Health Consultation

Evaluation of Health Concerns Associated with
Drinking Water from Grove Pond Wells

FORT DEVENS

AYER, MIDDLESEX COUNTY, MASSACHUSETTS

CERCLIS NO. MA7210025154

JULY 30, 1998

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation 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.

You May Contact ATSDR TOLL FREE at
1-800-447-1544
or
Visit our Home Page at: http://atsdr1.atsdr.cdc.gov:8080/

HEALTH CONSULTATION

EVALUATION OF HEALTH CONCERNS ASSOCIATED WITH
DRINKING WATER FROM GROVE POND WELLS

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

INTRODUCTION

The Agency for Toxic Substances and Disease Registry (ATSDR) is evaluating the potential public health hazards from potential exposure to environmental contaminants at the Fort Devens site in Devens, Massachusetts. ATSDR has prepared this health consultation in response to community members' concerns about the past and future potential for contaminants from the Fort Devens site to harm Ayer residents using public water from the Grove Pond wells. This health consultation addresses two specific concerns:

- Have Ayer residents been exposed to harmful levels of arsenic, iron, or manganese when using Ayer public drinking water originating from Grove Pond wells ?
- Could Ayer residents be exposed in the future to harmful levels of contaminants when drinking water originating from Grove Pond wells ?

In preparing this health consultation, ATSDR reviewed available information from Fort Devens, the Massachusetts Department of Environmental Protection (MADEP), and the U.S. Environmental Protection Agency (EPA). Because community concerns are an important aspect of the public health assessment process, ATSDR also consulted Ayer residents about their health concerns. ATSDR is preparing a separate public health assessment that will review site-wide environmental information and public health concerns.

Because ATSDR prepares its reports for a diverse audience, this health consultation includes both nontechnical discussions of site-related public health issues as well as some technical analyses of exposure dose calculations. To acquaint readers with terminology used in this report, a list of comparison values, a list of abbreviations, and a glossary are included in Appendices A, B, and C, respectively. In addition, Appendix D presents the methods and assumptions used to estimate exposures and support some of the report's conclusions. All figures and tables appear at the end of the health consultation.

For more information on ATSDR or this report, you may call the agency toll free at: 1-800-447-1544.

BACKGROUND

Fort Devens Site Description

The Fort Devens site is a former military base located 35 miles northwest of Boston, Massachusetts. The site covers approximately 9,311 acres in the towns of Ayer, Harvard,

Lancaster, and Shirley. 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).

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.

In support of its mission, the Army conducted operations (e.g., storage and distribution of fuel oil, maintenance of vehicles and air craft, photographic processing, and landfilling) that caused accidental releases of chemicals to the surrounding soil. Some of these chemicals, including volatile organic compounds (VOCs), explosive compounds, fuels, and, perhaps, inorganic compounds (e.g., arsenic), moved through the soil into the underlying groundwater (BRAC, 1996).

In 1989, EPA placed Fort Devens on the National Priorities List of sites identified for possible long-term remedial response because of groundwater contamination. Today, the post is largely inactive while undergoing cleanup with MADEP and EPA oversight. Large portions of the post were transferred to the local redevelopment authority, the Massachusetts Government Land Bank, in 1996. With state legislative approval, portions of the Main Post and North Post will eventually be transferred to the local community for economic reuse and development (MADEP, 1998b; Vanasse Hangen Brustlin, Inc., 1994). The military will retain the South Post for training.

Ayer Public Water Supply (Grove Pond Wells)

Most residents of Ayer (almost 100%) use drinking water from the Ayer public water supply. Since 1993, the water supply has relied on two gravel-packed groundwater wells located at Spectacle Pond, near Littleton (ADPW, 1998). To ensure the safety of the water supply, the Ayer Department of Public Works has routinely tested water from these wells for compliance with EPA's safe drinking water standards that are enforced by MADEP. Historically, water from the Spectacle Pond wells has also been treated for naturally occurring iron and manganese by a green-sand filtration system (ADPW, 1998).

Before 1993, the Ayer Department of Public Works also used two groundwater wells located near Grove Pond (see Figure 2). These wells were taken out of service after high levels of iron and manganese, which impart undesirable taste and color to water, were repeatedly detected in the well water. In 1997, MADEP granted approval for the town of Ayer to resume operation of the Grove Pond wells. Starting this summer, the wells will resume regular production (ADPW, 1998).

DISCUSSION

In this section, ATSDR assesses whether harmful levels of contaminants exist in the Grove Pond wells or whether groundwater containing harmful contaminant levels might reach Grove Pond wells in the future. The following paragraphs first describe the ATSDR exposure evaluation process then apply the process to groundwater and Ayer drinking water data to evaluate health concerns about Grove Pond well water. For each concern, ATSDR's evaluation of the potential health hazard and ATSDR's conclusions on whether a health hazard exists are presented.

Exposure Evaluation Process

ATSDR used a conservative process to evaluate whether Ayer residents drinking water from the Grove Pond wells might be exposed to harmful levels of chemicals originating from Fort Devens. Figure 3 describes the exposure evaluation process. As the figure indicates, ATSDR first reviews environmental and exposure data to identify factors that, if present, might lead to human exposure. These factors include a source of contamination, a contaminated environmental medium (e.g., groundwater), a route of exposure (e.g., ingestion), and the presence of a receptor population.

