contained no explosive charge (MADEP, 1999b). An underwater metal survey confirmed that the removal was complete. Additionally, a 1995 supplemental site investigation indicated that there was no explosive contaminants associated with the grenades in Mirror Lake's surface water or sediment.

- *Concern about health hazards for trespassers who may unknowingly contact contaminated media along the shoreline of Grove Pond or Plow Shop Pond.*

In all likelihood, people who walk along the shoreline of the ponds are not incurring harmful exposures. People trespassing in nonpublic areas of the shoreline probably do so infrequently and/or for a short period, spending relatively little time standing or walking with exposed skin in areas of the highest contaminated sediment. Limited exposures of this type are not likely to lead to adverse health effects. Most importantly, we doubt that young children (1 to 6 years of age) who are most suspectable to the effects of contaminants would travel into these areas—and come in contact with the most contaminated sediment—without adult supervision.

- *Concern that subsistence fishing populations might have consumed harmful amounts of contaminated fish from Grove Pond or Plow Shop Pond in the past.*

Subsistence fishing populations rely on freshwater fish as a major staple in their diet. Because they eat so much more fish than most people, there is a concern that they have a greater exposure to

potentially harmful levels of chemicals found in freshwater fish of some areas. To date, however, there is only anecdotal information to suggest that few anglers, if any at all, regularly fished for food at either Grove Pond or Plow Shop Pond. As such, it is unclear if subsistence anglers ever relied on either pond for food.

In the "Evaluation of Food Chain Pathway" section of this PHA, we looked at potential health hazards for a more realistic exposure scenario—that is, for someone likely to consume a moderate amount Grove Pond or Plow Shop Pond fish. Based on this evaluation, we determined that consumption of a moderate amount (one meal a month, the average consumption of fish and shellfish from estuarine and freshwaters by the general U.S. population) of Grove Pond or Plow Shop Pond fish was not harmful to either the adult or child consumer.

Because a few people might have routinely eaten Grove Pond and Plow Shop Pond fish, we also considered whether they might be at increased risk of health effects. We found that people who ate as much as seven meals a month (a substantial amount, based on EPA's upper bound value of fish consumption of recreationally caught fish) of Grove Pond or Plow Shop Pond fish still are not likely to develop any harmful health effects. As with the evaluation for moderate consumption of fish, we even assumed that individuals ate fish containing the highest detected concentrations over many years, a highly protective but unlikely scenario.

We hope through the existing fish consumption advisories that any subsistence anglers will become aware of the potential public health hazards of continuing to eat fish from Grove Pond and Plow Shop Pond. In efforts to target groups at risk throughout the state, the MDPH has initiated education and outreach programs to inform the state's medical community (e.g., primary care providers and health clinics) about health concerns relating to consumption of freshwater fish. ATSDR feels that the medical community can assist people relying on potentially contaminated freshwater fish to understand the potential health risks and find healthy alternatives.

- *Concern about health hazards from combined risks of exposure to contaminants in sediment, fish, and drinking water.*

As stated in this PHA, neither the sediment, fish, or groundwater/drinking water pathways alone pose a public health concern largely because either: 1) exposure was or is unlikely to occur or 2) contaminant concentrations detected were too low to pose a health hazard. As part of our evaluation, we conservatively derived exposure doses for chemicals (at levels above comparison values) in these pathways but found that the values were generally lower than acceptable health-based guidance levels such as minimal risk levels (MRLs) or reference doses (RfDs). It should be noted that MRLs and RfDs are conservative estimates of safe exposure doses that are generally orders of magnitude higher than the lowest levels to which health effects have been observed in occupational or animal studies. With this in mind, we feel that the sum of exposures to contaminants in these pathways should not pose health concerns or adversely impact public health.

- *Concern about potential future impacts to off-site groundwater near the South Post Impact Area.*

Testing of groundwater underlying the South Post Impact Area has revealed elevated levels of explosive compounds. While no formal remedial action (institutional controls) was deemed necessary to control groundwater contamination in this area, the Army, with EPA and MADEP oversight, developed a long-term monitoring plan in 1997 for the South Post Impact Area. As detailed in the plan, the Army monitors water in the shallow aquifer at discharge points as well as at sentinel wells located near the perimeter. Samples are then analyzed for metals and explosive compounds, and selected samples are analyzed for volatile organic compounds. Monitoring of sentinel wells helps investigators identify contaminants long before they reach area drinking water wells.

- *Concern that people living in former base housing or playing in a future school yard could be exposed to harmful levels of pesticides.*

Future residents of revitalized housing or children playing at the proposed school yard probably will not be exposed to harmful levels of soil pesticides.

The Massachusetts Development Finance Agency (MassDevelopment) is charged with returning portions of the former Fort Devens site (Devens) to productive use. Environmental testing at Devens has revealed, however, the widespread and pervasive presence of pesticides in soil (approximately 160,000 cubic yards of soil) beneath former base housing units (MADEP 1998). When these units were constructed in the 1960s, the Department of Defense commonly applied pesticides to control termite infestations beneath foundations built on slabs. At Fort Devens, the soil beneath the housing unit slabs was treated with the termiticides aldrin, chlordane, DDT, and dieldrin. Such pesticide applications are not permitted today. Aldrin, chlordane, and dieldrin are chlorinated hydrocarbon pesticides that are persistent in our environment. Even though applications at Devens occurred more than 30 years ago, one would still expect to see measurable levels of these compounds in the soil beneath the slabs.

MassDevelopment proposes either reusing several hundred of these units or demolishing these units and using the land on which they sit to build new structures. Of particular interest to ATSDR is proposed redevelopment of units for housing and other areas for a school.

Birch Circle and Grant Housing

The Birch Circle and Grant Housing areas are located in the northwest portion of the Devens site. MassDevelopment proposes to reuse 282 units for housing, of which approximately 25 percent will be reserved for low- and moderate-income families and persons who have special needs. Soil testing conducted in1996 revealed soil pesticide concentrations that exceed ATSDR comparison values (CVs). Additional testing of the air quality inside the 300 and 800 series units of the Birch

Circle and Grant Housing areas also indicated that pesticides found in soil had entered the units and were present in the indoor air. Aldrin (up to 2.1 micrograms per cubic meter [$\mu g/m^3$]), chlordane (up to 0.15 $\mu g/m^3$), and dieldrin (up to 1.00 $\mu g/m^3$) were detected in the indoor air of the 800 series units at concentrations greater than ATSDR CVs (and state and federal guidelines) (Haley & Aldrich 1998). Breathing air containing these levels of pesticides over an extended time could pose a health concern for future residents. Pesticide concentrations in the 300 series units were found to be within acceptable guidelines.

The higher concentrations of pesticides inside the 800 series units were most likely caused by features of the units' mechanical systems and, to a lesser extent, to the building foundation (TRC 1999). First, the air-handling systems of these units supply air through ducts beneath the floor—within the pesticide-contaminated soil. Because the ducts pass through the contaminated soil, they may be potential points of entry for contaminants into the units. Second, these units have whole-house fans, which increase the negative pressure and draw air in from soil beneath the slab. Third, the heating systems in these units lack a source of fresh air. In addition to diluting chemicals in indoor air, a fresh air supply would help reduce the negative pressure in the units.

There could be harmful effects to long-term residents in the 800 series units who breathe the highest concentrations of airborne pesticides detected inside the units. Because of this concern, ATSDR supports measures that will reduce indoor air pesticide concentrations to safe levels before the units are occupied in the future. According to MassDevelopment, *the units will remain unoccupied until the indoor air quality safely meets standards set by Massachusetts Department of Environmental Protection (MADEP) or the U.S. Environmental Protection Agency (EPA).* To date, MassDevelopment has evaluated several options to improve the air quality within the affected units, including modifications to the mechanical heating systems. The U.S. Army and MassDevelopment are negotiating terms of the cleanup. ATSDR will review the plans to ensure that the modifications will minimize exposures to pesticides inside the units (i.e., achieve air quality that meets ATSDR safety guidelines).

Future School

The town of Shirley considered the unoccupied Shirley Base Housing Area as a possible site for a future school. The 22-unit Shirley Base Housing area, also known as the 900 series units, is located to the west of the Main Post, adjacent to the Shirley base entrance gate. Eighteen of the units encompass the area intended for the school. Pesticides to control termites, including aldrin, chlordane, DDT, and dieldrin, were applied to the soil beneath the housing units before the concrete foundations were poured. Because the soil beneath the foundations would be exposed during construction of the new school, Shirley town officials asked ATSDR to evaluate the potential hazards from contact with residual pesticide contamination in soil. ATSDR evaluated this exposure and presented its findings in a September 1999 health consultation. The findings are summarized in the discussion that follows.

ATSDR reviewed soil sampling data collected in1996, which indicated that aldrin and dieldrin were at levels above ATSDR CVs, while concentrations of the other pesticides were below CVs. Because concentrations of aldrin and dieldrin exceeded CVs, ATSDR estimated potential exposure levels for a child playing in the exposed soil containing the maximum detected levels of these pesticides. The exposure estimates accounted for the ways in which the pesticides could enter a child's body either by ingestion, skin contact, or inhalation of dust. When these exposure routes were combined, the estimated average daily exposures to aldrin and dieldrin *were more than two times lower than ATSDR's conservative minimal risk levels (MRLs) for those pesticides.* An MRL is an estimated level of daily human exposure to chemicals that are unlikely to pose appreciable risk for adverse noncancer health effects. Therefore, ATSDR believes that no harmful effects are likely to occur in the future. It is important to note that no past or current exposure is possible, because the contaminated soil is under concrete slabs and is inaccessible.

Regulatory agencies involved in cleanup at Devens, such as EPA and MADEP, have established requirements that guide remedial activities. These requirements will be applied to the pesticide-contaminated soil at the housing units, and may necessitate remedial actions that possibly could include removal of pesticide-contaminated soil. Although ATSDR's evaluation found no increased hazard associated with future use of the area proposed for the school yard, the Agency supports any precautionary practices that would further minimize potential exposures to hazardous materials.

ATSDR CHILD HEALTH INITIATIVE

ATSDR recognizes that infants and children may be more sensitive than adults to environmental exposure in communities faced with contamination of their water, soil, air, or food. This sensitivity is a result of the following factors: 1) children are more likely to be exposed to certain media like soil when they play outdoors; 2) children are shorter and therefore might be more likely to breathe dust, soil, and vapors close to the ground; and 3) children are smaller than adults and therefore might receive a higher dose of chemical exposure relative to their body weight. Children also can sustain permanent damage if exposed to toxic substances during critical growth stages. ATSDR is committed to evaluating children's special interests at sites such as Fort Devens as part of its Child Health Initiative.

ATSDR identified no situations in which children were or are likely to be exposed to harmful levels of chemical contaminants associated with Fort Devens. ATSDR based its conclusion on the following factors:

- Children have not been exposed, nor are they now or should they be in the future, to harmful levels contaminants when drinking water. Some metals were found in the Ayer Grove Pond wells in the past, but the levels are considerably lower than levels associated with adverse health effects. Children drinking water from public supplies are protected because public suppliers routinely test their water supplies to ensure that it is free of harmful levels of chemicals and that it meets federal and state drinking water standards.

- Children are not likely to have contacted site-related contaminants often or for long periods when using nearby surface water bodies, and are unlikely to do so in the future. Even though some ponds were used for recreation, most located near Fort Devens probably offered limited recreational opportunity for a young child. Today, a precautionary advisory has been posted at the ponds to advise people against swimming in either Grove Pond and Plow Shop Pond. Any infrequent and brief contact to the contaminants that might occur from wading should not pose a hazard for a child.

- Children are not likely to have consumed harmful levels of contaminated fish, nor are they likely to in the future if they observe the fish consumption advisory. Elevated levels of mercury have been detected in some species of Grove Pond, Plow Shop Pond, and Mirror Lake fish. As a precautionary measure, a fish consumption advisory recommends that children not eat freshwater fish from these ponds. By following the advisory, children reduce their exposure to mercury.

CONCLUSIONS

Conclusions regarding potential past, current, and future exposures to various environmental media on and in the vicinity of Fort Devens are based on a thorough evaluation of remedial site investigation data, groundwater and surface water monitoring data, municipal drinking water supply data, and observations made during site visits. On the basis of its evaluation, ATSDR reached the following conclusions:

1. Elevated levels of VOCs and metals have been detected in groundwater beneath the Fort Devens site. No exposures resulting in public health hazards have occurred or are occurring. The Army will continue to monitor and treat contaminated groundwater to prevent migration to existing water supplies, thereby limiting potential future public health hazards.

2. Arsenic, iron, and manganese were detected in Ayer's Grove Pond wells before they were closed in 1993. ATSDR has determined that the concentrations of these compounds are unlikely to cause harmful effects, even for residents who used the water for extended periods. The Ayer Department of Public Works has returned the Grove Pond wells to regular service, but before the water is delivered to residential taps, it is treated for iron, manganese, and arsenic and tested to ensure that the water is safe to drink. The Army, with MADEP and EPA oversight, continues to take precautions and tests groundwater to best protect the underlying aquifers and prevent contamination from reaching the Grove Pond wells.

3. Elevated levels of metals were measured in Grove Pond and Plow Shop Pond sediment but were rarely found in surface water. No significant exposure has occurred, is occurring now, nor is expected in the future, however. As a precautionary measure, a "*no swimming*" advisory has been posted at each pond to advise people against swimming. Any brief and infrequent contact with the ponds' sediment is unlikely to lead to adverse health effects. The Army and EPA are continuing to investigate the contamination at these ponds.

4. Some Grove Pond, Plow Shop Pond, and Mirror Lake fish contain elevated levels of mercury. Mercury in fish likely originates from off base sources, including the former tannery. As a precaution, an advisory has been posted to either discourage people from eating fish or to advise them to limit their consumption of fish caught from these water bodies. ATSDR has concluded that by following the precautions, people, particularly young children and pregnant women, can reduce their exposure to mercury.

5. ATSDR has determined that air inside the former Devens Elementary School poses no current or future public health hazards from contaminants associated with historic fuel spills. The school was temporarily closed in 1993 (but will reopen in 1999) and the oil-

contaminated soil has been removed. Available monitoring data indicates that no harmful levels of contaminants have been found inside the school.

6. ATSDR has concluded that the Fort Devens site poses *no apparent public health hazard.* (A description of this public health hazard conclusion category is included in the glossary.)

PUBLIC HEALTH ACTION PLAN

The Public Health Action Plan (PHAP) for Fort Devens contains a description of actions taken and those to be taken by ATSDR, the Army, EPA, and MADEP at and in the vicinity of the site after the completion of this public health assessment. The purpose of the PHAP is to ensure that this public health assessment not only identifies public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. The public health actions that are completed, being implemented, or planned are as follows:

Completed Actions:

1. The Army has investigated more than 81 NPL sites and over 223 BRAC areas requiring further evaluation under CERCLA. Of these, several have been determined to pose no threat to human health or the environment. The Army has completed response actions at many of them. Initial site investigations for NPL sites at Fort Devens were completed by 1996.

2. The Army has investigated areas that may have contributed to underlying groundwater contamination and has treated (via soil-vapor extraction) or removed contaminated soil or waste from these areas. The Army has installed wells in many areas of the site to monitor groundwater quality over the long term.

3. ATSDR has previously prepared three health consultations that evaluated specific concerns about Fort Devens, including an evaluation of the potential exposure to groundwater contamination at the South Post (1994); an evaluation of potential public health concerns associated with the use of Ayer Grove Pond Drinking Water Wells (1998); and an evaluation of potential public health concerns associated with the recreational use of Grove Pond and Plow Shop Pond (1998).

4. MDPH evaluated cancer rates in Ayer for the years 1982 to 1992. Findings from their evaluation showed that the occurrence of cancer in Ayer during that period was approximately equal to or just slightly higher than expected for the majority of cancers.

5. The Army has capped the Shepley's Hill Landfill. The Army has conducted groundwater monitoring to determine whether contamination is or could migrate to off-site areas and taken additional measures to ensure the integrity of the cap.

6. The Army has studied seven other debris disposal areas, or landfills, located on the property, and found that they have not affected groundwater. Management options for the landfills have been proposed and are under review.

7. As precautionary measures, the Army posted a "catch and release fishing only and no swimming" advisory at Grove Pond and Plow Shop Pond, and the MDPH issued a limited fish consumption advisory for Mirror Lake.

8. The Ayer Department of Public Works closed the municipal Grove Ponds wells in 1993 following detection of iron, manganese, and arsenic. The ADPW has built a new water treatment system and reopened the wells. Water from the Grove Pond wells, as well as other wells, is regularly tested to ensure that the water is safe to drink.

Ongoing/Planned Actions:

9. .Investigations are in various stages at several AOCs and study areas as the Army continues to define the extent of contamination and recommend appropriate remedial actions.

10. The Army is conducting long-term groundwater monitoring and maintenance programs associated with Fort Devens, including monitoring near Shepley's Hill Landfill. This system will ensure that the contaminant migration will be carefully tracked and that corrective measures will be taken, if necessary.

11. The Ayer Department of Public Works, with EPA oversight, will continue to monitor and treat Grove Pond well water, ensuring that Ayer residents have a clean drinking water supply.

12. MADEP has recently completed additional sampling of the surface water and sediment at Grove Pond. Preliminary results indicate that the highest levels of sediment contamination do not appear to be contributing to elevated surface water concentrations (MADEP, 2000). ATSDR will review the final results when they become available.

13. EPA, Ayer Department of Public Works, and MassDevelopment have agreed to work cooperatively to replace and maintain signs at key access points (e.g., boat ramps, Pirone Parks, public landings) along Grove Pond and Plow Shop Pond.

14. ATSDR has noted that the heating system was inactive during the air monitoring of the Devens Elementary School. ATSDR recommends that if additional sampling is done to 1) ensure that the school is appropriately heated prior to sampling; 2) perform additional VOC sampling without the presence of methylene chloride to ensure that no

compounds are of health concern; and 3) collect sufficient grab or time weighted (restrictive orifice) sampling to ensure that methylene chloride is not present.

15. ATSDR will review new information on exposure pathways that may be generated from remedial investigation activities.

REFERENCES

ABB Environmental Services, Inc. (ABB). 1995. Fort Devens feasibility study for Group 1A sites. Draft Plow Shop Pond and Grove Pond sediment evaluation. Volume I. Sections 1.0-8.0. October 1995.

Agency for Toxic Substances and Disease Registry (ATSDR). 1992. Letters to local boards of health and abutting landowners. RE: Recommendation for "Catch and Release Fishing Only" and "No Swimming" Posting of Plow Shop and Grove Ponds. December 1992.

ATSDR. 1994. Health Consultation: Fort Devens Functional Area 1, Area of Contamination 25, 26, and 27. Ayer, Massachusetts. December 7, 1994.

ATSDR. 1995 Toxicological profile for fuel oils. Atlanta: US Department of Health and Human Services, Public Health Services, Agency for Toxic Substances and Disease Registry. June 1995.

ATSDR. 1998. ATSDR Public Availability Session. Ayer, Massachusetts. March 1998.

ATSDR 1999. Demographics in a 1-mile buffer of the Fort Devens site, based on 1990 U.S. census data. March 1999.

Ayer. 1998. Personal communication with the Ayer town administrator. November 1998.

Ayer Department of Public Works (ADPW). 1998a. Personal communication with Rick Linde, Ayer Department of Public Works. June and July, 1998.

ADPW. 1998b. Meeting at Ayer Department of Public Works with representatives from ATSDR, Environmental Protection Agency, Massachusetts Department of Environmental Protection, and Devens Commerce Commission. October 15, 1998.

ADPW. 2000. Personal communication with Rick Linde, Ayer Department of Public Works. June 14, 2000.

Base Realignment and Closure Environmental Offices (BRAC). 1996a. Cleanup Plan. Fort Devens, Fort Devens, Massachusetts. September 1996.

BRAC. 1996b. Environmental Updates. Spring 1996 to Spring 1998.

BRAC. 1997. Proposed Plan for SAs 6, 12, and 13, and AOCs 9, 11, 40, and 41. U.S. Army Reserve Forces Training Area. Devens, Massachusetts. December 1997.

BRAC. 199X. Proposed plan for defense reutilization marketing office yard (DMRO) (AOC 32) and petroleum, oils, and lubrication storage area (POL) (AOC 43A). Devens, Massachusetts.

BRAC. 1999. Cleanup Plan. Fort Devens, Fort Devens, Massachusetts. September 1999.

Camp Dresser & McKee, Inc. (CDM). 1968. Report on water works improvements HUD project no. P-Mass-3345. March 1968.

CDM. 1993. Town of Ayer, Massachusetts. Grove Pond Wells. Improvement to Grove Pond Wells and pilot treatment study proposal. January 1993.

Devens Commerce Center. 1998. Personal correspondence with Alan Delaney. October 29, 1998.

Ecology and the Environment, Inc. 1994. Remedial investigation report functional area I. Volumes I to V. General Information. Fort Devens, Massachusetts. August 1994.

EPA. 1998. Indoor air sampling study area of contamination 69W Devens Elementary School, Devens, Massachusetts. U.S. Environmental Protection Agency. New England Regional Laboratory. June 1998.

EPA. 1999. Personal communication with Jerry Keefe, EPA Region I. May 11, 1999.

Fort Devens. 1995a. Fort Devens community relations plan for environmental restoration 1995 Update. May 1995.

Fort Devens. 1995b. Record of decision. Shepley's Hill Landfill operable unit areas of contamination 4, 5, & 18. Fort Devens, Massachusetts. September 1995.

Fort Devens. 1996. Record of decision. Areas of contamination 43G and 43J. Fort Devens, Massachusetts. October 1997.

Fort Devens. 1997. Record of decision. Area of contamination 63AX Devens Reserve Forces Training Area. Fort Devens, Massachusetts. October 1997.

Fort Devens. 1999a. Personal communication with Jim Chambers, BRAC Environmental Coordinator. April 30, 1999.

Fort Devens. 1999b. Personal communication with Jim Chambers, BRAC Environmental Coordinator. February 12, 1999.

Haley & Aldrich. 1998. Residential indoor air quality results for Fort Devens base housing, Fort Devens, Massachusetts.

Harvard Water Department. 1998. Personal communication with Jim Smith. June 3, 1998.

Horne Engineering Services, Inc. 1996. Preliminary draft record of decision for the South Post Impact Area Groundwater areas of contamination 25, 26, and 27. February 14, 1996.

Horne Engineering Services, Inc. 1997. Preliminary final record of decision for the defense reutilization and marketing office yard (AOC 32) and petroleum, oil, and lubricants storage area (AOC 43A). Devens, Massachusetts. December 1997.

Lancaster Water Department. 1998. Personal communication with Brad Locke. June 4, 1998.

Massachusetts Department of Environmental Protection (MADEP). 1995. Memorandum from Robert Serbian, MADEP-Westborough to John Regan, MADEP-BWSC. RE: Results for fish samples from Mirror Lake, Fort Devens. September.

MADEP. 1998a. Personal communication with John Regan, Central Regional Office. July 1998.

MADEP. 1998b. Letter from John Regan, Central Regional Office, to Pauline Hamel and Cornielius Sullivan, Ayer Board of Selectman. September 15, 1998.

MADEP. 1998c. Memorandum from John Regan, Massachusetts Department of Environmental Protection. RE: Pesticides at Fort Devens base housing. May 8, 1998.

MADEP. 1999a. Personal communication with John Regan, Central Regional Office. March, 1999.

MADEP. 1999b. Personal communication with Caroline E. Williams, Regional Planner. Central Regional Office. May 7, 1999.

MADEP. 2000. Personal communication with Paul Ollila, Massachusetts Department of Environmental Protection, Central Regional Office. June 19, 2000.

MassDevelopment. 2000. Personal communication with Ron Ostrowski, MassDevelopment, June 16, 2000.

Massachusetts Department of Public Health (MDPH). 1995. Fish consumption advisories for mercury in freshwater fish. Massachusetts Department of Public Health. Presented to the Committee on Health Effects. May 1995.

MDPH. 1997. Letter from Theresa A. Barry, MDPH. RE: Cancer Incidence in Ayer. October 23, 1997.

Nashoba Associated Board of Health. 1999. Personal communication with Walter Murphy, Director. RE: Private wells installed in Ayer, Harvard, Lancaster, and Shirley in 1998.

New England Environmental Technologies Corporation (NEET). 1997. Massachusetts National Guard Maintenance Depot groundwater monitoring data. September 1997.

PACE. 1998. Personal communication from People of Ayer Concerned About the Environment to ATSDR. March 26, 1998.

SEA Consultants, Inc. 1990. Report on water supply and distribution systems study. Ayer, Massachusetts. Department of Public Works, Town of Ayer, Massachusetts. August 1990.
U.S. Army Environmental Center (USAEC). 1995. Record of decision. Barnum Road maintenance yards. Fort Devens, Massachusetts. March 1995.

Shacklett, H.T. and Boergen, J.G. 1984. Element concentrations in soil and other surficial materials of the conterminous United States. U.S. Geological Survey profession paper 1270.U.S. Government Printing Office. Washington, DC.

Shirley Water District. 1998. Personal communication with Brian Goodman. June 4, 1998.

TRC Environmental Corporation (TRC). 1999. Summary report for Fort Devens redevelopment-housing decontamination, Devens, Massachusetts.

U.S. Fish and Wildlife Service (U.S. F&W). 1993. Concentrations of mercury and other environmental contaminants in fish from Grove Pond, Ayer Massachusetts. September 1993.

U.S. F&W. 1997. Letter from Kenneth Carr, Acting Supervisor of U.S. Fish & Wildlife New England Field Office, to Dennis Gagne, U.S. Environmental Protection Agency. RE: Review of the draft Plow Shop Pond and Grove Pond sediment evaluation. January 22, 1997. 1993.

Vanasse Hangen Brustlin, Inc. 1994. Devens Reuse Plan. Fort Devens, Massachusetts. November 14, 1994.

TABLES

TABLE 1. Evaluation of Potential Public Health Hazards Associated with Major Study Areas and Areas of Contamination at Fort Devens

Site	Site Description/ Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Current Status	Evaluation of Public Health Hazard
MAIN POST				
Areas of Contamination (AOCs) 4, 5, and 18 Shepley's Hill Landfill	AOC 4: Incinerator for destruction of household debris (quantity unknown). AOC 5: Municipal sanitary landfill for disposal of household refuse, construction debris, and military refuse (6,500 tons/year). AOC 18: Asbestos cell for disposal of asbestos and asbestos-containing debris (about 6.6 tons).	**Groundwater**: Metals and volatile organic compounds (VOCs) were detected at levels above comparison values (CVs). Groundwater discharges into Plow Shop Pond may have contaminated sediments in the pond with arsenic, iron, and barium.	After closure in 1992, the Shepley's Hill Landfill was covered with a protective cap (layer of plastic sheeting covered with a topsoil layer) to prevent contamination from leaching into the groundwater. A ROD for the landfill was signed in 1995. Currently, Shepley's Hill Landfill is undergoing long-term groundwater monitoring, landfill cap inspection, and maintenance activities by the Army. The Army, U.S. Environmental Protection Agency (EPA), and Massachusetts Department of Environmental Protection (MADEP) are conducting a detailed review to assess the effectiveness of this cleanup option.	No public health hazards exist because no wells draw groundwater from beneath the landfill. No public health hazards are related to indirect exposure via contact with contaminants that may have entered Plow Shop Pond sediment/surface water.

TABLE 1. Evaluation of Potential Public Health Hazards Associated with Major Study Areas and Areas of Contamination at Fort Devens (continued)

Site	Site Description/ Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Current Status	Evaluation of Public Health Hazard
AOC 11 Landfill No. 7 Near Lowell Street	Active from 1975 to 1980, this 2-acre landfill is located near the Nashua River. The landfill received wood frame hospital demolition debris when active. After closure, it was covered and graded. Tree limbs and other vegetation were placed at the site between 1980 and 1982.	**Groundwater and Surface Water:** Metals were detected at levels above CVs. **Surface Soil**: Polycyclic aromatic hydrocarbons (PAHs) and pesticides were infrequently detected at levels above CVs. **Sediment**: PAHs were infrequently detected at levels above CVs.	A ROD signed in July 1999 states that the Army will fully excavate and consolidate AOC 11 contaminated media with materials from SA and 13 and AOC 9 and 40 in a on-site (the Golf Course Driving Range) or at an off-site location to be determined. If the material is disposed off on site, the cell will be lined and capped, and long-term groundwater monitoring will be performed.	No public health hazard exists because public exposure is limited.
SA 13 Lake George Street Landfill	The 10,000 cubic yard landfill located on the Main Post is used for the disposal of construction debris, tree stumps, and possibly oil. The landfill was used between 1965 and 1990.	**Groundwater and Surface Water**: Metals and/or explosives were detected; concentrations of some compounds exceeded CVs. **Surface Soil and Sediment**: Metals and/or PAHs were detected; some PAH levels exceeded CVs.	As outlined in a July 1999 ROD, surface material from this landfill will be excavated and consolidated with materials from AOCs 9, 11, and 40 in an on-site location (possibly at the Golf Course Driving Range) or at an off-site location.	The site is presently accessed only by occasional visitors, so public exposure is limited and not likely to pose a public health hazard. Future land use of the site will not be residential, but it may be used for recreational or commercial/industrial purposes.

TABLE 1. Evaluation of Potential Public Health Hazards Associated with Major Study Areas and Areas of Contamination at Fort Devens (continued)

Site	Site Description/ Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Current Status	Evaluation of Public Health Hazard
SA 17 Mirror Lake	WWII era grenades were placed in the lake. So far 200 grenades have been discovered and removed.	**Sediment**: Metals were detected, but at levels below CVs . **Fish**: Mercury was detected in fish tissue.	In the fall of 1995, the Army removed drums and debris from the site. A final No Further Action Decision Document and Close-Out Report was signed in March 1997.	No public health hazards are associated with the low levels of metals in sediment. Consumption of fish could pose a hazard to certain sensitive populations (e.g., children) if large quantities of fish were consumed for a long time, but a fish consumption advisory has been posted.
AOC 32 Defense Reutilization and Market Office (DRMO) Yard	AOC 32 consists of two paved, fenced enclosures. Used from 1964 to the present for temporary storage of scrap metal, vehicles, used and drained lead-acid batteries (40,000 pounds per month), tires, used photographic solution, and other wastes.	**Surface Soil**: Metals and pesticides were detected at levels above CVs. **Groundwater**: Metals and VOCs were detected; concentrations of some VOCs exceeded CVs.	A ROD calling for soil removal was signed in February 1998. The Army removed the contaminated soil and debris in July 1998 and monitored natural attenuation to address contaminated groundwater in the 1998/1999. A draft study done in July 1999 demonstrated that the remedial actions are operating effectively.	The area is inaccessible to the general public, and therefore is not likely to pose a public health hazard. Exposure to site contaminants is limited to occasional site visits by military personnel. Any future use of the groundwater as a drinking water source is unlikely because there is an existing public water system.

TABLE 1. Evaluation of Potential Public Health Hazards Associated with Major Study Areas and Areas of Contamination at Fort Devens (continued)

Site	Site Description/ Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Current Status	Evaluation of Public Health Hazard
AOC 40 Cold Spring Brook Landfill	Debris and fourteen 55-gallon drums that formerly stored antifreeze were uncovered in a 10- to 20-acre abandoned landfill near Cold Spring Brook in 1987. AOC 40 landfill is located within 600 feet of the Patton Well (a drinking water supply well).	**Groundwater and Surface water:** Metals were detected at levels above CVs. In the past and currently, all detected groundwater contaminant concentrations have been below state and federal drinking water standards. Downgradient wells (those that may have been affected by the landfill site) have not contained arsenic at levels greater than the drinking water standard. **Surface Soil:** PAH levels exceeded CVs. **Sediment**: Metals and PAHs were detected at levels above CVs.	A ROD signed in July 1999 states that the Army will fully excavate and consolidate AOC 40 contaminated media with materials from SA and 13 and AOC 9 and 11 in a on-site (the Golf Course Driving Range) or at an off-site location to be determined. If the material is disposed off on site, the cell will be lined and capped, and long-term groundwater monitoring will be performed.	Current and past exposures to sediment, soil, and groundwater contaminants have been too low to pose a public health hazard. There may be future health concerns associated with the site, depending on land and resource use. Future exposure to soil and sediment will likely remain limited because the area around AOC 40 has been designated for industrial /commercial use. Exposure to groundwater contaminants in the future may increase if the proposed expansion plan of the Patton well pumping capabilities is implemented.