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 chemicals present against comparison values. Comparison values are concentrations that health scientists have determined are not likely to cause adverse health effects, even assuming very conservative/safe exposure scenarios. (An exposure scenario refers to how a person is exposed to a chemical and for what length of time.) Comparison values are *not* thresholds of toxicity, however, and concentrations greater than the comparison values may or may not cause health effects among exposed people. Rather, if a chemical is found in the environment at levels exceeding its corresponding comparison value, ATSDR examines potential exposure to contamination in greater detail.

Concern: Have Ayer residents been exposed to harmful levels of arsenic, iron, or manganese when using Ayer public drinking water originating from Grove Pond wells?

Ayer community members expressed concern about arsenic, iron, and manganese in water provided to the Ayer public water supply by the Grove Pond wells (PACE, 1998). It is important to note that a human health hazard exists only when people drink or otherwise use water containing chemicals at levels high enough to cause adverse health effects. Therefore, ATSDR examined both use and water quality data for the Ayer public water supply and compared this

information against current health guidelines to determine whether Ayer residents could have been exposed or are exposed to harmful levels of these contaminants when they drank or drink their water.

Current Situation (1993 to present)

Between 1993 and the present, the Grove Pond wells were not used as a public drinking water source. Residents of Ayer, therefore, can be confident that they have not consumed water from the Grove Pond wells during this period. Instead, the Ayer drinking water supply relied solely on water provided by the Spectacle Pond wells (ADPW, 1998). The Spectacle Pond wells are situated near Littleton, several miles away from known areas of Fort Devens-related groundwater contamination (ADPW, 1998).

As required by regulations strictly enforced by MADEP, the Ayer Department of Public Works routinely tests well water for compliance with EPA's safe drinking water standards, ensuring the safety of the water supply. Water from the Spectacle Pond wells was treated for iron and manganese before it reached residential taps. Since 1993, the Ayer drinking water supply has met all of the EPA drinking water standards known as primary or secondary maximum contaminant levels (MCLs), including the MCLs for arsenic, iron, and manganese (ADPW, 1998).

Past Situation (prior to 1993)

Until 1993, the Ayer water supply obtained water from the Spectacle Pond wells *and/or* the Grove Pond wells. Between the 1940s and 1978, drinking water was supplied by one or both of the Grove Pond wells. Starting in 1978, the Ayer water supply was supplemented by a new well at Spectacle Pond. Another Spectacle Pond drinking water well was added in 1985 along with a well water treatment system for iron and manganese. Since these modifications, the Grove Pond wells have been used on very few occasions and only for emergencies (MADEP, 1998a; ADPW, 1998).

As mentioned previously, the Grove Pond wells were taken off line in 1993 after numerous instances in which iron and manganese were detected at high levels. 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.

Ayer Department of Public Works does not have complete sampling data for all operating years prior to the 1993 shutdown of the Grove Pond wells.[1] It is therefore unclear for how long Grove Pond wells contained elevated levels of iron and manganese and at what levels. Sampling data collected sporadically since the 1960s that are available in MADEP files indicate that iron and manganese levels in raw water often exceeded the current MCLs (CDM, 1968, 1993; SEA Consultants, Inc., 1990). After 1978, however, water from the Grove Pond wells (if any) was co-mingled with Spectacle Pond well water, thereby diluting the Grove Pond well water before it reached residential taps (ADPW, 1998).

ATSDR has found that maximum concentrations of iron, manganese, and arsenic recorded in raw Grove Pond well water were higher than ATSDR comparison values and/or EPA MCLs. All other contaminant concentrations were safely below safe drinking water standards.

Iron concentrations exceeded EPA's secondary MCL. EPA assigned this common, naturally occurring metal a secondary MCL because it imparts undesirable taste and color to drinking water at high enough levels (Federal Register, 1977). Iron, however, is not known to be toxic to humans, particularly at the levels detected in the Grove Pond wells. On the basis of this information, ATSDR does not expect iron to pose health concerns to people who drank or are drinking water from the Ayer public water supply.

The highest manganese concentrations (up to 1,900 parts per billion [ppb]) exceeded ATSDR comparison values of 50 ppb for a child and 200 ppb for an adult (SEA Consultants, Inc., 1990). Additionally, arsenic was detected at levels (up to 30 ppb) above ATSDR's comparison value of 0.02 ppb in untreated water, but *below* the enforceable safe drinking water standards (EPA's MCL of 50 ppb). It must be emphasized, however, that comparison values are *screening tools* and therefore exposure to contaminant concentrations above the comparison values will not necessarily produce harmful health effects.

To further assess the potential for harmful effects, ATSDR estimated an exposure dose that people might have received when they consumed water originating from the Grove Pond wells in the past. ATSDR then compared these dose estimates to the values in the current scientific literature and to standard health guidelines, such as ATSDR's minimal risk levels or EPA's reference doses. These health guidelines provide a conservative estimate of the amount of daily exposure over a lifetime that is unlikely to cause noncancer effects. By comparing the dose estimates with the health guidelines, ATSDR is able to evaluate the likelihood, if any, of arsenic and manganese causing adverse health effects.

---

[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).