TABLE 1. Evaluation of Potential Public Health Hazards Associated with Major Study Areas and Areas of Contamination at Fort Devens (continued)

Site	Site Description/ Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Current Status	Evaluation of Public Health Hazard
AOC 43A POL Storage Area	Located adjacent to Shepley's Landfill, the area was used for gasoline, diesel fuel, and heating oil storage and distribution. Five underground storage tanks (USTs) (four 12,600-gallon and one 10,000-gallon) that stored fuel oil No. 2 were removed along with soil containing fuels and petroleum products.	**Surface Soil**: Metals and pesticides were detected at levels above CVs. **Groundwater**: Metals and VOCs were detected; concentrations of some VOCs exceeded Cvs.	A ROD calling groundwater monitoring to evaluate natural attenuation was signed in 1998. The Army monitored natural attenuation to address contaminated groundwater in the 1998/1999. A draft study done in July 1999 demonstrated that the remedial actions are operating effectively.	No public health hazards are associated with the low levels of contaminants detected in on-site soil. Under current use scenarios, groundwater at this AOC is not a public health concern.
AOC 43G Historic Gas Station Site/ Gas Station	AOC 43G was used for gasoline and waste oil storage and distribution. A 5,000-gallon gasoline UST was removed.	**Groundwater**: Metals and VOCs were detected; concentrations of some metals exceeded CVs. **Subsurface Soil**: PAHs and/or metals were detected at levels above CVs.	In 1996, the Army signed a record of decision (ROD) for AOC 43G that called for the use of bioremediation technologies at this site. Today, the Army is measuring and assessing its success in reducing contaminant concentrations. They are also conducting long-term groundwater monitoring.	No public health hazard exists because subsurface soils are inaccessible and contaminants were not detected at levels of health concern. No one uses site groundwater for drinking purposes.

TABLE 1. Evaluation of Potential Public Health Hazards Associated with Major Study Areas and Areas of Contamination at Fort Devens (continued)

Site	Site Description/ Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Current Status	Evaluation of Public Health Hazard
AOC 43J Historic Gas Station Site	AOC 43J was used for gasoline and waste oil storage and distribution. A 5,000-gallon gasoline UST was removed.	**Groundwater**: Metal and VOC concentrations exceeded CVs. **Subsurface Soil**: PAHs and/or metals were detected at levels above CVs.	In 1996, the Army signed a ROD for AOC 43J that called for the use of bioremediation technologies at this site. Today, the Army is measuring and assessing its success in reducing contaminant concentrations. They are also conducting long-term groundwater monitoring.	No public health hazard exists because subsurface soils are inaccessible and contaminants were not detected at levels of health concern. No one uses site groundwater for drinking purposes.
AOC 44 Cannibalization Yard	Vehicles are stored on this 150-foot by 75-foot, unpaved area before being dismantled for reusable parts. Topsoil is periodically removed and disposed offsite. AOC 44 is being studied with AOC 52.	**Surface Soil**: PAHs were detected at levels above CVs.	The ROD was issued in March 1995. The Remedial Design and Removal Action (RD/RA) Work Plan was issued in June 1995. The site was combined with AOC 52 and removal actions were completed in December 1995. The Remedial Action Completion Report was issued in June 1996. Since March 1998, annual groundwater monitoring has been conducted.	No public health hazard exists because soils are inaccessible and contaminated soil has been removed.

TABLE 1. Evaluation of Potential Public Health Hazards Associated with Major Study Areas and Areas of Contamination at Fort Devens (continued)

Site	Site Description/ Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Current Status	Evaluation of Public Health Hazard
SA 49 Bldg 3602	SA 49 was used as a fuel handling and storage area.	**Groundwater**: Metals were detected at levels above CVs. VOCs were either not detected or detect at levels below CVs. **Surface Soil:** PAHs and metals were detected at levels below CVs.	A draft No Further Action was issued in April 1996.	No public health hazard exists because subsurface soils are inaccessible and contaminants were not detected at levels of health concern. No one uses groundwater at this study area for drinking purposes.
AOC 52 Maintenance Yard	AOC 52 is an active storage area for vehicles awaiting repair. Small patches of soil (2 - 3 feet) contain visible traces of motor oil or hydraulic fluid.	**Soil:** Petroleum products and organic chemicals were detected at levels above CVs.	The ROD was issued in March 1995. The RD/RA Work Plan was issued in June 1995. Removal actions were completed in December 1995. The Remedial Action Completion Report was issued in June 1996. Since march 1998, annual groundwater monitoring has been conducted.	Because it is inaccessible to the general public, this area is not likely to pose a public health hazard. Exposure to site contaminants, if any, is limited to occasional site visits
SA 56 Bldg 2417	SA 56 was used for fuel storage.	**Soil:** Petroleum products and organic chemicals were detected at levels above CVs.	The closure report is under review. A Draft No Further Action Decision was issued in April 1996.	Because it is inaccessible to the general public, this area is not likely to pose a public health hazard. Exposure to site contaminants, if any, is limited to occasional site visits by military personnel.

TABLE 1. Evaluation of Potential Public Health Hazards Associated with Major Study Areas and Areas of Contamination at Fort Devens (continued)

Site	Site Description/ Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Current Status	Evaluation of Public Health Hazard
AOC 57 Bldg 3713 Fuel Oil Spill Site	This building housed several industrial activities, including an Army vehicle repair shop. In 1978, No. 4 fuel oil was spilled. Oil products have been found on the banks of Cold Spring Brook.	**Soil:** Petroleum products and organic chemicals were detected were detected at levels above CVs.	An Interim Removal Action consisting of removal of approximately 1,300 cubic yards of oil-contaminated soil was completed in October 1994. A RI was completed in October 1998.	No one uses groundwater at this AOC for drinking purposes. Because this AOC is inaccessible to the general public, this area is not likely to pose a public health hazard. Exposure to site contaminants, if any, is limited to occasional site visits.
AOC 63AX Bldg 2517	Located north and near the western end of Patton Road on the southern portion of the Main Post, AOC 63AX consists of a large paved and fenced area, Building 2517 (currently used as a warehouse by the U.S. Bureau of Prisons), and Building 2514, which is abandoned. It is also the former location of a 1,000-gallon and a 5,000-gallon UST.	**Subsurface Soil**: Metals and PAHs were detected; concentrations of some PAHs exceeded CVs. **Groundwater**: Metals and VOCs were detected; concentrations of some metals exceeded CVs.	Prior to remedial activities, the Army had removed the underground storage tank at this site. In the fall of 1996, the Army completed the draft RI report. A final No Further Action ROD was signed in 1997.	The site poses no public health hazard. The site is presently accessed only by military personnel, so public exposure to on-site soil contamination is limited and not likely to pose a public health hazard. The area is served by the Fort Devens public water supply, therefore, exposure to contaminated groundwater is unlikely.

TABLE 1. Evaluation of Potential Public Health Hazards Associated with Major Study Areas and Areas of Contamination at Fort Devens (continued)

Site	Site Description/ Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Current Status	Evaluation of Public Health Hazard
AOC 69W Bldg 215 Elementary School	In 1972 and 1978 fuel oil No. 2 was accidentally released to the soil and groundwater in the area of the school. The suspected source was a broken pipe.	**Soil**: Total petroleum hydrocarbons (TPHC) were detected. **Groundwater**: TPHC, metals, semivolatile organic compounds, and VOCs were detected at levels above CVs. **Air:** No compounds related to the release were detected at levels above CVS.	The school has been closed since 1993. The fuel-oil contaminated soil has been removed and the heating system replaced. Groundwater contamination is being tracked by long-term monitoring. Air sampling has also been conducted at the school. A ROD calling for long-term groundwater monitoring and institutional controls that restrict groundwater access was signed in June 1999.	The site poses no current or future public health hazards. ATSDR is not fully able to evaluate past exposure because of the lack of data describing indoor air quality in the past.
SA 71 Railroad Roundhouse	The railroad roundhouse, located at the southern edge of Plow Shop Pond, was operated by the Boston & Maine Railroad between 1900 and 1935. Fort Devens currently owns the property where only portions of the roundhouse foundation remain.	Metals and petroleum products were detected at levels above CVs.	A RI/FS was SA 71 completed. The Army is removing contaminated soil from this area.	Because it is inaccessible to the general public, this area is not likely to pose a public health hazard. Exposure to site contaminants, if any, is limited to occasional site visits.

TABLE 1. Evaluation of Potential Public Health Hazards Associated with Major Study Areas and Areas of Contamination at Fort Devens (continued)

Site	Site Description/ Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Current Status	Evaluation of Public Health Hazard
AOC 72 Plow Shop Pond and Grove Pond	Plow Shop Pond is a shallow, 30-acre pond located outside the installation boundary at the northeast corner of the Main Post. The primary source of water to Plow Shop Pond is flow from Grove Pond, located just upstream.	**Sediment**: Metals and PAHs were detected at concentrations above CVs. **Surface Water**: Metal concentrations infrequently exceeded CVs. **Fish**: Mercury at concentrations above guidance levels was detected.	Investigations suggest Shepley's Landfill was a source of arsenic, barium, iron, and manganese in Plow Shop Pond sediment, but inflow from Grove Pond may also have contributed to iron and manganese concentrations. EPA is conducting an ecological risk evaluation and investigating the effectiveness of natural attenuation for reducing the level of contaminants in pond sediment.	Chronic exposure to arsenic and chromium in Grove Pond sediment (which might not be related to Fort Devens) may pose an unacceptable public health hazard. The likelihood of this occurring, however, is minimal. No public health hazard is expected from contact with surface water. Consumption of fish could pose a hazard to certain sensitive populations (e.g., children) if large quantities of fish were consumed for a long time, but a fish consumption advisory has been posted.

TABLE 1. Evaluation of Potential Public Health Hazards Associated with Major Study Areas and Areas of Contamination at Fort Devens (continued)

Site	Site Description/ Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Current Status	Evaluation of Public Health Hazard
SA 73 Lower Cold Spring Brook	Cold Spring Brook flows along the eastern boundary of the site, near the Cold Spring Landfill.	**Sediment**: Metals were detected.	A site investigation report was issued in December 1995. Supplemental sampling has been completed and the results were issued in a report dated July 1998.	Exposures that might occur during recreation are not likely to result in adverse health effects.
NORTH POST				
AOC 9 North Post Landfill	Operated from 1950s to 1978, the landfill is located just west of the Fort Devens wastewater treatment plant. This landfill contains approximately 112,000 cubic yards of construction debris and tree stumps and limbs.	**Groundwater**: Metals and other inorganic compounds were detected at concentrations above CVs. **Surface Soil and Sediment**: No chemicals were detected at concentrations above both background levels and CVs.	A ROD signed in July 1999 states that the Army will fully excavate and consolidate AOC 9 contaminated media with materials from SA and 13 and AOC 11 and 40 in a on-site (the Golf Course Driving Range) or at an off-site location to be determined. If the material is disposed off on site, the cell will be lined and capped, and long-term groundwater monitoring will be performed.	No public health hazard exists because no chemicals were detected in surface soil. No one uses site groundwater for drinking purposes. Moreover, public exposure to the site is limited because AOC 9 is a landfill, therefore, it is highly unlikely that structures (including residences) would be built at the site.
SA 30 Drum Storage Area	Area used for accumulation of hazardous waste (550-825 gallons).	**Surface Soil**: No contamination was found.	A No Further Action Site document was signed in September 1995.	No public health hazard exists because surface soil contaminants were not detected.

TABLE 1. Evaluation of Potential Public Health Hazards Associated with Major Study Areas and Areas of Contamination at Fort Devens (continued)

Site	Site Description/ Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Current Status	Evaluation of Public Health Hazard
AOC 50 WW II Fuel Points	Located along the northeastern boundary of the Moore Army Air Field, this site was used for aircraft fueling from 1941 to 1945. The area had five underground fuel storage tanks and associated piping. Tanks and piping have been removed. The area was also used for cleaning parachutes.	**Soil and Groundwater:** Petroleum products and tetrachloroethylene were detected at levels above CVs.	Phase I Removal of three USTs was completed in January 1993. Phase II Removal (soil vapor extraction for tetrachloroethylene [PCE]) was installed in January 1994, and remains on-going. Long-term monitoring of groundwater will continue. A draft RI was issued in 1997 and the Army is further investigating options to reduce the PCE contamination in groundwater.	No public health hazard exists because no one uses the groundwater beneath the site for drinking purposes. The Army, EPA, and MADEP are tracking the groundwater contamination to reduce the potential for future health hazards.
SOUTH POST				
Study Area (SA) 6 Landfill No. 2	Located on the South Post, this landfill was used between 1850 and 1920 for disposal of household refuse and glass.	No contamination found.	No further remedial action is proposed for SA 6.	No public health hazard exists because contaminants were not detected.

TABLE 1. Evaluation of Potential Public Health Hazards Associated with Major Study Areas and Areas of Contamination at Fort Devens (continued)

Site	Site Description/ Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Current Status	Evaluation of Public Health Hazard
SA 12 Range Control Landfill	Located atop a steep slope near the Nashua River, the landfill contains approximately 8,700 cubic yards of construction and range operation debris.	**Groundwater**: Metals were detected at levels above CVs. **Surface Soil and Sediment**: PCBs and/or metals were detected; some levels exceeded CVs.	A ROD signed in July 1999 calls for the removal of surface debris and surface soil from hot spots that pose a potential ecological risk. The MADEP will be responsible for future monitoring at AOC 12.	Because SA 12 is inaccessible to the general public, it is not likely to pose a public health hazard. Exposure to site contaminants is limited to occasional site visits by military personnel. Future public exposure will continue to be restricted because the site will remain under military control. No one uses site groundwater for drinking purposes.

TABLE 1. Evaluation of Potential Public Health Hazards Associated with Major Study Areas and Areas of Contamination at Fort Devens (continued)

Site	Site Description/ Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Current Status	Evaluation of Public Health Hazard
AOCs 25, 26, 27, and 41 South Post Groundwater Operable Unit	*AOC 25 - EOD Ranges.* Since 1979, about 1,200 pounds per year of explosives and ammunition have been soaked with diesel fuel and burned in open pits. Larger items are detonated with C-4 or TNT. Site is about 5 acres. *AOC 26 - ZULU I & II.* This 20-acre site has two range areas, Zulu I and II. Zulu I is used for hand grenade and demolition training. Explosives and items containing explosives residue are burned at Zulu II. *AOC 27 - Hotel Range.* The estimated 7-acre training range is used for firing rifle grenades and 20-mm automatic cannons with red phosphorous tracers. The area was used before 1979 for disposal of old/defective grenades and rockets. *AOC 41 - Unauthorized Dumping Area.* One-acre site used until the 1950s for disposal of nonexplosive military and household debris.	**Groundwater and Surface Soil**: Explosives and metals were infrequently detected at levels above CVs. **Groundwater**: Metals and PAHs were detected; concentrations of some metals exceeded CVs. **Surface Soil and Sediment**: Metals, explosives, and PAHs were detected; concentrations of PAHs exceeded CVs. **Groundwater**: Metals and explosives were detected at levels below CVs. **Sediment (Cranberry Pond)**: Metals, pesticides, and PAHs were generally detected at levels below CVs. Explosives were also detected. **Surface water and Sediments**: Metals were detected at levels above CVs.	AOCs 25, 26, 27, and 41 have been designated a groundwater operable unit. Long-term on-site groundwater monitoring is conducted. The Army will remove surface debris and surface soil from hot spots in areas that pose a risk to ecological receptors at AOC 41.	The Army will retain South Post for training. Because these AOCs are inaccessible to the general public, it is not likely to pose a public health hazard. Exposure to site contaminants is limited to occasional site visits by military personnel. Future public exposure will continue to be restricted because the site will remain under military control. No one uses site groundwater or surface water for drinking purposes.

TABLE 1. Evaluation of Potential Public Health Hazards Associated with Major Study Areas and Areas of Contamination at Fort Devens (continued)

Site	Site Description/ Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Current Status	Evaluation of Public Health Hazard
SA 39 Old Sylvania Building	SA 39 is a PCB leak from a transformer.	**Soil**: PCBs were detected at levels above CVs.	Removal actions occurred in September 1995. A Draft No Further Action Decision was issued in May 1996.	The area is inaccessible to the general public, and therefore is not likely to pose a public health hazard. Exposure to site contaminants is limited to occasional site visits by military personnel.

Sources: ABB Environmental Services, Inc., 1995; BRAC, 1996a, 1996b, 1997, and 1999; Fort Devens, 1995b; Fort Devens, 1996; Fort Devens, 1997; Horne Engineering Services, Inc., 1997.

TABLE 2. Local Public Water Supplies

Area	Well (s)	Years of Operation	Location	Use	< MCL?
Fort Devens	Shebokin	1941-present	Building 3628 on the Main Post	Fort Devens water supply	Yes
	Patton	1953-present	Building 3630 on the Main Post	Fort Devens water supply	Yes
	MacPherson	1966-present	East of the MacPherson Road and the Nashua River on the North Post	Fort Devens water supply	Yes
	Grove Pond Wellfield	unavailable	The wellfield consisting of eight wells, is located along the south shore of Grove Pond	Fort Devens water supply	Yes
	Well D-1	mid-1980s - present for military training	Along Dixie Road South Post	Short-term troop training	Yes
Ayer	Grove Pond	1943-1993; 1998-present	South shore of Grove Pond	Ayer public water supply	[1]
	Spectacle Pond	1978-present	Near Littleton town line	Ayer public water supply	[1]
Harvard	Well 1	1930s to 1990	Ayer Road	Closed in 1990; abandoned in 1997.	Yes
	Well 2	1960s-present	Pond Road, 1,600 feet from Fort Devens	Services 65 homes.	Yes
	Well 3	unavailable	Bolton Road. Not near Fort Devens	Emergency use only.	Yes
	Well 4	under construction	Pond Road, 100 feet from Well 2.	Will supplement well 2 supply.	[2]
Lancaster	Wells	various	Bolton Station Road	Serves 1,500-1,600 residents	Yes
Shirley	Patterson	1977-present	Patterson Road, near Morse Brook	Supplies 80% of annual average	Yes
	Catacunemaug	1953-present	Catacunemaug Road	Supplies 20% of annual average	Yes

Source: ADPW, 1998a; Harvard Water Department, 1998; Lancaster Water Department, 1998; Shirley Water District, 1998; Devens Commerce Center, 1998.
[1] Manganese has been detected at levels above the MCL in the past. The well water is currently treated for manganese. [2] The information is not available.

TABLE 3. Exposure Pathways

Pathway Name	Source of Contamination	Environmental Medium	Point of Exposure	Route of Exposure	Potentially Exposed Population	Comments
Public Drinking Water—Ayer Grove Pond Wells	Arsenic, iron, and manganese possibly from naturally occurring and site-related sources	Groundwater	Ayer public water	Ingestion, dermal contact, and inhalation	Ayer public water users	**Past :** • Arsenic, iron, and manganese were detected in the Grove Pond wells before they were closed in 1993. ATSDR has determined that the concentrations of these compounds are unlikely to cause harmful effects, even for residents who used the water for extended periods. No exposure occurred after 1993. **Current and Future :** • No exposure to harmful levels of contaminants is occurring or is expected to occur. During the summer of 1998, the Ayer Department of Public Works returned the Grove Pond wells to regular service. Before the water is delivered to residential taps, the water is treated to ensure that it is safe to drink. Since start-up, water has met EPA safe drinking water standards.

TABLE 3. Exposure Pathways (continued)

Pathway Name	Source of Contamination	Environmental Medium	Point of Exposure	Route of Exposure	Potentially Exposed Population	Comments
Surface Water/Sediment	Contaminants related to upgradient sources surrounding the lake, including Fort Devens and a former tannery	Surface Water Sediment	Grove Pond and Plow Shop Pond	Dermal contact while swimming, wading, boating, or fishing	Recreational users of the Grove Pond and Plow Shop Pond	**Past:** • Elevated levels of contaminants were detected in sediment, but use of the pond would not have resulted in adverse health effects. **Current and Future:** • As a precautionary measure, a no swimming advisory has been posted at Grove Pond and Plow Shop Pond. Any brief and infrequent contact that might occur through wading is unlikely to result in adverse health effects.

TABLE 3. Exposure Pathways (continued)

Pathway Name	Source of Contamination	Environmental Medium	Point of Exposure	Route of Exposure	Potentially Exposed Population	Comments
Food Chain	Contaminants related to sources surrounding the ponds or lake, including former tannery, Fort Devens, and naturally occurring sources	Fish	Grove Pond, Plow Shop Pond, and Mirror Lake	Ingestion of fish	Anglers	**Past:** • Largemouth bass in Grove Pond, Plow Shop Pond, and Mirror Lake contain elevated levels of mercury. ATSDR believes that people who ate moderate amounts of fish in a varied diet should not suffer adverse health effects. **Current and Future:** • As a precautionary measure, a fish consumption advisory has been posted at Grove Pond, Plow Shop Pond, and Mirror Lake. By following the precaution in the advisory people can best limit their exposure to mercury.

TABLE 3. Exposure Pathways (continued)

Pathway Name	Source of Contamination	Environmental Medium	Point of Exposure	Route of Exposure	Potentially Exposed Population	Comments
Indoor Air	Fuel oil release	Indoor air	Devens Elementary School	Inhalation	Teachers Students	**Past:** • No data are available on the indoor air quality at the school in the past, so it is unknown to what extent, if any, the indoor air was adversely impacted by the oil spill. It is unlikely, however, that people were exposed to air contaminants at levels of health concern. **Current and Future:** • No contaminants have been detected at levels of public health concern.

TABLE 4. Summary of Contaminants in On-Site Groundwater

Contaminant	Maximum Concentration (ppb) and Location		Comparison Value (ppb) [1]	
			Noncarcinogenic	Carcinogenic (CREG)
Volatile Organic Compounds				
Benzene	2,000	AOC 43G	5 MCL	1
Chloroethane	5.5	Shepley's Hill Landfill	---	---
Ethylbenzene	2,000	AOC 43G	700 MCL	---
Tetrachloroethylene	40,000	AOC 50	5 MCL	0.7
Toluene	300	AOC 43G	700 I-EMEG Adult	---
Xylenes	20,000	AOC 43G	7,000 I-EMEG Adult	---
1,1-Dichloroethane	4.4	Shepley's Hill Landfill	---	---
1,2-Dichloroethane	9.9	Shepley's Hill Landfill	5 MCL	0.4
Dichlorobenzenes (total)	11	Shepley's Hill Landfill	---	---
Metals				
Aluminum	75,500	Shepley's Hill Landfill	3,700 Region III RBC	---
Antimony	4 (filtered)	AOC 43G	3 LTHA	---
Arsenic	390	Shepley's Hill Landfill	10 C- EMEG Adult	0.02
Chromium	115	Shepley's Hill Landfill	100 MCL	---
Iron	97,400	Shepley's Hill Landfill	---	---
Lead	103	AOC 44	---	---
Manganese	14,300	AOC 43G	200 RMEG Adult	---
Nickel	177	Shepley's Hill Landfill	100 MCL	---

Source: Horne Engineering Services, Inc., 1996.

[1] The adult and child comparison values are based on ATSDR's most recent comparison values (expiration date of March 31, 1999).

Key: ppb = parts per billion; CREG = ATSDR's cancer risk evaluation guide; EMEG = ATSDR's environmental media evaluation guide; LTHA = EPA's Lifetime Health Advisory; MCL = EPA's maximum contaminant level; — = not available.

TABLE 5. Summary of Contaminants in Grove Pond and Plow Shop Pond Surface Water

Contaminant	Surface Water Concentrations (ppb)				Comparison Values (ppb)[1]		
					Non-Carcinogenic		Carcinogenic
	Grove Pond		Plow Shop Pond		Adult	Child	
	Range	Frequency	Range	Frequency			
Arsenic	3.94	1/6	2.99 - 6.84	13/13	10 EMEG	3 EMEG	0.02
Cadmium	nd	0/6	nd	0/6	7 EMEG	2 EMEG	—
Chromium	6.76 - 39.8	2/6	nd	0/13	100 MCL	100 MCL	—
Lead	2.39 - 3.04	2/6	nd	0/13	15 EPA's Action Level	—	—
Manganese	39.9 - 100	6/6	7.81 - 139	13/13	200 RMEG	50 RMEG	—
Mercury	nd	0/6	nd	0/6	—	—	—

Source: ABB, 1995.

[1] The adult and child comparison values are based on ATSDR's most recent comparison values (expiration date March 31, 1999).

Key: EMEG = ATSDR's environmental media evaluation guide; MCL = EPA's maximum contaminant level; RMEG = ATSDR's reference dose media evaluation guide; — = not available; nd = analyte not detected.

TABLE 6. Summary of Contaminants in Grove Pond and Plow Shop Pond Sediment

Contaminant	Concentration Range (ppm)						Comparison Values (ppm)[4]		
							Noncarcinogenic		
	Grove Pond[1]		Grove Pond (Pirone Park)[2]		Plow Shop Pond[3]				
	Range	Frequency	Range	Frequency	Maximum	Frequency	Adult	Child	Carcinogenic
Arsenic	4.16 - 1,300	41/41	9.23 - 110	7/7	3,200	63/63	200 EMEG	20 EMEG	0.5
Cadmium	3.07 - 110	22/41	18.7 - 23.3	3/7	60.2	21/63	100 EMEG	10 EMEG	—
Chromium	17.1 - 49,800	40/41	35.3 - 2,680	7/7	10,000	60/63	—	—	—
Lead	3.21 - 1,760	12/41	11.4 - 232	7/7	1,000	62/63	400 EPA Screening Value	400 EPA Screening Value	—
Manganese	14.4 - 1,730	41/41	145 - 792	7/7	54,800	59/63	100,000 RMEG	7,000 RMEG	—
Mercury	0.128 - 220	34/41	0.772 - 2.18	6/7	250	58/63	—	—	—
PAHs[5]	5	20/41	0.8	1/7	4.3	3/13	—	—	0.1

Source: ABB, 1995.

[1] Monitoring data from 1992 - 1995.
[2] Data subset includes samples (GRD-16x to GRD-22x) collected along the shoreline of Grove Pond at Pirone Park in 1995.
[3] Data from the 1991 RI, the 1992-1993 SRI, and the 1994 PSP sediment evaluation. Only the maximum concentrations were presented for the RI and PSP data.
[4] The adult and child comparison values are based on ATSDR's most recent comparison values (expiration date of March 31, 1999).
[5] The values represent the highest recorded concentration for an individual PAH. Pyrene was detected at the highest levels. A comparison value for benzo(a)pyrene of 0.1 ppm was used.

Key: PAHs = polycyclic aromatic hydrocarbons; EMEG = ATSDR's environmental media evaluation guide; RMEG = ATSDR's reference dose media evaluation guide; — = not available; nd = analyte not detected.

TABLE 7. Summary of Contaminants in Grove Pond Fish

Contaminant	Contaminant Concentrations (mg/kg)						Comparison Value (mg/kg)
	Largemouth Bass (Reconstructed Wholebody Samples) [1]		Brown Bullhead (Reconstructed Wholebody Samples) [1]		Bluegill (Wholebody Samples)		
	Range	Frequency	Range	Frequency	Range	Frequency	
Cadmium	0.03 - 0.88	3/10	0.01 - 0.19	2/8	0.05 - 0.24	10/10	—
Lead	0.14 - 4.32	4/10	0.18 - 1.12	3/8	0.16 - 1.38	10/10	—
Mercury	0.10 - 1.13	10/10	0.01 - 0.14	6/8	0.08 - 0.24	10/10	1 FDA action level
Selenium	0.22 - 0.51	10/10	0.13 - 0.39	3/8	0.27 - 0.38	10/10	—
Zinc	11.0 - 16.4	10/10	10.0 - 20.5	8/8	16.7 - 26.3	10/10	—
PCBs	0.10 - 0.43	10/10	0.08 - 0.12	2/8	0.025 - 0.21	10/10	2 FDA tolerance level
DDD	0.02 - 0.11	10/10	0.02 - 0.05	7/8	0.01 - 0.07	10/10	5 FDA action level
DDE	0.05 - 0.25	10/10	0.01 - 0.10	8/8	0.02 - 0.13	10/10	5 FDA action level

Source: U.S. Fish and Wildlife, 1993.

[1] Contaminant concentrations in reconstructed wholebody samples are presented because they were generally greater than concentrations detected in fillet samples.

Key: mg/kg = milligram per kilogram; DDD = 1,1-dichloro-2,2-*bis*(*p*-chlorophenyl)ethane; DDT = 1,1-dichloro-2,2-*bis*(*p*-chlorophenyl)ethylene; FDA = Food and Drug Administration; — = no FDA action level or tolerance level available.

TABLE 8. Summary of Contaminants in Plow Shop Pond Fish

Contaminant	Contaminant Concentrations (mg/kg)				Comparison Value (mg/kg)
	Largemouth Bass and Brown Bullhead (Fillet Samples)		Bluegill (Wholebody Samples)		
	Range	Frequency	Range	Frequency	
Arsenic	0.09 - 0.15	2/10	1.3	1/5	—
Lead	not analyzed		0.16	1/5	—
Manganese	0.3	1/10	39.1 - 94.7	5/5	—
Mercury	0.12 - 4	8/10	0.19 - 0.54	5/5	1 FDA action level
Selenium	0.11 - 0.2	10/10	0.42 - 0.67	5/5	—
Zinc	3.4 - 6.1	10/10	22.2 - 29.6	5/5	—
DDE	0.015 - 0.031	2/10	0.0121 - 0.0129	2/5	5 FDA action level

Source: Fort Devens, 1995b.

Key: ppb = parts per billion; mg/kg = milligram per kilogram; DDE = 1,1-dichloro-2,2-*bis*(*p*-chlorophenyl)ethylene; FDA = Food and Drug Administration; — = no FDA action level or tolerance level available.

TABLE 9. Summary of Contaminants in Mirror Lake Fish

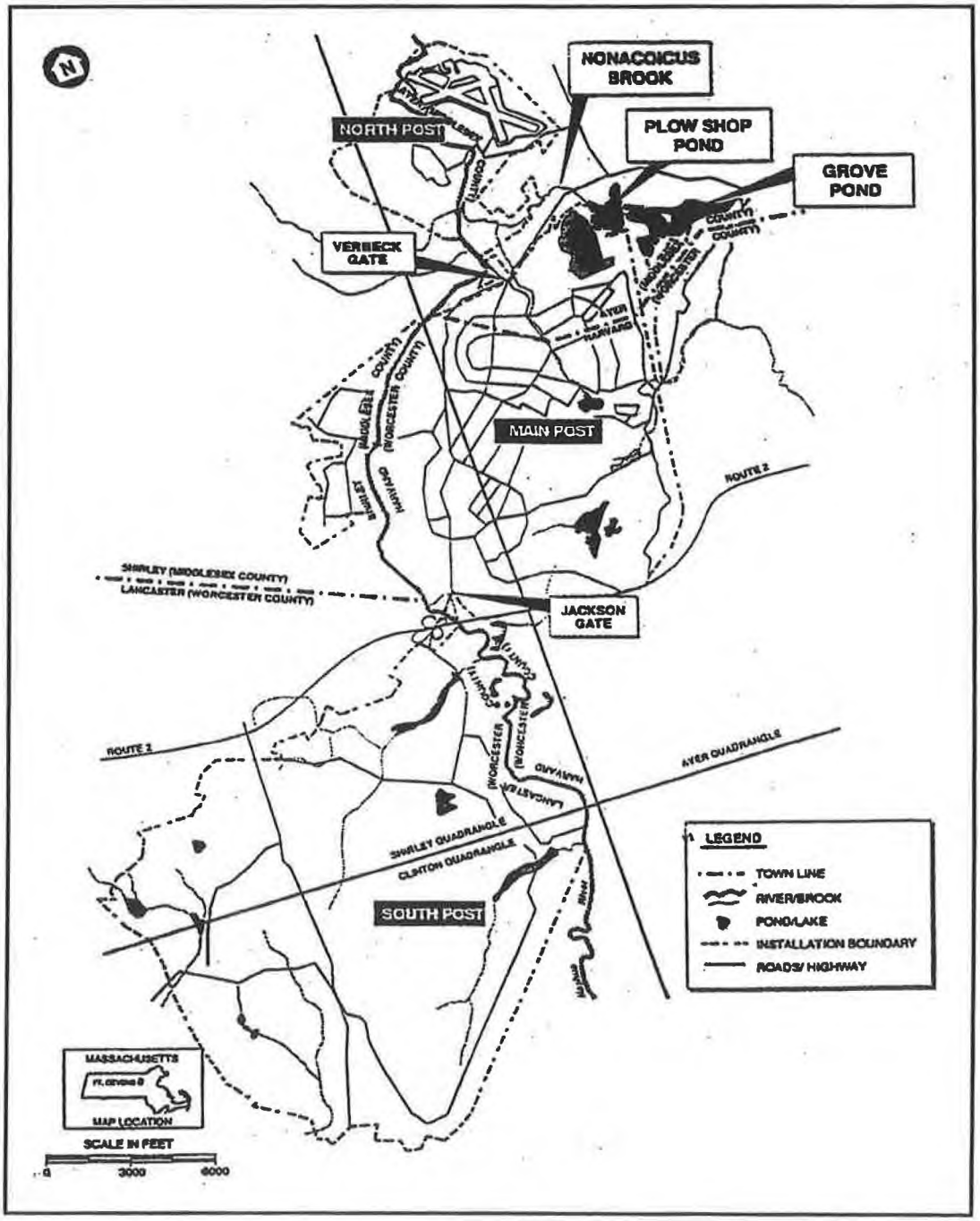
Contaminant	Contaminant Concentrations (mg/kg)		Comparison Value (mg/kg)
	Largemouth Bass and Brown Bullhead (Fillet Samples)		
	Range	Frequency	
Arsenic	nd	0/18	---
Lead	nd	0/18	---
Mercury	0.05 - 0.69	15/15	1 FDA action level
Selenium	0.065 - 0.264	18/18	---
Zinc	2.8 - 6.0	18/18	---
PCBs	nd	0/13	2 FDA action level
Pesticides	nd	0/13	---

Source: Fort Devens, 1995b.