When deriving human exposure doses, ATSDR incorporates information about frequency and duration of exposure. Because ATSDR does not know with certainty how much water people drank or for how long, ATSDR made several conservative assumptions about exposure. For example, ATSDR assumed that a child and an adult drank 1 liter and 2 liters, respectively, of water daily containing the maximum concentrations of arsenic and manganese detected in untreated Grove Pond well water. Overall, ATSDR believes that these assumptions overestimate the actual exposure a resident of Ayer may have had because it is unlikely that anyone drank water containing the highest detected levels of arsenic or manganese for a long time. ATSDR presents the methods and assumptions used in estimating exposures in Appendix D of this health consultation.

As the evaluation in Appendix D indicates, the estimated doses for Ayer residents are below levels at which health effects have been reported. Therefore, after reviewing this concern throughly, *ATSDR concludes that drinking water originating from Grove Pond wells in the past did not cause harmful effects for Ayer residents.*

Concern: Could Ayer residents be exposed in the future to harmful levels of contaminants when drinking water originating from Grove Pond wells?

Portions of Fort Devens sit over a medium- or high-yield aquifer that serves as a source to area drinking water supplies. Community members are concerned that harmful levels of toxic contaminants from Fort Devens could threaten the Grove Pond wells in the future. In this section, ATSDR first discusses information on the groundwater quality in potential areas of influence around the Grove Pond wells and then discusses proposed measures that Ayer will take to ensure the safety and quality of water delivered to Ayer residents in the future.

Potential Future Influences on the Grove Pond Wells

Several hazardous waste sites at Fort Devens could potentially threaten the Grove Pond wells because the sites are situated in the MADEP-designated Zone II area of influence for the Grove Pond wells (see Figure 2). 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.*" Five sites fall within the Zone II area of influence for the Grove Pond wells, including the Battery Repair and Storage Area (study area [SA] 38), the Maintenance Yards (areas of contamination [AOCs] 44 and 52), the Plow Shop and Grove Ponds (SA 72), Lower Cold Spring Brook (SA 73), and the Massachusetts National Guard property, a site located between Fort Devens property and the wells. Community members have also expressed specific concern about the Shepley's Hill Landfill, though it is not within the Zone II area of influence for the Grove Pond wells. ATSDR, closely evaluated information on these six sites for evidence of potential future threats to the Grove Pond wells. For each of the six sites, Table 1 describes the

site and its use history, identifies contamination, presents its current status, and summarizes the likelihood that contamination from the area will affect the Grove Pond wells in the future.

As Table 1 indicates, most sites probably will not affect the quality of water in the Grove Pond wells. Of the five sites within the Zone II area of influence for the Grove Pond wells, four sites (the Battery Repair and Storage Area, the Maintenance Yards, Lower Cold Spring Brook, and the Massachusetts National Guard property) are not expected to influence Grove Pond well water in the future because they have no or very low levels of groundwater contamination and the Army has removed the contaminated source material (e.g., contaminated soil). The fifth site (Plow Shop and Grove Ponds) should have minimal impact, if any, but ATSDR cannot be certain until information becomes available that more fully describes the relationship between the site and the wells. Currently, EPA is collecting data that should help characterize this relationship, including data on how much groundwater recharge from Grove Pond enters the wells and what levels of contaminants may be in that water.

Although the remaining site (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 (1) the landfill is located outside the Zone II area of influence for the Grove Pond wells and (2) water from landfill moves to the north and east and away from the Grove Pond wells. Furthermore, precautions (e.g., extensive groundwater testing) will be taken to safeguard the quality of the aquifer that lies beneath these sites.

Future Uses of Grove Pond Wells

Starting in the summer of 1998, the Ayer Department of Public Works will resume production at the Grove Pond wells. EPA, MADEP, and the Ayer Department of Public Works will take several measures to ensure that water delivered to residential taps will be safe to drink. These include:

- *Routine well water quality testing*. EPA will test untreated Grove Pond well water (semi-annually) for compliance with EPA's safe drinking water regulations.

- *Additional testing for arsenic*. In response to community concern, the Ayer Department of Public Works will conduct frequent testing (starting with daily testing) of arsenic levels in the Grove Pond well water.

- *Treating for iron, manganese, and arsenic*. To ensure that iron and manganese will not affect the quality of the drinking water delivered to Ayer residents, the Department of Public Works will treat Grove Pond well water using a new green-sand filtration system designed to reduce/remove iron and manganese. The system also reduces arsenic levels by as much as 90%.

- *Post-treatment testing*. After treatment, the Ayer Department of Public Works will retest Grove Pond well water to gauge the efficiency of the treatment system and to confirm that manganese, iron, and arsenic levels are safely below EPA safe drinking water standards.

After treating and testing the drinking water, the Ayer Department of Public Works will blend the Grove Pond well water with water from the Spectacle Pond wells.

ATSDR'S CHILD HEALTH INITIATIVE

ATSDR recognizes that infants and children may be more sensitive than adults to environmental exposure in communities facing water, soil, air, or food contamination because children (1) are more likely to be exposed to certain media like soil when they play outdoors; (2) are shorter and therefore may be more likely to breathe dust, soil, and vapors close to the ground; and (3) weigh less than adults and therefore may 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 the Child Health Initiative.

ATSDR identified no situations in which children are likely to be or have been exposed to harmful levels of chemical contaminants originating from Grove Pond wells. ATSDR based its conclusion on the following factors:

- *Children have not been exposed to harmful levels of contaminants when drinking Ayer public water from the Grove Pond wells in the past.* The Grove Pond wells (in combination with the Spectacle Pond wells) served the Ayer water supply on a regular or emergency service basis until high levels of iron and manganese prompted their closure in 1993. ATSDR determined that these contaminants, even at the maximum levels detected, would not have harmed children who drank from the public water supply.