Key: ppb = parts per billion; mg/kg = milligram per kilogram; DDE = 1,1-dichloro-2,2-*bis*(*p*-chlorophenyl)ethylene; FDA = Food and Drug Administration; nd = not detected; — = no FDA action level or tolerance level available.

FIGURES

FIGURE 1. Site Map



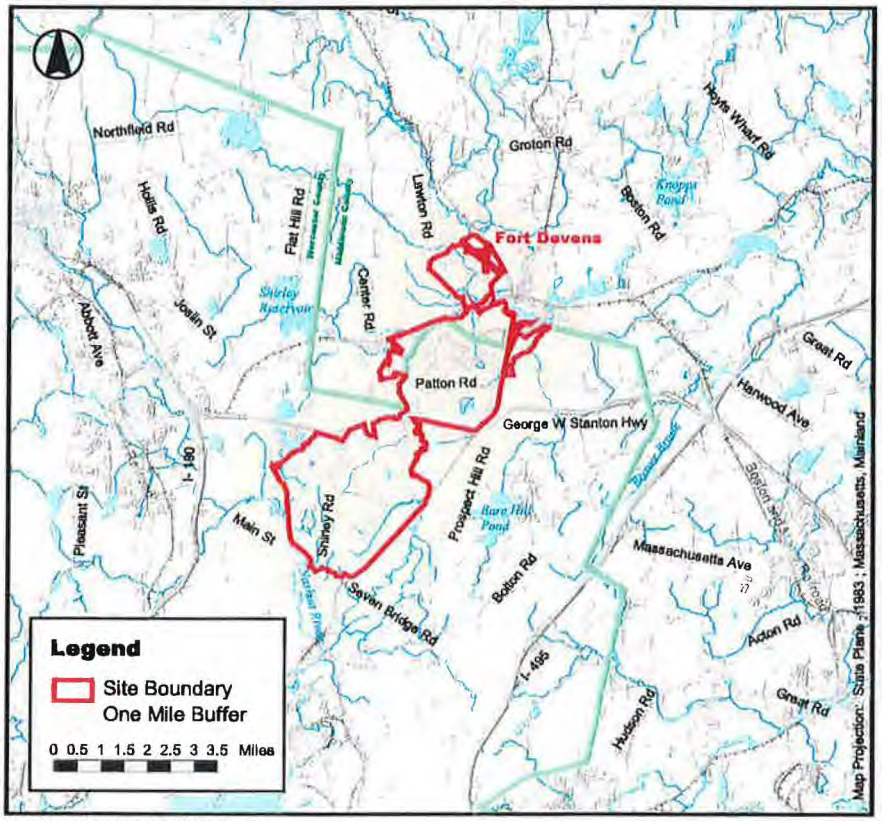
Source: ABB, 1995.

Fort Devens

INTRO MAP

Ayer, Massachusetts

CERCLIS No. MA7210025154



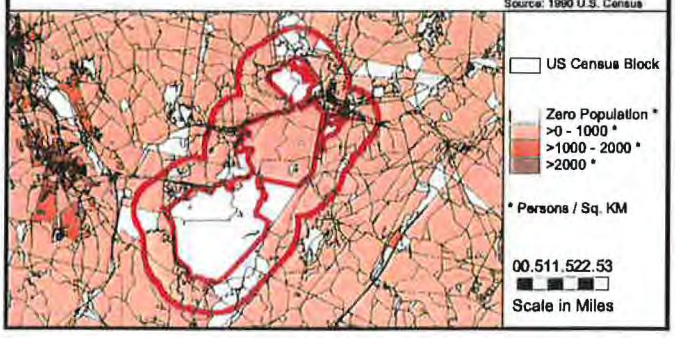
Base Map Source: 1995 TIGER/Line Files

Middlesex County, Massachusetts

Demographic Statistics Within One Mile of Site*	
Total Population	20847
White	16969
Black	2533
American Indian, Eskimo, Aleut	101
Asian or Pacific Islander	601
Other Race	641
Hispanic Origin	1288
Children Aged 6 and Younger	2617
Adults Aged 65 and Older	1051
Females Aged 15 - 44	5071
Total Housing Units	6436

Demographics Statistics Source: 1990 U.S. Census
*Calculated using an area-proportion spatial analysis technique

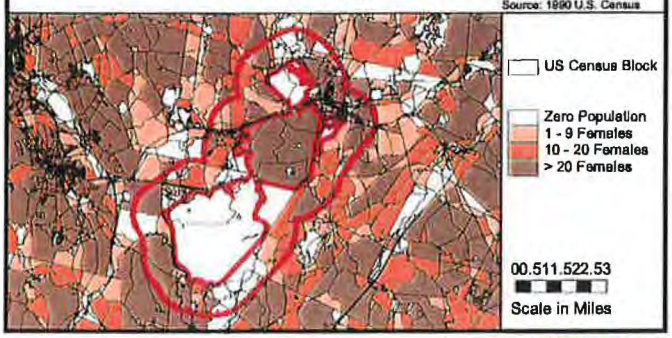
Population Density



Children 6 Years and Younger

Adults 65 Years and Older

Females Aged 15 - 44



SAAGIS

JVA110398

FIGURE 3. ATSDR's Exposure Evaluation Process

REMEMBER: For a public health threat to exist, the following three conditions must all be met:

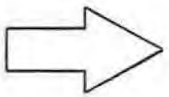
- People must come into contact with areas that have potential contamination
- Contaminants must exist in the environment
- The amount of contamination must be sufficient to affect people's health

Are People Exposed To Areas With Potentially Contaminated Media?

For exposure to occur, contaminants must be in locations where people can contact them.

People may contact contaminants by any of the following three exposure routes:

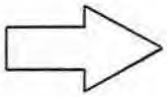
Inhalation
Ingestion
Dermal absorption



Are the Environmental Media Contaminated?

ATSDR considers:

Soil
Ground water
Surface water and sediment
Air
Food sources

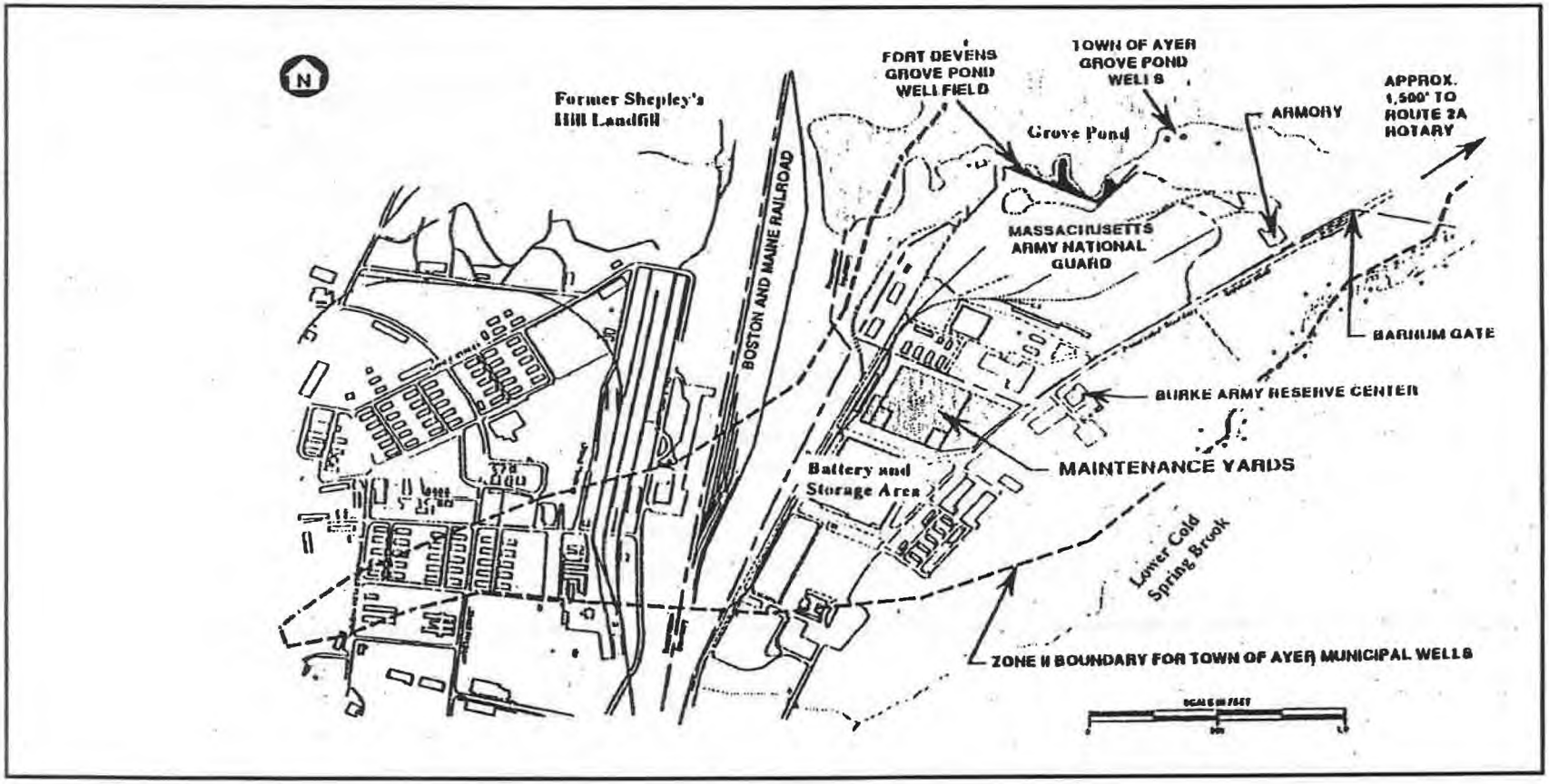


For Each Completed Exposure Pathway, Will the Contamination Affect Public Health?

ATSDR will evaluate existing data on contaminant concentration and exposure duration and frequency.

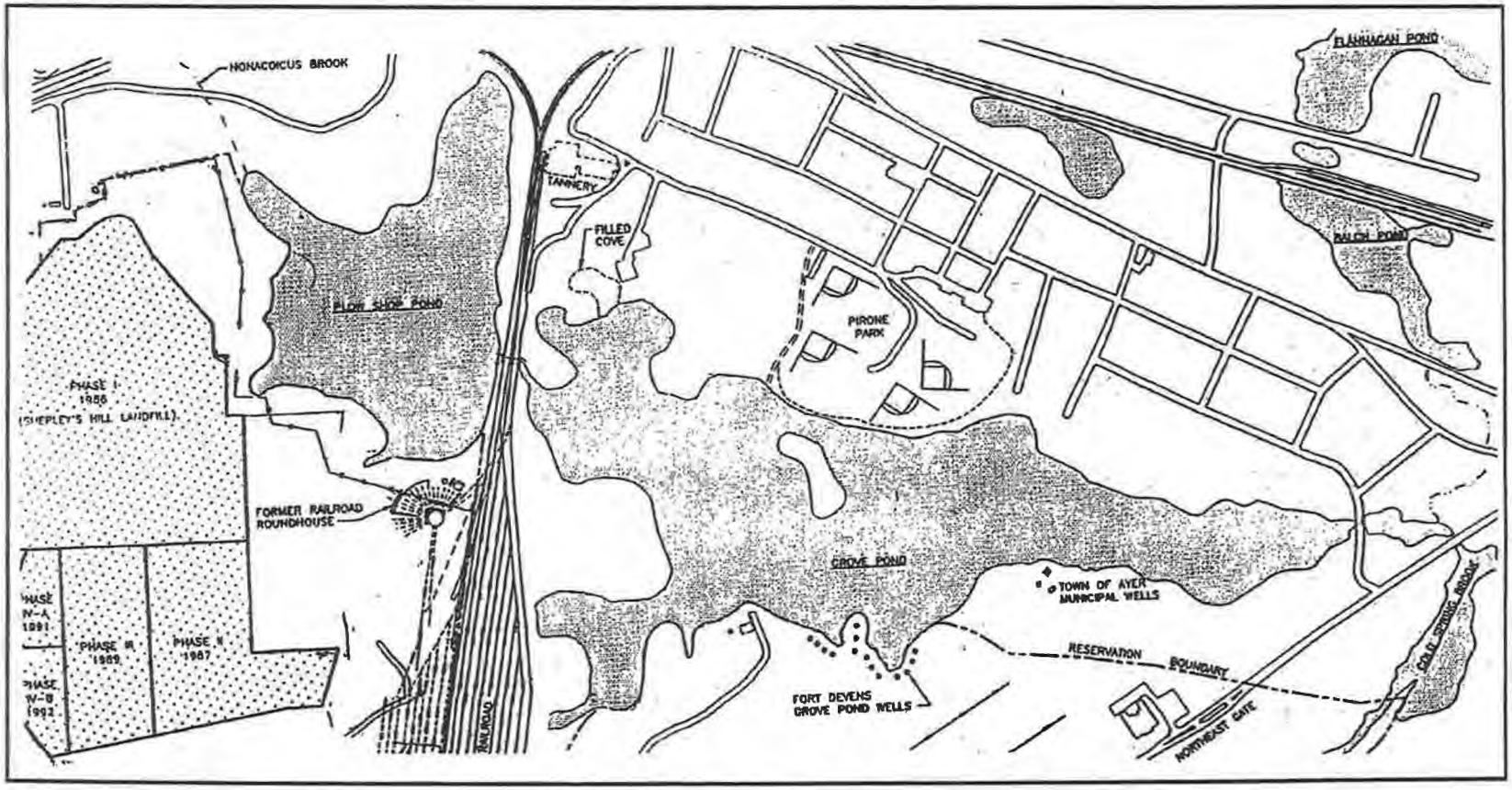
ATSDR will also consider individual characteristics (such as age, gender, and lifestyle) of the exposed population that may influence the public health effects of contamination.

FIGURE 4. Grove Pond Wells



Source: ABB, 1995.

FIGURE 5. Grove Pond and Plow Shop Pond



Source: ABB, 1995.

APPENDIX A: List of Comparison Values

Comparison values represent media-specific contaminant concentrations that are used to select contaminants for further evaluation to determine the possibility of adverse public health effects. The conclusion that a contaminant exceeds the comparison value does not mean that it will cause adverse health effects.

Cancer Risk Evaluation Guides (CREGs)

CREGS are estimated contaminant concentrations that would be expected to cause no more than one excess cancer in a million (10^{-6}) persons exposed over their lifetime. ATSDR's CREGs are calculated from EPA's cancer potency factors (CPFs).

Environmental Media Evaluation Guides (EMEGs)

EMEGs are based on ATSDR minimal risk levels (MRLs) that consider body weight and ingestion rates. An EMEG is an estimate of daily human exposure to a chemical (in mg/kg/day) that is likely to be without noncarcinogenic health effects over a specified duration of exposure to include acute, intermediate, and chronic exposures.

Maximum Contaminant Level (MCL)

The MCL is the drinking water standard established by EPA. It is the maximum permissible level of a contaminant in water that is delivered to the free-flowing outlet. MCLs are considered protective of public health over a lifetime (70 years) for individuals consuming 2 liters of water per day.