- *Children did not drink water from the Grove Pond wells between 1993 and the present.* The Grove Pond wells were taken off line in 1993 and therefore children of Ayer could not have consumed water originating from these wells. The Ayer Department of Public Works has regularly tested its water supply during this time to ensure that town water is safe to drink.

- *Children will continue to have public water that is safe to drink.* Starting in the summer of 1998, production will resume at the Grove Pond wells. The Ayer Department of Public Works will regularly test the well water as required by law. Water from the Grove Pond wells will be tested, then treated for iron, manganese, and arsenic, then tested a second

time. and finally mixed with water from the Spectacle Pond wells prior to delivery to residential taps. Together, these measures will help to ensure the quality of drinking water ultimately consumed by children.

CONCLUSIONS

On the basis of its evaluation of available environmental information and discussions with representatives from EPA, MADEP, the Ayer Department of Public Works, and the Army, ATSDR has reached the following conclusions:

- *Ayer residents have not been exposed to harmful levels of arsenic, iron, or manganese when using Ayer public drinking water originating from the Grove Pond wells.* Since 1993, the Grove Pond wells have not been used; therefore, Ayer adults and children were not exposed to Grove Pond well water when they consumed public drinking water. Before 1993, the Grove Pond wells contained arsenic, iron, and manganese, but the levels were unlikely to cause harmful effects, even for residents using the water for extended periods.

- *Ayer residents should not be exposed in the future to harmful levels of contaminants when drinking water from the Grove Pond wells.* The Ayer Department of Public Works plans to return the Grove Pond wells to regular service this summer. Water will be treated for iron, manganese, and arsenic and tested for compliance with safe drinking water standards before it is delivered to Ayer residents. Furthermore, the Army, MADEP, and EPA will continue to take precautions and test groundwater to best protect the underlying aquifers and prevent contamination from reaching the Grove Pond wells.

- ATSDR concludes that Ayer drinking water from the Grove Pond wells poses *no apparent public health hazard.* (A description of this public health hazard conclusion category is included in the glossary.)

RECOMMENDATIONS

Given the conclusions drawn in this health consultation, ATSDR has identified the following actions that are necessary to reduce any potential health hazards associated with the groundwater sources and drinking water supplies surrounding Fort Devens:

- Continue to monitor groundwater in the area of the wells. The Army is conducting long-term groundwater monitoring and maintenance programs associated with Fort Devens,

including monitoring near Shepley's Hill Landfill for VOCs and metals, including arsenic, manganese, and iron.

- Monitor treated drinking water to ensure that the water is safe to drink. The Ayer Department of Public Works will test the treated Grove Pond well water for compliance with safe drinking water standards.

ATSDR will present the issues discussed in this health consultation and address additional environmental health concerns in the forthcoming public health assessment.

PREPARERS OF REPORT:

Amanda D. Stoddard, MPH
Environmental Health Scientist
ATSDR/FFAB

Gary Campbell, PhD
Environmental Health Scientist
ATSDR/FFAB

Concurrence:

Amanda Stoddard
Environmental Health Scientist, FFAB, DHAC

Gary H Campbell PhD
Section Chief, Environmental Health Scientist, FFAB, DHAC

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.

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

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

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.

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.

Federal Register. 1977. National secondary drinking water regulations. Proposed rule Vol. 42, No. 62. March 31, 1977.

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.

Massachusetts Department of Environmental Protection (MADEP). 1998a. Communication with Susan Juncos, Massachusetts Department of Environmental Protection. July 1998.

MADEP. 1998b. Communication with John Regan, Massachusetts Department of Environmental Protection. June and July, 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.

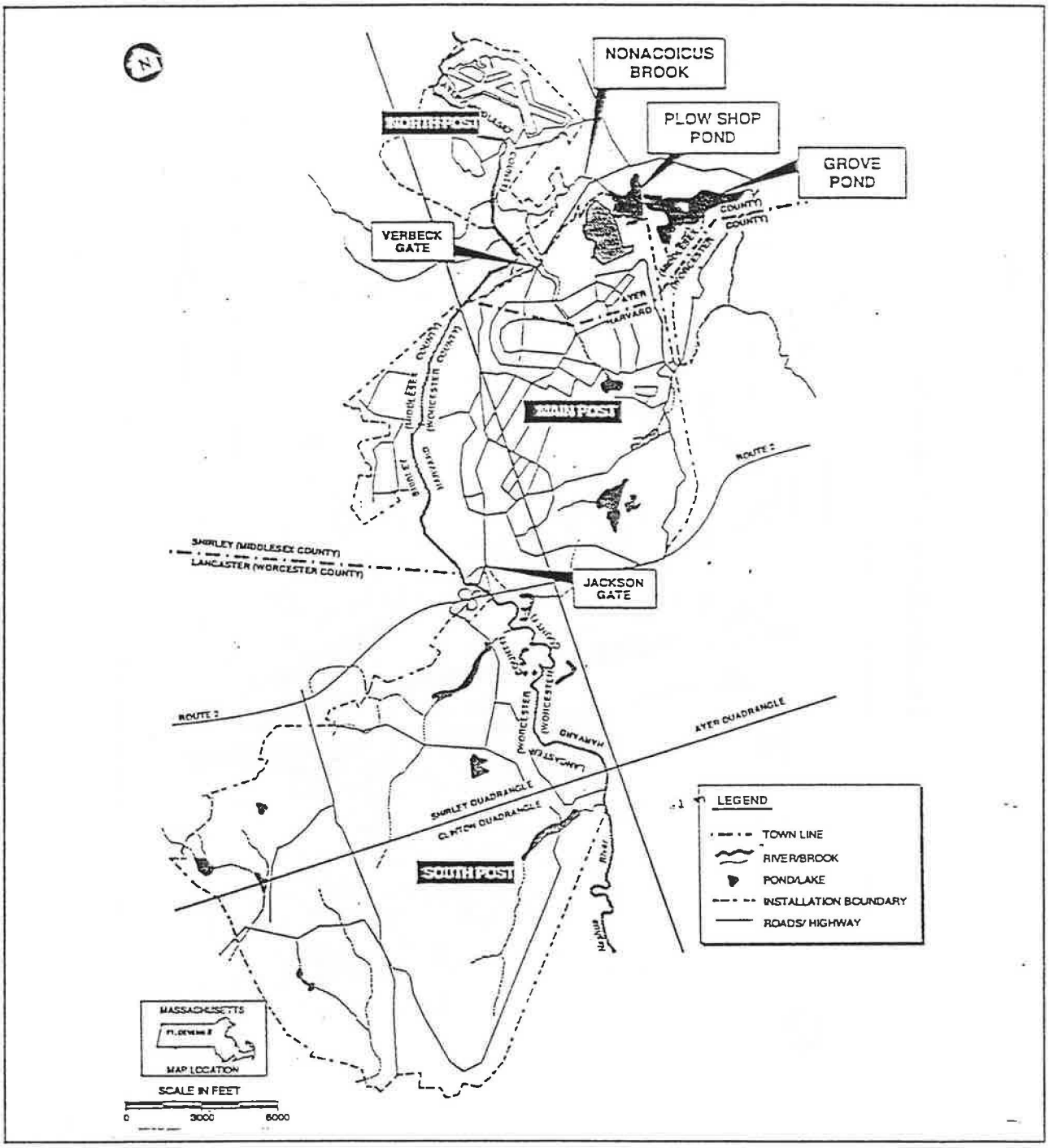
SEA Consultants, Inc. 1990. Report on water supply and distribution systems study. Ayer, Massachusetts. Department of Public Works, Town of Ayer, Massachusetts. August 1990.

U.S. Army Environmental Center (USAEC). 1995. Record of decision. Barnum Road Maintenance Yards. Fort Devens, Massachusetts. March 1995.

Vanasse Hangen Brustlin, Inc. 1994. Devens reuse plan. Fort Devens, Massachusetts. November 14, 1994.