Reference Media Evaluation Guides (RMEGs)

ATSDR derives RMEGs from EPA's oral reference doses. The RMEG represents the concentration in water or soil at which daily human exposure is unlikely to result in adverse noncarcinogenic effects.

APPENDIX B: Glossary

Comparison Values
Estimated contaminant concentrations in specific media that are not likely to cause adverse health effects, given a standard daily ingestion rate and standard body weight. The *comparison values* are calculated from the scientific literature available on exposure and health effects.

Concentration
The amount of one substance dissolved or contained in a given amount of another. For example, sea water contains a higher concentration of salt than fresh water.

Contaminant
Any substance or material that enters a system (the environment, human body, food, etc.) where it is not normally found.

Dose
The amount of a substance to which a person is exposed. *Dose* often takes body weight into account.

Environmental Contamination
The presence of hazardous substances in the environment. From the public health perspective, *environmental contamination* is addressed when it potentially affects the health and quality of life of people living and working near the contamination.

Exposure
Contact with a chemical by swallowing, by breathing, or by direct contact (such as through the skin or eyes). *Exposure* may be short term (acute) or long term (chronic).

Health Consultation
A response to a specific question or request for information pertaining to a hazardous substance or facility (which includes waste sites). It often contains a time-critical element that necessitates a rapid response; therefore, it is a more limited response than an assessment.

Ingestion
Swallowing (such as eating or drinking). Chemicals can get in or on food, drink, utensils, cigarettes, or hands where they can be ingested. After *ingestion*, chemicals can be absorbed into the blood and distributed throughout the body.

Media
Soil, water, air, plants, animals, or any other parts of the environment that can contain contaminants.

Minimal Risk Level (MRL)
An *MRL* is defined as an estimate of daily human exposure to a substance that is likely to be without an appreciable risk of adverse effects (noncancer) over a specified duration of exposure. *MRLs* are derived when reliable and sufficient data exist to identify the target organ(s) of effect or the most sensitive health effect(s) for a specific duration via a given route of exposure. *MRLs* are based on noncancer health effects only. *MRLs* can be derived for acute, intermediate, and chronic duration exposures by the inhalation and oral routes.

No Apparent Public Health Hazard
This category is used for sites where human exposure to contaminated media may be occurring, may have occurred in the past, and/or may occur in the future, but the exposure is not expected to cause any adverse health effects. This determination represents a professional judgement based on critical data available to ATSDR and that the data are judged sufficient to reach a decision. This does not necessarily imply that the available data are complete, in some cases additional data may be required to confirm or support the decision made.

Potentially Exposed
The condition where valid information, usually analytical environmental data, indicates the presence of contaminant(s) of a public health concern in one or more environmental media contacting humans (i.e., air, drinking water, soil, food chain, surface water), and there is evidence that some of those persons have an identified route(s) of exposure (i.e., drinking contaminated water, breathing contaminated air, having contact with contaminated soil, or eating contaminated food).

Parts per Billion (ppb)/ Parts per Million (ppm)
Units commonly used to express low concentrations of contaminants. As example of each, one part per billion (ppb) of trichloroethylene (TCE) equals one drop of TCE mixed in a competition-size swimming pool and one part per million (ppm) equals one ounce of trichloroethylene (TCE) in one million ounces of water.

Reference dose
The value used by EPA as an estimate of daily exposure (mg/kg/day) to the general human population (including sensitive populations) that is likely to be without appreciable risk of harmful effects during a lifetime of exposure.

Risk
In risk assessment, the probability that something will cause injury, combined with the potential severity of that injury.

Route of Exposure
The way in which a person may contact a chemical substance. For example, drinking (ingestion) and bathing (skin contact) are two different *routes of exposure* to contaminants that may be found in water.

Volatile organic compounds (VOCs)
Substances containing carbon and different proportions of other elements such as hydrogen, oxygen, fluorine, chlorine, bromine, sulfur, or nitrogen; these substances easily become vapors or gases. A significant number of the *VOCs* are commonly used as solvents (paint thinners, lacquer thinner, degreasers, and dry cleaning fluids).

Zone II Areas of Influence
Defined by Massachusetts Department of Environmental Protection as the area of an aquifer which contributes water to a well under the most severe pumping recharge conditions that can be realistically anticipated, as approved by the Department's Division of Water Supply.

APPENDIX C: Estimates of Human Exposure Doses and Determination of the Potential for Adverse Health Effects

Estimating Potential Exposure Levels

ATSDR estimated the human exposure levels (also called dose) from ingestion of drinking water from the Grove Pond wells, dermal contact with Grove Pond sediment along Pirone Park, and ingestion of fish. Deriving exposure doses requires evaluating the concentrations of the contaminants to which people may have been exposed and how often and how long exposure to those contaminants occurred. Together, these factors help influence the individual's physiological response to chemical contaminant exposure and potential noncancer (noncarcinogenic) or cancer (carcinogenic) outcomes. In the absence of exposure specific information, ATSDR applied several conservative exposure assumptions to define site-specific exposures as accurately as possible for area residents.

Evaluating Potential Health Hazards

The estimated exposure doses are used to evaluate potential noncancer and cancer effects associated with chemicals of concern. ATSDR uses standard toxicity values, including ATSDR's minimal risk levels (MRLs) and EPA's reference doses (RfDs) to evaluate *noncancer* effects. The MRLs and RfDs are estimates of daily human exposure to a substance that are unlikely to result in adverse noncancer effects over a specified duration. To be very protective of human health, MRLs and RfDs have "uncertainty" or "safety" factors built into them. Therefore, if an estimated dose is higher than an MRL or RfD, it does not necessarily follow that adverse health effects will occur.

To evaluate *cancer* effects, ATSDR sometimes uses cancer potency factors (CPFs) that define the relationship between oral exposure doses and the increased likelihood of developing cancer over a lifetime. The CPFs are developed using data from animal or human studies and often require extrapolation from high exposure doses administered in animal studies to the lower exposure levels typical of human exposure to environmental contaminants. CPFs represent the upper-bound estimate of the probability of developing cancer at a defined level of exposure; therefore, they tend to be very conservative (i.e., overestimate the actual risk) in order to account for a number of uncertainties in the data used in the extrapolation.

ATSDR estimated the potential for cancer to occur using the following equation. (The estimated exposure doses and CPF values for the contaminants of concern are incorporated into the equation):

$$\textit{Lifetime Cancer Risk} = \text{Estimated exposure dose (mg/kg/day)} \times \text{CPF (mg/kg/day)}^{-1}$$

Although no risk of cancer is considered acceptable, it is impossible to achieve a zero cancer risk. Consequently, ATSDR often uses a range of 10^{-4} to 10^{-6} estimated lifetime cancer risk (or 1 new case in 10,000 to 1,000,000 exposed persons), based on conservative assumptions about exposure, to determine the likelihood of excess cancer resulting from this exposure.

In addition to estimating the likelihood of noncancer and cancer effects, ATSDR reviewed the literature to evaluate possible health effects associated with exposure at the doses/concentrations estimated for the pathways described below.

Estimated Exposure Doses From Ingesting Drinking Water From Grove Pond Wells

Arsenic and manganese concentrations measured in Grove Pond well water exceeded ATSDR comparison values for drinking water, but ATSDR determined that drinking water containing even the highest detected levels of these contaminants is unlikely to cause adverse health effects.

To determine whether exposure to these contaminants in the well water may be related to adverse health effects, if any, ATSDR estimated exposure doses for people consuming water containing the highest measured concentrations in the Grove Pond wells. The estimated exposure doses were then used to evaluate potential noncancer outcomes. In estimating to what extent people might be exposed to contaminants, ATSDR used "conservative" or safe assumptions about possible human exposure and any associated health effects. ATSDR assumed that a person drank the most contaminated Grove Pond well water, before it is treated or blended with Spectacle Pond well water. ATSDR also used conservative assumptions about how often people drink water and how much they drink. These assumptions allow ATSDR to estimate the highest likely exposure dose and evaluate the potential health effects. Although ATSDR expects that few Ayer residents, if any, were exposed to the highest levels of contamination, the "conservative" estimates are used to protect public health.

Table C-1 summarizes the estimates of exposure to arsenic and manganese in Grove Pond well water and the following describes the equation and assumptions used to estimate the exposure:

$$\textit{Estimated exposure dose} = \frac{\text{Conc.} \times \text{CF} \times \text{IR} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

where:

Conc.	Maximum concentration in the Grove Pond water (ppb)
CF	Conversion factor to convert ppb to parts per million (1/1,000)
IR	Ingestion rate: adult=2 liters per day; child=1 liter per day
EF	Exposure frequency or number of exposure events per year of exposure: 7 days/week x 52 weeks/year
ED	Exposure duration or the duration over which exposure occurs: adult=30 years; child=6 years

BW	Body weight: adult=70 kg (154 pounds); child=10 kg (22 pounds)
AT	Averaging time or the period over which cumulative exposures are averaged (6 or 30 years x 365 days/year for noncancer effects)

Assumptions for Estimating Exposure Doses

- ATSDR assumed that an adult drank 2 liters and a child drank 1 liter of water a day and that all drinking water came from Grove Pond wells. This assumption likely leads to an overestimate of the actual exposure dose because well water was blended with Spectacle Pond well water before being distributed for consumption in homes.

- The exposure frequency (EF), or number of exposure events per year, was assumed to be 365 days per year, based on a 7-days-a-week exposure over 52 weeks per year. This assumes that all of the water consumed over the course of each day came from the Grove Pond wells.

- The duration of exposure (ED) is assumed to have occurred over a 30-year period for adults. This value is the 90% upper-bound limit for residency at a single residence (EPA, 1989). For a child, ATSDR used a 6-year exposure duration.

ATSDR's evaluation of potential arsenic and manganese exposures, the only contaminants of concern in drinking water are presented below.

Arsenic

Exposure to the detected levels of arsenic in Grove Pond well water is not expected to result in adverse health effects.

Arsenic was detected in the inactive Grove Ponds wells at concentrations above ATSDR's comparison value (cancer risk evaluation guide [CREG]) but below EPA's MCL of 50 ppb. As Table C-1 indicates, an adult who may have consumed the maximum detected concentration of Grove Pond well water in the past would have received a dose of 0.0009 milligram per kilogram per day (mg/kg/day) of arsenic. A child's dose was estimated as 0.003 mg/kg/day. Because the estimated doses are slightly higher than the MRL and RfD of 0.0003 mg/kg/day, ATSDR reviewed the scientific literature on arsenic to further evaluate the health significance of these estimated doses. Nonetheless, no one in Ayer is expected to have used water containing the highest levels of arsenic for the length of time used to estimate these exposure doses. By blending well water with Spectacle Pond well water, the Ayer Department of Public Works was able to reduce the arsenic concentrations and delivered safe drinking water to consumers.

At low level exposures, arsenic compounds are detoxified in the body—that is, changed into less harmful forms—and then excreted in the urine. At higher level exposures, our bodies capacity to detoxify arsenic may be exceeded. When this happens, blood levels of arsenic increase and adverse health effects may occur. Saturation of our bodies detoxification mechanism may explain noncancer and cancer arsenic effects exhibiting a threshold, or a minimal effective dose that may result in health effects.

The lowest observed levels at which adverse effects, such as skin and gastrointestinal effects, have been reported range from 0.014 to 0.05 mg/kg/day in humans drinking arsenic-contaminated water for up to 45 years (Tseng et al., 1968; Tseng, 1977). Thus, the estimated exposure dose (0.0009 mg/kg/day) for adults who consumed Grove Pond well water is almost 16 times lower than the lowest arsenic dose reported to cause health effects, while the exposure dose for a child (0.003 mg/kg/day) is almost five times lower than that literature-based value.

Regarding possible cancer effects, note that ATSDR's CREG is simply a screening value and set very low based on the conservative assumptions that no "threshold" exists. As mentioned above, people can tolerate certain levels of arsenic. Therefore, just because arsenic concentrations are higher than the CREG does not mean that people drinking water at those levels from the Grove Pond wells are at increased risk of developing cancer. ATSDR reviewed the available scientific literature to further evaluate the likelihood of cancer effects.

ATSDR looked more closely at the Taiwanese drinking water study from which scientists reported an association between arsenic and skin cancer. In this study, the lowest exposure levels associated with the onset of cancer (skin) were observed in people drinking water containing 170 to 800 ppb arsenic over a 45-year exposure period (Tseng et al., 1968; Tseng, 1977). Although the study demonstrated an association between arsenic in drinking water and skin cancer, the study failed to account for a number of complicating factors, including exposure to other nonwater sources of arsenic, genetic susceptibility to arsenic, and poor nutritional status of the exposed population. Furthermore, arsenic exposure may have been underestimated in the study, possibly leading to an overestimation of the actual risk. These uncertainties may limit the study's usefulness in evaluating cancer risk for residents drinking water containing arsenic in Ayer. It appears from these data, however, that arsenic levels shown to cause cancer in humans drinking contaminated water are much higher than arsenic levels detected in Grove Pond wells. Therefore, even if exposure did occur in the Ayer area over an extended period, it is unlikely that the level of exposure would lead to cancer.

Manganese

Exposure to the detected levels of manganese in Grove Pond well water is not likely to result in adverse health effects.

The highest concentrations of manganese detected in untreated Grove Pond well water (1900 ppb) were above ATSDR's health-based comparison value. Manganese is a naturally occurring element that is essential for normal functioning of the human body. Toxicity in humans has been associated with both deficiencies and excess intakes of manganese. Determination of safe and adequate intake of manganese is difficult because there are several factors, both environmental and biological, that greatly influence an individual's response to manganese (ATSDR, 1997a).

There are many reports of human toxicity from exposure to manganese by inhalation; however, ingested manganese has rarely been associated with toxicity (ATSDR, 1997). Therefore, when evaluating potential public health impacts most scientists focus on what is known to be a safe oral intake for the general population. The National Research Council has established "estimated safe and adequate daily dietary intakes" (ESADDIs) for manganese. The ESAADIs for manganese are 0.3 to 2.0 mg/day for children less than 6 years and 2 to 5 mg/day for adolescents (more than 11 years) and adults (NRC, 1989). The World Health Organization estimates an average daily consumption of manganese in adult diets range from 2 to 9 mg/day and an intake of 8 to 9 mg/day is "perfectly safe."

Absorption of manganese from the stomach is slow and incomplete. Only a small fraction (up to 5%) of ingested manganese, either from diet or water, is absorbed into the body (ATSDR, 1997). Absorption and retention of manganese varies by individual and is influenced by diet. Higher manganese intakes are associated with diets high in whole grain cereals, nuts, leafy vegetables, and tea. Persons with a vegetarian diet or high dietary levels of calcium, phosphorus, or other metals may have decreased absorption of manganese from the stomach (Ellenhorn and Barceloux, 1988).

Epidemiologic studies suggest that ingesting water containing high concentrations of manganese may be associated with neurological problems resembling Parkinson's disease (Kawamura et al., 1941; Goldsmith et al., 1990; Kondakis et al., 1989). One epidemiologic study investigated the effects in humans of exposure to excessive amounts of manganese (28,000 ppb) in drinking water (Kawamura et al., 1941). Symptoms reported included lethargy, muscle problems, and mental disturbances. Most symptoms were observed in the elderly, while children appeared to be unaffected. The levels associated with these symptoms are approximately 15 times higher than the maximum manganese concentration detected in the Grove Pond wells. Results from these studies suggest that environmental exposure to manganese may be of health concern; however, there are a number of limitations to these studies, including uncertainty about environmental exposure levels, dietary sources of manganese, and whether exposure occurred to manganese alone or to other agents as well, that make this conclusion uncertain.

Considerably more data are available on the adverse effects of manganese ingestion in animals. As with humans, neurological toxicity is the primary effect of manganese ingestion; however, only a few studies report adverse effects, including neurochemical changes in the brain, muscle

weakness, and rigidity of limbs following oral administration of manganese (ATSDR, 1997). The levels of manganese required to produce these effects in animals are higher than estimated for persons ingesting water from the Grove Pond well despite the fact that very conservative assumptions were used to estimate the human exposure doses.

There is some concern by scientists that infants may be at increased risk of toxicity because they retain a higher percentage of ingested manganese than adults due to greater uptake from the stomach and less ability to excrete manganese from the body. Additional concern for formula-fed infants has been expressed because manganese levels may be elevated in formula and formula made with contaminated tap water may contain higher levels of manganese than in human milk. However, there are no reports of manganese toxicity reported for infants (ATSDR, 1997). Elevated levels of manganese have been found in hair learning disabled children compared to normal children; however, no causal relationship was established for learning disabilities and manganese intake because information was lacking about how exposure occurred and whether it involved other agents such as lead (Collipp et al., 1983; Pihl and Parkes, 1977).

Using maximum concentrations detected in untreated well water and other conservative assumptions about exposure, ATSDR estimated that an adult who drank 2 liters and a child who drank 1 liter of Grove Pond well water daily in the past might have received a dose of manganese up to 0.05 mg/kg/day (3.5 mg/day) and 0.2 mg/kg/day (2 mg/day), respectively (see Table C-1). The doses fall within the range of concentrations generally considered to be "safe" dietary intakes and are lower than levels associated with adverse health effects in animal and human studies. Although there is concern that infants may be more sensitive than adults to manganese, there is no scientific data supporting increased toxicity from manganese in infants. More importantly, it is unlikely that persons were *ever* exposed to maximum concentrations of manganese in the Grove Pond well because water from this well was blended with uncontaminated water prior to distribution to households. Also, levels of manganese in the Grove Pond well fluctuated over time and were generally much lower than maximum levels while the well was used for drinking water.

Estimated Exposure Doses From Contact With Grove Pond and Plow Shop Pond Sediment

ATSDR determined that metal concentrations measured in Grove Pond and Plow Shop Pond do not indicate a public health hazard.

In evaluating whether exposure to contaminants in the sediment may be related to adverse health effects, if any, ATSDR estimated exposure doses for adults and children contacting sediment containing the highest measured contaminant levels detected at either Grove Pond and Plow Shop Pond. Because children are known to play at Pirone Park along Grove Pond, ATSDR also evaluated exposure to sediment containing the highest levels of sediment along the shoreline of

Pirone Park. [9] To estimate the extent to which people might be exposed to contaminants, ATSDR used "conservative" assumptions about possible human exposure and the associated health effects. ATSDR assumed that an adult or child contacted the most contaminated found anywhere at Grove Pond or Plow Shop Pond and the most contaminated sediment at Pirone Park while wading. ATSDR also used higher values than actually expected on how often people contacted the sediment. These assumptions allow ATSDR to estimate the highest possible exposure dose and evaluate the corresponding health effects. Although ATSDR does not expect that most people at the park were exposed to the highest levels of contamination, the "conservative" estimates are used to protect public health.

ATSDR used the following equation to estimate human exposure doses for dermal contact with sediment:

$$\textit{Estimated Exposure Dose} = \frac{\text{Conc.} \times \text{CF} \times \text{SA} \times \text{ABS} \times \text{AF} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

where:

Conc. = Maximum contaminant concentration in the sediment (ppm)

CF = Conversion factor: 10^{-6}

SA = Skin surface area available for contact (cm^2/event):
-For exposure to feet only: adult male (M) = 1,310 cm^2 and child = 334 cm^2 (EPA, 1995a)

ABS = Absorption factor= 1% for dermal exposure to inorganic compounds (EPA, 1995a)

AF = Skin to soil adherence factor = 0.6 mg/cm^2-event (EPA, 1992)

EF = Exposure frequency, or number of exposure events per year of exposure:
1 event/day x 7 days/week x 20 weeks/year or 140 events per year

ED = Exposure duration, or the duration over which exposure occurs: adult = 30 years; child = 6 years

BW = Body weight (kg): adult = 70 kg (154 pounds); child = 10 kg (22 pounds)

AT = Averaging time, or the time period over which cumulative exposures are averaged: 30 years x 365 days/year or 6 years x 365 days/year for noncancer effects; 70 years x 365 days/year for cancer effects

[9] ATSDR initially evaluated exposure to sediment containing the highest levels of contaminants detected along the Grove Pond shoreline of Pirone Park. In response to comments received during the public comment period for the draft public health assessment (June 3, 1999), ATSDR has additionally assessed contact with the highest level of contaminants detected at either Grove Pond or Plow Shop Pond.

Assumptions for Estimating Human Exposure Dose

- Absorbed doses were estimated based on the amount of contaminant expected to be absorbed into the body through the skin. The ABS-dermal values used represent the percent of the contaminant concentration contacted that is expected to pass through the skin.

- The surface skin area (SA) available for contact per exposure event was assumed to be the 50th percentile values for feet for adult males and children (2 to 3 years of age) (EPA, 1995a).

- The amount of sediment adherence to skin (the adherence factor, AF) per exposure event was assumed to be 0.6 mg/cm^2, the midpoint of the range recommended by EPA for dermal exposure to soil (EPA, 1992).

- ATSDR reviewed local climatologic data to estimate the period of seasonal activity. ATSDR used a 20-week period—or the length of time average air temperatures meet or exceed 70 degrees—to approximate this period (NOAA, 1997).

Determination of the Potential for Adverse Human Health Effects

As Table C-2 indicates, the exposure doses estimated by ATSDR for dermal contact with sediment containing arsenic or cadmium by adults and children were considerably lower than the MRL or RfD. Therefore, noncancer effect associated with these metals are not expected to occur. Although no health-based guidelines (MRL or RfD) currently exist for either chromium or mercury (inorganic), ATSDR believes that exposure to sediment containing the detected concentrations of these chemicals is likewise unlikely to result in harmful effects for visitors of either pond. Estimated exposure doses for both chromium and mercury, based on the maximum detected levels in sediment, are significantly lower than those shown to result in harmful effects in occupational and animal studies. In fact, the estimated doses for a child are more than 2 to 3 orders of magnitude lower than the lowest levels linked with adverse health effects in humans exposed to either chemical (ATSDR, 1997b; 1998b).

Because arsenic is classified as a carcinogen, ATSDR estimated the lifetime cancer risk from dermal contact with sediment containing the maximum concentration of this chemical. Based on the estimated cancer risks presented in Table C-3, ATSDR does not expect that contact with sediment containing arsenic will result in an increased likelihood of developing cancer.

Estimated Exposure Doses for Ingestion of Fish

ATSDR used the following equation to estimate exposure doses for ingestion of Grove Pond and Plow Shop Pond fish:

$$\textit{Estimated exposure dose} = \frac{\text{Conc.} \times \text{IR} \times \text{FI} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

where:

Conc.	=	Maximum concentration in fish (mg/kg)
IR	=	Ingestion rate: 0.0065 kg/day (approximately one 8-ounce meal per month), average consumption of fish and shellfish from estuarine and freshwater by the general U.S. population (EPA, 1989). Because a child likely eats smaller fish meals, ATSDR assumed that a child eats a one 4-ounce meal per month.
FI	=	Fraction ingested from contaminant source (assumed 100%)
EF	=	Exposure frequency, or number of exposure events: 365 days per year
ED	=	Exposure duration, or the duration over which exposure occurs: adult = 30 years; child = 6 years
BW	=	Body weight (kg): adult = 70 kg (154 pounds); child = 10 kg (22 pounds)
AT	=	Averaging time, or the time period over which cumulative exposures are averaged: 30 years x 365 days/year or 6 years x 365 days/year for noncancer effects; 70 years x 365 days/year for cancer effects

Determination of the Potential for Adverse Human Health Effects

Using maximum detected concentrations and other conservative assumptions about exposure, the doses estimated for ingestion of fish containing either arsenic, cadmium, manganese, selenium, and zinc are lower or just slightly higher than the corresponding MRL or RfD (see Table C-4). The estimated dose for a child exposed to mercury exceeds the MRL, but only by a factor of two. Conservative assumptions (e.g., maximum concentration) allow ATSDR to estimate the highest possible exposure dose, even though ATSDR does not expect that most people were exposed to the highest levels each time they ate fish. Based on these estimates, even when considering the highest levels detected in fish, exposures are very unlikely to lead to noncancer effects.

Because arsenic is classified as a human carcinogen, ATSDR estimated the lifetime cancer risk associated with consumption of fish containing the highest detected concentration of arsenic and using very conservative assumptions about exposure. The cancer risk was approximately 8×10^{-5}, or 8 new cancer cases in 100,000 exposed persons (see Table C-5). Therefore, ATSDR does not expect that ingestion of fish containing arsenic will result in an increased likelihood of developing cancer.

Sources:

Agency for Toxic Substances and Disease Registry (ATSDR). 1997a. Agency for Toxic Substances and Disease Registry. U.S. Department of Health and Human Services. Toxicological Profile for Manganese. September 1997 (Update-Draft).

ATSDR. 1997a. Agency for Toxic Substances and Disease Registry. U.S. Department of Health and Human Services. Toxicological Profile for Mercury. August 1997 (Update).

ATSDR. 1998a. Agency for Toxic Substances and Disease Registry. U.S. Department of Health and Human Services. Toxicological Profile for Arsenic. April 1998 (Update).

ATSDR. 1998b. Agency for Toxic Substances and Disease Registry. U.S. Department of Health and Human Services. Toxicological Profile for Chromium. August 1998 (Update).

Collipp, P.J., Chen, S.Y, and Maitinsky, S. 1983. Manganese in infant formulas and learning disability. Ann. Nutr. Metab. 27:488-494.

Ellenhorn M. J. and D.G. Barceloux. 1988. Medical toxicology: Diagnosis and treatment of human poisoning. New York, NY:Elsevier, 1047-1048.

Environmental Protection Agency (EPA). 1989. Risk assessment guidance for Superfund. Volume 1. Human health evaluation manual (part A). U.S. Environmental Protection Agency. EPA/540/1-89-001. December 1989.

EPA. 1992. Dermal Exposure Assessment: Principles and Applications. Office of Health and Environmental Assessment. INTERIM Report. 1992.

EPA. 1995a. Assessing Dermal Exposure. Region III Technical Guidance Manual Risk Assessment. Office of Superfund Programs. December 1995.

EPA. 1995b. Exposure Factors Handbook-Final Report. Office of Health and Environmental Assessment. 1995.

Goldsmith J., Herishanu, Y., Ababanel J., et al. 1990. Clustering of Parkinson's disease points to environmental etiology. Arch. Environ. Health. 44:88-94 (As cited in ATSDR's toxicological profile for manganese).

IRIS. 199. EPA's Integrated Risk Information System. National Library of Medicine.

Kawamura, R. Ikuta, H., Fukuzuml, S. et al. 1941. Intoxication by manganese in well water. Kitasato Arch Exp Med. 18:145-171. (As cited in IRIS, 1997).

Kondakis, X.G., Makris, N., Leotsinidis, M., et al. 1989. Possible health effects of high manganese concentrations in drinking water. Arch. Environ. Health. 44:175-178. (As cited in ATSDR, 1997).

Marcus, W.L. and A.S. Rispin. 1988. Threshold carcinogenicity using arsenic as an example. In: Advances in Modern Toxicology. Vol. XV. Risk Assessment and Risk Management of Industrial and Environmental Chemicals. Princeton Scientific Publishing, Co.1988.

NOAA. 1997. National Oceanic and Atmospheric Administration. Monthly summary of local climatological data. National Climatic Data Center. Asheville, NC.

NRC. 1989. Recommended dietary allowances. Washington, DC: National Research Council. Tenth Edition, 231-235.

Stohrer, G. 1991. Arsenic: Opportunity for risk assessment. Archives of Toxicology. Vol. 65. 1991.

Tseng, W.P., Chu, H.M., How, S.W., et al. 1968. Prevalence of skin cancer in an endemic are of chronic arsenicism in Taiwan. J. Natl Cancer Inst. 40:452-462 (As cited in ATSDR toxicological profile for arsenic).

Tseng, W.P. 1977. Effects and dose-response relationship of skin cancer and blackfoot disease with arsenic. Environ Health Perspect. 19:109-119 (As cited in ATSDR toxicological profile for arsenic).

TABLE C-1. Estimated Exposure Doses—Noncancer Effects
Ingestion of Grove Pond Well Water in the Past [1]

Contaminant	Maximum Detected Contaminant Concentration (ppb)	Estimated Exposure Dose (mg/kg/day)[2]		Health Guideline Chronic Oral (mg/kg/day)	Basis for Health Guideline
		Adult	Child		
Arsenic	30	0.0009	0.003	0.0003	MRL/RfD
Manganese	1,900	0.05	0.2	0.07	ATSDR Interim Guideline

[1] ATSDR estimated past exposure doses assuming that an individual was exposed to the highest concentration of manganese and arsenic in Grove Pond well water in the past. No one is likely to be exposed to these concentrations today because regular sampling of well water, together with effective treatment, now ensures that the levels of these metals are greatly reduced in water distributed to Ayer residents.

[2] *Estimated Exposure Dose* = $\frac{\text{Conc. x CF x IR x EF x ED}}{\text{BW x AT}}$

Conc. = Maximum contaminant concentration in the private well (ppb)
CF = Conversion factor to convert ppb to ppm (1/1000)
IR = Ingestion rate: adult = 2 liters per day; child = 1 liter per day
EF = Exposure frequency or the number of exposure events (1 event x 7 days x 52 weeks or 365 days per year)
ED = Exposure duration or the duration over which exposure occurs: adults = 30 years; child = 6 years
BW = Body weight: adult = 70 kg (154 pounds); child = 10 kg (22 pounds)
AT = Average time or the period over which cumulative exposures are averaged (6 or 30 years x 365 days)

Key: ppb = parts per billion; mg/kg/day=milligrams contaminant per kilogram body weight per day; MRL = Minimal Risk Level; RfD= Reference Dose.

TABLE C-2. Estimated Exposure Doses—Noncancer Effects
Dermal Contact with Grove Pond and Plow Shop Pond Sediment

Contaminant	Grove Pond/Plow Shop Pond			Pirone Park			Health Guideline Chronic Oral (mg/kg/day)	Basis for Health Guideline
	Maximum Detected Contaminant Conc. (ppm)	Adult Estimated Exposure Dose (mg/kg/day)	Child Estimated Exposure Dose (mg/kg/day)	Maximum Detected Contaminant Conc. (ppm)	Adult Estimated Exposure Dose (mg/kg/day)	Child Estimated Exposure Dose (mg/kg/day)		
Arsenic	3,200	0.00001	0.0003	110	0.000005	0.000009	0.0003	MRL/RfD
Cadmium	110	0.000005	0.000009	23.3	0.000001	0.000002	0.0002	MRL
Chromium	49,800	0.002	0.004	2,680	0.0001	0.0002	no value	
Mercury	250	0.00001	0.00002	2.18	0.00000009	0.0000002	no value	

[1] No MRL or RfD currently exists for inorganic mercury, the form most likely present in sediment.

Key: ppb=parts per billion; mg/kg/day=milligrams contaminant per kilogram body weight per day; MRL=minimal risk level; RfD=reference dose; ma = not available.

TABLE C-3. Estimated Exposure Doses—Cancer Effects
Dermal Contact with Grove Pond and Plow Shop Pond Sediment

Location	Maximum Detected Contaminant Concentration (ppm)	Estimated Exposure Dose - Cancer (mg/kg/day)	CPF	Lifetime Cancer Risk [1]
Arsenic - at Pirone Park	110	0.000002	1.5	3×10^{-6}
Arsenic - highest detected concentration in either pond	3,200	0.00006	1.5	9×10^{-6}

[1] Lifetime Cancer Risk = estimated dose (cancer) x CPF.

Key: CPF = cancer potency factor; ppb=parts per billion; mg/kg/day=milligrams contaminant per kilogram body weight per day.

TABLE C-4. Estimated Exposure Doses—Noncancer Effects
Ingestion of Fish

Contaminant	Maximum Detected Contaminant Concentration (ppm)	Estimated Exposure Dose (mg/kg/day)		Health Guideline Chronic Oral (mg/kg/day)	Basis for Health Guideline
		Adult	Child		
Arsenic	1.3	0.0001	0.0004[1]	0.0003	MRL/RfD
Cadmium	0.88	0.00008	0.0003[1]	0.0002	MRL
Manganese	94.7	0.009	0.03	0.14	RfD
Mercury	4	0.0004	0.001[1]	0.0005[2]	MRL
Selenium	0.67	0.00006	0.0004	0.005	MRL
Zinc	29.6	0.003	0.02	0.3	MRL

[1] Because of the conservative assumptions used in estimating the exposure doses, the slightly higher values *do not* indicate a health concern.

[2] The MRL for methylmercury is currently under review.

Key: ppm=parts per million; mg/kg/day=milligrams contaminant per kilogram body weight per day; MRL=minimal risk level; RfD=reference dose.