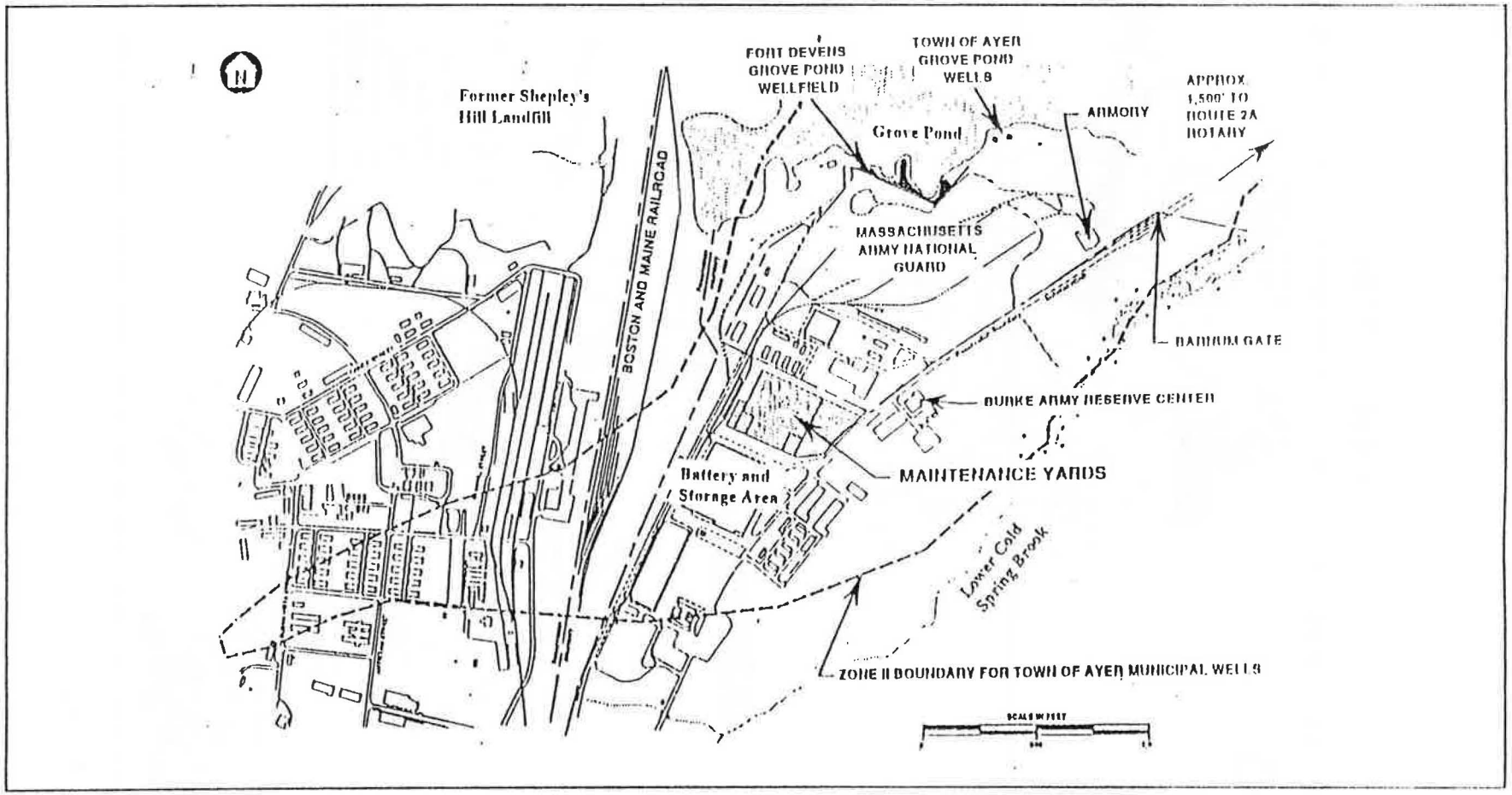
Figures

FIGURE 1. Site Map



Source: ABB, 1995

FIGURE 2. Grove Pond Wells



Source: ABB, 1995

FIGURE 3. ATSDR's Exposure Evaluation Process

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

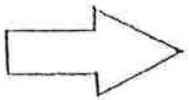
- People must come into contact with areas that have potential contamination
- Contaminants must exist in the environment
- The amount of contamination must be sufficient to affect people's health

Are People Exposed to Area With Potentially Contaminated Media?

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

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

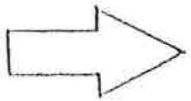
Inhalation
Ingestion
Dermal Contact



Are the Environmental Media Contaminated?

ATSDR considers:

Soil
Groundwater
Surface Water and Sediment
Air
Food Sources



Exposure Pathway, Will the Contamination Affect Public Health?

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

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

Table

TABLE 1. Sites Near Grove Pond Wells

Site	Description/ Use History	Contamination	Status	Potential to Impact Wells
SA 38 -Battery Repair and Storage Area	Over the years, lead from leaking batteries had contaminated the soil in this former storage area.	*Soil*: Lead. *Groundwater*: No contaminants have been detected.	A No Further Action designation has been pending for the site since 1994, when the Army removed all lead-contaminated soil.	Based on current site conditions, this area is not likely to threaten the Grove Pond wells in the future.
AOCs 44 and 52 - Maintenance Yards	Maintenance yards were used to store military vehicles. Motor oil, gasoline, and other automotive fluids were repeatedly released to soil in the yards.	*Groundwater*: Only limited sampling was done in 1992 and 1993. No volatile organic compounds (VOCs) were detected. Arsenic (49.1-157 ppb) and manganese (510-9,500 ppb) were measured in unfiltered samples; no high levels were found in filtered samples, however. Metals are likely a result of suspended particulates which would be filtered out.	The Army has removed potential sources (top 2 feet of surface soil) from across this site, paved the area used for vehicle parking, and prohibited future residential development/use of the Maintenance Yards.	Based on current site conditions, this area is not likely to threaten the Grove Pond wells in the future.

TABLE 1. Sites Near Grove Pond Wells (continued)

Site	Description/ Use History	Contamination	Status	Potential to Impact Wells
SA 73 - Lower Cold Spring Brook	The brook flows along most of the eastern boundary of Fort Devens. Surface water runoff from the Maintenance Yards drains into parts of the Fort Devens stormwater collection systems, which eventually empties into Lower Cold Spring Brook. Lower Cold Spring Brook joins Bowers Brook and eventually empties into Grove Pond.	*Surface Water*: No chemicals were detected in samples collected in 1992.	No action taken to date.	Based on current site conditions, this area is not likely to threaten the Grove Pond wells in the future.

TABLE 1. Sites Near Grove Pond Wells (continued)

Site	Description/ Use History	Contamination	Status	Potential to Impact Wells
AOC 72 - Plow Shop Pond and Grove Pond	Grove Pond is located about 150 feet from the Grove Pond wells. While Grove Pond wells do not directly draw water from the pond, modeling results suggest that the water at the wells is recharged from Grove Pond. Plow Shop Pond is not in the mapped Zone II area.	*Surface Water*: Arsenic (<2.93-3.94 ppb), iron (181-402 ppb), and manganese (39.3-100 ppb) exceeded the ATSDR comparison values and EPA's primary or secondary MCLs in Grove Pond. *Sediment*: High levels of chemicals, primarily metals, have been detected in the shallow sediment of Grove Pond. *Subsurface Soil*: High concentrations of chromium and PCBs were detected in the area of the former tannery. The chemical distribution patterns in sediment and surface water (in combination with groundwater flow patterns) suggest that some of the contamination may have originated from sources other than Fort Devens (e.g., the contamination is likely from the former tannery).	EPA and MADEP continue to sample sediment and surface water from the pond. Regulators are still uncertain about how much, if any, Grove Pond recharges the wells.	These ponds appear to have minimal affect, if any, on the Grove Pond wells. ATSDR, however, cannot be certain until information becomes available that more fully describes how recharge from Grove Pond enters the wells.

TABLE 1. Sites Near Grove Pond Wells (continued)

Site	Description/ Use History	Contamination	Status	Potential to Impact Wells
Massachusetts National Guard Property - Maintenance Depot	Not part of Fort Devens, the active National Guard Maintenance Depot lies between the post and the Grove Pond wells. Over the years of operation, several small fuel tank spills have occurred.	*Groundwater*: No VOCs or total petroleum hydrocarbons were detected in samples collected in September 1997.	In May 1998, a small fuel tank spill occurred, but the contaminated soil has been removed.	This area does not appear to pose a public health hazard. (ATSDR, however, is waiting for an update on the status of the site.)
AOC 4, 5, and 18 - Former Shepley's Hill Landfill	Located on the Main Post of Fort Devens, the landfill was used for the disposal of household refuse and construction debris from 1917 until 1992, when it closed.	*Groundwater*: During 1991 monitoring, VOCs, metals, and low concentrations of explosive were detected in groundwater along the eastern edge of the landfill. Some contamination is believed to have migrated into Plow Shop Pond, though other sources may also be responsible for contamination in sediment and surface water. During the 1998 monitoring, metals, primarily arsenic and VOCs were detected. Contaminants appeared to be moving northward.	Since closure, the Army has covered the landfill with a cap to reduce leaching of landfill contaminants to the groundwater. In March 1998, the Army completed its draft 5-year review of the effectiveness of the landfill remedy. While the current remedy is reducing some risk, EPA agreed with the Army's recommendation that additional evaluation of risk to downgradient receptors is needed.	Elevated levels of arsenic have been measured along the edge of the landfill, but it is not likely to affect Grove Pond wells because: (1) the highest levels appear to be migrating north and not toward the Grove Pond wells; (2) MADEP and EPA will oversee extensive monitoring efforts that should detect contamination before it could reach drinking water wells, and (3) the landfill and its associated off-site contamination is outside the Zone II area of influence.

Sources: ABB, 1995; BRAC, 1997, Fort Devens, 1995b; MADEP, 1998b; NEET, 1997; USAEC, 1995.

APPENDIX A: 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.

Environmental Media Evaluation Guides (EMEGs)

EMEGs are based on ATSDR minimal risk levels 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, including 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 (RMEG)

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: List of Abbreviations

AOC	area of contamination
AT	averaging time
ATSDR	Agency for Toxic Substances and Disease Registry
BW	body weight
CF	conversion factor
CREG	ATSDR's cancer risk evaluation guide
EF	exposure frequency
ED	exposure duration
EMEG	ATSDR's environmental media evaluation guide
EPA	U.S. Environmental Protection Agency
ESADDI	Estimated safe and adequate daily dietary intake
IR	ingestion rate
kg	kilogram
MADEP	Massachusetts Department of Environmental Protection
MCL	EPA's maximum contaminant level
MRL	ATSDR's minimum risk level
mg/kg/day	milligram of contaminant per kilogram body per day
ppb	parts per billion
RfD	EPA's reference dose
RMEG	reference media evaluation guides
SA	study area
VOCs	volatile organic compounds

APPENDIX C: 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).

Groundwater

Water beneath the surface of the ground in a saturated zone.

Health Consultation

A response to a specific question or request for information pertaining to a hazardous substance or facility (which includes waste sites).

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 public health conclusion category is used for sites where human exposure to contaminated media is occurring or has occurred in the past, but the exposure is below a level of health hazard.

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)

A common basis of reporting water quality analysis. As an example, one ppb of trichloroethylene (TCE) equals one drop of TCE mixed in a competition-size swimming pool.

Risk

Risk is 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 D: Estimated Exposure and Health Effects

Estimates of Human Exposure Doses and Determination of Health Effects

Deriving Exposures Doses

ATSDR estimated the human exposure doses from ingestion of Grove Pond well water containing the maximum detected concentrations of arsenic and manganese that may have occurred in the past. 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 outcomes. In the absence of complete exposure-specific information, ATSDR applied several conservative exposure assumptions to define site-specific exposures as accurately as possible for Ayer residents.

Evaluating Potential Health Hazards

The estimated exposure doses are used to evaluate potential noncancer and cancer effects associated with chemicals of concern. When evaluating *noncancer* effects, ATSDR uses standard toxicity values, including ATSDR's minimal risk levels (MRLs) and EPA's reference doses (RfDs), to determine whether adverse effects will occur. The chronic 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. ATSDR compares estimated exposure doses to conservative guidelines such as MRLs or RfDs for each contaminant. If the exposure dose is greater than the MRL or RfD, then a possibility exists for noncancer effects to occur. When evaluating *cancer* effects, ATSDR reviewed the current scientific literature to determine whether cancer has occurred following exposure to arsenic or manganese.

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. 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 estimate 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 possible exposure dose and determine the corresponding 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 D-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; child=10 kg
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 estimates 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 would have been blended before public use.

— 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.

— 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). This estimate most likely overestimates the actual duration of exposure, which is likely less than 30 years. For a child, ATSDR used a 6 year exposure duration.

— The averaging time (AT) represents the time over which exposure occurred and therefore is the time over which the total intake is averaged. For noncancer effects, AT was assumed to be 6 years or 30 years for 365 days/year.