TABLE C-5. Estimated Exposure Doses—Cancer Effects
Ingestion of Fish

Contaminant	Maximum Detected Contaminant Concentration (ppm)	Estimated Exposure Dose - Cancer (mg/kg/day)	CPF	Lifetime Cancer Risk [1]
Arsenic	1.3	0.00005	1.5	8×10^{-5}

[1] Lifetime Cancer Risk = estimated dose (cancer) x CPF.

Key: CPF = cancer potency factor; ppb=parts per billion; mg/kg/day=milligrams contaminant per kilogram body weight per day.

APPENDIX D: Responses to Public Comments

The Agency for Toxic Substances and Disease Registry (ATSDR) received the following comments and questions from community members regarding the draft public health assessment (PHA) for the Fort Devens site. Each comment is followed by a response from ATSDR. To facilitate the response, similar comments were grouped when possible. For comments that question the validity of statements made in the PHA, ATSDR verified or corrected the statements.

ATSDR issued a draft PHA for public comment on June 3, 1999, and organized community meetings during the public comment period, June 3, 1999, to September 13, 1999. Prior to the public comment period, ATSDR solicited community health concerns and received public comments on two health consultations that evaluated drinking water, sediment, and fish contamination in the communities adjacent to the Fort Devens site.

Groundwater/Drinking Water Comments

1. **Comment:** Past arsenic levels in Ayer drinking water were close to the current maximum contamination level (MCL). There is concern that the MCL for arsenic is not protective enough. ATSDR should reassess past exposure to arsenic in drinking water in light of current information on health effects of arsenic exposure.

   Response: Because of lack of demonstrated need, the absence of extensive regulatory requirements, and limitations in analytical methods, limited historical water quality data exist prior to 1993 when the Ayer Grove Pond wells were closed. Available data suggest that concentrations in the Grove Pond wells measured below 20 parts per billion (ppb), with the exception of a few detects around 30 ppb. The arsenic concentrations neither fluctuated greatly nor exceeded U.S. Environmental Protection Agency's (EPA) current MCL of 50 ppb. Since 1978, Grove Pond well water has been blended with water from Spectacle Pond wells prior to being distributed to customers. This process would have greatly diluted arsenic concentrations in water.

   Even though the reported concentrations never exceeded EPA's current MCL, ATSDR further evaluated the potential health consequences of drinking Grove Pond well water containing arsenic. This evaluation is described in the "Evaluation of the Groundwater Exposure Pathways" section of the PHA. As described, ATSDR conservatively assumed that an individual drank water containing the highest detected level of arsenic (30

ppb) over a 30-year time span. This would account for any exposure to arsenic through drinking water that might have occurred before blending and treatment began. ATSDR compared the estimated doses (based on a conservative hypothetical exposure scenario) to doses in animal and epidemiologic studies shown to result in adverse health effects. On the basis of this evaluation, ATSDR found that people who drank water originating from the Grove Pond wells were not likely to develop arsenic-related health effects.

Also of note, at EPA's request, a special subcommittee of the National Research Council (NRC) has reviewed the arsenic toxicity data base and evaluated the scientific basis of EPA's risk assessment for arsenic in drinking water (NRC, 1999). The subcommittee concluded that there is sufficient evidence to suggest that arsenic (at levels of several hundred parts per billion) causes adverse health effects, including cancer—*but those levels are much higher than the levels found in the Ayer Grove Pond wells.* Scientists are still studying the likelihood of health effects, if any, from low level exposure to arsenic in drinking water. Sufficient evidence exists, however, to suggest that arsenic is tolerated at low doses similar to those estimated for the Grove Ponds wells.

2. **Comment:** ATSDR should work with EPA and local governments in providing information to private well owners in this region that their wells may contain naturally-occurring arsenic at potentially unsafe levels and that well testing and treatment systems are available for individual home owners.

Response: Arsenic is a natural component of the earth's crust and releases to water by natural weathering processes, so it is not unusual to find arsenic in groundwater. Private well users can obtain current information about naturally occurring, or background, groundwater concentrations for their town from the Massachusetts Department of Environmental Protection (MADEP), Division of Water Supply, at 508 792–7653. If you are concerned about the quality of your private drinking water, you can arrange to have your well water tested by one of a number of reputable testing laboratories. (In general, there is no free testing services for Massachusetts private well owners.) The MADEP can provide you with a list of MADEP certified laboratories by calling the MADEP's Wall Experiment Station at 978-682-5237. MADEP can also provide you with guidance on choosing a treatment system that will reduce arsenic concentrations in drinking water.

3. **Comment:** Have private wells in the area around Fort Devens been sampled for a spectrum of contaminants that may have migrated from Fort Devens property?

Response: The Army, with state and EPA oversight, has closely monitored contaminated groundwater through several rounds of sampling of strategically placed groundwater wells. Over the course of these investigations, no contaminants associated with the Fort Devens site have been found beyond the western, eastern, and southern boundaries of the site. No additional monitoring of private wells located beyond these site boundaries has been done or is deemed necessary because groundwater contamination has been shown to be fully contained within these boundaries.

Some contamination has been detected in groundwater migrating north of and upgradient to Area of Concern (AOC) 50. Contamination has also been detected on private industrial property, the Merrimack Warehouse, beyond the Fort Devens northern boundary. Because the warehouse relies on public water, no exposures to contaminated groundwater have occurred at this property. Through extensive routine monitoring, no contamination has been detected beyond the railroad tracks north of the warehouse nor has contamination reached areas where private residences are located. The Army, state, and EPA continue to closely monitor this area of contamination.

Grove Pond and Plow Shop Pond Comments

4. **Comment:** ATSDR states that there is no likelihood of harmful exposures associated with using the ponds or consuming fish from the ponds. If so, why does ATSDR continue to support an advisory at Grove Pond and Plow Shop Pond?

Response: ATSDR continues to support the advisory as a precautionary measure to raise public awareness of contaminants in sediment and in fish. The advisory at Grove Pond and Plow Shop Pond was initially issued based on concerns about elevated contaminant concentrations in sediment in the ponds. There were also concerns that contaminant concentrations might be elevated in pond fish. During the course of the PHA process, ATSDR evaluated surface water, sediment, and fish tissue analytical data (which have become available since the issuance of the advisory) from a public

health perspective. Based on the evaluation, ATSDR considers the potential for past harmful exposures to be low, even though elevated concentrations of certain contaminants were measured in the sediment and in fish. Because contamination continues to be detected in pond sediment and because fish may continue to uptake certain contaminants, ATSDR believes that people who follow the advisory are taking the appropriate precautions to help reduce their chances of exposure to contaminants. In the future if the contaminant levels decline, ATSDR can work with the other agencies to further evaluate the necessity of retaining the advisory.

5. **Comment:** Why did ATSDR use the Food and Drug Administration (FDA) guideline for mercury in fish as a chronic health guideline?

Response: ATSDR used the FDA action level of 1 part per million (ppm) as a *screening value* to determine the elevated mercury levels in fish required further evaluation. The FDA promulgated the 1 ppm action level for commercial fish; however, many state health departments use the FDA action level as a basis for issuing freshwater fish consumption advisories. We want to emphasize that the FDA action level was used strictly for screening and that the value was not used in lieu of a chronic health guideline. Because the mercury concentrations in certain fish exceeded the screening value of 1 ppm, ATSDR further evaluated the possible chronic or long-term health consequences of consuming fish containing mercury at the highest detected levels. ATSDR describes its evaluation process (which included developing an exposure dose, comparing the dose to ATSDR's new minimal risk level (MRL) for methylmercury, and reviewing the current toxicologic literature) in the "Evaluation of the Food Chain Pathway" section of the PHA.[10] On the basis of this evaluation, ATSDR concluded that fish consumers were not likely to develop any harmful health effects associated with mercury.

6. **Comment:** ATSDR's analysis finds no public health hazard with contacting pond sediment, assuming exposure to Pirone Park sediment occurs for 140 days per year. Is there risk associated with other types of exposures, such as contact to higher levels of sediment contamination over a shorter time?

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[10]ATSDR has recently set a chronic MRL for methylmercury of 0.0003 mg/kg/day. The discussion in our PHA about methlymercury in fish has been modified slightly to reflect the new MRL, but our conclusions about exposure have not changed.

Response: ATSDR evaluated exposure to the maximum detected levels of contaminants in Pirone Park sediment in response to community concern about exposures occurring in this public area. Since its initial assessment, ATSDR conservatively evaluated exposure to the highest contaminant levels detected in the pond (which are located primarily at the cove near the former tannery). ATSDR added this evaluation to the "Evaluation of Surface Water/Sediment Pathway" section of the PHA. ATSDR found that even under this worst-case hypothetical scenario, an individual was not likely to experience harmful effects associated with the contaminants in sediment.

The reader should be aware that the Massachusetts Department of Environmental Protection (MADEP) recently completed another round of sediment sampling at Grove Pond. The location of the samples were selected with the assistance of community members. The preliminary results suggest that the highest contaminant levels are situated at the surface of the sediment and that the contaminants do not appear to be contributing to elevated surface water concentrations. When the final results of the sampling become available, ATSDR will review these data and, if necessary, modify its conclusions in the PHA and recommend appropriate actions as needed to protect public health.

7. **Comment:** Exposures from skin contact with mercury and chromium in pond sediments were not quantified in Table C-2.

Response: We want to reassure the reader that ATSDR evaluated the long-term health consequence of skin contact or dermal exposure to these metals found in sediment. As with other metals exceeding comparison values (CVs), ATSDR evaluated dermal exposure to mercury (as inorganic mercury in sediment) and chromium at the concentrations found in pond sediment. As you will note, Table C-2 presents the estimated exposure doses for mercury and chromium. Because a chronic health guideline does not exist for either mercury or chromium, ATSDR could not compare the estimated dose to a guideline (or include a guideline in the table). In the absence of a chronic guideline, ATSDR compared the estimated doses (for both a child and an adult) to the lowest observed adverse effect level reported in occupational and animal studies for mercury (inorganic) and chromium. As noted on page C-8 of the PHA, the estimated exposure doses are more than 2 to 3 times lower than the lowest levels linked with adverse health effects in humans. On the basis of this finding, ATSDR concludes that contact with sediment is unlikely to cause harmful effects.

8. **Comment:** What might happen if the town of Ayer's Park and Recreation Department pursues its proposal to pump untreated water from Grove Pond onto the fields at Pirone Park for irrigation purposes?

Response: Monitoring data for surface water samples collected to date suggest that only very low levels of contaminants (such as metals) exist in the untreated water of Grove Pond. With such low concentrations present in the surface water, we would not expect to see any appreciable accumulation of contaminants on the ground surface or in soil irrigated with this water. Furthermore, in the event accumulation occurred, grass or other vegetative cover in the areas to be irrigated would minimize direct contact with surface soils containing any potentially accumulated contaminants (such as metals). Based on these factors, ATSDR does not expect any harmful exposure to result from using Grove Pond water for irrigation.

9. **Comment:** I am concerned about exposure to chemicals in non-public areas of Grove Pond and Plow Shop Pond, specifically in or near the tannery cove area in the northwest corner of Grove Pond. Did ATSDR consider non-public areas of the Grove Pond shoreline in its evaluation of the sediment contamination?

Response: In its initial evaluation, ATSDR evaluated potential exposure to contaminant levels measured in sediment at Pirone Park in response to community concern (People of Ayer Concerned About the Environment [PACE]) about children wading along the shore in this public area. As noted in the PHA, wading along the shoreline of the park is safe for children. There is evidence that non-public areas of the pond are accessible, though use of these areas is likely infrequent and brief (such as trespasser access). In addressing exposure in non-public areas, ATSDR evaluated hazards associated with the highest detected levels of contaminants found in sediment near the former tannery. As noted in Comment/Response 6, no harmful exposures are expected even for people who choose to wade along non-public areas of the pond.

Other Comments

10. **Comment:** How can ATSDR make the determination that air inside the former Devens Elementary School posed no health hazard without contacting former pupils and teachers?

Response: ATSDR did not contact former occupants of the school because our evaluation suggests that no harmful exposures likely occurred in the past. In assessing health threats, ATSDR first examines the possible exposure pathways related to a site. If through this initial screening process ATSDR determines that a completed exposure pathway to environmental contaminants poses a potential public health hazard, ATSDR may contact potentially exposed individuals to gather health outcome data. In its evaluation of possible exposures at the school, ATSDR relied on the sampling data (collected after the release) that exist for air inside the school, along with information gathered from other sources. The other information included discussions with EPA and MADEP about site conditions that existed at the time of the release, information on the contaminants associated with the release, and information on how these contaminants react in the environment. Together, this information suggests that former occupants of the school were not likely to have been exposed to harmful levels of airborne contaminants. For more information, please see the "Evaluation of the Indoor Air Pathway" section of the PHA.

11. **Comment:** Some soil affected by the fuel leak still remains beneath the school. Can the contaminants in soil release into the indoor air of the school and cause health problems for future students and teachers?

Response: Most of the soil (3,500 cubic yards) affected by the fuel oil release was removed in January 1998. A small amount of the affected soil remains beneath the school because removal of this soil could threaten the structural integrity of the school building. It is important to note that the remaining soil is neither accessible or expected to contribute to poor air quality inside the school. Sampling conducted in March 1998 found no evidence of harmful levels of airborne contaminants associated with the release. Before the school is reopened (September 2000), MassDevelopment will replace the oil-based heating system with a gas heating system and renovate the school's ventilation system. Therefore, there is no reason to suspect that air quality inside the school will pose a health concern for future occupants of the school.

12. **Comment:** ATSDR's evaluation process does not address the possibility of harmful effects of exposure to combined chemicals.

Response: As a screening level evaluation, ATSDR compared contaminant concentrations detected in soil, groundwater, and surface water to media-

specific CVs. ATSDR found most contaminants detected in *completed* or *potential* exposure pathways were at levels below CVs. These conservative CVs are generally 10 to 1,000 times lower than the levels known to result in adverse health effects, which is what makes them conservative screening values. If the individual contaminants detected at the site are present at levels far below those that result in health effects, ATSDR considers the combined exposure to all of the contaminants unlikely to pose a public health hazard.

13. **Comment:** I believe the town of Ayer population was too low for the unexpected increase in cancer cases to be observable above the background cancer incidence. ATSDR should reassess whether the Massachusetts Department of Public Health (MDPH) cancer data prove that there was no risk from drinking water containing arsenic in the past.

Response: It is true that we are more likely to observe fewer cancer cases in a smaller community like Ayer (over a short period of time) than we are for a larger community. However, statistically significant increases in cancer rates can be observed in large and small communities alike. In its *evaluation of cancer rates in Ayer*, MDPH looked at the incidence of cancer in the community over a long period of time (1982-1992) and compared this rate to what is expected based on age-adjusted rates for the state as a whole. The benefit of this approach is that we are more likely to see infrequently occurring cancers that might not be noted in small communities over a short period of time. Therefore, communities that might not be expected to have an increase in cancer cases in any given year can still be evaluated and meaningful results can be obtained. It should be noted that this type of evaluation does not allow for an analysis of whether exposures are associated with, or contribute to, excess levels of cancer in the area.

It is important to note that contaminants only pose a health concern if ingested, inhaled, or contacted at levels shown to cause adverse health effects. As noted, ATSDR reviewed environmental and toxicologic data to determined whether harmful exposures associated with Fort Devens have occurred or could occur in the future. Based on its evaluation, ATSDR found that Ayer residents likely experienced exposures that were much lower than those shown to cause adverse effects or increase their likelihood of cancer.

14. **Comment:** The North Post Waste Water Treatment Plant is out of compliance with its water pollution permit. Does this pose a public health hazard?

Response: Operation of the North Post Waste Water Treatment Plant (WWTP) has not posed, nor is it posing, a public health hazard. The WWTP system was designed in the 1940s to remove solids from municipal waste and dispose of fluids via a rapid filtration bed, which allows treated water to recharge to the groundwater. Although Fort Devens did not hold a National Pollutant Discharge Elimination System permit under the Clean Water Act for the system, the WWTP was overseen by MADEP. According to MADEP, the system has never been out of compliance nor has it adversely affected the underlying groundwater. During basewide environmental investigations at Fort Devens, the three components of the system, WWTP, the infiltration beds, and the sludge drying beds, were evaluated for potential harmful releases to the environment. Based on these investigations, neither MADEP or EPA found evidence to suggest that past or present operations of or releases from the WWTP caused significant environmental contamination or posed a threat to human health. MADEP has issued a permit for an upgraded treatment system, which will include new technology for the treatment of fluids and renovated portions of the existing system. The design is about 90% complete and construction will begin following MADEP's approval of the final plan.