Toxicological evaluations for arsenic and manganese are presented below.

Arsenic

Arsenic was detected in the inactive Grove Ponds wells at concentrations above ATSDR's comparison values (cancer risk evaluation guide [CREG]) but below EPA's MCL of 50 ppb. As Table D-1 indicates, an adult who drank the maximum detected concentration of Grove Pond well water in that past was likely to be exposed to 0.0009 milligram per kilogram per day (mg/kg/day) of arsenic. A child was likely to be exposed to 0.003 mg/kg/day. It should be noted that 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. In fact, blending with Spectacle Pond well water, any arsenic levels would have been reduced significantly.

ATSDR reviewed scientific literature on arsenic to evaluate whether noncancer health effects are likely to occur at the estimated doses. At low level exposures, arsenic compounds are detoxified—that is, changed into less harmful forms—and then excreted in the urine. At higher level exposures, our body's capacity to detoxify arsenic may be exceeded. When this happens, blood levels of arsenic increase and adverse health effects may occur. Saturation of our body's detoxification mechanism may explain noncancer and cancer arsenic effects exhibiting a threshold, or a minimal effective dose that may result in health effects. The threshold for arsenic effects is somewhere between 0.25 and 0.5 milligrams per day (mg/day) (Marcus and Rispin, 1988; Stohrer, 1991).

Several epidemiologic investigations suggest an association between arsenic and noncancer health effects in humans. Symptoms of chronic oral exposure appear to be skin problems (e.g., hyperkeratosis, hyperpigmentation), neurological effects, and gastrointestinal irritations (e.g., vomiting, abdominal pain). The lowest observed levels at which adverse health effects have been reported range from 0.014 to 0.05 mg/kg/day for skin and gastrointestinal effects in humans drinking arsenic-contaminated water for up to 45 years (ATSDR, 1993). Thus, the overly conservative 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.

EPA has classified arsenic as a human carcinogen based on data provided in epidemiologic studies. In contrast to many carcinogens, arsenic, however, does not cause cancer in laboratory

animals when administered orally nor does it follow a zero-threshold model. It should be noted that the zero-threshold model is the basis for the ATSDR CREG. Because of these differences, ATSDR believes that at this time a review of current scientific literature is therefore the most useful means for evaluating the potential carcinogenic effects of arsenic.

The basis for classifying arsenic as a human carcinogen are results of a Taiwanese study in which 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 (ATSDR, 1993). 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

Elevated manganese concentrations (up to 1,900 ppb) were detected in untreated Grove Pond well water at levels above ATSDR's environmental media evaluation guides (EMEGs). Manganese is a naturally occurring element that is also essential for normal functioning of the human body. Numerous factors, including environmental and biological, greatly influence an individual's response to manganese; therefore, individual requirements for or sensitivity to manganese is highly variable (ATSDR, 1997).

In contrast with inhaled manganese, ingested manganese has rarely been associated with toxicity. Oral absorption of manganese is slow and incomplete. Gastrointestinal absorption of manganese is approximately 5%, and may be further decreased by high dietary iron, calcium, phosphorous, and other metals (Ellenhorn and Barceloux, 1988). Some epidemiologic studies suggest that ingesting water containing high concentrations of manganese may be associated with neurological problems (e.g., Parkinsonism) (Goldsmith et al., 1990; Kondakis et al., 1989). One epidemiologic study investigated the effects in humans of drinking water with high levels (estimated maximum, 28 ppm) of manganese. Symptoms reported included lethargy, muscle problems, and mental disturbances. The most symptoms were observed in the elderly, while children appeared to be unaffected. The levels associated with these symptoms are more than 17 times higher than the maximum manganese concentration detected in the Grove Pond wells. Results from these studies are largely inconclusive, however, because of a number of weaknesses and inconsistencies in

study designs. Therefore, additional information is needed to more fully evaluate potential health concerns from ingestion of manganese-contaminated drinking water.

To date, several slightly differing values exist to provide guidance for a safe daily intake of manganese. For example, the World Health Organization estimates that 8-9 mg/day is "perfectly safe." In comparison, the Food and Nutrition Board of the National Research Council, has determined that 2-5 mg/day is an "estimated safe and adequate daily dietary intake" (ESADDI) of manganese. In fact, EPA's RfD for manganese, 0.05 mg/kg/day (or 3.5 mg/day) corresponds to an intake exactly halfway between 2 and 5 mg/day (the ESADDI for adults) (IRIS, 1997).

Using the maximum concentrations detected in untreated well water and several other conservative assumptions, 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 of 0.05 mg/kg/day and 0.2 mg/kg/day, respectively (see Table D-1). These doses fall within the range of concentrations generally considered to be "safe" and below levels associated with neurological effects.

Sources:

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.

ATSDR 1993. Agency for Toxic Substances and Disease Registry. U.S. Department of Health and Human Services. Toxicological Profile for Arsenic. April 1993 (Update).

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

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

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 toxicological profile for manganese).

IRIS. 1997. EPA's Integrated Risk Information System. National Library of Medicine.

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's toxicological profile for manganese.).

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.

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

D-1. Estimated Exposure Doses—Noncancer Effects
Ingestion of Grove Pond Well Water

Contaminant	Maximum Detected Contaminant Concentration (ppb)	Estimated Exposure Dose (mg/kg/day)[a]		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	0.05	RfD

[a] *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 (kg): 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.